

*Mitigating the Problems in Select-Fire  
Perforating Operations*

IPS 16-22

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# AGENDA

- 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  
(Not being able to check individual guns down hole and or unable to fire upper gun unless lower gun fired with mechanical actuation)

## Solutions for Consistent Service Quality in Perforating Services

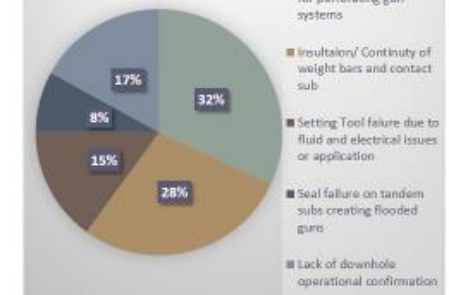
### ABSTRACT

- 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



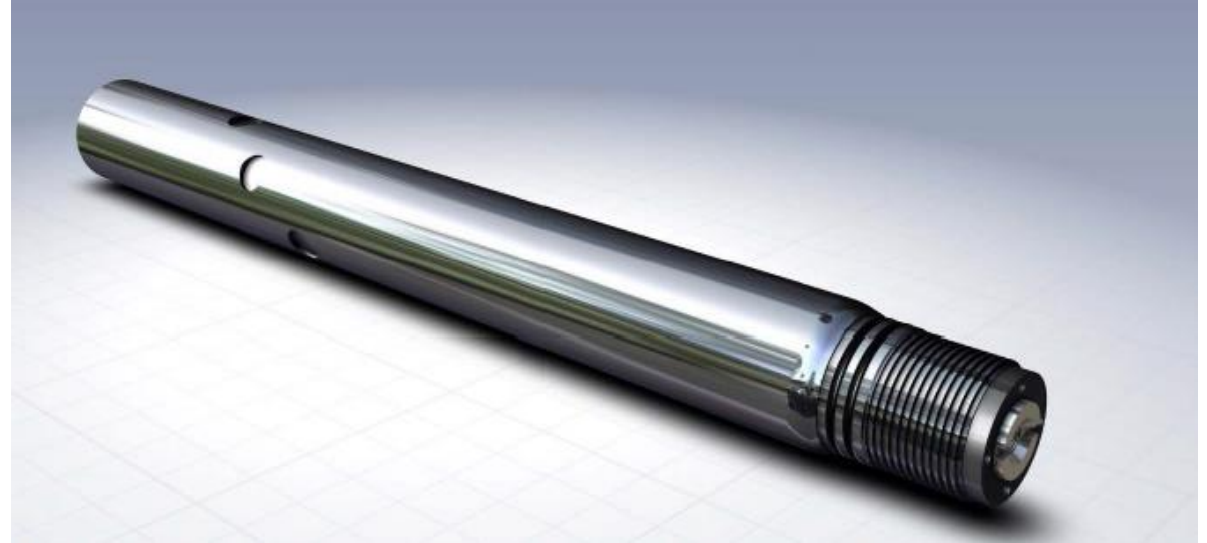
<p>13% of Perforating Service Quality Failures Tracked in a 12 month period</p> <p><b>Failure:</b> Wire insulation failures for perforating gun systems</p> <p><b>Solution:</b> Angle the hole to minimize sharp edges that could nick or damage wires</p> <p><b>Root Cause:</b> wire insulation damaged due to insertion into hole of the sub against sharp edges</p> <p><b>Advanced Outlook:</b> Minimize wiring complexity</p>	<p>28% of Perforating Service Quality Failures Tracked in a 12 month period</p> <p><b>Failure:</b> Insulation/ continuity of weight bars and contact sub</p> <p><b>Solution:</b> Eliminate excessive electrical connections and utilize the existing wire connections to avoid the need for a low line wire weight bar</p> <p><b>Root Cause:</b> Vibration down hole and lack of maintenance caused failures for electrical connections</p> <p><b>Advanced Outlook:</b> Design a tool string with the maximum pressure weight requirement</p>	<p>17% of Perforating Service Quality Failures Tracked in a 12 month period</p> <p><b>Failure:</b> Lack of down hole operational confirmation</p> <p><b>Solution:</b> Use a electronic switch system</p> <p><b>Root Cause:</b> Traditional Select Fire perforating only uses to shoot gun above the base gun service life</p> <p><b>Advanced Outlook:</b> Surface checks are only confirmation until execution of perforating attempt</p> <p><b>Advanced Outlook:</b> Down hole shot detection</p>
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<p>13% of Perforating Service Quality Failures Tracked in a 12 month period</p> <p><b>Failure:</b> Setting tool failure due to fluid and electrical issues or application</p> <p><b>Solution:</b> Centralize the tool string using collar the same diameter as the setting sleeve for the setting tool to minimize the wear zone being at the setting tool</p> <p><b>Root Cause:</b> Setting tool failed to set string correctly due to pipe load force created when tool string was too long and heavy in horizontal well</p> <p><b>Advanced Outlook:</b> The setting tool would be used till the tool string thus creating safety and operational failures</p> <p><b>Advanced Outlook:</b> Reduce the number of the tool string to its length weight minimum in an application</p>	<p>8% of Perforating Service Quality Failures Tracked in a 12 month period</p> <p><b>Failure:</b> Seal failures on tandem subs creating flooded guns</p> <p><b>Solution:</b> Create best practice for wire and maintenance for the subs and associated equipment</p> <p><b>Root Cause:</b> Poor Maintenance and cleaning of threads, bore, and case for the sub associated equipment</p> <p><b>Advanced Outlook:</b> Eliminate Tandem Subs</p>
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# 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

