



# Standard Specification for Steel Tubes, Carbon and Carbon Manganese, Fusion Welded, for Boiler, Superheater, Heat Exchanger and Condenser Applications<sup>1</sup>

This standard is issued under the fixed designation A1020/A1020M; 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.

## 1. Scope

1.1 This specification covers minimum wall thickness welded tubes made from carbon and carbon manganese steels listed in **Table 1**, with various grades intended for use in boiler, superheater, heat exchanger, or condenser applications.

1.2 The tubing sizes and thicknesses usually furnished to this specification are  $\frac{1}{4}$  to 5 in. [6.3 to 127 mm] in outside diameter and 0.015 to 0.375 in. [0.4 to 9.5 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 Mechanical property requirements do not apply to tubing smaller than  $\frac{1}{8}$  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 the specification is specified in the order.

1.5 Optional supplementary requirements are provided and when desired, shall be so stated on the purchase order.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory requirements prior to use.*

<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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## 2. Referenced Documents

2.1 *ASTM Standards*:<sup>2</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 (welded tubes).

3.1.3 Grade (**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, hydrostatic or nondestructive electric test, crush test, and bar coding).

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

3.1.8 Specification designation.

3.1.9 Optional supplementary requirements are provided and when desired, shall be designated on the order.

## 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. Materials and Manufacture

5.1 All steels shall be killed.

<sup>2</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.

**TABLE 1 Chemical Requirements, Composition, %**

Element	Grade A Low Carbon Steel	Grade C Medium Carbon Steel	Grade D Carbon Manganese Steel
Carbon	0.06–0.18	0.30 max	0.27 max
Manganese	0.27–0.63	0.80 max	1.00–1.50
Phosphorus	0.035 max	0.035 max	0.030 max
Sulfur	0.035 max	0.035 max	0.015 max
Silicon	No Requirement	No Requirement	0.10 min

5.2 The tubes shall be made by an automatic fusion welding process with no addition of filler metal.

## 6. Heat Treatment

6.1 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.

## 7. Chemical Composition

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

7.2 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.

## 8. Product Analysis

8.1 For the purpose of product analysis, a lot consists of 250 pieces for sizes up to and including 3 in. [76.2 mm] OD and 100 pieces for sizes over 3 in. [76.2 mm] OD; or when tubes are identified by heat number, all tubes within that heat.

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

8.3 If the original test for product analysis fails, retest of two additional tubes per lot 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 shall be rejected; or at the option of the producer, each tube may be individually tested for acceptance and those pieces that do not meet the requirements of the specification shall be rejected.

## 9. Tensile and Hardness Requirements

9.1 The term lot for tension and hardness tests applies to all tubes prior to cutting, of the same specified outside diameter 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 the same heat which 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.

9.2 For Grade A tubes, hardness test shall be made on specimens from each of two tubes from each lot and shall not have a hardness number exceeding 72 HRB.

9.3 Grade C and D tubes, one tension test shall be made on specimens from each of two tubes from each lot and shall conform to properties prescribed in **Table 2**.

9.4 **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, min, %, and  
 $t$  = actual wall thickness of specimen, in. [mm].

## 10. Crush Test

10.1 Where specified in the purchase order, crushing tests shall be made. The test specimens shall be sections of tube having a length that is at least 2½ times the specified outside diameter of the tube for tubes that are less than 1 in. [25.4 mm] in specified outside diameter, and at least 2½ in. [63 mm] for tubes that are 1 in. [25.4 mm] or larger in specified outside diameter. Slight surface checks shall not be cause for rejection. The test specimens shall withstand 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	Grades C and D Tubes
0.135 in. [3.4] and under	¾ in. [19] or until outside folds are in contact		Crush tests not required
Over 0.135 in. [3.4]	1¼ [32]		

## 11. Mechanical Tests Required

11.1 For mechanical tests, a lot consists of 250 tubes for sizes up to and including 3 in. [76.2 mm] and 100 tubes for sizes over 3 in. [76.2 mm], or fraction thereof, prior to cutting.

11.2 *Flattening Tests*—One flattening test shall be made on specimens from each of two tubes from each lot or fraction thereof.

11.3 *Flange Test*:

**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 elongation 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.

Note—For the purposes of design, the following tensile properties may be assumed for Grade A tubes:

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

**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
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

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

11.3.1 For Grade A, one flange test shall be made on specimens from each of two tubes from each lot or fraction thereof.

11.3.2 For Grades C and D, one flange test shall be made on specimens from each of two tubes from each lot or fraction thereof. The width of the flange shall not be less than 75 % of that specified in specification **A450/A450M**.

11.4 *Crush Test*—For Grade A, where specified in the purchase order, one crush test shall be made on specimens from each of two tubes from each lot or fraction thereof.

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

## 12. Nondestructive Examination

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

## SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements may become part of the specification when specified in the inquiry or invitation to bid, and production 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 ASME Requirements

S1.1 The weld seam of each tube shall be subjected to an ultrasonic inspection employing Practice **E273** or Practice **E213** with the rejection criteria referenced in Specification **A450/A450M**.

S1.2 If Practice **E273** is employed, a 100 % volumetric inspection of the entire length of each tube shall also be performed using one of the nondestructive electric tests permitted by Specification **A450/A450M**.

## 13. Surface Condition

13.1 The finished tubes shall be free of scale. A slight amount of oxidation shall not be considered as scale.

## 14. Forming Operations

14.1 When inserted in a boiler or heat exchanger, tubes shall be capable of withstanding expanding and beading without showing cracks or flaws, or opening at the weld. When properly manipulated, superheater tubes shall withstand all forging, welding, and bending operations necessary for applications without developing defects.

## 15. Product Marking

15.1 Marking shall be in accordance with Specification **A450/A450M**.

15.2 The manufacturer's name or symbol may be placed permanently on each tube by rolling or light stamping before normalizing. If a single stamp is placed on the tube by hand, this mark should not be less than 8 in. [200 mm] from one end of the tube.

15.3 *Bar Coding*—In addition to the requirements in **15.1** and **15.2**, bar coding is acceptable as a supplemental identification method. The purchaser may specify in the order a specific bar coding system to be used.

## 16. Keywords

16.1 automatic welded steel tube; boiler tube; carbon; steel tube; welded steel tube

S1.3 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.

S1.4 In addition to the marking prescribed in Specification **A450/A450M**, "S1" shall be added after the grade designation.

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