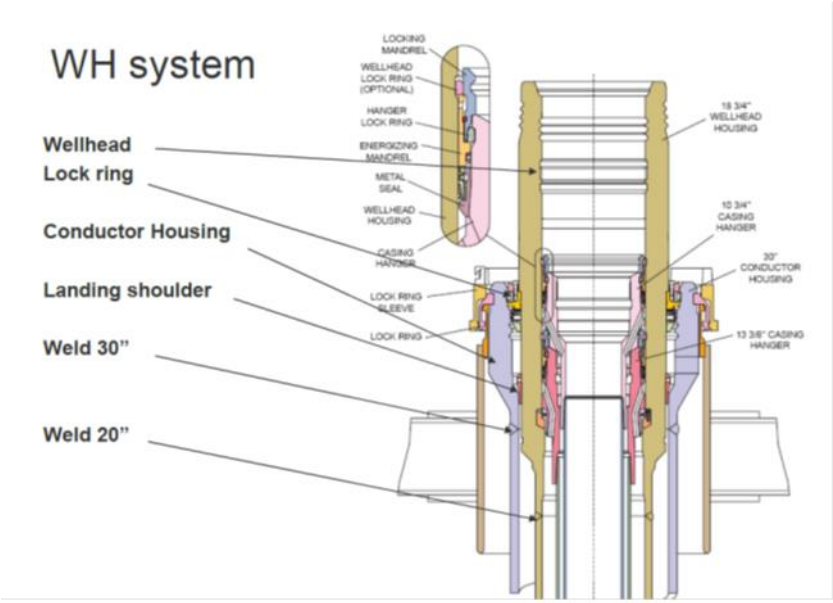
Latest Developments in Subsea Wellhead and Riser Fatigue Monitoring

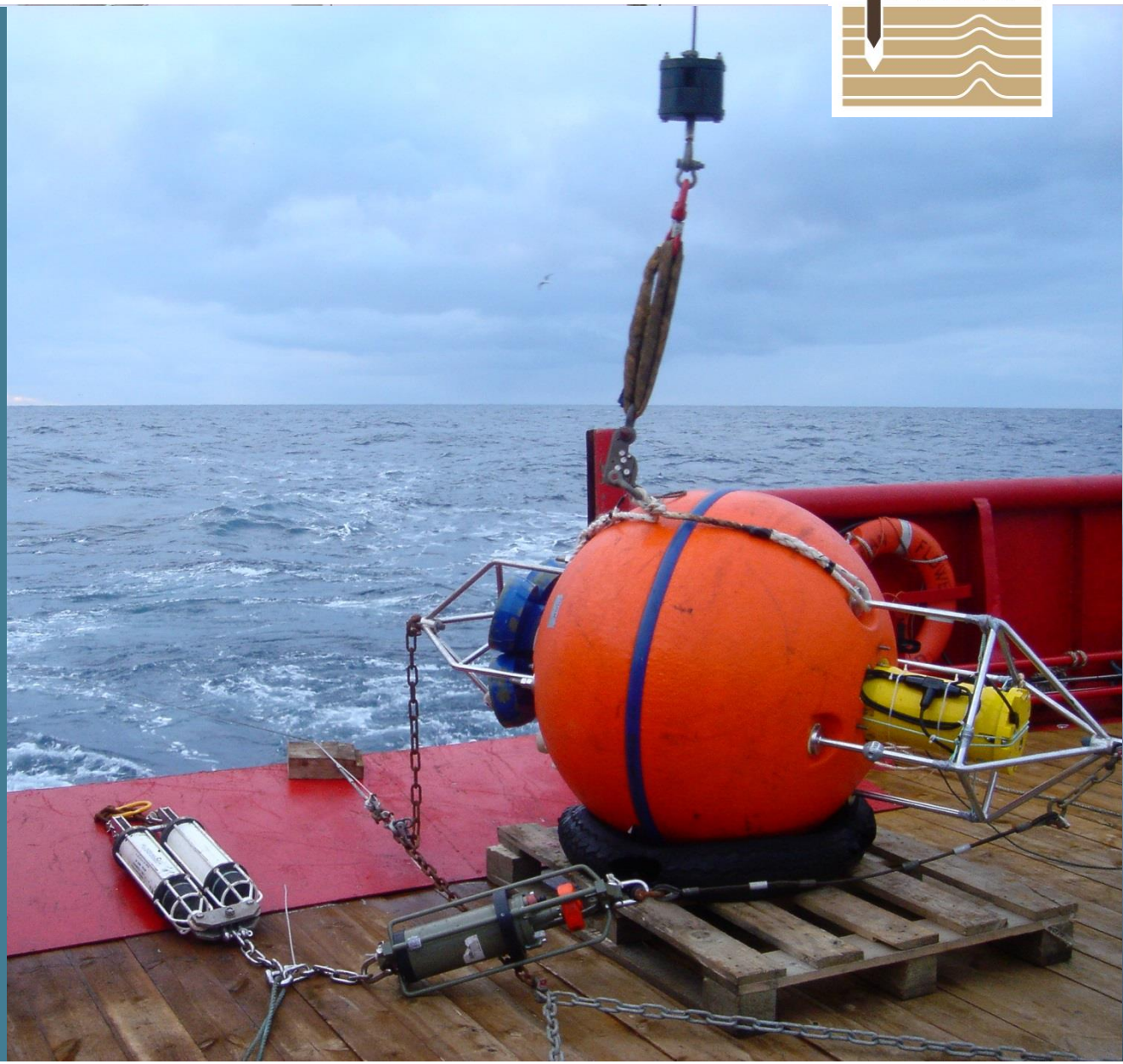
Wellhead and Riser Fatigue Monitoring

- **Background to wellhead fatigue measurement**
- **Off line data collection**
- **Real time data collection**
- **Examples of information available to tune the riser model**

