



Designation: E2598/E2598M – 21

Standard Practice for Acoustic Emission Examination of Cast Iron Yankee and Steam Heated Paper Dryers¹

This standard is issued under the fixed designation E2598/E2598M; 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1.1 This practice is no longer being updated but is being retained for historical value due to the procedures herein that are unique to the AE community.

1.2 This practice provides guidelines for carrying out acoustic emission (AE) examinations of Yankee and Steam Heated Paper Dryers (SHPD) of the type to make tissue, paper, and paperboard products.

1.3 This practice requires pressurization to levels used during normal operation. The pressurization medium may be high temperature steam, air, or gas. The dryer is also subjected to significant stresses during the heating up and cooling down periods of operation. Acoustic Emission data maybe collected during these time periods but this testing is beyond the scope of this document.

1.4 The AE measurements are used to detect, as well as, localize emission sources. Other methods of nondestructive testing (NDT) may be used to further evaluate the significance of acoustic emission sources.

1.5 *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.

1.6 *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.*

1.7 *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 Recom-*

mendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Referenced Documents

2.1 ASTM Standards:²

A278/A278M Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650 °F (350 °C)

E543 Specification for Agencies Performing Nondestructive Testing

E569/E569M Practice for Acoustic Emission Monitoring of Structures During Controlled Stimulation

E650 Guide for Mounting Piezoelectric Acoustic Emission Sensors

E976 Guide for Determining the Reproducibility of Acoustic Emission Sensor Response

E1316 Terminology for Nondestructive Examinations

E2374 Guide for Acoustic Emission System Performance Verification

2.2 ASNT Standards:³

SNT-TC-1A Recommended Practice for Nondestructive Testing Personnel

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

3. Terminology

3.1 *Definitions*—See Terminology E1316 for general terminology applicable to this practice.

4. Summary of Practice

4.1 Each mounted sensor, on the cast iron vessel, monitors while the vessel is stationary and pressurized to normal operating pressure. The vessel may be at ambient, or operating 120 °C–230 °C [250 °F–450 °F] temperature.

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>.

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



4.2 Each mounted AE sensor is connected to an acoustic emission signal processor. After a monitoring period (up to 10 min) and pre-examination sensor sensitivity checks, pressurization can begin.

4.3 Location

4.3.1 *Zone Location*—Each channel shall have the same system examination threshold. A simulated AE source generated anywhere on the vessel shall be detected by at least one sensor.

4.3.2 *Source Location*—All location data resulting from analysis shall be presented in a manner consistent with the previously established calibration accuracy. The simulated AE source generated in each structure mounted sensor array shall be detected by the minimum number of sensors required to locate the source within $\pm 5\%$ of sensor spacing.

4.4 Due to the potential for gasketed interfaces (at the heads/manway), multiple metal combinations (metalspray, cast steel-cast iron combinations), high vessel temperature, or random variations in the material velocity of cast iron, accurate source location ($\pm 5\%$ sensor spacing) may not always be possible.

4.5 Once the AE sensor source is localized, further evaluation is begun by observing a “history” of events involving the area [Head tilt (corrosion induced head strain), leak repair, objects through the nip (working contact with another roll), etc.]. This may give further direction to the selection of the NDE method to use for follow-up examination of the AE indication area.

4.6 Secondary examination establishes presence of flaws and measures flaw dimensions.

4.7 Cast iron Yankee dryers can be up to 6.7 m [22 ft] in diameter, 7.3 m [24 ft] long, and weigh 90 000 Kg [200 000 lb], or more. Vessel thickness measurements are available from the paper/tissue machine operator. Cast iron is a brittle metal and has no specific yield point. Yankee dryers must maintain specific dimensional tolerances. When a pressurized Yankee or steam heated paper dryer (SHPD) remains stationary, it fills with condensate at a rapid rate. In an hour, a steam pressurized Yankee or SHPD can fill half way with condensate, doubling the weight on the frame, and the floor. Some Yankee owners have corporate requirements that a cast iron Yankee dryer remain stationary for $\frac{1}{2}$ hour, then rotation is required. Permission is required, if the Yankee is to remain stationary for more time. This issue should be discussed with the responsible person prior to the examination.

4.8 Yankee dryers operate under a heated hood. The hood is in close proximity to the Yankee shell and allows only inches of clearance for the top half of the vessel.

4.9 Cast iron steam heated paper machine dryers are 1.8 m [6 ft] in diameter, or more, and may be 9 m [30 ft] long.

4.10 Gray cast iron experiences a continuing reduction in elastic modulus as it is stressed to increasing higher levels. It is prudent not to stress grey cast iron material beyond its operating stress level.

4.11 Flaws to be found are the same as those in any cast and machined product. Attempts have been made to characterize

strength properties of cast irons in compact tension tests. In a TAPPI sponsored laboratory study, two out of three cast iron compact tension specimens experienced unplanned failures. From that experience, it was cautioned that “cracks initiated and grew faster than expected resulting in brittle fracture before the process could be halted.” The failure of these two coupons demonstrated the rate in which cracks can grow in these materials and the material’s inability to stop a crack once it begins to grow. In each case, crack advance was extremely rapid and without warning.⁴

4.12 *Maximum Examination Pressure*—Maximum Allowable Working Pressure for cast iron vessels is set based on ASME (Section VIII) pressure calculations based on thickness, radius, and material strength values, and will not exceed 11 bar [160 psi] and 230 °C [450 °F] (Specification **A278/A278M**). When vessels are pressurized, anomalies produce emission at pressures less than normal fill pressure. Historically, if there is damage in a cast iron pressure boundary, AE activity will begin at load/stress levels less than 50 % of operating. Defects as small as 3 mm [$\frac{1}{8}$ in.] have been found using AE, during steam pressurization to operating pressure.

4.13 Pressure increments should not exceed 350 millibar/minute [5 psi/minute]. If pressurization medium is to be steam, the Yankee should have been through the warm-up process.

4.14 Yankee dryers may receive a subsequent examination, if necessary, after the Yankee is rotated to remove any condensate present.

4.15 *Pressurization Schedule*—Pressurization should proceed at rates that allow achieving maximum examination pressure within a 30 min period. During pressurization, pressure holds are not necessary; however, they may be useful for reasons other than measurement of AE. Pressure hold upon achieving maximum examination pressure may be up to 30 min.

4.16 Excess background noise may distort AE data or render the AE measurements useless. Users must be aware of the following common sources of background noise: (measurable filling or flow noise); mechanical contact with the vessel by objects; electromagnetic interference (EMI) from cranes, and radio frequency interference (RFI) from nearby broadcasting facilities and from other sources; leaks at pipe or hose connections, or rain drops. This practice should not be used if background noise cannot be eliminated or controlled.

4.17 Other nondestructive test methods may be used to evaluate the significance of AE sources. Magnetic particle, ultrasonic, and radiographic examinations have been used to establish circumferential position, depth, and dimensions of flaws that produce AE. Procedures for using other NDT methods are beyond the scope of this practice.

5. Significance and Use

5.1 Cast iron Yankee dryers can be up to 6.7 m [22 ft] in diameter, 7.3 m [24 ft] long, and weigh 91 000 Kg [100 tons],

⁴ Alleveto, C., and Williams D., Acoustic Emission Evaluation of Yankee Dryer Shell Material, 1991 TAPPI Engineering Conference Proceedings, pages 475-480.