“Main FPSO & FSO Vessel Conversion Options”
Options

Covered within this Presentation:

- Converted trading tanker to Floating Production Storage & Offloading (FPSO)
- Converted Floating Storage Unit (FSU) FSO (Offloading) to FPSO
- Converted shuttle tanker to FPSO
- Redeployment of existing FPSO
- Other options
- Conventional new build FPSO (not covered as not a conversion)

Evaluation of Conventional Floater Options
## Floater Requirements

### Main Elements to Vessel Options

<table>
<thead>
<tr>
<th>Required</th>
<th>Tanker Conversion</th>
<th>North Sea FSU Conversion</th>
<th>North Sea Shuttle Conversion</th>
<th>New Build</th>
<th>North Sea Redeployed Vessel</th>
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<tbody>
<tr>
<td>Complex Design</td>
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<td>Moderate Design</td>
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<td>Hull Mods</td>
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<td>Thrusters</td>
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<td>Storage Tanks Mods</td>
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<td>Cargo Handling</td>
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<td>Moorings</td>
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<td>Offloading</td>
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<tr>
<td>Process System</td>
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</table>

**Key:** ⚡ Required  
?= Dependant on it’s setup  
Shaded area – Complete Design
## Approximate DWT to BBL Sizing

<table>
<thead>
<tr>
<th>Tanker Type</th>
<th>From dwt</th>
<th>To dwt</th>
<th>From bbl (approx)</th>
<th>To bbl (approx)</th>
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<tbody>
<tr>
<td>Panamax</td>
<td>60,000</td>
<td>80,000</td>
<td>420,000</td>
<td>560,000</td>
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<tr>
<td>Aframax</td>
<td>80,000</td>
<td>120,000</td>
<td>560,000</td>
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<tr>
<td>Suezmax</td>
<td>120,000</td>
<td>200,000</td>
<td>840,000</td>
<td>1,400,000</td>
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<tr>
<td>VLCC (Malaccamax)</td>
<td>200,000</td>
<td>315,000</td>
<td>1,400,000</td>
<td>2,205,000</td>
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<td>ULCC</td>
<td>320,000</td>
<td>550,000</td>
<td>2,240,000</td>
<td>3,850,000</td>
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</table>

Note: Displayed bbl is only a rough approximate guide due to the differing vessel designs and tank size layouts etc.
Converted Trading Tanker to FPSO

Strengths
- Conventional facility / recovery method
- Mature concept (many yards have capability)
- Harsh environment capability
- Panamax or ULCC, depends upon storage requirements
- Candidate vessels available
- Large deck payload areas
- Build schedule typ 12 - 18 months (subject to yard slot availability) Other equip many be longer lead
- Conventional risers and turret mooring systems

Weaknesses
- Existing commercial environment dictating high cost for candidate vessels
- Yards with limited spare capacity (delaying schedule)
- May require extensive conversion work
- High IMR potential
- Requires follow up work for remaining residual value (if purchased)
- High leased day rates
Tanker Conversion to FPSO

Road Map:

- Source tanker
- Source yard and identify build slot, costs etc
- Vessel requirements for conversion include:
  - Vessel inspection report
  - Conversion plan / schedules and vessel classification covering:
    - Transportation and delivery of vessel to yard for conversion activities
    - Vessel preparation work, i.e. stripping out systems, tank repairs / preparations etc
    - New storage and cargo handling systems
    - Hull modifications and stiffening, particularly at the bow and deck loading areas
    - Marine systems including power generation
    - Turret and mooring systems
    - Accommodation block refurbishment or replacement (incl. life boats)
    - Identify if helicopter is required
    - Offloading system
    - Process system identification
    - Supporting riser systems
    - Supporting subsea systems
    - Installation and commissioning plan
    - Onshore vessel management team / offices
Converted Floating Storage Unit (FSU) to FPSO Status (also can be a FSO (Offloading))

