Standard Practice for Verifying Acoustic Emission Sensor Response[1]

This standard is issued under the fixed designation F2174; 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 is used for routinely checking the sensitivity of acoustic emission (AE) sensors. It is intended to provide a reliable, precisely specified way of comparing a set of sensors or telling whether an individual sensor's sensitivity has degraded during its service life, or both.

1.2 The procedure in this practice is not a "calibration" and does not give frequency-response information.

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.4 This practice does not purport to recommend one sensor manufacturer over another nor does it imply that one type of sensor will react differently from another when using this procedure.

1.5 *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:*[2]

E650 Guide for Mounting Piezoelectric Acoustic Emission Sensors

E750 Practice for Characterizing Acoustic Emission Instrumentation

E976 Guide for Determining the Reproducibility of Acoustic Emission Sensor Response

3. Significance and Use

3.1 Degradation in sensor performance can occur due to dropping, mechanical shock while mounted on the test structure, temperature cycles, and so forth. It is necessary and desirable to have a simple measurement procedure that will check the consistency of sensor response, while holding all other variables constant.

3.2 While test blocks of many different kinds have been used for this purpose for many years, an acrylic polymer rod offers the best all-around combination of suitable acoustic properties, practical convenience, ease of procurement, and low cost.

3.3 Because the acoustic properties of the acrylic rod are known to depend on temperature, this practice requires that the rod, sensors, and couplant be stabilized at the same working temperature, prior to application of the practice.

3.4 Attention should be paid to storage conditions for the acrylic polymer rod. For example, it should not be left in a freezing or hot environment overnight, unless it is given time for temperature stabilization before use.

3.5 Properly applied and with proper record keeping, this practice can be used in many ways, such as:

3.5.1 To determine when a sensor is no longer suitable for use.

3.5.2 To check sensors that have been exposed to high-risk conditions such as dropping, overheating, and so forth.

3.5.3 To get an early warning of sensor degradation over time.

3.5.4 To obtain matched sets of sensors and preamplifiers.

3.5.5 To verify sensors quickly but accurately in the field, and to assist troubleshooting when a channel does not pass a performance check.

4. Apparatus

4.1 *Acrylic Polymer Cylindrical Rod* (Fig. 1) should be used. The actual material of the acrylic polymer rod is poly(methylmethacrylate)(PMMA).

4.1.1 Dimensions of the rod should be 78.74 cm (31 in.) long by 3.81 cm (1.5 in.) in diameter with ends cut true and smooth with a surface finish of 0.4 µm rms (0.16 µin.).

4.1.2 Other lengths of rod are acceptable, provided that there is sufficient distance to attenuate and prevent reflected signals from the non-sensor end of the rod reaching the sensor.

4.1.3 A permanent reference mark (for example, an "X") is placed on the rod at a distance of 10.16 cm (4 in.) from one end; this marks the spot where the lead is to be broken. It is

[1] This practice is under the jurisdiction of ASTM Committee F18 on Electrical Protective Equipment for Workers and is the direct responsibility of Subcommittee F18.55 on Inspection and Non-Destructive Test Methods for Aerial Devices.

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[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.

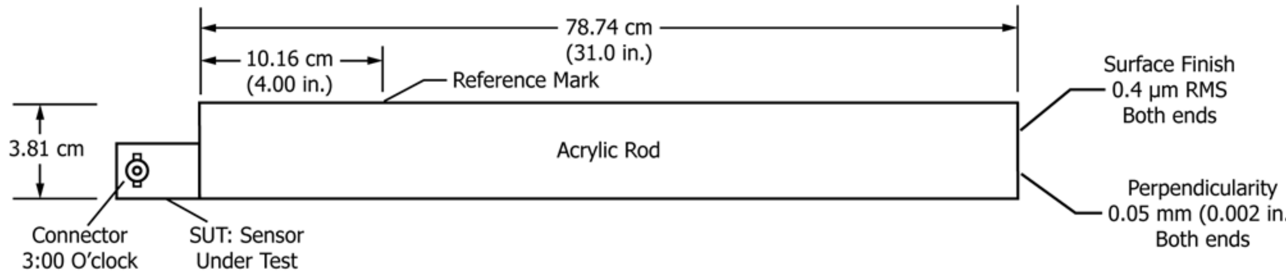

FIG. 1 Acrylic Rod Description

convenient to provide a very small spotface, for example, 0.79 ± 0.05-mm (0.031 ± 0.002-in.) diameter and 0.076 to 0.178 mm (0.003 to 0.007 in.) deep at this reference mark point, to rest the tip of the pencil lead to avoid slippage during the lead break process.

