SPE-212879-MS

Complex Operation to Insert Coiled Tubing Through Parted Production Tubing and Regain Pressure Integrity for Plugging and Abandonment

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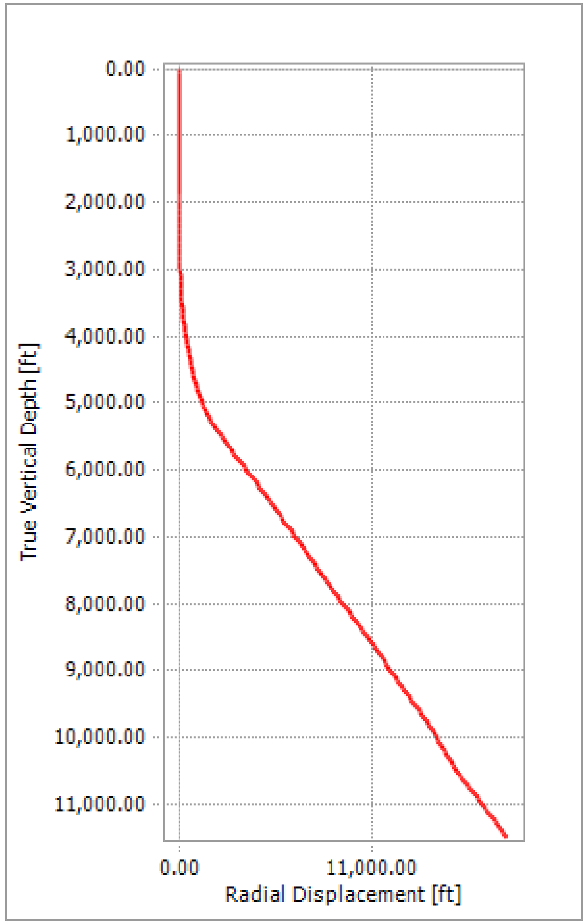
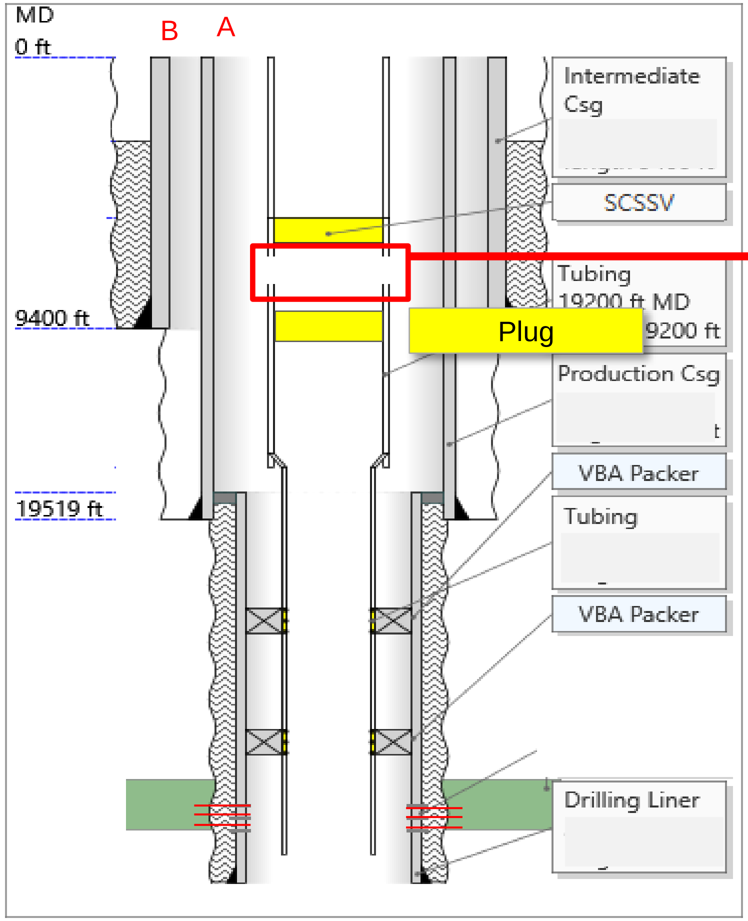
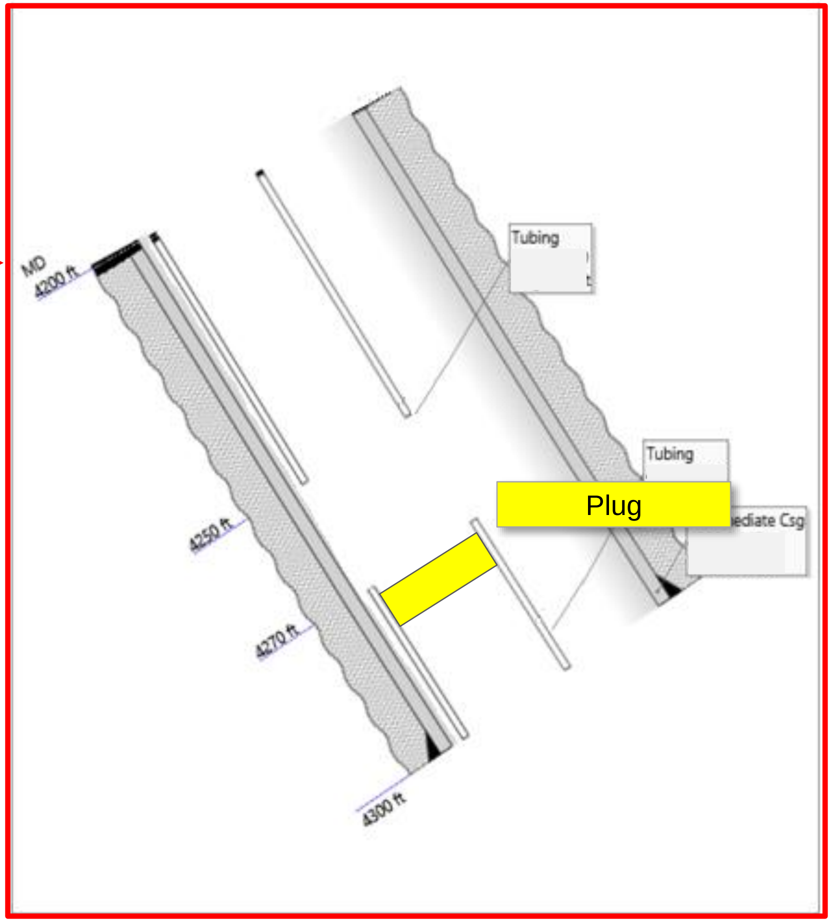
Agenda

