Designation: A578/A578M – 17 (Reapproved 2023)

Standard Specification for Straight-Beam Ultrasonic Examination of Rolled Steel Plates for Special Applications[1]

This standard is issued under the fixed designation A578/A578M; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This specification[2] covers the procedure and acceptance standards for straight-beam, pulse-echo, ultrasonic examination of rolled carbon and alloy steel plates, ⅜ in. [10 mm] in thickness and over, for special applications. The method will detect internal discontinuities parallel to the rolled surfaces. Three levels of acceptance standards are provided. Supplementary requirements are provided for alternative procedures.

1.2 Individuals performing examinations in accordance with this specification shall be qualified and certified in accordance with the requirements of the latest edition of ASNT SNT-TC-1A or an equivalent accepted standard. An equivalent standard is one which covers the qualification and certification of ultrasonic nondestructive examination candidates and which is acceptable to the purchaser.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.4 *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.*

1.5 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

A263 Specification for Stainless Chromium Steel-Clad Plate

A264 Specification for Stainless Chromium-Nickel Steel-Clad Plate

A265 Specification for Nickel and Nickel-Base Alloy-Clad Steel Plate

E317 Practice for Evaluating Performance Characteristics of Ultrasonic Pulse-Echo Testing Instruments and Systems without the Use of Electronic Measurement Instruments

E1316 Terminology for Nondestructive Examinations

E2491 Guide for Evaluating Performance Characteristics of Phased-Array Ultrasonic Testing Instruments and Systems

2.2 *ANSI Standard:*[4]

B 46.1 Surface Texture

2.3 *ASNT Standard:*[5]

SNT-TC-1A

3. Terminology

3.1 *Definitions*—For definitions of terms relating to nondestructive examinations used in this specification, refer to Terminology E1316.

4. Ordering Information

4.1 The inquiry and order shall indicate the following:

4.1.1 Acceptance level requirements (Sections 8, 9, and 10). Acceptance Level B shall apply unless otherwise agreed to by purchaser and manufacturer.

4.1.2 Any additions to the provisions of this specification as prescribed in 6.2, 14.1, and Section 11.

4.1.3 Supplementary requirements, if any.

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[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-578/SA-578M 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.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[5] Available from American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518, http://www.asnt.org.

5. Apparatus

5.1 The ultrasonic instrument shall be a pulse echo type instrument capable of addressing either a mono-element probe or a phased-array probe and shall be equipped with a standardized dB gain or attenuation control stepped in increments of 1 dB minimum. The system shall be capable of generating and displaying A-scans.

5.2 Vertical and horizontal linearity and amplitude control linearity shall be checked in accordance with Practice E317, Guide E2491, or another procedure approved by the users of this specification. An acceptable linearity performance may be agreed upon by the manufacturer and purchaser.

5.3 The transducer shall be 1 in. or 1⅛ in. [25 mm or 30 mm] in diameter or 1 in. [25 mm] square. When phased-array systems are used, focal laws using an equivalent active aperture shall be used.

5.4 Other search units may be used for evaluating and pinpointing indications.

6. Procedure

6.1 Perform the inspection in an area free of operations that interfere with proper performance of the test.

6.2 Unless otherwise specified, make the ultrasonic examination on either major surface of the plate.

6.3 The plate surface shall be sufficiently clean and smooth to maintain a first reflection from the opposite side of the plate at least 50 % of full scale during scanning. This may involve suitable means of scale removal at the manufacturer's option. Condition local rough surfaces by grinding. Restore any specified identification which is removed when grinding to achieve proper surface smoothness.

6.4 Perform the test by one of the following methods: direct contact, immersion, or liquid column coupling. Use a suitable couplant such as water, soluble oil, or glycerin. As a result of the test by this method, the surface of plates may be expected to have a residue of oil or rust or both.

6.5 A nominal test frequency of 2¼ MHz is recommended. When testing plates less than ¾ in. [20 mm] thick a frequency of 5 MHz may be necessary. Thickness, grain size or microstructure of the material and nature of the equipment or method may require a higher or lower test frequency. Use the transducers at their rated frequency. A clean, easily interpreted A-scan display should be produced during the examination.

