



Designation: B 165 – 93

Standard Specification of Nickel-Copper Alloy (UNS N04400)* Seamless Pipe and Tube¹

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This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This specification² covers nickel-copper alloy UNS N04400* in the form of cold-worked seamless pipe and tube in the conditions shown in Table 1 and Table X1.1.

1.1.1 Hot worked material is available. Properties and permissible tolerances are to be agreed upon between the manufacturer and purchaser.

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:

E 8 Test Methods for Tension Testing of Metallic Materials³

E 29 Practice For Using Significant Digits in Test Data to Determine Conformance with Specifications⁴

E 76 Test Methods for Chemical Analysis of Nickel-Copper Alloys⁵

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *average diameter*—average of the maximum and minimum outside diameters, as determined at any one cross-section of the pipe or tube.

3.1.2 *pipe*—tube conforming to the particular dimensions commercially known as pipe sizes, see Table X2.1.

3.1.3 *seamless pipe or tube*—pipe or tube produced with a continuous periphery in all stages of the operations.

3.1.4 *tube*—hollow product of round or any other cross-

TABLE 1 Mechanical Properties of Pipe and Tube

| Condition and Size | Tensile Strength, min, psi (MPa) | Yield Strength, min. (0.2% offset), min, psi (MPa) | Elongation in 2 in. or 50 mm (or 4 <i>D</i>), min, % |
|--|-------------------------------------|---|--|
| Annealed: | | | |
| 5 in. (127 mm) outside diameter and under | 70 000 (480) | 28 000 (195) | 35 |
| Over 5 in. (127 mm) outside diameter | 70 000 (480) | 25 000 (170) | 35 |
| Stress-Relieved: | | | |
| All sizes | 85 000 (585) | 55 000 (380) | 15 |

section having a continuous periphery.

4. Ordering Information

4.1 Orders for material to this specification shall include information with respect to the following:

4.1.1 Alloy name or UNS number.

4.1.2 ASTM designation and year of issue.

4.1.3 *Condition* (see Appendix X3).

4.1.4 *Finish* (see Appendix X3).

4.1.5 *Dimensions*:

4.1.5.1 *Tube*—Specify outside diameter and nominal or minimum wall.

4.1.5.2 *Pipe*—Specify standard pipe size and schedule.

4.1.5.3 *Length*—Cut to length or random.

4.1.6 *Quantity*—Feet or number of pieces.

4.1.7 *Hydrostatic Pressure Requirements*—Specify test pressure if other than required by 12.3.1.

4.1.8 *Certification*—State if certification or a report of test results is required (Section 15).

4.1.9 *Samples for Product (Check) Analysis*—State whether samples for product (check) analysis should be furnished (see 5.2).

4.1.10 *Purchaser Inspection*—If purchaser wishes to witness tests or inspection of material at place of manufacture, the purchase order must so state indicating which tests or inspections are to be witnessed (Section 13).

4.1.11 *Small-Diameter and Light-Wall Tube (Converter Sizes)*—See Appendix X1.

¹ This specification is under the jurisdiction of ASTM Committee B-2 on Nonferrous Metals and Alloys and is the direct responsibility of Subcommittee B02.07 on Refined Nickel and Cobalt, and Alloys Containing Nickel or Cobalt or Both as Principal Constituents.

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* New designation established in accordance with ASTM Practice E 527 and SAE J1086, Recommended Practice for Numbering Metals and Alloys (UNS).

² For ASME Boiler and Pressure Vessel Code applications, see related Specification SB-165 in Section II of that code.

³ *Annual Book of ASTM Standards*, Vol 03.01.

⁴ *Annual Book of ASTM Standards*, Vol 14.02.

⁵ *Annual Book of ASTM Standards*, Vol 03.05.



5. Chemical Composition

5.1 The material shall conform to the composition limits specified in Table 2.

5.2 If a product (check) analysis is performed by the purchaser, the material shall conform to the product (check) analysis variations in Table 2.

6. Mechanical and Other Requirements

6.1 *Tension Test*—The material shall conform to the tensile properties specified in Table 1.

6.1.1 Tensile properties for material specified as small-diameter and light-wall tube (converter sizes) shall be in accordance with Table X1.1

6.2 *Hydrostatic Test*—If any pipe or tube shows leaks during hydrostatic testing, it shall be rejected.

7. Dimensions and Permissible Variations

7.1 *Diameter and Wall Thickness*—The permissible variations in the outside diameter and wall thickness shall conform to the permissible variations prescribed in Table 3.

7.2 *Length*—When material is ordered cut-to-length, the length shall conform to the permissible variations prescribed in Table 4.

7.3 *Straightness*—material shall be reasonably straight and free of bends and kinks.

7.4 *Ends*—Ends shall be plain cut and deburred.

7.5 Permissible variations for material specified as small-diameter and light-wall tube (converter size) shall conform to the permissible variations prescribed in Table X1.2.

8. Workmanship, Finish and Appearance

8.1 The material shall be uniform in quality and temper, smooth, commercially straight, 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 all other testing shall consist of all material from the same heat, nominal size (excepting length), and condition.

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

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 and other Properties*—Samples of the material to provide test specimens for mechanical and other properties shall be taken from such locations in each lot as to be representative of that lot. Test specimens shall be taken from material in the final condition.

10. Number of Tests

10.1 *Chemical Analysis*—One test per lot.

10.2 *Tension*—One test per lot.

10.3 *Hydrostatic*—Each piece in each lot.

11. Specimen Preparation:

11.1 *Room Temperature Tensile Specimen*—Material shall be tested in the direction of fabrication. 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, shall be used. In the event of disagreement when full tubular testing is not possible, a longitudinal strip specimen with reduced gauge length as contained in Test Methods E 8 shall be used.

