RIPS 2017
RUSSIA INTERNATIONAL PERFORATING SYMPOSIUM

SPE-188769-MS
Configuring Dynamic Underbalance to Achieve Perforation Tunnel Cleanup in a Gas Well at High Static Overbalance

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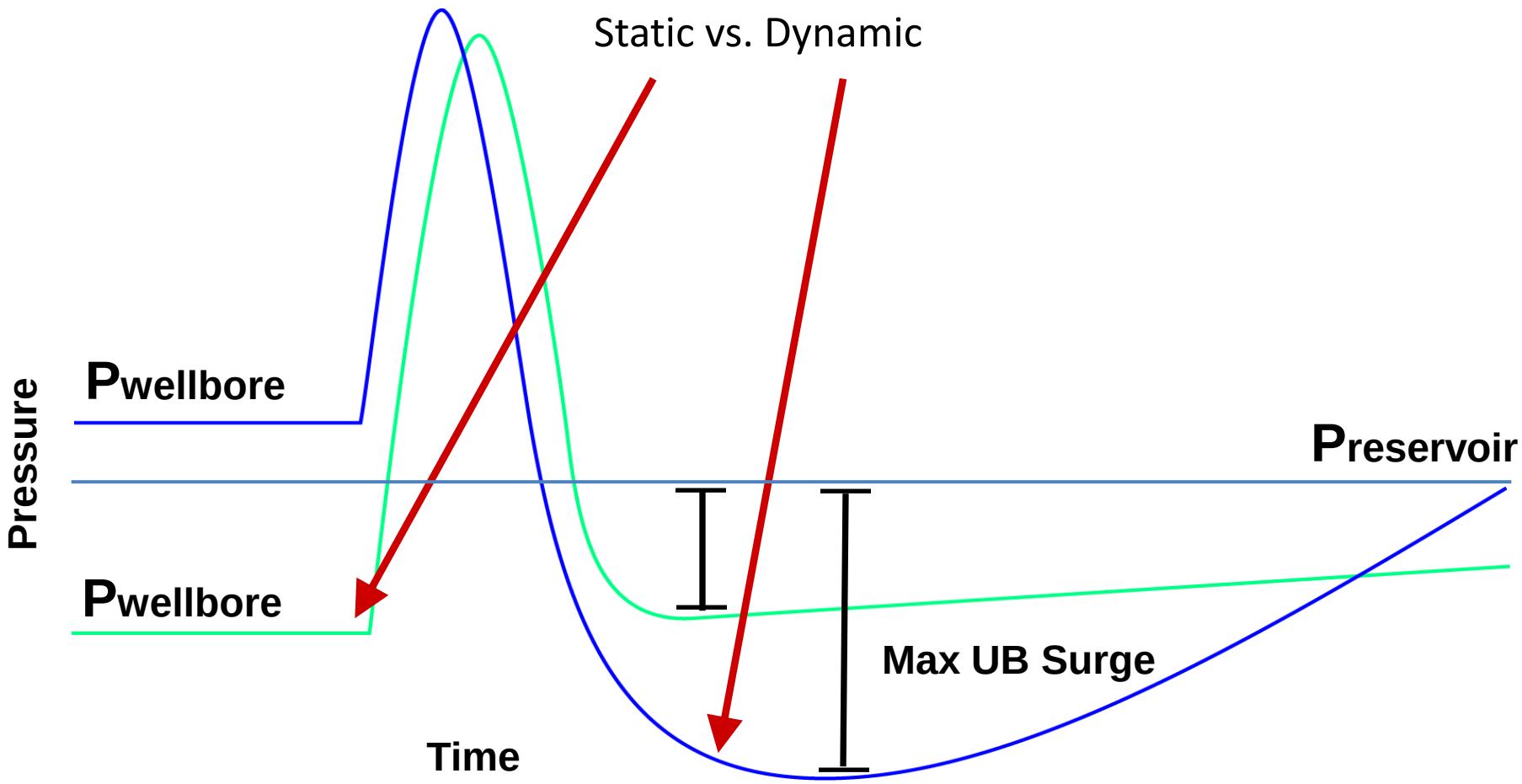
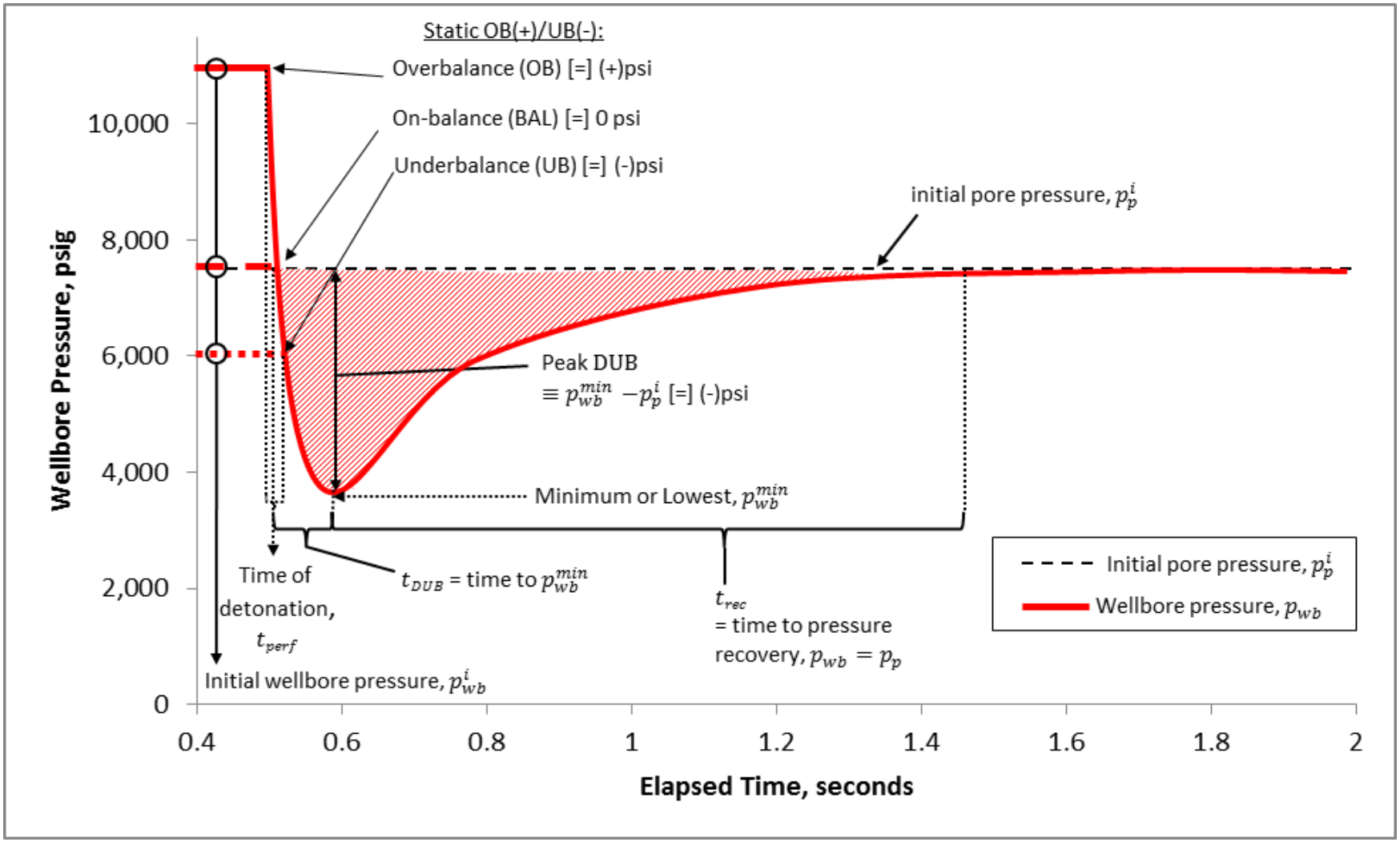
AGENDA

