Oil and Gas UK Workgroup
Well Suspension and Abandonment (WSA)

4th European SPE Seminar on Well Abandonment
Aberdeen, 18th April 2013
Jules Schoenmakers (Shell), on behalf of WSA
Well Life Cycle Practices Forum (WLC PF)

BOP Issues

Integrity Guidelines

Relief Well Planning Requirements

Competency, Behaviours, & Human Factors

Well Examination

Verification

HPHT Wells

Sub-committees

Cost liability estimation

Material Qualification Guideline

Well Suspension & Abandonment

Steering Committee

Capping devices
WSA Workgroup Purpose and Objectives

• Enhance capabilities for Well Abandonments and provide up-to-date guidelines for the industry.

• Create opportunities to make well abandonments more efficient and effective, and improve the health, safety and environmental aspects, by facilitation of technology development, trials, and promotion of commercial initiatives.

• Liaise with DECC and other regulators on technical issues specific to well abandonments.
## WSA has 19 members
(current and previous members shown)

<table>
<thead>
<tr>
<th>Name</th>
<th>Company</th>
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<tbody>
<tr>
<td>Jules Schoenmakers (WSA co-lead)</td>
<td>Shell</td>
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<tr>
<td>Stan Bain (WSA co-lead)</td>
<td>ADTI</td>
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<tr>
<td>Max Baumert</td>
<td>ExxonMobil</td>
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<tr>
<td>Donald Dobson</td>
<td>HSE</td>
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<td>John Ligertwood (Andrew McHardy)</td>
<td>Total E&amp;P UK</td>
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<tr>
<td>Martin Mosley</td>
<td>Talisman Energy (UK)</td>
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<tr>
<td>Tom Gillibrand (Bill Inglis)</td>
<td>BP</td>
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<tr>
<td>Garry Skelly</td>
<td>Well Abandonment</td>
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<tr>
<td>Jim Keenan (Colin Wight)</td>
<td>Halliburton</td>
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<tr>
<td>Rod Smith (Jorgen Berg)</td>
<td>Schlumberger</td>
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<td>Phil Chandler</td>
<td>Acteon</td>
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<td>Martin Street (Steve White)</td>
<td>Hess</td>
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<tr>
<td>Mark Madu (Anthony Onukwu)</td>
<td>ITF</td>
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<tr>
<td>Oliver Willis</td>
<td>Well Ops</td>
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<tr>
<td>Steve Cromar (Peter Irvine)</td>
<td>ConocoPhillips</td>
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<tr>
<td>Michael Muir (Simon Hough)</td>
<td>Chevron</td>
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<tr>
<td>Sandy Fettes</td>
<td>Fairfield</td>
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<tr>
<td>Steve Kirby, Taiwo Olaoya</td>
<td>Oil and Gas UK</td>
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<td>Oil and Gas UK</td>
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Presentation outline

1. Guidelines for the Suspensions and Abandonment of wells

2. Guidelines for the Qualification of Materials for the Suspension and Abandonment of wells

3. Cost estimating guidelines
DCR, Part IV, Wells, General Duty:-
The well-operator, shall ensure that a well is so designed, modified, commissioned, constructed, equipped, operated, maintained, suspended and abandoned that –

a) so far as is reasonably practicable, there can be no unplanned escape of fluids from the well; and

b) risks to the health and safety of persons from it or anything in it, or in the strata to which it is connected, are as low as is reasonably practicable.

