



Designation: A209/A209M – 03 (Reapproved 2022)

Standard Specification for Seamless Carbon-Molybdenum Alloy-Steel Boiler and Superheater Tubes¹

This standard is issued under the fixed designation A209/A209M; 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 (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification² covers several grades of minimum-wall-thickness, seamless, carbon-molybdenum alloy-steel, boiler and superheater tubes.

1.2 This specification covers tubes $\frac{1}{2}$ to 5 in. [12.7 to 127 mm] inclusive, in outside diameter and 0.035 to 0.500 in. [0.9 to 12.7 mm], inclusive, in minimum wall thickness.

1.3 An optional supplementary requirement is provided and, when desired, shall be so stated in the order.

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.

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:³

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

¹ This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.10 on Stainless and Alloy Steel Tubular Products.

Current edition approved March 1, 2022. Published March 2022. Originally approved in 1938. Last previous edition approved in 2017 as A209/A209M – 03 (2017). DOI: 10.1520/A0209_A0209M-03R22.

² For ASME Boiler and Pressure Vessel Code application see related Specification SA-209 in Section II of that Code.

³ 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.

3. General Requirements

3.1 Product furnished under this specification shall conform to the 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 conflict with the requirements of this specification and Specification **A1016/A1016M**, this specification shall prevail.

4. Materials and Manufacture

4.1 *Steelmaking Practice*—The steel shall be killed.

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

4.3 *Heat Treatment*—Hot-finished tubes shall be heat treated at a temperature of 1200 °F [650 °C] or higher. Cold-finished tubes shall, after the final cold finishing, be heat treated at a temperature of 1200 °F [650 °C] or higher, or tubing may be furnished in the full-annealed, isothermal annealed, or normalized and tempered condition. If furnished in the normalized and tempered condition, the minimum tempering temperature shall be 1200 °F [650 °C].

5. Chemical Composition

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

5.2 Product Analysis

5.2.1 An analysis shall be made by the manufacturer of one billet or one tube from each heat. The chemical composition thus determined, shall conform to the requirements given in **Table 1**.

5.2.2 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 7.1) shall be rejected or, at the option of the producer, each billet or tube may be individually tested for acceptance. Billets or tubes that do not meet the requirements of the specification shall be rejected.

TABLE 1 Chemical Composition Requirements

Element	Composition, %		
	Grade T1	Grade T1a	Grade T1b
Carbon	0.10–0.20	0.15–0.25	0.14 max
Manganese	0.30–0.80	0.30–0.80	0.30–0.80
Phosphorus, max	0.025	0.025	0.025
Sulfur, max	0.025	0.025	0.025
Silicon	0.10–0.50	0.10–0.50	0.10–0.50
Molybdenum	0.44–0.65	0.44–0.65	0.44–0.65

6. Mechanical Properties

6.1 Tensile Requirements

6.1.1 The material shall conform to the requirements given in **Table 2**.

6.1.2 **Table 3** gives the computed minimum elongation values for each $\frac{1}{32}$ -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:

$$E = 48t + 15.00 \quad [E = 1.87t + 15.00] \quad (1)$$

where:

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

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

6.3 Number of Tests

6.3.1 *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 7.2).

6.3.2 Flattening Test—One flattening test shall be made on specimens from each end of one finished tube, not the one used for the flaring test, from each lot (See 7.1)

6.3.3 Flaring Test—One flaring 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 7.1)

6.3.4 *Hardness Test*—Brinell or Rockwell hardness tests shall be made on specimens from two tubes from each lot (See 7.2)

TABLE 2 Tensile Requirements

	Grade T1	Grade T1b	Grade T1a
Tensile strength, min, ksi [MPa]	55 [380]	53 [365]	60 [415]
Yield strength, min, ksi [MPa]	30 [205]	28 [195]	32 [220]
Elongation in 2 in. or 50 mm, min, %	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	1.50 ^A	1.50 ^A	1.50 ^A
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	22	22	22

^ATable 3 gives the computed minimum values.

TABLE 3 Computed Minimum Values

Wall Thickness		Elongation in 2 in. or 50
in.	mm	mm, min, % ^A
5/16 (0.312)	8	30
9/32 (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

^ACalculated elongation requirements shall be rounded to the nearest whole number.

TABLE 4 Hardness Requirements

	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
Grade T 1	146	80
Grade T 1a	153	81
Grade T 1b	137	77

7. Sampling

7.1 Flattening, Flaring, and Product Analysis—For flattening, flaring, and product analysis requirements, the term *lot* applies to all tubes prior to cutting of the same nominal size and 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 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**.

7.2 Tension and Hardness Tests—For tension and hardness tests, the term *lot* applies to all tubes prior to cutting, of the same nominal diameter and 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.

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



8. Forming Operations

8.1 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.

9. Product Marking

9.1 In addition to the marking prescribed in Specification **A1016/A1016M**, the marking shall include whether the tube is hot-finished or cold-finished.

10. Keywords

10.1 boiler tubes; carbon-molybdenum; seamless steel tube; steel tube; superheater tubes

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirement shall apply only when specified by the purchaser in the inquiry, contract, or order.

S1. Surface Condition

S1.1 If pickling or shot blasting, or both, are required, this shall be specifically stated in the order. Details of this supplemental requirement shall be agreed upon between the manufacturer and the purchaser.

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org). Permission rights to photocopy the standard may also be secured from the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, Tel: (978) 646-2600; <http://www.copyright.com/>