



# Standard Specification for Nickel-Iron-Chromium Alloy Plate, Sheet, and Strip<sup>1</sup>

This standard is issued under the fixed designation B 409; 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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

## 1. Scope

1.1 This specification<sup>2</sup> 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:

- B 408 Specification for Nickel-Iron-Chromium Alloy Rod and Bar<sup>3</sup>
- B 880 Specification for General Requirements for Chemical Check Analysis Limits for Nickel, Nickel Alloys and Cobalt Alloys<sup>3</sup>
- E 8 Test Methods for Tension Testing of Metallic Materials<sup>4</sup>
- E 10 Test Method for Brinell Hardness of Metallic Materials<sup>4</sup>
- E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials<sup>4</sup>
- E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications<sup>5</sup>
- E 112 Test Methods for Determining the Average Grain Size<sup>4</sup>
- E 140 Hardness Conversion Tables for Metals<sup>4</sup>

E 1473 Test Methods for Chemical Analysis of Nickel, Cobalt, and High-Temperature Alloys<sup>6</sup>

F 155 Test Method for Temper of Strip and Sheet Metals for Electronic Devices (Spring-Back Method)<sup>7</sup>

## 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 X1.

4.1.3 *Finish*—Appendix X1.

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).

<sup>1</sup> 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 Dec. 10, 2001. Published February 2002. Originally published as B 409 – 57 T. Last previous edition B 409 – 96a.

<sup>2</sup> 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).

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 02.04.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 03.01.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 14.02.

<sup>6</sup> *Annual Book of ASTM Standards*, Vol 03.06.

<sup>7</sup> Discontinued—see 1983 *Annual Book of ASTM Standards*, Vol 10.04.

**TABLE 1 Product Description**

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

<sup>A</sup>Material  $\frac{3}{16}$  to  $\frac{1}{4}$  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.

<sup>B</sup>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.

<sup>C</sup>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
	remainder <sup>A</sup>	remainder	39.5 min <sup>A</sup>
Manganese, max	1.5	1.5	1.5
Carbon	0.02 min	0.06 min	...
	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 <sup>C</sup>	0.40 max	0.05 min	0.15 min
	...	0.60 max	0.60 max
Titanium <sup>C</sup>	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	...	...

<sup>A</sup>Iron shall be determined arithmetically by difference.

<sup>B</sup>Alloy UNS N08800: 0.10 max.

Alloy UNS N08810: 0.05–0.10.

Alloy UNS N08811: 0.06–0.10.

<sup>C</sup>Alloy UNS N08811: Al + Ti, 0.85–1.20.

## 5. Materials and Manufacture

5.1 *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.

## 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.<sup>3</sup> (7.944 g/cm<sup>3</sup>).

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  $\frac{3}{8}$  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.

### 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  $\frac{1}{8}$  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:

**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 <sup>A</sup> (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 <sup>B,C</sup>	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 <sup>D</sup>	Annealed	65 000 (450)	25 000 (170)	30
UNS N08811 <sup>D</sup>	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 <sup>D</sup>	Annealed	65 000 (450)	25 000 (170)	30
UNS N08811 <sup>D</sup>	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 <sup>E</sup>
UNS N08810 <sup>D</sup>	Annealed	65 000 (450)	25 000 (170)	30
UNS N08811 <sup>D</sup>	Annealed	65 000 (450)	25 000 (170)	30
UNS N08890	Annealed	75 000 (520)	30 000 (205)	35

<sup>A</sup>Yield strength requirements do not apply to material under 0.020 in. (0.51 mm) in thickness.

<sup>B</sup>As-rolled plate may be given a stress-relieving heat treatment subsequent to final rolling.

<sup>C</sup>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.

<sup>D</sup>Available only in thicknesses 0.115 in. (2.92 mm) and over.

<sup>E</sup>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 <sup>A,B</sup> 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) <sup>C</sup>			
0.005 <sup>D</sup> to 0.010 (0.13 to 0.25), incl	0.0009 (0.022)	8 <sup>E</sup>	88 <sup>E</sup>
Over 0.010 to 0.125 (0.25 to 3.2), incl	0.0030 (0.075)	4.5	86

<sup>A</sup>For Rockwell or equivalent hardness conversions see Hardness Conversion Tables E140.

