



Designation: B599 – 92 (Reapproved2009)^{ε1}

Standard Specification for Nickel-Iron-Chromium-Molybdenum-Columbium Stabilized Alloy (UNS N08700) Plate, Sheet, and Strip¹

This standard is issued under the fixed designation B599; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

^{ε1} NOTE—An editorial correction was made in 1.1 in April 2009.

1. Scope

1.1 This specification covers nickel-iron-chromium-molybdenum-columbium stabilized alloy (UNS N08700)* plate, sheet, and strip in the solution-annealed condition.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to become familiar with all hazards including those identified in the appropriate Material Safety Data Sheet (MSDS) 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:²

A262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels

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

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* New designation established in accordance with ASTM E527 and SAE J1086, Practice for Numbering Metals and Alloys (UNS).

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

E55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition

E140 Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, and Scleroscope Hardness

E350 Test Methods for Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron

E353 Test Methods for Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 The terms plate, sheet, and strip as used in this specification are described as follows:

3.1.2 *plate, n*—material 0.1875 in. (4.76 mm) and over in thickness and over 10 in. (254 mm) in width.

3.1.3 *sheet, n*—material under 0.1875 in. (4.76 mm) in thickness and over 24 in. (610 mm) in width.

3.1.4 *strip, n*—material under 0.1875 in. (4.76 mm) in thickness and under 24 in. (610 mm) in width.

4. Ordering Information

4.1 Orders for material under this specification should include the following information:

4.1.1 Quantity (weight or number of pieces).

4.1.2 Name of material or UNS N08700.

4.1.3 Form (plate, sheet, or strip).

4.1.4 Dimensions.

4.1.5 Type of edge required (for strip only, see 9.4).

4.1.6 *Finish* (Section 10)—For sheet ordered with No. 4 finish, specify whether one or both sides are to be polished.

4.1.7 ASTM designation and year of issue.

4.1.8 *Corrosion Test*—State if intergranular corrosion test is required (Section 8).

4.1.9 *Marking*—State if metal die identification is required on plate ¼ in. (6.35 mm) or thicker (Section 17).

TABLE 1 Chemical Requirements

| Element | Composition, % |
|-----------------|------------------------|
| Nickel | 24.0–26.0 |
| Iron | remainder ^A |
| Chromium | 19.0–23.0 |
| Molybdenum | 4.3–5.0 |
| Columbium | 8 × carbon to 0.40 |
| Carbon, max | 0.04 |
| Silicon, max | 1.00 |
| Manganese, max | 2.00 |
| Phosphorus, max | 0.040 |
| Sulfur, max | 0.030 |
| Copper, max | 0.50 |

^A Determined arithmetically by difference.

TABLE 2 Product (Check) Analysis

| Element | Tolerances Over the Maximum |
|------------|-------------------------------------|
| | Limit or Under the Minimum Limit, % |
| Nickel | 0.20 |
| Chromium | 0.20 |
| Molybdenum | 0.10 |
| Columbium | 0.05 |
| Carbon | 0.01 |
| Silicon | 0.05 |
| Manganese | 0.04 |
| Phosphorus | 0.005 |
| Sulfur | 0.005 |
| Copper | 0.03 |

4.1.10 *Certification or Test Reports*—State if certification or test reports are required (Section 16).

5. Materials and Manufacture

5.1 *Heat Treatment*—The final heat treatment shall be a solution anneal. Minor cold working such as flattening or temper rolling may be performed after the final solution annealing treatment.

NOTE 1—This recommended solution anneal consists of heating to a minimum temperature of 2000°F (1090°C) and cooling rapidly to room temperature.

6. Chemical Composition

6.1 The material sampled, in accordance with 11.2, shall conform to the composition limits prescribed in Table 1.

6.2 If a product analysis is subsequently made, the material shall conform to the composition limits with the product analysis variation prescribed in Table 2.

7. Mechanical Requirements

7.1 The material shall conform to the requirements as to the mechanical property prescribed in Table 3.

TABLE 3 Mechanical Property Requirements

| Form | Tensile Strength, min, ksi (MPa) | Yield Strength (0.2% offset), min, ksi (MPa) | Elongation in 2 in. or 50 mm, or 4D, min, % | Rockwell Hardness (or equivalent) ^A |
|-------|----------------------------------|--|---|--|
| Sheet | 80 (550) | 35 (240) | 30 | 75–90 HRB |
| Strip | 80 (550) | 35 (240) | 30 | 75–90 HRB |
| Plate | 80 (550) | 35 (240) | 30 | 75–90 HRB |

^A Hardness values are shown for information only and shall not constitute a basis for acceptance or rejection as long as the other mechanical properties are met.

8. Intergranular Corrosion Test

8.1 All material supplied to this specification shall be capable of passing the intergranular corrosion test, but the test need not be performed on any given lot unless it is specified on the purchase order. If the test is specified, it shall be performed by the manufacturer on specimens taken in the as-shipped condition. Specimens shall be tested in the sensitized condition (1 h at 1250°F (677°C)), and tested in accordance with Practice C of Practices A262. The corrosion rate shall not exceed 2.5 mils/month (165 mg/dm²·day).

