



Standard Specification for Nickel-Chromium-Molybdenum-Tungsten Alloys (UNS N06110) Plate, Sheet, and Strip¹

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1. Scope

1.1 This specification covers rolled nickel-chromium-molybdenum-tungsten alloys (UNS N06110)² plate, sheet, and strip.

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 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

B446 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

B756 Specification for Nickel-Chromium-Molybdenum-Tungsten Alloy (UNS N06110) Rod and Bar

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

E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

E1473 Test Methods for Chemical Analysis of Nickel, Cobalt and High-Temperature Alloys

3. Terminology

3.1 *Definitions of Terms Specific to This Standard*—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*—**Table 2** and **Appendix X1**.

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, and

4.1.7.2 *Plate*—How plate is to be cut (**Table 3** and **Table 4**).

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

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

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 (see **Section 13**).

5. Chemical Composition

5.1 The material shall conform to the composition limits specified in **Table 5**.

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 New designation established in accordance with Practice E527 and SAE J1086, Recommended 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* volume information, refer to the standard's Document Summary page on the ASTM website.



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) ^B
Hot-rolled sheet ^A	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 Material 3/16 to 1/4 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.

^B 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 B446 provided the mechanical property requirements of this specification are met.

^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 Mechanical Properties for Plate, Sheet, and Strip (All Thicknesses and Sizes Unless Otherwise Indicated)

Condition (Temper)	Tensile strength, min, ksi (MPa)	Yield strength ^A (0.2% offset), min, ksi (MPa)	Elongation in 2 in. or 50 mm (or 4D) min, % ^B
	Hot-Rolled Plate ^C		
Annealed	95 (655)	45 (310)	50
	Hot-Rolled Sheet		
Annealed	95 (655)	45 (310)	50
	Cold-Rolled Sheet		
Annealed	95 (655)	45 (310)	50
	Cold-Rolled Strip		
Annealed	95 (655)	45 (310)	50

^A Yield strength requirements do not apply to material under 0.020 in. (0.51 mm) in thickness.

^B Not applicable for thicknesses under 0.010 in. (0.25 mm).

^C Applicable to 2.75 in. (70 mm) thickness and below.

5.2 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.

6. Mechanical Properties

6.1 The material shall conform to the mechanical properties specified in Table 2.

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 variation under the specified thickness and permissible excess in overweight shall not exceed the amounts prescribed in Table 6.

7.1.1.1 For use with Table 6, plate shall be assumed to weigh 0.303 lb/in.³ (8.386 g/cm³).

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 7.

7.1.3 *Sheet and Strip*—The permissible variations in thickness of sheet and strip shall be as prescribed in Table 8. The thickness of strip and sheet shall be measured with the micrometer spindle 3/8 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. in width.

7.2 Width or Diameter:

7.2.1 *Plate*—The permissible variations in width or rectangular plates and diameter of circular plates shall be as prescribed in Table 3 and Table 9.

7.2.2 *Sheet and Strip*—The permissible variations in width for sheet and strip shall be as prescribed in Table 10.

7.3 Length:

7.3.1 Sheet and strip of all sizes may be ordered to cut lengths, in which case a variation of 1/8 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 4.

7.4 Straightness:

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

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 (machines, abrasive cut, powder cut, or inert arc cut) edges, as specified.

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.

8. Workmanship, Finish, and Appearance

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

9. Sampling

9.1 Lot Definition:

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

9.1.2 A lot for mechanical testing shall consist of all material from the same heat, nominal thickness, and condition.

9.1.2.1 Where material cannot be identified by heat, a lot shall consist of not more than 500 lb (227 kg) of material in the same thickness and condition, except for plates weighing over 500 lb in which case only one specimen shall be taken.

9.2 Test Material Selection:

9.2.1 *Chemical Analysis*—Representative samples from each lot shall be taken during pouring or subsequent processing.

9.2.1.1 *Product (check) Analysis*—Product analysis shall be wholly the responsibility of the purchaser.

TABLE 3 Permissible Variations in Width^A of Sheared, Plasma Torch-Cut, and Abrasive-Cut Rectangular Plate^{BC}

