



Designation: B805 – 06

Standard Specification for Precipitation Hardening Nickel Alloys Bar and Wire¹

This standard is issued under the fixed designation B805; 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 alloys UNS N07716, N07725, N07773, N07776, N09777, and N09925 in the form of hot or cold finished rounds, squares, hexagons, rectangles, and cold finished 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.

1.3 The following precautionary caveat pertains only to the test methods, portion, Section 13, 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 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

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 Test Methods for Tension Testing of Metallic Materials

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

3. Terminology

3.1 *Definitions*:

3.1.1 Definitions for terms defined in Terminology **B899** shall apply unless otherwise defined by the requirements of this document.

3.2 *Definitions of Terms Specific to This Standard*:

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

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

4. Ordering Information

4.1 It is the responsibility of the purchaser to specify all requirements that are necessary for material ordered under this specification. Examples of such requirements include, but are not limited to the following:

4.1.1 Alloy name or UNS number,

4.1.2 ASTM designation and date of issue,

4.1.3 Quantity,

4.1.4 Form (bar or wire),

4.1.5 Dimensions,

4.1.6 Condition,

4.1.7 Finish,

4.1.8 *Certification*—State if certification is required,

4.1.9 *Samples for Product Analysis*—State if samples for product analysis are to be furnished, and

4.1.10 *Purchaser Inspection*—State if purchaser inspection is required and which tests 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, the material shall conform to the tolerances provided in Specification **B880**.

6. Condition

6.1 Bar shall be supplied in the solution treated conditions.

NOTE 1—The recommended solution treatment shall consist of heating the material to temperature in the range from 1850 to 1950°F (1010 to 1065°C), followed by rapid cooling. For alloy N09925, the recommended solution treatment shall consist of heating the material to temperature of 1875°F (1024°C), followed by air cooling or faster for 1 in. (25.4 mm) diameter or less and water quenching or faster for greater than 1 in. (25.4

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 Dec. 1, 2006. Published January 2007. Originally approved in 1990. Last previous edition approved in 2002 as B805 – 02. DOI: 10.1520/B0805-06.

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, Weight %					
	Alloy N07716	Alloy N07725	Alloy N07773	Alloy N07776	Alloy N09777	Alloy N09925
Carbon	0.03 max	0.03 max	0.03 max	0.03 max	0.03 max	0.03 max
Manganese	0.20 max	0.35 max	1.00 max	1.00 max	1.00 max	1.0 max
Phosphorous	0.015 max	0.015 max	0.030 max	0.030 max	0.030 max	0.03 max
Sulfur	0.010 max	0.010 max	0.010 max	0.010 max	0.010 max	0.03 max
Silicon	0.20 max	0.20 max	0.50 max	0.50 max	0.50 max	0.5 max
Chromium	19.00–22.00	19.00–22.50	18.0–27.0	12.0–22.0	14.0–19.0	19.5–22.5
Nickel	59.00–63.00	55.00–59.00	45.0–60.0	50.0–60.0	34.0–42.0	42.0–46.0
Molybdenum	7.00–9.50	7.00–9.50	2.5–5.5	9.0–15.0	2.5–5.5	2.5–3.5
Columbium (Niobium)	2.75–4.00	2.75–4.00	2.5–6.0	4.0–6.0	0.10 max	0.5 max
Titanium	1.00–1.60	1.00–1.70	2.0 max	1.00 max	2.0–3.0	1.9–2.40
Aluminum	0.35 max	0.35 max	2.0 max	2.00 max	0.35 max	0.1–0.5
Iron	remainder ^A	remainder ^A	remainder ^A	remainder ^A	remainder ^A	22.0 min
Other	...	...	mo + 0.5 W = 2.5–5.5	...	...	Cu 1.5–3.0
Tungsten	...	...	6.0 max	0.5–2.5	...	...

^A Determined arithmetically by difference.

mm) diameter. For alloy N07725, the recommended solution treatment shall consist of heating the material to temperature of 1900°F (1038°C), followed by air cooling.

6.2 Wire shall be supplied in the solution treated and cold finished condition.

6.3 Upon agreement between the purchaser and the manufacturer, the material may be supplied in the as-hot worked, solution treated plus aged, or other conditions.

7. Mechanical Properties

7.1 Unless otherwise specified, the material shall be supplied in the solution treated condition, suitable for subsequent age hardening, and shall conform to the minimum room temperature mechanical properties shown in [Table 2](#).

7.2 The solution treated material shall be capable of meeting the mechanical property requirements of [Table 3](#) following the precipitation hardening aging treatment described in [Table 3](#).

