
RFID
JOURNAL
LIVE!
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PHOENIX CONVENTION CENTER | PHOENIX, AZ

Weatherford Reduces Carbon Footprint in the Oil Industry with RFID

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Global Product Line Manager RFID Completions

Agenda

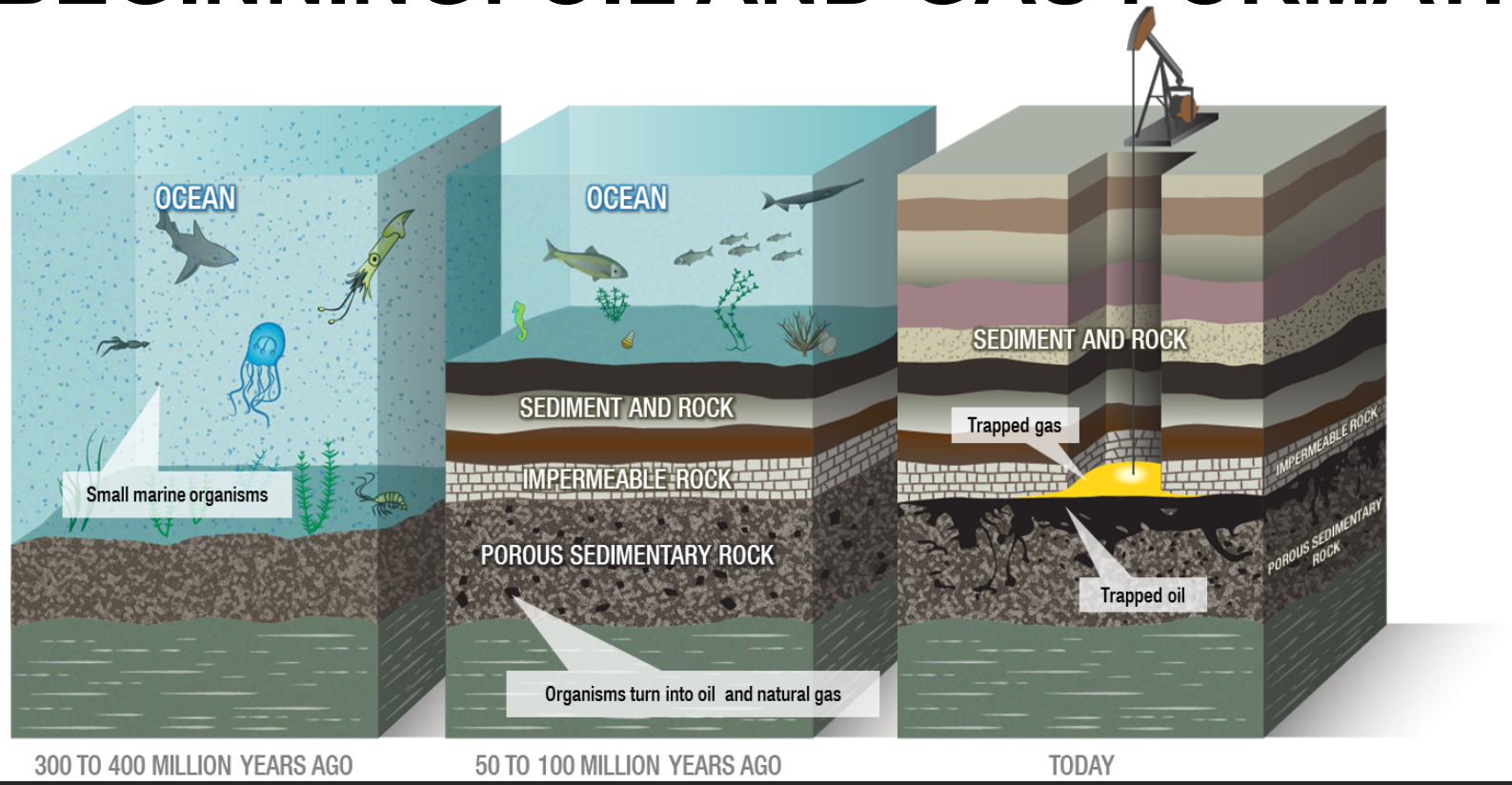
1. What is TR1P
2. Oilfield Basics
3. TR1P RFID Components
4. TR1P Operational Overview
5. TR1P Case Study

WHAT IS TR1P?

- System designed to run upper and lower completion in single trip
  - From toe to tubing hanger
- Based on field-proven RFID Technology
  - 100's of field runs with RFID tools
- Evolution of multiple Advance Deployment Systems into a single integrated one trip completion

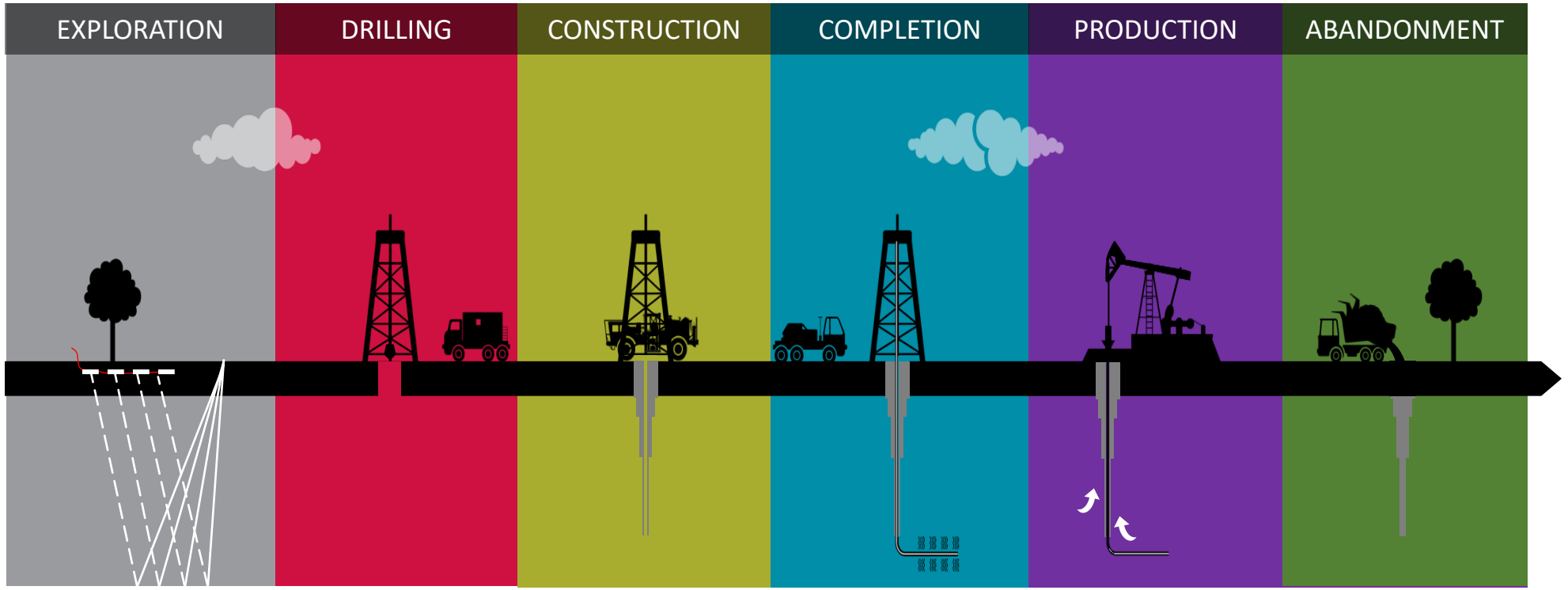
TR1P Animation placeholder

THE BEGINNING: OIL AND GAS FORMATION



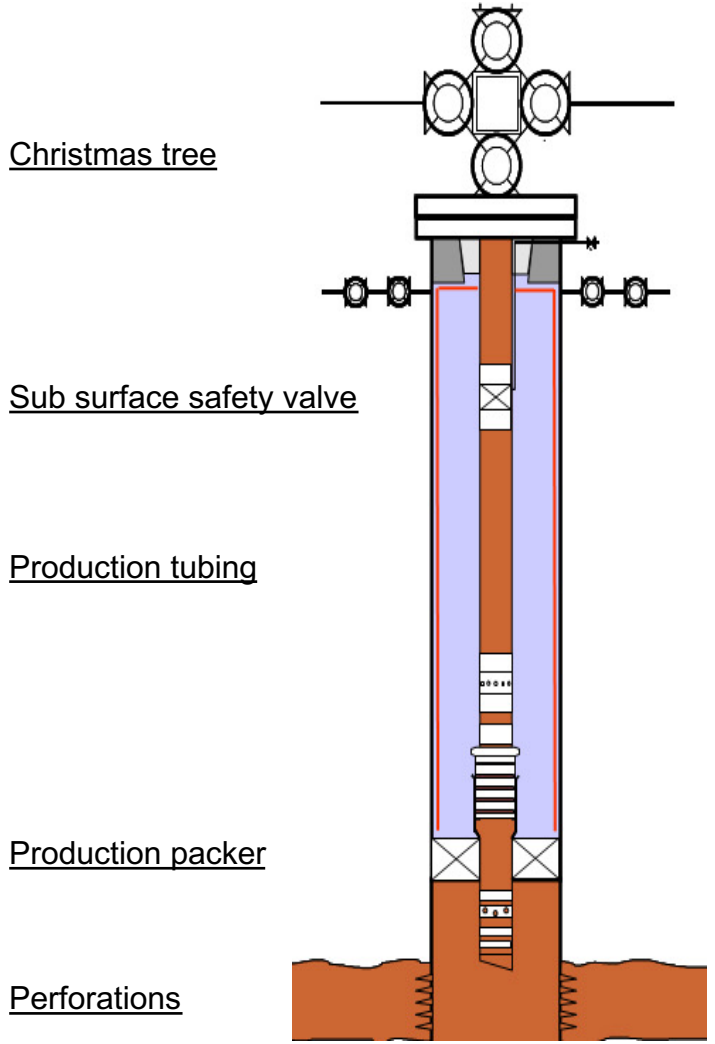
The mixture of oil and natural gas slowly moves through porous layers of rock until it is pushed up against a layer of rock that it cannot move through. This causes it to build up. As it does, it forms a reservoir that is big enough to produce oil.

