

Protecting our wells employing well barrier envelopes

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What's Next?

SIS Global Forum 2017

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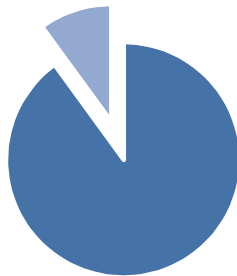
Le Palais des Congrès de Paris

Schlumberger

Well barriers

90%

... of well integrity is about technical well barriers



Figuratively speaking:

90% Technical, specific – **Strong**

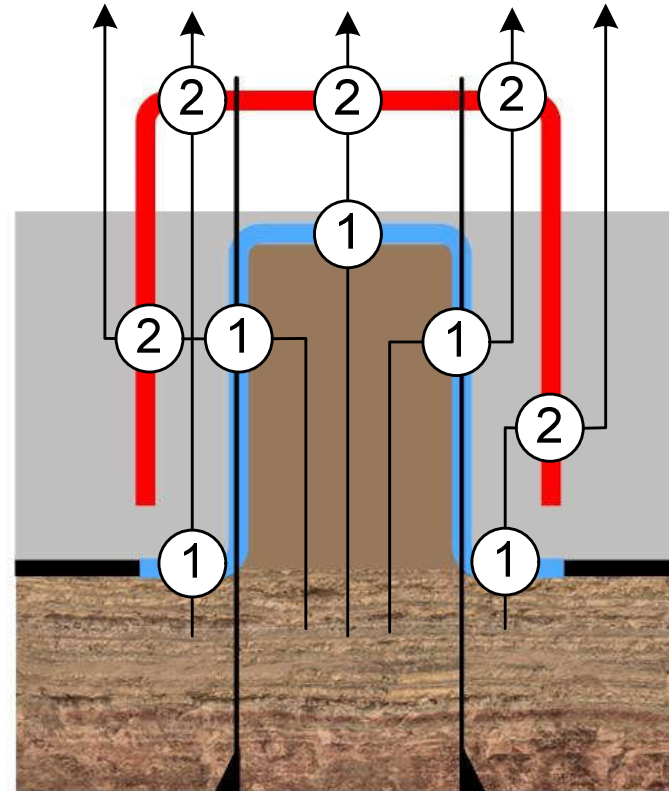
... this is what will contain pressure and hydrocarbons

