Designation: A 813/A 813M – 07

Standard Specification for Single- or Double-Welded Austenitic Stainless Steel Pipe[1]

This standard is issued under the fixed designation A 813/A 813M; 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 covers two classes of fit-up and alignment quality straight-seam single- or double-welded austenitic 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 304, 304L, and 347 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, TP304N, TP316H, TP316N, TP321H, TP347H, and TP348H are modifications of Grades TP304, TP316, TP321, TP347, and TP348, and are intended for high-temperature service.

1.3 Two classes of pipe are covered as follows:

1.3.1 *Class SW*—Pipe, single-welded with no addition of filler metal and

1.3.2 *Class DW*—Pipe, double-welded with no addition of filler metal.

1.4 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.

1.5 Table 1 lists the dimensions of welded stainless steel pipe as shown in ANSI B36.19. Pipe having other dimensions may be furnished provided such pipe complies with all other requirements of this specification.

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.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

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 480/A 480M Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

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

E 213 Practice for Ultrasonic Examination of Metal Pipe and Tubing

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

E 426 Practice for Electromagnetic (Eddy-Current) Examination of Seamless and Welded Tubular Products, Austenitic Stainless Steel and Similar Alloys

E 527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

2.2 *ANSI Standards:*[3]

B1.20.1 Pipe Threads, General Purpose

B31.3 Chemical Plant and Refinery Piping Code

B36.10 Welded and Seamless Wrought Steel Pipe

B36.19 Stainless Steel Pipe

2.3 *ASME Boiler and Pressure Vessel Code:*

[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 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.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

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

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TABLE 1 Dimensions of Welded and Seamless Stainless Steel Pipe[A]

NOTE 1—Table 1 is based on Table number 1 of the American National Standard for Stainless Steel Pipe (ANSI B36.19-1965).
NOTE 2—The decimal thickness listed for the respective pipe sizes represents their nominal or average wall dimensions.

NPS Designator	Outside Diameter		Nominal Wall Thickness							
	in.	mm	Schedule 5S[B]		Schedule 10S[B]		Schedule 40S		Schedule 80S	
			in.	mm	in.	mm	in.	mm	in.	mm
⅛	0.405	10.29	. . .	. . .	0.049[C]	1.24	0.068	1.73	0.095	2.41
¼	0.540	13.72	. . .	. . .	0.065[C]	1.65	0.088	2.24	0.119	3.02
⅜	0.675	17.15	. . .	. . .	0.065[C]	1.65	0.091	2.31	0.126	3.20
½	0.840	21.34	0.065[C]	1.65	0.083[C]	2.11	0.109	2.77	0.147	3.73
¾	1.050	26.67	0.065[C]	1.65	0.083[C]	2.11	0.113	2.87	0.154	3.91
1.0	1.315	33.40	0.065[C]	1.65	0.109[C]	2.77	0.133	3.38	0.179	4.55
1¼	1.660	42.16	0.065[C]	1.65	0.109[C]	2.77	0.140	3.56	0.191	4.85
1½	1.900	48.26	0.065[C]	1.65	0.109[C]	2.77	0.145	3.68	0.200	5.08
2	2.375	60.33	0.065[C]	1.65	0.109[C]	2.77	0.154	3.91	0.218	5.54
2½	2.875	73.03	0.083	2.11	0.120[C]	3.05	0.203	5.16	0.276	7.01
3	3.500	88.90	0.083	2.11	0.120[C]	3.05	0.216	5.49	0.300	7.62
3½	4.000	101.60	0.083	2.11	0.120[C]	3.05	0.226	5.74	0.318	8.08
4	4.500	114.30	0.083	2.11	0.120[C]	3.05	0.237	6.02	0.337	8.56
5	5.563	141.30	0.109[C]	2.77	0.134[C]	3.40	0.258	6.55	0.375	9.52
6	6.625	168.28	0.109	2.77	0.134[C]	3.40	0.280	7.11	0.432	10.97
8	8.625	219.08	0.109[C]	2.77	0.148[C]	3.76	0.322	8.18	0.500	12.70
10	10.750	273.05	0.134[C]	3.40	0.165[C]	4.19	0.365	9.27	0.500[C]	12.70[C]
12	12.750	323.85	0.156[C]	3.96	0.180[C]	4.57	0.375[C]	9.52[C]	0.500[C]	12.70[C]
14	14.000	355.60	0.156[C]	3.96	0.188	4.78	. . .	. . .	. . .	. . .
16	16.000	406.40	0.165[C]	4.19	0.188	4.78	. . .	. . .	. . .	. . .
18	18.000	457.20	0.165[C]	4.19	0.188	4.78	. . .	. . .	. . .	. . .
20	20.000	508.00	0.188[C]	4.78	0.218[C]	5.54	. . .	. . .	. . .	. . .
22	22.000	558.80	0.188[C]	4.78	0.218[C]	5.54	. . .	. . .	. . .	. . .
24	24.000	609.60	0.218[C]	5.54	0.250	6.35	. . .	. . .	. . .	. . .
30	30.000	762.00	0.250	6.35	0.312	7.92	. . .	. . .	. . .	. . .

