

WORK-OVER OPERATIONS

PULLING UPPER COMPLETION STRING

Version 19/06/14

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“SHARING TO BE BETTER”

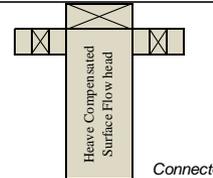
Under the direction of Norwegian Oil and Gas, a joint industry task force of Operator and Drilling Contractor personnel has been formed to recommend ways to reduce the number and potential severity of well control events on the NCS.

- One team recommendation was communicating actual well control incidents that have recently occurred on the NCS so lessons are shared and understood.
- This is the tenth in a series of case histories. The incident highlights the importance of appreciating and realizing that an incident seldom develops on a single cause. The lesson shows that a number of issues had to be addressed and mitigated.
- Please take some time to review this case history with the drilling crew and discuss the questions raised during the presentation. Please invite and encourage related drilling service personnel to participate.
- It is hoped that sharing of incidents is helpful and any feedback is welcome.

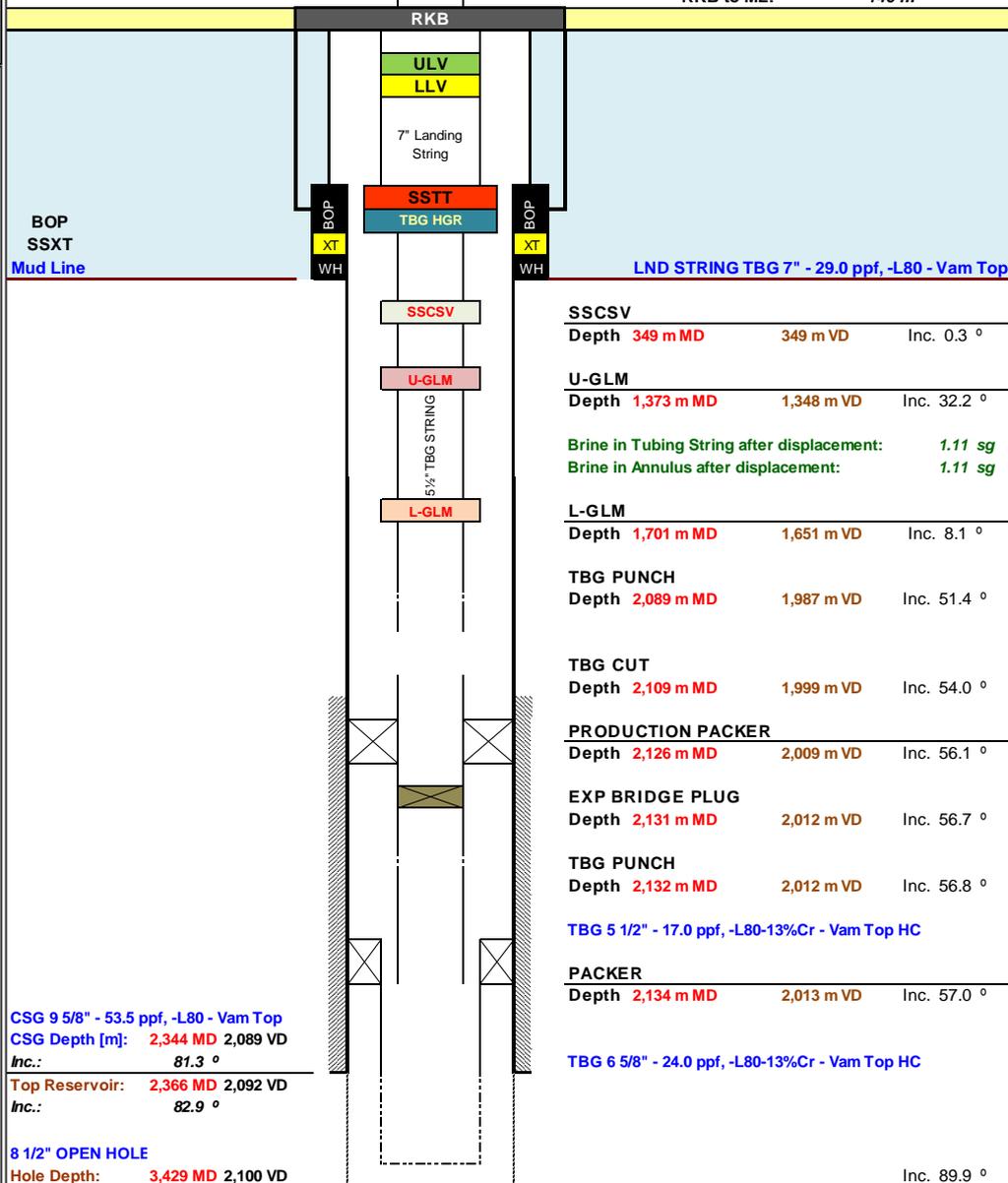
“SHARING TO BE SAFER”

ABBREVIATIONS

- BSR: blind shear rams
- C&K: choke & kill
- DHPG: down-hole pressure gauge
- EXP-BP: Expandable bridge plug
- HCSFH: Heave Compensated Surface Flow-Head
- HGR: hanger
- L-GLM: lower gas lift mandrel
- L-LV: lower lubricator valve
- LND STR: landing string
- LVs: lubricator valves
- MD: measured depth
- ML: mud line
- PCE: pressure containment equipment
- PKR: packer
- RKB: rotary kelly bushing
- RSR: riser
- SSCSV: subsurface controlled safety valve
- SSTT: subsea test tree
- TBG: tubing
- TDS: top drive system
- U-GLM: upper gas lift mandrel
- U-LV: upper lubricator valve
- VD: vertical depth
- WH: well head
- XT: X-mas tree



RKB to MSL: 29 m
 Water Depth: 111 m
 RKB to ML: 140 m



CSG 9 5/8" - 53.5 ppf, -L80 - Vam Top
 CSG Depth [m]: 2,344 MD 2,089 VD
 Inc.: 81.3 °
 Top Reservoir: 2,366 MD 2,092 VD
 Inc.: 82.9 °
 8 1/2" OPEN HOLE
 Hole Depth: 3,429 MD 2,100 VD

SSCSV	Depth 349 m MD	349 m VD	Inc. 0.3 °
U-GLM	Depth 1,373 m MD	1,348 m VD	Inc. 32.2 °
Brine in Tubing String after displacement:		1.11 sg	
Brine in Annulus after displacement:		1.11 sg	
L-GLM	Depth 1,701 m MD	1,651 m VD	Inc. 8.1 °
TBG PUNCH	Depth 2,089 m MD	1,987 m VD	Inc. 51.4 °
TBG CUT	Depth 2,109 m MD	1,999 m VD	Inc. 54.0 °
PRODUCTION PACKER	Depth 2,126 m MD	2,009 m VD	Inc. 56.1 °
EXP BRIDGE PLUG	Depth 2,131 m MD	2,012 m VD	Inc. 56.7 °
TBG PUNCH	Depth 2,132 m MD	2,012 m VD	Inc. 56.8 °
TBG 5 1/2" - 17.0 ppf, -L80-13%Cr - Vam Top HC			
PACKER	Depth 2,134 m MD	2,013 m VD	Inc. 57.0 °
TBG 6 5/8" - 24.0 ppf, -L80-13%Cr - Vam Top HC			

Rig type: Semi-Sub
 Well type: Oil Producer gas lift assisted
 Activity: Work-Over
 Operation: Pull Completion String

SUMMARY DESCRIPTION (Part 1)

Scope of Work:

Re-entry producer well and perform killing.
 Pull failed upper completion string and replace same with new one.

Well Status:

- Bullhead tubing and annulus (thru TBG punch) with 1.11 sg brine.
- Punch TBG below Production PKR as per completion program (see note below).
- Deep barrier EXP-BP set and positive pressure tested to 220 bar.
- Displace annulus to fresh 1.11 sg K-formate brine thru tubing punches (no gas reading, observed contaminated fluid at surface)
- Well on trip tank: static.

Note: the execution of lower TBG punch was performed as contingency procedure to by-pass the EXP-BP once new completion string was installed in the unlikely case it was not possible to retrieve the same. Additional set of TBG punch was planned in case just above the EXP-BP.

Operations Sequence:

- De-Ballast rig 2 m and un-latched TBG HGR.
- Well on trip tank: static.
- Pull tension and cut tubing.
- Pull landing string positioning TBG HGR above BOP.
- Rig down wireline string and equipment and prepare for pulling out completion string.
- Set landing string on slip.
- Unlatched and stroked out Heave Compensated Surface Flow Head.
- Well on trip tank: static.

