ONLINE PIGGING TOOL MANAGEMENT SYSTEM

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Abstract

Pipeline Engineering opened a Service Centre within the city of Aberdeen, Scotland in 2008 to offer a pigging tool management and tool refurbishment service to the North Sea Pipeline Operators for their routine pigging tools.

Routine pigging tools are used by the pipeline operators to carry out cleaning operations within the production pipelines without impacting on production flow or revenues.

The Aberdeen Service Centre receipts the pigging tools from the customer post run, and then conducts a full service which comprises of cleaning, stripping, inspection, spares replacement, refurbishment, and final testing. The pigging tools are then ready to be utilised on another routine cleaning run.

Once the pigging tool has been fully serviced, a detailed refurbishment report is submitted to the customer, providing visibility on the pigging tools condition and information of the service work carried out by Pipeline Engineering. This pigging tool management and tool refurbishment service has helped customers make large savings on their annual pigging tool costs, whilst also receiving the required engineering expertise to optimise their pigging operations.

The Aberdeen Service Centre has a pigging tool tracking system in place for each customer which highlights their full pigging tool fleet location, condition, configuration, last test date, run details and GA details. This information was previously submitted to the customer on a weekly basis, along with a summary report of all activities. The customers used this system on a regular basis to monitor their pigging tool logistics, and to advise the platform personnel on what the next pigging requirement were to be.

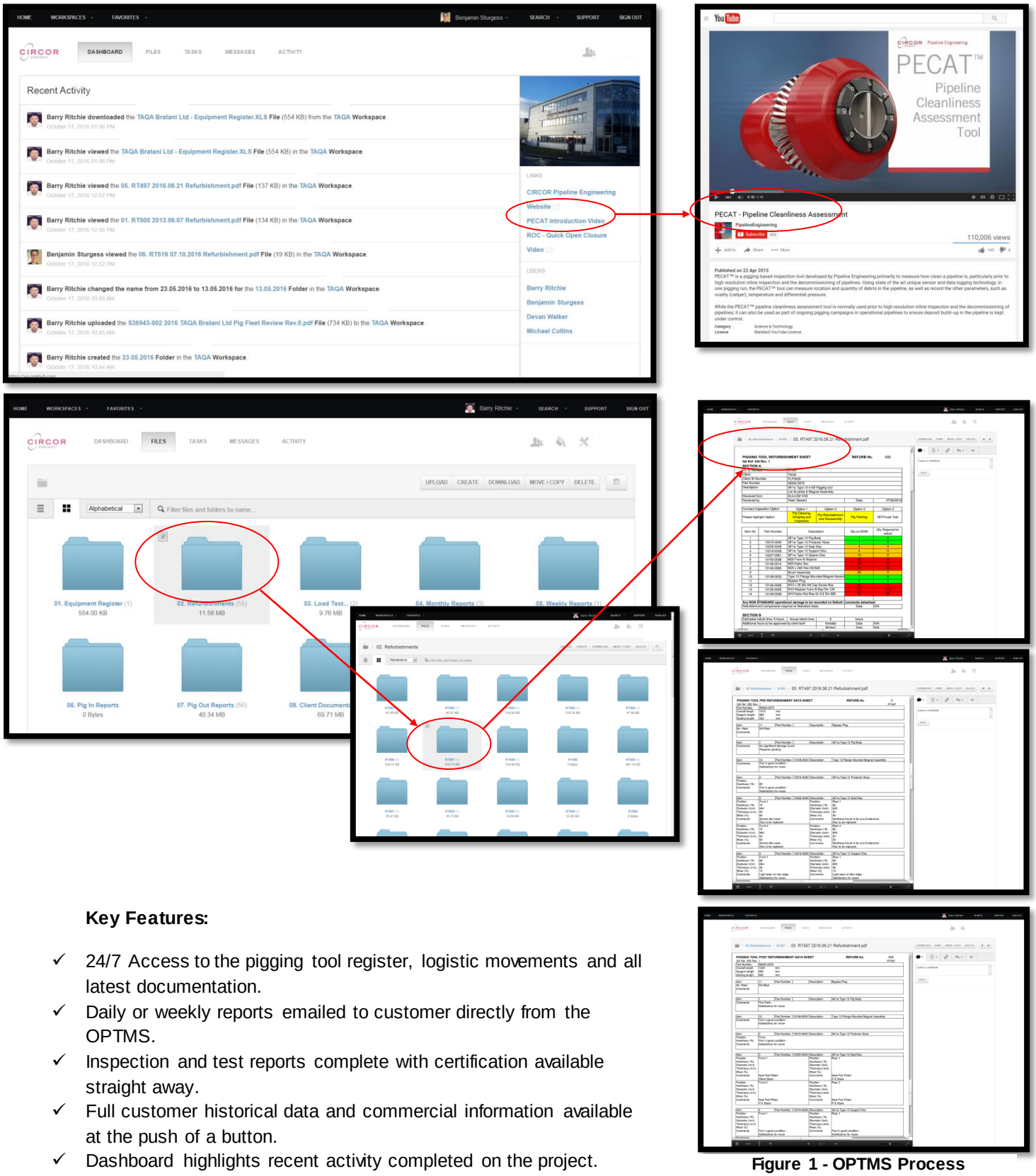
In Q3 of 2016, Pipeline Engineering has upgraded their pigging tool management service to their customers by introducing an ***Online Pigging Tool Management System***. This online management system, with a personalised customer log in, helps each customer improve visibility of their pigging tool fleet whilst providing the option to remotely access the data via a mobile phone or tablet app. Having such up to date data at hand reduces the customers and/or platforms time spent sourcing the required information via the previous method of emails or saved folders.

