



Standard Specification for Nickel-Iron-Chromium Alloy Seamless Pipe and Tube¹

This standard is issued under the fixed designation B 407; 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 specification² covers UNS N08120, UNS N08800, UNS N08801, UNS N08810, UNS N08811, UNS N08890, and UNS N06811 in the form of cold-worked and hot-finished annealed seamless pipe and tube. Alloys UNS N08800 and UNS N06811 are normally employed in service temperatures up to and including 1100°F (593°C). Alloys UNS N08120, UNS N08810, UNS N08811, and UNS N08890 are normally employed in service temperatures above 1100°F (593°C) where resistance to creep and rupture is required, and they are annealed to develop controlled grain size for optimum properties in this temperature range.

1.2 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.

1.3 The following safety hazards caveat pertains only to the test method portion, Section 7, 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.*

2. Referenced Documents

2.1 ASTM Standards:³

B 829 Specification for General Requirements for Nickel and Nickel Alloys Seamless Pipe and Tube

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 ASME Boiler and Pressure Vessel Code applications see related Specification SB-407 in Section II of that Code.

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.

E 140 Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, and Scleroscope Hardness

3. General Requirements

3.1 Material furnished under this specification shall conform to the applicable requirements of Specification **B 829** unless otherwise specified herein.

4. Ordering Information

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

4.1.1 Alloy (**Table 1**).

4.1.2 Condition Temper (**Table 2** and **Table X3.1**, and **Appendix X2** and **Appendix X3**).

4.1.3 Finish (**Table X1.1** and **Table X3.2**).

4.1.4 *Dimensions*:

4.1.4.1 *Tube*—May be specified in two dimensions only (length excepted) as follows: Outside diameter and average or minimum wall, inside diameter and average wall, or outside diameter and inside diameter.

NOTE 1—Tube produced to outside diameter and minimum wall may be furnished upon agreement between the manufacturer and the purchaser.

4.1.4.2 *Pipe*—Standard pipe size and schedule (**Table X3.1**).

4.1.5 *Fabrication Details*—Not mandatory but helpful to the manufacturer:

4.1.5.1 Cold Bending or Coiling.

4.1.5.2 Hot Forming.

4.1.5.3 *Welding or Brazing*—Process to be employed.

4.1.5.4 *Pressure Requirements*—Test pressure if other than required by **7.3**.

4.1.5.5 *Machining*—Indicate finished size and length in which to be machined and whether to be chucked to outside diameter or inside diameter.

4.1.5.6 *Ends*—Plain ends cut and deburred will be furnished. If threaded ends or ends beveled for welding are desired, give details.

4.1.6 *Certification*—State if certification or a report of test results is required.

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

TABLE 1 Chemical Requirements

Element	Composition Limits, %				
	UNS N08120	UNS N08800, UNS N08810, and UNS N08811	UNS N08801	UNS N08890	UNS N06811
Nickel	35.0 min 39.0 max	30.0 min 35.0 max	30.0 min 34.0 max	40.0 min 45.0 max	38.0 min 46.0 max
Chromium	23.0 min 27.0 max	19.0 min 23.0 max	19.0 min 22.0 max	23.5 min 28.5 max	27.0 min 31.0 max
Iron	remainder	39.5 min ^A	39.5 min ^A	remainder	remainder
Manganese, max	1.5	1.5	1.5	1.5	2.0
Carbon	0.02 min 0.10 max	^B	0.10 max	0.06 min 0.14 max	0.03 max ...
Copper, max	0.5	0.75	0.5	0.75	...
Silicon	1.0	1.0	1.0	1.0 min 2.0 max	0.60 max ...
Sulfur, max	0.03	0.015	0.015	0.015	0.010
Aluminum ^C	0.40 max	0.15 min 0.60 max	...	0.05 min 0.60 max	...
Titanium ^C	0.20 max	0.15 min 0.60 max	0.75 min 1.50 max	0.15 min 0.60 max	...
Columbium	0.4 min 0.9 max	...	...	...	...
Molybdenum	2.50 max	...	...	1.0 min 2.0 max	0.50 min 1.50 max
Niobium	...	...	...	0.2 min 1.0 max	...
Tantalum	...	...	...	0.10 min 0.60 max	...
Phosphorus	0.040 max	...	...	...	0.030 max
Tungsten	2.50 max	...	...	...	...
Cobalt, max	3.0	...	...	...	...
Nitrogen	0.15 min 0.30 max	...	...	...	0.10 min 0.20 max
Boron	0.010 max	...	...	...	...

