Water services for supply and sanitation

Technological capacity, determining factors and solutions

Pressure management in water supply networks
Technological means

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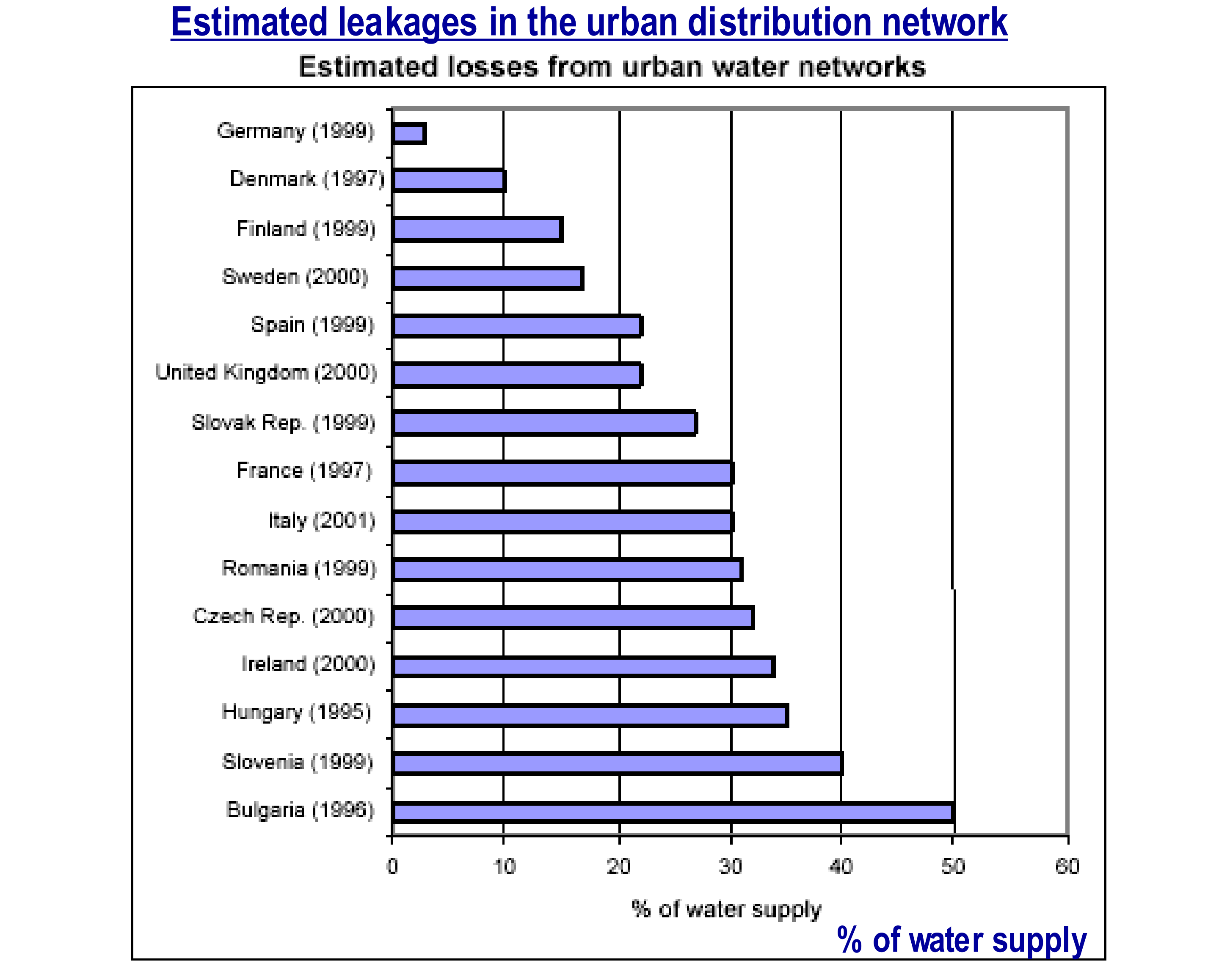
Zaragoza, 17 de julio de 2008

Water leakage in the distribution network



Water balance as per IWA (simplified)

<table>
<tr><td rowspan="4">System Inlets</td><td rowspan="2">Authorized consumption</td><td>Authorized and invoiced consumption</td><td>Water with income</td></tr>
<tr><td>Authorized consumption not invoiced</td><td rowspan="3">Water without income</td></tr>
<tr><td rowspan="2">Leakages</td><td>Apparent leakages</td></tr>
<tr><td>Real leakages</td></tr>
</table>

The 4 parameters diagram

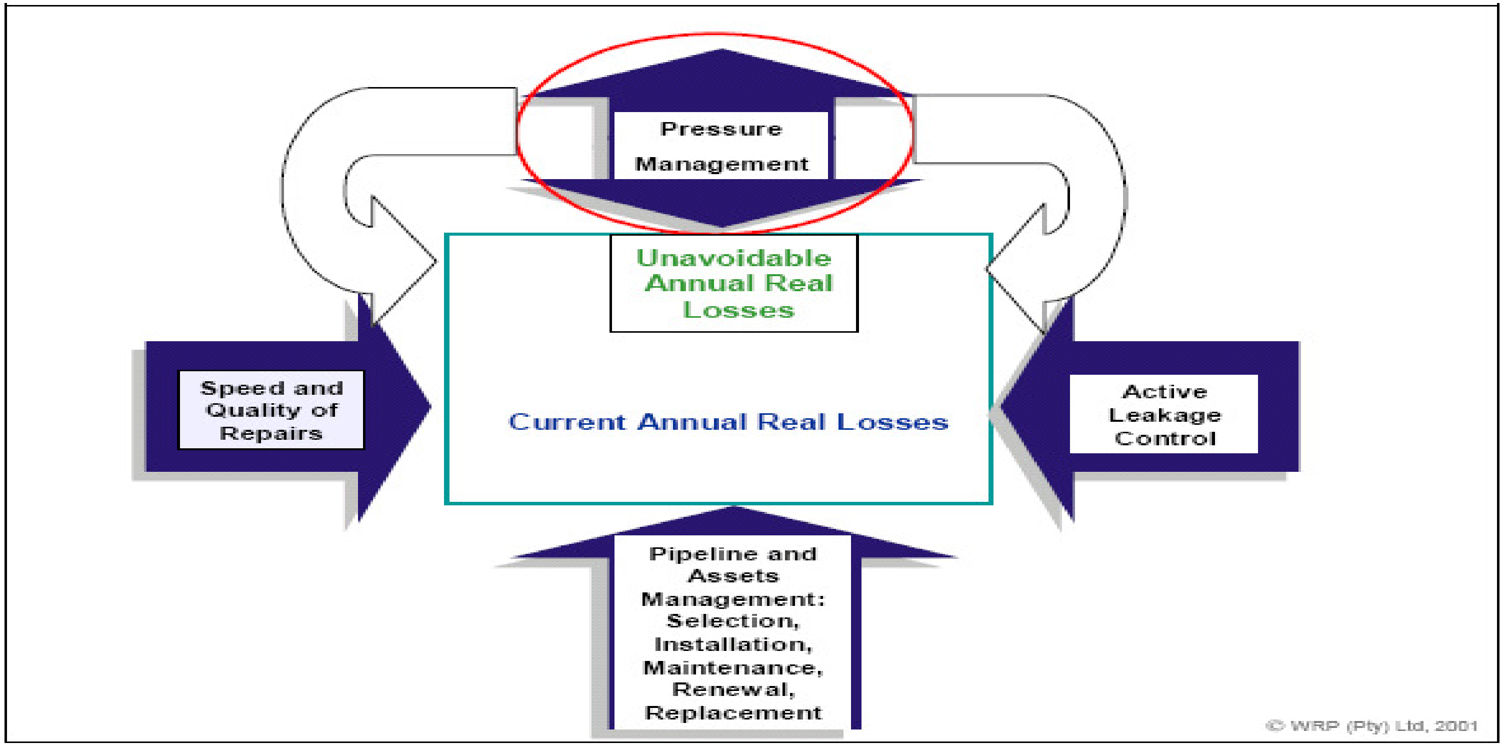


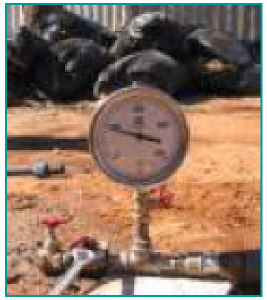
Figure 18: The four components diagram, with secondary influences of pressure management

Infrastructure Leakage Index ILI can be calculated

Unavoidable Annual Real Losses

Current Annual Real Losses

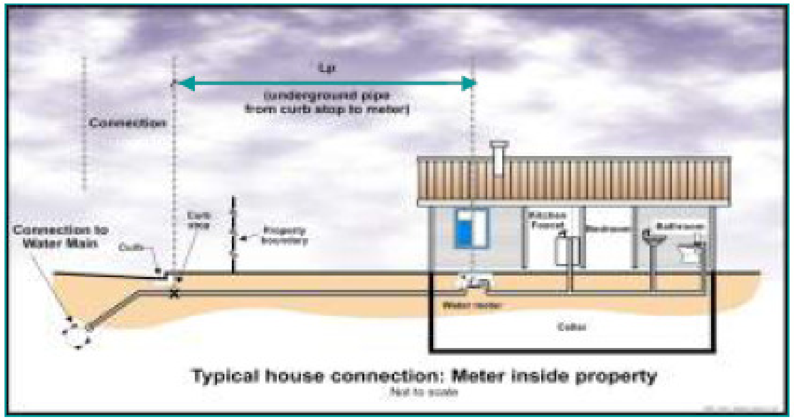
$$UARL = (18 \times Lm + 0.8 \times Nc + 25 \times Lp) \times P$$



Main length

Number of conn.

Length of private pipe



ILI = CARL / UARL

ILI = International Leakages Index

$$ILI = \frac{\text{Actual real leakages level}}{\text{UARL = Unavoidable annual real leakages}}$$

General description of the categories for the management of real leakages

Countries in course of development ***ILI***	*Developed countries* ***ILI***	**BAND** ***ILI***	
Less than 4	**Less than 2**	**A**	Improvements in the reduction of leakages can be non economic unless there is a lack of water. It is necessary to make a careful analysis in order to identify improvements that have an impact on the cost-effective.
from 4 to 8	**from 2 to 4**	**B**	Potential for marked improvements. Consider pressure management, better practicing of leakages control and a better network maintenance.
from 8 to 16	**from 4 to 8**	**C**	There is no systematic registration of leakages. It is tolerable only in case of plenty and cheap water. Even so, it should be analyzed the level and nature of the leakages, and intensify the efforts for its reduction.
16 and more	**8 and more**	**D**	Very poor use of resources. The programs for the reduction of leakages are imperative and of high priority.

Pressure Management

THE PRESSURE MANAGEMENT REDUCES THE NIGHT LEAKAGES AS WELL AS THE NUMBER OF "INTERVENTIONS" IN THE ACTIVE DETECTION OF LEAKAGES.

