



Designation: ~~B446 – 19~~ B446 – 23

Standard Specification for ~~Nickel-Chromium-Molybdenum-Columbium Alloy (UNS N06625), Nickel-Chromium-Molybdenum-Silicon Alloy (UNS N06219), Nickel-Chromium-Molybdenum-Niobium Alloy, Nickel-Chromium-Molybdenum-Silicon Alloy, and Nickel-Chromium-Molybdenum-Tungsten Alloy (UNS N06650) Rod and Bar~~¹

This standard is issued under the fixed designation B446; 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 U.S. Department of Defense.

1. Scope*

1.1 This specification covers ~~nickel-chromium-molybdenum-columbium-nickel-chromium-molybdenum-niobium alloy (UNS N06625), nickel-chromium-molybdenum-silicon alloy (UNS N06219), and Nickel-Chromium-Molybdenum-Tungsten Alloy (UNS N06650)~~² in the form of both hot-worked and cold-worked rod and bar and ~~cold-worked rod~~ in the conditions shown in **Table 1**.

1.1.1 UNS N06625 products are furnished in ~~two~~three 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)~~1100 °F (593 °C).

1.1.1.2 *Grade 2 (Solution Annealed)*—Material is normally employed in service temperatures above ~~1100°F (593°C)~~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.

1.1.1.3 *Grade 3 (Solution Annealed and Cold Worked)*—Material is normally employed in services where higher strengths are needed.

1.1.2 Alloys UNS N06219 and UNS N06650 are 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 The following precautionary caveat pertains only to the test methods portion, Section 12, of this specification: ~~*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*~~*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*

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 Designation (UNS N06650) was established in accordance with Practice E527 and SAE J 1086, Practice for Numbering Metals and Alloys (UNS).

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

TABLE 1 Conditions for Hot-Worked and Cold-Worked Rod and Bar and Cold-Worked Rod^A

Diameter or Distance Between Parallel Surfaces, in. (mm)	Tensile Strength min, ksi (MPa)	Yield Strength (0.2 % offset), min, ksi (MPa)	Elongation in 2 in. or 50 mm or 4D, min, %
UNS N06625 Grade 1 (Annealed) ^B			
Up to 4 (102), incl	120 (827)	60 (414)	30
Over 4 (102) to 10 (254), incl	110 (758)	50 (345)	25
UNS N06625 Grade 2 (Solution Annealed) ^C			
All sizes	100 (690)	40 (276)	30
UNS N06625 Grade 3 (Solution Annealed and Cold-Worked)			
Up to 2.5 in. (63 mm)	135 (930)	100 (690)	25
UNS N06219 All (Solution Annealed)			
All sizes	96 (660)	39 (270)	50
UNS N06650 All (Solution Annealed)			
All sizes	116 (800)	58 (400)	45

^A Forging quality is furnished to chemical requirements and surface inspection only. No tensile properties are required. Forging stock is typically supplied in the hot worked condition, (see X1.1.5).

^B Annealed 1600°F (871°C) 1600 °F (871 °C) minimum.

^C Solution annealed at 2000°F (1093°C) 2000 °F (1093 °C) minimum, with or without subsequent stabilization anneal at 1800°F (982°C) 1800 °F (982 °C) minimum to increase resistance to sensitization.

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, health, and 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

- [B443 Specification for Nickel-Chromium-Molybdenum-Columbium Alloy and Nickel-Chromium-Molybdenum-Silicon Alloy 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/E8M Test Methods for Tension Testing of Metallic Materials](#)
- [E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications](#)
- [E1473 Test Methods for Chemical Analysis of Nickel, Cobalt, and High-Temperature Alloys](#)

3. Terminology

3.1 Definitions:

3.1.1 For definitions of terms used in this specification, refer to Terminology [B899](#).

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *bar, n*—material of rectangular (flats) or square solid section up to and including 10 in. (254 mm) in width and 1/8 in. (3.2 mm) and over in thickness in straight lengths.

3.2.1.1 Discussion—

Hot-worked rectangular bar in widths 10 in. (254 mm) and under may be furnished as hot-rolled plate with sheared or cut edges in accordance with Specification [B443](#), provided the mechanical property requirements of this specification are met.

3.2.2 *rod, n*—material of round solid section furnished in straight lengths.