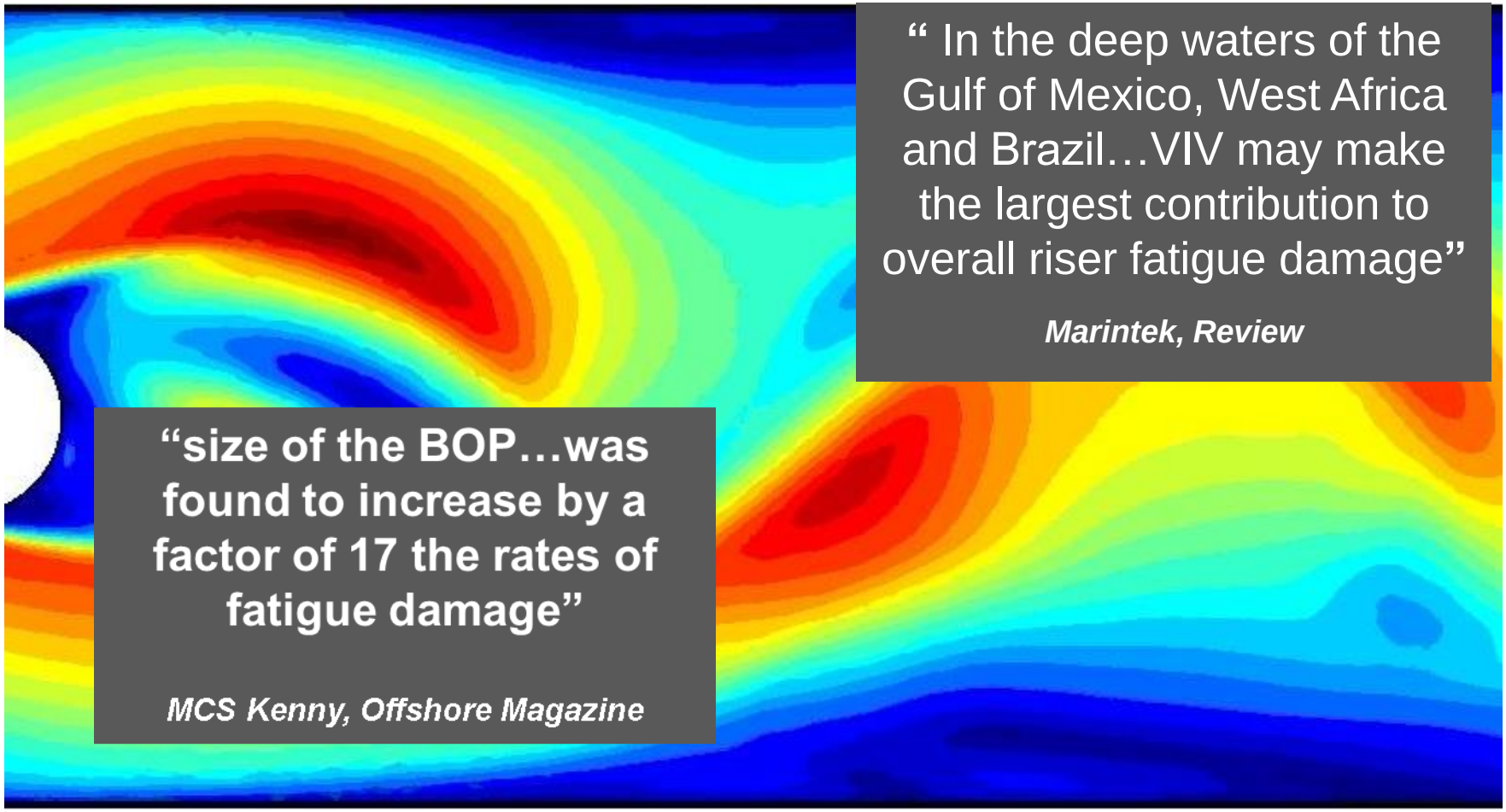


Wellhead and Riser Fatigue Monitoring

Wellheads and risers are experiencing greater fatigue due to deepwater operations, heavier Blow Out Preventers (BOP) and deployment in areas of high ocean current.



