The Entrepreneurial Approach to Implementing a Leakage Control System in Municipal Networks – Case Studies

N Naveh*, M Ingham, C Melamed***, Y Enav****, O Cohen*, G B Shalom***

* BERMAD, Evron – Israel, navehn@bermad.com

** Mitre Associates, Brackley, Northants. NN13 5LT – UK, mikei@envisionenergy.co.uk

*** C.H.Y.E.M (CN), Naharia – Israel, elnon@bezeqint.net

**** Enav Waternets, Azmon – Israel, enavy@bezeqint.net

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Tackling the reduction of water leakage

The problem

Reduction of water leakage as an economic problem

Reduction of water leakage and waste in municipal networks is primarily an economic problem. The two principal questions to be considered by both operational and financial managers are always:

1. How much can be invested?, and
2. How much will be saved by that investment?

If it can be shown that the return on investment is economically viable with a reasonable “pay-back” in months rather than years, leakage or more precisely ”unaccounted for water” is tackled and the problem is dealt with.

Occasionally reducing leakage or reducing background consumption for example by installing water-conserving devices, will always result in added benefits.

It is generally accepted that selective reduction in pressure across a pipe network will result in a reduced number of burst pipe occurrences and therefore reduced maintenance and repair costs as well as extending the operational life of the system.

Similarly, reducing consumption by education, good housekeeping and the introduction of water saving products will extend the availability of the water resource and postpone the need to invest in the development of alternative water sources.

The economic dilemma in Israel

In Israel, however, analysis of the economic equation is problematic. This is due to the fact that most municipalities and local authorities receive their water supply from Mekorot – The National Water Company, with the water defined as a national resource. Most water sources are therefore developed by the state. This creates a situation whereby the cost of developing water sources is shouldered entirely by the state, while the cost of dealing with water loss in municipal water systems is the responsibility of the local authorities. (Feldman, 2004)

The dilemma of the water manager

A conventional economic approach requires that the supplier of water asks the question:

"How can I achieve, and what will it cost me, to supply 'x' amount of water as opposed to losing that amount in leakage?"

In Israel there is a simple answer: I'll buy more from Mekorot and I'll pay $ 0.45 per cubic metre. From the point of view of the head of a municipal water department, there is no need for additional investment in the development of new water sources, nor is there any shortage.

In Israel, notwithstanding full exploitation of water sources, there is no shortage of water for municipal consumption. Heads of municipal water departments do not have to cope with a situation where consumers turn on their taps and nothing comes out (except, of course, during temporary mishaps). One can always buy more water from Mekorot. On the other hand, the country invests huge sums in water desalination and the cost of a cubic metre of water – including the cost of desalination, Mekorot's setting up of an infrastructure for storing and conveying the water, operations and energy costs – can easily come to $0.70-$0.80 per cubic metre. In other words, it equates to a sum nearly double what the municipalities are paying – but yet not realistic in economic terms! (Feldman, 2004)

Consumption reduction

There is also a conflict of interests here between the local authorities and the state. The former sells water at a profit – $ 0.77/m3 and more – thereby making water a source of income. Reducing pressure in the system will reduce water loss, but it is also liable to (or will definitely – depending on your point of view) reduce consumption, thereby also reducing income. It must be stated, however, that in dynamic operation, the reduction of pressure is introduced mainly during low consumption or off-peak hours, and therefore its effect on actual consumption is minimal. The head of the local authority or municipality and manager of the water department, whether he is a professional person aware of the country's water situation, or just a concerned citizen, undoubtedly and with good will, desires to positively contribute to the economy and to reduce water demand. However, as the head of an economic organization, usually faced with a deficit, can they really take a decision that will mean a reduction of income – a serious dilemma?

If preliminary investigations confirm that leakage reduction is economically viable, then practical steps can be taken to deal with the problem. Without doubt reducing leakage, tackling wastage, removing illegal connections and minimizing domestic and commercial consumption by, for example, installing water-conserving devices can have beneficial consequences. The reduction in distribution pressures throughout the network - **without compromising service levels and fire protection** - will result in reduced leakage and a drop in the re-occurrence of burst pipes in the network. Tangible benefits therefore include reduced maintenance costs as well as extended life of the system. Similarly, reducing overall consumption will extend the availability of water resources and postpone the need to invest in the development of alternative and often more expensive water sources.