OIL AND GAS EXTRICATION PROCESS



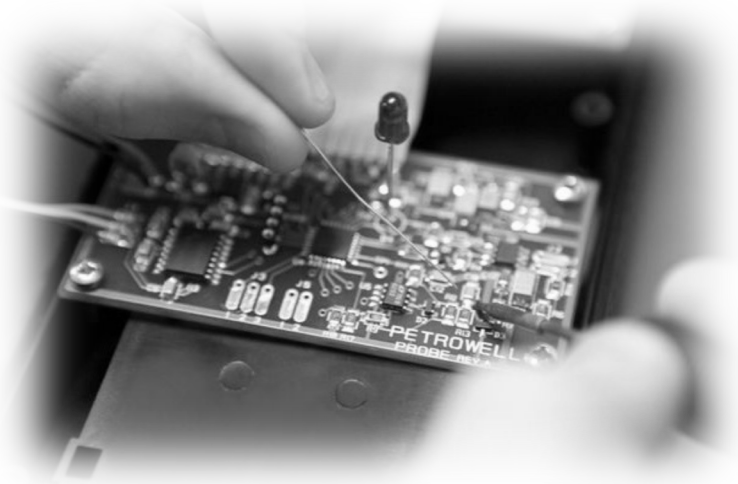
DEFINITION OF A COMPLETION

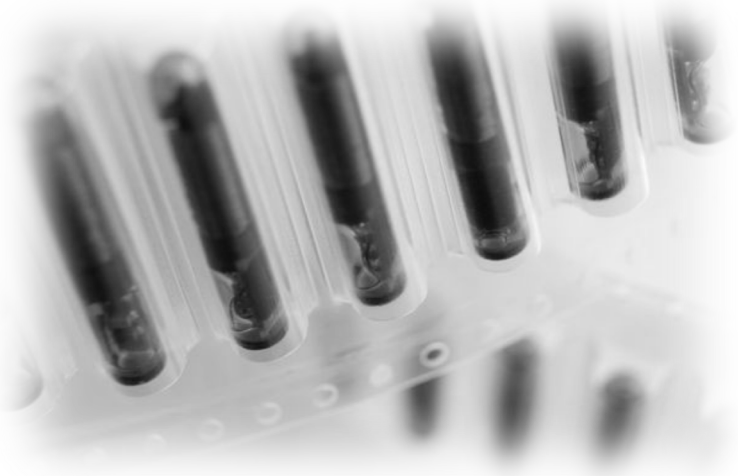
- Hydraulic conduit between the reservoir and the surface production system
- Manage the flow of fluids in the most efficient manner possible
- Limits the energy lost in the process of lifting the fluid to surface
- Offer a means of isolating the production system from the reservoir when needed or in emergency shut down scenarios
- Provide a means of accessing the reservoir for remedial work



WHAT IS RFID? – IN A DOWNHOLE CONTEXT

- RFID tags used to communicate to tools downhole
- Each downhole tool contains a tag reader
- Tags are coded at surface
- Pumped from the surface into the well
- Downhole tools carry out actions based on the tag programming
- No limit to number of tools run in one well



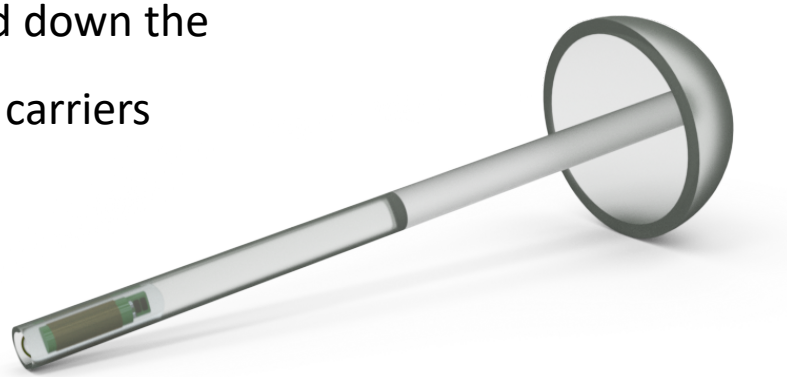


ENGINEERING CHALLENGES

Condition	Value
Temperature	4-150°C
Pressure	Up to 30,000 psi Electronics housed at ATM pressure
Electrical	RFID system selection Battery life 1 year +
Mechanical	Limited envelope Conveyance of tags Very Harsh environment Housed in tool wall section

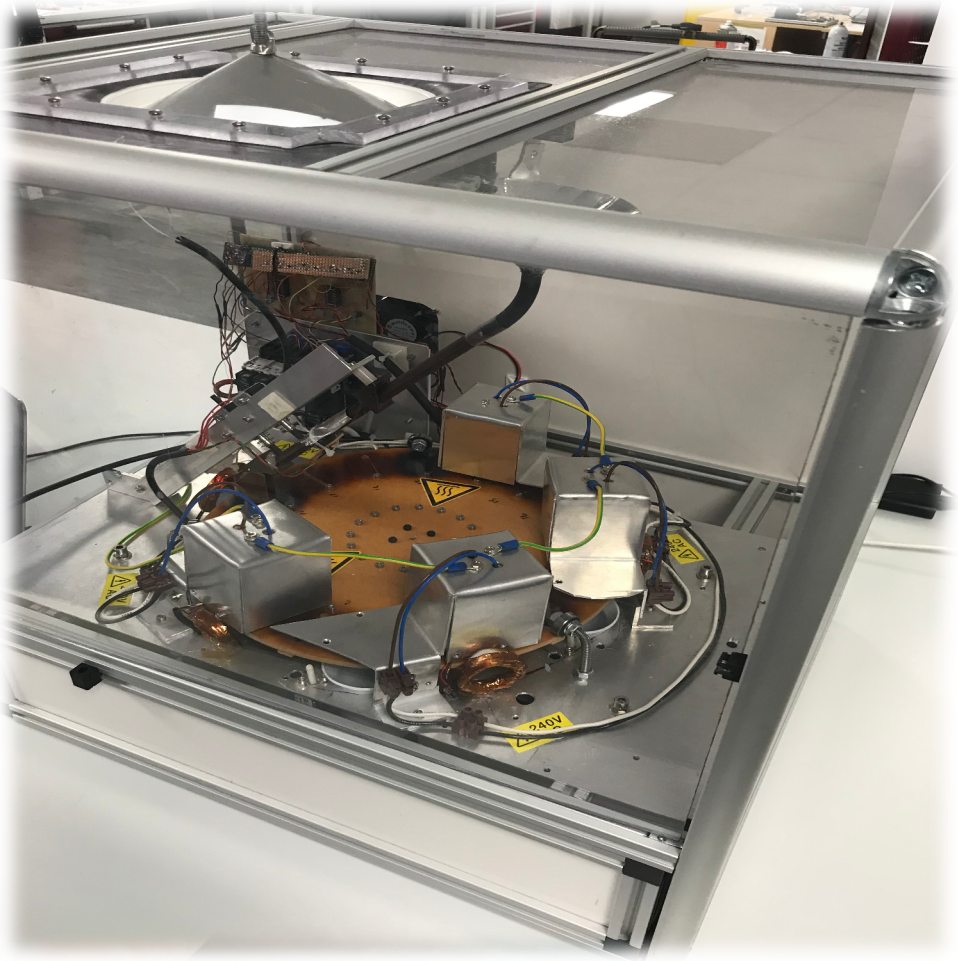
ENGINEERING CHALLENGES - RFID SYSTEM

- RFID system
  - LF systems selected for use in fluid
  - FM and AM systems
  - Read/Write system
- AM system trailed for Control line applications (through metal)
- FM system became the predominate system. Tags circulated down the completion in silicone carriers



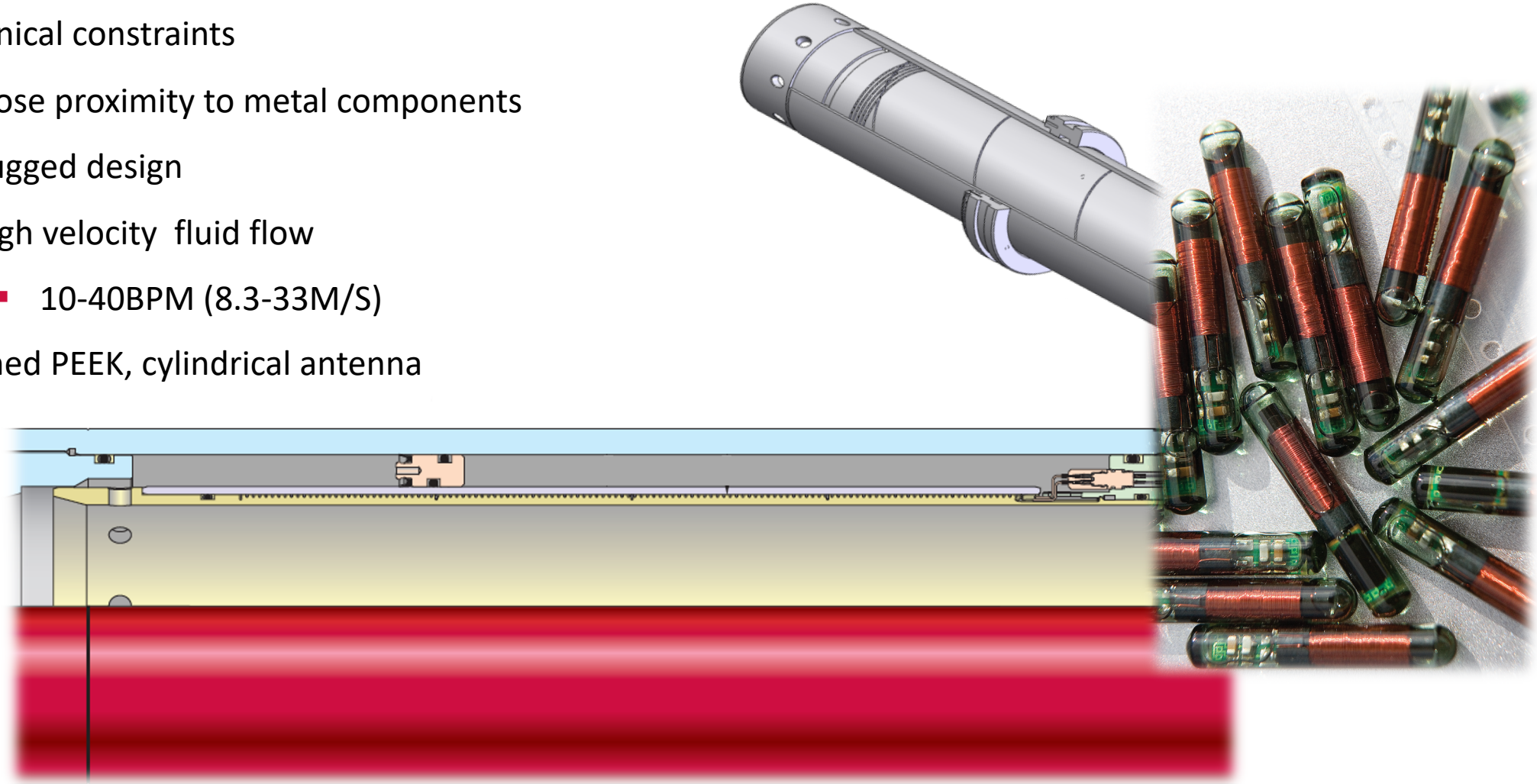
ENGINEERING CHALLENGES - RFID SYSTEM

- Off the shelf 23mm glass encapsulated tags
- Temperature performance
  - No commercial system available
  - Typical performance ~90°C
- Established Temp screening procedure
- Only 5% of tags function at 150°C
- Tags repackaged for high pressure operations
  - 25’000psi +



