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BOP Tethering and Motion Measurements – Enabling Safe Subsea Well Decommissioning

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- Benefits of BOP tether system
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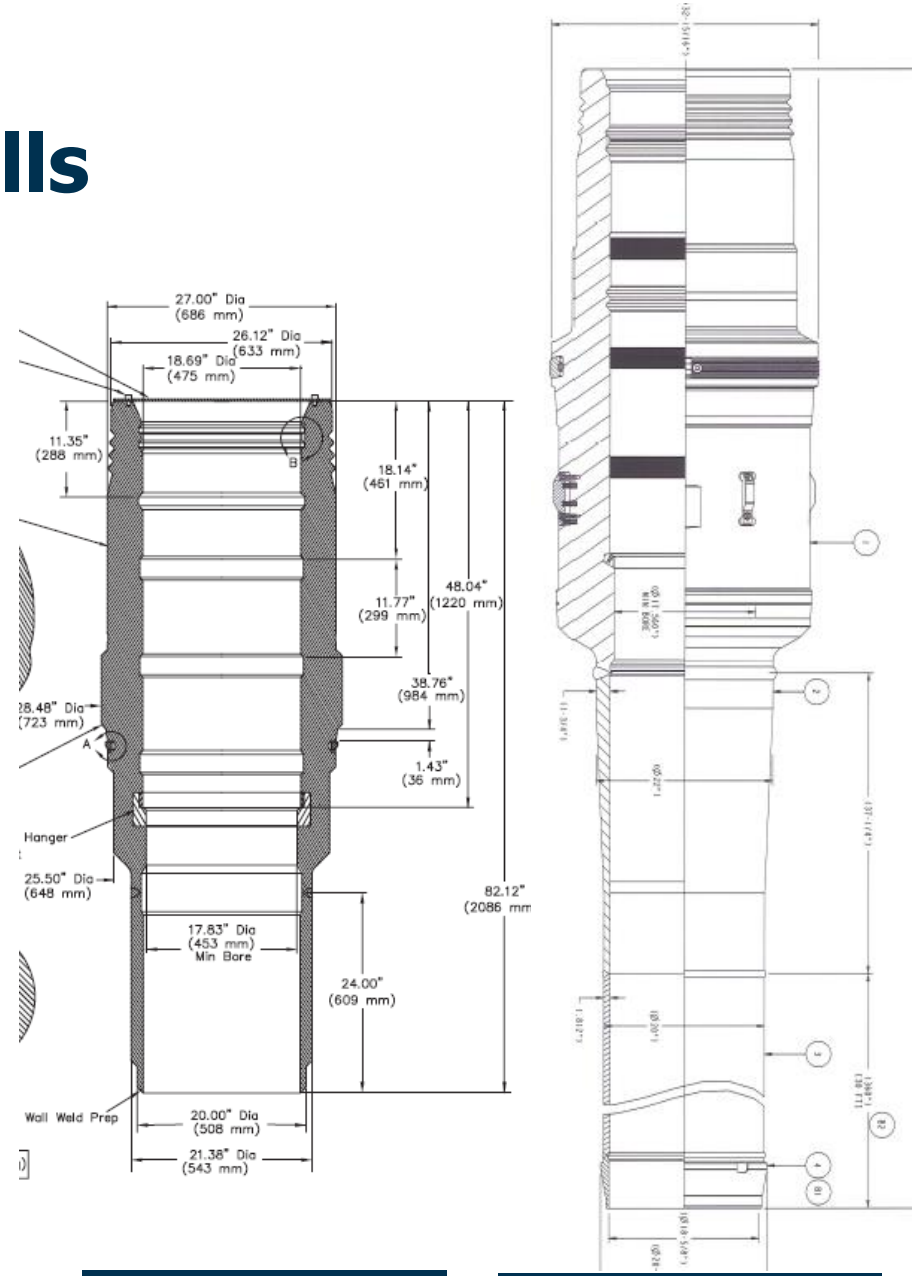
P&A Challenges for Older Wells

- 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?

