

MICEDD

DEEPWATER DEVELOPMENT

28 - 30 March 2023 | Millennium Gloucester Hotel | London, UK

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Quest Offshore

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**Addressing Production and Flow Assurance
Challenges with world first In-Riser Velocity
String installation on a deepwater
production facility**

Ryan Sangster

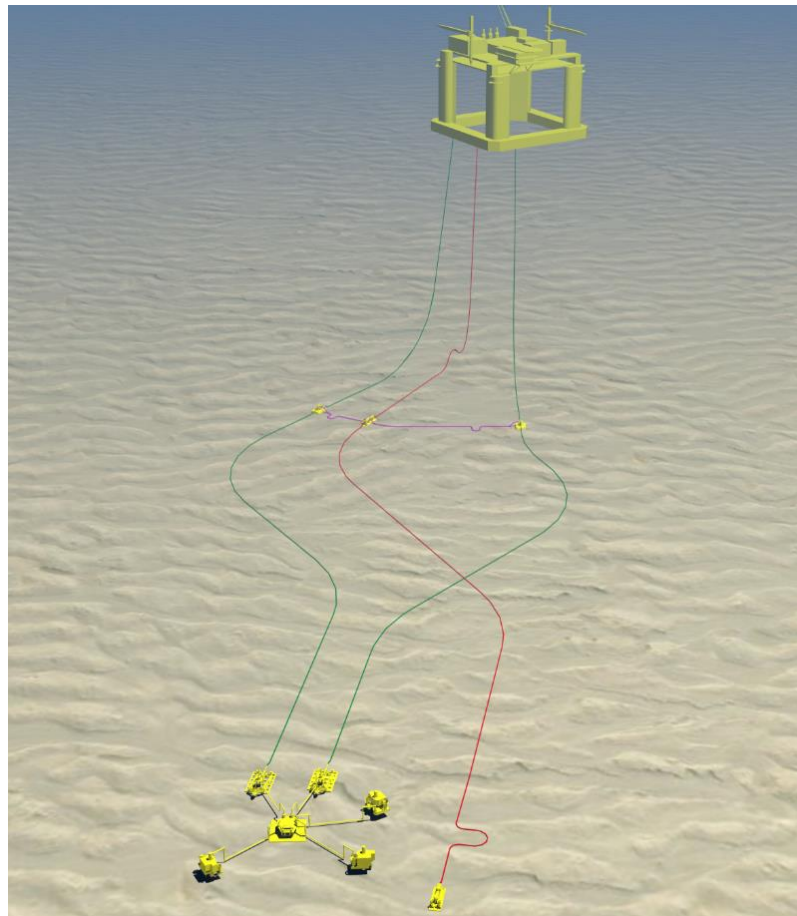
Managing Director

Paradigm Flow Services

Overview

1. **Field Overview**
2. **Challenges of an aging tie-back**
3. **Velocity string solution and advantages**
4. **Overview of Flexi-Coil**
5. **Offshore installation plan**
6. **Offshore installation execution**
7. **Main lessons learned**
8. **Conclusions**

Field Overview



- Deepwater 4-well subsea tie-back in the Gulf of Mexico
- Dual Flowlines
- Approximately 30 km step-out
- 5,800m water depth
- 7" Catenary Riser hung on pontoon of FPS

