White paper - AG/LEAKAGE-EN

Leakage monitoring
Reducing leakage through effective flow measurement

Introduction

The ability to better manage water supplies is becoming increasingly important as demand for water continues to escalate. Even in the UK, which enjoys a wetter climate than many global regions, concerns about water availability, particularly in the light of recent freak droughts, have led to increased investment in the country's water production and distribution infrastructure.

Safeguarding against future water shortages is not just about producing enough water to meet demand. Equally as important is the need to control the amount of water that is lost in transit between the point of production and the end user.

Losses attributable to water leakage are a major concern in any water network. Even a small leak could potentially result in the loss of thousands of litres of water if left undetected.

Given that each litre of this wasted water has been treated and energy has been expended pumping it around the network, such losses also represent lost revenue for water operators.

Furthermore, the challenges presented by the Government's Carbon Reduction Commitment (CRC) scheme means there is now even greater pressure on water operators to minimise energy wasted on treating and pumping additional water supplies to replace lost water.

As such, leakage is a pressing issue that needs to be carefully tackled and controlled in order to minimise its impact on the bottom line.

This document aims to explain the key issues underlying water leakage and how it can be managed using ABB's latest flowmetering technology.

What is leakage?

What is leakage?

Although it varies in magnitude from country to country, leakage is common to every water network. The term is used to describe the water lost from pipes, joints and fittings and overflowing service reservoirs. As such, it is one of the categories within the catch-all description of total water loss, which itself describes the difference between the total amount of water going into a distribution network compared to the amount that is consumed and billed for.

During the 1990s, the UK's National Leakage Initiative (NLI) developed two main approaches to identifying and quantifying leakage. The first, known as the 'water balance', accounts for every aspect of the water supplied to the network. As such, it encompasses both sources of supply, such as reservoirs, and the mains distribution network.

The second approach is the Burst and Background Estimates (BABE) approach. This method entails creating models that can be used to predict potential losses, based on specific characteristics within a set leakage management policy. Leakage generally falls into two categories – background leaks and bursts or breaks. Background leakage is the aggregation of losses from all the fittings on the network. Such leaks are typically too small to detect individually. Burst leakage occurs from holes or fractures in the network that can be located using a range of specialist equipment.

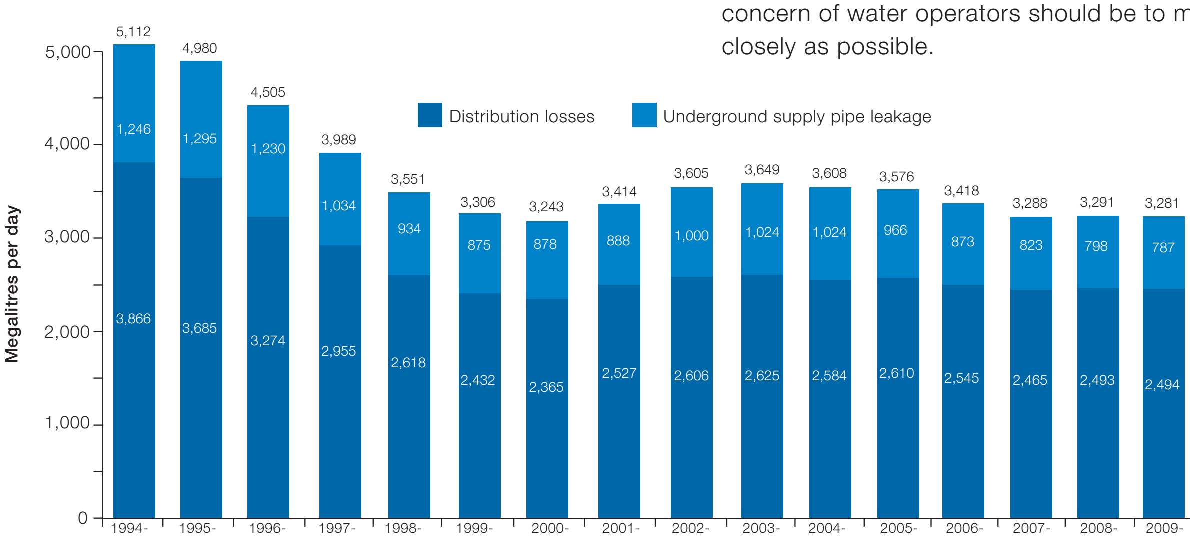
While major bursts and gushes on the surface may be reported to water companies by the public, it's vital to keep on top of other, less obvious leaks. While the most visible leaks may be losing water at a high rate, they are usually reported and rectified quickly. Lesser leaks may not result in such spectacular losses per hour, but they can run undetected for far longer and often lead to higher overall losses.

