



# 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 A 479/A 479M; 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 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 inch-pound units or SI (metric) units are to be regarded separately as standards; within the text and tables, the SI units are shown in [brackets]. The values stated in each system are not exact equivalents; therefore, each system must be used independent of the other. Combining values from the two systems may result in nonconformance with the specification.~~

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:<sup>3</sup>

- A 262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels
- A 370 Test Methods and Definitions for Mechanical Testing of Steel Products
- A 484/A 484M Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings
- A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
- E 112 Test Methods for Determining Average Grain Size
- E 527 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 A 484/A 484M.

- 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,

<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](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.

<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.

- 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 A 484/A 484M shall apply. Failure to comply with the general requirements of Specification A 484/A 484M 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 A 484/A 484M 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 A 751.

#### 6. Grain Size for Austenitic Grades

6.1 All austenitic grades shall be tested for average grain size by Test Methods E 112.

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 E 112, 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].

#### ASTM A479/A479M-08

**TABLE 1 Chemical Requirements**

UNS Designation <sup>A</sup>	Type	Composition, % <sup>B</sup>									
		Carbon	Man-ganese	Phos-phorus	Sulfur	Silicon	Chromium	Nickel	Nitrogen	Molyb-denium	Other Elements <sup>C</sup>
Austenitic Grades											
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
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>C</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 10×C- 1.10
S30880	ER308 <sup>D</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	...	...	...
S31040	310Cb	0.08	2.00	0.045	0.030	1.00	24.0–26.0	19.0–22.0	...	...	Cb 10×C-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



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>
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 5×(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 10×C- 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>E</sup>	2.00	0.045	0.030	1.00	17.0–19.0	9.0–12.0	...	...	Ti 5×(C+N)- 0.70 <sup>F</sup>
S32109	321H	0.04–0.10	2.00	0.045	0.030	1.00	17.0–19.0	9.0–12.0	...	...	Ti 4×(C+N)- 0.70 <sup>F</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	...
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	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 10×C–1.10
S34700	347	0.08 <sup>E</sup>	2.00	0.045	0.030	1.00	17.0–19.0	9.0–12.0	...	...	Cb 8×C–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 8×C–1.10
S34800	348	0.08 <sup>E</sup>	2.00	0.045	0.030	1.00	17.0–19.0	9.0–12.0	...	...	(Cb+Ta) 10×C–1.10; 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) 8×C–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
S32760 <sup>G</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
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 <sup>H</sup>	0.40	0.020	0.020	0.40	25.0–27.5	0.50	0.015 <sup>H</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 E 527 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> American Welding Society designation.

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

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

<sup>G</sup> % Cr + 3.3 × % Mo + 16 × % N ≥ 40.

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

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

**TABLE 2 Mechanical Property Requirements**

UNS Designation	Type	Condition	Tensile Strength, min, ksi [MPa]	Yield Strength, <sup>A</sup> min, ksi [MPa]	Elongation in 2 in. [50 mm] or 4D, min, %	Reduction of Area, min, % <sup>B,C</sup>	Brinell Hardness, max
Austenitic Grades							
N08367	...	annealed	95 [655]	45 [310]	30	...	241
S20161	...	annealed	125 [860]	50 [345]	40	40	311
S20910	XM-19	annealed	100 [690]	55 [380]	35	55	293
	Up to 2 in. [50.8 mm], incl	hot-rolled	135 [930]	105 [725]	20	50	...
	Over 2 to 3 in. [50.8 to 76.2 mm], incl	hot-rolled	115 [795]	75 [515]	25	50	...
	Over 3 to 8 in. [76.2 to 203.2 mm], incl	hot-rolled	100 [690]	60 [415]	30	50	...
	Up to 1½ in. [38.1 mm], incl	strain-hardened	145 [1000]	125 [860]	12	40	...
	Over 1½ to 2¼ in. [38.1 to 57.2 mm], incl	strain-hardened	120 [825]	105 [725]	15	45	...
S21600, S21603	XM-17, XM-18	annealed	90 [620]	50 [345]	40	50	212
S21800	...	annealed	95 [655]	50 [345]	35	55	241
S21904	XM-11	annealed	90 [620]	50 [345]	45	60	...
S24000	XM-29	annealed	100 [690]	55 [380]	30	50	...
S30200, S30400, S30409, S30453, S30880, S30908, S30909, S30940, S31008, S31009, S31040, S31600, S31609, S31635, S31640, S31653, S31700, S32100, S32109, S34700, S34709, S34800, S34809, S30403, S31603	302, 304, 304H, 304LN, ER308, <sup>D</sup> 309S, 309H, 309Cb, 310S, 310H, 310Cb, 316, 316H, 316Ti, 316Cb, 316LN, 317, 321, 321H, 347, 347H, 348, 348H	annealed	75 [515] <sup>E</sup>	30 [205]	30	40	...
	316, 316L	strain-hardened	85 [585]	65 [450] <sup>F</sup>	30	60	...
	304, 304L	level 1	...	...	...	...	...
	2 in. and under	strain-hardened level 2	95 [655]	75 [515]	25	40	...
	Over 2 to 2½ in. [50.8 to 63.5 mm], incl.	strain-hardened level 2	90 [620]	65 [450]	30	40	...
	Over 2½ to 3 in. [63.5 to 76.2 mm], incl	strain-hardened level 2	80 [550]	55 [380]	30	40	...
S30403, S31603	304L, 316L	annealed	70 [485]	25 [170]	30	40	...
S30451, S31651	304N, 316N	annealed	80 [550]	35 [240]	30	40	...
S30600	...	annealed	78 [540]	35 [240]	40	...	...
S30815	...	annealed	87 [600]	45 [310]	40	50	...
S31254	...	annealed	95 [655]	44 [305]	35	50	...
S31725	...	annealed	75 [515]	30 [205]	40	...	...
S31726	...	annealed	80 [550]	35 [240]	40	...	...
S31727	...	annealed	80 [550]	36 [245]	35	...	217
S32050	...	annealed	98 [675]	48 [330]	40	...	...
S32053	...	annealed	93 [640]	43 [295]	40	...	217
S32615	...	annealed	80 [550]	32 [220]	25	40	...
S32654	...	annealed	109 [750]	62 [430]	40	40	250
S33228	...	annealed	73 [500]	27 [185]	30	...	...
S34565	...	annealed	115 [795]	60 [415]	35	40	230
S35315	...	annealed	94 [650]	39 [270]	40	...	...
S38815	...	annealed	78 [540]	37 [255]	30	...	...
Austenitic-Ferritic Grades							
S31803	...	annealed	90 [620]	65 [450]	25	...	290
S32101	...	annealed	94 [650]	65 [450]	30	...	290
S32202	...	annealed	94 [650]	65 [450]	30	...	290
S32205	...	annealed	95 [655]	65 [450]	25	...	290
S32506	...	annealed	90 [620]	65 [450]	18	...	302
S32550	...	annealed	110 [760]	80 [550]	15	...	297
S32750	2 in. and under	annealed	116 [800] <sup>G</sup>	80 [550] <sup>G</sup>	15	...	310
	over 2 in.	annealed	110 [760]	75 [515]	15	...	310
S32760	...	annealed	109 [750]	80 [550]	25	...	300