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OPTIMIZING RIG TIME WITH LONG, LARGE DIAMETER GUN STRINGS RUN ON WIRELINE CABLE FOR THE FIRST TIME IN THE UAE

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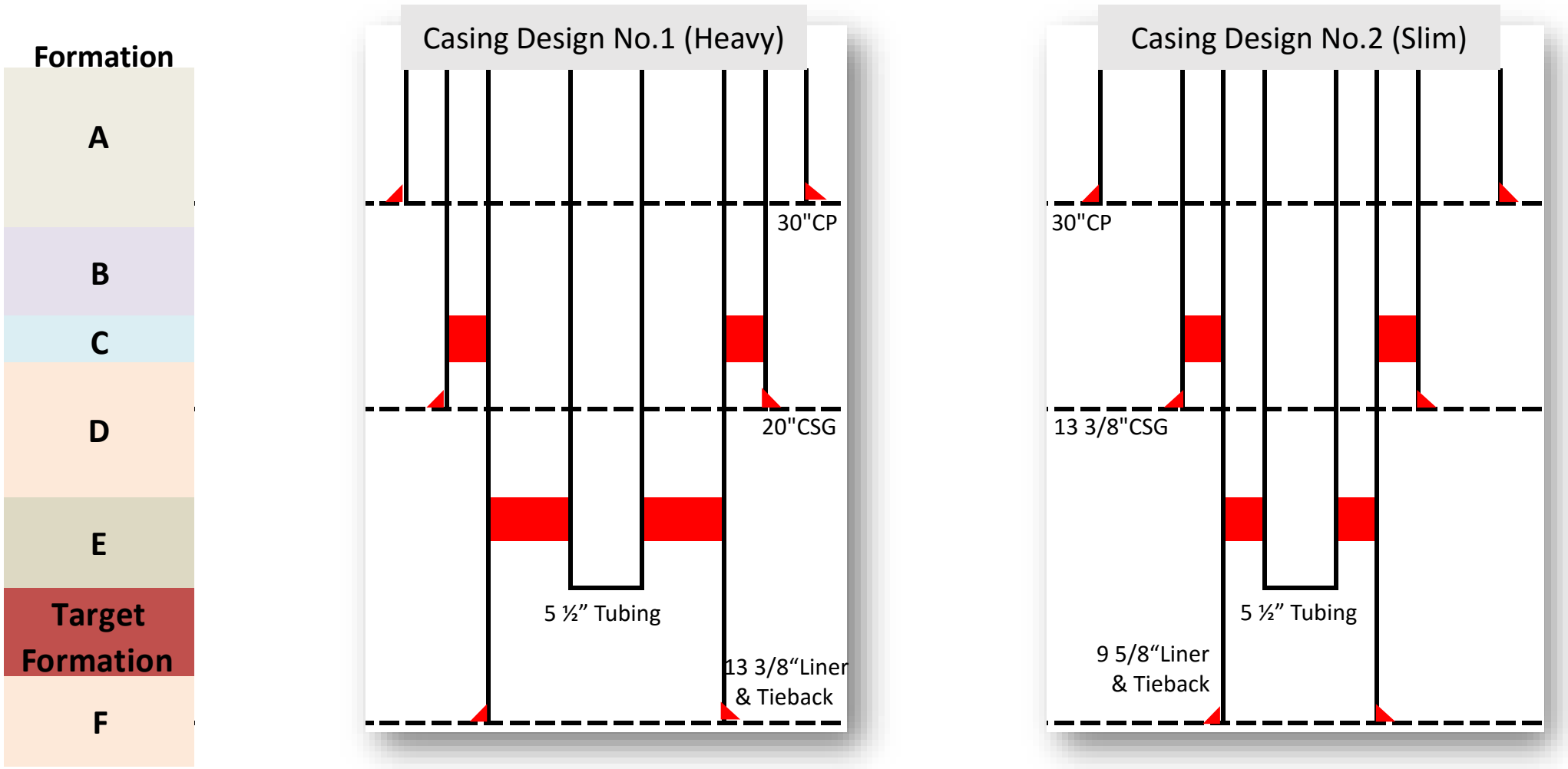
Introduction



- Injection wells to dispose of cuttings from development wells in the field
- Target injection rate of 5 bpm
- Total injection volume of 2 MMbbls

