Well Initiation Service Tool (WIST)

a novel way to revive killed wells back into production

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Contents

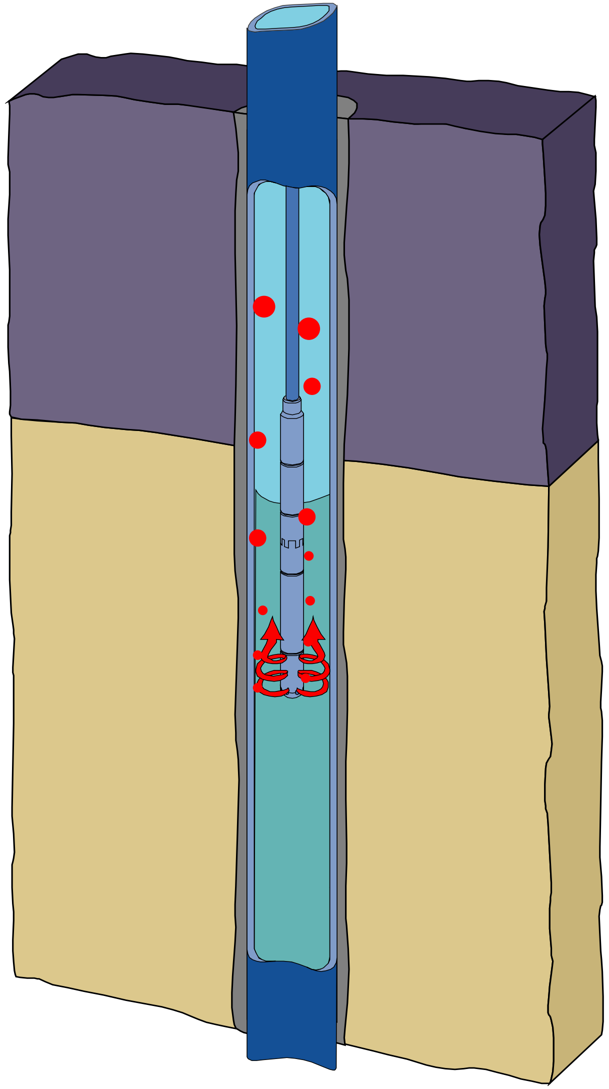
Business driver

A safer, faster, lower cost "kick-off" alternative to Nitrogen Lift for Natural Flowing wells after intervention onshore and particularly offshore where space on the pipe-deck is at a premium

Nitrogen Kick-Off

Inducing flow from reservoir

- Lowering hydrostatic pressure
- System optimized when:
  - Software used to select optimum depth
  - N2 rate at lowest practicable