Challenges of an aging tieback

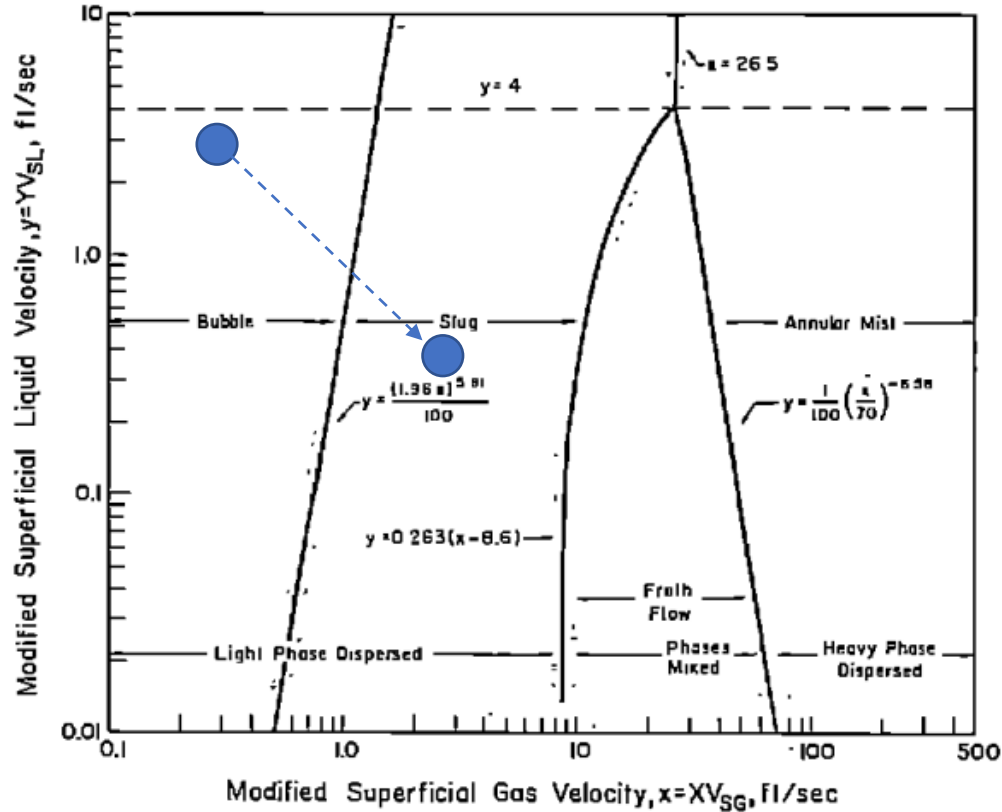
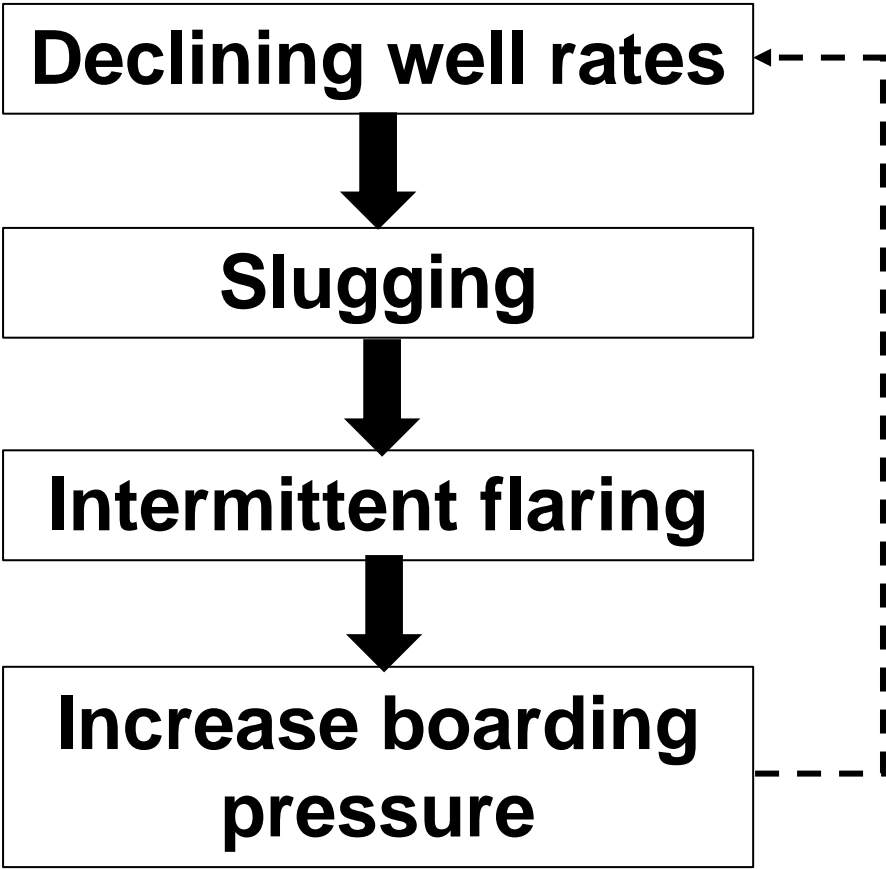


FIGURE 2 — Generalized flow pattern map for flow of gas-liquid mixtures.

Aziz & Govier, JCPT vol 11, no 3, 1972



Future Focused Solution

Project Requirements:

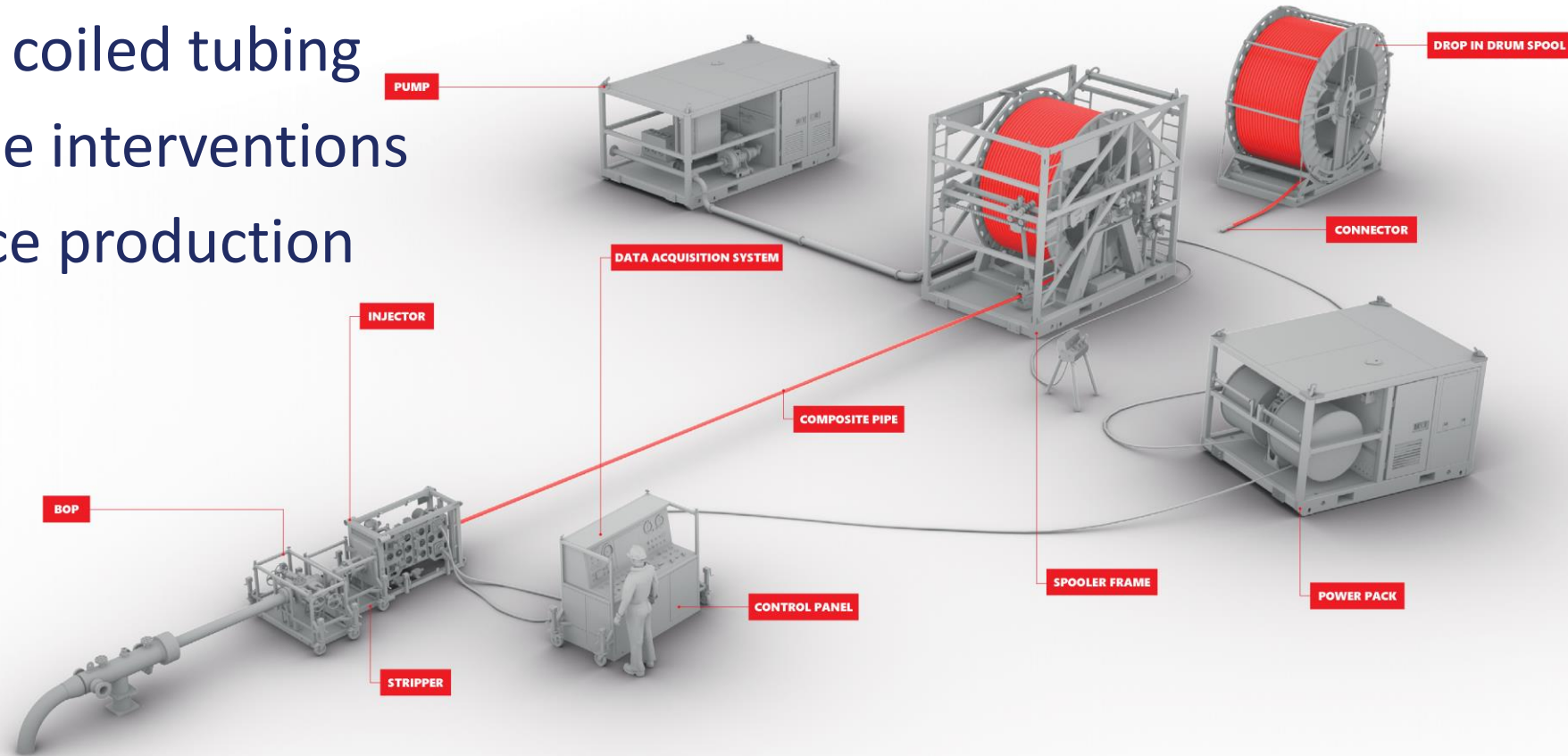
- Decrease slugging severity and increase production
- Leadtime and Installation <12 months
- Additional Weight <6,000 kg
- Small installation and permanent footprint

Options Considered:

- Smart Choke Valve ❌
- Riser Based Gas Lift ❌
- Subsea Pump ❌
- In-riser Gas Lift ❌
- In-riser Velocity String ✓

Overview of Flexi-Coil

- Miniaturized, flexible coiled tubing
- Complex riser-flowline interventions
- Re-establish / enhance production
- Improve oil recovery



