Design Challenges & Solutions for Large Diameter Export Risers

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Design Challenges & Solutions for Large Diameter Export Risers

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2H Offshore Engineering

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Agenda

- WA export riser design challenges
- Development options & design parameters
- Current industry examples
- Export riser types and design limitations
- Alternative large diameter export riser arrangements

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WA Export Riser Design Challenges

- Severe environments
  - Cyclones
  - Swells
- Floaters in ‘shallow’ water
- Long service lives (40+ years)
- Design for larger return periods
- Sour service
- Minimal processing on vessel

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Development Options

- Export Risers
  - Flexible
  - Steel Catenary Riser (SCR)
  - Top Tension Riser (TTR)
  - Freestanding Hybrid Riser (FSHR)

- Vessel
  - Semi Submersible
  - TLP
  - FPSO
  - Spar

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Design Parameters

- Gas developments
- Water depths 300m to 1,300m
- Flexible riser ID 16”+
- Steel riser OD 18” +
- Operating Pressure 135 to 550 bar

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# Large Diameter Risers

## Current Industry Examples

<table>
<thead>
<tr>
<th>Riser Type</th>
<th>Field Name</th>
<th>Water Depth (m)</th>
<th>Max OD/ID (in)</th>
<th>Vessel Type</th>
<th>Location</th>
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</thead>
<tbody>
<tr>
<td>Flexible</td>
<td>Bonga</td>
<td>370</td>
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<td>FPSO</td>
<td>Nigeria</td>
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<td>Statfjord B</td>
<td>145</td>
<td>19</td>
<td>FPSO</td>
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<tr>
<td>SCR</td>
<td>Prince</td>
<td>450</td>
<td>12</td>
<td>TLP</td>
<td>GoM</td>
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<td>Ind. Hub</td>
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<td>GoM</td>
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<td>Thunder Horse</td>
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<td>GoM</td>
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<td>TLP</td>
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<tr>
<td>FSHR</td>
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<td>Brazil</td>
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</table>

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Flexible Pipe Technology Limits
Large Diameter Risers

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Steel Catenary Risers (SCR) Large Diameter Limits

GoM Projects
Large Diameter SCR by Function and Vessel Type

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Why might WA export risers be different?

- Many riser system variations evaluated in the past

- Gulf of Mexico
  - Deep and Ultra deep water (1,000m to 2,500m+)
  - Predominately Oil service
  - Harsh environment

- West Africa
  - Deep water (1,300m to 2,700m)
  - Predominately Oil service
  - Mild environment

- Norwegian Sea/West of Shetland
  - Shallow and marginally deep water (350m to 1000m)
  - Gas and oil
  - Harsh environment

- Australia’s NWS does not fully fit into any of these categories
  - Water depth (300m to 1300m)
  - Gas
  - Harsh environment

- Modifications may be needed for robust riser solutions

- Alternative arrangements based on extensive work done previously for WoS and Norwegian Sea

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Steel Catenary Risers (SCR) and Alternatives

Learn more at www.2hoffshore.com
Weighting near touchdown improves performance

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SCR Alternatives
Weight Optimization

SCR curvature in TD zone is reduced by 20% with additional weight

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OMAE 29049, 2007
Lazy Wave Catenaries 800m

Plan length 1.25 – 2.5 x water depth

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Lazy Wave Catenary Response
Large Diameter/Deep Water

28in, 2300m water depth

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Lazy Wave Catenary Response
Effect of Internal Fluid - 30” OD

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SCR Vessel Interface Design

- **Flex-joints**
  - Historic failures
  - Pressure cycles
  - High Temperature
  - Larger diameter – increased stiffness
  - Gas service – high and low temp
  - 24”, 90C, 3700psi (255 bar)

- **Stress Joints**
  - Large loads from vessel offset
  - Multiple forgings for large diameters
  - Titanium alternative

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SCR Alternatives
Bottom Weighted Riser

Vertical Section
Flex Joint/Elbow and Weight Assembly
Horizontal Section

Tether (3 Off)
Pile Foundation

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SCR Alternatives
Bottom Weighted Riser

Learn more at www.2hoffshore.com
SCR Alternative
Tethered Riser Buoy

Petrobras Pre Salt Development

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Top Tensioned Risers

- Wellbay interface
  - Large valve stacks
  - Flexible jumper
  - Congestion/routing of topside piping
- Stroke sensitive
- Connector design

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Export TTR

Alternatives Jumper Arrangements

- 30” OD TTR
- Single 24” rigid jumper with flex joints
- Multiple 12” rigid jumper with flex joints
- Multiple 12” titanium jumpers

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Export TTR Base Arrangement

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Freestanding Hybrid Riser

- Clearance issues
- Large spatial requirement
- Size of flexible jumper ID
- Pigging

Solutions
- Dual Jumpers
- Bundle with multiple jumpers/modified manifold
- Use of intervention vessel for pigging

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FSHR Alternative Bundle

- Manifold Block
- Flexjoint
- Ball valve
- 14 inch ID gas export jumpers
- Latch Connector
- Ball valve
- 30 inch gas export line
- 14 inch ID production

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Bundle Riser Base with 30in Core

Learn more at www.2hoffshore.com
Summary

- Current and future production systems for offshore Western Australia require the use of large diameter risers for export of gas
- Riser design limits may impact the selection of production facility
- Export riser choice dependant on water depth, diameter, vessel and environment
- Flexible riser greater than 16”ID - limited by water depth and pressure ratings
- SCR, TTR and FSHR are optimal solutions for large diameter export riser solutions in WD>500m
- Use of Norway NS and WOS concepts and current GoM deep water riser technology will enable feasible riser solutions for NWS

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