**NEW TECHNOLOGY**

**Run the gamut**

Technology providers are looking at means other than acoustic testing to most accurately identify leaks.

Sewage- and water-network leaks are a prominent problem in many countries whose underground pipe systems are aged and struggling to cope with leaks in usage.

Legacy leak-detection methods include acoustic sensors, data loggers, correlators, helium tracers and visual inspection.

“Available in both portable and permanently installed configurations, acoustic sensors, including data loggers, correlators, hydrophones and other listening devices, while inexpensive to operate, also have a number of disadvantages,” Carissa Boudwin, sales and marketing administrator at Electro Scan, tells TW.

Acoustic testing could be interrupted by surrounding ambient noise not allowing the sensors to hear leak noise in the system, American Leak Detection’s senior director of field services Jimmy Carter says.

Pipe material and diameter have a significant effect on the attenuation of acoustic patterns that are necessary to detect anomalies. Boudwin elaborates: “Leak signals travel farthest in metal pipes, while patterns are more attenuated in plastic ones, making plastic pipes ‘quieter’ than other pipes by not transmitting sound or vibrations sufficient to accurately or consistently locate leaks.”

**Water and air**

Due to the drawbacks of acoustic sensors, other methods have been pursued, namely helium gas tracers, thermography or infrared sensors, and electromagnetic sensors.

IBAK specialises in the sewer industry and manufactures camera systems for optical inspection and systems for leak-testing underground pipelines. A distinction must be made between two basic methods: testing with water and air.

When testing with air, the location, pipe diameter and length, a maximum permissible water loss and a test time are determined. The test is considered to have been passed if the permissible water loss is not exceeded during the test time.

When testing with air, the area is sealed off with pipe stoppers. The test area is charged with positive or negative pressure (+/-200mbar). The test is subdivided into four phases: filling the test area, equalisation time (equalisation of the air and sewer temperature – refilling may be necessary), test time and venting. The permissible pressure drop depends on the test pressure and the pipe diameter.

The purpose of the test is to confirm the watertightness of the wastewater facility. If a test with air is not passed, a subsequent test with water can still be performed. If a test with water is passed, it overrides the result of the test with air.

“Airtight sealing of the test area for accurate leak testing with air presents a challenge. The IBAK system has a unique mechanism for this: when deflated, the concertina-shaped sleeve [inflatable balloon] is protected by two half-shells.

“The closed half-shells form a compact assembly that is easy to push,” Markus Stock, mechatronics engineer and IBAK Helmut Hunger development team member, says.

When the sleeve is inflated, the half-shells open and the concertina sleeve expands like a balloon and presses against the pipe over a relatively long distance (in relation to the pipe diameter). This ensures that the pipe is sealed off reliably. For pipe-connection testing, this task is also solved by a well-thought-out method: the sealing bladder of a specialised packer with an integrated, bend-capable axial camera is pushed up to 40m into the lateral.

The packer seals off the area in front of and behind the branch pipe with sleeves. Finally, the push-rod sealing unit is closed. The test area thus produced is charged with the required test pressure and the leak test is performed accurately.

**Other options**

Helium gas can be used as a tracer to locate leaks, where helium is injected into live water mains, without needing to isolate a zone, depressurise the main, or shut the water system down. Helium mixes with flowing water and travels throughout the pipe network to the desired area(s) to survey for leaks, notes Boudwin.

When the helium-marked water leaves the pipe network through leaks in the pipe wall, the helium separates from the water. Because helium is four times lighter than air, it floats to the surface where it can be measured above ground with specialised monitoring equipment.

“However, helium might travel dozens of feet through the soil without a clear indication of the location of a defect, or whether a leak has occurred from the water main or from a customer’s service connection,” Boudwin explains.

Thermography can also be used. Water leaking from an underground pipe changes the thermal characteristics of the adjacent soil, making it a more effective heat sink than the surrounding dry soil. The resulting thermal anomalies above
American Leak Detection technicians perform complete system surveys and distribution audits

pipes are detected with handheld cameras, vehicle-assisted sensors, or from aeroplane-mounted infrared cameras. “More complex and expensive to operate, leak signatures may sometimes best be located during cold periods,” adds Boudwin.

In addition, electromagnetic sensors have recently been used to assess large-diameter pipes and transmission mains. “Not able to locate actual leaks, electromagnetic sensors essentially take cross-sectional images of the pipe wall to attempt to locate anomalies in the wire mesh imbedded in the concrete liner. Given a broken or irregular wire, pressure in a water main may eventually build up to a main break. Highly costly, this method has had mixed results,” states Boudwin.

Evolution of technology
Technology has come a long way over the last 10 years. “Sensors are now very user-friendly, [which] allows a system or a company to monitor areas without being manned. [It also] allows a person to take the information and look for leaks the next day from the office using the data collected the previous night,” American Leak Detection’s Carter explains.

“The use of multi sensors allows you to check housing tracts or spread out to cover larger areas depending on the needs of the system.”

While the American Water Works Association’s (AWWA) M77 Condition Assessment is developing its first standards manual, the drawbacks of legacy techniques, including recurring false-positive readings, lack of data repeatability and the requirement for third-party data interpretation, are spurring new innovations, like Electro Scan, to automatically detect, locate and measure (in gallons per minute) specific leaks.

“The growing adoption of plastic pipes, particularly polyethylene (PE) and high-density polyethylene (HDPE) pipes, is also a key factor pushing sophisticated new technologies as traditional acoustic methods cannot detect leaks in water mains using these materials,” Boudwin says.

