



Standard Practice for Leak Location on Exposed Geomembranes Using the Water Puddle System¹

This standard is issued under the fixed designation D 7002; 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 standard is a performance-based practice for electrical methods for detecting leaks in exposed geomembranes. For clarity, this document uses the term “leak” to mean holes, punctures, tears, knife cuts, seam defects, cracks and similar breaches in an installed geomembrane (as defined in 3.1.5).

1.2 This standard 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.

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 limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

D 4439 Terminology for Geosynthetics

D 6747 Guide for Selection of Techniques for Electrical Detection of Potential Leak Paths in Geomembranes

3. Terminology

3.1 Definitions:

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

3.1.2 *electrodes, n*—the conductive plate that is placed in earth ground or in the material under the geomembrane or a conductive structure, such as a copper manifold, that is placed in the water puddle on the geomembrane.

3.1.3 *electrical leak location, n*—a method which uses electrical current or electrical potential to detect and locate leaks.

3.1.4 *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 man made project, structure, or system.

3.1.5 *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. Leaks detected during surveys have been grouped into five categories:

3.1.5.1 *holes*—round shaped voids with downward or upward protruding rims.

3.1.5.2 *tears*—linear or areal voids with irregular edge borders.

3.1.5.3 *linear cuts*—linear voids with neat close edges.

3.1.5.4 *seam defects*—area of partial or total separation between sheets.

3.1.5.5 *burned through zones*—voids created by melting polymer during welding.

3.1.6 *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 be reliably detected.

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

3.1.8 *water puddle, n*—for the purposes of this document, a water puddle is a small pool of water being contained and pushed by a squeegee installed on the leak location system.

3.1.9 *squeegee, n*—for the purposes of this document, a squeegee is a device used to contain and push water on top of an exposed geomembrane. It may consist of a handle and a transverse piece at one end set with a strip of leather or rubber.

3.1.10 *metalized geotextile, n*—a geotextile incorporating metallic strips that can conduct electrical current.

4. Summary of Practice

4.1 *The Principle of the Electrical Leak Location Method Using the Water Puddle System:*

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4.1.1 The principle of the electrical leak location method is to place a voltage across a geomembrane and then locate areas where electrical current flows through discontinuities in the geomembrane and at seams.

4.1.2 Fig. 1 show a diagram of the electrical leak location method of the water puddle system for exposed geomembranes. One output of an electrical excitation power supply is connected to an electrode placed in a water puddle created 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.

4.1.3 Measurements are made using an electrical current measurement system, the magnitude of the current being related to the size of the leak. An electronic assembly is usually used to produce an audio tone whose frequency is proportional to the current flow.

4.2 *Leak Location Surveys of Exposed Geomembrane Using the Water Puddle System:*

4.2.1 The water puddle detection system usually consists of a horizontal water spray manifold with multiple nozzles that spray water onto a geomembrane, a squeegee device to push the resultant puddle of water, and a handle assembly as shown in Fig. 2. A pressurized water source, usually from a tank truck parked at higher elevation, is connected to the spray manifold using a plastic or rubber hose. Figs. 3 and 4 show one example of such an apparatus.

4.2.2 Direct current power supplies (usually a 12 or 24 volt battery) have been used for leak location surveys. An alternating current (output requirement of 12 to 30 volt AC) could be used.

4.2.3 For leak location surveys of exposed geomembrane, the water puddle created is pushed systematically over the geomembrane area to locate the points where the electrical current flow increases.

4.2.4 The signal from the probe is typically connected to an electronic detector assembly that converts the electrical signal to a detector and an audible signal that increases in pitch and amplitude as the leak signal increases.

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

4.2.6 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.

4.2.7 The survey rate depends primarily on the manifold and squeegee width and the presence of wrinkles and waves in the geomembrane.

4.3 *Preparations and Measurement Considerations:*

4.3.1 There must be a conductive material below the geomembrane being tested. Leak location survey of geomembrane have been conducted with a conductivity of a subgrade equivalent to sand with moisture greater than 0.7 % (by weight). A properly-prepared subgrade typically will have sufficiently conductivity. Under proper conditions and preparations, geosynthetic clay liners (CGLs) can be also adequate.

4.3.2 Measures should be taken to perform the leak location survey when geomembrane wrinkles are minimized. For flexible geomembranes, sometimes the wrinkles can be flattened by personnel walking on them immediately in front of the

survey. For surveys with wrinkles in rigid geomembranes, the leak location survey should be conducted at night or early morning.

4.3.3 For lining systems comprised of two geomembranes with only a geonet or geocomposite between them, the method is not applicable. For lining systems comprised of two geomembranes separated by a metalized geotextile, the method is applicable.

4.3.4 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 puddle on the geomembrane. These conductive paths conduct electricity and mask nearby leaks from detection.

