

Testing **Be certain.**

Effective Perforating Methodology for a Multi-Sand Zone Producer

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Schlumberger

Perforating Requirements

Perforate lower, consolidated zone with deep penetrating charges

Perforate upper, unconsolidated zone with big hole charges

Avoid gun sticking from sanding

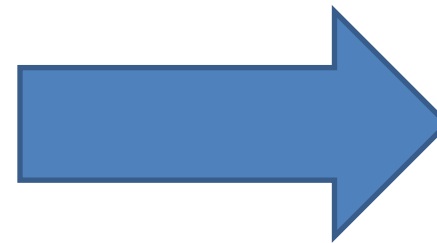
Optimize operations without compromising on the requirements to achieve clean perforations

| ZONES | INTERVALS (ft MD) |
|---------------|-------------------|
| Short String | |
| I3.0 | 4934 – 4941 |
| I3.5 | 4984 - 4991 |
| I3.6 | 5022 - 5026 |
| I4.0 | 5042 – 5049 |
| I9.0 | 5134 - 5138 |
| I9.1 | 5162 - 5167 |
| J1.0 | 5227 - 5238 |
| J3.0 | 5297.5 - 5306 |
| J3.5 | 5328.5 – 5339.5 |
| | |
| Long String 1 | |
| L1 | 5948.5 – 5961 |
| L3 | 6086.5 - 6094 |
| L4 | 6203.5 – 6208 |
| L4 | 6212 - 6216 |

- Net interval = 93 ft
- Gross interval = 1282 ft

Perforating Plan vs. Goal

| Completion |
|----------------------------------|
| R/D Suspension cap. N/U BOP |
| Scrape clean-up |
| Cement Log |
| TCP Lower Interval K, L & M |
| Clean up trip |
| Run & set tailpipe |
| TCP & surge Upper Interval I & J |
| Clean up trip |
| RIH screens & GP Upper Interval |
| Replace rams & dummy run |
| RIH Dual Upper Completion |
| Test tubing & TRSCSSV |
| N/D BOP |
| Install Xmas Tree |
| Handover the well to production |



| Completion |
|---|
| R/D Suspension cap. N/U BOP |
| Scrape clean-up |
| Cement Log |
| TCP All Intervals and Surge |
| Clean up trip |
| Run & set tailpipe |
| TCP & surge Upper Interval I & J |
| Clean-up trip |
| RIH screens & GP Upper Interval |
| Replace rams & dummy run |
| RIH Dual Upper Completion |
| Test tubing & TRSCSSV |
| N/D BOP |
| Install Xmas Tree |
| Handover the well to production |

Challenges

Static or dynamic UB recommended for consolidated reservoir and surging
recommended for unconsolidated reservoir requiring sand control – how to achieve both in one run?

Static underbalance perforation risky as it might cause gun sticking especially at the unconsolidated zone

Long distance between upper and lower perforations (600 ft)

- use of gun spacers costly
- Increased number of gun to gun ballistic transfer, risk of interrupted detonation train

Proposed Solution

Single perforation run to perforate all intervals

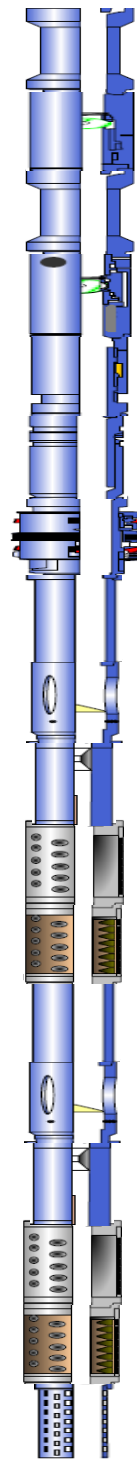
Use of drill pipe and multiple firing heads in between upper and lower zone

Dynamic Underbalance Perforation for lower zone

Shoot and Surge for upper zone

Perforate in overbalance condition to avoid sanding in

Proposed BHA Design and Job Steps



| |
|--|
| Drill Pipe to Surface |
| Single Shot Downhole Shut In Valve - Run with Ball Valve Closed |
| Drill Pipe - Surge Chamber |
| Integrated Downhole Shut In & Circulating Valve - Run with Ball Valve Closed |
| Hydraulic Jar |
| Safety Joint |
| Packer |
| Drill Pipe |
| Debris Barrier Sub |
| Electronic Firing Head |
| Safety Spacer |
| Big Hole Guns |
| Tubing |
| Debris Barrier Sub |
| Electronic Firing Head |
| Safety Spacer |
| Deep Penetrating Guns - Dynamic Underbalance |
| Fast Gauge |