[A] For pipe sizes not listed, the dimensions and tolerances shall be by agreement between the purchaser and producer.
[B] Schedules 5S and 10S wall thicknesses do not permit threading in accordance with the American National Standard for Pipe Threads (ANSI B1.20.1).
[C] These do not conform to the American National Standard for Welded and Seamless Wrought Steel Pipe (ANSI B36.10-1979).

Section VIII Division 1, Pressure Vessels[4]

2.4 *Other Standard:*

SAE J1086 Practice for Numbering Metals and Alloys (UNS)[5]

SNT-TC-1A Personnel Qualification and Certification in Nondestructive Testing[6]

3. Ordering Information

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

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

3.1.2 Name of material (austenitic steel pipe),

3.1.3 Class (1.3). If not specified by the purchaser, the producer shall have the option to furnish either single-welded (SW) or double-welded (DW) pipe,

3.1.4 Grade (Table 2),

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

3.1.6 Length (specific or random), (Section 9),

3.1.7 End finish (section on Ends of Specification A 999/A 999M),

3.1.8 Optional requirements (hydrostatic or nondestructive electric test, Section 13,) (Supplementary Requirements S1 to S6),

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

3.1.10 Specification number, and

3.1.11 Special requirements or exceptions to the specification.

4. Materials and Manufacture

4.1 *Manufacture*:

4.1.1 The pipe shall be made by a machine-welding or an automatic-welding process, welding from one or both sides and producing full penetration welds with no addition of filler metal in the welding operation.

4.1.2 Weld repairs, with the addition of compatible filler metal, may be made to the weld joint in accordance with the requirements of the section on Repair by Welding of Specification A 999/A 999M.

4.1.3 The pipe shall be pickled free of scale. When bright annealing is used, pickling is not necessary.

4.2 *Heat Treatment*:

4.2.1 Except as provided in 4.2.6 and 4.2.7, all pipe shall be furnished in the heat-treated condition, except pipe sizes over NPS 6 may be furnished in the unheat-treated condition when specified in the order. When the pipe is furnished without final heat treatment, each pipe shall be marked HT-O and when a material test report for such pipe is furnished to the purchaser, the report shall indicate that the pipe has not been heat-treated.

[4] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, http://www.asme.org.
[5] Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.
[6] Available from American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518, http://www.asnt.org.

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TABLE 2 Chemical Requirements

