Designation: E2261/E2261M – 17 (Reapproved 2021)

Standard Practice for Examination of Welds Using the Alternating Current Field Measurement Technique[1]

This standard is issued under the fixed designation E2261/E2261M; 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 to be followed during alternating current field measurement examination of welds for baseline and service-induced surface breaking discontinuities.

1.2 This practice is intended for use on welds in any metallic material.

1.3 This practice does not establish weld acceptance criteria.

1.4 *Units*—The values stated in either inch-pound units or SI units are to be regarded separately as standard. The values stated in each system might 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.

1.5 *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.*

1.6 *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 Standard:*[3]

SNT-TC-1A Personnel Qualification and Certification in Nondestructive Testing

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

2.3 *ISO Standard:*[4]

ISO 9712 Nondestructive Testing—Qualification and Certification of Nondestructive Testing Personnel

3. Terminology

3.1 *Definitions*—For definitions of terms relating to this practice refer to Terminology E1316, Section A, Common NDT terms, and Section C, Electromagnetic testing. The following definitions are specific to the alternating current field measurement technique:

3.2 *Definitions:*

3.2.1 *exciter*—a device that generates a time varying electromagnetic field, usually a coil energized with alternating current (AC); also known as a transmitter.

3.2.2 *detector*—one or more coils or elements used to sense or measure a magnetic field; also known as a receiver.

3.2.3 *uniform field*—as applied to nondestructive testing with magnetic fields, the area of uniform magnetic field over the surface of the material under examination produced by a parallel induced alternating current, which has been passed through the weld and is observable beyond the direct coupling of the exciting coil.

3.2.4 *graduated field*—as applied to nondestructive testing with magnetic fields, a magnetic field having a controlled gradient in its intensity.

3.3 *Definitions of Terms Specific to This Standard:*

3.3.1 *alternating current field measurement system*—the electronic instrumentation, software, probes, and all associated components and cables required for performing weld examination using the alternating current field measurement technique.

[1] This practice is under the jurisdiction of ASTM Committee E07 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.07 on Electromagnetic Method.

Current edition approved Nov. 1, 2021. Published November 2021. Originally approved in 2003. Last previous edition approved in 2017 as E2261/E2261M – 17. DOI: 10.1520/E2261_E2261M-17R21.

[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 National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[4] 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.

***A Summary of Changes section appears at the end of this standard**

3.3.2 *operational reference standard*—a reference standard with specified artificial slots, used to confirm the operation of the system.

3.3.3 *Bx*—the x component of the magnetic field, parallel to the weld toe, the magnitude of which is proportional to the current density set up by the electric field.

3.3.4 *Bz*—the z component of the magnetic field normal to the inspected base metal/heat affected zone surface, the magnitude of which is proportional to the lateral deflection of the induced currents in the plane of that surface.

3.3.5 *X-Y Plot*—an X-Y graph with two orthogonal components of magnetic field plotted against each other.

3.3.6 *time base plots*—these plot the relationship between Bx or Bz values with time.

3.3.7 *surface plot*—for use with array probes. This type of plot has one component of the magnetic field plotted over an area, typically as a color contour plot or 3-D wire frame plot.

3.3.8 *data sample rate*—the rate at which data is digitized for display and recording, in data points per second.

3.3.9 *configuration data*—standardization data and instrumentation settings for a particular probe stored in a computer file.

3.3.10 *twin fields*—magnetic fields generated in two orthogonal directions by use of two exciters

NOTE 1—Different equipment manufacturers may use slightly different terminology. Reference should be made to the equipment manufacturer's documentation for clarification.

