

SPECIFICATION FOR ELECTRIC-RESISTANCE-WELDED FERRITIC ALLOY-STEEL BOILER AND SUPERHEATER TUBES



SA-250/SA-250M

(Identical with ASTM Specification A250/A250M-05(2014) except that Supplementary Requirement S1 is mandatory when 100% weld joint efficiency is required.)

Standard Specification for Electric-Resistance-Welded Ferritic Alloy-Steel Boiler and Superheater Tubes

1. Scope

1.1 This specification covers several grades, designated T1, T1a, T1b, T2, T11, T12 and T22, of minimum-wall-thickness, electric-resistance-welded, carbon-molybdenum and chromium-molybdenum alloy-steel, boiler and superheater tubes.

1.2 The tubing sizes and thicknesses usually furnished to this specification are ½ to 5 in. [12.7 to 127 mm] in outside diameter and 0.035 to 0.320 in. [0.9 to 8.1 mm], inclusive, in minimum wall thickness. Tubing having other dimensions may be furnished, provided such tubes comply with all other requirements of this specification.

1.3 Mechanical property requirements do not apply to tubing smaller than ⅛ in. [3.2 mm] in inside diameter or 0.015 in. [0.4 mm] in thickness.

1.4 An optional supplementary requirement is provided for non-destructive examination for certain ASME applications.

1.5 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.5.1 Within the text, the SI units are shown in brackets.

1.5.2 The inch-pound units shall apply unless the “M” designation of this specification is specified in the order.

2. Referenced Documents

2.1 *ASTM Standards:*

A1016/A1016M Specification for General Requirements for Ferritic Alloy Steel, Austenitic Alloy Steel, and Stainless Steel Tubes

E213 Practice for Ultrasonic Testing of Metal Pipe and Tubing

E273 Practice for Ultrasonic Testing of the Weld Zone of Welded Pipe and Tubing

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 (electric-resistance-welded tubes),

3.1.3 Grade (Table 1),

3.1.4 Size (outside diameter or minimum wall thickness),

3.1.5 Length (specific or random),

3.1.6 Optional requirement (7.3.6),

3.1.7 Test report required (see Certification Section of Specification A1016/A1016M),

3.1.8 Specification designation, and

3.1.9 Special requirements and any supplementary requirements selected.

4. General Requirements

4.1 Product furnished under this specification shall conform to the applicable requirements of Specification A1016/A1016M, including any supplementary requirements that are indicated in the purchase order. Failure to comply with the general requirements of Specification A1016/A1016M constitutes nonconformance with this specification. In case of conflicts with the requirements of this specification and Specification A1016/A1016M, this specification shall prevail.

5. Materials and Manufacture

5.1 The steel shall be killed.

5.2 The tubes shall be made by electric-resistance welding.

5.3 Heat Treatment

5.3.1 After welding, or when cold finished, after the final cold-drawing pass, all tubes shall be heat treated and, except as provided in 5.3.2, furnished in the full annealed, isothermal annealed, normalized, or normalized and tempered condition at

TABLE 1 Chemical Requirements

| Element | Composition, % | | | | | | |
|-----------------|----------------|-----------|-----------|-----------|-----------|-----------|-----------|
| | Grade T1 | Grade T1a | Grade T1b | Grade T2 | Grade T11 | Grade T12 | Grade T22 |
| Carbon | 0.10–0.20 | 0.15–0.25 | 0.14 max | 0.10–0.20 | 0.05–0.15 | 0.05–0.15 | 0.15 max |
| Manganese | 0.30–0.80 | 0.30–0.80 | 0.30–0.80 | 0.30–0.61 | 0.30–0.60 | 0.30–0.61 | 0.30–0.60 |
| Phosphorus, max | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.030 | 0.025 |
| Sulfur, max | 0.025 | 0.025 | 0.025 | 0.020 | 0.020 | 0.020 | 0.020 |
| Silicon | 0.10–0.50 | 0.10–0.50 | 0.10–0.50 | 0.10–0.30 | 0.50–1.00 | 0.50 max | 0.50 max |
| Molybdenum | 0.44–0.65 | 0.44–0.65 | 0.44–0.65 | 0.44–0.65 | 0.44–0.65 | 0.44–0.65 | 0.87–1.13 |
| Chromium | ... | ... | ... | 0.50–0.81 | 1.00–1.50 | 0.80–1.25 | 1.90–2.60 |

