

ZHI offshore

Riser & Conductor Engineering

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

an **ACTEON** company

Advances in Riser Technology for Mineral Exploration

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Offshore & Deep Sea Mining 2016

29 November 2016

London, UK

Overview

- 2H Offshore and Risers
- Seabed Mining Project Experience
- Mining Riser Design Issues
- Deepwater Challenges
- Water Depth Exceeding 3000m
- Questions



About 2H Offshore

Riser & Conductor Engineering

Founded in 1993

300+ highly
qualified
engineers

Global standardised
procedures for
seamless
operation

Extensive
experience in all
riser types

Practical
understanding of
hardware and
installation

Leaders in
marine structure
dynamics

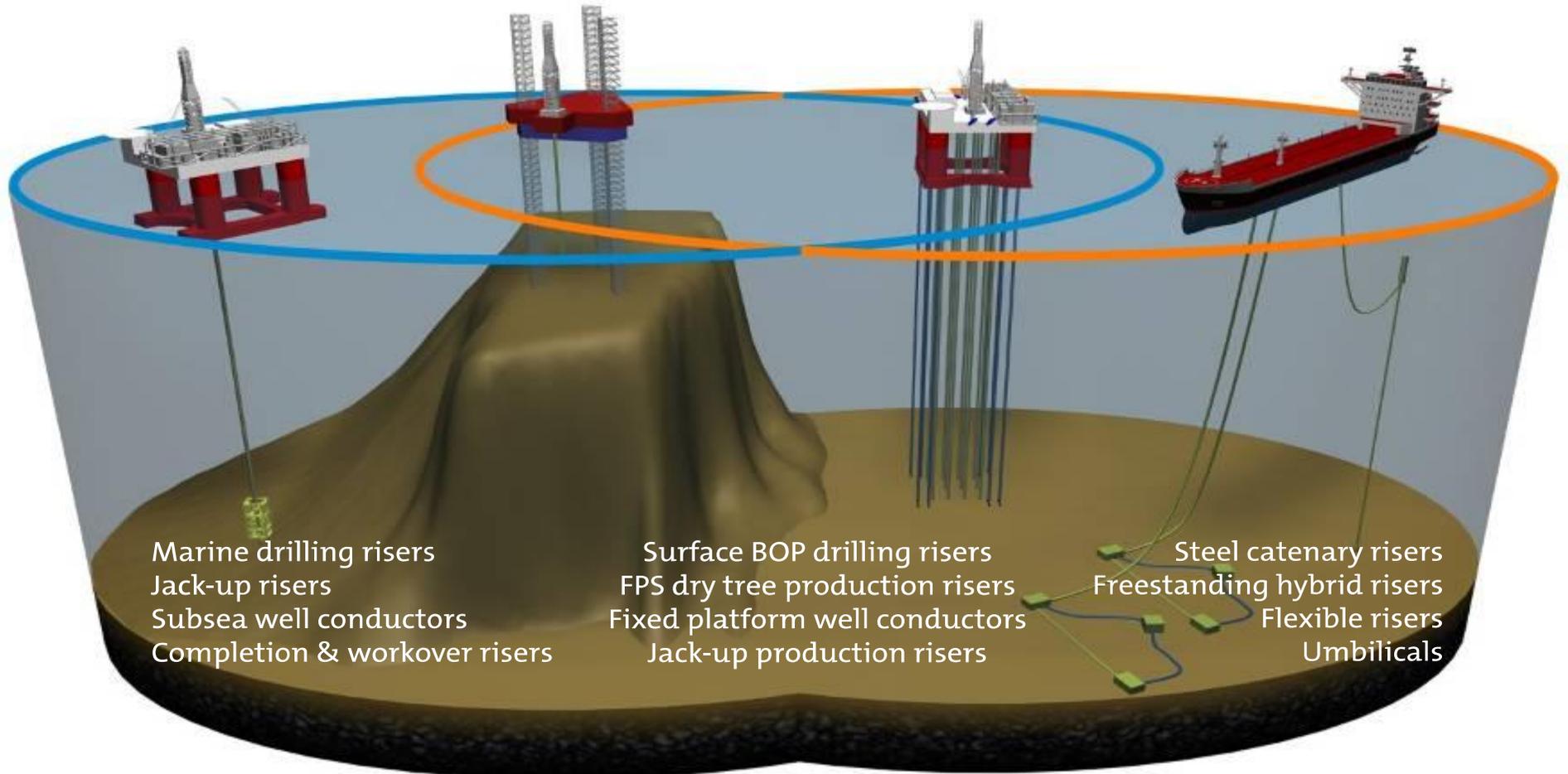
An independent,
technology
driven
company