Although the size of a hole may often be tiny – in some cases no larger than a pin – the extent of water losses through leakage can be considerable, particularly where they go undetected for long periods of time. It is these types of losses, rather than the more easily identifiable, large-scale losses, that pose the biggest problem for water operators.

At this point, it is important to emphasise that leakage can never be eliminated. The sheer scale of water distribution networks and the inherent difficulties in accessing pipework, coupled with other factors such as supply pressures, age of pipework and soil characteristics, means zero leakage can never be achieved.

This point is illustrated by the fact that the UK's water distribution networks, even following considerable countrywide investment and modernisation, continue to exhibit an average leakage figure of around 15-25 percent, equating to some 3,300 megalitres of lost water per day.

Rather than striving to achieve zero leakage, therefore, the main concern of water operators should be to manage leakage as closely as possible.



Source: Ofwat service and delivery-performance of the water companies in England and Wales 2009-10

Total industry leakage 1994-95 to 2009-10

What causes leakage?

What causes leakage?

Despite a raft of recent replacement and renewal works using modern plastic piping, much of the country's water mains are still made from iron or lead, with some dating back to the Victorian era.

Coupled with this is the high number of joints, fittings, interconnections and relatively short pipe runs that characterise even the most modern water distribution networks, presenting multiple opportunities for leaks to occur.

These factors, together with higher supply pressures, mean that some degree of leakage is inevitable. Generally, leaks can be attributed to four main causes, namely:

- Higher supply pressures – supply pressures that exceed the original parameters of installed pipework (particularly older pipework) can cause pipes and/or joints to rupture or burst
- Corrosion – rusting of pipes, fittings and joints steadily reduces their integrity, eventually resulting in failure. Causes of corrosion can arise from both within the pipe, such as acidic waters from upland areas, and outside of the pipe where the external pipe wall is attacked by elements in the soil. In both cases, the resulting corrosion can weaken the pipe wall, reducing its ability to withstand the supply pressure and leading to eventual failure.
- Erosion – this problem often occurs where a leak has already formed. Jets of water from the leak collect sand or stones from the installation environment which then hit the pipe, gradually weakening it and increasing the likelihood of a secondary leak
- Soil characteristics – changes in the soil characteristics at the point of installation can have a material impact on the pipeline. Changes in temperature and moisture can cause the soil to expand and contract, potentially causing the pipeline to bend. Movements in the soil can also cause movement of the pipeline and its associated fittings, increasing the risk of damage and failure

Reducing the amount of water lost through leakage depends on both the distribution pressure and the amount of time taken to address a leak. Where losses stem from relatively small but steady leaks from a joint or fitting, such leaks can be especially hard to detect, particularly where the installation environment prevents water from rising to the surface.

Losses stemming from small but steady leaks can be hard to detect.

Controlling and minimising the consequences of a leak therefore requires close monitoring and detection of potential leaks at the earliest possible stage. Advice on how to achieve this is outlined later in this document.

Consequences

Consequences of 'lost water'

For every litre of water lost in a water network, another litre of water has to be treated and pumped through the distribution network to compensate. With the UK consuming an estimated 9,000 megalitres of water per day, the impact this can have on the cost of production and the available water supply quickly becomes evident. By way of illustration, around 65 percent of Thames Water's yearly electricity consumption can be attributed to pumping water and sewage across the Thames region.

With water currently in plentiful supply in the UK, the issue of water leakage is one which often tends to arouse public interest only when the supply becomes restricted or when water companies attempt to introduce higher water prices or water demand saving measures like compulsory metering.

For water companies, however, the issue is an ongoing one, having an impact on key areas of their operations, including:

Profitability

Water lost from pipelines means more water needs to be treated, pushing up costs. For example, if leakage accounted for 50 percent of a water company's production, then the cost of treatment, including energy consumption in terms of pumping and electricity, will have doubled.

The increased need for water treatment may also mean that more water treatment plants are built than is truly necessary, incurring excessive capital investment and reducing profitability.

