SPECIFICATION FOR SEAMLESS AND WELDED FERRITIC AND MARTENSITIC STAINLESS STEEL TUBING FOR GENERAL SERVICE

SA-268/SA-268M

(Identical with ASTM Specification A 268/A 268M-05a.)

1. Scope

1.1 This specification covers a number of grades of nominal-wall-thickness, stainless steel tubing for general corrosion-resisting and high-temperature service. Most of these grades are commonly known as the "straight-chromium" types and are characterized by being ferromagnetic. Two of these grades, TP410 and UNS S41500 (Table 1), are amenable to hardening by heat treatment, and the high-chromium, ferritic alloys are sensitive to notch-brittleness on slow cooling to ordinary temperatures. These features should be recognized in the use of these materials. Grade TP439 is used primarily for hot-water tank service and does not require post-weld heat treatment to prevent attack of the heat affected zone.

1.2 An optional supplementary requirement is provided, and when desired, shall be so stated in the order.

1.3 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:*

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

A 763 Practices for Detecting Susceptibility to Intergranular Attack in Ferritic Stainless Steels

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

E 213 Practice for Ultrasonic Examination of Metal Pipe and Tubing

E 273 Practice for Ultrasonic Examination of the Weld Zone of Welded Pipe and Tubing

3. Terminology

3.1 *Lot Definitions:*

3.1.1 For flange and flaring requirements, the term lot applies to all tubes, prior to cutting, of the same nominal size and wall thickness that are produced from the same heat of steel. If final heat treatment is in a batch-type furnace, a lot shall include only those tubes of the same size and from the same heat that are heat treated in the same furnace charge. If the final heat treatment is in a continuous furnace, the number of tubes of the same size and from the same heat in a lot shall be determined from the size of the tubes as given in Table 2.

3.1.2 For tensile and hardness test requirements, the term lot applies to all tubes, prior to cutting, of the same nominal diameter and wall thickness that are produced from the same heat of steel. If final heat treatment is in a batch-type furnace, a lot shall include only those tubes of the same size and the same heat that are heat treated in the same furnace charge. If the final heat treatment is in a continuous furnace, a lot shall include all tubes of the same size and heat, heat treated in the same furnace at the same temperature, time at heat, and furnace speed.

4. Ordering Information

4.1 It is the responsibility of the purchaser to specify all requirements that are necessary for material ordered

under this specification. Such requirements may include, but are not limited to, the following:

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

4.1.2 Name of material (seamless or welded tubes),

4.1.3 Grade (Table 1),

4.1.4 Size (outside diameter and nominal wall thickness),

4.1.5 Length (specific or random),

4.1.6 Optional requirements (hydrostatic or nondestructive electric test, Section 16),

4.1.7 Test report required (Certification Section of Specification A 1016/A 1016M),

4.1.8 Specification designation,

4.1.9 Intergranular corrosion test, and

4.1.10 Special requirements.

5. General Requirements

5.1 Material furnished under this specification shall conform to the applicable requirements of Specification A 1016/A 1016M unless otherwise provided herein.

6. Manufacture

6.1 The tubes shall be made by the seamless or welded process with no filler metal added.

7. Heat Treatment

7.1 As a final heat treatment, tubes shall be reheated to a temperature of 1200°F [650°C] or higher and cooled (as appropriate for the grade) to meet the requirements of this specification.

7.2 The martensitic grade UNS S41500 shall be reheated to a temperature of 950°F [510°C] or higher and cooled as appropriate to meet the requirements of this specification.

8. Chemical Composition

8.1 The steel shall conform to the chemical requirements prescribed in Table 1.

9. Product Analysis

9.1 An analysis of either one billet or one length of flatrolled stock or one tube shall be made from each heat. The chemical composition thus determined shall conform to the requirements specified.

9.2 The product analysis tolerance of the Chemical Requirements Table of A 480/A 480M shall apply. The product analysis tolerance is not applicable to the carbon content for material with a specified maximum carbon of 0.04% or less.

9.3 If the original test for product analysis fails, retests of two additional billets, lengths of flat-rolled stock or tubes shall be made. Both retests for the elements in question shall meet the requirements of the specification; otherwise all remaining material in the heat or lot shall be rejected or, at the option of the producer, each billet or tube may be individually tested for acceptance. Billets, lengths of flat-rolled stock or tubes which do not meet the requirements of the specification shall be rejected.

10. Tensile Requirements

10.1 The material shall conform to the tensile properties prescribed in Tables 3 and 4.

11. Hardness Requirements

11.1 The tubes shall have a hardness number not to exceed those prescribed in Table 5.

12. Permissible Variations in Dimensions

12.1 Variations in outside diameter, wall thickness, and length from those specified shall not exceed the amounts prescribed in Table 6.

