

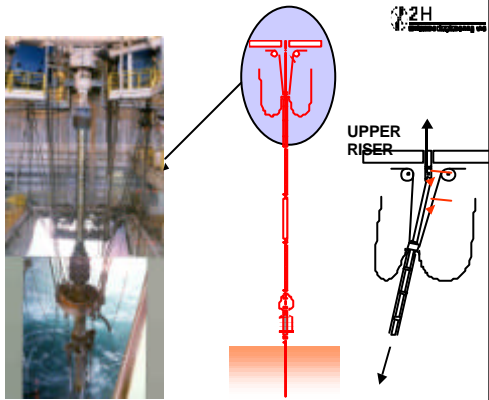
## The Effect of Deepwater Currents on Drilling Riser Operations

By  
Stephen Hatton

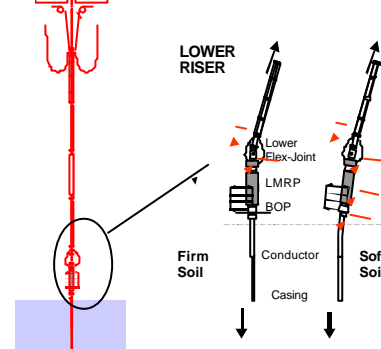
2H Offshore Engineering Ltd

## Overview

- Drilling riser system overview
- Effect of current on drilling riser response
- Drag and VIV issues
- Uncertainties
- Large scale riser data
- Benefit of monitoring programs



## Riser Deflections and Wear Hotspots



## Drilling Riser Deflections

- Top tension & buoyancy
- Vessel motions and offsets
- Mud weights and work strings
- Seabed stiffness
- Conductor stiffness
- Flexjoint stiffness
- Current velocity and profile
- **Drag coefficient**

## Drag Coefficients

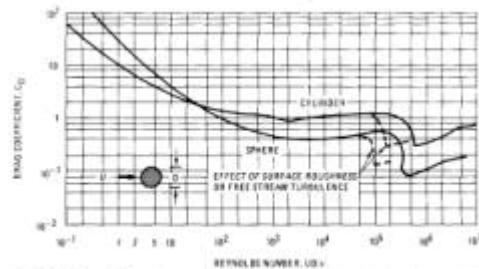


Fig. 6-9 Drag coefficient in a steady flow for smooth circular cylinders. (Mansy, 1979)

2H

### Effect of VIV on Drilling Risers

Increased Drag Load

Latest Developments in Riser Design

deep water riser engineering

2H

### VIV FATIGUE DAMAGE - 28in SCR

Latest Developments in Riser Design

deep water riser engineering

2H

### VIV Drag Amplification Factors

Latest Developments in Riser Design

deep water riser engineering

2H

### Deepwater drilling is sensitive to current profile because of:

- Length of the riser subject to current
- Limited tension available to support riser weight resulting in deflections
- Effect of deflections on wear and passage of tools

Therefore, deepwater currents can:

- Disrupt riser installation
- Incur costly drilling downtime
- Reduce survival envelopes for drift-off
- Cause fatigue by Vortex Induced Vibration

Latest Developments in Riser Design

deep water riser engineering

2H

### 1 Year Current Profiles

Latest Developments in Riser Design

deep water riser engineering

2H

### West of Africa

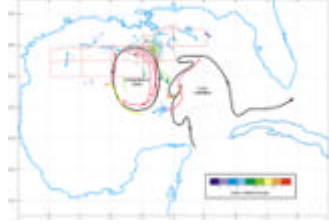
- Mild currents driven by large scale ocean circulation
- Except for extreme surface wind and Congo river discharge

Latest Developments in Riser Design

deep water riser engineering



### Gulf of Mexico – Loop Currents



- Severe currents due to Gulf Stream
- Short-lived, but sufficient to disrupt drilling



### Assessment of Current on Drilling Riser Response

- Operational Envelopes
  - Installation
  - Drilling
  - Survival
  - Disconnect
- VIV Fatigue

**All aspects are drag (VIV) dependent**

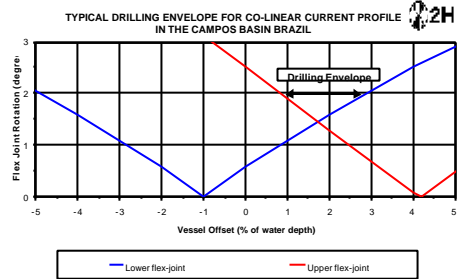


### Assessment of Drilling Downtime

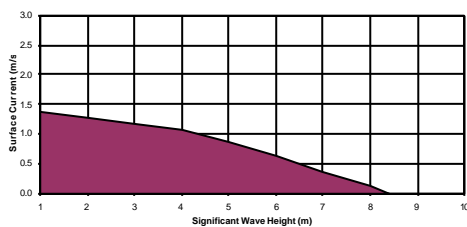
- Need to accurately represent currents with respect to:
  - Directionality
  - Exceedence Probability
  - Oceanographic processes
  - Seasonal occurrence
- Correct vessel & riser data
  - RAO
  - Riser stack-up
  - Equipment capacities
  - Operating conditions (mud weights)
- Correct understanding of VIV response