Reduced customer satisfaction and impaired public image

In the UK, access to a constant supply of treated water is regarded as an automatic right. Failure to provide such access, either because of failed water mains or restricted water supply in times of drought, can lead to reduced customer satisfaction and an increased interest in water leakage issues. These can often have a detrimental impact on a water company's public image.

Reduced resources

Detecting and repairing damage caused by water leakage can put a strain on resources, requiring water companies to prioritise which leaks most urgently need to be addressed. Limitations on the resources available to find and repair leaks can be particularly problematic where damage is being caused by small-scale leaks over long periods of time. As these leaks are difficult to detect, they can cause extensive damage before they are found, even leading to the collapse of roads and/or footpaths in extreme cases.

Tackling leakage

The importance of the above factors puts the onus on water operators to employ a continuous leakage management strategy. Such strategies can be passive, where the amount of water in the network is measured over time to determine overall levels of leakage; active, where a strategy is employed to identify and tackle specific leakage points; or a combination of the two.

Whichever tactic is chosen, the starting point for any leakage management programme is to ascertain the overall characteristics of the network, including factors such as age, installation characteristics and operating pressures.

To this end, the programme should address the following key points:

- How much water is being lost?
- Where is the water being lost from?
- What are the reasons for the losses?
- How can any losses be reduced?
- What is the best strategy to reduce the losses in both the short and long term?

By identifying the answers to these questions and the root causes of the leaks, an action plan strategy can then be devised. Starting with schemes to identify and quantify leaks, these strategies may range from anything from replacing aged pipe infrastructure through to establishing zoning or district metering schemes, as outlined on the following page.

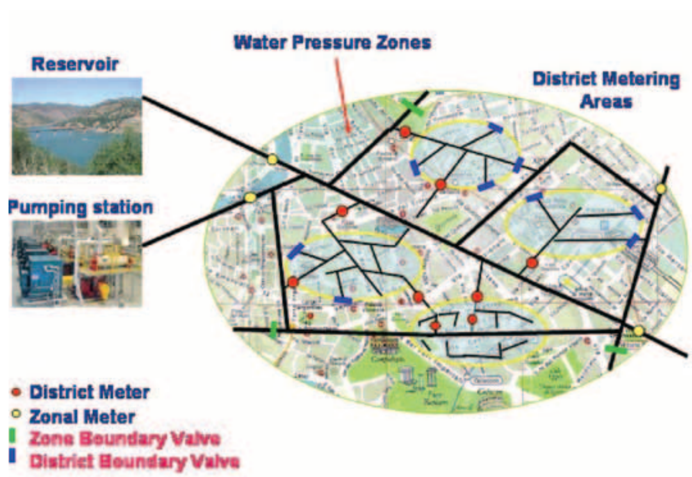
The following table is an extract from the World Health Organisation's (WHO) publication, 'Leakage management and control – a best practice manual', which sets out the key stages that should be included in an effective leakage management programme:

Element	Tool
How much is being lost?	Water audit – Measure components – Check production/consumption – Recalculate water balance – Review records/operating procedures/skills
Where is it happening?	Pilot studies – Quantify total losses – How much is leakage? – Distribution network – Transmission mains – Reservoirs – How much are non-leakage losses? – Refine the water balance calculation
Why is there water loss?	Review network and investigate: – Historical reasons – Poor practice/poor quality assurance – Poor materials/infrastructure – Local influences
How can performance be improved?	Action plans/strategy development – Update records and systems – Introduce zoning/DMAs – Monitor water losses and leakage – Prioritise areas – Address non-physical losses – Detect and locate leaks – Initiate repair policy
How can a leakage management strategy be maintained?	Training/awareness – Improve awareness – Transfer skills – Introduce best practice technology – Give hands-on experience / continual reinforcement – Monitor and follow up action plans

Source: World Health Organisation (WHO) 'Leakage management and control - a best practice manual.'

A key weapon against leaks

District metering is a key weapon in the war against leaks. The concept of District Metered Areas (DMAs) was first introduced to the UK at the start of the 1980s by the UK Water Authorities Association. A district is a defined area of the distribution system that can be isolated by boundary valves and for which the quantities of water entering and leaving can be metered. The subsequent analysis of flow and pressure, especially at night when a high proportion of users are inactive, enables leakage specialists to calculate the level of leaks in the district. This can be used to determine not only whether work should be undertaken to reduce leakage, but also to compare levels of leakage in different districts and thereby target maintenance teams into those areas where they will have the greatest impact.



