Designation: D7703 – 16

Standard Practice for Electrical Leak Location on Exposed Geomembranes Using the Water Lance Method[1]

This standard is issued under the fixed designation D7703; 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 3.2.5).

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 Leak Location of Leaks in Geomembranes

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

D7953 Practice for Electrical Leak Location on Exposed Geomembranes Using the Arc Testing Method

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 *artificial leak, n*—an electrical simulation of a leak in a geomembrane.

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

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

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

3.2.5 *leak, n*—for the purposes of this practice, 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. Type of leaks detected during surveys include, but are not limited to: burns, circular holes, linear cuts, seam defects, tears, punctures, and material defects.

3.2.6 *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.

3.2.7 *poor contact condition, n*—for the purposes of this practice, 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.

---

[1] This practice is under the jurisdiction of ASTM Committee D35 on Geosynthetics and is the direct responsibility of Subcommittee D35.10 on Geomembranes.

Current edition approved Jan. 1, 2016. Published January 2016. Originally approved in 2011. Last previous edition approved in 2015 as D7703-15. DOI: 10.1520/D7703-16.

[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.

3.2.8 *probe, n*—for the purposes of this practice, any conductive rod that is attached to a power source.

3.2.9 *water stream, n*—for the purposes of this practice, a continuous stream of water between the water lance and the geomembrane that creates a conduit for current to flow through any leaks.

3.2.10 *water lance, n*—for the purposes of this practice, a probe (lance) incorporating one or two electrodes that directs a solid stream of water through a single nozzle mounted at the end.

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 Leak 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 arc testing method (Practice D7953), and the water lance 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 advice on the advantages and disadvantages of each method for a specific project.

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. Water Lance Method

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

6.2 *The Principle of the Water Lance Method:*

6.2.1 Fig. 1 shows a diagram of electrical leak location using the water lance method for exposed geomembranes. One output of an electrical excitation power supply is connected to an electrode placed in the water reservoir; a pump sends this charged water to the water lance that jets the water in a solid stream on top of the geomembrane. The other output of the power supply is connected to an electrode placed in electrically conductive material under the geomembrane.

6.2.2 The water lance method can also be set up with the same configuration as the water puddle method, as shown in Fig. 2, if the detector electronics are capable of measuring current and converting that to an audible alarm.

6.3 *Leak Location Surveys of Exposed Geomembrane Using the Water Lance Method:*

TABLE 1 Summary of Water Lance Method

Geomembranes	Bituminous, CSPE, CPE, EIA, fPP, HDPE, LLDPE, LDPE, PVC, VLDPE,	✓	applicable
	Conductive-backed Geomembrane	✓	applicable[A]
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)	✓	project specific
Climate	Sunny, temperate, warm	✓	applicable
	Rainy weather	X	not applicable
	Frozen conditions	X	not applicable
Leaks detected	Discrimination between multiple leaks	✓	applicable

[A] 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.

