

# SPECIFICATION FOR NICKEL AND NICKEL-BASE ALLOY-CLAD STEEL PLATE



SA-265



(Identical with ASTM Specification A265-12(2019).)

# Standard Specification for Nickel and Nickel-Base Alloy-Clad Steel Plate

## 1. Scope

1.1 This specification covers plate of a carbon steel or low-alloy steel base to which is integrally and continuously bonded on one or both sides a layer of nickel or nickel-base alloy. The material is generally intended for pressure vessel use but may be used in other structural applications where corrosion resistance of the alloy is of prime importance.

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.

## 2. Referenced Documents

### 2.1 ASTM Standards:

- A6/A6M Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
- A20/A20M Specification for General Requirements for Steel Plates for Pressure Vessels
- A370 Test Methods and Definitions for Mechanical Testing of Steel Products
- A578/A578M Specification for Straight-Beam Ultrasonic Examination of Rolled Steel Plates for Special Applications
- A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
- B127 Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip
- B162 Specification for Nickel Plate, Sheet, and Strip
- B168 Specification for Nickel-Chromium-Iron Alloys (UNS N06600, N06601, N06603, N06690, N06693, N06025, N06045, and N06696), Nickel-Chromium-Cobalt-

Molybdenum Alloy (UNS N06617), and Nickel-Iron-Chromium-Tungsten Alloy (UNS N06674) Plate, Sheet, and Strip

- B333 Specification for Nickel-Molybdenum Alloy Plate, Sheet, and Strip
  - B409 Specification for Nickel-Iron-Chromium Alloy Plate, Sheet, and Strip
  - B424 Specification for Ni-Fe-Cr-Mo-Cu Alloy (UNS N08825, UNS N08221, and UNS N06845) Plate, Sheet, and Strip
  - B443 Specification for Nickel-Chromium-Molybdenum-Columbium Alloy (UNS N06625) and Nickel-Chromium-Molybdenum-Silicon Alloy (UNS N06219) Plate, Sheet, and Strip
  - B463 Specification for UNS N08020 Alloy Plate, Sheet, and Strip
  - B575 Specification for Low-Carbon Nickel-Chromium-Molybdenum, Low-Carbon Nickel-Chromium-Molybdenum-Copper, Low-Carbon Nickel-Chromium-Molybdenum-Tantalum, and Low-Carbon Nickel-Chromium-Molybdenum-Tungsten Alloy Plate, Sheet, and Strip
  - B582 Specification for Nickel-Chromium-Iron-Molybdenum-Copper Alloy Plate, Sheet, and Strip
  - B625 Specification for UNS N08925, UNS N08031, UNS N08932, UNS N08926, UNS N08354, and UNS R20033 Plate, Sheet, and Strip
- 2.2 *Other Standards:*  
ASME Code Boiler and Pressure Vessel Code, Section IX, Welding Qualifications

## 3. Terminology

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

3.1.1 This material is considered as single-clad or double-clad nickel or nickel-base alloy clad steel plate, depending on whether one or both sides are covered.

3.1.2 The term plate as used in this specification applies to material  $\frac{3}{16}$  in. (2.73 mm) and over in thickness, and over 10 in. (254 mm) in width.

3.1.3 *alloy cladding*—the nickel or nickel-base alloy component of the composite plate.

3.1.4 *base metal (backing steel)*—component to which the alloy cladding is applied, usually the greater percentage of the composite plate and usually consisting of carbon or low-alloy steel.

3.1.5 *integrally and continuously bonded*—the process by which the alloy cladding and base metal are brought together to form a metallurgical bond at essentially the entire interface of the two metals by means other than those processes that do not produce a homogeneous composite plate.