<sup>B</sup>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.

<sup>C</sup>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.

<sup>D</sup>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.

<sup>E</sup>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.

8.4.1 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 centimetres).

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

#### 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):

**TABLE 5 Permissible Variations in Width<sup>A</sup> of Sheared, Plasma Torch-Cut, and Abrasive-Cut Rectangular Plate<sup>B,C</sup>**

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: <sup>D</sup>										
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: <sup>E,F</sup>										
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: <sup>G</sup>										
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: <sup>D</sup>										
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: <sup>E,F</sup>										
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: <sup>G</sup>										
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

<sup>A</sup>Permissible variations in width for powder- or inert arc-cut plate shall be as agreed upon between the manufacturer and the purchaser.  
<sup>B</sup>Permissible variations in machined, powder-, or inert arc-cut circular plate shall be as agreed upon between the manufacturer and the purchaser.  
<sup>C</sup>Permissible variations in plasma torch-cut sketch plates shall be as agreed upon between the manufacturer and the purchaser.  
<sup>D</sup>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.  
<sup>E</sup>The minimum abrasive-cut width is 2 in. (50.8 mm) and increases to 4 in. (101.6 mm) for thicker plates.  
<sup>F</sup>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.  
<sup>G</sup>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.

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 so specified, shall have permissible variations in flatness as agreed upon between the manufacturer and the purchaser.

**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 mechanical properties, hardness, and grain size shall be taken from such locations in each lot as to be representative of that lot.

**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.)

**TABLE 6 Permissible Variations in Length<sup>A</sup> of Sheared, Plasma Torch-Cut,<sup>B</sup> and Abrasive-Cut Rectangular Plate<sup>C</sup>**

Specified Thickness	Permissible Variation in Length for Lengths Given, in. (mm)															
	Up to 60 (1520), incl		Over 60 to 96 (1520 to 2440), incl		Over 96 to 120 (2440 to 3050), incl		Over 120 to 240 (3050 to 6096) incl		Over 240 to 360 (6096 to 9144), incl		Over 360 to 450 (9144 to 11430), incl		Over 450 to 540 (11430 to 13716), incl		Over 540 (13716)	
	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
Inches																
Sheared: <sup>D</sup>																
3/16 to 5/16, excl	3/16	1/8	1/4	1/8	3/8	1/8	1/2	1/8	5/8	1/8	3/4	1/8	7/8	1/8	...	...
5/16 to 1/2, excl	3/8	1/8	1/2	1/8	1/2	1/8	1/2	1/8	5/8	1/8	3/4	1/8	7/8	1/8	1	1/8
1/2 to 3/4, excl	1/2	1/8	1/2	1/8	5/8	1/8	5/8	1/8	3/4	1/8	7/8	1/8	1 1/8	1/8	1 3/8	1/8
3/4 to 1, excl	5/8	1/8	5/8	1/8	5/8	1/8	3/4	1/8	7/8	1/8	1 1/8	1/8	1 3/8	1/8	1 5/8	1/8
1 to 1 1/4, incl	3/4	1/8	3/4	1/8	3/4	1/8	7/8	1/8	1 1/8	1/8	1 3/8	1/8	1 5/8	1/8	...	...
Abrasive-cut: <sup>E</sup>																
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	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	3/16	1/8	3/16	1/8	...	...
Plasma torch-cut: <sup>F</sup>																
3/16 to 2, excl	1/2	0	1/2	0	1/2	0	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	5/8	0	5/8	0	5/8	0
Millimetres																
Sheared: <sup>D</sup>																
4.8 to 7.9, excl	4.8	3.2	6.4	3.2	9.5	3.2	12.7	3.2	15.9	3.2	19.0	3.2	22.2	3.2	...	...
7.94 to 12.7, excl	9.5	3.2	12.7	3.2	12.7	3.2	12.7	3.2	15.9	3.2	19.0	3.2	22.2	3.2	25.4	3.2
12.7 to 19.0, excl	12.7	3.2	12.7	3.2	15.9	3.2	15.9	3.2	19.0	3.2	22.2	3.2	28.6	3.2	34.9	3.2
19.0 to 25.4, excl	15.9	3.2	15.9	3.2	15.9	3.2	19.0	3.2	22.2	3.2	28.6	3.2	34.9	3.2	41.2	3.2
25.4 to 31.8, incl	19.0	3.2	19.0	3.2	19.0	3.2	22.2	3.2	28.6	3.2	34.9	3.2	41.2	3.2	...	...
Abrasive-cut: <sup>E</sup>																
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	3.2	3.2	3.2	...	...	...
Over 31.8 to 69.9, incl	4.8	3.2	4.8	3.2	4.8	3.2	4.8	3.2	4.8	3.2	4.8	3.2	4.8	3.2	...	...
Plasma torch-cut: <sup>F</sup>																
4.8 to 50.8, excl	12.7	0	12.7	0	12.7	0	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	15.9	0	15.9	0	15.9	0