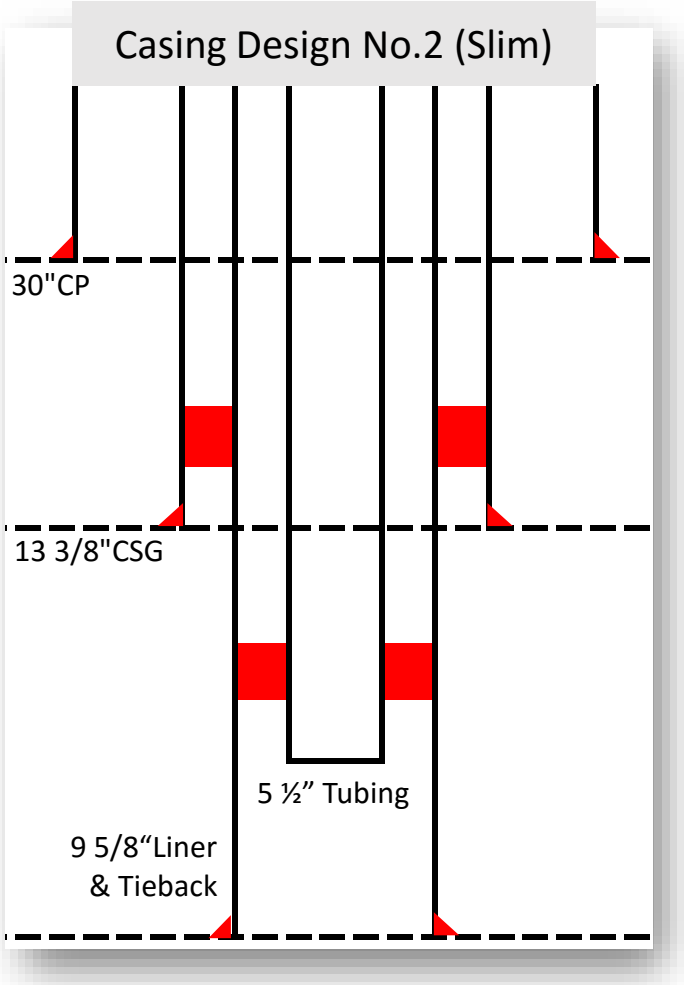
Perforation Gun Considerations

To reduce plugging the perforations in the injectors with the cuttings residues, the following was required from the guns:

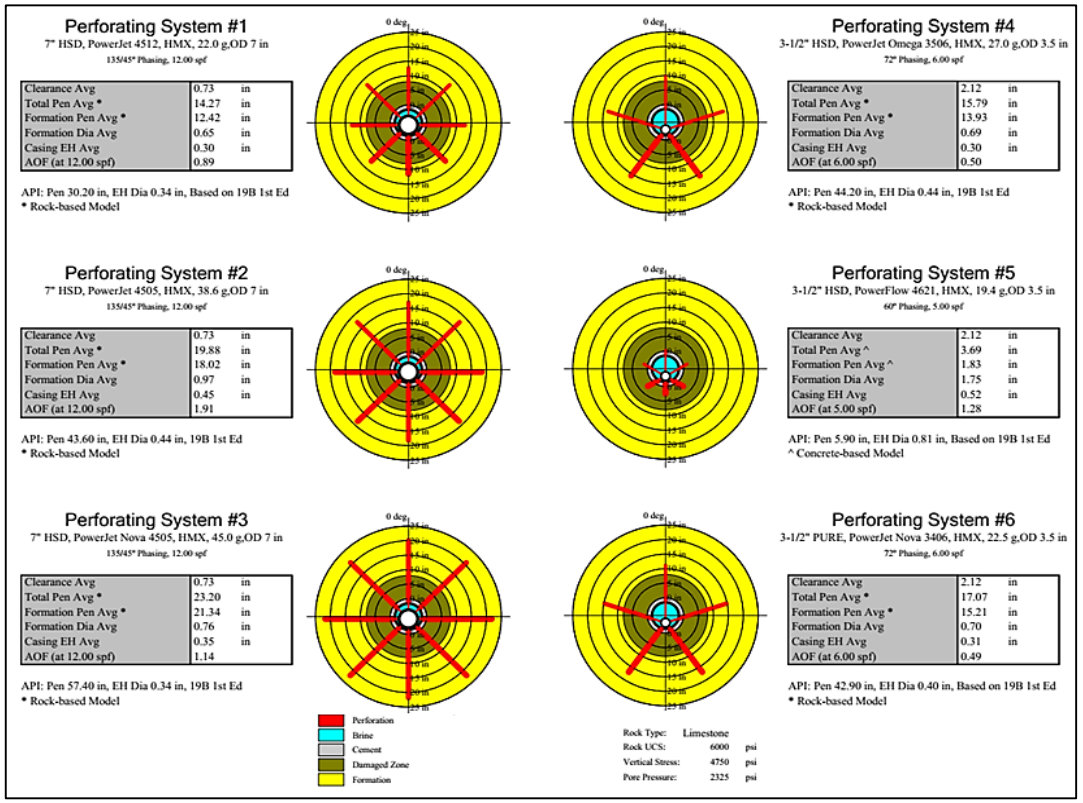
- Large hole diameter in the casing
- Deep penetration in the formation
- Large area open to flow

