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Standard Practice for Electrical Leak Location on Exposed Geomembranes Using the Arc Testing Method[1]

This standard is issued under the fixed designation D7953; 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 (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice is a performance-based standard for an electrical method for locating leaks in exposed geomembranes. For clarity, this practice uses the term "leak" to mean holes, punctures, tears, knife cuts, seam defects, cracks, and similar breaches in an installed geomembrane (as defined in 3.2.4).

1.2 This practice can be used for geomembranes installed in basins, ponds, tanks, ore and waste pads, landfill cells, landfill caps, canals, and other containment facilities. It is applicable for geomembranes made of materials such as polyethylene, polypropylene, polyvinyl chloride, chlorosulfonated polyethylene, bituminous geomembrane, and any other electrically insulating materials. This practice is best applicable for locating geomembrane leaks where the proper preparations have been made during the construction of the facility.

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

1.4 *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 limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D4439 Terminology for Geosynthetics

D6747 Guide for Selection of Techniques for Electrical Detection of Leaks in Geomembranes

D7002 Practice for Leak Location on Exposed Geomembranes Using the Water Puddle System

D7703 Practice for Electrical Leak Location on Exposed Geomembranes Using the Water Lance System

3. Terminology

3.1 *Definitions:*

3.1.1 For general definitions used in this practice, refer to Terminology D4439.

3.2 *Definitions of Terms Specific to This Standard:*

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

3.2.2 *current, n*—the flow of electricity or the flow of electric charge.

3.2.3 *electrical leak location, n*—a method which uses electrical current or electrical potential to locate leaks in a geomembrane.

3.2.4 *leak, n*—for the purposes of this document, a leak is any unintended opening, perforation, breach, slit, tear, puncture, crack, or seam breach. Significant amounts of liquids or solids may or may not 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.

3.2.5 *leak detection sensitivity, n*—the smallest leak that the leak location equipment and survey methodology are capable of detecting under a given set of conditions. The leak detection sensitivity specification is usually stated as a diameter of the smallest leak that can likely be detected.

3.2.6 *poor contact condition, n*—for the purposes of this document, a poor contact condition means that a leak is not in intimate contact with the conductive layer above or underneath the geomembrane to be tested. This occurs on a wrinkle or wave, under the overlap flap of a fusion weld, in an area of liner bridging and in an area where there is a subgrade depression or rut.

3.2.7 *probe, n*—for the purposes of this document, any conductive rod or conductive brush that is attached to a power source to initiate the arc test.

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[1] This practice is under the jurisdiction of ASTM Committee D35 on Geosynthetics and is 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.

4. Significance and Use

4.1 Geomembranes are used as barriers to prevent liquids from leaking from landfills, ponds, and other containments. For this purpose, it is desirable that the geomembrane have as little leakage as practical.

4.2 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.

4.3 Geomembranes are often assembled in the field, either by unrolling and welding panels of the geomembrane material together in the field, unfolding flexible geomembranes in the field, or a combination of both.

4.4 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.

4.5 Electrical leak location methods are an effective and proven quality assurance measure to detect and locate leaks.

5. Summary of Exposed Geomembrane Electrical Location Methods

5.1 *Principles of the Electrical Leak Location Methods for Exposed Geomembranes:*

5.1.1 The principle of the electrical leak location methods is to place a voltage across a geomembrane and then locate areas where electrical current flows through leaks in the geomembrane.

5.1.2 Currently available methods include the water puddle method (Practice D7002), the water lance method (Practice D7703), and the arc testing method.

5.1.3 All of the methods listed in 5.1.2 are effective at locating leaks in exposed geomembranes. Each method has specific site and labor requirements, survey speeds, advantages and limitations. A professional specializing in the electrical leak location methods can provide guidance on the advantages and disadvantages of each method for a specific project (see Guide D6747).

5.1.4 Alternative ASTM Standard Practices for electrical leak location survey methods should be allowed when mutually agreeable and warranted by adverse site conditions, clearly technical superiority, logistics, or schedule.

6. Arc Testing Method

6.1 A summary of the method capabilities and limitations is presented in Table 1.

NOTE 1—If used, conductive-backed geomembrane must be installed per the manufacturer's recommendations in order to allow it to be tested using all of the available electrical leak location methods. In particular, there must be some means to break the conductive path through the fusion welds along the entire lengths of the welds, the undersides of adjacent panels (and patches) should be electrically connected together, and a means of preventing unwanted grounding at the anchor trenches or other unwanted earth grounds should be provided.

