



Designation: B 805 – 95

Standard Specification for Precipitation Hardening Nickel Alloys UNS N07716, N07725, N07773, N07776, and N09777, Bar and Wire¹

This standard is issued under the fixed designation B 805; 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, and N09777 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 establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

E 8 Test Methods for Tension Testing of Metallic Materials²

E 354 Test Methods for Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys³

E 1019 Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel and in Iron, Nickel, and Cobalt Alloys⁴

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *bar*—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.

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

4. Ordering Information

4.1 Orders for material conforming to this specification should include 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 Table 2.

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.

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 3.

7.2 The solution treated material shall be capable of meeting the mechanical property requirements of Table 4 following the precipitation hardening aging treatment described in Table 4.

7.3 When the material is to be supplied in the solution

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² *Annual Book of ASTM Standards*, Vol 03.01.

³ *Annual Book of ASTM Standards*, Vol 03.05.

⁴ *Annual Book of ASTM Standards*, Vol 03.06.



treated plus aged condition, mechanical property requirements shall be those shown in Table 4, 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 4 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 5-13, inclusive, as applicable.

8.2 *Wire*—Wire shall conform to the variations in dimensions prescribed in Tables 14-18, 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.

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.

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	E 354, E1019 ^A
	E 8

^A Test Methods E 1019 are to be used only for those elements not covered by Test Methods E 354.

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 Rehearing

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 rehearing.

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, cosignor 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; UNS N07716; UNS N07725; wire



TABLE 1 Chemical Requirements

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

^ADetermined arithmetically by difference.

TABLE 2 Product (Check) Analysis Tolerances

Element	Tolerances over max or under min, limit, %			
	Alloys N07716 and N07725	Alloy N07773	Alloy N07776	Alloy N09777
Carbon	0.01	0.01	0.01	0.01
Manganese	0.03	0.03	0.03	0.03
Phosphorus	0.005	0.005	0.005	0.005
Sulfur	0.003	0.003	0.003	0.003
Silicon	0.02	0.03	0.03	0.03
Chromium	0.25	0.25 under, 0.30 over	0.15 under, 0.25 over	0.15 under, 0.25 over
Nickel	0.35	0.35	0.35	0.30 under, 0.35 over
Molybdenum	0.15	0.05 under, 0.15 over	0.15	0.05 under, 0.15 over
Columbium (Niobium)	0.15	0.10 under, 0.20 over	0.15 under, 0.20 over	0.05
Titanium	0.05	0.05	0.04	0.05 under, 0.07 over
Aluminum	0.05	0.10	0.10	0.05
Tungsten	...	0.10	0.04 under, 0.10 over	...

TABLE 4 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

^AProperties after aging solution treated material. Aging treatment 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).

TABLE 3 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