

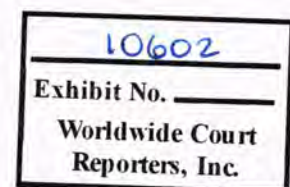
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**From:** William Burch  
**Sent:** Tuesday, June 08, 2010 3:29 PM  
**To:** David Barnett  
**Subject:** Hydraulic Kill Technical Note  
**Attachments:** Dynamic Kill Technical Note rev 0.docx

See attached.

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## Shallow Intercept

The earliest anticipated shallow intercept is the first "pass-by" of the original MC252 #1 wellbore at 15,914 ft TVDss (15,989 ft TVD Horizon / 16,002 ft TVD DD3). In this scenario, an unanticipated intersection would occur while drilling the 10-5/8" x 12-1/4" section towards the next casing point of the 9-7/8" liner at 16,912 ft TVDss (16,987 ft TVD Horizon / 17,000 ft TVD DD3). It is anticipated that the 11-7/8" liner will achieve a down-hole leak off test of the Most Likely Shale Frac of 14.6 ppg equivalent mud weight (11,540 psi). This fracture pressure at the 11-7/8" liner shoe is assumed to be the weakest formation exposed during the dynamic kill.

For the purposes of calculating the equivalent mud weights, only TVD depths are taken into consideration. Measured Depths are only of concern regarding frictional pressure loss calculations. To convert between TVDss and the TVD of the various datum,

DD3 has 88 ft of RKB above the mean sea level.

Horizon had 75 ft of RKB above the mean sea level.

There is 13 ft of TVD difference.

To simply, all depths are referenced to TVDss to help clarify and unify discussions.

Although the probability of shallow intercept is extremely low, there is a remote possibility of early collision. There is no possibility of shallower intercept on the first relief well (MC252 #3) due to the directional path currently planned and cone of uncertainty around the target well.

The blowout and dynamic kill simulator used for primary determination of production and kill rate is OLGA-WellKill as built and run by Add WellFlow AS. The results and graphs are built by Add WellFlow AS.

Since the model does not calculate the pressure at the exposed 11-7/8" liner shoe directly, it was assumed that the fracture pressure can be moved down to the intercept point. In order to do so, it is assumed that the hydrostatic pressure of a 14.2 ppg mud weight will be acting downwards to the intercept point to yield an equivalent fracture pressure. There is 802 ft TVD difference between the liner shoe and the shallowest intercept point. Therefore, 592 psi of 14.2 ppg added onto the 11,540 psi fracture pressure giving a maximum allowable pressure of 12,132 psi (or an equivalent of 14.58 ppg.) This maximum allowable pressure was used in the simulations to determine the limits for the dynamic kill and circulation rate available.

## Simulations

The simulations are based on the most likely flow path of casing annulus to the seafloor exit. For these models, it was not taken into consideration any exiting flow at the casing burst disks or liner tops. No flow restrictions were placed on the annulus or at the subsea BOP – i.e. it is assumed wide open flow from the reservoir to the seafloor.

A custom PVT file was built by Add WellFlow AS and was based on the molecular composition of the reservoir fluid sample collected during the formation evaluation logging program of the M56E formation. No flow was modeled from the M57 formation nor the M56A, M56B, or M56C formations. It is assumed that all formations that are contributing to the flow are flowing at an equal equivalent bottom hole mud weight. The statement of requirements (SOR) objective for the dynamic kill was to successfully bring the producing formations back under control by achieving an equivalent mud weight greater than 12.60 ppg by using 14.2 ppg SOBM. The SOR states for the successful isolation of the producing

formations that an equivalent of 14.20 ppg bottom hole pressure will be achieved for the highest possible virgin pore pressure observed in the MC252 #1 well (M57C formation).

The reservoir productivity data (PI) was supplied as 50 bbl/psi/day and a liner inflow performance relationship was assumed appropriate. The reservoir injectivity data (EI) was supplied as 1/10 of the productivity data (~5 bbl/psi/day).

Earlier blowout rate estimations by Add WellFlow AS indicated that a maximum of 43,000 bopd rate was possible at the seafloor with no restrictions in the flow path. All simulations are run for worst-case dynamic kill requirements. The previous work assumed that the reservoir injectivity data was equal to the reservoir productivity data.

**Case 1 – EI = 50 bbl/psi/day**

28 bpm dynamic kill rate of 14.2 ppg SOBM can be pumped into the annular flow path and result in a successful dynamic kill of the producing formations. The maximum pressure at the intercept point was 11,969 psi which indicates that no fracturing of the 11-7/8" liner shoe was initiated. The pumping time for the dynamic kill took less than 2 hours.

**Case 2a – EI = 5 bbl/psi/day**

28 bpm dynamic kill rate of 14.2 ppg SOBM can be pumped into the annular flow path and result in a successful dynamic kill of the producing formations. The maximum pressure at the intercept point was 12,003 psi which indicates that no fracturing of the 11-7/8" liner shoe was initiated. The pumping time for the dynamic kill took approximately 4 hours.

**Case 2b – EI = 5 bbl/psi/day**

33 bpm dynamic kill rate of 14.2 ppg SOBM can be pumped into the annular flow path and result in a successful dynamic kill of the producing formations. The maximum pressure at the intercept point was 12,620 psi which indicates that fracturing of the 11-7/8" liner shoe was initiated while circulating the annulus. The pumping time for the dynamic kill took less than 2 hours. It is possible to adjust the dynamic kill rate to keep the circulation pressures below the fracture pressure while keeping the well under control.

**Intermediate Intercept**

An intermediate intercept case was run assuming the 11-7/8" liner shoe was still exposed but the intercept point occurred right at the end of the 10-5/8" x 12-1/4" section. In similar fashion as above, the fracture pressure was moved down to the intercept point which is 1,800 ft TVD deeper. Therefore, 1,329 psi was added onto the 11,540 psi fracture pressure giving a maximum allowable pressure of 12,869 psi (or an equivalent of 14.56 ppg.)

**Case 3 – EI = 5 bbl/psi/day**

21 bpm dynamic kill rate of 14.2 ppg SOBM can be pumped into the annular flow path and result in a successful dynamic kill of the producing formations. The maximum pressure at the intercept point was 12,680 psi which indicates that no fracturing of the 11-7/8" liner shoe was initiated. The pumping time for the dynamic kill took approximately 4 hours.

