Designation: B435 – 22

Standard Specification for Heat and Corrosion Resistant High Temperature Alloy Plate, Sheet, and Strip[1]

This standard is issued under the fixed designation B435; 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 in the form of rolled plate, sheet, and strip that are typically used for (though not limited) heat-resisting and general corrosive service.

1.2 Alloys that can currently be certified to this specification are UNS N06002, UNS N06230, UNS N12160, and UNS R30556.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered 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 become familiar with all hazards including those identified in the appropriate Safety Data Sheet (SDS) for this product/material as provided by the manufacturer, 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:*[3]

B880 Specification for General Requirements for Chemical Check Analysis Limits for Nickel, Nickel Alloys and Cobalt Alloys

B899 Terminology Relating to Non-ferrous Metals and Alloys

B906 Specification for General Requirements for Flat-Rolled Nickel and Nickel Alloys Plate, Sheet, and Strip

B1015 Practice for Form and Style of Standards Relating to Refined Nickel and Cobalt and Their Alloys

3. Terminology

3.1 Common B02.07 terminology is found in Specification B899.

3.2 The definitions for plate, sheet, and strip used in Specification B906 apply to the products of this specification with the following adjustments:

3.2.1 Strip can be either a cold rolled or hot rolled material.

3.2.2 The finishes allowed for products certified to this specification are stipulated in Section 6.

4. General Requirements

4.1 Material furnished under this specification shall conform to the applicable requirements of Specification B906 unless otherwise provided herein.

4.2 Product furnished to this specification shall conform to the requirements of Specification B906. Failure to comply with the general requirements of Specification B906 constitutes nonconformance with this specification. In case of conflict between the requirements and this specification, and the requirements of Specification B906, this specification shall prevail.

5. Ordering Information

5.1 It is the responsibility of the purchaser to specify all requirements that are necessary for material ordered to this specification.

5.2 Refer to the ordering information section of Specification B906 for examples of requirements.

6. Materials and Manufacture

6.1 The products certified to this specification shall have been manufactured in accordance with Specification B906.

6.2 The finish of the final products certified to this specification are:

[1] This specification is under the jurisdiction of ASTM Committee B02 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.

[3] 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**

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

6.2.2 *Plate*—Hot-rolled, annealed, and descaled.

7. Chemical Composition

7.1 The material shall conform to the chemical requirements prescribed in Table 1.

7.2 If a product (check) analysis is made by the purchaser, it shall be done in conformance with Specification B880.

8. Mechanical Properties and Other Requirements

8.1 *Tensile Properties*—The material shall conform to the room temperature tensile properties prescribed in Table 2.

8.2 *Grain Size for Sheet and Strip:*

8.2.1 Annealed alloys UNS N06002, UNS N06230, and UNS R30556 sheet and strip shall conform to the grain size requirements given in Table 3.

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

9. Dimensions, Mass, and Permissible Variations

9.1 *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)

9.2 *Thickness:*

9.2.1 *Plate*—The permissible variations in thickness of plate shall be as prescribed in Table A2.1 in Specification B906.

9.2.2 *Sheet and Strip*—The permissible variations in thickness of sheet and strip shall be as prescribed in Table A2.2 in Specification B906.

TABLE 2 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	110 (760)	45 (310)	40
R30556	100 (690)	45 (310)	40
N12160	90 (620)	35 (240)	40

[A] *D* refers to the diameter of the tension specimen.

TABLE 3 Grain Size for Annealed Sheet

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

9.2.3 Products that are at least 1.00 in. (25.4 mm) in width shall have thickness measured with the micrometer spindle positioned 0.375 in. (9.53 mm) or more from any edge. Products that are less than 1.00 in. (25.4 mm) width may have the thickness measured with the micrometer spindle positioned anywhere.

9.3 *Width:*

9.3.1 *Plate*—The permissible variations in width of rectangular plates shall be as prescribed in Table A2.3 in Specification B906.

9.3.2 *Sheet and Strip*—The permissible variations in width for sheet and strip shall be as prescribed in Table A2.4 in Specification B906.

9.4 *Length:*

9.4.1 *Plate*—Permissible variations in the length of rectangular plate shall be as prescribed in Table A2.3 in Specification B906.

TABLE 1 Chemical Requirements[A]

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

[A] Values in the table are maximums unless a range or minimum is indicated.

9.4.2 *Sheet and Strip*—Sheet and strip may be ordered to cut lengths, in which case a variation of 0.125 in. (3.18 mm) over the specified length shall be permitted, with a 0 minus tolerance.

9.5 *Straightness:*

9.5.1 The edgewise curvature (depth of chord) of flat sheet, strip, and plate shall not exceed the number calculated by the equation below. The calculated number is the maximum allowed curvature in inches (inch-pound units) or millimeters (SI units).

$$\text{Curvature (customary unit)} = 0.05 \times \text{length (in feet)}$$
$$\text{Curvature (SI unit)} = 0.04 \times \text{length (in cm)}$$

9.5.2 Straightness for coiled strip is subject to agreement between the manufacturer and the purchaser.

9.6 *Squareness (Sheet)*—For sheets of all thicknesses and widths of 6.00 in. (152.4 mm) or more, the angle between adjacent sides shall be 90 ± 0.15° (0.031 in./ft or 2.60 mm/m). If diagonals are measured, then the two diagonals shall be within ±0.25 in. (6.35 mm).

9.7 *Flatness*—Plate, sheet, and strip shall be commercially flat.

9.8 *Edges:*

9.8.1 Plates shall have sheared, abrasive-cut or plasma-torch-cut edges as specified.

9.8.2 Sheet and strip shall have sheared or slit edges.

10. Product Marking

10.1 Each plate, sheet, or strip shall be marked on one face with the specification number, the name of the material or UNS number, heat number, and size. The markings shall have no deleterious effect on the material or its performance and shall be sufficiently stable to withstand normal handling.

10.2 The following information shall be included on the package or on a label or tag attached thereto: gross and net weight; consignor and consignee address; contract or order number; and such other information as may be defined in the contract or order. The UNS number, material's name, specification number, and size may be included as well.

11. Keywords

11.1 plate; sheet; strip; UNS N06002; UNS N06230; UNS N12160; UNS R30556

APPENDIX

(Nonmandatory Information)

X1. HEAT TREATMENT

X1.1 Proper heat treatment during or subsequent to fabrication is necessary for optimum performance, and the manufacturer shall be consulted for details.

SUMMARY OF CHANGES

Committee B02 has identified the location of selected changes to this standard since the last issue (B435 – 06 (2016)) that may impact the use of this standard. (Approved October 1, 2022.)

(1) Revised title to remove UNS numbers.
(2) Revised Terminology (Section 3) and ordering information (Section 4) to defer to general Specification B906.
(3) Specification structure brought in alignment with Practice B1015 by adding materials and manufacture section (6); moving manufacturing and finishing information from the Scope to this section; and restructuring the chemistry table (Section 7).
(4) Revised Table 3 to correct grain size requirements.
(5) Improved permissible variations for thickness explanation (9.2).
(6) Improved the presentation of maximum curvature equation used to determine straightness (9.5.1).
(7) Added requirements for sheet squareness if diagonal method is used (9.6).
(8) General edits to improve readability.
(9) Revised product marking section (10).