Rig Type: Semi Sub
 Well Type: Oil Producer
 Activity: Work-Over
 Operation: EVENT

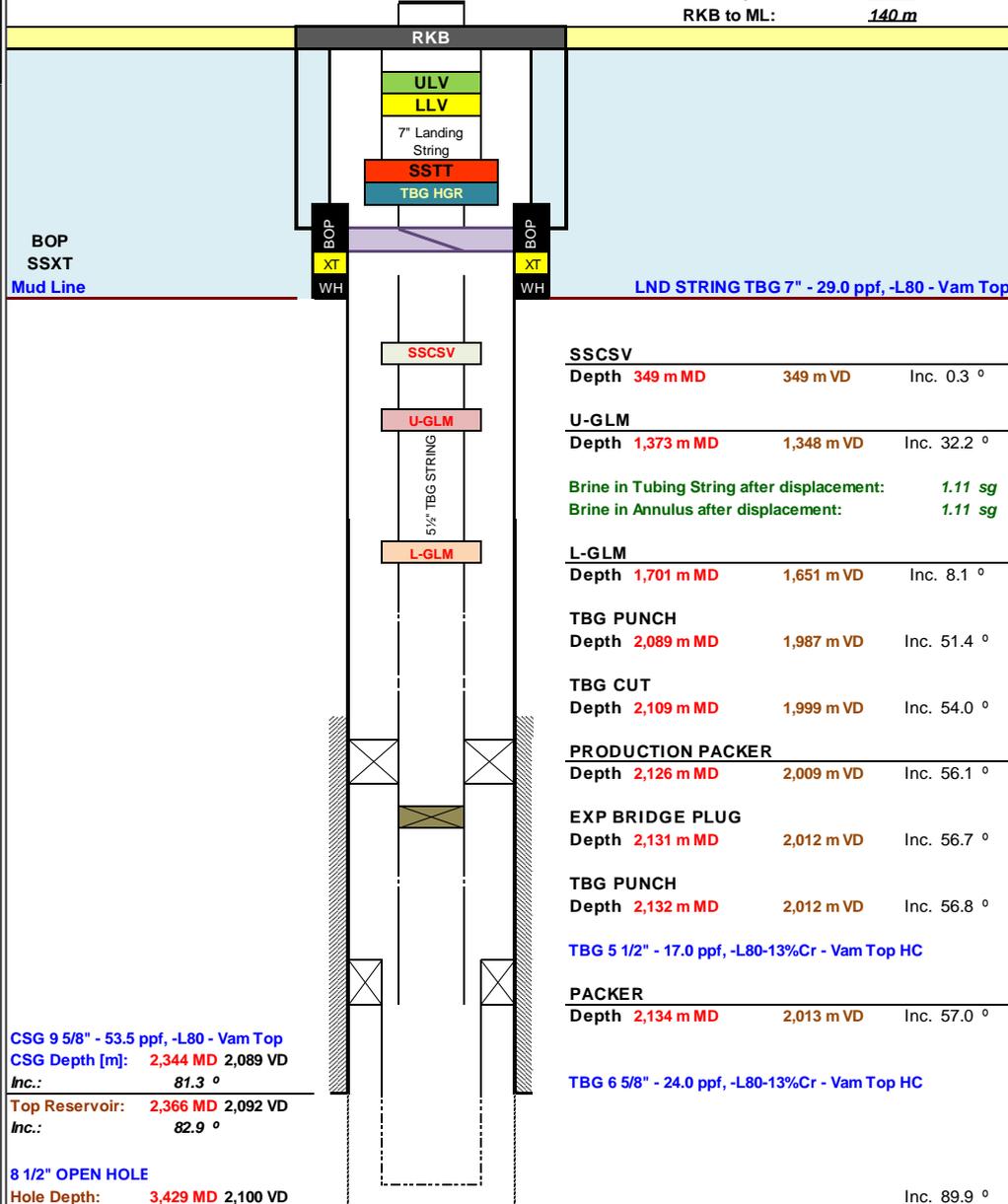
RKB to MSL: 29 m
 Water Depth: 111 m
 RKB to ML: 140 m

Rig type: Semi-Sub
 Well type: Oil Producer gas lift assisted
 Activity: Work-Over
 Operation: Pull Completion String

SUMMARY DESCRIPTION (Part 2)

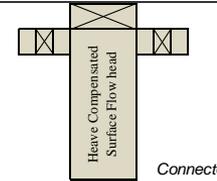
Event:

- Disconnected Sub-Sea Test Tree (SSTT) control jumper from reel.
- Disconnected Lubricator Valves (LVs) control umbilical from control panel.
- Broke-out compensated surface flow head from special snap-in connector.
- Experienced u-tube effect from tubing string.
- Trip tank pump turned off to minimize u-tube effect. Rig heave approx. 2.3 m.
- During the rigging down of equipment, the suspected u-tube effect from the landing string progressively increasing.
- Called SSTT operator to rig floor to reconnect LVs umbilical.
- The rate of surged of contaminated brine increased rapidly: the fluid struck the TDS causing loss of visibility from driller's cabin window.
- The shear rams were closed on the tubing string resulting in stopping the flow.
- The cut tubing dropped approximately 15 m into the well.
- The rig was de-ballasted additional 2 m avoiding contact between tubing cut and BSR.
- The well integrity envelop (BSR, CSG, PKR & EXP-BP) was confirmed with a 50 bar test.

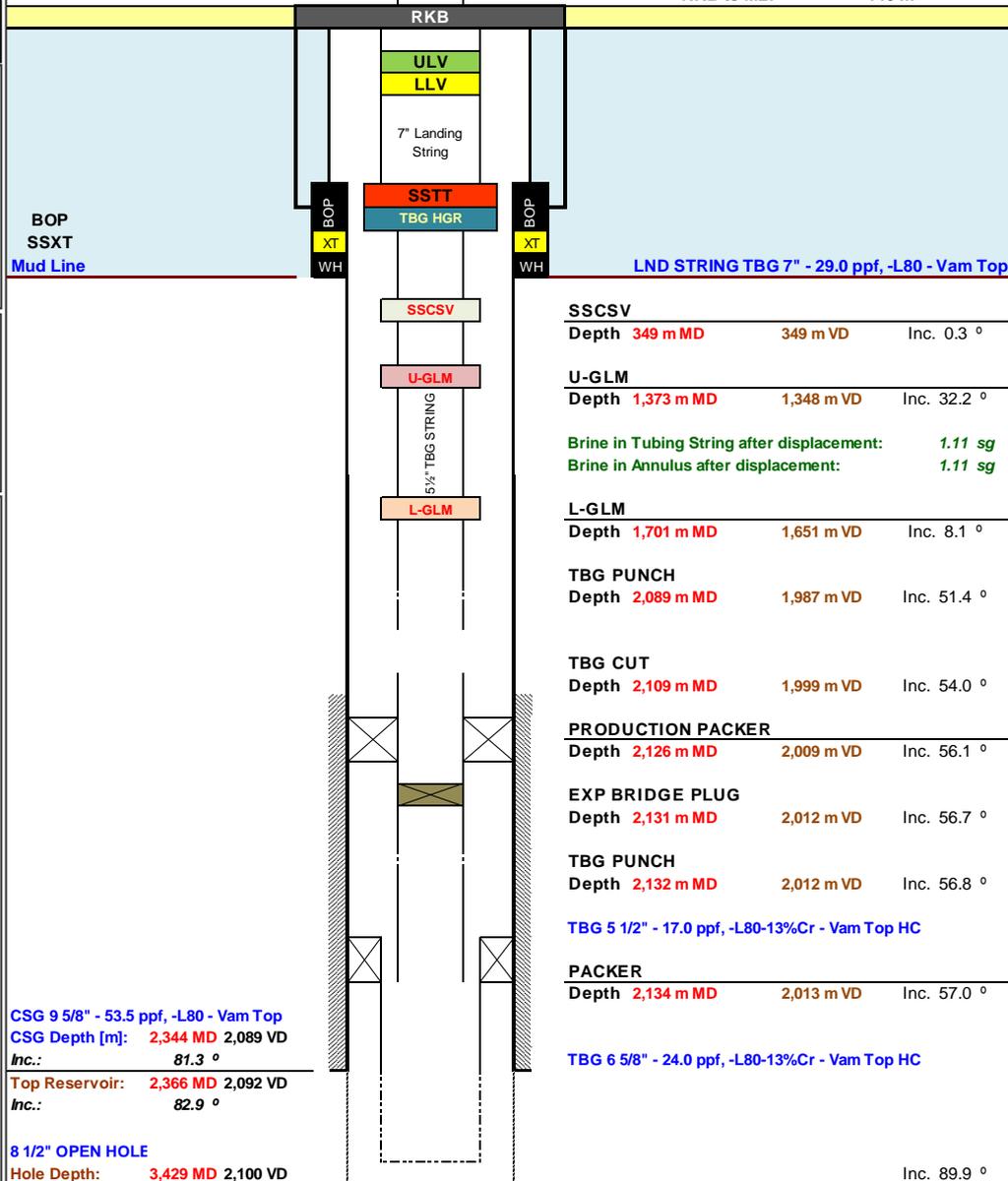


Rig Type: Semi Sub
 Well Type: Oil Producer
 Activity: Work-Over
 Operation: **DISPLACEMENT**

