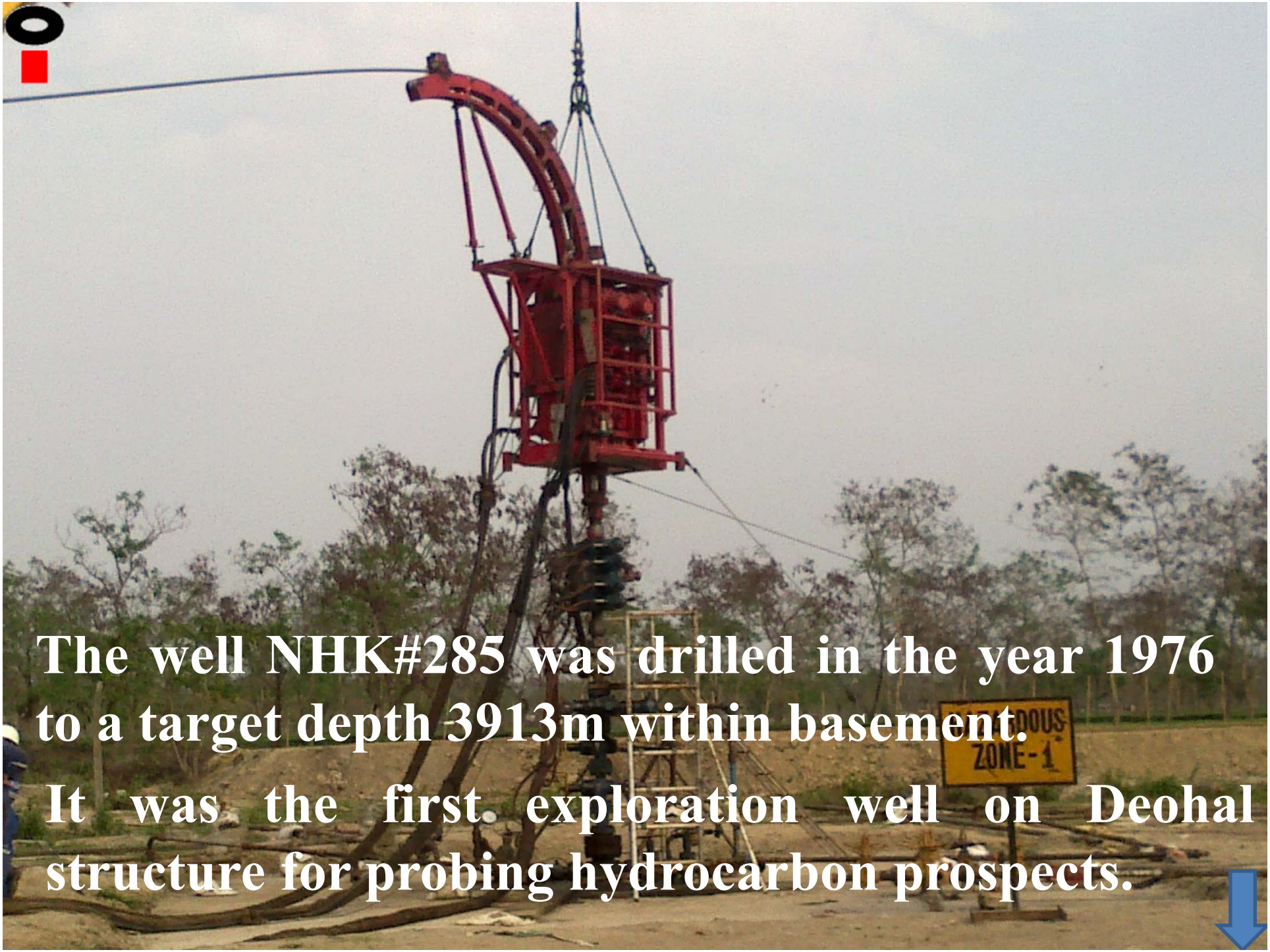
WELCOME

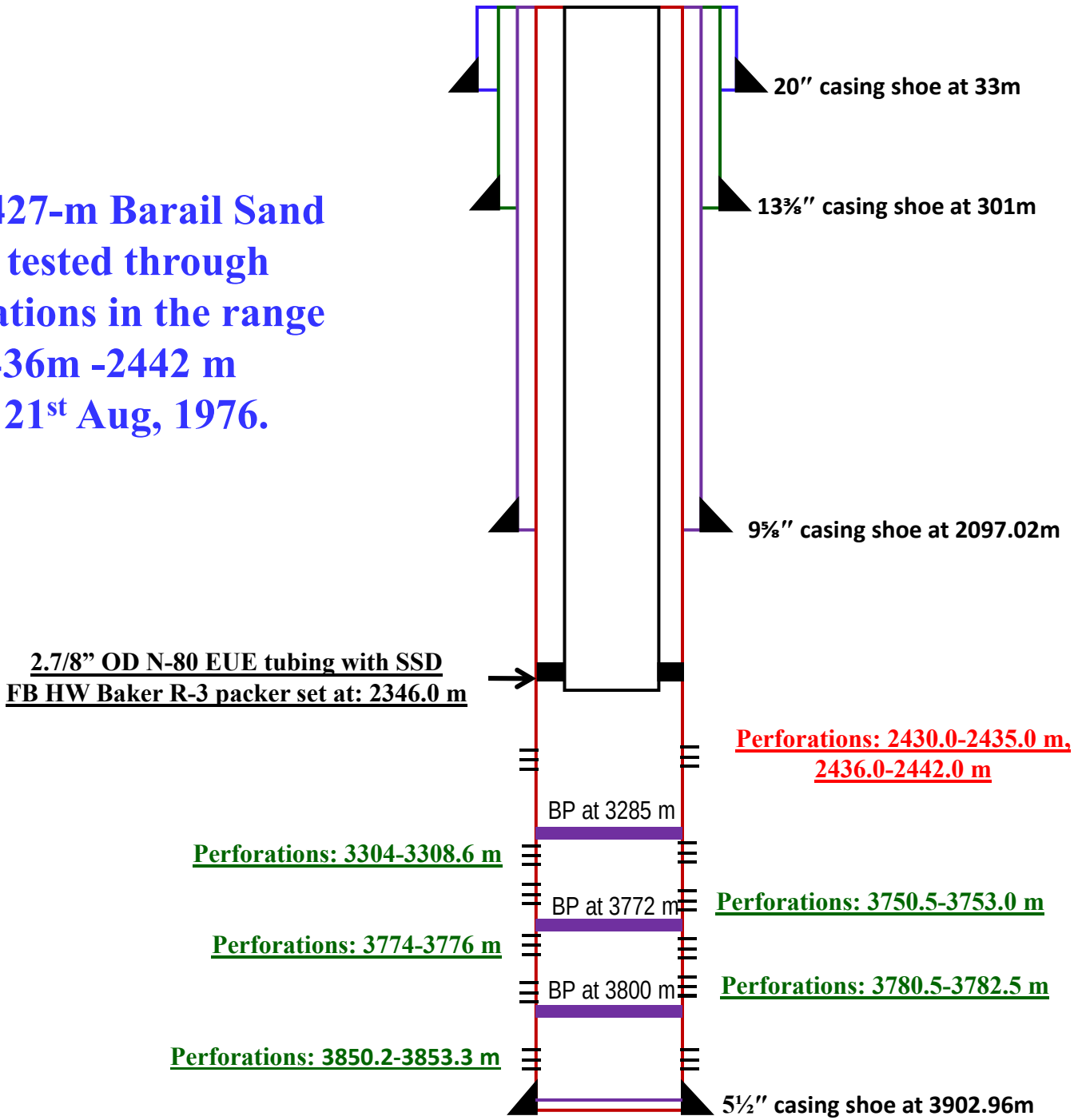
Underground Blowout Control at Well NHK# 285 OIL, Assam.



