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Standard Specification for Pressure Vessel Plates, Low-Carbon Manganese-Molybdenum-Columbium Alloy Steel, for Moderate and Lower Temperature Service[1]

This standard is issued under the fixed designation A 735/A 735M; 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 (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers low-carbon manganese-molybdenum-columbium alloy steel plates for piping components and welded pressure vessels.

1.2 Four different classes are covered, which provide various tensile strength properties. A Charpy V-notch energy absorption requirement of 20 ft·lbf [27J] at −50°F [−45°C] is specified for all grades.

1.2.1 *Classes 1 and 2* provide minimum yield strength levels of 65 ksi [450 MPa] and 70 ksi [485 MPa] respectively. Both classes can be provided in the as-rolled condition or in the quenched-and-tempered condition.

1.2.2 *Class 3* provides a minimum yield strength level of 75 ksi [515 MPa]. This grade can be provided in the as-rolled and precipitation heat-treated condition or in the quenched-and-tempered condition.

1.2.3 *Class 4* provides a yield strength level of 80 ksi [550 MPa] in the as-rolled and precipitation heat-treated condition.

1.3 Current practice limits plate thickness furnished under this specification. The individual manufacturer should be consulted on size and thickness limitations.

1.4 Welding procedures are of fundamental importance and must be such as not to adversely affect the properties of the material, especially in the heat-affected zone. It is presupposed that welding procedures will be suitable for the materials being welded.

1.5 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:* [2]

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 Plates supplied to this product specification shall conform to the requirements of Specification A 20/A 20M, which outlines the testing and retesting methods and procedures, permissible variations in dimensions and mass, quality and repair of defects, marking, loading, and so forth.

3.2 Specification A 20/A 20M also establishes the rules for ordering information that should be compiled when purchasing plates to this specification.

3.3 In addition to the basic requirements of this specification, certain supplementary requirements are available where additional control, testing, or examination is required to meet the end use requirements.

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 Coils are excluded from qualification to this specification until they are processed into finished plates. Plates produced from coil means plates that have been cut to individual lengths from coil. The processor directly controls, or is responsible for, the operations involved in the processing of coils into finished plates. Such operations include decoiling,

[1] 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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[2] 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.

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leveling, cutting to length, testing, inspection, conditioning, heat treatment (if applicable), packaging, marking, loading for shipment, and certification.

NOTE 1—For plates produced from coil and furnished without heat treatment or with stress relieving only, three test results are reported for each qualifying coil. Additional requirements regarding plates from coil are described in Specification A 20/A 20M.

4. Materials and 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 As-rolled Class 3 and 4 plates shall be precipitation heat treated in the temperature range from 1000 to 1200°F [540 to 650°C] for a time to be determined by the manufacturer or processor. Precipitation heat treatment is a subcritical temperature thermal treatment performed to cause precipitation of submicroscopical constituents, and so forth, so as to result in enhancement of some desirable property.

5.2 When quenching and tempering Class 1, 2, or 3 products, the austenitizing temperature shall be 1725°F [940°C] maximum. Tempering temperature shall be 1150 to 1300°F [620 to 705°C].

5.3 If the purchaser elects to perform the heat treatment, the plates shall be accepted on the basis of mill tests made from test coupons heat treated as specified in the purchase order. If the test coupon heat treatment requirements are not specified in the purchase order, the manufacturer or processor shall heat treat the test coupons under conditions it considers appropriate. The manufacturer or processor shall inform the purchaser of the heat treatment used for the test coupons.

6. Chemical Requirements

6.1 The steel shall conform to the requirements as to chemical composition prescribed in Table 1.

TABLE 1 Chemical Requirements

Element	Heat Analysis, %	Product Analysis, %
Carbon, max	0.06	0.08
Manganese		
5/8 in. [16 mm] and under in thickness	1.20–1.90	1.12–2.04
Over 5/8 in. [16 mm]	1.50–2.20	1.41–2.36
Phosphorus, max	0.035	0.035
Sulfur, max	0.025	0.025
Silicon, max	0.40	0.45
Columbium	0.03–0.09	0.02–0.10
Molybdenum	0.23–0.47	0.20–0.50
Copper (when specified)	0.20–0.35	0.18–0.37

7. Mechanical Properties

7.1 *Tension Test*:

7.1.1 The plates, as represented by the test specimens, shall conform to the requirements given in Table 2.

7.1.2 For nominal plate thicknesses of 3/4 in. [20 mm] and under, where requirements for elongation in 2 in. [50 mm] are to be determined, the 1½-in. [40-mm] wide rectangular test 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.

7.2 *Notch-Toughness Test*:

7.2.1 Charpy V-notch impact tests shall be made in accordance with Specification A 20/A 20M.

7.2.2 The test results of 10 by 10-mm specimens shall meet an average of 20 ft·lbf [27J] at −50°F [−45°C].

8. Retreatment

8.1 Heat-treated plates that fail to meet the tensile or notch-toughness requirements may be re-heat treated. All required tests shall be repeated when the plates are resubmitted for inspection.

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TABLE 2 Tensile Requirements

	Class 1,[A] ksi [MPa]	Class 2,[A] ksi [MPa]	Class 3, ksi [MPa]	Class 4, ksi [MPa]
Yield strength, min	65 [450]	70 [485]	75 [515]	80 [550]
Tensile strength	80–100 [550–690]	85–105 [585–725]	90–110 [620–760]	95–115 [655–790]
Elongation in 8 in. [200 mm], min, %[B]	12	12	12	12
Elongation in 2 in. [50 mm], min, %[B]	18	18	18	18

[A] Class 1 as-rolled and Class 2 as-rolled are limited to 1 in. [25 mm] maximum thickness.
[B] See Specification A 20/A 20M for elongation adjustments.

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 A 20/A 20M. Those that are considered suitable for use with this specification are listed below by title.

S1. Vacuum Treatment,

S2. Product Analysis,

S3. Simulated Post-Weld Heat Treatment of Mechanical Test Coupons,

S5. Charpy V-Notch Impact Test,

S6. Drop Weight Test (for Material 0.625 in. [16 mm] and Over in Thickness),

S8. Ultrasonic Examination in accordance with Specification A 435/A 435M,

S9. Magnetic Particle Examination,

S11. Ultrasonic Examination in accordance with Specification A 577/A 577M,

S12. Ultrasonic Examination in accordance with Specification A 578/A 578M,

S24. Strain Age Test, and

S25. Weldability.

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