10% Organizational, operational, functional – *Weak*

... yet the «lubricant» that helps the process run smooth

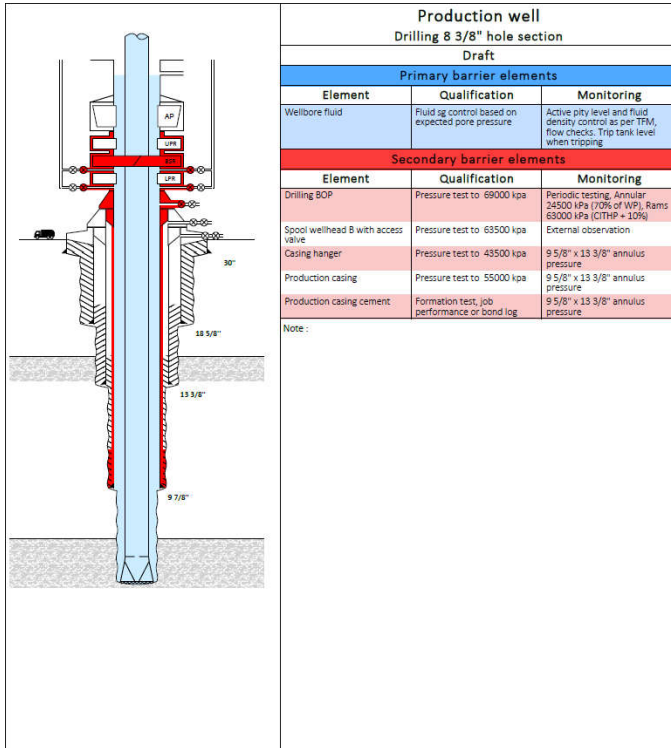
The two barrier philosophy

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



WELL BARRIER ILLUSTRATIONS

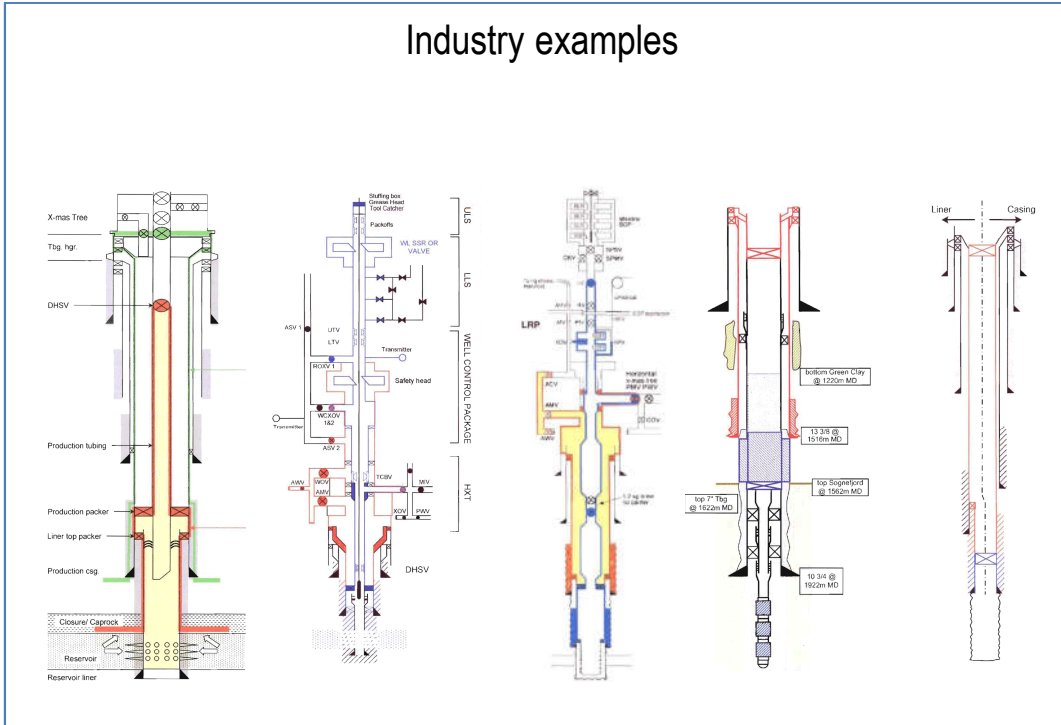
Document the well barrier definitions



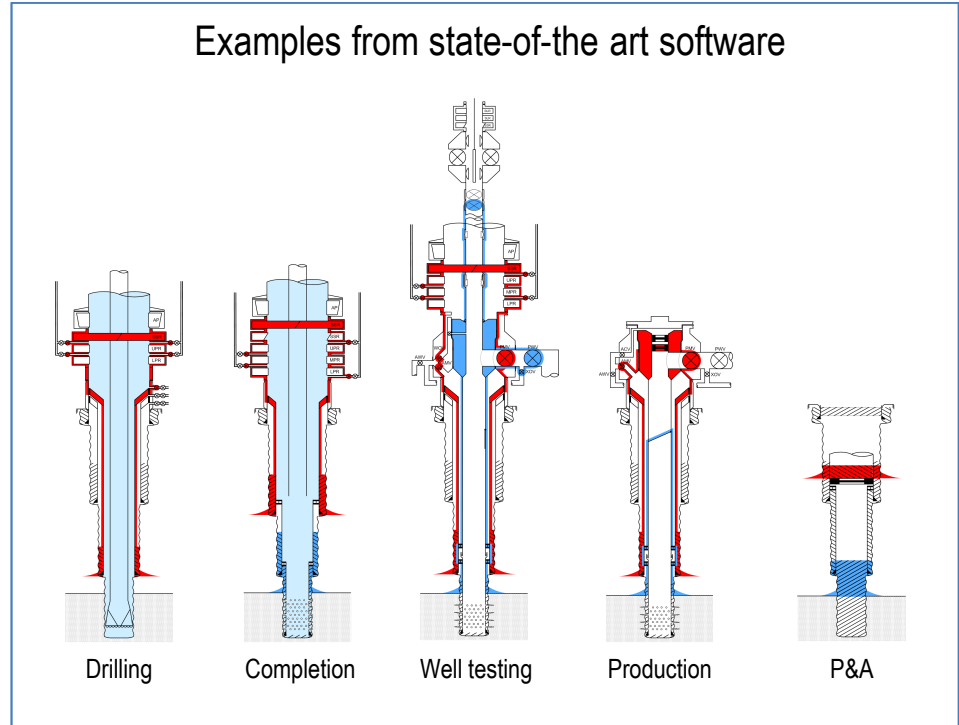
- Clearly identifies the barrier elements involved
- Qualification/verification method
- Monitoring method
- Identify particularities
- Clear graphics will help discussions and see challenges
- Makes all stakeholders see the same picture - literally

