IPS-14-04

Perforating Gunshock Loads

Simulation and Optimization in 2014

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Wellbore Dynamics - Gunshock Loads – Tools Damage

This is what we need to avoid!

The Importance of Gunshock Prediction

- Gunshock is a significant cause of serious failure - from the most simple wireline job to the most costly TCP operation
- Failures lead to very costly NPT due to fishing jobs, lost holes and lost production
- Higher pressure and deeper wells lead to greater exposure to gun shock failure
- Severity of the problem often not recognised or understood by Operators
- Leads to acceptance of Contractors' models without in depth understanding of the models or the parameters effecting the design

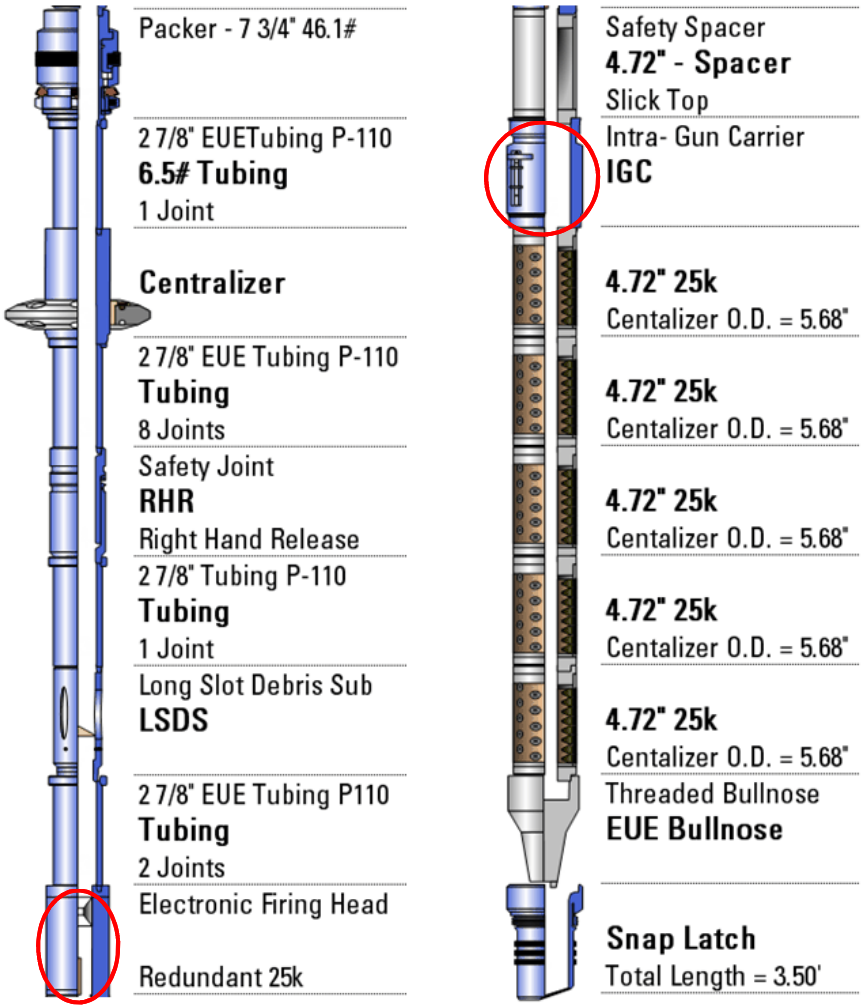
The Importance Gunshock Prediction

Starting the Debate

- Started a debate regarding the key gun shock models with their vendors to lead to a detailed and collaborative study of gun shock modeling and an SPE paper
- Should lead to further collaboration with multiple parties
- Accepting that these are post job models without audit
- Not a test of which model is best
- A route to improve awareness of modelling, as well as improved models and new models
- First a presentation to IPS with Schlumberger and Shell comparing existing models in an example well (initial comparison)