- Static preperforation wellbore balancing, comparison with dynamic underbalance (DUB) and how it is achieved
- How to create underbalance dynamically
- DUB design service and its application
- Findings
- Expansion-of-application opportunities

Defining Dynamic Underbalance (DUB)

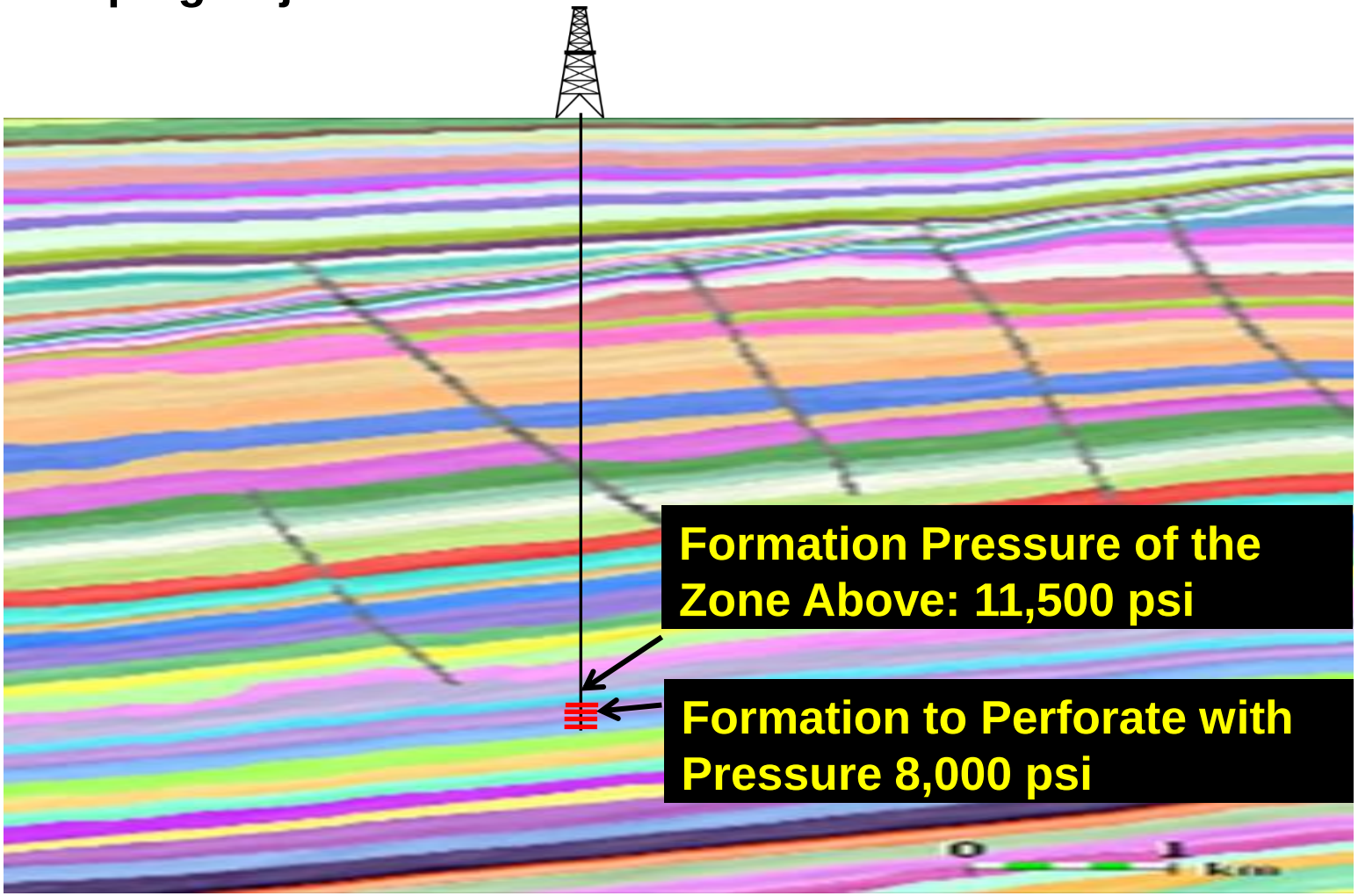


Defining Dynamic Underbalance (DUB)

