



Designation: D 6747 – 02<sup>e1</sup>

## Standard Guide for Selection of Techniques for Electrical Detection of Potential Leak Paths in Geomembranes<sup>1</sup>

This standard is issued under the fixed designation D 6747; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

<sup>e1</sup> NOTE—Editorial corrections were made in November 2002.

### 1. Scope

1.1 This standard guide is intended to assist individuals or groups in assessing different options available for locating potential leak paths in installed geomembranes through the use of electrical methods. For clarity, this document uses the term potential leak path to mean holes, punctures, tears, knife cuts, seam defects, cracks and similar breaches over the partial or entire area of an installed geomembrane.

1.2 This guide does not cover systems that are restricted to seam testing only, nor does it cover systems that may detect leaks non-electrically. It does not cover systems that only detect the presence, but not the location of leaks.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory requirements prior to use.*

### 2. Referenced Documents

- 2.1 *ASTM Standards:*  
D 4439 Terminology for Geosynthetics<sup>2</sup>

### 3. Terminology

#### 3.1 Definitions:

3.1.1 *electrical leak location, n*—any method which uses electrical current or electrical potential to detect and locate potential leak paths.

3.1.2 *geomembrane, n*—an essentially impermeable membrane used with foundation, soil, rock, earth or any other geotechnical engineering related material as an integral part of a manmade project, structure, or system.

3.1.3 *geosynthetic, n*—a planar product manufactured from polymeric material used with soil, rock, earth, or other geotechnical engineering related material as an integral part of a manmade project, structure, or system.

3.1.4 *potential leak paths, n*—for the purposes of this document, a potential leak path is any unintended opening, perforation, breach, slit, tear, puncture, crack, or seam breach. Scratches, gouges, dents, or other aberrations that do not completely penetrate the geomembrane are not considered. Leak paths detected during surveys have been grouped into five categories: (1) Holes—round shaped voids with downward or upward protruding rims, (2) Tears—linear or areal voids with irregular edge borders, (3) Linear cuts—linear voids with neat close edges, (4) Seam defects—area of partial or total separation between sheets, and (5) Burned through zones—areas where the polymer has been melted during the welding process.

### 4. Significance and Use

4.1 Types of potential leak paths have been related to the quality of the sub-grade material, quality of the cover material, care in the cover material installation and quality of geomembrane installation.

4.2 Experience demonstrates that geomembranes can have leaks caused during their installation and placement of material(s) on the liner.

4.3 The damage to a geomembrane can be detected using electrical leak location systems. Such systems have been used successfully to locate leak paths in electrically-insulating geomembranes such as polyethylene, polypropylene, polyvinyl chloride, chlorosulfonated polyethylene and bituminous geomembranes installed in basins, ponds, tanks, ore and waste pads, and landfill cells.

4.4 The principle behind these techniques is to place a voltage across a synthetic geomembrane liner and then locate areas where electrical current flows through discontinuities in the liner (as shown schematically in Fig. 1). Insulation must be secured prior to a survey to prevent pipe penetrations, flange bolts, steel drains, and batten strips on concrete to conduct electricity through the liner and mask potential leak paths. The liner must act as an insulator across which an electrical potential is applied. This electric detection method of locating potential leak paths in a geomembrane can be performed on

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 04.09.