<sup>A</sup>Permissible variations in length for powder- or inert arc-cut plate shall be agreed upon between the manufacturer and the purchaser.

<sup>B</sup>The tolerance spread shown for plasma torch cutting may be obtained all on the minus side, or divided between the plus and minus sides if so specified by the purchaser.

<sup>C</sup>Permissible variations in machined, powder- or inert arc-cut circular plate shall be as agreed upon between the manufacturer and the purchaser.

<sup>D</sup>The minimum sheared length is 10 in. (254 mm).

<sup>E</sup>Abrasive-cut applicable to a maximum length of 144 to 400 in. (3658 to 10160 mm) depending on the thickness and width ordered.

<sup>F</sup>The tolerance spread shown for plasma torch-cut sketch plates shall be as agreed upon between the manufacturer and the purchaser.

**TABLE 7 Permissible Variations in Thickness and Overweight of Rectangular Plates**

NOTE 1—All plates shall be ordered to thickness and not to weight per square foot (cm). No plates shall vary more than 0.01 in. (0.25 mm) under the thickness ordered, and the overweight of each lot<sup>A</sup> in each shipment shall not exceed the amount given in the table. Spot grinding is permitted to remove surface imperfections, such spots not to exceed 0.01 in. (0.25 mm) under the specified thickness.

Specified Thickness, in. (mm)	Permissible Excess in Average Weight <sup>B,C</sup> , per Square Foot of Plates for Widths Given in Inches (Millimeters) Expressed in Percentage of Nominal Weights									
	Under 48 (1220)	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 132 (3050 to 3350), excl	132 to 144 (3350 to 3660), excl	144 to 160 (3660 to 4070), incl
3/16 to 5/16 (4.76 to 7.94), excl	9.0	10.5	12.0	13.5	15.0	16.5	18.0	...	...	...
5/16 to 3/8 (7.94 to 9.52), excl	7.5	9.0	10.5	12.0	13.5	15.0	16.5	18.0	...	...
3/8 to 7/16 (9.52 to 11.11), excl	7.0	7.5	9.0	10.5	12.0	13.5	15.0	16.5	18.0	19.5
7/16 to 1/2 (11.11 to 12.70), excl	6.0	7.0	7.5	9.0	10.5	12.0	13.5	15.0	16.5	18.0
1/2 to 5/8 (12.70 to 15.88), excl	5.0	6.0	7.0	7.5	9.0	10.5	12.0	13.5	15.0	16.5
5/8 to 3/4 (15.88 to 19.05), excl	4.5	5.5	6.0	7.0	7.5	9.0	10.5	12.0	13.5	15.0
3/4 to 1 (19.05 to 25.4), excl	4.0	4.5	5.5	6.0	7.0	7.5	9.0	10.5	12.0	13.5
1 to 2 (25.4 to 50.8), incl	4.0	4.0	4.5	5.5	6.0	7.0	7.5	9.0	10.5	12.0

<sup>A</sup>The term "lot" applied to this table means all of the plates of each group width and each group thickness.