The well NHK#285 was drilled in the year 1976 to a target depth 3913m within basement.

It was the first exploration well on Deohal structure for probing hydrocarbon prospects.

2427-m Barail Sand was tested through perforations in the range 2436m -2442 m on 21st Aug, 1976.



The well started flowing and produced gas @ 0.0312 MMSCMD through 4 mm bean with flowing tubing pressure of 2950 psi.

However, the well could not be brought into production due to lack of market demand of gas at that time.

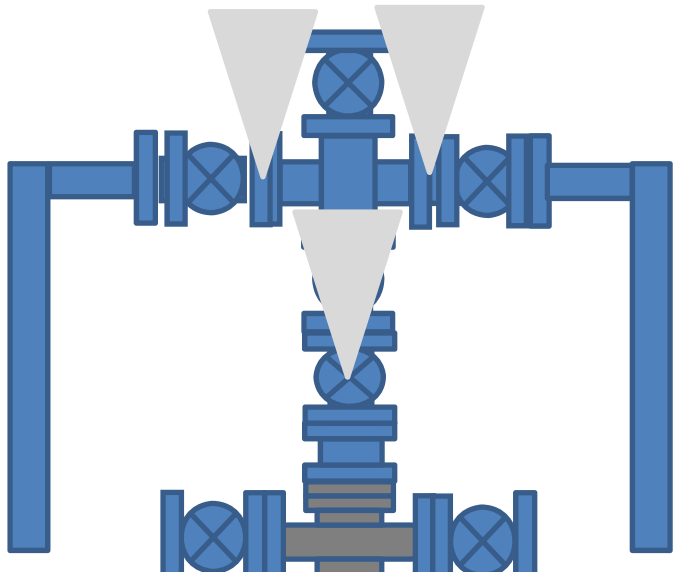
With increase in market demand for natural gas, the well was put on production on 17th June, 2005 and was producing @ maximum 0.076 MMSCMD with flowing tubing head pressure of 2600 psi through 7mm bean.

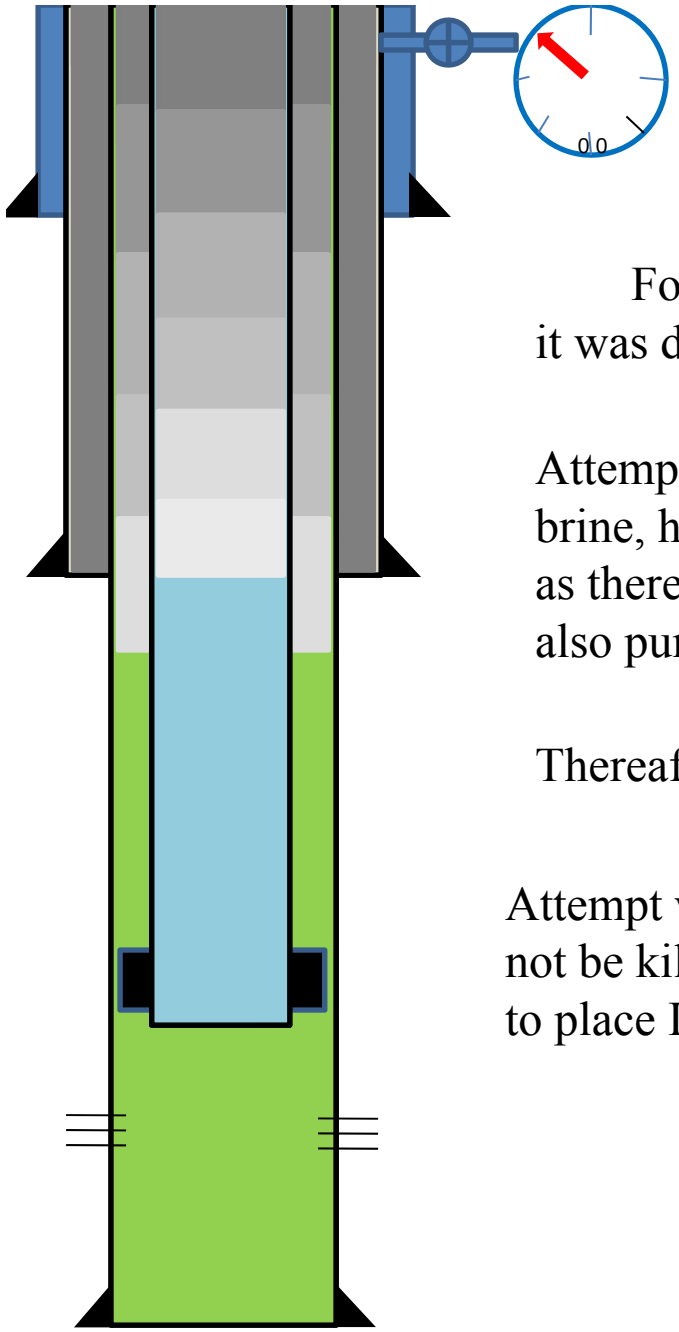
In July, 2010 sand production was observed at the surface and hence production was reduced to @60,000 SCMD with 5.0 mm bean.

However sand production continued at reduced production rate also. Hence, production was further reduced to @20,000- 30,000 SCMD by reducing bean size to 3.0 mm on 30th Oct. 2010 to arrest sand production at surface.

On 14th July, 2011 at around 1 A.M, it was reported about a high intensity sound from the well NHK 285.

It was found that there was leakage from the wellhead fittings above the master valve. Subsequently the master valve of the wellhead was closed.





WELL KILLING OPERATIONS

Following the gas leakage at several places of the wellhead it was decided to kill the well and repair the wellhead.

Attempt was made to kill the well with water and then with weighted brine, however, the well could not be killed. During the killing process, as there was fluid loss, viscous fluid & loss circulating material was also pumped, but no result could achieved.

Thereafter, it was decided to kill the well with drilling mud.

Attempt was made to kill the well with drilling mud, but the well could not be killed as there was heavy fluid loss. Accordingly, it was decided to place LCM to arrest lost circulation.

On 17th Oct, 2011 during the process of placing loss circulating material, gushing out of gas/well fluid was observed around the cellar and well plinth.

Considering the gravity of the situation, well control experts from **Crisis Management Team, ONGCL** were called and attempt was made to kill the well dynamically with water, but the same gushing out of gas with water was observed again and it subsided of its own after one day.