### **Deep Intercept (Planned)**

The planned deep intercept of 17,132 ft TVDss (17,207 ft TVD Horizon / 17,220 ft TVD DD3) has been modeled assuming the relief well has successfully drilled the 10-5/8" x 12-1/4" hole section and cemented the 9-7/8" liner in place. In this scenario, the planned intersection would occur while drilling the 8-1/2" section towards the original MC252#1 9-7/8" open hole and into the run 7" casing. This intercept depth is above any exposed hydrocarbon formations which may or may not have been originally isolated. It is anticipated that the 9-7/8" liner will achieve a down-hole leak off test of the Most Likely Shale Frac of 15.1 ppg equivalent mud weight (13,348 psi). This fracture pressure at the 9-7/8" liner shoe is assumed to be the weakest formation exposed during the dynamic kill. In similar fashion as above, the fracture pressure was moved down to the intercept point which is 220 ft TVD deeper. Therefore, 162 psi was added onto the 13,348 psi fracture pressure giving a maximum allowable pressure of 13,510 psi (or an equivalent of 15.09 ppg.)

#### **Case 4 – EI = 50 bbl/psi/day**

21 bpm dynamic kill rate of 14.2 ppg SOBM can be pumped into the annular flow path and result in a successful dynamic kill of the producing formations. The maximum pressure at the intercept point was 12,945 psi which indicates that no fracturing of the 9-7/8" liner shoe was initiated. The pumping time for the dynamic kill took less than 2 hours.

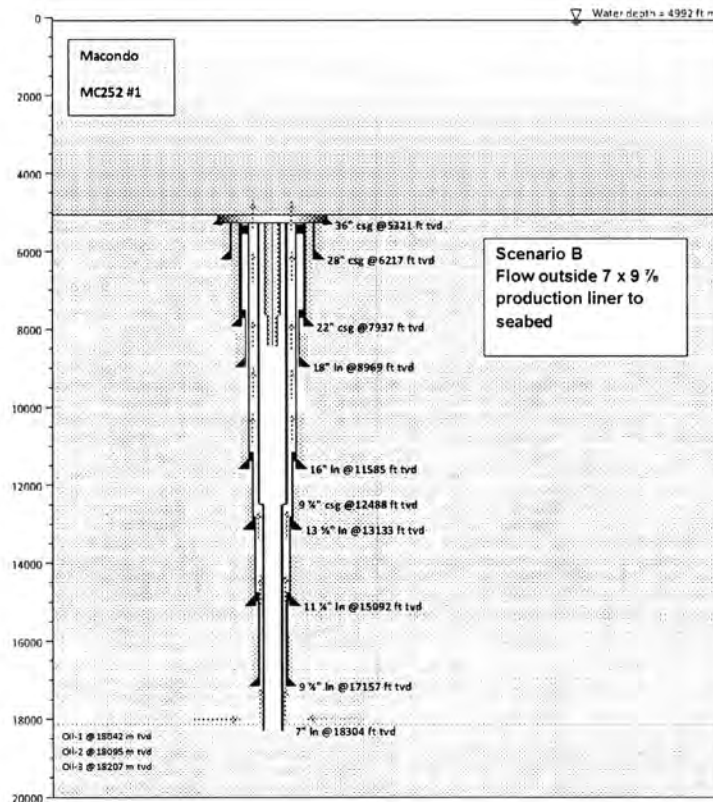
#### **Case 5 – EI = 5 bbl/psi/day**

21 bpm dynamic kill rate of 14.2 ppg SOBM can be pumped into the annular flow path and result in a successful dynamic kill of the producing formations. The maximum pressure at the intercept point was 12,963 psi which indicates that no fracturing of the 9-7/8" liner shoe was initiated. The pumping time for the dynamic kill took approximately 4 hours.

#### **Case 6 – EI = 5 bbl/psi/day**

25 bpm dynamic kill rate of 14.2 ppg SOBM can be pumped into the annular flow path and result in a successful dynamic kill of the producing formations but fracturing of the 9-7/8" liner shoe was initiated during the kill. The maximum pressure at the intercept point was 13,630 psi. The pumping time for the dynamic kill took less than 2 hours.

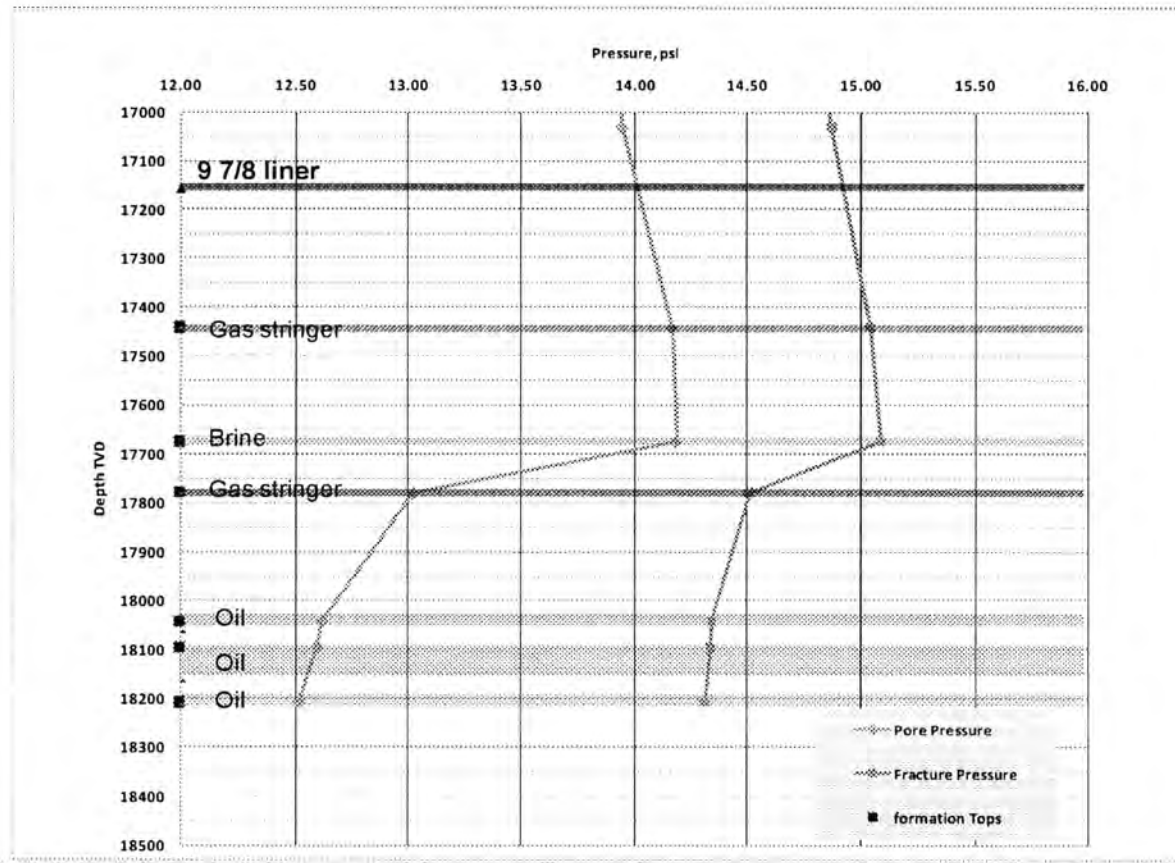
## Scenario B – Flow outside 7 inch liner