Reliability of Predictions

TCP job with 4.72-in HP HSD guns – Fast pressure gauges: 2



Net perforation interval 200 ft

19-gram HMX big-hole charges at 20 spf

Top of safety spacer to packer 360 ft

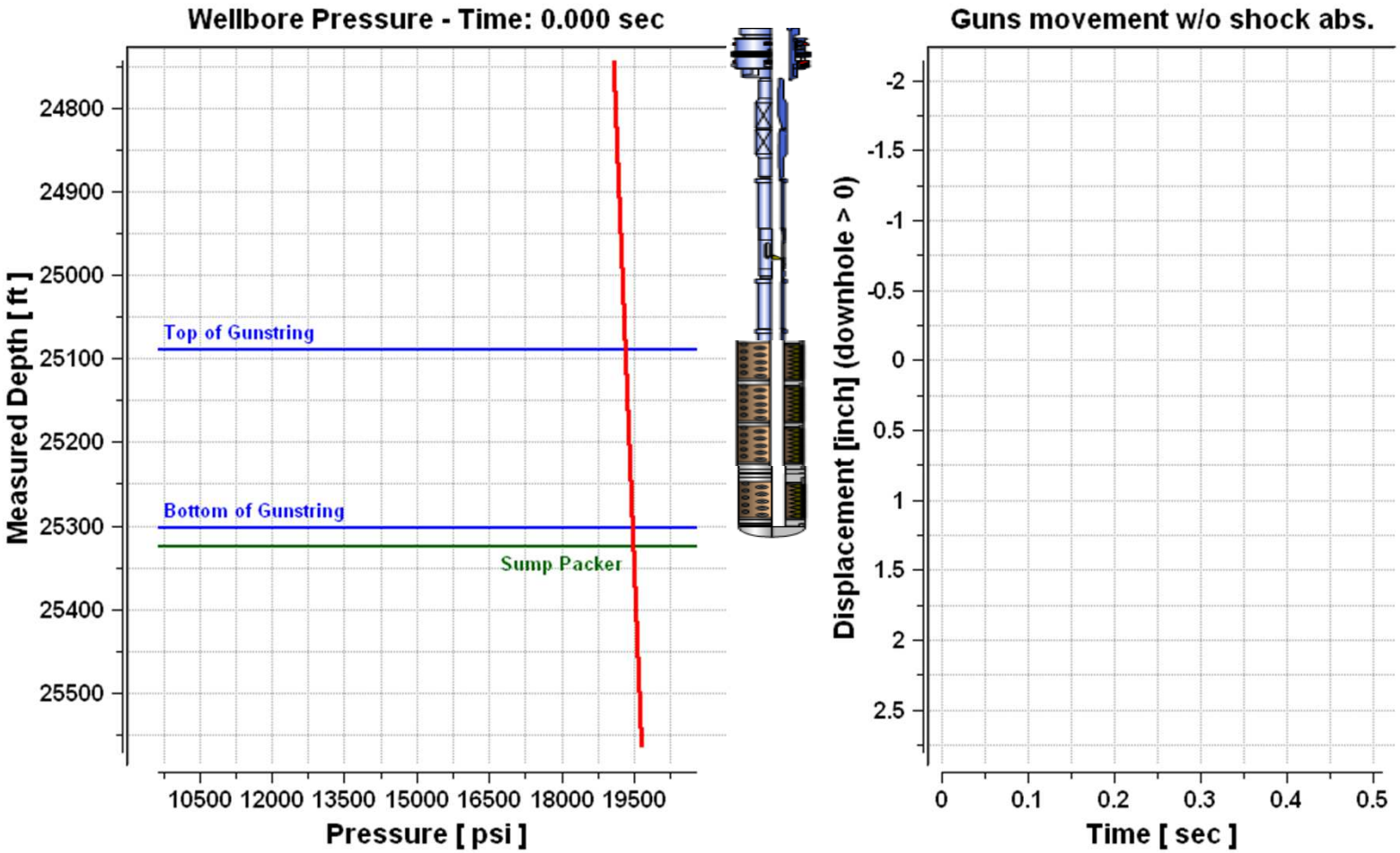
Bull-nose to sump packer 10 ft

Bull-nose to PBTD 267 ft

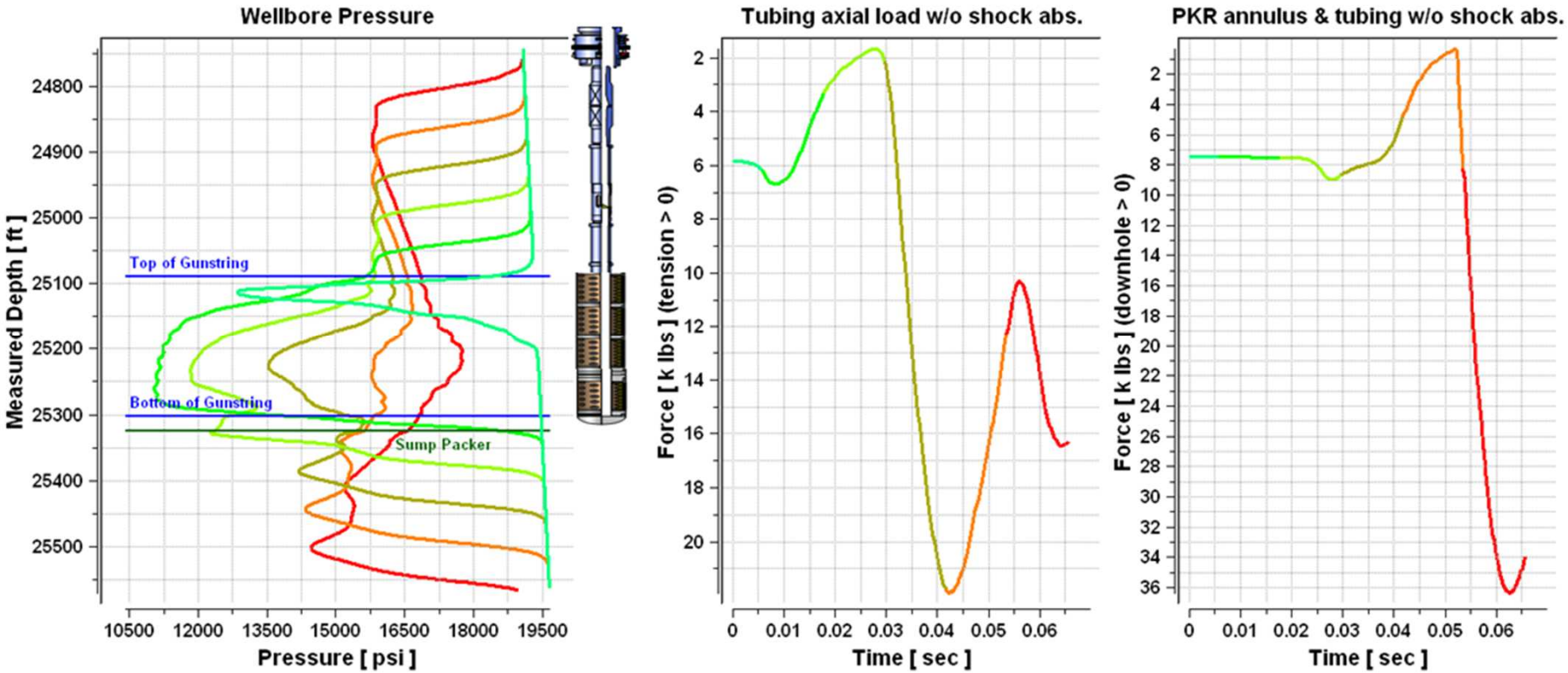
Initial wellbore pressure at depth 19,320 psi

14.8 ppg brine

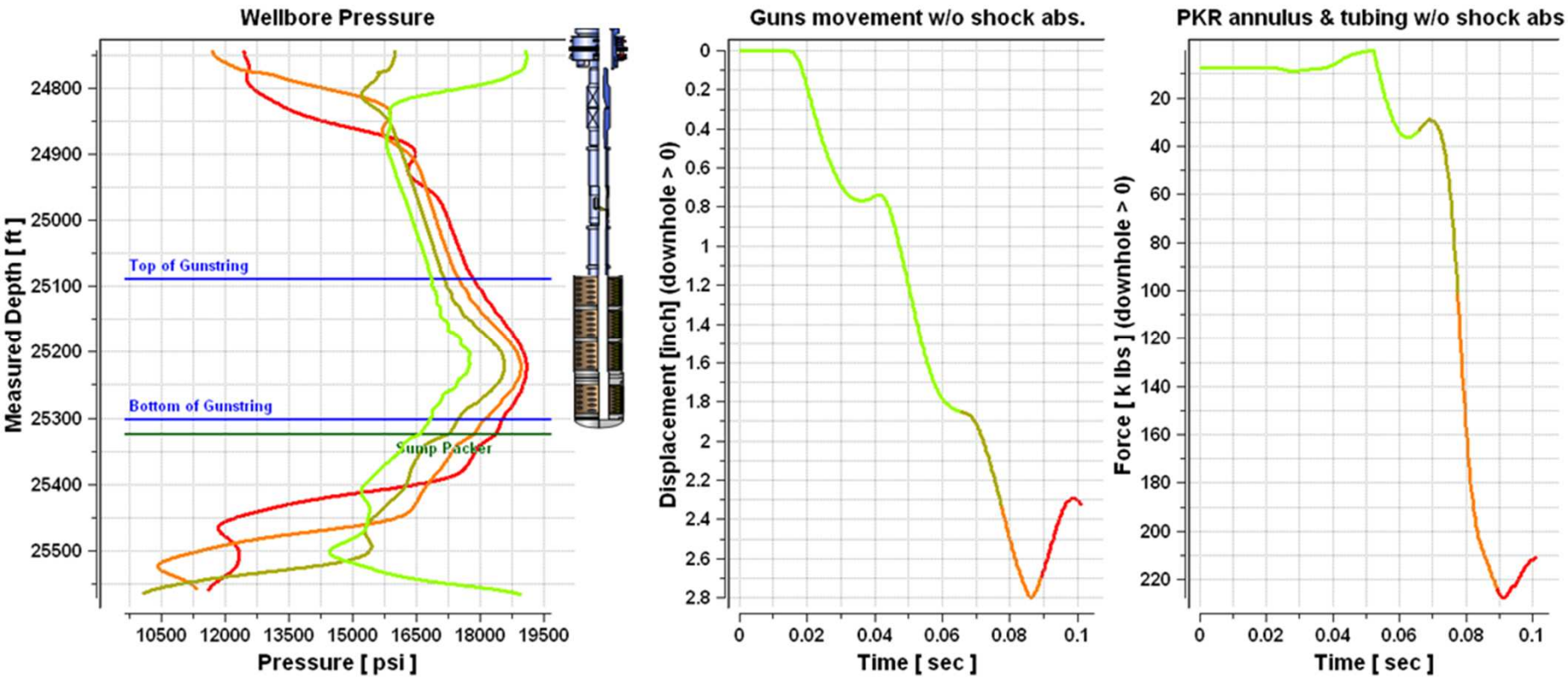
Animation of wellbore pressure and gunstring movement



