Case Study:

Riserless Light Well Intervention Restores Production on Oyo-8 Subsea Well

8th March 2018
Agenda

*Business Structure & Strategy – UPDATE...*

Case Study – Oyo-8 well workover to reinstate oil production

- **Overview**
- **Operational sequences/diagnostics process:**
  - Problem definition
  - Troubleshooting Process
  - Preferred Solution
- **Workover Schematic**
- Asset:
  - LWI Vessel & Subsea Well Control package
- **Implementation of Preferred Solution:**
  - Timelines – Overview
  - Project Planning
  - Project Execution
- **Project Timings**
- **Key Achievements**
- **Conclusion**
Business Structure & Strategy – UPDATE…

- Island Offshore & TechnipFMC (along with Altus Intervention) have been delivering integrated LWI services in more than 500 wells since 2005

- In 2016 the companies performed the first ever LWI Operation offshore Nigeria

- On February 1st 2018 the companies formed a Strategic Collaboration Agreement for Riserless Light Well Intervention

- With this, TechnipFMC acquires 51% of Island Offshore Management’s LWI business & subsidiary – Island Offshore Subsea

- Island Offshore Subsea is to become the operating function for TechnipFMC’s LWI activities worldwide

- It will be a standalone business, with a P&L and dedicated Managing Director who will report directly to a Board of Directors – TechnipFMC & Island Offshore Management

The added value to our clients:
- Global footprint...
- In-Country commercial management on local content & contracting needs...
- Regional operational, logistics & equipment support services...
- Blue-chip service company – many E&Ps with production facilities...
- Experienced/competent offshore WI Team – purpose-built LWIV’s...
Overview – OML 120 Location, Subsea Specifics & Well (Oyo-8) History

Location & Subsea Specifics:

• OML 120 is located about 94n.m from Lagos and 32n.m off the coast of Warri
• OML 120 consists of 2 of. subsea production wells & 1 gas injection well
• Wells are connected to the Armada Perdana FPSO
• The Oyo-8 well is situated in 314m water depth
• Production facilities – Aker HXT without guideposts

Well History:

• Oyo-8 was completed on 6th April, 2015 and flow-line hooked up on 10th April 2015
• Production commenced from Oyo-8 to the Armada Perdana FPSO on 3rd May 2015
• The well was produced at an average of 8,500bbl/pd until 26th September 2015, where the well was shut-in due to oil production approaching tank top levels at the FPSO
• Attempts to reopen the well on completion of FPSO unloading (off-take) on 18th October 2015 was unsuccessful; the well would not flow...TRSV was suspected to have slammed shut
Objective of Well Intervention:
• To reinstate Oyo-8 well back to production safely without harm to people, damage to equipment and the environment

Reason for Well Intervention:
• After several trouble shooting and diagnostics attempts, it was concluded by a process of elimination that the barrier to production on the Oyo-8 well was the TRSV
• Several attempts to re-open the valve had been unsuccessful due to suspected blockage in the hydraulic line preventing hydraulic communication

Trouble Shooting Process:
• Attempt to function TRSV with maximum control line pressure – unsuccessful
• Attempt to disintegrate and dislodge (chemical soak) possible hydrate plugs in control line – unconfirmed
• Bullheaded N2 down production tubing to achieve complete displacement to gas scenario – THP registered ~130 bar. On opening up, THP declined rapidly to ~7 bar, confirming mechanical barrier issue – TRSV flapper shut
• Reviewed control line hydraulic pressure signature – observed sharp right-angle crest. A curved crest typifies force acting on control piston during flow-tube travel & power spring compression – conclusion...