Well Bore Diagram



RKB to MSL: 29 m
 Water Depth: 111 m
 RKB to ML: 140 m



BOP
 SSXT
 Mud Line

BOP
 XT
 WH

BOP
 XT
 WH

LND STRING TBG 7" - 29.0 ppf, -L80 - Vam Top

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U-GLM			
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Brine in Annulus after displacement:		1.11 sg	

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Depth	2,089 m MD	1,987 m VD	Inc. 51.4 °

TBG CUT			
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PRODUCTION PACKER			
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TBG 5 1/2" - 17.0 ppf, -L80-13%Cr - Vam Top HC

PACKER			
Depth	2,134 m MD	2,013 m VD	Inc. 57.0 °

TBG 6 5/8" - 24.0 ppf, -L80-13%Cr - Vam Top HC

Inc. 89.9 °

CSG 9 5/8" - 53.5 ppf, -L80 - Vam Top	
CSG Depth [m]:	2,344 MD 2,089 VD
Inc.:	81.3 °
Top Reservoir:	2,366 MD 2,092 VD
Inc.:	82.9 °

8 1/2" OPEN HOLE	
Hole Depth:	3,429 MD 2,100 VD

Rig type: Semi-Sub
 Well type: Oil Producer gas lift assisted
 Activity: Work-Over
 Operation: **WELL DISPLACEMENT**

Sequence of the Events – Step-By-Step:

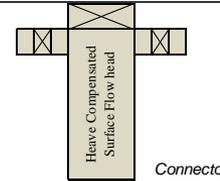
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- Punch TBG below Production PKR as per completion program.
- Deep barrier EXP-BP set and positive pressure tested to 220 bar.
- Displace annulus to fresh 1.11 sg K-formate brine thru tubing punches (no gas reading, observed contaminated fluid at surface).
- Well on trip tank: static.

Point to consider:

- Are the operations correct?
- What is important to check and verify?
- Which are the barrier in place?
- Could something have been done differently?

Discussion:

Rig Type: Semi Sub
 Well Type: Oil Producer
 Activity: Work-Over
 Operation: **DISPLACEMENT**



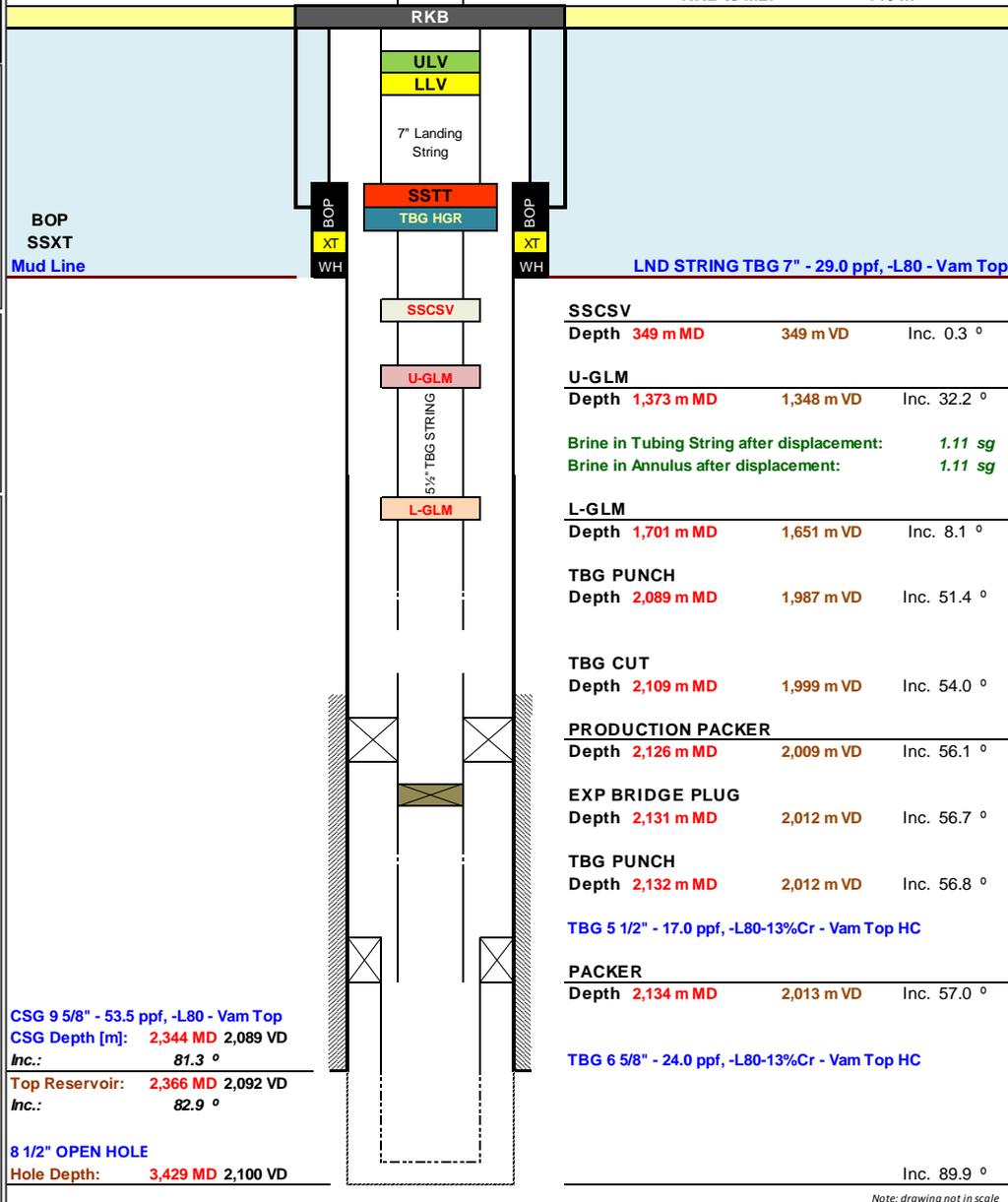
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 Well type: Oil Producer gas lift assisted
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 Operation: **WELL DISPLACEMENT**

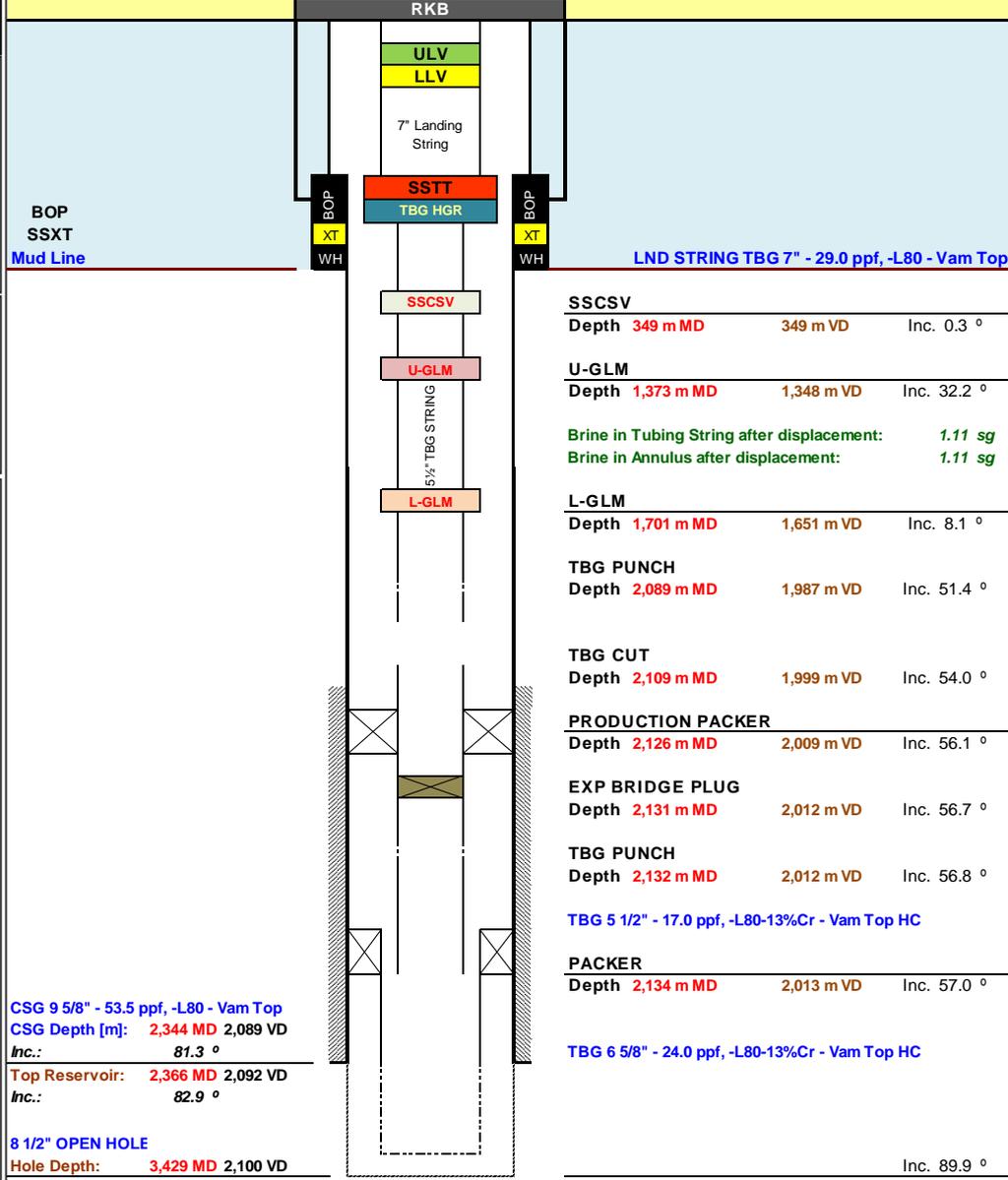
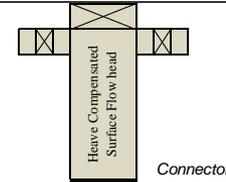
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 - Displace annulus to fresh 1.11 sg K-formate brine thru tubing punches (no gas reading, observed contaminated fluid at surface).
 - Well on trip tank: static.

