



## **COST AND TIME EFFECTIVE REPAIRS OF FAULTY PIPELINE VALVES AND FITTINGS**

By, Mark Sim, TDW Offshore Services A/S, Stavanger, Norway

### Abstract

The continuous development of the remote controlled high-pressure pipeline isolation technology has resolved a range of operational problems caused by faulty pipeline valves and fittings. Recent applications includes change of a faulty insulation joint on a 42" pipeline in Georgia, rerouting of the Frigg and Heimdal to St. Fergus pipelines during Frigg Decommissioning, repair of a faulty subsea clamp on a 26 inch pipeline in GOM, all on live pressurized gas pipelines. The piggable high-pressure isolation train can include a pressure test barrier allowing leak test or pressure test upon completed repair work. Other recent applications includes protection of pressurized pipelines during heavy lift operations.

This paper describes a range of application focusing on the time and cost saving achieved by the operator whilst minimizing environmental impact.

### Introduction

The TDW SmartPlug (Remote Controlled Isolation Tool System) is a remotely controlled and operated (umbilical-less) pipeline isolation system used for isolation of oil and gas pipelines in all dimensions. They are designed, manufactured, and tested to withstand MAOP (Maximum Allowable Operating Pressure). This allows repairs, maintenance and/or intervention to be carried out, whilst maintaining pipeline pressure. Benefits of this are continuing downstream production, zero flaring, no emptying of product, reduced decommissioning/recommissioning effort, time and expense, reduced possibilities of hydrates forming on start up.

Communication with the SmartPlug for typical subsea application is done from a surface vessel, via acoustic signals to a subsea module, then through the pipeline wall via Extremely Low Frequency (ELF) electromagnetic waves. All critical parameters such as pressures and temperatures are monitored. The SmartPlug design is fail safe, as long as there is sufficient differential pressure over the isolation system it cannot unset.

This paper presents the how the SmartPlug system works, and applications it can be used in reducing repair and maintenance costs and schedules.

### System Description

The Standard SmartPlug comprises two isolation Plug Modules and two Pigging Modules (see fig. 1).

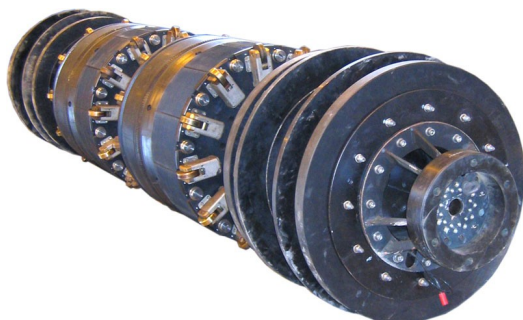


Fig. 1. Standard TDW SmartPlug

The TDW SmartPlug System consists of the SmartPlug, the Surface Control Center (PC), an ELF Communication Link and an Actuation System (see fig. 2).

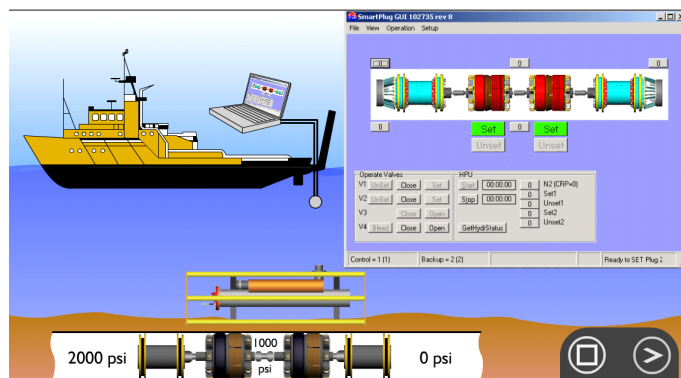


Fig. 2. TDW SmartPlug System

The standard tool is designed to seal against 200 barg operating pressure. The two Plug Modules perform the seal and lock function, and provides these functions independent of the other.