Specified Thickness	Permissible Variations in Widths for Widths Given, in. (mm)									
	Up to 30 (760), incl		Over 30 to 72 (760 to 1830), incl		Over 72 to 108 (1830 to 2740), incl		Over 108 to 144 (2740 to 3660), incl		Over 144 to 160 (3660 to 4070), incl	
	+	-	+	-	+	-	+	-	+	-
	Inches									
Sheared: ^D										
$\frac{3}{16}$ to $\frac{5}{16}$, excl	$\frac{3}{16}$	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{1}{8}$	$\frac{1}{2}$	$\frac{1}{8}$
$\frac{5}{16}$ to $\frac{1}{2}$, excl	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{1}{8}$	$\frac{1}{2}$	$\frac{1}{8}$	$\frac{5}{8}$	$\frac{1}{8}$
$\frac{1}{2}$ to $\frac{3}{4}$, excl	$\frac{3}{8}$	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{1}{8}$	$\frac{1}{2}$	$\frac{1}{8}$	$\frac{5}{8}$	$\frac{1}{8}$	$\frac{3}{4}$	$\frac{1}{8}$
$\frac{3}{4}$ to 1, excl	$\frac{1}{2}$	$\frac{1}{8}$	$\frac{1}{2}$	$\frac{1}{8}$	$\frac{5}{8}$	$\frac{1}{8}$	$\frac{3}{4}$	$\frac{1}{8}$	$\frac{7}{8}$	$\frac{1}{8}$
1 to $1\frac{1}{4}$, incl	$\frac{5}{8}$	$\frac{1}{8}$	$\frac{5}{8}$	$\frac{1}{8}$	$\frac{3}{4}$	$\frac{1}{8}$	$\frac{7}{8}$	$\frac{1}{8}$	1	$\frac{1}{8}$
Abrasive-cut: ^{E, F}										
$\frac{3}{16}$ to $1\frac{1}{4}$, incl	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$
Over $1\frac{1}{4}$ to $2\frac{3}{4}$, incl	$\frac{3}{16}$	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{1}{8}$
Plasma torch-cut: ^G										
$\frac{3}{16}$ to 2, excl	$\frac{1}{2}$	0	$\frac{1}{2}$	0	$\frac{1}{2}$	0	$\frac{1}{2}$	0	$\frac{1}{2}$	0
2 to $2\frac{3}{4}$, incl	$\frac{5}{8}$	0	$\frac{5}{8}$	0	$\frac{5}{8}$	0	$\frac{5}{8}$	0	$\frac{5}{8}$	0
	Millimetres									
Sheared: ^D										
4.8 to 7.9, excl	4.8	3.2	6.4	3.2	9.5	3.2	12.7	3.2
7.9 to 12.7, excl	6.4	3.2	9.5	3.2	9.5	3.2	12.7	3.2	15.9	3.2
12.7 to 19.1, excl	9.5	3.2	9.5	3.2	12.7	3.2	15.9	3.2	19.1	3.2
19.1 to 25.4, excl	12.7	3.2	12.7	3.2	15.8	3.2	19.1	3.2	22.2	3.2
25.4 to 31.8, incl	15.9	3.2	15.9	3.2	19.1	3.2	22.2	3.2	25.4	3.2
Abrasive-cut: ^{E, F}										
4.8 to 31.8, incl	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
Over 31.8 to 69.8, incl	4.8	3.2	4.8	3.2	4.8	3.2	4.8	3.2	4.8	3.2
Plasma torch-cut: ^G										
4.8 to 50.8, excl	12.7	0	12.7	0	12.7	0	12.7	0	12.7	0
50.8 to 69.8, incl	15.9	0	15.9	0	12.7	0	12.7	0	12.7	0

^A Permissible variations in width for powder- or inert arc-cut plate shall be as agreed upon between the manufacturer and the purchaser.
^B Permissible variations in machined, powder-, or inert arc-cut circular plate shall be as agreed upon between the manufacturer and the purchaser.
^C Permissible variations in plasma torch-cut sketch plates shall be as agreed upon between the manufacturer and the purchaser.
^D The minimum sheared width is 24 in. (610 mm).
^E The minimum abrasive-cut width is 2 in. (50.8 mm) and increases to 4 in. (101.6 mm) for thicker plates.
^F These tolerances are applicable to lengths of 240 in. (6100 mm), max. For lengths over 240 in., an additional $\frac{1}{16}$ in. (1.6 mm) is permitted, both plus and minus.
^G The tolerance spread shown for plasma torch cutting may be obtained all on the minus side, or divided between the plus and minus side if so specified by the purchaser.

9.2.2 *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.

10. Number of Tests

- 10.1 *Chemical Analysis*—One test per lot.
- 10.2 *Mechanical Properties*—One test per lot.

11. Specimen Preparation

- 11.1 Tension test specimens shall be taken from material in the final condition (temper) and tested transverse to the direction of rolling when width will permit.
- 11.2 Tension test specimens shall be any of the standard or subsize specimens shown in Test Methods E8.
- 11.3 In the event of disagreement, referee specimens shall be as follows:
 - 11.3.1 Full thickness of the material, machined to the form and dimensions shown for the sheet-type specimen in Test Methods E8 for material under $\frac{1}{2}$ in. (12.7 mm) in thickness.
 - 11.3.2 The largest possible round specimen shown in Test Methods E8 for material $\frac{1}{2}$ in. (12.7 mm) and over.

12. Test Methods

12.1 The chemical composition, mechanical, and other properties of the material as enumerated in this specification shall be determined, in case of disagreement, in accordance with the following methods:

Test	ASTM Designation
Chemical analysis	E1473
Tension	E8
Rounding procedure	E29

12.2 For purposes of determining compliance with the specified limits for requirements of the properties listed in the following table, an observed value or a calculated value shall be rounded in accordance with the rounding method of Practice E29.

Test	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 %