



Multi-Diameter Pig Development for the Gannet Field

PPSA – Aberdeen 2018

7th November 2018



Michael Cridland
Gannet Pipeline Engineer
Shell UK Ltd



Cautionary Note

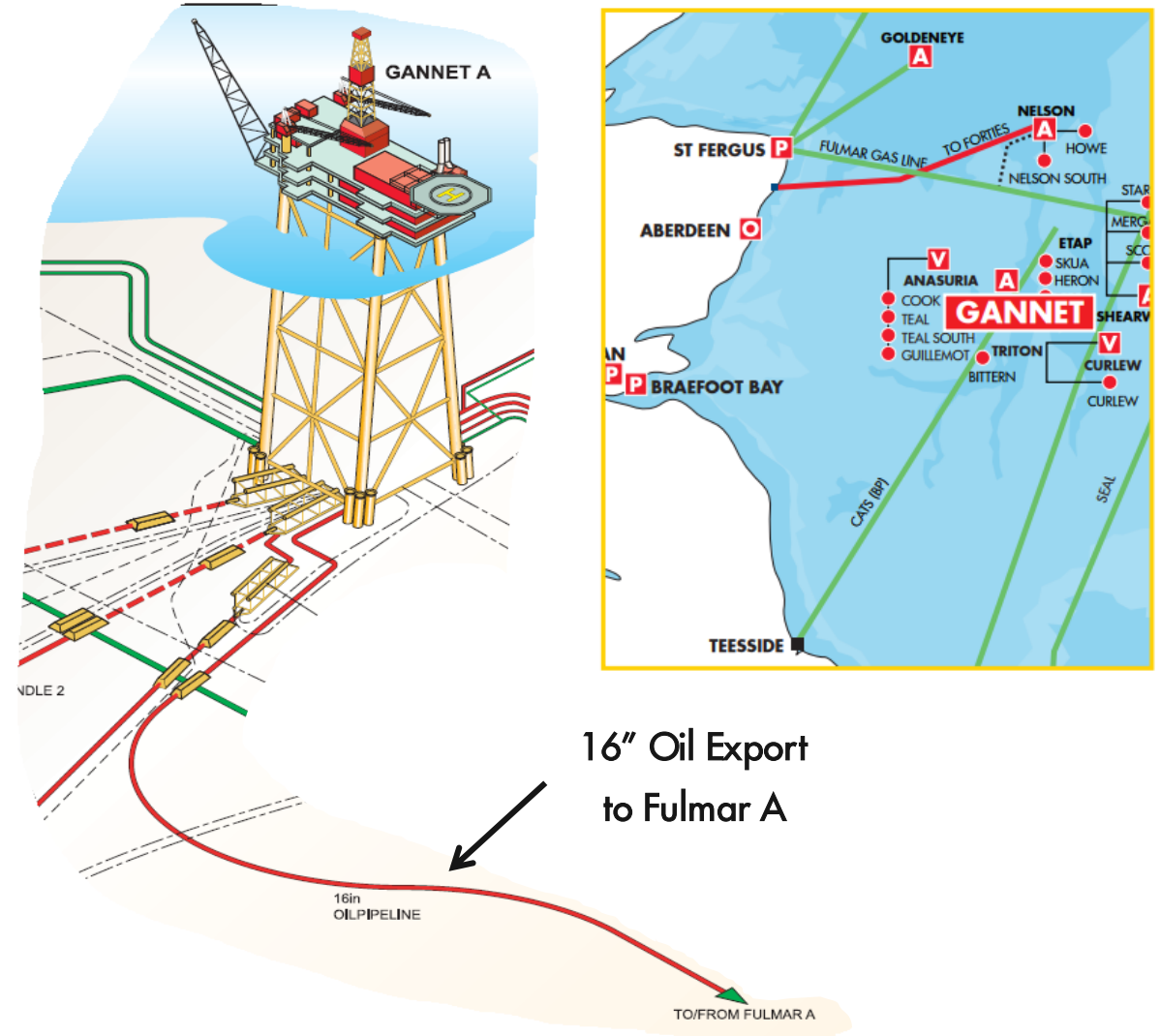
The companies in which Royal Dutch Shell plc directly and indirectly owns investments are separate legal entities. In this presentation “Shell”, “Shell group” and “Royal Dutch Shell” are sometimes used for convenience where references are made to Royal Dutch Shell plc and its subsidiaries in general. Likewise, the words “we”, “us” and “our” are also used to refer to Royal Dutch Shell plc and subsidiaries in general or to those who work for them. These terms are also used where no useful purpose is served by identifying the particular entity or entities. “Subsidiaries”, “Shell subsidiaries” and “Shell companies” as used in this presentation refer to entities over which Royal Dutch Shell plc either directly or indirectly has control. Entities and unincorporated arrangements over which Shell has joint control are generally referred to as “joint ventures” and “joint operations”, respectively. Entities over which Shell has significant influence but neither control nor joint control are referred to as “associates”. The term “Shell interest” is used for convenience to indicate the direct and/or indirect ownership interest held by Shell in an entity or unincorporated joint arrangement, after exclusion of all third-party interest.

