



THE *Apache* INTELLIGENT PIGGING PROJECT

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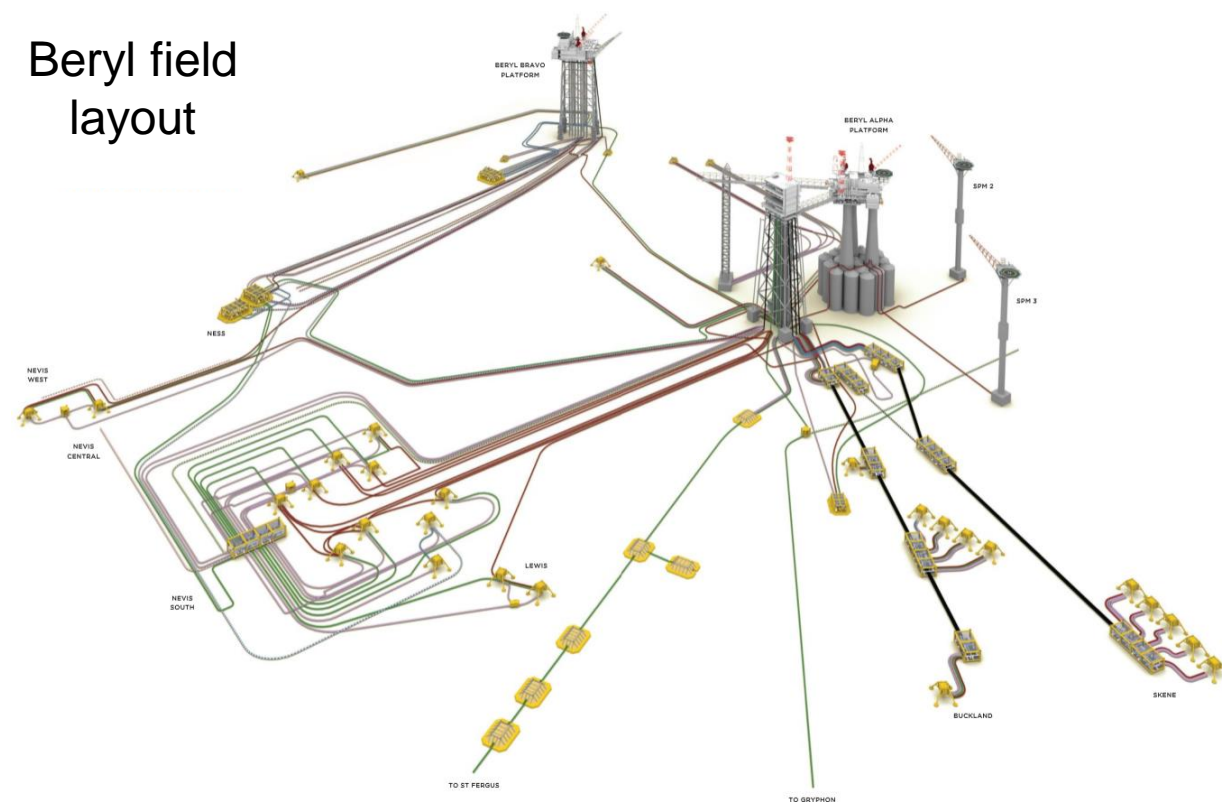
BACKGROUND

- Apache North Sea Limited (ANS) operates the Beryl Field in the Northern North Sea sector of the UKCS.
 - The Beryl field consists of two jacket platforms (Beryl Alpha and Beryl Bravo) as well as various subsea tiebacks.
- Stabilised crude is conveyed from Beryl Bravo to Beryl Alpha via a 20” pipeline.
 - Following previous pipeline integrity and corrosion assessments, ANS recognised the importance for validating the results by way of an ILI (InLine Inspection).
 - Previous ILI attempt using UT technology only partially successful due to excessive wax
- Due to the pipeline configuration and process parameters the pipeline was considered to pose a significant pigging challenge, however ANS were committed to achieving a successful ILI.
 - Through developing a strong working relationship with Rosen as well as the ANS Operations team, the challenges were overcome and a successful ILI was achieved.
 - *This working relationship was instrumental in ensuring the successfulness of the ILI.*

