



# Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing (Small-Diameter) for General Service<sup>1</sup>

This standard is issued under the fixed designation A 632; 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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

## 1. Scope

1.1 This specification covers grades of stainless steel tubing in sizes under  $\frac{1}{2}$  down to 0.050 in. (12.7 to 1.27 mm) in outside diameter and wall thicknesses less than 0.065 in. down to 0.005 in. (1.65 to 0.13 mm) for general corrosion-resisting and low- or high-temperature service, as designated in Table 1.

NOTE 1—The grades of austenitic stainless steel tubing furnished in accordance with this specification have been found suitable for low-temperature service down to  $-325^{\circ}\text{F}$  ( $-200^{\circ}\text{C}$ ) in which Charpy notched-bar impact values of 15 ft-lbf (20 J), minimum, are required and these grades need not be impact tested.

1.2 Optional supplementary requirements are provided and, when desired, shall be so stated in the order.

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

## 2. Referenced Documents

### 2.1 ASTM Standards:

A 262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels<sup>2</sup>

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products<sup>3</sup>

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products<sup>3</sup>

A 941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys<sup>4</sup>

E 165 Test Method for Liquid Penetrant Examination<sup>5</sup>

E 527 Practice for Numbering Metals and Alloys (UNS)<sup>4</sup>

### 2.2 SAE Standard:

SAE J 1086 Practice for Numbering Metals and Alloys (UNS)<sup>6</sup>

<sup>1</sup> 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.

Current edition approved May 10, 2001. Published June 2001. Originally published as A 632 – 69. Last previous edition A 632 – 98.

<sup>2</sup> *Annual Book of ASTM Standards*, Vol 01.03.

<sup>3</sup> *Annual Book of ASTM Standards*, Vols 01.01, 01.02, 01.03, 01.04, and 01.05.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 01.01.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 03.03.

<sup>6</sup> Available from Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

## 3. Terminology

3.1 *Definitions*—For definitions of terms used in this specification, refer to Terminology A 941.

## 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 or number of lengths),

4.1.2 Name of material (seamless or welded tubes),

4.1.3 Grade (see Table 1),

4.1.4 Size (only two of the following: outside diameter, inside diameter, and average wall),

4.1.5 Length (specific or random),

4.1.6 Optional requirements (check analysis, see Section 15; hydrostatic or nondestructive electric test, see Section 16),

4.1.7 Test report required,

4.1.8 Specification designation, and

4.1.9 Special requirements or any supplementary requirements selected, or both.

## 5. Manufacture

5.1 *Manufacture*—The tubes shall be cold finished and shall be made by the seamless or welded process.

5.2 *Heat Treatment*—All material shall be furnished in the heat-treated condition. The heat-treatment procedure shall consist of heating the material to a minimum temperature of  $1800^{\circ}\text{F}$  ( $980^{\circ}\text{C}$ ) and quenching in water or rapidly cooling by other means.

## 6. Chemical Composition

6.1 The steel shall conform to the requirements as to chemical composition as specified in Table 1.

## 7. Product Analysis

7.1 When specified on the purchase order, an analysis of either one billet or one length of flat-rolled stock or one tube shall be made from each heat. Samples for chemical analysis, except spectrochemical analysis, shall be taken in accordance with Test Methods A 751. The chemical composition thus determined shall conform to the requirements specified.

7.2 If the analysis made in accordance with 7.1 does not conform to the requirements specified, an analysis of each

TABLE 1 Chemical Requirements

Element	Composition, %									
	Grade	TP 304	TP 304L	TP 310	TP 316	TP 316L	TP 317	TP 321	TP 347	TP 348
UNS Designation <sup>A</sup>	S30400	S30403	S31000	S31600	S31603	S31700	S32100	S34700	S34800	
Carbon, max	0.08	0.030	0.15	0.08	0.030	0.08	0.08	0.08	0.08	
Manganese max	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	
Phosphorus, max	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	
Sulfur, max	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	
Silicon, max	0.75	0.75	0.75	0.75	0.75 <sup>B</sup>	0.75	0.75	0.75	0.75	
Nickel	8.0–11.0	8.0–13.0	19.0–22.0	11.0–14.0 <sup>C</sup>	10.0–15.0	11.0–14.0	9.0–13.0	9.0–13.0	9.0–13.0	
Chromium	18.0–20.0	18.0–20.0	24.0–26.0	16.0–18.0	16.0–18.0	18.0–20.0	17.0–20.0	17.0–20.0	17.0–20.0	
Molybdenum	...	...	...	2.00–3.00	2.00–3.00	3.00–4.00	...	...	...	
Titanium	...	...	...	...	...	...	<sup>D</sup>	...	...	
Columbium + tantalum	...	...	...	...	...	...	...	<sup>E</sup>	<sup>E</sup>	
Tantalum, max	...	...	...	...	...	...	...	...	0.10	

