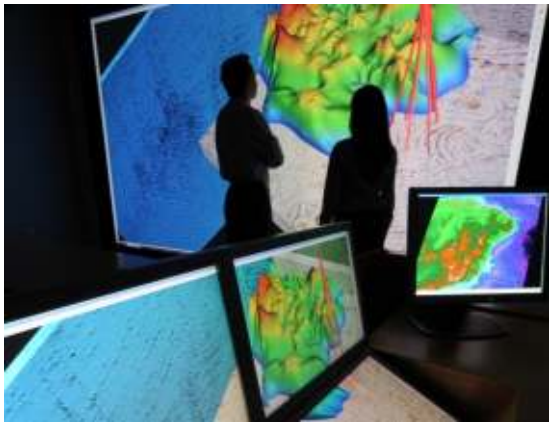
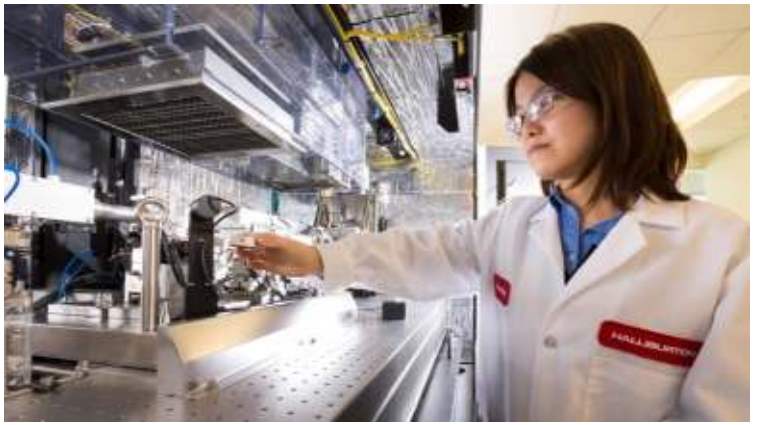

# Optimizing Fracturing Design by Applying Multicluster (TCP) in Horizontal Wells for Unconventional Development

SLAP 16-8

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HALLIBURTON

# AGENDA

- Introduction
- TCP Multi-cluster & Coiled Tubing - Objective
- Multi-cluster sequence – TCP Step by Step
- Case History: Well conditions
- Case History: Solution - TCP
- Case History: BHA design Coiled Tubing – Challenge
- Case History: Solution – Coiled Tubing
- Case History: Operational description & Outcomes
- Conclusion

# INTRODUCTION

- Unconventional completions optimization is important for shale/tight field development to provide the industry with cost-effective solutions.
- Several technologies are available to create the toe perforations (1st stage perforations) required to enable using the pump-down technique.
- In Argentina, several unconventional completions methods are available, such as fracturing sleeves, sand jetting, tractor conveyed perforating, etc.
- However, complex geometry or collapsed wells requires a more reliable completion technic.

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## TCP Multi-cluster & Coiled Tubing

Objective

- A single tubing conveyed perforating (TCP) run can make a Toe Perforating possible, not only accomplishing cluster distribution to optimize the fracturing design but also allowing complex-geometry well completions for which coiled tubing (CT) is the only conveyance option.
  - Reduce Breakdown pressure of 1st stage.
  - Avoid pre-frac treatment.
  - Flexible perforating design for clean perforation tunnel.
  - Provide independent perforating of selected zones.
  - Leave the stage ready for hydraulic stimulation eliminating additional Pump Down run.
  - A safe and reliable system for Toe perforating