PARADIGM

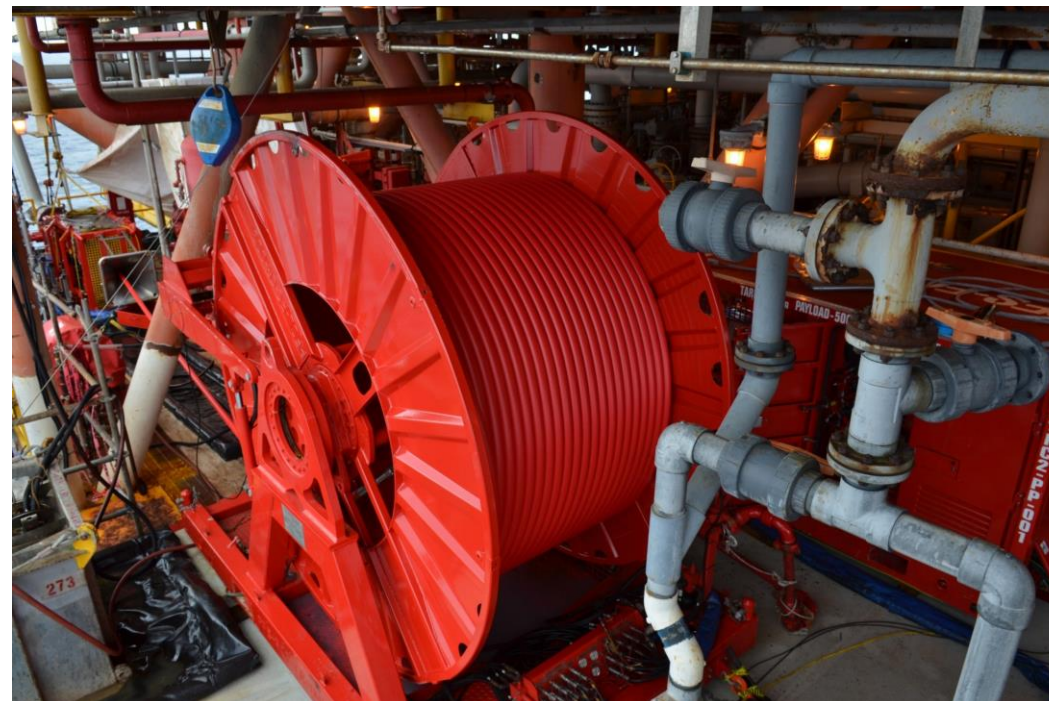
Overview of Flexi-Coil



Flexi-Coil Equipment Spread

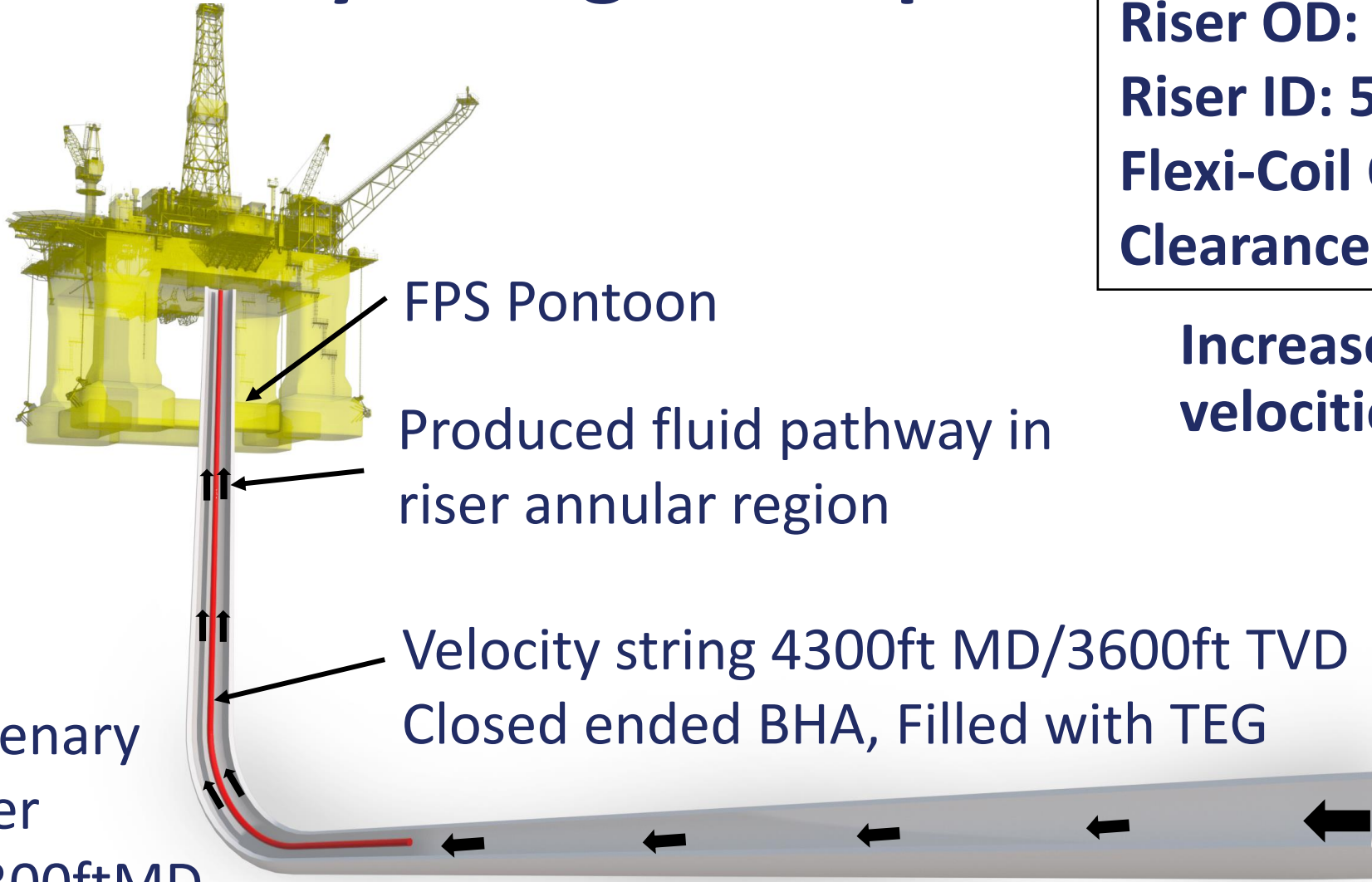
Overview of Flexi-Coil

- Direct vertical access not required for installation
- Compact topside equipment laydown requirements