Finding and restoration

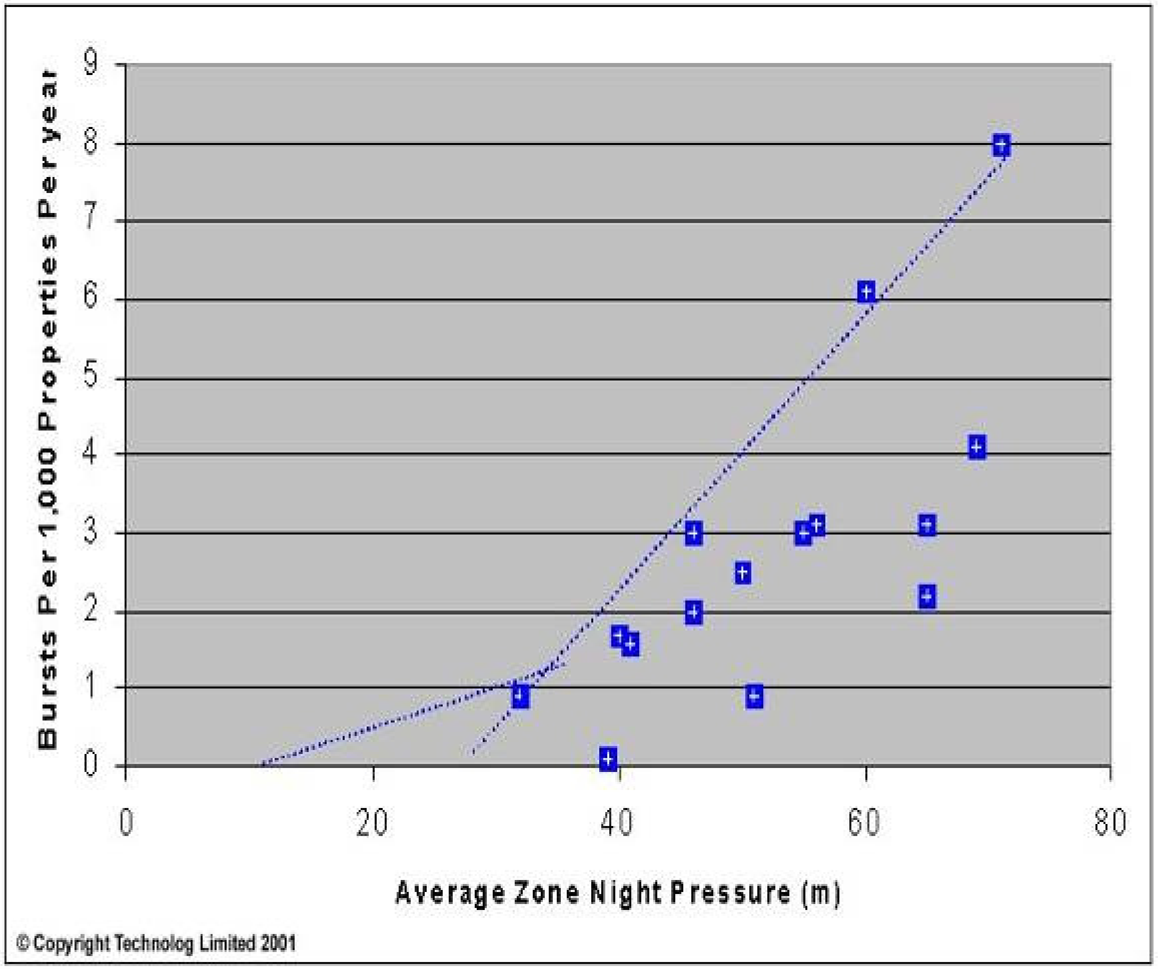
LEVEL OF LEAKAGES

Minimum level of leakages without pressure management

Minimum level of leakages with pressure management

Time/Years

Failure rate according to the system pressure



Failure rate (no/Km/year)

Pressure (meters)

Failure rate according to the system pressure

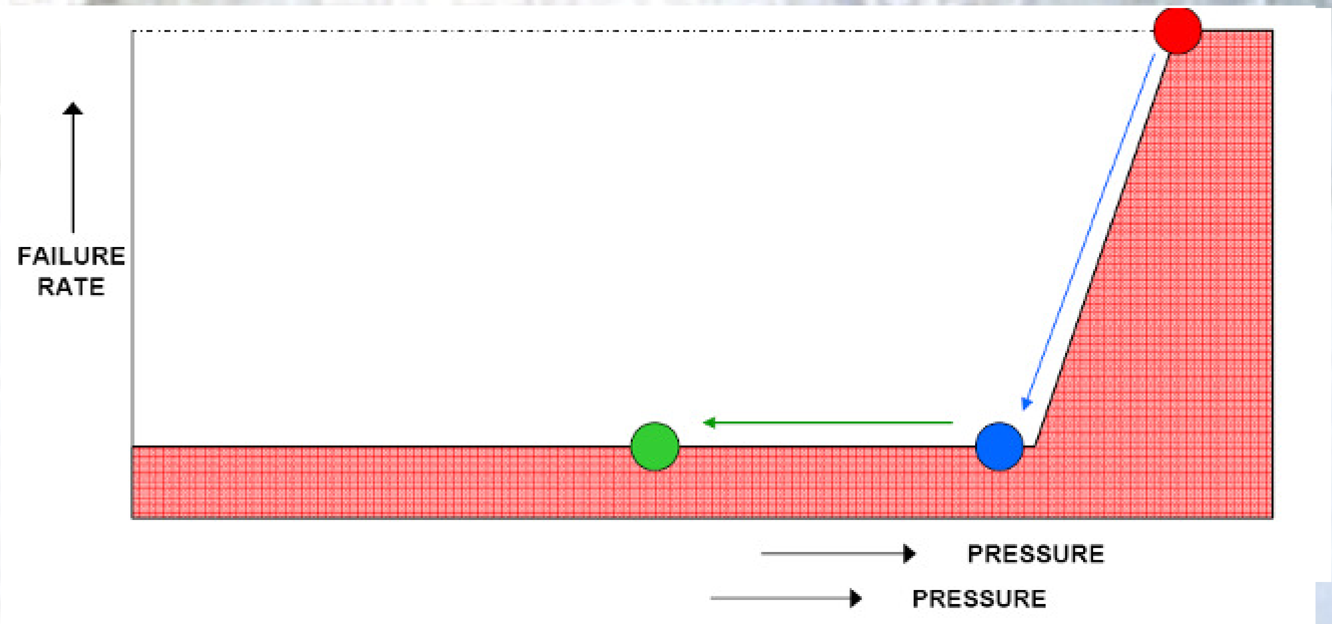
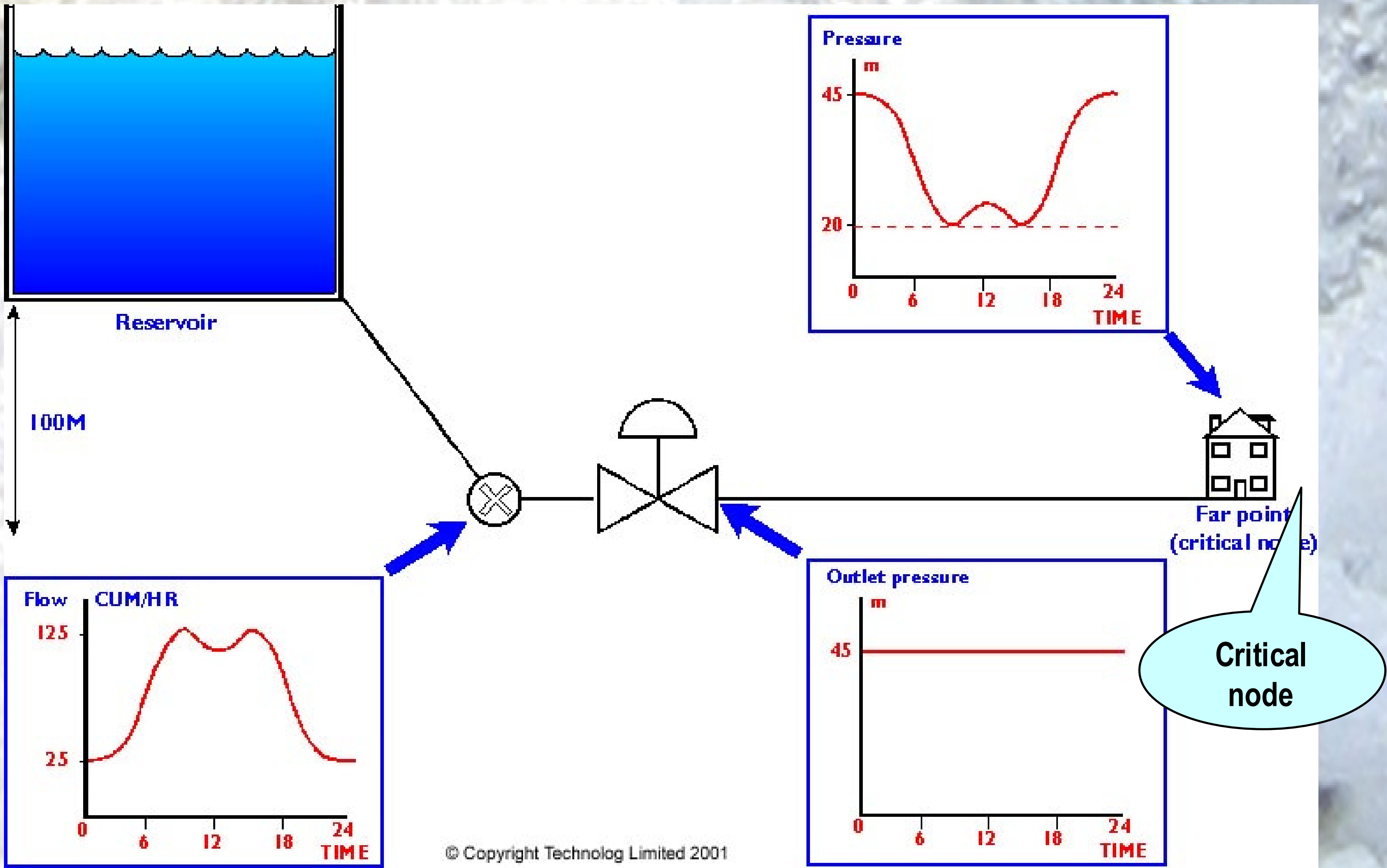