6.2 *The Principle of the Arc Testing Method:*

6.2.1 The principle of this electrical leak location method is to introduce a high voltage between a leak detection test probe and the conductive medium underneath the geomembrane. The area is then swept with a test probe to locate points where the current completes the circuit through a leak. A visible electrical arc is formed when the current completes the circuit and the current flow is also converted into an alarm (audible, visual or other, which confirms leak detection and location).

6.2.2 Fig. 1 shows a wiring diagram of the arc tester, power supply and test probe for the arc testing electrical leak location method.

6.3 *Leak Location Surveys of Exposed Geomembrane Using the Arc Testing Method:*

6.3.1 A grid, test lanes or other acceptable system should be used to ensure that the entire area is tested with the test probe.

6.3.2 The probe attachment can be different shapes and lengths, depending on the application to be surveyed. The test probe may be wider than 1 m, but with a longer the probe it may be more difficult to make good contact with the geomembrane along its length.

6.4 *Preparations and Measurement Considerations:*

6.4.1 Testing must be performed on geomembranes that are generally clean and dry. For geomembrane covered by water or soils, other test procedures, such as described in Guide D6747 are used for testing the geomembrane.

6.4.2 Proper field preparations and other measures shall be implemented to ensure an electrical connection to the conductive material directly below the geomembrane is in place to successfully complete the leak location survey.

6.4.3 There shall be a sufficiently conductive material below the geomembrane being tested. A properly-prepared subgrade typically will have sufficiently conductivity. Under proper

TABLE 1 Summary of Arc Testing Method

Geomembranes	Bituminous, CSPE, CPE, EIA, fPP, HDPE, LLDPE, LDPE, PVC, VLDPE	✓	applicable
	Conductive-backed Geomembrane	✓	applicable 1
Seams	All types: welded, tape, adhesive, glued and other	✓	applicable: project specific
Junctions	At synthetic pipes and accessories	✓	applicable: project specific
	At grounded conducting structures	X	not applicable
Survey	During construction phase (installation of GM)	✓	applicable
	After installation (exposed)	✓	applicable
	Slopes	✓	applicable: project specific
	Insufficiently conductive subgrade	X	not applicable
	During the service life (if exposed)	✓	must be generally clean and dry
Climate	Sunny, temperate, warm	✓	applicable
	Rainy weather	X	not applicable
	Frozen conditions	✓	applicable
Leaks detected	Discrimination between multiple leaks	✓	applicable

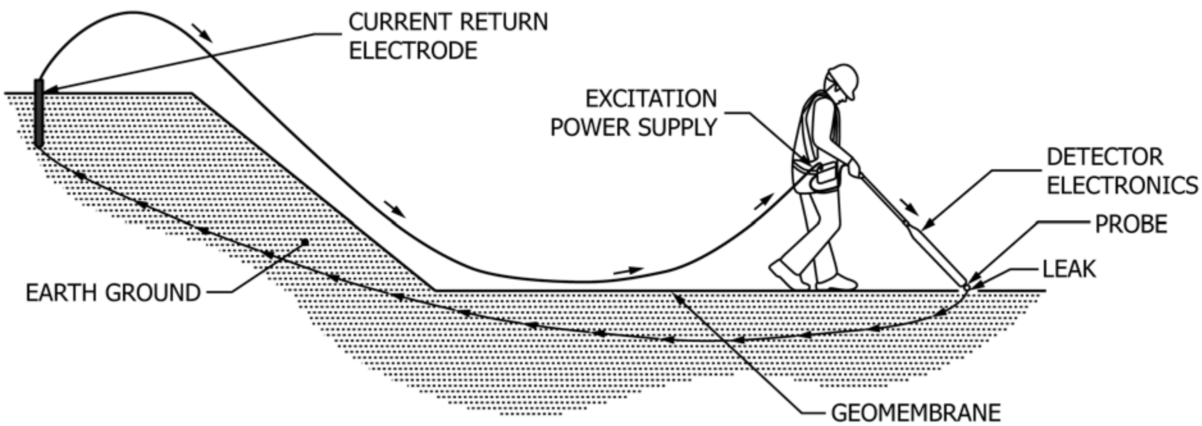

FIG. 1 Diagram of the Arc Testing Method

conditions and preparations, geosynthetic clay liners (GCLs) can be adequate as conductive material. There are some other conductive layers such as conductive geotextiles and aluminum foils with successful field experience which can be installed beneath the geomembrane to facilitate electrical leak survey (that is, on dry subgrades, or as part of a planar drainage geocomposite).

