Designation: A312/A312M – 21

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 A312/A312M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This specification[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, ASME 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 ASME 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 SI units or inch-pound units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard. 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."

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

A262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys

A999/A999M Specification for General Requirements for Alloy and Stainless Steel Pipe

A1016/A1016M Specification for General Requirements for Ferritic Alloy Steel, Austenitic Alloy Steel, and Stainless Steel Tubes

E112 Test Methods for Determining Average Grain Size

[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.

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[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**

E381 Method of Macroetch Testing Steel Bars, Billets, Blooms, and Forgings
E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

2.2 *ASME Standards:*
B1.20.1 Pipe Threads, General Purpose
B36.10M Welded and Seamless Wrought Steel Pipe
B36.19 Stainless Steel Pipe
ASME Boiler and Pressure Vessel Code : Section VIII[4]

2.3 *AWS Standard:*
A5.9 Corrosion-Resisting Chromium and Chromium-Nickel Steel Welding Rods and Electrodes[5]

2.4 *Other Standard:*
SAE J1086 Practice for Numbering Metals and Alloys (UNS)[6]

3. Terminology

3.1 *Definitions:*

3.1.1 The definitions in Specification A999/A999M and Terminology A941 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 A999/A999M.

5. General Requirements

5.1 Material furnished under this specification shall conform to the applicable requirements of the current edition of Specification A999/A999M unless otherwise provided herein.

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.

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 minimum solution treatment temperature specified in Table 2, pipes shall be individually quenched in water or rapidly cooled by other means (direct quenched).

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 A999/A999M, 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.

[4] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, http://www.asme.org.

[5] Available from American Welding Society (AWS), 550 NW LeJeune Rd., Miami, FL 33126, http://www.aws.org.

[6] Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.

TABLE 1 Chemical Requirements

Grade	UNS Designation[A]	Composition, %[B] Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Molybdenum	Titanium	Niobium[M]	Tantalum, max	Nitrogen[C]	Vanadium	Copper	Cerium	Boron	Aluminum	Other
TP201	S20100	0.15	5.5–7.5	0.060	0.030	1.00	16.0–18.0	3.5–5.5	. . .	. . .	. . .	. . .	0.25	. . .	. . .	. . .	. . .	. . .	
TP201LN	S20153	0.03	6.4–7.5	0.045	0.015	0.75	16.0–17.5	4.0–5.0	. . .	. . .	. . .	. . .	0.10–0.25	. . .	1.00	. . .	. . .	. . .	
. . .	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	8.0–11.0	. . .	. . .	. . .	. . .	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	. . .			
. . .	S30601	0.015	0.50–0.80	0.030	0.013	5.0–5.6	17.0–18.0	17.0–18.0	0.20	. . .	. . .	. . .	0.05	. . .	0.35	. . .	. . .	. . .	. . .
. . .	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	. . .	. . .	. . .		. . .			

TABLE 1 *Continued*

Grade	UNS Designation[A]	Composition, %[B]																
		Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Molybdenum	Titanium	Niobium[M]	Tantalum, max	Nitrogen[C]	Vanadium	Copper	Cerium	Boron	Aluminum	Other
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	...	...	...	...	...	...	...				
	S31035	0.04–0.10	0.60	0.025	0.015	0.40	21.5–23.5	23.5–26.5			0.40–0.60		0.20–0.30		2.5–3.5		0.002–0.008		W 3.0–4.0 Co 1.0–2.0
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	...	...	...	0.18–0.25	...	0.50–1.00	...			
...	S31266	0.030	2.00–4.00	0.035	0.020	1.00	23.0–25.0	21.0–24.0	5.2–6.2				0.35–0.60		1.00–2.50				W 1.50–2.50
	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	10.0–14.0	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	10.0–14.0	2.00–3.00	...	...	...	...	...	...	...			
TP316Ti	S31635	0.08	2.00	0.045	0.030	0.75	16.0–18.0	10.0–14.0	2.00–3.00	5× (C+N) –0.70	...	...	0.10	...	...	...	...	...	
TP316N	S31651	0.08	2.00	0.045	0.030	1.00	16.0–18.0	10.0–14.0	2.00–3.00				0.10–0.16	...	...	...			
TP316LN	S31653	0.035	2.00	0.045	0.030	1.00	16.0–18.0	10.0–14.0	2.00–3.00	...	...	...	0.10–0.16	...	...	...			
...	S31655	0.030	2.00	0.045	0.015	1.00	19.5–21.5	8.0–9.5	0.50–1.50	...	...	...	0.14–0.25	...	1.00	...	...	...	...
TP317	S31700	0.08	2.00	0.045	0.030	1.00	18.0–20.0	11.0–15.0	3.0–4.0	...	...	...	...	...	...	...			

