Riser less Light Well Intervention (RLWI) - "A success for reducing OPEX - cost and increasing oil recovery for subsea completed fields"

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StatoilHydro Subsea IOR Ambition and Technologies

Ambition

- Identify drainage points and intervention needs
- Low cost drainage

Subsea recovery 55%

- Increased fluid handling
- Reduced wellhead pressure

Low cost well intervention

Integrated operations
Category A  
RLWI

Category B  
Heavy intervention & TTD

Category C  
Drilling and completion

High pressure small bore (7”) riser standard

• Wireline / tractor only
• Limited bha length

Full range of through tubing services

Low pressure marine riser (21”) standard
HP concentric riser and SSTT required for live well intervention
• Limited live well through tubing services
Statoil RLWI Experience 2000 - 2008

**Typical applications:**
- Data gathering (PLT)
- Perforating/ re-perforation
- Zone isolation (plug/straddle)
- Inspection/repair/installation of insert DHSV
- Milling of short scale bridges - planned
- Camera runs: visual or x-ray
- Well killing operation
- Selective tracer injection or sampling
Contract with Island Offshore

RLWI-alliance contract

ISLAND OFFSHORE - Aker Solutions (Wireline Equipment) - FMC Technology
(subsea lubricator stack)

- Contract duration is 6 years (campaigns) starting 1st of April 2006
- Options included:
  - The contract is originally for Island Wellserver.
  - Island Frontier as second vessel from 1.4.2008
- StatoilHydro and the licences have committed campaign lengths as follows:

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
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<tr>
<td>Island Frontier</td>
<td>176</td>
<td>196</td>
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<tr>
<td>Island Frontier exercised option*</td>
<td>189</td>
<td>169</td>
<td>225</td>
<td>125</td>
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<tr>
<td>Island Wellserver</td>
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<td></td>
<td>177</td>
<td>166</td>
<td>150</td>
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</table>
Riser Less Well Intervention - RLWI

Total height: 31.5m
Total weight: approx 55 ton

- Pressure Control Head (PCH)
- Upper Lubricator Package (ULP)
  - Shear seal ram with wire cutting
  - Grease return system
- Lower Lubricator Package (LLP)
- Lower Intervention Package (LIP)
- Connector/adapter assy.
Positive experiences in the 2006 - 2008 campaign:

• Many successful well operations are performed with RLWI
• Good HSE management onboard the vessel
• Good working environment on Island Frontier.
• Well control equipment worked well on high pressure wells - injection pressure above 430 bar.
• Subsea Intervention equipment is working good after new umbilical was installed in 2007.
• Good ROV performance
• IO - Integrated operations.
• Increased operational efficiency in 2008
Challenges in the 2006 - 2008 campaign:

- New vessel – Island Frontier and contractor – Island Offshore in 2006 with limited experience with RLWI operations.
- Several equipment problems with vessel, umbilical, winch tuning, RLWI stack & ROV in 2006.
- Reprogramming of WOCS workover control system - spend a lot of time.
- Not sufficient competence from W/L contractor – W/L toolstrings to light, PCH – pressure control head gave much more friction than expected.
- Had to establish new Statoil "best practice" for pulling tubing hanger crown plugs - THCP.
Challenges in the 2006 - 2008 campaign:

- **RLWI stack:**
  - Complexity of system – easy to get failure.
  - High maintenance level – time consuming in between wells.
  - Flushing of stack is time consuming.

- Crew changes with helicopter – limitations on weather.

- Waiting on weather in autumn and winter.

