Current Status and Strategies for Deep Sea Oil and Gas Development

JITI Seminar, Tokyo, 25 February 2015

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Contents

■ Introduction of Aker Solutions
■ Overview of Offshore Floating Facilities
■ Floating Facilities Selection
■ Engineering and Subsea Technologies
  ■ Subsea Compression
  ■ Dry Tree Semi
  ■ KBe Design
■ Concluding Remarks
This is Aker Solutions

- Aker Solutions is a global provider of products, systems and services to the oil and gas industry
- Built on more than 170 years of industrial tradition
- Employs approximately 17,000 people in 18 countries

Employees: 17,000
Revenue: 29.1 bn
EBITDA: 2.2 bn
EBIT: 1.7 bn
Market Cap: 12.5 bn

Revenue and profits are in NOK and pro forma for 2013. Market capitalization as of October 15, 2014.
Unique Subsea Technology and Field Design

Subsea

Umbilicals

Field Design

Engineering

Maintenance, Modifications and Operations
What is Front End Spectrum?

Value creation through *earliest involvement*
- Front End Spectrum is a combined offering for study work between all Business Areas (BA) in Aker Solutions.
- Front End Spectrum is responsible for the total execution, coordination and quality of all cross BA feasibility, evaluation, and concept studies.

**Front End Spectrum**

Feasibility and concept engineering by Aker Solutions
Front End Spectrum

- 25 years experience in Front End / Field Development solutions
- Approximately 350 front end work personnel worldwide covering both greenfield and brownfield developments
- Expertise includes:
  - Floaters - Semi’s, TLP’s, FPSO’s
  - Drilling Technology
  - Subsea systems
  - Flow Assurance
  - Fixed offshore platforms
  - Onshore and Offshore developments
  - Brownfield / Rejuvenation projects
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Floating Platform Experience / References


37 × H3 Semis Veslefrikk Snorre TLP Heidrun TLP Genesis Spar Norne FPSO Laminaria


Asgard B Snorre B White Rose FPSO Blind Faith 2 x Aker H6e Gjøa Skarv FPSO Ichthys Semi & FPSO

2012 2012 2013 2014

Aasta Hansteen SPAR Recent GOM Semi Concept Recent GOM Semi Concept Castberg Semi/FPSO

More than 50 floating facilities designed 4 decades of experience in Floater design
Semi – Main Characteristics

- Subsea completed wells
  - Remote subsea wells with workover by specialist vessel
  - Wells below with integrated drilling/workover facilities
- No oil storage
- Wide range of payload capacity
- Large number of flexible risers possible
- Short to medium development schedule
- Installed as fully integrated system
- New-build or conversion
- Good motions, feasible for Steel Catenary Risers (SCRs) in deep water
 Blind Faith – Deep Draft Semi
Semi - Fabrication and Installation

- World wide fabrication facilities
- Simple transport and installation
- No offshore lift and integration
- Dry transport of Semi on heavy lift vessel is possible.
Ichthys Semi – Hull Design Requirements

- Support a fully integrated topside with “not to exceed” weight of 67,800 tonnes
- Designed for Far East construction with float-over integration or topside assembly on top of hull.
- 27 flexible risers in guide tubes
- 40 years service life
- Water depth 260m
- Hull dry weight 41,600 tonnes
- Displacement 152,700 tonnes
TLP - Main Characteristics

- Allows surface wellheads (dry trees) with vertical access to wells
- Station keeping and stability by tethers
- Tensioned rigid risers for production
- Drilling and workover capability
- Single drill center
- Support of remote wells
- Improved motion characteristics
- No oil storage
- Water depth/payload limited
- Relatively long development schedule
- Installed as fully integrated system
- Custom designed for site specific application
TLP - Browse DTUs

Design Parameters
- Condensate export capacity 69000 bopd
- Gas export capacity 2000 MMscfd
- Topside Dry weight 16000 tonnes + drilling modules
- Topsides size 96 x 45m
- Water depth 590 m

Topside
- 1st stage separation
- Modular drilling
- Gas export to CPF (jacket)