Nitrogen and WIST lift logistics

Wells with kill fluid that require (CT) N_2 job to start flowing naturally again

→ Well Initiation Service Tool ***WIST***

Coiled Tubing N_2 Job

8 CREW

221 MT equipment

Wireline WIST job

4 CREW

73 MT equipment

EFFICIENCY: Replace N_2 job with Wireline Job

How WIST lightens the fluid column and "kicks-off" a naturally flowing well

i. Deploy pump on wireline into well

ii. Set isolation Packer

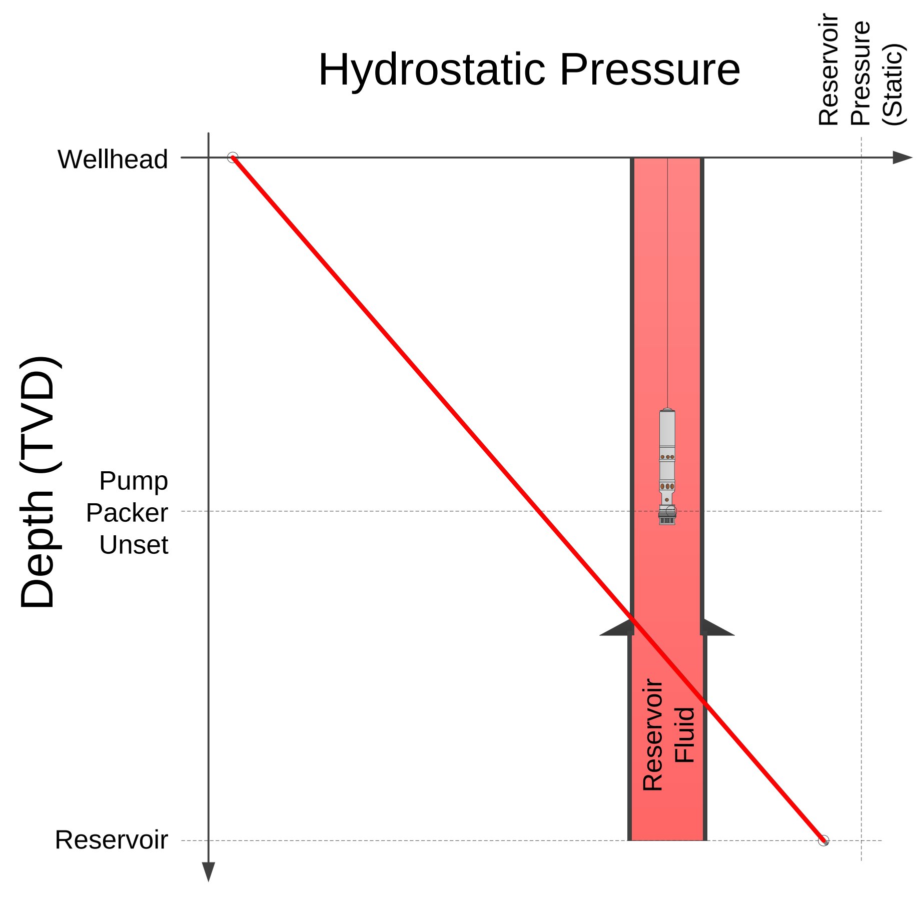
iii. Pump fluids out of well

iv. Fluids moved through pump get replaced by lighter fluids

v. Well starts flowing unassisted, pump no longer required

vi. Pump and packer retrieved from well

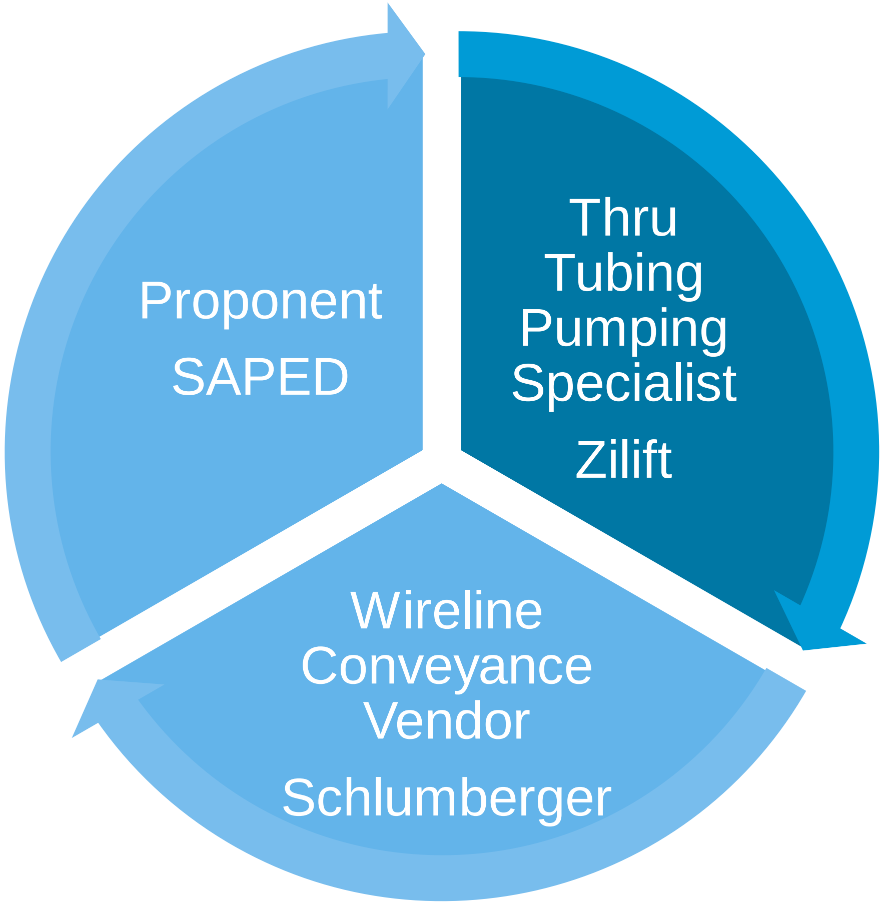
4. Reservoir fluid reaches wellhead, well flowing naturally



Project Structure

Program split into 4 phases

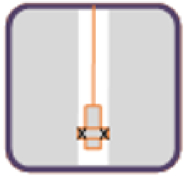
A Joint Development Program over 3 years between three parties was initiated to investigate whether this concept is feasible



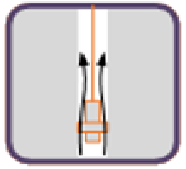
Technical Challenges

SIZE

POWER



ISOLATION

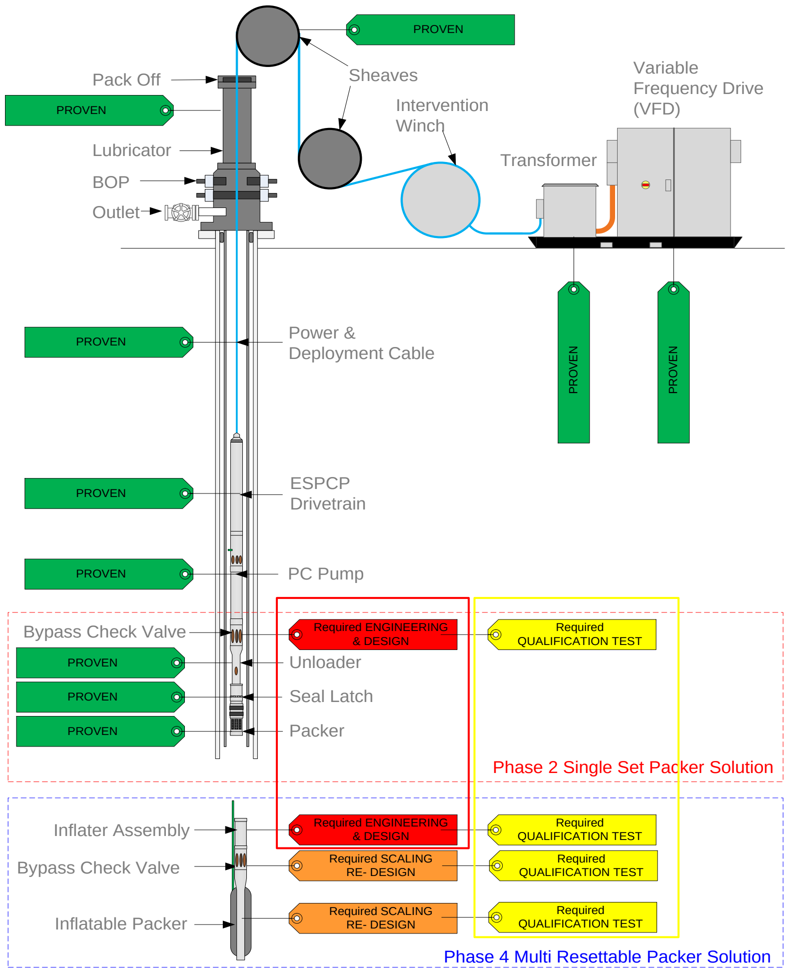


KICKOFF
FLOW BYPASS

DEPLOYMENT

1. Size - run a pumping system through a completion
2. Deliver power to the pumping system through a conveyance cable
3. Isolating the intake and the discharge of the pumping system within the wellbore
4. Flow bypass to prevent the pumping assembly from being pushed uphole when well kicks-off
5. Interfacing the WIST system with existing live well intervention deployment equipment