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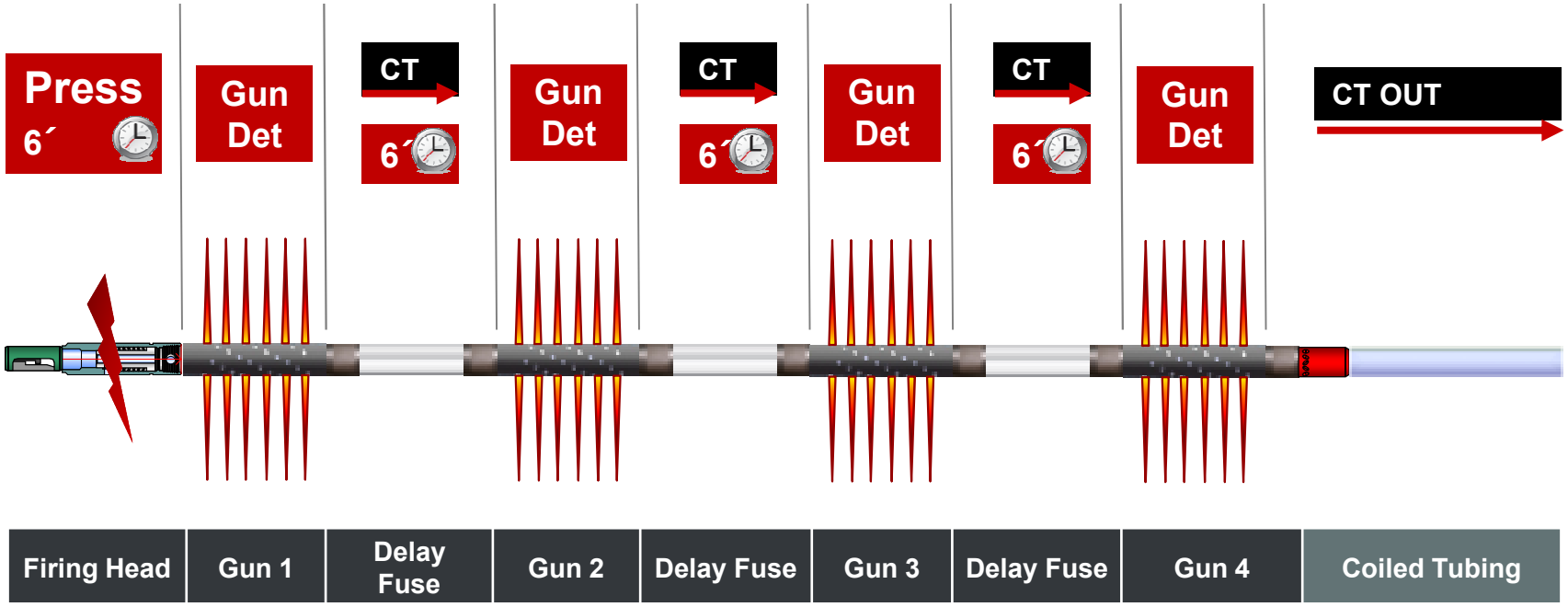
# Multi-cluster sequence

TCP Step by Step

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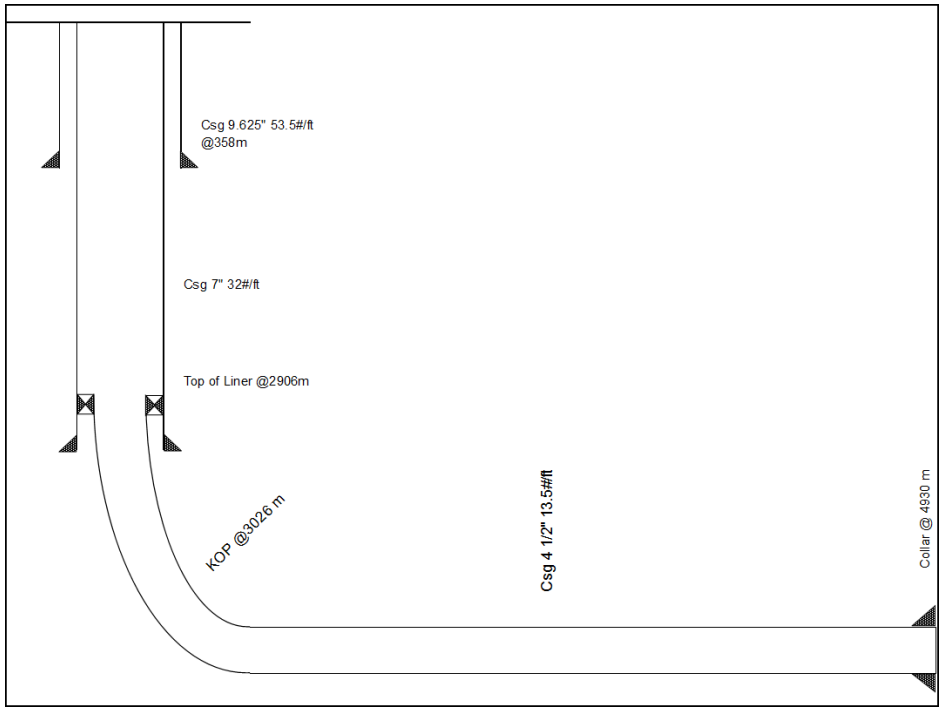
# CASE HISTORY

