Defining a two-barrier philosophy

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WELLBARRIER®
A Schlumberger Technology

Speaker

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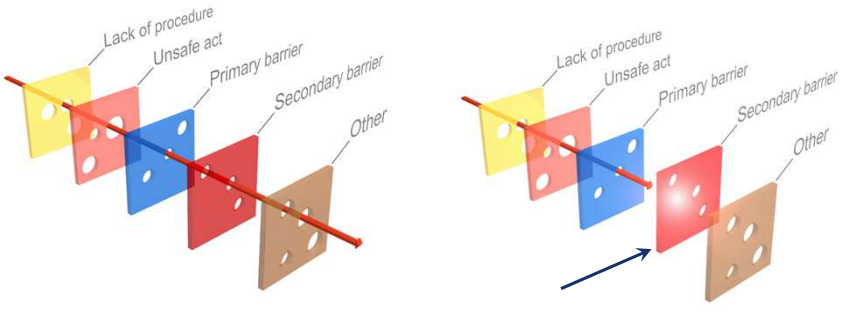
Could you be part of this?

In hindsight it is easy to see why things goes wrong

The purpose of having two independent barrier envelopes is that we can allow incidents to happen, without escalating into accidents

Make sure you have full understanding of your well barriers and how you can verify and monitor them all

Swiss cheese effect



A small shift in one parameter or event is sometimes all it takes to prevent an accident

The well barrier envelope(s) and elements are crucial in this context
One small effort from you can make a big difference!

Well integrity and well barriers

Well integrity:
"application of technical, operational and organizational solutions to reduce risk of uncontrolled release of formation fluids and well fluids throughout the life cycle of a well"

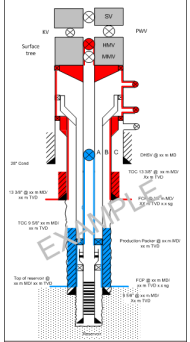
Well barrier (envelope):
"envelope of one or several well barrier elements pre-venting fluids from flowing unintentionally from the formation into the wellbore, into another formation or to the external environment"

Well barrier element:
"a physical element which in itself does not prevent flow but in combination with other WBE's forms a well barrier"

Defining well barriers (NORSOK 4.2.1/4.2.2)

- Well barriers shall be defined prior to commencement of an activity or operation by identifying the required well barrier elements (WBE) to be in place, their acceptance criteria and monitoring method.
- Well barrier schematics (WBS) shall be prepared for each well activity and operation (see figure)

Well information (as built)	
Field/Installation:	
Well name:	
Well type:	Producer
Well status:	Shut-in
Well design pressure:	xx bar
Revision number:	Version 1.0
Date prepared/revised:	
Prepared by:	
Verified/Approved by:	



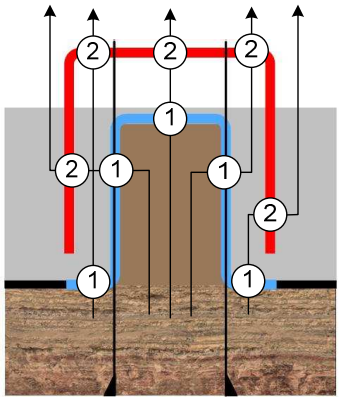
Note 1: Well shut-in due to tubing leak above DHSV.

Nomenclature:
PT: Pressure test
IT: Inflow test
FCP: fracture closure pressure
XLOT: extended leak off test
AC: acceptance criteria

Well barrier elements	EAC table	Verification / Monitoring
Primary well barrier		
In-situ formation (caprock)	51	FCP: x.x s.g. Based on field model n/a after initial verification
Casing cement (9 5/8")	22	Length: xx mMD Cement bond logs Daily pressure monitoring of B-annulus
Casing (9 5/8")	2	PT: xx bar with x.x s.g. EMW n/a after initial verification
Production packer	7	PT: xx bar with x.x s.g. EMW Continuous pressure monitoring of A-annulus
Completion string	26	PT: xx bar with x.x s.g. EMW Continuous pressure monitoring of A-annulus See Note 1.
Completion string component (Chemical injection valve)	29	PT: xx bar with x.x s.g. EMW Periodic leak testing AC DHSV: xx bar/xx min
Downhole safety valve (incl. control line)	8	IT: xx bar (DHSV) PT: xx bar (control line) Periodic leak testing AC DHSV: xx bar/xx min
Secondary well barrier		
In-situ formation (13 3/8" shoe)	51	FCP: x.x s.g. Based on XLOT n/a after initial verification
Casing cement (13 3/8")	22	Length: xx mMD Method: Volume control Daily pressure monitoring of C-annulus
Casing (13 3/8")	2	PT: xx bar with x.x s.g. EMW Daily pressure monitoring of C-annulus
Wellhead (Casing hanger with seal assembly)	6	PT: xx bar Daily pressure monitoring of C-annulus/ Periodic leak testing
Wellhead / annulus access valves	12	PT: xx bar Periodic leak testing of valve AC: xx bar/xx min
Tubing hanger (body seals and neck seal)	10	PT: xx bar Periodic leak testing
Wellhead (WH/XT Connector)	5	PT: xx bar Periodic leak testing
Surface tree	33	PT: xx bar Periodic leak testing of valves AC: xx bar/xx min

