# Improving Late Life Well Integrity through Sustained Casing Pressure Remediation

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# Improving Late Life Well Integrity Through Sustained Casing Pressure Remediation

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## The Industry Challenge

Sustained Casing Pressure (SCP) is a typical Brownfield well integrity issue that requires close monitoring and management. Where SCP is formation-driven, typically the annular cement isolation behind production casing has failed and cannot be easily remediated by simply replacing tubing or installing an additional tieback string

However, it is not uncommon for ca. 15-20% of platform wells to exhibit this phenomenon, which represents a significant challenge to the industry.

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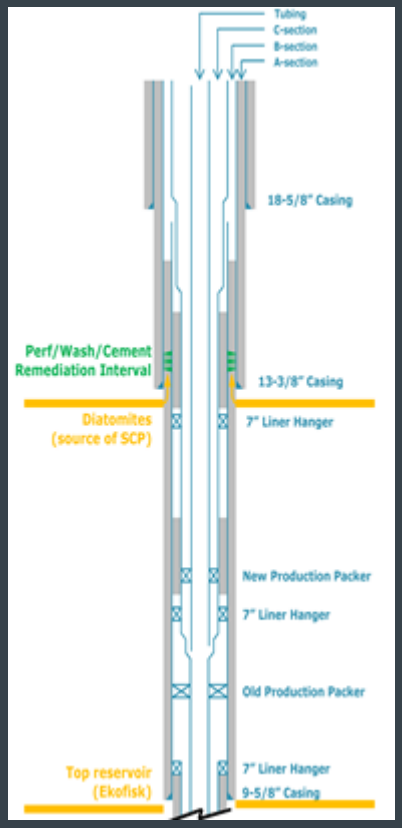
## The Industry Challenge

This presentation reports some recent Danish North Sea examples of successful remedial workovers. Technology and solutions used to met objective of remediating the SCP.

And finally how wells may be monitored before, during and after to verify the success of SCP remediation.




Source of SCP is the shallow Diatomites
Just below the 13 3/8 casing shoe

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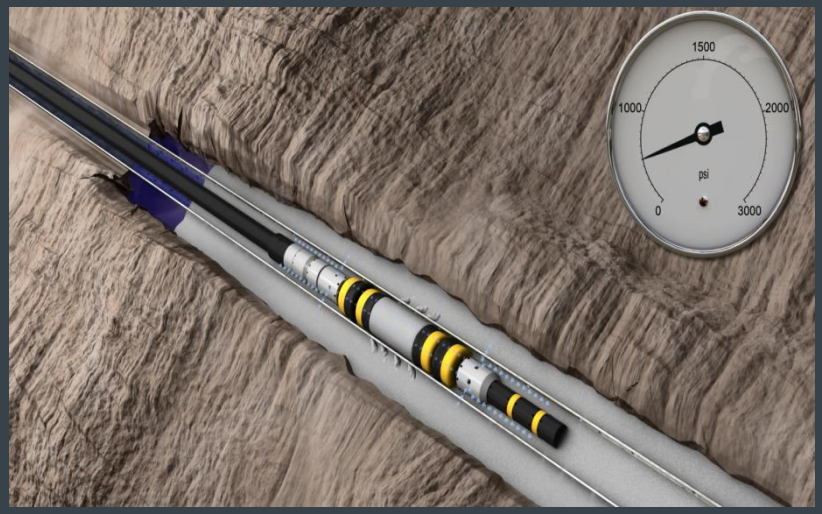
## The Solution

Perforate, Wash And Cement  is a method developed over the past few years to remediate cement behind casings, which has been widely applied to the plugging and abandoning (P&A) of wells.

This technique can also be applied to the remediation of cement behind production casing and the curing of Sustained Casing Pressure, so that wells can be recompleted and successfully returned to production, thereby addressing a key late asset life well integrity issue.



