

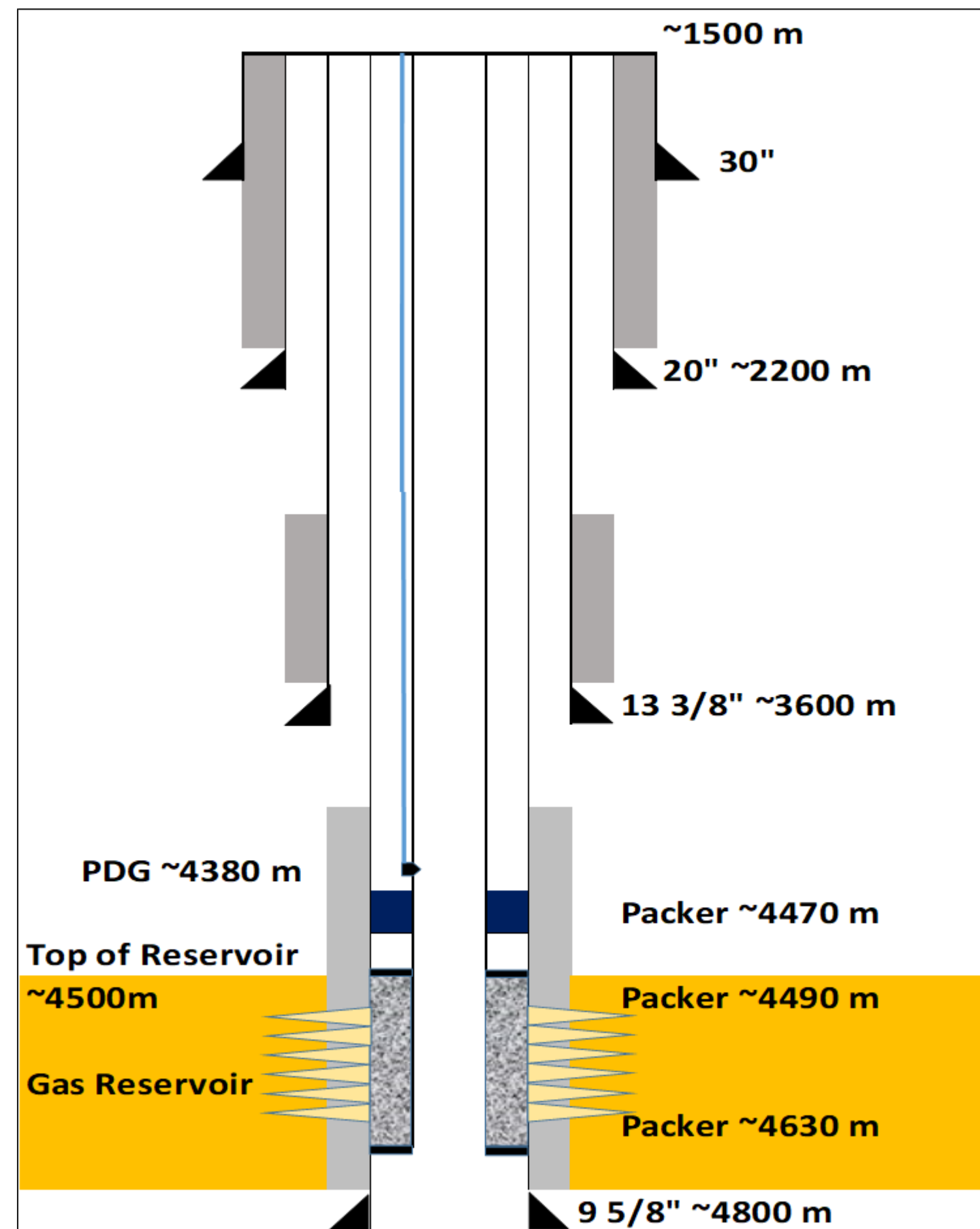
Unconventional P&A (Phase 1) by bullheading a combination of gasified and foamed fluids in a deepwater gas well

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__INTRODUCTION

The Well



WD ~1500 m / 4 phases / 5 ½" tubing, 2 packers, SC

HT subsea well (125°C) with depleted reservoir (~5,6ppg)

Minimum required pressure on A annulus of ~1000 psi

Static Level after bullheading 7,2 ppg diesel:

$$SL = \frac{0,17 \times 5,6 \times 4500}{0,17 \times 7,2} = 3500 \text{ m (2000 m below mudline)}$$

in case of tubing x A annulus communication...

