Designation: A 666 – 03

Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar[1]

This standard is issued under the fixed designation A 666; 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 covers austenitic stainless steels in the annealed and normally required cold-worked conditions for various structural, architectural, pressure vessel, magnetic, cryogenic, and heat-resisting applications. (This revision of Specification A 666 replaces prior Specifications A 412 and A 177.)

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.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A 240/A 240M Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

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

A 480/A 480M Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip

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

3. Material Test Report and Certification

3.1 In addition to the requirements of Specification A 480/A 480M, the cold-worked condition (annealed, ¼ H, ½ H, and so forth) shall be noted.

4. Chemical Composition

4.1 The steel shall conform to the requirements as to chemical composition specified in Table 1, and shall conform to applicable requirements specified in the current edition of Specification A 480/A 480M.

5. Mechanical Properties

5.1 The material shall conform to the mechanical properties specified in Table 2 and Table 3, or Table 2 and Table 4.

6. General Requirements

6.1 The following requirements for orders for material furnished under this specification shall conform to the applicable requirements of the current edition of Specification A 480/A 480M or A 484/A 484M:

6.1.1 Definitions,
6.1.2 General requirements for delivery,
6.1.3 Ordering information,
6.1.4 Process,
6.1.5 Special tests,
6.1.6 Heat treatment,
6.1.7 Dimensions and permissible variations,
6.1.8 Workmanship, finish and appearance,
6.1.9 Number of tests/test methods,
6.1.10 Specimen preparation,
6.1.11 Retreatment,
6.1.12 Inspection,
6.1.13 Rejection and rehearing,
6.1.14 Material test report,
6.1.15 Certification, and
6.1.16 Packaging, marking, and loading.

7. Sampling

7.1 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.

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

[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.

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

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

8. Number of Tests

8.1 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.

8.2 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.

8.3 Annealed material produced to Table 2 requirements shall be tested in accordance with Specification A 480/A 480M.

9. Test Methods

9.1 *Tension Test*:

9.1.1 The yield strength shall be determined by the offset method as described in Test Methods and Definitions A 370. An alternative method of determining field strength may be used based on the following total extension under load:

Yield Strength, min. psi	Total Extension under Load in 2 in. Gage Length, incl.
45 000	0.0071
75 000	0.0098
110 000	0.0125
135 000	0.0144
140 000	0.0148

9.1.2 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.

9.2 *Bend Test*:

9.2.1 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.

9.2.2 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.

9.2.3 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]

Type	UNS Designation	Composition, %[B]							
		Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Other Elements
201	S20100	0.15	5.5–7.5	0.060	0.030	0.75	16.0–18.0	3.5–5.5	N 0.25
201L	S20103	0.03	5.5–7.5	0.045	0.030	0.75	16.0–18.0	3.5–5.5	N 0.25
201LN	S20153	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
202	S20200	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
205	S20500	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
301	S30100	0.15	2.00	0.045	0.030	1.00	16.0–18.0	6.0–8.0	N 0.10
301L	S30103	0.03	2.00	0.045	0.030	1.00	16.0–18.0	6.0–8.0	N 0.20
301LN	S30153	0.03	2.00	0.045	0.030	1.00	16.0–18.0	6.0–8.0	N 0.07–0.20
302	S30200	0.15	2.00	0.045	0.030	0.75	17.0–19.0	8.0–10.0	
304	S30400	0.08	2.00	0.045	0.030	0.75	18.0–20.0	8.0–10.5	N 0.10
304L	S30403	0.030	2.00	0.045	0.030	0.75	18.0–20.0	8.0–12.0	N 0.10
304N	S30451	0.08	2.00	0.045	0.030	0.75	18.0–20.0	8.0–10.5	N 0.10–0.16
304LN	S30453	0.030	2.00	0.045	0.030	0.75	18.0–20.0	8.0–12.0	N 0.10–0.16
316	S31600	0.08	2.00	0.045	0.030	0.75	16.0–18.0	10.0–14.0	Mo 2.00–3.00
316L	S31603	0.030	2.00	0.045	0.030	0.75	16.0–18.0	10.0–14.0	Mo 2.00–3.00
316N	S31651	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
XM–11	S21904	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
XM–14	S21460	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

[A] Types XM–10 and XM–19, which appeared in Specification A 412, do not appear as XM–10 is no longer produced and XM–19 is covered in Specification A 240/A 240M.