- Well Background
- Planning
- Challenges
- Technology
- Solutions
- Execution Details
- Best Practices/Lessons Learned
- Results/Summary
- Q&A

Well Background







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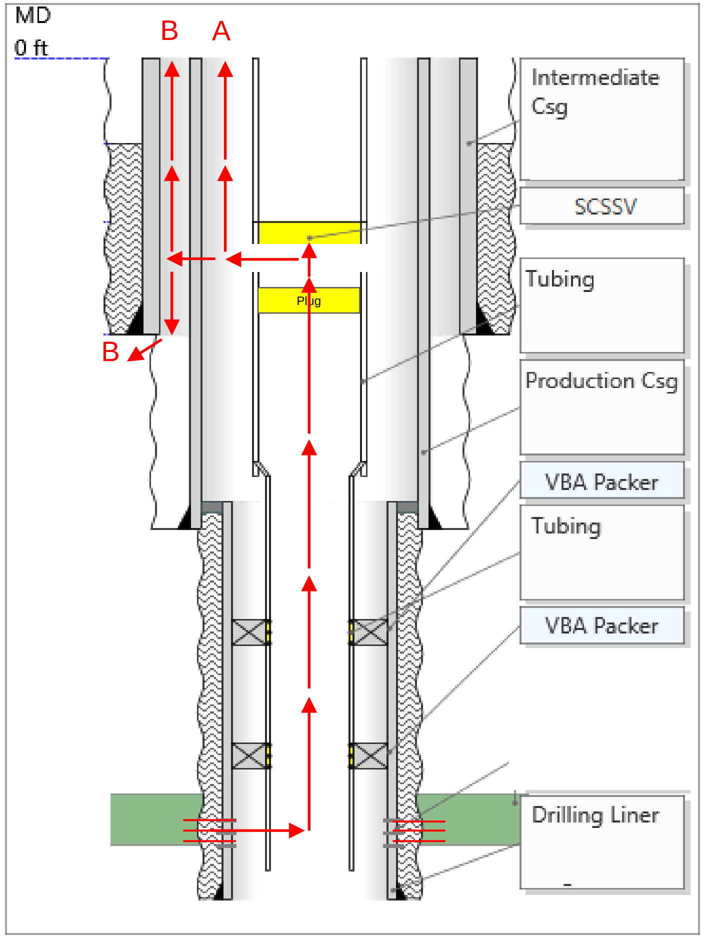
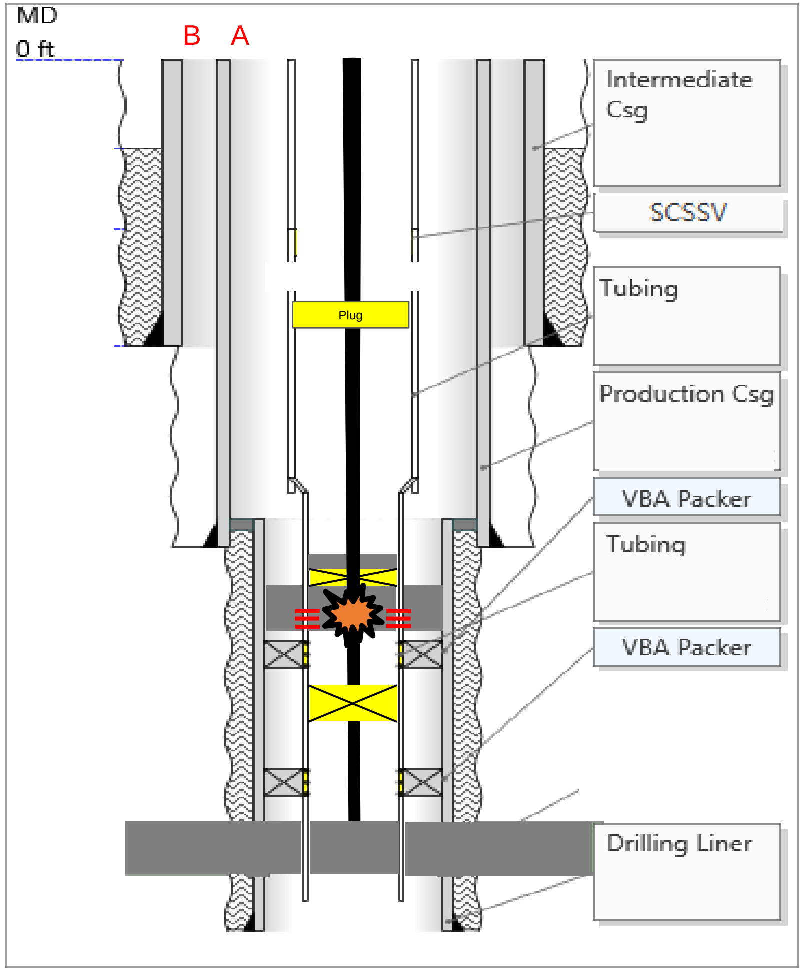