Part of the
ACTEON
group

Areas of Expertise

Drilling, Completion &
Workover

Production & Export



Concept Design & FEED

Detailed Engineering

Procurement management

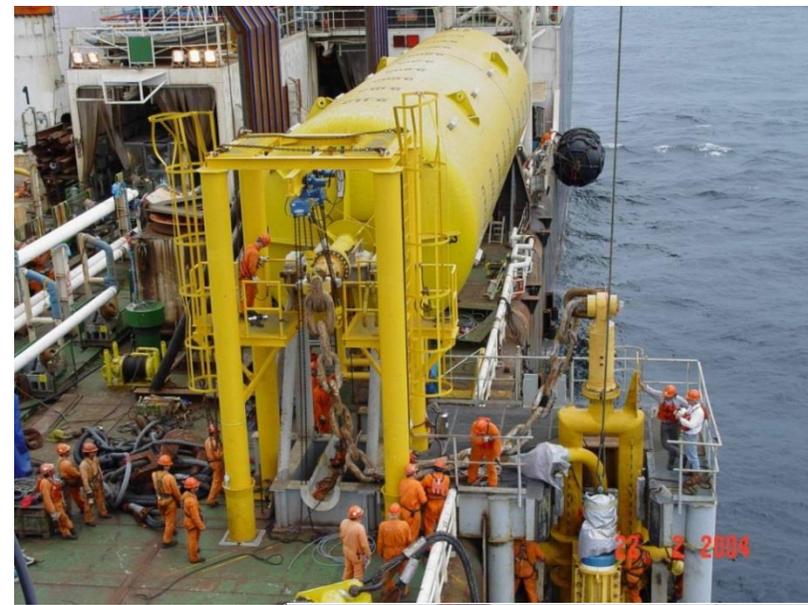
Fabrication & Installation Support

Integrity Management & Monitoring



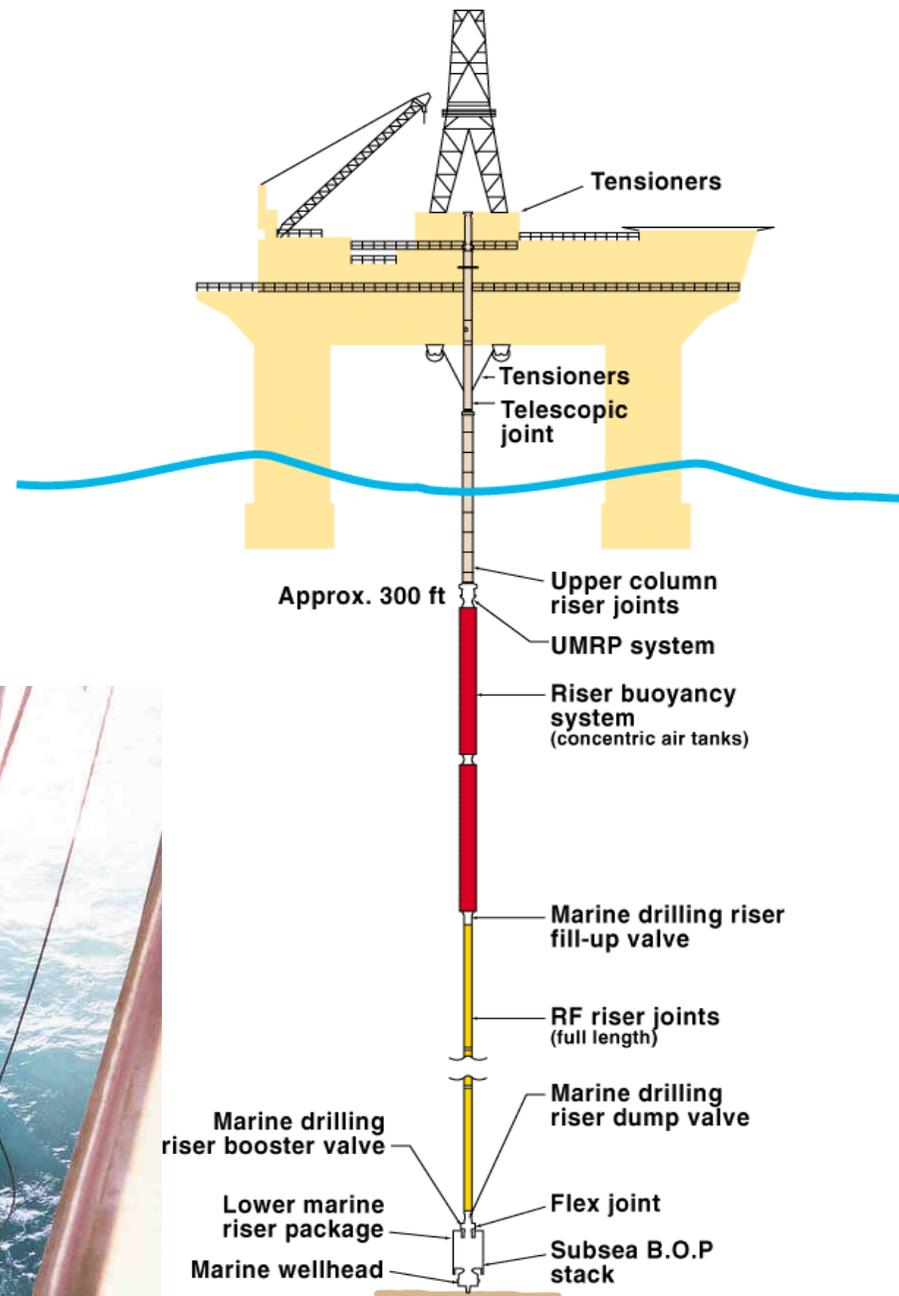
