



Standard Specification for General Requirements for Nickel and Nickel Alloys Seamless Pipe and Tube¹

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1. Scope

1.1 This specification contains various requirements that, with the exception of Sections 5 and 10, are mandatory requirements to the following ASTM nickel and nickel alloy, seamless pipe and tube specifications:

Title of Specification	ASTM Designation ²
Nickel Seamless Pipe and Tube	B 161
Seamless Nickel and Nickel Alloy, Condenser and Heat Exchanger Tubes	B 163
Nickel-Copper Alloy (UNS N04400) Seamless Pipe and Tube	B 165
Nickel-Chromium-Iron Alloys (UNS N06600, N06601, and N06690) Seamless Pipe and Tube	B 167
Nickel-Iron-Chromium Alloy Seamless Pipe and Tube	B 407
Nickel-Iron-Chromium-Molybdenum-Copper Alloy (UNS N08825 and N08221) Seamless Pipe and Tube	B 423
Nickel-Chromium-Molybdenum-Columbium Alloys (UNS N06625) Pipe and Tube	B 444
Nickel-Chromium-Iron-Columbium-Molybdenum-Tungsten Alloy (UNS N06102) Seamless Pipe and Tube	B 445
Nickel-Iron-Chromium-Silicon Alloys (UNS N08330 and UNS N08332) Seamless Pipe	B 535
Copper-Beryllium Alloy Forgings and Extrusion	B 570
Seamless Nickel and Nickel-Cobalt Alloy Pipe and Tube	B 622
UNS N08028 Seamless Tubes	B 668
UNS N08904, UNS N08925 and UNS N08926 Seamless Pipe and Tube	B 677
Iron-Nickel-Chromium-Molybdenum Alloys (UNS N08366 and UNS N08367) Seamless Pipe and Tube	B 690
Ni-Cr-Mo-Co-W-Fe-Si Alloy (UNS N06333) Seamless Pipe and Tube	B 722
Seamless UNS N08020, UNS N08026, and UNS N08024 Nickel-Alloy Pipe and Tube	B 729

1.2 One or more of the test requirements of Section 5 apply only if specifically stated in the product specification or in the purchase order.

1.3 In case of conflict between a requirement of the product specification and a requirement of this general specification, only the requirement of the product specification needs to be satisfied.

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 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.

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

1.5 The following safety hazards caveat pertains only to the test requirements portion, Section 5, 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:²

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 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials

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

E 39 Methods for Chemical Analysis of Nickel³

E 76 Test Methods for Chemical Analysis of Nickel-Copper Alloys³

E 112 Test Methods for Determining the Average Grain Size

E 213 Practice for Ultrasonic Examination of Metal Pipe and Tubing

E 426 Practice for Electromagnetic (Eddy-Current) Examination of Seamless and Welded Tubular Products, Austenitic Stainless Steel and Similar Alloys

E 571 Practice for Electromagnetic (Eddy-Current) Examination of Nickel and Nickel Alloy Tubular Products

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

2.2 ANSI Standards:⁴

B 1.20.1 Pipe Threads

B 36.10 Welded and Seamless Wrought Steel Pipe

B 36.19 Stainless Steel Pipe

³ Withdrawn.

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.



3. Terminology

3.1 Definitions:

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

3.1.2 *nominal wall, n*—a specified wall thickness with a plus or minus tolerance from the specified thickness.

3.1.3 *seamless pipe, n*—a round hollow produced with a continuous periphery in all stages of manufacture, and produced to the particular dimensions commercially known as pipe sizes (NPS).

3.1.4 *seamless tube, n*—a tube produced with a continuous periphery in all stages of the operation.

3.1.5 *thin wall tube, n*—tube with specified wall thickness 3 % or less of the specified outside diameter.