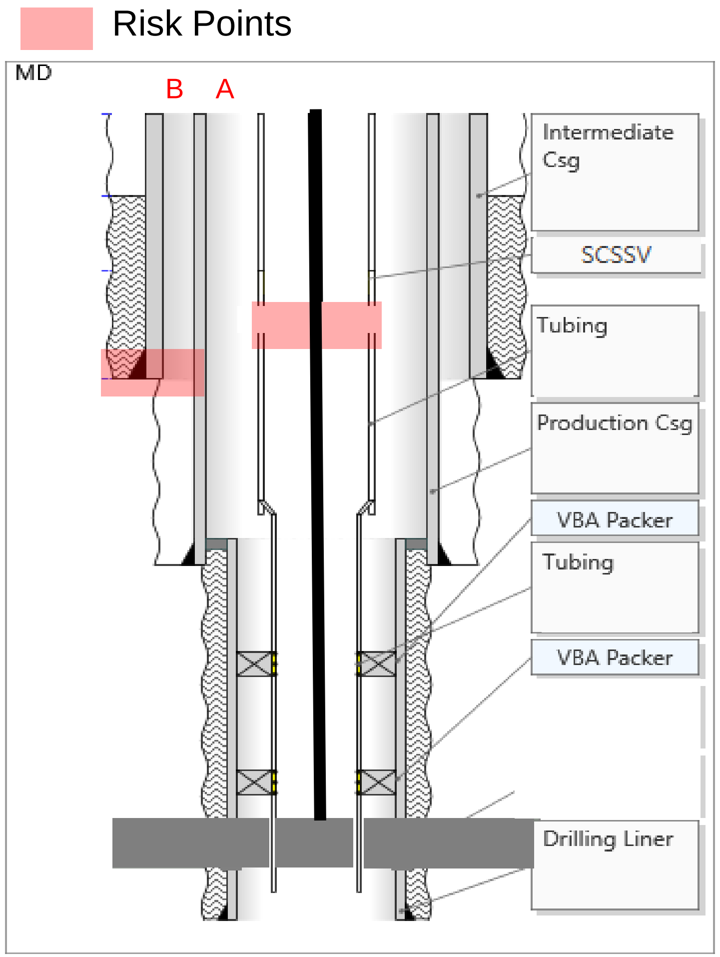
- Well shut-in and still building pressure
- Plug not holding, additional tubing leaks or completion VBA packer leaking
- Known communication between A-annulus and B-annulus
- Single barrier on both the A-annulus and B-annulus (casing hanger) history of leaks/repairs
- Attempt to further mitigate the risk profile by setting an abandonment plug before hurricane season
- Alternatives considered to return well to safe state/in compliance:
  - Zonal isolation via electric line with tractor
  - Permanent abandonment via hydraulic workover unit

Planning



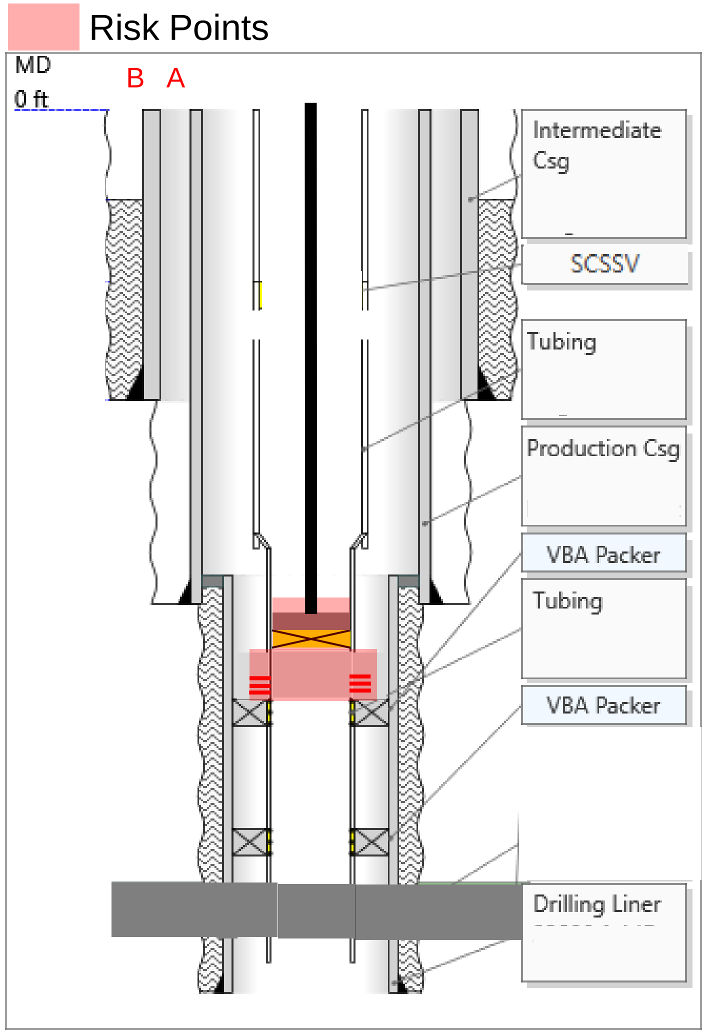
Plan to Restore Pressure Integrity in the Well	Depth [ft]
E-line pull plug	~4,900 MD
Abandon the producing zone by Bradenhead squeezing cement	~23,500 MD
(Contingency) Test this cement barrier by setting packer	
Perforate the 3 1/2-in. tubing in preparation for balanced plug	~22,350 MD
Set a retainer and place 500-ft balanced plug in A-annulus and tubing	~21,850 MD
Lay in cement on top the retainer	
(Contingency) Test this cement barrier by setting packer	

