Guide for the application of Electrical Leak Location methods on GEOCONDUCT® and DRAINTUBE® Conductive

AFITEX Texel
LE DRAINAGE SUR MESURE • THE DRAINAGE YOU WANT

PREPARED BY
GROUPE ALPHARD INC.

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Alphard

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AFITEX-TEXEL INC.

Prepared by Groupe Alphard inc.

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Prepared by:

Carl Charpentier
Head of Electrical Leak Location Services

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1. Introduction

The Conductive product range manufactured by AFITEX-TEXEL Geosynthetics Inc. offers protective (GEOCONDUCT®) and draining (DRAINTUBE®) geocomposite materials fitted with conductive elements that allow for the application of electrical leak location methods.

Based in North America, AFITEX-TEXEL has had production facilities in Quebec since 2008. The company combines the industry expertise of AFITEX and TEXEL Technical Materials, a division of Lydall Inc. AFITEX, based in France, has specialized in drainage technologies for over 30 years and is today considered a European leader in the sector. TEXEL, founded in 1967, manufacture all types of non-woven materials, including high quality non-woven needle punched geotextiles, and is an industry leader in North America. DRAINTUBE® and GEOCONDUCT® are used in a variety of domains in Europe, Africa, Canada and the United States for the drainage of fluid or gas and for geomembrane electrical leak location. More than 20 million square metres (200 million square feet) of DRAINTUBE® and GEOCONDUCT® has been installed since 1988.

1.1 Applications

The Conductive range of products has been developed specifically to allow for electrical leak location in situations where it would normally be impossible – generally in impermeable systems without a naturally conductive layer beneath the geomembrane. Products in the Conductive range are therefore mainly used in double liner confinement systems that allow for electrical current to pass between the two geomembrane layers. They can also be used in confinement systems installed on a natural soil layer with low or variable conductivity (e.g. layers of dry material). Installed beneath the geomembrane, the Conductive range products guarantee a minimum level of conductivity, providing a homogenous electrical profile and facilitating electrical leak location.

The Conductive range can also be used on high-gradient slopes and even on vertical surfaces (to allow for electrical leak location in a tank or silo, for example).

The electrical leak location methods suitable for products in the Conductive range are the Water Puddle (ASTM D7002) and the Arc Test (ASTM D7953) methods for exposed geomembranes, and the Dipole method (ASTM D7007) for covered geomembranes.

1.2 Objective of the Guide

The objective of this guide is to provide a technical basis for engineers working in the design of impermeable systems who wish to ensure the quality and integrity of finished works through the application of electrical leak location methods.

2. Detailed Description of the Solution

The Conductive range includes various models of conductive geomembrane that can be paired with other products, notably DRAINTUBE® geocomposite drainage materials, and can be adapted to meet project-specific requirements.

2.1 Conductive Range of Products

2.1.1 GEOCONDUCT® 250

GEOCONDUCT® 250 is composed of a conductive grid of stainless-steel wires woven on a 50 mm spaced nylon fibre mesh. The conductive layer is fixed between two non-woven needle punched geotextiles layers. The lower geotextile layer on GEOCONDUCT® 250 is punch resistant and can be sized in accordance with project needs.

Figure 1: GEOCONDUCT® 250 sample

2.1.2 GEOCONDUCT® L

GEOCONDUCT® L is composed of a 50 mm spaced stainless-steel grid fixed to a non-woven needle punched geotextile.

