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Standard Guide for Acoustic Emission System Performance Verification[1]

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1. Scope*

1.1 System performance verification methods launch stress waves into the examination article on which the sensor is mounted. The resulting stress wave travels in the examination article and is detected by the sensor(s) in a manner similar to acoustic emission.

1.2 This guide describes methods which can be used to verify the response of an Acoustic Emission system including sensors, couplant, sensor mounting devices, cables and system electronic components.

1.3 Acoustic emission system performance characteristics, which may be evaluated using this document, include some waveform parameters, and source location accuracy.

1.4 Performance verification is usually conducted prior to beginning the examination.

1.5 Performance verification can be conducted during the examination if there is any suspicion that the system performance may have changed.

1.6 Performance verification may be conducted after the examination has been completed.

1.7 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.8 *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.*

1.9 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E750 Practice for Characterizing Acoustic Emission Instrumentation

E976 Guide for Determining the Reproducibility of Acoustic Emission Sensor Response

E1316 Terminology for Nondestructive Examinations

E1419 Practice for Examination of Seamless, Gas-Filled, Pressure Vessels Using Acoustic Emission

E1781 Practice for Secondary Calibration of Acoustic Emission Sensors

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *examination article*—the item which is being examined with AE and to which AE sensors are attached.

3.1.2 *velocity*—the measured velocity of a stress wave, traveling in the examination article, using specified AE system parameters and components. Velocity is often used in triangulation calculations to determine the position of the AE source.

3.1.3 *auto sensor test (AST)*—an electronic means by which a sensor can be fed an electronic pulse to excite the examination article. The resulting stress wave in the examination article can be measured by the same sensor or by other sensors that are on the same examination article. See 3.1.4 and 3.1.5.

3.1.4 *auto sensor test-self test mode*—a means by which an AST sensor may be used to check its own performance.

3.1.5 *auto sensor test-near neighbor mode*—a means by which an AST sensor may be used to determine the sensitivity of one or more neighboring sensors on the same examination article.

4. Significance and Use

4.1 Acoustic Emission data acquisition can be affected by numerous factors associated with the electronic instrumentation, cables, sensors, sensor holders, couplant, the

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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.

*A Summary of Changes section appears at the end of this standard examination article on which the sensor is mounted, background noise, and the user's settings of the acquisition parameters (for example, threshold).

4.2 This guide is not intended to replace annual (or semi-annual) instrumentation calibration (see Practice E750) or sensor recertification (see Practice E1781).

4.3 This guide is not intended to replace routine electronic evaluation of AE instrumentation or routine reproducibility verification of AE sensors (see Guide E976).

4.4 This guide is not intended to verify the maximum processing capacity or speed of an AE system.

4.5 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 appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

5. Apparatus

5.1 To determine system performance a sensor must be subjected to a stress wave traveling in the examination article. Transient stress waves are launched by mechanical or electromechanical devices that produce a waveform with fast rise-time, short duration and repeatable peak amplitude. Steady state (continuous) stress waves are launched by mechanical or electromechanical devices that produce a waveform with long duration constant amplitude. Various apparatus can be used as verification sources including the following:

5.1.1 *Pencil Lead Break (PLB)*—A mechanical pencil technique whereby lead is pushed against the examination article's surface with sufficient force to break the lead. When the lead breaks, there is a sudden release of stress on the surface. (See Guide E976, subsection 4.3.3 and Fig. 5.)

5.1.1.1 The distance between the PLB and the sensor must be specified and kept consistent.

5.1.1.2 The "Hsu pencil source" uses a mechanical pencil with a 2.5 mm lead extension, 2H hardness and 0.3 mm or 0.5 mm diameter (0.3 mm is preferred).

5.1.1.3 The "Nielsen shoe" can aid in breaking the lead consistently.

5.1.1.4 The pencil should be held at an angle of 30 degrees to the surface.

5.1.1.5 Three to five lead breaks are generally conducted to show a consistent result.

5.1.1.6 Application standards (for example, Test Method E1419, Table X1.2) specify the minimum signal amplitude that must be measured by the AE instrumentation.

5.1.1.7 Channels which are found to have unacceptably low or high sensitivity can be re-coupled (that is, replace couplant), repaired (that is, replace sensor, or cable, or both), or replaced to the examination article (that is, exchanged for another channel), or both.

5.1.1.8 PLB can be used to determine the apparent velocity in the examination article (apparent velocity = sensor spacing/ time-of-flight). "Time-of-flight" is the time required for a stress wave to travel the sensor-spacing distance

5.1.2 *Independent Piezoelectric Pulser*—An electromechanical device held against the examination article and used in conjunction with an electronic signal or pulse generator. The electrical signal from the signal/pulse generator is converted into a mechanical displacement by the transducer's crystal. (See Guide E976, subsection 4.3.1.) One significant advantage of this technique is that the output of the electronic signal/pulse generator can be adjusted in numerous ways (for example, amplitude and repetition rate).

5.1.2.1 The independent pulser can be used to excite the receiving AE sensor before, during and after an examination as verification that there were no changes in coupling or sensor response. The independent pulser technique is particularly useful when there is limited access to the examination article that would preclude the use of manual techniques (for example, PLB).

5.1.2.2 The independent pulser technique is particularly useful in continuous monitoring situations where sensors will be on the examination article for a long period of time. In this situation the independent pulser is left in place and used periodically to assure system performance.

5.1.3 *AST Capable Integrated Pulser/Sensor*—An AE sensor that has been designed to accept an electronic signal/pulse into its crystal. The mechanical displacement of the crystal excites the examination article. The stress wave generated in the examination article can be detected by other sensors on the same examination article. With certain realizations of the AST function (self test mode), it can also be detected by the exciting sensor.

5.1.3.1 *Auto Sensor Test: Near Neighbor Mode*—An integrated pulser/sensor can be used to measure sensitivity and time-of-flight (that is, the time required for a stress wave to travel the sensor-spacing distance) for neighboring sensors on the same examination article. The time-of-flight can be used to calculate the apparent velocity of the stress wave (apparent velocity = sensor spacing/time-of-flight).

5.1.3.2 *Auto Sensor Test: Self Test Mode*—An integrated pulser/sensor can be used to verify the performance of the sensor coupling and the sensor and channel electronics to which it is attached by establishing a baseline duration (or energy) measured from the AST pulse using a sensor that is known to be operating properly and mounted optimally on the examination article. The baseline duration number (for example, 10 000 µs) can then be compared with the AST duration measurements from each channel on the examination article. Channels, which produce AST duration measurements that are low compared to the baseline, should be recoupled, repaired or replaced as necessary.

5.1.4 *Spring Loaded Center Punch*—A spring loaded device that imparts a mechanical impact force, creating a very large stress wave on the examination article. The spring assures a consistent and repeatable force.

5.1.4.1 The spring-loaded center punch is of particular advantage when AE sensors are distributed over large distances on an examination article, as the imparted force is so strong it can be detected easily.

5.1.4.2 The spring-loaded center punch is readily available and easy to apply anywhere on the examination article, at any time.