


DRILLING RISER FATIGUE AND WEAR IN DEEPWATER ENVIRONMENTS

by
Dr Hugh Howells and Stephen Hatton

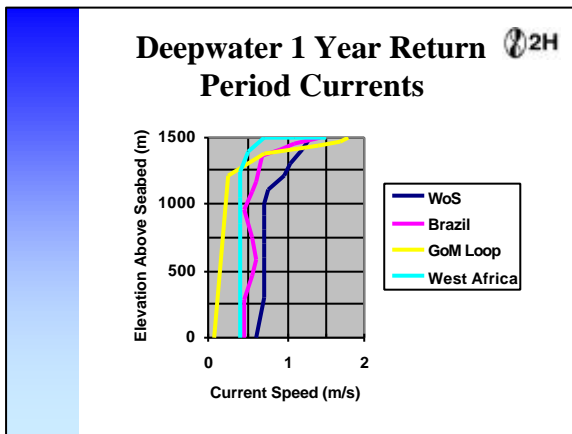

2H Offshore Engineering Ltd

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Introduction

- VIV - effects and implications
- Wear - reasons for concern
- Inspection of deepwater drilling risers
- VIV and wear mitigation
- Alternative riser configurations
 - Slimline, FSDR, Liner,

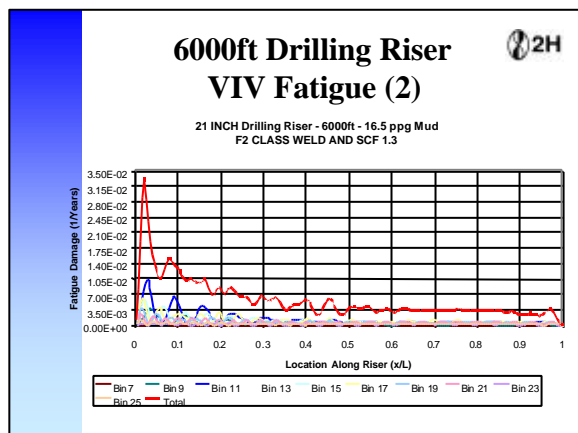
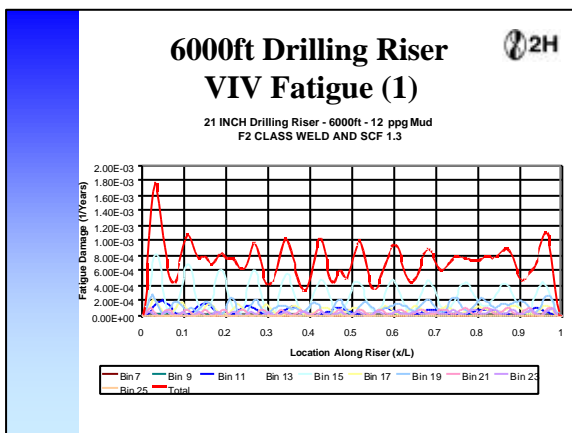



