



Standard Specification for Precipitation Hardened or Cold Worked, Seamless Nickel Alloy Pipe and Tube¹

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1. Scope*

1.1 This specification covers high strength, seamless pipe and tube of nickel alloys (UNS N07022, UNS N07725, UNS N07740, UNS N09945, UNS N09925, UNS N07718, UNS N10276, UNS N06985)² as shown in [Table 1](#).

1.2 Pipe and tube shall be supplied in the cold worked or cold worked and precipitations hardened or solution annealed plus precipitation hardened and descaled conditions. When atmosphere control is used, descaling is not necessary.

1.3 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.

1.4 *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 Safety Data Sheet (SDS) 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:³

[B829 Specification for General Requirements for Nickel and Nickel Alloys Seamless Pipe and Tube](#)

[B899 Terminology Relating to Non-ferrous Metals and Alloys](#)

[E8 Test Methods for Tension Testing of Metallic Materials](#)

[E527 Practice for Numbering Metals and Alloys in the](#)

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 New designation established in accordance with Practice [E527](#) and SAE J1086, Practice for Numbering Metals and Alloys (UNS).

³ 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.

Unified Numbering System (UNS)

3. Terminology

3.1 Terms shall be defined in accordance with Terminology [B899](#).

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *average diameter, n*—See Terminology [B899](#).

3.2.2 *pipe, n*—See Terminology [B899](#) and Specification [B829](#).

3.2.3 *tube, n*—See Terminology [B899](#).

4. General Requirements

4.1 Material furnished under this specification shall conform to the applicable requirements of Specification [B829](#) unless otherwise provided herein.

5. Ordering Information

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

5.1.1 *Alloy*—[Table 1](#).

5.1.1.1 *Heat Treatment or Cold Work or Type* ([Table 2](#) and [Table 3](#)).

5.1.2 *Dimensions:*

5.1.2.1 *Tube*—Outside diameter, minimum or average wall thickness, and length.

5.1.2.2 *Pipe*—Standard pipe size and schedule (Specification [B829](#)).

5.1.3 *Ends*—Plain ends cut and deburred will be furnished.

5.1.4 *Certification*—State if certification or a report of test results is required (Section [16](#)).

5.1.5 *Samples for Check Analysis*—State whether samples for check analysis should be furnished.

5.1.6 *Purchaser Inspection*—If the purchaser wishes to witness tests or inspection of material at the place of manufacture, the purchase order must so state, indicating which tests or inspections are to be witnessed (Section [15](#)).

6. Chemical Composition

6.1 The material shall conform to the composition limits specified in [Table 1](#).

*A Summary of Changes section appears at the end of this standard

TABLE 1 Chemical Requirements

| Element | UNS N07022 | UNS N07725 | UNS N07740 | UNS N09945 | UNS N09925 | UNS N07718 | UNS N10276 | UNS N06985 |
|-------------------------|------------------------|------------------------|------------------------|------------------------|-----------------------|------------------------|------------------------|------------------------|
| Carbon | 0.010 max | 0.03 max | 0.005-0.08 | 0.005-0.04 | 0.03 max | 0.08 max | 0.02 max | 0.015 max |
| Manganese | 0.5 max | 0.35 max | 1.0 max | 1.0 max | 1.00 max | 0.35 max | 1.0 max | 1.0 max |
| Silicon | 0.08 max | 0.20 max | 1.0 max | 0.5 max | 0.50 max | 0.35 max | 0.08 max | 1.0 max |
| Phosphorous | 0.025 max | 0.015 max | 0.03 max | 0.03 max | ... | 0.015 max | 0.030 max | 0.04 max |
| Sulfur | 0.015 max | 0.010 max | 0.03 max | 0.03 max | 0.030 max | 0.015 max | 0.030 max | 0.03 max |
| Chromium | 20.0-21.4 | 19.0-22.5 | 23.5-25.5 | 19.5-23.0 | 19.5-23.5 | 17.0-21.0 | 14.5-16.5 | 21.0-23.5 |
| Cobalt | 1.0 max | ... | 15.0-22.0 | ... | ... | 1.0 max | 2.5 max | 5.0 max |
| Molybdenum | 15.5-17.4 | 7.00-9.50 | 2.0 max | 3.0-4.0 | 2.50-3.50 | 2.80-3.30 | 15.0-17.0 | 6.0-8.0 |
| Columbium | ... | 2.75-4.00 | ... | 2.4-4.5 | 0.50 max | 4.75-5.50 | ... | ... |
| Titanium | ... | 1.00-1.70 | 0.5-2.5 | 0.5-2.5 | 1.90-2.40 | 0.65-1.15 | ... | ... |
| Aluminum | 0.5 max | 0.35 max | 0.2-2.0 | 0.01-0.7 | 0.10-0.50 | 2.20-0.80 | ... | ... |
| Zirconium | ... | ... | ... | ... | ... | ... | ... | ... |
| Boron | 0.006 max | ... | 0.0006–0.006 | ... | ... | 0.006 max | ... | ... |
| Iron | 1.8 max | Remainder ^B | 3.0 max | Remainder ^B | 22.0 min ^A | Remainder ^B | 4.0-7.0 | 18.0-21.0 |
| Copper | 0.5 max | ... | 0.50 max | 1.5-3.0 | 1.50-3.00 | 0.30 max | ... | 1.5-2.5 |
| Nickel | Remainder ^B | 55.0–59.0 | Remainder ^B | 45.0-55.0 | 38.0-46.0 | 50.0-55.0 | Remainder ^B | Remainder ^B |
| Tantalum | 0.2 max | ... | ... | ... | ... | ... | ... | ... |
| Tungsten | 0.8 max | ... | ... | ... | ... | ... | 3.0-4.5 | 1.5 max |
| Columbium + Tantalum | ... | ... | 0.50–2.5 | ... | ... | ... | ... | 0.50 max |
| Vanadium | ... | ... | ... | ... | ... | ... | 0.35 max | ... |

