

## IBC FPSO Training Course

Paris 2016

### Developing an Execution Strategy

Daniel Holman – Crondall Energy

[www.crandall-energy.com](http://www.crandall-energy.com)

## Value

"It is unwise to pay too much, but it's unwise to pay too little. When you pay too much you lose a little money, that's all.

When you pay too little, you sometimes lose everything, because the thing you bought was incapable of doing the thing you bought it to do.

The common law of business balance prohibits paying a little and getting a lot. It can't be done. If you deal with the lowest bidder, it's well to add something for the risk you run.

And if you do that you'll have enough to pay for something better."

*John Ruskin (1819-1900)*

## Agenda



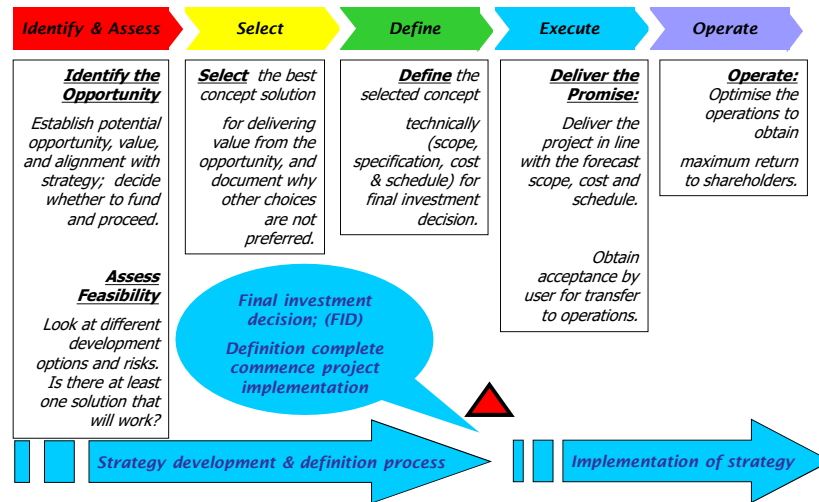
1. Developing an execution and contracting strategy
2. Strategic options and alternatives
  - a) Procurement options- Lease and EPC strategies
  - b) Select & Define Options - Engineering and procurement options
  - c) Execute Options – Detailed design & construction
  - d) Alternatives - Redeployment of existing facilities
3. The market place
4. Management of risk
5. Cost & schedule
6. Summary



## 1. *Developing an execution and contracting strategy.*



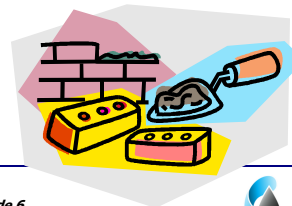
## Typical field development gateway process



## Key building blocks for success

From Crondall's consulting work, we see three fundamental building blocks which are required to build a solid foundation for the project:

1. The development of a **clear strategy and scope definition for the execution of project** and for the procurement of the required goods and services;
2. Understand the compliance requirements of the bodies that have jurisdiction over the development – and ensure that these requirements are fully integrated into the definition of the FPSO facility at the definition stage;
3. Develop clear, detailed and **unambiguous technical definition of the configuration of the FPSO facility during the definition phase** – and use this detail as the basis for the contracts in the execution phase;



## Empirical data from FPSO Projects



| Outcomes                                 | FPSO Median 2012 | FPSO Median 2009 | Other Concepts Median |
|--|------------------|------------------|-----------------------|
| Cost Deviation                           | 15%              | 33%              | 5%                    |
| Schedule Deviation                       | 18%              | 18%              | -3%                   |
| Production Attainment                    | 74%              | 67%              | 90%                   |
| Incidence of Major Operability Problems* | 50%              | 69%              | 40%                   |

*Poor FPSO outcomes are a problem -but better outcomes are possible by developing a clear project execution plan and completing good project definition.*

*Courtesy of Independent Project Analysis, Inc. 2009/12*

*Read also: Industrial Megaprojects: Concepts, strategies and practices for success.  
Edward W Merrow.*

## Field Development Plan



### The overall plan for the development of the field and the facility :

- ☐ Encompasses all stakeholder agendas and considers wider political, issues - drives all decisions regarding the development of the field:
  - Reservoir and wells;
  - Subsea;
  - **FPSO**;
  - Operations;
  - Local content plan;
  - In-country support etc. etc.
- ☐ Provides the context and guidance for the development of an **FPSO procurement** strategy;
- ☐ Needs to be clearly articulated and communicated to all stakeholders.

## FPSO procurement strategy



**Defines how the project approaches the market to obtain the goods and services for all stages of the project from concept evaluation through construction to operations.**

- ☐ The procurement strategy needs to detail the “who”, “what”, “where” and “when” of the way the project will be executed on a phase-by-phase basis;
- ☐ Understand what you are going to procure: identify, understand and document the key facility configuration choices/decision issues that need to be resolved before framing the strategy: manage the decision making process;
- ☐ Ensure all engineering, procurement and construction decisions throughout the project are consistent with the strategy;
- ☐ Take into account market conditions and limitations, local content issues; recognises and addresses key project drivers and risks.



## Start by defining key project drivers and risks



- ☐ **Define success** – what are the (project specific) key drivers; the more specific - the easier it is to craft a strategy that addresses these drivers; e.g. for North Sea projects – regulatory compliance.
- ☐ **Define key project risks** - what are main mitigation measures open to the various strategic alternatives?
- ☐ Check that the strategy **mitigates** these key risks;
- ☐ Understand your organisation’s capabilities (skills inventory); match the strategy to the organisation’s capabilities; Don’t choose a strategy that your organisation cannot resource adequately;
- ☐ Understand the market – can the market respond to the strategy & provide competition?

