I-CORP INTERNATIONAL

OVERVIEW OF I-CORP'S LINER INTEGRITY AND LEAK LOCATION TECHNOLOGIES

I-CORP's staff have been performing liner integrity and leak location surveys since 1987. They have been performing plastic pipe, geomembrane, and seam failure analyses since 1981, and have been performing liner CQA since 1982. Consequently, I-CORP has developed the most appropriate, cost-effective, integrated suite of mobile **technologies for locating leaks and flaws** in lining systems in the industry worldwide, suitable for both CQA and problem resolution applications. These five technologies include:

1. APPLIED POTENTIAL ELECTRICAL METHOD

Liquid

Handheld Probe

While wading in liquid with a **handheld probe**, we measure the iso-potential contours in the liquid while a constant potential gradient is applied between the liquid above the geomembrane and the leaked liquid, or subgrade, below the geomembrane. Holes about *0.5 mm* can be pinpointed. A soil cover on the liner, covered by liquid, is not a problem – it slightly reduces the accuracy of location by a few centimeters. For large deep ponds, a combination of wading on the floor and water lance on the slopes can be very cost-effective.

Remote Probe

When water is too deep for wading, a **remote probe** can be dragged from one side of the pond to the other, thereby reproducing the wading survey. Leak size and location sensitivities are a function of the presence, depth, topography, and chemistry of any soil/sludge cover.

Slopes and/or Exposed Liner

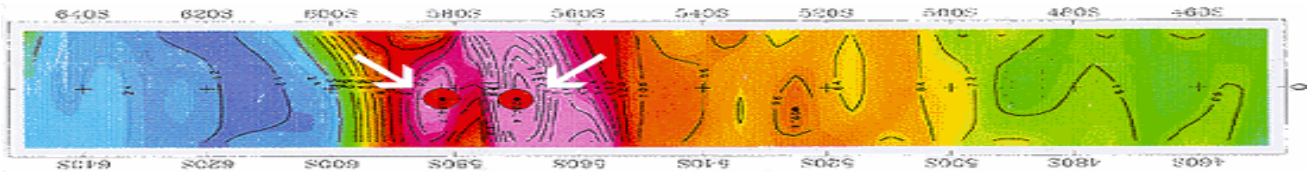
Water Lance

The **water lance** method directs a positively charged stream of water on the surface of the exposed geomembrane. When the water contacts the negatively charged subgrade through a hole in the liner, current flows through the water stream and is recorded. Again, holes about *0.5 mm* diameter can be pin-pointed. Thus, there is no need to fill a pond to do a survey.

Soil Covered

Handheld Probe (Dipole or Single Pole)

When there is sand, drainage stone, or solid waste above the liner, a **handheld probe** consisting of two copper/copper sulfate standard half cells is used to measure the potential gradient (or resistance) contours on top of the cover layer at orthogonal grid nodes. In this case a DC current (5 to 100 mA) is imposed across the geomembrane. Sensitivity is a function of cover layer thickness, conductivity (and variability), and liner features (trenches, toe of slope, riser pipes) but *2 mm holes under about 750 mm of sand are detectable to within a few centimeters.*



Electrical surveys can cover about 2 acres per day.

2. INFRARED SPECTROMETRY (IRS)

A novel **infrared spectrometry technology** is used to locate leaks in both geomembrane and compacted clay caps. This method requires no surface preparation (no electrically insulating trench around the periphery, or no placement

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of an electrode under the cap) – it simply measures methane distribution (to 0.1 ppm) above the cap. Holes are located to within about *300 mm*. Depending on topography we can survey *15-50 acres per day*. The technology can be adjusted for other gases depending on waste composition and gases emitted, and there are ways to extend this methodology (and speed) to bottom liners. This service is only available from I-CORP.

3. ACOUSTIC

When electrical surveys are not effective, acoustic methods can be used at batten strips and pipe boots utilizing **sensitive microphones** that "hear" the noise of water and air flowing through a hole. Interestingly, they typically identify the exit of a leak while electrical methods find the entrance to a leak. There can be a difference.

4. NATURAL POTENTIAL

When a geomembrane placed on soil cannot be tested by the applied potential method due to, for instance, unsuitable boundary conditions (see sheet piling in figure), or when a conductive liner such as a GCL is used, the small potential lows generated at a hole can be measured by the **natural potential** method. These potential anomalies are the result of current being generated as water flows through a soil or mineral layer. This survey can be done with or without free standing water on the soil layer, but water must be actively flowing through the leak during the survey.

5. INFRARED THERMOGRAPHY (IRT)

Revolutionary **infrared thermography** (IRT) on exposed geomembrane seams (particularly suited to potentially troublesome tie-in seams) will continuously evaluate, *nondestructively*, seam bond strength (no more destructive sample holes, destructive testing, or extrusion seams around destructive sample patches). IRT will identify leaks, partially penetrating channels, internal voids, and internal foreign matter (sand, bentonite) that, while not leaking at the time of testing, could potentially develop into leaks during service. A hard copy videotape record of every millimeter of seam can be provided in the report. No other technology generates a continuous hard copy of test data. This technology will also eventually preclude the need to perform air channel, vacuum box, air lance, and maybe even spark testing. Seams can be interrogated at speeds of 5 to10 km/hr. This new technology is again only available from I-CORP.

This integrated suite of technologies is a unique resource from which can be selected individual or combinations of methods to rapidly and economically perform almost any type of liner integrity or leak location survey. And when the leak has been found, should it be necessary, *I-CORP has the materials science/failure analysis expertise* to assess the cause of the leak and to help assign responsibility for its occurrence.

In addition, we can point you in the direction of the better providers of any of the increasing number of in-situ systems that continuously monitor for leakage and, to various degrees, locate leaks when they occur. Now, if only we could develop a practical method of remotely repairing a leak under 30 m of waste. We're working on it.

We will be honored to work with you on well-planned CQA projects or at a moment's notice to resolve an urgent problem - **Anywhere - Worldwide.**

Contact **I-CORP** first, or when you have run out of options.

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