Surface casing corrosion
Grane platform wells

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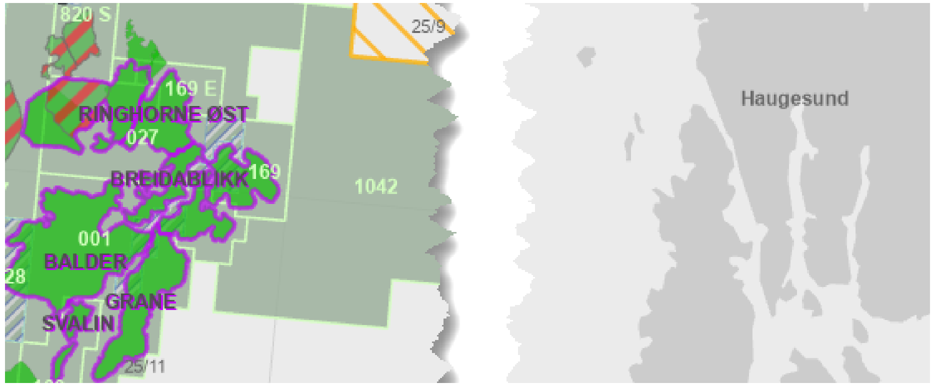
Agenda.

- Grane – Surface casing corrosion finding
- Immediate actions after finding
- Analyses
- Group task
- Key learning from Grane investigation
- Spinoffs