4. Chemical Composition

4.1 In case of disagreement, the chemical composition shall be determined in accordance with the following methods.

UNS No. Prefixes	ASTM Method
N02	E 39
N04	E 76
N06, N08	E 1473

4.2 The ladle analysis of the material shall conform to the chemical requirements prescribed by the individual product specification.

4.3 The product (check) analysis of the material shall meet the requirements for the ladle analysis within the tolerance limits prescribed in B 880.

5. Test Requirements

5.1 *Flare Test*—The flare test shall consist of flaring a test specimen with an expanding tool having an included angle of 60° until the specified outside diameter has been increased by 30 %. The flared specimen shall not exhibit cracking through the wall.

5.2 *Hydrostatic Test*— Each pipe or tube shall be tested by the manufacturer to an internal hydrostatic pressure of 1000 psi (6.9 MPa) provided that the fiber stress, calculated from the following equation, does not exceed the allowable fiber stress for the material:

$$P = 2St/D \quad (1)$$

where:

P = hydrostatic test pressure, psi (MPa),

S = allowable fiber stress, for material in the condition (temper) furnished as specified in the product specification (S is calculated as the lower of $\frac{2}{3}$ of the specified minimum 0.2 % offset yield strength or $\frac{1}{4}$ of the specified minimum ultimate strength for the material),

t = minimum wall thickness permitted, in. (mm), including minus tolerance, if any, and

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

5.2.1 The test pressure must be held for a minimum of 5 s.

NOTE 1—Testing at a pressure greater than 1000 psi may be performed upon agreement between purchaser and manufacturer provided that the allowable fiber stress is not exceeded.

5.2.2 If any pipe or tube shows leaks during hydrostatic testing, it shall be rejected.

5.3 Nondestructive Electric Test:

5.3.1 *Eddy Current Testing*—Testing shall be conducted in accordance with Practices E 426 or E 571. The eddy current examination reference in this specification has the capability of detecting significant discontinuities, especially of the short, abrupt type.

5.3.1.1 Unless otherwise specified by the purchaser, the calibration standard shall contain, at the option of the manufacturer, any one of the following discontinuities to establish a minimum sensitivity level for rejection.

5.3.1.2 *Drill Hole*—A hole not larger than 0.031 in. (0.79 mm) diameter shall be drilled radially and completely through the wall, care being taken to avoid distortion of the material while drilling.

5.3.1.3 *Transverse Tangential Notch*—Using a round file or tool with a $\frac{1}{4}$ in. (6 mm) diameter, a notch shall be filed or milled on the tube or pipe outside diameter tangential to the surface and transverse to the longitudinal axis of the material. Said notch shall have a depth not exceeding 12.5 % of the specified wall thickness of the material, or 0.004 in. (0.10 mm), whichever is greater.

5.3.2 *Ultrasonic Testing*—Testing shall be conducted in accordance with Practice E 213. The ultrasonic examination referred to in this specification is intended to detect longitudinal discontinuities having a reflective area similar to or larger than the calibration reference notches specified in 5.3.2.1. The examination may not detect circumferentially oriented imperfections or short, deep defects.

5.3.2.1 For ultrasonic testing, longitudinal calibration notches shall be machined on the outside and inside diameter surfaces. The depth of the notches shall not exceed 12.5 % of the specified wall thickness or 0.004 in. (0.10 mm), whichever is greater.

5.3.3 *Calibration Frequency*—The frequency of calibration checks shall be as follows:

5.3.3.1 At the beginning of each production run or lot.

5.3.3.2 At least every four hours during testing.

5.3.3.3 At the end of each production run or lot.

5.3.3.4 After any suspected equipment malfunction or work stoppage.

5.3.3.5 If, during any check, the equipment fails to detect the calibration defects, the instrument must be recalibrated and all material tested since the last satisfactory check shall be retested.

5.3.4 *Acceptance and Rejection*—Material producing a signal equal to or greater than the calibration defect shall be subject to rejection.

