



Designation: B162 – 99 (Reapproved 2019)

## Standard Specification for Nickel Plate, Sheet, and Strip<sup>1</sup>

This standard is issued under the fixed designation B162; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the U.S. Department of Defense.*

### 1. Scope

1.1 This specification<sup>2</sup> covers rolled nickel (UNS N02200) and low-carbon nickel (UNS N02201)<sup>3</sup> plate, sheet, and strip.

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:*<sup>4</sup>

**B160** Specification for Nickel Rod and Bar

**B880** Specification for General Requirements for Chemical Check Analysis Limits for Nickel, Nickel Alloys and Cobalt Alloys

**E8/E8M** Test Methods for Tension Testing of Metallic Materials

**E10** Test Method for Brinell Hardness of Metallic Materials

**E18** Test Methods for Rockwell Hardness of Metallic Materials

**E29** Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

**E39** Methods for Chemical Analysis of Nickel (Withdrawn 1995)<sup>5</sup>

**E112** Test Methods for Determining Average Grain Size

**E140** Hardness Conversion Tables for Metals Relationship 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)<sup>5</sup>

### 3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 The terms given in **Table 1** shall apply.

### 4. Ordering Information

4.1 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:

4.1.1 *Alloy*—Name and UNS number. (See **Table 2**.)

4.1.2 *ASTM Designation*, including year of issue.

4.1.3 *Condition*. (See **6.1**, **6.2**, and **Appendix X1**.)

4.1.4 *Finish*. (See **Appendix X1**.)

4.1.5 *Dimensions*—Thickness, width, and length.

4.1.6 *Quantity*.

4.1.7 *Optional Requirements*:

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

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

4.1.7.3 *Plate*—Whether to be furnished specially flattened (see **7.7.2**); also how plate is to be cut (see **7.2.1** and **7.3.2**).

4.1.8 *Fabrication Details*—Not mandatory but helpful to the manufacturer.

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

<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.

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<sup>2</sup> For ASME Boiler and Pressure Vessel Code applications, see related Specification SB-162 in Section II of that Code.

<sup>3</sup> New designation established in accordance with Practice E527 and SAE J1086, Practice for Numbering Metals and Alloys (UNS).

<sup>4</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>5</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).



**TABLE 1 Product Description**

Product	Thickness, in. (mm)	Width, in. (mm)
Hot-rolled plate <sup>A</sup>	$\frac{3}{16}$ and over (Table 5 and Table 6)	(Table 8) <sup>B</sup>
Hot-rolled sheet <sup>A</sup>	0.018 to 0.250 (0.46 to 6.4), incl (Table 7)	(Table 10)
Cold-rolled sheet <sup>C</sup>	0.018 to 0.250 (0.46 to 6.4), incl (Table 7)	(Table 10)
Cold-rolled strip <sup>C</sup>	0.005 to 0.250 (0.13 to 6.4), incl (Table 7)	(Table 10)

<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 B160, 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, %	
	Nickel (UNS N02200)	Low-Carbon Nickel (UNS N02201)
Nickel, <sup>A</sup> min	99.0	99.0
Copper, max	0.25	0.25
Iron, max	0.40	0.40
Manganese, max	0.35	0.35
Carbon, max†	0.15	0.02
Silicon, max	0.35	0.35
Sulfur, max	0.01	0.01

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

†Corrected editorially.

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

4.1.9 *Certification*—State if certification or a report of test results is required (see Section 15).

4.1.10 *Samples for Product (Check) Analysis*—Whether samples for product (check) analysis should be furnished (see 5.2).

4.1.11 *Purchaser Inspection*—If the purchaser wishes to witness tests or inspection of material at the place of manufacture, the purchase order must so state indicating which tests or inspections are to be witnessed (see Section 13).

## 5. Chemical Compositions

5.1 The material shall conform to the requirements as to chemical composition prescribed in Table 2.

5.2 If a product (check) analysis is performed by the purchaser, the material shall be done per Specification B880 and the material shall conform to the product (check) analysis variations defined in Table 1 of Specification B880.

