Sounds under the sea

Luigi Barbagelata, Co.L.Mar, Italy, discusses the techniques available for subsea inspections.

Co.L.Mar. Srl specialises in underwater acoustics and in 1998 it started to apply this technology for subsea inspection to detect leaks on pipelines and other pressurised installations. The system developed for this purpose was called Acoustic Leak Detector (ALD), which has been patented and continuously developed for 20 years. In December 2017, the ALD technology was certified by DNV GL. Today the system is available in several

Figure 1. ALD installed in a light observation class ROV.

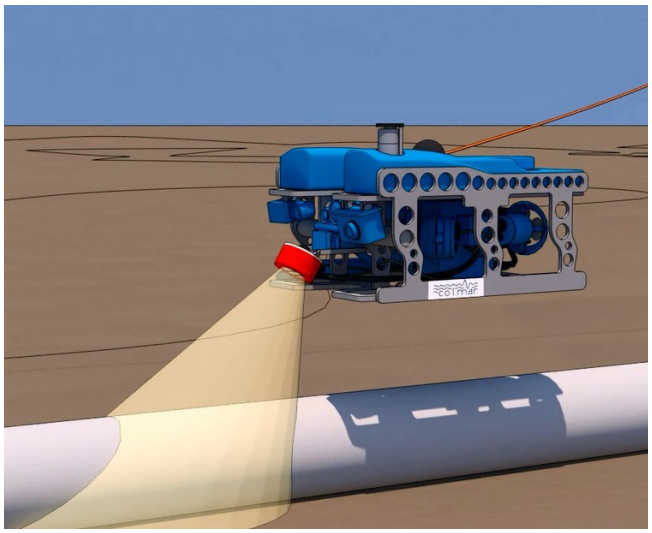

Figure 2. Inspection of a line by ALD installed on an ROV.

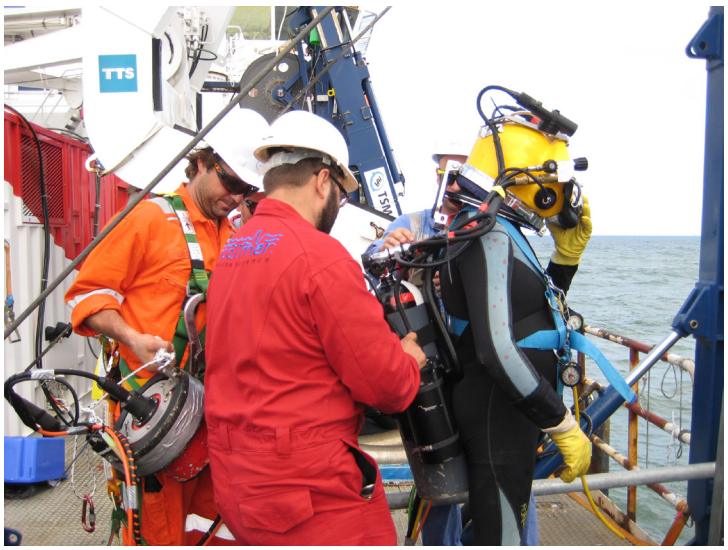

Figure 3. Diver ready for a leak inspection with ALD.

configurations corresponding to different inspection techniques, including ROV, towfish, diver and AUV.

A pressurised fluid flowing through a leak generates an acoustic signal due to the turbulence and the sudden expansion of its mass. ALD has been optimised to be capable of detecting this signal, even if it is very weak and in a noisy environment. As a result, it has been able to detect in the field leaks as small as 0.04 l./min.

Over the past 20 years, Co.L.Mar has detected 54 leaks of different natures, from places such as: field joints, flanges, valves, wellheads, clamps, pipes, and in pipes with different conditions: buried pipelines, zero visibility, strong currents, depths down to 1800 m. Currently, the company has a success rate of 100% and it believes that one of the reasons for this effectiveness is that Co.L.Mar have always refused to sell its equipment. In fact, ALD is not supplied as a product but as a service, which includes the company's trusted operators. Co.L.Mar believes that even the best equipment benefits from a good operator, its experience and its will to get the job done.

