

IPS 2024



IPS 24-7.2

# Large GoM's HP wells: Perforating multiple long pay zones in a single run

**Presented by:**  
**Ray L. Verges Jr. - SLB**

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# GoM's Deepwater – The largest HP wells

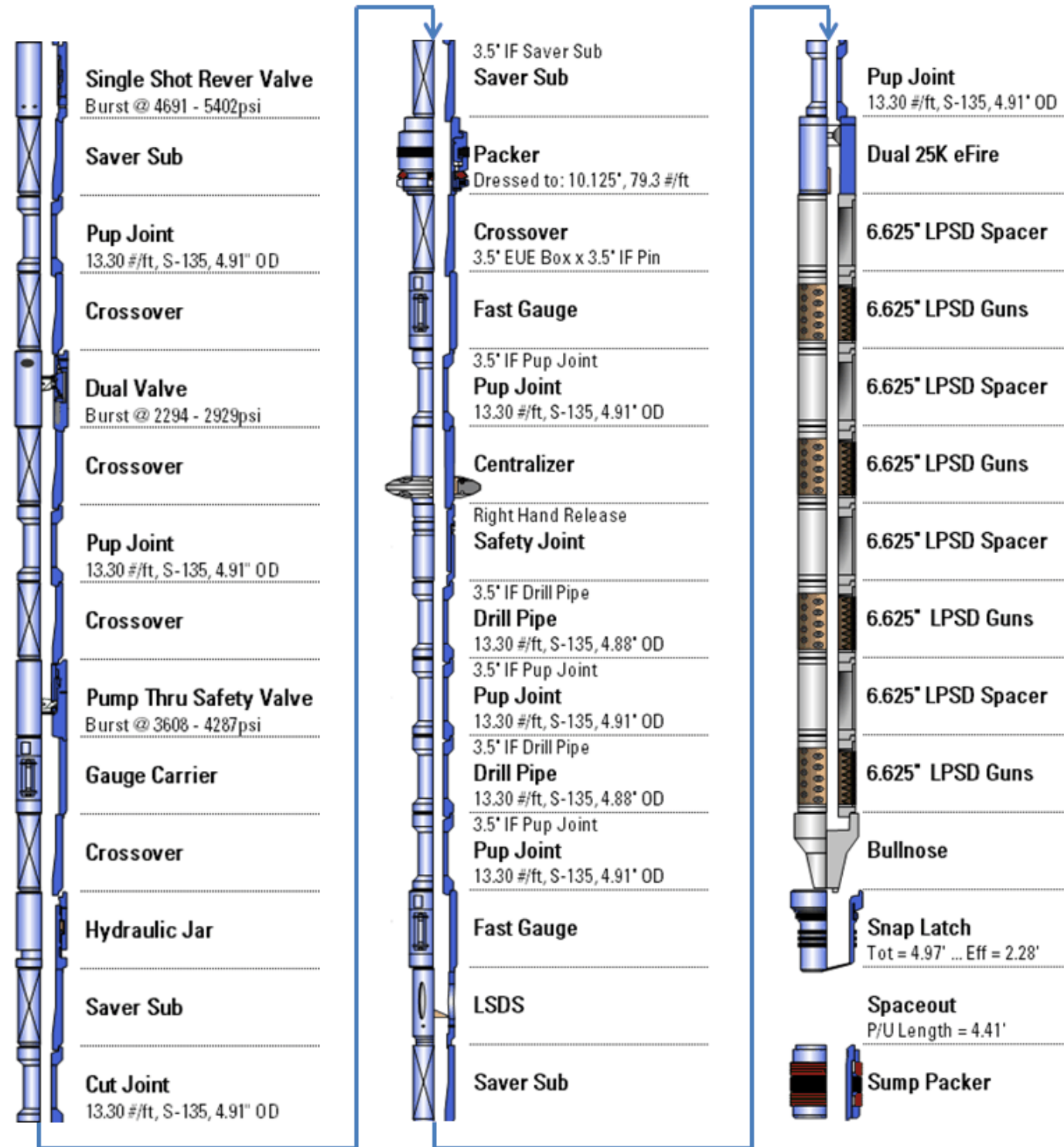
- Net pays reaching more than 1000-ft
- 9-5/8" casing requiring 6-5/8-in guns
- BHP sometimes reaching 20 to 25 ksi
- Extreme conditions pose high risks when perforating
- Rig cost reaching > 1MM/day<sub>2</sub> require careful planning
- Challenges when mobilizing large amounts of explosives

