Designation: A 479/A 479M – 01

An American National Standard
Used in USDOE-NE Standards

Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels[1]

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 (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 specification[2] 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 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.

1.3 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:*

A 262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels[3]

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products[3]

A 484/A 484M Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings[3]

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products[3]

E 112 Test Methods for Determining the Average Grain Size[4]

E 527 Practice for Numbering Metals and Alloys (UNS)[5]

2.2 *Other Document:*

SAE J1086 Recommended Practice for Numbering Metals and Alloys[6]

3. Ordering Information

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

3.1.1 Quantity (weight or number of pieces),

3.1.2 Dimensions, including diameter or thickness (and width), shape or form, applicable prints or sketches, length, etc.,

3.1.3 Type or UNS designation, (Table 1),

3.1.4 ASTM designation and edition year if other than latest edition,

3.1.5 Heat treated condition (Section 4),

3.1.6 Finish (see Manufacture section of Specification A 484/A 484M),

3.1.7 Supplementary Requirements invoked for special services (described at the end of this specification),

3.1.8 Whether bars are to be rolled as bars or cut from strip or plate,

3.1.9 Preparation for delivery (see Preparation for Delivery section of Specification A 484/A 484M),

3.1.10 Marking requirements (see Marking section of Specification A 484/A 484M),

3.1.11 Surface preparation of shapes (see Manufacture section of Specification A 484/A 484M),

3.1.12 The intended use of the material, if the purchaser considers this useful information.

NOTE 2—A typical ordering description is as follows: 5000 lb [2000

[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 Products.

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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] *Annual Book of ASTM Standards*, Vol 01.03.

[4] *Annual Book of ASTM Standards*, Vol 03.01.

[5] *Annual Book of ASTM Standards*, Vol 01.01.

[6] Available from Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

kg]; 1.000 in. [25 mm] round bar by 10 to 12 ft [3 to 4 m]; Type 304 or UNS S30400; to Specification A 479 [A 479M]; annealed; centerless ground; plus any optional supplementary requirements, such as, for example, special marking instructions.

4. Heat Treatment

4.1 *Austenitic Grades*:

4.1.1 Except for the strain-hardened grade (see 4.1.3) and the hot-rolled grade (see 4.1.4), all austenitic grades of stainless steel shall be furnished in the solution annealed condition, with subsequent light cold drawing and straightening permitted. (See Supplementary Requirement S5 if annealing must be the final operation.) Solution annealing for all grades, except the H grades (see 4.1.2), N08367 (see 4.1.8), S31254 (see 4.1.5), S32050 (see 4.1.5), S33228 (see 4.1.7), S34565 (see 4.1.6), and S35315 (see 4.1.9), shall consist of *(1)* heating the material to a temperature of 1900°F [1040°C] minimum so that grain boundary carbides enter into solution, and cooling rapidly to prevent grain boundary carbide precipitation; or alternatively[7] *(2)* (except for the columbium and titanium stabilized grades 309Cb, 310Cb, 316Cb, 316Ti, 321, 347, and 348) immediately following hot working while the temperature is above 1750°F [955°C] so that grain boundary carbides are in solution, cooling rapidly to prevent grain boundary carbide precipitation. When Supplementary Requirement S2 is invoked, all austenitic grades except S30815 shall pass the intergranular corrosion test requirements described in S2.

4.1.2 For H grades, the minimum solution annealing temperatures shall be as follows:

4.1.2.1 When hot finished, 1900°F [1040°C] for Types 304H, 309H, 310H, and 316H; 1925°F [1050°C] for Types 321H, 347H, and 348H,

4.1.2.2 When cold worked prior to solution annealing, 1900°F [1040°C] for Types 304H, 309H, 310H, and 316H; 2000°F [1095°C] for Types 321H, 347H, and 348H.

NOTE 3—Solution annealing temperatures above 1950°F [1065°C] may impair the resistance to intergranular corrosion after subsequent exposure to sensitizing conditions in the stabilized grades, Types 321, 321 H, 347, 347 H, 348 and 348 H. When intergranular corrosion is of concern, the purchaser should specify the corrosion test of S2 (to be conducted on sensitized specimens). The manufacturer may, if necessary, use a lower temperature resolution anneal or a stabilization anneal after a high temperature solution anneal in order to meet corrosion test requirements. Consideration should be given to the corrosive media before using a stabilization anneal at less than 1800°F [980°C], as such a treatment may not be fully effective for all media.

NOTE 4—Grain size requirements for the H grades are described in Section 7.

4.1.3 *Strain-Hardened Austenitic Type 316*—When Type 316 is desired with increased mechanical properties, the strain-hardened condition may be specified and is produced by solution annealing, as described in 4.1.1, followed by strain hardening sufficient to meet the required mechanical properties. Solution-annealed and strain-hardened material shall be capable of meeting the intergranular corrosion test of Supplementary Requirement S2.

4.1.3.1 Two strain hardened conditions have been established for different applications: Level 1 and Level 2 (see Table 2).

4.1.4 High tensile Type XM-19 shall be in the hot-rolled or strain-hardened condition and shall be capable of meeting the mechanical property requirements of Table 2 and passing the intergranular corrosion test prescribed in S2. The strain hardened condition is achieved by solution annealing followed by cold working sufficient to develop the required mechanical properties.

