Optimizing Drillouts using Real-Time Modeling

Increase visibility, define measurables, improve operations

Presented by:
Travis Thomas, Director of Digital Completions
NOV Inc.

Agenda

- What is the Problem?
- CT Data History
- Solution
- Conclusion
- Future Uses

What is the Problem?

- Coiled tubing is still getting stuck after decades of horizontal shale drillouts
  - A multitude of engineering and operational efficiency projects have been dedicated to alleviating stuck scenarios

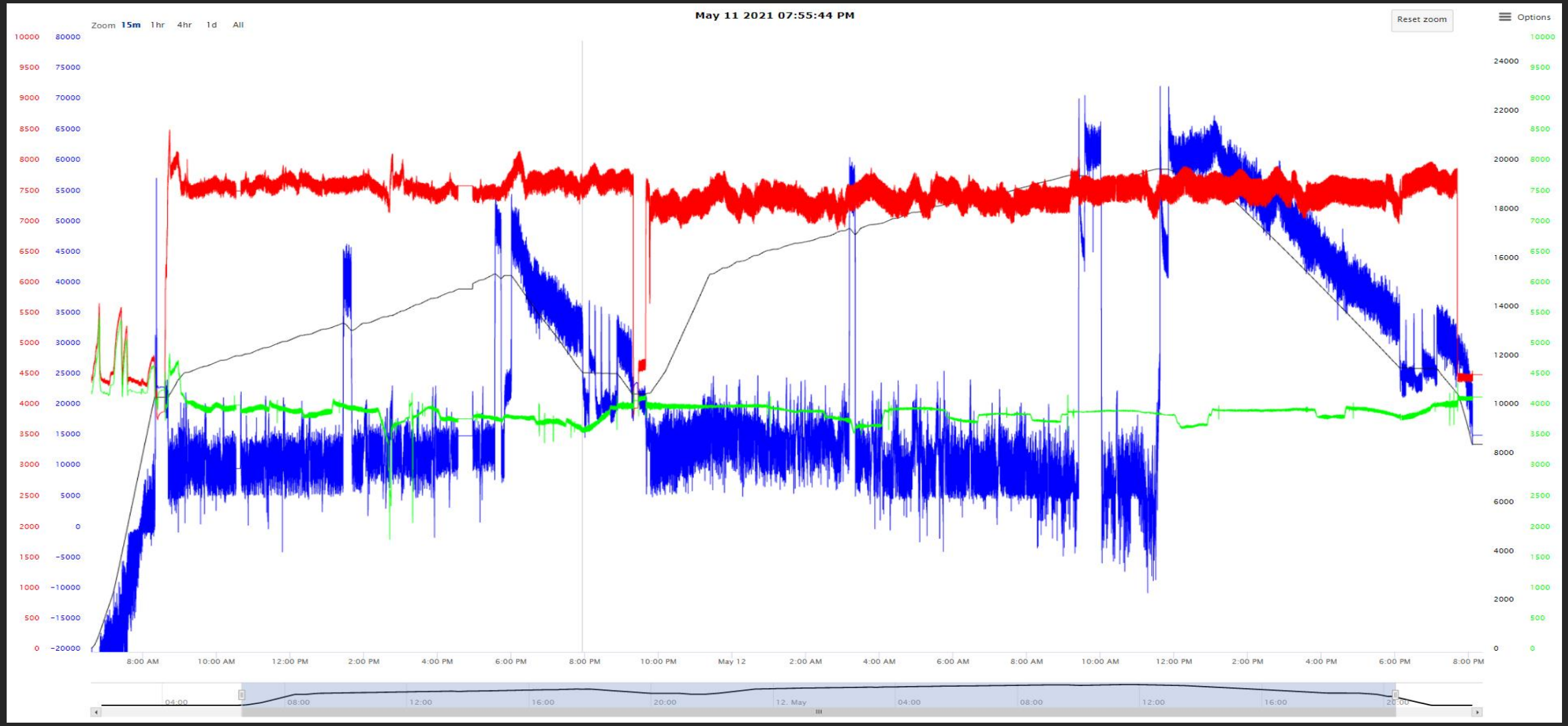
What is the Problem? (continued)

- Field operations utilize inherited practices and rules of thumb in place of proven technology
  - High-viscosity sweeps in HP horizontal wells are still common practice
  - Short trips
  - RIH – POOH speeds
  - Pounds of plug parts in 5-gal buckets
- Data captured but not shared in the CT unit
  - Only used post job or post-failure
  - Downhole tool data
  - Flowback data
  - Fluid rheology, (chemicals, rates)
  - Previous well info – drilling, frac, plug info
- Engineering processes are disconnected from field operations
  - Tubing force analysis (TFA) are performed prior to drillout operations but the information is not shared with CT or E&P field operations
  - Only shared in the event there is a problem
  - Guidelines, SOP, Information not shared with field operations.