Wellhead and Riser Fatigue



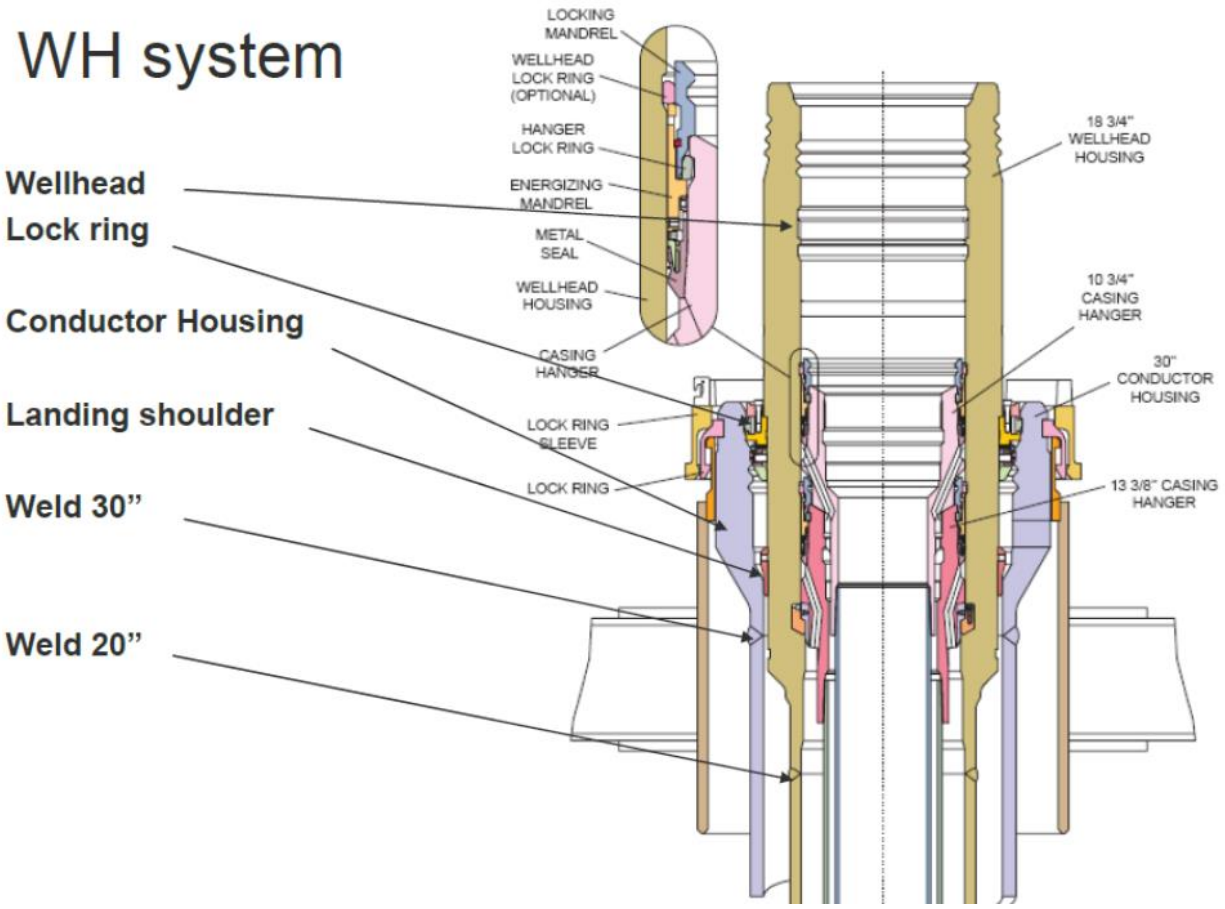
“ In the deep waters of the Gulf of Mexico, West Africa and Brazil…VIV may make the largest contribution to overall riser fatigue damage”

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



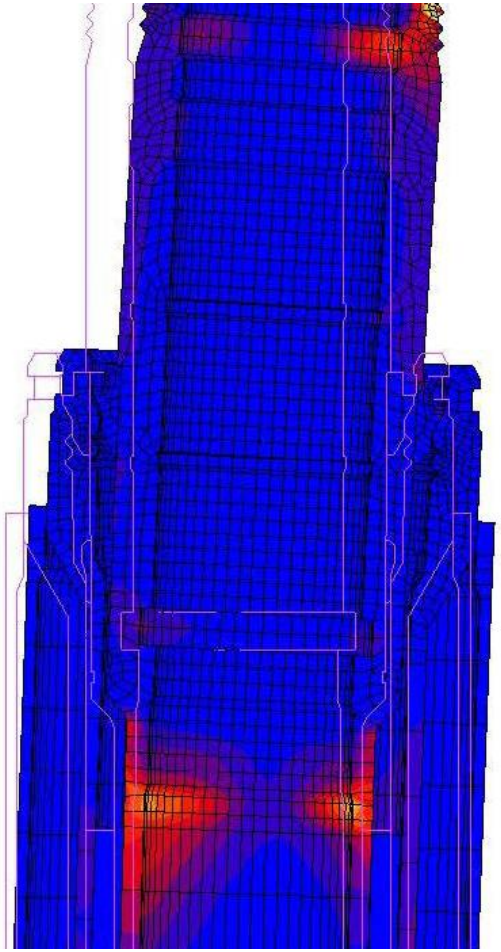
Background to Wellhead Fatigue Monitoring

"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"

