TECHNICAL PAPER

Drilling Riser Fatigue & Wear in Deepwater Environments

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DRILLING RISER FATIGUE AND WEAR IN DEEPWATER ENVIRONMENTS

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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,

Deepwater 1 Year Return Period Currents

VIV Effects

- High rates of fatigue damage
- Increased drag loading

6000ft Drilling Riser VIV Fatigue (1)

6000ft Drilling Riser VIV Fatigue (2)

Learn more at www.2hoffshore.com
6000ft Drilling Riser
VIV Drag Amplification

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

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Riser Inspection

• Shallow water approach
  – total kip-days
  – 1 year usage approach

• Deep water
  – increased wear
  – increased fatigue

• Cost:
  – 6000ft, 80 No 75ft joints, $5,000/ft
  – at 75% usage = $3M/year, $8000/day

Inspection Difficulties

• 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

Riser Joint Rack (1)

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VIV and Wear Mitigation

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

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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
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Riser Joint Rack (2)
VIV Suppression

- 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

SCR Strakes

- 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

Slimline Risers

Lined Low Pressure Riser

- 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

Lined Riser Features

Learn more at www.2hoffshore.com
**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

**Free-Standing Drilling Riser (FSDR)**

**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

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