- Initiation cartridge uses intelligent, electronic switch technology
- 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

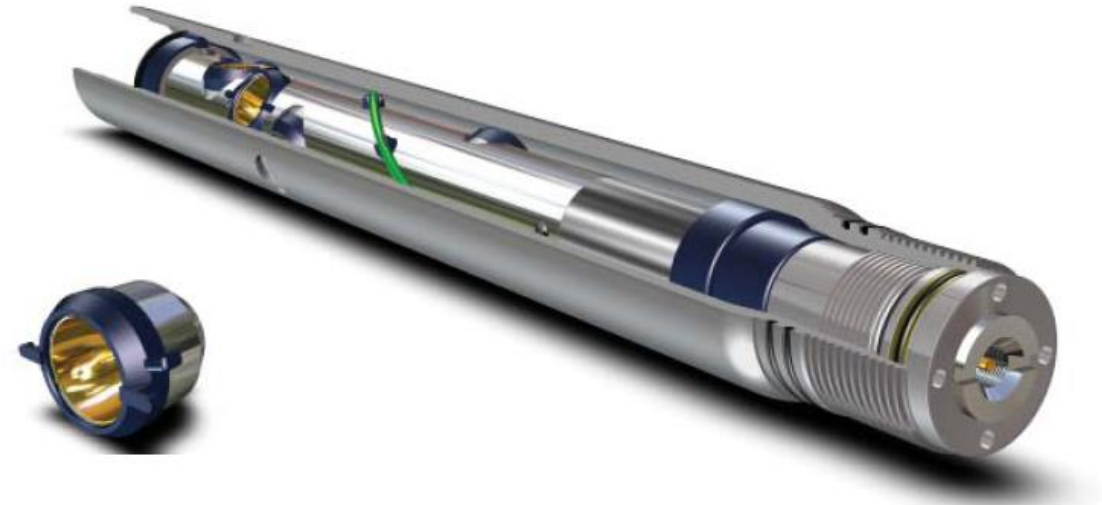
- Failure - Pinched or nicked lead wire
- **Solution - Eliminate wires**
- Failure - Seal Failure
- **Solution - Eliminate ports and tandem subs**
- Failure- Lack of operational confirmation
- **Utilize proven intelligent electronic select-fire system which confirms shot gun**





# Operational Benefits

- Box by pin gun
  - Reduces tool string length
  - Allows for more perf clusters per run
- No subs
  - No auxiliary hardware to clean
  - No ports, less seals
- Charge tube is the conductor
  - No wires or wire connections
- Insulated unique design shaped charge
  - Reduced gun loading time
  - No charge clips or pull over tabs on charge tube