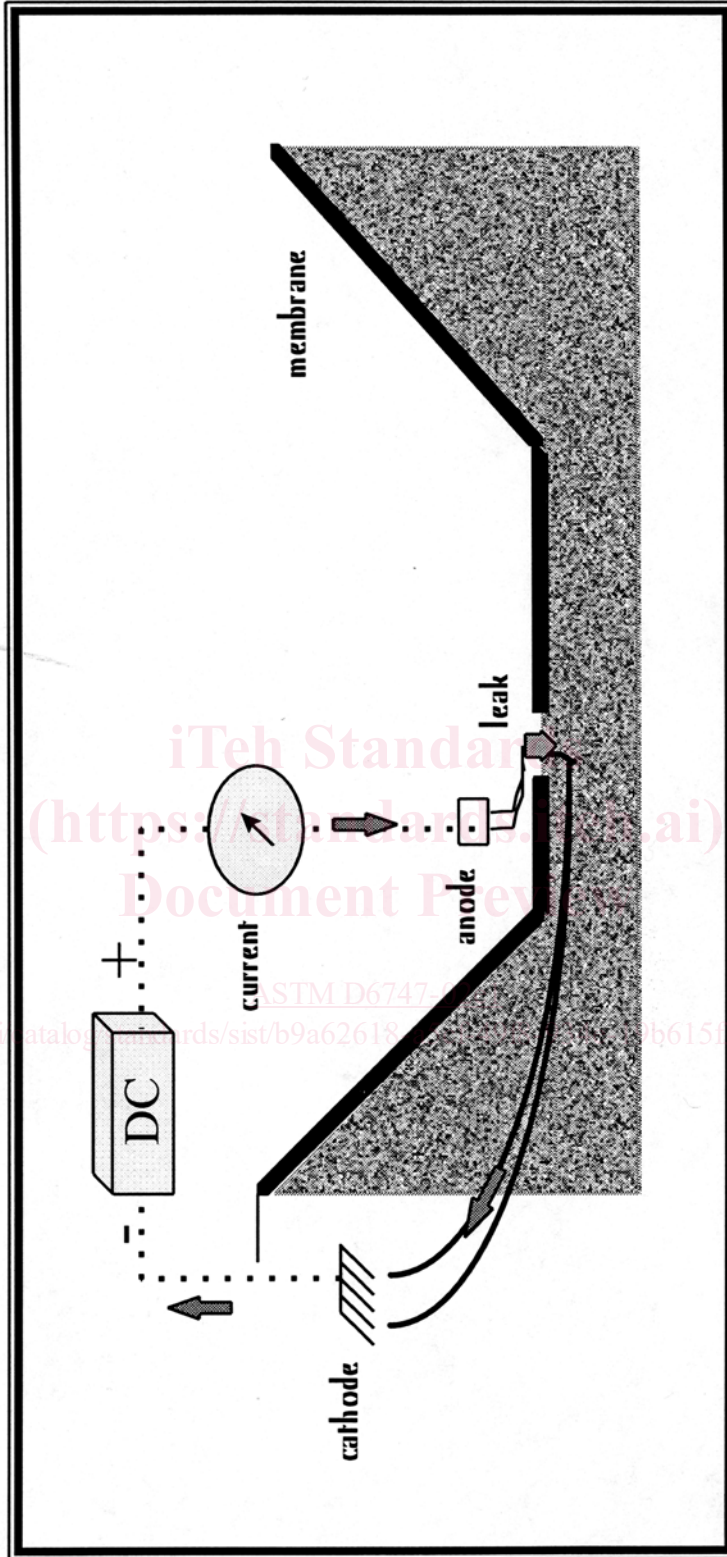


FIG. 1 Schematic of Electrical Leak Detection Method

exposed liners, on liners covered with water, or on liners covered by a protective soil layer, or both.

## 5. Developed Systems

5.1 Electrical leak detection systems were developed in the early 1980's and commercial surveys have been available since 1985. A short description of these systems is presented in this section.

5.2 *The Water Puddle and Water Lance System*—The technique is appropriate to survey a dry uncovered geomembrane during its installation when placed directly on a subgrade that is an electrically conductive layer below the geomembrane. The lower conductive layer is usually the soil and the upper conductive layer being water. A cathode ground is established and an anode is placed in a water puddle maintained by a squeegee or to the water stream of a lance (as shown schematically in Fig. 2). Water is usually supplied by gravity from a tank truck parked at a higher elevation than the lined area. For this technique to be effective, the leaking water must come into contact with the electrical conducting medium to which the ground electrode of the 12 or 24 volts dc supply can be connected. Since the geomembrane is not a perfect electrical insulator, a steady background signal can be audible. As the water flows through a leak path, there is an increase in the signal. Leak paths as small as 1 mm in size are then located by an audio signal or by measuring a current of magnitude related to the size of the leak. It can also be used to search for leak paths in geomembrane-lined concrete and steel tanks.