History – How did this problem occur

- Operation Pluto – CT inception
  - Vertical cleanouts, acidizing, vertical drillouts, fishing, and interventions
- Data capture – 100% for fatigue analysis
  - Operations predominantly on paper logs
- Various operations required engineering on location
- Shale Revolution – Canned 24/7 operations, engineer now in the office
  - Remote operations but not connected to the field
  - Constant phone communication from multiple sources
- 10+ years of CT evolution, DHT evolution, drillout fluid evolution, and rejection of data

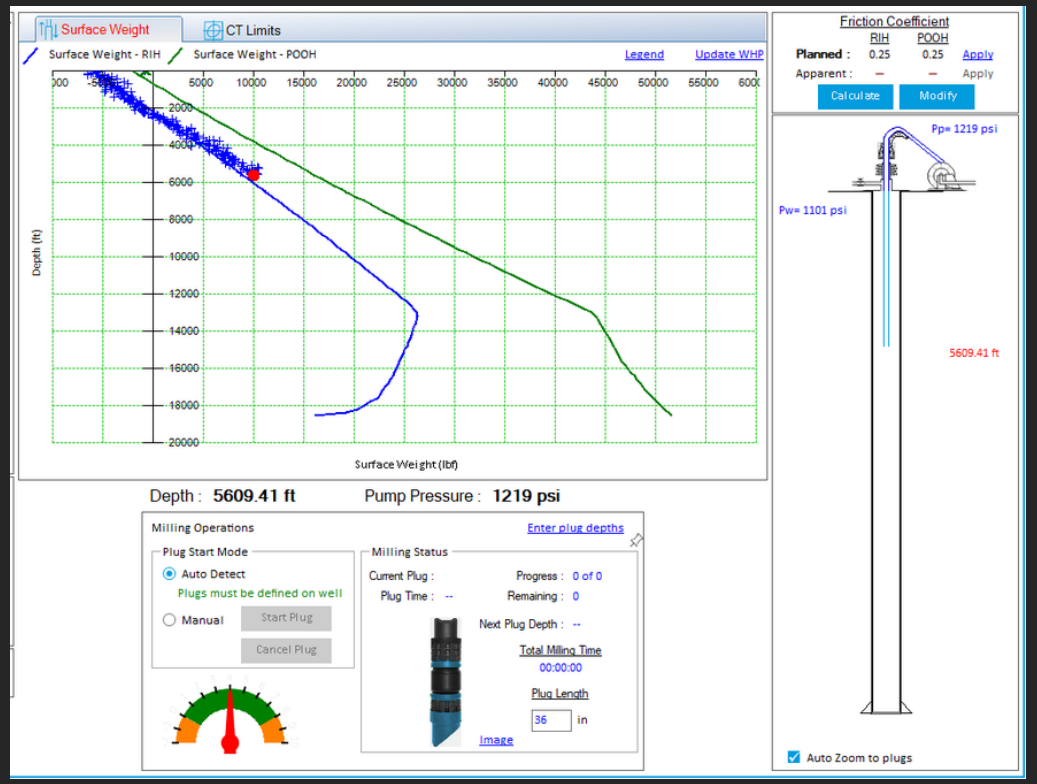
Common CT Drillout View