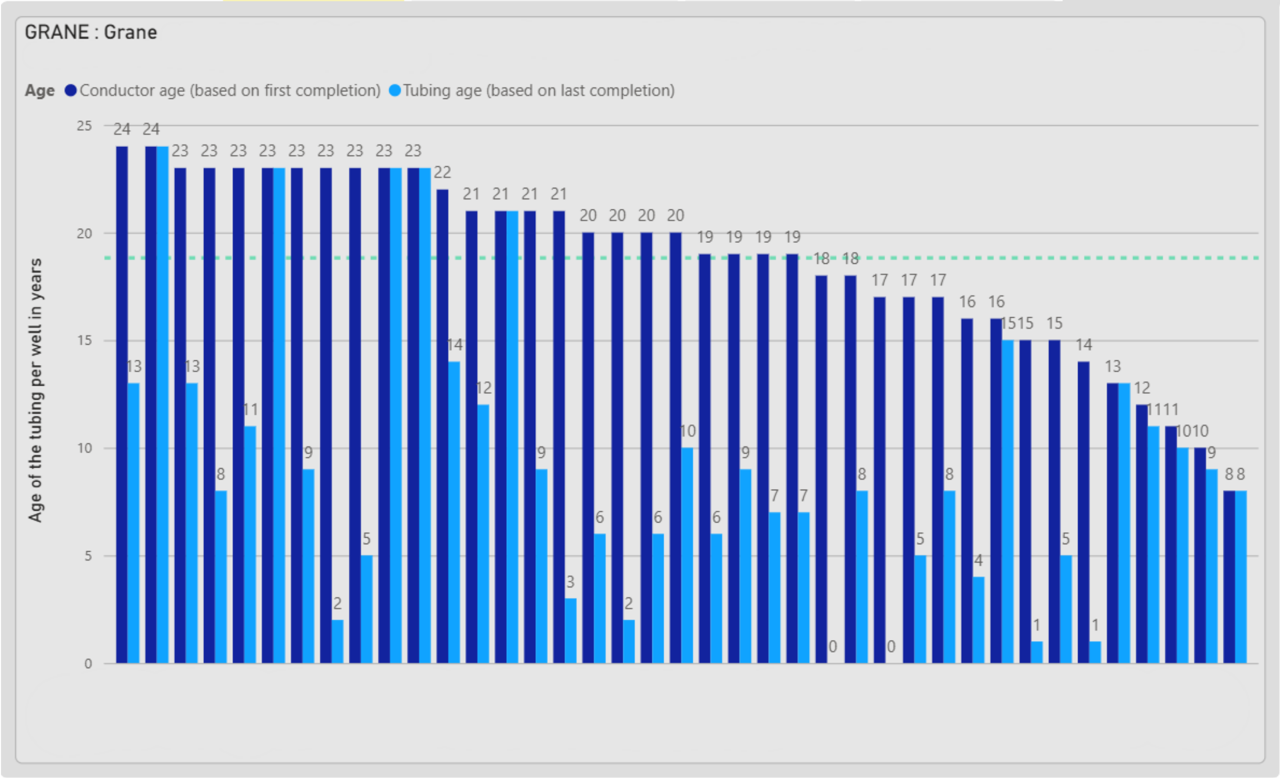
Grane Platform

- Well design life 30 years
- Oldest wells: 24 years
- Youngest wells: 8 years

- 28˝ conductor 19.05mm wall thickness
- 18 5/8˝ surface casing 11,05 mm wall thickness



Grane location: 185 km west of Haugesund



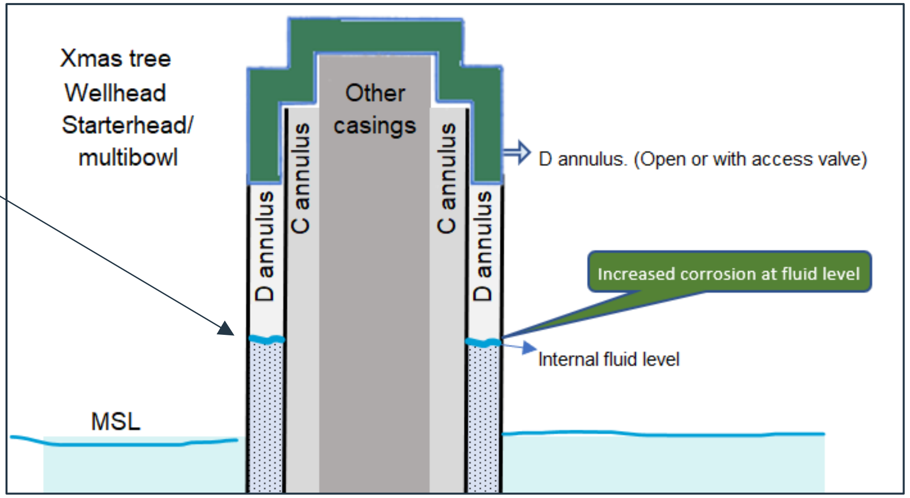
Grane platform wells age profile

Finding - Severe corrosion on surface casing on two wells

During slot recovery

- Logged surface casing and found severe corrosion 0,5m below casing hanger
- The surface casing was cut and pulled 1 m below hanger on both wells
  - 16" surface casing and new 18 5/8" wellhead was run

- The location corresponded with liquid level in D annulus
- Correspondence with corrosion inside conductor/outside surface casing.



- The wells were 16 and 12 years at the time
- Actual lifetime of surface casing < design life

Immediate actions performed on a representative number of wells (4 actions)