<sup>B</sup>The permissible overweight for lots of circular and sketch plates shall be 25 % greater than the amounts given in this table.

<sup>C</sup>The weight of individual plates shall not exceed the nominal weight by more than 1 1/4 times the amount given in the table and Footnote B.

**TABLE 8 Permissible Variations in Thickness for Rectangular Plates Over 2 in. (50.8 mm) in Thickness**

NOTE 1—Permissible variation under specified thickness, 0.01 in. (0.25 mm).

Specified Thickness, in. (mm)	Permissible Variations, in. (mm), Over Specified Thickness for Widths Given, in. (mm)					
	To 36 (915), excl	36 to 60 (915 to 1520), excl	60 to 84 (1520 to 2130), excl	84 to 120 (2130 to 3050), excl	120 to 132 (3050 to 3350), excl	132 (3350) and Over
Over 2 to 3 (50.8 to 76.2), excl	1 / 16 (1.59)	3 / 32 (2.38)	7 / 64 (2.78)	1 / 8 (3.18)	1 / 8 (3.18)	9 / 64 (3.57)
3 to 4 (76.2 to 101.6), incl	5 / 64 (1.98)	3 / 32 (2.38)	7 / 64 (2.78)	1 / 8 (3.18)	1 / 8 (3.18)	9 / 64 (3.57)

**TABLE 9 Permissible Variations in Thickness of Sheet and Strip (Permissible Variations, Plus and Minus, in Thickness, in. (mm), for Widths Given in in. (mm))**

Specified Thickness, in. (mm)	Sheet <sup>A</sup>			
	Hot-Rolled		Cold-Rolled	
	48 (1220) and Under	Over 48 to 60 (1220 to 1520), incl	48 (1220) and Under	Over 48 to 60 (1220 to 1520), incl
0.018 to 0.025 (0.5 to 0.6), incl	0.003 (0.08)	0.004 (0.10)	0.002 (0.05)	0.003 (0.08)
Over 0.025 to 0.034 (0.6 to 0.9), incl	0.004 (0.10)	0.005 (0.13)	0.003 (0.08)	0.004 (0.10)
Over 0.034 to 0.043 (0.9 to 1.1), incl	0.005 (0.13)	0.006 (0.15)	0.004 (0.10)	0.005 (0.13)
Over 0.043 to 0.056 (1.1 to 1.4), incl	0.005 (0.13)	0.006 (0.15)	0.004 (0.10)	0.005 (0.13)
Over 0.056 to 0.070 (1.4 to 1.8), incl	0.006 (0.15)	0.007 (0.18)	0.005 (0.13)	0.006 (0.15)
Over 0.070 to 0.078 (1.8 to 1.9), incl	0.007 (0.18)	0.008 (0.20)	0.006 (0.15)	0.007 (0.18)
Over 0.078 to 0.093 (1.9 to 2.4), incl	0.008 (0.20)	0.009 (0.23)	0.007 (0.18)	0.008 (0.20)
Over 0.093 to 0.109 (2.4 to 2.8), incl	0.009 (0.23)	0.010 (0.25)	0.007 (0.18)	0.009 (0.23)
Over 0.109 to 0.125 (2.8 to 3.2), incl	0.010 (0.25)	0.012 (0.31)	0.008 (0.20)	0.010 (0.25)
Over 0.125 to 0.140 (3.2 to 3.6), incl	0.012 (0.31)	0.014 (0.36)	0.008 (0.20)	0.010 (0.25)
Over 0.140 to 0.171 (3.6 to 4.3), incl	0.014 (0.36)	0.016 (0.41)	0.009 (0.23)	0.012 (0.31)
Over 0.171 to 0.187 (4.3 to 4.8), incl	0.015 (0.38)	0.017 (0.43)	0.010 (0.25)	0.013 (0.33)
Over 0.187 to 0.218 (4.8 to 5.5), incl	0.017 (0.43)	0.019 (0.48)	0.011 (0.28)	0.015 (0.38)
Over 0.218 to 0.234 (5.5 to 5.9), incl	0.018 (0.46)	0.020 (0.51)	0.012 (0.31)	0.016 (0.41)
Over 0.234 to 0.250 (5.9 to 6.4), incl	0.020 (0.51)	0.022 (0.56)	0.013 (0.33)	0.018 (0.46)