7.3 When the material is to be supplied in the solution treated plus aged condition, mechanical property requirements shall be those shown in [Table 3](#), or as agreed upon between the purchaser and the manufacturer as part of the purchase contract.

NOTE 2—An aging treatment other than that described in [Table 3](#) may be used provided the mechanical property and other requirements of this specification or the governing purchase contract are met.

8. Dimensions and Permissible Variations

8.1 *Bar*—Bar shall conform to the variations in dimensions prescribed in [Tables 4-12](#), inclusive, as applicable.

8.2 *Wire*—Wire shall conform to the variations in dimensions prescribed in [Tables 13-17](#), inclusive, as applicable.

9. Workmanship, Finish, and Appearance

9.1 The product shall be uniform in quality and condition, smooth, commercially straight or flat, and free from injurious imperfections.

10. Sampling

10.1 Lot Definition:

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

10.1.2 A lot for mechanical properties shall consist of all material from the same heat, nominal diameter, or thickness, subjected to the same heat treatment at the same time.

TABLE 2 Solution Treated Mechanical Properties^A

Alloy	Tensile Strength, min		Yield Strength, min		Elongation in 4D, % min	Reduction of Area, % min
	ksi	MPa	ksi	MPa		
N07716 and N07725	110	758	45	310	30	40
N07773 and N07776	90	621	35	241	35	50
N09777	75	517	30	207	35	50
N09925	75	517	35	241	35	50

TABLE 3 Capability Mechanical Properties^A

Alloy	Tensile Strength, min		Yield Strength, min		Elongation in 4D, % min	Reduction of Area, % min
	ksi	MPa	ksi	MPa		
N07716 and N07725	165	1137	120	827	20	35
N07773 and N07776	140	965	120	827	20	30
N09777	125	862	110	758	25	35
N09925 ^B	140	965	105	724	18	25
N09925 ^C	140	965	110	758	18	25

^A Properties after aging solution treated material.

Aging treatment for UNS N07716 and N07725 consists of 1350°F (732°C) for 8 h followed by furnace cooling to 1150 to 1200°F (621 to 649°C), holding 8 h, and air cooling. See [Note 2](#).

Aging treatment for UNS N07773 consists of 1275°F (690°C) for 20 h followed by air cooling (see [Note 2](#)).

Aging treatment for UNS N07776 consists of 1335°F (725°C) for 8 h followed by furnace cooling to 1155°F (625°C), holding 8 h, and air cooling (see [Note 2](#)).

Aging treatment for UNS N09777 consists of 1330°F (720°C) for 8 h followed by furnace cooling to 1150°F (620°C), holding 8 h, and air cooling (see [Note 2](#)). Aging treatment for UNS N09925 consists of 1365°F (740°C), hold at temperature for 6 to 9 h, furnace cool to 1150°F (62°C), hold until total precipitation heat treatment time has reached 18 h, air cool or faster.

^B Cold worked, solution annealed and aged.

^C Hot worked, solution annealed and aged.

10.2 Test Material Selection:

10.2.1 *Chemical Analysis*—Representative samples shall be taken at the time of final ingot casting or during subsequent processing.

10.2.2 *Product Analysis*— Shall be solely the responsibility of the purchaser.

10.2.3 *Mechanical Properties*—Samples of material to provide test specimens shall be taken from locations in each lot as to be representative of that lot.

11. Number of Tests

11.1 *Chemical Analysis*—One test per lot.

11.2 *Mechanical Properties*—One test per lot.