Two barrier principle

Hat-over-hat arrangement



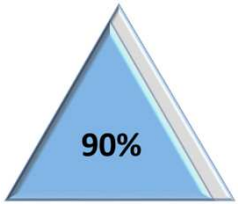
A two barrier philosophy will allow incidents to happen without escalating into accidents

If two independent barriers are not in place
it is equally important to define available barriers

Well Integrity and well barriers

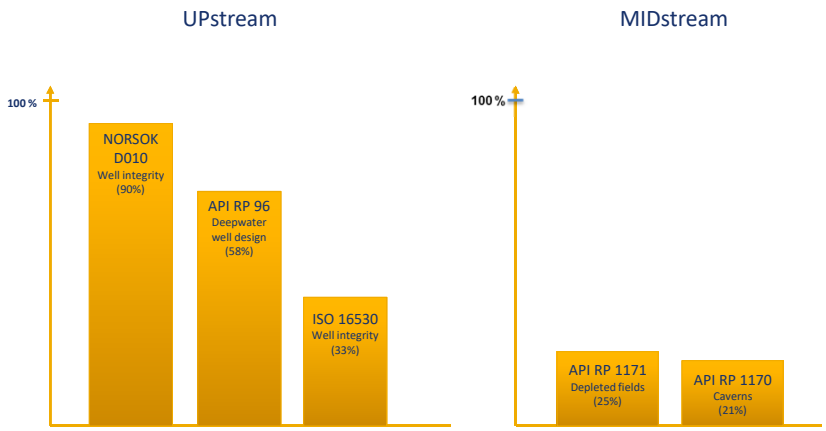
90%

… of well integrity is about technical well barriers



Figuratively:
90% Technical, specific – **Strong**
… this is what will contain pressure and hydrocarbons
10% Organizational, Operational, functional – Weak
… yet the «lubricant» that helps it run smooth

Upstream – Midstream technical barrier focus



Definition of primary and secondary barrier

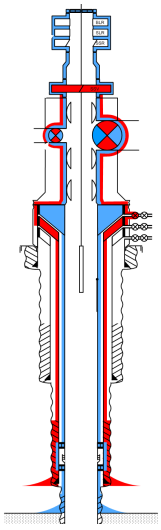
Primary Well Barrier (NORSOK 3.1.38) :
First well barrier that prevents flow from a potential source of inflow.
Example - blue items: WL Stuffing box + WL Riser + WL BOP+ production tree,+++

On an illustration the primary well barrier is shown in its normal working stage, where the WBE is exposed to the wellbore pressure

Secondary Well Barrier (NORSOK 3.1.47) :
Second well barrier that prevents flow from a potential source of inflow.
Example - red items: Safetyhead+ X-mas tree + wellhead,+++

On an illustration the secondary well barrier is shown in its ultimate stage, where a WBE (e.g. shear/seal ram/valve) is activated to close the well barrier envelope

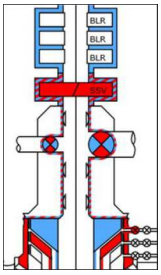
Common Well Barrier Element (NORSOK 3.1.7):
This is a barrier element that is shared between primary and secondary barrier.
Examples: X-mas tree production wing valve



Common barriers (NORSOK 4.2.3.3/4)

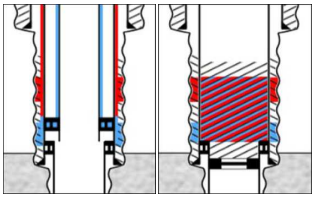
Webinars

X-Mas tree area



During intervention there will almost always be a common well barrier element in the x-mas tree area

Casing cement and plugs



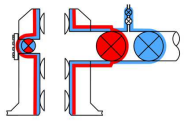
The casing cement may be both primary and secondary barrier is distinct intervals are identified.

A cement plug may be set as a common barrier if set on top of a verified foundation and dressed to hard cement

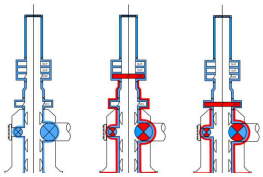
Different barrier terms

Webinars

1 Double block and bleed

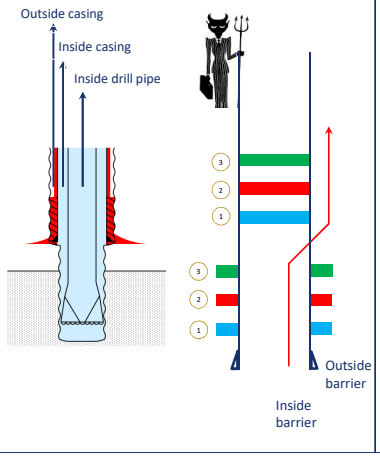


2 Well control

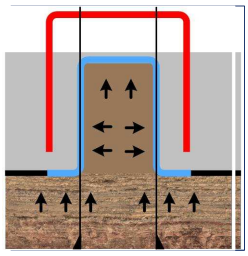


Primary - Secondary - Tertiary

3 Flow-path philosophy

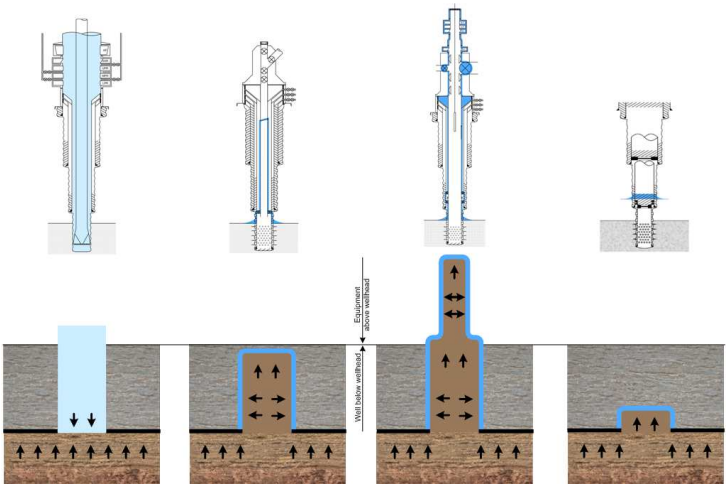


4 Hat-over-hat philosophy



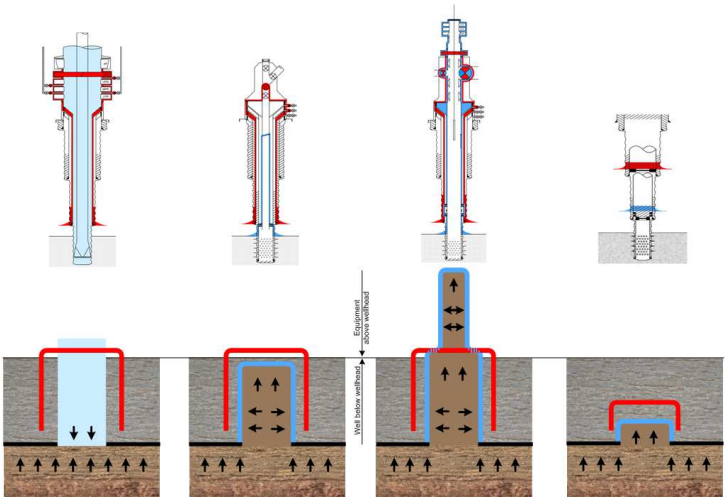
Primary well barrier

The barrier that sees pressure during normal operation



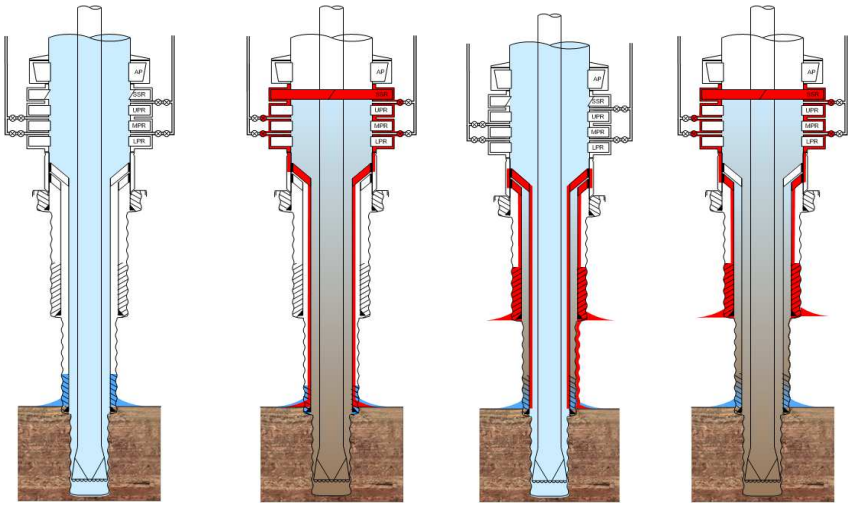
