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Standard Specification for Welded Unannealed Ferritic Stainless Steel Tubing¹

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1. Scope

1.1 This specification covers welded, unannealed, ferritic stainless steel tubing intended for high-temperature and corrosive service where post-weld heat treatment is not necessary for corrosion resistance. These grades are commonly known as the "straight-chromium" types and are characterized by being ferromagnetic. 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. The user requiring additional testing or examination is referred to the Supplementary Requirements or Ordering Information Section, or both. Users requiring a tubular product with post-weld heat treatment are referred to Specification A 268/A 268M.

1.2 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.

NOTE 1—For tubing smaller than 1/2 in. [12.7 mm] in outside diameter, the elongation values given for strip specimens in Table 1 shall apply. Mechanical property requirements do not apply to tubing smaller than 1/8 in. [3.2 mm] in outside diameter or with walls thinner than 0.015 in. [0.4 mm].

2. Referenced Documents

2.1 ASTM Standards:

- A 268/A 268M Specification for Seamless and Welded Ferritic and Martensitic Stainless Steel Tubing for General Service²
- A 450/A 450M Specification for General Requirements for Carbon, Ferritic Alloy, and Austenitic Alloy Steel Tubes²
- A 763 Practices for Detecting Susceptibility to Intergranular Attack in Ferritic Stainless Steels³
- E 527 Practice for Numbering Metals and Alloys (UNS)²

¹ This specification is under the jurisdiction of ASTM Committee A-1 on Steel, Stainless Steel, and Related Alloys and is the direct responsibility of Subcommittee A01.10 on Tubing.

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² Annual Book of ASTM Standards, Vol 01.01.

³ Annual Book of ASTM Standards, Vol 01.03.

TABLE 1 Tensile Requirements

Grade	UNS Designation	Tensile Strength, min, ksi [MPa]	Yield Strength, min, ksi [MPa]	Elongation ^A in 2 in. or 50 mm min, %
TP 409	S40900	55 [380]	30 [205]	20
TP 439	S40335	60 [415]	30 [205]	20
TP XM-27	S44627	65 [450]	40 [275]	18
TP XM-33	S44626	68 [410]	45 [310]	20
25-4-4	S44635	90 [620]	75 [515]	12
26-3-3	S44660	85 [585]	65 [450]	20
29-4	S44700	80 [550]	60 [415]	20
29-4-2	S44800	80 [550]	60 [415]	20
18-2	S44400	60 [415]	35 [240]	20
29-4C	S44735	75 [515]	60 [415]	12

^A For longitudinal strip tests, a deduction of 0.60 % for 29-4C, 0.90 % for TPXM-27 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 1/16 in. [1.6 mm]. The following table gives the computed minimum values:

Wall Thickness in.	mm	Elongation in 2 in. or 50 mm, min, %		
		29-4C	TP XM-27	All other Grades
5/16 [0.312]	8	12	18	20
3/32 [0.281]	7.2	11	17	19
1/4 [0.250]	6.4	11	16	18
7/32 [0.219]	5.6	10	15	17
3/16 [0.188]	4.8	10	14	16
5/32 [0.156]	4	9	13	15
1/8 [0.125]	3.2	8	13	14
3/32 [0.094]	2.4	8	12	13
1/16 [0.062]	1.6	7	11	12
0.062 to 0.035, excl	1.6 to 0.9	7	10	12
0.035 to 0.022, excl	0.9 to 0.6	7	10	11
0.022 to 0.015, excl	0.6 to 0.4	6	10	11

NOTE—The above table gives the computed minimum elongation 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:^B

$$\begin{aligned} \text{Grade 29-4C } E &= 19.2t + 6.00 \quad [E = 0.75t + 6.00] \\ \text{Grade TP XM-27 } E &= 28.8t + 9.00 \quad [E = 1.13t + 9.00] \\ \text{All Other Grades } E &= 32t + 10.00 \quad [E = 1.25t + 10.00] \end{aligned}$$

where:

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

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

SAE Standard:⁴
SAE J 1086

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 conforming to this specification

⁴ Available from Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

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TABLE 2 Chemical Requirements