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## Solution – Equipment

**Retrievable Bridge plug (RBP) with Stinger and Washover Retrieval Tool**

- API 11 D1 qualified
- ISO 14310 V0 Qualified
- No weight needed below for setting
- Washover Retrieval Tool
- Retrievable and resettable
- Testing from above and below
- Millable
- 3” Straight-through bore

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## Solution – Equipment

## Single Casing Perforation Gun System

- Specially designed to perforate 9 5/8 40# without damaging 13 3/8 68#
- 5,5 Inch centralized TCP Gun System
- Produces 0,44 Inch average EHD Optimized for this specific Perforate, Wash and Cement System.
- Succesfully tested and validated
- Field Proven

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## Solution – Equipment

**Closed System Cup Type  Perforate, Wash and Cement Tool**

- Efficient Washing with continues hydraulic indication of performance with standpipe pressure as main performance indicator.
- Focus all the mudpump horsepower within a limit area at the time while moving. Provides excellent annular velocity
- Heavy Duty Cup System blocking the ability for the fluid to bypass up DP x Casing Annulus
- Field Proven in over 120 + runs globally

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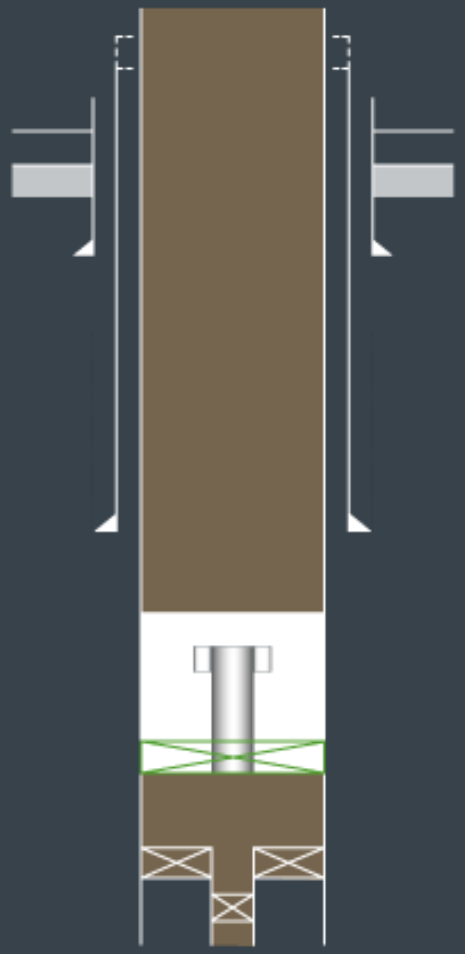
## Sequeence of Events

Ran in hole with the 9 5/8 Retrievable bridge plug and test from above and below.

Spot 300 ft of Formseal on top of plug, to make sure the plug does not get stuck in cement.

The lower completion and the plugged tubing was then isolated.



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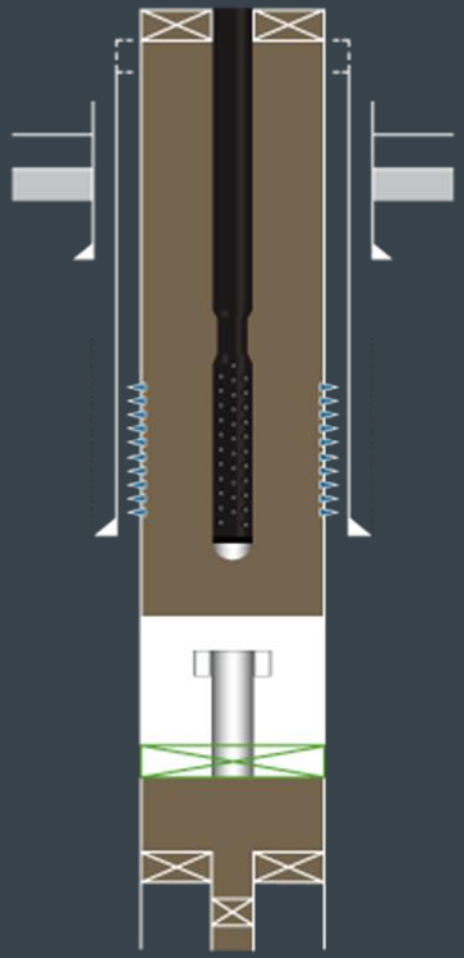
## Sequeence of Events

Ran in hole to target depth with the TCP Guns and perform the shot and pull operation.

The depth was choosen based on the Pre CBL Log, and operational window for the technology.

| Casing size | | Cement quality / ability to circulate by CBL mV level over majority of interval | | |
|---|---|---|---|---|
| | CBL 'Free pipe' level | Good cement/circulation not possible | Inconclusive/ Circulation difficult | Poor cement/circulation possible |
| **9-5/8"** | 57.415 mV | < 5mV | 6 - 14 mV | ≥15mV |

The CBL values was on this well 20 – 38 mV for the three quarters of the interval, dropped below 15 mV on the bottom 33 ft.