5.3.4.1 Test signals produced by imperfections that cannot be identified or produced by cracks or crack-like imperfections shall result in rejection of the pipe or tube, subject to rework and retest.

5.3.4.2 If the imperfection is judged as not fit for use, the tube shall be rejected, but may be reconditioned and retested providing the wall thickness requirements are met. To be accepted, retested material shall meet the original electric test requirements.



5.3.4.3 If the imperfection is explored to the extent that it can be identified, and the pipe or tube is determined to be fit for use, the material may be accepted without further testing, providing the imperfection does not encroach on minimum wall thickness requirements.

5.4 When specified by the purchaser, a nondestructive electric test, in accordance with Practices E 213, E 426, or E 571, may be used for seamless pipe or tube, instead of the hydrostatic test.

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

5.5.1 The material shall conform to the tensile properties prescribed in the individual product specification.

5.6 *Hardness Test*— Hardness testing shall be conducted in accordance with Test Methods E 18.

5.7 *Grain Size*—The measurement of average grain size may be carried out by the planimetric method, the comparison method, or the intercept method described in Test Methods E 112. In case of dispute, the “referee” method for determining average grain size shall be the intercept method.

5.8 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 in accordance with the rounding method of Practice E 29:

Requirements	Rounded Unit for Observed or Calculated Value
Chemical composition and tolerances	nearest unit in the last right-hand place of figures of the specified limit
Tensile strength and yield strength	nearest 1000 psi (7 MPa)
Elongation	nearest 1 %
Grain size	
0.0024 in. (0.060 mm) or larger	nearest multiple of 0.0002 in. (0.005 mm)
Less than 0.0024 in. (0.060 mm)	nearest multiple of 0.0001 in. (0.002 mm)

6. Dimensions and Permissible Variations

6.1 Dimensions of pipe are shown in Table 1.

6.1.1 Permissible variations in outside diameter and wall thickness are shown in Table 2, Table 3, and Table 4.

6.2 *Length*—When material is ordered as cut-to-length, the length shall conform to the permissible variations prescribed in Table 5. When material is ordered to random lengths, the lengths and variations shall be agreed upon between the manufacturer and purchaser.

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

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

7. Workmanship, Finish, and Appearance

7.1 The material shall be uniform in quality and temper, smooth, and free from imperfections that would render it unfit for use.

TABLE 1 Dimensions of Pipe

NOTE 1—The following table is a reprint of Table 1 of ANSI B36.19.

NOTE 2—The decimal thicknesses listed for the respective pipe sizes represent their nominal wall dimensions.