12.2 The permissible variations in outside diameter given in Table 6 are not sufficient to provide for ovality in thin-walled tubes, as defined in the Table. In such tubes, the maximum and minimum diameters at any cross section shall deviate from the nominal diameter by no more than twice the permissible variation in outside diameter given in Table 6; however, the mean diameter at that cross section must still be within the given permissible variation.

12.3 When the specified wall is 2% or less of the specified outside diameter, the method of measurement is in accordance with the agreement between the purchaser and the manufacturer (see Note 1).

NOTE 1 — Very thin wall tubing may not be stiff enough for the outside diameter to be accurately measured with a point contact test method, such as with the use of a micrometer or caliper. When very thin walls are specified, "go" – "no go" ring gages are commonly used to measure diameters of 1½ in. [38.1 mm] or less. A0.002 in. [0.05 mm] additional tolerance is usually added on the "go" ring gage to allow clearance for sliding. On larger diameters, measurement is commonly performed with a pi tape. Other test methods such as optical test methods may also be considered.

13. Surface Condition

13.1 All tubes shall be free of excessive mill scale, suitable for inspection. A slight amount of oxidation will

not be considered as scale. Any special finish requirements shall be subject to agreement between the manufacturer and the purchaser.

14. Mechanical Tests Required

14.1 *Tension Tests* — One tension test shall be made on a specimen for lots of not more than 50 tubes. Tension tests shall be made on specimens from two tubes for lots of more than 50 tubes.

14.2 *Flaring Test (for Seamless Tubes)* — One test shall be made on specimens from one end of one tube from each lot of finished tubes. The minimum expansion of the inside diameter shall be 10%. For tubes over 8 in. [203.2 mm] in outside diameter, or tubes with wall thickness $\frac{3}{8}$ in. [9.52 mm] and over, the flattening test may be performed instead of the flaring test unless the flaring test is specified in the purchase order.

14.3 *Flange Test (for Welded Tubes)* — One test shall be made on specimens from one end of one tube from each lot of finished tubes. For tubes over 8 in. [203.2 mm] in outside diameter, or tubes with wall thickness $\frac{3}{8}$ in. [9.52 mm] and over, the flattening test may be performed instead of the flange test unless the flange test is specified in the purchase order.

14.4 *Hardness Test* — Brinell or Rockwell hardness tests shall be made on specimens from two tubes from each lot.

14.5 When more than one heat is involved, the tension, flaring, flanging, and hardness test requirements shall apply to each heat.

14.6 *Reverse Flattening Test* — For welded tubes, one reverse flattening test shall be made on a specimen from each 1500 ft [450 m] of finished tubing.

15. Intergranular Corrosion Test

15.1 If intergranular corrosion testing is specified in the purchase order, the test shall be made in accordance with Practices A 763, using samples prepared as agreed upon between the seller and the purchaser.

16. Hydrostatic or Nondestructive Electric Test

16.1 Each tube, seamless or welded, 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.

17. Product Marking

17.1 In addition to the marking described in Specification A 1016/A 1016M, the marking shall indicate whether the tubing is seamless or welded.

18. Keywords

18.1 ferritic stainless steel; seamless steel tube; stainless steel tube; steel tube; welded steel tube