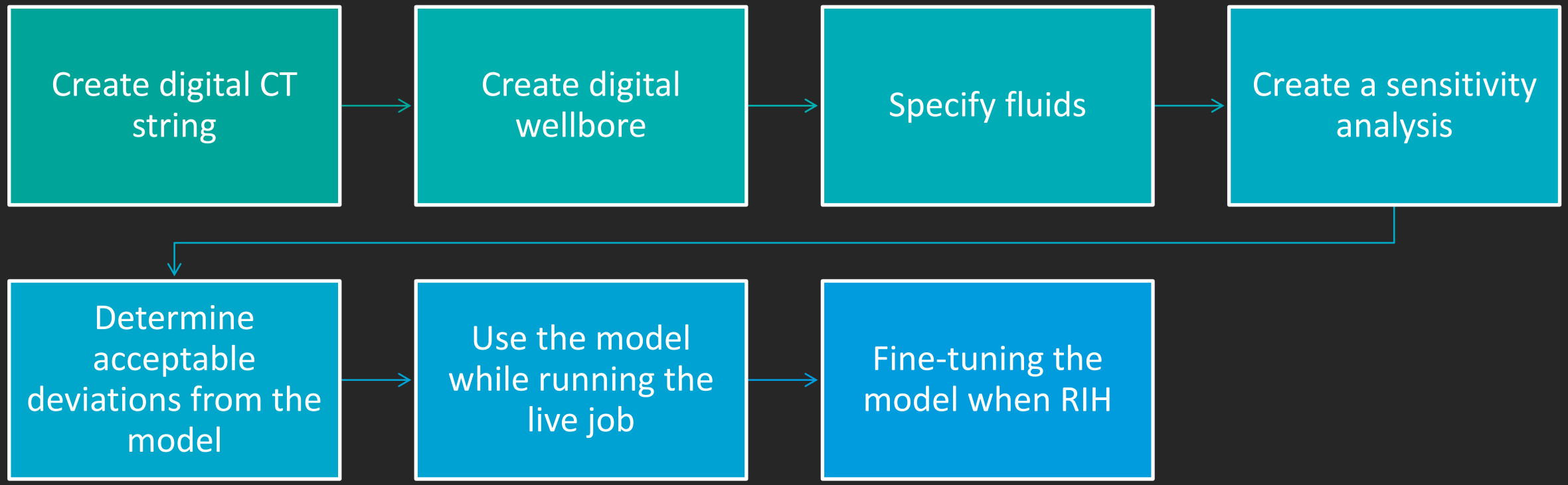
Solution

- Connect real-time data to the engineering model allowing operators and supervisors to make operational decisioned based on deviations from the model and proven efficiency metrics.

- Through integrated live data streams, this can be monitored, and critical well parameters can be changed on the fly to create a more accurate model



Relating TFA to Real-Time Process Data



RT Analysis & Deviations – RIH

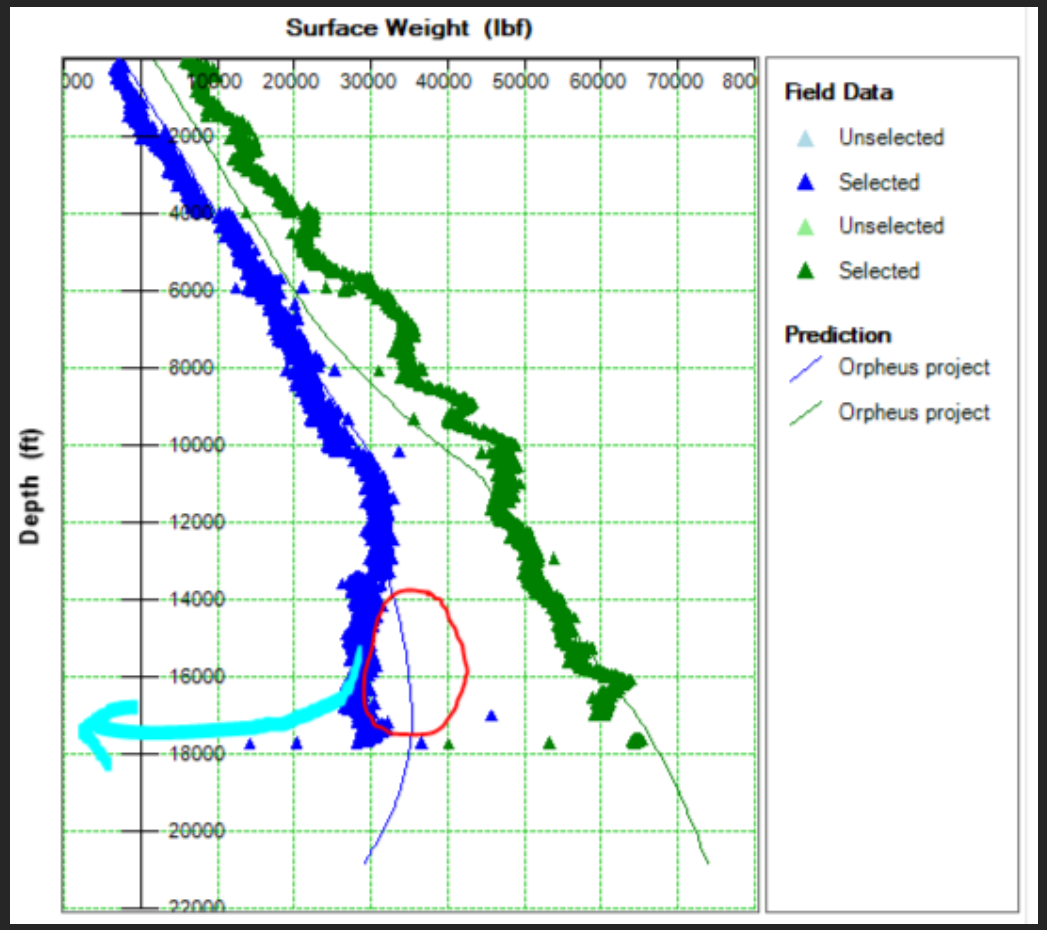
If the RIH values are less than the planned value by the predetermined offsets, this is indicative of the following issues:

