2014 International Perforating Symposium

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Using a Perforation Flow Lab to select Shaped Charges and the Proper Underbalance Technique for Deepwater Subsea Wells, Offshore Africa.

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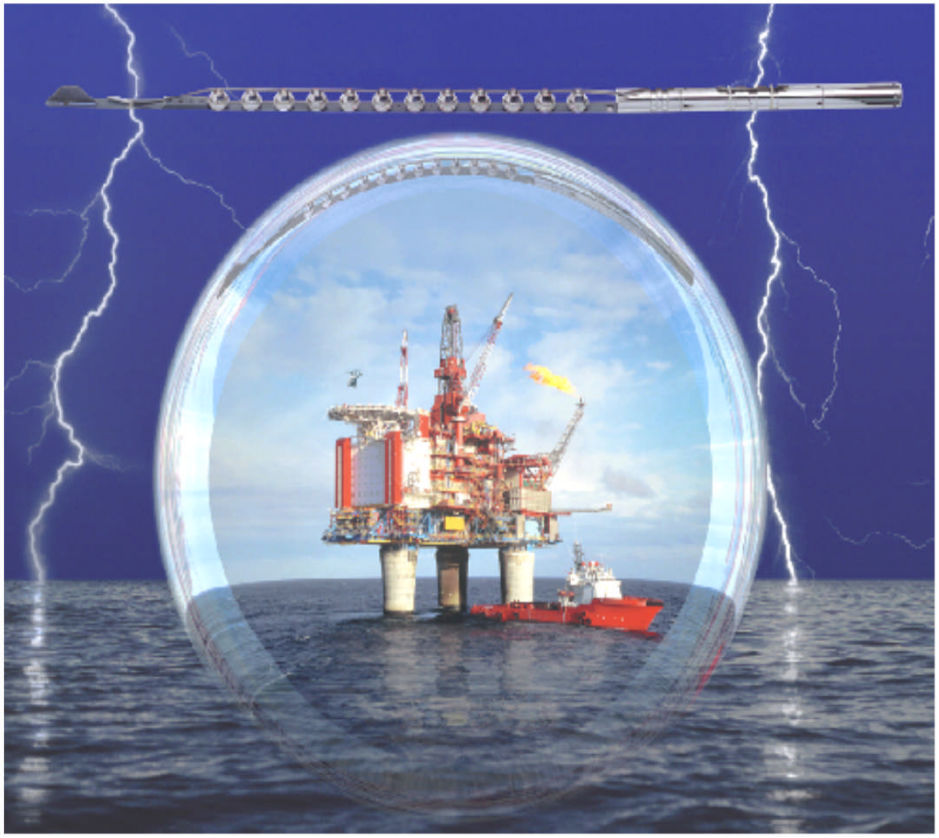
Introduction

- Offshore West Africa
- 1000 m – 1700 m water depth
- Sandstone reservoir
- Natural completion

<u>Typical Well Data</u>

- Reservoir depth: 3300 – 3600 mTVD
- Reservoir pressure: 6300 – 6412 psi
- Permeability : 200 – 600 md
- Porosity : 14 – 21%
- Temp: 200 – 230° F



Perforation Flow Laboratory – Section-IV Capabilities

Rock sample diameter: 7 in.

Rock sample length: 30 in.

