



Designation: B 536 – 02

## Standard Specification for Nickel-Iron-Chromium-Silicon Alloys (UNS N08330 and N08332) Plate, Sheet, and Strip<sup>1</sup>

This standard is issued under the fixed designation B 536; 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.

### 1. Scope

1.1 This specification covers nickel-iron-chromium silicon alloys (UNS N08330 and UNS N08332)\* plate, sheet, and strip intended for heat resisting applications and general corrosive service.

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.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to become familiar with all hazards including those identified in the appropriate Material Safety Data Sheet for this product/material as provided by the manufacturer, to establish appropriate safety and health practices, and determine the applicability of regulatory limitations prior to use.*

### 2. Referenced Documents

#### 2.1 ASTM Standards:

- B 880 Specification for General Requirements for Chemical Check Analysis Limits for Nickel, Nickel Alloys, and Cobalt Alloys<sup>2</sup>
- E 8 Test Methods for Tension Testing of Metallic Materials<sup>3</sup>
- E 10 Test Method for Brinell Hardness of Metallic Materials<sup>3</sup>
- E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials<sup>3</sup>
- E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications<sup>4</sup>
- E 112 Test Methods for Determining the Average Grain Size<sup>3</sup>
- E 140 Hardness Conversion Tables for Metals<sup>3</sup>

E 1473 Test Methods for Chemical Analysis of Nickel, Cobalt, and High-Temperature Alloys<sup>5</sup>

### 3. Terminology

#### 3.1 Definitions of Terms Specific to This Standard:

- 3.1.1 *plate*—material  $\frac{3}{16}$  in. (4.76 mm) and over in thickness and over 10 in. (254 mm) in width.
- 3.1.2 *sheet*—material under  $\frac{3}{16}$  in. (4.76 mm) in thickness and 24 in. (610 mm) and over in width.
- 3.1.3 *strip*—material under  $\frac{3}{16}$  in. (4.76 mm) in thickness and under 24 in. (610 mm) in width.

### 4. Ordering Information

4.1 It is the responsibility of the purchaser to specify all requirements that are necessary for material ordered to this specification. Examples of such requirements include, but are not limited to, the following:

- 4.1.1 *Quantity* (weight or number of pieces),
- 4.1.2 *Alloy* (Table 1),
- 4.1.3 *Form* (plate, sheet, or strip),
- 4.1.4 ASTM designation and year of issue,
- 4.1.5 *Dimensions*—Thickness, width, and length,
- 4.1.6 *Edge* (for strip only),
- 4.1.7 *Finish* (Appendix) for sheet specify whether one or both sides are to be polished,
- 4.1.8 *Certification*—State if certification is required (Section 15),
- 4.1.9 *Samples for Product (Check) Analysis*—State whether samples for product (check) analysis should be furnished, and
- 4.1.10 *Purchaser Inspection*—If purchaser wishes to witness tests or inspections of material at place of manufacture, the purchase order must so state indicating which tests or inspections are to be witnessed.

### 5. Chemical Composition

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

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

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

<sup>2</sup> *Annual Book of ASTM Standards*, Vol 02.04.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 03.01.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 14.02.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 03.05.

**TABLE 1 Mechanical Properties**

Alloy	Condition	Tensile Strength, min, psi (MPa)	Yield Strength, 0.2 % offset, min, psi (MPa)	Elongation in 2 in. or 50 mm, or 4D, min, %	Hardness <sup>A</sup>
UNS N08330	annealed	70 000 (483)	30 000 (207)	30	70 to 90 HRB
UNS N08332	annealed	67 000 (462)	27 000 (186)	30	65 to 88 HRB

<sup>A</sup>Hardness values are informative only and not to be constructed as the basis for acceptance.

**TABLE 2 Chemical Requirements**

Element	Composition Limits, %
C	... <sup>A</sup>
Mn	2.00 max
P	0.03 max
S	0.03 max
Si	0.75–1.50
Cr	17.0–20.0
Ni	34.0–37.0
Cu	1.00 max
Pb	0.005 max
Sn	0.025 max
Fe	remainder <sup>B</sup>

<sup>A</sup> Alloy UNS N08330: 0.08 max

Alloy UNS N08332: 0.05–0.10

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

**TABLE 4 Permissible Variations in Width and Length for Hot-Rolled and Cold-Rolled Resquared Sheets (Stretcher Leveled Standard of Flatness)**

Specified Dimensions, in. (mm)	Tolerances		
	Over		Under
	in.	mm	
For thicknesses under 0.131 (3.33):			
Widths up to 48 (1219) excl	1/16	1.6	0
Widths 48 (1219) and over	1/8	3.2	0
Lengths up to 120 (3048) excl	1/16	1.6	0
Lengths 120 (3048) and over	1/8	3.2	0
For thicknesses 0.131 (3.33) and over:			
All widths and lengths	1/4	6.4	0

