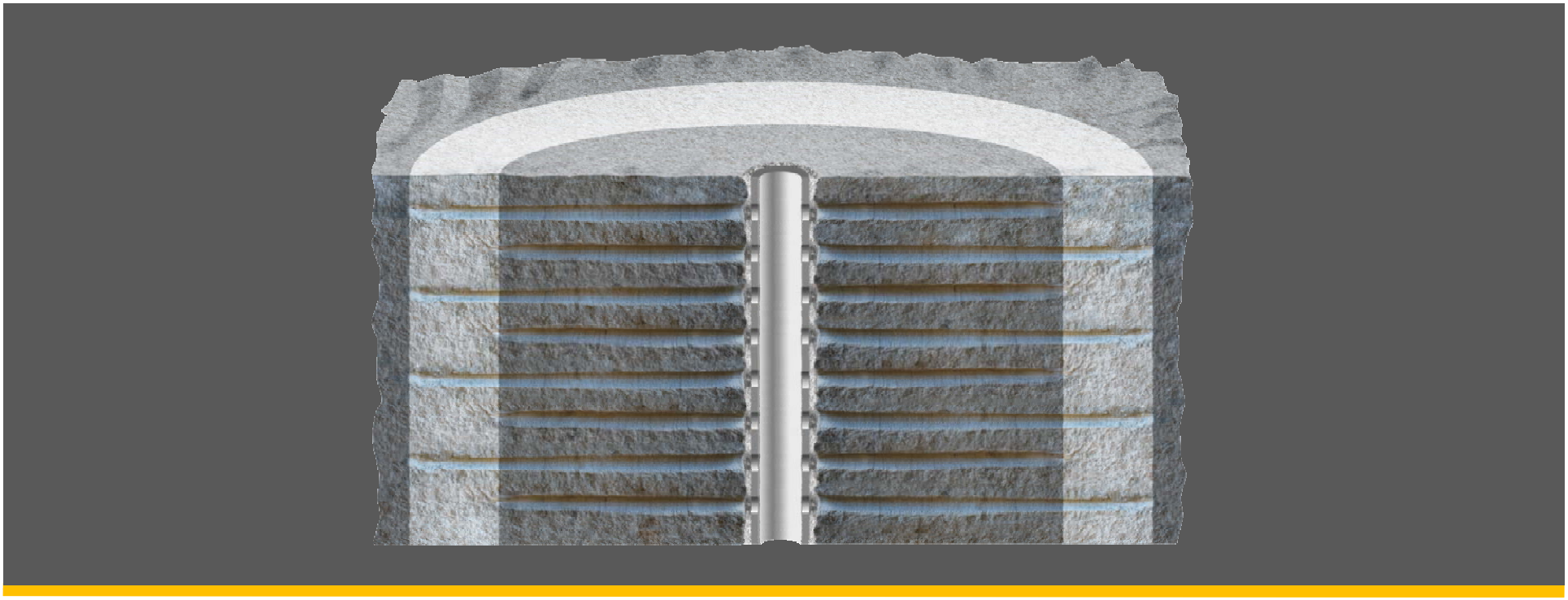


MENAPS-11-14
Reliable Prediction of Perforating Wellbore Pressure and Gun Shock Loads

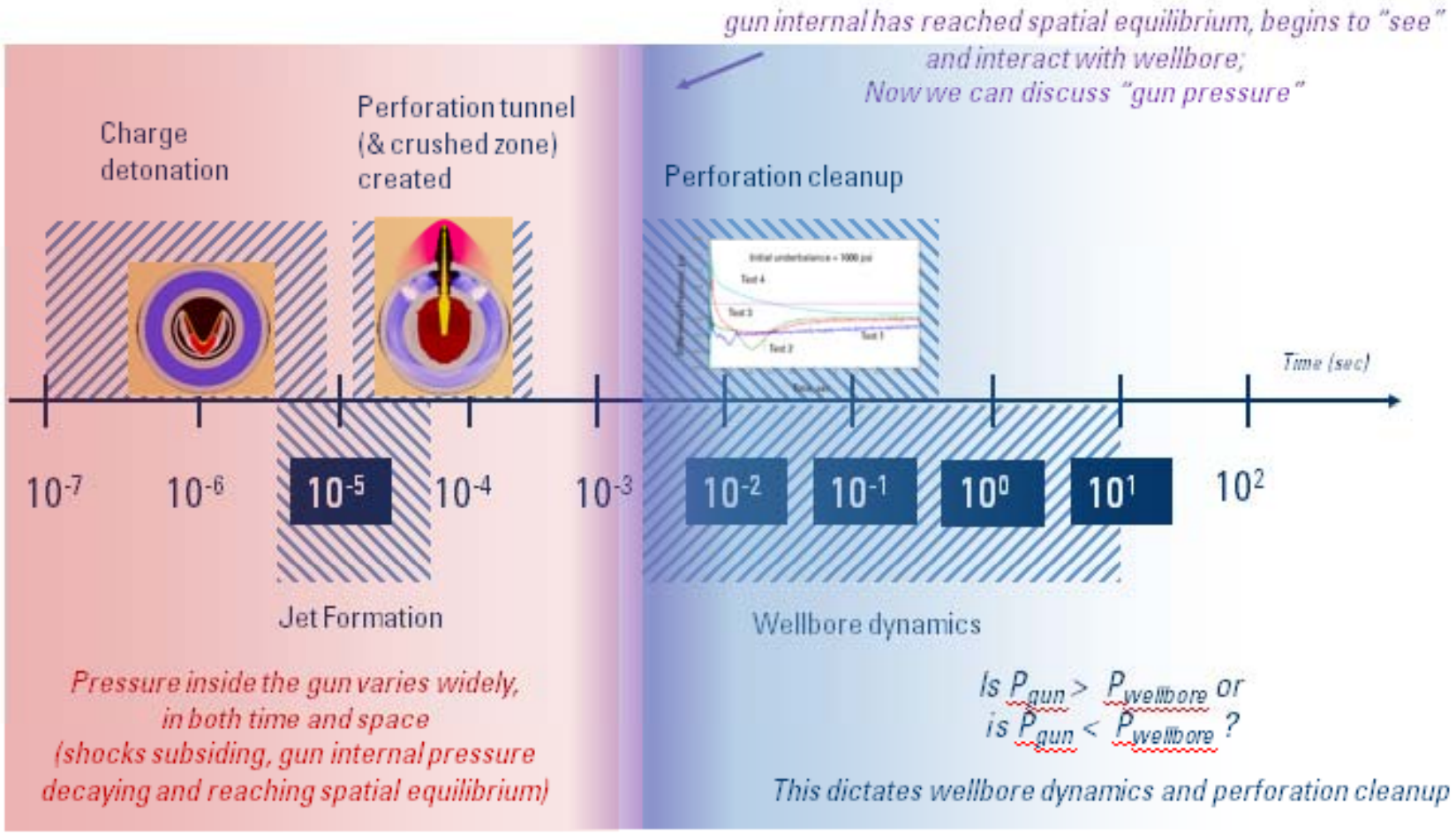
Andy Martin, Alan Salsman, Carlos Baumann, and Harvey Williams

Schlumberger

Prediction of Wellbore Pressure and Gun Shock Loads

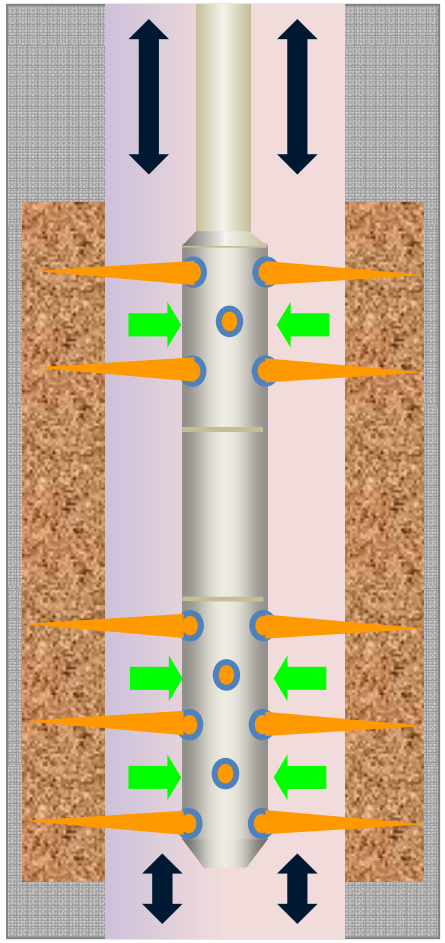
- Model Overview
- Example of Wellbore Dynamics
- Wireline Perforating Example
- Scale Cleanup in Libya Example
- Completion Perforating Example
- HP Well Study

Wellbore Hydrodynamics - Timeline



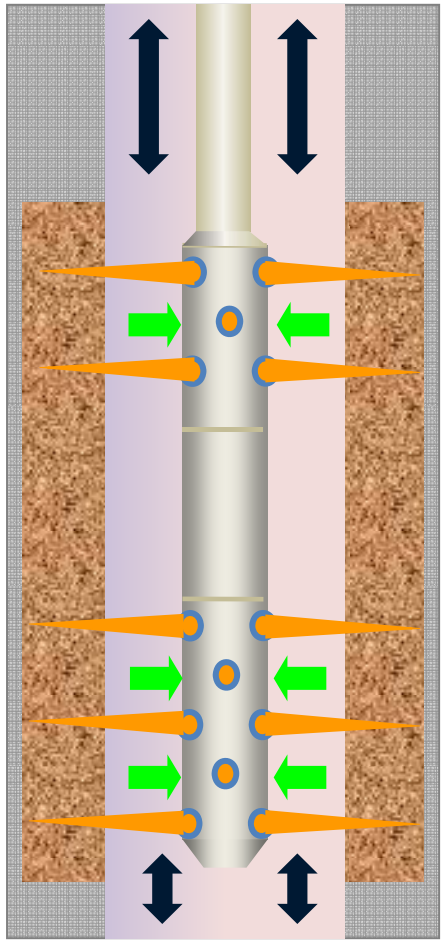
Model Overview

- Guns and spacers act as a pressure sink generating pressure waves in the wellbore
- Pressure waves acting on cross-sectional area changes produce gun shock loads
- Model predicts interaction between guns and wellbore, and wellbore and reservoir
- Discontinuous finite element method used to solve governing equations in both space and time

