



Standard Specification for Nickel-Chromium-Molybdenum-Cobalt-Tungsten- Iron-Silicon Alloy (UNS N06333) Bar¹

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1. Scope

1.1 This specification covers wrought alloy UNS N06333 in the form of hot-finished and cold-finished bars and flats intended for heat resisting applications and general corrosive service.

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.

2. Referenced Documents

2.1 *ASTM Standards*:²

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 10 Test Method for Brinell Hardness of Metallic Materials

E 18 Test Methods for Rockwell Hardness of Metallic Materials

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E 140 Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, and Scleroscope Hardness

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*:

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 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.

3.1.1 *bars, n*—material of round, hexagonal, octagonal, or square solid section, furnished in straight lengths, ¼ in. (6.35 mm) and over in diameter or size.

3.1.2 *flats, n*—material ¼ to 10 in. (6.35 to 254 mm), inclusive, in width and 120 in. (3.05 mm) and over in thickness.

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 name or UNS number.

4.1.2 Quantity.

4.1.3 ASTM Designation and year of issue.

4.1.4 Section (round, square, hexagonal, and so forth).

4.1.5 Dimensions, including length.

4.1.6 Finish, hot or cold.

4.1.7 *Certification*—state if certification is required (Section 16).

4.1.8 *Samples for Product (Check) Analysis*—State whether samples shall be furnished.

4.1.9 *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. Material and Manufacture

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

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.

6. Chemical Requirements

6.1 The material shall conform to the requirements as to chemical composition specified in **Table 1**.

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**.

**TABLE 1 Chemical Requirements**

Element	Composition Limits, %
Carbon	0.10 max
Manganese	2.0 max
Phosphorus	0.03
Sulfur	0.03
Silicon	1.5 max
Chromium	24.0–27.0
Nickel	44.0–48.0
Molybdenum	2.5–4.0
Cobalt	2.5–4.0
Tungsten	2.5–4.0
Iron ^A	remainder

^A Element may be determined arithmetically by difference.

7. Mechanical and Other Requirements

7.1 The mechanical properties of the material at room temperature shall conform to those shown in **Table 2**.

8. Permissible Variations in Dimensions

8.1 All bars shall conform to the permissible variations in dimensions specified in **Tables 3–8**, inclusive.

9. Workmanship, Finish, and Appearance

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

10. Sampling

10.1 Lot Definitions:

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

10.1.2 A lot for mechanical properties shall consist of material from one heat of the same condition and cross section, and no more than 40 000 lb (18 100 kg) in mass.

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*—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 *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 2 Mechanical Properties

Tensile Strength, min psi (MPa)	Yield Strength, 0.2 % offset, min. psi (MPa)	Elongation in 2 in. or 50 mm, or 4D, min%	Hardness ^A
80 000 (551)	35 000 (241)	30	75 to 95 HRB

^A Hardness values are informative only and not to be construed as the basis for acceptance.

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 in Test Methods **E 8** shall be used.

13. Test Methods

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

Test	ASTM Designation
Chemical analysis	E 1473
Tension	E 8
Brinell Hardness	E 10
Rockwell Hardness	E 18
Hardness Conversion	E 140
Rounding procedure	E 29
Requirement	Rounded-Off 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 and yield strengths	Nearest 1000 psi (6.9 MPa)
Elongation	Nearest 1 %

14. Inspection

14.1 Inspection of the material by the purchaser shall be as agreed upon by 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 grade of the material or UNS number and heat number.

18. Keywords

18.1 N06333; bar



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 in. (6.4 mm) to approximately ⅝ 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)	
in.	mm	Over		Under		in.	mm
		in.	mm	in.	mm		
¼ to ⅝	6.4 to 7.9	0.005	0.13†	0.005	0.13	0.008	0.20
Over ⅝ to ⅞	7.9 to 11.1	0.006	0.15	0.006	0.15	0.009	0.23
Over ⅞ to 1	11.1 to 15.9	0.007	0.18	0.007	0.18	0.010	0.25
Over 1 to 1 ⅛	15.9 to 22.2	0.008	0.20	0.008	0.20	0.012	0.30†
Over 1 ⅛ to 1 ¼	22.2 to 25.4	0.009	0.23	0.009	0.23	0.013	0.33†
Over 1 ¼ to 1 ½	25.4 to 28.6	0.010	0.25	0.010	0.25	0.015	0.38
Over 1 ½ to 1 ¾	28.6 to 31.8	0.011	0.28	0.011	0.28	0.016	0.41
Over 1 ¾ to 2	31.8 to 34.9	0.012	0.30†	0.012	0.30†	0.018	0.46
Over 2 to 2 ½	34.9 to 38.1	0.014	0.36	0.014	0.36	0.021	0.53
Over 2 ½ to 3	38.1 to 50.8	⅛	0.4	⅛	0.4	0.023	0.58
Over 3 to 3 ½	50.8 to 63.5	⅜	0.8	0	0	0.023	0.58
Over 3 ½ to 4	63.5 to 88.9	⅜	1.2	0	0	0.035	0.89
Over 4 to 4 ½	88.9 to 114.3	⅜	1.6	0	0	0.046	1.17
Over 4 ½ to 5	114.3 to 139.7	⅝	2.0	0	0	0.058	1.46
Over 5 to 5 ½	139.7 to 165.1	⅝	3.2	0	0	0.070	1.78
Over 5 ½ to 8	165.1 to 203.2	⅝	4.0	0	0	0.085	2.16

