



Designation: E 214 – 05

Standard Practice for Immersed Ultrasonic Testing by the Reflection Method Using Pulsed Longitudinal Waves¹

This standard is issued under the fixed designation E 214; 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 Department of Defense.

1. Scope

1.1 This practice² describes an ultrasonic examination procedure for detecting discontinuities in material using instruments that transmit and receive pulsed longitudinal ultrasonic waves introduced into the material to be examined while immersed in or impinged upon by a liquid coupling agent. This practice applies to any material that can conduct sound waves of an appropriate frequency, and can be immersed in a liquid coupling agent for inspection, or can be subject to inspection by the use of a column or stream of the couplant between the search unit and the material being examined.

NOTE 1—Practice E 1001 is a complementary document that extends Practice E 214 by describing more detailed procedures.

1.2 *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.*

2. Referenced Documents

2.1 ASTM Standards:³

- E 127 Practice for Fabricating and Checking Aluminum Alloy Ultrasonic Standard Reference Blocks
- E 317 Practice for Evaluating Performance Characteristics of Ultrasonic Pulse-Echo Examination Instruments and Systems Without the Use of Electronic Measurement Instruments
- E 428 Practice for Fabrication and Control of Steel Reference Blocks Used in Ultrasonic Inspection
- E 543 Practice for Agencies Performing Nondestructive Testing

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

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² For ASME Boiler and Pressure Vessel Code applications see related Practice SE-214 in the 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.

E 1001 Practice for Detection and Evaluation of Discontinuities by the Immersed Pulse-Echo Ultrasonic Method Using Longitudinal Waves

E 1316 Terminology for Nondestructive Testing

2.2 ASNT Documents

SNT-TC-1A Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing⁴

ANSI/ASNT-CP-189 Standard for Qualification and Certification of Nondestructive Testing Personnel⁴

2.3 AIA Standard:⁵

NAS-410 Certification and Qualification of Nondestructive Test Personnel

2.4 Military Specifications⁶

NOTE 2—For DoD contracts, unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS (Department of Defense Index of Specifications Standards) cited in the solicitation.

3. Terminology

3.1 *Definitions*—For definitions of terms used in this practice, see Terminology E 1316.

4. Basis of Application

4.1 Personnel Qualification. 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 practice or standard used and its applicable revision shall be identified in the contractual agreement between the using parties.

4.2 Written Procedure. A detailed written procedure shall be used for the performance of ultrasonic examinations in accordance with this practice. The written procedure should address

⁴ Available from the American Society for Nondestructive Testing, 1711 Arlington Plaza, P.O. Box 28518, Columbus, OH 43228-0518.

⁵ Available from Aerospace Industries Association of America, Inc. (AIA), 1250 Eye St., NW, Washington, DC 20005.

⁶ Copies of specifications, standards, drawings and publications required by manufacturers in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.



all applicable portions of this practice, for the purposes of consistency in application and the repeatability of the examination results. Specific requirements regarding the preparation and approval of the written procedure should be determined by the purchaser and supplier agreement.

4.3 NDT Agencies. If a NDT agency is to be used to perform the testing, the agency should be qualified in accordance with Practice E 543.

5. Apparatus

5.1 *Electronic Apparatus*—The electronic apparatus shall be capable of producing, receiving, and displaying electrical pulses at the required frequency and energy levels, and employ A-Scan, B-Scan, C-Scan, or other data presentation as described in the written procedure. Instrument performance shall be verified on a periodic basis, using Practice E 317 or an equivalent procedure. Appropriate means shall be employed to ensure electronic instrument stability in the presence of typical line-voltage fluctuations and temperature and humidity extremes at the examination site.

5.2 *Immersion Search Units*—The search unit to be selected should be compatible with the electronic equipment being used and with the material to be inspected. The search units should be of the immersion type. The search unit may have flat or focused acoustic lenses (some types of search units use elements that are curved).

