



Standard Specification for Seamless and Welded Austenitic Stainless Steel Sanitary Tubing¹

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This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This specification covers grades of seamless and welded austenitic stainless steel sanitary tubing intended for use in the dairy and food industry and having special surface finishes. Pharmaceutical quality may be requested, as a supplementary requirement.

1.2 This specification covers tubes in sizes up to and including 12 in. (304.8 mm) in outside diameter.

1.3 The values stated in inch-pound units are to be regarded as the standard.

1.4 Optional supplementary requirements are provided, and when one or more of these are desired, each shall be so stated in the order.

2. Referenced Documents

2.1 ASTM Standards:

A 262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels²

A 450/A 450M Specification for General Requirements for Carbon, Ferritic Alloy, and Austenitic Alloy Steel Tubes³

A 480/A 480M Specification for General Requirements for Flat Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip²

A 967 Specification for Chemical Passivation Treatments for Stainless Steel Parts²

E 527 Practice for Numbering Metals and Alloys (UNS)³

2.2 ASME Standard:

B46.1 Surface Texture (Surface Roughness, Waviness, and Lay)⁴

2.3 Other Standard:

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

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 Annual Book of ASTM Standards, Vol 01.03.

³ Annual Book of ASTM Standards, Vol 01.01.

⁴ Available from ASME International, Three Park Avenue, New York, NY 10016–5990.

⁵ Available from Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

3. Terminology

3.1 Definition:

3.1.1 *roughness average, Ra, n*—arithmetic average surface roughness normally reported in microinches or microns; a measurement of surface roughness usually performed by moving a stylus in a straight line along the surface, although other methods may be used.

4. Ordering Information

4.1 Orders for material under this specification should include the following, as required, to describe 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 Size (outside diameter and average wall thickness),

4.1.4 Length (specific or random),

4.1.5 Surface finish (Section 14),

4.1.6 Optional requirements (product analysis, see Section 9; hydrostatic or nondestructive electric test, see Section 11).

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

4.1.8 Specification designation,

4.1.9 Special requirements, and

4.2 Any supplementary requirements.

5. General Requirements

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

6. Manufacture

6.1 The tubes shall be made by the seamless or welded process.

6.2 At the manufacturer's option, tubing may be furnished either hot finished or cold finished.

7. Heat Treatment

7.1 All material shall be furnished in the heat-treated condition. The heat treatment procedure, except for N08926 and N08367, shall consist of heating the material to a minimum temperature of 1900°F (1040°C) and quenching in water or

rapid cooling by other means.

7.2 N08926 shall be heat-treated to a minimum temperature of 2010°F [1100°C] followed by quenching in water or rapidly cooling by other means. UNS N08367 should be solution annealed from 2025°F (1107°C) minimum followed by rapid quenching.

8. Chemical Composition

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

9. Product Analysis

9.1 When specified on the purchase order, a product analysis of either one billet (when seamless material is supplied) or one coil (when welded product is supplied), or from each of two finished tubes per heat shall be supplied. The product analysis tolerance of Specification A 480/A 480M shall apply.

9.2 If the analysis of one of these test specimens does not conform to the requirements specified, an analysis of two billets or two lengths of flat-rolled stock from the same heat or an analysis of two tubes from the same lot may be made, each of which shall conform to the requirements specified.

10. Mechanical Tests Required

10.1 *Reverse Flattening Test*—For welded tubes, one reverse flattening test shall be made on a specimen from each 1500 ft (457 m) of finished tubing.

11. Hydrostatic or Nondestructive Electric Test

11.1 Each tube 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.

12. Permissible Variations in Dimensions

12.1 The following variations in dimensions shall apply, unless pharmaceutical tubing (Supplementary Requirement S2) is specified. When S2 is specified, the dimensions of Table S2.3 shall apply.

12.1.1 Variations in outside diameter and length from those specified shall not exceed the amount prescribed in Table 2 for tubes with specified wall thicknesses of 0.049 in. (1.24 mm) and over. For tubes specified with wall thicknesses under 0.049 in. (1.24 mm), the diameter tolerances shall be a matter for agreement by the manufacturer and the purchaser.

12.1.2 When tubing >4 in. (101.6 mm) diameter is ordered, additional ovality may be required for thin wall tubing. Thin wall tubing applies when the specified wall is less than 0.150 in. (3.81 mm). When thin wall tubing is ordered, the maximum and minimum diameter at any cross section shall deviate from the specified diameter by no more than twice the permissible variation in outside diameter given in Table 2; however, the mean diameter at that cross section must still be within the given permissible variation.

12.1.3 The wall thickness at any point shall not vary more than 12½ %, over and under, from the average wall thickness specified.

