Standardised Freestanding Hybrid Risers for Deepwater FPSOs

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FPSO Summit
Nov. 2011
Standardized Freestanding Hybrid Riser Systems for Deepwater FPSOs

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1st November 2011

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Freestanding Hybrid Risers

- 2H overview
- Why is there a need for them?
- Configurations
- Current examples
- Alternatives

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2H Overview

- Riser and conductor systems specialists
- 170+ high quality engineers
- Unique combination:
  - Complex analysis
  - Equipment detail design
- Part of Acteon Group

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Acteon Group

- 18 specialist subsea Companies
- £310m Turnover
- 51% owned by First Reserve Corporation

Linking Subsea Services

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Deepwater Riser Design Challenges

- Long unsupported lengths
- High pressures
- Design life of 20-30 years
- Environmental loading
  - Current
  - Wave
- FPSO
  - Vessel motions
  - Vessel offsets
  - Payload limitations
  - Riser-FPSO interfaces
- High extreme stresses
- High fatigue damage rates
Deep Water Riser Design Options: Flexible Risers

- Compliant response
- Not fatigue sensitive
- Installation friendly
- Limitations
  - Water depth
  - Pressure
  - Diameter
  - Temperature
- Expensive
- Reliability?

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Deep Water Riser Design Options: Steel Catenary Riser (SCR)

- 6-30” diameter
- 1,000 – 10,000ft water (8,000ft installed)
- Sensitive to vessel and environment
  - Extreme loads
  - Fatigue motions
  - VIV
- Payload impact on host facility
- Complex vessel interface
  - Flex joint
  - Stress joint
- Heave optimised vessels (Spar, TLP)

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Freestanding Hybrid Riser

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Free Standing Riser Configuration

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Single Line and Bundle FSHRs

SINGLE LINE  
(SLOR / COR)  
Kiz A & P52  
Kiz B

BUNDLES  
(Internal)  
Girassol  
(External)  
Block 18

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Buoyancy Tank

- Maintain riser verticality
- Steel plate structure
- Flat or hemispherical ends
- Pressure balanced design
- Compartmentalised

- Design up to:
  - 40m tall
  - 6m diameter
  - ~700Te upthrust

- Limited by:
  - Fabrication site
  - Handling / Installation restrictions

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Upper Assembly - Conventional

- Tubular frame structure
- Loading interface between:
  - Top of riser pipe
  - Buoyancy tank
  - Flexible jumper
- May require:
  - Articulation connection
  - Flexible jumper pull-in
  - Intervention entry point
- Design up to:
  - 23m tall
  - 55Te

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Upper Assembly - Alternatives

Learn more at www.2hoffshore.com
Lower Assembly

- Tubular frame structure

- Loading interface between:
  - Bottom of riser pipe
  - Foundation
  - Rigid base jumper

- May require:
  - Articulation connection
  - Stress joint
  - Riser base gas lift

- Design up to:
  - 5m – 20m tall
  - 10 - 30Te

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Rigid Base Jumper

- Steel pipe / induction bends

- Accommodate relative movement between riser and flowline
  - Pipeline expansion
  - Riser motions

- Critical fatigue mechanisms
  - Riser motions (drift / riser VIV)
  - Jumper VIV
  - Thermal cycling
  - Slugging

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Freestanding Riser Evaluation

**Advantages**
- Decoupled from vessel motions
- Not sensitive to environmental loading
- Excellent fatigue performance
- Low vessel payload
- Pre-installable
- Flow assurance flexibility
  - Large insulation thicknesses
  - Pipe-in-Pipe
  - CRA lined pipe
- Local content
  - Piles
  - Buoyancy Can
- Opportunity for design standardisation

**Disadvantages**
- Large spatial requirement
- Clearance issues
- Increased design complexity
- High CAPEX compared to SCR
- Installation challenges
  - Large components
  - Overall lift weight/height

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Benefits of Standardising Freestanding Hybrid Risers

- Differentiate on ability to install pipe efficiently, NOT ability to:
  - Develop riser concepts
  - Conduct detail design of products/components

- Allows Operator to drive technical solution

- Risk & responsibility fairly distributed:
  - Operator - Global system performance
  - Contractors - Component design & installation

- System engineered once

- Increased market competition

- Wider application of ‘available’ installation vessels

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## Freestanding Risers to Date