Grade	UNS Designation[A]	Composition, %															
		Carbon, max[B]	Manganese, max[B]	Phosphorus, max	Sulfur, max	Silicon	Nickel	Chromium	Molybdenum	Titanium	Columbium	Tantalum, max	Nitrogen[C]	Vanadium	Copper	Cerium	Cobalt
TP304	S30400	0.08	2.00	0.045	0.030	1.00 max	8.0–11.0	18.0–20.0	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
TP304H	S30409	0.04–0.10	2.00	0.045	0.030	1.00 max	8.0–11.0	18.0–20.0	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
TP304L	S30403	0.030[D]	2.00	0.045	0.030	1.00 max	8.0–12.0	18.0–20.0	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
TP304N	S30451	0.08	2.00	0.045	0.030	1.00 max	8.0–11.0	18.0–20.0	. . .	. . .	. . .	. . .	0.10–0.16	. . .	. . .	. . .	. . .
TP304LN	S30453	0.030	2.00	0.045	0.030	1.00 max	8.0–11.0	18.0–20.0	. . .	. . .	. . .	. . .	0.10–0.16	. . .	. . .	. . .	. . .
TP309Cb	S30940	0.08	2.00	0.045	0.030	1.00 max	12.0–16.0	22.0–24.0	. . .	. . .	10 × C min, 1.10 max	. . .	. . .	. . .	. . .	. . .	. . .
TP309S	S30908	0.08	2.00	0.045	0.030	1.00 max	12.0–15.0	22.0–24.0	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
TP310Cb	S31040	0.08	2.00	0.045	0.030	1.00 max	19.0–22.0	24.0–26.0	. . .	. . .	10 × C min, 1.10 max	. . .	. . .	. . .	. . .	. . .	. . .
TP310S	S31008	0.08	2.00	0.045	0.030	1.00 max	19.0–22.0	24.0–26.0	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
TP316	S31600	0.08	2.00	0.045	0.030	1.00 max	10.0–14.0	16.0–18.0	2.00–3.00	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
TP316H	S31609	0.04–0.10	2.00	0.045	0.030	1.00 max	10.0–14.0	16.0–18.0	2.00–3.00	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
TP316L	S31603	0.030[D]	2.00	0.045	0.030	1.00 max	10.0–14.0	16.0–18.0	2.00–3.00	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
TP316N	S31651	0.08	2.00	0.045	0.030	1.00 max	10.0–15.0	16.0–18.0	2.00–3.00				0.10–0.16	. . .	. . .	. . .	. . .
TP316LN	S31653	0.030[D]	2.00	0.045	0.030	1.00 max	10.0–13.0	16.0–18.0	2.00–3.00	. . .	. . .	. . .	0.10–0.16	. . .	. . .	. . .	. . .
TP317	S31700	0.08	2.00	0.045	0.030	1.00 max	11.0–15.0	18.0–20.0	3.0–4.0	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
TP317L	S31703	0.030	2.00	0.045	0.030	1.00 max	11.0–15.0	18.0–20.0	3.0–4.0	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
. . .	S31727	0.030	1.00	0.030	0.030	1.00 max	14.5–16.5	17.5–19.0	3.8–4.5	. . .	. . .	. . .	0.15–0.21	. . .	2.8–4.0	. . .	. . .
. . .	S32053	0.030	1.00	0.030	0.010	1.00 max	24.0–26.0	22.0–24.0	5.0–6.0	. . .	. . .	. . .	0.17–0.22	. . .	. . .	. . .	. . .
TP321	S32100	0.08	2.00	0.045	0.030	1.00 max	9.00–12.0	17.0–19.0	. . .	[E]	. . .	. . .	. . .	. . .	. . .	. . .	. . .
TP321H	S32109	0.04–0.10	2.00	0.045	0.030	1.00 max	9.00–12.0	17.0–19.0	. . .	[F]	. . .	. . .	. . .	. . .	. . .	. . .	. . .
TP347	S34700	0.08	2.00	0.045	0.030	1.00 max	9.00–12.0	17.0–19.0	. . .	. . .	[G]	. . .	. . .	. . .	. . .	. . .	. . .
TP347H	S34709	0.04–0.10	2.00	0.045	0.030	1.00 max	9.00–12.0	17.0–19.0	. . .	. . .	[H]	. . .	. . .	. . .	. . .	. . .	. . .
TP348	S34800	0.08	2.00	0.045	0.030	1.00 max	9.00–12.0	17.0–19.0	. . .	. . .	[G]	0.10	. . .	. . .	. . .	. . .	0.20 max
TP348H	S34809	0.04–0.10	2.00	0.045	0.030	1.00 max	9.00–12.0	17.0–19.0	. . .	. . .	[H]	0.10	. . .	. . .	. . .	. . .	0.20 max
TPXM-10	S21900	0.08	8.0–10.0	0.045	0.030	1.00 max	5.5–7.5	19.0–21.5	. . .	. . .	. . .	. . .	0.15–0.40	. . .	. . .	. . .	. . .
TPXM-11	S21903	0.04	8.0–10.0	0.045	0.030	1.00 max	5.5–7.5	19.0–21.5	. . .	. . .	. . .	. . .	0.15–0.40	. . .	. . .	. . .	. . .
TPXM-15	S38100	0.08	2.00	0.030	0.030	1.50–2.50	17.5–18.5	17.0–19.0	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
TPXM-19	S20910	0.06	4.0–6.0	0.045	0.030	1.00 max	11.5–13.5	20.5–23.5	1.50–3.00	. . .	0.10–0.30	. . .	0.20–0.40	0.10–0.30	. . .	. . .	. . .
TPXM-29	S24000	0.08	11.5–14.5	0.060	0.030	1.00 max	2.3–3.7	17.0–19.0	. . .	. . .	. . .	. . .	0.20–0.40	. . .	. . .	. . .	. . .
. . .	S31254	0.020	1.00	0.030	0.010	0.80 max	17.5–18.5	19.5–20.5	6.0–6.5	. . .	. . .	. . .	0.18–0.22	. . .	0.50–1.00	. . .	. . .
. . .	S30815	0.05–0.10	0.80	0.040	0.030	1.40–2.00	10.0–12.0	20.0–22.0	. . .	. . .	. . .	. . .	0.14–0.20	. . .	. . .	0.03–0.08	. . .
. . .	N08367	0.030	2.00	0.040	0.030	1.00 max	23.5–25.5	20.0–22.0	6.0–7.0	. . .	. . .	. . .	0.18–0.25	. . .	0.75 max	. . .	. . .

