



Designation: B409 – 22

Standard Specification for Nickel-Iron-Chromium Alloy Plate, Sheet, and Strip¹

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1. Scope*

1.1 This specification² covers UNS N08120, UNS N08890, UNS N08800, UNS N08810, and UNS N08811³ in the form of rolled plate, sheet, and strip. Alloy UNS N08800 is normally employed in service temperatures up to and including 1100 °F (593 °C). Alloys UNS N08120, UNS N08810, UNS N08811, and UNS N08890 are normally employed in service temperatures above 1100 °F (593 °C) where resistance to creep and rupture is required, and they are annealed to develop controlled grain size for optimum properties in this temperature range.

1.2 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.

1.3 *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.*

1.4 *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:*⁴

B408 Specification for Nickel-Iron-Chromium Alloy Rod and Bar

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 409 in Section II of that Code.

³ New designations established in accordance with Practice E527 and SAE J1086, Practice for Numbering Metals and Alloys (UNS).

⁴ 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.

B906 Specification for General Requirements for Flat-Rolled Nickel and Nickel Alloys Plate, Sheet, and Strip
E140 Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness

3. General Requirements

3.1 Product furnished to this specification shall conform to the requirements of Specification B906 including any supplementary requirements indicated in the purchase order or contract. Failure to comply with the general requirements of Specification B906 constitutes nonconformance with this specification. In case of conflict between the requirements of this specification and Specification B906, this specification shall prevail.

4. General Requirements

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

5. Ordering Information

5.1 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:

5.1.1 Alloy (Table 2),

5.1.2 Condition (Temper)—Table 3 and Table 4, Appendix X1, and Specification B906.

5.1.3 Finish—Appendix X1 and Specification B906.

5.1.4 Dimensions—Thickness, width, and length.

5.1.5 *Optional Requirements:*

5.1.5.1 *Sheet and Strip*—Whether to be furnished in coil, in cut straight lengths, or in random straight lengths.

5.1.5.2 *Strip*—Whether to be furnished with commercial slit edge, square edge, or round edge.

5.1.5.3 *Plate*—Whether to be furnished specially flattened (see 9.7.2); also how plate is to be cut (Specification B906, Table A3.4 and Table A3.7).

5.1.6 *Fabrication Details*—Not mandatory but helpful to the manufacturer:

5.1.6.1 *Welding or Brazing*—Process to be employed.

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

TABLE 1 Product Description

Product	Thickness, in. (mm)	Width, in. (mm)
Hot-rolled plate ^A	3/16 and over (B906, Table A3.1 and Table A3.2)	(B906, Table A3.4) ^B
Hot-rolled sheet ^A	0.018 to 0.250 (0.46 to 6.4), incl (B906, Table A3.3)	(B906, Table A3.6)
Cold-rolled sheet ^C	0.018 to 0.250 (0.46 to 6.4), incl (B906, Table A3.3)	(B906, Table A3.6)
Cold-rolled strip ^C	0.005 to 0.250 (0.13 to 6.4), incl (B906, Table A3.3)	(B906, Table A3.6)

^A Material 3/16 to 1/4 in. (4.8 to 6.4 mm), incl, in thickness may be furnished as sheet or plate provided the material meets the specification requirements for the condition ordered.

^B Hot-rolled plate, in widths 10 in. (254 mm) and under, may be furnished as hot-finished rectangles with sheared or cut edges in accordance with Specification B408, provided the mechanical property requirements of this specification are met.

^C Material under 48 in. (1219 mm) in width may be furnished as sheet or strip provided the material meets the specification requirements for the condition ordered.

TABLE 2 Chemical Requirements^A

Element	Composition Limits, %				
	Alloy N08120	Alloy N08890	Alloy N08800	Alloy N08810	Alloy N08811
Nickel	35.0 – 39.0	40.0 – 45.0	30.0 – 35.0	30.0 – 35.0	30.0 – 35.0
Chromium	23.0 – 27.0	23.5 – 28.5	19.0 – 23.0	19.0 – 23.0	19.0 – 23.0
Iron	remainder ^B	remainder	39.5 min ^B	39.5 min ^B	39.5 min ^B
Manganese	1.5	1.5	1.5	1.5	1.5
Carbon	0.02 – 0.10	0.06 – 0.14	0.10	0.05 – 0.10	0.06 – 0.10
Copper	0.50	0.75	0.75	0.75	0.75
Silicon	1.0	1.0 – 2.0	1.0	1.0	1.0
Sulfur	0.03	0.015	0.015	0.015	0.015
Aluminum	0.40	0.05 – 0.60	0.15 – 0.60	0.15 – 0.60	0.25 – 0.60 ^C
Titanium	0.20	0.15 – 0.60	0.15 – 0.60	0.15 – 0.60	0.25 – 0.60 ^C
Molybdenum	2.50	1.0 – 2.0	...	...	...
Niobium ^D	0.4 – 0.9	0.2 – 1.0	...	...	...
Tantalum	...	0.10 – 0.60	...	...	...
Phosphorus	0.040	...	0.045	0.045	0.045
Tungsten	2.50	...	...	...	...
Cobalt	3.0	...	...	...	...
Nitrogen	0.15 – 0.30	...	...	...	...
Boron	0.010	...	...	...	...

