**Designation: ~~B435 – 06 (Reapproved 2016)~~ B435 – 22**

# Standard Specification for ~~UNS N06002, UNS N06230, UNS N12160, and UNS R30556~~ 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~~ 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~~ that are typically used for (though not limited) heat-resisting and general corrosive service.

1.2 ~~The following products are covered under this specification:~~Alloys that can currently be certified to this specification are UNS N06002, UNS N06230, UNS N12160, and UNS R30556.

~~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 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~~ safety, health, and ~~health~~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

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[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**

E527B1015 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)Form and Style of Standards Relating to Refined Nickel and Cobalt and Their Alloys

## 3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *plate, n*—material ¾16 in. (4.76 mm) and over in thickness.

3.1.2 *sheet and strip, n*—material under ¾16 in. (4.76 mm) in thickness.

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 under this specification. Examples of such requirements include, but are not limited to the following:to this specification.



5.1.1 *Alloy;*

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

5.1.3 *Certification*—State if certification or a report of test results is required (Specification B906, section on Material Test Report an Certification),

5.1.4 *Optional Requirement*—Plate; state how plate is to be cut (Specification B906, Table titled Permissible Variations in width and Length of Sheared, Torch-Cut, or Abrasive-Cut Rectangular Plate),

5.1.5 *Purchase Inspection*—State which tests or inspections are to be witnessed (Specification B906, section on Inspection), and

5.1.6 *Samples for Product (Check) Analysis*—State whether samples should be furnished (Specification B906, section on Sampling).

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:

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 ~~requirements as to chemical composition~~chemical requirements prescribed in Table 1.

7.2 If a product (check) analysis is made by the purchaser, ~~the material shall conform to the requirements specified~~ it shall be done in ~~Table 1 and~~conformance with Specification ~~B906~~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:



**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 max~~ | ~~remainder~~ | ~~3.5 max~~ |
| 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 max~~ | ~~16.0–21.0~~ | ~~27.0–33.0~~ |
| 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 max~~ |
| 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 max~~ |
| 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 max~~ |
| Carbon | 0.05–0.15 | 0.05–0.15 | 0.05–0.15 | 0.15 |
| ~~Silicon~~ | ~~1.00 max~~ | ~~0.25–0.75~~ | ~~0.20–0.80~~ | ~~2.4–3.0~~ |
| Silicon | 1.00 | 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~~ |
| Manganese | 1.00 | 0.30–1.00 | 0.50–2.00 | 1.5 |
| ~~Phosphorus~~ | ~~0.04 max~~ | ~~0.030 max~~ | ~~0.04 max~~ | ~~0.030 max~~ |
| Phosphorus | 0.04 | 0.030 | 0.04 | 0.030 |
| ~~Sulfur~~ | ~~0.03 max~~ | ~~0.015 max~~ | ~~0.015 max~~ | ~~0.015 max~~ |
| Sulfur | 0.03 | 0.015 | 0.015 | 0.015 |
| ~~Columbium (N6)~~ | ~~...~~ | ~~...~~ | ~~0.30 max~~ | ~~1.0 max~~ |
| Columbium (N6) | ... | ... | 0.30 | 1.0 |
| Tantalum | ... | ... | 0.30–1.25 | ... |
| ~~Aluminum~~ | ~~...~~ | ~~0.50 max~~ | ~~0.10–0.50~~ | ~~...~~ |
| 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 max~~ | ~~0.02 max~~ | ~~...~~ |
| Boron | ... | 0.015 | 0.02 | ... |
| Titanium | ... | ... | ... | 0.20–0.80 |

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

**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[B]~~ | ~~110 (760)~~ | ~~45 (310)~~ | ~~40~~ |
| N06230 | 110 (760) | 45 (310) | 40 |
| ~~R30556[C]~~ | ~~100 (690)~~ | ~~45 (310)~~ | ~~40~~ |
| R30556 | 100 (690) | 45 (310) | 40 |
| ~~N12160[D]~~ | ~~90 (620)~~ | ~~35 (240)~~ | ~~40~~ |
| N12160 | 90 (620) | 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.~~

**TABLE 3 Grain Size for Annealed Sheet**

| Thickness, in. (mm) | ASTM Micrograin Size ~~Number, max~~Number | Average Grain, Diameter, ~~max,~~ 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) |

| Alloy | Density lb/in.$^3$ | Density (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.



9.2.3 ~~*Sheet and Strip*—The thickness shall be~~ Products that are at least 1.00 in. (25.4 mm) in width shall have thickness measured with the micrometer spindle ~~¾~~positioned 0.375 in. ~~(9.525~~(9.53 mm) or more from any ~~edge for material 1~~ edge. Products that are less than 1.00 in. (25.4 mm) ~~or over in width and at any place on material under 1 in. in width.~~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.

9.4.2 *Sheet and Strip*—Sheet and strip may be ordered to cut lengths, in which case a variation of ~~⅛~~0.125 in. ~~(3.175~~(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 ~~product of 0.05 in. multiplied by~~