Designation: B 435 – 98a

Standard Specification for UNS N06002, UNS N06230, UNS N12160, and UNS R30556 Plate, Sheet, and Strip[1]

This standard is issued under the fixed designation B 435; 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.

1. Scope

1.1 This specification[2] covers alloys UNS N06002, UNS N06230, UNS N12160, and UNS R30556* in the form of rolled plate, sheet, and strip for heat-resisting and general corrosive service.

1.2 The following products are covered under this specification:

1.2.1 *Sheet and Strip*—Hot- or cold-rolled, annealed, and descaled unless solution annealing is performed in an atmosphere yielding a bright finish.

1.2.2 *Plate*—Hot-rolled, solution-annealed, and descaled.

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:*

B 880 Specification for General Requirements for Chemical Check Analysis Limits for Nickel, Nickel Alloys and Cobalt Alloys[3]

E 8 Test Methods for Tension Testing of Metallic Materials[4]

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[5]

E 55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition[6]

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

E 1473 Test Methods for Chemical Analysis of Nickel, Cobalt, and High-Temperature Alloys[7]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *plate*—material 3⁄16 in. (4.76 mm) and over in thickness.

3.1.2 *sheet and strip*—material under 3⁄16in. (4.76 mm) in thickness.

4. Ordering Information

4.1 It is the responsibility of the purchaser to specify all requirements that are necessary for the safe and satisfactory performance of material ordered under this specification. Examples of such requirements include, but are not limited to the following:

4.1.1 *Alloy*,

4.1.2 *Dimensions*—Thickness (in decimals of an inch), width, and length (inch or fraction of an inch),

4.1.3 *Certification*—State if certification or a report of test results is required (Section 15),

4.1.4 *Optional Requirement*—Plate; state how plate is to be cut (see 7.8.1 and Table 1),

4.1.5 *Purchase Inspection*—State which tests or inspections are to be witnessed (Section 13), and

4.1.6 *Samples for Product (Check) Analysis*—State whether samples shall be furnished (9.2.2).

5. Chemical Composition

5.1 The material shall conform to the requirements as to chemical composition prescribed in Table 2.

5.2 If a product (check) analysis is made by the purchaser, the material shall conform to the requirements specified in Table 2 subject to the permissible tolerances per B 880.

6. Mechanical Properties and Other Requirements

6.1 *Tensile Properties*—The material shall conform to the room temperature tensile properties prescribed in Table 3.

6.2 *Grain Size for Sheet and Strip*:

6.2.1 Annealed alloys UNS N06002, UNS N06230, and

[1] This specification is under the jurisdiction of ASTM Committee B-2 on Nonferrous Metals and Alloys and is the direct responsibility of Subcommittee B02.07 on Refined Nickel and Cobalt and Their Alloys.

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[2] For ASME Boiler and Pressure Vessel Code applications, see related Specification SB-435 in Section II of that Code.

* New designation established in accordance with ASTM E527 and SAE J1086, Practice for Numbering Metals and Alloys (UNS).

[3] *Annual Book of ASTM Standards*, Vol 02.04.

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

[5] *Annual Book of ASTM Standards*, Vol 14.02.

[6] *Annual Book of ASTM Standards*, Vol 03.05.

[7] *Annual Book of ASTM Standards*, Vol 03.06.

TABLE 1 Permissible Variations in Width and Length of Sheared, Plasma Torch-Cut, or Abrasive-Cut Rectangular Plate

Specified Thickness	Permissible Variations in Widths and Lengths for Dimensions Given, in. (mm)			
	Up to 30 (760), incl		Over 30 (760)	
	+	−	+	−
Inches				
Sheared:				
3/16 to 5/16, excl	3/16	1/8	1/4	1/8
5/16 to 1/2, incl	1/4	1/8	3/8	1/8
Abrasive-cut:				
3/16 to 1 1/2, incl	1/16	1/16	1/16	1/16
Over 1 1/2 to 2 1/2, incl	1/8	1/8	1/8	1/8
Plasma torch-cut:[A]				
3/16 to 2, excl	½	0	½	0
2 to 3, incl	⅝	0	⅝	0
Millimetres				
Sheared:				
4.76 to 7.94, excl	4.76	3.18	6.35	3.18
7.94 to 12.70, incl	6.35	3.18	9.52	3.18
Abrasive-cut:				
4.76 to 38.1, incl	1.59	1.59	1.59	1.59
Over 38.1 to 63.5, incl	3.18	3.18	3.18	3.18
Plasma torch-cut:[A]				
4.8 to 50.8, excl	12.7	0	12.7	0
50.8 to 76.2, incl	15.9	0	15.9	0

[A]The tolerance spread shown for plasma torch cutting may be obtained all on the minus side, or divided between the plus and the minus side if so specified by the purchaser.

TABLE 2 Chemical Requirements

Element	Composition Limits, %			
	UNS N06002	UNS N06230	UNS R30556	UNS N12160
Nickel	remainder[A]	remainder[A]	19.0–22.5	remainder[A]
Iron	17.0–20.0	3.0 max	remainder[A]	3.5 max
Chromium	20.5–23.0	20.0–24.0	21.0–23.0	26.0–30.0
Cobalt	0.5–2.5	5.0 max	16.0–21.0	27.0–33.0
Molybdenum	8.0–10.0	1.0–3.00	2.5–4.0	1.0 max
Tungsten	0.2–1.0	13.0–15.0	2.0–3.5	1.0 max
Carbon	0.05–0.15	0.05–0.15	0.05–0.15	0.15 max
Silicon	1.00 max	0.25–0.75	0.20–0.80	2.4–3.0
Manganese	1.00 max	0.30–1.00	0.50–2.00	1.5 max
Phosphorus	0.04 max	0.030 max	0.04 max	0.030 max
Sulfur	0.03 max	0.015 max	0.015 max	0.015 max
Columbium (N6)	...	...	0.30 max	1.0 max
Tantalum	...	...	0.30–1.25	...
Aluminum	...	0.20–0.50	0.10–0.50	...
Zirconium	...	...	0.001–0.10	...
Lanthanum	...	0.005–0.050	0.005–0.10	...
Nitrogen	...	...	0.10–0.30	...
Boron	...	0.015 max	0.02 max	...
Titanium	...	...	...	0.20–0.80

[A]See 12.1.1.