9. Dimensions and Permissible Variations

9.1 *Sheet*—The material referred to as sheet shall conform to the variations in dimensions prescribed in Tables 4-9, inclusive.

9.2 *Cold-Rolled Strip*—The material referred to as cold-rolled strip shall conform to the permissible variations in dimensions prescribed in Tables 10-13, inclusive.

9.3 *Plate*—The material referred to as plate shall conform to the permissible variations in dimensions prescribed in Tables 14-20, inclusive.

9.4 Edges for Cold-Rolled Strip:

9.4.1 The various types of edges procurable shall be as follows:

9.4.1.1 *No. 1 Edge*—Rolled edge, contour as specified.

9.4.1.2 *No. 3 Edge*—An edge produced by slitting.

9.4.1.3 *No. 5 Edge*—Approximately square edge produced by rolling or filing, or both, after slitting.

10. Workmanship, Finish, and Appearance

10.1 The material shall be free of injurious imperfections and shall correspond to the designated finish as described as follows:

10.1.1 *Sheet*—The various types of finish procurable on sheet products shall be as follows:

10.1.1.1 *No. 1 Finish*—Hot rolled, annealed, and descaled; produced by hot rolling to specified thicknesses followed by annealing and descaling (see 10.2).

10.1.1.2 *No. 2D Finish*—Dull, cold-rolled finish; produced by cold rolling to the specified thickness, annealing, and descaling. The dull finish results from the descaling and pickling operations.

10.1.1.3 *No. 2B Finish*—Bright, cold-rolled finish; produced by giving a final light cold-rolled pass with polished rolls, to a sheet that has been annealed and descaled.

10.1.1.4 *No. 4 Finish*—General-purpose polished finish. Following initial grinding with coarser abrasives, sheets are generally finished last with abrasives approximately 120 to 150

TABLE 4 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 0.1875 (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) |

TABLE 5 Width and Length Tolerances for Hot-Rolled and Cold-Rolled Resquared Sheets (Stretcher Leveled Flatness)

| Specified Dimensions, in. (mm) | Tolerance, in. (mm) | |
|--|---------------------|-------|
| | Over | Under |
| For thicknesses under 0.031 (0.79): | | |
| 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 0.031 (0.79) and over: | | |
| All widths and lengths | 1/4 (6.4) | 0 |

TABLE 6 Width, Length, and Camber Tolerances for Hot-Rolled and Cold-Rolled Sheets Not Resquared

| Width Tolerances | | |
|------------------------------------|---|---------------|
| Specified Thickness, in. (mm) | Tolerance for Specified Width, in. (mm) | |
| | 24 to 48 (610 to 48 (1219) and 1219), excl | Over |
| Less than 3/16 (4.76) | 1/16 (1.6) over, | 1/8 in. (3.2) |
| | 0 under | over, |
| | | 0 under |
| Length Tolerances | | |
| Specified Length, ft (mm) | Tolerance, in. (mm) | |
| | Over | Under |
| Up to 10 (3050), incl | 1/4 (6.4) | 0 (0) |
| Over 10 to 20 (3050 to 6100), incl | 1/2 (12.7) | 0 (0) |
| Camber Tolerances ^A | | |
| Specified Width, in. (mm) | Tolerance per Unit Length of any 8 ft (2440 mm), in. (mm) | |
| | 24 to 36 (610 to 914), incl | 1/8 (3.2) |
| Over 36 (914) | 3/32 (2.4) | |

^A 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.

mesh. Sheets can be produced with one or two sides polished. When polished on one side only, the other side may be rough ground in order to obtain the necessary flatness.

10.1.1.5 *Bright Annealed*—Bright finish produced by cold rolling to thickness, then annealing in a protective atmosphere.

10.1.2 *Strip*—The type of finish procurable on cold-rolled strip shall be as follows:

10.1.2.1 *No. 1 Finish*—Cold rolled to specified thickness, annealed, and pickled (see 10.2). Appearance of this finish is a dull gray.

10.1.2.2 *No. 2 Finish*—Same as No. 1 finish, followed by a final light cold-rolled pass, generally on highly polished rolls.

10.1.2.3 *Bright Annealed*—Bright finish produced by cold rolling to thickness, then annealing in a protective atmosphere.

10.1.3 *Plate*—The types of finish procurable on plates shall be as follows:

10.1.3.1 *Hot- or Cold-Rolled, Annealed*—Scale not removed (see 10.2).

10.1.3.2 *Hot- or Cold-Rolled, Annealed, Descaled*—Scale removed by a blast cleaning or pickling operation (see 10.2).

10.2 Spot grinding to remove surface imperfections is permitted for material produced in accordance with 10.1.1.1, 10.1.2.1, 10.1.3.1, and 10.1.3.2, provided such grinding does not reduce the thickness or width at any point beyond the permissible variations in dimensions.

