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Standard Practices for Electrical Methods for Mapping Leaks in Installed Geomembranes[1]

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1. Scope

1.1 These practices describe standard procedures for using electrical methods to locate leaks in geomembranes covered with liquid or earthen materials, or both.

1.2 These practices are intended to ensure that leak location surveys are performed to the highest technical capability of electrical methods, which should result in complete liquid containment (no leaks in geomembrane).

1.3 Not all sites will be easily amenable to this method, but some preparation can be performed in order to enable this method at nearly any site as outlined in Section 6. If ideal testing conditions cannot be achieved, the method can still be performed, but any issues with site conditions are documented.

1.4 Leak location surveys can be used on geomembranes installed in basins, ponds, tanks, ore and waste pads, landfill cells, landfill caps, and other containment facilities. The procedures are applicable for geomembranes made of materials such as polyethylene, polypropylene, polyvinyl chloride, chlorosulfonated polyethylene, bituminous material, and other sufficiently electrically insulating materials.

1.5 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.6 The electrical methods used for geomembrane leak location should be attempted only by qualified and experienced personnel. Appropriate safety measures should be taken to protect the leak location operators, as well as other people at the site. A current limiter of no greater than 290 mA should be used for all direct current power sources used to conduct the survey.

1.7 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D4439 Terminology for Geosynthetics

D7909 Guide for Placement of Intentional Leaks During Electrical Leak Location Surveys of Geomembranes

3. Terminology

3.1 For general definitions related to geosynthetics, see Terminology D4439.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *actual leak, n*—for the purposes of this standard, the term "actual leak" is used for a leak to distinguish it from an artificial leak.

3.2.2 *anomaly, n*—electrical measurement caused by some aberration in the survey area, which may or may not be a leak.

3.2.3 *artificial leak, n*—for the purposes of this standard, an artificial leak is an electrically insulated disk with a circular conductive electrode, which electrically mimics a leak in the lining system and is used to confirm method functionality without creating an actual leak in the lining system.

3.2.4 *conductive-backed geomembrane, n*—a specialty geomembrane manufactured using co-extrusion technology featuring an insulating layer in intimate contact with a conductive layer.

3.2.5 *current source electrode, n*—the electrode that is placed in the water or earthen material above the geomembrane.

[1] These practices are under the jurisdiction of ASTM Committee D35 on Geosynthetics and are the direct responsibility of Subcommittee D35.10 on Geomembranes.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3.2.6 *dipole measurement, n*—an electrical measurement made on or in a partially conductive material using two closely spaced electrodes.

3.2.7 *earthen material, n*—sand, gravel, clay, silt, combinations of these materials, and similar materials.

3.2.8 *electrically isolated conductive-backed geomembrane installation, n*—an installation of conductive-backed geomembrane that achieves a continuously conductive surface on the bottom layer while electrically isolating the bottom conductive layer from the top insulating layer of the entire geomembrane installation.

3.2.9 *known leak, n*—for the purposes of this standard, a known leak is a circular hole in the geomembrane intentionally placed by the owner or owner's representative per Guide D7909.

3.2.10 *leak, n*—for the purposes of this standard, a leak is any opening, perforation, breach, slit, tear, puncture, crack, or seam breach in the lining system. Liquid must flow through a leak. Scratches, gouges, dents, or other aberrations that do not completely penetrate the geomembrane are not considered to be leaks. Types of leaks detected during surveys include but are not limited to: burns, circular holes, linear cuts, seam defects, tears, punctures, and material defects.

3.2.11 *potential, n*—electrical voltage measured relative to a reference point.

3.2.12 *primary geomembrane, n*—the uppermost geomembrane in a lining system containing multiple geomembranes.

3.2.13 *site response current, n*—the value of current, typically expressed in milliamps, resulting from applying a voltage to a current source electrode inserted into the material covering the geomembrane in the survey area with the current return electrode connected to the underlying conductive layer.

3.2.14 *survey, n*—for the purposes of this standard, a survey is an electrical evaluation of a geomembrane-lined containment facility to check for leaks in the geomembrane.

3.2.15 *survey area, n*—the portion of the geomembrane-lined containment facility subjected to an electrical leak location survey.

4. Significance and Use

4.1 Geomembranes are used as impermeable barriers to prevent liquids from leaking from landfills, ponds, and other containment facilities. The liquids may contain contaminants that, if released, can cause damage to the environment. Leaking liquids can erode the subgrade, causing further damage. Leakage can result in product loss or otherwise prevent the installation from performing its intended containment purpose. For these reasons, it is desirable that the geomembrane have as little leakage as practical.

4.2 Geomembrane leaks can be caused by poor quality of the subgrade, poor quality of the material placed on the geomembrane, accidents, poor workmanship, manufacturing defects, and carelessness.

4.3 The most significant causes of leaks in geomembranes that are covered with only water are related to construction activities, including pumps and equipment placed on the geomembrane, accidental punctures, and punctures caused by traffic over rocks or debris on the geomembrane or in the subgrade.

4.4 The most significant cause of leaks in geomembranes covered with earthen materials is construction damage caused by machinery that occurs while placing the earthen material on the geomembrane. Such damage also can breach additional layers of the lining system such as geosynthetic clay liners.

4.5 Electrical leak location methods are used to detect and locate leaks for repair. These practices can achieve a zero-leak condition at the conclusion of the survey(s). If any of the requirements for survey area preparation and testing procedures is not adhered to, then leaks could remain in the geomembrane after the survey. Not all of the survey area requirements are possible to achieve at some sites, but the closer the site can come to the ideal condition, the more successful the method will be.

5. Summary of the Electrical Leak Location Methods

5.1 One output of an electrical excitation power supply is connected to a current source electrode placed in the material covering the geomembrane. The other output of the power supply is connected to an electrode in contact with electrically conductive material under the geomembrane. This creates a voltage differential between the material over the geomembrane and the material under the geomembrane.

5.2 When there are leaks in the geomembrane, electrical current flows through the leaks, which produces high current density and a localized anomaly in the voltage potential distribution in the material above the geomembrane. Electrical measurements are made to locate those areas of high current density corresponding to the presence of leaks.

5.3 Direct current and alternating current excitation power supplies and potential measurement systems have been used for leak location surveys.

5.4 Various types of probes can be used to perform the surveys. Some are for placement upon earthen materials, some are for when the operator wades in water, some are for towing the probe back and forth across a filled pond, and some are for raising and lowering along vertical walls of a tank.

5.5 Measurements are typically made along parallel survey lines or in a grid pattern. They are recorded and then organized into an electrical map of the survey area.

5.6 Electrical measurements must be made as close to the geomembrane as possible. The thickness of earthen cover materials, including impenetrable sludge or concrete, should be minimized and should not exceed approximately 3 m, though this thickness limit is highly site specific and a thicker cover material will reduce sensitivity while not necessarily causing the survey to be ineffective.

5.7 An electrical map created from the electrical measurements is adjusted in order to clearly display a characteristic leak signal, and the survey area is analyzed for the presence of any signals characteristic of a leak.