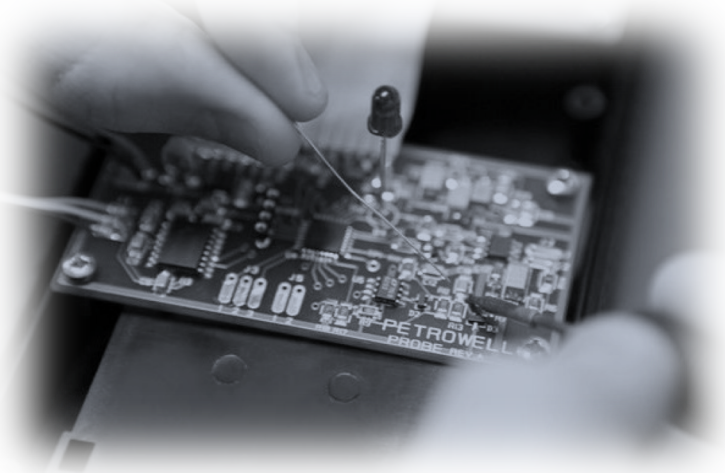
ENGINEERING CHALLENGES – ANTENNA DESIGN

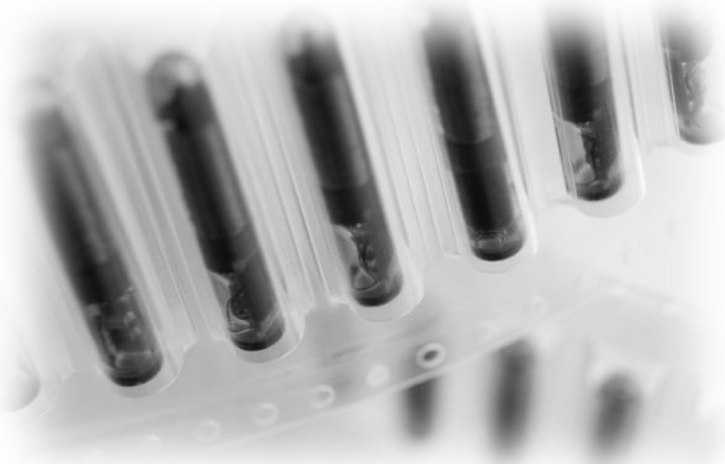
- Mechanical constraints
  - Close proximity to metal components
  - Rugged design
  - High velocity fluid flow
    - 10-40BPM (8.3-33M/S)
- Machined PEEK, cylindrical antenna



BENEFITS OF RFID

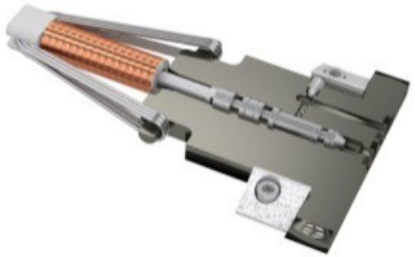
- Enables interventionless completion installation
- Eliminates need for wash pipe, wireline and coiled-tubing
- Reduces OPEX
  - Rig Time, POB, Operational Risk, HSE
- Delivers greater Operational Flexibility
  - Staged clean ups, lower completion isolation, delayed commissioning
- Reduced Rig time and logistics = $C0_2$ Footprint

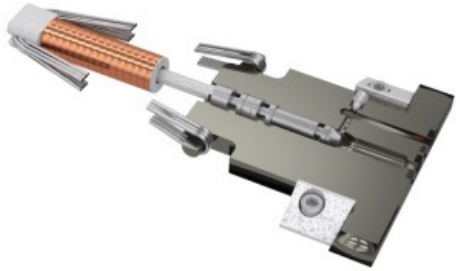




TOOL ACTIVATION METHODS – SINGLE SHOT TOOLS

- Valve held in position by Kevlar cord
- Dual heater elements to burn cord
- Piston driven by spring washers and slight over balance
- Reliable simple and fast
- Max 2 per tool



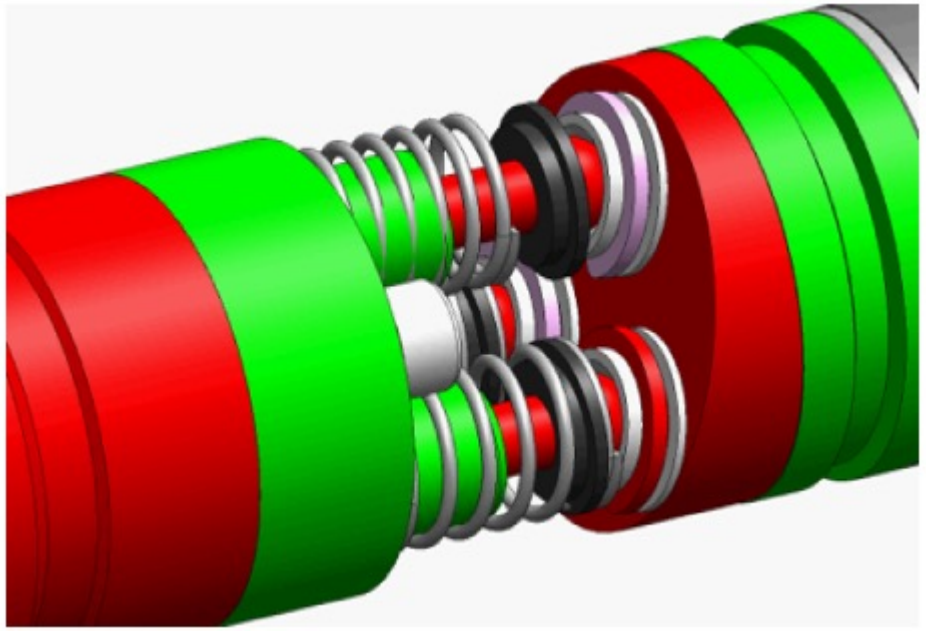


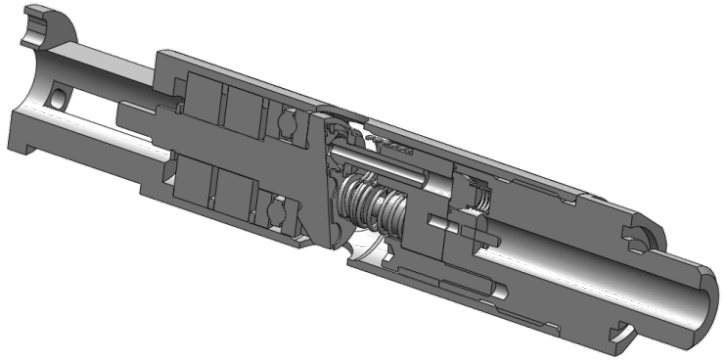
TOOL ACTIVATION METHODS – SINGLE SHOT TOOLS

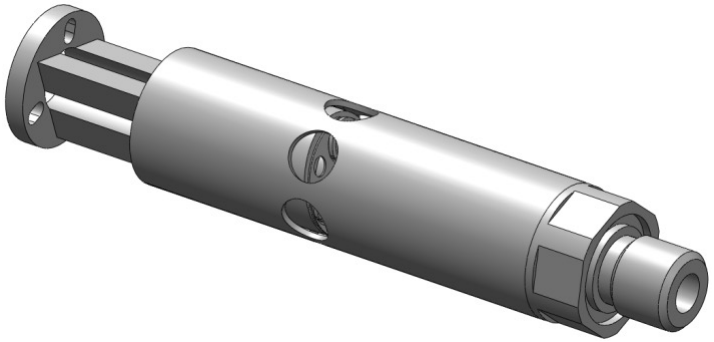
Fuse Animation placeholder

TOOL ACTIVATION METHODS – MULTI CYCLE TOOLS

- Micro pump produces pressure above hydrostatic to activate tools
- Micro pump developed in house
- 7000 psi output (regulated)
- Tools can operate multiple times