[A] New designation established in accordance with ASTM E 527 and SAE J1086 Practice for Numbering Metals and Alloys (UNS).
[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. [1.2 mm] in average wall thickness (0.044 in. [1 mm] in minimum wall thickness).
[E] The titanium content shall be not less than five times the carbon content and not more than 0.70 %.
[F] The titanium content shall be not less than four times the carbon content and not more than 0.70 %.
[G] The columbium plus tantalum content shall be not less than ten times the carbon content and not more than 1.0 %.
[H] The columbium plus tantalum content shall be not less than eight times the carbon content and not more than 1.10 %.

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The heat-treatment procedure, except for H grades, N08367, and S31254, 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.

4.2.2 All H grades shall be furnished in the solution-treated condition. If cold working is involved in processing, the minimum solution treating temperature for Grades TP321H, TP347H, and TP348H shall be 2000 °F [1100 °C] and for Grades TP304H and TP316H, 1900 °F [1040 °C]. If the H Grade is hot rolled, the minimum solution treating temperatures for Grades TP321H, TP347H, and TP348H shall be 1925 °F [1050 °C], and for Grades TP304H and TP316H, 1900 °F [1040 °C].

4.2.3 The heat-treatment procedure for S31254 shall consist of heating the pipe to a minimum temperature of 2100 °F [1150 °C] and quenching in water or rapidly cooling by other means.

4.2.4 S31727 and S32053 shall be heat treated 1975 to 2155 °F [1080 to 1180 °C] followed by quenching in water or rapidly cooling by other means.

4.2.5 UNS N08367 should be solution annealed from 2025 °F [1107 °C] minimum followed by rapid quenching.

4.2.6 Except for H Grades and S31254, pipe sizes over NPS 6 may be furnished in the unheat-treated condition when specified in the order.

4.2.7 H Grades and S31254 in pipe sizes NPS 6 may be furnished in the unheat-treated condition when specified in the order, provided the heat treatment of 4.2.2 or 4.2.3, as applicable, is applied by the purchaser.

4.2.8 When the pipe is furnished without final heat treatment, each pipe shall be marked HT-O and when a material test report for such pipe is furnished to the purchaser, the report shall indicate that the pipe has not been heat-treated.

5. Chemical Composition

5.1 The steel shall conform to the chemical composition in Table 2.

5.2 When specified on the purchase order, a product analysis shall be supplied from one tube or coil of steel per heat. The product analysis tolerance of Specification A 480/A 480M shall apply.

6. Product Analysis

6.1 At the request of the purchaser, an analysis of one length of flat-rolled stock from each heat, or one pipe 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 Number	Lengths of Pipe in Lot
Under 2	400 or fraction thereof
2 to 5 inclusive	200 or fraction thereof
6 and over	100 or fraction thereof

6.2 The results of these analyses shall be reported to the purchaser or his representative, and shall conform to the requirements specified in Section 5.

6.3 If the analysis of one of the tests specified in 6.1 does not conform to the requirements specified in Section 5, an analysis of each length of flat-rolled stock from each heat or pipe from the same heat or lot may be made, and all pipe conforming to the requirements shall be accepted.

6.4 For referee purposes, Test Methods, Practices, and Terminology A 751 shall be used.

7. Tensile Requirements

7.1 The tensile properties of the material shall conform to the requirements prescribed in Table 3.

8. Permissible Variations in Dimensions

8.1 Permissible variations in dimensions shall not exceed the following at any point in each length of pipe.

8.1.1 *Specified Diameter*—The outside diameter shall be based on circumferential measurement and shall not exceed the tolerances stated as follows:

8.1.1.1 For sizes up to and including NPS 1¼ , ±0.010 in. [±0.25 mm],

8.1.1.2 For sizes NPS 1½ up to and including NPS 6, ±0.020 in. [±0.5 mm],

8.1.1.3 For sizes NPS 8 up to and including NPS 18, ±0.030 in. [±0.75 mm],

8.1.1.4 For sizes NPS 20 up to and including NPS 24, ±0.040 in. [±1 mm], and

8.1.1.5 For sizes NPS 30, ±0.050 in. [±1.25 mm].

8.1.1.6 Outside diameter tolerances closer than shown above may be obtained by agreement between the pipe manufacturer and purchaser.

