Designation: A249/A249M – 16

Used in USDOE-NE Standards

# Standard Specification for Welded Austenitic Steel Boiler, Superheater, Heat-Exchanger, and Condenser Tubes[1]

This standard is issued under the fixed designation A249/A249M; 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.

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

## 1. Scope*

1.1 This specification[2] covers nominal-wall-thickness welded tubes and heavily cold worked welded tubes made from the austenitic steels listed in Table 1, with various grades intended for such use as boiler, superheater, heat exchanger, or condenser tubes.

1.2 Grades TP304H, TP309H, TP309HCb, TP310H, TP310HCb, TP316H, TP321H, TP347H, and TP348H are modifications of Grades TP304, TP309S, TP309Cb, TP310S, TP310Cb, TP316, TP321, TP347, and TP348, and are intended for high-temperature service such as for superheaters and reheaters.

1.3 The tubing sizes and thicknesses usually furnished to this specification are ⅛ in. [3.2 mm] in inside diameter to 12 in. [304.8 mm] in outside diameter and 0.015 to 0.320 in. [0.4 to 8.1 mm], inclusive, in wall thickness. Tubing having other dimensions may be furnished, provided such tubes comply with all other requirements of this specification.

1.4 Mechanical property requirements do not apply to tubing smaller than ⅛ in. [3.2 mm] in inside diameter or 0.015 in. [0.4 mm] in thickness.

1.5 Optional supplementary requirements are provided and, when one or more of these are desired, each shall be so stated in the order.

1.6 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. The inch-pound units shall apply unless the "M" designation of this specification is specified in the order.

1.7 The following safety hazards caveat pertains only to the test method described in the Supplementary Requirements of this specification. *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 limitations prior to use.* A specific warning statement is given in Supplementary Requirement S7, Note S7.1.

## 2. Referenced Documents

2.1 *ASTM Standards:*[3]

A262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels

A480/A480M Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip

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

E112 Test Methods for Determining Average Grain Size

E213 Practice for Ultrasonic Testing of Metal Pipe and Tubing

E273 Practice for Ultrasonic Testing of the Weld Zone of Welded Pipe and Tubing

E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

2.2 *ASME Boiler and Pressure Vessel Code:*

Section VIII [4]

2.3 *Other Standard:*

SAE J1086 Practice for Numbering Metals and Alloys (UNS)[5]

[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 May 1, 2016. Published May 2016. Originally approved in 1941. Last previous edition approved in 2015 as A249/A249M – 15a. DOI: 10.1520/A0249_A0249M-16.

[2] For ASME Boiler and Pressure Vessel Code applications see related Specification SA-249 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.

[4] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, http://www.asme.org.

[5] Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.

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

Copyright © ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959. United States



