Dry Tree vs. Wet Tree - Consideration for Deepwater Field Developments

S. Natarajan

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Dry Tree vs. Wet Tree - Considerations for Deepwater Field Developments

Shreenaath Natarajan

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Overview

- Introduction
  - Dry tree systems
  - Wet tree systems
- Dry Tree System Benefits and Challenges
- Wet Tree System Benefits and Challenges
- Emerging riser technology trends
- Optimised field development solution
Dry Tree Facilities

- Well access at the surface
- Gradual progression in to deepwater
  - Jacket platforms
  - Compliant towers
  - TLPs
  - Spars
- Deepest dry tree facility installed to date
  - Devils tower Spar – 5600ft, GoM
  - Magnolia TLP – 4700ft, GoM

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Deepwater Dry Tree Facilities

- 14 Spars; 16 TLP installed
- Extension of shallow water riser/conductor technology

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Wet Tree Facilities

- Subsea trees attached to a host facility
- Typical host facilities
  - Semi-submersibles
  - Compliant towers
  - TLPs
  - Spars
  - FPSOs
  - FPU
- In-field developments and long distance tie-backs
- Implemented in water depths of up to 7,000ft Atlantis, GoM

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Wet Tree Riser Systems

Flexible

Steel

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Design Benefits and Challenges for Concept Selection

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Dry-tree System Benefits

- Tree and well control at surface in close proximity of people
- Drilling conducted from the facility – reduced CAPEX
- Direct vertical access to wells for future intervention activities
- Minimal offshore construction
- Enable future drilling and expansion

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Dry-tree System Challenges

- Safety concern due to well access at surface
- Large vessel payloads due to the need for supporting risers
- Require high cost vessels such as Spar, TLP due to design sensitivity to vessel motions
- Complex riser design issues
  - Limited by existing riser tensioner capacity
  - Riser interface with vessel require speciality joints, e.g. keel joint, tapered stress joint
- Heavy lift requirement for riser installation

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Wet Tree System Benefits

- Tree and well access at the seabed isolated from people
- Full range of hull types can be used
- Low cost hull forms are feasible
- Simplified riser/vessel interfaces

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Drilling and workover will need a separate MODU or require hull with drilling/workover capability increasing the overall CAPEX.

Potentially large vessel payloads due to risers.

Flow assurance may be a challenge due to potentially long tie-in.

High spec pipe-lay vessels required to install risers and flowlines.
Wet Tree Riser Specific Challenges

Steel risers
- Fatigue critical requiring good quality offshore welds and fatigue testing requirement

Flexible risers
- Water depth (collapse) limitations
- Pipe diameter limitations for deep water and higher internal pressure
- Prone to external sheath damage during installation
- Potential of internal sheath (PA11) aging due to high water cut
- Potential end fitting integrity issue

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<table>
<thead>
<tr>
<th>Feature</th>
<th>Dry Tree Development</th>
<th>Subsea Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilling Cost</td>
<td>From facility</td>
<td>Requires MODU</td>
</tr>
<tr>
<td>OPEX Costs</td>
<td>From facility</td>
<td>Requires MODU</td>
</tr>
<tr>
<td>Facilities CAPEX Cost</td>
<td>High cost hull</td>
<td>Choose least cost hull</td>
</tr>
<tr>
<td>Offshore Construction</td>
<td>Heavy lift requirements</td>
<td>Depends on riser system</td>
</tr>
<tr>
<td>Development Flexibility</td>
<td>Restricted due to hull form</td>
<td>Minimal vessel impact</td>
</tr>
<tr>
<td>Riser/Vessel Interfaces</td>
<td>Complex interaction</td>
<td>Simpler interaction</td>
</tr>
<tr>
<td>Vessel Flexibility</td>
<td>Restricted to Spar or TLP</td>
<td>Full range</td>
</tr>
<tr>
<td>Shut in location</td>
<td>In well bay close to people</td>
<td>Seabed Isolation and Offset</td>
</tr>
<tr>
<td>Flow Assurance</td>
<td>Shortest Flow Path</td>
<td>Potentially long tie flowlines</td>
</tr>
</tbody>
</table>

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Preferred Features

- Host vessel type flexibility
- Minimise offshore construction
- Minimise vessel impact
- Reduced overall costs
- Standardised and modular components
- Improved schedule flexibility
- Enable phased field development

Combination of both dry-tree and wet tree system benefits

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SLOR™ PRODUCTION SYSTEM

Freestanding Risers (SLOR™)

Low Cost Facility (Semi)

Subsea Trees

Manifold System

HP Drilling Riser (SBOP)

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Single Line Offset Riser (SLOR™) Features

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SLOR Components are modular

- Foundation system
- Vertical riser pipe
- Buoyancy can
- Flexible jumper

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Freestanding Riser Benefits in Deepwater

- Host vessel flexibility
- Low vessel payload
- Good fatigue performance
- Adaptable for a range of water depths

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**SLOR™ Benefits**

- **Pre-install risers**
  - Use existing MODU in the field or any MSV
  - Provides *installation schedule flexibility*

- Shorter schedule to first oil
  - Need to **hook up only flexible jumper**
  - **Production** from pre-drilled wells **within 7-10 days**

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- **Exxon Kizomba A (5 SLOR’s)**
  - 3No. Water Inj. (12 inch)
  - 2No. Gas Inj. (8 inch)

- **Exxon Kizomba B (2 SLOR’s, 3 COR’s)**
  - 2No. Production (12 x 15 inch PIP)
  - 1No. Test (8 x 11 inch PIP)
  - 2No. Water Inj. (8inch & 12inch)

- **Petrobras P52 - 18 inch export SLOR**
  - BP Block 31 – 10 SLOR’s
  - Petrobras Cascade EPS, GoM (5 SLOR’s)
  - Exxon – Kizomba Satellites (2-3 SLORs)
  - Block 15 – Gas Export SLOR

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Summary

- Pre-installable
- Excellent fatigue response
- Host vessel flexibility
- Field proven components
- Modular components

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Summary

- SLOR based field development option can minimize CAPEX & OPEX
- Minimize offshore construction
- Improve schedule to first oil
- System flexibility
- Direct well access for cost efficient drilling and workover

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Thank you