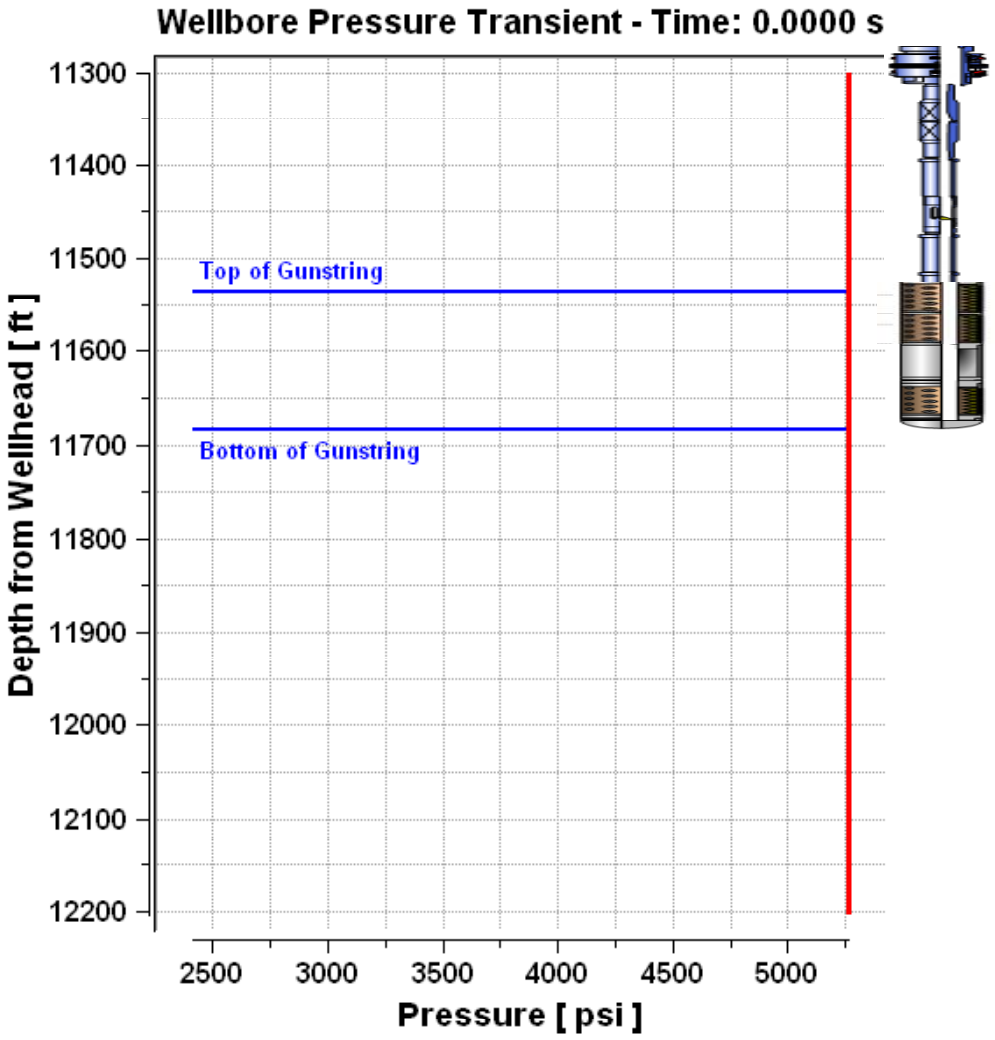


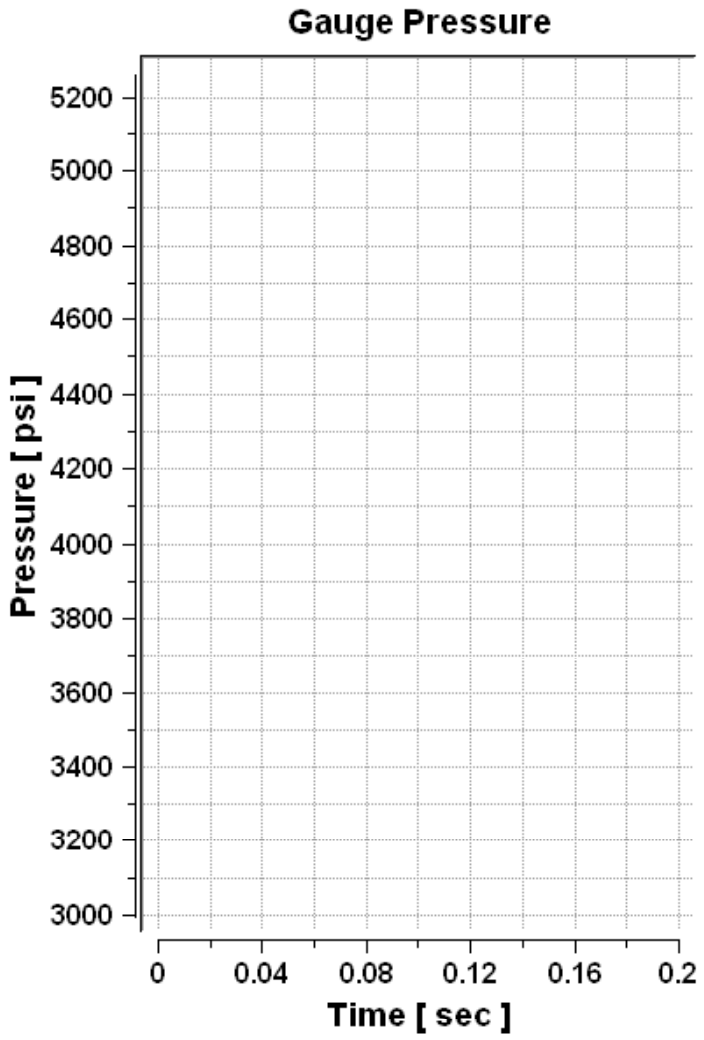
Model Overview

- Prediction of transient pressure around guns and sandface for perforation clean up (DUB)
- Prediction of gun movement, tubing and packer loads, cable tension and weak point load
- Gun shock is typically an issue in very high pressure wells and/or with large OD guns
- Typically not an issue for most perforating jobs
- Software verified using our extensive database of jobs

