

# **SMART UTILITY PIGGING - ITS ROLE IN PIPELINE INSPECTION**

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## Introduction

This paper summarises the role of Smart Utility Pigging in the Pipeline Inspection industry. It explains what a Smart Utility Pig is, how it works and explores the market in which the technology has been developed. It then goes on to discuss the applications for the technology and specifically how it can be used to inspect offshore pipelines. The paper also briefly discusses some of the current development plans for the technology and suggests where these may lead.

This paper is not intended to give a detailed insight into Smart Utility Pigging. Rather the intent is to provide an overview or introduction to the technology. More detailed information on specific applications of the technology can be found at [www.pipeline-inspection.com](http://www.pipeline-inspection.com).

This paper also makes reference to SAAM<sup>®</sup> (Smart Acquisition Analysis Module), and how this is used in Smart Utility Pigging. The SAAM technology is proprietary technology developed and owned by RST Projects Ltd. RST is now part of Weatherford Pipeline and Specialty Services. SAAM is the first in a series of new technology, which will be launched by Weatherford over the next three years.

## What is a Smart Utility Pig?

A Smart Utility Pig offers a fundamentally different approach to internal pipeline inspection. In essence a Smart Utility Pig is nothing more than a standard cleaning or gauging pig with on-board intelligence added in the form of a SAAM unit. Rather than deploying an instrument to directly measure a feature within a pipeline, the SAAM unit monitors the behaviour of the Utility Pig as it travels through the pipeline. From changes in this behaviour it is possible to identify features that have caused it to change. In effect *‘a Utility Pig’s dynamic behaviour is directly related to the internal condition of the pipeline it transits’*.

Figure 1 shows a bi-di pig with SAAM unit waiting to be fitted.

The specification of the SAAM unit is critical to the ability of the Smart Utility Pig to inspect a pipeline. It has been found that if the unit is not specified correctly then this can severely compromise its ability to inspect a pipeline. Tools can be deployed with:

- An instrument payload capable of measuring Temperature, Absolute Pressure, Angular Velocity, Pig Differential Pressure, Vibration and Acceleration/Inclination
- Operate in pipelines up to 130°C
- Operate in pipelines up to 325 barg
- Operate in pipelines for 336 hours
- Operate in pipelines of diameter 6” and greater

The specifications of SAAM tools are customised within the above limitations to reflect the requirements of specific projects.

## Why is Smart Utility Pigging Needed?

A question that is often asked is why are Smart Utility Pigs needed? It is argued that traditional inspection technology provides sufficient solutions for the needs of the market place. *The fact is that these existing tools and technologies do not and cannot provide all of the answers that the pipeline owner operators need.* Some of the reasons why are summarised below:

**Inspection Costs:** Pipeline inspection costs are high. As a consequence, this does to some extent self limit the use of tools such as the traditional Intelligent Pig. The cost of a Smart Utility Pig can be up to an order of magnitude less than other tools.

**Aging Infrastructure:** The average age of the North Sea pipeline network is circa 20 years. This compares with typical design lives of 20 – 25 years. Given plans to operate many of these systems for a further 20 – 25 years, this reveals an ongoing fitness for purpose issue. This is further complicated by the need to do this cost effectively given the ongoing modest production rates through many of these lines. Smart Utility Pigs can be used to screen and first pass assess many of these lines.

**Difficult Operating Conditions:** Many fields cannot be inspected using traditional methods due to either their design (complex systems) or operating conditions (HT/HP fields). Smart Utility Pigs can be deployed in these systems.

**On-going Assessment:** Regulations (particularly in the US) are moving very much towards a more continuous direct assessment of pipeline condition. This means that information is required more regularly than the traditional 5, 7 or 10 years intervals typically associated with an intelligent pig. Smart Utility Pigs can be used to provide this information.

**Intelligent Decision Making:** Pipeline maintenance and inspection decisions are often taken based on very limited information. Smart Utility Pigs provide a cost effective means of generating solid information against which informed decisions can be made and appropriate actions taken.

To date SAAM Smart Utility Pigs deployed by RST have been used to survey circa 5000km of pipeline.