Engineering Development Requirements



The schematic on the left shows the general arrangement of surface and sub-surface equipment

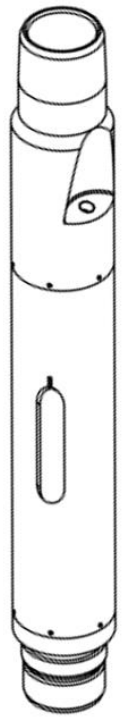
Most items relating to the thru tubing pumping system were already developed at the start of the project (green tag)

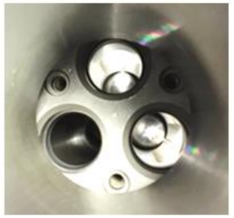
2 items (red tag) required design, engineering and testing to embed into WIST, namely:

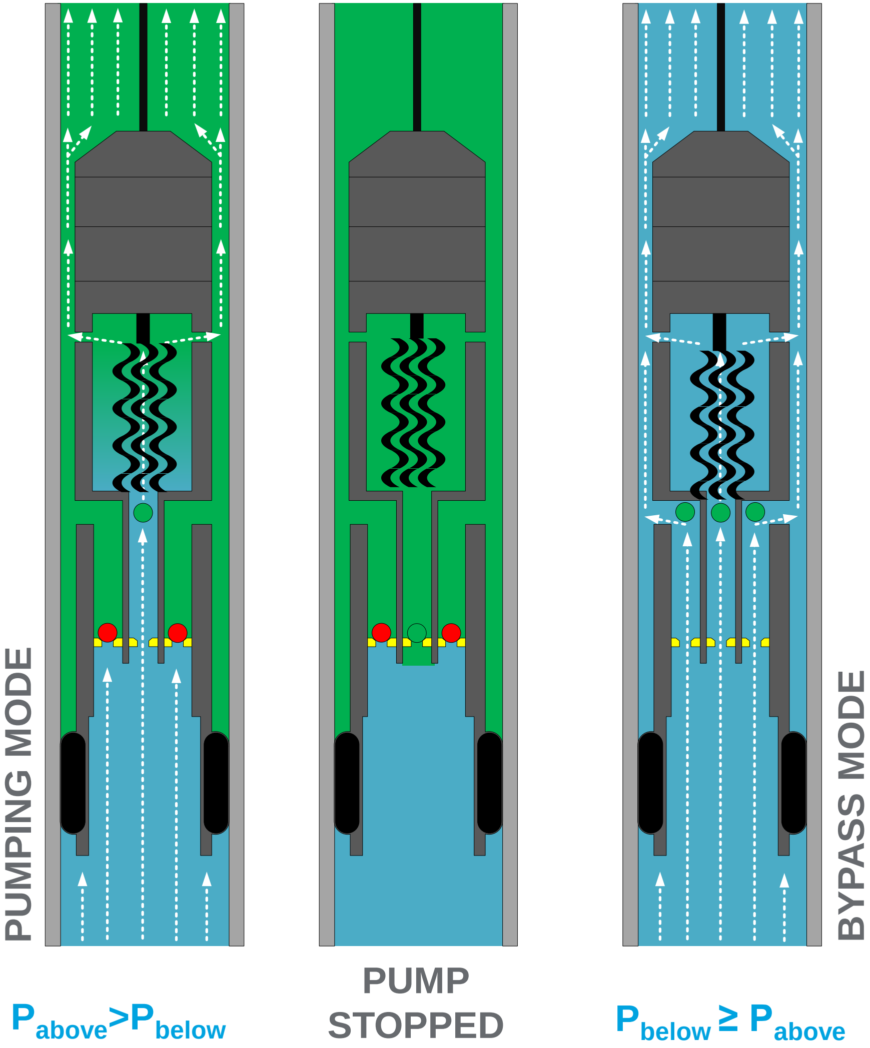
- Bypass/Check Valve
- Inflater for Packer System

4 items (yellow tag) required qualification testing

Bypass valve







Performs multiple functions:

1. A checked flow-path connected to pump intake, stops back flow if pump stopped (or run in reverse)
2. Checked flow-paths around pump intake, stops back flow if pump stopped (or run in reverse)
3. High flow from well around pump + pumping

Challenges:

- Packaging multi-flow conduits and valves within small diameter envelope
- *Must avoid a high flowrate choke point*

Development of a multi resettable packer assembly…..the journey

Unsuccessful – failed qualification testing:

- Iteration 1 to 3 – Cable manipulation concept changes to piston areas to balance
- Iteration 4 – Cable manipulation concept with addition of multi-use shear pins to overcome and resist piston force

Successful - promoted to field test stage:

- Iteration 5 - Major change of function to inflate using reverse pumping and sequence control valve…………..