Challenges



- Unable to enter lower section
- Uncertainty of whether CT entered the tubing or annular space
- Unable to pick back up into the upper section
- Surface pressure limitations due to open 13 3/8-in. shoe and A/B annulus communication
- Pumping cement through CT with fiber-optic cable installed
  - Cable can be buckled, kinked, or ripped off from the connections due to friction drag forces of cement
  - Erosion of fiber-optic cable from solids
  - Cement bonding between fiber-optic cable and CT/connectors
  - Leftover cement can interfere with the other BHAs
  - Pressure ports on tool can become plugged

Challenges



Perforating the 3½-in. production tubing

- Depth control for perforating (between VBA packer and downhole pressure gauge)
- Poor indications of guns firing
- Risk of retrieving live guns through parted production tubing
- CT becoming stuck with undetonated charges
- Orienting the guns with knuckle joints and bow spring

Setting retainer, placing 500-ft balanced plug

- Retainer element damaged by tubing part
- Not able to confirm retainer is fully set due to pressure communication at the part below and above the retainer
- If not fully set, cement could go around retainer onto backside of CT
- Retainer prematurely setting in production tubing

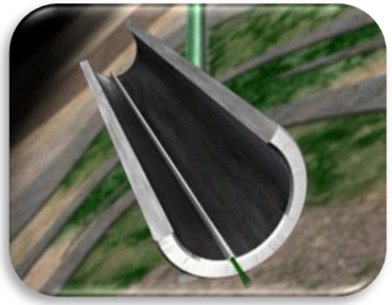
Technology

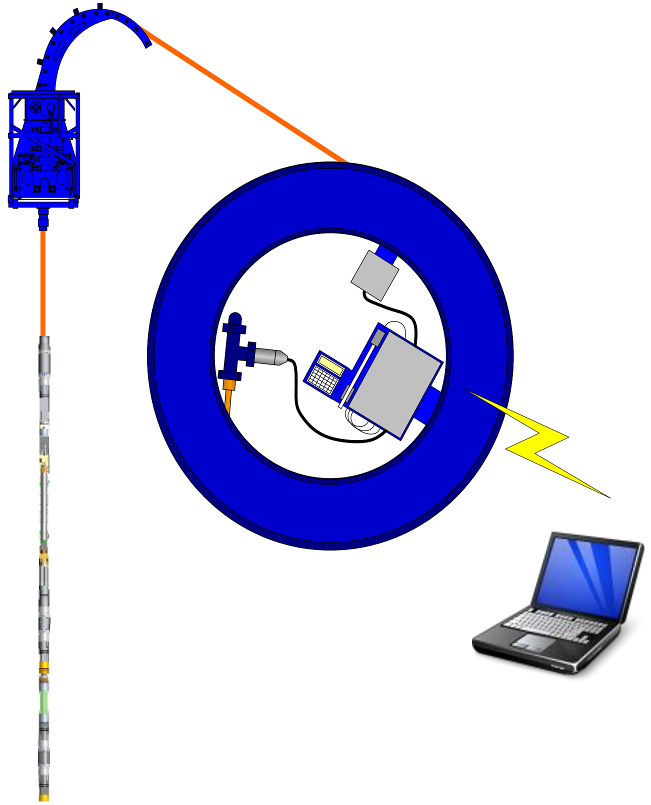
Real-Time CT Bottomhole Assembly (BHA)

- Pressure, temperature, and casing collar locator (CCL)
- Real-time fiber optic telemetry

Resolves Common CT Uncertainties

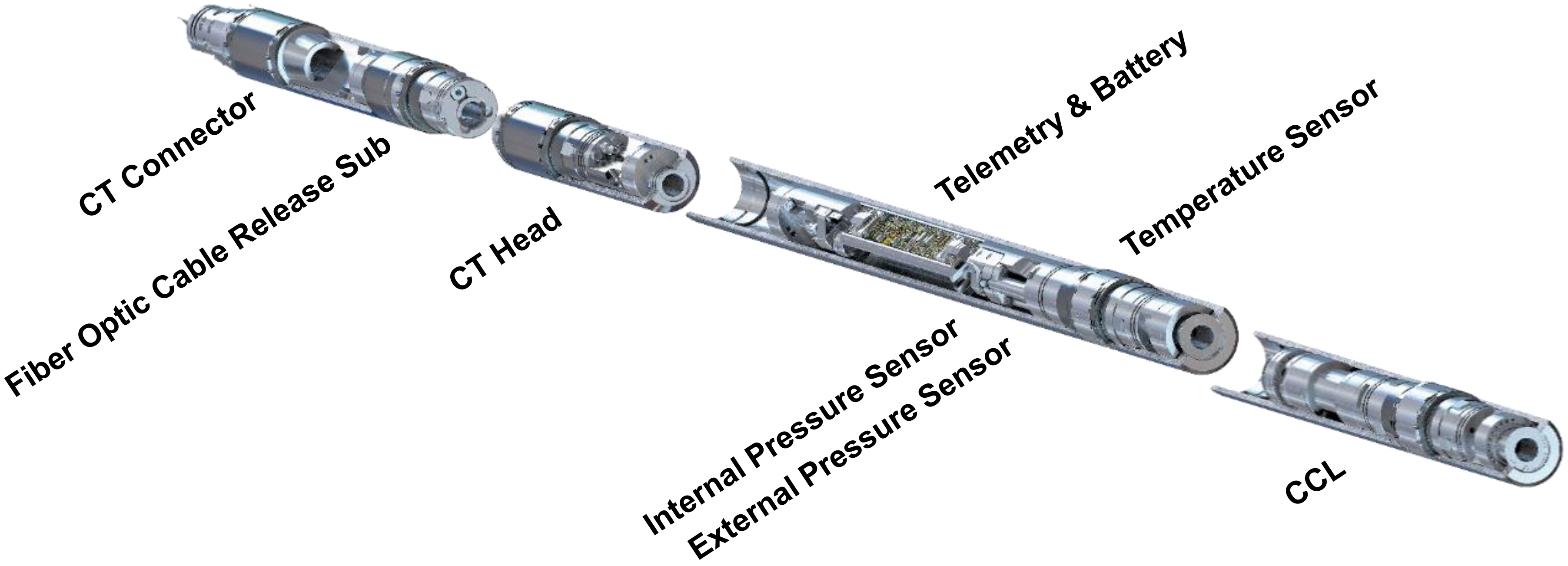
- Determining an accurate depth of the tool end
- Monitoring and controlling downhole pressure
- Identifying if wellbore is being loaded with sand or debris
- Monitoring differential pressure across the tool
- Verifying perforating tools are operating effectively