TOOL ACTIVATION METHODS – MULTI CYCLE TOOLS

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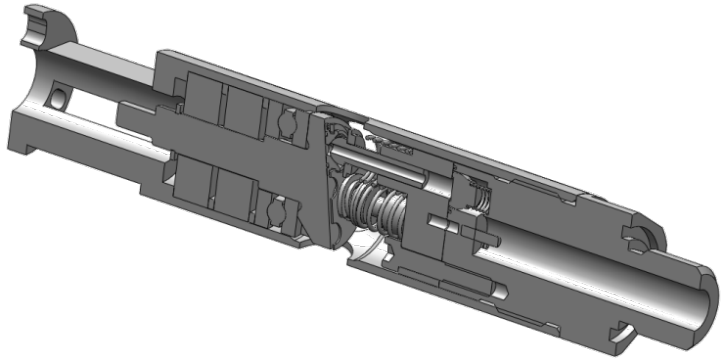
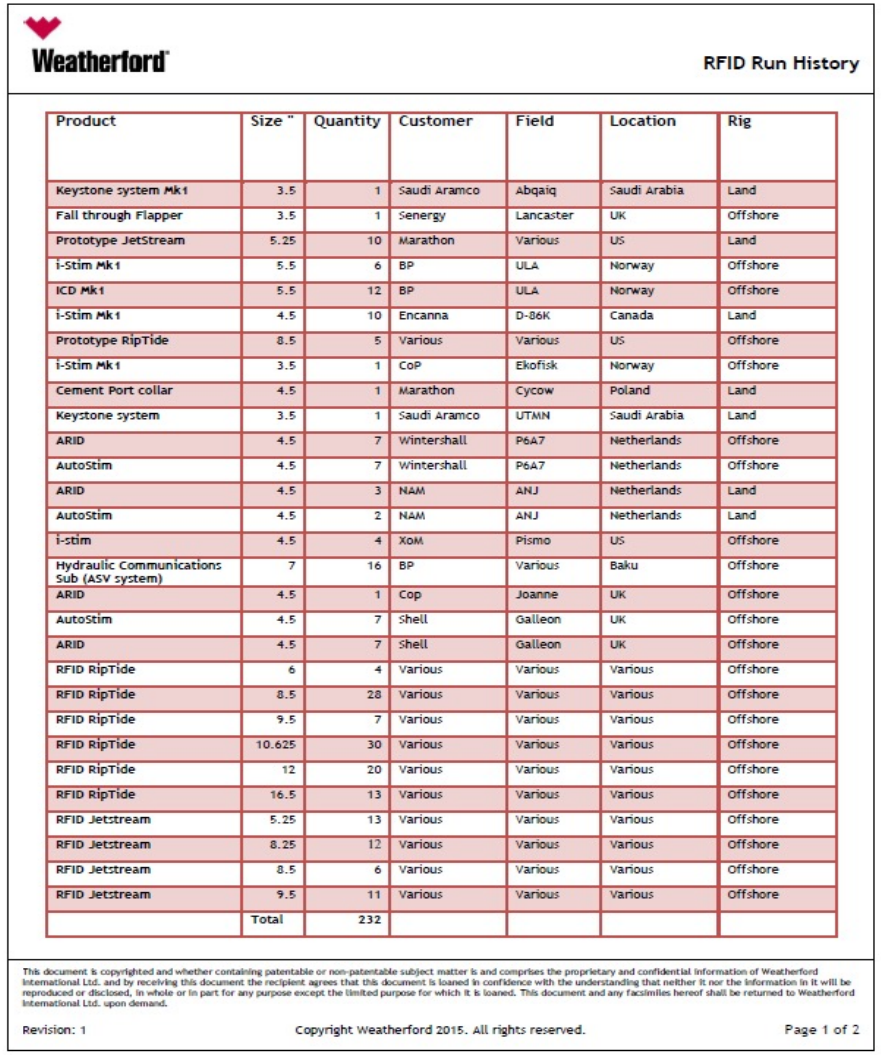
Pump Animation placeholder



RELIABILITY

- 300+ Runs 600+ activations
- 99% Success rate
- Common Technology platform across product lines
  - Completions
  - Well construction
  - Drilling
  - Cementation
- High reliability from testing from extreme environments in drilling
  - Vibration
  - Shock
  - Design for service

