



Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels¹

This standard is issued under the fixed designation A479/A479M; 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 Department of Defense.

1. Scope*

1.1 This specification² covers hot- and cold-finished bars of stainless steel, including rounds, squares, and hexagons, and hot-rolled or extruded shapes such as angles, tees, and channels for use in boiler and pressure vessel construction.²

NOTE 1—There are standards covering high nickel, chromium, austenitic corrosion, and heat-resisting alloy materials. These standards are under the jurisdiction of ASTM Subcommittee B02.07 and may be found in *Annual Book of ASTM Standards*, Vol 02.04.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. 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 Unless the order specifies the applicable “M” specification designation, the material shall be furnished to the inch-pound units.

2. Referenced Documents

2.1 ASTM Standards:³

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

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A484/A484M Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings

A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

E112 Test Methods for Determining Average Grain Size

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

2.2 SAE Document:⁴

SAE J 1086 Recommended Practice for Numbering Metals and Alloys 11

3. General Requirements

3.1 The following requirements for orders for material furnished under this specification shall conform to the applicable requirements of the current edition of Specification A484/A484M.

3.1.1 Definitions,

3.1.2 General requirements for delivery,

3.1.3 Ordering information,

3.1.4 Process,

3.1.5 Special tests,

3.1.6 Heat treatment,

3.1.7 Dimensions and permissible variations,

3.1.8 Workmanship, finish, and appearance,

3.1.9 Number of tests/test methods,

3.1.10 Specimen preparation,

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 A01.17 on Flat-Rolled and Wrought Stainless Steel.

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² For ASME Boiler and Pressure Vessel Code applications see related Specification SA-479/SA-479M 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 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.

- 3.1.11 Retreatment,
- 3.1.12 Inspection,
- 3.1.13 Rejection and reheating,
- 3.1.14 Material test report,
- 3.1.15 Certification, and
- 3.1.16 Packaging, marking, and loading.

4. Other Requirements

4.1 In addition to the requirements of this specification, all requirements of the current editions of Specification A484/A484M shall apply. Failure to comply with the general requirements of Specification A484/A484M constitutes nonconformance with this specification.

5. Chemical Composition

5.1 Chemical composition shall be reported to the purchaser, or his representative, and shall conform to the requirements specified in Table 1.

5.2 When a product analysis is performed or requested by the purchaser, the tolerance limits as described in Specification A484/A484M apply unless Supplementary Requirement S3 is invoked.

5.3 Methods and practices relating to chemical analysis required by this specification shall be in accordance with Test Methods, Practices, and Terminology A751.

6. Grain Size for Austenitic Grades

6.1 All austenitic grades shall be tested for average grain size by Test Methods E112.

6.2 The H grades shall conform to an average grain size as follows:

6.2.1 ASTM No. 6 or coarser for Types 304H, 309H, 310H, and 316H,

6.2.2 ASTM No. 7 or coarser for Types 321H, 347H, and 348H.

6.3 For S32615, the grain size as determined in accordance with Test Methods E112, comparison method, Plate 11, shall be No. 3 or finer.

6.4 Supplementary Requirement S1 shall be invoked when non-H grade austenitic stainless steels are ordered for ASME Code applications for service above 1000°F [540°C].

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TABLE 1 Chemical Requirements