### Example of Drilling Envelope for Campos Basin – Co-linear



### Hang-Off and Installation Envelopes



### Implication of VIV

- Fatigue damage
  - Accumulative
- Increased drag loading
  - Riser installation
  - Riser tension
- Suppression devices required
  - Expense
  - Hassle

Latest Developments in Riser Design

2H

### VIV Prediction Software

- VIVA (DTCE/ MIT)
- SHEAR7 (MIT)
- DEEPVIV (IFP)
- VIVANA (Marintek)
- VIVALL (BPP/UCL)

- Differences in approach
- Differences in results
- Limited modeling capabilities
- Not validated

deep water riser engineering

Latest Developments in Riser Design

2H

### BP SCHIEHALLION DRILLING RISER

- 360m water depth
- Bare and buoyant riser joints
- Response monitored at 3 points
- Max 2 knots
- Re up to  $1.0 \times 10^6$

deep water riser engineering

Latest Developments in Riser Design

2H

### NDP - DRILLING RISER

- Bare and buoyant riser joint
- Instrument up to 5 positions
- Riser tension logging?
- Nyk High, Vema
  - 1300m
  - Currents < 1 knot
- Ellen Hansen
  - 750m
  - Current monitoring?
  - Drill string?

deep water riser engineering

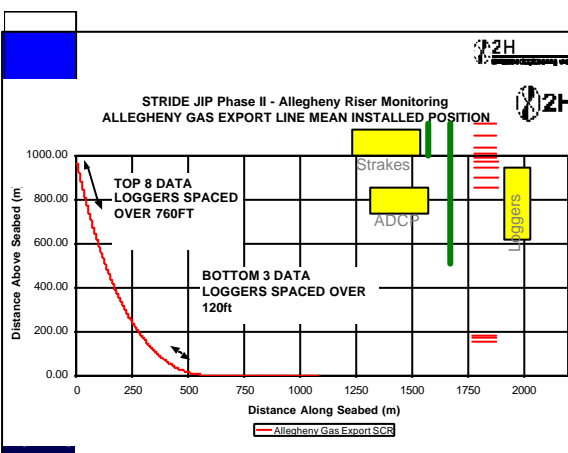
Latest Developments in Riser Design

2H

### STRIDE Allegheny

- 1000m GoM
- Gas export SCR
- Currents up to 2 knots
- 2H analysis of actual response completed
- Blind analysis conducted

deep water riser engineering



Latest Developments in Riser Design

2H



### 2H Riser Logger 1<sup>st</sup> Generation

deep water riser engineering

Latest Developments in Riser Design

2H

### Allegheny Loggers (12 off)





deep water riser engineering

Latest Developments in Riser Design

2H

### STRIDE Large Scale VIV Testing



deep water riser engineering

Latest Developments in Riser Design

2H

### STRIDE Riser Tow Trials




deep water riser engineering

Latest Developments in Riser Design

2H

### 2H Riser Logger - 2<sup>nd</sup> Generation

- Smaller
- Lighter
- More sensitive
- Higher storage




deep water riser engineering

Latest Developments in Riser Design

2H

### 2H Riser Logger Specification



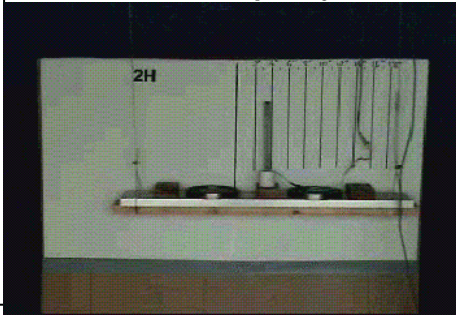
- 2-3/8" x 12 inches – 3000m rating
- +/-1g to +/-5g
- 8 analogue channels
- 128Mb Smart Media Disk
- Low noise
- Acceleration, Temperature, Strain, Pressure

deep water riser engineering

Latest Developments in Riser Design

2H

### Typical Drilling Riser VIV Motion and Frequency



deep water riser engineering

### Characteristics of Real Risers

- Multiple pipes
- Complex terminations - tensioners & soil
- Varying profile
- Varying current direction and profile
- Wave effects

### 2H DRMP JIP

- Objectives
  - Improve understanding of VIV through riser monitoring
- Strategy
  - Monitor 2-3 drilling risers over next 12 months using 2H loggers
- Benefits
  - Benchmark VIV codes and allow improved optimisation of risers
- Cost
  - \$30k per year

### In Summary.....

- Drag loads and VIV response are critical to all types of riser design
- Deepwater drilling particularly sensitive
- DRMP is a low cost program to obtain improved VIV data
- Stand alone loggers highly cost effective with low disruption and high flexibility
- Drilling riser monitoring gives increased understanding of full scale riser systems
- Calibration of VIV prediction tools
- Application to other riser types