Designation: B865 – 04 (Reapproved 2015)

Standard Specification for Precipitation Hardening Nickel-Copper-Aluminum Alloy (UNS N05500) Bar, Rod, Wire, Forgings, and Forging Stock[1]

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 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:*[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, Scleroscope Hardness, and Leeb Hardness

E602 Test Method for Sharp-Notch Tension Testing with Cylindrical Specimens (Withdrawn 2010)[3]

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 ⅛ 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,

[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.

Current edition approved May 1, 2015. Published May 2015. Originally approved in 1995. Last previous edition approved in 2010 as B865 – 04 (2010). DOI: 10.1520/B0865-04R15.

[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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

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

[A] The 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), 5/16 (7.9)	0	0.0062 (0.16)
⅜ (9.5), 7/16 (11.1), ½ (12.7)	0	0.0066 (0.17)
9/16 (14.3), ⅝ (7.9), 11/16 (17.5), ¾ (19.1), 13/16 (20.6), ⅞ (22.2)	0	0.0082 (0.21)
5/16 (7.9), 1 (25.4)	0	0.0098 (0.25)
1 1/16 to 1½ (27.0 to 38.1), in 1/16 (1.6) increments	0	0.0112 (0.28)

[A] Not applicable to forging stock.
[B] Dimensions 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 15/16 (23.8), incl	42 (1070)	0.005 (0.13)
Over 15/16 (23.8) to 1 15/16 (49.2), incl	42 (1070)	0.006 (0.15)
Over 1 15/16 (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 15/16 (23.8), incl	Specified lengths of 3 to 10 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 15/16 (23.8) 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

[A] No tensile tests are required except as provided for in 9.2.3.
[B] Rounds over 4¼ in. (108.0 mm) in diameter shall have hardness of 260 BHN, max.

4.1.8 Quantity—feet or number of pieces, and

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 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

TABLE 5 Mechanical Properties—Age-Hardened[A] (Bar, Rod, and Forgings)

Form	Condition	Maximum Section Thickness, in. (mm)	Tensile Strength, min, ksi (MPa)	Yield Strength[B], 0.2 % offset, min, ksi (MPa)	Elongation[B] in 2 in. or 4D, min,%	Hardness[C]	
						Brinell 3000 kg, min	Rockwell C, min
Rounds,[D] hexagons, squares, rectangles, and forgings[E]	Hot-worked and age-hardened	All sizes	140 (965)	100 (690)	20.0	265	27
Rounds	Cold-worked and age-hardened	¼ (6.4) to 1 (25.4), incl	145 (1000)	110 (760)	15.0	300	32
		over 1 (25.4) to 3 (76.2), incl	140 (965)	100 (690)	17.0	280	29
		over 3 (76.2) to 4 (101.6), incl	135 (930)	95 (655)	20.0	255	25
Hexagons	Cold-worked and age-hardened	¼ (6.4) to 2 (50.8), incl	140 (965)	100 (690)	15.0	265	27
Rounds, hexagons, squares, rectangles, and forgings	Annealed and age-hardened[F]	Up to 1 (25.4)	130 (895)	90 (620)	20.0	250	24
		1 (25.4) and over	130 (895)	85 (585)	20.0	250	24

[A] Age hardening heat treatment:

Age hardening shall be accomplished by holding at an aim temperature of 1100°F (595°C) for 8 to 16 h followed by furnace cooling to 900°F (480°C) at a rate of 15 to 25°F (10 to 15°C) per hour and then air cooling. An alternate procedure consists of holding at 1100°F (595°C) for up to 16 h, furnace cooling to 1000°F (540°C), holding for approximately 6 h, furnace cooling to 900°F (480°C), holding for approximately 8 h, and air cooling to room temperature.

(Mill age-hardened products have been precipitation heat treated by the manufacturer and further thermal treatment normally is not required. Hot-worked, cold-worked, or annealed material is normally age hardened by the purchaser after forming or machining.)

[B] Not applicable to subsize tensile specimens less than 0.250 in. (6.4 mm) in diameter.

[C] Hardness values are given for information only and are not the basis for acceptance or rejection.

[D] Rounds over 4¼ in. (108.0 mm) in diameter shall have an elongation in 2 in. (50.8 mm) or 4D of 17 %, min.

[E] When specified, for forged rings and discs, hardness measurements may be utilized in lieu of tensile test.

[F] Applicable to both hot-worked and cold-worked material.