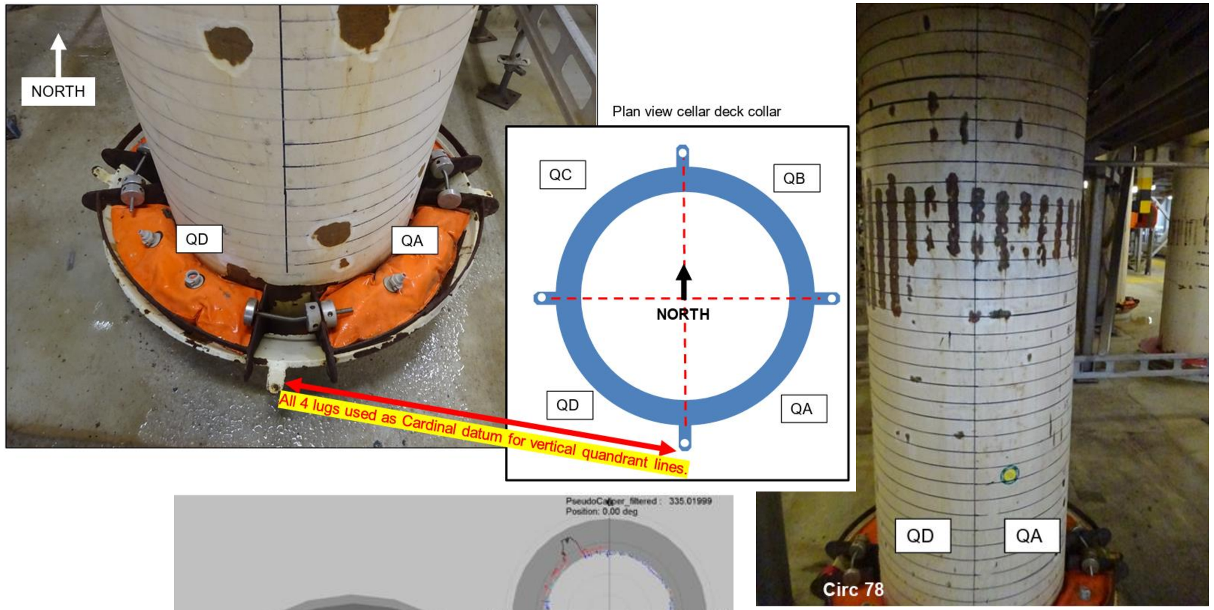
1. **Logged upper 5 m of conductor with phased array**

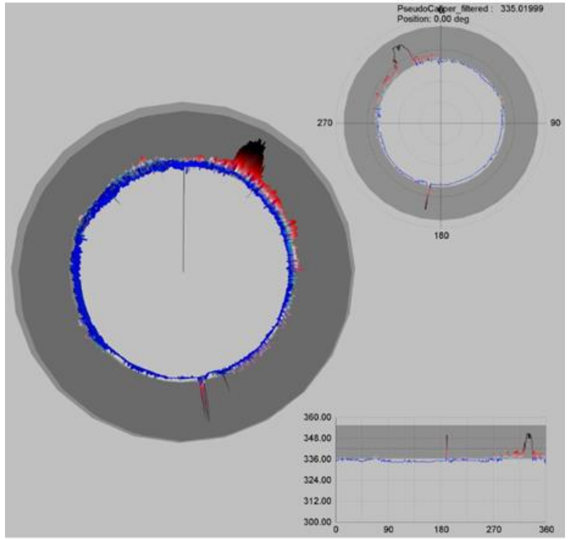
- **Result – worst case well**
  - Pitting: - WT reduced from 19mm to 4 mm.
  - Overall cross-sectional corrosion: - Minor.

Cause of corrosion

- Air vs liquid level
- Bacterial
- Inhibitive liquid vs non inhibitive liquid

Mapping of sectors/grid when logging with phased array





Pitting and cross sectional corrosion on worst case well

Immediate actions performed on a representative number of wells

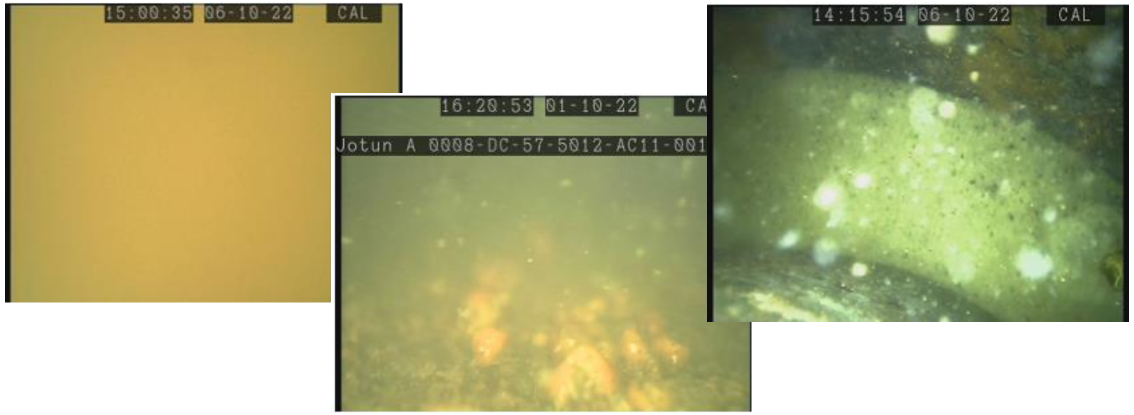
2. Tag TOC and determine liquid levels in D annuli