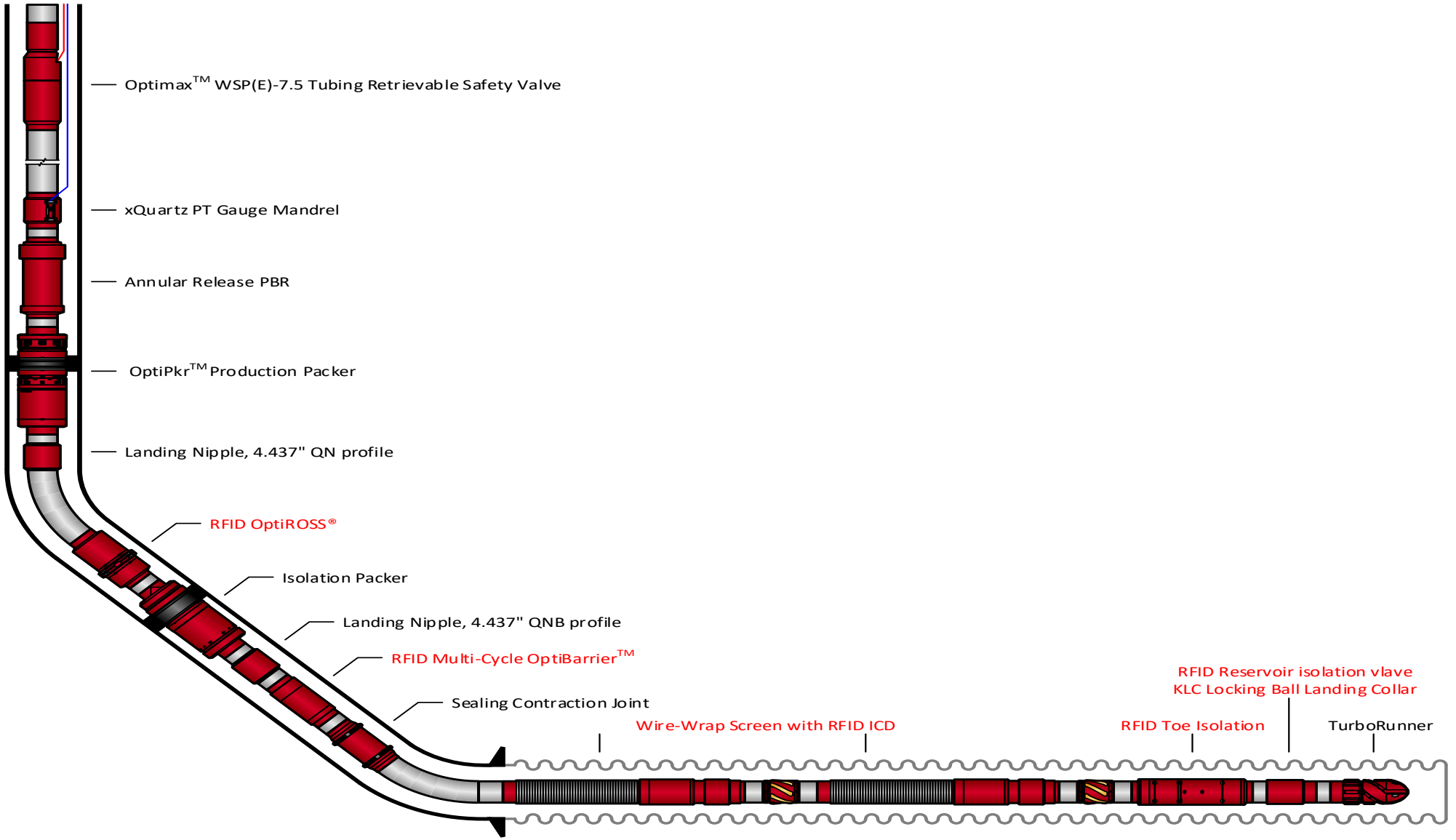


Weatherford

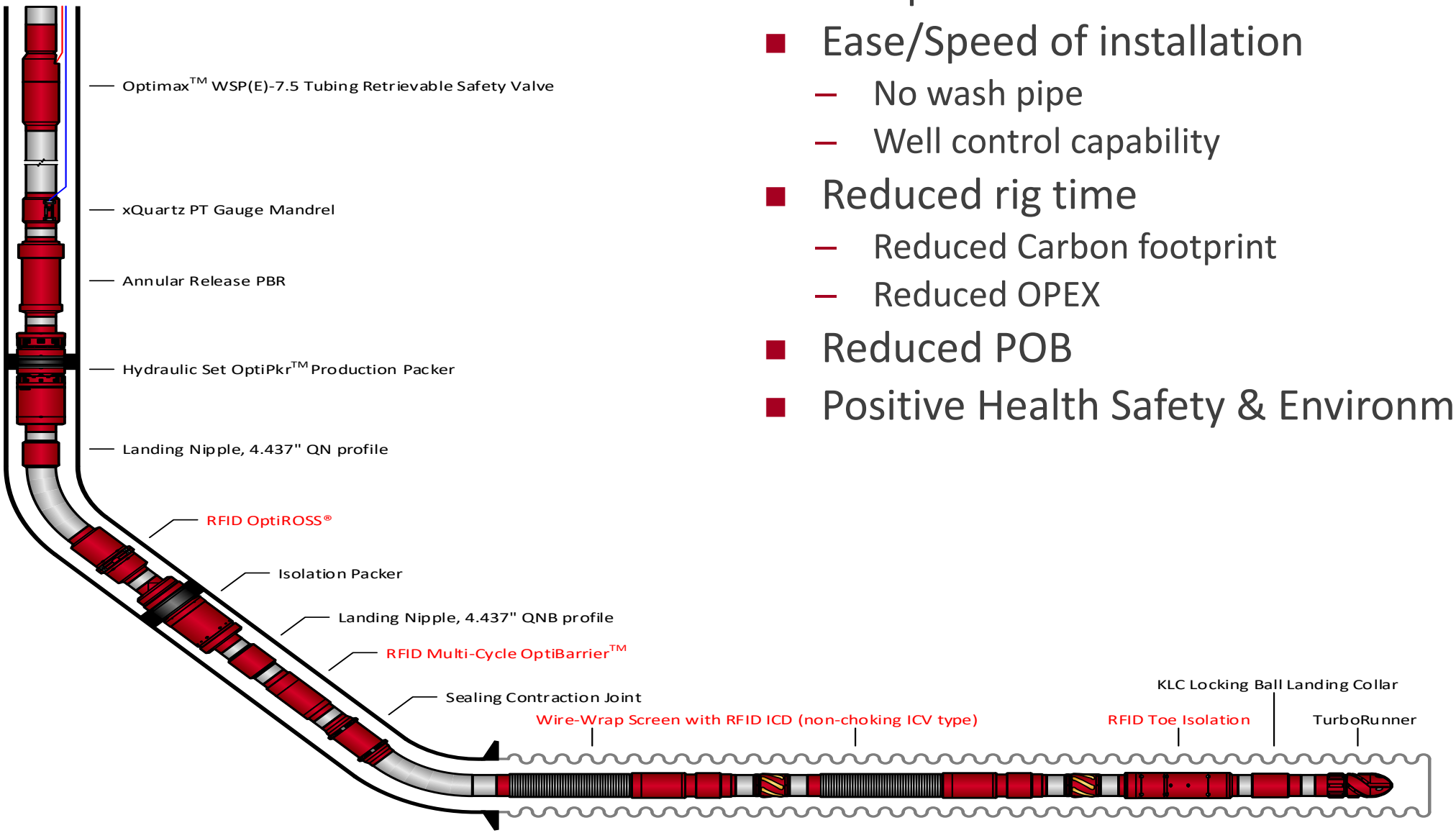
RFID Run History

Product	Size "	Quantity	Customer	Field	Location	Rig
Keystone system Mk1	3.5	1	Saudi Aramco	Abqaiq	Saudi Arabia	Land
Fall through Flapper	3.5	1	Senergy	Lancaster	UK	Offshore
Prototype JetStream	5.25	10	Marathon	Various	US	Land
i-Stim Mk1	5.5	6	BP	ULA	Norway	Offshore
ICD Mk1	5.5	12	BP	ULA	Norway	Offshore
i-Stim Mk1	4.5	10	Encanna	D-86K	Canada	Land
Prototype RipTide	8.5	5	Various	Various	US	Offshore
i-Stim Mk1	3.5	1	CoP	Ekofisk	Norway	Offshore
Cement Port collar	4.5	1	Marathon	Cycow	Poland	Land
Keystone system	3.5	1	Saudi Aramco	UTMN	Saudi Arabia	Land
ARID	4.5	7	Wintershall	P6A7	Netherlands	Offshore
AutoStim	4.5	7	Wintershall	P6A7	Netherlands	Offshore
ARID	4.5	3	NAM	ANJ	Netherlands	Land
AutoStim	4.5	2	NAM	ANJ	Netherlands	Land
i-stim	4.5	4	XoM	Pismo	US	Offshore
Hydraulic Communications Sub (ASV system)	7	16	BP	Various	Baku	Offshore
ARID	4.5	1	Cop	Joanne	UK	Offshore
AutoStim	4.5	7	Shell	Galleon	UK	Offshore
ARID	4.5	7	Shell	Galleon	UK	Offshore
RFID RipTide	6	4	Various	Various	Various	Offshore
RFID RipTide	8.5	28	Various	Various	Various	Offshore
RFID RipTide	9.5	7	Various	Various	Various	Offshore
RFID RipTide	10.625	30	Various	Various	Various	Offshore
RFID RipTide	12	20	Various	Various	Various	Offshore
RFID RipTide	16.5	13	Various	Various	Various	Offshore
RFID Jetstream	5.25	13	Various	Various	Various	Offshore
RFID Jetstream	8.25	12	Various	Various	Various	Offshore
RFID Jetstream	8.5	6	Various	Various	Various	Offshore
RFID Jetstream	9.5	11	Various	Various	Various	Offshore
	Total	232				

TR1P ONE TRIP COMPLETION SYSTEM

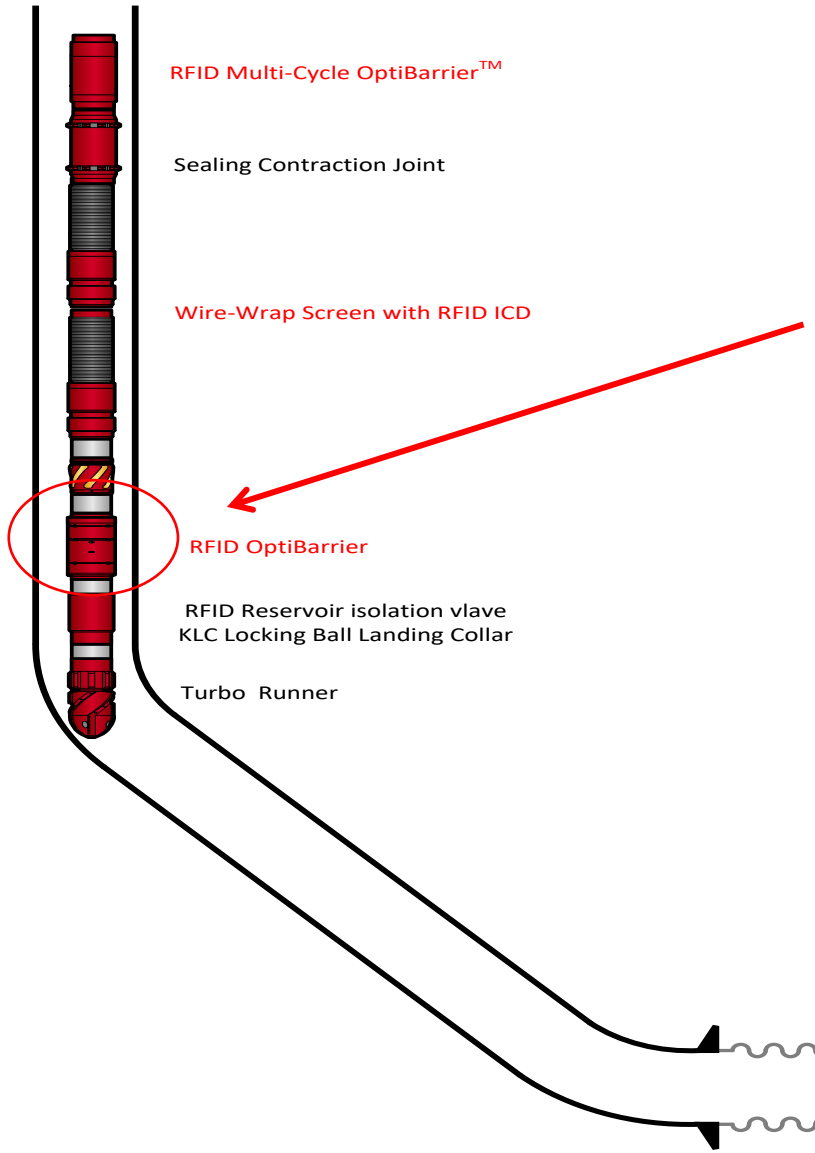


TR1P BENEFITS



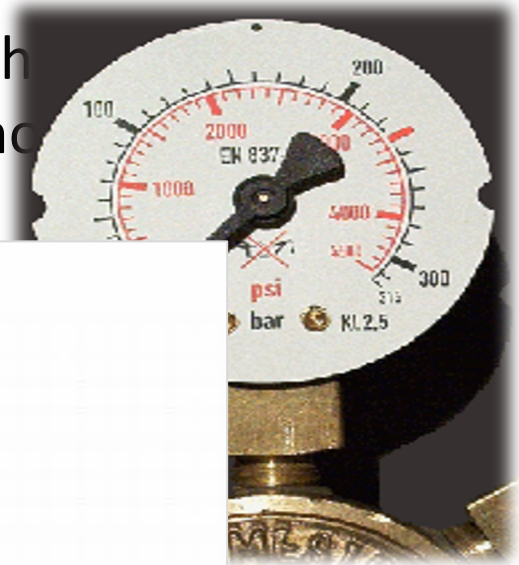
- Completion installed in one run
- Ease/Speed of installation
  - No wash pipe
  - Well control capability
- Reduced rig time
  - Reduced Carbon footprint
  - Reduced OPEX
- Reduced POB
- Positive Health Safety & Environment benefits

TR1P ONE TRIP COMPLETION SYSTEM

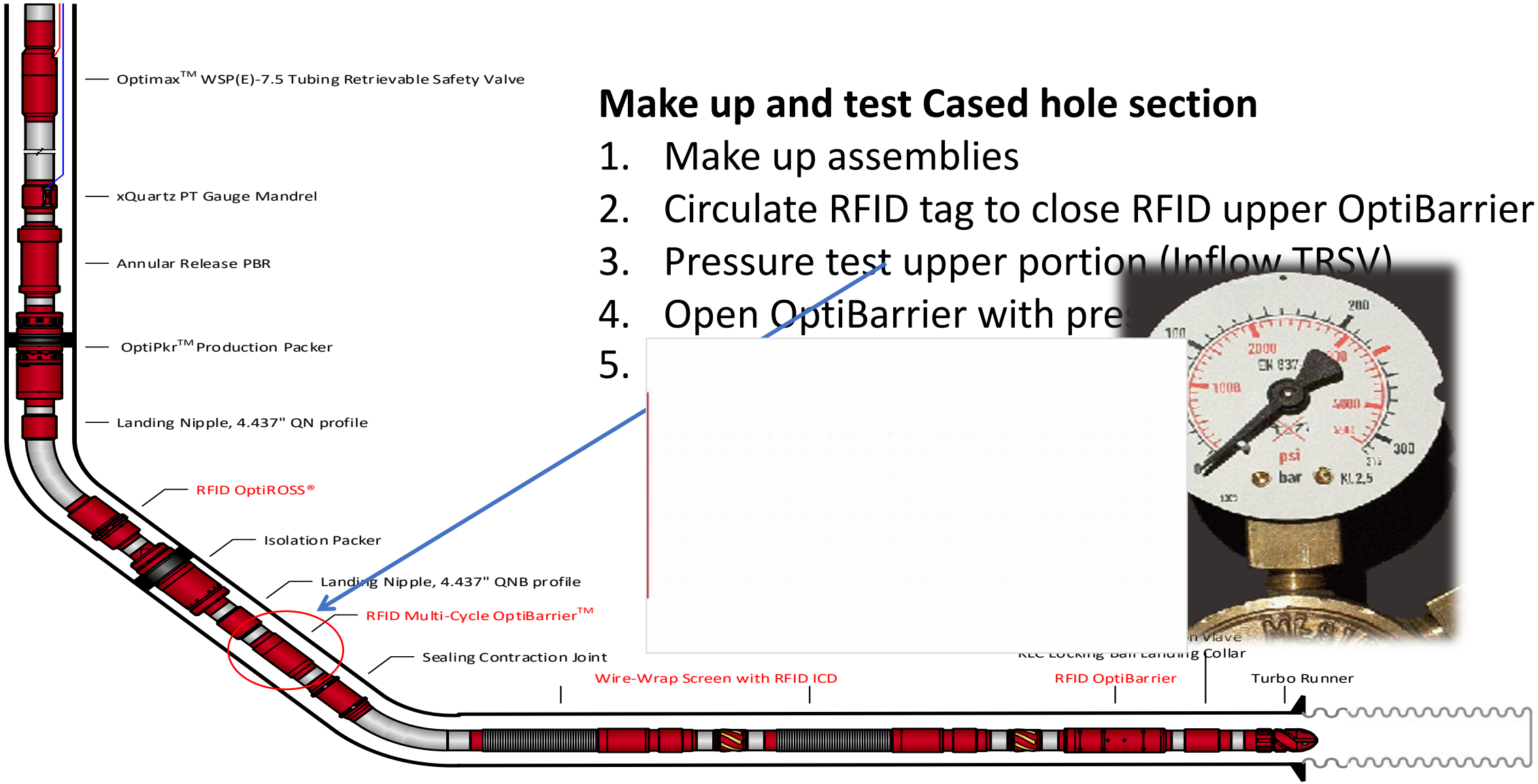


Make up and test Reservoir Section

1. Make up assemblies
2. Circulate RFID tag to close RFID OptiBarrier
3. Pressure test liner
4. Open OptiBarrier with
5. Continue to RIH to sh