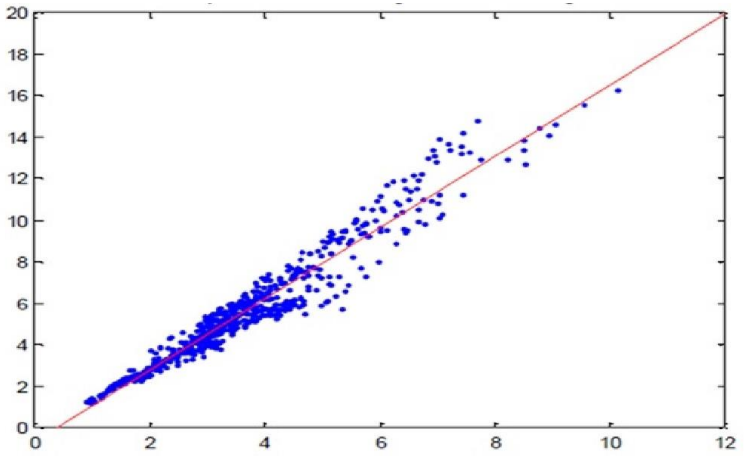
But…

"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

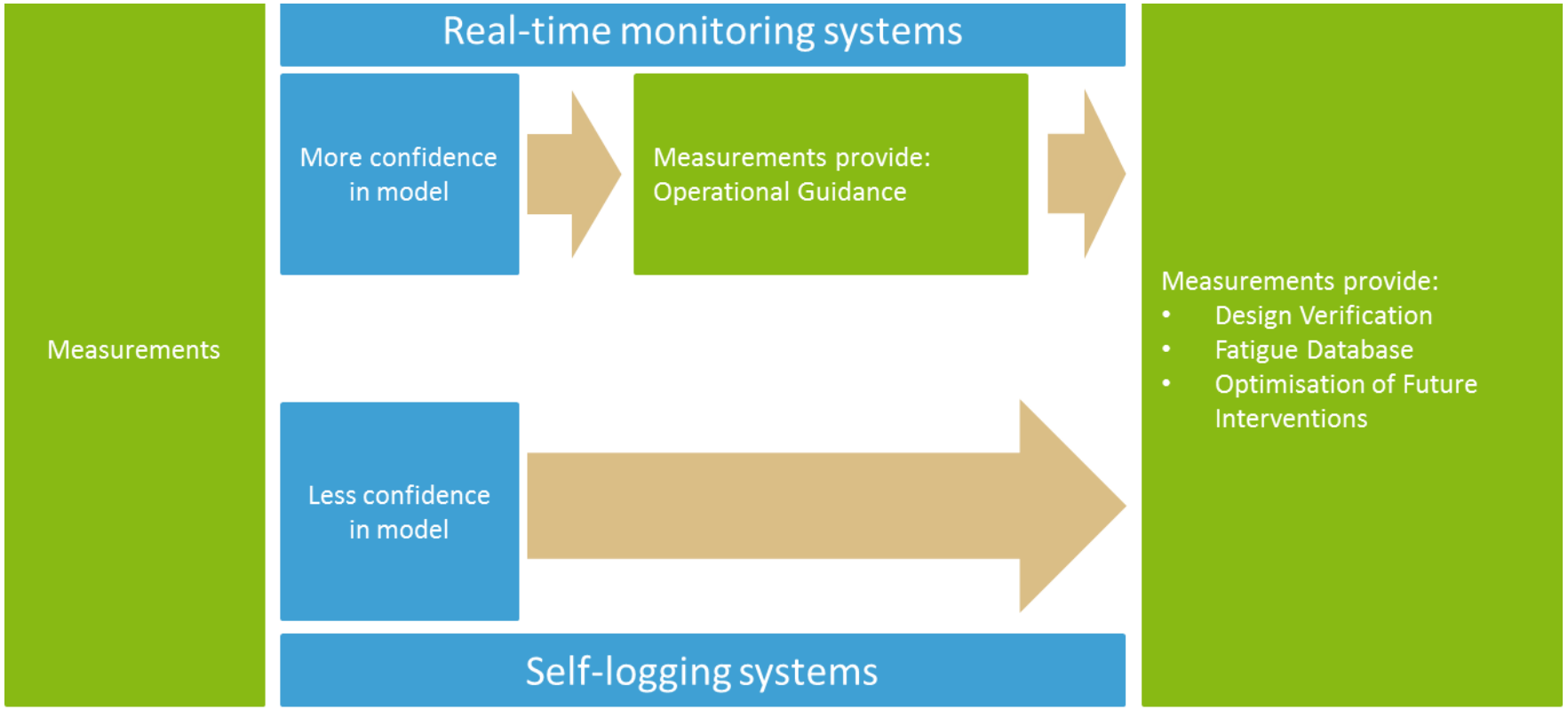


Background: Life of a Wellhead - Three Strategies

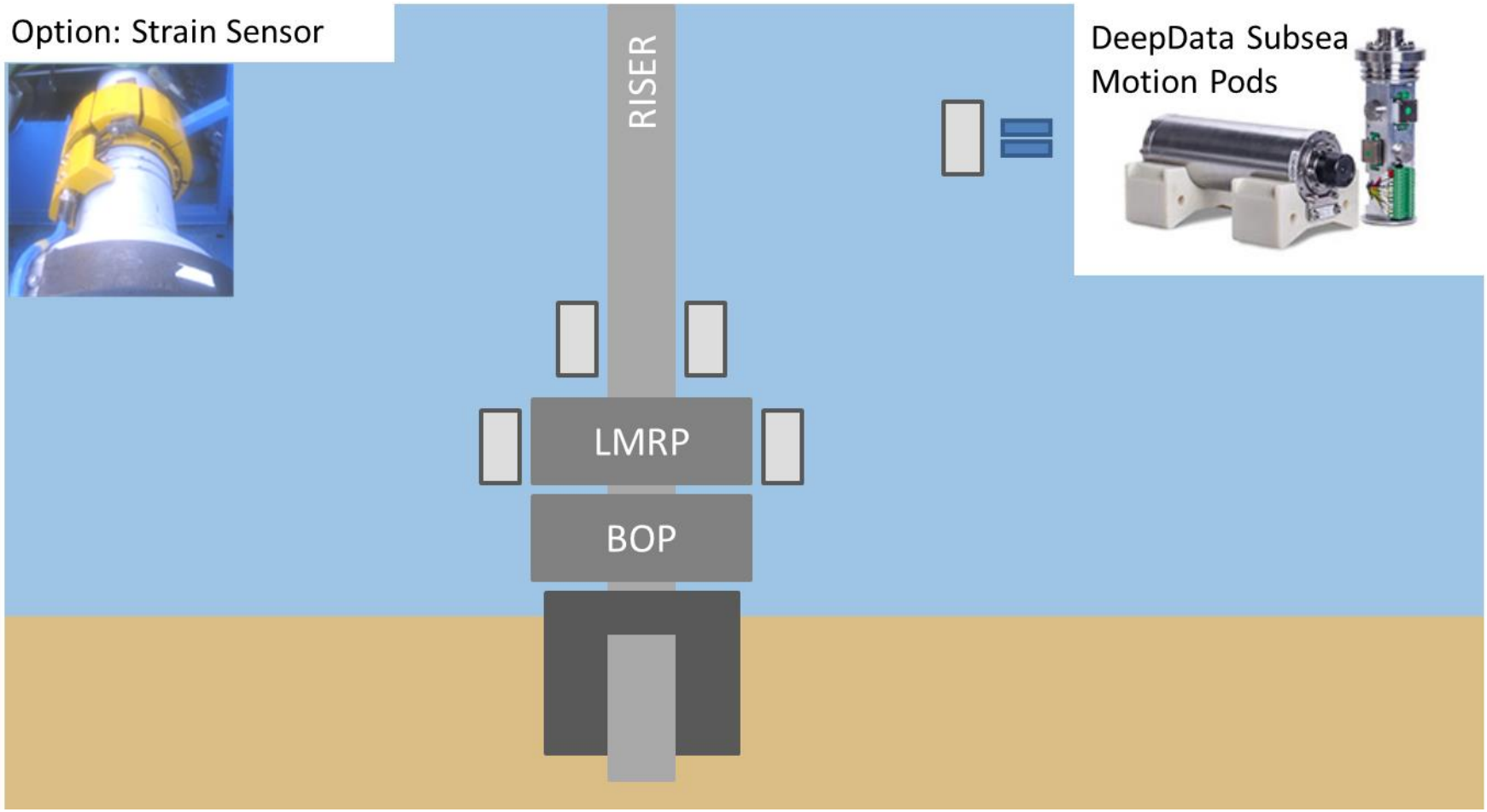
- Follow the codes and standards, so instrumentation not required.
- Log wellhead usage information into a long term database. Provides a record, can look to maximise usage based on the design model.
- Optimise operations by obtaining fatigue data in real time.

