Designation: A632 – 04 (Reapproved 2009)

Standard Specification for
Seamless and Welded Austenitic Stainless Steel Tubing
(Small-Diameter) for General Service

This standard is issued under the fixed designation A632; 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.

1. Scope
1.1 This specification covers grades of stainless steel tubing in sizes under 1/2 in. 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°F (−200°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 standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

2. Referenced Documents
2.1 ASTM Standards:
A262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels
A380 Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
E165 Practice for Liquid Penetrant Examination for General Industry
E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

2.2 SAE Standard:
SAE J 1086 Practice for Numbering Metals and Alloys (UNS)

3. Ordering Information
3.1 Orders for product under this specification should include the following, as required, to describe the desired material adequately:
3.1.1 Quantity (feet or number of lengths),
3.1.2 Name of product (seamless or welded tubes),
3.1.3 Grade (see Table 1),
3.1.4 Size (only two of the following: outside diameter, inside diameter, and average wall),
3.1.5 Length (specific or random),
3.1.6 Optional requirements (check analysis, see Section 7; hydrostatic, air underwater pressure test, or nondestructive electric test, see Section 13),
3.1.7 Test report required,
3.1.8 Specification designation, and
3.1.9 Special requirements or any supplementary requirements selected, or both.

4. General Requirements
4.1 Tubing furnished under this specification shall conform to the applicable requirements of the current edition of Specification E165, unless otherwise provided herein.

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°F (980°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. The chemical composition thus determined shall conform to the specified requirements.
7.2 If the analysis made in accordance with 7.1 does not conform to the specified requirements, an analysis of each 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 ½ in. (3.2 mm) and larger in outside diameter by 0.015 in. (0.38 mm) 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).

Note 2—For flaring 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 continuous furnace, a lot shall include all those tubes that are heat treated in the same furnace charge.

TABLE 2 Tensile Requirements

<table>
<thead>
<tr>
<th>Element</th>
<th>Grade 7</th>
<th>Grade 9</th>
<th>Grade 10</th>
<th>Grade 11</th>
<th>Grade 12</th>
<th>Grade 13</th>
<th>Grade 14</th>
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<tbody>
<tr>
<td>Outside Diameter Range</td>
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<td>Inside Diameter, in. (mm)</td>
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<td>Wall, plus and minus, %</td>
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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).

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 12.1 shall apply to each heat.

11.4 Each tube shall be subjected to a pressure test or the nondestructive test described in Section 13.

12. Flaring Test

12.1 Flaring Test—A section of tube approximately 4 in. (101.6 mm) in length shall stand being flared with a tool having a 60° included angle until the tube at the mouth of the flare has been expanded to the following percentages without cracking or showing flaws:

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Ratio of Inside Diameter to Outside Diameter | Minimum Expansion of Inside Diameter, %
--- | ---
0.9 | 21
0.8 | 22
0.7 | 25
0.6 | 30
0.5 | 39
0.4 | 51
0.3 | 68

**Note 4**—These flare tests shall not be required on sizes under 0.093 in. (2.38 mm) in inside diameter.

### 13. Hydrostatic, Air Underwater Pressure Test, or Nondestructive Electric Test

13.1 Each tube shall be subjected to the hydrostatic test, air underwater pressure test, or nondestructive electric test. The type of test to be used shall be at the option of the manufacturer, unless otherwise specified in the purchase order.

13.2 **Hydrostatic Test:** Each tube shall be subjected to a hydrostatic test at a test pressure not exceeding 1000 psi (6.89 MPa).

13.3 **Air Underwater Pressure Test:** Each tube shall be subjected to an air underwater pressure test, at a test pressure as given by the following equation or 500 psi (3.4 MPa), whichever is less:

\[ P = \frac{2St}{D} \]  

where:
- \( P \) = air pressure, psi or MPa
- \( S \) = allowable fiber stress of 16,000 psi (110.3 MPa),
- \( t \) = specified wall thickness, in. or mm, and
- \( D \) = specified outside diameter, in. or mm.

13.4 **Nondestructive Electric Test:**

13.5 Each tube shall be subjected to a nondestructive electric test that is capable of detecting imperfections with a depth exceeding 10% of the wall thickness or 0.002 in. (0.05 mm), whichever is greater. Testing will not be required on sizes under 0.125 in. (3.18 mm) in outside diameter. However, at the option of the purchaser, tubing to be drawn to a diameter under 0.125 in. may be tested while in the range from 0.156 in. (3.97 mm) to 0.125 in. outside diameter, and any defects that are found shall be culled out before any further reductions are made.

### 14. Keywords

14.1 austenitic stainless steel; seamless tube; small diameter; 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. Dye Penetrant Inspection

S1.1 Each tube shall be submitted to a visible dye or fluorescent dye penetrant examination. The procedure for this specification shall conform to Test Method E165. The type penetrant and the acceptance level shall be agreed upon between the purchaser and manufacturer.

#### S2. Embrittlement Test

S2.1 Tubing shall be capable of meeting the intergranular corrosion test specified in Practice E of Practices A262 in the as-shipped condition. Stabilized and low-carbon grades shall be capable of meeting the requirements of this test in the sensitized condition (1 h at 1240°F [675°C]).

#### S3. Cleanliness

S3.1 When specified, tubing shall be supplied *thermocouple clean* on the inside surface. *Thermocouple clean* is defined as being free of all drawing compounds, carbon, dirt, dust, visible surface oxides, scale, and other contaminants.

S3.1.1 Verify the freedom from inside visible surface oxides and scale by cutting two short lengths of tubing as specimens and longitudinally sectioning both. Pickle one of the specimens in accordance with Specification A380 and then wash both. Visually, without magnification, compare the pickled and unpickled specimens to confirm that neither exhibits surface oxides or scale on their inside surfaces.

S3.1.2 Verify cleanliness and freedom from contaminants, such as drawing compounds, carbon, dirt, and dust, by passing a solvent-saturated swatch of lint-free yarn or cloth, or a felt plug through the tube. Isopropyl alcohol, methanol, ethanol, denatured alcohol, or acetone followed by alcohol are acceptable solvents. Because acetone leaves a residual film, cleaning with acetone alone is not acceptable. While a heavy discoloration of the swatch or plug is unacceptable, a light discoloration is acceptable unless particles of grit or metallic flakes are visually detectable without the use of magnification.

S3.2 After verifying that the inside surface is thermocouple clean, the tubing shall be capped or otherwise protected to ensure cleanliness upon arrival at its destination. The producer and purchaser shall agree on the method of protection.

#### S4. Unstraightened Tubes

S4.1 When the purchaser specifies tubes unstraightened after final heat treatment (such as coils), the minimum yield strength of Table 2 shall be reduced by 5 ksi.

S4.2 On the certification, and wherever the grade designation for unstraightened tubing appears, it shall be identified with the suffix letter U (for example, 304-U, 321-U, and so forth.).