TABLE 4 Permissible Variations in Size of Hot-Rolled Round and Square Bars

	Permissible Variations from Specified Size, in. (mm)		Out-of-Round ^A or Out-of-Square, ^B in. (mm)
	Over	Under	
1/4 (6.35) to 5/16 (7.94), incl ^{C,D}	<i>E</i>	<i>E</i>	<i>E</i>
Over 5/16 (7.94) to 7/16 (11.11), incl ^{C,D}	0.006 (0.15)	0.006 (0.15)	0.009 (0.23)
Over 7/16 (11.11) to 5/8 (15.88), incl ^{C,D}	0.007 (0.18)	0.007 (0.18)	0.010 (0.25)
Over 5/8 (15.88) to 7/8 (22.22), incl	0.008 (0.20)	0.008 (0.20)	0.012 (0.30)
Over 7/8 (22.22) to 1 (25.40), incl	0.009 (0.23)	0.009 (0.23)	0.013 (0.33)
Over 1 (25.40) to 1 1/8 (28.58), incl	0.010 (0.25)	0.010 (0.25)	0.015 (0.38)
Over 1 1/8 (28.58) to 1 1/4 (31.75), incl	0.011 (0.28)	0.011 (0.28)	0.016 (0.41)
Over 1 1/4 (31.75) to 1 3/8 (34.92), incl	0.012 (0.30)	0.012 (0.30)	0.018 (0.46)
Over 1 3/8 (34.92) to 1 1/2 (38.10), incl	0.014 (0.36)	0.014 (0.36)	0.021 (0.53)
Over 1 1/2 (38.10) to 2 (50.80), incl	1/64 (0.40)	1/64 (0.40)	0.023 (0.58)
Over 2 (50.80) to 2 1/2 (63.50), incl	1/32 (0.79)	0	0.023 (0.58)
Over 2 1/2 (63.50) to 3 1/2 (88.90), incl	3/64 (1.19)	0	0.035 (0.89)
Over 3 1/2 (88.90) to 4 1/2 (114.30), incl	1/16 (1.59)	0	0.046 (1.17)
Over 4 1/2 (114.30) to 5 1/2 (139.70), incl	3/64 (1.98)	0	0.058 (1.47)
Over 5 1/2 (139.70) to 6 1/2 (165.10), incl	1/8 (3.18)	0	0.070 (1.78)
Over 6 1/2 (165.10) to 8 (203.20), incl	3/32 (3.97)	0	0.085 (2.18)

^A Out-of-round is the difference between the maximum and minimum diameters of the bar, measured at the same cross section.

^B Out-of-square section is the difference in the two dimensions at the same cross section of a square bar, each dimension being the distance between opposite faces.

^C Size tolerances have not been evolved for rounds in the size range of 1/4 to 5/16 in. (6.35 to 7.94 mm), inclusive. Size tolerances have not been evolved for round sections in the size range of 1/4 in. to approximately 5/8 in. (6.35 to 15.88 mm) in diameter which are produced on rod mills in coils.

^D Variations in size of coiled product made on rod mills are greater than size tolerances for product made on bar mills.

^E Squares in this size are not produced as hot-rolled products.

TABLE 5 Permissible Variations in Size of Hot-Rolled Hexagonal and Octagonal Bars

Specified Sizes Measured Between Opposite Sides, in. (mm)	Permissible Variations from Specified Size, in. (mm)		Maximum Difference in 3 Measurements for Hexagons only, in. (mm)
	Over	Under	
1/4 (6.35) to 1/2 (12.70), incl	0.007 (0.18)	0.007 (0.18)	0.011 (0.28)
Over 1/2 (12.70) to 1 (25.40), incl	0.010 (0.25)	0.010 (0.25)	0.015 (0.38)
Over 1 (25.40) to 1 1/2 (38.10), incl	0.021 (0.53)	0.021 (0.53)	0.025 (0.64)
Over 1 1/2 (38.10) to 2 (50.80), incl	1/32 (0.79)	1/32 (0.79)	1/32 (0.79)
Over 2 (50.80) to 2 1/2 (63.50), incl	3/64 (1.19)	3/64 (1.19)	3/64 (1.19)
Over 2 1/2 (63.50) to 3 1/2 (88.90), incl	1/16 (1.59)	1/16 (1.59)	1/16 (1.59)

12. Specimen Preparation

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

12.2 All bar and wire shall be tested in the full cross-section size, when possible. If the specimen size does not utilize the full product cross section, the specimens shall be located at mid-radius.

13. Test Methods

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

Test	ASTM
Chemical Analysis	Test Methods
Tension	E1473
	E8

14. Inspection

14.1 If specified, source inspection of the material by the purchaser at the manufacturer's plant shall be made as agreed upon between the purchaser and the manufacturer as part of the purchase contract.

15. Rejection and Reheating

15.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection should be reported

to the producer or supplier promptly and in writing. In case of dissatisfaction with the results of the test, the producer or the purchaser may make claim for a reheating.

16. Certification

16.1 When specified in the purchase order or contract, a producer's or supplier's certification shall be furnished to the purchaser that the material was manufactured, sampled, tested, and inspected in accordance with this specification and has been found to meet the requirements. When specified in the purchase order or contract, a report of the test results shall be furnished.

17. Product Marking

17.1 The following shall be marked on the material or included on the package, or on a label or tag attached thereto: the name of the material or UNS number, condition (temper), this specification number, the size, gross, tare, and net weight, consignor and consignee address, contract or order number, or other such information as may be defined in the contract or purchase order.

18. Keywords

18.1 bar; wire; UNS N07716; UNS N07725; UNS N07773; UNS N07776; UNS N09777; UNS N09925