**TABLE 5 Width, Length, and Camber Tolerances for Hot-Rolled and Cold-Rolled Sheets not Resquared or Stretcher Leveled Width Tolerances**

Specified Thickness, in. (mm)	Tolerance for Specified Width, in. (mm)	
	24 to 48 (610 to 1220), excl	48 in., (1220) and over
Less than 3/16 in. (4.76)	1/16 (1.6) over, 0 under	1/8 in. (3.2) over, 0 under
Length Tolerances		
Specified Length, ft (cm)	Tolerance, in. (mm)	
	Over	Under
Up to 10 (305), incl	1/4 (6.4)	0 (0)
Over 10 to 20 (305 to 610), incl	1/2 (12.7)	0 (0)
Camber Tolerances <sup>A</sup>		
Specified Width, in. (mm)	Tolerance per Unit Length of any 8 ft (244 cm), in. (mm)	
24 to 36 in. (610 to 914), incl	1/8 (3.2)	
Over 36 in. (914)	3/32 (2.4)	

<sup>A</sup>Camber is the greatest deviation of a side edge from a straight line, and measurement is taken by placing an 8-ft (2440-mm) straightedge on the concave side and measuring the greatest distance between the sheet edge and the straightedge.

## 6. Mechanical and Other Properties

6.1 The tensile properties of the material at room temperature shall conform to those shown in Table 1.

6.2 *Grain Size*—Annealed alloy UNS N08332 shall conform to an average grain size of ASTM No. 5 or coarser.

6.3 *Annealing Temperature*—Alloy UNS N08330 shall be annealed at 1900°F (1040°C) minimum. Alloy UNS N08332 shall be annealed at 2100°F (1150°C) minimum.

## 7. Permissible Variations in Dimensions and Weight

7.1 *Sheet*, shall conform to the variations in dimensions specified in Tables 3-8, inclusive.

7.2 *Cold-Rolled Strip*, shall conform to the permissible variations in dimensions as specified in Tables 9-13, inclusive.

7.3 *Plate*, shall conform to the permissible variations in dimensions specified in Tables 14-20, inclusive.

**TABLE 3 Thickness Tolerances for Hot-Rolled and Cold-Rolled Sheets**

Specified Thickness, in. (mm)	Tolerance Over and Under, in. (mm)
Over 0.145 to less than 3/16 (3.68 to less than 4.76)	0.014 (0.36)
Over 0.130 to 0.145 (3.30 to 3.68), incl	0.012 (0.30)
Over 0.114 to 0.130 (2.90 to 3.30), incl	0.010 (0.25)
Over 0.098 to 0.114 (2.49 to 2.90), incl	0.009 (0.23)
Over 0.083 to 0.098 (2.11 to 2.49), incl	0.008 (0.20)
Over 0.072 to 0.083 (1.83 to 2.11), incl	0.007 (0.18)
Over 0.058 to 0.072 (1.47 to 1.83), incl	0.006 (0.15)
Over 0.040 to 0.058 (1.02 to 1.47), incl	0.005 (0.13)
Over 0.026 to 0.040 (0.66 to 1.02), incl	0.004 (0.10)
Over 0.016 to 0.026 (0.41 to 0.66), incl	0.003 (0.08)
Over 0.007 to 0.016 (0.18 to 0.41), incl	0.002 (0.05)
Over 0.005 to 0.007 (0.13 to 0.18), incl	0.0015 (0.04)
0.005 (0.13)	0.001 (0.03)

7.4 *Sheet, Strip, and Plate*—Material with No. 1 finish may be ground to remove surface defects, provided such grinding does not reduce the thickness, width or length at any point beyond the permissible variations in dimensions.

## 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.

## 9. Sampling

9.1 *Lot*—Definition:

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

**TABLE 6 Flatness Tolerances for Hot-Rolled and Cold-Rolled Sheets**

Sheets not Specified to Stretcher Leveled Standard of Flatness

Specified Thickness, in. (mm)	Width, in. (mm)	Flatness Tolerance (max Deviation from a Horizontal Flat Surface), in. (mm)
0.062 (1.57) and over	To 60 (1524), incl	1/2 (12.7)
	Over 60 to 72 (1524 to 1829), incl	3/4 (19.1)
	Over 72 (1829)	1 (25.4)
Under 0.062 (1.57)	To 36 (914), incl	1/2 (12.7)
	Over 36 to 60 (914 to 1524), incl	3/4 (19.1)
	Over 60 (1524)	1 (25.4)