4.3.5 The system specifications are presented in Table 1.

5. Significance and Use

5.1 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.

5.2 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.

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

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

5.5 Electrical leak location methods are an effective quality assurance measure to locate previously undetected or missed leaks and check the integrity of a liner.

6. Practices for Surveys with Water Puddle System

6.1 A realistic test of the leak detection sensitivity should 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 be demonstrated to be able to detect the artificial or actual leak when water puddle is passed over the leak on the geomembrane.

6.2 *Artificial Leak*—If an artificial leak is used, it shall be constructed by drilling a 1 mm diameter hole in approximately the center of a piece of geomembrane. The piece of geomembrane should have a width of at least twice the width of the squeegee, and a length of at least four times the width of the squeegee. The hole should be drilled, and the drill bit reciprocated in the hole so the geomembrane material is removed rather than displaced. The artificial leak shall be placed on a subgrade that is prepared to be the same as the subgrade under the actual geomembrane. When surveying leak detection on existing containment facilities, a geomembrane sample equivalent to the liner installed should be used.

6.3 *Actual Leak*—If an actual leak is used, it shall be constructed by drilling a 1 mm diameter hole in the installed geomembrane that is to be tested. For double geomembranes,

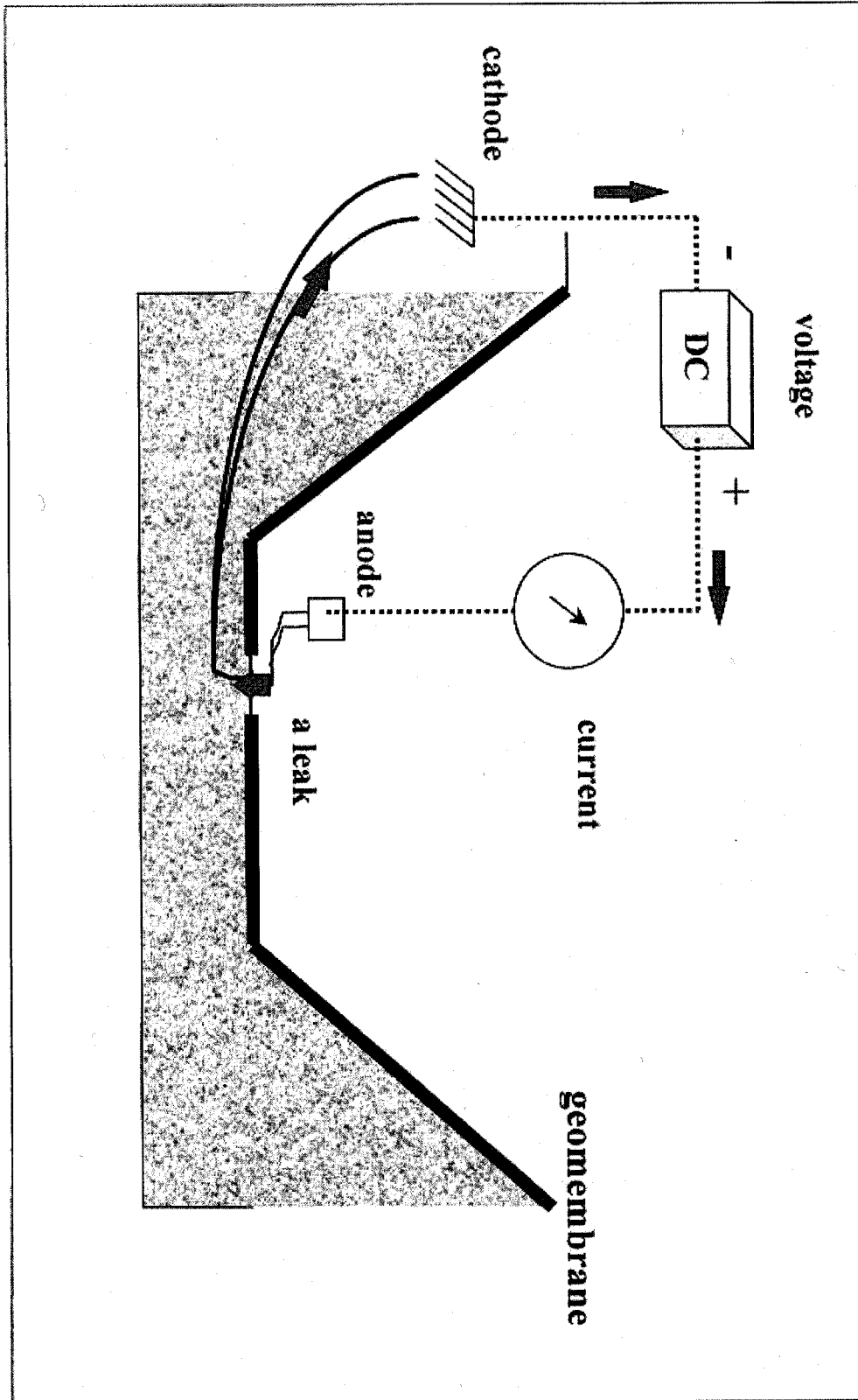


FIG. 1 Diagram of the Electrical Leak Location Method for Surveys with Water Puddle on Exposed Geomembrane

measures must be taken to ensure that the secondary geomem- brane is not damaged. The hole must be drilled at least the