TABLE 6 Tensile Strength of Cold-Drawn Wire in Coils

Condition and Size, in. (mm)	Tensile Strength, min, ksi (MPa)
Cold-worked, as-worked, all sizes	110–155 (760–1070)[A]
Cold-worked and annealed, all sizes	110 (760)[B]
Cold-worked, spring temper, as-drawn 0.057 (1.45) and less[C]	165 (1140)
Over 0.057 to 0.114 (1.45 to 2.90), incl	155 (1070)
Over 0.114 to 0.229 (2.90 to 5.82), incl	150 (1035)
Over 0.229 to 0.312 (5.82 to 7.92), incl	145 (1000)
Over 0.312 to 0.375 (7.92 to 9.52), incl	135 (930)
Over 0.375 to 0.437 (9.52 to 11.10), incl	125 (860)
Over 0.437 to 0.563 (11.10 to 14.30), incl	120 (825)
Cold-worked, annealed, and age-hardened,[D] all sizes	130 (895)
Cold-worked, as drawn, age-hardened,[D] all sizes	155 (1070)
Cold-worked, spring temper, and age-hardened[D]	
Up to 0.114 (2.90), incl	180 (1240)
Over 0.114 to 0.375 (2.90 to 9.52), incl	170 (1170)
Over 0.375 to 0.563 (9.52 to 14.30), incl	160 (1105)

[A] Maximum and minimum.

[B] Maximum.

[C] Applicable to material in coil. For material in straightened and cut lengths, deduct 15 ksi (105 MPa) from above values.

[D] Age hardening heat treatment:

Age hardening shall be accomplished by holding at an aim temperature of 1100°F (595°C) for 8 to 16 h followed by furnace cooling to 900°F (480°C) at a rate of 15 to 25°F (10 to 15°C) per hour and then air cooling. An alternate procedure consists of holding at 1100°F (595°C) for up to 16 h, furnace cooling to 1000°F (540°C), holding for approximately 6 h, furnace cooling to 900°F (480°C), holding for approximately 8 h, and air cooling to room temperature.

(Mill age-hardened products have been precipitation heat treated by the manufacturer and further thermal treatment is not normally required. Hot-worked, cold-worked, or annealed material is normally age hardened by the purchaser after forming or machining.)

TABLE 7 Permissible Variations in Diameter or Distance Between Parallel Surfaces of Cold-Worked Rod and Bar

Specified Dimension,[A] in. (mm)	Permissible Variations From Specified Dimension, in. (mm)	
	Plus	Minus
Rounds:		
1/16 (1.6) to 3/16 (4.8), excl	0	0.002 (0.05)
3/16 (4.8) to ½ (12.7), excl	0	0.003 (0.08)
½ (12.7) to 15/16 (23.8), incl	0	0.002 (0.05)[B]
Over 15/16 (23.8) to 1 15/16 (49.2), incl	0	0.003 (0.08)[B]
Over 1 15/16 (49.2) to 2½ (63.5), incl	0	0.004 (0.10)[B]
Over 2½ (63.5) to 3 (76.2), incl	0	0.005 (0.13)[B]
Over 3 (76.2) to 3½ (88.9), incl	0	0.006 (0.15)[B]
Over 3½ (88.9) to 4 (101.6), incl	0	0.007 (0.18)[B]
Hexagons, squares, rectangles:		
½ (12.7) and less	0	0.004 (0.10)
Over ½ (12.7) to ⅞ (22.2), incl	0	0.005 (0.13)
Over ⅞ (22.2) to 1¼ (31.8), incl	0	0.007 (0.18)
Over 1¼ (31.8) to 2 (50.8), incl	0	0.009 (0.23)

[A] Dimensions apply to diameter of rounds, to distance between parallel surfaces of hexagons and squares, and separately to width and thickness of rectangles.

[B] For cold-worked, age-hardened, bright finish shafting, an additional minus 0.002 (0.05) tolerance will be permitted.

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.

7.4 *Machining Allowances for Hot-Worked Materials*—When the surfaces of hot-worked products are to be machined, the allowances prescribed in Table 8 are recommended for normal machining operations.

7.5 *Length*—The permissible variations in length of cold-worked and hot-worked rod and bar shall be as prescribed in Table 9.

7.5.1 Rods and bars ordered to random or nominal lengths will be furnished with either cropped or saw-cut ends; material ordered to cut lengths will be furnished with square, saw-cut, or machined ends.

7.6 *Straightness:*

7.6.1 The permissible variations in straightness of precision-straightened cold-worked rod and bar as determined by the departure from straightness shall be as specified in Table 3.

