Designation:B443–99

An American National Standard Designation: B 443 – 00 (Reapproved 2009)

Standard Specification for Nickel-Chromium-Molybdenum-Columbium Alloy (UNS N06625)* Plate, Sheet, and StripNickel-Chromium-Molybdenum-Columbium Alloy (UNS N06625) and Nickel-Chromium-Molybdenum-Silicon Alloy (UNS N06219)* Plate, Sheet, and Strip[1]

This standard is issued under the fixed designation B 443; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This specification[2] covers rolled nickel-chromium-molybdenum-columbium alloy (UNS N06625)* plate, sheet, and strip. covers rolled nickel-chromium-molybdenum-columbium alloy (UNS N06625) and nickel-chromium-molybdenum-silicon alloy (UNS N06219)* plate, sheet, and strip.

1.1.1 TheseAlloy UNS N06625 products are furnished in two grades of different heat-treated conditions:

1.1.1.1 *Grade 1 (Annealed)* —Material is normally employed in service temperatures up to 1100°F (593°C).

1.1.1.2 *Grade 2 (Solution Annealed)*—Material is normally employed in service temperatures above 1100°F (593°C) when resistance to creep and rupture is required.

NOTE 1—Hot-working or reannealing may change properties significantly, depending on working history and temperatures.

1.2The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.1.2 Alloy UNS N06219 is supplied in solution annealed condition only.

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.

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:*[3]

B 446 Specification for Nickel-Chromium-Molybdenum-Columbium Alloy (UNS N06625) Rod and Bar Specification for Nickel-Chromium-Molybdenum-Columbium Alloy (UNS N06625), Nickel-Chromium-Molybdenum-Silicon Alloy (UNS N06219), and Nickel-Chromium-Molybdenum-Tungsten Alloy (UNS N06650) Rod and Bar

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

E354Test Methods for Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E 1473 Test Methods for Chemical Analysis of Nickel, Cobalt, and High-Temperature Alloys

[1] This specification is under the jurisdiction of ASTM Committee B-2 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 10, 1999. Published June 1999. Originally published as B443 – 66. Last previous edition B443 – 93$^{\epsilon 1}$.
Current edition approved Oct. 1, 2009. Published October 2009. Originally approved in 1966. Last previous edition approved in 2005 as B 443 - 00 (2005).

[2] For ASME Boiler and Pressure Vessel Code applications, see related Specification SB-443 in Section II of that Code.

* New designation established in accordance with Practice E 527 and SAE J1086, Practice for Numbering Metals and Alloys (UNS).

[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* , Vol 02.04.volume information, refer to the standard's Document Summary page on the ASTM website.

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:* ~~—The~~The terms given in Table 1 shall apply.

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 ASTM designation,

4.1.2 Alloy name or UNS number,

4.1.3 *Condition*—See 1.1.1, 1.1.2 and Appendix X1,

4.1.3.1 If neither grade of N06625 is specified, Grade 1 will be supplied,

4.1.4 *Finish*—Appendix X1,

4.1.5 *Dimensions*—Thickness, width, and length,

4.1.6 *Quantity*,

4.1.7 *Optional Requirements*:

4.1.7.1 *Sheet and Strip*—Whether to be furnished in coil, in cut straight lengths, or in random straight lengths,

4.1.7.2 *Plate*—How plate is to be cut (see 7.2.1 and 7.3.2),

4.1.8 *Certification*—State if certification is required (Section 15),

4.1.9 *Samples for Product (Check) Analysis*—Whether samples for product (check) analysis should be furnished (see 5.2), and

4.1.10 *Purchaser Inspection*—If the purchaser wishes to witness tests or inspection of material at place of manufacture, the purchase order must so state, indicating which tests or inspections are to be witnessed (Section 13).

5. Chemical Composition

5.1 The material shall conform to the composition limits specified in Table 2.

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

6. Mechanical Properties and Other Requirements

6.1 *Mechanical Properties*—The material shall conform to the heat treatment and room temperature tensile properties prescribed in Table 3.

7. Dimensions and Permissible Variations

7.1 *Thickness and Weight*:

7.1.1 *Plate*—For plate up to 2 in. (50.8 mm), inclusive, in thickness, the permissible variations under the specified thickness and permissible excess in overweight shall not exceed the amounts prescribed in Table 4.

