PIPELINE THROUGH-WALL COMMUNICATION CAPABILITIES

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Introduction

Pipeline pigging is a standard regular operational activity performed throughout the pipeline lifecycle and forms part of the Integrity Management System of a pipeline network. Typical examples of pigging applications include pre-commissioning, line-proving, cleaning, liquid removal, batching, inline inspection, inline isolation, and decommissioning. Key to all these activities is the ability to track the pigs in the pipeline, locate the pigs when necessary, and identify each pig when multiple pigs are in use at one time. More complex capabilities required are the ability to communicate, interrogate, and activate the pigs through the pipeline wall and induce sleep modes on transmitters, enabling battery life conservation during long operations.

Pig tracking can be performed by various methods—with devices fitted to the pig such as transmitters (electromagnetic or acoustic signal) or radioactive sources. External devices such as pipeline-fitted pig signaling devices, acoustic listening devices, or pressure pulse monitoring systems can also be used. The operational requirements and limitations of pigging activity will determine the best solution for tracking and monitoring.

Tracking of pigs in an offshore pipeline is challenging due to the environmental conditions. The pipelines tend to be constructed of thicker wall material (>15 mm) and are surrounded by large steel structures (platforms) as well as cyclic oscillating systems (pumps, turbines, etc.). Subsea sections may be covered for protection by rock dump, steel structures or buried below the seabed. These conditions provide challenges to transmitter tracking systems.

In the 1990s, T.D. Williamson designed and developed its proprietary inline isolation SmartPlug® tool, for isolation of a pressurized pipeline. The design requirements of this tool were that it could be pigged to an exact location, and once at the location, it could be remotely activated to effect the isolation. Once activated, it was essential that the system be remotely tested and monitored throughout the duration of the isolation, providing a safe controlled environment for the required works to be carried out. Communication capability at 100% was to be maintained throughout the operation. Due to the criticality of these design requirements, standard off-the-shelf transmitter systems were not found suitable for tracking the SmartPlug isolation tool.

Therefore, T.D. Williamson developed its own purpose-built system to support the SmartPlug tool, which was branded as the SmartTrack™ system (Fig. 1).

Figure 1: The SmartTrack™ remote tracking and pressure-monitoring system used to track and monitor the SmartPlug® inline tool as it travels through a pipeline.

SmartTrack™ Tracking and Monitoring System

The SmartTrack system is an electromagnetic signal transmitting system that operates at an adjustable extremely low frequency (ELF typically <15 Hz). This ELF enables communication to be maintained through the heaviest wall thicknesses (communication at 65 mm, tracking and location at 80 mm). To maintain such capabilities, battery consumption and preservation have to be managed to ensure successful completion of the project. The SmartTrack technology has advanced and evolved over time and is now a viable alternative to traditional pig tracking and monitoring technologies, as most pigs/inline tools can be fitted with the SmartTrack transponder and are functional in any piggable pipeline and its components, regardless of whether the pipeline is onshore, offshore topside, or subsea.

The SmartTrack system's two-way (bi-directional), through-wall communication takes place between the transponder, which is fitted in the body of the pig (or integrated into a SmartPlug tool), and an externally located transceiver. Each transponder mounted on the pig or inline tool is assigned one of up to 16 unique ID codes. As it moves through the pipeline, the transponder emits a unique signal that is picked up by transceivers situated near or on the pipeline. The signals are then relayed to a user interface (typ. PC, tablet/PDA, Smartphone, etc.), allowing the pig/tool to be easily identified as it moves through the pipeline system.

Configuration of System Parameters

One of the unique features of the SmartTrack system is that transponder settings, such as signal frequency, ping rate, and signal strength, can be initially set and then remotely adjusted during the operation by the operator, allowing battery life to be conserved. This feature is particularly useful in long-term or delayed operations. In such cases, the unit can be remotely deactivated and sent into dormant mode, then reactivated when required by the operator. In the dormant mode, the measurement functions are deactivated and power is conserved, extending battery life significantly (by several months). Internal testing has shown that the SmartTrack system is capable of alternating between active and dormant mode for periods in excess of 3 years with a 100% start up success. Thus, the SmartTrack system offers great flexibility and the possibility to extend battery life, particularly for operations that require monitoring for extended periods or where work is put on hold due to adverse weather conditions or other unforeseen circumstances and restarted at a later date.