5.2.1 *Features*—The main advantage of this system is the possibility to detect leak paths in geomembrane joints and sheets as work progresses during the construction phase. Larger leak paths do not mask smaller ones because this technique locates leak paths independently on uncovered liner. The electrical survey rate of approximately 500 m<sup>2</sup>/h per operator does not affect the installation work schedule and permits a rapid construction quality control (CQC) of the installer work. The approximate setup time varies from 1 to 3 h.

5.2.2 *Limitations*—This technique cannot be used with a protective layer covering the liner. The presence of wrinkles and waves, steep slopes and lack of contact between the liner and the conductive soil at bottom of slopes inhibits the survey speed. This technique cannot be used during stormy weather when the membrane is installed on a desiccated subgrade, or whenever conductive structures cannot be insulated or isolated. The procedure to detect potential leak paths in seams of repair patches is difficult and lengthy since it requires a certain infiltration time.

5.3 *The Water-Covered Geomembrane System*—The principle behind this system is to test the geomembrane while it is covered with water, a technique similar to the previous system requiring an electrically conductive layer below (subgrade) and above the liner (water or saturated drainage layer). A cathode ground is established and an anode is placed in contained water. The voltage impressed across the liner (by a high voltage dc or ac power supply) produces a low current flow and a relative uniform voltage distribution in the material above the geomembrane. To maximize this current, a high voltage power supply with safety circuits is used that can provide up to 400

volts DC. A hand-held probe is then traversed through the water. An electrical current flows through the potential leak paths causing localized abnormalities in the electrical paths as shown schematically in Fig. 3. The typical procedure is to flood the test area, then locate the potential leak paths, drain the area and perform repairs. A hand-held probe or a probe on a long cable is scanned through the water to locate these places where current is flowing through a leak. A typical procedure is to flood the test area to a depth of approximately 0.15 to 0.75 m. This technique can locate very small leaks, smaller than 1 mm. The signal amplitude is proportional to the amount of electrical current flowing through the leak, so practical measures should be taken to maximize the current through the leaks. The signal amplitude is inversely related to the distance from the leak, so the scanning spatial frequency should be designed to provide the desired leak detection sensitivity.

5.3.1 *Features*—This system has the advantage of being used to locate potential leak paths in in-service impoundments. Primary and secondary liners can be tested. The water head on the liner facilitates the survey speed by minimizing the presence of wrinkles and waves, and lack of contact between the liner and the conductive soil at the bottom of slopes. This technique can be used in wet conditions. The main advantage of this technique is the detection of leak paths with the protective granular layer covering the liner (after the installation of the drainage layer on the geomembrane) (refer to 5.5 for description of the method). The survey rate depends primarily on the spacing between sweeps and the depth of the water. A close spacing between sweeps is needed to detect the smallest leaks. The survey rate for a survey while wading, sweeping the probe so that it comes within 0.25 m of every point on the submerged geomembrane is 800 to 1200 m<sup>2</sup>/h per person. For a survey with a towed probe with the probe scanned within 0.4 m of every point, the survey rate is 800 to 1000 m<sup>2</sup>/h per two persons, including establishing the survey lines. The approximate setup time is 30 to 90 min. These times do not include the time to flood the liner.

5.3.2 *Limitations*—The main disadvantage of this system is that it cannot be applied to detect potential leak paths in geomembrane joints and sheets as work progresses during the construction phase since, because of the need to flood the geomembrane with water. The presence of large leak paths may influence the detection of small leak paths in their vicinity. Depending on the bottom configuration of the surveyed application, the water depth can be substantial in some areas; the procedure is more lengthy consisting of flooding the area, probing to locate the leak paths and draining of the area to perform repairs.

5.4 *The Electrically Conductive Geomembrane*—Coextrusion technology makes possible the manufacture of a polyethylene geomembrane that can be spark tested. The material has a thin layer of electrically conductive material as an integral part of the geomembrane. This provides a way to spark test the installed geomembrane. The spark testing that occurs in the field is very similar to the method used in the factory to identify holes during geomembrane manufacturing. The conductive geomembrane is installed such that the conductive side is against the sub-base and the non-conductive

