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## Standard Specification for General Requirements for Carbon, Ferritic Alloy, and Austenitic Alloy Steel Tubes<sup>1</sup>

This standard is issued under the fixed designation A 450/A 450M; 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 a group of requirements which, with the exceptions of 5.3 and Sections 6, 7, 18, 19, 20, 21, 22, 23, and 24, are mandatory requirements to the following ASTM tubular product specifications:<sup>3</sup>

Title of Specification	ASTM Designation <sup>4</sup>
Electric-Resistance-Welded Carbon Steel and Carbon Manganese Steel Boiler Tubes	A 178/A 178M
Seamless Cold-Drawn Low-Carbon Steel Heat-Exchanger and Condenser Tubes	A 179/A 179M
Seamless Carbon Steel Boiler Tubes for High-Pressure Service	A 192/A 192M
Seamless Medium-Carbon Steel Boiler and Superheater Tubes	A 210/A 210M
Electric-Resistance-Welded Carbon Steel Heat-Exchanger and Condenser Tubes	A 214/A 214M
Seamless and Electric-Welded Low-Alloy Steel Tubes	A 423/A 423M
Electric-Resistance-Welded Coiled Steel Tubing for Gas and Fuel Oil Lines	A 539
Seamless Cold-Drawn Carbon Steel Feedwater Heater Tubes	A 556/A 556M
Seamless, Cold-Drawn Carbon Steel Tubing for Hydraulic System Service	A 822

<sup>4</sup> These designations refer to the latest issue of the respective specifications.

1.2 One or more of Sections 5.3, 6, 7, 18, 19, 20, 21, 21.1, 23, and 24 apply when the product specification or purchase order has a requirement for the test or analysis described by these sections.

1.3 In case of conflict between a requirement of the product specification and a requirement of this general requirement specification only the requirement of the product specification need be satisfied.

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 (SI) of the product specification is specified in the order.

### 2. Referenced Documents

#### 2.1 ASTM Standards:<sup>4</sup>

- A 178/A 178M [Specification for Electric-Resistance-Welded Carbon Steel and Carbon-Manganese Steel Boiler and Superheater Tubes](#)
- A 179/A 179M [Specification for Seamless Cold-Drawn Low-Carbon Steel Heat-Exchanger and Condenser Tubes](#)
- A 192/A 192M [Specification for Seamless Carbon Steel Boiler Tubes for High-Pressure Service](#)
- A 210/A 210M [Specification for Seamless Medium-Carbon Steel Boiler and Superheater Tubes](#)
- A 214/A 214M [Specification for Electric-Resistance-Welded Carbon Steel Heat-Exchanger and Condenser Tubes](#)

<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-450 in Section II of that Code.

<sup>3</sup> *Annual Book of ASTM Standards*, Vols 01.01 and 01.04.

<sup>4</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto: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.

- A 370 Test Methods and Definitions for Mechanical Testing of Steel Products
- A 423/A 423M Specification for Seamless and Electric-Welded Low-Alloy Steel Tubes
- A 530/A 530M Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe
- A 539 Specification for Electric-Resistance-Welded Coiled Steel Tubing for Gas and Fuel Oil Lines<sup>5</sup>
- A 556/A 556M Specification for Seamless Cold-Drawn Carbon Steel Feedwater Heater Tubes
- A 700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Domestic Shipment
- A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
- A 822 Specification for Seamless Cold-Drawn Carbon Steel Tubing for Hydraulic System Service
- A 941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys
- D 3951 Practice for Commercial Packaging
- E 92 Test Method for Vickers Hardness of Metallic Materials
- E 213 Practice for Ultrasonic Examination of Metal Pipe and Tubing
- E 273 Practice for Ultrasonic Examination of the Weld Zone of Welded Pipe and Tubing
- E 309 Practice for Eddy-Current Examination of Steel Tubular Products Using Magnetic Saturation
- E 426 Practice for Electromagnetic (Eddy-Current) Examination of Seamless and Welded Tubular Products, Austenitic Stainless Steel, and Similar Alloys
- E 570 Practice for Flux Leakage Examination of Ferromagnetic Steel Tubular Products
- 2.2 *Federal Standard:*
- Fed. Std. No. 183 Continuous Identification Marking of Iron and Steel Products<sup>6</sup>
- 2.3 *Military Standards:*
- MIL-STD-271 Nondestructive Testing Requirements for Metals<sup>6</sup>
- MIL-STD-792 Identification Marking Requirements for Special Purpose Equipment<sup>6</sup>
- 2.4 *ASME Boiler and Pressure Vessel Code:*
- Section IX Welding Qualifications<sup>7</sup>
- 2.5 *Steel Structures Painting Council:*
- SSPC-SP 6 Surface Preparation Specification No. 6 Commercial Blast Cleaning<sup>8</sup>
- 2.6 *Other Document:*
- SNT-TC-1A Recommended Practice for Nondestructive Personnel Qualification and Certification.