Wellbore pressure, tubing axial load, and total packer load up to 0.065 seconds

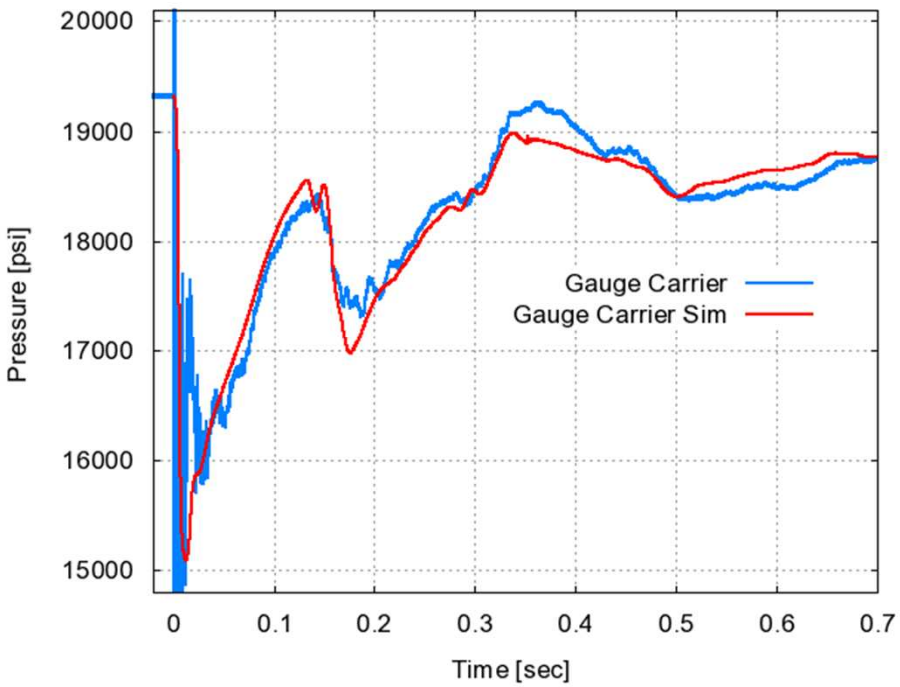


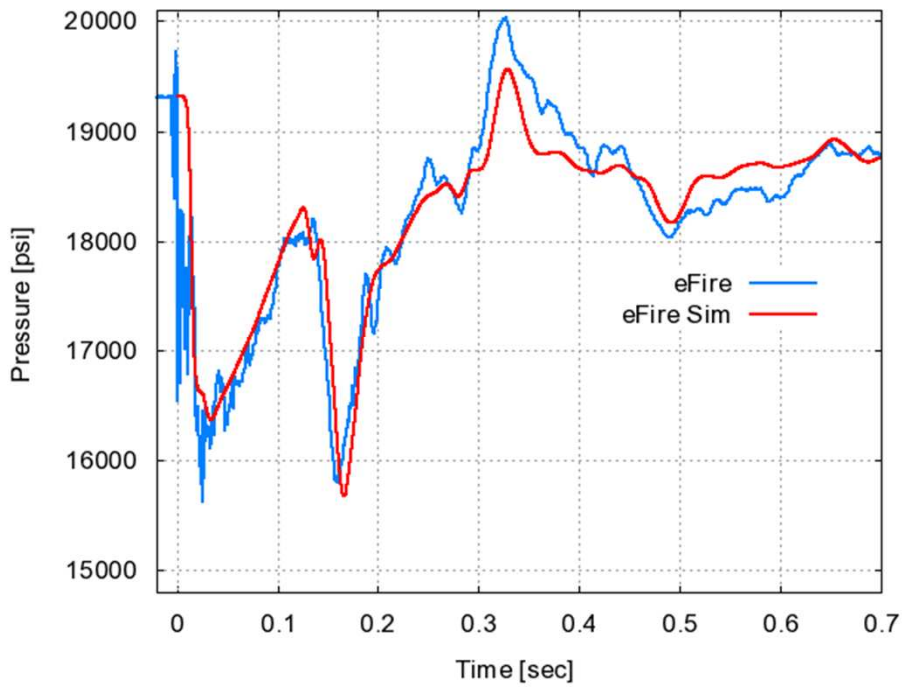
Wellbore pressure, gun-string movement, and total packer load up to 0.1 seconds



