



Designation: A498/A498M – 17

# Standard Specification for Seamless and Welded Carbon Steel Heat-Exchanger Tubes with Integral Fins<sup>1</sup>

This standard is issued under the fixed designation A498/A498M; 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 describes seamless or welded low-carbon steel tubes on which the external or internal surface, or both, have been modified by a cold forming process to produce an integral increased surface area for improved heat transfer. The tubes are used in tubular heat exchangers, surface condensers, evaporators, superheaters, and similar heat-transfer apparatus in outside diameters up to 2 in. [50 mm], inclusive.

1.2 *Units*—This specification is expressed in both inch-pound units and in SI units; however, unless the purchase order or contract specifies the applicable M specification designation (SI units), the inch-pound units shall apply. 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 may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.3 *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:<sup>2</sup>

- A179/A179M Specification for Seamless Cold-Drawn Low-Carbon Steel Heat-Exchanger and Condenser Tubes
- A214/A214M 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 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.

- A334/A334M Specification for Seamless and Welded Carbon and Alloy-Steel Tubes for Low-Temperature Service
- A450/A450M Specification for General Requirements for Carbon and Low Alloy Steel Tubes
- A941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys
- A1016/A1016M Specification for General Requirements for Ferritic Alloy Steel, Austenitic Alloy Steel, and Stainless Steel Tubes
- A1047/A1047M Test Method for Pneumatic Leak Testing of Tubing

## 3. Terminology

3.1 *Definitions*—For definitions of general terms used in this specification, refer to Terminology A941.

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

3.2.1 *land*—a length of unmodified tube between adjacent sections of modified tube; used as support zones for baffles, or for bending where surface modification might compromise material integrity, or for other reasons.

3.2.2 *modified surface*—the surface of a tube having a series of integral fins, grooves, or ribs on the outside diameter, inside diameter, or both, for the purpose of increasing the surface area and improving heat transfer.

3.2.3 *unmodified surface*—the cylindrical surface of a tube made to the reference standards.

### 3.3 Symbols (Integral Fin Tube Nomenclature):

- 3.3.1 Bare tube symbols, see Fig. 1, Fig. 2, or Fig. 3.
- 3.3.1.1  $OD$  = outside diameter of unmodified sections, and
- 3.3.1.2  $W$  = wall thickness of unmodified sections.
- 3.3.2 OD surface modification symbols, see Fig. 1.
- 3.3.2.1  $od$  = outside diameter of modified sections,
- 3.3.2.2  $rd$  = root diameter of outside fins,
- 3.3.2.3  $W_f$  = wall thickness at fin groove, either minimum or average,
- 3.3.2.4  $FH$  = fin height,
- 3.3.2.5  $N_{fpu}$  = number of fins per unit length, the reciprocal of  $p$ ,
- 3.3.2.6  $p$  = pitch, the distance from a point on one fin to the corresponding point on the adjacent fin along the tube longitudinal axis, and

