# Technical paper:

# Developing a leak detection system for NPPs

**Detecting leaking valves as quickly as possible is a priority for nuclear power station maintenance crews. In 2011 a new tool was developed which was quickly adopted because of its ability to identify very small leaks at low pressures. The new meter identifies the culprit "leaking" valve quickly, thus enabling maintenance activities to be re-focused on exactly what needs to be corrected.**

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In July 2011 a new type of hand-held leak detection system was released onto the market following a rigorous certification process. Known as the Midas Meter® leak detection system, it has since become broadly adopted by the US nuclear industry, and is currently owned or used by over half of the nuclear utilities in North America. The Appendix J Owners Group (APOG) was the first nuclear industry group to recognize the value of this purpose built, through valve, leak detection tool. APOG (www.apendixj.org) meets annually in June and provides training, lessons learned and industry best practices with respect to Appendix J programs and leak rate testing.

Once the tool gained traction as a Local Leak Rate Test (LLRT) troubleshooting tool, owners quickly discovered other applications, and it is now routinely utilized by maintenance technicians, Air Operated Valve (AOV), Motor Operated Valve (MOV) and Check Valve program owners, Condition Monitoring groups, Thermal Performance Engineers, Plant Operators, Fix it now (FIN) teams etc. to support leak rate testing and troubleshooting of valves in all systems.

One utility has incorporated seating surface evaluations using the meter into their maintenance procedures for a certain population of check valves.

The nuclear industry was quick to adopt the tool because of its ability to identify very small leaks at low pressures. This was a long sought-after solution for Appendix J testing, since the historical process required isolating sections of plant piping by closing many valves to create a test boundary. As long as the test pressure within the boundary was


*Figure 1: The valve leak detection system includes the handset, AE sensor, on board computer and electronics, rechargeable battery pack, and digital (dB) LCD display screen.*

maintained the test was successful and nuclear plant outage activities would then proceed as planned. However, when the test pressure could not be maintained, the process of eliminating each valve (one at a time) commenced, while progress toward plant restart either slowed or stopped.
The new meter identifies the culprit "leaking" valve quickly, thus enabling maintenance activities to be re-focused on exactly what needs to be corrected now. Available case studies have clearly demonstrated that the tool has picked up leaks during post maintenance tests (PMT) thereby focusing maintenance groups on determining the true root cause of a failed test and eliminating alternate leak paths.

## System components

The Midas Meter® valve leak detection system consists of the handset, which includes a Score designed and manufactured AE sensor, on board computer and electronics, rechargeable battery pack, and digital (dB) LCD display screen. (Figure 1)
The second and equally important part of the system is a hand-held ruggedized personal digital assistant (PDA), complete with proprietary leak estimation software. The handset transmits the readings to the PDA via Bluetooth and the PDA software converts the dB reading to a leak rate, using user-defined valve and process information. (Figure 2)
Additionally, the PDA can be connected to a PC to facilitate information input and reporting output via PC keyboard and mouse.
Valve leakage estimates can also be calculated and reported in standard units of mass or volumetric flow, but the tool was never intended to replace the LLRT cart used to quantify valve leaks in nuclear applications. It does however provide consistent qualitative results, so a valve's performance can be trended over time, then worked "just in time", or compared to similar valves in order to prioritise maintenance.
The third component of the system is the PC based Communicator™ software. This tracks license and calibration files, facilitates the import and export of PDA data, prepares valve performance reports and exports data. (Fig 3)


*Figure 2: The hand-held ruggedized PDA, complete with proprietary leak estimation software.*