# 6-5/8-in Low-Shock Low-Debris (LSLD) Guns

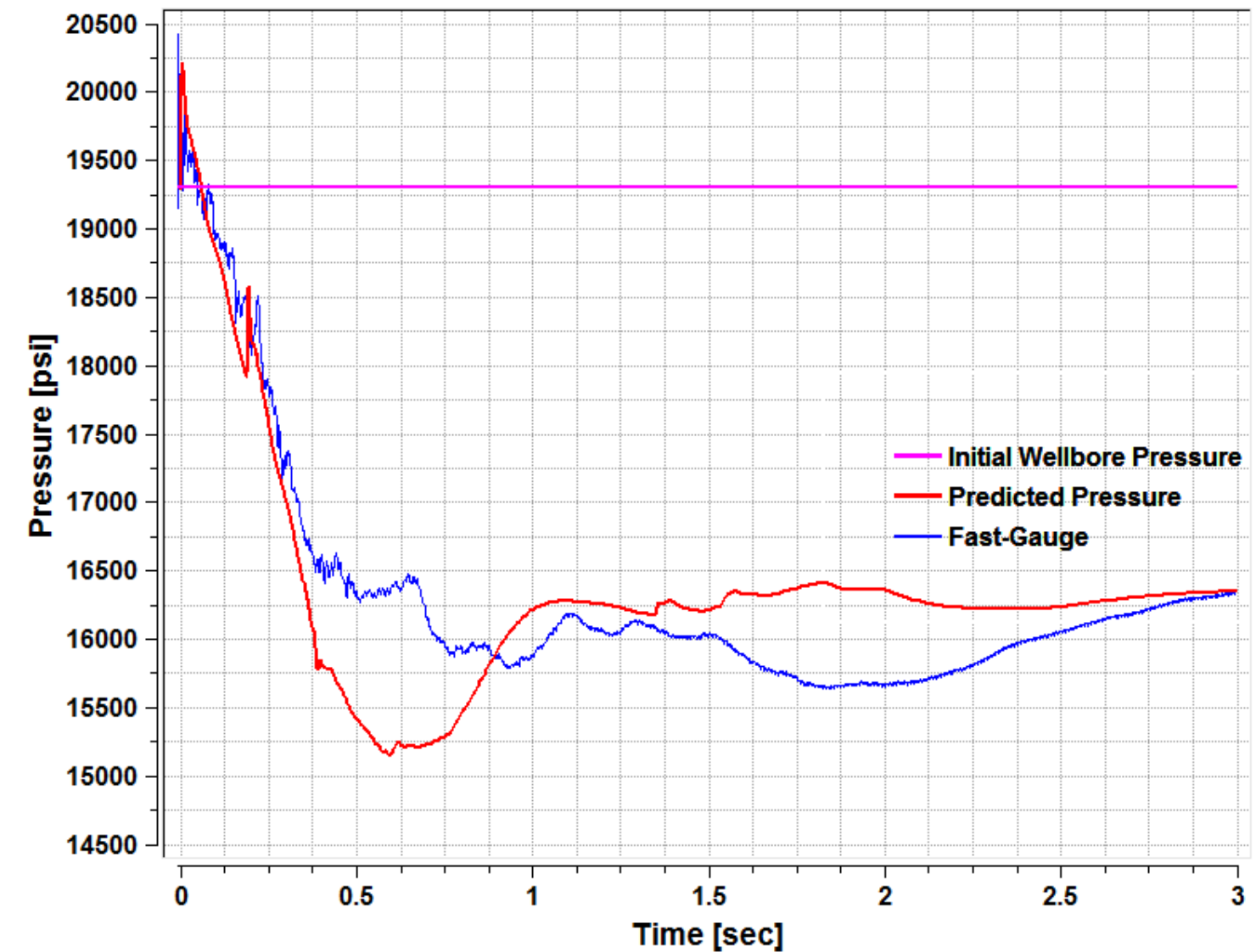


- Guns produce low shock loads, and very low debris
- Guns loaded with 18 spf BH steel-case charges, 39g HMX
- Since 2012 the largest HP wells in the GoM were perforated with 6-5/8" and 7.00" LSLD guns
- SPE-179002 - Perforating Large High-Pressure Wells with Low-Shock and Low-Debris Gun Systems
- OTC-26644 - Perforating the Largest High-Pressure Wells in the Gulf of Mexico

# Single Run – Gross 1500-ft LSLD/LPSD guns



OTC-26644 - Perforating Large High-Pressure Wells with Low-Shock and Low-Debris Gun Systems



# When reservoir zones are far apart

- Groups of reservoir zones to perforate can be wide apart (> 1000-ft)
- We can use N sets of firing heads in a single run:
  - Each set of firing heads has 2 firing heads: for redundancy, safety
  - N groups of perf zones are shot individually, separated by a couple of minutes from one another
- Lower gunshock loads on the tools, lower risk<sup>5</sup>
- Large cost savings, no need for long lengths of blank guns

## Case: two ~ 500-ft zones, 1,500-ft apart

- Benefits of using two firing heads when rig cost is ~ 1MM / day:
  - Large rig-time savings perforating both zones in a single run
  - Large savings substituting 1,500-ft of blank guns with drill pipe, and additional savings in less backup guns
  - Lower gunshock loads on the tools, lower risk
  - Lower rig-time making up and breaking down guns

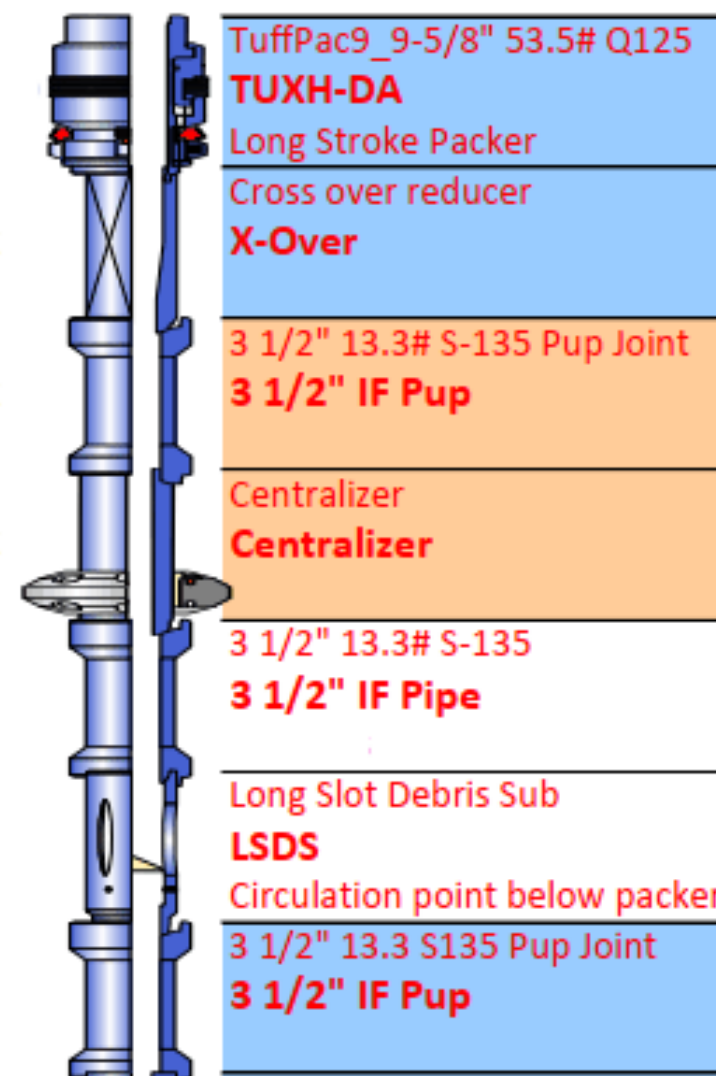
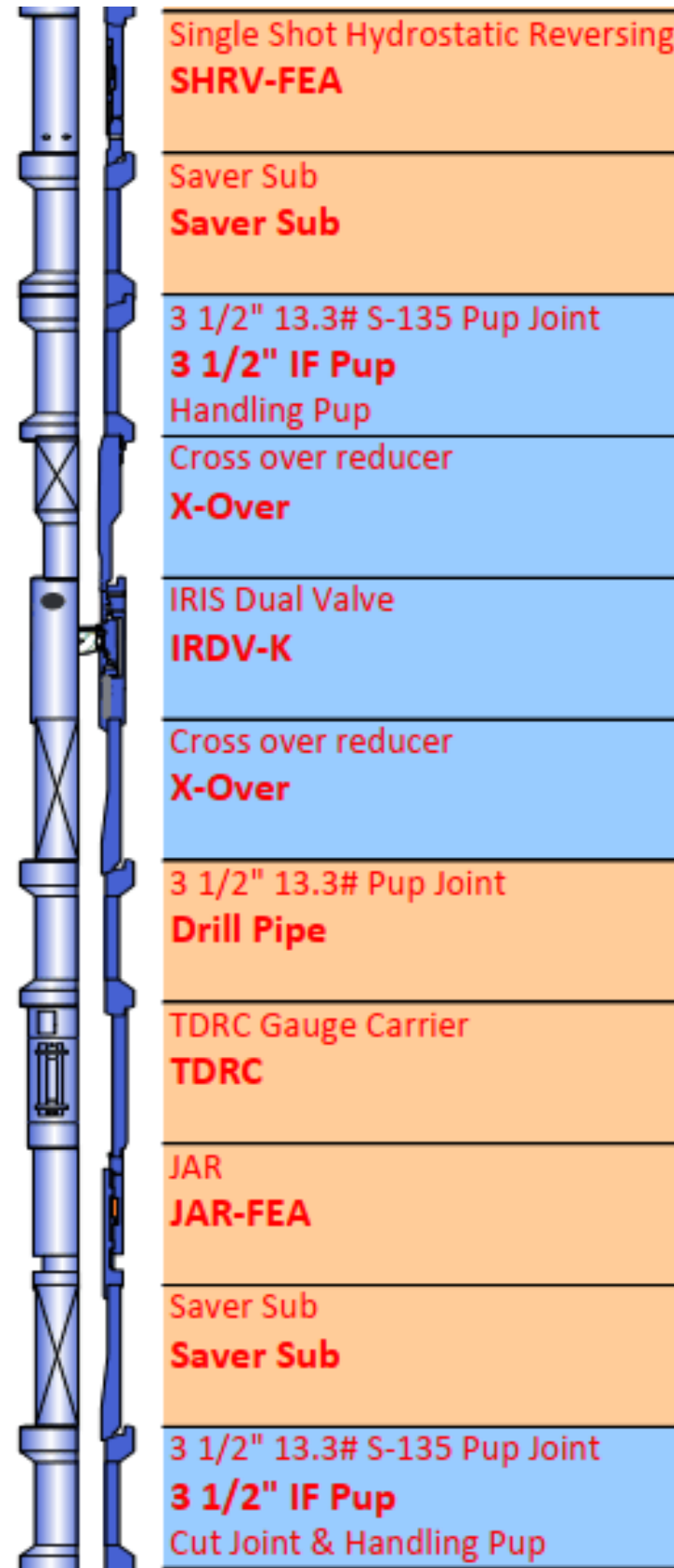
# Two ~ 500-ft zones, 1500-ft apart - Challenges