UNDERGROUND BLOWOUT CONTROL OPERATION

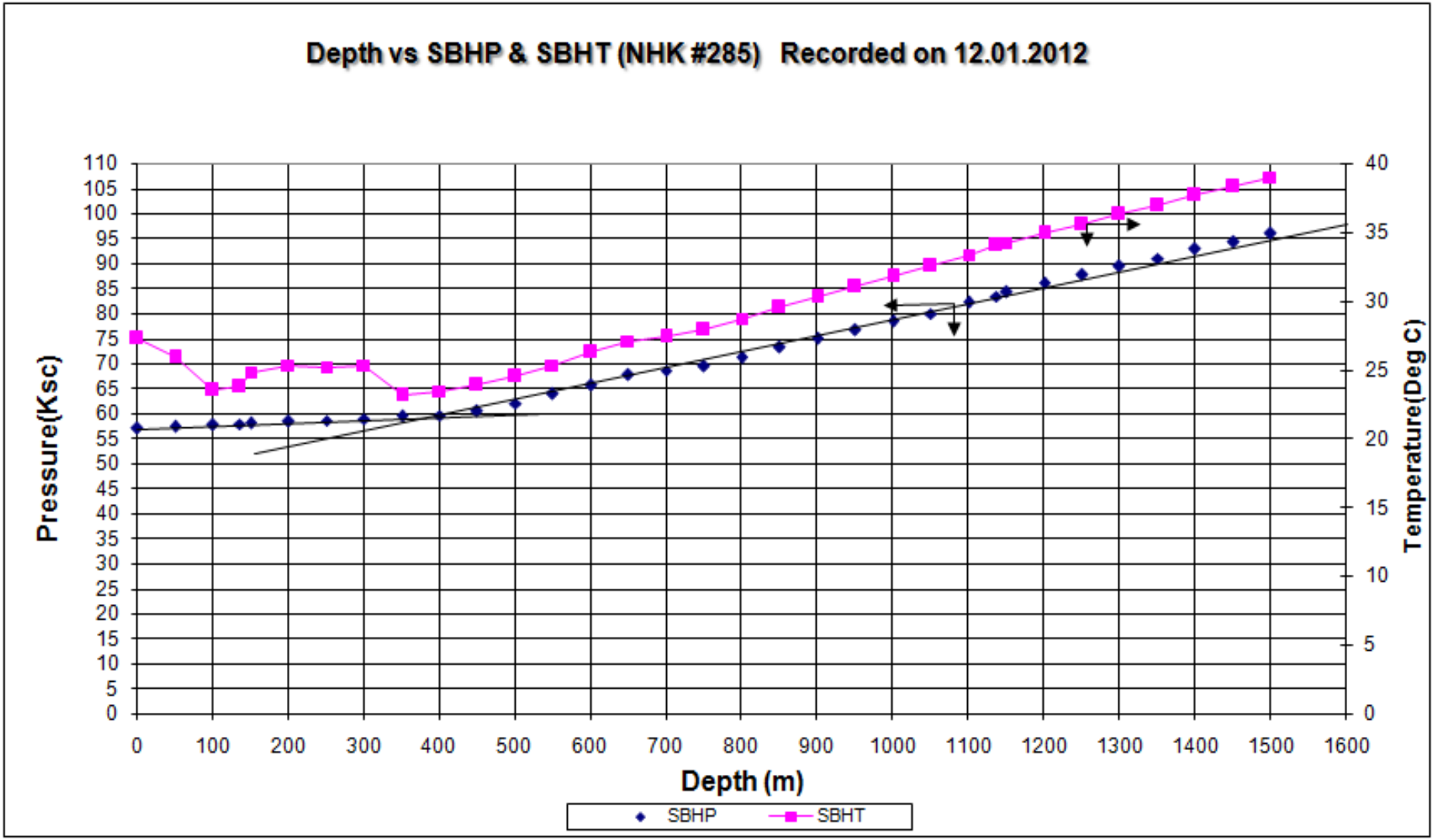
After the incident, on confirmation of underground blowout at the well, the well killing plan was reviewed in consultation with CMT, ONGCL, and decided to go for bottom kill.

Prior to bottom kill, the X-mass tree was changed with new one by setting two numbers of retrievable tubing plug at 26 & 27m and the plugs were retrieved after replacement of the X-mass tree.

After installation of X-mass tree, tried to lower coiled tubing, but got held up at 323 m. Subsequently, the 2⅞″ tubing could be cleared after several attempts and lower down CT to 1672 m using special tool (sharp edge) provided by ONGCL.

Tried to kill with water and 75 pcf brine at this depth, but observed no change in pressure.

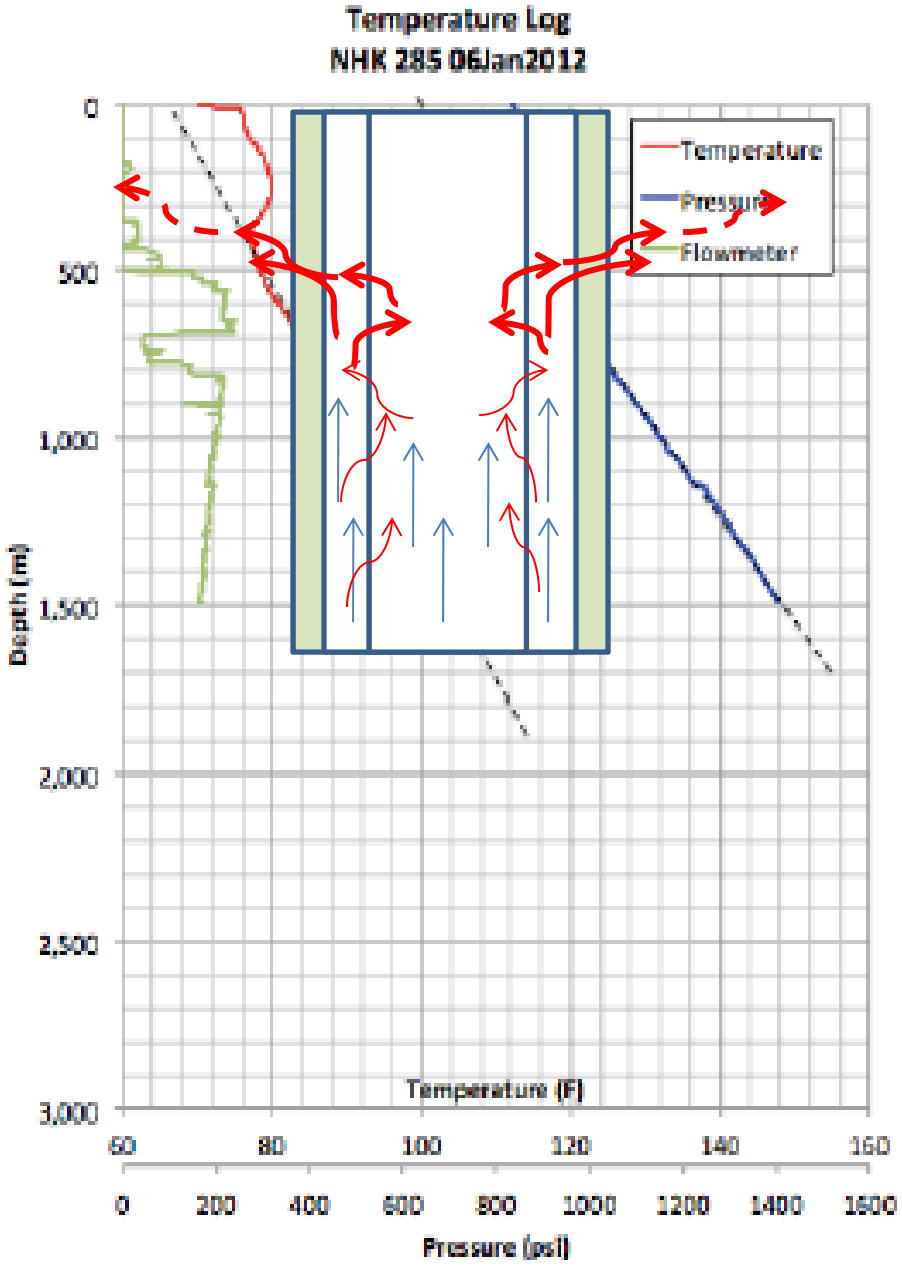
Thereafter, lowered BHP tool with slick line which got held-up at 1513m. Took BHP & Temperature measurement survey from 1500m upward and the results indicates that there is outward flow from the well at depth @ 400m.

