



Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar¹

This standard is issued under the fixed designation A666/A666M; 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 covers austenitic stainless steels in the annealed and normally required cold-worked conditions for various structural, pressure vessel, magnetic, cryogenic, and heat-resisting applications.

1.2 The application of this specification, or the use of material covered by this specification does not automatically allow usage in pressure vessel applications. Only annealed conditions of grades specifically approved by the ASME code are permitted for pressure vessel use.

1.3 This specification is expressed in both inch-pound units and in SI units; however, unless the purchase order or contract specifies the applicable *M* specification designation (SI units), the inch-pound units shall apply. 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.

1.4 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *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.*

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.

Current edition approved March 1, 2024. Published April 2024. Originally approved in 1972. Last previous edition approved in 2023 as A666 – 23. DOI: 10.1520/A0666_A0666M-24.

2. Referenced Documents

2.1 ASTM Standards:²

A240/A240M Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

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

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

A751 Test Methods and Practices for Chemical Analysis of Steel Products

A941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys

A1058 Test Methods for Mechanical Testing of Steel Products—Metric

E6 Terminology Relating to Methods of Mechanical Testing

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

2.2 SAE International³

SAE J 1086 Numbering Metals and Alloys

3. Terminology

3.1 Definitions:

3.1.1 For definitions of terms pertaining to this standard reference should be made to Terminology A941.

3.1.2 For definitions of terms pertaining to plate, sheet, and strip reference should be made to Specification A480/A480M.

² 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.

³ Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096, http://www.sae.org.

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

3.1.3 For definitions of terms pertaining to flat bar reference should be made to Specification **A484/A484M**.

3.1.4 For definitions of terms pertaining to methods of mechanical testing reference should be made to Specification **E6**.

4. Material Test Report and Certification

4.1 In addition to the requirements of Specification **A480/A480M** for plate, sheet, and strip or Specification **A484/A484M** for flat bar, the cold-worked condition (annealed, $\frac{1}{4}$ H, $\frac{1}{2}$ H, and so forth) shall be noted.

5. Chemical Composition

5.1 The steel shall conform to the chemical composition requirements specified in **Table 1**, and shall conform to applicable requirements specified in the current edition of Specification **A480/A480M** for plate, sheet, and strip or Specification **A484/A484M** for flat bar.

6. Mechanical Properties

6.1 The material shall conform to the mechanical properties specified in **Tables 2 and 3**, or **Tables 2 and 4**. This specification defines minimum properties only and does not imply a range. Depending on the work hardening characteristics of the particular grade, either the yield or the tensile strength can be the controlling factor in meeting the properties. The noncontrolling factor normally will exceed considerably the specified minimum.

7. General Requirements

7.1 The following requirements for orders for material furnished under this specification shall conform to the applicable requirements of the current edition of Specification **A480/A480M** or Specification **A484/A484M**:

- 7.1.1 Definitions,
- 7.1.2 General requirements for delivery,
- 7.1.3 Ordering information,
- 7.1.4 Process,
- 7.1.5 Special tests,
- 7.1.6 Heat treatment,
- 7.1.7 Dimensions and permissible variations,
- 7.1.8 Workmanship, finish and appearance,
- 7.1.9 Number of tests/test methods,
- 7.1.10 Specimen preparation,
- 7.1.11 Retreatment,
- 7.1.12 Inspection,
- 7.1.13 Rejection and reheating,
- 7.1.14 Material test report,
- 7.1.15 Certification, and
- 7.1.16 Packaging, marking, and loading.

8. Sampling

8.1 Tension and bend-test specimens of sheet, strip, and plate products shall be selected from finished material and shall be selected in the transverse direction, except in the case of strip under 9 in. (230 mm) in width, in which case tension test specimens shall be selected in the longitudinal direction.

8.2 Flat bar tension and bend-test specimens shall be selected from the finished material and shall be in the longitudinal direction.

8.3 Corrosion samples, if required, shall be taken from material after final annealing and descaling and prior to cold working.

9. Number of Tests

9.1 For cold-worked product produced in coil form, one tension test shall be made from each end of each coil. One bend test shall be made from one end of each coil.

9.2 For cold-worked flat bar and plate products, two tension test and one bend test shall be made on each size of flat bar and each thickness of plate from each heat in a lot annealed in a single charge or under the same conditions in a continuous furnace.

9.3 Annealed material produced to **Table 2** requirements shall be tested in accordance with Specification **A480/A480M**.

10. Test Methods

10.1 Tension Test:

10.1.1 The yield strength shall be determined by the offset method as described in Test Methods and Definitions **A370** or Test Methods **A1058**. An alternative method of determining yield strength may be used based on the following total extension under load:

Yield Strength, min. ksi [MPa]	Total Extension under Load in 2 in. or [50 mm] Gauge Length, incl. in./in. [mm/mm]
45 [310]	0.0071
75 [515]	0.0098
110 [760]	0.0125
135 [930]	0.0144
140 [965]	0.0148

10.1.2 The requirement of this specification for yield strength will be considered as having been fulfilled if the extension under load for the specified yield strength does not exceed the specified values. The values obtained in this manner should not, however, be taken as the actual yield strength for 0.2 %. In case of dispute, the offset method of determining yield strength shall be used.

