

Reducing Human Error When Select Fire Perforating

MENAPS 16-13

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AGENDA

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

Most Common Failures

- ~40% Pinched or nicked lead wire
- ~22% Seal failure
- ~20% 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 failure on tandem subs creating flooded guns
- Lack of downhole operational confirmation

13% of Perforating Service Quality Failures Tracked in a 12 month period

Failure: Wire insulation failures for perforating gun systems

Solution: Angle the bore to eliminate sharp edges that could nick or damage wires

Root Cause: Wire insulation damaged due to insertion into bore of the sub against sharp edges

Advanced Outlook: Fabricate wiring completely

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

Failure: Insulation/continuity of weight bars and contact sub

Solution: Develop wireless electrical connections and allow the grapple more clearance as well limit flow to over the line side weight bar

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

Advanced Outlook: Design a tool string with the maximum pressure weight requirements

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 Select Fire perforating only was to shoot gun when it is down 8'-10' below fire

Advanced Outlook: Lower hole shot detection

13% of Perforating Service Quality Failures Tracked in a 12 month period

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

Solution: Contingency the tool string using collar the same diameter as the setting sleeve for the setting bar to maintain the same point being at the setting tool

Root Cause: Setting tool failed to set plug correctly due to plug being too long and heavy to handle and the setting tool would try and lift the tool string thus causing setting and operational failures

Advanced Outlook: Reduce the weight of the tool string to its length weight maximum it is operational

8% of Perforating Service Quality Failures Tracked in a 12 month period

Failure: Seal failures on tandem subs creating flooded guns

Solution: Seal failures on tandem subs creating flooded guns

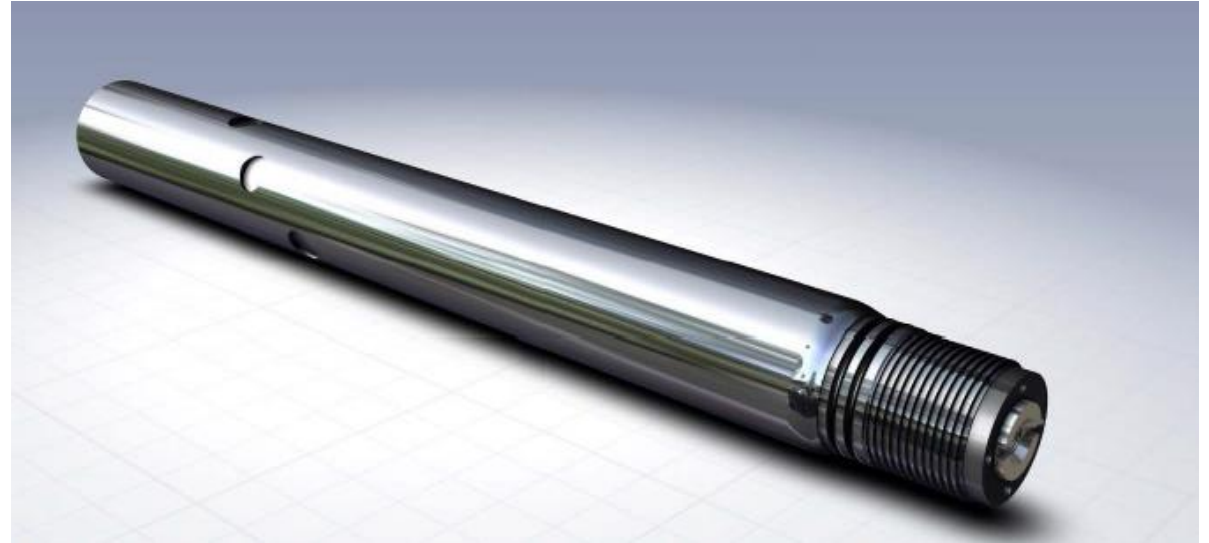
Root Cause: Poor Maintenance and cleaning of threads, bore, and case for the sub associated equipment

Advanced Outlook: Eliminate Tandem Subs



Objectives of the System

- Added level of safety to prevent surface detonations
- Reduce Human Errors during the loading, installing, and arming process
- Ease of use for operational efficiency
- Reduce footprint for extended laterals with an increase in 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 length of tool string - 4-6" per gun connection
- Reduce the number of tandem connections
- Lighter weight of tool string
- Reduced the number of pinch points
- No exposed detonating cord



