

**SPECIFICATION FOR PRESSURE VESSEL PLATES,
HEAT-TREATED, CARBON-MANGANESE-SILICON
STEEL, FOR MODERATE AND LOWER TEMPERATURE
SERVICE**



SA-738/SA-738M



(23)

(Identical with ASTM Specification A738/A738M-19.)

Specification for Pressure Vessel Plates, Heat-Treated, Carbon-Manganese- Silicon Steel, for Moderate and Lower Temperature Service

1. Scope

1.1 This specification covers heat-treated carbon-manganese-silicon steel plates intended for use in welded pressure vessels at moderate and lower temperature service.

1.2 Material under this specification is available in four strength levels, 75 ksi [515 MPa], 85 ksi [585 MPa], 80 ksi [550 MPa], and 90 ksi [620 MPa] minimum ultimate tensile strengths.

1.3 The maximum thickness of plates for Grades A, B, and C is limited only by the capacity of the chemical composition and heat treatment to meet the specified mechanical property requirements; however, current practice normally limits the maximum thickness of plates furnished under this specification to 6 in. [150 mm] for Grade A, 4 in. [100 mm] for Grade B, and 6 in. [150 mm] for Grade C. The maximum permitted nominal thickness is 1.5 in. [40 mm] for Grade D and 2 in. [50 mm] for Grade E.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

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

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 Grade A plates 2.5 in. [65 mm] and under in thickness shall be supplied in the normalized condition or in the quenched and tempered condition at the option of the manufacturer.

5.2 Grade A plates over 2.5 in. [65 mm] in thickness and Grade B, Grade C, Grade D, and Grade E plates in all thicknesses shall be quenched-and-tempered.

TABLE 1 Chemical Requirements

NOTE 1—Where “...” appears there is no requirement.

Element	Composition, %				
	Grade A	Grade B	Grade C	Grade D	Grade E
Carbon, max ^A	0.24	0.20	0.20	0.10	0.12 ^B
Manganese:					
Heat analysis					
1.5 in. [40 mm] and under	1.50 max	0.90–1.50	1.50 max	1.00–1.60	1.10–1.60 ^B
Over 1.5 to 2.0 in. [40 to 50 mm]	1.50 max	0.90–1.50	1.50 max	^C	1.10–1.60 ^B
Over 2.0 to 2.5 in. [50 to 65 mm], incl	1.50 max	0.90–1.50	1.50 max	^C	^C
Over 2.5 in. [65 mm]	1.60 max	0.90–1.60	1.60 max	^C	^C
Product analysis					
1.5 in. [40 mm] and under	1.62 max	0.84–1.62	1.62 max	0.92–1.72	1.02–1.72 ^B
Over 1.5 to 2.0 in. [40 to 50 mm], incl	1.62 max	0.84–1.62	1.62 max	^C	1.02–1.72 ^B
Over 2.0 to 2.5 in. [50 to 65 mm], incl	1.62 max	0.84–1.62	1.62 max	^C	^C
Over 2.5 in. [65 mm]	1.72 max	0.84–1.72	1.72 max	^C	^C
Phosphorus, max ^A	0.025	0.025	0.025	0.015	0.015
Sulfur, max ^A	0.025	0.025	0.025	0.006	0.006
Silicon:					
Heat analysis	0.15–0.50	0.15–0.55	0.15–0.50	0.15–0.50	0.15–0.50
Product analysis	0.13–0.55	0.13–0.60	0.13–0.55	0.13–0.55	0.13–0.55
Copper, max:					
Heat analysis	0.35	0.35	0.35	0.35	0.35
Product analysis	0.38	0.38	0.38	0.38	0.38
Nickel, max:					
Heat analysis	0.50	0.60	0.50	0.60	0.70
Product analysis	0.53	0.63	0.53	0.63	0.73
Chromium, max:					
Heat analysis	0.25	0.30	0.25	0.25	0.30
Product analysis	0.29	0.34	0.29	0.29	0.34
Molybdenum, max:					
Heat analysis					
1.5 in. [40 mm] and under	0.08	0.20	0.08	0.30	0.35
Over 1.5 in. [40 mm]	0.08	0.30	0.08	^C	^C
Product analysis					
1.5 in. [40 mm] and under	0.09	0.21	0.09	0.33	0.38
Over 1.5 in. [40 mm]	0.09	0.33	0.09	^C	^C
Vanadium, max:					
Heat analysis	0.07 ^D	0.07	0.05	0.08	0.09
Product analysis	0.08 ^D	0.08	0.05	0.09	0.10
Columbium (niobium), ^G max:					
Heat analysis	0.04 ^D	0.04	...	0.05	0.05
Product analysis	0.05 ^D	0.05	...	0.06	0.06
Columbium (niobium) ^G plus vanadium, max:					
Heat analysis	0.08 ^D	0.08	...	0.11	0.12
Product analysis	0.10 ^D	0.10	...	0.12	0.13
Titanium, max ^A	...	...	...	^E	^F
Boron, max ^A	...	...	...	0.0007	0.0007
Aluminum, min ^A	...	...	...	0.020 total or 0.015 acid soluble ^E	0.020 total or 0.015 acid soluble ^F