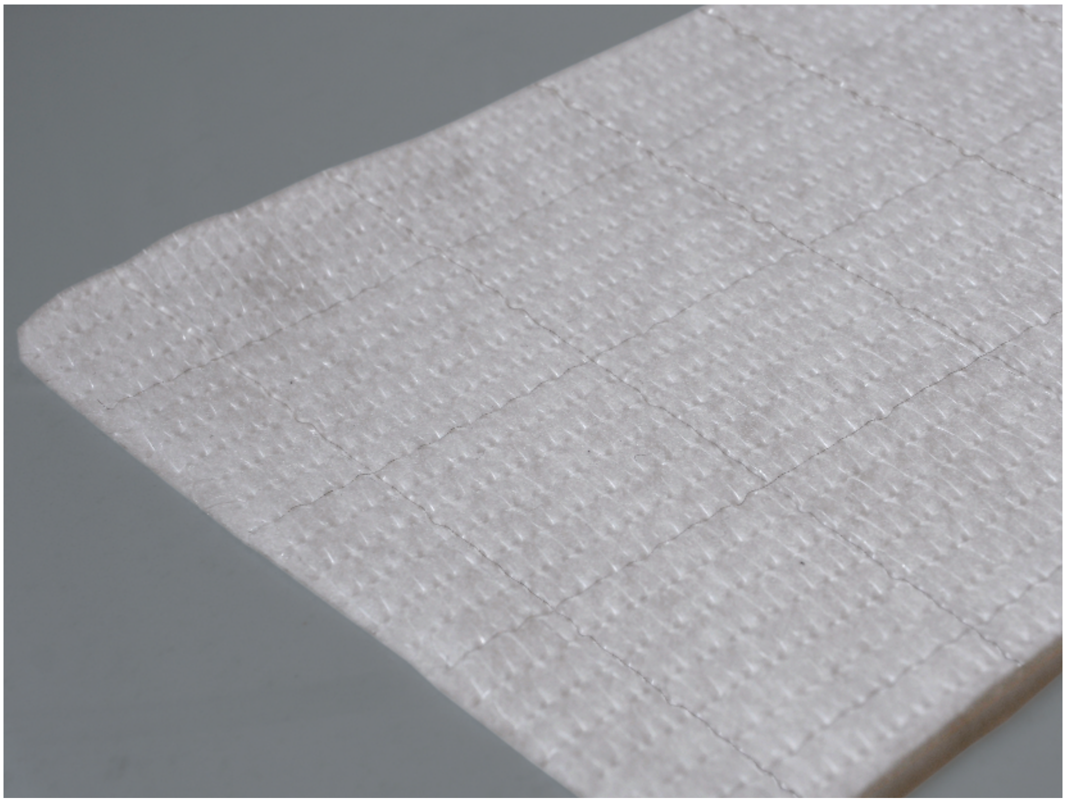

Figure 2: GEOCONDUCT® L sample

2.1.3 DRAINTUBE® Conductive

DRAINTUBE® Conductive incorporates the conductive grid described in section 2.1.1 in a drainage geocomposite, combining drainage, filtration, mechanical protection and electrical conductivity features in a single product requiring a single installation. The standard requirements of DRAINTUBE® installation apply, including procedures for overlapping panels and the connection of mini-drains.

Figure 3: Conductive DRAINTUBE® material

2.2 Features of the Conductive Range

2.2.1 Durability

Conductive range products (GEOCONDUCT® and DRAINTUBE® Conductive) can be used in systems that will undergo periodic testing following installation, with the stainless-steel conductive grid remaining functional for many years even in humid environments, in contrast to alternative products (using aluminum or other conductive materials) that degrade within a few months of installation.

2.2.2 Installation

The installation of Conductive range products requires special attention when overlapping panels to ensure continuity between the electrical contacts. The fixture of overlapping panels by heating or stitching does not provide a guarantee of electrical continuity.

In order to ensure electrical continuity across the whole of the geomembrane, guaranteeing the transmission of electrical signals from potential leaks to the grounding dipole positioned at the exterior of the site, the panels must be installed with the conductive grids in physical contact.

The overlap between two panels must be at least 300 mm (1 foot) wide and at least 600 mm (2 feet) wide in the case of an end-to-end overlap. Stitching of the panels is not recommended. The geotextiles can be heat bonded without affecting product electrical performances.

NOTE

If a DRAINTUBE® Conductive is used, mini-drains have to be connected following supplier installation recommendations.