Inspection techniques

ROV

One of the most frequent ways to use ALD is the ROV mounted technique. In this case, the equipment is composed of a sensor and an electronic bottle (POD) to be installed on the vehicle, whilst on the surface the data is received by a hardware unit and processed by the ALD software. The POD is connected to the vehicle electric panel. The POD has been designed to have the same requirements as a standard camera (24V power and a data channel) so that it can be interfaced with any size of vehicle from a small eyeball to a large work class. On the vessel, an ALD operator sets the receiver and it monitors in real time the data displayed by the software. The installation normally requires a few hours, then, after a short calibration, the inspection can start. If the inspection regards a pipeline (inline inspection) the vehicle will fly around 1 m above it at a speed between 0.5 and 1.5 knots, similar to a standard video inspection. The operator monitors the data in real time and will stop the inspection in the case of an anomaly. A few passes on the suspect location will allow the operator to definitively confirm the leak or discard the anomaly.

When the object of the inspection is a flange, valve or similar, the inspection is called point inspection. In this case, the procedures are different. First, a reading is taken as a reference in a non-suspect position before the readings taken on the target are compared to it in real time. While the ALD is taking the readings, the vehicle shall be as silent as possible, this way it is possible to make a very accurate inspection which is capable of detecting extremely small flows.

Using an ROV, Co.L.Mar has been operating at a depth of 2150 m (Blue Stream project, Black Sea) but the maximum depth the equipment can reach is 3000 m.

Diver

When convenient, ALD is supplied in the diver hand held version. In this case, a dedicated sensor is held by

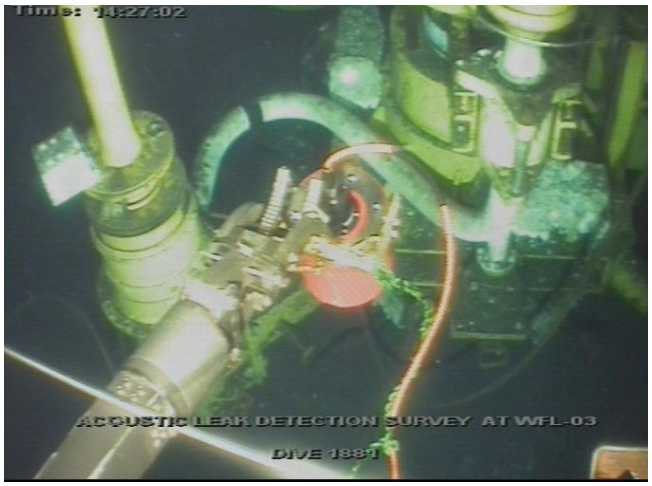

Figure 4. Inspection of a wellhead by ALD.

Figure 5. ALD system in AUV version.

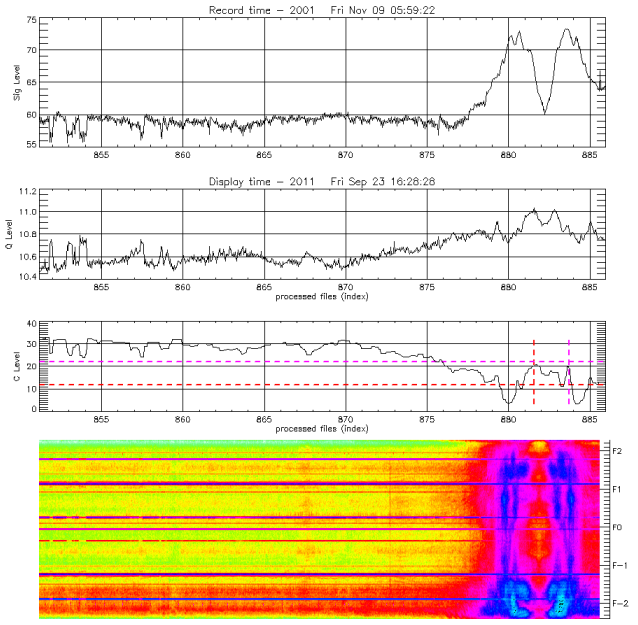

Figure 6. Acoustic signature of a leak.

the diver while the POD is fixed to the emergency bottle. A dedicated cable directly connects the surface power and the data link. The surface equipment is the same used for all the ROV configurations and the ALD operator shall communicate with the Diver Superintendent. Normally this technique is used just for point inspections or to investigate short pipeline segments.