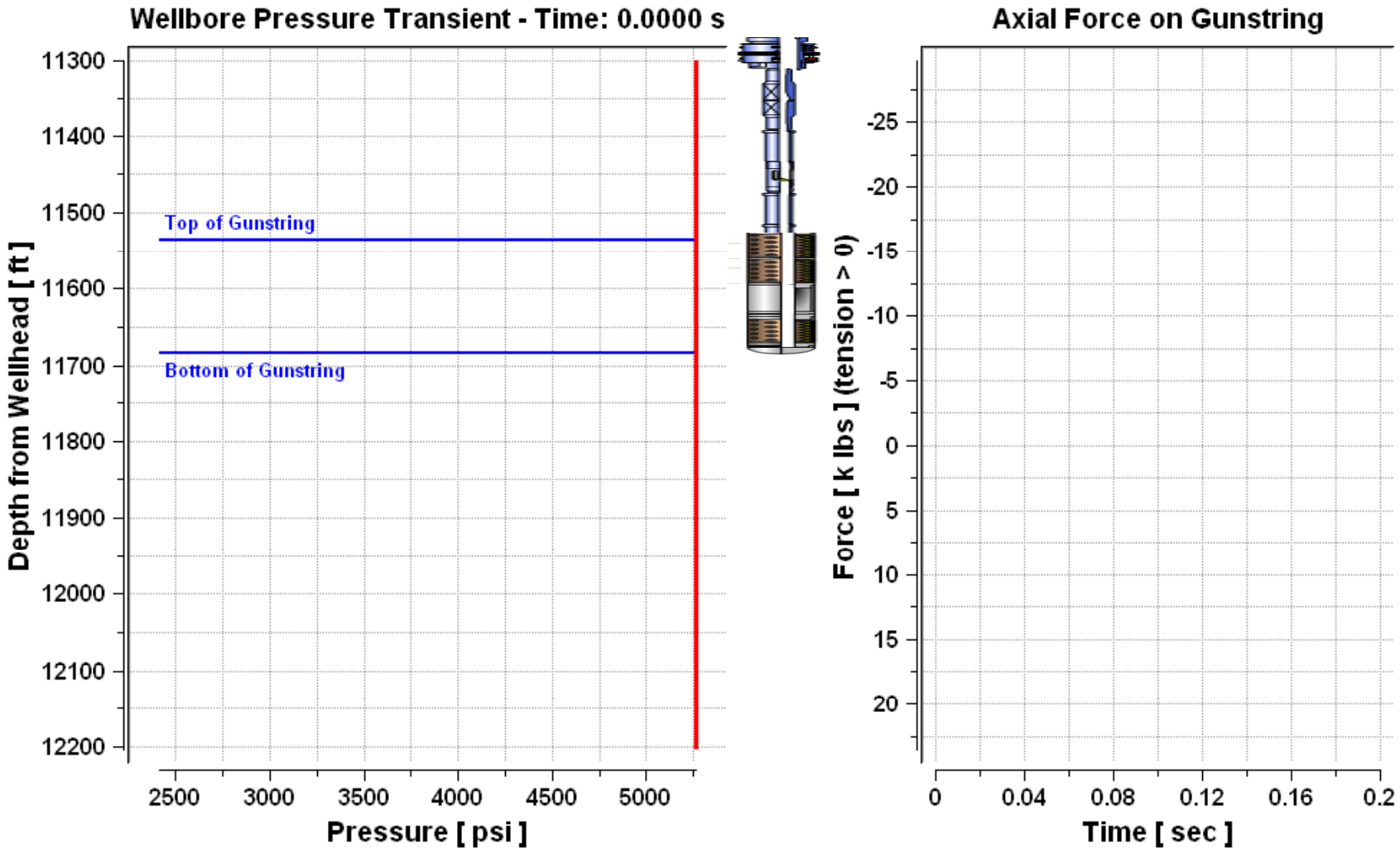


Wellbore Dynamics Animation - Pressure

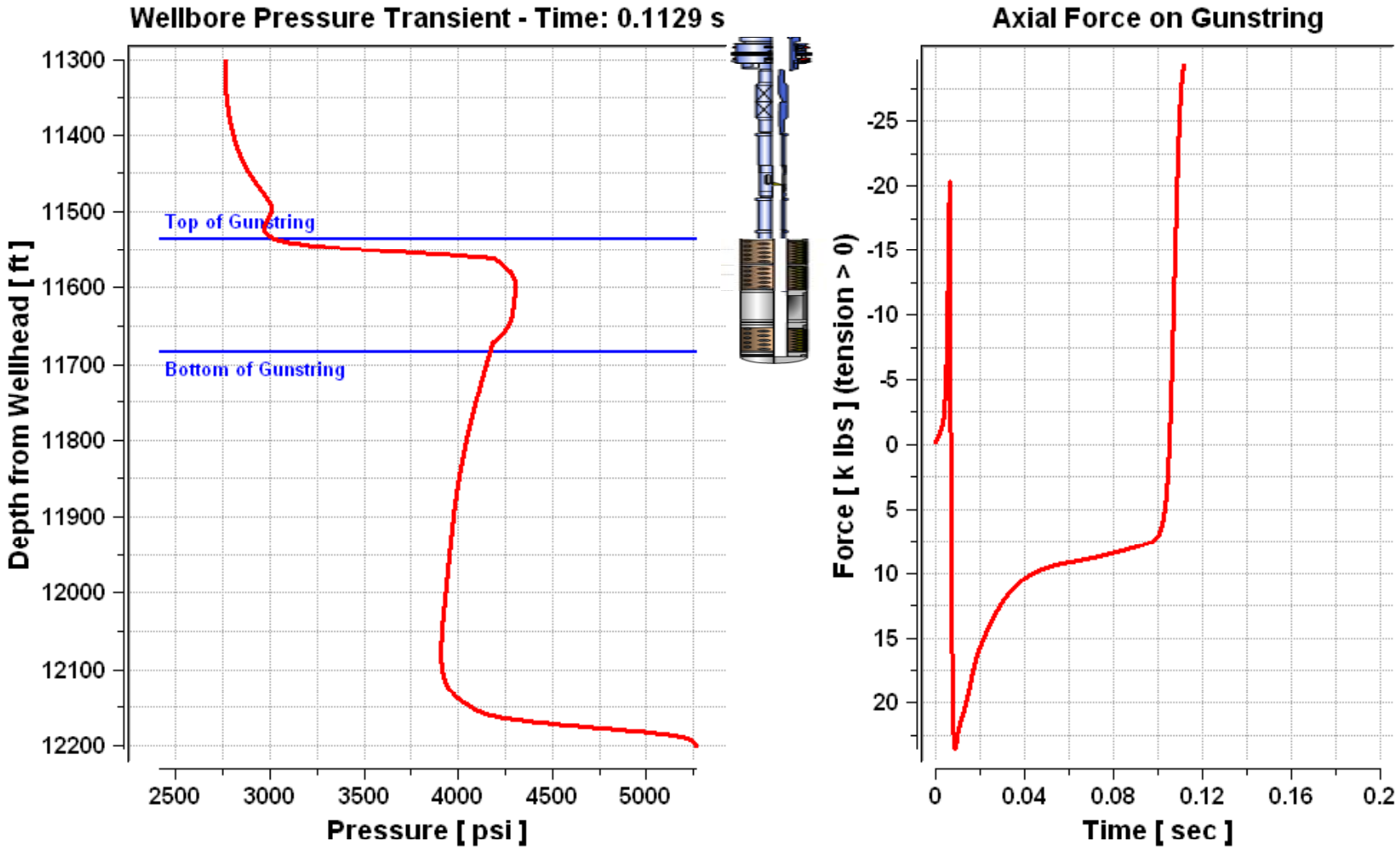




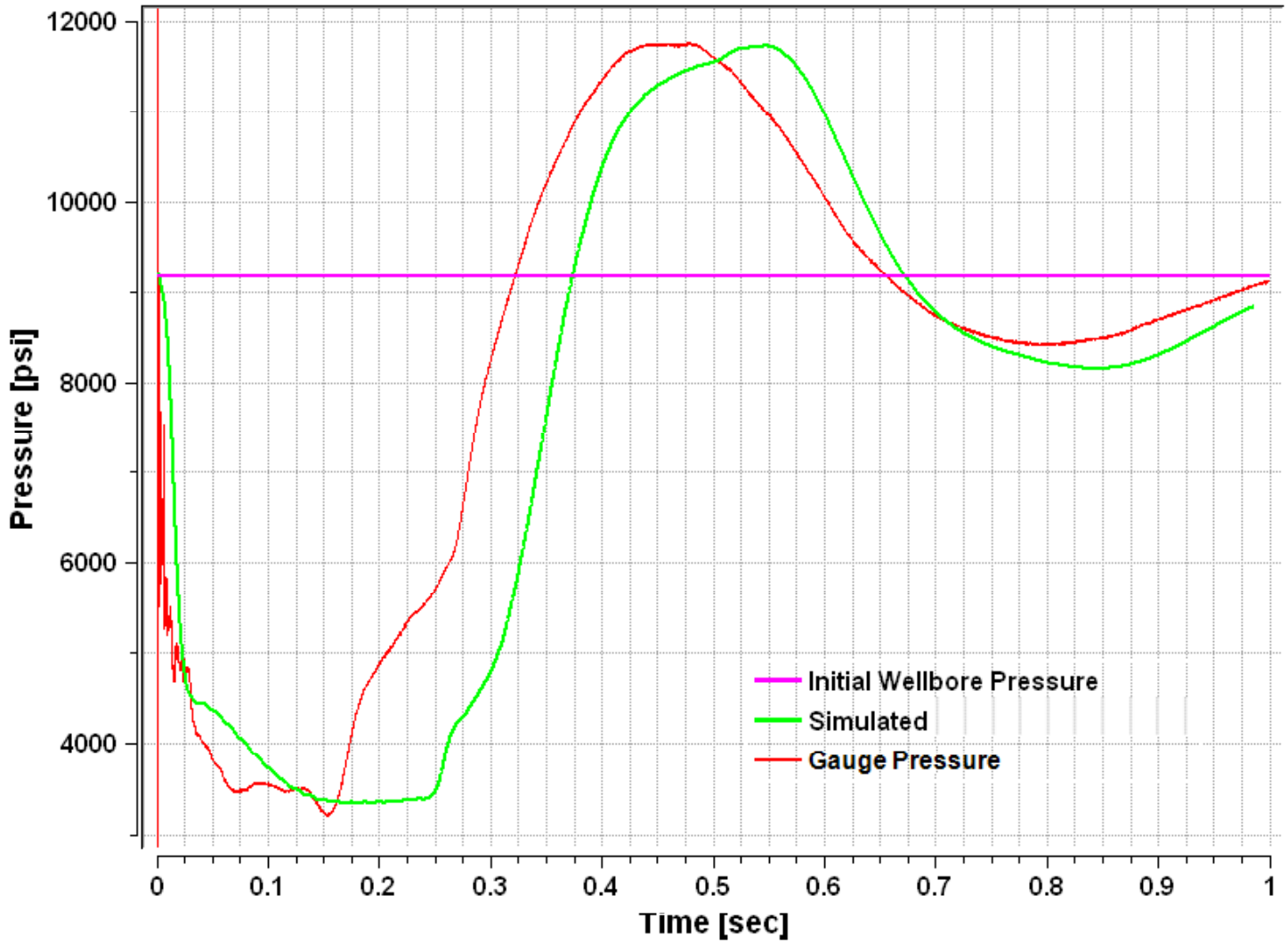
Wellbore Dynamics Animation - Force



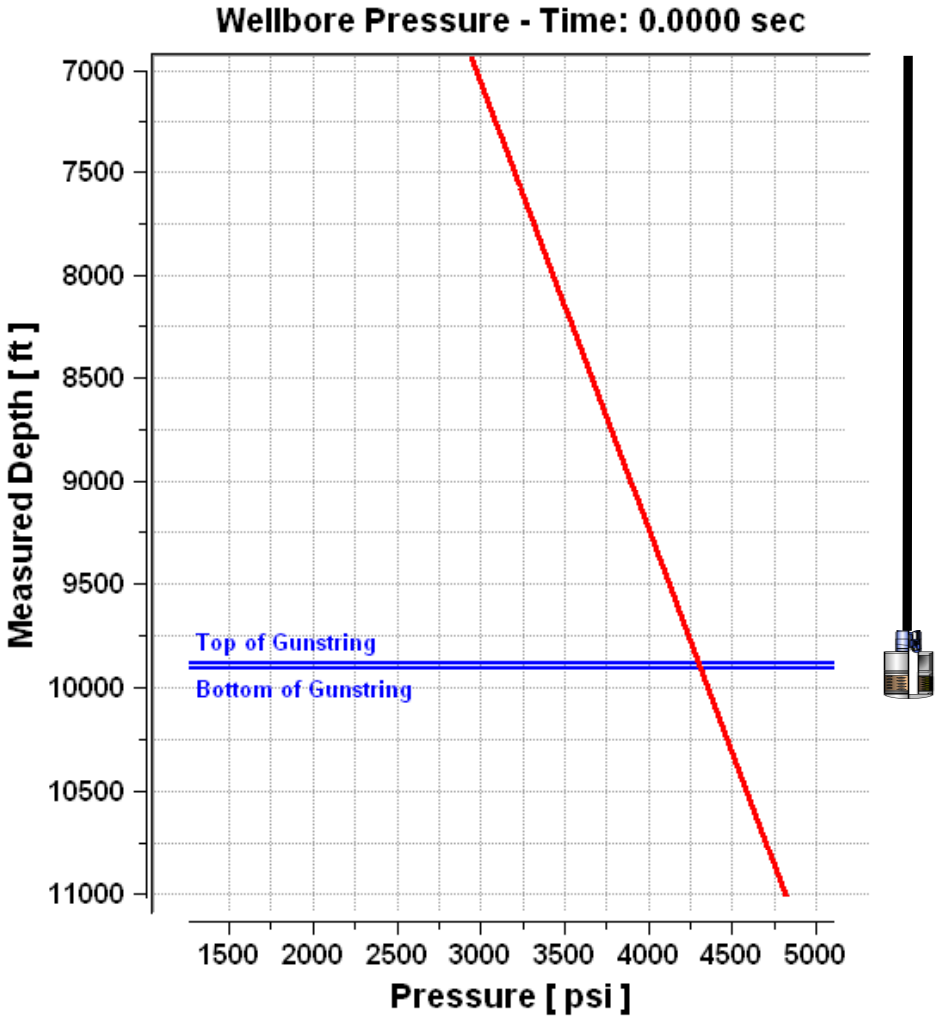
Wellbore Dynamics Animation – Instant of Max Force

