Designation: A 517/A 517M – 06

Standard Specification for Pressure Vessel Plates, Alloy Steel, High-Strength, Quenched and Tempered[1]

This standard is issued under the fixed designation A 517/A 517M; 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.

1. Scope*

1.1 This specification[2] covers high-strength quenched and tempered alloy steel plates intended for use in fusion welded boilers and other pressure vessels.

1.2 This specification includes a number of grades as manufactured by different producers, but all having the same mechanical properties and general characteristics.

1.3 The maximum thickness of plates furnished under this specification shall be as follows:

Grade	Thickness
A, B	1.25 in. [32 mm]
H, S	2 in. [50 mm]
P	4 in. [100 mm]
F	2.50 in. [65 mm]
E, Q	6 in. [150 mm]

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 is to be used independently of the other without combining values in any way.

2. Referenced Documents

2.1 *ASTM Standards:* [3]

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

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

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

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

3. General Requirements and Ordering Information

3.1 Plates furnished to this material specification shall conform to Specification A 20/A 20M. These requirements 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 Except as allowed by section 5.2, the plates shall be heat treated by heating to not less than 1650°F [900°C], quenching in water or oil and tempering at not less than 1150°F [620°C].

[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-517/SA-517M 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.**

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TABLE 1 Chemical Requirements

Elements	Composition, %							
	Grade A	Grade B	Grade E	Grade F	Grade H	Grade P	Grade Q	Grade S
Carbon:								
Heat analysis	0.15 –0.21	0.15 –0.21	0.12 –0.20	0.10 –0.20	0.12 –0.21	0.12 –0.21	0.14 –0.21	0.10 –0.20
Product analysis	0.13 –0.23	0.13 –0.23	0.10 –0.22	0.08 –0.22	0.10 –0.23	0.10 –0.23	0.12 –0.23	0.10 –0.22
Manganese:								
Heat analysis	0.80 –1.10	0.70 –1.00	0.40 –0.70	0.60 –1.00	0.95 –1.30	0.45 –0.70	0.95 –1.30	1.10 –1.50
Product analysis	0.74 –1.20	0.64 –1.10	0.35 –0.78	0.55 –1.10	0.87 –1.41	0.40 –0.78	0.87 –1.41	1.02 –1.62
Phosphorus, max[A]	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035
Sulfur, max[A]	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035
Silicon:								
Heat analysis	0.40 –0.80	0.15 –0.35	0.10 –0.40	0.15 –0.35	0.15 –0.35	0.20 –0.35	0.15 –0.35	0.15 –0.40
Product analysis	0.34 –0.86	0.13 –0.37	0.08 –0.45	0.13 –0.37	0.13 –0.37	0.18 –0.37	0.13 –0.37	0.13 –0.45
Nickel:								
Heat analysis	. . .	. . .	. . .	0.70 –1.00	0.30 –0.70	1.20 –1.50	1.20 –1.50	. . .
Product analysis	. . .	. . .	. . .	0.67 –1.03	0.27 –0.73	1.15 –1.55	1.15 –1.55	. . .
Chromium:								
Heat analysis	0.50 –0.80	0.40 –0.65	1.40 –2.00	0.40 –0.65	0.40 –0.65	0.85 –1.20	1.00 –1.50	. . .
Product analysis	0.46 –0.84	0.36 –0.69	1.34 –2.06	0.36 –0.69	0.36 –0.69	0.79 –1.26	0.94 –1.56	. . .
Molybdenum:								
Heat analysis	0.18 –0.28	0.15 –0.25	0.40 –0.60	0.40 –0.60	0.20 –0.30	0.45 –0.60	0.40 –0.60	0.10 –0.35
Product analysis	0.15 –0.31	0.12 –0.28	0.36 –0.64	0.36 –0.64	0.17 –0.33	0.41 –0.64	0.36 –0.64	0.10 –0.38
Boron	0.0025 max	0.0005 –0.005	0.001 –0.005	0.0005 –0.006	0.0005 min	0.001 –0.005	. . .	. . .
Vanadium:								
Heat analysis	. . .	0.03 –0.08	[B]	0.03 –0.08	0.03 –0.08	. . .	0.03 –0.08	. . .
Product analysis	. . .	0.02 –0.09	. . .	0.02 –0.09	0.02 –0.09	. . .	0.02 –0.09	. . .
Titanium:								
Heat analysis	. . .	0.01 –0.04	0.01 –0.10	. . .	. . .	. . .	. . .	0.06
Product analysis	. . .	0.01 –0.05	0.005 –0.11	. . .	. . .	. . .	. . .	0.07
Zirconium:								
Heat analysis	0.05[C] –0.15	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Product analysis	0.04 –0.16	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Copper:								
Heat analysis	. . .	. . .	. . .	0.15 –0.50	. . .	. . .	. . .	. . .
Product analysis	. . .	. . .	. . .	0.12 –0.53	. . .	. . .	. . .	. . .
Columbium, max								
Heat analysis	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.06
Product analysis	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.07

