



Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes¹

This standard is issued under the fixed designation A 312/A 312M; 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.

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

1. Scope

1.1 This specification² covers seamless, straight-seam welded, and heavily cold worked welded austenitic stainless steel pipe intended for high-temperature and general corrosive service.

NOTE 1—When the impact test criterion for a low-temperature service would be 15 ft-lbf [20 J] energy absorption or 15 mils [0.38 mm] lateral expansion, some of the austenitic stainless steel grades covered by this specification are accepted by certain pressure vessel or piping codes without the necessity of making the actual test. For example, Grades TP304, TP304L, and TP347 are accepted by the ASME Pressure Vessel Code, Section VIII Division 1, and by the Chemical Plant and Refinery Piping Code, ANSI B31.3, for service at temperatures as low as -425°F [-250°C] without qualification by impact tests. Other AISI stainless steel grades are usually accepted for service temperatures as low as -325°F [-200°C] without impact testing. Impact testing may, under certain circumstances, be required. For example, materials with chromium or nickel content outside the AISI ranges, and for material with carbon content exceeding 0.10 %, are required to be impact tested under the rules of ASME Section VIII Division 1 when service temperatures are lower than -50°F [-45°C].

1.2 Grades TP304H, TP309H, TP309HCb, TP310H, TP310HCb, TP316H, TP321H, TP347H, and TP348H are modifications of Grades TP304, TP309Cb, TP309S, TP310Cb, TP310S, TP316, TP321, TP347, and TP348, and are intended for high-temperature service.

1.3 Optional supplementary requirements are provided for pipe where a greater degree of testing is desired. These supplementary requirements call for additional tests to be made and, when desired, one or more of these may be specified in the order.

1.4 Table X1.1 lists the standardized dimensions of welded and seamless stainless steel pipe as shown in ANSI B36.19. These dimensions are also applicable to heavily cold worked pipe. Pipe having other dimensions may be furnished provided such pipe complies with all other requirements of this specification.

1.5 Grades TP321 and TP321H have lower strength require-

ments for pipe manufactured by the seamless process in nominal wall thicknesses greater than $\frac{3}{8}$ in. [9.5 mm].

1.6 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with the specification. The inch-pound units shall apply unless the “M” designation of this specification is specified in the order.

NOTE 2—The dimensionless designator NPS (nominal pipe size) has been substituted in this standard for such traditional terms as “nominal diameter,” “size,” and “nominal size.”

2. Referenced Documents

2.1 ASTM Standards:

A 262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels³

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products³

A 450/A 450M Specification for General Requirements for Carbon, Ferritic Alloy, and Austenitic Alloy Steel Tubes⁴

A 941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys⁴

A 999/A 999M Specification for General Requirements for Alloy and Stainless Steel Pipe⁴

E 112 Test Methods for Determining the Average Grain Size⁵

E 381 Method of Macroetch Testing Steel Bars, Billets, Blooms, and Forgings⁵

E 527 Practice for Numbering Metals and Alloys (UNS)⁴

2.2 ANSI Standards:⁶

B1.20.1 Pipe Threads, General Purpose

B36.10 Welded and Seamless Wrought Steel Pipe

B36.19 Stainless Steel Pipe

2.3 ASME Standard:

ASME Boiler and Pressure Vessel Code: Section VIII⁷

¹ This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel, and Related Alloys and is the direct responsibility of Subcommittee A01.10 on Stainless and Alloy Steel Tubular Products.

Current edition approved Apr. 10, 2001. Published September 2001. Originally published as A 312 – 48 T. Last previous edition A 312/A 312M – 00c.

² For ASME Boiler and Pressure Vessel Code applications see related Specification SA-312 in Section II of that Code.

³ *Annual Book of ASTM Standards*, Vol 01.03.

⁴ *Annual Book of ASTM Standards*, Vol 01.01.

⁵ *Annual Book of ASTM Standards*, Vol 03.01.

⁶ Available from American National Standards Institute, 11 West 42nd St., 13th Floor, New York, NY 10036.