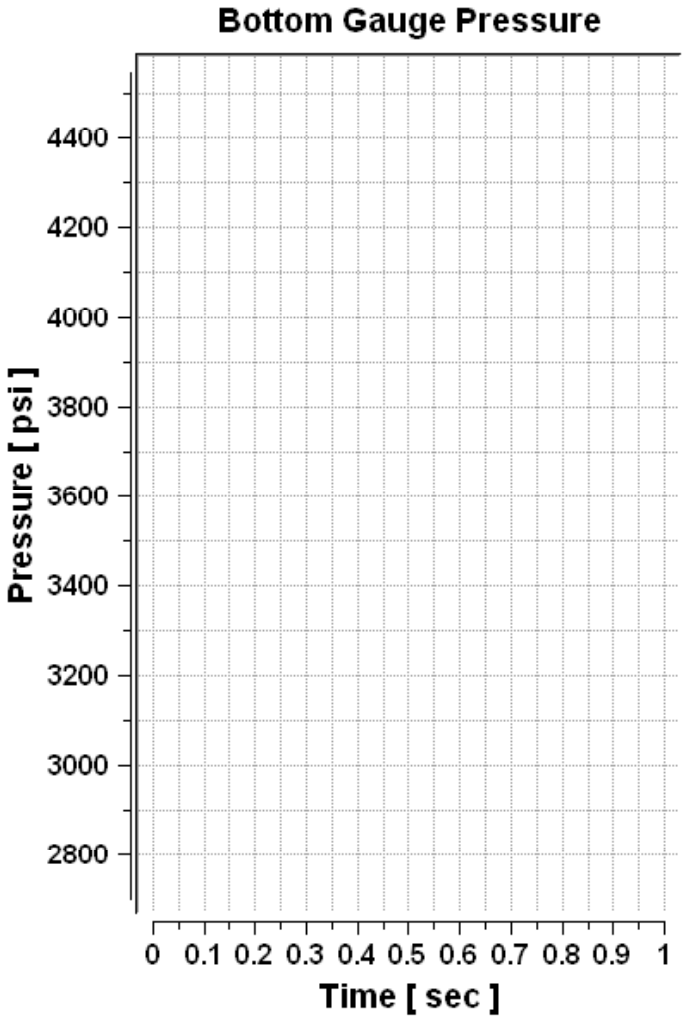


Example 4 ½” Wireline guns – IBP 3359

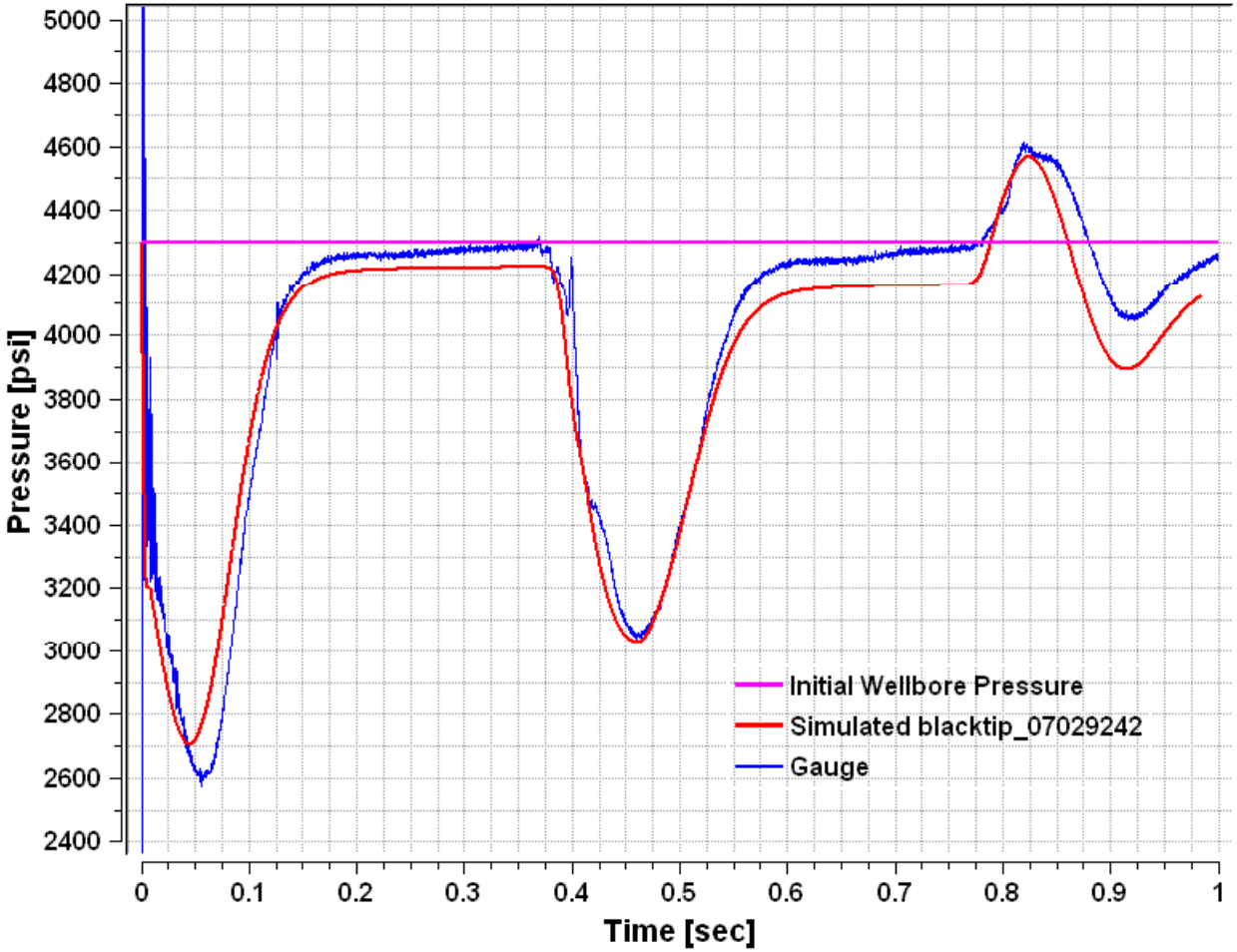


Example DUB Job – IPTC 14300

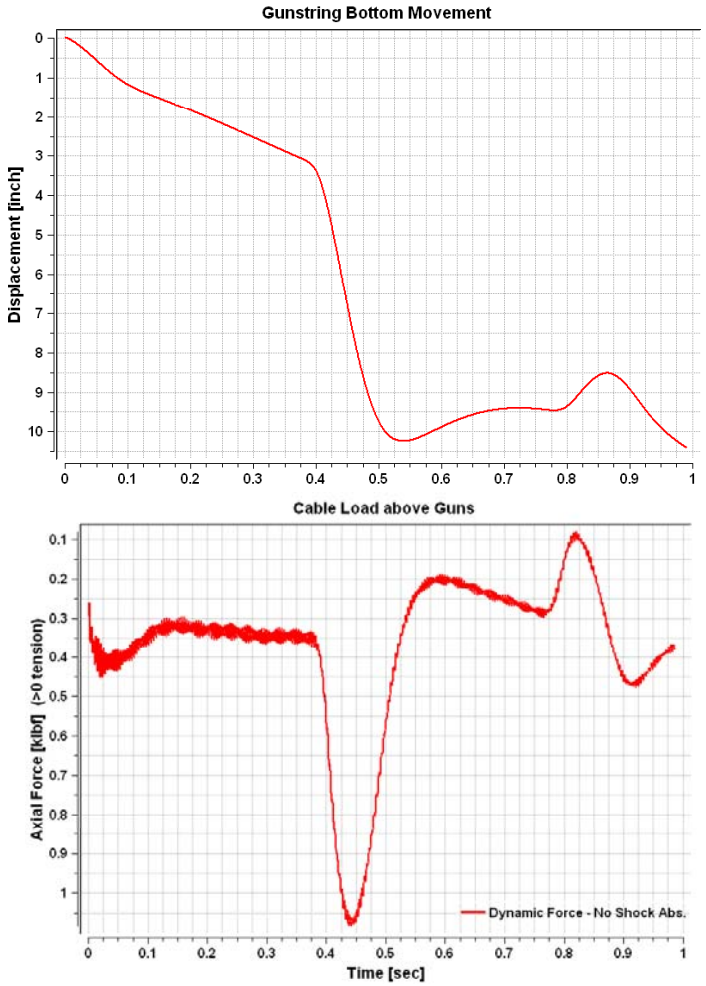


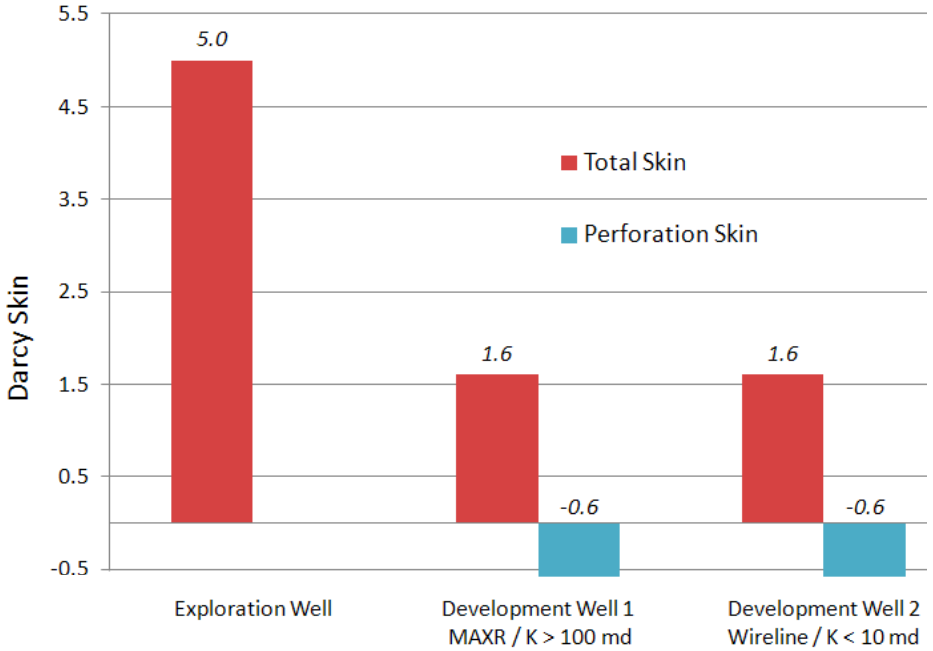


Example DUB Job – IPTC 14300

