BUCKLEYS

International Structural Waterproofing Conference

The advantages, and use, of Electronic Leak Detection Systems

The Slate, University of Warwick, Coventry, CV4 7SH

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Introduction

I'm Simon Dobson – I'm a Chartered Mechanical Engineer, and Managing Director of Buckleys UVRAL Limited

My career has mostly been within the Automotive Industry, working internationally on design and development of car body hardware.

I moved into Lithium Batteries for Consumer Products and Electric Vehicles some 12 years back, and joined Buckleys in 2016.

Buckleys UVRAL Ltd. is a leading UK producer of Non Destructive Test equipment, for the Construction, Industrial and Offshore sectors.

Our key product ranges are focussed on Leak Detection and Corrosion Monitoring.

The company is based in Folkestone, Kent, and we supply products worldwide.

We are very much looking forward to our centenary in the spring of 2026.

Podium Decks and Flat Roof Decks

Externally Weathered elevated platforms, on which traffic (pedestrian or wheeled) is intended.

Waterproofing is required to prevent

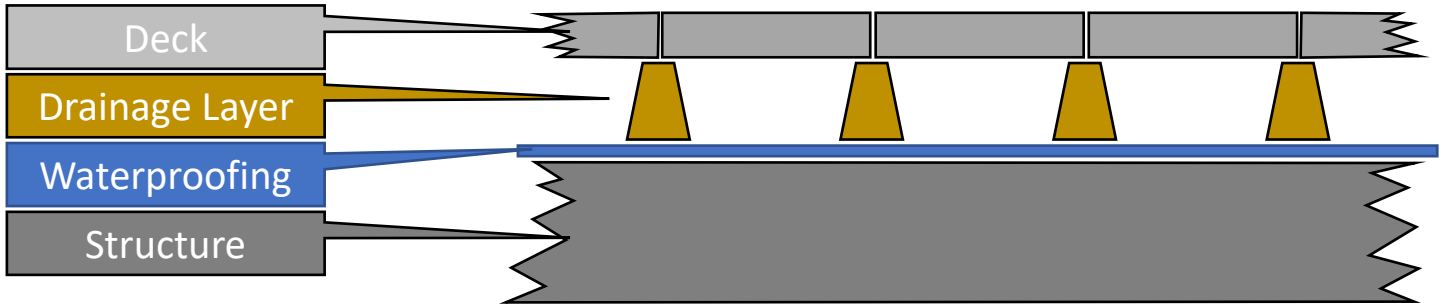
water accumulation on the deck surface

ingress of water to space below

ingress of water to adjacent buildings

Flat Roofs & Green Roofs have similar objectives but do not normally carry traffic.

Flat Roof waterproofing would normally be the exposed top layer.



A little History…

Electronic leak detection first applied to the detection of flammable gas leaks in the 1920s in the petroleum industry.

As solid-state electronics became commercially available in the 1970s, they were more generally applied to water leak detection.

There are now a number of standards applied across the globe referring to the various techniques available, several of which are applicable to rooftop leak detection.

These can also be applied to Podium Decks, Terraces, Underground Roofs, and Green Roof installations.

And a little Science

The general principle of most types of Electronic Leak Detection is simple:

If there is a flaw in a non-conductive waterproof layer — be it a membrane or a coating — then water *and* electricity can penetrate that layer.

