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Standard Guide for Acoustic Emission Examination of Small Parts[1]

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1. Scope

1.1 This guide covers techniques for conducting acoustic emission (AE) examinations of small parts. It is confined to examination objects (or defined regions of larger objects) where there is low AE signal attenuation throughout the examination region. This eliminates the consideration of complex attenuation factor corrections and multiple sensor and array placements based on overcoming signal losses over distances.

1.2 The guide assumes a typical AE examination as one where there is a controlled or measured stress acting upon the part being monitored by AE. Particular emphasis is placed on sensor and system selection, sensor placements, stressing considerations, noise reduction/rejection techniques, spatial filtering, location determination, use of guard sensors, collection of AE data, AE data analysis and report. The purpose of the AE examination is to analyze how an object under evaluation is withstanding the applied load.

1.3 Possible applications of this guide includes materials characterization, quality control of production processes, proof testing after fabrication, evaluating regions of interest of larger structures and retesting after intervals of service. The applied load may include mechanical forces (tension, compression or torsional) internal pressure and thermal gradients.

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.*

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

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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

E1316 Terminology for Nondestructive Examinations

E2374 Guide for Acoustic Emission System Performance Verification

[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.

3. Terminology

3.1 *Definitions*:

3.1.1 Terminology related to acoustic emission is defined in Terminology E1316.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *applied load*—a controlled or known force or stress which is applied to an object under examination for the purpose of analyzing the object's reaction (by means of AE monitoring) to that stress.

3.2.2 *guard sensors*—sensors whose primary function is the elimination of extraneous noise based on arrival sequences.

3.2.3 *spatial discrimination*—the process of using one or more (guard and data) sensors to eliminate extraneous noise based on arrival sequences.

3.2.4 *spatial filtering*—ability of an AE system or analysis to disregard AE activity based on source location of the AE event.

4. Significance and Use

4.1 The purpose of the AE examination is to analyze how an examination object is withstanding the applied load, or if it is suffering from some latent damage. Consequently the emission activity must be evaluated in relation to the applied load.

4.2 The applied load (on the examination object) may include mechanical forces (tension, compression or torsional), internal pressure and thermal gradients. It may be short to long, random or cyclic. The applied load may be controlled by the examiner or may already exist as part of the process. In either case the applied load is measured along with the AE activity.

4.3 Possible applications include the determination of part integrity, quality control assessment of production processes on a sampled or 100 % inspection basis, in-process examination during a period of applied load of a fabrication process (for example, spot welding, bonding, soldering, pressing, etc.), proof-testing after fabrication, monitoring a "region of interest" (or concern) of a structure (for example, bridge joint or repair, vessel, pipe), and re–examination after intervals of service.

5. Procedure

5.1 *Preliminary Information*:

5.1.1 Before examination, the following information, where relevant, should be obtained by the AE examiner:

5.1.1.1 Type of object to be examined, together with layout drawings or sketches.

5.1.1.2 Material specifications (including details of heat treatment where possible).

5.1.1.3 Proposed or existing applied load specification together with a layout or sketch of the pressure/stress application system.

5.1.1.4 Information regarding the measuring or recording of the applied load must also be obtained in order to determine the compatibility with the AE equipment.

5.1.1.5 Potential sources of background noise and the isolating mechanisms applied thereto.

5.1.1.6 Previous history, including the maximum applied load to which the object or system has been subjected.

5.1.1.7 Where possible, locations of known discontinuities and the general results of earlier AE or other NDE examinations.

5.1.1.8 Results of earlier examinations on similar objects.

5.1.2 Before examination, the AE examiner should consider the following information. Some details need to be coordinated with the on-site management or responsible personnel:

5.1.2.1 *The Type of AE Equipment to be Used*—Considerations should include the number of channels, the frequency range of the instrument's filters, the real-time data processing rates for the type of application, its location/guard/spatial filtering capabilities, the type of data being collected (for example, RMS, ASL, AE feature based or waveform based) and the compatibility of the system to monitor and record the applied load during the AE examination. These items must be able to perform at the anticipated levels of performance expected during the examination. In addition, consideration should be given to the data analysis, display and replay capabilities of the equipment to assure its ability to process the stored data in a way needed to arrive at a satisfactory conclusion and examination result.

5.1.2.2 *Application of Load*—Consideration should be given to the application of the load in relation to the integrity of the examination object and achieving a successful AE examination result. In cases where the applied load is part of the process being monitored, a suitable time for AE monitoring needs to be determined where process noise is low and applied load (for AE examination purposes) maximum. Sometimes (if needed) the applied loading can be altered to achieve this without compromising the process (for example, inserting a short load hold at maximum load).

(1) In cases where the applied load is controlled with the examination, then consideration should be given to design the loading schedule to appropriately stress the examination object in order to excite "latent flaws" without over-stressing or damaging the object. In addition, the loading schedule should be designed to provide best insight into the integrity of the part (for example, implementing a load schedule to evaluate the "Kaiser effect").

5.1.2.3 *Sensor Types*—Considerations that should guide the user into proper selection include the sensor's frequency range, size (including sensor height, diameter and weight), maximum or minimum temperature specification, the sensor's sensitivity and frequency response, and acoustic impedance matching of the sensor and part.

5.1.2.4 *Location of Sensors and Placement Strategy*—Considerations need to be given to the number of sensors required for the examination, their placement strategy and location on the part to be monitored.

(1) In cases where background noise can be controlled or does not exist, then a single sensor near the expected source of the AE is sufficient.

(2) In cases where there are a limited number of background noise sources (such as the grips in a tension test), a single AE data sensor near the expected source of AE and the use of a guard sensor near each background source will effectively block noises that emanate from a region closer to the guard sensors than to the AE data sensor. Alternatively, a group of two or more sensors can be strategically placed to perform spatial discrimination of background noise and allow processing of AE events.

(3) In cases where extraneous noise cannot be controlled and could be emanating from any or all directions, a multiple-sensor location strategy (such as linear or planar location) should be considered. In this situation, enough sensors should be specified to allow for an accurate source location, and means should be available to allow for the application of spatial filtering and/or spatial discrimination so that only data emanating from the region of interest is processed as relevant AE data.

5.1.2.5 *Data to be Recorded*—The AE examiner should know in advance the data and information to be recorded and have all the necessary equipment, hardware, accessories and software to acquire, store, and process this information. Other than the equipment for AE monitoring, appropriate sensors and devices are required for measuring and recording the applied load and other load or condition related parametric data.