The Entrepreneurial Approach

The solution

The solution to this problem must lie then, in the state creating financial motivation for the municipalities to save water or by the municipalities adopting a totally new approach – The Entrepreneurial Approach.

The "Aquaduct Group"

Following successful preliminary investigations and the creation of an acceptable General Working Plan in conjunction with an enlightened municipality – The Aquaduct Group was formed, comprising a group of experts from various technical and commercial disciplines. The individual experts committed to the Leakage Control and Water Management Project provides three main areas of expertise and experience:

- Creation of an appropriate Integrated Water Management Plan including site monitoring and leakage / wastage control.
- Project management and the creation of a legal framework to measure performance and achieve commercial success for both parties on a “profit sharing” basis.
- Product selection of flow meters and pressure management and control valves based on numerous years of site based experience in Israel, including maintenance, technical support and training of local municipality staff.

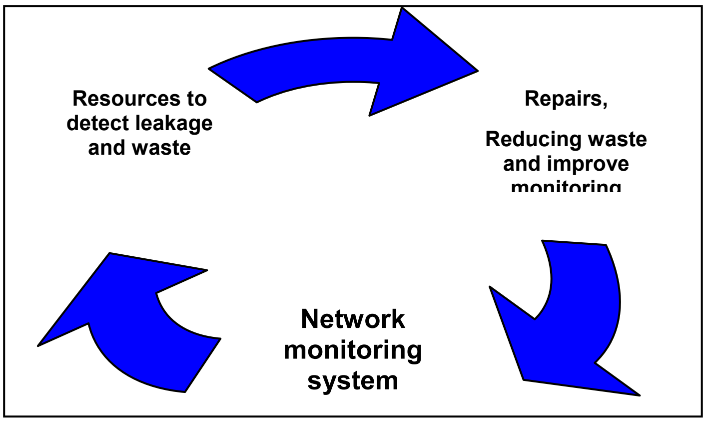
The Aquaduct Group offers this Entrepreneurial Approach by way of implementing a “proactive” Leakage Control System in the municipality and with the aim of sharing the savings from reduction of leakage. The municipality and the Aquaduct Group are committed to this approach and signed a detailed contract for a specified number of years. At the end of the contract period the municipality’s management and staff will be adequately trained and informed to be able to continue with an integrated approach to water management and leakage control, by themselves.

Integrated Water Management Plan

The main idea of every leakage control system is:

"What is not measurable cannot be managed"

To achieve such a system, the "Aquaduct Group" leads a circular working plan:



The “Aquaduct Group” Action Plan comprises the following overall Scope of Works as part of the site based project work, which includes **6 principal steps**:

Installation of District Meters

(Step no. 1: Flow & Pressure Readings)

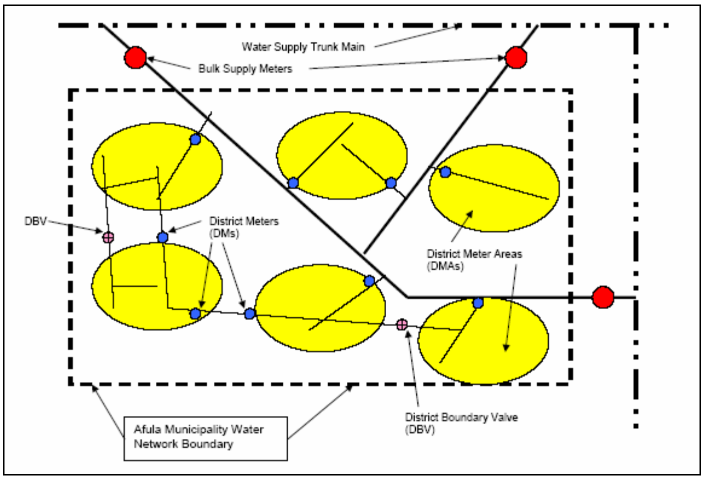


Figure 1 Design of District Meter Areas

Initial Monitoring Period

(Step no. 2: Nightlines & Pressure Variations established)

