Designation: ~~D7877 – 14~~ D7877 – 22

Standard Guide for Electronic Methods for Detecting and Locating Leaks in Waterproof Membranes[1]

This standard is issued under the fixed designation D7877; 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 guide describes standard procedures for using electrical conductance measurement methods to locate leaks in exposed or covered waterproof membranes.

1.2 This guide addresses the need for a general technical description of the current methods and procedures that are used to test and verify the integrity of waterproof membranes.

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

1.4 This guide recommends that the leak location equipment, procedures, and survey parameters used are calibrated to meet established minimum leak detection sensitivity. The leak detection sensitivity calibration should be verified on a regular basis according to the manufacturer's recommendations.

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

1.6 The procedures are applicable for membranes made of materials such as polyethylene, polypropylene, polyvinyl chloride, bituminous material, and other electrically insulating materials.

1.7 This guide provides a general description of the equipment and methods for locating membrane breaches using electric conductance. Refer to the manufacturer's instructions for the proper operation and use of the equipment described in this guide.

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~~ safety, health, and ~~health~~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.*

[1] This guide 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 ~~Aug. 1, 2014~~Oct. 15, 2022. Published ~~August 2014~~December 2022. Originally approved in 2014. Last previous edition approved in 2014 as D7877 – 14. DOI: ~~10.1520/D7877-14.~~10.1520/D7877-22.

2. Referenced Documents

2.1 *ASTM Standards:*[2]
D1079 Terminology Relating to Roofing and Waterproofing
~~D5957 Guide for Flood Testing Horizontal Waterproofing Installations~~
~~D6747 Guide for Selection of Techniques for Electrical Leak Location of Leaks in Geomembranes~~

2.2 *NFPA Standard:*[3]
NFPA 70 National Electric Code

3. Terminology

3.1 For definitions of terms, see Terminology D1079.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *breach*—as defined for this guide, a membrane breach is a defect in the membrane that allows surface water to reach the substrate below.

3.2.2 *conductance*—the ability of a material to pass electrons. The unit of conductance is the Siemens ~~(S),~~(S); the relationship that exists between resistance (R) and conductance (G) is a reciprocal one. In terms of resistance and conductance:

$$R = 1/G \text{ ohms}, G = 1/R \text{ Siemens} \quad (1)$$

3.2.3 *deck*—the structural surface to which the roofing or waterproofing system (including insulation) is applied.

3.2.4 *electric current*—the flow of electric charge. The electric charge that flows is carried by mobile electrons in a conductor measured in amps.

3.2.5 *electric gradient*—the potential difference between two points measured in volts.

3.2.6 *high voltage*—for purposes of this guide, the ~~United States 2005~~ National Electrical Code (NEC) 2020 defines high voltage as any voltage over ~~600 V (article 490.2).~~1000 V.

3.2.7 *leak*—any unintended opening, perforation, slit, tear, puncture, crack, hole, cut, or similar breaches through an installed waterproofing membrane which may allow the passage of liquid. Scratches, gouges, or other aberrations that do not completely penetrate the membrane are not considered to be leaks as the term is used in this guide although they may be defects requiring attention.

3.2.8 *leak detection sensitivity*—the smallest size liquid water leak that the leak location equipment and survey methodology are capable of detecting under a given set of conditions. The leak detection sensitivity specification is usually stated as the minimum electrical leakage current that can be detected and is directly related to the area of the smallest liquid water leak that can be reliably detected.

3.2.9 *low voltage*—for purposes of this guide, the ~~United States 2005~~ National Electrical Code (NEC) 2020 defines low voltage as ~~0 – 49 volts.~~0 to 60 V, inherently limited power source.

3.2.10 *potential*—electrical voltage measured relative to a reference point.

3.2.11 *sensitive voltmeter*—a voltmeter that is capable of reading voltage levels in the millivolt or microvolt range.

3.2.12 *substrate*—the surface upon which the roofing or waterproofing membrane is placed (structural deck or insulation).

[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.

3.2.13 *waterproof membrane*—an element of the exterior enclosure of a building intended to provide a continuous barrier to prevent the passage of water under hydrostatic pressure.

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

~~NOTE 2—Examples of waterproof membranes included in this guide are: below-grade waterproofing membranes, above-grade waterproofing membranes, waterproof membranes covered by wearing courses, vegetative roof membranes, planter waterproofing membranes, protected roof membranes, and roofing membranes.~~

3.2.13.1 *Discussion—*
Waterproof membranes tested by electrical conductance methods may be horizontal, sloped, or vertical.

