2H offshore

Riser & Conductor Engineering

Houston | Rio de Janeiro | London | Aberdeen | Kuala Lumpur | Perth

Secrets of a Healthy and Happy Old Age –

Putting Riser Monitoring Data to Good Use

Hugh Howells
Principal Director, 2H Offshore Engineering

SUT, Perth, 11th June 2014

Introduction

- Why Monitor
- Monitoring System Design
- Example Applications
- Riser Fatigue Design
- How Monitoring Data Can be Used
- Questions

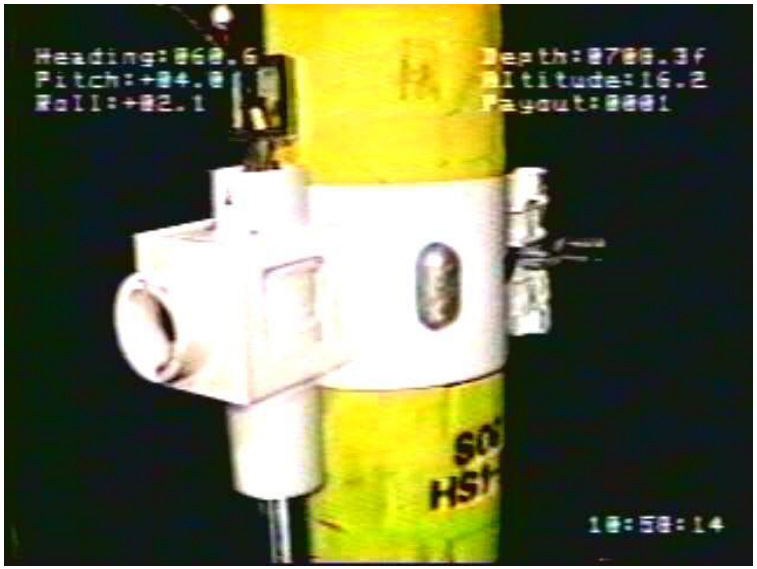
Why Monitor?

- Reasons not to
  - Not necessary from design perspective
  - Adds cost
  - Unreliable

- Reasons for
  - Novelty of arrangement or environment
  - Design or fabrication concerns/oversights
  - Observed in-service problems
  - Life extension

Monitoring System Design

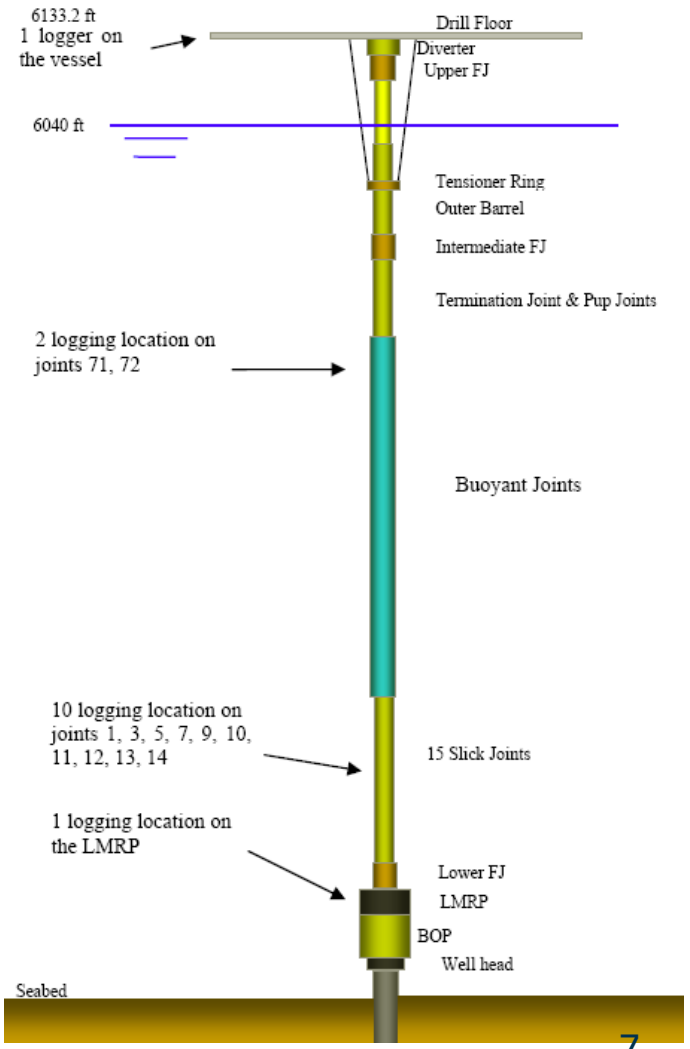
- Direct or indirect measurement
- Measurement parameters
- Measurement frequency
- Program duration
- Instrument accuracy and resolution
- Data transmission
- Installation/attachment
- Redundancy
- Data verification methods
- Data processing methods
- Data storage and access



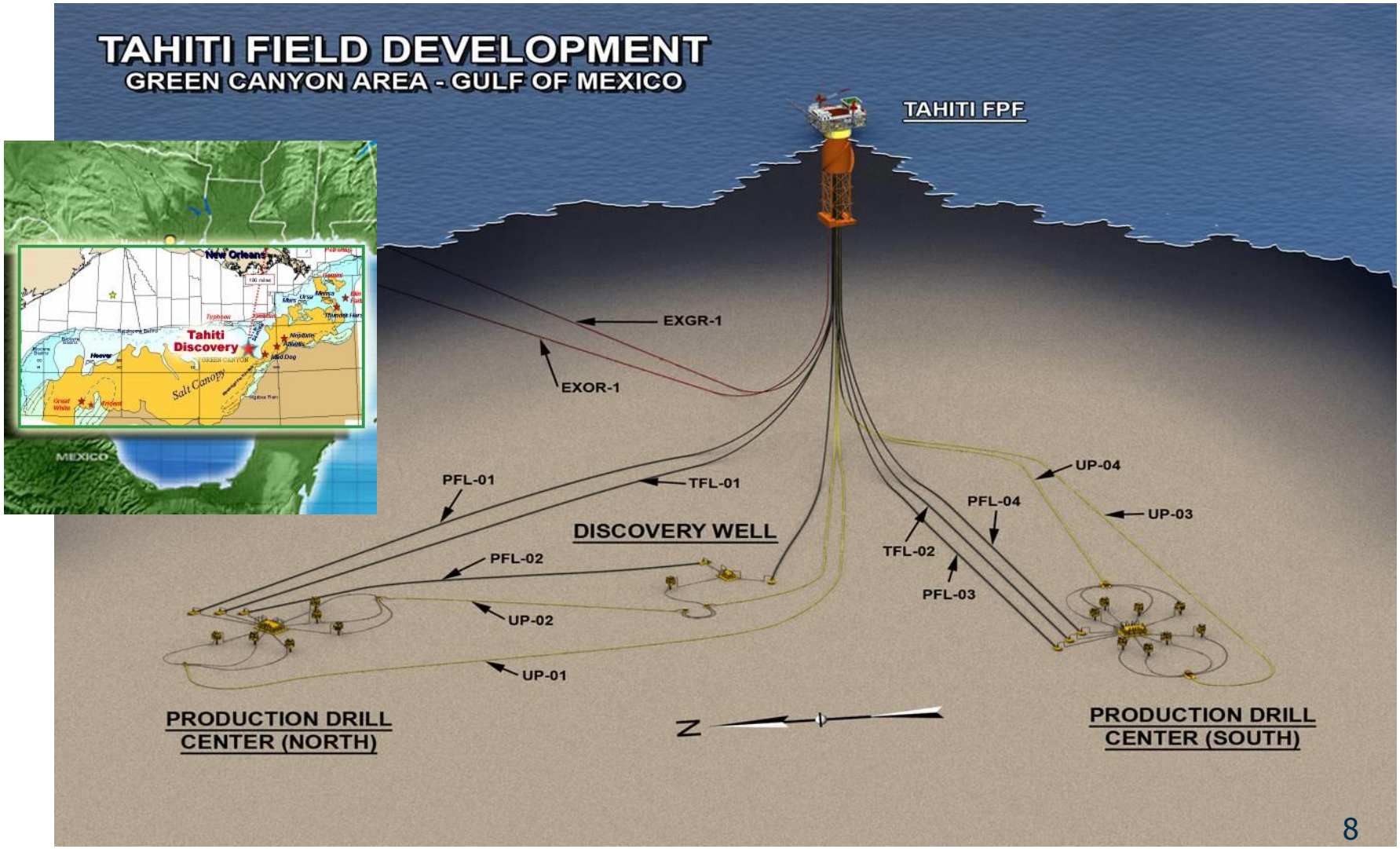
Example Applications

- Drilling riser vortex induced vibration (VIV)
- SCR hurricane and fatigue response
- Transfer line installation fatigue
- Pipeline span VIV
- Blockage induced vibrations
- SCR flex-joint degradation
- Export line wave and VIV fatigue
- Flowline slugging

