~~Designation:A533/A533M–93 (Reapproved 2004)$^{\varepsilon 1}$~~ Designation: A533/A533M – 09

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

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 Department of Defense.

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

1. ~~Scope~~ Scope*

1.1 This specification[2] ~~covers manganese-molybdenum and manganese-molybdenum-nickel alloy steel plates for use in the quenched and tempered condition for the construction of welded pressure vessels.~~

~~1.2This specification includes four types of chemical analysis and three classes of strength levels as follows:~~ 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.

~~Type~~	~~Molybdenum Content, %~~	~~Nickel Content, %~~
~~A~~	~~0.50~~	~~. . .~~
~~B~~	~~0.50~~	~~0.55~~
~~C~~	~~0.50~~	~~0.85~~
~~D~~	~~0.50~~	~~0.30~~

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

~~1.3The 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].~~

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 3¼ in. [80 mm] for Class 2.

1.4 The maximum thickness of Class 3 plates is 2½ ~~in. [65 mm].~~ 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 ~~with the~~ by mutual agreement of manufacturer and ~~fabricator.~~ the purchaser.

1.7 Plates covered by this specification are often used in the beltline region of nuclear reactor vessels where the material

[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 Sept. 1, 2004. Published September 2004. Originally approved in 1965. Last previous edition approved in 1999 as A533/A533M–93 (1999). DOI: 10.1520/A0533_A0533M-93R04E01.~~

Current edition approved Oct. 1, 2009. Published December 2009. Originally approved in 1965. Last previous edition approved in 2004 as A533/A533M – 93 (2004)$^{\varepsilon 1}$. DOI: 10.1520/A0533_A0533M-09.

[2] For ASME Boiler and Pressure Vessel Code applications, see related Specification SA-533/SA-533M in Section II of that Code.

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

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

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, ~~permissible~~permitted variations in dimensions, and mass, quality and repair of defects, marking, loading, ~~etc.~~and ordering information.

~~3.2Specification~~

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~~also establishes the rules for the ordering information which should be complied with when purchasing material to this specification.~~

~~3.3In 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:~~

~~3.3.1Vacuum treatment,~~
~~3.3.2Additional or special tension testing,~~
~~3.3.3Impact testing, and~~
~~3.3.4Nondestructive examination.~~

~~3.4The purchaser is referred to the listed supplementary requirements in this specification and to the detailed requirements in Specification A20/A20M~~.

[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.

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]~~:~~					
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]	~~0.035~~	~~0.035~~	~~0.035~~	~~0.035~~	~~0.020~~
~~Sulfur, max~~[A]	~~0.035~~	~~0.035~~	~~0.035~~	~~0.035~~	~~0.015~~
~~Silicon:~~					
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

[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.