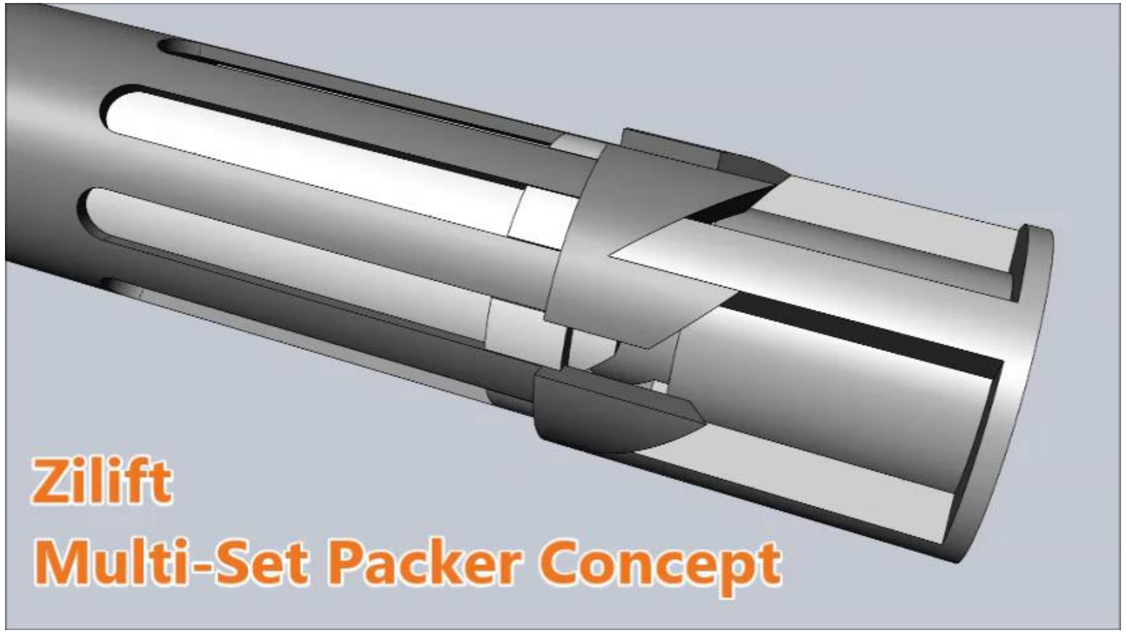
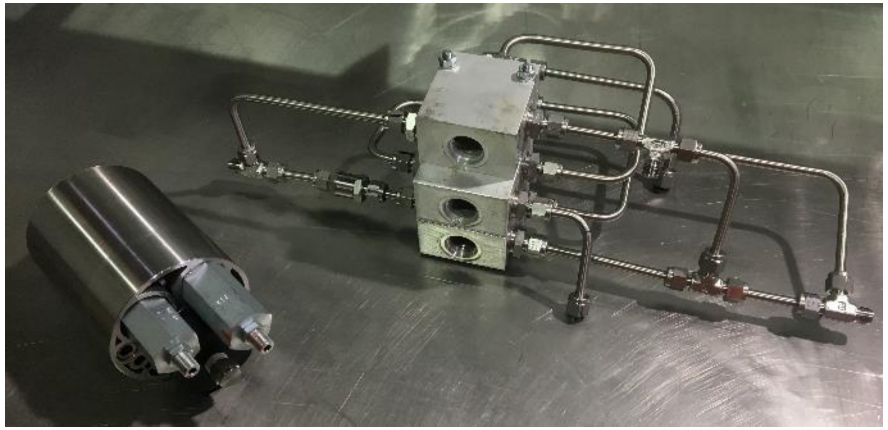


Figure 8 – UMP [10]

………Multi resettable packer assembly……final iteration

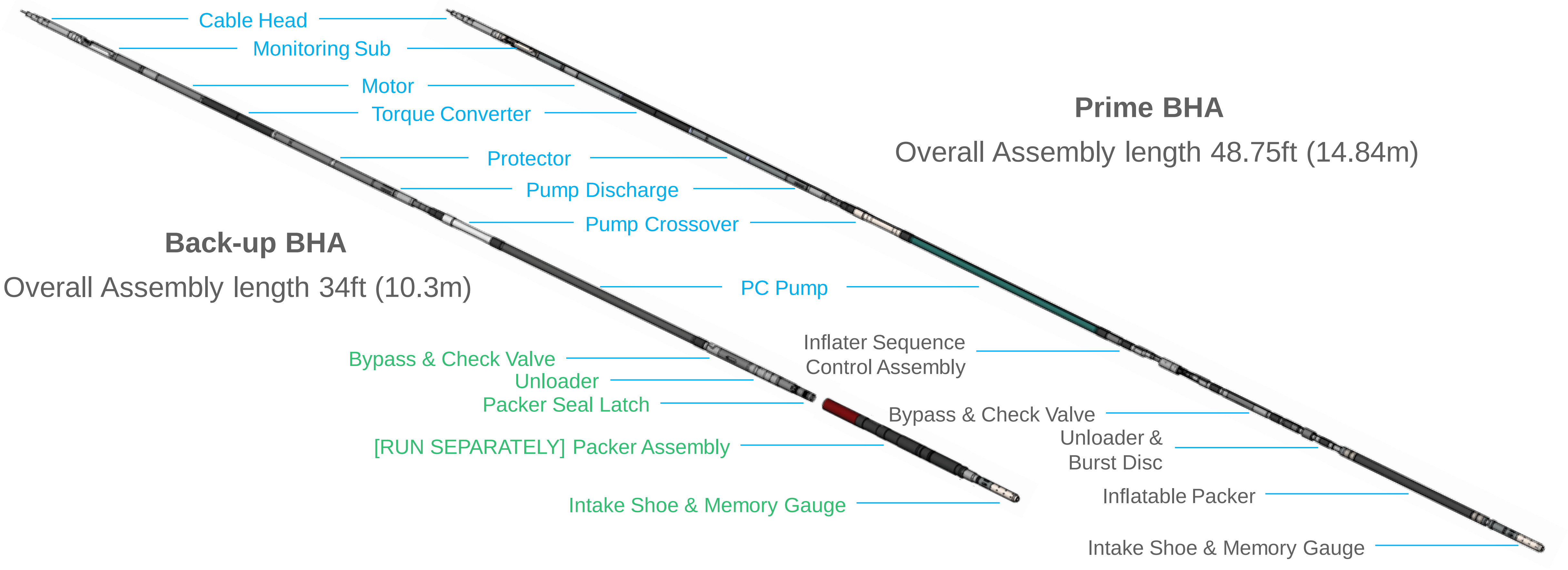


Complex manifold enabled with 3D printing
(Left) shows 3D printed part (3.5" OD)
(Right) shows bench test prototype manifold

