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Drilling & Wells Division

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Drilling and Intervention Riser Tensioner Load Modelling and its Impact on Wellhead Fatigue and Riser Loading

Subsea 2012 Exhibition & Conference 8th Feb

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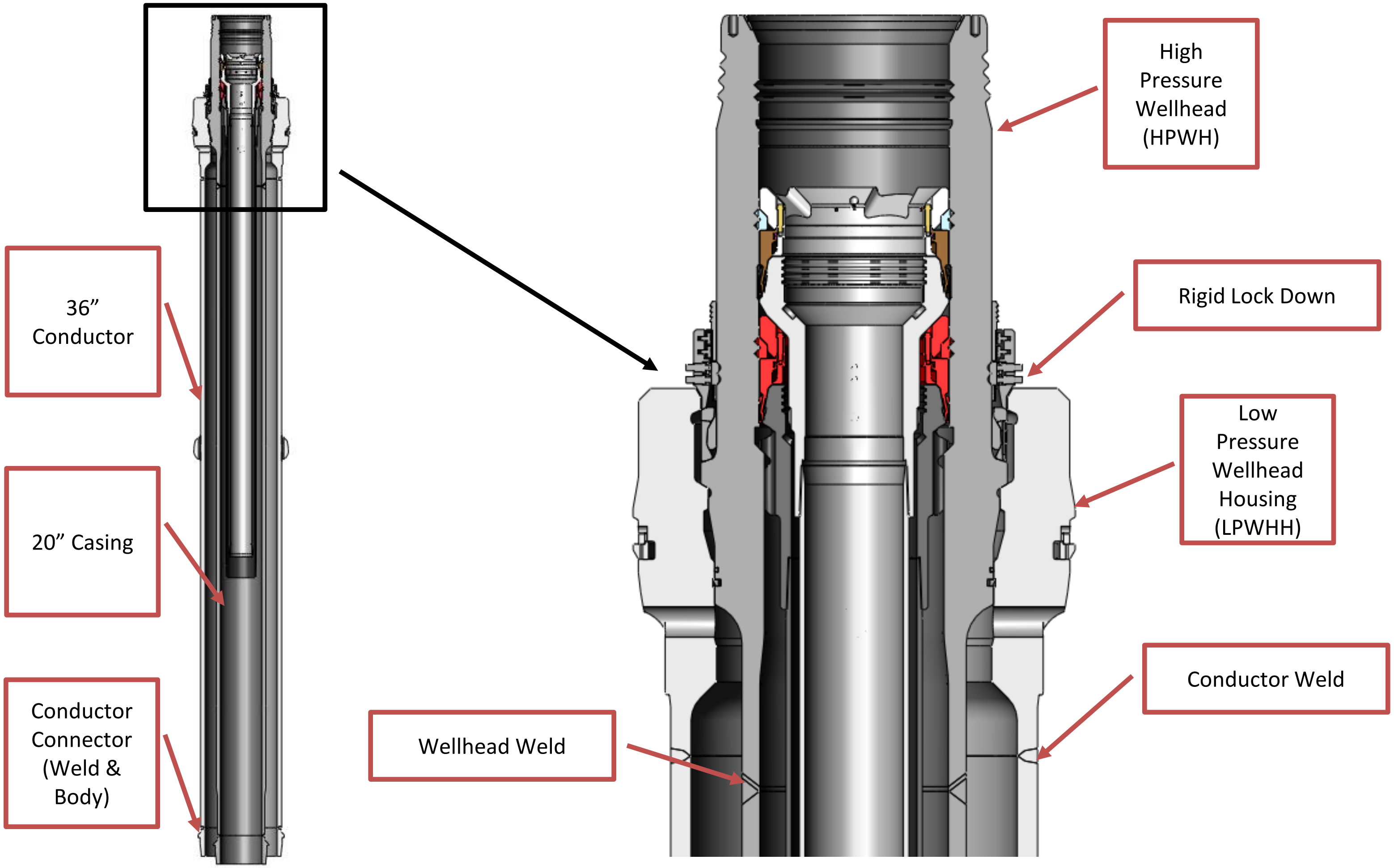
Introduction

- Wellhead & conductor fatigue loading key importance in offshore well design
- Deepwater oil and gas exploration (>10,000ft) – Modern vessels
- Modern tensioning systems - Complex hydro-pneumatic systems
- Detailed tensioner model - Includes individual hydraulic and pneumatic components (***DeepRiser*** *TM*)
- Existing modelling and API recommended practices
- Accurate assessment of expected fatigue damage and riser loading

