

## **E07.04 – Overview of Current and Developing ASTM Acoustic Emission Standards**

Mark F. Carlos, Physical Acoustics Corporation (PAC), USA.

### ***Abstract:***

The E07.04 Acoustic Emission Subcommittee is responsible for the formulation, standardization and maintenance of test methods, terminology, practices and guides, related to Acoustic Emission (AE) examinations. Currently there are 23 existing AE related ASTM standards in E07.04 and the associated Volume 03.03 Nondestructive Testing, Annual Book of Standards with two more currently in development. The goal of this document is to provide an overview of the existing standard documents, their importance in industry, an overview of new standard documents in process, and a call for support and participation in the development of new and relevant standard documents related to AE examination.

### ***Paper Summary:***

Below is a list of the existing AE standards that can be found in the Volume 03.03 Nondestructive Testing, Annual Book of Standards:

- E569**, Standard Practice for Acoustic Emission Monitoring of Structures During Controlled Stimulation
- E650**, Standard Guide for Mounting Piezoelectric Acoustic Emission Sensors
- E749**, Standard Practice for Acoustic Emission Monitoring During Continuous Welding
- E750**, Standard Practice for Characterizing Acoustic Emission Instrumentation
- E751**, Standard Practice for Acoustic Emission Monitoring During Resistance Spot-Welding
- E976**, Standard Guide for Determining the Reproducibility of Acoustic Emission Sensors Response
- E1067**, Standard Practice for AE Examination of Fiberglass Reinforced Plastic Resin(FRP)
- E1106**, Standard Method for Primary Calibration of Acoustic Emission Sensors
- E1118**, Standard Practice for Acoustic Emission Examination of Reinforced Thermosetting Resin Pipe (RTRP)
- E1139**, Standard Practice for Continuous Monitoring of Acoustic Emission from Metal Pressure Boundaries
- E1211**, Standard Practice for Leak Detection and Location Using Surface-Mounted Acoustic Emission Sensors
- E1419**, Standard Test Method for Examination of Seamless, Gas-Filled, Pressure Vessels Using Acoustic Emission
- E1495**, Standard Guide for Acousto-Ultrasonic Assessment of Composites, Laminates, and Bonded Joints
- E1736**, Standard Practice for Acousto-Ultrasonic Assessment of Filament-Wound Pressure Vessels
- E1781**, Standard Practice for Secondary Calibration of Acoustic Emission Sensors
- E1888**, Standard Test Method for Acoustic Emission Examination of Pressurized Containers Made of Fiberglass Reinforced Plastic with Balsa Wood Cores
- E1930**, Standard Test Method for Examination of Liquid Filled Atmospheric and Low Pressure Metal Storage Tanks Using Acoustic Emission.
- E1932**, Standard Guide for Acoustic Emission Examination of Small parts.
- E2075**, Standard Practice for Verifying the Consistency of AE-Sensor Response Using an Acrylic Rod.
- E2076**, Standard Test Method for Examination of Fiberglass Reinforced Plastic Fan Blades Using Acoustic Emission
- E2191**, Standard Test Method for Examination of Gas-Filled Filament-Wound Composite Pressure Vessels Using Acoustic Emission.
- E2374**, Standard Guide for Acoustic Emission System Performance Verification.
- E2478**, Standard Practice for Determining Damage-Based Design Criteria for Fiberglass Reinforced Plastics (FRP) materials, Using Acoustic Emission.

These documents can be broken out in various ways, the most important of which would be to classify the types of documents from the user perspective as discussed below:

1. There are 6 documents related to sensor primary and secondary calibration, sensor and system characterization and verification,
2. There are 2 tutorial documents associated with attaching sensors to the test article, or how to conduct a typical examination.
3. There are 13 documents associated with actual Acoustic Emission Examinations.
4. There are 2 documents associated with Acousto-Ultrasonic applications.

**Sensor and System Related Standards:** Of the 6 documents that are related to sensors and systems, they include the following; E1106 describes the primary AE sensor calibration system located at NIST in Washington DC while E1781 describes a secondary AE sensor calibration standard which parallels the NIST system for sensor developers and users. These two standards are recognized worldwide as the de-facto sensor calibration standard. Taking a step down for users who need a practical method of verifying the sensor response we have E976 which also is a worldwide de-facto standard, which describes various techniques of exciting an AE sensor and measuring its response in all types of situations. Lastly, there is a standard, E2075, which describes a method measuring consistency of the AE sensor response utilizing an acrylic rod. In terms of AE systems, E750 describes various measurements that can be made to characterize an AE system (on the bench), while E2374 describes a method of verifying an AE system before, during and after an AE examination.