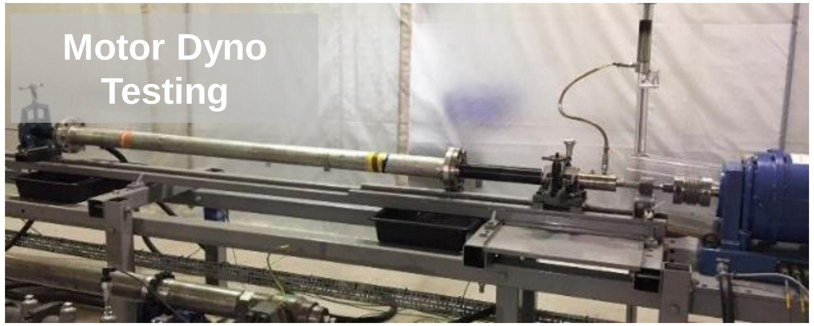
Final Field Test Sequencing Control Valve Assembly

- Could not use rotation, mechanisms with shear stock or dropping balls to activate packer multiple times
- Selected an inflatable packer system
    - Can be inflated and deflated multiple times without redress
    - No high setting forces required
    - Able to use existing electric submersible pump to inflate packer with well fluid
- Engineered an *Inflater Assembly* to select flow path from pump to inflater or from pump to annulus
    - 5 x design and test iterations within 8 months before success using a sequence control logic circuit

Final Downhole Assemblies



Testing Methodology



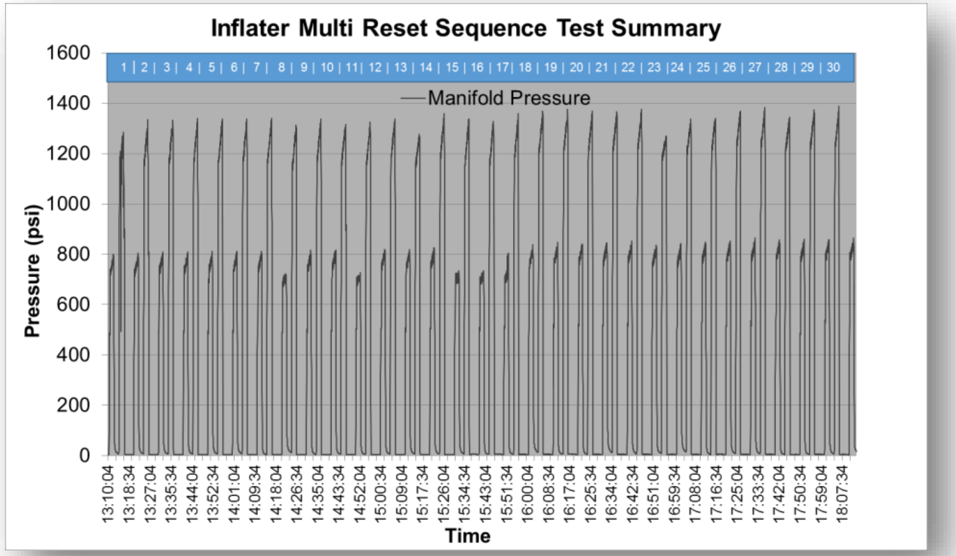
Qualification Testing

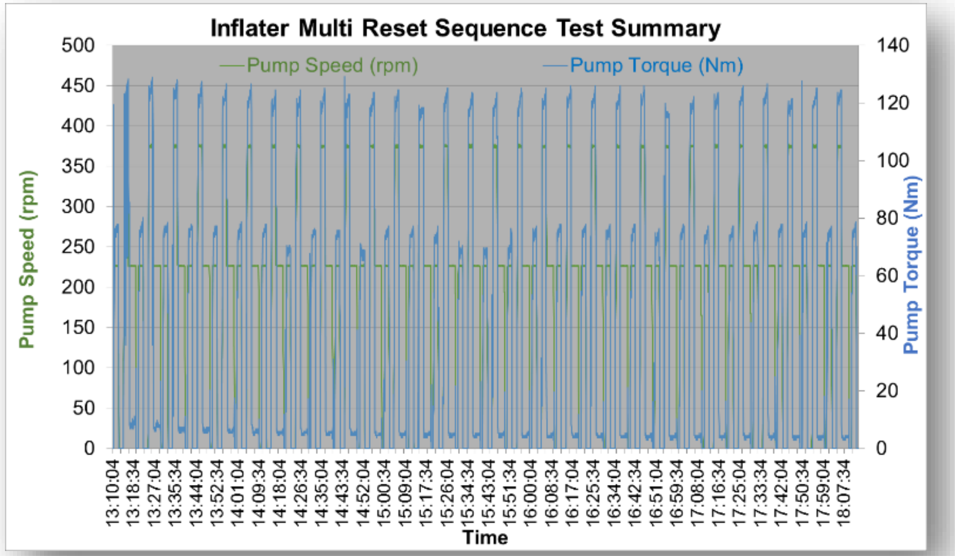
All test criteria passed

- System OD deflated to below drift OD after every test cycle
- Packer set in tubing repeatedly with no slip or leaks detected

Test results show project specification exceeded with significant factor of safety

- E.g. specification requires packer multi reset 3 times without redress. Achieved 30+ times during testing