Consistency

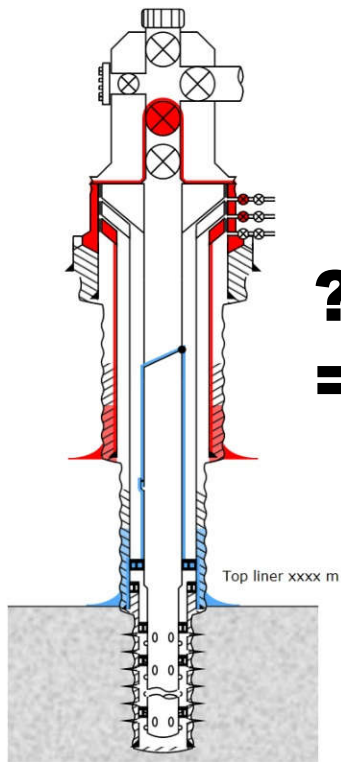
Industry examples



Examples from state-of-the-art software

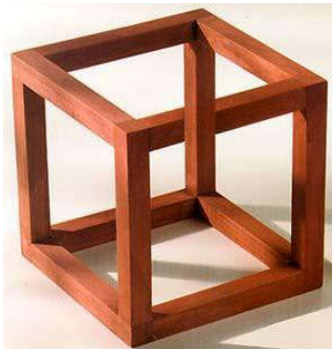


When is an illustration true?



?

=



Production/injection well Tubing landed inside liner, zone controlled		
Well Operation		
Primary well barrier		
Element	As built	Monitoring
SCSSV	Inflow tested to xxx bar	Frequent inflow test to xxx bar
Gaslift Valve	Pressure tested to xxx bar	Inflow tested to xxx bar (in accordance with detailed program)
Tubing	Pressure tested to xxx bar	A-annulus monitoring
Production Packer	Pressure tested to xxx bar	A-annulus monitoring
Production casing	Pressure tested to xxx bar	B-annulus pressure monitoring
Production casing cement	FIT tested to xxx bar	B - annulus monitoring
Secondary well barrier		
Element	As built	Monitoring
Surface production tree with PMV	Pressure tested to xxx bar	Frequent inflow test to xxx bar
Wellhead annulus access valve	Pressure tested to xxx bar	Pressure anomaly monitoring
Wellhead	Pressure tested to xxx bar	Manual external observation
Intermediate casing hanger	Pressure tested to xxx bar	C-annulus monitoring
Intermediate casing	Pressure tested to xxx bar	C-annulus pressure monitoring
Intermediate casing cement	FIT tested to xxx bar	C - annulus monitoring
Healthy well, no or minor issue		
Note:		