6.6 *Scanning:*

6.6.1 Scanning shall be along continuous perpendicular grid lines on nominal 9-in. [225 mm] centers, or at the option of the manufacturer, shall be along continuous parallel paths, transverse to the major plate axis, on nominal 4-in. [100 mm] centers, or shall be along continuous parallel paths parallel to the major plate axis, on 3-in. [75 mm] or smaller centers. Measure the lines from the center or one corner of the plate with an additional path within 2 in. [50 mm] of all edges of the plate on the examination surface.

6.6.2 Conduct the general scanning with an instrument adjustment that will produce a first reflection from the opposite side of a sound area of the plate from 50 % to 90 % of full scale. Minor sensitivity adjustments may be made to accommodate for surface roughness.

6.6.3 When a discontinuity condition is observed during general scanning adjust the instrument to produce a first reflection from the opposite side of a sound area of the plate of 75 % ± 5 % of full scale. Maintain this instrument setting during evaluation of the discontinuity condition.

7. Recording

7.1 Record all discontinuities causing complete loss of back reflection.

7.2 For plates ¾ in. [20 mm] thick and over, record all indications with amplitudes equal to or greater than 50 % of the initial back reflection and accompanied by a 50 % loss of back reflection.

NOTE 1—Indications occurring midway between the initial pulse and the first back reflection may cause a second reflection at the location of the first back reflection. When this condition is observed it shall be investigated additionally by use of multiple back reflections.

7.3 Where grid scanning is performed and recordable conditions as in 7.1 and 7.2 are detected along a given grid line, the entire surface area of the squares adjacent to this indication shall be scanned. Where parallel path scanning is performed and recordable conditions as in 7.1 and 7.2 are detected, the entire surface area of a 9-in. by 9-in. [225 mm by 225 mm] square centered on this indication shall be scanned. The true boundaries where these conditions exist shall be established in either method by the following technique: Move the transducer away from the center of the discontinuity until the height of the back reflection and discontinuity indications are equal. Mark the plate at a point equivalent to the center of the transducer. Repeat the operation to establish the boundary.

8. Acceptance Standard—Level A

8.1 Any area where one or more discontinuities produce a continuous total loss of back reflection accompanied by continuous indications on the same plane (within 5 % of plate thickness) that cannot be encompassed within a circle whose diameter is 3 in. [75 mm] or ½ of the plate thickness, whichever is greater, is unacceptable.

9. Acceptance Standards—Level B

9.1 Any area where one or more discontinuities produce a continuous total loss of back reflection accompanied by continuous indications on the same plane (within 5 % of plate thickness) that cannot be encompassed within a circle whose diameter is 3 in. [75 mm] or ½ of the plate thickness, whichever is greater, is unacceptable.

9.2 In addition, two or more discontinuities smaller than described in 9.1 shall be unacceptable unless separated by a minimum distance equal to the greatest diameter of the larger discontinuity or unless they may be collectively encompassed by the circle described in 9.1.

10. Acceptance Standard—Level C

10.1 Any area where one or more discontinuities produce a continuous total loss of back reflection accompanied by continuous indications on the same plane (within 5 % of plate

thickness) that cannot be encompassed within a 1-in. [25 mm] diameter circle is unacceptable.

11. Report

11.1 Unless otherwise agreed to by the purchaser and the manufacturer, the manufacturer shall report the following data:

11.1.1 All recordable indications listed in Section 7 on a sketch of the plate with sufficient data to relate the geometry and identity of the sketch to those of the plate.

11.1.2 Test parameters including: Make and model of instrument, surface condition, search unit (type and frequency), and couplant.

11.1.3 Date of test.

12. Inspection

12.1 The inspector representing the purchaser shall have access at all times, while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works that concern the ultrasonic testing of the material ordered. The manufacturer shall afford the inspector all reasonable facilities to satisfy him that the material is being furnished in accordance with this specification. All tests and inspections shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be conducted without interfering unnecessarily with the manufacturer's operations.

13. Rehearing

13.1 The manufacturer reserves the right to discuss rejectable ultrasonically tested plate with the purchaser with the object of possible repair of the ultrasonically indicated defect before rejection of the plate.

14. Marking

14.1 Plates accepted according to this specification shall be identified by stenciling (stamping) "UT A578—A" on one corner for Level A, "UT A578—B" for Level B, and "UT A578—C" for Level C. The supplement number shall be added for each supplementary requirement ordered.