^A All values are maximums unless a range is provided.

^B Iron shall be determined arithmetically by difference.

^C Alloy N08811: Al + Ti = 0.85 – 1.20.

^D Columbium and Niobium are interchangeable names for the same element and both names are acceptable for use in B02.07 specifications.

5.1.6.2 *Plate*—Whether material is to be hot-formed.

5.1.7 *Certification*—State if certification or a report of test results is required (Specification B906).

5.1.8 *Samples for Product (Check) Analysis*—Whether samples for product (check) analysis should be furnished (see 7.2).

5.1.9 *Purchaser Inspection*—If purchaser wishes to witness tests or inspection of material at place of manufacture, the purchase order must so state indicating which tests or inspections are to be witnessed (Specification B906).

6. Materials and Manufacture

6.1 *Heat Treatment*—The minimum temperature of the final heat treatment for each alloy shall be as follows:

6.1.1 UNS N08120—2150 °F (1177 °C);

6.1.2 UNS N08810—2050 °F (1121 °C); and

6.1.3 UNS N08811 and UNS N08890—2100 °F (1149 °C).

7. Chemical Composition

7.1 The material shall conform to the composition limits specified in Table 2.

7.2 If a product (check) analysis is performed by the purchaser, the material shall conform to the product (check) analysis variations in Specification B906.

8. Mechanical and Other Requirements

8.1 *Mechanical Properties*—The material shall conform to the mechanical properties specified in Table 3.

8.2 *Grain Size*—Annealed Alloys UNS N08120, UNS N08810, UNS N08811, and UNS N08890 shall conform to an average grain size of ASTM No. 5 or coarser.

8.3 *Deep-Drawing and Spinning Quality Sheet and Strip*—(Alloy UNS N08800) Shall conform to the grain size and hardness requirements as provided in Table 4.

8.3.1 The mechanical properties of Table 3 do not apply to deep drawing and spinning quality sheet and strip.

9. Dimensions and Permissible Variations

9.1 *Thickness and Weight*:

9.1.1 *Plate*—For plate up to 2 in. (50.8 mm), incl, in thickness, the permissible variation under the specified thickness and permissible excess in overweight shall not exceed the amounts prescribed in Table A3.1 in Specification B906.

9.1.1.1 For use with Table A3.1 in Specification B906, plate shall be assumed to weigh 0.287 lb/in.³ (7.944 g/cm³).

9.1.2 *Plate*—For plate over 2 in. (50.8 mm) in thickness, the permissible variations over the specified thickness shall not exceed the amounts prescribed in Table A3.2 in Specification B906.

TABLE 3 Mechanical Properties for Plate, Sheet, and Strip^A
 (All thicknesses and sizes unless otherwise indicated)

Alloy	Condition	Tensile Strength, psi (MPa)	Yield Strength ^B (0.2 % offset), psi (MPa)	Elongation in 2 in. or 50 mm (or 4D), %
Hot-Rolled Plate				
UNS N08120	Annealed	90 000 (621)	40 000 (276)	30
UNS N08800	Annealed	75 000 (520)	30 000 (205)	30
UNS N08800	As-rolled ^{C,D}	80 000 (550)	35 000 (240)	25
UNS N08810	Annealed	65 000 (450)	25 000 (170)	30
UNS N08811	Annealed	65 000 (450)	25 000 (170)	30
UNS N08890	Annealed	75 000 (520)	30 000 (205)	35
Hot-Rolled Sheet				
UNS N08120	Annealed	90 000 (621)	40 000 (276)	30
UNS N08800	Annealed	75 000 (520)	30 000 (205)	30
UNS N08810 ^E	Annealed	65 000 (450)	25 000 (170)	30
UNS N08811 ^E	Annealed	65 000 (450)	25 000 (170)	30
UNS N08890	Annealed	75 000 (520)	30 000 (205)	35
Cold-Rolled Sheet				
UNS N08120	Annealed	90 000 (621)	40 000 (276)	30
UNS N08800	Annealed	75 000 (520)	30 000 (205)	30
UNS N08810 ^E	Annealed	65 000 (450)	25 000 (170)	30
UNS N08811 ^E	Annealed	65 000 (450)	25 000 (170)	30
UNS N08890	Annealed	75 000 (520)	30 000 (205)	35
Cold-Rolled Strip				
UNS N08120	Annealed	90 000 (621)	40 000 (276)	30
UNS N08800	Annealed	75 000 (520)	30 000 (205)	30 ^F
UNS N08810 ^E	Annealed	65 000 (450)	25 000 (170)	30
UNS N08811 ^E	Annealed	65 000 (450)	25 000 (170)	30
UNS N08890	Annealed	75 000 (520)	30 000 (205)	35