- Point to consider:**
- Are the operations correct?
 - What is important to check and verify?
 - Which are the barrier in place?
 - Could something have been done differently?

- Discussion:**
- Bull-heading of the tubing was not repeated after the lower punch was executed: possible contaminated fluid migration inside completion tubing string between operations?
 - Once deep barrier EXP-BP was set, it was possible to establish circulation and confirm a homogeneous fluid.
 - Barriers in place:
 - EXP-BP – PKR – CSG envelop
 - BOP stack, SSTT & LVs (landing string)
 - Fluid in hole (?)
 - The contaminated fluid experienced during the displacement of fresh brine should have prompted a “well clean status” check or further circulation until a homogenous fluid was confirmed.



RKB to MSL: 29 m
 Water Depth: 111 m
 RKB to ML: 140 m



BOP
 SSXT
 Mud Line

LND STRING TBG 7" - 29.0 ppf, -L80 - Vam Top

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TBG 6 5/8" - 24.0 ppf, -L80-13%Cr - Vam Top HC			
Inc. 89.9 °			

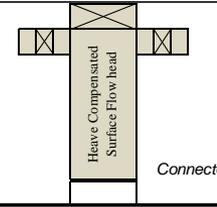
CSG 9 5/8" - 53.5 ppf, -L80 - Vam Top
 CSG Depth [m]: 2,344 MD 2,089 VD
 Inc.: 81.3 °
 Top Reservoir: 2,366 MD 2,092 VD
 Inc.: 82.9 °
 8 1/2" OPEN HOLE
 Hole Depth: 3,429 MD 2,100 VD

Rig type: Semi-Sub
 Well type: Oil Producer gas lift assisted
 Activity: Work-Over
 Operation: TUBING CUT

- Sequence of the Events – Step-By-Step:**
- De-Ballast rig 2 m and un-latched TBG HGR. Well on trip tank: static.
 - String on tension (O/P 10 ton) TBG HGR off seat approx. 2 m.
 - Cut tubing and pull TBG HGR assy above BOP. Well on trip tank: static.
 - Rig down wireline string and equipment and prepare for pulling out completion string. Well on trip tank: static.

- Point to consider:**
- Are the operations correct?
 - What is important to check and verify?
 - Which are the barrier in place?
 - Could something have been done differently?

Discussion:



RKB to MSL: 29 m
 Water Depth: 111 m
 RKB to ML: 140 m

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 Well type: Oil Producer gas lift assisted
 Activity: Work-Over
 Operation: **TUBING CUT**

- Sequence of the Events – Step-By-Step:**
- De-Ballast rig 2 m and un-latched TBG HGR. Well on trip tank: static.
 - String on tension (O/P 10 ton) TBG HGR off seat approx. 2 m.
 - Cut tubing and pull TBG HGR assy above BOP. Well on trip tank: static.
 - Rig down wireline string and equipment and prepare for pulling out completion string. Well on trip tank: static.

- Point to consider:**
- Are the operations correct?
 - What is important to check and verify?
 - Which are the barrier in place?
 - Could something have been done differently?

Discussion:

After the displacement the well was always on trip tank to check the fluid level: static.

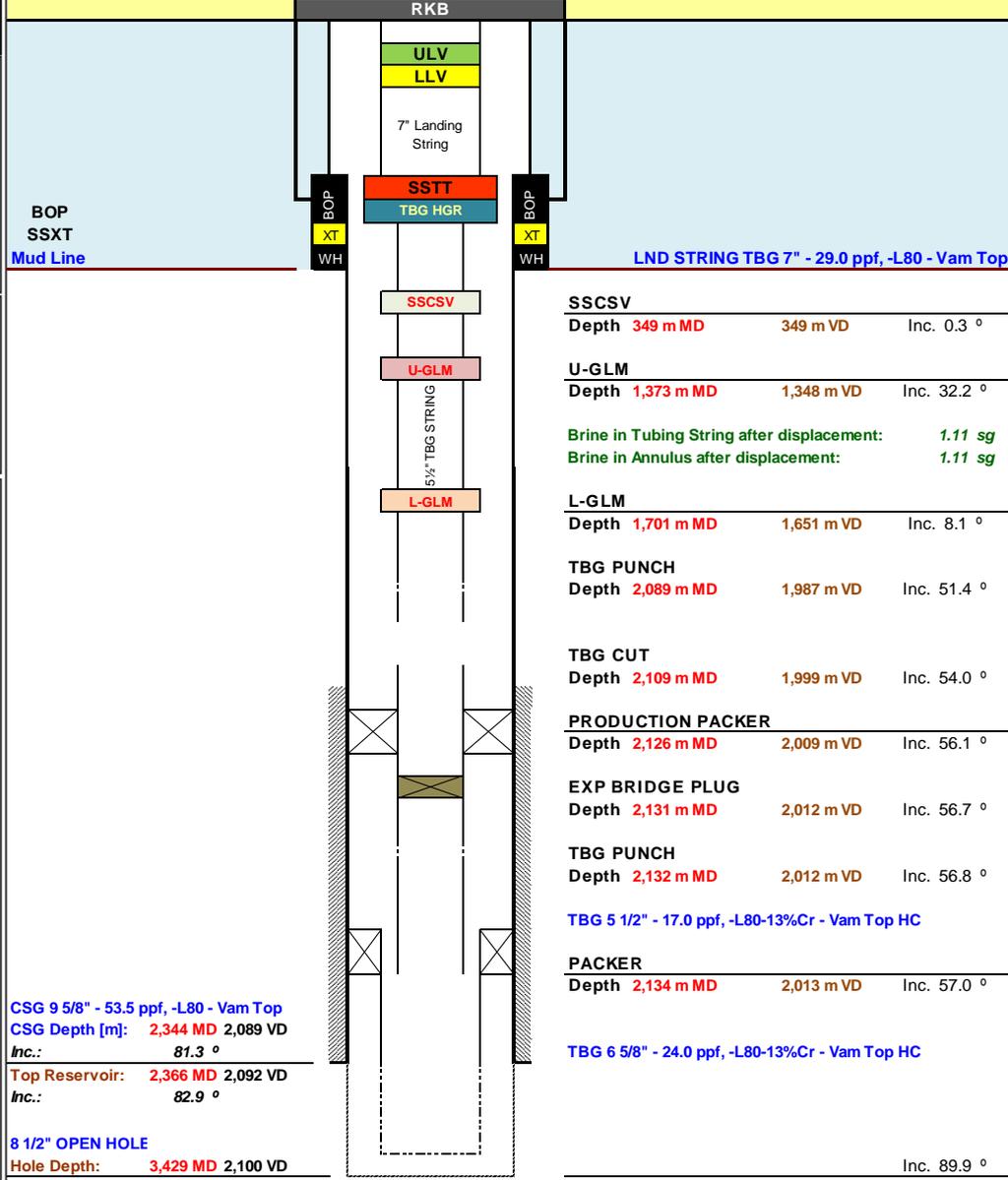
No bottom-up circulation was performed after the tubing was cut due to the hole was already displaced and a homogeneous fluid (1.11 sg brine) was assumed to be throughout the well.