- Oil Rate
  - 43 000 bopd (2244 psi)  
(No restrictions)
- Dynamic relief well kill.  
Intersection below 9 7/8 shoe (no restrictions)
  - 14.2 ppg mud: 21 bpm



# Pore pressure and fracture pressure, EMW

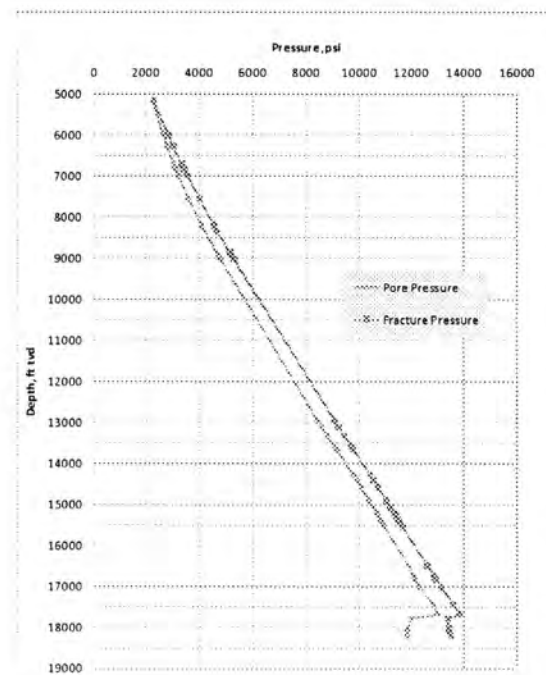
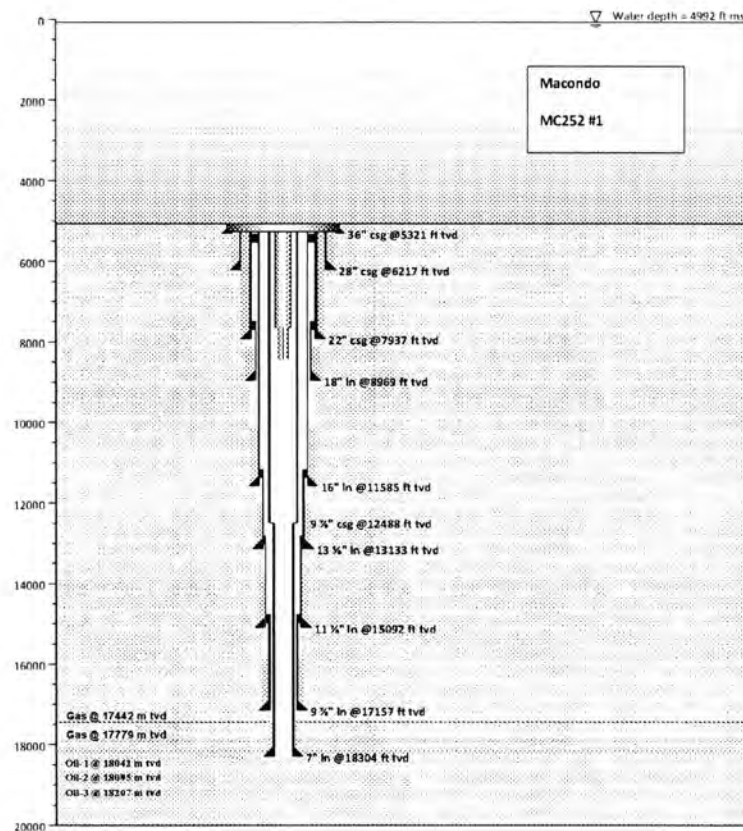


add energy

WW-MDL-00030851

WWC008-009059

# Well Schematic and Pore Pressure

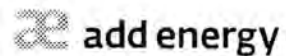
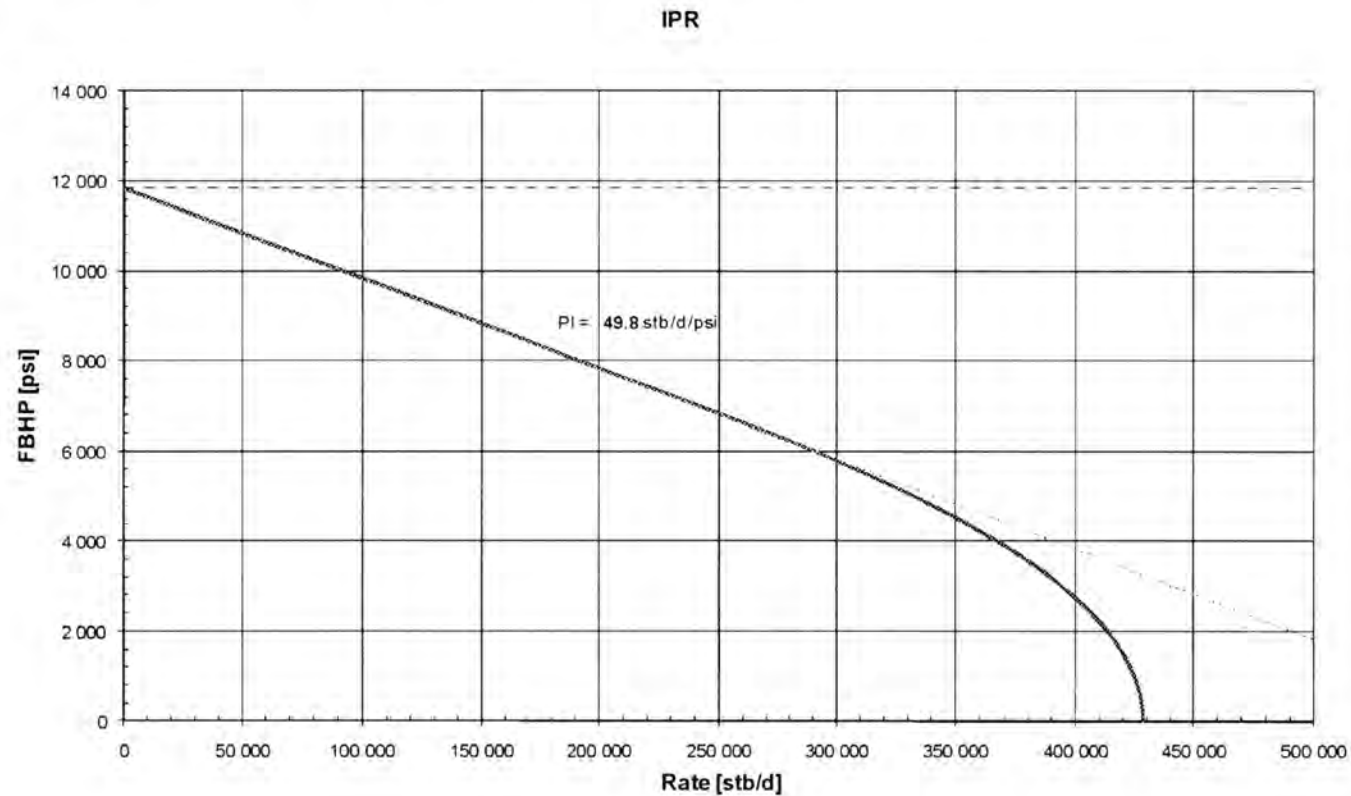


