



Designation: E 2223 – 02

Standard Practice for Examination of Seamless, Gas-Filled, Steel Pressure Vessels Using Angle Beam Ultrasonics¹

This standard is issued under the fixed designation E 2223; 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 practice describes a contact angle-beam shear wave ultrasonic technique to detect and locate the circumferential position of longitudinally oriented discontinuities and to compare the amplitude of the indication from such discontinuities to that of a specified reference notch. This practice does not address examination of the vessel ends. The basic principles of contact angle-beam examination can be found in Practice E 587. Application to pipe and tubing, including the use of notches for standardization, is described in Practice E 213.

1.2 This practice is appropriate for the ultrasonic examination of cylindrical sections of gas-filled, seamless, steel pressure vessels such as those used for the storage and transportation of pressurized gasses. It is applicable to both isolated vessels and those in assemblies.

1.3 The practice is intended to be used following an Acoustic Emission (AE) examination of stacked seamless gaseous pressure vessels (with limited surface scanning area) described in Test Method E 1419.

1.4 This practice does not establish acceptance criteria. These are determined by the reference notch dimensions, which must be specified by the using parties.

NOTE 1—Background information relating to the technical requirements of this practice can be found in the references cited in Test Method E 1419, Appendix X1.

1.5 Dimensional values stated in in-pound units are regarded as standard; SI equivalents, in parentheses may be approximate.

1.6 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

¹ This practice is under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and are the direct responsibility of Subcommittee E07.06 on Ultrasonic Method.

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2. Referenced Documents

2.1 ASTM Standards:

E 213 Practice for Ultrasonic Examination of Metal Pipe and Tubing²

E 543 Practice for Agencies Performing Nondestructive Testing²

E 587 Practice for Ultrasonic Angle-Beam Examination by the Contact Method²

E 1316 Terminology for Nondestructive Examinations²

E 1419 Test Method for Examination of Seamless, Gas-Filled, Pressure Vessels Using Acoustic Emission²

2.2 ASNT Documents:

Recommended Practice SNT-TC-1A for Personnel Qualification and Certification³

ANSI/ASNT-CP-189 Standard for Qualification and Certification of Nondestructive Testing Personnel³

2.3 AIA Document:

NAS-410 Nondestructive Testing Personnel Qualification and Certification⁴

3. Terminology

3.1 Terminology relating to this practice for angle-beam shear wave ultrasonic examination is defined in Terminology E 1316.

4. Summary of Methodology

4.1 An ultrasonic pulse-echo contact angle-beam, shear wave technique with the beam directed circumferentially is used to locate surface breaking discontinuities in the cylindrical wall of a pressure vessel. The amplitude of the reflected signal from the discontinuity is compared to that of a known reference notch. Scanning is performed in both clockwise and counter clockwise directions to detect and confirm the position of the discontinuity identified in the AE examination report.

² Annual Book of ASTM Standards, Vol 03.03.

³ Available from the American Society for Nondestructive Testing, 1711 Arlington Lane, P.O. Box 28518, Columbus, OH 43228-0518.

⁴ Available from Aerospace Industries Association of America, Inc., 1250 Eye St., NW, Washington, DC 20005..

5. Significance and Use

5.1 The purpose of this practice is to provide a procedure for locating, detecting and estimating the relevance of longitudinally oriented crack-like discontinuities which have been previously indicated by AE examination.

5.2 This practice may be used for a pressure vessel that is situated in such a way as to limit access to the vessel's wall. Typical examples include tube trailers and gas tube railroad cars. Since the pressure vessels are stacked horizontally in a frame, with limited space between them, the circumferential location of a discontinuity may be a distance away from the search unit (several skip distances).

5.3 This practice has been shown to be effective for cylinders between 9 in. (229 mm) and 24 in. (610 mm) in diameter and wall thicknesses between ¼ in. (6.4 mm) to 1 in. (26 mm) with discontinuities that are oriented longitudinally in pressure vessel sidewall.

5.4 To be reliably detected by the procedure in this practice, a significant part of the reflecting surface must be transverse to the beam direction.

