



Designation: ~~A553/A553M – 17<sup>ε1</sup>~~ A553/A553M – 22

## Standard Specification for Pressure Vessel Plates, Alloy Steel, Quenched and Tempered ~~7, 8, 7 %~~, 8 %, and 9 % Nickel<sup>1</sup>

This standard is issued under the fixed designation A553/A553M; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

<sup>ε1</sup> NOTE — An editorial correction was made to Footnote 1 in December 2019.

### 1. Scope\*

1.1 This specification<sup>2</sup> covers ~~7, 8, 7 %~~, 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 three types having different chemical composition as follows:

Type	Nominal Nickel Content, %
I	9
II	8
III	7

1.3 Plates produced under this specification are subject to impact testing at ~~–320°F [–195°C]~~–320 °F [–195 °C] for Type I or Type III, and ~~–275°F [–170°C]~~–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. requirements.

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.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.8 *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.*

<sup>1</sup> 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.

Current edition approved Nov. 1, 2017Nov. 1, 2022. Published November 2017December 2022. Originally approved in 1965. Last previous edition approved in 20142017 as ~~A553/A553M – 14~~A553/A553M – 17<sup>ε1</sup>. DOI: ~~10.1520/A0553\_A0553M-17E01~~10.1520/A0553\_A0553M-22.

<sup>2</sup> For ASME Boiler and Pressure Vessel Code applications, see related Specification SA-553/SA-553M in Section II of that Code.

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



## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>3</sup>

A20/A20M Specification for General Requirements for Steel Plates for Pressure Vessels

A435/A435M Specification for Straight-Beam Ultrasonic Examination of Steel Plates

A577/A577M Specification for Ultrasonic Angle-Beam Examination of Steel Plates

A578/A578M Specification for Straight-Beam Ultrasonic Examination of Rolled Steel Plates for Special Applications

## 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 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  $+475$ – $1475$  °F to  $+700$ – $1700$  °F [ $800$  °C 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  $+1050$ – $1050$  °F to  $+175$ – $1175$  °F [ $565$  °C to  $635$  °C] for Type I and Type II, or from  $+1000$ – $1000$  °F to  $+125$ – $1125$  °F [ $540$  °C to  $615$  °C] for Type III.

TABLE 1 Chemical Requirements

Element	Composition, %		
	Type I	Type II	Type III
Carbon, max <sup>A</sup>	0.13	0.13	0.13
Manganese, max:			
Heat analysis	0.90	0.90	0.90
Product analysis	0.98	0.98	0.98
Phosphorus, max <sup>A</sup>	0.015	0.015	0.010
Sulfur, max <sup>A</sup>	0.015	0.015	0.010
Silicon:			
Heat analysis	0.15–0.40 <sup>B</sup>	0.15–0.40 <sup>B</sup>	0.05–0.30 <sup>A</sup>
Product analysis	0.13–0.45 <sup>C</sup>	0.13–0.45 <sup>C</sup>	
Nickel:			
Heat analysis	8.50–9.50	7.50–8.50	6.50–7.50 <sup>A</sup>
Product analysis	8.40–9.60	7.40–8.60	
Molybdenum <sup>A</sup>	...	...	0.10–0.30
Columbium (Niobium), <sup>D</sup> max <sup>A</sup>	...	...	0.03

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

<sup>B</sup> 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.

<sup>C</sup> 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.

<sup>D</sup> Columbium and niobium are interchangeable names for the same element and both names are acceptable for use in A01 specifications.

<sup>3</sup> 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.



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, % <sup>A</sup>	20.0

<sup>A</sup> See Specification A20/A20M for elongation adjustment.

III, 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  $300^{\circ}\text{F/h}$  [ $300^{\circ}\text{F}$  /  $165^{\circ}\text{C/h}$ ] [ $165^{\circ}\text{C/h}$ ].

5.2.1 *Hardening*—The plates shall be heated to a temperature within the range from  $1475^{\circ}\text{F}$  to  $1700^{\circ}\text{F}$  [ $800^{\circ}\text{F}$  /  $1700^{\circ}\text{F}$  /  $800^{\circ}\text{C}$  to  $925^{\circ}\text{C}$ ] [ $925^{\circ}\text{C}$ ], 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  $1050^{\circ}\text{F}$  to  $1175^{\circ}\text{F}$  [ $565^{\circ}\text{F}$  /  $1175^{\circ}\text{F}$  /  $565^{\circ}\text{C}$  to  $635^{\circ}\text{C}$ ] [ $635^{\circ}\text{C}$ ] for Type I and Type II, or from  $1000^{\circ}\text{F}$  to  $1125^{\circ}\text{F}$  [ $540^{\circ}\text{F}$  /  $1125^{\circ}\text{F}$  /  $540^{\circ}\text{C}$  to  $615^{\circ}\text{C}$ ] [ $615^{\circ}\text{C}$ ] for Type III; 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  $300^{\circ}\text{F/h}$  [ $300^{\circ}\text{F}$  /  $165^{\circ}\text{C/h}$ ] [ $165^{\circ}\text{C/h}$ ].

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  $1165^{\circ}\text{F}$  to  $1290^{\circ}\text{F}$  [ $630^{\circ}\text{F}$  /  $1290^{\circ}\text{F}$  /  $630^{\circ}\text{C}$  to  $700^{\circ}\text{C}$ ] [ $700^{\circ}\text{C}$ ] for Type I, or  $1185^{\circ}\text{F}$  to  $1310^{\circ}\text{F}$  [ $640^{\circ}\text{F}$  /  $1310^{\circ}\text{F}$  /  $640^{\circ}\text{C}$  to  $710^{\circ}\text{C}$ ] [ $710^{\circ}\text{C}$ ] for Type II, or  $1205^{\circ}\text{F}$  to  $1330^{\circ}\text{F}$  [ $650^{\circ}\text{F}$  /  $1330^{\circ}\text{F}$  /  $650^{\circ}\text{C}$  to  $720^{\circ}\text{C}$ ] [ $720^{\circ}\text{C}$ ] for Type III; holding at that temperature for a suitable time, but in no case less than 15 min, and then water-quenching to below  $300^{\circ}\text{F}$  [ $150^{\circ}\text{C}$ ] [ $300^{\circ}\text{F}$  /  $150^{\circ}\text{C}$ ] in the case of plate thicknesses of more than  $\frac{5}{8}$  in. [16 mm] or cooling in air or water-quenching to below  $300^{\circ}\text{F}$  [ $150^{\circ}\text{C}$ ] [ $300^{\circ}\text{F}$  /  $150^{\circ}\text{C}$ ] in the case of plate thicknesses of  $\frac{5}{8}$  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 A20/A20M.

## 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  $\frac{3}{4}$  in. [20 mm] and under, the  $1\frac{1}{2}$  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.