  

Specified Thickness, in. (mm)	Cold-Rolled Strip <sup>A,B</sup>	
	Widths 12 in. (305 mm) and Under, plus and minus	
Up to 0.050 (1.27), incl	0.0015 (0.038)	
Over 0.050 to 0.093 (1.27 to 2.39), incl	0.0025 (0.063)	
Over 0.093 to 0.125 (2.39 to 3.18), incl	0.004 (0.11)	

<sup>A</sup>Measured  $\frac{3}{16}$ in. (9.5 mm) or more from either edge except for strip under 1 in. (25.4 mm) in width which is measured at any place.

<sup>B</sup>Standard sheet tolerances apply for thicknesses over 0.125 in. (3.2 mm) and for all thicknesses of strip over 12 in. (305 mm) wide.

## 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  $\frac{1}{2}$ in. (12.7 mm) in thickness.

12.3.2 The largest possible round specimen shown in Test Methods E 8 for material  $\frac{1}{2}$  in. (12.7 mm) and over.

## 13. Test Methods

13.1 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 following methods:

Test	ASTM Designation
Chemical Analysis	E 1473
Tension	E 8
Brinell Hardness	E 10
Rockwell Hardness	E 18
Rounding Procedure	E 29
Grain Size	E 112
Hardness Conversion	E 140
Spring-Back	F 155

13.2 The measurement of average grain size may be carried out by the planimetric method, the comparison method, or the intercept method described in Test Methods E 112. In case of dispute, the “referee” method for determining average grain size shall be the planimetric method.

13.3 For purposes of determining compliance with the specified limits for requirements of the properties listed in the following table, an observed value or a calculated value shall

**TABLE 10 Permissible Variations in Diameter for Circular Plates Sheared Plate**

Sheared Plate		Permissible Variations Over Specified Diameter for Thickness Given, in. (mm) <sup>A</sup>			
Specified Diameter, in. (mm)		To 3/8 (9.52), incl			
		20 to 32 (508 to 813), excl	1/4 (6.35)		
32 to 84 (813 to 2130), excl	5/16 (7.94)				
84 to 108 (2130 to 2740), excl	3/8 (9.52)				
108 to 140 (2740 to 3580), incl	7/16 (11.11)				

  

Plasma Torch-Cut <sup>B</sup>					
Specified Diameter, in. (mm)	Thickness, max. in. (mm)	Permissible Variations in Specified Diameter for Thickness Given, in. (mm) <sup>C</sup>			
		3/16 to 2 (4.76 to 50.8), excl		2 to 3 (50.8 to 76.2), incl	
		+	-	+	-
19 to 20 (483 to 508), excl	3 (76.2)	1/2 (12.70)	0	5/8 (15.88)	0
20 to 22 (508 to 559), excl	2 3/4 (69.8)	1/2 (12.70)	0	5/8 (15.88)	0
22 to 24 (559 to 610), excl	2 1/2 (63.5)	1/2 (12.70)	0	5/8 (15.88)	0
24 to 28 (610 to 711), excl	2 1/4 (57.3)	1/2 (12.70)	0	5/8 (15.88)	0
28 to 32 (711 to 812), excl	2 (50.8)	1/2 (12.70)	0	5/8 (15.88)	0
32 to 34 (812 to 864), excl	1 3/4 (44.5)	1/2 (12.70)	0	...	...
34 to 38 (864 to 965), excl	1 1/2 (38.1)	1/2 (12.70)	0	...	...
38 to 40 (965 to 1020), excl	1 1/4 (31.8)	1/2 (12.70)	0	...	...
40 to 140 (1020 to 3560), incl	3 (76.2)	1/2 (12.70)	0	5/8 (15.88)	0

<sup>A</sup>No permissible variations under.