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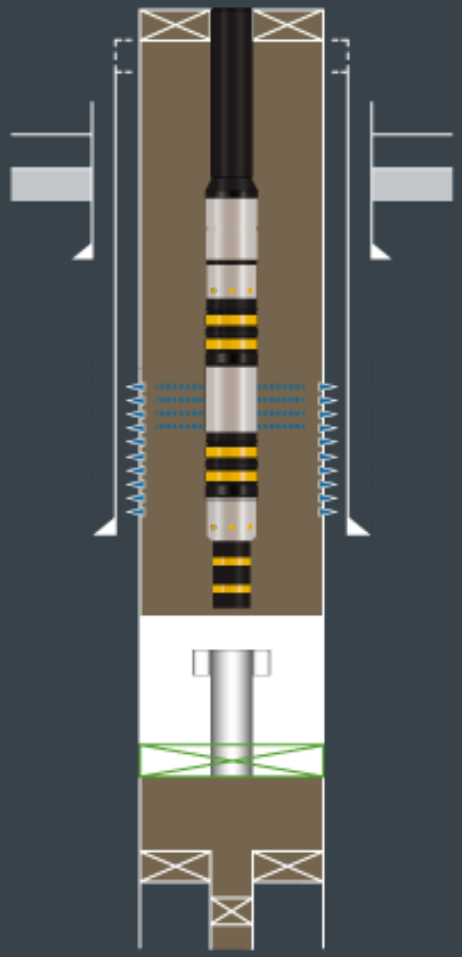
## Sequeence of Events

The perforations was cleaned from the top and down with the standpipe pressure as the main performance indicator, in addtion to debris comming over the shaker system.

The standpipe pressure was simulated, and can also be finger printed before the washing sequeence starts.

| Flow directed through tool in blank casing just above perforations | | Flow directed between swab cups and across perforations | |
|---|---|---|---|
| Pump rate (gpm) | Circulation Pressure (psi) | Pump rate (gpm) | Circulation pressure (psi) |
| 52 | 160 | 54 | 402 |
| 100 | 210 | 100 | 470 |
| 200 | 340 | 200 | 561 |
| 300 | 570 | 300 | 698 |
| 400 | 860 | 400 | 905 |
| 500 | 1170 | 500 | 1070 |



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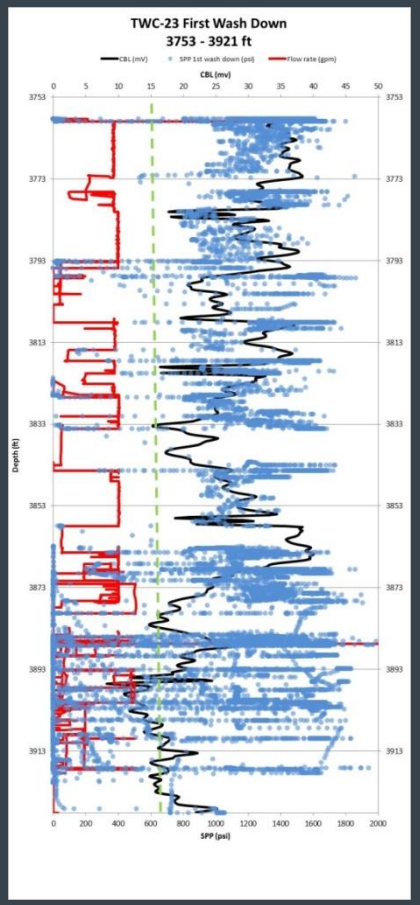
## Sequeence of Events

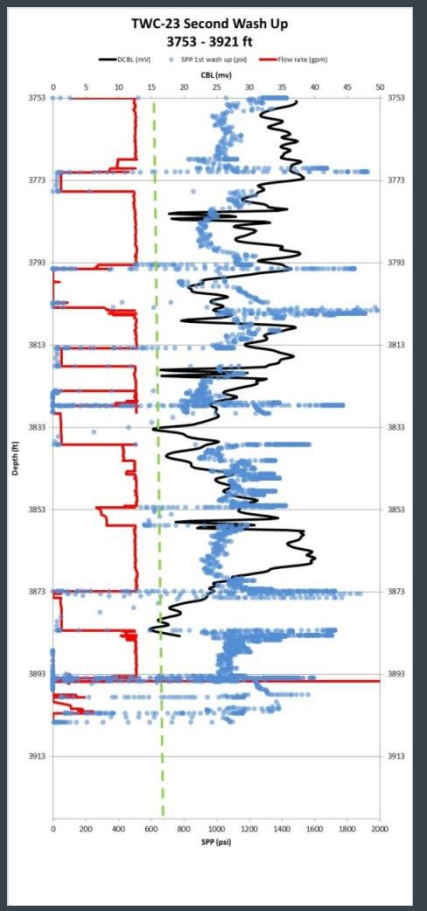
The perforations were intially planned to be washed up and down, but an addtional third pass with higher flowrates was performed.