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

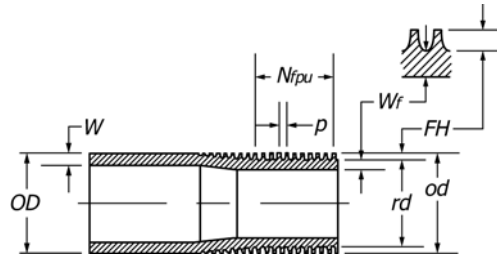


FIG. 1 OD Surface Modification Symbols – Fins

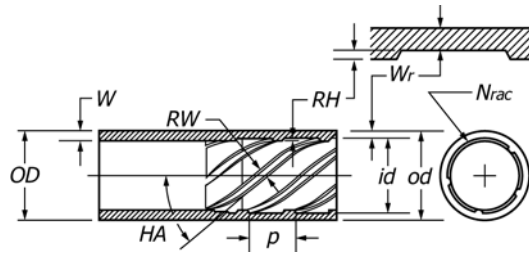


FIG. 2 ID Surface Modification Symbols – Ribs

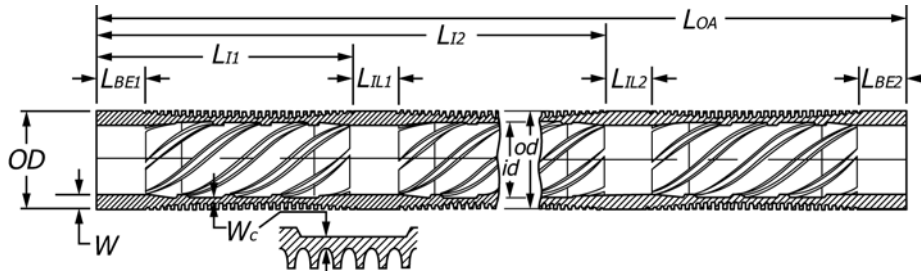


FIG. 3 Combined OD and ID Surface Modifications Plus Length Symbols

3.3.2.7  $p$  = the reciprocal of  $N_{fpu}$ .

3.3.3 ID surface modification symbols, see Fig. 2.

3.3.3.1  $od$  = outside diameter of modified sections,

3.3.3.2  $id$  = inside diameter of id modified sections, to root of rib,

3.3.3.3  $W_r$  = wall thickness at rib groove, either minimum or average,

3.3.3.4  $RH$  = rib height,

3.3.3.5  $RW$  = rib width,

3.3.3.6  $HA$  = helix angle,

3.3.3.7  $p$  = pitch, the distance from a point on one rib to the corresponding point on the adjacent rib along the tube longitudinal axis, and

3.3.3.8  $N_{rac}$  = number of ribs around circumference.

3.3.4 Combined (OD + ID) surface modification symbols, see Figs. 1-3.

3.3.4.1  $od$  = outside diameter of modified sections,

3.3.4.2  $id$  = inside diameter of modified sections, to root of rib, and

3.3.4.3  $W_c$  = wall thickness of combined modified surface, either minimum or average.

3.3.5 Length symbols, see Fig. 3.

3.3.5.1  $L_{OA}$  = overall length,

3.3.5.2  $L_{BE1}$  = length of first bare end,

3.3.5.3  $L_{BE2}$  = length of second bare end,

3.3.5.4  $L_{IL1}$  = length to first intermediate land,

3.3.5.5  $L_{IL1}$  = length of first intermediate land,

3.3.5.6  $L_{IL2}$  = length to second intermediate land,

3.3.5.7  $L_{IL2}$  = length of second intermediate land,

3.3.5.8  $L_{In}$  = length to  $n^{\text{th}}$  intermediate land, and

3.3.5.9  $L_{ILn}$  = length of  $n^{\text{th}}$  intermediate land.

3.4 Illustrations—See Figs. 1-3.

#### 4. Ordering Information

4.1 It is the responsibility of the purchaser to specify requirements that are necessary for tubing ordered under this specification. Such requirements may include, but are not limited to, the following:

4.1.1 ASTM designation and year of issue for the modified tube (this specification).

4.1.2 ASTM designation and year of issue of the plain tube from which the modified tube is to be manufactured.

4.1.3 Grade (if applicable).

4.1.4 Type of material (if applicable: seamless or welded).

4.1.5 Quantity.

4.1.6 Dimensions:

4.1.6.1 Outside diameter.

4.1.6.2 Wall thickness.

4.1.6.3 Length.



4.1.6.4 All other desired dimensional attributes as described in 3.3.2 – 3.3.5. Configuration of these modified surface attributes shall be as agreed between the purchaser and the manufacturer.

4.1.7 Temper (as-cold-worked or annealed).

4.1.8 Packaging.

4.1.9 Customer inspection.

4.1.10 Certification.

4.1.11 Special requirements and any supplementary requirements selected.

## 5. Material and Manufacture

5.1 The modified surface tubes shall be manufactured from plain tubes that conform to one of the following ASTM Specifications: A179/A179M, A214/A214M, or A334/A334M.