**Tutorial Documents:** There are two excellent tutorial documents on the use of AE. E650 describes a method for mounting piezoelectric Acoustic Emission sensors for maximum performance for different applications while E1932 is a step by step guide in preparing for, carrying out, analyzing and reporting on a typical AE examination on smaller parts. Small parts are emphasized in this standard guide in order to minimize complications arising from large structures.

**Acoustic Emission specific Examination documents:** There are 12 specific application documents which describe examinations on very specific types of items. These include the following:

1. **E569** describes the monitoring of structures such as pressure vessels and pipelines which can be stressed by mechanical or thermal means, such as raising the internal pressure or temperature.
2. **E749** describes AE examination procedures during continuous welding.
3. **E751** describes AE examination procedures during resistance spot welding.
4. **E1067** describes AE examination or monitoring of fiberglass reinforced plastic (FRP) tanks/vessels under pressure or vacuum to determine structural integrity.
5. **E1118** describes AE examination or monitoring of reinforced thermosetting resin pipe (RTRP) to determine structural integrity. It is applicable to lined or unlined pipe, fittings, joints and piping systems.
6. **E1139** describes techniques for continuous AE monitoring from metal pressure boundaries in industrial systems during operation. Examples include pressure vessels, piping and other system components which serve to contain system pressure. Pressure boundaries other than metal, such as composites are specifically not covered by this document.
7. **E1211** describes the method of detecting and locating the steady state source of gas and liquid leaking from pressurized systems.
8. **E1419** describes AE examination of seamless pressure vessels (tubes) of the type used for distribution or storage of industrial gases. This document is used worldwide and is based on a DOT inspection exemption.
9. **E1888** describes AE examination techniques of pressurized containers made of fiberglass reinforced plastic (FRP) with balsa wood cores. Containers of this type are commonly used on tank trailers for the transport of hazardous chemicals.
10. **E1930** describes guidelines for AE examination of new and in-service above-ground storage tanks of the type used for storage of liquids.
11. **E2076** describes a method for AE examination of fiberglass reinforced plastic (FRP) fan blades of the type used in industrial cooling towers and heat exchangers.
12. **E2191** describes guidelines for AE examination of filament-wound composite pressure vessels, for example the type used for fuel tanks in vehicles which use natural gas.
13. **E2478** describes how to use AE in the design process of testing of composites samples (specimens) in order to evaluate different designs for damage tolerance.

**Acousto-Ultrasonics Standards:** Of the 22 existing documents, 2 relate to Acousto-Ultrasonics. Acousto-Ultrasonic instruments utilize existing AE instruments but instead of passively listening for generation of stress waves, artificial means are used to pulse or excite the structure, while standard AE techniques are used for detection and processing of the artificial, known signals. Of the two documents, E1495 is a general tutorial guide to Acousto-Ultrasonics (A-U) in which the rationale and basic technology of the A-U technique is fully discussed. Also, E1495 provides guidelines for NDE of flaws and physical characteristics that influence the mechanical properties and relative strength of composite structures for example filament-wound pressure vessels, adhesive bonds and inter-laminar and fiber/matrix bonds in man-made composites and natural composites (such as wood). Finally, E1736 describes an A-U procedure for the assessment of filament-wound pressure vessels.

**Current Work Items in process:** Currently there are two standards in progress. The first entitled, "Standard Test Method for Acoustic Emission Examination of Seam-Welded High Energy Piping", provides guidelines for AE on-line monitoring of seam-welded high energy steam piping, of the type found in fossil power plants, for detection of flaws. This AE measurements are used to detect, locate and classify emission sources under normal operational conditions. The primary intent of the examination is to identify the presence and relative severity of high temperature creep damage to seam welds and is based on an EPRI approved test method that was developed for the energy industry.

The second ASTM Standard practice in development is based on testing of Aerospace composite panels as part of a qualification process. This procedure is being developed in conjunction with the Aerospace industry who is needing various NDT standards for testing and verifying Aerospace composites. There will be several documents coming out of this work.

Other documents are in a formulation stage and we are always very interested in entertaining new documents.

#### **Summary:**

Twenty three standard Acoustic Emission based documents are currently being maintained by the ASTM E07.04 AE Sub-Committee, with two additional standards in development. Our standards are used worldwide and some are actually de-facto worldwide standards. These days, standard documents and Examination procedures are very important to the growth and relevance of the Acoustic Emission technique. E07.04 is a small, close group. We are looking for interested volunteers to help and assist in growing the development of AE standards. We are also interested in new techniques and are open to inputs from all.