### 3. Terminology

#### 3.1 Definitions of Terms Specific to This Standard:

- 3.1.1 *remelted heat*—in secondary melting, all of the ingots remelted from a single primary heat.
- 3.1.2 *thin-wall tube*—a tube meeting the specified outside diameter and specified wall thickness set forth as follows:

Specified Outside Diameter	Specified Wall Thickness
2 in. [50.8 mm] and less	2 % or less of specified outside diameter
Greater than 2 in. [50.8 mm]	3 % or less of specified outside diameter
All diameters	0.020 in. [0.5 mm] or less

3.2 *Other defined terms*—The definitions in Test Methods and Definitions A 370, Test Methods, Practices, and Terminology A 751, and Terminology A 941 are applicable to this specification and to those listed in 1.1.

### 4. Process

- 4.1 The steel may be made by any process.
- 4.2 If a specific type of melting is required by the purchaser, it shall be as stated on the purchase order.
- 4.3 The primary melting may incorporate separate degassing or refining and may be followed by secondary melting, such as electroslag remelting or vacuum-arc remelting.
- 4.4 Steel may be cast in ingots or may be strand cast. When steel of different grades is sequentially strand cast, identification of the resultant transition material is required. The producer shall remove the transition material by an established procedure that positively separates the grades.

### 5. Chemical Composition

5.1 Samples for chemical analysis, and method of analysis shall be in accordance with Test Methods, Practices, and Terminology A 751.

<sup>5</sup> Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098.

<sup>5</sup> Withdrawn.

<sup>6</sup> Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990.

<sup>6</sup> Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098.

<sup>7</sup> Available from Steel Structures Painting Council (SSPC), 40 24th St., 6th Floor, Pittsburgh, PA 15222-4656.

<sup>7</sup> Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990.

<sup>8</sup> Available from Steel Structures Painting Council (SSPC), 40 24th St., 6th Floor, Pittsburgh, PA 15222-4656.

5.2 *Heat Analysis*—An analysis of each heat of steel shall be made by the steel manufacturer to determine the percentages of the elements specified. If secondary melting processes are employed, the heat analysis shall be obtained from one remelted ingot or the product of one remelted ingot of each primary melt. The chemical composition thus determined, or that determined from a product analysis made by the tubular product manufacturer, shall conform to the requirements specified in the product specification.

~~5.2.1 For stainless steels ordered under product specifications referencing this specification of general requirements, the steel shall not contain an unspecified element, other than nitrogen, for the ordered grade to the extent that the steel conforms to the requirements of another grade for which that element is a specified element having a required minimum content. For this requirement, a grade is defined as an alloy described individually and identified by its own UNS designation in a table of chemical requirements within any specification listed within the scope as being covered by this specification. —If the heat analysis reported by the steel producer is not sufficiently complete for conformance with the heat analysis requirements of the applicable product specification to be fully assessed, the manufacturer may complete the assessment of conformance with such heat analysis requirements by using a product analysis for the specified elements that were not reported by the steel producer, provided that product analysis tolerances are not applied and the heat analysis is not altered.~~

5.3 *Product Analysis*—Product analysis requirements and options, if any, are contained in the product specification.

