Opportunities and Challenges in Deepwater West Africa Projects

Finding Petroleum - Finding African Oil

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Opportunities and Challenges in Deepwater West Africa Projects

► Agenda
  ▪ Introduction
  ▪ Technical Issues
  ▪ Commercial Issues
  ▪ Local Content
  ▪ Summary
INTECSEA

Hull and Moorings for TLPS, Spars and Semisubmersibles and TTRs

WorleyParsons
Topsides, Jackets and overall PM services

INTECSEA
Marine Pipelines, Production Risers, Subsea, Flow Assurance and FPSOs
Ghana Offshore
There are a multitude of technical considerations in the layout and development of a deepwater oil field.

Here are the three which are most pertinent to West African developments based on our experience.

- Metocean conditions
- Seabed geotechnical conditions
- Flow assurance
## Technical Issues

### MetOcean Considerations

#### Ghana - Hs ROSE

#### Wind rose

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**Figure 6-1**: Polar diagram of the directional distribution (%) of the wind speed.

<table>
<thead>
<tr>
<th>Location</th>
<th>Significant wave height</th>
<th>Peak Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Africa</td>
<td>3.14</td>
<td>19.2</td>
</tr>
<tr>
<td>North Sea</td>
<td>13.2</td>
<td>18.4</td>
</tr>
<tr>
<td>Gulf of Mexico</td>
<td>16.7</td>
<td>15.6</td>
</tr>
</tbody>
</table>
FPSO Mooring Options

- Turret Type Mooring
- Spread Mooring
## Ghana FPSO Mooring Selection

<table>
<thead>
<tr>
<th>Operator</th>
<th>Field</th>
<th>Depth</th>
<th>Mooring</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tullow</td>
<td>Jubilee</td>
<td>1100</td>
<td>Turret</td>
<td>2013</td>
</tr>
<tr>
<td>Tullow</td>
<td>TEN</td>
<td>1500</td>
<td>Turret</td>
<td>2016</td>
</tr>
<tr>
<td>ENI</td>
<td>Sankofa</td>
<td>900</td>
<td>Spread</td>
<td>2017</td>
</tr>
<tr>
<td>Hess</td>
<td>Cape 3 Points</td>
<td>2500</td>
<td>Turret</td>
<td>2018</td>
</tr>
</tbody>
</table>
Technical Issues

- Seabed Geotechnical Considerations
Seabed conditions
Seabed conditions
Seabed Conditions

Lateral Buckling
Reduces the probability of Spans
Pipe-soil interaction governs Lateral buckling design
Safebuck JIP provides guidelines on lateral buckling in such conditions
Producing oil from very deep waters can provide many challenges for ensuring the flow of the fluid.

Pressures can be boosted by gas injection or pumping.

Temperatures need to be maintained in many cases to avoid waxing.

Efficient pipeline design and insulation becomes crucial.

In extreme cases Pipe-In-Pipe designs are used to provide maximum insulation.
**PIP Configuration**

**Inner Pipe Wall**
Thickness is about 25 mm, D/t ~10-15

**Outer Pipe Wall**
Thickness is about 21 mm, D/t ~15-20

**Aerogel Insulation**
around the Inner Pipe and Spacers every 4 m
Commercial Issues

- Fast Track Projects
- Gas Export
Fast Track Development

**Traditional Development**

1. EXPLORATION
2. APPRAISAL
3. RESERVOIR EVALUATION
4. FIELD DEVELOPMENT STUDIES
5. PROJECT IMPLEMENTATION

**Fast Track Development**

1. EXPLORATION
2. APPRAISAL & RESERVOIR EVALUATION
3. FIELD DEVELOPMENT DEFINITION
4. PRELIMINARY ENGINEERING
5. PROJECT IMPLEMENTATION

**Key Events**

- DISCOVERY
- AFE
- FIRST PRODUCTION
Fast Track – Jubilee, Ghana

**2004/2006**
Licences awarded offshore Ghana
2004 – West Cape Three Points
2006 – Deepwater Tano

**Jun 2007**
First discovery
The Mahogany-1 well discovered high quality oil in two sands with a net pay of 95 m

**Feb 2008**
IPT and Operator
Following 2nd Jubilee discovery at Hyedua-1 in August 2007, Integrated Project Team (IPT) created with partners Anadarko and Kosmos. Tullow designated Unit Operator and Kosmos Technical Operator

**Jun 2010**
FPSO arrived
The Kwame Nkrumah arrived in Ghanaian waters and final preparations for first oil commenced

**Dec 2010**
First Oil achieved
Initial production from the Jubilee filed commences at around 50,000 bopd before ramping up to 120,000 bopd in the next 3-6 months

**Fastest ever full scale comprehensive deepwater development**

**ESIA**

**Jul 2006**
Jubilee project registered with Ghana Environmental Protection Agency (EPA)

**Oct 2008**
Project scope submitted to EPA
The environmental baseline study and stakeholder engagements were undertaken from October 2008 to inform the project scope, which was approved by the EPA in February 2009

**Sep 2009**
Eight public hearings conducted over three months
Hearings formed part of the consultation and review process of the draft ESIA. A total of 34 public consultation meetings were held as part of the impact assessment process

**Nov 2009**
Final ESIA submitted for approval
Comments from the EPA and comments raised during the public hearings were addressed in the final ESIA. Approval received early 2010
Fast track developments look attractive from an NPV perspective. However, working on assumptions, because of lack of definition, has the potential to cost the company a lot more money than the time saving can expect to achieve.

It was over 30 months before the projected production could be achieved for Jubilee. This required additional wells to be drilled and subsea equipment to be added.

