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AMERICAN SOCIETY FOR TESTING AND MATERIALS

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Standard Specification for NICKEL-CHROMIUM-MOLYBDENUM-IRON- COLUMBIUM SHEET AND PLATE¹

This Standard is issued under the fixed designation B 436; 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 approval.

1. Scope

1.1 This specification² covers corrosion-resistant, nickel-chromium-molybdenum-iron-columbium plus tantalum alloy plate and sheet in the annealed and descaled condition, unless otherwise agreed upon between the manufacturer and the purchaser.

NOTE 1—The following definitions shall apply unless otherwise agreed upon between the manufacturer and the purchaser: *plate*—material $\frac{3}{16}$ in. (4.762 mm) and over in thickness and *sheet*—material 0.187 in. (4.761 mm) and under in thickness.

1.2 It should be understood that this specification is general. Provision is made herein for material suitable for the general run of drawing, forming, stamping, bending, joining operations, and all other common methods of fabrication. Since the material may be used for purposes where the requirements of the operations are too particular to be prescribed in a general specification, it is advisable in these instances for the purchaser to submit samples or drawings to the manufacturer and secure an adjustment of processing to suit the actual operations to which the material is to be subjected.

NOTE 2—The values stated in U.S. customary units are to be regarded as the standard. The metric equivalents of U.S. customary units may be approximate.

2. Basis of Purchase

2.1 Orders for material under this specification shall include information with respect to the following:

2.1.1 *Dimensions*—Thickness (in decimals of an inch, not gage number), width, and length (inch or fractions of an inch),

2.1.2 *Fabrication Details*—Not mandatory, but are helpful to manufacturer,

2.1.3 *Heat Treatment*—See Appendix A1.3,

2.1.4 *Special Tolerances and Special Test Requirements*—State nature and details of requirements (Section 6 and 7.8),

2.1.5 *Certification*—State if certification is required (Section 15),

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

2.1.7 *Samples for Check Analysis*—Whether samples for check analysis shall be furnished (see 9.1.2).

3. Material and Manufacture

3.1 The material shall be of such quality that the finished product shall have the chemical composition, properties, and characteristics described in this specification.

3.2 Plate and sheet shall be produced by hot working, annealing, pickling, cold working, reannealing, and polishing, or by any combination of these processes.

3.3 Plate and sheet shall be produced to the condition, finish, and dimensions specified.

4. Chemical Composition

4.1 The material shall conform to the requirements prescribed in Table 1.

¹ This specification is under the jurisdiction of ASTM Committee B-2 on Nonferrous Metals and Alloys.

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² For ASME Boiler and Pressure Vessel Code applications see related Specification SB-436 in Section II of that Code.

5. Physical Requirements

5.1 *Tensile Properties*—The material shall conform to the requirements as to mechanical properties prescribed in Table 2.

5.2 *Hardness*—Material tested in a single thickness shall conform to the Rockwell or equivalent hardness requirements prescribed in Table 2 with the exception that hardness values are informative only for those conditions of plate and sheet for which tensile requirements have been specified.

NOTE 3—For hardness conversions, see ASTM Hardness Conversion Tables E 140, for Metals (Relationship Between Vickers Hardness, Brinell Hardness, Rockwell Hardness, Rockwell Superficial Hardness, and Knoop Hardness).³

NOTE 4—Caution should be observed in using the Rockwell test on thin material as the results may be affected by the specimen thickness. For thicknesses under 0.050 in. (1.27 mm), the use of the Rockwell superficial or the Vickers hardness test is suggested.

5.3 *Grain Size for Sheet*—Sheet shall conform to the grain sizes as illustrated in Plate I of ASTM Methods E 112, Determining the Average Grain Size of Metals.³

6. Special Test Requirements

6.1 *Special analyses, test procedures, mechanical properties, and quality requirements not covered by this specification shall be as agreed upon by the manufacturer and the purchaser.*

6.2 When material is intended for nuclear applications and other critical end uses, the manufacturer shall be notified at the time of placement of the inquiry or order to determine if material of quality and inspection procedures normally employed for commercial material to this specification are adequate. In the event that more critical quality or more rigid inspection standards are indicated, the manufacturer and the purchaser shall agree upon such standards prior to production.

