Designation: A 353/A 353M – 04

Standard Specification for Pressure Vessel Plates, Alloy Steel, 9 Percent Nickel, Double-Normalized and Tempered[1]

This standard is issued under the fixed designation A 353/A 353M; 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 9 % nickel steel plates, double-normalized and tempered, intended particularly for welded pressure vessels for cryogenic service.

1.2 Plates produced under this specification are subject to impact testing at −320°F [−195°C] or at such other temperatures as are agreed upon.

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

1.4 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.

1.5 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:* [3]

A 20/A20M Specification for General Requirements for Steel Plates for Pressure Vessels

A 435/A435M Specification for Straight-Beam Ultrasonic Examination of Steel Plates

A 577/A577M Specification for Ultrasonic Angle-Beam Examination of Steel Plates

A 578/A578M 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 that 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.

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 that are heated for forming shall be heat treated after forming in accordance with 5.2.

5.2 *Heat Treatment Procedure*:

[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-353/SA-353M 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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5.2.1 *First Normalizing Treatment*—Heat the plate to a uniform temperature of 1650 ± 25 °F [900 ± 15 °C], hold 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 cool in air.

5.2.2 *Second Normalizing Treatment*—Reheat the plate to a uniform temperature of 1450 ± 25 °F [790 ± 15 °C], hold 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 cool in air.

5.2.3 *Tempering Treatment*—Reheat the plate to a uniform temperature within the range from 1050 to 1125 °F [565 to 605 °C], hold within that temperature range for a minimum of 1 h/in. 2.4 min/mm of thickness, but in no case less than 15 min, and cool in air or water quench at a rate not less than 300 °F/h [165 °C/h].

5.2.4 If hot forming is performed after heating to a temperature within the range from 1650 to 1750 °F [900 to 955 °C] the first normalizing treatment (5.2.1) may be omitted.

5.2.5 When the plates are heat treated by the fabricator, it shall be the fabricator's responsibility to apply the proper heat treatment and to conduct tests it deems necessary to ensure that the specified properties are attained.

6. Chemical Requirements

6.1 The steel shall conform to the chemical composition requirements shown in Table 1 unless otherwise modified in accordance with Supplementary Requirement S17, Vacuum Carbon-Deoxidized Steel, in Specification A 20/A 20M.

TABLE 1 Chemical Requirements

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

[A] Applies to both heat and product analyses.

[B] The specificed minimum limit does not apply if the total aluminum content is 0.030 % or more, or provided that acid soluble aluminum is 0.025 % or more.

7. Mechanical Requirements

7.1 *Tension Test Requirements*—The material as represented by the 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. [0.005 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.

7.1.3 One tension test shall be taken from each plate as heat treated.

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].

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. Keywords

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

TABLE 2 Tensile Requirements

Tensile strength, ksi [MPa]	100–120 [690–825]
Yield strength (0.2 % offset), min, ksi [MPa][A]	75 [515]
Elongation in 2 in. [50 mm], min, %[B]	20.0

[A] See 7.1.1.

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

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SUPPLEMENTARY REQUIREMENTS

Supplementary requirements shall not apply unless specified in the order.

A list of standardized 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,

S4.1 Additional Tension Test,

S6. Drop Weight Test,

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

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 353/A 353M–93 (1999)) that may impact the use of this standard.

(1) Table 1 was revised by the addition of Footnote B.

(2) Section 9 was added.

(3) S14 was deleted.

(4) Sections 5.1, 5.2.1, 5.2.2, 5.2.3, and 5.2.5 were revised.

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