Production Risers

- Conduit for fluid transportation to and from well
- Well control/pressure containment



Drilling Risers

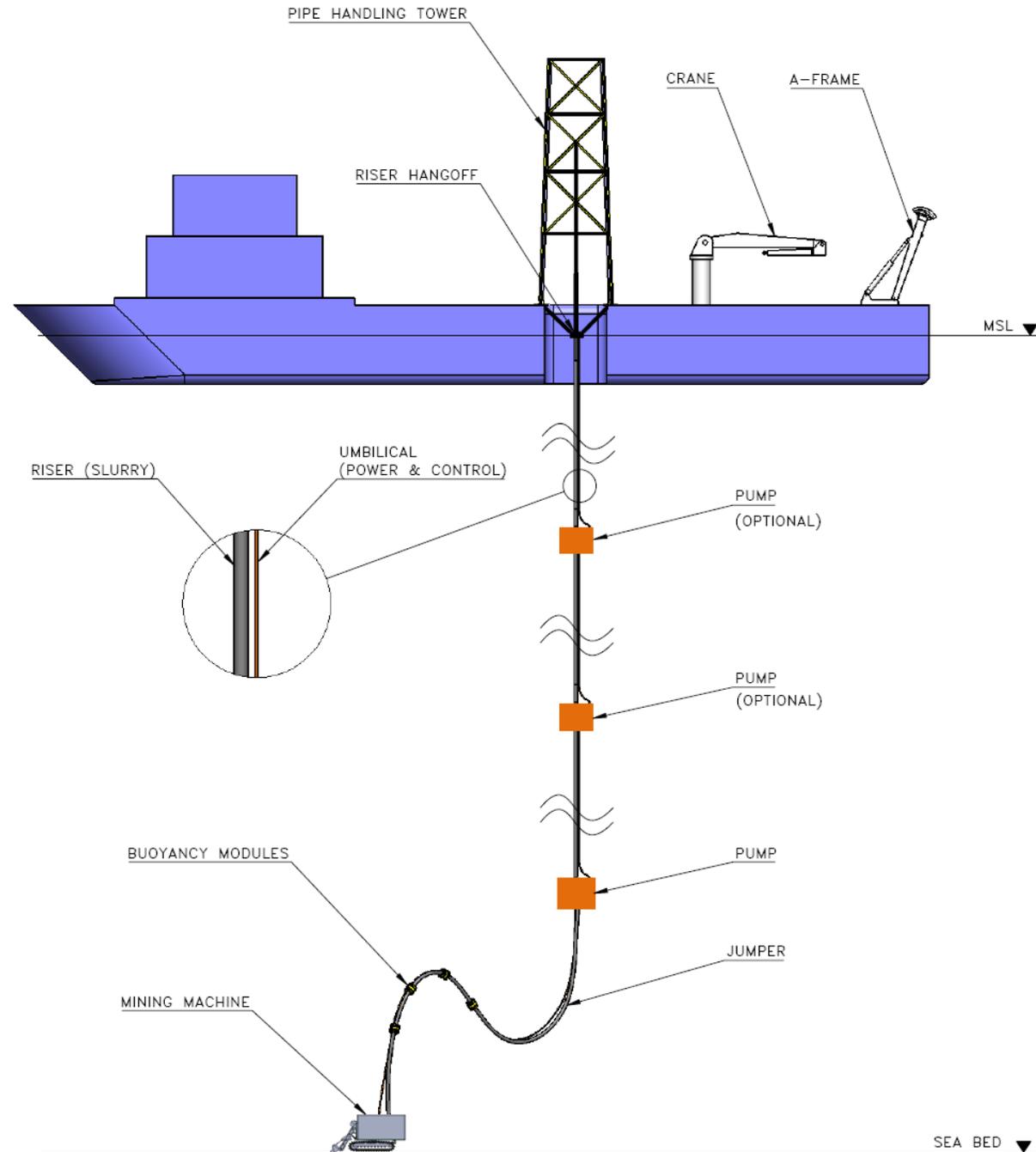
- Conduit for drilling into well, passage of drilling tools and well casings
- Carry BOP control umbilical and auxiliary lines
- Run and retrieve BOP in free hanging mode



