Conventional Roof Assemblies and Electronic Leak Detection (ELD)

David Vokey, P.Eng.
Detec Systems, LLC.

Background

Historically, architects and other designers have called for a flood test to be carried out on horizontal waterproofing systems when direct inspection of the roof membrane is difficult or impossible. This is the case when the membrane is under a green roof, wear-course or topping slab where direct inspection of the membrane is not possible. ASTM D5957 Standard Guide for Flood Testing Horizontal Waterproofing Installations is typically referenced for the test. Flood testing takes from 24 to 48 hours and is often considered inconclusive. As a result, NRCA and CRCA do not recommend conducting flood tests as part of a routine quality-control or quality-assurance program for a new roof system.

Today electronic leak detection (ELD) often replaces flood testing and is being used on waterproofing membranes installed on roofs, plaza decks, pools, water features, covered reservoirs and other roofing and waterproofing applications. The ELD test methods are applicable for membranes made of materials such as polyethylene, polypropylene, polyvinyl chloride, bituminous material, and other electrically insulating materials.

The first low voltage electronic methods to test waterproof membranes were developed in Europe dating back to the late 1970's. The method, which is a derivation of a technique used to locate cable sheath faults in buried telephone cables, was subsequently called electric field vector mapping. Over the last 20 years, several new ELD methods have been developed. They fall into two main categories; low voltage (48 volts or less) and high voltage (600 volts or more) conductance testing.

More recently an ASTM Standard D7877[1] was developed and issued to assist the industry in understanding ELD and to serve as a guide describing current methods for using electrical testing procedures to locate leaks in exposed or covered waterproof membranes. It addresses the need for a clearer understanding of both the capabilities and limitations of the various test methods.

As detailed in paragraph 5.5 of D7877, 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 an electric insulating material such as insulating foam and/or a protection board, the electric path to any conductive deck is interrupted.

Electronic Leak Detection in New or Remediated Conventional Assemblies

In conventional roof assemblies, the membrane is installed over insulating foam and/or a protection board, as a result, the electric path to any conductive deck is interrupted. This is shown in Figure 1, using a basic detection circuit for illustrative purposes.

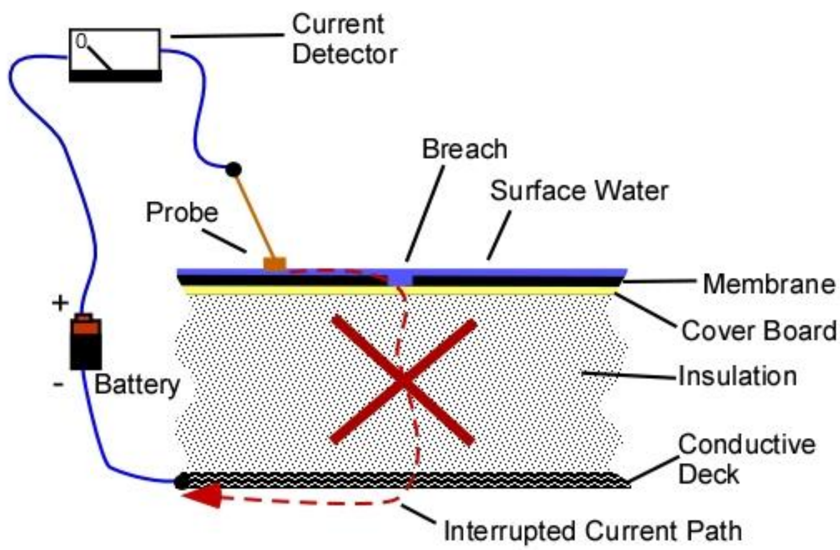


FIG 1: Conventional roof assembly with blocked ELD return path

This situation can only be remedied by placing a conductive surface *directly under* the membrane. The conductive surface provides the return path for the test currents.