^A Iron shall be determined arithmetically by difference.

^B Alloy UNS N08800: 0.10 max. Alloy UNS N08810: 0.05–0.10. Alloy UNS N08811: 0.06–0.10.

^C Alloy UNS N08811: Al + Ti, 0.85–1.20.

TABLE 2 Mechanical Properties^A of Pipe and Tube

Alloy	Condition (Temper)	Tensile Strength, min, psi (MPa)	Yield Strength, (0.2 % offset), min, psi (MPa)	Elongation in 2 in. or 50 mm (or 4D), min, %
UNS N08120	hot-finished annealed or cold-worked annealed	90 000 (621)	40 000 (276)	30
UNS N08800	cold-worked annealed	75 000 (520)	30 000 (205)	30
UNS N08800	hot-finished annealed or hot-finished	65 000 (450)	25 000 (170)	30
UNS N08810 and UNS N08811	hot-finished annealed or cold-worked annealed	65 000 (450)	25 000 (170)	30
UNS N08801	hot-finished annealed or cold-worked annealed	65 000 (450)	25 000 (170)	30
UNS N08890	hot-finished annealed or cold-worked annealed	75 000 (520)	30 000 (205)	35
UNS N06811	hot-finished annealed or cold-worked annealed	85 000 (585)	35 000 (240)	30

^A For properties of small-diameter and light-wall tubing, see [Table X3.1](#).

4.1.7 *Samples for Product (Check) Analysis*—State whether samples for product (check) analysis should be furnished (6.2).

4.1.8 *Purchaser Inspection*—If the 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.

4.1.9 *Small-Diameter and Light-Wall Tube*—(Converter Sizes) ([Table X3.2](#)).

4.1.10 *Optional Requirement*—Hydrostatic or Nondestructive Electric Test (see 7.3).

5. Materials and Manufacture

5.1 *Heat Treatment*—The final heat treatment of UNS N08120 shall be 2150°F (1177°C) minimum, UNS N08810,

2050°F (1121°C) minimum, UNS N08811, UNS N08890, 2100°F (1149°C) minimum, and UNS N06811, 1920°F (1050°C) minimum.

6. Chemical Composition

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

6.2 If a product (check) analysis is performed by the purchaser, the material shall conform to the product (check) analysis variations in Specification [B 829](#).

7. Mechanical Properties and Other Requirements

7.1 *Mechanical Properties*—The material shall conform to the mechanical properties specified in [Table 2](#).

7.2 *Grain Size*—Annealed UNS Alloys N08120, N08810, N08811, and UNS N08890 shall conform to an average grain size of ASTM No. 5 or coarser.

7.3 *Hydrostatic Test or Nondestructive Electric Test*—Each pipe or tube shall be subjected to either the hydrostatic test or the nondestructive electric test. The type of test to be used shall be at the option of the manufacturer, unless otherwise specified in the purchase order.

7.4 *Annealing Temperature*—Alloy UNS N08120 shall be annealed at 2150°F (1177°C) minimum, and UNS N08810 at 2050°F (1120°C) minimum.

8. Dimensions and Permissible Variations

8.1 Diameter and Wall Thickness:

8.1.1 The permissible variations in the outside and inside diameter and wall thickness of pipe and tube shall not exceed those prescribed in **Table 3** and **Table X3.2**, as applicable.

8.1.2 Permissible variations given in **Table 3** and **Table X3.2** are applicable only to two dimensions. Thus, if outside diameter and wall are specified, the inside diameter may not conform to the permissible variations shown. Similarly, if

outside diameter and inside diameter are specified, the wall may not conform to the permissible variations shown.

8.2 *Length*—When pipe or tube is ordered cut-to-length, the length shall not be less than that specified, but a variation of $+1/8$ in. (3.2 mm) will be permitted for cold-worked material and $+3/16$ in. (4.8 mm) for hot-finished tube, except that for lengths over 30 ft (9.1 m), a variation of $+1/4$ in. (6.4 mm) will be permitted. For small-diameter and light-wall tube, material shall conform to the applicable requirements of **Table X3.2**.