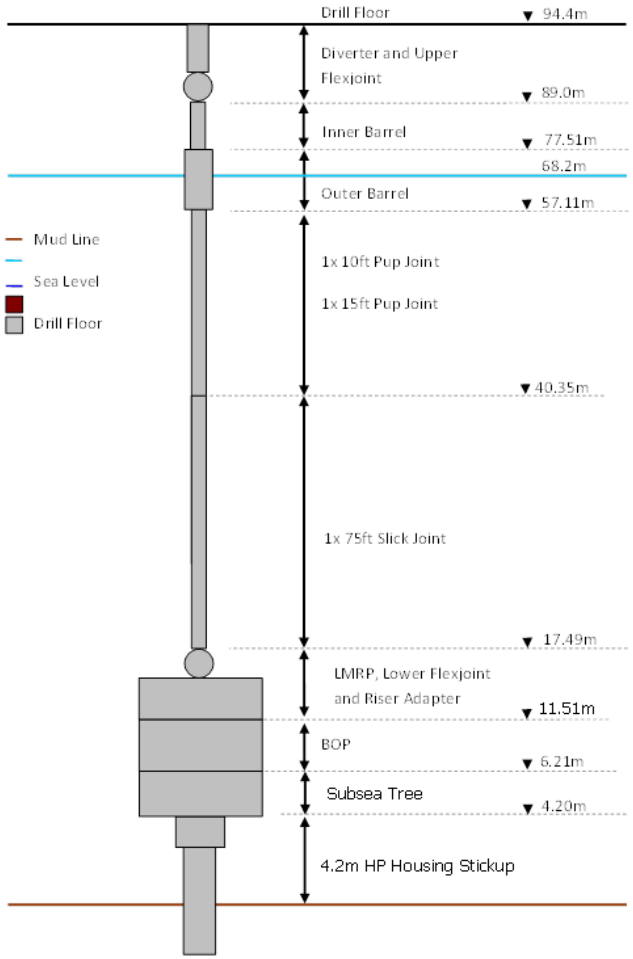


Older Wellhead

Newer Wellhead

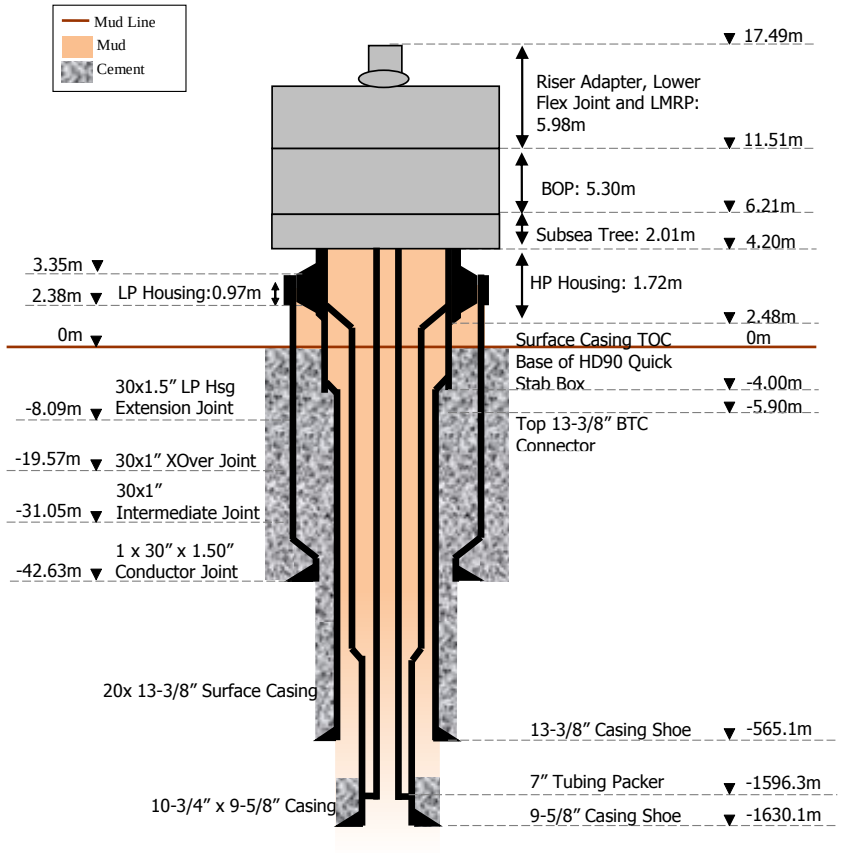
1st Case Study – Conventional P&A Approach