SYSTEM PARAMETERS

Beryl B – Beryl A Offshore Oil line with Wax (PL120) 18/20" x 8.4km	
Diameter	18/20" 20" Line transitions down to 18" at Beryl A riser
ID variation	385mm (measured in 1.5D bend) Beryl A riser 489mm max in Beryl B launcher & riser 473mm is nominal ID Step change between 466m and 489mm
MBR	20" Beryl A riser has 1.5 D bends. Back to back 1.5D in the 408mm (20" 50mm wt Beryl A riser) 3D bends in the 419mm (18" 19mm wt Beryl B riser) Miter bend at Bravo riser (design not available)
Line Length	8.4 km (@0.12 m/s ~ 20 hours run time)
Wall Thicknesses	20" mainline – 17.5mm 20" Beryl B Riser – 9.5mm / 12.5mm / 19.05 mm / 21 mm 20" Beryl A Riser – 50mm 18" Beryl A riser – 19mm
Water Depth	~ 120m

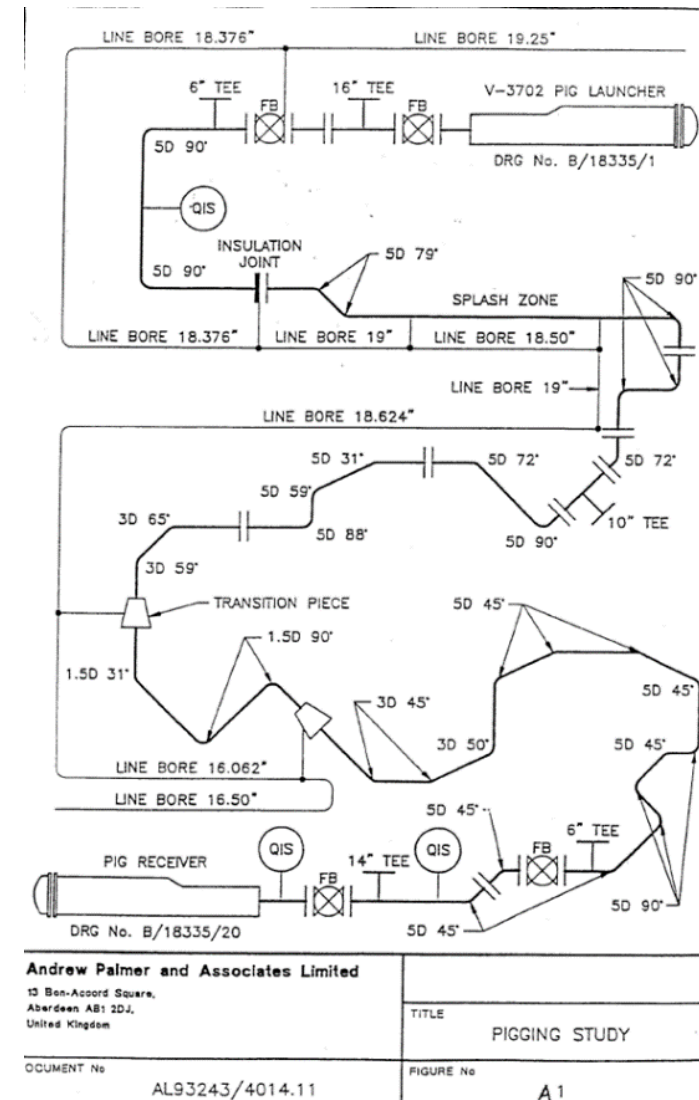
Beryl field layout



CHALLENGES

The Challenges to Inspecting PL120 Can be Summarized As:

- Line is Low Pressure & Low Flow (oil, 13.1 bar, 0.3 m/s)
- Line is known to produce wax and difficult to clean
- Line has complex geometry
 - 1.5D bends, back to back
 - Heavy Wall
 - Short pig receiver with short minor barrel and single isolation
 - Large ID variation (385 – 489 mm)
 - Mitred bend