12. Test Methods

12.1 *Chemical Composition*—In case of disagreement, the chemical composition shall be determined in accordance with Test Methods E 76.

12.2 *Tension Test*—Tension testing shall be conducted in accordance with Test Methods E 8.

12.3 *Hydrostatic Test*—Each pipe or tube with an outside diameter $\frac{1}{8}$ in. (3 mm) and larger and with wall thickness of 0.015 in. (0.38 mm) and over shall be tested by the manufacturer to an internal hydrostatic pressure of 1000 psi (6.9 MPa) provided that the fiber stress calculated in accordance with the following equation does not exceed the allowable fiber stress, S , indicated below:

$$P = 2St/D$$

where:

P = hydrostatic test pressure, psi (or MPa)

S = allowable fiber stress, for material in the condition (temper) furnished as follows:

| | |
|---|----------------------|
| <i>Annealed:</i> | |
| 5 in. (127 mm) outside diameter and under | 17 500 psi (120 MPa) |
| Over 5 in. (127 mm) outside diameter | 16 700 psi (115 MPa) |
| <i>Stress-relieved:</i> | |
| All sizes | 21 200 psi (145 MPa) |

t = minimum wall thickness, in. (or mm), equal to the specified nominal wall minus the permissible minus wall tolerance, or the specified minimum wall thickness, and,

D = outside diameter of the pipe or tube, in. (or mm).

12.3.1 When so agreed upon between the manufacturer and purchaser, pipe or tube may be tested to 1½ times the

TABLE 2 Chemical Requirements

| Element | Composition Limits, % | Product (Check) Analysis Variations, under min or over max, of the Specified Limit of Element |
|-----------------|-----------------------|---|
| Ni ^A | 63.0 min | 0.45 |
| Cu | 28.0 min 34.0 max | 0.15 0.20 |
| Fe | 2.5 max | 0.05 |
| Mn | 2.0 max | 0.04 |
| C | 0.3 max | 0.02 |
| Si | 0.5 max | 0.03 |
| S | 0.024 max | 0.005 |

^AElement shall be determined arithmetically by difference.



TABLE 3 Permissible Variations for Outside Diameter and Wall Thickness of Seamless Cold Worked Pipe and Tube^{A,B}

| Nominal Outside diameter, in. (mm) | Permissible Variations | | | | % of Thickness of Specified Minimum Wall | |
|--------------------------------------|----------------------------|--------------|--|------|--|---|
| | Outside Diameter, in. (mm) | | % of Thickness of Specified Nominal Wall | | + | - |
| | + | - | + | - | | |
| Over 0.400 (10) to 5/8(16), excl | 0.005(0.13) | 0.005(0.13) | 15.0 | 15.0 | 30 | 0 |
| 5/8 (16) to 1 1/2 (38), incl | 0.0075(0.19) | 0.0075(0.19) | 10.0 | 10.0 | 22 | 0 |
| Over 1 1/2 (38) to 3 (76), incl | 0.010(0.25) | 0.010(0.25) | 10.0 | 10.0 | 22 | 0 |
| Over 3 (76) to 4 1/2 (114), incl | 0.015(0.38) | 0.015(0.38) | 10.0 | 10.0 | 22 | 0 |
| Over 4 1/2 (114) to 6 (152), incl | 0.020(0.51) | 0.020(0.51) | 12.5 | 12.5 | 28 | 0 |
| Over 6 (152) to 6 5/8 (168), incl | 0.025(0.64) | 0.025(0.64) | 12.5 | 12.5 | 28 | 0 |
| Over 6 5/8 (168) to 8 5/8(219), incl | 0.031(0.79) | 0.031(0.79) | 12.5 | 12.5 | 28 | 0 |

^AOvality—The permissible variations in this table apply to individual measurements, including out-of-roundness (ovality) except for the following:

For pipe and tube having a nominal wall thickness of 3 % or less of the nominal outside diameter, the mean outside diameter shall conform to the permissible variations of this table and individual measurements (including ovality) shall conform to the plus and minus values of the table, with the values increased by 0.5 % of the nominal outside diameter.

For pipe and tube over 4 1/2 in. (114 mm) in outside diameter with a nominal wall thickness greater than 3 % of the nominal 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 the table.

^BEccentricity—The permissible variations in this table apply to individual measurements including eccentricity.

TABLE 4 Permissible Variations in Length^A

| Outside Diameter, in. (mm) | Cut Length, in. (mm) | |
|----------------------------|----------------------|-------|
| | Over | Under |
| Under 2 (50.8) | 1/8(3.2) | 0 |
| 2 (50.8) and over | 3/16 (4.8) | 0 |

^AThese permissible variations in length apply to pipe or tube in straight lengths. They apply to cut lengths up to and including 24 ft (7.3 m). For lengths over 24 ft, an additional over-tolerance of 1/8 in. (3.2 mm) for each 10 ft (3.0 m) or fraction thereof shall be permissible up to a maximum additional over-tolerance of 1/2 in. (12.7 mm).

allowable fiber stress given above.

12.4 *Rounding Method*—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 as indicated below, in accordance with the rounding method of Practice E 29:

| Test | Rounded Unit for Observed or Calculated Value |
|--|--|
| Chemical composition 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 followed only by zeros, choose the one ending in an even digit with zero defined as an even digit. |
| Tensile strength, yield strength | nearest 1000 psi (6.9 MPa) |
| Elongation | nearest 1 % |

13. Inspection

13.1 Inspection of the material shall be agreed upon between the purchaser and the supplier 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 producer or supplier promptly and in writing. In case of dissatisfaction with the results of the test, the producer 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 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 information 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, heat number, condition (temper), this specification number, the size, gross, tare and net weight, consignor and consignee address, contract or order number, or such other information as may be defined in the contract or order.