7. Dimensions, Weights, and Permissible Variations

7.1 *Permissible Variations in Thickness:*

7.1.1 The material covered by this specification shall be assumed to weigh 0.295 lb/in.³ (8.166 g/cm³).

7.1.2 *Plate*—The permissible variations in thickness of plate shall be as prescribed in Table 4.

7.1.3 *Sheet*—The permissible variations in thickness of sheet shall be as prescribed in Table 5. For referee purposes, the thickness of sheet shall be measured with the micrometer spindle $\frac{3}{8}$ in. (9.525 mm) or more from any edge for material 1 in. (25.4 mm) or over in width and at any place on material under 1 in. (25.4 mm) in width.

7.2 *Permissible Variations in Width:*

7.2.1 *Plate*—The permissible variations in width of rectangular plates shall be as prescribed in Table 6.

7.2.2 *Sheet*—The permissible variations in width for sheet shall not exceed $\frac{1}{8}$ in. (3.175 mm) over the width ordered, with a 0 minus tolerance.

7.3 *Permissible Variations in Length:*

7.3.1 Sheet may be ordered to cut lengths, in which case, a variation of $\frac{1}{8}$ in. (3.175 mm) over the specified length shall be permitted, with a 0 minus tolerance.

7.3.2 Permissible variations in the length of rectangular plate shall be as prescribed in Table 6.

7.4 *Straightness*—The edgewise curvature (depth of chord) of sheet and plate shall not exceed 0.05 in./ft (1.27 mm/m).

7.5 *Edges*—When no description of any required form of edge is given, it shall be understood that edges such as would result from shearing or abrasive cutting will be acceptable.

7.6 *Squareness (Sheet)*—For sheets of all thicknesses and widths of 6 in. (152.4 mm) or more, the angle between adjacent sides shall be 90 ± 0.15 deg ($\frac{1}{16}$ in. in 24 in. or 1.587 mm in 609.6 mm).

7.7 *Flatness*—Annealed and descaled sheet shall be commercially flat.

7.8 *Special Tolerances*—Special tolerances other than those specified herein shall be as agreed upon by the manufacturer and the purchaser.

8. Workmanship and Finish

8.1 The material shall be uniform in quality and condition, smooth, commercially straight or flat, and free from injurious defects.

³ Annual Book of ASTM Standards, Part 31.

9. Sampling

9.1 Samples for Chemical Analysis:

9.1.1 Unless otherwise agreed upon by the manufacturer and the purchaser, heat (ladle) analyses furnished by the manufacturer shall be accepted as defining the composition of the material furnished.

9.1.2 If samples for check analysis are desired, they shall be so specified by the purchaser, at the time of placement of the order. Such samples for chemical analysis shall be taken in accordance with the procedure described in ASTM Method E 55, Sampling Wrought Non-Ferrous Metals and Alloys⁴ and shall conform to the requirements of Section 5. The lot size, portion size, and selection of pieces shall be as follows:

9.1.2.1 *Lot Size*—5000 lb (2268 kg) or fraction thereof, of finished material,

9.1.2.2 *Portion Size*—Pieces from four individual lengths of finished material (if the lot consists of less than four lengths, a piece shall be taken from each individual length), and

9.1.2.3 *Minimum Weight of Composite Sample*—5.29 oz (150 g) divided into three equal parts, one for the manufacturer, one for the purchaser, and one for an umpire, if necessary.

9.1.3 Samples for check analyses, when requested after the date of placement of the order, shall be as agreed upon between the manufacturer and the purchaser.

9.2 Sampling for Mechanical Tests:

9.2.1 Samples of the material to provide test specimens for mechanical tests shall be taken from such locations in each lot as to be representative of that lot.

9.2.2 When samples are to be taken after delivery, the purchaser of material ordered to cut lengths may arrange with the manufacturer to have an excess length furnished, or request on the order additional material of adequate size to provide sample coupons for inspection purposes.

9.2.3 Unless otherwise specified, a lot of plate or sheet for mechanical testing shall be defined as the material from one heat in the same condition and specified thickness.