<table>
<thead>
<tr>
<th>Type</th>
<th>Field</th>
<th>Status</th>
<th>Owner/ Field Operator</th>
<th>Yr. Installed</th>
<th>Region</th>
<th>Water Depth (ft)</th>
<th>Water Depth (m)</th>
<th>Vessel</th>
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<tr>
<td>Bundle</td>
<td>Green Canyon 29/ Garden Banks 388</td>
<td>De-commissioned</td>
<td>Placid Oil Company/ Ensearch</td>
<td>1988/ 1994</td>
<td>GoM</td>
<td>1,529/ 2,096</td>
<td>466/ 639</td>
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<td>Girassol</td>
<td>Operating</td>
<td>Total Elf</td>
<td>2001</td>
<td>Angola</td>
<td>4,430</td>
<td>1,350</td>
<td>Spread Moored FPSO</td>
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<tr>
<td></td>
<td>Rosa</td>
<td>Operating</td>
<td>Total Elf</td>
<td>2007</td>
<td>Angola</td>
<td>4,430</td>
<td>1,350</td>
<td>Spread Moored FPSO</td>
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<tr>
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<td>BP Greater Plutonio</td>
<td>Operating</td>
<td>BP</td>
<td>2007</td>
<td>Angola</td>
<td>4,300</td>
<td>1,311</td>
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<td>Single Line</td>
<td>Kizomba A/B</td>
<td>Operating</td>
<td>Exxon</td>
<td>2003/ 2005</td>
<td>Angola</td>
<td>3,330 to 4,200</td>
<td>1,006 to 1,280</td>
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<td>* Block 31 NE</td>
<td>Fabrication</td>
<td>BP</td>
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<td>Angola</td>
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<td>2,100</td>
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<td>Roncador P-52</td>
<td>Operating</td>
<td>Petrobras</td>
<td>2007</td>
<td>Campos Basin</td>
<td>5,906</td>
<td>1,800</td>
<td>Semi-Sub FPU</td>
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<td>* Cascade/ Chinook</td>
<td>Detailed Design/ Execute</td>
<td>Petrobras</td>
<td>2011</td>
<td>GoM</td>
<td>8,531</td>
<td>2,600</td>
<td>Turret Moored FPSO</td>
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</tbody>
</table>

*To be installed

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Kizomba A & B - Exxon

- First field to use SLOR
- Kizomba A – 5 risers
  - 1 x Water Injection
  - 2 x Water Injection
  - 2 x Gas Injection
- Kizomba B – 5 risers
  - COR - riser base gas lift
  - 2 x Production PIP
  - 1 x Test PIP
  - 2 x Water Injection

- Kizomba Satellites – Two additional CORs (2011 installation)

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Girassol Riser Tower

Learn more at www.2hoffshore.com
BP Block 18 Riser Bundle

Learn more at www.2hoffshore.com
Other Developments

- **Petrobras Cascade & Chinook**
  - First FPSO in GoM
  - 2600m water depth
  - Disconnectable turret required for hurricane event
  - 5 single line freestanding risers
  - Freestanding Riser is ‘enabling technology’

- **BP Block 31 PSVM**
  - Deepest SLHRs in WoA
  - 2000m water depth
  - 9 SLHRs
  - External bow mounted turreted FPSO

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Alternatives/Developments

- Freestanding Risers
  - Reduced cost - top assembly optimisation
  - Grouped arrangement
- SCR
  - Weight optimised
  - Lazy Wave – Shell BC10
  - Buoyancy supported

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BSR – Riser Supporting Buoy

- Concept developed in the 90’s by DeepStar for 1000m.
- Being evaluated by Petrobras for Guara and Iara

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BSR - Riser Supporting Buoy

- BSR is a hybrid concept that takes advantage of the best features of SCRs and flexibles.
- SCRs: Less expensive than flexibles. Suitable for use in ultra-deep waters with large diameter sizes.
- Flexible jumpers have excellent fatigue behavior.

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FPSO Interfaces

- Key interfaces
  - Flexible end terminations and bend restrictors

- Key parameters affecting design
  - Turret vs spread moored
  - Position of riser hangoff
  - Space for riser end terminations
  - Maximum hang off weight
  - Vessel motions
  - Heading analysis
  - Mooring analysis

- Interface mechanism with FPSO contractor needs establishing early on!

Learn more at www.2hoffshore.com
Thank you for your time.

Questions....

Further information:

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