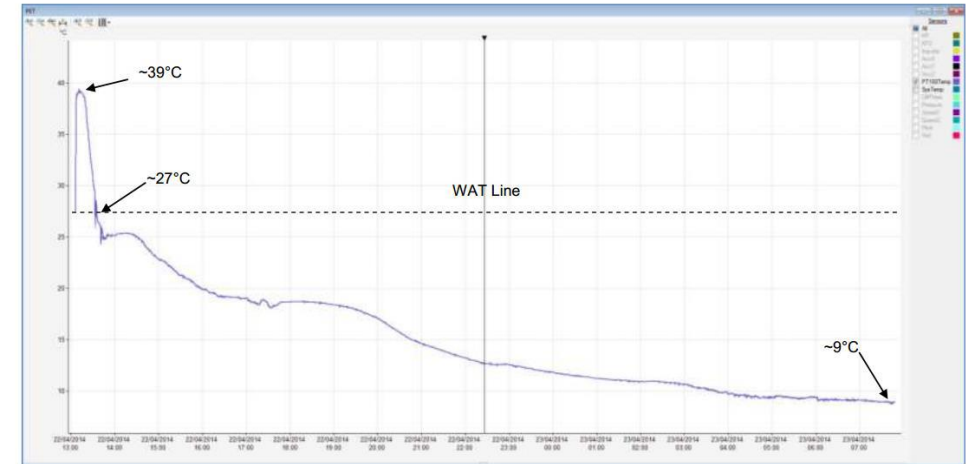
CHALLENGES

WAX

Progressive cleaning currently undertaken

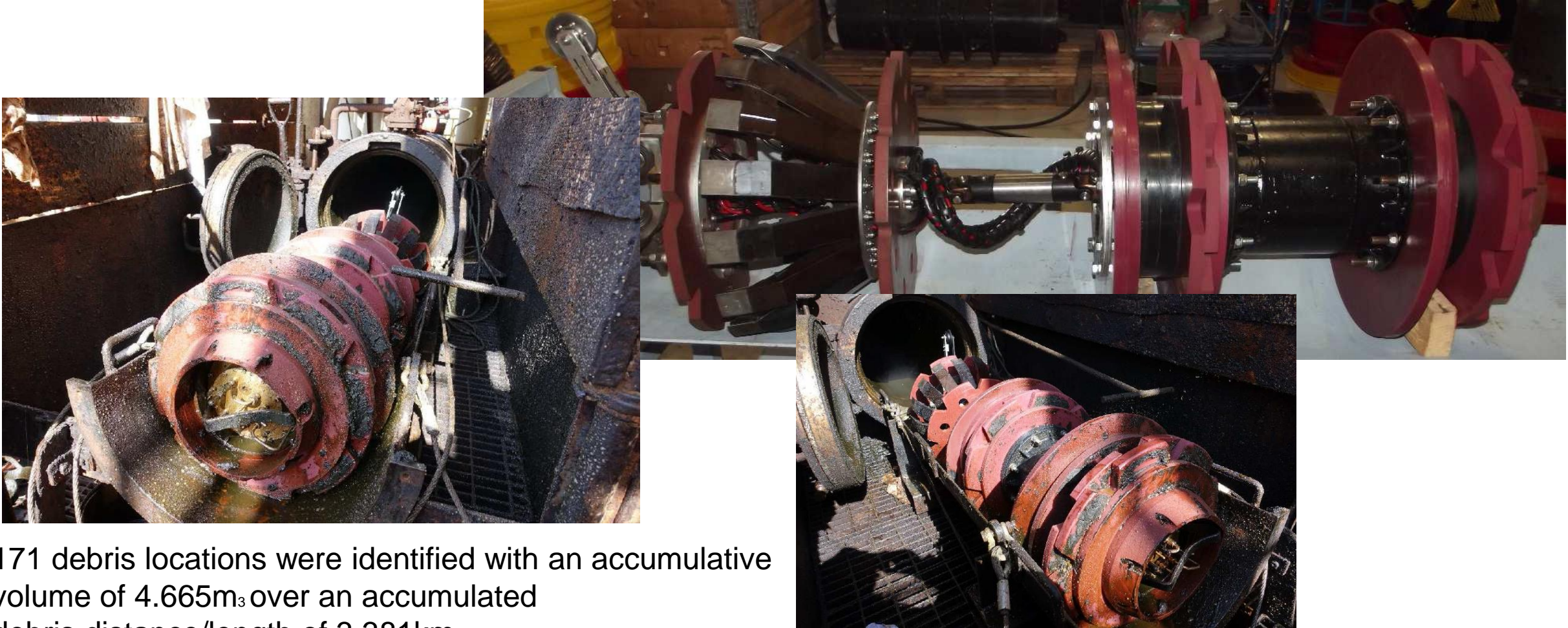
- Weekly metal bodied pig run through line
- 300-600 kg estimated wax returns
- Currently difficult to assess because of Benzene
- Debris Mapping used to track progress
- Low flow and pressure may result in bypass around tool critical in 1.5D bend features.
- MAOP is 13.1 bar