3.2.13.2 *Discussion—*
Examples of waterproof membranes included in this guide are: below-grade waterproofing membranes, above-grade waterproofing membranes, waterproof membranes covered by wearing courses, vegetative roof membranes, planter waterproofing membranes, protected roof membranes, and roofing membranes.

4. Significance and Use

4.1 The failure to correct membrane defects during and as soon as possible after its installation can cause premature failure of the membrane. Problems include design deficiencies, faulty application of the membrane system, and damage by subsequent trades.[4] Roof designs incorporating a waterproof membrane under overburden such as a vegetative roof, insulation layer, wear-course, or topping slab greatly exacerbate the problem of leak locating.

4.2 This guide describes methods for using electric conductance testing to locate breaches in waterproof membranes.[5] The methods described include testing procedures designed to provide a part of the construction quality control of membrane installations.

4.3 The methods described in this guide may also be used for integrity or forensic testing of existing waterproof ~~membranes,~~ membranes; specific limitations apply.

4.4 The electric conductance methods described in this guide require a conductive substrate under the membrane to serve as a ground return path for the test currents. In roof assemblies where the membrane is installed over electric insulating material such as insulating foam or a protection board, or both, the electric path to any conductive deck is interrupted. The situation can be remedied by placing a conductive material directly under the membrane. The conductive material provides the return path for the test currents.

5. Summary of Conductance Leak Location

5.1 The principle of the conductance leak location method is the establishment of an electrical potential between the electrically insulating waterproof membrane and the underlying substrate.

5.2 For methods employing low voltage electrical potential, 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 to the deck is formed through the water leaking to the deck below. A sensitive receiver detects the leakage current and alerts the operator.

5.3 For methods using a high voltage potential, an electrode is swept across the surface of the membrane. The electrode is charged to a high potential relative to the deck below. At a breach location an electrical arc occurs from the electrode to the deck below. The arc discharge is electronically detected and the operator alerted.

5.4 The leak-locate methods in this guide describe the electrical conductance techniques used to detect and locate membrane breaches. These methods, while accurate and effective, are subject to noted limitations.

[4] Bailey, ~~David~~D. M., et ~~al,~~al., "Survey of Passive Leak Location Technologies," ~~US~~U.S. Army ~~Corp~~Corps of Engineers Construction Engineering Research Laboratories, USACERL Technical Report FM-94/04.

[5] Vokey, ~~David~~D. and Townsend, ~~Duncan,~~D., "Electrical Conductance Methods for Locating Leaks in Roofing and Waterproof Membranes," *Journal of ASTM International*, Vol 8, No. 9.

5.5 Electric conductance leak location requires that the deck material directly below the membrane be sufficiently conductive for the test method employed. In most instances, a concrete substrate is sufficiently conductive to allow this method. In certain membrane ~~assemblies,~~assemblies where the substrate is nonconductive, it may be possible to install a conductive material directly under the membrane to facilitate testing.

6. Low Voltage Horizontal Membrane Scanning Platform

6.1 The principle of the scanning platform method is to establish a voltage potential between the platform and the roof deck and track any leakage current passing through the membrane. This is accomplished by wetting the surface of the membrane under test, generating a voltage with respect to the deck, and then locating areas where electrical current flows from the platform through membrane breaches to the deck.

6.2 The basic circuit and application of a dual sweep scanning platform is shown in Fig. 1. The platform is constructed with two sets of metal sweeps which make continuous electrical contact with the membrane surface. The outer sweep forms a continuous perimeter around the platform with the inner sweep contained within the perimeter of the outer sweep.[6]

6.3 The positive terminal of the voltage source is attached to the building electrical ground or the roof (concrete or metal) deck/substrate and the negative terminal connects to the conductive sweep of the platform through the measuring and indicator unit. Since the majority of roofing/waterproofing membranes are ~~non-conductive~~nonconductive (excluding high carbon black loaded materials such as certain types of ~~EPDM)~~EPDM), the electrical potential applied to the platform sweeps is provided 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 During the membrane scan, a light spray of water is applied to the membrane in front of the advancing platform (Fig. 2). The outer sweep responds to and displays any leakage current in the test area. The inner sweep, which is electrically shielded by the outer sweep, will detect a leakage current when the sweep platform is directly over the membrane defect. This will result in a noticeable deflection on the inner sweep meter accompanied by an audible alert. This is precisely the location where moisture is penetrating the membrane.

6.5 *Limitations*—The conductance leak ~~locate~~location method using the scanning platform cannot be carried out on conductive membranes such as EPDM. The deck material directly below the membrane must be sufficiently conductive for purposes of this test method (concrete decks typically meet this criterion). Drains and other grounding penetrations can cause a false reading if not isolated from the applied water spray. This method is not suited to scanning membranes with overburden. The equipment manufacturer's instructions provide recommendation for addressing these issues.