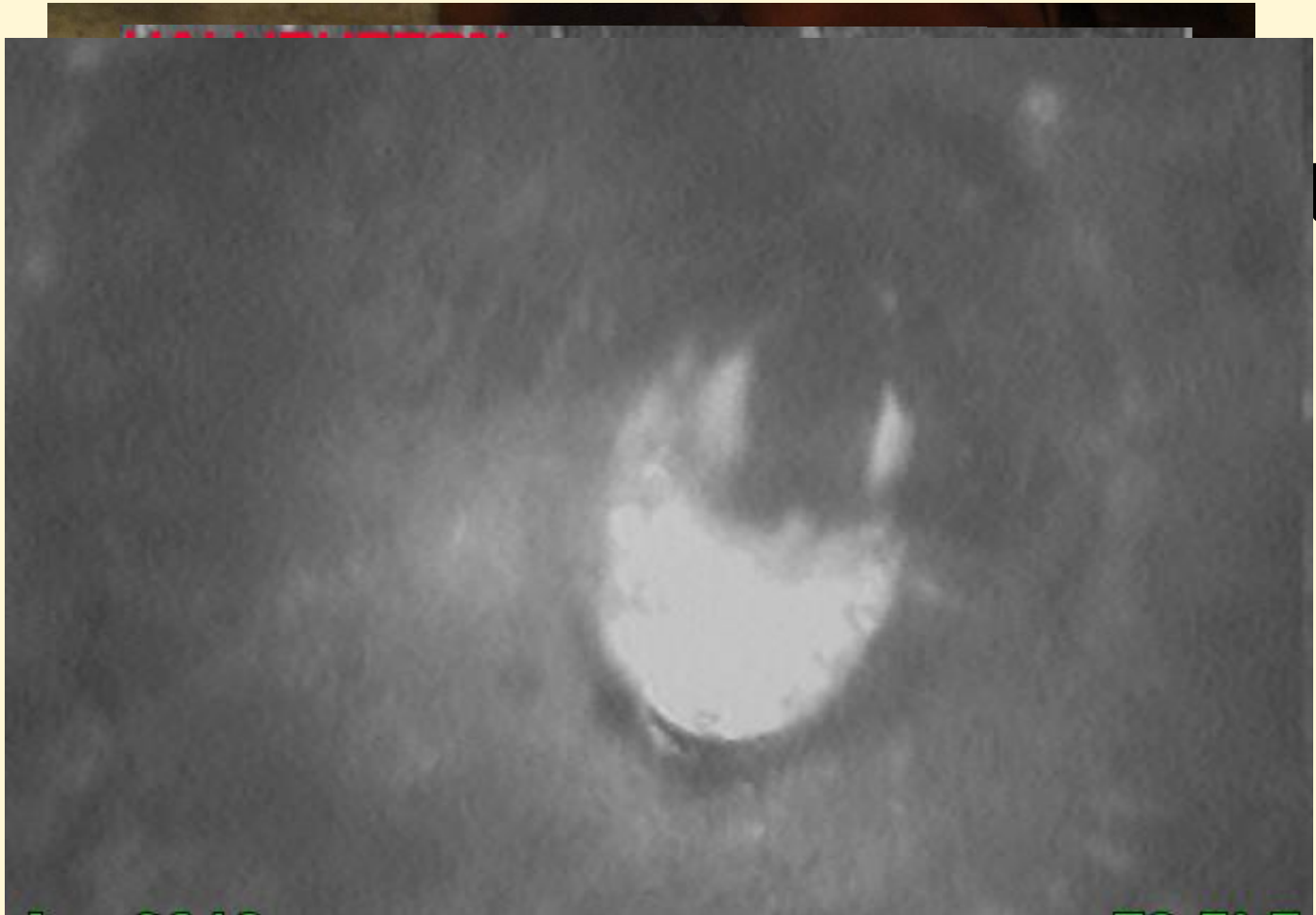
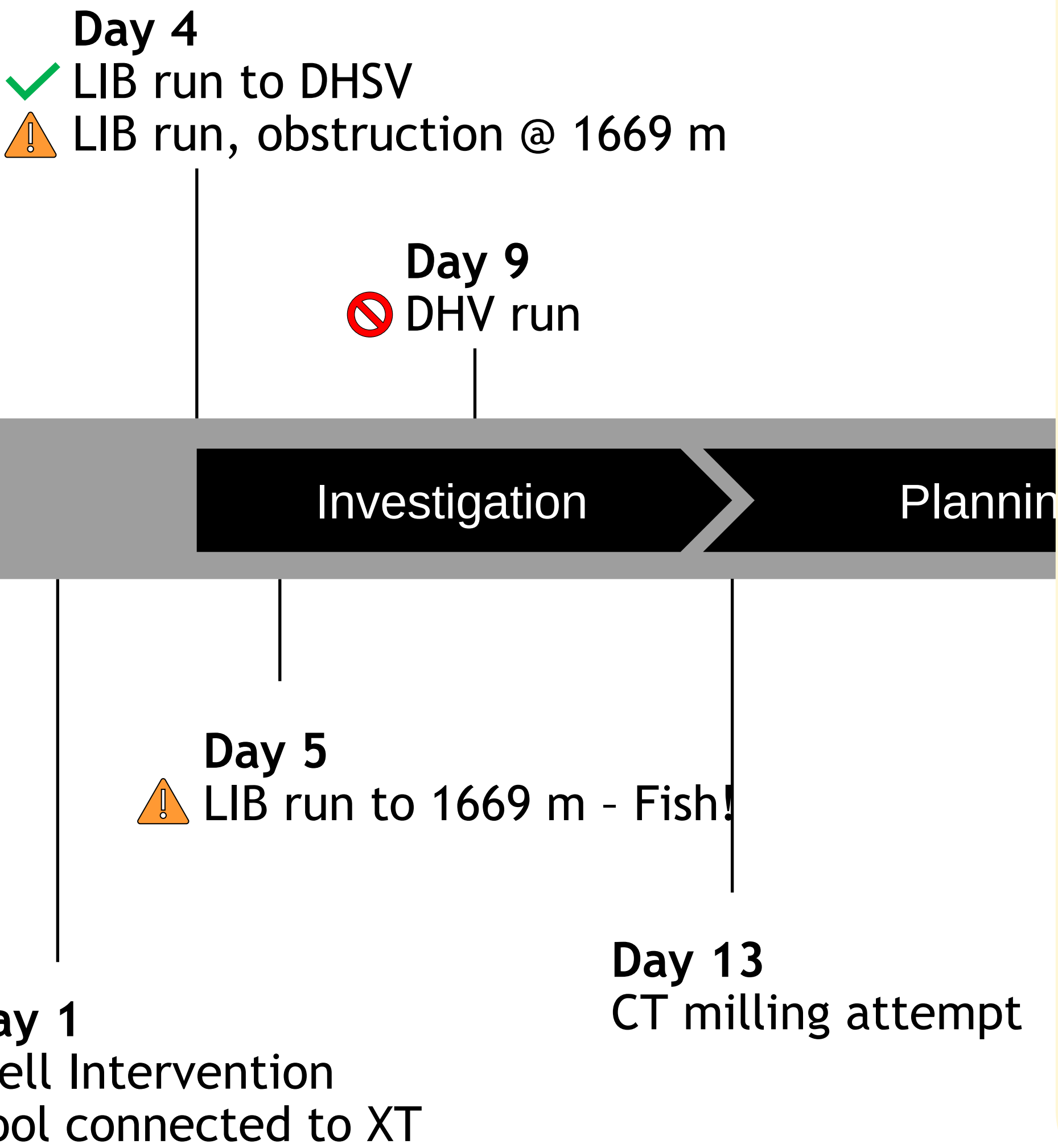
No problem to kill the well, but the well can't reach the static level