Diagram of a municipal distribution network



Pressure and leaks

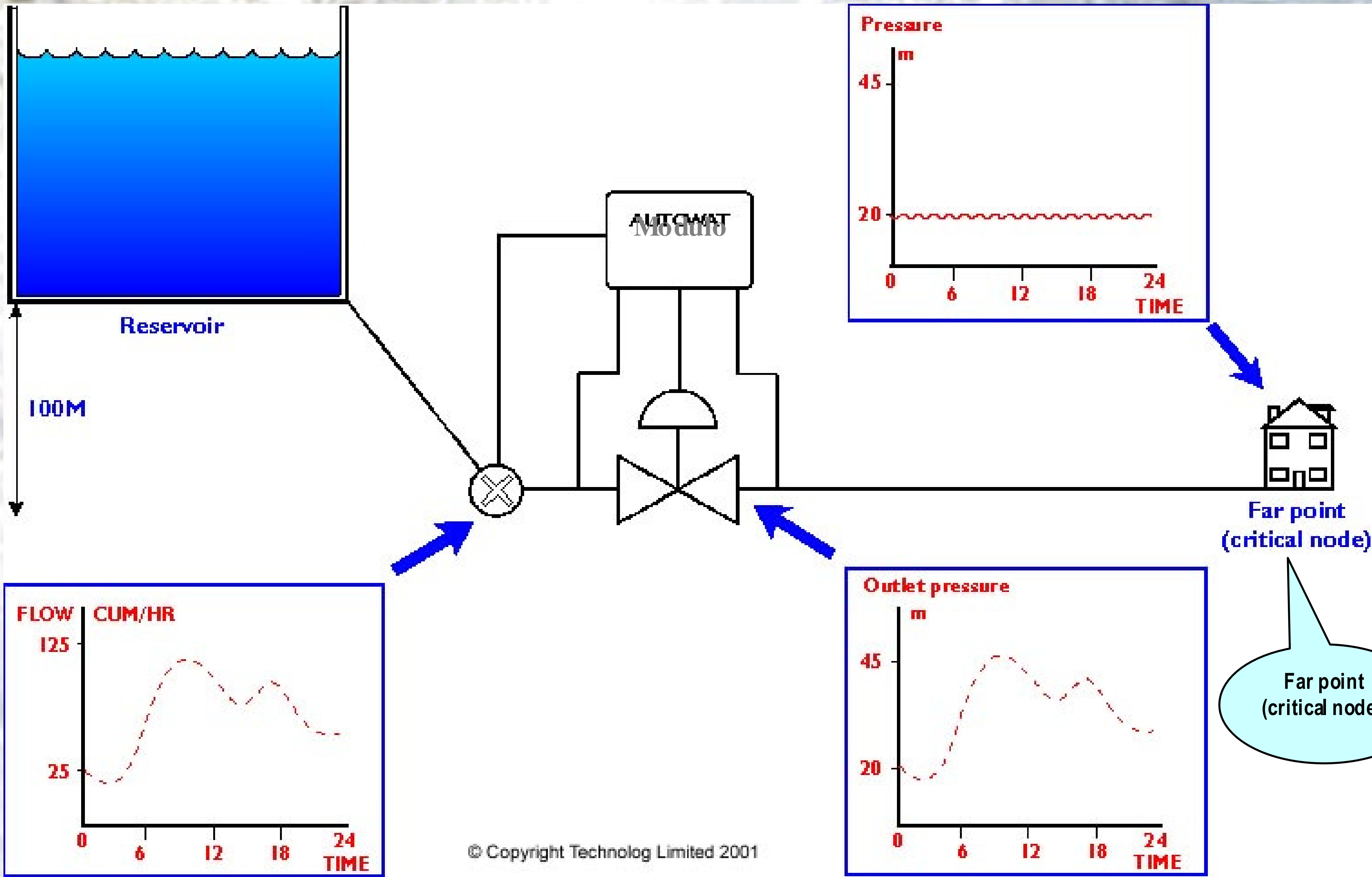
High pressure

Low pressure

Pressure Control

Constant regulation of the pipeline pressure, so that no surpluses will be created in the critical points of the network and to keep the minimum pressure required.

Dynamic pressure control



Presentation Contents

- Control Valve Installations
- Effectiveness of Pressure Control
- Economics of Pressure Management
- Closing Statement.

Control Valve Installations

Pressure Control Valve Installation

Simple 50mm Bermad 923 with 15mm lo-flo bypass on a 90mm HPPE pipe.

Installation Cost (Total)

Circa 6000 Euros.

Time - 1wk

Trunk Main Pressure Control

150mm Bermad 923 Hydrometer.
GSM Logger – Flow and Pressure.
0 Bursts in 2 years before was a different story .....

What we do not want to see !!

19mm service pipe loosing 30cu.m/hr

Inverness Bunker PRV's
Pressure Optimisation February – April 2008

The Bunker!

Water is supplied into Inverness from the Inverness WTW at Loch Ashie, 225m AOD.

The “Bunker” is situated at approximately 45m AOD, managing a static head of 180m.

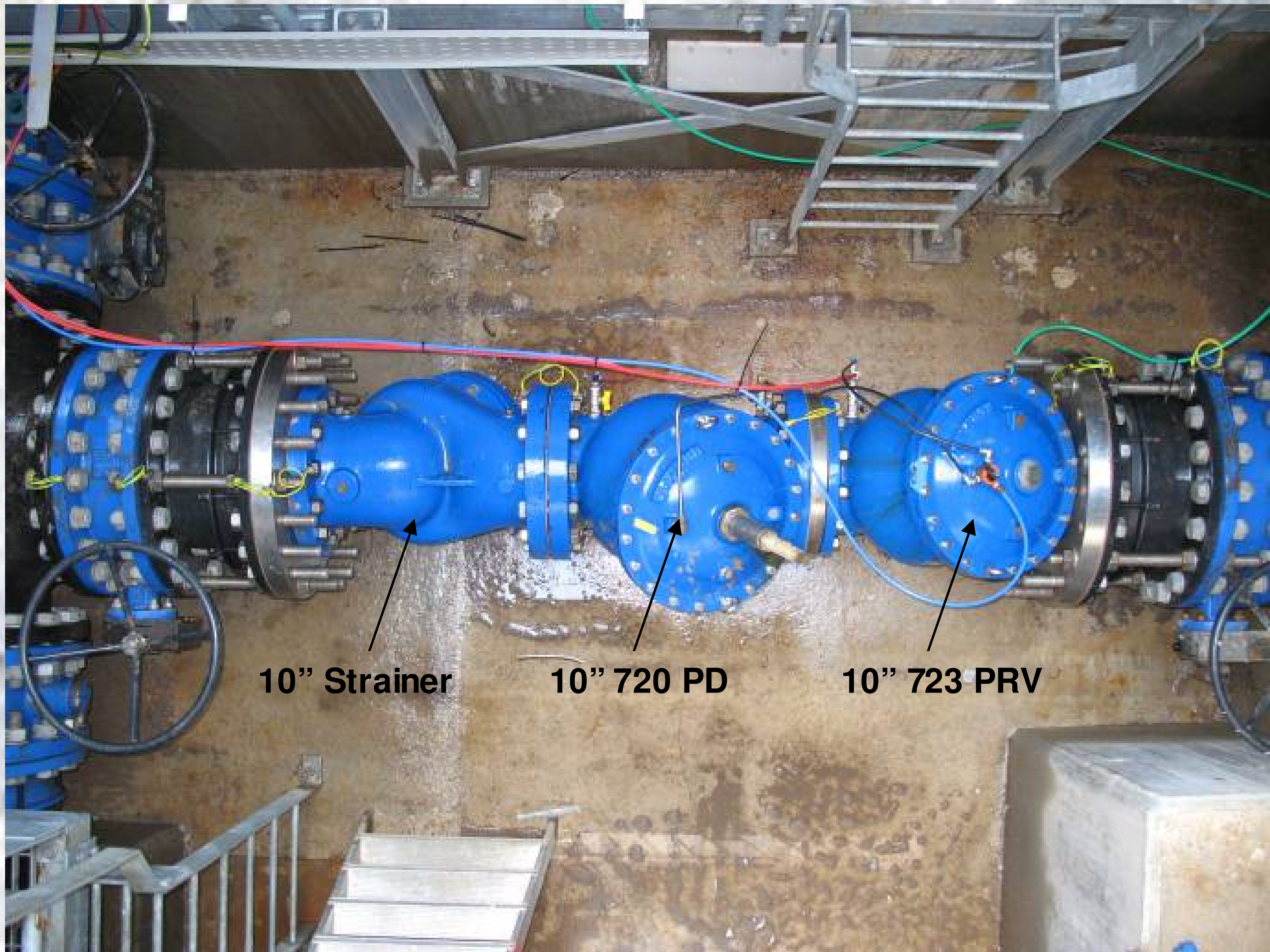
The purpose of the bunker is to pressure manage water entering the Inverness distribution system through the …

18” AC water main that supplies the East of Inverness.
16” CI & 12” CI water mains that supply the centre of Inverness.
16” PVC water main that supplies West of Inverness.

Each water main has a knockdown valve and a PRV. It’s the PRV’s that we optimised during this project.

Although there are 4 no. trunk mains in the Bunker I’m only showing graphs for the 18” AC!

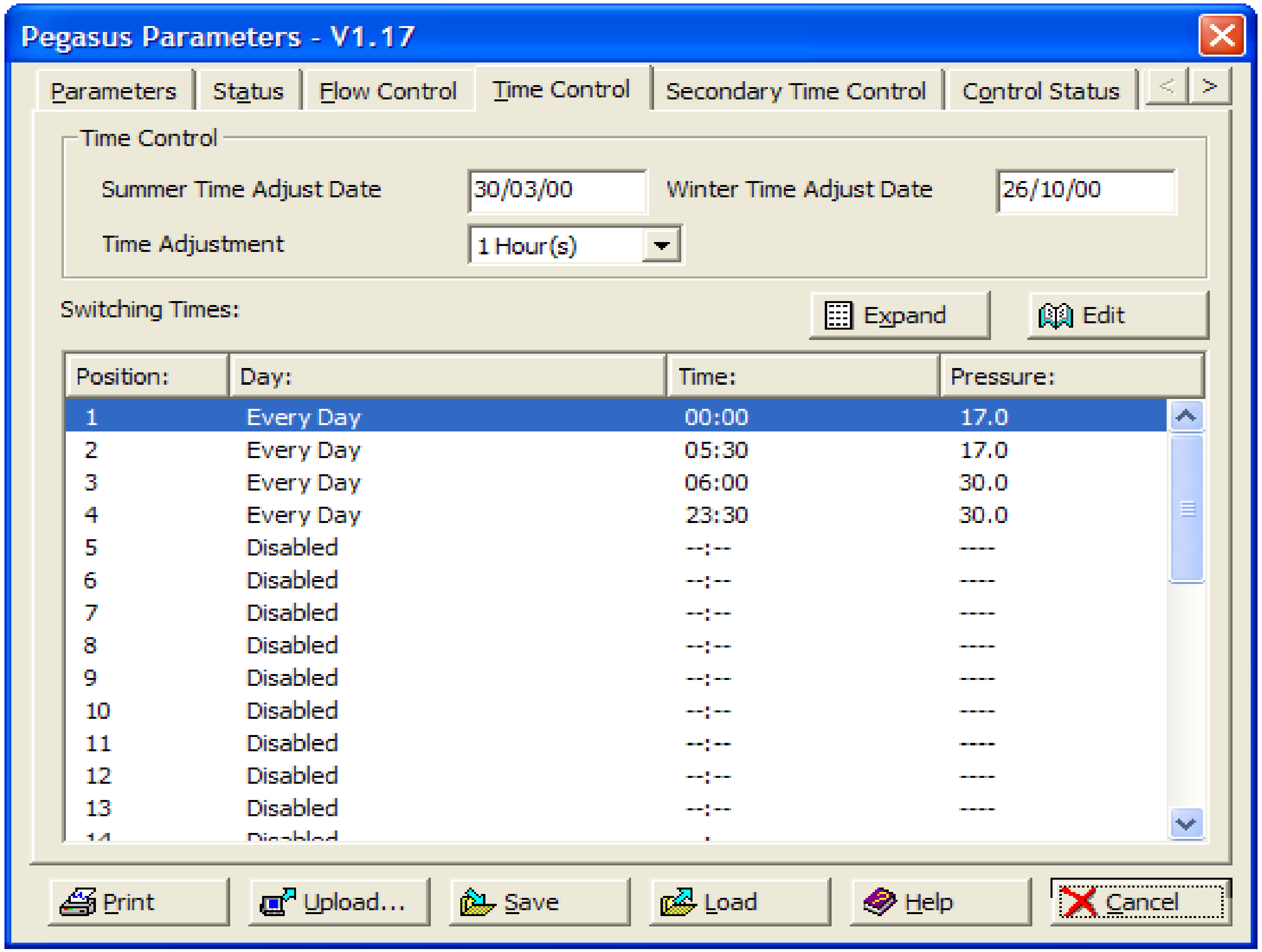
18” AC Main inc Bermad 720 PD valve & 723 PRV.