8.3 *Straightness*—Cold-drawn material shall be reasonably straight and free of bends and kinks. For small-diameter and light-wall tube, material shall conform to the applicable requirements of **Table X3.2**. The camber (depth of chord) of hot-finished tube 5 in. (127 mm) in outside diameter and under shall not exceed 0.01 in./ft (0.8 mm/m). For sizes over 5 in. in outside diameter, the camber shall not exceed 0.015 in./ft (1.4 mm/m).

9. Number of Tests

9.1 *Chemical Analysis*—One test per lot.

9.2 *Mechanical Properties*—One test per lot.

TABLE 3 Permissible Variations in Outside and Inside Diameter and Wall Thickness (Average Wall)

Specified Outside Diameter or Calculated Nominal Outside Diameter (When Ordered to Inside Diameter and Average Wall)	Permissible Variations			
	Outside Diameter or Inside Diameter		Wall Thickness, %	
	+	−	+	−
Cold-Finished ^{A,B,C,D} Pipe and Tube				
Inches				
0.500 to 5/8, excl	0.005	0.005	15.0	15.0
5/8 to 1 1/2, incl	0.0075	0.0075	10.0	10.0
Over 1 1/2 to 3 1/2, incl	0.010	0.010	10.0	10.0
Over 3 1/2 to 4 1/2, incl	0.015	0.015	10.0	10.0
Over 4 1/2 to 6, incl	0.020	0.020	12.5	12.5
Over 6 to 6 3/8, incl	0.025	0.025	12.5	12.5
Millimetres				
12.7 to 15.8, excl	0.127	0.127	15.0	15.0
15.8 to 38.1, incl	0.190	0.190	10.0	10.0
Over 38.1 to 88.9, incl	0.254	0.254	10.0	10.0
Over 88.9 to 114.3, incl	0.381	0.381	10.0	10.0
Over 114.3 to 152.4, incl	0.508	0.508	12.5	12.5
Over 152.4 to 168.3, incl	0.635	0.635	12.5	12.5
Hot-Finished Tube ^{E,F,G,H}				
Inches				
2 1/2 to 5 1/2, excl	0.031	0.031	12.5	12.5
5 1/2 to 9 1/4, incl	0.047	0.047	12.5	12.5
Millimetres				
63.5 to 139.7, excl	0.787	0.787	12.5	12.5
139.7 to 234.9, incl	1.19	1.19	12.5	12.5

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

1) *Thin-Wall Pipe and Tube*—For thin-wall pipe and tube having a nominal wall thickness of 3 % or less of the nominal outside diameter, in all conditions (temper), the mean outside diameter or mean inside diameter shall conform to the permissible variations of this table, and individual measurements (including ovality) shall conform to the plus and minus values of this table, with the values increased by 0.5 % of the nominal outside diameter.

2) *Annealed Pipe and Tube Over 4 1/2 in. (114.3 mm) in Nominal Outside Diameter*—For annealed pipe and tubing over 4 1/2 in. (114.3 mm) in nominal outside diameter with a nominal wall thickness greater than 3 % of the nominal outside diameter, the mean outside diameter or mean inside diameter shall conform to the permissible variations of this table, and individual measurements shall not exceed twice the permissible variations of this table.

^B For pipe and tube, in all tempers, with an inside diameter of less than 1/2 in. (12.70 mm) which cannot be successfully drawn over a mandrel, the inside diameter shall be governed by the outside diameter and the wall thickness variations.

^C For pipe and tube in all tempers with an inside diameter less than 50 % of the outside diameter, which cannot be successfully drawn over a mandrel, the inside diameter may vary over or under by an amount equal to 10 % of the nominal wall thickness and the wall thickness may vary ± 15 %.

^D *Eccentricity*—The variation in wall thickness in any one cross section of any one cold-finished pipe or tube shall not exceed ± 10 % of the actual (measured) average wall of that section (defined as the average of the thickest and the thinnest wall in that section).

^E For tube 5 in. (127.0 mm) and under in outside diameter the tolerance on the outside diameter applies for individual measurements and includes ovality. For tubes over 5 in. (127.0 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.

^F The diameter tolerances for tube with machined outside and inside diameters shall be $+0.031$ in. (0.787 mm), -0 for the outside diameter and $+0, -0.062$ in. (1.57 mm) for the inside diameter.

^G If tube is specified as minimum wall, the tolerance shall be $+28.5$ %, -0 .