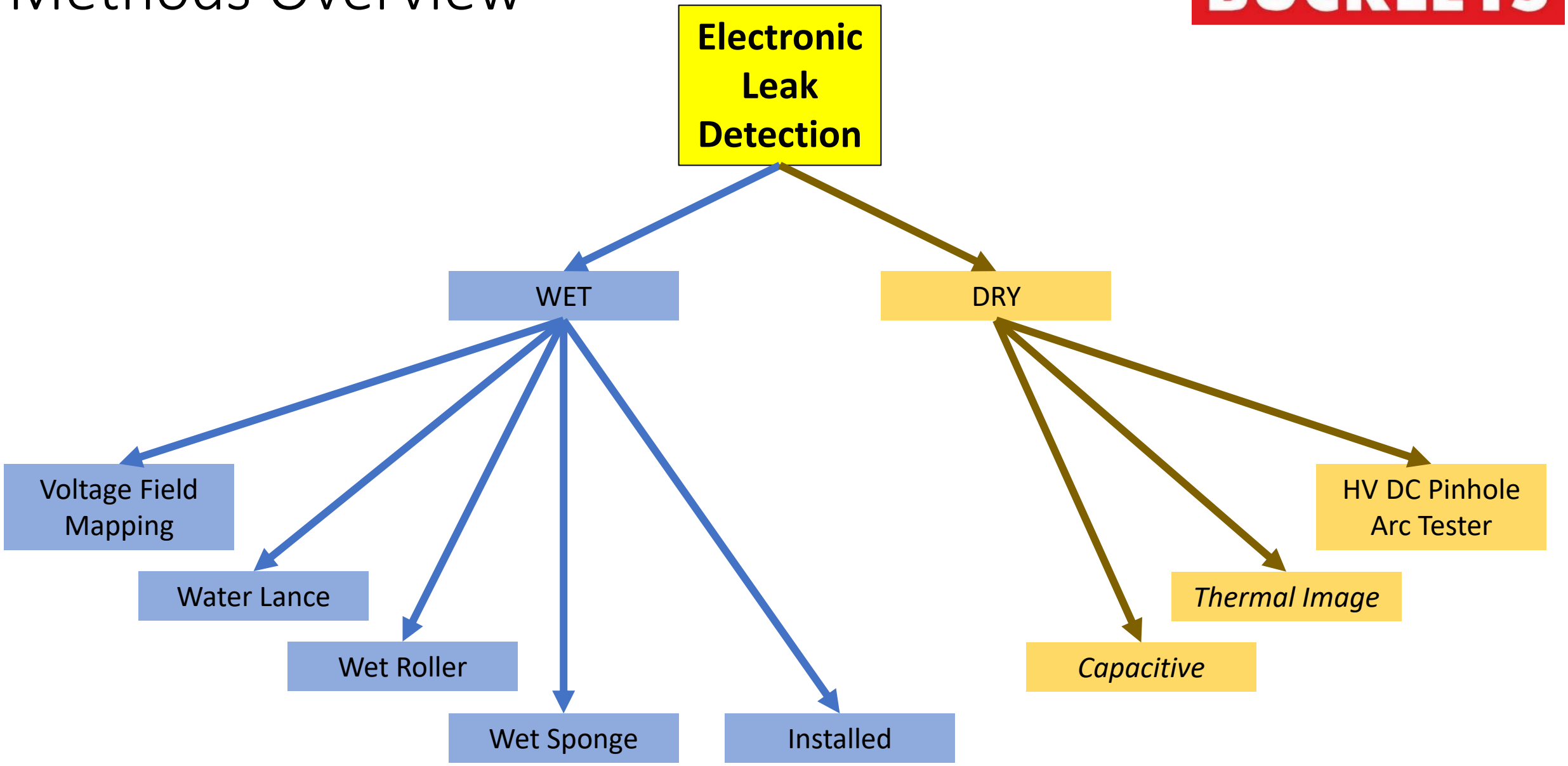
Provided there is a ground path and the voltage is sufficiently high, an electric current will be established that can be detected.

Voltage = Current x Resistance

The “electronic” part is really two systems: a means of creating the necessary voltage and a means of measuring a current flow to ground. These functions can be combined in a single instrument or two separate ones, depending on the particular product and method used.

Instruments detect the difference in conductivity between leak path and intact membrane

Methods Overview



Wet Methods

Wet methods depend on there being a conductive layer of water, which has had time to soak into any flaws in the coating. The water, being conductive, creates an electrical pathway through the leak which can be located electronically.

The necessary voltage for the equipment depends on the method used. The various “wet” methods using voltages as low as 6V, however 32V is typical. Higher voltages are used in some specifications but lower voltages may sometimes be necessary for safety reasons.

Detection of a leak will typically be the existence of a current between the ground electrode and the field electrode.