The Offshore Installations and Wells (Design and Construction, etc) Regulations 1996 (DCR)
• Legislation is Goal-setting, not prescriptive
  - States what to achieve, not what to do
  - Onus on well-operator to assess risks and reduce to ALARP
• Guidelines assist with compliance of the DCR
  and use of good industry practice
• Operators are expected to develop “in-house rules” for their
  own operations and apply a well examination scheme.
Basic principle of Guidelines is unchanged

Best practices

**Height of 500ft MD, containing at least 100 ft MD of good cement.**

**Plug depth determined by formation (impermeability and strength) and primary cementation.**

**Pipe stand-off**

**Support to prevent cement movement, slumping and gas migration while setting.**

**Good bond, clean surfaces, water wet.**

Barrier elements

**Sealing abandonment plug.**

**Tubing sealed with cement, in cement.**

**Casings, tubing embedded in cement.**

**Sealing primary cementations.**

**Formation: impermeable and adequate strength to contain future pressures.**

Permanent Abandonment Barrier (red dashed envelope)

“Restoring the caprock”
Issue 4: What has changed (1)

In general, an update based on experience and feedback.

Specifically:

- Highlight the importance of the overburden geology
- Barrier verification
  - Cement plug - Improved guidelines on tagging
  - Annular cement - Clearer guidance on assessing the sealing capability.
- Tables describing verification options for primary, secondary and combination barriers.
Issue 4: What has changed (2)

• Additional ‘Special Considerations’ (Chapter 7)
  – Sealing formations
  – Reservoir compaction and subsidence
  – Hydrocarbons of biogenic nature
• Suspension clarified as temporary abandonment
• Statutory notifications, approvals and record keeping
  – Rewritten to update and clarify
Issue 4: What has changed (3)

- New appendix on barrier integrity
  - potential hazards to help risk assessment
  - mitigation examples using good industry practice
- New appendix on P&A codes
  - Aligns coding to “Guideline on well abandonment cost estimation”
- New appendix on irretrievable radioactive sources.
Squeezing shale as a barrier (example)

LOG #2 in 2010
FREE PIPE IN 1981
GOOD BOND IN 2010

LOG #1 in 2010
GOOD BOND IN 2010

13 3/8' Casing Shoe
## Hazard Mitigations

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Mitigations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cement Slippage Downhole due to Cement density or losses</strong></td>
<td></td>
</tr>
<tr>
<td>• Cement density is higher that fluid in which it is placed.</td>
<td>• Ensure cement plug is set on suitable base that supports the cement slurry</td>
</tr>
<tr>
<td>• TOC no longer at required depth</td>
<td>• Mechanical base such as previously tested cement plug, cementing packer, or completion packer</td>
</tr>
<tr>
<td>• Soft cement plug due to contamination with mud (high risk with synthetic or oil based muds)</td>
<td>• Fluid base such as a Viscous Reactive Pill (VRP) or viscous mud pill.</td>
</tr>
<tr>
<td>• T-plug on casing stumps leak</td>
<td>• For VRP ensure suitable reaction with mud &amp; cement via lab testing.</td>
</tr>
<tr>
<td>• Plugs across milled sections without support for cement</td>
<td>• Consider setting cement plug at hole section with lower inclination. 30-70 degrees is high risk area for slippage if using a fluid base.</td>
</tr>
<tr>
<td></td>
<td>• Treat losses or use mechanical base</td>
</tr>
<tr>
<td></td>
<td>• Verify that the pill can carry the cement and that the fluid can carry the pill using a scale model testing to replicate wellbore geometry (e.g. glass cylinder test)</td>
</tr>
<tr>
<td></td>
<td>• Tag or wash down to confirm.</td>
</tr>
</tbody>
</table>

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This is what we think

![Idealised Case and Experimental results](image_url)

This is what actually happens!
Guidelines for the Qualification of Materials

- Cement is currently accepted as the primary material for well abandonment, but has its limitations
- Alternatives are being developed, but have found little application due to uncertainty of the long-term integrity

- Expert group compiled materials guidelines
- Framework for qualification testing
- Issued in 2012

“Guidelines for the Qualification of Materials for the Suspension and Abandonment of Wells” Issued by Oil and Gas UK, 2012.
Material Qualification Guidelines