Through-Wall Communication

The ability to transmit and receive signals through a pipe wall, whilst a pig/inline tool is moving is one challenge. The other challenge is obtaining the necessary information to and from the job site to personnel's working position, whether that is in the area around the worksite, in a control room on the facility, a vessel close to the workplace, or an operating office anywhere in the world. To do this requires a network of linked communication systems, operating individually or in parallel.

To overcome these challenges, the SmartTrack transponder (transmitter) is placed in a pig/inline tool, which is either integrated into the system, as in the case of the SmartPlug tool, or is offered as a bolt-on unit contained in a sealed housing with its own battery source. The transceiver is also placed in close proximity to the pipe to allow the transponder and transceiver to communicate with one another. Pipeline coatings or pipeline burial need not be removed or cleared for this purpose. The transceiver can be a handheld device or alternatively attached to the pipeline either via a strap arrangement or on a subsea skid placed parallel to the pipeline.

For tracking purposes, the display used can vary, from laptops and PC's to handheld devices like tablet/Personal Digital Assistant (PDA) or Smartphone connected via a wired link or Bluetooth. In the case of diver-held transceivers, a Light Emitting Diode (LED) display is available on the equipment to indicate the number of pigs that have passed and their unique IDs.

To enable two-way communication, the transceiver has to be connected to a laptop or PC, which will then initiate communication. The communication link between the transceiver and the laptop can be established through a number of ways or through a combination of various options:

1. Hardwired to a laptop via an interface
2. Acoustic transmission to a receiver connected to the laptop
3. Hardwired to a GSM phone or a satellite communication link, transmitting to the laptop
4. Hardwired to a radio link, transmitting to the laptop

Most subsea isolation projects would use a combination of these methods to allow information to be available at relevant vessels/locations, as shown in Fig. 2 below:

