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ABLE *Masters* Foinaven Produced Water Flow Measurement Problem

The Foinaven oilfield is located in blocks 204 / 19 and 204 / 24a of the North Sea UK Sector, which are operated by BP Exploration. Shell UK Exploration and Production is the co-venturer.

These blocks lie 190km west of the Shetland Islands, in a water depth of between 400m and 600m. Recoverable reserves are estimated to be in the region of 250 million-600 million barrels of oil.

The Foinaven project was carried out as a phased development. The first of these were based on the recovery of 200 million barrels within Foinaven. These developments centre on subsea wells completed on the seabed. They produce oil, via a manifold, which passes through rigid flowlines and then flexible risers into a floating production, storage and offloading system (FPSO), which is permanently stationed in the field. Shuttle tankers then export the crude oil.

Foinaven's FPSO Petrojarl IV was built in Finland by PGS Production by converting Anadyr, a Russian submarine tender ship. The vessel underwent a major rebuilding programme involving the removal of the bow and stern, which were upgraded and attached to a new mid-section of a double-skinned hull, thereby increasing its length to 240m.

The FPSO has the capacity to process up to 95,000 barrels of oil per day and to inject 165,000 barrels of water per day into the reservoir. Gas lift and re-injection were available from first oil.

Back in 2015, the Flash Drum produced water meter was given up as largely unusable on Foinaven.

The failure to get a reading across the 12" pipe was more an application process problem than a problem with the ultrasonic flowmeter being used. The produced water was highly aerated and its pipe was likely suffering build-up of scale and accumulated matter.

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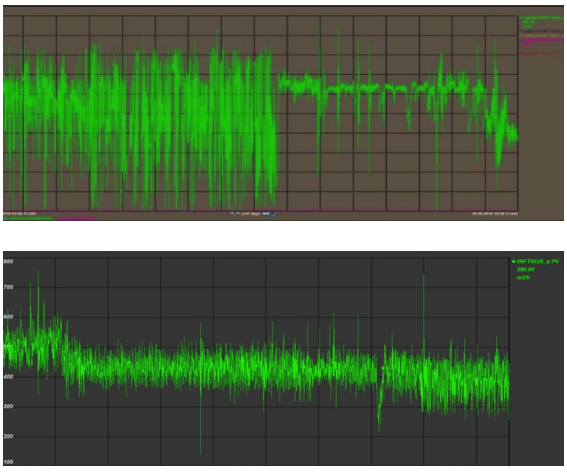
"the meter has significantly improved the measurement… it's looking very, very good"

Andrew Mackay,
Teekay Offshore Production

In November 2015, Teekay Offshore Production scheduled ABLE Instruments & Controls Ltd to investigate issues with the separator HIPS level transmitters on Foinavan FPSO. This presented an opportunity to add work scope for a flow measurement survey of the Flash Drum produced water line using ABLE's SlugMaster transducers and their ATEX 24-hour portable ultrasonic flowmeter and diagnostic package. After 3 days, the data collected proved that the SlugMaster plc based hybrid system would produce a good, continuous measurement using a combination of optimised transducers.

Foinaven Trends: Trend showing the signal from the Flexim being replaced by the Slugmaster output



In July 2016, after Teekay reviewed the survey report with BP, the ABLE SlugMaster was installed at the Foinaven Flash Drum, for trials in its ATEX Zone-1 enclosure. The 4-20mA output for continuous flow rate was relayed back to the control room whilst the SlugMaster plc logged all diagnostic data at 3 second intervals. The results were good, with some minor anomalies during recovery of signal from certain transducers.

After 4 months of trials, proving itself across all process conditions, the SlugMaster was purchased and an ABLE engineer was booked to attend the Foinaven FPSO to optimise the plc program logic, based on the collected diagnostic data, and fully commission the permanent installation. The optimisation has produced further improvement beyond expectations.

Andrew Mackay, of Teekay Offshore Production commented after commissioning that *"the meter has significantly improved the measurement… it's looking very, very good."*

Andrew also had this to say: *"The flow through this 12" pipe has been very challenging to measure accurately over the last few years with the initial thoughts on the problem leading to the build-up of scale. Removing the 12" line was not ideal and adding in the additional factor of aeration, the SlugMaster was looking like an attractive alternative, which did not disappoint. Once the flow meter was operational, immediate results could be seen and once tuned these were further improved to provide a steady accurate trend. The SlugMaster's ability to accurately measure across a whole range of process conditions including heavy aeration is exceptional."*

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