^A Minimum: The element may be determined arithmetically by difference.

^B Remainder: The element may be determined arithmetically by difference.

6.2 If a product (check) analysis is made by the purchaser, the material shall conform to the requirements specified in **Table 1** subject to the permissible tolerances per Specification **B829**.

7. Mechanical Properties

7.1 Unless otherwise specified, the material shall be supplied in the cold worked (cw), or cold worked and precipitation hardened (prec hard), or solution annealed plus precipitation hardened condition as described in **Table 2** and **Table 3**.

7.2 The mechanical properties of the material at room temperature shall conform to those shown in **Table 3**.

8. Hydrostatic Test or Non-Destructive Electric Test

8.1 Each pipe or tube shall be tested by the manufacturer by either hydrostatic or a non-destructive electric test in accordance with Specification **B829**. Hydrostatic testing at a pressure greater than 1000 psi may be performed upon agreement between the purchaser and manufacturer or at the option of the manufacturer provided that the allowable fiber stress per Specification **B829** is not exceeded.

9. Weight

9.1 For calculation of mass or weight, the following densities shall be tested:

| Alloy | Density | |
|------------|---------------------|-------------------|
| | lb/in. ³ | g/cm ³ |
| UNS N07022 | 0.311 | 8.60 |
| UNS N07725 | 0.300 | 8.31 |
| UNS N07740 | 0.291 | 8.05 |
| UNS N09945 | 0.296 | 8.2 |
| UNS N09925 | 0.292 | 8.08 |
| UNS N07718 | 0.296 | 8.19 |
| UNS N10276 | 0.321 | 8.89 |
| UNS N06985 | 0.294 | 8.14 |

10. Sampling

10.1 *Lots for Chemical Analysis and Mechanical Testing are as defined in Specification B829.*

10.2 *Sampling of Chemical Analysis:*

10.2.1 A representative sample shall be taken from each lot during pouring or subsequent processing.

10.2.2 Product (check) analysis shall be wholly the responsibility of the purchaser.

10.3 *Sampling for Mechanical Testing:*

10.3.1 A representative sample shall be taken from each lot of finished material.

11. Number of Tests and Retests

11.1 *Chemical Analysis*—One test per lot.

11.2 *Tension Test*—One test per lot.

11.3 *Retests*—If the specimen used in the mechanical test of any lot fails to meet the specified requirements, two additional specimens shall be taken from different sample pieces and tested. The results of the tests on both of these specimens shall meet the specified requirements.

12. Specimen Preparation

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

12.2 Whenever possible, all pipe and tube shall be tested in full tubular size. When testing in full tubular size is not possible, longitudinal strip specimens, or the largest possible round specimen prepared in accordance with Test Methods **E8**, shall be used.