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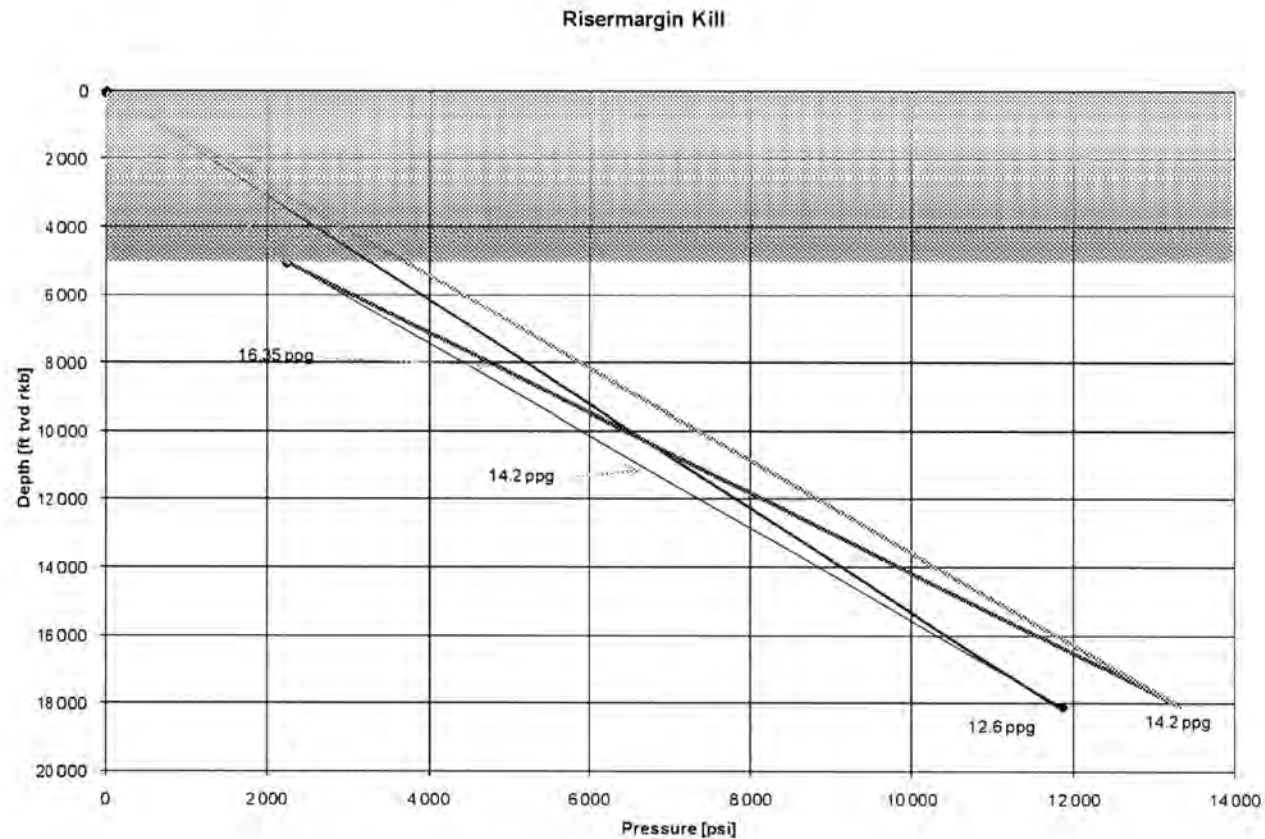
Oil Inflow – 300 mD and 86 ft NP  
GOR=3000 scf/stb, 35 API



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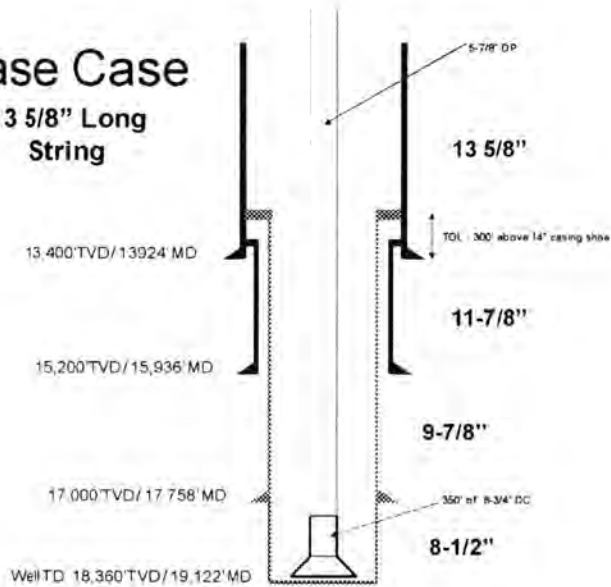