Positive indications were acheived that a clear hydraulic flow path was established to enable cementation.

The indications was a clear decliend standpipe pressure across the perforations, in addtion to a lot of debris.

A total of 445 kg of debris, mostly consisting of cement was recovered at the shakers.



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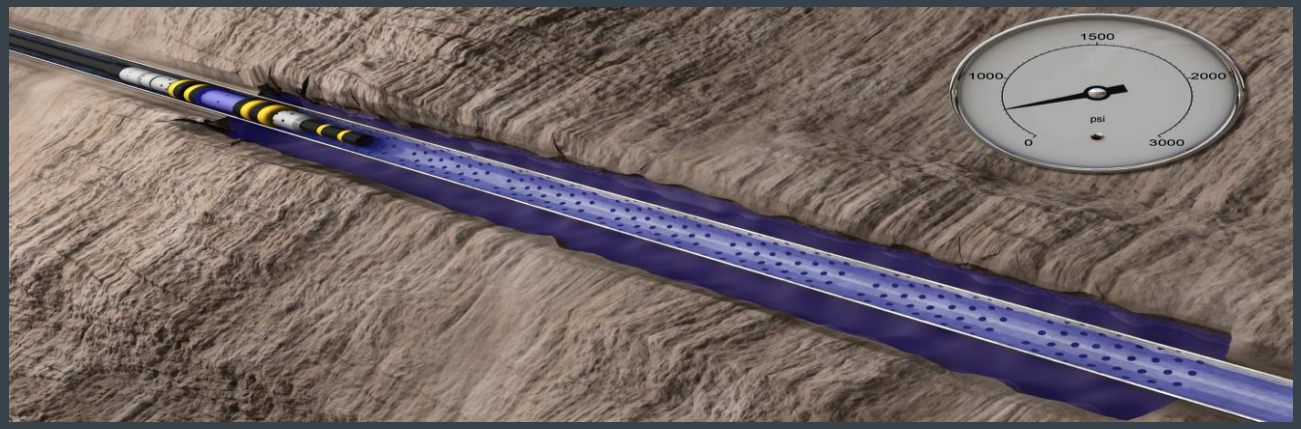
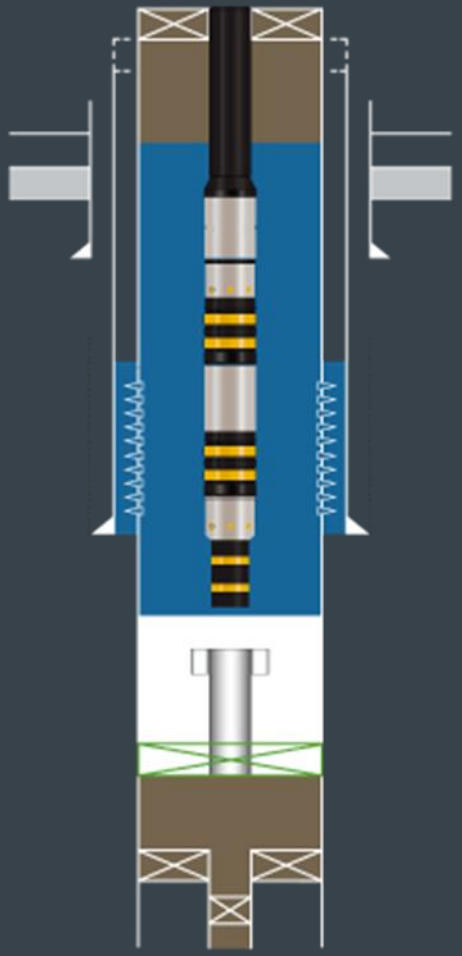
## Sequeence of Events

After the perforations were cleaned and the well was circulated free of solids, the spacer was then displaced across the perforations

The Spacer was displaced using a pump and pull technique effectivly injecting spacer into both the annular space and the inside of the casing.



