REDEFINING PUMP DOWN PERFORATING

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REDEFINING PUMP DOWN PERFORATING

- Industry Challenges
- Technical Advances
  - Gun Systems
  - Shaped Charges
  - Wireline Cables
  - Pressure Control
- Case Study
- Conclusions
Method to convey plug and perforating guns in horizontal or high-angle wells by pumping fluid into the wellbore to push the assembly into the lateral section of the well.
INDUSTRY CHALLENGES

NEW TECHNOLOGIES REQUIRED TO ADDRESS WORKFORCE SAFETY AND MAINTAIN COMPETITIVENESS

- Industry cycles
- Increased guns per stage
- Retention of workforce
- Regulatory impact
US LAND HORIZONTAL RIG, WELL AND STAGE COUNT

Horizontal Rigs vs. Horizontal Wells

Horizontal Wells vs. Horizontal Stages
CONVENTIONAL GUN SYSTEMS

- Labor intensive in both gun shop and field
- Service quality dependent on technique and experience
- Multiple opportunities for failure
PLUG AND PLAY GUN SYSTEMS

- Designed to eliminate the human factor when loading and arming guns
- Up to 40 guns can be shot using any drop-in charge
- Plug-in design eliminates crimping and scotchlocks
- Simplified seal and adapter design and integrated Plug Shoot Adapter
- Ballistic interrupt built into addressable switch board in place until ready to fire
- Guns loaded and armed at the gun shop, DOT approved for transport, zero wiring/arming at the wellsite
- Shorter, lighter guns reduce HSE impact on field crews
UNIFORM ENTRANCE HOLE CHARGES

- Introduced in 2012
- Entrance hole variation minimized based on standoff
- Allow for even distribution of pumping pressures
- Improved injection rates
- Reduced stimulation pressures/optimized proppant placement
CONVENTIONAL WIRELINE CABLES

- GIPS (steel) wireline cables introduced in 1950s
- Alloy cables introduced in 1960s
- High-strength cables developed in 1990s
- Stranded armor cable technology limits reached

CONVENTIONAL WIRELINE CABLES CHALLENGES

- Large Footprint
- Riser/Tool Length
- Complex Rig-Up
- Grease Usage
- Armor Stranding
- Tripping Speed
- Resource Heavy
SLICK GREASELESS WIRELINE CABLES

- Polymer technology introduced in 2005 with multiple iterations over the years
- Operates to surface conditions up to 15,000 psi
- Simplifies operation and reduces risk and environmental impact

OVERCOMING CONVENTIONAL WIRELINE CABLES CHALLENGES

- Reduced Footprint
- Shorter PCE Assembly
- Simplified Rig-Up/Operation
- No Grease, Dual Pack Off replaces Grease Head
- Torque Balanced, Polymer Locked, No Stranding, No Break-In
- Faster Tripping Speed, 40% Lower Friction
- Less Resources Required
CONVENTIONAL PRESSURE CONTROL RIG-UP

- Requires manual intervention
- Places personnel under suspended loads in awkward positions
- Unable to rig-up/rig-down perforating guns during adjacent frac
- Significant cause of safety incidents during operation
PRESSURE CONTROL RIG-UP

CONVENTIONAL PRESSURE CONTROL RIG-UP

- Requires manual intervention
- Places personnel under suspended loads in awkward positions
- Unable to rig-up/rig-down perforating guns during adjacent frac
- **Significant cause of safety incidents during operation**

- **19%** > 5 Years of Seniority
- **16%** 3-5 Years of Seniority
- **65%** ≤ 2 Years of Seniority

- **19%** TORSO
- **47%** ARMS, HANDS & FINGERS
- **21%** LEGS & FEET
- **11%** HEADS, FACES

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Schlumberger-Private
PRESSURE CONTROL RIG-UP

REMTELY ACTUATED HYDRAULIC PCE CONNECTIONS

- Developed in 2015 by FHE
- Remotely connects pressure control equipment to the wellhead
- Remote monitoring system with lockout protects against inadvertent unlocking
- Eliminates need for personnel intervention on frac tree
- Eliminates dead-time during adjacent frac operations
- New level of safety for personnel while maximizing pad efficiency

COURTESY OF FHE
WESTERN CANADA

- Using plug and play guns, uniform entrance hole charges, slick greaseless cables, and remotely actuated hydraulic PCE connections
- One unit completing 264 stages with 1,096 guns in 25 days
- Average of 10.5 stages a day with up to 19 stages completed in a single day
- Reduced crew size enables more total crew deployments
- Reduced overall HSE exposure to field personnel

Time Comparison of New vs. Conventional Technology

- **Gun Prep Time**
- **Rig onto Well**
- **RIH, Shoot, POOH**
- **Rig off Well**
CONCLUSIONS

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- New technologies are available that help improve workforce safety while improving operational efficiency

- Operators and service companies must continue to challenge the status quo to maintain competitiveness

- Continued R&D efforts with input from field operations are needed to stay ahead of the curve
Q&A

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PLUG AND PLAY GUN SYSTEMS

Highest level of safety controls

- Integrated ballistic interrupt built into addressable switch board in place until ready to fire
- IP addressable guns

Built for efficiency

- Reduced assembly length to maximize gun deployment
- Ability to shoot up to 40 selective guns in a single run

Engineered to eliminate failures

- Plug-in design
- Simplified seal and adapter design
- Guns loaded and ARMED in the Gun Shop
- ZERO wiring or detonator arming at the wellsite

Charge flexibility

- Compatible with a wide variety of GH and DP charges
- SLB or any 3rd party drop in charge