# Riser Margin – required static kill mud density

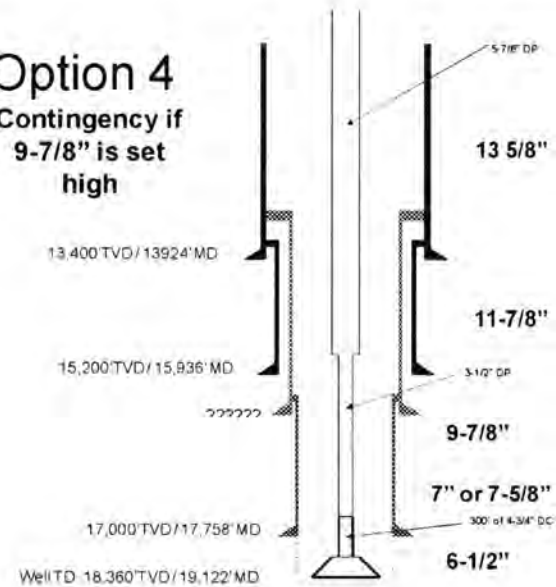


# Relief Configuration at intersection

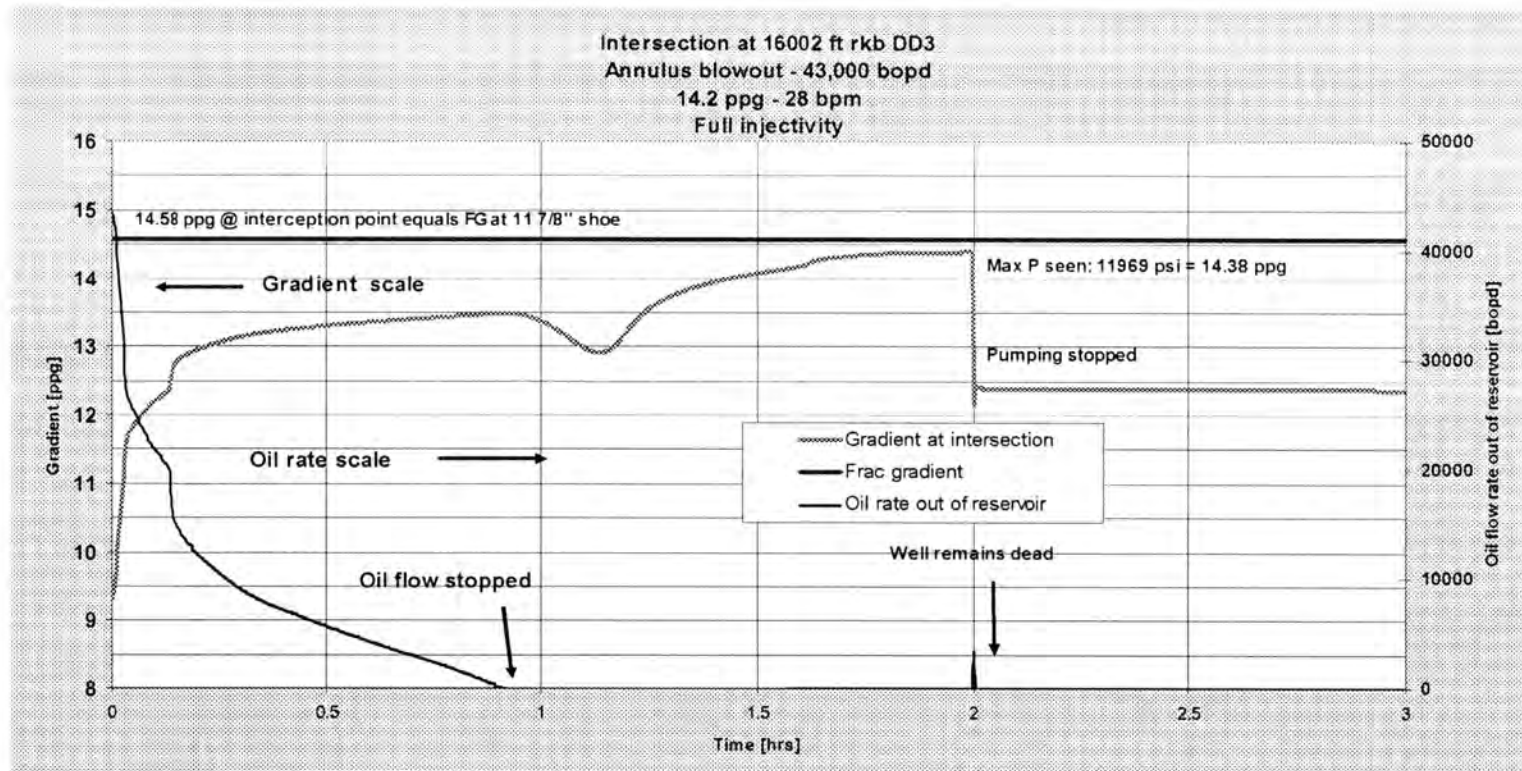
## Base Case 13 5/8" Long String



## Option 4 Contingency if 9-7/8" is set high



# Dynamic kill – 28 bpm, full