



Standard Specification for High-Frequency Induction Welded, Unannealed, Austenitic Steel Condenser Tubes¹

This standard is issued under the fixed designation A 851; 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 nominal-wall-thickness tubes intended for use as steam surface condenser tubes. These tubes are made from the austenitic steels listed in Table 1 using a high-frequency induction welding process where post-weld solution heat treatment is not necessary for corrosion resistance.

1.2 The tubing sizes and thickness usually furnished to this specification are 5/8 in. (15.9 mm) to 3 1/8 in. (79.4 mm) in outside diameter and 0.015 to 0.109 in. (0.40 to 2.8 mm), inclusive, in wall thickness. Tubing having other dimensions may be furnished, provided such tubes comply with all other requirements of this specification.

1.3 Optional supplementary requirements are provided in this specification and, when one or more of these are desired, each shall be so stated in the order.

1.4 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 Steels²

A 450/A450M-85a Specification for General Requirements for Carbon, Ferritic Alloy, and Austenitic Alloy Steel Tubes³

E 426 Practice for Electromagnetic (Eddy-Current) Examination of Seamless and Welded Tubular Products, Austenitic Stainless Steel and Similar Alloys⁴

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),

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² Annual Book of ASTM Standards, Vol 01.03.

³ Annual Book of ASTM Standards, Vol 01.01.

⁴ Annual Book of ASTM Standards, Vol 03.03.

TABLE 1 Chemical Requirements

Composition, %		
Grade:	TP304	TP304L
UNS Designation ^A	S30400	S30403
Carbon, max	0.08	0.035
Manganese, max	2.00	2.00
Phosphorus, max	0.040	0.040
Sulfur, max	0.030	0.030
Silicon, max	0.75	0.75
Nickel	8.00–11.0	8.00–13.0
Chromium	18.0–20.0	18.0–20.0

^A New designation established in accordance with ASTM-E-527 and SAE J 1086, Practice for Numbering Metals and Alloys (UNS).

3.1.2 Name of material (high-frequency, induction-welded, unannealed tubes),

3.1.3 Grade (see Table 1),

3.1.4 Size (outside diameter and nominal wall thickness),

3.1.5 Length (specific or random),

3.1.6 Optional requirement (Section 10),

3.1.7 Test report required (see Certification Section of Specification A 450/A 450M),

3.1.8 Specification designation, and

3.1.9 Special requirements and any supplementary requirements (S1, S2, S3, or S4) selected.

4. General Requirements

4.1 Material furnished under this specification should conform to the applicable requirements of the current edition of Specification A 450/A 450M, unless otherwise provided herein.

5. Materials and Manufacture

5.1 The tubes shall be manufactured from flat-rolled steel by a high-frequency induction welding process with no addition of filler metal.

5.2 The high-frequency welded tubes shall be manufactured by heating the edges of the formed strip to the required welding temperature using high-frequency electric current and pressing them firmly together causing a forge-type joint to be formed with internal and external flash or bead.

5.3 The external flash, that portion of the weld that extends beyond the nominal wall, shall always be removed.

5.4 The internal flash shall be removed to the extent that it shall not exceed 0.006 in. (0.15 mm) in height or 10 % of the nominal wall thickness, whichever is greater.

5.5 There shall be no evidence of cracks or lack of penetration or overlaps resulting from flash removal in the weld.

6. Strip Heat Treatment

6.1 The tubes shall be manufactured from strip solution heat treated by heating the material to a minimum temperature of 1900°F (1040°C) for a sufficient time, and then quenching in water or rapidly cooling by other means.

7. Chemical Composition

7.1 The austenitic steel (strip) shall conform to the chemical composition requirements in Table 1.

8. Product Analysis

8.1 When specified on the purchase order, sample analysis of either the flat-rolled stock or finished tube shall be made on each heat. The chemical composition determined shall conform to the requirements specified in Table 1.

