Safe Perforating Technologies in Today’s Complex Perforating Environment

Author: Adam Dyess and Josh Howk

2014 China International Perforating Symposium
October 15-17, 2014
Complex Perforating Environment

- E-line pump down and e-coil operations dominate the horizontal shale completions in North America

- Dozens of personnel from different service companies with varying experiences levels on one location
Electro-Explosive Devices (EED)

- EED: An explosive component that initiates an explosive train and is activated by electric current or a current pulse.

- Examples: electric detonator and igniter

- Electric detonators come in various forms with different firing specifications and energy immunity levels
Electro-Explosive Devices (EED)

- The electric detonator is most susceptible to hazards during arming and disarming procedures

- The explosive user in charge must eliminate all hazards prior to arming and disarming procedures
Potential Hazards: Electrical Energy

- **Electro-static Discharge (ESD):** Human body, contact with charged object, electrical storm

- **Stray Voltage:** Any potential difference between wellhead and rig, and wellhead and perforating unit.

- **Radio Frequency Transmitters:** Cell phones, GPS systems, radar, 2-way radios, WIFI, radio towers

- **Power Sources:** Electric welding, cathodic protection systems, top drive system, generators, power lines

- **Direct Voltage:** Voltage applied to the e-line by human error and negligence on surface
Controlling Potential Hazards

- **Explosive Safety Placard**: Procedure for field explosive operations to eliminate/reduce any hazards
Controlling Potential Hazards

• Controlling potential energy hazards is time consuming and costly

• Add possible human error to the already complex perforating environment

• Safe perforating technology should be implemented
Safe Technology: Safe Initiating Systems

Examples:
- Exploding Bridge Wire (EBW) detonator
- Exploding Foil Initiator (EFI) detonator
- Semiconductor Bridge Element (SCB) detonator
Safe Technology: Safe Initiating Systems

Features:
• Designed such that substantially higher input current or power is required to activate the detonator
• Contains no primary high explosive

Benefits:
• Immune to radio frequencies and stray voltages common to the well site
• Less sensitive to impact shock
Safe Technology: Electronic Switch/Detonating Systems

Examples:
• Electronic switch embedded in or assembled to specified detonator

Diagram:
- Electronic switch
- Detonator
- Wireline
- Cable head
- Gun 1, Gun 2, Gun 3, Gun 4, Gun 5
Safe Technology: Electronic Switch/Detonating Systems

Features:
• Designed such that detonator is not electrically armed until specified electrical signal is given from surface.

Benefits:
• Immune to radio frequencies and stray voltages common to the well site
• Can block direct voltage caused by human error/negligence on surface
Safe Technology: Power Safe Devices

Examples:
- Perforating safety subs, voltage protection modules
- Non explosive electronic switch

![Diagram of PSD with gun switches and detonator](image-url)
Safe Technology: Power Safe Devices

Features:
• Designed to isolate downhole explosive devices from any power generating devices above it or on surface
• Electrical connection to explosive device activated by specific sequence of events

Benefits:
• Can block direct voltage caused by human error/negligence on surface
Cost of Safety

• Implementation of safe perforating technology can increase the perforating costs by 10-30% depending on which system(s) used.

• By implementing safe initiating systems and/or electronic switch/detonating systems, there is considerable time savings because radio silence is avoided.
  10 stages * 5 wells = 50 runs * 1 hr RF control time per run = 50 hrs NPT

• Cost of non-productive time for radio silence to the operator may exceed the extra costs associated with running safe perforating technology.
Explosives Safety Education

- Explosives safety training is imperative due to the growing number of inexperienced personnel

- Manufacturers are willing and available to put on RP-67 classes

- Educate operators and service companies on the safe perforating technologies available
Conclusion

• Today’s complex perforating environment poses several hazards that can increase the likelihood of a perforating accident.

• The Explosive User in Charge may not be able to control all hazards and is susceptible to human error.

• Safe perforating technologies exist that protect against known hazards and even human error.

• The time savings associated with implementing safe perforating technology can outweigh the extra costs.

• Due to a growing inexperienced oilfield, explosives safety training and safe perforating technology is imperative for safe perforating operations.
References


• Selective switch diagrams. Courtesy of Bob Ference.

• EBW, EFI and SCB detonator images from Google Images