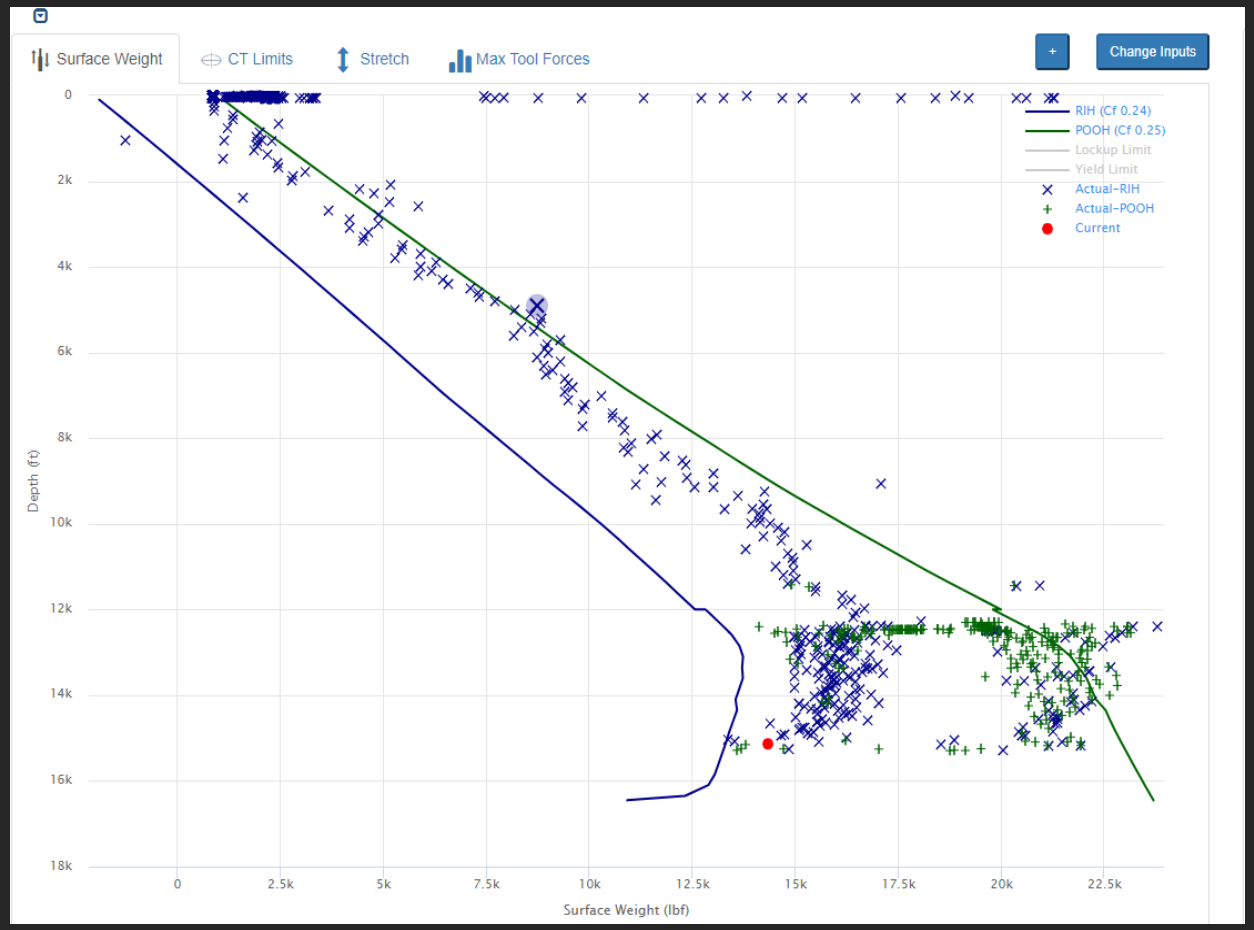
1. Weight indicator calibration issues
2. Updates needed to the model for actual well variables
3. Underperforming extended-reach tool (ERT)
4. Debris in the wellbore

