What’s in a Deep Sea Mining Riser System?

F. Lim

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About 2H Offshore
Riser & Conductor Engineering

- Founded in 1993
- 250+ 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

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Concept Design & FEED
Detailed Engineering
Procurement management
Fabrication & Installation Support
Integrity Management & Monitoring

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Drilling Risers

- Conduit for fluid transportation to and from well;
- Support auxiliary lines
- Support BOP control umbilicals
- Conduit for passage of drilling equipment and well casings
- Serves as a running and retrieval tool for the BOP

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Production Risers

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

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Typical Mining Riser Configuration
## Mining Riser Projects Overview

<table>
<thead>
<tr>
<th>Date</th>
<th>Client / Project</th>
<th>Location</th>
<th>Material</th>
<th>Water Depth (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007-2008</td>
<td>Nautilus Minerals</td>
<td>Offshore Papua New Guinea</td>
<td>eSMS</td>
<td>1700-2500</td>
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<tr>
<td>2008-2009</td>
<td>Marexin</td>
<td>Black Sea</td>
<td>Seabed sediments</td>
<td>200-2280</td>
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<tr>
<td>2012-2013</td>
<td>IHC Mining</td>
<td>Not defined</td>
<td>SMnN</td>
<td>Up to 5000</td>
</tr>
<tr>
<td>2014-date</td>
<td>BlueMining</td>
<td>Not defined</td>
<td>eSMS, SMnN</td>
<td>Up to 6000</td>
</tr>
<tr>
<td>2014-date</td>
<td>NIOT</td>
<td>South India Ocean</td>
<td>SMnN</td>
<td>Up to 6000</td>
</tr>
<tr>
<td>2016-date</td>
<td>CRI MM</td>
<td>Not defined</td>
<td>SMnN</td>
<td>Test 500</td>
</tr>
</tbody>
</table>

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Walking a Dog!

LEAD or FOLLOW

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

Miner
- 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

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Riser Configuration Options - Wave Catenary

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Riser Configuration Option – Vertical Hanging

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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

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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

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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

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Additional Issues for >3000m Depth

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

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

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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

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Hang-off Compensators

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