U.S. Businesses spend

*Over $1 Billion per Week*

on serious, nonfatal workplace injuries (all types)

Beyond business economics, lives change forever:

- Workers
- Families
- Co-workers

Perforating Safety

Fortunately, the Perforating Industry is very proactive:

• Company policies & procedures
• API RP 67, Recommended Practices for Oilfield Safety
• Informal Safety Forums
• Institute of Makers of Explosives (IME)
  – Safety Library Publications (SLP’s)
• International Perforating Symposiums (IPS)
  – Perforating Incident Database
• International Perforating Safety Forums
• And others
Perforating Safety

Discussion Today

• Review of incidents
  – Most common reasons for incidents

• Engineering for safety
  – System approach to designing for safety

• Perforating risks and ideal system needs
  – Increase reliability
  – Reduce risk
2007 Perforating Safety Review*

* Jim Brooks, PRJ Solutions, industry data presented at 2007 Completion Engineering Association (CEA) Perforating Symposium
2007 Perforating Safety Review*

2017 IPS Database Shows IMPROVEMENT BUT TRENDS CONTINUE: Applying Power Pinched Explosive

* Jim Brooks, PRJ Solutions, industry data presented at 2007 Completion Engineering Association (CEA) Perforating Symposium
Engineered Approach to System Safety

Perforating System Approach Includes Initiating Components and Other Gun Components
Engineered Approach to System Safety

Importance of Reliability

Failure at any point in the system

Incident Opportunity

Possible Misrun

Incident Opportunity

Troubleshoot

Incident Opportunity

Additional operation needed to complete job

Incident Opportunity

System Reliability is a Safety Multiplier!
Surface Assembly & Wellsite Rig Up

Risk

Firing due to Surface checks or Applied power

Need

Immune

Fail-safe Above rating

Firing due to RF Environment

Immune

Fail-safe Above rating

Pinched explosives

Eliminate Exposed Explosive

i.e. det. cord

Non-impact Assembly Tools

i.e. no screwdrivers
Surface Assembly & Wellsite Rig Up

Assembly Error
- Error Checking Capability at All Stages
- Fewer Components
- Fewer Connections
- No Wires
- Low Complexity
- Less Training Needed
- Foolproof Assembly
- Fewer Components
- Easy Assembly

Misrun
Post run incident

Human injury During assembly

Human injury During assembly
Running & Downhole Use

Misrun
Electrical Connection Failure
Post run incident

Fewer Connection Points
No exposed Wires

Safe Error checking Before running

Misrun
Seal Failure
Post run incident

Fewer Seals
Fewer Connections
Retrieval and Post Run Activities

- Firing due to Surface checks or Applied power
  - Immune
  - Fail-safe Above rating

- Firing due to RF Environment
  - Immune
  - Fail-safe Above rating
Retrieval and Post Run Activities

Unknown Hazardous Gun Retrieval Condition

Communicate Status While Still Downhole

Human injury During disassembly

Fewer Components

Easy Disassembly
Summary of Perforating System Requirements

Requirements for Initiating Components

- Immune to firing from Surface checks or Applied power Fail-safe above ratings
- Environmental RF Fail-safe above ratings
- Electrical Error Checking Safe by design
- Two way Surface to downhole Communication Indicating firing status
Summary of Perforating System Requirements

Requirements for Other Gun Components

- Protect explosives & Det. Cord From Pinch Points
- Design with Minimum components Minimum connections
- Design to Eliminate temptation to Use assembly tools With potential for impact
- Design with No exposed wires & Minimum electrical Failure points
- Low complexity Needing minimal training
“Ideal” Safe System?

Design in Reliability
✓ Decreased seal failures
✓ Fewer system components
✓ Intelligent error checking
✓ Minimal training required

Design out Risk
✗ Cord pinch points
✗ Impact during charge install & download
✗ Unsafe surface checks, applied power, stray voltage
✗ Insufficient RF Protection
✗ Wiring & connection failure
Improved Economics

Improved System Design

Upfront Investment

Increased Reliability

Long Term Savings

&

Increased Safety
Reliability

Most service companies consider 97%-98% operating efficiency good

Best for Most Companies: 99% stage efficiency (includes human error)

Is this Ideal? Reliability as good as it gets?
New Reliability Standard – 99.95%

Some Modern Systems are Now Reporting
99.95% Stage Efficiency
(includes human error)

Example based on:
4000 stages
24,000 guns & plugs

Closer to Ideal?
Perforating Safety – The “Ideal” System?

- Reduce risk
- Improve safety
- Reduce safety incident costs

_Simpler, More Reliable, Fewer Misruns_

_means_

_Fewer Incidents and Lower Cost_

_“Ideal”_
QUESTIONS?
THANK YOU!

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Perforating Safety – The “Ideal” Perforating System?
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