[A] Applied to both heat and product analyses.
[B] May be substituted for part or all of titanium content on a one for one basis.
[C] Zirconium may be replaced by cerium. When cerium is added, the cerium/sulfur ratio should be approximately 1.5 to 1, based on heat analysis.

5.2 Plates ordered without the heat treatment specified in section 5.1 shall be stress relieved by the manufacturer, and subsequent heat treatment of the plates to conform to section 5.1 shall be the responsibility of the purchaser.

6. Chemical Requirements

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

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TABLE 2 Tensile Requirements

	2.50 in. [65 mm] and Under	Over 2.50 to 6 in. [65 to 150 mm]
Tensile strength, ksi [MPa]	115–135 [795–930]	105–135 [725 to 930]
Yield strength, min, ksi [MPa]	100 [690]	90 [620]
Elongation in 2 in. [50 mm], min, %[A]	16	14
Reduction of area, min, %:		
Rectangular specimens	35	. . .
Round specimens	45	45

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

Supplementary Requirement S17, Vacuum Carbon-Deoxidized Steel, in Specification A 20/A 20M for grades other than Grade A.

7. Mechanical Requirements

7.1 *Tension Tests*:

7.1.1 *Requirements*—The plates as represented by the tension-test specimens shall conform to the requirements given in Table 2.

7.1.2 *Test Methods*:

7.1.2.1 The yield strength may be determined by the 0.2 % offset method or by the total extension under load of 0.5 % method.

7.1.2.2 For plates ¾ in. [20 mm] and under in thickness, the test specimen shall be the 1½-in. [40-mm] wide rectangular-test specimen.

7.1.2.3 For plates over ¾ in. [20 mm], either the full thickness rectangular-test specimen or the ½-in. [12.5-mm] round-test specimen may be used.

7.1.2.4 When the 1½-in. [40-mm] wide rectangular-test specimen is used, the elongation is measured in a 2-in. or [50-mm] gage length which includes the fracture.

7.2 *Impact Properties Requirements*:

7.2.1 Transverse Charpy V-notch impact test specimens shall have a lateral expansion opposite the notch of not less than 0.015 in. [0.38 mm].

7.2.2 The test temperature shall be agreed upon between the manufacturer and the purchaser, but shall not be higher than 32°F [0°C].

8. Keywords

8.1 alloy steel; boilers; high-strength; impact tested; plates; pressure vessels; quenched; tempered

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 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,

S5. Charpy V-Notch Impact Test,

S6. Drop Weight Test (for Material 0.625 in. [16 mm] and over in Thickness),

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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SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A 517/A 517M – 93 (2004)$^{\epsilon 1}$) that may impact the use of this standard.

(1) Revised Table 1.
(2) Revised section 1.3.
(3) Revised Section 5.
(4) Added keywords.
(5) Editorial changes made throughout.

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