Designation: E2096/E2096M – 22

Standard Practice for In Situ Examination of Ferromagnetic Heat-Exchanger Tubes Using Remote Field Testing[1]

This standard is issued under the fixed designation E2096/E2096M; 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 remote field examination of installed ferromagnetic heat-exchanger tubing for baseline and service-induced discontinuities.

1.2 This practice is intended for use on ferromagnetic tubes with outside diameters from 0.500 to 2.000 in. [12.70 to 50.80 mm], with wall thicknesses in the range from 0.028 to 0.134 in. [0.71 to 3.40 mm].

1.3 This practice does not establish tube acceptance criteria; the tube acceptance criteria must be specified by the using parties.

1.4 *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 are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

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

3. Terminology

3.1 *General*—Definitions of terms used in this practice can be found in Terminology E1316, Section A, "Common NDT Terms," and Section C, "Electromagnetic Testing."

3.2 *Definitions:*

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

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

3.2.3 *nominal tube, n*—a tube or tube section meeting the tubing manufacturer's specifications, with relevant properties typical of a tube being examined, used for reference in interpretation and evaluation.

3.2.4 *remote field, n—as applied to nondestructive testing*, the electromagnetic field which has been transmitted through the test object and is observable beyond the direct coupling field of the exciter.

3.2.5 *remote field testing, n*—a nondestructive test method that measures changes in the remote field to detect and characterize discontinuities.

3.2.6 *using parties, n*—the supplier and purchaser.

3.2.6.1 *Discussion*—The party carrying out the examination is referred to as the "supplier," and the party requesting the examination is referred to as the "purchaser," as required in *Form and Style for ASTM Standards*, April 2004. In common usage outside this practice, these parties are often referred to as the "operator" and "customer," respectively.

3.3 *Definitions of Terms Specific to This Standard:*

[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.

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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**

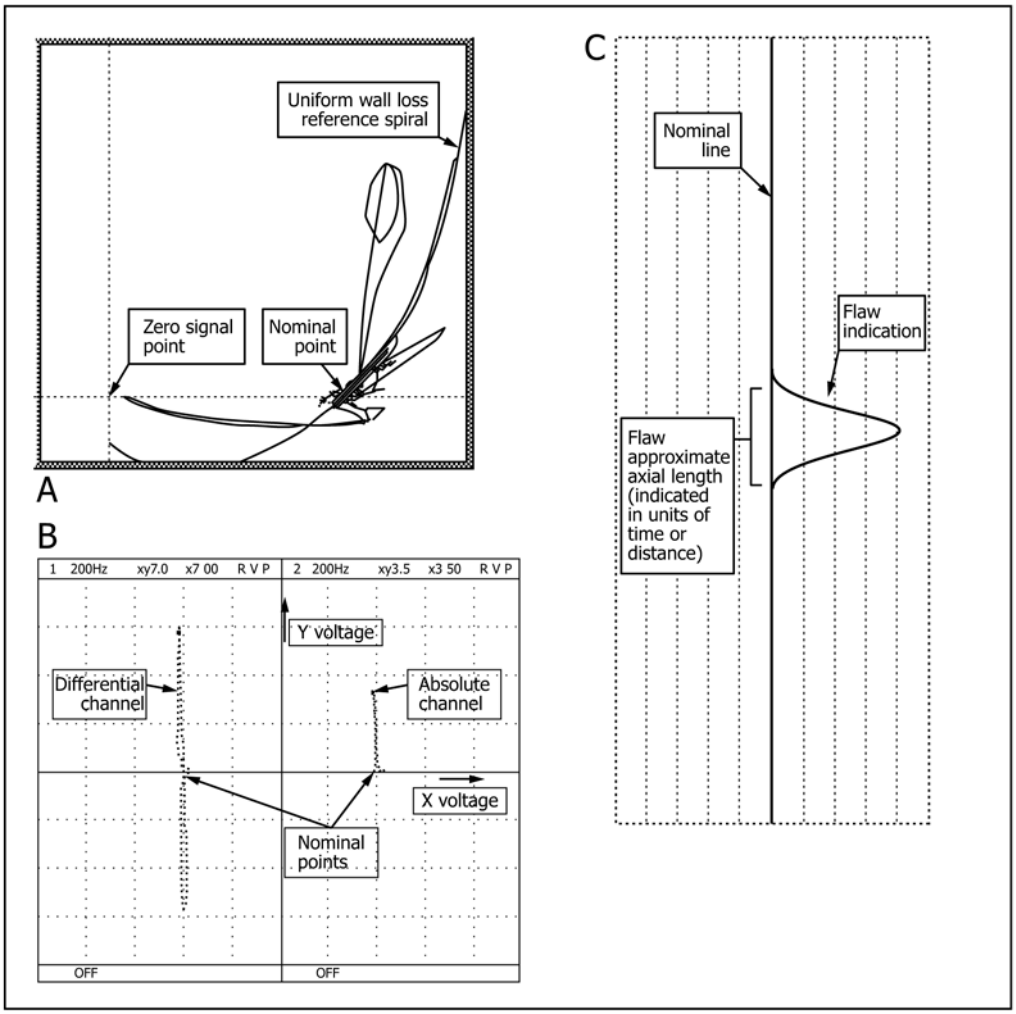

FIG. 1 A and B: Typical Phase-Amplitude Diagrams Used in RFT; C: Generic Strip Chart With Flaw

3.3.1 *flaw characterization standard, n*—a standard used in addition to the RFT system reference standard, with artificial or service-induced flaws, used for flaw characterization.

3.3.2 *nominal point, n*—a point on the phase-amplitude diagram representing data from nominal tube.

3.3.3 *phase-amplitude diagram, n*—a two-dimensional representation of detector output voltage, with angle representing phase with respect to a reference signal, and radius representing amplitude (Fig. 1a and 1b).

3.3.3.1 *Discussion*—In this practice, care has been taken to use the term "phase angle" (and "phase") to refer to an angular equivalent of time displacement, as defined in Terminology E1316. When an angle is not necessarily representative of time, the general term "angle of an indication on the phase-amplitude diagram" is used.

3.3.4 *RFT system, n*—the electronic instrumentation, probes, and all associated components and cables required for performing RFT.

3.3.5 *RFT system reference standard, n*—a reference standard with specified artificial flaws, used to set up and standardize a remote field system and to indicate flaw detection sensitivity.

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

3.3.7 *strip chart, n*—a diagram that plots coordinates extracted from points on a phase-amplitude diagram versus time or axial position (Fig. 1c).

3.3.8 *zero point, n*—a point on the phase-amplitude diagram representing zero detector output voltage.

3.3.8.1 *Discussion*—Data on the phase-amplitude diagram are plotted with respect to the zero point. The zero point is separate from the nominal point unless the detector is configured for zero output in nominal tube. The angle of a flaw indication is measured about the nominal point.

3.4 *Acronyms:*

3.4.1 *RFT, n*—remote field testing

4. Summary of Practice

4.1 The RFT data is collected by passing a probe through each tube. The electromagnetic field transmitted from the exciter to the detector is affected by discontinuities; by the dimensions and electromagnetic properties of the tube; and by objects in and around the tube that are ferromagnetic or conductive. System sensitivity is verified using the RFT system