TABLE 1
CHEMICAL REQUIREMENTS

Grade	UNS Designation	Composition, % Carbon Max	Manganese Max	Phosphorous Max	Sulfur Max	Silicon Max	Nickel	Chromium	Molybdenum	Aluminum	Copper	Nitrogen	Titanium	Columbium
...	S32803	0.015[C]	0.5	0.020	0.005	0.50	3.0–4.0	28.0–29.0	1.8–2.5	...	...	0.020 max	...	0.15–0.50[F]
TP405	S40500	0.08	1.00	0.040	0.030	1.00	0.50 max	11.5–14.5	...	0.10–0.30	...	...	...	...
...	S40800	0.08	1.00	0.045	0.045	1.00	0.80 max	11.5–13.0	...	...	...	...	12 × C min; 1.10 max	...
TP409	S40900	0.08	1.00	0.045	0.030	1.00	0.50 max	10.5–11.7	...	...	...	...	6 × C min; 0.75 max	...
...	S40977	0.03	1.50	0.040	0.015	1.00	0.30–1.00	10.50–12.50	...	...	...	0.030 max	...	...
TP410	S41000	0.15	1.00	0.040	0.030	1.00	...	11.5–13.5	...	...	...	...	...	...
...	S41500[B]	0.05	0.5–1.0	0.03	0.03	0.60	3.5–5.5	11.5–14.0	0.5–1.0	...	...	...	...	...
...	S42035	0.08	1.00	0.045	0.030	1.00	1.0–2.5	13.5–15.5	0.2–1.2	...	...	...	0.30–0.50	...
TP429	S42900	0.12	1.00	0.040	0.030	1.00	...	14.0–16.0	...	...	...	...	...	...
TP430	S43000	0.12	1.00	0.040	0.030	1.00	...	16.0–18.0	...	...	...	...	...	...
TP439	S43035	0.07	1.00	0.040	0.030	1.00	0.50 max	17.00–19.00	...	0.15 max	...	0.04 max	0.20 + 4 (C + N) min; 1.10 max	...
TP430 Ti	S43036	0.10	1.00	0.040	0.030	1.00	0.75 max	16.00–19.50	...	...	...	...	5 × C min; 0.75 max	...
...	S43932	0.030	1.00	0.040	0.030	1.00	0.50	17.0–19.0	...	0.15 max	...	0.030 max	(Ti + Cb) = 0.20 + 4 (C + N) min; 0.75 max	
...	S43940	0.03	1.00	0.040	0.015	1.00	...	17.50–18.50	...	...	...	...	0.10–0.60	(3 × %C + 0.30) min
TP443	S44300	0.20	1.00	0.040	0.030	1.00	0.75 max	18.0–23.0	...	...	0.90–1.25	...	...	...
18Cr-2Mo	S44400	0.025	1.00	0.040	0.030	1.00	1.00 max	17.5–19.5	1.75–2.50	...	...	0.035 max	(Ti + Cb) = 0.20 + 4 (C + N) min; 0.80 max	
TP446-1	S44600	0.20	1.50	0.040	0.030	1.00	0.75 max	23.0–27.0	...	...	...	0.25	...	...
TP446-2[A]	S44600	0.12	1.50	0.040	0.030	1.00	0.50 max	23.0–27.0	...	...	...	0.25	...	...
TPXM-33[A]	S44626	0.06	0.75	0.040	0.020	0.75	0.50 max	25.0–27.0	0.75–1.50	...	0.20 max	0.040 max	7 × (C + N) but no less than 0.20 min; 1.00 max	...
TPXM-27	S44627	0.01[A]	0.40	0.02	0.02	0.40	0.5[D] max	25.0–27.5	0.75–1.50	...	0.2 max	0.015 max	...	0.05–0.20
25-4-4	S44635	0.025	1.00	0.040	0.030	0.75	3.5–4.5	24.5–26.0	3.5–4.5	...	...	0.035 max	(Ti + Cb) = 0.20 + 4 (C + N) min; 0.80 max	

TABLE 1
CHEMICAL REQUIREMENTS (CONT'D)

Grade	UNS Designation	Composition, %												
		Carbon Max	Manganese Max	Phosphorous Max	Sulfur Max	Silicon Max	Nickel	Chromium	Molybdenum	Aluminum	Copper	Nitrogen	Titanium	Columbium
26-3-3	S44660	0.030	1.00	0.040	0.030	1.00	1.0–3.50	25.0–28.0	3.0–4.0	...	...	0.040 max	(Ti + Cb) = 0.20–1.00 and 6 × (C + N) min	
29-4	S44700	0.010	0.30	0.025	0.020	0.20	0.15 max	28.0–30.0	3.5–4.2	...	0.15 max	0.020[E]	...	...
...	S44735	0.030	1.00	0.040	0.030	1.00	1.00 max	28.00–30.00	3.60–4.20	...	...	0.045 max	(Ti + Cb) = 0.20–1.00 and 6 ×(C + N) min	...
29-4-2	S44800	0.010	0.30	0.025	0.020	0.20	2.0–2.5	28.0–30.0	3.5–4.2	...	0.15 max	0.020[E]	...	...
TP468	S46800	0.030	1.00	0.040	0.030	1.00	0.50	18.00–20.00	...	...	...	0.030 max	0.07–0.30	0.10–0.60 (Ti + Cb) = 0.20 + 4 (C + N) min; 0.80 max

[A] For small diameter or thin walls, or both, tubing, where many drawing passes are required, a carbon maximum of 0.015% is necessary. 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 (0.040 in. [1 mm] in minimum wall thickness).
[B] Plate version of CA6NM.
[C] Carbon plus nitrogen = 0.30 max.
[D] Nickel plus copper.
[E] Carbon plus nitrogen = 0.025% max.
[F] Cb/(C + N) = 12 min.