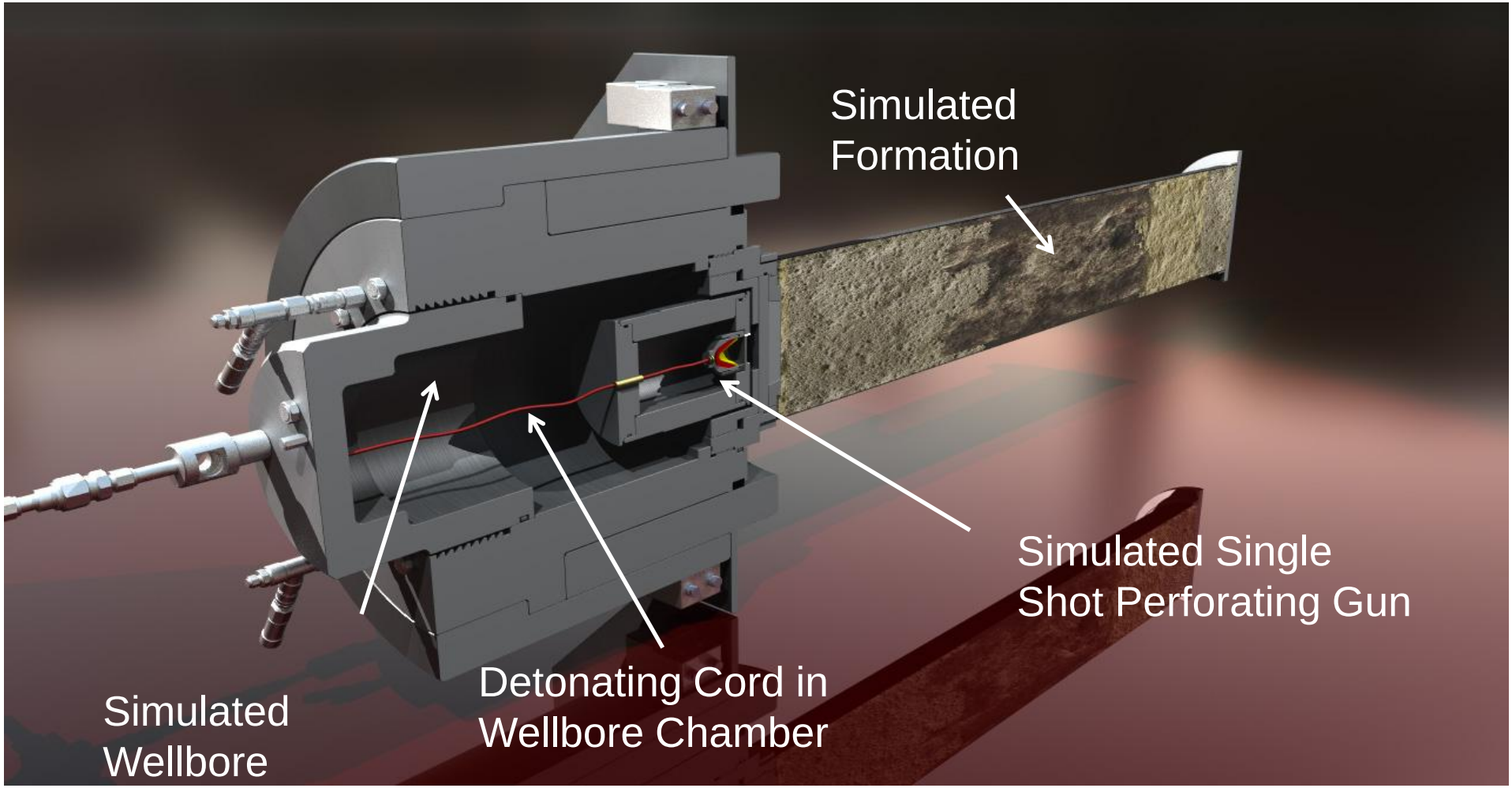


Why Static Overbalance is Used

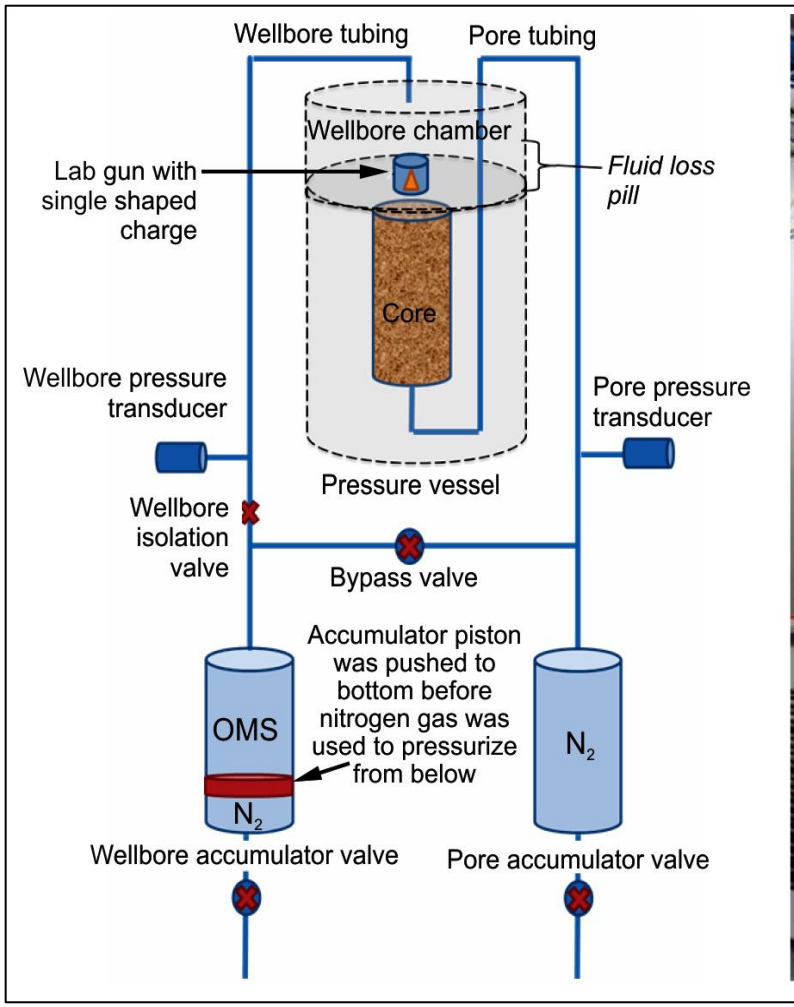
Keeping Adjacent Zones Under Control with Overbalance



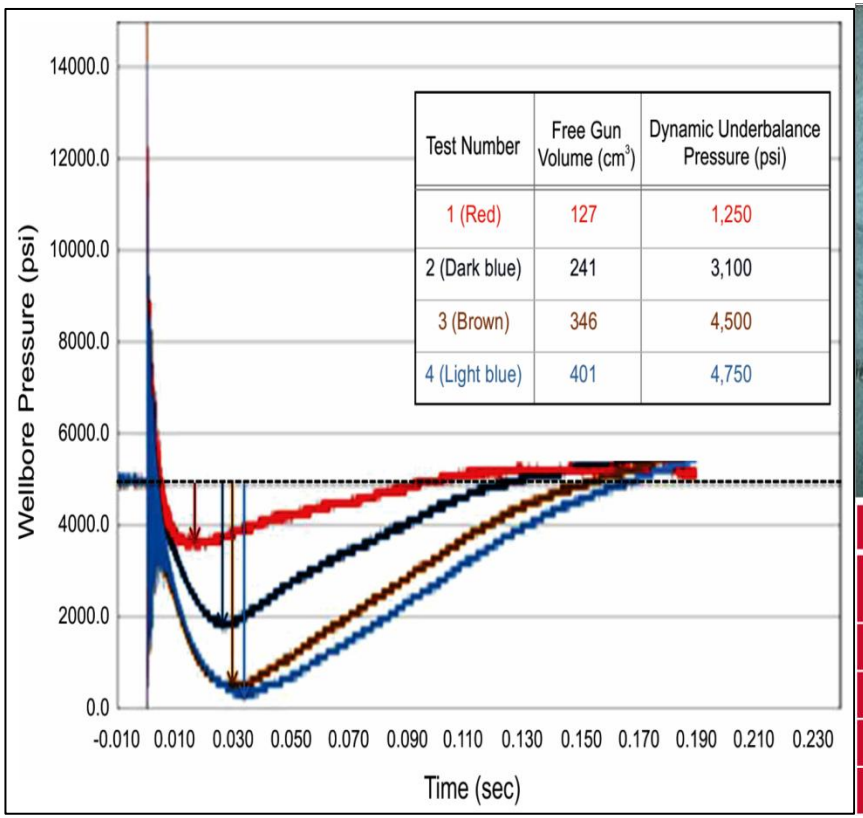
Laboratory Setup. Section IV Diagram



Flow Loop / Pressure Vessel



How Changing Only Free Gun Volume Affects Dynamic Underbalance



Test Number	Free Gun Volume (cm^3)	Dynamic Underbalance Pressure (psi)
1 (Red)	127	1,250
2 (Dark blue)	241	3,100
3 (Brown)	346	4,500
4 (Light blue)	401	4,750

