



Designation: A178/A178M – 02(Reapproved 2007)

# Standard Specification for Electric-Resistance-Welded Carbon Steel and Carbon- Manganese Steel Boiler and Superheater Tubes<sup>1</sup>

This standard is issued under the fixed designation A178/A178M; 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.

*This standard has been approved for use by agencies of the Department of Defense.*

## 1. Scope

1.1 This specification<sup>2</sup> covers minimum-wall-thickness, electric-resistance-welded tubes made of carbon steel and carbon-manganese steel intended for use as boiler tubes, boiler flues, superheater flues, and safe ends.

NOTE 1—Type C and D tubes are not suitable for safe-ending for forge welding.

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 0.360 in. [0.9 to 9.1 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 ¼ in. [3.2 mm] in inside diameter or 0.015 in. [0.4 mm] in thickness.

1.4 Optional supplementary requirements are provided and when desired, shall be so stated in the order.

1.5 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.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.09 on Carbon Steel Tubular Products.

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<sup>2</sup> For ASME Boiler and Pressure Vessel Code applications see related Specification SA-178 in Section II of that Code.

## 2. Referenced Documents

2.1 *ASTM Standards*:<sup>3</sup>

A450/A450M Specification for General Requirements for Carbon and Low Alloy 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 (A, C, or D, Table 1),

3.1.4 Size (outside diameter and minimum wall thickness),

3.1.5 Length (specific or random),

3.1.6 Optional requirements (product analysis, Section 7; crush test, Section 10; hydrostatic or nondestructive electric test, 11.6),

3.1.7 Test report required (Certification Section of Specification A450/A450M),

3.1.8 Specification designation,

3.1.9 Individual supplementary requirements, if required, and

3.1.10 Special requirements.

## 4. Manufacture

4.1 The steel for Grade D shall be killed.

4.2 Tubes shall be made by electric-resistance welding.

<sup>3</sup> For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

\*A Summary of Changes section appears at the end of this standard

**TABLE 1 Chemical Requirements**

Element	Composition, %		
	Grade A, Low-Carbon Steel	Grade C, Medium-Carbon Steel	Grade D, Carbon-Manganese Steel
Carbon	0.06–0.18	0.35 max	0.27 max
Manganese	0.27–0.63	0.80 max	1.00–1.50
Phosphorus, max	0.035	0.035	0.030
Sulfur, max	0.035	0.035	0.015
Silicon	...	...	0.10 min

## 5. Heat Treatment

5.1 After welding, all tubes shall be heat treated at a temperature of 1650°F [900°C] or higher and followed by cooling in air or in the cooling chamber of a controlled-atmosphere furnace. Cold-drawn tubes shall be heat treated after the final cold-draw pass at a temperature of 1200°F [650°C] or higher.

## 6. Chemical Composition

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

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

## 7. Product Analysis

7.1 When requested on the purchase order, a product analysis shall be made by the manufacturer or supplier from one tube per 100 pieces for sizes over 3 in. [76.2 mm] and one tube per 250 pieces for sizes 3 in. [76.2 mm] and under; or when tubes are identified by heat, one tube per heat shall be analyzed. The chemical composition thus determined shall conform to the requirements specified.

7.2 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 (**Note 2**) 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 which do not meet the requirements of the specifications shall be rejected.

**NOTE 2**—A lot consists of 250 tubes for sizes 3 in. [76.2 mm] and under and of 100 tubes for sizes over 3 in. [76.2 mm], prior to cutting to length.

## 8. General Requirements

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

## 9. Tensile Requirements

9.1 Grade C and D tubes shall conform to the requirements as to tensile properties prescribed in **Table 2**.

**NOTE 3**—*Explanatory Note*—For purposes of design the following tensile properties may be assumed for Grade A tubes:

**TABLE 2 Tensile Requirements**

	Grade C	Grade D
Tensile strength, min, ksi [MPa]	60 [415]	70 [485]
Yield strength, min, ksi [MPa]	37 [255]	40 [275]
Elongation in 2 in. or 50 mm, min, %	30	30
For longitudinal strip tests a deduction 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 shall be made.	1.50 <sup>A</sup>	1.50 <sup>A</sup>

<sup>A</sup> See **Table 3** for the computed minimum values.

Tensile strength, min, ksi [MPa]	47 [325]
Yield Strength, min, ksi [MPa]	26 [180]
Elongation in 2 in. or 50 mm, min, %	35

## 10. Crush Test

10.1 When required by the purchaser, crushing tests shall be made on sections of tube 2½ in. [63 mm] in length which shall stand crushing longitudinally without cracking, splitting, or opening at the weld, as follows:

Wall Thickness of Tubes, in. [mm]	Height of Crushed Section, in. [mm]	
	Grade A Tubes	Grade C and D Tubes
0.135 [3.43] and under	¾ [19] or until outside folds are in contact	Crush tests not required
Over 0.135 [3.43]	1¼ [32]	...

10.2 **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 shown above, 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. or 50 mm, %, and,  
 $t$  = actual thickness of specimen, in. [mm].

10.3 For tubing less than 1 in. [25.4 mm] in outside diameter, the length of the specimen shall be 2½ times the outside diameter of the tube. Slight surface checks shall not be cause for rejection.

**TABLE 3 Minimum Elongation Values**

Wall Thickness		Elongation in 2 in. or 50 mm, min, % <sup>A</sup>
in.	mm	
5/16 (0.312)	8	30
9/32 (0.281)	7.2	29
¼ (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

<sup>A</sup> Calculated elongation requirements shall be rounded to the nearest whole number.