Standard Specification for Seamless Medium-Carbon Steel Boiler and Superheater Tubes

1. Scope

1.1 This specification covers minimum-wall-thickness, seamless medium-carbon steel, boiler tubes and boiler flues, including safe ends (see Note 1), arch and stay tubes, and superheater tubes.

Note 1—This type is not suitable for safe ending by forge welding.

1.2 The tubing sizes and thicknesses usually furnished to this specification are 1/2 in. to 5 in. [12.7 to 127 mm] in outside diameter and 0.035 to 0.500 in. [0.9 to 12.7 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 1/8 in. [3.2 mm] in inside diameter or 0.015 in. [0.4 mm] in thickness.

1.4 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. 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. 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:

A450/A450M Specification for General Requirements for Carbon and Low Alloy Steel Tubes

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 tubes),
3.1.3 Grade,
3.1.4 Manufacture (hot-finished or cold-finished),
3.1.5 Size (outside diameter and minimum wall thickness),
3.1.6 Length (specific or random),
3.1.7 Optional requirements (Sections 7 and 10),
3.1.8 Test report required, (see Certification Section of Specification A450/A450M),
3.1.9 Specification designation, and
3.1.10 Special requirements.

4. General Requirements

4.1 Material furnished under this specification shall conform to the applicable requirements of the current edition of Specification A450/A450M, unless otherwise provided herein.

5. Manufacture

5.1 Steelmaking Practice—The steel shall be killed.

5.2 The tubes shall be made by the seamless process and shall be either hot-finished or cold-finished, as specified.

6. Heat Treatment

6.1 Hot-finished tubes need not be heat treated. Cold-finished tubes shall be given a subcritical anneal, a full anneal, or a normalizing heat treatment after the final cold finishing process.

7. Surface Condition

7.1 If pickling or shot blasting or both are required, this shall be specifically stated in the order.

8. Chemical Composition

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

8.2 When a grade is ordered under this specification, supplying an alloy grade that specifically requires the addition of
any element other than those listed for the ordered grade in Table 1 is not permitted.

9. Product Analysis

9.1 When requested on the purchase order, a product analysis shall be made by the supplier from one tube or billet per heat. The chemical composition thus determined shall conform to the requirements specified.

9.2 If the original test for product analysis fails, retests of two additional billets 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 Note 2) shall be rejected or, at the option of the producer, each billet or tube may be individually tested for acceptance. Billets or tubes which do not meet the requirements of the specification shall be rejected.

Note 2—For flattening and flaring requirements, the term “lot” applies to all tubes prior to cutting 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 lot shall include only those tubes of the same size and 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 treated in the same furnace at the same temperature, time at heat, and furnace speed.

10. Tensile Requirements

10.1 The material shall conform to the requirements as to tensile properties prescribed in Table 3.

### Table 1 Chemical Requirements

<table>
<thead>
<tr>
<th>Element</th>
<th>Grade A-1</th>
<th>Grade C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>0.27</td>
<td>0.35</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.93 max</td>
<td>0.29–1.06</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>0.035</td>
<td>0.035</td>
</tr>
<tr>
<td>Sulfur</td>
<td>0.10</td>
<td>0.10</td>
</tr>
</tbody>
</table>

\[ \text{E} = \text{t} \times 15.00 \]

10.2 Table 4 gives the computed minimum elongation values for each % reduction of 0.8-mm decrease in wall thickness. Where the wall thickness lies between two values shown above, the minimum elongation value shall be determined by the following equation:

\[ E = 48t + 15.00 \]

### Table 2 Number of Tubes in a Lot Heat Treated by the Continuous Process

<table>
<thead>
<tr>
<th>Size of Tube</th>
<th>Size of Lot</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 in. (50.8 mm) and over in outside diameter and 0.200 in. (6.1 mm) and over in wall thickness</td>
<td>not more than 50 tubes</td>
</tr>
<tr>
<td>2 in. (50.8 mm) and over in outside diameter and under 0.200 in. (5.1 mm) in wall thickness</td>
<td>not more than 75 tubes</td>
</tr>
<tr>
<td>Less than 2 in. (50.8 mm) but over 1 in. (25.4 mm)</td>
<td>not more than 75 tubes</td>
</tr>
<tr>
<td>1 in. (25.4 mm) or less in outside diameter</td>
<td>not more than 125 tubes</td>
</tr>
</tbody>
</table>