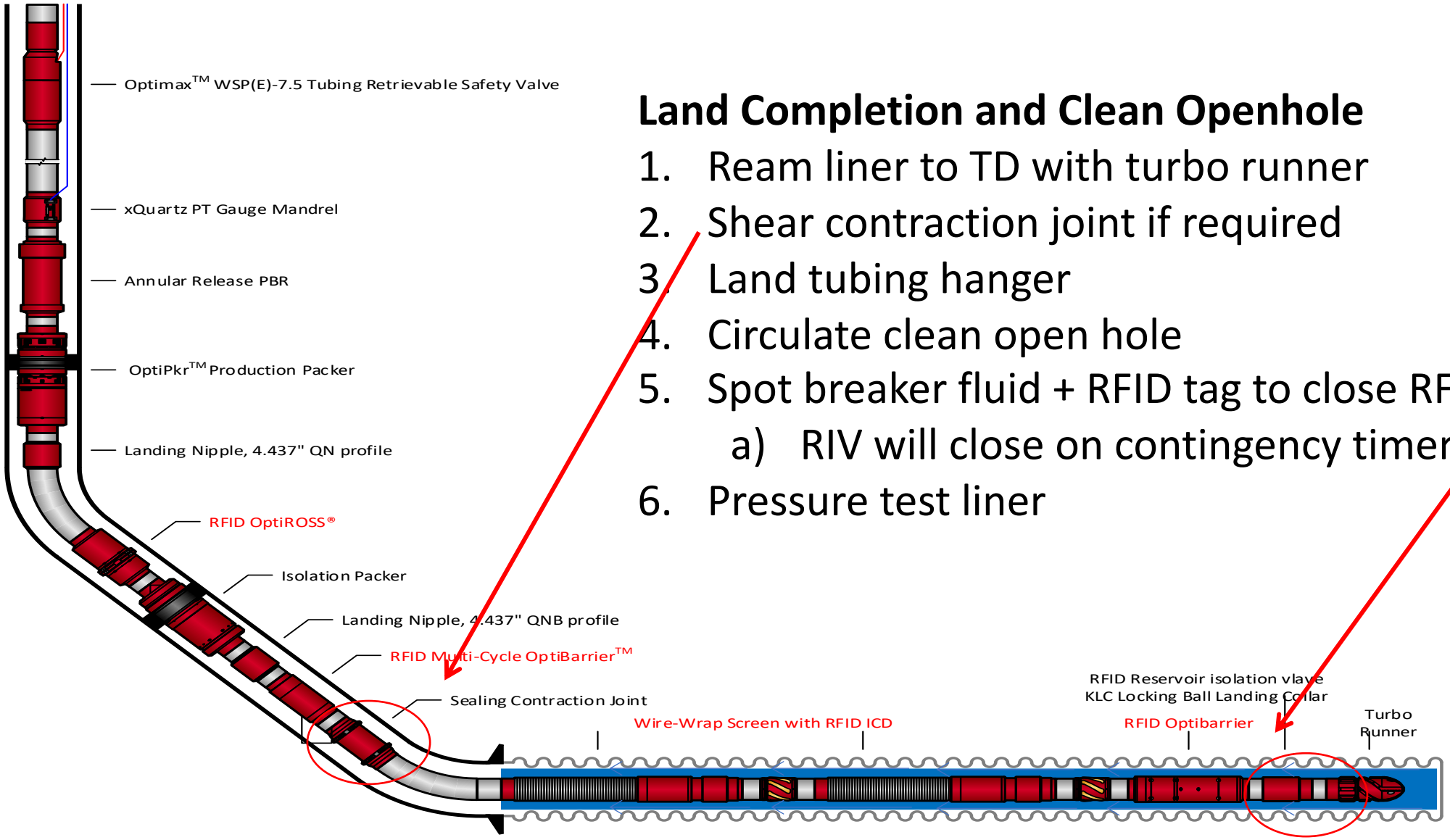
TR1P ONE TRIP COMPLETION SYSTEM



Make up and test Cased hole section

1. Make up assemblies
2. Circulate RFID tag to close RFID upper OptiBarrier
3. Pressure test upper portion (Inflow TRSV)
4. Open OptiBarrier with pres
5.

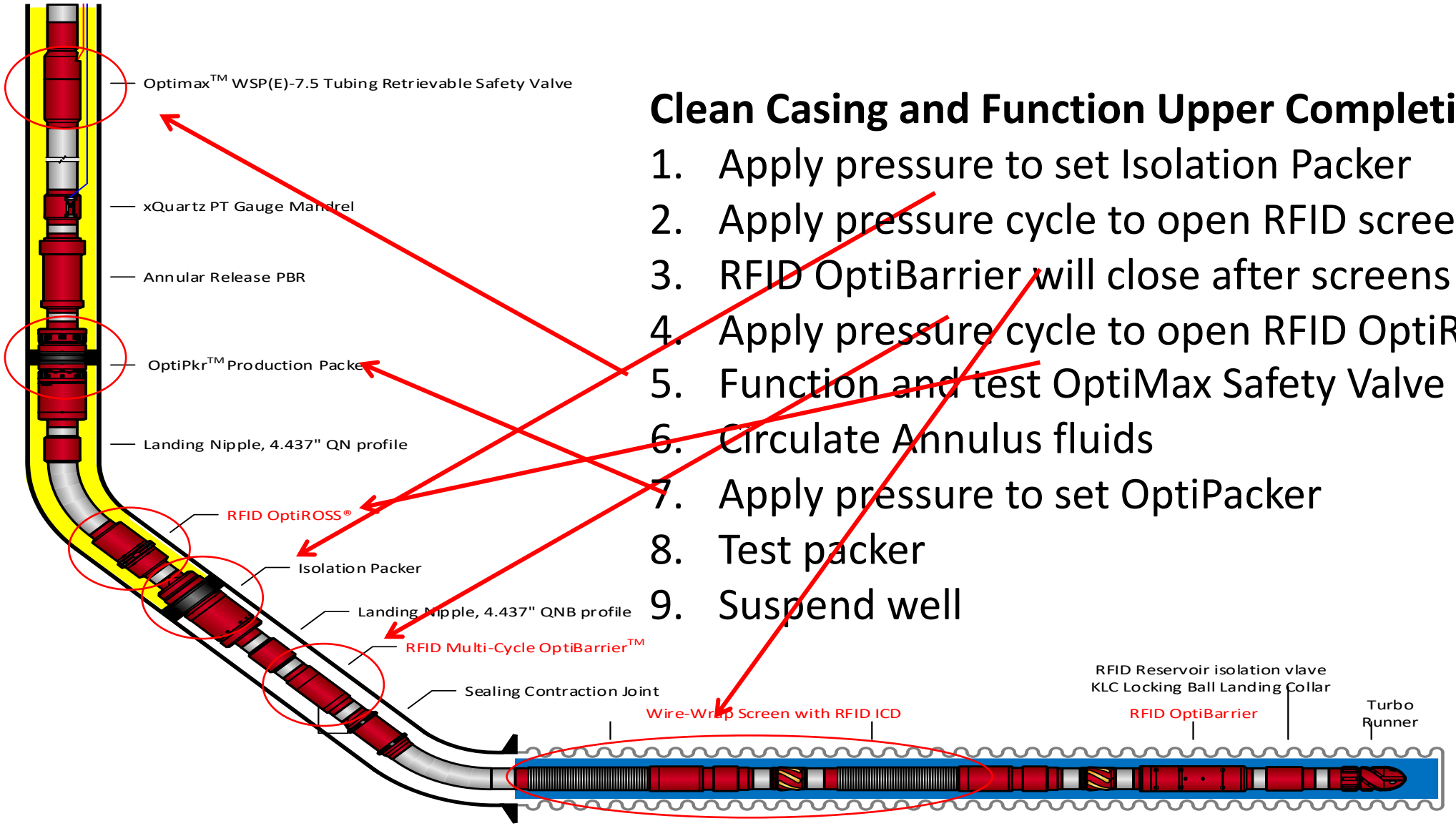
TR1P ONE TRIP COMPLETION SYSTEM



Land Completion and Clean Openhole

1. Ream liner to TD with turbo runner
2. Shear contraction joint if required
3. Land tubing hanger
4. Circulate clean open hole
5. Spot breaker fluid + RFID tag to close RFID OptiBarrier
   a) RIV will close on contingency timer
6. Pressure test liner