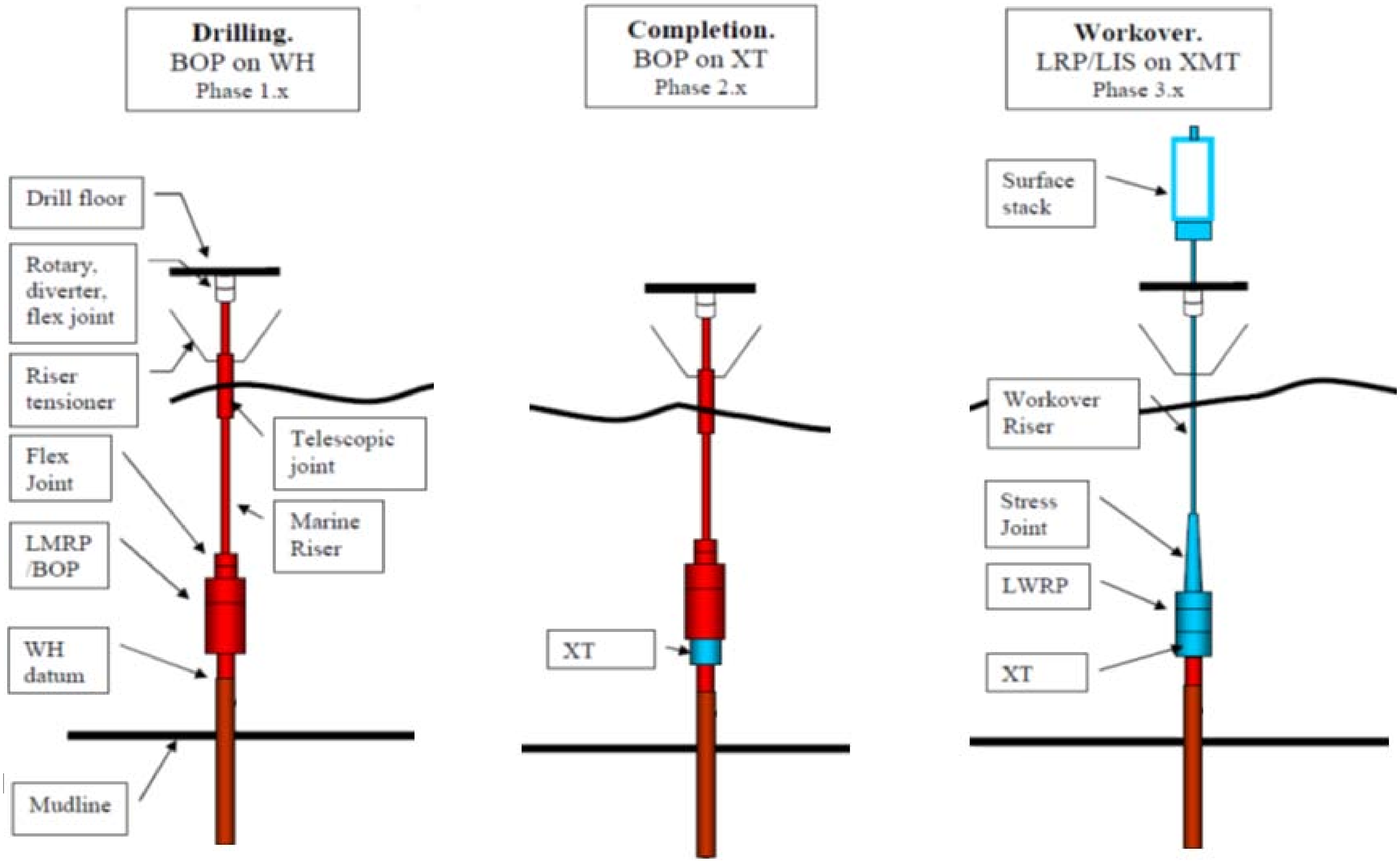
Presentation Outline

- Description of Riser, Wellhead and Conductor Systems
- Overview of Marine Riser Direct Acting Tensioners (DAT)
- Existing Industry Modelling Techniques for Wellhead Fatigue/Riser Loading
- Case Study #1 - Offshore Brazil (7,000ft Water depth) – Riser Loading
- Case Study #2 - North Sea (4,000ft Water Depth) – Wellhead Fatigue