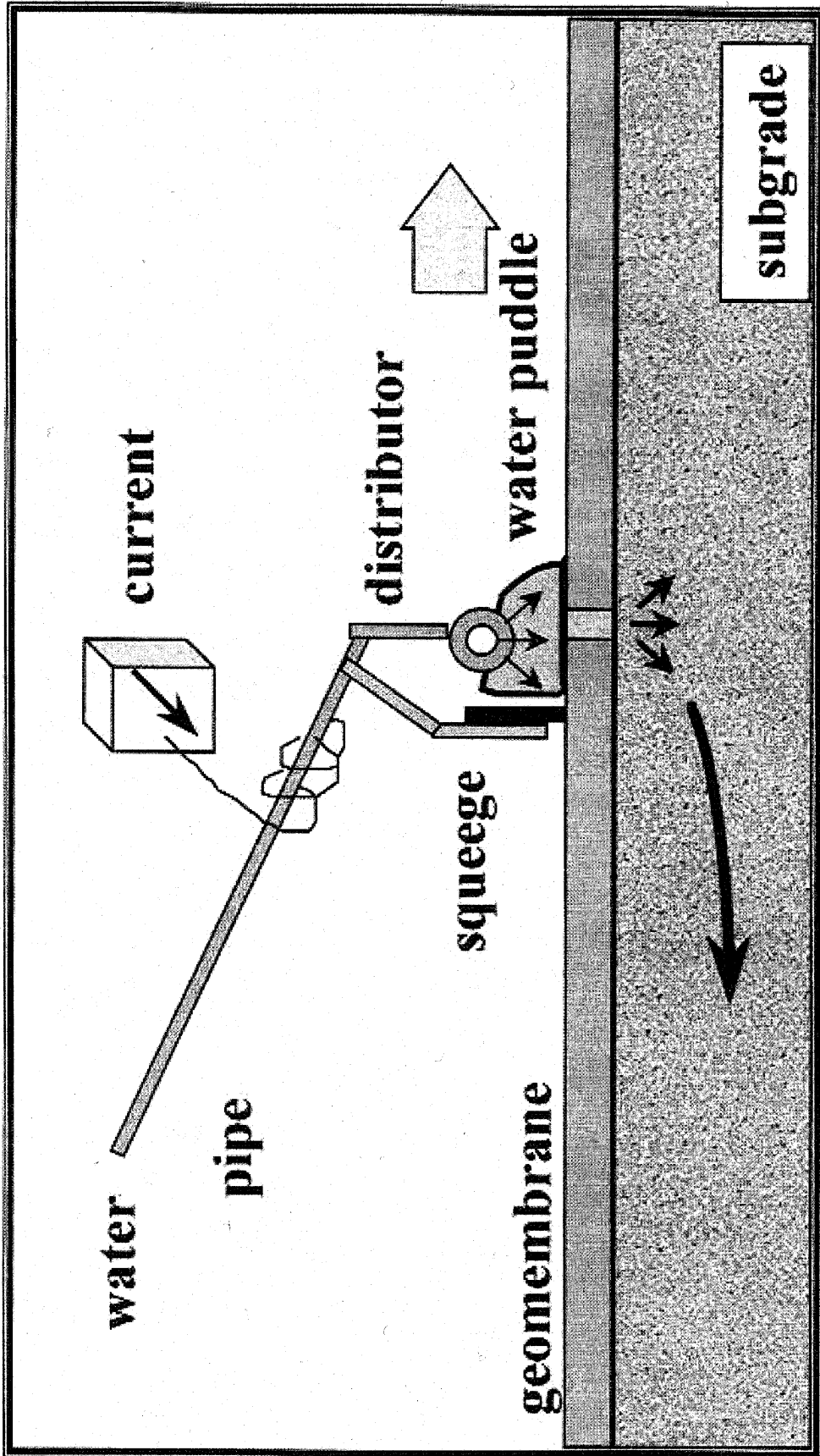


FIG. 2 Diagram of Electrical Leak Water Puddle System

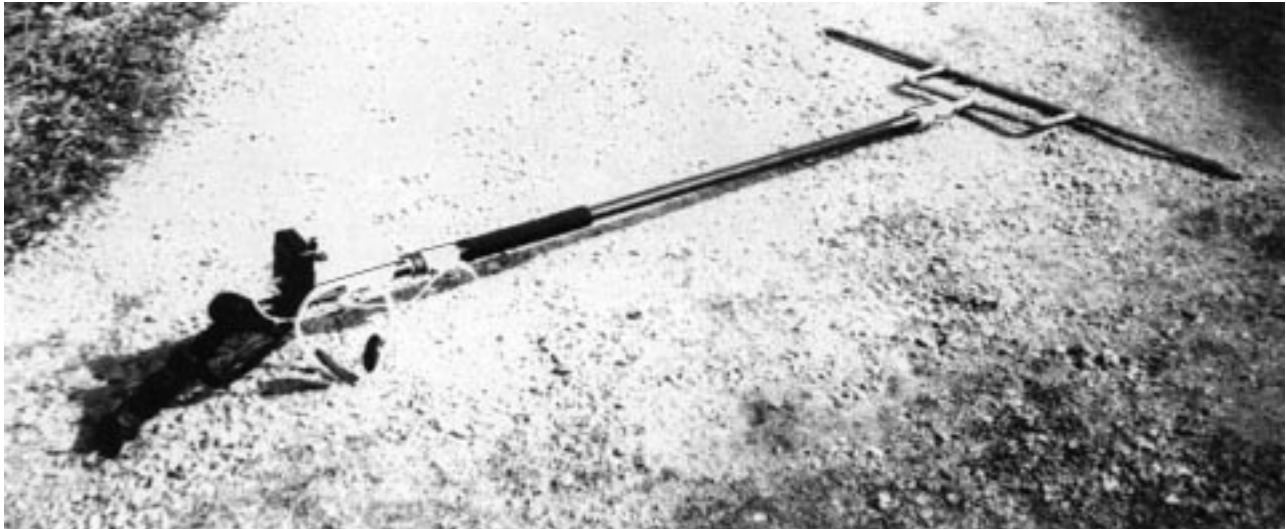


FIG. 3 Photograph of a Water Puddle Leak Location Equipment



FIG. 4 Photograph of Leak Location Equipment

width of the squeegee 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.

6.4 The excitation power supply and the water supply shall be turned on, and the water puddle detection system shall be pushed over the artificial or actual leak at a speed equal to the desired production survey speed.

6.5 If the resultant signal is at least 10 percent of the full scale reading of the detector electronics, the leak detection equipment and procedures shall be considered to be successfully demonstrated.

6.6 The leak location survey shall be conducted using the same water puddle detection system speed as that used for the calibration.

6.7 Periodic testing of the integrity of the electrical circuit is recommended. It is recommended to check every 15 to 20 min the integrity of electrical circuit by contacting (touching) the subgrade with the equipment squeegee unit or by using an extra electrical cable well-connected to the subgrade. As a minimum, this check shall be conducted 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.

7. Report

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

TABLE 1 Specifications—Water Puddle Leak Detection Techniques

geomembranes	HDPE, VLDPE, PVC, fPP, bituminous, CSPE, CPE	✓	applicable	
	EPDM, GCL	X	not applicable	
	exposed	✓	applicable	
	covered	X	not applicable	
characteristics	training time		1 day	
	set up time and calibration time		1 to 3 h	