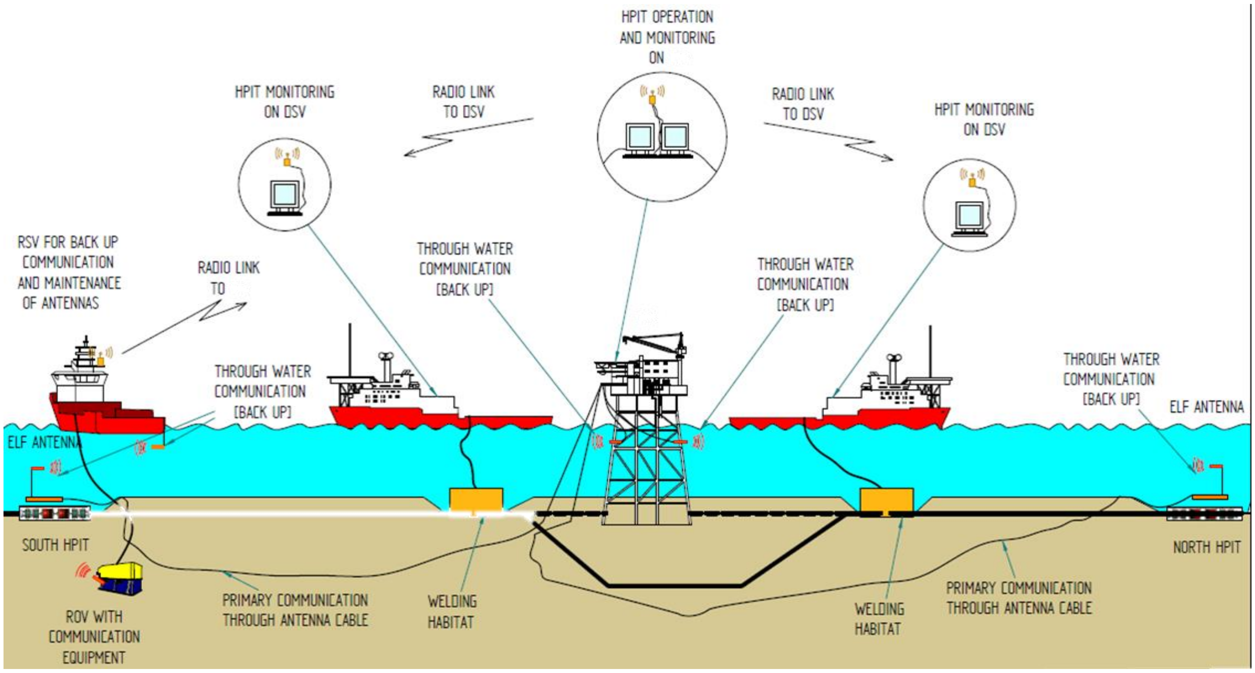


Figure 2: Example of a communication setup for a subsea isolation project

Case Study

Summary

A North Sea Company operated a 150-km, 22-inch gas pipeline in water depths of approximately 150 m. Although production in this field was coming to an end, the integrity and condition of the 22-inch pipeline was good. A new field was to be brought on stream whose location was approximately 22 km from the existing launch platform. The project intention was to tie in the new 22-km section of pipe to the existing 22-inch pipe, approximately 1 km from the original start of the pipeline (Fig. 3).

A number of options were available to the operator to carry out this work. The chosen method was to partially decommission the existing pipeline to approximately 1 km from the launch platform, using a decommissioning train followed by a SmartPlug tool. At this point, the SmartPlug tool was used to isolate the existing gas product at 90 barg. A new 22-km pipeline was tied into the existing pipeline. The new platform was commissioned ready to start gas export including using the SmartPlug tool as a barrier for locally hydrotesting the new section of pipeline without altering the integrity of the isolation. Upon tie in and when the new platform was ready, the SmartPlug tool and (now) commissioning train were returned to the new platform using the original gas pressure and volume to drive them back. This gave a new 171-km gas pipeline commissioned and ready for operation.

Phase 1

Gas production in the 22-inch, 150-km pipeline was stopped. Gas pressure in the pipeline was retained at 90 barg.

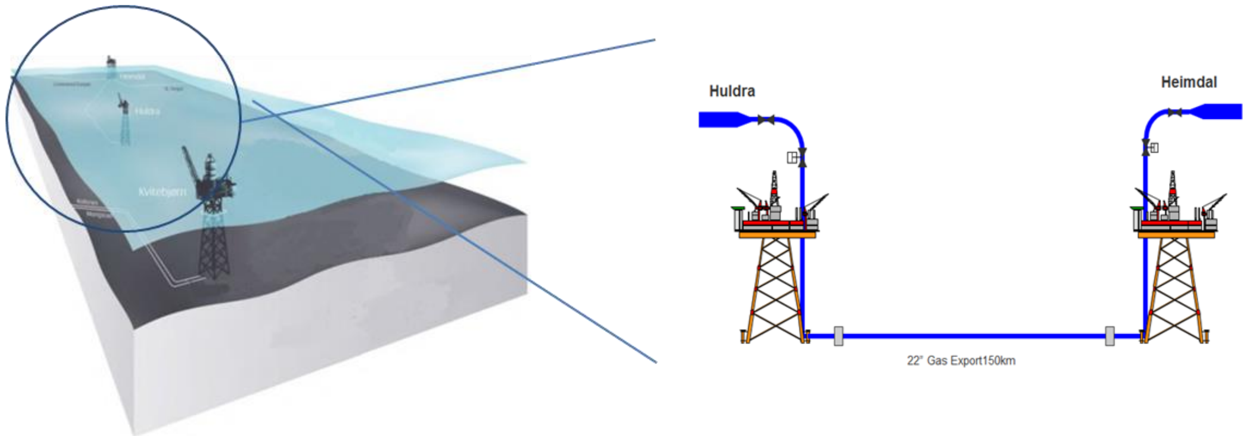


Figure 3: Field illustration
Source: Statoil ASA

Phase 2

Using a pump spread and inhibited seawater, 6 decommissioning pigs separated by glycol were pushed into the pipeline followed by a SmartPlug tool (Fig. 4). Each of the 6 decommissioning pigs had a SmartTrack transponder fitted. The transponders offered a unique code for identifying each pig as well as the SmartPlug tool. All 6 pigs and the SmartPlug tool were tracked to the predetermined isolation point. A transceiver skid unit was located subsea at the point of isolation and this was hard wired back to the launch platform to allow for tracking of the pigs and SmartPlug tool. The SmartPlug tool was set against the 90 barg gas pressure, utilizing this gas pressure as a failsafe method of maintaining the isolation. At this stage, all of the SmartTrack transponders on the decommissioning pig train were remotely set into dormant mode, to conserve battery power. All of this was done remotely from a laptop on the launch platform via a hard wire to the transceiver located subsea above the pipeline work area.