Wellhead and Conductor System



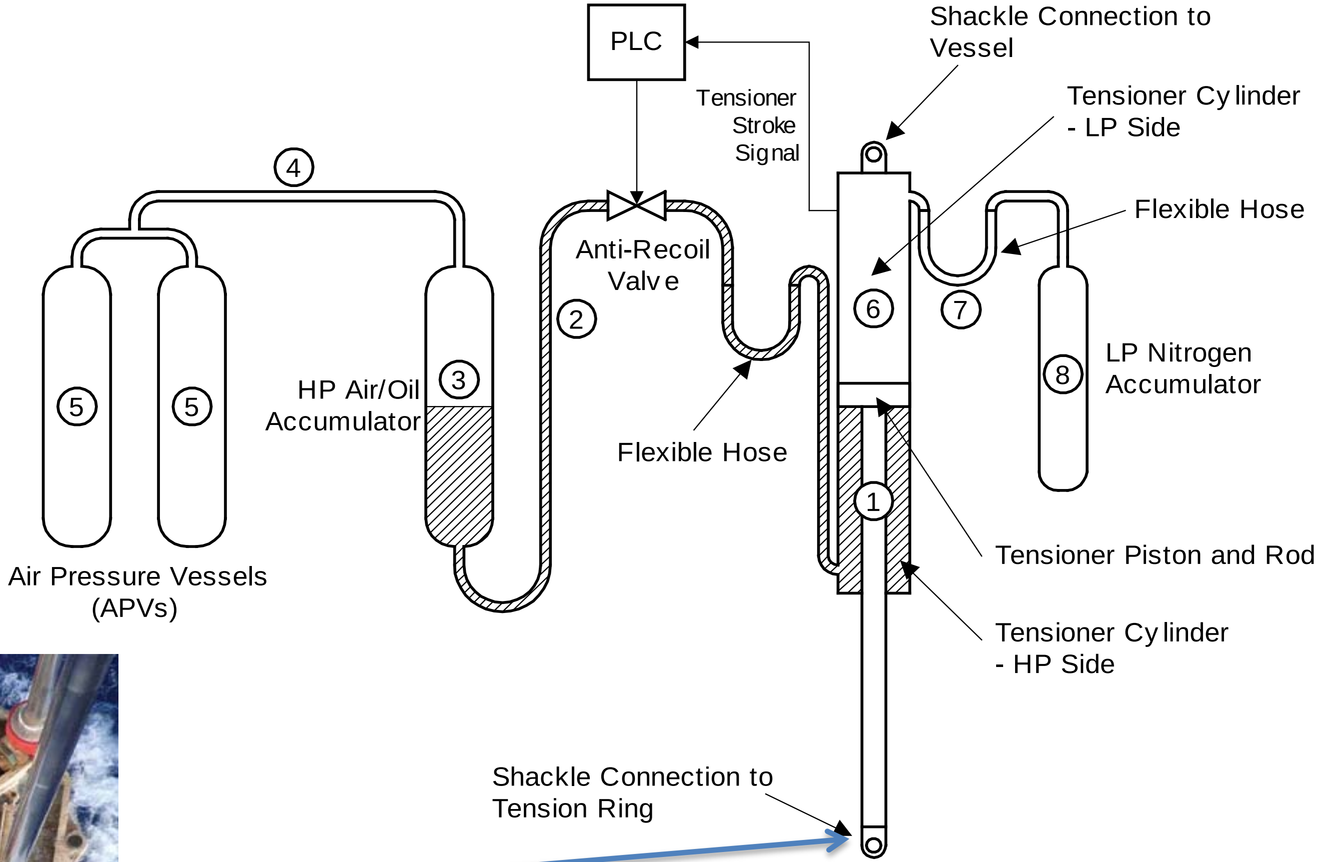
Wellhead and Conductor System



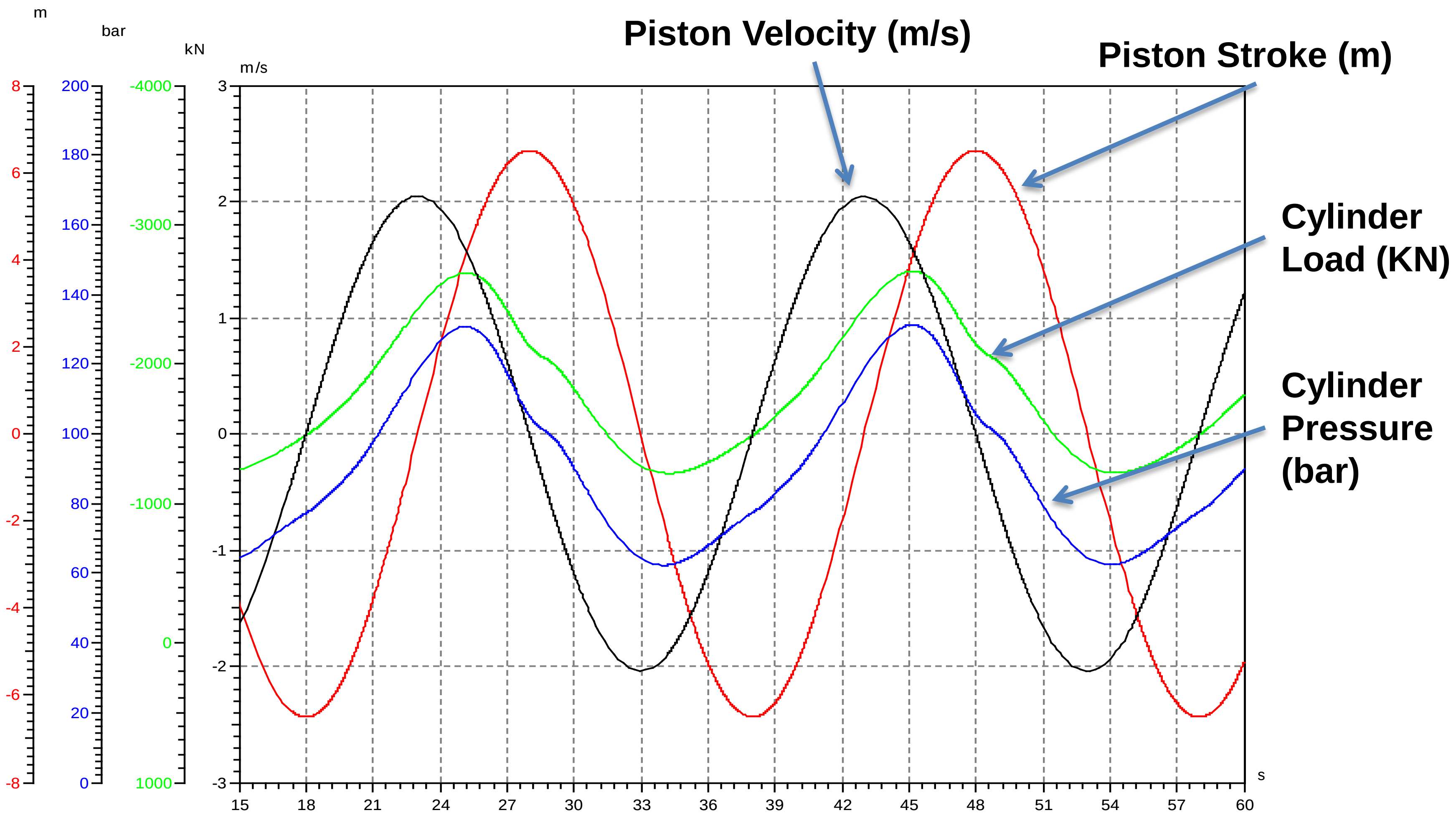
Direct Acting Tensioner System (DAT)

- Slip Ring – Direct Connection
- Trip Saver
- Up to 5,000,000 lbs Capacity
- 50ft Stroke Capacity
- Manufacturer – NOV N-Line, Aker MH
- Vessels – 5th & 6th Generation