Documents
Document Sharing Hub
Full document details: ASTM A249/A249M-16

**TABLE 1 Chemical Requirements, %[A]**

| Grade | UNS Designation[B] | Composition, % | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Carbon | Manganese | Phosphorous | Sulfur | Silicon | Chromium | Nickel | Molybdenum | Nitrogen[C] | Copper | Other |
| TP 201 | S20100 | 0.15 | 5.50–7.5 | 0.060 | 0.030 | 1.00 | 16.0–18.0 | 3.5–5.5 | ... | 0.25 | ... | ... |
| TP 201LN | S20153 | 0.03 | 6.4–7.5 | 0.045 | 0.015 | 0.75 | 16.0–17.5 | 4.0–5.0 | ... | 0.10–0.25 | 1.00 | ... |
| TP 202 | S20200 | 0.15 | 7.5–10.0 | 0.060 | 0.030 | 1.00 | 17.0–19.0 | 4.0–6.0 | ... | 0.25 | ... | ... |
| TPXM-19 | S20910 | 0.06 | 4.0–6.0 | 0.045 | 0.030 | 1.00 | 20.5–23.5 | 11.5–13.5 | 1.50–3.00 | 0.20–0.40 | ... | Nb[G] 0.10–0.30<br>V 0.10–0.30 |
| TPXM-29 | S24000 | 0.08 | 11.5–14.5 | 0.060 | 0.030 | 1.00 | 17.0–19.0 | 2.3–3.7 | ... | 0.20–0.40 | ... | ... |
| TP304 | S30400 | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 18.0–20.0 | 8.0–11.0 | ... | ... | ... | ... |
| TP304L[D] | S30403 | 0.030 | 2.00 | 0.045 | 0.030 | 1.00 | 18.0–20.0 | 8.0–12.0 | ... | ... | ... | ... |
| TP304H | S30409 | 0.04–0.10 | 2.00 | 0.045 | 0.030 | 1.00 | 18.0–20.0 | 8.0–11.0 | ... | ... | ... | ... |
| ... | S30415 | 0.04–0.06 | 0.80 | 0.045 | 0.030 | 1.00–2.00 | 18.0–19.0 | 9.0–10. | ... | 0.12–0.18 | ... | Ce<br>0.03–0.08 |
| TP304N | S30451 | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 18.0–20.0 | 8.0–11.0 | ... | 0.10–0.16 | ... | ... |
| TP304LN[D] | S30453 | 0.030 | 2.00 | 0.045 | 0.030 | 1.00 | 18.0–20.0 | 8.0–11.0 | ... | 0.10–0.16 | ... | ... |
| TP305 | S30500 | 0.12 | 2.00 | 0.045 | 0.030 | 1.00 | 17.0–19.0 | 11.0–13.0 | ... | ... | ... | ... |
| ... | S30615 | 0.16–0.24 | 2.00 | 0.030 | 0.030 | 3.2–4.0 | 17.0–19.5 | 13.5–16.0 | ... | ... | ... | ... |
| ... | S30815 | 0.05–0.10 | 0.80 | 0.040 | 0.030 | 1.40–2.00 | 20.0–22.0 | 10.0–12.0 | ... | 0.14–0.20 | ... | Ce<br>0.03–0.08 |
| TP309S | S30908 | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 22.0–24.0 | 12.0–15.0 | ... | ... | ... | ... |
| TP309H | S30909 | 0.04–0.10 | 2.00 | 0.045 | 0.030 | 1.00 | 22.0–24.0 | 12.0–15.0 | ... | ... | ... | ... |
| ... | S30601 | 0.015 | 0.50–0.80 | 0.030 | 0.013 | 5.0–5.6 | 17.0–18.0 | 17.0–18.0 | 0.20 | 0.05 | 0.35 | ... |
| TP309Cb | S30940 | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 22.0–24.0 | 12.0–16.0 | ... | ... | ... | Nb 10x<br>C-1.10 |
| TP309HCb | S30941 | 0.04–0.10 | 2.00 | 0.045 | 0.030 | 1.00 | 22.0–24.0 | 12.0–16.0 | ... | ... | ... | Nb 10x<br>C-1.10 |
| TP310S | S31008 | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 24.0–26.0 | 19.0–22.0 | ... | ... | ... | ... |
| TP310H | S31009 | 0.04–0.10 | 2.00 | 0.045 | 0.030 | 1.00 | 24.0–26.0 | 19.0–22.0 | ... | ... | ... | ... |
| TP310Cb | S31040 | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 24.0–26.0 | 18.0–22.0 | ... | ... | ... | Nb 10x<br>C-1.10 |
| TP310HCb | S31041 | 0.04–0.10 | 2.00 | 0.045 | 0.030 | 1.00 | 24.0–26.0 | 19.0–22.0 | ... | ... | ... | Nb 10x<br>C-1.10 |
| ... | S31050 | 0.030 | 2.00 | 0.030 | 0.015 | 0.40 | 24.0–26.0 | 21.0–23.0 | 2.00–3.00 | 0.10–0.16 | ... | ... |
| ... | S31254 | 0.020 | 1.00 | 0.030 | 0.010 | 0.80 | 19.5–20.5 | 17.5–18.5 | 6.0–6.5 | 0.18–0.25 | 0.50–1.00 | ... |
| ... | S31266 | 0.030 | 2.00–4.00 | 0.035 | 0.020 | 1.00 | 23.0–25.0 | 21.0–24.0 | 5.2–6.2 | 0.35–0.60 | 1.00–2.50 | W<br>1.50–2.50 |
| ... | S31277 | 0.020 | 3.00 | 0.030 | 0.010 | 0.50 | 20.5–23.0 | 26.0–28.0 | 6.5–8.0 | 0.30–0.40 | 0.50–1.50 | ... |
| TP316 | S31600 | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 16.0–18.0 | 10.0–14.0 | 2.00–3.00 | ... | ... | ... |
| TP316L[D] | S31603 | 0.030 | 2.00 | 0.045 | 0.030 | 1.00 | 16.0–18.0 | 10.0–14.0 | 2.00–3.00 | ... | ... | ... |
| TP316H | S31609 | 0.04–0.10 | 2.00 | 0.045 | 0.030 | 1.00 | 16.0–18.0 | 10.0–14.0 | 2.00–3.00 | ... | ... | ... |
| TP316N | S31651 | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 16.0–18.0 | 10.0–13.0 | 2.00–3.00 | 0.10–0.16 | ... | ... |
| TP316LN[D] | S31653 | 0.030 | 2.00 | 0.045 | 0.030 | 1.00 | 16.0–18.0 | 10.0–13.0 | 2.00–3.00 | 0.10–0.16 | ... | ... |
| | S31655 | 0.030 | 2.00 | 0.045 | 0.015 | 1.00 | 19.5–21.5 | 8.0–9.5 | 0.50–1.50 | 0.14–0.25 | 1.00 | ... |
| 317 | S31700 | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 18.0–20.0 | 11.0–15.0 | 3.0–4.0 | ... | ... | ... |
| P317L | S31703 | 0.030 | 2.00 | 0.045 | 0.030 | 1.00 | 18.0–20.0 | 11.0–15.0 | 3.0–4.0 | ... | ... | ... |
| | S31725 | 0.030 | 2.00 | 0.045 | 0.030 | 1.00 | 18.0–20.0 | 13.5–17.5 | 4.0–5.0 | 0.20 | ... | ... |
| | S31726 | 0.030 | 2.00 | 0.045 | 0.030 | 1.00 | 17.0–20.0 | 14.5–17.5 | 4.0–5.0 | 0.10–0.20 | ... | ... |
| | S31727 | 0.030 | 1.00 | 0.030 | 0.030 | 1.00 | 17.5–19.0 | 14.5–16.5 | 3.8–4.5 | 0.15–0.21 | 2.8–4.0 | ... |
| | S32050 | 0.030 | 1.50 | 0.035 | 0.020 | 1.00 | 22.0–24.0 | 20.0–23.0 | 6.0–6.8 | 0.21–0.32 | 0.40 | ... |