Background: Instrumentation Approaches

- 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.



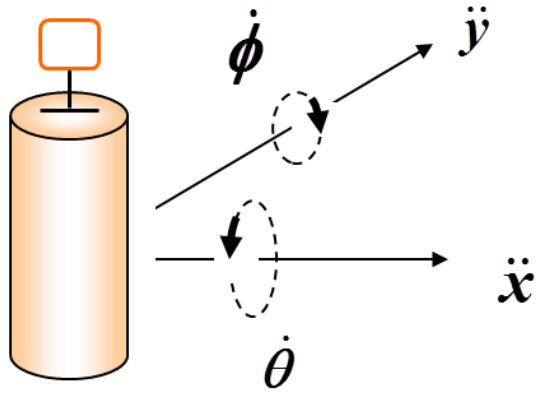
Offline Data Collection – Typical Installation

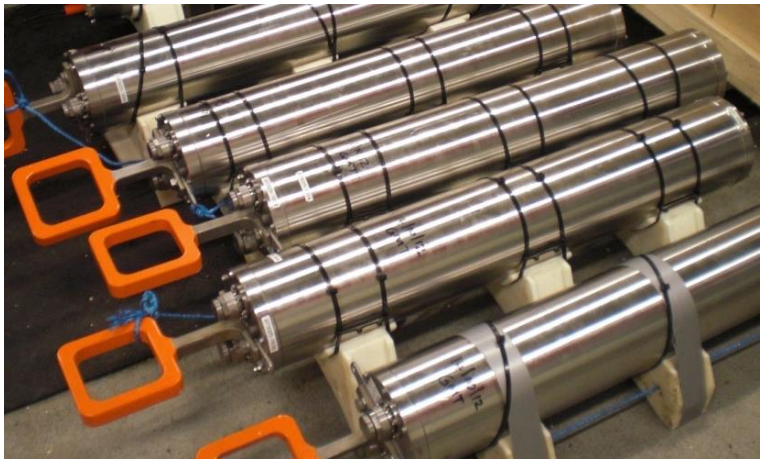


- *2 pods on LMRP*
- *2 pods above lower flex joint*
- *Option for strain measurements*

Typical Motion Pod

- 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



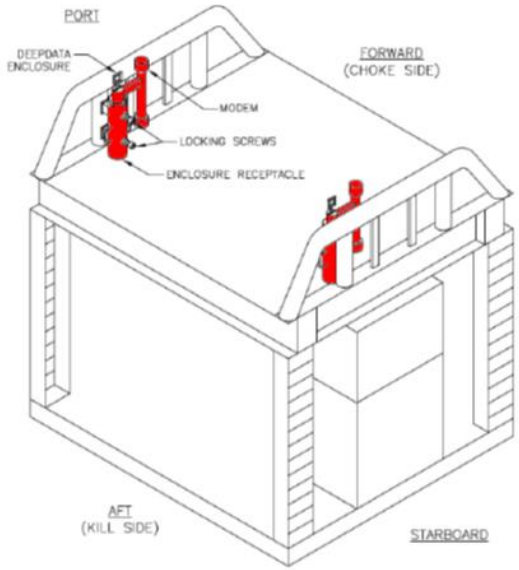


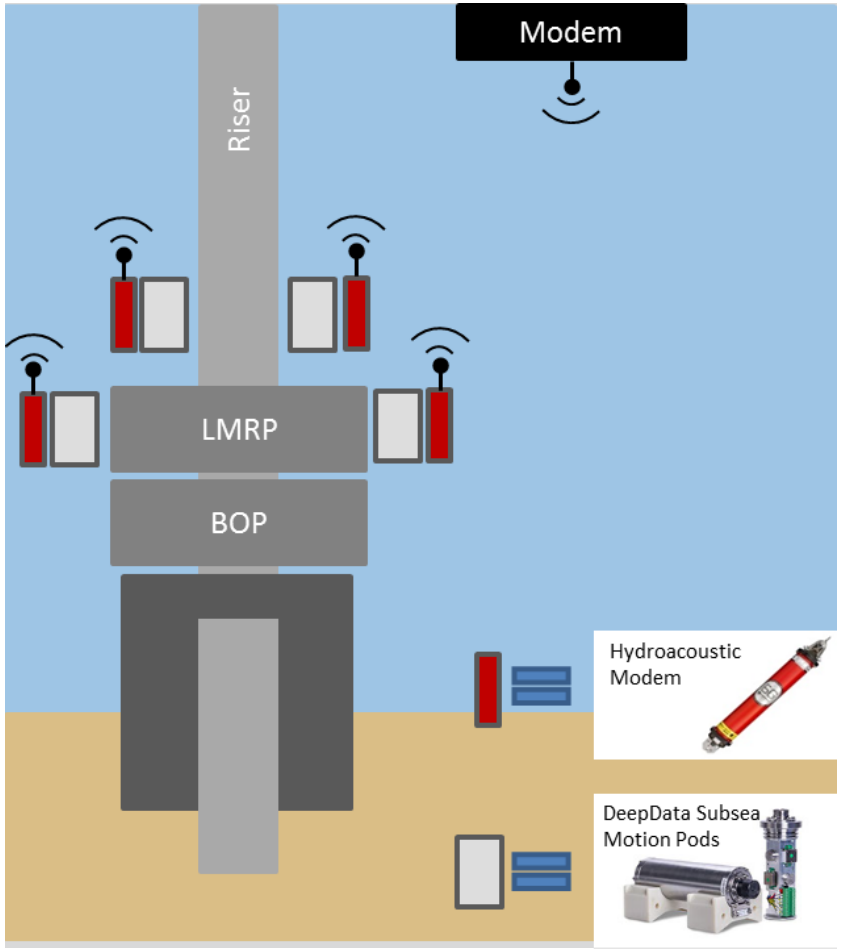
Offline Data Collection: Pre-Installed Receptacles