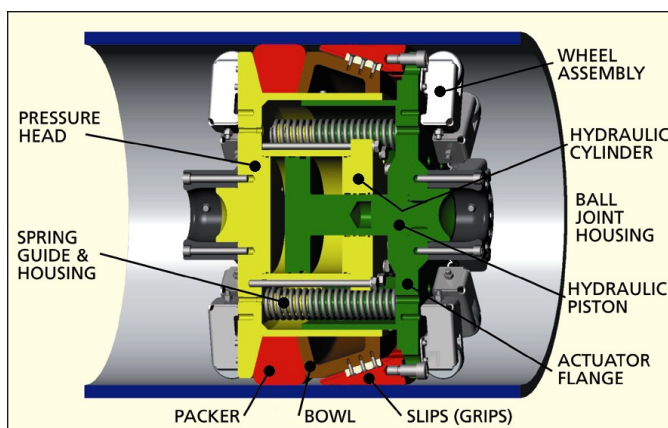


Fig. 3. Plug Module

The Plug Modules are self-locking, i.e., once they have been expanded against the pipe wall, a continued application of differential pressure will maintain or intensify their sealing and gripping ability.

The Plug is actuated (set) by applying the system hydraulic operating pressure to actuator cylinder. As the actuator cylinder pulls on the actuator flange, the slips are forced up the tapered ramp on the slip bowl and wedged between the outside diameter of the slip bowl and the pipeline inside diameter. Once the slips are in contact with the pipe wall, the movement of the actuator flange against the pressure head will begin to compress the packer radially, expanding it to seal against the inner diameter of the pipeline. The outer surfaces of the slips are machined with threads that are made as sharp as possible to enable the slip teeth to penetrate the surface of the pipeline inner wall. This penetration is only a few thousandths of a millimetre since the slips make uniform contact with the pipe wall. The penetration is well within the tolerances specified for scratch marks as published by API.

Further, engaging only one third of the slips with the inner diameter of the pipeline is sufficient to provide the gripping effect required for an acceptable isolation.

Each Plug Module is designed and tested to seal against the full pipeline differential pressure. Once set, the slips and seals remain self-energized by differential pressure to prevent an accidental release. The design provides the ability to test the sealing and gripping capability of each module.

#### Control and Communication System.

The communication and control system is based upon transmission of Extremely Low Frequency (ELF) electromagnetic waves. Its primary purpose is to bi-directionally convey digital data and control signals through steel pipelines between the antenna on the Pigging Module and the subsea antenna.

The signal strength is amplified to allow a distance of 10 m between the antennas, thereby allowing it to be readily used in conjunction with buried or physically inaccessible pipelines.

The battery pack is sized to provide a minimum of four SmartPlug actuation cycles as well as SmartPlug status monitoring during a 30 day operations period.

A computer system is used by an operator onboard the surface support vessel or platform to send and receive commands and data to and from the Subsea antenna.

#### Applications

Since the introduction of the SmartPlug system, various operations worldwide have been completed, offering new applications and alternatives to traditional pipeline operational issues.

##### 1 Valve Repairs or Changeouts.

By far the most common use of the SmartPlug is for valve repairs or changeouts. The SmartPlug can be pigged onto position against pipeline pressure and set upstream of the faulty valve, yet downstream of the production tee. This allows production to continue, whilst replacement or repair work is carried out.

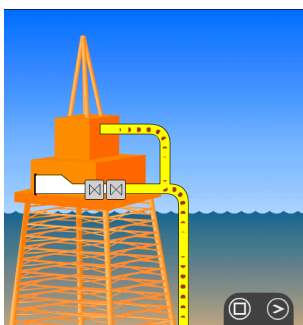


Fig. 4 - Launcher Valve replacement

The flexibility of the SmartPlug allows variations of this application to suit individual requirements. Figure 4 shows the use of single module SmartPlug as a secondary (or primary) isolation to allow the replacement of a launcher/receiver isolation valve. In this case, the second isolation valve acts as the secondary barrier. This can also be a requirement when space between the valves and the production tee, allows for only one plug module.