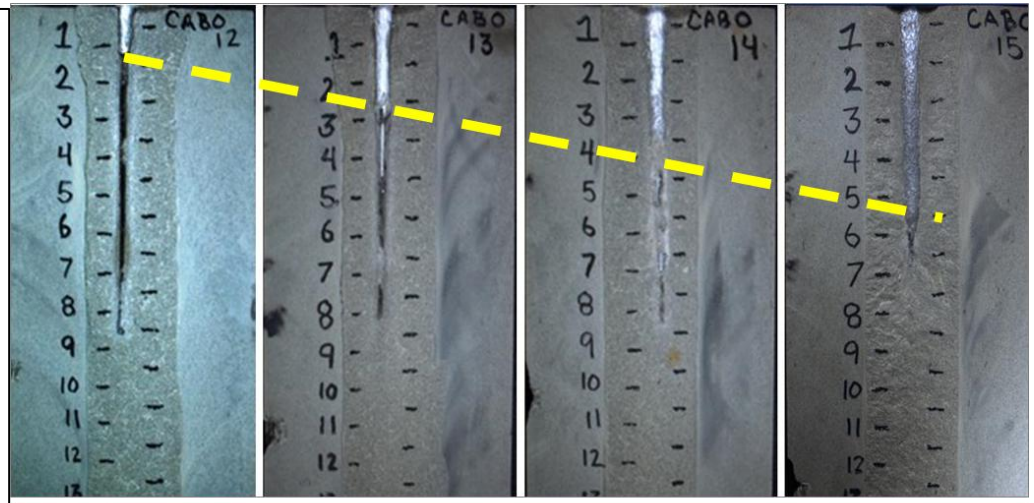
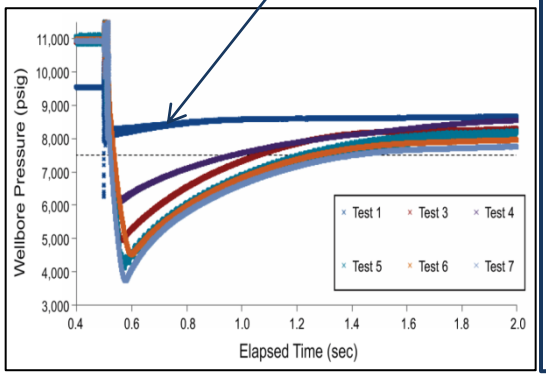
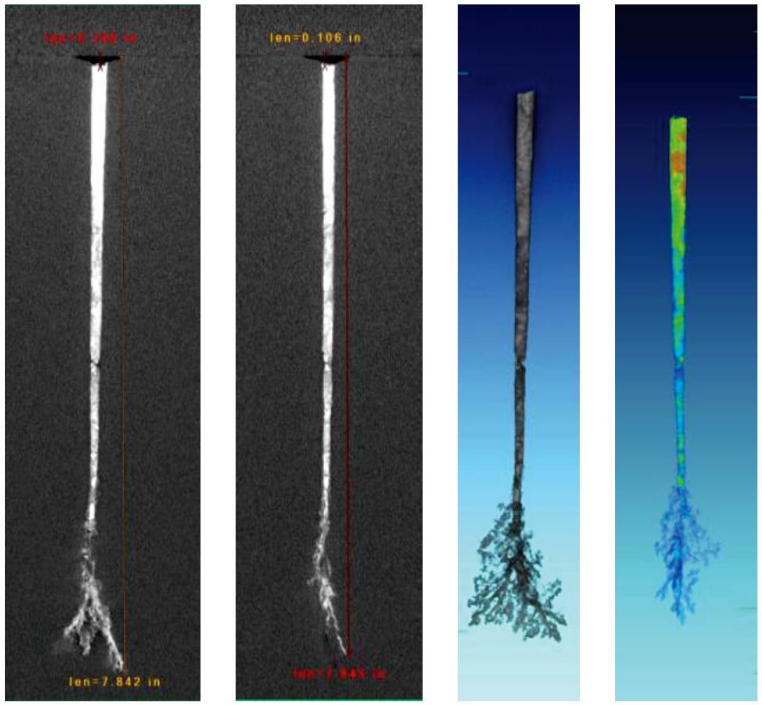


TABLE 2—SUMMARY OF FGV TEST RESULTS AND PARAMETERS.

Test ID	Entrance Hole Diameter, in.	Total Core Penetration, in.	Open Hole, in.	Percent Open Hole	Void Space in Gun, cc
12	0.35	8.7	1.2	13.80%	127
13	0.35	8.2	3	36.60%	241
14	0.32	8.35	6.95	83.20%	346
15	0,31	6.72	5.98	89.00%	401

