Designation: E751/E751M – 17 (Reapproved 2022)

Standard Practice for Acoustic Emission Monitoring During Resistance Spot-Welding[1]

This standard is issued under the fixed designation E751/E751M; 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 describes procedures for the measurement, processing, and interpretation of the acoustic emission (AE) response associated with selected stages of the resistance spot-welding process.

1.2 This practice also provides recommendations for feedback control by utilizing the measured AE response signals during the spot-welding process.

1.3 *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 nonconformance with the standard.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *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]

E543 Specification for Agencies Performing Nondestructive Testing

E1316 Terminology for Nondestructive Examinations

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 *AIA Standard:*[4]

NAS-410 Certification and Qualification of Nondestructive Personnel (Quality Assurance Committee)

2.4 *ISO Standard:*[5]

ISO 9712 Non-Destructive Testing: Qualification and Certification of NDT Personnel

3. Terminology

3.1 *Definitions*—For definitions of terms relating to acoustic emission testing, see Section B of Terminology E1316.

4. Summary of Practice

4.1 The resistance spot-welding process consists of several stages. These are the set-down of the electrodes, squeeze, current flow, forging, hold time, and lift-off. Various types of acoustic emission signals are produced during each of these stages. Often, these signals can be identified with respect to the nature of their source. The individual signal elements may be greatly different, or totally absent, in various materials, thicknesses, and so forth. Fig. 1 is a schematic representation showing typical signal elements which may be present in the AE signature from a given spot-weld.

4.2 Most of the depicted AE signal features can be related to factors of weld quality. The AE occurring during set-down and squeeze can often be related to the condition of the electrodes and the surface of the parts. The large, often brief, signal at current initiation can be related to the initial resistance, and the cleanliness of the part. For example, burning through of certain oxide layers contributes to the acoustic emission response during this time.

[1] This practice 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] 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] Available from American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518, http://www.asnt.org.

[4] Available from Aerospace Industries Association of America, Inc. (AIA), 1000 Wilson Blvd., Suite 1700, Arlington, VA 22209-3928, http://www.aia-aerospace.org.

[5] Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, http://www.iso.org.

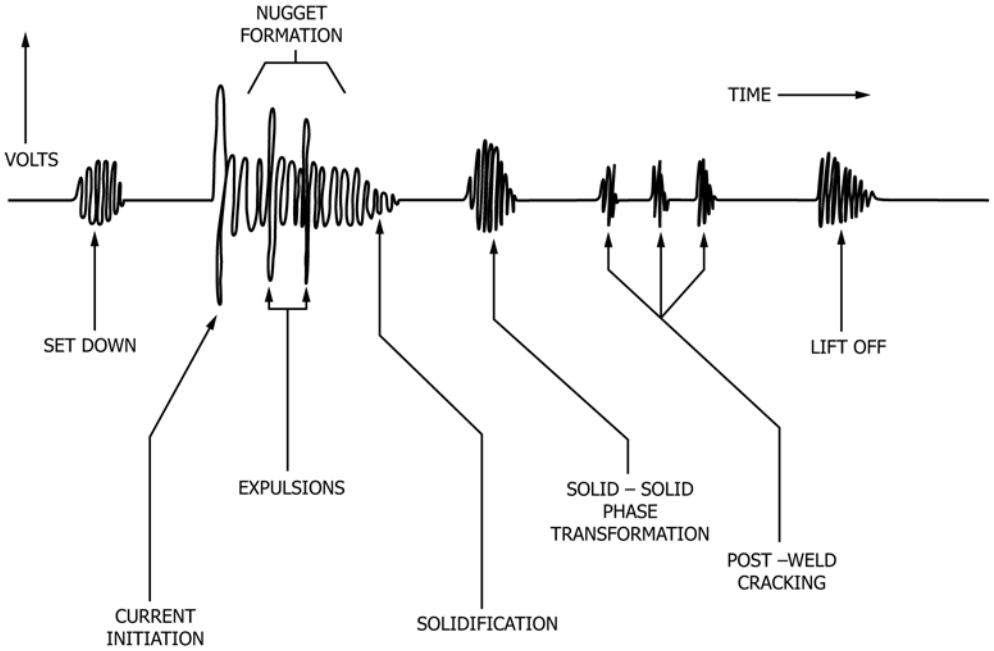

FIG. 1 Typical AE Response Signals During Resistance Spot Welding

4.2.1 During current flow, plastic deformation, nugget expansion, friction, melting, and expulsions produce AE signals. The signals caused by expulsion (spitting or flashing, or both) generally have large amplitudes and can be distinguished from the rest of the acoustic emission associated with nugget formation. Fig. 2 shows typical AE response signals during current flow for both d-c and a-c welding.

4.2.2 Following termination of the welding current, some materials exhibit appreciable AE during solidification which can be related to nugget size and inclusions. As the nugget cools during the hold period, AE can result from solid-solid phase transformations and cracking.

4.2.3 During the lift-off stage, separation of the electrode from the part produces signals that can be related to the condition of the electrode as well as the cosmetic condition of the weld.

4.3 Using time, and amplitude or energy discrimination, or both, the AE response corresponding to each stage can be separately detected and analyzed. Although the AE associated with each stage of the spot-welding process can be relevant to weld quality, this practice only gives detailed consideration to the AE generated by nugget formation and expansion, expulsion, and cracking.

5. Significance and Use

5.1 The AE produced during the production of a spot-weld can be related to weld quality parameters such as the strength and size of the nugget, the amount of expulsion, and the amount of cracking. Therefore, in-process AE monitoring can be used both as an examination method, and as a means for providing feedback control.

6. Basis of Application

6.1 The following items are subject to contractual agreement between the parties using or referencing this standard.

6.2 *Personnel Qualification:*

6.2.1 If specified in the contractual agreement, personnel performing examinations to this standard shall be qualified in accordance with a nationally or internationally recognized NDT personnel qualification practice or standard such as ANSI/ASNT CP-189, SNT-TC-1A, NAS-410, ISO 9712, or a similar document and certified by the employer or certifying agency, as applicable. The practice or standard used and its applicable revision shall be identified in the contractual agreement between the using parties.

6.3 *Qualification of Nondestructive Agencies*—If specified in the contractual agreement, NDT agencies shall be qualified and evaluated as described in Practice E543. The applicable edition of Practice E543 shall be specified in the contractual agreement.

6.4 *Procedures and Techniques*—The procedures and techniques to be utilized shall be as specified in the contractual agreement.

7. Ordering Information

7.1 If the spot-weld monitoring or process control methods described in this practice are performed as a service, the following items should be addressed in the purchase specification, and are subject to agreement between the purchaser and the supplier:

7.1.1 Description of the welded parts in terms of geometry, dimensions, number and position of welds, and materials.

7.1.2 Description of the welding machine, type and dimensions of the electrodes, type of weld controller, welding schedule, and distance between the welding head and the controller.

7.1.3 Location and mounting method for the acoustic emission sensors, and design of the mounting fixture, as appropriate.