Even new distribution networks experience leakage and the water industry in the UK must work with some of the oldest underground assets in the world. So it is completely unrealistic to expect to reduce total losses to zero in Britain's mains network, which runs to over 300,000 km. However, the role of DMAs is to divide the network into manageable sections that make it easier to determine where bursts are and to repair them.

District metering is now part of an established, active leak management programme among UK water companies. Typical districts cover somewhere between 1,000 and 2,000 properties in urban areas. However, coverage is by no means comprehensive, especially in more rural areas.

Developing role

A developing role for DMAs

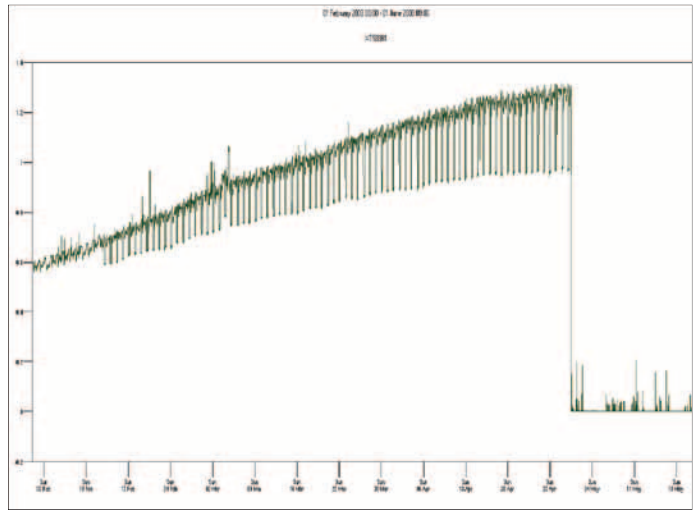
The role of the DMAs is changing as the leak management agenda progresses. Initially, DMAs are used as a tool to drive down leakage in networks that had received little or no previous leak detection work, apart from dealing with reported problems. At this stage, their role is to highlight those areas where companies should be concentrating their efforts, helping to get the biggest benefit for a given maintenance budget.

As work progresses and bursts are located and repaired, DMAs make the resulting successes easier to measure, since any improvements should be more noticeable when viewed locally, rather than by taking a snapshot of the distribution network as a whole. Eventually the repair work reaches the point where the DMAs are being used to look out for fresh leaks as they spring up. The metering accuracy required increases with each successive stage of the leak management programme.

In an ideal situation, it should be possible to estimate the level of leakage using a “top down” water balance. This requires an assessment of total customer use, which can then be subtracted from the total flow into the system. The difference equates to the leakage. This approach is difficult to apply in most areas, however, largely because there are very few DMAs in which all the properties are metered. This makes it impossible for water companies to get a sufficiently accurate picture of consumption. The situation is changing slowly, especially in areas of particular water scarcity, where compulsory metering is either being mooted, such as Thames Water’s request for compulsory metering in all homes sold in Bromley and Croydon from 2010, or made mandatory by Government legislation.

Most water companies therefore favour the option of a “bottom up” approach, which relies on metering the flows in and out of a district at night.

Using the data collected from night time flow measurements, commonly known as night lines, enables water operators to accurately spot any unexpected continual increases in a DMA’s water consumption that might suggest a burst or an undetected leak, as demonstrated by the following diagram. This diagram shows the impact of a leak over three months, with a continuous increase in apparent water consumption over the period. The sharp decrease shows the greatly reduced consumption after the leak was identified and repaired.



Best practice analysis of DMA flows requires the estimation of leakage when the flow is at its minimum, which is typically at night. Leakage teams close boundary valves around the DMA and take very accurate readings at around 3:00 or 4:00am, which is generally the time when night flow is at its lowest. Customer demand is typically at a minimum at night and the percentage of the flow made up of leaks is therefore at its highest.

For the purposes of such tests, water operators have a choice of techniques, involving either using existing zone meters, installing meters especially for the test, or using temporary insertion probe meters such as ABB’s AquaProbe.

However, certain urban areas are seeing an increase in activity at night, with nightclubs, late-night takeaways and the shift to 24-hour licensing. All this can lead to increased ‘leakage’ reporting when, in fact, increased flow rates could be the result of genuine rises in consumption at night.