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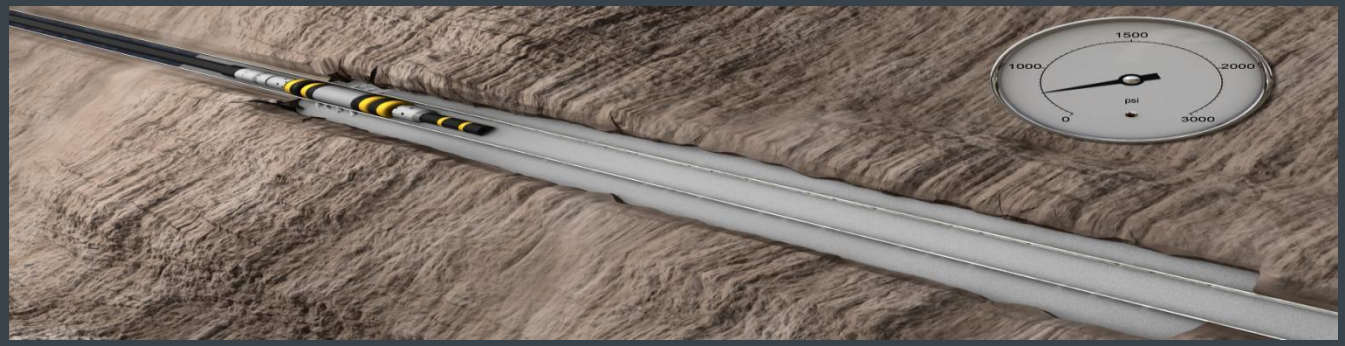
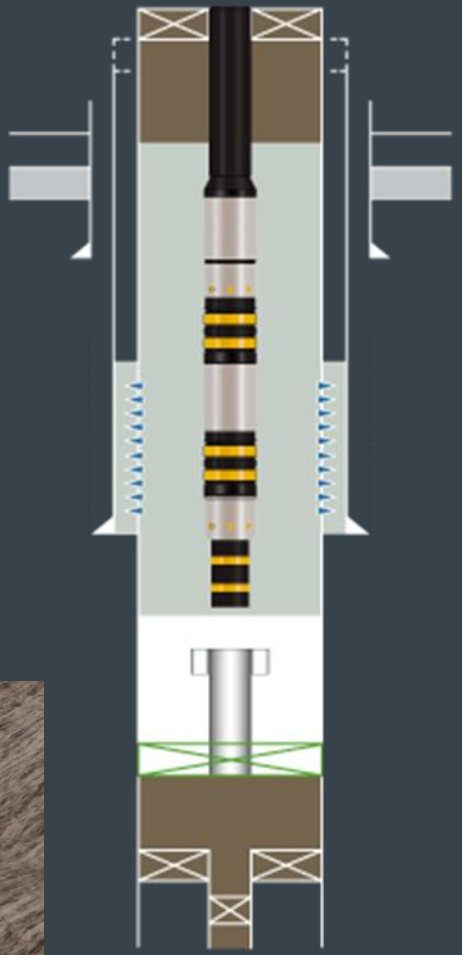
## Sequeence of Events

When the spacer were inplace the well was ready for the cement threatment.

The cement was pumped into the drillstring and the pump in assembly was racked back.

The cement was placed using the pump and pull technique to effectivly place the cement into both the annular space and the inside of the casing.