## Applications and Capabilities

Given the relative simplicity of the technology and its ease of deployment, a Smart Utility Pig can be used in a variety of ways. Its two most common uses are either to provide routine monitoring of pipeline condition, or as a one-off troubleshooting tool. Within these applications the technology offers a number of capabilities. The main ones are:

- Out-of-straightness measurement (2D and 3D)
- Internal debris detection and monitoring
- Internal bore restriction detection
- Internal corrosion detection
- Process data logging
- Diagnosing and optimising pigging programmes

The main capabilities of the technology are discussed below:

**Out-of-straightness Measurement:** The Smart Utility Pig provides accurate data on local pipeline out-of-straightness. Vertical and lateral curvature can be profiled, whether due to construction features such as process pipework, imperfections caused during pipelay, or movements that have occurred whilst in service, such as thermal expansion induced buckles.

SAAM can be used to identify, trend monitor and manage:

- Upheaval buckles
- Lateral buckles
- Pipeline scouring/spanning
- Low spots
- Subsidence
- River crossings

Figure 2 shows an upheaval buckle profile for a pipeline in the North Sea. Figure 3 illustrates the 3D capability for the tool presenting the shape of a feature profiled from a local reference point for a section of riser pipework.

**Internal Debris Detection and Monitoring:** The Smart Utility Pig provides a simple method to identify locations of wax deposits, and monitor their extent in conjunction with control and inhibition techniques. This enables both optimisation of pigging programmes (pig frequency and pig design), chemical dosage rates, and decreases risk of pipeline blockage. In addition it can be used as an initial exploratory and progress monitoring tool for major rehabilitation cleaning programmes.

Figure 4 illustrates how debris deposits within a pipeline causes distinctive pig behaviour. Figures 5 and 6 illustrate the differences between soft and hard wax.

**Internal Bore Restriction Detection:** Pipeline mechanical damage can be identified and located using a Smart Utility Pig. It can provide the operator with early warning of any new dents or buckles. Gauge plate damage locations can also be identified, as part of pipeline commissioning or proving prior to deployment of an intelligent pig.

Figure 7 shows a pig travelling towards and then becoming jammed at a damaged section of a pipeline. In this instance the welds were counted to position the defect and the pig reversed out of the line. Figure 8 shows a pig passing a flat spot in a pipeline represented as an increase in differential pressure and vibration.

**Internal Corrosion Detection:** A Smart Utility Pig provides the operator with the opportunity to cost effectively monitor pipelines for indications of internal corrosion, and to trend these instances over a period of time. Conventional pipeline inspection pigging costs can be optimised. A Smart Utility Pig can:

- Be used as a pipeline screening tool
- Correlate with accurate temperature and pressure profiles
- Assist in optimising corrosion inhibition programmes
- Manage necessity and frequency of wall thickness measurement tools
- Develop a basis for trend monitoring pipeline integrity
- Feed into pipeline integrity management programmes

The use of 'Condition Histograms' can provide information on the presence of corrosion within the pipeline. This is a technique developed by RST. The shape of these histograms can be used to confirm whether a pipeline is generally corroded or un-corroded. Figure 9 shows the histogram generated for a pipeline that is known to have little internal corrosion. The shape of this is near 'normal' and reflects the un-corroded condition of the pipeline. Figure 10 shows the histogram from a pipeline that has substantial internal corrosion. This histogram is 'skewed' and data points are scattered along the x-axis.

## Future Developments

The Smart Utility Pig concept is continuing to be developed and improved by RST. Recent developments have seen the upper temperature rating of the tool increasing to 130°C. A current project involves miniaturising the technology and increasing its pressure rating for use in ultra deepwater pipelines in the Gulf of Mexico. However, the main thrust of the current development programme is through the PIPEAIMS Joint Industry Project. This project is being run in collaboration with eight oil companies. It focuses on the development of the corrosion detection capability of a new generation of the SAAM tooling. The first prototype is currently undergoing field trials. This work also involves the codification of the knowledge developed so far with the technology and will result in the production of a Recommended Practice for Smart Utility Pigging.

## Summary

Smart Utility Pigs provide the pipeline owner operator with a relatively low cost alternative to traditional pipeline inspection methods. Its ease of use and its ability to operate in difficult environments, mean that it can inspect pipelines that no other tools can inspect. Furthermore, its relatively low cost means that it can be deployed more frequently than other tools, enabling genuine condition and trend monitoring of pipelines.