Perforating operation could be done:

- Rigless, through 5-1/2” tubing
- Rig on site, no tubing string



Perforation Gun Selection

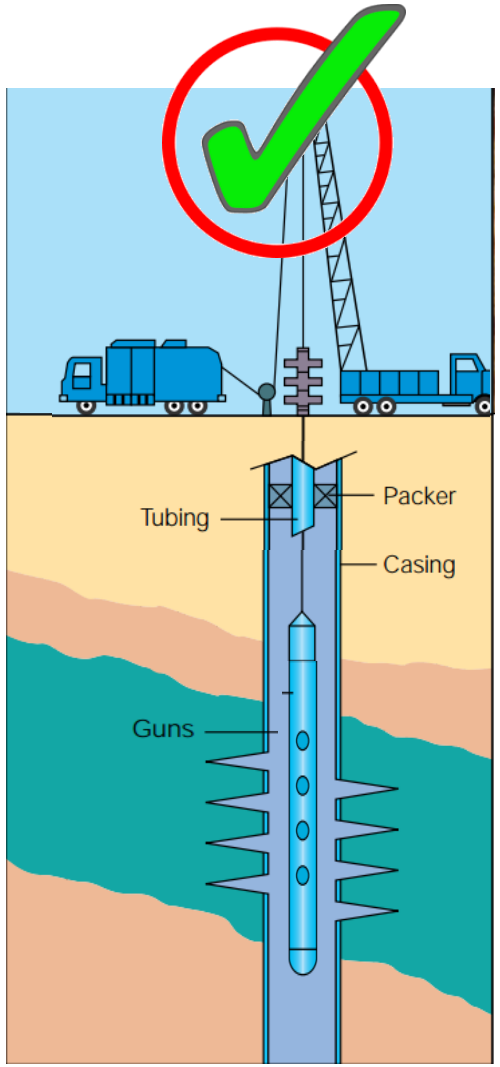


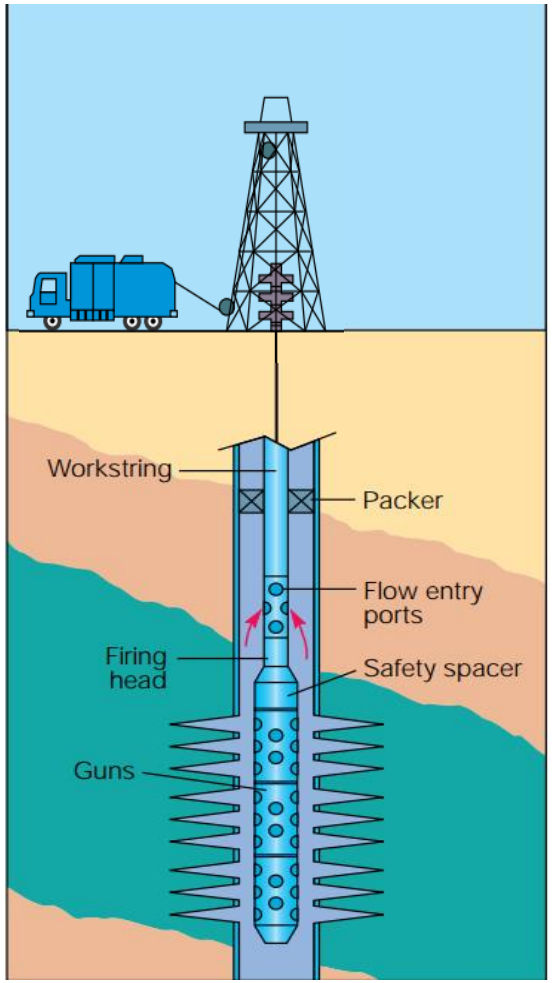
Gun System	Gun OD (in)	SPF	Average Casing Entry Hole Diameter (in)	Average Formation Penetration (in)	Area Open to Flow (in^2/ft)
1	7	12	0.30	12.42	0.89
2	7	12	0.45	18.02	1.91
3	7	12	0.35	21.34	1.14
4	3.5	6	0.30	13.93	0.50
5	3.5	5	0.52	1.83	1.28
6	3.5	6	0.31	15.21	0.49

- Larger 7 inch, 12 SPF gun selected
- Maximizes flow area to reduce risk of plugging
- Will reduce risk or frequency of future intervention operations to clean up perforations
- Rig needed to run tubing string after perforating

