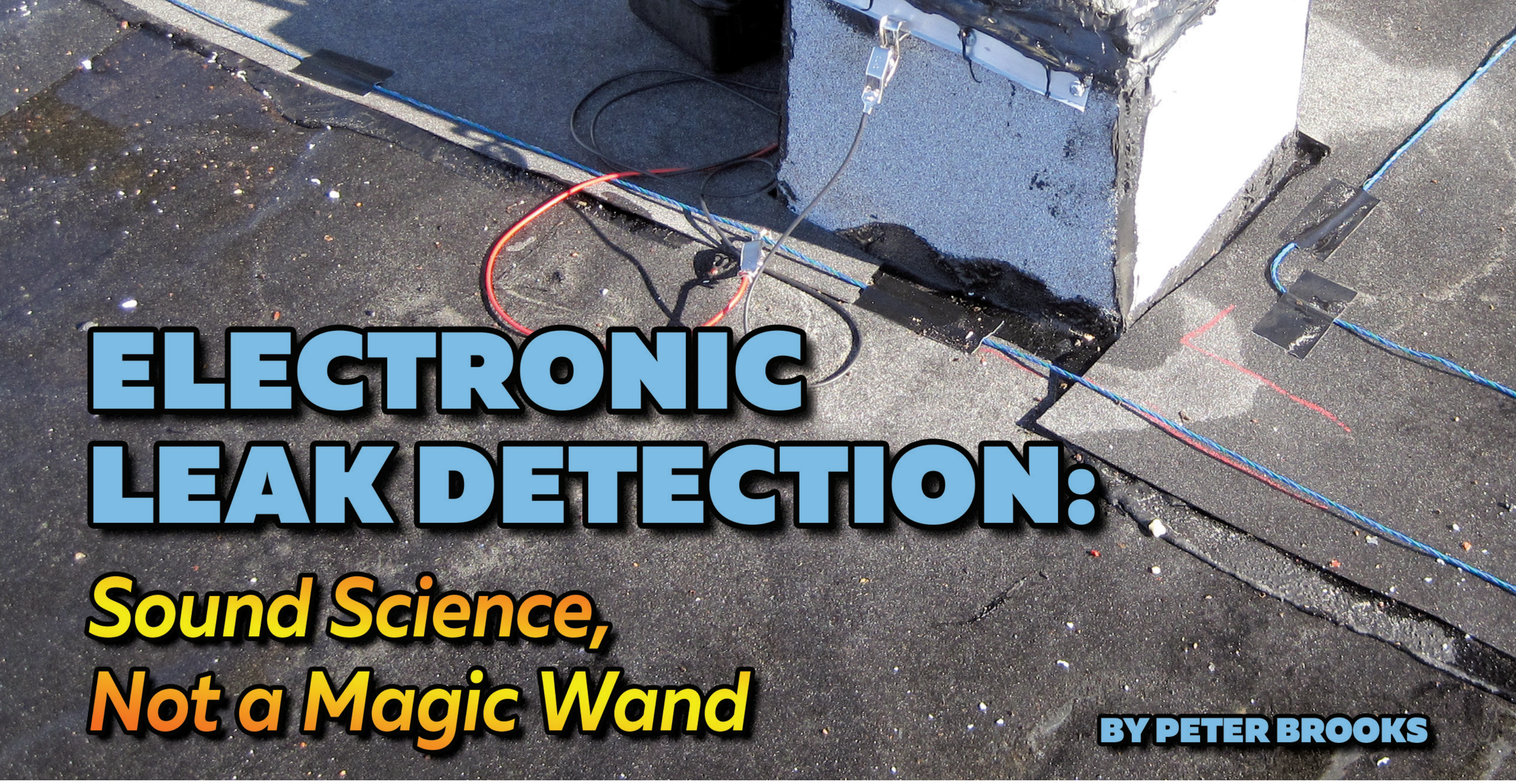

ELECTRONIC LEAK DETECTION:

Sound Science, Not a Magic Wand

BY PETER BROOKS

Due to its many advantages over flood testing, membrane integrity testing with electronic leak detection (ELD) has rapidly become the first choice for owners, manufacturers, specifiers, consultants, and contractors around the world. ELD on roofing and waterproofing membranes is proving to be faster, safer, more accurate, and often less expensive than flood testing. However, as with all new technologies, there are growing pains.

When first introduced, ELD was largely utilized for membrane integrity testing on vegetative roofing assemblies and other inverted roof membrane assemblies (IRMAs) that would receive overburden. Now that the benefits of ELD are more widely recognized, it is being specified for a much broader range of roofing and waterproofing projects. However, the vast array of roofing and waterproofing materials and constructions means there can be confusion as to what constitutes a testable assembly. Increasingly, testing firms are being asked to "wave the magic wands" and pinpoint leak locations in systems that can be challenging or impossible to test.

This article will address some of the factors affecting the testability of commonly employed roofing and waterproofing assemblies, the benefits of installing alternative grounding media, and the challenges involved in leak detection on systems with overburden.