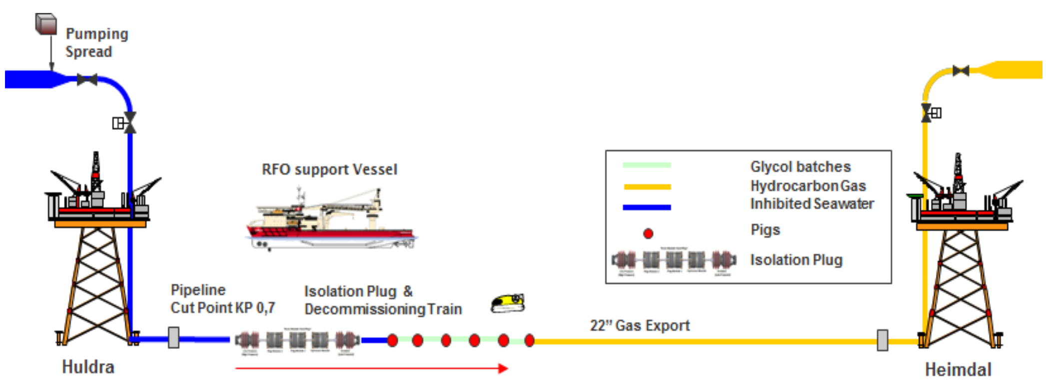


Figure 4: Decommissioning train with pigs and SmartPlug® tool
Source: TDW

Phase 3

The existing pipeline was cut and prepared. The new pipeline section was tied in to the old line. During the entire operation, the integrity of the SmartPlug isolation tool was continuously monitored (Fig. 5). This was primarily through the existing hardwiring communication link to the platform. An additional communication link was set up via an acoustic link back to the Diving Support Vessel (DSV) as a contingency. Radio links were set up from the platform and DSV direct to the dive team at the jobsite. This provided live information on the isolation, increasing the safety assurance level of the divers (Fig. 5). The full communication setup is shown (Fig. 6).

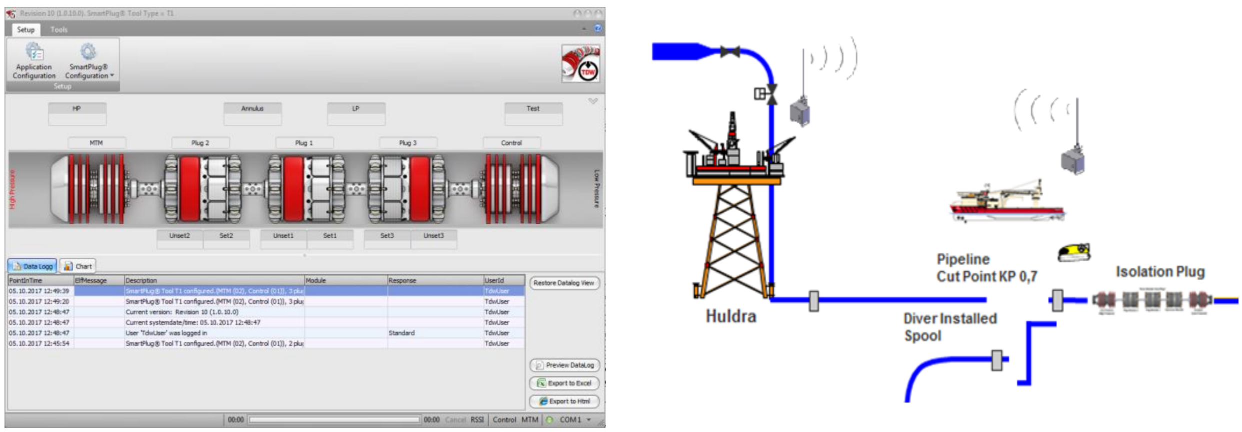
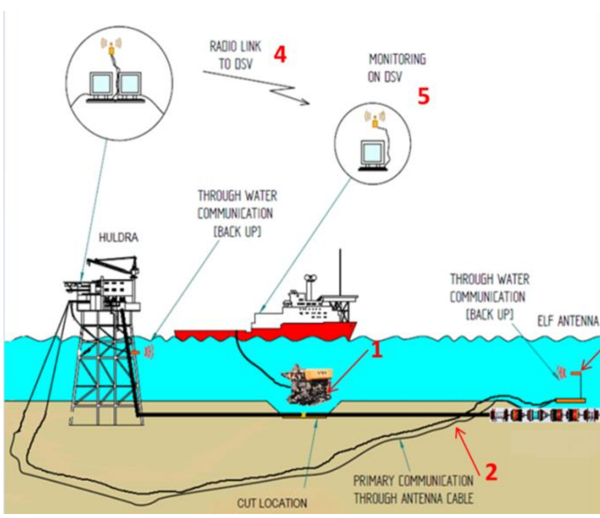