- Planning – Time consuming but key for success
- Predict risks due to gun-shock, optimize BHA
- Select tools to minimize lost time and reduce costs
- Logistics:
  - Optimize gun loading, transport to rig, placement on rig
  - Optimize making up and breaking down guns
  - Minimize rig-time by pre-programming all electronic tools

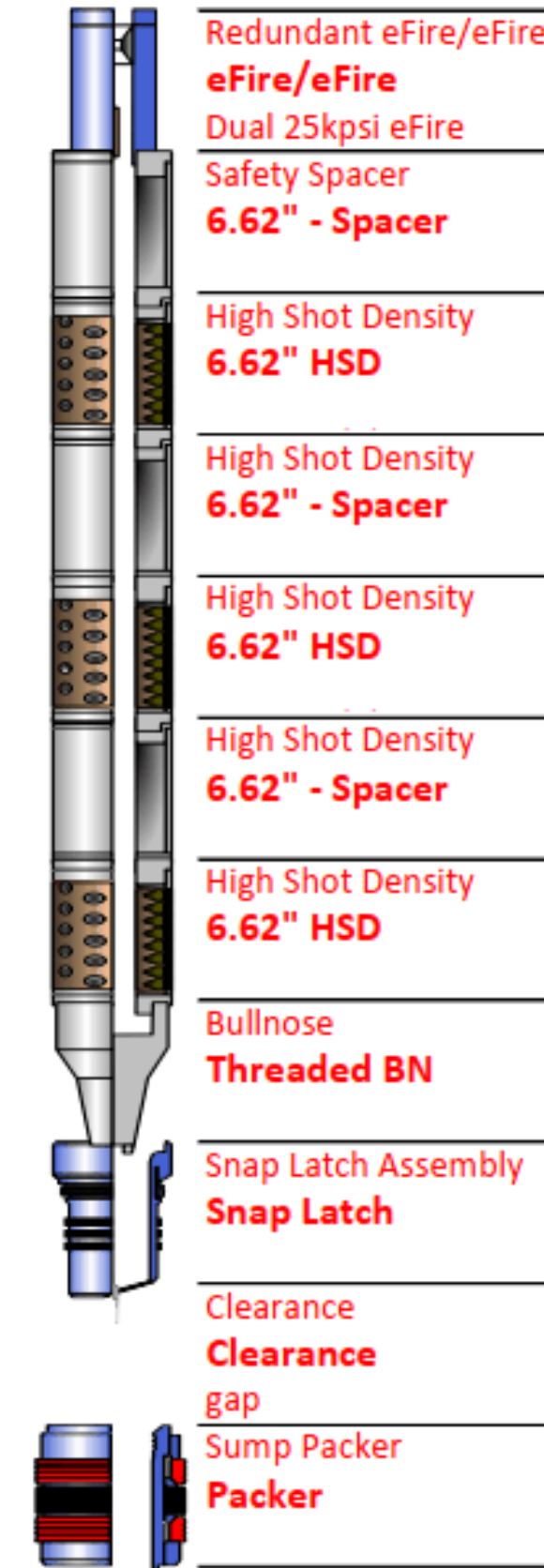
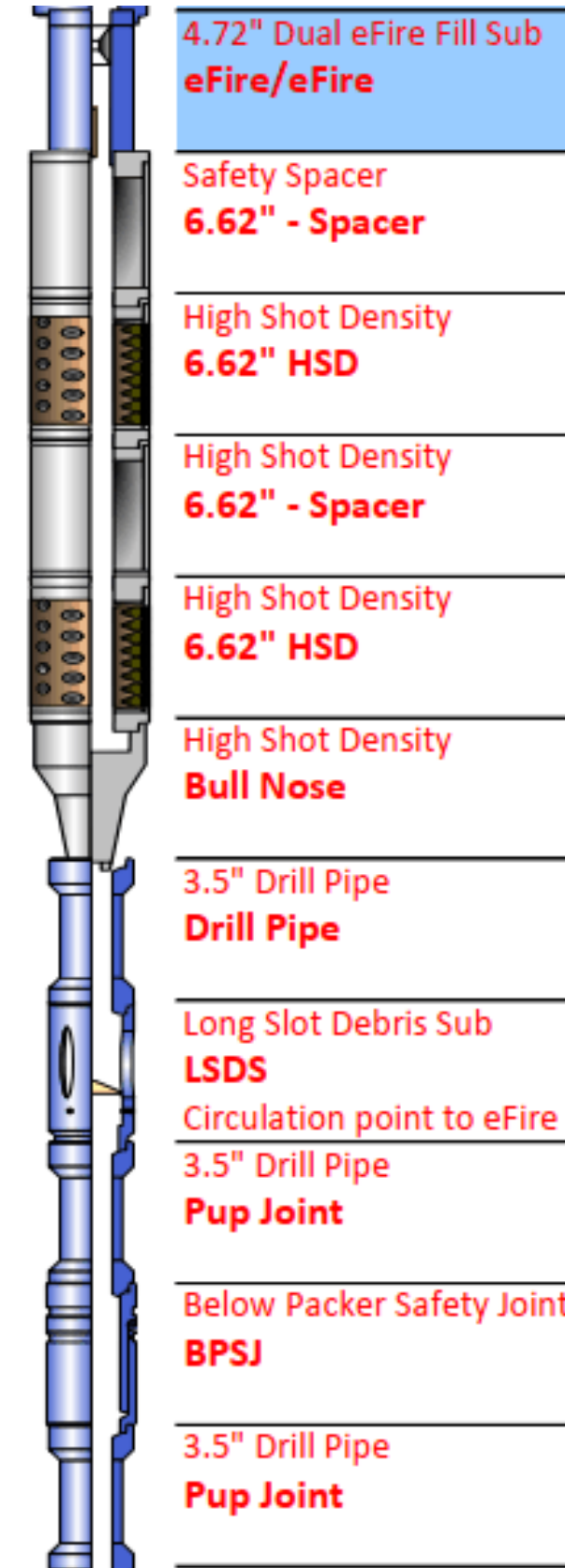


