FPSO Riser Solutions for Harsh environments

Hanh Ha and Hugh Howells
AOG
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Overview

- Design challenges
- Flexibles
  - Configurations and response
  - Mild Environment Riser
  - Harsh Environment Riser - Weight Dampened Riser Solution
  - Harsh Environment Riser – In-Service Example
- Hybrid Risers
  - Configuration and installation challenges
  - Alternative solutions
- Summary
Riser Challenges for Australia

- A number of developments for deep water being evaluated
- FPSO/FLNG are probable development options
- Risers are an expensive part of the infrastructure of a FPS
- Installation a major cost due to limited vessel availability
- How do we adapt systems used elsewhere to be cost effective in Australia?
Design Challenges

- 40 year design lives
- Design for 10,000 year wave and current conditions
- Cyclonic Survivability – Run and hide or stay and fight?
- High swell seas – reduced fatigue resistance
- Large variations in fluid density
- High pressures and high temperatures
- High fluid velocity: ~30m/s
- High design pressure: ~450bar
- High design temperature: ~130°C
Hang-off – tension, azimuth, angle and MBR, clashing against the vessel and/or any other risers/umbilicals

TDP – MBR, compression

Check clashing and interference

Hog and Sag – clashing and interference, tensions and MBR
Mild Environment Flexibles – Tullow Oil TEN

- Tweneboa, Enyenra, Ntomme fields in Offshore Ghana
- 1400m water depth
- Turret Moored FPSO
- Lazy Wave Flexible Risers
  - 3 Stages Campaigns
  - P50 – 11 risers, 4 umbilicals
  - P10 – 4 risers, 1 Umbilical
  - Future – 2 risers, 2 Power Cables
Harsh Environment Flexibles – Weight Damperned Riser Solution

- Flexible Riser feasibility study – harsh environment
- Challenge – 25m WD – 30m Vessel Offset
- Riser configuration needs to accommodate different fluid densities;
  - 100% Water = 1025kg/m^3
  - 100% Gas = 7kg/m^3
- Universal solution for both extreme conditions proposed
Harsh Environment Flexibles – Statoil Peregrino

- Offshore Brazil
- 95m-135m water depth
- External Turret Moored FPSOs
- 6 Weight Aided Wave Risers
- 4 Lazy Wave Power Umbilicals
Flexible Riser Current Limits

- **Pressure Range**
  - 4” ID – Up to 10,000psi
  - 12” ID – Up to 5,000psi
- **Temperature**: -50°C to +135°C
- **Water Depth Range**
  - 2800m (6” ID)
  - 1500m (12” ID)
  - 750m (16” ID)
- Flow velocity dependant on inner carcass roughness
FSHR Arrangements
Hybrid Riser Characteristics

- Accommodate large vessel motions
- Good fatigue performance
- Not highly sensitive to environmental loading
- Low vessel payload
- Pre-installable
- Large spatial requirement
- Clearance challenges
- Complex design
- High CAPEX
- Installation challenges
  - Long heavy components
Hybrid Riser Components

- Buoyancy Tank
- Upper Riser Assembly (URA)
- Lower Riser Assembly (LRA)
- Base Foundation
- Lower Flexible Joint
- Crossover Joint
- Pile/Gravity Base
- Upper Flexible Joint
- URA Frame
- URA Piping
- Base Foundation
FSHR Top Assembly
FSHR Lower Assembly and Jumper
Installation Steps

- Foundation - driven, suction, drilled and cemented
- Lower riser assembly
- Riser pipe – welded j-lay, reeled
- Upper riser assembly
- Buoyancy tank
- Ballast
- Latch base and de-ballast
- Flexible jumper
- Riser base survey
- Riser base jumper
Installation – Final Lift

Specialist vessels and a number of mobilizations needed for current systems
Key Targets for Improvement

- Reduce component sizes
- Reduce need for specialist vessels
- Enable faster installation
- Enable use of local vessels

- Use distributed buoyancy
- Simplify air-tank arrangement
- Connect pipe using mechanical couplings
- Make use of local MODU’s
Distributed Buoyancy and Simplified Air Tank

- Tank tension requirement reduced to 150te
- Tank size less than half unbuoyed arrangement
- Scope to use vertical tubular compartments or foam
- Simplified ballast operation
- Faster installation
Mechanical Connections and Local MODU’s

- Good connector track record for limited HC exposure
- Qualification to ISO 21329 underway
- Faster riser installation
- Foundation installation
- Reduced mobilisations
- Approach used for Macondo containment risers
Weight dampened flexible risers are a low cost enabling technology for large/severe FPSO motions. For issues with clashing/interference. For control of risers with significant fluid density variations (slugging).

Enabling technology for some deepwater projects
Scalable to the deepest developments
Provides installation schedule flexibility

Hybrid risers are likely choice for future deepwater developments in Western Australia
Considerable scope for FSHR cost reduction
Needs Operator drive and changes to contract strategy
Thank you

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