Secondary barrier

Redundant barrier, not necessarily number two in a sequence, but the last resort, closing in the well as close to source as possible, but outside primary barrier



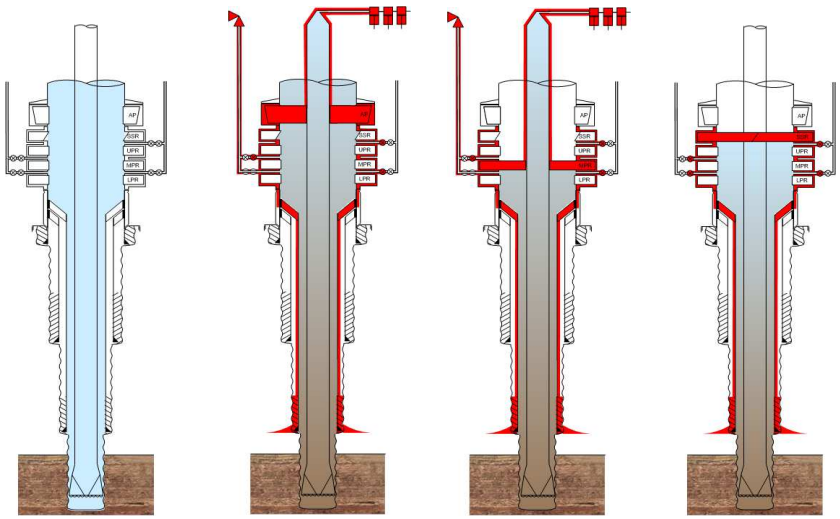
How to define the well barriers

The secondary barrier is the challenge – convey one clear definition



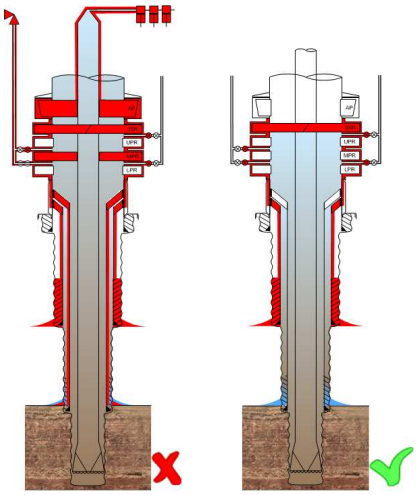
Well control alternatives – circulating kick

Ultimate solution is to close BOP – This is what we define as the secondary barrier



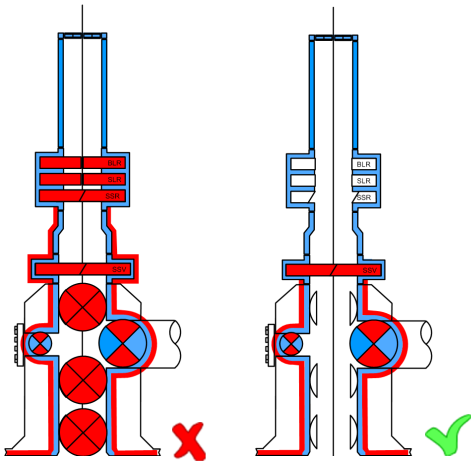
Presentation of secondary well barrier - drilling

