Designing Subsea Wells for Abandonment & Suspension

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Designing Subsea Wells for Abandonment & Suspension

- Subsea Well Design Aspects
- Annulus Pressure Build up (APB) mitigation v Abandonment / Suspension design
- Design Methods
- Other Focus Areas
- Closing Remarks
- Networking
Designing Subsea Wells for Abandonment & Suspension

1. This presentation is intended just to give an insight as to some of the issues relating to incorporating abandonment & suspension into Subsea Well Casing Design and solutions.

2. The act of considering redrill / abandonment / suspension design during the well design phase is a step in the right direction.

3. We need to move away from concept that it is some else's problem later on, as it also relates to sidetracking the well for infill opportunities later.

4. This is a big subject and an opportunity.
How Subsea Well Design can impact Abandonment

<table>
<thead>
<tr>
<th>Design Requirement</th>
<th>Subsea Well design driver</th>
<th>Does it fit with abandonment design</th>
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<tbody>
<tr>
<td>Open shoes (not cemented)</td>
<td>Yes</td>
<td>No, especially in deeper casings as need lateral barrier</td>
</tr>
<tr>
<td>APB Mitigation</td>
<td>Yes</td>
<td>In some cases. Depends on solution</td>
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<tr>
<td>Deep set completion barrier</td>
<td>Yes</td>
<td>No, Intricate isolation operations required</td>
</tr>
<tr>
<td>Deep Sidettrack contingency for infill wells</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Shallow Sidettrack contingency for infill wells</td>
<td>Depends on where TOC is.</td>
<td>Depends on where TOC is.</td>
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<tr>
<td>Liner v full string</td>
<td>Yes in certain cases</td>
<td>Yes, 1 less string to recover, deep barrier, 1 less seal assembly</td>
</tr>
<tr>
<td>Casing integrity</td>
<td>Yes</td>
<td>Yes, although true casing integrity at point of abandonment can be an unknown</td>
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</table>
**Subsea Well Design Example**

**Liner Type Design (without Tieback)**
- 1 Less Seal Assembly
- More Annular Clearance for completion
- **Stronger Casing**
- Proven Downhole Barrier (inflow tested)

**Full String Design**
- Extra Seal Assembly to remove (High NPT)
- **APB!**
- Production Casing (extra Barrier)
- Intermediate

**Zone Isolation**

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Annular Pressure Build-up (APB) Mitigation v Abandonment design

- Abandonment design requires a deep set lateral barrier and can be in conflict with Annulus Pressure Build Up Mitigations due to open shoes for APB.

- Two mitigation strategies
  1. Primary – open shoe for example. Leave the top of cement below the previous casing shoe (applies to the surface and intermediate casing shoes). *You need this in event of solids drop out which isolates the shoe*
  2. Secondary – See Next Slide
Annular Pressure Build-up (APB) Mitigation

- APB is conducted Using WellCat – A power user should be used for this task. Be cognisant of thermal effects from surrounding wells, especially in HPHT

- On a suspended well solids settlement can be considered to be insignificant but not in case of abandonment as cement spacer has poor gel strength and leak path at shoe can be sealed off by solids settlement, up to 1/3 of annular space can be taken up with solids.

- Do you need secondary Mitigation
Secondary Strategies - Examples

1. Vacuum Insulated Tubing
2. Burst / collapse disc
3. Pressure relief valves
4. Upgraded Casing String
5. Insulating Packer Fluid
6. Nitrogen / Shrinking Spacer
7. Crushable Foam Wrap
Other focus areas / technologies

1. Suspension packers, long term
2. Perforate, circ & squeeze solutions for annular isolation
3. Baseline log of casing (offline)
4. More information on casing in PO, define actual strength
5. Sidetrack points/ramps in well design
6. Innovative Calliper technologies, conductors
7. Shale as a barrier, 2 independent means of verification
8. Estimate Solids drop out above cement
9. Verification of TOC using LWD – An emerging area
10. HPHT and wells in tectonic areas consider impact of deformation on future re-entry – double skin design
11. Casing deformation in horizontal shale gas wells, how can you design it out
Closing Remarks

- First step is to consider it in the design.
- Consider other techniques to get most out of the Casing Strength
  - Reliability Based design techniques, Casing Information
  - Kuriyama on casing wear modelling
  - Base line casing logs /maps
  - Energy Resources Conservation Board – Directive 10 (changes in design factor for changes H₂S Levels – Shale gas approach
- Ease of abandonment to be compared against other design drivers.
  - How will you verify the barriers prior to abandonment
- High impact (NPT) low probability events in well abandonment are more common
- As well condition is sometimes unknown, need high levels of contingency are required in equipment, time & cost
Networking

There is a lot of experience out there, network like crazy. Most challenges in abandonment have been conquered but history has a tendency to repeat itself, sometimes due to level of uncertainty in abandonment operations.