Leaky roofs cost American businesses billions of dollars annually, with damage ranging from minor water stains and electrical outages to complete structural failure of the roof.

Fortunately, new leak detection methods have been developed that can locate even the smallest defects with pinpoint accuracy, in either new or existing roofing and waterproofing assemblies. Electronic leak detection (ELD) identifies breaches in the roof membrane by monitoring electric fields set up above and below the membrane surface. Peter Brooks, principal at Vector Mapping/IR Analyzers, says, “Unlike the interpretive process of flood, infrared, or nuclear testing, ELD detects membrane faults directly. Even pinhole leaks invisible to the naked eye can be identified, and repairs can be made on the spot and immediately retested to ensure watertight results.”

History

For much of the 20th Century, flood testing was the preferred method of finding leaks. It’s still used occasionally, but it’s time-consuming, messy, and in some cases, the sheer weight of the water can actually damage the roof. Because of these shortcomings, various other methods were developed in the 1960s and ’70s, including infrared thermography, nuclear moisture testing, and electrical impedance testing. These technologies are less invasive and more reliable than flood testing, but they still suffer from several significant drawbacks.

Primarily, all these “leak detection” methods actually test for moisture. None of them can detect a leak until water has built up in the insulation and other absorbent parts of the roof. The damage at that point is usually extensive. Second, because they test only for moisture, they don’t reveal the actual location of the leak. That work must be done separately—often on hands and knees.

Modern Methods

Europeans began experimenting with electronic leak detection in the 1980s, and by the mid-1990s, had developed two methods that were far superior to existing technologies.

Brooks says, “ELD is a faster, safer, more accurate and less expensive way to find leaks in low-slope roofing and waterproofing membranes. It goes by different names, but it all stems from the same basic breakthrough: using electrical current to precisely locate membrane breaches.” (Even the high-voltage method generates only a very small amount of current to minimize electrical hazards.)

During the testing, technicians create an electrical field on the membrane surface and a second electrical field in the structural roof deck (or other conductive material beneath the membrane). If there is a breach, the electric field above the membrane completes a circuit with the field below the membrane, triggering the testing device. The technician then pinpoints the location of the breach using sophisticated handheld equipment.

Low-Voltage

The low-voltage testing method was developed in Europe in the early 1990s. Technically described as “low-voltage impedance testing” it’s called Electric Field Vector Mapping (EFVM) by International Leak Detection, the company that imported the technology to North America.

Chris Eichhorn, owner of International Leak Detection, explains, “EFVM was developed by an electrical engineer in Germany, and although the principle worked, he had a hard time explaining the system to those that might be interested.” Eichhorn founded
International Leak Detection in 2001 to commercialize the technology.

Low-voltage ELD involves laying a conductive wire loop around the area to be tested, wetting the membrane, and running low-voltage current through it to create an upper electrical “plate”. On ballasted and green roofs, the overburden often contains enough moisture that additional wetting isn't necessary. A second lead is connected to the structural deck, which acts as the lower electrical plate. The membrane in between the two plates acts as the insulator.

Water is an extremely efficient conductor, and any defect, hole, or open seam in the membrane will allow an electrical connection between the two plates. The technician, using specialized probes, can determine which direction the current is flowing, thereby determining the location of the defect. By taking additional readings, the technician can pinpoint the exact locations that need to be repaired.

Note that in order to prevent false-positive readings, grounded penetrations within the test area must be isolated using wire loops that are connected to the perimeter trace wire. When multiple breaches are present, each individual fault must be either repaired immediately or isolated from the test bed with a temporary wire loop connected to the perimeter trace wire.

Low-voltage ELD is Europe's most widely-used method for detecting roof leaks, and is rapidly being adopted by manufacturers, contractors, and specifiers in the United States. It's proven to be so effective that many major membrane manufacturers now accept or even require ELD before issuing a warranty for newly installed materials. For example, Sika Sarnafil, Carlisle Construction Materials and Kemper all incorporate International...
Leak Detection’s EVFM testing as part of their long-term roof warranty programs.

High Voltage

High-voltage electrical testing also has its roots in Europe, and evolved out of a technique used to test coatings on metal pipes.

This method requires the membrane to be dry and exposed. One lead from the portable “pulse generator” is connected to the structural deck, and the other is attached to device resembling a push broom with copper bristles. As the operator “sweeps” the surface of the membrane, any breach in the membrane will complete the circuit between the measuring device and the roof deck. Although the testing is often conducted at relatively high voltages, the amperages are extremely low—similar to static electricity.

