



Designation: B865 – 04

Standard Specification for Precipitation Hardening Nickel-Copper-Aluminum Alloy (UNS N05500) Bar, Rod, Wire, Forgings, and Forging Stock¹

This standard is issued under the fixed designation B865; 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.

1. Scope

1.1 This specification covers nickel-copper-aluminum alloy (UNS N05500) in the form of rounds, squares, hexagons, or rectangles, and forgings and forging stock, manufactured either by hot working or cold working, and cold-worked wire.

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

2. Referenced Documents

2.1 *ASTM Standards*:²

E8 Test Methods for Tension Testing of Metallic Materials

E18 Test Methods for Rockwell Hardness of Metallic Materials

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E112 Test Methods for Determining Average Grain Size

E140 Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, and Scleroscope Hardness

E602 Test Method for Sharp-Notch Tension Testing with Cylindrical Specimens

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

2.2 *Federal Standards*:

Fed. Std. No. 102 Preservation, Packaging, and Packing Levels

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)

Fed. Std. No. 182 Continuous Identification Marking of Nickel and Nickel-Base Alloys

2.3 *Military Standards*:

MIL-STD-129 Marking for Shipment and Storage

MIL-STD-271 Nondestructive Testing Requirements for Metals

3. Terminology

3.1 *Definitions of Terms Specific to This Standard*:

3.1.1 *bar, n*—material of rectangular (flats), hexagonal, 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.

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

3.1.3 *wire, n*—a cold-worked solid product of uniform round cross section along its whole length, supplied in coil form.

4. Ordering Information

4.1 Orders for material to this specification should include the following information:

4.1.1 ASTM designation and year of issue,

4.1.2 Alloy name or UNS number (see Table 1),

4.1.3 Shape—rod (round) or bar (square, hexagonal, or rectangular),

4.1.3.1 Forging (sketch or drawing),

4.1.4 Dimensions, including length, (see Tables 2 and 3),

4.1.5 Condition (see Table 4, Table 5, and Table 6),

4.1.6 Forging stock—Specify if material is stock for reforging,

4.1.7 Finish,

4.1.8 Quantity—feet or number of pieces, and

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.

TABLE 1 Chemical Requirements

Element	Composition Limits, %	Product (check) analysis variations, under min or over max, of the specified limit of element, %
Nickel ^A	63.0 min	0.45
Aluminum	2.30–3.15	0.20
Carbon	0.18 max	0.01
Iron	2.0 max	0.05
Manganese	1.5 max	0.04
Silicon	0.50 max	0.03
Titanium	0.35–0.85	0.03 min 0.04 max
Sulfur	0.010 max	0.003
Copper	27.0–33.0	0.15 min 0.20 max

^AThe nickel content shall be determined arithmetically by difference.

TABLE 2 Permissible Variations in Diameter or Distance Between Parallel Surfaces of Hot-Worked Rod and Bar^A

Specified Dimension, ^B in. (mm)	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:		
Under 1 (25.4)	0.005 (0.13)	0.005 (0.13)
1 (25.4) and over	0.031 (0.79)	0
Round rod, semi-smooth, machined:		
Over 3½ (88.9)	0.031 (0.79)	0
Round rod, smooth finished, machined:		
Over 3½ (88.9)	0	0.005 (0.13)
Forging quality bolt stock (rounds only):		
¼ (6.4), ⅝ (7.9)	0	0.0062 (0.16)
⅜ (9.5), 7⁄16 (11.1), ½ (12.7)	0	0.0066 (0.17)
⅞ (14.3), ⅝ (7.9), 1½ (17.5), ¾ (19.1), 13⁄16 (20.6), 7⁄8 (22.2)	0	0.0082 (0.21)
⅝ (7.9), 1 (25.4)	0	0.0098 (0.25)
1½ (38.1), 1½ (38.1), in ¼ (6.4)	0	0.0112 (0.28)
increments		

^ANot applicable to forging stock.

^BDimensions apply to diameter of rods, to distance between parallel surfaces of hexagons and squares, and separately to width and thickness of rectangles.

TABLE 3 Permissible Variations in Straightness of Precision Straightened Cold-Worked Shafting

Specified Dimension, in. (mm)	Standard Distance Between Supports, in. (mm)	Permissible Variations Throw In One Revolution From Straightness, in. (mm)
½ (12.7) to 1½ (38.1), incl	42 (1070)	0.005 (0.13)
Over 1½ (38.1) to 1½ (38.1) (49.2), incl	42 (1070)	0.006 (0.15)
Over 1½ (38.1) (49.2) to 2½ (63.5), incl	42 (1070)	0.007 (0.18)
Over 2½ (63.5) to 4 (101.6), incl	42 (1070)	0.008 (0.20)
¾ (19.0) to 1½ (38.1), incl	Specified lengths of 3 to 100 ft (0.91 to 3.05 m)	0.004 (0.10) plus 0.0025 (0.064) for each foot, or fraction thereof, in excess of 3 ft (0.91 m)
Over 1½ (38.1) to 4 (101.6), incl	Specified lengths of 20 ft (6.10 m) and less	0.005 (0.13) plus 0.0015 (0.038) for each foot, or fraction thereof, in excess of 3 ft (0.91 m)

TABLE 4 Mechanical Properties—Unaged^A (Bar, Rod, Forgings)

Form	Condition	Hardness	
		Brinell 3000 kg, max	Rockwell, max
Rounds, ^B hexagons, squares, rectangles, and forgings	Hot-worked	245	C23
Hexagons	Cold-worked	260	C26
Rounds:			
¼ (6.4 mm) to 1 in. (25.4 mm), incl	Cold-worked	280	C29
Over 1 (25.4 mm) to 3 in. (76.2 mm), incl	Cold-worked	260	C26
Over 3 (76.2 mm) to 4 in. (101.6 mm), incl	Cold-worked	240	C22
Rounds, hexagons, squares, rectangles, and forgings	Hot-worked or cold-worked and annealed	185	B90

^ANo tensile tests are required except as provided for in 9.2.3.

^BRounds over 4¼ in. (108.0 mm) in diameter shall have hardness of 260 BHN, max.

in Table 4. After aging the material shall conform to the mechanical properties specified in Table 5 and Table 6.

7. Dimensions and Permissible Variations

7.1 Diameter, Thickness, or Width—The permissible variations from the specified dimensions as measured on the diameter or between parallel surfaces of cold-worked rod and bar shall be as prescribed in Table 7; of hot-worked rod and bar as prescribed in Table 2; and of wire as prescribed in Table 7.

7.2 Out-of-Round—Hot-worked rods and cold-worked rods (except “forging quality”) of all sizes, in straight lengths, shall not be out-of-round by more than one half the total permissible variations in diameter shown in Table 2 and Table 7, except for hot-worked rods ½ in. (12.7 mm) in diameter and under, which may be cut-of-round by the total permissible variations in diameter shown in Table 2. Cold-worked wire shall not be out-of-round by more than one-half the total permissible variations in diameter shown in Table 7.

7.3 Edges—Square, rectangular, and hexagonal bar and rod shall have angles and corners consistent with commercial practice.

4.1.9 Certification—State if certification or a report of test results is required (Section 15),

4.1.10 Samples for product (check) analysis—State whether samples for product (check) analysis should be furnished, and

4.1.11 Purchaser inspection—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 1.

5.2 If a product (check) analysis is performed by the purchaser, the material shall conform to the product (check) analysis variations in Table 1.

6. Mechanical Properties

6.1 Mechanical Properties—The material in the unaged condition shall conform to the mechanical properties specified