## Well conditions - Objective

- Operator requested to perform Toe perforation (1 gun)

- 2000mts Horizontal well
- TVD 3100 mts
- MD 5000 mts
- No Initial Perforation to perform Pump Down.
- No tractor in country.
- Shale Formation (Vaca Muerta)

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# CASE HISTORY

## Solution - TCP

- **TCP Multi-cluster with 4 guns**
- 1 ft of effective perforating length, each gun
- 2-3/4" Gun System
- Deep penetration Charges
- 6 SPF, phase 60° , RDX
- BHA Length 11.4 m
- Distance between clusters ~ 20 mts

| Element | Description |
|---|---|
| Firing Head | Pressure actuated, including delay fuse of 6´. |
| Delay Fuse | Time delay element that gives 6´ for gun positioning. |

| Item | | Description | I.D. | OD | Length | Depth (mKB) |
|---|---|---|---|---|---|---|
| CT | | Flapper | 25.4mm | 73mm | 0.00 | 4871.8 |
| | | Coil Disconnect | 21mm | 73mm | 0.00 | 4871.8 |
| | | Crossover 2,3/8 Box PAC-2,3/4 Acme SOLID | N/A | 73.00 | 0.13 | 4871.93 |
| TCP | | Gun Blank top shot | N/A | 72.00 | 0.86 | 4872.79 |
| | | Gun Load | N/A | 72.00 | 0.28 | 4873.07 |
| | | Gun Blank Botton | N/A | 72.00 | 0.23 | 4873.3 |
| | | Dual PAI | N/A | 72.00 | 0.21 | 4873.51 |
| | | Delay Element | N/A | 63.00 | 0.33 | 4873.84 |
| | | Crossover 2,3/8 Box Acme-2,1/2 Acme Box | N/A | 72.00 | 0.40 | 4874.24 |
| | | Gun Blank top shot | N/A | 72.00 | 0.86 | 4875.1 |
| | | Gun Load | N/A | 72.00 | 0.28 | 4875.38 |
| | | Gun Blank Botton | N/A | 72.00 | 0.23 | 4875.61 |
| | | Dual PAI | N/A | 72.00 | 0.21 | 4875.82 |
| | | Delay Element | N/A | 63.00 | 0.33 | 4876.15 |
| | | Crossover 2,3/8 Box Acme-2,1/2 Acme Box | N/A | 72.00 | 0.40 | 4876.55 |
| | | Gun Blank top shot | N/A | 72.00 | 0.86 | 4877.41 |
| | | Gun Load | N/A | 72.00 | 0.28 | 4877.69 |
| | | Gun Blank Botton | N/A | 72.00 | 0.23 | 4877.92 |
| | | Dual PAI | N/A | 72.00 | 0.21 | 4878.13 |
| | | Delay Element | N/A | 63.00 | 0.33 | 4878.46 |
| | | Crossover 2,3/8 Box Acme-2,1/2 Acme Box | N/A | 72.00 | 0.40 | 4878.86 |
| | | Gun Blank top shot | N/A | 72.00 | 0.86 | 4879.72 |
| | | Gun Load | N/A | 72.00 | 0.28 | 4880 |
| | | Gun Blank Botton | N/A | 72.00 | 0.23 | 4880.23 |
| | | Dual PAI | N/A | 72.00 | 0.21 | 4880.44 |
| | | TDF | N/A | 63.00 | 0.51 | 4880.95 |
| | | Plug Vent | N/A | 63.00 | 0.13 | 4881.08 |