15. Keywords

15.1 nondestructive testing; pressure containing parts; pressure vessel steels; steel plate for pressure vessel applications; steel plates; straight-beam; ultrasonic examinations

SUPPLEMENTARY REQUIREMENTS

These supplementary requirements shall apply only when individually specified by the purchaser. When details of these requirements are not covered herein, they are subject to agreement between the manufacturer and the purchaser.

S1. Scanning

S1.1 Scanning shall be continuous over 100 % of the plate surface along parallel paths, transverse or parallel to the major plate axis, with not less than 10 % overlap between each path.

S2. Acceptance Standard

S2.1 Any recordable condition listed in Section 7 that (*1*) is continuous, (*2*) is on the same plane (within 5 % of the plate thickness), and (*3*) cannot be encompassed by a 3-in. [75 mm] diameter circle, is unacceptable. Two or more recordable conditions (see Section 7), that (*1*) are on the same plane (within 5 % of plate thickness), (*2*) individually can be encompassed by a 3-in. [75 mm] diameter circle, (*3*) are separated from each other by a distance less than the greatest dimension of the smaller indication, and (*4*) collectively cannot be encompassed by a 3-in. [75 mm] diameter circle, are unacceptable.

S2.2 An acceptance level more restrictive than Section 8 or 9 shall be used by agreement between the manufacturer and purchaser.

S3. Procedure

S3.1 The manufacturer shall provide a written procedure in accordance with this specification.

S4. Certification

S4.1 The manufacturer shall provide a written certification of the ultrasonic test operator's qualifications.

S5. Surface Finish

S5.1 The surface finish of the plate shall be conditioned to a maximum 125 µin. [3 µm] AA (see ANSI B 46.1) prior to test.

S6. Withdrawn

See Specifications A263, A264, and A265 for equivalent descriptions for clad quality level.

S7. Withdrawn

See Specifications A263, A264, and A265 for equivalent descriptions for clad quality level.

S8. Ultrasonic Examination Using Flat Bottom Hole Calibration (for Plates 4 in. [100 mm] Thick and Greater)

S8.1 Use the following calibration and recording procedures in place of 6.6.2, 6.6.3, and Section 7.

S8.2 The transducer shall be in accordance with 5.3.

S8.3 *Reference Reflectors*—The *T*/4, *T*/2, and 3*T*/4 deep flat bottom holes shall be used to calibrate the equipment, where T is the thickness of the plate. The flat bottom hole diameter shall be in accordance with Table S8.1. The holes may be drilled in

TABLE S8.1 Calibration Hole Diameter as a Function of Plate Thickness (S8)

Plate Thickness, in. [mm]	4–6 [100–150]	>6–9 [>150–225]	>9–12 [>225–300]	>12–20 [>300–500]
Hole Diameter, in. [mm]	⅝ [16]	¾ [19]	⅞ [22]	1⅛ [29]

the plate to be examined if they can be located without interfering with the use of the plate, in a prolongation of the plate to be examined, or in a reference block of the same nominal composition, and thermal treatment as the plate to be examined. The surface of the reference block shall be no better to the unaided eye than the plate surface to be examined. The reference block shall be of the same nominal thickness (within 75 % to 125 % or 1 in. [25 mm] of the examined plate, whichever is less) and shall have acoustical properties similar to the examined plate. Acoustical similarity is presumed when, without a change in instrument setting, comparison of the back reflection signals between the reference block and the examined plate shows a variation of 25 % or less.

S8.4 *Calibration Procedure:*

S8.4.1 Couple and position the search unit for maximum amplitudes from the reflectors at *T*/4, *T*/2, and 3*T*/4. Set the instrument to produce a 75 % ± 5 % of full scale indication from the reflector giving the highest amplitude.

S8.4.2 Without changing the instrument setting, couple and position the search unit over each of the holes and mark on the screen the maximum amplitude from each hole and each minimum remaining back reflection.

S8.4.3 Mark on the screen half the vertical distance from the A-scan base line to each maximum amplitude hole mark. Connect the maximum amplitude hole marks and extend the line through the thickness for the 100 % DAC (distance amplitude correction curve). Similarly connect and extend the half maximum amplitude marks for the 50 % DAC. Alternatively, when time-corrected gain (TCG) is used, the responses from the flat bottom holes shall be equalized at 75 % screen height (±5 %) and the half-amplitude noted.

S8.5 *Recording:*

S8.5.1 Record all areas where the remaining back reflection is smaller than the highest of the minimum remaining back reflections found in S8.4.2.