This presentation contains forward-looking statements (within the meaning of the U.S. Private Securities Litigation Reform Act of 1995) concerning the financial condition, results of operations and businesses of Royal Dutch Shell. All statements other than statements of historical fact are, or may be deemed to be, forward-looking statements. Forward-looking statements are statements of future expectations that are based on management’s current expectations and assumptions and involve known and unknown risks and uncertainties that could cause actual results, performance or events to differ materially from those expressed or implied in these statements. Forward-looking statements include, among other things, statements concerning the potential exposure of Royal Dutch Shell to market risks and statements expressing management’s expectations, beliefs, estimates, forecasts, projections and assumptions. These forward-looking statements are identified by their use of terms and phrases such as “aim”, “ambition”, “anticipate”, “believe”, “could”, “estimate”, “expect”, “goals”, “intend”, “may”, “objectives”, “outlook”, “plan”, “probably”, “project”, “risks”, “schedule”, “seek”, “should”, “target”, “will” and similar terms and phrases. There are a number of factors that could affect the future operations of Royal Dutch Shell and could cause those results to differ materially from those expressed in the forward-looking statements included in this presentation, including (without limitation): (a) price fluctuations in crude oil and natural gas; (b) changes in demand for Shell’s products; (c) currency fluctuations; (d) drilling and production results; (e) reserves estimates; (f) loss of market share and industry competition; (g) environmental and physical risks; (h) risks associated with the identification of suitable potential acquisition properties and targets, and successful negotiation and completion of such transactions; (i) the risk of doing business in developing countries and countries subject to international sanctions; (j) legislative, fiscal and regulatory developments including regulatory measures addressing climate change; (k) economic and financial market conditions in various countries and regions; (l) political risks, including the risks of expropriation and renegotiation of the terms of contracts with governmental entities, delays or advancements in the approval of projects and delays in the reimbursement for shared costs; and (m) changes in trading conditions. No assurance is provided that future dividend payments will match or exceed previous dividend payments. All forward-looking statements contained in this presentation are expressly qualified in their entirety by the cautionary statements contained or referred to in this section. Readers should not place undue reliance on forward-looking statements. Additional risk factors that may affect future results are contained in Royal Dutch Shell’s 20-F for the year ended December 31, 2017 (available at www.shell.com/investor and www.sec.gov). These risk factors also expressly qualify all forward looking statements contained in this presentation and should be considered by the reader. Each forward-looking statement speaks only as of the date of this presentation, 7th November 2018. Neither Royal Dutch Shell plc nor any of its subsidiaries undertake any obligation to publicly update or revise any forward-looking statement as a result of new information, future events or other information. In light of these risks, results could differ materially from those stated, implied or inferred from the forward-looking statements contained in this presentation.

We may have used certain terms, such as resources, in this presentation that United States Securities and Exchange Commission (SEC) strictly prohibits us from including in our filings with the SEC. U.S. Investors are urged to consider closely the disclosure in our Form 20-F, File No 1-32575, available on the SEC website www.sec.gov.