NPS Designator	Outside Diameter		Nominal Wall Thickness							
	in.	mm	Schedule 5S ^A		Schedule 10S ^A		Schedule 40S		Schedule 80S	
			in.	mm	in.	mm	in.	mm	in.	mm
1/8	0.405	10.29	...	...	0.049	1.24	0.068	1.73	0.095	2.41
1/4	0.540	13.72	...	...	0.065	1.65	0.088	2.24	0.119	3.02
3/8	0.675	17.15	...	...	0.065	1.65	0.091	2.31	0.126	3.20
1/2	0.840	21.34	0.065	1.65	0.083	2.11	0.109	2.77	0.147	3.73
3/4	1.050	26.67	0.065	1.65	0.083	2.11	0.113	2.87	0.154	3.91
1.0	1.315	33.40	0.065	1.65	0.109	2.77	0.133	3.38	0.179	4.55
1 1/4	1.660	42.16	0.065	1.65	0.109	2.77	0.140	3.56	0.191	4.85
1 1/2	1.900	48.26	0.065	1.65	0.109	2.77	0.145	3.68	0.200	5.08
2	2.375	60.33	0.065	1.65	0.109	2.77	0.154	3.91	0.218	5.54
2 1/2	2.875	73.03	0.083	2.11	0.120	3.05	0.203	5.16	0.276	7.01
3	3.500	88.90	0.083	2.11	0.120	3.05	0.216	5.49	0.300	7.62
3 1/2	4.000	101.60	0.083	2.11	0.120	3.05	0.226	5.74	0.318	8.08
4	4.500	114.30	0.083	2.11	0.120	3.05	0.237	6.02	0.337	8.56
5	5.563	141.30	0.109	2.77	0.134	3.40	0.258	6.55	0.375	9.52
6	6.625	168.28	0.109	2.77	0.134	3.40	0.280	7.11	0.432	10.97
8	8.625	219.08	0.109	2.77	0.148	3.76	0.322	8.18	0.500	12.70
10	10.750	273.05	0.134	3.40	0.165	4.19	0.365	9.27	0.500 ^B	12.70 ^B
12	12.750	323.85	0.156	3.96	0.180	4.57	0.375 ^B	9.52 ^B	0.500 ^B	12.70 ^B
14	14.000	355.60	0.156	3.96	0.188 ^B	4.78 ^B	...	...	...	...
16	16.000	406.40	0.165	4.19	0.188 ^B	4.78 ^B	...	...	...	...
18	18.000	457.20	0.165	4.19	0.188 ^B	4.78 ^B	...	...	...	...
20	20.000	508.00	0.188	4.78	0.218 ^B	5.54 ^B	...	...	...	...
22	22.000	558.80	0.188	4.78	0.218 ^B	5.54 ^B	...	...	...	...
24	24.000	609.60	0.218	5.54	0.250	6.35	...	...	...	...
30	30.000	762.00	0.250	6.35	0.312	7.92	...	...	...	...

^ASchedules 5S and 10S wall thicknesses do not permit threading in accordance with ANSI B1.20.1.

^BThese do not conform to ANSI B36.10.

**TABLE 2 Permissible Variations for Outside Diameter and Wall Thickness of Seamless Cold-Worked Pipe and Tube^{A,B}**

Nominal Outside Diameter, in. (mm)	Permissible Variations				Thickness of Specified Minimum Wall, %	
	Outside Diameter, in. (mm)		Thickness of Specified Nominal Wall, %		Plus	Minus
	Plus	Minus	Plus	Minus		
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

^A*Ovality*—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.

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

TABLE 3 Permissible Variations for Outside Diameter and Wall Thickness of Hot-Finished Tube^A

Nominal Outside Diameter, in. (mm)	Permissible Variations				Thickness of Specified Minimum Wall, %	
	Outside Diameter or Inside Diameter, in. (mm)		% of Thickness of Specified Nominal Wall		Plus	Minus
	+	–	+	–		
3/4 (19) to 1 1/2 (38), incl	0.015 (0.4)	0.031 (0.8)	12.5	12.5	28.5	0
Over 1 1/2 (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 9 1/4 (235), incl	0.062 (1.6)	0.031 (0.8)	12.5	12.5	28.5	0

^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 over 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 4 Permissible Variations for Outside Diameter and Wall Thickness of Seamless Hot-Worked Pipe^{A,B}

Nominal Outside Diameter, in. (mm)	Permissible Variations				Thickness of Specified Minimum Wall, %	
	Outside Diameter, in. (mm)		Thickness of Specified Nominal Wall, %		Plus	Minus
	Plus	Minus	Plus	Minus		
1 (25) to 1.900 (48), incl	0.015 (0.40)	0.31 (0.79)	16.0	12.5	28.5	0
over 1.900 (48) to 4 1/2 (114), incl	0.031 (0.79)	0.031 (0.79)	16.0	12.5	28.5	0
over 4 1/2 (114) to 6 1/2 (165), incl	0.047 (1.2)	0.047 (1.2)	16.0	12.5	28.5	0
over 6 1/2 (165) to 9 1/4 (235), incl	0.062 (1.6)	0.062 (1.6)	16.0	12.5	28.5	0

^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.