The cost - circa $1,000 million CAPEX + over 2 years of lower than projected income.
Some areas that can cause this lack of definition are:

- Number of wells, top hole locations and drilling programme
- Completion Design
- Flow Assurance – Chemical injection requirements, pressure ratings, temperature issues etc
- Infield Flowline and Pipeline routing, and loadings to structures.
- Operation and commissioning philosophies
- Interface definitions between the Subsea Production System and drilling, Floating Production System, Installation, commissioning and operations
Technical Bid Appraisal

<table>
<thead>
<tr>
<th>Score</th>
<th>Definition</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>No supporting documentation was submitted and/or the tendered solution is not compliant with requirements at all</td>
</tr>
<tr>
<td>1</td>
<td>Significant non compliances for major aspects and/or poorly documented proposal</td>
</tr>
<tr>
<td>2</td>
<td>Some of the key requirements are addressed but several non-compliances still exist</td>
</tr>
<tr>
<td>3</td>
<td>Only minor non compliances and/or draft design meets requirements</td>
</tr>
<tr>
<td>4</td>
<td>Adequately documented full compliance with requirements</td>
</tr>
</tbody>
</table>

A risk analysis shall be carried out for all items from the bids that score lower or equal than 2 or outstanding qualifications (where appropriate) that have not been resolved.
# Fast Track – Cost Risks

<table>
<thead>
<tr>
<th>No</th>
<th>Severity</th>
<th>% of contract value (%)</th>
<th>Euro</th>
<th>Could happen in E&amp;P industry</th>
<th>Reported for E&amp;P industry</th>
<th>Has occurred at least once in company</th>
<th>Has occurred several times in Company (Global)</th>
<th>Has occurred several times in Company (Business Unit)</th>
<th>Happens several times in one SPS Supplier Contract</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Slight impact</td>
<td>&lt;0.5</td>
<td>€ 2,732,400</td>
<td>2</td>
<td>13</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
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<tr>
<td>2</td>
<td>Minor impact</td>
<td>&gt; 0.5 - 1</td>
<td>€ 5,464,800</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>3</td>
<td>Moderate impact</td>
<td>&gt;1 - 5</td>
<td>€ 27,324,000</td>
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<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>4</td>
<td>Major impact</td>
<td>&gt;5 - 10</td>
<td>€ 54,648,000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>5</td>
<td>Extensive impact</td>
<td>&gt;10</td>
<td>€ 54,648,000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
# Fast Track – Cost Risks

<table>
<thead>
<tr>
<th>Bidder</th>
<th>Technical Risk Cost Normalisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>US$ 12,569,000</td>
</tr>
<tr>
<td>B</td>
<td>US$ 29,031,000</td>
</tr>
<tr>
<td>C</td>
<td>US$ 12,295,000</td>
</tr>
<tr>
<td>D</td>
<td>US$ 11,407,000</td>
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</table>
Gas Export

Many West African Countries do not have infrastructure to use the gas produced from offshore fields.

A large investment will be needed to develop the electricity national grids, power generation, LNG or chemical plants that use surplus gas.

Development options are being restricted by the desire to prevent offshore flaring of associated gas.

Associated gas can be used for fuel for the FPSO, oil recovery enhancements such as gas lift and reinjection into the reservoirs to maintain wellhead pressures.
Exploration and Production Drilling Phases

► Storage and inspection of
  ▪ Wellheads
  ▪ Casing
  ▪ Tubing
  ▪ Mud supply
  ▪ Chemicals
  ▪ Drilling equipment etc.

► Welding of conductors to Wellheads

► Etc.
During Installation and Commissioning Phase

- Site received tests on the Subsea Production System equipment
- Site Integration tests
- Assembly and welding of rigid jumpers
- Storage of the
  - Xtrees and tooling
  - Connection system tooling
  - PLETS, FLETS and small manifolds
  - Controls equipment
  - Installation and commissioning spares
  - Capital and spares for operations
  - Miscellaneous running tools and handling equipment
- Testing of Xtrees including gas testing tanks
- Simple maintenance of equipment
During Operational Phase

- Maintenance, repairs and refurbishments on commissioned Subsea production systems.
- Management and replacement of spare parts
- Long term storage and preservation
- Support for shutdowns, interventions, work overs, sidetracks and other asset support activities
- Maintain integrity and certification of hardware and tooling through refurbishment, preventive maintenance and replacement
- Management and replacement of obsolete components and equipment
- Recording and management of all required certification documentation

Dedicated SPS support base has the potential to employ up to 40 locals
Recruit, hire and train an indigenous workforce – to operate the Service facility & deliver all necessary support required for operation of the offshore field

- On-the-job training,
- In-house and external training courses
- Workshops and seminars using expert in-house personnel

Utilize (and develop) local supply chain – for goods and services required to support the all in-country operations

- Qualify and include suitable suppliers in Approved vendor lists
- Implement partnerships with local companies to develop those goods and services that are not available
- Support local companies in their development with the aim of building capacity and capability to the level required by the Oil and Gas industry
Send Selected indigenous staff other locations in the world to gain exposure and experience on similar projects

- Mentoring

- Graduate development programs. Recruitment and development of graduates from local universities and nationals being educated overseas

- Scholarships. Sponsorship of selected students focussing on female students to pursue engineering programs currently dominated by males
There is enormous potential for deepwater developments in West Africa.

There are also significant challenges which need to be addressed and overcome.

These are not only technical but involve development of local infrastructure, skills base and resources.

In today's low oil price market, these challenges are even more important.
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