Plan: well intervention to change XT

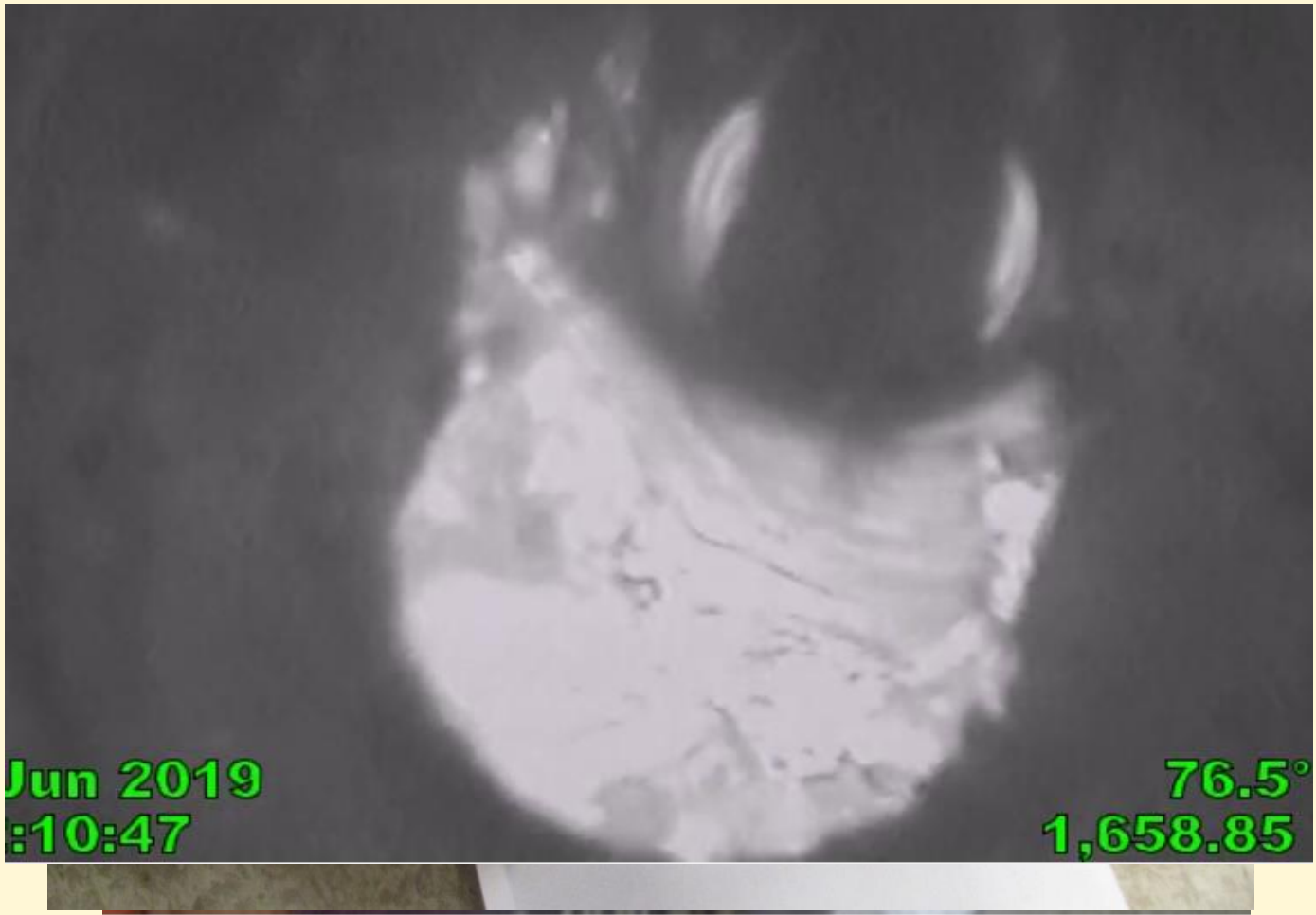
- 1 deepset barrier
- 1 "shallow" barrier