⁷ Available from American Society for Mechanical Engineers, Three Park Avenue, New York, NY 10016–5990.

2.4 *AWS Standard:*

A5.9 Corrosion-Resisting Chromium and Chromium-Nickel Steel Welding Rods and Electrodes⁸

2.5 *Other Standard:*

SAE J1086 Practice for Numbering Metals and Alloys (UNS)⁹

2.6 *Other Standard:*

SNT-TC-1A Personnel Qualification and Certification in Nondestructive Testing¹⁰

3. Terminology

3.1 *Definitions:*

3.1.1 The definitions in Specification A 999/A 999M and Terminology A 941 are applicable to this specification.

4. Ordering Information

4.1 Orders for material to this specification should include the following, as required, to describe the desired material adequately:

4.1.1 Quantity (feet, centimetres, or number of lengths),

4.1.2 Name of material (austenitic steel pipe),

4.1.3 Process (seamless (SML) or welded (WLD) or heavily cold worked (HCW)),

4.1.4 Grade (Table 1),

4.1.5 Size (NPS or outside diameter and schedule number or average wall thickness),

4.1.6 Length (specific or random) (Section 13),

4.1.7 End finish (Section on Ends of Specification A 999/A 999M),

4.1.8 Optional requirements (product analysis, see Section 8; hydrostatic or nondestructive electric test, see Section 12),

4.1.9 Test report required (Certification Section of Specification A 999/A 999M),

4.1.10 Specification number, and

4.1.11 Special requirements or any supplementary requirements selected, or both.

5. General Requirements

5.1 Material furnished under this specification shall con-

⁸ Available from the American Welding Society, 550 N.W. LeJeune Rd., Miami, FL 33135.

⁹ Available from Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

¹⁰ Society for Nondestructive Testing, 1711 Arlingate Plaza, PO Box 28518, Columbus, OH, 43228-0518.

form to the applicable requirements of the current edition of Specification A 999/A 999M unless otherwise provided herein.

5.2 *Heat Treatment:*

5.2.1 All pipe shall be furnished in the heat-treated condition in accordance with the requirements of Table 2. The heat-treatment procedure, except for “H” grades, S30815, S31272, S31254, S32654, N08367, N08904, and N08926 shall consist of heating the pipe to a minimum temperature of 1900°F [1040°C] and quenching in water or rapidly cooling by other means.

6. Materials and Manufacture

6.1 *Manufacture:*

6.1.1 The pipe shall be manufactured by one of the following processes:

6.1.2 *Seamless (SML) pipe* shall be made by a process that does not involve welding at any stage of production.

6.1.3 *Welded (WLD) pipe* shall be made using an automatic welding process with no addition of filler metal during the welding process.

6.1.4 *Heavily cold-worked (HCW) pipe* shall be made by applying cold working of not less than 35 % reduction in thickness of both wall and weld to a welded pipe prior to the final anneal. No filler shall be used in making the weld. Prior to cold working, the weld shall be 100 % radiographically inspected in accordance with the requirements of ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, latest revision, Paragraph UW-51.

6.1.5 Welded pipe and HCW pipe of NPS 14 and smaller shall have a single longitudinal weld. Welded pipe and HCW pipe of a size larger than NPS 14 shall have a single longitudinal weld or shall be produced by forming and welding two longitudinal sections of flat stock when approved by the purchaser. All weld tests, examinations, inspections, or treatments shall be performed on each weld seam.

6.1.6 At the option of the manufacturer, pipe shall be either hot finished or cold finished.

6.1.7 The pipe shall be free of scale and contaminating exogenous iron particles. Pickling, blasting, or surface finishing is not mandatory when pipe is bright annealed. The purchaser is permitted to require that a passivating treatment be applied to the finished pipe.

