~~Designation:A312/A312M–04a~~ Designation: A 312/A 312M – 04b

Used in USDOE-NE standards

Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes[1]

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 specification[2] 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 service at temperatures where creep and stress rupture properties are important.

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, it is permitted to specify in the order one or more of these supplementary requirements.

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 is permitted to be ordered and furnished provided such pipe complies with all other requirements of this specification.

1.5 Grades TP321 and TP321H have lower strength requirements for pipe manufactured by the seamless process in nominal wall thicknesses greater than ⅜ 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:*[3]

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

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

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

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

A 1016/A 1016M Specification for General Requirements for Ferritiic Alloy Steel, Austenitic Alloy Steel, and Stainless Steel Tubes

[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 ~~May~~Sept. 1, 2004. Published ~~June~~October 2004. Originally approved in 1948. Last previous edition approved in 2004 as A 312/A 312M – 04a.

[2] For ASME Boiler and Pressure Vessel Code applications see related Specification SA-312 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.

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

E 112 Test Methods for Determining the Average Grain Size
E 381 Method of Macroetch Testing Steel Bars, Billets, Blooms, and Forgings
E 527 Practice for Numbering Metals and Alloys (UNS)
2.2 *ANSI Standards:*[4]
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 VIII[5]
2.4 *AWS Standard:*
A5.9 Corrosion-Resisting Chromium and Chromium-Nickel Steel Welding Rods and Electrodes[6]
2.5 *Other Standard:*
SAE J1086 Practice for Numbering Metals and Alloys (UNS)[7]
2.6 *Other Standard:*
SNT-TC-1A Personnel Qualification and Certification in Nondestructive Testing[8]

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 shall conform to the requirements of the current edition of Specification A 999/A 999M.

5. General Requirements

5.1 Material furnished under this specification shall conform 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.

[4] Available from American National Standards Institute, 11 West 42nd St., 13th Floor, New York, NY 10036.
[5] Available from American Society for Mechanical Engineers, Three Park Avenue, New York, NY 10016–5990.
[6] Available from the American Welding Society, 550 N.W. LeJeune Rd., Miami, FL 33135.
[7] Available from Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.
[8] Society for Nondestructive Testing, 1711 Arlingate Plaza, PO Box 28518, Columbus, OH, 43228-0518.

TABLE 1 Chemical Requirements

Grade	UNS Designation[A]	Composition, %[B]																
		Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Molybdenum	Titanium	Columbium	Tantalum, max	Nitrogen[C]	Vanadium	Copper	Cerium	Boron	Aluminum
. . .	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	. . .	. . .	. . .	. . .	. . .
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	. . .	0.10–0.30	. . .	0.20–0.40	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	8.0–13.0	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .		
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	. . .	. . .	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	. . .	. . .	. . .	. . .	. . .	0.50 max	. . .		
. . .	S30615	0.16–0.24	2.00	0.030	0.03	3.2-4.0	17.0–19.5	13.5–16.0	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	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	. . .	. . .	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	. . .	10 × C min, 1.10 max	. . .	. . .	. . .		. . .		
TP309HCb	S30941	0.04–0.10	2.00	0.045	0.030	1.00	22.0–24.0	12.0–16.0	0.75	. . .	10 × C min, 1.10 max	. . .	. . .	. . .				
	S31002	0.015	2.00	0.020	0.015	0.15	24.0–26.0	19.0–22.0	0.10	. . .	. . .	. . .	0.10	. . .				
TP310S	S31008	0.08	2.00	0.045	0.030	1.00	24.0–26.0	19.0–22.0	0.75	. . .	. . .	. . .	. . .	. . .		. . .		
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	. . .	10 × C min, 1.10 max	. . .	. . .	. . .		. . .		
TP310HCb	S31041	0.04–0.10	2.00	0.045	0.030	1.00	24.0–26.0	19.0–22.0	0.75	. . .	10 × C min, 1.10 max	. . .	. . .	. . .				
. . .	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	. . .	0.50–1.00	. . .		
	S31272	0.08–012	1.5–2.00	0.030	0.015	0.25–0.75	14.0–16.0	14.0–16.0	1.00–1.40	0.30–0.60							0.004–0.008	
	S31277	0.020	3.00	0.030	0.010	0.50	20.5–23.0	26.0–28.0	6.5–8.0				0.30–0.40		0.50–1.50			
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	. . .	. . .	. . .	. . .	. . .	. . .	. . .		
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	5× (C+N) min, 0.70	. . .	. . .	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	. . .	. . .	. . .		
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	0.03	2.00	0.040[F]	0.030	1.00	18.0–20.0	13.5–17.5	4.0–5.0	. . .	. . .	. . .	0.10	. . .	0.75	. . .		
. . .	S31726	0.03	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	. . .	0.75	. . .		
TP321	S32100	0.08	2.00	0.045	0.030	1.00	17.0–19.0	9.0–12.0	. . .	[G]	. . .	. . .	0.10	. . .	. . .	. . .		