Sheets Specified to Stretcher Level Standard of Flatness

Specified Thickness in. (mm)	Width, in. (mm)	Length, in. (mm)	Flatness tolerance in. (mm)
Under 3/16 (4.76)	To 48 (1220), incl	To 96 (2440), incl	1/8 (3.2)
Under 3/16 (4.76)	To 48 (1220), incl	Over 96 (2440)	1/4 (6.4)
Under 3/16 (4.76)	Over 48 (1220)	To 96 (2440), incl	1/4 (6.4)
Under 3/16 (4.76)	Over 48 (1220)	Over 96 (2440)	1/4 (6.4)

**TABLE 7 Diameter Tolerances for Hot-Rolled and Cold-Rolled Sheets, Sheared Circles**

Specified Thickness, in. (mm)	Tolerance Over Specified Diameter (No Tolerance Under) in. (mm)		
	Under 30 (760)	30 to 48 (760 to 1220), incl	Over 48 (1220)
Over 0.097 (2.46)	1/8 (3.2)	3/16 (4.8)	1/4 (6.4)
Over 0.057 to 0.097 (1.45 to 2.46), incl	3/32 (2.4)	5/32 (4.0)	7/32 (5.6)
0.057 (1.45) and under	1/16 (1.6)	1/8 (3.2)	3/16 (4.8)

**TABLE 8 Weight Tolerances for Hot-Rolled and Cold-Rolled Sheets**

It is not practicable to produce hot-rolled and cold-rolled sheets to exact theoretical weight. Sheets of any one item of a specified thickness and size in any finish may be overweight to the following extent:

- (1) An item of five sheets or less, or an item estimated to weigh 200 lb (90 kg) or less, may actually weigh as much as 10 percent over the theoretical weight.
- (2) An item of more than five sheets and estimated to weigh more than 200 lb (90 kg) may actually weigh as much as 7 1/2 percent over the theoretical weight.
- (3) The underweight variations for sheets are limited by the under thickness tolerances shown in Table 3.

For determining theoretical weight the factor, 42 lb/ft<sup>2</sup>-in. (0.0008 kg/cm<sup>2</sup>-mm) thickness may be used.

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 that for plates weighing over 500 lb only one specimen shall be taken.

## 9.2 Test Material Selection:

9.2.1 *Chemical Analysis*—Representative samples from each lot 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 and Grain Size*—Samples of the material to provide specimens for mechanical properties and grain size shall be taken from such locations in each lot as to be representative of that lot.

## 10. Number of Tests

10.1 *Chemical Analysis*—One test per lot.

10.2 *Grain Size*—One test per lot.

10.3 *Tensile Properties and Hardness Test*—One test per lot.

## 11. Specimen Preparation

11.1 Tension test, hardness test, and grain size specimens shall be taken from material in the final condition (temper). Tension tests shall be transverse to the direction of rolling, where width will permit.

11.2 Tension test specimens shall be any of the standard or subsized specimens shown in Test Methods E 8.

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

11.3.1 Full thickness of the material, machine to the form and dimensions shown for the sheet-type specimen in Test Methods E 8 for material under 1/2 in. (12.7 mm) in thickness.

11.3.2 The largest possible round specimen shown in Test Methods E 8 for material 1/2 in. (12.7 mm) and over.

## 12. Methods of Test

12.1 *Chemical Composition*—In case of disagreement, the chemical composition shall be determined in accordance with Test Methods E 1473.

12.2 *Tension Test*—Tension testing shall be conducted in accordance with Test Methods E 8.

12.3 *Grain Size*—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.

12.4 *Rockwell Hardness*—Test Methods E 18.

12.5 *Brinell Hardness*—Test Method E 10.

**TABLE 9 Thickness Tolerances for Cold-Rolled Strip in Coils and Cut Lengths**

NOTE 1—Thickness measurements are taken at least 3/8 in. (9.5 mm) in from edge of the strip, except that on widths less than 1 in. (25.4 mm) the tolerances are applicable for measurements at all locations.

NOTE 2—Above tolerances include crown.