Temperature Profile °C



CHALLENGES

DEBRIS MAPPING TO TRACK CLEANING PROGRESS



171 debris locations were identified with an accumulative volume of 4.665m₃ over an accumulated debris distance/length of 3.381km.

SOLUTIONS

MFL ILI TOOL CONCEPT



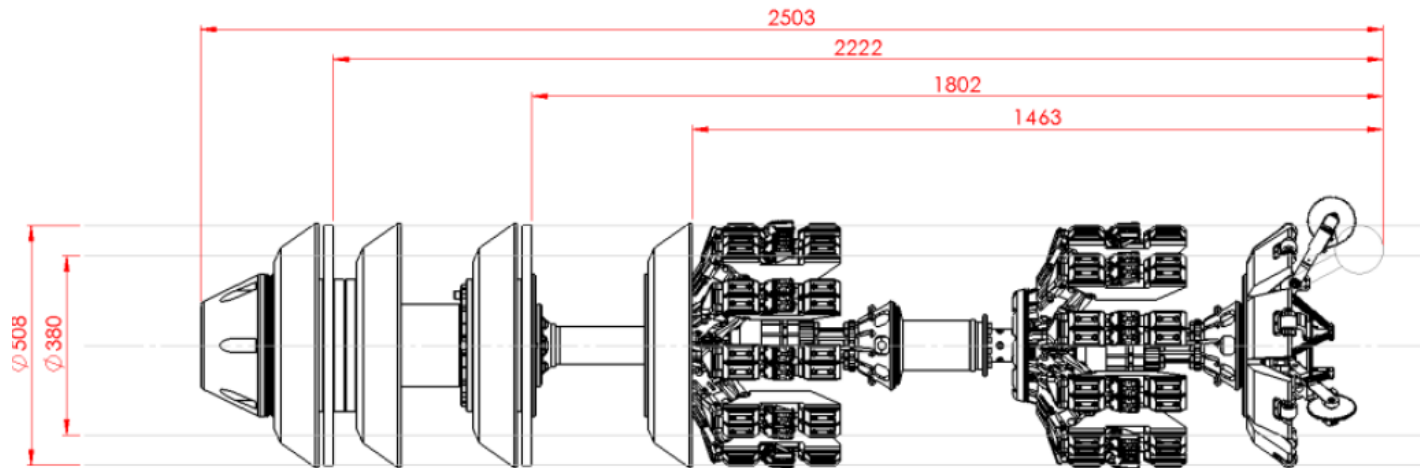
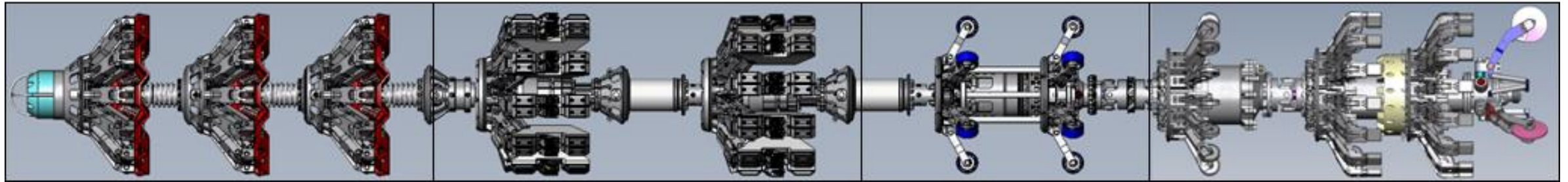
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Pull Unit