- Well A – TOC 73,5m liquid level 72,5m
- Well B – TOC 6,38m liquid level – At top
- Well C - TOC 23,5m liquid level 15m
- Well D - TOC 0,62m liquid level – At top.

3. Camera inspection of surface casing through D-annulus

- Limited access
- Algae growth
- Clouded liquid
- Hung up on cement patches

Camera inspections (pictures from 3 different wells)

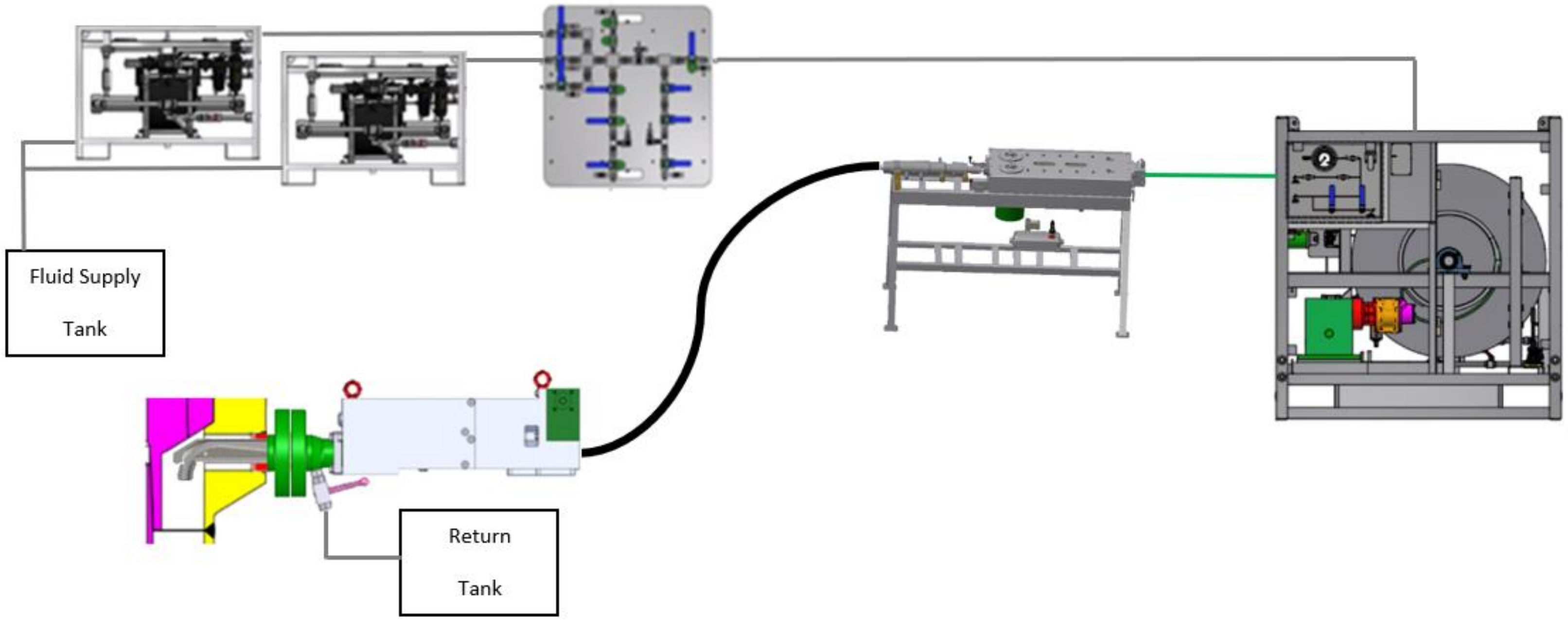


Immediate actions performed on a representative number of wells

4. **Replace annulus liquid with inhibitive liquids.**

    - Replaced liquid in wells with access
    - Top up in wells with limited or no access.