Technology

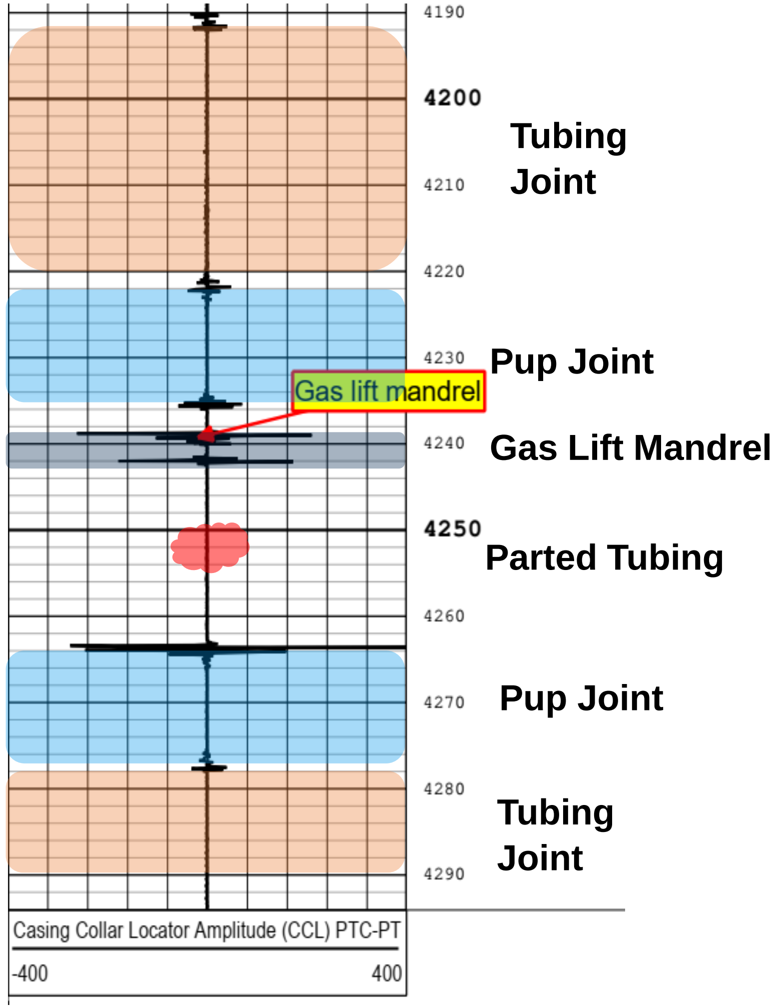
Real-Time CT Bottomhole Assembly (BHA)



Solutions

CCL used to detect tubing anomalies

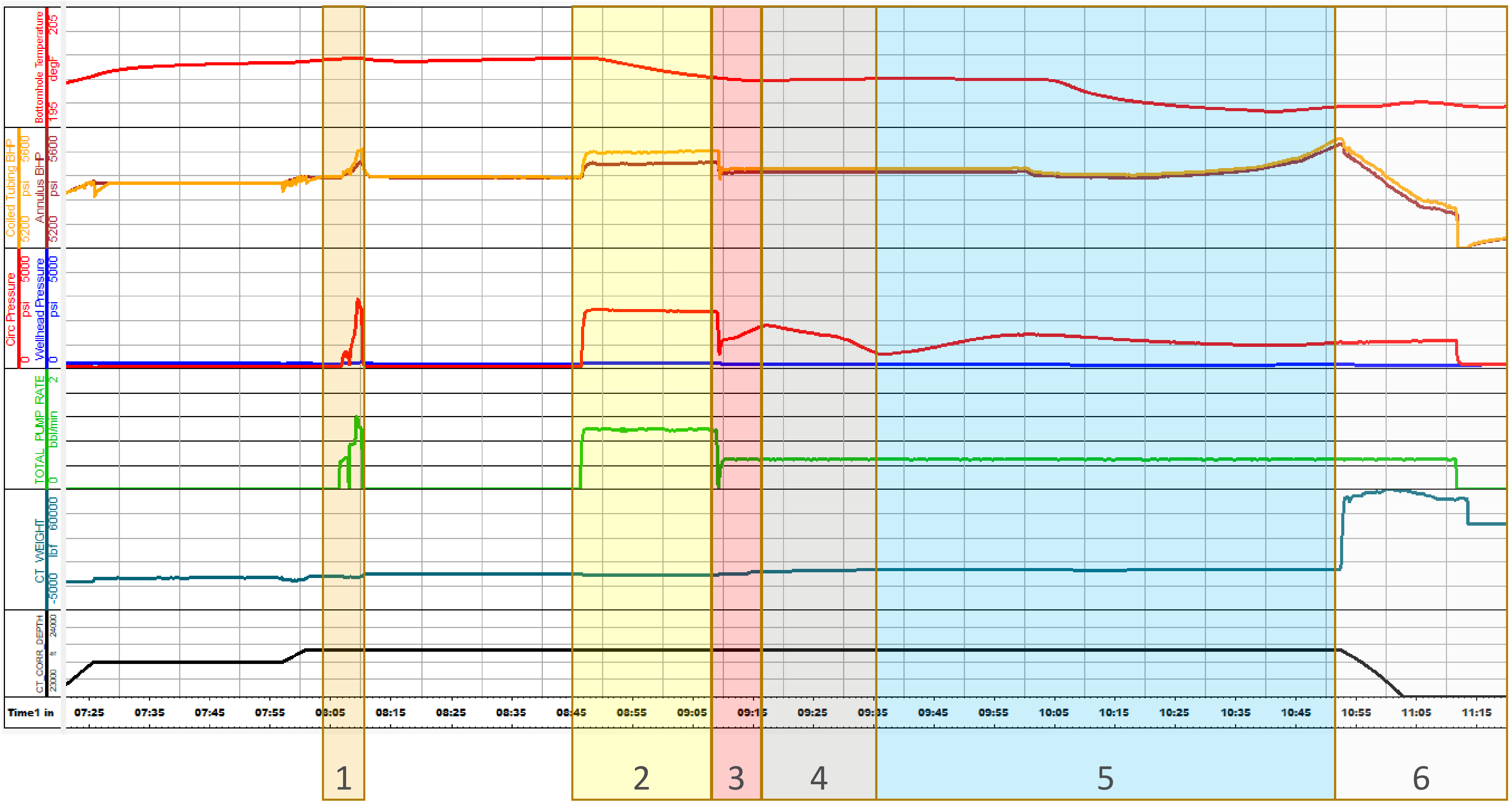
- Identify when CT entering the annular gap between the tubing and the casing, when entering the lower part of the tubing
- Verify CCL signature, amplitude, and spacing between the collars match the tubing tally
- Use in conjunction with surface weight trends