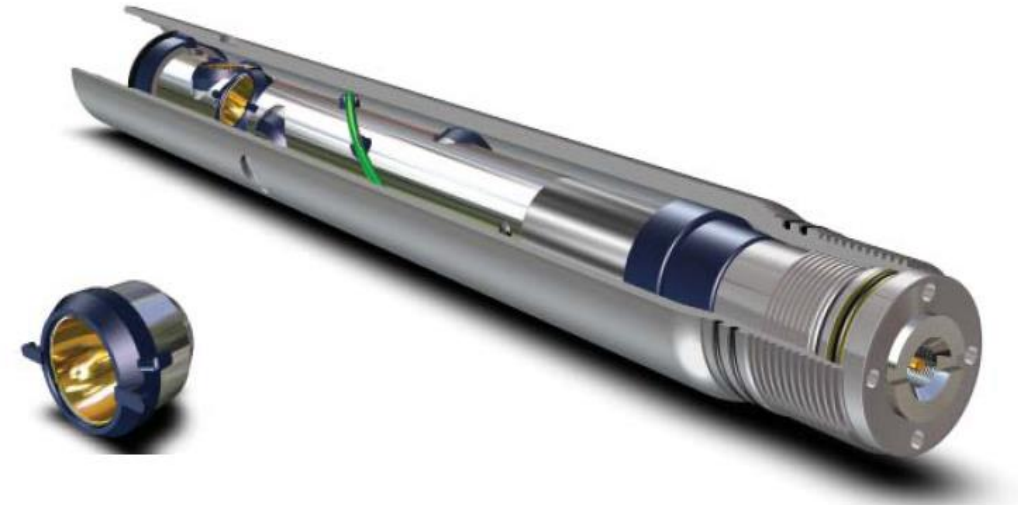
Service Quality Solutions

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



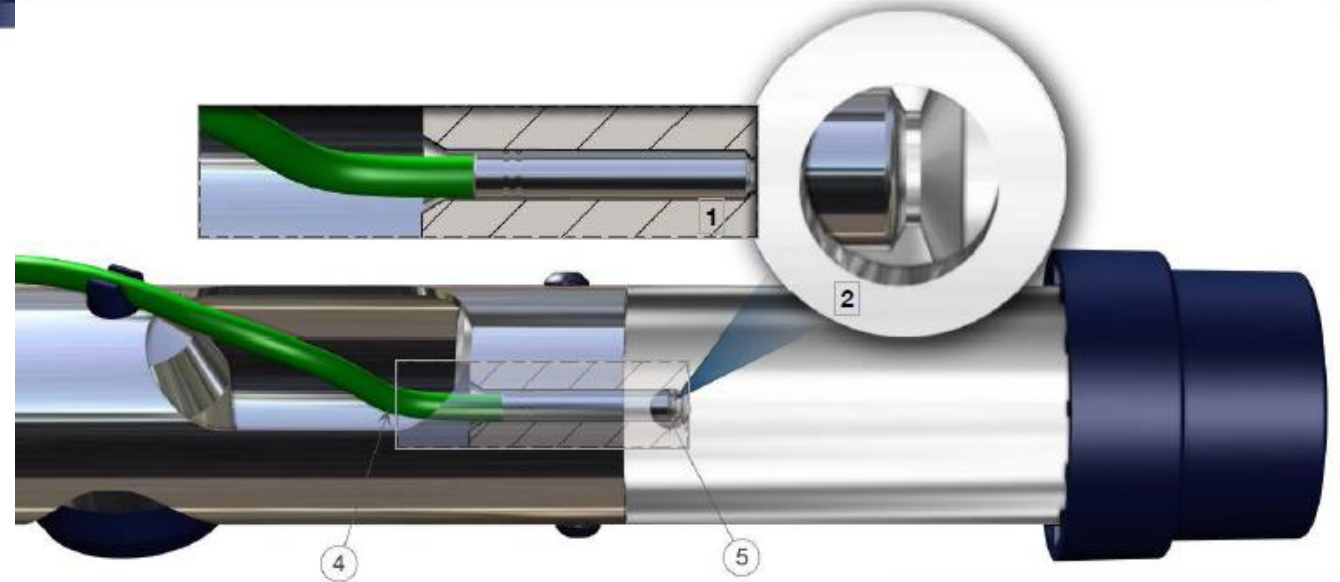
Operational Benefits

- Box by pin expendable hollow carrier (EHC)
 - No tandem subs
- No required auxiliary hardware clean up
- No wires in the assembly
- No pre-wiring required
- Charge tube is the electrical conductor
- Reduced loading time
- No charge clips or pull over tabs on charge tube