Control equipment

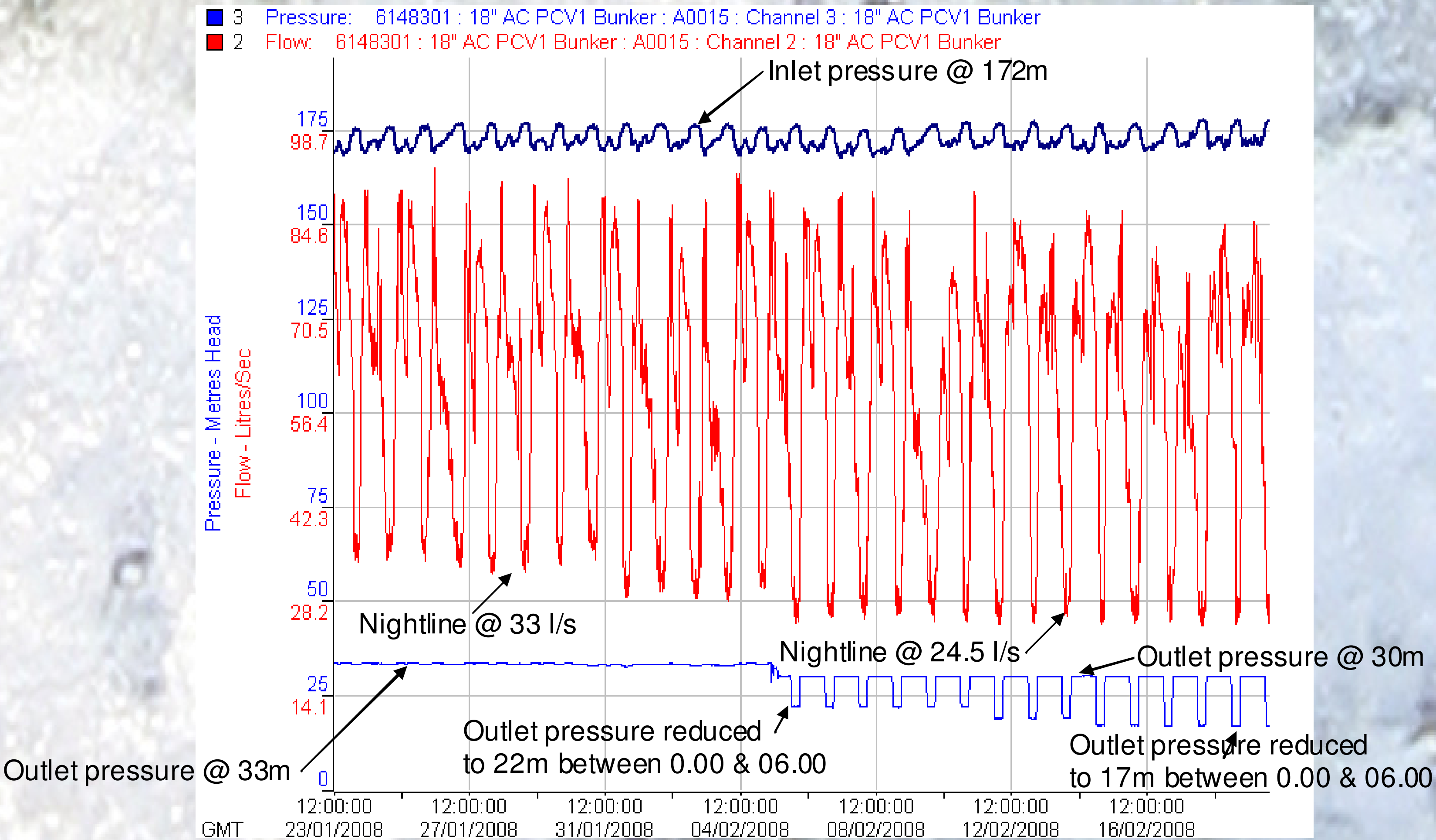
Radcom Pegasus PRV controller

Setup of time control.

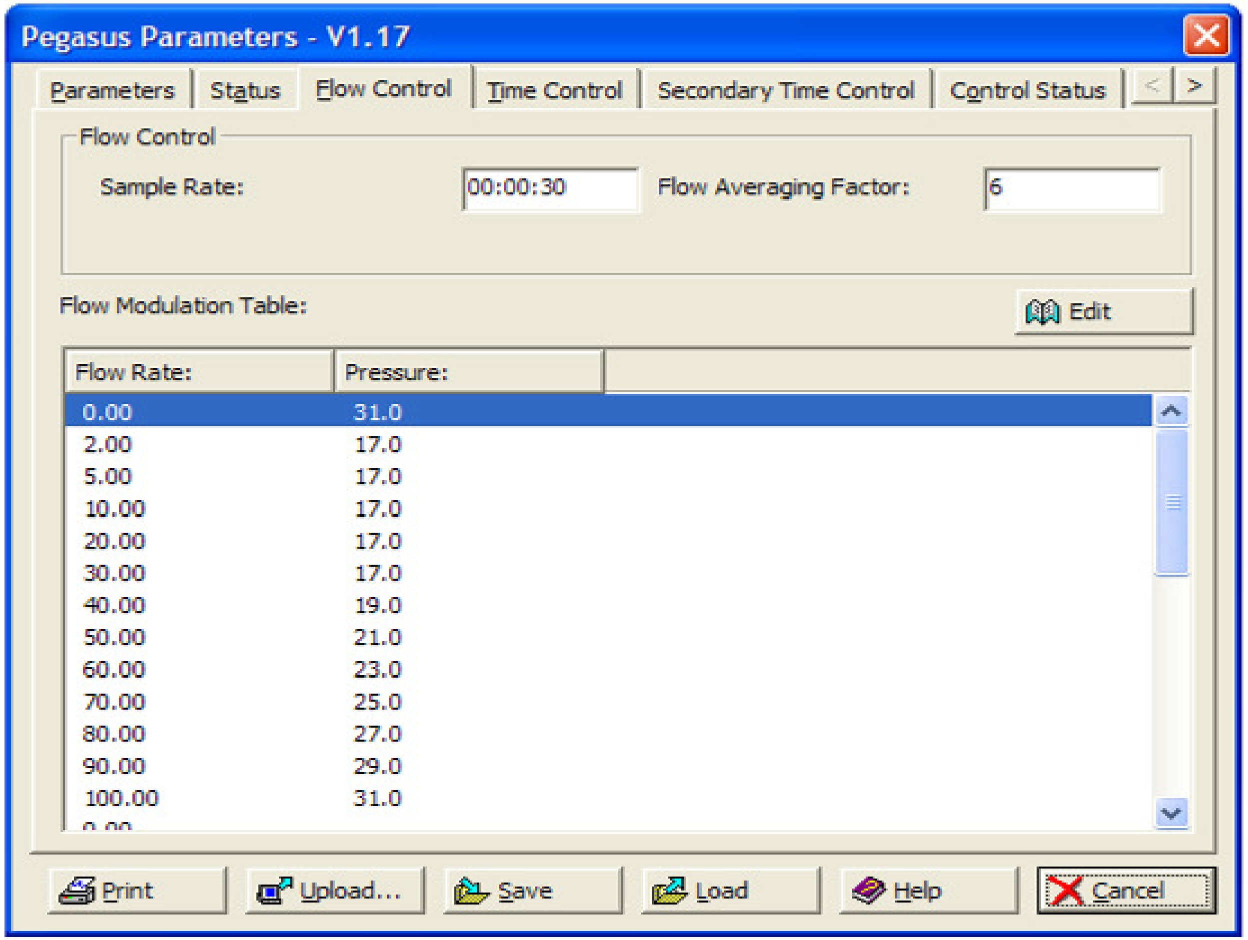


- 23.30 Pressure at 30m but starts reducing.
- 0.00 Pressure has reduced to 17m and stays at this setting until 05.30.
- 05.30 Pressure starts increasing.
- 06.00 Pressure has increased back to 30m and stays at this setting throughout the day.

Setup of time control on 18” AC valves.



Setup of flow modulation.



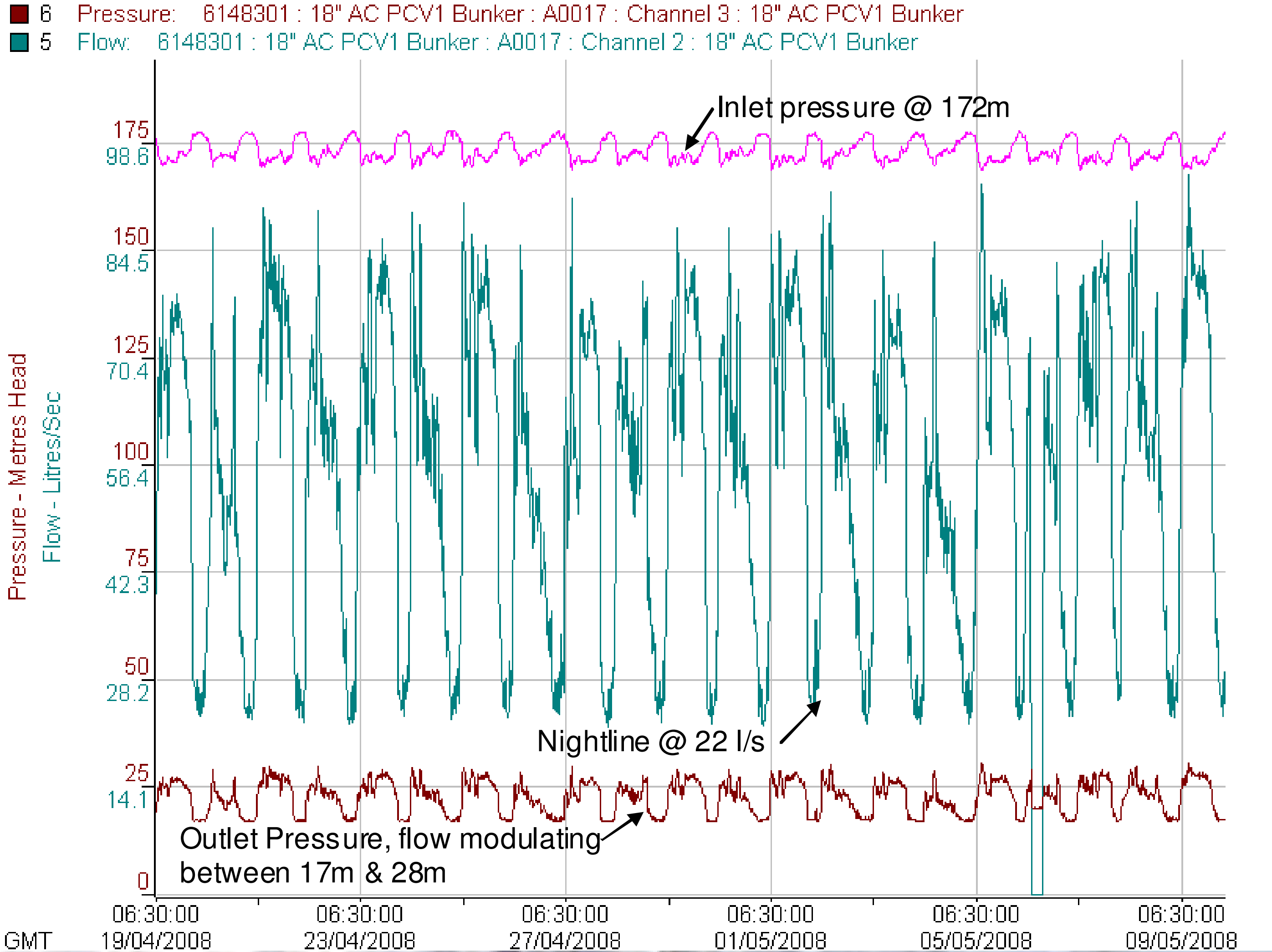
Flows of 100 l/s get 31m pressure, Flows of 90 l/s get 29m pressure

Flows of 50 l/s get 21m pressure and so on…….