Well barriers through the life cycle of the well

Planning

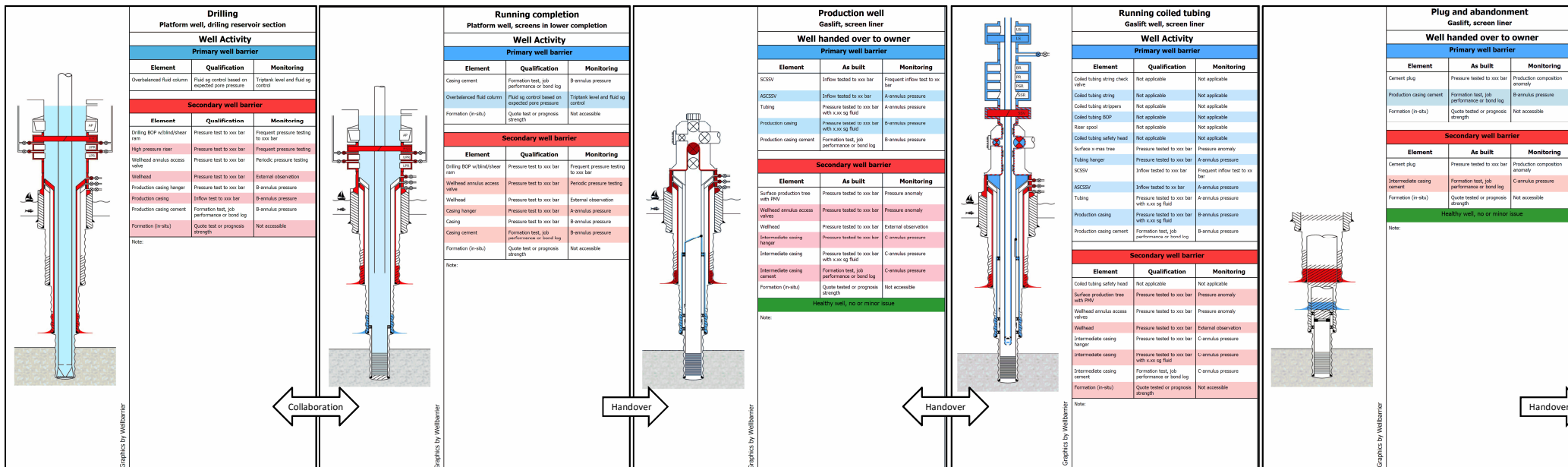
Execution

Operation

Intervention

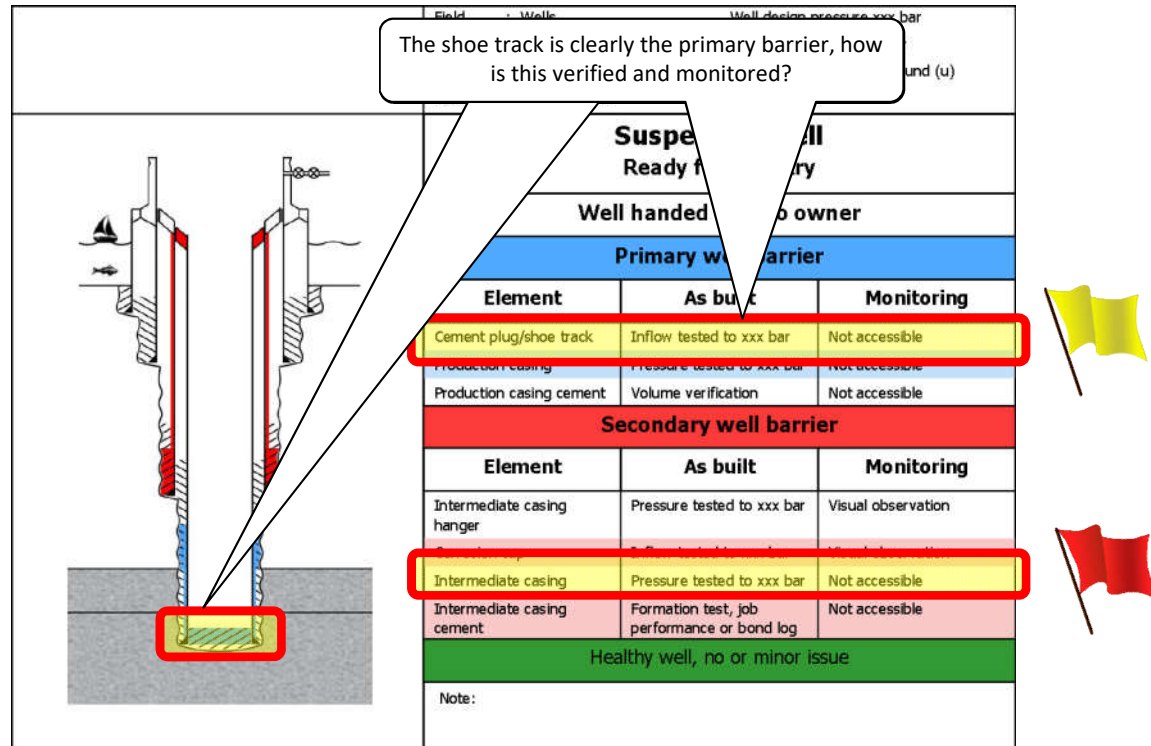
Plug & abandonment

The well barrier definitions follows us and changes as we go from stage to stage during the life of the well



