PIPELINE DECOMMISSIONING - CLEANING

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Abstract

Equinor performed decommissioning of the Veslefrikk field in the North Sea Q1 2022. One of the first task after Cease of Production was to decommission two export pipelines, one 10” Gas export pipeline and one 16” Oil export pipeline. The oil pipeline connects to Oseberg C export pipeline via the Veslefrikk wye after 25 km. Total length is approx. 37 km from Veslefrikk to Oseberg A. The task was to clean, cut and isolate the pipeline up stream wye while there was production from Oseberg C.

This paper will cover Government requirements, pipeline pigging history, chemicals treatment, precleaning, decommissioning pig train and the cleaning result.

Introduction

Early 2022 the Veslefrikk 16” oil export pipeline was decommissioned, disconnected from the infrastructure, and left buried on the seabed. The commitment to the authorities was to leave the pipeline as clean as reasonably practicable with use of BAT (Best Available Technology).

It was not possible to measure the cleanliness of the pipeline before cutting as the pipeline was connected to the Veslefrikk wye with Oseberg C pipeline in production.

A precleaning program was initiated one year before decommissioning. The production had reached a level where the flow was lower than 0.02 m/s when production pigging ceased.

A schematic of the pipeline layout is shown in figure 1. The Veslefrikk section was cut near the wye which was sealed to allow further production from the Oseberg C platform. The water depth at the wye is approximately 107 m.

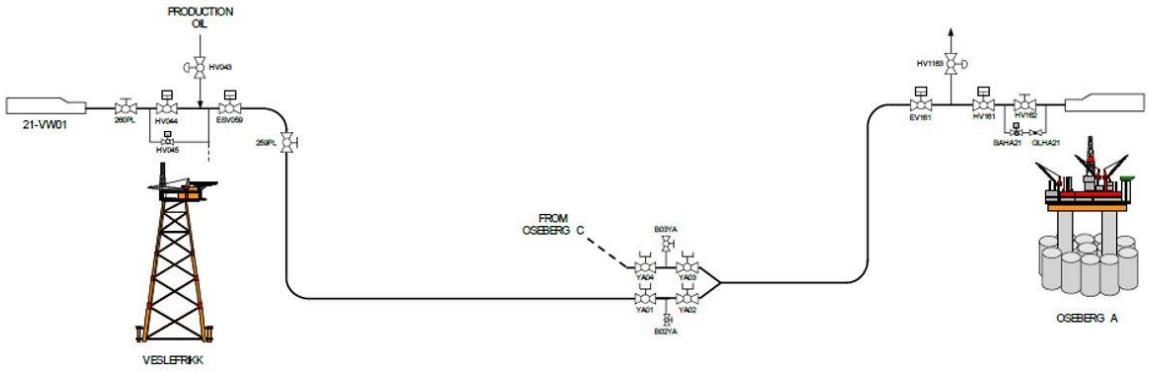

Figure 1: Veslefrikk 16” Pipeline system. The wye connects the Veslefrikk pipeline to the 16” Oseberg C pipeline.

Government requirements

Environmental aspects are key considerations for the decommissioning of all pipeline systems. Existing seabed condition, environmental sensitive areas, and materials in the pipelines, together with energy use and emissions during any planned decommissioning operations are all factors to be considered for decommissioning options.
The requirement for sampling cleaned pipelines and the associated cleanliness acceptance criteria may historically have been linked with acceptance criteria for produced water discharge offshore, but in the

absence of prescriptive regulation, reasonable endeavours/multi-volume purges demonstrating higher amount plateaus/ALARP principles are typically accepted.

Supporting Studies in the planning phase of the Decommissioning operation

The precleaning and decommissioning programmes are based on several studies. The results from the studies gave the confidence of pigging at low flows and resulted in a sufficiently clean pipeline with the proposed precleaning and decommissioning methods.

The studies consisting of the following:

- Pipeline wax status during the operational pigging over several years
- Data logger sent with operational pigs
- Pressure and flow data from the involved platforms during pig sending's
- Lab test of wax samples from the precleaning program
- Historical data from earlier Inline Inspections 2006, 2013 and 2018
- Pipeline flushing and cleaning methodology and acceptance criteria from similar operations
- Hazard Identification (HAZID)

Precleaning

Cleaning pigs (Rosen) were sent from Veslefrikk every 30th day during normal operation. One year before the decommissioning project a precleaning program using regular cleaning pigs started to achieve a clean pipeline in accordance with the best available technology. The precleaning program negotiated pigging from Veslefrikk and Oseberg C as only one pig was allowed in the pipeline system at any time. Two pigs were sent from Veslefrikk followed by a pig from Oseberg C. The pig run time to Oseberg A was 8 days from Veslefrikk and 2 days from Oseberg C, with by-pass set up on both pigs. The last pigs sent from Veslefrikk without by-pass and had a pigging time up to 14 days.