10.2 Bend Test:

10.2.1 Bend-test specimens shall withstand cold bending without cracking when subjected to either the free-bend method or the controlled-bend (V-block) method at the condition specified by **Table 3** or **Table 4**, respectively. Specimens shall be bent around a diameter equal to the product of the bend factor times the specified thickness of the test specimen. The choice of test method for materials in conditions other than annealed shall be at the option of the seller.

10.2.2 Free-bend test specimens shall be bent cold, either by pressure or by blows. However, in the case of dispute, tests shall be made by pressure.

10.2.3 Controlled-bend (V-block) test specimens shall be bent cold by means of V-blocks or a mating punch and die having an included angle of 45° and with proper curvature of surface at the bend areas to impart the desired shape and diameter of bend to the specimen.

TABLE 1 Chemical Composition Requirements^A

UNS Designation ^C	Type ^D	Composition, % ^B							
		Carbon ^E	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Other Elements
S20100	201	0.15	5.5–7.5	0.060	0.030	0.75	16.0–18.0	3.5–5.5	N 0.25
S20103	201L ^F	0.03	5.5–7.5	0.045	0.030	0.75	16.0–18.0	3.5–5.5	N 0.25
S20153	201LN ^F	0.03	6.4–7.5	0.045	0.015	0.75	16.0–17.5	4.0–5.0	N 0.10–0.25 Cu 1.00
S20200	202	0.15	7.5–10.0	0.060	0.030	0.75	17.0–19.0	4.0–6.0	N 0.25
S20400	...	0.030	7.0–9.0	0.040	0.030	1.00	15.0–17.0	1.50–3.00	N 0.15–0.30
S20500	205	0.12–0.25	14.0–15.0	0.060	0.030	0.75	16.5–18.0	1.00–1.75	N 0.32–0.40
S21460	XM–14 ^G	0.12	14.0–16.0	0.060	0.030	0.75	17.0–19.0	5.0–6.0	N 0.35–0.50
S21904	XM–11 ^G	0.04	8.0–10.0	0.060	0.030	0.75	19.0–21.5	5.5–7.5	N 0.15–0.40
S30100	301	0.15	2.00	0.045	0.030	1.00	16.0–18.0	6.0–8.0	N 0.10
S30103	301L ^F	0.03	2.00	0.045	0.030	1.00	16.0–18.0	6.0–8.0	N 0.20
S30153	301LN ^F	0.03	2.00	0.045	0.030	1.00	16.0–18.0	6.0–8.0	N 0.07–0.20
S30116	...	0.15	2.00	0.045	0.030	1.00–1.35	16.0–18.0	6.0–8.0	N 0.20, Mo 1.00
S30200	302	0.15	2.00	0.045	0.030	0.75	17.0–19.0	8.0–10.0	
S30400	304	0.08	2.00	0.045	0.030	0.75	18.0–20.0	8.0–10.5	N 0.10
S30403	304L	0.030	2.00	0.045	0.030	0.75	18.0–20.0	8.0–12.0	N 0.10
S30416	...	0.030	2.00	0.045	0.015	0.80–2.00	17.5–19.5	9.0–11.0	N 0.10 Mo 0.40–0.80
S30451	304N	0.08	2.00	0.045	0.030	0.75	18.0–20.0	8.0–10.5	N 0.10–0.16
S30453	304LN	0.030	2.00	0.045	0.030	0.75	18.0–20.0	8.0–12.0	N 0.10–0.16
S31600	316	0.08	2.00	0.045	0.030	0.75	16.0–18.0	10.0–14.0	Mo 2.00–3.00
S31603	316L	0.030	2.00	0.045	0.030	0.75	16.0–18.0	10.0–14.0	Mo 2.00–3.00
S31651	316N	0.08	2.00	0.045	0.030	0.75	16.0–18.0	10.0–14.0	Mo 2.00–3.00 N 0.10–0.16

^A Types XM–10 and XM–19, which appeared in Specification A412, do not appear as XM–10 is no longer produced and XM–19 is covered in Specification A240/A240M.

^B Maximum unless otherwise indicated.

^C Designation established in accordance with Practice E527 and SAE J 1086.

^D Unless otherwise indicated, a grade designation originally assigned by the American Iron and Steel Institute.

^E Carbon analysis shall be reported to nearest 0.01 % except for the low-carbon types, which shall be reported to nearest 0.001 %.

^F Common name, not a trademark, widely used, not associated with any one producer.

^G Naming system developed and applied by ASTM.

