



FiberLine Intervention for Well Decommissioning/ Plug & Abandonment



Capability Overview – FLI Diagnosis and Validation Techniques

The FiberLine Intervention (FLI) system can deploy bare optical fibres into the wellbore to capture distributed fibre optic measurements in real-time. A single FLI probe can be configured with two bare optical fibres, one for measuring distributed acoustic sensing (DAS) data and another for measuring distributed temperature sensing (DTS) data.

These two distributed measurements allow us to determine flow and fluid characteristics across the length of the deployed fibres. Fluid movements can be detected and characterised in the tubing, across all annuli and cement barriers, and out to the formation with DAS measurements. Utilising DTS measurements, we can determine cement placement, validate top of cement and evaluate cement integrity.

Once the FLI probe has been deployed to depth, we monitor the distributed measurements to:

Assess

- **Fluid levels** – by monitoring the difference in run-in-hole speed, acoustic response and temperature response, we can determine the gas/liquid interface depths.
- **Baseline Log** – with the well in a static condition, we capture a base log of the acoustics and thermal gradient and monitor any natural changes. This creates a baseline of measurements to compare at the next stage of logging.
- **Stimulation of the wellbore** – by either bleeding annuli and/or tubing pressure down or by increasing the annuli or tubing pressure, we can perform a leak detection survey to determine one or more leak points within the completion. We identify these flow events by comparing both acoustic and temperature data against the recorded baseline.

Plan

- **Informed decision making** – the outcome of the assessment stage allows detailed and focused planning of any abandonment work that needs to be carried out.
- **Identification of problem zones** – by understanding the leak points and paths at specific depths, you can address problem zones at the abandonment design stage and plan a barrier program to isolate these areas successfully at minimal cost.

Execute

- **Improved operational efficiency** – based on the outcomes from the assessment and planning stage you can execute an efficient work program.

Validate

- **Execution assurance** – once completed, FLI can be deployed again quickly to repeat the measurements of the assessment stage in order to validate the barrier placement (or rework) is effective.

Technology and Key Benefits

FiberLine Intervention (FLI) is a wellbore surveying technique consisting of three main elements:

- A single-use FLI probe, which is launched from surface and free-falls into the well.
- One or more bare optical fibres, acting as distributed sensors, which unspool from the probe as it falls.
- A surface acquisition system, which processes the data gathered by the fibre sensors.



This picture shows the FLI probe ready for rig-up and deployment.

FLI is built around these very specific attributes:

- Rapid speed of deployment, fast fully distributed data capture and quick rig down.
- A simple deployment method that is standalone and requires no other infrastructure, saving time, money and reducing risk.
- The use of bare optical fibre deployed the length of the wellbore for the purpose of distributed fibre optic sensing.

FLI is Fast

Running FLI is very fast compared to conventional well intervention methods. Rig-up times are short and, once launched, the FLI probe is typically on bottom within 10-30 minutes, depending upon well depth and fluids. As FLI measurements are distributed, rather than single-point, survey times are also short. In most circumstances the time from rig-up to rig-down is a few hours, which translates into substantial rig-time savings.

FLI has a Tiny Footprint

The FLI rig-up is minimal, using little space and few services at the well site. We typically use only a single wellsite engineer, so FLI is also good for minimising personnel on board (POB). Of increasing importance, the low level of resources associated with FLI surveys can contribute towards environmental targets on lowering carbon footprint.

FLI is Powerful

Speed and simplicity do not come at the expense of capability – FLI is a powerful surveying tool. The FLI probe deploys one or more bare optical fibres along the length of the wellbore. Using distributed acoustic (DAS) and/or temperature (DTS) sensing, FLI can take continuous measurements everywhere, simultaneously, in real time and over a period of time. Distributed sensing can also be combined with single-point sensors installed in the FLI probe itself. Used together with our powerful answer products, FLI surveys produce datasets that are rich in information.

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FiberLine Intervention



Current methodology



The image above compares our FLI system with that of a typical intervention spread used in operations today.

Late Life and Plug and Abandonment Applications

As operators seek to significantly reduce the financial burden of decommissioning the most effective solutions are those that reduce rig time and de-risk operations. With our FLI deployment of distributed and point sensors, we have developed a suit of solutions tailored specifically for Plug and Abandonment (P&A) planning and operations.

Through-Tubing Pre-Abandonment Well Assessment

Our pre-abandonment Well Status Survey and Thru-Tubing Leak Detection applications provide rapid and useful data for all wells under consideration. The output of either or both help to identify, assess, refine, plan and execute abandonment operations in an informed, safe and cost-effective manner. Operations with FLI can be performed as part of the temporary abandonment program or independent of other well entry operations.

