Latest Developments in Subsea Wellhead and Riser Fatigue Monitoring
• Background to wellhead fatigue measurement

• Off line data collection

• Real time data collection

• Examples of information available to tune the riser model
Wellhead and Riser Fatigue Monitoring

Wellheads and risers are experiencing greater fatigue due to deepwater operations, heavier Blow Out Preventers (BOP) and deployment in areas of high ocean current.
“In the deep waters of the Gulf of Mexico, West Africa and Brazil...VIV may make the largest contribution to overall riser fatigue damage”

*Marintek, Review*

“size of the BOP...was found to increase by a factor of 17 the rates of fatigue damage”

*MCS Kenny, Offshore Magazine*
Background to Wellhead Fatigue Monitoring

WH system

Wellhead
Lock ring
Conductor Housing
Landing shoulder
Weld 30"
Weld 20"
“There is potentially large conservatism in conductor fatigue estimates due to use of SN curves, safety factors and ignoring compression”

“Complex fatigue life analysis models provide predictions but are conservative”

But…

“Operational decisions … often based on extrapolation of the pre-analysis results and not on actual data”
Background: R&D Activities and Outcomes

- Ongoing wellhead fatigue JIP
- Some operators undertaking major R&D exercises
- Strain measurements on the conductor and on the 20”
- Lower Marine Riser Package (LMRP) motion can be used as a proxy for wellhead strain
- Motion measurements are much more readily achieved
Background: Life of a Wellhead - Three Strategies

• Follow the codes and standards, so instrumentation not required.

• Log wellhead usage information into a long term database. Provides a record, can look to maximise usage based on the design model.

• Optimise operations by obtaining fatigue data in real time.
Two ways of instrumenting during the lifecycle
Destination is the same, but operators with more confidence in the model can get added benefit with real time fatigue measurements during drilling.

- Real-time monitoring systems
  - More confidence in model
  - Measurements provide: Operational Guidance

- Self-logging systems
  - Less confidence in model

Measurements provide:
- Design Verification
- Fatigue Database
- Optimisation of Future Interventions
Option: Strain Sensor

- 2 pods on LMRP
- 2 pods above lower flex joint
- Option for strain measurements
• Same subsea motion pods used for offline and real-time systems

• Two pairs of linear accelerometers

• Two pairs of angular rate sensors

• Analogue 8 pole, anti-aliasing filter

• Typically sample at 10Hz
Offline Data Collection: Pre-Installed Receptacles

- Pods retrofitted by ROV
- Installation removed from critical path
- Relieves POB issues during riser running

Improves safety by reducing hazardous activities
Real Time Data Collection: ROV Installation
Real Time Data Collection: Enablers

Low power components
  • Logger, MEMS sensors

Lithium Metal Batteries
  • Negligible self-discharge, long shelf life
  • Maintain voltage level and current output before rapid discharge, highly predictable behaviour.

Subsea Data Processing
  • Transmit the necessary information in one hundredth of the size of the raw time series data.

Reliable Hydroacoustics
  • No requirement for data re-transmission
Summary – Self-logging approach

- With some forward planning:
  - Instrumentation can be deployed without the need for specialist instrumentation engineers offshore.
  - Installation can be performed by ROV, off the critical path.
  - Fatigue database can be developed over the life of the wellhead
  - NB: Operator needs to be sure to collect the other vessel and environmental parameters.
Summary – Real Time Approach

- Reliable wellhead fatigue data is obtained on a meaningful timescale (data transmitted every 15 minutes, fatigue data available with 30 minute lag)

- Fatigue information can be used to optimise operations.

- Model can be tuned in a timescale which makes the improvement useful for operations, in addition to improving fatigue history

- Long term deployment. One year battery life.
Self logging units with ROV recovery have been used to monitoring wellhead dynamic angles on a daily basis.
Backup locations on two sides of the LMRP. Usually one able to see the dunking modem.
Example Data – VIV Monitoring

- **Shell** required current and riser motion data for well in the little explored area of the Voring basin.

**Metocean and Riser Characterisation**

- 4x DD pods on riser (1.5 hours on, 3 hours off)
- 2x ADCP (1 downward looking, 1 upward from seabed)

**Install WARIS**

**WARIS Success**

- Analysis combining motion and current data to characterise VIV events
- Riser natural frequencies and mode shapes determined
- System designed and installed within 6 weeks

Run through of monitoring on Aker Barents at Voring basin

Waterfall plot showing excitation of various modes on riser
Risks
• Modelling identified short fatigue life.

Mitigations
• Verify pre-analysis model with measurements
• Track condition during drilling

Benefits for Client
• Measured motions demonstrated low fatigue
• Fatigue model was shown to be highly conservative
• Real time measurements allowed a rig operating envelope increase of 100%, and client saved 3 days that would have been lost to weather related wellhead fatigue concerns
Thank you

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