#### 4. Ordering Information

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

- 4.1.1 Quantity (weight or number of pieces).
- 4.1.2 Heat treatment, if required (see Section 5).
- 4.1.3 Dimensions, including the thickness of the cladding alloy and the backing steel, or of the total composite plate and if more or less restrictive thickness tolerances apply.
- 4.1.4 Cladding alloy specification (see Section 6).
- 4.1.5 Base metal specification (see Section 6).
- 4.1.6 Product analysis, if required. Specify whether applicable to the cladding alloy, backing steel, or both (see Section 10).
- 4.1.7 Mechanical Properties (see Sections 7, 13, and 14).
- 4.1.8 Restrictions, if required, on repair by welding (see Section 14).
- 4.1.9 Additions to the specification or special requirements such as applicable construction code rules.
- 4.1.10 Corrosions tests, if required.
- 4.1.11 Notification when the cladding alloy is to be used for inclusion in the design strength calculations for an applicable construction code.

NOTE 1—Construction codes may dictate certain fabrication requirements when the cladding is used in the design calculations that may be different than if the cladding is used for corrosion resistance only. This may be particularly important when the alloy cladding involves the use of welded components in the explosion bonded clad manufacturing process. It is incumbent on the purchaser to make the clad manufacturer aware of any such restrictions or applications at time of order.

4.2 In addition to the basic requirements of this specification and the backing steel specification, certain supplementary requirements are available when additional control, testing, or examination is required to meet end use requirements. The purchaser is referred to the listed supplementary requirements in this specification and to the detailed requirements in Specification A20/A20M.

- 4.2.1 Nondestructive examination,
- 4.2.2 Impact testing, and
- 4.2.3 Simulated Post-Weld Heat Treatment of Mechanical Test Coupons (SPWHT).

4.3 If the requirements of this specification are in conflict with the requirements of Specification A20/A20M, the requirements of this specification shall prevail.

- 4.4 Special tests.

#### 5. Materials and Manufacture

##### 5.1 Process:

5.1.1 The steel shall be made by the open-hearth, electric-furnace (with separate degassing and refining optional), or basic-oxygen processes, or by secondary processes whereby steel made from these primary processes is remelted using, but not limited to electroslag remelting or vacuum arc remelting processes.

5.1.2 The cladding metal may be metallurgically bonded to the base metal by any method that will produce a clad steel that will conform to the requirements of this specification.

5.1.3 For explosively bonded products, the alloy cladding metal may be comprised of two or more separate alloy plates or sheets completely welded together to form a single fabricated component.

5.2 *Heat Treatment*—Unless a specific heat treatment is required by the cladding material or base steel specification, or unless otherwise agreed upon by the purchaser and manufacturer, the clad plate shall be furnished in a condition that is appropriate for the cladding alloy, base metal, or both.

#### 6. Chemical Composition

6.1 The composite plate may conform to any desired combination cladding metal and base metal as described in 6.2 and 6.3, and as agreed upon between the purchaser and the manufacturer.

6.2 *Cladding Metal*—The nickel or nickel-base alloy cladding metal specified shall conform to the requirements as to chemical composition prescribed for the respective metal in Specifications B127, B162, B168, B333, B409, B424, B443, B463, B575, B582, and B625, or other nickel-base alloy as agreed upon by the purchaser and manufacturer.

6.3 *Base Metal*—The base metal shall be carbon steel or low-alloy steel conforming to the ASTM specifications for steels for either pressure vessels or general structural applications, or other, as agreed upon by the purchaser and manufacturer. The base metal shall conform to the chemical requirements of the specification to which it is ordered.

#### 7. Mechanical Properties

##### 7.1 Tensile Requirements:

7.1.1 The tensile properties shall be determined by a tension test of the composite plate for clad plates that meet all of the following conditions.

(1) The nominal composite gage is less than or equal to 1½ in (38 mm).

TABLE 1 Weights for Component Materials

	Density		Weight per Square Foot for Material 1 in. (25.4 mm) in Thickness, lb
	lb/in. <sup>3</sup>	g/cm <sup>3</sup>	
Steel	0.283	7.83	40.80
Nickel	0.321	8.88	46.22
Nickel-copper alloy	0.319	8.83	45.94
Nickel-chromium-iron alloy	0.307	8.49	44.21

(2) The specified minimum tensile strength of the base steel is less than or equal to 70 000 psi (485 MPa).