Strengths:
- Conventional facility / recovery method
- Mature concept (many yards have capability)
- Difficult to find as usually amongst first choice for conversions
- Expensive compared with trading tanker (advantages need to be judged against facility requirements)
- Potentially less conversion work than trading tanker
- Harsh environment capability
- Large deck payload area
- Build schedule typ 10 - 18 months (subject to yard slot availability) Other equip many be longer lead
- Conventional risers and turret mooring systems

Weaknesses:
- Existing commercial environment dictating high cost for candidate vessels
- Yards with limited spare capacity (delaying schedule)
- High IMR potential
- Needs follow up work for remaining residual value (if purchased)
- High lease day rate
- Availability of candidate vessel
Converted Floating Storage Unit (FSU) to FPSO

Road Map:

• Source FSU (North Sea or harsh environment capable)
• Source yard and identify build slot, costs etc
• Vessel requirements for conversion include:
  ▪ Vessel inspection report
  ▪ Conversion plan / schedules and vessel classification covering:
    – Transportation and delivery of vessel to yard for conversion activities
    – Vessel preparation work, i.e. stripping out existing systems, tank repairs / preparations
    – Review of deck loading requirements / modifications / stiffening
    – Review of existing storage and cargo handling systems
    – Review of existing turret mooring systems
    – Review of existing swivel for riser connection capability and numbers
    – Review of existing marine systems including power generation and identify required upgrades in-line with process facilities
    – Review existing accommodation block including helideck (if present) and life boats
    – Review existing loading / offloading systems
    – Review of any heading control thrusters
    – Process system identification
    – Supporting riser systems
    – Supporting subsea systems
    – Installation and commissioning plan
    – Onshore vessel management team / offices
Converted Shuttle Tanker to FPSO Status

**Strengths**
- Conventional facility / recovery method
- Mature concept (many yards have capability)
- Difficult to find as usually first choice for conversions
- Expensive compared with trading tanker (advantages need to be judged against facility requirements)
- Potentially less conversion work than trading tanker
- Harsh environment capability
- Large deck payload area
- Build schedule typ 10 - 18 months (subject to yard slot availability) Other equip many be longer lead
- Conventional risers and turret mooring systems

**Weaknesses**
- Existing commercial environment dictating high cost for candidate vessels
- Yards with limited spare capacity (delaying schedule)
- Needs follow up work for remaining residual value (if purchased)
- High leased day rate
- Availability of candidate vessel
Converted Shuttle Tanker to FPSO Status

Road Map:

- Source shuttle tanker (North Sea or harsh environment capable)
- Source yard and identify build slot, costs etc
- Vessel requirements for conversion include:
  - Vessel inspection report
  - Conversion plan / schedules and vessel classification covering:
    - Transportation and delivery of vessel to yard for conversion activities
    - Vessel preparation work, i.e. stripping out existing systems, tank repairs / preparations
    - Review of deck loading requirements / modifications / stiffening
    - Review of existing storage and cargo handling systems
    - Review of any existing turret mooring systems
    - Review of any existing swivel for riser connection capability and numbers
    - Review of existing marine systems including power generation and identify required upgrades in-line with process facilities
    - Review existing accommodation block including helideck (if present) and life boats
    - Review existing loading / offloading systems
    - Review of heading control thrusters or Dynamic Positioning systems
    - Process system identification
    - Supporting riser systems
    - Supporting subsea systems
    - Installation and commissioning plan
    - Onshore vessel management team / offices
Redeployment of Existing FPSO

**Strengths**
- Conventional facility / recovery method
- Ready to go solution, rapid mobilisation schedule (subject to field requirements)
- Minimal refurbishment work (if leased then supplier can sort)
- Difficult to find as usually first choice for Operators
- Harsh environment capability
- Large deck payload area
- Schedule aligned with vessel becoming available then rapid refurbishment at yard
- Often with reusable turret / moorings systems

**Weaknesses**
- Existing commercial environment dictating high cost for candidate vessels
- Yards with limited spare capacity (delaying schedule) for refurb work
- Needs follow up work for remaining residual value (if purchased)
- High lease day rates
- Availability of candidate vessel
Redeployment of Existing FPSO

Road Map:

- Source FPSO (North Sea or harsh environment capable)
- Source yard and identify build slot, costs for refurbishment work
- Vessel requirements for conversion include:
  - Vessel inspection report
  - Refurbishment plan / schedules and vessel classification covering:
    - Transportation and delivery of vessel to yard for refurbishment activities
    - Vessel preparation work
    - Review of deck loadings
    - Review of existing storage and cargo handling systems
    - Review of existing turret mooring systems
    - Review of existing swivel for riser connection capability and numbers
    - Review of existing process system
    - Review of existing marine systems including power generation and identify required upgrades in-line with any process modifications
    - Review existing accommodation block including helideck (if present) and life boats
    - Review existing loading / offloading systems
    - Review of heading control thrusters or if present Dynamic Positioning system
    - Supporting riser systems
    - Supporting subsea systems
    - Installation and commissioning plan
    - Onshore vessel management team / offices
## Redeployment of Existing FPSO - Issues

<table>
<thead>
<tr>
<th>Issue</th>
<th>Comments</th>
</tr>
</thead>
</table>
| **Compatibility of fluids (API°, sour service, HPHT)**               | The characteristics of the new reservoir fluids will determine the suitability of the existing topsides facilities in terms of metallurgy, pressure rating etc. It would not be economic to try and convert:  
  - sweet-service to sour service.  
  - light condensate to heavy oil  
  - standard unit to high-pressure service  
  This is a question of feasibility and not generally cost. If the process conditions are significantly different it would be better to look for another unit or convert/new-build. Lack of candidate vessels may make a new process facility attractive depending on field economics. |
| **Capability of processing facilities (capacity, gas/oil ratio, water injection, gas compression)** | Similarly the flow rates and production profile will determine the suitability of topsides equipment. Where insufficient capacity exists within any given process stream it may be possible to modify the topsides through de-bottlenecking. Cost of de-bottlenecking an FPSO plant is generally cheaper than a fixed platform as the work is done at quayside. Costs are difficult to estimate as this depends upon the age/condition of the existing facilities and the scope of the upgrade. |
| **Status of FPSO (mothballed or "hot" transfer)**                   | If the FPSO has been decommissioned and is in preservation there will be cost associated with refurbishment and commissioning of all equipment. If the topsides processing facilities are suitable it may be possible to make a direct transfer between fields. This has been done several times in the North Sea with the *Petrojarl 1*. |
| **Field location**                                                   | In general, an FPSO designed for mild environment cannot migrate to a field requiring a harsh environment production unit. While the reverse may be possible, the cost of installing a turret moored FPSO in a West Africa-type environment may make the relocation commercially unfeasible. |
Redeployment of Existing FPSO – Issues
(cont’d)

<table>
<thead>
<tr>
<th>Main Issues Associated with Re-use of FPSOs</th>
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<tbody>
<tr>
<td><strong>Issue</strong></td>
</tr>
<tr>
<td>Water depth (mooring facilities)</td>
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<tr>
<td>Storage/processing capacity</td>
</tr>
<tr>
<td>Capacity of existing riser/</td>
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<tr>
<td>offloading facilities</td>
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<tr>
<td>Distance between fields for</td>
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<tr>
<td>wet-tow</td>
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</tbody>
</table>
MOPU plus FSU or Storage Base

**Strengths**
- Conventional facility / recovery method
- Can be ready to go solution, rapid mobilisation schedule (subject to field requirements)
- Rapid conversion & installation schedules
- Benign to harsh environment capability
- Limited water depth, storage base extends depth
- Good deck payload area for small reservoirs
- No moorings or turret (not bound by long lead FPSO systems)
- Can come with storage base

**Weaknesses**
- Existing commercial environment dictating high cost for candidate MOPU
- Difficult to find as usually first choice for small shallow water fields with supporting infrastructure
- Yards with limited spare capacity (delaying schedule)
- If purchased needs follow up work for remaining residual value (another field)
- Availability of candidate vessel
- Base storage system expensive (so is FSO!)
MOPU plus FSU or Storage Base

Road Map:

- Identify candidate MOPU’s inline with field requirements
- Investigate feasibility / cost for storage base (if needed)
- Identify any conversion requirements
- Fully identify yard for construction work
- Vessel requirements include:
  - Classification society review of the design
  - Construction schedule and build plan covering:
    - Yard supervision off detailed design work including interface and package engineering
    - Coordination of procurement activities
    - Riser selection
    - Cargo handling systems
    - Mechanical rotating equipment
    - Process system
    - Marine systems including power generation
    - Accommodation block including helideck and life boats
    - Offloading or export system
    - Support for subsea systems
    - Installation and commissioning plan
    - Onshore vessel management team / offices
**Production Box FPSO**

- Novel design offering all FPSO features without the need for a turret or swivel /stack
- Stand alone production solution
- Simple design, can be fabricated in China (low cost yard)
- Rapid build schedule possible, subject to yard availability
- Benign to harsh environment capability
- Shallow to deepwater capability
- Large deck payload area
- Simple spread moored system
- Simple riser balcony arrangement for receiving risers
- Storage
- Opportunity to redeploy (min 25 year design life)

**Strengths**

**Weaknesses**

- Existing commercial environment taking up yard build slots
- If purchased needs follow up work for remaining residual value (another field)
- 80,000 bbl storage (could require more frequent shuttle visits than tanker FPSO depending on shuttle route length)
- New design (but Lloyds approved in principle)
Production Box FPSO

Road Map:

- Investigate the design for accurate cost data and design verification in-line with field development requirements
- Fully identify yard for construction work (China?)
- Vessel requirements include:
  - Classification society review of the design
  - Construction schedule and build plan covering:
    - Yard supervision off detailed design work including interface and package engineering
    - Coordination of procurement activities
    - Moorings selection
    - Riser selection
    - Cargo handling systems
    - Mechanical rotating equipment
    - Process system
    - Marine systems including power generation
    - Accommodation block including helideck (if required) and life boats
    - Offloading system
    - Support for subsea systems
    - Installation and commissioning plan
    - Onshore vessel management team / offices
New Build Small Semisubmersible with Floating Storage vessel

**Strengths**
- Small Semisubmersible design offering all FPSO features but without storage
- Stand alone production solution
- Basic design, can be fabricated in China (low cost yard)
- Rapid build schedule possible, subject to yard availability
- Benign to harsh environment capability
- Shallow to deepwater capability
- Large deck payload area
- Excellent motions characteristics
- Simple spread moored system
- Simple riser balcony arrangement for receiving risers
- Opportunity to re-deploy (min 25 year design life)

**Weaknesses**
- Existing commercial environment taking up yard build slots
- If purchased needs follow up work for remaining residual value (another field)
- No storage (requires export line or FSO)
- Can rely upon FSU
New Build Small Semisubmersible

Road Map:

- Investigate the design for accurate cost data and design verification in-line with field development requirements
- Fully identify and assess yard for construction work capability
- Vessel requirements include:
  - Classification society review of the design
  - Construction schedule and build plan covering:
    - Yard supervision off detailed design work including interface and package engineering
    - Coordination of procurement activities
    - Moorings selection
    - Riser selection
    - Cargo handling systems
    - Mechanical rotating equipment
    - Process system
    - Marine systems including power generation
    - Accommodation block including hellideck and life boats
    - Support for subsea systems
    - Installation and commissioning plan
    - Onshore vessel management team / offices
“Main FPSO & FSO Vessel Conversion Options”

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