Rig Time Efficiency

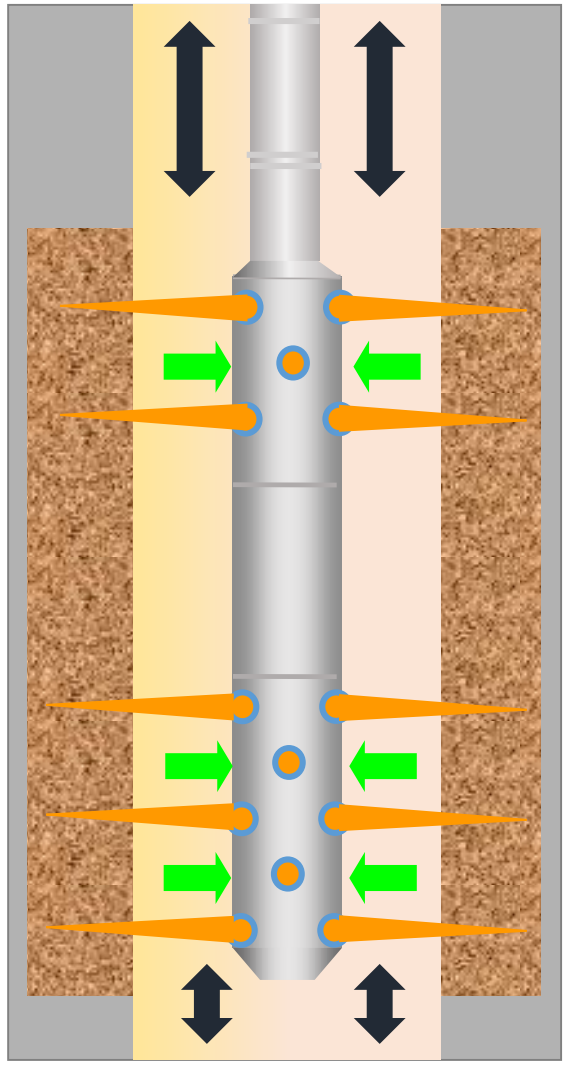
- 30 feet of interval to be perforated
- Gun string weight of about 2200 lbs
- First well drilled by this new rig and relatively inexperienced rig crew
- Operational safety considerations
- TCP or Wireline conveyance options
- Single run on wireline to be considered



