Where are the Advancements in Leak Detection?

T Waldron

Wide Bay Water, 29-31 Ellengown Street Hervey Bay, Queensland, Australia,
TimW@widebaywater.qld.gov.au

Keywords: Leak Detection; Prevention; Research needs;

Abstract

So you think you know everything about Leak Detection. You may have researched all the latest data on miracle noise loggers, digital correlators that magically give birth to triplet amplifiers, ground probing radar that has had nil advancement in fifteen (15) years, insertion microphones swilling in their own failure and acoustic listening devices made for our deaf, ageing and virtually redundant sounding inspectors.

The focus on leak detection appears to be becoming heavily reliant on electronics. Are we finding more leaks? Are we concentrating on being highly skilled at intervention analysis, economic assessment, searching for N1, talking about pressure control, and justifying what should be "good quality distribution monitoring practice" on the back of the budget for carrying out demand management? I ask you to reflect on whether this side track on justification analysis has distracted the industry from actually finding leaks, analysing why we have leaks and actually reducing the losses.

This paper asks you to study the ***properties of a leak***, and all the associated aspects related to these properties that may assist in new and improved methods of detection, or obviate the cause of leaks. "Accepting the norm" for leak detection outcomes will be constructively criticised and the potential process which may enable us to find more leaks will be examined. This debate is overdue and stimulation for research on water industry needs is essential.

Introduction

"Whether you think that you can or can't

You are usually right". *Henry Ford*

Should we be able to detect every leak on the first pass, once it has been decided to send a Leak Detection team into a District Meter Area? Have we limited ourselves to economic leakage levels that tolerate mediocre results? Of course economics change in a drought situation as every drop of water counts. Australia has predictions that by 2080 global warming will result in 50% less surface water. Therefore should there not be greater emphasis placed on detection and prevention of water losses.

This paper reflects on the slow advancements and the present outcomes of Leak Detection and compares this with the great success on "Accounting for Water", "Intervention Analysis" and "Pressure Management". This contradiction is due to the emphasis placed on prediction models that provide quality decision making. However, it is possible that we can influence great advances in Leak Detection if we, as an industry take on this challenge. This is providing that we have a vision that borders on idealism, and throws out the paradigm of accepting that "we can't".

Where are we now?

Firstly, the question is being raised as to whether the apparent modern technology used in detection techniques is giving any better results than the age old method of using a listening stick. Many of the advances made in the last ten years in relation to water demand management have been through the adoption of management systems related to water accounting, combined with intervention analysis. In recent years expertise in water demand management has correctly been focused on better methods of determining how to gain best results following the data analysis of a water distribution system.

The outcomes achieved are significant and the International Water Association have adopted a method of accounting for water that has been a paradigm shift for many water companies. The associated method of classifying "unaccounted for water" as a percentage is now clearly identified as old fashioned, inaccurate and redundant.

The other major advancement has been in pressure and flow related analysis of leaks, with the results of motivating many water companies towards reviewing and implementing pressure controls as a Demand Management application. These achievements are substantial and the team approach by the Water Loss Task Force has added refinements to these systems that are truly world class. However it is timely to consider other aspects of achieving reduced water losses. The most apparent of these is Leak Detection and Prevention. However, the water industry is heavily reliant on private industry manufacturers to push the boundaries of attainment in the provision of improved detection equipment.

Reflection

As an industry, we have a responsibility to not just sit back on this issue, but instead to motivate and work towards advancements.

In relation to leak detection:-

- What as an industry would we like to achieve?
- How would we achieve it?
- Who will pay for it?
- How could a plan to achieve this ideal situation be put into practice.

Whilst I give credit to all the technical papers being presented at Water Loss Task Force conferences, the lack of major advancements in Leak Detection equipment is obvious. It is of course widely accepted in most parts of the world that every distribution system should be permanently monitored with meters that identify when the leakage rate is rising. The action that each Water Company will take upon knowing leakage is rising, varies according to knowledge, equipment available and the cost of the losses compared to the cost of reducing them.

For many years we have all seen wonderful apparent technical advances with such things as ground probing radar, digital correlations, insertion microphones, acoustic data loggers and the thousand and one ways that the leak noise can be amplified. No doubt the availability of improved technology devices results in achieving greater water savings than ever previously done. But are they achieving anything better now than twenty years ago, or are all the improved results related to the focus of how to manage the network and where to direct teams to get the best results?

