Designation: D8231 – 19

Standard Practice for the Use of a Low Voltage Electronic Scanning System for Detecting and Locating Breaches in Roofing and Waterproofing Membranes[1]

This standard is issued under the fixed designation D8231; 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 standard procedures for using an electronic scanning system to locate membrane breaches on both horizontal and vertical surfaces to locate potential leaks in exposed roofing and waterproofing membranes.

1.2 This practice addresses the need for a detailed technical description of a scanning method and procedures that are used to test and verify the integrity of membranes.

1.3 This practice is not intended to replace visual or other methods of inspection. It is to be used in conjunction with other methods of roof inspection when specified.

1.4 This practice requires that the detection and location equipment, procedures, and survey parameters used are calibrated to meet established minimum leak detection sensitivity. The detection sensitivity calibration must be verified on a regular basis using the manufacturer's procedures to assure maximum confidence in the results.

1.5 Scanning surveys can be used on membranes installed on roofs, plaza decks, pools, water features, covered reservoirs, and other roofing and waterproofing applications.

1.6 This practice is applicable for membranes made of electrically insulating materials and is used on certain moderately conductive membranes (see Test Method D4496).

1.7 This practice provides a description of the scanning method and equipment for locating membrane breaches using electric conductance and is intended to be used in conjunction with the manufacturer's instructions for the proper operation and use of the equipment.

1.8 *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.*

1.9 *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]

D1079 Terminology Relating to Roofing and Waterproofing

D4496 Test Method for D-C Resistance or Conductance of Moderately Conductive Materials

D7877 Guide for Electronic Methods for Detecting and Locating Leaks in Waterproof Membranes

2.2 *NFPA Standards:*[3]

NFPA 70 National Electrical Code

3. Terminology

3.1 For definitions of terms, see Terminology D1079 and the terminology section of Guide D7877.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *membrane scanning, n*—a method for locating membrane breaches by passing a leak detection sensor over the entire surface of the membrane being tested.

3.2.2 *moderately conductive, adj*—materials that exhibit a surface resistivity in the range of 10^3 to 10^7 ohms-per-square.

3.2.3 *ohms-per-square, n*—the unit of measurement when measuring the resistance of a thin film of a material using the four point probe technique. It is equal to the resistance between two electrodes on opposite sides of a theoretical square. The size of the square is unimportant.

NOTE 1—Waterproofing membranes tested by electrical conductance methods may be horizontal, sloped, or vertical.

NOTE 2—Examples of waterproofing membranes included in this

[1] This practice is under the jurisdiction of ASTM Committee D08 on Roofing and Waterproofing and is the direct responsibility of Subcommittee D08.22 on Waterproofing and Dampproofing Systems.

Current edition approved July 1, 2019. Published July 2019. DOI: 10.1520/D8231-19.

[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 National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, http://www.nfpa.org.

practice are: below-grade waterproofing membranes, above-grade waterproofing membranes, waterproofing membranes covered by wearing courses, vegetative roof membranes, planter waterproofing membranes, and protected roof membranes.

4. Significance and Use

4.1 The failure to correct membrane breaches during and after its installation can cause premature failure of the membrane and damage to the structure. Root causes may include design deficiencies, faulty application of the membrane system, product failure, material incompatibility, and damage by other trades. Roof designs incorporating a waterproof membrane under overburden must be tested for breaches before overburden is installed.

4.2 This practice describes a low voltage (less than 50 V as defined by NFPA 70), dual sweep, scanning method using electronic leak detection to locate breaches in waterproof membranes. The method described includes testing procedures designed to provide a part of the quality assurance of roofing and waterproofing membranes.

4.3 The methods described in this practice may also be used for forensic testing of existing roofing and waterproofing membranes; however, specific limitations apply that are described later.

5. Summary of Membrane Breach Detection Using Electronic Scanning

5.1 The principle of the electronic breach detection method, as detailed in Guide D7877, is the establishment of an electrical potential between the electrically insulating or moderately conductive waterproofing membrane and its underlying conductive substrate.

5.2 For the low voltage method described in this practice, a controlled covering of water on the surface forms the conductive path horizontally across the membrane to any membrane breach. At a breach location, an electrical path is formed through the water to the conductive substrate below. A dual sweep scanning platform with an integrated sensitive receiver detects the leakage current through a membrane breach to the substrate.[4]

5.3 The substrate material directly below the membrane must be sufficiently conductive (approximately 10^4 ohms-per-square or less as determined using Test Method D4496) for the test method described in this practice to detect membrane breaches reliably. In most instances, a concrete substrate is sufficiently conductive to successfully detect membrane breaches using this method. In membrane assemblies, where the substrate is nonconductive, a conductive material can be placed directly under the membrane to facilitate testing.

5.4 This practice is applicable to moderately conductive membranes characterized by surface conductivity equal to or greater than 10^7 ohms-per-square as determined using Test Method D4496.

