



Light Well Intervention Vessel (LWIV) Abandonment

Problem Statement as presented at ITF Theme day
1st July 2009

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Background



A UK North Sea Well Abandonment Study (Issue 3 Nov 2008) commissioned by UK Oil and Gas concluded that in the subsea well abandonment sector

- Existing technology is capable of performing a rigless abandonment approach using Well Intervention Vessels, for approximately 554 wells (i.e.. 61% of UK North Sea subsea wells)
- An additional 220 wells (24% of subsea wells) could potentially be undertaken in a rigless manner, if new technology is developed.



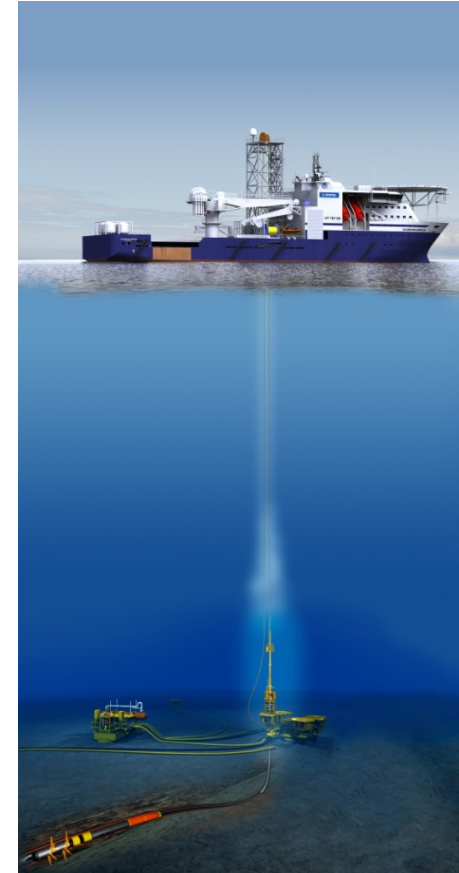
- BP aspiration is to reduce the use of Rigs for Plug & Abandonment (P&A) through increased use of Light Well Intervention Vessels (LWIV)
- Significant cost savings can be achieved by using a LWIV to permanently abandon wells.
- 200 BP subsea wells installed in the North Sea alone
- BP Don Subsea Asset identified as primary candidate for LWIV P&A

