SUCCESSFULLY DESIGNING RISERS FOR DEEPWATER FPSOS

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Presented at FPS'98, The Tower Thistle Hotel, London

INTRODUCTION

- Development targets
- Challenges
- Riser types
- Design process
- Storm and fatigue response
- Materials and fabrication
- Installation issues
- FPSO drilling and intervention
- Conclusions

DEVELOPMENT TARGETS

Gulf of Mexico	1500-3000m
West Africa	600-2000m
Campos Basin	900-2000m
West of Shetland	750-1500m
Voring Basin	800-1500m
Others	

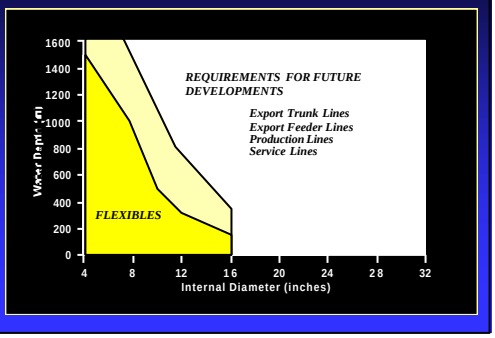
DEEPWATER CHALLENGES

- Deep water
  - *Weight*
  - *Collapse*
- Severe currents
  - *VIV fatigue, suppression devices*
- Insulation
  - *Needed to prevent hydrate formation*
  - *Increased drag*

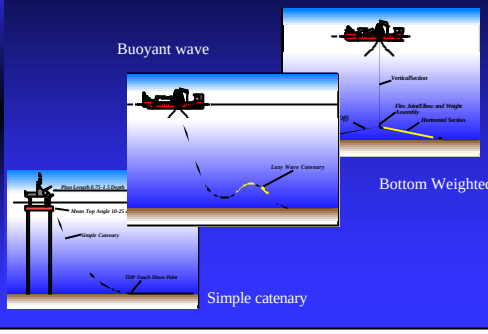
RISER TYPES

- Flexible
- Rigid Catenary
  - *simple*
  - *buoyant wave*
  - *bottom weighted*
- Hybrid

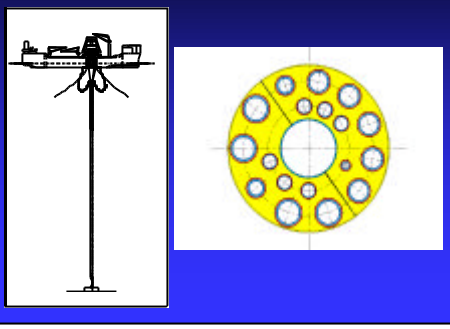
FLEXIBLE RISERS



RIGID CATENARY RISERS



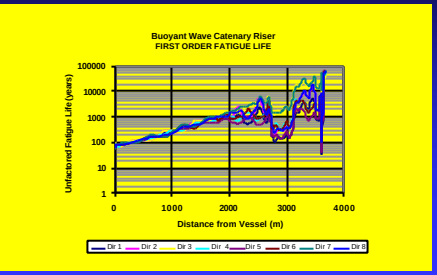
HYBRID RISER



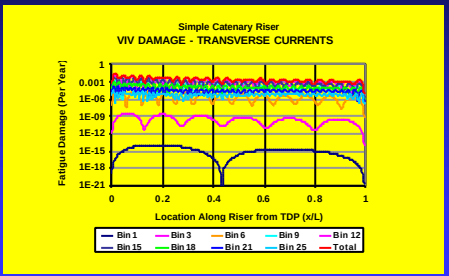
DESIGN PROCESS

- Sizing
  - *Burst, collapse, installation*
- Configuration
  - *Storm loading, intact and failed mooring conditions*
- Fatigue
  - *First and second order*
  - *VIV*
- Installation
  - *Weather windows - when, how long?*

FIRST ORDER FATIGUE



VIV FATIGUE



MATERIALS & FABRICATION

- Conventional
  - *Typically up to X65 steel*
  - *Single sided welding*
  - *High quality pre-fabrication in critical areas*
- Alternatives
  - *Titanium - local high strength, corrosive fluids*
  - *Composite? - water injection*

INSTALLATION ISSUES

- Weather windows - increased time, current
- Tension - limitation for large diameter lines
- Tow-out - optimum method, fatigue damage
- Reeled pipe - residual stresses
- Running - use of mechanical connectors
- VIV suppression - effect on method

FPSO DRILLING AND INTERVENTION

- Top-Tensioned Risers
  - *Catenary moored vessels, West Africa, well access and drilling*
- Compliant Vertical Access Risers (CVAR)
  - *Catenary or turret mooring, CT intervention*
- FPDSO
  - *Offset hybrids for production and import, drilling through turret*

CONCLUSIONS

- Rigid risers essential for feasibility of many current developments
- Riser and vessel selection dependent on location
- Many new concepts under evaluation
  - *Drilling and intervention capability*
- Key development targets
  - *VIV analysis and testing - SHEAR7, VIVA*
  - *Fatigue performance of girth welds and reeled pipe*
  - *Installation methods*