In certain membrane assemblies, where the substrate is nonconductive, it may be possible to install a conductive layer directly under the membrane to facilitate testing. In some installations where a wire mesh has been allowed, there is a reluctance to install it directly under the membrane and it is frequently placed under a cover board which is an electrical insulator. As shown in Figure 2, the wire mesh placed under the cover board does not provide a return path for the test current.

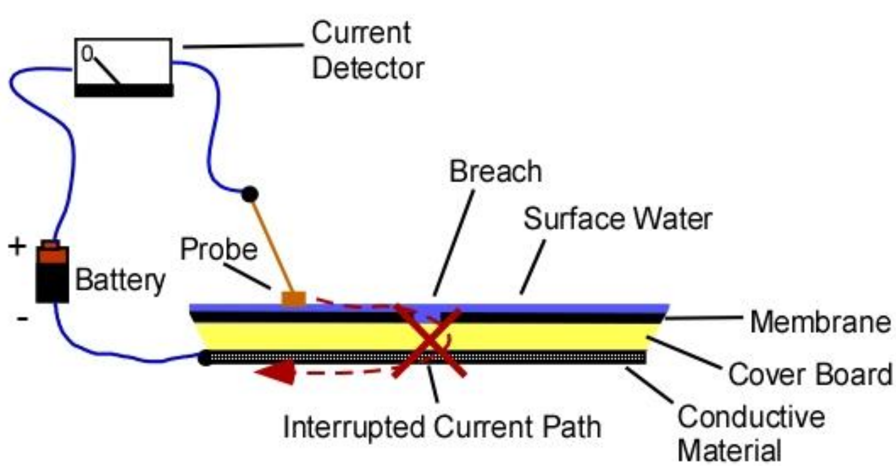


FIG 2: ELD test current interrupted by protection board

Some claim that the water which is sprayed on the membrane for the test will soak through the cover board and create a path to the conductive mesh underneath the board material. In most cases only a few hours are provided for the test after which the roof contractors want to carry on. Most cover board products including gypsum base material are constructed with a water resistant surface treatment to avoid water absorption. It follows that placing the conductive return path, such as a metal mesh, under the substrate makes the ELD test questionable at best or more likely invalid.

To ensure a proper and effective ELD test on a roof membrane it is important that the conductive return path for the test current is placed directly under the membrane as illustrated in Figure 3.

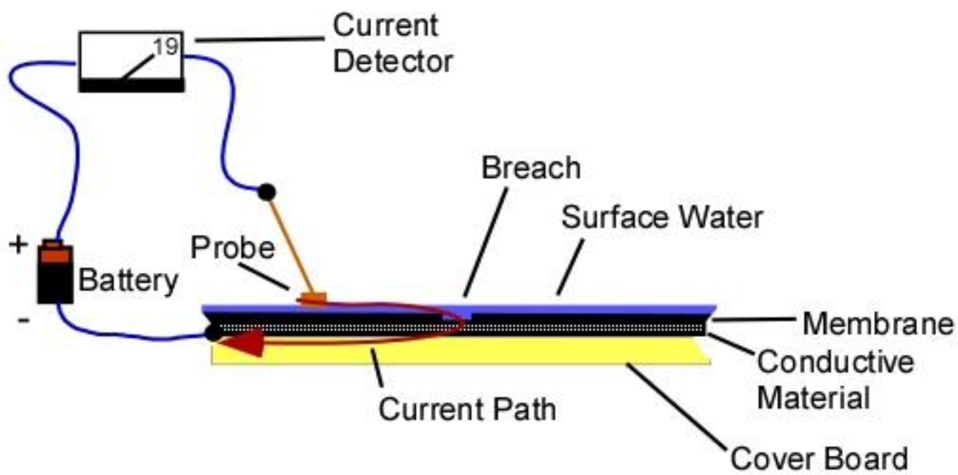


FIG 3: Proper location for the conductive return path

If the return path is a metal mesh then the aperture size needs to be small enough to ensure detection of the smallest breach. Unless the membrane is loose laid, this can present a problem with fully adhered membranes as the mesh can interfere with the bonding properties.

