RFID – Interventionless Completion Tools

Bruce Robertson | Weatherford
Presentation Agenda

- Introduction to RFID.
- Principles of Tool Activation.
- RFID Portfolio and Developments.
- Challenges Addressed.
- CASE STUDY – Upper Completion.
- CASE STUDY – Lower Completion.
- RFID Tools Track Record.
- Summary and Questions.
Introduction to RFID

- **New Technology?**
  - Used in WWII – ca. 1940’s.
- **Radio Frequency is Common.**
- **Secure, Reliable & Proven Technology.**
  - * Supermarket / Shop Security
  - * Building Entry, Hotels, Work-Place
  - * Tracking of Goods / Animals
  - * Passports
  - * Even golf-balls ([www.radargolf.com](http://www.radargolf.com))
Principles of Tool Activation

Time (T) can be 3, 5, 7 minute holds. Amplitude of pressure not important. Rate of change > 256 psi/min.

Acti Frac Signal Real-Time Clock
Principles of Tool Activation

**“Fuse” Based Technology**

Built On Fused Valve Block And Atmospheric Module Technologies.
This Platform Of Products Are Single Shot Devices That Use Well Hydrostatic Pressures To Function The Device Or Series Of Devices.

**Common/Standard Enablers**

- RFID Electronics Technology
- Pressure Telemetry Technology
- Antenna Technology
- Lithium Battery Technology
- i-Rabbit® Communication System Technology
- Graphic User Interface Software Technology
- Business Operating Facilities
- Operation & Service Facilities

**“Pump” Based Technology**

Built On Micro-Pump And Spool Valve Technologies.
This Platform Of Products Are Multi Shot Devices That Use A Positive Displacement Pump And A Multi-Position Spool Valve To Function A Device Or Series Of Devices.
RFID Portfolio and Development

**“Fuse” Based Technology**
- Port Collar Sleeve
- RFID HCS
- ICD Sleeve
- AutoStim™ / RIV
- ARID™ Sleeve
- Circ. Toe Sleeve

**Common/Standard Enablers**
- AutoStim™ / RIV
- ARID™ Sleeve
- Circ. Toe Sleeve

**“Pump” Based Technology**
- OptiBarrier™
- KeyStone™ HPU
- RFID OptiSleeve™
- Jetstream™ and RipTide™
- I-Stim™ Sleeve
Challenges Addressed

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RFID: A Platform for Success

Deepwater Challenges

- Well Construction
- Effective Completions & Simulation
- Reservoir Efficiency & Characterization
- Production Sustainability
- Health, Safety, Environment, Quality
- Relationships & Terms
- Optimized Facilities

- Well Placement
- Minimal Interventions
- Compensating For Poor Seismic Quality
- Well Clean up & Testing
- Well Assurance and Monitoring
- Compliance
- Capacity and Operability

- Drilling Hazards
- Effective Sand Control
- Delineating Complex Systems
- Flow Assurance
- Skilled & Experienced Workforce
- Good Collaboration With Partners
- Logistics

- Drilling Performance
- Sustained Zonal Isolation
- Predicting Reservoir Quality
- Reservoir Performance Prediction
- No Safety or Environmental Incidents
- Achieve Production Commitments
- Good Communication & Collaboration With Government

- Salt
- Intelligent Wells & Permanent Monitoring
- Predicting Reservoir Architecture
- Pressure Maintenance
- Tool Reliability
- Good Communication & Collaboration With Government
- Facility Reliability

- Geomechanics
- Multi-layered Reservoir
- Analysis & Optimization
- Local content

COST REDUCTION

REAL TIME INTEGRATED OPERATIONS
**Deepwater Challenges**

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<td>Optimized Facilities</td>
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**SERVICE QUALITY – REDUCED COST**
Case Study – RFID - Keystone

SYSTEM SUMMARY:

- Fully Remote Upper Completion System.
- RFID Operated via Keystone HPU.
- Currently Suitable for 7” x 3 ½” and 9 5/8” x 5 ½” Configurations

OPERATING LOGIC:

- Run upper completion to depth.
- Flow RFID Tag – Close OptiValve.
- Pressure Test Tubing.
- Apply Pressure Pulse to open the port in the HCS.
- Set Packer.
- Apply Pressure pulses to open OptiROSS Sliding Sleeve.
- Circulate out annulus.
- Flow RFID tag – Close OptiROSS sliding Sleeve.
- Apply Pressure Pulse to re-open OptiValve.
Case Study – RFID - Keystone

**Challenge:**
- Deliver a Remotely Operated Upper Completion.
- Remove the need for Intervention, Wash-Pipe, Control Lines.
- Isolate the Reservoir.
- Set the Production Packer in 7in. Casing.
- Open Isolation Valve and Turn Well Over to Production.

**Solution:**
- RFID based Keystone System deployed to include:
  - RFID Hydraulic Power Unit, Circulation Valve, Production Packer, and a Fall Through Flapper Valve.

**Result:**
- Simplified Upper Completion Deployment
- Tubing successfully tested without setting packer.
- One Day Rig Time Saved with no intervention crews.
Case Study – Lower Completion

**SYSTEM SUMMARY:**
- Remotely Operated stimulation sleeves.
- Deploy Lower Completion without wash-pipe or intervention.
- No Limitation on number of Sleeves
- Control over clean-up sequence to suit reservoir conditions.

**OPERATING LOGIC:**
- Run Lower Completion Liner to TD.
- Pump Breaker with RFID tag – Close RIV.
- Hydraulically set Liner Hanger / Packer and TerraForm Packers.
- Run Upper Completion.
- Pressure Pulse open I-Stim Sleeve to Stimulate Zone # 1.
- Drop RFID Tag during Flush to open Zone # 2 and close Zone # 1
- Stimulate Zone # 2 and repeat for remaining zones.
- Apply pulse to sequentially open all sleeves from toe to heel.
Case Study – Lower Completion

CHALLENGE:
- Long Reach Horizontal WAG injection well in Norway
- 6,000m with +1,000m horizontal lateral @ 150°C
- Injection Profile evenly distributed across 6 discreet intervals.
- Disrupt filter cake, establish injectivity independently per zone.
- No wash-pipe, intervention or control lines

SOLUTION:
- Open-Hole Lower Completion delivered to partition 6 intervals.
- Pressure pulse open 6 x frac sleeves, stimulate / tags to close
- Pressure pulse open 12 x ICD’s at 1 hr. intervals.

RESULT:
- Required Gas and Water Injection Rates Confirmed
- Client Comment “A Great Well”
RFID Tools Track Record

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<tr>
<th>RFID Tools</th>
<th>First RFID Tool RIH in May 2009</th>
<th>&gt;200 Tools / Systems Run Since Then</th>
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<td>Port Collar Sleeve</td>
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<td>JetStream™ / RipTide™</td>
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Which technologies do the industry require to meet the commercial or technical challenges you face?
Thank You!

Bruce Robertson | Weatherford
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ConocoPhillips Ekofisk – Case Study

- Dual Completion – 7-5/8” open hole completion & 4-1/2” IWS
- Successfully deployed 7-5/8” completion Q1 2012, included:
  - Multiple ROKANKORs
  - Toe Ankors
  - Intermediates
  - Expansion Joints
  - Acid Circulation Valves
  - i-detect diagnostics
BP Ula – Case Study

Water and Gas Alternating injector

- Establish injectivity in 6 zones independently
- Maintain injection flow profile for life of well
- No wash pipes or intervention
- From paper to well within 1 year