Evaluate Well Integrity to Inform Decisions on Abandonment Strategy and Safe Operations

Prior to cessation of production (CoP) detailed studies are undertaken and critical decisions made of the methods of abandonment. Confirming existing barrier integrity can enable large cost reductions to be achieved if rig-less or hydraulic work-over unit (HWU) abandonments can be performed. Alternatively, identifying barrier issues early can reduce the complexity and risk of subsequent operations by informing barrier placement strategies and reducing the number of contingency options required.

Confirm Reservoir Pressure to Inform Well Control Decisions

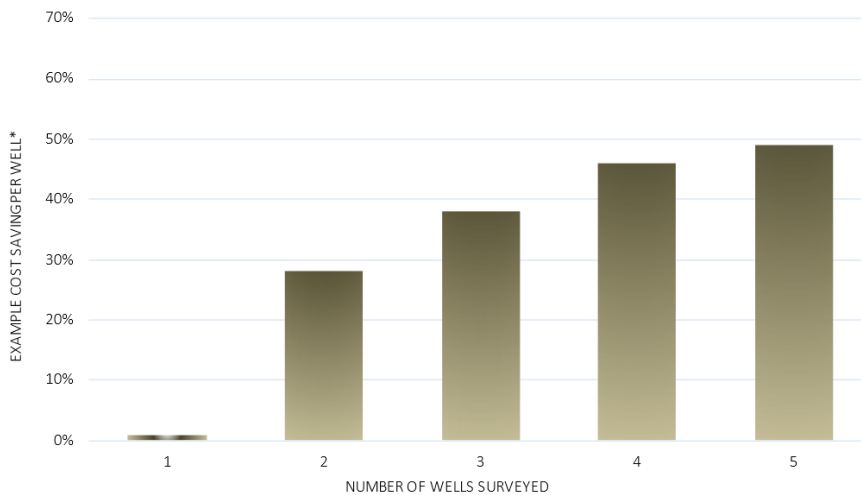
Many wells planned for abandonment have no recent well data to aid effective well control planning. Conventional interventions in old and shut-in wells presents a high risk of stuck tools and broken cables. A simple pressure survey and confirmation of the well fluid levels with FLI is a cost-effective means of obtaining valuable well data, while eliminating the risk of complex fishing operations.

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Batch Surveys

We can perform multiple well surveys in a short period of time, or even concurrently, enabling batch operations to be conducted, delivering real cost savings. The example below is based on single shift operations with one well survey per day.

Batch Well Surveying with FLI



Offline Operations

Surveys can be performed offline on large installations enabling simultaneous operations, and easily on unmanned platforms with lift and POB limitations. The picture below shows the full equipment load-out for a multi-well survey which is typically shipped offshore an 8ft half height container weighing under 100Kg. FLI is a standalone service and requires no third-party equipment.




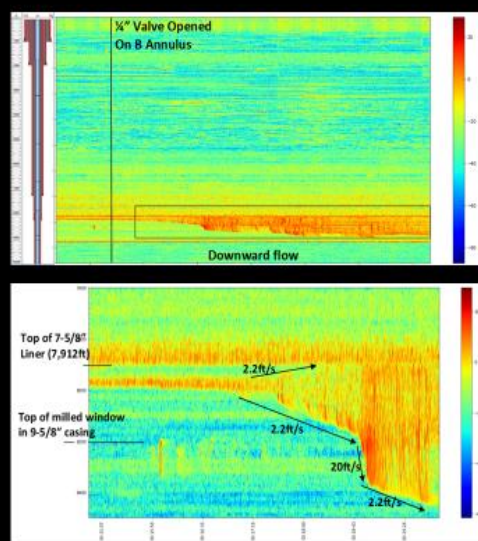
Entire load out for a five well campaign.

Through Tubing

FLI provides thru-tubing well integrity surveys that can detect leaks in the C-annulus and further afield. In the example below, we deployed FLI into a 4-1/2” tubing string after the operator observed leaks in the A-annulus during tubing cut and plug operations. FLI detected flow from a previous sidetrack over 30ft away from the logged well.

PROJECT: UK NORTH SEA THROUGH-TUBING LEAK DETECTION

- Status: During pre-abandonment work well integrity issues were noted with pressure build up in the tubing and A-annulus
- Objective: Locate well integrity issue so barriers can be regained for Xmas tree removal
- FLI was deployed in 4-1/2” tubing to a depth of 8,850ft
- B-annulus valve was opened to bleed down pressure and activate the leak
- An acoustic event was immediately recorded, originating at 7,960ft
- The flow is observed to move upwards from this point to the 7-5/8” liner top, and downwards to a depth of 8,200ft which correlates to the top of a milled window in the 9-5/8” casing

Abandonment Program

During the abandonment program all work is on the critical path and time is the key parameter driving cost. Surveys must be efficient and de-risk future activities. FLI can be utilised during these operations to achieve the following:

Locate Well Integrity Issues

During the abandonment program it may be necessary to investigate known well integrity issues in order to safely abandon the well and effectively plan barrier placement. Quantifying effective barrier depths can reduce milling operations in turn reducing rig time, debris and risk.