After the cut the tubing hanger assy was pulled above the BOP stack for proper space out: the rig was previously de-ballasted 2 meter as per space out plan.

During the rig-down of wireline PCE the fluid level was monitored on trip tank: static (elapsed/monitored time approx. 9 hours).

Barrier status:

- EXP-BP – PKR – CSG envelop
- BOP stack, SSTT & LVs (landing string)
- Fluid in hole (?)



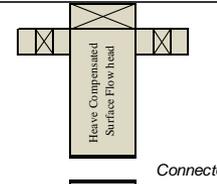
CSG 9 5/8" - 53.5 ppf, -L80 - Vam Top
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8 1/2" OPEN HOLE
 Hole Depth: 3,429 MD 2,100 VD

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TBG 6 5/8" - 24.0 ppf, -L80-13%Cr - Vam Top HC			
			Inc. 89.9 °

Rig Type: Semi Sub
 Well Type: Oil Producer
 Activity: Work-Over
 Operation: **B/OUT HCSFH**



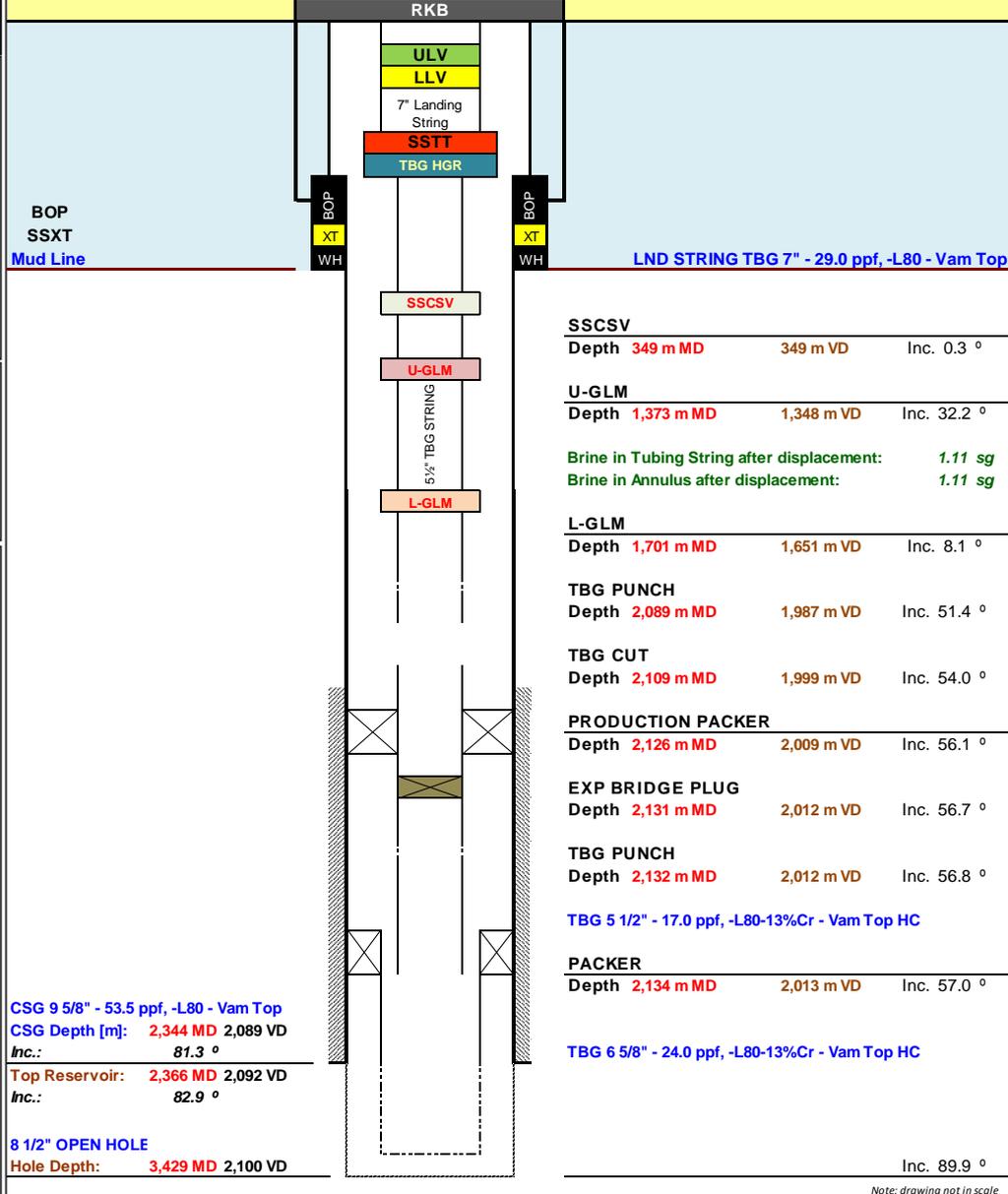
RKB to MSL: 29 m
 Water Depth: 111 m
 RKB to ML: 140 m

Rig type: Semi-Sub
 Well type: Oil Producer gas lift assisted
 Activity: Work-Over
 Operation: **BREAK-OUT HCSFH**

- Sequence of the Events – Step-By-Step:**
- Set landing string on slips. Unlatched and stroked out compensated surface flow head for inspection. Well on trip tank: static.
 - Disconnected SSTT control jumper from reel.
 - Disconnected Lubricator Valves (LVs) control umbilical from rig floor control panel. Broke-out compensated surface flow head from special snap-in connector.
 - Experienced u-tube effect from tubing string. Shut-in trip tank pump to minimize effect. Rig heave approx. 2.3 m.

- Point to consider:**
- Are the operations correct?
 - What is important to check and verify?
 - Which are the barrier in place? Are they operable?
 - Could something have been done differently?

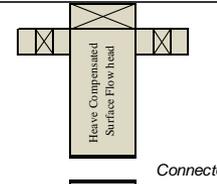
Discussion:



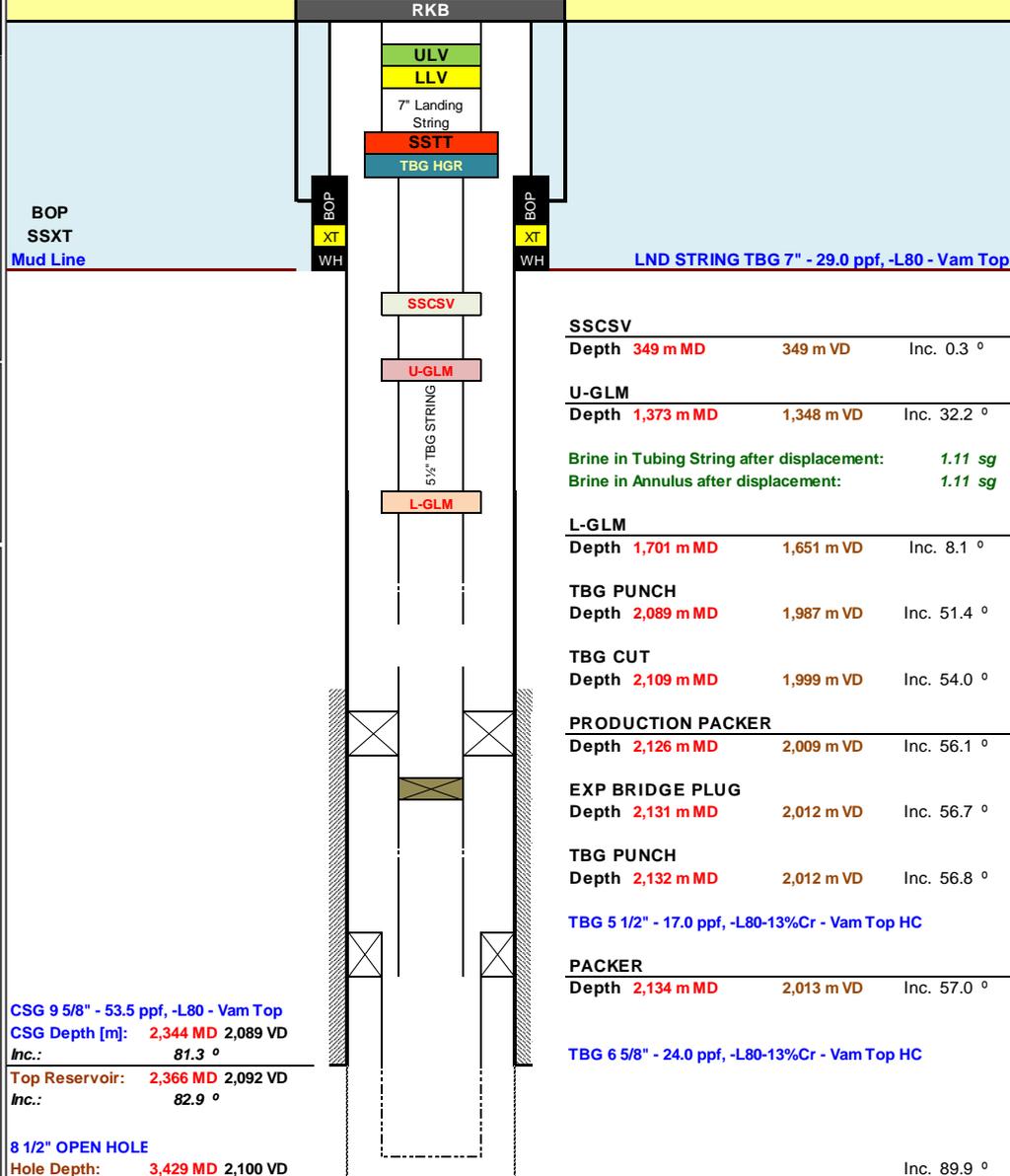
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 CSG Depth [m]: 2,344 MD 2,089 VD
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8 1/2" OPEN HOLE
 Hole Depth: 3,429 MD 2,100 VD