5.2 The modified surface tubes shall be produced by cold forming of steel plain tubes. To comply with this specification, the modified surface and tube material must be integral.

5.3 Modified surface tubes shall normally be furnished with unmodified ends, but may be furnished with modified surface ends if specified.

## 6. Temper

6.1 The tube after modification shall be supplied in either the *annealed* or *as-cold-worked* condition, one of which shall be specified on the purchaser order.

6.2 The *annealed* condition is defined as having both the modified and unmodified portions of the tube conforming to the heat-treatment requirements of the specified ASTM plain tube.

6.3 The *as-cold-worked* condition is defined as having the modified portions of the tube in the cold-worked condition produced by the modifying operation; and the unmodified portions of the tube conforming to the heat-treatment requirements of the specified ASTM plain tube.

## 7. Chemical Composition

7.1 The steel shall conform to the chemical requirements prescribed in the governing plain-tube specification.

## 8. Tensile Requirements

8.1 The tube prior to the modifying operation, and the unmodified portions of the tube, shall conform to the applicable requirements for tensile properties prescribed in the governing plain-tube specification.

## 9. Dimensions and Permissible Variations

9.1 *Diameter*—The outside diameter of the unmodified sections and the modified sections shall not exceed the diameter tolerances as specified in the governing plain tube specification as measured with micrometers and verified by a “go” ring gauge. The dimensions of the ring gauge shall be as described in 9.1.1.

9.1.1 The inside diameter of the “go” ring gauge shall be equal to the nominal tube diameter, plus the maximum diameter tolerance allowed by the governing plain tube

specification, plus 0.002 in. [0.05 mm]. The length of the ring gauge shall be not less than 1 in. [25 mm].

9.2 *Wall Thickness Tolerance*—Wall thickness is defined as the thickness “under the fin groove”, “under the rib groove”, or the combination of both, as illustrated in Figs. 1-3.

9.2.1 *Tubes Ordered to Minimum Wall Thickness at the Modified Section*—No tube at its thinnest point in the modified section shall be less than the minimum specified wall thickness; nor greater than 18 % over the specified wall thickness.

9.2.2 *Tubes Ordered to Average Wall Thickness at the Modified Section*—No tube at its thinnest point in the modified section shall be less than 9 % under the specified wall thickness; nor greater than 9 % over the specified wall thickness.

### 9.3 Length Tolerance:

9.3.1 *Overall Length*—The length of the tubes shall not be less than that specified when measured at a temperature of 68 °F [20 °C], but may exceed the specified value by the amounts given in Table 1.

TABLE 1 Tolerances for Specified Length of Tubes

Specified Length, ft [m]	Tolerance, in. [mm]
Up to 24 [7.3], incl	+ $\frac{1}{8}$ [3]
Over 24 to 34 [7.3 to 10.4], incl	+ $\frac{1}{4}$ [6]
Over 34 to 44 [10.4 to 13.4], incl	+ $\frac{3}{8}$ [9]
Over 44 [13.4]	+ $\frac{1}{2}$ [13] max

9.3.2 *Length of Bare Ends*—The length of bare ends shall not be less than specified, nor  $\frac{1}{2}$  in. [13 mm] greater than specified.

9.3.3 *Length to Intermediate Lands*—The length to intermediate lands shall not be greater than specified, nor  $\frac{1}{2}$  in. [13 mm] less than specified.

9.3.4 *Length of Intermediate Lands*—The length of intermediate lands shall not be less than specified, nor 1 in. [25 mm] greater than specified.

9.4 *Configuration of Modifications*—Configuration of modifications (fins per unit length, fin pitch, fin height, fin geometry, rib height, rib width, rib geometry, helix angle, rib pitch, etc.) shall be as agreed between purchaser and manufacturer.

