Designation: E 1106 – 86 (Reapproved 2002)$^{\epsilon 1}$

Standard Method for Primary Calibration of Acoustic Emission Sensors[1]

This standard is issued under the fixed designation E 1106; 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.

ϵ^1 NOTE—Editorially replaced the term "inspection" with "examination" in 6.2 in June 2002.

1. Scope

1.1 This method covers the requirements for the absolute calibration of acoustic emission (AE) sensors. The calibration yields the frequency response of a transducer to waves, at a surface, of the type normally encountered in acoustic emission work. The transducer voltage response is determined at discrete frequency intervals of approximately 10 kHz up to 1 MHz. The input is a given well-established dynamic displacement normal to the mounting surface. The units of the calibration are output voltage per unit mechanical input (displacement, velocity, or acceleration).

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:*

E 114 Practice for Ultrasonic Pulse-Echo Straight-Beam Examination by the Contact Method[2]

E 494 Practice for Measuring Ultrasonic Velocity in Materials[2]

E 650 Guide for Mounting Piezoelectric Acoustic Emission Sensors[2]

E 1316 Terminology for Nondestructive Examinations[2]

3. Terminology

3.1 Refer to Terminology E 1316 for terminology used in this method.

4. Significance and Use

4.1 *Transfer Standards*—One purpose of this method is for the direct calibration of displacement transducers for use as secondary standards for the calibration of AE sensors for use in nondestructive evaluation. For this purpose, the transfer standard should be high fidelity and very well behaved and understood. If this can be established, the stated accuracy should apply over the full frequency range up to 1 MHz.

NOTE 1—The stated accuracy applies only if the transfer standard returns to quiescence, following the transient input, before any wave reflected from the boundary of the calibration block returns to the transfer standard (~100 µs). For low frequencies with periods on the order of the time window, this condition is problematical to prove.

4.2 *Applications Sensors*—This method may also be used for the calibration of AE sensors for use in nondestructive evaluation. Some of these sensors are less well behaved than devices suitable for a transfer standard. The stated accuracy for such devices applies in the range of 100 kHz to 1 MHz and with less accuracy below 100 kHz.

5. General Requirements

5.1 A primary difficulty in any calibration of a mechanical/electrical transduction device is the determination of the mechanical-motion input to the device. Using this calibration procedure, the motional input may be determined by two different means: theoretical calculation and measurement with an absolute displacement transducer.

5.2 *Theoretical Calculation*—Elasticity theory has been used to calculate the dynamic displacement of the surface of an infinite half-space due to a normal point-force step function in time. The solutions give the displacement of any point on the surface as a function of time, yielding a waveform for the displacement called the seismic surface pulse.

5.2.1 This calibration method uses an approximation to this theoretical solution. See also Breckenridge[3] and Hsu and Breckenridge[4]. The half-space is approximated by a large metal block in the form of a circular cylinder and the pointforce step function is closely approximated by the breaking of a glass capillary against the plane surface of the block. The displacement as a function of time should be calculated for the location of the device under test (on the same surface of the block as the input). This calculation should be performed using a measured value of the step function force and the elastic constants that are determined by speed of sound measurements on the block.

[1] This method is under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.04 on Acoustic Emission.

Current edition approved April 25, 1986. Published June 1986.

[2] *Annual Book of ASTM Standards*, Vol 03.03.

[3] Breckenridge, F. R., "Acoustic Emission Transducer Calibration by Means of the Seismic Surface Pulse," *Journal of Acoustic Emission* Vol 1, pp. 87–94.

[4] Hsu, N. N., and Breckenridge, F. R., "Characterization and Calibration of Acoustic Emission Sensors," *Materials Evaluation*, Vol 39, 1981, pp. 60–68.

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