

# A complimentary COMBINATION

*Michael Twomey, ATMOS international, Inc., USA, explains how new technology can save time and money on hydrostatic tests.*

**W**hen a hydrostatic test fails, it is important to locate the leaks immediately for repair. Locating leaks that are no more than tiny holes or weld defects in a pipeline that is buried underground or submerged offshore is difficult, time consuming and expensive. It is even more challenging on pipelines that are hundreds of kilometers long. Failure to swiftly locate and repair such defects wreaks havoc with the schedule of multi-million dollar, mission critical projects. Although the conventional systems and calculations used for pressure testing can indicate the potential of a small leak they can sometimes be misleading and do not provide a method of determining location of the leak.

While testing a revolutionary new real-time pipeline leak detection technology called ATMOS Wave, an engineer from Enbridge Pipelines Gathering Systems (Enbridge) identified the potential of this new leak detection technology for identifying and locating leaks during hydrostatic testing. Enbridge suggested that ATMOS

Wave would complement the conventional equipment, as specified by regulation, used for hydrostatic testing of pipelines; i.e., dead-weight testers, temperature and pressure gauges and associated chart recorders. Thus Enbridge deployed the ATMOS Wave system for a series of five hydrotests being performed on part of their Saskatchewan gathering system.

The pipelines proved to be in excellent condition and did not leak during the hydro-test, however, when the test engineers made small controlled product withdrawals at a bleed valve on the pipeline, the leak detection system detected and located them accurately, demonstrating that this is indeed a good solution to improve hydrostatic testing.

The US Senate is working on a pipeline safety bill. The Strengthening Pipeline Safety and Enforcement Act of 2011, similar to legislation introduced last fall, is meant to ensure public safety in wake of the deadly pipeline blast last year in San Bruno, California. The bill also would enforce recommendations from the National Transportation

Safety Board (NTSB) released in early January. Pipelines with incomplete records must be pressure tested or replaced, and must operate at reduced pressure until testing is completed. This provision was recommended by the NTSB after it discovered serious problems with Pacific Gas and Electric's record keeping during the investigation of the San Bruno explosion. ATMOS Wave will provide an excellent tool to reduce cost if these tests are mandated.

## Vocabulary

AWAS: ATMOS Wave acquisition system.

LDS: Leak detection system.

MOP/MAOP: Maximum operating pressure/maximum allowed operating pressure.

SMYS: Specified minimum yield strength.

## Background

Engineers have used hydrostatic testing to determine and verify pipeline integrity for many years. This verification process can provide a lot of information. The hydrostatic test is used in pre-commissioning of new, re-activated or re-serviced pipelines. When a hydro-test fails, the leaks need to be quickly located for repair. This can be very difficult even in pipeline sections that are as short as 10 km, particularly when the leaks are very small. When a leak occurs, the inspection company has to respond quickly and locate the leaks. If they fail, the project can become very expensive as crews and rigs stand around waiting for a resolution.

## Discovering ATMOS Wave for hydrostatic testing

In July 2010, Enbridge successfully tested a new rarefaction wave leak detection system, ATMOS Wave, on an 8 in. diameter, 19.3 km long crude oil pipeline. The testing was accomplished by simulating 'leaks' through controlled product draws from the pipeline at an intermediate block valve setting. The ATMOS Wave leak detection system detected a 20.66 litre/hr (0.13 bph) 'leak' in three minutes during shut-in testing (static test). This

equates to total volume out of just one litre (0.0065 bbls). In fact, it was not possible during the static testing to create a 'leak' small enough to avoid detection. These fantastic results inspired Enbridge to propose this same technology to assist in hydrostatically testing a new NGL line as well as an existing NGL pipeline, which is being re-serviced for crude oil.

The ATMOS Wave LDS is based on the detection of the negative pressure waves associated with the onset of a leak. These rarefaction waves propagate out from the location of the release in both directions and can be sensed by high performance pressure meters at the ends or along the pipeline. The pressure signal generated by a leak can be strong, even if the source is a leak of relatively small dimension.

ATMOS Wave is the result of several years of research and development directed at producing a pressure-based LDS that is capable of differentiating between pressure waves that originate from pinhole leaks and the background noise and other pressure signals caused by normal pipeline operations. The system uses unique, patented algorithms that facilitate examination of all aspects of the negative pressure wave front and its propagation along the pipeline. Three comprehensive algorithms filter out noise and groom the analog pressure data into a detailed 3D map that allows the system to quickly detect leaks and accurately locate them.

## ATMOS Wave deployment for the hydro-testing

A standard, off-the-shelf, high-performance pressure sensor is connected to each end of the pipeline segment before the hydro-test. These pressure sensors are connected to a data acquisition unit (AWAS). Each AWAS unit has a built-in GPS unit to assure accurate time stamping of all pressure data collected. The AWAS units are connected by a temporary telecom system such as radios or GSM, allowing them to transmit all of the pressure data back to the central processing computer at the test trailer.