Drilling Riser VIV

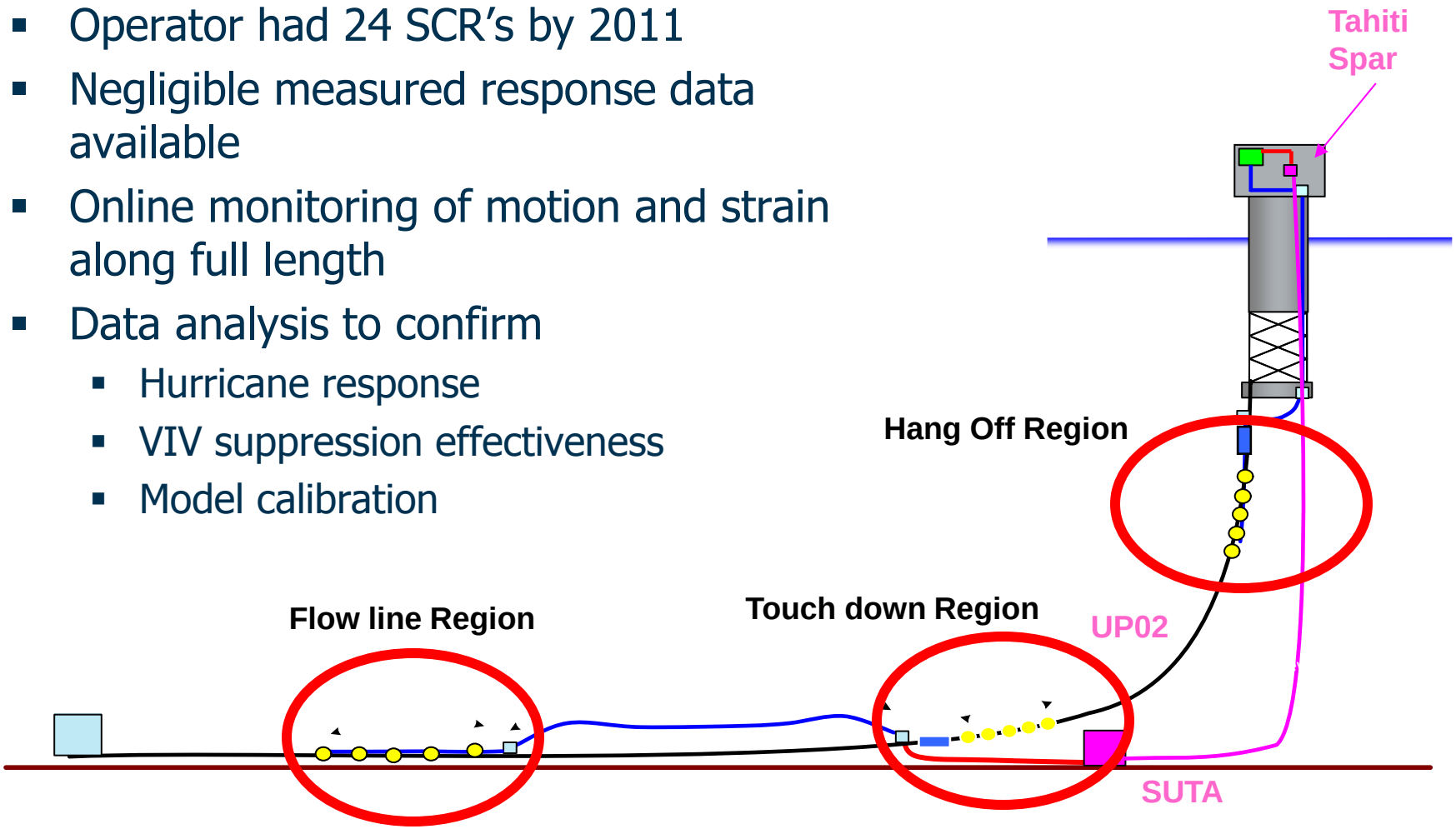


Chevron Tahiti



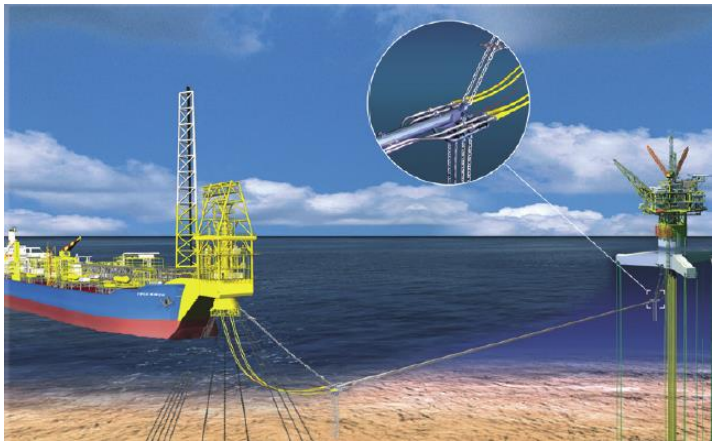
Chevron Tahiti SCR Monitoring

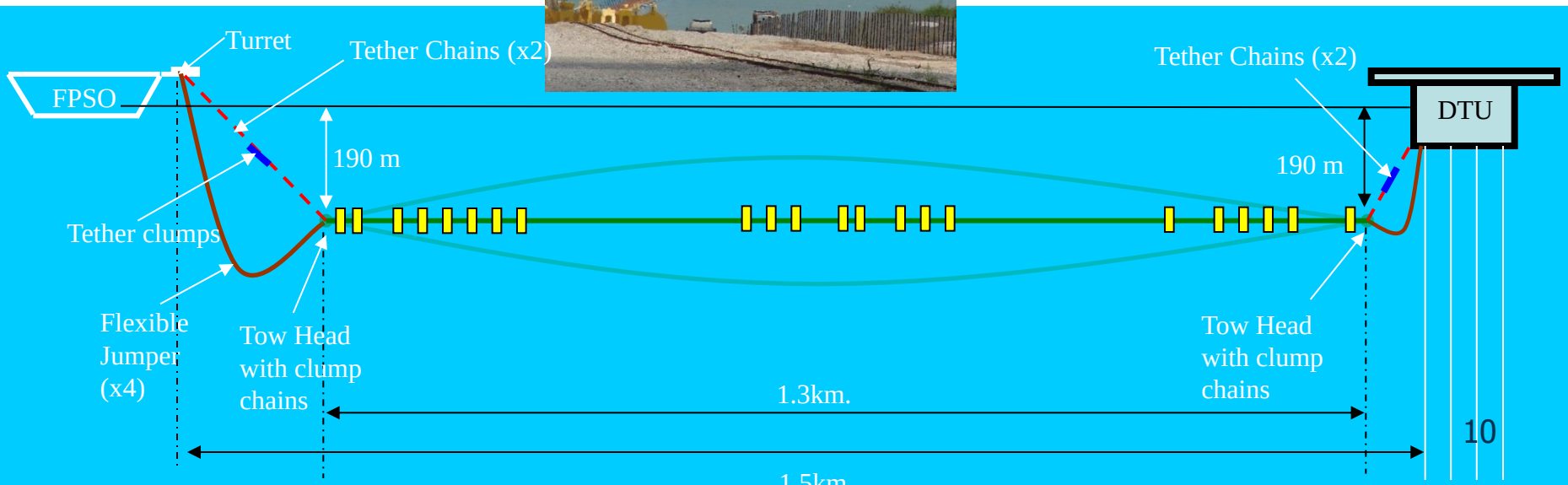
- Operator had 24 SCR's by 2011
- Negligible measured response data available
- Online monitoring of motion and strain along full length
- Data analysis to confirm
  - Hurricane response
  - VIV suppression effectiveness
  - Model calibration