Economic levels of Leak Detection reflect costs within an organisation. A sceptic would perhaps say that data recording noise loggers will only indicate a general location that would need actual leak location equipment, and that this method is extremely expensive to purchase, has a poor life of equipment record and is reducing the skill level of operators in the business compared to other methods. The negative view of ground probing radar could easily be that it has magnificently failed over the last twenty years to show any value whatsoever in tracing water mains or leaks. Digitalisation leak noise correlators and the sudden birth of additional triplet amplifiers may have improved correlation applications, however it is doubtful that they have had any impact on the overall leakage levels.

This is the very point of emphasis worthy to make. Have any of the technological advances in detection equipment actually had impact to speed up leak detection or to cut costs to a water organisation other than the advances through District Metering? Granted they may have changed some of those costs from human costs to equipment/capital costs, but this does not necessarily result in water saved.

What Guarantees Results?

Let us take time to consider that if we as individuals, had the responsibility of the supervisor of the Leak Detection Team, and had been notified that one District Meter Area has had recordings that indicate the night flow within that area has risen to the point where intervention by a leak detection team is necessary. Could we answer the question "what method of leak detection and control" will guarantee the greatest reduction in water losses?

If there is a simple answer to this question, then why is everyone not doing this?

Are we overly influenced by the equipment we have already purchased?

Are we overly influenced by the experience of the Leak Detection Team?

If you find you have a minimum night flow of say 10 litres/second, what would you expect to reduce it to after the first leak detection exercise?

8 litres?, 6 litres?, 5 litres?, 0 litres?.

What about after the second or third leak detection exercise. Often at 50% to 70% reduction becomes the accepted norm, without consideration of the pressure influence.

These results often masquerade as "Unavoidable Annual Real Losses", and the industry standards can, if we are not cautious, hide the reality that far greater savings can be made.

(Lambert & McKenzie 2002) pointed out that prediction models calculating UARL are best estimates and will improve with more data. These calculations have worked well, but actual leakage detection results are often incorrectly interpreted as this factor. (Brothers 2003) demonstrated this well in the Halifax outcomes for different regional results.

Additional worthy questions are:-

- Can a correlator find every leak?
- Can anything else find every leak?

Reflecting on these questions should motivate us to review what we are doing as an industry in this regard and to determine a way forward that would benefit every water company in the world. The haste to achieve quick savings that often accompanies knowledge of a high night flow situation, and the lack of good industry guidance on best

practice perhaps results in mediocre achievements, or protracted and expensive operations.

Of course this is easy to say, but what should be done? The “back to the drawing board” and “brain storming” applications could be worthy considerations. The remainder of this paper perhaps provides a foundation for this to be commenced.

What does the Industry want to achieve?

What do we want to achieve? First of all let’s create a vision as this will define where we are heading. Every other judgement call can be critically reviewed in line with the vision, as to whether these judgement calls will help us achieve in moving forward. So what will this vision be? Possibly from a water loss point of view we would need to split this into two different perspectives:

1. Old existing water distribution systems – what would be the perfect situation for the distribution engineer to achieve if he knew he had water losses within that system? This sounds a simplistic statement, however unless we target this as an outcome, we will forever be accepting a lesser standard or outcome.
2. New water distribution systems – prevention of leaks for the future is just as important, if not more so, than finding leaks. Therefore what is a perfect situation for the distribution engineer to achieve - the installation of new pipe work systems in order to either prevent any losses occurring or for it to be immediately apparent where the leak is.

This is determining ***what*** we want to achieve. In order to determine ***how*** we achieve this we need to examine all the properties of a leak and the associated impacts and condition changes. All existing leak detection methods have been developed from realisation of one or more of these properties, which then is investigated in order to find individual advantage for potential product development.

The Properties of a Leak

Below is a list of the properties related to a leak. This may not be comprehensive and should be advanced at every opportunity. Some of these issues are only associated with the properties of a leak but have been included to stimulate thought, in order to create opportunity for original or developed ideas.

Properties or Association with Leaks:

- Water loss
- Saturated ground
- Velocity change
- Vibration of rupture
- Noise of vibration
- Frequencies of noise levels
- Type and shape of orifice
- Water pressure difference
- Pressure related changes at each side of a leak
- Transmission co-efficients of a leak noise

- Pipe material type
- Potential of deterioration and collapse
- Viscosity changes
- Diurnal changes
- Ground temperature changes
- Ground compression changes
- Interaction between different materials at pipe joints
- Depth of pipe
- Type of material surrounding pipe
- Point of visibility
- Combination of any of the above

Most of these are not intended to indicate the cause of a leak. At base level evaluation these appear to be all the issues to be examined that could assist in determining best practice methods.

The majority of advances in detection techniques has come from private industry, who specialise in the manufacture equipment for this purpose. It is also worthy to note that certain water industry funded research centres are used to greatly assist in developments. Few of these have shown the progress that would be welcomed by the industry in developing better equipment.

