SUBSEA PIPELINE LEAK DETECTION

C h r i s T e a l

Director, Neptune Oceanographics Ltd

T h e Need F o r S u b s e a L e a k D e t e c t i o n

Neptune Oceanographics Ltd is a global leader in the field of detection of leaks from subsea pipelines, risers and control systems and has made, and continues to make, significant technical advances in this field.

Neptune has developed several new leak detection systems based on fluorometric, acoustic, differential temperature, MEG and direct hydrocarbon detection techniques.

Fluorometry

In the past detecting subsea pipeline leaks has relied on ‘black light’ (unfiltered ultraviolet light) to visually detect leaked fluorescent dyes either by diver or underwater camera, however, this method is very inefficient and relies on high dye concentrations and optimum visibility and tidal flow conditions for any chance of success. More recently, deploying submersible ‘tuned’ fluorometers that send data up to the attendant vessel providing a real time visual display has largely solved these problems. These submersible fluorometers are capable of measuring concentration levels thus allowing the operator to ‘home in’ on the highest values found at the leak source. They are very sensitive and will detect dye at concentration so low as to be invisible to the naked eye or underwater camera. However, with normal submersible fluorometers spatial coverage is poor and the dye has to be in contact before it is detected.

To overcome the problem of spatial coverage and the need for dye contact with the fluorometer, Neptune Oceanographics has developed a family of 'Long Ranger' leak detection systems that detect tracer dyes remotely.

The 'Long Ranger' sensors have forward facing 'tuned' light sources (like torches) producing beams of excitation light. The fluoresced light generated by leaking fluid is detected by the sensor without the need for contact. Because the sensors have high spatial coverage and long range, quick and easy scanning for leaks is achieved without needing to consider tidal flow direction to 'capture' dye.

The latest versions of Neptune's 'Long Ranger' leak detection sensors have the potential to detect leaking fluorescent dyes and crude oil, etc. at distances of up to 20m.

Other significant advantages of the 'Long Ranger' include the detection of leaks from risers while working at safe operating distances and detecting leaks within confined structures such as manifolds where ROV access is not possible or too hazardous.

Fig 1 – Long Ranger in operation

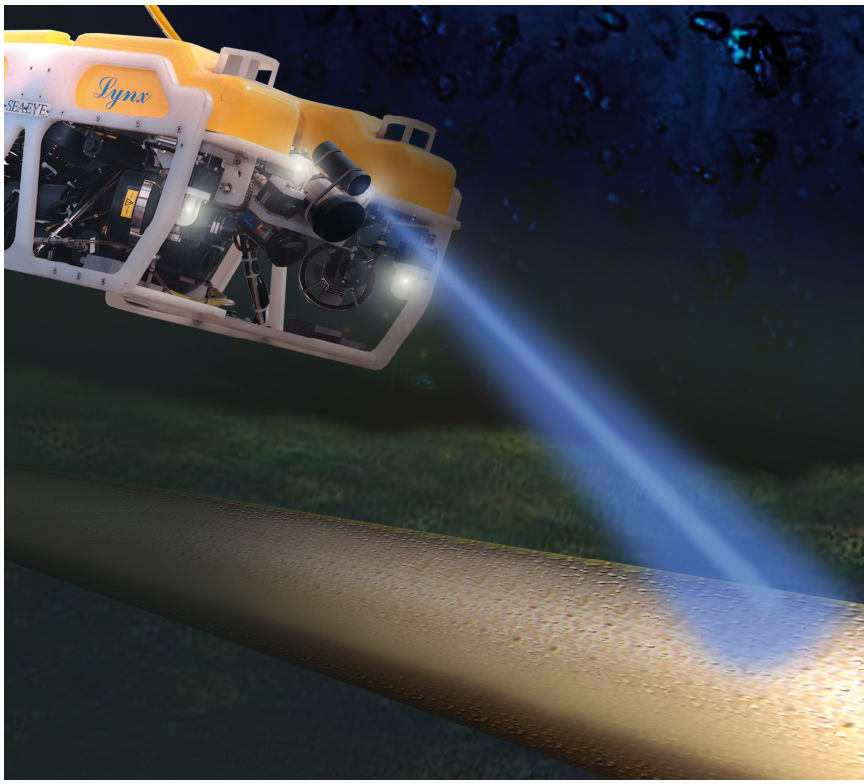
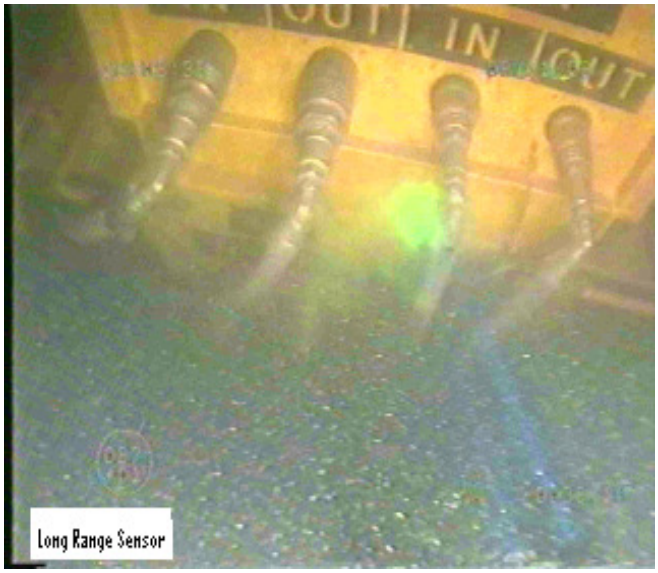