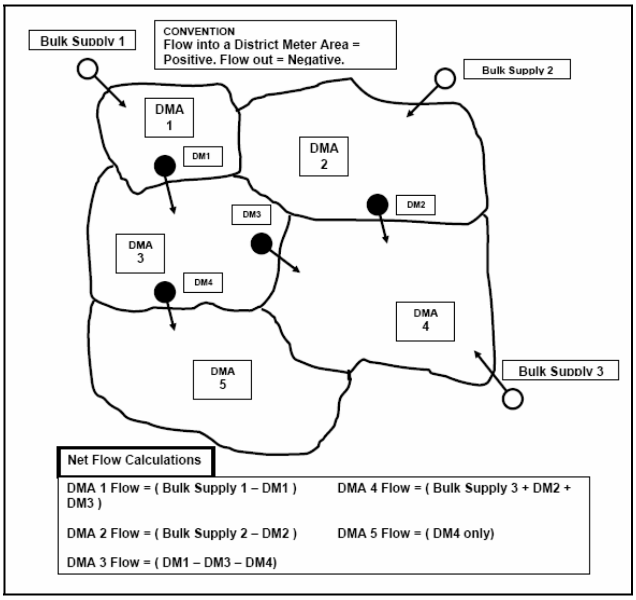


Figure 2 Net Flow Calculations

Decide if Pressure Management is Feasible

(Step no. 3)

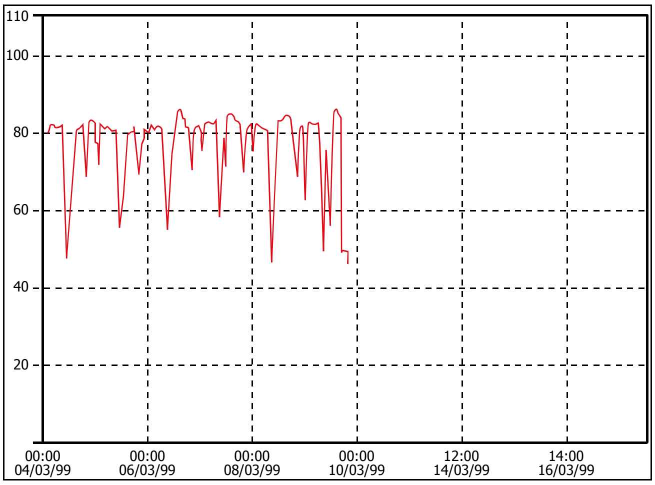


Figure 3 Pressure Data at the critical point before Pressure Management

Investigate Pressure Management

(Step no. 4: Activation of Automatic Control Valves)

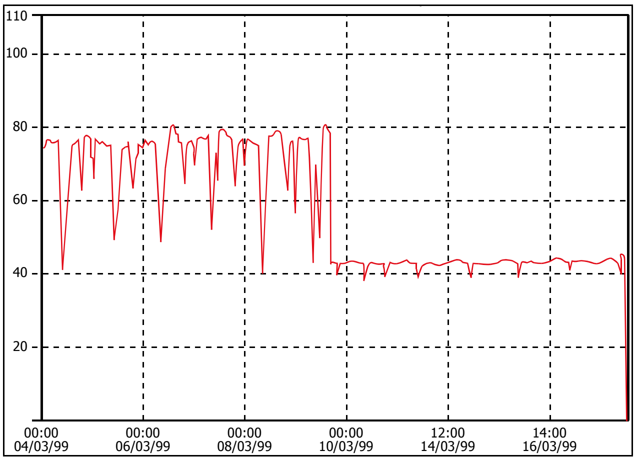


Figure 4 Pressure Data at the critical point before and during Pressure Management