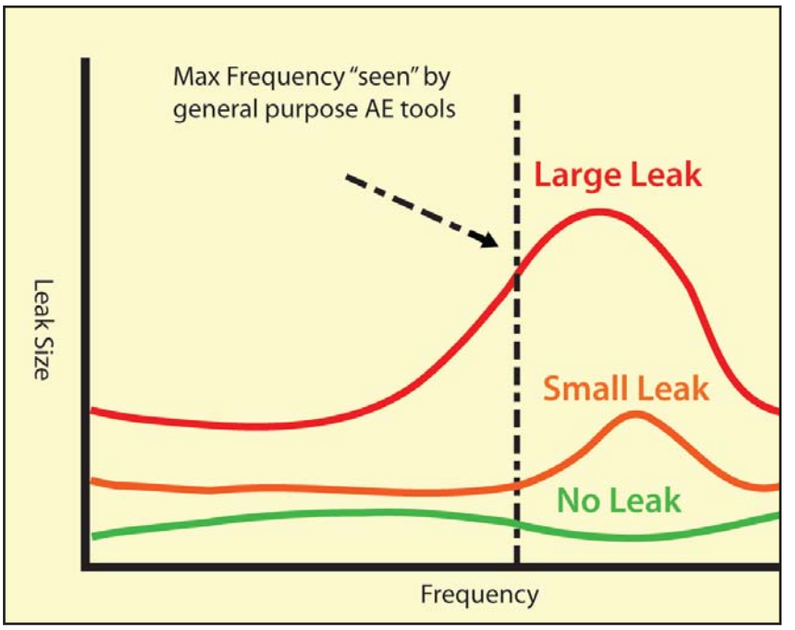


*Figure 3: Leak detection frequencies.*

## Acoustic emission tools

Ultrasonic and higher frequency acoustic emission tools are not new to the nuclear industry and some products have been used with limited success over the past 30 years. The primary difference between this new tool and any general purpose "listening device" is Midas Meter® is a high sensitivity leak detection tool for early and low leak rate detecting.
General purpose ultrasonic tools, some of which are advertised for leak detection, cover a specific range of lower frequencies. While these tools perform many tasks adequately, such as picking up low frequency gear or bearing noise, they typically do not conclusively identify low level gas or fluid leaks. The challenge for the general purpose ultrasonic instrument is the leak signal is often very low and thus overwhelmed by lower frequency mechanical interference.
Over time, as small high frequency leaks grow, the leak noise broadens as shown in Figure 3. As this happens the signal generated changes to a lower frequency, (more indicative of flow than leakage) and at this point the general purpose tool may then find the leak. While it can now pick up the leak associated signal, it is still also gathering every other low frequency interference and distraction emanating from continuous duty motors, pumps and other noisy components.
Discussions with various condition monitoring groups across the industry, have confirmed that the ease of

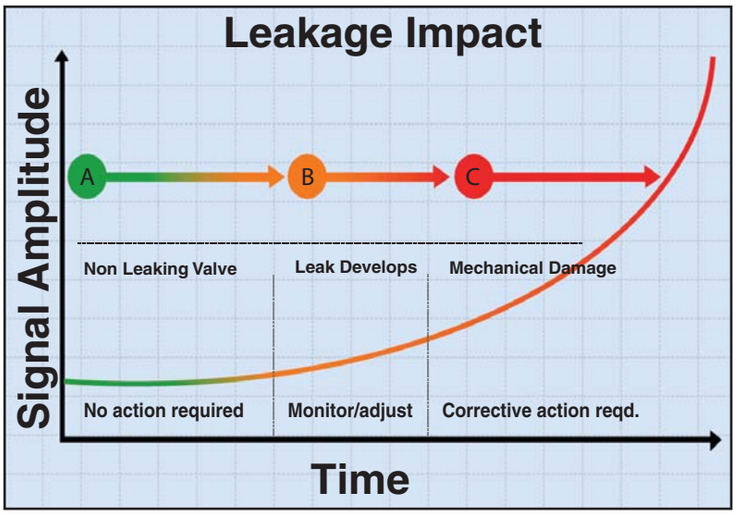


*Figure 4: The benefits of early leak detection.*

use – even at very low pressures - has given them a new tool. The biggest complaint they had in the past was that while they did eventually find the leaking valve, by the time they did it was already damaged and required corrective action. Figure 4 illustrates the value of identifying leaks as early as possible, i.e. while the possibility of adjustment and correction of the problem still exists.

Using the PDA to store data and provide leakage estimations allow users to trend leakage data over time and generate reports using the PC based Communicator™ software.

## Leak detection device

The Midas Meter is first and foremost a leak detection device - not a flow meter, and therefore does not have the accuracy of a flow meter. Currently this is not an issue because the calibrated LLRT cart does that, it just can't determine where the leak is if the test boundary doesn't hold pressure. This is why the tool has excelled in Appendix J programs.

While the tool currently comes with an uncertainty (accuracy) statement, the data used to derive this uncertainty was developed in the oil & gas industry where valve types, sizes, materials, operating pressures and other factors are significantly different from those encountered in nuclear power. As such the leak quantification process is restricted to "information only" troubleshooting, and not as a "stand alone", "safety related" decision making device in nuclear applications. However, growing nuclear power adoption, including an increased desire for use beyond just troubleshooting, has set it apart from other general purpose acoustic device.

In January 2013 Score Atlanta began an extensive validation testing program designed to re-validate – under very close controls - the entire leakage quantification process consistent with application in nuclear plant environments. This includes validation under the Score Atlanta nuclear QA program. A purpose built flow loop was designed and constructed in the Atlanta facility and acoustic emission signatures from a wide range of manufactured leak path geometries at varying pressures, on different mediums, are currently being evaluated. At the time of this writing over 20,000 test points at various pressures, leak path geometries and sensor locations had been recorded and evaluated. This phase of the program is approximately 20% complete. This will be followed by additional valve testing, and then field verification. Current nuclear plant Midas Meter® owners have also volunteered to participate in the field testing.

The tool has already been broadly adopted by nuclear plants for a wide range of valve leak detection purposes. At the conclusion of this program, Midas Meter® will be the first acoustic based leak detection system to be validated for nuclear safety-related use.

Once qualified, the technology will then become available to the nuclear industry as an online sensor based on currently installed Midas Sensors developed by Score Diagnostics limited, the UK based sister company of Score Atlanta. On Line valve leak detection with acoustic emission is expected to greatly enhance thermal efficiency and check valve testing programs at pressurized water reactors as well as monitor many other inaccessible critical valves at boiling water reactors. This will allow users to efficiently plan work scopes well in advance of maintenance and refueling outages by focusing on the exact equipment that needs maintenance at the time it is needed.

## About Score Group

The Midas Meter® was developed by Score Group PLC, a global valve services company headquartered in the UK. Initially a North Sea oil & gas oriented service company, Score has continuously added expertise and capability and now engages in all aspects of valve supply, valve service and valve asset management, including valve diagnostic testing for its customers worldwide.

A valve knowledge base and experience built up over thirty plus years of operations has enabled the Group companies to cross over into other industries such as military and commercial nuclear power. When Score Atlanta Inc. was established in 2009, it opened a conduit to facilitate the transfer of nuclear industry valve diagnostic experience and requirements back into Score Diagnostics Limited's product development process, while simultaneously transferring Score's developed and emerging diagnostic capabilities for oil & gas back into commercial nuclear power.