



# Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels<sup>1</sup>

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 ( $\epsilon$ ) 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<sup>2</sup> 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.<sup>2</sup>

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.

1.4 *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>3</sup>

[A262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels](#)

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

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<sup>2</sup> For ASME Boiler and Pressure Vessel Code applications see related Specification SA-479/SA-479M in Section II of that Code.

<sup>3</sup> 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.

[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:*<sup>4</sup>

[SAE J 1086 Recommended Practice for Numbering Metals and Alloys](#)

## 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,

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/](#)

<sup>4</sup> 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

**A484M** shall apply. Failure to comply with the general requirements of Specification **A484/A484M** constitutes non-conformance 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 For N08810 and N08811, the average grain size as determined in accordance with Test Methods **E112** shall be No. 5 or coarser.

6.5 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].

## 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. Testing for Intermetallic Compounds

8.1 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.

## 9. Certification

9.1 The material manufacturer's certificate of compliance certifying that the material was manufactured and tested in accordance with this specification, together with a report of the results required by this specification and the purchase order, shall be furnished at the time of shipment. The certification shall be positively relatable to the lot of material represented.

## 10. Product Marking

10.1 In addition to the marking requirements of Specification **A484/A484M**, materials that have been heat treated or have been strain hardened shall be identified by placement of the following symbols after the grade designation:

### 10.1.1 Austenitic Grades:

10.1.1.1 All grades in the annealed condition—A,

10.1.1.2 Strain hardened Type 316, Level 1—S1,

10.1.1.3 Strain hardened Type 316, Level 2—S2,

10.1.1.4 Hot-rolled Type XM-19—H,

10.1.1.5 Strain hardened Type XM-19—S,

10.1.1.6 Material meeting Supplementary Requirement S1—ELT (unnecessary for H grades).

10.1.1.7 In addition to all other marking requirements of this specification, when S1 is invoked, all grades in the direct quenched condition shall be marked "D".

10.1.2 Austenitic-Ferritic Grades—All grades in the annealed condition—A.

10.1.3 Ferritic Grades—All grades in the annealed condition—A.

### 10.1.4 Martensitic Grades:

10.1.4.1 All grades in the annealed condition—A.

10.1.4.2 Types 403 and 410—COND 1, COND 2, or COND 3 as appropriate for the tempering temperature employed.

10.1.4.3 Type 414, S41500, and Type XM-30 tempered materials—T.

## 11. Keywords

11.1 austenitic stainless steel; austenitic-ferritic duplex stainless steel; ferritic stainless steel; martensitic stainless steel; pressure-containing parts; pressure vessel service; stainless steel bars; stainless steel shapes; temperature service applications—high