Step Testing

(Step no. 5: Valve Operations to Confirm Leakage Volumes and Locations)

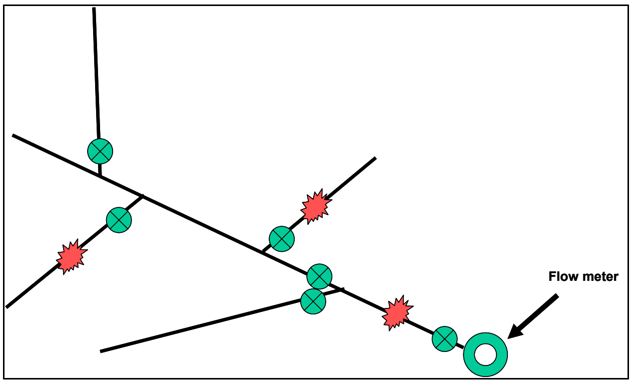


Figure 5 Leakage in a distribution network

Leak Sounding / Correlation

(Step no. 6)

Figure 6 Leak Noise Correlation Pods

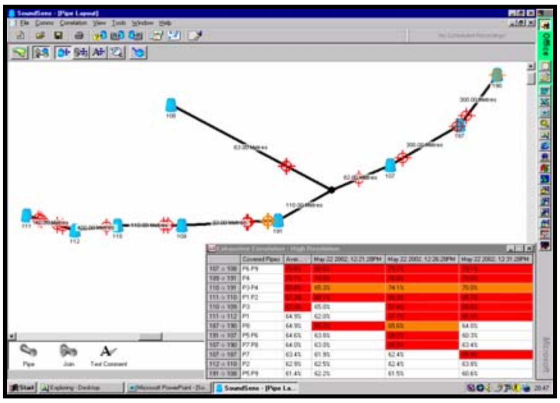


Figure 7 System analyses - Pods locations

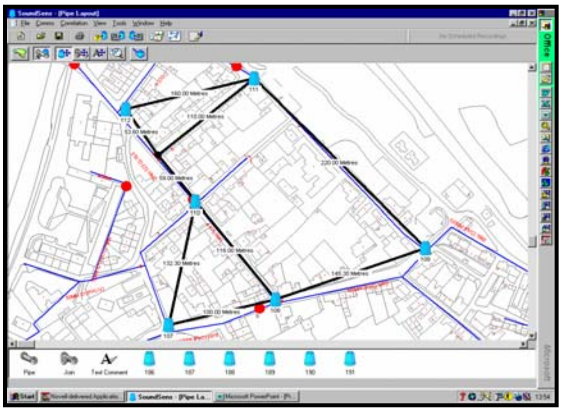


Figure 8 System analyses - Pods locations

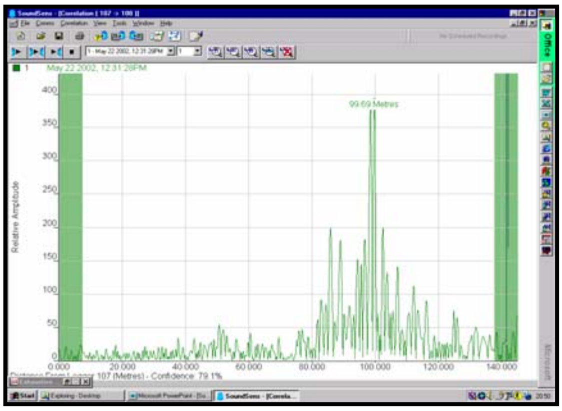


Figure 9 Leak detection result

Legal frameork to measure performance

The municipality and the Aquaduct Group are committed to this approach and signed a detailed contract for a specified number of years. At the end of the contract period following an extensive "transfer of technology and associated skills", the municipality's management and staff will be adequately trained and informed to be able to continue with an integrated approach to water management and leakage control, by themselves.

The "punch line" of this contract is the mechanism to be used to measure the saving of water. Once defining the mechanism, the Aquaduct Group offers the sharing on a basis of 50%-50% with the municipality.