As the Oil and Gas industry operates 24/7, Pipeline Engineering has created an excellent solution to provide continual all year support to the pigging industry.

This paper describes the optimisation process for cleaning tool maintenance via some customer case studies, demonstrates the software functionality and describes the benefits of having the data at your fingertips.

1. Introduction

The below images are taken from the online pigging tool management system (OPTMS) and give an overview of the user friendly system that helps the customer source the latest information for each pigging tool. The system also gives information on additional products that can assist with ad-hoc projects.



Key Features:

- ✓ 24/7 Access to the pigging tool register, logistic movements and all latest documentation.
- ✓ Daily or weekly reports emailed to customer directly from the OPTMS.
- ✓ Inspection and test reports complete with certification available straight away.
- ✓ Full customer historical data and commercial information available at the push of a button.
- ✓ Dashboard highlights recent activity completed on the project.

Figure 1 - OPTMS Process

2. Pigging Tool Management System – Beneficiaries

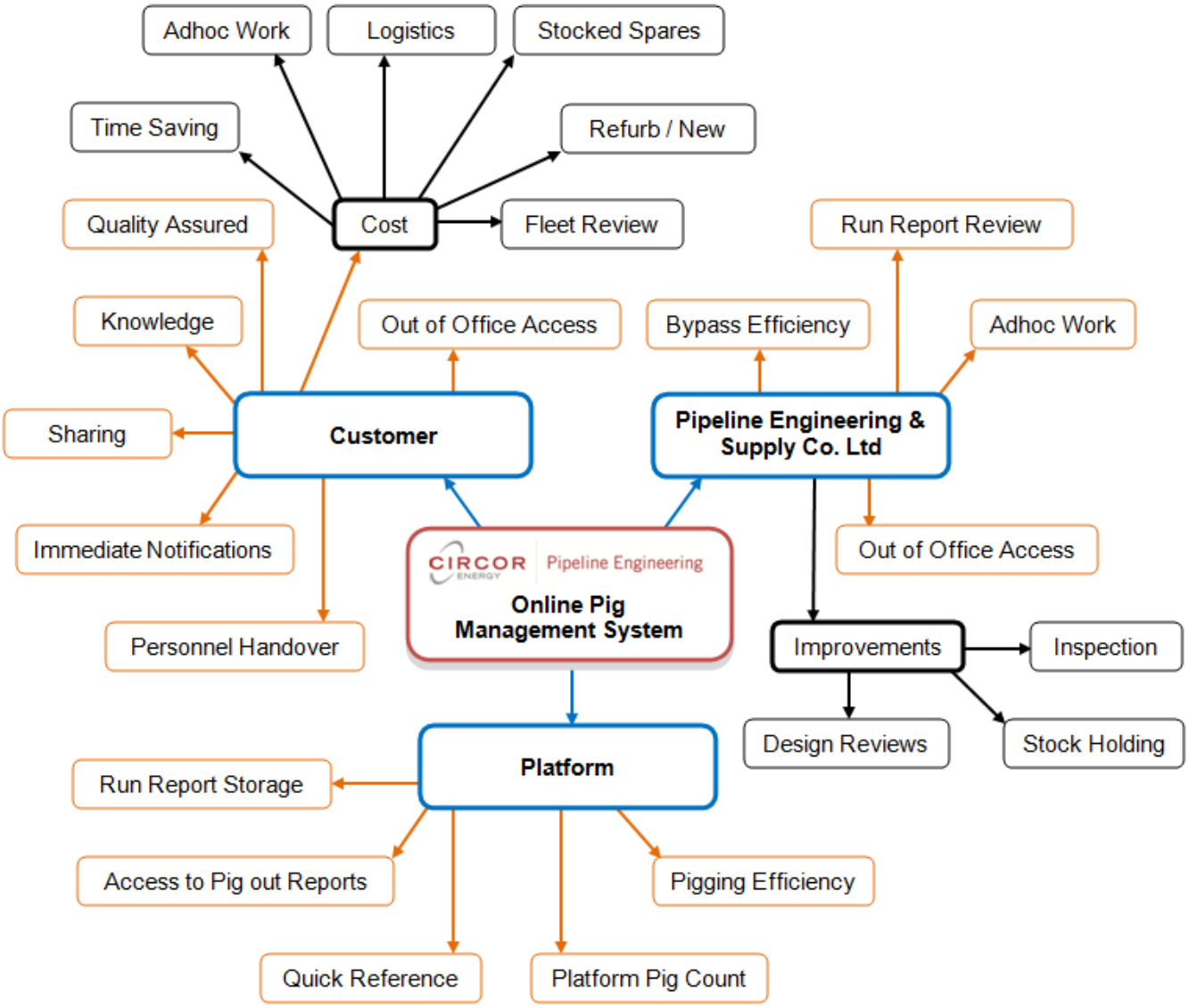


Figure 2 - OPTMS Beneficiaries

Key Beneficiaries:

- ✓ Customer:
  - Time and cost savings on project management.
  - Time and cost savings on identifying pigging tool locations, conditions & configurations.
  - Detailed inspection reports, shipping reports and certification available at anytime.
  - Information available when out of office via internet or mobile app.
- ✓ Platform:
  - Knowledge of pigging tool availability on platform.
  - Access to pigging tool certification documents.
  - Pipeline cleaning capabilities optimised.
- ✓ Pipeline Engineering:
  - Shared knowledge from pig runs.
  - Streamline pig fleet to reduce customer costs.
  - Optimise pigging tool capabilities against current pipeline conditions.
  - Additional data received to review pig run effectiveness.

Case Study 1: Optimising the Customers Pig Fleet to Reduce Annual Costs Whilst Increasing Pigging Efficiency

Pipeline Engineering was requested to carry out a review of a customer's current pig fleet of all North Sea assets to optimise the fleet and to reduce annual costs. The stock of pigs was firstly reviewed against the current pigging plans, future pigging plans and logistical cycle involved with a pig run and refurbishment activities. Based on the example shown within the figure below, Pipeline Engineering was able to reduce the overall operational pig fleet by 55%. This sizeable reduction in stock has resulted in large annual savings to the customer.

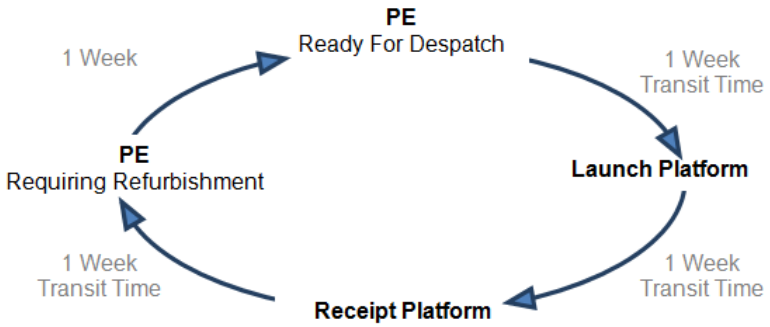


Figure 3 - Pigging Tool Cycle

Pipeline Engineering went through a design review to optimise the pigging efficiency of each pig type within the remaining pig fleet. The pig disc configuration, bypass optimisation, parts utilised and additional requirements were all investigated and significant changes were made throughout.

i. Parts Utilisation:

Common pig designs were used where possible to enable interchanging of spares between differing pig types. This reduces spare part stocking levels, and provides more consistent cleaning allowing for better comparisons between runs where inspection of returns is necessary. This included the provision of interchangeable ancillary items such as brushes, magnets, and cups where fitted.

ii. Parts Optimisation:

A clipped brush identified by its bristle design, is made from stainless steel clips set into a perforated steel band with a PU centre, see image 01 showing a typical clipped design. The original fitted brush fitted by the original manufacturer (Typically known as a GEM brush) is shown in image 02.

The clipped type of brush is best suited for both hard and soft wax and is strong enough to support the pig acting as a support method, required by the pig's design (The pig's configuration does not have support/guide discs and relies on the brushes for centralisation in the pipeline).

The GEM brush is more suited for dry light debris removal and easily clogs with wax which renders it much less effective than a clipped type brush.