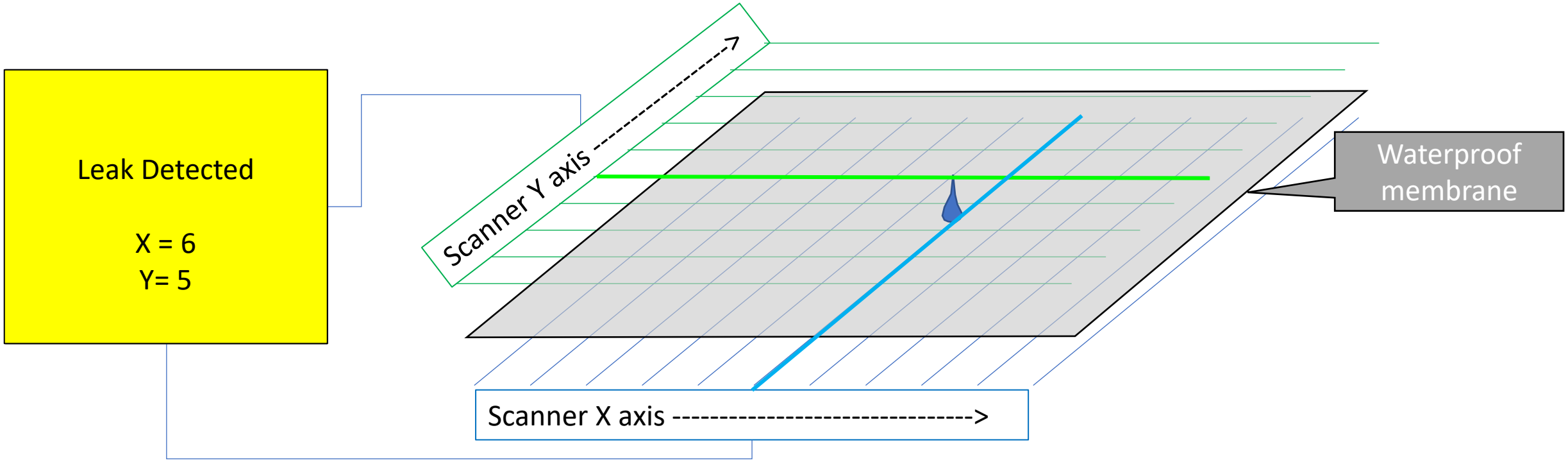
Localisation of any leaks found may be by sweeping a moving field electrode across the area to be tested, by scanning a matrix of detector wires in an installed system, or by Voltage Field Mapping, for which Buckleys supply the necessary equipment.

Installed Systems

Permanently installed leak detection and monitoring systems are becoming more common, and recent updates to the recommended standards are making them mandatory.

Systems in general comprise two grids of parallel conductors, placed perpendicular to one another. These conductors are scanned in turn by the system controller, and the resistance between conductors is logged.

If a leak forms, it will provide a conductive path between conductors, which the controller will detect. The locality of the leak will be determined by scanning process, the resolution of the location will depend on the spacing of the conductors.



Wet Sponge Method

The “wet sponge” method uses a battery-powered low voltage generator (between 9 and 90V depending on standards) in a hand-held unit fitted with a short pole ending in a sponge. A ground wire is connected to the item to be tested, and the sponge is wiped over the test item. An alarm operates if a failure in the surface coating allows a current to pass. Units may be fitted with various controls to set voltage and current threshold, and with lamps and alarm buzzers to signal a failure.

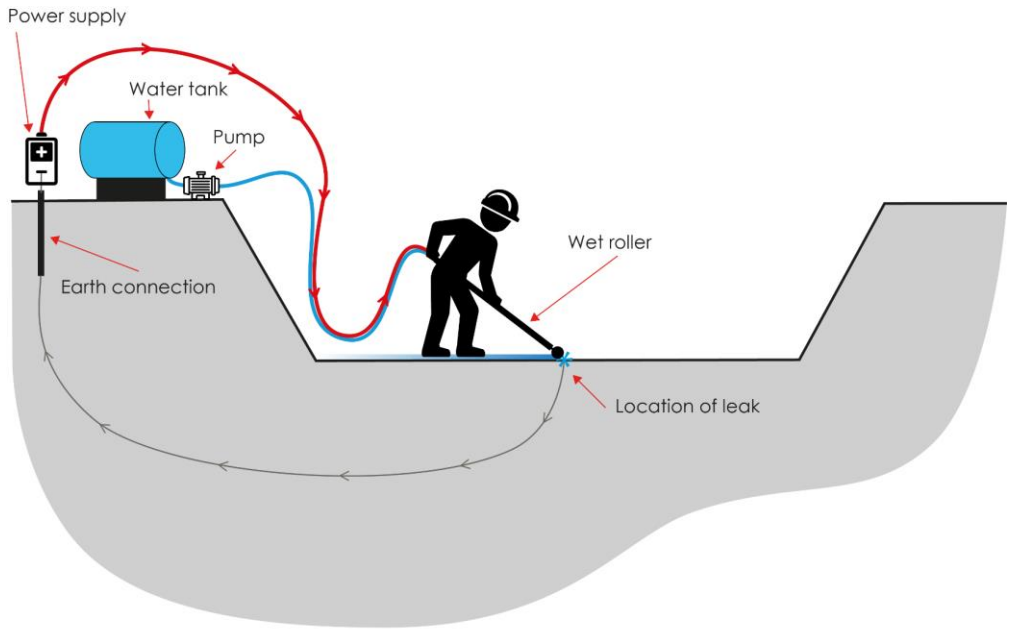
This type of test is typically applied to relatively small areas, such as car body panel repaint, surface coating testing in laboratory, etc.
It can also be applied to vertical upstands on building roofs and similar situations.