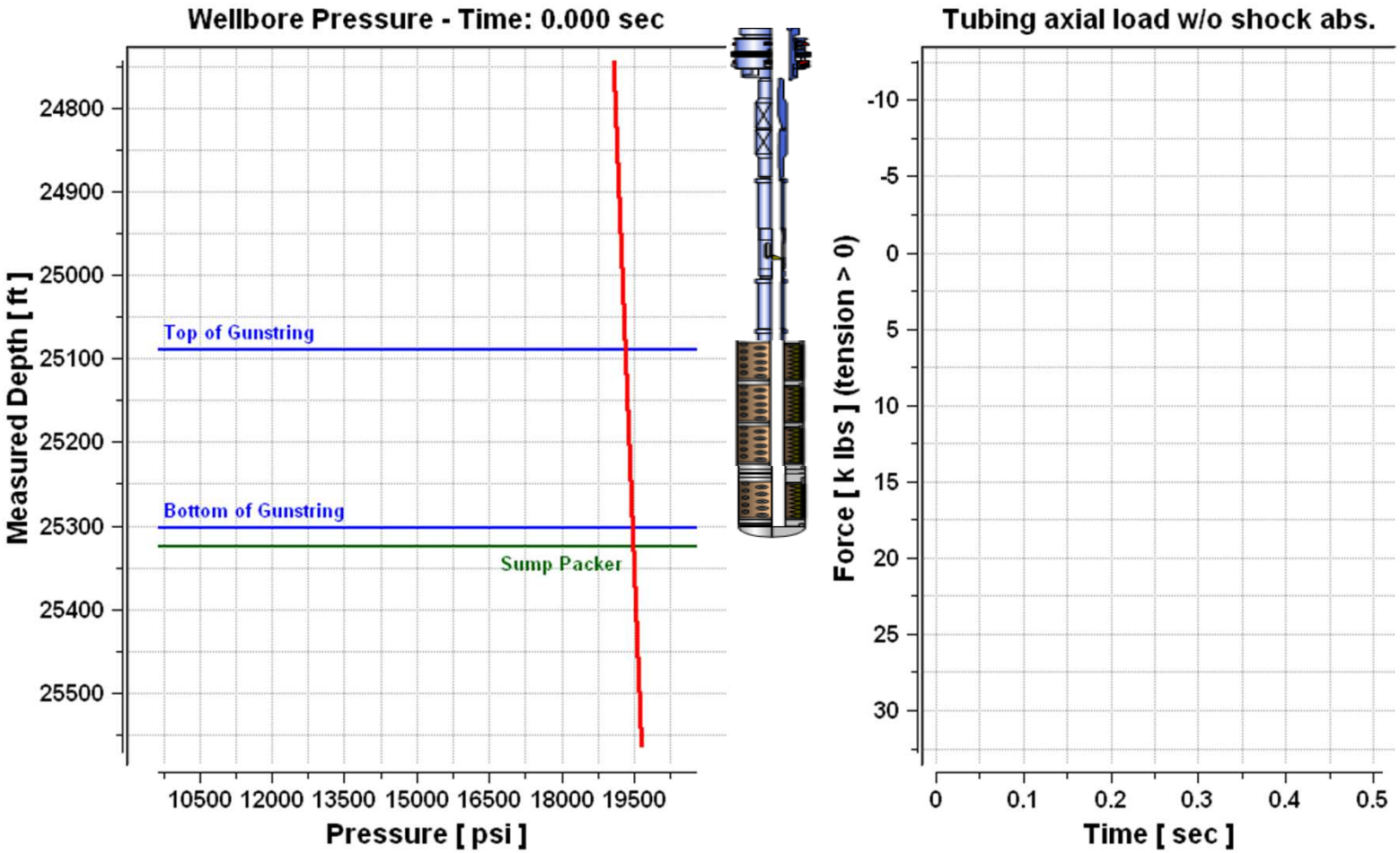
Gunstring with Two Fast-Gauges

Actual Run vs. Simulated

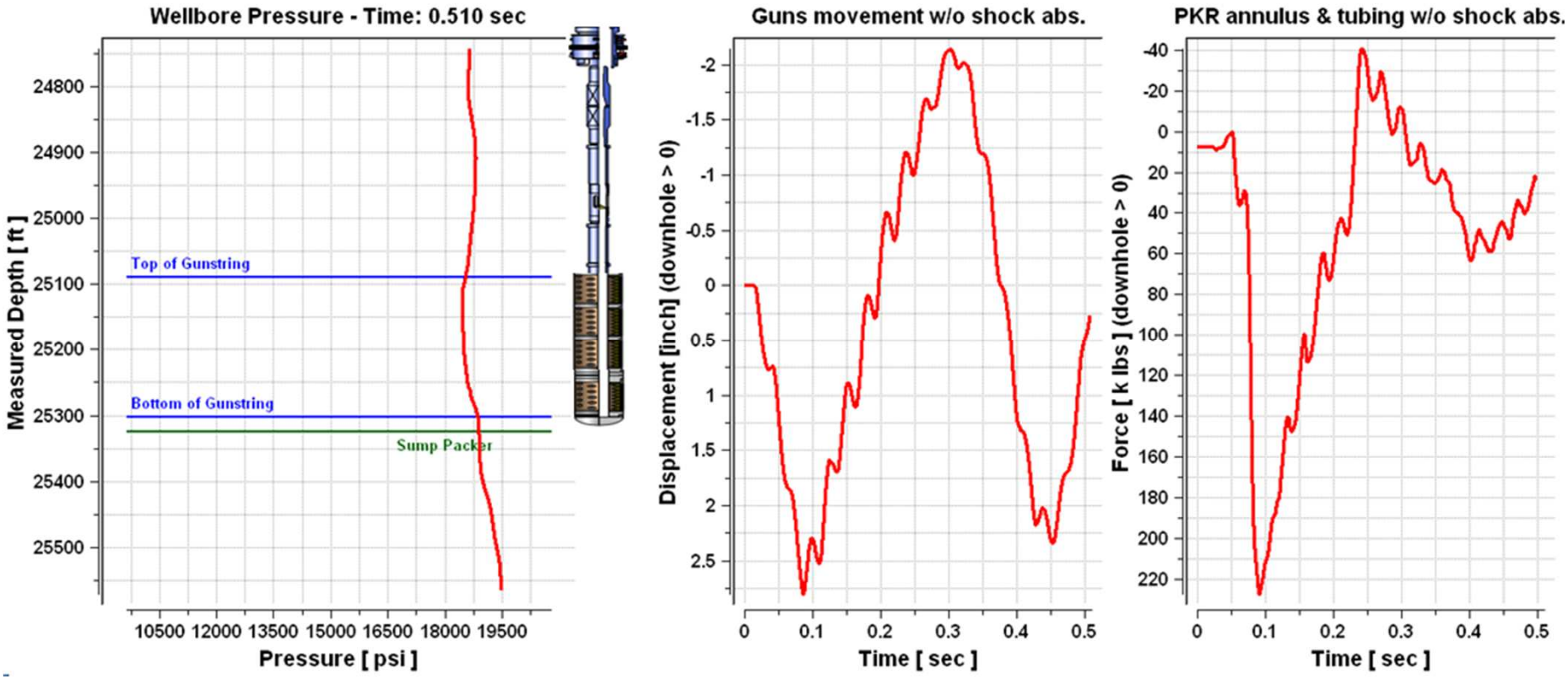




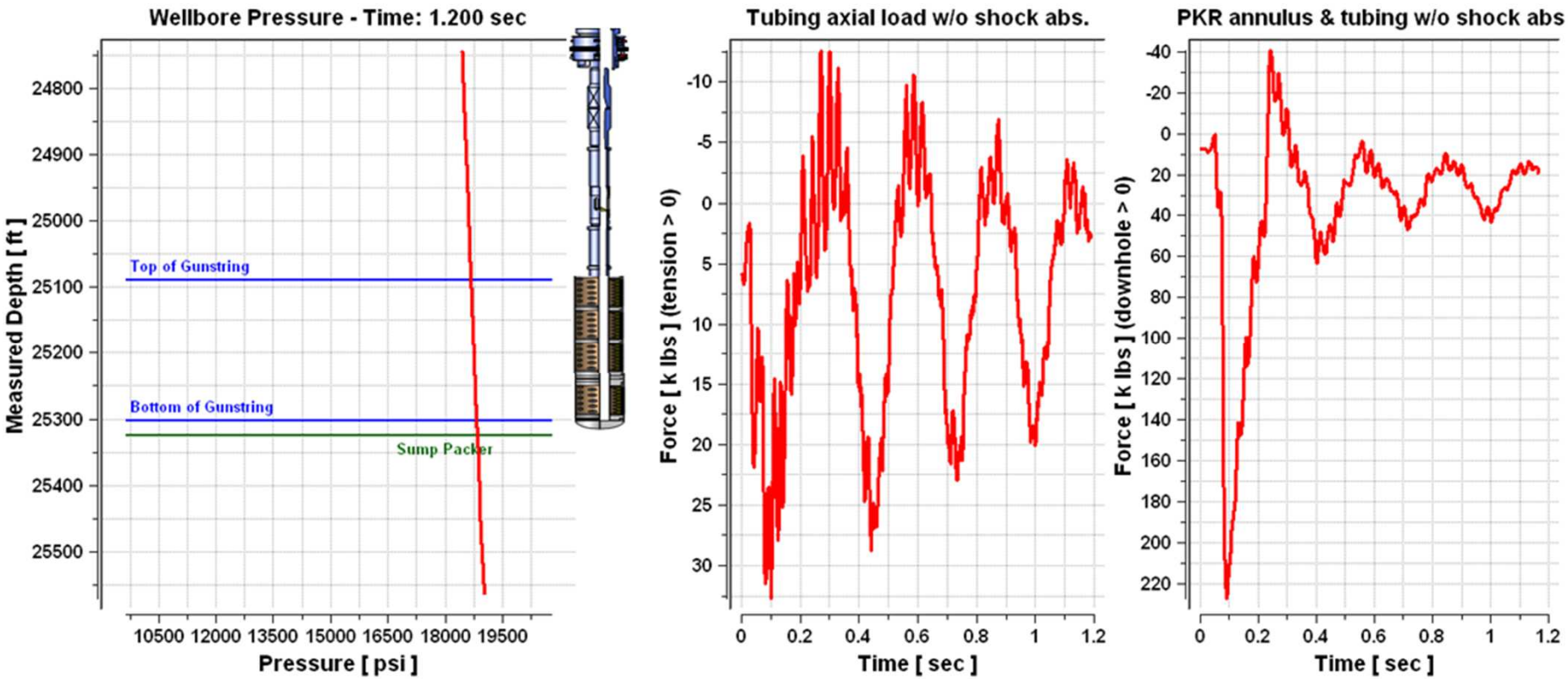
Animation of wellbore pressure and tubing axial load



