Chapter 5

Method E: In-line leak detection techniques

Specifically designed for large diameter transmission pipelines, in-line leak detection technologies can overcome some of the challenges relating to sound propagation in increasing diameters and discriminate between multiple leaks in a single length of pipeline. Pipelines can be inspected while they remain under normal operating conditions, meaning there is no disruption to the customer water supply. A comprehensive disinfection process occurs prior to equipment deployment, making it suitable for potable water applications.

There are two types of in-line systems: tethered and free swimming. Both have their advantages and limitations, but in both cases an acoustic hydrophone passes directly beside leaks allowing for leaks of all sizes to be detected irrespective of the pipe material. Leaks as small as 0.2 litres per minute have been detected by in-line technologies and since they do not rely on sound propagation through either the water column or pipe wall, systems are proven to be very sensitive, even for very small leaks.

5.1 TETHERED SYSTEMS

Tethered leak detection technologies operate by deploying a hydrophone into the pipeline to be inspected while it remains under normal operating conditions. The hydrophone is connected to a signal processing and display unit via an umbilical cable which can be up to 2 kilometres in length. The hydrophone traverses the pipeline pulled by the flow of water acting on a drogue (parachute) attached to the front of the hydrophone and cable. The hydrophone location along the pipeline length can be controlled by an above ground operator. As the hydrophone passes any leak on the pipeline, the above ground operator hears the unique acoustic signature created by the leak, and sees it visually on a frequency spectrum monitor, and can position the hydrophone so it is directly aligned with the leak. At this point, a second above-ground operator can locate the hydrophone through the ground surface and pinpoint the leak and mark it with appropriate methods. The tethered leak detection technology also has an odometer so there is an understanding of deployment length but given the nature of horizontal and vertical bends along the

Editor(s): Stuart Hamilton and Bambos Charalambous
doi: 10.2166/9781789060850_0029

Figure 5.1 Tethered system access through 48 mm or above connection and only goes with the flow. (Source: Pure Technologies and JD7)

Figure 5.2 Push tethered system which can be operated with or against the water flow with access through tapping point or fire hydrant. (Source: JD7 Ltd)

inspection length it is important to locate each leak with the above ground device (where possible and not restricted due to access).

Once the sensor is sited at the leak, the position of the sensor can be determined using a locating system mounted in the sensor head. A second operator can track the position of the sensor head during deployment using this locating device giving an accurate indication of the sensor location and pipe track. Having pin-pointed the position of the sensor, the exact location of any leak can be marked on the ground over the pipe (Figure 5.1).

Tethered technologies are best suited to work in relatively straight pipelines where deployments of up to 2 km from a single insertion point are possible; other constraints may restrict the length that can be surveyed from each insertion point. Careful planning of the work will maximise the distance that can be surveyed. The most recent versions of tethered leak detection technologies can traverse up to 270 degrees of cumulative bends per insertion before friction on the cable is too great.

Most tethered technologies have live video capability, allowing the asset owners to collect additional data sets and asset intelligence from a leak detection survey. This may include identification of valve status, cement-lining delamination, tuberculation or unknown tappings.

Tethered systems are typically deployed through existing tappings on the pipeline (such as air valves, flowmeter locations, etc.) or new tappings can be created. These are usually 50–100 mm in diameter. Tethered systems that can access the main through fire hydrants are also available, but limitations may exist with regards to length inspected (Figure 5.2). Alternative sensors, including video and ultrasonic pipe-wall inspection, are also available.

5.2 FREE SWIMMING SYSTEMS

Free-swimming leak detection technologies are also available. These devices are inserted into a live pipeline and are propelled along the pipeline by the water flow. At the end of the inspection, a net is used to catch and extract the system from the pipeline, while the pipeline remains under normal operating conditions (Figure 5.3 and Figure 5.4).

An acoustic recording is made during the entire inspection and tracking information is collected at intervals throughout the inspection. Leaks are identified during data analysis following the removal of the system from the pipeline.

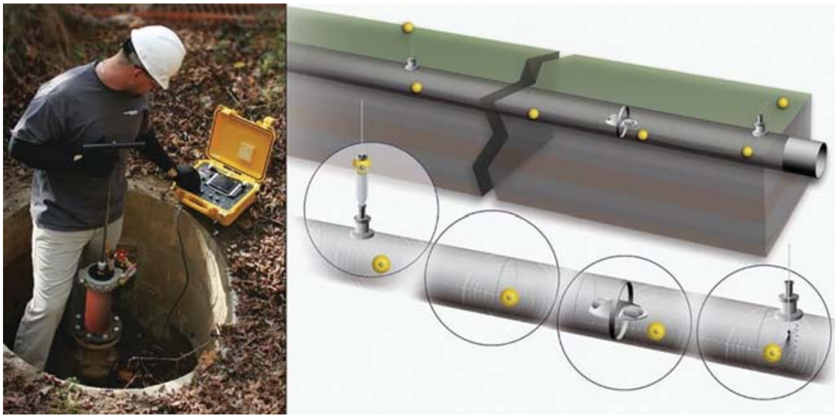

Figure 5.3 Free-swimming sensor deployment schematic. (Source: Pure Technologies)

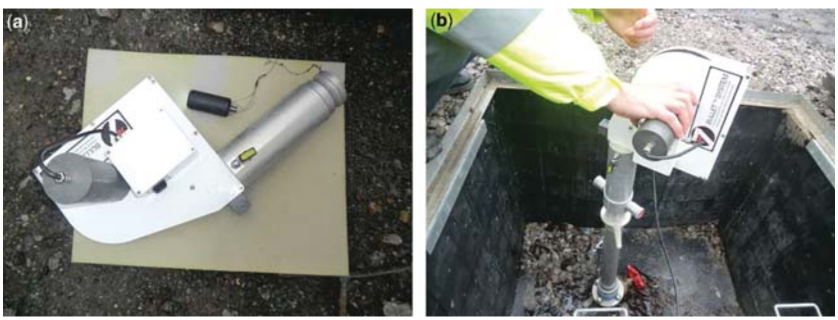

Figure 5.4 (a) Free flowing device combined CCTV, acoustic head, tracking device and launch tube. (b) Free flowing device launched into main. (Source: JD7 Ltd)

The free-swimming leak detection technology consists of the following components: (a) an acoustic sensor and other sensors, including acoustic transponder, data processor, temperature sensor, pressure sensor, gyroscope, magnetometer, memory device and batteries; (b) above-ground tracking devices (which are used to track the progress of the system as it moves through the pipeline); (c) insertion equipment; (d) retrieval equipment; (e) analysis software.

The maximum length of pipeline that can be surveyed is determined by the flow rate in the line. For instance, with a flow rate of 1 m/s and a maximum operating life of 18 hours, systems can survey 64 km from a single insertion point. The technology can traverse around tight bends and through inline valves, including butterfly valves, without issue.

The on-board instrumentation allows the velocity of the system at all points along the inspection route to be calculated during post-processing. This, combined with the use of above ground tracking devices, allow for the accurate location of any leaks. The magnetometer onboard the device allows the operators to see changes in the magnetic field strength throughout the inspection and assists with location accuracy.