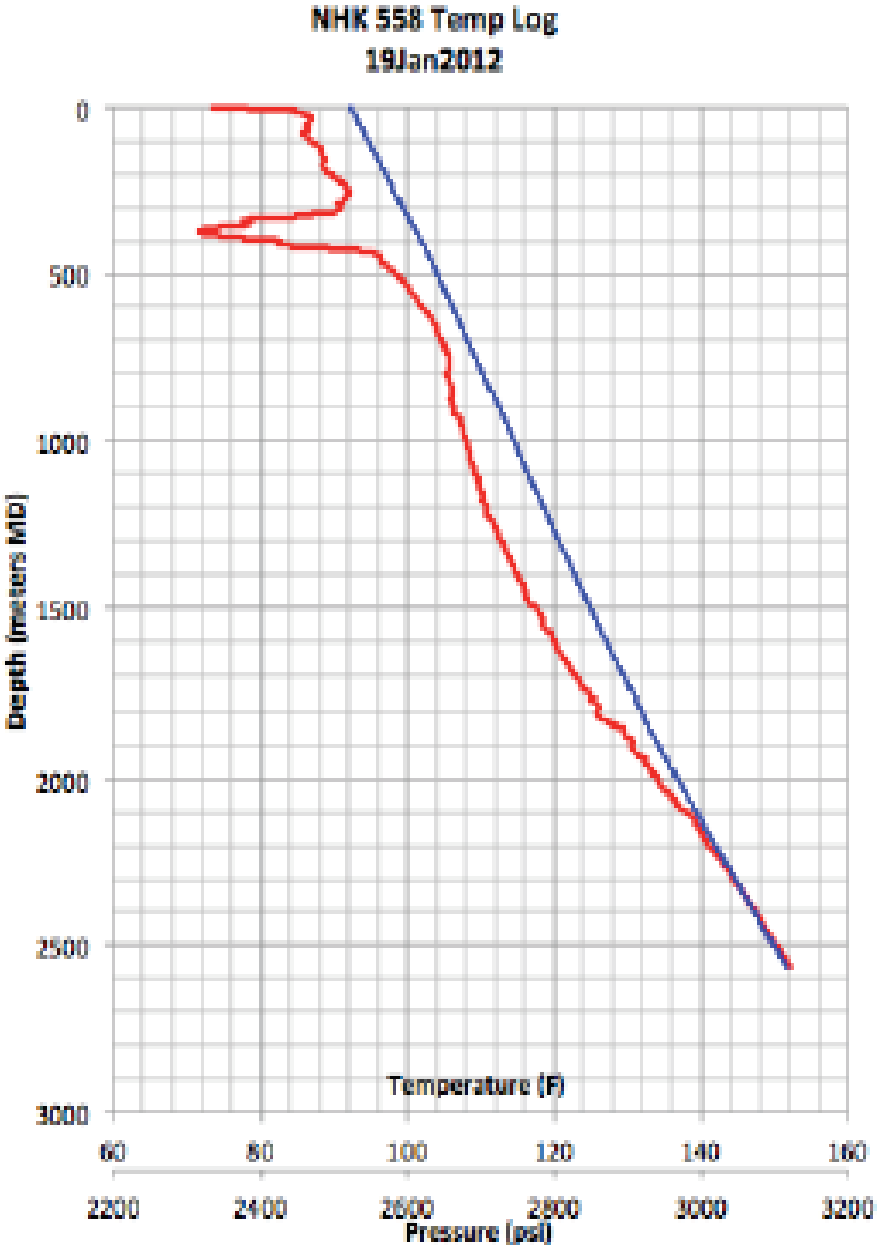

Depth vs SBHP & SBHT (NHK #285) Recorded on 12.01.2012
Pressure(Ksc)
Temperature(Deg C)
Depth (m)
SBHP
SBHT
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600

After getting anomalies in bottom hole pressure and temperature from BHP survey, a temperature log was recorded to reconfirm the results from a depth of 1500m (as logging tool could not be lowered beyond this point). Spinner log was also recorded along with temperature log.

Another temperature log was taken at the adjacent well NHK#558 from the reservoir depth for comparison. Next Fig. shows the summarized logs at well NHK#285 and NHK#558.

The BHP survey and logs indicate that there is outflow from the well at around 400m.


Temperature Log
NHK 285 06Jan2012
Temperature
Pressure
Flowmeter
Depth (m)
0
500
1,000
1,500
2,000
2,500
3,000
Temperature (F)
60
80
100
120
140
160
Pressure (psi)
0
200
400
600
800
1000
1200
1400
1600