TABLE 2 Heat Treatments

| Alloy | Recommended Solution Annealing Treatment | Recommended Precipitation Hardening Treatment |
|--------------------------|--|--|
| UNS N07022 Type 1A or 1B | 1800–2100°F (982–1149°C), hold ½ hr/in., 5 min. minimum, rapid air cool or water quench | none |
| UNS N07022 Type 2 | 1800–2100°F (982–1149°C), hold ½ hr/in., 5 min. minimum, rapid air cool or water quench | 1075–1150°F (579–621°C), hold 10 h, air cool |
| UNS N07725 Type 1 | 1900 ± 25°F (1040 ± 14°C), hold 1 h per in. of thickness, water quench or rapid air/gas cool | 1350 ± 25°F (730 ± 14°C), hold 8 h, furnace cool at 100°F (56°C) per min. to 1150 ± 25°F (620 ± 14°C), hold for 8 h, air cool |
| UNS N07725 Type 2 | 1900 ± 25°F (1040 ± 14°C), hold 1 h per in. of thickness, water quench or rapid air/gas cool | 1350 ± 25°F (730 ± 14°C), hold 8 h, furnace cool at 100°F (56°C) per min. to 1150 ± 25°F (620 ± 14°C), hold for 8 h, air cool |
| UNS N07740 | 2050 ± 25°F (1120 ± 14°C), hold ½ h., water quench | 1472 ± 25°F (800 ± 14°C), hold 4 to 16 h, air cool |
| UNS N09945 Type 1 | 1850–1950°F (1010–1066°C) hold 0.5 to 4 h, water quench | 1300–1350°F (704–732°C), for 6 to 8 h, furnace cool at 50–100°F (26–56°C)/h to 1125–1175°F (607–635°C) hold 6 to 8 h, air cool |
| UNS N09945 Type 2 | 1850–1950°F (1010–1066°C) hold 0.5 to 4 h, water quench | 1300–1350°F (704–732°C), for 6 to 8 h, furnace cool at 50–100°F (26–56°C)/h to 1125–1175°F (607–635°C) hold 6 to 8 h, air cool |
| UNS N09925 | Batch Anneal 1825–1875°F (996–1024°C) hold 0.5 to 4 h, air cool or faster | 1365–15°F (740–9°C) hold 6 to 9 h, furnace cool to 1150°F (621°C) for total aging time of 18 min., air cool |
| UNS N07718 | 1875 ± 25°F (1024 ± 14°C) for 1 to 2 h, water quench | 1425–1475°F (774–802°C) hold 6 to 8 h, air cool |
| UNS N10276 | 2050°F (1121°C) minimum for time commensurate with thickness | none |
| UNS N06985 | 2050°F (1121°C) minimum for time commensurate with thickness | none |

TABLE 3 Mechanical Properties

| Alloy | Condition ^A | Tensile Strength, min., ksi (MPa) | Yield Strength min., ksi (MPa) | Elongation in 2 in., (50 mm) or 4D ^B , min., % | Hardness Rc max |
|--------------------|-------------------------------|-----------------------------------|--------------------------------|---|-----------------|
| UNS N07022 Type 1A | Solution Ann + cw | 160 (1103) | 150 (1034) | 17 | 42 |
| UNS N07022 Type 1B | Solution Ann + cw | 185 (1276) | 180 (1240) | 13 | 46 |
| UNS N07022 Type 2 | Solution Ann + cw + prec hard | 178 (1227) | 160 (1103) | 15 | 50 |
| UNS N07725 Type 1 | Solution Ann + prec hard | 150 (1035) | 120 (827) | 20 | 43 |
| UNS N07725 Type 2 | Solution Ann + cw + prec hard | 150 (1035) | 120 (827) | 20 | ... |
| UNS N07740 | Solution Ann + prec hard | 150 (1035) | 90 (620) | 20 | ... |
| UNS N09945 Type 1 | Solution Ann + prec hard | 150 (1035) | 130 (896) | 18 | 42 |
| UNS N09945 Type 2 | Solution Ann + prec hard | 165 (1138) | 140 (965) | 18 | 42 |
| UNS N09925 | Solution Ann + prec hard | 140 (965) | 110 (758) | 18 | 38 |
| UNS N07718 | Solution Ann + prec hard | 150 (1034) | 125 (862) | 20 | 40 |
| UNS N10276 Type 1 | Solution Ann + cw | 115 (793) | 110 (758) | 11 | 40 |
| UNS N10276 Type 2 | Solution Ann + cw | 130 (896) | 125 (862) | 10 | 40 |
| UNS N06985 Type 1 | Solution Ann + cw | 115 (793) | 110 (758) | 11 | 40 |
| UNS N06985 Type 2 | Solution Ann + cw | 130 (896) | 125 (862) | 10 | 40 |

^A See Table 2.

^B D refers to the diameter of the tension specimen.