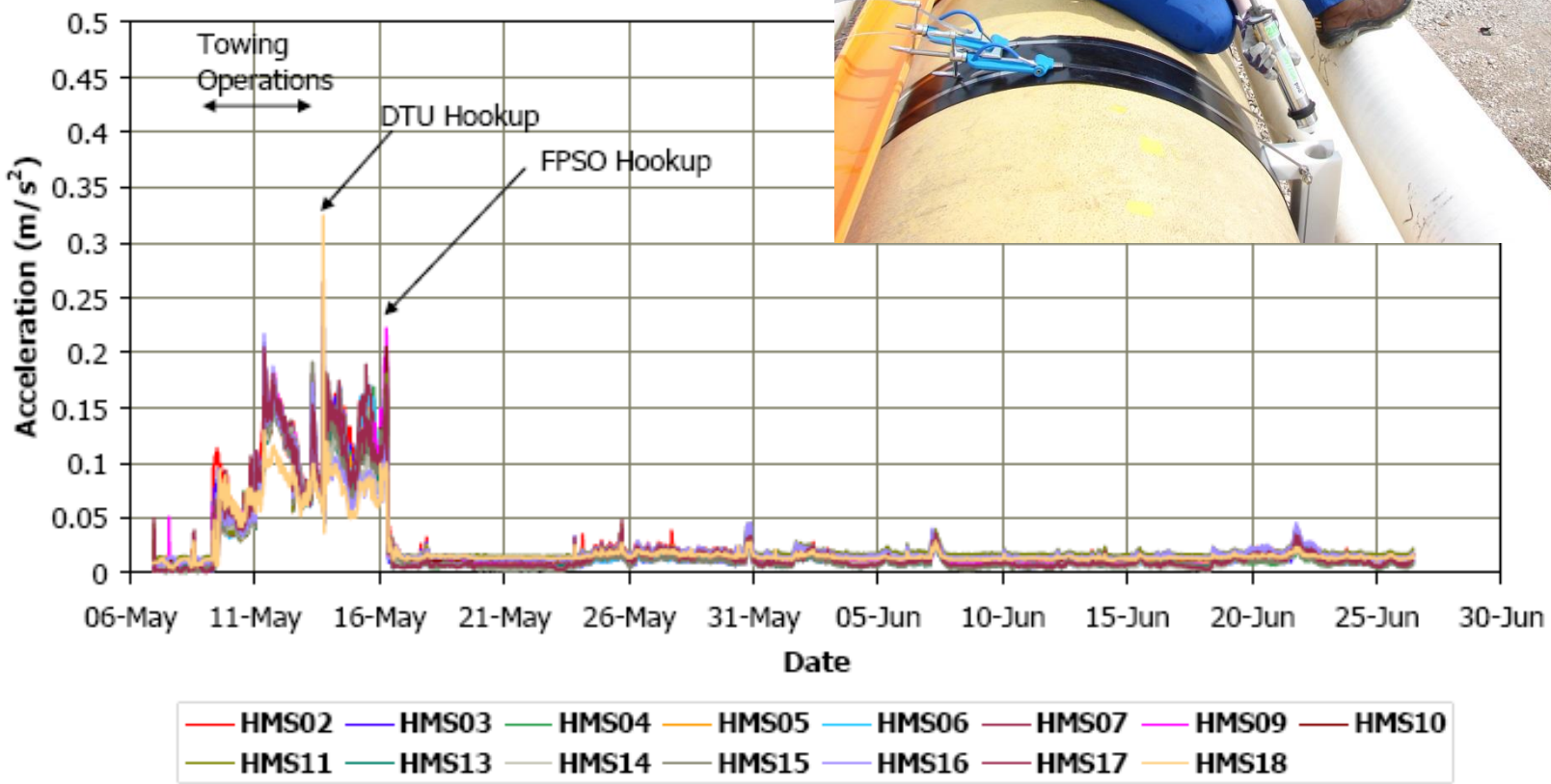
Transfer Line Fatigue

- 1.5km Horizontal Pipeline span, located at mid depth Offshore Malaysia
- New design concept
- Concerns about the response during launch and tow out