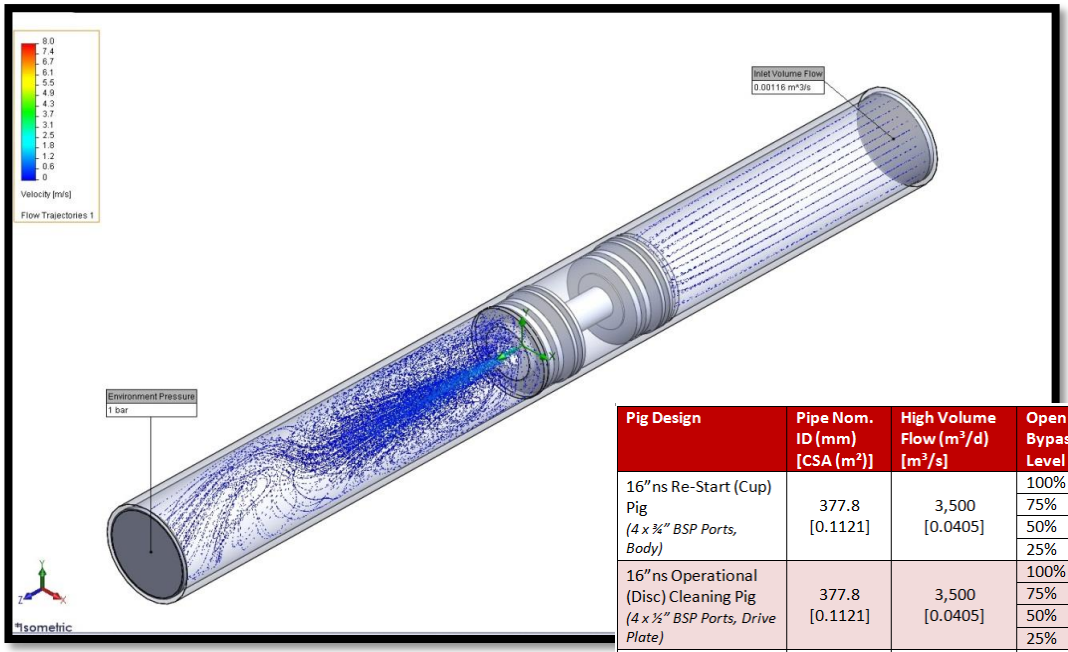
Figure 4 - Brush Type image 01

Figure 5 - Brush Type Image 02

iii. Bypass Optimisation:

Pipeline Engineering carried out a CFD (computational fluid dynamics) study focussing on the bypass flow through the pig within the pipeline. The study identified differing bypass port arrangements present on the pigging tools to confirm the optimal configuration for each pig type.

On conclusion of the report the bypass available to the customer was greatly increased and in one instance there was an increase of 25% to 100% open during average production case.



Pig Design	Pipe Nom. ID (mm) [CSA (m^2)]	High Volume Flow (m^3/d) [m^3/s]	Open Bypass Level	Total Bypass Area (mm^2)	Study Ref:
16"ns Re-Start (Cup) Pig *(4 x ¾" BSP Ports, Body)*	377.8 [0.1121]	3,500 [0.0405]	100%	2,290.2	*1a*
			75%	1,717.7	*1b*
			50%	1,145.1	*1c*
			25%	572.6	*1d*
16"ns Operational (Disc) Cleaning Pig *(4 x ½" BSP Ports, Drive Plate)*	377.8 [0.1121]	3,500 [0.0405]	100%	1,134.1	*2a*
			75%	850.6	*2b*
			50%	567.1	*2c*
			25%	283.5	*2d*
20"ns Re-Start (Cup) Pig *(4 x 1" BSP Ports, Body)*	478 [0.1795]	6,200 [0.0718]	100%	3,019.1	*3a*
			75%	2264.3	*3b*
			50%	1,509.5	*3c*
			25%	754.8	*3d*
20"ns Operational (Disc) Cleaning Pig *(4 x 1" BSP Ports, Drive Plate)*	478 [0.1795]	6,200 [0.0718]	100%	3,019.1	*4a*
			75%	2,264.3	*4b*
			50%	1,509.5	*4c*
			25%	754.8	*4d*

Figure 6 - Computational Fluid Diagram

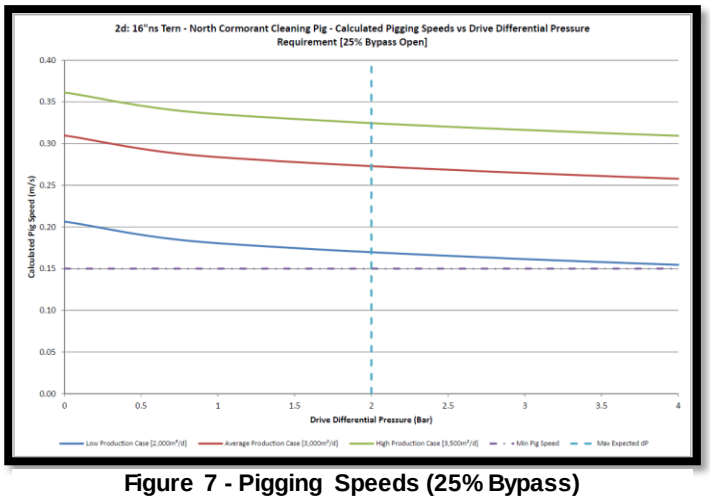


Figure 7 - Pigging Speeds (25% Bypass)

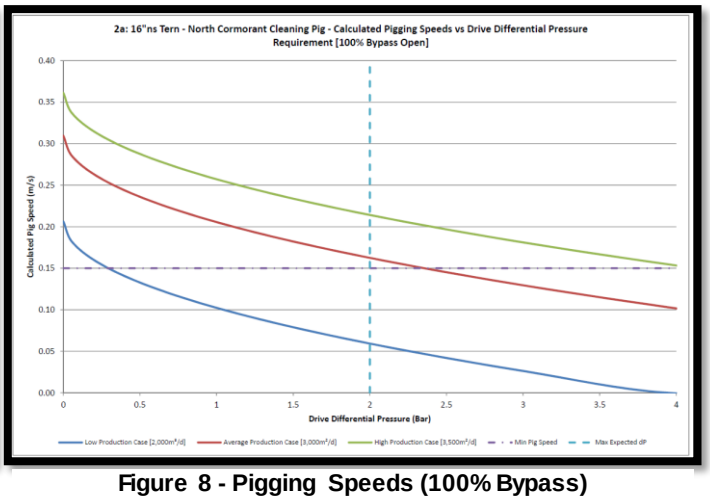


Figure 8 - Pigging Speeds (100% Bypass)

iv. Additional Requirements:

Request:

- Magnetic signalling capabilities and debris collection capabilities to be introduced into the pig fleet.
- Solution required for additional impact protection to prevent damage to body tube on impact.

