BOP Tethering and Motion Measurements – Enabling Safe Subsea Well Decommissioning

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Contents

- Subsea well P&A challenges
- Benefits of BOP tether system
- Specification of BOP tether system
- In-field measurements to validate response
- Conclusions

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P&A Challenges for Older Wells

- Typically old (pre-2000) 30” conductor designs
- Usually not designed for fatigue loading
- Lack of data
- 6th generation semi-submersibles in shallow water
- Prior fatigue damage?

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1st Case Study – Conventional P&A Approach

- Well Location: Offshore Australia
- Water Depth: 68m
- Drilling Rig: 6th generation moored semi-submersible
- Wellhead System: Rigid lockdown wellhead
- Originally installed approx. 2005

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## Wellhead & Conductor Stack-up

- **30” x 1.0” Conductor**
- **20”x13-3/8” Surface Casing**
- Conductor and surface casing cemented to mudline
- Combined wet weight of LMRP + BOP + Subsea Tree = 232.7Te
- 25 day duration = 250 days target life (0.68 years) FOS=10

![Diagram of Wellhead & Conductor Stack-up](image)

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Unfactored Fatigue Results

Min Fatigue Life is 11 days and does not meet Target Life.
Mitigation Options

- Reduce conservatisms – only applicable for marginal designs

- More accurate data

- Conventional remedial actions include:
  - BOP modifications – lighter BOP however can be costly
  - Different vessels – availability and cost implications

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BOP Tether System

Primary aim is to reduce BOP stack motions.

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Effect of BOP Tether on Bending along Conductor

Approx. 3 times reduction in bending load

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Unfactored Fatigue Results with BOP Tether System

Fatigue lives improved by a factor of 185x

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Specifying BOP Tether System
Key Considerations

- Consider how any change in the design will affect the overall tether wire stiffness:
  - Clump weight position
  - Tether wire length
  - Tether wire OD / Maximum Breaking Force

- How does tether wire pre-tension impact the efficiency of the system?

- Monitoring system can provide further assurance

- Bottom clump weight stability on seabed

- Axial loading resistance on conductor – Any additional axial load?

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Effect of Clump Weight Position

- 3 distances considered:
  - 13.5m
  - 41.0m
  - 45.0m

- Longer tether wire reduces stiffness

- System response is sensitive to wire stiffness

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Effect of Tether Pre-tension & Wire OD

- Tether wire OD reduced – Wire stiffness reduces by 87%

- 3 pre-tensions considered:
  - 5 kips
  - 10 kips
  - 15 kips

- Clump weight positions remains constant

- Wire pre-tension has little effect on system response

- System response is sensitive to wire stiffness

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Final Fatigue Results with BOP Tether System
2nd Case Study – Monitoring BOP Stack Motions

- Well Location: Offshore Australia
- Subsea well utilised a BOP tether system
- Motion monitoring equipment installed subsea onto the BOP frame and subsea tree
- Monitoring equipment recorded the BOP stack and subsea tree movement and accelerations
- Data available pre- and post-BOP tether system installation for multiple deployments

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Subsea Tree Accelerations – 1\textsuperscript{st} Deployment

STANDARD DEVIATION OF ACCELERATION & ANGULAR RATES
11-13 July

- X Acceleration
- Y Acceleration
- X-Z Angular Rate
- Y-Z Angular Rate
- Noise Level

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Subsea Tree Accelerations – 2nd Deployment

Subsea Tree Monitoring
STANDARD DEVIATION OF ACCELERATION & ANGULAR RATES
22-31 July

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Observations From In-field Measurements

- Use of the BOP tether system provided 2.5x reduction in motions

- Consistent reduction in BOP stack motions observed over multiple deployments

- The observed reduction in motions directly leads to improved fatigue performance

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Summary

- Use of 5/6th generation rig for subsea well P&A decommissioning may lead to fatigue complications

- Standard remedial actions may be insufficient or too costly

- BOP tether system offers a direct improvement on wellhead fatigue by reducing BOP stack motions

- Must consider wire stiffness when designing the BOP tether system

- In-field motion measurements confirm the effectiveness of a BOP tether system in reducing stack motions

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Questions?

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