TABLE 8 Normal Machining Allowances for Hot-Worked Material

Finished-Machined Dimensions for Finishes as Indicated Below, in. (mm)[A]	Normal Machining Allowance, in. (mm)			
	On Diameter, for Rods	Distance Between Parallel Surfaces for Hexagonal and Square Bar	For Rectangular Bar	
			On Thickness	On Width
Hot-worked:[B]				
Up to 7/8 (22.2), incl	1/8 (3.2)	1/8 (3.2)	1/8 (3.2)	3/16 (4.8)
Over 7/8 to 1 7/8 (22.2 to 47.6), incl	1/8 (3.2)	3/16 (4.8)	1/8 (3.2)	3/16 (4.8)
Over 1 7/8 to 2 7/8 (47.6 to 73.0), incl	3/16 (4.8)	1/4 (6.4)	...	3/16 (4.8)
Over 2 7/8 to 3 13/16 (73.0 to 96.8), incl	1/4 (6.4)	...	...	3/16 (4.8)
Over 3 13/16 (96.8)	1/4 (6.4)	...	...	3/8 (9.5)
Hot-worked rods:				
Rough-turned or rough-ground:[C]				
15/16 to 4 (23.8 to 101.6), incl in diameter	1/16 (1.6)	...	...	...
Over 4 to 12 (101.6 to 304.8), incl in diameter	1/8 (3.2)	...	...	...

[A] Dimensions apply to diameter of rods, to distance between parallel surfaces of hexagonal and square bar, and separately to width and thickness of rectangular bar.
[B] The allowances for hot-worked material in Table 5 are recommended for rods machined in lengths of 3 ft (0.91 m) or less and for bars machined in lengths of 2 ft (0.61 m) or less. Hot-worked material to be machined in longer lengths should be specified showing the finished cross-sectional dimension and the length in which the material will be machined in order that the manufacturer may supply material with sufficient oversize, including allowance for out-of-straightness.
[C] Applicable to 3 ft (0.91 m) max length.

TABLE 9 Permissible Variations in Length of Rods and Bars

Random mill lengths:	
Hot-worked	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)[A]
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[B]
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), minus 0.

[A] 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.
[B] For cold-worked rods and bars under 1/2 in. (12.7 mm) in diameter or distance between parallel surfaces 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.

7.6.2 The permissible variations in straightness of hot-worked, cold-worked, rough-turned, and machined rod and bar as determined by the departure from straightness shall be as specified in Table 10.

7.6.2.1 In determining straightness in the standard 42-in. (1.07-mm) distance between supports or, when specified, in determining straightness in length not in excess of those shown in Table 3, the rod shall be placed on a precision table equipped with ball bearing rollers and a micrometer or dial indicator. The rod then shall be rotated slowly against the indicator, and the deviation from straightness in any portion of the rod between the supports shall not exceed the permissible variations prescribed in Table 10. The deviation from straightness (throw in one revolution) is defined as the difference between the maximum and minimum readings of the dial indicator in one complete revolution of the rod.

TABLE 10 Permissible Variations in Straightness of Rod and Bar[A]

Ordered Condition, Finish, and Specified Dimension, in. (mm)	Permissible Deviations in Straightness, in. (mm)
Hot-worked:	Depth of chord[B]
Bar and rod (hot-finished surface)	0.050 (1.27) per ft (305) of length
Rounds:	Throw in one revolution[C]
Rough-turned or rough-ground	0.050 (1.27) per ft (305) of length
Semi-smooth machined	0.0031 (0.79) per ft (305) of length
Smooth-finished machined	0.0015 (0.038) per ft (305) of length
Cold-worked:	Depth of chord[B]
Rounds (diameter): Up to 4 (101.6), incl	0.030 (0.76) per ft (305) of length
Hexagons and squares:	Depth of chord[B]
All sizes	0.030 (0.76) per ft (305) of length

[A] Not applicable to forging stock.
[B] The maximum curvature (depth of chord) shall not exceed the value indicated multiplied by length in feet.
[C] The throw in one revolution in any 20 ft (6.10 m) maximum length shall not exceed the values indicated multiplied by length in feet.

7.7 *Forging*—Dimensions and tolerances shall be as specified on the order, sketch, or drawing.

7.8 *Forging Stock*—Dimensions and tolerances shall be as agreed upon between the purchaser and the manufacturer.

8. Workmanship, Finish, and Appearance

8.1 The material shall be uniform in quality and condition, 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 properties testing shall consist of all material from the same heat, same nominal cross-sectional or forging size, and condition.

