



Designation: B 409 – 01

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 N08811* 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 the standard. The values given in parentheses are for information only.

2. Referenced Documents

2.1 ASTM Standards:³

- B 408** Specification for Nickel-Iron-Chromium Alloy Rod and Bar
- B 880** Specification for General Requirements for Chemical Check Analysis Limits for Nickel, Nickel Alloys and Cobalt Alloys
- E 8** Test Methods for Tension Testing of Metallic Materials
- E 10** Test Method for Brinell Hardness of Metallic Materials
- E 18** Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
- E 29** Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
- E 112** Test Methods for Determining Average Grain Size
- E 140** Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, and

Scleroscope Hardness

- E 1473** Test Methods for Chemical Analysis of Nickel, Cobalt, and High-Temperature Alloys
- F 155** Test Method for Temper of Strip and Sheet Metals for Electronic Devices (Spring-Back Method)⁴

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*—The terms given in **Table 1** shall apply.

4. Ordering Information

4.1 Orders for material to this specification should include information with respect to the following:

- 4.1.1 Alloy (**Table 2**).
- 4.1.2 *Condition (Temper)*—**Table 3** and **Table 4**, and **Appendix XI**.
- 4.1.3 *Finish*—**Appendix XI**.
- 4.1.4 *Dimensions*—Thickness, width, and length.
- 4.1.5 *Optional Requirements:*
 - 4.1.5.1 *Sheet and Strip*—Whether to be furnished in coil, in cut straight lengths, or in random straight lengths.
 - 4.1.5.2 *Strip*—Whether to be furnished with commercial slit edge, square edge, or round edge.
 - 4.1.5.3 *Plate*—Whether to be furnished specially flattened (see **8.7.2**); also how plate is to be cut (**Table 5** and **Table 6**).
 - 4.1.6 *Fabrication Details*—Not mandatory but helpful to the manufacturer:
 - 4.1.6.1 *Welding or Brazing*—Process to be employed.
 - 4.1.6.2 *Plate*—Whether material is to be hot-formed.
 - 4.1.7 *Certification*—State if certification or a report of test results is required (**Section 16**).
 - 4.1.8 *Samples for Product (Check) Analysis*—Whether samples for product (check) analysis should be furnished (see **6.2**).
 - 4.1.9 *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 (**Section 14**).

5. Materials and Manufacture

5.1 *Heat Treatment*—The final heat treatment of UNS N08120 shall be 2150°F (1177°C) minimum, UNS N08810,

⁴ Withdrawn.

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.

* New designations established in accordance with ASTM E 527 and SAE J1086, Practice for Numbering Metals and Alloys (UNS).

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.

TABLE 1 Product Description

Product	Thickness, in. (mm)	Width, in. (mm)
Hot-rolled plate ^A	3/16 and over (Table 7 and Table 8)	(Table 5) ^B
Hot-rolled sheet ^A	0.018 to 0.250 (0.46 to 6.4), incl (Table 9)	(Table 11)
Cold-rolled sheet ^C	0.018 to 0.250 (0.46 to 6.4), incl (Table 9)	(Table 11)
Cold-rolled strip ^C	0.005 to 0.250 (0.13 to 6.4), incl (Table 9)	(Table 11)

^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 B 408, 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

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

^A Iron shall be determined arithmetically by difference.

^B Alloy UNS N08800: 0.10 max.

Alloy UNS N08810: 0.05–0.10.

Alloy UNS N08811: 0.06–0.10.

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

2050°F (1121°C) minimum, UNS N08811 and UNS N08890, 2100°F (1149°C) minimum.

6. Chemical Composition

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

6.2 If a product (check) analysis is performed by the purchaser, the material shall conform to the product (check) analysis variations in Specification B 880.

7. Mechanical and Other Requirements

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

7.2 *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.

7.3 *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.

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

7.4 *Annealing Temperature*—Alloy UNS N08120 shall be annealed at 2150°F (1177°C) minimum, and UNS N08810, 2050°F (1145°C) minimum.

8. Dimensions and Permissible Variations

8.1 Thickness and Weight:

8.1.1 *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 7.

8.1.1.1 For use with Table 7, plate shall be assumed to weigh 0.287 lb/in.³ (7.944 g/cm³).

8.1.2 *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 8.