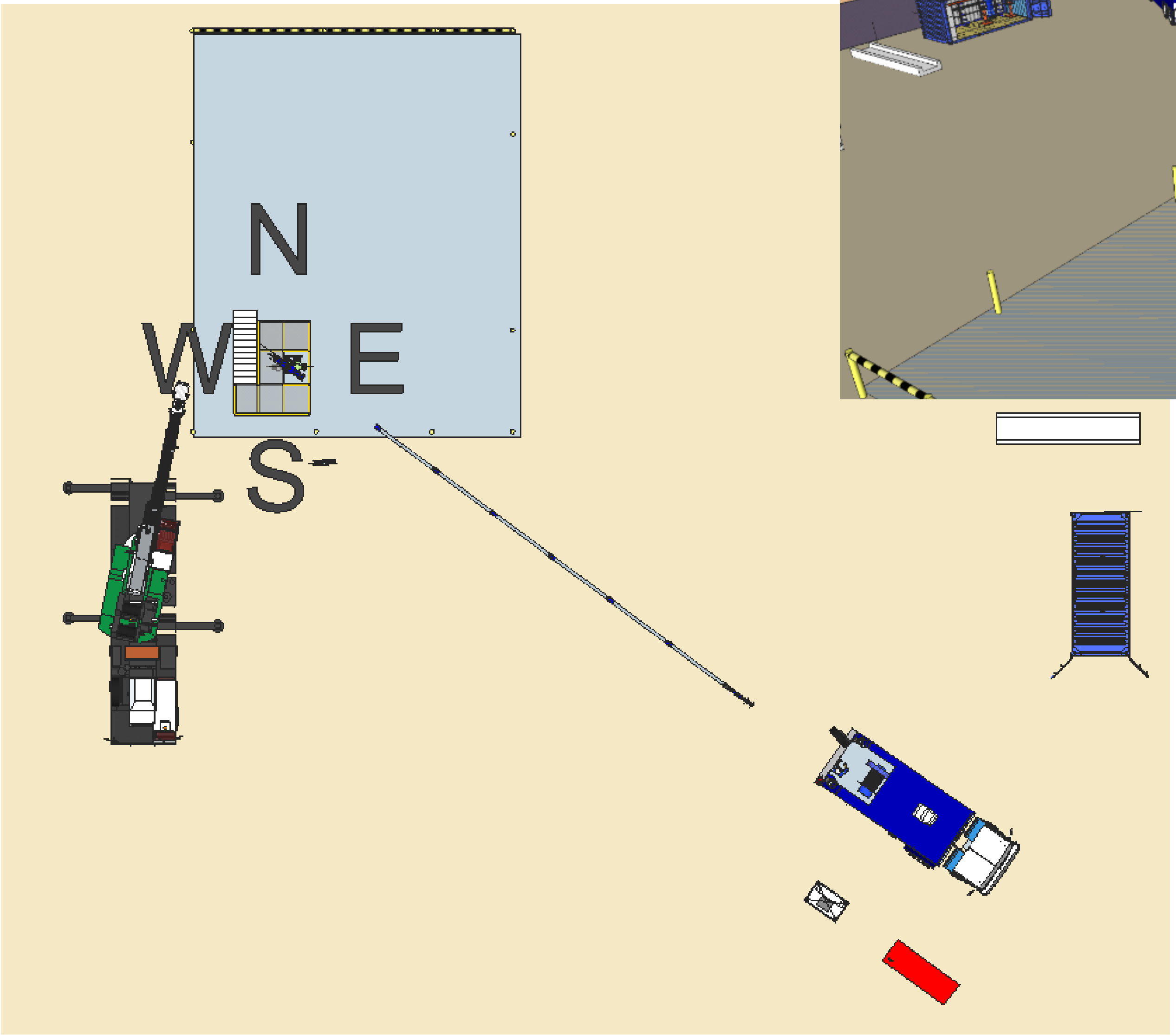


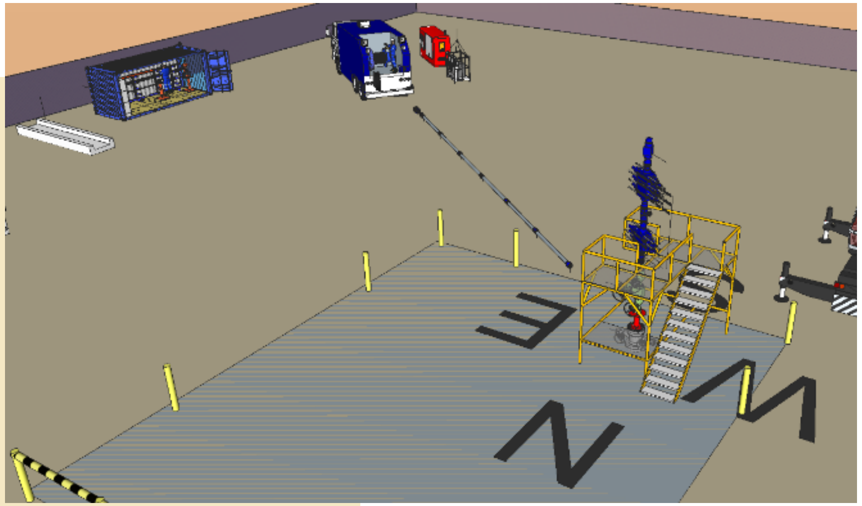


Design and Development Complete….ready for Field Trials

- A thru tubing cable deployed pumping system with a multi resettable packer assembly successfully developed and tested
- All WIST equipment qualified for field trials
- 2 sets of equipment shipped to KSA – ready for field trials