Low flows present a challenge

Under-registration of flows is a significant challenge. Many water companies are still relying on traditional mechanical DMA flow meters, which can't cope with the low flows they need to measure at night.

For example, typical mixed commercial and domestic urban DMAs will have two or three inward feeds and two or three pipes exiting the area. Each feed line might expect typical flows of the order of 60 m^3/h in the daytime, and this could peak at 1.6 to 2 times as much. The corresponding flow at night could drop as low as 2 m^3/h with low leakage. With a typical turndown ratio of only 40:1, mechanical meters sized to deal with the peak demands simply cannot provide the necessary accuracy.

With the recent economic downturn, this problem is exacerbated in areas where heavy industry has given way to commercial developments and housing. The overall level of consumption in such areas often falls to a fraction of the historical industrial demand, leaving mains pipes and flow meters hopelessly oversized for the job. So-called "right sizing" programmes are an attempt by water companies to overcome this problem.

These are just some of the reasons why many water companies are upgrading their district meters to electromagnetic technology. Electromagnetic meters offer improved accuracy over a far superior range of flows. For example, ABB's AquaMaster meters offer +/-0.5 percent uncertainty and a dynamic turndown range of 1000:1. In fact, the results available today are such that these meters could even detect a toilet flushing.

Long-term reliability and verification

As well as offering a lower accuracy than electromagnetic meters when new, mechanical meters also present an issue of long-term reliability, since mechanical wear causes a progressive deterioration in performance. A DMA-based leak reduction programme can only be successful if the data is reliable, so this is another strong driver for water companies to switch.

Of course, reputable instrumentation manufacturers put a great deal of effort into ensuring that meters of all types are accurate as they leave the factory. But meters must be peridocially verified or calibrated to maintain confidence in their accuracy in the longer term.

For example, installation damage on an electromagnetic meter may not be spotted immediately. Once the meter is in the ground, no one will know if the magnetic circuit has been distorted, if poor earth bonding is a problem, or if the meter is struggling against EMC interference from noisy pump motor cables or other sources of interference.

The ultimate check would be to remove the meter and send it away for recalibration using an accredited UKAS calibration rig. However, this is an expensive option and may be completely impractical.

In-situ testing can be carried out, for example, using an insertion probe. By taking a series of readings across the pipe, a skilled engineer can gauge the overall flowrate but it's a demanding job. Clamp-on ultrasonic meters can also be used to check meters. But the problem with both of these approaches is that neither is as accurate as the meters they're trying to check.

Software-based verification tools can help solve the problem. ABB's CheckMaster field validation and CalMaster2 IRIS verification tools, for example, rely on ABB installing an electronic "fingerprint" in its electromagnetic meters during calibration. This fingerprint stores information about the magnetic circuit associated with the individual meter. The original fingerprint can then be checked against the meter's current performance for signs of deterioration.

Water industry regulators like the Environment Agency recognised the benefits of verification tools several years ago for abstraction metering. It encouraged robust metering regimes and required regular checking and verification certificates.

New technology which extends the reach of verification tools to mains and battery-powered flow meters could allow water companies and OFWAT to implement periodic verification of strategic DMA meters. This would provide an extra level of confidence in DMA leakage data.

Whichever technology is being used, correct installation is vital. For example, meters need sufficient runs of straight pipework up and downstream to deliver accurate results.

Easy access

Easy access

Installing and accessing DMA meters can be difficult, especially in busy urban areas where the ground is already crowded with an array of underground assets, or where a pipeline runs under a major road. Conversely, meters in remote areas may be nowhere near a potential power supply. Thankfully, today's battery technology means that meters such as ABB's AquaMaster 3 can be sited pretty much anywhere, without having to worry about the availability of power supplies or the need for frequent access.

Accessing the data is the next challenge, but the latest technology can help here too. For example, ABB's AquaMaster 3 transmitters have flow and pressure measurement capabilities, integral data loggers with possibilities of 1 minute logging and GSM text messaging, so that leakage managers can collect all the flow and pressure data from the night lines from the comfort of the office.

Water companies face significant challenges in setting up and applying DMAs successfully, but there is now a growing body of experience in dealing with all the issues. The Water Research Centre (WRc) is a great source of further information. It has carried out many meter technology comparison studies and developed a comprehensive set of Best Practice guides. These should be the first port of call for anyone involved in leakage management and meter replacement strategies.

