P&A Opportunities

SPE 4th Well Abandonment seminar - Aberdeen

Presented by: Ole Eddie Karlsen, Vice President – Global Subsea Operations
Date: April 18th 2013
Well Abandonment Requirements

• References
  - Oil & Gas UK Guidelines
  - NORSOK D-010
  - BSEE

• Barriers
  - Dual Barrier Formation Isolation
  - Annular Cementation Permitted
    ▪ Requires that any annular space that communicates with open hole and extends to the mudline must be isolated with a cement plug of at least 200’ in length and be tested to verify isolation
  - Material Choice & Validation

• Non-Explosive Severance – 3-5m below mudline
P&A From Vessels
Categorization of Wells for P&A (UK guidelines)

- Categorized by the level of intervention required in order to achieve final abandonment

<table>
<thead>
<tr>
<th>Category 1 (C1)</th>
<th>1. The simplest wells requiring only wellhead removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category 2 (C2)</td>
<td>Wells which require shallow plugs set in the casing and adjacent annuli</td>
</tr>
<tr>
<td>Category 3 (C3)</td>
<td>Wells requiring deeper intervention e.g. to set supplementary reservoir plugs</td>
</tr>
<tr>
<td>Category 4 (C4)</td>
<td>All wells where the work scope is not clear - usually due to uncertainties regarding suspension status</td>
</tr>
</tbody>
</table>

- From the perspective of minimizing future abandonment costs, the guidelines should be incorporated into the planning of all new wells to ensure Category 1 classification

- A large percentage of the currently suspended well population does not meet C1 criteria

- The perforating and cementing required to satisfy UK Oil & Gas guidelines for C2 and C3 wells can be undertaken by a RLWI operation thus negating the need to mobilize a rig
WST - Welltec© Setting Tool

General Description
• Electro Hydraulic operational setting tool for plugs, packers and straddle systems
• The tool requires no form of explosives or pre-charge of pressure and is not dependent on well pressure for operation
• The WST can be used to set any plug run on Baker #20 – E4 setting tool

Technical Description
• Make up length: 4,2 m
• Maximum OD: 3 7/8”
• Maximum stroke length: 14”
• Maximum stroke force: 55.000 lbf
• Maximum operational temp: 135° C
• Maximum well pressure: 10.000 psi
• Setting sleeve connection: Running tool/plug connection:
  - *The stroke force can be doubled to 110.000 lbf by adding one piston stage to the tool
  - The increased tool length will be 60 cm
New Technology - Pipe Cutting Tool
### 4.5” Tubing Retrieval Sakhalin Energy

<table>
<thead>
<tr>
<th>Depth</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2327</td>
<td>Collar</td>
</tr>
<tr>
<td>2329</td>
<td>Collar</td>
</tr>
<tr>
<td>2333,6</td>
<td>Collar</td>
</tr>
</tbody>
</table>

Force > 10,000N (2248lbs)  
Proposed coefficient of friction = 0.25  
Force required to "lift" cutter free = 562 lbs

#### 9 5/8” Casing

#### 4 1/2” Tubing

#### 2341 Cut Depth

#### 2346 Collar

#### 2350 packer

Very fine debris
New Hydraulic Puncher - Prototype

Currently testing range of steel, hardness, thickness and pipe sizes
Well Integrity Tool: Description

**Product application**
- Tubing/casing inspection (internal and external metal loss)
- Inspects two pipe layers in a single pass
- Analyses thickness of inner and outer pipe (after processing)
- Locates ferromagnetic features outside inner pipe
  - Casing centralizers
  - Casing shoe
  - Other anomalies in the inner and outer pipe (cracks, holes, splits, etc.)

**Unique feature**
- Capable of analyzing the integrity of the outer pipe from inside the inner pipe

**Operating principle**
- Electromagnetic transmitter/receiver system
- Faraday’s induction principle
Extended features

Combined with multi-finger caliper

- Identifies both internal and external casing defects
- Quantifies scale
- Better accuracy of measurement in the inner pipe

Features

- Very short toolstring: 4.7 m (15.4 ft)
- Small tool OD for small restrictions/buckling (1 11/16”)
- 3 caliper sizes (24, 40 and 56 arms)
- Compact and robust design
# Analysis table example

When combined with a multi-finger Caliper

## Interpretation Summary Table

<table>
<thead>
<tr>
<th>Joint Depth</th>
<th>Min W (in)</th>
<th>Max W (in)</th>
<th>% Max wall loss</th>
<th>Grade</th>
<th>Depth of max wall loss</th>
<th>Type</th>
<th>Damage Profile (% wall loss)</th>
</tr>
</thead>
<tbody>
<tr>
<td>43.0</td>
<td>0.216</td>
<td>0.304</td>
<td>29</td>
<td>B</td>
<td>44.6</td>
<td>Pup Joint</td>
<td>[Graph showing damage profile]</td>
</tr>
<tr>
<td>46.2</td>
<td>0.000</td>
<td>0.202</td>
<td>100</td>
<td>F</td>
<td>83.8</td>
<td>Joint with severe corrosion up to 95%</td>
<td>[Graph showing damage profile]</td>
</tr>
<tr>
<td>85.9</td>
<td>0.000</td>
<td>0.242</td>
<td>74</td>
<td>C</td>
<td>94.7</td>
<td>Joint with considerable wall loss</td>
<td>[Graph showing damage profile]</td>
</tr>
<tr>
<td>122.0</td>
<td>0.130</td>
<td>0.288</td>
<td>57</td>
<td>C</td>
<td>123.8</td>
<td>Joint with wall loss</td>
<td>[Graph showing damage profile]</td>
</tr>
<tr>
<td>159.5</td>
<td>0.182</td>
<td>0.291</td>
<td>40</td>
<td>C</td>
<td>184.9</td>
<td>Joint with wall loss</td>
<td>[Graph showing damage profile]</td>
</tr>
<tr>
<td>196.6</td>
<td>0.214</td>
<td>0.325</td>
<td>30</td>
<td>B</td>
<td>224.6</td>
<td>Joint</td>
<td>[Graph showing damage profile]</td>
</tr>
<tr>
<td>234.5</td>
<td>0.196</td>
<td>0.313</td>
<td>36</td>
<td>B</td>
<td>257.4</td>
<td>Joint</td>
<td>[Graph showing damage profile]</td>
</tr>
</tbody>
</table>

## Grade Table

<table>
<thead>
<tr>
<th>Grade</th>
<th>%loss &lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>20</td>
</tr>
<tr>
<td>B</td>
<td>40</td>
</tr>
<tr>
<td>C</td>
<td>60</td>
</tr>
<tr>
<td>D</td>
<td>80</td>
</tr>
<tr>
<td>F</td>
<td>100</td>
</tr>
</tbody>
</table>
Down Hole Services for P&A

• Use Well Stroker to verify top of cement plug integrity (10-16 ton force)
• Set Plugs with Plug Setting Stroker without using explosives
• Milling services to remove obstructions (scales, stuck valves, nipple profiles)
• Cleaning services to remove debris, sand fill, swarf, metal or rubber, etc. to obtain access for other operations
• Logging, inspection and verification of annulus cement, pipe integrity and potential leaks – in conjunction with 3rd party
Process Suggested

Qualification of New Technology

FEED
Detailed Design
Pilot Wells
Dedicate RLWI vessel(s)
... and thank you for your time