## 6. Tensile Properties

6.1 The material shall conform to the requirements as to tensile properties prescribed in the individual specification.

6.2 The yield strength corresponding to a permanent offset of 0.2 % of the gage length or to a total extension of 0.5 % of the gage length under load shall be determined.

6.3 If the percentage of elongation of any test specimen is less than that specified and any part of the fracture is more than  $\frac{3}{4}$  in. [19.0 mm] from the center of the gage length, as indicated by scribe marks on the specimen before testing, a retest shall be allowed.

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## 7. Standard Weights

7.1 The calculated weight per foot, based upon a specified minimum wall thickness, shall be determined by the following equation:

$$W = C(D - t)t \quad (1)$$

where:

$C$  = 10.69 [0.0246615],

$W$  = weight, lb/ft [kg/m],

$D$  = specified outside diameter, in. [mm], and

$t$  = specified minimum wall thickness, in. [mm]

7.2 The permissible variations from the calculated weight per foot [kilogram per metre] shall be as prescribed in Table 1.

## 8. Permissible Variations in Wall Thickness

8.1 Variations from the specified minimum wall thickness shall not exceed the amounts prescribed in Table 2.

8.2 For tubes 2 in. [50.8 mm] and over in outside diameter and 0.220 in. [5.6 mm] and over in thickness, the variation in wall thickness in any one cross section of any one tube shall not exceed the following percentage of the actual mean wall at the section. The actual mean wall is defined as the average of the thickest and thinnest wall in that section.

Seamless tubes  $\pm 10\%$

Welded tubes  $\pm 5\%$

8.3 When cold-finished tubes as ordered require wall thicknesses  $\frac{3}{4}$  in. [19.1 mm] or over, or an inside diameter 60 % or less of the outside diameter, the permissible variations in wall thickness for hot-finished tubes shall apply.

## 9. Permissible Variations in Outside Diameter

9.1 Except as provided in 9.2 and 9.3, variations from the specified outside diameter shall not exceed the amounts prescribed in Table 3.

9.2 Thin-wall tubes usually develop significant ovality (out of roundness) during final annealing, or straightening, or both. The diameter tolerances of Table 3 are not sufficient to provide for additional ovality expected in thin-wall tubes, and, for such tubes, are applicable only to the *mean* of the extreme (maximum and minimum) outside diameter readings in any one cross section. However, for thin wall tubes the *difference* in extreme outside diameter readings (ovality) in any one cross section shall not exceed the following ovality allowances:

Outside Diameter	Ovality Allowance
1 in. [25.4 mm] and under	0.020 in. [0.5 mm]
Over 1 in. [25.4 mm]	2.0 % of specified outside diameter

9.3 For cold-finished seamless austenitic and ferritic/austenitic tubes an ovality allowance is necessary for all sizes less than 2 in. [50.8 mm] outside diameter since they are likely to become out of round during their final heat treatment. In such tubes, the maximum and minimum diameters at any cross section shall deviate from the nominal diameter by no more than  $\pm 0.010$  in. [ $\pm 0.25$  mm]; however, the mean diameter at that cross section must still be within the given permissible variation given in Table 3. In the event of conflict between the provisions of 9.3 and those of 9.2, the larger value of ovality tolerance shall apply.

## 10. Permissible Variations in Length

10.1 Variations from the specified length shall not exceed the amounts prescribed in Table 4.

## 11. Permissible Variations in Height of Flash on Electric-Resistance-Welded Tubes

11.1 For tubes over 2 in. [50.8 mm] in outside diameter, or over 0.135 in. [3.44 mm] in wall thickness, the flash on the inside of the tubes shall be mechanically removed by cutting to a maximum height of 0.010 in. [0.25 mm] at any point on the tube.

11.2 For tubes 2 in. [50.8 mm] and under in outside diameter and 0.135 in. [3.4 mm] and under in wall thickness, the flash on the inside of the tube shall be mechanically removed by cutting to a maximum height of 0.006 in. [0.15 mm] at any point on the tube.