ABB's AquaMaster GSM flowmeter - the most technically advanced flowmeter in the world

With tens of thousands of units installed in the water industry, the AquaMaster flow meter has come a long way since the idea of applying electromagnetic technology to a market dominated by mechanical flow meters was first proposed within ABB. At that time, in the late 1990s, water companies only used electromagnetic devices on large pipe diameter applications such as district mains, and the idea of applying this approach to DMA Leakage and revenue applications was a new one.

ABB's new AquaMaster 3 flowmeter.

However, ABB realised that a battery-powered electromagnetic meter could exceed the current needs of the market for accuracy. With mechanical meters, water companies were settling for an accuracy of ±2 per cent, but the metering experts at ABB knew that electromagnetic technology could beat this and save the water companies a lot of money in the process.

Even though there had not been any great demand from the water industry for better meters until that point, confidential consultations with key customers convinced ABB that a new product could generate fresh demand from scratch. It is an easy case to make – improved accuracy will have a direct impact on water companies' bottom lines.

When compared with a conventional mechanical meter installation, the installation benefits of the AquaMaster are clear. In a conventional mechanical meter installation, a considerable amount of ancillary equipment, including strainers, isolation valves and a bypass, is required in addition to the meter itself. The whole installation also has to be situated in a specially constructed chamber. Taken together, the requirement for the ancillary equipment and the chamber can add significantly to the cost of the installation.

In a typical AquaMaster installation, on the other hand, all that is required is the flow meter primary. A small chamber may also sometimes be required for the transmitter, although it can also be located above ground in a pillar or kiosk housing.

Consequently, the cost of an AquaMaster installation can often be 60 percent less than a traditional mechanical meter installation.

In addition to the headline improvement in accuracy, there are a number of other well-known advantages to electromagnetic water metering when compared with mechanical devices. First, the fact that electromagnetic systems contain no moving parts eliminates the need for routine maintenance. This in turn means that the overall installation costs are lower, because the end user does not need valves to isolate the meter during maintenance and replacement.

The lack of moving parts also means that the accuracy of electromagnetic flow readings will not deteriorate through wear, whereas a mechanical meter's accuracy will deteriorate with age resulting in under reading. And with so many wearing parts, a typical mechanical meter will have a useful life of just five years or possibly shorter if particulates are present in the water, while a correctly-installed AquaMaster should offer fit-and-forget service for 10 years or more.

Enhanced revenue management

Consider a mechanical DN150 flow meter that is accurate to within ±2 percent. This flow meter is installed in a line with an average flow rate of 10 litres per second, which equates to an annual usage of 315,360m^3. Assuming a cost just for water at £0.50 per m^3, over the course of one year the potential inaccuracy of the meter could be losing the operator around £2,500 of revenue.

If this meter is replaced with an ABB AquaMaster electromagnetic meter, which has an accuracy of ±0.5 percent, then the meter could pay for itself within just 23 days and continue to save money in the future. Further savings and increased revenue come from the far wider flow turn down or operating range of an electromagnetic meter compared with a mechanical meter, which gains additional revenue with night flows, where the flow rate normally drops and mechanical meters will stall and stop registering. This typically amounts to a similar sum, doubling the additional revenue to around £4,600 per annum.

The AquaMaster was originally launched in London in 2001 in mains and battery powered versions. Since that time, the product has been regularly upgraded. Upgrades have included the option of solar and wind power options alongside improved battery technology, plus GSM/SMS technology, which enables users to remotely access up-to-date information from anywhere around the world. Using the same technology as a mobile telephone, ABB's AquaMaster flowmeters can be contacted using a PC or laptop or through a mobile telephone via SMS messaging.

Via a GSM link to their PC or laptop, users can access the AquaMaster's three integral data loggers, two of which collect data on flow and pressure, with the third providing daily flow totalisation. Data can be downloaded from the flow and pressure loggers, based on both a 15 minute and a world leading high resolution one minute sample rate, to provide a range of information which can be used to pinpoint supply fluctuations and identify potential problems.

Operators can also remotely reconfigure and maintain their AquaMaster units online, including adjusting the configuration, reading flow meter totals or performing diagnostic tests without the time and cost of despatching an engineer or meter reader to carry out the work on site.