Solution:

- Design a conversion plate to allow the fitment of magnets where typically a brush is fitted.
- Design a flange mounted magnet assembly at the rear of the pig, replacing the standard flange.
- Design a protector nose suitable for receiving contact with a ball valve in the closed position.

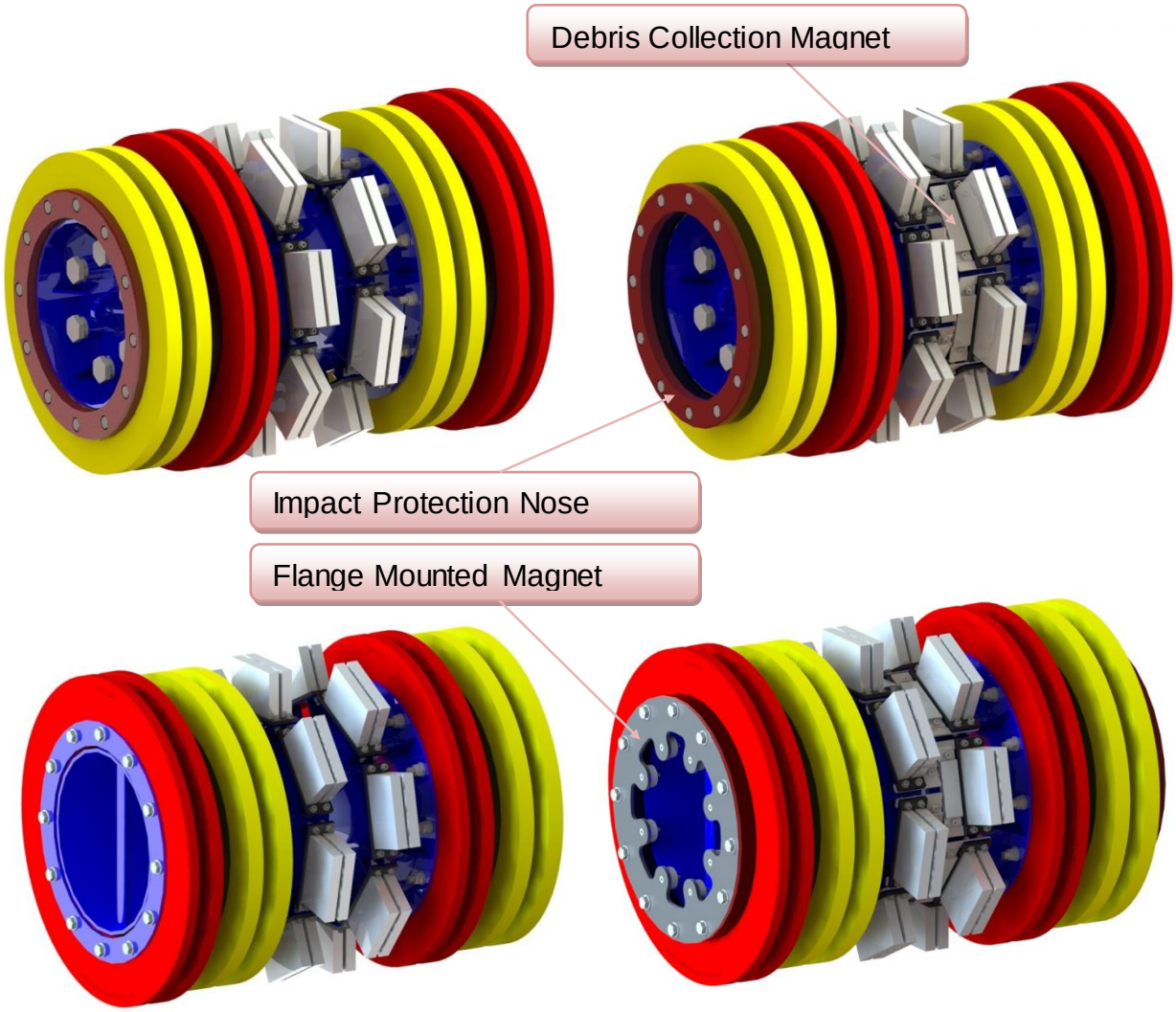


Figure 9 - Pigging Tool Redesigned to Meet Customer Requests

3. Case Study 2: Streamlining the Customers Pig Fleet to Increase Cleaning Efficiency

Pipeline Engineering receipted a new customer's pig fleet which was routinely used for maintenance pigging. The fleet consisted of various pig designs from several pig manufacturers which were manufactured periodically to meet the pigging requirements at the time of purchase.

A full dimensional analysis was completed on the fleet and the information gathered was measured against the pipeline parameters to identify each tool's suitability and cleaning effectiveness. The information also shows a wide range of component sizes across the pig fleet which will result in difficulties when comparing results between pig runs and may also increase the risk of a stuck/damaged pig during operation.