13. Surface Finishes

13.1 The following surface finishes may be specified:

13.1.1 *Mill Finish*—A finish without additional polishing or operations intended to smooth the surface.

13.1.2 *Mechanically Polished Surface Finish*—The purchaser may specify one of the following finish numbers for a mechanically polished surface:

13.1.2.1 *Finish No. 80*—A ground finish produced by polishing a tube with an abrasive media impregnated with No. 80 grit.

13.1.2.2 *Finish No. 120*—A ground finish produced by polishing a tube with an abrasive media impregnated with No. 120 grit.

13.1.2.3 *Finish No. 180*—A ground finish produced by polishing a tube with an abrasive media impregnated with No. 180 grit.

13.1.2.4 *Finish No. 240*—A ground finish produced by polishing a tube with an abrasive media impregnated with No. 240 grit.

13.1.2.5 Other mechanically polished finishes may be

TABLE 1 Chemical Requirements

Element	Grade	TP 304	TP 304L	...	TP 316	TP 316L	...	...
	UNS Designation ^A	S30400	S30403	S31254	S31600	S31603	N08926	N08367
		Composition, %						
Carbon, max		0.08	0.035 ^B	0.020	0.08	0.035 ^B	0.020	0.030
Manganese, max		2.00	2.00	1.00	2.00	2.00	2.00	2.00
Phosphorus, max		0.045	0.045	0.030	0.045	0.045	0.030	0.040
Sulfur, max		0.030	0.030	0.010	0.030	0.030	0.010	0.030
Silicon, max		1.00	1.00	0.80	1.00	1.00	0.50	1.00
Nickel		8.0–11.0	8.0–12.0	17.5–18.5	10.0–14.0	10.0–14.0	24.0–26.0	23.5–25.5
Chromium		18.0–20.0	18.0–20.0	19.5–20.5	16.0–18.0	16.0–18.0	19.0–21.0	20.0–22.0
Molybdenum		...	...	6.0–6.5	2.00–3.00	2.00–3.00	6.0–7.0	6.0–7.0
Nitrogen ^C		...	...	0.18–0.22	...	...	0.15–0.25	0.18–0.25
Copper		...	...	0.50–1.00	...	...	0.50–1.5	0.75 max

^A New designation established in accordance with ASTM E 527 and SAE J 1086.

^B 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. (1.24 mm) in average wall thickness (0.044 in. (1.12 mm) in minimum wall thickness).

^C The method of analysis for nitrogen shall be a matter of agreement between the purchaser and manufacturer.

TABLE 2 Permissible Variations in Dimensions^A

Size, Outside Diameter, in. (mm)	Permissible Variations in Outside Diameter, in. (mm)		Permissible Variations in Cut Length, in. (mm)	
	Over	Under	Over	Under
1 ½ (38.1) and under	0.002 (0.05)	0.008 (0.20)	⅛(3.2)	0
Over 1 ½ (38.1) to 2 ½ (63.5)	0.002 (0.05)	0.011 (0.28)	⅛ (3.2)	0
Over 2 ½ (63.5) to 3 (76.2)	0.003 (0.08)	0.012 (0.30)	⅛(3.2)	0
Over 3 (76.2) to 4 (101.6)	0.003 (0.08)	0.015 (0.38)	⅛ (3.2)	0
Over 4 (101.6) to 5 ½ (139.7), excl	0.015 (0.38)	0.015 (0.38)	⅜(4.8)	0
5 ½ (139.7) to 8 (203.2), excl	0.030 (0.76)	0.030 (0.76)	⅜(4.8)	0
8 (203.2) to 12 (304.8)	0.050 (1.27)	0.050 (1.27)	⅜(4.8)	0

^A This table does not apply to pharmaceutical tubing; use Table S2.3 for tolerances on pharmaceutical tubing.

agreed upon between the purchaser and manufacturer.

13.1.3 *Electropolished Finish*—A bright reflective finish produced by electropolishing. The manufacturer may use other polishing operations prior to electropolishing.

13.1.4 *Maximum Roughness Average (Ra) Surface Finish*—The customer may specify a maximum Ra on the inside surface, outside surface, or both. The measurement of surface roughness shall be in accordance with ASME B46.1.

13.1.4.1 When no agreement is made regarding Ra measurement of longitudinally polished tube, disputes shall be resolved using measurements made in accordance with ASME B46.1.

13.2 The manufacturer shall select a manufacturing method to produce the specified finish. The operations may or may not include polishing.

13.2.1 The purchaser may specify the polishing type for either the inside surface, outside surface or both for the final desired effect.

13.2.1.1 *Longitudinally Polished Finish*— It is usually performed on the inside surface only.