**Then develop a strategy addresses these issues.**



*“The discipline of writing something down is the first step toward making it happen.”*

Lee Iacocca

## 2. *Strategic options and alternatives*

## Evaluating options and alternatives in the **Select phase**

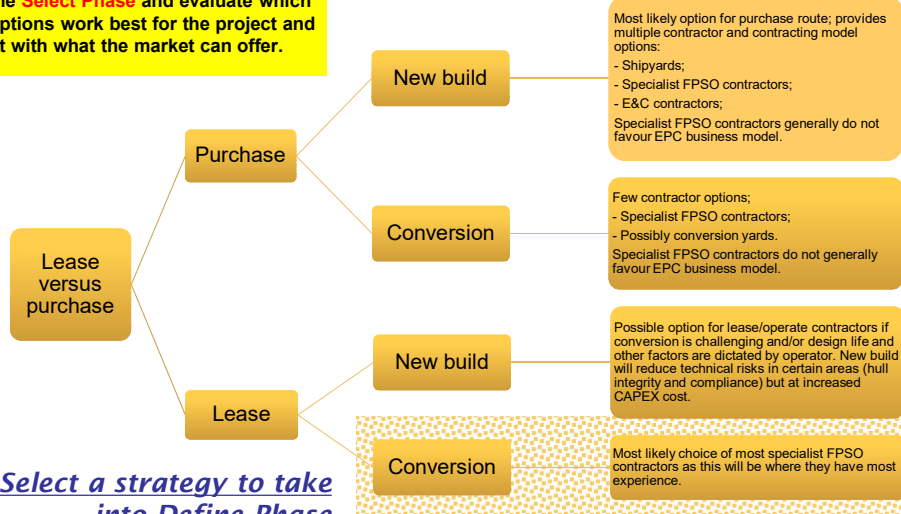


- ❑ A number of **alternative strategies** should be described (initially in select phase) and evaluated based on pre-determined objective criteria e.g.;
  - Does the strategy meet overall requirements of the project (key drivers such as local content, compliance assurance etc.);
  - Will the strategy deliver competition in the market (are there enough willing contractors)?
  - Will the strategy help to mitigate the major project risks?
- ❑ *The strategy needs to define the "who", "what", "where" and "when" for the various scope areas/phases;*
  - *Concept development;*
  - **FEED;**
  - **FEED transition into project delivery;**
  - *Execution*
    - Detailed engineering;
    - Procurement;
    - Construction and integration;
    - Installation & commissioning;
    - Operations and maintenance.

**Select**

**Select** the best concept solution for delivering value from the opportunity, and **document why other choices are not preferred.**

Use decision trees to help develop and evaluate the strategy options in the **Select Phase** and evaluate which options work best for the project and fit with what the market can offer.



**Select a strategy to take into Define Phase**

## Why is FEED (**Define phase**) so important?



" ... I believe there is now virtual consensus among project professionals within the community of industries we serve that FEL [Front End Loading] is the single most important predictive indicator of project success."

*Ref. Industrial Megaprojects:  
Concepts, strategies and practices for success.  
Edward W Merrow.*

| Define   |
|--|
| <i><b>Define</b> the selected concept technically (scope, specification, cost &amp; schedule) for final investment decision.</i> |

## Focus on FEED\* and Front End Loading



- ☐ FEED is the opportunity to create the scope and technical **definition** needed for a successful project;
- ☐ The project outcome will hinge on how well FEED is executed and how well it serves the objectives of subsequent phases;
- ☐ Project thinking needs to address what activities will be carried out before FEED so that for example the concept is clearly defined and there is limited optionality going into FEED;
- ☐ FEED work streams and deliverables need to address the needs of the subsequent execution phase and provide the definition that execution contracts will require;
- ☐ Challenge for FEED is generally budgeting for sufficient time, funding and resources, when the project is still in the pre-sanction phase.

**Think about who will do FEED, how much time and money the project will invest in FEED and how will it help to link the define phase with project execution?**

\*Front End Engineering Design



## 2a. PROCUREMENT OPTIONS - Lease and EPC strategies

## Why would you choose to lease?

### ❑ Field life & economics

- Leasing generally works when the life of the FPSO – perhaps 15-25 years is substantially greater than that of the field (perhaps 5-10 years):
- The owner of the FPSO takes some risk on the **residual value** of the FPSO after the end of that first contract and recovers the residual value by redeploying the asset to another field or extending the contract.
- The operator of the field benefits because the residual value makes the development more cost effective than fully depreciating the asset over one (short) field life.
- The lease operate model also sees a **transfer of risk** (FPSO delivery and operations performance) from the operator to the contractor.
- Leasing may also be desirable based on specifics of PSC terms.
- **Amount of residual value risk that contractors are willing to take has reduced following GFC, and in current Oil Price environment.**

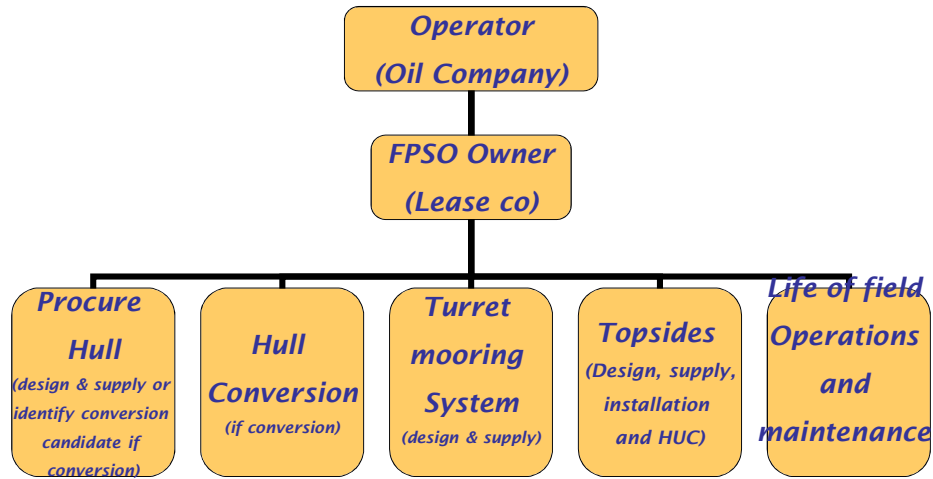
### ❑ Contractor experience

- Engineering & project management;
- Production operations;
- Same skills may be available with **different contracting structures?**