Confirm Cement Placement

A common challenge during abandonment operations is ensuring the cement barriers between casing strings or the well and surrounding subsurface formation is well executed. For example, verification of Perf-Wash-Cement (PWC) operations can be performed without the need to drill out the cement plug. Using FLI to monitor the exothermic reaction of the cement cure process can confirm cement placement, barrier length and top of cement.

Most value from FLI is realised through optimisation of the activities that come afterwards. The information provided by FLI can be used to meticulously plan subsequent operations, with more assurance about the work that needs to be done and less chance of surprise. Ultimately FLI provides operators with knowledge that helps to **reduce the time, cost and risk of well abandonments.**

Save Rig Time We offer a leak detection solution that gives you the answer you need and saves rig-time. In the example below both electric-line and FiberLine were deployed enabling a direct comparison between operational timelines.

PROJECT: UK NORTH SEA FLI LEAK DETECTION DEMONSTRATES 14 HOUR RIGTIME SAVING

- Objective: identify casing leak location into the 'B' Annulus to confirm the correct mud weight for safe well decommissioning.
- Operations were performed from a semi-submersible rig (£120k*/day)
- Acoustic logging tools (£250k*) and FiberLine Intervention (£60k) were both deployed

Wireline Log

FiberLine Intervention

Time (hours)

- Outcome: both surveys indicated a shallow leak below the tubing hanger.
- Cost of acoustic log ~ £370k
- Cost of FLI survey ~ £100k
- POTENTIAL SAVING ~ £260K**

*- estimate

Rapid Cement Survey FLI can provide confirmation of the placement of the cement job from just after the cement slurry is loaded into the casing annulus. Using a time lapse view of the exothermic curing process of the cement throughout the entire wellbore, we can immediately confirm top of cement and identify voids.

PROJECT: US ONSHORE CEMENT PLACEMENT CONFIRMATION

- Objective: Confirm height of cement in the annulus is sufficient to isolate the 95/8" casing shoe
- FLI was rigged up on the TIW cementing manifold immediately following cementing operations
- Cement placement is identified by a higher temperature signature
- Outcome: Top of cement was confirmed at 10,450ft.

Abandoned Well Remediation

Sometimes, even with careful planning, well decommissioning is not successful first time. Often problems are not detected until after the operations are complete and the rig or HWU moved onto other work. FLI can be deployed offline in this application to verify cement plugs, locate casing leaks and identify fluid movements in the annuli to validate PWC isolation.

Remote operations

A FLI probe is short in length and can be rigged up with a total stick up height of under 8ft, enabling off-line operations to be performed where well head access is limited by deck height. We can even rig up without access to a crane. This makes FLI an idea solution for abandoned well assessment whether on non-operational facilities or where rigs are still active.

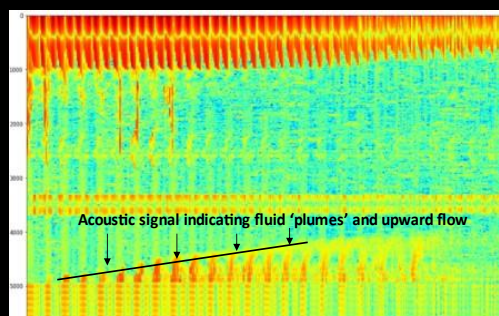
PROJECT: UK NORTH SEA ABANDONED WELL BARRIER ASSESSMENT



- Objective: Locate source of A-annulus (wellbore) gas to enable remedial operations
- FLI was rigged up through the skid deck hatch and the probe landed out on the internal cement plug
- Outcome: Clear indications were observed of flow from below the probe with all other depths indicating static fluids.

Sequence of events– Leak detection

21:35– Launch FLI probe
 21:55– FLI landed out on cement plug @ 5000ft
 22:45–Bleed down of well pressure
 00:04– Bleed down well pressure
 00:07– Shut-in well
 01:02– Bleed down well pressure
 01:17– Extended monitoring period
 04:00– Stop logging and close in well



Track Record

We have a solid track record and have successfully deployed FLI globally for independents, major and super major operators in over 100 wells with zero HSE incidents. This experience has enabled us to develop our specific P&A applications that are targeted at both pre-abandonment operations and entire abandonment programmes.

