

# SPECIFICATION FOR PRESSURE VESSEL PLATES, CARBON STEEL, FOR MODERATE- AND LOWER- TEMPERATURE SERVICE



SA-516/SA-516M



(Identical with ASTM Specification A 516/A 516M-90.)

## 1. Scope

**1.1** This specification covers carbon steel plates intended primarily for service in welded pressure vessels where improved notch toughness is important.

**1.2** Plates under this specification are available in four grades having different strength levels as follows:

Grade U.S. [SI]	Tensile Strength, ksi [MPa]
55 [380]	55–75 [380–515]
60 [415]	60–80 [415–550]
65 [450]	65–85 [450–585]
70 [485]	70–90 [485–620]

**1.3** The maximum thickness of plates is limited only by the capacity of the composition to meet the specified mechanical property requirements; however, current practice normally limits the maximum thickness of plates furnished under this specification as follows:

Grade U.S. [SI]	Maximum Thickness, in. [mm]
55 [380]	12 [305]
60 [415]	8 [205]
65 [450]	8 [205]
70 [485]	8 [205]

**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.

## 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 Plain and Clad 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, 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 that should be complied with when purchasing material to this specification.

**3.3** In addition the basic requirements of this specification, certain supplementary requirements are available when 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.

**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** Plates 1.50 in. [40 mm] and under in thickness are normally supplied in the as-rolled condition. The plates may be ordered normalized or stress relieved, or both.

**5.2** Plates over 1.50 in. [40 mm] in thickness shall be normalized.

**5.3** When notch-toughness tests are required on plates 1½ in. [40 mm] and under in thickness, the plates shall be normalized unless otherwise specified by the purchaser.

**5.4** If approved by the purchaser, cooling rates faster than those obtained by cooling in air are permissible for improvement of the toughness, provided the plates are subsequently tempered in the temperature range 1100 to 1300°F [595 to 705°C].

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

TABLE 1  
CHEMICAL REQUIREMENTS

Elements	Composition, %			
	Grade 55 [Grade 380]	Grade 60 [Grade 415]	Grade 65 [Grade 450]	Grade 70 [Grade 485]
Carbon, max <sup>A</sup> :				
$\frac{1}{2}$ in. [12.5 mm] and under	0.18	0.21	0.24	0.27
Over $\frac{1}{2}$ in. to 2 in. [12.5 to 50 mm], incl	0.20	0.23	0.26	0.28
Over 2 in. to 4 in. [50 to 100 mm], incl	0.22	0.25	0.28	0.30
Over 4 to 8 in. [100 to 200 mm], incl	0.24	0.27	0.29	0.31
Over 8 in. [200 mm]	0.26	0.27	0.29	0.31
Manganese:				
$\frac{1}{2}$ in. [12.5] and under:				
Heat analysis <sup>B</sup>	0.60–0.90	0.60–0.90	0.85–12.0	0.85–1.20
Product analysis <sup>B</sup>	0.55–0.98	0.55–0.98	0.79–1.30	0.79–1.30
Over $\frac{1}{2}$ in. [12.5]:				
Heat analysis	0.60–1.20	0.85–1.20	0.85–1.20	0.85–1.20
Product analysis	0.55–1.30	0.79–1.30	0.79–1.30	0.79–1.30
Phosphorus, max <sup>A</sup>	0.035	0.035	0.035	0.035
Sulfur, max <sup>A</sup>	0.035	0.035	0.035	0.035
Silicon:				
Heat analysis	0.15–0.40	0.15–0.40	0.15–0.40	0.15–0.40
Product analysis	0.13–0.45	0.13–0.45	0.13–0.45	0.13–0.45

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

<sup>B</sup> Grade 60 plates  $\frac{1}{2}$  in. [12.5 mm] and under in thickness may have 0.85–1.20% manganese on heat analysis, and 0.79–1.30% manganese on product analysis.

TABLE 2  
TENSILE REQUIREMENTS

	Grade			
	55 [380]	60 [415]	65 [450]	70 [485]
Tensile strength, ksi [MPa]	55–75 [380–515]	60–80 [415–550]	65–85 [450–585]	70–90 [485–620]
Yield strength, min, <sup>B</sup> ksi [MPa]	30 [205]	32 [220]	35 [240]	38 [260]
Elongation in 8 in. [200 mm], min, %	23 <sup>A</sup>	21 <sup>A</sup>	19 <sup>A</sup>	17 <sup>A</sup>
Elongation in 2 in. [50 mm], min, %	27 <sup>A</sup>	25 <sup>A</sup>	23 <sup>A</sup>	21 <sup>A</sup>

<sup>A</sup> See Specification A 20/A 20M.

<sup>B</sup> Determined by either the 0.2% offset method or the 0.5% extension-under-load method.

**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 is included in ASTM 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.

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