(3) The specified minimum yield strength of the base steel is less than or equal to 40 000 psi (275 MPa).

(4) The tensile properties thus determined shall not be less than the minimum and not more than 5000 psi (35 MPa) over the maximum prescribed in the specification for the base steel used. All other tensile test requirements of the specification for the base steel shall be met.

7.1.2 The tensile properties shall be determined by a tension test of the base steel only for clad plates that meet one of the following conditions. The properties thus determined shall meet all of the tensile test requirements for the base steel.

(1) The composite gage is greater than 1½ in. (38 mm).

(2) The specified minimum tensile strength of the base steel is greater than 70 000 psi (485 MPa).

(3) The specified minimum yield strength of the base steel is greater than 40 000 psi (275 MPa).

7.1.3 If the cladding is for corrosion allowance only, the cladding need not be included in the tensile test. The tensile properties thus determined shall meet the base steel requirements.

7.2 Test for strength of the bond, when required, must be specified by the purchaser and shall consist of one of the following.

7.2.1 *Shear Strength*—When required by the purchaser, the minimum shear strength of the alloy cladding and base metals shall be 20 000 psi (140 MPa). The shear test, when specified, shall be made in the manner indicated in Fig. 1. The minimum cladding thickness for shear testing shall be 0.075 in. (1.9 mm) exclusive as ordered. Testing for shear strength for clad plates with minimum cladding thickness of 0.075 in. (1.9 mm) or less shall be permitted upon agreement between the purchaser and the manufacturer.

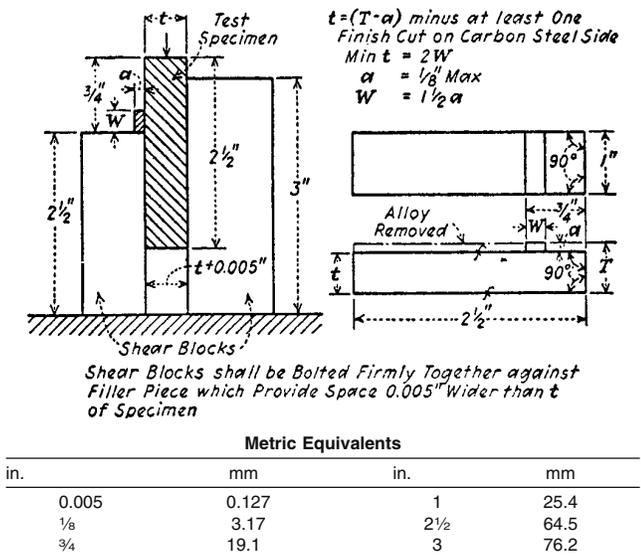


FIG. 1 Test Specimen and Method of Making Shear Test of Clad Plate

7.2.2 *Bond Strength*—As an alternative to the shear strength test provided in 7.2.1 or when agreed upon by the purchaser and the manufacturer, or both, three bend tests shall be made with the alloy cladding in compression to determine the quality of the bond. These bend tests shall be made in the manner of the tension tests indicated in Fig. 2 and shall be bent through an angle of 180° to the bend diameters provided for in either Specification A6/A6M or Specification A20/A20M (Appendix X4, or equivalent), as applicable. At least two of the three tests shall show not more than 50 % separation on both edges of the bent portion. Greater separation shall be cause for rejection.

7.3 Methods and practices relating to mechanical testing required by this specification shall be in accordance with the Test Methods and Definitions of A370.

