



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

This standard is issued under the fixed designation B409; 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 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 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 and health practices, and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:⁴

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

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

E140 Hardness Conversion Tables for Metals Relationship

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.

Current edition approved June 1, 2016. Published June 2016. Originally approved in 1957. Last previous edition approved in 2011 as B409 – 06 (2011). DOI: 10.1520/B0409-06R16.

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.

Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness

F155 Method of Test for Temper of Strip and Sheet Metals for Electronic Devices (Spring-Back Method) (Withdrawn 1982)⁵

3. Terminology

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

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.

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 The last approved version of this historical standard is referenced on www.astm.org.



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

Element	Composition Limits, %		
	Alloy N08120	Alloy N08890	Alloys N08800, N08810, and N08811
Nickel	35.0 min 39.0 max	40.0 min 45.0 max	30.0 min 35.0 max
Chromium	23.0 min 27.0 max	23.5 min 28.5 max	19.0 min 23.0 max
Iron	remainder ^A	remainder	39.5 min ^A
Manganese, max	1.5	1.5	1.5 ^B
Carbon	0.02 min 0.10 max	0.06 min 0.14 max	...
Copper, max	0.50	0.75	0.75
Silicon, max	1.0	1.0 min 2.0 max	1.0
Sulfur, max	0.03	0.015	0.015
Aluminum ^C	0.40 max	0.05 min 0.60 max	0.15 min 0.60 max
Titanium ^C	0.20 max	0.15 min 0.60 max	0.15 min 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.

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 final heat treatment of UNS N08120 shall be 2150°F (1177°C) minimum, UNS N08810, 2050°F (1121°C) minimum, UNS N08811 and UNS N08890, 2100°F (1149°C) minimum.

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.

8.4 *Annealing Temperature*—Alloy UNS N08120 shall be annealed at 2150°F (1177°C) minimum, and UNS N08810, 2050°F (1121°C) minimum.

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.

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 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.

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 F155, 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.

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 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.

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.



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 ¼ 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 to 60 (1220 to 1520), excl	60 to 72 (1520 to 1830), excl	72 to 84 (1830 to 2130), excl	84 to 96 (2130 to 2440), excl	96 to 108 (2440 to 2740), excl	108 to 120 (2740 to 3050), excl	120 to 144 (3050 to 3660), excl	144 (3660) and Over
Inches									
3/16 to ¼, excl	3/4	1 1/16	1 ¼	1 5/8	1 5/8	1 5/8	...	...	...
¼ to 3/8, excl	1 1/16	¾	1 5/16	1 5/8	1 3/8	1 7/16	1 9/16	1 7/8	...
3/8 to ½, excl	½	9/16	1 1/16	¾	1 5/16	1 1/8	1 ¼	1 7/16	1 ¾
½ to ¾, excl	½	9/16	5/8	5/8	1 3/16	1 1/8	1 1/8	1 1/8	1 3/8
¾ to 1, excl	½	9/16	5/8	5/8	¾	1 3/16	1 5/16	1	1 1/8
1 to 2, excl	½	9/16	9/16	9/16	1 1/16	1 1/16	1 1/16	¾	1
2 to 4, incl	¼	5/16	3/8	7/16	½	9/16	5/8	¾	7/8
Millimetres									
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

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 $90 \pm 0.15^\circ$ (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 as indicated below, in accordance with the rounding methods in Specification B906.

Test	Rounded Unit for Observed or Calculated Value
Elongation	nearest 1 %
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 and consignee address; contract or order number; or such other information as may be defined in the contract or order.

12. Keywords

12.1 plate; sheet; strip; UNS N08120; UNS N08800; UNS N08801; UNS N08810; UNS N08811; UNS N08890

APPENDIX

(Nonmandatory Information)

X1. CONDITIONS (TEMPERS) AND FINISHES

X1.1 This appendix lists the conditions and finishes in which plate, sheet, and strip are normally supplied. These are subject to change and the manufacturer should be consulted for the latest information available.

X1.1.1 *Plate, Hot Rolled:*

X1.1.1.1 *Annealed*—Soft with an oxide surface, and suitable for heavy cold forming. Available with a descaled surface, when so specified.

X1.1.1.2 *As-Rolled*—With an oxide surface. Available with a descaled surface, when so specified. Suitable for flat work, mild forming, or tube sheets. When intended for tube sheets, specify that plates are to be specially flattened. When intended for hot forming, this should be indicated on the purchase order so that the manufacturer may select appropriate material.

X1.1.2 *Plate, Cold Rolled:*

X1.1.2.1 *Annealed*—Soft with an oxide surface; available with a descaled surface when so specified.

X1.1.3 *Sheet, Hot-Rolled, Annealed, and Pickled*—Soft with a pickled matte finish. Properties similar to **X1.1.4.1** but with broader thickness tolerances. Not suggested for applications where the finish of a cold-rolled sheet is considered essential, or for deep drawing, or spinning.

X1.1.4 *Sheet and Strip, Cold-Rolled:*

X1.1.4.1 *Annealed*—Soft with a descaled or bright annealed finish.

X1.1.4.2 *Deep-Drawing or Spinning Quality*—Similar to **X1.1.4.1**, except furnished to controlled hardness and grain size and lightly leveled.

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org). Permission rights to photocopy the standard may also be secured from the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, Tel: (978) 646-2600; <http://www.copyright.com/>