No Dynamic Underbalance - Computed Tomography (CT) Imaging





FGV/WB = 0.007

Wellbore pressure = 9,500 psi

Pore pressure = 7,500 psi

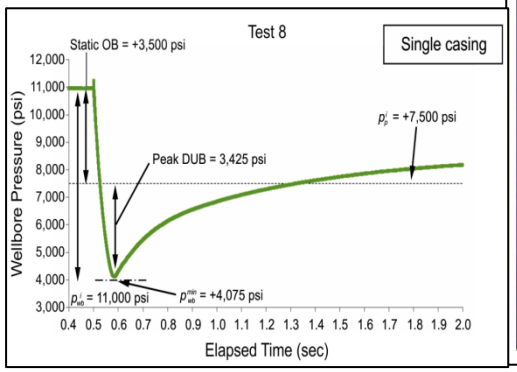
Static overbalance = 2,000 psi

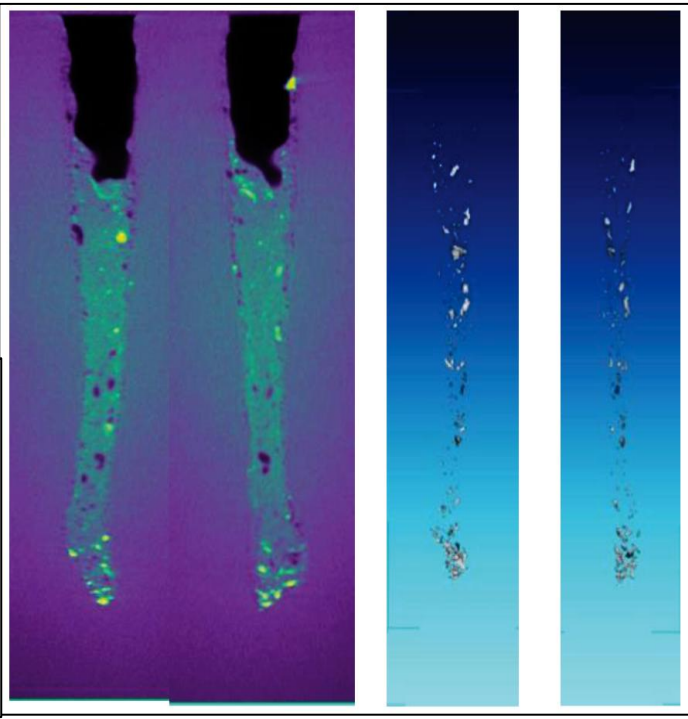
Penetration depth = 7.84 in.

Open tunnel = 0 in.

Dynamic underbalance = 0 psi

Partial Dynamic Underbalance





FGV/WB = max

Wellbore pressure = 11,000 psi

Pore pressure = 7,500 psi

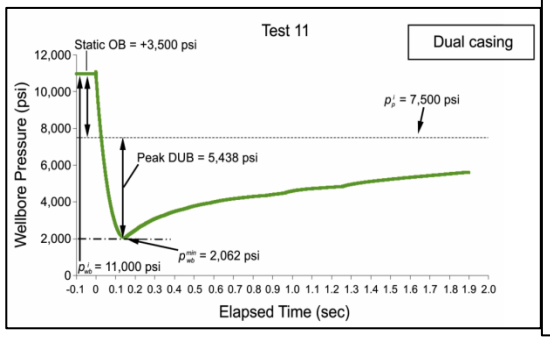
Static overbalance = 3,500 psi

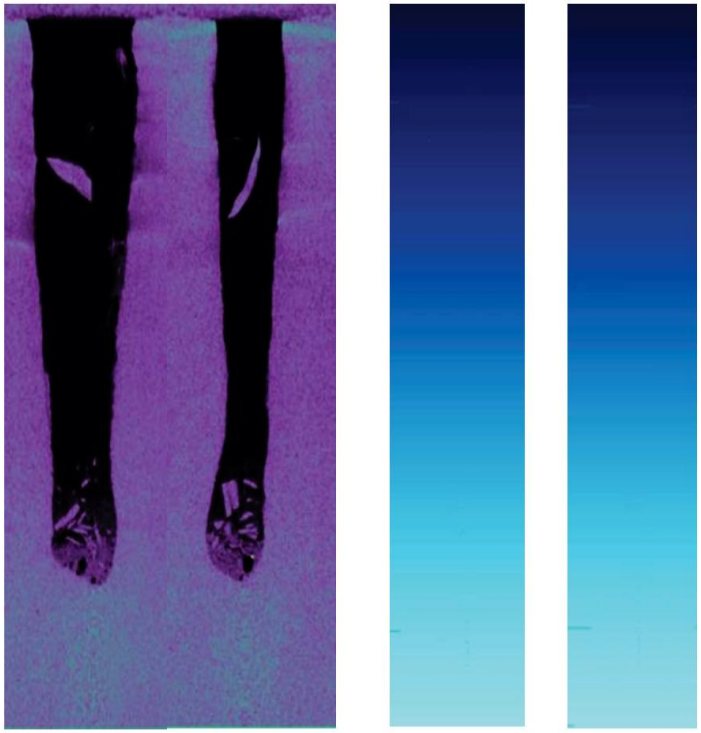
Penetration depth = 6.673 in.