**TABLE 1 Chemical Requirements**

UNS Designation <sup>A</sup>	Type	Composition, % <sup>B</sup>									
		Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Nitrogen	Molybdenum	Other Elements <sup>C</sup>
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
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
N08800	800	0.10	1.50	0.045	0.015	1.00	19.0–23.0	30.0–35.0	...	...	Fe <sup>K</sup> 39.5 min. Cu 0.75 Al 0.15–0.60 Ti 0.15–0.60
N08810	800H	0.05–0.10	1.50	0.045	0.015	1.00	19.0–23.0	30.0–35.0	...	...	Fe <sup>K</sup> 39.5 min. Cu 0.75 Al 0.15–0.60 Ti 0.15–0.60
N08811	...	0.06–0.10	1.50	0.045	0.015	1.00	19.0–23.0	30.0–35.0	...	...	Fe <sup>K</sup> 39.5 min. Cu 0.75 Al <sup>L</sup> 0.25–0.60 Ti <sup>L</sup> 0.25–0.60
N08700	...	0.040	2.00	0.040	0.030	1.00	19.0–23.0	24.0–26.0	...	4.3–5.0	Cu 0.50; Cb 8xC–0.40
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
N08925	...	0.020	1.00	0.045	0.030	0.50	19.0–21.0	24.0–26.0	0.10–0.20	6.0–7.0	Cu 0.80–1.50
N08926	...	0.020	2.00	0.030	0.010	0.50	19.0–21.0	24.0–26.0	0.15–0.25	6.0–7.0	Cu 0.50–1.50
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 <sup>D</sup>	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 <sup>E</sup>	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	...	...	...
S31010 <sup>F</sup>	...	0.030	5.50–6.50	0.030	0.0010	0.25–0.75	28.5–30.5	14.0–16.0	0.80–0.90	1.5–2.5	Al 0.05 B 0.005
S31040	310Cb	0.08	2.00	0.045	0.030	1.00	24.0–26.0	19.0–22.0	...	...	Cb 10xC-1.10
S31050	...	0.025	2.00	0.020	0.015	0.4	24.0–26.0	20.5–23.5	0.09–0.15	1.60–2.60	...
S31254	...	0.020	1.00	0.030	0.010	0.80	19.5–20.5	17.5–18.5	0.18–0.25	6.0–6.5	Cu 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	0.35–0.60	5.2–6.2	Cu 1.00–2.50 W 1.50–2.50
S31600	316	0.08 <sup>C</sup>	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 <sup>D</sup>	2.00	0.045	0.030	1.00	17.0–19.0	9.0–12.0	...	...	Ti 5x(C+N)- 0.70 <sup>G</sup>
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 <sup>G</sup>
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	0.45–0.55	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
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 0.10
S34700	347	0.08 <sup>D</sup>	2.00	0.045	0.030	1.00	17.0–19.0	9.0–12.0	...	...	Cb 10xC–1.10

**TABLE 1** *Continued*

UNS Designation <sup>A</sup>	Type	Composition, % <sup>B</sup>									
		Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Nitrogen	Molybdenum	Other Elements <sup>C</sup>
S34709	347H	0.04–0.10	2.00	0.045	0.030	1.00	17.0–19.0	9.0–12.0	...	...	Cb 8xC–1.10 (Cb+Ta) 10xC–1.10; Ta 0.10; Co 0.20
S34800	348	0.08 <sup>D</sup>	2.00	0.045	0.030	1.00	17.0–19.0	9.0–12.0	...	...	
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 <sup>M</sup>	...	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
S32760 <sup>H</sup>	...	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
S32808	...	0.030	1.10	0.030	0.010	0.50	27.0–27.9	7.0–8.2	0.30–0.40	0.80–1.2	W 2.10–2.50
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
S82441	...	0.030	2.5–4.0	0.035	0.005	0.70	23.0–25.0	3.0–4.5	0.20–0.30	1.00–2.00	Cu 0.10–0.80

**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 x (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 x (C+N)–0.80
S44627	XM-27	0.010 <sup>F</sup>	0.40	0.020	0.020	0.40	25.0–27.5	0.50	0.015 <sup>F</sup>	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	...	...	...

<sup>A</sup> 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.

<sup>B</sup> Maximum unless otherwise indicated.

<sup>C</sup> 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.

<sup>D</sup> See Supplementary Requirement S1.

<sup>E</sup> American Welding Society designation.

<sup>F</sup> UNS S31010 is a highly alloyed austenitic stainless steel type 3b as defined in NACE MR0175/ISO 15156-3.

<sup>G</sup> Nitrogen content is to be reported for this grade.

<sup>H</sup> % Cr + 3.3 x % (Mo + ½ W) + 16 x % N ≥ 41.

<sup>I</sup> Product analysis tolerance over the maximum limit for carbon and nitrogen to be 0.002 %.

<sup>J</sup> Wrought version of CA6NM.

<sup>K</sup> Iron shall be determined arithmetically by difference of 100 minus the sum of specified elements.

<sup>L</sup> (Al+Ti) 0.85–1.20.

<sup>M</sup> % Cr + 3.3 x % Mo + 16 x % N ≥ 41.