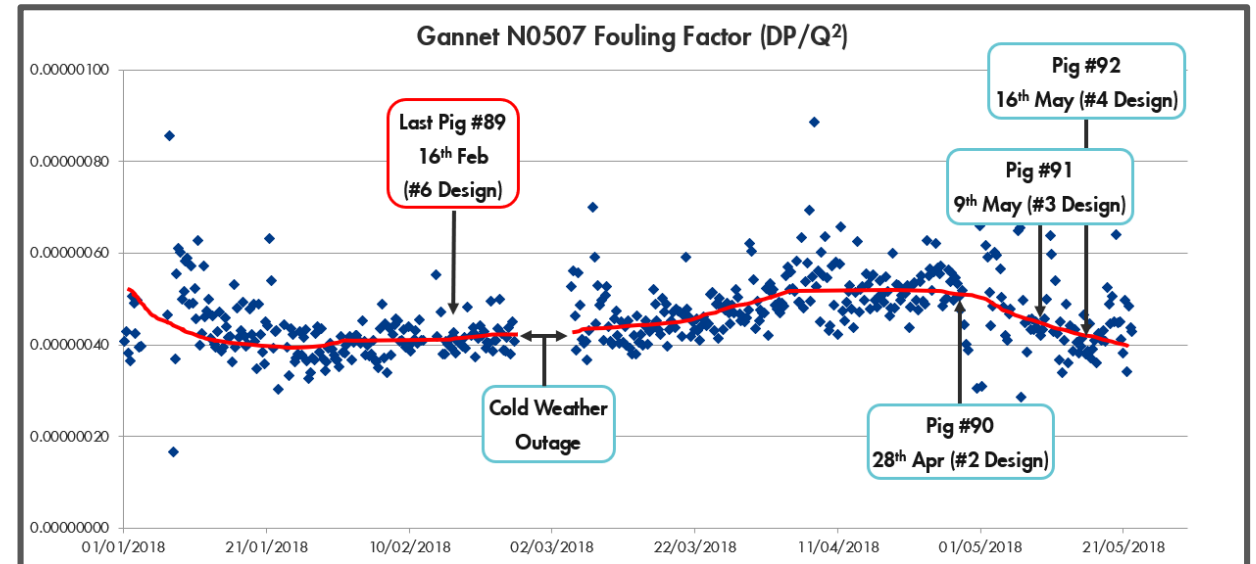
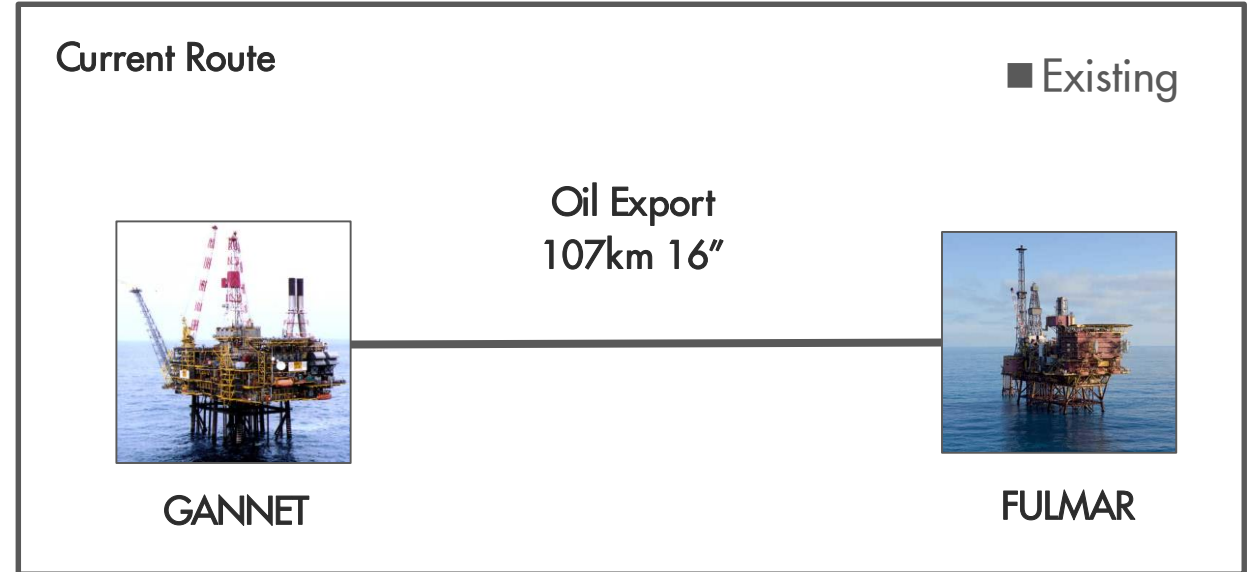