6. Horizontal Membrane Scanning Platform Basic Principles of Operation

6.1 The principle of the scanning platform method is to establish an electric potential between the scanning platform and a conductive substrate under a roofing or waterproofing membrane and track any leakage current passing through a breach in the membrane. This is accomplished by wetting the surface of the membrane to be tested, generating a voltage with respect to the substrate and then locating areas where electrical current flows from the scanning platform through membrane breaches to the substrate.

6.2 The basic circuit and application of a dual sweep scanning platform is shown in Fig. 1. The scanning platform is constructed with two sets of metal sweeps which make continuous electrical contact with the membrane surface. The

[4] The horizontal scanning platform and the vertical unit with roller are covered by patents held by Detec Systems LLC (US Patent 7,847,560 and 10,345,188, respectively). Interested parties are invited to submit information regarding the identification of an alternative(s) to these patented items to the ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend.

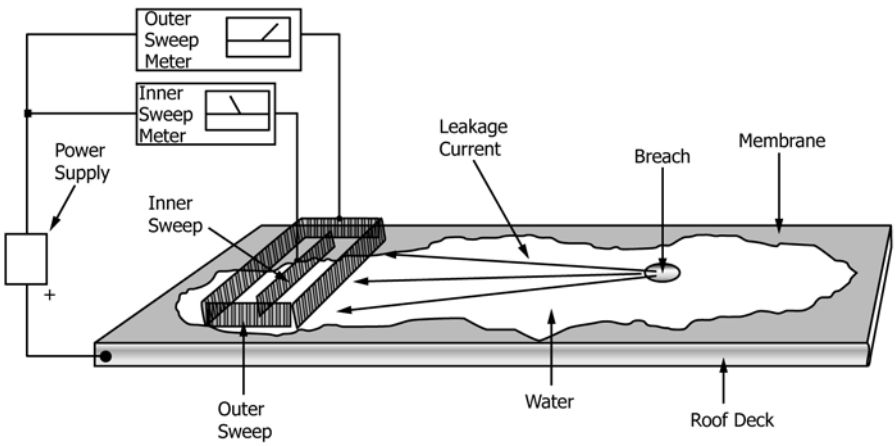

FIG. 1 Basic Circuit and Application of the Membrane Scanning Platform

outer sweep forms a continuous perimeter around the scanning platform with the inner sweep contained within the perimeter of the outer sweep.

6.3 The positive terminal of the voltage source is attached to building electrical ground or the roof (concrete or metal) deck/substrate and the negative terminal connects to the conductive sweep of the scanning platform through the measuring and indicator unit. Since the majority of roofing/waterproofing membranes are non-conductive, the electrical potential applied to the scanning platform sweeps provides a path through the water over the wetted area of the membrane to any breach thus completing the circuit to the substrate and back to the generator.

6.4 For a class of membranes which contain a high carbon black loading and are moderately conductive (Test Method D4496), the dual sweep scanning method is adjusted by a selector switch to compensate for the inherent conductivity of the membrane. When the selector switch is set according to the manufacturer's instructions, a membrane breach test is carried out successfully.

6.5 During the membrane scan, a light spray of water is applied to the membrane in front of the advancing scanning platform (Fig. 2). The outer sweep meter responds to and displays any leakage current in the test area. The inner sweep meter circuit, which is electrically shielded by the outer sweep, detects a leakage current when the sweep scanning platform is directly over the membrane breach. When this happens, it results in a noticeable deflection on the inner sweep meter accompanied by an audible alert. This is precisely, along the width of the inner sweep, the location where moisture is penetrating the membrane.

6.6 *Limitations*—The substrate material directly below the membrane must be sufficiently conductive (10^4 ohms-per-square or less) for purposes of this practice to ensure reliable results (concrete decks typically meet this criterion). Moderately conductive membranes can be successfully scanned if the surface resistance is 10^7 or greater as detailed in Test Method D4496. The suitability of a moderately conductive membrane for electronic scanning is determined by lab testing or hand-held commercial instruments that are suitable for field use. This scanning method is not suited for scanning membranes with overburden. Check with the manufacturer for conductivity levels with the specified membrane in this test.

7. Vertical Membrane Surface Scanning Basic Principles of Operation

7.1 Vertical scanning is a membrane breach locating system for vertical surfaces, corners, parapet walls, seams, etc.

7.2 The vertical membrane scanning method employs a generator-receiver electronic unit, connected water-moistened sensor, and ground connection. The generator-receiver supplies the electrical potential for the test circuit and generates audible alerts when a breach is detected (see Fig. 3).

7.3 In operation, the moistened roller sensor, which is connected through a cable to the electric potential source in the receiver, is pressed against the surface under test (Fig. 4). This action forces water onto the membrane surface and into any breaches. A leakage current will flow from the ground connection through any breach location, returning to the receiver through the moistened sensor. The receiver will register a signal level increase which then triggers an audible alert.

7.4 *Limitations*—The substrate material directly below the membrane must be sufficiently conductive (10^4 ohms-per-square or less) for purposes of this practice to ensure reliable results. This scanning method is not suited to scanning membranes with overburden.

8. Preparing the Site for Scanning

8.1 Do not perform scan(s) during heavy rain or in freezing conditions.

8.2 Assemble the scanning platform according to the manufacturer's instructions.

8.3 Ensure that there is a hose connected to a water supply, and of sufficient length to reach all points on surfaces to be surveyed.