TABLE 4 Permissible Variations for Outside Diameter and Wall Thickness of Hot-Finished Tube^A

| Nominal Outside Diameter, in. (mm) | Outside Diameter, in. (mm) | | Permissible Variations, % of Thickness of Specified Nominal Wall | | % of Thickness of Specified Minimum Wall | |
|---------------------------------------|-------------------------------|-------------|--|-------|---|-------|
| | | | Plus | Minus | Plus | Minus |
| | Plus | Minus | Plus | Minus | Plus | Minus |
| ¾ (19) to 1½ (38), incl | 0.015 (0.4) | 0.031 (0.8) | 12.5 | 12.5 | 28.5 | 0 |
| Over 1½ (38.1) to 4 (102), incl | 0.031 (0.8) | 0.031 (0.8) | 12.5 | 12.5 | 28.5 | 0 |
| Over 4 (102) to 9¼ (235), incl | 0.062 (1.6) | 0.031 (0.8) | 12.5 | 12.5 | 28.5 | 0 |
| Over 9¼ (235) to 12 (305), incl | 0.110 (2.8) | 0.110 (2.8) | 12.5 | 12.5 | ... | ... |

^A*Ovality*—Tube 5 in. (127 mm) and under in outside diameter, the tolerance on the outside diameter applies for individual measurements and includes ovality. Tube 5 in. (127 mm) in outside diameter, the mean outside diameter shall conform to the permissible variations of this table and individual measurements shall not exceed twice the permissible variations of this table.

TABLE 5 Permissible Variations for Outside Diameter and Wall Thickness of Seamless Hot-Worked Pipe^{A,B}

| Nominal Outside Diameter, in. (mm) | Outside Diameter, in. (mm) | | Permissible Variations, % of Thickness of Specified Nominal Wall | | % of Thickness of Specified Minimal Wall | |
|---------------------------------------|-------------------------------|--------------|--|-------|---|-------|
| | | | Plus | Minus | Plus | Minus |
| | Plus | Minus | Plus | Minus | Plus | Minus |
| 1 (25) to 1.900 (48), incl | 0.015 (0.40) | 0.031 (0.79) | 16.0 | 12.5 | 28.5 | 0 |
| Over 1.900 (48) to 4½ (114), incl | 0.031 (0.79) | 0.031 (0.79) | 16.0 | 12.5 | 28.5 | 0 |
| Over 4½ (114) to 6½ (165), incl | 0.047 (1.2) | 0.047 (1.2) | 16.0 | 12.5 | 28.5 | 0 |
| Over 6½ (165) to 9¼ (235), incl | 0.062 (1.6) | 0.062 (1.6) | 16.0 | 12.5 | 28.5 | 0 |
| Over 9¼ (235) to 14 (356), incl | 0.120 (30.5) | 0.120 (3.05) | 16.0 | 12.5 | ... | ... |
| Over 14 (356) to 24 (610), incl | 0.20 (5.08) | 0.20 (5.08) | 16.0 | 12.5 | ... | ... |

^A*Ovality*—For pipe 5 in. (127 mm) and under in outside diameter, the tolerance on the outside diameter applies for individual measurements and includes ovality. For pipe over 5 in. (125 mm) in outside diameter, the mean outside diameter shall conform to the permissible variations of this table and individual measurements shall not exceed twice the permissible variations of this table.

^B*Eccentricity*—The permissible variations in this table apply to individual measurements including eccentricity.

13. Test Methods

13.1 The chemical composition and mechanical properties of the material is as enumerated in this specification shall be determined in accordance with the methods in Specification **B829**.

14. Dimensions and Permissible Variations

14.1 The permissible variations for outside diameter and wall thickness of hot finished seamless tubes and pipes shall conform to **Table 4** and **Table 5**. The tables include permissible variations for pipes and tubes over 9¼ in. outside diameter that is not available in Specification **B829**.

14.2 Dimensions, straightness, ovality, and permissible variations of precipitation hardened or cold worked seamless pipe and tubes shall conform to the requirements specified in Section 6 of Specification **B829**.

15. Inspection

15.1 Inspection of the material shall be in accordance with this specification and agreements between the manufacturer and purchaser as part of the purchase contract.

16. Certification

16.1 When specified in the purchase order or contract, a manufacturer's certification shall be furnished to the purchaser stating that 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.

17. Keywords

17.1 seamless cold worked pipe; seamless cold worked tube; seamless precipitation hardened pipe; seamless precipitation hardened tube; UNS N07022; UNS N07725; UNS N07740; UNS N09945; UNS N09925; UNS N07718; UNS N10276; UNS N06985

APPENDIX**(Nonmandatory Information)****X1. HEAT TREATMENT**

X1.1 Proper heat treatment during or subsequent to fabrication is necessary for optimum performance and the manufacturer shall be consulted for details.

SUMMARY OF CHANGES

Committee B02 has identified the location of selected changes to this standard since the last issue (B983–13a) that may impact the use of this standard. (Approved October 1, 2015.)

- (1) Added Type 1A or 1B to UNS N07022 in Table 2.
- (2) Added UNS N07022 Type 1A and UNS N07022 1B to Table 3.

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