Mining Riser Design Experience

- Offshore Papua New Guinea - Riser and Lifting System Concept Design and Verification
- Black Sea Seabed Mining Production Riser Feasibility Study
- Generic Mining Riser Feasibility Study for 5,000m Water Depth
- European Union Blue Mining Joint Industry Project
- South Indian Ocean Mining Trial - Configuration and Handling Studies of Flexible Transport Riser System in 6,000m Water Depth
- Deployment Analysis and Safety Assessment of a Circulation Test Riser System in 500m Water Depth

Typical Mining Riser Configuration



Walking a Dog !

Vessel



Miner

LEAD

or

FOLLOW



Vessel and Miner Interactions

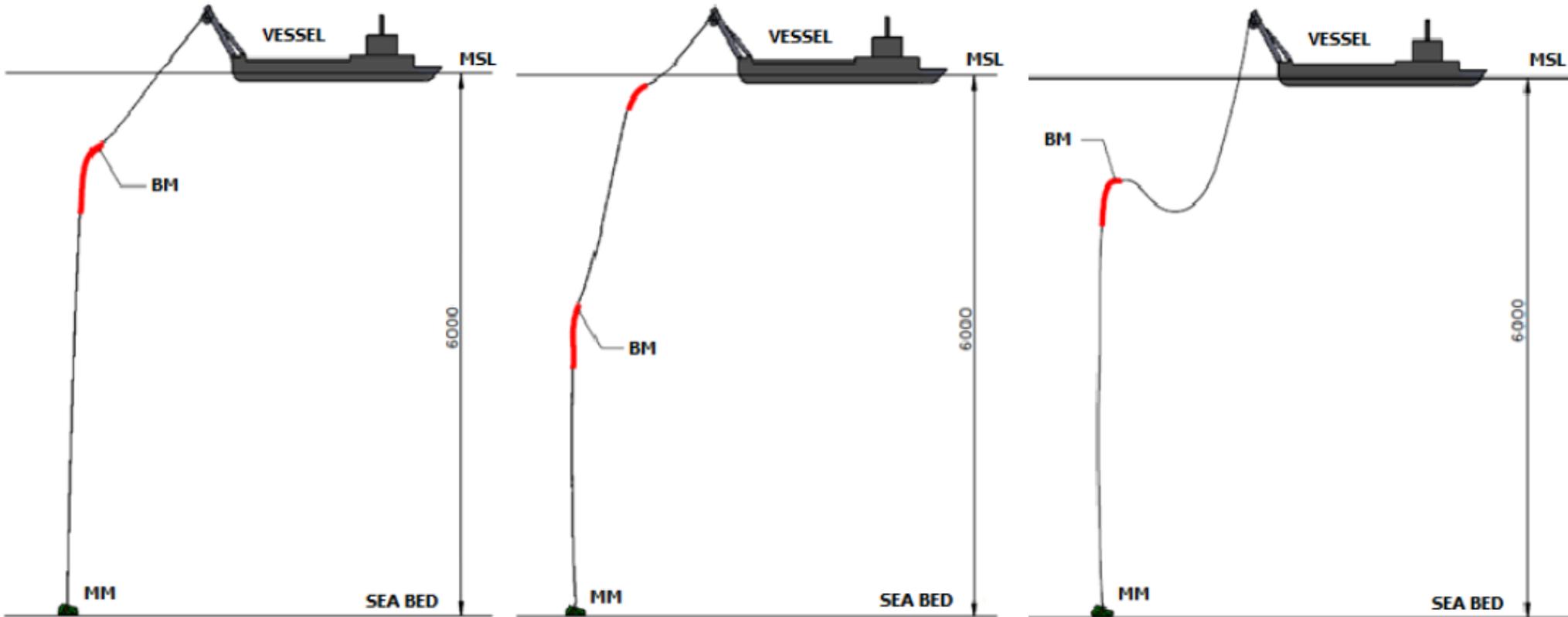
Vessel “leads”:

- Vessel “drives” seafloor mining pattern
- Vessel moves ahead of Miner and assists Miner forward movement
- Difficult to control – variable loads on Miner

Vessel “follows”:

- Miner dictates seafloor mining pattern
- Miner moves under its own power
- Vessel dynamically positioned to follow Miner
- Leave slack in riser so Miner can move with little restraint

Riser Configuration Options – Wave Catenary

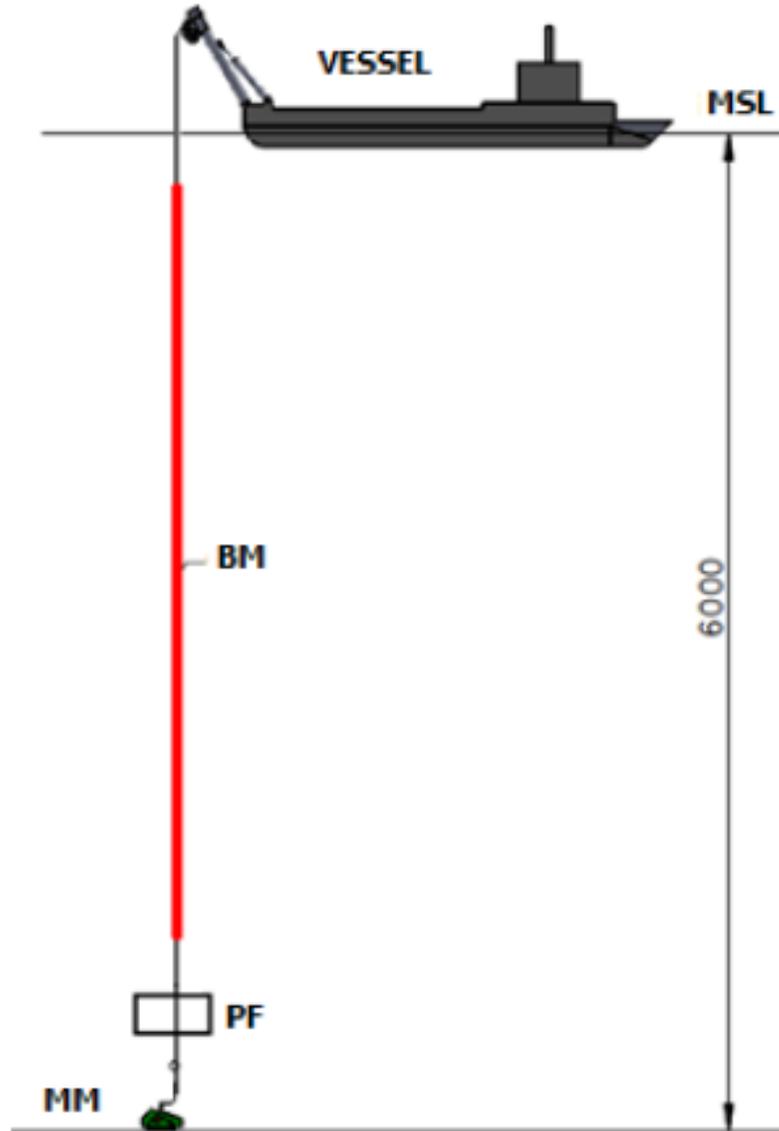


Steep Wave Riser

Multiple Steep Wave Riser

Lazy Wave Riser

Riser Configuration Option – Vertical Hanging



Comparison of Configurations

Wave Catenary

- Continuous riser from Vessel to Miner
- Pump located on Miner
- Steep Wave preferable to Lazy Wave because it does not present a sag bend that collects residue during shut-down
- Pipe wear in bends
- Restraining loads on Miner, highest in Steep Wave configuration
- Limited pipe material choices