## 6. Mechanical and Other Requirements

6.1 *Mechanical Properties*—The material shall conform to the requirements for mechanical properties prescribed in Table 3.

6.2 *Deep-Drawing and Spinning Quality Sheet and Strip*—The material shall conform to the requirements for grain size and hardness properties prescribed in Table 4.

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

## 7. Dimensions and Permissible Variations

### 7.1 Thickness and Weight:

7.1.1 *Plate*—For plate up to 2 in. (50.8 mm), inclusive, in thickness, the permissible variation under the specified thickness and permissible excess in overweight shall not exceed the amounts prescribed in Table 5.

7.1.1.1 For use with Table 5, plate shall be assumed to weigh 0.321 lb/in.<sup>3</sup> (8.89 g/cm<sup>3</sup>).

7.1.2 *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 6.

7.1.3 *Sheet and Strip*—The permissible variations in thickness of sheet and strip shall be as prescribed in Table 7. The thickness of strip and sheet 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 the strip under 1 in. in width.

### 7.2 Width and Diameter:

7.2.1 *Plate*—The permissible variations in width of rectangular plates and diameter of circular plates shall be as prescribed in Table 8 and Table 9.

7.2.2 *Sheet and Strip*—The permissible variations in width for sheet and strip shall be as prescribed in Table 10.

### 7.3 Length:

7.3.1 Sheet and strip of all sizes may be ordered to cut lengths, in which case a variation of  $\frac{1}{8}$  in. (3.2 mm) over the specified length shall be permitted.

7.3.2 Permissible variations in length of rectangular plate shall be as prescribed in Table 11.

### 7.4 Straightness:

7.4.1 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).

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

### 7.5 Edges:

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

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

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

7.5.1.3 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.

7.5.1.4 Sheet shall have sheared or slit edges.

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



**TABLE 3 Mechanical Properties for Plate, Sheet, and Strip (All Thicknesses and Sizes Unless Otherwise Indicated)**

Condition (Temper)	Tensile Strength, min, psi (MPa)	Yield <sup>A</sup> Strength (0.2 % offset), min, psi (MPa)	Elongation in 2 in. or 50 mm, or 4D, min, %	Rockwell Hardness (B Scale) <sup>B,C</sup>
<b>Nickel (UNS N02200) Hot-Rolled Plate</b>				
Annealed	55 000 (380)	15 000 (100)	40	...
As-rolled <sup>D,E</sup>	55 000 (380)	20 000 (135)	30	...
<b>Nickel (UNS N02200) Hot-Rolled Sheet</b>				
Annealed	55 000 (380)	15 000 (100)	40 <sup>F</sup>	...
<b>Nickel (UNS N02200) Cold-Rolled Sheet</b>				
Annealed	55 000 (380)	15 000 (100)	40 <sup>F</sup>	...
Quarter-hard	...	...	...	70 to 80
Half-hard	...	...	...	79 to 86
Hard	90 000 (620)	70 000 (480)	2	...
<b>Nickel (UNS N02200) Cold-Rolled Strip</b>				
Annealed	55 000 (380) <sup>G</sup>	15 000 (100)	40 <sup>F,G</sup>	...
Skin-hard	...	...	...	64 to 70
Quarter-hard	...	...	...	70 to 80
Half-hard	...	...	...	79 to 86
Three-quarter-hard	...	...	...	85 to 91
Hard	90 000 (620) <sup>G</sup>	70 000 (480)	2 <sup>G</sup>	...
Spring temper	...	...	...	95 min
<b>Low-Carbon Nickel (UNS N02201) Hot-Rolled Plate</b>				
Annealed	50 000 (345)	12 000 (80)	40	...
As-rolled <sup>D,E</sup>	50 000 (345)	12 000 (80)	30	...
<b>Low-Carbon Nickel (UNS N02201) Hot-Rolled Sheet</b>				
Annealed	50 000 (345)	12 000 (80)	40 <sup>F</sup>	...
<b>Low-Carbon Nickel (UNS N02201) Cold-Rolled Sheet</b>				
Annealed	50 000 (345)	12 000 (80)	40 <sup>F</sup>	...
<b>Low-Carbon Nickel (UNS N02201) Cold-Rolled Strip</b>				
Annealed	50 000 (345) <sup>G</sup>	12 000 (80)	40 <sup>F,G</sup>	...

