

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-94.)

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.

NOTE 1—TP329 (S32900) formerly in this specification, has been transferred to A 789/A 789M and A 790/A 790M.

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

NOTE 2—For tubing smaller than $\frac{1}{2}$ 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 $\frac{1}{8}$ in. [3.2 mm] in outside diameter or with walls thinner than 0.015 in. [0.4 mm].

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 450/A 450M Specification for General Requirements for Carbon, Ferritic Alloy, and Austenitic Alloy Steel Tubes
- 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 789/A 789M Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Tubing for General Service
- A 790/A 790M Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Pipe
- E 527 Practice for Numbering Metals and Alloys (UNS)

2.2 Other Standard:

- SAE J1086 Practice for Numbering Metals and Alloys (UNS)

3. General Requirements

3.1 Material furnished under this specification shall conform to the applicable requirements of Specification A 450/A 450M unless otherwise provided herein.

4. Ordering Information

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

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 electric test, 13.7),

4.1.7 Test report required (Certification Section of Specification A 450/A 450M),

4.1.8 Specification designation, and

4.1.9 Special requirements.

5. Manufacture

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

6. Heat Treatment

6.1 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.

6.2 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.

7. Chemical Composition

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

8. Product Analysis

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

8.2 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.

8.3 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 (Note 3) 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.

NOTE 3 — For flange and flaring requirements, the term *lot* applies to all tubes prior to cutting of the same nominal size and wall thickness which are produced from the same heat of steel. When final heat treatment is in batch-type furnace, a lot shall include only those tubes of the same size and from the same heat which are heat treated in the same furnace charge. When 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 prescribed in Table 2.

NOTE 4 — 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. When final heat treatment is in a batch-type furnace, a lot shall include only those tubes of the same size and the same heat which are heat treated in the same furnace charge. When 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.

9. Tensile Requirements

9.1 The material shall conform to the tensile properties prescribed in Table 3.

10. Hardness Requirements

10.1 The tubes shall have a hardness number not to exceed those prescribed in Table 4.

11. Permissible Variations in Dimensions

11.1 Variations in outside diameter, wall thickness, and length from those specified shall not exceed the amounts prescribed in Table 5.

11.2 The permissible variations in outside diameter given in Table 5 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 5; however, the mean diameter at that cross section must still be within the given permissible variation.

12. Surface Condition

12.1 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.

13. Mechanical Tests Required

13.1 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 (Note 4).

13.2 Flaring Test (For Seamless Tubes) — One test shall be made on specimens from one end of one tube from each lot (Note 3) 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.

13.3 Flange Test (For Welded Tubes) — One test shall be made on specimens from one end of one tube from each lot (Note 3) 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.

13.4 Hardness Test — Brinell or Rockwell hardness tests shall be made on specimens from two tubes from each lot (Note 4).

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

13.6 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.

13.7 Hydrostatic or Nondestructive Electric Test — Each welded tube shall be subjected to either the hydrostatic or nondestructive electric test. The purchaser may specify which test is to be used. Each seamless tube shall be subjected to the hydrostatic test, or, instead of this test, a nondestructive electric test may be used when specified by the purchaser.

14. Product Marking

14.1 In addition to the marking described in Specification A 450/A 450M, the marking shall indicate whether the tubing is seamless or welded.

15. Keywords

15.1 ferritic stainless steel; seamless steel tube; stainless steel tube; steel tube; welded steel tube

TABLE 1
CHEMICAL REQUIREMENTS

NOTE — TP329 (S32900), formerly part of this specification, has been transferred to A789/A789M and A790/A790M.

Grade	TP405	TP410	TP429	TP430	TP443	TP446-1	TP446-2 ^A	...	TP409
UNS Designation ^B	S40500	S41000	S42900	S43000	S44300	S44600	S44600	S40800	S40900
Element	Composition, %								
C, max	0.08	0.15	0.12	0.12	0.20	0.20	0.12	0.08	0.08
Mn, max	1.00	1.00	1.00	1.00	1.00	1.50	1.50	1.00	1.00
P, max	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.045	0.045
S, max	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.045	0.045
Si, max	0.75	0.75	0.75	0.75	0.75	0.75	0.75	1.00	1.00
Ni	0.50 max	0.50 max	0.50 max	0.50 max	0.50 max	0.50 max	0.50 max	0.80 max	0.50 max
Cr	11.5–13.5	11.5–13.5	14.0–16.0	16.0–18.0	18.0–23.0	23.0–30.0	23.0–30.0	11.5–13.0	10.50–11.75
Mo	...	...	...	...	...	...	...	...	...
Al	0.10–0.30	...	...	...	...	...	...	...	...
Cu	...	...	...	...	0.90–1.25	...	...	...	...
N	...	...	...	...	...	0.10–0.25	0.10–0.25	...	...
Ti	...	...	...	...	...	...	...	12 × C min; 1.10 max	6 × C min; 0.75 max