TABLE 3 Tensile Requirements

Grade	UNS Designation	Tensile Strength, min ksi [MPa]	Yield Strength, min ksi [MPa]
TP304L	S30403	70 [485]	25 [170]
TP316L	S31603	70 [485]	25 [170]
TP304	S30400	75 [515]	30 [205]
TP304H	S30409	75 [515]	30 [205]
TP309Cb	S30940	75 [515]	30 [205]
TP309S	S30908	75 [515]	30 [205]
TP310Cb	S31040	75 [515]	30 [205]
TP310S	S31008	75 [515]	30 [205]
TP316	S31600	75 [515]	30 [205]
TP316H	S31609	75 [515]	30 [205]
TP317	S31700	75 [515]	30 [205]
TP317L	S31703	75 [515]	30 [205]
. . .	S31727	80 [550]	36 [245]
. . .	S32053	93 [640]	43 [295]
TP321	S32100	75 [515]	30 [205]
TP321H	S32109	75 [515]	30 [205]
TP347	S34700	75 [515]	30 [205]
TP347H	S34709	75 [515]	30 [205]
TP348	S34800	75 [515]	30 [205]
TP348H	S34809	75 [515]	30 [205]
TPXM-10	S21900	90 [620]	50 [345]
TPXM-11	S21903	90 [620]	50 [345]
TPXM-15	S38100	75 [515]	30 [205]
TPXM-29	S24000	100 [690]	55 [380]
TPXM-19	S20910	100 [690]	55 [380]
TP304N	S30451	80 [550]	35 [240]
TP316N	S31651	80 [550]	35 [240]
TP304LN	S30453	75 [515]	30 [205]
TP316LN	S31653	75 [515]	30 [205]
. . .	S31254	94 [650]	44 [300]
. . .	S30815	87 [600]	45 [310]
. . .	N08367		
	t ≤ 0.187	100 [690]	45 [310]
	t > 0.187	95 [655]	45 [310]

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8.1.2 *Out-of-Roundness*—The difference between the major and the minor outside diameter shall not be more than 1.5 % of the specified outside diameter.

8.1.3 *Alignment (Camber)*—Using a 10-ft [3.0-m] straightedge placed so that both ends are in contact with the pipe, the camber shall not be more than 3⁄16 in. [4.8 mm].

8.1.4 *Thickness*—The wall thickness at any point in the pipe excluding the weld, shall not be more than 12 % under or over the nominal thickness for wall thickness less than 0.188 in. [4.8 mm] and not more than 0.030 in. [0.8 mm] under or over the nominal thickness for wall thickness 0.188 in. [4.8 mm] and greater. Weld reinforcement not to exceed 20 % of the wall thickness is permitted on each of the inside and outside surfaces of the pipe.

9. Lengths

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

9.1.1 Unless otherwise agreed upon, all sizes up to and including NPS 8 are available in a length up to 24 ft (Note 2) with the permissible range of 15 to 24 ft (Note 2). Short lengths are acceptable and the number and minimum length shall be agreed upon between the manufacturer and the purchaser.

NOTE 2—The 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 purchaser.

9.1.2 If definite cut lengths are desired, the lengths required shall be specified in the order. No pipe shall be under the specified length and not more than 1⁄4 in. [6 mm] over that specified.

10. Workmanship, Finish, and Appearance

10.1 The finished pipes shall be free of injurious imperfections and shall have a workmanlike finish. Minor imperfections may be removed by grinding, provided the wall thicknesses are not decreased to less than that permitted in Section 8.

11. Examination of Double-Welded Pipe

11.1 Both ends of each double-welded (Class DW) pipe shall be visually examined to determine that complete fusion was attained between the two welds. In lieu of examining the ends of the pipe, this examination may be performed on cropped ends removed from both ends of each double welded pipe.

12. Mechanical Tests Required

12.1 *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. Pipe size greater than NPS 6 shall be tested using the transverse tension test with the weld centered in the gage length of the test specimen. Test specimens 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 prolongation of the pipe longitudinal weld seam.