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

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

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

<sup>E</sup> As-rolled plate specified "suitable for hot forming" shall be furnished from heats of known good hot-malleability characteristics (see X1.2.2). There are no applicable tensile or hardness requirements for such material.

<sup>F</sup> Sheet and strip 0.010 to 0.049 in. (0.25 to 1.2 mm), inclusive, in thickness shall have an elongation of 30 % minimum. Sheet and strip 0.050 to 0.109 in. (1.3 to 2.7 mm), inclusive, in thickness shall have an elongation of 35 % minimum.

<sup>G</sup> Not applicable for thickness under 0.010 in. (0.25 mm).

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

Thickness, in. (mm)	Calculated Diameter of Average Grain Section, max		Corresponding ASTM Micro-Grain Size No.	Rockwell B <sup>A,B</sup> Hardness, max
	mm	in.		
Nickel (UNS N02200) Sheet <sup>C</sup> (56 in. (1420 mm) Wide and Under)				
0.050 (1.3) and less	0.110	0.0043	3.5	64
Over 0.050 to 0.250 (1.3 to 6.4), incl	0.120	0.0047	3.0	64
Nickel (UNS N02200) Strip (12 in. (305 mm) Wide and Under) <sup>D</sup>				
0.005 <sup>E</sup> to 0.010 (0.13 to 0.25), incl	0.025	0.0010	7.5 <sup>F</sup>	70 <sup>F</sup>
Over 0.010 to 0.024 (0.25 to 0.61), incl	0.065	0.0026	5.0	68
Over 0.024 to 0.125 (0.61 to 3.2), incl	0.110	0.0043	3.5	64
Low-Carbon Nickel (UNS N02201) Strip (12 in. (305 mm) Wide and Under) <sup>D</sup>				
0.005 <sup>E</sup> to 0.010 (0.13 to 0.25), incl	0.030	0.0012	7.0 <sup>F</sup>	66 <sup>F</sup>
Over 0.010 to 0.024 (0.25 to 0.61), incl	0.075	0.0030	4.5	64
Over 0.024 to 0.125 (0.61 to 3.2), incl	0.110	0.0043	3.5	64

<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> There are no applicable grain size requirements for low-carbon nickel (UNS N02201) sheet. The hardness of low-carbon nickel (UNS N02201) sheet shall be not over Rockwell B64, or equivalent.

<sup>D</sup> Sheet requirements in Table 4 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>E</sup> For ductility evaluations for strip under 0.005 in. (0.13 mm) in thickness, the spring-back test, such as that described in Test Method F155, is often used and the manufacturer should be consulted.

<sup>F</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.

**7.6 Squareness (Sheet)**—For sheets of all thicknesses, the angle between adjacent sides shall be  $90 \pm 0.15^\circ$  ( $\frac{1}{16}$  in. in 24 in.) (1.6 mm in 610 mm).

**7.7 Flatness:**





TABLE 5 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. 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 (millimetres) 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 (4.8 to 7.9), excl	9.0	10.5	12.0	13.5	15.0	16.5	18.0	...	...	...
5/16 to 3/8 (7.9 to 9.5), excl	7.5	9.0	10.5	12.0	13.5	15.0	16.5	18.0	...	...
3/8 to 7/16 (9.5 to 11.1), 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 (11.1 to 12.7), 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 (12.7 to 15.9), 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 (15.9 to 19.0), 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 (19.0 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 6 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 (51.0 to 76.0), excl	1/16 (1.6)	3/32 (2.4)	7/64 (2.8)	1/8 (3.2)	1/8 (3.2)	9/64 (3.6)
3 to 4 (76.0 to 102.0), incl	5/64 (2.0)	3/32 (2.4)	7/64 (2.8)	1/8 (3.2)	1/8 (3.2)	9/64 (3.6)