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 2 Chemical Requirements

Element	Composition Limits, %		
	N06625	N06219	N06650
Carbon	-0.10 max	-0.05 max	-0.03 max
Manganese	-0.50 max	-0.50 max	-0.50 max
Silicon	-0.50 max	-0.70-1.10	-0.50 max
Phosphorus	-0.015 max	-0.020 max	-0.020 max
Sulfur	-0.015 max	-0.010 max	-0.010 max
Chromium	20.0 min 23.0 max	18.0-22.0	19.0-21.0
Columbium + tantalum	-3.15 min -4.15 max	...	-0.05-0.50
Cobalt (if determined)	-1.0 max	-1.0 max	-1.0 max
Molybdenum	-8.0 min 10.0 max	-7.0-9.0	-9.5-12.5
Iron	-5.0 max	-2.0-4.0	12.0-16.0
Aluminum	-0.40 max	-0.50 max	-0.05-0.50
Titanium	-0.40 max	-0.50 max	...
Copper	...	-0.50 max	-0.30 max
Nickel ^A	58.0 min	Bal.	Bal.
Tungsten	...	...	-0.50-2.50
Nitrogen	...	...	-0.05-0.20

TABLE 2 Chemical Requirements^{A,B}

Element	Composition Limits, %		
	N06625	N06219	N06650
Carbon	0.10	0.05	0.03
Manganese	0.50	0.50	0.50
Silicon	0.50	0.70-1.10	0.50
Phosphorus	0.015	0.020	0.020
Sulfur	0.015	0.010	0.010
Chromium	20.0-23.0	18.0-22.0	19.0-21.0
Niobium + tantalum ^C	3.15-4.15	...	0.05-0.50
Cobalt (if determined)	1.0	1.0	1.0
Molybdenum	8.0-10.0	7.0-9.0	9.5-12.5
Iron	5.0	2.0-4.0	12.0-16.0
Aluminum	0.40	0.50	0.05-0.50
Titanium	0.40	0.50	...
Copper	...	0.50	0.30
Nickel ^D	58.0 min	Bal.	Bal.
Tungsten	...	...	0.50-2.50
Nitrogen	...	...	0.05-0.20

^A All values are maximums unless specified as a minimum or a range is provided.

^B Where ellipses (...) appear in this table there is no requirement and the element need neither be analyzed for or reported.

^C Columbium and Niobium are interchangeable names for the same element and both names are acceptable for use in B02.07 specifications.

^D Element Nickel shall be determined arithmetically by difference.

TABLE 3 Permissible Variations in Diameter/Dimension of Cold-Worked Rod and Bar

Specified Dimension, Dimension ^A , in. (mm)	Permissible Variations from Specified Dimension, in. (mm)	
	Plus	Minus
1/16 (1.6) to 3/16 (4.8), excl	0	0.002 (0.05)
3/16 (4.8) to 1/2 (12.7), excl	0	0.003 (0.08)
1/2 (12.7) to 15/16 (23.8), incl	0.001 (0.03)	0.002 (0.05)
Over 15/16 (23.8) to 1 1/16 (49.2), incl	0.0015 (0.04)	0.003 (0.08)
Over 1 1/16 (49.2) to 2 1/2 (63.5), incl	0.002 (0.05)	0.004 (0.10)

^A Dimensions apply to diameter of rods, to distance between parallel surfaces of squares and hexagonals, and separately to width and thickness of rectangles.

4. Ordering Information

4.1 It is shall be 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:

TABLE 4 Permissible Variations in Diameter Dimension or Distance Between Parallel Surfaces of Hot-Worked Rod and Bar

Specified Dimension, in. (mm) ^A	Permissible Variations from Specified Dimensions, in. (mm)	
	Plus	Minus
Rod and bar, hot-worked:		
1 (25.4) and under	0.016 (0.41)	0.016 (0.41)
Over 1 (25.4) to 2 (50.8), incl	0.031 (0.79)	0.016 (0.41)
Over 2 (50.8) to 4 (101.6), incl	0.047 (1.19)	0.031 (0.79)
Over 4 (101.6)	0.125 (3.18)	0.063 (1.60)
Rod, rough-turned or ground:		
Rod and bar, rough-turned or ground:		
Under 1 (25.4)	0.005 (0.13)	0.005 (0.13)
1 (25.4) and over	0.031 (0.79)	0
Forging quantity rod:^B		
Forging quality rod: ^B		
Under 1 (25.4)	0.005 (0.13)	0.005 (0.13)
1 (25.4) and over	0.031 (0.79)	0

^A Dimensions apply to diameter of rods, to distance between parallel surfaces of squares, and squares and hexagonals, and separately to width and thickness of rectangles.

^B Spot grinding is permitted to remove minor surface imperfections. The depth of these spot ground areas shall not exceed 3 % of the diameter of the rod.

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4.1.1 ~~ASTM designation, specification designation and year date to which the product is to be furnished and be certified as meeting,~~

4.1.2 UNS number,

4.1.3 ~~Section—Rod (round) or bar (square or rectangular), (square, rectangular, or hexagonal),~~

4.1.4 ~~Dimensions, including length,~~

4.1.5 ~~Condition (see 1.1.1, 1.1.2, and appendix); Appendix),~~

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

4.1.6 Grade designation,

4.1.6.1 If no grade of N06625 is specified, Grade 1 will be supplied.

4.1.7 ~~Finish—Shape and finish characteristics (Section 8),~~

4.1.8 ~~Quantity—Feet (or metres) or number of pieces,~~

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

4.1.10 ~~Product Marking (see Section 16)—State product marking requirements, requirements, and~~

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

5. Chemical Composition

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