Direct Acting Tensioner System (DAT)

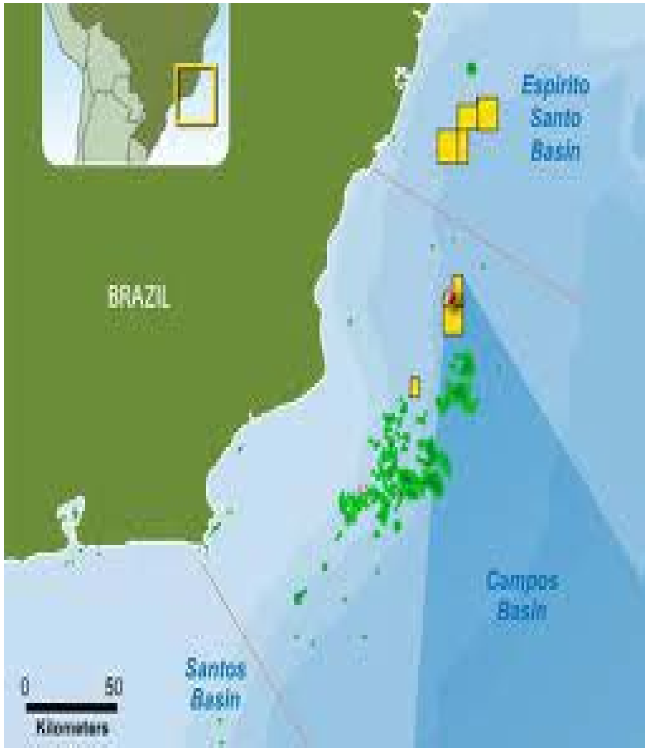


Dynamic Characteristics – DAT System



Case Study #1 – Offshore Brazil, 7,000ft Water Depth

- Location – Offshore Brazil
- Water Depth – (approx 7,000ft)
- Max Connected Seastate – (based on 8m allowable vessel heave)
- Max Drilling Seastate – (based on 5m allowable heave)
- Mud weight – Max 12ppg
- Tensioning System – 6 Cylinder DAT System rated to 3600 kips
- **Key Requirements – Maintain positive riser tension and keep wellhead loading to a minimum.**



