AGENDA

- Multistage Perforating in North America and Argentina
- Horizontal Frac Operations
- Conventional Gun Systems
- New Technology for Multistage Perforating
Multistage Perforating in North America and Argentina

https://www.eia.gov/maps/maps.htm#shaleplay

Vaca Muerta Shale in the Neuquen Basing (blue outline). (Adapted from the US EIA, reference 1)
Horizontal Stage Frac Operation

- Great amount of equipment and crews from various service companies
- Cost heavily influenced by Fracturing crew expenses
- Economical returns can only be achieved through maximized efficiency
How Efficient is Efficient?

Opportunities for WL improvement

- Time saved running in hole
- Time saved with faster rig-ups
- Time saved preventing misruns
Conventional Guns Reliability in Multistage Perforating

- Conventional Gun Systems have potential for service quality issues
- Wiring needs and assembly, are critical points in the process
Conventional Gun Shop Operations

Intermediate Adapters

Loading Process

Gun Strings
Conventional Gun Shop Operations
Conventional Wellsite Operations

- Perforating strings range from 3 to 10 guns per string
- Radio Silence zone required
- Gun string electrical connections
- Detonators armed at the well site
A Revolutionary Selective Gun System

A new benchmark for Perforating:
✓ Safest initiator system in the industry
✓ Improved Reliability
✓ Improved Operational Efficiency
  ▪ Gun Shop
  ▪ Well site
Safety- Ballistic Interrupt
Reliability & Efficiency - Gun Shop

Intermediate Adapters

Loading process

Gun Strings
Reliability & Efficiency - Well site

**Legacy Perforating** – Zipper Frac
- 1 Engineer
- 3 Operators
- 1 Arming Engineer
- 22 ft of Conventional Guns & Adapters

**Fractal Perforating** – Zipper Frac
- 1 Engineer
- 3 Operators
- 18 ft of Fractal Guns
- No Adapters
- No Arming
- No Wiring
- No RF Shutdown
- No Handling Explosives
North America Land Fractal Deployment

Gun shop Efficiency (Conventional vs. Fractal)

Gun Pre. Efficiency (Conventional vs. Fractal)

- Break Apart
- Clean
- Redress

Conventional
- Unpack
- Clean
- Prepare
- Assemble
- Label/ Move

Fractal
- Unpack
- Clean
- Prepare
- Assemble
- Label/ Move
# Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gun Diameter in, (mm)</td>
<td>2-7/8, 3-1/8, 3-1/2 (73.0, 79.4, 88.9)</td>
</tr>
<tr>
<td>Gun Length ft, (m)</td>
<td>1, 2, 3, 5 (0.3, 0.6, 0.9, 1.5)</td>
</tr>
<tr>
<td>Shot Phasing/ Density</td>
<td>60°/6 shots per foot (60°/20 shots per meter)</td>
</tr>
<tr>
<td>Reliability</td>
<td>99.9% or higher</td>
</tr>
<tr>
<td>Max Temperature / Pressure</td>
<td>340°F (171°C) – 18K Psi or 20Kpsi</td>
</tr>
<tr>
<td>Arming Options</td>
<td>Ballistic Interrupt Detonator / Radio Safe Detonator</td>
</tr>
<tr>
<td>Gun Housing type</td>
<td>Slick, Scalloped</td>
</tr>
<tr>
<td>Guns Selectivity</td>
<td>Up to 40 addresses</td>
</tr>
</tbody>
</table>
## Multistage Stimulation Perforating Solution

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<tr>
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<th>Reliability</th>
<th>Efficiency</th>
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<td>Ballistic interrupter</td>
<td>Modular approach – easier to load</td>
<td>No well site arming</td>
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<td>Addressable Switch</td>
<td>Pre-assembled from factory</td>
<td>Tested and verified</td>
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<td>Technology</td>
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<td>Optimized rig up</td>
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- Ballistic interrupter
- Addressable Switch Technology
- Modular approach – easier to load
- Pre-assembled from factory
- Fully disposable (no need for cleaning, quick TAT)
- No well site arming
- Tested and verified
- Optimized rig up
North America Land Fractal Deployment

- 9 locations in North America
- Proven reliability 99.9%
- > 18,000 guns shot
- ~ 3600 stages
- Reduces gun failures by up to 77%
2016 LATIN AMERICA PERFORATING SYMPOSIUM, BUENOS AIRES

QUESTIONS?
THANK YOU!

SLAP-16-3
A Step Change in Multistage Perforating