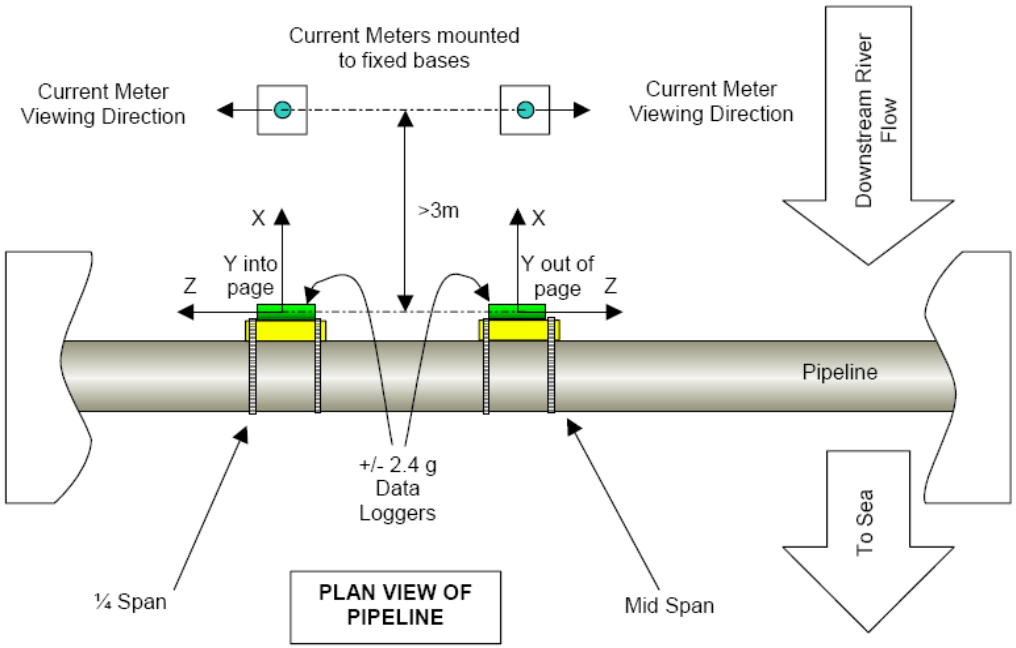


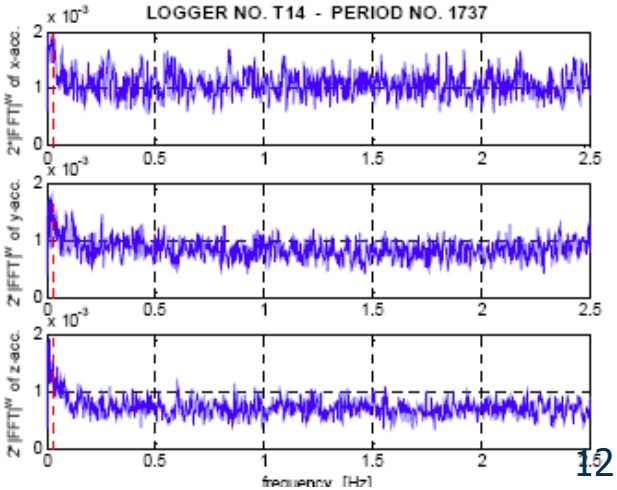


Transfer Line Response



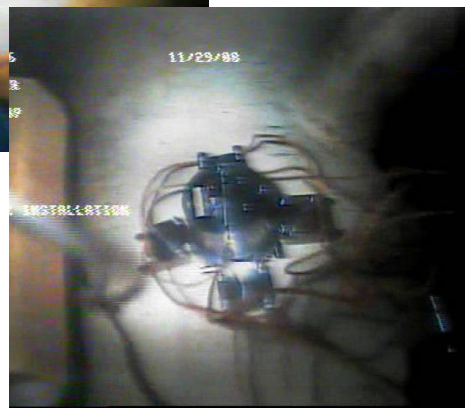
Pipeline Span VIV

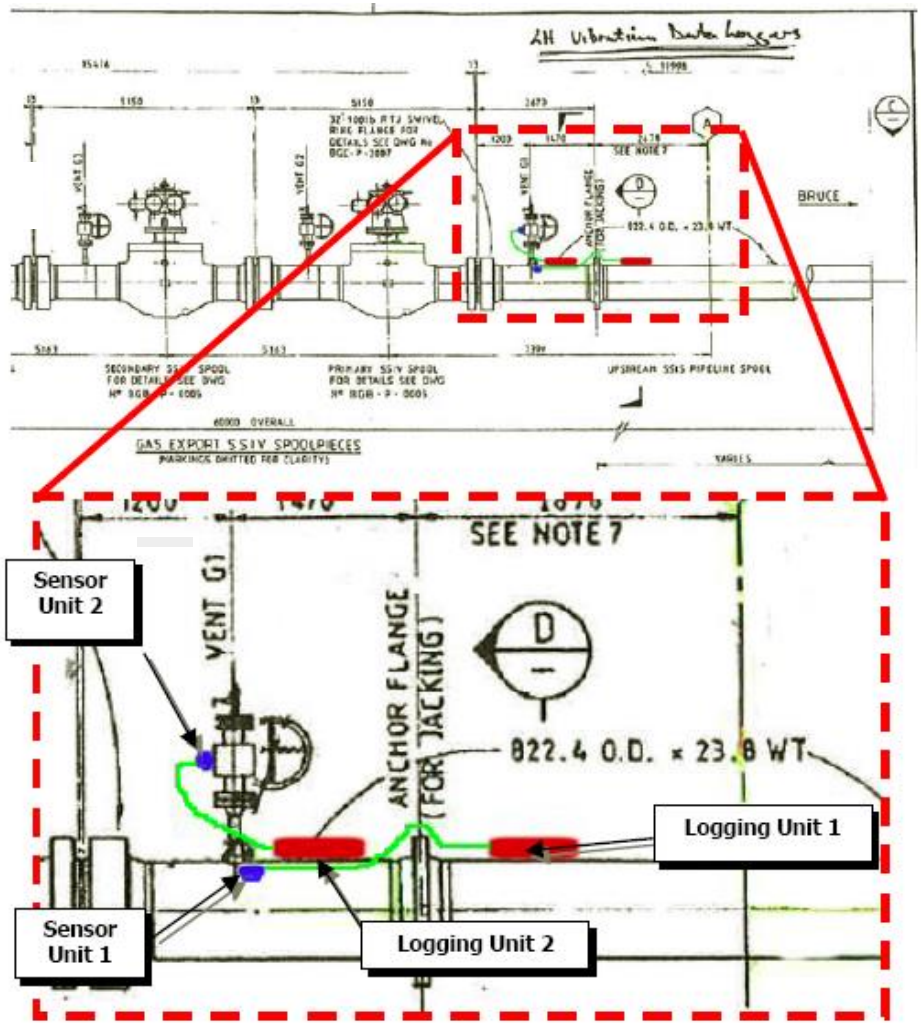




Blockage Induced Pipeline Vibration

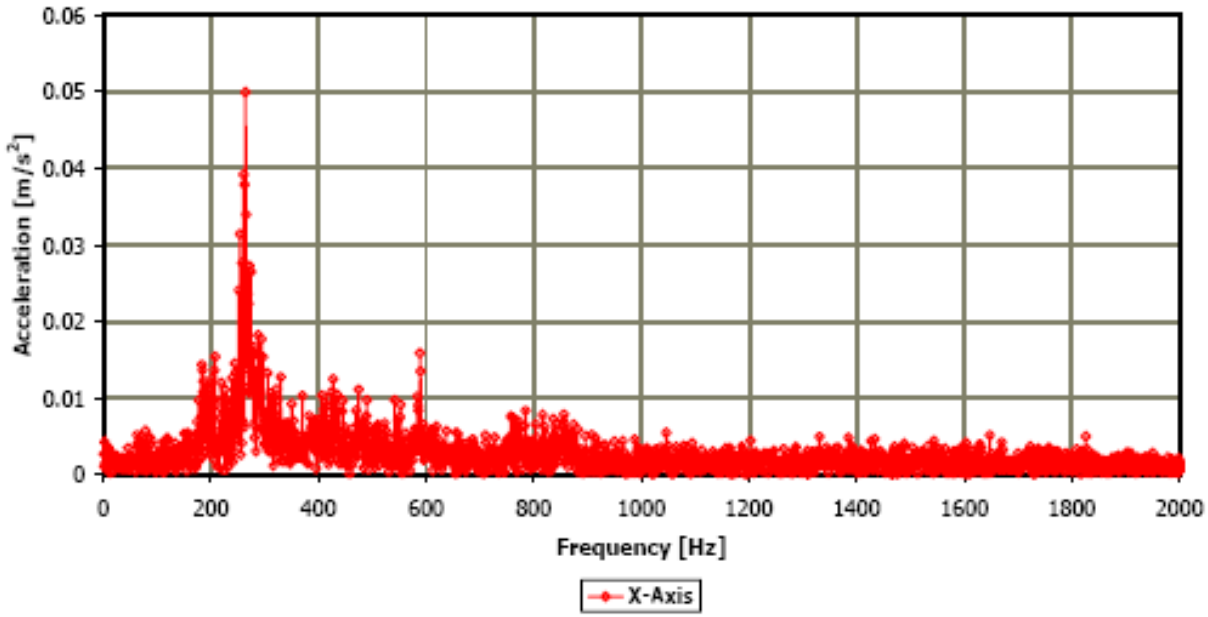
- North Sea gas export pipeline
- Vibration due to a trapped plug tool



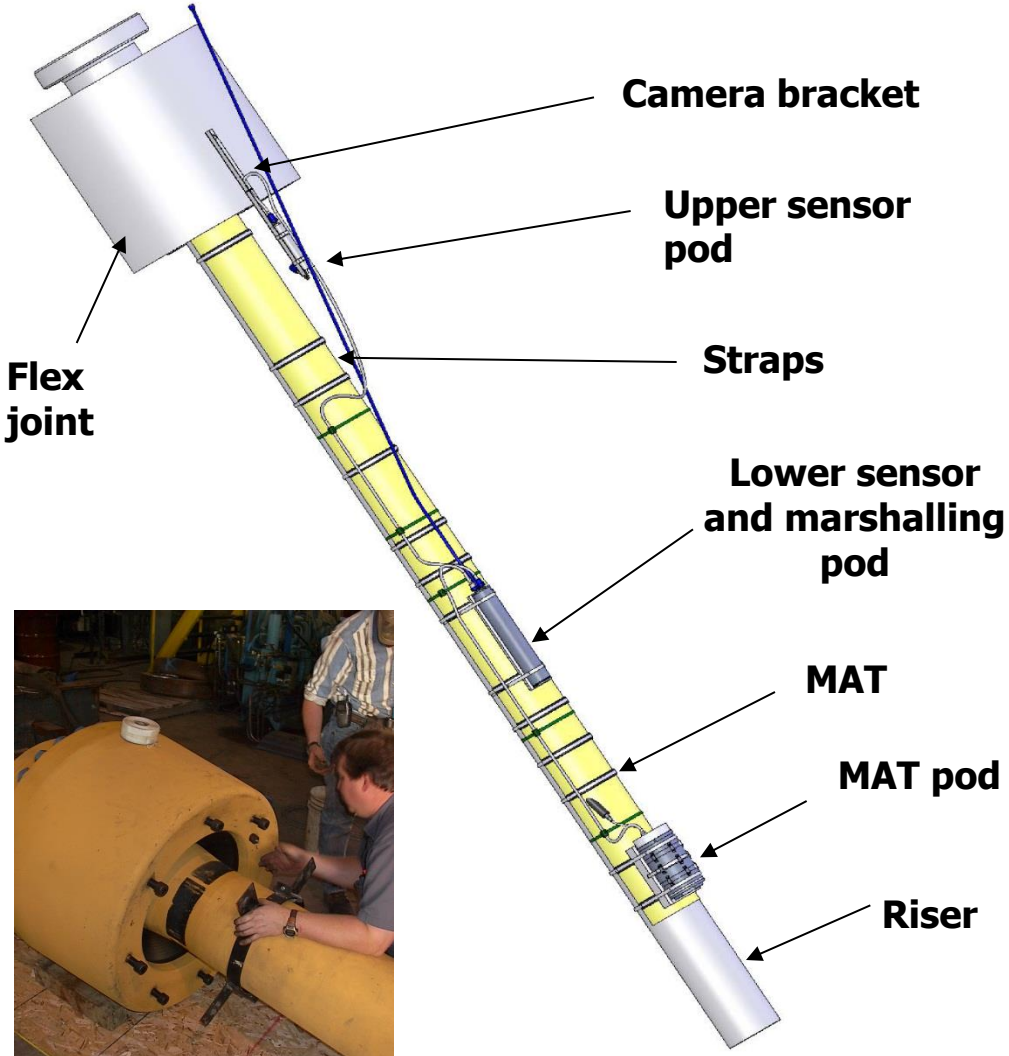


Pipeline Vibration Response

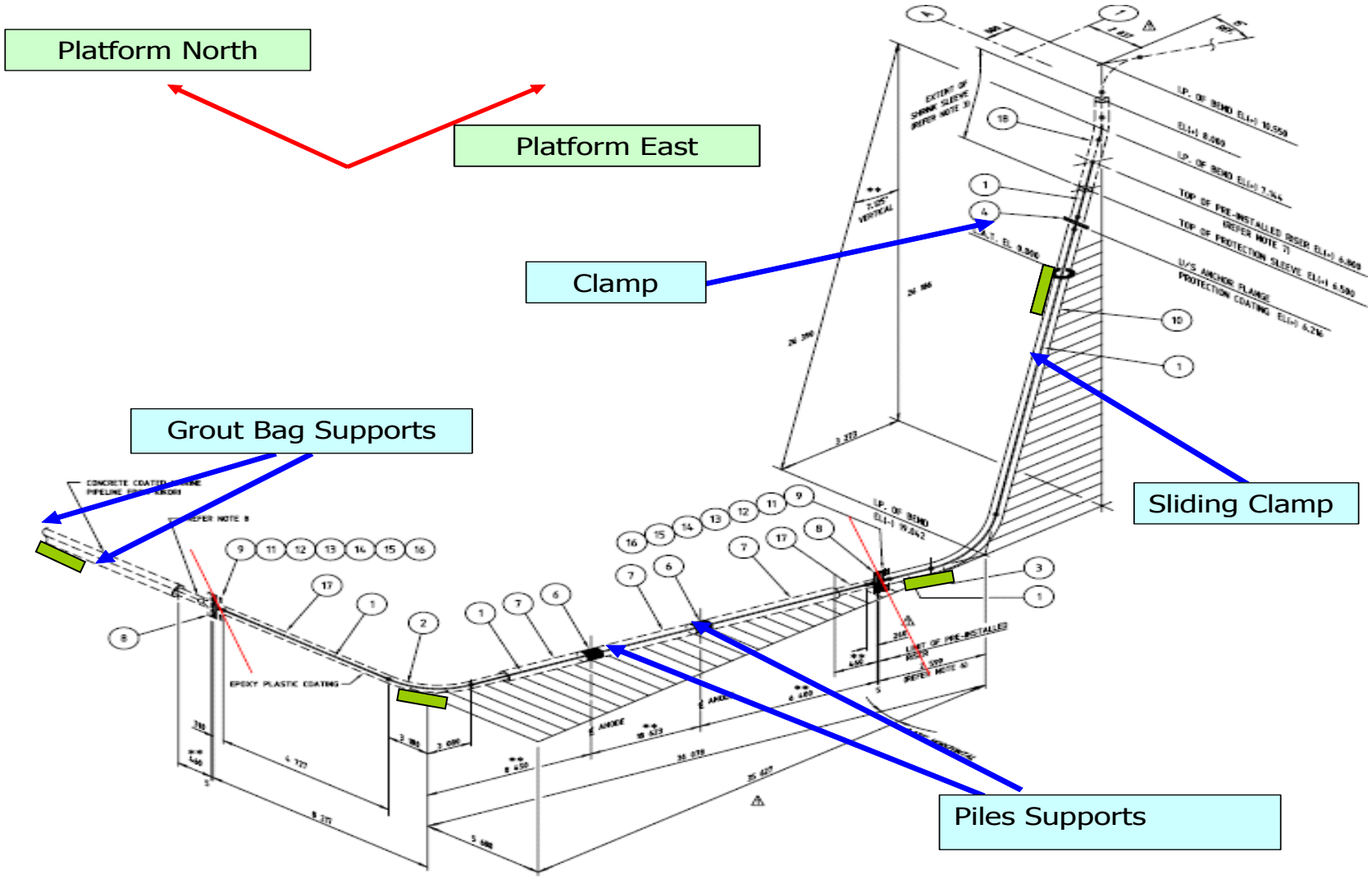
- High frequency vibration present
- Monitoring enabled selection of safe flow rate