Towfish

When the depth is limited (below 100 m) the use of the ALD towfish allows inspection speed above 4 knots and does not require a DP vessel. This will drastically bring down the cost per kilometre of the inspection. The surface equipment will be the same whereas the sensor is a towfish connected to an electromechanical cable. During the survey the towfish position is monitored by an USBL underwater positioning system. In 2011, for the Nord Stream project, Co.L.Mar manufactured a special version of the towed system capable of operating at a depth of around 250 m.

In some cases, if the current is too strong or the depth is too high to use the towfish, the ALD sensor is deployed from the vessel attached underneath a heavy clump weight, which is lowered by means of a steel wire and kept at an altitude of approximately 10 m above the pipeline. This procedure is called 'vertical mode' since the sensor will remain on the vertical of the lifting point, unlike the case of the towfish. This procedure requires a DP vessel and can operate at a speed of 1 knot.

AUV

The latest inspection procedure Co.L.Mar has developed is based on the use of an AUV. In this case, ALD is a stand-alone system. It is composed of a sensor and an electronic bottle where data is recorded and subject to preliminary processing. After the mission completion, data is downloaded and fully processed. The preliminary process provides a leak index which can be transmitted in real time to the AUV navigation processor and eventually used to modify the mission route and double check suspect points. The AUV is an excellent platform for ALD surveys because the background noise is quite low during the survey. The first ALD-AUV unit was developed for the Cleansea Project of Tecnomare (now EniProgetti) and two units are now in use on the Cleansea vehicles.

Mobilisation for inspection

Co.L.Mar has been involved in many projects where unexpected leaks have generated critical situations, but fortunately ALD has always been able to locate the leak and allow the client to proceed with the repair operations. The mobilisation has often been on very urgent request, so Co.L.Mar has had to organise its service consequently. The company tries to always have operators available for immediate departure and all its equipment is stored in military cases that weigh less than 20 kg each so they can fly as extra luggage with the operator.

In most of the leak cases the company has worked on, it was a situation of hydrotest failure. Normally, after the pressure drops a visual inspection is started to try locate signs of rodhamine or fluorescine escaping from the pipeline. Unless the leak is very large, spotting the signs of the dye is

very hard and become almost impossible in the case of poor visibility, currents, and pipeline burial. In many occasions, it is only after many days have passed and money spent on visual inspection, has Co.L.Mar been called out and detected the leak acoustically.

For this reason, many of the company's clients now request for mobilisation before the hydrotest as a preventive action, so that, in the need for inspection, Co.L.Mar can immediately take action. Co.L.Mar has proved that ALD acoustic inspection is far more effective than visual, chemical or optical techniques that are aimed to detect dye particles dispersed in the sea water. Moreover, most of the dye tracers are strong pollutants and their use is now interdicted in many parts of the world. What the company proposes to clients is a contingency service aimed to minimise costs in the case of pressure dropping during hydrotests.

A memorable case was in 2012, where one of the major EPC companies had a leak of just 0.2 l./min. during a hydrotest in the Middle East. The installation included two skids with a number of flanges and valves. The company involved started looking for dye using divers but, following no success, they decided to wrap all the flanges with transparent films to see if some dye was visible between the flanges and the films. This technique also failed and finally Co.L.Mar was contacted. Co.L.Mar was available but it took 10 days to arrive on site as result of personal visas and custom clearance. Once on site, the company detected the leak in less than 48 hours and the hydrotest could be completed successfully, but 25 days had passed since the initial pressure drop. In this case, an ALD contingency contract would have saved about 23 days of offshore operations.

Future inspections

In April 2017, Co.L.Mar started a technology qualification process with DNV GL, and in December 2017 obtained the certificate attesting the ALD capability to detect leaks during hydrotests in diver and ROV mode.

Pipeline integrity inspections mainly consist of ROV or AUV surveys. In addition to cameras, the vehicles are equipped with sensors to evaluate the conditions of the pipe and of the surrounding environment. Among those sensors, it is possible to add ALD. Acoustic data is acquired while the vehicle is flying above the pipeline for the standard visual inspection, so adding the leak survey results has a limited additional cost. Unlike emergency inspections, in the case of pipeline integrity surveys the budget is one of the priorities. AUVs do not need a DP vessel like ROVs do, therefore the total cost of the inspection can be considerably lower, and it is for this reason that AUVs may have a successful future in a time of limited budgets.