Grade	TP 439	...	TP430 Ti	TP XM-27	TP XM-33 ^D	18Cr-2Mo	29-4	29-4-2	26-3-3	25-4-4	... ^C	...
UNS Designation	S43035	S41500 ^E	S43036	S44627	S44626	S44400	S44700	S44800	S44660	S44635	S44735	S32803
Element	Composition, %											
C, max	0.07	0.05	0.10	0.01 ^D	0.06	0.025	0.010	0.010	0.030	0.025	0.030	0.015 ^H
Mn, max	1.00	0.5–1.0	1.00	0.40	0.75	1.00	0.30	0.30	1.00	1.00	1.00	0.5
P, max	0.040	0.03	0.040	0.02	0.040	0.040	0.025	0.025	0.040	0.040	0.040	0.020
S, max	0.030	0.03	0.030	0.02	0.020	0.030	0.020	0.020	0.030	0.030	0.030	0.005
Si, max	1.00	0.60	1.00	0.40	0.75	1.00	0.20	0.20	1.00	0.75	1.00	0.50
Ni	0.50 max	3.5–5.5	0.75 max	0.5 ^F max	0.50 max	1.00 max	0.15 max	2.0–2.5	1.0–3.50	3.5–4.5	1.00 max	3.0–4.0
Cr	17.00– 19.00	11.5–14.0	16.00– 19.50	25.0–27.5	25.0–27.0	17.5–19.5	28.0–30.0	28.0–30.0	25.0–28.0	24.5–26.0	28.00– 30.00	28.0–29.0
Mo	...	0.5–1.0	...	0.75–1.50	0.75–1.50	1.75–2.50	3.5–4.2	3.5–4.2	3.0–4.0	3.5–4.5	3.60–4.20	1.8–2.5
Al, max	0.15	...	...	...	...	...	...	...	...	...	...	...
Cu, max	...	...	...	0.2	0.20	...	0.15	0.15	...	...	...	...
N, max	0.04	...	...	0.015	0.040	0.035	0.020 ^G	0.020 ^G	0.040	0.035	0.045	0.020
Ti	0.20 + 4 (C + N) min; 1.10 max	...	5 × C min; 0.75 max	...	7 × (C + N) but no less than 0.20 min; 1.00 max	(Ti + Cb) 0.20 + 4 (C + N) min; 0.80 max	...	...	(Ti + Cb) = 0.20–1.00 and 6 × (C + N) min	(Ti + Cb) = 0.20 + 4 (C + N) min to 0.80 max	(Ti + Cb) = 0.20 1.00 with 6 (C + N) min	...
Cb	...	...	...	0.05–0.20	...	...	...	...	...	...	...	0.15–0.50 ^I

^A TP446-2 is a lower carbon version of TP446-1 that has a lower tensile strength but improved ductility and fracture toughness.

^B New designation established in accordance with Practice E 527 and SAE J1086, Practice for Numbering Metals and Alloys (UNS).

^C When intergranular corrosion testing is specified, the test will be Practices A 763, using samples prepared as agreed upon between the seller and the purchaser.

^D 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).

^E Plate version of CA6NM.

^F Nickel plus copper.

^G Carbon plus nitrogen = 0.025% max.

^H Carbon plus nitrogen = 0.30 max.

^I 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

NOTE—TP329 (S32900), formerly part of this specification, has been transferred to A 789/A 789M and A 790/A 790M.

Grade and UNS Designation	Tensile strength, min, ksi [MPa]	Yield strength, min, ksi [MPa]	Elongation ⁴ in 2 in. or 50 mm, min, %
TP405 S40500	60 [415]	30 [205]	20
...	55 [380]	30 [205]	20
S40800			
TP410 S41000	60 [415]	30 [215]	20
TP429, TP430, and TP430 Ti S429000, 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]	30 [205]	20
TP439 S43035	60 [415]	30 [205]	20
...	115 [795]	90 [620]	15
S41500			
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
...	75 [515]	60 [415]	18
S44735			
28-2-3.5 S32803	87 [600]	72 [500]	16