Gun baskets space-out per BATF and Coast Guard regulations

# BHA: two ~ 500-ft zones, 1500-ft apart



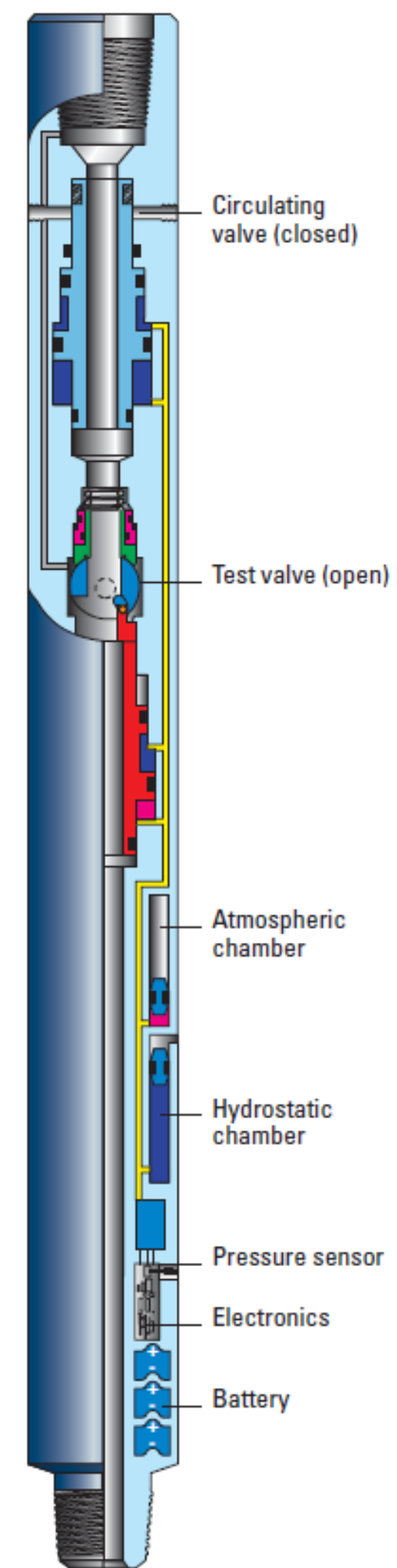
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# 30,000 psi Dual Valve

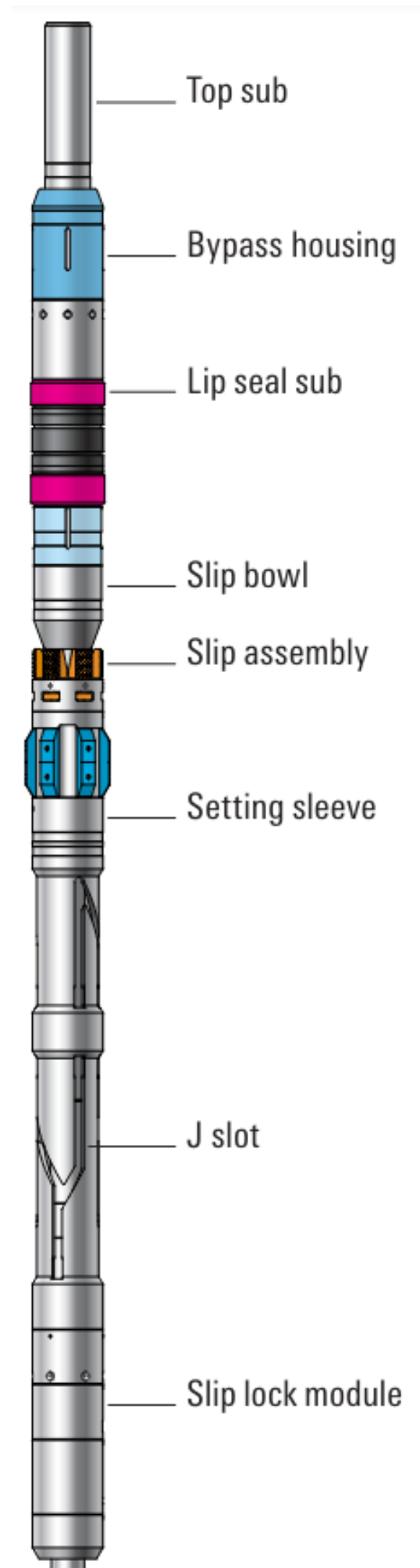
- Controls fluid production / losses
- Two full-bore multi-cycle valves per tool
- Low-amplitude pressure pulses or wireless commands
- Valves cycled independently or in sequence by pressure pulses
- Can run two dual valves together with independent operation
- All operations recorded in memory for post-job analysis
- High tolerance for mud debris and produced solids
- High-Tempe electronics and quartz pressure sensor technology