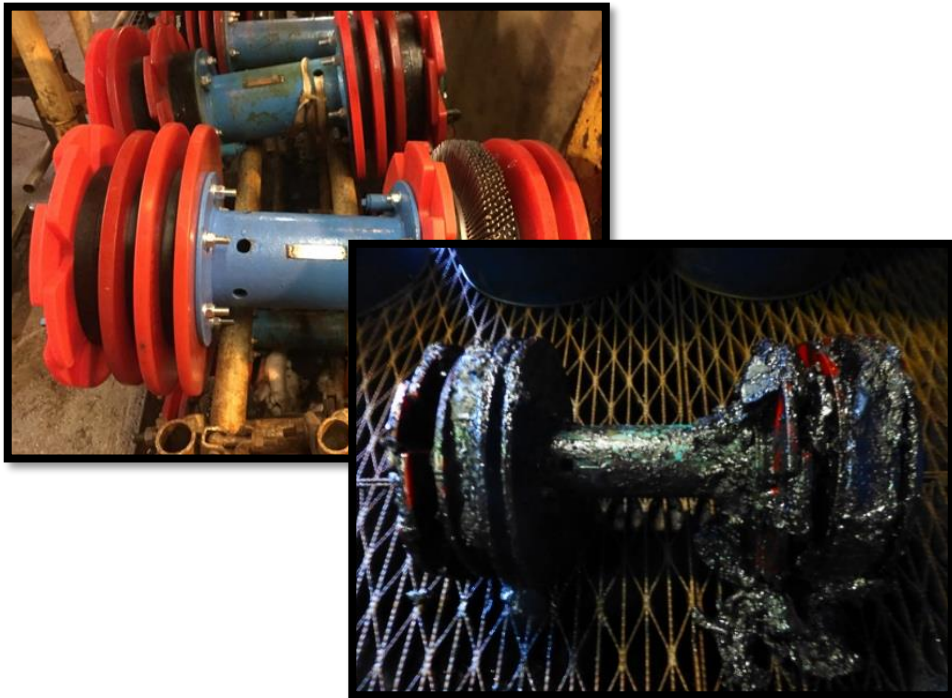
Background