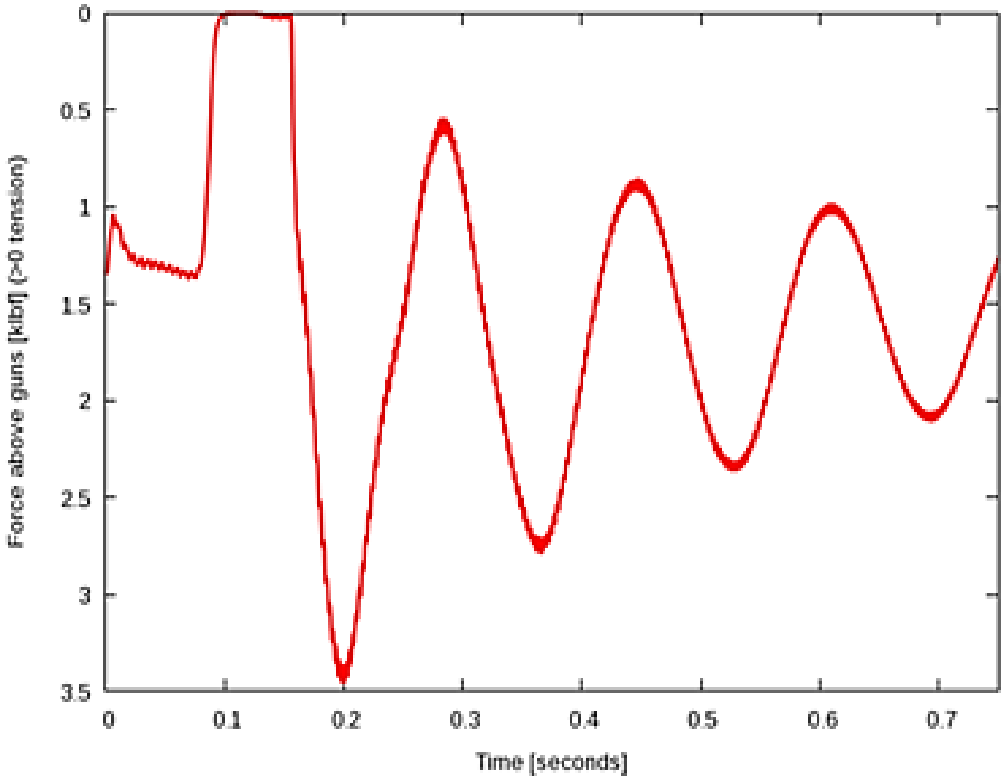


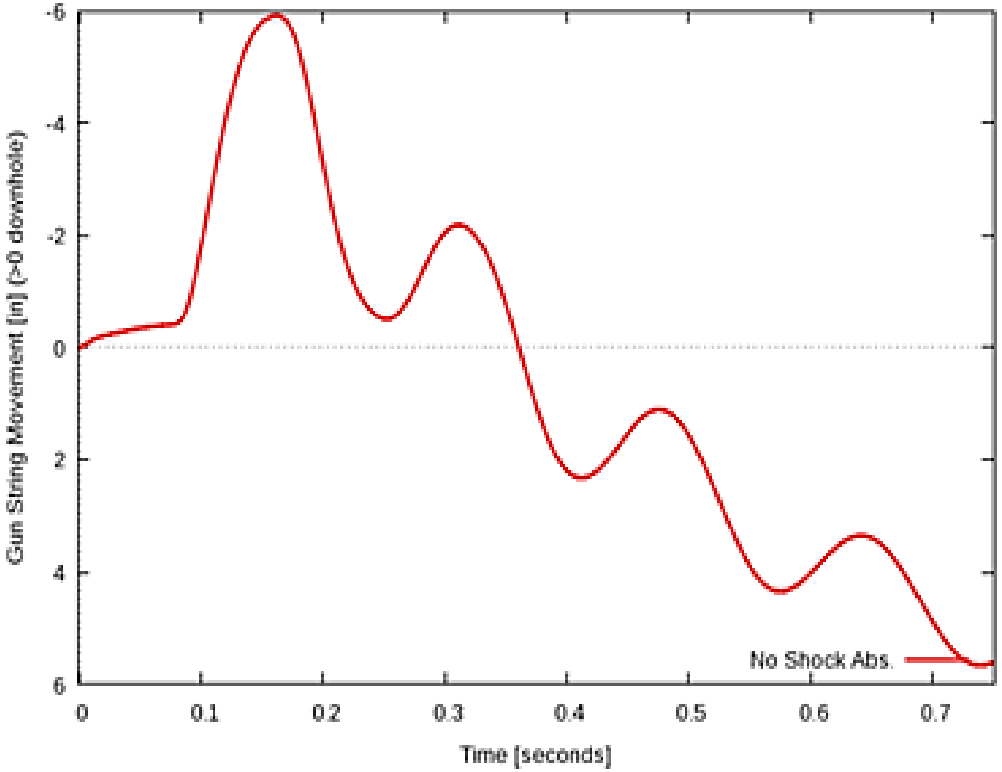
Challenges of Heavy Gun String on Cable

- Weight of guns and cable strength
- Wellbore dynamic shock on detonation
- Tension and compression effects on cable weak point
- Detonation shock
- Effects on downhole electronics



Wellbore Dynamic Shock Simulation

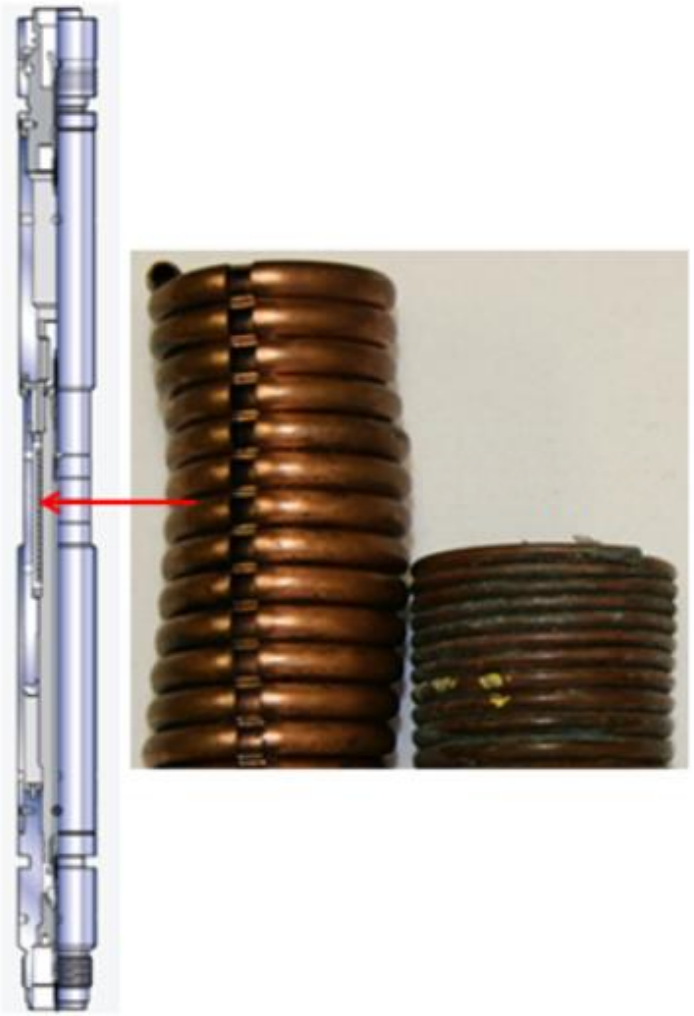




- Simulated for 30 ft of 7” gun on wireline, no shock absorber
- Maximum **3,500 lbs** of additional tension on weak point after detonation
- 6 inches of downward travel of gun string
- Unknown formation properties so extra safety margin required

