

INNOVATION LOW PRESSURE PIPELINE ISOLATION

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Introduction

In 2007, a passing vessel collided with the southeast face of a satellite platform, damaging the 12-inch export riser. Production from the platform was immediately shut-in via the emergency shutdown valves, leaving the pressure in the pipeline at approximately 4 barg. Before production could be resumed, repairs to the riser were required. The solution was to cut and remove the damaged riser section, and replace it with a new one. Being a world leader in isolation technology, TDW Offshore Services (TDW) was initially contacted for use of the patented SmartPlug® Isolation tool to facilitate the repair process. A SmartPlug® Isolation would have been an ideal solution, as it would have enabled an isolation of the damaged section, kept the line full of product and been the quickest route back to normal production. However; due to a number of challenging variables, such as steep bends and low pressure, TDW was asked to formulate a low-pressure isolation solution in order to isolate the damaged section of the pipeline riser from the export pipeline gas inventory. In doing so, the damaged riser section and associated topside pipework production system could be replaced, safely and efficiently. In September 2009, TDW successfully completed the innovative diver approved, low pressure isolation operation on the export pipeline riser in the Southern North Sea.

Designing the solution

TDW faced many challenges that had to be overcome in the design phase. The impact with the vessel had left the riser, and a large portion of the connected topside pipeworks, in bad state. This meant that any internal isolation had to be pigged through a dent, a 1,5 D bend and a narrow 45 degree traverse. The operation was planned to be diver assisted, so any solution would have to be approved by the dive contractor. There was also very limited space on the satellite platform, which again limited the size of any equipment or tool that was intended for use. Following intensive analysis, engineering and testing, TDW pooled existing technologies together and developed a solution using its range of specialist pipeline pigging, pig tracking and through-wall communications technology. The unique approach involved providing an innovative 'fit-for-purpose' low pressure isolation solution in order to isolate and replace the damaged riser section and topside pipework. The solution consisted of the following elements:

A special designed 'fit-for-purpose' low pressure isolation solution based on TDW SmartTrack™ subsea remote tracking and pressure-monitoring system.

A SmartTrack™ topsides tracking and monitoring system with radio link to the dive support vessel

After the SmartPlug isolation Tool was ruled out as an option, a design development phase was undertaken. After some brainstorming TDW engineers quickly realized that a special designed pig train would be the optimal solution in terms of isolation. However; many diving contractors will not accept this as a 'safe' isolation when divers are in the water. Combining the pig solution with TDW SmartTrack™ tracking, and pressure communication technology, would be able to meet all the criteria set by the client.

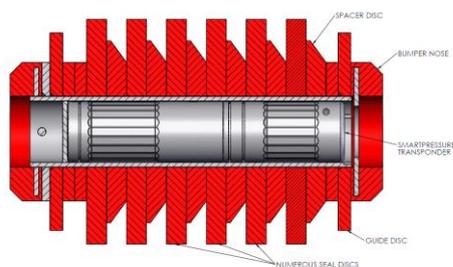


Fig. 1 Low pressure isolation pig

Communication and real time monitoring

The customized pigs outfitted with SmartTrack™ transponders allow accurate pig tracking (+/- 2”), positioning, identification, and continual pressure monitoring deemed necessary with divers in the water – providing an additional degree of safety. The SmartTrack™ system, when mounted in the pig body, essentially provides two-way “through pipe wall” communication. In addition, each pig in the train has a unique identifier, further minimizing risk in the event the train moves.

The system uses electromagnetic signals between the transponders and the transceiver. Fig 2 shows how the SmartTrack™ transponder is fitted into the Low pressure isolation pig.

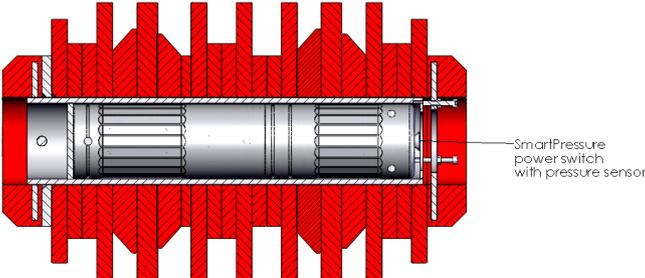


Fig. 2 Low pressure isolation pig fitted with SmartPressure

In this instance, the SmartTrack™ technology allowed constant monitoring across the pig train isolation and was set up to measure pressure for the duration of the shutdown. Once in place, the Remote Transceivers were secured to the pipeline allowing real time monitoring of the pressure across the train in addition to potential pig movement. By monitoring real time pressure in front of the train as well as between each pig throughout the operation, the diving contractor could safely perform the subsea cutting, and remove the damaged riser section. The ability to monitor pressure and pig movement is achieved by way of the SmartTrack™ system as outlined in the figure below. The system essentially comprises of subsea remote transceiver that transfer the tracking and pressure information to the TDW operator on the platform. The same info is transferred to the DSV by radio link to inform the Dive Supervisor of the status of ongoing isolation.

