



Standard Practice for Acoustic Emission Monitoring During Continuous Welding¹

This standard is issued under the fixed designation E 749; 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 provides recommended guidelines for acoustic emission (AE) monitoring of weldments during and immediately following their fabrication by continuous welding processes. The technique is in a developmental stage and is not used routinely on production welding. Depending on the results of ongoing research and preproduction weld monitoring experience, these procedures are subject to change before routine implementation on production welds.

1.2 The procedure described in this practice is applicable to the detection and location of AE sources in weldments and in their heat-affected zone during fabrication, particularly in those cases where the time duration of welding is such that fusion and solidification take place while welding is still in progress.

1.3 The effectiveness of acoustic emission to detect discontinuities in the weldment and the heat-affected zone is dependent on the design of the AE system, the calibration procedure, the weld process, and the material type. Materials that have been monitored include low-carbon steels, low-alloy steels, stainless steels, and some aluminum alloys. The system performance must be verified for each application by demonstrating that the defects of concern can be detected with the desired reliability.

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 543 Practice for Evaluating Agencies that Perform Non-destructive Testing²

E 569 Practice for Acoustic Emission Monitoring of Structures During Controlled Stimulation²

E 650 Guide for Mounting Piezoelectric Acoustic Emission Sensors²

E 1316 Terminology for Nondestructive Examinations²

2.2 ASNT Standards:³

SNT-TC-1A Recommended Practice for Nondestructive Testing Personnel Qualification and Certification

ANSI/ASNT CP-189 Standard for Qualification and Certification of Nondestructive Testing Personnel

2.3 Military Standard:

MIL-STD-410 Nondestructive Testing Personnel Qualification and Certification⁴

3. Terminology

3.1 *Definitions*—For definitions of terms relating to acoustic emission testing, see Section B of Terminology E 1316.

4. Significance and Use

4.1 Detection and location of AE sources in weldments during fabrication may provide information related to the integrity of the weld. Such information may be used to direct repair procedures on the weld or as a guide for application of other nondestructive evaluation (NDE) methods. A major attribute of applying AE for in-process monitoring of welds is the ability of the method to provide immediate real-time information on weld integrity. This feature makes the method useful to lower weld costs by repairing defects at the most convenient point in the production process. The AE activity from discontinuities in the weldment is stimulated by the thermal stresses from the welding process. The AE activity resulting from this stimulation is detected by AE sensors in the vicinity of the weldment which convert the acoustic signals into electronic signals. The AE instrumentation similar to that described in Practice E 569 processes signals and may provide means for immediate display or indication of AE activity and for permanent recordings of the data.

4.2 Items to be considered in preparation and planning for monitoring should include but not be limited to the following:

4.2.1 Description of the system or object to be monitored or examined,

4.2.2 Extent of monitoring, that is, entire weld, cover passes only, and so forth,

4.2.3 Limitations or restrictions on the sensor mounting procedures, if applicable,

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

³ Available from American Society of Nondestructive Testing, 1711 Arlingate Plaza, P. O. Box 28518, Columbus, OH 43228-0518.

⁴ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

4.2.4 Performance parameters to be established and maintained during the calibration procedure (sensitivity, locational accuracy, and so forth),

4.2.5 Maximum time interval between system calibration checks,

4.2.6 Performance criteria for purchased equipment,

4.2.7 Requirements for permanent records of the AE response, if applicable,

4.2.8 Content and format of testing report, if required, and

4.2.9 Operator qualification and certification, if required.

5. Basis of Application

5.1 Personnel Qualification:

5.1.1 Nondestructive Testing (NDT) personnel shall be qualified in accordance with a nationally recognized NDT personnel qualification practice or standard such as ANSI/ASNT CP-189, SNT-TC-1A, MIL-STD-410, or similar document. The practice or standard used and its applicable revision shall be specified in the contractual agreement between the using parties.

5.1.2 In those cases in which AE monitoring is restricted to use as a production tool to facilitate immediate repair, monitoring during welding may be performed by production personnel lacking the necessary certification; however, certified personnel should verify that proper procedures are implemented.

5.2 *Qualification of Nondestructive Agencies*—If specified in the contractual agreement, NDT agencies shall be qualified and evaluated as described in Practice E 543. The applicable edition of Practice E 543 shall be specified in the contractual agreement.