**TABLE 1 Permissible Variations in Weight Per Foot<sup>A</sup>**

Method of Manufacture	Permissible Variation in Weight per Foot, %	
	Over	Under
Seamless, hot-finished	16	0
Seamless, cold-finished:		
1½ in. [38.1 mm] and under OD	12	0
Over 1½ in. [38.1 mm] OD	13	0
Welded	10	0

<sup>A</sup> These permissible variations in weight apply to lots of 50 tubes or more in sizes 4 in. [101.6 mm] and under in outside diameter, and to lots of 20 tubes or more in sizes over 4 in. [101.6 mm] in outside diameter.

**TABLE 2 Permissible Variations in Wall Thickness<sup>A</sup>**

Outside Diameter, in. [mm]	Wall Thickness, %							
	0.095 [2.4] and Under		Over 0.095 to 0.150 [2.4 to 3.8], incl		Over 0.150 to 0.180 [3.8 to 4.6], incl		Over 0.180, [4.6]	
	Over	Under	Over	Under	Over	Under	Over	Under
Seamless, Hot-Finished Tubes								
4 [101.6] and under	40	0	35	0	33	0	28	0
Over 4 [101.6]	...	...	35	0	33	0	28	0
Seamless, Cold-Finished Tubes								
		Over				Under		
1½ [38.1] and under					20			0
Over 1½ [38.1]					22			0
Welded Tubes								
All sizes					18			0

<sup>A</sup> These permissible variations in wall thickness apply only to tubes, except internal-upset tubes, as rolled or cold-finished, and before swaging, expanding, bending, polishing, or other fabricating operations.

**TABLE 3 Permissible Variations in Outside Diameter<sup>A</sup>**

Outside Diameter, in. [mm]	Permissible Variations, in. [mm]	
	Over	Under
Hot-Finished Seamless Tubes		
4 [101.6] and under	¼ [0.4]	½ [0.8]
Over 4 to 7½ [101.6 to 190.5], incl	¼ [0.4]	¾ [1.2]
Over 7½ to 9 [190.5 to 228.6], incl	¼ [0.4]	⅙ [1.6]
Welded Tubes and Cold-Finished Seamless Tubes		
Under 1 [25.4]	0.004 [0.1]	0.004 [0.1]
1 to 1½ [25.4 to 38.1], incl	0.006 [0.15]	0.006 [0.15]
Over 1½ to 2 [38.1 to 50.8], excl	0.008 [0.2]	0.008 [0.2]
2 to 2½ [50.8 to 63.5], excl	0.010 [0.25]	0.010 [0.25]
2½ to 3 [63.5 to 76.2], excl	0.012 [0.3]	0.012 [0.3]
3 to 4 [76.2 to 101.6], incl	0.015 [0.38]	0.015 [0.38]
Over 4 to 7½ [101.6 to 190.5], incl	0.015 [0.38]	0.025 [0.64]
Over 7½ to 9 [190.5 to 228.6], incl	0.015 [0.38]	0.045 [1.14]

<sup>A</sup> Except as provided in 9.2 and 9.3, these permissible variations include out-of-roundness. These permissible variations in outside diameter apply to hot-finished seamless, welded and cold-finished seamless tubes before other fabricating operations such as upsetting, swaging, expanding, bending, or polishing.

**TABLE 4 Permissible Variations in Length<sup>A</sup>**

Method of Manufacture	Outside Diameter, in. [mm]	Cut Length, in. [mm]	
		Over	Under
Seamless, hot-finished	All sizes	⅜ [5]	0 [0]
Seamless, cold-finished	Under 2 [50.8]	⅙ [3]	0 [0]
	2 [50.8] and over	⅜ [5]	0 [0]
Welded	Under 2 [50.8]	⅙ [3]	0 [0]
	2 [50.8] and over	⅜ [5]	0 [0]

<sup>A</sup> These permissible variations in length apply to tubes before bending. They apply to cut lengths up to and including 24 ft [7.3 m]. For lengths greater than 24 ft [7.3 m], the above over-tolerances shall be increased by ⅙ in. [3 mm] for each 10 ft [3 m] or fraction thereof over 24 ft or ½ in. [13 mm], whichever is the lesser.