Vertical Hanging

- Separate pump free hangs underneath long vertical riser
- Pump hovers above seabed
- Wave shaped jumper connects Miner to pump
- Allows Miner to move freely with little restraint
- Less power required to manoeuvre lighter Miner
- Long vertical riser section opens to many material choices including steel pipes
- Steel riser can carry different pump types

Riser Design Engineering Scope

- Design basis preparation
- Concept and configuration selection
- Wall thickness definition
- Operability (static/dynamic) analysis
- First order fatigue analysis
- VIV fatigue analysis
- Handling and installation study
- Installation analysis
- Interference analysis
- System and component design
- Wear liner design



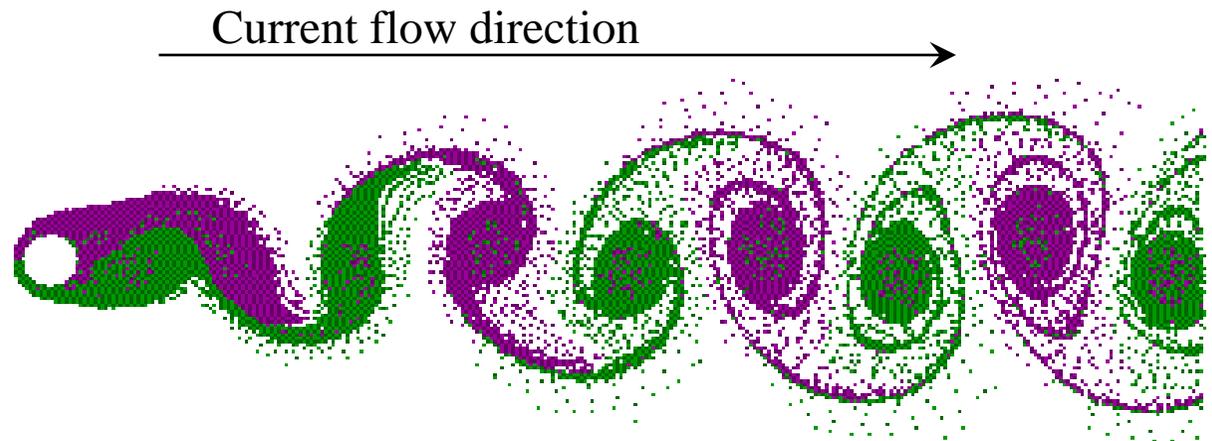
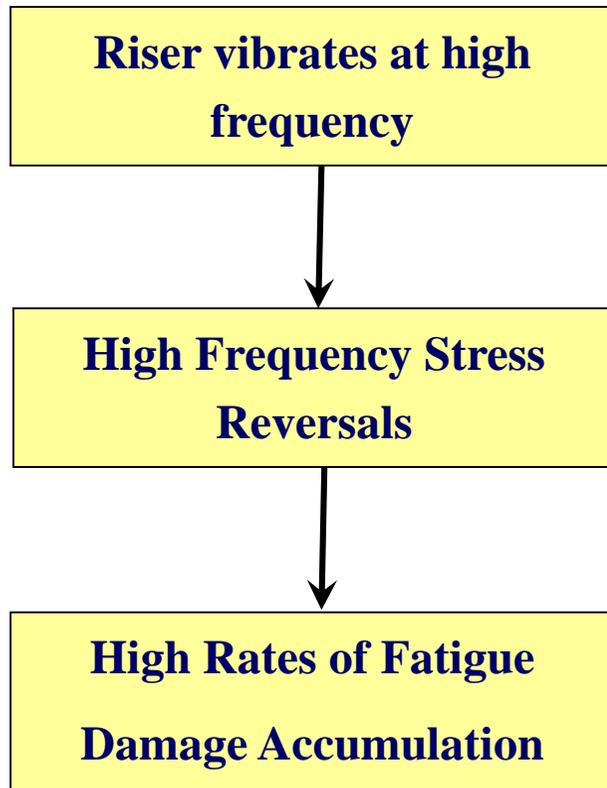
Deepwater Challenges

- High riser payload
- Large deck space for storing riser joints
- Long time to deploy and retrieve riser
- Uncertain metocean conditions
- Vortex induced vibrations
- Weld and connector fatigue