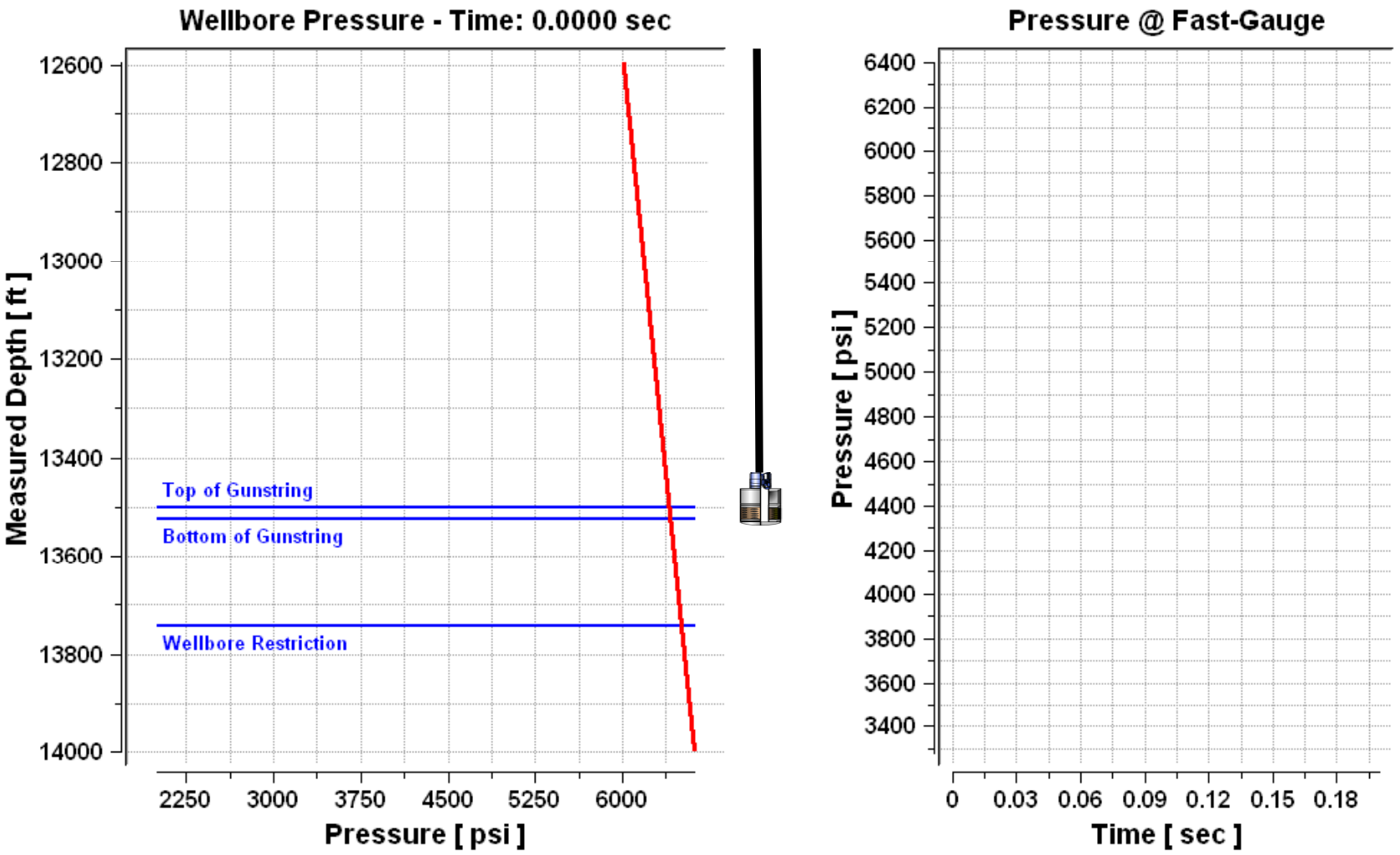


Example DUB Job – IPTC 14300

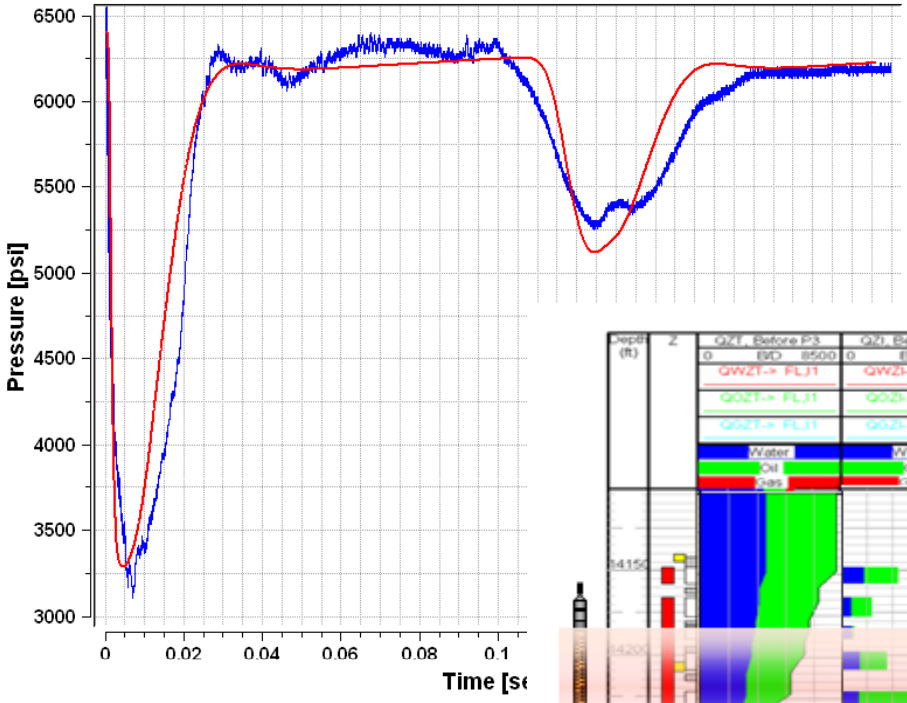


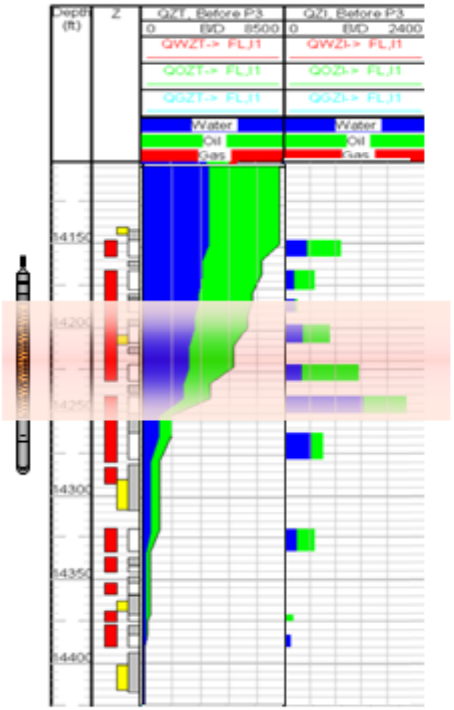


Example Implosion Scale Removal – SPE 144080

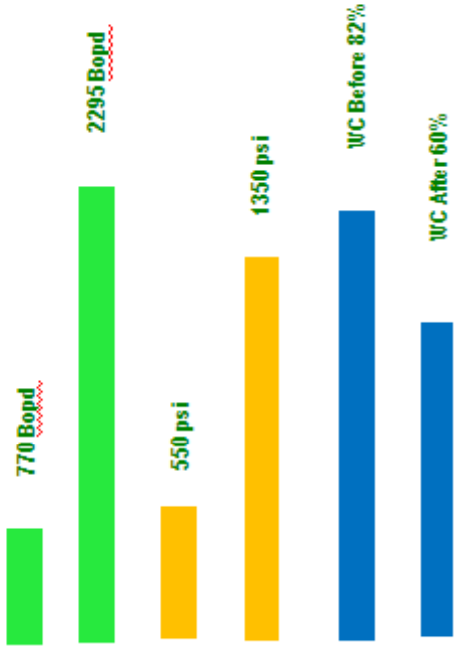


