



Designation: A542/A542M – 13

Standard Specification for Pressure Vessel Plates, Alloy Steel, Quenched-and- Tempered, Chromium-Molybdenum, and Chromium- Molybdenum-Vanadium¹

This standard is issued under the fixed designation A542/A542M; 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.

1. Scope*

1.1 This specification² covers two types of 2¼ Cr-1 Mo and three types of Cr-Mo-V alloy steel plates for use in the quenched-and-tempered condition, intended for the fabrication of welded pressure vessels and components.

1.2 Material under this specification is available in five types, designated “A,” “B,” “C,” “D,” and “E.” Type B is identical to Type A except for restrictive limits for carbon, phosphorus, sulfur, and nickel. The material is also available in five classes having the following strength levels. Type E is available only as Class 4 and 4a.

| Class | Minimum Tensile Strength, ksi [MPa] |
|----------|-------------------------------------|
| 1 | 105 [725] |
| 2 | 115 [795] |
| 3 | 95 [655] |
| 4 and 4a | 85 [585] |

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 thickness of plates is limited to ⅜ in. [5 mm].

1.5 The material is intended to be suitable for fusion welding. Welding technique is of fundamental importance and it is presupposed that welding procedures will be in accordance with approved methods.

1.6 These alloy steel plates in the as-rolled condition are sensitive to cracking during flame cutting, transit, and handling. They should be shipped in the as-rolled condition only with the mutual agreement of the manufacturer and the purchaser or fabricator.

1.7 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 this specification.

2. Referenced Documents

2.1 ASTM Standards:³

A20/A20M Specification for General Requirements for Steel Plates for Pressure Vessels

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A387/A387M Specification for Pressure Vessel Plates, Alloy Steel, Chromium-Molybdenum

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, 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.

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-542 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



TABLE 1 Chemical Requirements

NOTE 1—Where “...” appears there is no requirement. Values are maximum unless minimum or a range is indicated.

| Element | Composition, % | | | | |
|------------------|----------------|-----------|-------------|-----------|-------------|
| | Type A | Type B | Type C | Type D | Type E |
| Carbon: | | | | | |
| Heat analysis | 0.15 | 0.11–0.15 | 0.10–0.15 | 0.11–0.15 | 0.10–0.15 |
| Product analysis | 0.18 | 0.09–0.18 | 0.08–0.18 | 0.09–0.18 | 0.08–0.18 |
| Manganese: | | | | | |
| Heat analysis | 0.30–0.60 | 0.30–0.60 | 0.30–0.60 | 0.30–0.60 | 0.30–0.60 |
| Product analysis | 0.25–0.66 | 0.25–0.66 | 0.25–0.66 | 0.25–0.66 | 0.25–0.66 |
| Phosphorus: | | | | | |
| Heat analysis | 0.025 | 0.015 | 0.025 | 0.015 | 0.025 |
| Product analysis | 0.025 | 0.015 | 0.025 | 0.020 | 0.025 |
| Sulfur: | | | | | |
| Heat analysis | 0.025 | 0.015 | 0.025 | 0.010 | 0.010 |
| Product analysis | 0.025 | 0.015 | 0.025 | 0.015 | 0.010 |
| Silicon: | | | | | |
| Heat analysis | 0.50 | 0.50 | 0.13 | 0.10 | 0.15 |
| Product analysis | 0.50 | 0.50 | 0.13 | 0.13 | 0.15 |
| Chromium: | | | | | |
| Heat analysis | 2.00–2.50 | 2.00–2.50 | 2.75–3.25 | 2.00–2.50 | 2.75–3.25 |
| Product analysis | 1.88–2.62 | 1.88–2.62 | 2.63–3.37 | 1.88–2.62 | 2.63–3.37 |
| Molybdenum: | | | | | |
| Heat analysis | 0.90–1.10 | 0.90–1.10 | 0.90–1.10 | 0.90–1.10 | 0.90–1.10 |
| Product analysis | 0.85–1.15 | 0.85–1.15 | 0.85–1.15 | 0.85–1.15 | 0.85–1.15 |
| Copper: | | | | | |
| Heat analysis | 0.40 | 0.25 | 0.25 | 0.20 | 0.25 |
| Product analysis | 0.43 | 0.28 | 0.28 | 0.23 | 0.28 |
| Nickel: | | | | | |
| Heat analysis | 0.40 | 0.25 | 0.25 | 0.25 | 0.25 |
| Product analysis | 0.43 | 0.28 | 0.28 | 0.28 | 0.28 |
| Vanadium: | | | | | |
| Heat analysis | 0.03 | 0.02 | 0.20–0.30 | 0.25–0.35 | 0.20–0.30 |
| Product analysis | 0.04 | 0.03 | 0.18–0.33 | 0.23–0.37 | 0.18–0.33 |
| Titanium: | | | | | |
| Heat analysis | ... | ... | 0.015–0.035 | 0.030 | ... |
| Product analysis | ... | ... | 0.005–0.045 | 0.035 | ... |
| Boron: | | | | | |
| Heat analysis | ... | ... | 0.001–0.003 | 0.0020 | ... |
| Product analysis | ... | ... | ... | ... | ... |
| Columbium: | | | | | |
| Heat analysis | ... | ... | ... | 0.07 | 0.015–0.070 |
| Product analysis | ... | ... | ... | 0.08 | 0.010–0.075 |

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4. Manufacture

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

5. Heat Treatment

5.1 All plates shall be heat treated by heating to a suitable austenitizing temperature, holding for a sufficient period of time to attain uniform temperature throughout the thickness, and quenching in a suitable liquid medium by spraying or immersion. For Type D material, the minimum austenitizing temperature shall be 1650°F [900°C]. For Type E material, the minimum austenitizing temperature shall be 1850°F [1010°C].

5.2 After quenching, the plates shall be tempered to produce the specified tensile requirements by heating to a suitable temperature and holding for a period of time of not less than 30 min/in. [1.2 min/mm] of thickness but not less than ½ h. The minimum tempering temperature shall be as follows:

| Type | Class | Temperature, °F [°C] |
|------------|---------|----------------------|
| A, B, C | 1, 2, 3 | 1050 [565] |
| A, B, C | 4 | 1200 [650] |
| A, B, C, D | 4a | 1250 [675] |

5.3 Plates over 4 in. [100 mm] in thickness shall receive a prior heat treatment of normalizing at, or water quenching from, a temperature within the range from 1650 to 1850°F [900 to 1010°C] for Types A, B, C, and D and 1850 to 2050°F [1010 to 1120°C] for Type E before the heat treatment specified in **5.1**.

5.4 Plates ordered without the heat treatment required by **5.1 – 5.3** shall be furnished in either the stress-relieved or the annealed condition. Minimum stress relieving temperature shall be 1050°F [565°C] except for Type E which shall be 1200°F [650°C].

6. Chemical Composition

6.1 The steel shall conform to the chemical requirements shown in **Table 1**.

7. Mechanical Properties

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