Subsea Recovery, Subsea Compression, Subsea Factory

IEA GOT Workshop 13 June, 2016, London
Per Gerhard Grini, Statoil
Outline

- Subsea recovery challenge
- Ligth well intervention
- Subsea Compression
- Subsea Factory
Riserless Well interventions

PCH – Pressure Control Head
Installation package #3 (w/ wire line tool string)

LS – Lubricator Section
Installation package #2

WCP – Well Control Package
Installation package #1 (w/XT adaptor)

ULP & LUB TUB –
Upper Lubricator Package & Lubricator Tubular

LLP – Lower Lubricator Package

Statoil
Statoil LWI operations

- **MSV Seawell** (2000)
- **MSV Regalia** (2003)
- **MSV Seawell** (2004 - 2005)
- **Island Frontier** (2006)
- **Island Wellserver** (2009)
- **Island Constructor** (2011 - 2013)
Typical LWI applications

LWI applications:

- Tractor operations
- Data Acquisition (PLT, Calliper, Leak detection tool, Well diagnostics etc.)
- Perforating/ re-perforation
- Zone isolation (plug/ straddle)
- Installation of insert DHSV
- Scale removal (milling/string shot)
- Installation/change-out of subsea XT
- Well killing/Pumping operations
- Change out of gas lift valves
- Sleeve operations – DIACS valves
- P&A operations – pre-rig activities
Benefit of LWI operations

• Very good HSE - results
• Improved mobility
• Specialized vessel, crew and equipment

=>

Intervention cost reduced by 50 to 65 % compared with anchored rigs and riser systems
Subsea Processing experience in Statoil

1986
Poseidon
IFF, Total, Statoil

1994
Gulfaks A
topside

1997
Lufeng

1999
Troll Pilot

2007
Tordis

2009
Tyrhansa
Åsgard and Gullfaks Subsea Compression Projects

Åsgard Subsea Compression

Gullfaks Subsea Compression
Åsgard and Gullfaks Subsea Compression Projects

Åsgard Subsea Compression

Gullfaks Subsea Compression
## The Business Cases - 2 quite different projects

<table>
<thead>
<tr>
<th>Field</th>
<th>Gullfaks</th>
<th>Åsgard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start-up</td>
<td>7 October 2015</td>
<td>16 September 2015</td>
</tr>
<tr>
<td>Design gas flowrate</td>
<td>60 000 bboe/d</td>
<td>126 000 bboe/d</td>
</tr>
<tr>
<td>Water depth</td>
<td>135 m / 443 ft.</td>
<td>265 m / 886 ft.</td>
</tr>
<tr>
<td>Compression system weight</td>
<td>1070 tonnes</td>
<td>4800 tonnes</td>
</tr>
<tr>
<td>Step out</td>
<td>9 miles</td>
<td>25 miles</td>
</tr>
<tr>
<td>Additional recovery</td>
<td>26 million barrels of oil equivalent</td>
<td>306 million barrels of oil equivalent</td>
</tr>
<tr>
<td>Pressure boost - dP</td>
<td>32 bar (~460 psi)</td>
<td>52 bar (~750 psi)</td>
</tr>
<tr>
<td>Power</td>
<td>2 x 5 MW multiphase compressors</td>
<td>2 x 11.5 MW centrifugal compressors</td>
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</table>
A new location...for a compressor

Subsea compressor module

60T compressor ⇒ 290T module

Size L 12m, W 8m, H 11m
ÅSC – Key design drivers

• Availability requirement of 96%
• Need for «proven solutions»
• No time for «failure»

1. One complete spare set of modules «train 3»
2. Design for intervention in up to 4.5m Hs
3. Extensive test program
4. Conventional solutions for non-core technologies
5. 5 days mobilization time for North Sea Giant and SHS system
Test Philosophy

**Technology Qualification Program** 2007-2013

- Qualification of components according to relevant standards

**Functional Unit Testing (FUT)** 2014

- Control system – Aberdeen
- Pump - Tranby
- Compressor – K-lab

**System Integration Test (SIT)** 2014

- Trains – Egersund

**Commissioning Offshore** 2013-2015

- Topside module
- Subsea manifold template
- Subsea compression station
Compressor functional test at K-lab
Nothing leaves until we have completed testing!!

Main Challenge: Piping tolerances

1. Testing!
2. Testing!
3. Testing!
SCSt = Subsea Compressor Station template

Weight 1.800t
Weight 4.800t
(With all Modules)

70 x 45m
17m High
265m Depth
## The Subsea and UPP Factory
### ‘Cleaner- Leaner-Smarter’

<table>
<thead>
<tr>
<th>PRODUCT LINE</th>
<th>BUSINESS NEED</th>
<th>CONCEPT/FOCUS</th>
<th>KEY CUSTOMERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>BROWNFIELD FACTORY</td>
<td>50% reduced facility capex</td>
<td>Simplification &amp; Standardization</td>
<td>DPN Brownfield and Greenfield</td>
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<tr>
<td></td>
<td>60% recovery from existing fields</td>
<td>Reduced cost of Subsea Production and Processing through industry collaboration</td>
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<tr>
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<td></td>
<td><strong>Simplified Subsea Compression &amp; Boosting</strong> Subsea Wet Gas qualification to reduce cost of subsea compression</td>
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<tr>
<td>SUBSEA-TO-HOST FACTORY</td>
<td>Reducing CAPEX/OPEX through less topside modifications</td>
<td><strong>Subsea Power &amp; Controls</strong> Reduce capex, Flexibility of new tie-backs, Enable long tie-ins</td>
<td>DPN Brownfield and Greenfield</td>
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<td><strong>CO2 measures</strong> CO2 calculator, Subsea Storage and Green Subsea Processing</td>
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<td><strong>Gas-2-Pipe™ System</strong> Concept where gas is delivered directly to pipeline - utilizing established infrastructure in a flexible way</td>
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<td>EXTENDED REACH FACTORY</td>
<td>Allow subsea production and transport to host</td>
<td><strong>Lean Extended Reach System</strong> Low cost development solution based mainly on Smart Flow Assurance and Multiphase Flow</td>
<td>Barents Sea area</td>
</tr>
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<td>up to 250 km for gas</td>
<td><strong>Subsea Produced Water Treatment</strong> Produced water separation and treatment to enable re-injection or discharge</td>
<td>East Coast Canada</td>
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<tr>
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<td>up to 100 km for oil</td>
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<td>East Africa/Tanzania</td>
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<td>DEEP WATER FACTORY</td>
<td>Enable production from new fields to existing host /new facility down to 3000m water</td>
<td><strong>Deep Water Portfolio (Brazil - RCR)</strong> Deep Water separation and Subsea water treatment, Robust ESP development Production systems (Pipes/Risers)</td>
<td>Brazil East Coast Canada East Africa/Tanzania</td>
</tr>
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</table>
Cap-X™- new challenges, new solutions

Standardisation, simplification and lower cost in practice
Acknowledgements regarding Gullfaks and Åsgard Compression projects

Gullfaks partners:
- Petoro AS
- OMV Norge AS

Åsgard and Mikkel partners:
- Petoro AS
- ENI Norge AS
- Total E&P Norge AS
- ExxonMobil Exploration and Production Norway AS

Operator Statoil