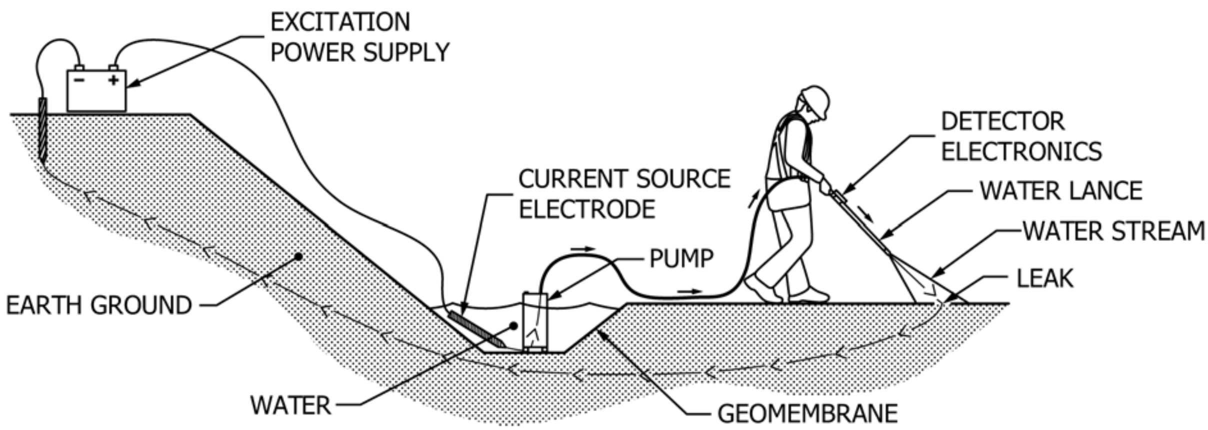

FIG. 1 Diagram of the Water Lance Method Using Voltage Measurement

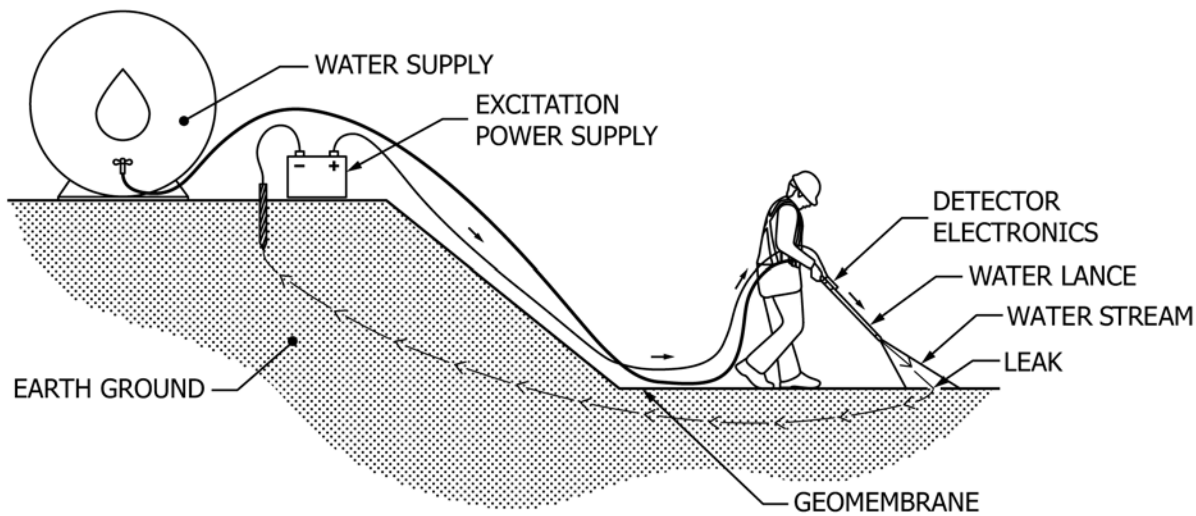

FIG. 2 Diagram of the Water Lance Method Using Current Measurement

6.3.1 The water lance leak location method usually consists of a single nozzle mounted at the end of a probe (lance) that directs a solid stream of water onto a geomembrane, and an electronic detector assembly, as shown in Figs. 1 and 2. A pressurized water source, usually from a reservoir on top of the liner, or from a tank truck isolated from ground parked at higher elevation, is connected to the water lance using a plastic or rubber hose.

6.3.2 Direct current power supplies (often a 12 to 36 volt battery or series of batteries) have been used for water lance leak location surveys.

6.3.3 For leak location surveys of exposed geomembrane, the solid water stream (not a spray) is moved systematically over the geomembrane area to locate the points where the electrical current flow increases as the charged water from the water lance contacts the oppositely charged conductive media under the geomembrane through a hole.

6.3.4 The voltage drop signal between the two electrodes in the water column in the water lance (or the current flow through the detector electronics) is connected to an electronic detector assembly that converts the electrical signal to an audible signal that increases in pitch and amplitude as the leak signal increases.

6.3.5 When a leak signal is detected, the location of the leak is then marked or located relative to fixed points.

6.3.6 The leak detection sensitivity can be very good for this technique. Leaks smaller than 1 mm in diameter are routinely found, including leaks through seams in the geomembrane.

6.4 *Preparations and Measurement Considerations:*

6.4.1 Proper field preparations and other measures must be implemented to assure an electrical connection to the sufficiently conductive material directly below the geomembrane is in place to successfully complete the leak location survey.

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

6.4.3 Measures should be taken to perform the leak location survey when geomembrane wrinkles are minimized. If a hole is located on a wrinkle, then this poor contact condition may result in an undetected leak. 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.

6.4.4 Conversely, surveys should not be made in areas with bridging geomembrane. The survey of areas with minor bridging might be accomplished when the geomembrane is warmer.

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 For best results, conductive paths such as metal pipe penetrations, pump grounds, and batten strips on concrete should be isolated or insulated from the water lance on the geomembrane. These conductive paths conduct electricity and mask nearby leaks from detection.

6.4.7 The water stream applied to the geomembrane should not be allowed to flow out of the survey area, connecting the water to the ground of the power supply. The results in a false positive signal and will compromise survey sensitivity.

6.4.8 Depending on specific construction practices and site conditions, other preparations and support may still be needed to successfully perform the leak location survey.

6.5 *Practices for Surveys with the Water Lance Method:*

6.5.1 A realistic test of the leak detection sensitivity shall be performed and documented as part of the leak location survey. An actual or artificial leak can be used. The leak location equipment and procedures should demonstrate the ability to detect the artificial or actual leak when the water stream is passed over the leak in the geomembrane.

6.5.2 *Artificial Leak*—An artificial leak may consist of the cut end of an insulated solid core or standard wire, with a cross section no larger than 1.0 mm diameter, IEC 0.75 mm^2 or 18 AWG. The other end of the insulated wire shall be connected to a ground electrode or an electrode between the geomembranes in a double geomembrane installation. The distance between the artificial leak ground and the return electrode of the excitation power supply shall be greater than 3 m.

6.5.3 *Actual Leak*—If an actual leak is used, which is technically preferred, it shall be constructed by drilling a 1 mm diameter hole in the installed geomembrane that is to be tested. For double geomembranes, measures must be taken to ensure that the secondary geomembrane is not damaged. The hole must be drilled at least 600 mm away from the edge of the geomembrane. The hole should be drilled, and the drill bit reciprocated in the hole so the geomembrane material is removed rather than displaced.

6.5.4 The excitation power supply and the water supply shall be turned on, and the water stream shall be moved over the artificial or actual leak at a speed equal to the desired production survey speed.

6.5.5 The resulting signal as the stream passes over the artificial or actual leak shall be distinctly and consistently greater than the background level. The applied potential across the liner and the signal meter controls shall be adjusted to achieve such a signal.

6.5.6 The leak location survey shall be conducted using the same water distribution speed as that used for the leak detection sensitivity test. Ideally testing shall progress from areas of lower elevation to areas of higher elevation.

6.5.7 At a minimum, the leak location equipment and procedure should be demonstrated to be able to detect the artificial or actual leak at the beginning and end of each day of survey. If the equipment fails to pass the leak detection sensitivity test, then the area surveyed with that set of equipment in the period since the previous leak detection sensitivity test shall be repeated.

6.5.8 Periodic testing of the integrity of the electrical circuit is recommended. It is recommended to check the integrity of the electrical circuit every 15 to 20 min. This can be done by checking on a leak, or by directing the stream to touch the end of an insulated wire whose other end is connected to the subgrade.

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; linear integrity survey; spark testing method; water lance method; water puddle method