Troubleshooting Conclusion:
1) Control line was plugged
2) Mechanical malfunctioning of the TRSV operating mechanism
3) TRSV flow tube was stuck in a closed position
Operational sequences/diagnostics process (Solutions Considered, Chosen & Reasoning)

Solutions Considered:
- Attempt to function TRSV directly at the subsea XT with WROV
- Slickline operation to exercise the flow-tube and shift it into open position
- Slickline operation to permanently lock TRSV open, followed by installation of a WRSV
- Isolate TRSV by installing a velocity valve assembly to hold open TRSV flapper

Solution Chosen:
- Isolate the damaged safety valve and replace it with a SSCSV that is directly operated by production flow

Reason for Choice:
- Lowest risk and an acceptable permanent fix
- Can be done rigless using the RLWI approach
- A rig-less intervention was therefore planned to:

1. Re-enter the well and troubleshoot the faulty TRSV
2. Install a Packer/Storm Choke/Sleeve assembly to hold open the Safety Valve
3. Flow the well (N2 lift) once 'locked-open' & to reinstate production from Oyo-8...
Retrofitted Assembly:
- A thru-tubing packer to hang-off the assembly
- A velocity valve as a retrofit safety valve c/w no-go
- A flush extension pipe across the TRSV flapper

<table>
<thead>
<tr>
<th>Well Parameters</th>
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<tbody>
<tr>
<td>Tubing ID</td>
<td>4.982 in</td>
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<tr>
<td>Valve Depth</td>
<td>2089.89 ft</td>
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<tr>
<td>BHT (assumed)</td>
<td>188°F</td>
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<tr>
<td>Flowing Wellhead Pressure</td>
<td>1100 psi</td>
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<tr>
<td>Flowing Wellhead Temperature</td>
<td>168°F</td>
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<tr>
<td>Oil Production Rate</td>
<td>8500 bbl/day</td>
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<tr>
<td>Water Production Rate</td>
<td>0 bbl/day</td>
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<tr>
<td>Oil Specific Gravity</td>
<td>0.846</td>
</tr>
<tr>
<td>Gas Specific Gravity</td>
<td>0.6636</td>
</tr>
<tr>
<td>Water Specific Gravity</td>
<td>1.02</td>
</tr>
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</table>
Asset – LWI Vessel & Subsea Well Control package (Island Constructor LWIV – specification)

Specification:
- Delivered 2008
- DP-3 Dynamic Positioning (full redundancy station keeping – fire, flooding)
- PoB 90 persons
- 8m x 8m Moon Pool with Curser Frame System
- 2 WROV’s – Oceaneering Magnum class (3000m)
- Modular Handling Tower 100Te AHC Main Winch 1 Fall, 200Te (2 falls)
- 140Te AHC Main Deck Crane (500m), 94Te (2500m)
- Cargo Cranes 15Te and 2.5Te
- 1500m Control and Chemical Umbilical's – FMC WCP system (3000m)
- Automated Deck Skidding System
- Mud/Brine Tanks 500m³ (3144 bbls)
- Chemical Tanks 199m³ (1250 bbls)
- Well Service/Well Kill Pumps – integrated/purpose design/built

Main Characteristics:
- Length 120.2m
- Breadth 25.0m
- Design draught 7.0m
- Draught (max) 8.0m
- Deadweight 9100 Te
- Deck (main deck area) 1380m²
- Deck (mezz deck area) 320m²
- Max speed (at d=6,0 m) 15.3 knots
- Generator power 13200 ekW
- Tanks (fluid storage)
  - 500m³ (bulk tanks)
  - 4 x 50m³ (returns/hydrocarbons)

Additional project specific tanks – storage on back deck
Asset – LWI Vessel & Subsea Well Control package (TechnipFMC Mk. II WCP – specification)

**Compliance:**
- DNV certified and designed according to relevant API and ISO standards
- Interface to manage all OEM XT’s and VXT/HXT XT operations

**System Specification:**
- MKII stack
- 7 1/16” ID mainbore
- 10kpsi pressure rating
- Capacity for operations up to 1500m water depth (upgraded by Q2 2018)
- Well Control Package – certified to 3000m water depth
  - PCH – slickline/e-line
  - Gate valve
  - Wireline BOP configuration
  - Shear Seal Ram (2 7/8” C/T – API 16A certified)
- Controls/umbilicals:
  - Full redundant controls – power and communication system
  - MEG/chemical injection downlines ¾” ID umbilical
  - Electric subsea pumps control system managed via controls umbilical from topside WOCs

**Operations:**
- 22m tool string capacity
- Slickline
- E-line
- XT deployment/recovery
- High rate/high volume pumping capability through pumping cap, through main production bore (up to 40bbls/min)
- Well kill – in-built (WCP) via umbilical from surface
Timelines – Overview