### Table 3 Tensile Requirements

<table>
<thead>
<tr>
<th>Grade A-1</th>
<th>Grade C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile strength, min, ksi [MPa]</td>
<td>60 [415]</td>
</tr>
<tr>
<td>Yield strength, min, ksi [MPa]</td>
<td>37 [255]</td>
</tr>
<tr>
<td>Elongation in 2 in. or 50 mm, min, %</td>
<td>30</td>
</tr>
</tbody>
</table>

When longitudinal strip tests, a deduction shall be made for each % reduction of 0.8-mm decrease in wall thickness under the basic minimum elongation of the following percentage points:

\[ E = 1.50 \times 4 \] (four times the diameter) is used.

### Table 4 Computed Minimum Elongation Values

<table>
<thead>
<tr>
<th>Wall Thickness, in. [mm]</th>
<th>Elongation in 2 in. or 50 mm, min, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/8 (0.125) [3.2]</td>
<td>21</td>
</tr>
<tr>
<td>3/16 (0.188) [4.8]</td>
<td>24</td>
</tr>
<tr>
<td>1/4 (0.250) [6.4]</td>
<td>27</td>
</tr>
<tr>
<td>5/32 (0.156) [4]</td>
<td>22</td>
</tr>
<tr>
<td>3/32 (0.238) [6.1]</td>
<td>26</td>
</tr>
<tr>
<td>1/8 (0.250) [6.4]</td>
<td>27</td>
</tr>
<tr>
<td>5/32 (0.312) [7.9]</td>
<td>30</td>
</tr>
</tbody>
</table>

When standard round 2-in. or 50-mm gage length or smaller proportionally sized specimen with the gage length equal to 4D (four times the diameter) is used

\[ E = 48t + 15.00 \]

where:

\[ E = \text{elongation in 2 in. or 50 mm, %} \]

10.2 Table 4 gives the computed minimum elongation values for each % reduction of 0.8-mm decrease in wall thickness. Where the wall thickness lies between two values shown above, the minimum elongation value shall be determined by the following equation:

\[ E = 48t + 15.00 \]

11. Hardness Requirements

11.1 The tubes shall have a hardness not exceeding the following: 79 HRB or 143 HB for Grade A-1, 89 HRB or 179 HB for Grade C.

12. Mechanical Tests Required

12.1 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 not more than 50 tubes (see Note 3).

12.2 Flattening Test—One flattening test shall be made on specimens from each end of one finished tube from each lot (see Note 2), but not the one used for the flaring test. Tears or breaks occurring at the 12 or 6 o’clock positions on Grade C tubing with sizes of 2.375 in. [60.3 mm] in outside diameter and smaller shall not be considered a basis for rejection.
12.3 *Flaring Test*—One flaring test shall be made on specimens from each end of the one finished tube from each lot (see Note 2), but not the one used for the flattening test.

12.4 *Hardness Test*—Brinell or Rockwell hardness tests shall be made on specimens from two tubes from each lot (see Note 3).

12.5 *Hydrostatic or Nondestructive Electric Test*—Each tube shall be subjected to the hydrostatic, or, instead of this test, a nondestructive electric test may be used when specified by the purchaser.

13. **Forming Operations**

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

14. **Product Marking**

14.1 In addition to the marking prescribed in Specification A450/A450M, the marking shall indicate whether the tube is hot-finished or cold-finished.

14.2 *Bar Coding*—In addition to the requirements in 14.1 bar coding is acceptable as a supplemental identification method. The purchaser may specify in the order a specific bar coding system to be used.

15. **Keywords**

15.1 boiler tubes; carbon; seamless steel tube; steel tube; superheater tubes