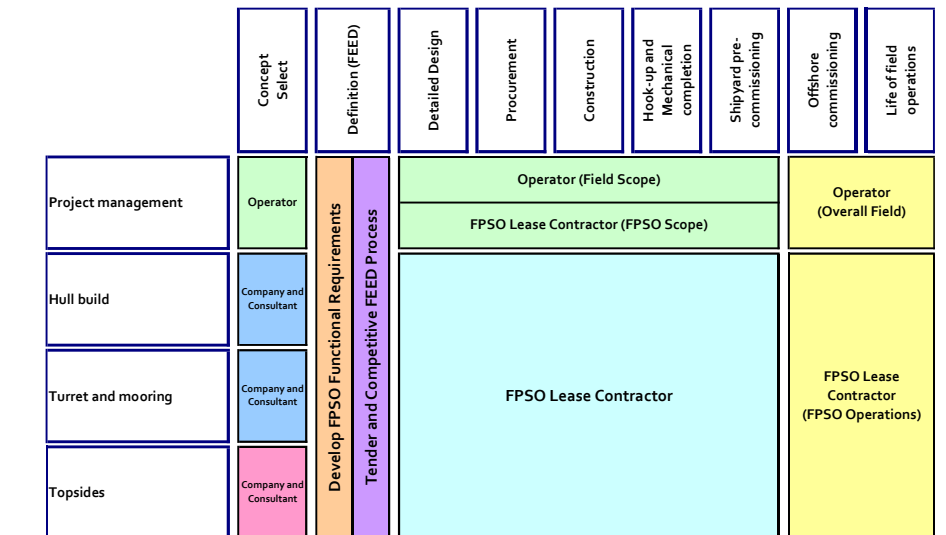
### ❑ Flexibility

- Creates the opportunity for significant options:
- Purchase;
- Extension of term;
- Relocation.

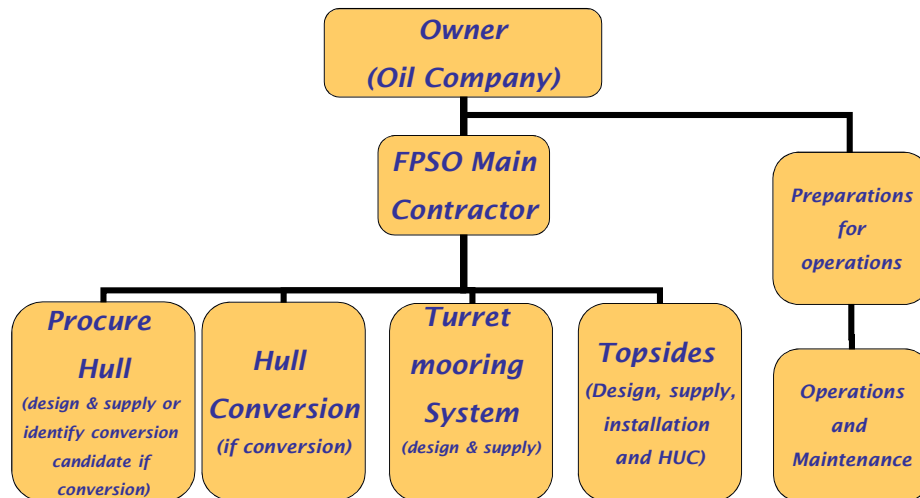
## FPSO Lease/operate contract arrangement



## Contracting Structures – Lease/operate



## FPSO purchase via EPC (or Turnkey) contract arrangement

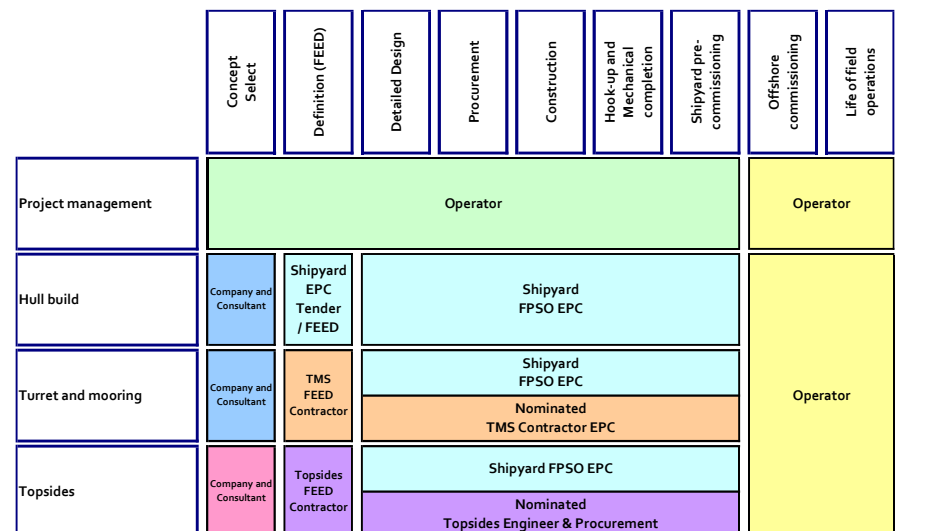


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## Contracting Structures – EPC Contract



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## Add more detail with subsea scope

### Subsea

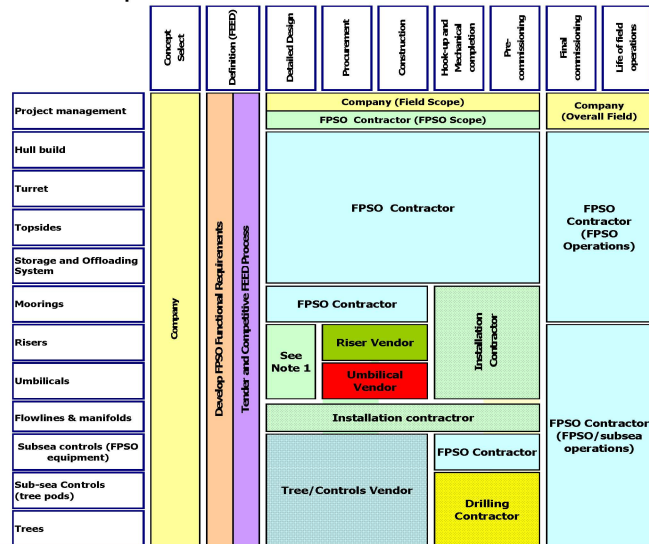
The split of scope between the subsea contractor and the FPSO contractor (e.g. risers & umbilicals, FPSO installation) varies considerably from contract to contract.