INTRODUCTION

Timeline



Head

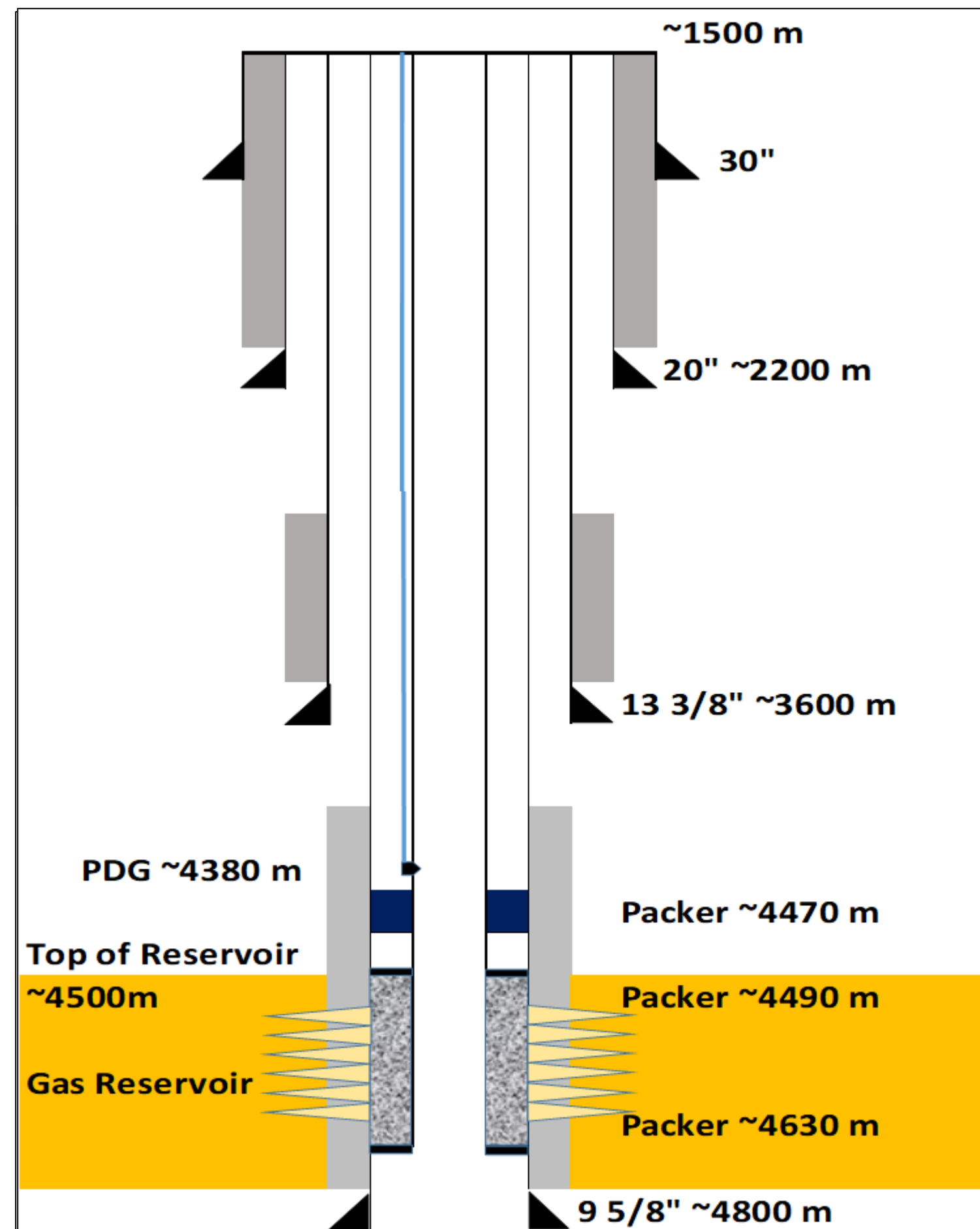


test



INTRODUCTION

The Well The Problem



Partial collapse of casing and tubing identified during intervention

20 in casing last barrier to mud line leakage path

No wireline or coiled tubing tool able to be pass through restriction

N₂ bullhead would fracture 20 in casing shoe

Heavy cement/fluid with high risk of 20 in collapse during P&A

Strategy selected → Multiphase Bullheading and Foamed Strategy for P&A Phase 1

__WELL STATUS BEFORE P&A

Strategy selected → Multiphase Bullheading and Foamed Strategy for P&A Phase 1

New boundary conditions to design

- Confirmed Tubing x A Annulus communication;
- Minimum allowable pressure on well: 1000 psi;
- Uncertain Well Barrier after collapse;
- Maximum allowable pressure @ wellhead depth: 3000 psi (current pressure ~3200 psi);
- Tubing: collapse confirmed @ aprox. 1669m with a stuck LIB fish;
- Production & Intermediate casing: also expected to be collapsed;
- Uncertain flow area along collapsed interval.