The municipality invests the first amount on the preliminary plan and leakage analysis, while the group invests on the accessories and implementation of the DMAs. Both parties work hand-in-hand to follow all six steps of the action plan.

There are two methods for the mechanism of calculating the saving:

1. The most common method is to relay on existing data of the amount of water bought by the municipality vs. the amount of water sold to the consumers. If such data is on-hand, it is recommended to define a test period of several months and compare this period to the next period after the implementation of

the leakage control system. The difference in water volume is the saving for that period.

2. The second method is required for many places that we do not have any available data to start with. It can be in municipalities that do not measure the amount of water that sold to the consumers or any other reason. In the method to be used in these places we define the minimum night-line after short period of measurements. Then, we implement the leakage control system and operate the system for an agreed time period. At the end of the time period we measure night-line again and calculate the saving as the difference between the two night-lines is multiplied by the price of a cubic Metre. Some operators might say: "minimum night-line is not the leakage and waste during day time", that is correct but also is easy to calculate the adjustment to correct the values of leakage and waste.

The agreed algorithm to measure the saving from reducing the leakage and waste with this method will be to calculate the volume of water that is shown in the graph below (the dark color).

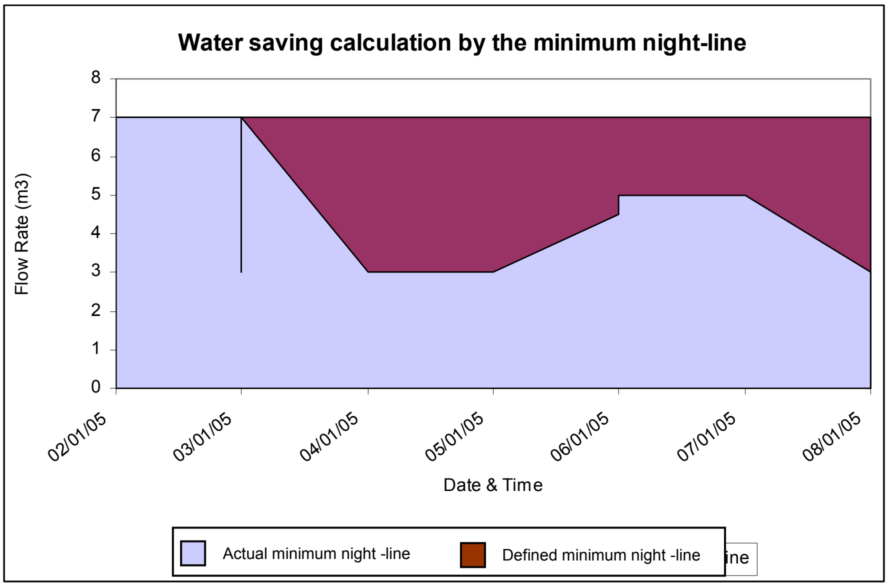


Figure 10 defined and actual minimum night-lines

Data from the case studies

The data shown in the paper is a summary of three different case studies that are currently ongoing. One is located in the city of Inverness Scotland and two are from Israel the city of Afula and the village Azmon).

Performance Related Reasons

Why has the leakage increased in that area?

The leakage has increased due to the increase in pressure that caused by a Boundary Valve being operated or lack of maintenance on a PRV, thus driving up the leakage levels. ***The clever bit is to sort the problem and show the whole scenario.***