injectivity Shallow intercept

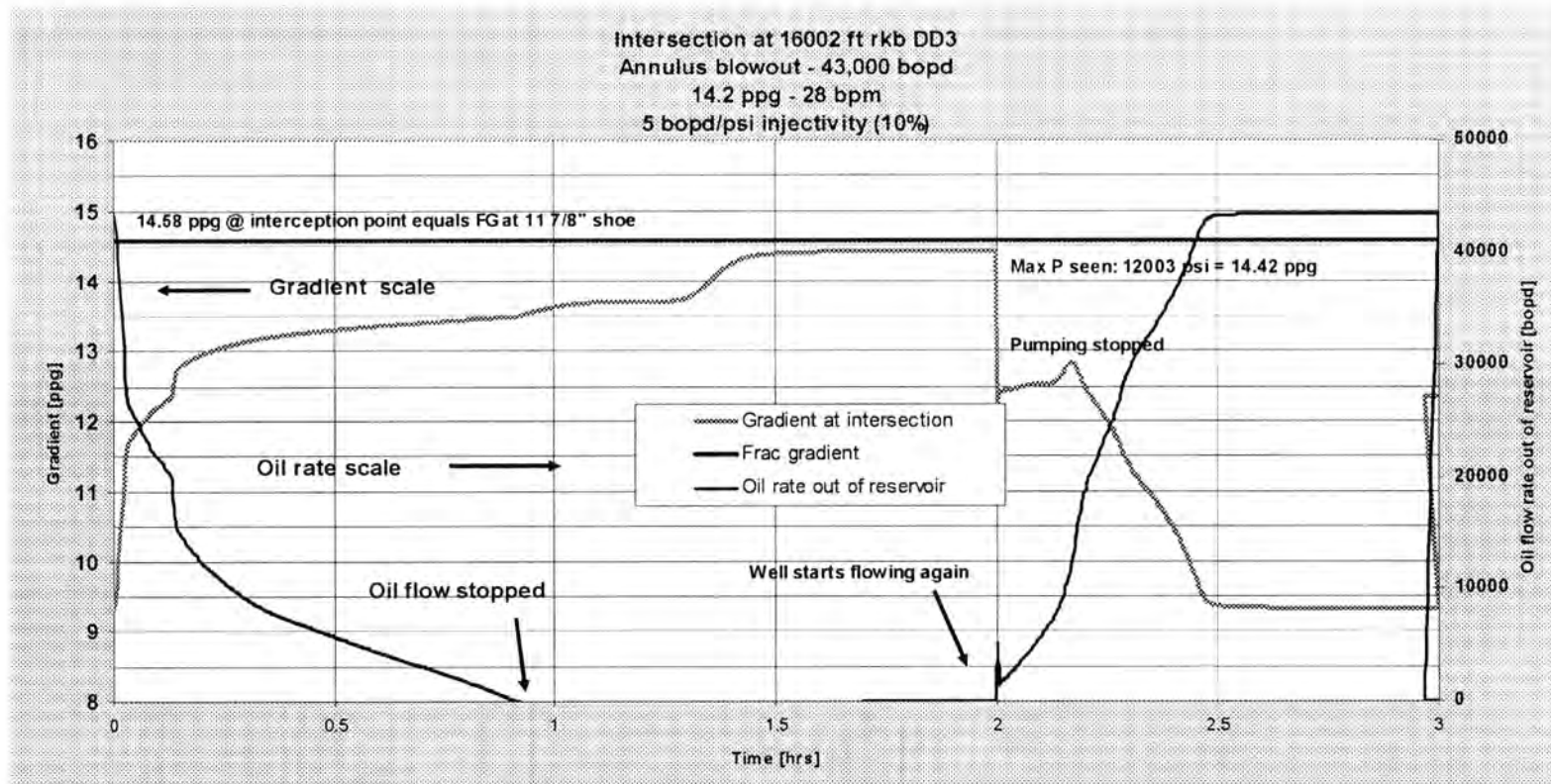


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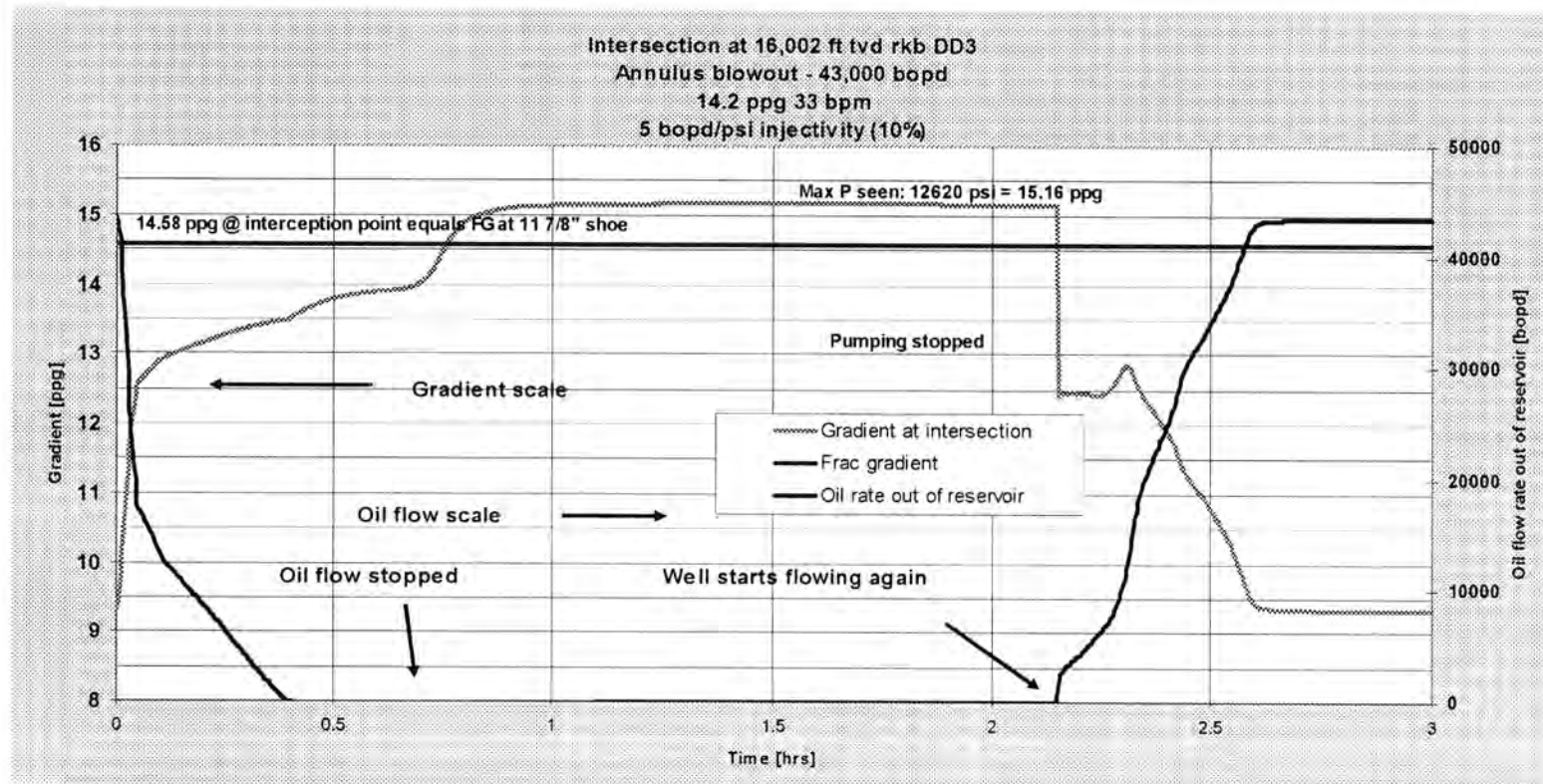
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# Dynamic kill – 28 bpm, injectivity = 5 bopd/psi Shallow intercept