^A Applies to both heat and product analyses.^B For each reduction of 0.01 percentage point below the specified maximum for carbon, an increase of 0.06 percentage point above the specified maximum for manganese is permitted, up to a maximum of 1.85 % by heat analysis, and 1.99 % by product analysis.^C Not applicable because of maximum thickness.^D Vanadium and columbium (niobium)^G may be added only by agreement between the manufacturer and the purchaser.^E By agreement between the manufacturer and the purchaser, the steel may be produced with titanium, in which case the minimum aluminum content shall not apply. If this option is exercised, the titanium content, by heat analysis, shall be 0.006 % to 0.03 %, and the titanium content for the heat and product analyses shall be reported on the test report.^F By agreement between the manufacturer and the purchaser, the steel may be produced with titanium, in which case the minimum aluminum content shall not apply. If this option is exercised, the titanium content, by heat analysis, shall be 0.006 % to 0.03 % inclusive and the titanium content for the heat and product analyses shall be reported on the test report.^G Columbium and niobium are interchangeable names for the same element and both names are acceptable for use in A01 specifications.

TABLE 2 Tensile Requirements

NOTE 1— t = plate nominal thickness.

	Grade A	Grade B	Grade C	Grade D	Grade E
Tensile strength, ksi [MPa]					
1.5 in. [40 mm] and under	75–95 [515–655]	85–102 [585–705]	80–100 [550–690]	85–105 [585–724]	90–110 [620–760]
Over 1.5 to 2.0 in. [40 to 50 mm], incl	75–95 [515–655]	85–102 [585–705]	80–100 [550–690]	^A	90–110 [620–760]
Over 2.0 to 2.5 in. [50 to 65 mm]	75–95 [515–655]	85–102 [585–705]	80–100 [550–690]	^A	^A
Over 2.5 to 4 in. [65 to 100 mm], incl	75–95 [515–655]	85–102 [585–705]	75–95 [515–655]	^A	^A
Over 4 in. [100 mm]	75–95 [515–655]	85–102 [585–705]	70–90 [485–620]	^A	^A
Yield strength, min, ksi [MPa]					
1.5 in. [40 mm] and under	45 [310]	60 [415]	60 [415]	70 [485]	75 [515]
Over 1.5 to 2.0 in. [40 to 50 mm], incl	45 [310]	60 [415]	60 [415]	^A	75 [515]
Over 2.0 to 2.5 in. [50 to 65 mm], incl	45 [310]	60 [415]	60 [415]	^A	^A
Over 2.5 to 4 in. [65 to 100 mm], incl	45 [310]	60 [415]	55 [380]	^A	^A
Over 4 in. [100 mm]	45 [310]	60 [415]	46 [315]	^A	^A
Elongation in 2 in. [50 mm], min, % ^B					
1.5 in. [40 mm] and under	20	20	22	20	20
Over 1.5 to 4 in. [40 to 100 mm], incl	20	20	22	^A	^A
Over 4 in. [100 mm]	20	20	20	^A	^A

^A Not applicable.^B See Specification A20/A20M for elongation requirement adjustments.

5.3 When plates are tempered, the minimum tempering temperature shall be 1100°F [595°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 S 17, Vacuum Carbon-Deoxidized Steel in Specification A20/A20M.

7. Mechanical Requirements

7.1 *Tension Test Requirements*—The plates as represented by the tension test specimens shall conform to the requirements of Table 2.

7.1.1 For nominal plate thicknesses of $\frac{3}{4}$ in. [20 mm] and under, the 1.5-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 pressure-containing parts; pressure vessel steel; steel plates; steel plates for pressure vessel applications

SUPPLEMENTARY REQUIREMENTS

Supplementary requirements shall not apply unless specified in the purchase order. A list of standardized supplementary requirements for use at the option of the purchaser is 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 | S6. Drop Weight Test (for Material 0.625 in. [16 mm] and Over in Thickness). |
| S2. Product Analysis. | S9. Magnetic Particle Examination. |
| S3. Simulated Post-Weld Heat Treatment of Mechanical Test Coupons. | S12. Ultrasonic Examination in accordance with Specification A578/A578M. |
| S4. Additional Tension Test. | S20. Maximum Carbon Equivalent for Weldability |
| S5. Charpy V-Notch Impact Test. | |

APPENDIX

(Nonmandatory Information)

X1. CHARPY V-NOTCH IMPACT TEST

X1.1 The energy values below are shown only for information as to the guarantees that are generally available. Mandatory conformance to any of the values listed is a matter of agreement between the purchaser and the manufacturer.

X1.1.1 *Longitudinal*—20 ft·lbf [27 J] at -50°F [-45°C].

X1.1.2 *Transverse*—20 ft·lbf [27 J] at -20°F [-30°C].

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