

SPECIFICATION FOR PRESSURE VESSEL PLATES, ALLOY STEEL, QUENCHED AND TEMPERED, NICKEL- CHROMIUM-MOLYBDENUM



SA-543/SA-543M



(Identical with ASTM Specification A543/A543M-09(2014).)

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1. Scope

1.1 This specification covers nickel-chromium-molybdenum alloy steel plates for use in the quenched and tempered condition, intended for the fabrication of welded pressure vessels and other pressure equipment. These alloy compositions are normally considered for construction involving plate thicknesses of 2 in. [50 mm] or greater.

1.2 Material under this specification is available in two types, B and C. The material is also available in three classes as follows:

Class	Minimum Tensile Strength, ksi [MPa]
1	105 [725]
2	115 [795]
3	90 [620]

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 plate thickness is $\frac{3}{16}$ in. [5 mm].

1.5 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.

1.6 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:

- 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 Rolled Steel Plates for Special Applications

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, 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 A 20/A 20M.

3.3 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 heat treated by heating to a suitable austenitizing temperature, holding for a sufficient time period to attain uniform temperature through the thickness and quenching in a suitable liquid medium by spraying or immersion. The plates shall then be tempered to produce the required properties by heating to a suitable temperature not lower than 1100°F [595°C] with a holding time of not less than $\frac{1}{2}$ h/in. [1.2 min/mm] of thickness but not less than $\frac{1}{2}$ h.

5.2 Plates over 4 in. [100 mm] in thickness shall receive a prior treatment of normalizing at, or water quenching from a temperature within the range from 1650 to 1850°F [900 to 1010°C] before the heat treatment specified in 5.1.

5.3 When the fabricator elects to perform the heat treatment in 5.1 and 5.2, the manufacturer shall normalize the plates at an appropriate temperature prior to shipment unless otherwise agreed to.

TABLE 1
CHEMICAL REQUIREMENTS

Element	Composition, %	
	Type B	Type C
Carbon, max ^A	0.20	0.18
Manganese, max ^A	0.40	0.40
Phosphorus, max ^A	0.020	0.020
Sulfur, max ^A	0.020	0.020
Silicon:		
Heat analysis	0.15–0.40	0.15–0.40
Product analysis	0.13–0.45	0.13–0.45
Nickel:		
Heat analysis	2.25–4.00	2.00–3.50
Product analysis	2.18–4.07	1.93–3.57
Chromium:		
Heat analysis	1.00–1.90	1.00–1.90
Product analysis	0.94–1.96	0.94–1.96
Molybdenum:		
Heat analysis	0.20–0.65	0.20–0.65
Product analysis	0.16–0.69	0.16–0.69

^A Applies to both heat and product analyses.

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 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 $\frac{3}{4}$ in. [20 mm] and under, the $1\frac{1}{2}$ 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 shows the greatest elongation.

8. Keywords

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

TABLE 2
TENSILE REQUIREMENTS

	Class 1	Class 2	Class 3
Tensile strength, ksi [MPa]	105–125 [725–860]	115–135 [795–930]	90–115 [620–795]
Yield strength, min, ksi [MPa]	85 [585]	100 [690]	70 [485]
Elongation, 2 in. [50 mm], min, % ^{A, B}	14	14	16

^A See 7.1.2.

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

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 below 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, |
| S4.2 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, | |