

*Mitigating the Problems in Select-Fire Perforating
Operations*

SLAP-16-21

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AGENDA/INTRODUCTION

Mitigating the Problems in Select-Fire Perforating Operations

- Reported Failures
- Objectives of the System
- Safety Benefits
- Service Quality Solutions
- Operational Benefits
- System Overview
- Conclusion
- Questions

Reported Failures

CIPS 2014 Poster Session “Solutions for Consistent Service Quality in Perforating Services”

- 18 month period 750+ Reported Select Fire Issues/ problems
- 38% Pinched or nicked lead wire
- 22% Seal failure
- 18% Lack of operational confirmation

Solutions for Consistent Service Quality in Perforating Services

ABSTRACT

- Consistent Service Quality is what the perforating industry strives for. Poor service quality is due to the volume of work and the lack of experienced personnel providing perforating services.
- It is the industry's responsibility to constantly seek input to better understand the user needs and offer solutions. Through failure root cause analysis, engineering changes and best practices the solutions exist for consistent service quality.
- The challenge is identifying issues and capturing trends of the highest reported failures. By tracking failures over the last twelve months and working with the users to determine a root cause, solutions were offered to prevent future failures through design and engineering advancements.

REPORTED FAILURES



TOP FIVE SERVICE QUALITY FAILURES

Top 5 Service Quality Failures



- Wiring insulation failures for perforating gun systems
- Insulation/ Continuity of weight bars and contact sub
- Setting Tool Failure due to fluid and electrical issues or application
- Seal failures on tandem subs creating flooded guns
- Lack of downhole operational confirmation

32% of Perforating Service Quality Failures Tracked in a 12-month period

Failure: Wiring insulation failures for perforating gun systems

Solution: Single fire line to all strings. Three strings that could work on alternate wires.

Root Cause: Wire insulation damaged due to insertion into base of the sub against sharp edge.

Advanced Outlook: Eliminate wiring completely.

28% of Perforating Service Quality Failures Tracked in a 12-month period

Failure: Insulation/continuity of weight bars and contact sub

Solution: Remove excessive electrical connections and strip the weight bars and contact sub.

Root Cause: Vibration down hole and lack of maintenance caused failure for electrical connections.

Advanced Outlook: Design a tool string with the maximum electrical weight equipment.

17% of Perforating Service Quality Failures Tracked in a 12-month period

Failure: Lack of down hole operational confirmation

Solution: Use a electronic switch system.

Root Cause: Traditional Serial Fire perforating wire needs to send gun down to the base gun down to the surface. Check on only confirmation and exclusion of perforating element.

Advanced Outlook: Down hole data stream.

22% of Perforating Service Quality Failures Tracked in a 12-month period

Failure: Setting tool failure due to fluid and electrical issues or application

Solution: Control the tool stringing, time in the string, and the setting time for the setting tool.

Root Cause: Setting tool failure, setting time, control time, setting time, long and heavy on manual and

Advanced Outlook: Reduce the time required of the tool string to set the length which decreases in production.

18% of Perforating Service Quality Failures Tracked in a 12-month period

Failure: Seal failures on tandem subs creating flooded guns

Solution: Create best practice for care and maintenance for the tandem associated equipment.

Root Cause: Poor Maintenance and cleaning of threads, Bore, and case for the sub associated equipment.

Advanced Outlook: Develop better tools.



Objectives of the System

- Added level of safety to prevent surface detonations
- Eliminate service quality failures in select fire perforating
- Ease of use for operational efficiency
- Reduce footprint for extended laterals with increased perf clusters
- Advanced technology for today's perforating market



Safety Benefits

- Added level of safety
 - Electrically unarmed
 - Protection up to 500V
- RF SAFE
- API RP 67 Compliant
- Third Party Tested



Safety Benefits

- Shorter tool string
 - 4-6" per gun connection
- Lighter tool string
 - 18# lighter per gun connection
- Reduced pinch points
- No exposed detonating cord



Service Quality Solutions

- Failure - Pinched or nicked lead wire
- **Solution - Eliminate wires**
- Failure - Seal Failure
- **Solution - Eliminate ports and tandem subs**
- Failure- Lack of operational confirmation
- **Utilize proven intelligent electronic select-fire system**



Operational Benefits

- Box by pin gun
- No subs
- No required auxiliary hardware clean up (throw away gun)
- No wires
- Charge tube is the conductor
- Reduced loading time
- No charge clips or pull over tabs on charge tube

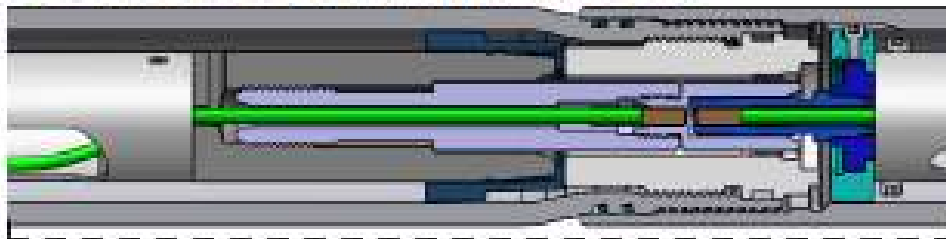


Operational Benefits

- Allows for closer shot to shot between two guns (TCP and P/A operations)
- Allows added perforated clusters in horizontal operations
- Compatible with SDP, GH, BH or Consistent Hole shape charges