## 12. Straightness and Finish

12.1 Finished tubes shall be reasonably straight and have smooth ends free of burrs. They shall have a workmanlike finish. Surface imperfections (see Note 1) may be removed by grinding, provided that a smooth curved surface is maintained, and the wall

thickness is not decreased to less than that permitted by this or the product specification. The outside diameter at the point of grinding may be reduced by the amount so removed.

NOTE 1—An imperfection is any discontinuity or irregularity found in the tube.

### 13. Repair by Welding

13.1 Repair welding of base metal defects in tubing is permissible only with the approval of the purchaser and with the further understanding that the tube shall be marked “WR” and the composition of the deposited filler metal shall be suitable for the composition being welded. Defects shall be thoroughly chipped or ground out before welding and each repaired length shall be reheat treated or stress relieved as required by the applicable specification. Each length of repaired tube shall be tested hydrostatically as required by the product specification.

13.2 Repair welding shall be performed using procedures and welders or welding operators that have been qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX.

### 14. Retests

14.1 If the results of the mechanical tests of any group or lot do not conform to the requirements specified in the individual specification, retests may be made on additional tubes of double the original number from the same group or lot, each of which shall conform to the requirements specified.

### 15. Retreatment

15.1 If the individual tubes or the tubes selected to represent any group or lot fail to conform to the test requirements, the individual tubes or the group or lot represented may be retreated and resubmitted for test. Not more than two reheat treatments shall be permitted.

### 16. Test Specimens

16.1 Test specimens shall be taken from the ends of finished tubes prior to upsetting, swaging, expanding, or other forming operations, or being cut to length. They shall be smooth on the ends and free of burrs and flaws.

16.2 If any test specimen shows flaws or defective machining, it may be discarded and another specimen substituted.

### 17. Method of Mechanical Testing

17.1 The specimens and mechanical tests required shall be made in accordance with Annex A2 of Test Methods and Definitions A 370.

17.2 Specimens shall be tested at room temperature.

17.3 Small or subsize specimens as described in Test Methods and Definitions A 370 may be used only when there is insufficient material to prepare one of the standard specimens. When using small or subsize specimens, the largest one possible shall be used.

### 18. Flattening Test

18.1 A section of tube not less than 2 ½ in. [63 mm] in length for seamless and not less than 4 in. [100 mm] in length for welded shall be flattened cold between parallel plates in two steps. For welded tubes, the weld shall be placed 90° from the direction of the applied force (at a point of maximum bending). During the first step, which is a test for ductility, no cracks or breaks, except as provided for in 18.4, on the inside, outside, or end surfaces shall occur in seamless tubes, or on the inside or outside surfaces of welded tubes, until the distance between the plates is less than the value of  $H$  calculated by the following equation:

$$H = \frac{(1 + e)t}{e + t/D} \quad (2)$$

where:

$H$  = distance between flattening plates, in. [mm],

$t$  = specified wall thickness of the tube, in. [mm],

$D$  = specified outside diameter of the tube, in. [mm], and

$e$  = deformation per unit length (constant for a given grade of steel: 0.07 for medium-carbon steel (maximum specified carbon 0.19 % or greater), 0.08 for ferritic alloy steel, 0.09 for austenitic steel, and 0.09 for low-carbon steel (maximum specified carbon 0.18 % or less)).

During the second step, which is a test for soundness, the flattening shall be continued until the specimen breaks or the opposite walls of the tube meet. Evidence of laminated or unsound material, or of incomplete weld that is revealed during the entire flattening test shall be cause for rejection.

18.2 Surface imperfections in the test specimens before flattening, but revealed during the first step of the flattening test, shall be judged in accordance with the finish requirements.

18.3 Superficial ruptures resulting from surface imperfections shall not be cause for rejection.

18.4 When low  $D$ -to-  $t$  ratio tubular products are tested, because the strain imposed due to geometry is unreasonably high on the inside surface at the six and twelve o'clock locations, cracks at these locations shall not be cause for rejection if the  $D$  to  $t$  ratio is less than 10.