

# SPECIFICATION FOR PRESSURE VESSEL PLATES, HEAT-TREATED, CARBON-MANGANESE-SILICON STEEL



SA-537/SA-537M



(Identical with ASTM Specification A537/A537M-20.)

# Specification for Pressure Vessel Plates, Heat-Treated, Carbon-Manganese- Silicon Steel

## 1. Scope

1.1 This specification covers heat-treated carbon-manganese-silicon steel plates intended for fusion welded pressure vessels and structures.

1.2 Plates furnished under this specification are 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 in. [Over 65 mm]	45 [310]	65 [450]
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 in. [Over 100 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 in. [Over 100 mm]	40 [275]	70 [485]

1.3 The maximum thickness of plates is limited only by the capacity of the material to meet the specified mechanical property requirements.

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.

1.5 *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:

- A20/A20M Specification for General Requirements for Steel Plates for Pressure Vessels
- 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 Plates furnished supplied to this material specification shall conform to Specification A20/A20M. These requirements outline the testing and retesting methods and procedures; permissible 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.

TABLE 1 Chemical Requirements

Element	Composition, %
Carbon, max <sup>A</sup>	0.24
Manganese:	
1½ in. [40 mm] and under in thickness: <sup>B</sup>	
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 <sup>A</sup>	0.025
Sulfur, max <sup>A</sup>	0.025
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: <sup>B</sup>	
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

<sup>A</sup> Applies to both heat and product analyses.

<sup>B</sup> 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.

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 conform to the fine austenitic grain size requirement of Specification A20/A20M.

#### 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

TABLE 2 Tensile Requirements

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

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

<sup>B</sup> There is no requirement for elongation in 8 in.

not be less than 1100°F [595°C] and not less than 1150°F [620°C] for Class 3 plates.

#### 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 A20/A20M.

#### 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

**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 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 A435/A435M,      |
| S2. Product Analysis,  | S9. Magnetic Particle Examination,   |
| S3. Simulated Post-Weld Heat Treatment of Mechanical Test Coupons,           | S11. Ultrasonic Examination in accordance with Specification A577/A577M,     |
| S4.1 Additional Tension Test,  | S12. Ultrasonic Examination in accordance with Specification A578/A578M, and |
| S5. Charpy V-Notch Impact Test,  | S17. Vacuum Carbon-Deoxidized Steel.   |
| S6. Drop Weight Test (for Material 0.625 in. [16 mm] and over in Thickness), |  |
| S7. High-Temperature Tension Test,   |  |