ELD ON CONVENTIONAL INSULATED ROOFING SYSTEMS

Electronic leak detection requires three conditions for accurate testing: a grounding medium beneath the membrane to receive the electric current (typically a structural concrete deck, metal deck, or alternative grounding medium), a membrane that is electrically nonconductive, and no electrically insulating materials between the membrane and the ground.

ELD testing has always been straightforward on membranes applied directly to a highly conductive substrate such as a structural concrete deck (*Figure 1*). Now ELD is often the go-to integrity test on conventional roofing systems, with insulation installed between the membrane and the conductive deck. However, the same properties that make insulations and coverboards thermally insulating also create electrical resistance to the current utilized with ELD (*Figure 2*). The presence of these poorly conductive and nonconductive materials typically requires that an alternative ground be placed in the system. Two commonly available ground materials are lightweight wire grid and electrically conductive primer. However, there are differences of opinion regarding the reliability of leak detection utilizing these alternative grounds. In 2014, ASTM released Standard D7877, providing guidelines for ELD testing on conventional insulated systems:

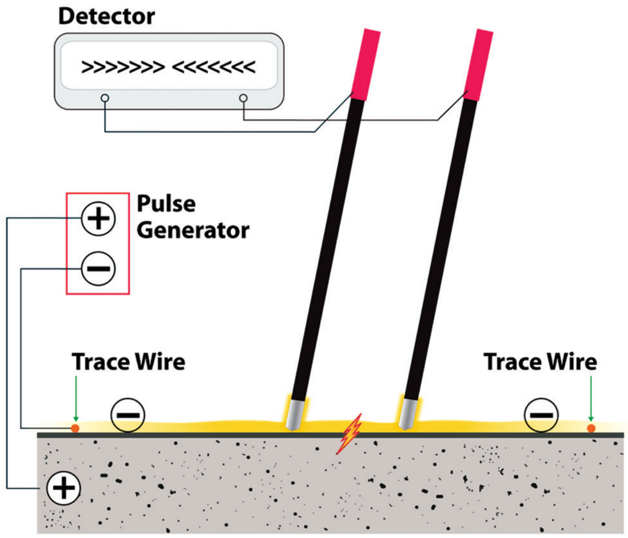

Figure 1 – ELD test results are extremely reliable when the membrane is applied directly to a highly conductive structural concrete deck.

"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."

There are two commonly employed responses to the requirements of D7877. An electrically conductive primer can be applied directly under the membrane (*Figure 3*), or conductive wire grids can be installed directly under some membrane products (*Figure 4*). However, while some manufacturers have approved the use of conductive primer in their assemblies, others are still performing compatibility testing with their materials. Also, some membrane manufacturers have not approved the installation of wire grid directly under their membranes. This often leads to the placement of the metal grid between the coverboard and the insulation, rather than directly under the membrane (*Figure 4*).

The effectiveness of placing wire grids under coverboards remains in dispute. While some ELD vendors express confidence in testing assemblies where a wire grid is installed under the coverboard, other service providers have found that commonly employed coverboards such as fiber-reinforced gypsum are insulators and interrupt the flow of current to ground unless the coverboards are wet. This calls into question the accuracy of ELD testing on systems with the wire grid between the coverboard and the insulation, unless the assembly has experienced significant rain events. It would greatly benefit the entire industry if these testability questions were resolved through an independent evaluation of a wide variety of membranes, insulations, coverboards, structural decks, and grounding media.

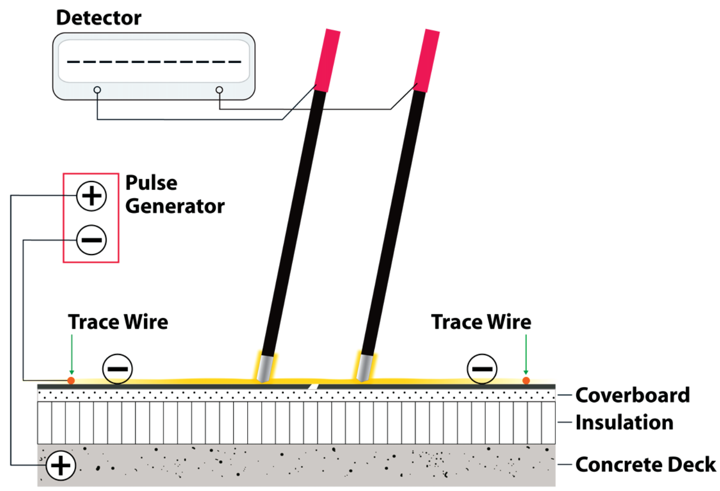

Figure 2 – When electrically insulating materials are present between the membrane and the conductive deck, breaches can remain undetected unless an alternative grounding medium is installed.

ELD ON SYSTEMS WITH OVERBURDEN

Ideally, ELD integrity testing of a new assembly is performed on an exposed membrane. Once overburden materials such as vegetation, pavers, ballast, etc. are installed, leak investigations are subject to a number of practical limitations.