Perforating Shock Mitigation

- Strong 7-conductor, 0.48” diameter wireline cable selected
  - Breaking strength > 30,000 lbs
- Special Flexible weak point
  - Safety margin > 150% over the maximum tension modeled by the shock simulator
- The weak point rating well within the safety rating for this strong cable
- Shock absorber added to string



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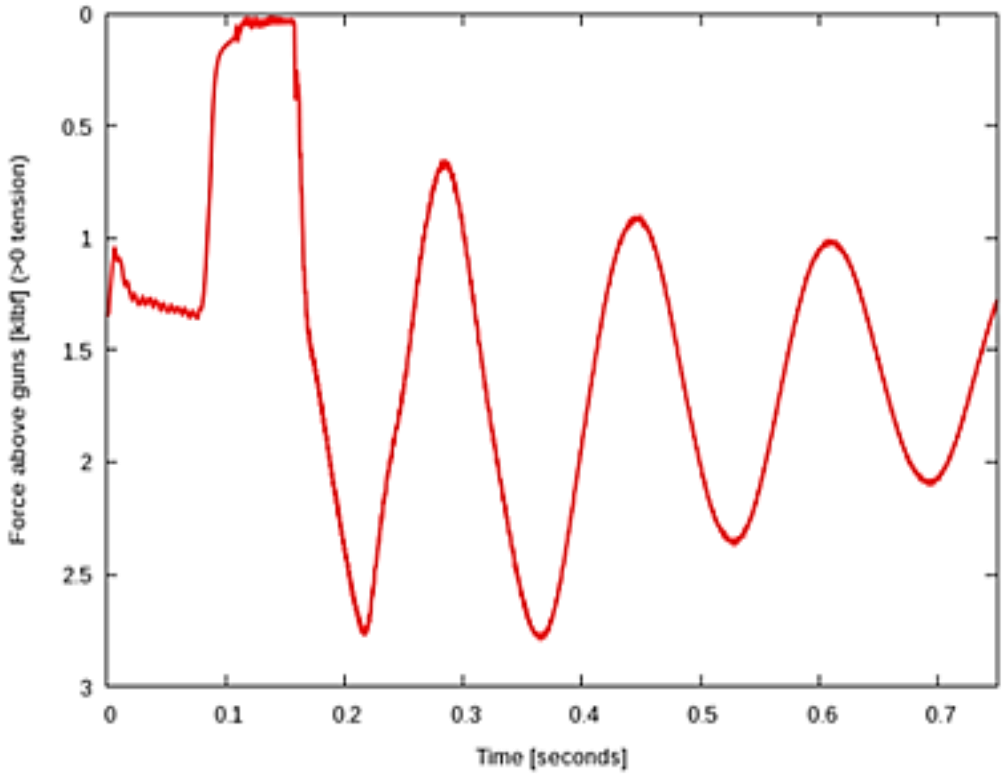
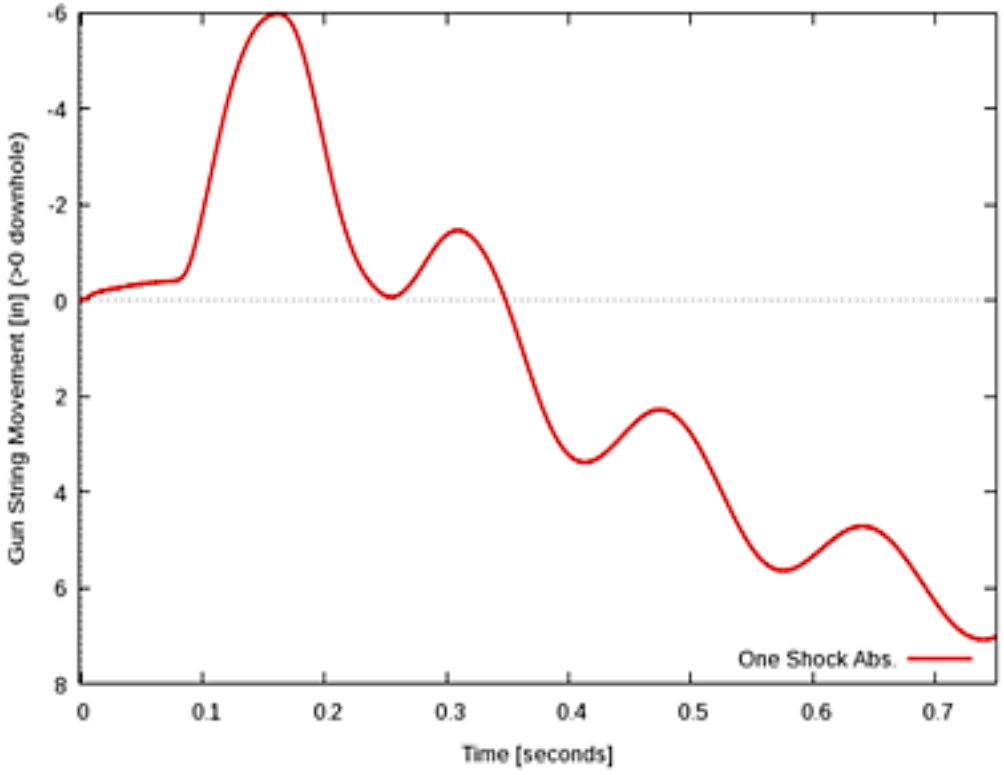
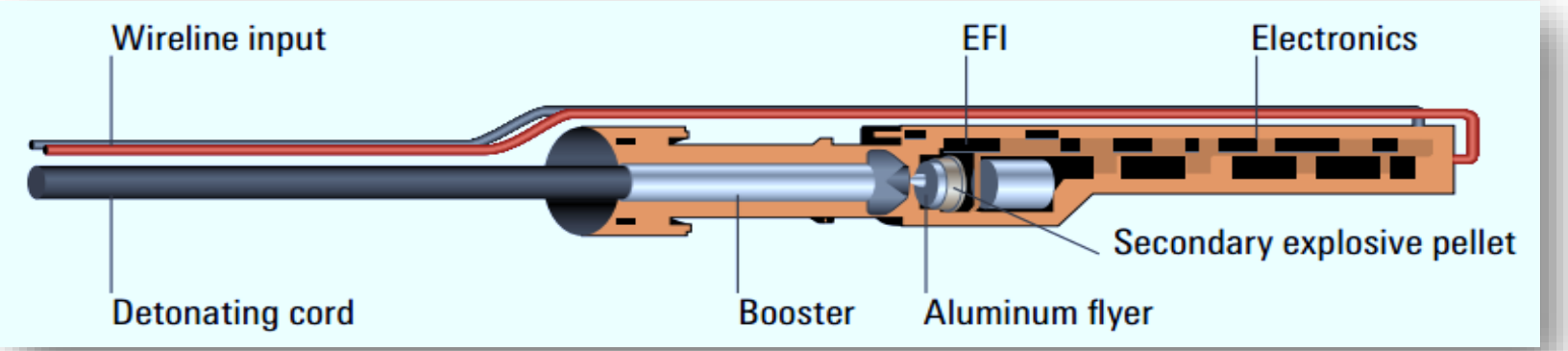