- Gannet to Fulmar 16" oil export pipeline commissioned 1992
- Regular operational pigging currently carried out for wax removal and corrosion management
- Alternative export route required
- New oil export route will require pigs to traverse 16", 24" and 34" sections with increase in travel distance from 107km to 450km
- Not an option to stop pigging, use of wax inhibitors/depressants and corrosion inhibitors will not be sufficient
 - Multi-diameter pigging with 132% increase in pipeline size is unknown territory for Shell (& the industry?)

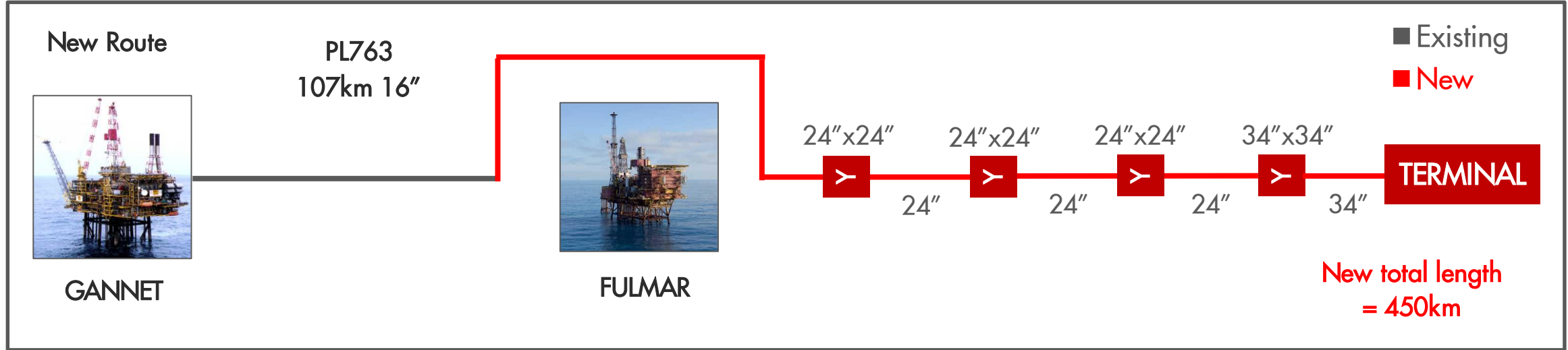


Current Route

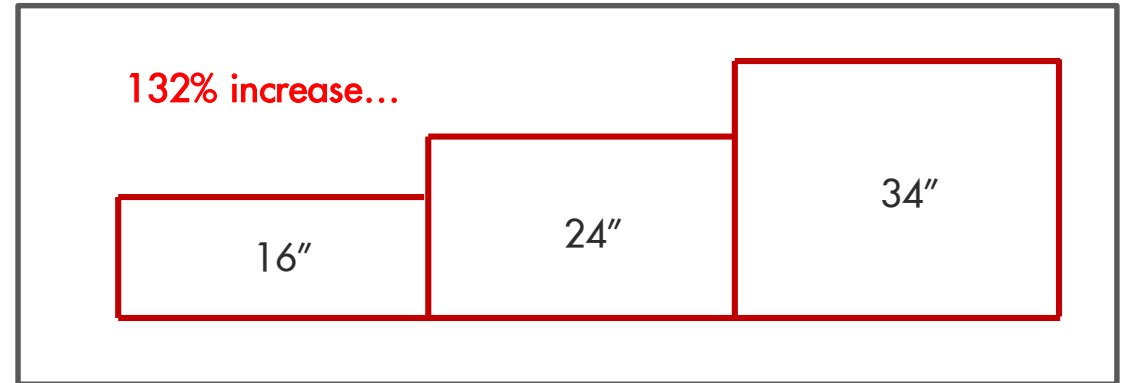
- Bi-directional metal bodied pigs varying in aggressiveness launched approximately every 7 – 10 days
- Selection of pigs dependent on wax returns recovered at Fulmar and monitoring of pipeline fouling factor



Future



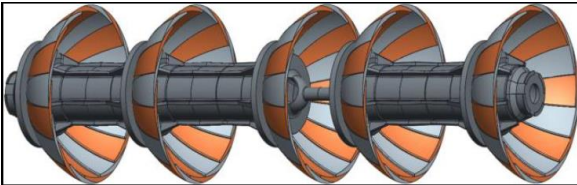
- Requirements vary for each section of the pipeline
 - 16" → Sweep water and remove wax
 - 24" → Sweep water and remove wax
 - 34" → Travel only
- Low flow rates through x4 wye sections which decrease over time...



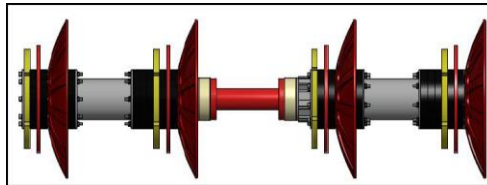
Trial Overview

- Series of trials completed at vendor facility to test multi-diameter prototypes in February and June 2018 (with new trials ongoing)

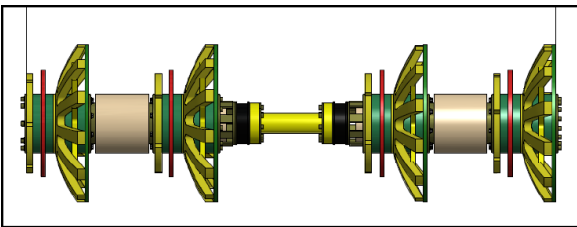
- "Sun" Pig – Prototype 16/24 A



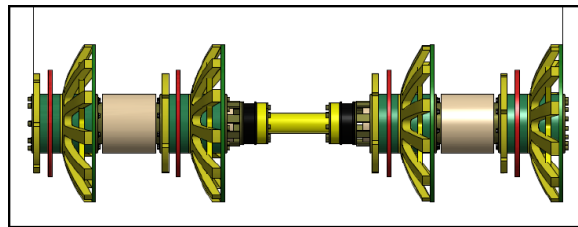
- Metal Body Pig – Prototype 16/24 B



- Titanium Body Pig – Prototype 16/24 C



- Steel Body Pig – Prototype 16/24 D



- Prototype E currently awaiting testing



- Trial Criteria

- Remove wax & water in 16" & 24" sections
- Traverse asymmetrical diameter changes from 16", 24" & 34"
- Traverse wye structures at low flow
- Self travel in 34" sections