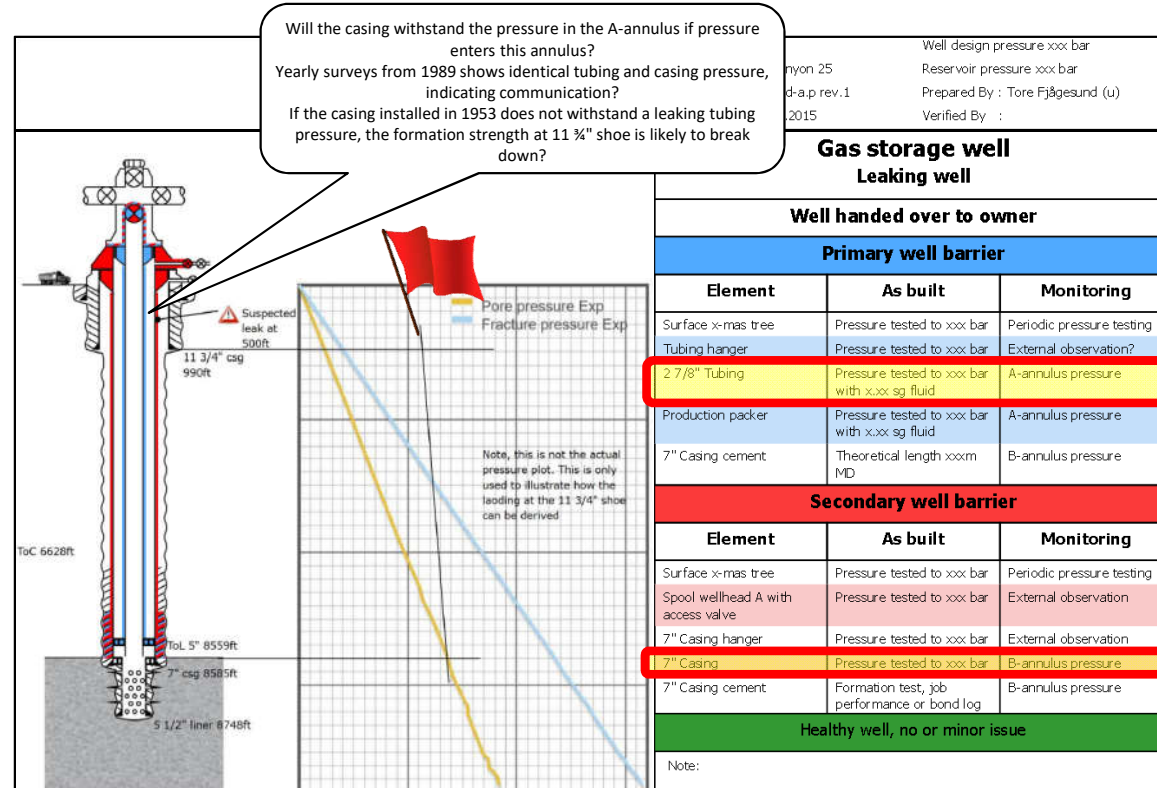
The value of well barrier schematics

The primary barrier failed with no secondary barrier in place



The shoe track was never tested and the secondary barrier was disabled

Underground blow-out

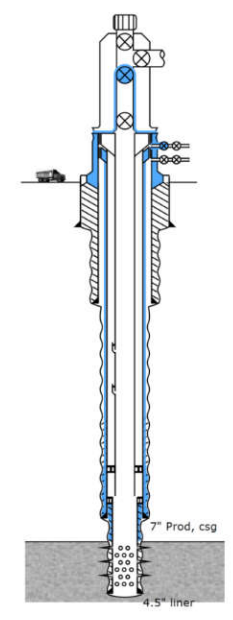


Important to qualify tubing, casing and act on annuli anomalies

Wells with common or only one barrier

Make sure that the one barrier is clearly understood

WELLBARRIER		Field : SPE	Well design pressure xxx bar
		Well : Illustrations	Reservoir pressure xxx bar
		Schematic : WB 4.3.d-a rev.1	Prepared By : Tore Fjågesund (u)
		Date : 05.Mar.2014	Verified By :
Oil producer Onshore gaslift			
Well handed over to owner			
Primary well barrier			
Element	As built	Monitoring	
Surface production tree with PMV	Pressure tested to xxx bar	Periodic pressure testing	
Wellhead annulus access valve	Pressure tested to xxx bar	Periodic pressure testing	
Wellhead	Pressure tested to xxx bar	External observation	
Production casing hanger	Pressure tested to xxx bar	B-annulus pressure	
Production casing	Pressure tested to xxx bar	B-annulus pressure	
Production casing cement	FIT tested to xxx bar	B-annulus pressure	
Liner cement	Volume verification	Not accessible	
Secondary well barrier			
Element	As built	Monitoring	
Secondary barrier not present	Not applicable	Use of contingency procedure	
Healthy well, no or minor issue			
Note:			



- Know and describe your leak sources
- Know your potential leak paths
- Ensure all elements can withstand exposed loads
- Ensure you have adequate design margin
- Ensure all elements are adequately qualified
- Is appropriate monitoring in place?
- Apply mitigating actions or contingencies
- Know your barrier envelope!