NOTE 5—Where material cannot be identified by heat, a lot shall consist of not more than 500 lb (226.8 kg) of material in the same thickness and condition, except that for plates weighing over 500 lb (226.8 kg) only one specimen shall be taken.

10. Number of Tests

10.1 *Tension Tests*—Unless otherwise specified, one tension test shall be made on each lot of material as defined in 9.2.3.

10.2 *Hardness Tests*—Unless otherwise specified, hardness tests need not be made where hardness requirements are designated to be “for information only.”

11. Test Specimens

11.1 Tension test specimens from material $\frac{1}{2}$ in. (12.7 mm) and under in thickness shall be of the full thickness of the material, and shall be machined to the form and dimensions shown in Fig. 7 of ASTM Methods E 8, Tension Testing of Metallic Materials.³

11.2 Tension test specimens from material over $\frac{1}{2}$ in. (12.7 mm) in thickness may be of the full thickness or may be machined to the form shown in Fig. 8 of Methods E 8. In case of dispute, the referee method shall be to machine specimens to the form and dimensions shown in Fig. 8 of Methods E 8.

11.3 Tension test specimens from plate and sheet shall be taken transverse to the direction of rolling when width will permit.

12. Methods of Test

12.1 The chemical compositions and mechanical properties of the material as enumerated in this specification shall be determined, in case of disagreement, in accordance with the following methods:

Test	ASTM Designation ^a
Chemical analysis	E 8
Tension	E 18
Rockwell hardness	E 140
Hardness conversion	E 112
Grain size	E 29
Rounding-off procedure	E 55
Method of sampling	E 354 ^{b, c}
Chemical Analysis	E 354 ^{b, c}

^a These designations refer to the following methods of test:

- E 8, Tension Testing of Metallic Materials,³
- E 18, Test for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials,³
- E 140, Hardness Conversion Table for Metals (Relationship Between Vickers Hardness, Brinell Hardness, Rockwell Hardness, Rockwell Superficial Hardness, and Knoop Hardness),³
- E 112, Estimating the Average Grain Size of Metals,³
- E 29, Recommended Practice for Indicating Which

⁴ Annual Book of ASTM Standards, Part 32.



Places of Figures Are to Be Considered Significant in Specified Limiting Values.^{3,4}

E 55, Sampling Wrought Non-Ferrous Metals and Alloys for Determination of Chemical Composition,⁴ and E 354, Chemical Analysis of High-Temperature Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt-Base Alloys.⁴

^b For elements not covered by E 354, the referee method shall be agreed upon between manufacturer and purchaser.

^c Iron shall be determined arithmetically by difference.

12.2 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 off as indicated below, in accordance with the rounding-off method of ASTM Recommended Practice E 29.

Test	Rounded-off 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
Tensile strength, yield strength	nearest 1000 psi (0.7 kgf/mm ²)
Elongation	nearest 1 percent
Grain size	nearest multiple of 0.005 mm or nearest multiple of 0.0002 in.

12.3 Instead of the offset methods, the minimum yield strength may be determined as the stress required to produce the elongation under load as calculated by the following equation:

$$X = [(Y/Z) + 0.002] \times L$$

where:

X = limiting extension under load, in.,

Y = specified yield strength at 0.2 percent offset, from Table 2,

Z = modulus of elasticity (29,000,000 psi) (2,040,000 kgf/cm²), and

L = gage length, in.

12.4 In case of dispute, the offset method shall be used as the referee procedure.

12.5 The measurement of grain size may be carried out by the planimetric method, the comparison method, or the intercept method described in Methods E 112. However, in case of disagreement, the "referee" method for determining grain size shall be the planimetric method.

13. Inspection

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

14. Rejection and Rehearing

14.1 Material not conforming to this specification or to authorized modifications thereof shall be subject to rejection.

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

15. Certification

15.1 Upon request of the purchaser in the contract or order, a manufacturer's certification that the material was manufactured and tested in accordance with this specification, together with a report of the test results, shall be furnished at the time of shipment.

16. Marking

16.1 Unless otherwise specified, each bundle or shipping container shall be marked with the name of the material; this specification number; the size; gross, tare, and net weight; consignor and consignee address; contract or order number; or such other information as may be defined in the contract or order.