NOTE 3—The term lot, for mechanical tests, applies to all pipe of the same nominal size and wall thickness (or schedule) which is produced from the same heat of steel and subjected to the same finishing treatment: (*1*) in a continuous heat-treatment furnace, or (*2*) in a batch-type heat-treatment furnace, equipped with recording pyrometers and automatically controlled within a 50 °F [30 °C] range, the larger of: (*a*) each 200 ft [60 m] or fraction thereof or (*b*) that pipe heat treated in the same batch furnace charge.

12.2 *Flattening Test*—For material heat treated in a batch-type furnace, flattening tests shall be made on 5 % of the pipe from each heat-treated lot. For material heat treated by the continuous process, 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.

12.2.1 For pipe where the diameter equals or exceeds NPS 10, 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.

13. Hydrostatic or Nondestructive Electric Test

13.1 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.

13.2 The hydrostatic test shall be in accordance with Specification A 999/A 999M.

13.3 *Nondestructive Examination*—Each pipe shall be examined with a nondestructive test in accordance with Practice E 213, or E 426. Unless specifically called out by the purchaser, the selection of the nondestructive electric test will be at the option of the manufacturer. The range of pipe sizes that may be examined by each method shall be subject to the limitations in the scope of the respective practices.

13.3.1 The following information is for the benefit of the user of this specification:

13.3.1.1 The reference standards defined in 13.9.1-13.9.4 are convenient standards for calibration of nondestructive testing equipment. The dimensions of these standards should not be construed as the minimum size imperfection detectable by such equipment.

13.3.1.2 The ultrasonic testing (UT) can be performed to detect both longitudinally and circumferentially oriented defects. It should be recognized that different techniques should be employed to detect differently oriented imperfections. The examination may not detect short, deep, defects.

13.3.1.3 The eddy-current testing (ET) referenced in this specification, (Practice E 426), has the capability of detecting significant discontinuities, especially the short abrupt type.

13.3.1.4 A purchaser interested in ascertaining the nature (type, size, location, and orientation) of discontinuities that can be detected in the specific application of these examinations should discuss this with the manufacturer of the tubular product.

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13.4 *Time of Examination*:

13.4.1 Nondestructive testing for specification acceptance shall be performed after all mechanical processing, heat treatments, and straightening operations. This requirement does not preclude additional testing at earlier stages in the processing.

13.5 *Surface Condition*:

13.5.1 All surfaces shall be free of scale, dirt, grease, paint, or other foreign material that could interfere with interpretation of test results. The methods used for cleaning and preparing the surfaces for examination shall not be detrimental to the base metal or the surface finish.

13.5.2 Excessive surface roughness or deep scratches can produce signals that interfere with the test.

13.6 *Extent of Examination*:

13.6.1 The relative motion of the pipe and the transducer(s), coil(s), or sensor(s) shall be such that the entire pipe surface is scanned, except as in 13.5.2.

13.6.2 The existence of end effects is recognized, and the extent of such effects shall be determined by the manufacturer, and, if requested, shall be reported to the purchaser. Other nondestructive tests may be applied to the end areas, subject to agreement between the purchaser and the manufacturer.

13.7 *Operator Qualifications*:

13.7.1 The test unit operator shall be certified in accordance with SNT-TC-1A, or an equivalent recognized and documented standard.

13.8 *Test Conditions*:

13.8.1 For eddy-current testing, the excitation coil frequency shall be chosen to ensure adequate penetration yet provide good signal-to-noise ratio.

13.8.2 The maximum eddy-current coil frequency used shall be as follows:

On specified walls up to 0.050 in.—100 KHz max

On specified walls up to 0.150 in.—50 KHz max

On specified walls above 0.150 in.—10 KHz max

13.8.3 *Ultrasonic*—For examination by the ultrasonic method, the minimum nominal transducer frequency shall be 2.00 MHz and the maximum nominal transducer size shall be 1.5 in.

(1) If the equipment contains a reject notice filter setting, this shall remain off during calibration and testing unless linearity can be demonstrated at that setting.

13.9 *Reference Standards*:

13.9.1 Reference standards of convenient length shall be prepared from a length of pipe of the same grade, size (NPS, or outside diameter and schedule or wall thickness), surface finish and heat treatment condition as the pipe to be examined.

13.9.2 *For Ultrasonic Testing*, the reference ID and OD notches shall be any one of the three common notch shapes shown in Practice E 213, at the option of the manufacturer. The depth of each notch shall not exceed 12½ % of the specified nominal wall thickness of the pipe or 0.004 in., whichever is greater. The width of the notch shall not exceed twice the depth. Notches shall be placed on both the OD and ID surfaces.