Example Implosion Scale Removal – SPE 144080

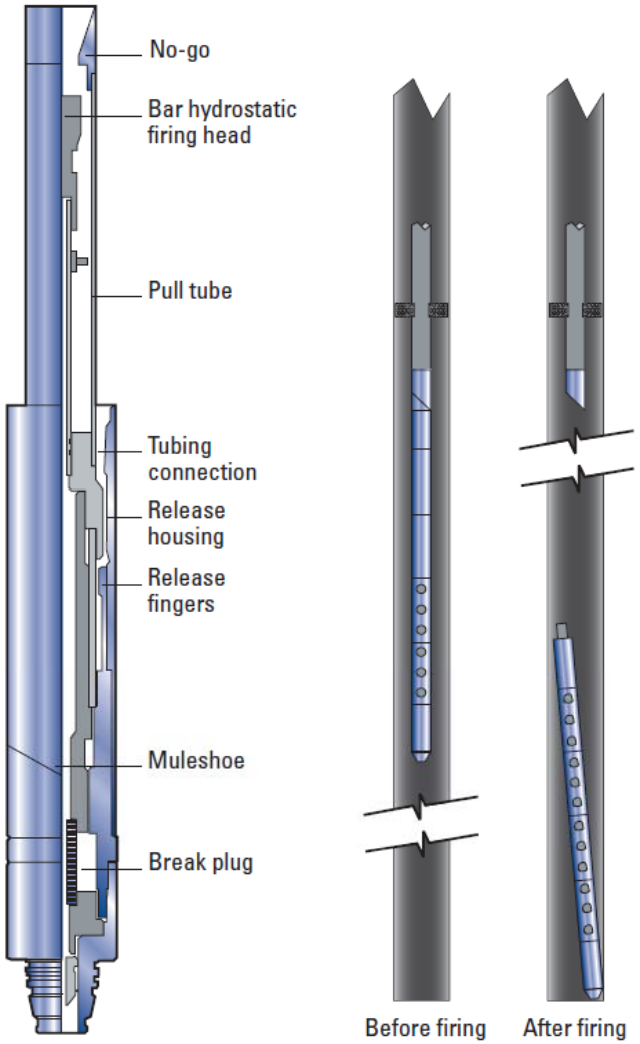


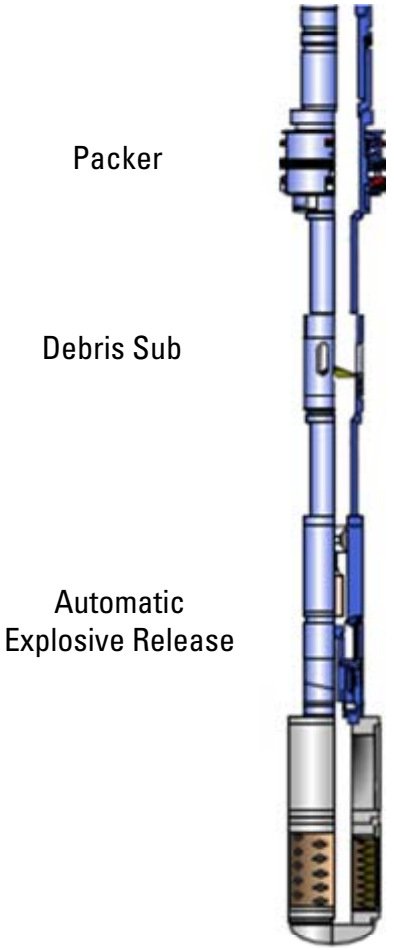


Treated zone

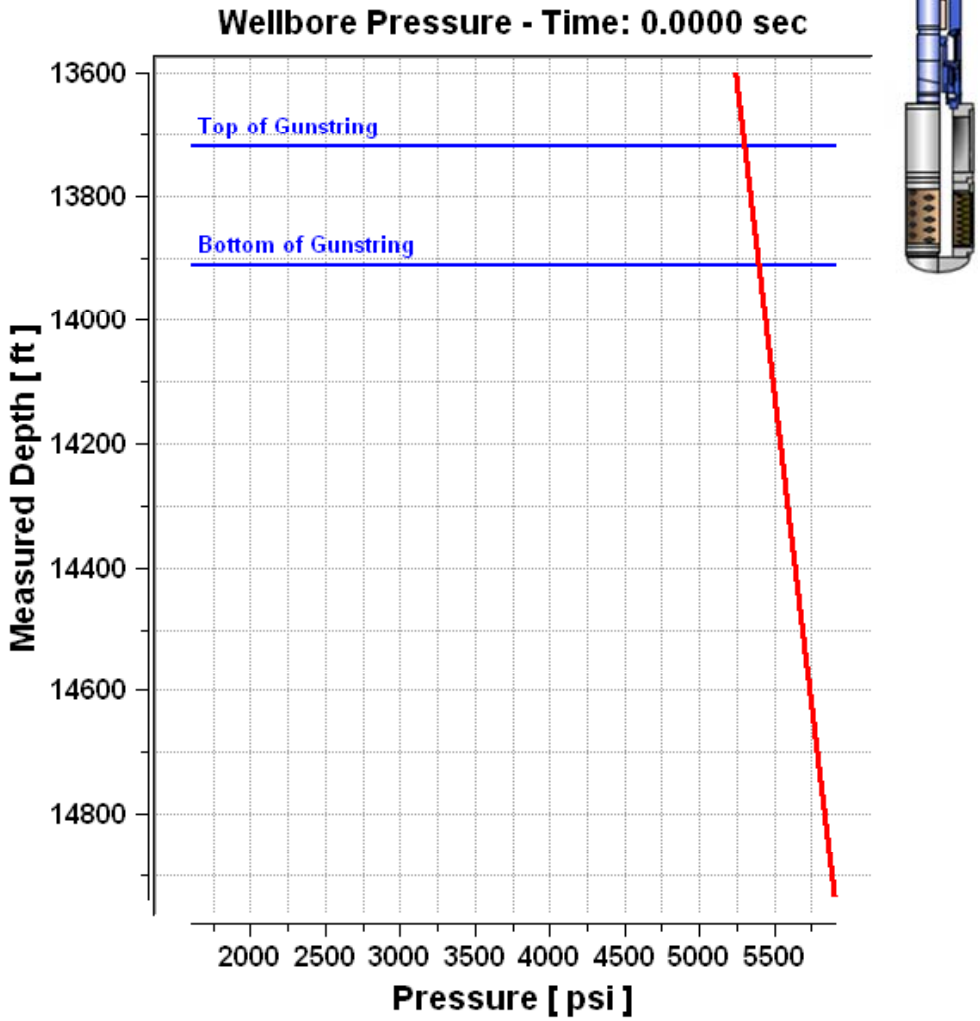


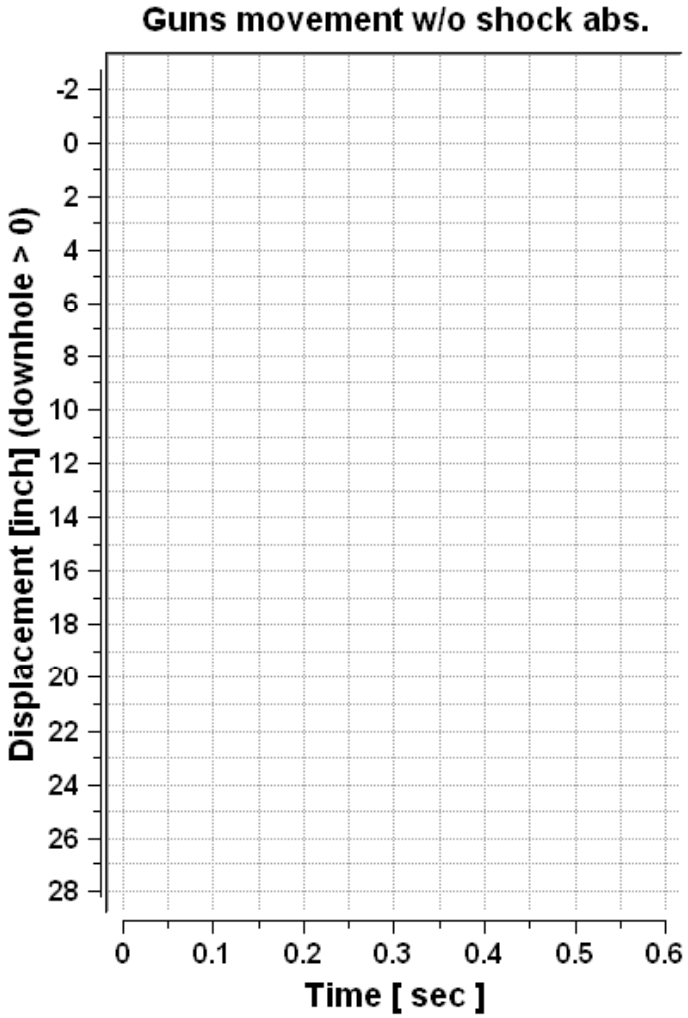
Example Reducing Dynamic Loads on Completions