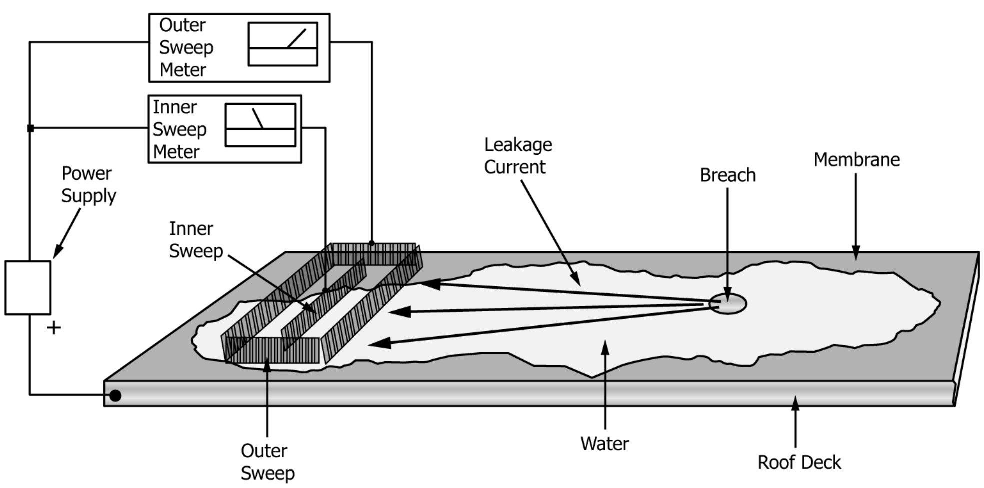

FIG. 1 Basic Circuit and Application of the Membrane Scanning Platform

[6] The (name of material, product, process, apparatus and may include the patent number for reference) is covered by a patent. Interested parties are invited to submit information regarding the identification of an alternative(s) to this patented item to the ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

FIG. 2 Testing a Membrane with a Scanning Platform

NOTE 1—Certain scanning equipment designs provide built-in isolation of the sweep from drains and other grounds, thereby lowering the potential for false readings.

7. Low Voltage Membrane Electric Field Vector Mapping

7.1 The electric field vector mapping technique employs an electric potential gradient across the membrane surface along with a sensitive voltmeter and probes to locate membrane leaks. As illustrated in Fig. 3, a conductor cable loop is installed around the perimeter of the area to be tested. A signal generator is connected to the loop cable and the building ground. The area within the loop is covered with a spray of water to form a continuous conductive surface in the test area. Since most roofing/waterproofing membranes are ~~non-conductive~~nonconductive, the electrical signal from the perimeter cable loop looks for an electrical path over the wet area of the roof to any breach within the wetted area, thus completing the circuit to the substrate. The resulting current from the breach location to the perimeter cable sets up a voltage gradient in the water within the perimeter.

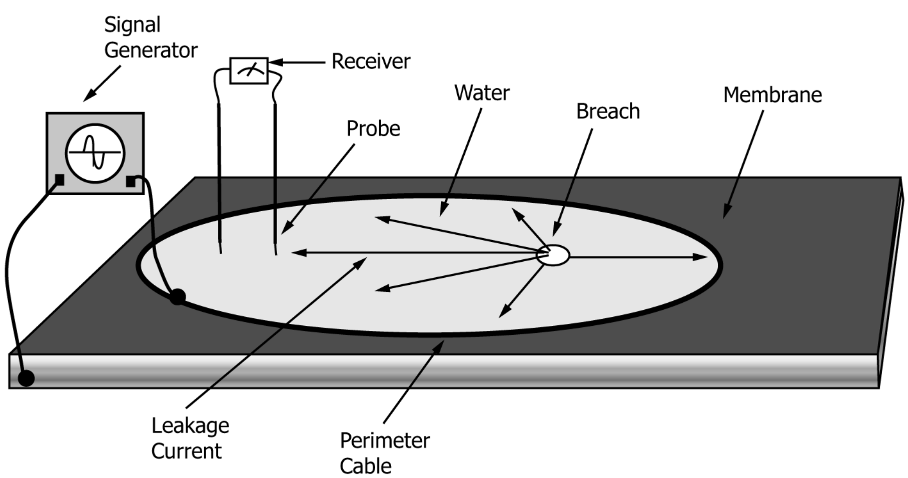

FIG. 3 Basic Circuit of Electric Field Vector Mapping Leak Locator