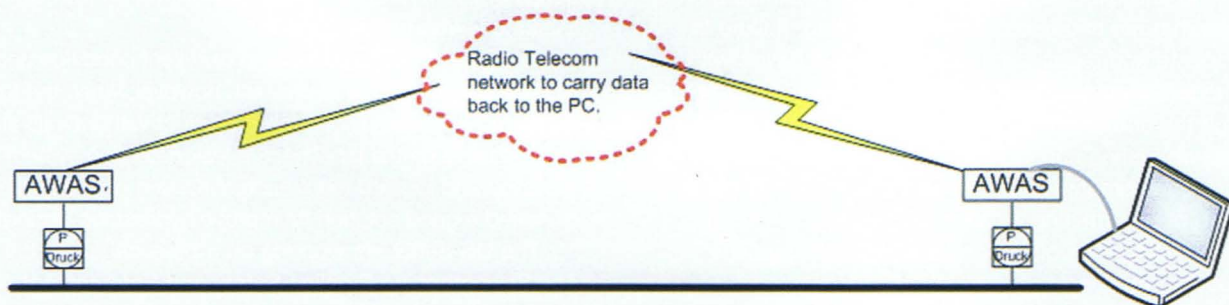


Figure 1. ATMOS Wave configuration using radio telecommunications.

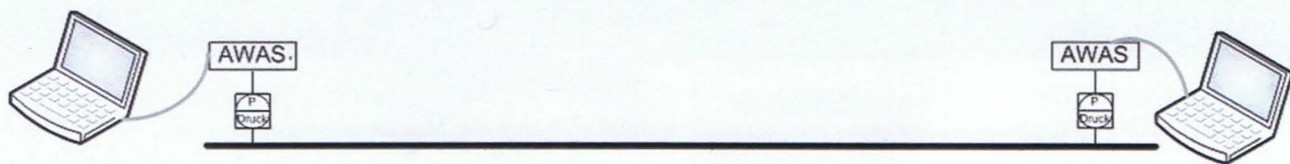


Figure 2. ATMOS Wave configuration for offline data collection.

Unique algorithms in the ATMOS Wave software detects leaks in two completely new ways:

1. One algorithm arranges all of the time stamped data into a 3D pressure map, showing location, time and intensity of the wave. Another algorithm combs the 3D pressure map according to preset rules, searching for pressure intensity peaks caused by real leaks.
2. Proprietary Post Leak Indication Build-up (PLIB) algorithms calculate the pressure intensity accumulation at the site of an existing leak allowing detection of existing small leaks.

These features assure that ATMOS Wave detects small leaks without false leak alarms.

### How the site tests were performed

Four of the five hydrostatic tests that Enbridge pipelines used ATMOS Wave on were conducted on a 61 km long, 12 in. diameter pipeline that is being re-serviced from NGL to crude oil. The pipeline was divided by two intermediate 'break points' into four test segments for hydro-testing.

- ➔ Segment 1: 14 km long.
- ➔ Segment 2: 15 km long.
- ➔ Segment 3: 19 km long.
- ➔ Segment 4: 13 km long.

The pipeline contractor exposed the existing buried pipeline at the break points and installed test headers at the beginning and end of each segment. Due to the extreme winter weather conditions, a mixture of methanol and water was used as the test medium. The pressure sensors and ATMOS Wave data acquisition units (AWAS) were installed to monitor the pressure while the test segment was packed, held at pressure for the required shut-in period and while un-packing the segment. Had a leak occurred during any part of the testing process, ATMOS Wave would have identified the breach in containment, calculated the location of the leak and estimated the leak size. This would apply to both existing and newly created defects in the test segment.

Typically the AWAS units can communicate, passing data to the central processor, via a communications

network, using either the built in GSM cards or radio links. However, as with most projects, not all things went according to plan. Late November in Saskatchewan brought weather conditions even worse than normal for this northern climate and logistic developments forced the test team to deploy ATMOS Wave without the planned temporary radio communications link. Instead, the AWAS-3 unit at each end of the segment was connected to a notebook that logged the data locally and monitored the pipeline pressure data. This data was used as an early warning indication for any loss in pressure that may have been caused by a leak. The data from each Notebook was copied to the ATMOS Wave data analysis programme for 'off-line' data processing and analysis at predefined intervals during each test.

Throughout the entire process, i.e., packing, strength test period, leak test period and un-packing of the pipeline, the pressure was constantly monitored and logged from the dead-weight tester and chart recorder as required by regulations. In addition, the pressures were displayed on a trend within the ATMOS Wave system that was compared with the readings taken from the dead-weight tester on site. The ATMOS Wave equipment and software trending tools allowed the engineers to monitor the line pressure for losses with a much higher accuracy, particularly during the shut-in periods. For example, ATMOS Wave was able to detect pressure losses as small as 0.05 bar/hr, caused by temperature changes.

### Conclusion

The ATMOS Wave system can accurately locate a leak almost immediately during a hydrostatic test and provide an estimate of the leak size and the leak location. ATMOS Wave Ltd has now used this pressure data and experience to develop application-specific software that will allow the same level of sensitivity using a single pressure sensor on a test segment. This eliminates the need for a communications link between the two ends of the pipeline segment, while maintaining the ability to quickly detect and accurately locate and size small leaks during hydro-testing. **WP**

### Bibliography

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