4.1.5 Solution annealing of S31254, S32050, and S32654 shall consist of heating the material to a temperature of 2100°F [1150°C] minimum for an appropriate time, followed by water quenching or rapidly cooling by other means.

4.1.6 Solution annealing of S34565 shall consist of heating the material in the range of temperature from 2050°F [1120°C] to 2140°F [1170°C] for an appropriate time, followed by water quenching or rapidly cooling by other means.

4.1.7 Solution annealing of S33228 shall consist of heating the material in the temperature range 2050 to 2160°F [1120 to 1180°C] for an appropriate time, followed by water quenching or rapid cooling by other means.

4.1.8 Solution annealing of N08367 shall consist of heating the material to a temperature of 2025°F [1105°C] minimum for an appropriate time, followed by water quenching or rapidly cooling by other means.

4.1.9 Solution annealing of S35315 shall consist of heating the material to a temperature of 2100°F [1150°C] minimum for an appropriate time, followed by water quenching or rapidly cooling by other means.

4.2 *Austenitic-Ferritic Grades*:

4.2.1 S31803, S32205, and S32550 shall be furnished in the annealed condition with subsequent straightening permitted. The annealing treatment of S31803 and S32550 shall consist of heating the material to a temperature of 1900°F [1040°C] minimum for an appropriate time followed by water quenching or rapid cooling by other means. The annealing treatment for S32205 shall consist of heating the material to a temperature of 1900°F [1040°C] minimum for an appropriate time, followed by water quenching.

4.2.2 S32950 shall be annealed by heating the material to a temperature of 1825°F [995°C] to 1875°F [1025°C] for an appropriate time, followed by water quenching or rapid cooling by other means.

4.2.3 S32750 shall be annealed by heating the material to a temperature of 1880°F [1025°C] to 2060°F [1125°C] for an appropriate time, followed by water quenching or rapid cooling by other means. Subsequent straightening shall be permitted.

4.2.4 S32760 shall be annealed by heating the material to a temperature of 2010°F [1100°C] to 2085°F [1140°C] for an appropriate time, followed by water quenching or rapid cooling by other means.

4.2.5 UNS S32906 shall be annealed by heating the material to a temperature of 1900°F (1040°C) to 1980°F (1080°C) for an appropriate time followed by rapid cooling in air or water. Subsequent straightening shall be permitted.

4.2.6 S39277 shall be annealed by heating the material to 1940°F [1060°C] to 2060°F [1125°C] for an appropriate time, followed by water quenching or rapid cooling by other means.

[7] For explanation see Appendix X1.

Subsequent straightening shall be permitted.

4.3 *Ferritic Grades*—Ferritic grades shall be annealed to meet the requirements of Table 2.

4.4 *Martensitic Grades*:

4.4.1 All grades of martensitic steels shall be supplied in either the annealed condition or in the tempered condition as specified by the purchaser (see 3.1.3). Tempered material shall be normalized, or shall be liquid quenched from 1700°F [925°C] minimum, followed by tempering in accordance with 4.4.2, 4.4.3, or 4.4.5.

4.4.2 Types 403 and 410 tempered material shall be held at tempering temperature for at least 1 h/in. [25.4 mm] of cross section as follows:

TABLE 1 Chemical Requirements

UNS Designation[A]	Type	Composition, %[B]									
		Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Nitrogen	Molybdenum	Other Elements[C]
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[C]	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[D]	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
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 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	. . .
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
S32100	321	0.08[E]	2.00	0.045	0.030	1.00	17.0–19.0	9.0–12.0	. . .	. . .	Ti 5×(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 4×(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	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
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[E]	2.00	0.045	0.030	1.00	17.0–19.0	9.0–12.0	. . .	. . .	Cb 10×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[E]	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	. . .
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	. . .

TABLE 1 *Continued*

UNS Designation[A]	Type	Composition, %[B]									
		Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Nitrogen	Molybdenum	Other Elements[C]
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[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	[I]	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 E 527 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] American Welding Society designation.

[E] See Supplementary Requirement S1.

[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.

4.4.2.1 *Condition 1*—1250°F [675°C] minimum, 1400°F [760°C] maximum.

4.4.2.2 *Condition 2*—1100°F [595°C] minimum, 1400°F [760°C] maximum.

4.4.2.3 *Condition 3*—1050°F [565°C] minimum, 1400°F [760°C] maximum.

4.4.3 Types XM-30, 414, and 431 tempered materials shall be held at 1100°F [595°C] minimum for at least 1 h/in. [25 mm] of cross section. Maximum tempering temperature shall be 1400°F [760°C].

4.4.4 For S41425, heat to 1700°F [925°C] minimum and hold for 1 h at temperature minimum. Air cool to below 90°F [32°C] and temper at 1100°F [595°C] minimum of 1 h per inch of cross-sectional thickness minimum.

4.4.5 For S41500 heat to 1750°F [955°C] minimum, air cool to 200°F [95°C] or lower prior to any optional intermediate temper and prior to the final temper. The final temper shall be between 1050°F [565°C] and 1150°F [620°C].

4.4.6 When the purchaser elects to perform the hardening and tempering heat treatment, martensitic materials shall be supplied by the manufacturer in the annealed condition (see 4.4.1). In this case it shall be the purchaser's responsibility to apply the proper heat treatment and to conduct the tests he deems necessary to assure that the required properties are obtained.

5. General Requirements

5.1 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.

6. Chemical Composition

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

6.2 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.