

Electronic Leak Detection: The Future of Membrane Integrity Testing

By Peter Brooks

Electronic leak detection (ELD), the next generation in non-destructive membrane testing, is rapidly becoming the first choice for manufacturers, specifiers, consultants, and contractors around the world. It is providing faster, safer, more accurate, and less expensive leak locating and integrity testing on waterproofing and roofing membranes, pinpointing leaks directly so they can be immediately repaired and retested.

However, as often happens with new

techniques, many people find themselves unfamiliar with the functional details of the technology, the principles employed, and the procedures followed when performing the inspection. In fact, familiarity with these issues can help ensure the testing will be conducted in the optimal manner and yield accurate results.

In this article we will provide an overview of the benefits of ELD over traditional flood testing, describe

the two most commonly employed types of ELD, and identify important considerations when specifying and purchasing these testing services. Note: While ELD goes by several trade names (e.g., electronic field vector mapping [EFVM[®]], Integriscan[™], etc.), for the purposes of this discussion, all electrically based integrity testing will be referred to as ELD, either high- or low-voltage.

ELECTRONIC LEAK DETECTION VS. FLOOD TESTING

Traditional flood testing can be time-consuming and expensive, especially when retesting is required. The load-carrying capacity of the building and the weight of the required water must be clearly understood in order to avoid potentially catastrophic damage. If leaks are present, flood testing can cause significant water damage within the building. Flood testing doesn't pinpoint membrane breaches; locating leaks still requires visual inspection and

one or more additional tests.

ELD is quick and safe, as high-voltage testing is performed on dry membranes and low-voltage inspections require only wetting

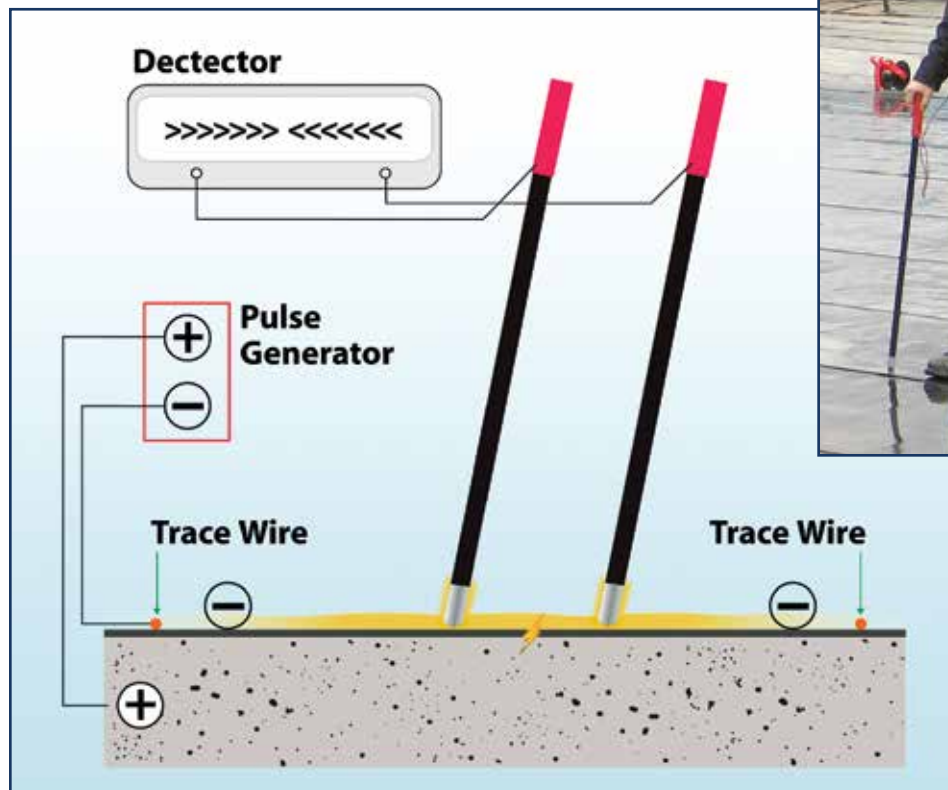


Figure 1 – Probe and trace wire low-voltage vector mapping pinpoints breaches by interpreting the direction of current vectors across a moistened membrane.



Figure 2 – Technician performing probe and trace wire method of low-voltage vector mapping on a wet membrane.

the membrane, not flooding. Unlike flood testing, inspections pinpoint the actual breaches for immediate repair and retesting. Even pinholes too small to be seen can be quickly located. In addition, breaches can even be isolated on many roofs with overburden. The test techniques are also easy to apply to vertical surfaces, and significant time and expense can be saved by not having to dam sloped areas.

PRINCIPLES AND APPLICATIONS

In order for ELD to be performed, two conditions must be met: First, the membrane must be nonconductive (i.e., have a high dielectric strength); and second, a conductive grounding medium (typically a structural concrete or metal deck or metal mesh) must be present beneath the membrane. Fortunately, most roofing and waterproofing membranes are nonconductive and are excellent candidates for ELD. One notable exception is black M-class ethylene propylene diene monomer (EPDM) rubber membrane, which contains carbon black, an electrically conductive substance. Integrity testing on EPDM membranes is typically conducted with infrared cameras and/or nuclear moisture gauges, as ELD will not work on this material.