TABLE 5 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 m) or fraction thereof shall be permissible up to a maximum additional over-tolerance of 1/2 in. (12.7 mm).

8. Sampling

8.1 Lot Definition:

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

8.1.2 A lot for all other testing shall consist of all material from the same heat, nominal size (excepting length), and condition (temper). When final heat treatment is in a batch-type furnace, a lot shall include only those pipes or tubes of the same size and the same heat that are heat-treated in the same furnace charge. When heat treatment is in a continuous

furnace, a lot shall include all pipes or tubes of the same size and heat, heat-treated in the same furnace at the same temperature, time at temperature, and furnace speed during one production run. At no time shall a lot consist of more than 20 000 lb (9100 kg).

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

NOTE 2—For tension, hardness, grain size, and flare test requirements, the term lot applies to all lengths prior to cutting.

8.2 Test Material Selection:

8.2.1 *Chemical Analysis*—Representative samples from each lot shall be taken during pouring or subsequent processing.

8.2.2 *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 (temper).

9. Retests and Retreatment

9.1 *Retests*—If the results of the mechanical tests of any group or lot do not conform to the requirements specified in the individual specification, retests may be made on additional tubes of double the original number from the same group or lot, each of which shall conform to the requirements specified.

9.2 *Retreatment*— If the individual pipes/tubes or the material selected to represent any lot fail to conform to the test requirements, the individual pipes/tubes or the lot represented may be reheat treated and resubmitted for test. Not more than two reheat treatments shall be permitted.

10. Specimen Preparation

10.1 Room Temperature Tensile Specimen:

10.1.1 Material shall be tested in the direction of fabrication. Whenever possible, the pipe or tube shall be tested in full cross section. When testing in full section is not possible, longitudinal strip specimens or the largest possible round section shall be used. In the event of disagreement when full section testing is not possible, a longitudinal strip specimen with reduced gage length as contained in Test Methods E 8 shall be used.

10.2 Hardness Specimen:

10.2.1 The hardness specimen shall be prepared in accordance with Test Methods E 18. The test shall be made on the inside diameter surface of a specimen cut from the end, or on the inside of the pipe near the end, at the option of the manufacturer.

10.3 Grain Size:

10.3.1 If required, the grain size specimen shall be a transverse sample representing full wall thickness.

11. Inspection

11.1 Witnessing of testing or inspection by the purchaser's representative shall be agreed upon by the purchaser and the manufacturer as part of the purchase contract.

12. Rejection and Rehearing

12.1 Material tested by the purchaser that fails to conform to the requirements of this specification may be rejected. Rejection

should be reported to the 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.

13. Certification

13.1 When specified in the purchase contract, a manufacturer's certification shall be furnished to the purchaser stating that the 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 contract, a report of the test results shall be furnished.

14. Product Marking

14.1 Material Marking:

14.1.1 The name or brand of the manufacturer, the name of the material or UNS number, the letters ASTM, the product specification number, heat number, class (if applicable) and nominal size shall be legibly marked on each piece $\frac{3}{4}$ in. (19.0 mm) outside diameter and larger and lengths greater than 3 ft (914 mm). The material marking shall be by any method that will not result in harmful contamination.

14.1.2 For material smaller than $\frac{3}{4}$ in. (19.0 mm) outside diameter, or lengths under 3 ft (914 mm), the information specified in 14.1.1 shall be legibly marked on each piece or marked, at the option of the manufacturer, on a tag securely attached to the bundle or box in which the material is shipped.

15. Packaging and Package Marking

15.1 The following information shall be marked on the material or included on the package, or on a label or tag attached thereto: name of the material or UNS number, heat number, condition (temper), the letters ASTM, the product specification number, the nominal pipe size, gross, tare, and net weight, consignor and consignee addresses, contract or order number, and such other information as may be defined by the purchase contract.

16. Keywords

16.1 cold worked; hot finished; nickel; nickel alloys; seamless pipe; seamless tube

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