Wellbarrier Illustration Tool

A proprietary editor will ensure consistency regardless of who prepare the work

The screenshot displays the Wellbarrier software interface. The main window shows a well schematic on the left and a table of barrier elements on the right. The table is divided into Primary barrier elements and Secondary barrier elements. The Primary barrier elements table has the following data:

Element	Qualification	Monitoring
Wellbore fluid	Fluid sg control based on expected pore pressure	Active pty level and fluid density control as per TFM, flow checks. Trip tank level when tripping

The Secondary barrier elements table has the following data:

Element	Qualification	Monitoring
Drilling BOP	Pressure test to 69000 kPa	Periodic testing, Annual: 24500 kPa (70% of WP), Rems 83000 kPa (CTHP + 10%)
Upper wellhead section	Pressure test to 63500 kPa	External observation
Head B with valve	Pressure test to 43500 kPa	9 5/8" x 13 3/8" annulus pressure
Production casing	Pressure test to 55000 kPa	9 5/8" x 13 3/8" annulus pressure
Production casing cement	Formation test, job performance or bond log	9 5/8" x 13 3/8" annulus pressure

The well schematic on the left shows a vertical well with various components labeled, including a barrier. A context menu is open over the barrier, showing options: Show, Right access line quantity, Delete, Upper wellhead section, Right access line, Left access line.

The right sidebar shows a list of updates and a 'Need help?' button.

Wellbarrier Illustration Tool

A screen friendly illustration will show the current status when you open a well file.

The screenshot displays the Wellbarrier Illustration Tool interface. The top navigation bar includes 'HOME', 'WELL OVERVIEW', 'WELL BARRIERS (10)', 'ACTION DIAGRAM (1)', 'PRESSURE PLOT (1)', 'WELL SCHEMATIC (2)', and 'SEQUENCE DIAGRAM (1)'. The main content area is divided into three sections:

- Left Panel:** A sidebar with navigation options: 'Current well barrier schematic', 'Well design data', 'Hole-casing data', 'Rig data', and 'Pressure plot data'.
- Center Panel:** A well schematic diagram showing a vertical wellbore with various components labeled, including 'RELIEF VALVE', '150m water depth', '26" 290/290m MD/TVD', '18.75" 880/940m MD/TVD', 'FIT 1.34 12', 'TOC 1650m', 'LOT 1.65 16', 'TOC 2020m, 95% return', 'TOC 2750m', 'FCP 388 Bar', 'Top 17" 2750/2400m MD/TVD', '9.825" 2900/2500m MD/TVD', and '17" 3900/3300m MD/TVD'. Below the diagram, it states 'Depth reference to RKE Platform A' and 'Depth correlation None'.
- Right Panel:** A table of barrier elements, categorized into 'Primary barrier elements' and 'Secondary barrier elements'. Each element has columns for 'Element', 'Qualification', and 'Monitoring', along with a status indicator (color-coded box).

Primary barrier elements table:

Element	Qualification	Monitoring	Status
Downhole safety valve	Inflow test to xxx bar	Periodic inflow testing	Green
Tubing	Pressure test to xxx bar	A-annulus pressure	Yellow
Production packer	Pressure test to xxx bar	A-annulus pressure	Green
Liner top packer	Pressure test to xxx bar	A-annulus pressure	Green
Production casing	Pressure test to xxx bar	Not accessible	Green
Casing cement	Formation test, job performance or bond log	Not accessible	Green

Secondary barrier elements table:

Element	Qualification	Monitoring	Status
Surface x-mas tree	Pressure test to xxx bar	External observation	Green
Wellhead annulus access valve	Pressure test to xxx bar	Periodic pressure testing	White
Wellhead	Pressure test to xxx bar	External observation	Green
Casing hanger	Pressure test to xxx bar	B-annulus pressure	Green
Production casing	Pressure test to xxx bar	B-annulus pressure	Green
Casing cement	Formation test, job performance or bond log	B-annulus pressure	Green
Formation (in-situ)	Quote test or prognosis strength	Not accessible	Green

Below the secondary barrier elements table, a yellow bar indicates 'One barrier degraded'.