Forensic Electronic Leak Detection in Leaking Conventional Assemblies

When a roof leak develops in a conventional roof assembly, several forensic methods are often used to access the problem. These include infrared surveys[2], electrical impedance scanning[3], nuclear thermography[4] and under the proper conditions ELD surveys.

Electronic leak detection as defined in ASTM D7877 can be used as a forensic tool if there is sufficient water in the roof assembly to provide a path from a breach in membrane surface to a building ground. As illustrated in Figure 4, if a continuous water path from breach in the membrane through any cover board, insulation, and vapor barrier to the structural deck occurs it will form a conductive water path for the ELD test current.

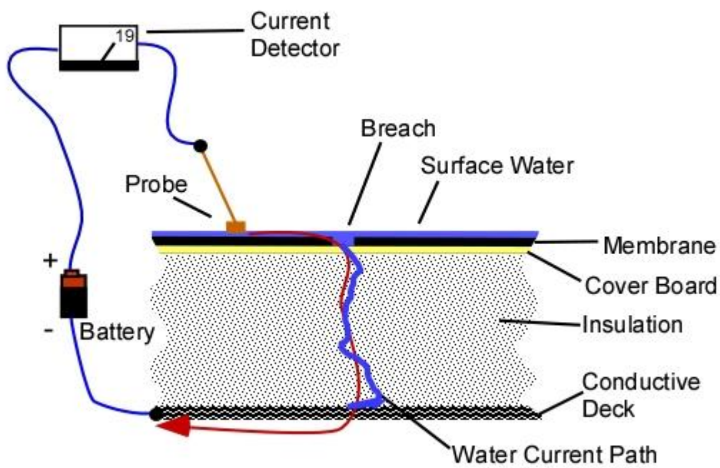
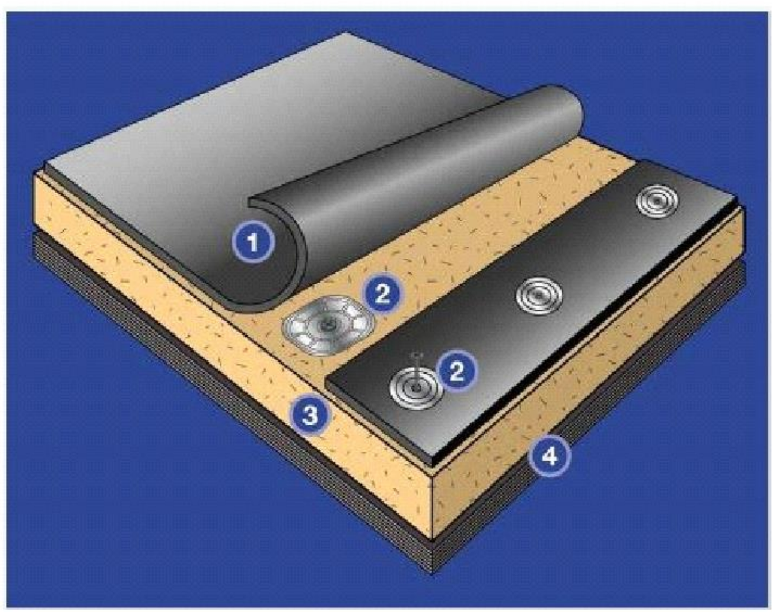


FIG 4: Water based conductive path

Mechanical Attachment and ELD Testing

On occasion, ELD testing is carried out on roof assemblies which are mechanically attached as shown in Figure 5.