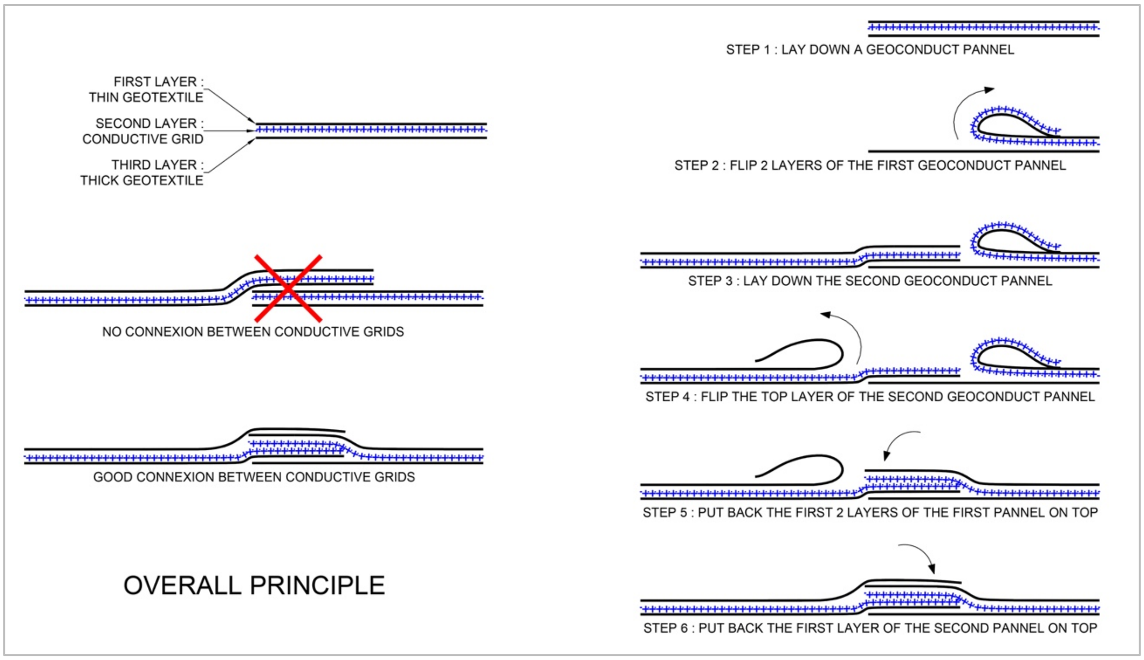

Figure 4: Joins between GEOCONDUCT® 250 and DRAINTUBE® Conductive panels

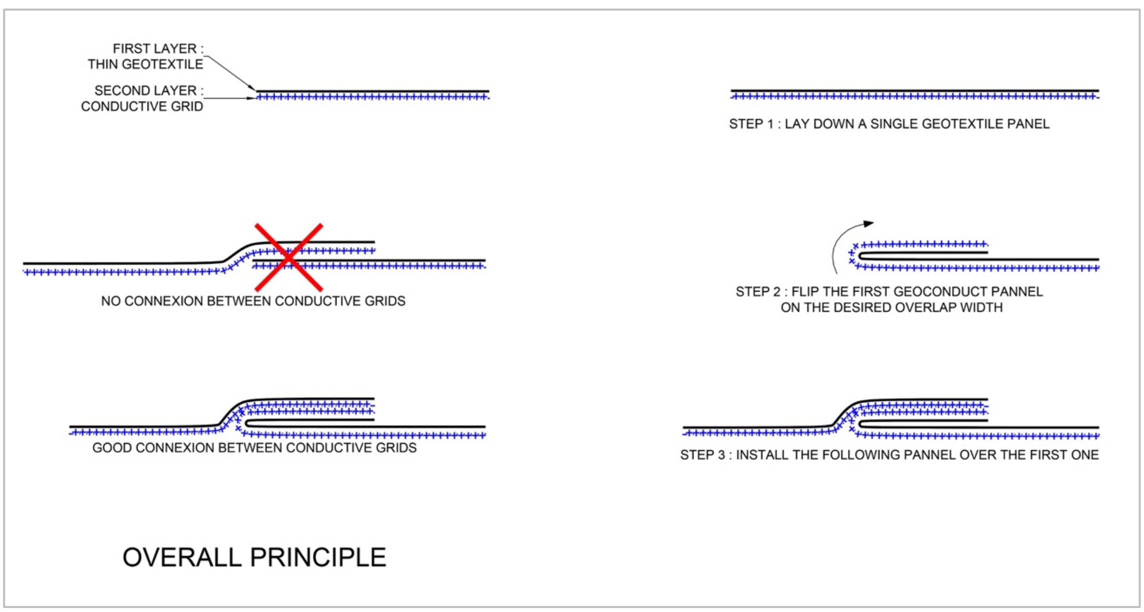

Figure 5: Joins between GEOCONDUCT® L panels

2.2.3 Quality Control

Electrical continuity between panel joins can be verified using a continuity tester provided to the installation contractor on request. The continuity tester is comprised of two units joined by a flexible cable. The units are positioned on either side of the join directly in contact with the upper geotextile layer. The geotextile is moistened prior to the positioning of the units (a small amount of water is poured or sprayed over a 5 cm area). If the join has been performed correctly, the blue signal light on the unit is illuminated and the unit alarm sounds.

The electrical continuity of the joins should be tested at every 25 linear metres (80 linear feet) of installed product or at least at 3 points along the entire length of each roll.

Figure 5: Continuity tester for quality control

3. Summary of Electrical Leak Location Methods

The following sections present the electrical leak location methods available for use on the Conductive range. For further information on electrical leak location methods in general see ASTM standard D6747 and the relevant ASTM standard for each individual method.

3.1 Water Puddle Method (ASTM D7002)

The water puddle method has been used on exposed geomembranes for over 30 years. The method uses low voltages, generally less than 50 volts of direct current, and requires a water source usually supplied by a tanker or tank and pump system. A power source is installed at the exterior of the site with its negative pole in contact with the conductive grid of the GEOCONDUCT®/DRAINTUBE® Conductive material (see section 4.2: Temporary Connection to GEOCONDUCT®/DRAINTUBE® Conductive Materials).

The operator moves across the membrane with a water lance connected to a water supply hose and the water is distributed across the geomembrane surface. In the case of a fault in the geomembrane material, the water passes through the fault and creates an electrical circuit between the water lance apparatus and the conductive grid of the GEOCONDUCT®/DRAINTUBE® Conductive material. The electrical signal resulting from this circuit is recorded by the water lance apparatus and an audiovisual alarm is activated to inform the operator that a leak has been detected. The geomembrane must be installed flat to the supporting soil layer, as air pockets and folds can prevent the creation of an electrical circuit between the lance and the conductive grid (see section 5.6).