The below table highlights components which are considered under sized or over sized for the pipeline segments:

Pig ID	Pig Sealing disc OD (mm)	% Min ID	% Nominal ID	% Max ID	Pig Support Disc OD	% Min ID	% Nominal ID	% Max ID	Pig Cup OD	% Min ID	% Nominal ID	% Max ID	Pig Circular Brush OD	% Min ID	% Nominal ID	% Max ID
Priority 1 Refurbished Pigs																
RT717	625	114%	108%	106%	576	105%	100%	97%	N/A				585	107%	101%	99%
RT700	620	113%	107%	105%	576	105%	100%	97%	N/A				585	107%	101%	99%
RT713	620	113%	107%	105%	576	105%	100%	97%	605	110%	105%	102%	N/A			
RT703	610	111%	106%	103%	576	105%	100%	97%	N/A				585	107%	101%	99%
RT719	615	112%	106%	104%	576	105%	100%	97%	N/A				N/A			
Priority 2 Refurbished Pigs																
RT704	610	111%	106%	103%	576	105%	100%	97%	N/A				585	107%	101%	99%
RT705	615	112%	106%	104%	576	105%	100%	97%	N/A				N/A			
RT706	615	112%	106%	104%	578	105%	100%	98%	N/A				N/A			
RT707	-				N/A				585	107%	101%	99%	N/A			
RT716	615	112%	106%	104%	572	104%	99%	97%	N/A				N/A			
RT720	615	112%	106%	104%	572	104%	99%	97%	N/A				N/A			

Table 1 - Pigging Disc Dimensional Analysis

Pipeline Engineering recommended standardising the disc sizes:

- Sealing Disc: Ø610mm
- Support Disc: Ø572mm

The benefit from the recommended changes was the capability of comparing pig run results from run to run. By comparing run data the customer also benefited from cleaning efficiency, reduced risk of damaged pigs, reduction in the quantity of replacement parts following each run and a more manageable stocking level required for the replacement discs used during the refurbishment activities.

The customer also benefited commercially as there was a large reduction in replacement parts used as the excessive wear previously found on the seal and support discs was rectified, resulting in the discs being suitable for reuse.

The streamlined pig fleet was utilised within the pipeline as part of the routine maintenance cleaning and the pigging data and pigging tool condition was reviewed from each run.

Pipeline Engineering confirmed that the pipeline was in a satisfactory clean state by running the cleanliness assessment tool, PECAT™. By using PECAT's unique sensor and data logging technology, Pipeline Engineering was able to record the location and quantity of debris within the pipeline as well as other parameters including ovality (Calliper), temperature, orientation and differential pressure.

The table and graphs show a summary of the 7.1 million readings that were taken during the individual assessment:

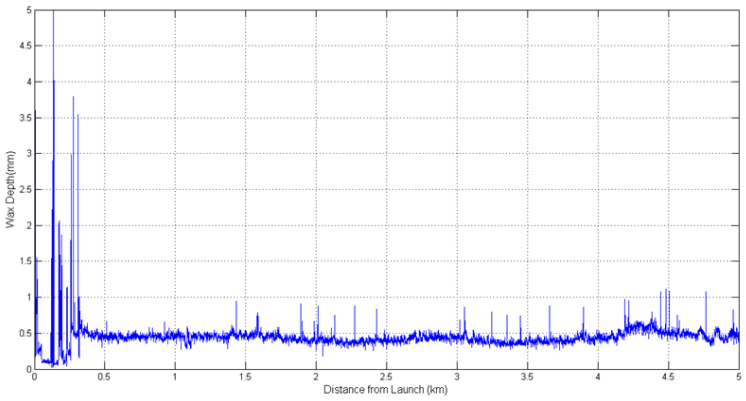


Figure 10 - Average Arm Reading KP10 to KP15

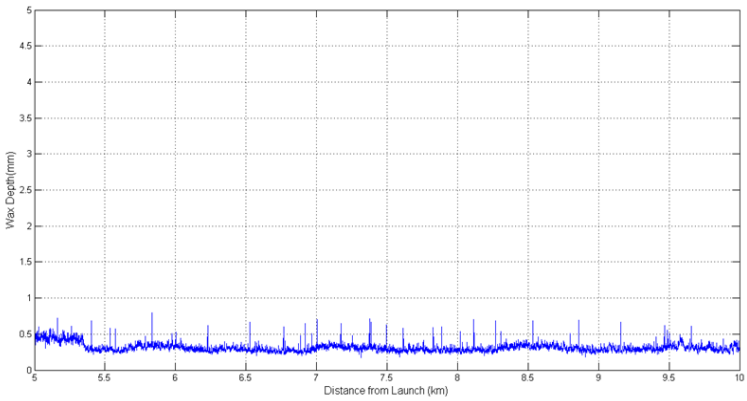


Figure 11 - Average Arm Reading KP5 to KP10

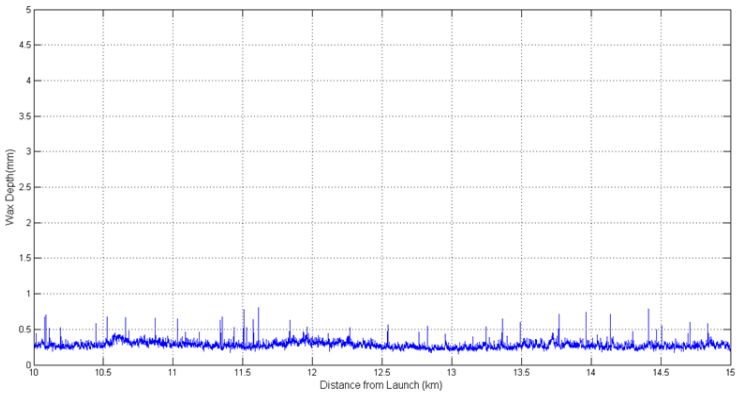


Figure 10 - Average Arm Reading KP10 to KP15

Start Distance (km)	End Distance (km)	Mean Depth (mm)	Estimated Volume (m^3)	Comments
0.135	1	0.48	0.755	From bottom of Riser
1	2	0.45	0.826	
2	3	0.42	0.758	
3	4	0.40	0.735	
4	5	0.50	0.917	Highest volume of wax identified
5	6	0.36	0.658	
6	7	0.29	0.520	
7	8	0.30	0.549	
8	9	0.31	0.562	
9	10	0.31	0.559	
10	11	0.30	0.549	
11	12	0.29	0.527	
12	13	0.28	0.502	
13	14	0.27	0.492	
14	15	0.27	0.487	
15	16	0.25	0.452	
16	17	0.28	0.510	
17	18	0.32	0.574	
18	19	0.28	0.506	
19	20	0.29	0.530	
20	21	0.28	0.515	
21	22	0.27	0.499	
22	23	0.26	0.480	
23	24	0.27	0.486	Suspected corrosion point
24	25	0.27	0.492	
25	26	0.28	0.515	
26	27	0.29	0.532	
27	28	0.31	0.562	
28	29	0.32	0.579	
29	30	0.32	0.587	
30	31	0.33	0.603	
31	32	0.36	0.651	Suspected dent KP31.58
32	33	0.43	0.775	
33	34	0.38	0.684	
34	End	0.52	0.048	To bottom of Riser