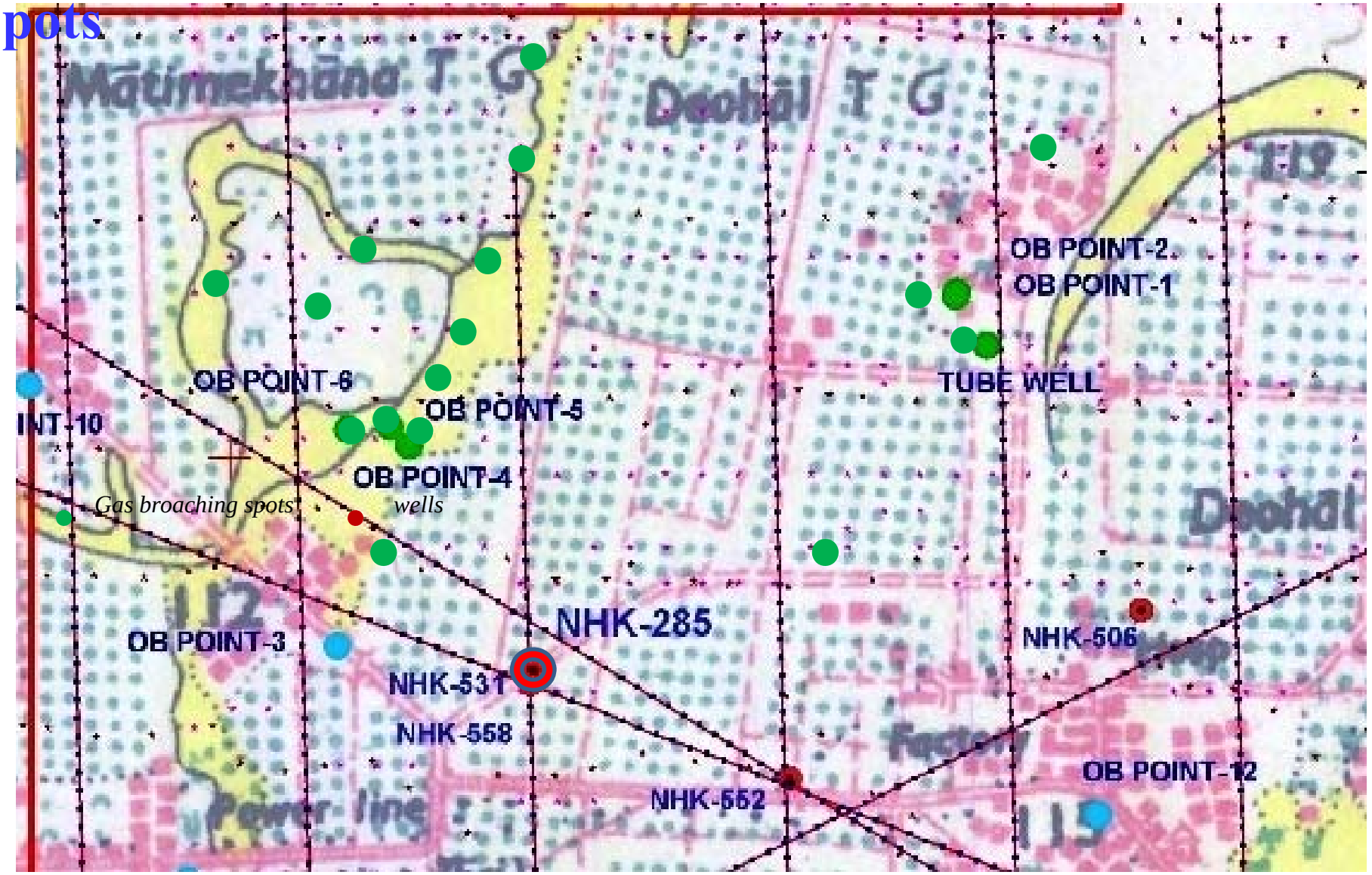

NHK 558 Temp Log
19Jan2012
Depth (meters MD)
0
500
1000
1500
2000
2500
3000
Temperature (F)
60
80
100
120
140
160
Pressure (psi)
2200
2400
2600
2800
3000
3200

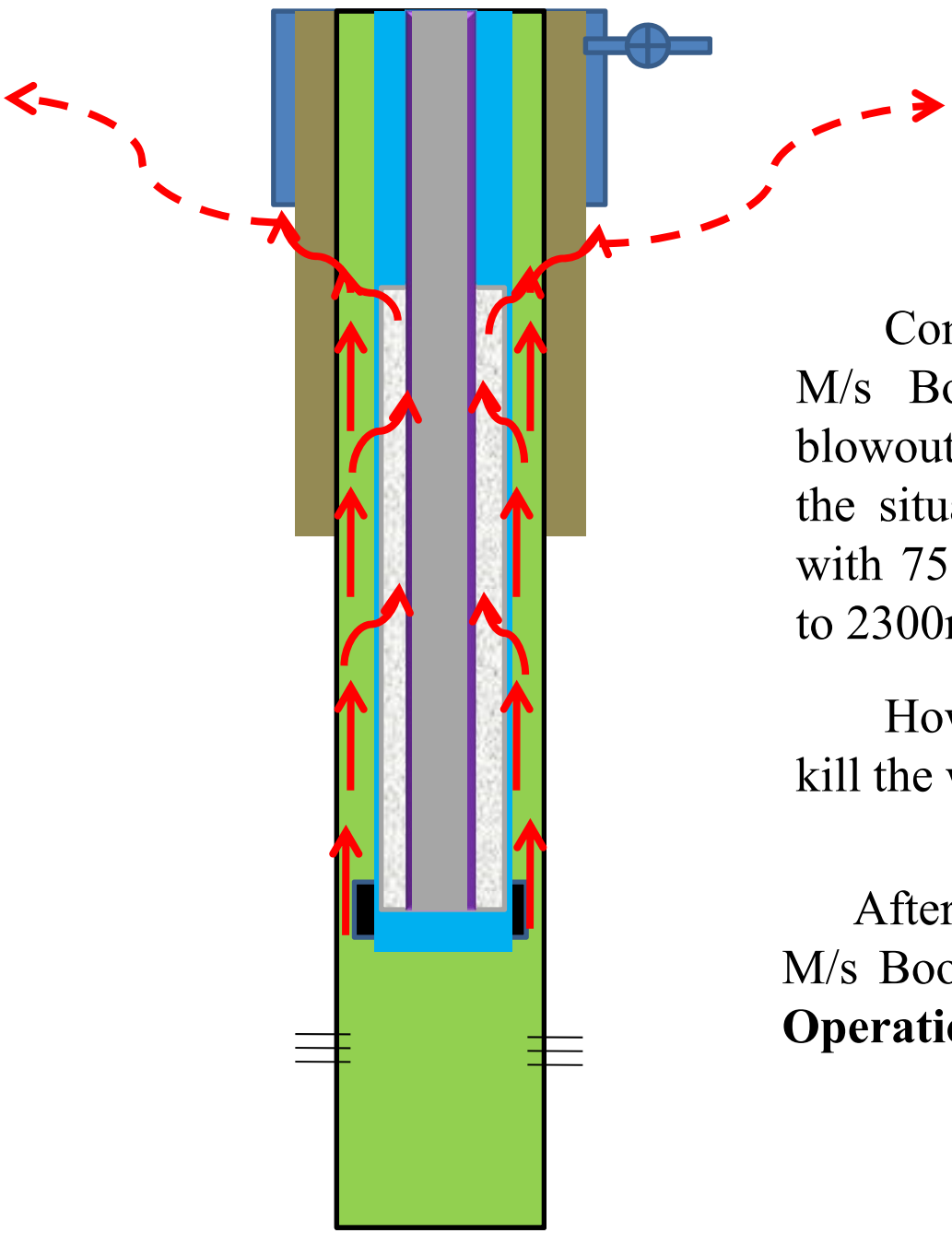
During the 2nd week of December, 2011, surface broaching of gas at around 1.5 km away from the well NHK#285 in N-E direction was reported and there was a fire incident in night hours on 31st Dec, 2011.

Subsequently, in the first week of January, 2012, surface broaching of gas was noticed at an area about 1 km away from the well in N-W direction .

Gas sample was collected from these spots and it was found to be of similar composition as of NHK#285 gases.