Velocity String Concept

Riser OD: 7inch
Riser ID: 5.231inch
Flexi-Coil OD: 2.375inch
Clearance (annular): 1.428 inch



FPS Pontoon

Produced fluid pathway in riser annular region

Velocity string 4300ft MD/3600ft TVD
Closed ended BHA, Filled with TEG

Catenary Riser
~5300ftMD

Increased superficial liquid velocities in annular region

Produced fluids from wells

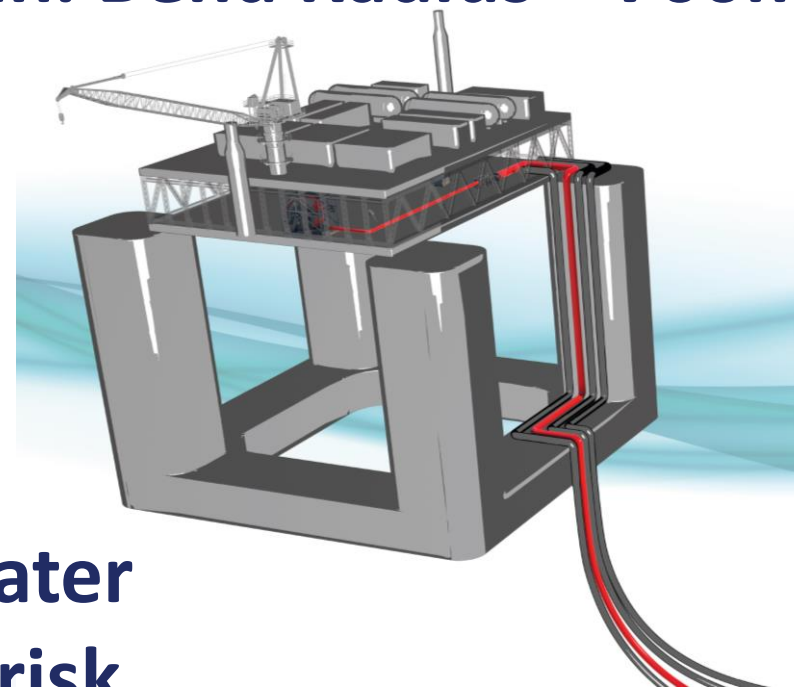
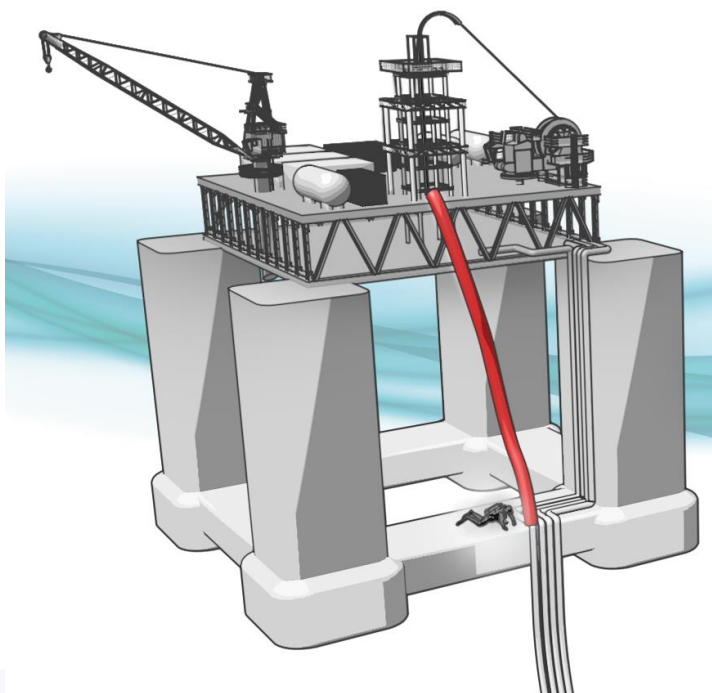
**Assuming current boarding pressure ~1000psi*