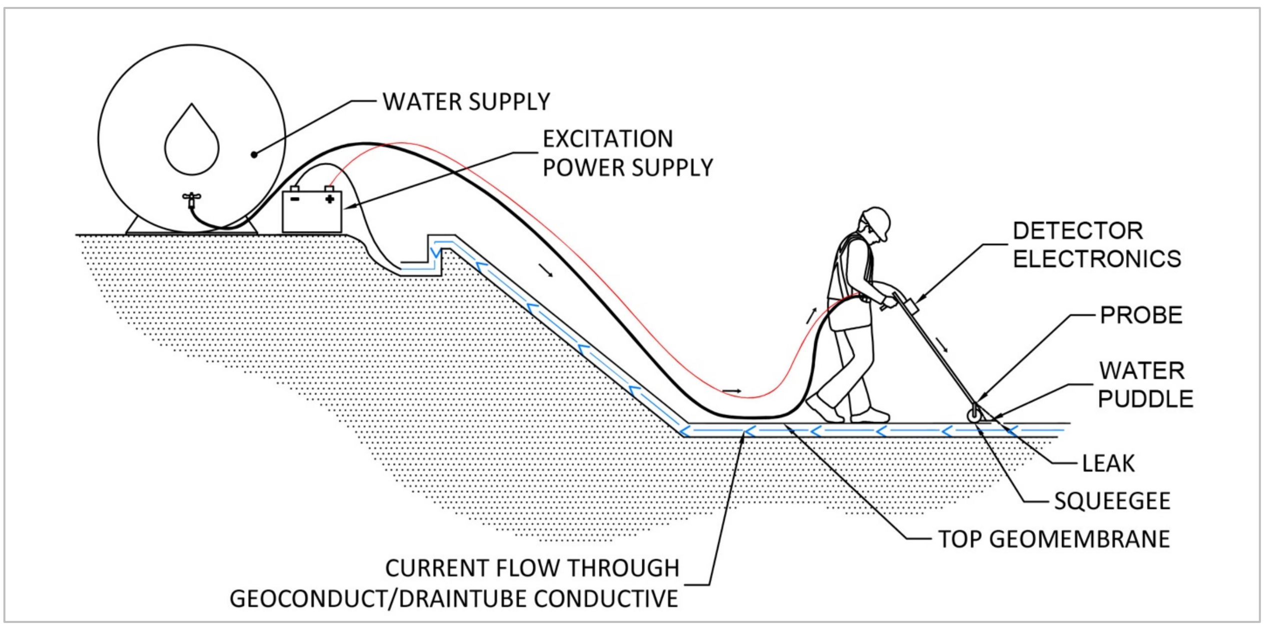

Figure 6: Diagram of the water puddle method

3.2 Arc Test Method (ASTM D7953)

The art test method of electrical leak location on exposed geomembranes does not require a water source. The lance is generally lighter than the lance used in the water puddle method and the operator carries an electrical connector rather than a water supply hose. As the water puddle method, the negative pole of the power source is connected to the conductive grid of the GEOCONDUCT®/DRAINTUBE® Conductive material at the exterior of the site.

The arc test equipment operates at a voltage of around 30,000 volts. This is sufficient to create an electrical arc that will pass through faults in the geomembrane, creating a circuit between the lance and the conductive grid of the GEOCONDUCT®/DRAINTUBE® Conductive material. The main advantages of the arc test method include the low weight of the leak location equipment and that the method requires no water.

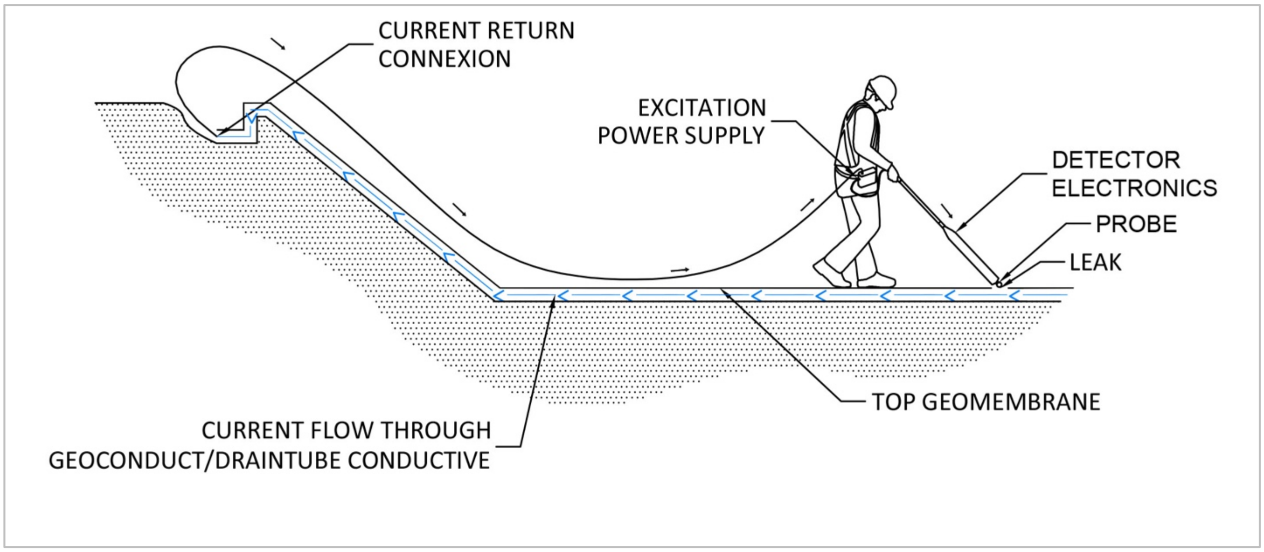

Figure 7: Diagram of the arc test method

3.3 Dipole Method (ASTM D7007)

The dipole method is the only electrical leak location method that can be applied following the installation of a protection or drainage layer covering the geomembrane. It allows for the detection of faults 6 mm or larger in diameter, dependent on survey conditions. Whilst the typical thickness of covering material suitable for the dipole method is around 30 cm, the method can be used on layers of up to 1 m thick, with precision diminishing progressively as the thickness of the covering material increases.

