Active leakage control in low pressure situations

By Stuart Hamilton*

Is it possible to carry out an active leakage control strategy using traditional methods and equipment when pressures are extraordinarily low?

Leaks make noise or acoustic sound because the pressurized water forced out through a leak loses energy to the pipe wall and to the surrounding soil area. This acoustic sound, depending on the material of the pipe work either dissipates over a long distance or is absorbed very quickly into the pipe wall.

In metallic or hard walled pipes, the sound transfer is extremely good and in non metallic or soft walled pipes, the transfer is extremely bad. Other considerations are pressure and size of the orifice. The higher the pressure and the smaller the leak, the greater the noise or "energy" is created and this can be reduced depending on the orifice size or pressure.

Table 1 shows what is ideal for leakage location or detection.

Leak Noise Factors

Factors producing good quality leak noise	Factors producing poor quality leak noise
High water pressure	Low water pressure
Hard backfill	Soft backfill
Small rupture	Split mains
Clean pipes	Encrusted pipes
Metallic pipes	Soft/Lined pipes
Small diameter pipes	Large diameter pipes

Case study - Hanoi

The initial water balance as well as the measurements in the five pilot areas indicated very high levels of leakage. It was uncertain which percentage of the existing leaks could be detected given the extraordinarily low pressure (6.6 m average pressure system-wide).

The leak detection was carried out between 23:00 and 04:00 during the period from October 2007 to February 2008. The equipment used included: Listening stick, stethoscope, ground microphone (Gutermann Aqua Scope 3), leak noise correlator (Gutermann Aqua Scan 610), and advanced noise loggers (Gutermann Zone Scan 800).

Hanoi has carried out a large-scale pressure monitoring program on about 140 points on transmission, distribution, and service lines.

The weighted average pressures observed were:

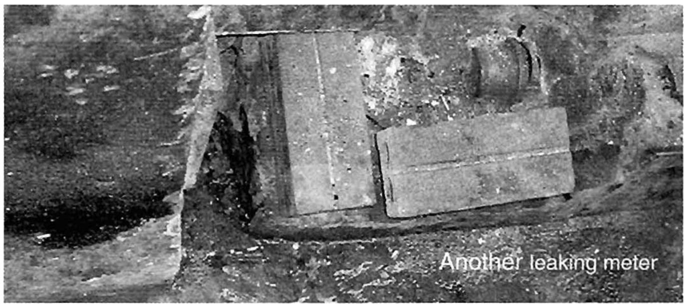
- Transmission lines: 9.0 m
- Distribution lines: 7.4 m
- Service lines: 6.0 m

The system-wide weighted average was calculated to be 6.6 meter, +/- 10%.

Pilot areas were selected in different parts of the distribution system. For each of the five pilot areas, data was collected which comprised of length of distribution, service lines and number of service connections. Flow and pressure data was collected for each of these regions over a 48-hour period. The period was restricted to this time as low pressure was being experienced in adjoining systems, preventing a permanent DMA from being established or extending the measurement period.

Summary of findings during leakage survey

A mixture of approaches was decided to see which ones could be used within a low pressure system and to ascertain if acoustic equipment can be used in low pressure areas with different



Another leaking meter

service and mains materials. Decisions for the methodology of Active Leakage Control (ALC) were originally made from studying the distribution system plans. It was clear that the ALC methodology had to be different for each area to obtain best results from the equipment; this was mainly dependent on the pressure available, the material of pipe work, background noise level, and the availability of fittings.

Here, we will discuss pilot areas 1, 2, and 5.

Area 1

The leakage model indicated that there might be up to five ESPBs (Equivalent Service Pipe Bursts) after adjustment for pressure. For area 1 it was decided that all fittings should be listened on for audible leak noise. However, it was quickly realized that there was a distinct lack of visible service connections to enable ALC to be satisfactory completed. This is a major problem in ALC and it can be assumed that a number of small leaks may have been missed.

The noise transfer from the leaks within the distribution system was very poor and can be accredited to the service pipe and mains material which in certain areas was found to be polythene. The quantity of polythene pipes in this area is unknown.

When a leaking service was located, the noise transfer from the ground close to the leak was very good and the leak noise was clearly audible. However, when listening on the water meter some 0.5m away from the leak position, the leak noise was barely audible. When this leak was excavated, it was found that the service pipe was black polythene.

The only feasible way of detecting all leaks in a situation like Area 1 will be to carry out a comprehensive ground microphone leak detection survey listening to all distribution mains and service connections, keeping the distances between contact points as short as possible. Any other acoustic methodology may be unsuccessful due to the distinct lack of fittings, be it distribution mains or service connections.

Area 2

The leakage model indicated that there might be up to 19 burst after adjustment for pressure. This was deemed as the oldest and the most problematic of the five chosen areas due to its age, service connection material, mains material and usage.

The methodology of ALC in this area was to listen on all services with a listening device of both electronic amplified and non electronic types. This method was chosen as the deemed approach as there were only a small number of mains fittings available and

AquaScope 3 training with Hanoi Water

oldest and the most problematic of the five chosen areas due to its age, service connection material, mains material and usage.

The methodology of ALC in this area was to listen on all services with a listening device of both electronic amplified and non electronic types. This method was chosen as the deemed approach as there were only a small number of mains fittings available and a large number of suspected leaks in the area. It was not known at this early stage if the leaks were present on service connections or distribution mains.
Noise loggers were deployed on the valves that were present within the distribution system and with success as they indicated an area where a leak could be present. This area was investigated and the leak was located and repaired. More success would have been possible but with the low number of valves within this area not enough coverage was possible.