SCR Flex-Joint Integrity

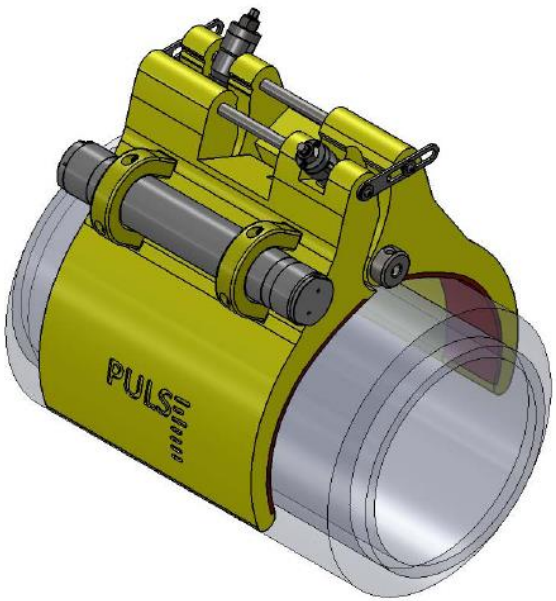


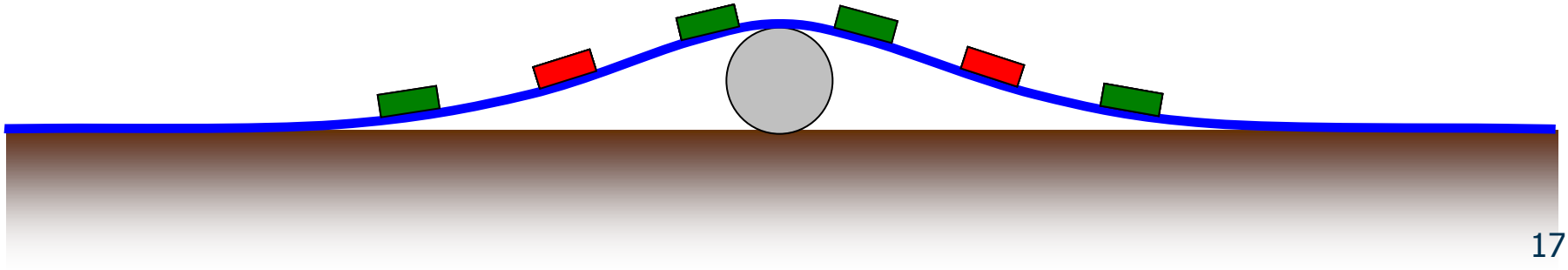
Export Line Spool Fatigue



Flowline Slugging

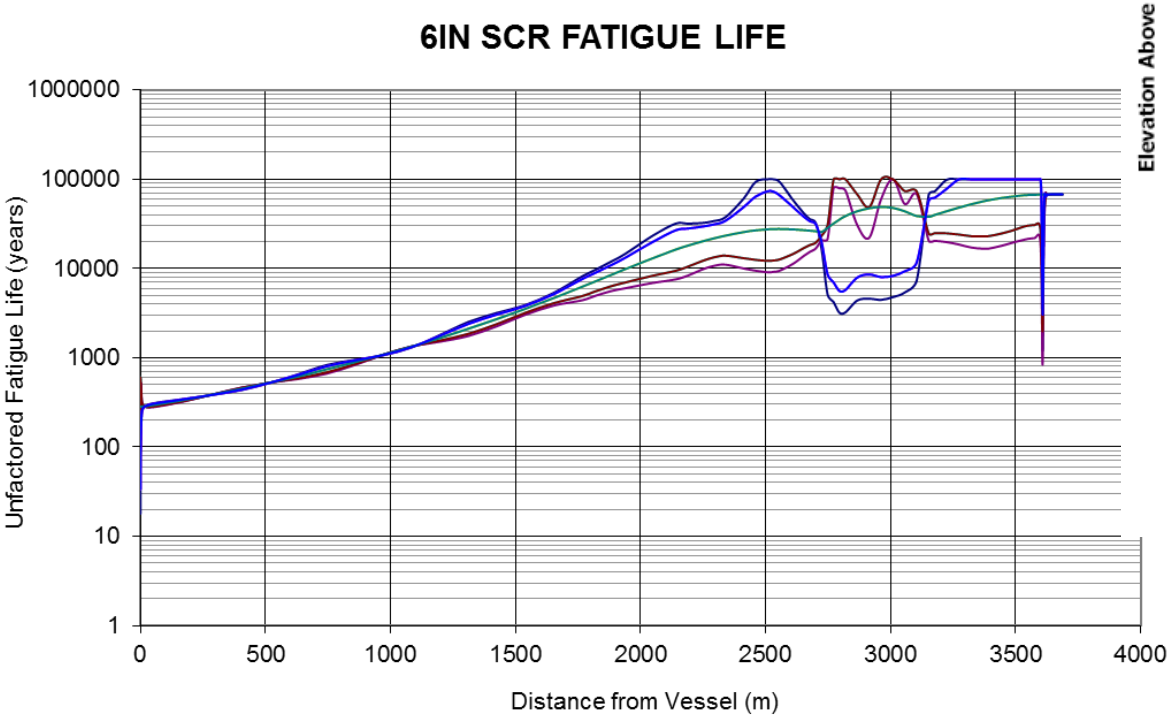
- Fatigue induced due to weight change and slug inertia
- Measurements of displacement and angle
- Objectives to measure fatigue and slugging characteristics

