“FPSO Topsides Integration Approach”
FPSO Examples

Belenak FPSO

Schiehallion FPSO

Terra Nova FPSO

Gryphon FPSO
Integration – Issue 1

• Many bid teams experience problems for estimating and scheduling the topsides integration work.

• Many FPSO projects have suffered cost / schedule overruns which often starts at the integration phase.
Integration – Issue 2

![Integration Diagram]

**Time**

**Man-hours**

- **Integration Starts**
- **Planned**
- **Actual** (tight schedule)
- Planned completion date ▼
- Actual completion date ▼
Integration Risk

Additional Cost Risks

- 5,000 tonnes topside ->> up to US$ 20 million
- 10,000 tonnes topside ->> up to US$ 40 million
- 20,000 tonnes topside ->> up to US$ 80 million

“Schedule delay up to 6 month”

Integration Cost Risks Includes:

- Under estimates
- Re-work
- Design changes
- Inefficiencies
- Carry-over work and delays incurred during the integration phase.
Integration Problems - Causes

• Under estimating of integration work scope due to lack of experience and / or historical data.
• Inexperienced / motivated contractors.
• Carry-over work from shipyard, vendors or topside fabricators.
• Incomplete designs.
• Poor facilities and systems.
• Culture differences between offshore and shipyard practices.
Escalation of Integration Problem

- Installation of in-complete PAU’s due to tight lifting window/schedule pressure.
- Preferential engineering.
- Efficiency drop due to poor material/personnel logistics.
- Weather influence (work in open air).
- Design does not support building sequence.
- Limited number of work faces per period.
Escalation of Integration Problem cont’d

• Poor design change management (mis-use of safety arguments)
• Rework on marine systems due to culture clash between marine engineers and topside engineers
• Poor engineering support during construction/integration
• Incomplete/late equipment package delivery
• Late involvement of Operations and/or missing acceptance criteria
Design - Construction Clashes

Wrong (higher amounts of clashes)

Right (minimal clashes)
Integration Related Problems

• Unnecessary bureaucracy

• Poor planning

• Work force fear to loose job after project completion

• Low level of supervision

• Poor availability of skilled labour

• Lack of project team / workforce incentives

• Poor work by vendors and shipyards
Project Management Practices

• Check contractors capacities / capability before contracting

• Develop integration plan prior to award jointly with contractor

• Contracts provide protection but do not guarantee performance of the subcontractor

• Condition clients when schedule / budget expectations are too tight
  – Use IPA or PACE benchmarking data or risk assessment
Project Management Practices cont’d

• Identify integration risks and develop contingency plans
• Create flexibility in integration plan
• Develop material / information logistics tools
• Assess and improve integration facilities
• Develop a specific execution plan for instrumentation and control systems including a technical system philosophy
Project Management Practices cont’d

• Make engineers responsible for making the design work
  – Appoint responsible engineers per area / PAU that carry the technical responsibility from start until first oil. (start to finish engineering)

• Construction approves release of AFC integration drawings
  (check drawing on completion prior start of integration work)

• Object engineering supports efficient integration
Project Management Practices cont’d

- Integrate operations personnel from project start
- Commissioning leads the factory acceptance tests
  - Commissioning approves release of equipment
- Integrate operations personnel in commissioning team and have one (1) final acceptance procedures accepted by all parties
Develop detailed integration plan with Contractor which includes:

- PAU completion works (carry-over)
- Prefabrication of hook-up elements
- PAU installation
- Structural hook-up activities (including paint repairs)
- Piping hook-up activities (incl. bolt tensioning, painting and insulation)
- Electrical / Instrument hook-up activities
- Hydro / NHe leak testing
- Loop checking
- Mechanical completion inspections
- Commissioning and start-up
- Sail away activities
Project Management Practices cont’d

• Develop a sail away / first oil check list (count down plan) early
  – Appoint count down plan manager
  – Appoint custodian per activity
  – Arrange regular sail away / first oil meetings
  – Identify problems early
  – Appoint separate task force to deal with urgent problems

• Develop punch list for outstanding work
  – Minimize carry-over work
  – Monitor carry-over work man-hours weekly and later daily
  – Include completion of punch list in count down plan
Project Management Practices cont’d

- Set-up progress reporting in % on various levels
- Count outstanding work per activity regularly, example:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total spools to be installed</td>
<td>5000</td>
</tr>
<tr>
<td>Total spools installed</td>
<td>3567</td>
</tr>
<tr>
<td>Number of spools installed this week</td>
<td>345</td>
</tr>
<tr>
<td>Planned number of spools</td>
<td>300</td>
</tr>
</tbody>
</table>

*Note: show progress as graphs*
Design Practices

- Size of PAU is determined by fabrication facilities, lifting capacity, PAU design and COST
- Maximizing or minimizing number/size of PAU has no benefit
  - minimizing: more complex modules but less hook-up work
  - maximizing: simple skids/pancakes but more hook-up work
- Distribute control system per PAU
- Keep pipe rack separate of PAU’s
- Minimize integration of topside and marine systems
- Set design freeze date and apply sail away practices (punch list)
- Demobilize engineers after design freeze and appoint team to close-out the documented design punch list
Integration Practices 1

- Maximize PAU completion prior to installation
- Create flexibility within lifting schedule
- Minimize any shipyard carry-over work (define interfaces)
- Develop material control systems
- Built / rent facilities to optimize personnel logistics
- Develop cranage plan during design
- Identify weather sensitive activities up front (create schedule flexibility or develop weather protection)
- Set-up rigid procedure for change management
• Keep offshore commissioning team away from marine systems
• Mobilize small marine team to operate and final test marine systems
• Keep pragmatic engineers on site for queries (allow no changes)
• Foster open team approach with certifying/verifying inspectors
Integration Practices 2

Logical Approach

Detailed Engineering → Check for Completeness

Materials → Check & Confirm Availability

Services → Implement Mobilization Plan

Efficient Integration Starts with Correct Work Preparation and Planning
Integration Practices 3

Integration by Offshore Fabricator

*Risks*
- Rework on ship systems
- Inefficient completion of carry-over work
- Poor handling of vessel
- Inefficient people / material logistics
- Inefficient cranage arrangement

Integration by shipyard

*Risks*
- Availability of offshore skilled labor
- Poor understanding of integration scope of work
- Lower quality of hook-up work
- Availability of commissioning personnel

The Offshore Fabricator is Preferred for Integration, but Final Selection Should Depend on Availability of Quayside and Proper Risk Assessment
Integration Practices - Facilities

- PAU lifting
- Crane facilities
- Access
- Moorings
- Facilities
- Logistics
Land Based Crane

**Pro’s**
- Lift capacity up to 1600 tonnes
- Long rental period possible (create schedule flexibility)
- Can be used as general fabrication crane

**Con’s**
- Requires quayside with high bearing capacity (15 ton/m)
PAU Lifting cont’d

Shear Leg

**Pro’s**
- Lift capacity up to 3000 tonnes
- No specific quayside requirements

**Con’s**
- Expensive to rent for longer periods
- High mobilisation cost for remote locations
- Unreliable availability
Clear Walkways

Access lifts

Walkways

Temp. cable / hose bridges
Moorings

Integration at quayside without facilities, allow for mooring budget (typ. fab yard)

Shipyards have mooring facilities.

- Large lateral area generate large mooring forces
- FPSO mooring require bollards up to 100 tonnes
- Tidal water will require adjustable mooring using winches
- Try to use existing winches (conversion only)

Note: take crane locations into account during mooring design
Personnel Logistic Problems

Offices

Fabrication shop

Canteen

Warehouse

500 meter

60 minutes

30 minutes

45 minutes

Timing - vise versa

500 meter

IRVINE ENGINEERING
Preferred Integration Facility

- Fabrication shop / warehouse
- Offices / canteen / changing rooms in loft
- Additional portacabins on roof
- Quayside
Material Logistics

- Use computerized material control system
- Set-up lifting and rigging coordination and appoint responsible manager
- Tag all components for location
- Appoint night shift for lifting and rigging of non critical lifts i.e. scaffolding material, skips, etc.
- Create paved material set down area close to FPSO
- Equip all foreman with radios
- Analyze and optimize material flow and number of activities
- Use waste management systems
Commissioning Practices 1

- Balance number of sub system (flexibility versus efficiency)
- Set and agree acceptance criteria during design
- Rationalize number of mechanical completion checks
  - watch for job creation
- Integrate commissioning activities in integration plan
- Commissioning approves release of vendor equipment and possible carry-over work is part of the commissioning work
- Single mechanical completion inspection procedures signed by Construction, Commissioning and Operations (Client)
- Make commissioning team responsible to identify the outstanding work together with Operations / Construction
- Do not use offshore work permit system, use yard permit practices
1. Design input & review
2. Factory acceptance test
3. Mechanical completion
Handover

- Integrated commissioning and operations / client team
- Crew operates commissioned system prior sail away
- Hand-over is part of commissioning process
Estimating Practices

1. Estimate hook-up work (S, P, E and I)  
   (Apply norms which reflect outdoor work on vessel)  
2. Estimate minimum PAU completion work  
3. Estimate minimum shipyard carry-over work  
4. Estimate minimum rework / changes  
5. Estimate work to make FPSO ready for sea  
6. Estimate repair work  
7. Integration cost  
   sub total  
8. Estimate integration risks  
   sub total  
9. Risked integration cost  
   Total
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Thank You
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