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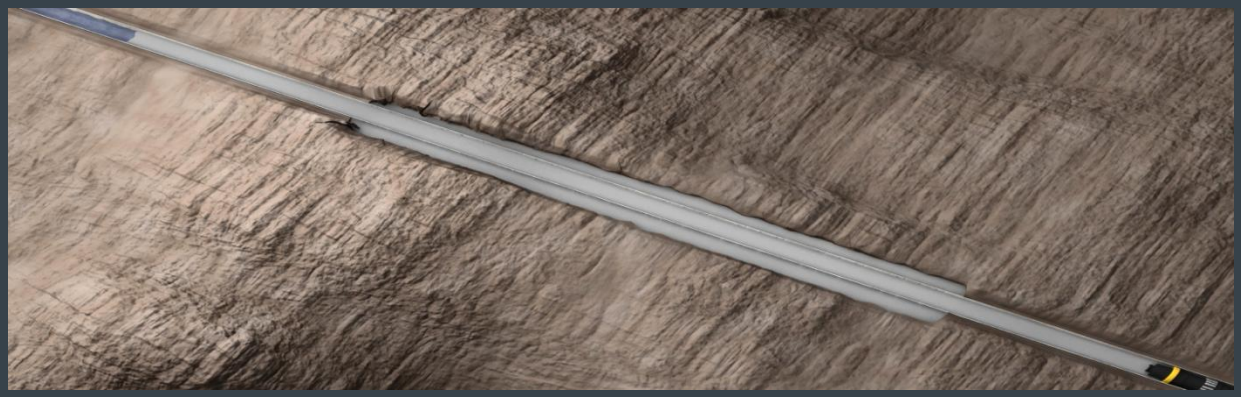
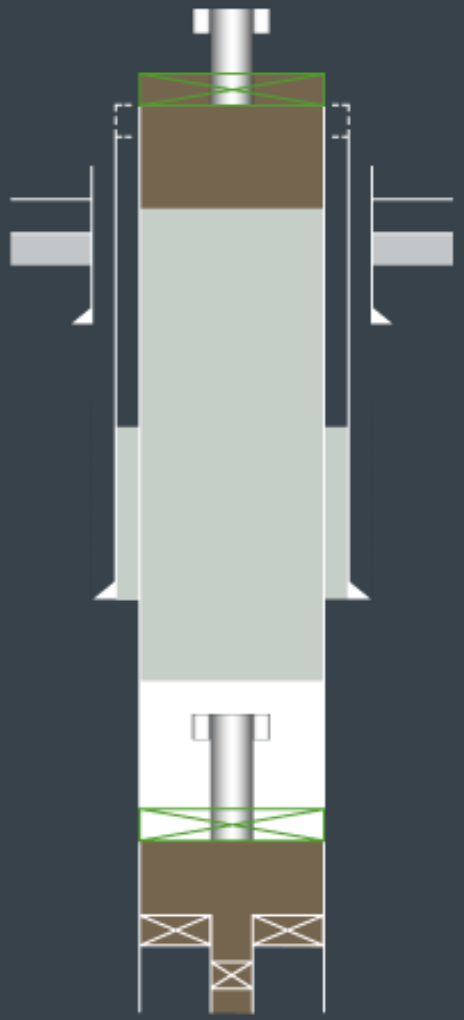
## Sequeence of Events

After the pump and pull cement job was finished the well was circulated clean above theoretical top of cement.

The cement plug was succesfully tagged with 10 klbs, but not pressure tested.

The reason for not pressure testing was to leave the cement plug undisturbed to build lateral strength.





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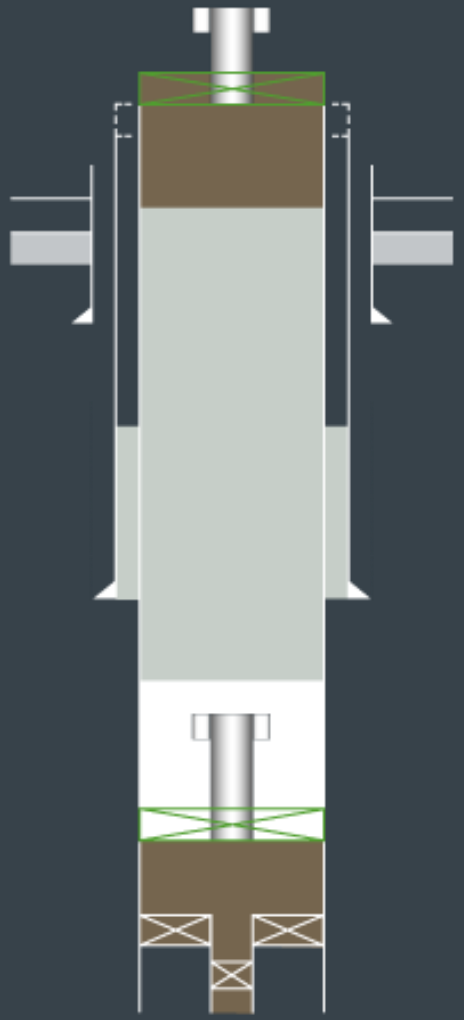
## Sequeence of Events

A RBP was ran into the well and the cement plug was tagged with 10 klbs using the bottom of the RBP.

The RBP was then set and tested.

The pre-planned b-annulus monitoring period could start to prove the integrity of the remedial cement job.