MFL-A Unit

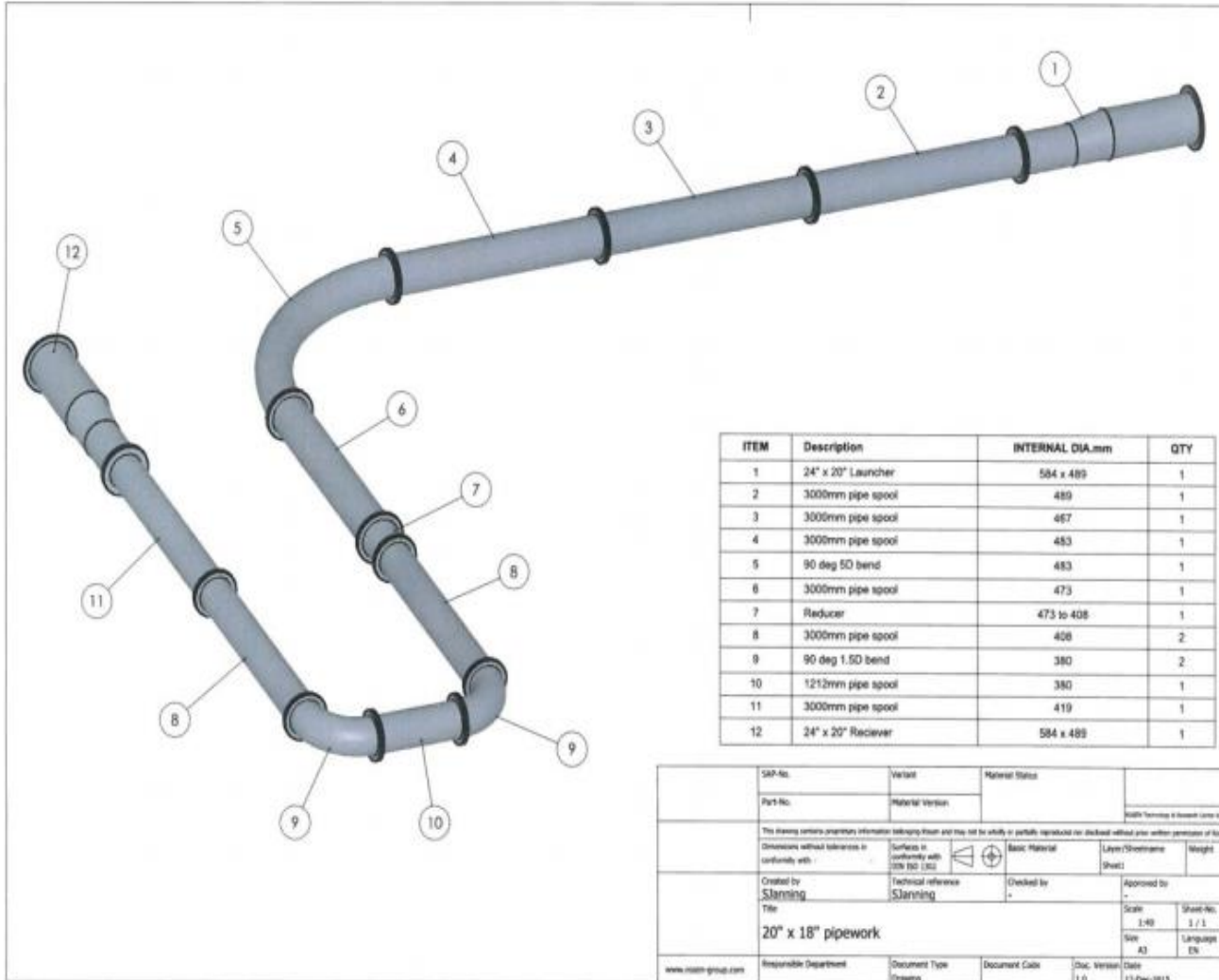
Electronic Unit

Eddy Current/GEO/XYZ Unit



14-20" MuDi MFL – XGP
combo tool used as basis for
ultra compact 16-20" MFL tool

SOLUTION TESTING



Test loop was made available by Apache and modified with 90 deg 1.5D B2B bends with ID 380mm, in order to replicate the geometry of the PL120 pipeline and also following a geometry inspection which indicated an internal diameter of 385mm in the Beryl Alpha 1.5D bends.

The effect of modifying the test loop was to replicate the possible “worst case” scenario of the actual situation in PL120 with 1.5D back to back bends at the Beryl Alpha riser.