5 : Map showing wells and gas broaching spots



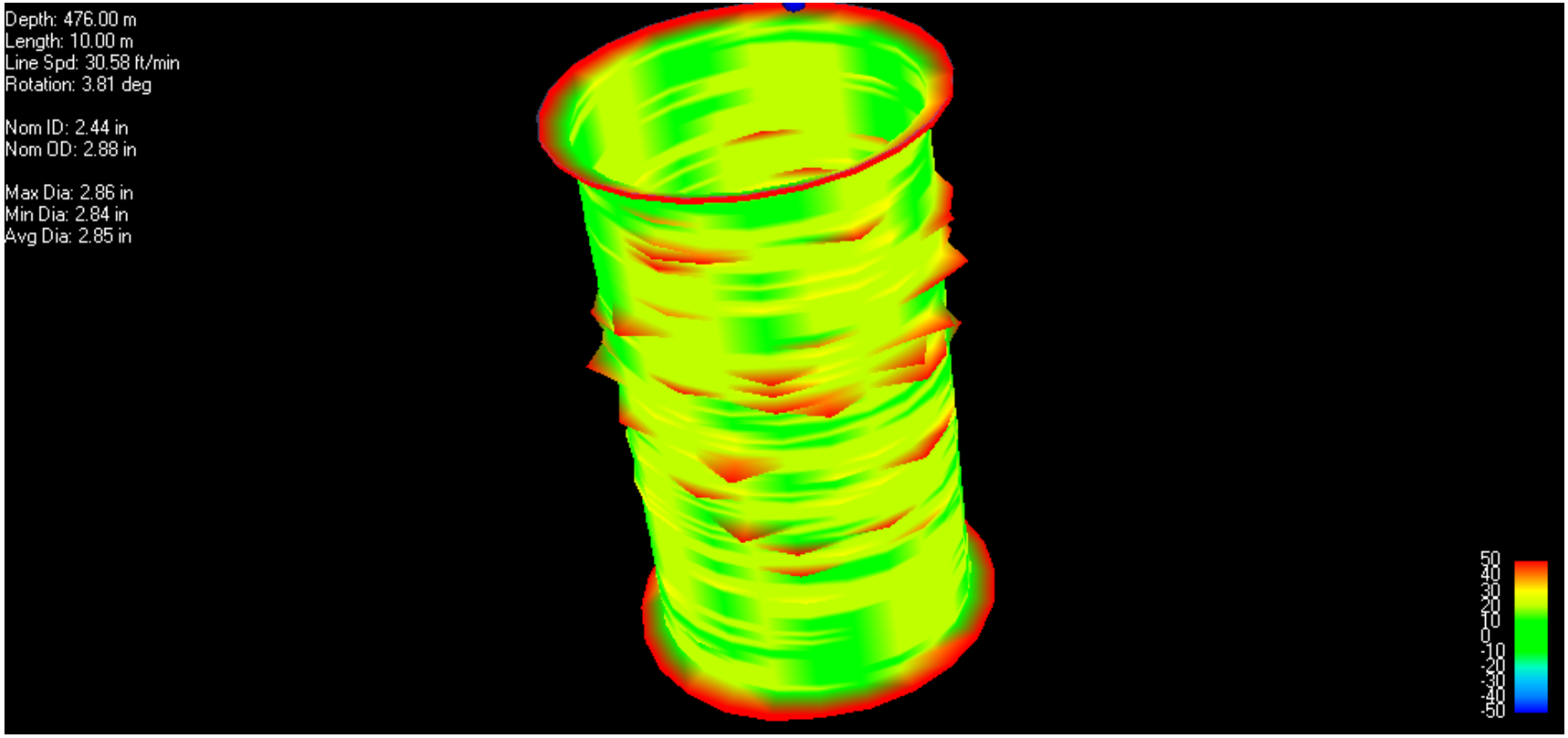


Considering the gravity of the situation, M/s Boots & Coots, a world renowned blowout control agency, were called to tackle the situation and they tried to kill the well with 75 pcf brine, lowering coiled tubing up to 2300m.

However, M/s Boots & Coots could not kill the well by this process .

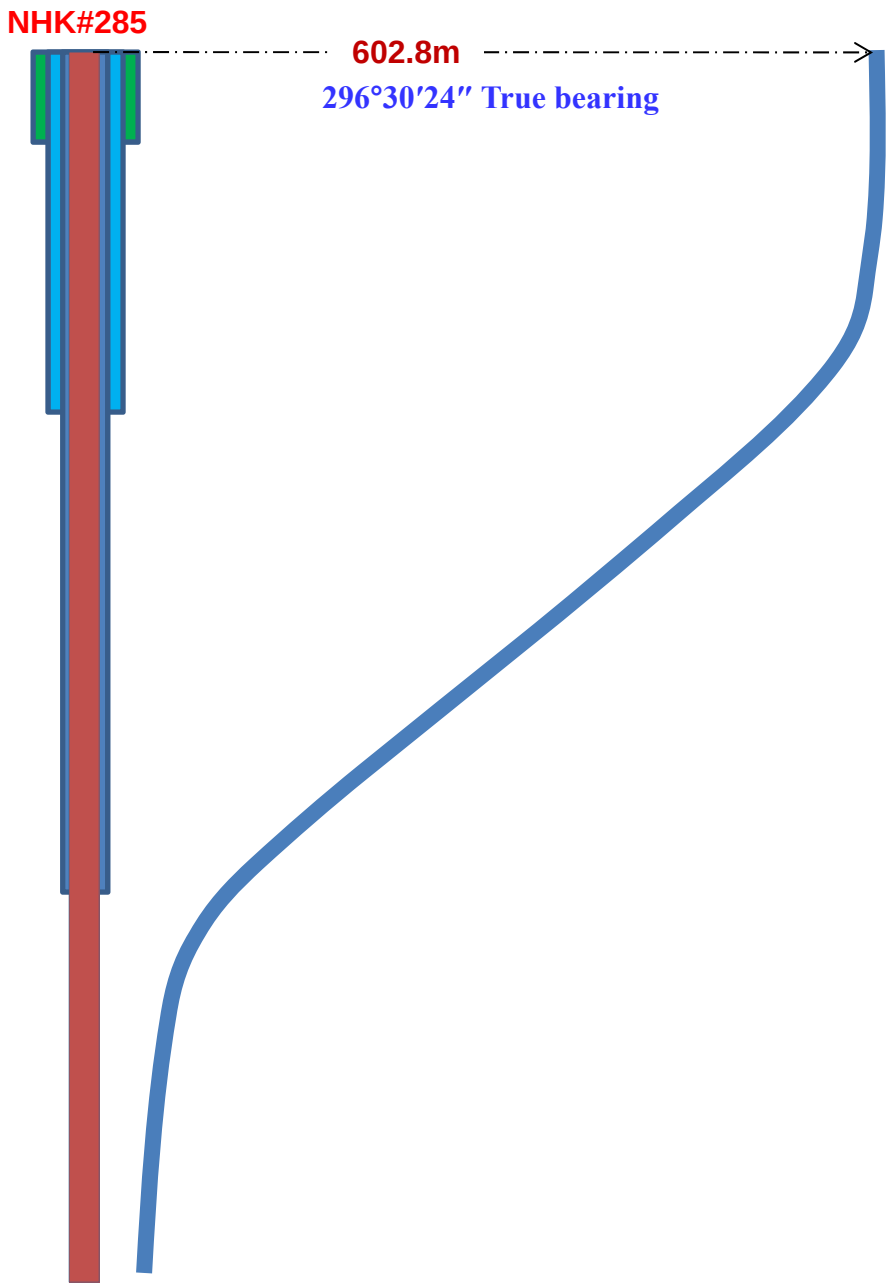
After assessment of the well condition M/s Boots & Coots proposed for **Snubbing Operation** (HWO) to control the well.