Current LWIV Operating Limitations

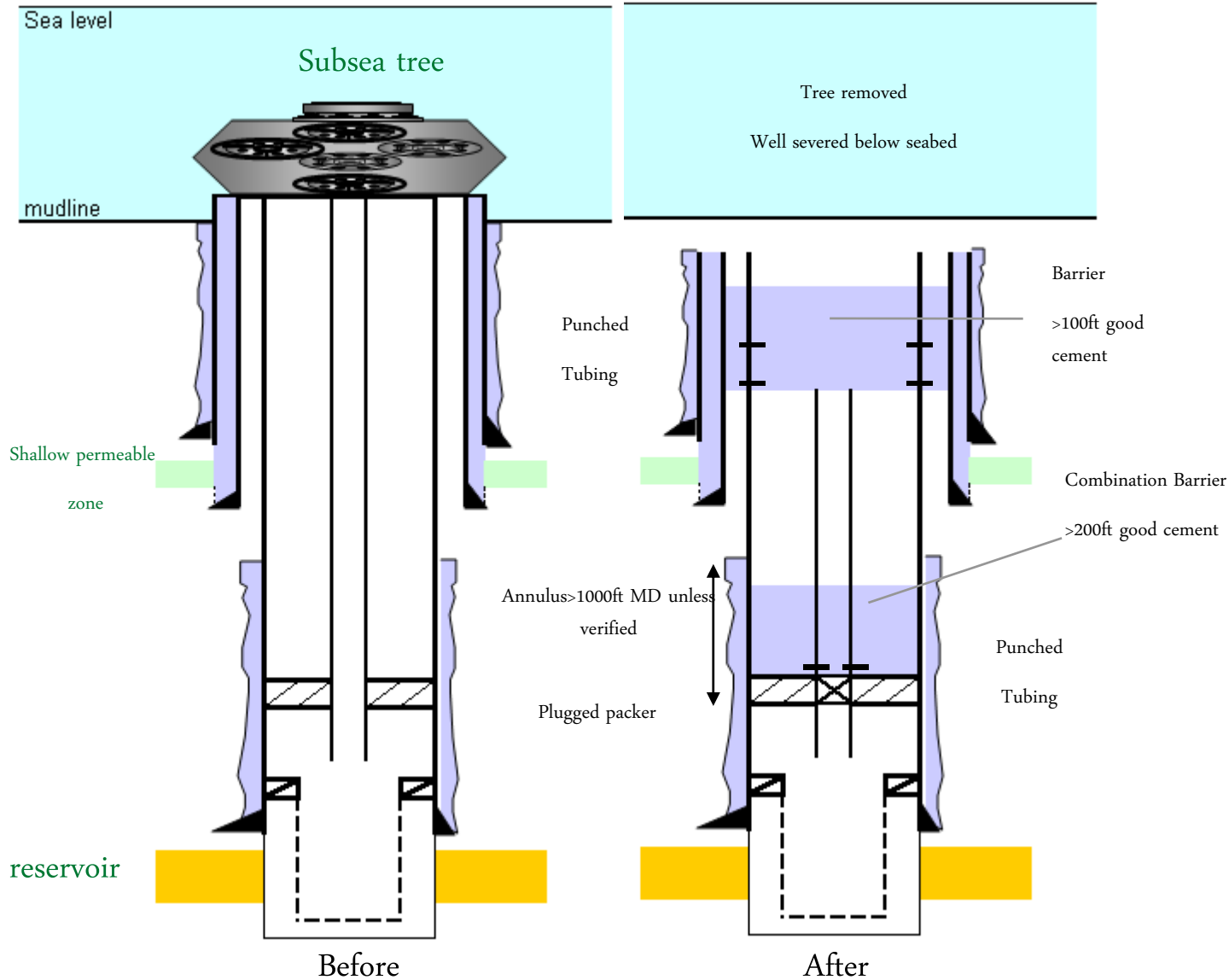


The use of LWIV does provide a number of operating limitations compared to a drilling rig:

- No marine riser hence no circulation path (i.e. no returns to surface other than via small diameter hose)
- Difficulty pulling the completion tubing or casing strings.
- Limited to wireline and potentially coiled tubing deployed tools (i.e. no jointed pipe / minimum rotation)



Through Tubing Abandonment



Challenges

- gauge cable on OD of Completion tubing
- Ability to place cement in the B & C
- Verification of the permanent barrier
- Removal of the wellhead
- Logging annuli through tubing

1) Gauge Cable Removal via LWIV

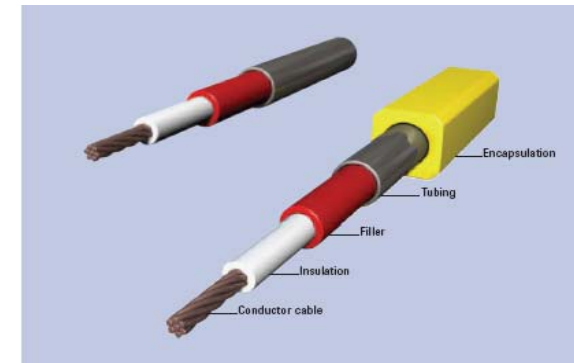


Challenge:

- Section 7.2 of the UKOOA *Guidelines for the Suspension and Abandonment of Wells*, Issue 3 2009 states:

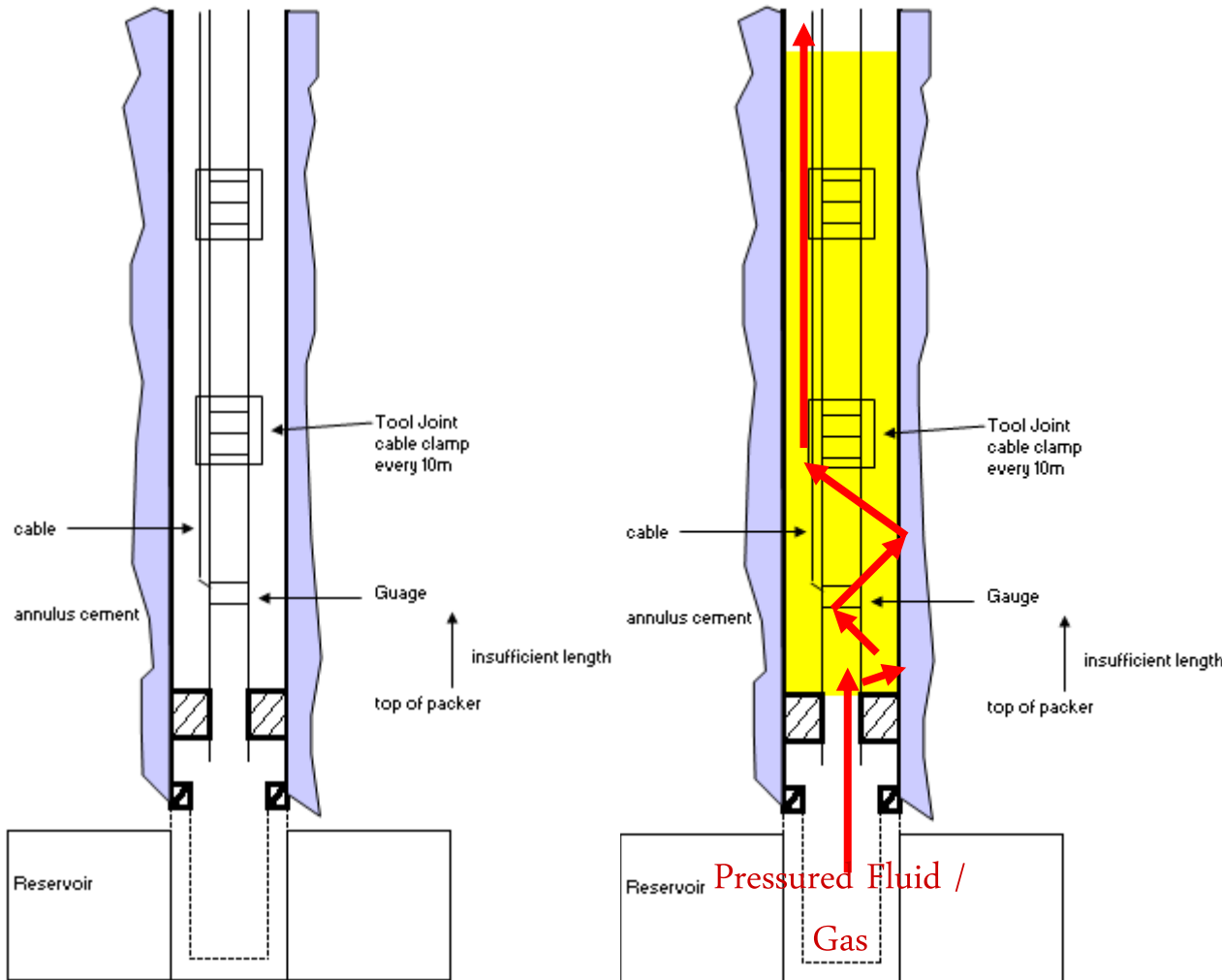
“Cables and control lines should not form part of Permanent Barriers, since they may be a potential leak path.”

- Using an LWIV for P&A means that the completion tubing cannot be recovered.
- A gauge cable is clamped to the OD of the completion tubing, across its length



Example Gauge Cable

Impact of cable on through tubing abandonment



- Close Cable proximity to packer gives insufficient length to allow cement to be qualified as an acceptable barrier. (<200ft)
- At present tubing has to be removed out the hole in order to place an acceptable length of barrier.

1) Gauge Cable Removal via LWIV

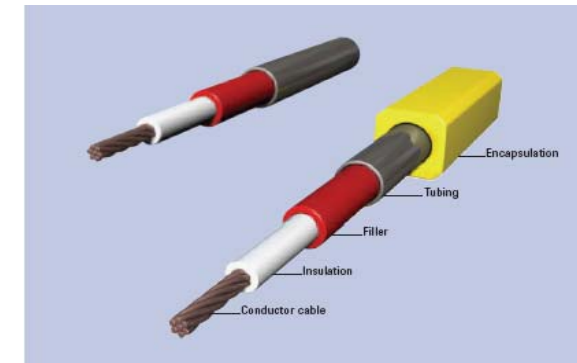


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Example Gauge Cable

Solution Sought:

- Means to removing at least 200ft of the gauge cable on the OD of the completion tubing across each of the plug setting depths in order to comply with the UKOOA Guidelines

2) B & C Annulus Cementation via LWIV



Challenge:

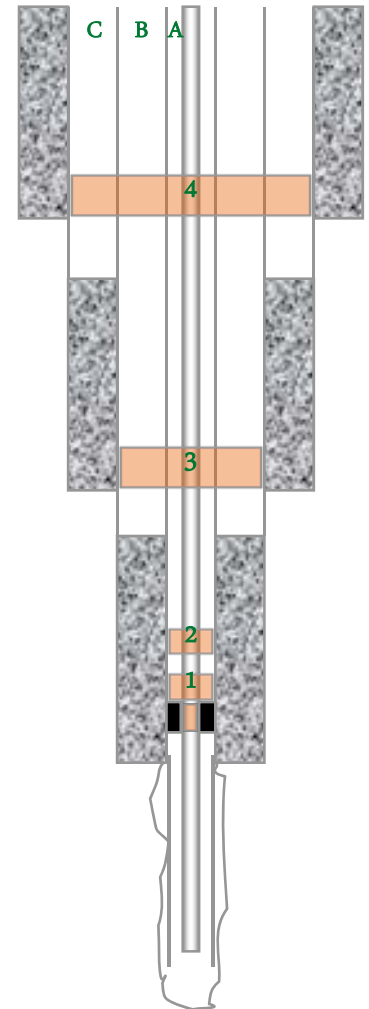
- The UKOOA guidelines define a permanent barrier as:

“A verified barrier that will maintain a permanent seal. A Permanent Barrier must extend across the full cross-section of the well and include all annuli.”

- Using an LWIV for P&A means that the completion tubing cannot be recovered.
- The 9 5/8” and 13 3/8” casing strings on the Don wells have not been cemented to surface and may not have been cemented appropriately to permit placement of laterally extensive cement plugs.

Solution Sought:

- Means to circulate / squeeze a minimum of 100ft MD of good cement into the B & C annuli in order to comply with the UKOOA Guidelines (Plugs 3 & 4)



3) Verification of Permanent Barrier

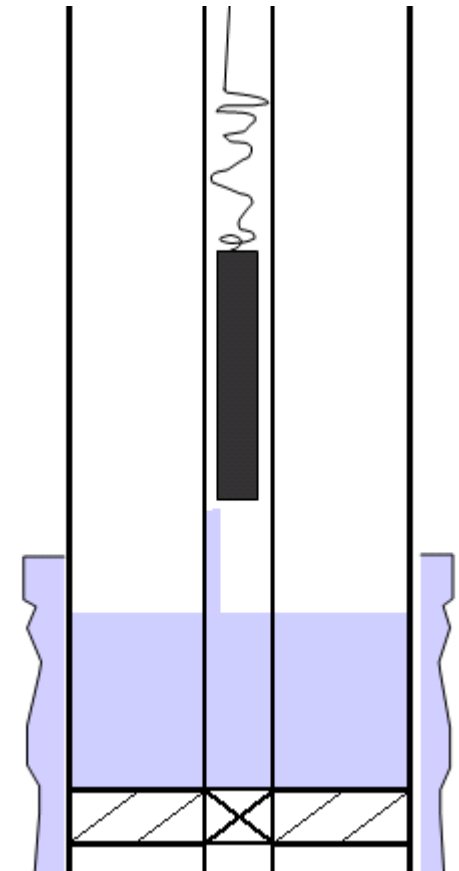


Challenge:

- The UKOOA guidelines stipulate that:
“Any Permanent Barrier should be verified to ensure the barrier is placed at the required depth and will have the required sealing capability”
- Verification would be by tagging and pressure / inflow testing the mechanical plug or cement plug.
- Using an LWIV for P&A means limited to wireline and potentially coiled tubing deployed tools (i.e. no jointed pipe / minimum rotation)

Solution Sought:

- Means to verify the permanent plug should coiled tubing not be available on the vessel
- Additional assurance required given limitations of wireline tagging



4) Wellhead Removal



Challenge:

- The UKOOA guidelines stipulate that:

“Redundant subsea equipment must not present a hazard to other users of the sea. It is an OSPAR requirement to retrieve all casing strings to a minimum of 10ft below seabed.”