# Testing Packer

- Non-rotational retrievable compression-set packer
- Packer setting by string reciprocation (not by rotation)
- Reliable set/release independently of wellbore deviation
- Suitable for high-heave operations on floating rigs
- Built-in slip lock to prevent setting while RIH
- Special slip inserts to grip on hard casings
- Hydraulic hold-down for stimulation ops
- Withstands high shock, high flow rates

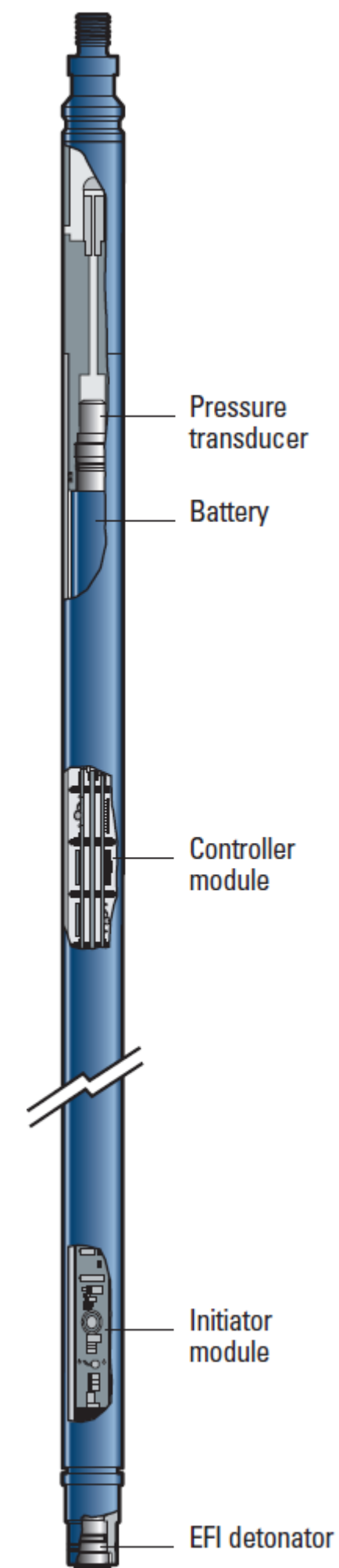
Service	Sour Service per NACE MR0175 <sup>1</sup>
Overall length	252.07 ft [76.8 m]
Overall weight	1756 lbm [796.5 kg]
Casing weight	47 to 53.5 lbm
Maximum outer diameter (exclusive of gauge rings)	7.97 in [202.4 mm]
Minimum inner diameter	2.25 in [57 mm]
Differential pressure rating (across elements)	12,500 psi [86.2 MPa] above and below
Temperature rating	275°F [135°C]
ID test pressure at surface (packer not set)	15,000 psi
Tensile strength at minimum yield (exclusive of end connections)	400,000 lbf
Compressive strength at minimum yield	400,000 lbf
Top connection	3-1/2 in IF box
Bottom connection	3-1/2 in IF pin



# 30,000 psi TCP electronic firing head

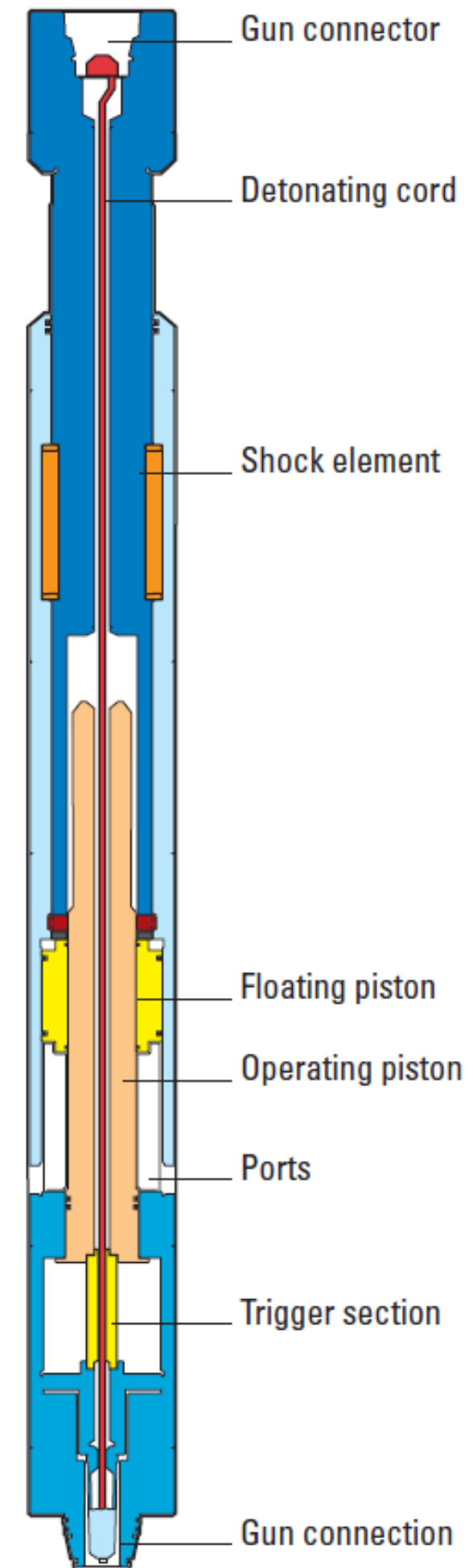
- Electronic firing head with a perfect track record for 20 years
- Fully programmable electronic firing head: arm, disarm, delay
- Activated by low amplitude (~400 psi) pressure pulses
- Immune to radio frequency; no radio silence required
- No primary high explosives used in the firing head
- Cannot be initiated until reaching a specified BHP
- Typically used in sets of two, redundant (even with a perfect TR)
- Integrated fast-gauge data recorder, independent of firing mechanism (\*\*\*)