While working on M/s Boots & Coots HWO (Hydraulic Workover Operation) proposal, a tubing inspection log was recorded using “Multifinger Imaging Tool” from 19.01m to 1513.26m (Logging tool could not be lowered beyond this depth) and it indicate that there are possible holes in 19 numbers of tubing at various depths. Fig. shows the 3D view of 49th joint.



(Red spots indicates total metal loss, Yellow indicates partial metal loss & Green indicates no metal loss)

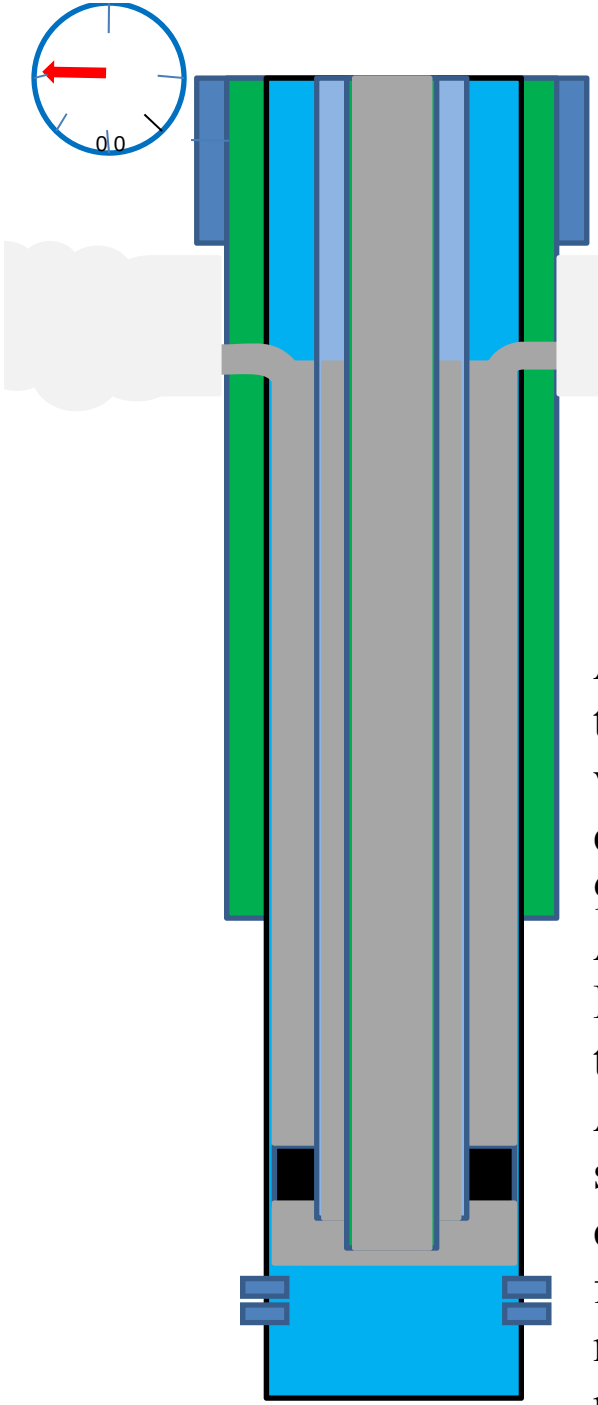
Meanwhile, it was planned to drill a replacement well from the nearby well plinth of NHK#552. It was aimed to use this replacement well for killing the NHK#285 if required.



How the underground blowout was controlled

Mud parameter consideration: Mud weight was designed to balance the reservoir pressure at 600m below the surface (2430m – 600m = 1830m) and Viscosity of mud was kept optimal to minimize friction loss inside CT as well as to arrest gas percolation rate.

Mud Weight (MW) = Pressure (psi) ÷ {Depth (ft.) x const. (.0069) } pcf
= [(239.4 x 14.23) ÷ {(2430-600)(3.28) x 0.0069}] pcf
= [3406 ÷ (6002.4 x 0.0069)] pcf
= (3406 ÷ 41.42) pcf
= 82.23 pcf
≈ **85 pcf** (considering safety margin)



As planned, on 29th Mar, 2012, coiled tubing was lowered slowly pumping high viscous fluid (XC-polymer + CMC-HVG of 75 sec/quart) using high pressure kill pump. By this process any debris inside the tubing was cleaned and finally the CT could be lowered beyond 2⅞″ tubing shoe.

After lowering CT to 2200m, started pumping mud and finally the CT was lowered near to the perforations. Thereafter, increased the pumping rate up to the 80% of CTU pressure limit and could pump up to 1.2 to 1.3 bbls/min. During the process, kept tubing, casing and annulus open through single choke to balance pressures and also avoid further charging of the loss zone at around 1400m.

After pumping 30 bbls of mud observed entire annuli pressure trend to decrease and gradually pressure decreased proportionate to the volume pumped. Continued pumping at high rate, controlling the choke, till all three pressure (2⅞″ Tubing, 5½″ Casing & 5½″ × 9⅝″Annulus) came to zero.

All three pressure came to zero after pumping 170 bbls of mud. Pumped another 30 bbls of mud and shut the well after pulling out the CT.

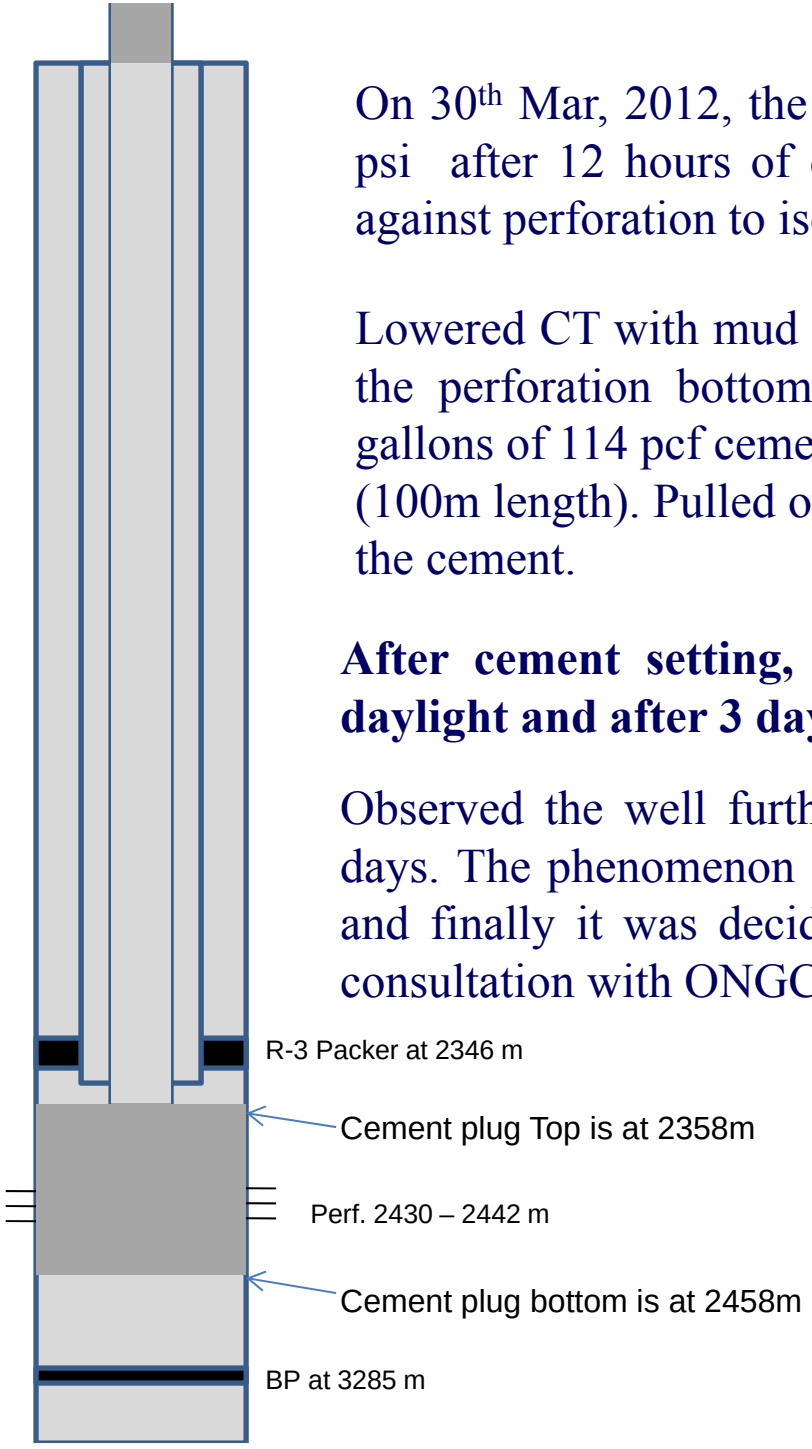
After half an hour of observation, the wellhead pressure became stable at 250 psi which was expected back pressure from the charged formation. However, the well kept shut-in overnight for further observation. It was decided not to pump mud further which may push back charged gas away from the well and contaminate nearby water bearing zone.