Trial Setup

- Trials proved that pigs can travel through 16" and 24" sections
- Key challenge is transiting through the wye pieces... pigs do not seal completely and require very high flow rates



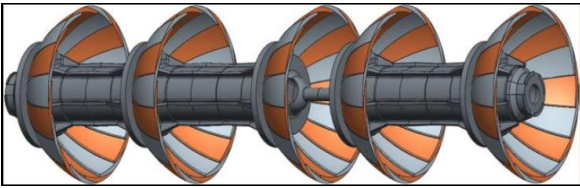
■ Test Cases

- 16", 24" & 34" transitions with wye pieces
- Wax removal
- Buoyancy tests
- Interaction with other 24" and 34" pigs

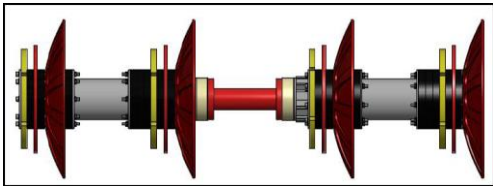
Trial #1 – February 2018

- Prototypes A & B tested... Sun and metal bodied pigs

- Sun Pig – Prototype 16/24 A



- Metal Body Pig – Prototype 16/24 B



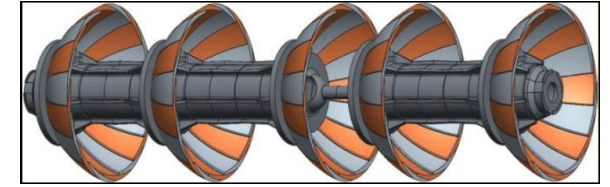
- Different hardness of polyurethane trialled to test wax removal and sealing capabilities (different colour discs)
- Similar performance from both prototypes, though type B slightly more successful hence selected for further development

Prototype A – Sun Pig

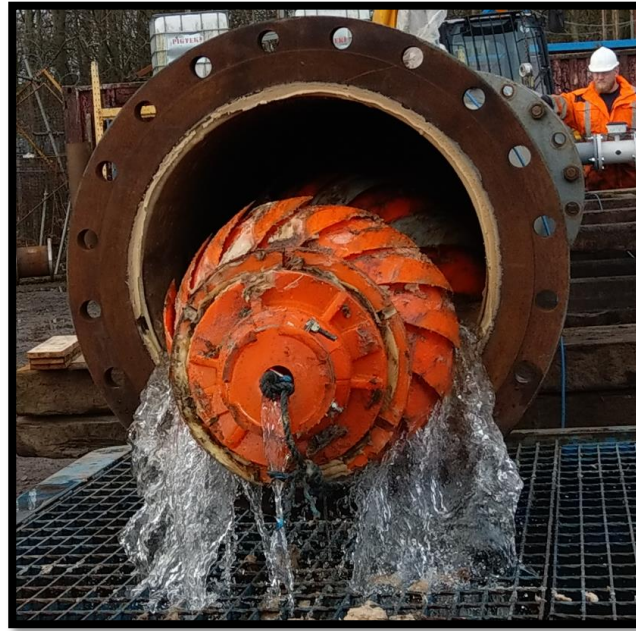
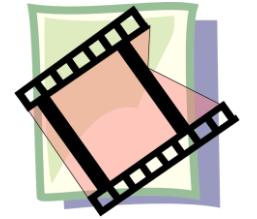
- Able to travel in 16" and 24" sections
 - Successfully removed wax in 16", more limited in 24"
 - Issues with transition from 16" to 24"
 - Large flow rates required to move in 34"



■ Sun Pig – Prototype 16/24 A



■ [VIDEO](#)