- Using an LWIV for P&A means that the completion tubing cannot be recovered.

Solution Sought:

- Means to cut through the 4.5” completion tubing as well 9 5/8”, 13 3/8”, 20” & 30” casing at a minimum of 10ft below seabed in order to allow the wellhead to be retrieved
- Method of tubing hanger removal using LWIV



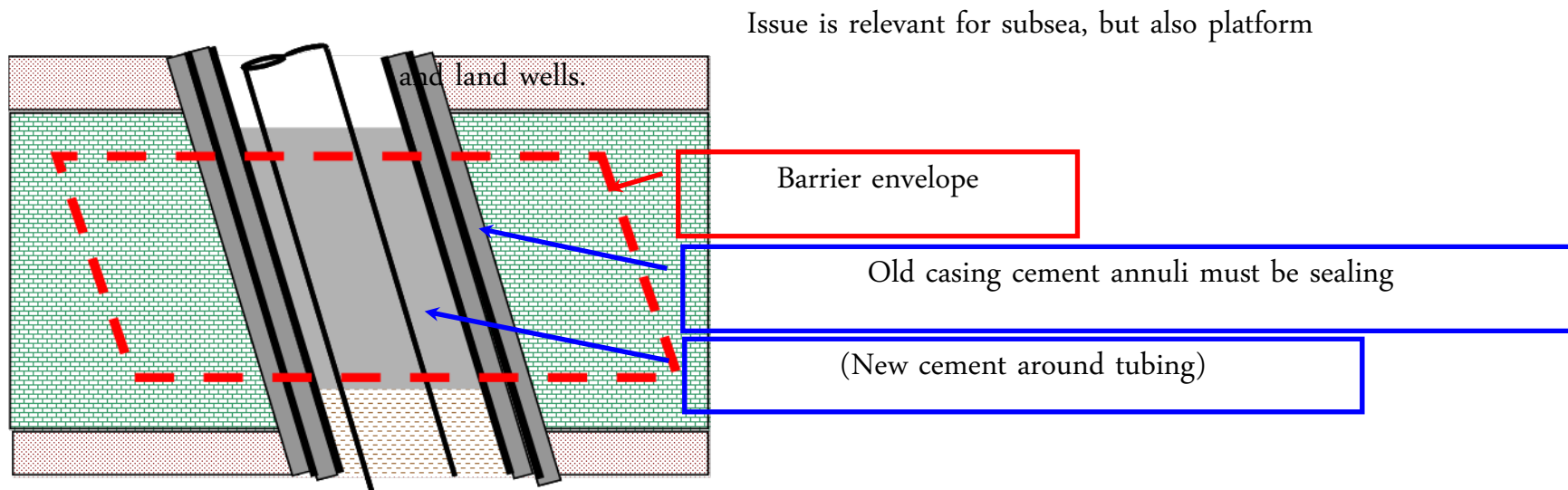
Key Challenges using LWIV



1. Removal of the gauge cable on OD of Completion tubing in order to qualify the abandonment plug
2. Ability to place cement in the B & C annuli with the completion tubing in place
3. Verification of the permanent barrier (tag / pressure test of mechanical or cement plug)
4. Removal of the wellhead (cut 4.5" tubing, 9 5/8", 13 3/8", 20" & 30" casing at a minimum of 10ft below seabed)
5. Logging through tubing - currently we are unable to log through tubing to establish quality of the cement bond or pack-off behind casing (i.e. sense through packer fluid). This may help decide upfront where annuli are a problem and need addressing, hence jeopardising a through-tubing approach.