<sup>B</sup>Permissible variations in plasma torch-cut sketch plates shall be as agreed upon between the manufacturer and the purchaser.

<sup>C</sup>The tolerance spread shown may also be obtained all on the minus side or divided between the plus and minus sides if so specified by the purchaser.

**TABLE 11 Permissible Variations in Width of Sheet and Strip**

Specified Thickness, in. (mm)	Specified Width, in. (mm)	Permissible Variations in Specified Width, in. (mm)	
		+	-
Sheet			
Up to 0.250 (6.35)	all	0.125 (3.18)	0
Strip <sup>A</sup>			
Under 0.075 (1.9)	Up to 12 (305), incl	0.007 (0.18)	0.007 (0.18)
	Over 12 to 48 (305 to 1219), incl	0.062 (1.6)	0
0.075 to 0.100 (1.9 to 2.5), incl	Up to 12 (305), incl	0.009 (0.23)	0.009 (0.23)
	Over 12 to 48 (305 to 1219), incl	0.062 (1.6)	0
Over 0.100 to 0.125 (2.5 to 3.2), incl	Up to 12 (305), incl	0.012 (0.30)	0.012 (0.30)
	Over 12 to 48 (305 to 1219), incl	0.062 (1.6)	0
Over 0.125 to 0.160 (3.2 to 4.1), incl	Up to 12 (305), incl	0.016 (0.41)	0.016 (0.41)
	Over 12 to 48 (305 to 1219), incl	0.062 (1.6)	0
Over 0.160 to 0.187 (4.1 to 4.7), incl	Up to 12 (305), incl	0.020 (0.51)	0.020 (0.51)
	Over 12 to 48 (305 to 1219), incl	0.062 (1.6)	0
Over 0.187 to 0.250 (4.7 to 6.4), incl	Up to 12 (305), incl	0.062 (1.6)	0.062 (1.6)
	Over 12 to 48 (305 to 1219), incl	0.062 (1.6)	0.062 (1.6)

<sup>A</sup>Rolled round- or square-edge strip in thicknesses of 0.071 to 0.125 in. (1.80 to 3.18 mm), incl, in widths 3 in. (76.2 mm) and under, shall have permissible width variations of ±0.005 in. (±0.13 mm). Permissible variations for other sizes shall be as agreed upon between the manufacturer and the purchaser.

be rounded as indicated below, in accordance with the round-  
method of Practice E 29.

Test	Rounded Unit for Observed or Calculated Value
Chemical composition, hardness, and tolerances (when expressed in decimals)	nearest unit in the last right-hand place of figures of the specified limit. If two choices are possible, as when the digits dropped are exactly a 5, or a 5 followed only by zeros, choose the one ending in an even digit, with zero defined as an even digit.
Tensile strength and yield strength	nearest 1000 psi (6.9 MPa)
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)

**14. Inspection**

14.1 Inspection of the material shall be made as agreed upon by the manufacturer and the purchaser as part of the purchase contract.

**15. Rejection and Rehearing**

15.1 Material not conforming to this specification or to authorized modifications will be subject to rejection.

15.2 Samples tested in accordance with this specification that represent rejected material shall be preserved for not less than 3 weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

**TABLE 12 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 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	11/16	3/4	15/16	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	11/16	3/4	15/16	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	13/16	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	13/16	15/16	1	1 1/8	
1 to 2, excl	1/2	9/16	9/16	9/16	11/16	11/16	11/16	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	
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	

**16. Certification**

16.1 When specified in the purchase order or contract, a manufacturer’s certification shall be furnished to the purchaser stating that material has been manufactured, tested, and inspected in accordance with this specification, and that the test results on representative samples meet specification requirements. When specified in the purchase order or contract, a report of the test results shall be furnished.

**17. Product Marking**

17.1 Each bundle or shipping container shall be marked with the name of the material; condition (temper); this speci-

fication 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.

**18. Keywords**

18.1 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.

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