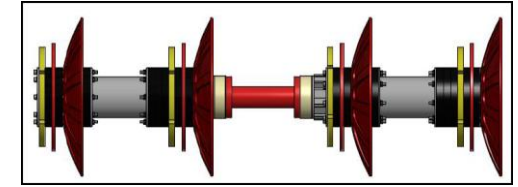


Prototype B – Metal Bodied

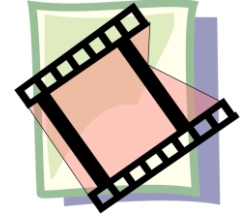
- Similar performance to 'Sun' pig, though slightly better at removing wax in 24"
- Some issues noted with uniform fold away of 24" discs in 16"



■ Metal Body Pig – Prototype 16/24 B



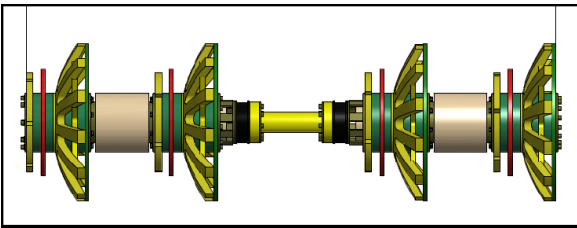
■ [VIDEO](#)



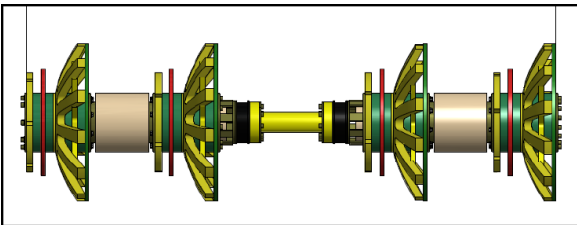
Trial #2 – June 2018

- Prototypes C & D tested... Steel and titanium metal bodied pigs

- Titanium Body Pig – Prototype 16/24 C



- Steel Body Pig – Prototype 16/24 D



- Titanium pig able to self-transit at lower flow rates in 34"



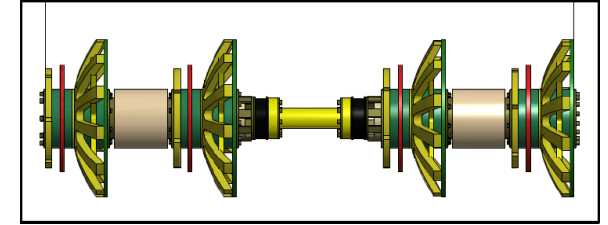
- Finger spacers added to the front of sealing discs to give additional support in 24" and centralise the pig, more uniform folding of 24" sealing discs in 16" section
- Syntactic foam added to try make it neutrally buoyant for self transit in 34" section

Prototype C – Titanium Metal Bodied

- Steel metal bodies replaced with titanium and syntactic foam added
- Fingers good at removing wax in 24" but leaving streaks of wax