TABLE 1 *Continued*

Grade	UNS Designation[A]	Composition, %[B] Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Molybdenum	Titanium	Columbium	Tantalum, max	Nitrogen[C]	Vanadium	Copper	Cerium	Boron	Aluminum
TP321H	S32109	0.04–0.10	2.00	0.045	0.030	1.00	17.0–19.0	9.0–12.0	. . .	[H]	. . .	. . .	. . .	. . .	. . .	. . .		
. . .	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	. . .	. . .	. . .	. . .	. . .	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	. . .	0.30–0.60	. . .		
. . .	S33228	0.04–0.08	1.00	0.020	0.015	0.30	26.0–28.0	31.0–33.0	. . .	. . .	0.60–1.00	. . .	. . .	. . .	. . .	0.05–0.10	. . .	0.025
. . .	S34565	0.03	5.0–7.0	0.030	0.010	1.00	23.0–25.0	16.0–18.0	4.0–5.0	. . .	0.10		0.40–0.60	. . .	. . .	. . .	. . .	
TP347	S34700	0.08	2.00	0.045	0.030	1.00	17.0–19.0	9.0–13.0	. . .	. . .	[I]	. . .	. . .	. . .	. . .	. . .		
TP347H	S34709	0.04–0.10	2.00	0.045	0.030	1.00	17.0–19.0	9.0–13.0	. . .	. . .	[J]	. . .	. . .	. . .	. . .	. . .		
TP347LN	S34751	0.005–0.020	2.00	0.045	0.030	1.00	17.0–19.0	9.0–13.0	. . .	. . .	0.20–0.50[F,K]	. . .	0.06–0.10	. . .	. . .	. . .	. . .	. . .
TP348	S34800	0.08	2.00	0.045	0.030	1.00	17.0–19.0	9.0–13.0	. . .	. . .	[I]	0.10	. . .	. . .	. . .	. . .		
TP348H	S34809	0.04–0.10	2.00	0.045	0.030	1.00	17.0–19.0	9.0–13.0	. . .	. . .	[J]	0.10	. . .	. . .	. . .	. . .		
. . .	S35045	0.06-0.10	1.50	. . .	0.015	1.00	25.0-29.0	32.0-37.0	. . .	0.15-0.60	. . .	. . .	. . .	. . .	0.75	. . .	. . .	0.15-0.60
. . .	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	. . .	. . .	0.03–0.08	. . .	. . .
TPXM-15	S38100	0.08	2.00	0.030	0.030	1.50–2.50	17.0–19.0	17.5–18.5	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .		
. . .	S38815	0.030	2.00	0.040	0.020	5.5–6.5	13.0–15.0	15.0–17.0	0.75–1.50	. . .	. . .	. . .	. . .	. . .	0.75–1.50	. . .	. . .	0.30
. . .	N08367	0.030	2.00	0.040	0.030	1.00	20.0–22.0	23.5–25.5	6.0–7.0	. . .	. . .	. . .	0.18–0.25	. . .	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	. . .	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	. . .	0.50–1.50	. . .	. . .	. . .