the option of the manufacturer. If furnished in the normalized and tempered condition, the minimum tempering temperature shall be 1200 °F [650 °C], except T22 shall be tempered at 1250 °F [676 °C] minimum.

5.3.2 When grades T1, T1a, T1b, and T2 are cold finished, the tubes may, at the option of the manufacturer, be heat treated after the final cold-drawing pass at a temperature of 1200 °F or higher, provided one of the heat treatments specified in 5.3.1 was applied after welding.

6. Chemical Composition

6.1 The steel shall conform to the requirements given in Table 1.

6.2 Product Analysis

6.2.1 An analysis of either one length of flat-rolled stock or one tube shall be made on each heat. The chemical composition thus determined shall conform to the requirements given in Table 1.

6.2.2 If the original test for product analysis fails, retests of two additional 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 (See 8.1) 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.

7. Mechanical Requirements

7.1 Tensile Requirements

7.1.1 The material shall conform to the requirements as to tensile properties given in Table 2.

7.1.2 Table 3 gives the computed minimum elongation values for each 1/32-in. [0.8-mm] decrease in wall thickness. Where the wall thickness lies between two values given in Table 3, the minimum elongation value shall be determined by the following equation:

$$E = 48t + 15.00 [E = 1.87t + 15.00]$$

where:

E = elongation in 2 in. [50 mm] %, and
 t = actual thickness of specimen, in.[mm].

7.2 *Hardness Requirements*—The tubes shall have a hardness not exceeding the values given in Table 4.

7.3 Mechanical Tests Required

7.3.1 *Tension Test*—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 8.2).

7.3.2 *Flattening Test*—One flattening test shall be made on specimens from each end of one finished tube, not the one used for the flange test, from each lot (See 8.1).

7.3.3 *Flange Test*—One flange test shall be made on specimens from each end of one finished tube, not the one used for the flattening test, from each lot (See 8.1).

7.3.4 *Reverse Flattening Test*—One reverse flattening test shall be made on a specimen from each 1500 ft [450 m] of finished tubing.

7.3.5 *Hardness Test*—Brinell and Rockwell hardness tests shall be made on specimens from two tubes from each lot (See 8.2).

7.3.6 *Hydrostatic or Nondestructive Electric Tests*—Each tube shall be subjected to either the hydrostatic or the nondestructive electric test. The purchaser may specify which is to be used.

8. Sampling

8.1 For flattening and flange requirements, the term *lot* applies to all tubes prior to cutting of the same specified outside diameter and specified 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 from the same heat that are heat treated in the same furnace charge. When the final heat treatment is in a

TABLE 2 Tensile Requirements

| Grade | T1 | T1a | T1b | T2 | T11 | T12 | T22 |
|---|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| Tensile strength, min, ksi [MPa] | 55 [380] | 60 [415] | 53 [365] | 60 [415] | 60 [415] | 60 [415] | 60 [415] |
| Yield strength, min, ksi [MPa] | 30 [205] | 32 [220] | 28 [195] | 30 [205] | 30 [205] | 32 [220] | 30 [205] |
| Elongation in 2 in. or 50 mm, min, % | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| For longitudinal strip tests a deduction shall be made for each 1/32-in. [0.8-mm] decrease in wall thickness below 5/16 in. [8 mm] from the basic minimum elongation of the following percentage points | 1.50 ^A |

^A See Table 3 for the computed minimum values.