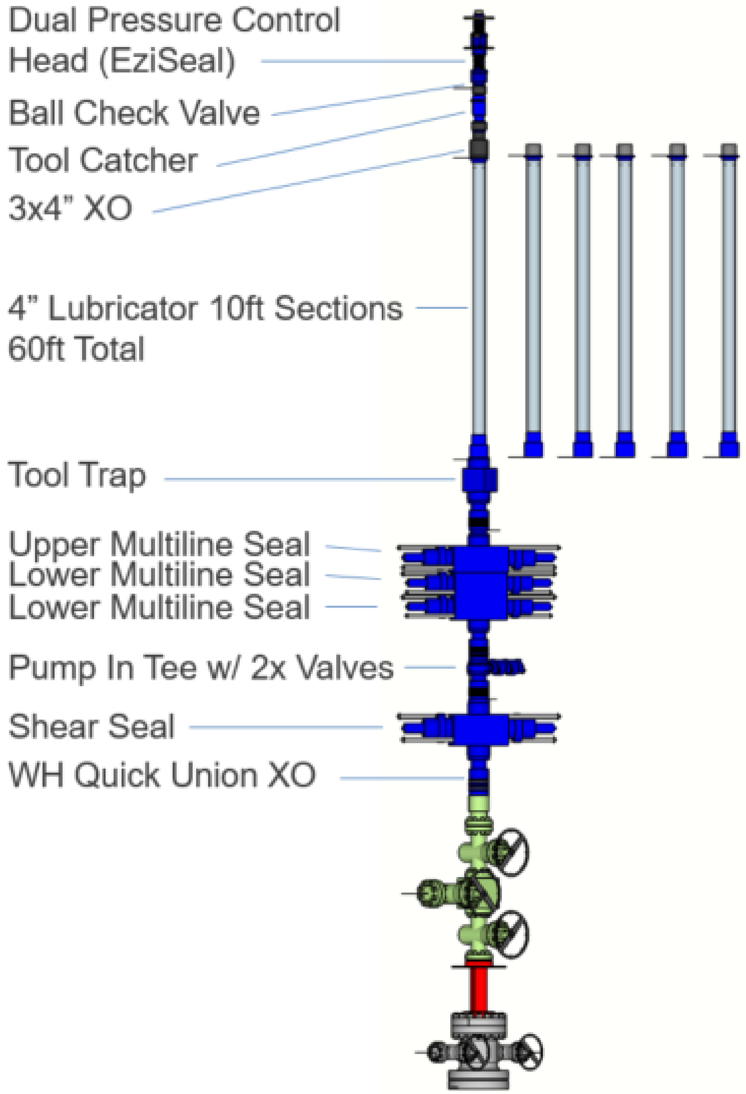
Site layout for WIST activity





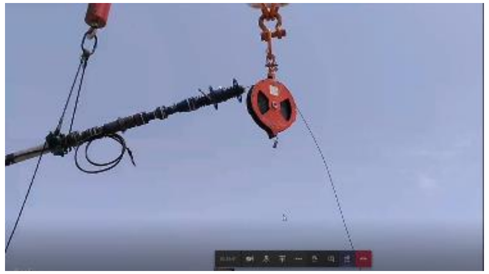
Company General Use

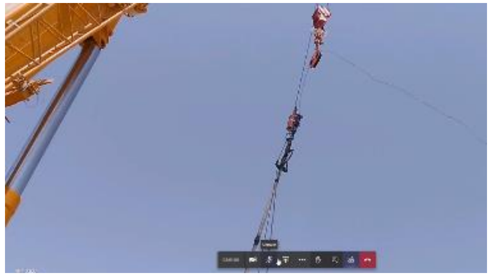
Pressure Control Equipment (PCE) Stackup



Raising and lowering PCE

Up

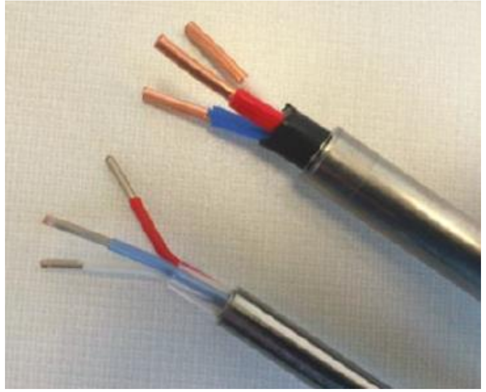


Down




TECline Cable

Mechanical	3/8" TECline
Number of Conductors :	3, Solid Copper
Cable Outer Diameter :	0.375" (9.52mm)
Maximum Safe Pull :	4,000lbf
Ends-Fixed Break Strength :	5,000lbf
Weight in Air :	0.262 lb/ft (0.39kg/m)
Weight in Water :	TBC
Stretch Coefficient :	TBC
Temperature rating :	390°F (200°C)
Materials :	825 Incoloy
Outer Diameter :	
Outer Jacket Wall Thickness :	0.049" (1.25mm)
Outer Jacket Material Yield Strength :	100,000 – 131,000 psi
Outer Jacket Material Tensile Strength :	112,000 -146,000 psi
Max working tensile load :	5,000 lbf
Electrical	
Voltage Rating :	3000Vrms
Current Rating :	20 Amps
Resistance Rating :	1.63 Ohms/kft
Insulation Resistance :	6,500 MOhms/kft minimum
Wire AWG :	12 AWG



