DEEPWATER DRILLING RISER INTEGRITY - FATIGUE, WEAR, INSPECTION AND MONITORING
by
Dr Hugh Howells and Dave Walters
2H Offshore Inc
Presented at OMAE, New Orleans, February 2000

Introduction
- Characteristics of deepwater drilling risers
- VIV - effects and implications
- Wear - reasons for concern
- Inspection of deepwater drilling risers
- VIV and wear mitigation
- Monitoring requirements

Purpose of Drilling Riser Inspection
- Detect and quantify deterioration in integrity
- Sources of deterioration:
  - fatigue damage accumulation
  - impact / handling damage
  - wear from drill string rotation
  - corrosion

Deep Water v Shallow Water
- Larger tensions
- Larger internal and external pressures
- Longer, heavier riser joints
- Exposure to severe currents
- Subject to vortex induced vibrations
- Larger curvature

Deepwater 1 Year Return Period Currents

Effects of VIV
- High rates of fatigue damage
- Increased drag loading
6000ft Drilling Riser
VIV Fatigue (1)
21 INCH Drilling Riser - 6000ft - 12 ppg Mud
F2 CLASS WELD AND SCF 1.3

Fatigue Damage (1/Years)

Location Along Riser (x/L)


6000ft Drilling Riser
VIV Fatigue (2)
21 INCH Drilling Riser - 6000ft - 16.5 ppg Mud
F2 CLASS WELD AND SCF 1.3

Fatigue Damage (1/Years)

Location Along Riser (x/L)


6000ft Drilling Riser
VIV Drag Amplification
21 INCH Drilling Riser - 12 ppg Mud - Operational Top Tension
F2 CLASS WELD AND SCF 1.3

Cd Amplification

Location Along Riser (x/L)


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

Wear in Deep Water
• 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

Wear Hotspots

• Lower Risers
• Conductor Casing
• Soft Soil
• Firm Soil

• Upper Risers
• Lower Interlock
• Upper Interlock

LOWER RISER
UPPER RISER
Wear Control

- 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 Integrity Issues

- Increased fatigue damage from severe currents
- Increased wear from riser curvature
- Increased susceptibility to handling damage from the use of longer, heavier riser joints
- Increased wall thickness integrity required to accommodate higher tensions and pressures

Status of Drilling Riser Inspection

- Shallow water
  - total kip-days
  - 1 year usage approach
- Deep water
  - increased wear and fatigue
  - limited long term experience
  - strategies need to be defined

Deepwater 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

Riser in Rack

Riser Joint Rack (1)
Deepwater 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

How to Rationalise?

- Fatigue based approach:
  - Severity of operating conditions
  - Time in service
  - Inspection detail
  - Inspection frequency
  - Inspection coverage
- Wear
  - Joint position
  - Time in service

Fatigue Crack Growth

Lower Riser - Surface Crack Growth

How to Rationalise?

- Fatigue based approach:
  - Severity of operating conditions
  - Time in service
  - Inspection detail
  - Inspection frequency
  - Inspection coverage
- Wear
  - Joint position
  - Time in service

Influence of Operational Practices

- Tension and tension variation
  - reduced VIV, vessel capacity may limit, increased wellhead loading
- Joint rotation
  - spread fatigue damage
  - scope may be limited
- Flex-joint angle limits
  - reduced limits give less wear
  - more downtime

VIV Fatigue at Riser Base
Deepwater Inspection Strategy

- Use current time based approach as basis
- Account for increased wear and fatigue
- Account for operational practices

Variables to Accommodate

- Drilling in different water depths
- Different usage of different joints
  - lower rated joints used more often
- Actual operating conditions
  - may be more or less severe than predicted
- Requires rigorous usage logging

Usage Logging Requirements

- Operations log
  - riser history
- Riser stack-ups
  - joint position and dates
  - basis for selective inspection
- Operating conditions
  - tension, mud-weight, drill string tension, current and wave
  - verify operation and identify extreme events

Summary

- Current inspection practices must be extended for long term deepwater drilling
- Rationalisation dependent on:
  - depth and environmental conditions
  - time each joint in service
  - operational practices
- Logging necessary to verify correct operation and enable selective coverage
- Experience will enable refinement