Table 2 - Debris Estimated Volume

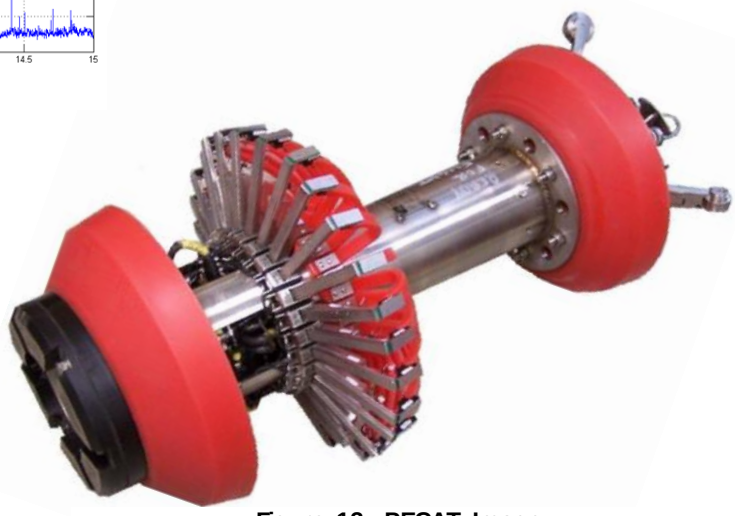


Figure 13 - PECAT Image

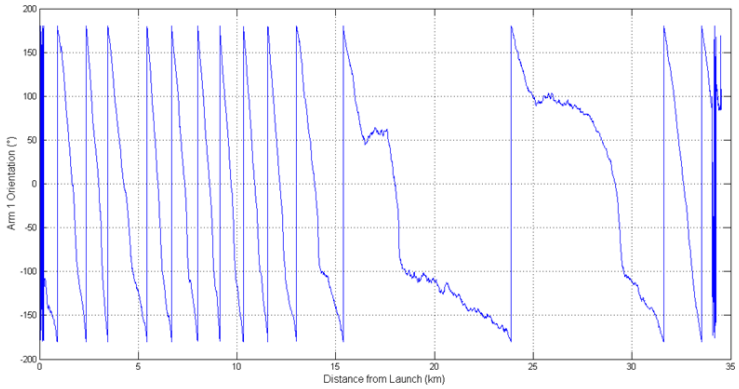


Figure 14 - Differential Pressure Overview

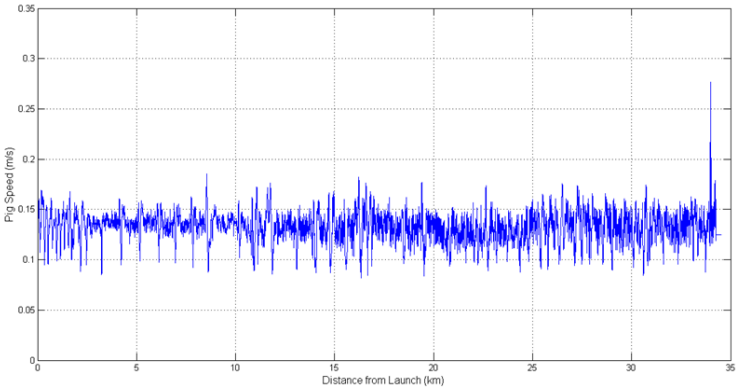


Figure 15 - Temperature Overview

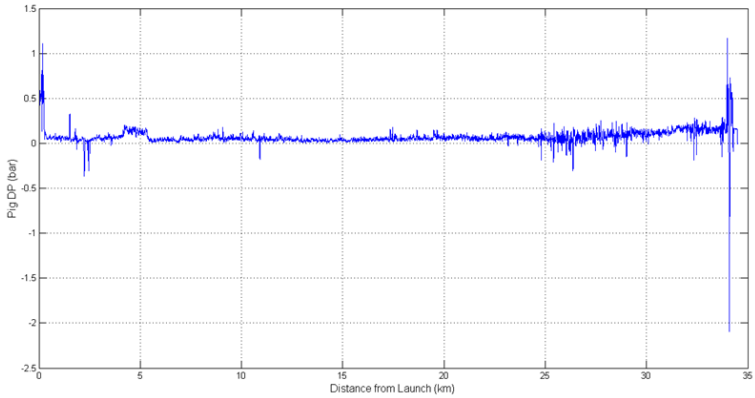


Figure 16 - Pig Orientation Overview

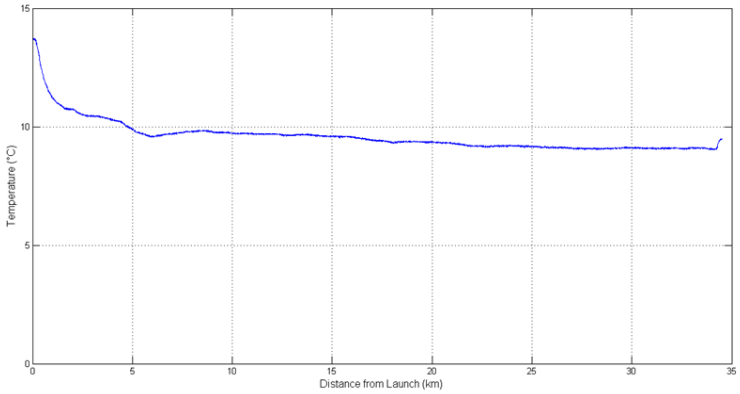


Figure 13 - Pig Speed Overview

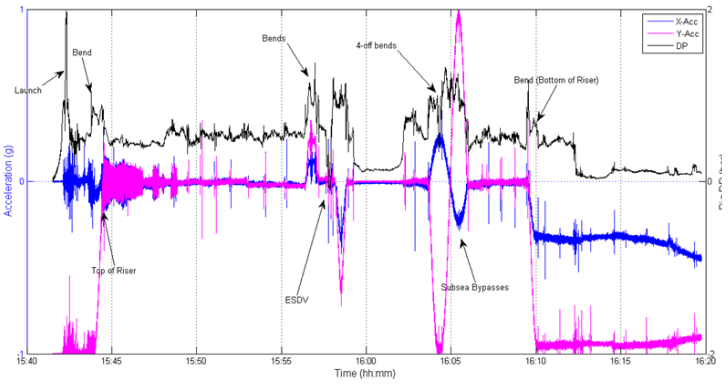


Figure 11 - dp and Acceleration Detail, Topsides and Riser

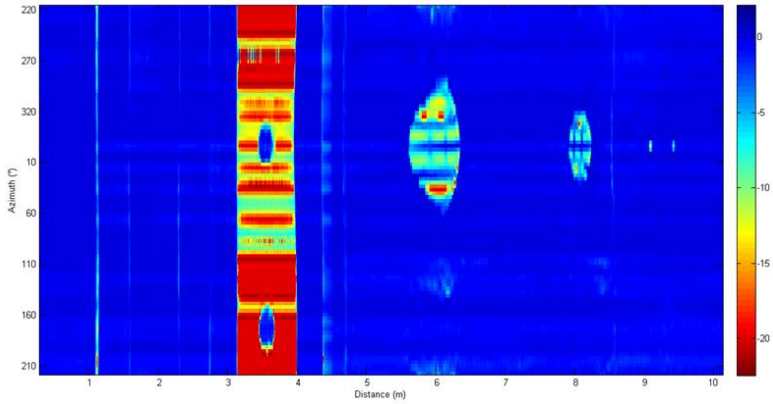


Figure 12 - Visualisation Carpet View

4. Summary

By Pipeline Engineering incorporating the OPTMS into their management of pig fleets a significant reduction in project management and administration hours can be achieved. The customer now has full access to the latest records and receives regular notifications of logistic and refurbishment information. Having access to the OPTMS allows the customer to support the platform much easier than before with any pigging tool logistics, configuration and condition queries.

Pipeline Engineering has identified the OPTMS a good opportunity to share pigging information between platform, customer and the Pipeline Engineering Service Centre so full data analysis can be completed on each pigging tool post run. These findings can be used to determine the most effective pig configuration for pipeline cleaning, resulting in cleaner pipelines and reduced chances of blockages. As shown within the case studies, regular improvements can be achieved, measured and monitored to achieve the optimal pigging solution.