Open tunnel = 1.949 in., 6.50 in. loose material

Dynamic underbalance = 3,425 psi

Dynamic Underbalance





FGV/WB = max

Wellbore pressure = 11,000 psi

Pore pressure = 7,500 psi

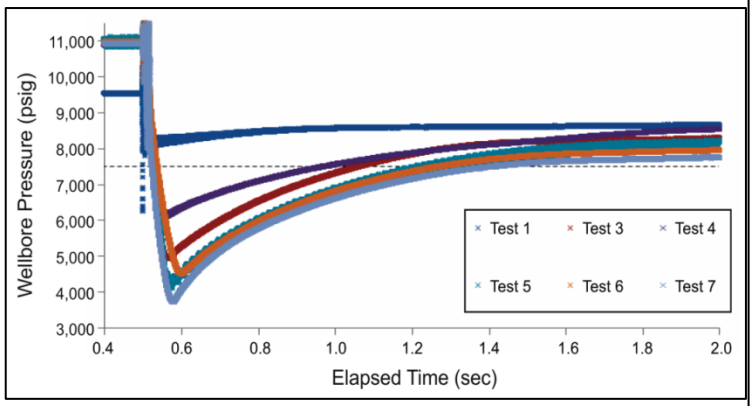
Static overbalance = 3,500 psi

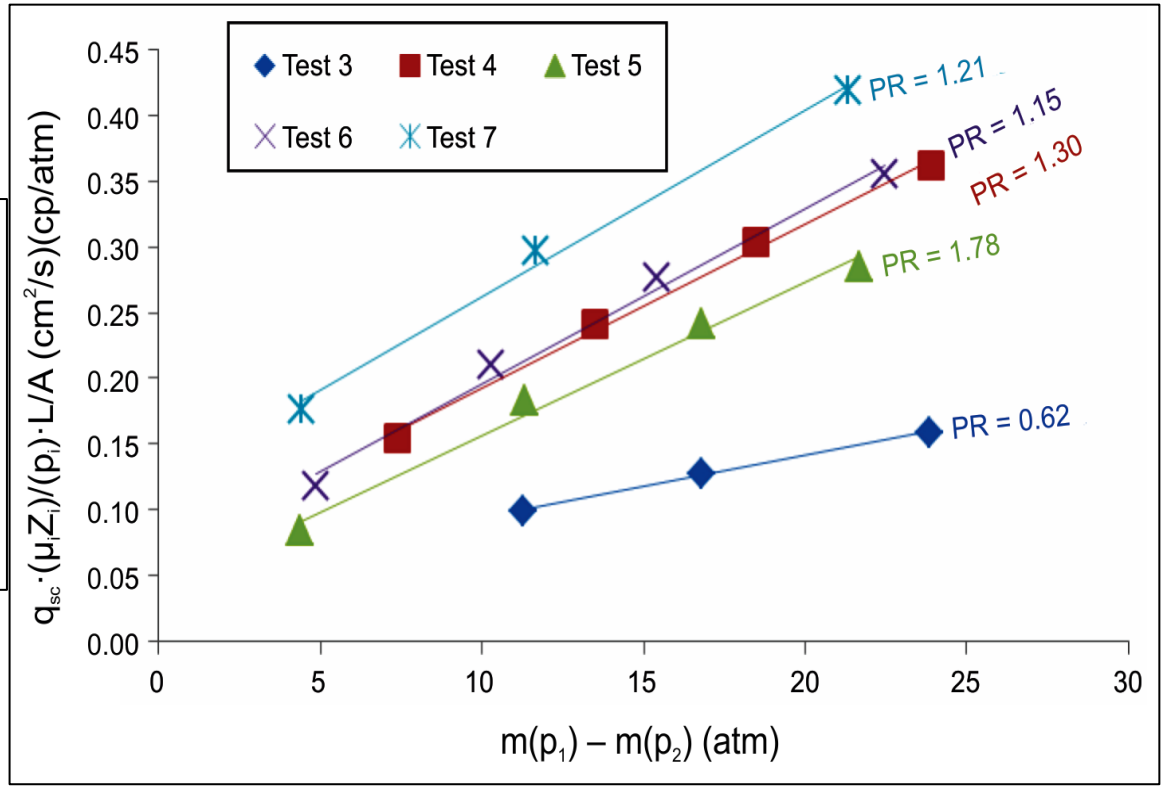
Penetration depth = 5.440 in.