Hull
- Column spacing 72 m
- Draft 32.00 m
- Displacement 88,000 tonnes

Mooring system
- 12 tethers, 44” dia.
- Gravity anchors

Risers
- 14 TTR (3,400 tonnes)
- SCR export
SPAR - Characteristics

- Weight stable (by counter weight)
- Limited capacity, offshore lift of topside.
- Limited footprint
- Excellent motions, TTRs
- Dry Trees
- Storage (limited)
- Integration and commissioning offshore

Genesis  Aasta Hansteen  Arctic Shtokman
Spar Upending
FPSO – Characteristics

- Remote subsea completed wells
- Drilling/workover requires specialist vessel
- Integrated oil storage and offloading
- Large topside capacity, good separation between hazardous and non-hazardous areas
- Flexible risers
- Short development schedule
- Integration and commissioning inshore
- Installed as fully integrated system
- New-build or tanker conversion
Risers

Main types:

- Flexible risers
  - Consist of layers of steel and plastic to make it flexible, wet trees
- Top Tensioned Risers (TTRs)
  - Vertical pipe with tension, allow dry trees
- Steel Catenary Risers (SCRs)
  - Steel tube hanging in a catenary shape, wet trees
- Hybrid Risers
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Managing and Engineering what You need - From reservoir to processing facility

1. Land-based production and processing
2. Terminals
3. Marine concrete structures for harsh environments
4. Floating production, storage & offloading (FPSO) vessels
5. Mooring and transfer systems
6. Floating LNG and methanol systems
7. Drilling systems
8. Tension Leg Platforms (TLP)
9. Riser and tether technologies
10. Semisubmersibles
11. Deep draft semisubmersibles
12. LNG terminals, onshore and offshore
13. Topsides and modules
14. Installation and removal (floatover/mating)
15. Jacket technology
16. Pipelines and flow assurance
17. Subsea solutions
18. Umbilicals and flowlines
19. Downhole technologies
20. Reservoir modelling and interpretation

Project Mgmt., Planning and Control

Exploration & drilling

Concept screening & selection

FEED

Engineering & Procurement

Construction

Installation

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Front End Spectrum Methodology

The front end phase is a unique opportunity to optimise the overall cost of the project.

Our execution method provides a reliable decision base that is transparent, traceable, and unbiased:

- **Transparent**
  Aker Solutions use a staged process developed to accommodate the decision gates of our clients. Close cooperation with our clients is a key success factor.

- **Traceable**
  As-built data from multiple sources within our organisation is systematically used as basis for all estimation in any deliverable.

- **Unbiased**
  Front End Spectrum will recommend solutions that optimise the value for our clients.
Front End Spectrum
Key elements that distinguish our services

- We work concurrently in **multidisciplinary teams**, removing silos and barriers
- We include **reservoir, flow assurance and SURF expertise** in our study teams
- We have hands on experience with **state of the art technologies and products**
- We use project managers and technical experts with a **holistic view**
- We feed knowledge from **detailed engineering, construction, commissioning, installation and operation** back to our front end team
Concept Selection Criteria

- Location
  - Environmental conditions
  - Water depth
  - Infrastructure
  - Geophysical and geotechnical conditions

- Production rates and volumes

- Reservoir area extent, depth and complexity

- Well intervention frequency

- Production chemistry
Building Blocks – Floater Concept Selection

- Storage or pipeline
  - FPSO
    - Mild weather
      - No turret
    - Severe weather
      - Turret
  - Direct well access or independent drilling
    - Dry trees or wet trees
    - Semi / mini TLP
      - Semi w. drill
      - TLP / Spar
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Aasgard Subsea Gas Compression System

- All electrical control systems
  - Low voltage distribution system
  - High voltage electrical power transmission

Compression station
Weight: 5063 tonnes
Size: 75x45x20m

Manifold station
Weight: 911 tonnes
Size: 34x28x9m
Overall View of Aasgard Subsea Compression Station
Subsea Gas Compression – the Benefits