Set up for liquid replacement and top up



Analyses to map limits (performed on 2 worst case wells with regards to corrosion)

Total failure of both conductor and surface casing:

Analysing independency in barriers, structural vs well integrity barriers.

- Result – Total failure of conductor and surface casing does not have an immediate effect of well barriers…. BUT
- Result – Total failure of conductor and surface casing will lead to **wellhead drop of 1,4m on analysed well**

Strength and stability (conductor)

- Result – Minimum required average circumferential wall thickness 9mm

Buckling – Result very dependant on cement in annuli. (conductor).

- Result – Uncemented - Minimum required average circumferential wall thickness 15mm
- Result cemented - Minimum required average circumferential wall thickness 8,6mm

2 years BOP load (Fatigue on conductor)

- Result – The margins to failure with current minimum thickness is considered robust.

Group Task: Well 1 Oil producer with severely corroded surface casing WBS against reservoir

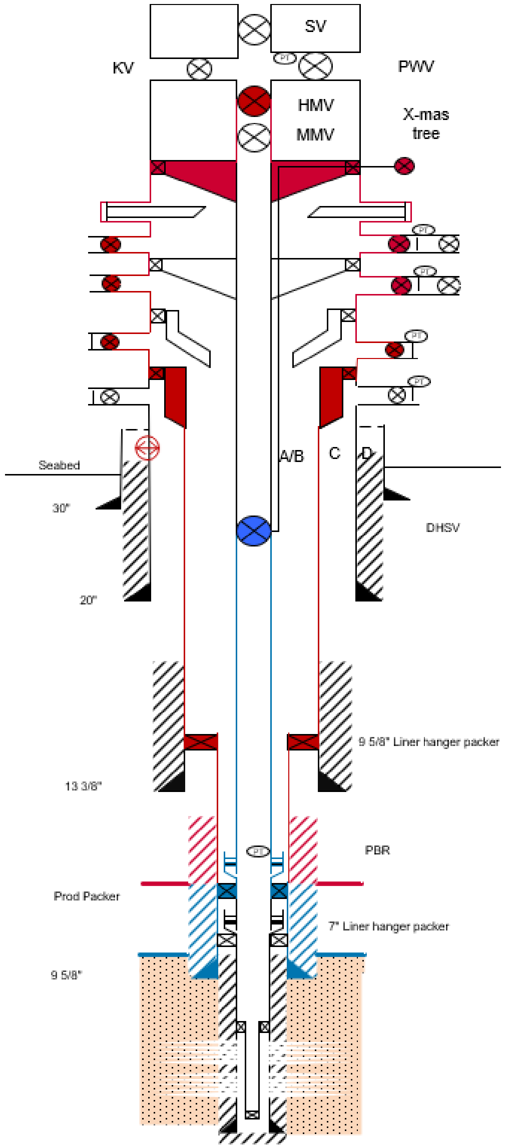
What do you consider to be the main risks for this well with a severely corroded surface casing?