No viable operation provided by service companies

__PLUGGING DESIGN

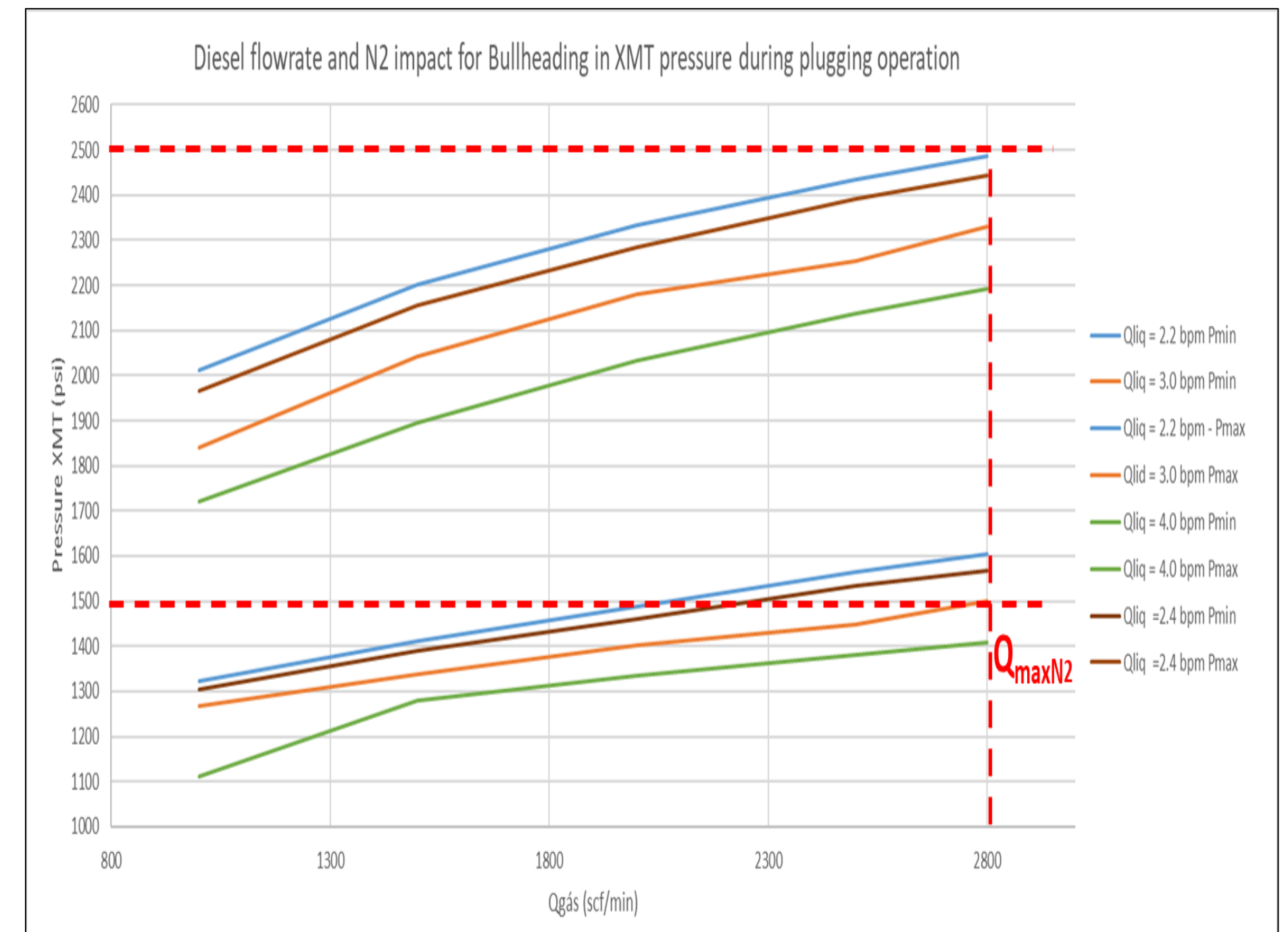
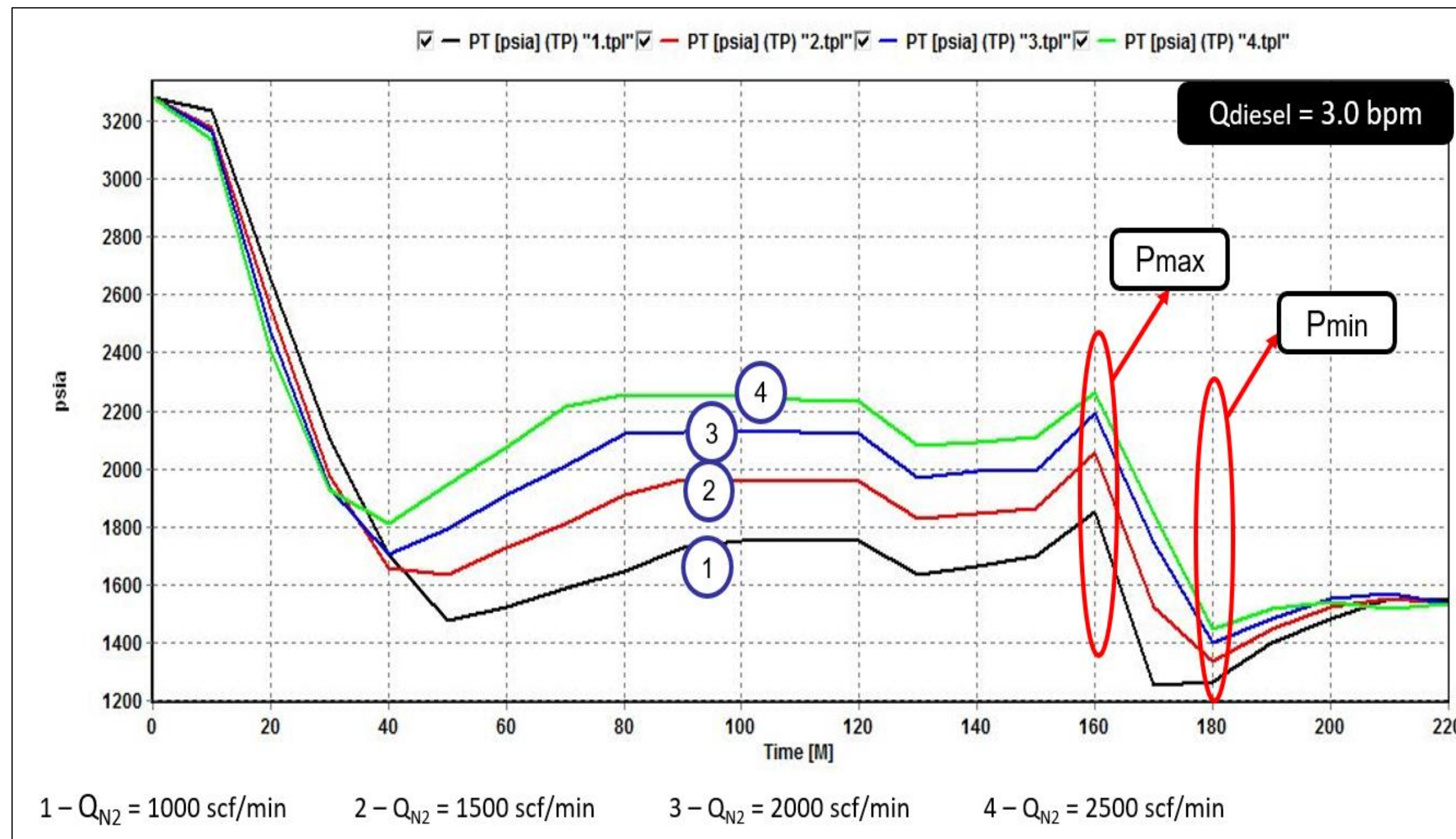
Pumping parameters evaluated through multiphase flow modeling

Diesel + Nitrogen
(multiphase bullheading)

Spacer

Foamed Cement

Foamed displacement
fluid



Several Liquid and Gas Pump Rates were evaluated to design best pumping parameters