UNS Designation ^A Grade	S40900 TP409	S40335 TP 439	S44627 TP XM-27	S44626 TP XM-33	S44635 25-4-4	S44660 26-3-3	S44700 29-4	S44800 29-4-2	S44735 29-4C	S44400 18-2
	Composition, %									
Carbon, max	0.08	0.07	0.01 ^C	0.06	0.025	0.030	0.010	0.010	0.030	0.025
Manganese, max	1.0	1.00	0.40	0.75	1.00	1.00	0.30	0.30	1.00	1.00
Phosphorus, max	0.045	0.040	0.02	0.040	0.040	0.040	0.025	0.025	0.040	0.040
Sulfur, max	0.045	0.030	0.02	0.020	0.030	0.030	0.020	0.020	0.030	0.030
Silicon, max	1.00	1.00	0.40	0.75	0.75	1.00	0.20	0.20	1.00	1.00
Nickel	0.50 max	0.50 max	0.5 ^D max	0.50 max	3.5–4.5	1.0–3.50	0.15 max	2.0–2.5	1.00 max	1.00 max
Chromium	10.50–11.75	17.00–19.00	25.0–27.5	25.0–27.0	24.5–26.0	25.0–28.0	28.0–30.0	28.0–30.0	28.00–30.00	17.5–19.5
Molybdenum	...	...	0.75–1.50	0.75–1.00	3.5–4.5	3.0–4.0	3.5–4.2	3.5–4.2	3.60–4.20	1.75–2.50
Aluminum	...	0.15 max	...	...	...	...	...	...	...	...
Copper	...	...	0.2 max	0.20 max	...	...	0.15 max	0.15 max	...	...
Nitrogen	...	0.04 max	0.015 max	0.040 max	0.035 max	0.040 max	0.020 max ^B	0.020 max ^B	0.045 max	0.035 max
Titanium	6 × C min; 0.75 max	0.20 + 4 (C + N) min; 1.10 max	...	7 × (C + N) but no less than 0.20 min; 1.00 max	(Ti + Cb) = 0.2 + 4(C + N) min; 0.80 max	Ti + Cb = 6 × (C + N) but no less than 0.20 min; 1.00 max	...	...	Ti + Cb = 6 × (C + N) but no less than 0.20 min; 1.00 max	(Ti + Cb) = 0.20 + 4 (C + N) min; 0.80 max
Columbium	...	...	0.05–0.20	...	...	...	...	...	...	...

^A New designation established in accordance with ASTM E 527 and SAE J1086.

^B Carbon plus nitrogen = 0.025 max.

^C 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).

^D Nickel plus copper.

should include the following, as required, to describe the desired material adequately:

- 4.1.1 Quantity (feet, metres, or number of pieces),
- 4.1.2 Name of material (welded, unannealed ferritic stainless steel tubing),
- 4.1.3 Grade (see Table 2),
- 4.1.4 Size (outside diameter and nominal wall thickness),
- 4.1.5 Length (specific or random),
- 4.1.6 Optional requirements (Supplementary Requirements S1 and S2),
- 4.1.7 Test report required (Inspection 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 a welded process with no filler metal added.

6. Chemical Composition

6.1 The steel shall conform to the chemical requirements prescribed in Table 2.

7. Product Analysis

7.1 An analysis of either 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.

7.2 If the original test for product analysis fails, retests of two additional lengths of flat-rolled stock or tubes shall be made. Both retests, for the elements in question shall meet

TABLE 3 Hardness Requirements

Grade	Brinell Hardness, max	Rockwell Hardness, B Scale, max
TP 409	207	95
TP 439	207	95
TP XM-27	241	100
TP XM-33	241	100
25-4-4	255	30
26-3-3	265	25 ^A
29-4	241	100
29-4-2	241	100
18-2	217	95
29-4C	...	25 ^A

^A Rockwell hardness, C scale.

the requirements of the specification; otherwise all remaining material in the heat or lot (Note 2) shall be rejected, or, at the option of the producer, each tube may be individually tested for acceptance. Lengths of flat-rolled stock or tubes that do not meet the requirements of the specification shall be rejected.

NOTE 2—For product analysis and flange 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. 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 4.

NOTE 3—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.

8. Tensile Properties

8.1 The material shall conform to the tensile properties prescribed in Table 2.