Types of materials:
A. **Cements, ceramics (setting)**, porous
   e.g. Portland Class H and G cement, (Pozmix, Slag)
B. **Grouts (non-setting)**, porous.
   e.g. sand or clay mixtures
C. **Polymers thermal-setting** & composites, not porous.
   e.g. resins
D. **Polymers thermoplastics** & composites, not porous.
E. **Polymers elastomers** & composites, not porous.
   e.g. silicone rubber
F. **Formation**, not porous.
   e.g. shale, salt
G. **Gels**, not porous.
   e.g. bentonite gels, clay gels, polymer gels
H. **Glass**, not porous
I. **Metals**, not porous.
   e.g. steel, alloys, bismuth
COMPLEMENTED BY AGING TESTS ON LABORATORY SCALE

- Gas/Water receiving point with dummy plug during Product Placement
- Pressure recording on high side to allow extrapolation of plug length. Recording points 1, 2, 3 are compulsory, and 4, 5, others are optional
- Accommodates 30 ft Product 7” casing
- 45 degrees inclination
- Heating
- Product overflow port with disposable valve
- Product fill port with disposable valve
Industry guidelines for cost estimating liabilities of wells (Asset Retirement Obligations; ARO) Issued 2011.

Structured approach to support cost estimates for:
- Financial statements
- Asset sales
- Securities

Not for AFE or detailed estimates.

P&A Code for work scope has been introduced. This will dovetail with benchmarking.
### Questions to establish the P&A code

<table>
<thead>
<tr>
<th>X: Not Feasible</th>
<th>✓: Required</th>
<th>O: Optional</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Well Abandonment Complexity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Type 1 Simple Rig-less</strong></td>
<td><strong>Type 2 Complex Rig-less</strong></td>
<td><strong>Type 3 Simple Rig</strong></td>
</tr>
<tr>
<td><strong>Well Characteristics / Condition at abandonment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Sustained Casing Pressure due to hydrocarbons or overpressures</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2. Not cemented casing or liner at barrier depths (cap rock)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>3. Restricted access to tubing</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>4. Deep electrical or hydraulic lines present at barrier depth</td>
<td>X</td>
<td>X</td>
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<tr>
<td>5. Annular Safety Valve (ASV) present</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>6. Packer set above cap rock</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>7. Site does not allow for CT/HWU pumping operations</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>8. Multiple reservoirs to be isolated</td>
<td>X</td>
<td>✓</td>
</tr>
<tr>
<td>9. Tubing has leak (e.g. corrosion, accessories)</td>
<td>X</td>
<td>✓</td>
</tr>
<tr>
<td>10. Inclination &gt;60 deg above packer (wireline access)</td>
<td>X</td>
<td>✓</td>
</tr>
<tr>
<td>11. Well with good integrity, no limitations</td>
<td>✓</td>
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P&A code: Phases and Types

### P&A Code = PL 3/3/3

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<th>Abandonment Complexity</th>
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<tr>
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<td>TYPE 0</td>
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<tr>
<td></td>
<td>No work required</td>
</tr>
<tr>
<td>1 Reservoir Abandonment</td>
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<tr>
<td>2 Intermediate Abandonment</td>
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<tr>
<td>3 Wellhead Conductor Removal</td>
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### P&A Code = PL 2/3/0

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P&A Code dovetails with benchmarking

Initiated by WSA in 2010
Now 25 participants
274 abandonments
Managed by Rushmore Reviews
Challenges

- Cement Logging through-tubing. ITF project started.
- Use of supply boats for well abandonments (moving bridge). Call for abstracts issued. Insufficient returns.
- Downhole Cables and Lines: still no solutions
Work plan WSA 2012-2015

1. Issue technology call request for deep cables
2. Through-tubing abandonment challenges
3. Review alignment with Norsok-D010
4. Update cost estimation guideline in 2014
5. Update well suspension and abandonment guidelines in 2015
6. Update material qualification guidelines in 2015
Discussion

1. Comments on the Guidelines or presented topics?

2. Is the work programme of WSA supported?

3. Suggestions for other topics for WSA?

4. In which areas are you willing to give support?

Thank you for your attention and feedback