- With shock absorber
- Maximum **2,800 lbs** of additional tension on weak point after detonation
- Slightly more downward travel of gun string at about 7 inches
- Electronics will be protected by the shock absorber

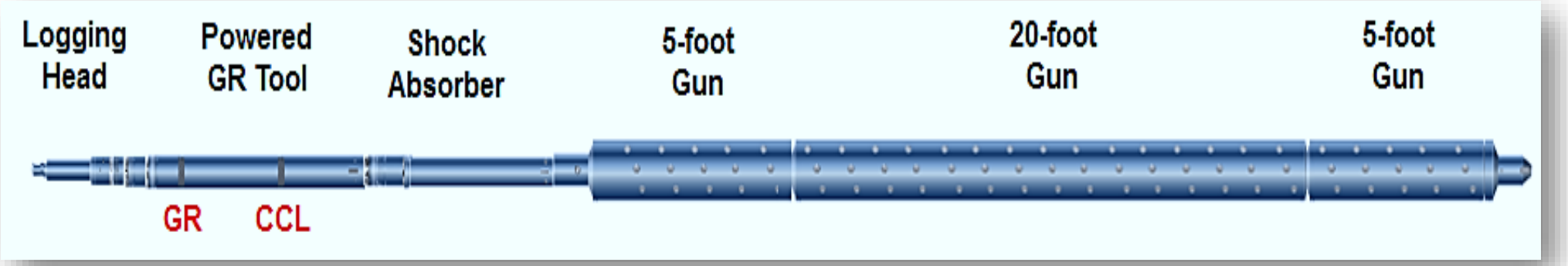
Radio Safe Frequency Detonator

- Special Radio Frequency (RF) Safe Detonator used
- Heightened safety on wellsite activities during explosive operations
- Many routine or critical wellsite operations like radar, radio, cellular communications and welding in appropriate locations can often continue
- Increased productivity and reduced non-productive time (NPT)
- Especially important to maintain safety and efficiency on this particular site on the artificial island with many other operations going on, not involving the CRI well