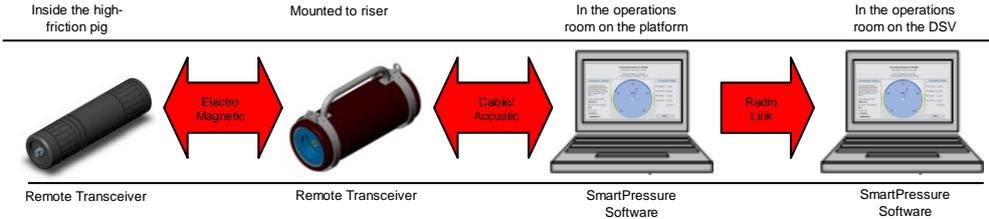


Fig. 3 Components to the SmartTrack™ system

Design features

For the case of the damaged riser application, the pig body design was customized with a bi-directional high-friction disc configuration as shown in Figure 1. The pigs alone would provide a good solution for low pressure isolations, but only after the design had been thoroughly tested and the characteristics proven before field application. The high-friction pig train alone would traditionally be pigged into position, but once isolation is achieved, there is little indication to tell what is happening to the train during the course of the isolation. In the offshore environment, specifically where divers are

involved, the requirement to monitor the parameters across the isolation is a necessity to ensure that any changing state becomes apparent as it happens.

There are several configurations possible in the design of a suitable, fit for purpose high-friction pig. The principles are however, the same in each case. As a general statement the functionality of the tools are as follows:

The pig or pig train has to be pumped into position without excessive wear to the pigging discs. Frictional forces have to be manageable and can be optimized through choice of disc material. Once in position the high-friction pig has to contain the pressure against it with a suitable margin of safety.

On completion of the operation, the pigs have to be removed from the pipeline and in this scenario the pig train was reversed out of the pipeline. The pressure required to reverse the sealing discs, effectively flipping the discs over, has to be predictable and manageable within the confines of the operation. This can be pre-determined during F.A.T.

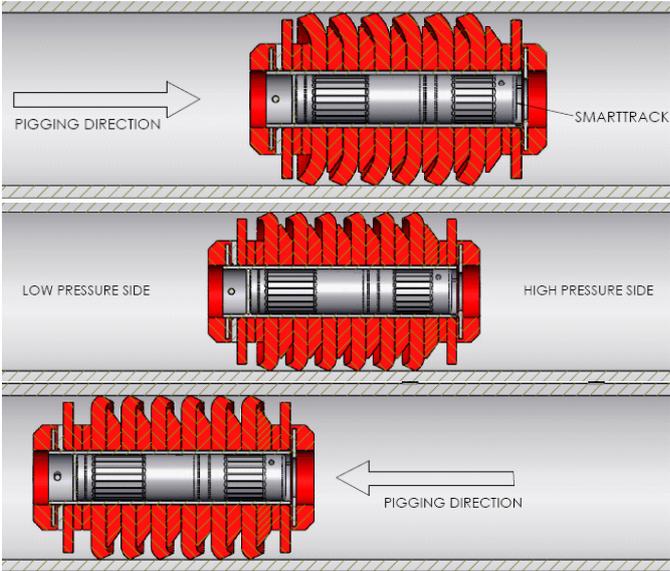


Fig. 4 Demonstrating flip pressure as the high-friction pig moves through the pipeline

Pig development, testing and proving

Factory Acceptance Tests were carried out to confirm pressure capabilities prior to executing the job. A test rig was designed and built at TDW facilities in Stavanger, Norway with pig launcher/receiver, a 1,5 D bend and a 45 degree traverse in order to simulate the environment on the satellite platform. Various configurations were tried and tested, as much as possible mirroring the expected scenario. The various pressure tests conducted included pigging pressure tests, isolation pressure tests and flip pressure tests.

High-friction pigs are used for pipeline isolation with low delta pressures. Typical tasks are separating different pipeline contents, and pipeline repair and modification projects. In addition to isolation applications, a combination of numerous soft and hard polyurethane sealing discs makes the high-friction pig an excellent dewatering pig as well as cleaning pig.

