Drilling Riser Design Challenges and Improving Integrity

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Drilling Riser Design Challenges and Improving Integrity

Session 3: Drilling and Completions
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Should we be concerned?
Objectives

- Loading
- Design Issues and Field Problems
- Strength and Fatigue Assessment
- Past Failures
- Integrity Monitoring and Effective Operations Management
Design Challenges

- Uncertainty in soils and currents
  - Limited or no data for new regions
- Uncertainty in rig selection
  - Want to assess fitness-for-purpose before selection
  - Data may not be available
- Lack of guidance on wellhead selection
  - Why choose one over another
- Variability in casing programme
  - No two programmes are the same
  - Variability in soil properties
    - Even when data is defined we have to work between bounds

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Loading

- Well Construction Loads (Exploration and Development)
  - Weight of casing
  - Pressure from mud, cement and formation fluids
  - Temperature
- Drilling Mode (Exploration and Development)
  - Weight of BOP and LMRP
  - Loads due to vessel offset
  - Wave action and first order vessel motions
- VIV response of riser (currents)
Loading

• Intervention/Workover Mode (Development)
  • Loading from drilling riser with horizontal tree in place
  • Loading from WO/completion riser (like drilling riser) – applicable on the wellhead and conductor system

• Production Mode (Development)
  • Snag loading from fishing gear
  • Thermal and pressure loading from well fluids

• Seismic (Development)
Unknowns

- How many slick/buoyant joints to use?
- Optimum top tension to pull?
- Limiting seastate/current loading for drilling operations
- Limiting seastate/current for staying connected to the wellhead with the BOP
- Response time to disconnect riser during mooring line/DP failure
- Strength and fatigue capacity
Operating Envelope

- Minimise rig down time with prior knowledge of field specific operating limits

Shreenaath Natarajan

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Operating Envelope

- Minimise rig down time with prior knowledge of field specific operating limits
Wellhead and Conductor System

- Wellhead and conductor components are integral part of the whole system
- Know the component limits and maximise rig operability

**What-Breaks-First Analysis For 350m Water Depth**

30in Conductor, Moderate Loading, 300kips Base Tension, 13.6ppg Mud

![Graph](graph.png)

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Fatigue Capacity

- How long can I stay connected to the wellhead?
- Do I expect to re-enter the well for intervention/workover?
- Is it possible to extend the drilling duration due to side-tracking of the well?
Can Failure Happen?

- High pressure housing to surface casing weld fatigue failure

Censored intentionally

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Can Failure Happen?

- Soft soil coupled with large motions

Censored intentionally

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Field Problems

• Design Issues
  • Inadequate fatigue life, usually VIV driven
  • Changes in vessel and riser arrangement

• Field Problems
  • External cement shortfall
  • Conductor-casing cement shortfall
  • Wellhead stick-up
  • LP to HP housing lock malfunction
  • Extended drilling /workover operations
Conductor and Casing Installation Issues

• Elevation Tolerance
  • +2m not uncommon (drilling or jetting)
  • Adds to lever arm of loading on wellhead
  • Can make VIV response severe

• Inclination Tolerance
  • Typical target +/- 1.5 degrees
  • Expectation less than 0.5 degrees due to weight of conductor
  • Quality dependent on care during initial penetration
    • Vessel position
    • Current conditions
    • Soil uniformity
Improving System Integrity

- BP Schiehallion – severe currents and high VIV in 350-500m West of Shetland
- BP GoM – severe currents
- BP West Nile Delta VIV (4 well campaign)
- Statoil – old wells, new vessels with big BOP’s and large motions observed
- Total – severe currents and high VIV in 350-500m West of Shetland
- Woodside, Petronas, Repsol, and many others..
Improving System Integrity

- Norwegian North Sea
  - Motions and Fatigue
- West Nile Delta
  - Fatigue
- 3 Axis Accelerometer
- Dual axis angular rate
- Loggers located on
  - BOP
  - Wellhead
  - Conductor
  - Template
- Magnetic Holders
  - ROV Installed

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Conclusions

• Design issues due to complex response and lack of prior field specific data can be overcome by the following:
  • Develop operating envelopes and incorporate in to a manual
  • Observe requirements of the manuals
  • Record operating conditions and confirm limits are not exceeded
  • Record times on well
  • Monitoring riser/wellhead to confirm acceptable fatigue response
  • Calibrate analysis software
  • Verify design data – soils, currents etc