Well 1 risks

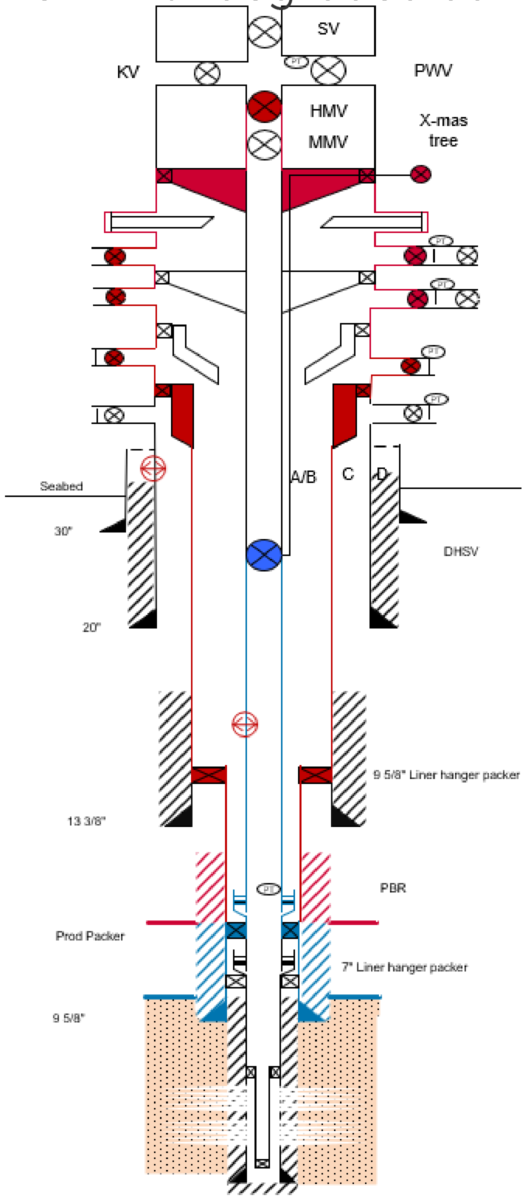
Well 1 risks with degraded barrier

Any showstoppers or operational constraints?

Well 1



Well 1 with degraded barrier



Group Task: Well 2 Oil producer with severely corroded surface casing WBS against reservoir

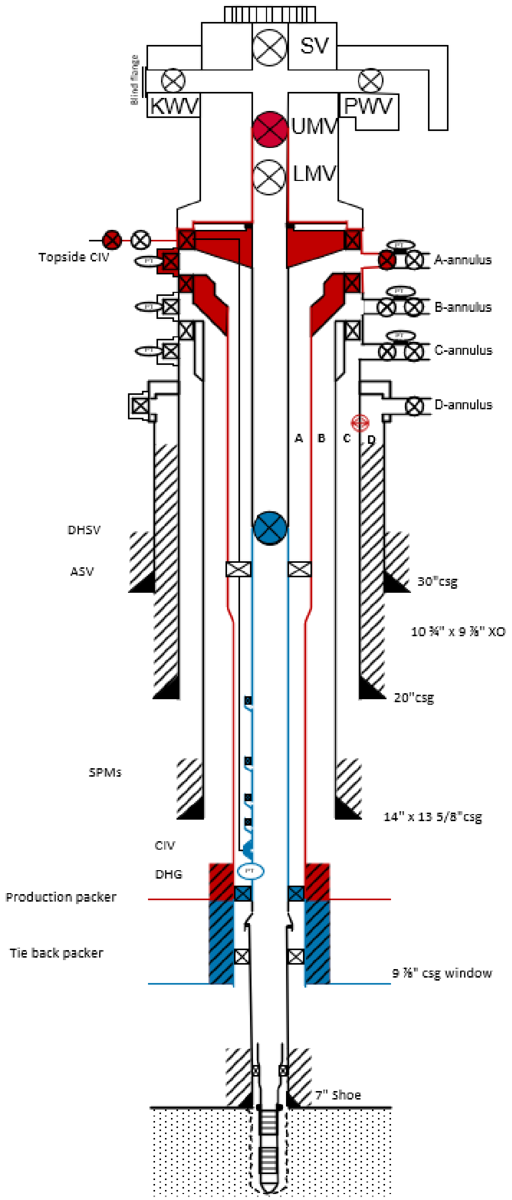
What do you consider to be the main risks for this well with a severely corroded surface casing?