4. Summary of Practice

4.1 In a basic alternating current field measurement system, a small probe is moved along the toe of a weld. The probe contains an exciter coil, which induces an AC magnetic field in the material surface aligned to the direction of the weld. This, in turn, causes alternating current to flow across the weld. The depth of penetration of this current varies with material type and frequency but is typically 0.004 in. [0.1 mm] deep in magnetic materials and 0.08 to 0.3 in. [2 to 7 mm] deep in non-ferrous materials. Any surface breaking discontinuities within a short distance of either side of the scan line at this location will interrupt or disturb the flow of the alternating current. The maximum distance from the scan line to a target discontinuity, potentially detectable at a specified probability of detection, is determined by the probe assembly size, but is typically 0.4 in [10 mm]. Measurement of the absolute quantities of the two major components of the surface magnetic fields (Bx and Bz) determines the severity of the disturbance (see Fig. 1) and thus the severity of the discontinuity. Discontinuity sizes, such as crack length and depth, can be estimated from key points selected from the Bx and Bz traces along with the standardization data and instrument settings from each individual probe. This discontinuity sizing can be performed automatically using system software. Discontinuities essentially perpendicular to the weld may be detected (in ferritic metals only) by the flux leakage effect. However confirmation of such transverse discontinuities (and detection of the same in non-ferritic metals) requires scans with the induced magnetic field perpendicular to the direction of the weld.

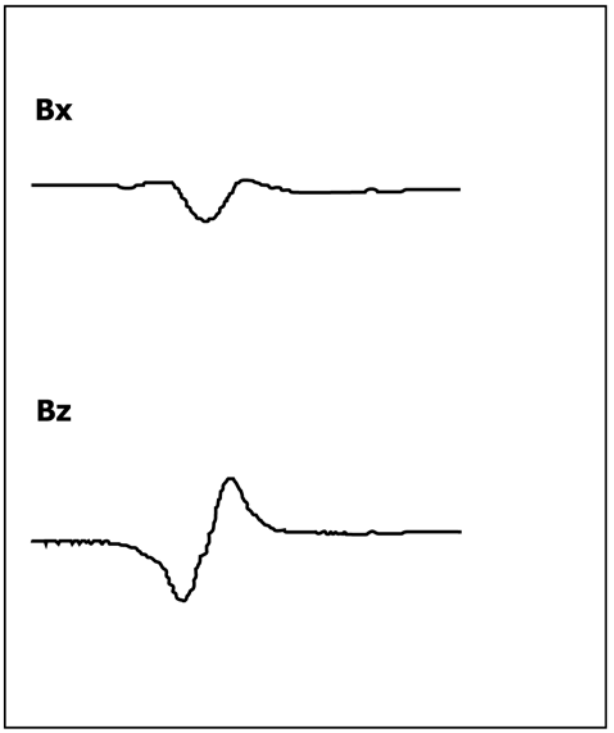

FIG. 1 Example Bx and Bz Traces as a Probe Passes Over a Crack
(The orientation of the traces may differ depending upon the instrumentation.)

4.2 Configuration data is loaded at the start of the examination. System sensitivity and operation is verified using an operation reference standard. System operation is checked and recorded prior to and at regular intervals during the examination. Note that when a unidirectional input current is used, any decay in strength of the input field with probe lift-off or thin coating is relatively small so that variations of output signal (as may be associated with a discontinuity) are reduced. If a thick coating is present, then the discontinuity size estimation must compensate for the coating thickness. The coating thickness requiring compensation is probe dependent. This can be accomplished using discontinuity-sizing tables in the system software and an operator-entered coating thickness or automatically if the equipment measures the coating thickness or stand-off distance during the scanning process. Using the wrong coating thickness would have a negative effect on depth sizing accuracy if the coating thickness discrepancy is too large. Data is recorded in a manner that allows archiving and subsequent recall for each weld location. Evaluation of examination results may be conducted at the time of examination or at a later date. The examiner generates an examination report detailing complete results of the examination.

5. Significance and Use

5.1 The purpose of the alternating current field measurement method is to evaluate welds for surface breaking discontinuities such as fabrication and fatigue cracks. The examination results may then be used by qualified organizations to