8.1.3 *Sheet and Strip*—The permissible variations in thickness of sheet and strip shall be as prescribed in Table 9. The thickness of sheet and strip shall be measured with the micrometer spindle 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.

8.2 Width or Diameter:

8.2.1 *Plate*—The permissible variations in width of rectangular plates and diameter of circular plates shall be as prescribed in Table 5 and Table 10.

8.2.2 *Sheet and Strip*—The permissible variations in width for sheet and strip shall be as prescribed in Table 11.

8.3 Length:

8.3.1 Sheet and strip of all sizes may be ordered to cut lengths, in which case a variation of 1/8 in. (3.18 mm) over the specified length shall be permitted.

8.3.2 Permissible variations in length of rectangular plate shall be as prescribed in Table 6.

8.4 Straightness:

8.4.1 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).

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

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

Alloy	Condition	Tensile Strength, min, psi (MPa)	Yield Strength ^A (0.2 % offset), min, psi (MPa)	Elongation in 2 in. or 50 mm (or 4D), min, %
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 ^{B,C}	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 ^D	Annealed	65 000 (450)	25 000 (170)	30
UNS N08811 ^D	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 ^D	Annealed	65 000 (450)	25 000 (170)	30
UNS N08811 ^D	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 ^E
UNS N08810 ^D	Annealed	65 000 (450)	25 000 (170)	30
UNS N08811 ^D	Annealed	65 000 (450)	25 000 (170)	30
UNS N08890	Annealed	75 000 (520)	30 000 (205)	35

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

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

^C 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.

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

^E 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	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 ^D to 0.010 (0.13 to 0.25), incl	0.0009 (0.022)	8 ^E	88 ^E
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 For ductility evaluations for strip under 0.005 in. (0.13 mm) in thickness, the spring-back test such as described in Test Method F 155, is often used and the manufacturer should be consulted.

^E 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.

8.5 Edges:

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

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

8.5.1.2 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.

8.5.1.3 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.

8.5.1.4 Sheet shall have sheared or slit edges.

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

8.6 Squareness (Sheet):

8.6.1 For sheets of all thicknesses, the angle between adjacent sides shall be $90 \pm 0.15^\circ$ ($1/16$ in. in 24 in.) (1.59 mm in 610 mm).

8.7 Flatness:

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

8.7.2 Standard flatness tolerances for plate shall conform to the requirements of Table 12. "Specially-flattened" plate when

TABLE 5 Permissible Variations in Width^A of Sheared, Plasma Torch-Cut, and Abrasive-Cut Rectangular Plate^{B,C}

Specified Thickness	Permissible Variations in Widths for Widths Given, in. (mm)									
	Up to 30 (760), incl		Over 30 to 72 (760 to 1830), incl		Over 72 to 108 (1830 to 2740), incl		Over 108 to 144 (2740 to 3660), incl		Over 144 to 160 (3660 to 4070), incl	
	+	-	+	-	+	-	+	-	+	-
	Inches									
Sheared: ^D										
3/16 to 5/16, excl	3/16	1/8	1/4	1/8	3/8	1/8	1/2	1/8	...	...
5/16 to 1/2, excl	1/4	1/8	3/8	1/8	3/8	1/8	1/2	1/8	5/8	1/8
1/2 to 3/4, excl	3/8	1/8	3/8	1/8	1/2	1/8	5/8	1/8	3/4	1/8
3/4 to 1, excl	1/2	1/8	1/2	1/8	5/8	1/8	3/4	1/8	7/8	1/8
1 to 1 1/4, incl	5/8	1/8	5/8	1/8	3/4	1/8	7/8	1/8	1	1/8
Abrasive-cut: ^{E,F}										
3/16 to 1 1/4, incl	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8
Over 1 1/4 to 2 3/4, incl	3/16	1/8	3/16	1/8	3/16	1/8	3/16	1/8	3/16	1/8
Plasma torch-cut: ^G										
3/16 to 2, excl	1/2	0	1/2	0	1/2	0	1/2	0	1/2	0
2 to 3, incl	5/8	0	5/8	0	5/8	0	5/8	0	5/8	0
	Millimetres									
Sheared: ^D										
4.8 to 7.9, excl	4.8	3.2	6.4	3.2	9.5	3.2	12.7	3.2	...	...
7.9 to 12.7, excl	6.4	3.2	9.5	3.2	9.5	3.2	12.7	3.2	15.9	3.2
12.7 to 19.1, excl	9.5	3.2	9.5	3.2	12.7	3.2	15.9	3.2	19.1	3.2
19.1 to 25.4, excl	12.7	3.2	12.7	3.2	15.8	3.2	19.1	3.2	22.2	3.2
25.4 to 31.8, incl	15.9	3.2	15.9	3.2	19.1	3.2	22.2	3.2	25.4	3.2
Abrasive-cut: ^{E,F}										
4.8 to 31.8, incl	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
Over 31.8 to 69.8, incl	4.8	3.2	4.8	3.2	4.8	3.2	4.8	3.2	4.8	3.2
Plasma torch-cut: ^G										
4.8 to 50.8, excl	12.7	0	12.7	0	12.7	0	12.7	0	12.7	0
50.8 to 76.2, incl	15.9	0	15.9	0	15.9	0	15.9	0	15.9	0