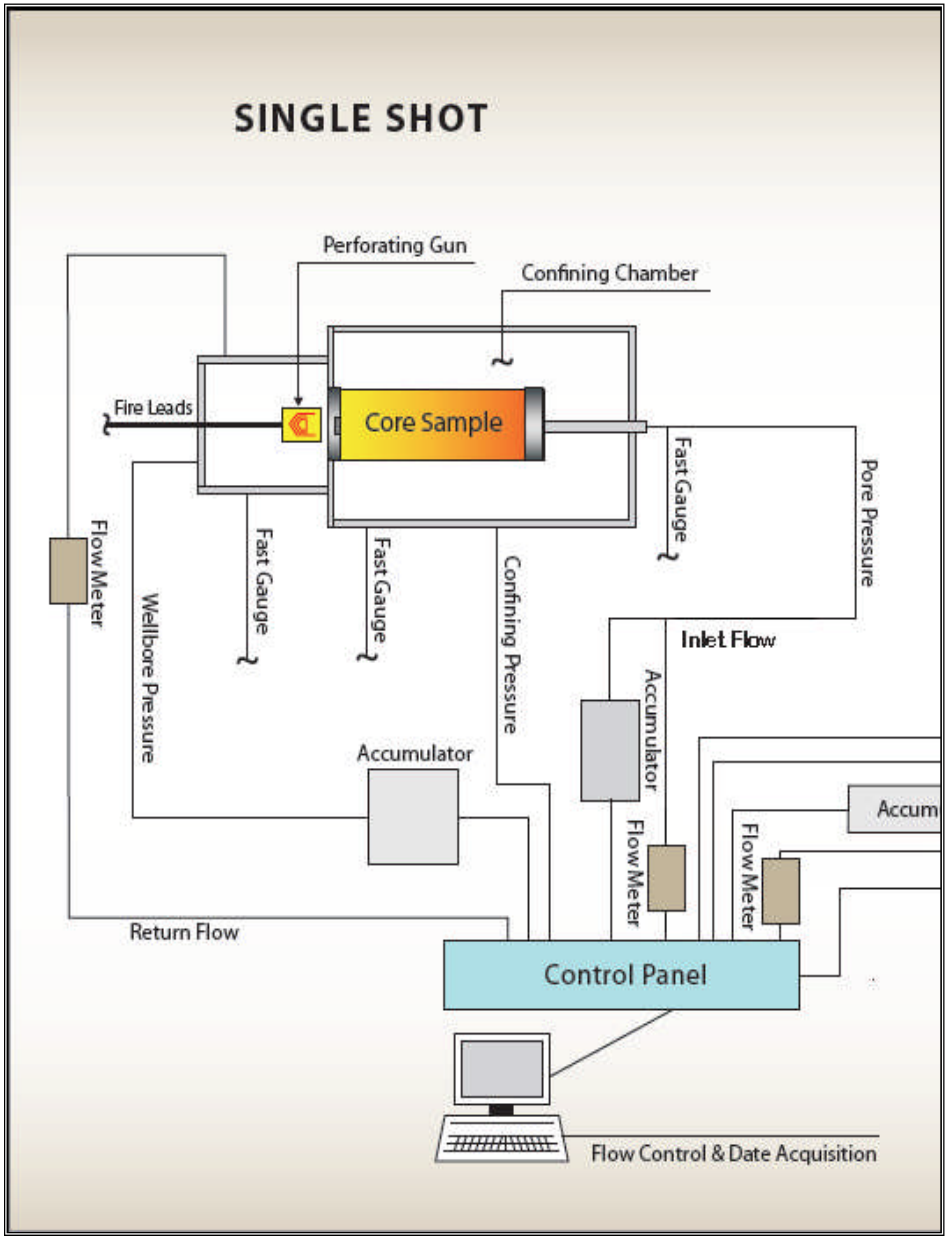
Confining pressure: 15,000 psi

Wellbore pressure: 10,000 psi

Pore pressure: 10,000 psi

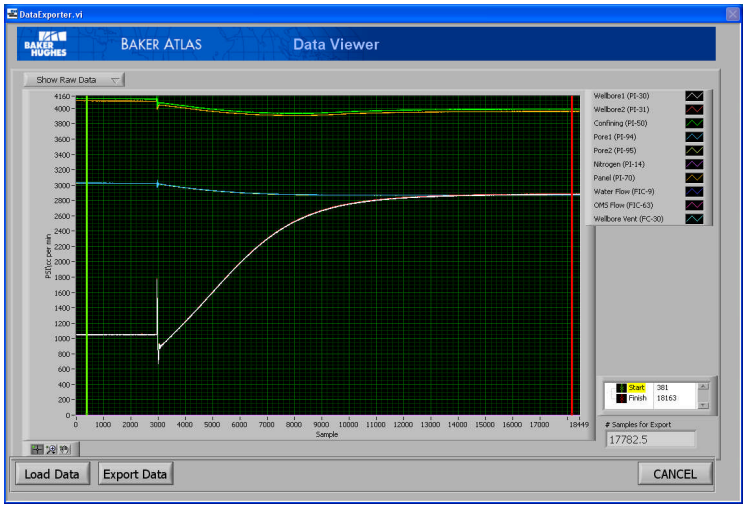
Temperature: 350° F

Data acquisition:
- Low speed – 100/sec
- High speed – 100,000/sec

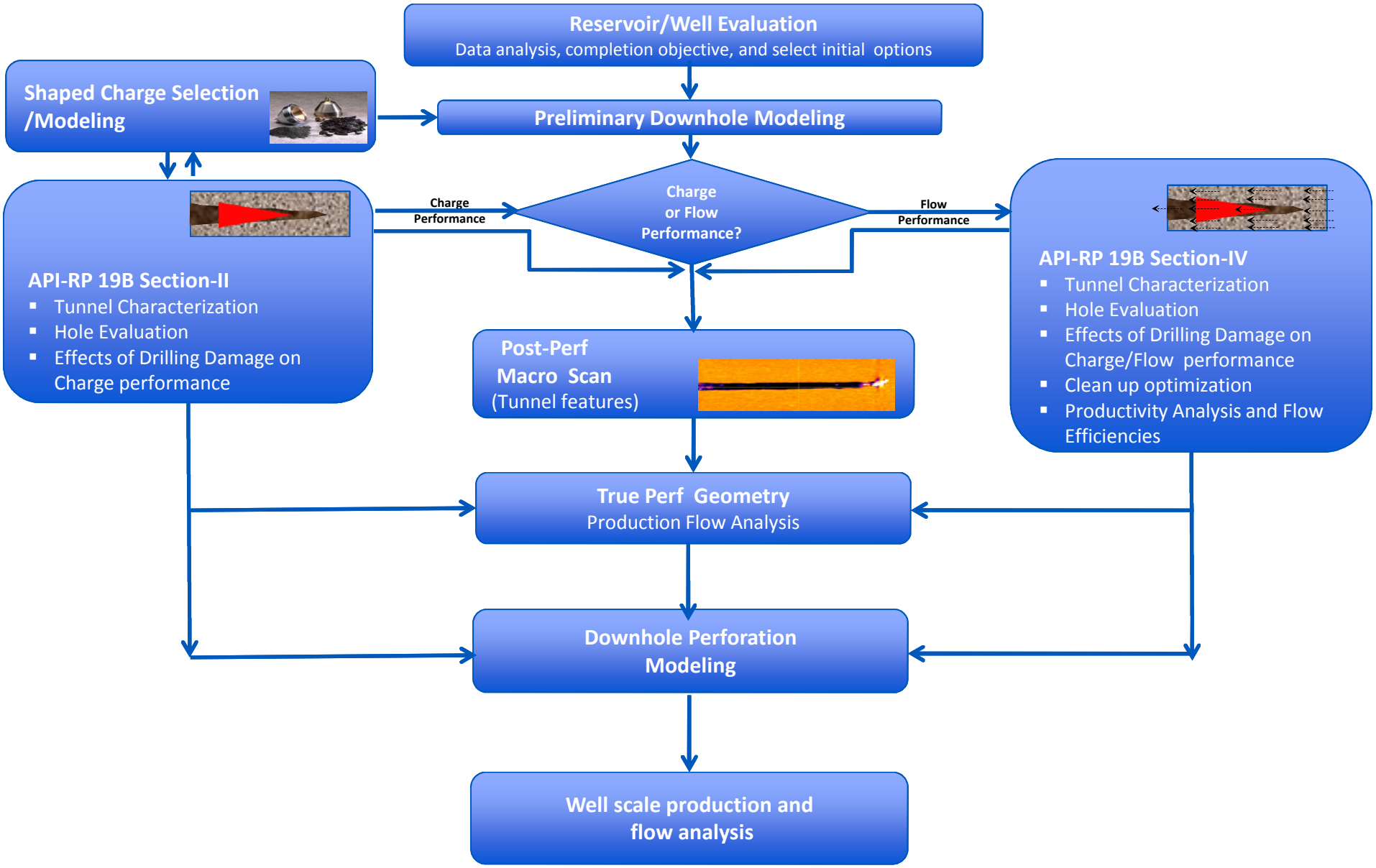


Perforation Flow Lab Measurements

- Pre-shot porosity
- Pre/post perforation permeability
- Perforation tunnel diameter
- Perforation tunnel depth
- Detailed tunnel characterization using advanced CT scanning methods
- Dynamic pressure data
- Core flow efficiency and productivity ratio
- Evaluate perforation cleanup mechanisms
- Optimization of underbalance methods