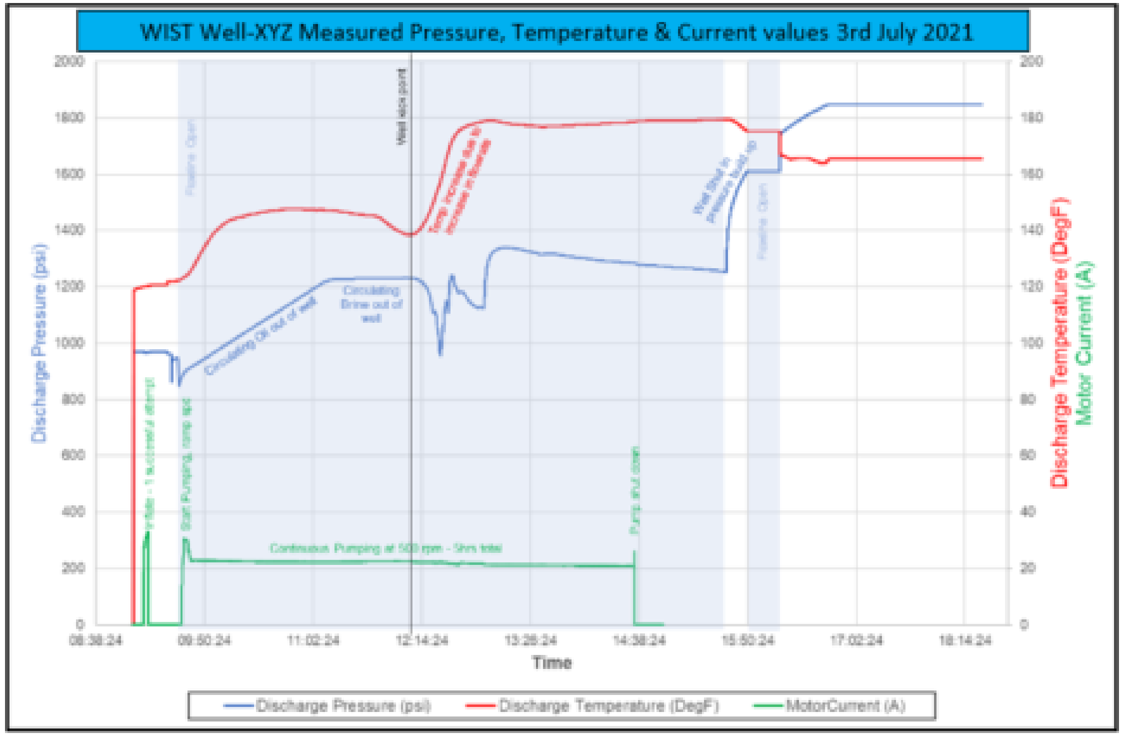
Well-XYZ WIST Activity

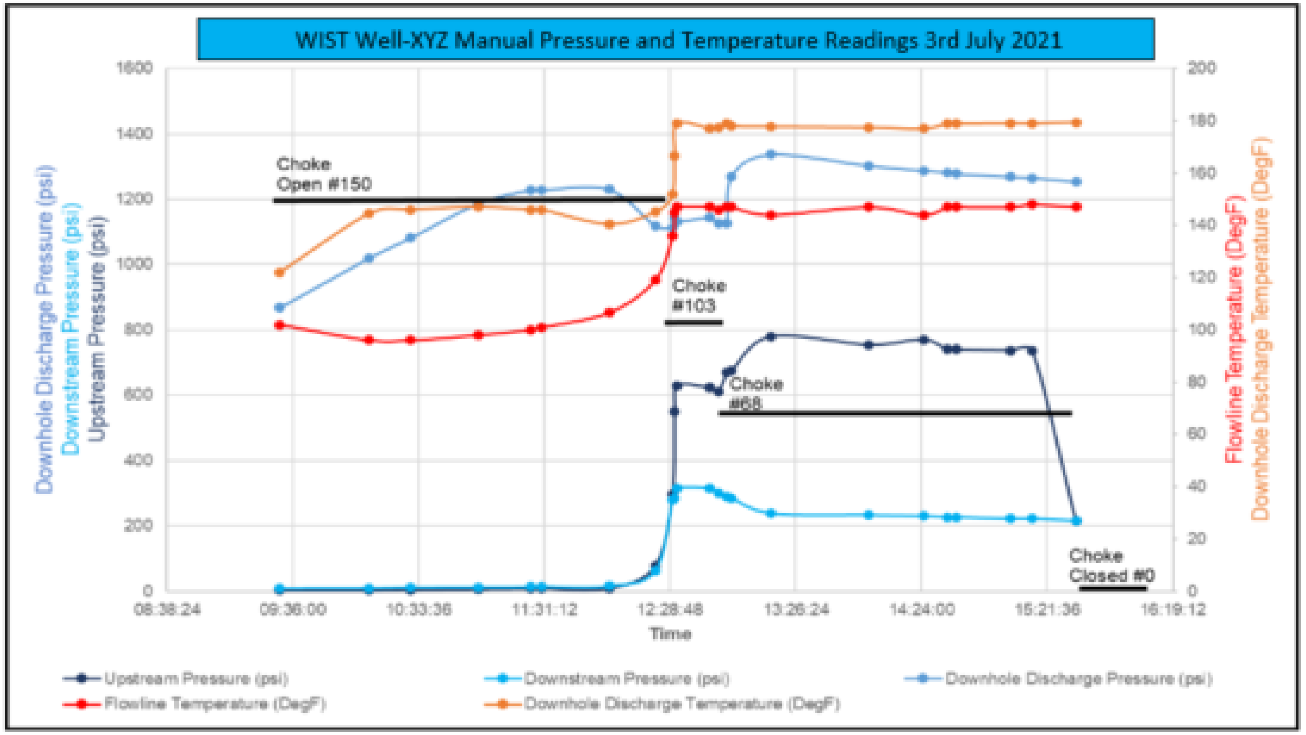
What happened….

Result:
Well returned to full production 12 days faster than CT N2 method

WELL-XYZ: Successfully "kicked-off" on 3rd July 21 at 1214 hrs local time:

- Downstream flowline pressure 230 psi
- Max Wellhead pressure 800 psi
- Max load on pump 400 psi
- Max power 7.5 kW input
- WL Time to rig up & RIH 4.5 hrs
- Duration to unload 3 hours ~ 2000-4000 BPD bbls





The value of replacing N2 CT with WIST

Coiled Tubing N_2	Wireline WIST	
5 day operation	1 day operation	80% saving
221 MT equipment	73 MT equipment	66% saving
8 CREW	4 CREW	50% saving
32.4 MT CO_2 per job	4.8 MT CO_2 per job	85% saving
Cost of CT and N2 Services	Cost of Wireline Services	50% saving

Many thanks to the following, supporters of WIST:

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Mohammed Alhuraifi – PE Southern Area Production Eng.

Thank you