On 30th Mar, 2012, the wellhead pressure was found to be stable at 250 psi after 12 hours of observation and decided to place a cement plug against perforation to isolate the producing zone.

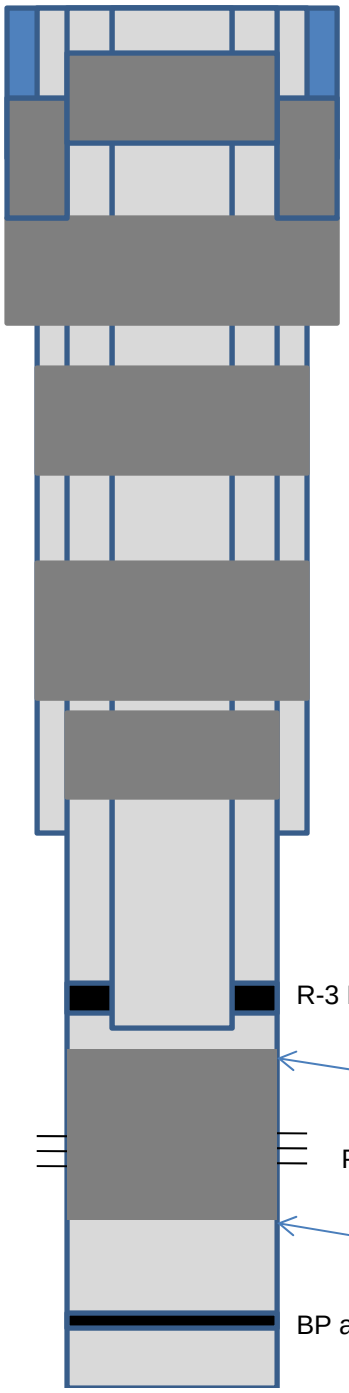
Lowered CT with mud circulation and got held up at 2458m, 16m below the perforation bottom (perforations: 2430m – 2442m). Pumped 270 gallons of 114 pcf cement slurry and placed a plug from 2458m to 2358m (100m length). Pulled out CT and kept the well shut-in for 48 hours to set the cement.

After cement setting, bled off charged gas from the well during daylight and after 3 days there was no pressure at wellhead.

Observed the well further and found no pressure at wellhead after 15 days. The phenomenon implies that there are no flow behind the casing and finally it was decided to abandon the well as per policy made in consultation with ONGCL.



WELL ABANDONMENT



Recover production tubing from 1381m.
Recorded USIT log from 1379m.

Placed 2nd cement plug from 1380m-1290m.

Perforated 5.1/2” casing 1242m-1243m.

Placed 3rd cement plug from 1290m-1075m. Cement slurry squeezed to 9.5/8” annulus.

Placed 4th cement plug from 667m-617m. Cement slurry squeezed to 9.5/8” annulus.

Placed 5th cement plug from 617m-451m. Cement slurry squeezed to 9.5/8” annulus.

Placed 6th cement plug from 188m-88m. Cement slurry squeezed to 9.5/8” annulus.

CONCLUSION

Underground blowouts are a growing problem because of aging wells. Tubular corrosion/erosion is the single largest cause of underground blowout in producing wells.

Operators many times fail to respond immediately and correctly when an underground blowout occurs. That makes control more difficult as flow paths erode, downhole tubular degrade (erosion added to corrosion) and supercharging occurs.

In this particular well, recognition of underground blowout was little late because of inexperience as this is the first well having such problem in the history of OIL and due to the restriction inside the tubing to lower inspection tools.

Initially, it was thought to be a loss circulation problem only and utmost attempts were made to arrest lost circulation. On recognition of the problem, detailed control plan was made for bottom kill and accordingly the well was controlled as described.

Key Learning:

- Sand control measures must be taken immediately after observation of sand problem / unconsolidated sand stone reservoirs.
- Gas tight (premium threaded) casing and tubing should be used in all gas wells & HGOR well completion.
- Packer fluid should be suitably selected and designed based on reservoir fluid considering long life of the well.
- Annular pressure build-up must be addressed immediately once it is noticed.
- Well control operation must be executed by trained & experienced person and well control problems must be studied properly.
- Recompletion of the existing wells in higher up prospects is to be done only after assessing the integrity of production casing.
- Production packers to be used in wells are to be procured from the reputed and proven manufacturers only for reliable performance.

THANKS

Probable causes for this incident may be drawn as-

- Aging of the well (35 years) and /or production of gas with sand content for a long duration (July 2010 to 14.07.2011) might have caused erosion added to corrosion leading to loss of tubing and casing integrity.
- As per recommended practice, gas tight (premium threaded) casing and tubing should be used in gas wells completion. But, this well was completed with round threaded casings and tubing. This could have led to leakage in the thread connections of the tubing and production casing string.
- 78 pcf Salt Solution ($CaCl_2$) was the packer fluid since October, 2005, which might have accelerated tubular corrosion leading to loss of tubular integrity.
- Annular pressure build-up was not addressed in time – 5½″ pressure was recorded as 2700 psi (190 kg/cm^2) on 9th September, 2009 and 9⅝″ casing pressure was recorded as 1160 psi (82 kg/cm^2) on 1st May, 2010. But, proper action was not taken to address these unwanted pressures.
- Prolong attempt to arrest loss circulation and inexperience in pumping heavy mud & cement slurry through Coiled tubing led to delay in operation and aggravated the situation.