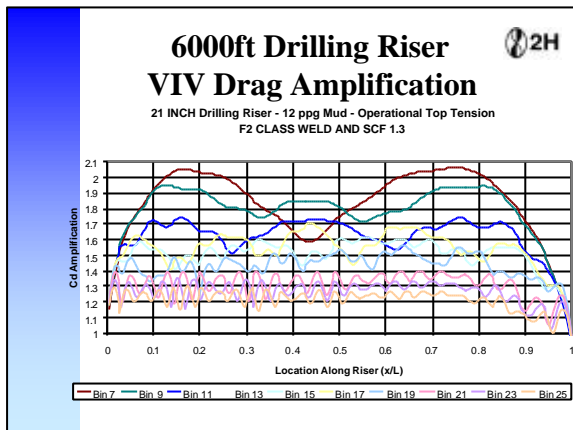
VIV Effects

- High rates of fatigue damage
- Increased drag loading



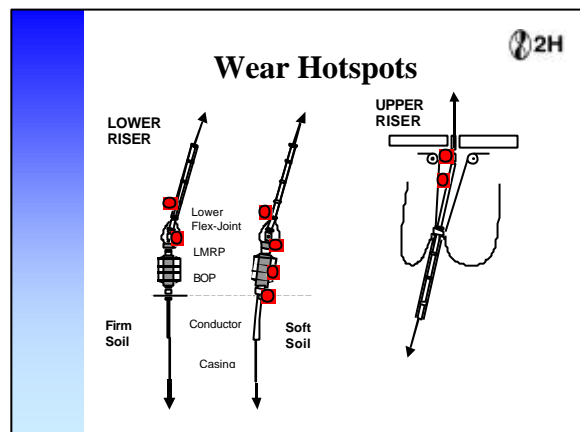
The diagram illustrates the formation of vortices around a riser, leading to VIV. The vortices are shown as swirling patterns around the riser, which is depicted as a vertical line.





- ### Implications of VIV
- High rates of fatigue damage
 - Increased top tension
 - Increased vessel and base loading
 - Suppression devices
 - Increased drag loading
 - Increased curvature
 - More wear
 - More downtime

- ### Deepwater Wear Considerations
- Larger mean angles
 - Larger tensions
 - Higher external pressures
 - 2667/4445psi at 6,000/10,000ft
 - Higher internal pressures
 - 4393/7321psi 14ppg mud, 6,000/10,000ft
 - Integrity of wall more important



- ### Approach to Limit Wear
- Flex joint angle limits
 - 2 degrees mean, 4 degree max (API)
 - Criteria based on historical performance
 - Deepwater limits?
 - 0.5 to 1 degree mean used by some drilling contractors

Deepwater Inspection Issues

Increased fatigue damage
+
Increased wear
=
More detailed inspection
+
More frequent inspection

Riser Inspection

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- Shallow water approach
 - total kip-days
 - 1 year usage approach
- Deep water
 - increased wear
 - increased fatigue
- Cost:
 - 6000ft, 80 No 75ft joints, \$5,000/jt
 - at 75% usage = \$3M/year, \$8000/day

Inspection Difficulties

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- Joint length - 75-90ft
- Joint weight - 60-70kips
- Difficult to handle - damage to buoyancy
- More remote - longer turn around
- More joints
- More expensive
- Need to rationalise
- Need to improve response

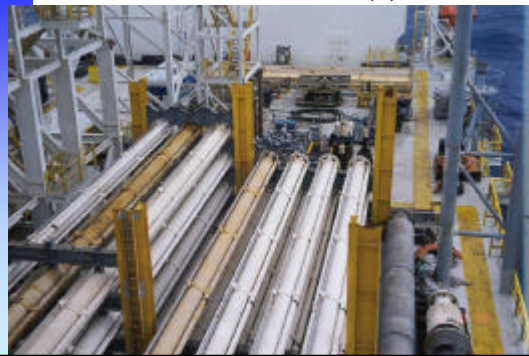
Riser in Rack

2H



Riser Joint Rack (1)

2H



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VIV and Wear Mitigation

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- Using existing equipment
 - Top tension
 - Joint rotation
 - Suppression devices
- Novel approaches
 - Slimline risers
 - Liners
 - Free-standing risers

VIV Reduction by Increasing Tension



- Vessel capacity may limit ability
- Limited benefit in very deep water
 - change in mode
 - change in frequency
 - partial reduction
- Increased load on wellhead system

VIV Fatigue Reduction by Joint Rotation

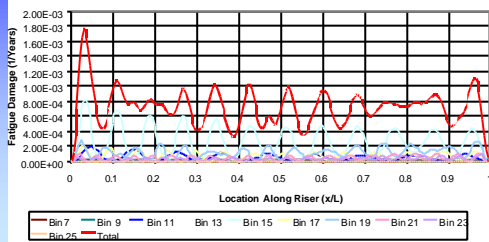


- Fatigue damage concentrated in lower joints - 2, 3, 4
- Rotating spreads high damage over a number of joints
- Joint storage may limit scope for rotation
- Use of different joints may limit rotation