RT Analysis & Deviations – RIH

- Relating data to the model to determine deviation cause:
- Determine the cause of the deviation.
  - If modeled data's inputs have not deviated from the actual well conditions and the weight data was previously matching the modeled data, the model can be eliminated as the deviation.
  - If the measured depth is less than the .30 CoF lockup depth, an ERT performance issue can be eliminated as the cause of deviation.
  - BHA performance issues are indicated when the project experiences an apparent friction increase, and the CT can still progress in hole, but the weight checks do not indicate any debris in the well.
- Debris as the cause of the deviation can be assumed by the following:
  - Eliminating the above concerns
  - Witnessing torque differential on the BHA
  - Witnessing divergent pressures indicate bridging behind the BHA
  - Continued movement in hole, but only with increased set-down force and overpulls on weight checks

RT Analysis & Deviations – RIH





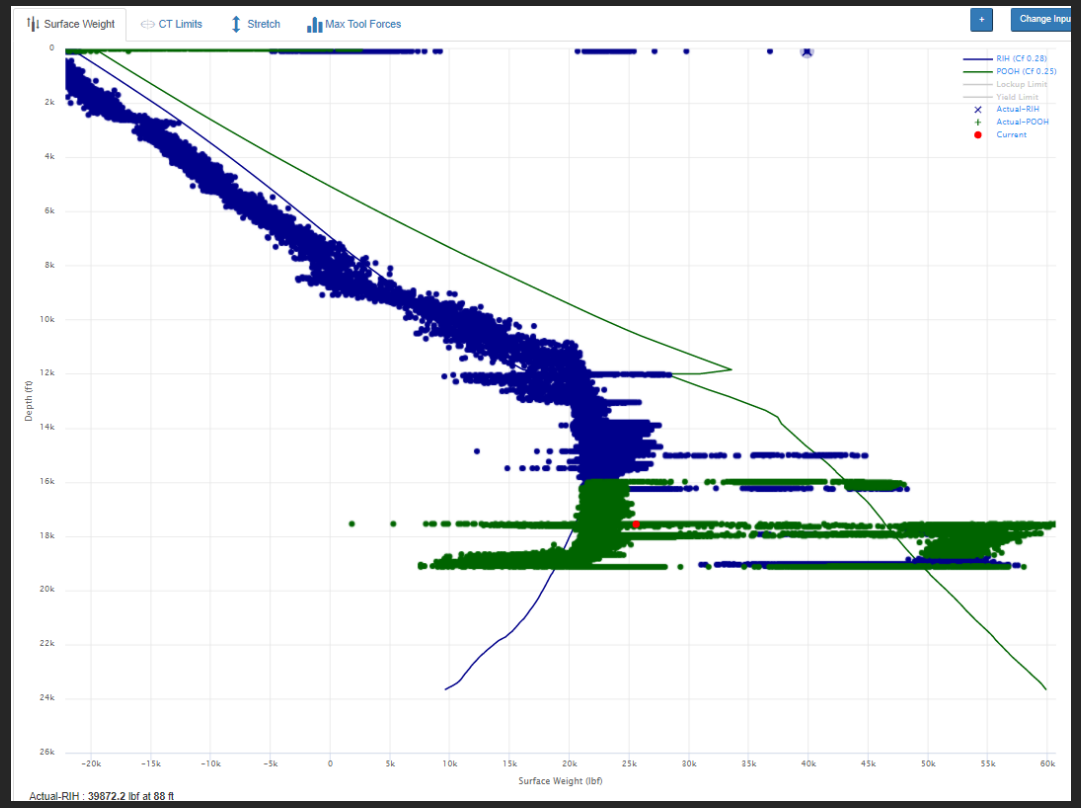
RT Analysis & RT Deviations – POOH

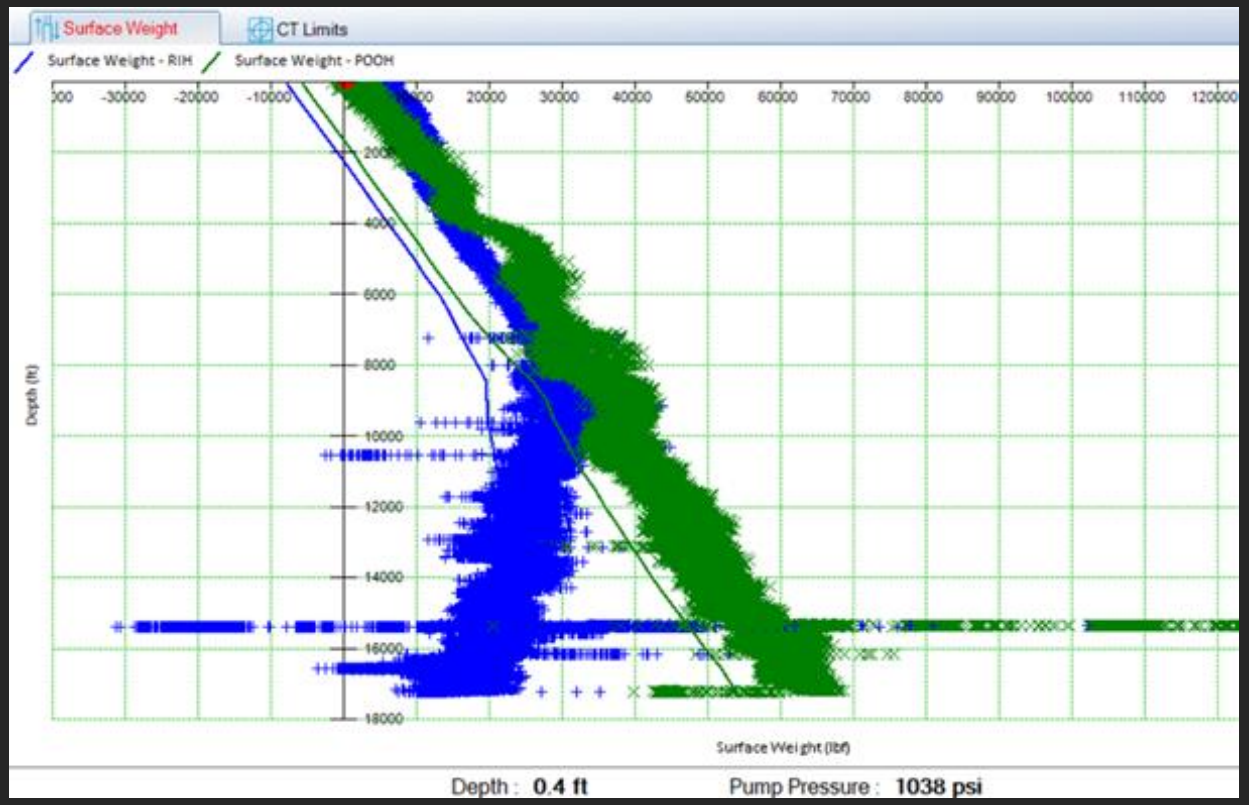
If POOH values are greater than the planned values by more than the predetermined offsets, this is indicative of one of the following issues:

1. Weight indicator calibration issues
2. Updates needed to the model for actual well variables
3. Debris in the wellbore

- Relating data to the model to determine deviation cause:
- Verify the weight indicator readings versus the hydraulic calculations
  - If weight indicator varies from the hydraulic calculations, calibrate the weight indicator and continue with operations.
  - If the weight indicator does not vary from the hydraulic calculation, this indicates debris in the wellbore. Further pulling heavy can result in debris bridging and stuck pipe. Stop and circulate the well clean. If possible, RIH to assist in static friction reduction of the debris, which increases debris removal.

RT Analysis & RT Deviations – POOH





Conclusion

- CT modeling and real-time data are used to retroactively analyze job operations and when actively engaged during a job, it allows the user to make optimized job decisions.
- Data is king: without data, you only have stories, as per Pope (2017)
- The tools to analyze and act on TFA deviations are available in most coiled tubing units today
- Real-time monitoring can allow both the service company and well operators see the key indicators of stuck pipe situations prior to experiencing a stuck event

Future Uses – Questions?