Deep Offshore Developments – Subsea / Topsides Integrated Approach

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SUMMARY

1. Subsea Processing - Integrated Methodology

2. Case Study Description
   a. Conventional Architecture
   b. Advanced Architecture

3. Subsea Processing Selection

4. Impact on other packages
   Flowlines Design
   Subsea Layout
   Electrical and Umbilical
   Floating Facilities and Topsides Layout

5. Availability, Schedule and Cost elements

Conclusion
SUBSEA PROCESSING - INTEGRATED METHODOLOGY

Subsea

Flow Assurance
Pipeline Design
Riser Design
Umbilicals
Structure

Subsea Processing

Process,
Flow Assurance,
Rotating, Electrical,

Topside

Process,
Rotating, Electrical
Layout
Naval Instrumentation

INTERFACE MANAGEMENT

IMPACTS

IMPACTS

OPERABILITY

INTEGRATION

MAINTAINABILITY

HEALTH, SAFETY,
ENVIRONMENT

PROJECT

BUSINESS DRIVER
CONVENTIONAL ARCHITECTURE (W/O SUBSEA PROCESSING)
proven and approved technologies for FPSO, subsea flowlines and risers
ADVANCED ARCHITECTURE (WITH SUBSEA PROCESSING)
cutting edge approach encompassing advanced industry approved components and technologies
SUBSEA PROCESSING SELECTION

- **Choice based on following Criteria**
  - Technologies mature in 2020, modules weight limited to 400t
  - Selection criteria: HSE, Cost, Performance, Operation, Project execution

- **Main Selection drivers and impacts**

  **Separator**
  - Located at riser base with gas free flowing to the Topsides
  - Pressure selected to minimise Topsides Compression and Subsea Boosting
  - More flexible operations

  **Pump**
  - Selection of an Hybrid pump for all operations
  - Removal of Gas Lift requirement
  - Impact on the Umbilical (control, fluids, electrical)

  **Chemical Storage and Injection**
  - Located close to the Satellite Wells
  - Impact on Umbilicals, Electrical and Topsides facilities designs

  **Seawater treatment and injection**
  - Located close to the Water Injection Wells
  - Impact on Riser, Flowlines and Topsides facilities design
# FLOWLINES DESIGN

<table>
<thead>
<tr>
<th></th>
<th>CONVENTIONAL</th>
<th>ADVANCED</th>
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<tbody>
<tr>
<td><strong>Main Field</strong></td>
<td>Loop Lines</td>
<td>Single Line</td>
</tr>
<tr>
<td></td>
<td>2 x 2 x 8” ID</td>
<td>2 x 1 x 8” ID</td>
</tr>
<tr>
<td></td>
<td>Wet insulated</td>
<td>Wet insulated &amp; <strong>active heating</strong></td>
</tr>
<tr>
<td><strong>Satellite Field</strong></td>
<td>Hybrid Loop Lines</td>
<td>Single Line</td>
</tr>
<tr>
<td></td>
<td>1 x 12” ID PiP</td>
<td>1 x 9” ID</td>
</tr>
<tr>
<td></td>
<td>1 x 12” ID service line</td>
<td>Wet insulated &amp; <strong>active heating</strong></td>
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**ADVANCED ARCHITECTURE:**

**OPERATION Philosophy**
- Intermittent heating (Main Field)
- Continuous heating (Satellite)

**TECHNOLOGY - Active Heating**
- DEH wet insulated single pipe
- Trace Heated Single Pipe

Best Thermal management
Easier Operation: shutdown, restart, preservation
Reduction of Subsea Lines and Sizes
SUBSEA LAYOUT – RISER BASE

ADVANCED ARCHITECTURE:

Module Arrangement Design with Process and Installation constraints
### ELECTRICAL and UMBILICAL SYSTEMS

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<tbody>
<tr>
<td>Subsea Power Requirement</td>
<td>Only control</td>
<td>SSP Equipment, Active Heating, Control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15 MW Main Field</td>
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<tr>
<td></td>
<td></td>
<td>7 MW Satellite</td>
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<tr>
<td>Umbilical Main Field</td>
<td>1 x 5” OD – Wellhead</td>
<td>1 x 5” OD – Wellhead</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 x 7” OD – Active Heating</td>
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<td></td>
<td></td>
<td>2 x 6” OD – SSP Equipment</td>
</tr>
<tr>
<td>Umbilical Satellite</td>
<td>1 x 9” OD – Wellhead</td>
<td>1 x 6” OD – Power Cable to Tie-back + Wellhead</td>
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<tr>
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<td></td>
<td>1 x 8” OD – SSP Equipment + Active Heating</td>
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**ADVANCED ARCHITECTURE:**

- **Main Field**
  - No Electrical showstopper
  - Power through Umbilicals

- **Satellite**
  - Long Distance Transport
  - Flowline Active Heating
  - Simplified Umbilical
FLOATING FACILITY AND LAYOUT

- Conventional Architecture

- Advanced Architecture

ADVANCED ARCHITECTURE:

- Reduction in Hull size (up to 30m)
- Reduction in Topsides weights (-12%)
AVAILABILITY, SCHEDULE AND COST ELEMENTS

ADVANCED ARCHITECTURE:

▪ **Availability**
  Subsea Processing equipment failure has minimal impact on the global production availability (RAM study)

▪ **Project Schedule**
  FPSO construction time can be reduced due to less Topside

▪ **Cost elements**
  
  i. Equivalent global CAPEX compared to the conventional Architecture but SSP costs could be optimised
  
  ii. Cost savings with:
      - SURF Main Field: -13%
      - SURF Satellite Field: -30%
      - FPSO: -10%
  
  iii. Potentially increased reserves thanks to lower subsea tie-in pressure
Advanced subsea architectures including Subsea Processing and Active Heating are economic enablers for developing deepwater fields and very long tie-backs.

Integration of Subsea Processing equipment brings the following benefits compared to a conventional approach:

- Simplified SURF system combined with active heating
- Smaller and lighter FPSO
- More flexible operations
- Increase of Reserves with the Subsea Separation & Boosting

Subsea / Topside integrated approach is paramount for a project’s success.

Opportunities for a « full subsea to shore » project are currently investigated.
Subsea to Shore Concept without floater support is being studied
We would like to extend our thanks to Technip and Total, for giving us the opportunity and encouragement to carry out this project.

Furthermore, we would like to recognize all of those who contributed, directly or indirectly, to this work.

Questions?