Designation: A 553/A 553M – 06

Standard Specification for Pressure Vessel Plates, Alloy Steel, Quenched and Tempered 8 and 9 % Nickel[1]

This standard is issued under the fixed designation A 553/A 553M; 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 8 and 9 % nickel alloy steel plates for use in the water quenched and tempered condition intended for the fabrication of welded pressure vessels.

1.2 Material under this specification is available in two types having different chemical composition as follows:

Type	Nominal Nickel Content, %
I	9
II	8

1.3 Plates produced under this specification are subject to impact testing at −320°F [−195°C] for Type I, and −275°F [−170°C] for Type II or at such other temperatures as are agreed upon.

1.4 The maximum thickness of plates is limited only by the capacity of the material to meet the specified mechanical property requirements; however, current mill practice normally limits this material to 2 in. [50 mm] max.

1.5 This material is susceptible to magnetization. Use of magnets in handling after heat treatment should be avoided if residual magnetism would be detrimental to subsequent fabrication or service.

1.6 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:* [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 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 which should be complied with when purchasing material to this specification.

3.3 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. 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.

[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-553/SA-553M 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.

***A Summary of Changes section appears at the end of this standard.**

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5. Heat Treatment

5.1 All plates shall be heat treated in accordance with 5.2. Shell plates and other parts, including heads and reinforcing pads, which are heated for forming, shall be heat treated after forming in accordance with 5.2.

5.2 *Heat Treatment Procedure*—Heat treat all plates by heating to a suitable temperature within the range from 1475 to 1700°F [800 to 925°C], holding for a sufficient time to obtain uniform temperature throughout the plate thickness and then quenching in water. Subsequently, temper the plates within the range from 1050 to 1175°F [565 to 635°C], holding at this temperature for a minimum of 30 min/in. [1.2 min/mm] of thickness but not less than 15 min, and cool in air or water quench at a rate not less than 300°F/h [165°C/h].

5.2.1 *Hardening*— The plates shall be heated to a temperature within the range from 1475 to 1700°F [800 to 925°C], held at that temperature for a sufficient time to obtain uniform temperature throughout the plate thickness, and then quenched in a liquid media.

5.2.2 *Tempering*— The plates shall be tempered at a temperature within the range from 1050 to 1175°F [565 to 635°C], being held at that temperature for a minimum of 30 min/in. [1.2 min/mm] of thickness, but in no case less than 15 min., and then cooled in air or liquid-quenched at a rate not less than 300°F/h [165°C/h].

5.2.2.1 Prior to the tempering treatment, the plates may be subjected to an intermediate heat treatment consisting of heating to a temperature in the range from 1165 to 1290°F [630 to 700°C] for Type I, or 1185 to 1310°F [640 to 710°C] for Type II, holding at that temperature for a minimum of 1 h/in. [2.4 min/mm] of thickness, but in no case less than 15 min, and then water-quenching to below 300°F [150°C] in the case of plate thicknesses of more than ⅝ in. [16 mm] or cooling in air or water-quenching to below 300°F [150°C] in the case of plate thicknesses of ⅝ in. [16 mm] and under.

NOTE 1—The intermediate heat treatment is for the purpose of enhancing elongation and notch-toughness and for reducing susceptibility to strain-aging embrittlement and temper embrittlement. It may be performed at the option of the material manufacturer or may be specified by the purchaser.

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 tension-test specimens shall conform to the requirements specified in Table 2.

7.1.1 Upon agreement between the purchaser and the manufacturer, yield strength may be determined by the extension under load method, using 0.005 in./in. [mm/mm] total extension.

7.1.2 For nominal plate thicknesses 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 shows the greatest elongation.

TABLE 1 Chemical Requirements

Element	Composition, %	
	Type I	Type II
Carbon, max[A]	0.13	0.13
Manganese, max:		
Heat analysis	0.90	0.90
Product analysis	0.98	0.98
Phosphorus, max[A]	0.035	0.035
Sulfur, max[A]	0.035	0.035
Silicon:		
Heat analysis[B]	0.15–0.40	0.15–0.40
Product analysis[C]	0.13–0.45	0.13–0.45
Nickel:		
Heat analysis	8.50–9.50	7.50–8.50
Product analysis	8.40–9.60	7.40–8.60

[A] Applies to both heat and product analyses.
[B] Silicon may be less than 0.15 %, provided total aluminum is 0.030 % or over, or provided acid soluble aluminum is 0.025 % or over.
[C] Silicon may be less than 0.13 %, provided total aluminum is 0.030 % or over, or provided acid soluble aluminum is 0.025 % or over.

TABLE 2 Tensile Requirements

Tensile strength, ksi [MPa]	100 to 120 [690–825]
Yield strength (0.2 % offset), min, ksi [MPa]	85 [585]
Elongation in 2 in. [50 mm], min, %[A]	20.0

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

7.2 *Impact Test Requirements*:

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

7.2.2 The longitudinal axis of the test specimens shall be transverse to the final rolling direction of the plate.

7.2.3 Unless otherwise agreed, tests shall be conducted at −320°F [−195°C] for Type I and at −275°F [−170°C] for Type II.

7.2.4 Each test specimen shall have a lateral expansion opposite the notch of not less than 0.015 in. [0.381 mm].

8. Finish

8.1 Because retained scale may mask surface imperfections, as well as mar the plate surface, plates shall be descaled by the producer after heat treatment. In the case of material to be heat-treated by the purchaser, the plates shall be descaled by the producer prior to shipment.

9. Marking

9.1 In addition to the marking required in Specification A 20/A 20M, each plate shall be legibly stamped or stenciled, depending upon the ordered thickness, with the letters *QT*, except as otherwise specified in 9.1.1.

9.1.1 When the optional heat treatment in 5.2.2.1 is performed, the plates shall be marked with the letters QTT instead of QT.

10. Keywords

10.1 alloy steel; alloy steel plate; pressure containing parts; pressure vessel steels; steel plates; steel plates for pressure vessel applications

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SUPPLEMENTARY REQUIREMENTS

Supplementary requirements shall not apply unless specified in the order.

A list of standard supplementary requirements for use at the option of the purchaser are included in 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.

S1. Vacuum Treatment,

S2. Product Analysis,

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

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, and

S17. Vacuum Carbon-Deoxidized Steel.

ADDITIONAL SUPPLEMENTARY REQUIREMENTS

Also listed below are additional optional Supplementary Requirements S55 and S56, which are suitable for this specification.

S55. Longitudinal Charpy Impact Energy Absorption Requirement

S55.1 The longitudinal Charpy V-notch impact properties shall not be less than 25 ft·lbf [34 J] at the specified temperature.

S55.2 Each impact test value shall constitute the average value of three specimens, with not more than one value below the specified minimum value of 25 ft·lbf [34 J] but in no case below 20 ft·lbf [27 J] for full size specimens.

S56. Transverse Charpy Impact Energy Absorption Requirement

S56.1 The transverse Charpy V-notch impact properties shall not be less than 20 ft·lbf [27 J] at the specified temperature.

S56.2 Each impact test value shall constitute the average value of three specimens, with not more than one value below the specified minimum value of 20 ft·lbf [27 J] but in no case below 15 ft·lbf [20 J] for full size specimens.

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A 553/A 553M – 95 (2000)) that may impact the use of this standard.

(1) Revised the title.

(2) Added Section 10.

(3) Removed Supplementary Requirement S14, Bend Test.

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