Pre-Inspection Cleaning of “Unpiggable” Subsea Operational Pipelines

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Safety Moment: Management of Change

- Hotel walkway collapse, July 1981
  - Elevated walkways collapsed in a hotel atrium during a tea dance
  - 114 People killed
  - 216 People injured
Safety Moment: Management of Change

- Design changed during construction
- Change not risk assessed
- Change not communicated
- Resulted in disaster
Pre-Inspection Cleaning of “Unpiggable” Subsea Operational Pipelines
Project Overview

▪ Ultimate requirement to perform in-line inspection (ILI) on subsea lines

▪ Which meant a requirement for pre-inspection cleaning

▪ Which meant a requirement to retrofit pig launch/receive capability

▪ Which meant a requirement to clean/flush lines to allow for intervention
Field Layout: Field 1

Floating production storage and offloading (FPSO)

Wells

10 in. × 22 km

10 in. × 22 km

8 in. × 22 km
Field Layout: Field 2

Platform

Subsea Tree

8 in. × 14.5 km

Field Layout: Field 3
Challenges

- Subsea lines not designed for pigging operations
- Subsea lines in operation
  - Requirement for minimal interruption to production
- Internal line conditions unknown
  - Crude, produced water, possible H₂S, corrosion products, scale, wax, sand
- No two fields alike
  - Configuration, production profile, end conditions
- Operational planning – the right pigs in the subsea traps at the right time
- Process constraints – handling and processing of received fluids
Challenges: Project Structure

- Requirement to tailor solutions

- Multiple parties involved
  - Ultimate client
  - Field partners
  - Subsea construction company
  - Pigging and testing contractor
  - ILI Contractor
  - Regulatory authorities
  - Cleaning/disposal contractors

Need for 3 C’s.

Communication, Collaboration, Common Goal
Solution: Simple Terms

1. Make fields piggable
   - Clean/flush pipelines with solvents without using solid pigs
   - Retrofit pig launch and receive facilities

2. Clean pipelines and measure cleanliness
   - Conventional pigging
   - Flushing

3. Perform ILI runs

4. Remove pigging facilities and reinstate systems
Field 1

Floating production storage and offloading (FPSO)

Wells

10 in. × 22 km

10 in. × 22 km

8 in. × 22 km
Solution: Field 1

- FPSO water injection system used to flush lines
  - Two loops — 10 and 8/10 in.
- Flowlines disconnected from risers at FPSO and temporary wye and spools fitted
- Temporary pig traps fitted to allow flowline cleaning
  - Pumping conducted from dive support vessel (DSV)
  - Pumping carried out in a closed loop
    » Cleaned/Processed on DSV and reinjected to minimise waste
Solution: Field 1, 10 inch Loop

- Caliper foam pig run
- Progressively aggressive pigs run through line
- Gauge pig/proving pig run through line
- ILI performed
Solution: Field 1, 8 inch/10 inch Loop

- Progressively aggressive pigs run through line
- Gauge pig/proving pig run through line
- ILI performed
- System reinstated
Field 2

- No topsides Pig Launcher/Receiver
- Undersize Riser – 6”
Solution: Field 2

- Operations conducted from Dive Support Vessel
  - Wax dissolver pumped into line
  - Crosslinked gel used to batch debris pickup gel
  - Line flushed with treated seawater (120%)

- After DPG train was run, more than 3.5 tonnes of sand was recovered from the production separator
Solution: Field 2

- Post Flush
  - Riser disconnected
  - Pig traps fitted
  - Pig receiver outlet routed to riser
  - Returns handled on platform
Solution: Field 2

- Two caliper foam pigs — run as a train
  - High ppm oil in water measured so 120% line volume flush conducted
- Mechanical pig train run with small amounts of debris received

- 120% Line volume flush
Solution: Field 2

- Second mechanical pig train run with little debris recovered and pigs in good condition

- ILI tool run

- System reinstated
  - Pig traps removed
  - Riser re-connected
  - Well re-connected
Field 3
Solution: Field 3

- 10-in. Line de-oiled using 2 X foam caliper pigs separated by 100 linear metres (LM) of monoethylene glycol (MEG)

- Propelled with 110% line volume of chemically treated water

- Line product diverted into 16-in. flowline

- 10-in. Subsea pig traps fitted
Solution: Field 3
Solution: Field 3

- 16-in. Line de-oiled with the following train

- Solid gel pigs used
- MEG used as an interface between seawater and hydrocarbons
- Chemical cleaning train then run with 105% line volume of treated seawater
Solution: Field 3

- 16-in. Line chemical soak

- Gel cross linked on the fly to batch wax dissolver
- Dissolver train parked approx. 25km from launch end to allow soak on advice of client production chemists
- Soak held for approx. 96 hrs whilst pigging 10” line was ongoing
- 16-in. Pig Launcher fitted
Solution: Field 3

- 10-in. Line — progressive pigging performed
  - Pigs run in ones and twos
- 10-in. ILI run conducted

- 16-in. Line — 2 X foam caliper pigs run
- 16-in. Progressive pigging performed
- 16-in. ILI run conducted

- Systems reinstated

Note: Fluids received topsides were processed via temporary spread before being injected into platform storage cells
Benefits

- Increased production throughput — post-cleaning
- ILI data received and used to confirm flowline integrity
- ILI data used to increase field life/change of use
- Proof of concept for other lines
Summary

▪ Use of gels, chemical applications, and system flushing can allow for line cleaning to acceptable limits to allow subsea intervention to be performed without the need for solid pigs.

▪ Retrofitting of pig launch and receive equipment can then facilitate progressive pigging to remove solids and adhered debris to allow ILI to be performed.

▪ Early collaboration among all relevant parties allow the best fit-for-purpose methodologies to be devised.

▪ Ability to react to operational findings is crucial because of unknown variables.

▪ In certain circumstances and with the right planning, the “unpiggable” can become piggable.
THANK YOU