SOLUTION

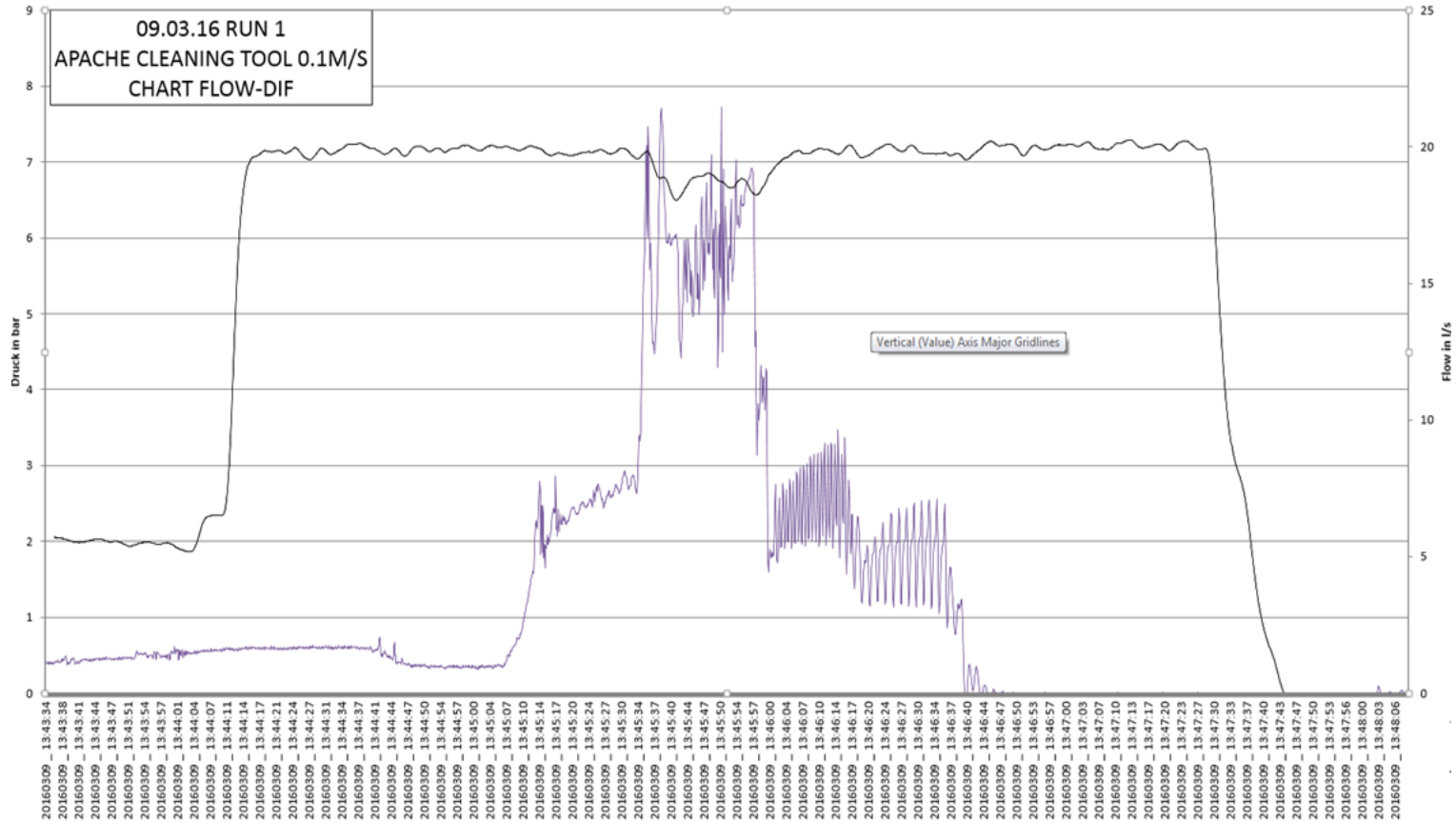
TESTING

Acceptance criteria

1. Passage through 1.5d back to back bends of 380mm ID
2. Tool can be launched with a flowrate of 50 L/s or less (0.3 m/s)
 - Increase in produced export water permitted to provide an increased flow rate up to 0.4 m/s
3. Maximum recorded pressure during the test is less than or equal to 10 bar
 - 75% of pipeline's MAOP and setting that as the maximum pressure the tool needs to pass through the test loop. The remaining 3.1 bar (25% MAOP) allows for contingency during the actual inspection because the condition of the pipeline (wax) is not fully understood.
