



# Standard Specification for Austenitic Chromium-Nickel-Silicon Alloy Steel Seamless and Welded Tubing<sup>1</sup>

This standard is issued under the fixed designation A 953; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This specification covers grades of nominal-wall-thickness, austenitic alloy steel tubing for general corrosion-resisting and low- or high-temperature service, having a specified minimum chromium content of less than 10.50 %.

1.2 The tubing sizes and thicknesses usually furnished to this specification are ¼ in. (6.4 mm) in inside diameter and larger and 0.020 in. (0.51 mm) in nominal wall-thickness and heavier.

1.3 Mechanical property requirements do not apply to tubing smaller than ⅛ in. (3.2 mm) in inside diameter or 0.015 in. (0.38 mm) in thickness.

1.4 Some steels covered by this specification, especially the high silicon containing steels, because of their particular alloy content and specialized properties, may require special care in their fabrication and welding. Specific procedures are of fundamental importance, and it is presupposed that all parameters will be in accordance with approved methods capable of producing the desired properties in the finished fabrication.

1.5 The values stated in either inch-pound units or SI units are to be regarded separately as standard. 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. Unless the order specifies the applicable “M” specification designation (SI units), the material shall be furnished in inch-pound units.

## 2. Referenced Documents

### 2.1 ASTM Standards:

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products<sup>2</sup>

A 450/A450M Specification for General Requirements for Carbon, Ferritic Alloy, and Austenitic Alloy Steel Tubes<sup>3</sup>

A 480/A480M Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip<sup>2</sup>

A 632 Specification for Seamless and Welded Austenitic

Stainless Steel Tubing (Small-Diameter) for General Service<sup>3</sup>

### 2.2 ANSI Standard:

B 31.3 Chemical Plant and Petroleum Refinery Piping<sup>4</sup>

### 2.3 ASME Pressure Vessel Code:

Section VIII Division 1, Pressure Vessels<sup>5</sup>

## 3. Ordering Information

3.1 Orders for material under this specification should include the following, as required, to describe the desired material adequately:

3.1.1 Quantity (feet, metres, or number of lengths),

3.1.2 Name of material (seamless or welded tubes),

3.1.3 Grade (Table 1),

3.1.4 Size (outside diameter and nominal wall thickness),

3.1.5 Length (specific or random),

3.1.6 Test report required (see Section on Inspection of Specification A 450/A 450M),

3.1.7 Specification designation, and

3.1.8 Special requirements.

## 4. General Requirements

4.1 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.

## 5. Manufacture

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

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

## 6. Heat Treatment

6.1 All material shall be furnished in the heat-treated condition. Except as provided in 6.2, the heat-treatment procedure shall, consist of heating the material to a minimum temperature of 1900°F (1040°C) and quenching in water or rapidly cooling by other means.

<sup>1</sup> 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 Steel Tubing.

Current edition approved March 10, 1996. Published May 1996.

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

<sup>3</sup> Annual Book of ASTM Standards, Vol 01.01.

<sup>4</sup> Available from American National Standards Institute, W. 42nd St., 11th Floor, New York, NY 10036.

<sup>5</sup> Available from American Society for Mechanical Engineers, 345 E. 47th St., New York, NY 10017.

**TABLE 1 Chemical Requirements**

Grade	S70003
UNS Designation	
C max	0.020
Mn max	2.00
P max	0.025
S max	0.010
Si	6.5–8.0
Ni	22.0–25.0
Cr	8.0–11.0
Mo max	0.50
Fe	Balance

6.2 Controlled structural or special service characteristics shall be specified as a guide for the most suitable heat treatment. If the final heat treatment is at a temperature under 1900°F and is so specified on the order, each tube shall be stenciled with the final heat treatment temperature in degrees Fahrenheit after the suffix “HT.”

6.3 S70003 shall be heat treated in the range 1920°F (1050°C) minimum to 2010°F (1100°C) maximum followed by a water quench or rapid cooling by other means.

## 7. Chemical Composition

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

## 8. Product Analysis

8.1 An analysis of either one billet or 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.

8.2 A product analysis tolerance found in the Chemical Requirements (Product Analysis Tolerances) table 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.

8.3 If the original test for product analysis fails, retests of two additional billets, 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 shall be rejected or, at the option of the producer, each billet, length of flat-rolled stock, or tube may be individually tested for acceptance. Billets, lengths of flat-rolled stock, or tubes which do not meet the requirements of the specification shall be rejected.

## 9. Mechanical Tests Required

9.1 *Flaring Test (Seamless Tubes)*—One test shall be made on specimens from one end of one tube from each lot (Note 1) of finished tubes.

NOTE 1—The term lot applies to all tubes prior to cutting to length of the same nominal size and wall thickness which are produced from the same heat of steel. When final heat treatment is in a batch-type furnace, a heat-treatment 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 heat-treatment lot shall be determined from the size of the tubes as prescribed in Table 2.

9.2 *Flange Test (Welded Tubes)*—One test shall be made on specimens from one end of one tube from each lot (Note 1) of finished tubes.