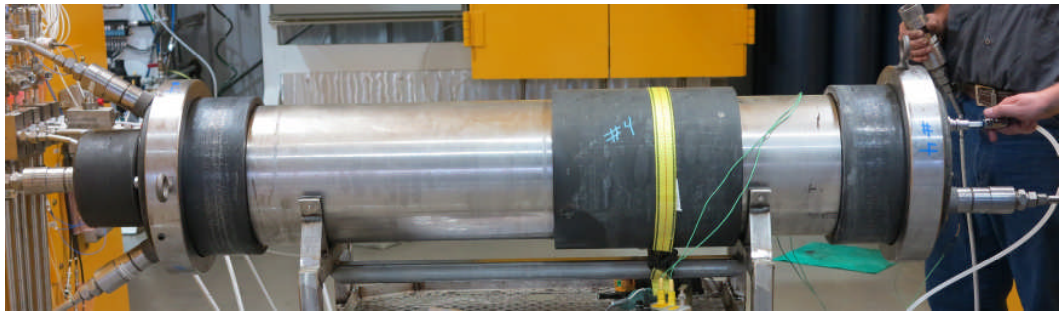


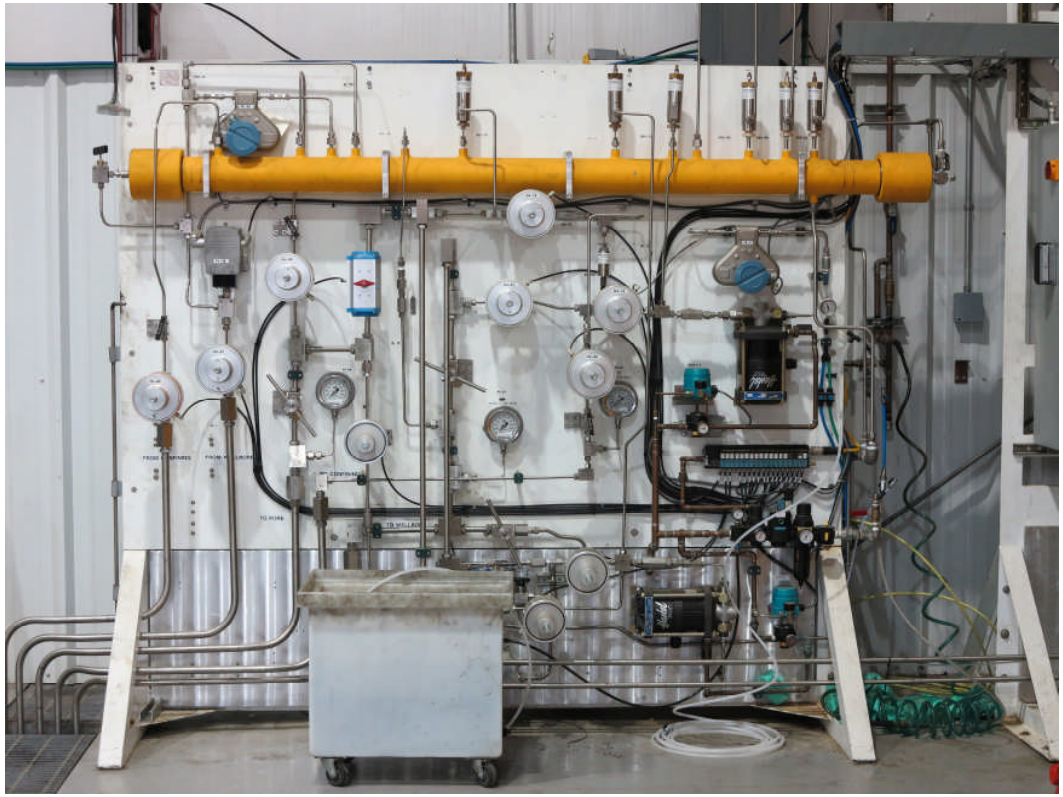
Design Workflow



Test Configuration

- Sandstone cores: 7-in. OD X 30-in.
- Type: Buff Berea
- Permeability: 150 - 350 md
- UCS: 3800 psi
- Porosity: 22%
- Confining pressure : 9,300 psi
- Pore pressure: 6,000 psi



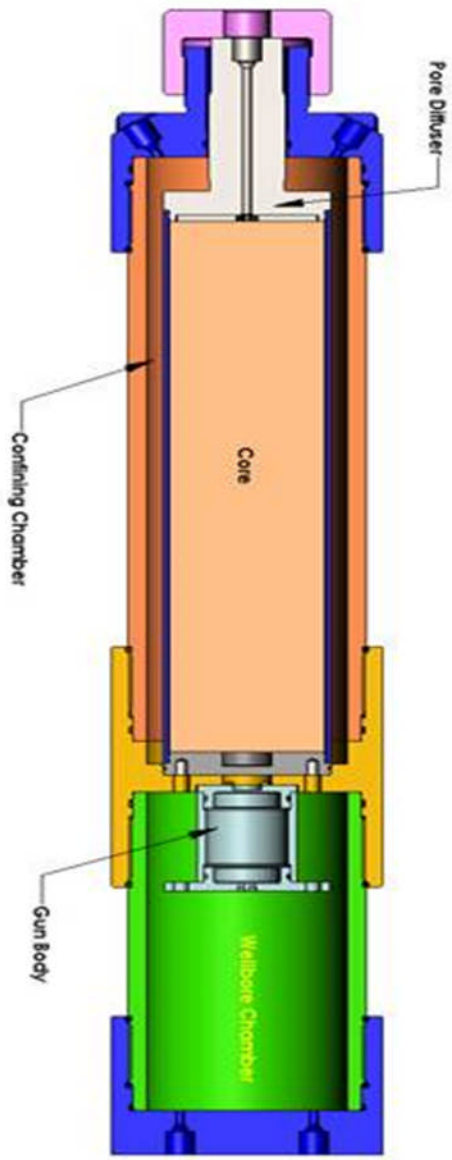


Test Configuration contd.

Two charge types (different designs);

- 39-gm steel case, HMX
- 39-gm zinc case, HMX

	39 gm Steel Case Charge, HMX	39 gm Zinc Case Charge , HMX
Test Conditions	**Gun Free Volume (cc)**	
Static UB w/DUB	600	660
Static OB w/DUB	600	660
StaticUB w/Standard *	585	360