An ELD device works by creating an electrical field on the membrane surface and a second electrical field in a ground in the system. Although the voltages vary, the ELD equipment generates only a very small amount of current, so electrical hazards are minimized.

When the electric field on the membrane surface encounters a breach, electricity travels from the roofing/waterproofing membrane surface through the breach to the grounding medium below. This completes the circuit, triggering the testing device to alert the technician that a breach has been detected. The technician then uses the test equipment to pinpoint the location of the breach.

There are two types of ELD surveys—low-voltage and high-voltage—sometimes referred to as “low-voltage electrical conductance testing” and “high-voltage spark testing.” Both types use a mobile battery-powered electrical generator to create the necessary electrical charge. Each type has its particular advantages and limitations. Selecting the most appropriate technique for each particular application will minimize costs and enable the technician to obtain the most thorough and accurate testing results.

Although manufacturers have developed two distinctly different approaches to low-voltage ELD, both are performed on a wet surface and find leaks when the current connects to ground through the moisture.

PROBE AND TRACE WIRE LOW-VOLTAGE VECTOR MAPPING

For low-voltage devices that use handheld probes to detect current flow through breaches, the test area is prepared by laying a loop of exposed metal wire (referred to as

a trace wire) on the membrane around the perimeter (*Figure 1*). To prevent false-positive readings, grounded penetrations within the test area are isolated using wire loops that are connected to the perimeter trace wire. The completed trace wire is then connected to one terminal of a pulse generator. The other terminal of the generator is attached to a ground connected to the structural deck of the system (usually a drain, railing, etc.) or to an alternative-grounding medium installed in the system.

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Figure 3 – Scanning deck method of low-voltage testing uses metal chains hanging from the deck instead of a trace wire and probes.

A pulsating electrical current (typically 38-40 volts DC) is introduced into the trace wire. An electrical field is maintained above the membrane by spraying water on the membrane surface to keep it completely moistened (not flooded). The size of the test area is governed by surface conditions of the membrane, the ability to maintain surface moisture, and the equipment used.

Using two metal sensor poles connected to a detector unit (potentiometer), the technician methodically surveys the test area while monitoring the detector (Figure 2). When no membrane breaches are present, the electric current in the test bed is static, with no significant current vectors. When there are breaches, the potentiometer senses electrical flow across the field as current travels from the trace wire to the breach where it is grounded, and the circuit is completed. The technician follows the current direction until the breach is pinpointed. When multiple breaches are present, each individual fault must be either repaired or isolated from the test bed with a temporary wire loop connected to the perimeter trace wire. This effectively “screens” or removes the breach from the inspected area. The technician then resumes the testing until all breaches have been identified.

Because a significant advantage of ELD is that detected breaches can be quickly repaired and retested, the ideal situation is for the membrane installation contractor to be on site during the testing. This way, any faults can be repaired and retested; and at

the conclusion of the testing, the membrane can be certified breach-free. If the membrane will receive overburden, the trace wire is usually left in place and connection boxes are provided so that low-voltage leak detection can be performed after the installation of the overburden.

SCANNING DECK LOW-VOLTAGE TESTING

A second type of low-voltage test device employs a roughly 1.5- x 2-ft. mobile “scanning deck” that is pushed over a continuously moistened membrane surface (Figure 3). Small metal chains hanging from the outer edges of the deck take the place of the trace wire. A similar array

of chains hangs from the inner part of the deck, and both sets of chains are connected to the device’s power generator. When the deck passes over a membrane breach, there is a change in the electrical potential between the two chain arrays, and the testing technician is alerted that current has connected to ground directly beneath the platform.

HIGH-VOLTAGE SPARK TESTING

High-voltage ELD works on the principle of arcing: the passage of electrical current through a normally nonconductive medium

such as air. Typically, high-voltage ELD equipment has adjustable current outputs from 1,000-30,000 volts DC. This allows for testing membranes from a thickness of a few mils up to 1/2 to 5/8 in. In addition to the high-voltage arcing, if moisture is present in the system, it will act as a conductive path for completing the circuit.

This test is conducted on a dry membrane surface, so a water source is not required. Although sometimes referred to as “high-voltage vector mapping,” in high-voltage testing, the technician locates breaches directly rather than through interpretation of current vectors. Thus, there is no need to lay a trace wire or isolate penetrations and located breaches from the rest of the test area.

Technicians employ a broom-like metal brush, typically 2 to 3 ft. wide, connected to one terminal of the generator. The other terminal of the generator is connected to the structural deck or other grounding medium (Figure 4). The technician walks in straight lines across the membrane surface, pushing or pulling the electrically charged brush (Figure 5). When the brush passes over a breach, current travels through the breach to the ground. The completed electrical circuit triggers an audible alarm to alert the technician, who then uses a corner of the brush to pinpoint the exact breach location. The current is capable of arcing through air (up to 3/4 in.), so water does not have to be present in the system; but if the schedule permits, it can be helpful to have the membrane experience several rain events.