TABLE 1 Chemical Requirements

Grade	UNS Designation ^A	Composition, % ^B										Other Elements
		Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Molybdenum	Nitrogen ^C		
...	S20400	0.030	7.0-9.0	0.045	0.030	1.00	15.0-17.0	1.50-3.00	...	0.15-0.30	...	Cb 0.10-0.30
TPXM-19	S20910	0.06	4.0-6.0	0.045	0.030	1.00	20.5-23.5	11.5-13.5	1.50-3.00	0.20-0.40	...	V 0.10-0.30
TPXM-10	S21900	0.08	8.0-10.0	0.045	0.030	1.00	19.0-21.5	5.5-7.5	...	0.15-0.40	...	...
TPXM-11	S21904	0.04	8.0-10.0	0.045	0.030	1.00	19.0-21.5	5.5-7.5	...	0.15-0.40	...	...
TPXM-29	S24000	0.08	11.5-14.5	0.060	0.030	1.00	17.0-19.0	2.3-3.7	...	0.20-0.40	...	...
TP304	S30400	0.08	2.00	0.045	0.030	1.00	18.0-20.0	8.0-11.0	...	...	...	...
TP304L	S30403	0.035 ^D	2.00	0.045	0.030	1.00	18.0-20.0	8.0-11.0	...	...	...	...
TP304H	S30409	0.04-0.10	2.00	0.045	0.030	1.00	18.0-20.0	8.0-11.0	...	...	...	...
...	S30415	0.04-0.06	0.80	0.045	0.030	1.00-2.00	18.0-19.0	9.0-10.0	...	0.12-0.18	...	Ce 0.03-0.08
TP304N	S30451	0.08	2.00	0.045	0.030	1.00	18.0-20.0	8.0-18.0	...	0.10-0.16	...	...
TP304LN	S30453	0.035	2.00	0.045	0.030	1.00	18.0-20.0	8.0-12.0	...	0.10-0.16	...	...
...	S30600	0.018	2.00	0.02	0.02	3.7-4.3	17.0-18.5	14.0-15.5	0.20	...	...	Cu 0.50
...	S30615	0.16-0.24	2.00	0.030	0.03	3.2-4.0	17.0-19.5	13.5-16.0	...	...	...	Al 0.80-1.50
...	S30815	0.05-0.10	0.80	0.040	0.030	1.40-2.00	20.0-22.0	10.0-12.0	...	0.14-0.20	...	Ce 0.03-0.08
TP309S	S30908	0.08	2.00	0.045	0.030	1.00	22.0-24.0	12.0-15.0	0.75	...	...	...
TP309H	S30909	0.04-0.10	2.00	0.045	0.030	1.00	22.0-24.0	12.0-15.0	...	...	...	...
TP309Cb	S30940	0.08	2.00	0.045	0.030	1.00	22.0-24.0	12.0-16.0	0.75	...	...	Cb (10 × C)-1.10
TP309HCb	S30941	0.04-0.10	2.00	0.045	0.030	1.00	24.0-26.0	19.0-22.0	0.75	...	...	Cb (10 × C)-1.10
...	S31002	0.015	2.00	0.020	0.015	0.15	19.0-22.0	24.0-26.0	0.10	0.10	...	...
TP310S	S31008	0.08	2.00	0.045	0.030	1.00	24.0-26.0	19.0-22.0	...	...	...	...
TP310H	S31009	0.04-0.10	2.00	0.045	0.030	1.00	24.0-26.0	19.0-22.0	...	...	...	...
TP310Cb	S31040	0.08	2.00	0.045	0.030	1.00	24.0-26.0	19.0-22.0	0.75	...	...	Cb (10 × C)-1.10
TP310HCb	S31041	0.04-0.10	2.00	0.045	0.030	1.00	24.0-26.0	19.0-22.0	0.75	...	...	Cb (10 × C)-1.10