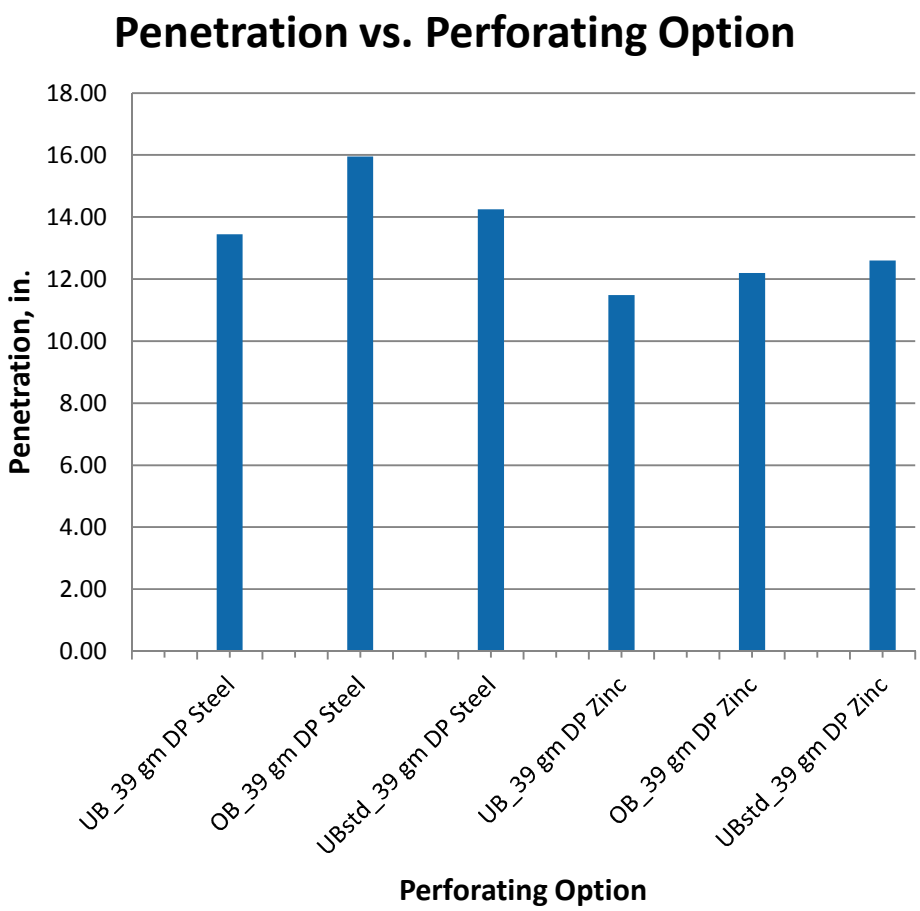


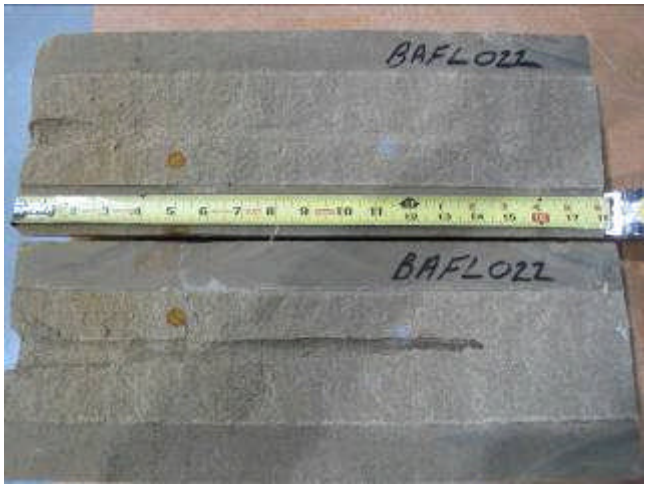
Static UB = 500 psi

Static OB = 250.

*Standard conditions represent the natural dynamic pressure response of fully loaded guns without additional chambers.