| UNS Designation ^A | Type | Composition, % ^B | | | | | | | | | |
|------------------------------|--------------------|-----------------------------|--------------------|------------------|------------------|-----------------|----------------------|----------------------|----------------------|----------------------|---|
| | | Carbon | Manganese | Phosphorus | Sulfur | Silicon | Chromium | Nickel | Nitrogen | Molybdenum | Other Elements ^C |
| Austenitic Grades | | | | | | | | | | | |
| N08020 | Alloy 20 | 0.07 | 2.00 | 0.045 | 0.035 | 1.00 | 19.0–21.0 | 32.0–38.0 | ... | 2.00–3.00 | Cu 3.0–4.0 Cb 8xC–1.00 Cu 0.75 |
| N08367 | ... | 0.030 | 2.00 | 0.040 | 0.030 | 1.00 | 20.0–22.0 | 23.5–25.5 | 0.18–0.25 | 6.0–7.0 | Cu 0.75 |
| N08904 | 904L | 0.020 | 2.00 | 0.045 | 0.035 | 1.00 | 19.0–23.0 | 23.0–28.0 | 0.10 | 4.0–5.0 | Cu 1.0–2.0 |
| S20161 | ... | 0.15 | 4.0–6.0 | 0.045 | 0.030 | 3.0–4.0 | 15.0–18.0 | 4.0–6.0 | 0.08–0.20 | ... | ... |
| S20910 | XM-19 | 0.06 | 4.0–6.0 | 0.045 | 0.030 | 1.00 | 20.5–23.5 | 11.5–13.5 | 0.20–0.40 | 1.50–3.00 | Cb 0.10–0.30; V 0.10–0.30 |
| S21600 | XM-17 | 0.08 | 7.5–9.0 | 0.045 | 0.030 | 1.00 | 17.5–20.5 | 5.0–7.0 | 0.25–0.50 | 2.00–3.00 | ... |
| S21603 | XM-18 | 0.03 | 7.5–9.0 | 0.045 | 0.030 | 1.00 | 17.5–20.5 | 5.0–7.0 | 0.25–0.50 | 2.00–3.00 | ... |
| S21800 | ... | 0.10 | 7.0–9.0 | 0.060 | 0.030 | 3.5–4.5 | 16.0–18.0 | 8.0–9.0 | 0.08–0.18 | ... | ... |
| S21904 | XM-11 | 0.04 | 8.0–10.0 | 0.045 | 0.030 | 1.00 | 19.0–21.5 | 5.5–7.5 | 0.15–0.40 | ... | ... |
| S24000 | XM-29 | 0.08 | 11.5–14.5 | 0.060 | 0.030 | 1.00 | 17.0–19.0 | 2.3–3.7 | 0.20–0.40 | ... | ... |
| S30200 | 302 | 0.15 | 2.00 | 0.045 | 0.030 | 1.00 | 17.0–19.0 | 8.0–10.0 | 0.10 | ... | ... |
| S30400 | 304 | 0.08 ^D | 2.00 | 0.045 | 0.030 | 1.00 | 18.0–20.0 | 8.0–10.5 | ... | ... | ... |
| S30403 | 304L | 0.030 | 2.00 | 0.045 | 0.030 | 1.00 | 18.0–20.0 | 8.0–12.0 | ... | ... | ... |
| S30409 | 304H | 0.04–0.10 | 2.00 | 0.045 | 0.030 | 1.00 | 18.0–20.0 | 8.0–10.5 | ... | ... | ... |
| S30451 | 304N | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 18.0–20.0 | 8.0–12.0 | 0.10–0.16 | ... | ... |
| S30453 | 304LN | 0.030 | 2.00 | 0.045 | 0.030 | 1.00 | 18.0–20.0 | 8.0–11.0 | 0.10–0.16 | ... | ... |
| S30600 | ... | 0.018 | 2.00 | 0.020 | 0.020 | 3.7–4.3 | 17.0–18.5 | 14.0–15.5 | ... | 0.20 | Cu 0.50 |
| 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 0.03–0.08 |
| S30908 | 309S | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 22.0–24.0 | 12.0–15.0 | ... | ... | ... |
| S30909 | 309H | 0.04–0.10 | 2.00 | 0.045 | 0.030 | 1.00 | 22.0–24.0 | 12.0–15.0 | ... | ... | ... |
| S30940 | 309Cb | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 22.0–24.0 | 12.0–16.0 | ... | ... | Cb 10xC– 1.10 |
| S30880 | ER308 ^E | 0.08 | 1.00–2.50 | 0.030 | 0.030 | 0.25–0.60 | 19.5–22.0 | 9.0–11.0 | ... | ... | ... |
| S31008 | 310S | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 24.0–26.0 | 19.0–22.0 | ... | ... | ... |
| S31009 | 310H | 0.04–0.10 | 2.00 | 0.045 | 0.030 | 1.00 | 24.0–26.0 | 19.0–22.0 | ... | ... | ... |
| S31040 | 310Cb | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 24.0–26.0 | 19.0–22.0 | ... | ... | Cb 10xC–1.10 |
| S31254 | ... | 0.020 | 1.00 | 0.030 | 0.010 | 0.80 | 19.5–20.5 | 17.5–18.5 | 0.18–0.22 | 6.0–6.5 | Cu 0.50–1.00 |
| S31600 | 316 | 0.08 ^C | 2.00 | 0.045 | 0.030 | 1.00 | 16.0–18.0 | 10.0–14.0 | ... | 2.00–3.00 | ... |
| S31603 | 316L | 0.030 | 2.00 | 0.045 | 0.030 | 1.00 | 16.0–18.0 | 10.0–14.0 | ... | 2.00–3.00 | ... |