- 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: Methodology





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

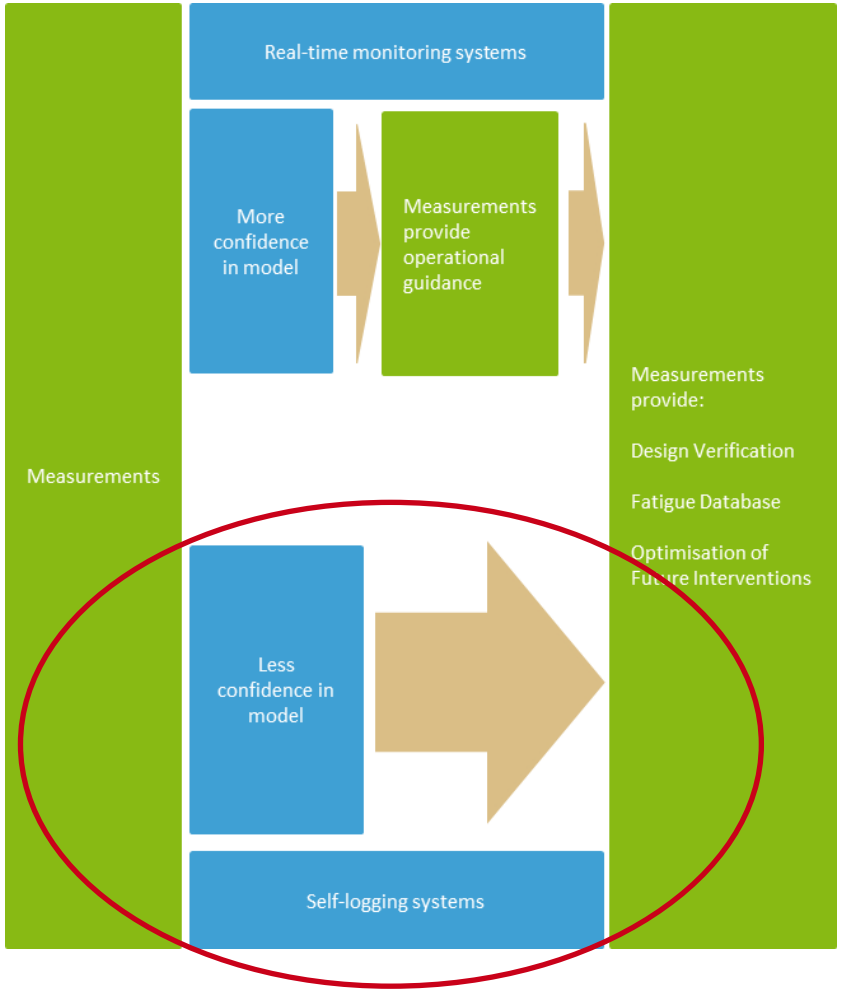
- Transmit the necessary information in one hundredth of the size of the raw time series data.