5.5 Evaluation of possible discontinuity in the end faces indicated by AE is not covered by this practice.

6. Basis of Application

6.1 Personnel Qualification

6.1.1 If specified in the contractual agreement, personnel performing examinations to this standard shall be qualified in accordance with a nationally recognized NDT personnel qualification practice or standard such as ANSI/ASNT-CP-189, SNT-TC-1A, NAS-410, or a similar document and certified by the employer or certifying agency, as applicable. The standard used and its applicable revision shall be specified by the regulatory authority, or stated in the contractual agreement, or both.

6.1.2 Additional Personnel Training

6.1.2.1 Personnel performing this type of examination shall have additional training in the following topics.

6.1.3 Construction and manufacturing techniques for seamless steel pressure vessels.

6.1.4 Familiarity with the types of discontinuities that may occur in this type of pressure vessels.

6.2 Qualification of Nondestructive Agencies

6.2.1 If specified in the contractual agreement, NDT agencies shall be qualified and evaluated as described in the applicable Sections 5 through 9 of Practice E 543. The applicable edition shall be specified by the regulatory authority, or stated in the contractual agreement, or both.

6.3 Extent of Examination

6.3.1 The extent of the examination shall be in accordance with the procedures in Sections 9 and 10 unless otherwise specified.

6.3.2 The reference notch dimensions shall be specified by the regulatory authority, or stated in the contractual agreement, or both.

6.4 Reporting Criteria

6.4.1 Reporting criteria for the examination results shall be in accordance with Section 11 unless otherwise specified. Since acceptance criteria are not specified in this standard, they shall

be defined in accordance with Section 8 and by the regulatory authority or stated in the contractual agreement.

6.5 Reexamination of Repaired/Reworked Items

6.5.1 Reexamination of repaired/reworked items is not addressed in this standard and if required shall be specified by the regulatory authority, or stated in the contractual agreement, or both.

7. Apparatus

7.1 Ultrasonic pulse-echo instrumentation shall have a minimum capacity of examining at center frequencies from 2¼ to 5 MHz. The instrument, search units and related equipment shall be capable of displaying the peak amplitude of the indication from the reference notch in the standardization ring, as described in Section 8, and locating its circumferential position over the full sweep range required for coverage of the vessel to be examined.

7.1.1 Each search unit used for this technique shall have the appropriate frequency and refracted angle for the material and geometry of the pressure vessel that is being examined. The frequency and angle of the search unit is selected during standardization and is related to diameter, wall thickness and the type of steel used for the vessel and corresponding standardization rings.

7.1.1.1 The angle and frequency of the search unit to be used shall be determined by using different search units on a reference ring that represents the examination piece. A search unit which can satisfactorily detect and display the indication from the notch in the reference ring at the maximum distance to be used during the examination shall be selected for setting up the Distance Amplitude Correction (DAC) curve for examination in accordance with 9.3.

7.1.1.2 Select search units for evaluation from those having frequencies 2¼ and 5 MHz with refracted angles of 45° to 75° in steel, and in available commercial sizes. Those producing the required sensitivity and DAC response on the appropriate reference ring are acceptable. These search units have generally been found satisfactory for the examination of the type of vessels specified in 5.3.

7.1.1.3 The search unit shall be comprised of a transducer mounted on a plastic wedge that is designed to have continuous acoustic coupling between search unit and the pressure vessel wall.

NOTE 2—This is usually accomplished with a wedge that is radiused to match the cylinder diameter.

7.2 Couplant for this practice shall be a liquid that is used between the ultrasonic search unit and examination piece to remove the air and transmit ultrasonic waves. Water is a preferred couplant. Other couplant such as oil or glycerin may be used. Couplant shall be the same for both standardization and actual examination. Care shall be taken to ensure that the couplant does not freeze when the examination is conducted at low temperatures.

8. Standardizing Ring with Reference Notches

8.1 The reference ring shall be fabricated from the same type of pressure vessel that is being examined. That is,