FPSO Riser Solutions for Harsh environments

Hanh Ha and Hugh Howells
AOG
Perth, March 2015
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
Typical Flexible Riser Configurations

- 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
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
Tullow Oil TEN
Harsh Environment Flexibles – Weight Dampered 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
- LRA
- Lower Flexible Joint
- Pile/Gravity Base
- Upper Flexible Joint
- URA Piping
- URA Frame
- Crossover Joint
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
**Summary**

- 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