The mooring/riser interface is a key challenge because of the dynamic interaction between riser system performance and the allowable offsets provided by the mooring system.

### Drilling

Usually some if not all production & injection/disposal wells will be drilled & subsea trees to be landed and wells cleaned up before FPSO arrives – to enable rapid start-up and ramp up to full capacity.

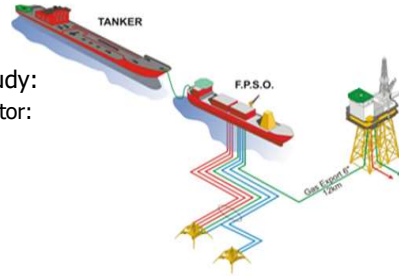
Note 1: Refer to responsibility matrix



## 2b. SELECT & DEFINE OPTIONS - engineering

## Concept selection

- ❑ High level screening of suitable development options;
- ❑ Generally carried out by independent (technology neutral) consultants;
- ❑ May be carried out in more than a single phase/study:
  - First, look at all development options with e.g. Questor:
    - Subsea tie-back to beach
    - Fixed versus floating options;
    - Floater options such as FPSO, FPU & pipeline etc.
  - Second, refine the concept(s) until final concept is:
    - Selected based on clearly defined metrics;
    - Well enough defined & understood to start FEED;
    - May require input from specialist consultants in certain areas to obtain better resolution.



## How you do the FEED depends on the strategy

### **Lease/Operate**

- ❑ *Most often done as a competitive FEED process (design competition);*
- ❑ *Needs to be specific to contractor's selected hull (may be a conversion), turret technology (if applicable) and design/delivery philosophy;*
- ❑ *FEED work product generally used in part for the evaluation of the preferred contractor.*

### **EPC (or EPCM)**

- ❑ Generally done by an independent contractor (not normally the head EPC contractor unless design competition);
- ❑ Need to involve providers of specialist technology e.g. turret mooring;
- ❑ Note that if FEED is not carried out by head EPC contractor there will usually need to be a period of validation;

### **Subsea**

- ❑ *Usually covers SURF (Subsea, Umbilicals, Risers and Flow-lines);*
- ❑ *Normally let as a separate FEED study to specialist in the field of subsea and pipelines; (Generally different skill set to FPSO FEED contractors – although some areas of market overlap);*
- ❑ *Timing of subsea FEED needs to link into FPSO FEED in order to deliver interface data e.g. flow assurance/arrival data, riser size/weight data - in good time.*

## 2c. EXECUTE OPTIONS – detailed design & construction

### Detailed engineering will be driven by the strategy

- ❑ In general the shipyards are best placed to carry out detailed hull engineering for new builds; (basic versus detailed). For conversions, generally FPSO contractors.
- ❑ For any turret mooring & swivel system (TMS), the technology is proprietary – so they are best placed to do both FEED and detailed engineering for the TMS scope – and will generally deliver the TMS package on a mini EPC basis;
- ❑ For topsides, there are more options; depending on the level of control or scope integration that the project requires;
  - Topside detailed engineering may be retained as a separate contract (E&P or EPCM);
  - Or - included within a topside or complete FPSO scope EPC – with or without a nominated topsides engineering contractor.



## Construction – depends on your strategy



- ❑ Full EPC for complete FPSO in a single yard - or a segmented strategy?
- ❑ Hull:
  - New build – Korea or China?
  - Conversion – Singapore or Dubai?
  - New build yards generally better equipped to do detailed engineering – conversion yards will require high level of engineering support/management.
- ❑ Topsides modules:
  - One topsides contractor – may include engineering (full EPC scope)?
  - Multiple contractors e.g. one per module (requires overall engineering and procurement co-ordination)?
  - Multiple sites worldwide?
- ❑ Topsides to hull integration:
  - Hull build yard – better for schedule – but yard may not have the best skills for HUC;
  - Topsides module yard – better skills base for HUC – but more challenging schedule.
- ❑ Turret:
  - Turret generally procured as EPC package from specialist vendor;
  - Hull structure integration elements – and dry dock requirements in hull yard;
  - Upper turret sections can be completed in integration yard.



## 2e. *ADDITIONAL OPTIONS - Redeployment of existing facilities*

## FPSO Re-deployment



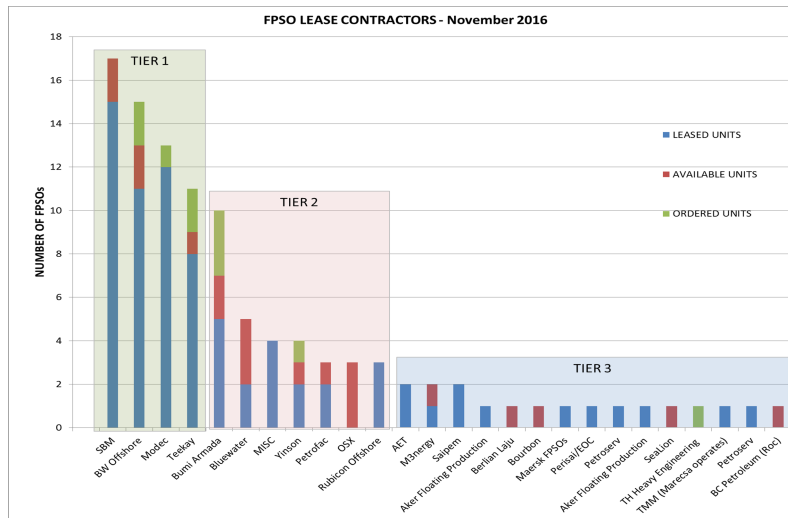
- ❑ FPS technology and the inherent mobility of the assets has created the opportunity for redeployment;
- ❑ As examples Teekay's **Petrojarl1**, and the Bluewater owned **Glas Dour** have been repeatedly redeployed;
- ❑ Redeployment may require extensive **upgrades** to the facility; upgrades can form part of a continuous programme of work to manage vessel residual value; - we expect best results to be obtained when redeployment has been considered from day one;
- ❑ Redeployment offers the industry a chance to capture significant **economic benefits** – but project teams and vessel owners will have to confront some major challenges to deliver this value.



### 3. *Understanding the market place*



## Specialist FPSO contractors



Crandall estimate:  
November 2016

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## Top FPSO contractors

- ☐ Large number of worldwide FPSO contractors;
- ☐ More and more consolidation of smaller FPSO contractors;
- ☐ Large gap between the top 4 contractors with 10 or more FPSOs and rest of the field;
- ☐ These 4 "major contractors" account for approximately 50% of the total contractor owned/operated FPSO fleet;
- ☐ The remainder of lease FPSOs are held by smaller contractors most of whom own 2 or fewer units.

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## Shipbuilding

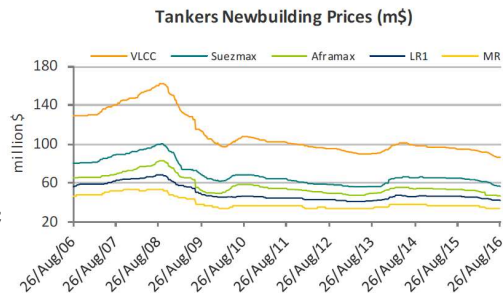
- ❑ Shipbuilding's traditional markets have been depressed but are currently recovering– but new build prices are still reduced from pre GFC highs;

- ❑ New build hulls:

- Dominated by the big three Korean yards (Samsung, Daewoo and Hyundai), with some Chinese yards entering the competition;
- Major yards not apparently at capacity, so offshore sector seems to be a major focus area;
- Some indication that the Japanese yards are beginning to take another look at the offshore sector.

- ❑ Converted hulls:

- Singaporean yards still leading the market, with competition from Dubai and increasing competition from China.



## Topsides contractors – a regional business

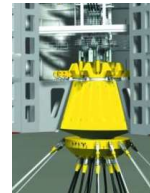
- ❑ Increasing use of local yards in Brazil to satisfy local demand;
- ❑ DSME in Oct '10 acquired 30% interest in Paenal, established in 2007 to provide local content for Angolan offshore projects;
- ❑ Main Korean new builders – Hyundai, Samsung and Daewoo – have been expanding their work scope to embrace both new hulls and complete and integrated topsides:
  - e.g. Clov, Goliat, Skarv, Knarr.
- ❑ Major fabricators have been acquiring fabrication capability in low cost areas e.g. McDermott in China with Qingdao McDermott Wuchan;
- ❑ Specialist FPSO contractors – tending to buy at module or package level.



## Contractors – Turret mooring system and swivel vendors



- ❑ Most turret mooring system and swivel vendors are integral part of specialist FPSO contractors, e.g.
  - SBM;
  - Bluewater;
  - Modec.
- ❑ Some have been acquired by major FPSO contractors:
  - LMC acquired by Ezra (EMAS).
- ❑ There are now relatively few independent turret system vendors with proven technology:
  - APL (independent again after NOV bought from BWO);
  - Framo (in conjunction with Teekay Petrojarl).
- ❑ Same is true for swivel system vendors:
  - Framo; APL; Scana.
- ❑ Utility swivels generally from specialists like Focal.



*Image courtesy of Tullow Ghana & Modec*

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## 4. Management of risk



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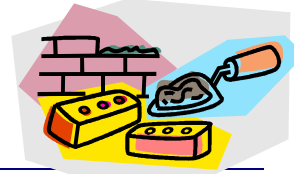


## Key building blocks for success



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1. The development of a **clear strategy and scope definition for the execution of project** and for the procurement of the required goods and services;
2. Understand the compliance requirements of the bodies that have jurisdiction over the development – and ensure that these requirements are fully integrated into the definition of the FPSO facility at the definition stage;
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## What tends to go wrong? ~ main source of problems



### ❑ Poor scope & technical definition

- Scope as originally envisaged needs to be revised at detail engineering (poor FEED – e.g. weights and space requirements increase);
- Scope poorly defined at scope boundaries (poor interface engineering e.g. hull to topsides systems interfaces);
- Poor compliance planning - e.g. unforeseen regulatory requirements – additional safety engineering requirements;
- For conversions specifically - Hull scope grows when vessel is under conversion (poor understanding of vessel and marine equipment condition when vessel is selected).

### ❑ How to mitigate this?

- **Good quality FEED** – relevant for the selected asset/technology – allow sufficient time and funding!
- Understanding of Shelf state and International regulations – communication to team;
- Definition of interface areas/responsibilities at scope boundaries;
- Good hull specification and/or survey/appreciation of condition (if conversion);
- Convert all definition into ***detailed, prescriptive & verifiable specifications*** (or procure that others do).

## Lease/operate – additional commercial risks



### ❑ As for EPC plus.....

- Scope & cost leakage from CAPEX (fixed day rate) to OPEX (reimbursable day rate?);
- Delays during installation: – FPSO turns up late – mismatch with sub-sea installation schedule;
- Delays during start-up: – Poor pre-commissioning leading to late first oil and start of gas compression;
- Performance: – Poor safety performance during operations;
- Performance: – Failure to meet performance requirements e.g. off-spec or below volume;
- Performance: – Facility downtime exceeds contracted requirements;
- Performance: – Major equipment failure during operations.

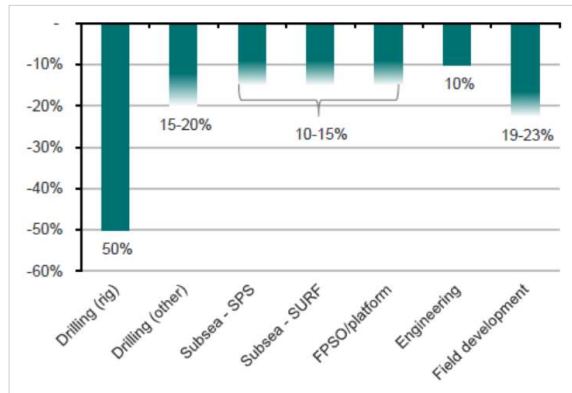
## 5. Cost & schedule

## Price trends (Source EMA April 2014)

Prices for recent awards suggest that costs are continuing to escalate: driven by supply chain cost increases, expanding contractor margins, increasing complexity and local content issues. e.g.

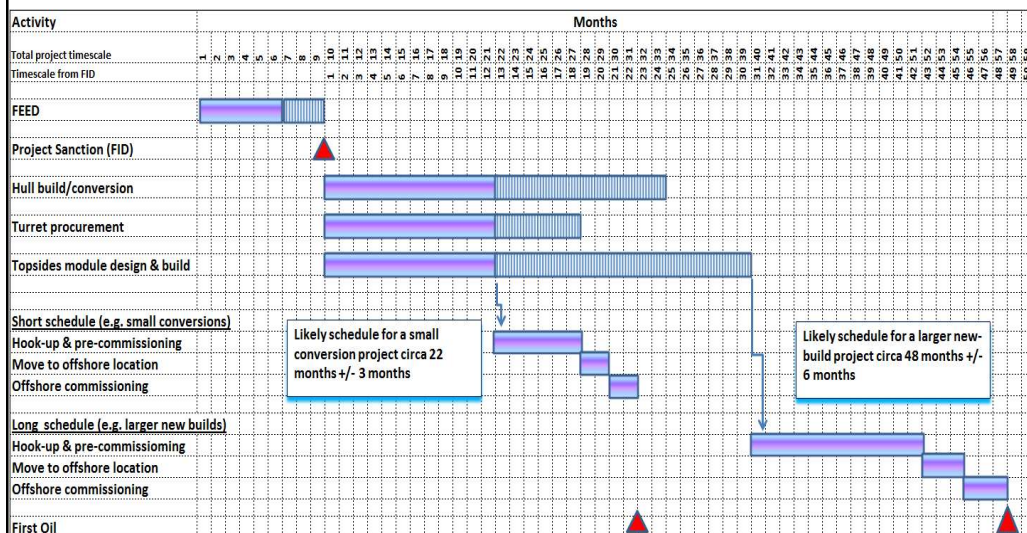
- ❑ Egina OML 130 Nigeria) Total operated New build @ Samsung
  - 200,000 b/d 360 mmcf/d; 2.3 mmbbl storage; FPSO will have a 36,000 ton topside
  - Reported to be the largest FPSO order in history @ US\$3 billion
  - The hull and some structures will be built in Korea at a cost of \$1.72 bn. The remainder (over 40% of the cost) will be spent on the topsides and other scopes locally.
  - Delivery from yard scheduled for June 2016 and first oil in late 2017.
- ❑ Daewoo to supply FPSO to Inpex for use on the Ichthys field offshore Australia. The EPC contract to Daewoo is valued at ~\$2 billion.
- ❑ Petrobras awarded contracts to SBM and its Brazilian partner Queiroz Galvão for two FPSOs to operate in the Lula alto and Lula Central presalt fields in block BM-S-11, 300km offshore Brazil in the Santos Basin.
  - Local press have reported the daily lease rate for each unit to be \$620,000.
- ❑ EnQuest awarded Bumi Armada a Letter of Interim Agreement on Nov 15, 2013 to provide a leased FPSO for the Kraken development.
  - The FPSO will require a 16,000 ton topside to process 80,000 b/d oil and inject 500,000 b/d of water.
  - An Aframax tanker will be converted for the project. The estimated FPSO CAPEX is \$1 billion. First oil is targeted for 2016/17.

## Price trends (Source DNB - 2016 oil market outlook; November 2015)



- ❑ Less (smaller / marginal) projects sanctioned, more redeployment availability;
- ❑ Greater standardisation;
- ❑ More JVs / consolidation (Technip/FMC).

## Typical schedule ranges



## 6. Summary

## Key factors for a successful strategy (1)

- ☐ Establish and **document** clear project goals and drivers;
- ☐ Develop and **document** a clear field development plan and contracting strategy; consider how the contracting strategy will **help you and your contractors** to reach a successful outcome;
- ☐ Select a strategy which recognises the opportunities, limitations and constraints in the market e.g.
  - ***Creates competition;***
  - Availability of experienced resources;
  - Contractors willing to accept selected contract model;
  - Availability of suitable facilities e.g. dock slots to meet schedule;
  - Availability of existing assets.
- ☐ Select a strategy which manages the identified risks:
  - Create a robust strategy;
  - Look to have risks managed by those parties best placed to manage the risks; - if the project comes off the rails everybody suffers.



## Key factors for a successful strategy (2)



- ❑ Invest in robust concept definition:
  - Good and detailed definition of the concept and configuration at the stage at which budgets are sanctioned and contracts are awarded;
  - Good quality FEED or basic engineering, before committing to project sanction & award of supply contracts.
  - **Understand compliance requirements & impact of safety engineering.**
- ❑ Project execution – **make a plan and stick to it:**
  - Maintain the plan on which cost and schedule estimates have been built.
- ❑ Manage decisions
  - Ensure that key decisions are identified, resolved and documented (Key Decision Register);
  - Resist changes as far as possible – but manage tightly when required.
- ❑ Configuration control/change management
  - Having established good project definition it is equally important, that this definition is maintained – resist the temptation to finesse the project whilst design and construction is underway.

## Key factors for a successful strategy (3)



- ❑ Keep engineering on track through **strong engineering management/technical leadership:**
  - Timely engineering execution and liquidation of engineering deliverables is vital to any design, procure and build contract. (e.g. piping and electrical drawings for hook-up phase).
- ❑ Building experience through **Operations:**
  - The lease/operate contractors have built up a wealth of experience through operations, and have the opportunity to feed this experience back into the design, procure and build phase of their projects.
  - Create mechanisms to ensure that this feedback is available for definition & detailed design is built into the strategy, whatever the contracting strategy.
- ❑ Standardisation where applicable:
  - Standardisation in this context is more about methods of execution than the finished product – can help to **reduce risk by reducing degrees of freedom for certain decisions.**

"There is hardly anything in the world today that some man cannot make just a little cheaper- and just a little worse. And the people who buy on price alone are this man's lawful prey"

*John Ruskin (1819-1900)*





Thank you

Any Questions?



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Floating Production & Subsea Specialists

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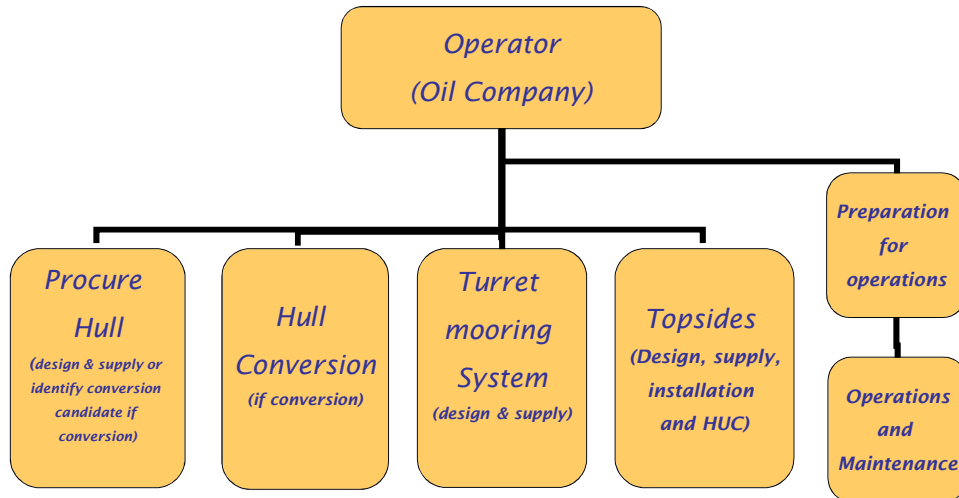
*Winchester ~ Haarlem ~ Aberdeen ~ Singapore ~ Perth WA ~ Houston*



*Additional reading.*

*These slides are recommended for further reading and as a resource for the workshops.*

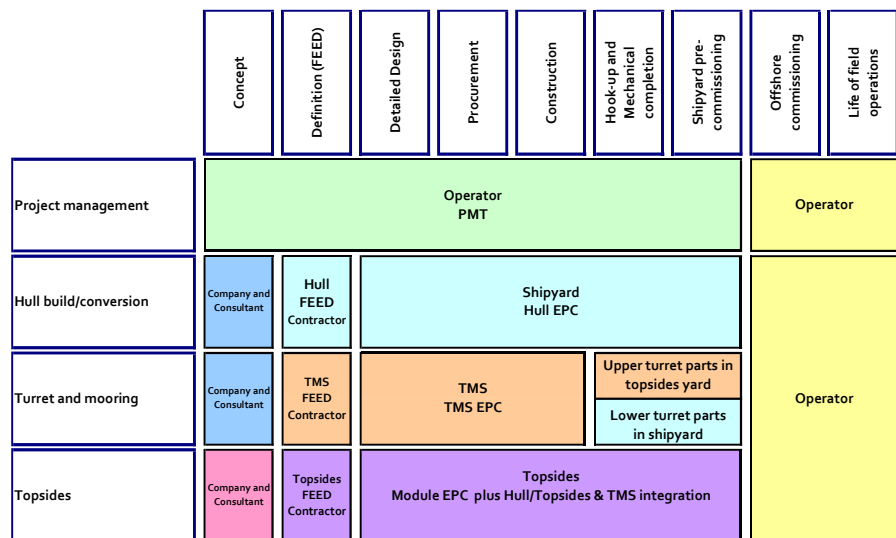
## Other strategy options -segmented contract arrangement



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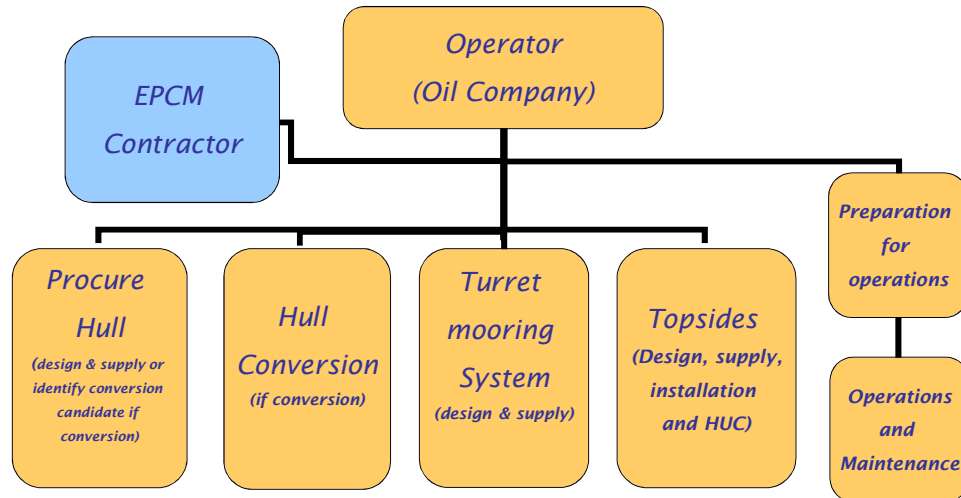
## Other strategy options– Segmented-Operator Managed



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## Other strategy options -EPCM contract arrangement

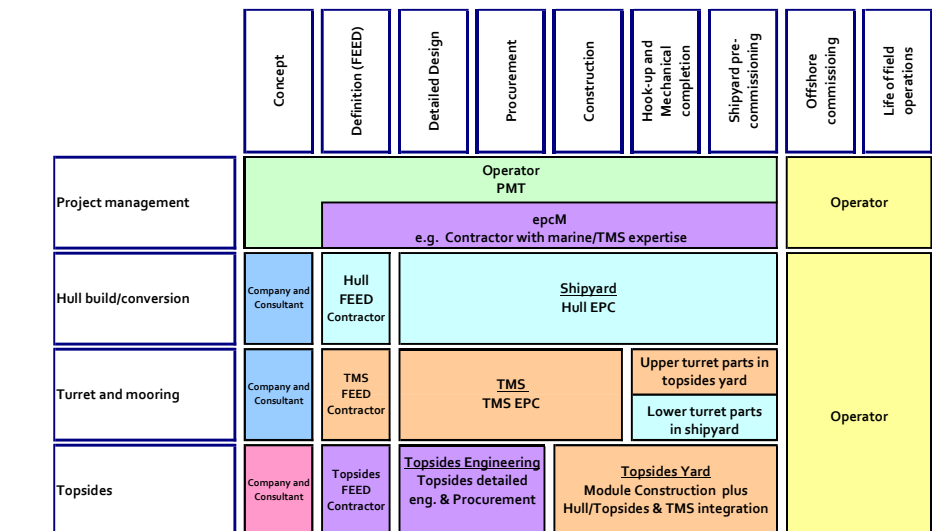


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## Other strategy options - EPCM contract arrangement