Specified thickness, in. (mm), incl	Thickness Tolerances, in. (mm), for the Thicknesses and Widths given, over and under		
	Width, in. (mm)		
	3/16 (4.8) to 6 (152), incl	Over 6 (152) to 12 (305), incl	Over 12 (305) to 24 (610), excl
0.005 (0.13) to 0.010 (0.25)	10 %	10 %	10 %
Over 0.010 (0.25) to 0.011 (0.28)	0.0015 (0.04)	0.0015 (0.04)	0.0015 (0.04)
Over 0.011 (0.28) to 0.013 (0.33)	0.0015 (0.04)	0.0015 (0.04)	0.002 (0.05)
Over 0.013 (0.33) to 0.017 (0.43)	0.0015 (0.04)	0.002 (0.05)	0.002 (0.05)
Over 0.017 (0.43) to 0.020 (0.51)	0.0015 (0.04)	0.002 (0.05)	0.0025 (0.06)
Over 0.020 (0.51) to 0.029 (0.74)	0.002 (0.05)	0.0025 (0.06)	0.0025 (0.06)
Over 0.029 (0.74) to 0.035 (0.89)	0.002 (0.05)	0.003 (0.08)	0.003 (0.08)
Over 0.035 (0.89) to 0.050 (1.27)	0.0025 (0.06)	0.0035 (0.09)	0.0035 (0.09)
Over 0.050 (1.27) to 0.069 (1.75)	0.003 (0.08)	0.0035 (0.09)	0.0035 (0.09)
Over 0.069 (1.75) to 0.100 (2.54)	0.003 (0.08)	0.004 (0.10)	0.005 (0.13)
Over 0.100 (2.54) to 0.125 (3.18)	0.004 (0.10)	0.0045 (0.11)	0.005 (0.13)
Over 0.125 (3.18) to 0.161 (4.09)	0.0045 (0.11)	0.0045 (0.11)	0.005 (0.13)
Over 0.161 (4.09) to 3/16 (4.76) excl	0.005 (0.13)	0.005 (0.13)	0.006 (0.15)

**TABLE 10 Width Tolerances Cold-Rolled Strip in Coils and Cut Lengths, Edge Numbers 1 and 5**

Specified Edge No.	Width, in. (mm)	Thickness, in. (mm)	Width Tolerance, in. (mm) for Thickness and Width given over and under
1 and 5	3/32 (7.1) and under	1/16 (1.6) and under	0.005 (0.13)
1 and 5	Over 3/32 (7.1) to 3/4 (19.1) incl	3/32 (2.4) and under	0.005 (0.13)
1 and 5	Over 3/4 (19.1) to 5 (127) incl	1/8 (3.2) and under	0.005 (0.13)
5	Over 5 (127) to 9 (229) incl	1/8 (3.2) to 0.008 (0.20) incl	0.010 (0.25)
5	Over 9 (229) to 20 (508) incl	0.105 (2.67) to 0.015 (0.38) incl	0.010 (0.25)
5	Over 20 (508) to 24 (610) excl	0.080 (2.03) to 0.023 (0.58) incl	0.015 (0.38)

**TABLE 11 Width Tolerances Cold-Rolled Strip in Coils and Cut Lengths Edge Number 3**

Specified Thickness in. (mm)	Width Tolerance, in. (mm) Over and Under, for Thickness and Width Given					
	Under 1/2 (12.7) to 3/16 (4.8)	1/2 (12.7) to 6 (152)	Over 6 (152) to 9 (229)	Over 9 (229) to 12 (305)	Over 12 (305) to 20 (508)	Over 20 (508) to 24 (610)
0.068 (1.73) and under	0.005 (0.13)	0.005 (0.13)	0.005 (0.13)	0.010 (0.25)	0.016 (0.41)	0.020 (0.51)
Over 0.068 (1.75) to 0.099 (2.51), incl	0.008 (0.20)	0.008 (0.20)	0.010 (0.25)	0.010 (0.25)	0.016 (0.41)	0.020 (0.51)
Over 0.099 (2.51) to 0.160 (4.06), incl	0.010 (0.25)	0.010 (0.25)	0.016 (0.41)	0.016 (0.41)	0.020 (0.51)	0.020 (0.51)
Over 0.160 (4.06) to under 3/16 (4.76) excl	...	0.016 (0.41)	0.020 (0.51)	0.020 (0.51)	0.031 (0.79)	0.031 (0.79)

**TABLE 12 Length Tolerances Cold-Rolled Strip in Cut Lengths**

Specified Length, in. (mm)	Tolerance, in. (mm) over Specified Length, No Tolerance Under,
Up to 60 (1524) incl	3/8 (9.5)
Over 60 (1524) to 120 (3048) incl	1/2 (12.7)
Over 120 (3048) to 240 (6096) incl	5/8 (15.9)

**TABLE 13 Camber Tolerances Cold-Rolled Strip in Coils and Cut Lengths**

NOTE 1—Camber is the deviation of a side edge from a straight line, and measurement is taken by placing an 8-ft (24-mm) straight edge on the concave side and measuring the greatest distance between the strip edge and the straight edge.

Specified Width, in. (mm)	Tolerance in. (mm) per unit length of any 8 ft. (2440 mm)
Up to 1 1/2 (38.1) incl	1/2 (12.7)
Over 1 1/2 (38.1) to 24 (609.6) excl	1/4 (6.4)

12.6 *Hardness Conversion*—Hardness Conversion Tables E 140.

12.7 *Rounding Method*—For purposes of determining compliance with the limits in this specification, an observed value or a calculated value shall be rounded off as indicated below, in accordance with the rounding-off method of Practice E 29: