Control Buoys
Operability and Reliability Perceptions
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Long Distance Tiebacks session
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Agenda

- What is a Control Buoy?
- Existing Control Buoys
- Control Buoy Concepts
- Economic Drivers
- Awareness and Perceptions Survey
- Address Perceptions

Control Buoy? Umbilical?
What is a Control Buoy?

- Alternative to long umbilicals
  - Permanently moored floating structure
  - Not normally manned
  - Communication
    - Satellite or radio communications from shore
    - Short umbilical to subsea wells
  - Control
    - LP/HP hydraulic supplies to subsea
    - Electrical power
  - Chemical injection
    - Corrosion inhibitor
    - Hydrate inhibitor
      - For start up (high rate)
      - Continuous (low rate)
  - Annulus venting
  - Hydrate remediation
Installed Buoys – Only Six World Wide

- Regnar Control Buoy (1993), North Sea. Converted CALM buoy
- Petrobas 4-ALS-39 Control Buoy (1996), Brazil. Converted Metocean Data Buoy
- Western Mining - East Spar NCC Buoy (1996), Australia
- Mobil – Zafiro Flare Buoy (1996), Equatorial Guinea
- MossGas - Mossel Bay EM Control Buoy (2000), South Africa
- CNR Lyell Power Buoy (2006), North Sea (Project Stalled) EcoNomics
Control Buoy – Design Issues

- How Big?
  - Well control only
  - Well control + Chemical injection
  - Well control + Chemicals + Helipad
  - How many wells?
  - Chemical flow rate?

- Hull Form?
  - Environment – Benign or Harsh?
  - Buoy Motions
  - Accessibility and maintainability
  - Acceptable working environment

- Cost
  - Fabrication + Installation
  - Operations

- Reliability / Redundancy

- Environmental

- Access
  - Helicopter
  - Supply Boat

- Maintenance
  - Schedule
  - Fuel / Chemical re-supply
  - Unplanned maintenance

- Safety
  - Personnel
  - Asset

- Communications
  - VHF/UHF/Satellite

- Step-out distance

- Control Buoy contents
  - Power generation
  - Electronics
  - Fluids
  - Pumps
  - Hydraulic power
  - Controls system
## Range of Control Buoy Concepts

<table>
<thead>
<tr>
<th>Type</th>
<th>Virtual</th>
<th>Mini</th>
<th>Tension Leg</th>
<th>Disc</th>
<th>Spar</th>
<th>Multi-hull</th>
</tr>
</thead>
<tbody>
<tr>
<td>Displacement</td>
<td>100 kg</td>
<td>2-100 tonnes</td>
<td>400-800 tonnes</td>
<td>400-1,000 tonnes</td>
<td>1000-4,000 tonnes</td>
<td>2,000-10,000 tonnes</td>
</tr>
<tr>
<td>Payload</td>
<td>20 kg</td>
<td>2-20 tonnes</td>
<td>20-80 tonnes</td>
<td>100-300 tonnes</td>
<td>200-800 tonnes</td>
<td>500-2,000 tonnes</td>
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</tbody>
</table>
Tension Leg

- Extreme Environment
- Excellent Motions
- Modular Equipment packages
- Access and work environment

Examples
East Spar, Mossel Bay
Spar Control Buoy Concept

- **Spar concept**
  - Extreme Environment
  - Large Payload
  - Benign motions
  - Access by supply vessel or helicopter

- **Multi-Hull Buoy concepts**
  - Well Work Over Facility

(Marine Innovative Technology)
Mini Control Buoy Concept

- ~10-20 tonne payload
- Potential recovery to vessel
- Potential modular retrieval

Example
Petrobras 4-ALS-39 Control Buoy (1996)
Regnar (1993)
Disc Buoy concept

- Moderate environment
- Large payload
- Access by supply vessel or helicopter (Hs<2.0m)
- Similar to CALM
- Simple installation
Virtual Control Buoy concept

- No fixed infrastructure
- Autonomous vehicles
  - Divers
  - Floaters
  - Boats
- Station-keeping
- Self-powered wellheads
- Satellite communications to shore
- Acoustic communications to wellheads
CAPEX – Step out distance

- Umbilical CAPEX
- Buoy CAPEX

Umbilical cheaper than Control Buoy at certain distance.
NPV OPEX Control Buoy > Umbilical

Control Buoy cheaper Umbilical

+ Umb. OPEX (5yr)
+ Buoy OPEX (5yr)
Control Buoy Economics

NPV of OPEX Increases with Field Life

- Umbilical cheaper
- Control Buoy cheaper

+ Umb. OPEX (20yr)
+ Buoy OPEX (20yr)
Survey of major oil and gas companies
- Awareness and Perceptions of Control Buoys Survey 2008
- Undertaken for Department of Industry and Resources
- Data is Australian skewed
Control Buoy Survey - Awareness

- Are you aware of control buoys?
  - Yes 100%
  - No 0%

- How well informed are you regarding control buoys?
  - Very Little 0%
  - Moderate 50%
  - Well 50%

- Have you considered using a control buoy prior to 2007?
  - Yes 70%
  - No 30%

- Will you consider using a control buoy 2007-2015?
  - Yes 100%
  - No 0%
Why Were Control Buoys Rejected?

- **Operational**
  - Safety risk of personnel transfer / access
  - Enclosed and unventilated work environment
  - Response time to shut-down / repairs
  - Using helipad in remote areas
  - Supply boat access – sea sickness, time

- **Cost**
  - Risk weighted cost of Control Buoy was not compelling
  - CAPEX saving not enough to offset higher OPEX

- **Reliability**
  - Not sufficiently reliable for fixed delivery contracts (gas)
  - Local community interference
  - Potential shipping hazard

- **Field Specific Technical Feasibility**
What are your perceptions of control buoy reliability?

- Reliably: 20%
- Moderately Reliable: 80%
- Unreliable: 0%
Risk Cost: Control Buoy >> Umbilical

Case: CAPEX + OPEX (5yr)
Experience with Regnar buoy

- Converted CALM tanker loading buoy, 11 m diameter
- Marginal field - short tieback of 13 km – one well
- First 9 months of operation – no shutdowns
- Overall uptime has been 98%, only shutdowns have been due to platform
- Extensive pre-testing onshore resulted in a problem-free startup
- Access from vessels is “feasible”
- No lost time accidents (including transfers)
- Operated from 1993 to 2007
Experience with Petrobras buoy

- Converted metocean buoy – only 3.5 metres diameter
- Marginal field - short tieback of 22 km – one well
- Retrieval of buoy after one year for rebuild
  - Buoy hull selection was inappropriate - excessive heave
  - Pump failures due to water entry
  - Battery explosion
  - Difficult access
- Most of these problems solved after rebuild
- Field was a commercial success
Experience with East Spar buoy

- Purpose built spar – tension leg moored
- Long tieback – 65 km west of Varanus island – multi-well
- Loadout and installation before precommissioning completed
- Problems in first years of operation were mainly subsea
  - no communication or major failures with the buoy
  - earth leakage on one of the two redundant power lines
  - a failure to one multi-phase flow meter power pack
  - a failure in one of the two choke position indicators
  - a loss of signal from one well's DHP gauges
- Majority of minor failures on the buoy
  - Hydraulic Power Unit (HPU)
  - utility backup systems
- Access aided by “excellent” tension leg mooring
- Confined work environment
- Met reliability target of 98.5%
- Field was a commercial success
Conclusions and Best Practice

- Local user perceptions skewed by East Spar
  - The East Spar buoy was designed and built in a hurry to meet a commitment to supply gas

- What has been learnt puts us in a good position to improve new generations of control buoys
  - Address reliability, access and safety issues in FEED
  - Hull design for metocean conditions
  - Good working environment
    - Acceptable motions
    - Access to equipment compartments
  - Extensive onshore precommissioning
  - Equipment reliability with multiple sparing
  - Concept is also cost-effective for marginal short tiebacks

- Is the risk premium for control buoys over umbilicals justified?