Wet Roller Method

The Wet Roller Method is very similar, but more suitable for large areas such as decks, roofs and geomembranes.

It is effectively exactly the same technique, but by means of a hose and roller, keeps the moving field electrode wet, and therefore conductive. The operator works from the low edge of the membrane, methodically covering the whole area under test, until the upper boundary is reached. The electronic current detector advises the operator of the presence of a flaw.

This requires an isolated, low pressure water supply, and generally dry conditions.



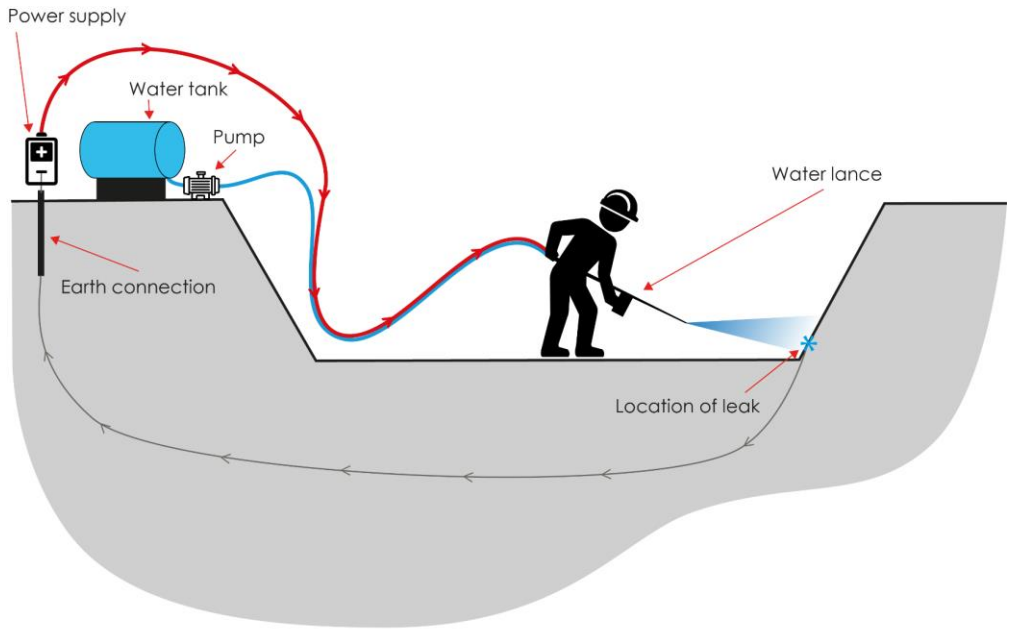
Water Lance Method

The Water Lance method is more suitable for areas with a significant slope, and again, depends on direct detection of the ground current, between the water stream from high-pressure water lance and the ground electrode, via any flaws or defects in the waterproof membrane, and electronics are used to advise the user of the existence of such a ground path.

Again, working upslope from the drainage, the operator “scans” the surface to be tested with the water jet.

This requires a pressurised, isolated water supply, and generally dry conditions.

It is not generally recommended for construction work, but may be suitable for some installations, I mention it for completeness.



Voltage Field Mapping

With voltage field measurement, a thin layer of water is spread across sections of, or the whole, area under test which are bounded by a field electrode, the trace wire. The generator applies a voltage between the field electrode and the building ground.