TABLE 3 Mechanical Property Requirements

UNS	Tensile Strength, min, ksi (MPa)	Yield Strength (0.2 % Offset), min, ksi (MPa)	Elongation in 2 in. (50.8 mm) or 4*D*,[A] min, %
N06002	95 (655)	35 (240)	35
N06230[B]	110 (760)	45 (310)	40
R30556[C]	100 (690)	45 (310)	40
N12160[D]	90 (670)	35 (240)	40

[A]*D* refers to the diameter of the tension specimen.
[B]Solution annealed at a temperature between 2200 and 2275°F (1204 and 1246°C) followed by a water quench or rapidly cooled by other means.
[C]Solution annealed at 2100°F (1150°C) minimum.
[D]Solution annealed at 1950°F (1065°C) minimum.

UNS R30556 sheet and strip shall conform to the grain size requirements given in Table 4.

TABLE 4 Grain Size for Annealed Sheet

Thickness, in. (mm)	ASTM Micrograin Size Number, max	Average Grain, Diameter, max, in. (mm)
0.125 (3.175) and under	3.0	0.0050 (0.127)
Over 0.125 (3.175)	1.5	0.0084 (0.214)

TABLE 5 Permissible Variations in Thickness of Plate[A]

Specified Thickness, in. (mm)	Permissible Variations in Thickness, in. (mm)[B,C]	
	+	−
3/16 to 7/32 (4.762 to 5.556), incl	0.021 (0.53)	0.010 (0.25)
Over 7/32 to 1/4 (5.556 to 6.350), incl	0.024 (0.61)	0.010 (0.25)
Over 1/4 to 3/8 (6.350 to 9.525), incl	0.027 (0.69)	0.010 (0.25)
Over 3/8 to 1/2 (9.525 to 12.70), incl	0.030 (0.76)	0.010 (0.25)
Over 1/2 to 5/8 (12.70 to 15.88), incl	0.035 (0.89)	0.010 (0.25)
Over 5/8 to 3/4 (15.88 to 19.05), incl	0.040 (1.02)	0.010 (0.25)
Over 3/4 to 7/8 (19.05 to 22.22), incl	0.045 (1.14)	0.010 (0.25)
Over 7/8 to 1 (22.22 to 25.4), incl	0.050 (1.27)	0.010 (0.25)
Over 1 to 2 1/2 (25.4 to 63.5), incl	5[D]	0.010 (0.25)

[A]Applicable to plate 48 in. (1.22 m) and under in width.
[B]Measured ⅜ in. (9.525 mm) or more from any edge.
[C]Buffing or grinding for removal of light surface imperfections shall be permitted. The depth of such buffed or ground areas shall not exceed the minimum tolerance thickness.
[D]Expressed as percentage of thickness.

TABLE 6 Permissible Variations in Thickness of Sheet[A] and Strip

Specified Thickness, in. (mm)	Permissible Variations in Thickness, in.[B,C] (mm) (All Widths)	
	+	−
0.020 to 0.034 (0.51 to 0.86), incl	0.004 (0.10)	0.004 (0.10)
Over 0.034 to 0.056 (0.86 to 1.42), incl	0.005 (0.13)	0.005 (0.13)
Over 0.056 to 0.070 (1.42 to 1.78), incl	0.006 (0.15)	0.006 (0.15)
Over 0.070 to 0.078 (1.78 to 1.98), incl	0.007 (0.18)	0.007 (0.18)
Over 0.078 to 0.093 (1.98 to 2.36), incl	0.008 (0.20)	0.008 (0.20)
Over 0.093 to 0.109 (2.36 to 2.77), incl	0.009 (0.23)	0.009 (0.23)
Over 0.109 to 0.125 (2.77 to 3.18), incl	0.010 (0.25)	0.010 (0.25)
Over 0.125 to 0.140 (3.18 to 3.56), incl	0.013 (0.33)	0.010 (0.25)
Over 0.140 to 0.171 (3.56 to 4.34), incl	0.016 (0.41)	0.010 (0.25)
Over 0.171 to 0.187 (4.34 to 4.75), incl	0.018 (0.46)	0.010 (0.25)

[A]Applicable to sheet 48 in. (1.22 m) and under in width.
[B]Measured ⅜ in. (9.525 mm) or more from any edge.
[C]Buffing for removal of light surface imperfections shall be permitted. The depth of such buffed areas shall not exceed the permissible minus variation.

6.2.2 Annealed alloy UNS N12160 shall conform to an average grain size of ASTM No. 5 or coarser.

7. Dimensions, Mass, and Permissible Variations

7.1 *Weight*—For calculations of mass or weight, the following densities shall be used:

Alloy	Density	
	lb/in.^{3}	(g/cm^3)
N06002	0.297	(8.23)
N06230	0.324	(8.97)
R30556	0.297	(8.23)
N12160	0.292	(8.08)

7.2 *Thickness*:

7.2.1 *Plate*—The permissible variations in thickness of plate shall be as prescribed in Table 5.