4. No visible damage to tools or polyurethane after each test
 - Avoid that the sealing will be compromised.
5. A further test criterion was introduced that the MFL tool should drive fully into the receive cassette designed for the project.

SOLUTIONS

CLEANING TOOL WITH DATA LOGGER



Tool with Pipeline Data Logger used as bench mark for DP

SOLUTION

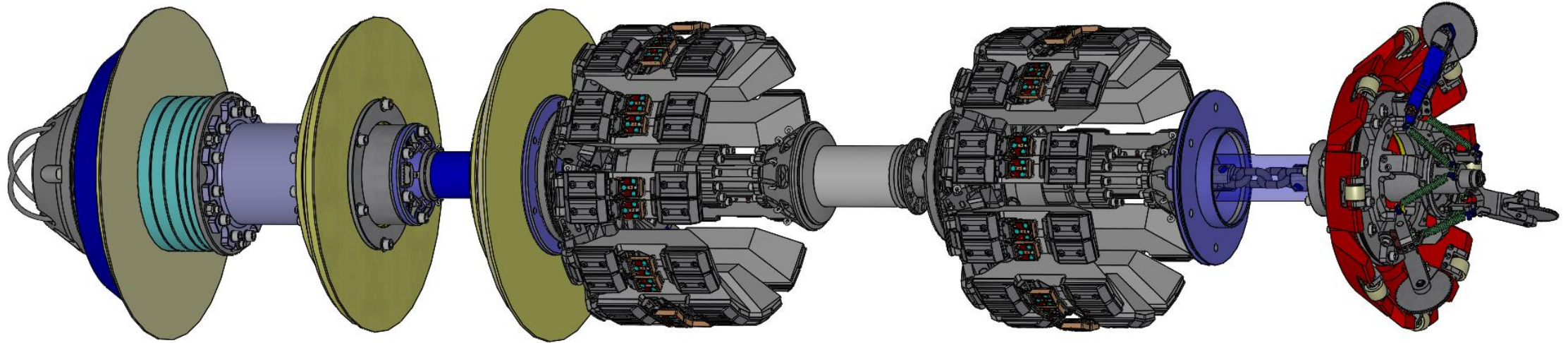
PUMP TESTING



Extensive testing performed (>70 pump tests) through iterative process to identify optimum set-up of seals as well as for the magnetizer.