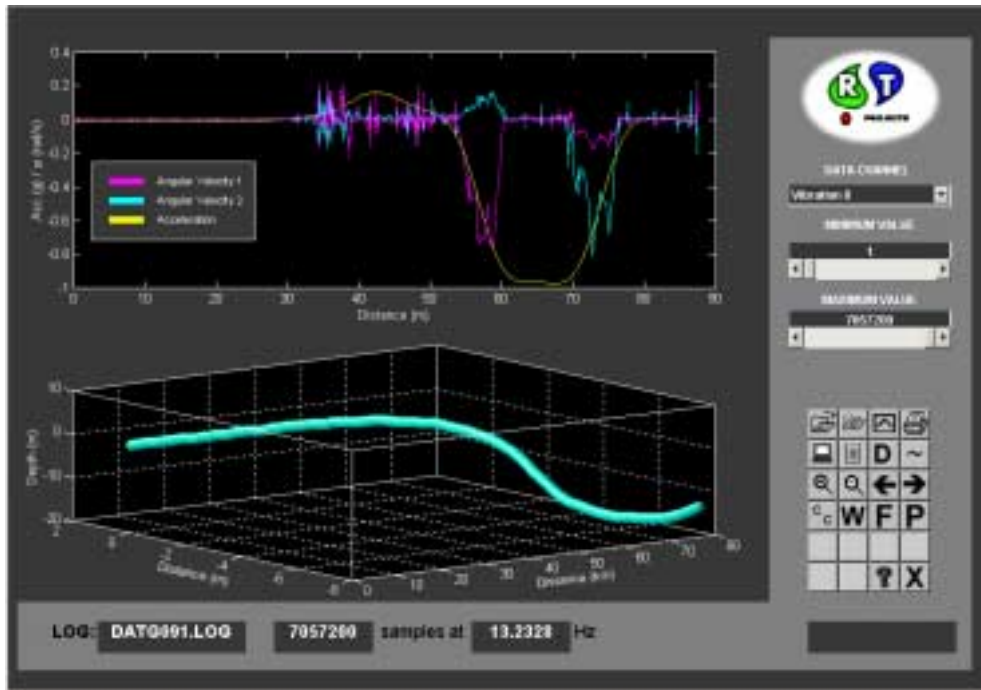
In summary, the use of Smart Utility Pigs provides an ability to generate information and data on pipeline condition that enables *intelligent and informed* decisions to be made on pipeline maintenance and inspection.