TABLE 2 Mechanical Property Requirements^A

UNS Designation ^A	Type ^B	Annealed		Elongation in 2 in. or 50 mm, min, %	Hardness, ^D max			
		Tensile Strength, min ksi	MPa		Yield Strength, ^C min ksi	MPa	Brinell, HBW	Rockwell HRBW
S20100	201–1 ^E	75	515	38	260	40	217	95
Class 1								
S20100	201–2 ^E	95	655	45	310	40	241	100
Class 2								
S20103	201L	95	655	38	260	40	217	95
S20153	201LN	95	655	45	310	45	241	100
S20200	202	90	620	38	260	40	241	...
S20400	...	95	655	48	330	35	241	100
S20500	205	115	790	65	450	40	241	100
S21460	XM–14	105	725	55	380	40	...	...
S21904	XM–11							
Sheet		100	690	60	415	40	...	...
and Strip								
Plate		90	620	50	345	45	...	...
S30100	301	75	515	30	205	40	217	95
S30103	301L	80	550	32	220	45	241	100
S30153	301LN	80	550	35	240	45	241	100
S30200	302	75	515	30	205	40	201	92
S30116	...	75	515	30	205	40	217	95
S30400	304	75	515	30	205	40	201	92
S30403	304L	70	485	25	170	40	201	92
S30416	...	73	500	32	220	40	217	95
S30451	304N	80	550	35	240	30	217	95
S30453	304LN	75	515	30	205	40	217	95
S31600	316	75	515	30	205	40	217	95
S31603	316L	70	485	25	170	40	217	95
S31651	316N	80	550	35	240	35	217	95

¹/₁₆ Hard^F

TABLE 2 *Continued*

UNS Designation	Type	Tensile Strength, min		Yield Strength, min		Elongation in 2 in. or 50 mm, min, %		
		ksi	MPa	ksi	MPa	<0.015 in. [<0.380 mm]	≥ 0.015 in. to ≤ 0.030 in. [≥ 0.380 mm to ≤ 0.760 mm]	>0.030 in. [>0.760 mm]
S20100	201							
Plate, Sheet and Strip		95	655	45	310	40	40	40
Flat Bar		75	515	40	275	...	...	40
S20103	201L	100	690	50	345	40	40	40
S20153	201LN	100	690	50	345	40	40	40
S20500	205	115	790	65	450	40	40	40
S30100	301	90	620	45	310	40	40	40
S30103	301L	100	690	50	345	40	40	40
S30153	301LN	100	690	50	345	40	40	40
S30200	302							
Plate, Sheet and Strip		85	585	45	310	40	40	40
Flat Bar		90	620	45	310	...	...	40
S30400	304							
Plate, Sheet and Strip		80	550	45	310	35	35	35
Flat Bar		90	620	45	310	...	...	40
S30403	304L	80	550	45	310	40	40	40
S30451	304N	90	620	45	310	40	40	40
S30453	304LN	90	620	45	310	40	40	40
S31600	316							
Plate, Sheet and Strip		85	585	45	310	35	35	35
Flat Bar		90	620	45	310	...	...	40
S31603	316L	85	585	45	310	35	35	35
S31651	316N	90	620	45	310	35	35	35

 $\frac{1}{8}$ Hard^F

UNS Designation	Type	Tensile Strength, min		Yield Strength, min		Elongation in 2 in. or 50 mm, min, %		
		ksi	MPa	ksi	MPa	<0.015 in. [<0.380 mm]	≥ 0.015 in. to ≤ 0.030 in. [≥ 0.380 mm to ≤ 0.760 mm]	>0.030 in. [>0.760 mm]
S20100	201	100	690	55	380	45	45	45
S20103	201L	105	725	55	380	35	35	35
S20153	201LN	110	760	60	415	35	35	35
S20500	205	115	790	65	450	40	40	40
S30100	301	100	690	55	380	40	40	40
S30103	301L	110	760	60	415	35	35	35
S30153	301LN	110	760	60	415	35	35	35
S30200	302	100	690	55	380	35	35	35
S30400	304	100	690	55	380	35	35	35
S30403	304L	100	690	55	380	30	30	30
S30451	304N	100	690	55	380	37	37	37
S30453	304LN	100	690	55	380	33	33	33
S31600	316	100	690	55	380	30	30	30
S31603	316L	100	690	55	380	25	25	25
S31651	316N	100	690	55	380	32	32	32

 $\frac{1}{4}$ Hard

UNS Designation	Type	Tensile Strength, min		Yield Strength, min		Elongation in 2 in. or 50 mm, min, %		
		ksi	MPa	ksi	MPa	<0.015 in. [<0.380 mm]	≥ 0.015 in. to ≤ 0.030 in. [≥ 0.380 mm to ≤ 0.760 mm]	>0.030 in. [>0.760 mm]
S20100	201	125	860	75	515	25	25	25
S20103	201L	120	825	75	515	25	25	25
S20153	201LN	120	825	75	515	25	25	25
S20200	202	125	860	75	515	12	12	...
S20400	...	140	965	100	960	20	20	20
S20500	205	125	860	75	515	45	45	45
S21904	XM-11	130	895	115	795	15	15	...
S30100	301	125	860	75	515	25	25	25
S30103	301L	120	825	75	515	25	25	25
S30153	301LN	120	825	75	515	25	25	25
S30200	302	125	860	75	515	10	10	12
S30400	304	125	860	75	515	10	10	12
S30403	304L	125	860	75	515	8	8	10
S30451	304N	125	860	75	515	12	12	12
S30453	304LN	125	860	75	515	10	10	12
S31600	316	125	860	75	515	10	10	10
S31603	316L	125	860	75	515	8	8	8