Using SMS text messaging, operators can request updates on current flowmeter status simply by sending a text message to the AquaMaster's 'telephone' number. Via this medium, operators can request and receive data on any of the meter parameters including flow rate, pressure, total water consumption, alarms and tariff totals.

Summary

Summary

As stressed at the start of this document, leakage in a water distribution network can never be completely eliminated. However, experience has shown that combining an effective leakage management strategy with the latest technology can have a major positive impact on helping water operators to greatly reduce leakage in their networks.

As a leading manufacturer and supplier of flowmetering technology, ABB has a wealth of experience and expertise in water management issues. For more information on how ABB could help you to tackle leakage in your network, please email **moreinstrumentation@gb.abb.com** or call **0870 600 6122 ref. 'leakage'.**

Electronic vs Mechanical flowmeters – a comparison	
Electronic meters	
Advantages	**Disadvantages**
No moving parts eliminates need for routine maintenance	Higher initial purchase price
Electronic verification possible	Requires installation by approved and competent installers
Reduced overall flow system cost – e.g. no isolating valves need to be installed for maintenance	
No filters required	
Flow reading will always be accurate – will not be affected by wear	
Capable of logging flow and pressure information	
Logged information can be retrieved remotely via GSM	
If installed properly, AquaMasters meters can offer fit-and-forget operation for up to 10 years	
Payback can typically be achieved within one month	
Reduced straight lengths required	
Traditional meters	
Advantages	**Disadvantages**
Lower initial purchase price	Frequent routine maintenance is required – e.g. to change filter inserts
Traditional simple approach	Maintenance requires purchase of isolating valves to shut off flow
	Reading accuracy is affected by mechanical deterioration true accuracy will only ever be achieved in the first days of operation
	Typical lifespan of just five years
	Need to install two meters in parallel for widest possible turndown
	Increased straight lengths required for correct installation and accuracy

Case study

Overview

ABB's AquaMaster electromagnetic flowmeter played a key role in cutting water leakage across a large swathe of the Ministry of Defence estate with reductions of 60 percent achieved at some sites. Leakage dropped by approximately 2 million m^3/year across more than 1,500 MoD sites where water and waste utility assets are managed by C2C Services.

By applying the latest techniques and technologies in leakage detection and repair across the Defence estate, the MoD has been able to smash government consumption targets a decade ahead of schedule, delivering savings of 25 million litres of water every day.

The problem

The Government provided the MoD with a target to reduce its water consumption by 25 percent by 2020. This objective was hampered by the lack of a joined-up water metering strategy across the sites involved, which made it difficult to obtain an accurate picture of overall consumption and leakage levels.

ABB AquaMaster has the answer

C2C Services is a consortium of Severn Trent Services and Costain which is responsible for providing water services to MoD sites in the North, East and South East of England, known as 'Package C'. The 25-year £1billion contract is part of Project Aquatrine, which transferred responsibility for MoD's water services to three different contractors.

C2C services commissioned ABB to install around 900 AquaMasters, with additional meters fitted where additional flow data was required. With a measuring range of 1000:1, AquaMasters are accurate across a very wide range of flows, making them ideal for this project. C2C's water resources manager, Mark Amor, says that the AquaMaster meters from ABB have been central to the success of C2C's leak reduction programme. "We've used a targeted approach and it's all based on the availability of high quality data."

'Gross Meters' were used to measure the consumption on each site by monitoring the gross incoming water supply. These are also used to continuously validate Statutory Undertaker (SU) revenue meters which are used by local Water Companies to generate bills. 'Night line meters' provide a critical indication of leakage levels during periods when legitimate consumption is at its lowest.

A key feature of the AquaMasters supplied is the convergence of flow measurement, data logging and GSM-SMS technology into one unit. Using this technology, C2C can remotely set the integral data logger to either high resolution 1 minute logging for in-depth investigation of night lines, or a standard 15 minute frequency for normal operation. Once a day, all the readings are uploaded to a central server using text messages sent via the AquaMaster's built-in GSM facilities.

Once on the server, the data is managed using AutoChart software from Information and Performance Services (I+P). AutoChart's Windows-based interface lists all the meters and their readings graphically or numerically. It also shows the status of each meter using a traffic light alarm system.

From the secure server, the data can be read and manipulated over the internet from anywhere in the world. "This approach means that C2C doesn't need to have sophisticated software loaded on all of its PCs," says I+P Managing Director, Ashley Roe. "It's all on the server."

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