The principle of the dipole method is similar to that of the two previous methods in that it uses the isolating properties of geomembrane materials to ensure that an electrical current can only pass through faults in the material, generating an anomalous electrical signal that can be detected by the operator.

In the dipole method, an electrode is inserted into the soil covering layer, allowing electrical current to pass freely through any faults to the conductive grid of the GEOCONDUCT®/DRAINTUBE® Conductive material. A qualified operator then takes a series of electrical potential measurements at preestablished intervals. The signal generated by a fault is sufficiently strong to be distinguishable from the background noise and following detection, the operator may proceed to the excavation stage to confirm the presence of the fault.

The high conductivity offered by the Conductive range facilitates the dipole method by supporting strong electrical signals, ensuring that there is almost no voltage loss across the entirety of the conductive material when compared to the same area of natural covering material.

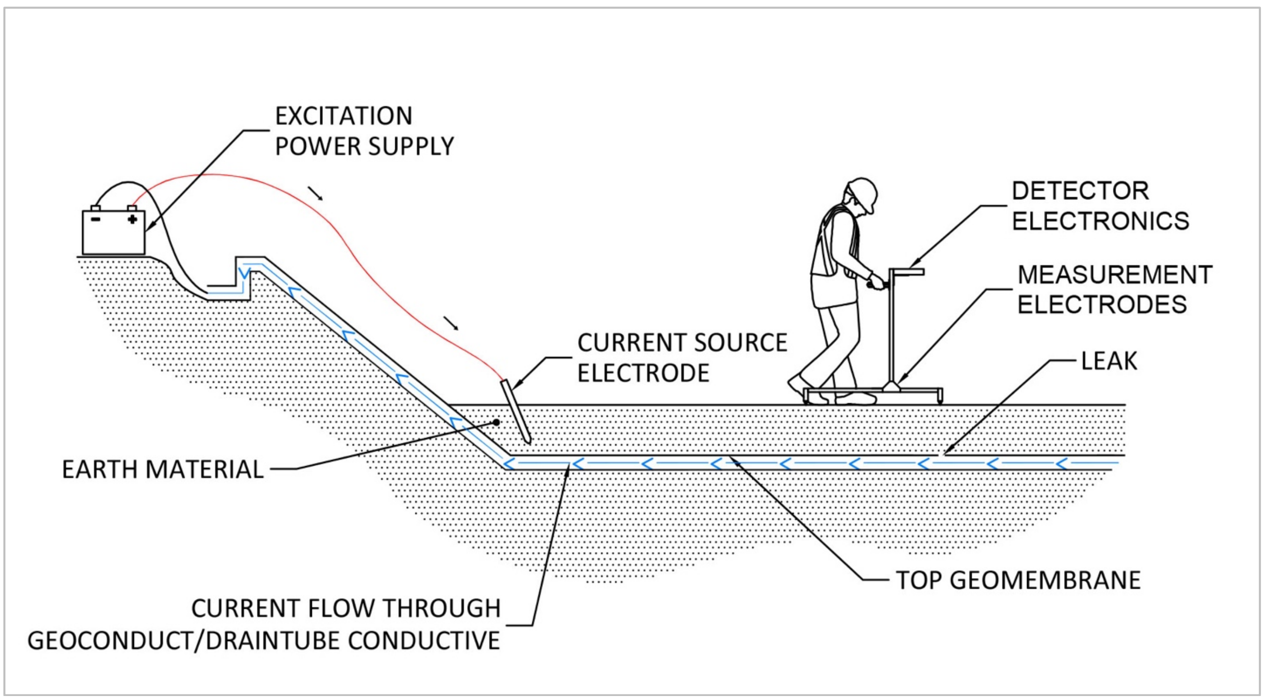

Figure 8: Diagram of the dipole method

4. Connections and Additional Information

4.1 Permanent Access to GEOCONDUCT® for Electrical Leak Location Surveys

The different electrical leak location methods presented above require a direct connection to the geocomposite material or to its conductive grid. This is generally achieved by using a metallic plate, a nail, or any other conductive connection. The connection to the geocomposite requires the operator to moisten the surface of the material to guarantee adequate conductivity. It is also recommended that the operator put a weight on the connection to ensure that the connection stays in place.