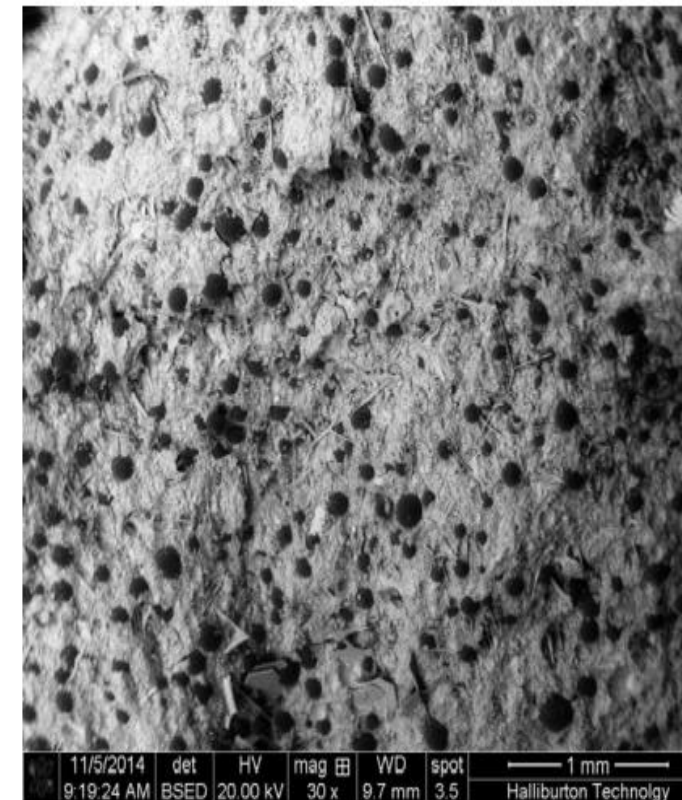
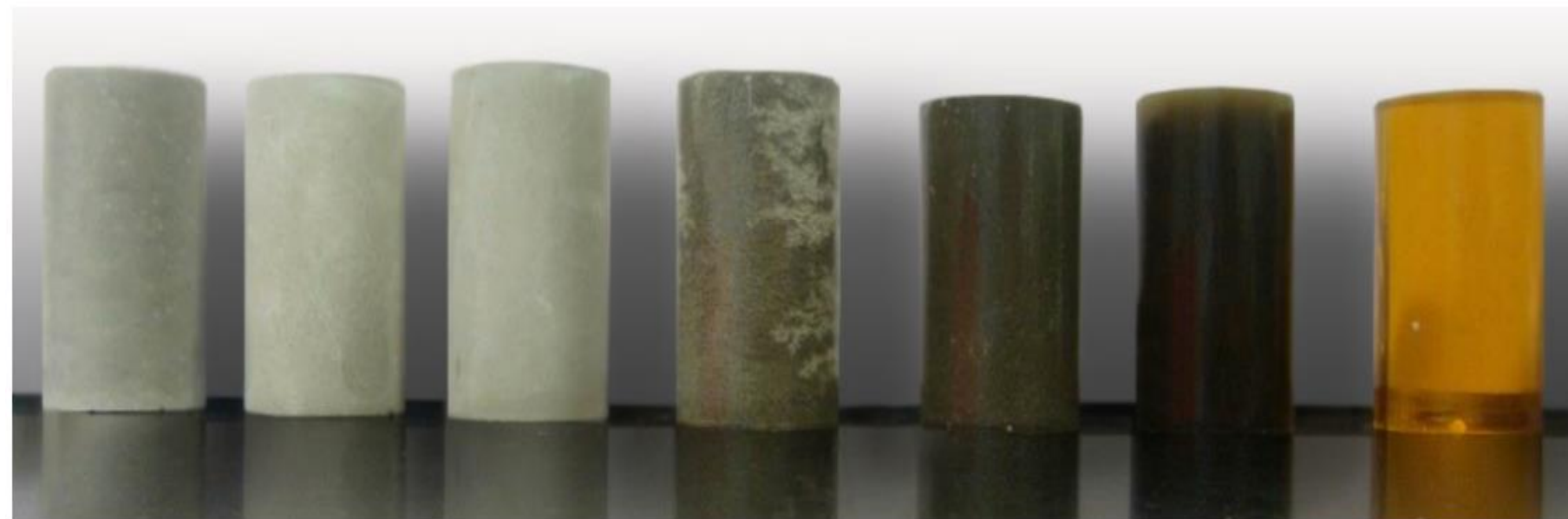
Pmax – Cement flow through restriction

Pmin – Free-fall flow of cement on tubing

__PLUGGING DESIGN

Critical cement slurry and displacement desgin

- Low density cement slurry
- Gas migration control base cement slurry
 - 10% resin content
 - High fluid loss control
 - Gas migration control
 - Expansive