Current Loading – Vortex Induced Vibrations

Cross flow vibration of risers caused by presence of severe currents

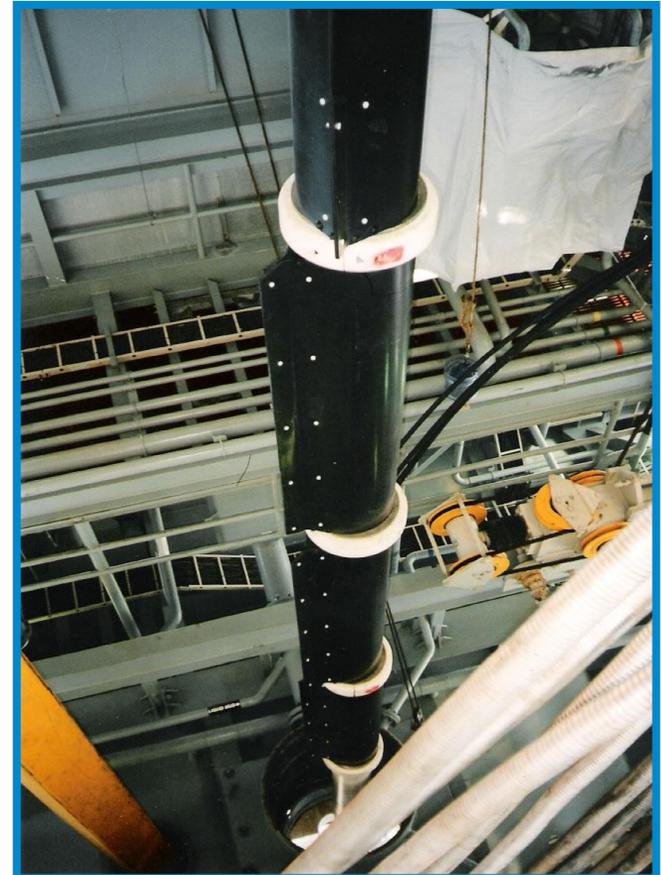


VIV Suppression Devices



Strakes

Fairings



Additional Issues for >3000m Depth



- Same issues as <3000m depth but worse
- **AXIAL RESONANCE !**
- Leading to extreme stresses, snatch loading, or possibly fatigue failure

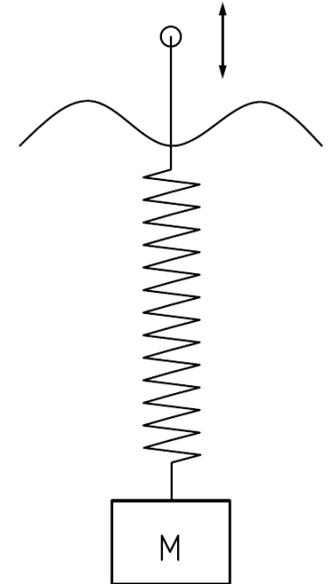
Axial Resonance

When riser is mining

- A suspended spring-mass system with axial natural period falling within range of exciting wave periods

During deployment

- A suspended spring-mass system going through various length-dependent natural periods