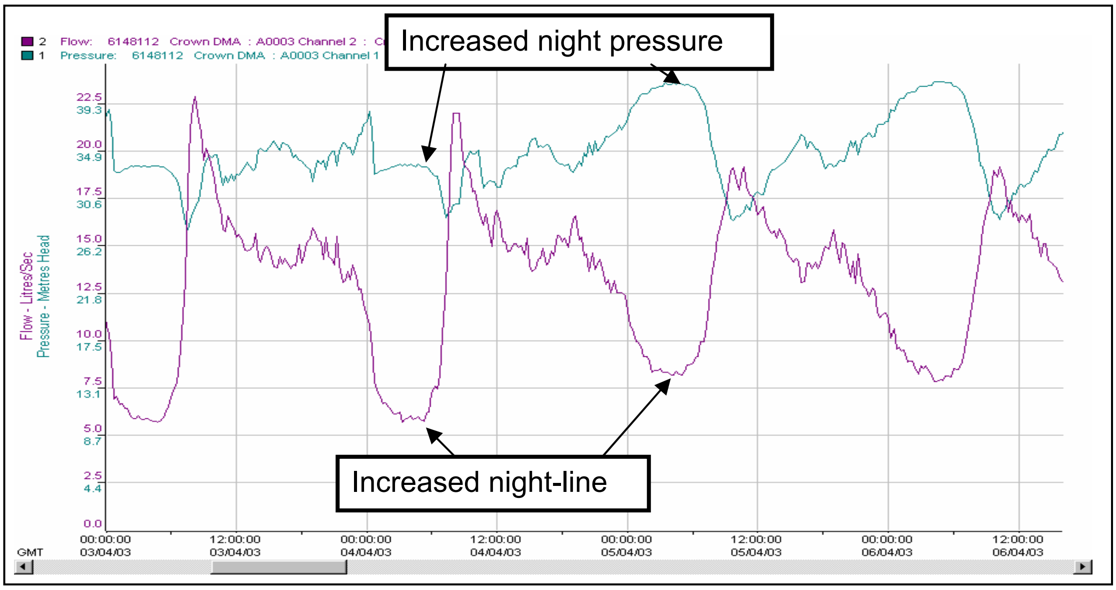


Figure 11 Pressure Management – Inverness, Scotland - Crown DMA – Increase night-line

Case study Azmon, Israel:

Azmon is a small size village in a mountain area in north Israel. The population in Azmon is about 1,200. The age of the distribution network in Azmon is about 30 years. The system in Azmon includes a single DMA with two pressure zones.

The table shows the water balance that the village carries for billing in the last six months. At the first five months there is a difference of about 1,100 cubic Metre between the amount of water the village buys and sells. While at the six month, after initialization of the pressure control project the amount is reduced to about 760 cubic Metre – 30% reduction. The calculated International Leakage Index (ILI) for Azmon is 4.70.

Figure 12 Table of water balance for billing in Azmon, Israel

Date of measure	Volume of water bought from Mekorot	Volume of water sold to consumers	Volume of water sold to external consumer	Volume of water supplied to public facility	Volume of water supplied to public Gardening	Total volume of water sold or supplied w/o selling	Leakage
23 Jan 05	5182	3741	93	87	43	3964	1218
23 Feb 05	5023	3615	93	87	38	3833	1190
27 Mar 05	5836	4208	150	87	158	4603	1233
19 Apr 05	8397	6538	0	87	615	7240	1157
23 May 05	13807	10933	215	87	1412	12647	1160
19 Jun 05	11365	8679	167	139	1621	10606	759

The common practice to the above problems is reducing and maintaining the maximum pressure in the system by pressure reducing valve (PRV). The figure below (11) shows measurements the flow and pressure data from DMA Azmon, Israel: 10 days data after installing a standard pressure reducing valve (PRV). The measurements are in the DM – system head.

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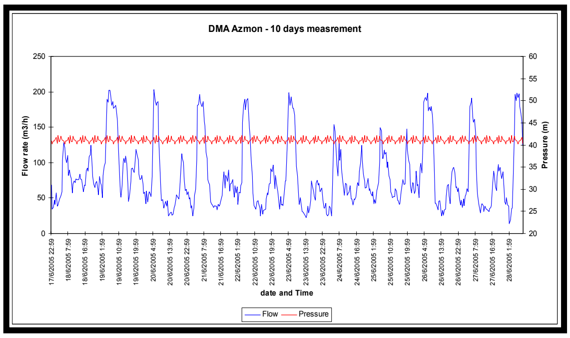

Figure 13 Flow and pressure data from DMA Azmon, Israel after installation of PRV

The figure below (13) shows the measurements of the pressure data at the critical point of DMA Azmon: 10 days data after installing a standard pressure reducing valve (PRV).