TABLE 1 *Continued*

Grade	UNS Desig- nation[A]	Composition, %[B]																	
		Carbon	Manga- nese	Phos- phorus	Sulfur	Silicon	Chrom- ium	Nickel	Molyb- denum	Tita- nium	Niobium[M]	Tanta- lum, max	Nitro- gen[C]	Vana- dium	Copper	Cerium	Boron	Alum- inum	Other
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[E]	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[E]	0.030	1.00	17.0–20.0	13.5–17.5	4.0–5.0	. . .	. . .	. . .	0.10–0.20	. . .	0.75	. . .			
. . .	S31727	0.03	1.00	0.030	0.030	1.00	17.5–19.0	14.5–16.5	3.8–4.5	. . .	. . .	. . .	0.15–0.21	. . .	2.8–4.0	. . .	. . .	. . .	
. . .	S31730	0.030	2.00	0.040	0.010	1.00	17.0–19.0	15.0–16.5	3.0–4.0	. . .	. . .	. . .	0.045	. . .	4.0–5.0	. . .	. . .	. . .	. . .
. . .	S31740	0.005–0.020[N]	2.00	0.045	0.030	1.00	17.0–19.0	11.0–15.0	3.0–4.5	. . .	0.20–0.50[N]	. . .	0.06–0.15	. . .	. . .	. . .	. . .	. . .	. . .
. . .	S32053	0.03	1.00	0.030	0.010	1.00	22.0–24.0	24.0–26.0	5.0–6.0	. . .	. . .	. . .	0.17–0.22	. . .	. . .	. . .	. . .	. . .	
TP321	S32100	0.08	2.00	0.045	0.030	1.00	17.0–19.0	9.0–12.0	. . .	[F]	. . .	. . .	0.10	. . .	. . .	. . .			
TP321H	S32109	0.04–0.10	2.00	0.045	0.030	1.00	17.0–19.0	9.0–12.0	. . .	4(C+N) min; 0.70 max	. . .	. . .	0.10	. . .	. . .	. . .			
. . .	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	. . .	. . .	[G]	. . .	. . .	. . .	. . .	. . .			
TP347H	S34709	0.04–0.10	2.00	0.045	0.030	1.00	17.0–19.0	9.0–13.0	. . .	. . .	[H]	. . .	. . .	. . .	. . .	. . .			
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[I]	. . .	0.06–0.10	. . .	. . .	. . .	. . .	. . .	
	S34752	0.005–0.020	2.00	0.035	0.010	0.60	17.0–19.0	10.0–13.0	0.20–1.20	. . .	0.20–0.50[I]	. . .	0.06–0.12	. . .	2.50–3.50	. . .	0.001–0.005	. . .	
TP348	S34800	0.08	2.00	0.045	0.030	1.00	17.0–19.0	9.0–13.0	. . .	. . .	[G]	0.10	. . .	. . .	. . .	. . .			
TP348H	S34809	0.04–0.10	2.00	0.045	0.030	1.00	17.0–19.0	9.0–13.0	. . .	. . .	[H]	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	. . .	. . .	

TABLE 1 *Continued*

Grade	UNS Designation[A]	Composition, %[B]																	
		Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Molybdenum	Titanium	Niobium[M]	Tantalum, max	Nitrogen[C]	Vanadium	Copper	Cerium	Boron	Aluminum	Other
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	
Alloy 20	N08020	0.07	2.00	0.045	0.035	1.00	19.0–21.0	32.0–38.0	2.0–3.0	. . .	[L]	[L]	. . .	. . .	3.0–4.0	. . .	. . .	. . .	
	N08028	0.030	2.50	0.030	0.030	1.0	26.0–28.0	30.0–34.0	3.0–4.0						0.60–1.4				
	N08029	0.020	2.0	0.025	0.015	0.6	26.0–28.0	30.0–34.0	4.0–5.0						0.6–1.4				
. . .	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	. . .	. . .	. . .	
800	N08800	0.10	1.50	0.045	0.015	1.00	19.0–23.0	30.0–35.0	. . .	. . .	. . .	. . .	. . .	. . .	0.75	. . .	. . .	0.15–0.60	Fe[J] 39.5 min.
800H	N08810	0.05–0.10	1.50	0.045	0.015	1.00	19.0–23.0	30.0–35.0	. . .	0.15–0.60	. . .	. . .	. . .	. . .	0.75	. . .	. . .	0.15–0.60	Fe[J] 39.5 min.
	N08811	0.06–0.10	1.50	0.045	0.015	1.00	19.0–23.0	30.0–35.0	. . .	0.15–0.60[K]	. . .	. . .	. . .	. . .	0.75	. . .	. . .	0.15–0.60[K]	Fe[J] 39.5 min.
. . .	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	. . .	. . .	. . .	
. . .	N08925	0.020	1.00	0.045	0.030	0.50	19.0–21.0	24.0–26.0	6.0–7.0	. . .	. . .	. . .	0.10–0.20	. . .	0.80–1.50	. . .	. . .	. . .	
. . .	N08926	0.020	2.00	0.030	0.010	0.50	19.0–21.0	24.0–26.0	6.0–7.0	. . .	. . .	. . .	0.15–0.25	. . .	0.50–1.50	. . .	. . .	. . .	

