HPHT - Single vs Dual Barrier
High Pressure Drilling Risers

T. Eyles

Subsea Communities - HPHT
Mar. 2011
Single / Dual Barrier
HP Drilling Risers

Acteon HPHT Subsea Community Breakfast Meeting

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Agenda

- Introduction
- Drilling Riser Configurations
- Deepwater TLP Drilling Risers
- Jack-up Drilling Risers
- Conclusions
- References and Further Reading

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Why are some deep water HP drilling risers dual barrier?

What is current industry best practise?

Is a dual barrier system lower risk than a single barrier?

Why are most jack-up drilled tie-back wells drilled with a single barrier HP riser?

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Drilling Riser Configurations

- **Shallow water – Jack-up**
  - Surface wellhead (Platform)
    - Surface BOP
    - Conductor/casing strings continued
    - No dedicated drilling riser
  - **Subsea wellhead (Tieback)**
    - Surface BOP + High pressure drilling riser
    - Avoid use of floating drilling unit

- **Deep water**
  - **Surface wellhead (Spar/TLP)**
    - Surface BOP + High pressure drilling riser
  - **Subsea wellhead (Tieback - Floating Drilling Unit)**
    - Subsea BOP + Low pressure drilling riser
    - Surface BOP + High pressure drilling riser

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Drilling Riser Configurations

- Conventional shallow water drilling from Jack-up
- Conventional Subsea Drilling
- Surface BOP Drilling
- Surface BOP Drilling with ESG

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High Pressure Drilling Risers
Existing Barrier Philosophies

Jack-up Unit
Tieback wells

Floating Drilling Unit
e.g.
Total Donggalla (13-3/8”)
Ophia/Shell (13-3/8”)

Spars/TLPs
e.g.
Dominion Devils Tower
Statoil Snorre

Spars/TLPs
e.g.
Shell Mars
BP Horn Mountain
Chevron Bigfoot

Single

Dual

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Deepwater TLP Drilling Risers
Primary drivers for dual barrier

- Riser mud pressure significant contribution
  - Riser mud loss could compromise well control
- Excessive weight with a single barrier riser
  - Tensioner limitations
- Excessive wall thickness with a single barrier
  - Pipe availability
  - Weld quality
- Local legislation
- Seen as “best practise”

Shell Mars TLP

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Deepwater TLP Drilling Risers Design Selection Process

- CAPEX – CAPital EXpenditure
- OPEX – Operational EXpenditure
- RISKEEX – RISK EXpenditure
- RAMEX – Reliability-Availability-Maintainability EXpenditure
- Profit = Max(Revenue-CAPEX-OPEX-RISKEEX-RAMEX)

Ref: Deepwater Development Lifecycle Costs for Subsea Systems JIP (1999)

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Deepwater TLP Drilling Risers
Dual Barrier Pros & Cons

<table>
<thead>
<tr>
<th>Pros</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inner string failure may not result in loss of well control</td>
<td>Lower RISKEX</td>
</tr>
<tr>
<td>Can monitor annulus pressure for leaks (small volume)</td>
<td>Lower RISKEX</td>
</tr>
<tr>
<td>Reduced wall thickness (esp. if diff. pressure ratings)</td>
<td>Lower CAPEX</td>
</tr>
<tr>
<td>Less demanding weld/material criteria</td>
<td>Lower CAPEX</td>
</tr>
<tr>
<td>Reduced system weight (esp. if diff. pressure ratings)</td>
<td>Lower CAPEX</td>
</tr>
<tr>
<td>Can continue drilling operations if small annulus pressure</td>
<td>Lower RAMEX</td>
</tr>
<tr>
<td>Use inner string as casing on next well to improve wear management</td>
<td>Lower RISKEX</td>
</tr>
<tr>
<td>Easier mud control (smaller volume)</td>
<td>Lower OPEX</td>
</tr>
<tr>
<td>Better cuttings management</td>
<td>Lower OPEX</td>
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## Deepwater TLP Drilling Risers Dual Barrier Pros & Cons

<table>
<thead>
<tr>
<th>Cons</th>
<th>Cost Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased riser hardware</td>
<td>Increased CAPEX</td>
</tr>
<tr>
<td>Increased riser running time</td>
<td>Increased OPEX</td>
</tr>
<tr>
<td>Increased riser weight (esp. if matched pressure ratings)</td>
<td>Increased CAPEX</td>
</tr>
<tr>
<td>Reduced flexibility for optimised casing hanger and programme</td>
<td>Increased OPEX</td>
</tr>
<tr>
<td>Limit on maximum number of casings</td>
<td>Increased OPEX</td>
</tr>
<tr>
<td>Increased number of components (may have common failure mode)</td>
<td>Increased RISKEX</td>
</tr>
<tr>
<td>Requires a good metal-to-metal seal at seabed</td>
<td>Increased RISKEX</td>
</tr>
</tbody>
</table>

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Deepwater TLP Drilling Risers
Selection Process

- Final selection should depend on full development lifecycle
  - CAPEX
  - OPEX
  - RISKEX
  - RAMEX
- Different operators will have different expenditure profiles
- Outcome location, operator and market dependent
Jack-up HP Drilling Risers
Design Challenges

- Increasing pressure, temperature, water depth, harsher environment
- Demanding fluid compositions
- Reduced desirable risk profile
- Increasing CAPEX
- Increased wall thickness & riser weight
- High tensioner utilisations
- Rig modifications
- Susceptibility to fatigue
  - Wave driven
  - Vortex-induced-vibration
- Increased riser wellhead loading/utilisation
- Increased vessel motion

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Jack-up HP Drilling Risers Selection Process

- Consider project
  - CAPEX
  - OPEX
  - RISKEX
  - RAMEX

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Jack-up HP Drilling Risers
Single Barrier System Considerations

- Reducing RI SKEEX
  - Adopt high performance connectors
    - Proven fatigue resistance
    - Proven make-and-break (and OPEX)
    - Proven sealing
  - Ensure appropriate materials and welding
  - Simplify design
  - Reduce number of components
  - Design for wear and corrosion
    - Appropriate base material specification
    - Adequate corrosion allowances with emphasis on splash zone
    - Adequate corrosion barriers on riser OD such as coatings and anodes
  - Ensure quality offshore installation
  - Consider riser monitoring
  - Consider seabed safety device

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Jack-up HP Drilling Risers
Single Barrier System Considerations

- **Reducing OPEX**
  - Perform regular maintenance and inspection

- **Reducing CAPEX**
  - Consider high strength materials
    - Reduce wall thickness
    - Reduce riser weight
    - Reduce rig modifications
    - Decrease tensioner utilisation
  - Consider alternative connection systems
    - Reduce need for integral forgings
    - Permit high strength materials

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Conclusions

- Selection of single or dual barrier systems should be taken on a case-by-case basis
- Should consider
  - CAPEX
  - OPEX
  - RISKEX
  - RAMEX
- Higher pressure, temperature and water depth, harsher environments and internal fluids increase the need for an assessment to be performed
- However a dual barrier system may not always give reduced risk

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References and Further Reading


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Questions?

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Thank you

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