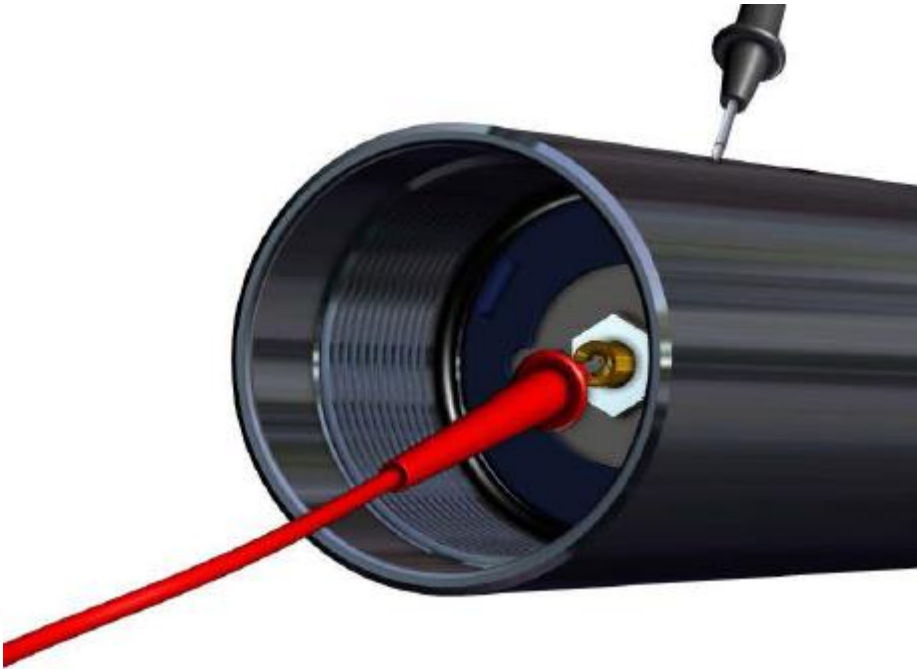


System Overview

- Insulated shape charges and charge tube
- End to end ballistic transfer between detonator and det cord / bi-direction booster



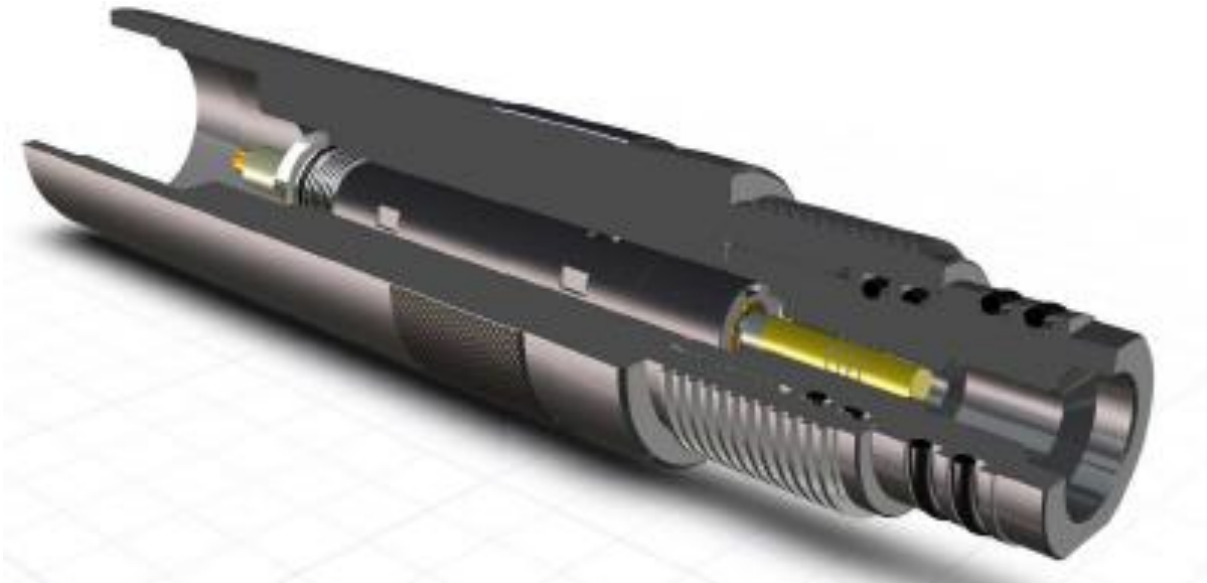
System Overview



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



System Overview



- One piece plug shoot adapter and firing head adapter 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
- EHC can be easily downloaded as the job scope changes



Conclusion

- System mitigates up to ~82% of reported failures and problems in select fire perforating
- Creates RF Safe, API RP 67 compliant, and proven operating gun system
- Advanced technology in the current market situation
- Ease of Operations in the field

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QUESTIONS?
THANK YOU!

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