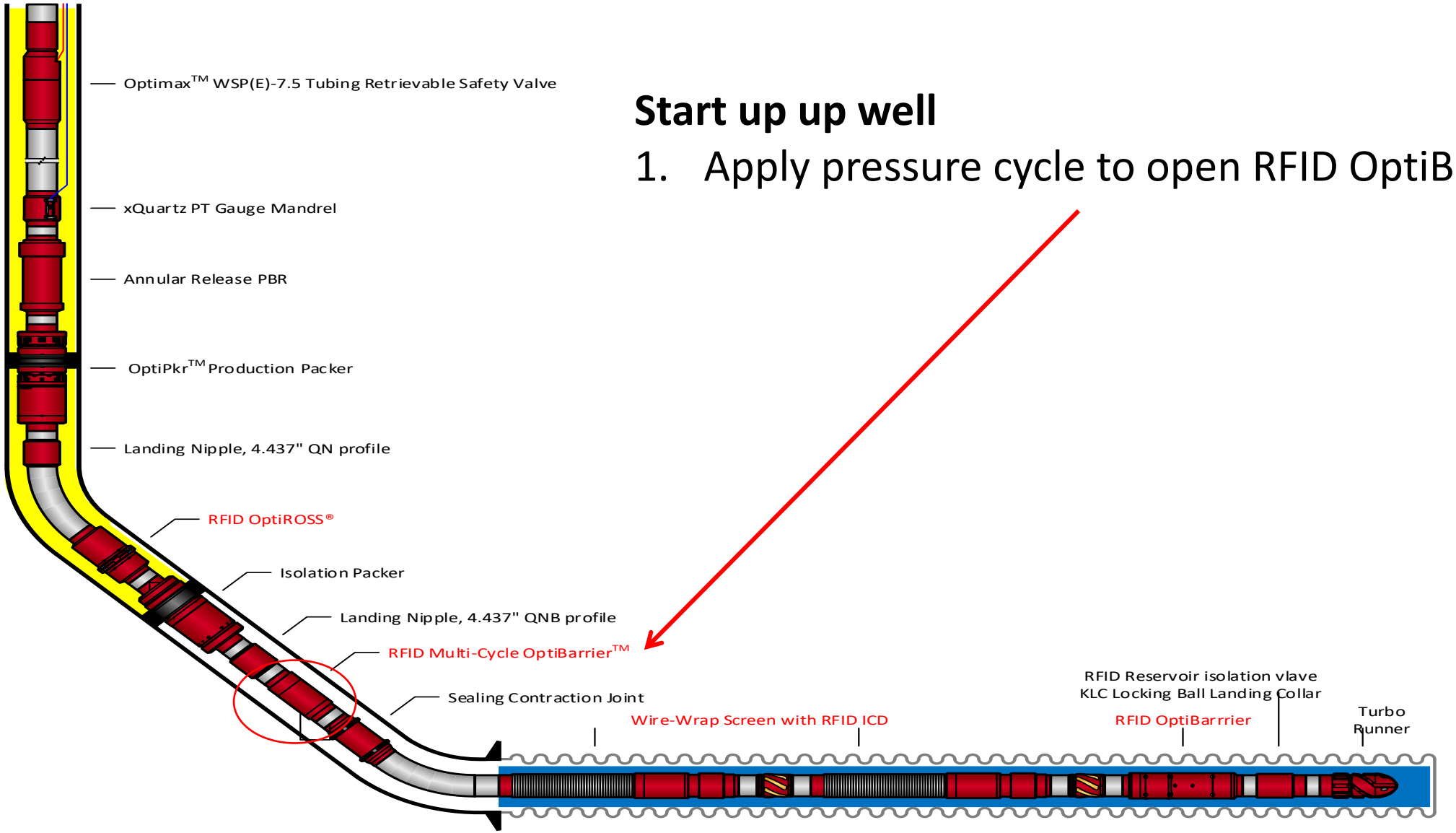
TR1P ONE TRIP COMPLETION SYSTEM



Clean Casing and Function Upper Completion

1. Apply pressure to set Isolation Packer
2. Apply pressure cycle to open RFID screens
3. RFID OptiBarrier will close after screens open
4. Apply pressure cycle to open RFID OptiROSS
5. Function and test OptiMax Safety Valve
6. Circulate Annulus fluids
7. Apply pressure to set OptiPacker
8. Test packer
9. Suspend well

TR1P ONE TRIP COMPLETION SYSTEM

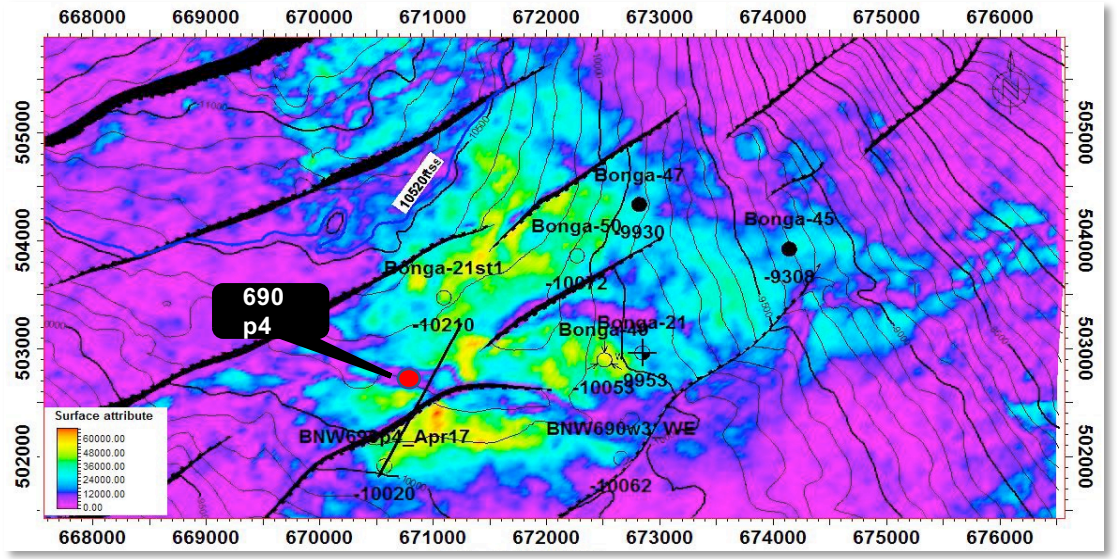


Start up up well

1. Apply pressure cycle to open RFID OptiBarrier

TR1P SYSTEM DEPLOYMENT

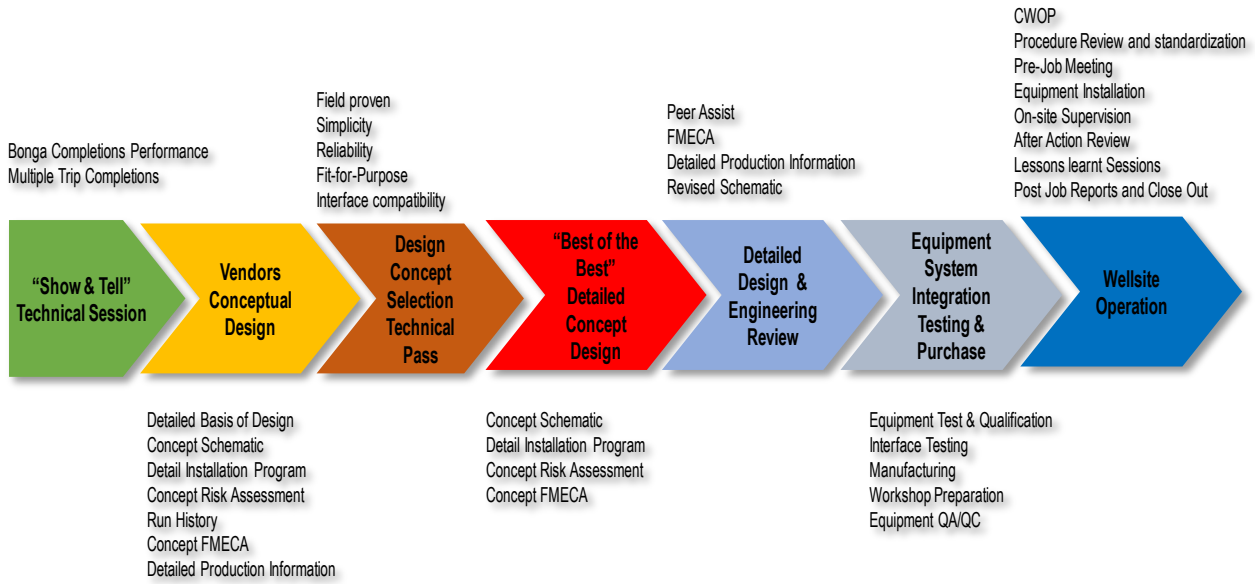
- Offshore in the Niger Delta, Nigeria in 905-1500m of water depth.
- First oil achieved in 2005, more than 65 wells have been drilled.
- ERD wells with inclinations as high as 105 deg.
- High porosity (24-32%) and multi-darcy permeability.
- Oil Saturation , 77- 90% and Average N/G 35 - 56%.
- Reservoir 50 ft tvt net thickness and 60 ft tvt gross thickness.



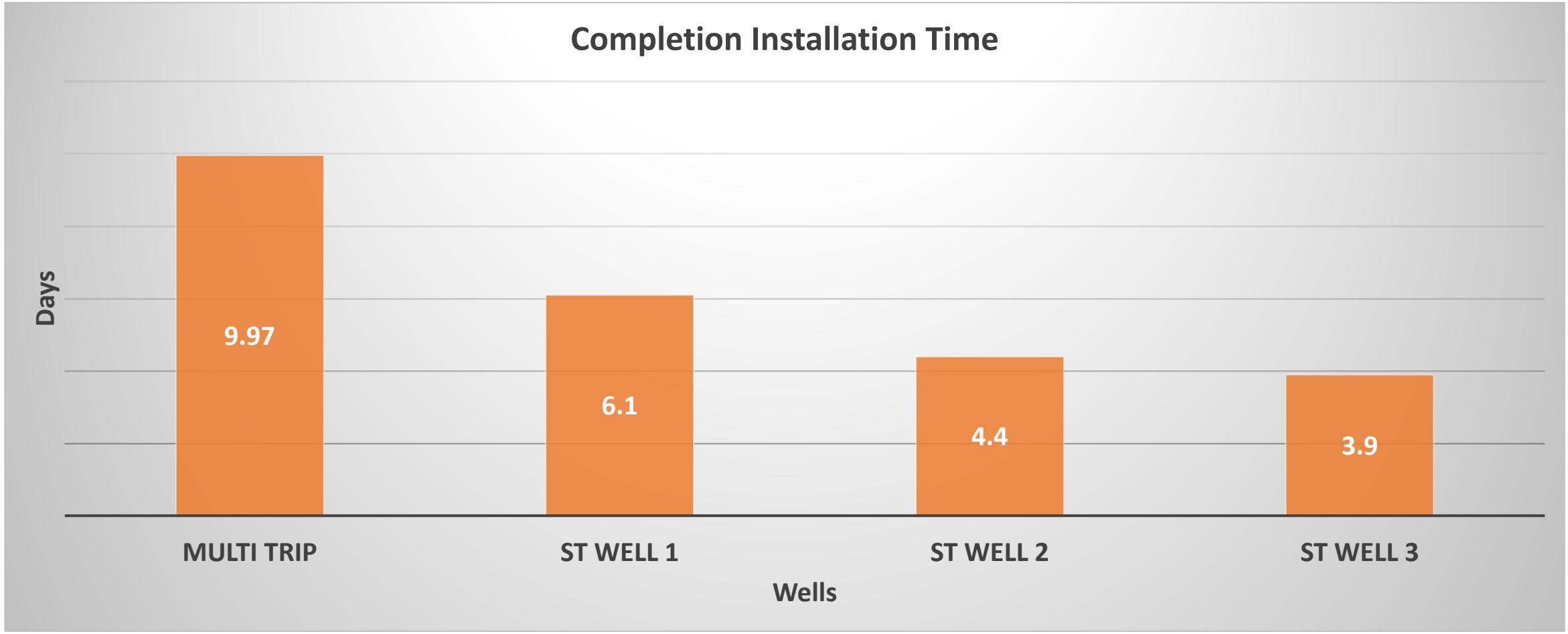
Pressure (psia)	3400 - 5400
Temp (degC)	70 - 95
Bubble Point Pressure (psia)	3500 - 4800
Solution GOR (scf/bbl)	350 - 1400
Formation Volume Factor (rb/stb)	1.2 – 1.54
API Gravity	25 - 33
Viscosity (cp)	0.3 – 3.6
Porosity (%)	24 - 32
Permeability (mD)	800 - 2500