Towards the end of the program two Scraper Tools designed by Reinhart Hydrocleaning were sent to remove possible hard wax deposits on the pipe wall. As can be seen in the photographs in figures 2 and 3, considerable amount of wax was removed in the precleaning phase, Throughout the precleaning program roughly two tons of wax was removed. The precleaning program started in March 2021 and ended in December 2021. During the precleaning program the flow decreased from 20 m³/h to 8 m³/h. The pig speed was initially 0.03 m/s with by-pass and was reduced to 0.02 m/s, without bypass.

Figure 2. Illustration of operational cleaning pig and photo of cleaning pig after pig run.

Figure 3. Reinhart cleaning tool, before and after running Chemicals and Wax

During the precleaning operation wax inhibitor Waxtreat 3729 was used continuously together with pigging. To find the best wax dissolving chemicals to be used in the Decommissioning pig train, lab testing of wax from the precleaning program was performed by the chemical supplier Clariant. The conclusion from the test was to use tree different chemical batches in the decommissioning train. The first batch was diesel which has low hazard and low-cost solvent with good ability to dissolve/soften the wax. The next batch was Waxtreat 355ND which is a pure aromatic solvent with aggressive properties toward hard wax. The third batch involved a mild glycol-based solvent known to be soluble in both oil and water, hence the name “mutual solvent”. The purpose for this batch is to displace the previous chemicals and pick up the last remaining oil, diesel, and aromatic solvent. The mutual solvent will leave the pipe available for water to wet all the surfaces and flush any remaining solvent.

Decommissioning Pig Train

The decommissioning pig train was set up to remove the remaining wax and set the High Pressure Isolation Tools (HPIT) before cutting and isolating the Veslefrikk pipeline. Halliburton managed the decommissioning pig train loading, pumping, detection of pigs and positioning of the High Pressure Isolation Tools. Communication was established between the different sites including live streaming from the E-ROV via the control room onshore.

The decommissioning pig train was pumped from Veslefrikk towards the wye. First a batch of diesel was of pumped into the pipeline followed by two swabbing pigs separated by chemical batches. The following batches were all sea water separated by two Reinhart Tiger Tools, tree swabbing pigs and two High Pressure Isolation Tools. All liquid batches were 20 m^3. The Decommissioning pig train was propelled by filtered seawater at a speed of 0.2 m/s. The Decommissioning pig train is illustrated in figure 4. Picture of swabbing pigs and Reinhart Tiger tools in figure 5.

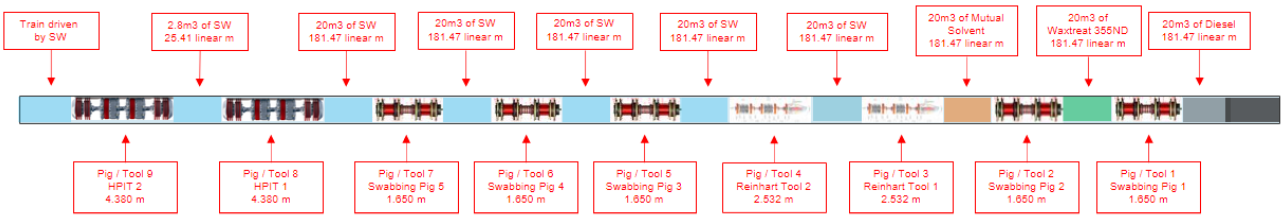

Figure 4. Illustration of the decommissioning pig train

Figure 5. Pictures of Reinhart Tiger tool and swabbing pigs

When the Decommission pig train approached the wye it had to be accurately controlled to ensure that only the desired pigs passed the wye. The train had to be split to accommodate the pigs in the receiver at Oseberg A. Two swabbing pigs could be received in the receiver, but the Reinhart and High Pressure Isolation Tools had to be handled separately. The consequence of introducing to many pigs into the production line from Oseberg C would be production stop at Oseberg C.

All pigs and tools were equipped with isotopes and RAI detectors were positioned at the cut location upstream and downstream the wye. An E-ROV operated from onshore monitored the RAI detectors to keep track of the pig movements allowing the pig train to be stopped once the desired pigs had passed the wye. Positioning and setting of the High Pressure Isolation Tools were also performed by the E-ROV. The positions of the detectors are indicated in figure 6 as well as the position of the High Pressure Isolation Tools.