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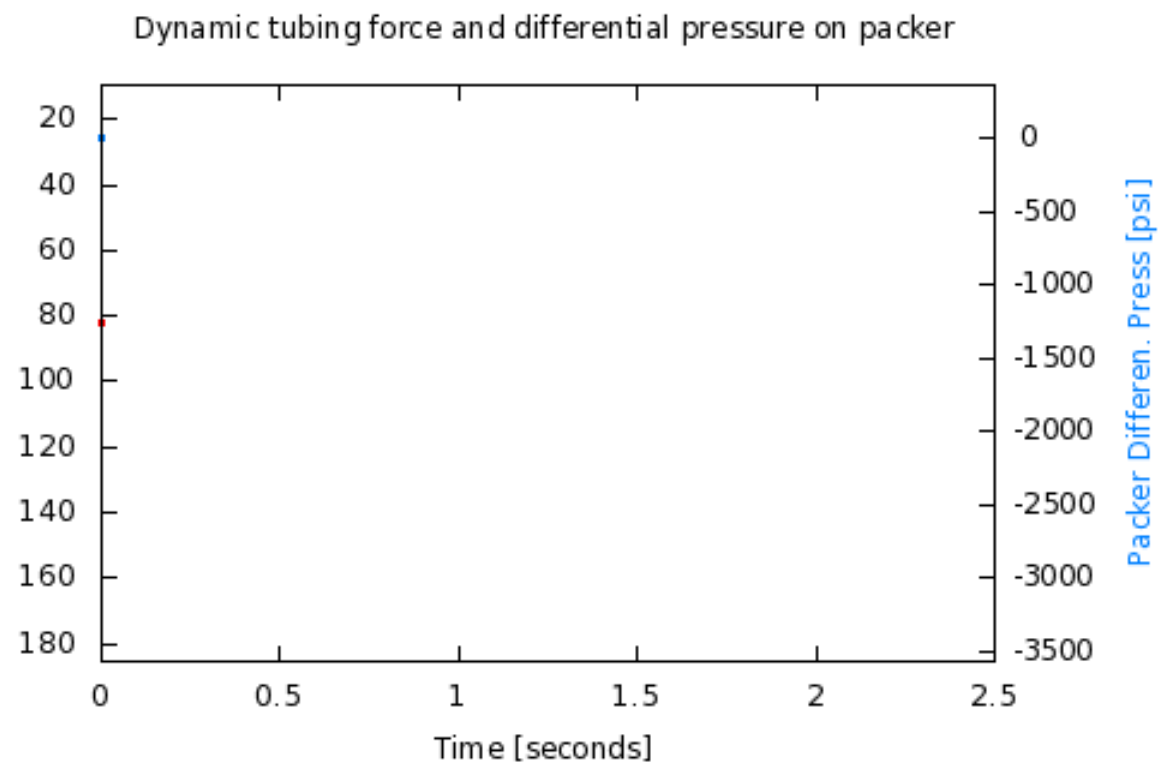
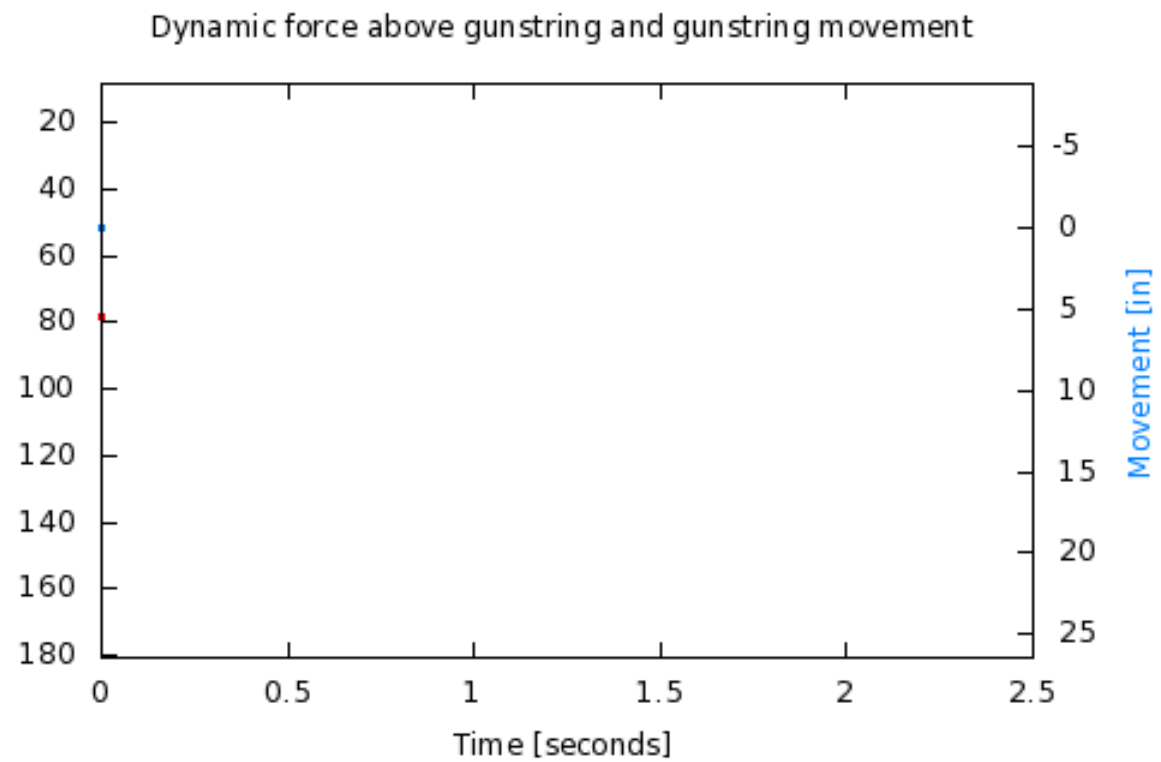
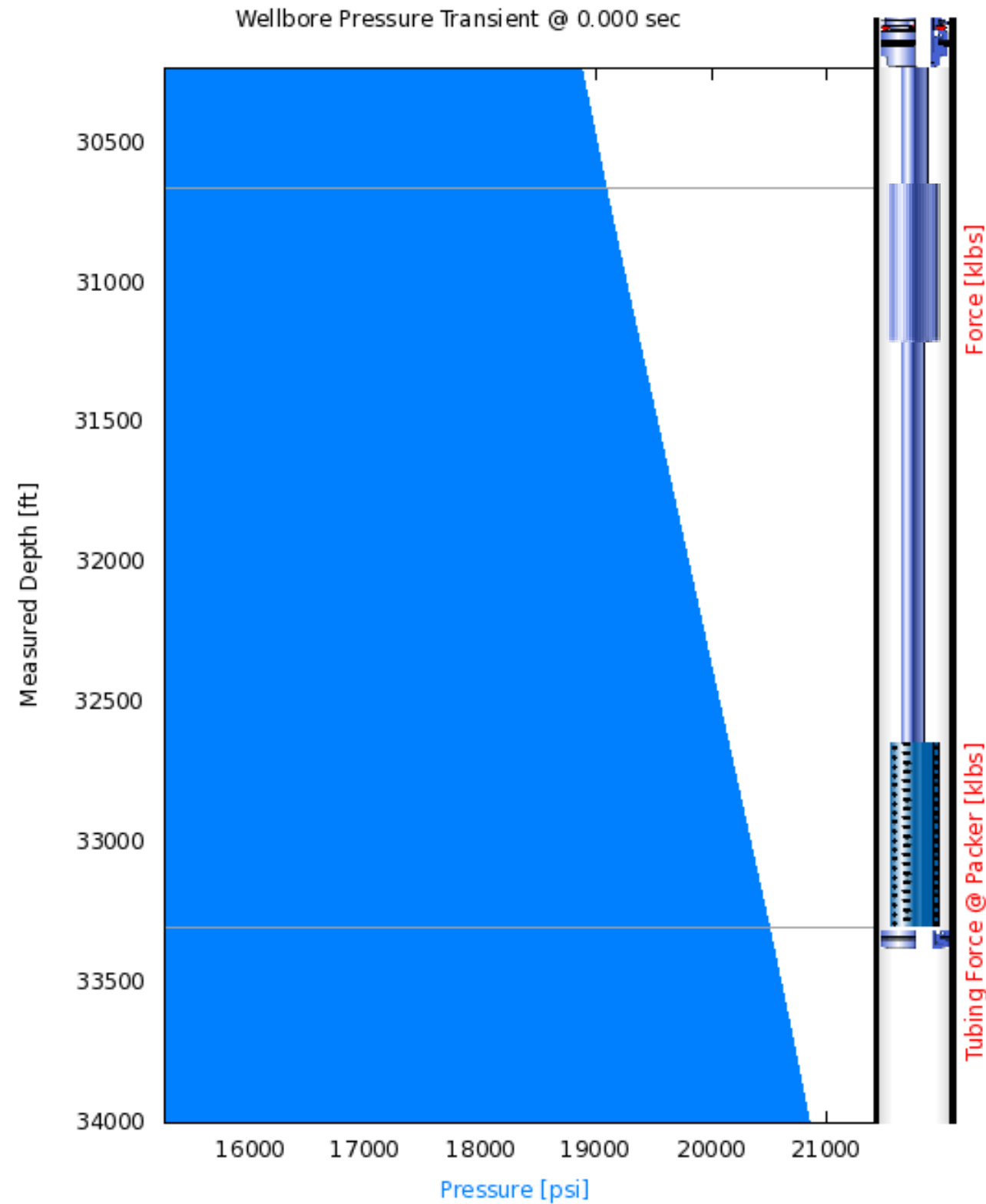