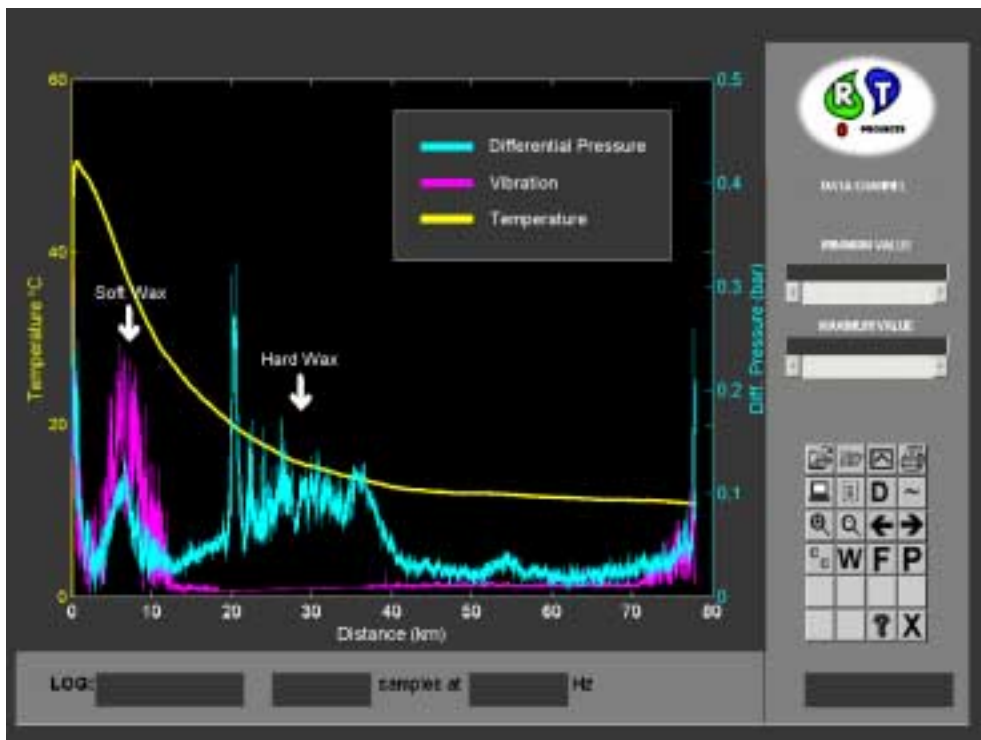
**Figure 1 – Bidi Pig and SAAM Unit**



**Figure 2 – Upheaval Buckle**



**Figure 3 – 3D Image of a Process Bend**



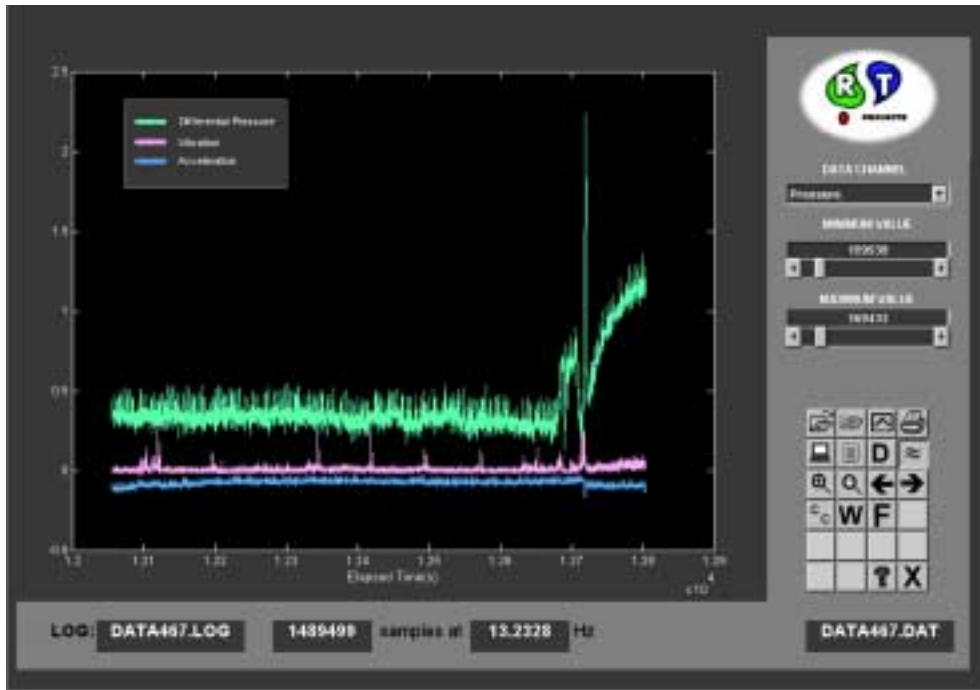
**Figure 4 – Pig Behaviour in a Waxy Crude Pipeline**