^A All values are minimums.

^B Yield strength requirements do not apply to material under 0.020 in. (0.51 mm) in thickness.

^C As-rolled plate may be given a stress-relieving heat treatment subsequent to final rolling.

^D As-rolled plate specified "suitable for hot forming" shall be furnished from heats of known good hot-malleability characteristics (see X1.1.1.2). The purchaser must specify Alloy UNS N08800 or UNS N08810. There are no applicable tensile or hardness requirements for such material.

^E Available only in thicknesses 0.115 in. (2.92 mm) and over.

^F Not applicable for thickness under 0.010 in. (0.25 mm).

TABLE 4 Grain Size and Hardness for Alloy UNS N08800 Cold-Rolled, Deep-Drawing, and Spinning Quality Sheet and Strip

Thickness, in. (mm)	Calculated Diameter of Average Grain Section, max, in. (mm)	Corresponding ASTM Micro-Grain Size No.	Rockwell B ^{A,B} Hardness, max
Sheet (56 in. (1.42 m) Wide and Under)			
0.050 (1.3) and less	0.0030 (0.075)	4.5	86
Over 0.050 to 0.250 (1.3 to 6.4), incl	0.0043 (0.110)	3.5	86
Strip (12 in. (305 mm) Wide and Under) ^C			
0.005 to 0.010 (0.13 to 0.25), incl	0.0009 (0.022)	8 ^D	88 ^D
Over 0.010 to 0.125 (0.25 to 3.2), incl	0.0030 (0.075)	4.5	86

^A For Rockwell or equivalent hardness conversions see Hardness Conversion Tables E140.

^B Caution should be observed in using the Rockwell test on thin material, as the results may be affected by specimen thickness. For thicknesses under 0.050 in. (1.3 mm), the use of the Rockwell superficial or the Vickers hardness test is suggested.

^C Sheet requirements (above) apply to strip thicknesses over 0.125 in. (3.2 mm), and for all thicknesses of strip over 12 in. (305 mm) in width.

^D Accurate grain size and hardness determinations are difficult to make on strip under 0.005 in. (0.13 mm) in thickness and are not recommended.

9.1.3 *Sheet and Strip*—The permissible variations in thickness of sheet and strip shall be as prescribed in Table A3.3 in Specification B906. The thickness of sheet and strip shall be measured with the micrometer spindle $\frac{3}{8}$ in. (9.5 mm) or more from either edge for material 1 in. (25.4 mm) or over in width and at any place on strip under 1 in. in width.

9.2 Width or Diameter:

9.2.1 *Plate*—The permissible variations in width of rectangular plates and diameter of circular plates shall be as prescribed in Table A3.4 and Table A3.5 in Specification B906.

9.2.2 *Sheet and Strip*—The permissible variations in width for sheet and strip shall be as prescribed in Table A3.6 in Specification B906.

9.3 Length:

9.3.1 Sheet and strip of all sizes may be ordered to cut lengths, in which case a variation of $\frac{1}{8}$ in. (3.18 mm) over the specified length shall be permitted.

9.3.2 Permissible variations in length of rectangular plate shall be as prescribed in Table A3.7 in Specification B906.

9.4 Straightness:

9.4.1 The edgewise curvature (depth of chord) of flat sheet, strip, and plate shall not exceed 0.05 in. multiplied by the length in feet (0.04 mm multiplied by the length in centimeters).

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

TABLE 5 Permissible Variations From Flatness of Rectangular, Circular, and Sketch Plates

NOTE 1—Permissible variations apply to plates up to 12 ft (366 cm) in length, or to any 12 ft (366 cm) of longer plates.

NOTE 2—If the longer dimension is under 36 in. (914 mm), the permissible variation is not greater than 1/4 in. (6.35 mm).

NOTE 3—The shorter dimension specified is considered the width, and the permissible variation in flatness across the width does not exceed the tabular amount of that dimension.

