

RELIABLE STEEL DISTRIBUTORS

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Standard Specification for Pressure Vessel Plates, Heat-Treated, Carbon-Manganese- Silicon Steel¹

This standard is issued under the fixed designation A 537/A 537M; 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 (e) 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 specification² covers heat-treated carbon-manganese-silicon steel plates intended for fusion welded pressure vessels and structures.

1.2 Material under this specification is available in the following three classes:

| Class | Heat Treatment | Thickness, | Yield Strength, min, ksi [MPa] | Tensile Strength, min, ksi [MPa] |
|-------|-----------------------|---|--------------------------------|----------------------------------|
| 1 | Normalized | 2½ in. and under [65 mm and under] | 50 [345] | 70 [485] |
| | | Over 2½ to 4 in. [Over 65 to 100 mm] | 45 [310] | 65 [450] |
| | | Over 4 to 6 in. [Over 100 to 150 mm] | 46 [315] | 70 [485] |
| 2 | Quenched and tempered | 2½ in. and under [65 mm and under] | 60 [415] | 80 [550] |
| | | Over 2½ to 4 in. [Over 65 to 100 mm] | 55 [380] | 75 [515] |
| | | Over 4 to 6 in. [Over 100 to 150 mm] | 46 [315] | 70 [485] |
| 3 | Quenched and tempered | 2½ in. and under [65 mm and under] | 55 [380] | 80 [550] |
| | | Over 2½ to 4 in. [Over 65 to 100 mm] | 50 [345] | 75 [515] |
| | | Over 4 to 6 in. [Over 100 to 150 mm] | 40 [275] | 70 [485] |

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.

4. Referenced Documents

2.1 ASTM Standards:

A 20/A20M Specification for General Requirements for Steel Plates for Pressure Vessels³

A 435/A435M Specification for Straight-Beam Ultrasonic Examination of Steel Plates³

A 577/A577M Specification for Ultrasonic Angle-Beam Examination of Steel Plates³

A 578/A578M Specification for Straight-Beam Ultrasonic Examination of Plain and Clad Steel Plates for Special Applications³

3. General Requirements and Ordering Information

3.1 Material supplied 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

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1.3 The maximum thickness of plates furnished under this specification is 4 in. [100 mm] for Class 1 and 6 in. [150 mm] for Class 2 and Class 3.

¹ This specification is under the jurisdiction of ASTM Committee A-1 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 for 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.
- SA-537/SA-537M in Section II of that Code. ³ *Annual Book of ASTM Standards*, Vol 01.04.

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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 thermally treated as follows:

5.1.1 Class 1 plates shall be normalized.

5.1.2 Class 2 and Class 3 plates shall be quenched and tempered. The tempering temperature for Class 2 plates shall not be less than 1100°F [595°C] for not less than ½ h and 1150°F [620°C] for Class 3 plates for not less than ½ h.

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 Tests*:

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

7.1.2 For Class 2 and Class 3 plates with a nominal thickness 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 that shows the greatest elongation.

8. Keywords

8.1 carbon steel plate; pressure containing parts; pressure vessel steels; steel plates for pressure vessel application

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TABLE 1 Chemical Requirements

| Element | Composition, % |
|---|----------------|
| Carbon, max ^A | 0.24 |
| Manganese: | |
| 1½ in. [40 mm] and under in thickness: ^B | |
| Heat analysis | 0.70–1.35 |
| Product analysis | 0.64–1.46 |
| Over 1½ in. [40 mm] in thickness: | |
| Heat analysis | 1.00–1.60 |
| Product analysis | 0.92–1.72 |
| Phosphorus, max ^A | 0.035 |
| Sulfur, max ^A | 0.035 |
| Silicon: | |
| Heat analysis | 0.15–0.50 |
| Product analysis | 0.13–0.55 |
| Copper, max: | |
| Heat analysis | 0.35 |
| Product analysis | 0.38 |
| Nickel, max: ^B | |
| Heat analysis | 0.25 |
| Product analysis | 0.28 |
| Chromium, max: | |
| Heat analysis | 0.25 |
| Product analysis | 0.29 |
| Molybdenum, max: | |
| Heat analysis | 0.08 |
| Product analysis | 0.09 |

^A Applies to both heat and product analyses.

^B Manganese may exceed 1.35 % on heat analysis, up to a maximum of 1.60 %, and nickel may exceed 0.25 % on heat analysis, up to a maximum of 0.50 %, provided the heat analysis carbon equivalent does not exceed 0.57 % when based upon the following equation:

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

When this option is exercised, the manganese and nickel contents on product analysis shall not exceed the heat analysis content by more than 0.12 % and 0.03 %, respectively.

TABLE 2 Tensile Requirements

| | Class 1 | Class 2 | Class 3 |
|---|-----------------|------------------|------------------|
| | ksi [MPa] | ksi [MPa] | ksi [MPa] |
| Tensile strength: | | | |
| 2½ in. and under [65 mm and under] Over | 70–90 [485–620] | 80–100 [550–690] | 80–100 [550–690] |
| 2½ to 4 in., incl [Over 65 to 100 mm, incl] | 65–85 [450–585] | 75–95 [515–655] | 75–95 [515–655] |
| Over 4 to 6 in., incl | ^A | 70–90 | 70–90 |
| [Over 100 to 150 mm, incl] | ^A | [485–620] | [485–620] |
| Yield strength, min: | | | |
| 2½ in. and under [65 mm and under] Over | 50 [345] | 60 [415] | 55 [380] |
| 2½ to 4 in., incl [Over 65 to 100 mm, incl] | 45 [310] | 55 [380] | 50 [345] |
| Over 4 in. to 6 in., incl | ^A | 46 | 40 |
| [Over 100 to 150 mm, incl] | ^A | [315] | [275] |
| Elongation in 2 in. [50 mm], min, %: ^B | | | |
| 4 in. [100 mm] and under | 22 | 22 | 22 |
| Over 4 in. [100 mm] | ^A | 20 | 20 |
| Elongation in 8 in. [200 mm], min, % ^B | 18 | ^C | ^C |

^A Product is not available in this size range.

^B See Specification A 20/A 20M for elongation adjustments.

^C There is no requirement for elongation in 8 in.

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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.

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| S1. Vacuum Treatment, | S8. Ultrasonic Examination in accordance with Specification A 435/A 435M, |
| S2. Product Analysis, | S9. Magnetic Particle Examination, |
| S3. Simulated Post-Weld Heat Treatment of Mechanical Test Coupons, | S11. Ultrasonic Examination in accordance with Specification A 577/A 577M, |
| S4.1 Additional Tension Test, | S12. Ultrasonic Examination in accordance with Specification A 578/A 578M, |
| S5. Charpy V-Notch Impact Test, | S14. Bend Test, and |
| S6. Drop Weight Test, | S17. Vacuum Carbon-Deoxidized Steel. |
| S7. High-Temperature Tension Test, | |

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