## 10. Workmanship and Finish

10.1 Finished tubes shall be reasonably straight and have smooth ends free from burrs. They shall be free from injurious defects and shall have a workmanlike finish. A slight amount of oxidation will not be considered as scale.

## 11. Pneumatic Test

11.1 At the completion of modifying operations, each tube shall be subjected to a pneumatic test at a pressure of not less than 250 psi [1.72 MPa]. At the option of the manufacturer, this can either be the *Air Under Water Test* or the *Pneumatic Leak Test*.

11.1.1 *Air Under Water Test*—This test is to be in accord with Specification A450/A450M or Specification A1016/A1016M.



11.1.2 *Pneumatic Leak Test*—This test is to be in accord with Specification **A450/A450M** or Specification **A1016/A1016M**, and Test Method **A1047/A1047M**.

NOTE 1—Tubes made to Specifications **A179/A179M** and **A214/A214M** also comply with the general requirements of Specification **A450/A450M**. Tubes made to Specification **A334/A334M** also comply with the general requirements of Specification **A1016/A1016M**. Reference the appropriate general requirements for testing details.

## 12. Package Marking

12.1 The name or brand of the manufacturer, name and order number of the purchaser, Specification A498/A498M, plain tube specification, Grade (if applicable), Type of Material (seamless or welded), Quantity, Tube Diameter, Tube Wall Thickness, and Tube Length, Temper (annealed or as-cold-worked) shall be marked on a tag securely attached to the bundle or box in which the tubes are shipped. The marking need not include the year of issue of the specification.

12.2 *Bar Coding*—In addition to the requirements stated in **12.1**, bar coding is acceptable as a supplementary identification method. Bar coding should be consistent with the Automotive Industry Action Group (AIAG) standard prepared by the Primary Metals Subcommittee of the AIAG Bar Code Project Team.

## 13. Inspection

13.1 An inspector representing the purchaser shall have entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works

that concern the manufacture of the material ordered. The manufacturer shall afford the inspector all reasonable facilities to satisfy him that the material is being furnished in accordance with this specification. All required tests and inspections shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be conducted so as not to interfere unnecessarily with the operation of the works.

## 14. Certification

14.1 When specified in the purchase order or contract, the manufacturer shall furnish a dated report certifying that the material was manufactured, sampled, tested, and inspected in accordance with the requirements of this specification, including the year of issue of the specification.

## 15. Rejection

15.1 Any rejection based on tests made in accordance with this specification, and those allowed by the governing plain-tube specification, shall be reported to the manufacturer. Disposition of rejected tubing shall be a matter of agreement between the manufacturer and the purchaser.

15.2 Material that fails in the process of installation shall be set aside and the manufacturer notified for mutual evaluation of suitability of the material. Disposition of such material shall be a matter for agreement.

## 16. Keywords

16.1 carbon steel tube; heat exchanger tube; seamless steel tube; steel tube; welded steel tube

## SUPPLEMENTARY REQUIREMENTS

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

### S1. Optional Nondestructive Tests

S1.1 *Eddy Current Test*—At the option of the purchaser, each tube shall be subjected to the Eddy Current Test as described in Specification **A450/A450M** or Specification **A1016/A1016M**. The reference standard shall be as agreed between the purchaser and manufacturer.

S1.2 *Hydrostatic Test*—At the option of the purchaser, each tube shall be subjected to the Hydrostatic Test described in Specification **A450/A450M** or Specification **A1016/A1016M**.

NOTE 2—Tubes made to Specifications **A179/A179M** and **A214/A214M** also comply with the general requirements of Specification **A450/A450M**. Tubes made to Specification **A334/A334M** also comply with the general requirements of Specification **A1016/A1016M**. Reference the appropriate general requirements for testing details.



**SUMMARY OF CHANGES**

Committee A01 has identified the location of selected changes to this specification since the last issue, A498/A498M – 14, that may impact the use of this specification. (Approved March 15, 2017)

(1) Revise the standard for external, or internal, or both, modification types.

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