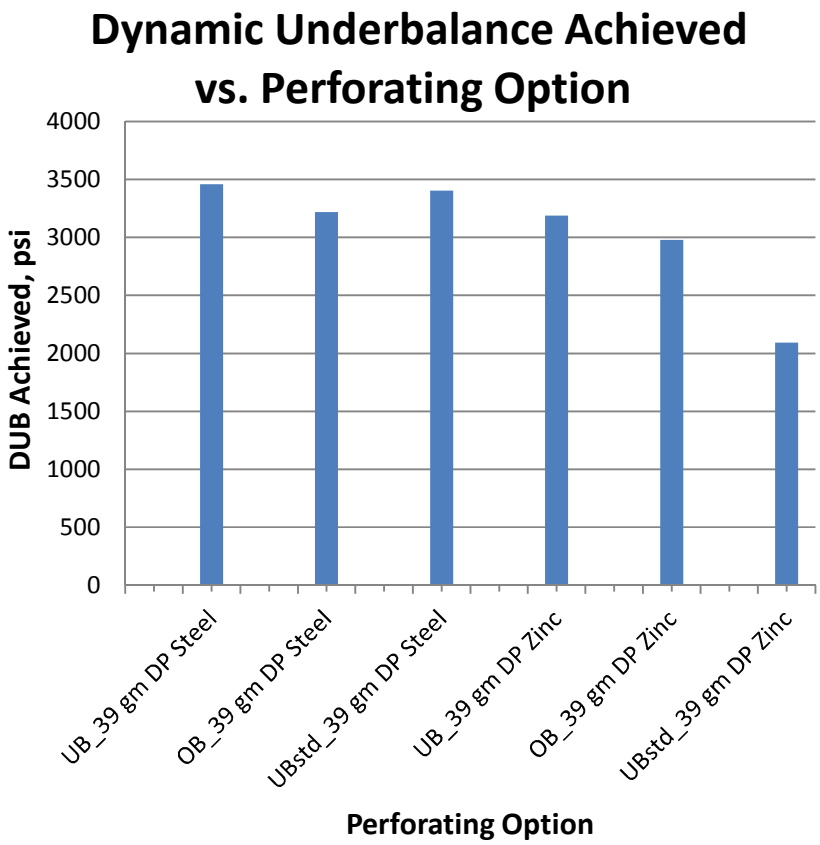
Results Overview

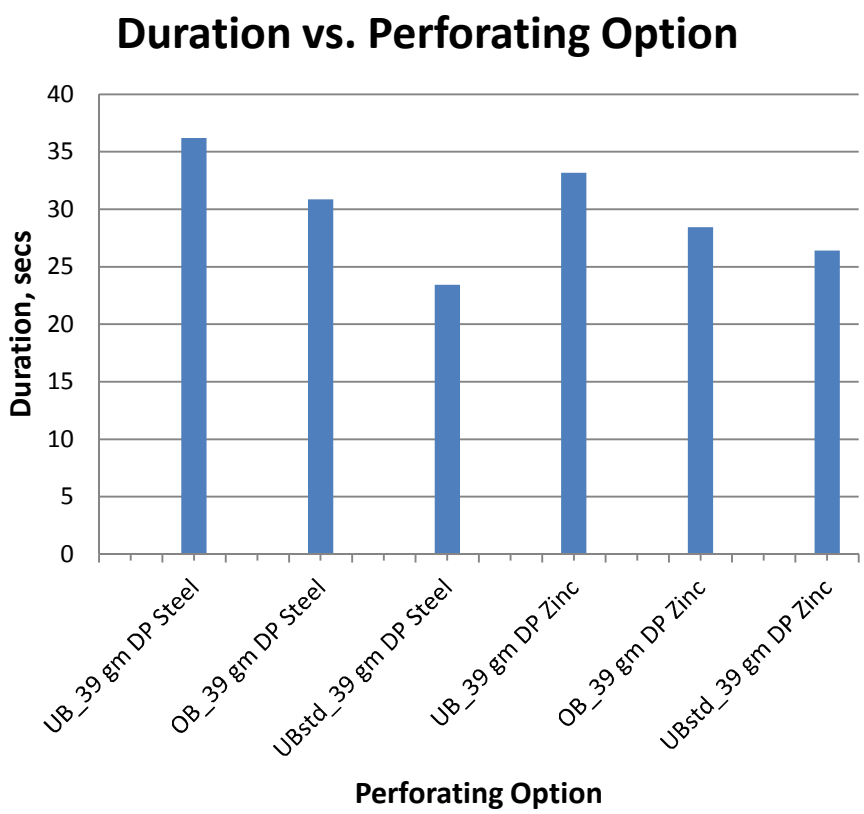




- Core Penetration - Length of Perforation tunnel excluding casing, and cement