Challenging FPS Geometry

Conventional steel coiled tubing set up for in riser intervention

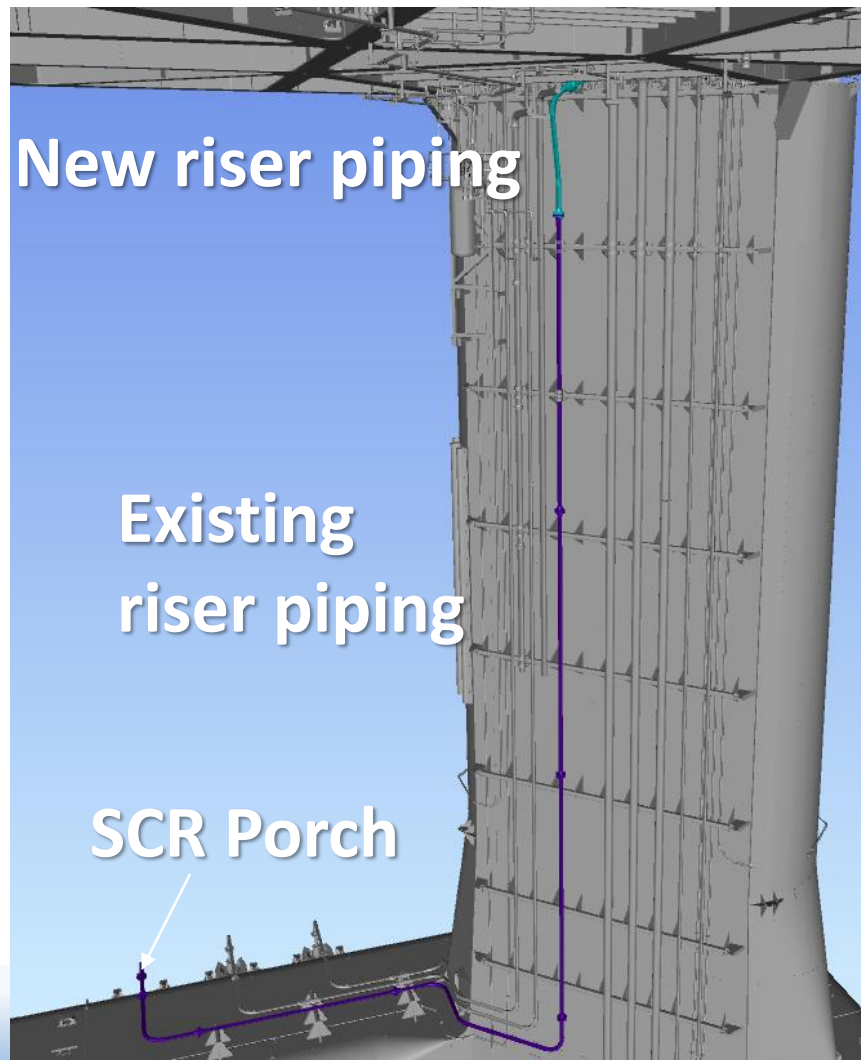
Miniaturized flexible coiled tubing system (Flexi-Coil)

Min. Bend Radius = 700mm



Eliminate underwater construction HSE risk

Offshore Installation Plan



**Coiled tubing hanger
523deg of bends
Smallest Radius: 809mm**

- 1. Pig subsea loop**
- 2. Seawater flush**
- 3. Pipework Modifications**
- 4. Install new surface piping**
- 5. Install Flexi-Coil**
- 6. Leak test**
- 7. De-water loop**

Pig Subsea Loop / Seawater Flush



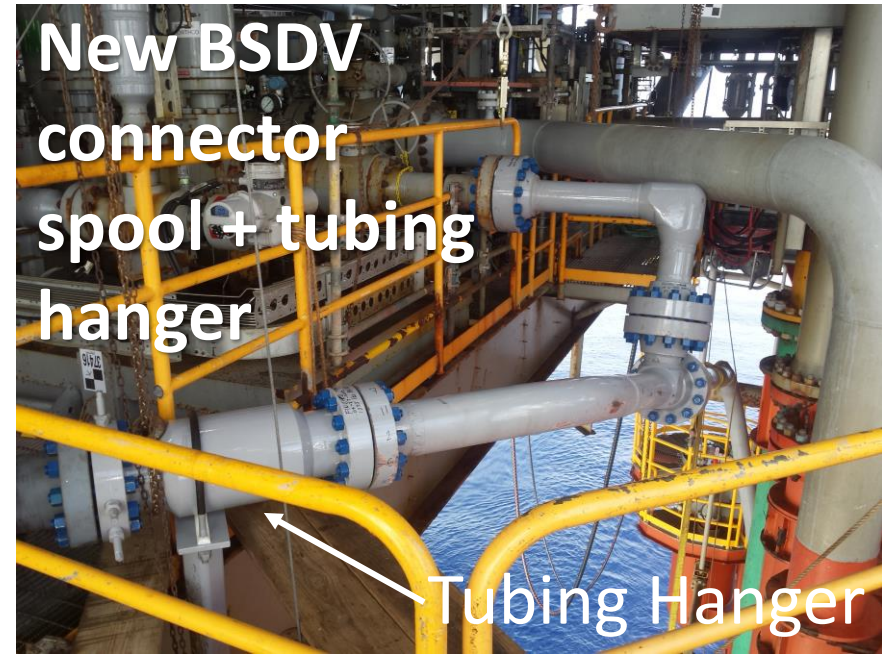
✓ Seawater flush cleaned up water to <28ppm O&G in 2x displacement