TABLE 3 Minimum Elongation Values

| Wall Thickness | | Elongation in 2 in. or 50 mm, min,% ⁴ |
|----------------|-----|---|
| in. | mm | Grades T1, T1a, T1b, T2, T11, T12, and T22 |
| 5/16 (0.312) | 8 | 30 |
| 3/32 (0.281) | 7.2 | 29 |
| 1/4 (0.250) | 6.4 | 27 |
| 7/32 (0.219) | 5.6 | 26 |
| 3/16 (0.188) | 4.8 | 24 |
| 5/32 (0.156) | 4 | 22 |
| 1/8 (0.125) | 3.2 | 21 |
| 3/32 (0.094) | 2.4 | 20 |
| 1/16 (0.062) | 1.6 | 18 |

⁴ Calculated elongation requirements shall be rounded to the nearest whole number.

TABLE 4 Hardness Requirements

| Grade | Brinell Hardness Number (Tubes 0.200 in. [5.1 mm] and over in wall thickness), HBW | Rockwell Hardness Number (Tubes less than 0.200 in. [5.1 mm] in wall thickness), HRB |
|-------|---|---|
| T1 | 146 | 80 |
| T1a | 153 | 81 |
| T1b | 137 | 77 |
| T2 | 163 | 85 |
| T11 | 163 | 85 |
| T12 | 163 | 85 |
| T22 | 163 | 85 |

continuous furnace, the number of tubes of the same size and from the same heat in a lot shall be determined from the size of the tubes given in Table 5.

8.2 For tensile and hardness test requirements, the term *lot* applies to all tubes prior to cutting, of the same specified outside diameter and specified 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.

9. Forming Operations

9.1 Tubes when inserted in the boiler shall stand expanding and beading without showing cracks or flaws. Superheater tubes when properly manipulated shall stand all forging, welding, and bending operations necessary for application without developing defects.

TABLE 5 Number of Tubes in a Lot Heat Treated by the Continuous Process

| Size of Tube | Size of Lot |
|---|-------------------------|
| 2 in. [50.8 mm] and over in outside diameter and 0.200 in. [5.1 mm] and over in wall thickness | not more than 50 tubes |
| Less than 2 in. [50.8 mm] but over 1 in. [25.4 mm] in outside diameter or over 1 in. [25.4 mm] in outside diameter and under 0.200 in. [5.1 mm] in wall thickness | not more than 75 tubes |
| 1 in. [25.4 mm] or less in outside diameter | not more than 125 tubes |

10. Product Marking

10.1 In addition to the marking prescribed in Specification A1016/A1016M, the marking shall include the words “Electric Resistance-Welded Steel.”

11. Keywords

11.1 boiler tube; resistance welded steel tube; steel tube, alloy; superheater tube; welded steel tube

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements may become a part of the specification when specified in the inquiry or invitation to bid, and purchase order or contract. These requirements shall not be considered, unless specified in the order and the necessary tests shall be made at the mill.

S1. Additional Testing of Welded Tubing for 100 % Joint Efficiency in Certain ASME Applications

S1.1 Where this supplement is specified in the purchase order, in certain ASME applications it is permissible to use 100 % joint efficiency for the longitudinal weld, provided the following additional requirements are met:

S1.1.1 Each tube shall be subjected to an ultrasonic inspection employing Practices E273 or E213E273E213 with the rejection criteria referenced in Specification A1016/A1016M.

S1.1.2 If Practice E273 is employed, a 100 % volumetric inspection of the entire length of each tube shall also be performed using one of the non-destructive electric tests permitted by Specification A1016/A1016M.

S1.1.3 The test methods described in the supplement may not be capable of inspecting the end portions of tubes. This condition is referred to as end effect. This portion, as determined by the manufacturer, shall be removed and discarded.

S1.1.4 In addition to the marking prescribed in Specification A1016/A1016M, “S1” shall be added after the grade designation.

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