Water Loss Group: IWA Task Force

LEAK DETECTION PRACTICES & TECHNIQUES – A Practical Approach

- In this fourth article in a special series for *Water 21* by the IWA Water Loss Task Force, **RICHARD PILCHER** describes the advances of leak detection practices and techniques over the last twenty years in reducing water loss from public water supply distribution networks.

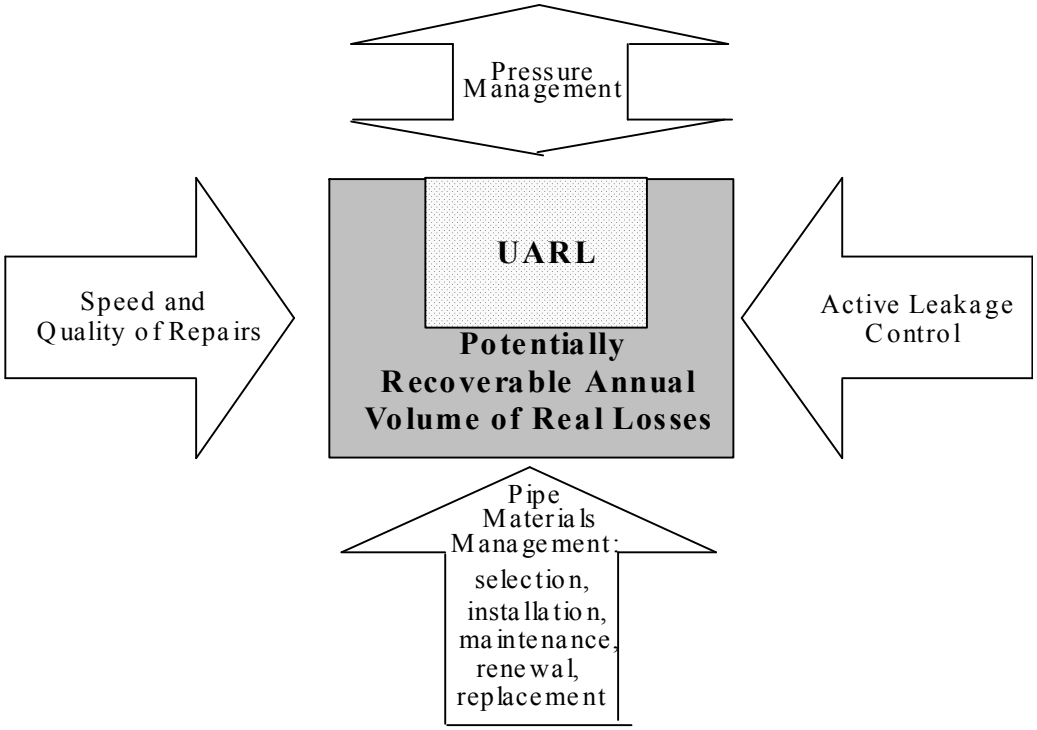
Ken Brothers, Chair of the Water Loss Task Force, recently outlined the scope of this series of articles 'A Practical Approach to Water Loss Reduction' in Water 21,

This article outlines the importance of an active leakage control programme as part of a demand management strategy. The efficient location of visible and non-visible leaks from a water distribution system and their prompt repair represent two of the four basic leakage management techniques.

The four basic leakage management techniques

The control of water losses has been an activity associated with water distribution since some of the earliest systems were built. The Romans were aware that a good proportion of the water put into supply did not reach its intended destination.
Sextus Julius Frontinus, Water Commissioner to Rome, used a crude measuring device to determine losses in the system. He recorded losses of approximately 60% from one particular source of water. Although illegal connections were commonplace it was apparent that water loss through leakage was a serious problem, similar to many of today's distribution systems around the world.

The fight for the reduction and control of losses is never ending and fortunately, for today's water distribution engineers, a range of good equipment and techniques have been developed to assist him or her to tackle the four basic leakage management activities. Julian Thornton very well described pressure management in the previous article in the series published in October 2003. This article deals with two of the other three activities – active leakage control, speed and quality of repairs



The Four Basic Leakage Management Techniques

The reduction of water loss by means of leakage control is vital in today's world and many utilities have developed a strategy to reduce losses to an economic or acceptable level. These strategies have inevitably included Active leakage Control. Active Leakage Control can best be described as a proactive strategy to reduce water loss by the detection of non-visible leaks using highly trained engineers and technicians using specialized equipment followed by the prompt repair of leaks.

Before examining the equipment and techniques used by leakage engineers and technicians let us consider the main factors that influence leakage (is this info from a referenced source?).

FACTORS	%
1. Soil/ground movement	27
2. Corrosion of pipe	19
3. Traffic loading	11
4. High pressure	8
5. Roadwork's excavations	8
6. Age of mains	6
7. Frost damage in winter	6
8. Defects in pipes	5
9. Damaged joints	4
10. Ground conditions	3

The frequency at which bursts and leaks occur depends upon the overall condition of the infrastructure and how well it is managed. Dependent upon the specific ground type there will always be a good proportion of leaks and bursts that do not appear on the surface i.e. non-visible leaks and these need to be detected.