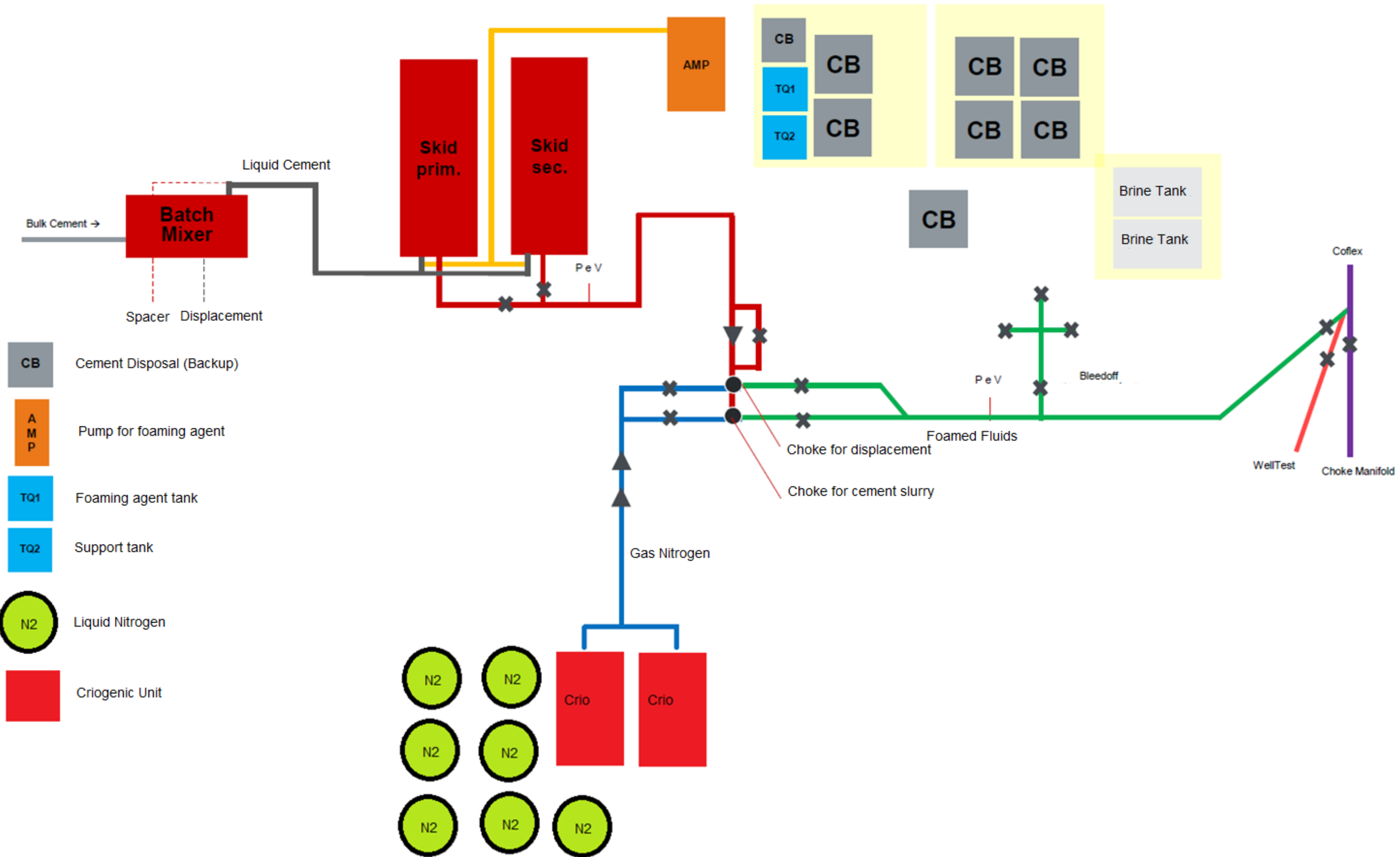


Foam cement and Foamed Displacement Stability (lab tested)



<http://www.iadc.org/wp-content/uploads/2016/06/IADC-Q2-Technology-Forum-Oilfield-Resins-for-Plug-and-Abandonment-distribution-version.pdf>