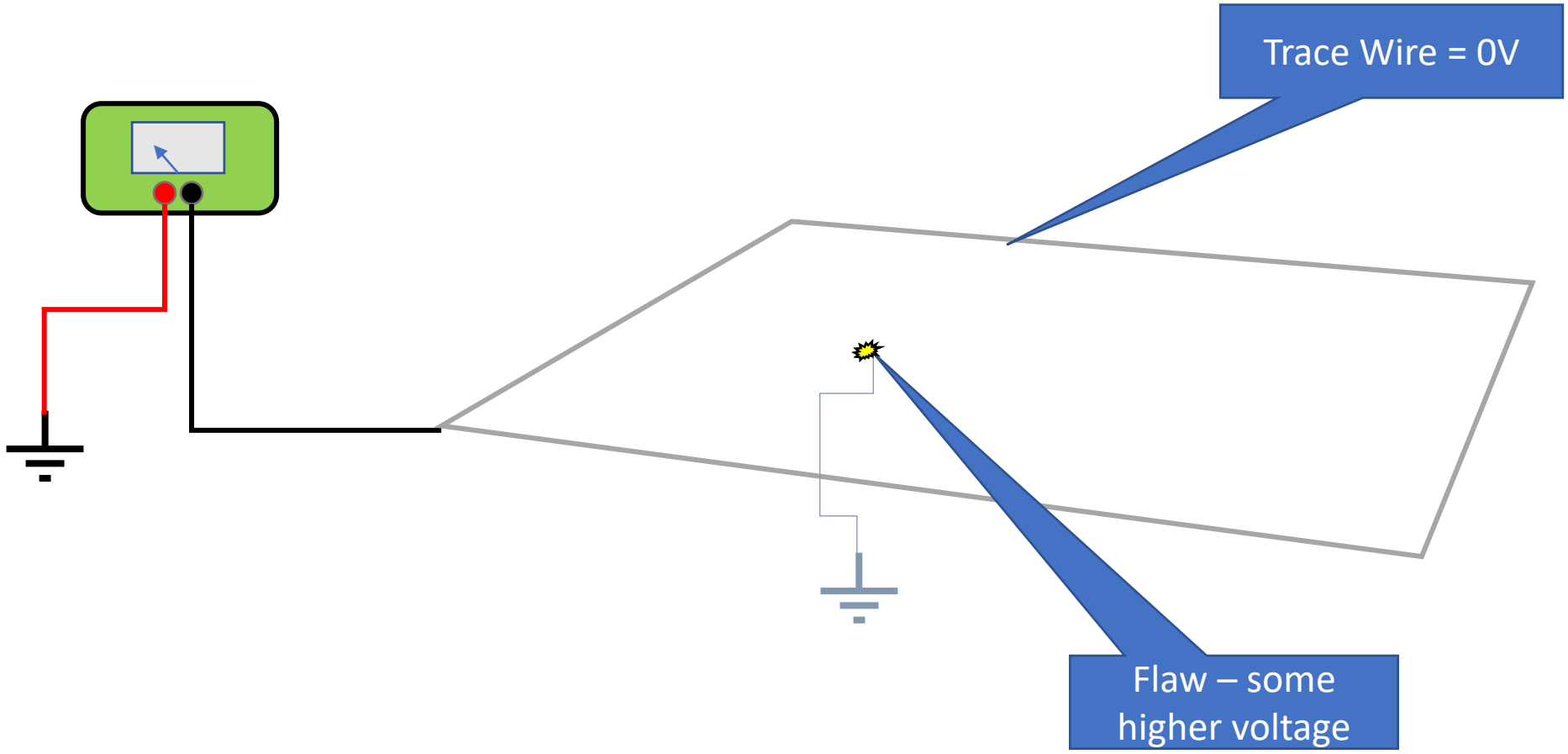
This technique is applicable to substantially flat surfaces including decks and roofs. It can also be used on shallow slopes.

If there are flaws through which water is able to penetrate, a current will flow between these electrodes, and it will be indicated by the generator – this shows that there is a leak in the area being tested.

The detector uses electrodes similar to ski poles, which the operator touches on the surface to measure the voltage between them. The magnitude and direction of this electric field is used to home in on any flaws. With a little practice, an operator can confirm the presence of flaws very quickly and, within a few minutes, determine the precise location of the flaw.

