Challenging Inspections of Offshore Pipelines by Intelligent Pig

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Introduction

Shell UK have completed many pipeline inspections as part of their ongoing Pipeline Integrity Management System (PIMS).

A number of these can be considered routine, but many can be considered as falling into the category “Difficult to Pig”, the focus of this presentation.

- The “Pipeline Integrity Project (PIP)” was formed to bring together a team to execute a number of these pipelines that had Inspection Due Dates (IDD) falling in close succession, all of which needed an element of subsea intervention.

- Alongside the PIP, the Asset Pipeline Engineers also have their pipelines to focus upon and one major trunk pipeline brought its own unique challenges.
PIP Basis for Inspection

Shell use a Risked Based Inspection (RBI) process to generate an appropriate Inspection Due Date. Over the span of the PIP, 10 individual pipelines have been considered with IDDs covering a few years. The final result was the inspection of 6 of these pipelines.

Givens:
- Quality inspection data delivered without harm to people or the environment.
- System to be left in the same condition as found ready for flawless start up by the Asset
PIP Workscape

The pipelines that were inspected by the PIP were:

Bittern, 2 x 10”, 1 x 8”, 22km. Subsea to Subsea

Howe, 8”, PiP, 14km. Subsea to Subsea

Penguins, to follow…….
Penguins to Brent C Field Layout

**Penguins Data**

<table>
<thead>
<tr>
<th>Property</th>
<th>DC2-DC3</th>
<th>DC3-DC4</th>
<th>DC4-DC5</th>
<th>DC5-BRENT C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Diameter</td>
<td>10”</td>
<td>16”</td>
<td>16”</td>
<td>16”</td>
</tr>
<tr>
<td>Length</td>
<td>3.6</td>
<td>5.7</td>
<td>4.8</td>
<td>52.1</td>
</tr>
<tr>
<td>Service</td>
<td>Multiphase Oil</td>
<td></td>
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</tbody>
</table>
**Inspection Philosophy**

- Integrated Project with the Asset and Project Team.
- Utilise the previous vendors and USC team for continuity.
- Maximum Debris Assessment, Corrosion Products, sand & wax.
- Wax deposition modelling.
- Tool selection for best data.
- Progressive pigging.
- Re-start pre-commissioning.
- Incorporate previous lessons learned from Bittern and Howe.
- Wet store campaign in 2015 to assisting in the proposed winter pigging campaign w.r.t over boarding in swell limitations.
- Upfront testing of Brent C receiver for ops.
- Load receiving cassette.
- Execution delayed to align with TAR & reduce deferment.
Tool Technology Selection

- Quality data was the primary objective for the PIP.
- Evaluate all primary inspection technologies, UT, MFL, SIC, DMR.
- UT – Best Primary technology but requires high levels of cleanliness.
- MFL – Acceptable technology, influence by pipe in pipe, heavy wall thickness.
- SIC – only good for internal corrosion defects. Secondary technique.
- DMR – Secondary technology for internal wall information only.
- Shell Framework agreement options were:
  - UT – MFL – SIC – Combo.
- UT-MFL combo selected to give the best chance of quality data in a single run.
Isolation and Construction

- Verified SSIV open and closing
- Isolate and test all 4 drill centres
- Significant topside package for debris handling
- Installation of spoolpieces
- Installation of signallers
  - Mechanical & magnetic
De-oiling and Cleaning

- De-oil 10" into 16" using 10" pathfinder pigs
- De-oil 16" to Brent C process using gel pigs
- Switch to temporary debris handling package
- Run debris pick up gel
- Load chemical soak train
- Clean 10" & Inspect 10"
- Run 16" pathfinders
- Clean 16" & Inspect 16"
10” & 16” Inspection

- Driven in accordance with specification from pumping spread on DSV.
- 10” ILI found stalled just prior to receiver in the tie-in spools (EM Pinger).
- Re-connect, increased pumping rates to max out pumps and cycle.
- Notable spike in pressure indicated home.
- Pig trash – very small quantity.
  - Corrosion flakes & steel swarf.
- 16” stalled in the topside just prior to the receiver, again pumped home.
- Successful data was collected by both tools, validated on board the DSV and platform by the ILI Field Engineer.
De-watering & Restart

- 10” dewatering completed with MEG/Water mix supplied from the DSV.
- 16” dewatering completed with a pig train left in pipeline.
- Platform successfully re-started the Penguins Field following completion of the turnaround.
Inspection Results

Both 16” & 10” Pipelines in excellent conditions with no internal corrosion. There were a number of mill anomalies, weld anomalies and laminations.

Previous inspections from the PIP on the other pipelines had revealed both pipelines in pristine condition and those that were in a worse condition with many defects of differing corrosion types.

No pipeline was exactly in the condition predicted.

FIND WHAT YOU INSPECT NOT WHAT YOU EXPECT!
Lessons Learned – Examples

- Swapped out Flange connection to ROV destec connection on the 16” PLR, HSE and schedule advantages.
- Even the latest 4G communication system may have comms problems, back ups worked.
- Awareness of platform personnel operation roles (they have a day job as well).
- FAT/SIT including loading/unloading, pumping, signalling may prove very useful as much of this equipment is still not 100% reliable or compatible.
- Industrial action, weather, flight delays, cranes etc. can all trip you up.
- DSV held IRM work incase of platform based delays.
- Planning flexibility – worked with TAR, Flotel, Rig activation, P&L campaign.
- Use all steps to gain data on pipeline condition, visual, equipment gauges, historical databooks, the more knowledge you have, the better armed you are
The Pipeline Integrity Project successfully completed 3 inspection campaigns, safely, on time and on budget.

Looking back over 5 years of work, we had an initial plan to do on a campaign style over two years, doing one pipeline after another. Even with the dedicated multi-discipline team the subsea aspects of the scope deem this impossible without a significantly larger team. Never be afraid to take a step back and re-evaluate to ensure you deliver the promises you make.

The additional complexity of including a subsea launch or receive aspect should not be underestimated.

Need to be supported from the top down and bottom up, ONE TEAM.

Early heads up and engagement with any Partners is essential.

Although inspecting these pipelines is difficult and expensive, it was considerably cheaper than replacement.
FLAGS IP – Summary

Ram Subramanian
Pipeline Engineer
Key system parameters

- St Fergus to HTT: 1.5 - 4 m/s
  - Transit time: 48 hrs

- HTT to Barred Tee: 0.27 - 0.28 m/s
  - Transit time: ~1.2 hrs

- Brent B to Barred Tee: 0.05 - 0.07 m/s
  - Transit time: 16 - 18 hrs

- VASP to Barred Tee: ~3.2 km

- Barred Tee to HTT: ~1.2 km

- HTT to St Fergus: ~449 km

- Width of Barred Tee: 24"x36"
Key system parameters

Challenges:

• Low flow from Brent Bravo to Brent Alpha Tee ~ 5 cm/s - Never been pigged at such low flow
• VASP (clapper valve) – has been pigged previously
• Hot Tap Tee negotiation + high side flow – Never been pigged
• MFL pig velocity to be below 4 m/s specification

Strategy:

• 4 x sealing capacity vs normal pig
• Bespoke design – specially designed PU nose
• Reduced flow through HTT for safe passage of pig
• Maintain landing pressure at St. Fergus to ensure pipeline in single phase (gas)
Conclusion

- The IP Project was successfully completed.
- Planning key to get it right first time!!
- Technical solutions comprehensively tested with adequate FoS (test medium – water)
- Early engagement with stakeholders, especially for the reduction of flow through HTT.