[B] Maximum unless otherwise indicated.

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TABLE 2 Tensile Property Requirements[A]

Annealed

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

1/16 Hard[C]

Type	UNS Designation	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.
201	S20100 PSS[D]	95 000	655	45 000	310	40	40	40
	FB[E]	75 000	515	40 000	275	. . .	. . .	40
201L	S20103	100 000	690	50 000	345	40	40	40
201LN	S20153	100 000	690	50 000	345	40	40	40
205	S20500	115 000	790	65 000	450	40	40	40
301	S30100	90 000	620	45 000	310	40	40	40
301L	S30103	100 000	690	50 000	345	40	40	40
301LN	S30153	100 000	690	50 000	345	40	40	40
302	S30200 PSS	85 000	585	45 000	310	40	40	40
	FB	90 000	620	45 000	310	. . .	. . .	40
304	S30400 PSS	80 000	550	45 000	310	35	35	35
	FB	90 000	620	45 000	310	. . .	. . .	40
304L	S30403	80 000	550	45 000	310	40	40	40
304N	S30451	90 000	620	45 000	310	40	40	40
304LN	S30453	90 000	620	45 000	310	40	40	40
316	S31600 PSS	85 000	585	45 000	310	35	35	35
	FB	90 000	620	45 000	310	. . .	. . .	40
316L	S31603	85 000	585	45 000	310	35	35	35
316N	S31651	90 000	620	45 000	310	35	35	35

1/8 Hard[C]

Type	UNS Designation	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.
201	S20100	100 000	690	55 000	380	45	45	45
201L	S20103	105 000	725	55 000	380	35	35	35
201LN	S20153	110 000	760	60 000	415	35	35	35
205	S20500	115 000	790	65 000	450	40	40	40
301	S30100	100 000	690	55 000	380	40	40	40
301L	S30103	110 000	760	60 000	415	35	35	35
301LN	S30153	110 000	760	60 000	415	35	35	35
302	S30200	100 000	690	55 000	380	35	35	35
304	S30400	100 000	690	55 000	380	35	35	35
304L	S30403	100 000	690	55 000	380	30	30	30
304N	S30451	100 000	690	55 000	380	37	37	37

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TABLE 2 *Continued*

304LN	S30453	100 000	690	55 000	380	33	33	33
316	S31600	100 000	690	55 000	380	30	30	30
316L	S31603	100 000	690	55 000	380	25	25	25
316N	S31651	100 000	690	55 000	380	32	32	32

¼ Hard

Type	UNS Designation	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.
201	S20100	125 000	860	75 000	515	25	25	25
201L	S20103	120 000	825	75 000	515	25	25	25
201LN	S20153	120 000	825	75 000	515	25	25	25
202	S20200	125 000	860	75 000	515	12	12	. . .
. . .	S20400	140 000	965	100 000	960	20	20	20
205	S20500	125 000	860	75 000	515	45	45	45
301	S30100	125 000	860	75 000	515	25	25	25
301L	S30103	120 000	825	75 000	515	25	25	25
301LN	S30153	120 000	825	75 000	515	25	25	25
302	S30200	125 000	860	75 000	515	10	10	12
304	S30400	125 000	860	75 000	515	10	10	12
304L	S30403	125 000	860	75 000	515	8	8	10
304N	S30451	125 000	860	75 000	515	12	12	12
304LN	S30453	125 000	860	75 000	515	10	10	12
316	S31600	125 000	860	75 000	515	10	10	10
316L	S31603	125 000	860	75 000	515	8	8	8
316N	S31651	125 000	860	75 000	515	12	12	12
XM-11	S21904	130 000	895	115 000	795	15	15	. . .