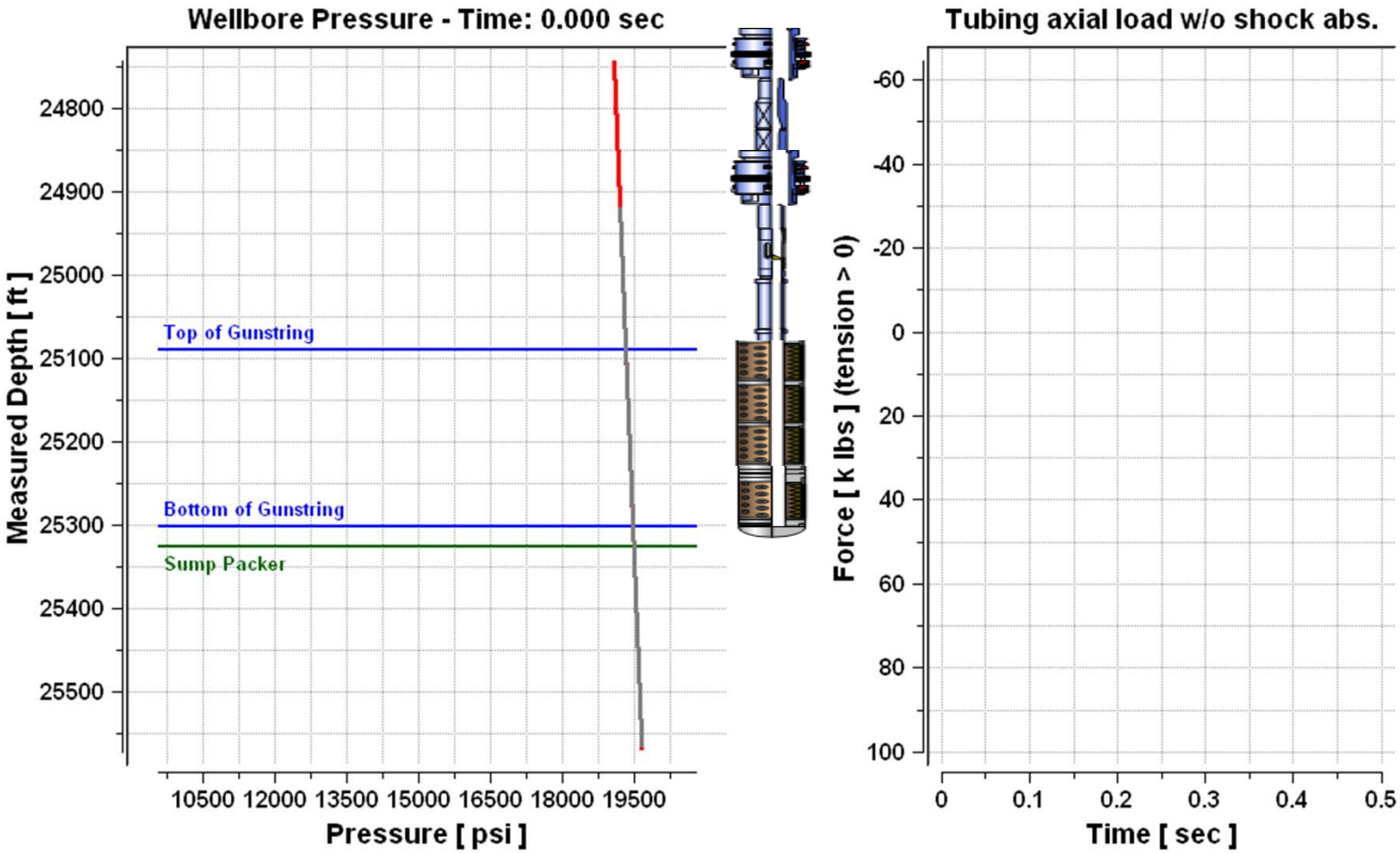
Gunstring movement and total packer load up to 0.5 seconds



Tubing axial load and total packer load up to 1.2 seconds

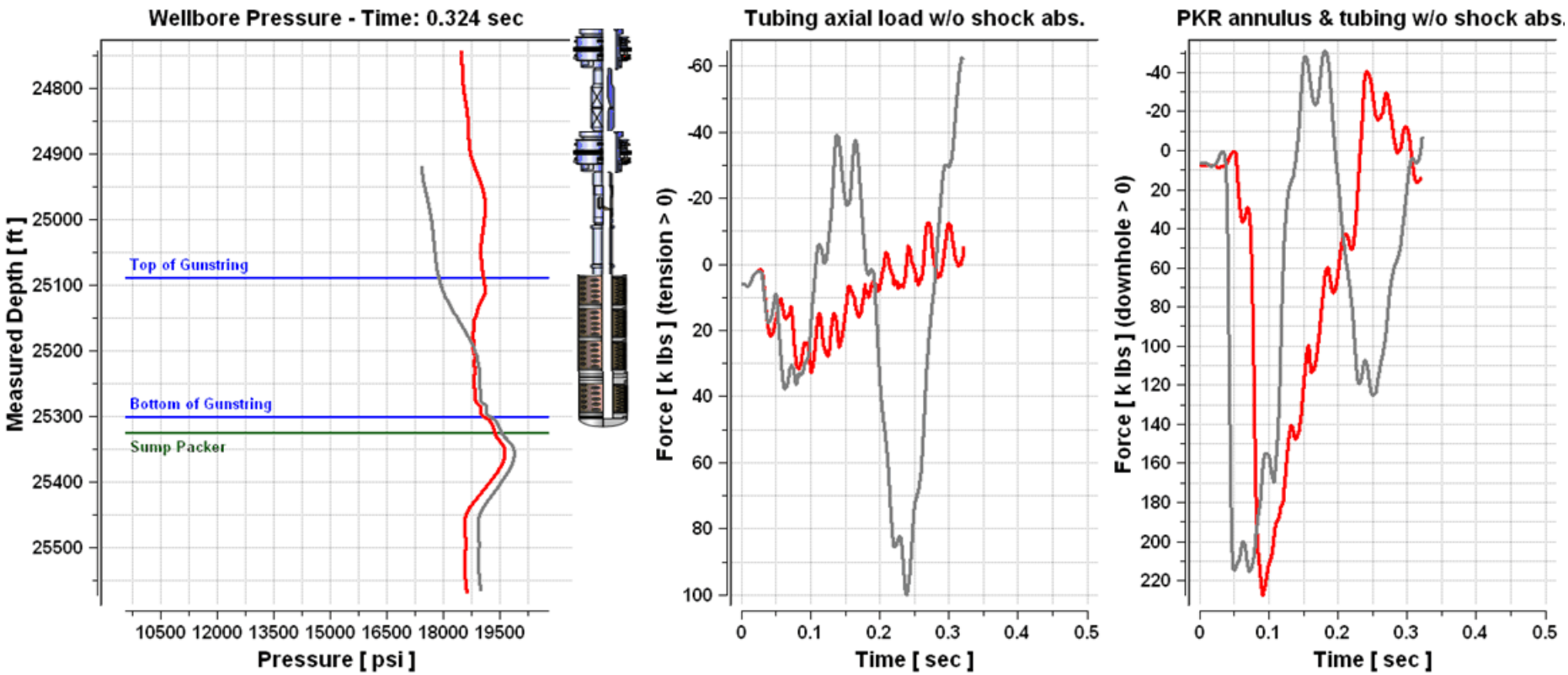


Tubing Axial Load Sensitivity to Tubing Length: 180-ft vs. 360-ft (as run)



Tubing Axial Load Sensitivity to Tubing Length: 180-ft vs. 360-ft (as run)