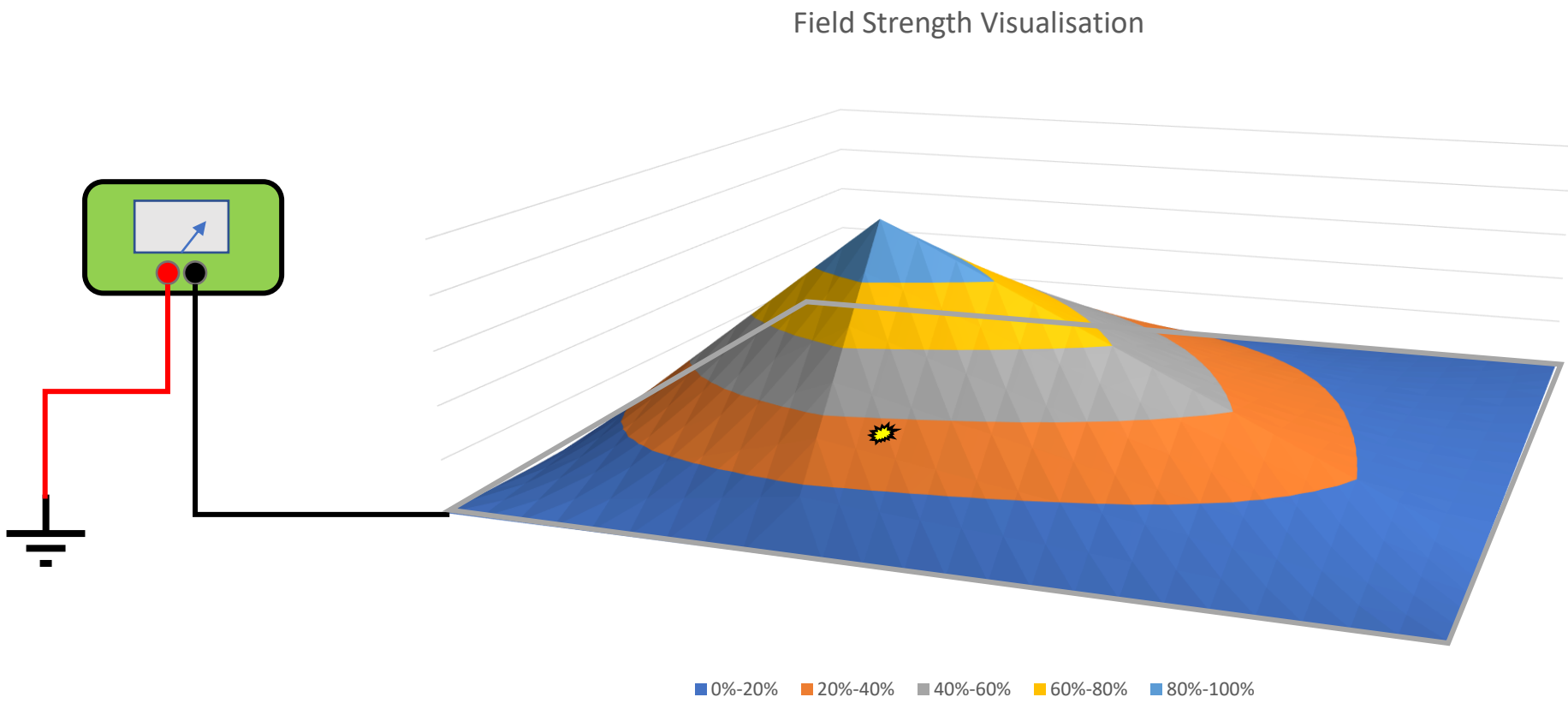
Wet Method – Voltage Field – Fundamentals

The Generator creates a ***voltage field*** between the trace wire and the flaw.



