Riserless Operations – Structural Considerations for Deepwater

Vamsee Achanta
Agenda

• Introduction
• System Description
• Design Considerations
  • Configuration development
  • Installation and retrieval
  • Strength
  • Fatigue
  • Monitoring
• Conclusions
Introduction

• Structure may be considered riserless if
  • only fluid conveyance
  • no tooling conveyance (API RP 17G2 Draft)

• Intervention/workover operations make subsea wells more productive
  • Riserless systems more economical
  • Smaller monohull vessels with riserless solutions will further lower the cost
Life of Field Riserless Operations

Subsea Construction & Installation
- Surf Installation
- Installation of production tubing
- Well Perforation
- Installation of tree
- Flowing

Development
- Well Flow Startup

Well Intervention
- Inspection
- Repair & Maintenance
- Stimulation of well
- Retrieval/installation of tree for repair
- Retrieval/installation of tubing for repair
- Flowing
- Intervene in Well

Operations
- Well Suspensions
- Plugging
- Facility Removal

Subsea Decommissioning
- Retrieval of tree
- Retrieval of tubing
- Plug and abandon well
- Plug retrieval
System Description

- **Objective**: Introduce/remove fluids from wellbore
- **Single or multiple conduits**
  - Interface with vessel
  - Interface with subsea safety module
  - May pass vertically through safety module
- **Coiled tubing or jointed pipe or flexible pipe**
- **Safety module**
- **Disconnect mechanism**

Reference: API RP 17G2
Vessel Interface – Coiled tubing

- Vessel interface
  - Sheave
  - Injector head

- Location of hang-off (Moonpool, aft, port)
Vessel Interface – Jointed Pipe

• Interface at the rig floor
  • Thick tapered joint
  • Gimbal arrangement
  • Conduit interface with vessel piping (flexible or rigid)

• Pipe handing equipment availability for
  • Installation
  • Operations
Seabed Interface

• Seabed interface (protect or restrict)
  • Clump weight
  • Clump weight with restrain for deepwater systems

• Buoyancy modules on structures to manage and maintain well approach angles
Design Parameters

• As water depth increases
  • Pipe collapse resistance should increase
  • Tension requirements at the top also increase

• Internal pressure:
  • Designed for MAOP pressure along with environmental loads
  • Typically drives wall thickness

• System availability based on design conditions (eg: Normal operations for up to 99% non exceedance or 95% non exceedance System). Seasonal (non-hurricane) availability.

• Ability to stay connected up to 1 year conditions

• Presence of bottom currents may pose clearance issues
Design Parameters - Continued

- Weathervaning limitation (eg: +/- 110 deg for multiple conduits)
- Watch circles and planned excursions
- Disconnect mechanism
  - Operating pressures
  - Reconnect using ROV or retrieval required
  - Fluid containment
- Weak link design
- Always possible to design for anticipated response
- Unplanned and what-if scenarios need special attention or FMECA
  - Disconnect mechanism not work as intended
  - Vessel excursions larger than intended watch circles

Increased design flexibility may increase system cost
Strength Design

• Jointed pipe
  • Overpressure (burst)
  • Under pressure (collapse)
  • Tension requirements
• Coiled tubing
  • Strength criteria for deepwater water and higher pressures

• Is there possibility of compression at bottom?
Weather Windows

• System response may have a natural frequency response

• Response analysis taking into account normal operations, vessel excursions and system limits for emergency disconnect
Installation

- Reeled pipe easier to deploy
- Jointed pipe requires make/break time
- Preparation time for approaching severe weather

Installation
- Response may be water depth dependent
- Assess structural response for multiple water depths
Fatigue Hotspots

• Coiled tubing
  • At the sheave exit
  • Non-linear behavior
  • Can be subjected to pressure cycles

• Jointed Pipe
  • At vessel interface and/or seabed interface
Fatigue management

- Inspection plan
- Change critical hotspot by
  - Rotation of key joints
  - Reeling in coiled tubing
- Spare philosophy
- Use seastate and directionality dependent damage rates to actively track accumulated fatigue during operations
- Test retired components when practically possible
Monitoring

- Monitoring program to be based on fatigue criticality
- A well defined monitoring program will drive the program success
- Monitor during system infancy

<table>
<thead>
<tr>
<th>Structural Monitoring</th>
<th>Data Obtained</th>
<th>Analytical Projections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strain sensors</td>
<td>Structure stresses</td>
<td>Measurements on riser (VIV + 1st + 2nd order)</td>
</tr>
<tr>
<td>Accelerometers</td>
<td>Structure Motions</td>
<td>Measurements on riser (VIV + 1st + 2nd order)</td>
</tr>
<tr>
<td>ADCP</td>
<td>Local Environment Data</td>
<td>1st order, 2nd order and VIV Analysis</td>
</tr>
<tr>
<td>Wave Radar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vessel Accelerometers</td>
<td>6 DOF vessel motions</td>
<td>1st order and 2nd order fatigue analysis</td>
</tr>
<tr>
<td>No monitoring</td>
<td>Nearby measured environment data</td>
<td>Measures vs. Design Exceedance</td>
</tr>
<tr>
<td>No monitoring</td>
<td>Vessel GPS Data</td>
<td>Compare design</td>
</tr>
</tbody>
</table>
Technological advancements

• Metallic conduits
  • High strength alloys
  • Other lighter materials (Al, Ti)

• Flexible conduits
  • Composites
  • Bonded flexibles

• High angle release connectors

Maximum disconnection angle of 45 Degrees in any orientation.
Conclusions

• Deeper waters and higher pressures make riserless system design challenging
• Riserless systems may require custom engineering
• Monitoring and inspection during infancy recommended
  • Level can be based on criticality
• Use seastate and directional data to actively track accumulated fatigue during operations
Questions?

• Acknowledgements
  • API 17 baby G2 committee
  • Mitch Holloway (Shell) and Richard Wakefield (SECC)
  • Mark Cerkovnik, John Gaver and Erica Bruno (2H)