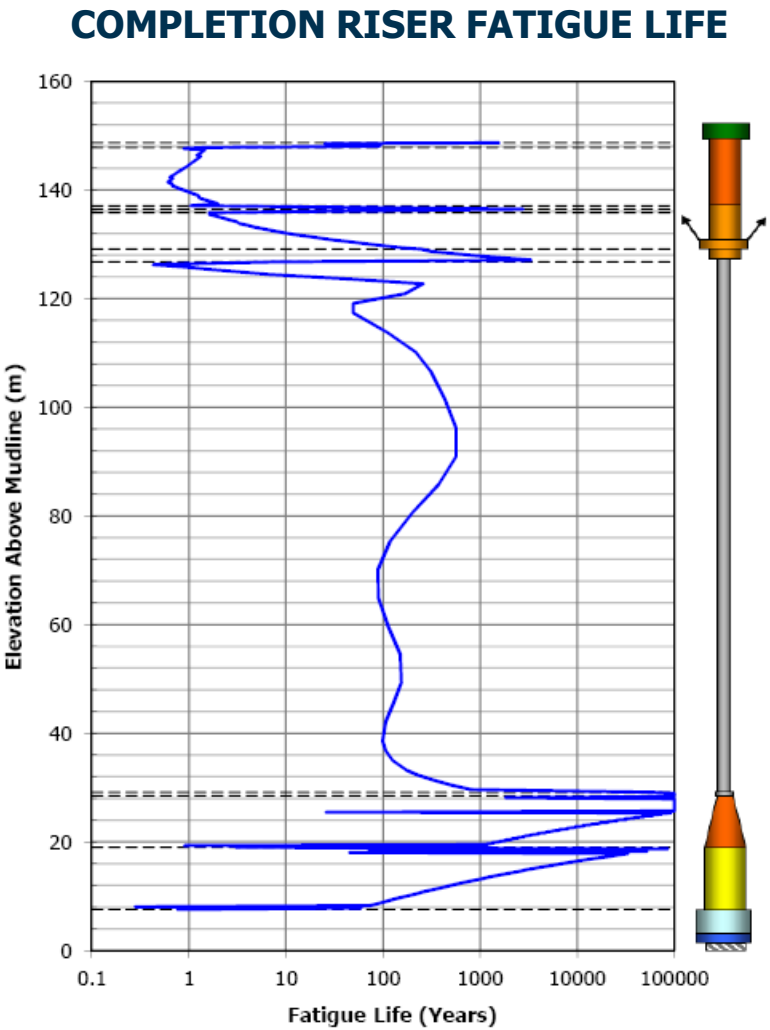




Riser Fatigue Drivers

- Waves
- Currents
- Vessel motions
- Slugging





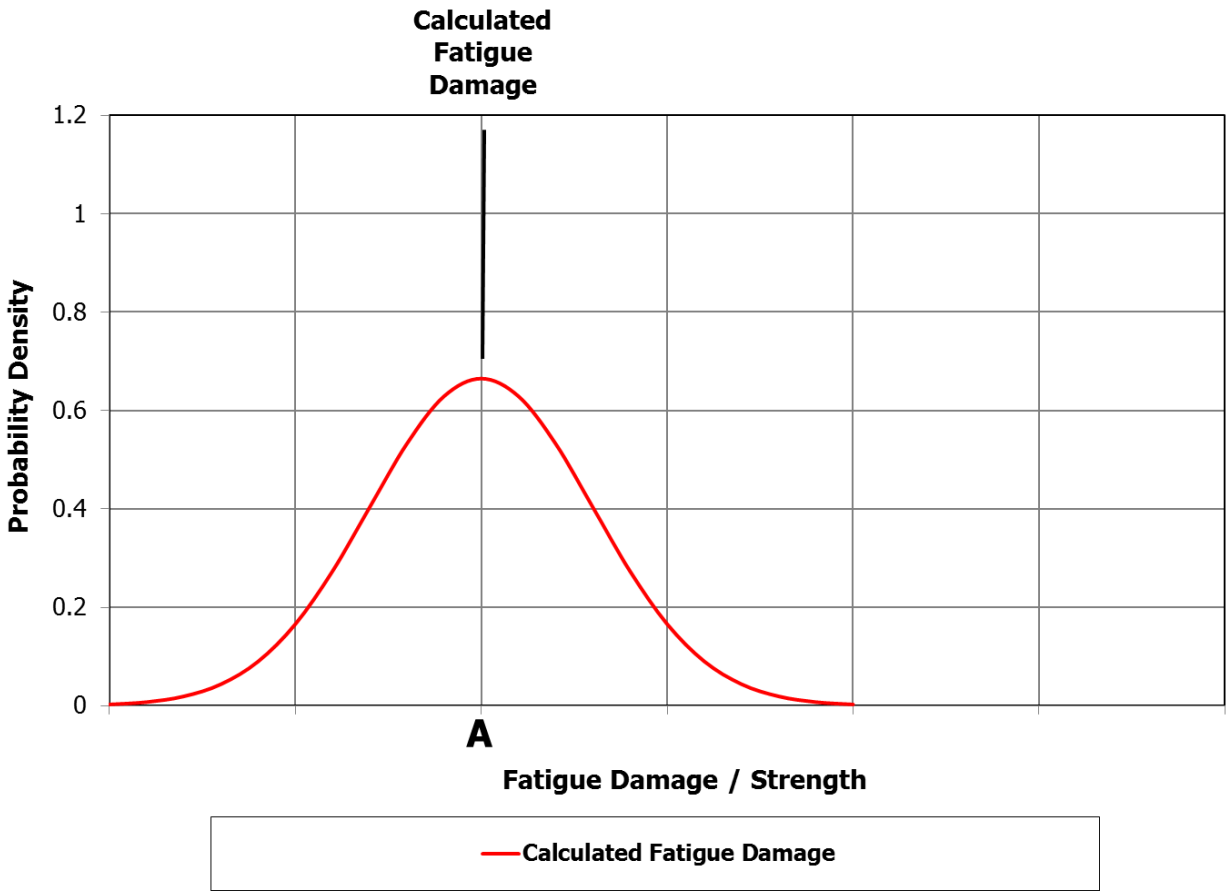
Vortex Induced Vibration

Riser Fatigue Design

- Conduct analysis to simulate long term environment
- Combine fatigue damage from different phenomena
- Many variables to accommodate:
  - Environmental loading
  - Vessel motions
  - Soil characteristics
  - Response modelling
  - Material fatigue resistance
- Approach:
  - Conservative analysis parameters
  - Large factors of safety (10)
  - Design code objective to obtain target probability of failure (~10-5)

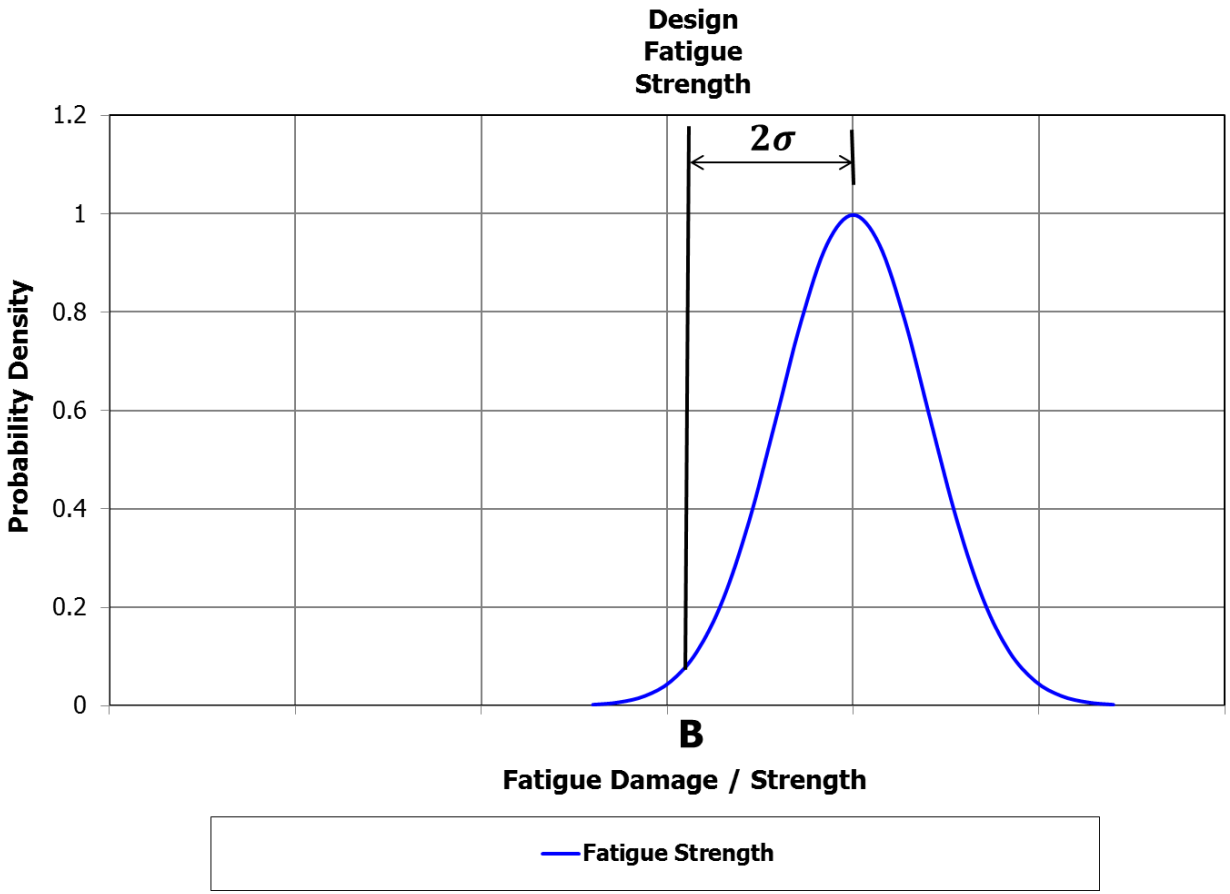
Calculated Fatigue Damage

- Calculated fatigue damage, A, obtained by dynamic analysis
- Uncertainty in calculated result due to:
  - Environmental loading
  - Vessel motions
  - Soil characteristics
  - Response modelling
- Calculation is typically conservative