Make up BHA

Correlate with e-line to space out guns

Send pressure pulse command through annulus to activate delay time for both sets of firing head

Set packer during delay time

Guns fire simultaneously

Unset packer, monitor losses

Pick up string till guns above perf intervals

Open lower ball valve and surge perforation

Open upper ball valve, close lower ball valve

Open circulating valve, reverse out string contents

Open packer bypass, monitor losses

Reverse circulate

Pull out of hole

Results

DUB achieved

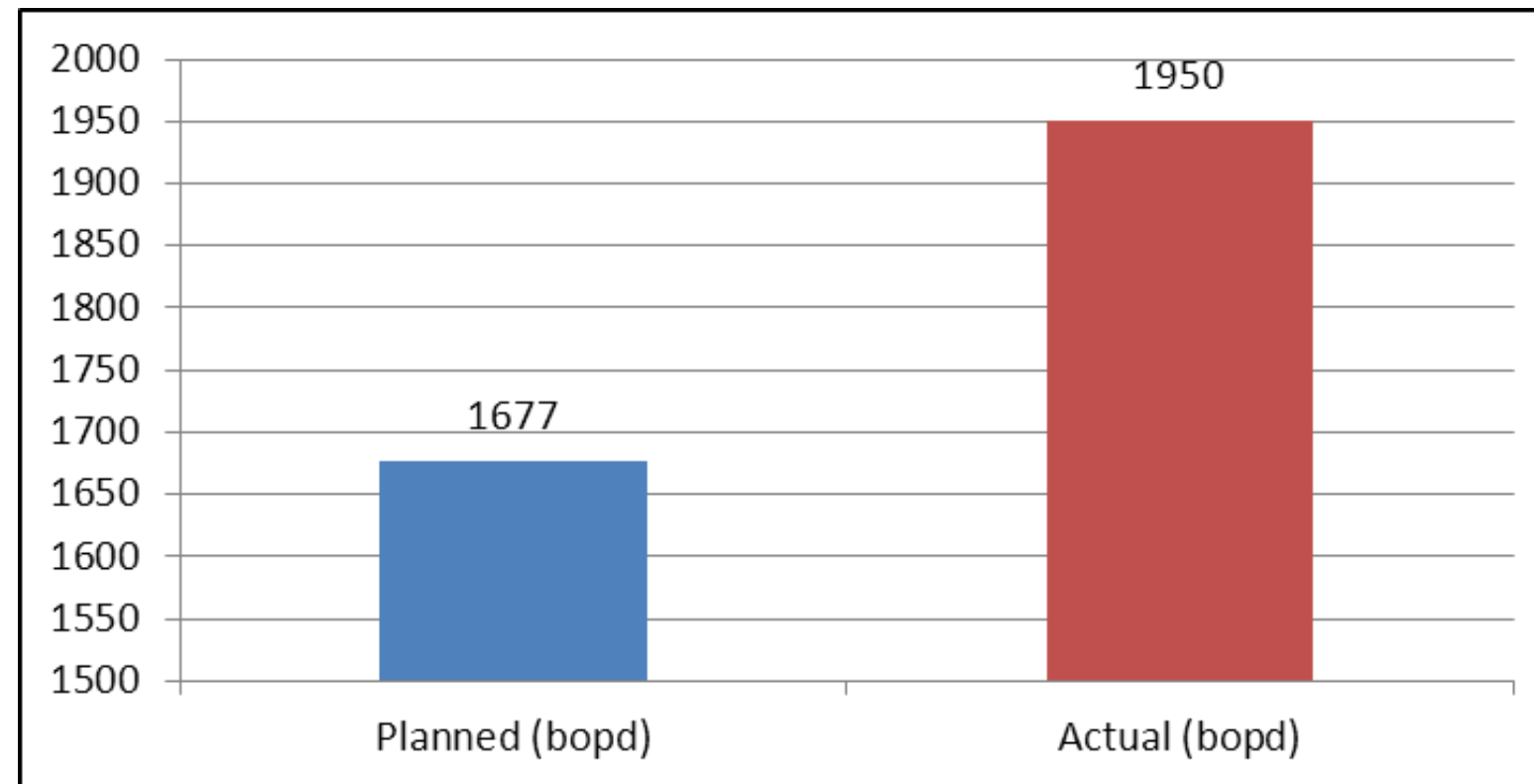
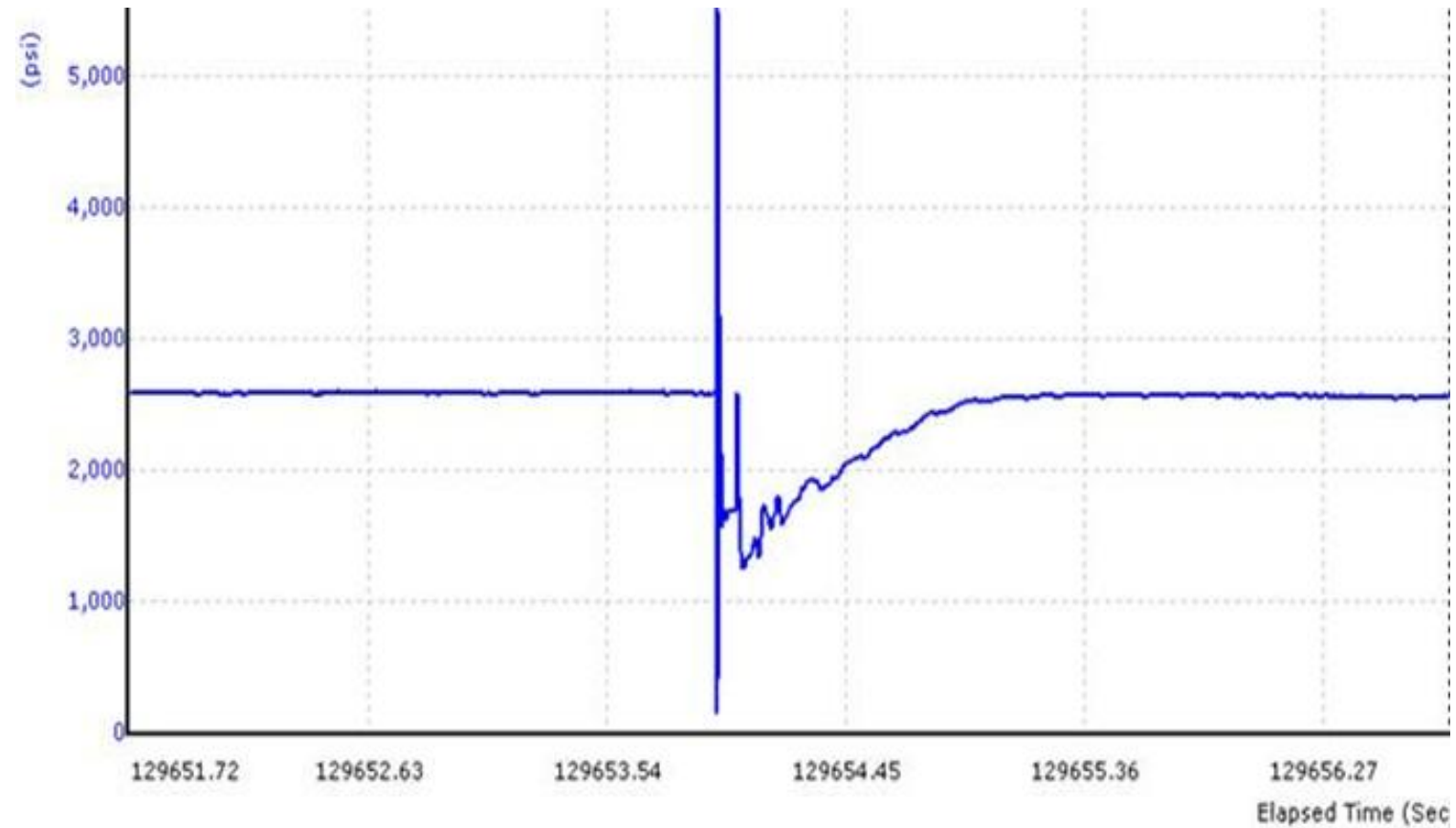
Losses before and after surging

■ Before: 90 bph

■ After: 250 bph

Initial production data shows 17% improvement in production

2.2 days rig time saving by eliminating additional runs





Thank You

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