Solutions

- Custom cement blend with limited suspended solids, low plastic viscosity, and yield point
- QA/QC performed on location during mixing
- Maximum pump rate of 1 bbl/min, when passing pressure bulkhead
- Retarded pill pumped immediately after finishing cementing
- Once back at surface, CT displaced to a custom laboratory-tested solvent and allowed to soak
- Tools serviced thoroughly and external pressure ports cleaned once back at surface

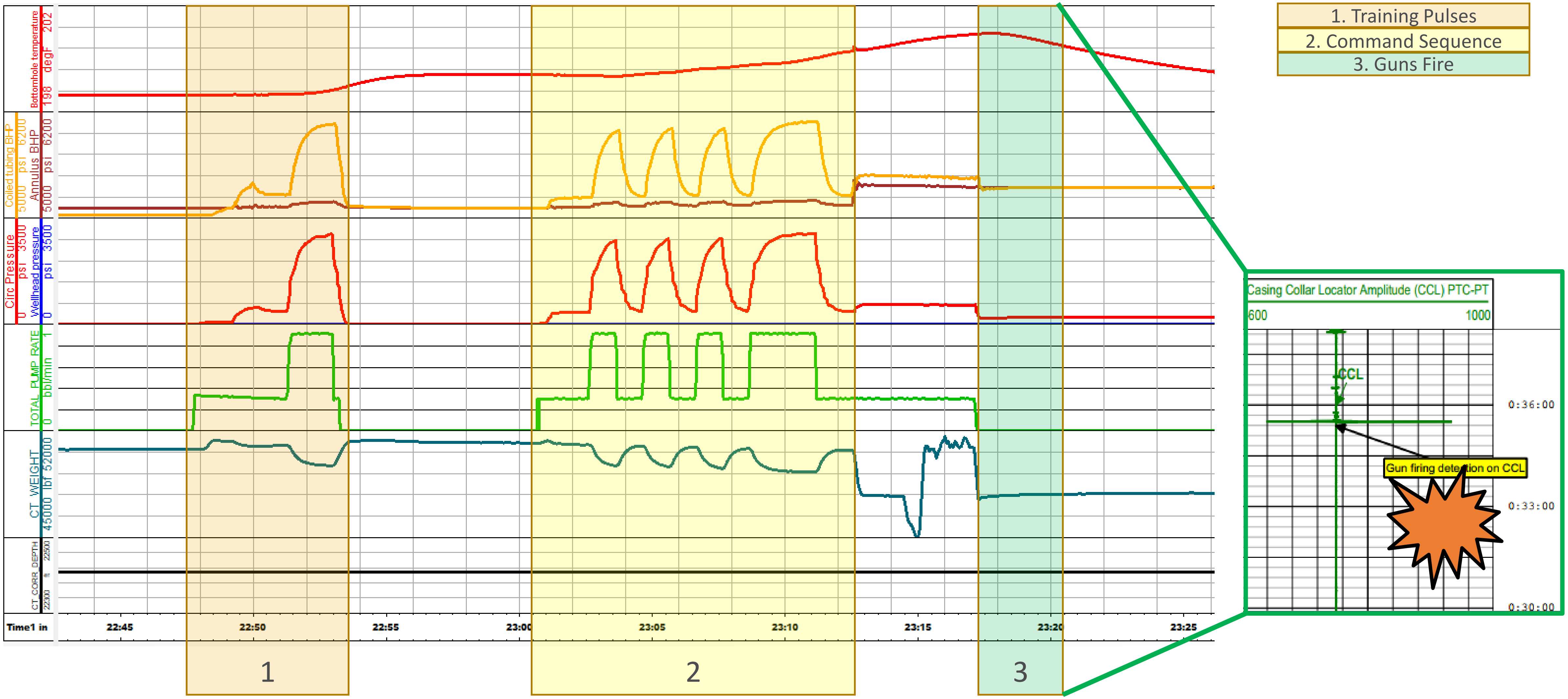
Run 1 - Isolate the Producing Zone



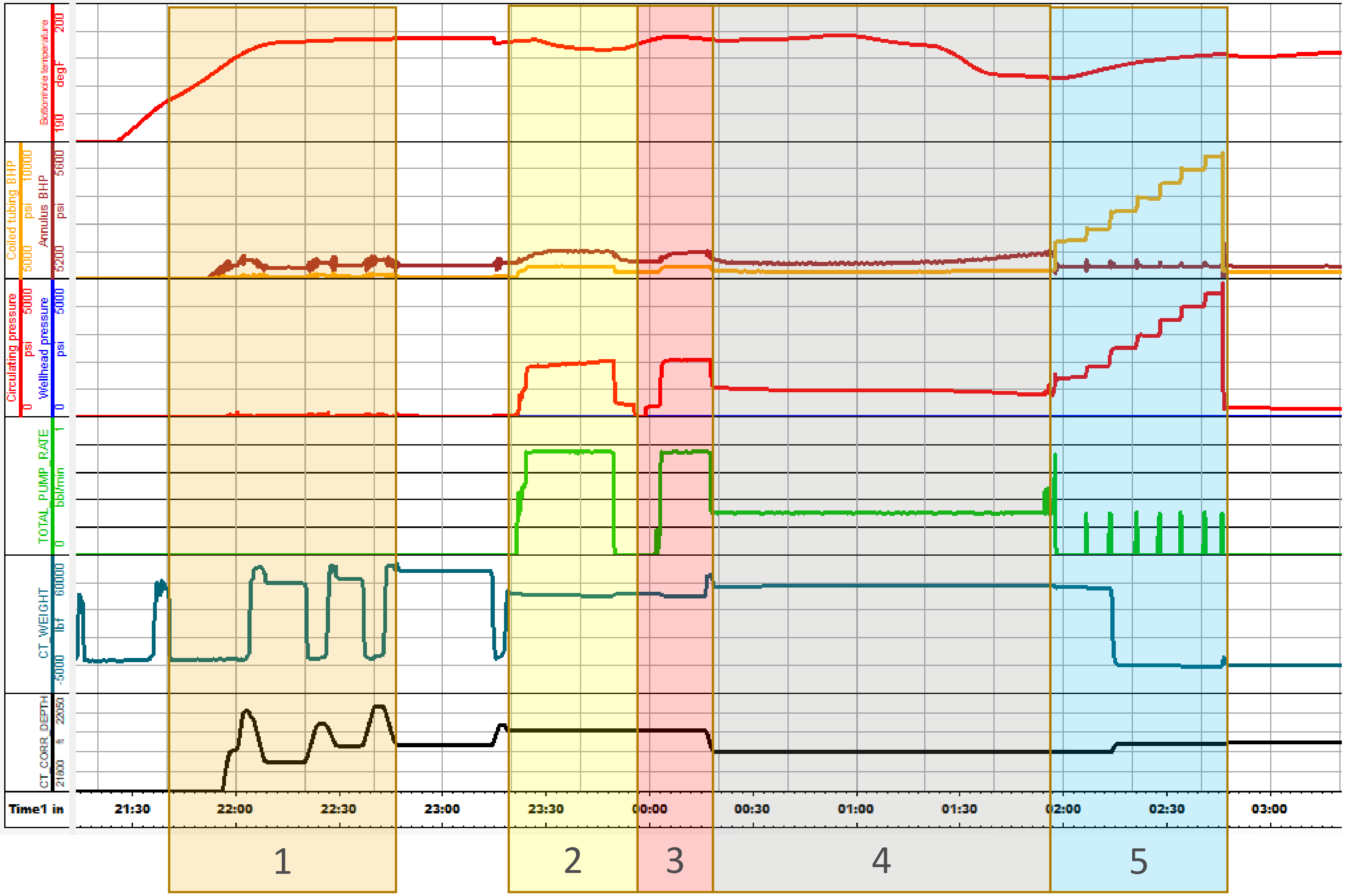
1. Injection Test
2. Lead Spacer
3. Cement
4. Tail Spacer
5. Displacement
6. Lay in Cement

