



Standard Specification for Iron-Nickel-Chromium-Molybdenum Alloys (UNS N08366 and UNS N08367) Seamless Pipe and Tube¹

This standard is issued under the fixed designation B 690; 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 iron-nickel-chromium-molybdenum alloys (UNS N08366 and UNS N08367)* cold-finished annealed or hot-finished annealed seamless pipe and tube intended for use in special corrosive service and for heat-resisting applications.

1.2 Pipe and tube shall be supplied in the solution heat treated and descaled condition. When bright annealing is used, descaling is not necessary.

1.3 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.4 The following safety hazards caveat pertains only to the test method portion, Section 12, 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

A 450/A 450M Specification for General Requirements for Carbon, Ferritic Alloy, and Austenitic Alloy Steel Tubes

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 Nov. 1, 2007. Published November 2007. Originally approved in 1981. Last previous edition approved in 2002 as B 690 – 02.

* New designation established in accordance with ASTM E 527 and SAE S1086, Practice for Numbering Metals and Alloys (UNS).

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.

B 880 Specification for General Requirements for Chemical Check Analysis Limits for Nickel, Nickel Alloys and Cobalt Alloys

E 8 Test Methods for Tension Testing of Metallic Materials

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E 1473 Test Methods for Chemical Analysis of Nickel, Cobalt, and High-Temperature Alloys

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

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

3.1.2 *pipe, n*—seamless tube conforming to the particular dimensions commercially known as standard pipe (**Appendix X1**).

3.1.3 *tube, n*—hollow product of round or any other cross section having a continuous periphery.

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 Quantity (feet, metres, or number of lengths),

4.1.2 Form (seamless tube or pipe),

4.1.3 Name of material or UNS number,

4.1.4 Finish,

4.1.5 Dimensions:

4.1.5.1 *Tube*—Outside diameter, minimum wall thickness,

4.1.5.2 *Pipe*—Standard pipe size and schedule (**Appendix X1**),

4.1.5.3 *Length*—Specified or random,

4.1.6 Certification, if required (**Section 15**),

4.1.7 Purchaser's inspection, if required, (**Section 13**),

4.1.8 ASTM designation and year of issue, and

4.1.9 Samples for product analysis, if required.

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 made by the purchaser, the material shall conform to the permissible variations for product (check) analysis in Specification [B 880](#).

6. Mechanical and Other Properties

6.1 The material shall conform to the mechanical property requirements specified in [Table 2](#).

6.2 Hydrostatic Test:

6.2.1 Each pipe or tube with an outside diameter $\frac{1}{8}$ in. (3.2 mm) and larger, or tubes with a 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 (68.9 kPa) provided that the fiber stress calculated in accordance with the following equation does not exceed the allowable fiber stress, S , indicated below:

$$S = (PD/2t) \quad (1)$$

where:

S = allowable fiber stress for material in cold-drawn condition, ($\frac{1}{4} \times$ UTS.) 16 700 psi (1150 kPa),

P = hydrostatic test pressure, psi (or kPa),

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

t = minimum wall thickness, in. (or mm), equal to the specified wall thickness minus the permissible “minus” wall tolerance, [Table 3](#), or the specified minimum wall thickness.

6.2.2 Any pipe or tube showing leaks during hydrostatic test shall be rejected.

6.2.3 When so agreed upon between the purchaser and manufacturer at the time of the purchase order, pipe or tube may be treated to $1\frac{1}{2}$ times the allowable fiber stress of S in [6.2.1](#).

6.2.4 When specified by the purchaser, a nondestructive electric test in accordance with Specification [A 450/A 450M](#) may be used in place of or in addition to, the hydrostatic test.

7. Dimensions and Permissible Variations

7.1 Outside Diameter and Wall Thickness:

TABLE 1 Chemical Requirements

| Element | Composition Limits, % | |
|-------------------|-----------------------|----------------|
| | N08366 | N08367 |
| Carbon | 0.035 max | 0.030 max |
| Manganese | 2.00 max | 2.00 max |
| Silicon | 1.00 max | 1.00 max |
| Phosphorus | 0.040 max | 0.040 max |
| Sulfur | 0.030 max | 0.030 max |
| Chromium | 20.00 to 22.00 | 20.00 to 22.00 |
| Nickel | 23.50 to 25.50 | 23.50 to 25.50 |
| Molybdenum | 6.00 to 7.00 | 6.00 to 7.00 |
| Nitrogen | ... | 0.18 to 0.25 |
| Iron ^A | remainder | remainder |
| Copper | | 0.75 max |

^A Iron shall be determined arithmetically by difference.