Reliable Hydroacoustics

- No requirement for data re-transmission

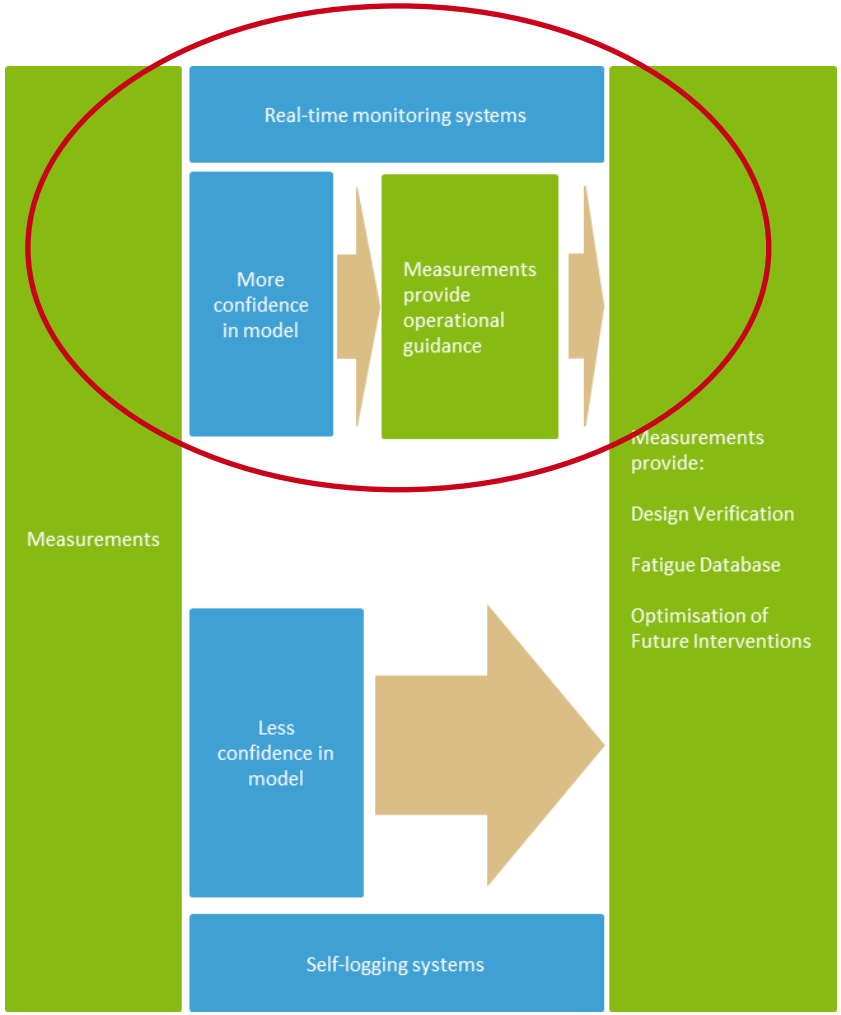
Summary – Self-logging approach

- 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.



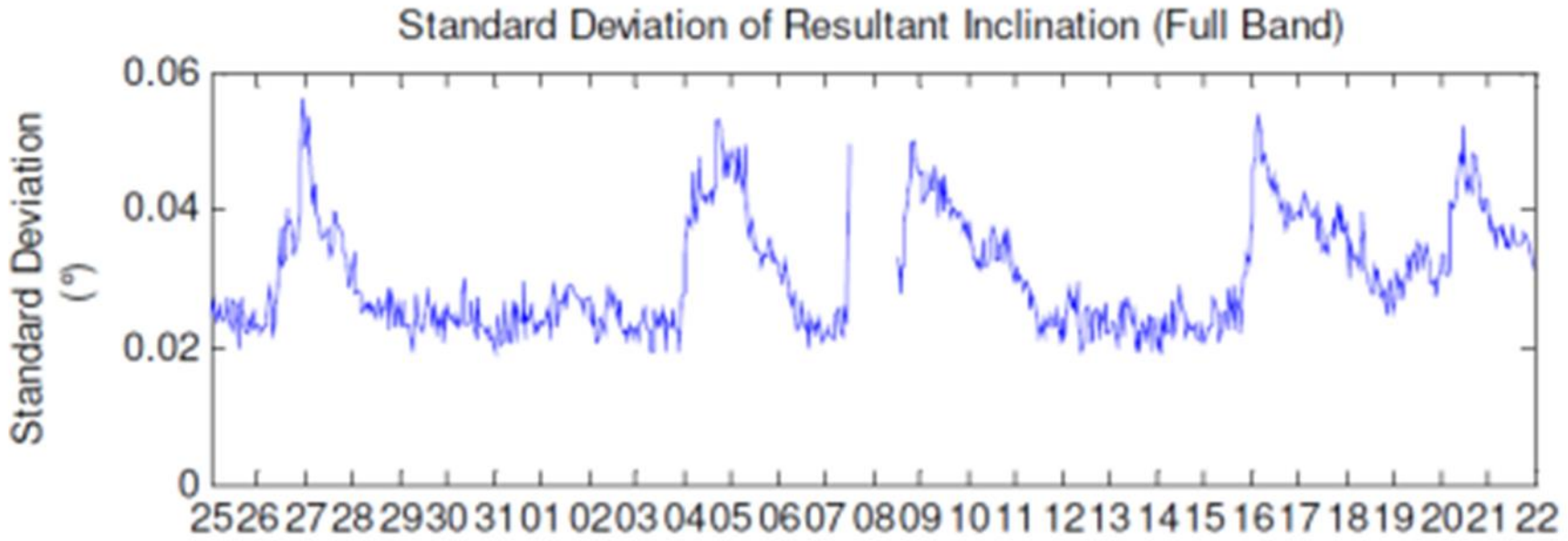
Summary – Real Time Approach

- 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.