Leakage detection 100 years ago

For many years leakage engineers or "waste inspectors" as they used to be called in the UK would carry out regular house to house surveys looking for the evidence of leaks from buried pipes or customer connections. The method relied upon a wooden listening stick which, when placed on the main or fitting such as a stop tap allowed the inspector to listen for the sound of escaping water. The leak noise was transmitted from the fitting to the engineer's ear via the listening stick similar to a doctor listening to a heartbeat through a stethoscope. Identifying leaks using this traditional technique was a reasonably low cost operation but the success rate was moderate with many "dry holes" or incorrectly sited excavations, especially on non-metallic pipelines.

Leak localising

The above system of routine sounding was time consuming and not very efficient with the waste inspectors often looking for leaks in areas where they did not exist. Leak detection gave way to two activities; leak localising and leak location. Leak localising is an activity that prioritises the pinpointing of leaks and was undertaken by carrying out waste metering. Waste metering was another traditional technique commonly used until the 1980's, where flows into a small area were measured using a single meter that had been temporarily set up to enable leakage to be identified. Step testing was, and still is, carried out by some utilities in waste meter areas; this is an activity whereby the area is subdivided by the systematic closing of valves during the period of minimum night flow. The flow data is then analysed to determine the areas of suspected leakage. Leak location or the pinpointing of leaks was then carried out in the section of the waste meter area that had high night flows.

A typical waste meter area covered approximately 1000 connections and has, in many utilities been replaced by a District Meter Area (DMA) that covers between 1500 and 3000 connections. In many cases a waste meter area has become a sub-part of a DMA.

Leak localising by means of the step test was largely replaced by acoustic logging during the 1990s, as it does not require night work and the shutting down of various parts of the distribution system. Acoustic loggers are used to define the general area (normally a DMA or part of a DMA) in which leaks are located and they can be used in any type of distribution network. They are installed on pipe fittings by way of a strong magnet and are programmed to listen for leak characteristics. By recording and analyzing the intensity and consistency of noise, each logger indicates the likely presence (or absence) of a leak. Acoustic loggers can either be permanently located in the network or they can be deployed at certain points for a user definable period, often two nights.

Leak location

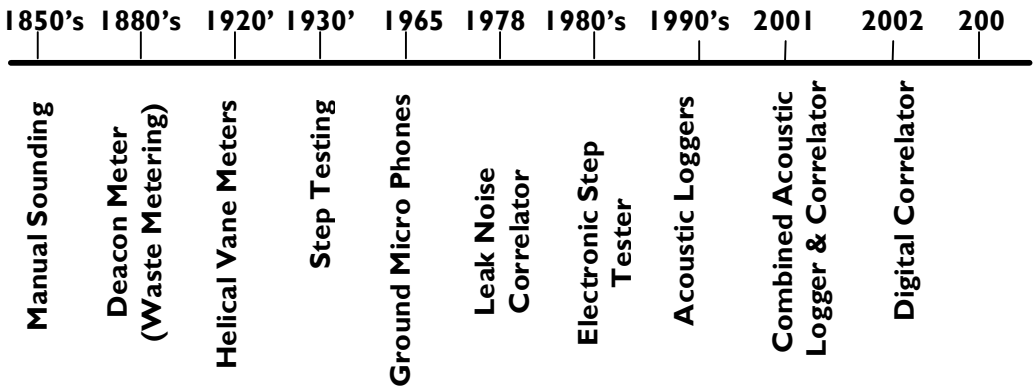
Listening sticks moved into the electronic age in the mid 1960's and were called ground microphones. This is a device placed on the ground that amplifies the sound produced by a leak to enable easier detection. These devices came in many shapes and sizes but one of the most popular was the "elephant's foot", which was extremely sensitive and identified the strongest leak noise and the location of the leak

During the late 1970's the leak location activity dramatically improved with the development of the leak noise correlator. Similar to the traditional sonic equipment the correlator relied upon the noise generated by a leak on a buried pipeline. The fundamental difference however, was that the leak noise was picked up by sensors deployed at two locations e.g. two valves on the pipeline either side of the leak. The difference in the arrival time of the leak noise at each sensor, coupled with the knowledge of the pipe material, diameter and length, enables the leak to be pinpointed precisely. During the following 20 or so years the correlator developed from being the size of a large safe that took two men half a day to find a leak to a device that almost fitted into the palm of your hand and leaks were pinpointed in minutes rather than hours. In 2002 the digital correlator was developed offering the following advantages over its analogue predecessor:

- Superior leak location performance on all pipe materials and sizes
- Quick and easier to use, especially for less experienced operators
- No interference or data loss in digital radio transmissions

In the first year of the 21st century a combined acoustic logger and leak noise correlator was developed. This system has the advantage of reducing the wait time between identification of a leak noise and pinpointing of the leak thus reducing the run time for the leak and possibly the cost of repair.

Leakage Detection Technology Timeline



Repair of leaks

As can be seen from the above, leak location practices and techniques have advanced rapidly in the last few years with the result that leakage awareness and detection times have been greatly reduced. It is then vital that a good quality repair is carried out as quickly as possible in order to maximize the savings and also of course, reduce the inconvenience to customers.
It is important that specific targets need to be developed for the speed and quality for the repair work and these need to be regularly reviewed.

Leakage Monitoring

For the activities of leak localising and leak location to be truly effective, leakage monitoring needs to be introduced. The technique of leakage monitoring requires the installation of flowmeters at strategic points throughout the distribution system, each recording flows to a discrete district which has a defined and permanent boundary. Such a district is called a District Meter Area (DMA).