# Explosively Activated Shock Absorber

- Some jobs may require shock absorbers to reduce shock loads
- Placed right below the firing head, above the guns
- Rigid when RIH, releases when the firing head fires
- Crushable / Shock absorbing element does not deform by the BHA weight before firing
- Crushable element absorbs shock in both directions

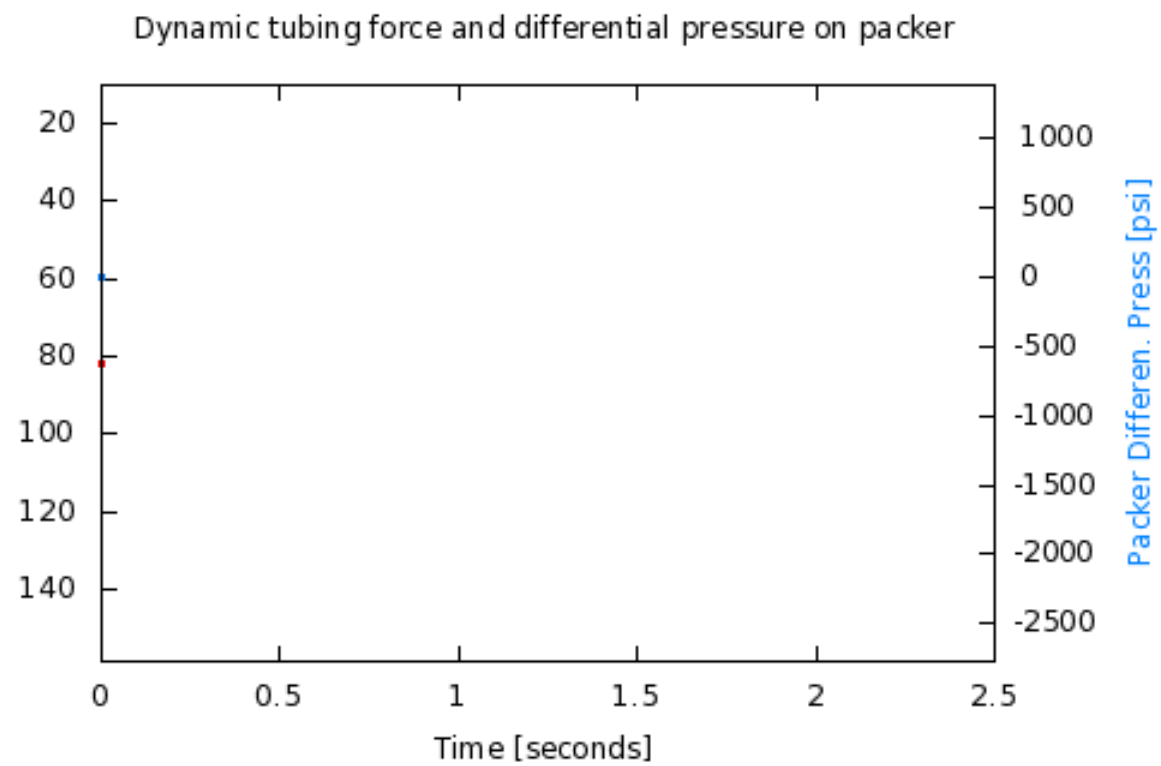
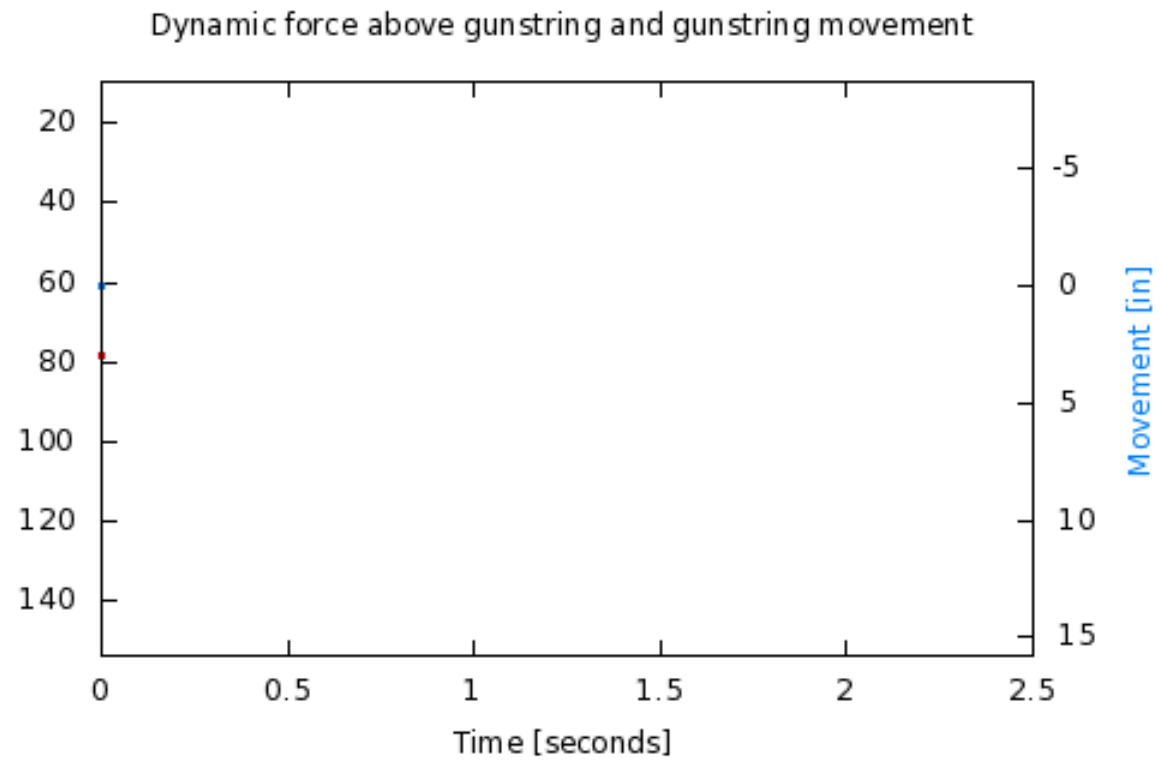
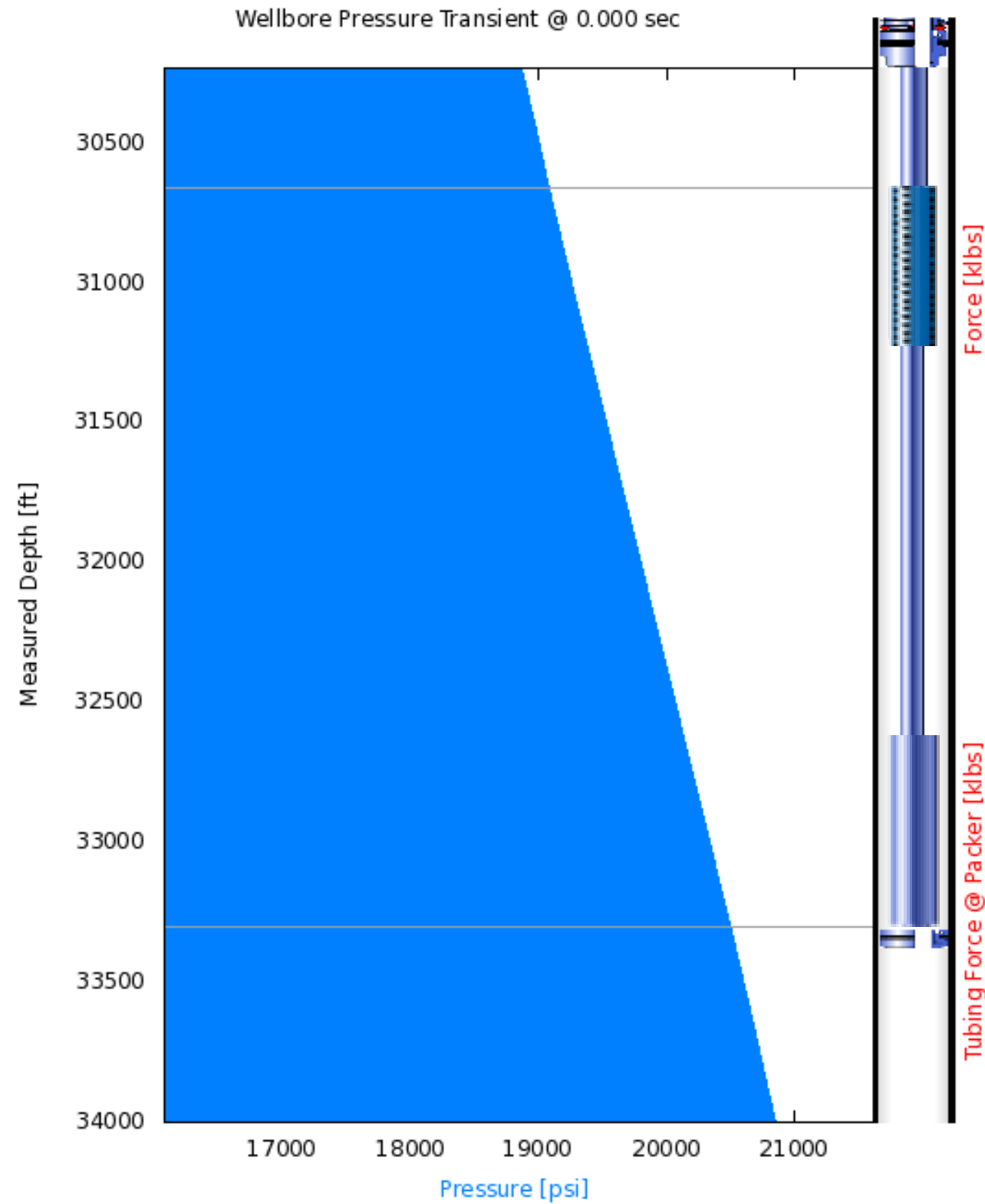


# Shooting the lower zones



- Upper Zones: ~ 500 ft
- Blank-tubing: ~ 1500 ft
- Lower Zones: ~ 500 ft
- 6-5/8" Low-Shock and Low-Debris guns, 18spf
- Peak packer differential: 3.5 ksi
- Peak Tubing: 0 – 180 klbf

# Shooting the upper zones



- Upper Zones: ~ 500 ft
- Blank-tubing: ~ 1500 ft
- Lower Zones: ~ 500 ft
- 6-5/8" Low-Shock and Low-Debris guns, 18spf
- Peak packer differential: 2.5 ksi
- Peak Tubing: 0 – 150 klbf

## Two ~ 500-ft zones, 1,500-ft apart - Conclusions

- Large rig-time (1MM / day) savings perforating both zones in one run.
- Large savings substituting 1,500-ft of blank guns with drill pipe, additional savings in less backup guns.
- Sequential/Delayed firing: Lower shock loads on the tools, lower risk.
- Lower rig-time making up and breaking down guns.
- LSLD guns: less shock when perforating and less debris for subsequent completion operations.

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# QUESTIONS?

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