Tubing axial load and total packer load up to 0.32 seconds



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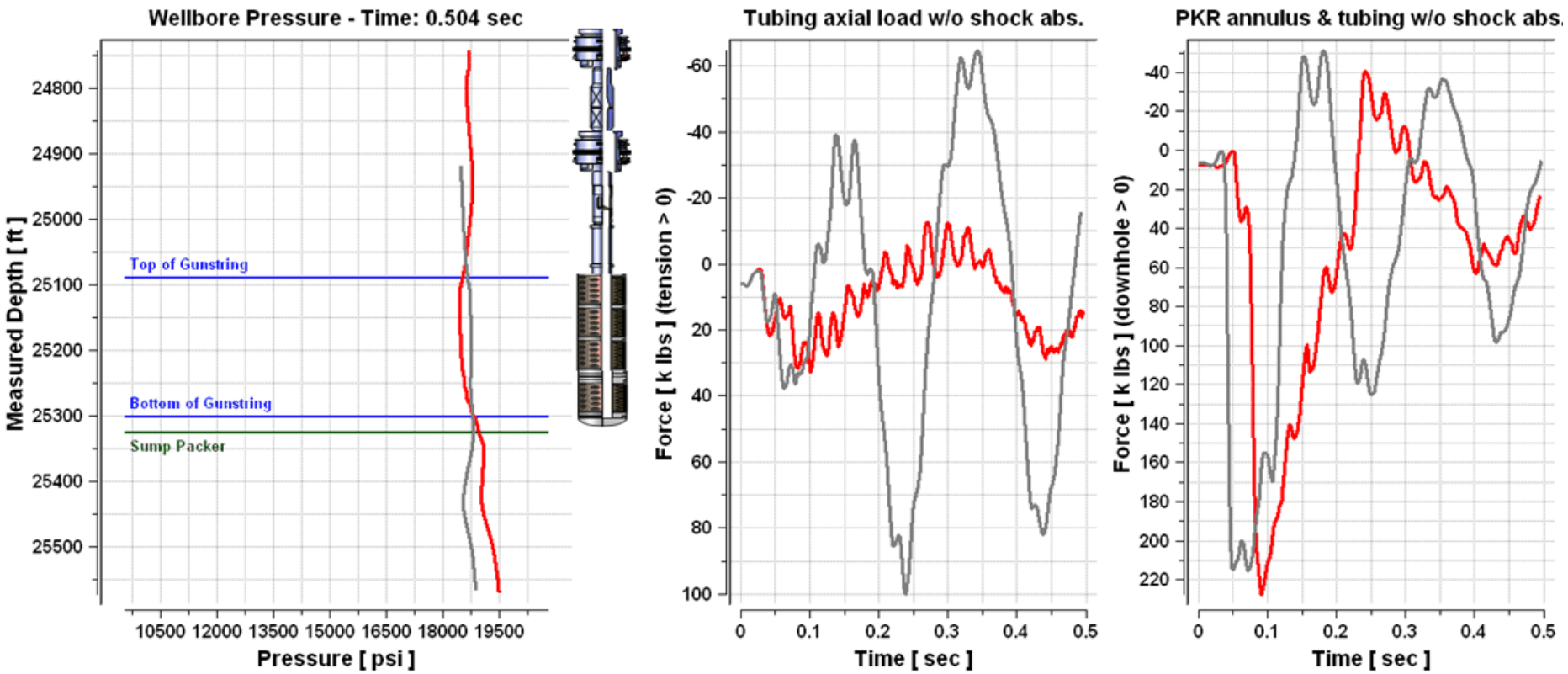
Tubing axial load and total packer load up to 0.5 seconds



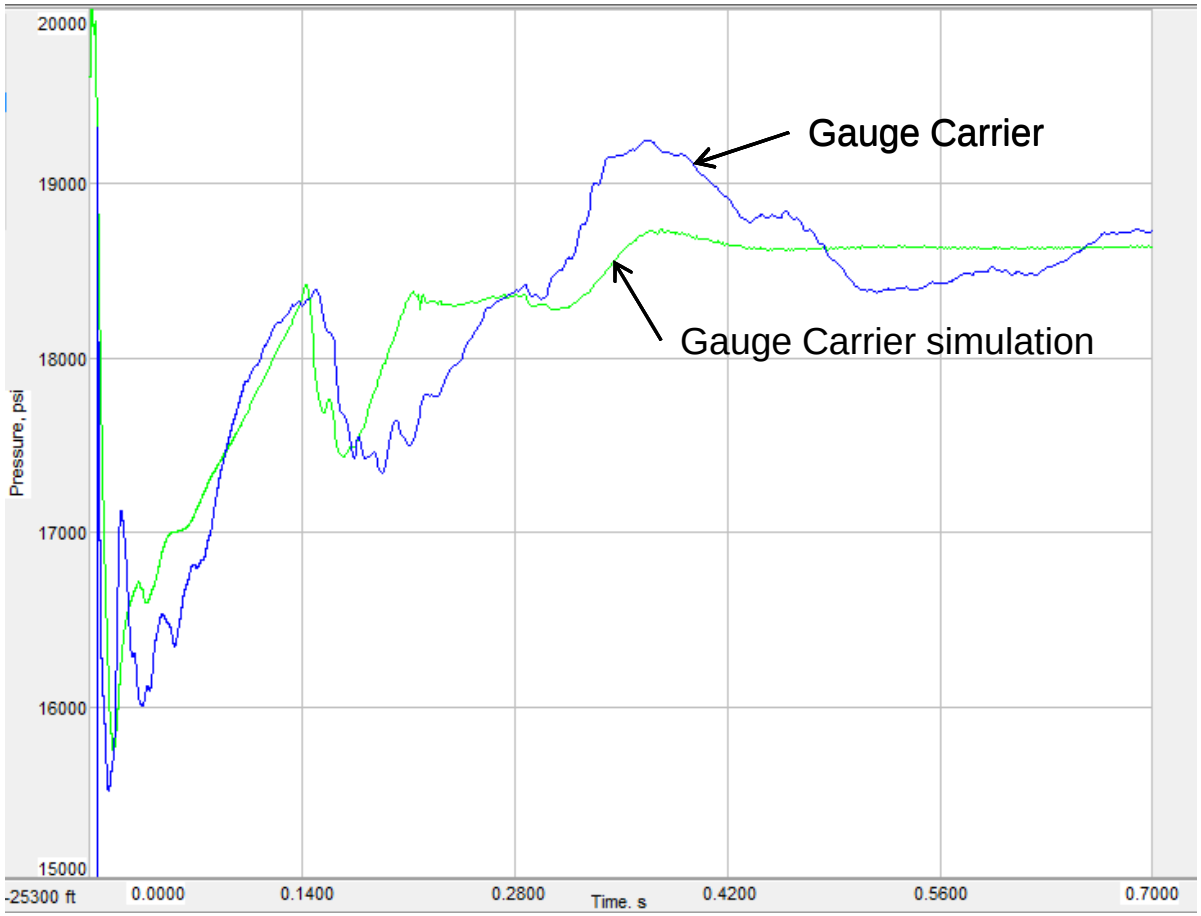
Reliable prediction of TCP gunshock loads

Effect of all components / variables can be analyzed:

- Position of packers
- Size and length of conveyance
- Type and number of shock absorbers
- Types and sizes of guns and shaped charges
- Guns loading strategies
- Reservoir pressure and properties