To access the material for connection, it is generally possible to find a non-covered segment of GEOCONDUCT®/DRAINTUBE® Conductive material at the mechanical anchoring point at the top of the site's embankment. When the anchoring section is closed, access to the conductive grid may require opening of the geomembrane. Where leak location surveys are required at regular intervals (every 5 years, for example), it is suggested that a permanent access connected to the GEOCONDUCT®/DRAINTUBE® Conductive material be considered in the project's design phase.

Figure 9: Example of a permanent access connected to the GEOCONDUCT®/DRAINTUBE® Conductive grid

4.2 Temporary Connections to GEOCONDUCT®/DRAINTUBE® Conductive Material

- Use crocodile clips to connect the electrical source directly to the conductive grid;
- Make a 30 cm long opening in the upper geotextile layer, insert a grounding plate in contact with the conductive grid, replace the upper geotextile layer, moisten, and add weight to ensure contact between the plate and the grid and to prevent evaporation (a sandbag, large rock, etc.);
- Make a 10 cm long opening, insert a grounding rod, roll the grounding rod in the geotextile material and tighten using a vise grip;
- As a last resort, the GEOCONDUCT® material can be soaked and the electrode placed on top, with a weight placed on top to maintain a minimum level of humidity (a sandbag, large rock, etc.).

Figure 10: Example of a connection to GEOCONDUCT®

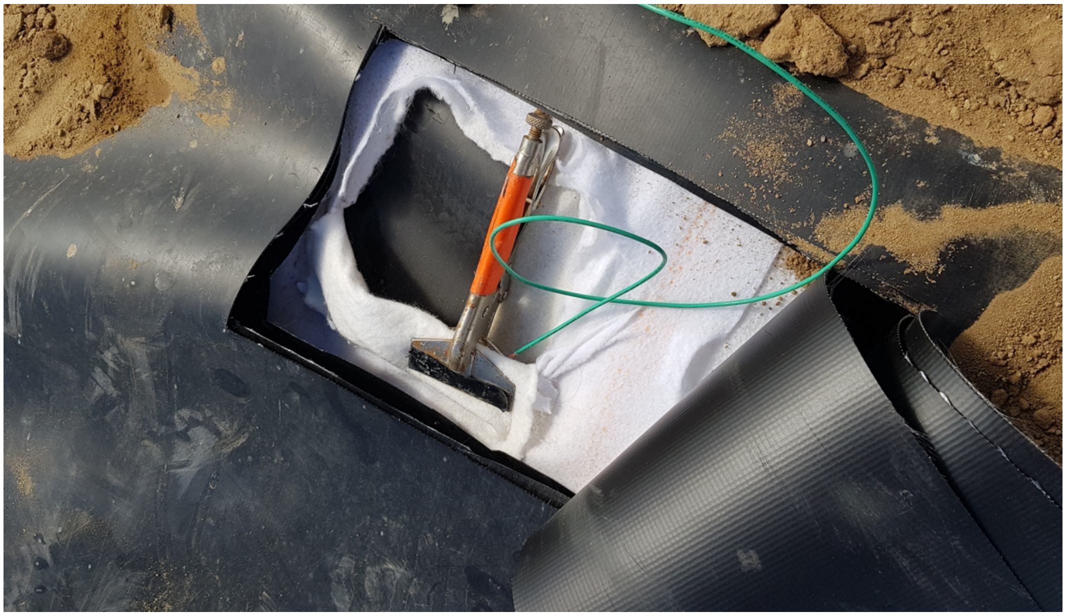

Figure 11: Alternative example of a connection to GEOCONDUCT®

4.3 Applicable Distance of the Conductive Range

For the electrical leak location methods outlined above, the electrical conductivity of humid soil is sufficient to carry an electrical current around 100 metres (300 feet). In the case of GEOCONDUCT®/DRAINTUBE® Conductive materials, the electrical conductivity of the conductive grid is much greater, even when panels are overlapped one on top of the other (mechanical contact). There is therefore no maximum distance between the connection point and the operator, with the only limiting factor being the length of available hoses and cables. If the water supply is repositioned to another sector of the site, the electrical connection to the GEOCONDUCT®/DRAINTUBE® Conductive material can remain in place, provided available cables are long enough.