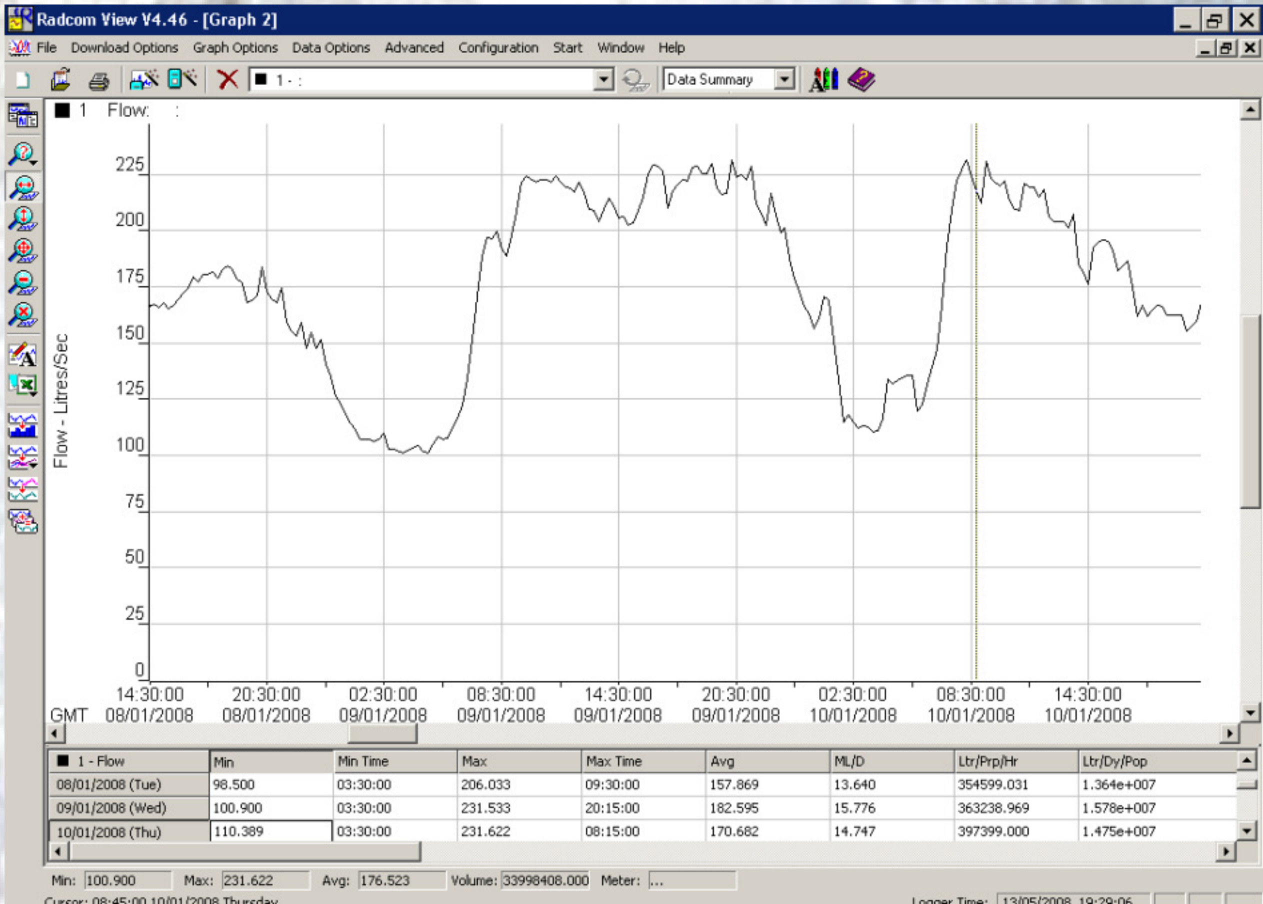
The valve modulates the outlet pressure depending upon the required flow rate.

Setup of flow modulation

on 18” AC valves.

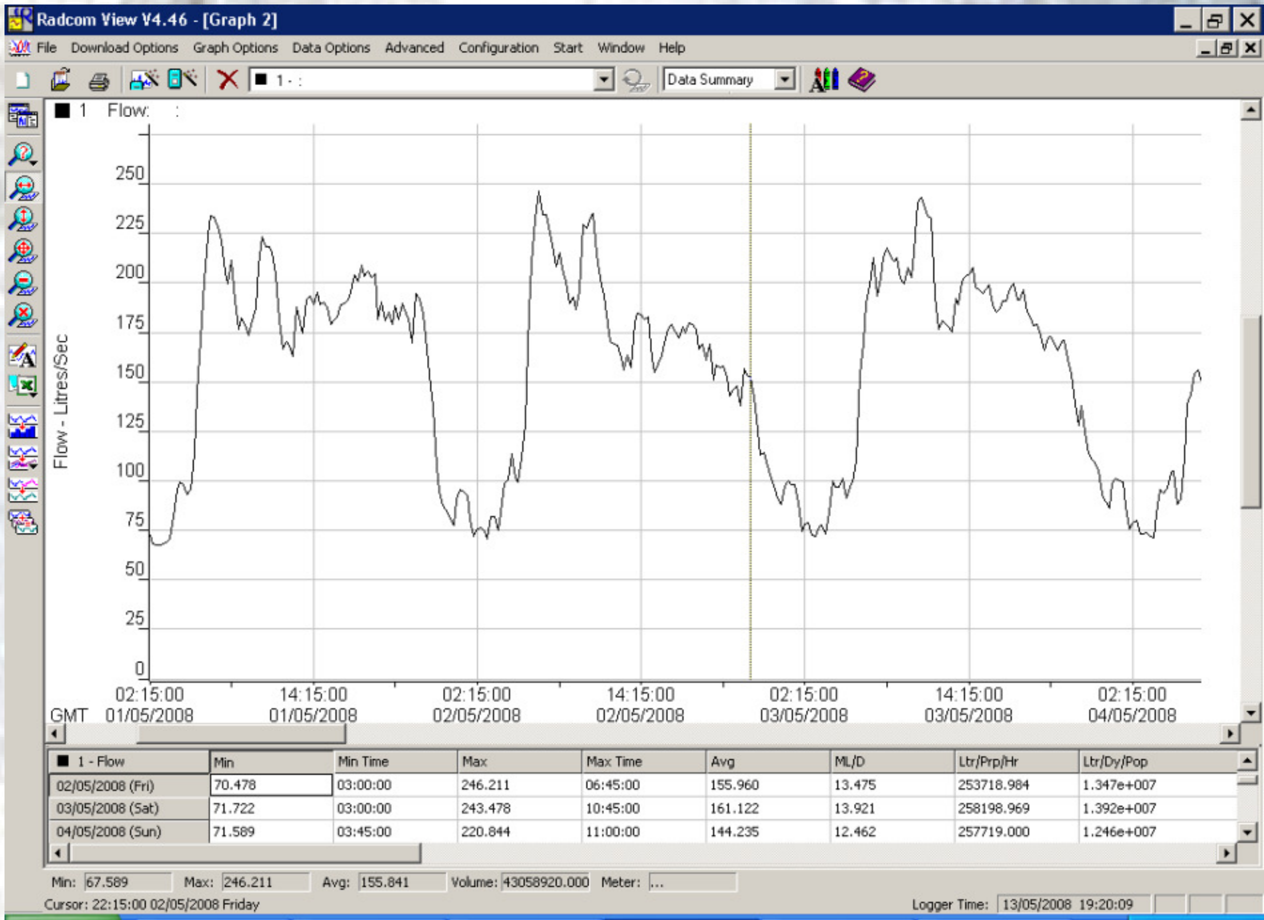


Flow data 9th January 2008



Flow data from 9th January 2008.
Nightline @ 100 l/s with volumetric flow through Bunker at 15.8 ML/D.

Flow data May 2008



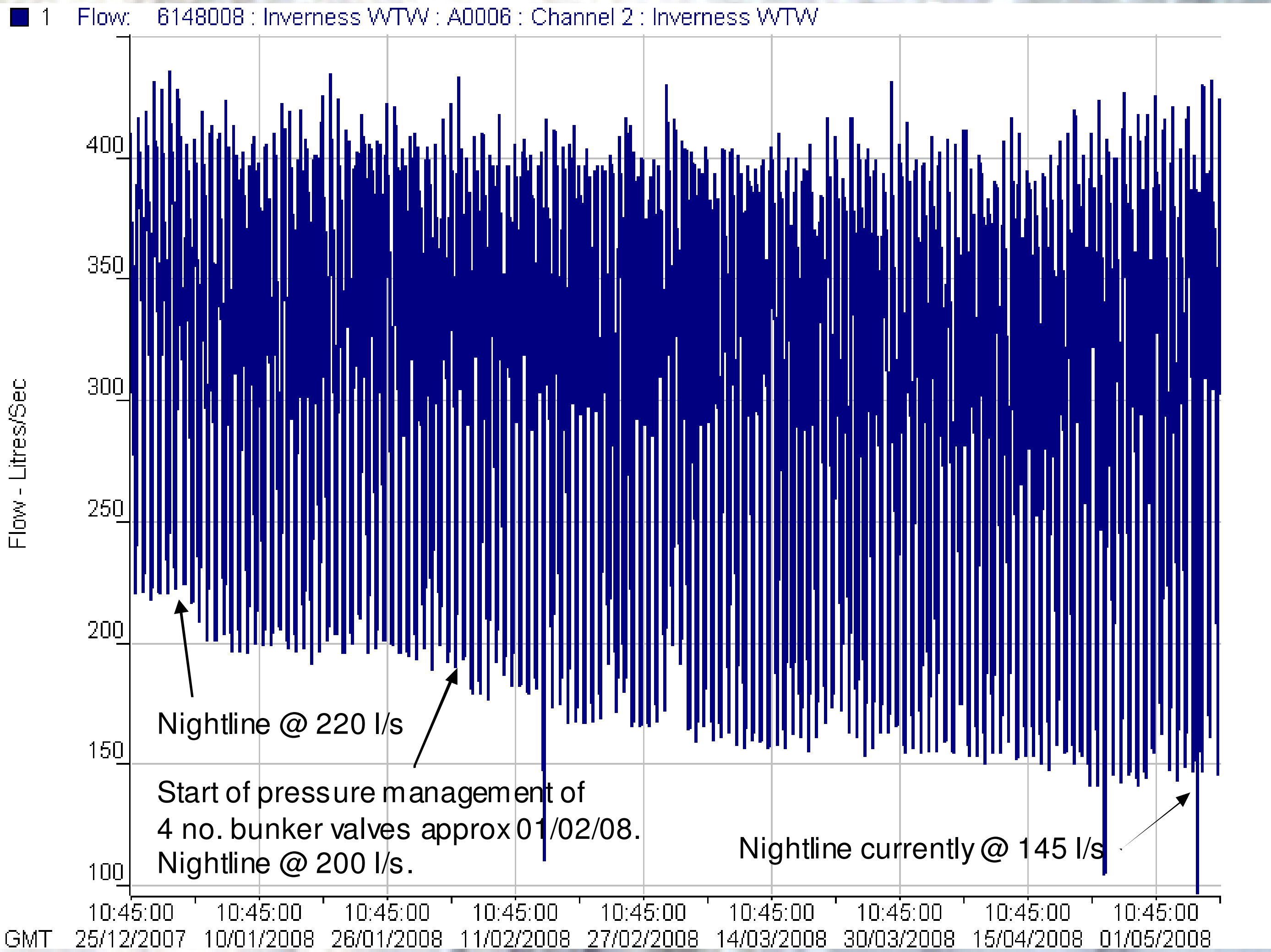
Flow data from beginning of May 2008.
Nightline @ 70 l/s with volumetric flow through Bunker at 13.2 ML/D.