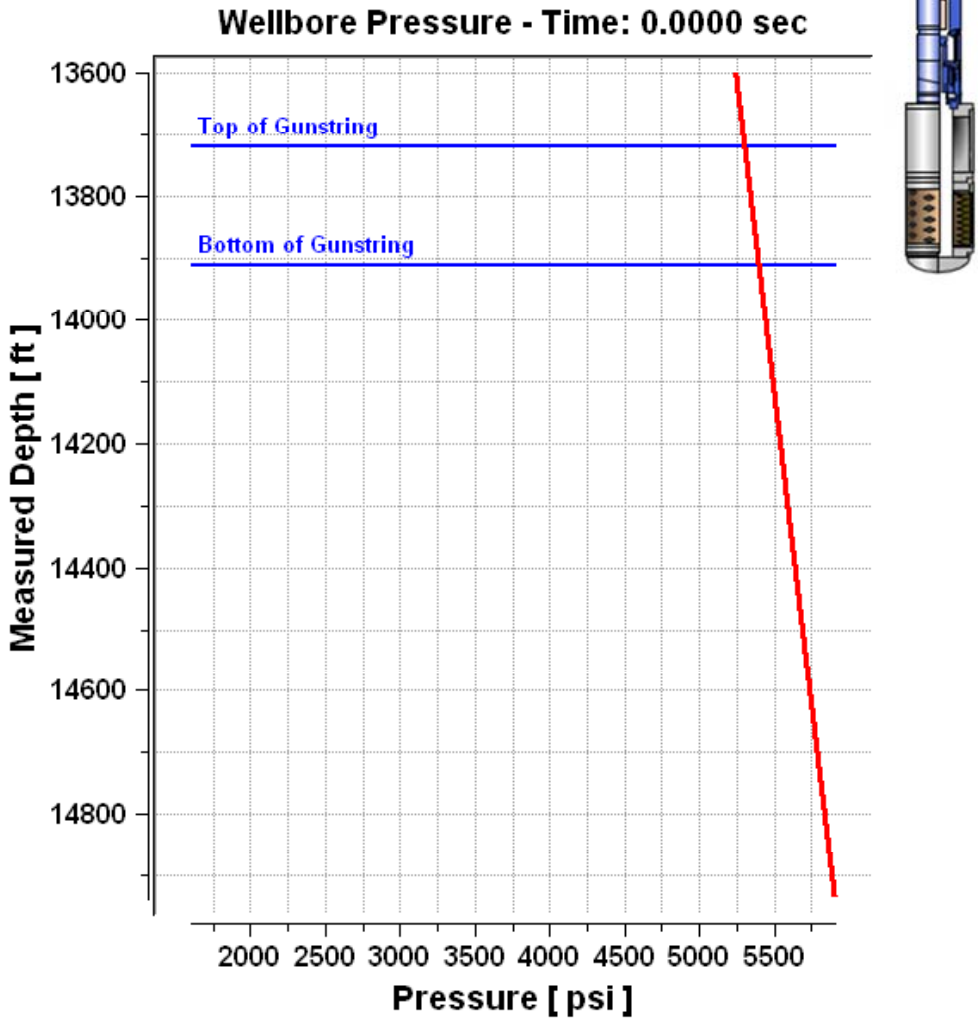


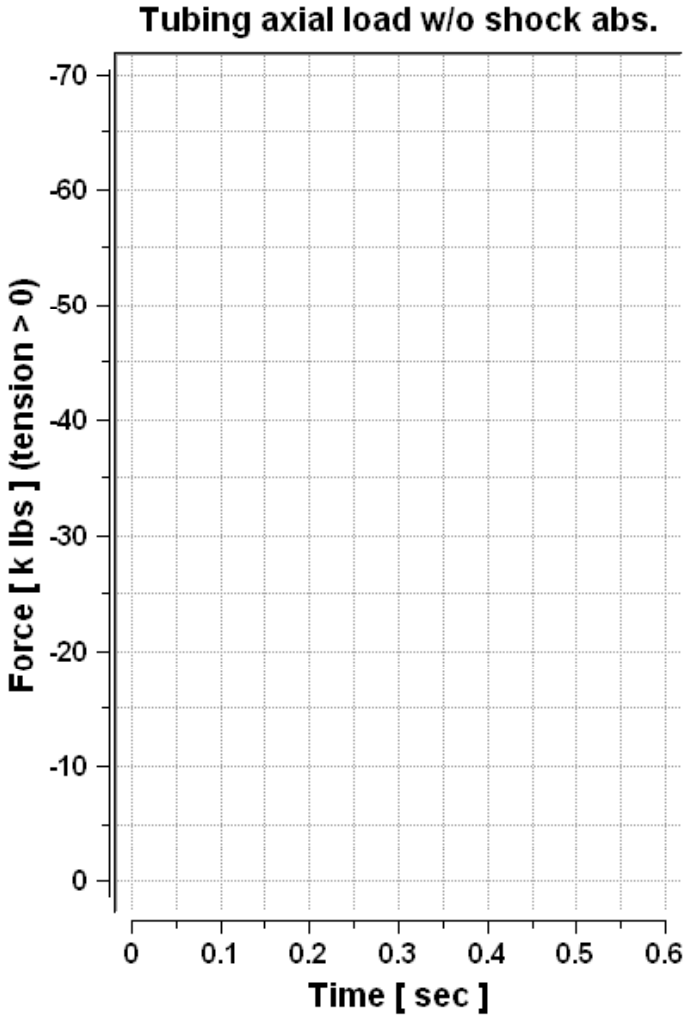
String Movement – Original vs Modified



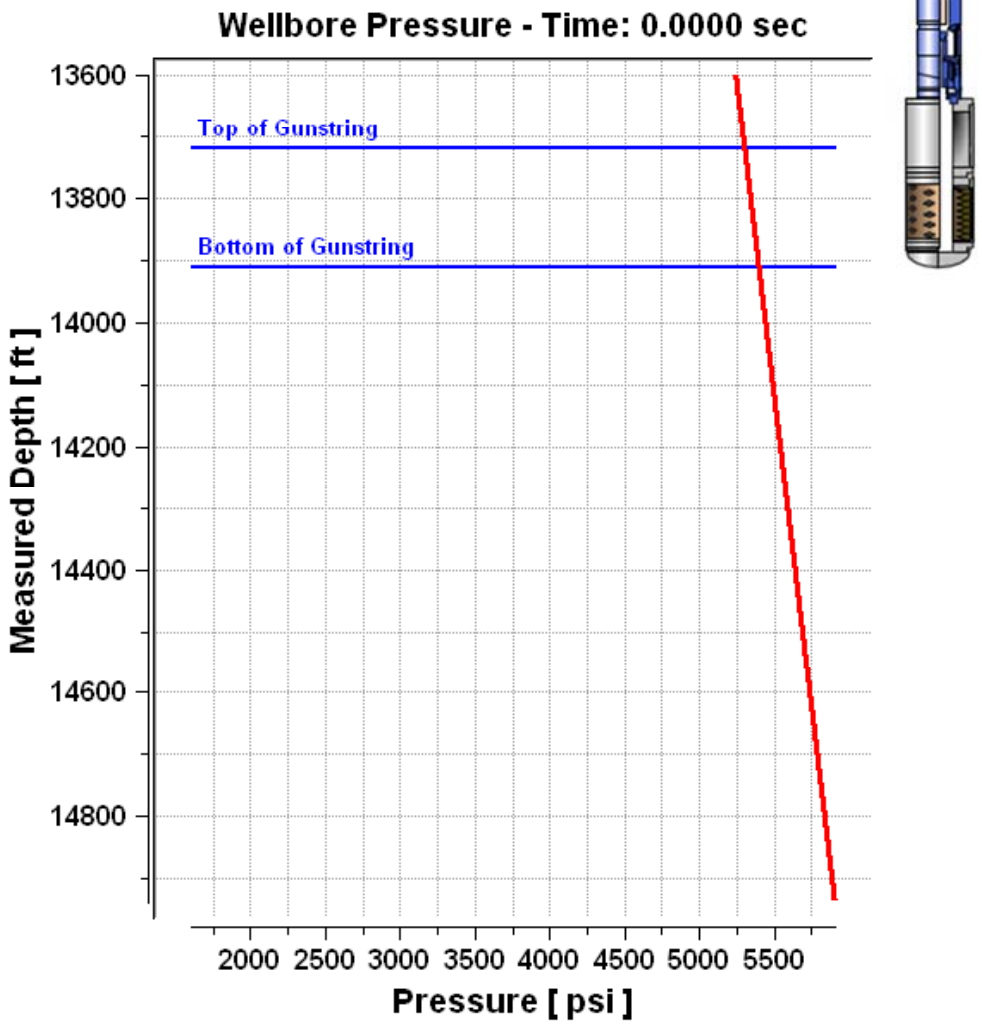


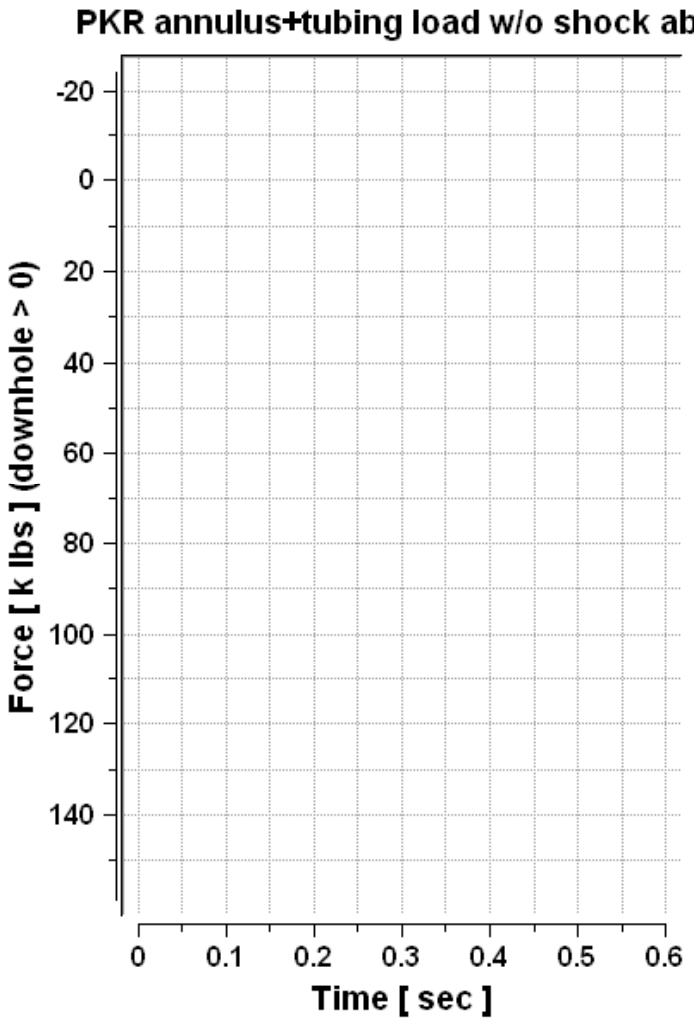
Axial Force Reduced on Tubing





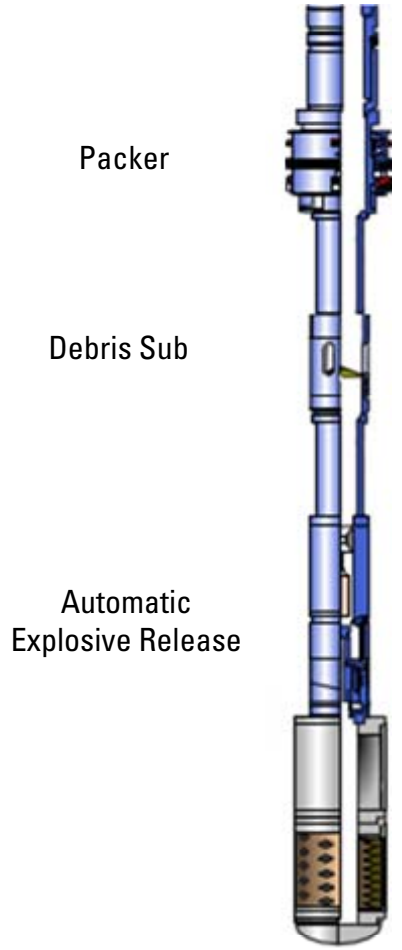
Loads Reduced on Packer



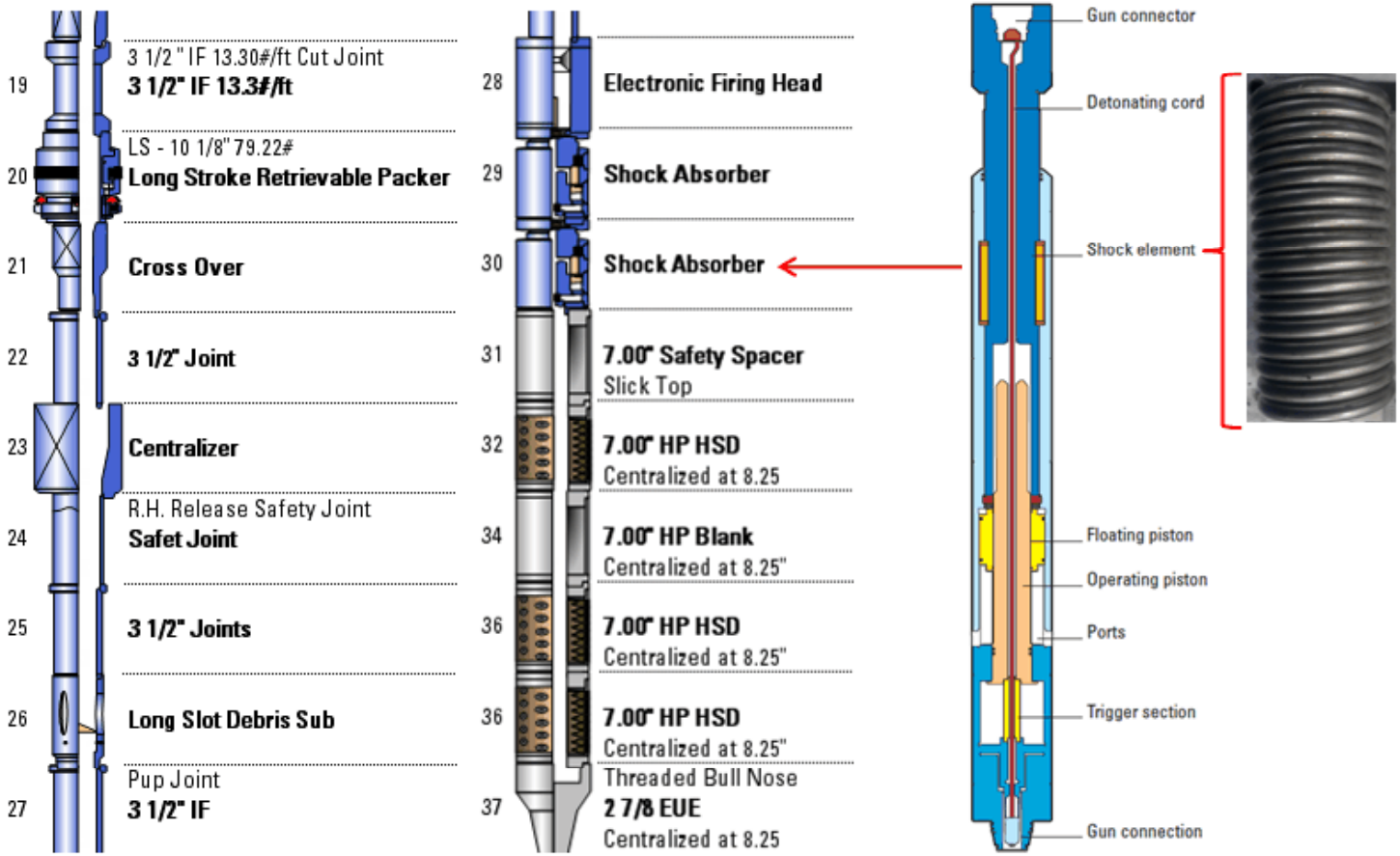


Summary

- Simulation of original design shows axial forces on explosive gun release of 70 klbs and 160 klbs on packer
- Adding spacer at bottom of gun reduced load on packer to 100 klbs and force on explosive gun release to 3 klbs. String movement downwards.
- Modified design was used on jobs and executed successfully

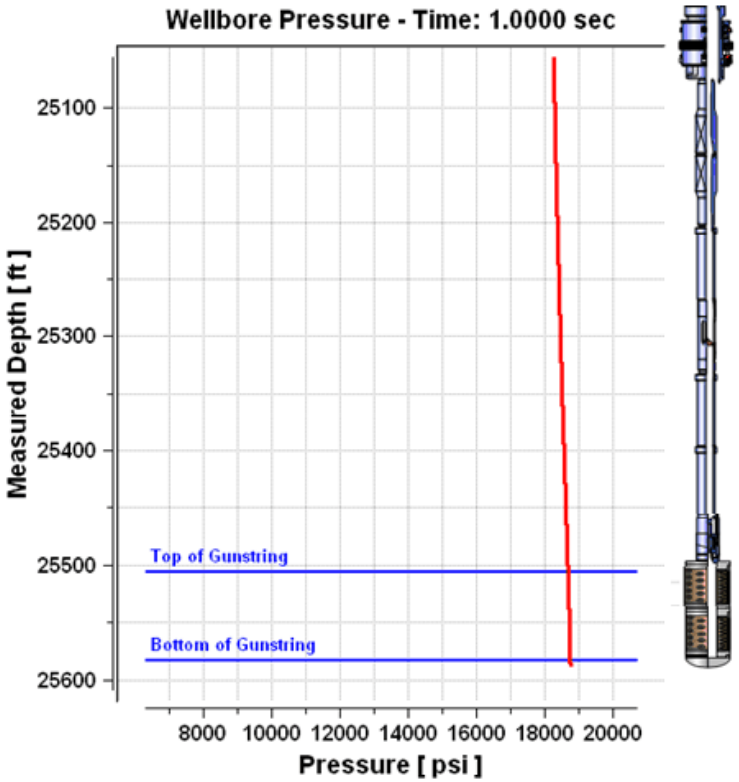


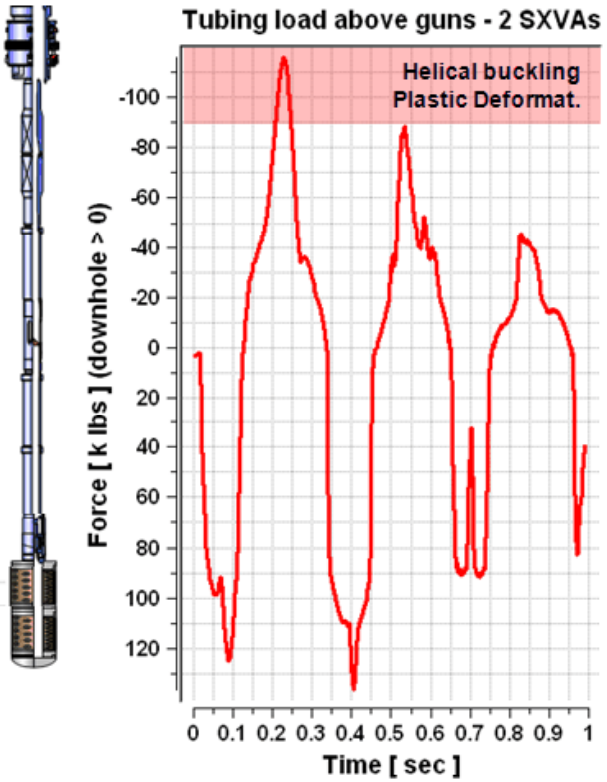
Gun Shock Study in HP Wells – SPE 146809

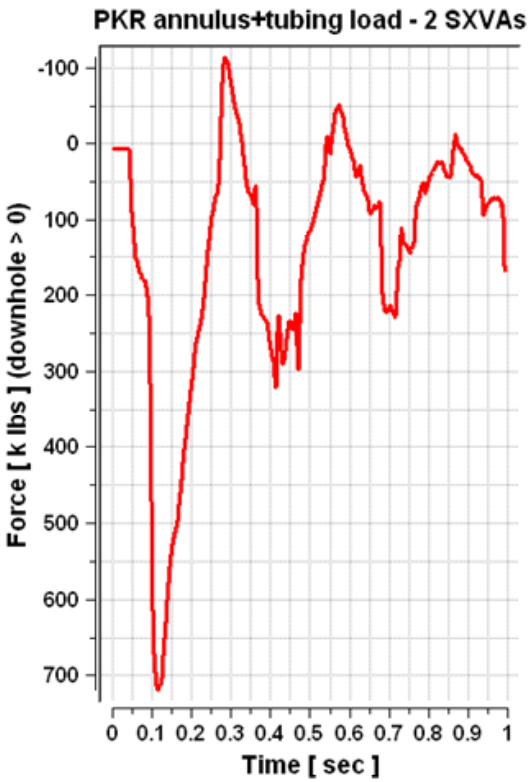