...	S31050	0.025	2.00	0.020	0.015	0.4	24.0-26.0	20.5-23.5	1.6-2.6	0.09-0.15	...	...
...	S31254	0.020	1.00	0.030	0.010	0.80	19.5-20.5	17.5-18.5	6.0-6.5	0.18-0.22	...	Cu 0.50-1.00
...	S31272	0.08-0.12	1.5-2.00	0.030	0.015	0.25-0.75	14.0-16.0	14.0-16.0	1.00-1.40	...	...	Ti 0.30-0.60
TP316	S31600	0.08	2.00	0.045	0.030	1.00	16.0-18.0	11.0-14.0 ^E	2.00-3.00	...	...	B 0.004-0.008
TP316L	S31603	0.035 ^D	2.00	0.045	0.030	1.00	16.0-18.0	10.0-14.0	2.00-3.00	...	...	...
TP316H	S31609	0.04-0.10	2.00	0.045	0.030	1.00	16.0-18.0	11.0-14.0 ^E	2.00-3.00	...	...	...
...	S31635	0.08	2.00	0.045	0.030	0.75	16.0-18.0	10.0-12.0	2.00-3.00	0.10	...	...
TP316N	S31651	0.08	2.00	0.045	0.030	1.00	16.0-18.0	11.0-14.0 ^E	2.00-3.00	0.10-0.16	...	T (5 × C)-0.70
TP316LN	S31653	0.035	2.00	0.045	0.030	1.00	16.0-18.0	11.0-14.0 ^E	2.00-3.00	0.10-0.16	...	...
TP317	S31700	0.08	2.00	0.045	0.030	1.00	18.0-20.0	11.0-14.0	3.0-4.0	...	...	...
TP317L	S31703	0.035	2.00	0.045	0.030	1.00	18.0-20.0	11.0-15.0	3.0-4.0	...	...	...
...	S31725	0.030	2.00	0.040 ^F	0.030	1.00	18.0-20.0	13.5-17.5	4.0-5.0	0.10	...	Cu 0.75
...	S31726	0.030	2.00	0.040 ^F	0.030	1.00	17.0-20.0	14.5-17.5	4.0-5.0	0.10-0.20	...	Cu 0.75
TP321	S32100	0.08	2.00	0.045	0.030	1.00	17.0-19.0	9.0-12.0	...	0.10	...	Ti (5 × C)-0.70
TP321H	S32109	0.04-0.10	2.00	0.045	0.030	1.00	17.0-19.0	9.0-12.0	...	0.10	...	Ti (4 × C)-0.60
...	S32615	0.07	2.00	0.045	0.030	4.8-6.0	16.5-19.5	19.0-22.0	0.30-1.50	...	...	Cu 1.50-2.50
...	S32654	0.020	2.0-4.0	0.030	0.005	0.50	24.0-25.0	21.0-23.0	7.0-8.0	0.45-0.55	...	Cu 0.30-0.60
...	S33228	0.04-0.08	1.0	0.020	0.015	0.30	26.0-28.0	31.0-33.0	...	...	...	Cb 0.60-1.00
...	S34565	0.030	5.0-7.0	0.030	0.015	1.00	23.0-25.0	16.0-18.0	4.0-5.0	0.40-0.60	...	Ce 0.05-0.10
TP347	S34700	0.08	2.00	0.045	0.030	1.00	17.0-19.0	9.0-13.0	...	...	...	Al 0.025
TP347H	S34709	0.04-0.10	2.00	0.045	0.030	1.00	17.0-19.0	9.0-13.0	...	...	...	Cb 0.10
TP347LN	S34751	0.005-0.020	2.00	0.045	0.030	1.00	17.0-19.0	9.0-13.0	...	0.06-0.10	...	Cb (10 × C)-1.00
TP348	S34800	0.08	2.00	0.045	0.030	1.00	17.0-19.0	9.0-13.0	...	...	...	Ta 0.10
TP348H	S34809	0.04-0.10	2.00	0.045	0.030	1.00	17.0-19.0	9.0-13.0	...	...	...	Cb (8 × C)-1.10