13.9.3 *For Eddy-Current Testing*, the reference standard shall contain, at the option of the manufacturer, any one of the following discontinuities:

(1) Drilled Hole—The reference standard shall contain three or more holes, equally spaced circumferentially around the pipe and longitudinally separated by a sufficient distance to allow distinct identification of the signal from each hole. The holes shall be drilled radially and completely through the pipe wall, with care being taken to avoid distortion of the pipe while drilling. One hole shall be drilled in the weld, if visible. Alternately, the producer of welded pipe may choose to drill one hole in the weld and run the calibration standard through the test coils three times with the weld turned at 120° on each pass. The hole diameter shall vary with NPS as follows:

NPS Designator	Hole Diameter
½	0.039 in. [1 mm]
above ½ to 1¼	0.055 in. [1.4 mm]
above 1¼ to 2	0.071 in. [1.8 mm]
above 2 to 5	0.087 in. [2.2 mm]
above 5	0.106 in. [2.7 mm]

(2) Transverse Tangential Notch—Using a round tool or file with a ¼ in. [6.4 mm] diameter, a notch shall be filed or milled tangential to the surface and transverse to the longitudinal axis of the pipe. Said notch shall have a depth not exceeding 12½ % of the specified nominal wall thickness of the pipe or 0.004 in. (0.102 mm), whichever is greater.

(3) Longitudinal Notch—A notch 0.031 in. or less in width shall be machined in a radial plane parallel to the tube axis on the outside surface of the pipe, to have a depth not exceeding 12½ % of the specified wall thickness of the pipe or 0.004 in., whichever is greater. The length of the notch shall be compatible with the testing method.

13.9.4 More or smaller reference discontinuities, or both, may be used by agreement between the purchaser and the manufacturer.

13.10 *Standardization Procedure*:

13.10.1 The test apparatus shall be standardized at the beginning and end of each series of pipes of the same size (NPS or diameter and schedule or wall thickness), Grade and heat treatment condition, and at intervals not exceeding 4 h. More frequent standardization may be performed at the manufacturer's option or may be required upon agreement between the purchaser and the manufacturer.

13.10.2 The test apparatus shall also be standardized after any change in test system settings, change of operator, equipment repair, or interruption due to power loss, process shutdown or when a problem is suspected.

13.10.3 The reference standard shall be passed through the test apparatus at the same speed and test system settings as the pipe to be tested.

13.10.4 The signal-to-noise ratio for the reference standard shall be 2½ to 1 or greater. Extraneous signals caused by identifiable causes such as dings, scratches, dents, straightener marks, etc., shall not be considered noise. The rejection amplitude shall be adjusted to be at least 50 % of full scale of the readout display.

13.10.5 If upon any standardization, the rejection amplitude has decreased by 29 % (3 dB) of peak height from the last standardization, the pipe since the last calibration shall be rejected. The test system settings may be changed, or the

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transducer(s), coil(s) or sensor(s) adjusted, and the unit restandardized, but all pipe tested since the last acceptable standardization must be retested for acceptance.

13.11 *Evaluation of Imperfections*:

13.11.1 Pipes producing a signal equal to or greater than the lowest signal produced by the reference standard(s) shall be identified and separated from the acceptable pipes. The area producing the signal may be reexamined.

13.11.2 Such pipes shall be rejected if the test signal was produced by imperfections that cannot be identified or was produced by cracks or crack-like imperfections. These pipes may be repaired per Sections 4 and 10. To be accepted, a repaired pipe must pass the same non-destructive test by which it was rejected, and it must meet the minimum wall thickness requirements of this specification.

13.11.3 If the test signals were produced by visual imperfections such as:

(1) Scratches,
(2) Surface roughness,
(3) Dings,
(4) Straightener marks,
(5) Cutting chips,
(6) Steel die stamps,
(7) Stop marks, or
(8) Pipe reducer ripple.

The pipe may be accepted based on visual examination provided the imperfection is less than 0.004 in. [0.1 mm] or 12½ % of the specified wall thickness (whichever is greater).

13.11.4 Rejected pipe may be reconditioned and retested providing the wall thickness is not decreased to less than that required by this or the product specification. The outside diameter at the point of grinding may be reduced by the amount so removed. To be accepted, retested pipe shall meet the test requirement.

13.11.5 If the imperfection is explored to the extent that it can be identified as non-rejectable, the pipe may be accepted without further test providing the imperfection does not encroach on the minimum wall thickness.