^H The wall thickness tolerance includes eccentricity tolerance up to ± 12.5 %.

9.3 *Grain Size*—One test per lot.

9.4 *Hydrostatic or Nondestructive Electric Test*—Each piece per lot.

10. Keywords

10.1 seamless pipe; seamless tube; UNS N08120; UNS N08800; UNS N08801; UNS N08810; UNS N08811; UNS N08890; UNS N06811

APPENDIXES

(Nonmandatory Information)

X1. SCHEDULES OF COLD-DRAWN, SEAMLESS NICKEL-IRON-CHROMIUM ALLOY PIPE

X1.1 The schedules of cold-worked, seamless nickel-iron-chromium alloy 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
¾	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
2½	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					
6.35	13.72	...	1.65	2.24	...
9.52	17.14	...	1.65	2.31	3.20
12.70	21.34	1.65	2.11	2.77	3.73
19.05	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.

X2. CONDITIONS AND FINISHES NORMALLY SUPPLIED

X2.1 This appendix lists the conditions and finishes in which pipe and tube (other than converter sizes) are normally supplied. These are subject to change and the manufacturer should be consulted for the latest information available.

X2.2 Cold-Finished Tube and Pipe:

X2.2.1 *Cold-Finished, Annealed, with Ground Outside Diameter*—The inside diameter may have a bright finish when material is annealed in a protective atmosphere; otherwise, the inside diameter is supplied descaled as necessary. Available in sizes ½ to 4 in. (12.7 to 102 mm), inclusive, in outside diameter in both normal and heavy-wall tube, and pipe sizes, all schedules, of corresponding outside diameter dimensions.

X2.2.2 *Cold-Finished, Annealed, and Pickled (Not Ground)*—Outside and inside diameter will have dull, matte (pickled) surfaces. Available in sizes ½ to 6⅝ in. (12.7 to 168 mm), inclusive, in outside diameter in both normal and

heavy-wall tube, and pipe sizes, all schedules, of corresponding outside diameter dimensions.

X2.3 Hot-Finished Tube:

X2.3.1 *Hot-Finished, or Hot-Finished Annealed (Not Pickled) Tube*—Has an oxide surface resulting from the hot-finishing operation. Intended generally for machined parts where the oxide surface will be removed.

X2.3.2 *Hot-Finished, or Hot-Finished Annealed (Pickled) Tube*—Has the oxide surface removed on both outside and inside diameters by pickling. Surface may be spot ground for removal of minor surface imperfections at the manufacturer's option.

X2.3.3 *Hot-Finished, or Hot-Finished Annealed (Machined Outside and Inside Diameters) Tube*—The outside and inside diameter surfaces are machined to specified dimensions. Minor surface imperfections may be spot ground for removal, at the manufacturer's option.

X3. CONVERTER SIZES (ALLOY (UNS N08800) ONLY)

X3.1 Small diameter and light-wall tube in outside diameters 1¼ in. (31.8 mm) and under may be furnished in the following conditions or tempers shown in [Table X3.1](#) and [Table X3.2](#) when so specified. The material is furnished in a limited range of sizes and the manufacturer should be con-

sulted as to the various outside diameters and wall thicknesses that may be furnished. Material will have a bright finish. Such material shall conform to the applicable requirements for the conditions indicated in [Table X3.1](#) and [Table X3.2](#).

TABLE X3.1 Mechanical Properties^A of Small-Diameter and Light-Wall Tubing (Converter Sizes) (Alloy UNS N08800)

Material	Tensile Strength, min, psi (MPa)	Yield Strength (0.2 % offset), min, psi (MPa)	Elongation in 2 in. or 50 mm, min, %	Rockwell Hardness ^B (or Equivalent)
Annealed ^{C,D}	75 000 to 100 000 (520 to 690)	30 000 (205)	30	B95 max
Half-hard ^E	105 000 (725)	60 000 (415)	13	B93 to C26
Full-hard ^F	130 000 (895)	105 000 (725)	4	C24 to C38

^A Not applicable to outside diameters under ⅞ in. (3.18 mm) and to wall thickness under 0.015 in. (0.381 mm).

^B Hardness values, indicative of tensile strength, are shown for information only. All tests are subject to confirmation by tension tests. For hardness conversions see Hardness Conversion Tables [E 140](#).

^C This condition is sometimes designated as "No. 1 Temper."

