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

- 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

<table>
<thead>
<tr>
<th>Gun System</th>
<th>Gun OD (in)</th>
<th>SPF</th>
<th>Average Casing Entry Hole Diameter (in)</th>
<th>Average Formation Penetration (in)</th>
<th>Area Open to Flow (in²ft)</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>12</td>
<td>0.30</td>
<td>12.42</td>
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<td>2</td>
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<td>12</td>
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<td>5</td>
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<tr>
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<td>3.5</td>
<td>6</td>
<td>0.31</td>
<td>15.21</td>
<td>0.49</td>
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</tbody>
</table>
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
Wellbore Dynamic Shock Simulation

- 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

- Estimated Time of TCP Gun: 24.5 hours
- CRI Well No.1 Gun on wireline -2 runs: 14 hours
- CRI Well No.2 Gun on wireline -1 run: 9.5 hours

- Reduced 43%
- Reduced 61%
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!

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