



Designation: E317 – 21

Standard Practice for Evaluating Performance Characteristics of Ultrasonic Pulse-Echo Testing Instruments and Systems without the Use of Electronic Measurement Instruments¹

This standard is issued under the fixed designation E317; 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 practice describes procedures for evaluating the following performance characteristics of ultrasonic pulse-echo examination instruments and systems: Horizontal Limit and Linearity; Vertical Limit and Linearity; Resolution - Entry Surface and Far Surface; Sensitivity and Noise; Accuracy of Calibrated Gain Controls. Evaluation of these characteristics is intended to be used for comparing instruments and systems or, by periodic repetition, for detecting long-term changes in the characteristics of a given instrument or system that may be indicative of impending failure, and which, if beyond certain limits, will require corrective maintenance. Instrument characteristics measured in accordance with this practice are expressed in terms that relate to their potential usefulness for ultrasonic testing. Instrument characteristics expressed in purely electronic terms may be measured as described in Guide E1324.

1.2 Ultrasonic examination systems using pulsed-wave trains and A-scan presentation (rf or video) may be evaluated.

1.3 The procedures are applicable to shop or field conditions; additional electronic measurement instrumentation is not required.

1.4 This practice establishes no performance limits for examination systems; if such acceptance criteria are required, these must be specified by the using parties. Where acceptance criteria are implied herein, they are for example only and are subject to more or less restrictive limits imposed by customer's and end user's controlling documents.

1.5 The specific parameters to be evaluated, conditions and frequency of test, and report data required must also be determined by the user.

1.6 This practice may be used for the evaluation of a complete examination system, including search unit, instrument, interconnections, fixtures and connected alarm and auxiliary devices, primarily in cases where such a system is used repetitively without change or substitution. This practice is not intended to be used as a substitute for calibration or standardization of an instrument or system to inspect any given material. There are limitations to the use of standard reference blocks for that purpose.²

1.7 Required test apparatus includes selected test blocks and a precision external attenuator (where specified) in addition to the instrument or system to be evaluated.

1.8 Precautions relating to the applicability of the procedures and interpretation of the results are included.

1.9 Alternate procedures, such as examples described in this document, or others, may only be used with customer approval.

1.10 *Units*—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.

1.11 *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.*

1.12 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the*

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 Method.

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² Beck, K. H., "Limitations to the Use of Reference Blocks for Periodic and Preinspection Calibration of Ultrasonic Inspection Instruments and Systems," *Materials Evaluation*, Vol 57, No. 3, March 1999.

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

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

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

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

E1316 Terminology for Nondestructive Examinations

E1324 Guide for Measuring Some Electronic Characteristics of Ultrasonic Testing Instruments

2.2 Other Standard:⁴

IEEE Std 100 *IEEE Standard Dictionary of Electrical and Electronic Terms*

3. Terminology

3.1 *Definitions*—For definitions of terms used in this practice, see Terminology **E1316**. Other relevant definitions may be found in IEEE Standard 100.

4. Summary of Practice

4.1 An examination system to be evaluated comprises an ultrasonic pulse-echo instrument, search unit, interconnecting cables, and couplant; for immersion examination systems, suitable fixturing is required.

4.2 When checking an entire system to be used for a given examination, test conditions are selected that are consistent with the intended end-use as determined by the user.

4.3 The ultrasonic response from appropriate test blocks is obtained, and presented in numerical or graphical form.

5. Significance and Use

5.1 This practice describes procedures applicable to both shop and field conditions. More comprehensive or precise measurements of the characteristics of complete systems and their components will generally require laboratory techniques and electronic equipment such as oscilloscopes and signal generators. Substitution of these methods is not precluded where appropriate; however, their usage is not within the scope of this practice.

5.2 This document does not establish system acceptance limits, nor is it intended as a comprehensive equipment specification.

5.3 While several important characteristics are included, others of possible significance in some applications are not covered.

5.4 Since the parameters to be evaluated and the applicable test conditions must be specified, this practice shall be prescribed only by those familiar with ultrasonic NDT technology

and the required tests shall be performed either by such a qualified person or under his supervision.

5.5 Implementation may require more detailed procedural instructions in the format of the using facility.

5.6 In the case of evaluation of a complete system, selection of the specific tests to be made should be done cautiously; if the related parameters are not critical in the intended application, then their inclusion may be unjustified. For example, vertical linearity may be irrelevant for a go/no-go test with a flaw gate alarm, while horizontal linearity might be required only for accurate flaw-depth or thickness measurement from the display screen.

5.7 No frequency of system evaluation or calibration is recommended or implied. This is the prerogative of the using parties and is dependent on application, environment, and stability of equipment.

5.8 Certain sections are applicable only to instruments having receiver gain controls calibrated in decibels (dB). While these may sometimes be designated “gain,” “attenuator,” or “sensitivity” on various instruments, the term “gain controls” will be used in this practice in referring to those which specifically control instrument receiver gain but not including reject, electronic distance-amplitude compensation, or automatic gain control.

5.9 These procedures can generally be applied to any combination of instrument and search unit of the commonly used types and frequencies, and to most straight-beam examination, either contact or immersed. Certain sections are also compatible with angle-beam, wheel, delay-line, and dual-search unit techniques. Their use, however, should be mutually agreed upon and so identified in the test report.

5.10 The validity of the results obtained will depend on the precision of the instrument display readings. This is assumed to be ± 0.04 in. (± 1 mm), yielding between 1 % and 2 % of full scale (fs) readability for available instrumentation having suitable screen gratitudes and display sharpness.

6. Procedures for Obtaining Ultrasonic Response Data

6.1 General:

6.1.1 A procedure, using this document as a guide, should be prepared for each specific type of instrument or system to be evaluated. For each procedure determine from the requesting documents the instrument examination range to be evaluated, select the appropriate search unit, fixtures, and test blocks, and establish the required display conditions. Unless otherwise required, mid-range values are suggested for most panel controls and “reject” must be off unless specifically desired to be evaluated. It may be desirable to vary the instrument controls from these initial values. If so, it is important to observe and report any anomalous effects on the parameters being evaluated when the controls are so varied.

6.1.2 When a procedure requires a change in receiver gain by the use of a calibrated control, it is assumed that those which increase sensitivity with higher panel readings are designated “gain” and those which decrease sensitivity with higher readings are designated “attenuation.” Fine (reference)

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 Published by Wiley-Interscience, New York, NY.