The measurements are in the critical point of the DMA.

It is possible to see the variation in the pressure values at the critical point of the DMA and understand that the common practice is not enough to solve the excess pressure in the system.

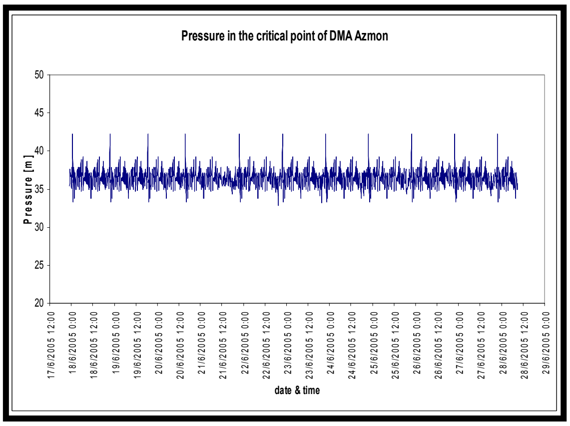

Figure 14 Pressure data from the critical point of DMA Azmon, Israel after installation of PRV

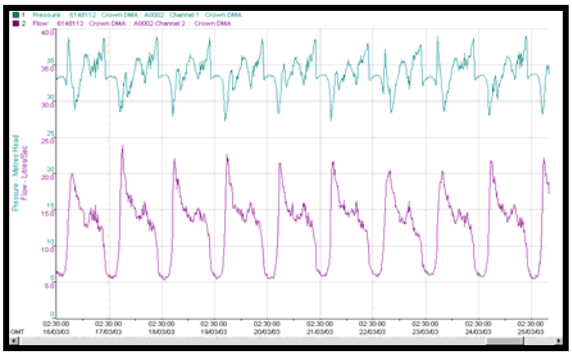

Figure 15 Flow and pressure data from City of Inverness before installation of PCV (Pressure control valves)

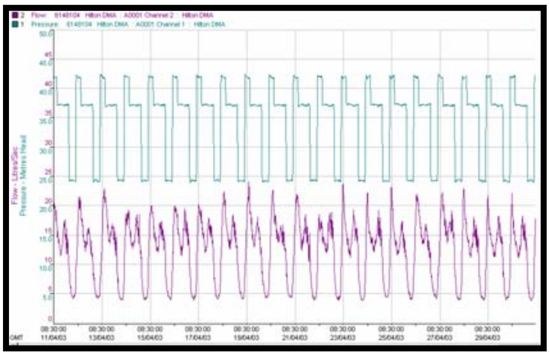

Figure 16 Flow and pressure data from City of Inverness before installation of PCV (Pressure control valves)

The data from the city of Inverness (figures 15 & 16) shows how the installation of PCVs changes the flow/pressure in a way that during low flow the system experiences low pressures, while during peak demand the pressure in the system is high enough to supply the minimum required pressure. This system uses two pressure timing – day pressure and night pressure.

Equipment for pressure control

The pressure control valves (PCV) in Inverness and Azmon are controlled by individual valve controllers.

Figure 17 two units of two-step pressure control system (PCVs)

The Hydrometer – Flow monitoring and pressure control in a single device, used in Scotland.

Figure 17 Installation of the hydrometer for Flow and Pressure Control system (FPCV)

Conclusion

Reduction of water leakage and waste in municipal networks is primarily an economic problem.

If it can be shown that the return on investment is economically viable with a reasonable "pay-back" in months rather than years, leakage or more precisely "unaccounted for water" is tackled and the problem is dealt with.

In some countries the water sources are developed by the state. This creates a situation whereby the cost of developing water sources is shouldered entirely by the state, while the cost of dealing with water loss in municipal water systems is the responsibility of the local authorities. In these countries there is not enough motivation for the municipalities to deal with water leakage and waste.

The solution to this problem must lie then, in the state creating financial motivation for the municipalities to save water, or by the municipalities adopting a totally new approach – The Entrepreneurial Approach.

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