✓ Much less deposit than expected

Piping Modifications



Old BSDV connector spool



New BSDV connector spool + tubing hanger

Tubing Hanger

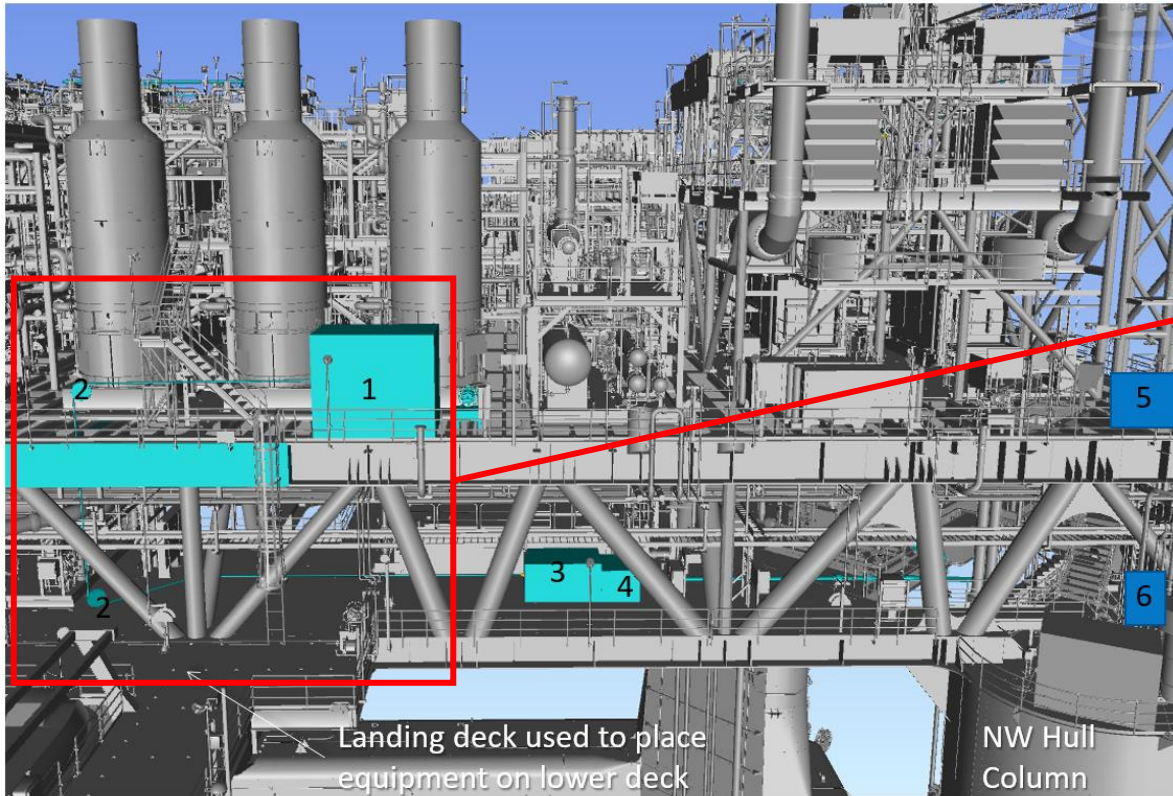


Over open water scaffolding and crane assisted installation with no incidents



Lack of laser scan of original install delayed onshore fab 3 weeks

Install Flexi-Coil Velocity String



1 – Coiled Tubing Hose Reel

2 – Roller Sheave

3 – Injector

4 – Stripper

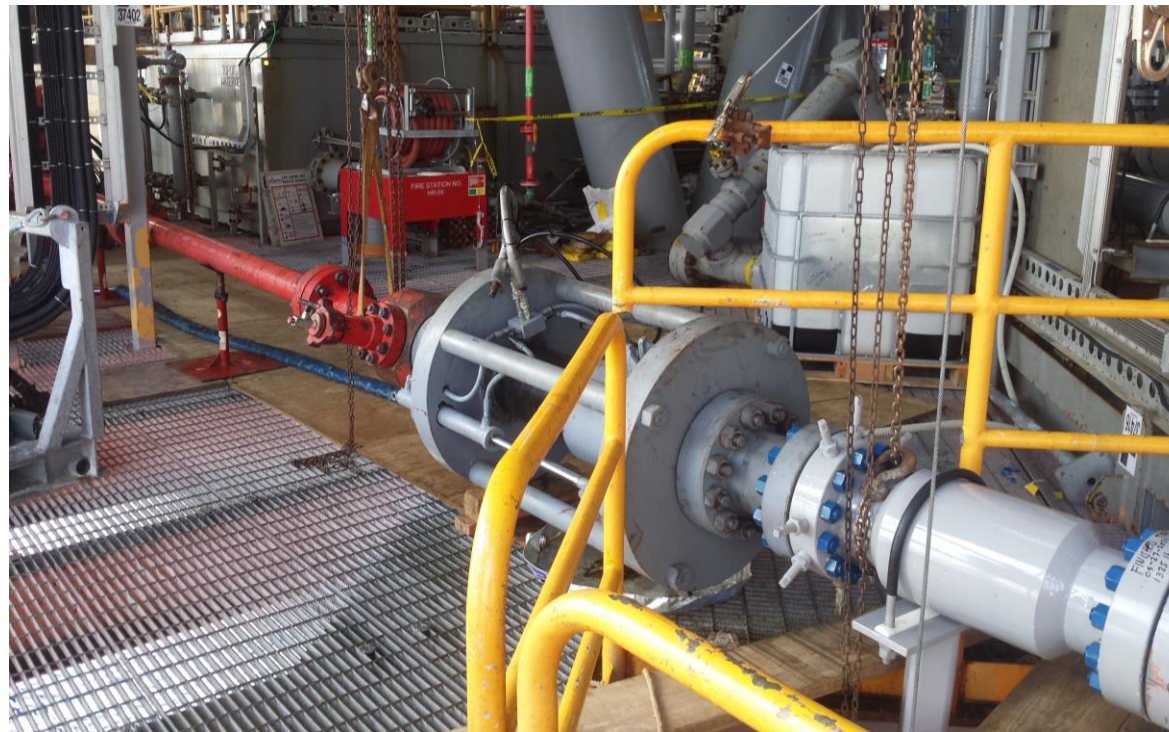
5 – Power Pack

6 – Control Station

Install Flexi-Coil Velocity String



2 – Roller Sheave's (lower deck)



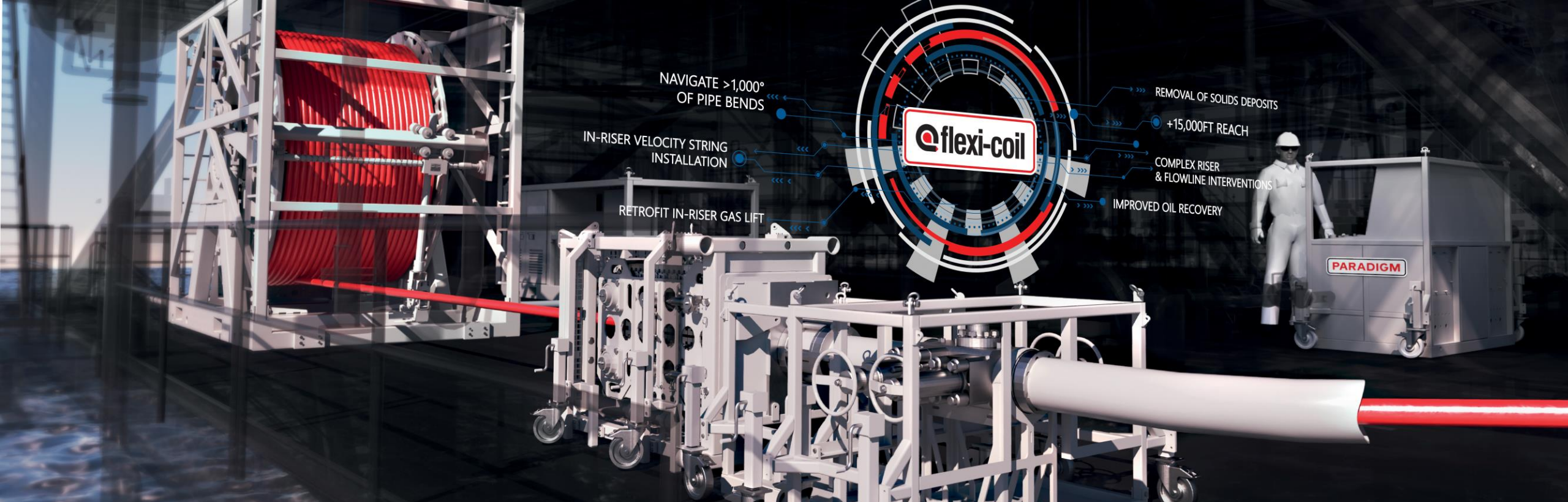
7 – Work window and tubing hanger

Lessons Learned

1. Extra time for prep offshore site visits and thorough modeling were keys to success
2. De-watering procedure needs to account for removal of residual oil during installation period
3. Have a back up plan and procedures in case coil tags on a bend
4. In-riser coiled tubing installations are possible thru hull piping if you have favorable bend geometry

Conclusions

- >30% uplift to production due to reduced boarding pressure
- Slugging severity and frequency reduced
- >60% cost reduction versus comparable conventional method due to avoidance of subsea construction activity in splash zone
- Client will retrieve IRVS in 2024 and use Flexi-Coil to deploy gas injection tubing as part of its medium-term production strategy for field



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