# Dynamic kill – 33 bpm, injectivity = 5 bopd/psi Shallow intercept

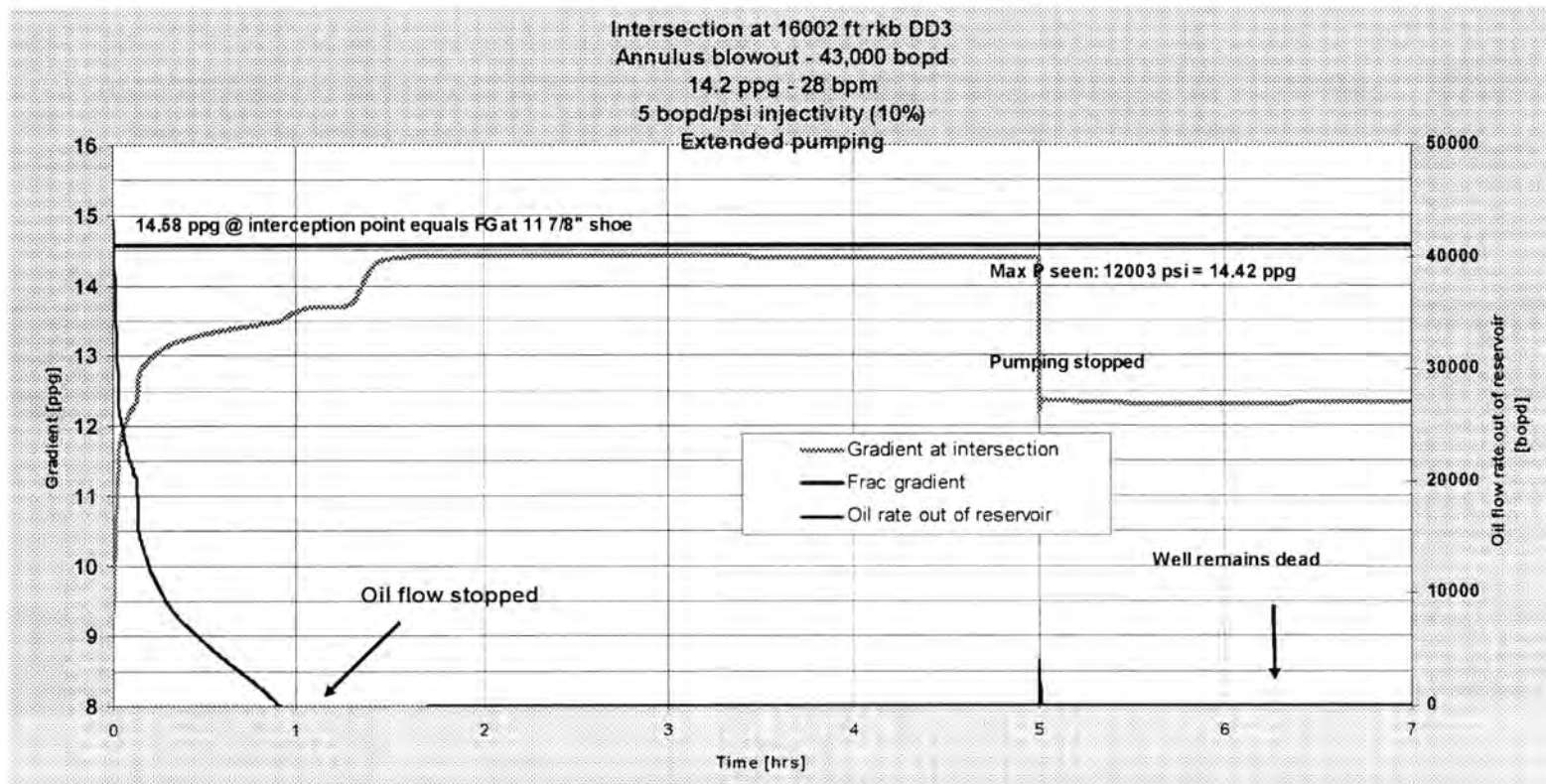


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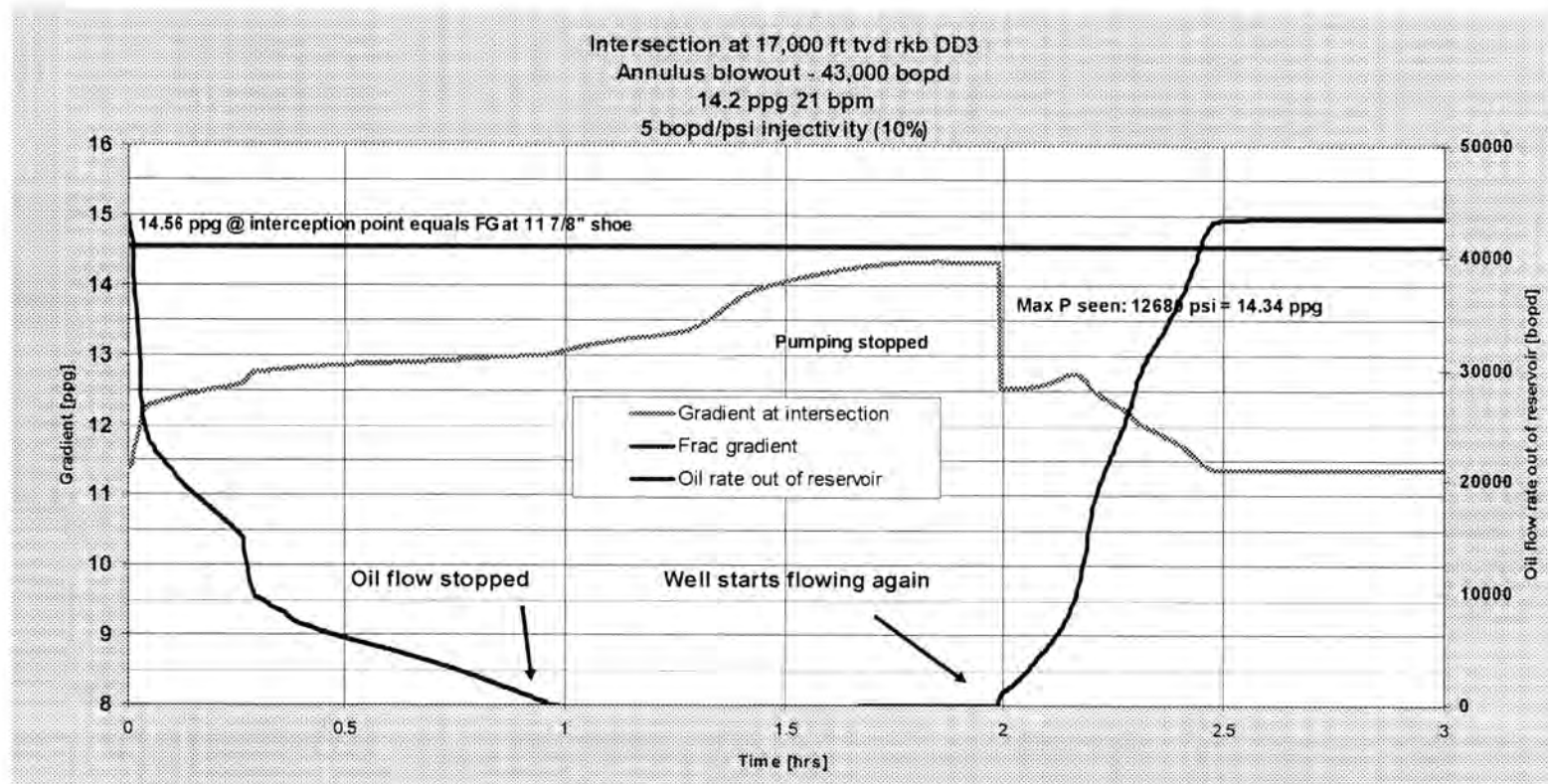
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# Dynamic kill – 28 bpm, injectivity = 5 bopd/psi Shallow intercept – extended pumping