- Gas fields require boosting of the reservoir flow as reservoir pressure depletes
- Subsea gas compression replaces the need for an offshore platform or onshore compression facility
  - Cost-efficient development solution (CAPEX)
  - Reduced operational costs (OPEX)
- Advantageous to place the compressor close to the well
  - Increased and accelerated production
  - Reducing CO2 emissions through lower energy consumption
  - No emissions or disposals to sea
- Safer due to unmanned operation
Subsea Gas Compression – the Challenges

Relocating processing systems onto the seabed also introduces challenges:

- Subsea development **perception** (conventional vs. “conceptual”)

- **IMR** strategy for remote subsea environment

- **Standardization**

- **Long step outs** (power and controls)
Aasgard Subsea Compression – Increasing Recovery

Source: Statoil presentation from UTC 2011

- 29.7 BSm3 gas
- 3.5 MSm3 condensate

Total gain: 278 mill boe

- 15 years
Aker Solutions’ GasBooster™ System Road-Map

Technology
Specifications
Tools
Supply chain
People
Facilities
Methodology

Qualification

Feasibility

2001-2003
Demo 2000 GasBooster™ qualification

1989-1993
Kvaerner Booster Station

2004-2011
Ormen Lange Subsea Compression Pilot - Qualification, delivery, testing
1 x 12.5 MW
120 km

2011-2013
Ormen Lange Subsea Compression Pilot - System Testing at Nyhamna
1 x 6 MW
> 350 km

2010-2015
Åsgard Subsea Compression Station - EPC
2 (+1) x 11.5 MW
40 km

2012 - 2019
CGB™ Compact Gas Booster for deep waters and long step-out

Execution

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Dry Tree Semi (DTS) – Key Features

- The purpose:
  - Add drilling capability to a production Semi with wellheads on the platform

- The motivations:
  - Reach greater water depth beyond TLP
  - Carry larger facilities than Spar
  - Reduce cost vs TLP & Spar

- Design principle:
  - TTRs increase system stiffness
  - Platform natural periods maintained outside wave periods
  - Two general categories:
    - designs that focus on reducing the heave motions
    - designs that focus on optimizing tensioner and wellbay design
## DTS compared to other floater solution

<table>
<thead>
<tr>
<th>Floater type</th>
<th>Deepdraft DTS</th>
<th>TLP</th>
<th>SPAR</th>
<th>Deepdraft SEMI</th>
<th>Conventional SEMI</th>
<th>FPSO (ship shaped)</th>
</tr>
</thead>
<tbody>
<tr>
<td>When used</td>
<td>Dry trees</td>
<td>Dry trees</td>
<td>Dry trees</td>
<td>Subsea trees</td>
<td>Subsea trees</td>
<td>Subsea trees</td>
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<tr>
<td>Water depth (m)</td>
<td>+500-3000</td>
<td>200-1500</td>
<td>500-3000</td>
<td>200-3000</td>
<td>200-3000</td>
<td>50-3000</td>
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<td>Integration</td>
<td>Quayside</td>
<td>Quayside</td>
<td>Offshore</td>
<td>Quayside</td>
<td>Quayside</td>
<td>Quayside</td>
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<td>Drilling</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>References</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Flexible wellbay</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>NA</td>
</tr>
<tr>
<td>Riser type</td>
<td>All</td>
<td>All</td>
<td>All</td>
<td>All</td>
<td>All, but Top Tensioned Risers</td>
<td>Flexibles and riser tower</td>
</tr>
<tr>
<td>Oil handling</td>
<td>Pipeline/FSU</td>
<td>Pipeline/FSU</td>
<td>Pipeline/FSU</td>
<td>Pipeline/FSU</td>
<td>Pipeline/FSU</td>
<td>Storage</td>
</tr>
</tbody>
</table>
Dry Tree Semi Benefits

- Capability for large topsides (vs Spar)
- Capability for large water depth (vs TLP)
- Flexibility for future expansion and tie-ins
- Relocation and decommissioning friendly