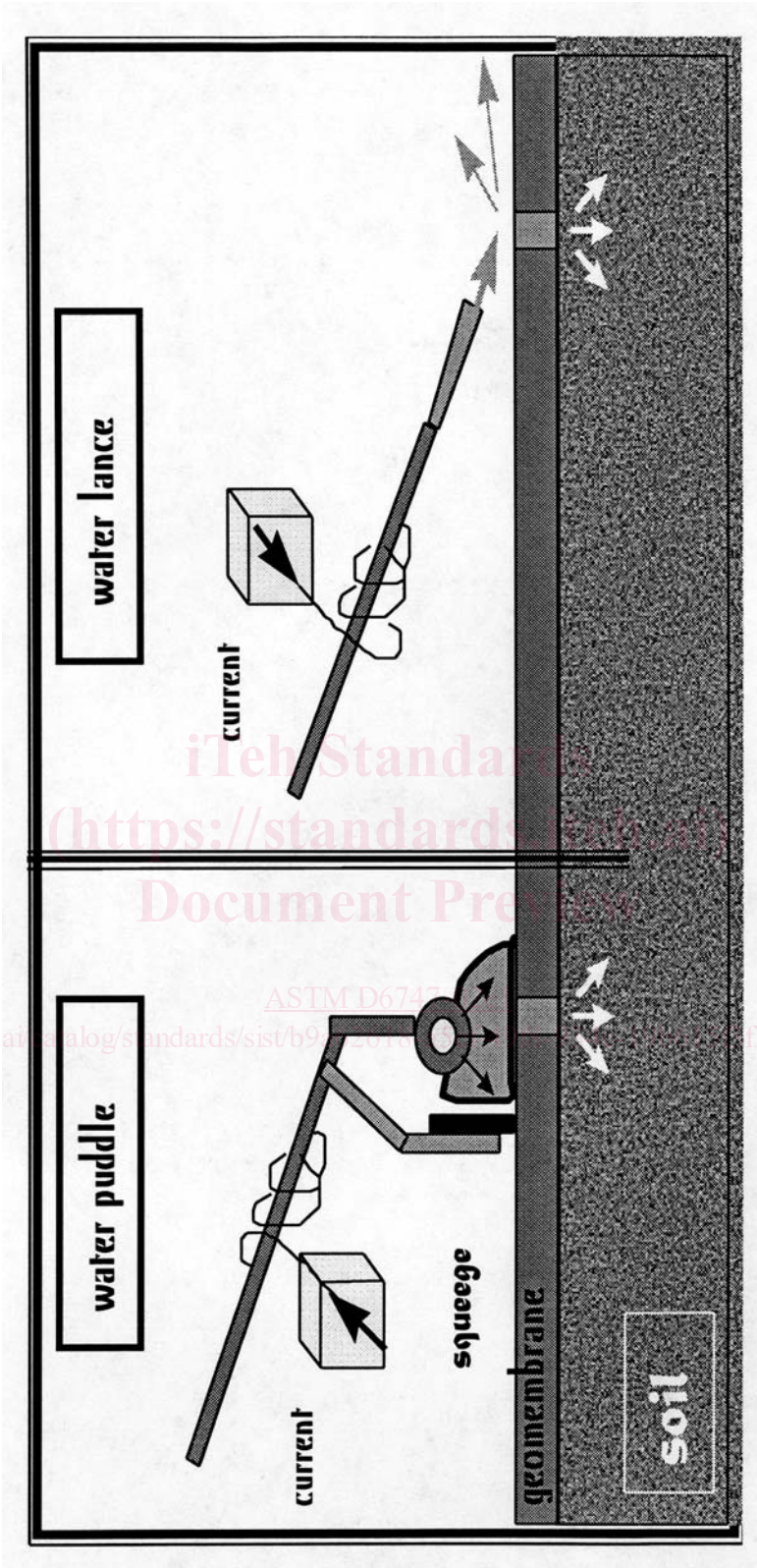


FIG. 2 Schematic of Water Puddle and Lance Systems

side is on top. The testing utilizes a voltage source to charge an element such as an electrically conductive neoprene pad. The charge is then transferred to the (underlying) conductive layer of the geomembrane through the capacitance effect. Another

conductive element is then swept over the upper surface to inspect for the presence of potential leak paths. Where a potential leak path occurs, a closed circuit is created and a spark is produced as shown in Fig. 4. To facilitate leak path