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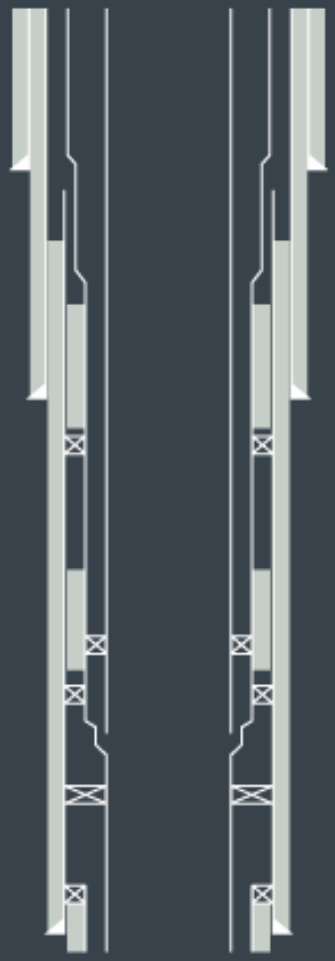
## Result

After the cement had set up the B-section pressure build had adequatly reduced to satisfy the accptance criteria.

After a montoring period of 22 days the rig skidded back over the well and the B-section pressure was stable at close to zero psi.

The cement was drilled out and logged showing improved quality across the majority of the remediated area.



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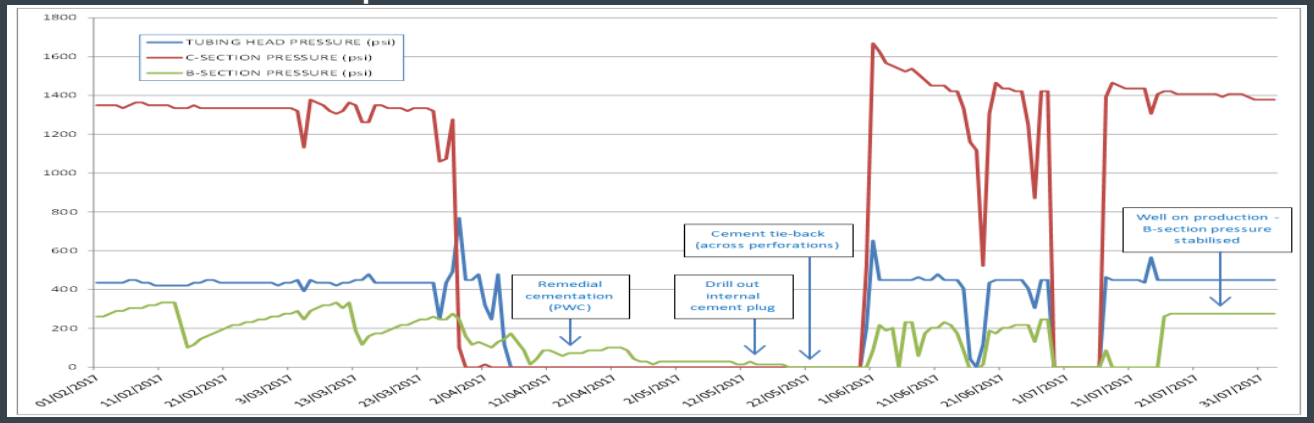
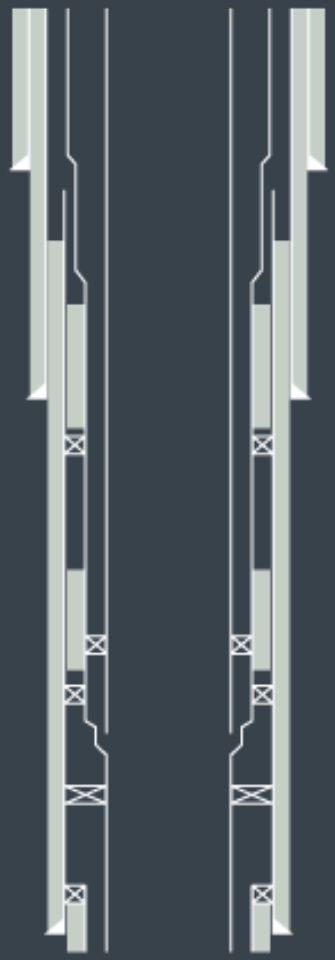
## Result

After 22 days the RBP was succesfully retrieved and cement drilled out. The formseal and the deepset RBP was also succesfully retrieved

The 7” x 7-5/8” x 9-5/8” casing tie-back was installed, the well was re-completed with a new upper completion and when the well was handed back to Production 40 days after remedial cementing was performed, the B-section pressure was stable at 0 psi