Well 2 risks

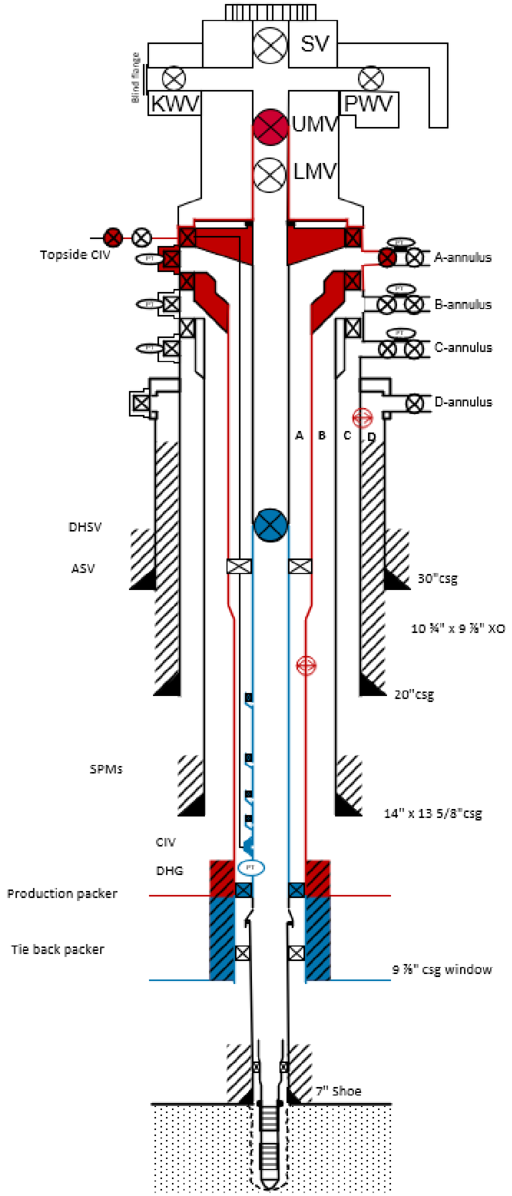
Well 2 risks with degraded barrier

Any showstoppers or operational constraints?

Well 2

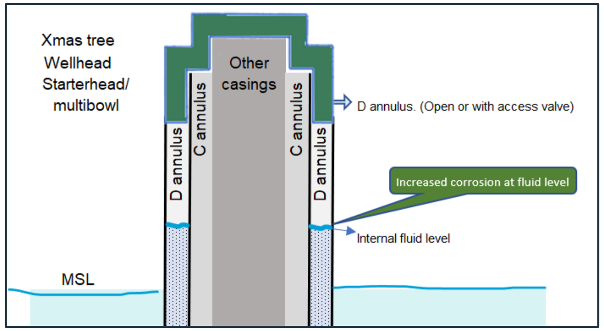


Well 2 with degraded barrier



Key learning from Grane investigation

- Access in D annuli can be difficult
- Visual internal inspections (camera) can be challenging.
- Top of liquid level in annulus is a very important data point as this is most likely the worst spot for corrosion
- Liquid filled annulus can reduce corrosion rate (inhibitive liquid)
- Structural integrity of the conductor and surface casing will remain even with severe corrosion (On this field)
- Consequence of failed structural integrity with regards to well integrity should be investigated for all fields
  - Evaluation of potential drop of wellhead
  - Evaluation of independency of well barrier vs structural barrier



Spinoffs

- **New department** to perform well lifetime assessments that ease learning and sharing across all Equinor licenses
- Updated **requirements** and **work process**
- Increased focus on **design documentation and updated analyses**
- Investigating **new technology** for better logging
  - Tool to screen out point of interest
  - Tool to have high accuracy and is less time consuming to use than phased array
- Closer cooperation with third party engineering companies to perform **analyses.**
- Tracking of **well components age** in iWIT (Equinor's well integrity management system)

Spinoffs

- Better detail level and expanded **periodic maintenance programmes**:
  - Conductor inspection to include logging of internal corrosion – At least at main point of interests
  - Change out or top up D-annuli with inhibitive fluids (top up only if no access to change out)
    - Keep track of liquid level – Key point of interest for wall thickness measurements
- Establish a conductor **corrosion limit** on all platform fields
- **Logging** of surface casing whenever there is access.