TABLE 1 Continued

Grade	UNS Designation ^A	Composition, % ^B										Other Elements
		Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Molybdenum	Nitrogen ^C		
...	S35045	0.06-0.10	1.50	...	0.015	1.00	25.0-29.0	32.0-37.0	...	...	Ti 0.15-1.10 Cu 0.75 Al 0.15-0.60 Ce 0.03-0.08
...	S35315	0.04-0.08	2.00	0.040	0.030	1.20-2.00	24.0-26.0	34.0-36.0	...	0.12-0.18		
TPXM-15	S38100	0.08	2.00	0.030	0.030	1.50-2.50	17.0-19.0	17.5-18.5	...	...
...	N08367	0.030	2.00	0.040	0.030	1.00	20.0-22.0	23.5-25.50	6.0-7.0	0.18-0.25	Cu 0.75	
...	N08904	0.020	2.00	0.040	0.030	1.00	19.0-23.0	23.0-28.0	4.0-5.0	0.10	Cu 1.00-2.00	
...	N08926	0.020	2.00	0.030	0.010	0.50	24.0-26.0	19.0-21.0	6.0-7.0	0.15-0.25	Cu 0.50-1.50	

^A Maximum, unless otherwise indicated.

^B New designation established in accordance with Practice E 527 and SAE J1086.

^C The method of analysis for nitrogen shall be a matter of agreement between the purchaser and manufacturer.

^D For small diameter or thin walls or both, where many drawing passes are required, a carbon maximum of 0.040 % is necessary in grades TP304L and TP316L. Small outside diameter tubes are defined as those less than 0.500 in. [12.7 mm] in outside diameter and light wall tubes as those less than 0.049 in. [1.20 mm] in average wall thickness (0.044 in. [1.10 mm] in minimum wall thickness).

^E For welded TP316, TP316N, TP316LN, and TP316H pipe, the nickel range shall be 10.0-14.0 %.

^F For welded pipe, the phosphorus maximum shall be 0.045 %.

TABLE 4 Tensile Requirements

Grade	UNS Designation	Tensile Strength, min ksi [MPa]	Yield Strength, min ksi [MPa]
...	S20400	95 [635]	48 [330]
TPXM-19	S20910	100 [690]	55 [380]
TPXM-10	S21900	90 [620]	50 [345]
TPXM-11	S21904	90 [620]	50 [345]
TPXM-29	S24000	100 [690]	55 [380]
TP304	S30400	75 [515]	30 [205]
TP304L	S30403	70 [485]	25 [170]
TP304H	S30409	75 [515]	30 [205]
...	S30415	87 [600]	42 [290]
TP304N	S30451	80 [550]	35 [240]
TP304LN	S30453	75 [515]	30 [205]
...	S30600	78 [540]	35 [240]
...	S30615	90 [620]	40 [275]
...	S30815	87 [600]	45 [310]
TP309S	S30908	75 [515]	30 [205]
TP309H	S30909	75 [515]	30 [205]
TP309Cb	S30940	75 [515]	30 [205]
TP309HCb	S30941	75 [515]	30 [205]
...	S31002	73 [500]	30 [205]
TP310S	S31008	75 [515]	30 [205]
TP310H	S31009	75 [515]	30 [205]
TP310Cb	S31040	75 [515]	30 [205]
TP310HCb	S31041	75 [515]	30 [205]
...	S31050:		
...			
t ≤ 0.25 in.		84 [580]	39 [270]
t > 0.25 in.		78 [540]	37 [255]
...	S31254:		
t ≤ 0.187 in. [5.00 mm]		98 [675]	45 [310]
t > 0.187 in. [5.00 mm]		95 [655]	45 [310]
...	S31272	65 [450]	29 [200]
TP316	S31600	75 [515]	30 [205]
TP316L	S31603	70 [485]	25 [170]
TP316H	S31609	75 [515]	30 [205]
...	S31635	75 [515]	30 [205]
TP316N	S31651	80 [550]	35 [240]
TP316LN	S31653	75 [515]	30 [205]
TP317	S31700	75 [515]	30 [205]
TP317L	S31703	75 [515]	30 [205]
...	S31725	75 [515]	30 [205]
...	S31726	80 [550]	35 [240]
TP321	S32100:		
Welded		75 [515]	30 [205]
Seamless:			
≤ 3/8 in.		75 [515]	30 [205]
> 3/8 in.		70 [485]	25 [170]
TP321H	S32109:		
Welded		75 [515]	30 [205]
Seamless:			
≤ 3/16 in.		75 [515]	30 [205]
> 3/16 in.		70 [480]	25 [170]
...	S32615	80 [550]	32 [220]
...	S32654	109 [750]	62 [430]
...	S33228	73 [500]	27 [185]
...	S34565	115 [795]	60 [415]
TP347	S34700	75 [515]	30 [205]
TP347H	S34709	75 [515]	30 [205]
TP347LN	S34751	75 [515]	30 [205]
TP348	S34800	75 [515]	30 [205]
TP348H	S34809	75 [515]	30 [205]
...	S35045	70 [485]	25 [170]
...	S35315	94 [650]	39 [270]
TPXM-15	S38100	75 [515]	30 [205]
...	N08367:		
t ≤ 0.187		100 [690]	45 [310]
t > 0.187		95 [655]	45 [310]
...	N08904	71 [490]	31 [215]
...	N08926	94 [650]	43 [295]
Elongation in 2 in. or 50 mm (or 4D), min, %:		Longitudinal	Transverse
All Grades except S31050 and S32615		35	25
S32615, S31050		25	...
N08367		30	...

