Multi-Lines Hybrid Riser
Cost-Effective System for Deep Waters

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Multi-Lines Hybrid Riser System

- Agenda
  - Challenges & Design Premise
  - Main Components
  - Outline Installation Procedure
  - Dynamic Behavior
  - New URA Design Development
Multi-Lines Hybrid Riser System

- **Challenges of (Ultra) Deep Water Design**
  - Prospects at 3,000m WD or more
    - Deepwater (pressure) conditions
    - Seabed Conditions & Riser-Soil interaction
    - Qualification of Components
    - Fatigue
    - Etc.
  - Development cost effectiveness
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- **Design Premise**
  - One riser bundle per reservoir (“mini” riser tower):
    - Production (pipe-in-pipe riser, as stem tendon)
    - Gas Lift (PiP annular, injection @ riser base)
    - Service Line (e.g. ‘loop’ with production line)
    - Water Injection
  - Fully assembled offshore
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- **Main Components**
  - ‘Open’ Frame Upper Riser Assembly (URA)
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- **Main Components**
  - Lower Riser Assembly (LRA)
    - Rigid ‘M’ Spools
    - Flexible Jumpers or “Flex-tails”
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- Outline Installation Procedure
  - Foundation Installation
  - Production PIP Riser deployment
  - URA Connection & transfer to hang-off platform
  - Lateral Riser Deployment
  - Lateral Riser Assembly to FSR x 2
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- **Outline Installation Procedure**
  - Foundation Installation
  - Production PIP Riser deployment
  - URA Connection & transfer to hang-off platform
  - Lateral Riser Deployment
  - Lateral Riser Assembly to FSR
  - Buoyancy Tank Connection (crane master)
  - FSR Lowering & Connection to Foundation
  - Buoyancy Tank N2 Filling

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- **Outline Installation Procedure**
  - Foundation Installation
  - Production PIP Riser deployment
  - URA Connection & transfer to hang-off platform
  - Lateral Riser Deployment
  - Lateral Riser Assembly to FSR
  - Buoyancy Tank Connection (crane master)
  - FSR Lowering & Connection to Foundation
  - Buoyancy Tank N2 Filling
  - RBJs Installation
  - Flexible Jumpers Installation
  - ML-FSR Pre-Commissioning
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- **Hydrodynamic Behavior checked, including**
  - Different Riser Configurations (spacing, diameters...)
  - Vortex Induced (including Wake) Dynamics

- Steady (e.g. Galloping) Instability Phenomena
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- **New URA Design Development**
  - Two-tiered design arranged around a central open pipe structural member
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    - Direct Load Transfer from Buoyancy Tank to Central Riser
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  - Two-tiered design arranged around a central open pipe structural member
    - Direct Load Transfer from Buoyancy Tank to Central Riser
    - Compact design / load reductions

Previous URA Design

1300mm
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- **New URA Design Development**
  - Two-tiered design arranged around a central open pipe structural member
    - Direct Load Transfer from Buoyancy Tank to Central Riser
    - Compact design / load reductions
    - New Load Decoupling System
      - Lower cost ‘clamp’ connector
  - Installation effectiveness
  - Cost Reduction
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- Cost comparison with HRT and array of FSHR, Case study: 3 reservoirs @ 1,700m water depth;

- Multi Line Free Standing Riser (3 off) cost estimate:
  - ~17% lower than FSHR array (9 off);
  - ~12% lower than HRT (3 off).
Thank You / Questions

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