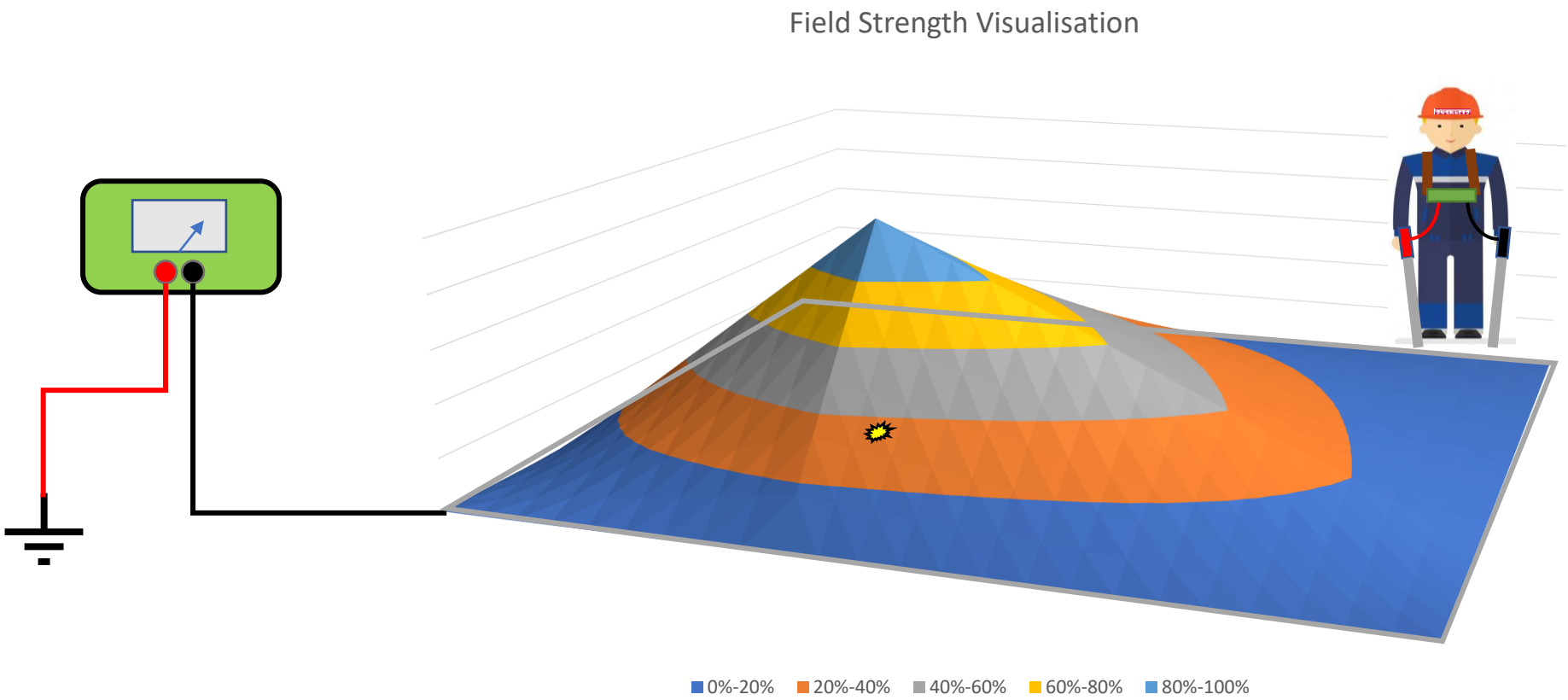
Wet Method – Voltage Field – Visualisation

We can visualise this voltage field as a “mountain” whose peak is directly above the flaw in the membrane.
(If there were multiple flaws, the field might look more like a range of mountains.)



Wet Method – Voltage Field – Detection

The Detector enables the operator to know which of the ski-poles is at a higher voltage, ie which one is nearer the “top of the mountain”. The operator can then move around until the peak is found – that’s where the flaw is.



Wet Method – Voltage Field – Advantages

The voltage field wet test approach is ideal for surfaces that are substantially level, smooth, and do not have numerous grounded items within the area to be tested. It is also the preferred method to be used when it's raining!

Wet approaches offer one capability far superior to the dry method: If the leak path is long and complex, as may result from a multi-layer waterproofing over a thermally insulating layer, the voltage required would be beyond the capability of any High Voltage instrument.

The Voltage Field approach will detect such leak paths provided that the water has had time and the opportunity to soak through the waterproof layer and the substrate on which it is applied. Therefore, this approach is often a method of choice in remedial work, where the waterproof layer has been in place for some time.

Dry Methods

There are several Dry Methods of Leak Detection – Buckleys supply Arc Testing equipment which I will describe in detail, however two other Dry approaches are available;

Thermal Imaging provides a convenient means of detecting water hidden below a membrane – water has a very high Specific Heat Capacity, and thus can be readily detected by a temperature difference between a wet area and a dry area – this is effective early on sunny mornings, when the dry areas of a deck will warm much more quickly than any that are saturated. This method proves that water ingress has occurred, but typically does not provide specific guidance in location of the leak that allowed it.

Capacitive methods also detect water under the membrane – and again, can prove that a leak has occurred, but again, this method does not provide guidance to locate the source of the leak.

Dry Method - Arc Testing

Arc testing requires much higher voltages than wet methods. These are in a range similar to automotive spark-plug voltages.

A scanning approach is required for dry methods. A battery-powered high-voltage source is connected to an electrode that is brushed over the entire area to be tested. The instrument is normally carried in a shoulder bag, and the ground wire is connected to the building ground.