6.4.4 Measures should be taken to perform the leak location survey when geomembrane wrinkles are minimized. The maximum arc length for the site conditions can be determined during equipment calibration. Any hole located on wrinkles with a height exceeding the maximum arc length will likely not be detected. The leak location survey should be conducted at night or early morning when wrinkles are minimized. Sometimes wrinkles can be flattened by personnel walking or standing on them as the survey progresses.

6.4.5 For lining systems comprised of two geomembranes with only a geonet or geonet geocomposite between them, to make the method feasible a sufficiently conductive layer such as a conductive geotextile, conductive geocomposite, aluminum foil, or any appropriate conductive material shall be installed under the geomembrane or integrated into the geonet geocomposite. Conductive-backed geomembrane can also be used as the primary geomembrane to enable the method. See Guide D6747.

6.4.6 If the test probe gets too close to the edge of the geomembrane or to grounded objects, the electrical charge can arc to the grounded object or surrounding soil and will cause a false positive.

6.5 *Practices for Surveys with the Arc Testing Method:*

6.5.1 Before beginning a leak survey, the equipment must be checked to ensure it is in working order. The power source should have a range of voltage from 6,000 to 30,000 volts. A wider voltage range is acceptable but the maximum practical value is typically 30,000 volts.

6.5.2 Once the equipment has been checked and wired properly, the equipment should be adjusted to the appropriate sensitivity level according to the thickness of the geomembrane being tested.

6.5.3 Once the equipment has been checked and wired properly, a trial test must be performed. A puncture (deliberate defect) should be introduced in a test piece of geomembrane. The deliberate defect should be no greater than 1 mm in diameter. The test piece of geomembrane must be of sufficient size to enable movement of the testing probe at normal testing speed over the deliberate defect without touching the edges of the test piece.

6.5.3.1 Adjust the sensitivity if necessary in order to easily detect the deliberate defect.

6.5.3.2 Ensure the audible alarm sounds when the test probe passes over the deliberate defect. If the alarm does not sound, recheck the connections and retest. If the alarm sounds prior to passing over the damage, turn the sensitivity down and retest the area. The sensitivity setting is site specific and will vary with atmospheric and other site conditions.

6.5.3.3 At a minimum, the equipment should be checked before testing begins and after any shut down of an hour or more. In the event a test reveals the equipment is not working properly, the entire area arc tested since the last passing check of the equipment must be retested to assure it was arc tested with working equipment.

6.5.4 Field testing may be performed by marking a predetermined grid, or another acceptable method, and performing the survey within that grid at the same speed as the sensitivity test was performed.

6.5.5 The leak location survey shall be conducted using procedures whereby the test probe contacts every point on the surface of the geomembrane being surveyed for leaks - neglecting the edge and other ground effects.

6.6 *Safety:*

6.6.1 (**Warning—**The electrical methods used for geomembrane leak location use high voltage, low current power supplies, resulting in the potential for electrical shock. The electrical methods used for geomembrane leak location should be attempted by only qualified and experienced personnel. Appropriate safety measures must be taken to protect the leak location operators as well as other people at the site.)

7. Report

7.1 The leak location survey report shall contain the following information:

7.1.1 Description of the survey site,

7.1.2 Weather conditions,

7.1.3 Type and thickness of geomembrane, 7.1.4 Liner system layering,

7.1.5 Description of the electrical leak location method,

7.1.6 Survey methodology,

7.1.7 Identification of equipments and operators,

7.1.8 Results of sensitivity test,

7.1.9 Specific conditions of survey,

7.1.10 Location, type and size of detected leaks, and

7.1.11 Map of the surveyed areas showing the approximate locations of the leaks.

8. Keywords

8.1 arc testing method; bare geomembrane survey; damage; electrical leak detection method; electrical leak location; electrical leak location method; exposed geomembrane survey; geoelectric leak location; geomembrane; leak detection; leak location survey; leak survey; liner integrity survey; spark testing method; water lance method; water puddle method