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# Standard Guide for Mounting Piezoelectric Acoustic Emission Sensors[1]

This standard is issued under the fixed designation E650/E650M; 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 document provides guidelines for mounting piezoelectric acoustic emission (AE) sensors.

1.2 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.3 *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.*

1.4 *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]

E976 Guide for Determining the Reproducibility of Acoustic Emission Sensor Response

E1316 Terminology for Nondestructive Examinations



## 3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *bonding agent*—a couplant that physically attaches the sensor to the structure.

3.1.2 *couplant*—a material used at the structure-to-sensor interface to improve the transfer of acoustic energy across the interface.



3.1.3 *mounting fixture*—a device that holds the sensor in place on the structure to be monitored.



3.1.4 *sensor*—a detection device that transforms the particle motion produced by an elastic wave into an electrical signal.

3.1.5 *waveguide, acoustic*—a device that couples acoustic energy from a structure to a remotely mounted sensor. For example, a solid wire or rod, coupled to a sensor at one end and to the structure at the other.

3.2 *Definitions:*

3.2.1 For definitions of additional terms relating to acoustic emission, refer to Terminology E1316.

## 4. Significance and Use

4.1 The methods and procedures used in mounting AE sensors can have significant effects upon the performance of those sensors. Optimum and reproducible detection of AE requires both appropriate sensor-mounting fixtures and consistent sensor-mounting procedures.

## 5. Mounting Methods

5.1 The purpose of the mounting method is to hold the sensor in a fixed position on a structure and to ensure that the acoustic coupling between the sensor and the structure is both adequate and constant. Mounting methods will generally fall into one of the following categories:

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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

5.1.1 *Compression Mounts*—The compression mount holds the sensor in intimate contact with the surface of the structure through the use of force. This force is generally supplied by springs, torqued-screw threads, magnets, tape, or elastic bands. The use of a couplant is strongly advised with a compression mount to maximize the transmission of acoustic energy through the sensor-structure interface.

5.1.2 *Bonding*—The sensor may be attached directly to the structure with a suitable adhesive. In this method, the adhesive acts as the couplant. The adhesive must be compatible with the structure, the sensor, the environment, and the examination procedure.

## 6. Mounting Requirements

6.1 *Sensor Selection*—The correct sensors should be chosen to optimally accomplish the ~~acoustic-emission~~AE examination objective. ~~Sensor~~Selection parameters to be considered are as follows: size, sensitivity, frequency response, surface-motion response, ~~and environmental and material compatibility.~~ environmental compatibility, background noise, source location requirements, and material properties of the structure under examination. When a multichannel acoustic-emission examination is being conducted, a subset of sensors with characteristics similar to each other should be selected. See Guide E976 for methods of comparing sensor characteristics.

6.1.1 If the examination objective is to include AE source location, sensor selection may be governed by the material properties of the structure and may affect subsequent sensor spacing due to attenuation. It may be necessary to evaluate attenuation effects as part of the pre-examination procedure. If performed, the attenuation data shall be retained as part of the experimental record.

6.1.2 When a multichannel acoustic-emission examination is being conducted, a subset of sensors with characteristics similar to each other should be selected. See Guide E976 for methods of comparing sensor characteristics.

6.2 *Structure Preparation*—The contacting surfaces should be cleaned and mechanically prepared. This will enhance the detection of the desired acoustic waves by assuring reliable coupling of the acoustic energy from the structure to the sensor. Preparation of these surfaces must be compatible with the construction materials used in both the sensor and the structure. Possible losses in acoustic energy transmission caused by coatings such as paint, encapsulants, loose-mill scale, weld spatter, and oxides as well as losses due to surface curvature at the contact area must be considered.

6.2.1 The location of each sensor should be measured and marked accordingly on the structure and recorded as part of the examination record.

6.2.2 If surface preparation requires removing paint from a metal surface, the paint may be removed with a grinder or other mechanical means, down to bare metal. The area of paint removal should be slightly larger than the diameter of the sensor. If the metal surface is smooth, sandpaper may be used to roughen the surface prior to bonding.

6.2.2.1 After paint removal, the surface should be cleaned with a degreaser and wiped clean with a cloth.

6.2.2.2 If corrosion is present on the structure, additional cleaning may include using a conditioner (mild acid) and neutralizer to minimize potential corrosion beneath the sensor after mounting.

6.2.2.3 If the structure is located in a marine environment, soluble salts (e.g. chlorides, nitrates, sulfates) may still reside on the steel surface even after cleaning. These types of salts attract moisture from the air, and may result in additional corrosion beneath the sensor and failure of the bond. As such, a liquid soluble salt remover is recommended as an additional step in surface preparation prior to sensor mounting.



6.3 *Couplant or Bonding Agent Selection:*

6.3.1 The type of couplant or bonding agent should be selected with appropriate consideration for the effects of the environment (for example, temperature, pressure, composition of gas, or liquid environment) on the couplant and the constraints of the application. It should be chemically compatible with the structure and not be a possible cause of corrosion. In some cases, it may be a requirement that the couplant be completely removable from the surface after examination. In general, the selection of the couplant is as important from an environmental standpoint as it is from the acoustical standpoint.

6.3.2 For sensors that are primarily sensitive to particle motion perpendicular to their face, the viscosity of the couplant is not an important factor. Most liquids or greases will work as a couplant if they wet the surfaces of both the structure and the sensor. For those few sensors which are sensitive primarily to motion in the plane of their face, very high-viscosity couplant or a rigid bond is recommended.

6.3.2.1 Testing has shown that in most cases, when working at frequencies below 500 kHz, most couplants will suffice. However, due to potential loss of high frequency (HF) spectra when working above 500 kHz, a low viscosity couplant or rigid bond, relative to sensor motion response, is recommended. Additionally, when spectral response above 500 kHz is needed, it is recommended that FFT be performed to verify adequacy of HF response.

6.3.3 The thickness of the couplant may alter the effective sensitivity of the sensor. The thinnest practical layer of continuous couplant is usually the best. Care should be taken that there are no entrapped voids in the couplant. Unevenness, such as a taper from one side of the sensor to the other, can also reduce sensitivity or produce an unwanted directionality in the sensor response.

6.3.4 A useful method for applying a couplant is to place a small amount of the material in the center of the sensor face, then carefully press the sensor on to the structure surface, spreading the couplant uniformly from the center to the outside of the sensor face. Typically, this will result in a small band (fillet) of couplant around the outside circumference of the sensor.

6.3.5 In some applications, it may be impractical to use a couplant because of the nature of the environment (for example, very high temperatures or extreme cleanliness requirements). In these situations, a dry contact may be used, provided sufficient