##### 2 Valve Repairs / Changeouts incl Hydrotest.

When a mainline ESDV had to be replaced and a subsequently tested, the operator was faced with depressurizing, flooding and recommissioning 20km x 16" Gas Pipelines. By adding a third module, the SmartPlug could isolate against 70 gas pressure to allow the valve replacement. Subsequently, the third module was set, in the reverse direction to the other two modules, allowing a full pressure hydrotest of all new joints.

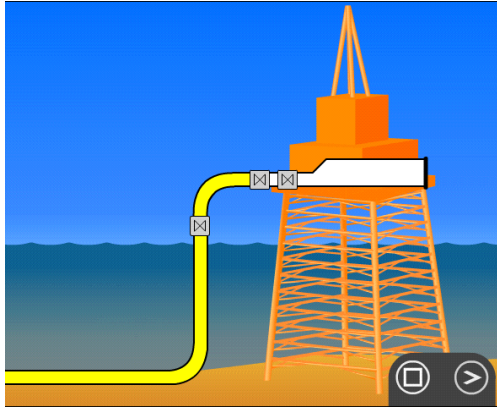


Fig. 5 - Valve replacement and Hydrotest

### 3 System Hydrotest.

Damage caused by Hurricane Ivan in the GOM required the replacement of a riser section on a remote platform. On completion of tie-ins, there was a requirement for a full system hydrotest. The client alternative was to disconnect and blind all associated topsides pipework, a task that was estimated to take over 48 hours, using a large construction crew, with associated requirement for temporary accommodation. A single module SmartPlug was utilized, upstream of the final ESDV, but downstream of the existing pipework, launcher and associated production pipework. On completion of the hydrotest, there was no requirement for another 48 hours re-instatement or subsequent leak testing of disturbed flanges. The benefits were such that when Hurricane Katrina damaged the same pipeline, the client re-performed the same operation.

### 4 Minimisation of Production Disruption.

Perhaps the biggest economical impact of the SmartPlug comes when its use allows these projects to proceed whilst minimizing throughput disruption.

A typical example of this was the replacement of two risers on Bombay High. The objective was to install expansion spools, SSIV's and replace the risers of the two main export gas (26") and oil (30") pipelines that run from the Bombay High NF platform to shore. By isolating the two pipelines the three platforms tied into these two lines could keep producing at maximum capacity. In this instance 25 days of production was saved.

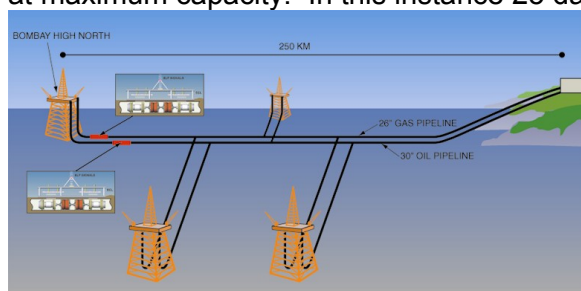


Fig. 6 – Riser replacement and Production Continuation

Similarly, on the Zakum Field in the Persian Gulf, isolations allowed work to proceed whilst minimizing pipeline downtime.