TABLE 3 (CONT'D)
TENSILE REQUIREMENTS

Wall Thickness		Elongation in 2 in. or 50 mm, min, %		
in.	mm	TP446-1 and S44735	S41500	All Other Grades
$\frac{5}{16}$ [0.312]	8	18	15	20
$\frac{9}{32}$ [0.281]	7.2	17	14	19
$\frac{1}{4}$ [0.250]	6.4	16	14	18
$\frac{7}{32}$ [0.219]	5.6	15	13	17
$\frac{3}{16}$ [0.188]	4.8	14	12	16
$\frac{5}{32}$ [0.156]	4	13	11	15
$\frac{1}{8}$ [0.125]	3.2	13	11	14
$\frac{3}{32}$ [0.094]	2.4	12	10	13
$\frac{1}{16}$ [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

NOTES — The above table gives the computed minimum values for each $\frac{1}{32}$ 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, %, and
 t = actual thickness of specimen, in. [mm].

^A 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 $\frac{1}{32}$ in. [0.8 mm] decrease in wall thickness below $\frac{5}{16}$ in. [8 mm]. The following table gives the computed minimum values.

^B Calculated elongation requirements shall be rounded to the nearest whole number.

TABLE 4
HARDNESS REQUIREMENTS

NOTE — TP329 (S32900), formerly part of this specification, has been transferred to A 789/A 789M and A790/A 790M.

Grade	UNS Designation	Brinell Hardness, max	Rockwell Hardness, B Scale, max
TP405	S40500	207	95
...	S40800	207	95
TP410	S41000	207	95
TP429, TP430, and TP430 TI	S42900, S43000, and S43036	190	90
TP443	S44300	207	95
TP446-1 and TP446-2	S44600	207	95
TP409	S40900	207	95
TP439	S43055	190	90
...	S41500	295 ^A	32
TPXM-33 and TPXM-27	S44626 and S44627	241	100
18Cr-2Mo	S44400	217	95
29-4 and 29-4-2	S44700 and S44800	207	100
26-3-3	S44660	265	25 ^A
25-4-4	S44635	270	27 ^A
...	S44735	...	100
28-2-3.5	S32803	240	100

^A Rockwell hardness, C scale.

TABLE 5
PERMISSIBLE VARIATIONS IN DIMENSIONS

Group	Size, Outside Diameter, in. [mm]	Permissible Variations in Outside Diameter, in. [mm]	Permissible Variations in Wall Thickness, % ^C	Permissible Variations in Cut Length, in. ^A [mm]		
				Over	Under	Thin Walled Tubes ^B
1	Up to ½ [12.7], excl	±0.005 [0.13]	±15	⅛ [3]	0	...
2	½ to 1½ [12.7 to 38.1], excl	±0.005 [0.13]	±10	⅛ [3]	0	less than 0.065 in. [1.6 mm] nominal
3	1½ to 3½ [38.1 to 88.9], excl	±0.010 [0.25]	±10	⅜ [5]	0	less than 0.095 in. [2.4 mm] nominal
4	3½ to 5½ [88.9 to 139.7], excl	±0.015 [0.38]	±10	⅜ [5]	0	less than 0.150 in. [3.8 mm] nominal
5	5½ to 8 [139.7 to 203.2], incl	±0.030 [0.76]	±10	⅜ [5]	0	less than 0.150 in. [3.8 mm] nominal

^A These tolerances apply to cut lengths up to and including 24 ft [7.3 m]. For lengths greater than 24 ft [7.3 m], the above over tolerances shall be increased by ⅛ in. [3 mm] for each 10 ft [3 m] or fraction thereof over 24 ft, or ½ in. [13 mm], whichever is lesser.

^B Ovality provisions of 12.2 apply.

^C When tubes as ordered require wall thicknesses ¼ in. [19 mm] or over, or an inside diameter 60% or less of the outside diameter, a wider variation in wall thickness is required. On such sizes a variation in wall thickness of 12.5 % over or under will be permitted. For tubes less than ½ in. [12.7 mm] in inside diameter which cannot be successfully drawn over a mandrel, the wall thickness may vary ±15 % from that specified.

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirement shall apply only when specified by the purchaser in the inquiry, contract, or order.

S1. Air-Underwater Pressure Test

S1.1 Each tube, with internal surface clean and dry, shall be internally pressurized to 150 psi [1000 kPa] minimum with clean and dry compressed air while being submerged in clear water.

S1.2 The tube shall be well-lighted, preferably by underwater illumination.

S1.3 Any evidence of air leakage of the pneumatic couplings shall be corrected prior to testing.

S1.4 After holding the pressure for not less than 5 s after the surface of the water has become calm, an inspection shall be made of the entire external surface of the tube.

S1.5 If any tube leaks during the air-underwater test, it shall be rejected. Any leaking areas may be cut out and the tube retested as above.