Designation: E 2075 – 00

Standard Practice for Verifying the Consistency of AE-Sensor Response Using an Acrylic Rod[1]

This standard is issued under the fixed designation E 2075; 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 recommended 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 is degrading during its service life, or both.

1.2 This procedure is not a "calibration" nor does it give frequency response information. It is simply a way of verifying consistency of sensor peak amptitude response.

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

1.4 *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 650 Guide for Mounting Piezoelectric Acoustic Emission Sensors[2]

E 750 Practice for Characterizing Acoustic Emission Instrumentation[2]

E 976 Guide for Determining the Reproducibility of Acoustic Emission Sensor Response[2]

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, etc. It is necessary and desirable to have a simple measurement procedure that will check the consistency of sensor response, over time or within a batch, 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-round 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 standard 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 procedure can be used in many ways. The user organization must determine the context for its use, the acceptance standards and the actions to be taken based on the lead break results. The following uses are suggested:

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, etc;

3.5.3 To get an early warning of sensor degradation with time. This can lead to identifying conditions of use which are damaging sensors, and thus, to better equipment care and lower replacement costs;

3.5.4 To obtain matched sets of sensors, preamplifiers, or instrumentation channels for more uniform performance of the total system, or a combination thereof;

3.5.5 To save time and money, by eliminating the installation of bad sensors; and,

3.5.6 To verify sensors quickly but consistently in the field and to assist trouble-shooting when a channel does not pass a performance check.

3.6 All the above uses are recommended for consideration. The purpose of this practice is not to call out how these uses are

[1] This practice is under the jurisdiction of ASTM Committee E-07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.04 on Acoustic Emission Method.

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

to be implemented, but only to state how the test itself is to be performed so that the results obtained will be accurate and reliable.

4. Apparatus

4.1 *Acrylic Polymer Cylindrical Rod* (Fig. 1), should be used. The actual material of the acrylic polymer rod is polymethylmethacrylate.[3]

4.1.1 Dimensions of the rod should be 78.74 cm (31 in.) long by 3.81 cm (1.5 in.) in diameter, sensors end 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 nonsensor 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 convenient to provide a very small spotface, for example, 0.79 ± 0.05 mm (0.031 ± 0.002 in.) diameter and 0.076–0.178 mm (0.003–0.007 in.) deep at this reference mark point, to rest the tip of the pencil lead to avoid slippage during the lead break process.

NOTE 1—The surface finish of the cylindrical rod section could produce reflections that affect AE response. The surface finish should be maintained in a clean, undamaged condition.

4.2 *0.3 or 0.5-mm Hsu-Nielsen Pencil Lead Break Source*, with Nielsen shoe as described in Guide E 976, with 2H pencil lead.

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 Assure that the acrylic rod, sensors and couplant have been allowed to stabilize to the working temperature of the examination environment.

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

5.3 Prepare and power-up 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 E 750.

5.4 Mount the sensor to be tested on the flat end of the rod using the prescribed couplant and normal good application techniques (see Guide E 650). Wipe off old couplant before mounting and do not let couplant from previous sensors accumulate under the rod. Mount the sensor in the six o'clock position so that it is resting on the same surface supporting the acrylic rod. This will prevent slipping of the sensor during sensor verification.

5.5 Using the Hsu-Nielsen pencil lead source, break lead with the end of the 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.). Use the Nielsen shoe to obtain a consistent 30° angle between the lead and the surface. Hold the pencil pointing towards 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 pencil and sensor, except for the hard surface on which the acrylic rod is resting.

5.6 Maintaining instrument settings, make three consistent lead breaks for each sensor, recording amplitude responses on a "Sensor Performance Verification Form," for example, similar to that shown in Appendix X1. Determine the average sensor amplitude response and proceed to the next sensor.

5.7 Acceptance criteria, which should be assigned prior to conducting this practice by the testing organization, should be documented, for example as shown in Appendix X1, and applied to the sensor data recorded. Sensors failing the criteria should not be used during the examination, and should be returned for a more comprehensive analysis, repaired or discarded.

[3] Some of the generic brand names of this material include, but are not limited to, Lucite, PMMA, plexiglass, perspex, etc.

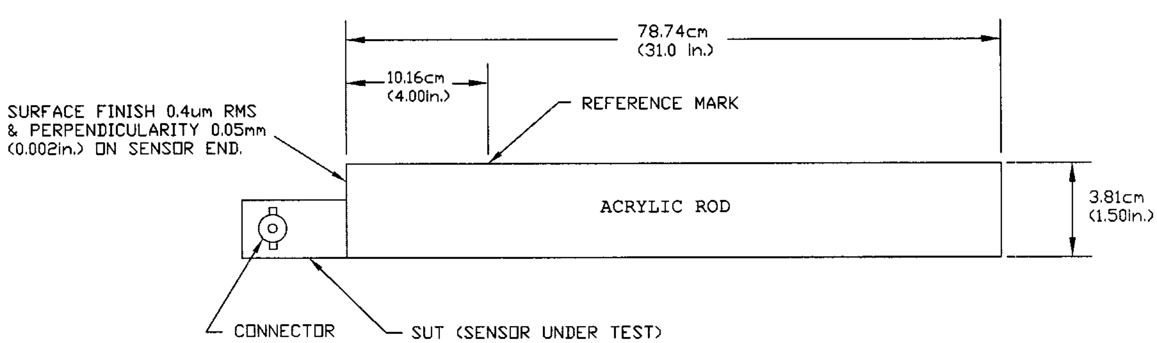

FIG. 1 Acrylic Rod Description

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 often can 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 While uniformity of material is a major quality goal of the lead manufacturer, runs of bad lead can occur due to manufacturing variations.

7. Keywords

7.1 acoustic emission sensors; AE; sensor check; sensor consistency check; sensor response; sensor test; sensor verification

APPENDIX

(Nonmandatory Information)

X1. Sensor Performance Verification Form

DATE: ____________ Start/End Times: __________________ Job ID: ______________

OPERATOR(S): __________________________ AMBIENT TEMPERATURE: ___________

PENCIL TYPE: _________________ LEAD TYPE: _______________ SHOE: Y/N ____

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. X1.1 Example of Sensor Performance Verification Form