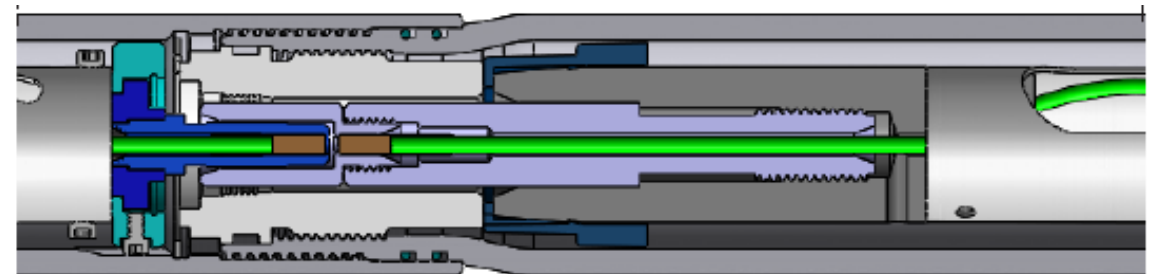




# System Overview

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]		

- Compatible with SDP, GH, BH or Consistent Hole shape charges
- Available for Wireline and TCP applications



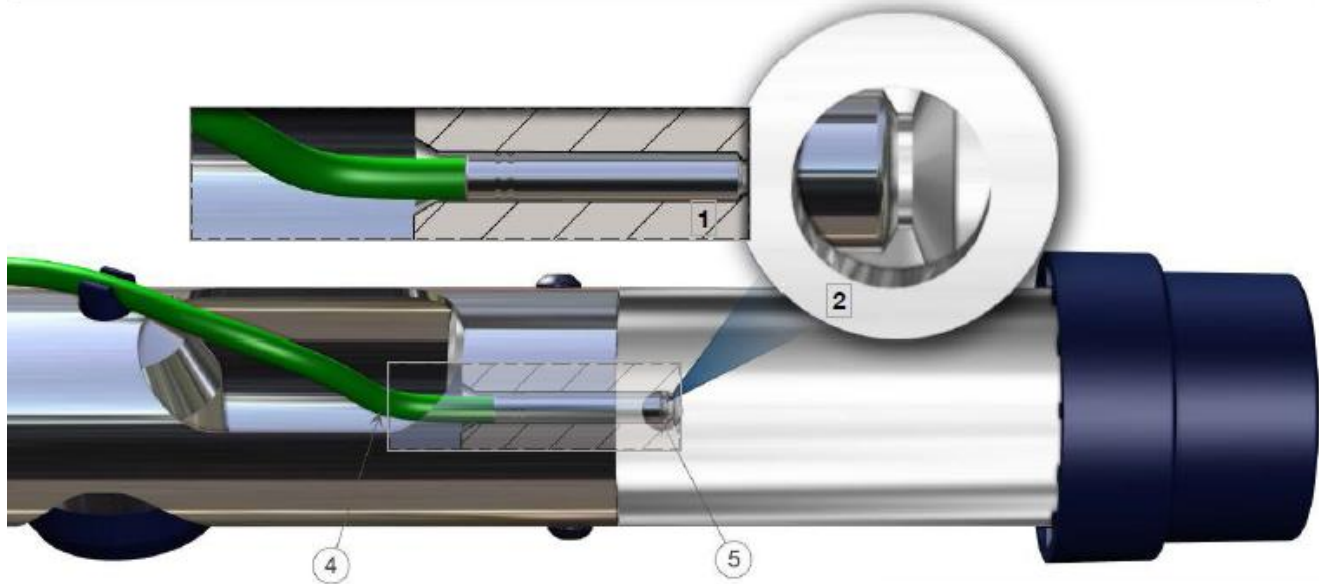
TCP Version

# System Overview

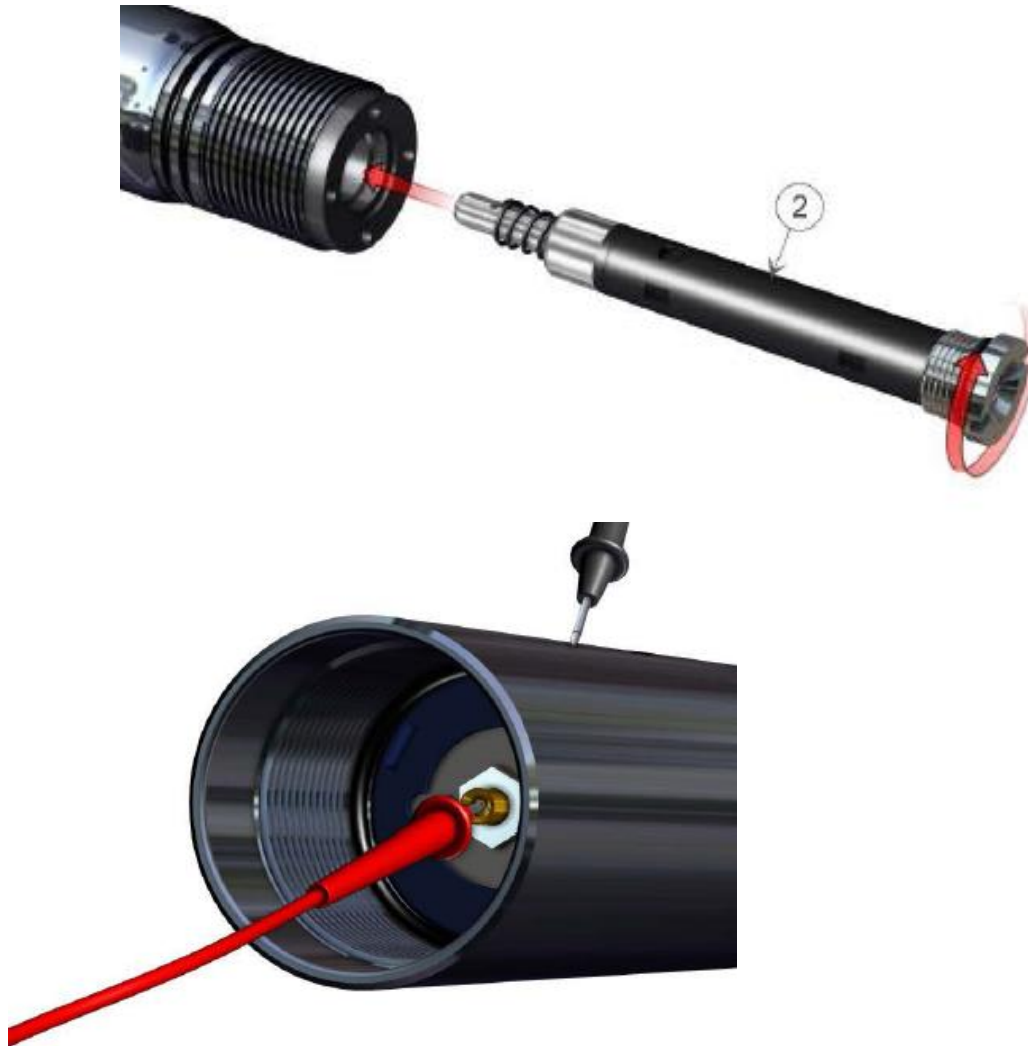


## Gun Loading

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



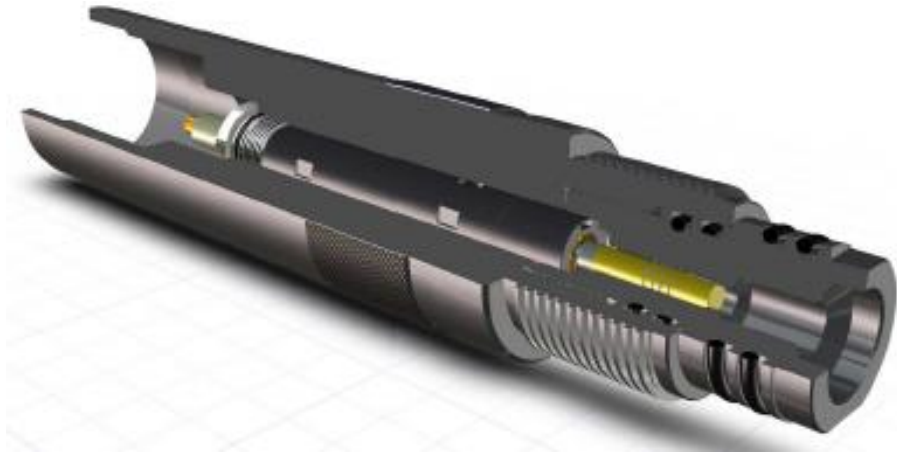
# System Overview



## Gun Arming

- No wires or wire connections
- Pressure bulkhead, detonator, and intelligent electronic switch in one package
- Ability to check electronic switch and continuity through gun

# System Overview



## Hardware

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

# System Overview

## Assembly

- Screw together system with no wire connections
- 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
- Provides a RF Safe, API RP 67 compliant, and reliable perforating gun system for the user
- Advanced technology in the current market situation

# 2016 INTERNATIONAL PERFORATING SYMPOSIUM GALVESTON

QUESTIONS? THANK YOU!

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Operations*