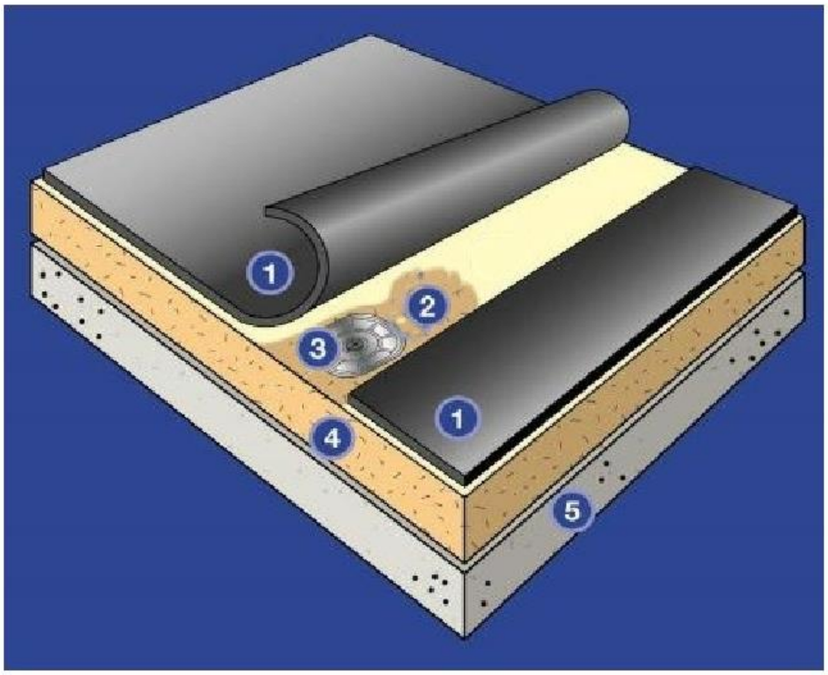


Mechanically Fastened Membrane
1. Membrane, 2. Fasteners and Plates, 3 Insulation, 4 Roof Deck

FIG 5: Mechanically attached deck and membrane

There are those who believe or at least state that that the fasteners which are screwed into the structural deck provide the grounding path return for ELD testing. While that could be the case when a membrane breach is at or near an attachment plate, the plates are only a few inches in diameter and the attachment centers are up to 12 inches[5]. The water spray for ELD testing would have to travel up to 6 inches underneath the membrane in order for a water path to develop to complete the return circuit. It seems to be a questionable assumption if the expectation is to always locate any breach.

In an assembly where the membrane is fully adhered to the mechanically attached deck as illustrated in Figure 5 the assumption of attachment plates providing a return path is clearly in error. In the fully adhered case the water path cannot travel horizontally, the only time a membrane breach will be detected is when it occurs on top of an attachment plate.



Fully Adhered Membrane
1. Membrane, 2. Adhesive, 3.Fasteners and Plates, 4.Insulation, 5 Deck

FIG 6: A fully adhered membrane over deck attachments

Conclusion

Electronic leak detection (ELD) is quickly becoming a more popular alternative to flood testing and is being used on waterproofing membranes installed in roofs, plaza decks, pools, water features, covered reservoirs and other roofing and waterproofing applications. All of the ELD methods detailed in ASTM D7877 require that an electrical circuit must be complete above and below a membrane breach before the breach can be detected. To achieve a closed test circuit for conventional assemblies, a conductive substrate or material must be located directly under the membrane. In the case of an existing roof leak a water path to the structural deck may close the circuit to building ground and allow a forensic ELD survey.

References:

1. ASTM D7877 - 14 Standard Guide for Electronic Methods for Detecting and Locating Leaks in Waterproof Membranes
2. ASTM C1153 - 10(2015) Standard Practice for Location of Wet Insulation in Roofing Systems Using Infrared Imaging
3. ASTM D7954 / D7954M - 15a Standard Practice for Moisture Surveying of Roofing and Waterproofing Systems Using Non-Destructive Electrical Impedance Scanners
4. Ansi/Spri/Rci Nt-1 Detection and Location of Latent Moisture in Building Roofing Systems by Nuclear Radioisotopic Termalization
5. Florida Building Code – Test Protocol HVHZS, (RAS) 117.10