■ Titanium Body Pig – Prototype 16/24 C

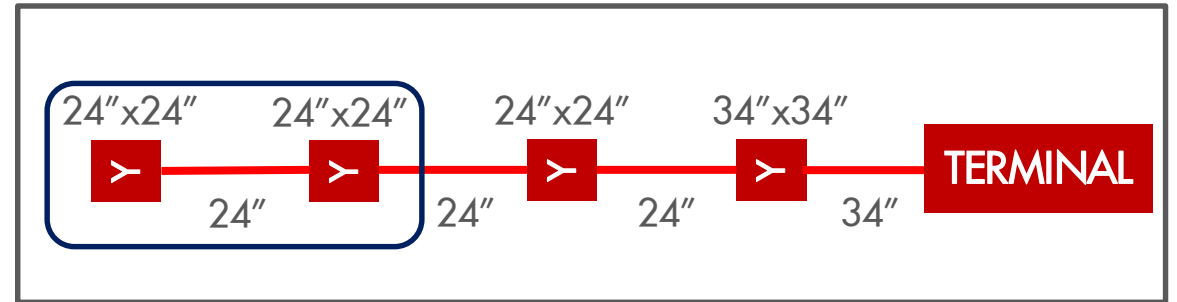
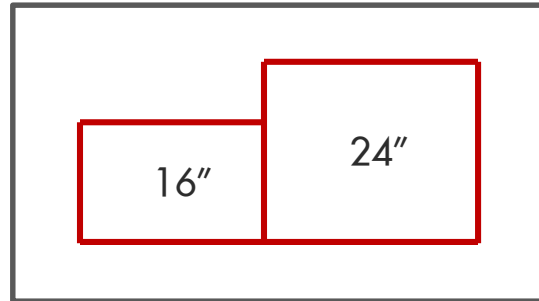
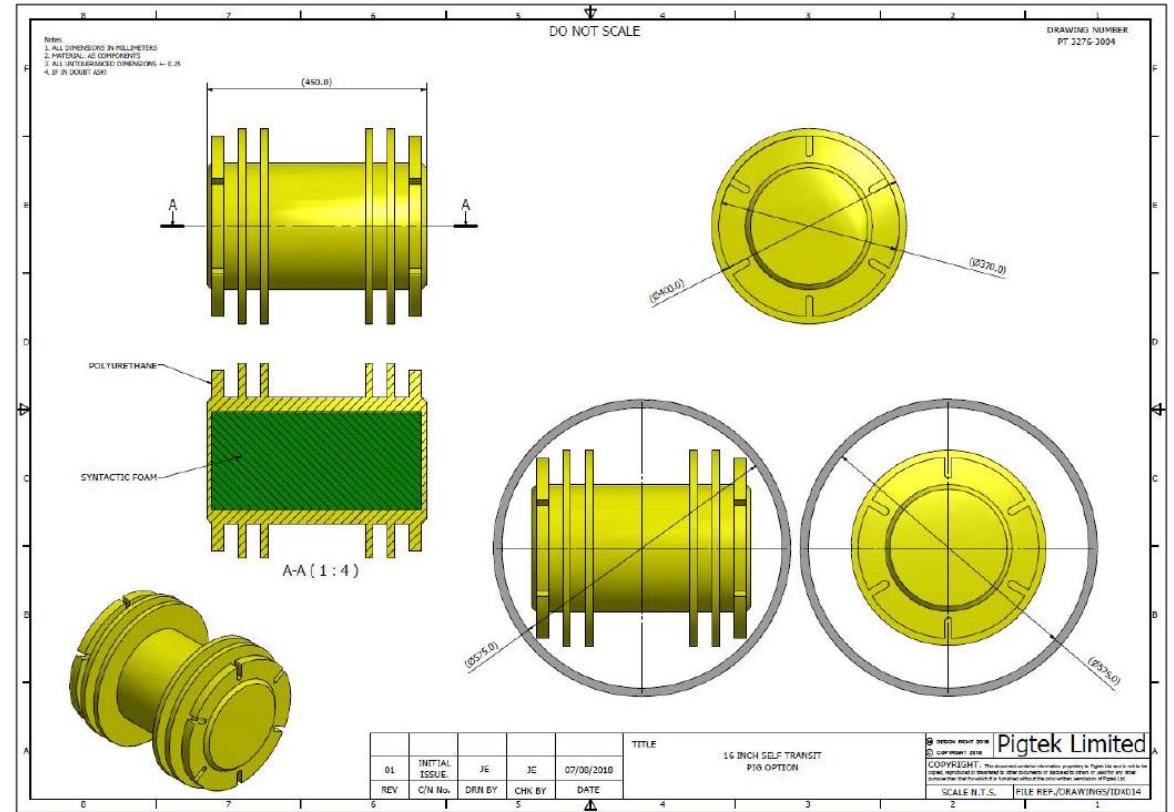


- Prototype D... similar performance but heavier due to steel instead of titanium



Backup Option

- 16" cast PU pig with syntactic foam
 - Wax removal and water sweep in 16" section only
 - Able to self transit in both 24" and 34"
- No water removal from 70m section between two wyes... mitigate with larger corrosion allowance
- Dual diameter foam pig considered to sweep water from 70m section... not viable



Next Steps

- Prototype E currently in development...
 - Investigate replacing PU support components with carbon fibre or composites
 - Trial low drag materials where PU components contact pipe wall
- Trials have identified a suitable design to progress...
Results expected November 2018



Pig design too heavy... high flow rates required

➤

1. Replace all steel components with titanium (bolts, tow arm)
2. Add syntactic foam to PU discs
3. Replace non-wear PU components with syntactic foam