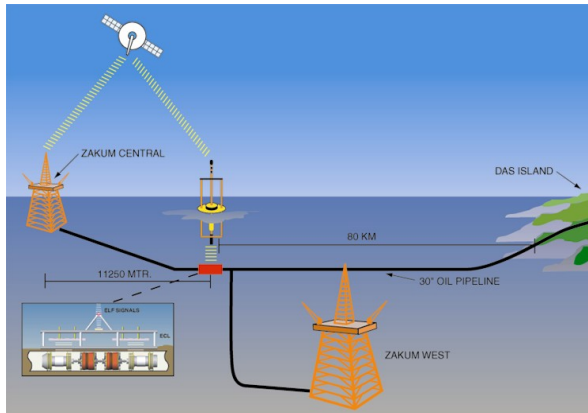


Fig. 7 – Pipeline Repair and Production Continuation

The objective was to isolate the 11 km leg of the main export oil pipeline, and to enable other production facilities connected to the pipeline to continue producing and exporting oil to the shore facility. The 11 km leg had serious corrosion and there was uncertainty as to whether the pipeline could operate for another 2 years while a new pipeline was constructed and commissioned. The SmartPlug was pigged into position in November 1999 and remotely set. The SmartPlug was set and isolated the pipeline for 400 days, before being re-activated, unset and pigged out.

## 5 Mid-Line Tie-in or Repairs.

Environmental concerns related to disposal / venting of product, as well as those associated with decommissioning and recommissioning activities lends itself to use of the SmartPlug for mid-line applications.

A leaking Subsea Plidco clamp was replaced with a flanged spool piece (See figure 8). 2 x dual module SmartPlug's were inserted against pipeline pressure and pigged to isolate either side of the clamp. The line was cut and recovered to the side of the vessel, whereby the flanges were welded on. The operation prevented the operator depressuring the pipeline and also delays associated with stabilization of friction barriers.

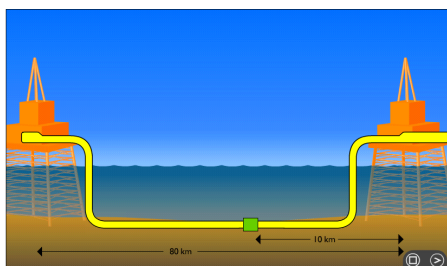
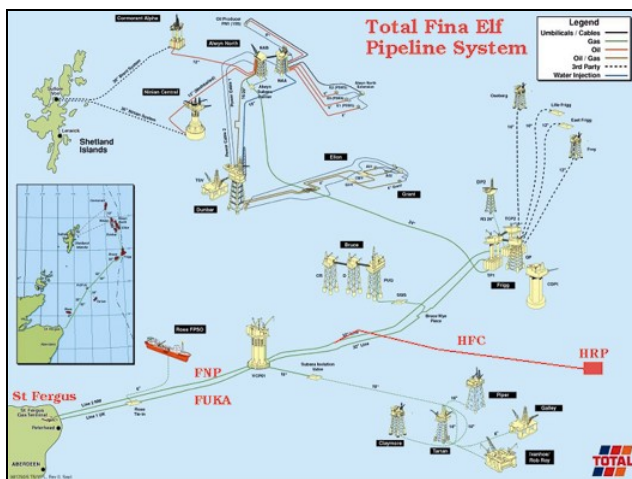


Fig. 8 – Mid-Line Pipeline Repair  
6 Platform Abandonment / Pipeline Re-Route.

The largest project performed to date, was the Frigg and MCP-01 bypass project. 3 x 32" and 1 x 24" SmartPlus were used to isolate the required pipelines.

The 24" SmartPlug was pigged 3km into the Alwyn line and isolated against 93 bar. There were numerous drivers for this, such as preventing the depressurisation of the Gas Export system from Alwyn / Dunbar. Decommissioning and recommissioning costs were minimised compared to traditional methods, and start-up was achieved far quicker, than could normally be anticipated.

Similarly with the 32" pipeline, two x 32" SmartPlugs isolated Bruce platform from the main construction work, as was required.



## Summary

Use of the SmartPlug can provide cost effective solutions to operational problems, that would otherwise require more costly and/or environmentally prohibitive solutions. The benefits can be described as follows: -

- Reduced impact on production throughput
- Reduced venting of gas
- Reduced pipeline downtime
- Reduced decommissioning / recommissioning requirements.