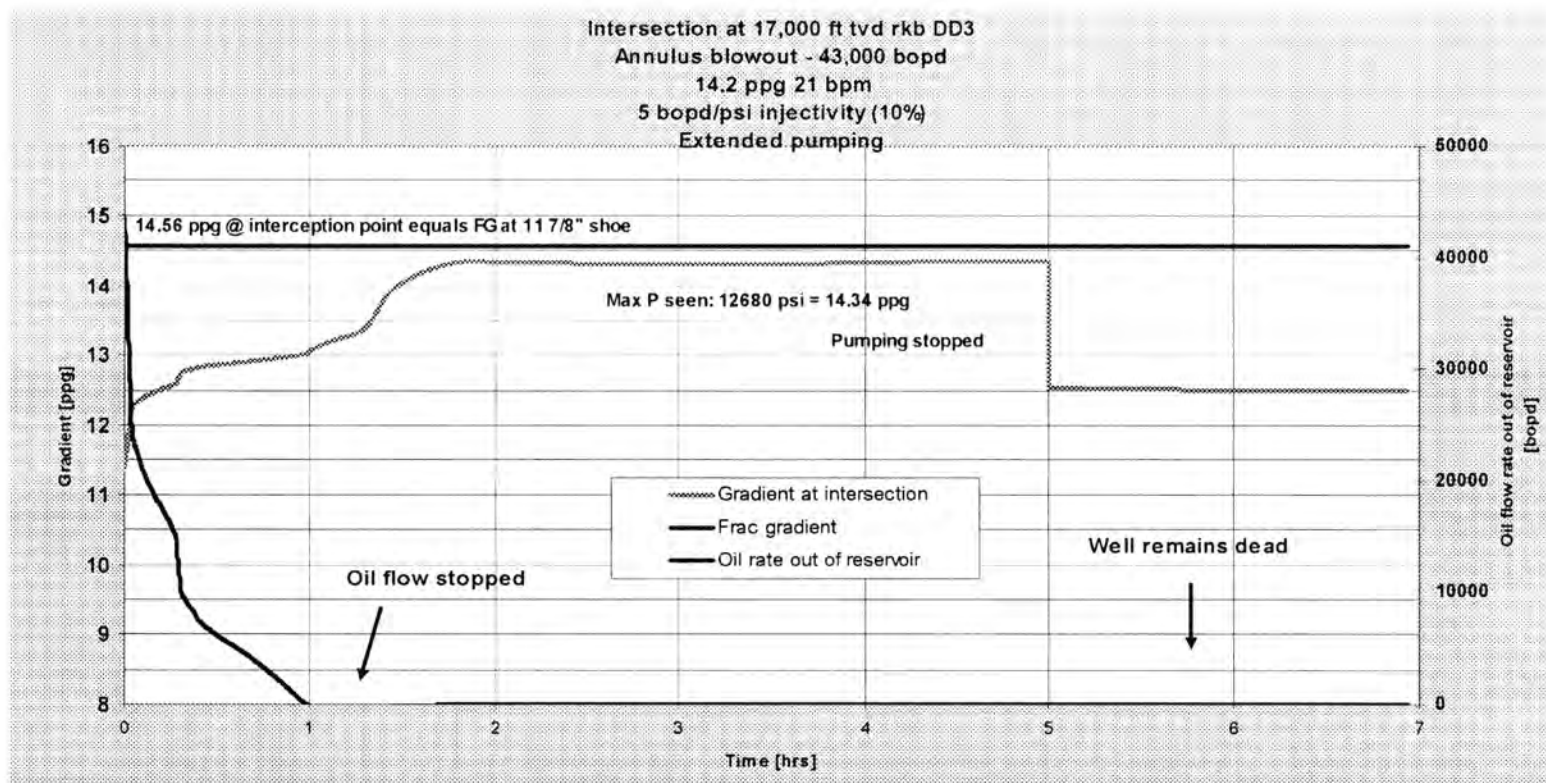




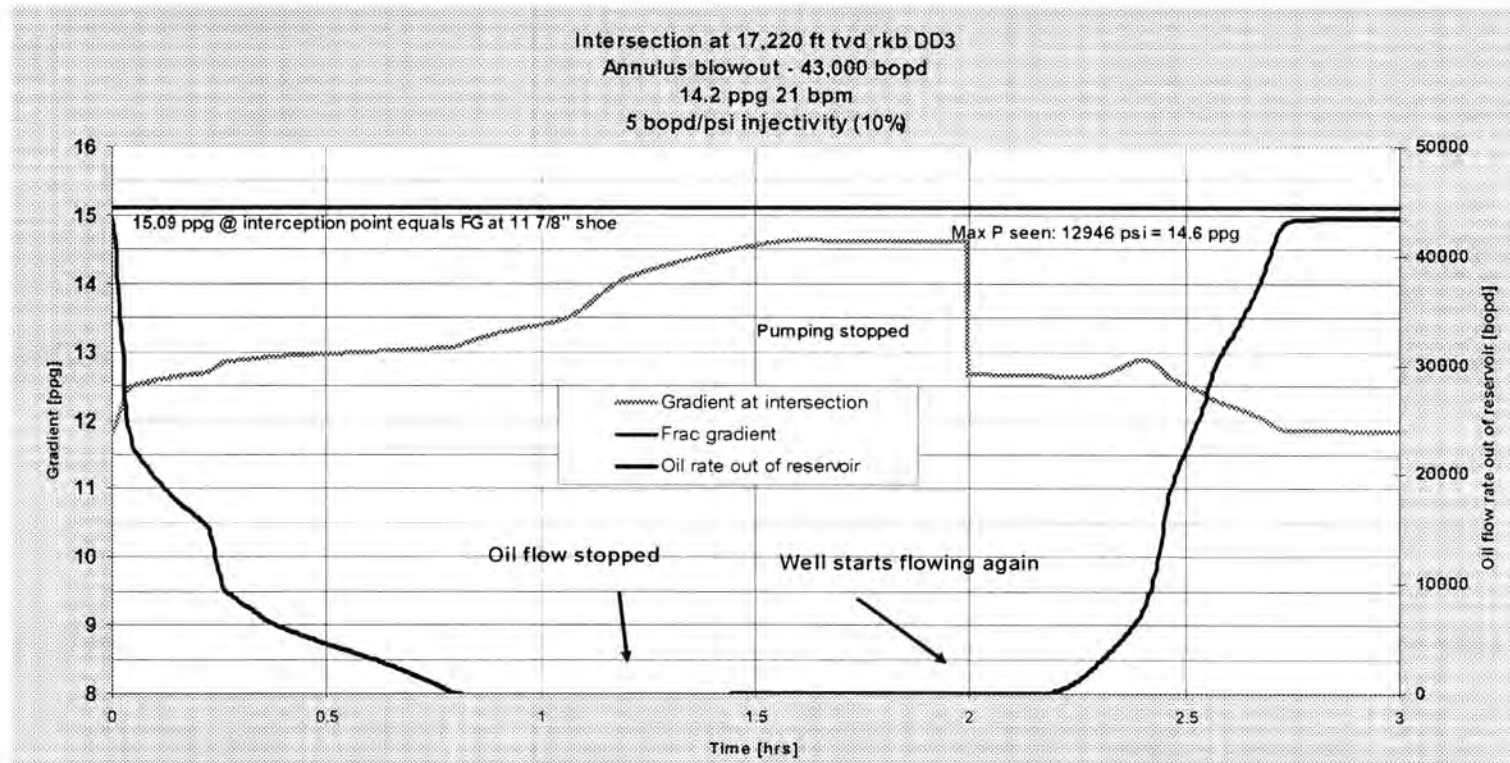
# Dynamic kill – 21 bpm, injectivity = 5 bopd/psi Intermediate intercept



# Dynamic kill – 21 bpm, injectivity = 5 bopd/psi Intermediate intercept – extended pumping



# Dynamic kill – 21 bpm, injectivity = 5 bopd/psi Deep intercept



# Dynamic kill – 21 bpm, injectivity = 5 bopd/psi Deep intercept – extended pumping