Fig 2 – Long Ranger dye excitation as seen by ROV camera



Long Range Sensor.

Two blue excitation light beams are visible.

Fluoresced light produced by the dye shows as a green cloud at the leak location. Tracer dye is Fluorescein

Leak detection system output is graphically displayed on the onboard PC.

For many years the fluorescent dye typically used for leak detection has been Fluorescein, however, this is being phased out of general use as it no longer complies with the latest legislation for discharges at sea. Other tracers such as Castrol's SPF, Champion Clear Dye and other clear UV dyes, MacDermid's Oceanic range of fluids, Rhodamine, Roemex's 9022 red dye, etc., have been tested to demonstrate their compliance with the latest legislation and are now widely used. Neptune's family of 'Long Ranger' fluorescent leak detection sensors are capable of detecting these dyes and by deploying the UV version can detect crude oil, lubricating oil and hydrocarbon based control fluids such as Castrol's Brayco fluid.

Acoustics

Hydrophones are effectively underwater microphones that can be tuned to 'listen' for ultrasounds generated by fluids leaking under pressure. For small leaks these leak generated signals tend to be at frequencies well above the audible range, i.e. above 20kHz, thus requiring sophisticated sensors and software to reliably determine the difference between leak generated and ambient 'noise'. The major

problems with this method are the sounds caused by the attendant (ROV) and other vessels in the vicinity.

In collaboration with Aquatec Group, Neptune Oceanographics have produced an acoustic leak detection sensor that incorporates a directional hydrophone with a high pass filter that significantly reduces the effects of non leak generated sounds. The sensors have been tuned to respond in the range of frequencies known to be emitted by high pressure leaks through small apertures.

Acoustic signals are sent to an onboard PC via an ROV umbilical or diver cable where acoustic intensity is displayed graphically and also recorded for later playback.

Typical applications are detection of leaks of gas from subsea installations, locating fluid leaks from buried pipelines and from pipe within pipe configurations. More recently, Neptune Oceanographics supplied a modified acoustic detection system complete with acoustic modem that successfully monitored the opening and closing of a large control valve during pipeline maintenance and replacement operations.

Direct detection of hydrocarbons

Hydrocarbons in liquid form such as crude oil can be detected using a 'Long Ranger' leak detector, however, a different method is required for gas. A direct reading hydrocarbon sensor has been added to the range of Neptune Oceanographics leak detection systems. This sensor is essentially a methane detector but it is equally a general hydrocarbon detector that will respond to most hydrocarbons, however, the potential for oil contamination on the sensors membrane make it less suitable for oil detection but good for gas detection. The very high sensitivity of the sensor also makes it ideal for the detection of gas leakages, gas in trapped in structure voids, seepage from the seabed, etc.

Direct detection of Mono Ethylene Glycol (MEG)