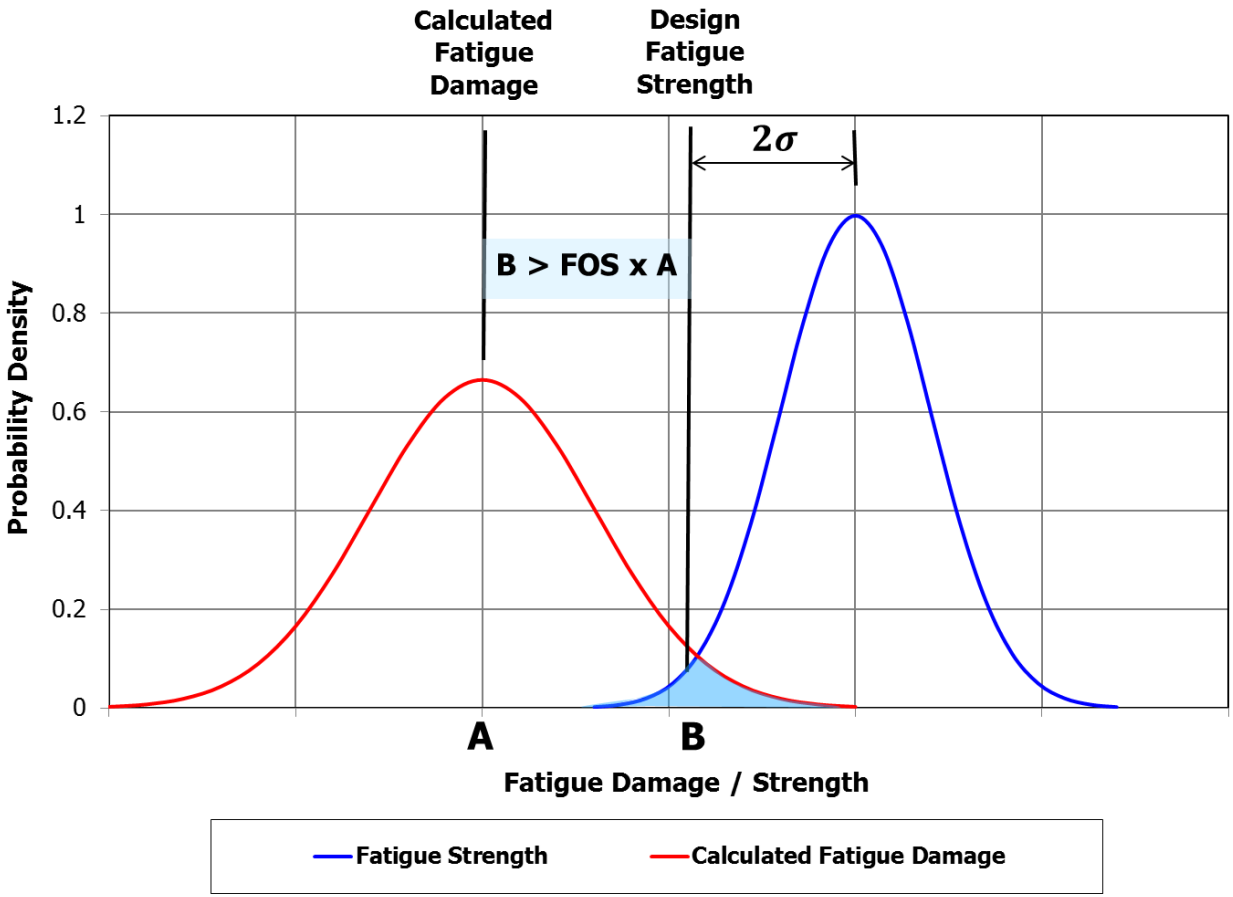
Fatigue Strength

- Strength (fatigue curves) determined through testing
- Variability due to:
  - Materials
  - Welding procedures
- Design fatigue strength, B, defined by mean – 2 standard deviations



Calculated Fatigue Damage v Fatigue Strength

- Objective to achieve design code target probability of failure (10^{-5} - the blue bit)
- Achieved by specifying a large safety factor to account for variability
  (B > 10 x A)

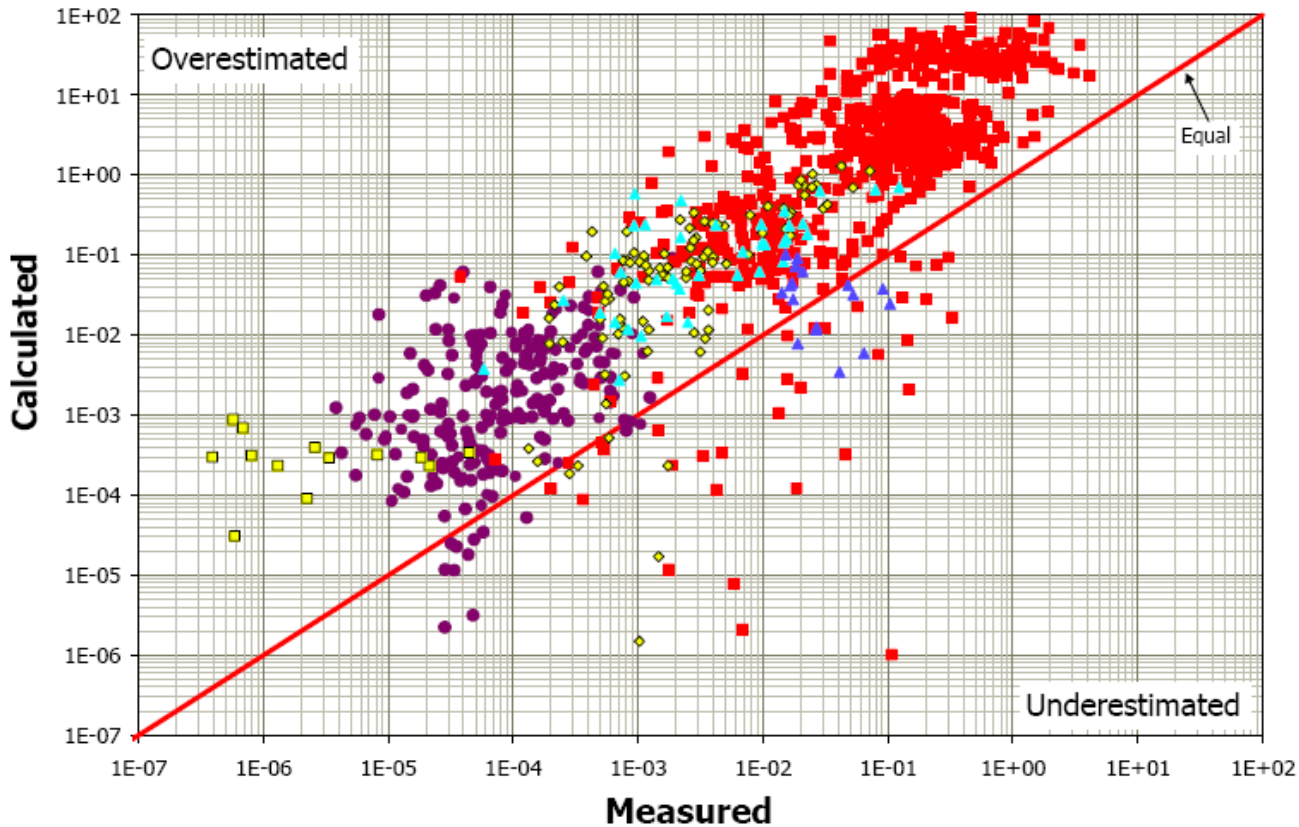


Use of Measurements

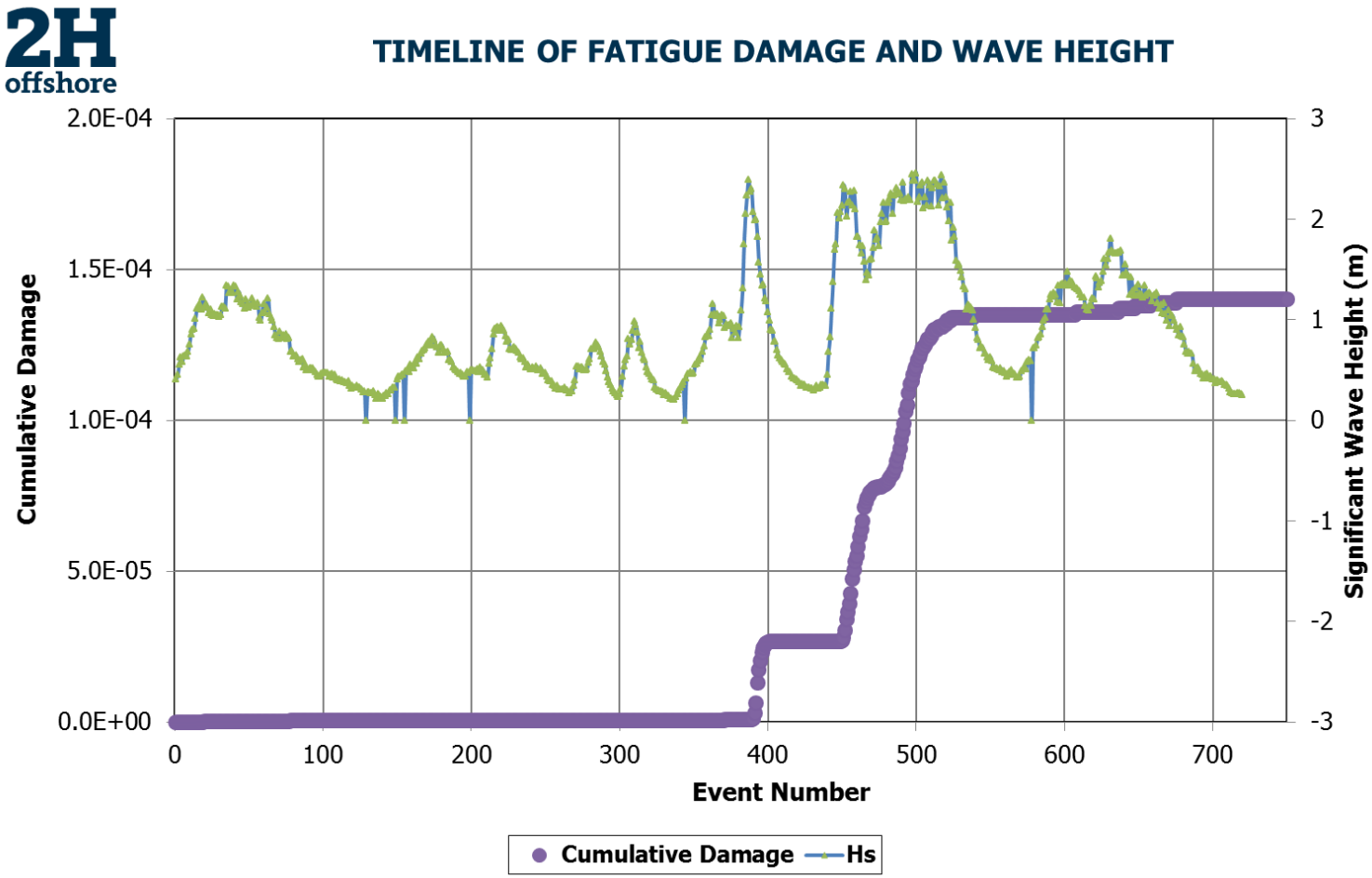
- Conduct verification
- Determine and apply transfer functions
- Calculate fatigue damage
- Compare measured v calculated response
- Produce more realistic life estimates
  - Reduced safety factors / life extension