TABLE 7 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 (0.46 to 0.64), incl	0.003 (0.08)	0.004 (0.10)	0.002 (0.05)	0.003 (0.08)
Over 0.025 to 0.034 (0.64 to 0.86), incl	0.004 (0.10)	0.005 (0.13)	0.003 (0.08)	0.004 (0.10)
Over 0.034 to 0.043 (0.86 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 2.0), incl	0.007 (0.18)	0.008 (0.20)	0.006 (0.15)	0.007 (0.18)
Over 0.078 to 0.093 (2.0 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 (0.30)	0.008 (0.20)	0.010 (0.25)
Over 0.125 to 0.140 (3.2 to 3.6), incl	0.012 (0.30)	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 (0.30)
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 (0.30)	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, ±			
	Up to 0.050 (1.3), incl		0.0015 (0.04)	
	Over 0.050 to 0.093 (1.3 to 2.4), incl		0.0025 (0.06)	
	Over 0.093 to 0.125 (2.4 to 3.2), incl		0.004 (0.11)	

<sup>A</sup> Measured 3/8 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.

7.7.1 There shall be no flatness requirements for “deep drawing quality,” “spinning quality,” or “as rolled,” sheet and strip (see X1.4).



**TABLE 8 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 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 19.0, excl	9.5	3.2	9.5	3.2	12.7	3.2	15.9	3.2	19.0	3.2
19.0 to 25.4, excl	12.7	3.2	12.7	3.2	15.9	3.2	19.0	3.2	22.2	3.2
25.4 to 31.8, incl	15.9	3.2	15.9	3.2	19.0	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-cut or inert-arc-cut plate shall be as agreed upon between the manufacturer and the purchaser.

<sup>B</sup> Permissible variations in machined, powder-cut, 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. (19.0 mm) 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. (6100 mm), 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.

**TABLE 9 Permissible Variations in Diameter for Circular Plates**

Sheared Plate					
Specified Diameter, in. (mm)	Permissible Variations Over Specified Diameter for Thickness Given in in. (mm) <sup>A</sup>				
	To 3/8 (9.5), incl				
20 to 32 (508 to 813), excl	1/4 (6.4)				
32 to 84 (813 to 2130), excl	5/16 (7.9)				
84 to 108 (2130 to 2740), excl	3/8 (9.5)				
108 to 140 (2740 to 3580), incl	7/16 (11.1)				
Plasma-Torch-Cut Plate <sup>B</sup>					
Specified Diameter, in. (mm)	Permissible Variations in Specified Diameter for Thickness Given in in. (mm) <sup>C</sup>				
	Thickness max, in. (mm)	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 (12.7)	0	5/8 (15.9)	0
20 to 22 (508 to 559), excl	23/4 (69.8)	1/2 (12.7)	0	5/8 (15.9)	0
22 to 24 (559 to 610), excl	21/2 (63.5)	1/2 (12.7)	0	5/8 (15.9)	0
24 to 28 (610 to 711), excl	21/4 (57.3)	1/2 (12.7)	0	5/8 (15.9)	0
28 to 32 (711 to 812), excl	2 (50.8)	1/2 (12.7)	0	5/8 (15.9)	0
32 to 34 (812 to 864), excl	13/4 (44.5)	1/2 (12.7)	0	...	...
34 to 38 (864 to 965), excl	11/2 (38.1)	1/2 (12.7)	0	...	...
38 to 40 (965 to 1020), excl	11/4 (31.8)	1/2 (12.7)	0	...	...
40 to 140 (1020 to 3560), incl	3 (76.2)	1/2 (12.7)	0	5/8 (15.9)	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.