TABLE 2
NUMBER OF TUBES IN A LOT HEAT TREATED BY THE CONTINUOUS PROCESS

Size of Tube	Size of Lot
2 in. [50.8 mm] and over in outside diameter and 0.200 in. [5.1 mm] and over in wall thickness	Not more than 50 tubes
Less than 2 in. [50.8 mm] but over 1 in. [25.4 mm] in outside diameter or over 1 in. [25.4 mm] in outside diameter and under 0.200 in. [5.1 mm] in wall thickness	Not more than 75 tubes
1 in. [25.4 mm] or less in outside diameter	Not more than 125 tubes

TABLE 3
TENSILE REQUIREMENTS

Grade and UNS Designation	Tensile Strength, Min, ksi [MPa]	Yield Strength, Min, ksi [MPa]	Elongation[A,B] in 2 in. or 50 mm, Min, %
TP405 S40500	60 [415]	30 [205]	20
. . . S40800	55 [380]	30 [205]	20
TP410 S41000	60 [415]	30 [205]	20
TP429, TP430, and TP430 Ti S42900, S43000, and S43036	60 [415]	35 [240]	20
TP443 S44300	70 [485]	40 [275]	20
TP446-1 S44600	70 [485]	40 [275]	18
TP446-2 S44600	65 [450]	40 [275]	20
TP409 S40900	55 [380]	25 [170]	20
TP439 S43035	60 [415]	30 [205]	20
S43932	60 [415]	30 [205]	20
. . . S41500	115 [795]	90 [620]	15
TPXM-27 S44627	65 [450]	40 [275]	20
TPXM-33 S44626	68 [470]	45 [310]	20
18Cr-2Mo S44400	60 [415]	40 [275]	20
29-4 and 29-4-2 S44700 and S44800	80 [550]	60 [415]	20
26-3-3 S44660	85 [585]	65 [450]	20
25-4-4 S44635	90 [620]	75 [515]	20
. . . S44735	75 [515]	60 [415]	18
28-2-3.5 S32803	87 [600]	72 [500]	16
S40977	65 [450]	41 [280]	18
S43940	62 [430]	36 [250]	18
S42035	80 [550]	55 [380]	16
TP468 S46800	60 [415]	30 [205]	22

[A] For tubing smaller than ½ in. [12.7 mm] in outside diameter, the elongation values given for strip specimens in Table 2 shall apply. Mechanical property requirements do not apply to tubing smaller than ⅛ in. [3.2 mm] in outside diameter or with walls thinner than 0.015 in. [0.4 mm].
[B] For longitudinal strip tests a deduction of 0.90% for TP446-1 and S44735 and 1.00% for all other grades shall be made from the basic minimum elongation for each 1/32 in. [0.8 mm] decrease in wall thickness below 5/16 in. [8 mm]. The following table gives the computed minimum values:

TABLE 4
MINIMUM ELONGATION VALUES

Wall Thickness		Elongation[A] in 2 in. or 50 mm, Min, %		
in.	mm	TP446-1 and S44735	S41500	All Other Grades
5/16 [0.312]	8	18	15	20
9/32 [0.281]	7.2	17	14	19
1/4 [0.250]	6.4	16	14	18
7/32 [0.219]	5.6	15	13	17
3/16 [0.188]	4.8	14	12	16
5/32 [0.156]	4	13	11	15
1/8 [0.125]	3.2	13	11	14
3/32 [0.094]	2.4	12	10	13
1/16 [0.062]	1.6	11	9	12
0.062–0.035, excl	1.6–0.9	10	8	12
0.035–0.022, excl	0.9–0.6	10	8	11
0.022–0.015, incl	0.6–0.4	10	8	11

[A] Calculated elongation requirements shall be rounded to the nearest whole number.

NOTE — The above table gives the computed minimum values for each 1/32 in. [0.8 mm] decrease in wall thickness. Where the wall thickness lies between two values shown above, the minimum elongation value shall be determined by the following equation:

Grade	Equation
TP446-1 and S44735	$E = 28.8t + 9.00$ [$E = 1.13t + 9.00$]
S41500	$E = 24t + 7.5$
All other grades	$E = 32t + 10.00$ [$E = 1.25t + 10.00$]

where:

E = elongation in 2 in. or 50 mm, %.
t = actual thickness of specimen, in. [mm].

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3/32 [0.094]	2.4	12	10	13
1/16 [0.062]	1.6	11	9	12
0.062–0.035, excl	1.6–0.9	10	8	12
0.035–0.022, excl	0.9–0.6	10	8	11
0.022–0.015, incl	0.6–0.4	10	8	11

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3/32 [0.094]	2.4	12	10	13
1/16 [0.062]	1.6	11	9	12
0.062–0.035, excl	1.6–0.9	10	8	12
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