| S31609 | 316H | 0.04–0.10 | 2.00 | 0.045 | 0.030 | 1.00 | 16.0–18.0 | 10.0–14.0 | ... | 2.00–3.00 | ... |
| S31635 | 316Ti | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 16.0–18.0 | 10.0–14.0 | 0.10 | 2.00–3.00 | Ti 5x(C+N)- 0.70 |
| S31640 | 316Cb | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 16.0–18.0 | 10.0–14.0 | 0.10 | 2.00–3.00 | Cb 10xC– 1.10 |
| S31651 | 316N | 0.08 | 2.00 | 0.045 | 0.030 | 1.00 | 16.0–18.0 | 10.0–14.0 | 0.10–0.16 | 2.00–3.00 | ... |
| S31653 | 316LN | 0.030 | 2.00 | 0.045 | 0.030 | 1.00 | 16.0–18.0 | 10.0–14.0 | 0.10–0.16 | 2.00–3.00 | ... |
| S31700 | 317 | 0.08 | 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 | 0.20 | 4.0–5.0 | ... |
| S31726 | ... | 0.030 | 2.00 | 0.045 | 0.030 | 1.00 | 17.0–20.0 | 14.5–17.5 | 0.10–0.20 | 4.0–5.0 | ... |
| S31727 | ... | 0.030 | 1.00 | 0.030 | 0.030 | 1.00 | 17.5–19.0 | 14.5–16.5 | 0.15–0.21 | 3.8–4.5 | Cu 2.8–4.0 |
| S32050 | ... | 0.030 | 1.50 | 0.035 | 0.020 | 1.00 | 22.0–24.0 | 20.0–23.0 | 0.21–0.32 | 6.0–6.8 | Cu 0.40 |
| S32053 | ... | 0.030 | 1.00 | 0.030 | 0.010 | 1.00 | 22.0–24.0 | 24.0–26.0 | 0.17–0.22 | 5.0–6.0 | ... |
| S32100 | 321 | 0.08 ^D | 2.00 | 0.045 | 0.030 | 1.00 | 17.0–19.0 | 9.0–12.0 | ... | ... | Ti 5x(C+N)- 0.70 ^F |
| S32109 | 321H | 0.04–0.10 | 2.00 | 0.045 | 0.030 | 1.00 | 17.0–19.0 | 9.0–12.0 | ... | ... | Ti 4x(C+N)- 0.70 ^F |
| S32615 | ... | 0.07 | 2.00 | 0.045 | 0.030 | 4.8–6.0 | 16.5–19.5 | 19.0–22.0 | ... | 0.30–1.50 | Cu 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 | 0.70–0.80 | 0.45–0.55 | Cu 0.30–0.60 |
| S32654 | ... | 0.020 | 2.0–4.0 | 0.030 | 0.005 | 0.50 | 24.0–25.0 | 21.0–23.0 | 0.45–0.55 | 7.0–8.0 | Cu 0.30–0.60 |
| S33228 | ... | 0.04–0.08 | 1.00 | 0.020 | 0.015 | 0.30 | 26.0–28.0 | 31.0–33.0 | ... | ... | Cb 0.60–1.00; Ce 0.05–0.10; Al 0.025 Cb 0.10 |
| S34565 | ... | 0.030 | 5.0–7.0 | 0.030 | 0.010 | 1.00 | 23.0–25.0 | 16.0–18.0 | 0.40–0.60 | 4.0–5.0 | Cb 10xC–1.10 |
| S34700 | 347 | 0.08 ^D | 2.00 | 0.045 | 0.030 | 1.00 | 17.0–19.0 | 9.0–12.0 | ... | ... | Cb 8xC–1.10 |
| S34709 | 347H | 0.04–0.10 | 2.00 | 0.045 | 0.030 | 1.00 | 17.0–19.0 | 9.0–12.0 | ... | ... | (Cb+Ta) 10xC–1.10; |
| S34800 | 348 | 0.08 ^D | 2.00 | 0.045 | 0.030 | 1.00 | 17.0–19.0 | 9.0–12.0 | ... | ... | Ta 0.10; Co 0.20 |
| S34809 | 348H | 0.04–0.10 | 2.00 | 0.045 | 0.030 | 1.00 | 17.0–19.0 | 9.0–12.0 | ... | ... | (Cb + Ta) 8xC–1.10; Co 0.20; Ta 0.10 |
| S35315 | ... | 0.04–0.08 | 2.00 | 0.040 | 0.030 | 1.20–2.00 | 24.0–26.0 | 34.0–36.0 | 0.12–0.18 | ... | Ce 0.03–0.08 |
| S38815 | ... | 0.030 | 2.00 | 0.040 | 0.020 | 5.50–6.50 | 13.0–15.0 | 15.0–17.0 | ... | 0.75–1.50 | Al 0.30; Cu 0.75–1.50 |
| Austenitic-Ferritic Grades | | | | | | | | | | | |
| S31803 | ... | 0.030 | 2.00 | 0.030 | 0.020 | 1.00 | 21.0–23.0 | 4.5–6.5 | 0.08–0.20 | 2.5–3.5 | ... |
| S32101 | ... | 0.040 | 4.0–6.0 | 0.040 | 0.030 | 1.00 | 21.0–22.0 | 1.35–1.70 | 0.20–0.25 | 0.10–0.80 | Cu 0.10–0.80 |
| S32202 | ... | 0.030 | 2.00 | 0.040 | 0.010 | 1.00 | 21.5–24.0 | 1.00–2.80 | 0.18–0.26 | 0.45 | ... |
| S32205 | ... | 0.030 | 2.00 | 0.030 | 0.020 | 1.00 | 22.0–23.0 | 4.5–6.5 | 0.14–0.20 | 3.0–3.5 | ... |
| S32506 | ... | 0.030 | 1.00 | 0.040 | 0.015 | 0.90 | 24.0–26.0 | 5.5–7.2 | 0.08–0.20 | 3.0–3.5 | W 0.05–0.30 |
| S32550 | ... | 0.04 | 1.50 | 0.040 | 0.030 | 1.00 | 24.0–27.0 | 4.5–6.5 | 0.10–0.25 | 2.9–3.9 | Cu 1.50–2.50 |
| S32750 | ... | 0.030 | 1.20 | 0.035 | 0.020 | 0.80 | 24.0–26.0 | 6.0–8.0 | 0.24–0.32 | 3.0–5.0 | Cu 0.50 |