TABLE 2 Mechanical Properties of Pipe and Tube

| | Cold-Worked Annealed N08366 | Hot-Worked Annealed N08366 | Cold-Worked or Hot- Worked Annealed N08367 | |
|--|--------------------------------|----------------------------------|--|----------------------|
| | | | $\leq \frac{3}{16}$ | $> \frac{3}{16}$ |
| Tensile strength, min, ksi (MPa) | 75 (517) | 75 (517) | | |
| Yield strength, 0.2 % offset, min, ksi (MPa) | 30 (206) | 30 (206) | 100 (670) 45 (310) | 95 (655) 45 (310) |
| Elongation in 2 in. or 50 mm, or 4D, min,% | 30 | 30 | 30 | 30 |

TABLE 3 Permissible Variations in Outside Diameter^A Tube

| Outside Diameter, in. (mm) | Permissible Variations, in. (mm) | |
|--|----------------------------------|----------------------|
| | Plus | Minus |
| Hot-Finished Seamless Tubes | | |
| 4 (101.6) and under | $\frac{1}{64}$ (0.4) | $\frac{1}{32}$ (0.8) |
| Over 4 (101.6) to $7\frac{1}{2}$ (190.5) incl | $\frac{1}{64}$ (0.4) | $\frac{3}{64}$ (1.2) |
| Over $7\frac{1}{2}$ (190.5) to 9 (228.6) incl | $\frac{1}{64}$ (0.4) | $\frac{1}{16}$ (1.6) |
| Cold-Finished Seamless Tubes | | |
| Under $2\frac{1}{2}$ (63.5) | 0.010 (0.25) | 0.010 (0.25) |
| $2\frac{1}{2}$ (63.5) to 3 (76.2), excl | 0.012 (0.30) | 0.012 (0.30) |
| 3 (76.2) to 4 (101.6), incl | 0.015 (0.38) | 0.015 (0.38) |
| Over 4 (101.6) to $7\frac{1}{2}$ (190.5), incl | 0.015 (0.38) | 0.025 (0.64) |
| Over $7\frac{1}{2}$ (190.5) to 9 (228.6), incl | 0.015 (0.38) | 0.045 (1.14) |

^A These permissible variations include out-of-roundness. These permissible variations in outside diameter apply to hot-finished seamless, and cold-drawn seamless tubes before other fabricating operations such as upsetting, swaging, expanding, bending, or polishing.

7.1.1 The permissible variations in the outside diameter and wall thickness of pipe and tube shall not exceed those specified in [Table 3](#), [Table 4](#), and [Table 5](#).

7.1.2 Permissible variations given in [Table 3](#), [Table 4](#), and [Table 5](#) are applicable only to two dimensions.

7.2 *Length*—When pipe or tube is ordered cut-to-length, the permissible variations in length shall be those specified in [Table 6](#) for tubes; the permissible variation in length for pipe shall be plus $\frac{1}{4}$ in. (6.4 mm), minus 0 in.

TABLE 4 Permissible Variations in Outside Diameter, Pipe

| Nominal Pipe Size in. (mm) | Permissible Variations in Outside Diameter | | | |
|---|--|-----|----------------|-----|
| | Plus | | Minus | |
| | in. | mm | in. | mm |
| $\frac{1}{8}$ (3.2) to $1\frac{1}{2}$ (38.1) incl | $\frac{1}{64}$ | 0.4 | $\frac{1}{32}$ | 0.8 |
| Over $1\frac{1}{2}$ (38.1) to 4 (101.6) incl | $\frac{1}{32}$ | 0.8 | $\frac{1}{32}$ | 0.8 |
| Over 4 (101.6) to 8 (203.2) incl | $\frac{1}{16}$ | 1.6 | $\frac{1}{32}$ | 0.8 |
| Over 8 (203.2) to 18 (457.2) incl | $\frac{3}{32}$ | 2.4 | $\frac{1}{32}$ | 0.8 |
| Over 18 (457.2) to 26 (660.4) incl | $\frac{1}{8}$ | 3.2 | $\frac{1}{32}$ | 0.8 |
| Over 26 (660.4) to 34 (863.6) incl | $\frac{5}{32}$ | 4.0 | $\frac{1}{32}$ | 0.8 |
| Over 34 (863.6) to 48 (1219.2) incl | $\frac{3}{16}$ | 4.8 | $\frac{1}{32}$ | 0.8 |