5.3 *Procedures and Techniques*—The procedures and techniques to be used shall be as described in this practice unless otherwise specified. Specific techniques may be specified in the contractual agreement.

6. Examination Preparation

6.1 The following preparatory procedures should be completed before initiating AE monitoring:

6.1.1 Select the location(s) where the sensor(s) will be acoustically coupled. The sensor(s) should be centrally located near the weldment to provide for optimal AE response from all portions of the weld. If the sensor(s) are piezoelectric, this location should be such that the maximum temperature stays substantially below the Curie temperature of the sensor(s). Take care in selecting the sensor mounting locations to avoid contact or disturbance, or both, of the sensor by any of the welding or structural positioning equipment. Typical distances from 6 in. to 1 ft (150 to 300 mm) from the heat-affected zone of the weld are usually satisfactory. Typical fixed sensor placement patterns that have been successfully used are shown in Figs. 1-3.

6.1.1.1 If a fixed contact sensor(s) is used, clean the area(s) where attachment will be made to eliminate loose scale, welding flux, or other debris, and attach the sensor in accordance with Guide E 650.

6.1.1.2 If moving sensors are used, clean the coupling path so that uniform sensitivity is maintained as the sensor moves.

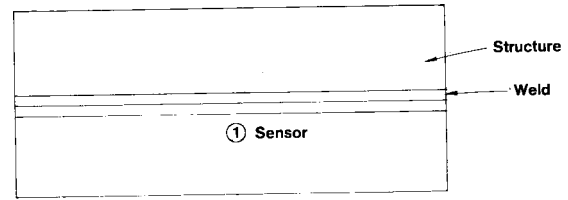


FIG. 1 Typical Sensor Placement for Single Channel AE Monitoring of a Linear Weld

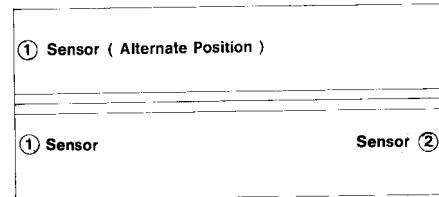


FIG. 2 Typical Sensor Placement for Two-Channel AE Monitoring of a Linear Weld

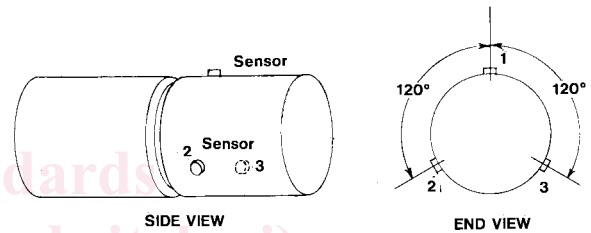


FIG. 3 Typical Sensor Placement for Three-Channel AE Monitoring of a Circular Weld

Fig. 4 shows side and top views of a typical configuration for moving sensors.

6.1.2 Position and route the signal cables connecting the sensor(s) to the AE instrumentation to avoid contacting the hot weld bead or entangling the welding and positioning equipment.

6.1.3 Adjustment of Apparatus:

6.1.3.1 After all sensors are mounted, connected, and operational (without objectionable background noise), the AE monitoring system can then be adjusted using an AE simulator.

6.1.3.2 *Gain Adjustment*—To set the gain for a channel, locate the acoustic emission simulator at a selected distance adjacent to the sensor. Monitor the response to the simulated emission, and adjust the channel gain to a specified amplitude level. Repeat this procedure two times, placing the simulator at the same distance from the sensor but at different azimuthal positions relative to the original simulator positions (see Fig. 5). Record the average gain for the three simulator positions. Repeat the entire procedure for each AE sensor on the structure, and adjust the gains. The average gains for all channels should give responses to the simulator that have peak voltages identical to within ± 3 dB.

6.1.4 *Determination of Source-Location Accuracy*—Check the operation of the AE source-location function by analyzing simulated AE signals from several random locations in the weld and on the structure, as well as from any specific critical locations. For each placement of the simulator, determine and record the precision and accuracy of the AE location function. It should be noted that the accuracy of locating the simulator