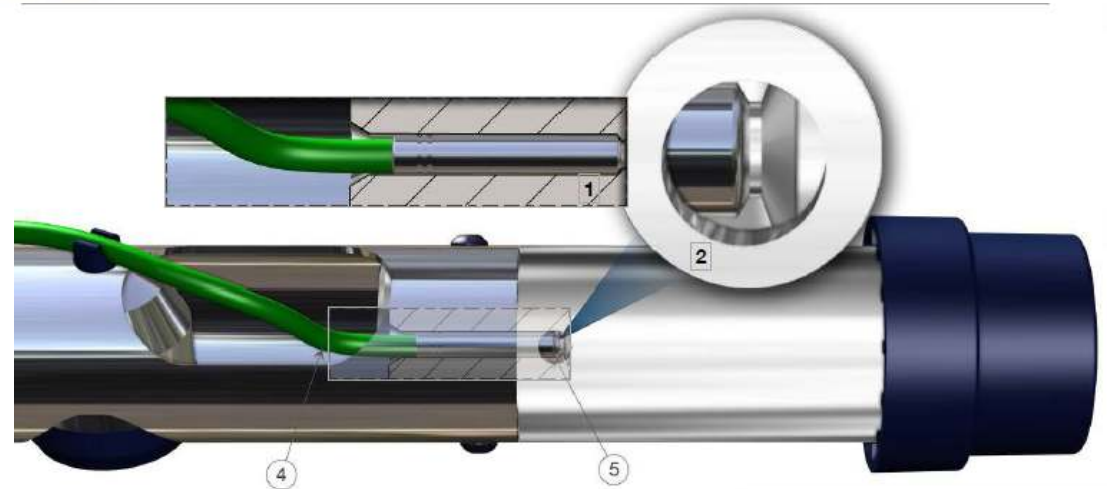
Gun Diameter	2.75 in. [70 mm]	3.125 in. [79 mm]	3.375 in. [86 mm]
Shot Density	Up to 6 SPF		
Phasing	60		
Temperature (°F)[°C]	350 [177]		
Pressure (psi)[MPa]	20,000 [138]		
Overall Length (ft)[m]	Up to 21 [6.4]		

BOOSTER TO BOOSTER TRANSFER CONNECTION



System Overview

- Insulated shape charges and charge tube
- End to end ballistic transfer

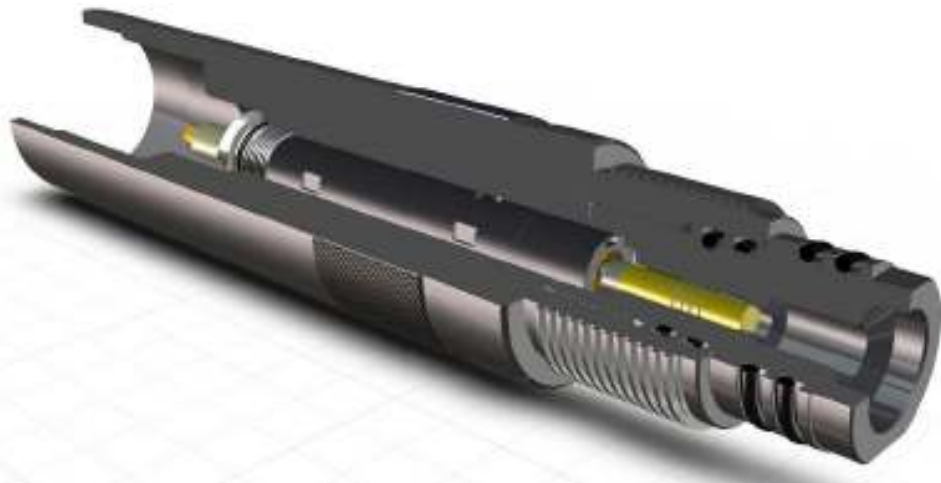


System Overview

- Pin to pin contact no wires required
- Pressure bulkhead, detonator, and intelligent electronic switch in one package



System Overview



- One piece plug shoot and firing head to reduce length and electrical connections
- Uniformed outside diameter quick connection with reduced length



System Overview

- Allows more guns to be run with reduced tool string length
- Guns can be easily downloaded as the job scope changes



Conclusion

- System mitigates 78% of reported failures and problems in select fire perforating
- Creates RF Safe, API RP 67 compliant, and proven operating gun system for the user.
- Advanced technology in the current market situation.

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QUESTIONS?
THANK YOU!

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