S8.5.2 Record all areas where indications exceed 50 % DAC or 50 % TCG.

S8.5.3 Where recordable conditions listed in S8.5.1 and S8.5.2 are detected along a given grid line, continuously scan the entire surface area of the squares adjacent to the condition and record the boundaries or extent of each recordable condition.

S8.6 Scanning shall be in accordance with 6.6.

S8.7 The acceptance levels of Section 8 or 9 shall apply as specified by the purchaser except that the recordable condition shall be as given in S8.5.

S9. Ultrasonic Examination of Electroslag Remelted (ESR) and Vacuum-Arc Remelted (VAR) Plates, from 1 in. to 16 in. [25 mm to 400 mm] in Thickness, Using Flat-Bottom Hole Calibration and Distance-Amplitude Corrections

S9.1 The material to be examined must have a surface finish of 200 µin. [5 µm] as maximum for plates up to 8 in. [200 mm] thick, inclusive, and 250 µin. [6 µm] as maximum for plates over 8 in. to 16 in. [200 mm to 400 mm] thick.

S9.2 Use the following procedures in place of 6.6.1, 6.6.2, 6.6.3, and Section 7.

S9.3 The transducer shall be in accordance with 5.3.

S9.4 *Reference Reflectors*—The *T*/4, *T*/2, and 3*T*/4 deep flat bottom holes shall be used to calibrate the equipment, where T is the thickness of the plate. The flat bottom hole diameter shall be in accordance with Table S9.1. The flat bottoms of the holes shall be within 1° of parallel to the examination surface. The holes may be drilled in the plate to be examined if they can be located without interfering with the use of the plate, in a prolongation of the plate to be examined, or in a reference block of the same nominal composition and thermal treatment as the plate to be examined. The surface of the reference block shall be no better to the unaided eye than the plate surface to be examined. The reference block shall be of the same nominal thickness (within 75 % to 125 % or 1 in. [25 mm] of the examined plate, whichever is less) and shall have acoustical properties similar to the examined plate. Acoustical similarity is presumed when, without a change in instrument setting, comparison of the back reflection signals between the reference block and the examined plate shows a variation of 25 % or less.

S9.5 *Calibration Procedure:*

S9.5.1 Couple and position the search unit for maximum amplitudes from the reflectors at *T*/4, *T*/2, and 3*T*/4. Set the instrument to produce a 75 % ± 5 % of full-scale indication from the reflector giving the highest amplitude.

S9.5.2 Without changing the instrument setting, couple and position the search unit over each of the holes and mark on the screen the maximum amplitude from each of the holes.

S9.5.3 Mark on the screen half the vertical distances from the sweep line to each maximum amplitude hole mark. Connect the maximum amplitude hole marks and extend the line through the thickness for the 100 % DAC (distance amplitude correction curve). Similarly connect and extend the half maximum amplitude marks for the 50 % DAC. Alternatively, when time-corrected gain (TCG) is used, the responses from the flat bottom holes shall be equalized at 75 % screen height (±5 %) and the half-amplitude noted.

S9.6 *Scanning*—Scanning shall cover 100 % of one major plate surface, with the search unit being indexed between each pass such that there is at least 15 % overlap of adjoining passes in order to assure adequate coverage for locating discontinuities.

S9.7 *Recording*—Record all areas where the back reflection drops below the 50 % DAC or 50 % TCG. If the drop in back reflection is not accompanied by other indications on the screen, recondition the surface in the area and reexamine ultrasonically. If the back reflection is still below 50 % DAC, the loss may be due to the metallurgical structure of the material being examined. The material shall be held for metallurgical review by the purchaser and manufacturer.

S9.8 *Acceptance Standards*—Any indication that exceeds the 100 % DAC or 100 % TCG shall be considered unacceptable. The manufacturer may reserve the right to discuss

TABLE S9.1 Calibration Hole Diameter as a Function of Plate Thickness (S9)

Plate Thickness, in. [mm]	1–4 [25–100]	>4–8 [>100–200]	>8–12 [>200–300]	>12–16 [>300–400]
Hole Diameter, in. [mm]	⅛ [3]	¼ [6]	⅜ [10]	½ [13]

rejectable ultrasonically examined material with the purchaser, the object being the possible repair of the ultrasonically indicated defect before rejection of the plate.