VIV Fatigue at Riser Base



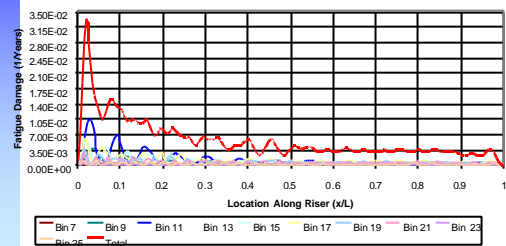
21 INCH Drilling Riser - 6000ft - 12 ppg Mud
F2 CLASS WELD AND SCF 1.3



VIV Fatigue at Riser Base



21 INCH Drilling Riser - 6000ft - 16.5 ppg Mud
F2 CLASS WELD AND SCF 1.3



VIV Fatigue Reduction by Joint Rotation



- Fatigue damage concentrated in lower joints - 2, 3, 4
- Rotating spreads high damage over a number of joints
- Joint storage may limit scope for rotation
- Use of different joints may limit rotation

Riser Joint Rack (2)



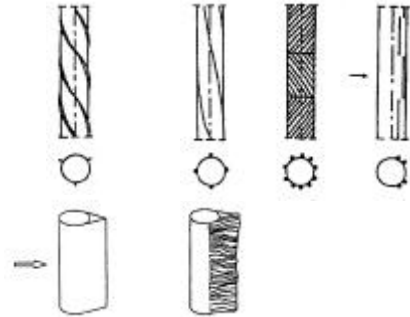
VIV Suppression

2H

- Strakes
 - increased drag, rotation, wear
 - may be pre-installed but increased RT opening required
 - lower cost
- Fairings
 - reduced drag and less downtime
 - increased installation time
 - larger cost

VIV Suppression Systems

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SCR Strakes

2H



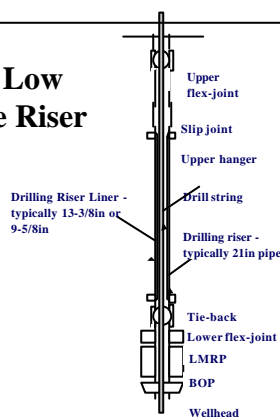
Slimline Risers

2H

- Same arrangement as 21in riser
- 16in or 13-3/8in riser tube
- Omit larger casing sizes
- Reduced diameter gives:
 - reduced riser and mud weight
 - less buoyancy and riser top tension
 - improved circulation
- Requires new riser system

Lined Low Pressure Riser

2H



Lined Riser Features

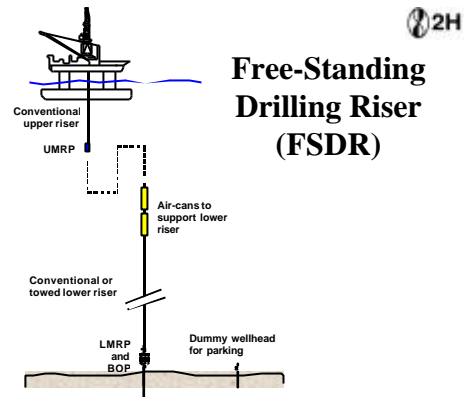
2H

- 9-5/8 or 13-3/8 inner casing
- High strength steel for low weight
- Different fluids in inner and outer annuli
- Hung from below slip-joint
- Packed-off above termination spool at bottom

Liner Benefits



- Reduces mud pressure on 21in string
- Reduces tension in 21in string
- Reduces wall thickness
- Reduces buoyancy (diameter) and tension
- Reduces wear on 21in string
- Reduces mud volume and disconnect loss
- Improves hang-off response
- Reduces VIV through mass damping



FSDR Features



- Quick retrieval and re-connection of upper riser
- May disconnect for severe currents
 - reduced VIV
- More responsive to hurricane warnings
- Reduced implications of false alarms
- Reduced vessel tension
- Enables use of older vessels

Summary



- VIV fatigue and wear drive inspection of deepwater drilling risers
- Inspection can be costly
- Benefits of increased tension may be small
- VIV suppression adds to downtime
- Novel arrangements offer many benefits
- Experience will drive development