14. Product Marking

14.1 In addition to that specified in Specification A 999/A 999M, the marking shall include the manufacturer's private identifying mark and identified as either single welded (SW) or double welded (DW) as applicable. For Grades TP304H, TP316H, TP321H, TP347H, and TP348H, the marking shall also include the heat number and heat-treatment lot identification. If specified in the purchase order, the marking for pipe larger than NPS 4 shall include the weights.

14.2 When heat treatment of the pipe is not performed, the pipe shall be marked HT-O.

14.3 When a hydrostatic test of the pipe is not performed, the pipe shall be marked NH.

15. General Requirements

15.1 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.

SUPPLEMENTARY REQUIREMENTS

One or more of the following supplementary requirements shall apply only when specified in the purchase order. The purchaser may specify a different frequency of test or analysis than is provided in the supplementary requirement. Subject to agreement between the purchaser and manufacturer, retest and retreatment provisions of these supplementary requirements may also be modified.

S1. Product Analysis

S1.1 For all pipes NPS 5 and larger in nominal size, there shall be one product analysis made of a representative sample from one piece for each ten lengths or fraction thereof from each heat of steel.

S1.2 For pipe smaller than NPS 5, there shall be one product analysis made from ten lengths per heat of steel or from 10 % of the number of lengths per heat of steel, whichever number is smaller.

S1.3 Individual lengths failing to conform to the chemical requirements specified in Section 5 shall be rejected.

S2. Transverse Tension Tests

S2.1 There shall be one transverse tension test made from one end of 10 % of the lengths furnished per heat of steel. This applies only to pipe NPS 8 and larger in nominal size.

S2.2 If a specimen from any length fails to conform to the tensile properties specified that length shall be rejected.

S3. Flattening Test

S3.1 The flattening test of Specification A 999/A 999M shall be made on a specimen from one or both ends of each pipe. Crop ends may be used. If this supplementary requirement is specified, the number of tests per pipe shall also be specified. If a specimen from any length fails because of lack of ductility prior to satisfactory completion of the first step of the flattening test requirement, that pipe shall be rejected subject to retreatment in accordance with Specification A 999/A 999M and satisfactory retest. If a specimen from any length of pipe fails because of a lack of soundness, that length shall be tested, unless subsequent retesting indicates that the remaining length is sound.

S4. Etching Tests

S4.1 The steel shall be homogeneous as shown by etching tests conducted in accordance with the appropriate portions of Method E 381. Etching tests shall be made on a cross section from one end or both ends of each pipe and shall show sound

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welds and reasonably uniform material free of injurious laminations, cracks, and similar objectionable imperfections. If this supplementary requirement is specified, the number of tests per pipe required shall also be specified. If a specimen from any length shows objectionable imperfections, the length shall be rejected subject to removal of the defective end and subsequent retests indicating the remainder of the length to be sound and reasonably uniform material.

S5. Radiographic Examination

S5.1 Weld soundness shall be determined through radiographic examination made in accordance with requirements as agreed upon between the pipe manufacturer and purchaser.

S6. Corrosion Requirements

S6.1 *Boiling Nitric Acid Test*—Except for Grade TP 321, coupons representing finished pipe made of nonmolybdenum-bearing material (0.50 % and less molybdenum) shall meet the requirements of Practice C of Practices A 262. The condition of the test specimens and the corrosion rates are as follows: Types 304L, 304LN, 347, and 348 shall be tested in the sensitized condition (heated for 1 h at 1240 °F [670 °C]) and the rate of penetration when the solution is tested in accordance with Practice C shall not exceed 0.0020 in. [0.05 mm] per month. All other nonmolybdenum-bearing types, except for Grade TP 321, shown in Table 2, shall be tested in the annealed and unsensitized condition and the rate of penetration shall not exceed 0.0015 in. [0.038 mm] per month.

S6.2 *Acidified Copper Sulfate Test*—Coupons representing finished pipe made of molybdenum-bearing material (over 0.50 % molybdenum) and Type 321 shall meet the requirements of Practice E of Practices A 262. The condition of the test specimen is as follows: Types 316L, 316LN, 317L, and 321 shall be tested in the sensitized condition (heated for 1 h at 1240 °F [670 °C]). All molybdenum-bearing types shown in Table 2 shall be tested in the annealed and unsensitized condition. All specimens shall meet the requirements of the prescribed bend tests.

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this specification since the last issue, A 813/A 813M – 01(2005), that may impact the use of this specification. (Approved September 1, 2007)

(*1*) Added S31727 and S32053 to Tables 2 and 3 and introduced their heat treatment requirements in new 4.2.4 and renumbered subsequent paragraphs.

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