SOLUTIONS

MFL ILI TOOL CONCEPT



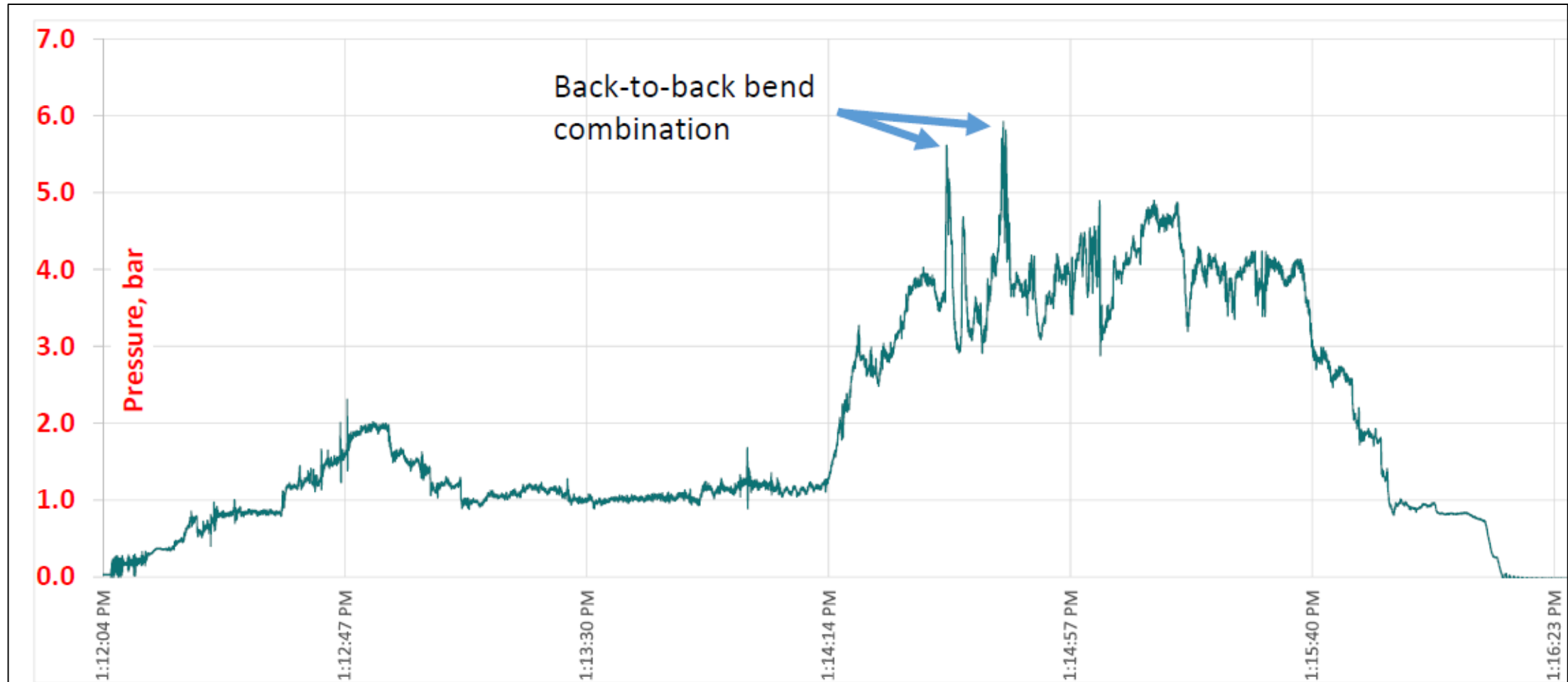
Pull unit

- Type of sealing: cups, slotted guiding discs, sealing discs
- Position, diameter and thickness of the sealing elements
- Hardness

Magnetizer

- Split magnet units
- Magnet strength
- Yoke design

FINAL ACCEPTANCE TEST DP TEST RESULTS



RESULTS



Launch date: 11th Feb 2018
Debris: Approx 50 kg of wax came off the tool

Traveling time: 11 hours 21 minutes
primary channel loss: 0.03%



**THANK YOU FOR JOINING
THIS PRESENTATION.**