<sup>A</sup> New designation established in accordance with Practice E 527 and SAE J 1086, Practice for Numbering Metals and Alloys (UNS).  
<sup>B</sup> For seamless TP316L tubes, the silicon maximum shall be 1.00 %.  
<sup>C</sup> For welded TP 316 tubes, the nickel range shall be 10.0–14.0 %.  
<sup>D</sup> Grade TP 321 shall have a titanium content of not less than five times the carbon content and not more than 0.60 %.  
<sup>E</sup> Grades TP 347 and TP 348 shall have a columbium plus tantalum content of not less than ten times the carbon content and not more than 1.0 %.

billet or length of flat-rolled stock or tube from the same heat may be made and all billets, stock, or tubes thus conforming to the requirements shall be accepted so far as chemical composition is concerned.

8. Mechanical Properties

8.1 *Tensile Requirements*—The material shall conform to the requirements as to tensile properties specified in Table 2. These mechanical properties apply to tubing 1/8 in. (3.2 mm) and larger in outside diameter by 0.015 in. (0.38 mm) in wall thickness and heavier. Smaller sizes are available meeting the minimum tensile strength specified in Table 2; however, yield strength is not generally determined on such sizes, and the minimum elongation shall be 25 %.

9. Permissible Variations in Dimensions

9.1 Variations in diameter and wall thickness from those specified shall not exceed the amounts specified in Table 3.

10. Surface Condition

10.1 The tubes shall be pickled free of scale. When bright annealing is used, pickling is not required.

11. Number of Tests

11.1 For each lot of 100 finished tubes or fraction thereof, two tubes shall be selected at random for the flaring test (see Note 2).

11.2 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 (see Note 3).

TABLE 3 Permissible Variations in Dimensions

Outside Diameter Range	Outside Diameter, in. (mm)	Inside Diameter, in. (mm)	Wall, plus and minus, %
Up to, but not including 3/32 (0.094) in. (2.38 mm)	+0.002 (0.05) -0.000	+0.000 -0.002 (0.05)	10
3/32 (0.094) in. (2.38 mm) but not including 3/16 (0.188) in. (4.76 mm)	+0.003 (0.08) -0.000	+0.000 -0.003 (0.08)	10
3/16 to, but not including, 1/2 (0.500) in. (12.70 mm)	+0.004 (0.10) -0.000	+0.000 -0.004 (0.10)	10

NOTE 2—For flaring requirements, the term *lot* applies to all tubes of the same nominal size and wall thickness that are produced from the same heat of steel and subjected to the same finishing treatment in a continuous furnace; when final heat treatment is in a batch-type furnace, the lot shall include only those tubes that are heat treated in the same furnace charge.

NOTE 3—For tensile 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, heat treated in the same furnace at the same temperature, time at heat and furnace speed.

11.3 When more than one heat is involved, the test requirements prescribed in 15.1 shall apply to each heat.

11.4 Each tube shall be subjected to a pressure test or the nondestructive test described in Section 16.

12. Retests

12.1 If the results of tension or flaring tests do not conform to the specified requirements, retests may be made on additional tubes of double the original number from the same lot, each of which shall conform to the specified requirements.

12.2 If any tension test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted. If the elongation of any tension test specimen is less than that specified, and any part of the fracture is more than 3/4 in. (19.0 mm) from the center of the gage

TABLE 2 Tensile Requirements

Tensile strength, min, ksi (MPa)	75 <sup>A</sup> (515) <sup>A</sup>
Yield strength, min, ksi (MPa)	30 <sup>A,B</sup> (205) <sup>A,B</sup>
Elongation in 2 in. or 50 mm, min, %	35 <sup>B</sup>

<sup>A</sup> Grades TP 304L and TP 316L shall have a minimum tensile strength of 70 ksi (485 MPa) and a minimum yield strength of 25 ksi (170 MPa).

<sup>B</sup> Yield strength is not generally determined on tubing sizes smaller than 1/8 in. (3.2 mm) in outside diameter or thinner than 0.015 in. (0.38 mm) wall, so yield strength is not required on such sizes. Also, the minimum elongation required on these smaller or thinner sizes is 25 %.