7.7.2 Standard flatness tolerances for plate shall conform to the requirements prescribed in **Table 12**. “Specially flattened”



**TABLE 10 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 (6.4)	all	0.125 (3.2)	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. (1.8 to 3.2 mm), inclusive, in widths 3 in. (76.2 mm) and under, shall have permissible width variations of  $\pm 0.005$  in. ( $\pm 0.130$  mm). Permissible variations for other sizes shall be as agreed upon between the manufacturer and the purchaser.

**TABLE 11 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 11 430), incl		Over 450 to 540 (11 430 to 13 716), incl		Over 540 (13 716)	
	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−
	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	...	...	...	...
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	...	...	...	...
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	...	...
7.9 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	...	...	...	...
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	...	...	...	...
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-cut 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-cut 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 10 160 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.

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

## 8. Workmanship, Finish, and Appearance

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

8.2 *Sheet, Strip, and Plate*—Sheet, strip, and plate supplied in the conditions and finishes as listed in the appendix may be ground or machined to remove surface imperfections, provided such removal does not reduce the material below the minimum specified dimensions. Surface eliminated depressions shall be faired smoothly into the surrounding material. The removal of



**TABLE 12 Permissible Variations From Flatness of Rectangular, Circular, and Sketch Plates**

NOTE 1—Permissible variations apply to plates up to 12 ft (3.66 m) in length, or to any 12 ft of longer plates.

NOTE 2—If the longer dimension is under 36 in. (914 mm), the permissible variation is not greater than ¼ in. (6.4 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.<sup>†A</sup>

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 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	¾	1 1/16	1 ¼	1 3/8	1 5/8	1 5/8	...	...	...
¼ to 3/8, excl	1 1/16	¾	1 5/16	1 1/8	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 ½	1 ¼	1 7/16	1 ¾
½ to ¾, excl	½	9/16	5/8	5/8	1 3/16	1 ½	1 ½	1 ½	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	¾	7/16	½	9/16	5/8	¾	7/8
Millimetres									
4.8 to 6.4, excl	19.0	27.0	31.7	34.9	41.3	41.3	...	...	...
6.4 to 9.5, excl	17.5	19.0	23.8	28.6	35.0	36.5	39.7	47.6	...
9.5 to 12.7, excl	12.7	14.3	17.5	19.0	23.8	28.6	31.7	35.0	44.4
12.7 to 19.0, excl	12.7	14.3	15.9	15.9	20.6	28.6	28.6	28.6	34.9
19.0 to 25.4, excl	12.7	14.3	15.9	15.9	19.0	20.6	23.8	25.4	28.6
25.4 to 50.8, excl	12.7	14.3	14.3	14.3	17.5	17.5	17.5	19.0	25.4
50.8 to 101.6, incl	6.4	7.9	9.5	11.1	12.7	14.3	15.9	19.0	22.2

<sup>A†</sup> Editorially corrected.

a surface imperfection shall be verified by the method originally used to detect the imperfection.

## 9. Sampling

### 9.1 Lot—Definition:

9.1.1 A lot for chemical analysis shall consist of one heat.

9.1.2 A lot for mechanical properties, hardness, and grain size testing shall consist of all material from the same heat, nominal thickness, and condition.

9.1.2.1 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.

### 9.2 Test Material Selection:

9.2.1 *Chemical Analysis*—Representative samples shall be taken during pouring or subsequent processing.

9.2.1.1 Product (check) analysis shall be wholly the responsibility of the purchaser.

9.2.2 *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. (Hardness and grain size required only on the products as specified in [Table 3](#) and [Table 4](#).)

## 10. Number of Tests

10.1 *Chemical Analysis*—One test per lot.

10.2 *Mechanical Properties*—One test per lot.

10.3 *Hardness*—One test per lot. (Required only as specified in [Table 3](#) and [Table 4](#).)

10.4 *Grain Size*—One test per lot. (Required only as specified in [Table 4](#).)

## 11. Specimen Preparation

11.1 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.

11.2 Tension test specimens shall be any of the standard or subsize specimens shown in Test Methods [E8/E8M](#).

11.3 In the event of disagreement, referee specimens shall be as follows:

11.3.1 Full thickness of the material, machined to the form and dimensions shown for the sheet-type specimen in Test Methods [E8/E8M](#) for material under ½ in. (12.7 mm) in thickness.