8. Number of Tests and Retests

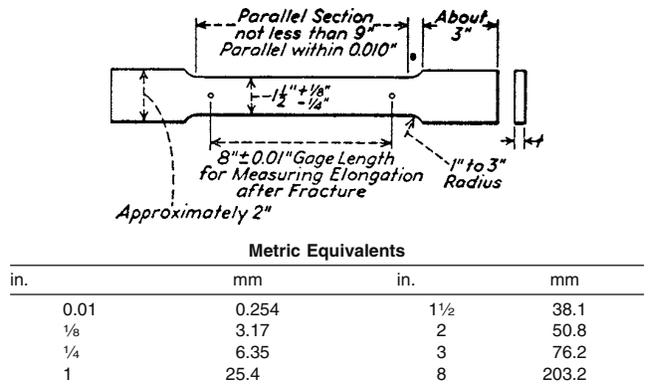
8.1 One or more tension tests, as required by the specifications for the base metal and when specified, one shear test or three bond bend tests shall be made, representing each plate as rolled. Each specimen shall be in the final condition of heat treatment required for the plate, including any SPWHT if required.

8.2 If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted.

9. Test Specimens

9.1 The tension test specimens shall conform to the requirements prescribed in the specifications for the base metal.

9.2 Bend test specimens for the alternative bond strength tests shall be taken at right angles to its longitudinal axis.



NOTE 1—When necessary, it is permissible to use a narrower specimen, but in such a case the reduced portion shall be not less than 1 in. in width.

NOTE 2—Punch marks for measuring elongation after fracture shall be made on the flat or on the edge of the specimen and within the parallel section; either a set of nine punch marks 1 in. apart, or one or more sets of 8-in. punch marks may be used.

NOTE 3—The dimension  $t$  is the thickness of the test specimen as provided for in the applicable material specifications.

FIG. 2 Standard Rectangular Test Specimens with 8-in. Gage Length

9.3 When required by the purchaser, the shear test specimen shall be taken near a top or bottom corner of the plate as rolled, parallel to its longitudinal axis, or other location that is representative of the final product.

9.4 For plates 1½ in. (38 mm) and under in thickness, tension test specimens shall be the full thickness of the material, except as specified in 7.1.2 and 7.1.3.

9.5 For plates over 1½ in. (38 mm) in thickness, tension tests shall be of the form shown in Fig. 3 and shall be of all base steel conforming to the requirements of the specification for the base steel.

9.6 The bend test specimen used for bond strength determination shall be 1½ in. (38 mm) by not more than ¾ in. (19 mm) in thickness and shall be machined to the form and dimensions shown in Fig. 2, or may be machined with both edges parallel. In reducing the thickness of the specimen, both the alloy cladding and the base steel shall be machined so as to maintain the same ratio of clad metal to base steel as is maintained in the plate, except that the thickness of the clad material need not be reduced below ⅛ in. (3.1 mm). The sides of the bend test specimen used for bond strength determination may have the corners rounded to a radius not over ¼ in. (1.6 mm) for plates, 2 in. (50 mm) and under in thickness, and not over ⅛ in. (3.1 mm) for plates over 2 in. (50 mm) in thickness.

**10. Product Analysis**

10.1 Product analysis may be required for the cladding alloy on finished product. Chemical analysis may be accomplished by wet chemical or instrumental procedures. If wet chemical procedures are used, millings may be taken only when the composite plate thickness is sufficient to permit obtaining millings without danger of contamination from the adjacent layer. If spectrometric procedures are used, the sample shall be exposed on the center line of the cladding when there is

sufficient cladding thickness available so that there is no contamination from the adjacent base metal.

10.2 If product analysis is specified by the purchaser for the cladding alloy, it shall be made on a sample taken from the finished product or a broken test specimen. For wet chemical analysis, in order to avoid contamination by the base plate metal, millings of cladding samples shall be taken from the test coupon by removal and discard of all the base metal plus 40 % of the cladding thickness from the bonded side, not to exceed ¼ in. (1.6 mm). The material shall be cleaned and sufficient millings taken to represent the full cross-section of the remainder. If there is insufficient cladding thickness available to spectrographically expose on the center line of the cladding without contamination, 50 % of the cladding shall be removed and the sample exposed on this surface.