Open tunnel = 4.578 in., 5.39 in. loose material

Dynamic underbalance = 5,438 psi

Flow Comparison Chart





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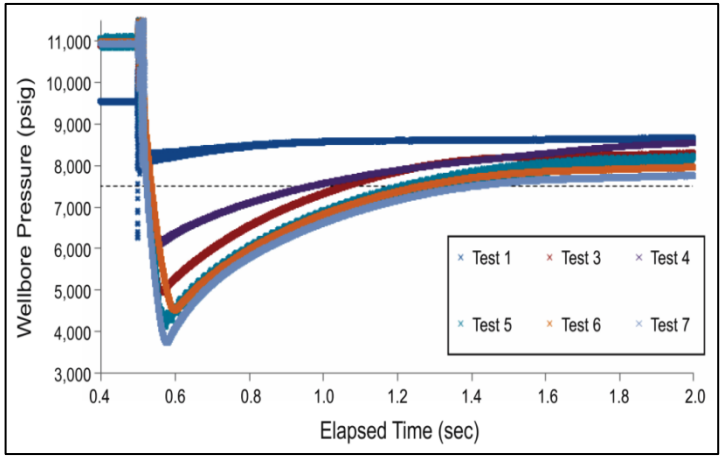
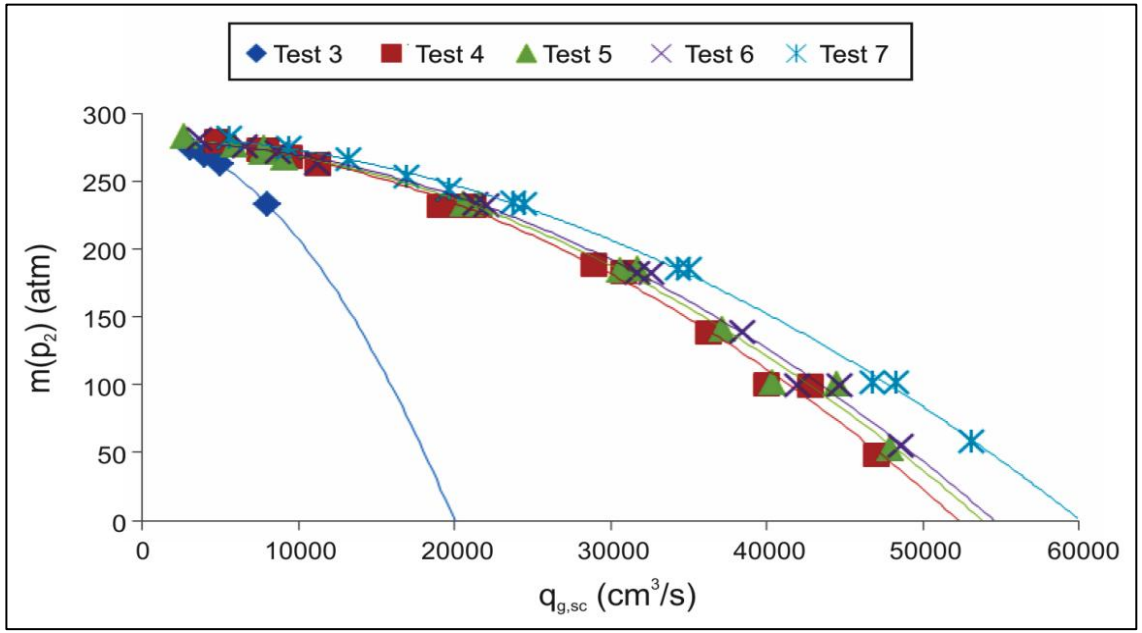
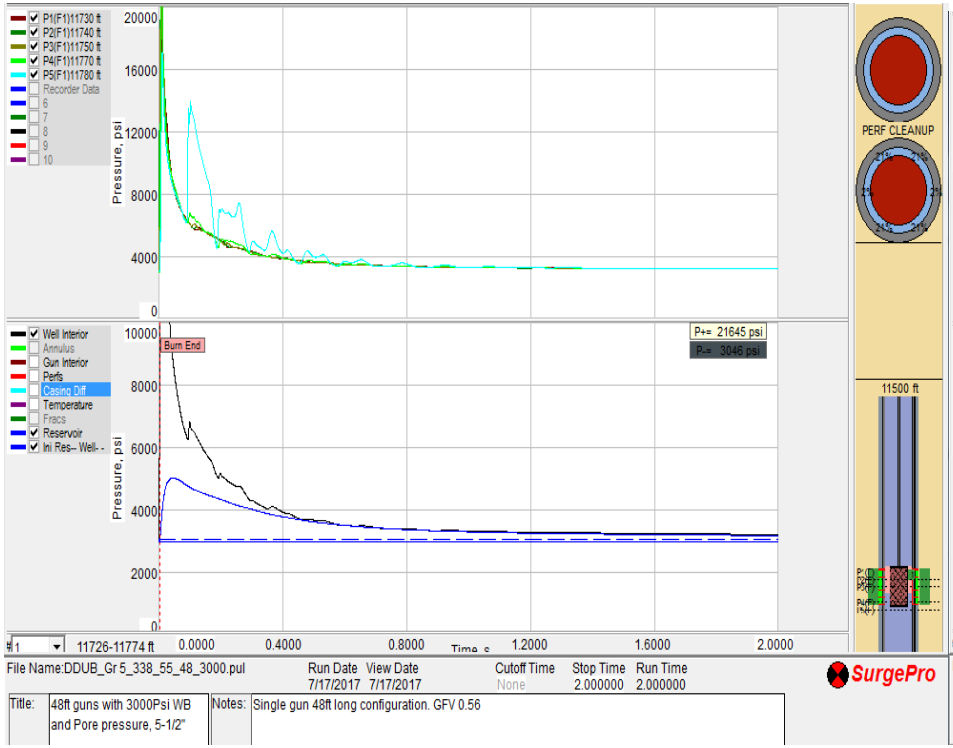
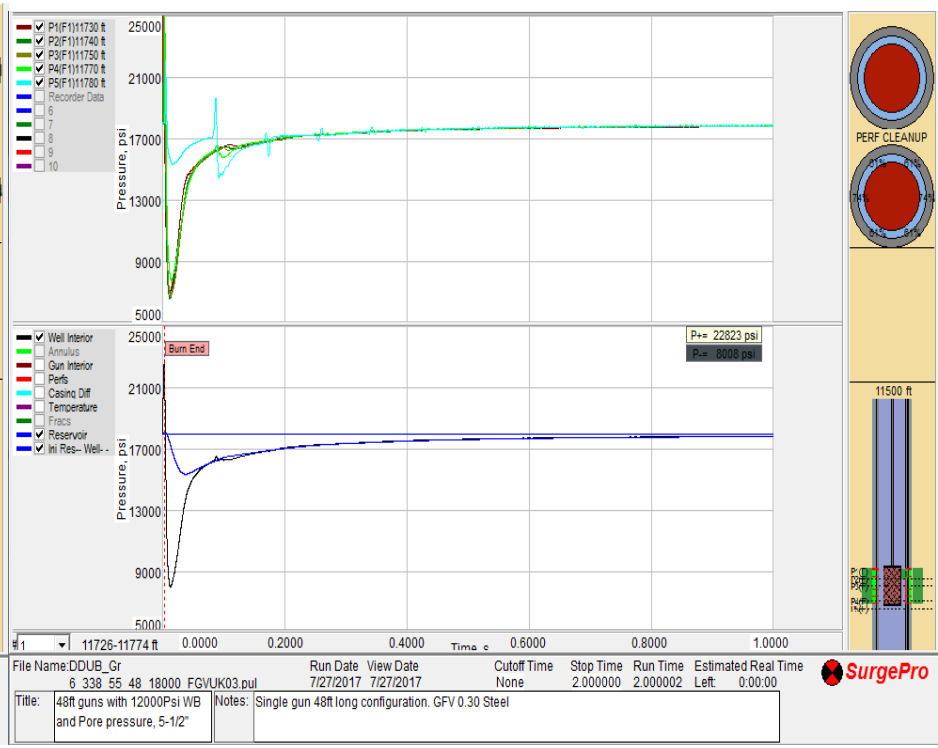




DUB Design. Modelling.





Conclusions

- DUB can be achieved, even at a high static overbalance, provided the formation pressure is adequate.
- DUB effectiveness at high static overbalance can be assessed both qualitatively with CT scan images and quantitatively with an API RP 19B Section 4 flow loop.
- Results show that increasing the free gun volume increases the magnitude of DUB, which in turn cleans debris from the perforation tunnels and leads to higher production rates.
- Laboratories have the option to set a wide range of over- or underbalance pressure scenarios along with testing the effects of varying wellbore or formation fluids.

Thank you!

Questions?