4.2 *Hsu-Nielsen Pencil Lead Break Source,* 0.3 or 0.5 mm. A Nielsen shoe as described in Guide E976 is optional.

4.3 *Sensor(s),* to be tested.

4.4 *Acoustic Emission Equipment ,* with amplitude measurement capability, for recording sensor response. (Operating familiarity with the apparatus is assumed.)

4.5 *Couplant,* to be standardized and documented by the user of this practice.

5. Procedure

5.1 Ensure that the acrylic rod, sensors, and couplant have been allowed to stabilize to the ambient temperature of the examination environment.

5.2 Place the prepared acrylic rod horizontally on a suitable hard, flat surface (such as a bench top) with the 10.16-cm (4.0-in.) reference mark facing vertically up (12 o'clock). The rod may be secured with tape or other means no closer than 12 in. from the reference mark.

5.3 Prepare and power the AE measurement system including preamplifier (if used) and connecting cables. Allow warm-up time as necessary. Verify the system's performance. Verification may be accomplished on the rod using a reference sensor that is dedicated to this purpose and not exposed to the hazards of field use; or it may be accomplished by electronic procedures such as those described in Practice E750.

5.4 Mount the sensor to be tested on the flat end of the rod using the prescribed couplant and normal good application techniques (refer to Guide E650). Wipe off old couplant before mounting and do not position so that it is resting on the same surface supporting the acrylic rod. This will prevent slipping of the sensor during sensor verification. If the sensor is a side-connector type, have the connector pointing in the 3 o'clock direction as indicated in Fig. 1.

5.5 Using the pencil lead source, break lead with the end of the 9.3-mm lead in the center of the reference mark, within 0.5 mm (0.020 in.) with a lead extension of 2.5 ± 0.5 mm (0.1 ± 0.20 in.). A Nielsen shoe may be used to obtain a consistent 30° angle between the lead and the surface. Hold the pencil pointing toward the sensor but with its axis approximately 22° (a quarter of a right angle) off from the axis of the rod, so that the lead flies off to one side and does not hit the sensor. Fingers may be rested on the rod on the side away from the sensor to steady the pencil, but there must be no finger contact or other materials in contact with the rod between the pencil and the sensor, except for the hard surface on which the acrylic rod is resting.

5.6 Make three consistent lead breaks for each sensor, recording amplitude responses on a Sensor Performance Verification Form, similar to that shown in Fig. 2. Determine the average sensor amplitude response and proceed to the next sensor. When complete, compile an average of all amplitudes.

5.7 The acceptance criteria for each sensor shall be a value that does not deviate more than ±2 dB from the average amplitude of the other sensors tested in the group. All sensors that fall outside this criteria shall be removed from service and repaired or replaced. Use of sensors outside the average amplitude of the group will compromise the validity of the AE test results.

6. Precision and Bias

6.1 Temperature variations are known to affect the acoustic absorption properties of the acrylic rod. However, since this is a comparative technique rather than an absolute one, this practice can be carried out with good results if all component parts used in the practice have been allowed to stabilize to the examination (environmental) temperature prior to application.

6.2 Person-to-person variations can be reduced to a range of 1 dB by proper technique and training.

6.3 Variations in fracture performance within a lead and between leads are possible. With experience, occasional bad breaks can often be identified by the operator, even without reference to the results of the measurement.

6.4 Bad breaks are relatively common as the pencil is about to run out of lead.

6.5 Uniformity of material is a major quality goal of the lead manufacturer, but, even so, runs of bad lead can occur due to manufacturing variations.

7. Keywords

7.1 acrylic rod; calibration; sensor

DATE: ______________________________ JOB ID: ______________________

OPERATOR(S): ____

AMBIENT TEMP.: ____________ PENCIL TYPE: _____________ LEAD TYPE: ______

SYSTEM MANUFACTURER MODEL: _______________________________________

SYSTEM SERIAL#: ____________________________ CHANNEL#: _____________

ROD ID: ____

SENSOR COUPLANT: ____________________ SENSOR CABLE LENGTH: __________

Sensor Model, SN#	Amplitudes (dB_{AE})					Avg.	Sensor Model, SN#	Amplitudes (dB_{AE})					Avg.

AVG. AMPL. OF ALL SENSORS: ______dB ACCEPTANCE CRITERIA: ± 2 dB of Average Amplitude

COMMENTS/NOTES: ____

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FIG. 2 Sensor Performance Verification FORM