TABLE 5 Permissible Variations in Wall Thickness^A—Tube

| Outside Diameter, in. (mm) | Wall Thickness, % | | | | | | | |
|-------------------------------|-----------------------------------|-------|---|-------|---|-------|------------------------------|-------|
| | 0.095 (2.7) in. (mm) and Under | | Over 0.095 (2.7) to 0.150 (3.8) in. (mm), incl | | Over 0.150 (3.8) to 0.180 (4.6) in. (mm), incl | | Over 0.180 (4.6) in. (mm) | |
| | Plus | Minus | Plus | Minus | Plus | Minus | Plus | Minus |
| Seamless, Hot-Finished Tubes | | | | | | | | |
| 4 (101.6) and under | 40 | 0 | 35 | 0 | 33 | 0 | 28 | 0 |
| Over 4 (101.6) | ... | ... | 35 | 0 | 33 | 0 | 28 | 0 |
| Seamless, Cold-Finished Tubes | | | | | | | | |
| Plus | | | | | | | | |
| 1½ (38.1) and under | | | | | Minus | | | |
| Over 1½ (38.1) | | | | | 0 | | | |

^A These permissible variations in wall thickness apply only to tubes, except internal-upset tubes, as rolled or drawn, and before swaging, expanding, bending, polishing, or other fabricating operations.

TABLE 6 Permissible Variations in Length^A—Tube

| Method of Manufacture | Outside Diameter, in. (mm) | Cut Length, in. (mm) | |
|--------------------------|-------------------------------|----------------------|-------|
| | | Plus | Minus |
| Seamless, hot-finished | all sizes | 3/16 (4.8) | 0 |
| Seamless, cold-finished | under 2 (50.8) | 1/8 (3.2) | 0 |
| | 2 (50.8) and over | 3/16 (4.8) | 0 |

^A These permissible variations in length apply to tubes before bending. They apply to cut lengths up to and including 24 ft (7.3 m). For lengths over 24 ft (7.3 m) 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 of 1/2 in. (12.7 mm).

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

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 Lots for mechanical testing and check analysis shall consist of the material from one heat, in the same condition (temper), and of the same specified size (excepting length) and cross section.

9.2 Test Material Selection:

9.2.1 Sampling for Chemical Analysis:

9.2.1.1 An analysis of each lot shall be made by the manufacturer from a representative sample obtained during the pouring of the heat or subsequent processing.

9.2.1.2 If samples for product (check) analysis are specified, a representative sample shall be taken from each lot (see 9.1.2) of finished material.

9.2.2 *Sampling for Mechanical Testing*—Samples of the material to provide test specimens for mechanical testing shall be taken from such locations in each lot (see 9.1.2) as to be representative of that lot.

10. Number of Tests and Retests

10.1 *Chemical Analysis*—One test per lot.

10.2 *Mechanical Tests—Tension tests*—One test per lot.

10.3 *Nondestructive Test*—Each piece in each lot (9.1.2).

10.4 *Retests*—If the specimen used in the mechanical test of any lot fails to meet the specified requirements, an additional specimen shall be taken from a different sample piece and tested. The results of this test specimen shall meet the specified requirements.

11. Specimen Preparation

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

11.2 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 largest possible round specimen prepared in accordance with Test Methods E 8, shall be used.

12. Test Methods

12.1 Determine the chemical composition and mechanical properties of the material, as enumerated in this specification, in the case of disagreement, in accordance with the following ASTM methods:

12.1.1 *Chemical Analysis*—Test Methods E 1473.

12.2 *Tension Test*—Test Methods E 8.

12.3 *Determination of Significant Places*—For purposes of determining compliance with the specified limits for the requirements of the properties listed in the following table, round an observed or a calculated value as indicated, in accordance with the rounding methods of Practice E 29.

| Requirement | Rounded Unit for Observed or Calculated Value |
|----------------------|--|
| Chemical composition | nearest unit in the last righthand place of figures of the specified limit |
| Tensile strength | nearest 1000 psi (7 MPa) |
| Yield strength | |
| Elongation | nearest 1 % |

13. Inspection

13.1 Inspection of the material shall be made 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 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 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.

