In the past, the focus for leak detection programs in water delivery systems has been primarily on distribution (reticulation) networks and service connections. Even today, trunk main leaks tend to be addressed only when there is a pipe rupture or when there is visual evidence of the leak above ground. So are leaks from trunk mains a problem?

The introduction of a new leak detection technology, called SmartBall®, has the potential to resolve the uncertainty about the rate of loss, if any, from trunk mains. Following two years of development, the system has been available commercially since June 2007 and experience to date has demonstrated that it is a valuable tool for identifying, locating and quantifying leakage. Results indicate that trunk main leakage is indeed a concern for many agencies, and that most leaks are not evident from visual inspection or metering.

SmartBall is an acoustic data logger that is enclosed in a 2-inch diameter aluminum sphere.

The sphere is placed inside an open-cell foam ball and inserted into the pipeline through a 3.5-inch diameter opening (a hydrant, air-release valve or other suitable appurtenance). The ball is smaller than the pipe diameter and is designed to roll along the invert of the pipeline, collecting acoustic data as it travels. If the ball passes a leak, the sound of the leak is recorded for later analysis. On-board instrumentation records the rotation of the ball and above-ground GPS receivers detect an ultrasonic pulse emitted by the ball to allow real-time tracking of the device. The real time progress of the ball can be monitored for up to 1.2 kilometres away from each tracking device. The ball rotation and tracking information is used in post-processing to determine the location of any leaks. At the end of the run, the ball is retrieved with a net inserted into the pipeline. An in-pipe camera ensures proper alignment of the net and confirms arrival of the ball in the net. The ball can pass through open in-line valves, past off-takes and tees, and up vertical rises given correct flow.

SmartBall has several advantages over conventional correlator systems. Because the ball passes directly by the leak, it records the noise from the pressure drop through the leak and is not dependent on a pressure wave travelling through the water or the pipe wall to a distant sensor. Hence, the system will work in large-diameter pipes and in pipes of any material. Furthermore, because the system logs the acoustic information from each leak as it passes, interference from multiple leaks is not an issue, as it can be with correlators. The system can operate for up to thirteen hours. The total range is dependent on the flow rate in the line. For example, if the flow rate is 0.5 m/s, the system can survey over 23 km in a single run. This minimizes set-up and access requirements.

Because the device travels past the leak, sensitivity is extremely high. While dependent on pressure, detection thresholds are generally less than 2 l/min. In high-pressure lines, sensitivity is better than 1 l/min. The device is calibrated with simulated leaks on every survey so that the size of actual leaks recorded can be estimated. This is important when prioritizing repairs, or to evaluate whether the line needs to be replaced or relined. Location resolution is dependent on pipeline alignment information, but is generally within 1 metre.

The system was recently used by the City of Airdrie and the City of Calgary to find leaks in large-diameter transmission mains. Here are some of the project details:

**CITY OF AIRDRIE:**

The City of Airdrie is situated approximately 20 km north of Calgary and is supplied with potable water from Calgary through a 900 mm diameter pre-stressed concrete pipeline. Flow data collected over a number of years indicated that the line was losing a significant amount of water, but the cause of the loss could not be determined. As part of its SmartBall development process, Pure Technologies offered to survey the line. The inspection took place on July 10, 2007. The insertion location was at the City of Calgary metering station on the northern outskirts of the city through an existing 4” gate valve.

The retrieval point was at the City of Airdrie metering station. Rather than use the conventional net arrangement to capture the ball, it was decided to insert an in-line “strainer” at the Airdrie metering station.

**Figure 2:** City of Airdrie inspection insertion location.
The total length of the SmartBall run was 12,713 metres. The duration of the survey was 12 hrs.

Upon analysis of the data using the proprietary SmartBall Analyst software, three leaks were identified. The size and location of the leaks is shown in Table 1.

The largest leak was excavated during a period of low demand on February 4th, 2008 and was confirmed to be within 200 mm of the reported location. The cause of the leak was a hole in the steel cylinder at a pipe joint. The leak was repaired and the line returned to service within two days.

**CITY OF CALGARY, ELBOW DRIVE**

During the week of February 25th The City of Calgary unsuccessfully tried using typical correlator technology to determine the location of a leak on a 1220mm pre-stressed concrete line that runs under a busy four lane section of Elbow Drive. Two of the four lanes were closed down while the correlators were placed at nearby appurtenances to the suspected leak site. However, because of its proximity to such a busy street the correlators technologies had difficulties identifying the location of the leak.

Since the SmartBall has the advantage of traveling through the water column inside the pipe it was able to positively identify the leak with no interference from above ground noise. Also, since

**Table 1: Summary of inspection results from Airdrie line.**

<table>
<thead>
<tr>
<th>Leak ID No</th>
<th>Calculated distance from Launch (ft.)</th>
<th>Chainage at this location</th>
<th>Estimated size of Leak (1/min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10,088</td>
<td>47+39</td>
<td>19</td>
</tr>
<tr>
<td>2</td>
<td>16,268</td>
<td>54+99</td>
<td>113</td>
</tr>
<tr>
<td>3</td>
<td>18,692</td>
<td>23+16</td>
<td>2</td>
</tr>
</tbody>
</table>

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**For large diameter pipe**

*SoundPrint® SmartBall™* is a new and innovative leak detection technology from Pure Technologies. It is a free-swimming foam ball with an instrumented aluminum core capable of detecting very small acoustic events in pipelines. SmartBall™ can be inserted into a pipeline and can travel with the water flow for more than twelve hours, collecting information about leaks over many miles of pipeline with a single deployment.

Call us toll free (North America) at 1-800-537-2806, or visit www.puretechnologiesltd.com
Finally, here are some statistics from project experience to date:

Total length of pipeline inspected: 170 km
Average survey length: 5.1 km
Pipe materials: Concrete, steel, cast iron, ductile iron, PVC.
Applications: Potable water, recycled water, industrial and domestic wastewater, crude oil.
Total number of leaks detected: 117
Average leak size: 20 l/min

For further information on how Pure Technologies Ltd. can save you time and money on loss reduction and asset management in trunk mains, contact them at 403-261-6471 or visit their website at www.puretechnologiesltd.com.

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Figure 5: Typical extraction net setup to remove the ball from the pipeline.

Figure 6: Calibration curve created by simulating different leak rates at extraction point.

Figure 7: City of Calgary – Elbow Drive Excavation.

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The SmartBall was inserted 300 metres upstream and extracted and 325 metres downstream from the suspected leak location it had no impact on traffic.

Using a typical extraction net setup above an existing gate valve, the setup of the equipment began on the morning of March 1st. The SmartBall travelled the 625 metres of pipeline and arrived in the extraction net in fifteen minutes. Prior to extraction of the ball, the system was calibrated by generating simulated leaks of different sizes. This allows an estimation of the size of actual leaks to be made.

After extracting the SmartBall, the Pure Technologies crew was able analyze the data and have a location marked out on site the same day. The leak was excavated following day and was confirmed to be within 300 mm of the reported location. The leak was repaired and the line returned to service within 24 hours.

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**Figure 6:** Calibration curve created by simulating different leak rates at extraction point.

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**Figure 7:** City of Calgary – Elbow Drive Excavation.