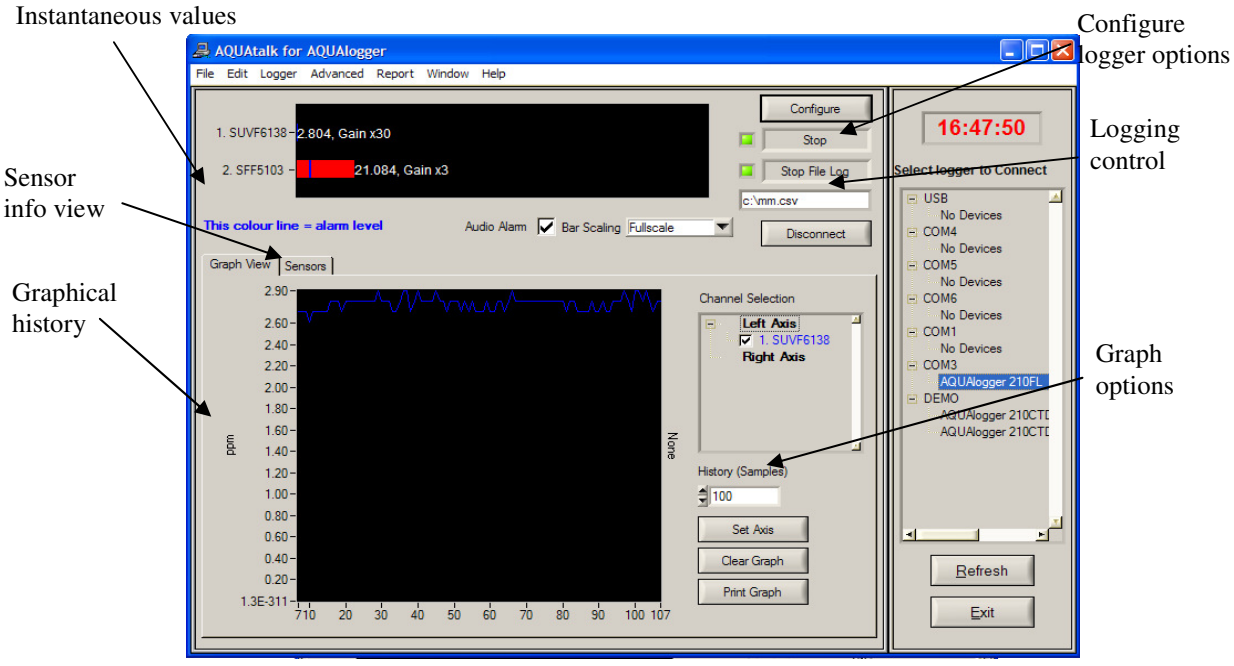
A new addition to Neptune's subsea leak detection capability is a MEG (Mono ethylene glycol) sensor. This sensor detects leaks of MEG from the subsea

systems without the need to add tracer dye. By eliminating tracer dye, leak detection can be accomplished with no additional environmental downside.

Differential temperature measurements

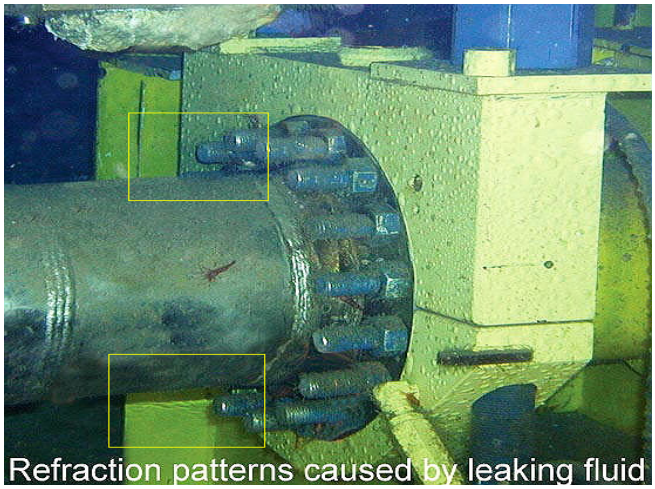
Under some circumstances such as with water injection flow lines, leaks can be identified using the temperature difference between the surrounding seawater and the water leaking from the flowline. The flowline water temperature is normally above ambient seawater temperature due to the high pressure pumping required. Neptune has developed a differential temperature technique that can detect very small temperature changes. The sensors comprise fast, high precision thermistors connected through the Neptune leak detection system to the ROV umbilical for onboard display and recording.

Fig 3 – typical screen display



The 2 channel on-board PC displays data as a colour time series plot in real time allowing the operator to easily see changes in signal that indicate the presence of a leak. The software also allows the user record data and set alarm levels.

Fig 4 - refraction patterns caused by leaking fluid



Refraction patterns caused by leaking fluid

Other news

During 2006 Neptune Oceanographics formed a strategic alliance with Aberdeen based Dynamic Positioning Services (DPS) who provide full workshop facilities, equipment deployment, technical expertise and experienced offshore engineers to support Neptune's global leak detection operations.

Neptune's growing list of agents includes established companies in:- Norway, Singapore, Houston, India and UAE

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