^D The minimum tensile strength value applies only to tubing in straight lengths.

^E This condition is sometimes designated as "No. 2 Temper."

^F This condition is sometimes designated as "No. 3 Temper."

TABLE X3.2 Permissible Variations for Small-Diameter and Light-Wall Tube (Converter Sizes)^{A,B,C,D,E,F,G,H}

Specified Outside Diameter	Outside Diameter		Inside Diameter		Wall Thickness, %	
	+	-	+	-	+	-
Inches						
Under 3/32	0.002	0	0	0.002	10	10
3/32 to 3/16 (0.1875), excl	0.003	0	0	0.003	10	10
3/16 to 1/2 (0.500), excl	0.004	0	0	0.004	10	10
1/2 to 1 1/4 (1.250), incl	0.005	0	0	0.005	10	10
Millimetres						
Under 2.38	0.051	0	0	0.051	10	10
2.38 to 4.76, excl	0.076	0	0	0.076	10	10
4.76 to 12.70, excl	0.102	0	0	0.102	10	10
12.70 to 31.8, incl	0.127	0	0	0.127	10	10
Permissible Variations, in.						
Length, ft	Tube Size, in.	Permissible Variations, in.				
		Over	Under			
Under 1	up to 1.250, incl	1/32	0			
1 to 4, incl	up to 1.250, incl	1/16	0			
Over 4 to 10, incl	up to 1.250, incl	3/32	0			
Over 10	up to 1.250, incl	3/16	0			
Permissible Variations, mm						
Length, cm	Tube Size, mm	Permissible Variations, mm				
		Over	Under			
Under 30	up to 31.75, incl	0.794	0			
30 to 122, incl	up to 31.75, incl	1.59	0			
Over 122 to 300, incl	up to 31.75, incl	2.38	0			
Over 300	up to 31.75, incl	4.76	0			

^A Ovality, Normal Wall Tube:

Annealed (No. 1) Temper—Ovality will be held within 2 % of the theoretical average outside diameter.

^B Ovality, Light-Wall Tube:

Annealed (No. 1) Temper—Ovality will be held within 3 % of the theoretical average outside diameter.

^C *Wall Tolerances, Light-Wall Tube*—The plus and minus wall tolerance shown in the table shall apply down to and including 0.005 in. (0.12 mm) in wall thickness. For wall thicknesses less than 0.005 in. (0.1 mm) the tolerance shall be ± 0.0005 in. (0.0127 mm).

^D *Random Lengths*: Where nominal random lengths on tubing 1/8 in. (3.18 mm) and larger in outside diameter are specified, a length tolerance of $\pm 3\frac{1}{2}$ ft (106 cm) applies to the nominal length. This is a total spread of 7 ft (210 cm).

Random lengths in sizes 1/8 in. (3.18 mm) and larger in outside diameter shall be subject to a length range of 5 to 24 ft (150 to 730 cm). Long random lengths are subject to a range of 15 to 22 ft (457 to 670 cm).

Random lengths in sizes up to, but not including 1/8 in. (3.18 mm) in outside diameter, and fragile light-wall tubes over this outside diameter are subject to the length range of 1 to 15 ft (30 to 457 cm).

^E *Cut Lengths*—Tolerances on cut lengths shall be as follows:

^F *Straightness*—Round tubing is subject to a straightness tolerance of one part in 600 (equivalent to a depth of arc of 0.030 in. (0.762 mm) in any 3 ft (91 cm) of length).

^G *Eccentricity*—Eccentricity as defined in Table 3, Footnote D shall be limited to ± 10 % of the specified wall or calculated average wall.

^H When specified, the tolerance spreads of this table may be applied as desired. However, when not specified, the tolerances in this table will apply. It should be noted that inside diameter tolerances are based upon the outside diameter range.

SUMMARY OF CHANGES

Committee B02 has identified the location of selected changes to this standard since the last issue (B 407 - 08) that may impact the use of this standard. (Approved November 1, 2008.)

(1) Added Specification B 829 to Referenced Documents section, deleted information found in Specification B 829, and renumbered subsequent sections.

(2) Added allowance for ultrasonic testing as alternate nondestructive test method.

Committee B02 has identified the location of selected changes to this standard since the last issue (B 407 - 04) that may impact the use of this standard. (Approved March 1, 2008.)

(1) Revised chemistry of N06811 in Table 1.

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