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

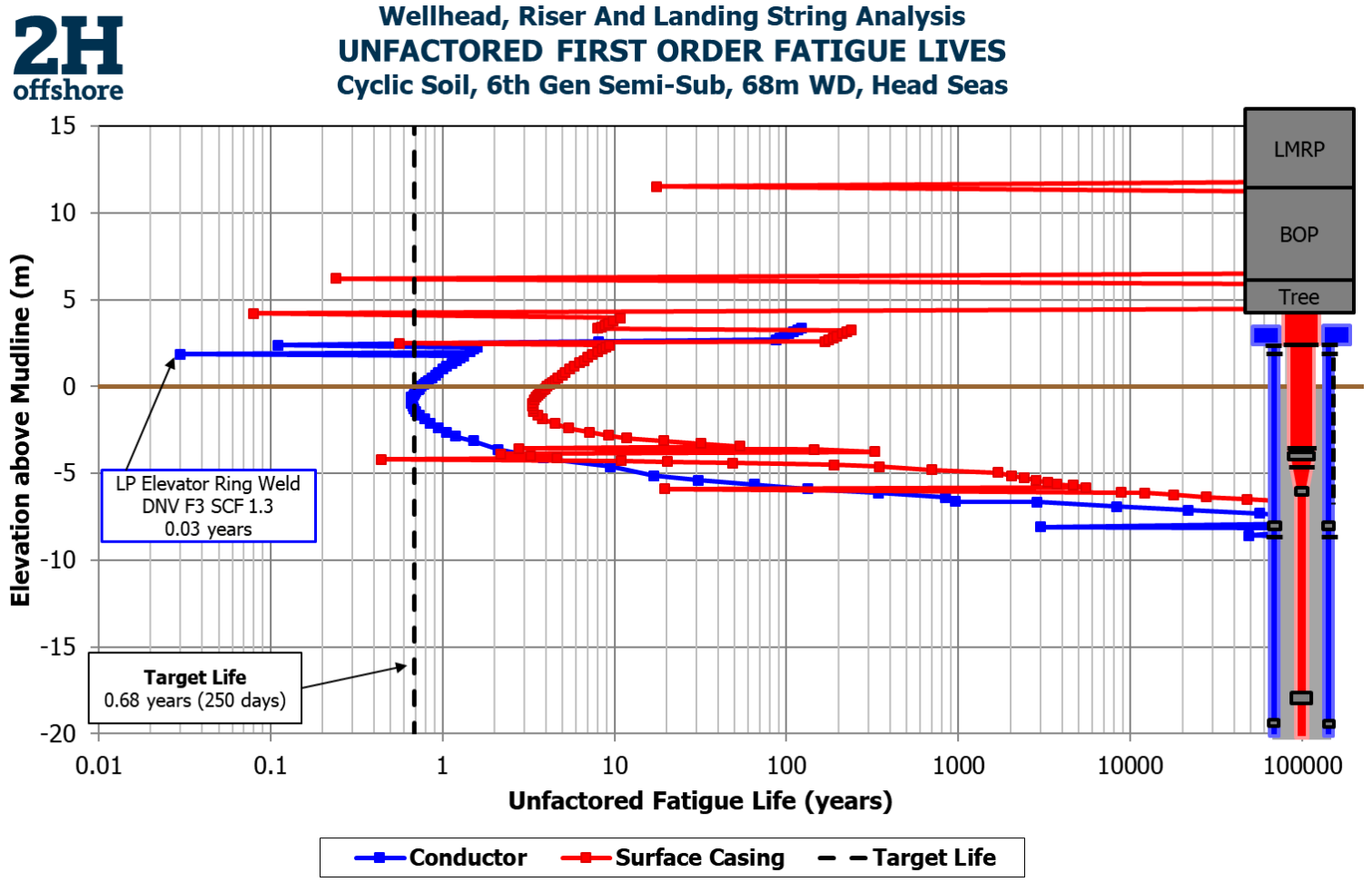


Wellhead & Conductor Stack-up

- 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

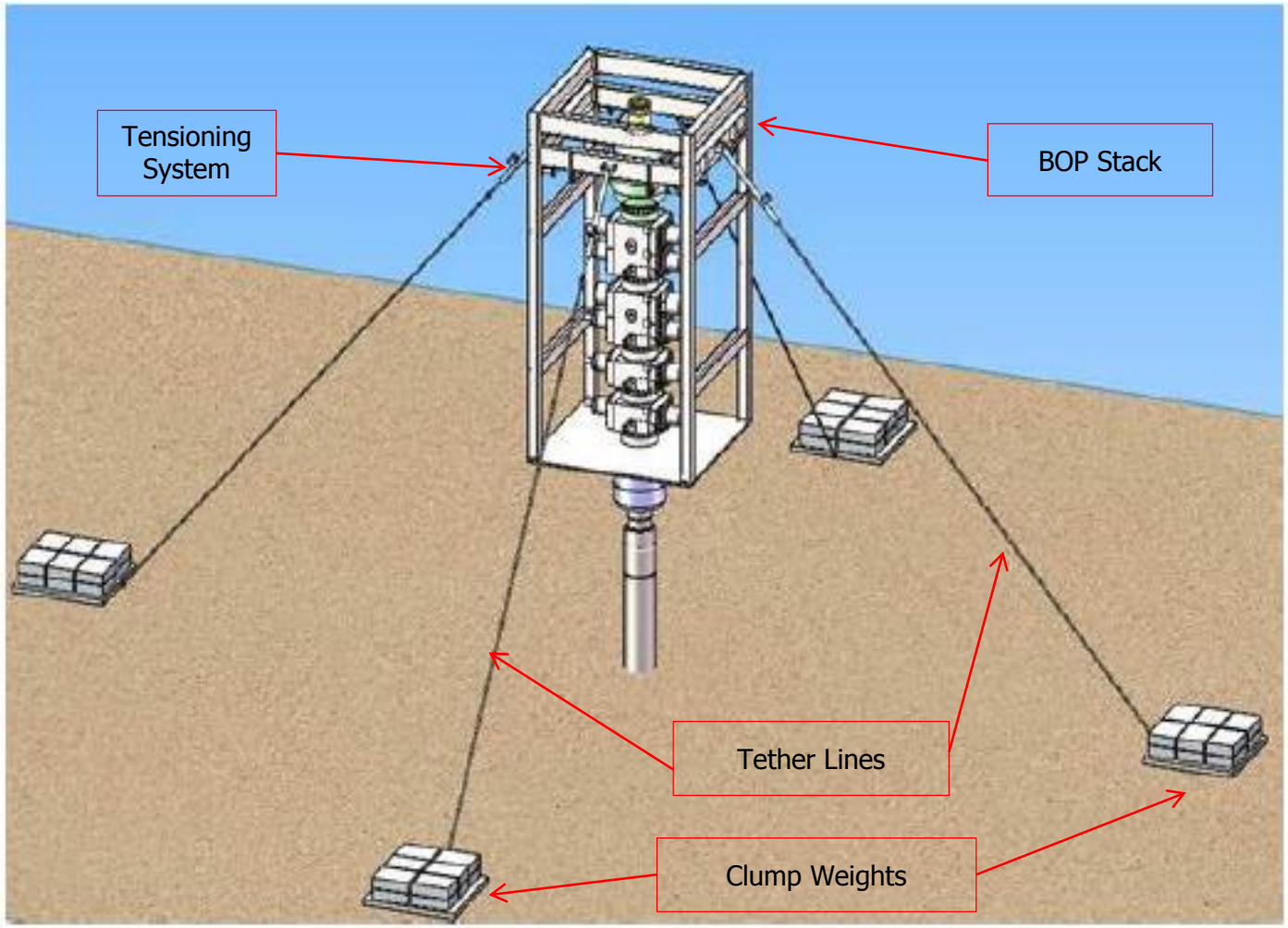


Min Fatigue Life is 11 days and does not meet Target Life