from each heat-treated lot. For material heat treated by the continuous process, or by direct quenching after hot forming this test shall be made on a sufficient number of pipe to constitute 5 % of the lot, but in no case less than two lengths of pipe.

11.2.1 For welded pipe a transverse-guided face bend test of the weld may be conducted instead of a flattening test in accordance with the method outlined in the steel tubular product supplement of Test Methods and Definitions A 370. The ductility of the weld shall be considered acceptable when there is no evidence of cracks in the weld or between the weld and the base metal after bending. Test specimens from 5 % of the lot shall be taken from the pipe or test plates of the same material as the pipe, the test plates being attached to the end of the cylinder and welded as a prolongation of the pipe longitudinal seam.

11.3 Grain Size—Grain size determinations on Grades TP309H, TP309HCb, TP310H, TP310HCb, and UNS S32615 shall be made on the same number of tubes as prescribed for the flattening test.

11.4 HCW pipe shall be capable of passing the weld decay tests listed in Supplementary S9 with a weld metal to base metal loss ratio of 0.90 to 1.1. The test is not required to be performed unless S9 is specified in the purchase order.

12. Hydrostatic or Nondestructive Electric Test

12.1 Each pipe shall be subjected to the nondestructive electric test or the hydrostatic test. The type of test to be used shall be at the option of the manufacturer, unless otherwise specified in the purchase order.

12.2 The hydrostatic test shall be in accordance with Specification A 999/A 999M, unless specifically exempted under the provisions of 12.3.

12.3 For pipe whose dimensions equal or exceed NPS10, the purchaser, with the agreement of the manufacturer, may waive the hydrostatic test requirement when in lieu of such test the purchaser performs a system test. Each length of pipe furnished without the completed manufacturer's hydrostatic test shall include with the mandatory markings the letters "NH."

12.4 Nondestructive Electric Test:

Nondestructive electric tests shall be in accordance with Specification A 999/A 999M.

13. Lengths

13.1 Pipe lengths shall be in accordance with the following regular practice:

13.1.1 Unless otherwise agreed upon, all sizes from NPS 1/8 to and including NPS 8 are available in a length up to 24 ft (Note 4) with the permissible range of 15 to 24 ft (Note 4). Short lengths are acceptable and the number and minimum length shall be agreed upon between the manufacturer and the purchaser.

NOTE 4—This value(s) applies when the inch-pound designation of this specification is the basis of purchase. When the "M" designation of this specification is the basis of purchase, the corresponding metric value(s) shall be agreed upon between the manufacturer and the purchaser.

13.1.2 If definite cut lengths are desired, the lengths required shall be specified in the order. No pipe shall be under the