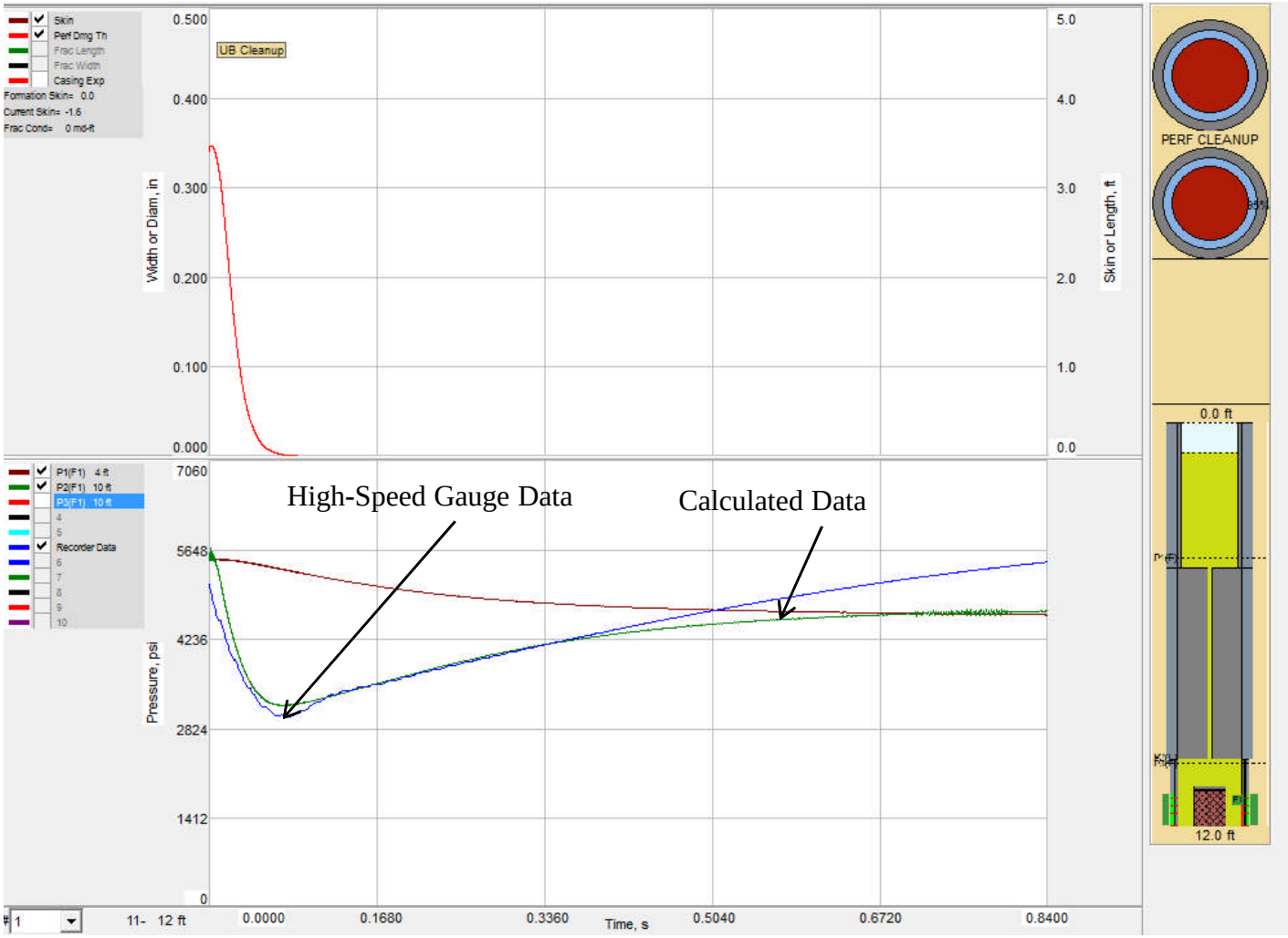
Results Overview





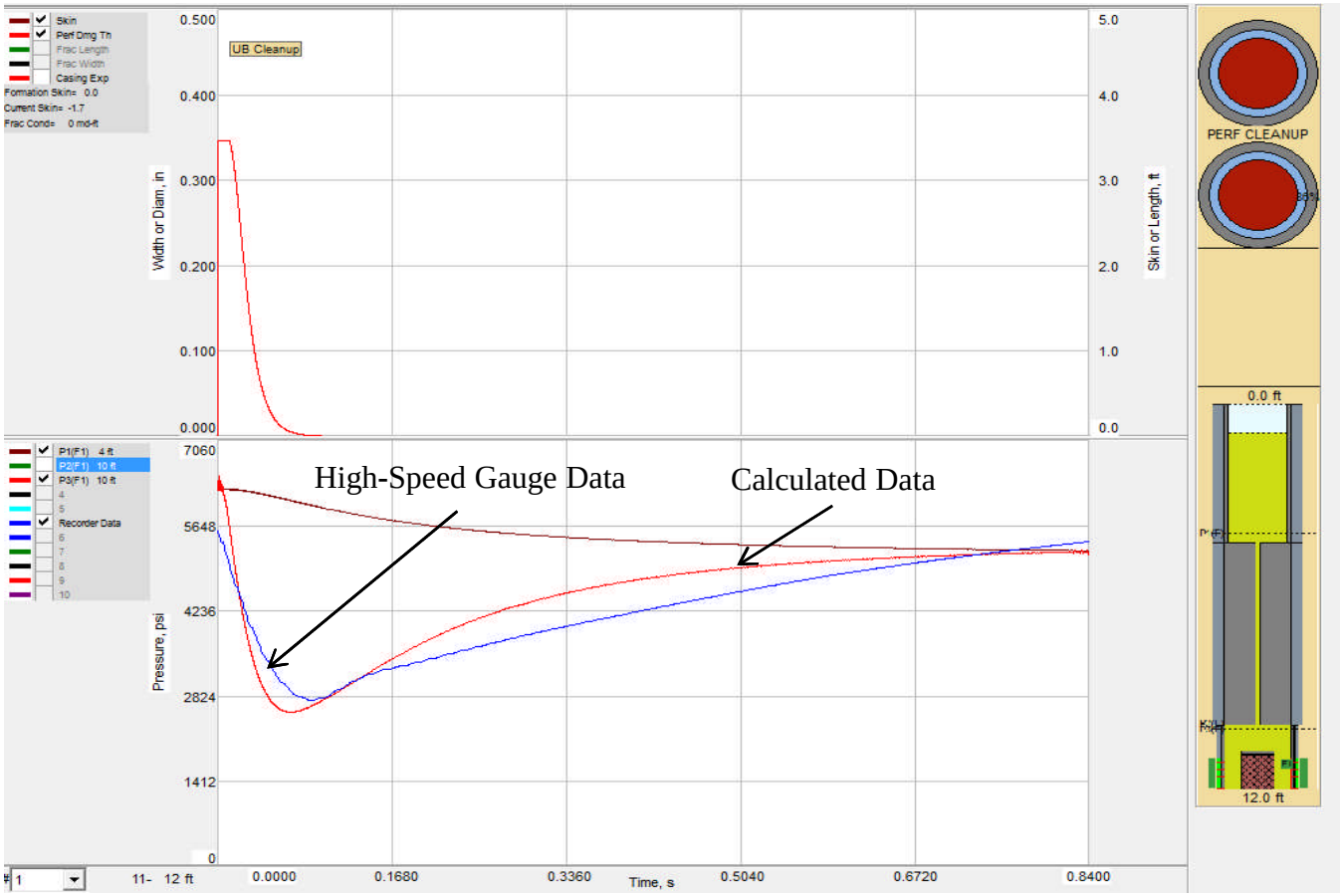
- Duration – Time from Detonation to Pressure Equalization