Rate (bbl/min)	Pressure (psi)
0.5	233
0.75	243
1.0	272

Run 2 – Perforate 3 1/2-in.Tubing



Run 3 – Set Retainer, Pump 500-ft Balanced Plug



1. Depth Correlation
2. Lead Spacer
3. Ball Dropped
4. Ball Displacement
5. Seating Retainer

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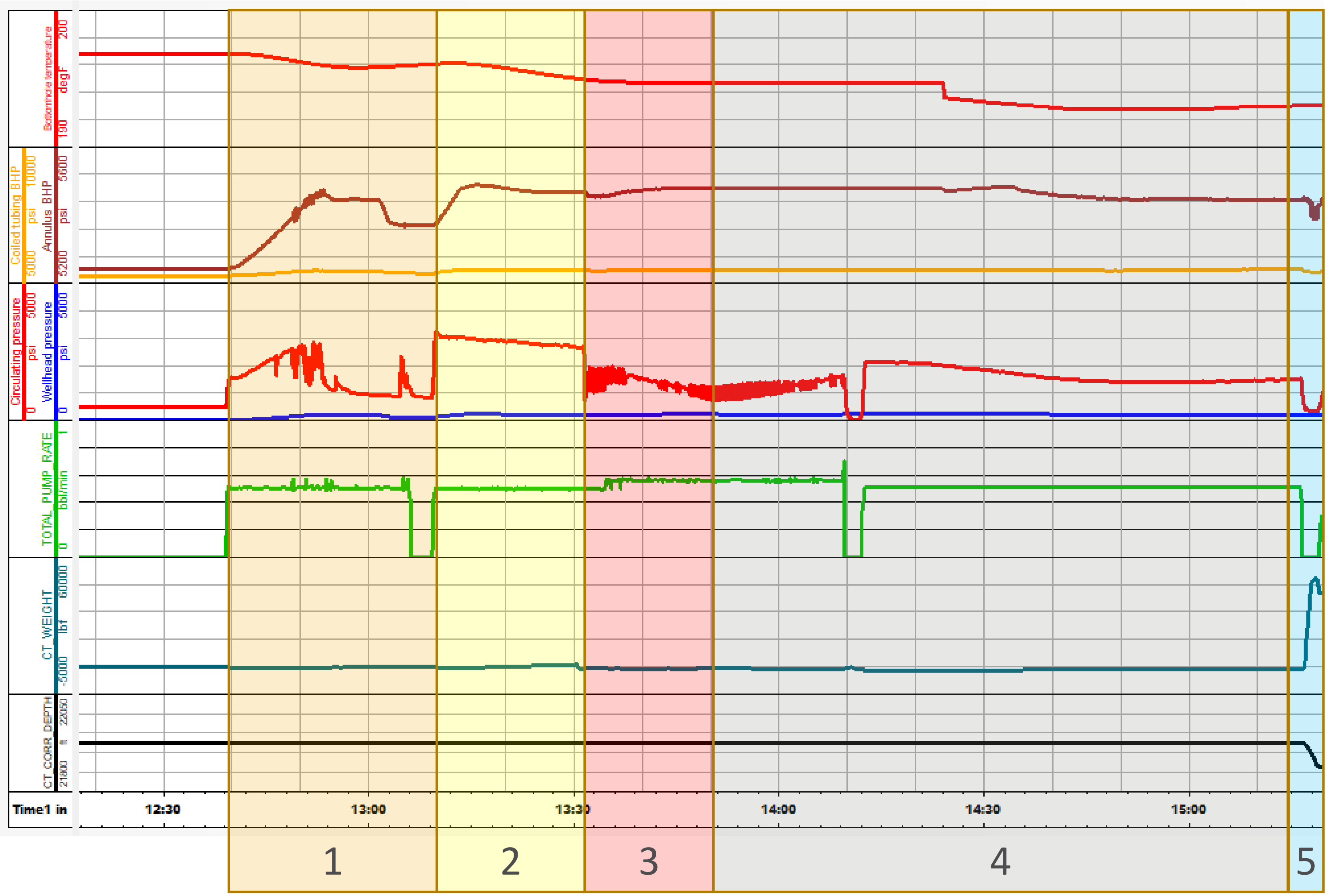
Run 3 – Set Retainer, Pump 500-ft Balanced Plug



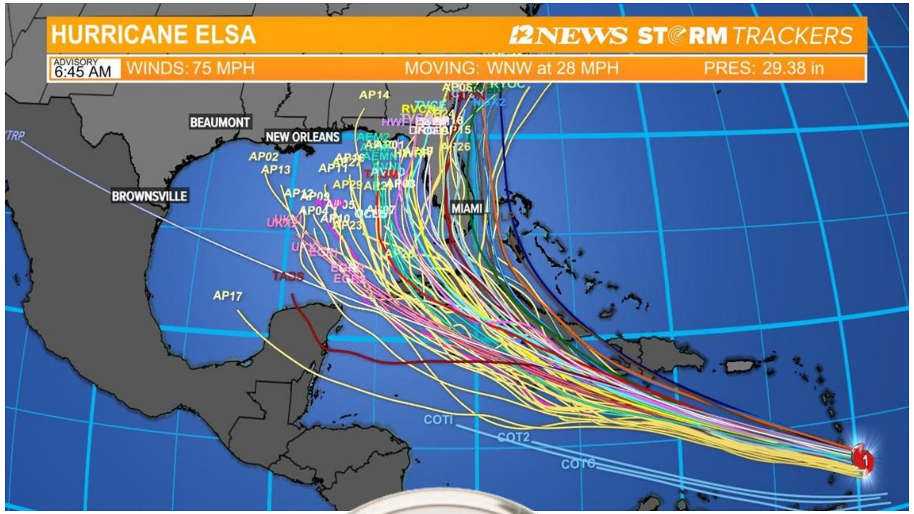
1. Lead Spacer
2. Cement
3. Tail Spacer
4. Displace and Set Cement
5. Disconnecting From Retainer

Lessons Learned/Best Practices

Key Challenges	Key Risks	Lessons Learned/Best Practices
Running tools across tubing part	Not being able to get into the tubing stump, stuck CT, damaged tools	CCL for confirmation, BHA length to straddle part, centralizers contingency, camera contingency
Depth control with CT for perforating	Additional run needed, perforate off depth, not sufficient uninterrupted cement (TEC cables)	CCL for depth correlation
Confirmation of TCP guns firing	Retrieving live guns through tubing part or back to surface, mis-run, safety concerns	Pressure, temperature, and CCL signals for confirmation of detonation
Potential to circulate cement on top of CT without testing if retainer is fully set	Cement CT in the well, stuck CT	Monitor annular BHP, circulate out cement if BHP increases

Results/Summary

- ✓ No stuck pipe incidents, mis-runs, or additional trips
- ✓ CT able to enter/exit tubing stump in highly deviated well with parted tubing
- ✓ Real-time CT bottomhole assembly provided confirmation of perforating and prevented cement from bypassing retainer
- ✓ Real-time depth control eliminated additional CT correlation run with memory tool
- ✓ No need to resort to a full hydraulic workover unit
- ✓ Barriers placed and tested and well returned to safe state and in compliance before Hurricane Elsa



Conclusion

This case study emphasizes the importance of complementing conventional cementing techniques with real-time downhole measurements.

The real-time CT downhole measurements provided key data to safely access the lower completion and enabled conducting the zonal isolation work required to suspend a highly deviated well after 20 ft of parted production tubing, annulus communication, and leaks in the 9 5/8-in. casing and 13 3/8-in. casing shoe were identified.

The pressure, temperature, and CCL measurements proved invaluable by providing the necessary guidance to successfully set the inflatable packer and fire the perforating guns.

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Thank you! Questions?