TABLE 1 *Continued*

| UNS Designation ^A | Type | Composition, % ^B | | | | | | | | | |
|------------------------------|-------|-----------------------------|------------|-------------|--------|---------|-----------|-----------|--------------------|--------------|---|
| | | Carbon | Man-ganese | Phos-phorus | Sulfur | Silicon | Chromium | Nickel | Nitrogen | Molyb-denium | Other Elements ^C |
| S32760 ^G | ... | 0.030 | 1.00 | 0.030 | 0.010 | 1.00 | 24.0–26.0 | 6.0–8.0 | 0.20–0.30 | 3.0–4.0 | Cu 0.50–1.00; W 0.50–1.00 |
| S32906 | ... | 0.030 | 0.80–1.50 | 0.030 | 0.030 | 0.50 | 28.0–30.0 | 5.8–7.5 | 0.30–0.40 | 1.50–2.60 | Cu 0.80 |
| S32950 | ... | 0.03 | 2.00 | 0.035 | 0.010 | 0.60 | 26.0–29.0 | 3.5–5.2 | 0.15–0.35 | 1.00–2.50 | ... |
| S39277 | ... | 0.025 | 0.80 | 0.025 | 0.002 | 0.80 | 24.0–26.0 | 6.5–8.0 | 0.23–0.33 | 3.0–4.0 | Cu 1.20–2.00 W 0.80–1.20 |
| Ferritic Grades | | | | | | | | | | | |
| S40500 | 405 | 0.08 | 1.00 | 0.040 | 0.030 | 1.00 | 11.5–14.5 | 0.50 | ... | ... | Al 0.10–0.30 |
| S43000 | 430 | 0.12 | 1.00 | 0.040 | 0.030 | 1.00 | 16.0–18.0 | ... | ... | ... | ... |
| S43035 | 439 | 0.07 | 1.00 | 0.040 | 0.030 | 1.00 | 17.0–19.0 | 0.50 | 0.04 | ... | Ti 0.20 + 4 × (C+N) –1.10; Al 0.15 |
| S44400 | 444 | 0.025 | 1.00 | 0.040 | 0.030 | 1.00 | 17.5–19.5 | 1.00 | 0.035 | 1.75–2.50 | (Ti+Cb) 0.20 + 4 × (C+N)-0.80 |
| S44627 | XM-27 | 0.010 ^H | 0.40 | 0.020 | 0.020 | 0.40 | 25.0–27.5 | 0.50 | 0.015 ^H | 0.75–1.50 | Cu 0.20; Cb 0.05–0.20; (Ni+Cu) 0.50 |
| S44700 | .. | 0.010 | 0.30 | 0.025 | 0.020 | 0.20 | 28.0–30.0 | 0.15 | 0.020 | 3.5–4.2 | (C+N) 0.025; Cu 0.15 |
| S44800 | ... | 0.010 | 0.30 | 0.025 | 0.020 | 0.20 | 28.0–30.0 | 2.00–2.50 | 0.020 | 3.5–4.2 | (C+N) 0.025; Cu 0.15 |
| Martensitic Grades | | | | | | | | | | | |
| S40300 | 403 | 0.15 | 1.00 | 0.040 | 0.030 | 0.50 | 11.5–13.0 | ... | ... | ... | ... |
| S41000 | 410 | 0.15 | 1.00 | 0.040 | 0.030 | 1.00 | 11.5–13.5 | ... | ... | ... | ... |
| S41040 | XM-30 | 0.18 | 1.00 | 0.040 | 0.030 | 1.00 | 11.5–13.5 | ... | ... | ... | Cb 0.05–0.30 |
| S41400 | 414 | 0.15 | 1.00 | 0.040 | 0.030 | 1.00 | 11.5–13.5 | 1.25–2.50 | ... | ... | ... |
| S41425 | ... | 0.05 | 0.50–1.00 | 0.020 | 0.005 | 0.50 | 12.0–15.0 | 4.0–7.0 | 0.06–0.12 | 1.50–2.00 | Cu 0.30 |
| S41500 | ... | 0.05 | 0.50–1.00 | 0.030 | 0.030 | 0.60 | 11.5–14.0 | 3.5–5.5 | ... | 0.50–1.00 | ... |
| S43100 | 431 | 0.20 | 1.00 | 0.040 | 0.030 | 1.00 | 15.0–17.0 | 1.25–2.50 | ... | ... | ... |