	measurement time		instantaneous	
	leak location time		10 min max	
	subgrade moisture (by weight)		equivalent to sand with > 0.7 %	
	average survey speed (horizontal surface)		500 m ² per hour per operator	
	power supply		12 or 24 volts DC or AC	
	seams	all types: welded, tape, adhesive, glued and other	✓	applicable: project specific
	junctions	at synthetic pipes and accessories	✓	applicable: project specific
		at permanent structure	✓	applicable: project specific
survey	during construction phase (installation of GM)	✓	applicable	
	after installation (exposed)	✓	applicable	
	after soil covering	X	not applicable	
	presence of large wrinkles and waves	X	not applicable	
	slopes	✓	applicable: project specific	
	desiccated subgrade (conductivity equivalent to sand with < 0.7 % moisture)	X	not applicable	
	during the service life (if exposed)	✓	applicable	
	electrical isolated conductive structures	✓	applicable	
climate	sunny, temperate, warm	✓	applicable	
	rainy weather, freezing weather	X	not applicable	
leak detected	size of 1 mm and larger	✓	applicable	
	discrimination between multiple leaks	✓	applicable	

- 7.1.1 Description of the survey site,
- 7.1.2 Climatic conditions,
- 7.1.3 Type and thickness of geomembrane,
- 7.1.4 Liner system layering,
- 7.1.5 Description of the leak location method,
- 7.1.6 Survey methodology,
- 7.1.7 Identification of equipments and operators,
- 7.1.8 Results of artificial leak 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.

8. Keywords

- 8.1 electrical leak location method; geomembrane; leak detection

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