Designation: A 736/A 736M – 03 (Reapproved 2007)

Standard Specification for Pressure Vessel Plates, Low-Carbon Age-Hardening Nickel-Copper-Chromium-Molybdenum-Columbium and Nickel-Copper-Manganese-Molybdenum-Columbium Alloy Steel[1]

This standard is issued under the fixed designation A 736/A 736M; 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[2] covers two grades of low-carbon age-hardening alloy steel plates for welded pressure vessels and piping components. The two grades are nickel-copper-chromium-molybdenum-columbium and nickel-copper-manganese-molybdenum-columbium steels.

1.2 Plates under this specification are available in three classes, as follows:

1.2.1 *Class 1*—As-rolled and precipitation heat treated. Available in thicknesses of ¾ in. [20 mm] and under. Grade A, Class 1 has a minimum specified tensile strength of 90 ksi. Grade C, Class 1 has a minimum specified tensile strength of 100 ksi.

1.2.2 *Class 2*—Normalized and precipitation heat treated.

1.2.2.1 Available in Grade A only. Grade A has minimum specified tensile strength of 72 ksi for thinner plates and 65 and 60 ksi for thicker plates, with the minimum tensile strength dependent upon the plate thickness. The maximum thickness of Grade A, Class 2 is limited only by the capacity of the chemical composition and heat treatment to meet the specified mechanical property requirements; however, current practice usually limits the maximum thickness to 8 in. [200 mm].

1.2.3 *Class 3*—Quenched and precipitation heat treated.

1.2.3.1 Available as Grade A with a minimum specified tensile strength of 85 ksi for thinner plates and 75 and 70 ksi for thicker plates, with the minimum tensile strength dependent upon the plate thickness. The maximum thickness of Grade A, Class 3 plates is limited only by the capacity of the chemical composition and heat treatment to meet the specified mechanical property requirements; however, current practice usually limits the maximum thickness to 8 in. [200 mm].

1.2.3.2 Available as Grade C with a specified minimum tensile strength of 95 ksi for plates ¾ in. [20 mm] and under in thickness and 90 ksi for plates over ¾ in. in thickness. The maximum thickness of Grade C, Class 3, plates is 2 in. [50 mm].

1.3 This specification is expressed in both inch-pound units and in SI units. However, unless the order specifies the applicable "M" specification designation (SI units), the material shall be furnished in inch-pound units.

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 this specification.

2. Referenced Documents

2.1 *ASTM Standards:* [3]

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,

[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 ASME Boiler and Pressure Vessel Code applications, see related Specification SA-736 in Section II of that Code.

[3] 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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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 complied with 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 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, 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.

3.6 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. Materials and Manufacture

4.1 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 *Class 1*—The plates shall be precipitation heat treated at a temperature in the range from 1000 to 1300°F [540 to 705°C] for a time to be determined by the manufacturer or processor.

5.2 *Class 2*—The plates shall be normalized at a temperature in the range from 1600 to 1700°F [870 to 930°C] and then precipitation heat treated at a temperature in the range from 1000 to 1300°F [540 to 705°C] for a time to be determined by the manufacturer or processor.

5.3 *Class 3*—The plates shall be quenched in a liquid medium from a temperature in the range from 1600 to 1700°F [870 to 930°C] and then precipitation heat treated at a temperature in the range from 1000 to 1300°F [540 to 705°C] for a time to be determined by the manufacturer or processor.

5.4 If the purchaser elects to perform the thermal 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 procedure followed in thermally treating the test coupons at the mill.

6. Chemical Composition

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

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 ¾ in. [20 mm] and under, 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 minimum value of 20 ft·lbf [27 J] at −50°F [−45°C].

TABLE 1 Chemical Requirements

Element	Composition, %	
	Grade A	Grade C
Carbon, max		
Heat analysis	0.07	0.07
Product analysis	0.09	0.090
Manganese		
Heat analysis	0.40–0.70	1.30–1.65
Product analysis	0.35–0.78	1.21–1.77
Phosphorus, max[A]	0.025	0.025
Sulfur, max[A]	0.025	0.025
Silicon, max		
Heat analysis	0.40	0.40
Product analysis	0.45	0.45
Chromium		
Heat analysis	0.60–0.90	...
Product analysis	0.56–0.94	...
Nickel		
Heat analysis	0.70–1.00	0.70–1.00
Product analysis	0.67–1.03	0.67–1.03
Molybdenum		
Heat analysis	0.15–0.25	0.15–0.25
Product analysis	0.12–0.28	0.12–0.28
Copper		
Heat analysis	1.00–1.30	1.00–1.30
Product analysis	0.95–1.35	0.95–1.35
Columbium, min		
Heat analysis	0.02	0.02
Product analysis	0.01	0.01

[A] Applies to both heat analysis and product analysis.

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TABLE 2 Tensile Requirements

	Grade A Class 1, ksi [MPa]	Grade A Class 2, ksi [MPa]	Grade A Class 3, ksi [MPa]	Grade C Class 1, ksi [MPa]	Grade C Class 3, ksi [MPa]
Yield strength, min					
¾ in. and under	80	65	75	90	85
[20 mm and under]	[550]	[450]	[515]	[620]	[585]
Over ¾ to 1 in., incl	. . .	65	75	. . .	80
[Over 20 to 25 mm, incl]	. . .	[450]	[515]	. . .	[550]
Over 1 to 2 in., incl	. . .	60	75	. . .	80
[Over 25 to 50 mm, incl]	. . .	[415]	[515]	. . .	[550]
Over 2 to 4 in., incl	. . .	55	65	. . .	. . .
[Over 50 to 100 mm, incl]	. . .	[380]	[450]	. . .	. . .
Over 4 in.	. . .	50	60	. . .	. . .
[Over 100 mm]	. . .	[345]	[415]	. . .	. . .
Tensile strength					
¾ in. and under	90–110	72–92	85–105	100–120	95–115
[20 mm and under]	[620–760]	[495–635]	[585–725]	[690–825]	[655–795]
Over ¾ to 1 in., incl	. . .	72–92	85–105	. . .	90–110
[Over 20 to 25 mm, incl]	. . .	[495–635]	[585–725]	. . .	[620–760]
Over 1 to 2 in., incl	. . .	72–92	85–105	. . .	90–110
[Over 25 to 50 mm, incl]	. . .	[495–635]	[585–725]	. . .	[620–760]
Over 2 to 4 in., incl	. . .	65–85	75–95	. . .	. . .
[Over 50 to 100 mm, incl]	. . .	[450–585]	[515–655]	. . .	. . .
Over 4 in.	. . .	60–80	70–90	. . .	. . .
[Over 100 mm]	. . .	[415–550]	[485–620]	. . .	. . .
Elongation					
2 in. [50 mm], min, %[A]	20	20	20	20	20

[A] See Specification A 20/A 20M for elongation adjustment.

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,
S4. Additional Tension Test,
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,
S10. Charpy V-Notch Test Curve,
S11. Ultrasonic Examination in accordance with Specification A 577/A 577M,
S12. Ultrasonic Examination in accordance with Specification A 578/A 578M,
S13. NDT Temperature Determination,
S15. Reduction of Area Measurement,
S17. Vacuum Carbon-Deoxidized Steel,
S19. Restricted Chemical Requirements,
S24. Strain Age Test, and
S25. Weldability.

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