Final Thoughts

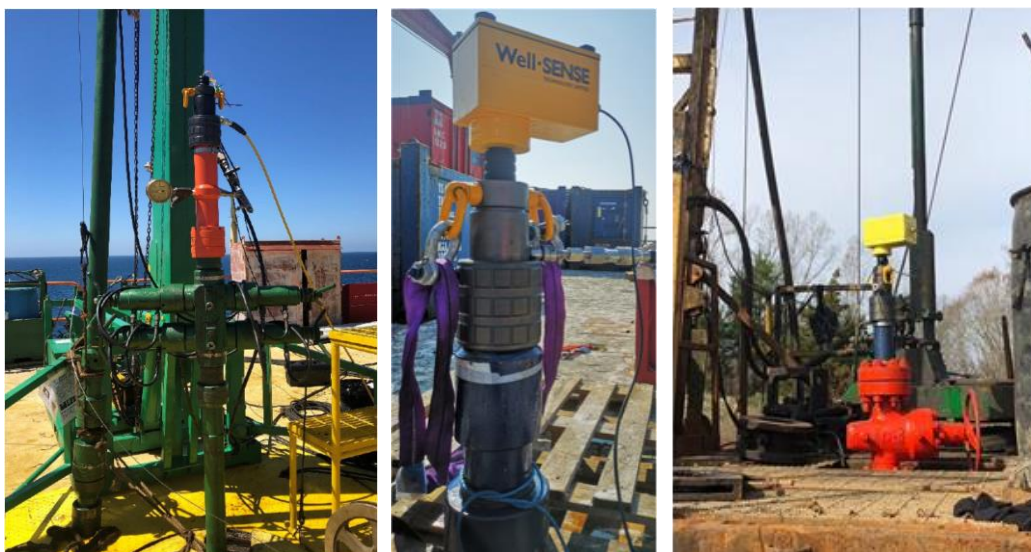
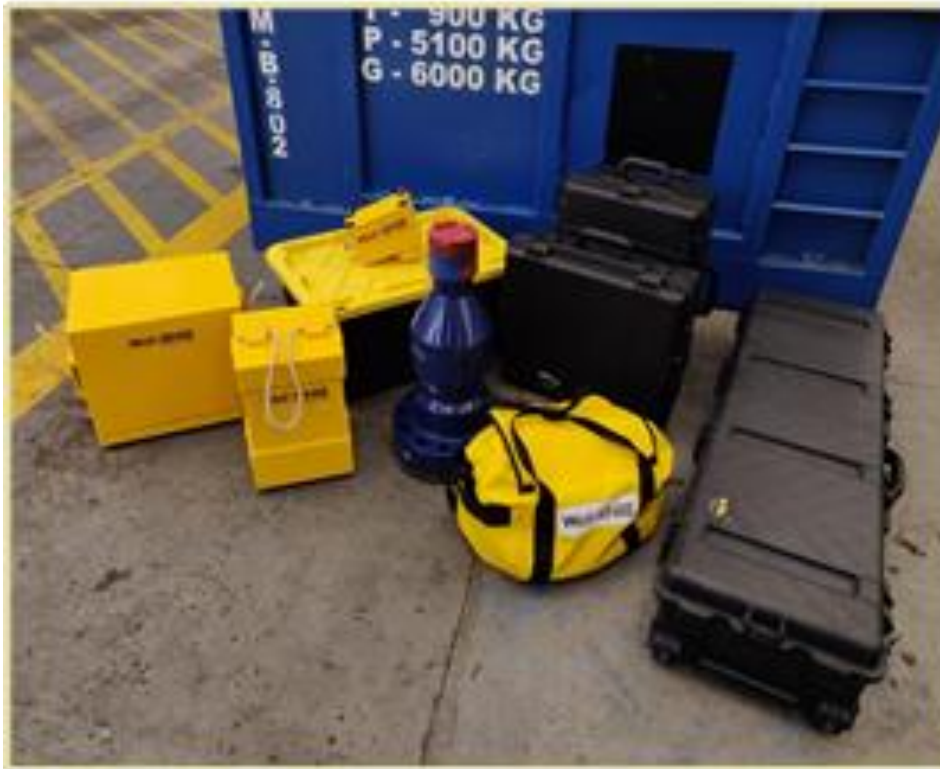
With a flexible solution to P&A operations, we have the knowledge, expertise and experience to significantly add value across the programme from pre-abandonment planning and diagnostics, through program execution. With fast mobilisation and minimal on-site footprint, we are ideally placed to go out in advance of operations, deploy FLI across all wells and provide the end user with a formal status report of each well. The results from this pre-abandonment work will inform the end user who can refine and plan a P&A programme accordingly, with the potential to decrease risk, whilst saving time and money.

Assess.....Plan.....Execute.....Validate

Contacts

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