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			Inc. 89.9 °

Rig type: Semi-Sub
 Well type: Oil Producer gas lift assisted
 Activity: Work-Over
 Operation: **BREAK-OUT HCSFH**

Sequence of the Events – Step-By-Step:

- Set landing string on slips. Unlatched and stroked out compensated surface flow head for inspection. Well on trip tank: static.
- Disconnected SSTS control jumper from reel.
- Disconnected Lubricator Valves (LVs) control umbilical from rig floor control panel. Broke-out compensated surface flow head from special snap-in connector.
- Experienced u-tube effect from tubing string. Shut-in trip tank pump to minimize effect. Rig heave approx. 2.3 m.

Point to consider:

- Are the operations correct?
- What is important to check and verify?
- Which are the barrier in place? Are they operable?
- Could something have been done differently?

Discussion:

The (2) valves on the SSTS are fail close, The valves are still operable when the umbilical was disconnected. Closure time is less than 1 min by bleeding-off pressure from reel's control panel.

The (2) LVs cannot be operated without the control umbilical being connected. The umbilical should not be disconnected until the Lubricator Valve is at surface (out of hole) as these form part of the landing string barrier envelop.

The u-tube effect observed after the breaking-out of the Heave Compensated-Surface-Flow-Head and the disconnection of (2) LVs umbilical.

Even though the well was confirmed static for 9 hours, it is not a good practice to shut-in the trip tank pump to balance the hydrostatics. The fluid level must continuously be monitored to be a barrier.

It is important to have full control of shearing capability once string is set on slips for long period: weather limitation/rig motion criteria have to be established (max acceptable heave for TBG pulling was set to 3.0 m).

RKB to MSL: 29 m
 Water Depth: 111 m
 RKB to ML: 140 m

Rig type: Semi-Sub
 Well type: Oil Producer gas lift assisted
 Activity: Work-Over
 Operation: ASSUMED U-TUBE EFFECT

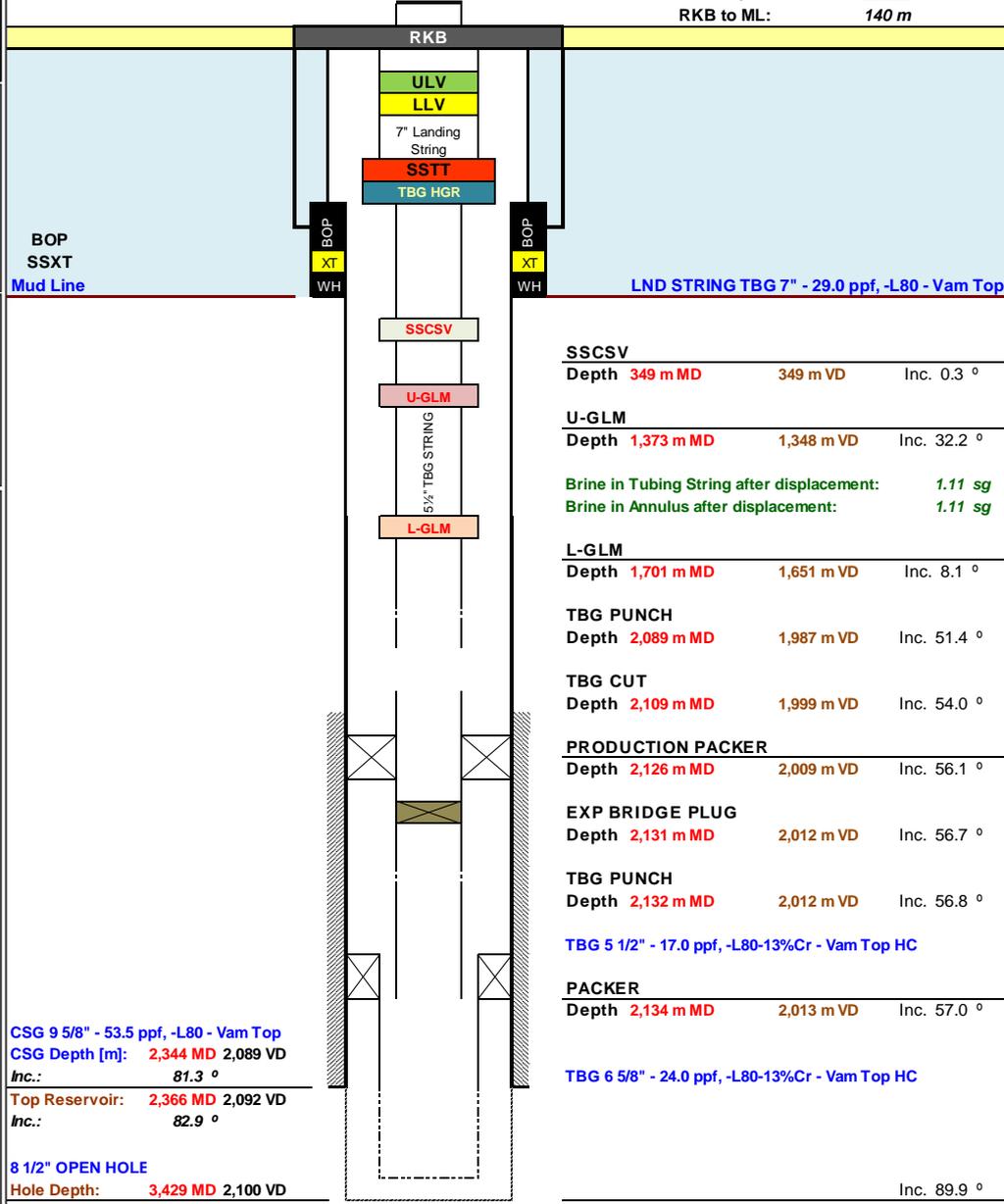
Sequence of the Events – Step-By-Step:

- Continuing the rigging down of compensated surface flow head and long bails, the suspected U-tubing effect increased despite having the trip tank pump off.
- Called SSTS operator back to the rig floor to reconnect LVs umbilical.

Point to consider:

- Are the operations correct?
- What is important to check and verify?
- Which are the barrier in place?
- Could something have been done differently?

Discussion:



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Inc. 89.9 °			

CSG 9 5/8" - 53.5 ppf, -L80 - Vam Top
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 Top Reservoir: 2,366 MD 2,092 VD
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Rig Type: Semi Sub
 Well Type: Oil Producer
 Activity: Work-Over
 Operation: **U-TUBE**

RKB to MSL: 29 m
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 Well type: Oil Producer gas lift assisted
 Activity: Work-Over
 Operation: **ASSUMED U-TUBE EFFECT**

Sequence of the Events – Step-By-Step:

- Continuing the rigging down of compensated surface flow head and long bails, the suspected U-tubing effect increased despite having the trip tank pump off.
- Called SSTT operator back to the rig floor to reconnect LVs umbilical.

Point to consider:

- Are the operations correct?
- What is important to check and verify?
- Which are the barrier in place?
- Could something have been done differently?

Discussion:

The focus of the TBT was on laying down the heavy surface equipment as the well was considered safe with fully tested barriers to 220 bar.