Mitigation Options

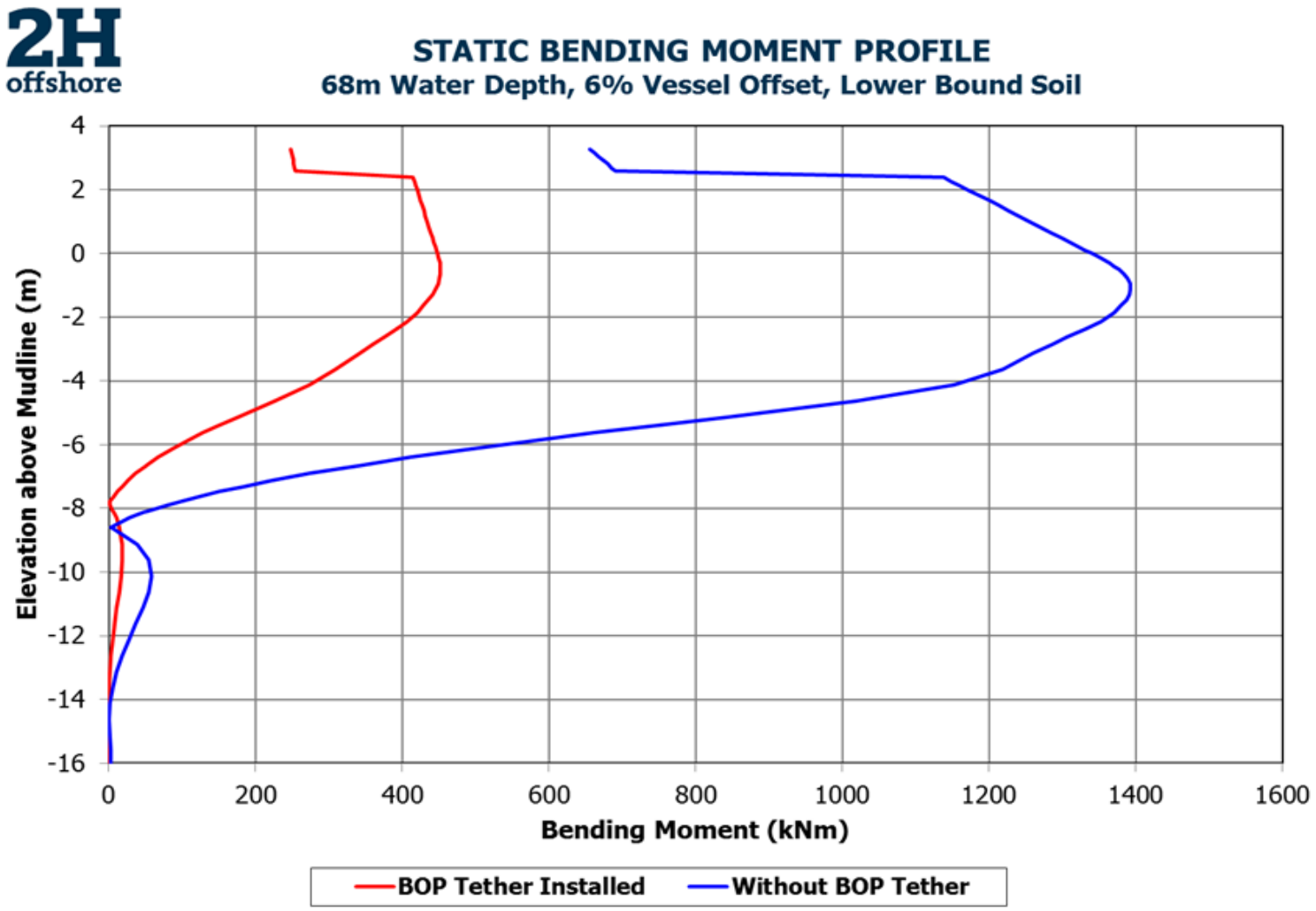
- Reduce conservatisms – only applicable for marginal designs
- More accurate data
- Conventional remedial actions include:
  - BOP modifications – lighter BOP however can be costly
  - Different vessels – availability and cost implications