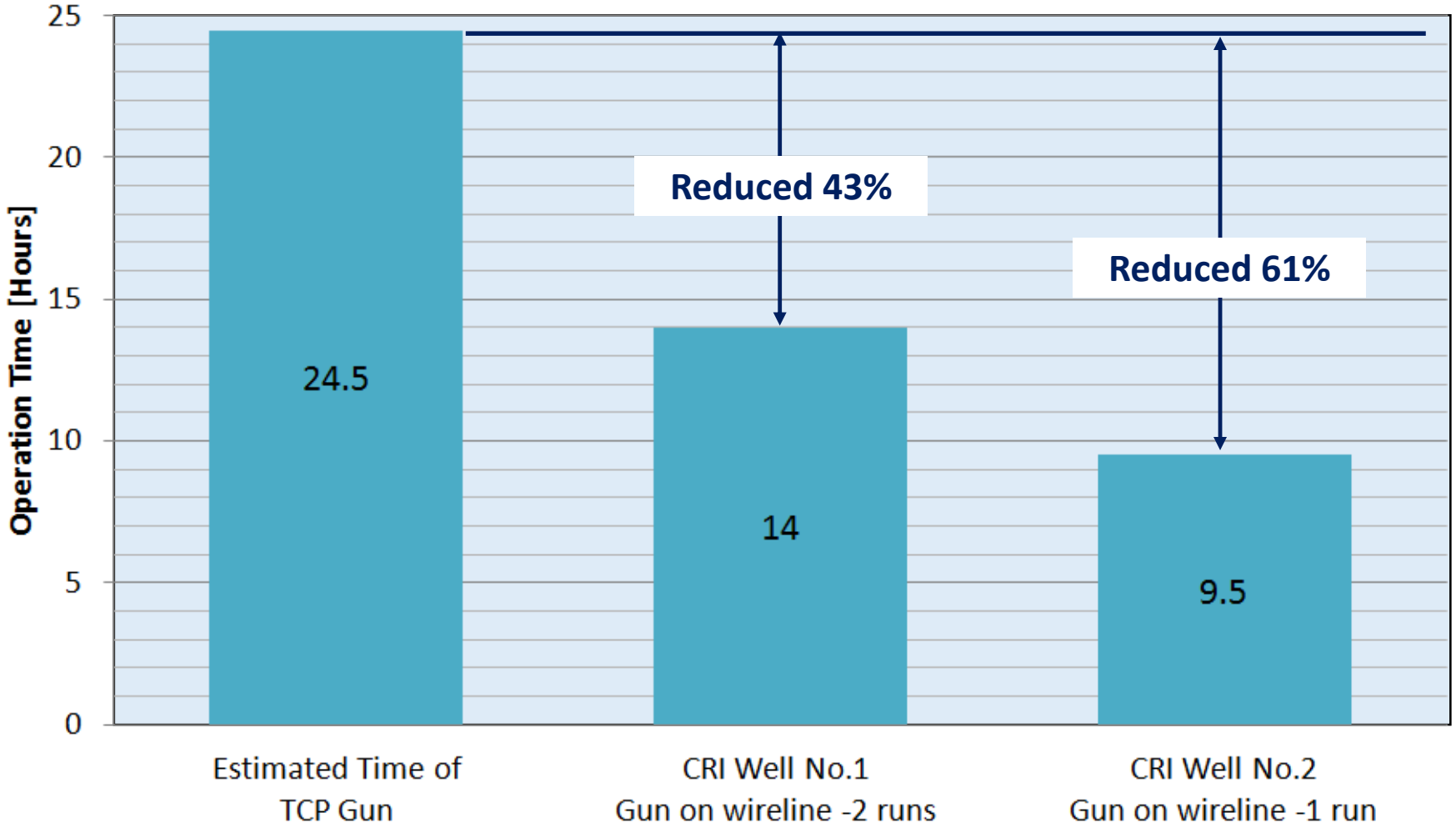


Rig Operation

- Heavy gun weight did not permit making up guns on catwalk
- Gun string prepared on the ground alongside the catwalk with crane
- Crane used to lift complete string horizontally to rig floor
- Wireline cable then used to take weight of gun slowly until vertical in the derrick
- Good communication essential throughout the operation
- Same procedure followed to bring down gun string after perforating



Operational Time Saving



Conclusions

- Advances in cable technology and auxiliary equipment such as flexible weak points and shock absorbers make shooting longer and heavier guns strings feasible
- Operation conducted safely in a single run
- Decreased rig operation time by 61%
- Achieved the objective for the well
- Successful completion on first attempt in the UAE
- Plenty of safety margin and longer strings can be handled in future

Acknowledgements

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QUESTIONS?
THANK YOU!