



Standard Specification for Pressure Vessel Plates, Alloy Steel, Quenched and Tempered, Manganese-Molybdenum and Manganese- Molybdenum-Nickel¹

This standard is issued under the fixed designation A533/A533M; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope-~~Scope~~*

1.1 This specification² covers one type of manganese-molybdenum and four types of manganese-molybdenum-nickel alloy steel plates for use in the quenched and tempered condition for the construction of welded pressure vessels.

1.2 Material under this specification is available in five types, designated “A”, “B”, “C”, “D”, and “E”. The material is also available in three classes having the following strength levels.

Class	Tensile Strength, ksi [MPa]
1	80–100 [550 to 690]
2	90–115 [620 to 795]
3	100–125 [690 to 860]

1.3 The maximum thickness of Class 1 and Class 2 plates is limited only by the capacity of the composition to meet the specified mechanical property requirements; however, current practice normally limits the maximum thickness to 12 in. [300 mm] for Types A through D. ~~Current practice limits the maximum thickness for Type E to 6 in. [150 mm] for Class 1 and 3D and to 7 in. [180 mm] for Type E.~~ 1/4 in. [80 mm] for Class 2.

1.4 The maximum thickness of Class 3 plates is 2½ in. [65 mm] for Types A through D and 2 in. [50 mm] for Type E.

1.5 The minimum nominal thickness of plates of all classes is 0.25 in. [6.5 mm].

1.6 These alloy steel plates in the as-rolled condition are sensitive to cracking during transit and handling, particularly in thicknesses over about 1 or 2 in. [25 or 50 mm]. They should be shipped in the as-rolled conditions only by mutual agreement of manufacturer and the purchaser.

1.7 Plates covered by this specification are often used in the beltline region of nuclear reactor vessels where the material properties may be affected by high levels of radiation. **Appendix X1** provides some information pertinent to this usage.

1.8 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

[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](#)

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.

Current edition approved March 1, 2014 May 1, 2016. Published March 2014 May 2016. Originally approved in 1965. Last previous edition approved in 2009 2014 as A533/A533M – 09^{ε1}–(2014). DOI: 10.1520/A0533_A0533M-09R14-10.1520/A0533_A0533M-16.

² For ASME Boiler and Pressure Vessel Code applications, see related Specification SA-533/SA-533M 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



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, 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. Manufacture

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

5. Heat Treatment

5.1 All plates shall be heat treated by heating to a suitable temperature within the range from 1550 to 1800°F [845 to 980°C], holding for a sufficient time to obtain uniform temperature throughout the plate thickness and then quenching, in water. Subsequently the plates shall be tempered at a suitable temperature to produce the specified properties, but not less than 1100°F [595°C] with a minimum holding time of ½ h/in. [1.2 min/mm] of thickness, but not less than ½ h.

5.2 When the plates are heat treated by the fabricator, it shall be his responsibility to apply the proper heat treatment and to conduct tests he deems necessary to assure that the specified properties are attained. Plates thicker than 2 in. [50 mm] shall be stress-relieved by the manufacturer prior to shipment at a temperature no 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 **A20/A20M**.

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, and the elongation may be determined in a 2-in. [50-mm] gage length that include the fracture and that shows the greatest elongation.

TABLE 1 Chemical Requirements

NOTE 1—Where “...” appears there is no requirement.

	Composition, %				
	Type A	Type B	Type C	Type D	Type E
Carbon, max ^A	0.25	0.25	0.25	0.25	0.20
Manganese: ^B					
Heat analysis	1.15–1.50	1.15–1.50	1.15–1.50	1.15–1.50	1.15–1.70
Product analysis	1.07–1.62	1.07–1.62	1.07–1.62	1.07–1.62	1.04–1.84
Phosphorus, max ^A	0.025	0.025	0.025	0.025	0.020
Sulfur, max ^A	0.025	0.025	0.025	0.025	0.015
Silicon:					
Heat analysis	0.15–0.40	0.15–0.40	0.15–0.40	0.15–0.40	0.15–0.40
Product analysis	0.13–0.45	0.13–0.45	0.13–0.45	0.13–0.45	0.13–0.45
Molybdenum:					
Heat analysis	0.45–0.60	0.45–0.60	0.45–0.60	0.45–0.60	0.25–0.60
Product analysis	0.41–0.64	0.41–0.64	0.41–0.64	0.41–0.64	0.21–0.64
Nickel:					
Heat analysis	...	0.40–0.70	0.70–1.00	0.20–0.40	0.60–1.00
Product analysis	...	0.37–0.73	0.67–1.03	0.17–0.43	0.57–1.03
Chromium, max:					
Heat analysis	...	...	...	...	0.60
Product analysis	...	...	...	...	0.64

^A Applies to both heat and product analyses.

^B For Types A, B, C, and D, the maximum manganese content may be increased to 1.60 % on heat analysis and 1.65 % on product analysis when Class 2 or Class 3 properties are specified and when Supplementary Requirement S3 (see Specification **A20/A20M**) is specified with a total holding time of more than 1 h/in. [2.4 min/mm] of thickness.