Mitigating Axial Resonance

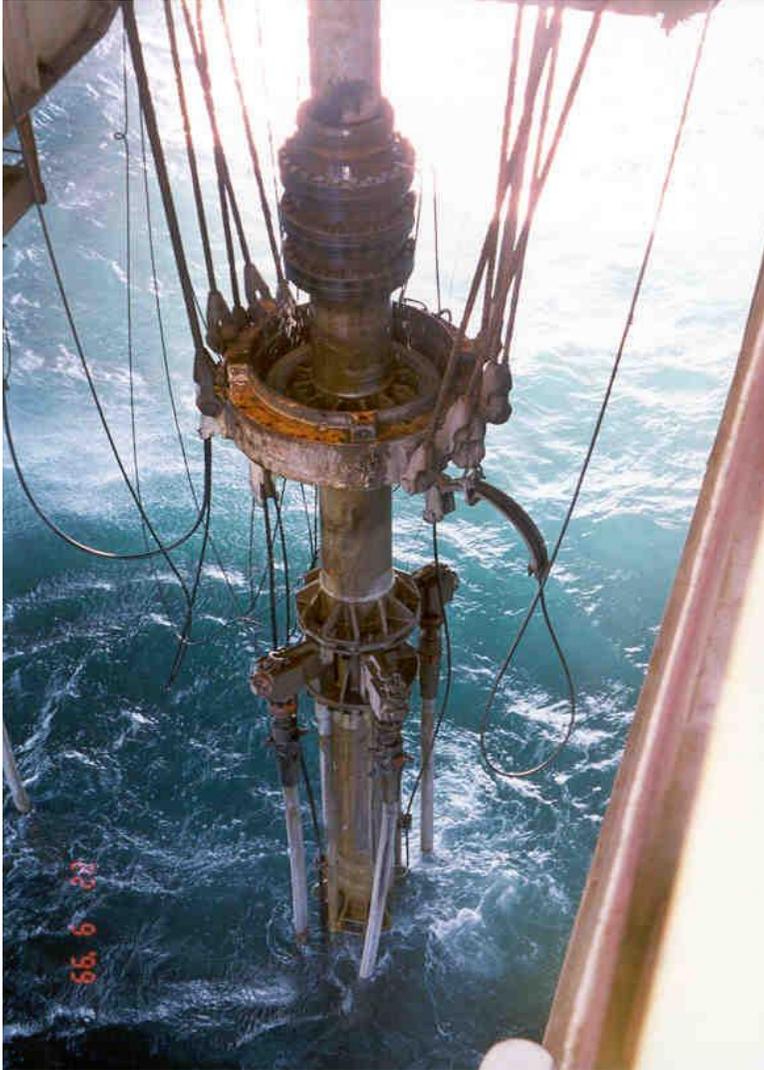
When riser is mining

- Adjust riser hang-off stiffness and damping characteristics to reduce exciting loads on riser
- Add in-line motion compensators to 'de-tune' the riser axial natural period
- Add tuned mass dampers to 'cancel' vertical riser motions

During deployment

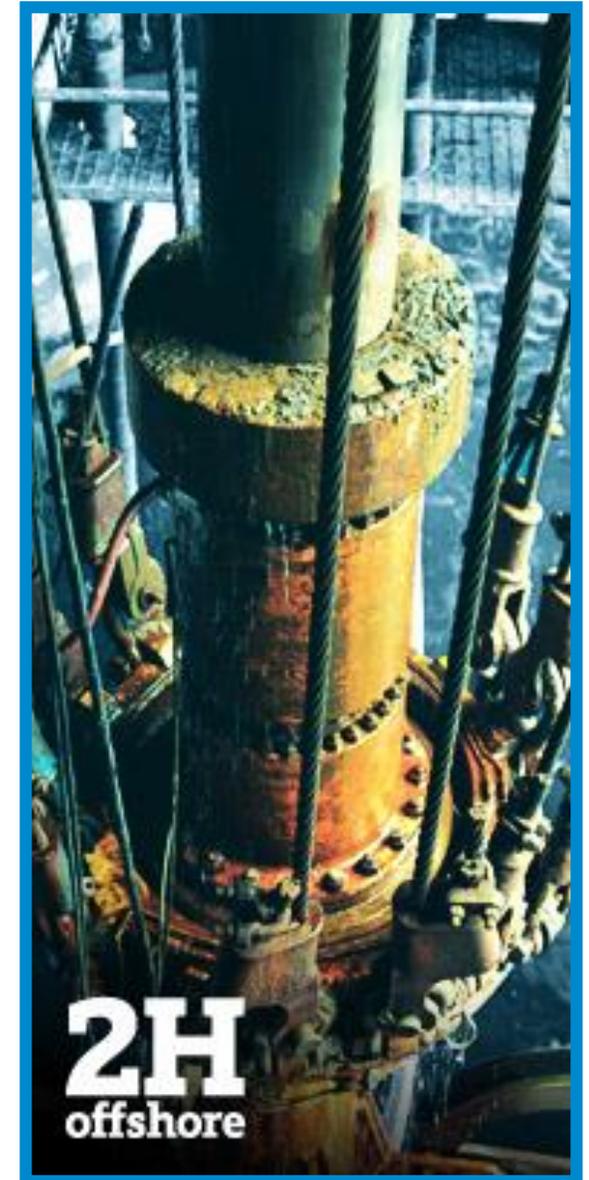
- In-line motion compensators
- Tuned mass dampers
- Compensated drawworks
- Compensated drill floor

Hang-off Compensators



Concluding Remarks

- Risers are not commodity items
- Challenging component of mining systems
- Deepwater riser experience is improving
- Industry continues to learn
- Materials technology and riser weight driven
- Early engineering & assessment critical



Thank you for your time.

Questions.....

Further information:

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