BOP Tethering and Motion Measurements – Enabling Safe Subsea Well Decommissioning

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J Lodhia
Contents

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

Older Wellhead

Newer Wellhead
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
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
Unfactored Fatigue Results

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

- Reduce conservatism – 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
BOP Tether System

Primary aim is to reduce BOP stack motions
Effect of BOP Tether on Bending along Conductor

Approx. 3 times reduction in bending load
Unfactored Fatigue Results with BOP Tether System

Fatigue lives improved by a factor of 185x
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?
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
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

BENDING MOMENT PROFILE
BOP Tether Wire Pre-tension Sensitivities, Irregular Wave Analysis, 0.2m/s Background Current

- No Tether
- 5 kips (Base Case)
- 5 kips
- 10 kips
- 15 kips
Final Fatigue Results with BOP Tether System

Wellhead, Riser And Landing String Analysis
UNFACTORED FIRST ORDER FATIGUE LIVES
Cyclic Soil, Head Seas, 20mm Tether OD

Elevation above Mudline (m)

Target Life
0.68 years (250 days)

Unfactored Fatigue Life (years)

Conductor
Surface Casing
Target Life

LP Elevator Ring Weld
DNV F3 SCF 1.3
0.44 years

LMRP
BOP
Tree
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
Subsea Tree Accelerations – 1st Deployment

STANDARD DEVIATION OF ACCELERATION & ANGULAR RATES
11-13 July

- Logger installed
- BOP landed
- BOP tether system activated
- Logger removed
- BOP tether system pressure topup
- Noise level
Subsea Tree Accelerations – 2nd Deployment

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

Acceleration (m/s²)

Date

22/07 23/07 24/07 25/07 26/07 27/07 28/07 29/07 30/07 31/07 01/08

- BOP disconnected
- BOP landed
- BOP tether system activated
- BOP tether system pressure top-up
- Logger installed
- Logger removed
- Noise level

X Acceleration  Y Acceleration
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
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
Questions?
Thank you

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