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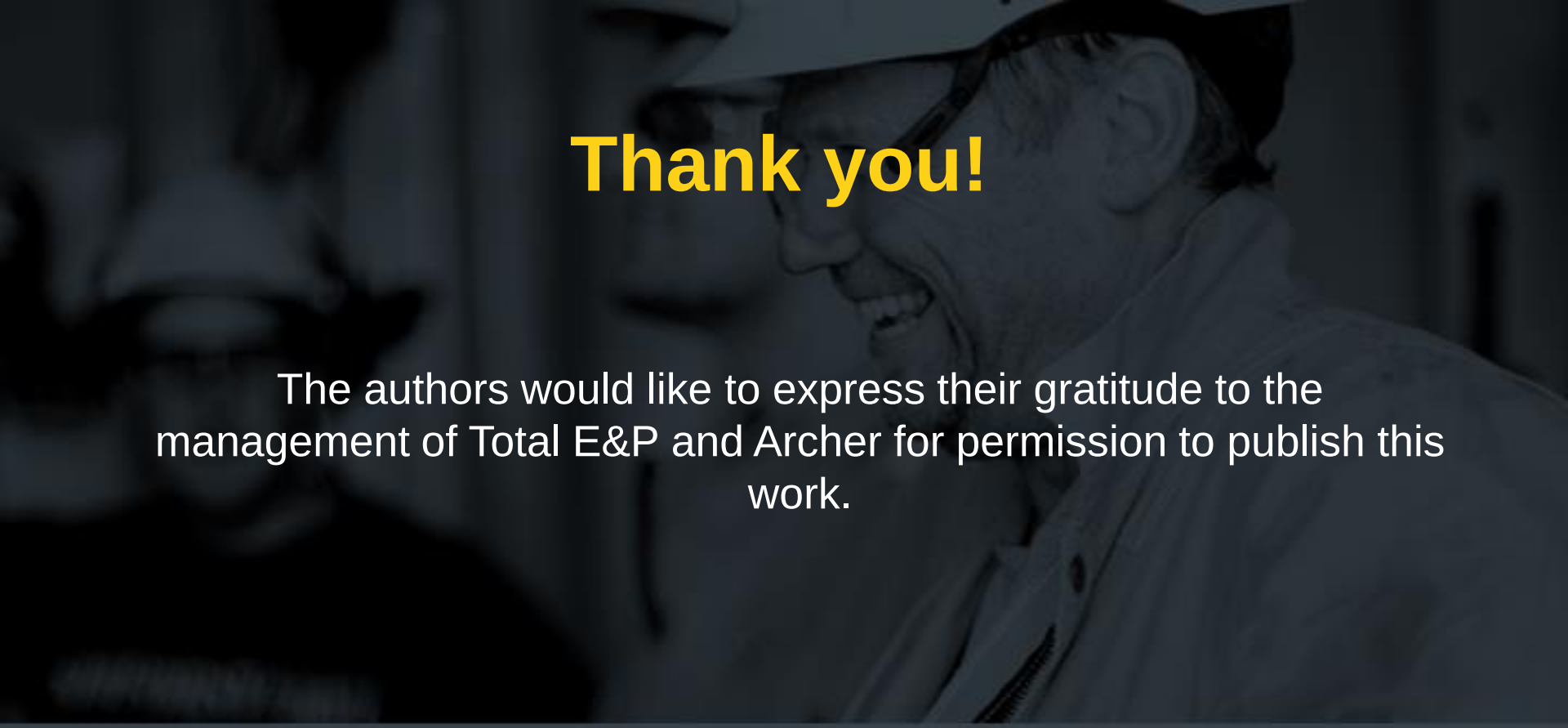
## Lessons Learned

- Remediation inside concentric casings has less geomechanical risk/hole collapse/plugged annuli
- Easier to know when the annulus is ‘clean’ with hydraulic simulations and standpipe pressure as main performance indicator.
- Improved remedial cementing and bonding to outer interface
- Less well control risk (losses to formation, borehole breathing, kicks)
- Perforate Wash and Cement operation carried out in a more controlled environment with fewer variables

## Conclusions

- The Perforate Wash & Cement Technology is very effective for Sustained casing pressure remediation if applied under the right circumstances
- CBL values >15 mV can be washed efficiently and with confidence for 9 5/8” Casing
- 5 wells has been successfully remediated using this technique on the Danish continental shelf with b-annulus monitoring as clear evidence of success.
- Monitoring period is key and validates the success of the remedial job
- Use CBL Values to choose the right technology first time, every time.



# Thank you!

The authors would like to express their gratitude to the management of Total E&P and Archer for permission to publish this work.

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