½ Hard

Type	UNS Designation	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.
201	S20100	150 000	1035	110 000	760	15	18	18
201L	S20103	135 000	930	100 000	690	22	22	20
201LN	S20153	135 000	930	100 000	690	22	22	20
205	S20500	150 000	1035	110 000	760	15	18	18
301	S30100	150 000	1035	110 000	760	15	18	18
301L	S30103	135 000	930	100 000	690	20	20	20
301LN	S30153	135 000	930	100 000	690	20	20	20
302	S30200	150 000	1035	110 000	760	9	10	10
304	S30400	150 000	1035	110 000	760	6	7	7
304L	S30403	150 000	1035	110 000	760	5	6	6
304N	S30451	150 000	1035	110 000	760	6	8	8
304LN	S30453	150 000	1035	110 000	760	6	7	7
316	S31600	150 000	1035	110 000	760	6	7	7
316L	S31603	150 000	1035	110 000	760	5	6	6
316N	S31651	150 000	1035	110 000	760	6	8	8

¾ Hard

Type	UNS Designation	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.
201	S20100	175 000	1205	135 000	930	10	12	12
205	S20500	175 000	1205	135 000	930	15	15	15
301	S30100	175 000	1205	135 000	930	10	12	12
302	S30200	175 000	1205	135 000	930	5	6	6

Full Hard

Type	UNS Designation	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.
201	S20100	185 000	1275	140 000	965	8	9	9
205	S20500	185 000	1275	140 000	965	10	10	10
301	S30100	185 000	1275	140 000	965	8	9	9
302	S30200	185 000	1275	140 000	965	3	4	4

[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] 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.

[C] Annealed material that naturally meets mechanical properties may be applied.

[D] PSS means plate, strip, sheet.

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[E] FB means flat bar.

TABLE 3 Free Bend Requirements

Type	UNS Designation	Thickness ≤0.050 in.		Thickness >0.050 to ≤0.1874 in.	
		Included Bend Angle,°	Bend Factor	Included Bend Angle,°	Bend Factor
Annealed and 1/16 and 1/8 Hard					
201	S20100	180	1	180	1
201L	S20103	180	1	180	1
201LN	S20153	180	1	180	1
202	S20200	180	1	180	1
. . .	S20400	180	1	180	1
205	S20500	180	1	180	1
301	S30100	180	1	180	1
301L	S30103	180	1	180	1
301LN	S30133	180	1	180	1
302	S30200	180	1	180	1
304	S30400	180	1	180	1
304L	S30403	180	1	180	2
304N	S30451	180	1	180	1
304LN	S30453	180	1	180	2
316	S31600	180	1	180	2
316L	S31603	180	1	180	2
316N	S31651	180	1	180	1
XM-11	S21904	180	1	180	1
XM-14	S21460	180	1	180	2
1/4 Hard					
201	S20100	180	1	90	2
201L	S20103	180	1.5	135	1.5
201LN	S20153	180	1.5	135	1.5
202	S20200	180	2	90	2
. . .	S20400	180	1	90	2
205	S20500	180	1	90	2
301	S30100	180	1	90	2
301L	S30103	180	1.5	90	1.5
301LN	S30153	180	1.5	90	1.5
302	S30200	180	1	90	2
304	S30400	180	1	90	2
304L	S30403	180	2	90	3
304N	S30451	180	1	90	2
304LN	S30453	180	2	90	3
316	S31600	180	2	90	2
316L	S31603	180	2	90	3
316N	S31651	180	1	90	2
XM-11	S21904	90	2	90	2
1/2 Hard					
201	S20100	180	2	90	2
201L	S20103	180	2	135	2
201LN	S20153	180	2	135	2
205	S20500	180	2	90	2
301	S30100	180	2	90	2
301L	S30103	180	2	90	2
301LN	S30153	180	2	90	2
302	S30200	180	2	90	2
304	S30400	180	2	90	2
304L	S30403	180	3	90	3
304N	S30451	180	2	90	2
304LN	S30453	180	3	90	3
316	S31600	180	3	90	3
316L	S31603	180	3	90	3
316N	S31651	180	2	90	2

