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Standard Specification for Pressure Vessel Plates, Alloy Steel, Quenched and Tempered Nickel-Chromium-Molybdenum[1]

This standard is issued under the fixed designation A 543/A 543M; 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.

ε[1] NOTE—Supplementary Requirement S14, Bend Test, was editorially removed in September 2004.

1. Scope

1.1 This specification[2] covers nickel-chromium-molybdenum alloy steel plates for use in the quenched and tempered condition, intended for the fabrication of welded pressure vessels and other pressure equipment. These alloy compositions are normally considered for construction involving plate thicknesses of 2 in. [50 mm] or greater.

1.2 Material under this specification is available in two types, B and C. The material is also available in three classes as follows:

Class	Minimum Tensile Strength, ksi [MPa]
1	105 [725]
2	115 [795]
3	90 [620]

1.3 The maximum thickness of plates is limited only by the capacity of the chemical composition to meet the specified mechanical property requirements.

1.4 The minimum plate thickness is 3⁄16 in. [5 mm].

1.5 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.

2. Referenced Documents

2.1 *ASTM Standards:* [3]

A 20/A20M Specification for General Requirements for Steel Plates for Pressure Vessels

A 435/A435M Specification for Straight-Beam Ultrasonic Examination of Steel Plates

A 577/A577M Specification for Ultrasonic Angle-Beam Examination of Steel Plates

A 578/A578M Specification for Straight-Beam Ultrasonic Examination of Plain and Clad Steel Plates for Special Applications

TABLE 1 Chemical Requirements

Element	Composition, %	
	Type B	Type C
Carbon, max[A]	0.20	0.18
Manganese, max[A]	0.40	0.40
Phosphorus, max[A]	0.020	0.020
Sulfur, max[A]	0.020	0.020
Silicon:		
Heat analysis	0.15–0.40	0.15–0.40
Product analysis	0.13–0.45	0.13–0.45
Nickel:		
Heat analysis	2.25–4.00	2.00–3.50
Product analysis	2.18–4.07	1.93–3.57
Chromium:		
Heat analysis	1.00–1.90	1.00–1.90
Product analysis	0.94–1.96	0.94–1.96
Molybdenum:		
Heat analysis	0.20–0.65	0.20–0.65
Product analysis	0.16–0.69	0.16–0.69
Vanadium, max[A]	0.03	0.03

[A] Applies to both heat and product analyses.

3. General Requirements and Ordering Information

3.1 Material supplied to this material specification shall conform to Specification A 20/A 20M. These requirements

TABLE 2 Tensile Requirements

	Class 1	Class 2	Class 3
Tensile strength, ksi [MPa]	105–125 [725–860]	115–135 [795–930]	90–115 [620–795]
Yield strength, min, ksi [MPa]	85 [585]	100 [690]	70 [485]
Elongation, 2 in. [50 mm], min, %[A,B]	14	14	16

[A] See 7.1.2.

[B] See Specification A 20/A 20M for elongation adjustment.

[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 for Boilers and Pressure Vessels.

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[2] For ASME Boiler and Pressure Vessel Code applications, see related Specification SA-543 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.

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outline the testing and retesting methods and procedures, permissible variations in dimensions, and mass, quality and repair of defects, marking, loading, etc.

3.2 Specification A 20/A 20M also establishes the rules for the ordering information which should be complied with when purchasing material to this specification.

3.3 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. These include:

3.3.1 Vacuum treatment,

3.3.2 Additional or special tension testing,

3.3.3 Impact testing, and

3.3.4 Nondestructive examination.

3.4 The purchaser is referred to the listed supplementary requirements in this specification and to the detailed requirements in Specification A 20/A 20M.

3.5 If the requirements of this specification are in conflict with the requirements of Specification A 20/A 20M, 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 A 20/A 20M.

5. Heat Treatment

5.1 All plates shall be heat treated by heating to a suitable austenitizing temperature, holding for a sufficient time period to attain uniform temperature through the thickness and quenching in a suitable liquid medium by spraying or immersion. The plates shall then be tempered to produce the required properties by heating to a suitable temperature not lower than 1100°F [595°C] with a holding time of not less than ½ h/in. [1.2 min/mm] of thickness but not less than ½ h.

5.2 Plates over 4 in. [100 mm] in thickness shall receive a prior treatment of normalizing at, or water quenching from a temperature within the range from 1650 to 1850°F [900 to 1010°C] before the heat treatment specified in 5.1.

5.3 When the fabricator elects to perform the heat treatment in 5.1 and 5.2, the manufacturer shall temper the plates prior to shipment at a temperature not lower than 1100°F [595°C].

6. Chemical Requirements

6.1 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 A 20/A 20M.

7. Mechanical Requirements

7.1 *Tension Test Requirements*:

7.1.1 The material as represented by the tension-test specimens shall conform to the requirements shown in Table 2.

7.1.2 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.

SUPPLEMENTARY REQUIREMENTS

Supplementary requirements shall not apply unless specified in the order.

A list of standardized supplementary requirements for use at the option of the purchaser are included in Specification A 20/A 20M. 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.

S1. Vacuum Treatment,

S2. Product Analysis,

S3. Simulated Post-Weld Heat Treatment of Mechanical Test Coupons,

S4.2 Additional Tension Test,

S5. Charpy V-Notch Impact Test,

S6. Drop Weight Test,

S7. High-Temperature Tension Test,

S8. Ultrasonic Examination in accordance with Specification A 435/A 435M,

S9. Magnetic Particle Examination,

S11. Ultrasonic Examination in accordance with Specification A 577/A 577M,

S12. Ultrasonic Examination in accordance with Specification A 578/A 578M, and

S17. Vacuum Carbon-Deoxidized Steel.

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