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## Key execution risks



### *Key risk issues before clearing the select gate:*

- *Well defined FPSO & subsea concept & functional requirements (with limited options to be confirmed);*
- *Well defined Basis of Design data with minimal (well understood) data uncertainties – e.g. H<sub>2</sub>S, Mercury, metocean etc.;*
- *Outline strategy and understanding of the market's ability to deliver;*
- *Good understanding of main contract scopes and interface points;*
- *Good understanding of compliance requirements (FEED & execution);*
- *Robust cost and schedule estimates; (confirm that project is sufficiently viable to proceed to FEED).*

## Key execution risks



### *Key risk issues before completion of FEED and project FID:*

- *Good quality asset and technology specific FEED completed; (see separate slides)*
- *Good quality FEED deliverables:*
  - *Validated by EPC contractor - if EPC contract;*
  - *Sufficient to evaluate design competition if lease/operate;*
- *Well defined scope for all contracts;*
- *Competition (at some level) up to the point of completion of FEED;*
- *Contract documents and technical appendices consistent and aligned.*

## Key execution risks



### **Cost & schedule growth/slippage**

- ✓ Scope growth/creep due to poor definition/understanding;
- ✓ Poor rate of liquidation of work e.g. engineering into construction;
- ✓ Changes to the plan during execution e.g. lay-out/module configuration;
- ✓ Lack of resources/sub-contractors (poor quality resources);
- ✓ Yard availability/ capacity;
- ✓ Procurement/LLI/ delivery;

### **Quality**

- ✓ Lack of understanding of requirements & obligations (Regulations);
- ✓ Specification & scope compliance;
- ✓ Vendor delays/ compliance/QC failures;

### **Interfaces**

- ✓ Poor interface management between FPSO and subsea scopes e.g. arrival conditions, changes to riser sizes etc.;
- ✓ Mismatch between FPSO and subsea schedules.

## Key execution risks



### **Key risks for start-up are:**

- ✓ Poor completion planning and MC completion at yard;
- ✓ Incomplete MC/pre-commissioning at yard;
- ✓ Poor preservation (pre-start-up);
- ✓ Design defects discovery;
- ✓ Poor initial reliability (infant mortality of equipment);
- ✓ Poor uptime following start-up (usually gas compression).



## What constitutes a good quality FEED.....



### □ HULL

- Basic hull dimensions and lay-out are frozen (if a conversion - then this means that the hull is selected);
- Maximum hull payload frozen and confirmed in accordance with statutory stability and strength requirements (full range of loading conditions);
- Motions and accelerations and hull deflection limits set for the complete FPSO;
- Main hull utility system philosophies frozen;
- Main hull utility and interfacing systems defined to P&ID level (or equivalent);
- Main systems HAZOPs completed
- All main accommodation lay-outs defined (or modifications identified if a conversion).

### □ TURRET

- Identification of turret location, space & weight requirements and interface requirements with sub-sea, hull and topsides;
- (Note: Strong preference for turret vendor to be selected early in FEED as variation in turret systems will otherwise render much of this work redundant if it is based on incorrect vendor & thus incorrect weight/space/interface data).

## Good quality FEED.....



### □ TOPSIDES

- Topsides PFDs and main system P&IDs frozen;
- Main systems HAZOPs completed;
- Flow assurance studies completed to develop as a minimum arrival conditions/ranges;
- Main equipment list items frozen;
- Topsides weight/space requirements and lay-out frozen;
- Construction methodology (module arrangement) frozen;
- Power generation & distribution philosophy frozen (hull/topsides main and emergency);
- Fuel strategy frozen;
- Control system philosophy frozen;
- Drains system (open and closed) philosophy frozen;
- Process heating requirements & sources philosophy frozen.

## Good quality FEED.....



### ❑ FPSO

- Preliminary safety risks analysis completed including development of design accidental loads & other safety related design parameters;
- Main hull/turret/topsides system interfaces defined to block diagram level;
- Hazardous area classification identified;
- Location of all main safety equipment confirmed;
- Identification of all escape routes and access/egress ways;
- Identification of main aspects of mechanical handling requirements (cranes, lay-down areas, major equipment handling philosophy, stores handling, helideck access etc.) and mechanical handling philosophy frozen.

**Ensure engineering efforts & deliverable support scope definition**

## Key Risk Management Tools (1)



- ❑ Project Execution Plan
  - Execution plan & key project documentation, project baseline cost and schedule;
  - Needs to be robust, and flexible;
  - Needs to address major risk and decision issues.
- ❑ Risk Register
  - Generated early in the process;
  - Focus on identification, management and mitigation;
  - Should incorporate lessons learned from past projects;
  - Continues through project – all actions to be closed out.
- ❑ Logic linked and resourced execution schedule;
- ❑ Risk analysis:
  - Monte Carlo type simulation on cost & schedule;
- ❑ Front end loading evaluation – various practitioners, e.g. IPA

## Key Risk Management Tools (2)



- ❑ Decision register – Management of Change Process:
  - Captures decision issues and then the basis for making those decisions;
  - Cross reference with risk register on decisions – key part of close out;
  - Integrate with change management process.
- ❑ Interface Register:
  - Use an established (proprietary) tool;
  - Focus on early identification of key interface areas;
  - Establish communication network for interfaces;
- ❑ Lessons Learned:
  - Systematic process to ensure that lessons learned from previous Operator, Contractor and general industry experience are captured and input into the project decision making process.

## Estimating



- ❑ Start with use of industry standard concept screening & estimating tools such as Que\$tor; (+/-40%)
- ❑ Refine Que\$tor estimates by:
  - Benchmarking weights against reliable data from analogue projects (particularly topsides bulks);
  - Benchmarking costs against up to date vendor and/or contractor data (e.g. turret, conversions);
  - Perhaps +/-25%.
- ❑ Further refinement requires more engineering definition (FEED): to allow bottom-up approach - equipment costs from vendors and MTOs for bulks etc. (Perhaps +/-10%).