Make one clearly defined secondary barrier envelope



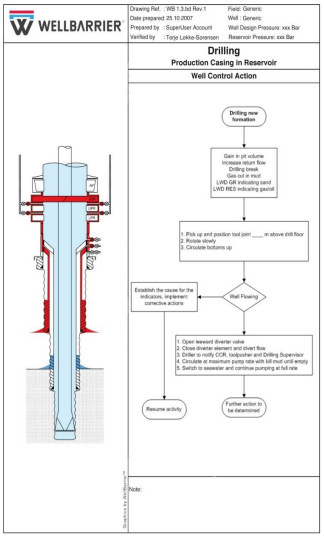
Presentation of secondary well barrier - wireline

Make one clearly defined secondary barrier envelope



Well control action (NORSOK 4.2.6)

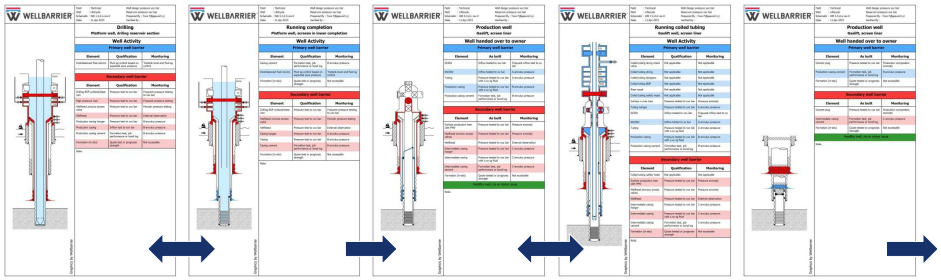
- There shall be a plan for activating well barrier(s)
- Bridging document between operator and contractor shall be prepared
  - Roles and responsibilities
  - Shut-in procedures
  - Re-establishing well barriers
- What do you do if the primary barrier fails?
- Prevent escalation by activating secondary barrier!
- Normalize by restoring primary barrier or alternative barrier!
- Then go back to your normal business
- Drills (NORSOK 4.2.7)



Visualization, communication and documentation tool throughout the life cycle of the well

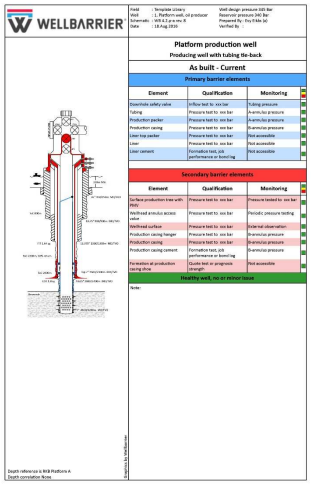
Planning → Execution → Operation → Intervention → Plug & abandonment

The well barrier definitions changes through the life cycle of the well but is always part of the ongoing work



Well barrier illustrations

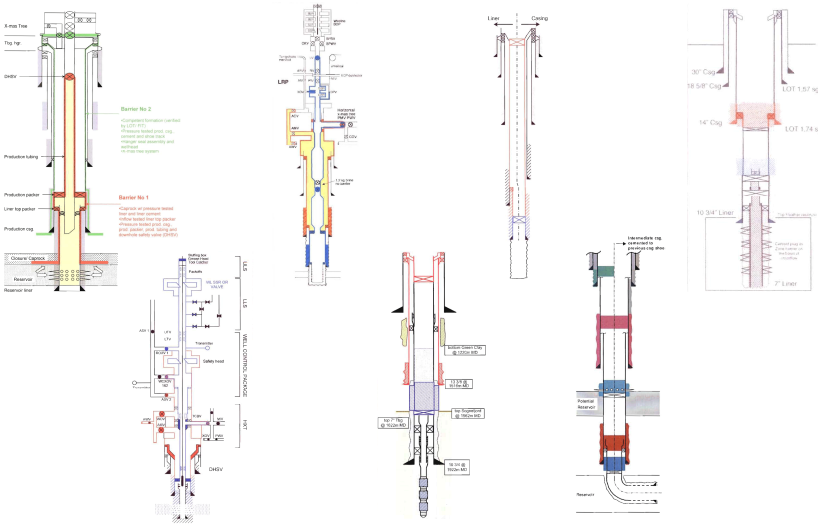
Use as basis and documentation of the well design



- Clear graphics will help discussions and see challenges
- Clearly identify the barrier elements involved
- Qualification method
- Monitoring method
- Identify particularities