16. Product Marking

16.1 *Material*—The name or brand of the manufacturer, the trade name of the material or UNS number, the letters ASTM, the specification number, heat number, and nominal size shall be legibly stenciled on each piece ½ in. (12.7 mm) and over in outside diameter, provided the length is not under 3 ft (914 mm). The material marking shall be any method which will not result in harmful contamination.

16.1.1 For material less than ½ in. (12.7 mm) in outside diameter and material under 3 ft (914 mm) in length, the

information specified in 16.1 shall be either stenciled or marked on a tag securely attached to the bundle or box in which the tube is shipped.

16.2 *Packaging*—Each bundle or shipping container shall be marked with the name or brand of the manufacturer, the trade name of the material or UNS number, the letters ASTM, the specification number, heat number, condition (temper), and nominal 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.

17. Keywords

17.1 seamless pipe; seamless tube; UNS N08367

APPENDIX

(Nonmandatory Information)

X1. SCHEDULES OF COLD-FINISHED SEAMLESS PIPE

X1.1 The schedules of cold-finished, seamless UNS N08366 pipe as given in Table X1.1 are regularly available. Other schedules may be furnished, and the manufacturer should be consulted. Table X1.1 is published for information only.

TABLE X1.1 Pipe Schedules^A

| Nominal Pipe Size | Outside Diameter | Nominal Wall Thickness | | | |
|-------------------|------------------|------------------------|-----------------|-----------------|-----------------|
| | | Schedule No. 5 | Schedule No. 10 | Schedule No. 40 | Schedule No. 80 |
| Inches | | | | | |
| ¼ | 0.540 | ... | 0.065 | 0.088 | ... |
| ⅜ | 0.675 | ... | 0.065 | 0.091 | 0.126 |
| ½ | 0.840 | 0.065 | 0.083 | 0.109 | 0.147 |
| ⅝ | 1.050 | 0.065 | 0.083 | 0.113 | 0.154 |
| 1 | 1.315 | 0.065 | 0.109 | 0.133 | 0.179 |
| 1¼ | 1.660 | 0.065 | 0.109 | 0.140 | 0.191 |
| 1½ | 1.900 | 0.065 | 0.109 | 0.145 | 0.200 |
| 2 | 2.375 | 0.065 | 0.109 | 0.154 | 0.218 |
| 1½ | 2.875 | 0.083 | 0.120 | 0.203 | 0.276 |
| 3 | 3.500 | 0.083 | 0.120 | 0.216 | 0.300 |
| 3½ | 4.000 | 0.083 | 0.120 | 0.226 | 0.318 |
| 4 | 4.500 | 0.083 | 0.120 | 0.237 | 0.337 |
| 5 | 5.563 | ... | ... | 0.258 | ... |
| 6 | 6.625 | ... | ... | 0.280 | ... |
| Millimetres | | | | | |
| 6.4 | 13.72 | ... | 1.65 | 2.24 | ... |
| 9.5 | 17.14 | ... | 1.65 | 2.31 | 3.20 |
| 12.7 | 21.34 | 1.65 | 2.11 | 2.77 | 3.73 |
| 19.1 | 26.67 | 1.65 | 2.11 | 2.87 | 3.91 |
| 25.4 | 33.40 | 1.65 | 2.77 | 3.38 | 4.55 |
| 31.8 | 42.16 | 1.65 | 2.77 | 3.56 | 4.85 |
| 38.1 | 48.26 | 1.65 | 2.77 | 3.68 | 5.08 |
| 50.8 | 60.32 | 1.65 | 2.77 | 3.91 | 5.54 |
| 63.5 | 73.02 | 2.11 | 3.05 | 5.16 | 7.04 |
| 76.2 | 88.90 | 2.11 | 3.05 | 5.49 | 7.62 |
| 88.9 | 101.60 | 2.11 | 3.05 | 5.74 | 8.08 |
| 101.6 | 114.30 | 2.11 | 3.05 | 6.02 | 8.56 |
| 127.0 | 141.30 | ... | ... | 6.55 | ... |
| 152.4 | 168.28 | ... | ... | 7.11 | ... |

^A The pipe schedules shown above conform with standards adopted by the American National Standards Institute.

 **B 690 – 02 (2007)**

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org).