Gunstring with Lower Fast-Gauge

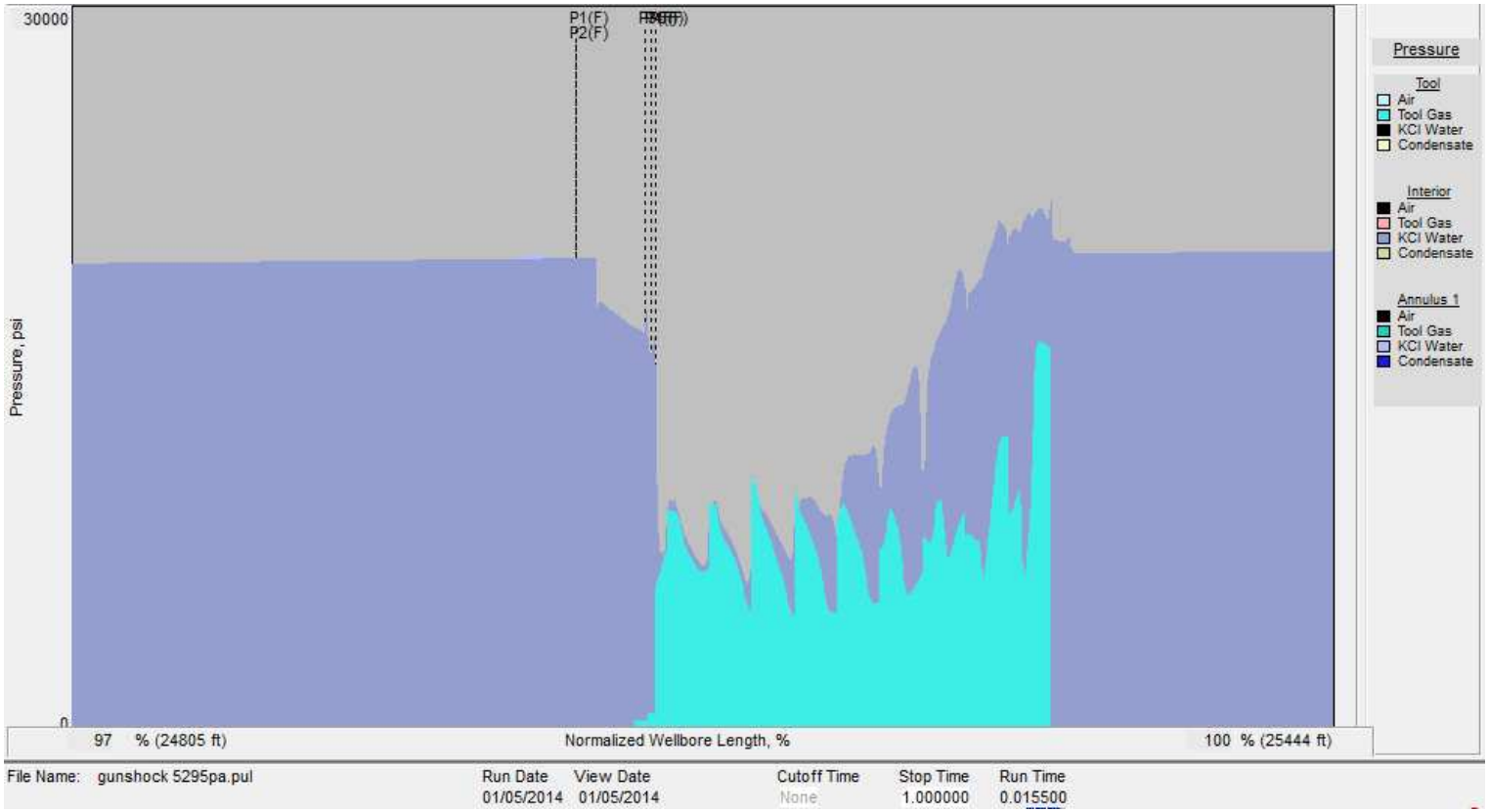
Actual Run vs. Simulated

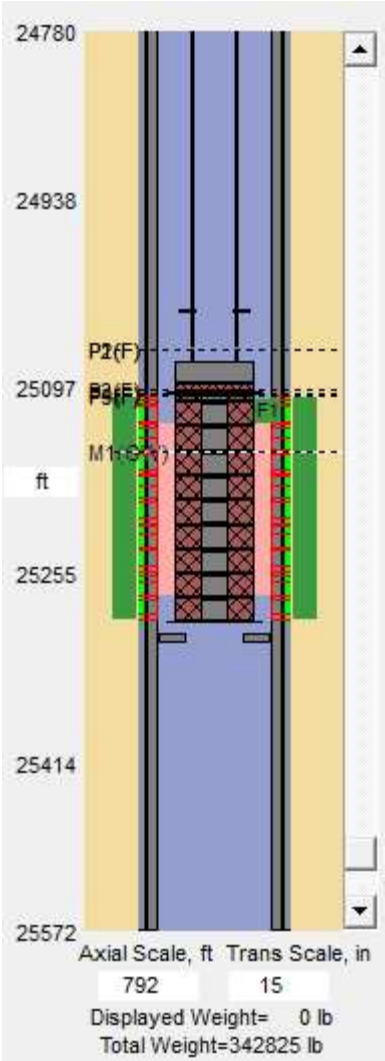


- To generate a match for BH charges, this model needs to include additional energy generated in the annulus.
- HSD BH charges generate a delayed pressure pulse due to the large amount of gun metal and casing removed on firing

Animation of wellbore pressure

- Gun generates significant dynamic under balance as well as overpressure.
- Understanding and having the correct input data for these extremes of pressure - essential