^A Permissible variations in width for powder- or inert arc-cut plate shall be as agreed upon between the manufacturer and the purchaser.
^B Permissible variations in machined, powder-, or inert arc-cut circular plate shall be as agreed upon between the manufacturer and the purchaser.
^C Permissible variations in plasma torch-cut sketch plates shall be as agreed upon between the manufacturer and the purchaser.
^D The minimum sheared width is 10 in. (254 mm) for material 3/4 in. (19.0 mm) and under in thickness and 20 in. (508 mm) for material over 3/4 in. in thickness.
^E The minimum abrasive-cut width is 2 in. (50.8 mm) and increases to 4 in. (101.6 mm) for thicker plates.
^F These tolerances are applicable to lengths of 240 in. (6100 mm), max. For lengths over 240 in., an additional 1/16 in. (1.6 mm) is permitted, both plus and minus.
^G The tolerance spread shown for plasma torch-cutting may be obtained all on the minus side, or divided between the plus and minus side if so specified by the purchaser.

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so specified, shall have permissible variations in flatness as agreed upon between the manufacturer and the purchaser. Mechanical properties, hardness, and grain size shall be taken from such locations in each lot as to be representative of that lot.

9. Workmanship, Finish, and Appearance

9.1 The material shall be uniform in quality and temper, smooth, commercially straight or flat, and free of injurious imperfections.

10. Sampling

10.1 Lot:
 10.1.1 A lot for chemical analysis shall consist of one heat.
 10.1.2 A lot for mechanical properties, hardness and grain size testing shall consist of all material from the same heat, nominal thickness, and condition (temper).
 10.1.2.1 Where material cannot be identified by heat, a lot shall consist of not more than 500 lb (227 kg) of material in the same thickness and condition, except for plates weighing over 500 lb, in which case only one specimen shall be taken.

10.2 Test Material Selection:
 10.2.1 Chemical Analysis—Representative samples shall be taken during pouring or subsequent processing.
 10.2.1.1 Product (check) analysis shall be wholly the responsibility of the purchaser.
 10.2.2 Mechanical Properties, Hardness, and Grain Size—Samples of the material to provide test specimens for mechani-

11. Number of Tests

11.1 Chemical Analysis—One test per lot.
 11.2 Mechanical Properties—One test per lot.
 11.3 Hardness—One test per lot. (Required only as specified in Table 4.)
 11.4 Grain Size—One test per lot. (Required only as specified in 7.2 and in Table 4.)

12. Specimen Preparation

12.1 Tension test specimens shall be taken from material in the final condition (temper) and tested transverse to the direction of rolling when width will permit.
 12.2 Tension test specimens shall be any of the standard or subsize specimens shown in Test Methods E 8.
 12.3 In the event of disagreement, referee specimens shall be as follows:
 12.3.1 Full thickness of the material, machined to the form and dimensions shown for the sheet-type specimen in Test Methods E 8 for material under 1/2 in. (12.7 mm) in thickness.
 12.3.2 The largest possible round specimen shown in Test Methods E 8 for material 1/2 in. (12.7 mm) and over.