Case Study #1 – Top Tension Methodology

API RP 16Q

$T_{min} = T_{SRmin} N/[R_f (N-n)]$

Tension (kips)	1515
Mud (ppg)	10
T_{SRmin} (kips)	1200
N	6
n	1
Rf	0.95

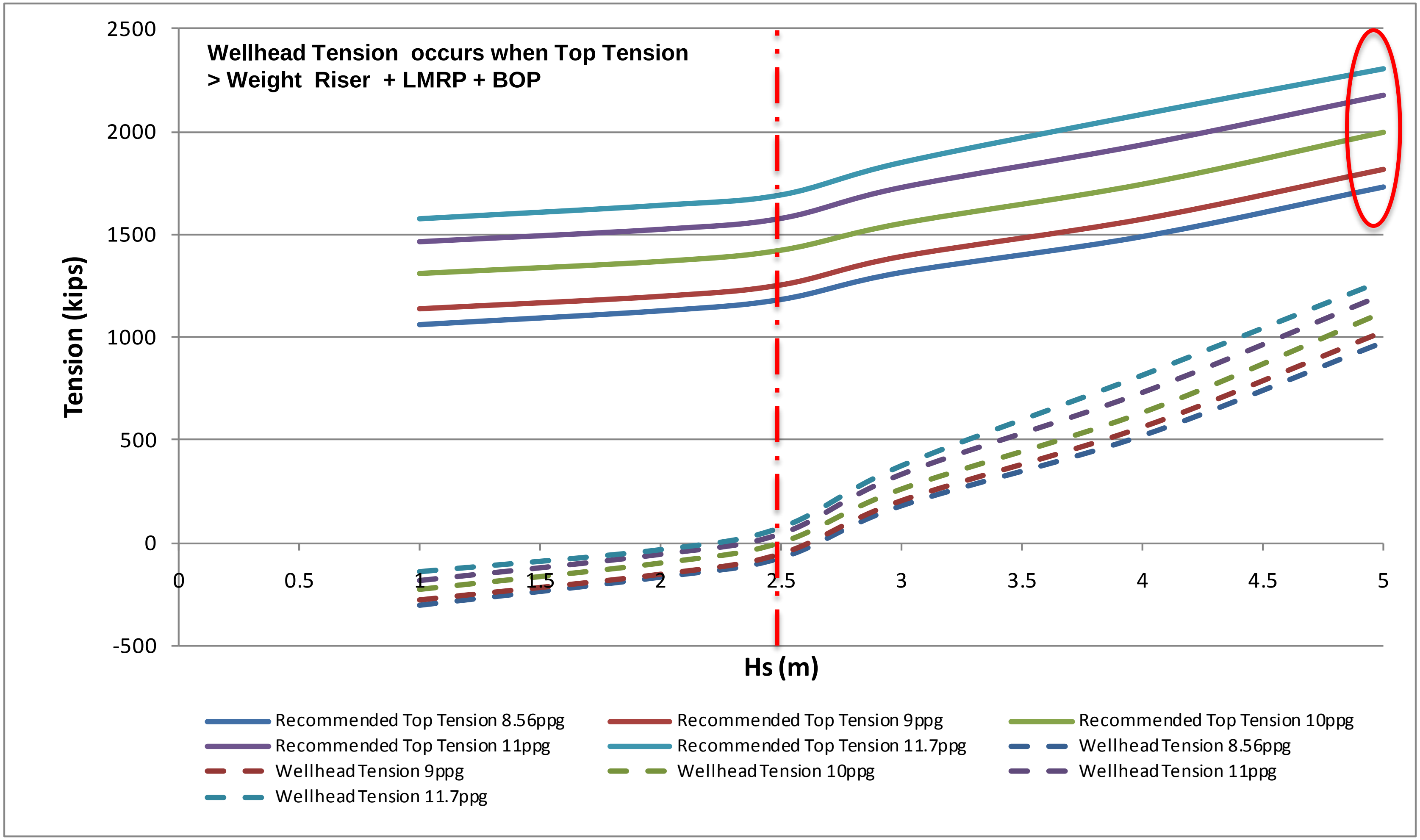
Detailed Tensioner Model

Seastate – Max Connected

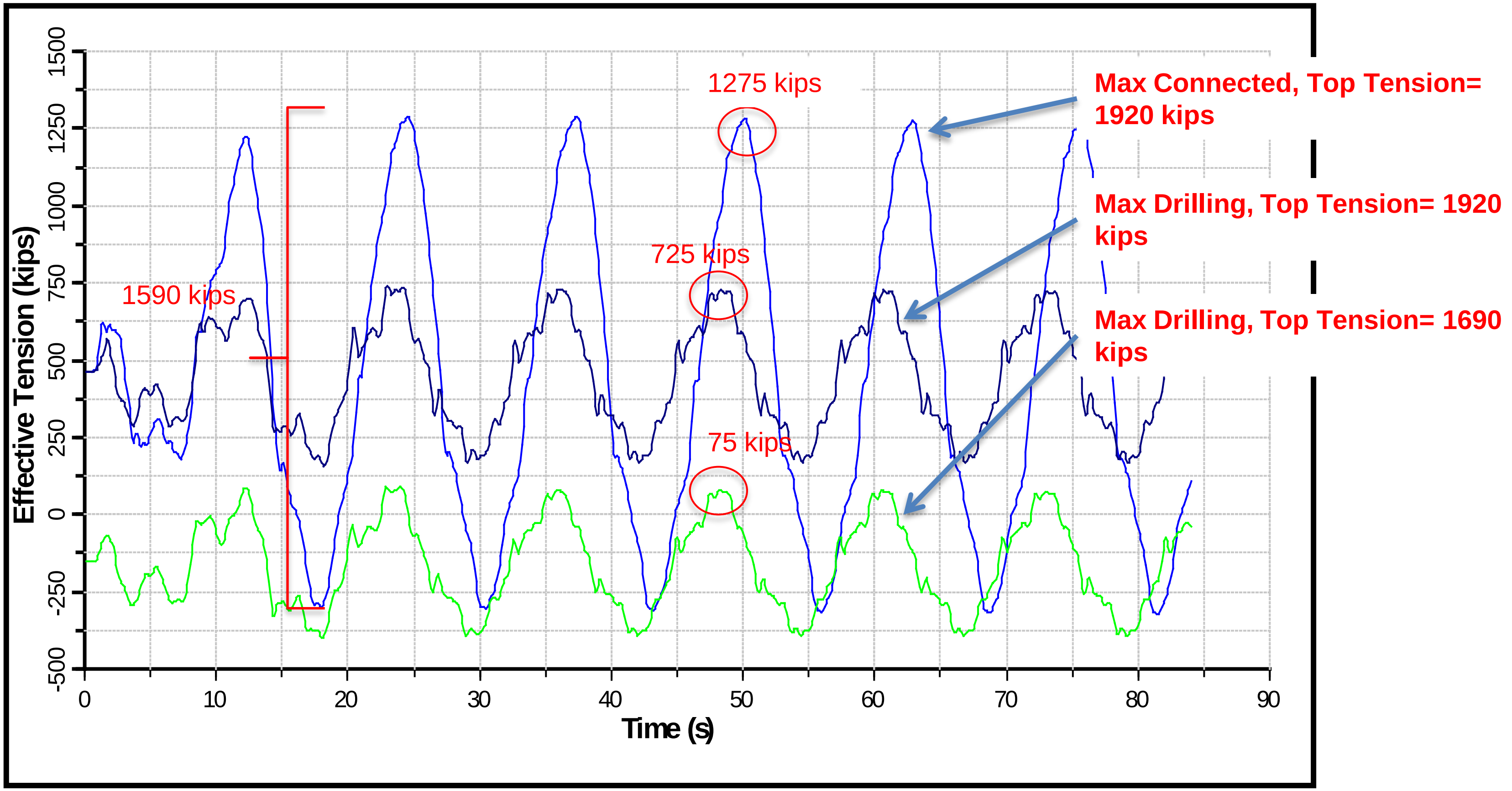
Tension (kips)	1920
Mud (ppg)	10
T_{SRmin} (kips)	1200
N	6
n	1
Rf	0.75

Detailed Tensioner Model – Iterate on top tension for given seastate to achieve positive tension at base of riser (factored up by 1.2 to account for 1 tensioner failure)