Full document details: ASTM A249/A249M-16
Documents
Document Sharing Hub

**TABLE 1** *Continued*

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ... | S32053 | 0.030 | 1.00 | 0.030 | 0.010 | 1.00 | 22.0–24.0 | 24.0–26.0 | 5.0–6.0 | 0.17–0.22 | ... | ... |
| TP321 | S32100 | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 17.0–19.0 | 9.0–12.0 | ... | 0.10 | ... | Ti 5(C+N)-0.70 |
| TP321H | S32109 | 0.04–0.10 | 2.00 | 0.045 | 0.030 | 1.00 | 17.0–19.0 | 9.0–12.0 | ... | 0.10 | ... | Ti 5(C+N)-0.70 |
| ... | S32615 | 0.07 | 2.00 | 0.045 | 0.030 | 4.80–6.00 | 16.5–19.5 | 19.0–22.0 | 0.30–1.50 | ... | 1.50–2.50 | ... |
| ... | S32654 | 0.020 | 2.0–4.0 | 0.030 | 0.005 | 0.50 | 24.0–25.0 | 21.0–23.0 | 7.0–8.0 | 0.45–0.55 | 0.30–0.60 | ... |
| ... | S33228 | 0.04–0.08 | 1.00 | 0.020 | 0.015 | 0.30 | 26.0–28.0 | 31.0–333.0 | ... | ... | ... | Nb 0.60–1.00 Ce 0.05–0.10 Al0.025 |
| ... | S34565 | 0.030 | 5.0–7.0 | 0.030 | 0.010 | 1.00 | 23.0–25.0 | 16.0–18.0 | 4.0–5.0 | 0.40–0.60 | ... | Nb 0.10 |
| TP347 | S34700 | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 17.0–19.0 | 9.0–12.0 | ... | ... | ... | Nb 10xC-1.10 |
| TP347H | S34709 | 0.04–0.10 | 2.00 | 0.045 | 0.030 | 1.00 | 17.0–19.0 | 9.0–12.0 | ... | ... | ... | Nb 8xC-1.10 |
| TP348 | S34800 | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 17.0–19.0 | 9.0–12.0 | ... | ... | ... | (Nb+Ta) 10xC-1.10 Ta 0.10 Co 0.20 |
| TP348H | S34809 | 0.04–0.10 | 2.00 | 0.045 | 0.030 | 1.00 | 17.0–19.0 | 9.0–12.0 | ... | ... | ... | (Nb+Ta) 8xC-1.10 Ta 0.10 Co 0.20 |
| ... | S35045 | 0.06–0.10 | 1.50 | 0.045 | 0.015 | 1.00 | 25.0–29.0 | 32.0–37.0 | ... | ... | 0.75 | Al 0.15–0.60 Ti 0.15–0.60 |
| TPXM-15 | S38100 | 0.08 | 2.00 | 0.030 | 0.030 | 1.50–2.50 | 17.0–19.0 | 17.5–18.5 | ... | ... | ... | ... |
| ... | S38815 | 0.030 | 2.00 | 0.040 | 0.020 | 5.5–6.5 | 13.0–15.0 | 15.0–17.0 | 0.75–1.50 | ... | 0.75–1.50 | Al 0.30 max |
| Alloy 20 | N08020 | 0.070 | 2.00 | 0.045 | 0.035 | 1.00 | 19.0–21.0 | 32.0–38.0 | 2.00–3.00 | ... | 3.00–4.00 | Nb 8 × C min. to 1.00 max |
| ... | N08367 | 0.030 | 2.00 | 0.040 | 0.030 | 1.00 | 20.0–22.0 | 23.5–25.5 | 6.0–7.0 | 0.18–0.25 | 0.75 | ... |
| 800 | N08800 | 0.10 | 1.50 | 0.045 | 0.015 | 1.00 | 19.0–23.0 | 30.0–35.0 | ... | ... | 0.75 | Al 0.15–0.60 Ti 0.15–0.60 Fe[E] 39.5 min |
| 800H | N08810 | 0.05–0.10 | 1.50 | 0.045 | 0.015 | 1.00 | 19.0–23.0 | 30.0–35.0 | ... | ... | 0.75 | Al 0.15–0.60 Ti 0.15–0.60 Fe[E] 39.5 min |



Full document details: ASTM A249/A249M-16
Documents
Document Sharing Hub