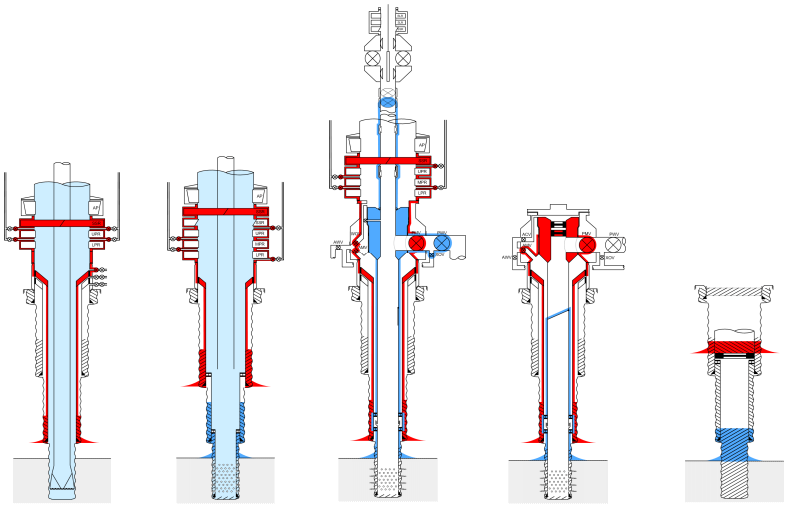
Industry examples

All sort of graphics

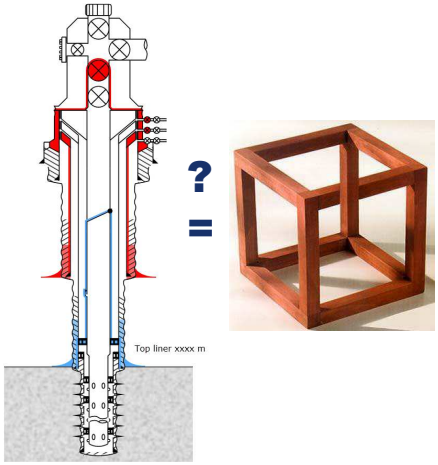


Well barrier examples

Consistent graphics



When is an illustration true?



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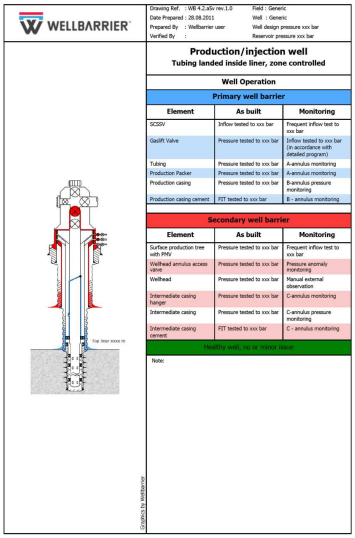
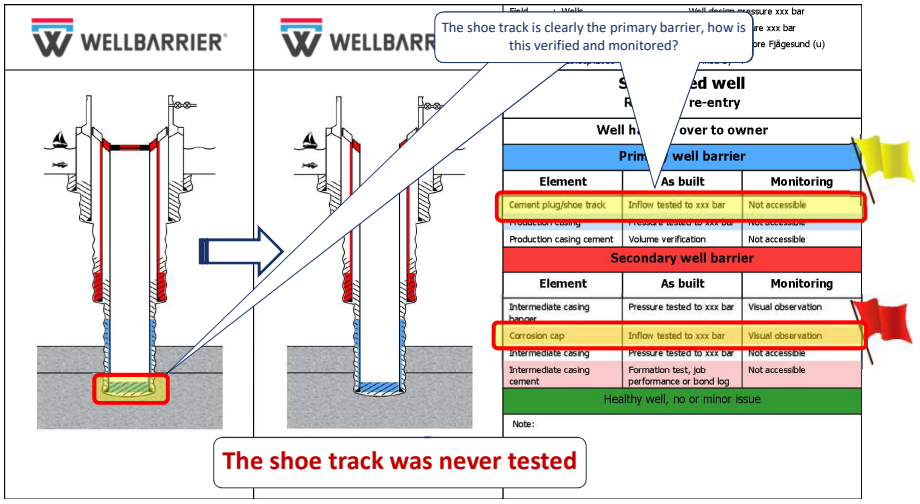


An industry example

Failed shoe track



Q & A