Designation: ~~A312/A312M – 15b~~ A312/A312M – 16

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.

This standard has been approved for use by agencies of the U.S. 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 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."

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

[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**

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
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 *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]

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).

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.
[5] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, http://www.asme.org.
[6] Available from American Welding Society (AWS), 550 NW LeJeune Rd., Miami, FL 33126, http://www.aws.org.
[7] 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	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	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	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	. . .	. . .	. . .	. . .	. . .	. . .	. . .			
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	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	. . .	. . .	. . .			
. . .	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 Designation[A]	Composition, %[B]																
		Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Molybdenum	Titanium	Niobium	Tantalum, max	Nitrogen[C]	Vanadium	Copper	Cerium	Boron	Aluminum	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[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	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	. . .	. . .	. . .	. . .
. . .	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	. . .	[G]	. . .	. . .	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	. . .	. . .	[H]	. . .	. . .	. . .	. . .	. . .			
TP347H	S34709	0.04–0.10	2.00	0.045	0.030	1.00	17.0–19.0	9.0–13.0	. . .	. . .	[I]	. . .	. . .	. . .	. . .	. . .			
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[J]	. . .	0.06–0.10	. . .	. . .	. . .	. . .	. . .	
TP348	S34800	0.08	2.00	0.045	0.030	1.00	17.0–19.0	9.0–13.0	. . .	. . .	[H]	0.10	. . .	. . .	. . .	. . .			
TP348H	S34809	0.04–0.10	2.00	0.045	0.030	1.00	17.0–19.0	9.0–13.0	. . .	. . .	[I]	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	

TABLE 1 *Continued*

Grade	UNS Designation[A]	Composition, %[B]																
		Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Molybdenum	Titanium	Niobium	Tantalum, max	Nitrogen[C]	Vanadium	Copper	Cerium	Boron	Aluminum	Other
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	. . .	[M]	[M]	. . .	. . .	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[K] 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[K] 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[L]	. . .	. . .	. . .	. . .	0.75	. . .	. . .	0.15–0.60[L]	Fe[K] 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 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] Ti 5 × (C+N) min, 0.70 max.
[H] The niobium content shall be not less than ten times the carbon content and not more than 1.00 %.
[I] The niobium content shall be not less than eight times the carbon content and not more than 1.0 %.
[J] Grade S34751 shall have a niobium content of not less than 15 times the carbon content.
[K] Iron shall be determined arithmetically by difference of 100 minus the sum of the other specified elements.
[L] Al + Ti shall be 0.85 % min; 1.20 % max.
[M] Niobium (Nb) + Tantalum = 8 × Carbon min, 1.00 max.