Figure 5: Monitoring of the isolation (Left) and communication setup (Right)
Source: TDW



1. *Remote Operated Vehicle (ROV)-held Remote Transceiver*
2. *Cabled communication with subsea skid (which held a transceiver)*
3. *Acoustic through-water communication with subsea skid*
4. *Radio link*
5. *GSM monitoring*

Figure 6: Full Communication Spread
Source: TDW

Phase 4

Once the tie in was complete, the new section of pipe was flooded with inhibited seawater from the platform to the SmartPlug tool. At this stage, the third plug module on the SmartPlug tool was remotely activated from the platform. This allowed for hydrotesting of the new pipe section and connection joints. The SmartPlug isolation itself remained unaffected during this process ensuring the integrity of the isolation remained intact during this time and the pressurized gas section remained segregated from the new section under test. During this phase, the isolation was continuously monitored from the platform and the information relayed to the necessary work teams.

After completion of the hydrotest, there was to be a waiting period before the new section of line could be recommissioned and gas production commenced. During this period, the requirement was for the isolation plug to remain in place and monitoring of the isolation to continue. There was a preference to free up accommodation on the platform during this time. To enable this, a GSM link was added to the communication set up allowing all of the monitoring to be carried out remotely from offices in Stavanger, enabling release of personnel from the platform (Fig. 7). The monitoring data was relayed to the platform and support vessel to enable them to be kept abreast of the isolation condition.