- Well related issues:
  - Annulus tubing collapse due to pressure applied to annulus.
  - Scale, Lost perforation guns (overbalance), element swell on a PI plug.
  - Personnel, competence.
Operational RLWI - summary 2007 and 2008

LWI operational time breakdown 2007-2008
Operational RLWI – summary 2005 - 2008

LWI Operational efficiency by year

<table>
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<th>Year</th>
<th>Efficiency</th>
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<tbody>
<tr>
<td>2005 Seawell</td>
<td>89,0</td>
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<tr>
<td>2006 Island Frontier</td>
<td>72,7</td>
</tr>
<tr>
<td>2007 Island Frontier</td>
<td>77,4</td>
</tr>
<tr>
<td>2008 Island Frontier pr May</td>
<td>77,5</td>
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</table>
RLWI in StatoilHydro – “the future”

- Two RLWI vessels are contracted for 2008/2009:
- Present StatoilHydro have 444 subsea wells on the Norwegian shelf and more to come.
- RLWI stack - MK 2 expectations from StatoilHydro
  - Higher regularity
  - More efficient
  - Increased weather window.
  - More efficient maintenance and in between well service.
  - Possibility for increased lubricator length.
- The stack is 4 month delayed – Island Wells server will earliest be in operation in August 2008
RLWI stacks

Mark II

Mark I
Åsgard field installations – RLWI operations

- Åsgard B
  - Gas center
- Åsgard C
  - Condensate storage
- Åsgard A
  - Oil producer
- Smørbukk
  - Gas condensate and oil
- Smørbukk Sør
  - Oil and gas condensate
- Pipelines for gas export

StatoilHydro
Åsgard
Drilling and completion challenges, production and injection wells

Asgard - 31 wells
Smørbukk - 31 wells
Smørbukk Sør - 14 wells

Midgard - 9 wells

MD = 5000 - 6000 m
P = 500 bar
T = 165 °C
GOR$^{\text{init}}$ = 600-2000 Sm³/Sm³

MD = 5000 - 6000 m
P = 400 bar
T = 140 °C
GOR$^{\text{init}}$ = 300-500 Sm³/Sm³

MD = 3500 - 4500 m
P = 250 bar
T = 90 °C
GOR$^{\text{init}}$ = 5-6000 Sm³/Sm³
Summary RLWI operations at Åsgard

• PLT results
  • Tilje 1.1 verified open (suspected closed)
  • Tilje 2 takes more gas than expected
  • Higher pressures than expected

• Consequences
  • Zonal rates important for history match: Control the potential for all future infill well targets and zonal isolation.
  • Large Tilje 2 flow revealed: explains GBT in J-2H?
  • High reservoir pressures: Communication is poorer than expected, may lead to infill wells
  • Low Tilje 1 flow: May change plans for K3/K1 reperforation/plugging campaign.
Tilje pressure

- All PLTs in the central part of the field confirm that the pressures in Tilje 1.1 are lower than predicted in simulations.
- A result of this is that we have less time available to access the low GOR oil/rich condensate in Tilje 1.1.

Predicted and measured pressures in Tilje 1.1

<table>
<thead>
<tr>
<th>Well</th>
<th>Predicted Pres. (bar)</th>
<th>Measured Pres. (bar)</th>
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<tbody>
<tr>
<td>L-2H</td>
<td>374</td>
<td>318</td>
</tr>
<tr>
<td>L-3H</td>
<td>370</td>
<td>334</td>
</tr>
<tr>
<td>L-4H</td>
<td>427</td>
<td>358</td>
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<tr>
<td>I-1H</td>
<td>399</td>
<td>365</td>
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</table>
Integrated operations – IO for RLWI operations
Conclusions

• RLWI has been performed on regular basis in StatoilHydro with high HSE – standard since 2003.

• RLWI is one of the key elements to reach StatoilHydros IOR ambition of 55% oil recovery from subsea completed fields

• RLWI is giving reduced operational costs – OPEX for subsea completed fields compared with the costly alternatives, as drilling rigs and drill ships.

• StatoilHydro has performed totally approximately 50 subsea RLWI interventions since 2003 using three different contractors with high degree of success.

• RLWI has become a routine operation with continuously increasing demands.

• Improved operational efficiency is an ongoing activity to meet the overall ambitions for RLWI.