10.3 The results of the product analysis shall conform to the requirements of standards referenced in Section 2.

10.4 Methods and practices relating to chemical analysis required by this specification shall be in accordance with the Test Methods, Practices, and Terminology of A751.

10.5 Results of the product analysis for the backing steel when required shall conform to the requirements of Section 7 of Specification A20/A20M or A6/A6M, as applicable.

**11. Permissible Variations**

11.1 Permissible variations except for thickness shall be in accordance with Specification A20/A20M or A6/A6M as applicable based on the backing specification.

11.2 Minimum thickness of the alloy cladding metal and of the backing steel, or of the total composite plate shall be as required by purchase order documents when ordered to minimum thickness.

11.3 Permissible variation in thickness when ordered to nominal thicknesses shall be 0.01 in. (0.3 mm) under each for backing steel or total composite, and 0.03 in. (0.8 mm) under for the alloy cladding.

11.4 Permissible variations for excess thickness of the total composite shall be the greater of 0.125 in. (3 mm) or 10 % of the total composite thickness ordered and may occur in either backing steel, cladding, or both, provided the minimum for each is met.

11.5 More restrictive or less restrictive permissible variations may be agreed upon by the purchaser and the manufacturer.

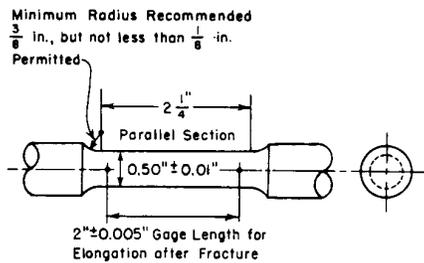
**12. Workmanship Finish, and Appearance**

12.1 The material shall be free of injurious defects and shall have a workmanlike appearance.

12.2 Unless otherwise specified, the clad surface may be supplied as-rolled, blasted (descaled by means of sand, grit, shot or wire followed by pickling), or 100 % conditioned.

**13. Bond Quality**

13.1 The cladding metal shall be integrally and continuously bonded to the base metal.



Metric Equivalents			
in.	mm	in.	mm
0.003	0.076	⅜	9.53
0.005	0.127	0.50	12.7
0.01	0.254	2	50.8
⅛	3.18	2¼	64.5

NOTE 1—The gage length and fillets shall be as shown, but the ends may be of any shape to fit the holders of the testing machine in such a way that the load shall be axial. The reduced section shall have a gradual taper from the ends toward the center, with the ends 0.003 to 0.005 in. larger in diameter than the center.

**FIG. 3 Standard Round Tension Tests Specimen with 2-in. Gage Length**

### 13.2 Inspection:

13.2.1 Clad plates less than  $\frac{3}{8}$  in. (10 mm) total minimum composite thickness shall be visually inspected for bond integrity prior to shipment.

13.2.2 Clad plates  $\frac{3}{8}$  in. (10 mm) and thicker total minimum composite thickness, and when specified by the purchaser, clad plates less than  $\frac{3}{8}$  in. (10 mm) total minimum composite thickness, shall be ultrasonically inspected for bond integrity prior to shipment in accordance with the Procedures and Methods of Specification A578/A578M.

13.2.3 Areas of non-bond detected visually shall be explored ultrasonically to determine the extent of the condition in accordance with 13.2.2. For purposes of defining non-bond, the cladding shall be interpreted to be unbonded when there is complete loss of back reflection accompanied by an echo indication from the plane of the interface of the clad and backing steel. Areas within 1 in. (25 mm) of a cut edge on the plate that contain indications exceeding 50 % of the back reflection at the bond interface shall be considered to be unbonded.

13.2.4 Extent of ultrasonic examination shall be at the discretion of the manufacturer and sufficient enough to provide the quality level required by the purchaser. Plates may be ordered with 100 % coverage (see Supplementary Requirement S12).

