



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; 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 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

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.*

2. Referenced Documents

2.1 *ASTM Standards:*²

[A240/A240M Specification for Chromium and Chromium-](#)

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 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.

[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, and Forgings](#)

[A941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys](#)

[E527 Practice for Numbering Metals and Alloys in the Unified Numbering System \(UNS\)](#)

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](#).

3.1.3 For definitions of terms pertaining to flat bar reference should be made to Specification [A484/A484M](#).

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](#).

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

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. (229 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**. An alternative method of determining yield strength may be used based on the following total extension under load:

Yield Strength, min. psi	Total Extension under Load in 2 in. Gauge Length, incl.
45 000	0.0071
75 000	0.0098
110 000	0.0125
135 000	0.0144
140 000	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
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 Tensile Property Requirements^A

UNS Designation	Type ^B	Tensile Strength, min		Yield Strength, ^C min		Elongation in 2 in. or 50 mm, min, %	Hardness, ^D max	
		psi	MPa	psi	MPa		Brinell	Rockwell B
S20100 Class 1	201–1 ^E	75 000	515	38 000	260	40	217	95
S20100 Class 2	201–2 ^E	95 000	655	45 000	310	40	241	100
S20103	201L	95 000	655	38 000	260	40	217	95
S20153	201LN	95 000	655	45 000	310	45	241	100
S20200	202	90 000	620	38 000	260	40	241	...
S20400	...	95 000	655	48 000	330	35	241	100
S20500	205	115 000	790	65 000	450	40	241	100
S21460	XM–14	105 000	725	55 000	380	40	...	...
S21904	XM–11	100 000	690	60 000	415	40	...	...
Sheet and Strip								
Plate		90 000	620	50 000	345	45	...	...
S30100	301	75 000	515	30 000	205	40	217	95
S30103	301L	80 000	550	32 000	220	45	241	100
S30153	301LN	80 000	550	35 000	240	45	241	100
S30200	302	75 000	515	30 000	205	40	201	92
S30116	...	75 000	515	30 000	205	40	217	95
S30400	304	75 000	515	30 000	205	40	201	92
S30403	304L	70 000	485	25 000	170	40	201	92
S30451	304N	80 000	550	35 000	240	30	217	95
S30453	304LN	75 000	515	30 000	205	40	217	95
S31600	316	75 000	515	30 000	205	40	217	95
S31603	316L	70 000	485	25 000	170	40	217	95
S31651	316N	80 000	550	35 000	240	35	217	95
				^{1/16} Hard ^F				
UNS Designation	Type	Tensile Strength, min		Yield Strength, min		Elongation in 2 in. or 50 mm, min, %		
		psi	MPa	psi	MPa	<0.015 in.	≥0.015 to ≤0.030 in.	>0.030 in.
S20100	201	95 000	655	45 000	310	40	40	40
Plate, Sheet and Strip								

TABLE 2 *Continued*

Flat Bar		75 000	515	40 000	275	...	...	40
S20103	201L	100 000	690	50 000	345	40	40	40
S20153	201LN	100 000	690	50 000	345	40	40	40
S20500	205	115 000	790	65 000	450	40	40	40
S30100	301	90 000	620	45 000	310	40	40	40
S30103	301L	100 000	690	50 000	345	40	40	40
S30153	301LN	100 000	690	50 000	345	40	40	40
S30200	302							
Plate, Sheet and Strip		85 000	585	45 000	310	40	40	40
Flat Bar		90 000	620	45 000	310	...	...	40
S30400	304							
Plate, Sheet and Strip		80 000	550	45 000	310	35	35	35
Flat Bar		90 000	620	45 000	310	...	...	40
S30403	304L	80 000	550	45 000	310	40	40	40
S30451	304N	90 000	620	45 000	310	40	40	40
S30453	304LN	90 000	620	45 000	310	40	40	40
S31600	316							
Plate, Sheet and Strip		85 000	585	45 000	310	35	35	35
Flat Bar		90 000	620	45 000	310	...	...	40
S31603	316L	85 000	585	45 000	310	35	35	35
S31651	316N	90 000	620	45 000	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, %		
		psi	MPa	psi	MPa	<0.015 in.	\geq 0.015 to \leq 0.030 in.	>0.030 in.
S20100	201	100 000	690	55 000	380	45	45	45
S20103	201L	105 000	725	55 000	380	35	35	35
S20153	201LN	110 000	760	60 000	415	35	35	35
S20500	205	115 000	790	65 000	450	40	40	40
S30100	301	100 000	690	55 000	380	40	40	40
S30103	301L	110 000	760	60 000	415	35	35	35
S30153	301LN	110 000	760	60 000	415	35	35	35
S30200	302	100 000	690	55 000	380	35	35	35
S30400	304	100 000	690	55 000	380	35	35	35
S30403	304L	100 000	690	55 000	380	30	30	30
S30451	304N	100 000	690	55 000	380	37	37	37
S30453	304LN	100 000	690	55 000	380	33	33	33
S31600	316	100 000	690	55 000	380	30	30	30
S31603	316L	100 000	690	55 000	380	25	25	25
S31651	316N	100 000	690	55 000	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, %		
		psi	MPa	psi	MPa	<0.015 in.	\geq 0.015 to \leq 0.030 in.	>0.030 in.
S20100	201	125 000	860	75 000	515	25	25	25
S20103	201L	120 000	825	75 000	515	25	25	25
S20153	201LN	120 000	825	75 000	515	25	25	25
S20200	202	125 000	860	75 000	515	12	12	...
S20400	...	140 000	965	100 000	960	20	20	20
S20500	205	125 000	860	75 000	515	45	45	45
S21904	XM-11	130 000	895	115 000	795	15	15	...
S30100	301	125 000	860	75 000	515	25	25	25
S30103	301L	120 000	825	75 000	515	25	25	25
S30153	301LN	120 000	825	75 000	515	25	25	25
S30200	302	125 000	860	75 000	515	10	10	12
S30400	304	125 000	860	75 000	515	10	10	12
S30403	304L	125 000	860	75 000	515	8	8	10
S30451	304N	125 000	860	75 000	515	12	12	12
S30453	304LN	125 000	860	75 000	515	10	10	12
S31600	316	125 000	860	75 000	515	10	10	10
S31603	316L	125 000	860	75 000	515	8	8	8
S31651	316N	125 000	860	75 000	515	12	12	12