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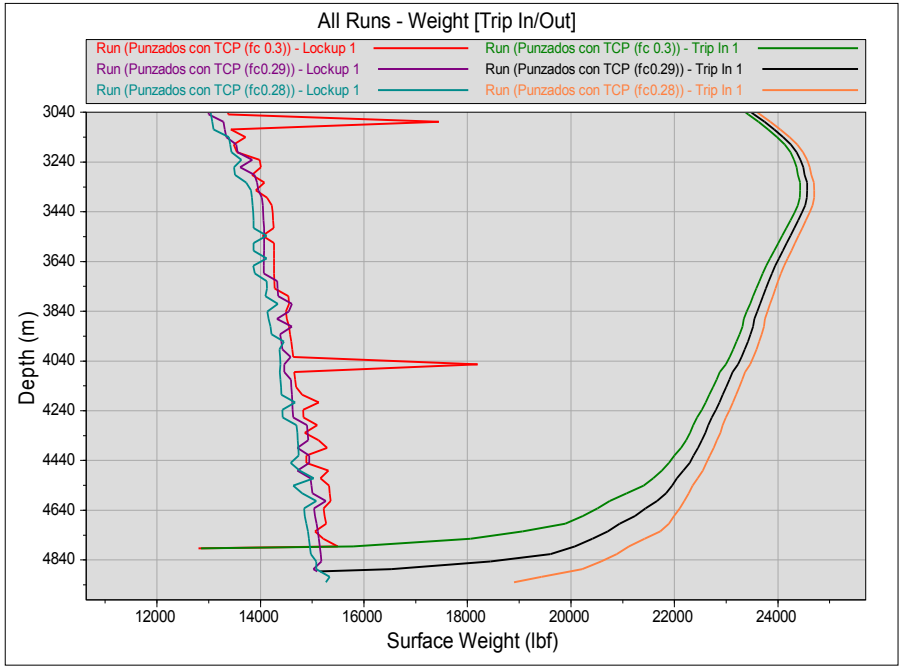
# CASE HISTORY

## BHA design Coiled Tubing - Challenge

- Achieve well depth with a no flowing tool.
- LockUp following simulation results

| FC | Lock Up Depth |
|---|---|
| 0.30 | 4793 mts |
| 0.29 | 4886 mts |
| 0.28 | No LockUp |

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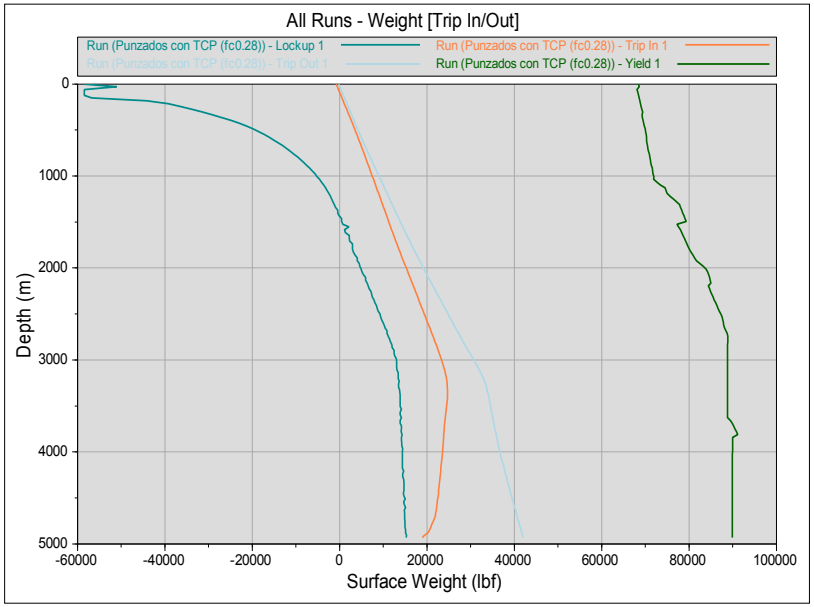
# CASE HISTORY

## BHA design Coiled Tubing - Challenge

- Based on the simulations and experience, it is necessary to perform the job with a vibrating tool and a circulation port that allows pumping through.
- Pump friction reducer.
- Following these conditions, we can consider a FC of 0.28 in order to achieve the bottom of the well.

| Depth | 4930 m | |
|---|---|---|
| **Variable** | **Value** | **Unit** |
| Max Weight RIH | 24698 | Lbf |
| Max Weight POOH | 41983 | Lbf |
| Lock Up | N/A | Lbf |
| Max Pick Up at Depth | 17124 | Lbf |
| Max Surface tension | 90291 | Lbf |
| Max set down on end | -150 | Lbf |
| CT inner pressure | 1486 | Psi |
| Annular velocity | 190(4.5")/65(7") | Ft/min |

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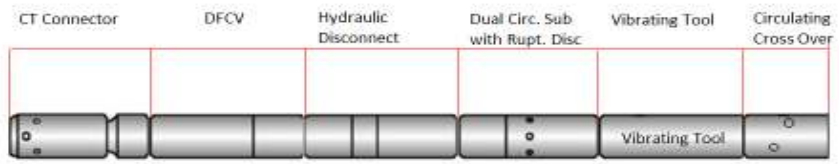
# CASE HISTORY