Examples of savings made On 4 No. Bunker valves.

	1st February 2008								12th May 2008	
	Start of optimisation works		Initial pressure reduction		Additional pressure reduction		Flow modulation		Final Savings	
Bunker trunk main.	Pressure (m)	Nightline (l/s)	Pressure (m)	Nightline (l/s)	Pressure (m)	Nightline (l/s)	Pressure (m)	Nightline (l/s)	Pressure (m)	Nightline (l/s)
18" AC	33	34	22	25	17	24	17	23	16	11
16" CI	33	45	22	37	17	31	17	28	16	17
12" CI	37	14	24	7	27	9	33	12	4	2
16" PVC	40	9	25	6	33	6	No flow modulation		7	3
							Total Nightline reduction		l/s	33
										or
									ML/D	2.85

Inverness WTW DI flow

Inverness WTW – Reduction of nightline from 200 l/s to 145 l/s



Effectiveness of Pressure Control.

How do you measure the effectiveness of a Pressure Management scheme ?

Data …. Data …. Data …. Data !!

- Flow data - Distribution Input and Night line monitoring.
- Burst frequency - Before and after burst flow data
  Active Leakage Control costs
  Burst repair cost data.
  Burst repair time data
- Inlet and Outlet Pressure Monitoring - Stability of pressure control
  PRV effectiveness
  Servicing Requirement
  AZNP reduction

Examples – Scottish Water

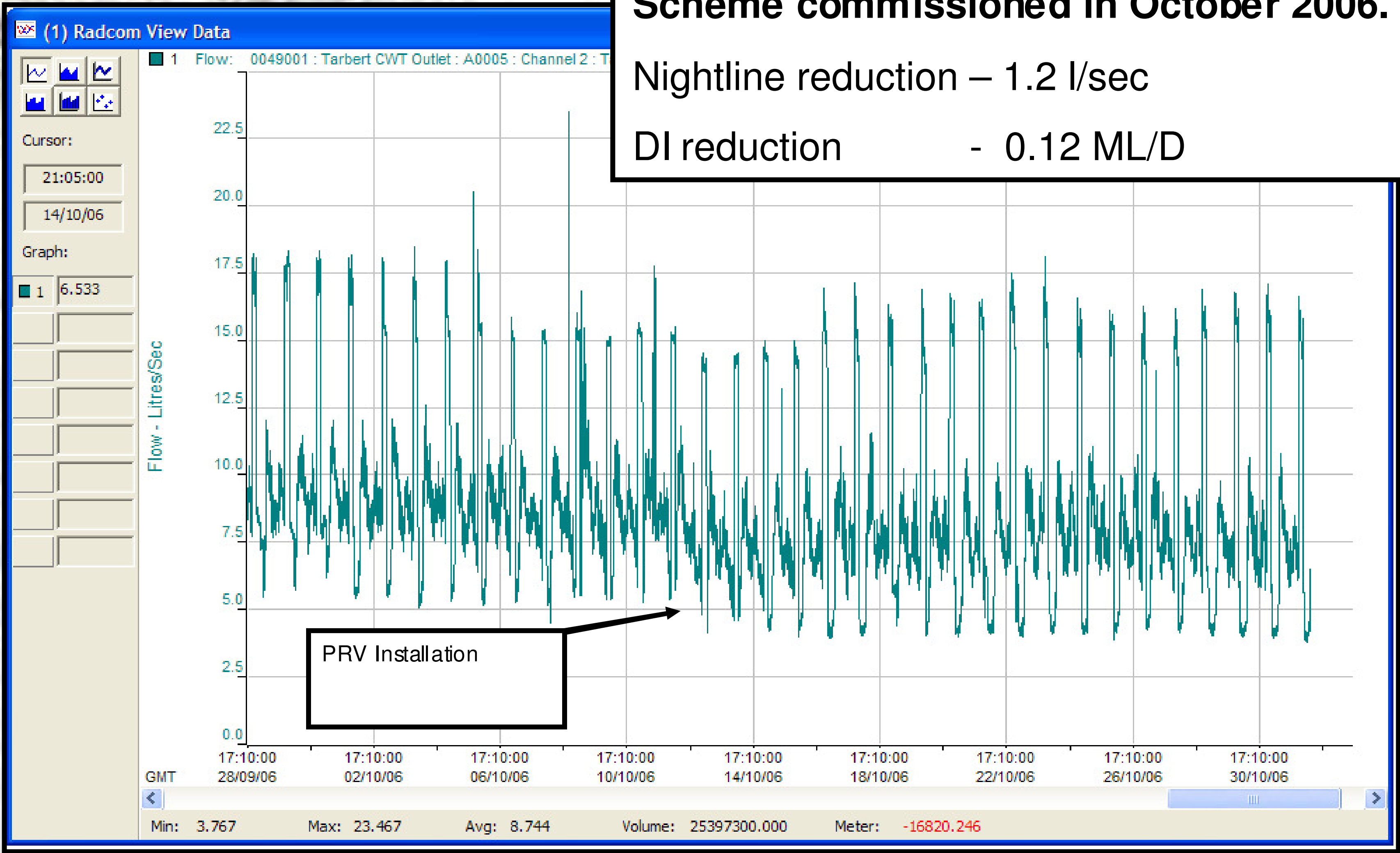
Tarbert WOA	Argyll	0.7 ML/D
Campbeltown WOA	Argyll	3.0 ML/D
Inverness WOA	Highlands	30 ML/D

Tarbert WOA - Argyll

Scheme commissioned in October 2006.