BOP Tether System



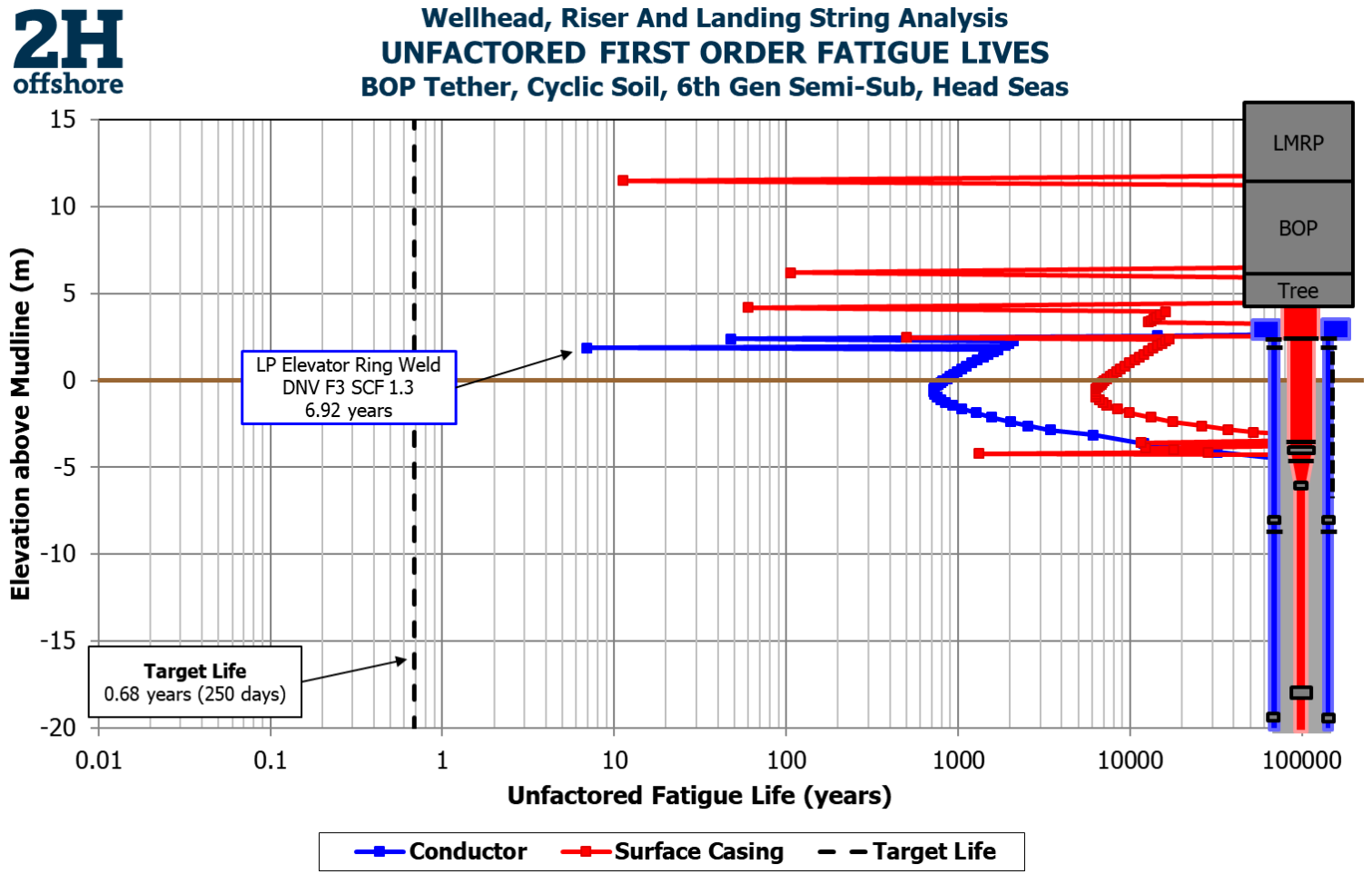
Primary aim is to reduce BOP stack motions

Effect of BOP Tether on Bending along Conductor



Approx. 3 times reduction in bending load

Unfactored Fatigue Results with BOP Tether System



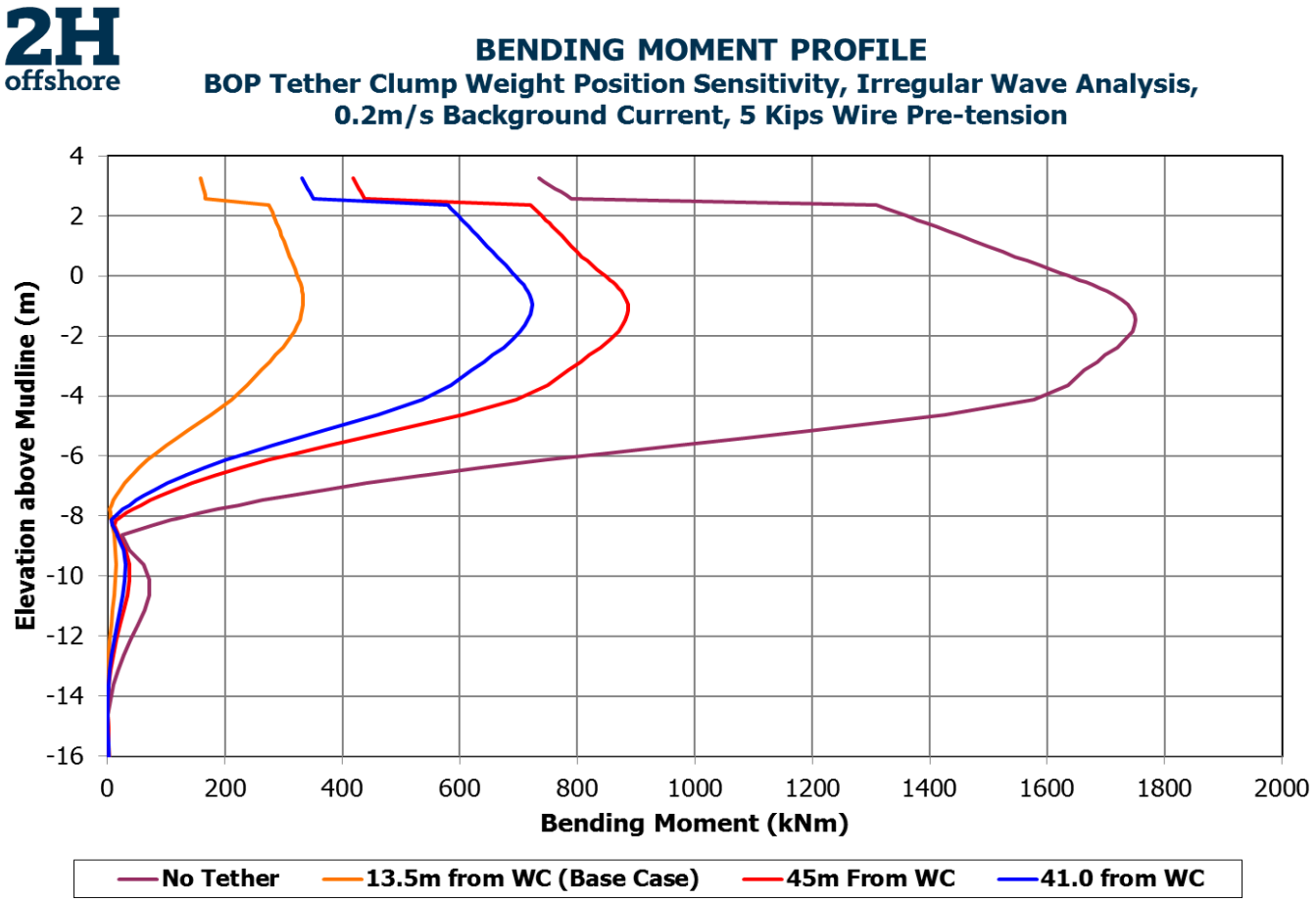
Fatigue lives improved by a factor of 185x

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?

