

2019 NAPS

NORTH AMERICA PERFORATING SYMPOSIUM

AND SAFETY FORUM

DALLAS - FORT WORTH. AUGUST 5-6, 2019.

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Increasing Safety by Advancing
Perforating Technology

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Increasing Safety by Advancing Perforating Technology



Agenda

- **Abstract**

- **Select Fire Perforating**
 - Addressable Switch Technology
 - Electronic vs Mechanical Switches
 - Packaged Initiation Devices
- **Perforating Gun Systems**
 - Plug & Play and Disposable Gun systems
- **Perforating Hardware**
 - Man-less Wellhead Connections
 - Improved/Disposable Downhole Hardware
 - Greaseless Coated Wireline

- **Q&A**

Abstract

- Maximizing efficiency is the main objective of Perforating Technology
- Increased safety is a natural byproduct
- Technology Improvements -> Reliable operations -> Reduce human error
- Most safety incidents occur after a misrun
- Reliable Product(s) -> Less chance a rushed operator skips SOP or takes shortcuts
- New Technology transformed the industry by increasing efficiency, reliability and safety, while staying economically feasible in a cost-sensitive market

Select Fire Perforating

Addressable Switches

- **Addressable Switch Technology**
 - Reduces misruns with its ability to skip over misfired guns
 - Reduces NPT with Real time switch communication downhole
 - Electrically unarmed at surface by default/design
 - Real time surface shot confirmation
 - Some systems are capable of running 100+ guns in a single run
 - Proven & Reliable technology



Addressable Switches

■ Electronic Switches vs. Mechanical Switches

- Most incidents occurred after a misrun or during troubleshooting and inspection
- Increased reliability of addressable switches has reduced opportunities for safety incidents to occur
- Increased market year after year due to safety benefits, operational advantages and price reductions
- The implementation of addressable switches has improved industry ratio of runs-to-misruns from 40 to 100-300

Year	Mechanical Switch	Electronic/Addressable Switch
2012	94%	6%
2013	86%	14%
2014	73%	27%
2015	63%	37%
2016	61%	39%
2017	59%	41%
2018	48%	52%
Est. 2019	~30%	~70%

Addressable Switches

- **Packaged Initiation Devices**
 - Fully encapsulated wires/connections reducing failure-prone points
 - Eliminate wiring issues in tandem subs
 - Eliminate wiring issues between bottom gun and plug switch
 - Increased reliability = less opportunity for a miss run and reduced exposure to live explosives at surface



Perforating Gun Systems

Plug & Play and Disposable Perforating Gun Systems

- **Engineered out root cause(s) of SQ failures**
 - Failures analysis and tracking showed 32% due to pinched or nicked wire(s)
 - Less connections, enclosed wires, or No wire connections at all
 - No ports or port plugs
 - Reduced maintenance

- **Case Study - A service company and operator in west Texas tracked efficiencies running a plug and play disposable Perforating Gun System for a 3 month period**
 - Ran 500 stages totaling 2000+ guns before having a miss run. Prior, best run rate was 100 using conventional wired guns
 - 80% improved reliability and efficiency in gun loading, arming, and assembly operations compared to conventional select fire systems.
 - Safer operations as no opportunities were presented for bringing a live miss fired gun string out of hole



Perforating Hardware

Perforating Hardware

■ Improved/Disposable Downhole Hardware

- Uniform diameter, robust quick changes less prone to breaking
- Disposable tandems and top subs eliminate maintenance
- Disposable Setting Tools eliminate user error



■ Man-less Wellhead Connections

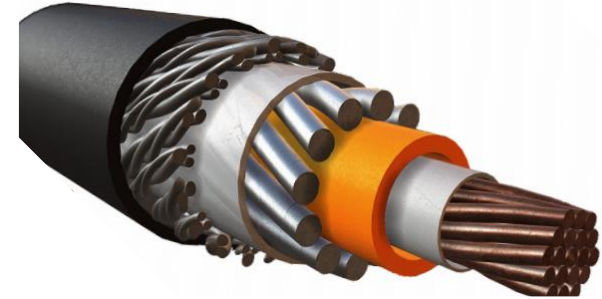
- Safe and quick connection of Wireline Pressure Control Equipment to wellhead
- Remotely operated/controlled to remove individuals from dangerous and compromised positions under suspended loads
- Reduces exposure/operation around pinch points to reduce hand injuries while making connections
- Eliminates time consuming activities (man basket) to provide better wellsite efficiency
- Reduces wellsite personnel/crew
- Allows for gunstring/lubricator stabbing on/off during frac ops without getting into the hot-zone



Perforating Hardware

■ Greaseless Coated Wireline

- No grease needed for pressure control – reducing operating cost significantly
- No stranded armor procedures reducing risk of operating on pressurized vessels at close proximity
- Jacketed cable reduces downhole friction, resulting in less tension during operation
- Less tension reduces chances of wireline, sheave wheels, and/or rig-up equipment breakage on surface (attempts to free stuck tools/cable downhole) reducing injuries
- Time saving for reheads – every 40 runs rather than every 5 runs
- 5-10 gallons per stage and more for extended reach (\$8 to \$12 per gallon)



■ Case Study/Example (Standard):

- 120 stages job requires 23 reheads (35min.) = 805 minutes = 13.5 hours
- 120 stages job requires 7 gallons/stage = 840 gallons = \$8,400.00

■ Case Study/Example (Greaseless Wireline)

- 120 stages job requires 2 reheads (50min.) = 100 minutes = 1.66 hours
- 120 stages job requires NO GREASE = \$0.00

Conclusion

- **Reliability and efficiency are the primary objectives in advancing perforating technology**
- **Reliability -> reduced opportunity for handling miss run explosives -> Safer Operations**
- **Efficiency -> reduced human interaction with equipment -> reduced opportunity for human error -> Safer Operations**

***Let's Increase Safety by Advancing
Perforating Technology...***

QUESTIONS?

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