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TABLE 3 *Continued*

¾ Hard					
Type	UNS Designation	Thickness ≤0.050 in.		Thickness >0.050 to ≤0.1874 in.	
		Included Bend Angle,°	Bend Factor	Included Bend Angle,°	Bend Factor
201	S20100	180	3	90	3
205	S20500	180	3	90	3
301	S30100	180	3	90	3
302	S30200	180	4	90	5
Full Hard					
Type	UNS Designation	Thickness ≤0.050 in.		Thickness >0.050 to ≤0.1874 in.	
		Included Bend Angle,°	Bend Factor	Included Bend Angle,°	Bend Factor
201	S20100	180	4	90	5
205	S20500	180	4	90	5
301	S30100	180	4	90	5
302	S30200	180	6	90	8

TABLE 4 V-Block Bend Requirements

Annealed and ⅛ Hard					
Type	UNS Designation	Thickness ≤0.050 in.		Thickness >0.050 to ≤0.1874 in.	
		Included Bend Angle,°	Bend Factor	Included Bend Angle,°	Bend Factor
201	S20100	135	2	135	3
201L	S20103	135	2	135	3
201LN	S20153	135	2	135	3
202	S20200	135	4	135	4
205	S20500	135	2	135	3
301	S30100	135	2	135	3
301L	S30103	135	2	135	3
301LN	S30153	135	2	135	3
302	S30200	135	2	135	3
304	S30400	135	2	135	3
304L	S30403	135	5	135	6
304N	S30451	135	3	135	4
304LN	S30453	135	4	135	5
316	S31600	135	5	135	6
316L	S31603	135	6	135	7
316N	S31651	135	5	135	6
¼ Hard					
Type	UNS Designation	Thickness ≤0.050 in.		Thickness >0.050 to ≤0.1874 in.	
		Included Bend Angle,°	Bend Factor	Included Bend Angle,°	Bend Factor
201	S20100	135	2	135	3
201L	S20103	135	2	135	3
201LN	S20153	135	2	135	3
205	S20500	135	2	135	3
301	S30100	135	2	135	3
301L	S30103	135	2	135	3
301LN	S30153	135	2	135	3
302	S30200	135	2	135	3
304	S30400	135	2	135	3
304L	S30403	135	5	135	6
304N	S30451	135	3	135	4
304LN	S30453	135	4	135	5
316	S31600	135	5	135	6
316L	S31603	135	6	135	7
316N	S31651	135	5	135	6

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TABLE 4 *Continued*

½ Hard					
Type	UNS Designation	Thickness ≤0.050 in.		Thickness >0.050 to ≤0.1874 in.	
		Included Bend Angle,°	Bend Factor	Included Bend Angle,°	Bend Factor
201	S20100	135	4	135	4
201L	S20103	135	4	135	4
201LN	S20153	135	4	135	4
205	S20500	135	4	135	4
301	S30100	135	4	135	4
301L	S30103	135	4	135	4
301LN	S30153	135	4	135	4
302	S30200	135	4	135	4
304	S30400	135	4	135	4
304L	S30403	135	7	135	8
304N	S30451	135	5	135	6
304LN	S30453	135	6	135	7
316	S31600	135	7	135	8
316L	S31603	135	8	135	9
316N	S31651	135	7	135	8
¾ Hard					
Type	UNS Designation	Thickness ≤0.050 in.		Thickness >0.050 to ≤0.1874 in.	
		Included Bend Angle,°	Bend Factor	Included Bend Angle,°	Bend Factor
201	S20100	135	6	135	7
205	S20500	135	6	135	7
301	S30100	135	6	135	7
302	S30200	135	8	135	9
Full Hard					
Type	UNS Designation	Thickness ≤0.050 in.		Thickness >0.050 to ≤0.1874 in.	
		Included Bend Angle,°	Bend Factor	Included Bend Angle,°	Bend Factor
201	S20100	135	6	135	8
205	S20500	135	6	135	8
301	S30100	135	6	135	8
302	S30200	135	8	135	10

10. Keywords

10.1 austenitic stainless steel; cold-worked stainless steel; stainless steel flat bar; stainless steel plate; stainless steel sheet; stainless steel strip

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue, A 666–00, that may impact the use of this standard. (Approved Oct. 1, 2003.)

(*1*) Revised tensile strength of S20100 and hardness of S20500 in Table 2.

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