**TABLE 2 Number of Tubes in a Lot Heat Treated by the Continuous Process**

Size of Tube	Size of Lot
2 in. and over in outside diameter and 0.200 in. (5.08 mm) and over in wall thickness	not more than 50 tubes
Less than 2 in. but over 1 in. in outside diameter or over 1 in. in outside diameter and under 0.200 in. (5.06 mm) in wall thickness	not more than 75 tubes
1 in. or less in outside diameter	not more than 125 tubes

9.3 *Hardness Test*—Brinell or Rockwell hardness determination shall be made on specimens from two tubes from each lot. 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 which 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.

9.4 When more than one heat is involved, the flaring, flanging, and hardness test requirements shall apply to each heat.

9.5 *Reverse Flattening Test*—For welded tubes, one reverse flattening test shall be made on a specimen from each 1500 ft (460 m) of finished tubing. Coiled tubing greater than 1500 ft (450 m) in length shall be sampled at both ends. A coil must be continuous without any circumferential butt welds.

9.6 *Hydrostatic or Nondestructive Electric Test*—Each tube, seamless or welded, shall be subjected to the Nondestructive Electric Test or the Hydrostatic Test. Unless specified by the purchaser, either test may be used at the option of the producer.

## 10. Hardness Requirements

10.1 S70003 shall have a maximum hardness of 220 HV or 95 HRB in the annealed condition.

10.2 For tubing less than 0.065 in. (1.65 mm) in wall thickness, it is permissible to use the Rockwell superficial hardness test or the Vickers hardness test. The superficial hardness number for S70003 shall not exceed 79 on the 30 T scale or 91 on the 15 T scale.

10.3 No hardness test shall be required on tubes smaller than ¼ in. (6.4 mm) in inside diameter or tubes having a wall thickness thinner than 0.020 in. (0.51 mm).

## 11. Tensile Requirements

11.1 The tensile properties of the material shall conform to the requirements of Table 3.

## 12. Permissible Variations in Dimensions

12.1 Variations in outside diameter, wall thickness, and length, from those specified, shall not exceed the amounts prescribed in Table 4.

12.2 The permissible variations in outside diameter given in Table 4 are not sufficient to provide for ovality in thin-walled tubes, as defined in the table. In such tubes, the maximum and minimum diameters at any cross section shall deviate from the nominal diameter by no more than twice the permissible

**TABLE 3 Tensile Requirements**

Grade	UNS Designation	Tensile Strength, min psi (MPa)	0.2 Y.S. min psi (MPa)	Elongation 2 in. or 50 mm or 4D min, %
...	S70003	78 (540)	35 (240)	40

**TABLE 4 Permissible Variations in Dimensions**

Group	Size, Outside Diameter, in.	Permissible Variations in Outside Diameter, in. (mm)	Permissible Variations in Wall Thickness, <sup>A</sup> %	Permissible Variations in Cut Length, in. (mm) <sup>B</sup>		Thin Walled Tubes <sup>C</sup>
				Over	Under	
1	Up to ½	±0.005 (0.13)	±15	⅛ (3.2)	0	...
2	½ to 1½, excl	±0.005 (0.13)	±10	⅛ (3.2)	0	less than 0.065 in. (1.65 mm) nominal
3	1 ½ to 3 ½, excl	±0.010 (0.25)	±10	⅜ (4.8)	0	less than 0.095 in. (2.41 mm) nominal
4	3½ to 5 ½, excl	±0.015 (0.38)	±10	⅜ (4.8)	0	less than 0.150 in. (3.81 mm) nominal
5	5½ to 8, excl	±0.030 (0.76)	±10	⅜ (4.8)	0	less than 0.150 in. (3.81 mm) nominal

<sup>A</sup>When tubes as ordered require wall thicknesses ¾ in. (19.0 mm) or over, or an inside diameter 60 % or less of the outside diameter, a wider variation in wall thickness is required. On such sizes a variation in wall thickness of 12.5 % over or under will be permitted.

For tubes less than ½ in. (12.7 mm) in inside diameter which cannot be successfully drawn over a mandrel, the wall thickness may vary ±15 % from that specified.

<sup>B</sup>These tolerances apply to cut lengths up to and including 24 ft (7.3 m). For lengths over 24 ft an additional over tolerance of ⅛ in. (3.2 mm) for each 10 ft (3.0 m) or fraction thereof shall be permissible, up to a maximum tolerance of ½ in. (12.7 mm).

<sup>C</sup>Ovality provisions of 12.2 apply.

variation in outside diameter given in Table 3; however, the mean diameter at that cross section must still be within the given permissible variation.

### 13. Surface Condition

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

### 14. Product Marking

14.1 In addition to the marking prescribed in Specification A 450/A 450M, the marking shall include whether the tubing is seamless or welded and the final heat-treatment temperature in

degrees Fahrenheit after the suffix “HT” if the final heat treatment temperature is under 1900°F (1040°C).

14.2 When the Nondestructive Electric Test is performed, each length of tubing shall be marked with the letters “NDE,” and the certification, when required, shall also indicate this test.

### 15. Keywords

15.1 steel; tube

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