

## New Perforating Gun System Increases Safety and Efficiency

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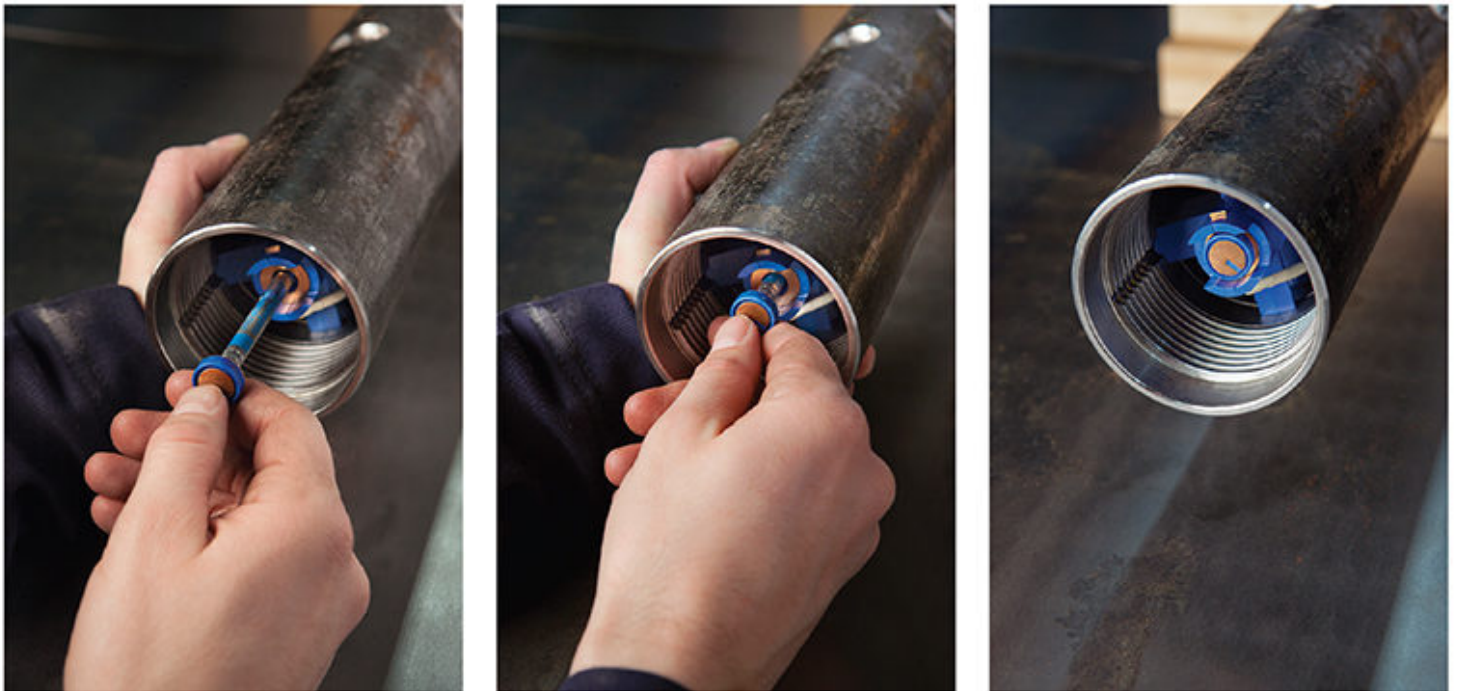


Photo courtesy of DynaEnergetics

Fig. 2—From left, the installation of the detonator in a new perforating gun is a simple plug-and-go insertion process.

Achieving greater efficiency in perforation systems can help lower operating costs, particularly when completing long horizontal wellbores in unconventional plays.

The DynaStage perforating system, developed by DynaEnergetics, incorporates new technology in the addressable firing system and an improved mechanical design that eliminates potential human error. The system can operate more efficiently than traditional systems and, with its additional safety features, allow other wellsite operations to run in parallel with the perforation process.

As a result, the system can achieve improvements in perforation quality and performance reliability, with fewer misruns, while operating efficiently enough to lower total completion costs. The DynaStage system has successfully completed field trials in multiple basins and been commercialized.

The system targets two areas to improve operational efficiency and reduce operating cost.

- *Safety*—the system has a simple, intrinsically safe design that eliminates the risk of inadvertent detonation from stray current or voltage. Surface explosive handling and arming can be conducted in less time and in parallel with other operations. The design eliminates the need to hold the gun system at shallow subsurface depth during simultaneous operations. Both factors reduce wait times at the wellsite.
- *Reliability*—the design of the electronic system and simplification of the mechanical field assembly process

help to reduce the number of misruns, which increases efficiency and lowers the cost of completions.

## **Surface Assembly**

Perforating operations with explosives place the explosive components and workers in close proximity, especially during the arming process. Traditional resistorized detonators can contribute to an increased risk of injury and destruction when connecting the detonator to the gun string and the wireline truck.

Safety procedures have been developed to address the risks in this process, and the American Petroleum Institute (API) provides guidelines for safe handling of explosives through Recommended Practice 67 (API RP 67). One of the established best practices is to suspend all surface operations while working with the resistorized detonators. The arming and connection of a gun string at the surface can take up to an hour, meaning that no other wellsite operations can be completed during this time.

The DynaStage system removes the risks of this process by providing an addressable and radio frequency (RF)-safe system with immunity to high voltage and current levels. The firing system is built on a low-voltage, digital communication platform that uses the DynaEnergetics detonator technology, proven to successfully communicate and initiate on command

during more than 300,000 perforating operations, without a safety incident. This technology enables the verification of all components in the system, including the addressable switch, the RF-safe detonator, and the RF-safe ignitor, during all phases of the operation.

Electrical connections and component functions can be checked during assembly and pumpdown operations with a communication verifier, proving that the gun string is fully functional, with no mechanical or electrical connection issues. Independent, third-party testing verifies the additional protection against voltage and current provided by the DynaStage system (**Table 1**).

TABLE 1—THIRD-PARTY TESTING RESULTS—PROVEN PROTECTION LEVELS	
Static Electricity	2,500 pF 30,000 V
Voltage and Current	50 V and 20 A
Surge Testing	6,600 V and 2,500 A
RF Frequency and Electrical Field Strength	4 GHz, 300 V/m
Fluid Desensitized	2 min in water
Impact Testing	70 J
DC Resistance	Exceeds API RP 67 standard of DC resistance not less than 50 ohm and a no-fire current of not less than 200 mA.

The safety measures built into the system allow surface assembly to happen in parallel with other operations. The gun string can be fully built and tested before connection to the wireline and without stopping other wellsite operations. System features, including the plug-and-go-style detonator and single-use connector subs, minimize the assembly time. The time required for changeover from a used assembly to the connection of a new gun system is less than 10 minutes from rig down to rig up.

## **Parallel Operations**

During assembly of conventional perforating systems, including mechanical component assembly, arming the system, and connecting the gun string to the wireline, there is a risk that resistorized detonators can be initiated with RF energy, stray current, or stray voltage at a wellsite, under certain conditions.

When a traditional gun string with a resistorized detonator is used, all surface operations—including hydraulic fracturing, radio communications, cell phone communications, and other wellsite activities, are suspended at the start of a perforating run until the gun string is at least 200 ft into the well. Operations must be halted again after perforation when the gun is raised to within 200 ft of the surface.

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