Limitations

Both ELD methods are extremely versatile, but there are limitations.

For instance, they require conductive roof decks. Metal and concrete—the two most common materials in commercial roof decks—work well. Wooden substrates and traditional roofing systems (with the insulation layer placed between the membrane and the roof deck) are typically not testable. To get around this limitation, alternative grounding media can be installed below the waterproofing membrane during construction. ILD developed a conductive medium about ten years ago, which makes it possible to verify the integrity of newly installed membrane that would have previously been unsuitable for EFVM testing. This medium comes in a variety of materials, such as a conductive glass felt, aluminum mesh or a highly conductive stainless steel grid.

This “detection membrane” can also be used to check for leaks on a regular schedule. Similarly, on ballasted and green roofs, a trace wire for low-voltage ELD scans is sometimes installed during construction between the membrane and the overburden to facilitate future leak detection scans.

Finally, while ELD works with a wide variety of membrane types—as nearly all roof membranes are non-conductive—there is one notable exception. Black EPDM, a popular rubber single-ply, contains significant amounts of carbon black which makes it electrically conductive. ELD testing will not work on black EPDM roofs, but is suitable for factory-laminated white grey, tan, and other lighter color EPDM.

Which System Is Best

Both low-voltage and high-voltage systems have advantages and limitations. Selecting the most appropriate technology will minimize cost and deliver the most accurate testing results.

High voltage testing can be conducted by a single technician and often takes less time to complete, so it can be a more cost-effective choice. However, it requires the tested area to be completely dry and exposed, so for roofs with overburden, such as ballasted or green roofs, low-voltage testing is nearly always a better choice, as the overburden would need to be removed for any other method. Also, high-voltage methods may not be as sensitive to defective seams as low-voltage testing.

Low-voltage ELD does require a
trace wire to be set up, which takes time, but it allows for testing without having to wait for the membrane to dry—which may be an overall timesaver in damp climates.

Green Roof Considerations

Eichhorn says, “EFVM is exceptionally well-suited for green roof and ballast roof systems, because overburden can stay in place during testing, and the roof doesn’t have to be perfectly dry. It can be employed on sloped surfaces, and repairs can be made immediately and retested.”

Eichhorn does caution that root barriers can present a challenge during testing, as they prevent the tips of the probe from contacting the actual waterproofing membrane. “We can sometimes get directional flow for a general area,” he says, “but to pinpoint the exact location, you’ll need to penetrate the root barrier.”

Going Vertical

Electronic leak detection is also useful for moisture testing vertical surfaces, such as foundations, parapet walls, and non-metallic flashings. While ASTM has not yet established standards for electronic leak detection, both high- and low-voltage methods have a proven track record. High voltage ELD might be preferable in hot, dry weather, as there’s no need to maintain a moist surface during testing. (In wet climates, care must be taken to ensure that all test surfaces are completely dry.)

Eichhorn notes that low-voltage EFVM is also perfectly capable of testing vertical surfaces. “EFVM is a great tool for testing walls,” he says. “We’ve been doing this type of testing since 2004 with great success, and the number of clients requesting this type of testing is steadily increasing.”

Conclusions

ELD is rapidly becoming the new leak detection standard in Europe and North America. Suitable for testing membrane integrity during construction and forensic leak detection years after installation, it has been specified on some of the nation’s most prominent roofing projects.

While high-voltage and low-voltage systems differ considerably, both save time and money, and can work with a wide variety of rooftop waterproofing assemblies. Both methods are usually far superior to older technology because they pinpoint the actual breach in the membrane, not simply the presence of water, and repairs can be made and re-tested immediately.
As waterproofing professionals and contractors, we have a responsibility to the homeowners we service to provide them with the best possible options when it comes to finishing their basements and creating comfortable, usable spaces in their homes. A mold and moisture-resistant panel finishing system can put you well on your way to doing just that, and save valuable time in the process.

The basement is unlike any other part of the home. While traditional wood and drywall construction work just fine for above-ground living areas, they can warp, rot and allow mold to grow in high-moisture areas like basements. Some basement finishing systems utilize inorganic materials designed specifically for the tricky basement environment. They are resistant to dampness, mold and mildew. They also allow for a faster, cleaner, more efficient installation process, with most systems boasting installation in half the time of traditional basement finishing.

It is important to note that not all systems can be painted or customized. With some panels, what you see is what you get in terms of color and texture, or you may have just two or three color options available. You might also have visible seams where the panels join together. There are systems, however, that can be painted or papered, and give the walls a seamless appearance no different than drywall.