The necessary test voltage is dependant on the thickness of the layer to be tested, with an additional allowance; various published standards exist that provide this information. The better instruments also provide automatic voltage calculation according to various published standards, allowing direct input of the thickness of the material to be tested.

When a flaw is detected, the instrument will flash an alarm, and the operator can manipulate the test electrode to detect the exact location of the fault.

Dry Method – Arc Testing

Dry Method – Arc Testing – Advantages

Trying to keep a large, flat, possibly windswept, and sun-baked roof wet would be extremely difficult in hot, dry climates - even in the UK, summer conditions can make the Wet approach difficult, and the Dry method is clearly preferable once the dew has evaporated.

The dry instruments are generally lighter, smaller, and more portable than the instruments required for wet testing and, of course, no water supply or drainage is required.

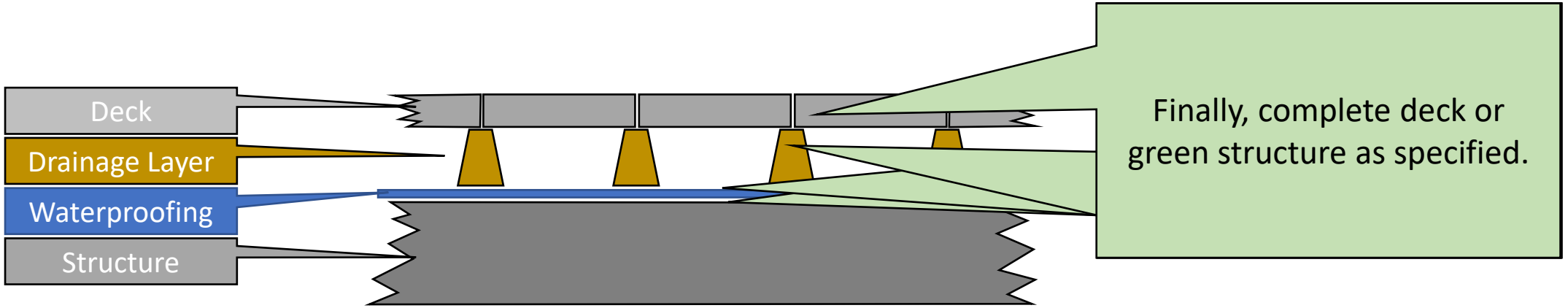
The electrodes for dry instruments can also be applied to curved, sloped, vertical, and even inverted surfaces.

Leak detection - Sequencing

Regardless of the approach used, the detection of leaks on a rooftop substrate before occupation is crucial for the architect, building and roofing material suppliers and contractors and the clients themselves, to ensure that the building meets and will continue to meet design and specification.

This is yet more important when the waterproof layer will be covered by a traffic deck or vegetation layer, and particularly so if a permanently installed monitoring system is not used.

Given that remedial work will require removal of the overburden, it is crucial to confirm the watertight integrity of the structure ***before*** the drainage layer and deck layer, or green roof is installed.



Leak detection - Summary

System	Advantages	Constraints
Permanently Installed Monitor	Provides prompt alerts in case of leaks, with localisation. 24/7 “on time” Can detect & localise leaks under overburden.	Impossible to retrofit after build. Expense. Difficult to repair if damaged. Resolution dependent on conductor spacing.
Wet Sponge	Convenient and easy to use on small test areas	Slow. Cannot operate through overburden.
Wet Roller	May be suitable for larger areas, sloped surfaces	Cumbersome, requires pumped water supply. Cannot operate through overburden.
Water Lance	May be suitable for larger areas, sloped surfaces	Cumbersome, requires pressurised water supply. Cannot operate through overburden.
Voltage Field Mapping	Can detect and locate complex leaks in multi-layer membrane systems easily, quickly and efficiently. Easy to use.	Substantially level surface. May be able to detect presence of leaks, but cannot effectively detect location through overburden.
Thermal Imaging	Highly portable, very quick detection of hidden wet areas in suitable conditions.	Optimal use when sharp atmospheric temperature changes occur. Very limited ability to localise source of leak. Cannot operate through overburden.
Capacitive Detectors	Accurate detection of water under membrane	Very limited ability to localise source of leak. Cannot operate through overburden.
High Voltage Arc Testing	Can detect and locate flaws in most waterproofing coatings and membranes easily, quickly and efficiently. Highly portable and very easy to use.	Limited ability to detect long and complex leak paths. Cannot operate through overburden.