13.2.1.2 *Circumferential (Rotary) Polished Finish*—This can be performed on either the inside surface, outside surface, or both.

13.2.1.3 When the surface is finished by circumferential mechanical polishing, the Ra measurement shall be measured in the longitudinal direction. Roughness measurement of a

longitudinal mechanical polished surface shall be a matter of agreement between the manufacturer and the purchaser.

13.3 Acceptance criteria for minor surface imperfections shall be a matter for agreement by the manufacturer and the purchaser.

13.4 Combinations of the above finishes for internal and external surfaces may be specified. When tubes are polished on one surface only, the other surface may be the regular mill finish.

14. Product Marking

14.1 In addition to the marking prescribed in Specification A 450/A 450M and specified in the order, the marking shall include whether the tubing is seamless or welded, and the surface finish.

15. Packaging

15.1 Unless otherwise specified in the order, all tubing shall be protected for shipment by bundling, paper or burlap wrapping, or boxing at the discretion of the manufacturer.

16. Keywords

16.1 austenitic stainless steel; seamless steel tube; stainless steel tube; steel tube; welded steel tube

SUPPLEMENTARY REQUIREMENTS

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

S1. Intergranular Corrosion Test

S1.1 When specified on the order, intergranular corrosion tests shall be performed by the manufacturer on specimens representative of the as-shipped condition. Tubes shall be capable of passing intergranular corrosion tests in the as-shipped condition. Tests shall be performed in accordance with Practice E of Practices A 262.

S2. Pharmaceutical Quality Tubing

S2.1 Chemistry:

S2.1.1 When S31600 and S31603 are ordered, sulphur content shall be restricted to the range of 0.005 to 0.017 %.

S2.2 Tensile Requirements:

S2.2.1 The material shall conform to the tensile requirements in Table S2.1.

S2.2.2 Tensile Test—One tension test shall be made on a specimen of lots not more than 50 tubes. Tension tests shall be made on specimens from two tubes for lots of more than 50 tubes (see Note S2.1).

S2.3 Hardness Requirements:

S2.3.1 The hardness shall meet the requirements in Table S2.1.

S2.3.2 Rockwell hardness tests shall be made on specimens from two tubes from each lot (see Note S2.1).

S2.4 Manipulation Tests:

S2.4.1 One flattening test shall be made on specimens from each end of one finished tube, not the one used for the flange test, from each lot (see Note S2.2).

S2.4.2 One flange test shall be made on specimens from each end of one finished tube, not the one used for the flattening test, from each lot (see Note S2.2).

S2.5 Finish:

S2.5.1 Requirements for surface finish shall be stated on the purchase order.

S2.6 Packaging:

S2.6.1 Unless the customer specified otherwise, all tubing shall be end capped, plastic sleeved, and boxed.

NOTE S2.1—For tension 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 that 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, annealed in the same furnace at the same temperature, time at heat, and furnace speed.

NOTE S2.2—For flattening 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. When 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. 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 S2.2 and Table S2.3.

S3. Chemical Cleaning (Passivation)

S3.1 When specified on the purchase order, the tubing shall be chemically cleaned in accordance with a chemical treatment listed in Specification A 967 following the final polishing operation. When tubing is supplied in an unpolished condition, the cleaning shall be performed after the final finishing operation.

TABLE S2.1 Tensile and Hardness Requirements

Grade	UNS Designation	Tensile Strength min, ksi (MPa)	Yield Strength min, ksi (MPa)	Elongation in 2 in. min, %	Rockwell Hardness Number, max.
TP304	S30400	75 (515)	30 (205)	35	B90
TP304L	S30403	70 (485)	25 (170)	35	B90
TP316	S31600	75 (515)	30 (205)	35	B90
TP316L	S31603	70 (485)	25 (170)	35	B90

TABLE S2.2 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 S2.3 Permissible Variations in Dimensions

Size, Outside Diameter, in. (mm)	Permissible Variations					
	Outside Diameter, in. (mm)		Wall, in. percent of, nominal		Cut Length, in. (mm)	
	Over	Under	Over	Under	Over	Under
1.000 (25.4) and under	0.005 (0.13)	0.005 (0.13)	10 %	10 %	2 (50.8)	0
1½ (38.1) to 2 (50.8)	0.008 (0.20)	0.008 (0.20)	10 %	10 %	2 (50.8)	0
2½ (63.5) to 3 (76.8)	0.010 (0.25)	0.010 (0.25)	10 %	10 %	2 (50.8)	0
4 (101.6)	0.015 (0.38)	0.015 (0.38)	10 %	10 %	2 (50.8)	0
6 (152.4)	0.030 (0.76)	0.030 (0.76)	10 %	10 %	2 (50.8)	0

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