With any remodeling or finishing project in the basement, homeowners can have specific demands when it comes to hanging items on the wall. Flat screen televisions, storage shelves or custom artwork are very popular in basements right now, and while most finishing systems allow for a substantial amount of weight to be hung on the wall panels, some require special hardware and may not carry the weight without special reinforcement.

While custom design options may vary among the systems, the benefits of using a panel system in the basement are many. Of course, not all systems are created equal. Each comes with its own benefits and challenges. In this article, I will evaluate four finishing systems and outline what features to look for when choosing a product for your customers.

Owens Corning

The originator of the panel finishing system concept, Owens Corning, has been offering a water- and mold-resistant solution for basement finishing since 2001. According to their marketing materials, the Owens Corning Basement Finishing System is a soft-wall system. It is comprised of lightweight R-11 fiberglass panels, PVC lineals (which replace conventional framing) and foamed PVC trim moldings (which replace wooden trim). The trim moldings snap into the

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**Do your homework and due diligence before buying into the marketing hype of any basement finishing product, particularly regarding a mold and maintenance-free system.**

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lineals, holding the panels in place. The seams between panels are finished with small battens, which also lock the panels in place.

“Our system is solely sold by us to homeowners, and it has to be installed by an Owens Corning certified installer that goes through specific training,” said marketing manager Carey Smeck. “The product comes with a lifetime warranty.”

The Owens Corning System features easy and speedy installation. Most systems are installed within two weeks, and come without the mess and dust of traditional drywall finishing. Like most systems, Owens Corning also comes with removable panels that allow for easy access to foundation walls, wiring and plumbing fixtures whenever necessary. With traditional methods, foundation work and rewiring are labor-intensive projects requiring demolition.

Designed specifically for basement conditions, the materials used in this system are breathable. When moisture is present, the walls actually “breath” and allow it to pass through instead of trapping or absorbing it. The Owens Corning insulation that makes up the walls keeps the basement warmer in the winter and cooler in the summer, which may add up to savings for homeowners.

The system’s 2½-inch-thick walls are certified with a .95 Noise Reduction

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Finishing a basement is a hefty investment that is certainly worth protecting. If water somehow finds its way in, drywall, carpeting, electronics and furniture could all be ruined.

While there’s no stopping Mother Nature, steps can be taken to minimize the potential of future water issues ruining a finished basement.

Before finishing a basement, it should first be inspected by a basement waterproofing contractor who can identify and properly address any existing problems or concerns– some of which may not be obvious to the untrained eye. This “basement pre-finishing” phase is the homeowner’s last chance to make sure everything is right, before it’s too late.

All cracks in poured foundations should be filled with an injectable epoxy resin or polyurethane foam. It might be tempting to leave them as is, especially cracks that haven’t previously leaked water. However, such cracks can in fact leak years after forming as surrounding soil settles or freeze-thaw cycles finally shift the foundation. Another reason for filling cracks in the foundation as well as in slabs, is because they can be the point of entry for harmful soil gases, including radon, compromising air quality.

Soil gases and moisture can penetrate through porosity in concrete, even when no cracks are present. Sealing the concrete with a quality concrete sealer can significantly reduce gas and moisture penetration.

Poor air quality in the basement will likely impact the rest of the home. At least 50% of the air circulating throughout a house originates from the basement. Such soil gases can worsen allergy or asthma symptoms, while added moisture can result in mold and mildew growth.

Mold and mildew thrive in moist, dark environments, and can grow behind drywall, beneath carpeting, even on furniture or stored items. Mold can be properly cleaned and disinfected by an EPA-approved mold killer. After removal, a preventative treatment should be applied to the walls and floors to prevent future growth. Even when mold has not previously been present, it’s usually wise to apply this treatment.

The biggest scare for any finished basement is flooding. Ensuring the basement is protected with a highly functional and efficient pump will make a huge difference. (It may not be wise to rely solely on the sump pump installed by the builder, since some builders install the cheapest pump possible to minimize costs. These pumps usually don’t operate at the same rate and efficiency as higher-end sump pumps and may wear out quicker.) Homeowners can further protect their investment with a battery back-up system to ensure their basement stays dry during a power outage.

Lou Cole is the owner of Emecole, Inc. a manufacturer and distributor of basement and crawl space repair supplies.
Coefficient (NRC), which means almost all sound it comes in contact with is absorbed. This is compared to a .05 NRC for drywall. The drop ceiling specific to this systems is also designed to prevent sound from travelling up to the rest of the house.

