



Designation: B 162 – 99

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

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

### 1. Scope

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

1.2 The values stated in inch-pound units are to be regarded as the standard. The other values given are for information only.

### 2. Referenced Documents

#### 2.1 ASTM Standards:

B 160 Specification for Nickel Rod and Bar<sup>3</sup>

B 880 General Requirements for Chemical Check Analysis of 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 39 Test Methods for Chemical Analysis of Nickel<sup>6</sup>

E 112 Test Methods for Determining the Average Grain Size<sup>4</sup>

E 140 Hardness Conversion Tables for Metals<sup>4</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:

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.

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

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee B-2 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.

\* New designation established in accordance with ASTM E527 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 03.05.

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

**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	...
Carbon, max	...	0.02
Silicon, max	0.35	0.35
Sulfur, max	0.01	0.01

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

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 ASTM B 880 and the material shall conform to the product (check) analysis variations defined in Table 1 of ASTM B 880.

## 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.

**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>
Nickel (UNS N02200) Hot-Rolled Plate				
Annealed	55 000 (380)	15 000 (100)	40	...
As-rolled <sup>D,E</sup>	55 000 (380)	20 000 (135)	30	...
Nickel (UNS N02200) Hot-Rolled Sheet				
Annealed	55 000 (380)	15 000 (100)	40 <sup>F</sup>	...
Nickel (UNS N02200) Cold-Rolled Sheet				
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	...
Nickel (UNS N02200) Cold-Rolled Strip				
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
Low-Carbon Nickel (UNS N02201) Hot-Rolled Plate				
Annealed	50 000 (345)	12 000 (80)	40	...
As-rolled <sup>D,E</sup>	50 000 (345)	12 000 (80)	30	...
Low-Carbon Nickel (UNS N02201) Hot-Rolled Sheet				
Annealed	50 000 (345)	12 000 (80)	40 <sup>F</sup>	...
Low-Carbon Nickel (UNS N02201) Cold-Rolled Sheet				
Annealed	50 000 (345)	12 000 (80)	40 <sup>F</sup>	...
Low-Carbon Nickel (UNS N02201) Cold-Rolled Strip				
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 E 140.

<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 E 140.

<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 F 155, 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.

**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>4</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.

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 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:**

**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)	3/64 (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)	3/64 (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  $\frac{3}{16}$  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.

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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.

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:**

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

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