A large number of leaks were found in area 2 between that of the communication pipe and supply pipe. The majority of the property/private (supply pipe) side leaks located were that of open taps (could not be closed), leaking joints, homemade repairs or just general deterioration of the pipe work where no good metal was left within the galvanized iron pipe work. Nearly all the leaks that were found on the communication pipe work were that of deterioration of the pipe work where no good metal was left within the galvanized iron pipe work or on joints.

Area 5
The leakage model indicated that there might be up to 5 bursts after adjustment for pressure. It was after viewing the distribution network/plans for this area that it was decided that noise loggers could be tried on this distribution system.
The noise loggers were deployed and left in situ and downloaded each morning to view the reports of where leaks may be present. On each download occasion, a leak position was clearly indicated on the sluice valve closest to the water meter. This was thought to be the meter causing the noise and was ignored on the first night reading. On the second night, this was much the same and was investigated during the early hours of the morning to see if a leak is present or not.
A leak position was located with the use of the electronic listening device and the ground was marked for excavation. On the following day, the ground was excavated and a leak was located and repaired on a 63mm polythene service/main. Several excavations had been made in this vicinity in the past as the water was seen to be running from the ground, causing problems.
The position was logged again with the noise loggers and the valve was shown to be quiet and no other leaks were present. This was confirmed from the flow data obtained. No other ALC method was used in this area i.e. sounding of services.

Conclusions
<u>Leak detection</u>
The most important conclusion of the trial leak detection campaign is that it is possible to detect leaks in the Hanoi water distribution network using acoustic equipment. It should be noted that the trials were conducted by a fully trained engineer and it cannot be assumed that the same results could be obtained by a non-trained member of staff.

This trial has demonstrated that using acoustic technology, with the help of an experienced engineer, leakage detection can be achieved in areas where the night time pressure does not reach 10m. However, experiences from this trial show that not all techniques work in every situation and that the correct method of approach should be used to gain maximum benefit.

Data collection

<u>Electronic listening stick</u>
Electronic technology like the one used for this trial is very easy to use for both the experienced and non experienced engineer. The Aqua-scope 3 used in Hanoi had a numerical display which indicated the level of noise, thereby eliminating the limitations of human hearing.

<u>Ground microphone</u>
The ground microphone is mainly used for leak pinpointing – this means to finally decide the exact location of the leak (for excavation) after it has been localized by any of the other methods.

<u>Leak noise correlator</u>
Leak noise correlation on soft walled pipes i.e. non metallic pipes is generally not as effective as on hard walled pipes i.e. metallic pipes. Hence, only short distances must be kept between the two sensors up to a maximum of 60m and this is depending on the pressure within the distribution system at the time of correlation. Due to this problem, in many areas in the Hanoi distribution network, where there are (i) plastic pipes and (ii) a lack of access points to the network, the use of correlators will be limited.

A successful correlation was possible in Hanoi where the correlator was used to locate a leak on a 200mm PVC main over short distances (maximum of 60m at 10m pressure) during the early hours of the morning between 2am and 4am. It was

found that the leak was an illegal connection to a house and workshop which contained a leak or open end causing the leak noise.

Leak noise loggers

The biggest surprise of the leak detection trial was that leak noise loggers worked well despite the extraordinarily low pressures. However, a serious problem for the large scale use of noise loggers is the lack of access points to the network. In the future, if access points were made available, such as fittings in chambers, valves and underground hydrants, then the use of noise loggers may become more common.
Permanently installed leak noise loggers may not be an option, labor being cheap. However, it must be considered as new technology now allows for remote reading of the loggers giving a 24-hour report on the state of the distribution system.

Leaks located

A total of 19 leaks on service connections were reported and repaired. However there was one leak that has to be accounted for and one big leak on a service line was detected bringing the total to 21. In addition, an even larger number of smaller leaks before and after the customer meter have been found. Some of these were so minor that repairing them was deemed uneconomical but 12 were deemed large enough to report for repairing. Quantification of leaks has been tried but with the low level of confidence in the flow or DMA data, this may not be totally accurate ■

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يتناول هذا المقال عمليات التحكّم بتسربات المياه من الأنابيب في المنشآت المنخفضة الضغط بواسطة الأدوات السمعيّة. يُناقش المؤلّف التقنيات المتّبعة ويتّخذ مثالاً الأعمال التي نُفّذت في هذا المجال في مدينة هانوي الفييتنامية. أقيمت أعمال الكشف على التسرّبات في هانوي من الساعة ١١ ليلاً حتى الرابعة صباحاً على فترة إمتدت من تشرين الأوّل (أكتوبر) ٢٠٠٧ إلى شباط (فبراير) ٢٠٠٨، وذلك بإستخدام عدّة أدوات من مكبّرات صوت وأدوات تنصّت لرصد أصوات التسربات ومعدّات تسجيل ضجيج متطوّرة. وكانت المدينة قد نفّذت برنامج مراقبة ضغط واسعة النطاق في ١٤٠ نقطة على خطوط أنابيب لنقل وتوزيع وتأمين المياه. أكّدت هذه التجارب إمكانية إجراء إختبارات كشف عن التسربات بواسطة معدّات كشف سمعية وصوتية وذلك إذا ما أجريت الإختبارات بواسطة مهندس ذات خبرة عالية، وخاصة في المنشآت المنخفضة الضغط. كُشف عن ١٩ حالة تسرّب تم معالجتها ضمن هذه الحملة، ذلك قبل الكشف عن تسربين إضافيين، أحدهما كبير على خطة خدمة. بعض التسربات كانت أصغر من أن تعالج نظراً لتكلفة صيانتها التي هي أعلى من تكلفة الخسارة التي قد تُسبّبها، **فقط ١٢ تسرب من ضمن التسربات الصغيرة عولجت نظراً لحجمها الخطير نسبياً** على المدى الطويل.

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