 $\frac{1}{2}$ Hard

UNS Designation	Type	Tensile Strength, min		Yield Strength, min		Elongation in 2 in. or 50 mm, min, %		
		psi	MPa	psi	Mpa	<0.015 in.	\geq 0.015 to \leq 0.030 in.	>0.030 in.
S20100	201	150 000	1035	110 000	760	15	18	18
S20103	201L	135 000	930	100 000	690	22	22	20
S20153	201LN	135 000	930	100 000	690	22	22	20
S20500	205	150 000	1035	110 000	760	15	18	18
S30100	301	150 000	1035	110 000	760	15	18	18
S30103	301L	135 000	930	100 000	690	20	20	20
S30153	301LN	135 000	930	100 000	690	20	20	20

TABLE 2 Continued

S30200	302	150 000	1035	110 000	760	9	10	10
S30400	304	150 000	1035	110 000	760	6	7	7
S30403	304L	150 000	1035	110 000	760	5	6	6
S30451	304N	150 000	1035	110 000	760	6	8	8
S30453	304LN	150 000	1035	110 000	760	6	7	7
S31600	316	150 000	1035	110 000	760	6	7	7
S31603	316L	150 000	1035	110 000	760	5	6	6
S31651	316N	150 000	1035	110 000	760	6	8	8
¾ Hard								
UNS Designation	Type	Tensile Strength, min		Yield Strength, min		Elongation in 2 in. or 50 mm, min, %		
		psi	MPa	psi	MPa	<0.015 in.	≥0.015 to ≤0.030 in.	>0.030 in.
S20100	201	175 000	1205	135 000	930	10	12	12
S20500	205	175 000	1205	135 000	930	15	15	15
S30100	301	175 000	1205	135 000	930	10	12	12
S30200	302	175 000	1205	135 000	930	5	6	6
Full Hard								
UNS Designation	Type	Tensile Strength, min		Yield Strength, min		Elongation in 2 in. or 50 mm, min, %		
		psi	MPa	psi	MPa	<0.015 in.	≥0.015 to ≤0.030 in.	>0.030 in.
S20100	201	185 000	1275	140 000	965	8	9	9
S20500	205	185 000	1275	140 000	965	10	10	10
S30100	301	185 000	1275	140 000	965	8	9	9
S30200	302	185 000	1275	140 000	965	3	4	4
Super Full Hard								
UNS Designation	Type	Tensile Strength, min		Yield Strength, min		Elongation in 2 in. or 50 mm, min, %		
		psi	MPa	psi	MPa	<0.015 in.	≥0.015 to ≤0.030 in.	>0.030 in.
S30100	301	270 000	1860	260 000	1790	...	...	...
S30116	...	270 000	1860	260 000	1790	...	...	...

^A 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.

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

^C Yield strength shall be determined by the offset method at 0.2 % in accordance with Test Methods and Definitions A370. Unless otherwise specified (see Specification A480/A480M Ordering Information), an alternative method of determining yield strength may be based on total extension under load of 0.5 % (see 10.1.1).

^D Either Brinell or denoted Rockwell Hardness scale is permissible. For thin materials, see Specification A480/A480M (17.2.1) and Test Methods A370 (18.1.2) on superficial testing.

^E Type 201 is generally produced with a chemical composition balanced for rich side (Type 201-1) or lean side (Type 201-2) austenite stability depending on the properties required for specific applications.

^F Annealed material that naturally meets mechanical properties may be applied.

TABLE 3 Free Bend Requirements

		Annealed and ¼ and ½ Hard			
UNS Designation	Type	Thickness ≤0.050 in.		Thickness >0.050 to ≤0.1874 in.	
		Included Bend Angle,°	Bend Factor	Included Bend Angle,°	Bend Factor
S20100	201	180	1	180	1
S20103	201L	180	1	180	1
S20153	201LN	180	1	180	1
S20200	202	180	1	180	1
S20400	...	180	1	180	1
S20500	205	180	1	180	1
S21460	XM-14	180	1	180	2
S21904	XM-11	180	1	180	1
S30100	301	180	1	180	1
S30103	301L	180	1	180	1
S30133	301LN	180	1	180	1
S30200	302	180	1	180	1
S30400	304	180	1	180	1
S30403	304L	180	1	180	2
S30451	304N	180	1	180	1
S30453	304LN	180	1	180	2
S31600	316	180	1	180	2
S31603	316L	180	1	180	2
S31651	316N	180	1	180	1
		¼ Hard			
UNS Designation	Type	Thickness ≤0.050 in.		Thickness >0.050 to ≤0.1874 in.	
		Included Bend Angle,°	Bend Factor	Included Bend Angle,°	Bend Factor
S20100	201	180	1	90	2
S20103	201L	180	1.5	135	1.5
S20153	201LN	180	1.5	135	1.5
S20200	202	180	2	90	2
S20400	...	180	1	90	2
S20500	205	180	1	90	2