7.1.1.1 For use with Table 4, plate shall be assumed to weigh 0.305 lb/in.^{3}(8.442 g/cm^3).

7.1.2 *Plate*—For plate over 2 in. (50.8 mm) in thickness, the permissible variations over the specified thickness shall not exceed the amounts prescribed in Table 5.

7.1.3 *Sheet and Strip*—The permissible variations in thickness of sheet and strip shall be as prescribed in Table 6. The thickness of strip and sheet shall be measured with the micrometer spindle ⅜ in. (9.5 mm) or more from either edge for material 1 in. (25.4 mm) or over in width and at any place on the strip under 1 in. (25.4 mm) in width.

TABLE 1 Product Description

Product	Thickness, in. (mm)	Width, in. (mm)
Hot-rolled plate[A]	3⁄16 (4.8) and over (Table 4 and Table 5)	(Table 7)[A]
Cold-rolled plate[B]	3⁄16 to ⅜ (4.8 to 9.5), incl (Table 4)	(Table 7)
Hot-rolled sheet[B]	0.018 to 0.250 (0.46 to 6.4), incl (Table 6)	(Table 9)
Cold-rolled sheet[C]	0.018 to 0.250 (0.46 to 6.4), incl (Table 6)	(Table 9)
Cold-rolled strip[C]	0.005 to 0.250 (0.13 to 6.4), incl (Table 6)	(Table 9)

[A] Hot-rolled plate, in widths 10 in. (254 mm) and under, may be furnished as hot-finished rectangles with sheared or cut edges in accordance with Specification B 446 provided the mechanical property requirements of this specification are met.

[B] Material 3⁄16 to ¼ in. (4.8 to 6.4 mm), incl, in thickness may be furnished as sheet or plate provided the material meets the specification requirements for the condition ordered.

[C] Material under 48 in. (1219 mm) in width may be furnished as sheet or strip provided the material meets the specification requirements for the condition ordered.

TABLE 2 Chemical Requirements

Element	Composition Limits, %	
	N06625	N06219
Carbon	0.10 max	0.05 max
Manganese	0.50 max	0.50 max
Silicon	0.50 max	0.70-1.10
Phosphorus	0.015 max	0.020 max
Sulfur	0.015 max	0.010 max
~~Chromium~~	~~20.0 min~~	
Chromium	20.0 min	18.0-22.0
	~~23.0 max~~	–
	23.0 max	...
Columbium + tantalum	3.15 min	...
	4.15 max	...
Cobalt (if determined)	1.0 max	1.0 max
Molybdenum	8.0 min	7.0-9.0
	~~10.0 max~~	–
	10.0 max	...
Iron	5.0 max	2.0-4.0
Aluminum	0.40 max	0.50 max
Titanium	0.40 max	0.50 max
Copper	...	0.50 max
Nickel[A]	58.0 min	Bal.

[A] Element shall be determined arithmetically by difference.

TABLE 3 Room Temperature Tensile Properties and Heat Treatment
(All Thicknesses and Sizes Unless Otherwise Indicated)

Product	Tensile Strength, min, ksi (MPa)	Yield Strength[A] (0.2 % Offset), min, ksi (MPa)	Elongation in 2 in. or 50 mm (or 4*D*), min, %[B]
Grade 1			
~~(Annealed)[C]~~			
UNS N06625 (Annealed)[C]			
Cold-rolled sheet and strip	120 (827)	60 (414)	30
Hot-rolled sheet and hot-rolled plate up to 2.75 in. (70 mm), incl	110 (758)	55 (379)	30
Cold-rolled plate up to 0.375 in. (9.5 mm), incl	110 (758)	55 (379)	30
Grade 2			
~~(Solution Annealed)[D]~~			
UNS N06625 (Solution Annealed)[D]			
Cold-rolled sheet and strip, hot-rolled sheet, cold-rolled plate, and hot-rolled plate	100 (690)	40 (276)	30
All			
UNS N06219 (Solution Annealed)			
All plate, sheet, and strip	96 (660)	39 (270)	50

[A] Yield strength requirements do not apply to material under 0.020 in. (0.508 mm) in thickness.
[B] Elongation requirements do not apply to material under 0.010 in. (0.254 mm) in thickness.
[C] Annealed at 1600°F (871°C) minimum.
[D] Solution annealed at 2000°F (1093°C) minimum, with or without subsequent stabilization anneal at 1800°F (982°C) minimum to increase resistance to sensitization.

