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Standard Specification for Steel Plates, 9 % Nickel Alloy, for Pressure Vessels, Produced by the Direct-Quenching Process[1]

This standard is issued under the fixed designation A844/A844M; 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.

1. ~~Scope*~~Scope

1.1 This specification covers 9 % nickel-alloy steel plates produced by the direct-quenching process. The plates are intended primarily for use in welded pressure vessels.

1.2 The direct-quenching process consists of quenching the plates directly after rolling, without permitting the plates to cool below the critical temperature prior to initiation of the quenching operation, and subsequently tempering the plates. (This differs from the "conventional" process in which the plates are permitted to cool to a temperature significantly below the critical temperature, usually to ambient temperature, prior to reheating to a temperature above the upper critical temperature, then quenching, and subsequently tempering.)

1.3 The maximum nominal thickness of plates furnished under this specification shall not exceed 2 in. [50 mm].

1.4 This material is susceptible to magnetization. Use of magnets in handling after heat treatment should be avoided if residual magnetism would be detrimental to subsequent fabrication or service.

1.5 The values stated in either inch-pound or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore each system must be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A20/A20M Specification for General Requirements for Steel Plates for Pressure Vessels
A435/A435M Specification for Straight-Beam Ultrasonic Examination of Steel Plates
A577/A577M Specification for Ultrasonic Angle-Beam Examination of Steel Plates
A578/A578M Specification for Straight-Beam Ultrasonic Examination of Rolled Steel Plates for Special Applications

3. General Requirements and Ordering Information

3.1 Material supplied to this material specification shall conform to Specification A20/A20M. These requirements outline the testing and retesting methods and procedures, permitted variations in dimensions, quality and repair of defects, marking, loading, and ordering information.

3.2 In addition to the basic requirements of this 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.

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

4. Manufacture

4.1 *Steelmaking Practice*—The steel shall be killed and shall conform to the fine austenitic grain size requirement of Specification A20/A20M.

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[1] This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.11 on Steel Plates for Boilers and Pressure Vessels.

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[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.

***A Summary of Changes section appears at the end of this standard**

TABLE 1 Chemical Requirements

Element	Composition, %
Carbon, max[A]	0.13
Manganese, max:	
Heat analysis	0.90
~~Heat analysis~~	~~0.90~~
~~Product analysis~~	~~0.98~~
Product analysis	0.98
Phosphorus, max[A]	0.015
~~Phosphorus, max[A]~~	~~0.015~~
~~Sulfur, max[A]~~	~~0.015~~
~~Silicon:~~	
Sulfur, max[A]	0.015
Silicon:	
~~Heat analysis~~	~~0.15–0.40[B]~~
~~Product analysis~~	~~0.13–0.45[B]~~
Heat analysis	0.15–0.40[B]
Product analysis	0.13–0.45[B]
Nickel:	
Heat analysis	8.50–9.50
~~Heat analysis~~	~~8.50–9.50~~
~~Product analysis~~	~~8.40–9.60~~
Product analysis	8.40–9.60

[A] Applies to both heat and product analyses.
[B] The specified minimum limit does not apply if the total aluminum content is 0.030 % or more, or provided that acid soluble aluminum is 0.025 % or more.

4.2 *Heat Treatment:*

4.2.1 The plates shall be quenched directly after rolling, without being allowed to cool below 1205°F [650°C]. The quenching shall be initiated from a temperature within the range from 1205 to 1670°F [650 to 910°C]. (The temperature shall be reported in accordance with 19.2 of Specification A20/A20M.)

4.2.2 Subsequent to quenching, the plates shall be tempered within the range from 1050 to 1175°F [565 to 635°C], holding at that temperature for a minimum of 30 min/in. [1.2 min/mm] of thickness but for not less than 15 min., and then cooling at a rate of not less than 300°F/h [165°C/h], either in air or by quenching in water, to ambient temperature.

4.2.2.1 Prior to the tempering treatment, the plates may be subjected to an intermediate heat treatment consisting of heating to a temperature in the range from 1165 to 1290°F [630 to 700°C], holding at that temperature for a minimum of 1 h/in. (2.4 min/mm) of thickness, but in no case less than 15 min, and then water-quenching to below 300°F [150°C] in the case of plate thicknesses of more than ⅝ in. [16 mm] or cooling in air or water-quenching to below 300°F [150°C] in the case of plate thicknesses of ⅝ in. [16 mm] and under.

NOTE 1—The intermediate heat treatment is for the purpose of enhancing elongation and notch-toughness and for reducing susceptibility to strain-aging embrittlement and temper embrittlement. It may be performed at the option of the material manufacturer or may be specified by the purchaser.

5. Chemical Composition

5.1 The steel shall conform to the chemical requirements shown in Table 1 unless otherwise modified in accordance with Supplementary Requirement S17, Vacuum Carbon-Deoxidized Steel, in Specification A20/A20M.

6. Finish

6.1 The plates shall be descaled by the producer prior to shipment.

7. Mechanical Requirements

7.1 *Tension Test Requirements*—The material as represented by the tension-test specimens shall conform to the requirements specified in Table 2.

7.1.1 For nominal plate thicknesses of ¾ in. [20 mm] and under, the 1½-in. [40-mm] wide rectangular specimen may be used for the tension test and the elongation may be determined in a 2-in. [50-mm] gage length that includes the fracture and shows the greatest elongation.

7.2 *Impact Test Requirements:*

7.2.1 Charpy V-notch impact tests shall be made in accordance with Specification A20/A20M.

7.2.2 *Number and Location of Test Coupons*—Two impact tests shall be made from each plate-as-heat-treated, with the test coupons being taken from locations adjacent to the tension test coupons.

7.2.3 *Orientation*—The longitudinal axis of the test specimen shall be transverse to the final rolling direction of the plate.

7.2.4 *Test Temperature*—Unless otherwise specified on the order, the tests shall be conducted at −320°F [−195°C].

7.2.5 *Acceptance Criteria*—Each test specimen shall have a lateral expansion opposite the notch of not less than 0.015 in. [0.381 mm].