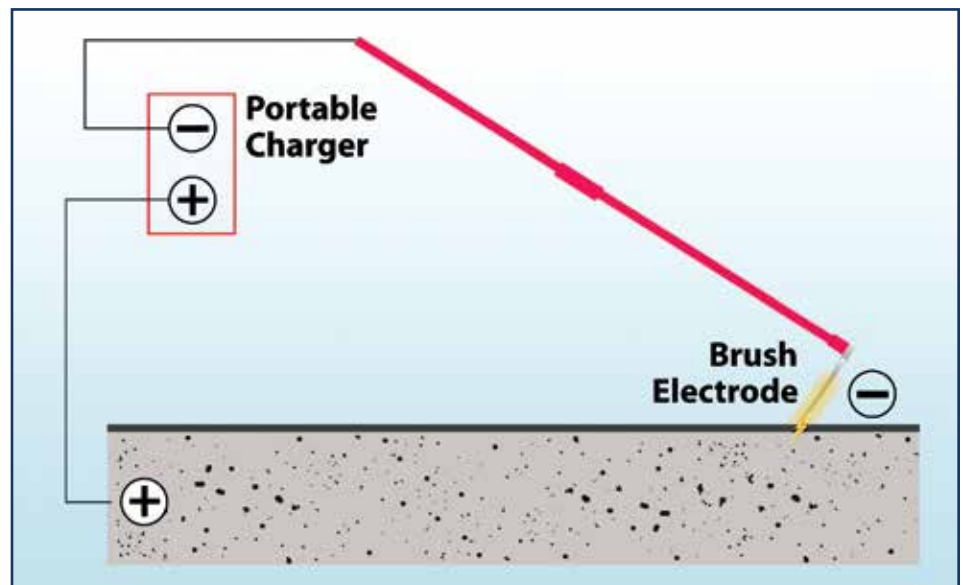


Figure 4 – High-voltage ELD locates breaches directly when the current arcs through a breach to ground.

In systems where there are nonconductive materials between the membrane and the structural deck (e.g., insulation or vapor retarders), it may be necessary to install an alternative grounding medium as close to the membrane surface as possible. Stainless steel and aluminum meshes are commonly employed to act as alternative grounds, while conductive felts are often employed in modified-bitumen and built-up systems.

LOW VOLTAGE OR HIGH?

Because there is no need for trace wire and it is not necessary to wet the membrane, high-voltage testing may take less time than low-voltage, particularly if there are many grounded penetrations or numerous breaches. It is also excellent for testing vertical surfaces such as curbs, parapets, and foundation walls, because there is no need to maintain a moist surface (Figure 6). However, the test surface must be completely dry, and ponded water or even dew will create unstable test conditions. Low-voltage testing typically requires a second person to spray water and maintain moisture on the membrane, while a single technician can conduct high-voltage testing.

High-voltage testing requires that the electrically charged brush be in contact with the membrane and is not suitable for testing systems with overburden (vegetation, pavers, ballast, etc.). If the overburden can be sufficiently wetted and a trace wire is installed at the perimeter, low-voltage testing can usually deliver sound test results with these overburden materials in place. It is common practice to utilize ELD as an integrity test of the waterproofing membrane prior to the installation of any overburden, in which case either method may be used.

SPECIFYING ELECTRONIC LEAK DETECTION

Because these testing methodologies are relatively new and specifiers and consultants are often unfamiliar with the technology, ELD specifications are sometimes incomplete or inaccurate.

The specifications may fail to adequately define the equipment to be employed, procedures to be followed, qualifications of the testing agency, or requirements for the final report. In some cases, ELD may be speci-

Figure 6 – High-voltage testing is excellent for vertical surfaces and congested areas.



Figure 5 – High-voltage ELD is conducted by sweeping a dry membrane with an electrified brush.



fied on systems that, as designed, cannot be inspected with an electric current technique. When in doubt, specifiers can work with experienced ELD providers in order to ensure accurate and complete specifications are employed.

PURCHASING THIRD-PARTY ELD SERVICES


Several considerations are important when evaluating and purchasing these third-party services:

- Construction schedules are often tight and demanding. Be certain that the testing firm can adequately

respond to scheduling needs.

- In order to utilize the best test methodology and generate accurate results, it is critical that the ELD technician be provided with complete and accurate information about the assembly being inspected.
- As with all nondestructive testing techniques, training and experience are essential for high-quality, accurate test results. Be sure that the technician has adequate experience with the testing techniques employed and the assembly being inspected.

BRIGHT FUTURE

Electronic leak detection is a major step forward for the waterproofing and roofing industries. It is already saving significant time and money and improving the ability of all parties to deliver higher-quality, more trouble-free products and services. Look for ELD to play a greater and greater role in quality control and leak investigations for both roofing and waterproofing membranes. 

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