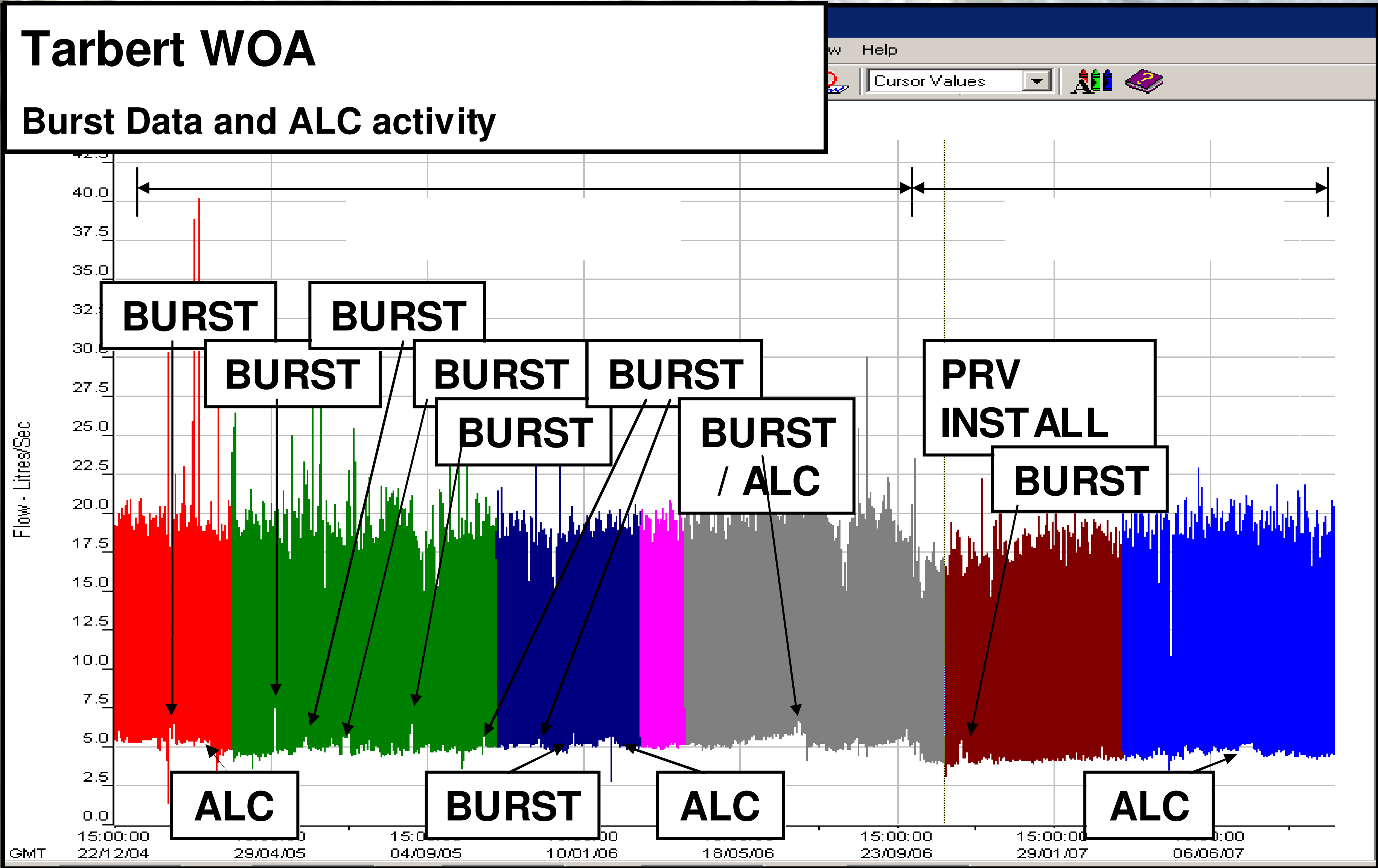
Nightline reduction – 1.2 l/sec

DI reduction - 0.12 ML/D



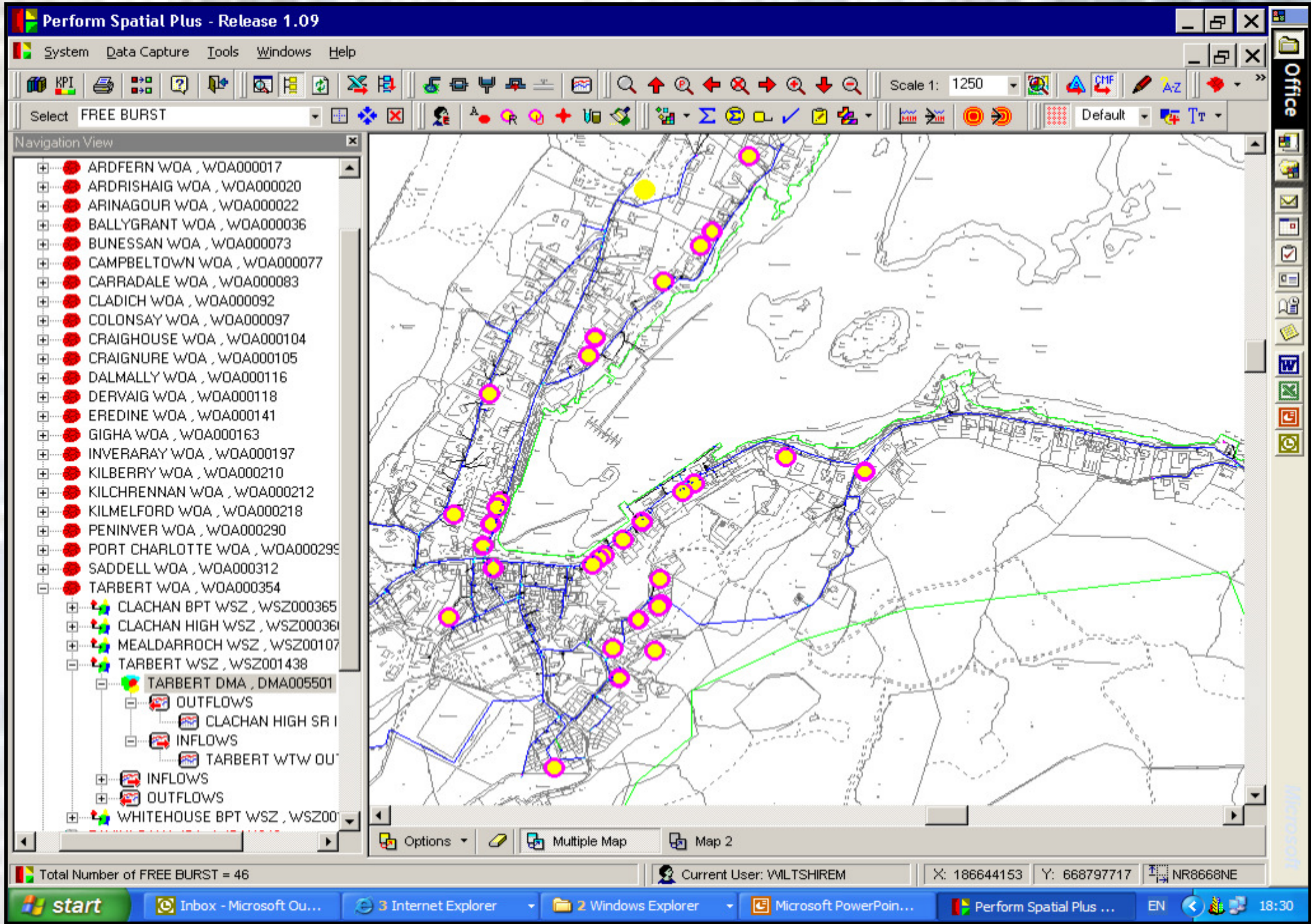
Tarbert WOA

Burst Data and ALC activity



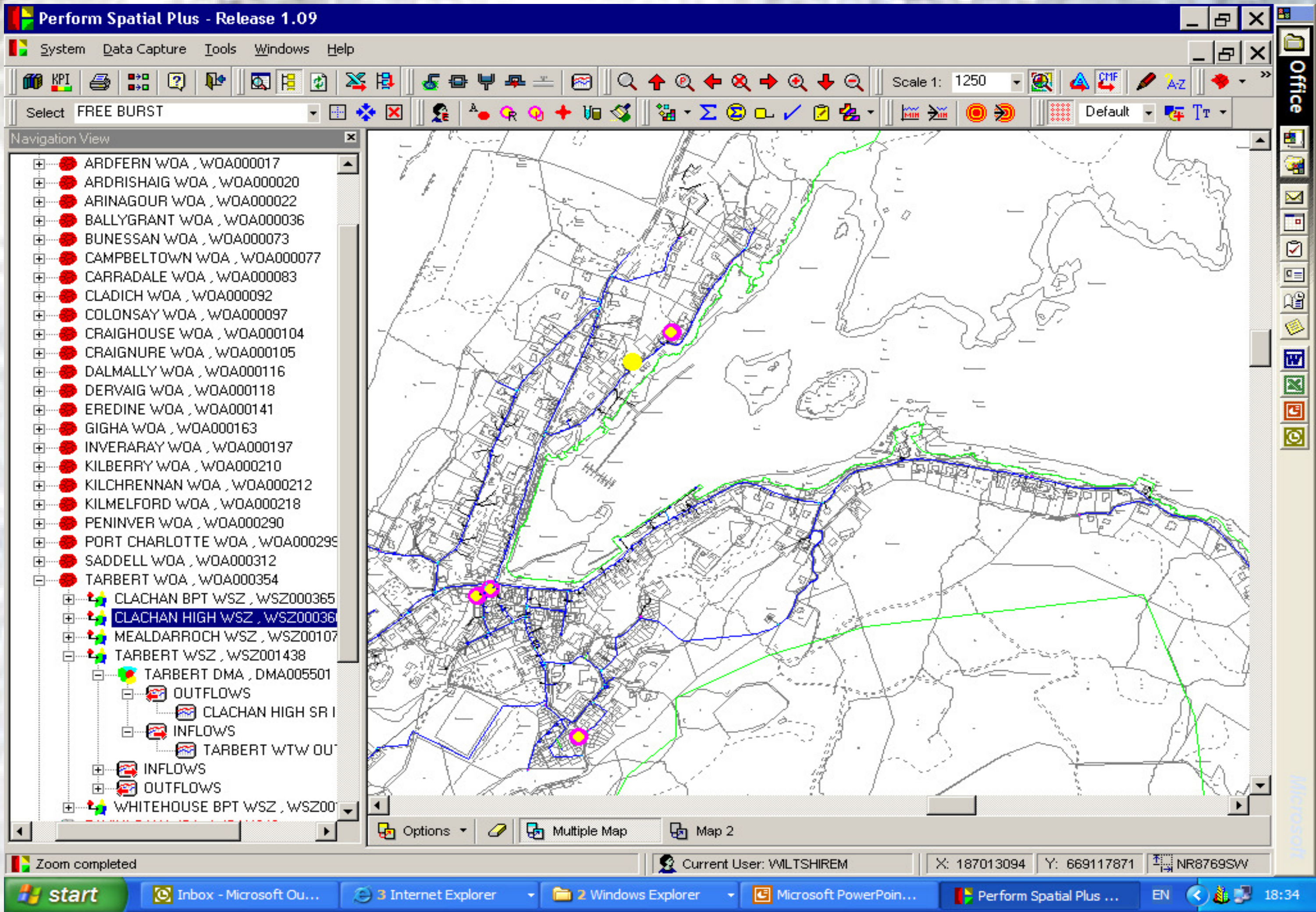
Tarbert WOA

Burst Data – Perform Spatial Plus 09/04 – 09/06



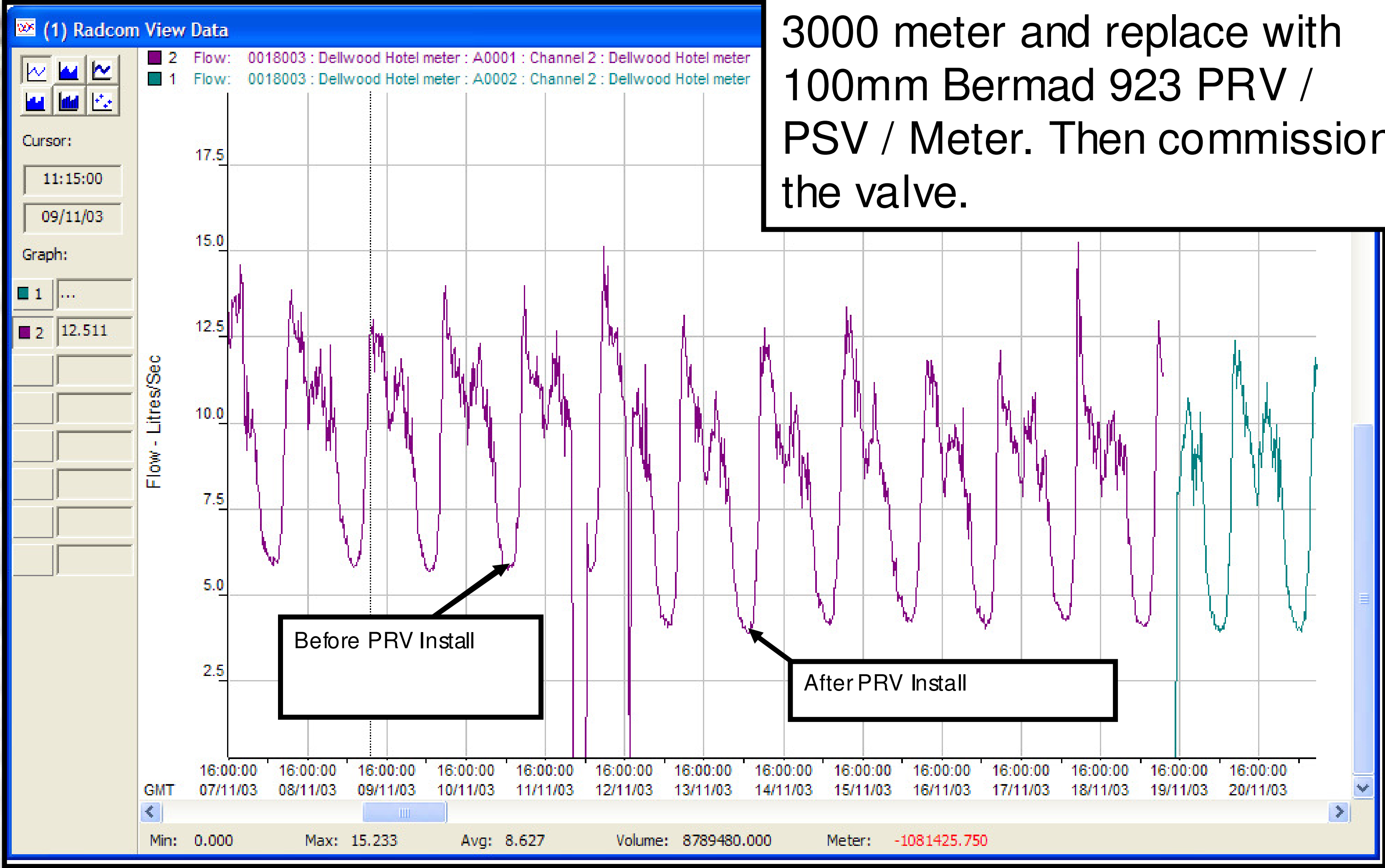
Tarbert WOA

Burst Data – Perform Spatial Plus 10/06 – 09/07

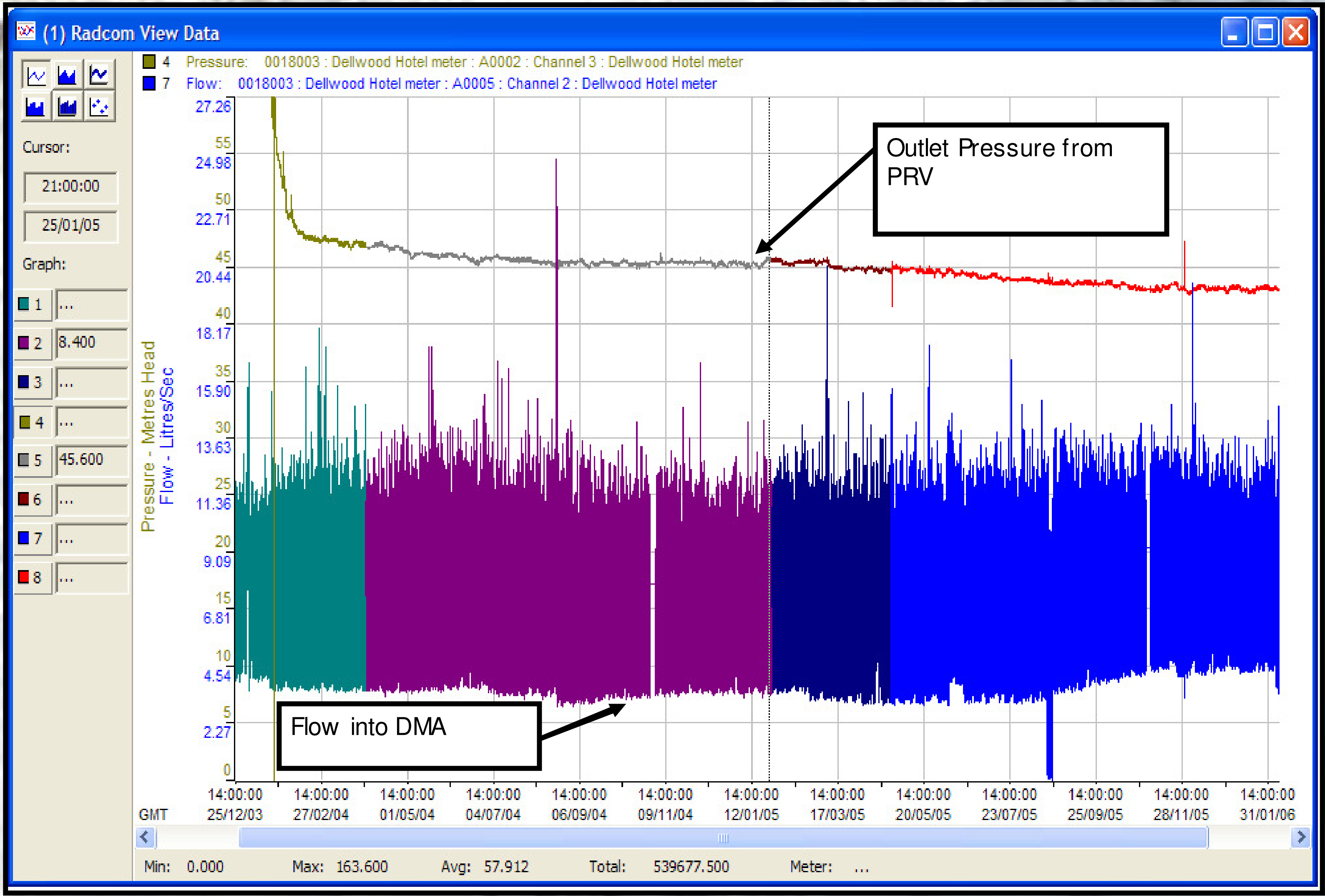


Campbeltown WOA - Argyll

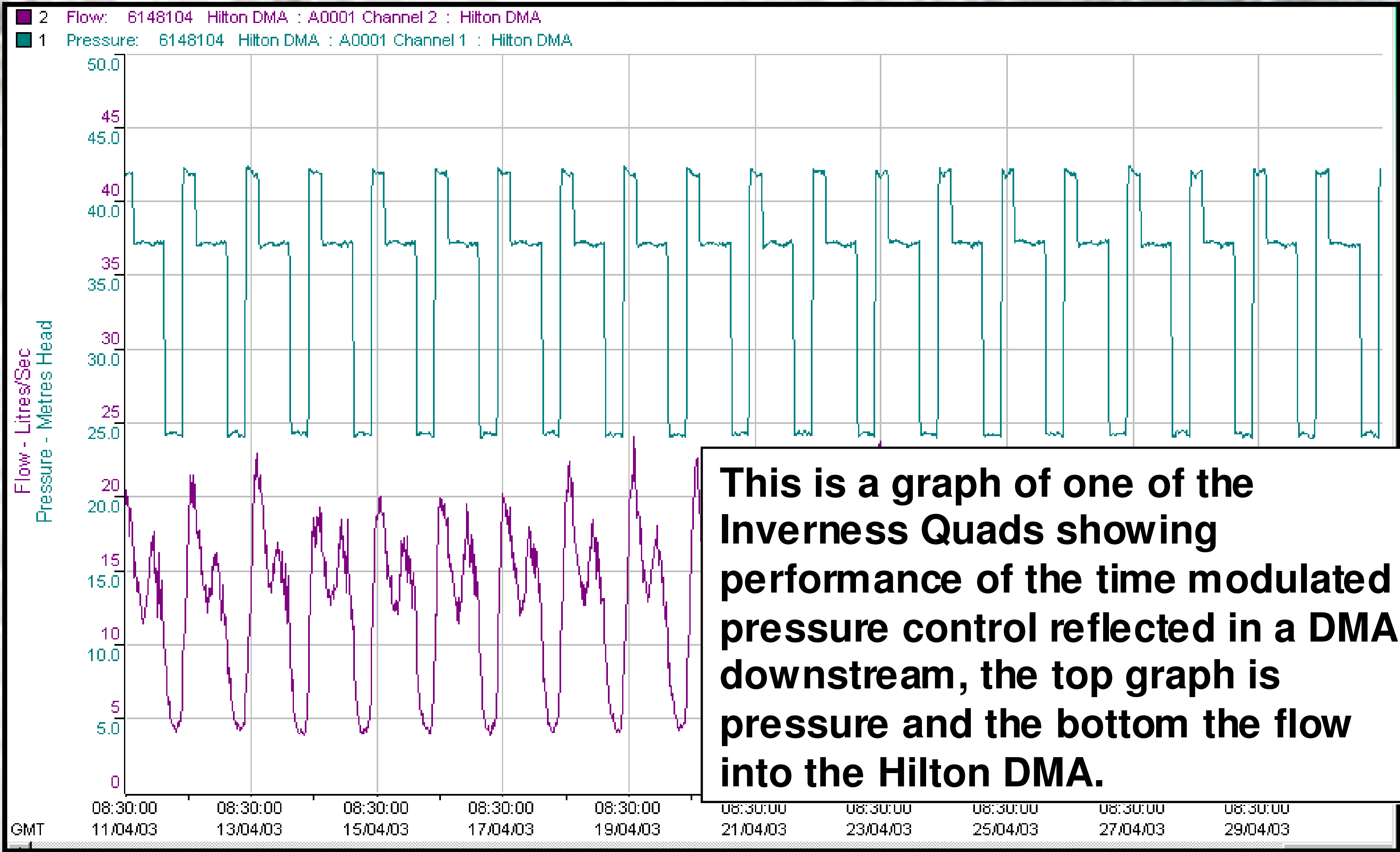
Remove 100mm Kent Helix 3000 meter and replace with 100mm Bermad 923 PRV / PSV / Meter. Then commission the valve.



Campbeltown WOA - Argyll



Inverness WOA



This is a graph of one of the Inverness Quads showing performance of the time modulated pressure control reflected in a DMA downstream, the top graph is pressure and the bottom the flow into the Hilton DMA.

Summary of Effectiveness of Pressure Management.

- Tarbert - Lower natural rate of rise of leakage
  DI managed at reduced levels
  ALC intervention reduced from 6 times per year to once a year.
  Reduced AZP / AZNP
  Network Stability

- Campbeltown - Low natural rate of rise of leakage.
  Nightline managed at 15 – 20 l/sec before was 30-35 l/sec.
  Reduced AZP / AZNP
  Network Stability.

- Inverness - DI managed at reduced levels
  Lowered AZP / AZNP
  Flow Modulation to be introduced giving further network stability and reduced ALC benefits.

Economics of Pressure Management.

Economics of Pressure Management.

The technical benefits of pressure management are clear but the economics require a precise measurement of network activity – active leakage control costs and activity , numbers of burst pipes and services, costs of repair, burst reoccurrence rates, measurement of water lost and most importantly the nominal cost of water per cubic metre.

In Scottish Water they have systems that can measure almost all of these parameters but still cannot state the cost of water per m^3 per WOA .

It all comes back to DATA.

Economic example of Tarbert in October 2006

I have assumed a cost of water per cubic metre of 20pence (UK), 30 cents (Euro).

Activity	**Costs**	**Savings**
Chamber Construction	11000 Euros	
Pressure Control Valves	4500 Euros	
Loggers	3750 Euros	
Total Cost of Install	**19250 Euros**	
Maintenance of PRV's	1200 Euros per year	
Cost of Water saved – 120 cubic metres per day		13,140 Euros per year
Burst reductions – 5 bursts per year at 850 euros per burst		4,250 per year
Active Leakage control costs (1 weeks per year)	3000 Euros per year	
Totals	**19250 Euros install** **4200 Euros per year**	**17,390 euros per year**