Possible Challenges: The fabric panels used in this system can be torn and are available in just one color. The seams between the panels are visible, and the panels themselves require special hardware for hanging items up to 30 pounds.

The fiberglass insulation used will need to be replaced if it becomes wet. The dust that settles in the fiberglass is organic material and that has the potential to attract mold.

Basement Tuxedo

Like Owens Corning, the Basement Tuxedo finishing system was designed specifically with the basement environment in mind, meaning it is resistant to moisture, mold and mildew. The inside of each wall panel is made of one-pound structural closed cell foam with R-13 energy efficiency. The walls are designed to allow for a 1½ inch air gap between the foundation and the new wall. Basement Tuxedo uses a taping system to join each panel and the corners.

The wall panels that make up this system are available in two colors with the option to customize your walls through paint. The panels are also built to hold the weight of artwork and flat panel televisions. These panels can be easily removed for service to basement walls and are built to accommodate electrical wiring so that it is hidden from view.

A unique taping system hides the seams between the panels, so the room looks like a traditionally drywalled one, and the entire project can be installed in as little as one week depending upon the
scope of the project.

**Possible Challenges:** While this panel has tape at the seams to give it the look of drywall, the seams are visibly different than that of the upper levels of the home. The adhesive on the tape can support microbial activity if it gets wet, and the panels themselves are heavy.

**Total Basement Finishing**

Total Basement Finishing (TBF) offers a complete basement remodeling package comprised of insulated walls, waterproof floors and sag-proof ceilings.

The wall system is rated R-13. TBF basement walls are built with a concrete core instead of foam, and have a washable finished surface, rather than fabric. The walls are rigid, waterproof, non-absorbent, and inorganic. Additionally, they can be painted or wallpapered to a homeowner’s design preference, and are able to withstand hanging items such as flat screen televisions, artwork and shelving without special hardware.

The wall surface is pre-textured, and can be painted in any color.

For flooring, the system uses ThermalDry tiles, which creates a break between the finished basement area and the unfinished concrete floor, warming the floor and allowing the space to be more effectively heated. These tiles also prevent moisture from seeping into the carpet. ThermalDry flooring is designed not to warp, bow or delaminate like wood products, and individual tiles can be removed for cleaning, replacement or to provide access to the concrete floor.

**Possible Challenges:** Like the Owens Corning system, TBF leaves visible seams in the finished wall. And while TBF is a very effective form of basement finishing, it is the most costly of the options reviewed. The panels are very heavy. This can increase shipping costs and make the panels hard to maneuver in the home.

**Magic Wall**

Magic Wall is a truly customizable basement finishing system that was designed to be used below-grade with water and mold-resistant R-16 rigid polystyrene foam insulation. The system creates a waterproof barrier between the living space and a damp foundation wall. Due to the type of insulation used (XPS), this panel will not lose R-value over time due to water absorption. The bottom edge of the wall system sits on waterproof, mold-resistant risers that protect the finished wall from water damage. Furthermore, the panels are manufactured with Borax in the insulation to make the panel resistant to termites.

“Magic Wall does not waterproof your basement, but it is designed to work perfectly with a waterproofing system,” said Otto Fleck, founder and CEO of DryBasement Waterproofing Systems. “Magic Wall is absolutely mold and moisture-resistant because of the inorganic materials used and it is designed for the basement specifically.”

Fleck’s company designed the system with the intention of creating an environment in the basement that is the same as upstairs but without all of the challenges usually present in the basement. With the Magic Wall System, walls are smooth, seamless, and can be painted a client’s color of choice. The engineered walls exceed building code by four times, meaning TVs and shelving systems can be hung without worrying about the structural integrity of the wall. The Magic Wall System also creates a straight interior wall even if the foundation wall is curved from age or soil settlement.

While gaining the benefits of a basement finishing system can mean a larger investment for homeowners, Fleck said Magic Wall and its moisture barrier can actually save money each month on heating and cooling bills by up to 33%.

“If you live in the home for more than 10 years, essentially the utility company has paid for the remodel with the savings on your utility bills,” he said.

**Possible Challenges:** Because Magic Wall is a combination of traditional basement finishing and a paneling system, there are some conventional materials used. Should the basement flood more than a couple of inches, some of the drywall may need to be replaced. However, the panel itself will require no repair.

While wood and/or metal stud finishing is still the most common form of basement finishing, these four popular systems demonstrate some of the advantages basement kits offer.

Prefabricated systems do cost more than conventional framing, but they can speed up the installation time, recouping some of the increased cost by reducing labor expenses. They may also create a healthier living space.
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