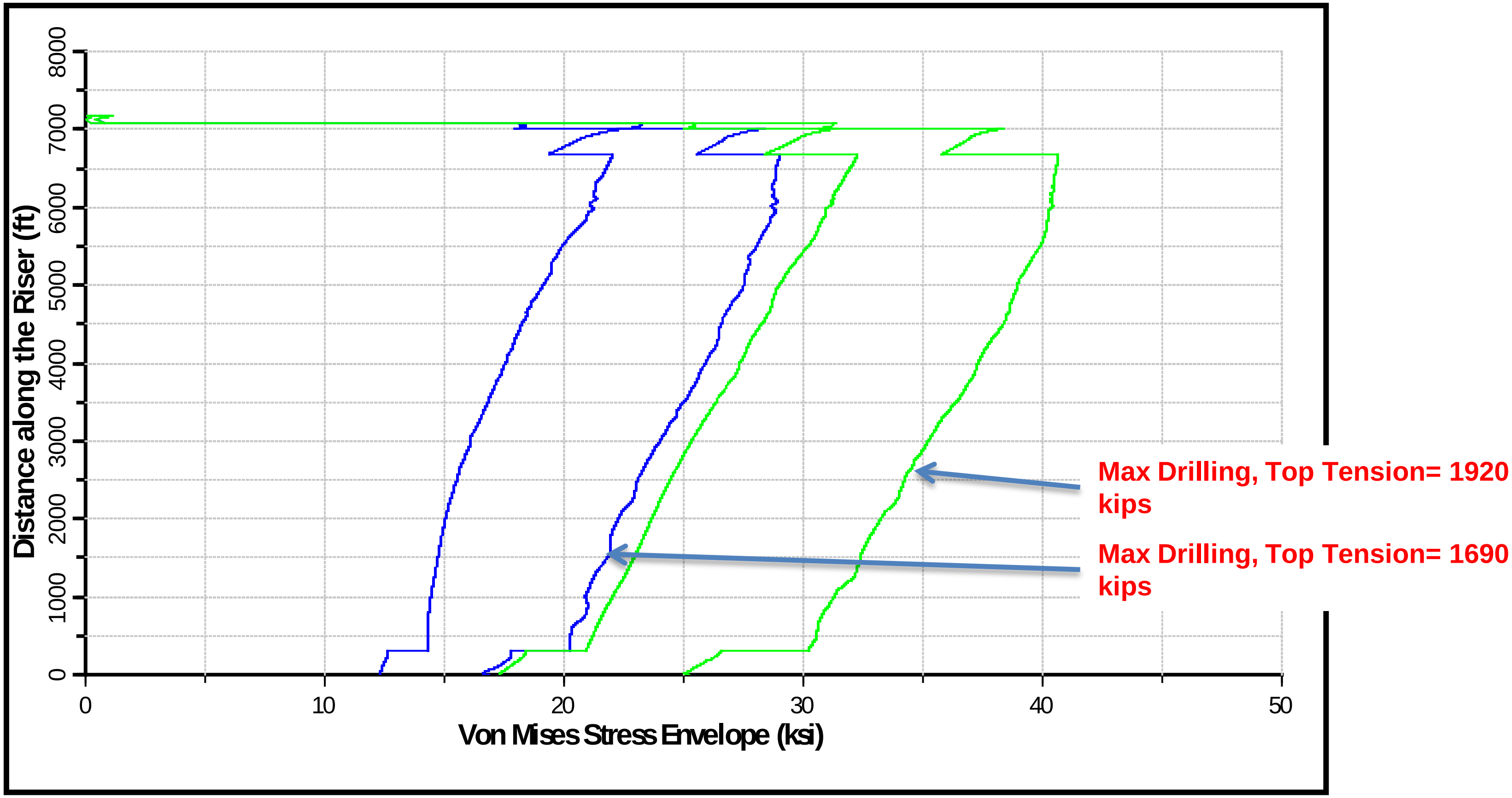
Case Study #1 – Top Tension V Wellhead Tension