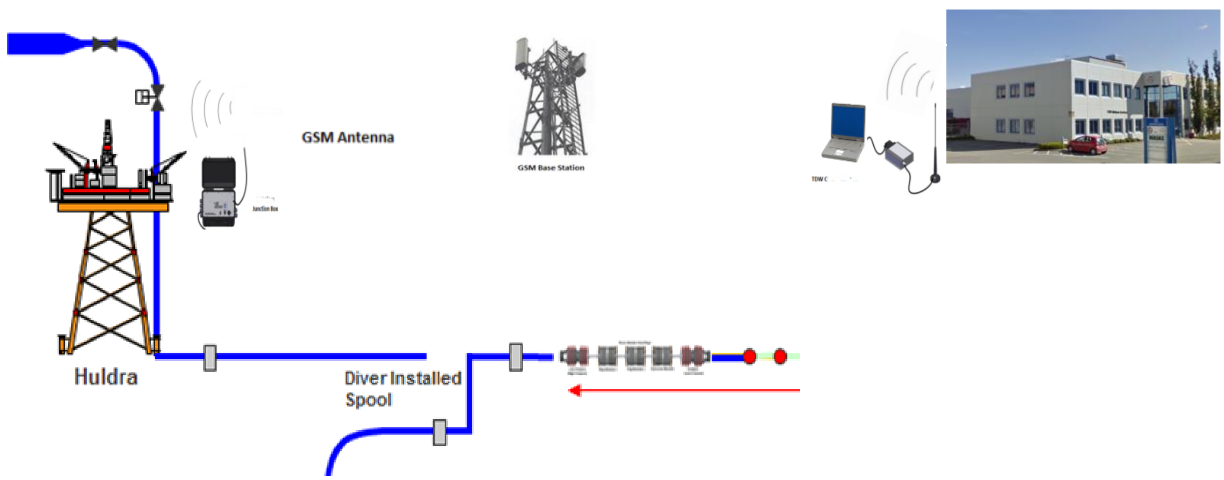


Figure 7: GSM remote monitoring of the isolation
Source: TDW

Phase 5

Once all work was completed on the new platform and pipeline section, the isolation crew returned to the platform. Unsetting of the SmartPlug tool was carried out, using the original hard wired communication system to the transceiver above the isolation point. In addition to this, using the same communication method, the SmartTrack transponders on all 6 decommissioning pigs were remotely reactivated to switch these from dormant mode to active mode. This allowed for tracking of all 7 devices back to the new platform through the previously unpigged new pipeline (Fig. 8). A major pigging challenge enroute was a check valve with a Glass Reinforced Plastic GRP cover giving about 1.5 m cover above it. All 7 pigging devices were required to be successfully tracked and identified through this valve.

A transceiver was located above the valve GRP cover and an acoustic signal was relayed to a laptop on a support vessel located above.

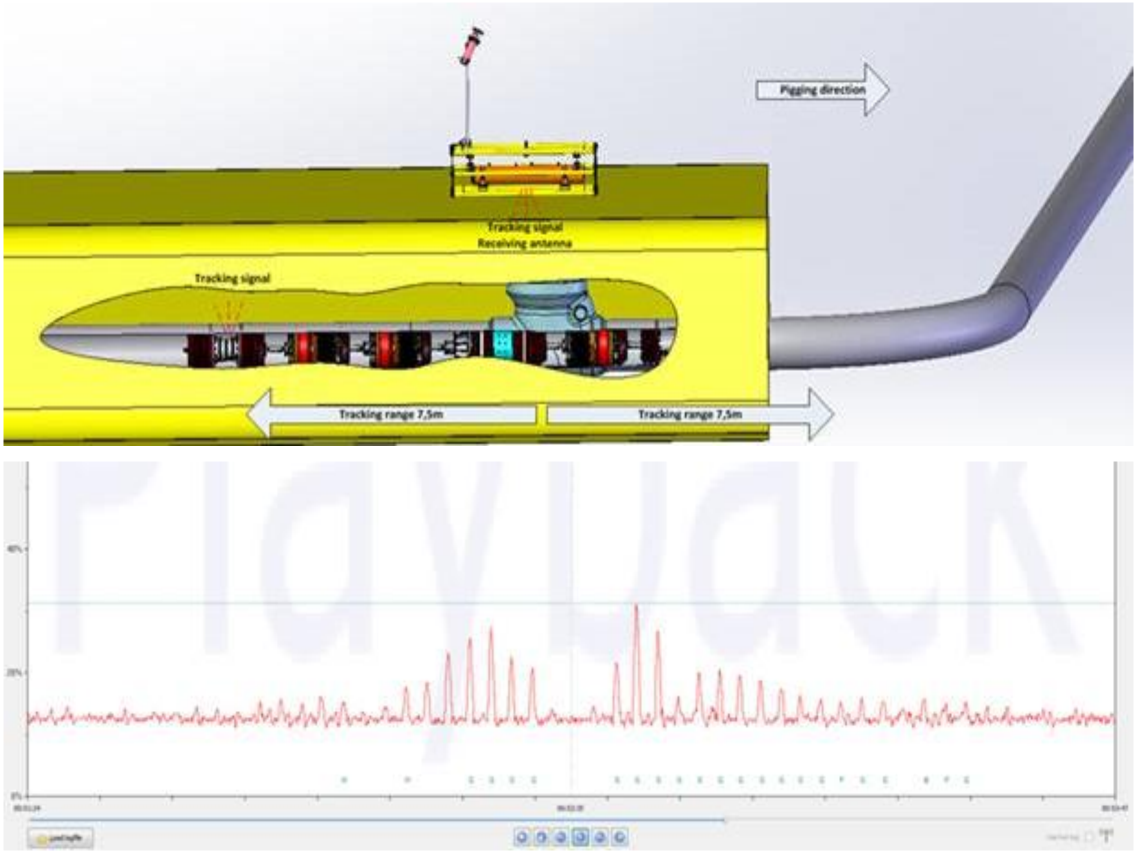


Figure 8: Received tracking signal

Source: TDW

<u>Phase 6</u>
Gas production commenced.

Keywords: SmartTrack system, Subsea pipeline isolation, Pig tracking, Extremely Low frequency (ELF), Electromagnetic signals, Through-wall communication, SmartPlug, Pipeline decommissioning