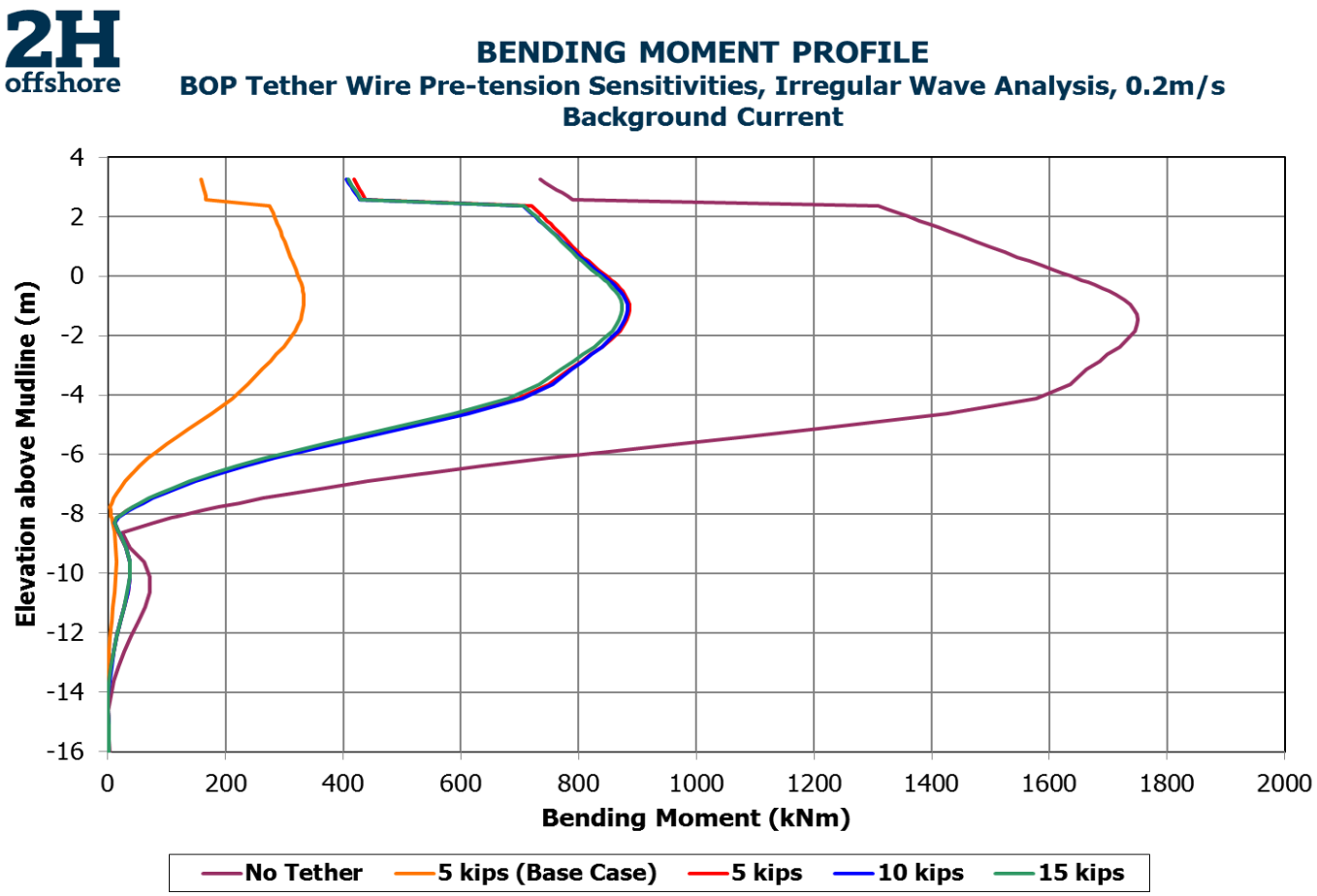
Effect of Clump Weight Position

- 3 distances considered:
  - 13.5m
  - 41.0m
  - 45.0m
- Longer tether wire reduces stiffness
- System response is sensitive to wire stiffness