NOTE 4—The maximum deviation from a flat surface does not customarily exceed the tabular tolerance for the longer dimension specified.

Specified Thickness	Permissible Variations from a Flat Surface for Thickness and Widths Given, in. (mm)								
	To 48 (1220), excl	48 – 60 (1220), excl	60 – 72 (1520), excl	72 – 84 (1830), excl	84 – 96 (2130), excl	96 – 108 (2440), excl	108 – 120 (2740), excl	120 – 144 (3050), excl	144 (3660) and Over
	Inches								
3/16 to 1/4, excl	3/4	1 1/16	1 1/4	1 3/8	1 5/8	1 5/8	...	...	...
1/4 to 3/8, excl	1 1/16	3/4	1 5/16	1 1/8	1 3/8	1 7/16	1 9/16	1 7/8	...
3/8 to 1/2, excl	1/2	9/16	1 1/16	3/4	1 5/16	1 1/8	1 1/4	1 7/16	1 3/4
1/2 to 3/4, excl	1/2	9/16	5/8	5/8	1 3/16	1 1/8	1 1/8	1 1/8	1 3/8
3/4 to 1, excl	1/2	9/16	5/8	5/8	3/4	1 3/16	1 5/16	1	1 1/8
1 to 2, excl	1/2	9/16	9/16	9/16	1 1/16	1 1/16	1 1/16	3/4	1
2 to 4, incl	1/4	5/16	3/8	7/16	1/2	9/16	5/8	3/4	7/8
	Millimeters								
4.76 to 6.35, excl	19.05	27.0	31.7	34.9	41.3	41.3	...	...	...
6.35 to 9.52, excl	17.46	19.05	23.81	28.6	35.0	36.5	39.7	47.6	...
9.52 to 12.70, excl	12.70	14.29	17.46	19.05	23.8	28.6	31.7	35.0	44.4
12.70 to 19.05, excl	12.70	14.29	15.88	15.88	20.64	28.6	28.6	28.6	34.9
19.05 to 25.4, excl	12.70	14.29	15.88	15.88	19.05	20.64	23.81	25.4	28.6
25.4 to 50.8, excl	12.70	14.29	14.29	14.29	17.46	17.46	17.46	19.05	25.4
50.8 to 101.6, incl	6.35	7.94	9.52	11.11	12.70	14.29	15.88	19.05	22.22

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9.5 Edges:

9.5.1 When finished edges of strip are specified in the contract or order, the following descriptions shall apply:

9.5.1.1 Square-edge strip shall be supplied with finished edges, with sharp, square corners, without bevel or rounding.

9.5.1.2 Round-edge strip shall be supplied with finished edges, semicircular in form, the diameter of the circle forming the edge being equal to the strip thickness.

9.5.1.3 When no description of any required form of strip edge is given, it shall be understood that edges such as those resulting from slitting or shearing will be acceptable.

9.5.1.4 Sheet shall have sheared or slit edges.

9.5.1.5 Plate shall have sheared or cut (machined, abrasive-cut, powder-cut, or inert arc-cut) edges, as specified.

9.6 Squareness (Sheet):

9.6.1 For sheets of all thicknesses, the angle between adjacent sides shall be 90 ± 0.15° (1/16 in. in 24 in.) (1.59 mm in 610 mm).

9.7 Flatness:

9.7.1 There shall be no flatness requirements for “deep-drawing quality” and “spinning quality” sheet and strip (see X1.1.3).

9.7.2 Standard flatness tolerances for plate shall conform to the requirements of Table 5. “Specially-flattened” plate when so specified, shall have permissible variations in flatness as agreed upon between the manufacturer and the purchaser.

10. Test Methods

10.1 The chemical composition, mechanical, and other properties of the material as enumerated in this specification shall be determined, in case of disagreement, in accordance with the methods in Specification B906.

10.2 The measurement of average grain size may be carried out by the planimetric method, the comparison method, or the intercept method described in Specification B906. In case of dispute, the “referee” method for determining average grain size shall be the planimetric method.

10.3 For purposes of determining compliance with the specified limits for requirements of the properties listed in Specification B409, an observed value or a calculated value shall be rounded in accordance with the rounding methods in Specification B906, or in the case of grain size, as indicated below.

Test	Rounded Unit for Observed or Calculated Value
Grain size:	
0.0024 in. (0.060 mm) or larger	nearest multiple of 0.0002 in. (0.005 mm)
less than 0.0024 in. (0.060 mm)	nearest multiple of 0.0001 in. (0.002 mm)

11. Product Marking

11.1 Each bundle or shipping container shall be marked with the name of the material; condition (temper); this specification number; the size; gross, tare, and net weight; consignor