11. Sampling

11.1 *Lots of Chemical Analysis, Mechanical Testing, and Corrosion Testing:*

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

11.1.2 *Plate*—A lot of plate for testing and inspection purposes shall consist of the products resulting from the rolling of one heat of material in the same condition and specified thickness, solution annealed by the same practice, but in no case more than 25 000 lb (11 340 kg).

11.1.3 *Sheet and Strip*—A lot of sheet or strip for testing and inspection purposes shall consist of material from one heat in the same form (sheet or strip), condition, finish, and specified thickness, solution annealed by the same practice but in no case more than 25 000 lb (11 340 kg).

11.2 *Sampling for Chemical Analysis:*

11.2.1 A representative sample shall be taken from each lot during pouring or subsequent processing.

11.2.2 Product analysis, if performed, shall be wholly the responsibility of the purchaser.

11.3 *Sampling for Mechanical Tests:*

11.3.1 A sample of the material to provide test specimens for mechanical tests shall be taken from such a location in each lot as to be representative of that lot.

11.3.2 When samples are to be taken after delivery, the purchaser of material ordered to cut lengths may request on the purchase order additional material of adequate size to provide sample coupons for inspection purposes.

11.4 *Sampling for Corrosion Tests*—A sample for corrosion testing shall be taken from a location chosen to be representative of the lot.

12. Number of Tests and Retests

12.1 In the case of sheet or strip supplied in coil form, two or more tension tests (one from each end of each coil), and one or more hardness tests shall be made on specimens taken from each end of the coil. When material is supplied in flat sheet, flat strip, or plate, one tension and one or more hardness tests shall be made on each 100 or less sheets, strips, or plates of the same lot. When specified, one corrosion test shall be conducted for each lot.

TABLE 7 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) | |
| Under 0.062 (1.57) | over 72 (1829) | 1 (25.4) | |
| | 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 (4.76) | to 48 (1219), incl | to 96 (2438), incl | 1/8 (3.2) |
| Under 3/16 (4.76) | to 48 (1219), incl | over 96 (2438) | 1/4 (6.4) |
| Under 1/8 (4.76) | over 48 (1219) | to 96 (2438), incl | 1/4 (6.4) |
| Under 3/16 (4.76) | over 48 (1219) | over 96 (2438) | 1/4 (6.4) |

TABLE 8 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 (762) | 30 to 48 (762 to 1219), incl | Over 48 (1219) |
| 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 9 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 weight 200 lb (90.7 kg) or less, may actually weigh as much as 10 % over the theoretical weight.

(2) An item of more than five sheets and estimated to weigh more than 200 lb (90.7 kg) may actually weigh as much as 7 1/2 % over the theoretical weight.

(3) The underweight variations for sheets are limited by the under thickness tolerances shown in **Table 4**.

For determining theoretical weight the factor, 42 lb/ft²-in. (0.0008 kg/cm²-mm) thickness may be used.

12.2 If any specimens selected to represent any lot fail to meet any of the test requirements, the material represented by such specimens may be retested. If there is valid reason to believe the result is not representative, the material may be re-annealed and retested.

13. Specimen Preparation

13.1 Tension test specimens from material under 1/2 in. (12.7 mm) in thickness shall be of the full thickness of the material and machined to the form and dimensions shown for the sheet-type specimen in Test Methods **E8/E8M**. Tension test specimens from material 1/2 in. (12.7 mm) and over shall be of the full thickness of the material, machined to the form and dimensions shown for the plate-type specimen in Test Methods **E8/E8M**, or shall be the largest possible round specimen shown in Test Methods **E8/E8M**. Tension test specimens shall be

taken from material after final heat treatment and shall be selected in the transverse direction unless prohibited by width.

13.2 Corrosion test specimens shall be prepared so that at least one major surface represents the as-supplied surface, with only light surface grinding permitted on this surface.

14. Test Methods

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

| Test | ASTM Designations |
|---|---------------------------------|
| Chemical analysis | E350, E353^{A,B} |
| Tension | E8/E8M |
| Brinell hardness | E10 |
| Rockwell hardness | E18 |
| Hardness conversion | E140 |
| Rounding procedure | E29 |
| Method of sampling for product analysis | E55 |
| Intergranular corrosion test | A262, Practice C |

^A Iron shall be determined arithmetically by difference.

^B Test Methods **E350** are to be used only for elements not covered by Test Methods **E353**.

14.2 For purpose of determining compliance with the limits in this specification, an observed value or a calculated value shall be rounded as indicated in accordance with the rounding method of Practice **E29**.

| Requirements | Rounded Unit for Observed or Calculated Value |
|--|---|
| Chemical composition hardness and tolerance (when expressed in decimals) | Nearest unit in the last right-hand place of figures of the specified limit |
| Tensile strength and yield strength | nearest 1000 psi (7 MPa) |
| Elongation | nearest 1 % |

15. Rejection and Rehearing

15.1 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.

16. Certification

16.1 When specified in the purchase order or contract, a manufacturer’s certification shall be furnished to the purchaser