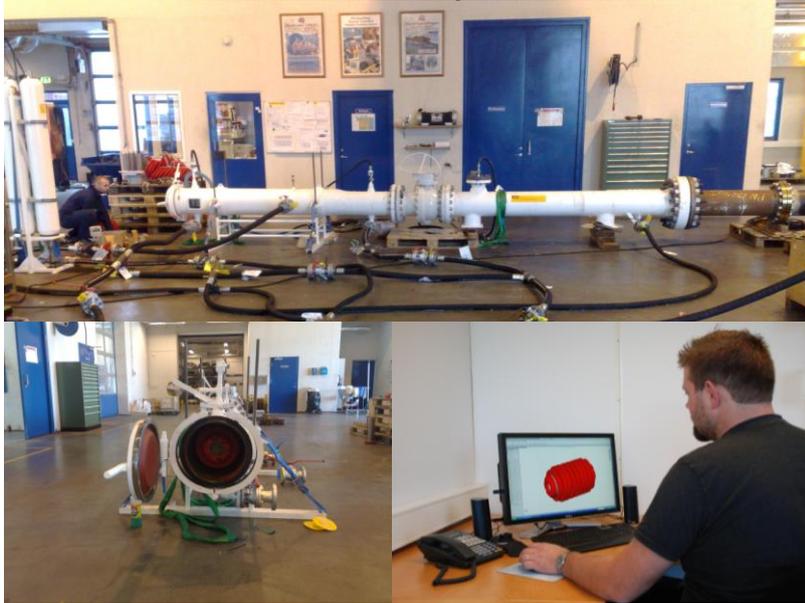


Fig. 5 Testing the high-friction pig prior to actual job performance

Performing the job

During August 2009, TDW successfully isolated the damaged riser section from the gas inventory in the export pipeline without venting or flooding the pipeline or displacing the pipeline inventory. A three-module high-friction pig train created an isolation against the gas pressure in the pipeline.

The first step was to verify and record the pipeline inventory gas pressure, and close and isolate the ESDV. The redundant topside pipework located upstream of the ESDV was removed, and a custom designed pigtrap and 12-inch valve were installed. Leakage over the ESDV was monitored closely, with a view to minimising pressure build-up in the spool.

Using the pig trap and pigging pump, the high-friction isolation pig train was launched horizontally and pigged vertically with water into the riser. Using SmartTrack™ system remote tracking technology, TDW operators onboard the DSV tracked the position of each pig to verify that the high-friction isolation pig train was located below the damaged section of riser that was designated for replacement. SmartTrack™ communication units were positioned over the three pigs and connected to the pig monitoring system. In doing so, TDW could monitor the downstream pressure of each isolation pig continuously throughout the operation. Via “through pipe wall” communications technology it was possible to send isolation integrity data by radio link to a dive support vessel.

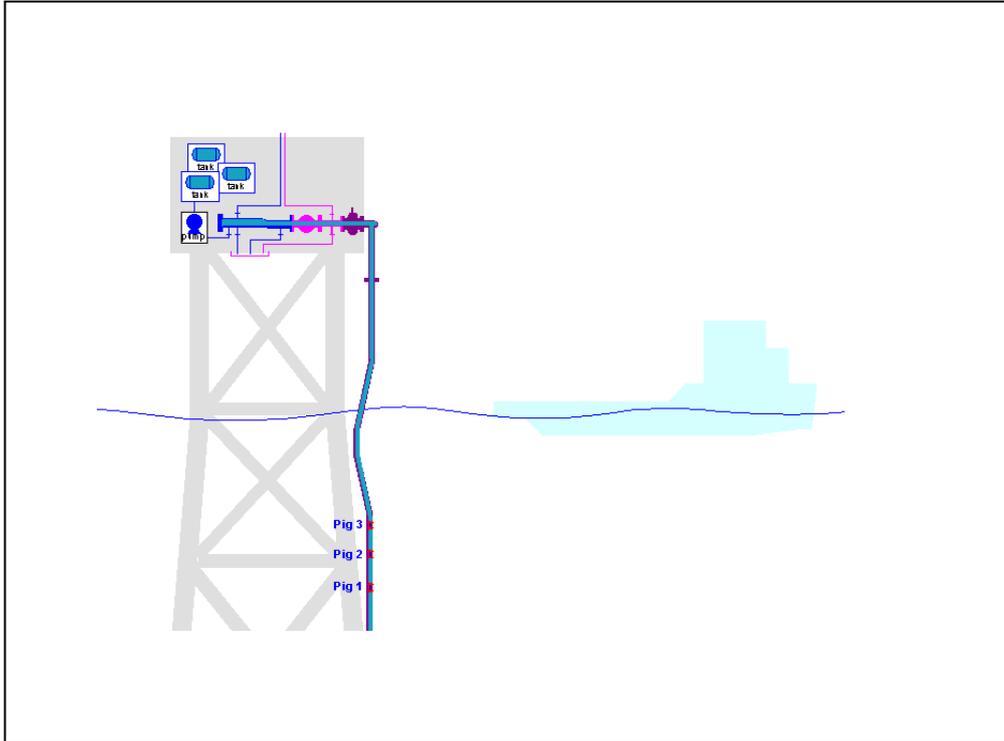


Fig 6 Isolation train in place in the damaged riser

The existing topside pipework was removed and replaced with new pipework. Divers were deployed from the DSV. The section was successfully cut, and removed using a crane onboard the DSV. A mechanical connector was locked onto the existing riser. The new riser was lifted by crane and lowered down to rope access workers who installed it on the topsides pipework closing spool and to the existing riser located above the high-friction isolation pig train.

Following installation of the new riser section, TDW verified that the ESDV and new 12-inch ball valve were operating properly and fully open. After purging the riser and topside pipework with treated seawater, the client increased pipeline inventory pressure downstream of pig train. By controlled draining of water, TDW pigged back the train and successfully retrieved all three pigs from the trap. Using the platform crane and dive crew, all pigging equipment was removed and the TDW crew demobilized.

Conclusion

Innovative use of proprietary TDW technology led to the development of a new Low Pressure Isolation service that satisfied the safety requirements of divers, whilst reducing downtime and achieving objectives in an environmentally safe manner.