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Standard Guide for Detection and Evaluation of Discontinuities by Contact Pulse-Echo Straight-Beam Ultrasonic Methods¹

This standard is issued under the fixed designation E1901; 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 guide covers procedures for the contact ultrasonic examination of bulk materials or parts by transmitting pulsed ultrasonic waves into the material and observing the indications of reflected waves. This guide covers only examinations in which one search unit is used as both transmitter and receiver (pulse-echo). This guide includes general requirements and procedures that may be used for detecting discontinuities, locating depth and distance from a point of reference and for making a relative or approximate evaluation of the size of discontinuities as compared to a reference standard.

1.2 This guide complements Practice E114 by providing more detailed procedures for the selection and standardization of the examination system and for evaluation of the indications obtained.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 *This guide 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 guide to establish the 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.*

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

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2. Referenced Documents

2.1 ASTM Standards:²

E114 Practice for Ultrasonic Pulse-Echo Straight-Beam Contact Testing

E127 Practice for Fabrication and Control of Flat Bottomed Hole Ultrasonic Standard Reference Blocks

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

E543 Specification for Agencies Performing Nondestructive Testing

E1316 Terminology for Nondestructive Examinations

2.2 ASNT Standard:³

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

2.3 ANSI/ASNT Standard:³

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

2.4 Aerospace Industries Association Document:⁴

NAS-410 NAS Certification and Qualification of Nondestructive Test Personnel

2.5 ISO Standard:⁵

ISO 9712 Non-destructive testing — Qualification and certification of NDT personnel

3. Terminology

3.1 *Definitions*—For definitions of terms used in this guide, see Terminology E1316.

² 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.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

⁴ Available from Aerospace Industries Association of America, Inc. (AIA), 1000 Wilson Blvd., Suite 1700, Arlington, VA 22209-3928, <http://www.aia-aerospace.org>.

⁵ Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, <http://www.iso.org>.

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

4. Basis for Application

4.1 *Contractual Agreement*—The cognizant engineering organization and the suppliers should agree on the applicable procedural requirements listed in 4.1.1 through 4.1.12, prior to the examination of any material.

4.1.1 Materials, sizes, and shapes examined.

4.1.2 Stage of manufacture when examined (time of examination).

4.1.3 Surface finish requirements.

4.1.4 Search unit size, frequency and type.

4.1.5 Couplant,

4.1.6 Automated turning, fixturing or scanning, or both, as applicable.

4.1.7 Type of reference block standards including surface curvature.

4.1.8 Standardization details, including attenuation compensation and DAC techniques.

4.1.9 The surfaces to be examined and the scanning path.

4.1.10 Acceptance standards.

4.1.11 Personnel certification level.

4.1.12 Instrument characteristics.

4.2 *Written Procedure*—Ultrasonic examinations performed in accordance with this guide should be detailed in a written procedure. Documentation of procedure qualification should be maintained by the preparer. Procedures should be sufficiently detailed so that other qualified personnel may duplicate the examination and obtain equivalent results.

4.3 *Personnel Qualifications*—If specified in the contractual agreement, personnel performing examinations to this standard shall be qualified in accordance with a nationally or internationally recognized NDT personnel qualification practice or standard such as ANSI/ASNT-CP-189, SNT-TC-1A, NAS-410, ISO 9712 or a similar document and certified by the employer or certifying agency, as applicable. The practice or standard used, and its applicable revision, should be identified in the contractual agreement between the using parties.

4.4 If specified in the contractual agreement, NDT agencies should be qualified and evaluated as described in Practice E543.

5. Summary of Guide

5.1 This guide describes a means for obtaining an evaluation of discontinuities in materials by contact examination using longitudinal waves. Equipment, reference standards, examination and evaluation procedures, and documentation of results are described in detail.

6. Significance and Use

6.1 This guide provides procedures for the application of contact straight-beam examination for the detection and quantitative evaluation of discontinuities in materials.

6.2 Although not all requirements of this guide can be applied universally to all examinations, situations, and materials, it does provide basis for establishing contractual criteria between the users, and may be used as a general guide for preparing detailed specifications for a particular application.

6.3 This guide is directed towards the evaluation of discontinuities detectable with the beam normal to the entry surface. If discontinuities or other orientations are of concern, alternate scanning techniques are required.

7. Apparatus

7.1 Apparatus should include the following:

7.1.1 *Electronic Equipment*—The electronic equipment should be capable of producing and processing electronic signals at frequencies in the range of the search unit frequencies being used. The equipment and its display should provide characteristics as listed in Table 1, that are suitable for the

TABLE 1 Minimum Equipment Requirements (Longitudinal Wave)

Instrument Characteristics	Ultrasonic Test
	Frequency MHZ (Record)
Vertical limit, percent of full screen height	
Upper vertical linearity limit, percent of full screen height	
Lower vertical linearity limit, percent of full screen height	
Ultrasonic sensitivity, Reflector size, in. (mm)	
Entry surface resolution, in. (mm)	
Back surface resolution in. (mm)	
Horizontal limit, percent of full screen width	
Horizontal linearity range, in. (mm) or percent of full screen width	

specific application at the specified frequency, as determined in accordance with the procedures and tolerances described in Practice E317. The equipment, including the search unit, should be capable of producing echo amplitudes of at least 60 % of full screen height from the reference reflector required for the examination, with the material noise level, from front to back surface not exceeding 20 % of full screen height. Alternatively, if these conditions can be met at one half the part thickness, the part may be inspected from both sides.

7.1.2 *Voltage Regulator*—If fluctuations in line voltage cause indication amplitude variations exceeding $\pm\frac{1}{2}$ dB, a voltage regulator should be required on the power source. This requirement is not applicable to battery-operated units.

7.1.3 *Search Units*—The contact search unit selected should be capable of transmitting and receiving ultrasound at the required frequencies and energy levels necessary for discontinuity detection in the material being examined. Only longitudinal wave, straight beam, non-focused search units should be used. Dual element search units may provide better near-surface resolution and detection of small discontinuities. Generally, round or rectangular search units are used for examination whereas round search units with symmetrical sound beam patterns are used for evaluation. Typical search unit sizes range from $\frac{1}{8}$ in. (3.2 mm) in diameter to 1 $\frac{1}{2}$ in. (28.6 mm) in diameter with other sizes and shapes available for special applications. Search units may be fitted with contoured shoes to enhance coupling with curved surfaces.

7.1.4 *Alarm(s)*—For the examination of parts with regular shape and parallel surfaces such as machined cylinders, rounds, bars, forgings, etc. an audible/visual alarm may be used in conjunction with visual monitoring of the display for the detection of discontinuities or for the monitoring and detection