Let's now examine the perfect situations and the vision towards what we as an industry could desirably be heading towards.

The Old Water Distribution System:

A vision statement

When leakage levels have risen to such a level to require intervention activities to detect leaks, we will always reduce losses to a level that gives us a minimum night flow of zero at a cost reflecting economic returns. The hydraulic affect on the condition factor of the pipe work or joints to then be altered to create a stable network without the likelihood of further pressure related leakage. Alternatively the fragility factor of the pipe work will be improved to create a stronger hydraulic environment.

The New Water Distribution System:

A vision statement

That new distribution networks be designed and installed in a manner different to the present culturally accepted practices which inherently has standards less than desirable in relation to leakage prevention. Systems should include monitoring and testing facilities permanently installed on new developments that immediately indicate water loss and its location. A specification of installation would be dependent on ambient conditions of temperature et cetera. The pipe jointing technique and material would guarantee freedom of failure. The installation and bedding material would guarantee tolerance for ground movement and remove the possibility of external friction on pipe work.

These words may not be the ones to adopt. They are an example to challenge the existing void, and change the thinking pattern to what is generally accepted – to what "can be".

Water Industry Research

If it is accepted that the perfect situation does not exist, then it is reasonable to ask "what can the water industry do to improve the situation?" The Water Loss Task Force through the International Water Association has influence to redirect considerations related to research on Leak Detection.

The vast majority of water industry research is pointed towards water quality issues. Indeed the International Water Association Journal on Research clearly identifies that the quality issue is its main objective. The "aims and scope" listed by the publication identifies such things as Treatment Processes for Water and Wastewater, Water Quality Standards, Studies on Inland Tidal and Coastal Waters, The Limnology of Lakes, Solid and Hazardous Waste Management, Mathematical Modelling and Public Health and Risk Assessment.

Whilst not wishing to detract from this good work, there is little obvious investment by the industry as a whole in leak prevention and detection. Research around the world is similar. It is quite amazing when you consider the billions of dollars that are spent every year at every University Research Campus and appears to provide nothing to the advancement of water loss control. The redirection of University funding is an obvious choice in order to attempt to reach a vision and the associated objectives. Unless this research is ***applied*** to industry needs and finances directed to this cause, then the vision will never be achieved. The opportunity exists through the International Water Association and the Water Loss Task Force to persuade funding agencies to redirect finances to this most worthy cause.

Quality Controls

If as specialists we start to question how we detect leaks, we should also question the quality of setting up monitoring systems. Designing and setting up District Meter Areas needs to take into account that gained improvements are not short term.

When setting up District Meter systems and Real Loss Management procedures, it is worthy to consider that methods reflecting world's best practice will come from experienced designers and operators. So how can a water company be sure that this is best practice?

Quality of implementation, construction and maintenance is reflected internationally on a vast array of issues through the ISO accreditation system. Consideration of appropriate accreditation should also be considered in Demand Management practice.

The benefits to the environment from water saving demonstrates that this type of work would be appropriate under the ISO 14000 banner. This can be further developed through the Water Loss Task Force advancing the knowledge base and acceptance of such an accreditation.

Conclusions

The dedicated work shown by industry engineers and scientists who are continually assessing their leak detection methods is commendable. Many of these are demonstrated in the large number of technical papers presented at Water Loss Task Force conferences and gatherings. The vibrant activities of the group has projected the work into the international arena, which has had positive outcomes for all the water companies that have been influenced.

Also the advances made in the last ten years of overall network assessment which determines the level of water loss through good practices such as the IWA Water Accounting method, and the significant developments on pressure related leakage, have pointed many water companies in the right direction of policy decisions. It appears that there has been neglect given to achieving the ideal situation as an outcome, from leakage detection. This has come about through conventional practice of leaving research and development to Universities and private manufacturing industry.

We all have our comfort zone which accepts the present “norm” as standard. The author suggests that it is time we changed our perspective of Leak Detection. In order to advance entrenched water industry values, in relation to this issue, then changes are needed.

One concept proposed includes accepting a method that would target the perfect outcome, which in turn will focus the attention on all possibilities, and then perhaps provide an insight to what “can be” achieved.

The author suggests:

- that a vision statement be adopted related to leakage detection and prevention.
- that a vision statement be adopted for new water networks design and construction in relation to leakage prevention.
- that funding agencies be approached to redirect funds to applied industry research related to Water Demand.
- that the International Water Association Water Loss Task Force considers a quality assurance procedure to ISO 14,000 standards for the implementation of demand management practices.
- that the Water Loss Task Force work with the International Water Association Research arm to identify procedures and methods to encourage research on innovational methods for leak detection.

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