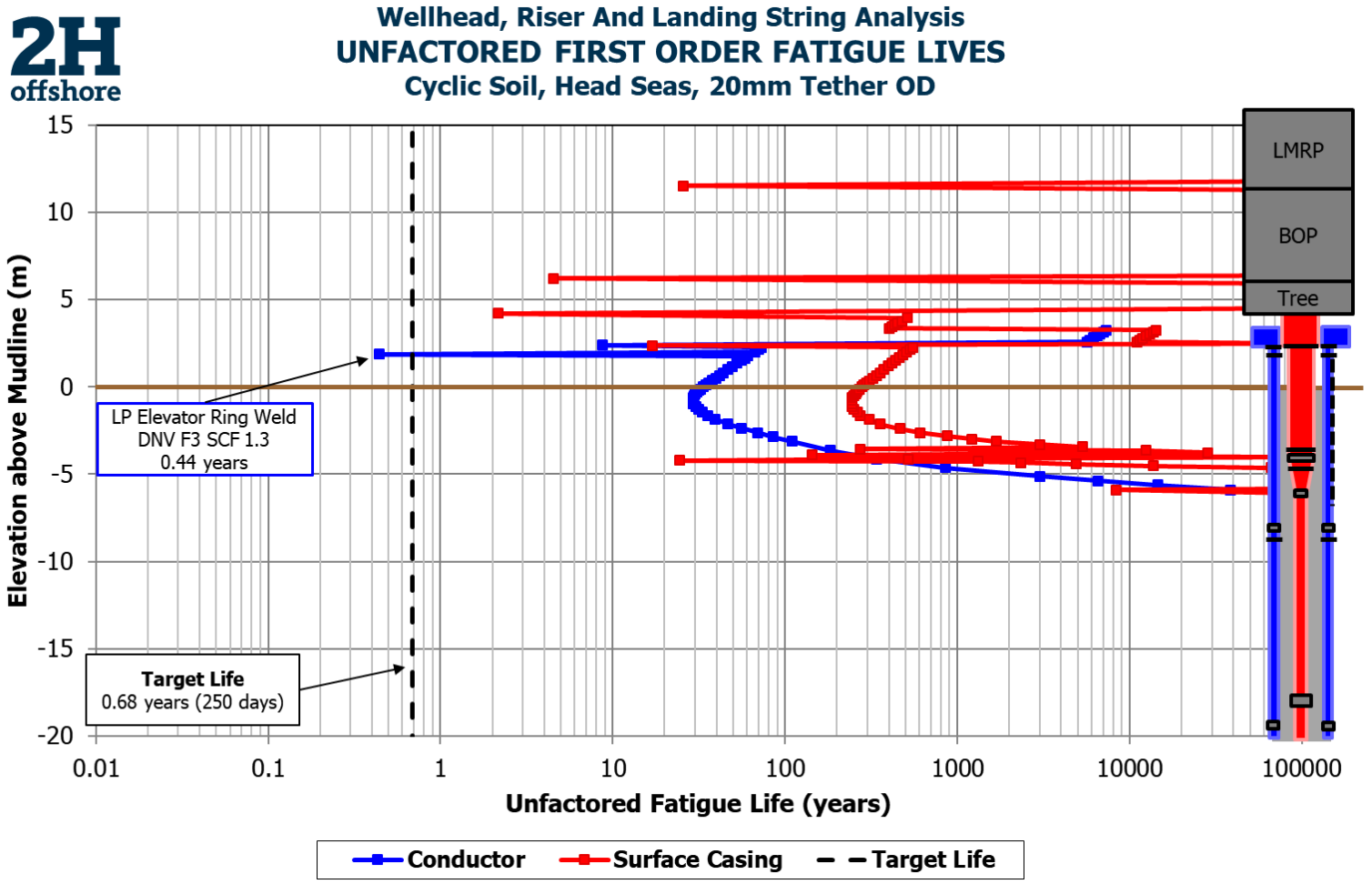


Effect of Tether Pre-tension & Wire OD

- 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



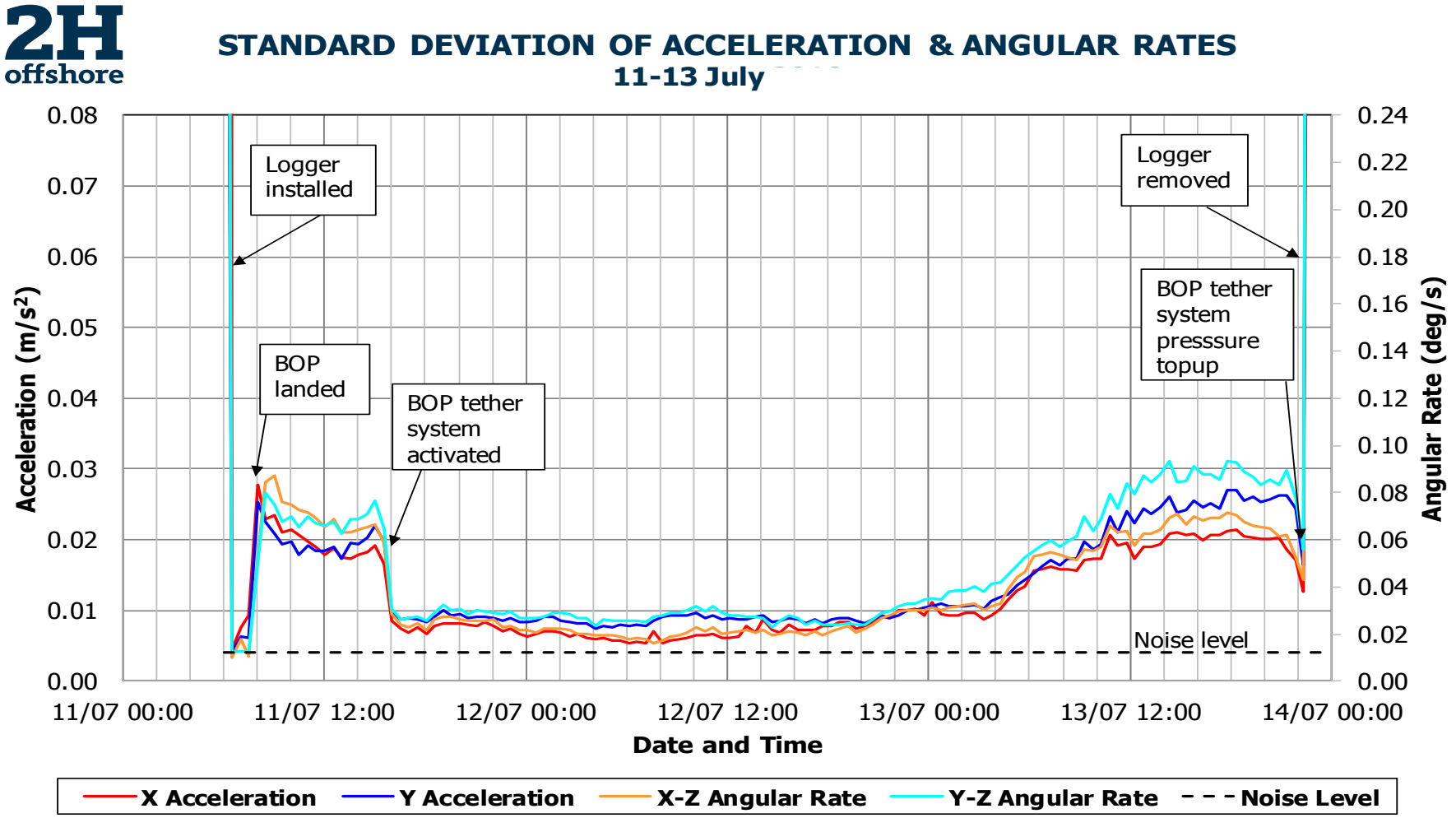
Final Fatigue Results with BOP Tether System