Payback	19250 / (17390 - 4200) = **1.5 years**	

This example shows that even allowing for maintenance of the PRV's twice per year, one ALC sweep per year the payback period for a Pressure Management scheme is about 1.5 years.
The effective life of a PRV is typically 20 years.

Economic example of Tarbert in October 2006

The payback period of 1.5 years makes Pressure Management an easily justified option.

The payback period of 1.5 years is measured purely on water savings and physical installation and maintenance costs and ALC costs.

This is before we take into account the reduction of customer contacts due to water supply interruptions and water quality issues. These all have costs associated with them and therefore they have consequent savings.

Closing Statement.

People ….. Our most expensive commodity.

Some colleagues are resistant to Pressure Management – why ?

Some colleagues are resistant to Pressure Management – why ?

reduces the activity on the network, (**JOB SECURITY**)

reduces and sustains lower leakage levels, (**REDUCED ALC**)

reduces costs dramatically – most importantly though .

it reduces their overtime ….. Can that be the only reason ?

Yes its also something called change !

People do not like change!

Change is UNCOMFORTABLE and they have to think!

Change challenges long held beliefs so lets smash the ‘Tablets of Stone’ .

We need training and better personnel management not just the technical stuff that’s easy to make the change.

Its all about people so lets help them change.

By doing all this, we can reach the Holy Grail of all Leakage Managers – A sustainable, managed, stable water network delivering a high quality product with highly motivated staff and through a highly efficient water system.

At this point we should pause and reflect:

- Pressure Management is only one of a number of tools to reduce and manage leakage but it is the one tool that will pay you back many times more than leakage detection.

- Pressure management must be carried out only after the creation of DMA's, active leakage control is in place and working and a system of monitoring of pressure critical points has been installed. Then and only then can you effectively install, monitor, measure and maintain a pressure management system.

- Pressure and flow control valves, correctly maintained, controlled and monitored are one of the most effective methods of creating a sustainable leakage management system.

Gracias

Thank you

References:
Naveh, N. (2005) Dynamic pressure control in the operation of supply systems.
Wiltshire, M. (2004) Water management - Integrating Telemetry to the Network. Scottish water report.