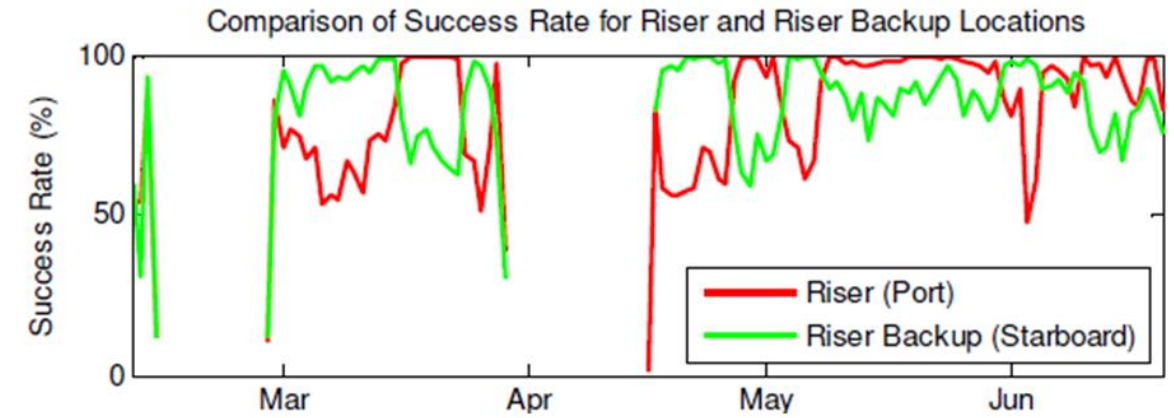


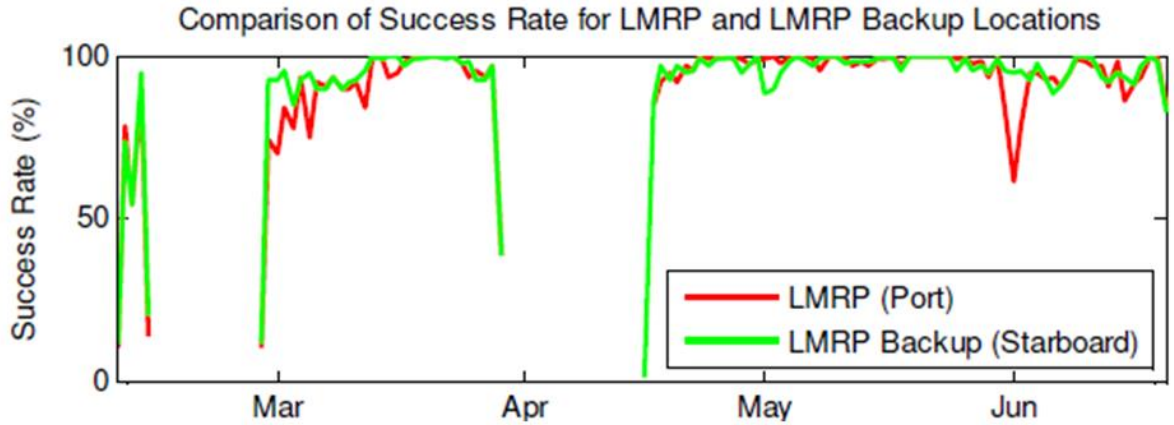
Example Data: Review of Inclinations

Self logging units with ROV recovery have been used to monitoring wellhead dynamic angles on a daily basis.

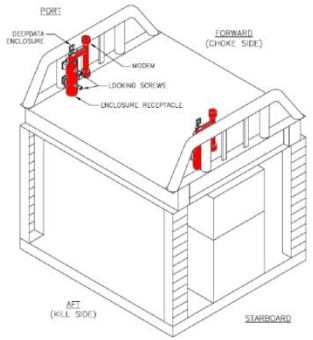


Example Data: Hydroacoustic Transmission Reliability





Backup locations on two sides of the LMRP. Usually one able to see the dunking modem.



Example Data – VIV Monitoring

Metocean and Riser Characterisation

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

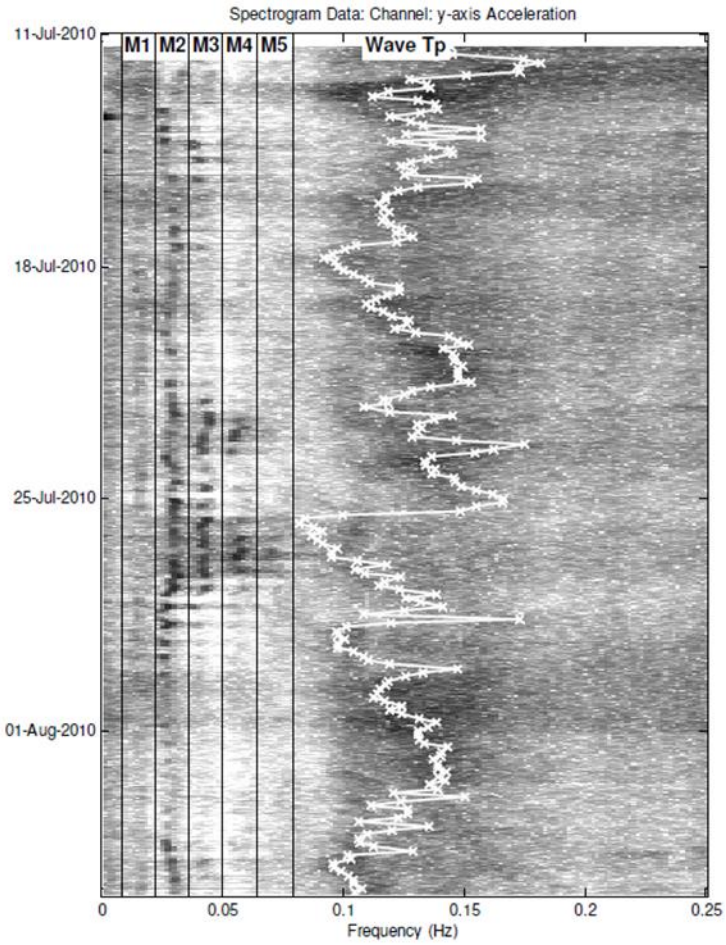
Install WARIS

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

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

Wellhead and Riser Fatigue – Mediterranean Project

Risks

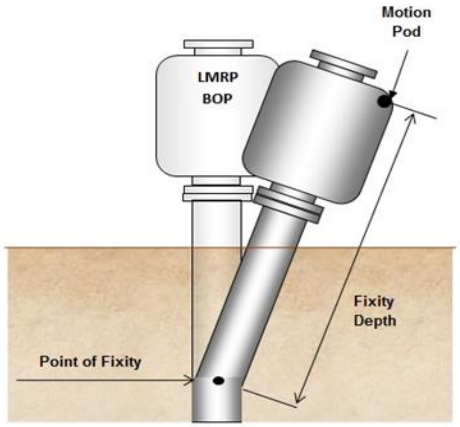
- Modelling identified short fatigue life.

Mitigations

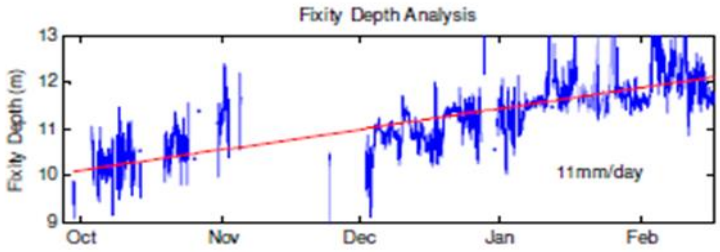
- Verify pre-analysis model with measurements
- Track condition during drilling

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



Point of Fixity due to stack motion



Fixity depth increasing during drilling campaign

Thank you

Gordon Hamilton
Fugro GEOS