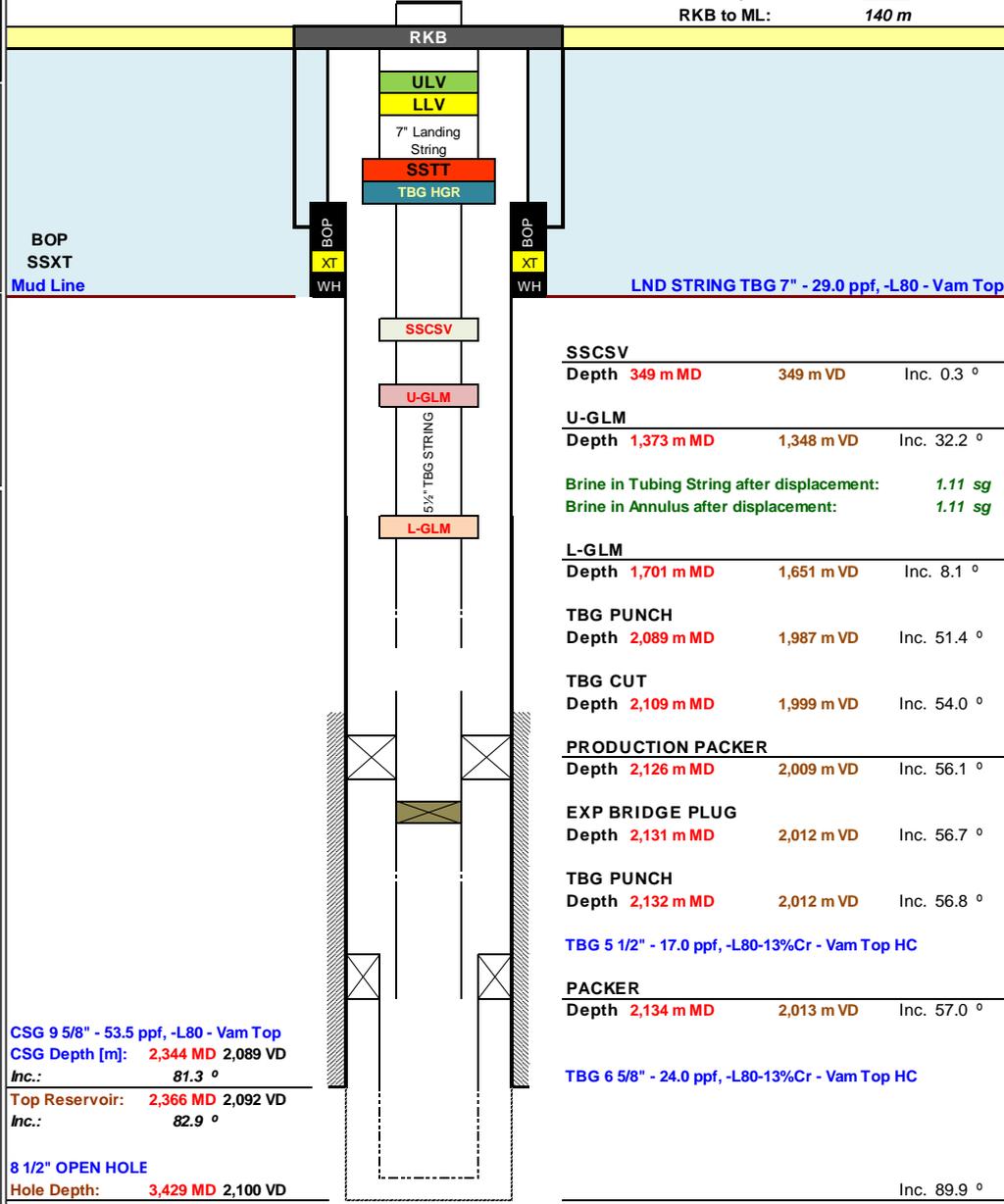
The Detailed Section Guidelines and Well Barrier Diagrams were not clear for the “laying down” of landing string components.

The u-tubing effect did not reduce. The (2) LVs where not operable as the control lines where disconnected. The SSTT valves were operable but no one was requested to be positioned at the location to function them.

Barrier status:

- EXP-BP – PKR – CSG envelop
- BOP stack, SSTT & LVs (landing string)
- Fluid in hole (??)

Late decision was taken to reconnect the LVs umbilical instead of closing the fail-safe SSTT valves in the landing string.



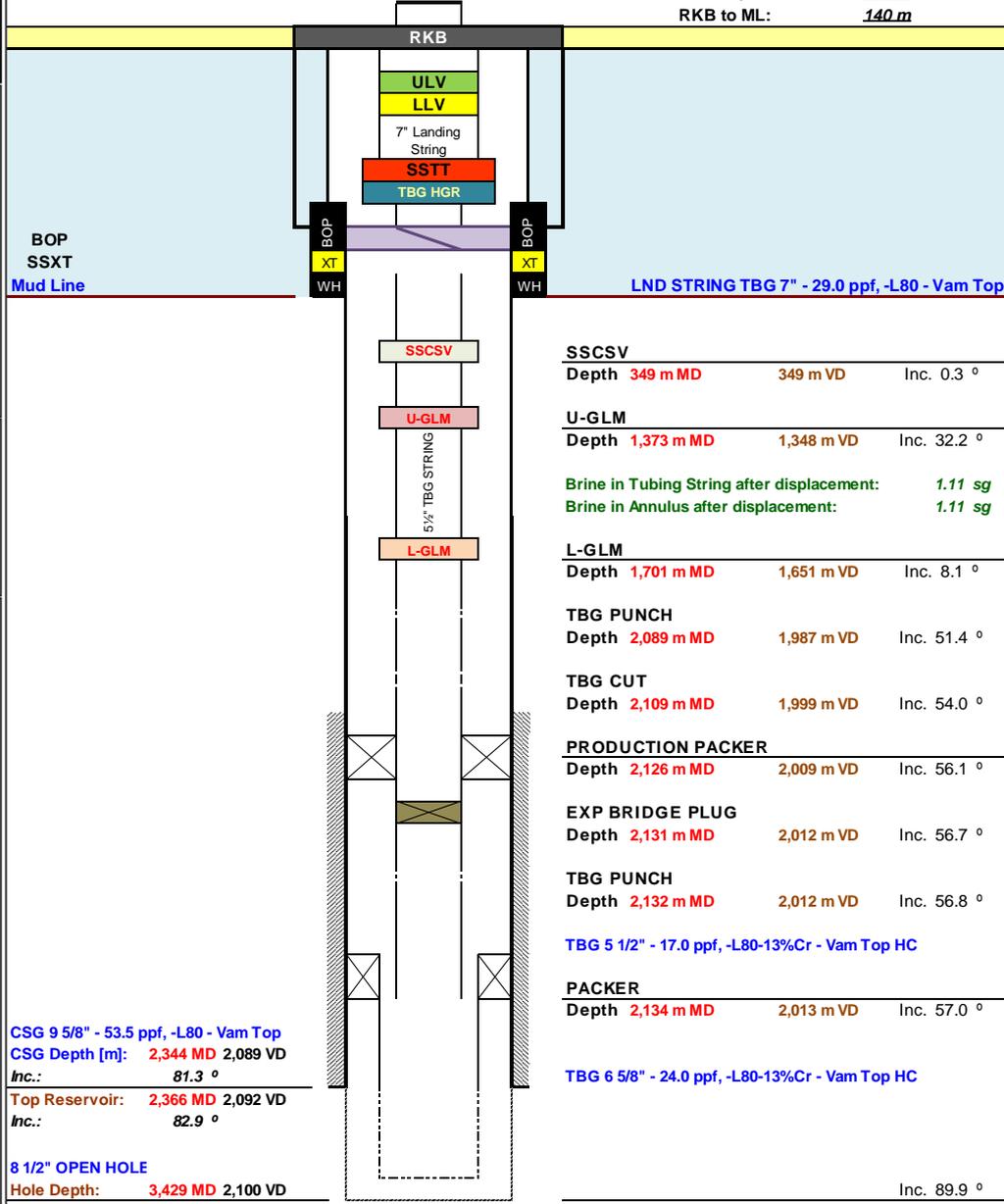
CSG 9 5/8" - 53.5 ppf, -L80 - Vam Top
 CSG Depth [m]: 2,344 MD 2,089 VD
 Inc.: 81.3 °

Top Reservoir: 2,366 MD 2,092 VD
 Inc.: 82.9 °

8 1/2" OPEN HOLE
 Hole Depth: 3,429 MD 2,100 VD

SSCSV	Depth 349 m MD	349 m VD	Inc. 0.3 °
U-GLM	Depth 1,373 m MD	1,348 m VD	Inc. 32.2 °
Brine in Tubing String after displacement:		1.11 sg	
Brine in Annulus after displacement:		1.11 sg	
L-GLM	Depth 1,701 m MD	1,651 m VD	Inc. 8.1 °
TBG PUNCH	Depth 2,089 m MD	1,987 m VD	Inc. 51.4 °
TBG CUT	Depth 2,109 m MD	1,999 m VD	Inc. 54.0 °
PRODUCTION PACKER	Depth 2,126 m MD	2,009 m VD	Inc. 56.1 °
EXP BRIDGE PLUG	Depth 2,131 m MD	2,012 m VD	Inc. 56.7 °
TBG PUNCH	Depth 2,132 m MD	2,012 m VD	Inc. 56.8 °
TBG 5 1/2" - 17.0 ppf, -L80-13%Cr - Vam Top HC			
PACKER	Depth 2,134 m MD	2,013 m VD	Inc. 57.0 °
TBG 6 5/8" - 24.0 ppf, -L80-13%Cr - Vam Top HC			
Inc. 89.9 °			