History Log (Right Panel):

- 03-Aug-2016 08:18: Tore Fjågesund (u) updated WB 4.2 p-d rev. 1 - Production well, Completion. Tore Fjågesund (u) has changed state to Planned. Well schematic modified.
- 27-Jul-2016 13:38: Tore Fjågesund (u) updated WB 1.5 p-b rev. 1 - Production well, Demo II. Well barrier schematic created.
- 27-Jul-2016 10:39: Tore Fjågesund (u) updated WB 1.5 p-a rev. 1 - Production well, Sch demo. Well barrier schematic modified.
- 27-Jul-2016 10:07: Tore Fjågesund (u) updated WB 1.5 p-a rev. 1 - Production well, Sch demo. Well barrier schematic created.
- 17-Jul-2016 20:33: Tore Fjågesund (u) updated WB 4.2 p-a rev. 5 - Production well, Production mode. Tore Fjågesund (u) has set this Well barrier schematics as Current.
- 17-Jul-2016 11:39: Tore Fjågesund (u) updated WB 4.2 p-c rev. 1 - Production well, Production mode. Well barrier schematic modified.
- 17-Jul-2016 11:39: Tore Fjågesund (u) updated WB 4.2 p-c rev. 1 - Production well, Production mode. Well schematic created.

At the bottom right of the interface, there is a 'View more' link.

Well barriers in DrillPlan

Save Share Rename View History

ACTIVITIES & DIAGRAM

Current Activities Add Well Barrier

- Move rig
- Mobilize rig
 - Prepare to mobilize rig
 - Mobilize rig ⚠
- Skid rig
 - Prepare to skid rig
 - Skid in rig
- Rig up
 - Rig acceptance
- Construct section (17.5 in)
- Drilling run
 - Rig up pipe and BHA handling
 - Pick up BHA
 - Drill to depth (1005-1655)
 - Circulate to condition hole
 - Trip out drill pipe to depth
 - Lay down BHA
 - New Activity 🚩



No Diagram selected
Select a diagram on your left.

We offer help with your wells



- The two barrier principle gives you a back-up
- Barrier envelopes and elements are clearly defined
- Clear to understand graphics
- One page description of verification and monitoring
- Available for all steps of the well activity plan
- A logical part of the Well program and Drillers Procedures



Thank You

Questions?



Well barriers in DrillPlan

Save Share Rename View History

ACTIVITIES & DIAGRAM

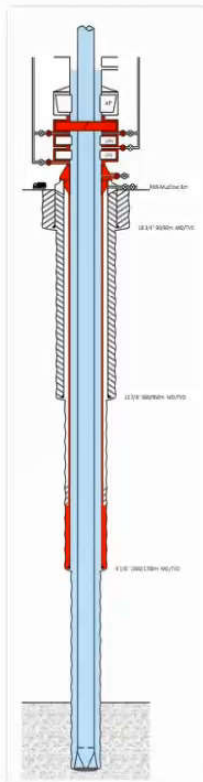
Current Activities Add Well Barrier

Move rig

- Mobilize rig
 - Prepare to mobilize rig
 - Mobilize rig ⚠
- Skid rig
 - Prepare to skid rig
 - Skid in rig
- Rig up
 - Rig acceptance
- Construct section (17.5 in)
- Drilling run
 - Rig up pipe and BHA handling
 - Pick up BHA
 - Drill to depth (1005-1655)
 - Circulate to condition hole
 - Trip out drill pipe to depth
 - Lay down BHA
 - New Activity 🚩

Well Barrier

- Running shearable drillstring
- Running Non-shearable drillstring
- Running shearable drillstring
- Diagram name



Primary barrier elements			
Element	Qualification	Monitoring	
Wellbore fluid	EAC Fluid sg control based on expected pore pressure	Triptank level and fluid sg control	
Secondary barrier elements			
Element	Qualification	Monitoring	
Drilling BOP	EAC Pressure test to xxx Bar	Frequent pressure testing to xxx Bar	
Spool wellhead A with access valve	EAC Pressure test to xxx Bar	External observation	
Casing hanger	EAC Pressure test to xxx Bar	A-annulus pressure	
Production casing	EAC Pressure test to xxx Bar	B-annulus pressure	
Production casing cement	EAC Formation test, job performance or bond log	B-annulus pressure	