Designation: A 270 – 03a

Standard Specification for Seamless and Welded Austenitic and Ferritic/Austenitic Stainless Steel Sanitary Tubing[1]

This standard is issued under the fixed designation A 270; 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.

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

1. Scope*

1.1 This specification covers grades of seamless, welded, and heavily cold worked welded austenitic and ferritic/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:* [2]

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

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

A 923 Test Methods for Detecting Detrimental Intermetallic Phase in Wrought Duplex Austenitic/Ferritic Stainless Steels

A 967 Specification for Chemical Passivation Treatments for Stainless Steel Parts

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

E 527 Practice for Numbering Metals and Alloys (UNS)

2.2 *ASME Standard:*

B46.1 Surface Texture (Surface Roughness, Waviness, and Lay)[3]

2.3 *ASME Boiler and Pressure Vessel Code:*

Section VIII Pressure Vessels[3]

2.4 *Other Standard:*

SAE J1086 Practice for Numbering Metals and Alloys (UNS)[4]

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 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 (austenitic steel tube),

4.1.3 Process seamless (SML), welded (WLD), or heavily cold worked (HCW),

4.1.4 Size (outside diameter and average wall thickness),

4.1.5 Length (specific or random),

4.1.6 Surface finish (Section 13),

4.1.7 Optional requirements (product analysis, see Section 9; hydrostatic or nondestructive electric test, see Section11).

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

4.1.9 Specification designation,

4.1.10 Special requirements, and

[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 ASME International, Three Park Avenue, New York, NY 10016–5990.

[4] Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001.

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

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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 1016/A 1016M, unless otherwise provided herein.

6. Manufacture

6.1 The tubes shall be manufactured by one of the following processes:

6.1.1 Seamless (SML) tubes shall be made by a process that does not involve welding at any stage.

6.1.2 Welded (WLD) tubes shall be made using an automated welding process with no addition of filler metal during the welding process.

6.1.3 Heavily cold worked (HCW) tubes shall be made by applying cold working of not less than 35 % reduction of thickness of both wall and weld to a welded tube prior to the final anneal. No filler shall be used in making the weld. Prior to cold working, the weld shall be 100 % radiographically inspected in accordance with the requirements of ASME Boiler and Pressure Vessel Code Section VIII, Division 1, latest revision, Paragraph UW 51.

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 S31803, S32003, S32205, S32750, 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.

7.3 S31803 and S32205 shall be heat-treated in a temperature range of 1870°F [1020°C] to 2010°F [1100°C] followed by quenching in water or rapidly cooling by other means.

7.4 S32750 shall be heat-treated in a temperature range of 1880°F [1025°C] to 2060°F [1125°C] followed by quenching in water or rapidly cooling by other means.

7.5 S32003 shall be heat-treated in a temperature range of 1850°F (1010°C) to 2010°F (1100°C).

8. Chemical Composition

8.1 An analysis of either one length of flat-rolled stock or one tube shall be made for each heat. The chemical composition thus determined shall conform to the requirements given in Table 1.

9. Product Analysis

9.1 When requested by the purchaser, product analysis tolerance in Specification 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.

9.2 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 the requirements of the specification; otherwise all remaining material in the heat or lot (Note 1) shall be rejected or, at the option of the producer, each length of flat-rolled stock or 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.

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:

12.1.1 For tubes with a specified wall thickness of 0.049 in. (1.24 mm) and greater, variations in outside diameter from those specified shall not exceed the amount prescribed in Table 2. For tubes with a specified wall thickness less than 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) outside 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 outside diameter at any cross section shall deviate from the specified outside 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 12.5 %, from the specified wall thickness.

12.1.4 Variations in length shall meet the requirements in Table 2 except when the Pharmaceutical Quality Tubing (Supplementary Requirement S2) is 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.

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TABLE 1 Chemical Requirements

Element	Grade	TP 304	TP 304L	. . .	TP 316	TP 316L	. . .	. . .	. . .	. . .	. . .	2003
	UNS Designation[A]	S30400	S30403	S31254	S31600	S31603	N08926	N08367	S31803	S32205	S32750	S32003
				Composition, %								
Carbon, max		0.08	0.035[B]	0.020	0.08	0.035[B]	0.020	0.030	0.030	0.030	0.030	0.030 max
Manganese, max		2.00	2.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00	1.20	2.00 max
Phosphorus, max		0.045	0.045	0.030	0.045	0.045	0.030	0.040	0.030	0.030	0.035	0.030
Sulfur, max		0.030	0.030	0.010	0.030	0.030	0.010	0.030	0.020	0.020	0.020	0.020 max
Silicon, max		1.00	1.00	0.80	1.00	1.00	0.50	1.00	1.00	1.00	0.80	1.00 max
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	4.5–6.5	4.5–6.5	6.0–8.0	3.0–4.0
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	21.0–23.0	22.0–23.0	24.0–26.0	19.5–22.5
Molybdenum		. . .	. . .	6.0–6.5	2.00–3.00	2.00–3.00	6.0–7.0	6.0–7.0	2.5–3.5	3.0–3.5	3.0–5.0	1.5–2.0
Nitrogen[C]		. . .	. . .	0.18–0.22	. . .	. . .	0.15–0.25	0.18–0.25	0.08–0.20	0.14–0.20	0.24–0.32	0.14–0.20
Copper		. . .	. . .	0.50–1.00	. . .	. . .	0.50–1.5	0.75 max	...	...	0.50 max	

[A] New designation established in accordance with Practice 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.