RKB to MSL: 29 m
 Water Depth: 111 m
 RKB to ML: 140 m



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			Inc. 89.9 °

Rig type: Semi-Sub
 Well type: Oil Producer gas lift assisted
 Activity: Work-Over
 Operation: **BLIND SHEAR-RAMS CLOSED**

Sequence of the Events – Step-By-Step:

- The fluid surged increased rapidly with each heave and contaminated brine struck the TDS causing loss of visibility from driller’s cabin.
- No gas alarm went off on rig floor or in other rig areas.
- The shear rams were closed on the tubing string resulting in stopping the flow. The cut tubing dropped approximately 15 m into the well
- The rig was de-ballasted additional 2 m avoiding contact between tubing cut and BSR
- Well integrity confirmed: test BSR, PKR & EXP-BP : 50 bar - OK

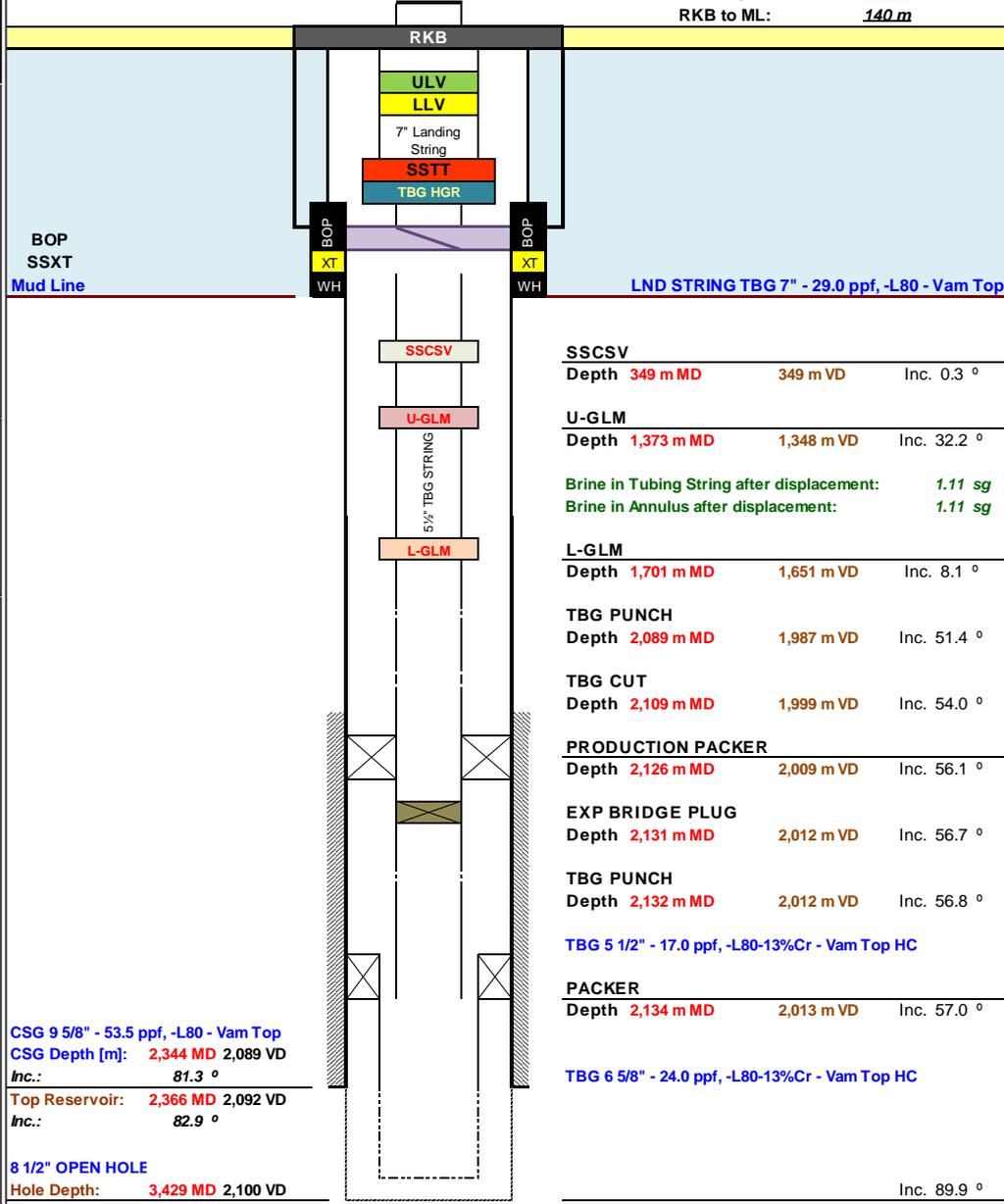
Point to consider:

- Are the operations correct?
- What is important to check and verify?
- Which are the barrier in place?
- Could something have been done differently?

Discussion:

Rig Type: Semi Sub
 Well Type: Oil Producer
 Activity: Work-Over
 Operation: **BSR CLOSED**

RKB to MSL: 29 m
 Water Depth: 111 m
 RKB to ML: 140 m



CSG 9 5/8" - 53.5 ppf, -L80 - Vam Top
 CSG Depth [m]: 2,344 MD 2,089 VD
 Inc.: 81.3 °
 Top Reservoir: 2,366 MD 2,092 VD
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 8 1/2" OPEN HOLE
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TBG 6 5/8" - 24.0 ppf, -L80-13%Cr - Vam Top HC			

Note: drawing not in scale

Rig type: Semi-Sub
 Well type: Oil Producer gas lift assisted
 Activity: Work-Over
 Operation: **BLIND SHEAR-RAMS CLOSED**

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Point to consider:

- Are the operations correct?
- What is important to check and verify?
- Which are the barrier in place?
- Could something have been done differently?

Discussion:

Operator has supported the decision taken to secure the well.

Following the loss of visual control from the Drillers cabin and not having the ability to close the (2) SSTS valves or the (2) LVs dictated the ultimate action to close the shear rams to secure the well.

The space out was correct and the tubing string was sheared properly (considering the string on slips and the rig movement due to the heave - approx. 2.3 m) securing the well: the flow stopped immediately.

The rig was then de-ballasted again additional 2 meter avoiding contact between the closed shear rams and the tubing cut-off lower end.

The integrity test of well barriers (EXP-BP & BSR) was confirmed testing to 50 bar:

- EXP-BP – PKR – CSG envelop
- BOP (BSR)

INVESTIGATION FINDINGS, LEARNING & CORRECTIVE ACTIONS

Well Barrier Status

Minimum of 2 barriers were always present: Tubing Hanger envelop and/or BOP stack tested (proper space out) and/or deep-set mechanical barrier fully tested and/or completion/kill fluid (experienced later contaminated)

Shear Rams activation event

The presumed well control situation was addressed immediately without hesitation.

Proper space-out was planned/performed: string sheared correctly and well secured successfully.

DIRECT CAUSE : INTERNAL STRING BARRIER ACTIVATION – U-tubing effect and troubleshooting management

Internal string barriers were not activated: preparation was not made to effectively utilize the two (2) Lubricator valves and/or the two (2) Sub-Sea test tree valves during pulling out and laying down of landing string components.

Recommended Corrective Action:

- Maintain control umbilical's to valves (barriers) and assign responsibilities for activation.
- Structure Tool Box Talks and handovers to include the well status, barrier diagrams and barriers in place (discuss “what-if” scenario) that can be activated.
- Well Barrier Diagrams must be prepared and used as a verification tool representing the barriers available.

ROOT CAUSE: NON HOMOGENEOUS FLUID - Well bullhead and displacement inadequate

A homogenous fluid was not through out the entire wellbore. Residual hydrocarbons were still present in the well resulting in fluid barrier being degraded. Contaminated brine was observed at surface once the wash train was circulated out of hole. Further circulation of the entire wellbore following setting of the deep set barrier is needed to confirm a clean homogenous fluid throughout the wellbore.

Recommended Corrective Action:

- Revise bull-head program/sequence to reduce the time from completion of pumping operations and setting of the deep barrier,
- Revise procedures to adequately circulate the well and use the observed returns (density, contamination and in balance fluid column) as guidance to ensure a homogenous fluid is an effective barrier.