Establish quality of cement bond outside casing with tubing in place

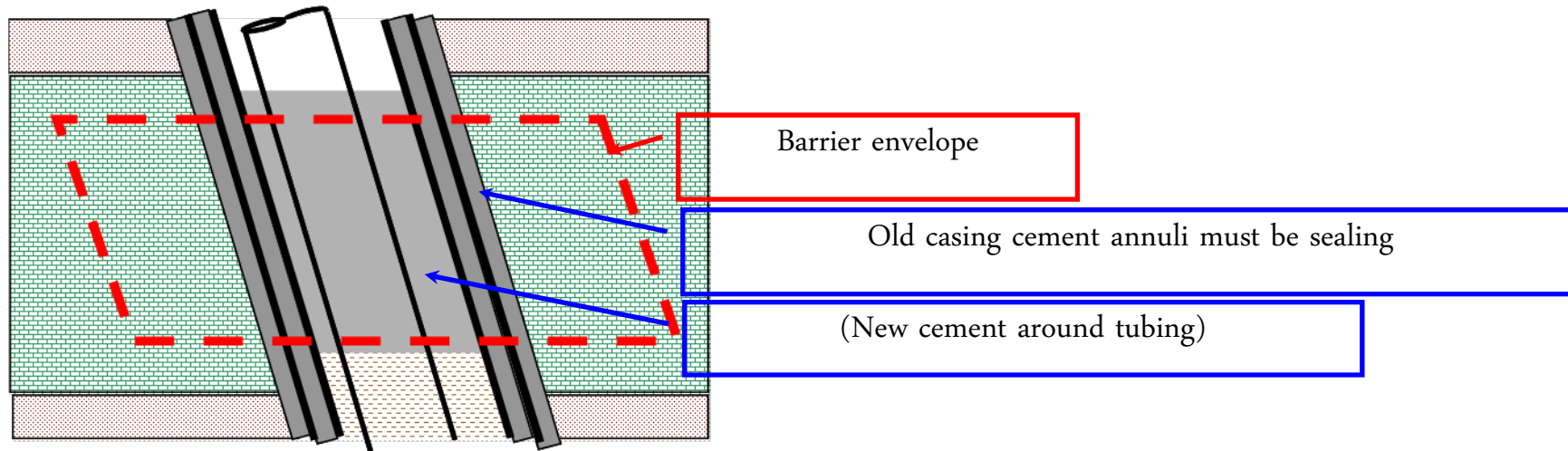
- Strategy is to abandon wells through tubing where possible. This is an enabler for Light Well Intervention Vessels. Better in time, cost, HSE (handling, waste).
- Abandonment barrier to be across the well, but casing annuli at times uncertain. See picture. For subsea wells cannot monitor annuli (old cement may be leaking).
- Method to resolve the annulus uncertainty is to run a logging tool for casing cement bond. However, no tools available through tubing (hence need to remove tubing).



What a logging tool would sense

A logging tool when run through the tubing would sense:

1. Fluid in tubing (gas, water, brine, oil)
2. Tubing (steel, may be stainless, more be corroded, connections)
3. A-annulus fluid (water, brine, oil, residue)
4. Casing (steel, may be corroded, connections)
5. B-annulus (cement, drilling mud and spacers, brine, gas, oil, channels, cracked cement, micro annulus on casings or formation)
6. Formation (e.g. shale, sand, limestone, salt), or further casing (repeat point 4,5,6).



Logging tool for cement bond outside casing with tubing in place; Specs

- Size to fit through tubing (subsurface safety valve restriction). Tubing size range with outside diameter of tubing 2.7/8", 3.1/2", 4.1.2", 5", 7".
- Casings outside diameter OD from 4.1/2" to 13.3/8".
Formation 6" to 18"+ possible washouts
- Pressure range (5ksi, 10 ksi,15 ksi), temperature range <120 degC (<150 degC)
- Compatibility with fluids (oil, brine, seawater, gas, possibly H₂S, N₂, CO₂)
- Conveyance (electric line or slick line), memory recording acceptable. Height of tool compatible with handling capability of vessels.
- Calibration and proof of concept against current cement bond logs in suitable wells where the tubing is recovered.
- No HSE hazards like radioactive sources, hazardous chemicals, explosives.
- Combine with other tools, e.g. CCL for depth correlation.

Innovative Abandonment materials

- Expanding cement
(several suppliers, e.g. Schlumberger, Halliburton, BJ)
- Resins (epoxy, phenolic, polyacrylate, polyester, silicon)
(several suppliers, e.g. CSI, Cemwell)
- Silicone rubbers (Dow Corning)
- Clay gels (betonite, synthetic)
- Beryllium: Tin alloy (Sealwell)
- Thermatek (Halliburton)
- Phosphate ceramics (Cemblend)
- Others ?