9.1.2.1 A lot for forging stock shall consist of one heat.

9.1.2.2 Where material cannot be identified by heat, a lot shall consist of not more than 500 lb (227 kg) of material in the same size and condition.

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 shall be wholly the responsibility of 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.

9.2.3 *Unaged Material*—For material ordered in the unaged condition, one test specimen shall be taken from each lot as defined in 9.1.2. The specimen shall be obtained from the actual material to be shipped or from a forged test coupon when applicable. The specimen shall be aged, or annealed and aged, as required by either applicable Table 5 or Table 6. Tests need not be repeated when unaged material from the same heat can be identified with a lot that has been tested in the specified condition and found to meet the requirements of this specification.

10. Number of Tests

10.1 *Chemical Analysis*—one test per lot.

10.2 *Tension*—one test per lot.

10.3 *Hardness*—one test per lot.

11. Specimen Preparation

11.1 *Rod and Bar:*

11.1.1 Tension test specimens shall be taken from material in the final condition and tested in the direction of fabrication.

11.1.2 All rod, bar, and wire shall be tested in full cross section size when possible. When a full cross section size test cannot be performed, the largest possible round specimen shown in Test Methods E8 shall be used. Longitudinal strip specimens shall be prepared in accordance with Test Methods E8 for rectangular bar up to ½ in. (12.7 mm), inclusive, in thicknesses that are too wide to be pulled full size.

11.1.3 Forging stock test specimens shall be taken from a forged-down coupon or a sample taken directly from stock.

11.2 *Forgings:*

11.2.1 The tension test specimen representing each lot shall be taken from a forging or from a test prolongation.

11.2.2 The axis of the specimen shall be located at any point midway between the center and the surface of solid forgings and at any point midway between the inner and outer surfaces of the wall of hollow forgings, and shall be parallel to the direction of greatest metal flow.

11.2.3 The specimens shall be the largest possible round type as prescribed in Test Methods E8.

11.3 Hardness test specimens shall be taken from material in the final condition.

NOTE 1—In order that the hardness determinations may be in reasonably close agreement, the following procedures are recommended:

(1) For rod less than ½ in. (12.7 mm) in diameter, hardness readings shall be taken on a flat surface prepared by filing or grinding approximately 1⁄16 in. (1.6 mm) from the outside surface of the rod.

(2) For rod ½ in. (12.7 mm) in diameter and larger, and for hexagonal, square, and rectangular bar, all sizes, hardness readings shall be taken on a cross section midway between the surface and center of the section.

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:

Test	ASTM Designation
Chemical Analysis	E1473
Tension	E8
Rockwell Hardness	E18
Hardness Conversion	E140
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 as follows:

Test	Rounded Unit for Observed or Calculated Value
Chemical composition, hardness, 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 f ollowed 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 %

13. Inspection

13.1 Inspection of the material shall be conducted as agreed upon between the manufacturer and the purchaser as part of the purchase contract.

14. Rejection and Rehearing

14.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection should be reported to the manufacturer or supplier promptly and in writing. In case of dissatisfaction with the results of the test, the manufacturer or supplier may make claim for a rehearing.

15. Certification

15.1 When specified in the purchase order or contract, a manufacturer's certification shall be furnished to the purchaser stating that the material has been manufactured, tested, and inspected in accordance with this specification, and that the test results on representative samples meet specification requirements. When specified in the purchase order or contract, a report of the test results shall be furnished.

16. Product Marking

16.1 The following shall be marked on the material or included on the package, or on a label or tag attached thereto:

16.1.1 The name of the material or UNS Number,

16.1.2 Heat number,

16.1.3 Condition (temper),

16.1.4 This specification number and year of issue,

16.1.5 The size,

16.1.6 Gross, tare, and net weights,

16.1.7 Consignor and consignee address, and

16.1.8 Contract or order number or such other information as may be defined in the contract or order.

17. Keywords

17.1 bar; forgings; precipitation; rod; UNS N05500; wire

SUPPLEMENTARY REQUIREMENTS

S1. Special End Uses

S1.1 When material is intended for nuclear applications or other critical end uses, or when any special requirements are to apply, the manufacturer shall be notified at the time of placement of the inquiry or order to determine if material of quality and inspection procedures normally employed for commercial material to this specification is adequate. In the event that more critical quality or more rigid inspection standards than those called out in this specification are indicated, the manufacturer and the purchaser shall agree upon such standards prior to production.