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## 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 standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered 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:<sup>2</sup>

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 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 in the Unified Numbering System (UNS)

#### 2.2 ASME Standard:

B46.1 Surface Texture (Surface Roughness, Waviness, and Lay)<sup>3</sup>

2.3 ASME Boiler and Pressure Vessel Code: Section VIII Pressure Vessels<sup>3</sup>

2.4 Other Standard: SAE J1086 Practice for Numbering Metals and Alloys(UNS)<sup>4</sup>

### 3. Terminology

#### 3.1 Definition:

3.1.1 roughness average,  $R_a$ ,  $n$ —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.

TABLE 1 Chemical Requirements

Element	Grade	TP 304	TP 304L	...	TP 316	TP 316L	...	...	...	...	...	2003
	UNS	S30400	S30403	S31254	S31600	S31603	N08926	N08367	S31803	S32205	S32750	S32003
Composition, %												
Carbon, max		0.080	0.035B	0.020	0.080	0.035B	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	0.03	0.045	0.045	0.03	0.04	0.03	0.03	0.035	0.03
Sulfur, max		0.03	0.03	0.01	0.03	0.03	0.01	0.03	0.02	0.02	0.02	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.

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) <sup>A</sup>	
	Over	Under	Over	Under
1.000 (25.4) and under	0.005 (0.13)	0.005 (0.13)	1/8 (3.2)	0
Over 1 (25.4) to 2 (50.8)	0.008 (0.20)	0.008 (0.20)	1/8 (3.2)	0
Over 2 (50.8) to 3 (76.2)	0.010 (0.25)	0.010 (0.25)	1/8 (3.2)	0
Over 3 (76.2) to 4 (101.6)	0.015 (0.38)	0.015 (0.38)	1/8 (3.2)	0
Over 4 (101.6) to 5 1/2 (139.7), excl	0.015 (0.38)	0.015 (0.38)	3/16 (4.8)	0
5 1/2 (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

<sup>A</sup> The cut tolerances do not apply to Pharmaceutical Tubing in S2 (see paragraph S2.7).

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	C32

ASTM A249/A269/A270, JIS G3447/G3463, CNS 6668/7383						
Standard/Item	Outside Diameter				Thickness	Length
ASTM A249		O.D. <	25mm	+0.10mm	, -0.11mm	O.D. < 50.8mm +3.0mm
	25mm ≤	O.D. ≤	40mm	± 0.15mm		-0mm
	40mm <	O.D. <	50mm	±0.20mm		O.D. ≥ 50.8mm +5.0mm
	50mm ≤	O.D. <	65mm	±0.25mm		-0mm
	65mm ≤	O.D. <	75mm	±0.30mm		
	75mm ≤	O.D. ≤	100mm	±0.38mm		
	100mm <	O.D. ≤	200mm	+0.38mm	, -0.64mm	
	200mm <	O.D. ≤	225mm	+0.38mm	, -1.14mm	
ASTM A269		O.D. <	38.1mm	±0.13mm		O.D. < 12.7mm ±15%
	38.1mm ≤	O.D. <	88.9mm	±0.25mm		O.D. ≥ 12.7mm ±10%
	88.9mm ≤	O.D. <	139.7mm	±0.38mm		O.D. ≥ 38.1mm +4.8mm
	139.7mm ≤	O.D. <	203.2mm	±0.76mm		-0mm
ASTM A270		O.D. ≤	25mm	±0.13mm		O.D. ≤ 100mm +3mm
	25mm <	O.D. ≤	50mm	±0.20mm		-0mm
	50mm <	O.D. ≤	75mm	±0.25mm		O.D. > 100mm +5mm
	75mm <	O.D. <	140mm	±0.38mm		-0mm
CNS 6668		O.D. ≤	25.4mm	± 0.15mm		+10mm
JIS G3447	25.4mm <	O.D. ≤	31.8mm	± 0.16mm		-0mm
	31.8mm <	O.D. ≤	38.1mm	± 0.19mm		
	38.1mm <	O.D. ≤	76.3mm	± 0.25mm		
	76.3mm <	O.D. ≤	89.1mm	± 0.30mm	, -0.40mm	
	89.1mm <	O.D. ≤	101.6mm	± 0.35mm	, -0.40mm	
	101.6mm <	O.D. ≤	114.3mm	± 0.40mm	, -0.60mm	
	114.3mm <	O.D. ≤	139.8mm	± 0.40mm	, -0.80mm	
	139.8mm <	O.D. ≤	165.2mm	± 0.40mm	, -1.20mm	

JIS G3463		O.D. <	60mm	±0.25mm		O.D. < 40mm	t < 2mm +0.4mm	O.D. ≤ 50mm + 7mm
	60mm ≤	O.D. <	80mm	±0.30mm			-0.0mm	- 0mm
	80mm ≤	O.D. <	100mm	±0.40mm			t ≥ 2mm +20%	O.D. > 50mm +10mm
	100mm ≤	O.D. <	120mm	+0.40mm	, -0.60mm	O.D. ≥ 40mm	-0mm	-0mm
	120mm ≤	O.D. <	160mm	+0.40mm	, -0.80mm		22%	
	160mm ≤	O.D. <	200mm	+0.40mm	, -1.20mm		-0mm	
	200mm ≤	O.D.		+0.40mm	, -1.60mm			