[A] New designation established in accordance with Practice E 527 and SAE J1086.
[B] Maximum, unless otherwise indicated.
[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 %.
[G] The titanium content shall be not less than five times the carbon content and not more than 0.70 %.
[H] The titanium content shall be not less than four times the carbon content and not more than 0.60 %.
[I] The columbium content shall be not less than ten times the carbon content and not more than 1.00 %.
[J] The columbium content shall be not less than eight times the carbon content and not more than 1.0 %.
[K] Grade S34751 shall have a columbium (niobium) plus tantalum content of not less than 15 times the carbon content.

6.2 *Heat Treatment*— All pipe shall be furnished in the heat-treated condition in accordance with the requirements of Table 2. Alternatively, for seamless pipe, immediately following hot forming while the temperature of the pipes is not less than the specified minimum solution treatment temperature, pipes shall be individually quenched in water or rapidly cooled by other means.

6.3 *Grain Size:*

6.3.1 The grain size of Grade UNS S32615, as determined in accordance with Test Methods E 112, shall be No. 3 or finer.

6.3.2 The grain size of grades TP309H, TP309HCb, TP310H and TP310HCb, as determined in accordance with Test Methods E 112, shall be No. 6 or coarser.

6.3.3 The grain size of grades 304H, 316H, 321H, 347H, and 348H, as determined in accordance with Test Methods E 112, shall be No. 7 or coarser.

TABLE 2 Annealing Requirements

Grade or UNS Designation[A]	Heat Treating Temperature[B]	Cooling/Testing Requirements
All grades not individually listed below:	1900 °F [1040 °C]	C
TP321H, TP347H, TP348H		
Cold finished	2000 °F [1100 °C]	D
Hot finished	1925 °F [1050 °C]	D
TP304H, TP316H		
Cold finished	1900 °F [1040 °C]	D
Hot finished	1900 °F [1040 °C]	D
TP309H, TP309HCb, TP310H, TP310HCb	1900 °F [1040 °C]	D
S30600	2010–2140 °F [1100–1170 °C]	D
S30815, S31272	1920 °F [1050 °C]	D
S31254, S32654	2100 °F [1150 °C]	D
S31277	2050 °F [1120 °C]	D
S33228	2050–2160 °F [1120–1180 °C]	D
S34565	2050–2140 °F [1120–1170 °C]	D
S35315	2010 °F [1100 °C]	D
S38815	1950 °F [1065 °C]	D
N08367	2025 °F [1110 °C]	D
N08904	2000 °F [1100 °C]	D
N08926	2010 °F [1100 °C]	D

[A] New designation established in accordance with Practice E 527 and SAE J1086.

[B] Minimum, unless otherwise stated.

[C] Quenched in water or rapidly cooled by other means, at a rate sufficient to prevent reprecipitation of carbides, as demonstrable by the capability of passing Practices A 262, Practice E. The manufacturer is not required to run the test unless it is specified on the purchase order (see Supplementary Requirement S7). Note that Practices A 262 requires the test to be performed on sensitized specimens in the low-carbon and stabilized types and on specimens representative of the as-shipped condition for other types. In the case of low-carbon types containing 3 % or more molybdenum, the applicability of the sensitizing treatment prior to testing shall be a matter for negotiation between the seller and the purchaser.

[D] Quenched in water or rapidly cooled by other means.

7. Chemical Composition

7.1 The steel shall conform to the requirements as to chemical composition prescribed in Table 1.

8. Product Analysis

8.1 At the request of the purchaser, an analysis of one billet or one length of flat-rolled stock from each heat, or two pipes from each lot shall be made by the manufacturer. A lot of pipe shall consist of the following number of lengths of the same size and wall thickness from any one heat of steel:

NPS Designator	Lengths of Pipe in Lot
Under 2	400 or fraction thereof
2 to 5	200 or fraction thereof
6 and over	100 or fraction thereof

8.2 The results of these analyses shall be reported to the purchaser or the purchaser's representative, and shall conform to the requirements specified in Section 7.