† Editorially corrected.

TABLE 4 Permissible Variations in Thickness and Width for Hot-Rolled Flat Bars

Specified Widths, in.	Thickness Tolerances, in., for Given Thickness										
	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		Width Tolerance	
	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

Specified Widths, in.	Thickness Tolerances, mm, for Given Thickness										
	3.2 to 12.7, incl	Over 12.7 to 25.4, incl	Over 25.4 to 50.8, incl	Over 50.8 to 101.6, incl		Over 101.6 to 152.4, incl		Over 152.4 to 203.2, incl		Width Tolerance	
	Over and Under			Over	Under	Over	Under	Over	Under	Over	Under
To 25.4, incl	0.20	0.25	...	...	...	...	...	...	...	0.38	0.38
25.4 to 50.8, incl	0.31	0.38	0.80	...	...	...	...	...	...	0.80	0.80
50.8 to 101.6, incl	0.38	0.51	0.80	1.58	0.80	...	...	...	...	1.58	0.80
101.6 to 152.4, incl	0.38	0.51	0.80	1.58	0.80	2.36	1.58	...	...	2.36	1.58
152.4 to 203.2, incl	0.41	0.64	0.80	1.58	0.80	2.36	1.58	3.18	3.96	3.18	3.96
203.2 to 254.0, incl	0.53	0.80	0.80	1.58	0.80	2.36	1.58	3.18	3.96	3.96	4.75



TABLE 5 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.

Specified Size		Size Tolerance (Note 1)			
in.	mm	Over		Under	
		in.	mm	in.	mm
Over ½ to 1, incl	12.7 to 25.4	0.002	0.05	0.002	0.05
1 to 1½, incl	25.4 to 38.1	0.0025	0.06	0.0025	0.06
1½ to 4, incl	38.1 to 101.6	0.003	0.08	0.003	0.08

TABLE 6 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 (3.66 m), incl		Over 12 to 25 ft (3.66 to 7.62 m), incl	
		Over	Under	Over	Under
To 2, incl	51	½ (13)	0	¾ (19)	0
Over 2 to 4, incl	51 to 102	¾ (19)	0	1 (25)	0
Over 4 to 6, incl	102 to 152	1 (25)	0	1¼ (32)	0
Over 6 to 9, incl	152 to 229	1¼ (32)	0	1½ (38)	0
Over 9 to 10, incl	229 to 254	1½ (38)	0	2 (51)	0

^A The maximum width of bar flats is 10 in. (254 mm).

**TABLE 7 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 (3.66 m), incl		Over 12 ft to 25 ft (3.66 to 7.62 m), incl	
		Over	Under	Over	Under
To 3, incl	76	1/8 (3.2)	0	3/16 (4.8)	0
Over 3 to 6, incl	76 to 152	3/16 (4.8)	0	1/4 (6.4)	0
Over 6 to 9, incl	152 to 229	1/4 (6.4)	0	5/16 (7.9)	0
Over 9 to 12, incl	229 to 305	1/2 (12.7)	0	1/2 (12.7)	0

^A The maximum width of bar flats is 10 in. (254 mm).

TABLE 8 Permissible Variations in Straightness (Camber) of Hot-Finished Bars and Cold-Finished Bars

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

Hot-Finished Bars:

1/8 in. in any 5 ft, but may not exceed (1/8 × number of feet in length)/5
(3.2 mm in any 1.5 m, but may not exceed (2.1 mm × number of metres in length)/5)

Cold-Finished Bars:

1/16 in. in any 5 ft, but may not exceed (1/16 × number of feet in length)/5
(1.6 mm in any 1.5 m, but may not exceed (1.05 mm × number of metres in length)/5)

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