Project Drivers and Objectives

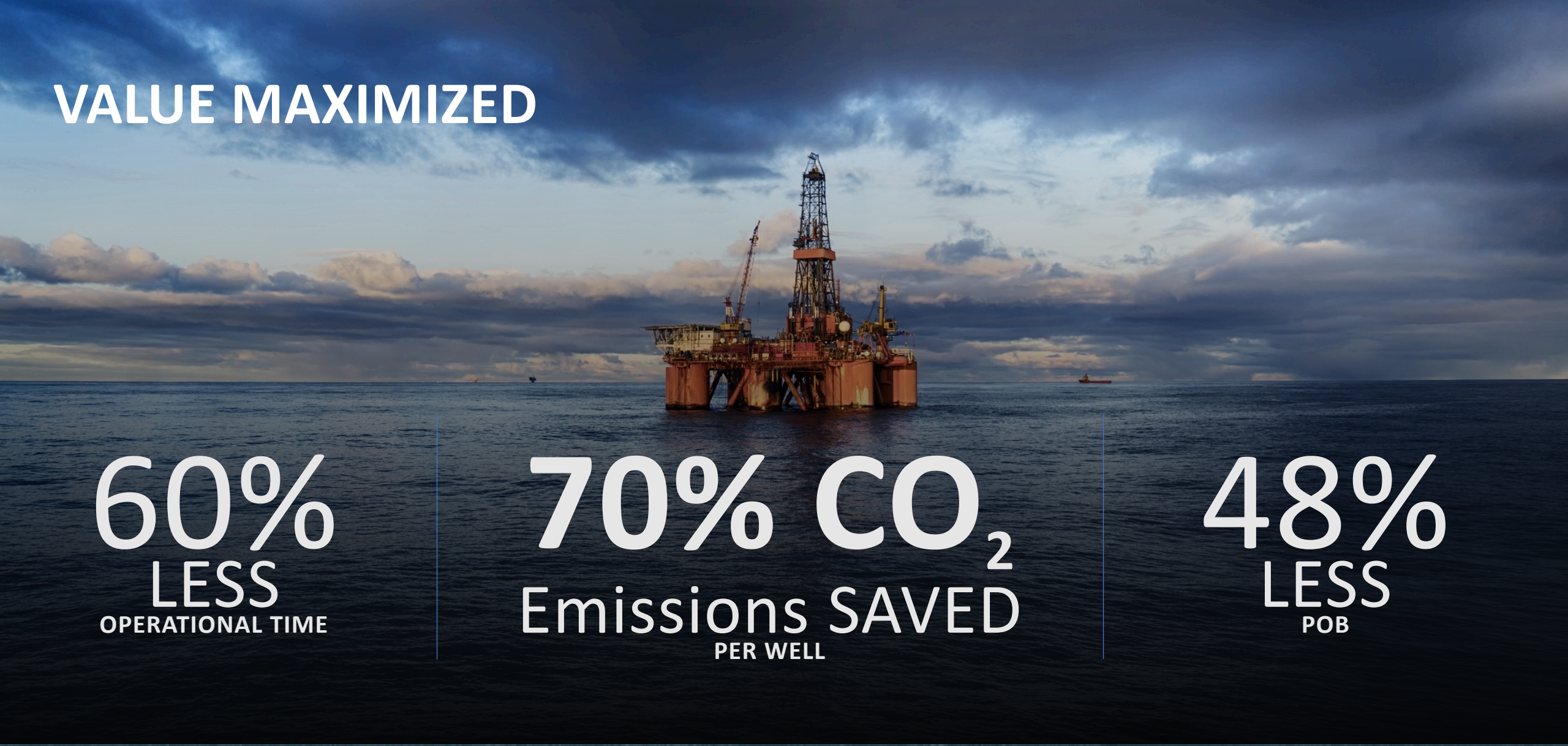
- Deploy the upper and lower completions in one trip.
- An intervention-less deployment
- Use of matured and proven systems and technologies.
- Have the capabilities to displace the OH section to breaker fluid.
- Close, test and open reservoir isolation valve remotely, without deployment of intervention tools.
- Have the capabilities to displace packer fluid, set and test production packers.
- Successfully land the tubing hanger (TH) and pressure test all barrier elements.
- Safe, compliant, reduced personnel exposure to HSE risks & delivery of completion within budget.
- Reduce completion installation days by half.



TR1P Results



VALUE MAXIMIZED



60%
LESS
OPERATIONAL TIME

70% CO_2
Emissions SAVED
PER WELL

48%
LESS
POB

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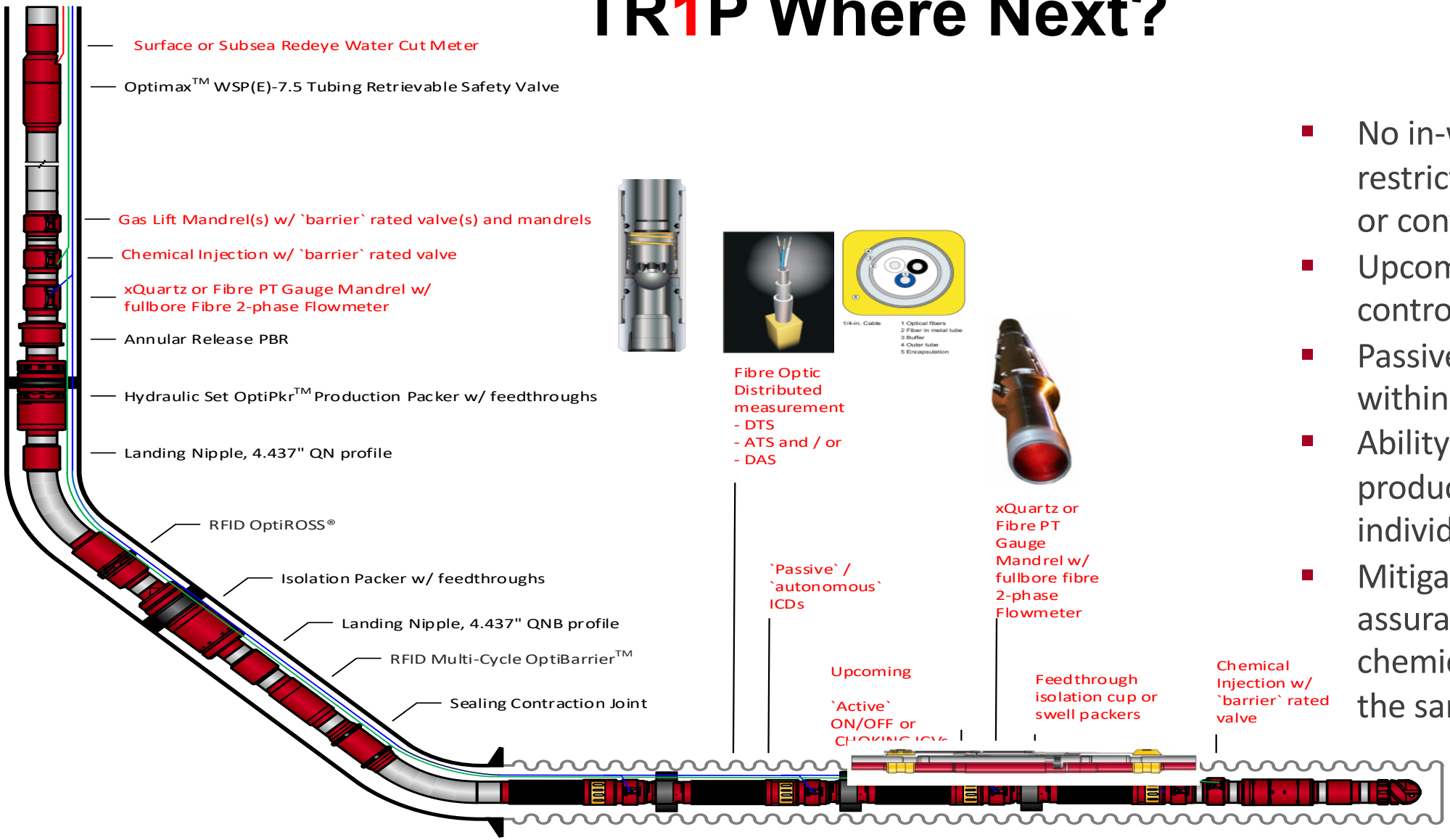
Meritorious Award for Engineering Innovation

World Oil Best Completion Technology

TR1P Where Next?



- No in-well wet connector restriction to surveillance or control lines
- Upcoming active zonal control ICV
- Passive ICD / AICD control within zones
- Ability to perform production tests on individual zones at will
- Mitigate a number of flow assurance problems with chemical injection across the sandface

THANK YOU

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