8.2 If the initial test for product analysis fails, retests of two additional samples of flat-rolled stock or tubes shall be made. Both retests, for the elements in question, shall meet the requirements of this 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.

NOTE 1—For Product Analysis 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.

9. Tensile Properties

9.1 The austenitic steel welded tubes shall conform to the tensile properties prescribed in Table 2.

10. Forming Operations

10.1 The tubes, when inserted in the condenser and properly manipulated, shall be capable of roller expanding and impact flaring without showing cracks or flaws.

11. Permissible Variations in Dimensions

11.1 Dimensional tolerances other than wall thickness tolerances shall be in accordance with Specification A 450/A 450M. Wall thickness tolerances shall be $\pm 10\%$ of the nominal wall for all tubing sizes.

12. Finish and Appearance

12.1 Finished tubes shall have smooth ends free of burrs and shall not deviate from straightness by more than 0.50 in. (12.7 mm) in 10 ft. (3048 mm) of length.

TABLE 2 Tensile Requirements

Grade	UNS Designation	Tensile Strength min. ksi (MPa)	Yield Strength min. ksi (MPa)	Elongation, in 2 in. or 50 mm, min, %
TP340	S30400	75 (515)	30 (205)	35
TP304L	S30403	70 (485)	25 (170)	35

13. Surface Condition

13.1 The tubes shall be furnished clean and free of scale.

14. Mechanical Tests

14.1 *Tension Test*—Two tubes shall be selected from each lot (Note 2) and subjected to the tension test.

14.2 *Flattening Test*—One flattening test shall be made on a specimen from each of two pieces selected from each lot (Note 2).

14.3 *Reverse Bend Test*—One reverse bend test shall be made on a specimen from each of two pieces selected from each lot (Note 2).

14.4 *Flare Test*—One flare test shall be made on a specimen from each of two pieces selected from each lot (Note 2).

NOTE 2—For the tension test, flattening test, reverse bend test, and flare test, the lot size shall be 500 tubes or 6000 lbs (2724 kg) or a fraction of either, whichever constitutes the greater weight, of the same size and nominal wall thickness tube manufactured from the same heat of steel. Samples taken for the purpose of the tests prescribed in the specification shall be selected in a manner that will correctly represent the material furnished and avoid needless destruction of finished material when samples representative of the material are available from other sources.

15. Reverse-Bend Test

15.1 A 3 in. (100 mm) in length shall be split longitudinally 90° on each side of the weld. The sample shall then be opened and bent around a mandrel with a diameter four times the wall thickness, with the mandrel parallel to the weld and on the outside of the tube. The weld shall be at the point of maximum bend. There shall be no evidence of cracks or lack of penetration in the weld.

16. Eddy-Current Test

16.1 All tubes shall be 100 % full-length eddy-current tested in the mill line prior to cutoff in accordance with E 426 and A 450/A 450M except for the following requirements:

16.1.1 *Transverse Tangential Notch*—Using a round tool or file with a ¼-in. (6.4-mm) diameter, four notches shall be filed in a line tangential to the surface and transverse to the longitudinal axis of the tube. Said notches shall have a depth not exceeding 12½ % of the specified wall thickness of the tube or 0.004 in. (0.10 mm), whichever is greater.

16.1.2 Calibrate the testing apparatus at the start of each production run and at least once during each 4 h of continuous operation or whenever improper functioning of the equipment is suspected, except as agreed upon between purchaser and supplier.

17. Intergranular Corrosion Test

17.1 Intergranular corrosion tests shall be performed by the manufacturer on specimens of TP304L that have received a sensitizing heat treatment and for the other austenitic types on specimens representative of the as-shipped condition. Tests shall be performed in accordance with Practice E of Practices A 262.

18. Product Marking

18.1 In addition to the marking requirements in Specification A 450/A 450M, the marking shall include the letters “HT-O” to indicate that the tube was not heat treated.