8.3 If the analysis of one of the tests specified in 8.1 does not conform to the requirements specified in Section 7, an analysis of each billet or pipe from the same heat or lot may be made, and all billets or pipe conforming to the requirements shall be accepted.

9. Permitted Variations in Wall Thickness

9.1 In addition to the implicit limitation of wall thickness for seamless pipe imposed by the limitation on weight in Specification A 999/A 999M, the wall thickness for seamless and welded pipe at any point shall be within the tolerances specified in Table 3, except that for welded pipe the weld area shall not be limited by the "Over" tolerance. The wall thickness and outside diameter for inspection for compliance with this requirement for pipe ordered by NPS and schedule number is shown in Table X1.1.

10. Tensile Requirements

10.1 The tensile properties of the material shall conform to the requirements prescribed in Table 4.

11. Mechanical Tests, Grain Size Determinations, and Weld Decay Tests Required

11.1 *Mechanical Testing Lot Definition* — The term *lot* for mechanical tests shall be as follows:

11.1.1 Where the final heat treated condition is obtained, consistent with the requirements of 6.2, in a continuous furnace, by quenching after hot forming or in a batch-type furnace equipped with recording pyrometers and automatically controlled within a 50 °F (30 °C) or lesser range, the term *lot* for mechanical tests shall apply to all pipes of the same specified outside diameter and specified wall thickness (or schedule) that are produced from the same heat of steel and subjected to the same finishing treatment within the same operating period.

TABLE 3 Permitted Variations in Wall Thickness

	Tolerance, % from Nominal	
NPS Designator	Over	Under
⅛ to 2½ incl., all t/D ratios	20.0	12.5
3 to 18 incl., t/D up to 5 % incl.	22.5	12.5
3 to 18 incl., t/D > 5 %	15.0	12.5
20 and larger, welded, all t/D ratios	17.5	12.5
20 and larger, seamless, t/D up to 5 % incl.	22.5	12.5
20 and larger, seamless, t/D > 5 %	15.0	12.5

where:
t = Nominal Wall Thickness
D = Ordered Outside Diameter

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]~~
. . .	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]~~
. . .	S31272	65 [450]	29 [200]
. . .	S31277	112 [770]	52 [360]
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:			
≤ ⅜ in.		75 [515]	30 [205]
> ⅜ 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]
. . .	S38815	78 [540]	37 [255]
. . .	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 4*D*), min, %:		Longi-tudinal	Trans-verse
All Grades except S31050 and S32615		35	25
S32615, S31050		25	. . .
S31277		40	. . .
N08367		30	. . .

11.1.2 Where the final heat treated condition is obtained, consistent with the requirements of 6.2, in a batch-type furnace not equipped with recording pyrometers and automatically controlled within a 50 °F (30 °C) or lesser range, the term *lot* shall apply to the larger of: (a) each 200 ft [60 m] or fraction thereof and (b) those pipes heat treated in the same furnace batch charge for pipes of the same specified outside diameter and specified wall thickness (or schedule) that are produced from the same heat of steel and are subjected to the same finishing temperature within the same operating period.

11.2 *Transverse or Longitudinal Tension Test*—One tension test shall be made on a specimen for lots of not more than 100 pipes. Tension tests shall be made on specimens from two tubes for lots of more than 100 pipes.

11.3 *Flattening Test*—For material heat treated in a continuous furnace, by quenching after hot forming or in a batch-type furnace equipped with recording pyrometers and automatically controlled within a 50 °F (30 °C) or lesser range, flattening tests shall be made on a sufficient number of pipe to constitute 5 % of the lot, but in no case less than 2 lengths of pipe. For material heat treated in a batch-type furnace not equipped with recording pyrometers and automatically controlled within a 50 °F (30 °C) or lesser range, flattening tests shall be made on 5 % of the pipe from each heat treated lot.

11.3.1 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.

11.4 *Grain Size*—Grain size determinations on Grades TP309H, TP 309HCb, TP310H, TP310HCb, and UNS S32615 shall be made on each heat treatment lot, as defined in 11.1, for the same number of pipes as prescribed for the flattening test in 11.3.

11.5 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, is permitted to 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