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TABLE 2 Permissible Variations in Dimensions

Size, Outside Diameter, in. (mm)	Permissible Variations in Outside Diameter, in. (mm)		Permissible Variations in Cut Length, in. (mm)[A]	
	Over	Under	Over	Under
1.000 (25.4) and under	0.005 (0.13)	0.005 (0.13)	⅛ (3.2)	0
Over 1 (25.4) to 2 (50.8)	0.008 (0.20)	0.008 (0.20)	⅛ (3.2)	0
Over 2 (50.8) to 3 (76.2)	0.010 (0.25)	0.010 (0.25)	⅛ (3.2)	0
Over 3 (76.2) to 4 (101.6)	0.015 (0.38)	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)	3⁄16 (4.8)	0
5 ½ (139.7) to 8 (203.2), excl	0.030 (0.76)	0.030 (0.76)	3⁄16 (4.8)	0
8 (203.2) to 12 (304.8)	0.050 (1.27)	0.050 (1.27)	3⁄16 (4.8)	0

[A] The cut tolerances do not apply to Pharmaceuitical Tubing in S2 (see paragraph S2.7).

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 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 1016/A 1016M and specified in the order, the marking shall include whether the tubing is seamless (SML), welded (WLD), or heavily cold worked (HCW), 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; duplex stainless steel; ferritic/austenitic stainless steel; heavily cold worked tube; seamless steel tube; stainless steel tube; steel tube; welded steel tube

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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 corrosion tests in the as-shipped condition. Tests shall be performed in accordance with Practice E of Practices A 262 for austenitic stainless alloys (intergranular corrosion test) or Practice C of Test Methods A 923 for duplex alloys (S31803, S32205, or S32750, Intermetallic phase detection).

S2. Pharmaceutical Quality Tubing

S2.1 *Chemistry:*

S2.1.1 When S31600 and S31603 are ordered, sulfur 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:*

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
	S31803	90 (620)	65 (450)	25	C30.5
2205	S32205	95 (655)	70 (485)	25	C30.5
2507	S32750	116 (800)	80 (550)	15	C32
2003	S32003	90 (620)	65 (450)	25	C30

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.

S2.7 *Permissible Variations in Dimensions:*

S2.7.1 The wall thickness shall not vary from the specified wall thickness by more than 10 %.

S2.7.2 The cut length shall not vary over the specified length by more than 2 in. (50.8 mm) or less than 0 in. (0 mm).

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.

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

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.

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SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this specification since the last issue, A 270–03, that may impact the use of this specification. (Approved December 1, 2003).

(*1*) Added paragraph 7.5, annealing temperature range.
(*2*) Added S32003 chemistry to Table 1.
(*3*) Added Physical Requirements of S32003 in Table S2.1
(*4*) Clarified ordering requirements to include purchaser's responsibility in paragraph 4.1.
(*5*) Revised Outside Diameter tolerances in Table 2 to include all intermediate sizes.
(*6*) Removed comma after "Table 2" in 12.1.4.
(*7*) Added heavily cold worked (HCW) processing in paragraphs 1.1, 4.1.3, 6.1.3, 14.1, and 16.1.

Committee A01 has identified the location of selected changes to this specification since the last issue, A 270–02a, that may impact the use of this specification. (Approved April 10, 2003).

(*1*) Changed title.
(*2*) Updated scope.
(*3*) Added Specification A 480/A 480M and Test Methods A 923 to Referenced Documents section.
(*4*) Modified 7.1, added 7.3 and 7.4.
(*5*) Changed wording of 8.1.
(*6*) Added product check tolerances from Specification A 249.
(*7*) Added keywords.
(*8*) Added S31803, S32205, and S32750 to Table 1.
(*9*) Updated S1 and S1.1.
(*10*) Added Physical Requirements for S31803, S 32205, and S 32750 in Table S2.1.

Committee A01 has identified the location of selected changes to this specification since the last issue, A 270–02, that may impact the use of this specification. (Approved November 10, 2002).

(*1*) Modified OD tolerances to 4 inch and less to match the requirements of S2.
(*2*) Clarified wording of the thickness requirement.
(*3*) Elininated Table S2.3, as it is no longer required.
(*4*) Removed Table S2.3 from Note S2.2.

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