The importance of water-leak detection continues to draw university research and innovation. “For example, a team at Sheffield University’s Department of Mechanical Engineering [UK] developed a way to send a pressure wave along the pipe that sends back a signal if it passes any anomalies in the pipe’s surface.”

Fitted on a standard hydrant, a valve is rapidly opened and closed to generate a pressure wave that is sent down the pipe. When this wave encounters any unexpected features, such as a leak or a crack in the pipe’s surface, it sends back a reflection that can be analysed to reveal the location and size of the leak.

Another effort teamed members of MIT’s Mechatronics Research Laboratory (MRL) in the US with the King Fahd University of Petroleum and Minerals (KFUPM) in Saudi Arabia. Together they created an in-pipe leak-detection robot that uses pressure gradients to identify leaks. Leaks create a fluidic region in the neighbourhood of each leak, often characterised by a rapid change in static pressure, i.e. dropping from high pressure inside the pipeline to low pressure in the surrounding medium.

“However, a promising new technology, referred to as low-voltage conductivity (LVC) or focused electrode leak location (FELL), has showed the most commercial readiness with large and small users in the Canada, Japan, the UK and the US,” comments Boudwin.

Electro Scan unveiled its multi-sensor water-leak detection probe at WEFTEC in Chicago on September 28. Designed specifically for entering pressurised water mains without service interruption, the new product adds a high-definition closed-circuit camera (primarily used for in-pipe navigation and location entry in the water main) and an acoustic hydrophone (primarily used to readily compare old vs. new technology data results).

Combined with Electro Scan’s international patent-pending LVC sensor and a pressure sensor that aids in calculating leakage rates, the new 4-in-1 multi-sensor probe greatly enhances the ability to detect, locate and measure leaks in gallons per minute.

The IBAK leak-test system is designed for operation in circular pipes with diameters of DN 100 upwards. Depending on the model, positive air pressure, negative air pressure and water tests can be performed.

“The flexible system covers the whole range of leak-testing applications in sewers: sections between manholes, joints, pipe connections, underground pipes and laterals can be tested for leaks,” notes Stock.

This technology consists of being able
to seal off any desired part or a particular location in sewers. “The sleeve designed by IBAK can also be pushed through complex sections of sewer systems and can therefore be positioned at locations that cannot be accessed by other systems on the market.

“This makes it possible to pinpoint leaks in small-diameter pipes in complex pipe networks.”

**All things considered**

How do you get the best out of your equipment? “I think it really boils down to good training, the ongoing use of equipment to know the inside and out of what it is telling you, and having the field experience on how to perform the best survey possible,” Carter comments.

An advanced survey beyond a basic hydrant-to-hydrant finds leaks normally unseen and not found. When a utility has a percentage of water loss and unaccounted-for revenue, it is very important to conduct a thorough investigation.

“We continually have systems that have a loss such as 15% in their systems; by conducting a good inspection or survey, it is not uncommon to find 15 to 30 leaks in a 25-mile system with age,” says Carter.

Having back-up equipment available could also save the day. “There’s nothing worse than getting to a job and having a failure due to a bad battery or having a sensor or cord go bad in the field. Have someone from the system work with you that is familiar with the system’s layout and valves for the unknown lines running through the woods or other rural areas.”

IBAK Helmut Hunger places emphasis on the seals. Stock explains: “To implement leak testing successfully, the sleeves must produce a reliable seal irrespective of the pipe material and its characteristics. Concrete, for example, can be very porous. In this case, the pipe should be soaked with water beforehand and a reference test should be made. As a basic principle, it is advisable to clean the sewer before performing a leak test.”

Leak-detection equipment users must undergo thorough planning and preparation. Electro Scan’s water-leak detection surveys require a good set of maps to identify usable access points (e.g. hydrants, valves, flow meters, pressure fittings, etc.).

Boudwin adds: “Working with water utility operations crews to prepare access points by temporarily closing hydrant valves, removing hydrant caps in preparation for Electro Scan’s placement of its launcher (typically fitted directly on top of the hydrant), Electro Scan is able to survey 1,500 feet in either direction of the main.”

**Better data = better detection**

“I just attended a water-smart summit and the wave of the future is going to be electronic meters and loggers able to read information at any given time, allowing them to address a residential problem or a part of a system that is indicating usage, allowing these areas to be addressed promptly,” Carter envisages. This enables leaks to be found before surfacing and high water usage to be addressed before the billing cycle. It also allows comparisons with other water agencies.

Boudwin agrees. She says: “Better data means better decision making, and given the higher level of precision of pipe-condition assessment, water utilities will be better able to rank and prioritise their capital and operating expenditures.”

“Pipe-manufacturing trade associations have long resisted more stringent leak tolerances for newly installed pipes, with state and local governments often setting their own standards for acceptable leakage rates.”

Retail water suppliers may no longer be willing to certify and accept new pipes, repairs, or rehabilitation projects that cannot provide a 50-gallon or less per inch diameter mile leakage rate, she adds.

In the water industry, Electro Scan looks forward to the first edition of a Standards of Practice document from the AWWA M77 Committee on Condition Assessment. Similarly, the wastewater industry awaits the upcoming seventh edition of ‘Operation and Maintenance of Wastewater Collection Systems’, Volume 1, featuring a new chapter written and edited by Ken Kerri, Ph.D., Office of Water Programs, California State University, Sacramento, before his passing in December 2014.