SPE-166589-MS
Structural Response Monitoring Of Huntington HP Drilling And Completion Riser

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OUTLINE

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HP system design challenge

HP riser system description

Reasons for monitoring – Riser analysis outcomes

Riser monitoring system

Measured data vs predictions

Lessons learnt

Summary and Conclusions
BACKGROUND

Increased use of HP risers to drill and complete subsea wells from jackup rigs:
- Deeper water depths (>>70m)
- More challenging locations and environments
- Longer duration of operations

Increased requirement to collect in-situ data to:
- Confirm riser design acceptable
- Calibrate analysis models
- Confirm riser integrity through operations
HUNTINGTON HP RISER DESCRIPTION

Block 22/14b of North Sea

“Deep” 91m water depth

Heavy duty jackup MODU

Harsh environment

24inch OD, 1.5inch wall HP riser

18 ¾” surface BOP

350Te Tensioning System

18 ¾” subsea housing
HP RISER DESIGN CHALLENGE

Detailed analysis required to confirm:
• Tensioning requirements
• Design code acceptance
• Operating guidance

Detailed analysis challenges:
• Predictions of marginal performance
• Conservative approach?
• Effect of assumptions?
• Limitations of our knowledge?
• Safety margin understood?
DETAILED RISER ANALYSIS OUTCOMES

Acceptance of HP riser and operating guidance to be developed for:
- Strength (up to 50 year storm)
- Wave fatigue (>1 year design life)
- Vortex induced vibration fatigue (>1 year design life)
- Operating & Installation envelopes

Key challenges to Huntington HP riser:
- High CTU deck loads – lateral & vertical
- High stresses in tension / stress joint
- Acceptance only achieved through:
  - Design change
  - Reduced analysis conservatism
  - Careful management of tension based on weather forecast (fatigue vs extreme loads trade-off)
  - Careful management of pressure based on weather forecast
WHY MONITOR AT HUNTINGTON?

A number of integrity threats from riser analysis and risk assessment identified:
• CTU deck loads
• Tension joint loads
• CTU failure
• Rig settlement
• Fatigue

Assumptions in the analysis = uncertain safety margin

Long duration of operations

Monitoring to verify analysis & confirm loads/deflections/fatigue within safe limits
HUNTINGTON HP RISER MONITORING SYSTEM

- Acoustic Doppler Current Profiler
- Wave Radar
- Jackup (3 axis accelerometer)
- CTU Deck EEXD box (3 axis accelerometer, CTU cylinder pressures)
- Tension Joint EEXD box (3 axis accelerometer + 2 axis angular rate)
- Central Control Console (with Communication link to shore)
- Tension Joint Strain Stick

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MEASURED VS PREDICTED DATA COMPARISON

Fatigue predictions during intervention operation not conservative – accelerated fatigue damage!
MEASURED VS PREDICTED DATA COMPARISON

Why?
- Other fatigue sources
- Jackup motion assumption
- Other modelling assumptions
- Model doesn’t include intervention riser string or coiled tubing

Difficult to calibrate model for all conditions & due to data scatter
- Apply calibration factor

Fatigue design limits not exceeded
MEASURED VS PREDICTED DATA COMPARISON

The monitoring equipment therefore:
• Demonstrated equipment operated within design limits
• Provided estimates of the residual design fatigue

Based on this information the operator can make informed decisions:
• Can riser continue to be operated safely
• Do critical joints in the system need inspecting
• Do critical joints in the system need replacing
• Is increased/reduced frequency of monitoring data review required

Usage of the riser can be better managed to ensure integrity and safe operation.
LESSONS LEARNED

• Extreme response difficult to verify.
• The ADCP should be installed away from the jackup leg - interference when the ADCP is blown next to the leg.
• The drilling report should be used to tie rig events into monitoring data.
• Full current and wave information should be obtained to allow accurate analysis calibration, with directions measured and in the case of wave, the surface elevation timetrace recorded.
• Improved and more direct measurements of stroke and lateral loading (from strain) would improve accuracy of measurements.
• Results inferred from the analysis should be minimized to ensure a robust calibration factor between the model and measured data.
SUMMARY AND CONCLUSIONS

• Detailed riser analysis vital as part of planning process for offshore operations.
• Can be difficult to quantify safety margin – conservative approach to analysis and design adopted.
• Monitoring system deployed at Huntington to quantify safety margin and manage risks.
• Data collected highlighted that analysis can be under-conservative, but confirmed riser operated within design limits.
• Calibration of fatigue predictions possible using a “calibration factor”.
• Use of the real time monitoring system allows the fatigue usage of the system to be more actively managed.
• Extreme response of the system is difficult to verify.
• Further development of the system in progress (software & hardware).
Acknowledgements / Thank You / Questions

E.On E&P UK Ltd
Claxton
Pulse Structural Monitoring