7.2 *Width or Diameter*:

7.2.1 *Plate*—The permissible variations in width of rectangular plates and diameter of circular plates shall be as prescribed in Table 7 and Table 8.

7.2.2 *Sheet and Strip*—The permissible variations in width for sheet and strip shall be as prescribed in Table 9.

7.3 *Length*:

7.3.1 Sheet and strip of all sizes may be ordered to cut lengths, in which case a variation of ⅛ in. (3.2 mm) over the specified length shall be permitted.

7.3.2 Permissible variations in length of rectangular plate shall be as prescribed in Table 10.

7.4 *Straightness*:

7.4.1 The edgewise curvature (depth of chord) of flat sheet, strip, and plate shall not exceed 0.05 in. (1.27 mm) multiplied by the length in feet (0.04 mm multiplied by the length in centimetres).

7.4.2 Straightness for coiled material is subject to agreement between the manufacturer and the purchaser.

7.5 *Edges*:

7.5.1 Sheet and strip shall have sheared or slit edges.

7.5.2 Plate shall have sheared or cut (machined, abrasive cut, powder cut, or inert arc cut) edges, as specified.

TABLE 4 Permissible Variations in Thickness and Overweight of Rectangular Plates

NOTE 1—All plates shall be ordered to thickness and not to weight per square foot. No plates shall vary more than 0.01 in. (0.3 mm) under the thickness ordered, and the overweight of each lot[A] in each shipment shall not exceed the amount given in the table. Spot grinding is permitted to remove surface imperfections, such spots not to exceed 0.01 in. (0.3 mm) under the specified thickness.

Specified Thickness, in. (mm)	Permissible Excess in Average Weight,[B,C] per Square Foot of Plates for Widths Given in Inches (Millimetres) Expressed in Percent of Nominal Weights									
	Under 48 (1220)	48 to 60 (1220 to 1520), excl	60 to 72 (1520 to 1830), excl	72 to 84 (1830 to 2130), excl	84 to 96 (2130 to 2440), excl	96 to 108 (2440 to 2740), excl	108 to 120 (2740 to 3050), excl	120 to 132 (3050 to 3350), excl	132 to 144 (3350 to 3660), excl	144 to 160 (3660 to 4070), excl
3/16 to 5/16 (4.8 to 7.9), excl	9.0	10.5	12.0	13.5	15.0	16.5	18.0	...	...	...
5/16 to 3/8 (7.9 to 9.5), excl	7.5	9.0	10.5	12.0	13.5	15.0	16.5	18.0	...	...
3/8 to 7/16 (9.5 to 11.1), excl	7.0	7.5	9.0	10.5	12.0	13.5	15.0	16.5	18.0	19.5
7/16 to 1/2 (11.1 to 12.7), excl	6.0	7.0	7.5	9.0	10.5	12.0	13.5	15.0	16.5	18.0
1/2 to 5/8 (12.7 to 15.9), excl	5.0	6.0	7.0	7.5	9.0	10.5	12.0	13.5	15.0	16.5
5/8 to 3/4 (15.9 to 19.1), excl	4.5	5.5	6.0	7.0	7.5	9.0	10.5	12.0	13.5	15.0
3/4 to 1 (19.1 to 25.4), excl	4.0	4.5	5.5	6.0	7.0	7.5	9.0	10.5	12.0	13.5
1 to 2 (25.4 to 50.8), incl	4.0	4.0	4.5	5.5	6.0	7.0	7.5	9.0	10.5	12.0

[A] The term "lot" applied to this table means all of the plates of each group width and each group thickness.
[B] The permissible overweight for lots of circular and sketch plates shall be 25 % greater than the amounts given in this table.
[C] The weight of individual plates shall not exceed the nominal weight by more than 1¼ times the amount given in the table and Footnote *B*.

TABLE 5 Permissible Variations in Thickness for Rectangular Plates Over 2 in. (51 mm) in Thickness

NOTE 1—Permissible variation under specified thickness, 0.01 in. (0.3 mm).