Case Study #1 – Wellhead Tension Variations

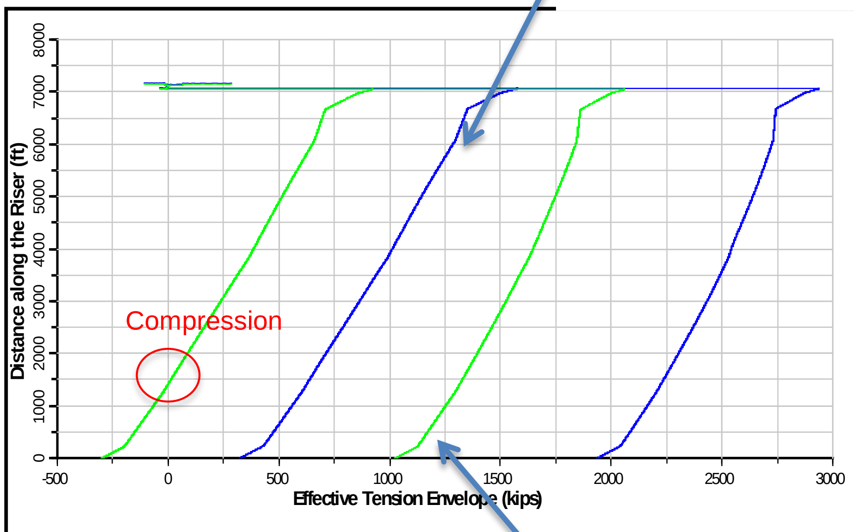


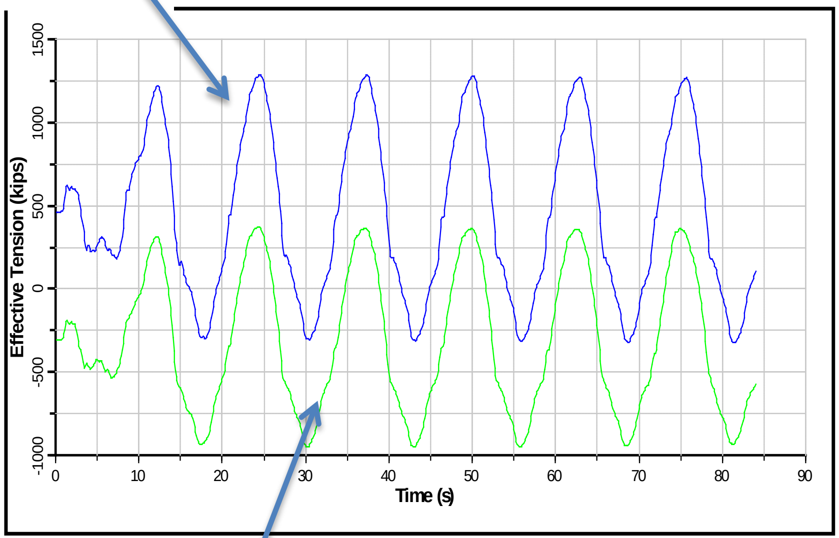
Case Study #1 – Riser Stress Comparison



Case Study 1# – Detailed Tensioner Model With API Top Tension

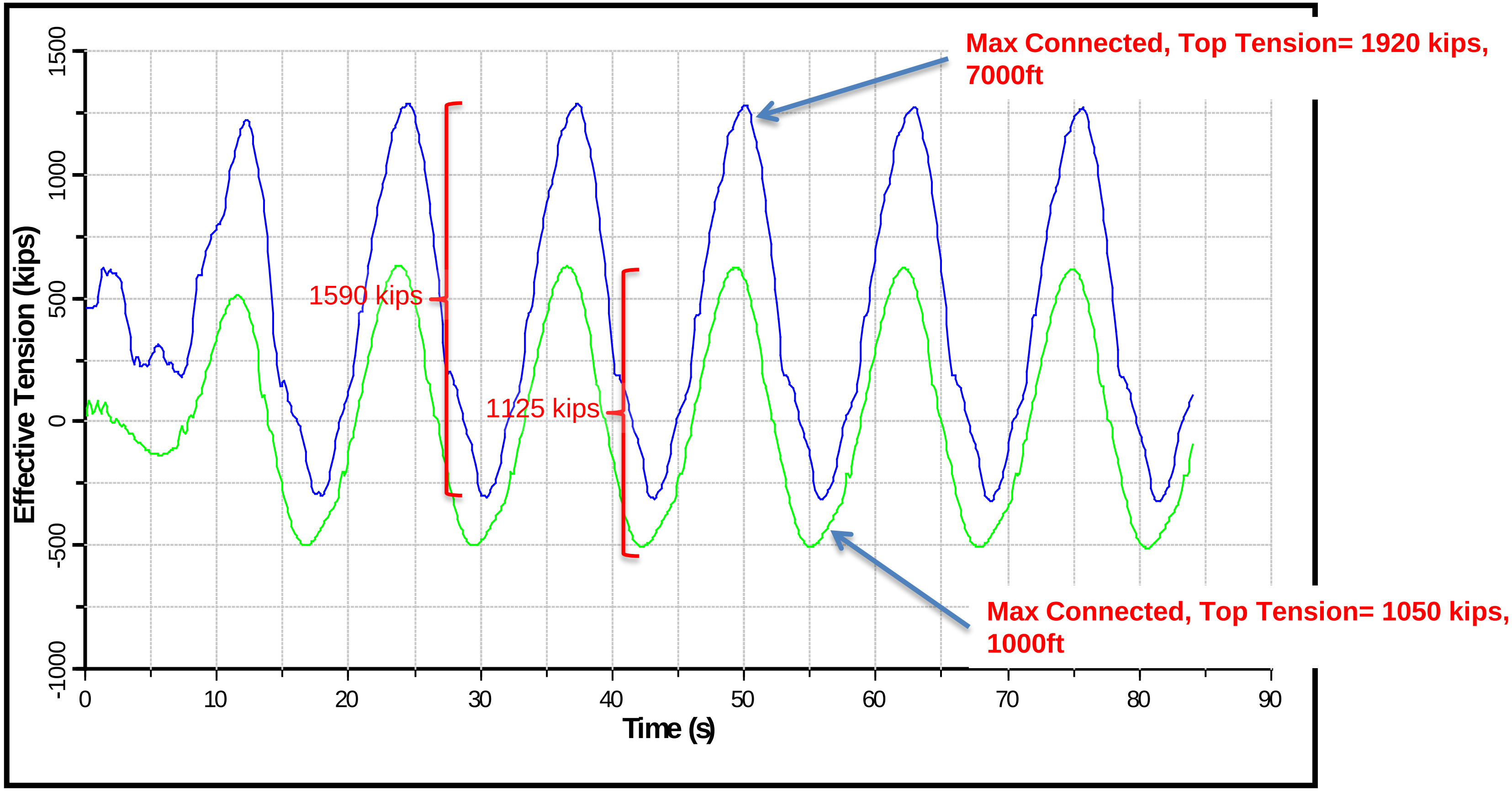
Max Connected, Top Tension=1920 kips, 7000ft





Max Connectd, API Top Tension=1515 kips, 7000ft

Case Study #1 – Shallow Water (1,000ft) - Wellhead Tensions



Case Study #2 – North Sea, 4200ft Water Depth

- Location – North Sea
- Water Depth – 4,200ft
- Vessel – 6th Generation
- Tensioning System – 6 Cylinder DAT System rated to 3600 kips
- Wellhead Stick-up – 12ft
- Conductor System – 36” x 20” – 200ft BML
- Soil Type – Soft
- **Objective – Assess Fatigue Damage – Detailed V Simplified Tensioner**