Contracting & Commercial process (commenced December 2015 – March 2016)
- Project Definition; Dealing and negotiation
- Established contractual agreement

Project Planning (January – April 2016)
- Engineering Plan: Bi-weekly & weekly meetings
- Logistics, Immigration, Cabotage Waiver and Regulatory Compliance

Project Execution
Onshore Mobilisation (March – April 2016)
- Mobilised Equipment from Norway and transit to Las Palmas
- Crew & Vessel fortification in Las Palmas and transit to Oyo field, OML 120

Project Execution
Offshore Light Well Intervention (April – May 2016)
- Sailed directly to the field and lifted onboard additional CPI equipment from PSV
- Performed LWI Operation – successfully

Demobilisation and Project Close Out (May 4 – 28 2016)
- Transit from field and Demobilise LWI Crew and ISPS-2 equipment in Las Palmas
- Transit to Norway and Demobilise Island offshore alliance equipment
Project Planning – Overview

Project Management Team:
The Team was based in 3 locations – Lagos, Stavanger & Houston
The Team comprised of Erin, IO/Alliance and 3rd party:
• Schlumberger
• Hermes
• Aker
• Lbnerg

Engineering Plan:
• Interface requirement
• Clash checks
• Guidelineless operations
• No Guidepost operation: WCP bucket
• Well Specific Operations Manual + Drawings
• Nitrogen pumping operation
• Sea fastening Design
• Manufacture of Stinger/Production stab seal

Mobilisation Plan:
• Equipment Logistics delivery
• MEG, Methanol, Base Oil and others
• Personnel: Visas & Medicals
• Equipment Seafastening
• Bunkering: Fuel and Fresh Water
• Deck layout – Deck plan
• Master Equipment List
• Main Lift List
• LOLER compliance
• Dangerous good handling
• Vessel Fortification

HSE Plan:
• Risk Assessment carried out
• ISPS Level 2 fortification
• HAZID/HAZOP and Close out of actions
• Emergency Response plan
• SMS & ER Bridging Document

Regulatory Compliance:
• NIMASSA Cabotage Waiver
• Regulatory Compliance (DPR)

Vessel Inspection:
• Inspection team visited – Norway for compliance requirements & Project planning assessment
Project Planning – Mob Vessel/Equipment

Interface Equipment:
- Well specific production seal stab for the HXT was manufactured
- HXT adapter kit was assembled, tested and mobilized from Bergen, Norway prior to departure in March 2016
- HXT adapter kit was a combination of using existing HXT adapter complete with an Torus IV H4 connector combined with the production seal
- HXT adapter kit was completed with a successful hydrostatic and gas test onshore in Bergen at Contractor’s workshop facilities
- Guide-funnel for landing WCP w/o the use of guidewires was modified and attached prior to deployment of the Well Control Package (WCP)

Mobilisation – LWIV & Equipment Bergen, Norway:
- Mobilised Island Offshore Alliance equipment – including the above
- Mobilised LWI supplies: MEG, methanol, grease
- Bunkering of fuel and fresh water

Transit to Las Palmas, Canary Islands, Spain

Mobilisation – Crew and security personnel Las Palmas, Canary Islands:
- Crew mobilization
- Final sea fastening checks
- Vessel Fortification & ISPS2 Equipment

Implementation of HSE plan including – Security Measures:
- Radar Watch performed from FPSO and from Island Constructor LWIV
- Two experienced security officers from Norway risk perform radar watch c/w on the job bridge crew training to perform visual watch – 24/7
- Lockdown procedure c/w Citadel in place any suspected pirate attack
- Communications with OML 120 Field security in place – managing Armada Perdana FPSO
- 2 of. security vessels – ready and in-Field OML 120

Direct transit to OML 120 – Oyo Field, offshore Nigeria
Project – Execution

Summary of LWI Operations:

1. Sailed to location and conducted DP trials
2. As found site survey – ROV
3. Pulled Debris Cap with ROV
4. Deployed Well Control Package & Lubricator
5. Retrieved 2 x Crown Plugs from Tubing Hanger
6. Installed Protection Sleeve
7.Performed slickline drift run to TRSV (Failed)
8. Performed 2nd drift run
9. Run velocity valve assembly and install across TRSV
10. Flow Well to FPSO (~48 hours/2 days of overall ops time accounted for)
11. Installed 2 x Crown Plugs
12. Recovered Lubricator and Well Control Package
13. Installed Debris Cap
14. As left site survey – ROV
15. Moved Vessel Off Location

Armada Perdana FPSO controlled XT functions during the operation, in close communication with Island Constructor
## Project Timings

**Erin Energy 2016 OYO-8 LWI Operations Island Constructor - LWI Ops**

<table>
<thead>
<tr>
<th>Job Step</th>
<th>Phase</th>
<th>Description of activity</th>
<th>Est Duration</th>
<th>Actual Duration</th>
<th>Vessel NPT</th>
<th>WOC</th>
<th>WOW</th>
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**Summary - activity/timing**

<table>
<thead>
<tr>
<th>Gross Time (hrs)</th>
<th>NPT (hrs)</th>
<th>WOW (hrs)</th>
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<tbody>
<tr>
<td>Mob &amp; Transit: Norway to Las Palmas, Canaries</td>
<td>234.50</td>
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<tr>
<td>Mob - LWI Crew &amp; undertake LWIV fortification process</td>
<td>191.17</td>
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<tr>
<td>Transit: Las Palmas to Oyo Field, offshore Nigeria</td>
<td>249.10</td>
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<tr>
<td>Offshore LWI Operations - Oyo-8 subsea production facility</td>
<td>206.24</td>
<td>6.00</td>
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<tr>
<td>Transit: Oyo Field to Las Palmas, Canaries</td>
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<tr>
<td>Demob - LWI Crew &amp; Equipment</td>
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<tr>
<td>Transit: Las Palmas, Canaries to Norway</td>
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<tr>
<td>Demob - Alliance &amp; Rental Equipment</td>
<td>35.00</td>
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**Summary**

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<tr>
<th>Gross Time (hrs)</th>
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<th>WOW (hrs)</th>
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<td>1412.51</td>
<td>6.00</td>
<td>0.00</td>
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</table>

- Under planning/AFE Field ops/well work
- Mob c. 50 days, via Las Palmas, Canaries
- Still cost effective to Client!
- **Justifies, removing Mob in order to have an in Region LWIV on a Shared ‘Rig club’ basis??**
Key Achievements

Demand: logistical, equipment, program planning – achieved!

- Planning – Lagos/Stavanger/Houston
- Execution – Bergen (Mob)/Las Palmas/OML 120 – following 3 months extensive collaboration between multidiscipline teams – domestically & internationally
- Visit from NAPIMS/DPR – prior to work commencing. Left satisfied with all Marine, TI & associates assurances & compliance matters in place

Performance Delivery – achieved!

- 1st LWIV activity in Nigerian waters
- ZERO HSE incidents/accidents – no harm to People/Environment
- Project uptime over 99% uptime – in-Field operations
- LWI project estimate / actual = 10.0 / 8.6 days
- Only 6 hours downtime/NPT minor failure on deck equipment. HPU & Hydraulic hose leak. Issue resolved
- Reinstated well production – 3rd May 2016. Well producing ~ 8,500 bbl/pd

Operations Objectives – achieved!

- Equipment – build/commission/test – integral to project delivery. Production Stab/interface – WCP to HXT
- Successful mobilisation and demobilisation in both Bergen and Las Palmas
- Coordinated & operated multi service operations utilising:
  - Slickline operations
  - Pumping operations – Nitrogen (N2) to support lifting the well
  - WROV operations
- Successfully installed velocity valve assembly – 8 successful wireline runs
- Guidelineless operations (HXT without guideposts)
Conclusion

- Oyo-8 was restored to full production without loss of productivity

- The velocity valve is performing and living up to expectation

- Well Intervention operation was completed within time and budget

- RLWI approach is an efficient way of solving the problem on Oyo-8

- The RLWI operation was the first of its kind offshore Nigeria
Questions please???

Island Constructor LWIV crew & 3rd party/client reps
Oyo-8 subsea well light well intervention project – May 2016