Designation: ~~A645/A645M – 10~~ A645/A645M – 10 (Reapproved 2016)

Standard Specification for Pressure Vessel Plates, 5 % and 5½ % Nickel Alloy Steels, Specially Heat Treated[1]

This standard is issued under the fixed designation A645/A645M; 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[2] covers specially heat treated 5 % and 5 ½ % nickel alloy steel plates intended primarily for welded pressure vessels for service at low or cryogenic temperatures.

1.2 The maximum thickness of plates which can be supplied under this specification is limited only by the capacity of the material to meet the specified requirements.

1.3 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.

1.4 The values stated in either inch-pound units 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.

1.5 *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 establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

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 Plates 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 and mass, 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. Materials and Manufacture

4.1 *Steelmaking Practice*—The steel shall be killed and shall conform to the fine austenitic grain size requirements 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 ASME Boiler and Pressure Vessel Code applications see related Specification SA-645 in Section II of that Code.

[3] 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**

5. Heat Treatment

5.1 Grade A plates shall be heat treated in accordance with 5.2. Grade B plates shall be heat treated in accordance with 5.3. Shell plates and other parts, including heads and reinforcing pads that are heated above 1125°F [605°C] for forming, shall be heat treated after forming,

5.2 *Grade A, Procedure and Sequence:*

5.2.1 *Hardening*—The plates shall be heated to a temperature within the range from 1575 to 1675°F [855 to 915°C], held within that temperature range for a minimum of 1 h/in. [2.4 min/mm] of thickness, but in no case less than 15 min, and then water-quenched to below 300°F [150°C].

5.2.2 *Intermediate Heat Treatment*—The plates shall be reheated to a temperature within the range from 1275 to 1400°F [690 to 760°C], held within that temperature range for a minimum of 1 h/in. [2.4 min/mm] of thickness, but in no case less than 15 min, and then water-quenched to below 300°F [150°C].

5.2.3 *Tempering*—The plates shall be reheated to a temperature within the range from 1150 to 1225°F [620 to 665°C], held within that temperature range for a minimum of 1 h/in. [2.4 min/mm] of thickness, but in no case less than 15 min, and then water-quenched or air cooled to below 300°F [150°C].

5.3 *Grade B, Procedure and Sequence:*

5.3.1 *Hardening*—The plates shall be heated to a temperature within the range from 1470 to 1600°F [800 to 870°C], held within that temperature range for a sufficient time to obtain uniform temperature throughout the plate thickness, and then quenched in a liquid medium.

5.3.2 *Intermediate Heat Treatment*—The plates shall be reheated to a temperature within the range from 1200 to 1330°F [650 to 720°C], held within that temperature range for a minimum of 1 h/in. [2.4 min/mm] of thickness, but in no case less than 15 min, and then water-quenched to below 300°F [150°C] for nominal plate thicknesses over ⅝ in. [16 mm], or cooled in air or water-quenched to below 300°F [150°C] for nominal plate thicknesses of ⅝ in. [16 mm] and under.

5.3.3 *Tempering*—The plates shall be reheated to a temperature within the range from 1020 to 1150°F [550 to 620°C], held within that temperature range for a minimum of 30 min/in. [1.2 min/mm] of thickness, but in no case less than 15 min, and then water-quenched to below 300°F [150°C].

6. Chemical Requirements

6.1 The steel shall conform to the chemical requirements given in Table 1 unless otherwise modified in accordance with

TABLE 1 Chemical Requirements

Element	Composition, %	
	Grade A	Grade B
Carbon, max		
Heat Analysis	0.13	0.13
Produce Analysis	0.15	0.15
Manganese		
Heat Analysis	0.30–0.60	0.90–1.50
Product Analysis	0.25–0.66	0.84–1.59
Phosphorus, max		
Heat Analysis	0.025	0.020
Product Analysis	0.025	0.025
Sulfur, max		
Heat Analysis	0.025	0.010
Product Analysis	0.025	0.015
Silicon		
Heat Analysis	0.20–0.40	0.15–0.30[A]
Product Analysis	0.18–0.45	0.13–0.33[A]
Nickel		
Heat Analysis	4.8–5.2	5.0–6.0
Product Analysis	4.7–5.3	4.9–6.1
Chromium		
Heat Analysis	...	0.10–1.00
Product Analysis	...	0.06–1.05
Molybdenum		
Heat Analysis	0.20–0.35	0.10–0.30
Product Analysis	0.17–0.38	0.09–0.33
Aluminum, total		
Heat Analysis	0.02–0.12	0.02–0.05
Product Analysis	0.01–0.16	0.015–0.06
Nitrogen, max		
Heat Analysis	0.020	0.010
Product Analysis	0.025	0.010

[A] The specified minimum limit does not apply if the total aluminum is 0.030 % or more, ore if the acid soluble aluminum content is 0.025 % or more.