Calculated v Measured Fatigue (by event)

- Demonstrates conservatism in fatigue prediction by a factor of 20
- Bias is consistent regardless of severity

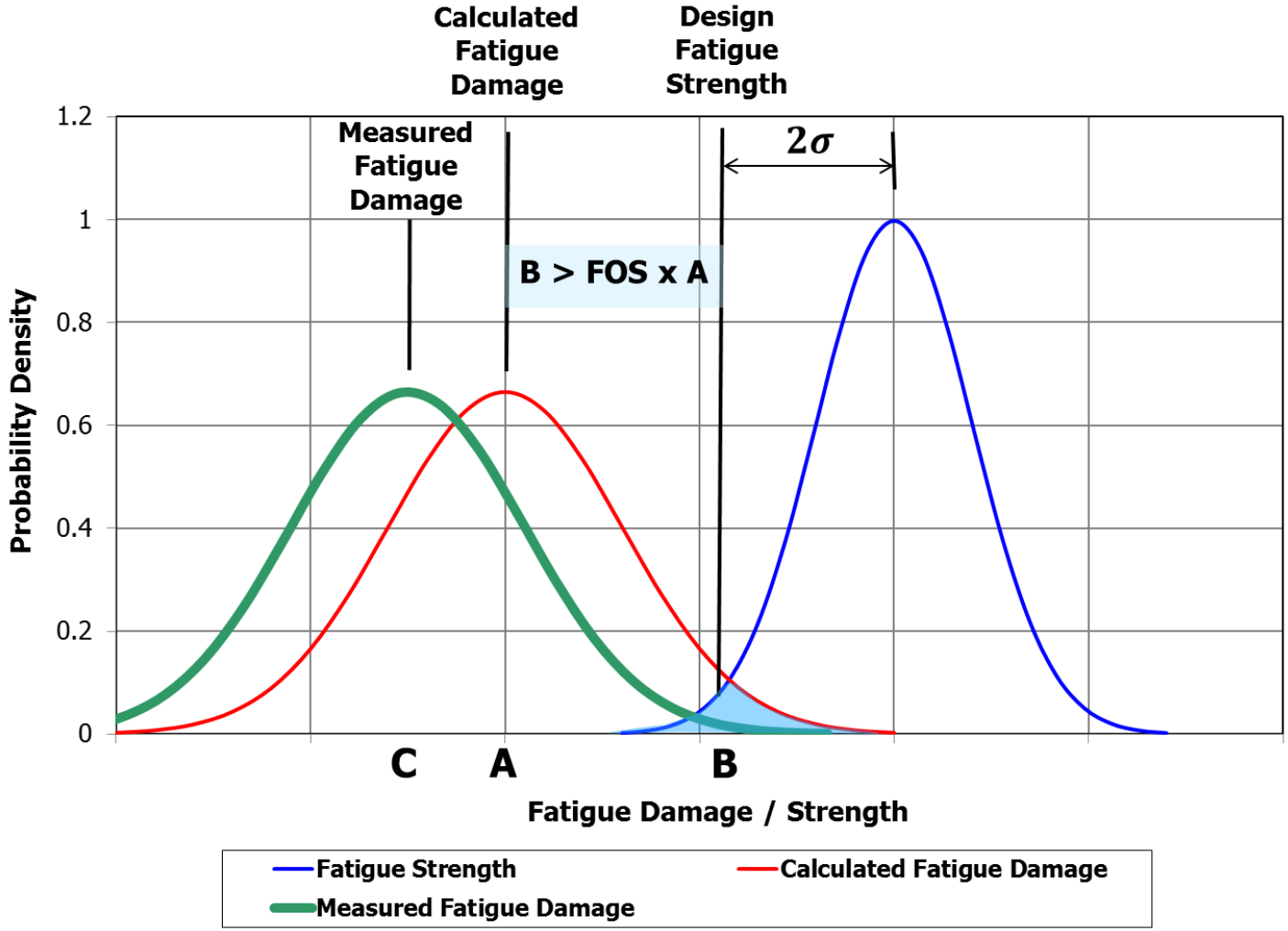


Fatigue Damage Accumulation



May use an event, time or environment based approach

Benefit of Fatigue Measurements

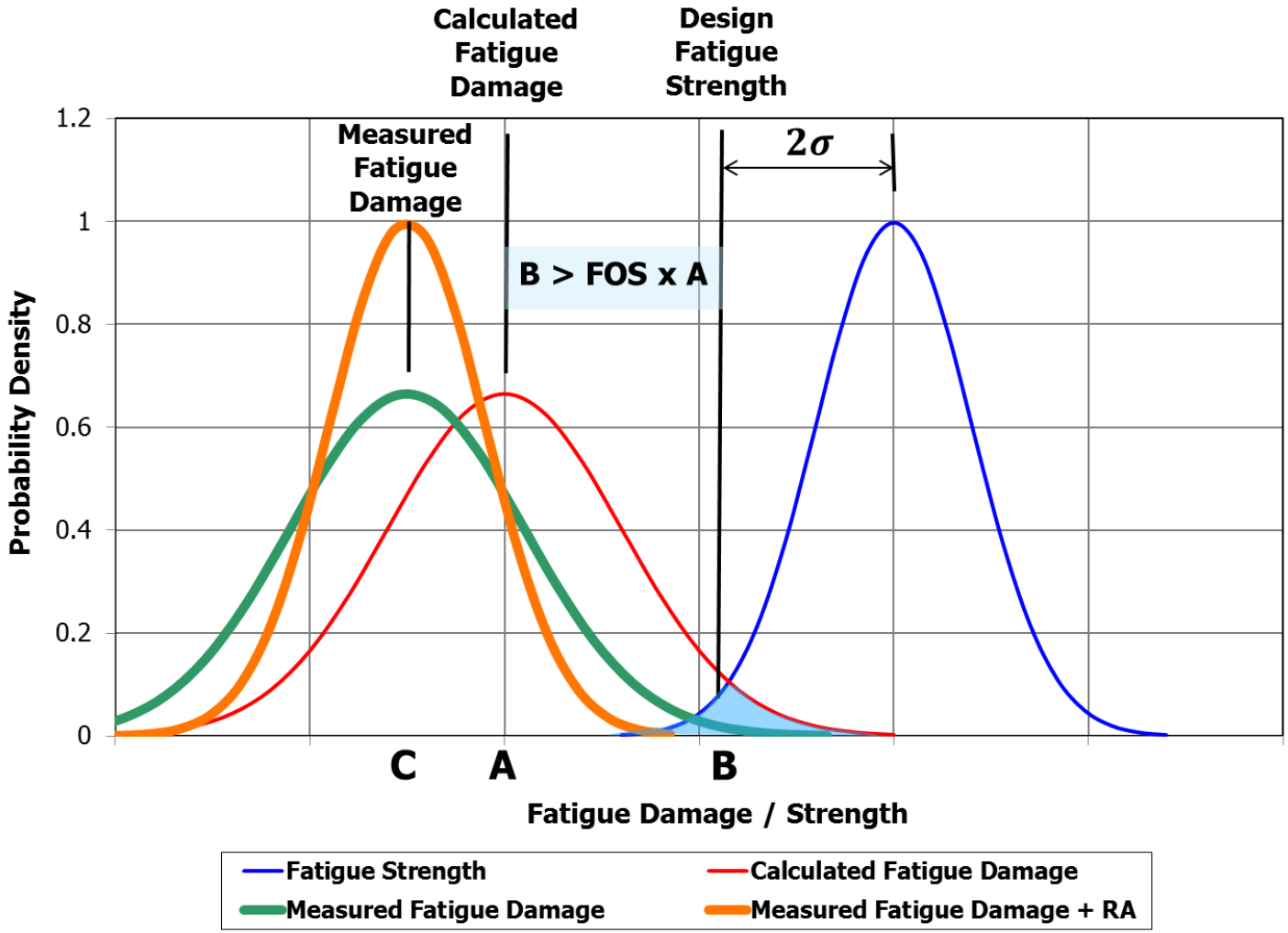


Measurements enable definition of conservatism or bias = A/C

What Other Benefits Can Be Gained?

- Use of bias alone gives 3 to 10 times improvement
- Measurements remove major uncertainties:
  - Wave loading and vessel motions
  - Hydrodynamic coefficients
  - Modelling
  - Soil parameters
- Uncertainty remains only in transfer function and local SCF's
- Reliability analysis can be used to take advantage of reduced variability – DNV RP-F204, DNV CN 30.6

Extended Use of Measurements



Reduction in variability can be defined using reliability analysis

Conclusions

- Monitoring reduces uncertainties
- Determining bias and reducing uncertainty can be used to extend life, while achieving the same target probabilities of failure
- Monitoring provides information to confirm that equipment is healthy and to keep the people responsible happy
- Standardisation of reduced safety factors for monitored response should be feasible and is being investigated

Thank you for your time

Questions….

Further information:

2H Offshore Engineering
www.2hoffshore.com

+61 89480 0658
+44 1483 774900