

# ASTM B446 / ASM SB446

## 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

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

### A. Heat Treatment :-

1. UNS N06625 products are furnished in two grades of different heat-treated conditions:
  - i. Grade 1 (Annealed)—Material is normally employed in service temperatures up to 1100°F (593°C).
  - ii. Grade 2 (Solution Annealed)—Material is normally employed in service temperatures above 1100°F (593°C) when resistance to creep and rupture is required.
2. Alloys UNS N06219 and UNS N06650 are supplied in solution annealed condition only.

### B. Chemical Composition :-

The material shall conform to the composition limits specified in Table 1.

**Table 1**

Element	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 <sup>A</sup>	58.0 min	Bal.	Bal.
Tungsten	...	...	0.50-2.50
Nitrogen	...	...	0.05-0.20

<sup>A</sup> Element shall be determined arithmetically by difference.

**C. Mechanical Properties :-**

The material shall conform to the heat treatment and room temperature tensile properties prescribed in Table 2.

**Table 2<sup>A</sup>**

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) <sup>B</sup>			
Up to 4 (102), incl	120	60	30
Over 4 (102) to 10 (254), incl	110	50	25
UNS N06625 Grade 2 (Solution Annealed) <sup>C</sup>			
All sizes	100	40	30
UNS N0621 9 All (Solution Annealed)			
All sizes	96 (660)	39 (270)	50
UNS N06650 All (Solution Annealed)			
All sizes	116 (800)	58 (400)	45

<sup>A</sup> 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.

<sup>B</sup> Annealed 1600°F (871 °C) minimum.

<sup>C</sup> 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.

**D. Length :-**

The permissible variations in length of coldworked and hot-worked rod and bar shall be as prescribed in Table 3.

**Table 3**

Random mill lengths:	
Hot-worked <sup>A</sup>	6 to 24 ft (1.83 to 7.31 m) long with not more than 25 weight % between 6 and 9 ft (1.83 and 2.74 m) <sup>B</sup>
Cold-worked	6 to 20 ft (1.83 to 6.1 m) long with not more than 25 weight % between 6 and 10 ft (1.83 and 3.05 m).
Multiple lengths	furnished in multiples of a specified unit length, within the length limits indicated above. For each multiple, an allowance of 1/4 in. (6.4 mm) will be made for cutting, unless otherwise specified. At the manufacturer's option, individual specified unit lengths may be furnished
Nominal lengths	specified nominal lengths having a range of not less than 2 ft (610 mm) with no short lengths allowed <sup>A</sup>
Cut lengths	A specified length to which all rods and bars will be cut with a permissible variation of plus 1/8 in. (3.2 mm), minus 0 for sizes 8 in. (203 mm) and less in diameter or distance between parallel surfaces. For larger sizes, the permissible variation shall be + 1/4 in. (6.4 mm), - 0.

<sup>A</sup> For cold-worked rod under 1/2 in. (12.7 mm) in diameter ordered to nominal or stock lengths with a 2-ft (610-mm) range, at least 93 % of such material shall be within the range specified; the balance may be in shorter lengths but in no case shall lengths less than 4 ft (1220 mm) be furnished.

<sup>B</sup> For hot-worked sections weighing over 25 lb/ft (37 kg/m) and for smooth forged products, all sections, short lengths down to 2 ft (610 mm) may be furnished.

**E. Test Methods :-**

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

<u>Test</u>	<u>ASTM Designation</u>
Chemical analysis	E1 473
Tension	E8
Rounding procedure	E29

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