The pipeline was cut and a Morgrip coupling mounted for permanent isolation of the pipeline. The High Pressure Isolation Tool was pumped through the wye one at the time and transported by the oil flow from Oseberg C to Oseberg A.

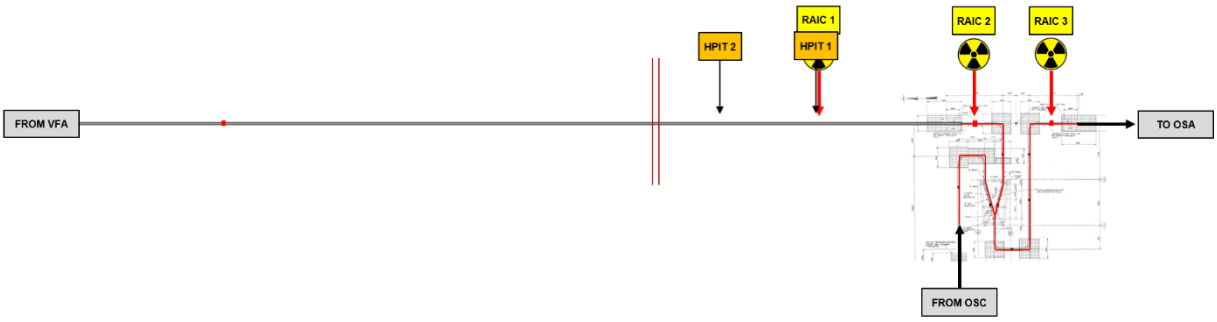

Figure 6. Showing the location of the pig detectors and location of the HPITs when cutting the pipeline

The use of E-ROV for positioning and setting of HPIT was done for the first time in Equinor. It made the operation more flexible, less weather sensitive and reduced operation time on site for the Diver vessel. Figure 7 shows illustration and picture of the E-ROV.

Figure 7. Illustration and picture of the E-ROV

Result

It was not possible to measure the cleanliness of the pipeline before cutting as the pipeline was connected to the Veslefrikk wye with Oseberg C pipeline in production. Hence no OIW measurements or debris assessment on the pigs could be performed at the pig receiver.

After cutting a diver took pictures inside the pipeline and stated following to the dive supervisor: "Pipe is in good condition, no scale or damage and it is a good clean pipe with no trace of oil." Picture from the diver, see figure 8 of the pipeline shows the clean pipe wall.

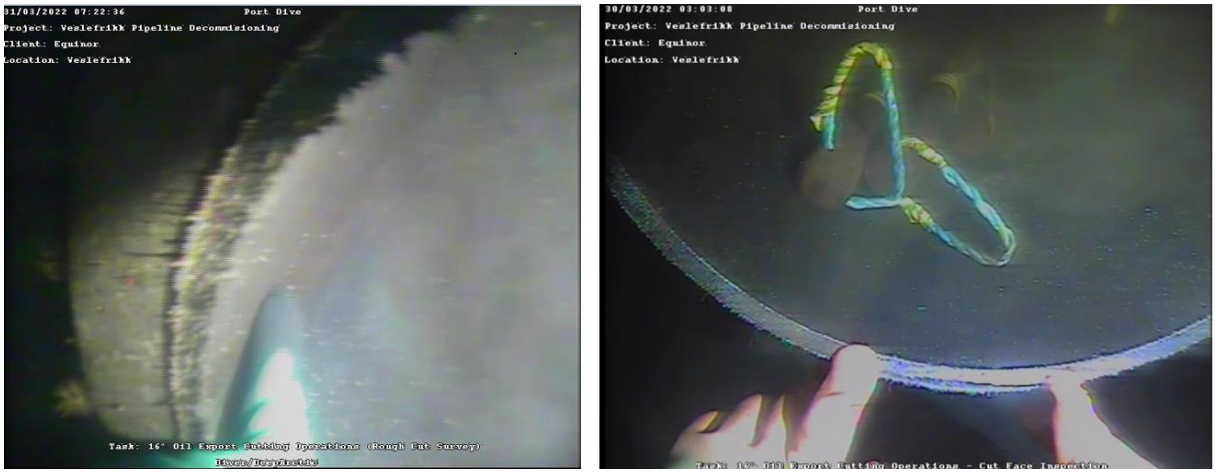

Figure 8. Pictures from the diver show the clean pipe wall.

Reference

[1] Report 632 -Offshore Oil and Gas Pipeline Decommissioning Briefing November 2020.
[2] Halliburton Operational procedure 2399-2021-OP-192