THE Apache INTELLIGENT PIGGING PROJECT

Ed Bartlett, Apache & Tom Steinvoorte, ROSEN · PPSA Aberdeen · 07-11-2018
CONTENT

• Background
• System parameters
• Pigging challenges
• Solutions
• FAT
• Results
• Conclusion
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 successfullness of the ILI.
**SYSTEM PARAMETERS**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Beryl B – Beryl A Offshore Oil line with Wax (PL120) 18/20” x 8.4km</strong></td>
<td></td>
</tr>
<tr>
<td>Diameter</td>
<td>18/20”  20” Line transitions down to 18” at Beryl A riser</td>
</tr>
<tr>
<td>ID variation</td>
<td>385mm (measured in 1.5D bend) Beryl A riser  489mm max in Beryl B launcher &amp; riser  473mm is nominal ID  Step change between 466m and 489mm</td>
</tr>
<tr>
<td>MBR</td>
<td>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)</td>
</tr>
<tr>
<td>Line Length</td>
<td>8.4 km  (@0.12 m/s ~ 20 hours run time)</td>
</tr>
<tr>
<td>Wall Thicknesses</td>
<td>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</td>
</tr>
<tr>
<td>Water Depth</td>
<td>~ 120m</td>
</tr>
</tbody>
</table>
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
171 debris locations were identified with an accumulative volume of 4.665 m$^3$ over an accumulated debris distance/length of 3.381 km.
SOLUTIONS
MFL ILI TOOL CONCEPT

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
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.
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.
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
RESULTS

Launch date: 11\textsuperscript{th} 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.