11.3.2 The largest possible round specimen shown in Test Methods [E8/E8M](#) for material ½ in. (12.7 mm) and over.

## 12. Test Methods

12.1 Determine the chemical composition, mechanical, and other properties of the material as enumerated in this specification, in case of disagreement, in accordance with the following methods:

Test	ASTM Designation
Chemical analysis	<a href="#">E39</a>
Tension	<a href="#">E8/E8M</a>
Brinell hardness	<a href="#">E10</a>
Rockwell hardness	<a href="#">E18</a>
Hardness conversion	<a href="#">E140</a>
Grain size	<a href="#">E112</a>
Rounding procedure	<a href="#">E29</a>



Spring-back

F155

12.2 The measurement of the average grain size may be carried out by the planimetric method, the comparison method, or the intercept method described in Test Methods E112. In case of dispute, the “referee” method for determining the average grain size shall be the planimetric method.

12.3 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 be rounded as indicated, in accordance with the rounding method of Practice E29.

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)

### 13. Inspection

13.1 Inspection of the material shall be as agreed upon between the purchaser and the supplier as part of the purchase contract.

### 14. Rejection and Rehearing

14.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection should be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with the results of the test, the producer or supplier may make claim for a rehearing.

### 15. Certification

15.1 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.

### 16. Product Marking

16.1 Each plate, sheet, or strip shall be marked on one face with the specification number, alloy, condition (temper), heat number, manufacturer’s identification, and size. The markings shall not have a deleterious effect on the material or its performance and shall be sufficiently stable to withstand normal handling.

16.2 When applicable, each bundle or shipping container shall be marked with the name of the material, condition (temper), this specification number, alloy, size, consignor and consignee address, contract or order number, and such other information as may be defined in the contract or order.

## APPENDIX

### (Nonmandatory Information)

#### X1. CONDITIONS AND FINISHES

##### X1.1 Scope

X1.1.1 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.

##### X1.2 Plate, Hot-Rolled

X1.2.1 *Annealed*—Soft with an oxide surface, and suitable for heavy cold forming. Available with a descaled surface, when so specified.

X1.2.2 *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.

##### X1.3 Plate, Cold-Rolled

X1.3.1 *Annealed*—Soft with an oxide surface; available with a descaled surface when so specified.

##### X1.4 Sheet, Hot-Rolled

X1.4.1 *Annealed and Pickled*—Soft with a pickled matte finish. Properties similar to X1.5.1 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.

##### X1.5 Sheet and Strip, Cold-Rolled

X1.5.1 *Annealed*—Soft with a pickled or bright annealed finish.

X1.5.2 *Deep-Drawing or Spinning Quality*—Similar to X1.5.1, except furnished to controlled hardness and grain size and lightly leveled.

X1.5.3 *Skin Hard*—Similar to X1.5.1, but given a light cold reduction to hardness range shown in Table 3.

X1.5.4 *Quarter-Hard*—Cold rolled to the hardness range indicated in Table 3, bright finish. Out-of-flatness must be expected and will vary with temper and thickness.



X1.5.5 *Half-Hard*—Cold rolled to the hardness range indicated in **Table 3**, bright finish. Out-of-flatness must be expected and will vary with temper and thickness.

X1.5.6 *Three-Quarter Hard*—Cold rolled to the hardness range indicated in **Table 3**, bright finish. Out-of-flatness must be expected and will vary with temper and thickness.

X1.5.7 *Hard*—Cold rolled to the tensile requirements indicated in **Table 3**, bright finish. Out-of-flatness must be expected and will vary with temper and thickness.

X1.5.8 *Spring Temper*—Cold rolled to the minimum hardness indicated in **Table 3**, bright finish. Out-of-flatness must be expected and will vary with temper and thickness.

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Fax: +1.610.832.9555  
[service@astm.org](mailto:service@astm.org)  
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Corporate Communications  
Tel: +610.832.9603