FIG. 2 Testing a Horizontal Membrane with a Scanning Platform

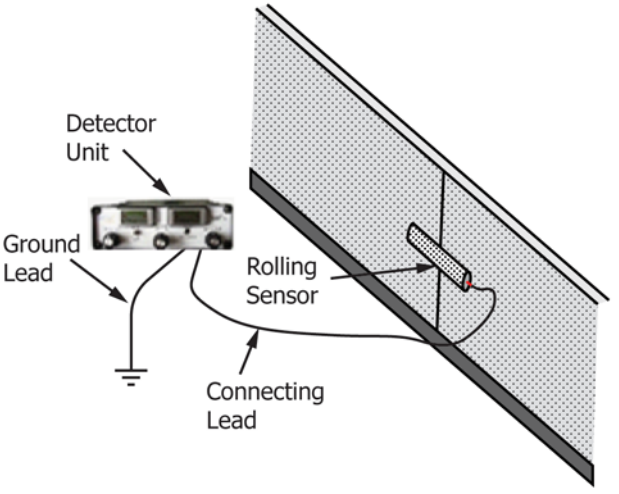

FIG. 3 Basic Circuit of Vertical Surface Leak Locate Unit

FIG. 4 Testing a Detail Area with the Vertical Surface Unit

8.4 Membranes to be scanned must be broom-clean and free of construction materials, equipment, and debris. Membranes characterized by surface conductivity equal to or greater than 10^7 ohms-per-square as determined in accordance with Test Method D4496 are suitable for scanning using this practice.

8.5 Liquid applied membranes must be cured and not tacky to the touch. Additionally, the surface resistance as measured by a suitable field instrument must be 10^7 ohms-per-square or greater.

8.6 The scanning platform electronics must be connected to an electrical building ground for proper operation of the electronic unit. HVAC units, anchors, or other grounded objects provide a good low resistance ground for scanning purposes (Fig. 5).

8.7 Plaza and garage decks often do not have grounded objects close by to provide a ground. In this case, an adequate ground is established by placing a metal sheet on the exposed area of the concrete deck (Fig. 6) to which the ground is connected. The surface under the sheet metal must be soaked with water to ensure a good electrical contact with the concrete surface.

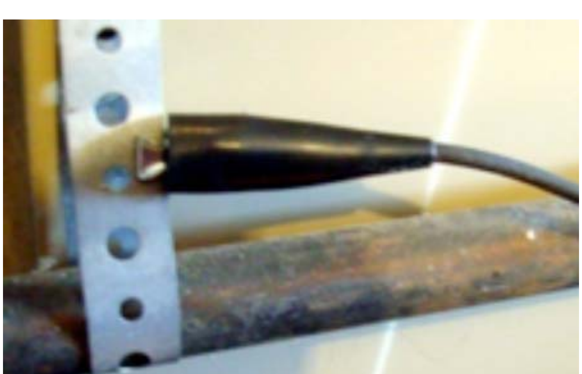

FIG. 5 Ground Connection to a HVAC Strap

FIG. 6 Ground Connection Using a Metal Plate

9. Electronic Unit Operation

9.1 The equipment must be tested for sensitivity prior to initial use and periodically thereafter, in accordance with the equipment manufacturer's instructions.

9.2 Verify equipment calibration in accordance with the manufacturer's latest published instructions. If out of calibration, the instrument must be calibrated in accordance with the instrument manufacturer's latest published instructions, or returned for calibration.

9.3 The electronic unit has all the controls and meters mounted on the front panel facing the operator (Fig. 7). The adjustments for the inner and outer sweep, sweep level indicators, sweep alert volume control, EPDM switches, battery test, and earphone jack are all located on the front panel.

9.4 The GAIN controls for the inner and outer sweeps rotate clockwise from a minimum to a maximum gain position. The corresponding analog meters show the level of any detected fault-to-ground current for a particular GAIN setting. In operation, the outer sweep controls and metering circuit measure and respond to membrane breaches along any water path outside of the scanning platform. The inner sweep control and metering circuit responds to membrane breaches immediately underneath the inner sweep.

9.5 The unit is switched on by pulling out on the VOLUME control. The volume control provides an acoustic feedback for the Inner Sweep circuit. As the Inner Sweep nears a membrane breach the downward facing speaker will transition from a rapid "click" sound to a high pitched buzz.

9.6 A battery test button is included. Pressing it will show the battery condition on the right side meter. A reading of 70 % or greater of full scale deflection (F.S.D.) indicates that the batteries are OK. Both batteries need to be replaced where a test reading shows less than 70 % F.S.D.

9.7 A mini-jack headphone plug in is located on the right side panel for noisy environments.

10. Horizontal Scanning Procedures

10.1 With the scanning platform located at the start of the test area, turn the unit on by pulling out on the switch located on the VOLUME control. The inner and outer sweep GAIN should initially be set at the 12 o'clock position. An audible "click" should be heard from the speaker. Adjust the volume control accordingly.