Perforation Safety, Priority or Nuisance? Or...why isn’t the industry demanding more?

Rustam Aliyev
Director of Operations
DynaEnergetics US
Explosives Incidents

- Association of Energy Service Companies (AESC)
  - Global database – voluntary input
  - Not accurate enough to give a true picture
- Shell initiated Perforating Safety Forum May 2013
  - Initiative to establish new database
- International Perforating Forum (IPF)
  - Established a voluntary database in 2014
- Only Estimates exist
- Total number unknown
- Yet... Incidents do happen and make the news
Accidents in the US Oilfield

• There is no global data base available

• In the US oilfield there are about 12 serious accidents per year.

• In a 20 year study of 3 major service providers, there were 94 incidents, 49 injuries and 28 deaths.

• All preventable
Causes of oilfield accidents with explosives

<table>
<thead>
<tr>
<th></th>
<th>Incidents</th>
<th>Injuries</th>
<th>Fatality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power on panel</td>
<td>15</td>
<td>19</td>
<td>15</td>
</tr>
<tr>
<td>Stray power</td>
<td>6</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Pinched explosives</td>
<td>13</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Pressure</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Unknown problems</td>
<td>9</td>
<td>7</td>
<td>2</td>
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</tbody>
</table>
Perforating Safety

• Definition of Safety: “Protected from or not exposed to danger or risk, not likely to be harmed“

• The US Standard for handling explosives is API RP67
  • Covers both Wireline and TCP (Incl. CT, Tractors, etc.)
  • “Only” a recommended practise

• So…Why isn’t the industry demanding more???
Existing Technology

- Most companies have products or patents that enhance safety
  - Many are not commercial
  - Many are not used because they incur additional cost

- We often hear that the service company argues that the operator does not ask for additional safety tools and the operator argues that the service company does not offer and recommend additional safety devices
Existing Technology

• Tools range from basic devices to advanced systems
  • Interrupts
    • Ballistic
    • Electric
  • Safety electronics
    • Safe detonators (electronic, EFI, EBW)
    • Voltage protection switches
    • Selective perforating switches
  • Methods/ procedures
    • Run without firing head
Ballistic Interrupts

- Basic (gravity)
- Advanced (pressure)
- Expert (down hole manipulation)
Electric Interrupt

- Independent from Detonator Type
- Prevent unintentional Detonation
- Detonator permanently shunted
  - Min 20bar / 290psi to activate
  - Min 10bar / 145psi to reset
- Works with all types of detonators (with leg wires)
- Needs fluid (pressure) inside wellbore
Safety Electronics

- Low Voltage (digital electronics)
  - RF-safe, Stray current/ voltage safe

- High Voltage Detonators (EFI, EBW)
  - RF-safe, Stray current/ voltage safe

- Voltage protection devices

- Selective perforating switches

- Combination of the above
Digital Coded Electronic Detonators

• Safety tested
  • Against max. static electricity: 2,500 PF 30 KV
  • Against max. high frequency: 4 GHz, 300 V/m
  • Burst tested up to maximum of: 4.4kV
  • Safety tested at: 50 V and 20 A.
  • Surge tested up to maximum of: 6.6kV and 2500A

• These Digital Coded Electronic Detonators are stray current, induced current and stray voltage safe.

• Not just RF-safe
Methods / Procedures

- Deploying guns without firing head or means of initiation
  - Run firing head separately
  - Sealed ballistic transfer

- Necessity for multiple events or conditions
  - Min temperature
  - Min pressure
Hydro Mechanical Firing Head

- Hybrid Mechanical and Hydraulic Firing Head
- Safety Firing Head
- Multiple events required for initiation
- Utilize Drop Bar and needs hydrostatic pressure to detonate guns.
The technology exists, but where is the demand?

This is not scare mongering, but a real opportunity to save lives, property and reputation.
• This company has a number of patents…
• …all of which would have avoided this incident!
• Totally preventable!

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Summary

- Explosives safety is everyone's responsibility
- Understand the risk
- Follow best possible procedure, use best possible techniques and technology
- If failure is an option it should always fail safe
- Use multiple devices / techniques to enhance safety
- Make a difference…
Don’t let this be you ...
Thank you!

Questions?

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