### 13.3 Quality Levels:

13.3.1 *Class 1*—No single unbonded area exceeding 1 in. (25 mm) in its longest dimension with total unbonded area not to exceed 1 % of the total clad surface area.

13.3.2 *Class 3*—No single unbonded area exceeding 3 in. (75 mm) in its longest dimension with total unbonded area not to exceed 3 % of the total clad surface area.

13.3.3 *Class 5*—No single unbonded area exceeding 9 in.<sup>2</sup> (58 cm<sup>2</sup>) with total unbonded area not to exceed 5 % of the total clad surface area.

13.3.4 The class to be supplied shall be listed on the purchase order. When none has been specified, plates shall be furnished as Class 5 at the option of the manufacturer.

## 14. Welding

14.1 All welding which is a part of the delivered product, including any made in the fabrication of the cladding alloy component, shall be performed with a procedure and welders or welding operators that are qualified in accordance with Section IX of the ASME Code.

14.2 The material manufacturer may repair defects in cladding by welding provided the following requirements are met:

14.2.1 When specified in the purchase order, prior approval shall be obtained from the purchaser.

14.2.2 The defective area shall be removed and the area prepared for repair shall be examined by a liquid penetrant method to ensure all defective area has been removed. Method

of test and acceptance standard shall be as agreed upon between the purchaser and the manufacturer.

14.2.3 The repair weld shall be deposited in accordance with a welding procedure and welding materials suitable for the cladding material. The surface condition of the repaired area shall be restored to a condition similar to the rest of the cladding.

14.2.4 The repaired area shall be examined by a liquid penetrant method in accordance with 14.2.2.

14.2.5 The location and extent of the weld repairs together with the repair procedure and examination results shall be transmitted as a part of the certification.

## 15. General Requirements for Delivery

15.1 Material furnished under this specification shall conform to the applicable requirements of Specification A6/A6M or A20/A20M as appropriate for the backing metal.

15.2 In the event of conflicts between this specification and the general delivery requirement specification for the backing steel, this specification shall apply.

## 16. Certification

16.1 The chemical analysis of the base metal and the alloy cladding shall be certified to the purchaser by the clad plate manufacturer.

16.2 The results of the tests in Section 7 and any other tests required by the purchase order shall be reported to the purchaser.

16.3 Compliance with the clad quality level of 13.3 shall be certified. Reports shall include the results of ultrasonic inspection when Supplementary Requirement S12 is specified.

16.4 Compliance with any applicable construction code shall be certified and the appropriate documentation provided when appropriate in the case of explosively bonded clad produced using welded alloy cladding components (see 4.1.9 and 4.1.11).

## 17. Product Marking

17.1 Except as specified in 17.2, plates shall be marked in accordance with the requirements of Specification A6/A6M or A20/A20M for the backing steel as applicable, the cladding alloy designation, and this specification number.

17.2 For double-clad material or for material under  $\frac{3}{8}$  in. (6.35 mm) nominal in thickness or for clad plates provided with conditioned surfaces, the marking specified in 17.1 shall be legibly stenciled instead of stamped when the material is shipped with the alloy surface up.

## 18. Keywords

18.1 alloy cladding; bond strength; carbon steel; clad steel plate; low-alloy steel; nickel; nickel-base alloy

**SUPPLEMENTARY REQUIREMENTS**

Supplementary requirements shall not apply unless specified on the order. A list of standardized supplementary requirements for use at the option of the purchaser are included in Specification A20/A20M. Several of those considered suitable for use with this specification are listed below by title. Other tests may be performed by agreement between the supplier and the purchaser.

**S2. Product Analysis****S3. Simulated Post-Weld Heat Treatment of Mechanical Test Coupons****S5. Charpy V-Notch Impact Test****S12. Ultrasonic Examination in accordance with Specification A578/A578M**

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