FPSO Riser Solutions for Harsh Environments

H. Ha, H. Howells, E. Tellier

AOG
Mar. 2015
FPSO Riser Solutions for Harsh environments

Hanh Ha and Hugh Howells
AOG
Perth, March 2015

Learn more at www.2hoffshore.com
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

Learn more at www.2hoffshore.com
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?

Learn more at www.2hoffshore.com
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

Learn more at www.2hoffshore.com
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

Learn more at www.2hoffshore.com
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

Learn more at www.2hoffshore.com
Tullow Oil TEN

Learn more at www.2hoffshore.com
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

Learn more at www.2hoffshore.com
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

Learn more at www.2hoffshore.com
FSHR Arrangements

Learn more at www.2hoffshore.com
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

Learn more at www.2hoffshore.com
Hybrid Riser Components

- Buoyancy Tank
- Upper Riser Assembly (URA)
- Lower Riser Assembly (LRA)
- Base Foundation
- Lower Flexible Joint
- LRA
- Pile/Gravity Base
- Upper Flexible Joint
- URA Piping
- URA Frame
- Crossover Joint

Learn more at www.2hoffshore.com
FSHR Lower Assembly and Jumper

Learn more at www.2hoffshore.com
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

Learn more at www.2hoffshore.com
Installation – Final Lift

Specialist vessels and a number of mobilizations needed for current systems

Learn more at www.2hoffshore.com
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

Learn more at www.2hoffshore.com
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

Learn more at www.2hoffshore.com
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

Learn more at www.2hoffshore.com
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

Learn more at www.2hoffshore.com
Thank you

www.2hoffshore.com