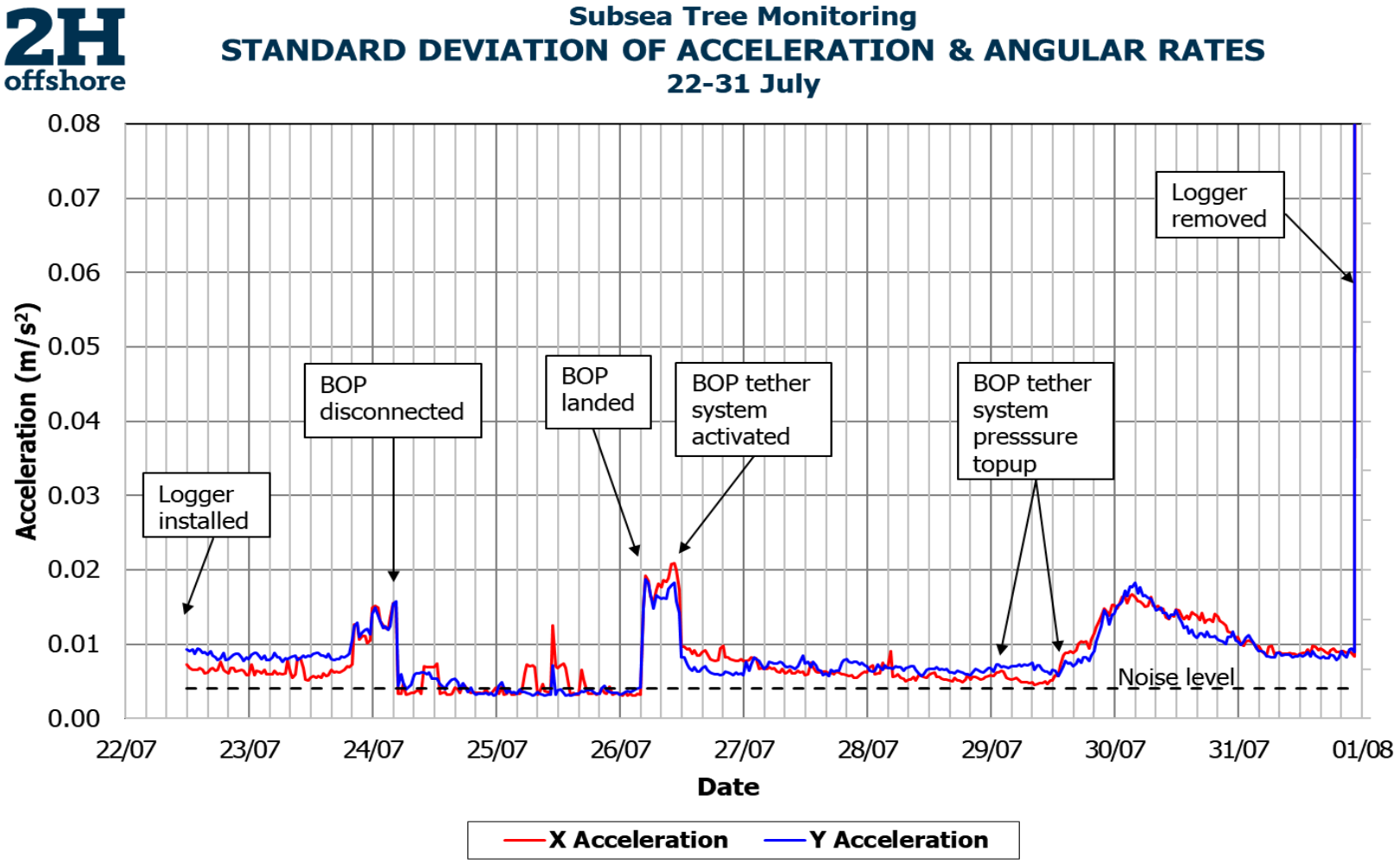
2nd Case Study – Monitoring BOP Stack Motions

- 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

Subsea Tree Accelerations – 1st Deployment



Subsea Tree Accelerations – 2nd Deployment



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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