5.3 *Couplant*—A liquid such as water, oil, glycerin, etc., capable of conducting ultrasonic vibrations from the transducer to the material being tested shall be used. Rust inhibitors, softeners, and wetting agents may be added to the couplant. The couplant liquid with all additives should not be detrimental to the surface condition of the test specimen or the container, and should wet the surface of the material to provide for transmission of the ultrasound. Couplant may be heated to a comfortable working temperature and must be free of air bubbles.

5.4 *Manipulator*—The holder for the search tube and search unit that provides angular manipulation of the transducer for optimum response from the internal discontinuities. The maximum tolerance or play allowable in the manipulator and in the traversing unit should be adequate to permit ultrasonic testing at the sensitivity specified.

5.5 *Accessory Equipment*—Coaxial cables and search tubes used in conjunction with the electronic apparatus capable of conducting the electrical pulses while immersed in a liquid, and collimators for shaping the sound beam shall be used.

5.6 *Reference Blocks*—To correct for the many variables involved in ultrasonic examination, it is necessary to use references to establish instrument settings, assist reproducibility of techniques, and evaluate discontinuities. Such reference blocks, often called test blocks or reference standards, are used to standardize the equipment and evaluate the indications received from reflectors or discontinuities within the material being examined. The ultrasonic characteristics of the reference standards such as attenuation, noise level, surface condition, and velocity should be similar to the material being examined. The material characteristics and the size and type of reference reflectors used in the reference blocks should be established in

the contractual documents. Practices E 127 and E 428 address the fabrication and control of aluminum and steel reference blocks, respectively.

NOTE 3—In general, reference standards from one wrought aluminum alloy are representative of most wrought aluminum alloys, and 4130 or 4340 steel alloy standards are representative of most low-carbon alloy steels.

6. Standardization of Apparatus

6.1 The ultrasonic system should be standardized by means of reference blocks as specified in the product specification. Other alternative setups may be employed depending upon the type of reference reflector specified and as given in the detailed procedure.

6.2 If reference blocks are used, they should have ultrasonic characteristics, such as attenuation, noise level, and velocity similar to the material being examined, or suitable correction should be made. Ideally, the reference block should have the same geometric as well as ultrasonic characteristics as the material to be examined. These include section thickness as well as surface curvature and roughness.

6.3 Ultrasonic characteristics should be evaluated by comparison of unsaturated first back-surface reflection or back-surface pattern from material tested with that of the reference standard with similar surface conditions, for example roughness and angularity. Any reduction of the back-reflection pattern in the material under test is indicative of increased attenuation or loss of transmitted energy due to absorption or scatter within the material being tested, provided front- and back-surface roughness and parallelism of the test piece are approximately the same as that of the standard. In this case, correction for differences in acoustical properties should be made.

6.4 The distance between search unit and work should be adjusted to suit the particular size, type, and frequency of the search unit being used. The search unit-to-part spacing should be such that the multiple-entry- or back-surface reflections do not fall within the area of interest. The search unit-to-part couplant distance shall be maintained to a sufficient accuracy to prevent a change in sensitivity during scanning.

6.5 Periodic verification of standardization shall be performed at full scanning speed and increment. Any indication of a decrease in sensitivity that could have resulted in a missed defect shall require reexamination of all pieces tested since the last successful standardization.

7. Procedure

7.1 *Examination Surface*—Surfaces shall be uniform and free of loose scale machining or grinding particles, discontinuities such as pits or gouges, or foreign matter. In the case of steel, scale reasonably smooth and securely bonded to the metal need not be removed for testing. The surface must be adequate to permit ultrasonic inspection at the sensitivity specified.

7.2 *Examination Frequency*—Select a suitable test frequency after due consideration of the material thickness and the minimum discontinuity that is to be detected, plus the attenuation factor of the material to be tested. Theoretically, the higher the frequency, the smaller the detectable discontinuity.