Solution – Coiled Tubing

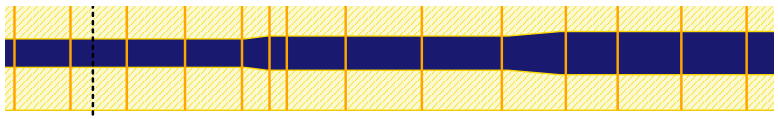
## BHA details

- CT Connector
- DFCV
- Hydraulic Disconnect
- Circulating Sub + Rupture Disc
- Vibrating Tool
- Cross Over with circulating ports (2 of 1/4”)
- Perforating Guns




## CT String

- Quality: QT-1000
- Wall Thickness
- 0 – 1897 mts → 0.188”
- 1897 – 4012 mts → 0.175”
- 4012 – 5300 mts → 0.156”



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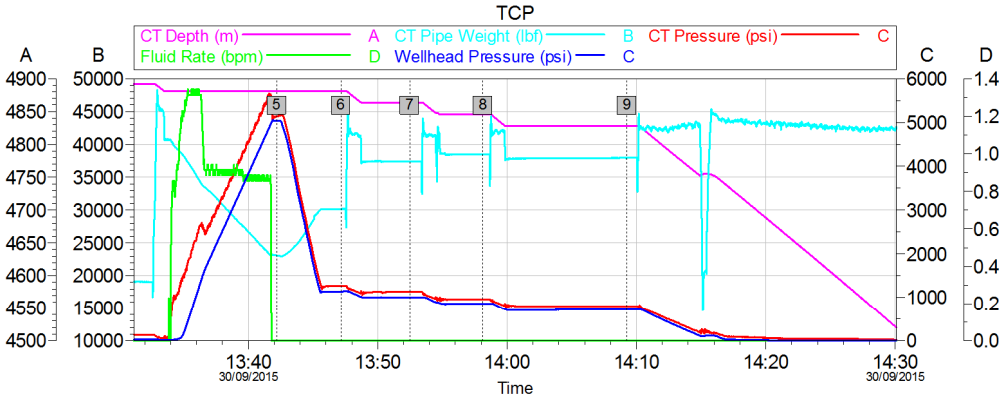
# CASE HISTORY

## Operational Description & Outcomes




Global Event Log

| | Intersection | | CD | CPW | CP | FR | WP |
|---|---|---|---|---|---|---|---|
| 5 | Initiator Activation | 13:42:12 | 4881 | 23112 | 5140 | 0.000 | 5037 |
| 6 | Fire #1 | 13:47:11 | 4881 | 30184 | 1266 | 0.000 | 1143 |
| 7 | Fire #2 | 13:52:29 | 4864 | 37384 | 1132 | 0.000 | 1005 |
| 8 | Fire #3 | 13:58:08 | 4846 | 38498 | 957.0 | 0.000 | 858.0 |
| 9 | Fire #4 | 14:09:17 | 4828 | 37947 | 793.0 | 0.000 | 721.0 |

- CT reaches Max Depth to correlate with Collar.
- Detonation sequence initiated by applying 5000 psi over Firing head (pressure actuated)
- Gun detonation not detected at surface.
- Guns positioning performed by monitoring time and delay sequence.
- Coiled Tubing POOH and Gun detonation confirmed at surface.

**Hydraulic treatment executed avoiding the additional Wireline intervention for Pump-Down run.**

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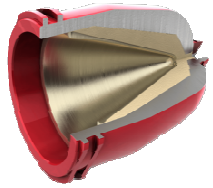
# CONCLUSION



- Cluster distribution (for Toe Perforating) executed according to the frac plan.
- Improved perforating design to reduce the need of pumping additional treatments.
  - Increase N° of shots/guns
  - Use of different shaped charges technology to improve tunnel clean up.
- Has been proven effective and safe for toe perforating.
  - This is a feasible option for complex-geometry well.
  - Early production of collapsed wells.
- Operator saving and additional Perforating run to complete the stage design.

- Execute the entire completion program replacing other perforating technics.
  - Plug & Perforating run deployed by Coiled Tubing.

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# QUESTIONS? THANK YOU!