5. Electrical Leak Location Methods Recommendations

5.1 Beginning the Survey

It is strongly recommended to begin the survey at the lowest point of the site to ensure that the rest of the site remains as dry as possible and to facilitate the detection of faults. If the installation contractor is still on-site, it is recommended that the lowest point of the site is checked immediately and that any faults are repaired as soon as possible. In the case that the survey is carried out over several days, the lowest point of the site can become flooded, slowing down or preventing the survey and related repair works. Beginning at the lowest point of the site is especially important when using the Water Puddle method, as this method requires a significant volume of water be distributed across the geomembrane.

5.2 Connection Tests

Before beginning the electrical leak location survey, it is important to verify that all leak location equipment is correctly connected and functional. In the case of a survey on exposed geomembrane, this can be done by simply establishing a contact with the exterior of the site (which serves as an electrical ground) to generate an electrical circuit and produce a signal to test the equipment's audiovisual alarms.

For the dipole method, a simulated fault is used to test the equipment, as explained in detail in the ASTM standard D7007. The negative pole of the voltage source and the test line should both be connected to the GEOCONDUCT®/DRAINTUBE® Conductive material.

When GEOCONDUCT®/DRAINTUBE® Conductive materials are used in systems without direct contact with the underlying soil (i.e. when installed between two geomembranes), the connection test should be performed with any available section of the GEOCONDUCT®/DRAINTUBE® Conductive material, either on material which exceeds the mechanical anchoring limit, or, on an unfinished site, on material which has not yet been covered by geomembrane. In the latter case, a wire can be connected to the uncovered section and run to the exterior of the site to facilitate continuity tests during site coverage works.

5.3 Direction of the Survey

The direction of the survey is left to the operator's discretion. The direction in which the GEOCONDUCT®/DRAINTUBE® Conductive panels are installed has no effect on the survey. One installed and joined according to the recommendations of this guide, the product forms a homogenous and uniformly conductive layer beneath the geomembrane.

5.4 Verification of Repairs

Following the localization of a fault and its reparation by a qualified installation technician, a final verification using the same leak location method should be performed to confirm the impermeability of the repair.

5.5 Conditions Specific to the Water Puddle Method: Overlap

It is recommended to always provide an overlap between surveying routes to ensure that all areas of the geomembrane are surveyed. The geomembrane should be sufficiently watered, and all folds should be levelled. These measures are even more important for surveys of sites using GEOCONDUCT® /DRAINTUBE® Conductive materials, as the upper geotextile layer needs to absorb enough water to ensure contact with the stainless-steel wire grid. For smaller faults, this absorption delay can last a few seconds and an operator moving too quickly across the geomembrane layer may have already moved from the source of the leak. Overlapping surveying routes allows for the fault signal to be detected at the second pass, as long as the sector being surveyed remains sufficiently humid.

5.6 Conditions Specific to the Water Puddle Method: Flattening Folds

For both black and white geomembrane materials, folds or waves will be created in the material by thermic dilation as its temperature increases. These folds create air pockets that can negatively affect electrical leak location by interrupting the electrical connection between the water and the conductive material. It is strongly recommended that the folds be flattened during the survey, or to prioritize working in cooler temperatures to ensure that the geomembrane lies as flat as possible. This issue also applies to the Arc Test method, but the Arc Test equipment is generally too lightweight to effectively flatten folds when compared to the Water Lance and connected sponge. The high voltages created by the Art Test equipment also prevent the operator using their feet to apply pressure to the end of the equipment to flatten folds.

5.7 Conditions specific to the Arc Test Method: Clean Geomembrane Surface

For the Arc Test method, it is essential that the geomembrane surface be free from puddles of water, from dust, or from other foreign materials in order to reduce the risk of false positive readings and to increase the reliability of fault detection.

5.8 Conditions specific to the Dipole Method: Fault Areas

For the Dipole Method, it is recommended that a fault be excavated as soon as possible following its detection. Once the fault has been located and isolated, it is important to repeat the survey in the surrounding area to verify that the electrical signals indicative of smaller faults were not hidden by the signal produced by the initial fault.