Assemblies that will receive overburden are typically fitted with on-demand leak detection systems when the initial integrity test is performed. These systems consist of conductive wire loops installed on the surface of the membrane and connection boxes installed above the overburden to provide access to the wire loops at a later date. Specifications typically require that the loops be installed in area increments not exceeding 7000 sq. ft. However, there are many factors that can impair the accuracy of testing through overburden.

Low-voltage ELD is required on systems with overburden installed. (High-voltage ELD relies on direct contact between the electrically charged brushes and the membrane and is not an option on assemblies with overburden.) Low-voltage testing involves generating and interpreting electrical patterns on the membrane surface at low levels of voltage and amperage. To achieve accurate test results, these relatively subtle patterns must be sensed and interpreted through the overburden material. The membrane surface must be wet, which may require large volumes of water; dry areas of membrane will not be tested. In some cases, the type and/or thickness of the overburden can negatively impact the testing. The difficulty of interpreting these patterns increases with the depth of the overburden, and thick layers of insulation and/or vegetation can weaken and even disrupt the signal.

Electrical interference within the overburden can also adversely affect the test results. Some assemblies contain electrically insulating protection membranes between the overburden and waterproofing membrane. Lightning protection systems, roof drains, metal conduit, and other unintended metal grounds in the overburden can create false positives or disrupt the patterns so that accurate testing cannot be performed. Metal counterflashings that contact the overburden can also cause unintentional grounding.

Pavers in setting beds involve unique challenges, while pavers on pedestals are not reliably testable assemblies. The prospects for a successful test of a membrane in the middle of a split slab are also poor due to their monolithic nature. Also, topping slabs often contain reinforcing steel, which disrupts the electrical patterns.

Unfortunately, many of these potential pitfalls may not be recognized due to the presence of the overburden, and often the testability of an assembly can only be established on-site as the ELD technician conducts the low-voltage procedure.

If the plan is to employ ELD on the system after the overburden installation, the design team must be certain that it is using material and design approaches that will not interfere with any subsequent testing. Designers can benefit from utilizing experienced ELD service providers to provide guidance in the selection of materials and techniques.

On-demand leak detection systems are relatively inexpensive and are often included in the base cost when quality assurance ELD testing is performed on a newly installed membrane. They can prepare the system for future testing without the expense of moving overburden to install the wire at a later date. While the presence of the system does not guarantee successful leak detection with the overburden in place, they are recommended in most assemblies, as they can often locate leaks and can help avoid the costs involved in removing and replacing overburden to perform visual leak inspections.

Since there are several factors that can negatively impact the success and accuracy of leak detection through overburden, it is important that consultants, contractors, and leak detection service providers carefully manage the customer's expectations. Even with everyone's best efforts to design and install an ELD-compatible assembly, all parties should be made aware that the presence of the wire loops does not necessarily guarantee that an accurate leak test can be performed through the overburden.

Technically advanced auto-

Figure 3 – Electrically conductive primer is installed directly under the membrane and meets ASTM Standard D7877.

Figure 4 – In some assemblies, lightweight wire grids can be installed directly under the membrane, but due to manufacturer's concerns, they are often placed between the insulation and a coverboard.

mated leak detection systems are also available. Typically these systems use leak detection sensors that are installed in the roof assembly during construction, and allow continuous monitoring of roof assembly performance. Any developing maintenance issues are quickly identified and reported for action. While more expensive than simple "on-demand" systems, they are often specified for critical roof applications such as hospitals, data centers, museums, and government facilities.

NONTESTABLE MEMBRANES

ELD requires a nonconductive membrane to separate the positive and neutral sides of the circuit. If there are no breaches, the circuit will never be completed. When breaches are present, the ELD instruments can determine the location where the current has grounded through a breach in the membrane.

Ethylene propylene diene monomer (EPDM) membranes are manufactured with an electrically conductive carbon black filler, and will not function as an insulating material between the two sides of the circuit. Other examples of materials that can't be tested are metal flashings and membranes with metallic coatings. Butyl membranes are also conductive and cannot be tested with ELD.

Electronic leak detection has quickly become standard practice on roofing and waterproofing membranes and has been specified on some of the nation's most prestigious buildings. All stakeholders—owners, manufacturers, designers and contractors—benefit greatly from sound, watertight installations. Properly applied, ELD testing will help us all deliver higher-quality, more trouble-free assemblies.

REFERENCES

1. ASTM D7877-14, *Standard Guide for Electronic Methods for Detecting and Locating Leaks in Waterproof Membranes*. ASTM International.
2. Sika Sarnafil Technical Bulletin #15-8, "Electronic Leak Detection Testing Limitations," 8/11/2015, https://s3.us-east-2.amazonaws.com/roofing-technical-download/Technical+Bulletins/Waterproofing/15-8+ELD+Testing+Limitations.pdf.

Peter Brooks

Peter Brooks is president of IR Analyzers/Vector Mapping. He has over 35 years of experience in nondestructive testing and has worked closely with hundreds of architects, engineers, consultants, and contractors and performed infrared, nuclear, and ELD testing and analysis in a wide variety of built environments. Brooks has written a number of articles on the technical and practical aspects of applied infrared thermography and ELD. He is a former director of Region I of RCI.