**Figure 5 – Pig Behaviour in a Soft Wax**



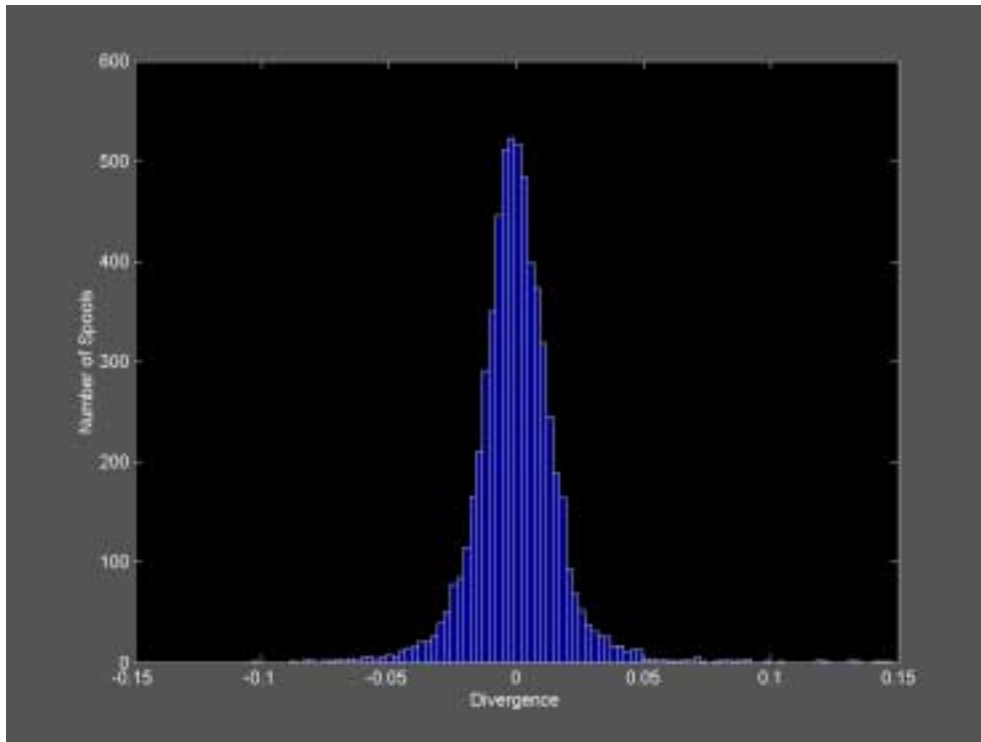
**Figure 6 – Pig Behaviour in a Hard Wax**



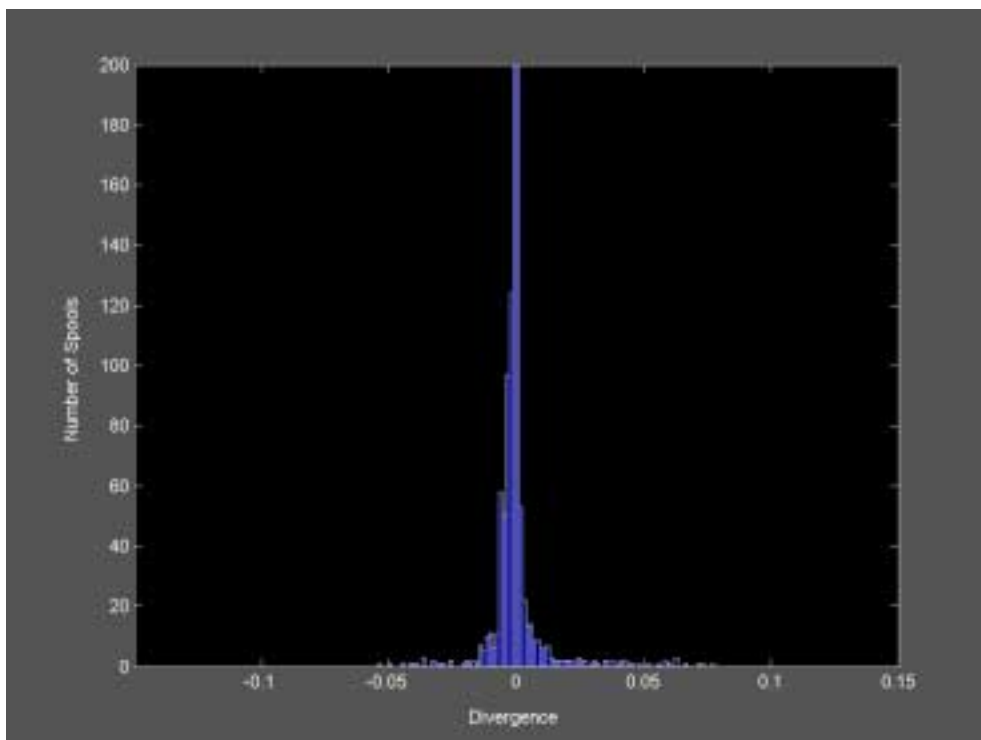
**Figure 7 – Pig Jamming in a Damaged Pipeline**



**Figure 8 – Pig Passing a Flat Spot**



**Figure 9 – Condition Histogram Pipeline in ‘Good’ Condition**



**Figure 10 – Condition Histogram ‘Corroded’ Pipeline**