^A New designations established in accordance with Practice E527 and SAE J 1086 published jointly by ASTM and SAE. See ASTM DS–56C, available from ASTM Headquarters.

^B Maximum unless otherwise indicated.

^C Except as required for specific alloy type, molybdenum, titanium, nickel, cobalt, tantalum, nitrogen, and copper need not be reported but shall not be present in other than residual amounts, the intent being to prohibit substitution of one alloy type for another due to absence of control of the above named elements in certain alloys.

^D See Supplementary Requirement S1.

^E American Welding Society designation.

^F Nitrogen content is to be reported for this grade.

^G % Cr + 3.3 × % Mo + 16 × % N ≥ 40.

^H Product analysis tolerance over the maximum limit for carbon and nitrogen to be 0.002 %.

^I Wrought version of CA6NM.

7. Mechanical Properties Requirements

7.1 The material shall conform to the mechanical property requirements specified in Table 2 for the grade ordered. At least one room-temperature test shall be performed by the manufacturer on a sample from at least one bar or shape from each lot of material.

7.2 The yield strength shall be determined by the offset (0.2 %) method as prescribed in Test Methods and Definitions A370.

7.3 Martensitic material supplied in the annealed condition shall be capable of meeting the hardened and tempered mechanical properties when heat treated.

7.4 Hardness measurements, when required, shall be made at a location midway between the surface and the center of the cross section.

7.5 Martensitic grades shall be capable of meeting the hardness requirements after heat treating as specified in Table 3.

8. Corrosion Testing

8.1 Austenitic stainless steels solution annealed by the alternative method shall be tested and pass the intergranular corrosion test requirements described in S2.

9. Testing for Intermetallic Compounds

9.1 When specified by the purchaser in the purchase order, the manufacturer shall test the austenitic or austenitic-ferritic (duplex) stainless steel material in its final condition in accordance with supplementary test requirements S6.

NOTE 2—Many, if not all, duplex stainless steels and some austenitic stainless steels will form intermetallic phases or compounds such as sigma, chi, and laves phases when exposed to temperatures below the specified annealing temperature or cooled slowly from a higher temperature during casting, welding, or annealing. These phases can have a negative effect on mechanical properties and corrosion resistance. These phases can typically be removed by correct annealing and cooling practices. The presence of these phases can be demonstrated by tests, typically involving metallography, impact toughness, or corrosion resistance, although the testing requirements may be different for different alloy grades. Such testing may or may not be routinely performed by the manufacturer.