Cost benefit:
- Lighter hull and simplified topside integration (vs Spar)
- Simplified mooring system and installation (vs TLP)

Combines benefit of Spar (simple mooring and ultradeepwater) and TLP (large topside and quayside integration)
Aker Solutions Dry Tree Semi Development

Recent work

- 2010, DeepStar 10404
  - Global engineering
  - Model testing
  - Tensioning system

- 2011, Technology Qualification
  - Selected by DeepStar for Technology Qualification by DnV
  - System evaluated
  - Critical component identified: long stroke tensioners

- 2012, Internal study
  - Global engineering
  - Riser engineering
  - Structural design

- 2013, participated in DeepStar 11404
  - Comparison of DTS designs for marginal fields in Gulf of Mexico, West Africa, Offshore Australia
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KBeDesign™ - World Class Engineering Automation

- KBE objects are developed based on:
  - Classification societies rules and regulations
  - Global arrangement based on Aker Solutions extensive track-record of proven designs
  - Standard rules developed from Aker Solutions track record designs

- Automated building of 3D model
KBeDesign™ - Is about

**Standardize**

**Sharing**

**Reuse**

Support standardization, reuse and sharing of knowledge and rules across projects

=> **Quality Improvements**

**Automate**

**Geometry**

**Deliverables**

Automates deliverables of 3D Models, Analyses Models and Drawing Packages to Front End & Detail Engineering projects

=> **Productivity**

**Empower**

**Engineering**

**Projects**

KBe Design Dept. Develops technology & provides next gen tools & services to Front End and Detail Engineering projects

=> **Innovation**
KBeDesign™ Solutions – Key Features

- Re-use proven designs
- Increased engineering capacity – let engineers do engineering
- Continuous improvement
- Increased flexibility
- Effective handling of global changes
- Improved quality and reduced cost and design time
- Fewer people are needed to deliver high quality results, using less time in shorter schedules
KBeDesign™ is used to efficiently reuse Aker Solutions best practice

KBeDesign Generated
Topside main structures +
major outfitting structures

KBeDesign Generated Hull Main
Structures
KBeDesign™ Used on Gjøa SEMI Hull
Example: Gjøa Field Development, Statoil – Norway

Case 1
Full Process

Case 1A
Full Process & Drilling

Case 2
Minimum Process

Case 3
Full Process & Tie-in

Length of pontoons : 71.0 m  
Column distance C/C : 55.5 m  
Width of pontoons : 15.5 m  
Height of pontoon : 8.0 m  
Height of columns : 33.5 m  
Height to main deck : 43.5 m  
Displacement : 40 671 t  
Draft : 21.0 m  
Freeboard : 22.5 m

85.0 m  
67.5 m  
17.5 m  
8.5 m  
41.0 m  
50.5 m  
56 628 t  
21.0 m  
20.0 m

68.5 m  
53.0 m  
15.5 m  
8.0 m  
35.0 m  
43.5 m  
36 622 t  
21.0 m  
22.5 m

73.5 m  
58.0 m  
15.5 m  
8.0 m  
33.5 m  
43.5 m  
41 933 t  
21.0 m  
22.5 m

With KBe Design™ alternatives can easily be modelled
Use of KBeDesign™ for design of Aker Solutions SEMI Structures

KBeDesign™ Process

- Sizing
  - Configure & Arrange
- Tailor-making based on reuse
  - Standardized Building Blocks
- Multidiscipline
  - Piping & Outfitting Arr.

KBeDesign™ Output

- Global/Local Analyses
- Gen Arr. Drawings
- Reports
  - Weights, MTO
- Multidiscipline 3D CAD
KBeDesign™ for Floater - Impact/Competitive Advantage

- Improve Capability to deliver
- Improve Quality on deliverables
- Savings on time and man-hours

Material exported very early from model for use by Yard for placing steel orders. Very little changes from first to last material export from model.
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Concluding Remarks

How to identify the right deepwater field development solution?
- Experience
- Creativity
- Toolbox – with all potential concepts/solutions
- Cost data
- Agreed evaluation criteria
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