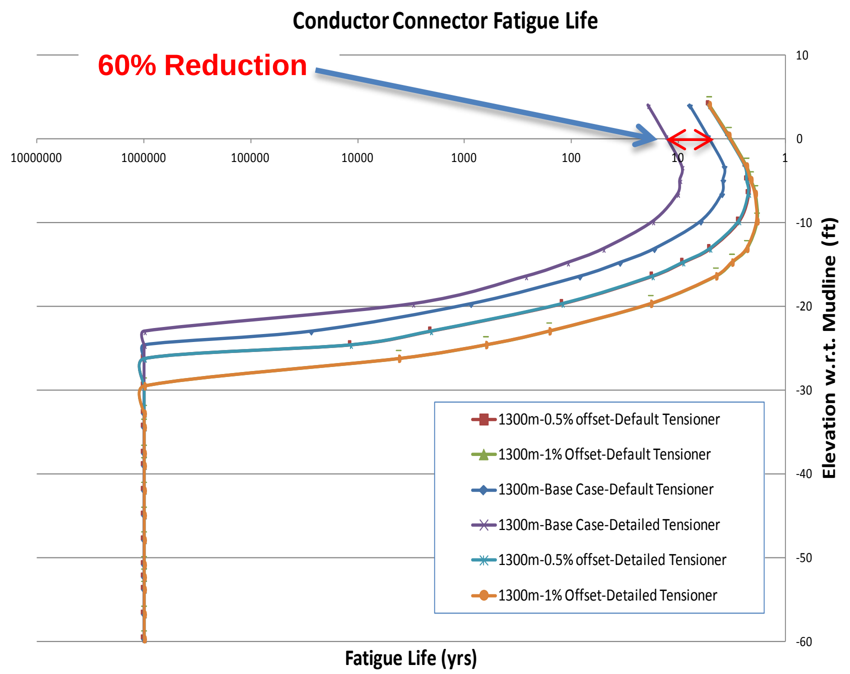
Case Study #2 – Effect of Tensioner Model on Fatigue Life (yrs)

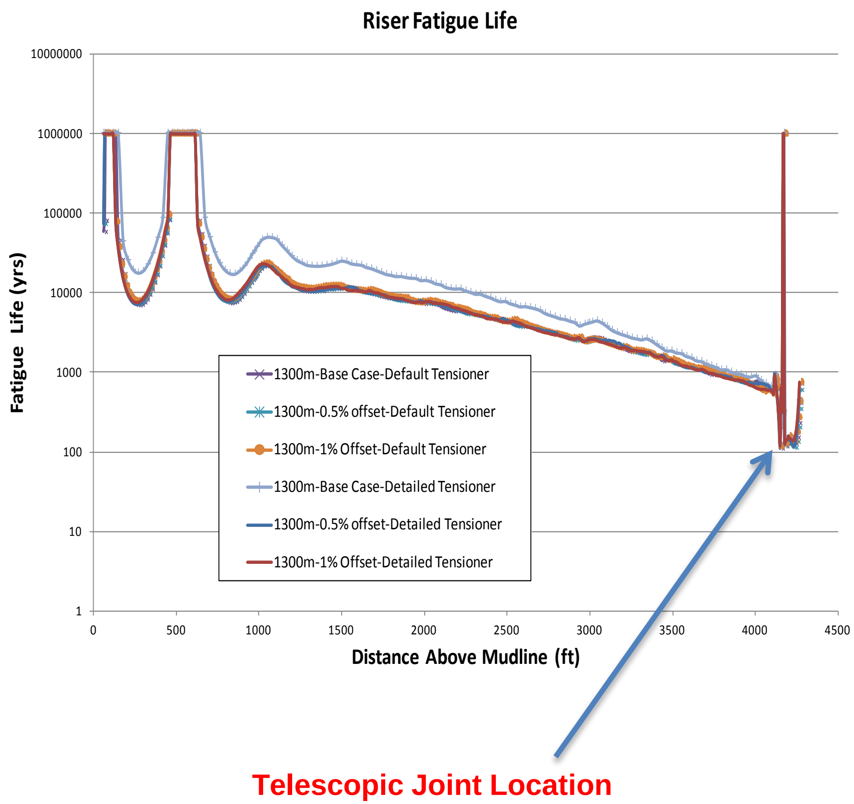
- Riser: SCF=1.3, DnV E Curve Conductor: SCF=5.0, DnV B1 Curve

Location	Detailed Tensioner model			Simplified Tensioner model		
	0m offset	6.5m offset	13m offset	0m offset	6.5m offset	13m offset
Drilling Riser	**124.5**	117.6	123	**112.5**	115.3	118.7
LPWHH Weld	**2.5**	0.74	**0.10**	**4.2**	0.72	**0.15**
36-inch Conductor	**9.3**	2.2	1.9	**3.7**	2.2	1.8

- Unfactored Fatigue Life

Case Study #2 – Effect of Tensioner Model on Fatigue Life (yrs)





Key Conclusions

- Accurate Fatigue & Riser modelling must incorporate tensioner load variations – Drilling & Intervention Fatigue Budgets
- Modern tensioning systems - Large wellhead tensions and stress ranges for large seastates
- Existing API top tension recommendations – Riser compression
- Accurate seastate forecasting – Reduce top tensions and risk of wellhead fatigue issues
- Tension primarily dependent on stroke velocity - Independent of water depth

Acknowledgements

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Thank You

Any Questions?