Specified Thickness, in. (mm)	Permissible Variations, in. (mm), over Specified Thickness for Widths Given, in. (mm)					
	To 36 (915), excl	36 to 60 (915 to 1520), excl	60 to 84 (1520 to 2130), excl	84 to 120 (2130 to 3050), excl	120 to 132 (3050 to 3350), excl	132 (3350 and over)
Over 2 to 2¾ (51 to 69.8), incl	1/16 (1.6)	3/32 (2.4)	7/64 (2.8)	1/8 (3.2)	1/8 (3.2)	9/64 (3.6)

TABLE 6 Permissible Variations in Thickness of Sheet and Strip
(Permissible Variations, Plus and Minus, in Thickness, in. (mm), for Widths Given in in. (mm))

Specified Thickness, in. (mm), incl	Sheet[A]			
	Hot-Rolled		Cold-Rolled	
	48 (1220) and Under	Over 48 to 60 (1220 to 1520), incl	48 (1220) and Under	Over 48 to 60 (1220 to 1520), incl
0.018 to 0.025 (0.5 to 0.6)	0.003 (0.08)	0.004 (0.10)	0.002 (0.05)	0.003 (0.08)
Over 0.025 to 0.034 (0.6 to 0.9)	0.004 (0.10)	0.005 (0.13)	0.003 (0.08)	0.004 (0.10)
Over 0.034 to 0.043 (0.9 to 1.1)	0.005 (0.13)	0.006 (0.15)	0.004 (0.10)	0.005 (0.13)
Over 0.043 to 0.056 (1.1 to 1.4)	0.005 (0.13)	0.006 (0.15)	0.004 (0.10)	0.005 (0.13)
Over 0.056 to 0.070 (1.4 to 1.8)	0.006 (0.15)	0.007 (0.18)	0.005 (0.13)	0.006 (0.15)
Over 0.070 to 0.078 (1.8 to 1.9)	0.007 (0.18)	0.008 (0.20)	0.006 (0.15)	0.007 (0.18)
Over 0.078 to 0.093 (1.9 to 2.4)	0.008 (0.20)	0.009 (0.23)	0.007 (0.18)	0.008 (0.20)
Over 0.093 to 0.109 (2.4 to 2.8)	0.009 (0.23)	0.010 (0.25)	0.007 (0.18)	0.009 (0.23)
Over 0.109 to 0.125 (2.8 to 3.2)	0.010 (0.25)	0.012 (0.31)	0.008 (0.20)	0.010 (0.25)
Over 0.125 to 0.140 (3.2 to 3.6)	0.012 (0.31)	0.014 (0.36)	0.008 (0.20)	0.010 (0.25)
Over 0.140 to 0.171 (3.6 to 4.3)	0.014 (0.36)	0.016 (0.41)	0.009 (0.23)	0.012 (0.31)
Over 0.171 to 0.187 (4.3 to 4.8)	0.015 (0.38)	0.017 (0.43)	0.010 (0.25)	0.013 (0.33)
Over 0.187 to 0.218 (4.8 to 5.5)	0.017 (0.43)	0.019 (0.48)	0.011 (0.28)	0.015 (0.38)
Over 0.218 to 0.234 (5.5 to 5.9)	0.018 (0.46)	0.020 (0.51)	0.012 (0.31)	0.016 (0.41)
Over 0.234 to 0.250 (5.9 to 6.4)	0.020 (0.51)	0.022 (0.56)	0.013 (0.33)	0.018 (0.46)

Cold-Rolled[A,B]	
Specified Thickness, in. (mm), incl	Widths 12 in. (305 mm) and under, plus and minus
Up to 0.050 (1.27), incl	0.0015 (0.038)
Over 0.050 to 0.093 (1.27 to 2.39)	0.0025 (0.063)
Over 0.093 to 0.125 (2.39 to 3.18)	0.004 (0.11)

[A] Measured 3/8 in. (9.5 mm) or more from either edge except for strip under 1 in. (25.4 mm) in width which is measured at any place.
[B] Standard sheet tolerances apply for thicknesses over 0.125 in. (3.2 mm) and for all thicknesses of strip over 12 in. (305 mm) wide.

7.6 *Squareness (Sheet)*—For sheets of all thicknesses, the angle between adjacent sides shall be 90 ± 0.15° (1/16 in. in 24 in.) (1.6 mm in 610 mm).

7.7 *Flatness*—Standard flatness tolerances for plate shall conform to the requirements of Table 11.