[A] New designation established in accordance with Practice E527 and SAE J1086.
[B] Maximum, unless otherwise indicated. Where elipses (...) appear in this table, there is no requirement and analysis for the element need not be determined or reported.
[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 pipe, the phosphorus maximum shall be 0.045 %.
[F] Ti 5 × (C+N) min, 0.70 max.
[G] The niobium content shall be not less than ten times the carbon content and not more than 1.00 %.
[H] The niobium content shall be not less than eight times the carbon content and not more than 1.0 %.
[I] Grade S34751 and Grade S34752 shall have a niobium content of not less than 15 times the carbon content.
[J] Iron shall be determined arithmetically by difference of 100 minus the sum of the other specified elements.
[K] Al + Ti shall be 0.85 % min; 1.20 % max.
[L] Niobium (Nb) + Tantalum = 8 × Carbon min, 1.00 max.
[M] The terms Niobium (Nb) and Columbium (Cb) are alternative names for the same element.
[N] S31740 shall have a niobium (columbium) content of not less than 15 times the carbon content.

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]
S30601	2010–2140 °F [1100–1170 °C]	[D]
S30815, S31272	1920 °F [1050 °C]	[D]
S31035	2160–2280 °F [1180–1250 °C]	[D]
S31254, S32654	2100 °F [1150 °C]	[D]
S31266	2100 °F [1150 °C]	[D]
S31277	2050 °F [1120 °C]	[D]
S31727, S32053	1975–2155 °F [1080–1180 °C]	[D]
S33228	2050–2160 °F [1120–1180 °C]	[D]
S34565	2050–2140 °F [1120–1170 °C]	[D]
S34752	1940–2138 °F [1060–1170 °C]	[D]
S35315	2010 °F [1100 °C]	[D]
S38815	1950 °F [1065 °C]	[D]
N08367	2025 °F [1110 °C]	[D]
N08020	1700–1850 °F [925–1010 °C]	[D]
N08028	2000 °F [1100 °C]	[D]
N08029	2000 °F [1100 °C]	[D]
N08810	2050 °F [1120 °C]	[D]
N08811	2100 °F [1150 °C]	[D]
N08904	2000 °F [1100 °C]	[D]
N08925, N08926	2010–2100 °F [1100–1150 °C]	[D]

[A] New designation established in accordance with Practice E527 and SAE J1086.
[B] Minimum, unless otherwise stated.
[C] Quenched in water or rapidly cooled by other means, at a rate sufficient to prevent re-precipitation of carbides, as demonstrable by the capability of pipes, heat treated by either separate solution annealing or by direct quenching, of passing Practices A262, 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 A262 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.

TABLE 3 Permitted Variations in Wall Thickness

NPS Designator	Tolerance, % from Nominal 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

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 or by quenching after hot forming, the term *lot* for mechanical tests shall apply to all pipes of the same specified outside diameter and specified wall thickness (or schedule) of the same heat, heat treated in the same furnace at the same temperature, time at heat, and furnace speed in the same production run, or all pipes of the same specified outside diameter and specified wall thickness (or schedule) of the same heat, hot formed and quenched in the same production run.

11.1.2 Where the final heat treated condition is obtained, consistent with the requirements of 6.2, in a batch-type furnace equipped with recording pyrometers and automatically controlled within a 50 °F [30 °C] or lesser range, the term lot shall apply to all pipes of the same specified outside diameter and specified wall thickness (or schedule), of the same heat, subjected to the same finishing temperature within the same production run.

11.1.3 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 production run.

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 A370. For welded pipe with a specified wall thickness over ⅜ in., two side bend tests may be made instead of the face bend test. The