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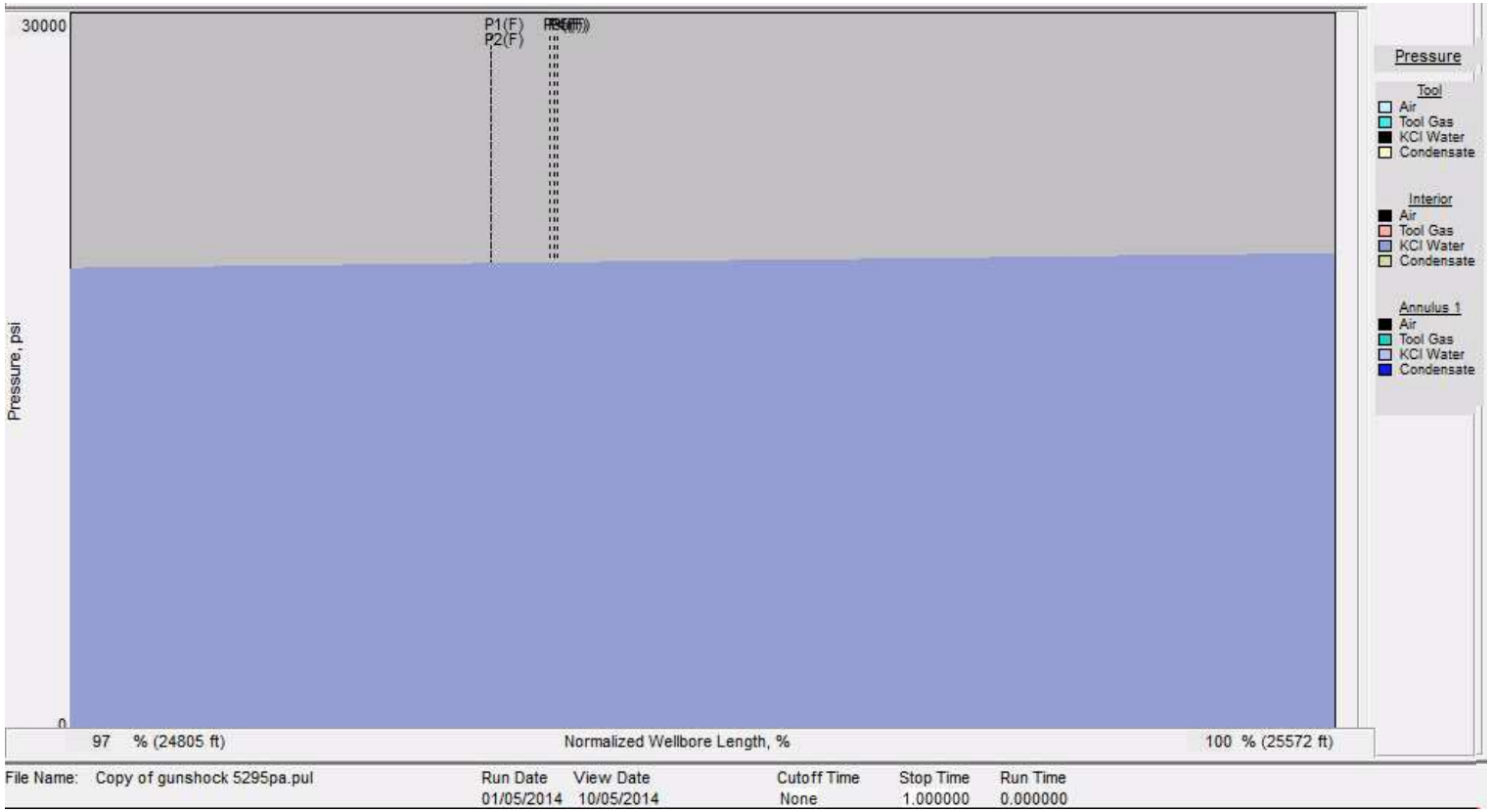
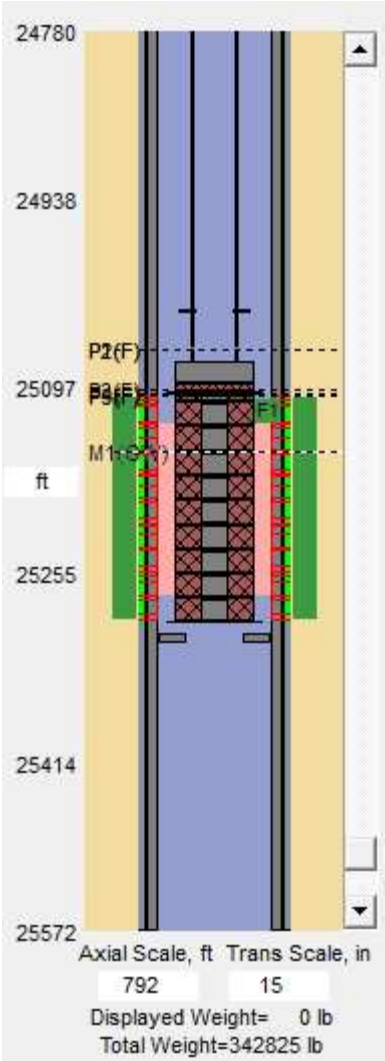
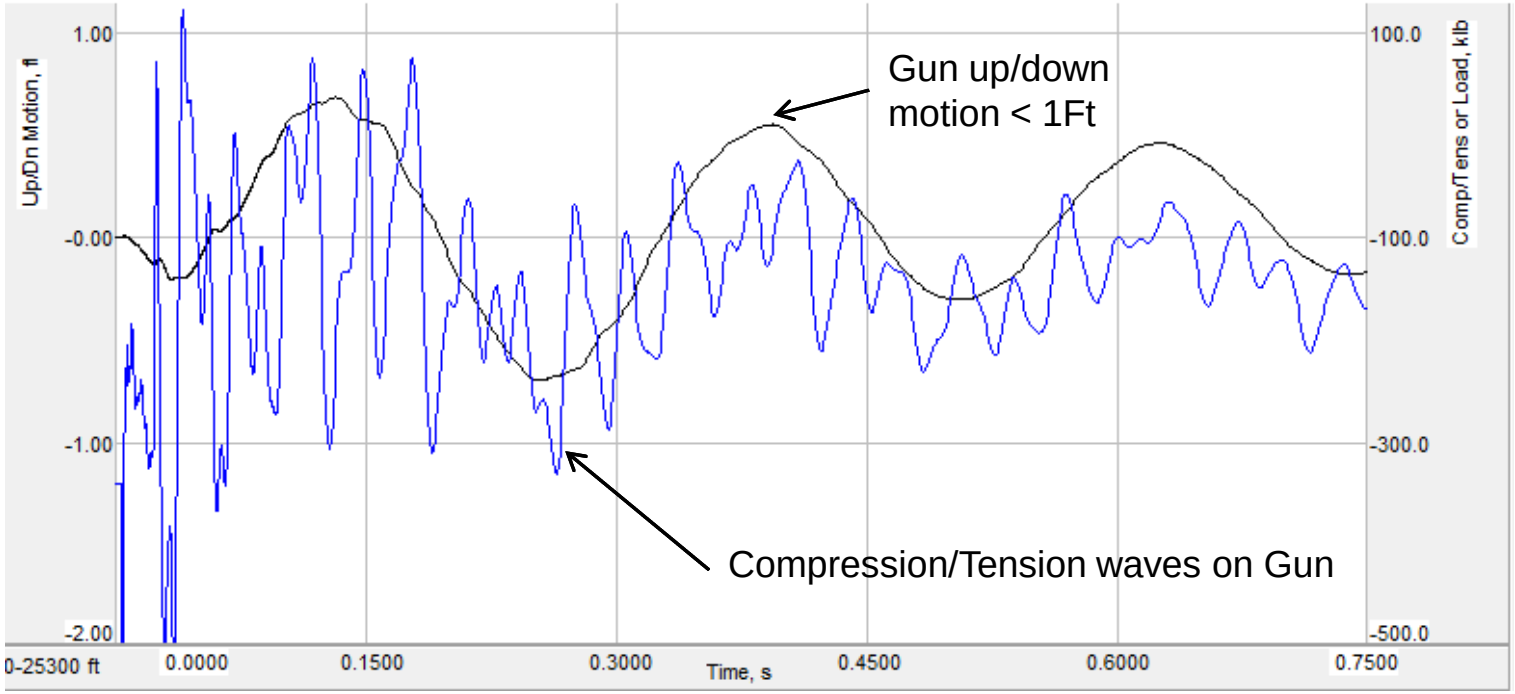
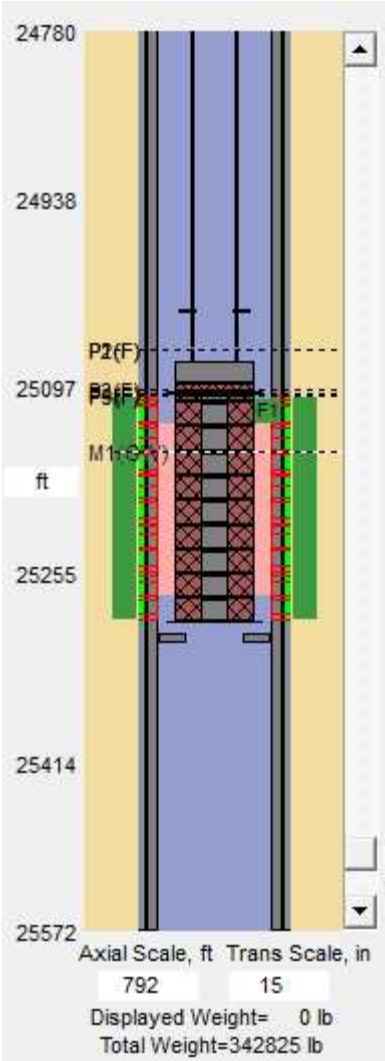




Gunstring movement and total packer load up to 0.7 seconds

- Gun displays a long wave up/down movement of about 0.25 sec.
- At the same time the gun ‘rings’ like a bell with multiple reflected waves.
- These waves can be compounded and can lead to gun failure in extreme cases





Way Forward

1. Challenging and understanding the models currently available
2. Carry out detailed case study of models to identify strengths and weaknesses followed by publication of findings
3. Ensure that more complex wells are modelled correctly using relevant parameters
4. Review opportunities to improve current models and promote the development of new models
5. Start a dialogue to develop an Operator and Contractor led advanced model

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Thank You !

Questions ?

Transient Packer Differential Pressure and Tubing Load