



## Designation: **A542/A542M – 13** **A542/A542M – 19**

# Standard Specification for Pressure Vessel Plates, Alloy Steel, Quenched-and-Tempered, Chromium-Molybdenum, and Chromium-Molybdenum-Vanadium<sup>1</sup>

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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope\*

1.1 This specification<sup>2</sup> 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 ¾ 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.

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

2.1 *ASTM Standards:*<sup>3</sup>

[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](#)

<sup>1</sup> 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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<sup>2</sup> For ASME Boiler and Pressure Vessel Code applications, see related Specification SA-542 in Section II of that Code.

<sup>3</sup> 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:					
Columbium (niobium): <sup>A</sup>					
Heat analysis	...	...	...	0.07	0.015–0.070
Product analysis	...	...	...	0.08	0.010–0.075

<sup>A</sup> Columbium and niobium are interchangeable names for the same element and both names are acceptable for use in A01 specifications.

### 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 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].



TABLE 2 Tensile Requirements

	Class 1	Class 2	Class 3	Class 4	Class 4a
Tensile strength, ksi [MPa]	105–125 [725–860]	115–135 [795–930]	95–115 [655–795]	85–110 [585–760]	85–110 [585–760]
Yield strength, min, ksi [MPa]	85 [585]	100 [690]	75 [515]	55 [380]	60 [415]
Elongation in 2 in. [50 mm], min, % <sup>A</sup>	14	13	20	20	18

<sup>A</sup> See Specification A20/A20M for elongation adjustment.

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 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.

### 7.2 Notch Toughness Requirements—Classes 4 and 4a:

7.2.1 A transverse Charpy V-notch test from each plate-as-heat-treated shall have a minimum energy absorption value of 40 ft-lbf [54 J] average of three specimens and 35 ft-lbf [48 J] for one specimen only in the set.

7.2.2 For Class 4, the impact test temperature shall be as specified on the order.

7.2.3 For Class 4a, the impact test temperature shall be 0°F [–18°C].

## 8. Keywords

8.1 alloy steel; alloy steel plate; pressure containing parts; pressure vessel steels; steel plates for pressure vessels

## 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 A20/A20M. Several of those considered suitable for use with this specification are listed in this section 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,

S4.2 Additional Tension Test,