Hunting Down Water Leaks

by Brian Dumbleton

Britain's driest summer in 20 years has highlighted the relevance of developing new methods for water network monitoring and leakage detection.

The difference between the volume of water that leaves the water treatment works and the estimated amount that is used by consumers is termed "water unaccounted for." Quite often, this is mistakenly called leakage when it can arise from meter under-registration or an under-estimate of demand. However, leakage is the major culprit.

In the past, an expert waterman relied heavily on a well-trained ear to locate a leak in a water main. Times have definitely changed. While human experience is still a valuable aid, microelectronic and computerized systems now available are more accurate and, in some instances, enable old and leaking mains to be repaired rather than relayed. Because of these new systems, capital costs are reduced.

Computers are playing an ever-increasing role in the monitoring and control of leaks. Many water distribution networks are now analyzed by using programs and sophisticated mathematical models. The department of manufacturing and engineering systems of the United Kingdom's Brunel University has developed such a program entitled WASMACS (Water Systems Monitoring and Control Software). This program was designed to optimize pressure control for leakage minimization.

Minimum Cost

Based on applications in the aerospace and power supply industries, WASMACS has been developed for real-time on-line applications. It is primarily for use in a control room to provide a continuous balance between supply and demand at a minimum cost. It is designed not to violate any pre-defined limits of pressure, quality or volume of water stored in the system for emergency purposes.

According to Powell, a senior lecturer at Brunel University, a process known as state estimation is used for the program. This process is capable of detecting any errors in the incoming data not possible when you use a standard SCADA system. The method is claimed to be sufficiently sensitive to detect bursts from signals generated at points remote from the actual burst location. It can also detect meter errors and pipe blockages.

Using a leak noise correlator, an engineer can quickly locate a suspected water leak in a city street.

Two leading British water companies, Thames Water and South West Water, are currently evaluating the system with a view to incorporating it in their rapidly expanding telemetry systems, according to Dr. Powell.

Rapid Advance

The introduction of district metering systems using sophisticated microprocessor-controlled data loggers and telemetry also helps the engineer to monitor a distribution network on a regular basis. Without these systems, individuals need to spend hours outside, often at night when demand is at its lowest, to identify where this unaccounted water is going.

WRc, an important UK water research company, has been a market leader in the development of leakage control systems. According to WRc, success in the UK can be attributed to two major influences. First, the rapid advance in flow-metering technology has expanded the range of conventional mechanical meters and led to the introduction of electromagnetic and ultrasonic equipment. Second, data capture has become more sophisticat-

ed using techniques ranging from simple remote reading devices to programmable data loggers and telemetry.

Microprocessor-controlled data loggers are programmed to make the best use of available memory by their ability to change data-storage facilities dynamically. They are equipped with either long-life or rechargeable batteries so they can store data for long periods without attention. When used for monitoring leaks, these loggers can be operated on a continuous basis. They then can be replaced when they are full and the data downloaded into a permanent storage facility. The loggers are then reprogrammed.

Look and Listen

Despite all this sophistication, modern leak detection still depends on the noise generated by a leak. No longer is this accomplished by the waterman using his listening stick, but electronic amplifiers are now used to enhance the sound quality by filtering out unwanted distracting sounds and increasing the acoustic intensity of noisy leaks. To assist the operator in discriminating between levels of sound and identifying the possible source, a visual display is now widely used, so look and listen still applies. The nature of the material overlaying a pipe can sometimes distort the apparent location of a leak.

One way of preventing this from happening is to calculate the speed of sound in a pipe and the water flowing through. This is accomplished by measuring the distance between two sensors attached to it. A system developed by Palmer Environmental Ltd. for Thames Water does this measurement.

Using a database programmed with the speed of sound in different materials, the precise location of a leak can be displayed on a VDU without the problem of the information being distorted by traffic noise or other sounds. This is an important consideration in urban areas. The new technology means it can now tell the size and exact location of each leak and save billions of gallons of good clean water from going to waste.

Efficient Solution

Spectrascan, a company acquired in 1991 by Biwater Industries Ltd., has developed its own data-logging system. This system uses low-cost PCs and claims to reduce costs and program times by up to 50 percent. The "AquaCorr" precise leak-location detector uses correlation technology. It provides a cost-efficient solution to high-performance leak location.

This technology finds the leak by measuring the Td (time difference) of its sound arriving at two sensors corresponding to the distance of each of them from the leak location. Correlation analysis then compares and matches the random wave form of the leak noise. This information is then transmitted to the detection unit. This detector is fully portable and equipped with an interactive touch-sensitive display enabling all operator inputs to be made through the screen.

Biwater also produces Water Spider, a permanent, low-cost and easy-to-use data logger, available in two versions for recording pressure or flow. It has its own host software and can be operated using portable or desktop computers.

Battery Operated

Summaries of minimum night flows, daily demands, diurnal patterns and minimum daily pressures can all be readily logged. The date and time of each reading are also logged. Both versions are battery operated and have eight-digit LCD displays. Batteries are guaranteed for five years and have a forecast life of 10 years.

Another system is composed of an integrated pressure and flow-data logger designed to be mounted directly on water meters. In one single instrument, it combines the functions of a meter index, flow-rate indicator, night line indicator, data logger and telemetry outstation. It accomplishes this by the addition of a battery-powered modem.

For leakage control, a telemetry scheme needs either continuous monitoring or a system of distributed intelligence, remotely downloadable data loggers. With a continuous monitoring system, meter readings are logged and the location interrogated once in 24 hours. This is done when a day's readings are downloaded.

One of the main causes of leaks is unduly high water pressure. To counteract this problem, a system of pressure reducing valves (PRVs) can be introduced into the distribution network. These valves still need to leave sufficient pressure for the satisfactory operation of the system.

Controlling pressure in this manner lowers leaks by flow reduction and removing unnecessary strain on pipes and joints. Conventional mechanical PRVs control only the pressure immediately downstream. However, with the arrival of microprocessor control and telemetry, it is now possible to vary the pressure at any critical point between two valves.

A word of warning is necessary. Not all leak detection and control schemes have proved to be totally effective. Some British water companies are still having trouble achieving total coverage by leakage schemes. Other companies have found that the anticipated cost savings of reducing leaks to below 15 percent are not always achievable.

Therefore, despite all the modern sophisticated electronic aids, total elimination of leaks from a water distribution network (despite strenuous efforts by the UK water industry) may remain, for the time being, just another pipe dream.

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Brian Dumbleton is a technical editor with *Water and Wastewater International*, a UK trade publication.

The following is a list of manufacturers who are mentioned in this article. For more information, circle the appropriate number on the reader service card.

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Spectrascan - see Biwater Group HQ as above.