Gun Shock Study in HP Wells – SPE 146809

- Some tubing damage on one well. If simulation run before the job, helical buckling with plastic deformation would have been predicted.

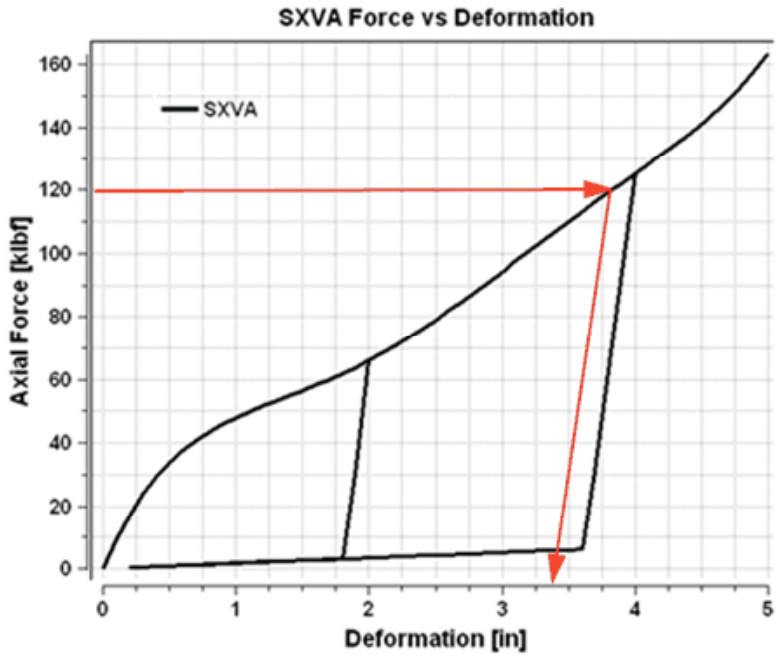






Gun Shock Study in HP Wells – SPE 146809

- Recovered crushable elements from explosive activated shock absorbers are evidence of loads. Model can be used to predict shock loading with or without shock absorbers.



Summary

- Wellbore dynamics are accurately predicted for DUB and DOB modeling
- Forces on completions are accurately predicted
- Loads on wireline strings are accurately predicted
- Solutions to reduce gun shock can be quickly analyzed

Prediction of Wellbore Pressure and Gun Shock Loads

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- Completion Perforating Example
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Questions ?