__RIG LAYOUT

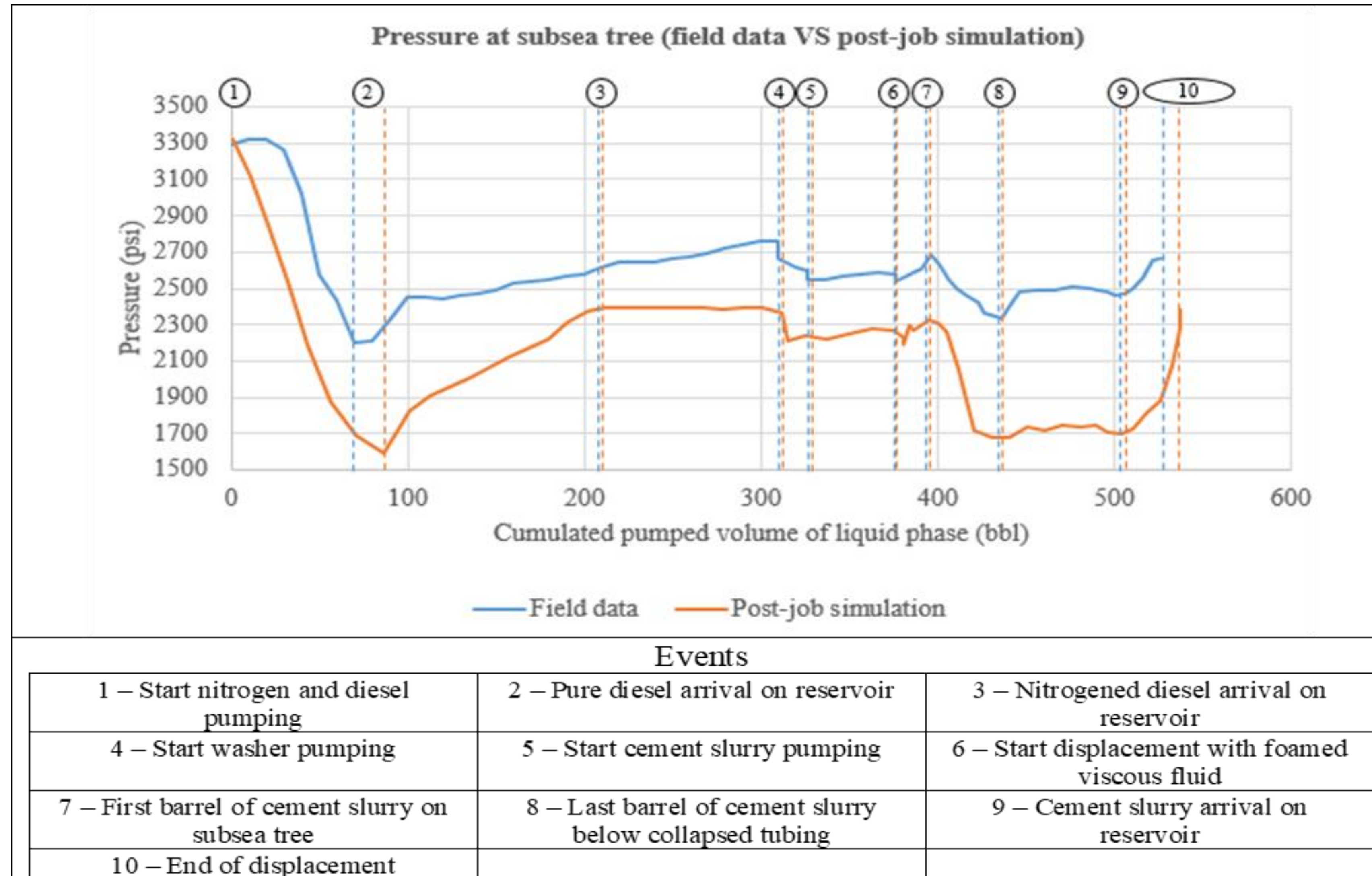


Layout assembled in light well intervention unit



__POS-JOB ANALISYS

Pressure data comparison (field vs post-job simulation) of plugging operation

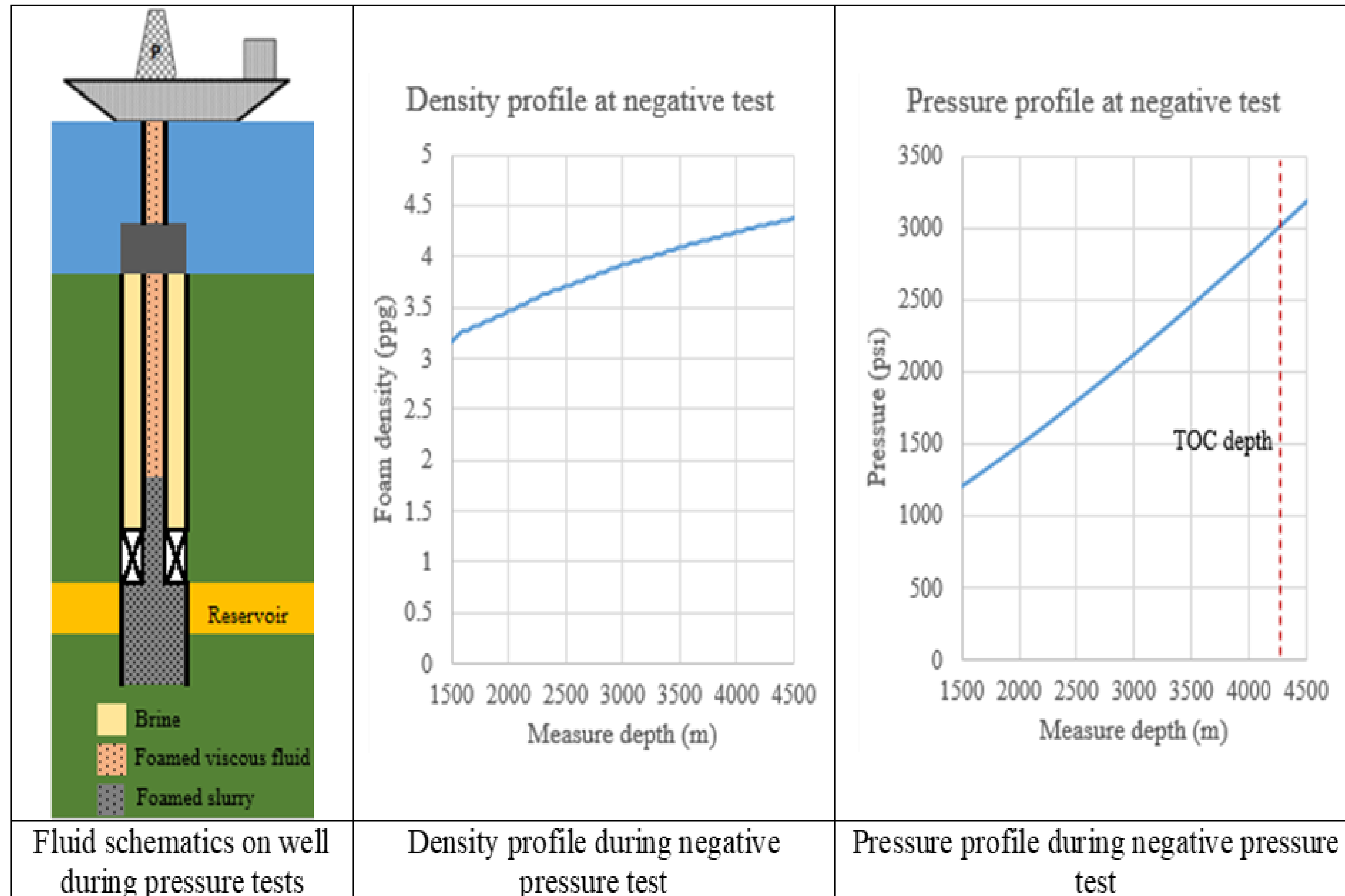


Remarks:

- Good correlation between simulated and field data behavior and close timing;
- True reservoir injectivity lower than estimated and field pressure was above expected;
- Foamed cement flow through restriction successful with controlled pump rate.

__PLUG VERIFICATION

Remote verification due to restriction in tubing



Remarks:

- TOC estimation based on pumping parameters as modeled and records
- Differential pressure (+1000psi) applied held for 2+ hours - positive and negative

Static reservoir pressure = 4300 psi

__CONCLUSIONS

- Successful and useful modeling for bullheading with multiphase fluids and foamed cement and displacement;
- Successful isolation achieved verified by both negative and pressure tests and pumping parameters;
- Extremely valuable information provided by both XT sensors for the control of pumping parameters;
- Well in safe conditions for phase 2 P&A;
- There is opportunity to develop / improve simulation capabilities for challenging P&A operations.

THANK YOU

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