Results Overview



Post-Shot Transient Pressure match: UB_ 39 gm DP Steel

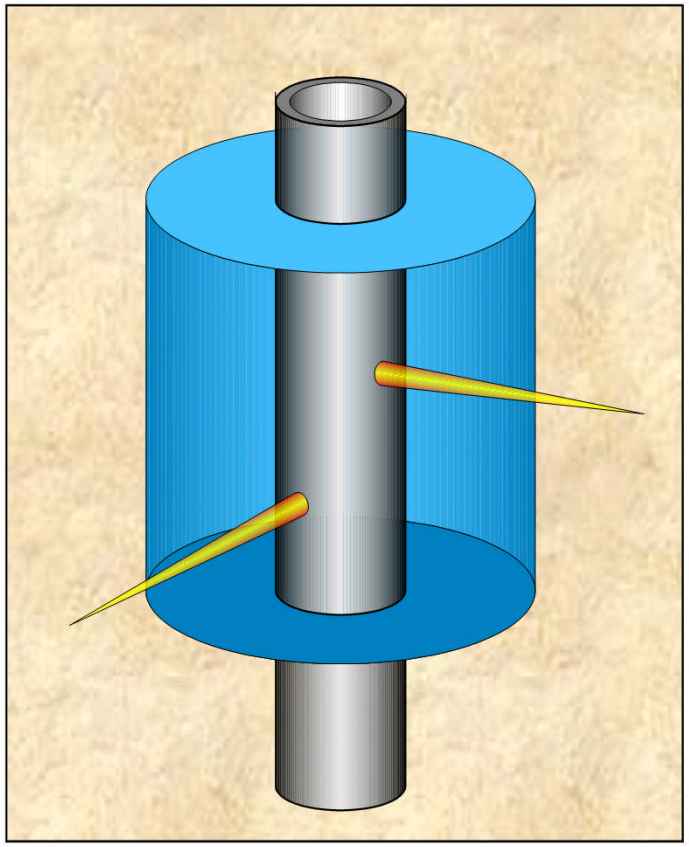
Results Overview



Post-Shot Transient Pressure match: OB_ 39 gm DP Steel

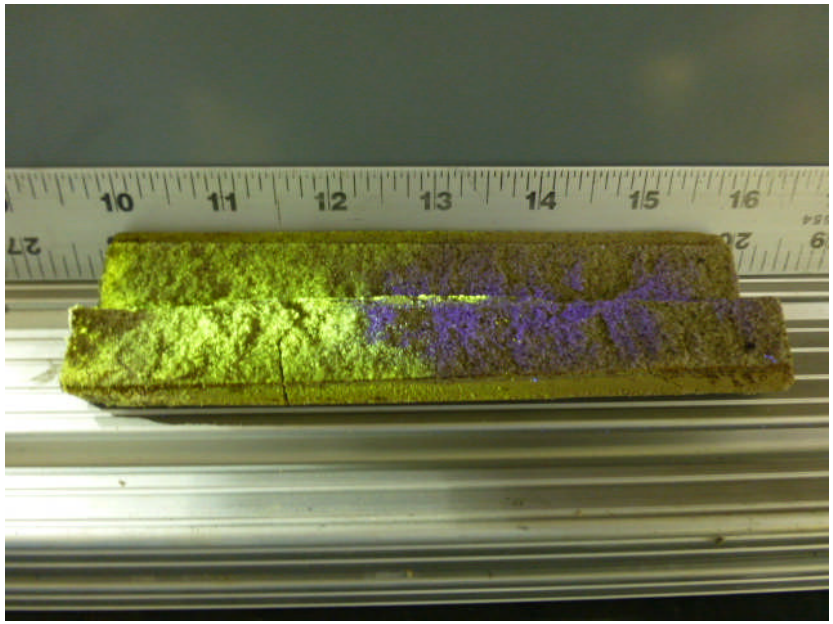
Conclusions

- Dynamic underbalance achieved with 7-in. OD X 39-gm steel case charges under all conditions.
- Dynamic underbalance achieved with 7-in. OD X 39-gm zinc case charges under all conditions.
- Charge performance in core significantly less than predicted from models
- Tunnel geometry impacted by variation in core structure (examining additional factors).



Ongoing work

- Effects of fluid invasion on charge performance, perforation geometry, and productivity.
- Effects of higher magnitude of static underbalance on perforation clean up
- Effect of fluid loss control pill on productivity as used in shoot-and-pull applications



Publication Works in Progress

"Shaped Charge Selection and Underbalance Optimization Using the Perforation Flow Laboratory for Deepwater Subsea Wells in Offshore Africa"

- Accepted for the SPE Deepwater Drilling and Completions Conference 2014, Galveston, TX. 10-11 Sept

Thank You!