

Underbalanced CT Drilling With Real-Time Downhole Instrumentation: Lessons Learned



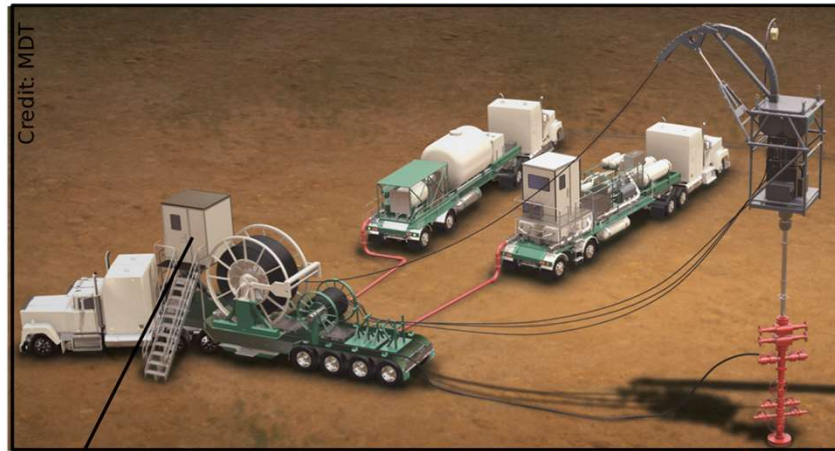
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Timberstone Tools Inc.

Introduction

- Project (Vertical deepening, underbalanced CT drilling)
- Contributors (STEP, GDI, TTI)

Presentation Overview

- What equipment was used to collect the data?
- The operator interface and data merging
- Real-time downhole data – Who cares?
- Four examples taken during drilling

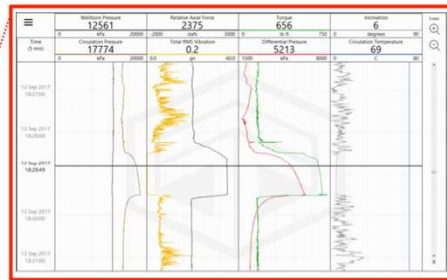


Surface Measurements

Feed Rate
Depth
String Weight

Pumping Rates
Circulation Pressure
Wellhead Pressure

Coil-Link Control Unit
logs data and
broadcasts data stream

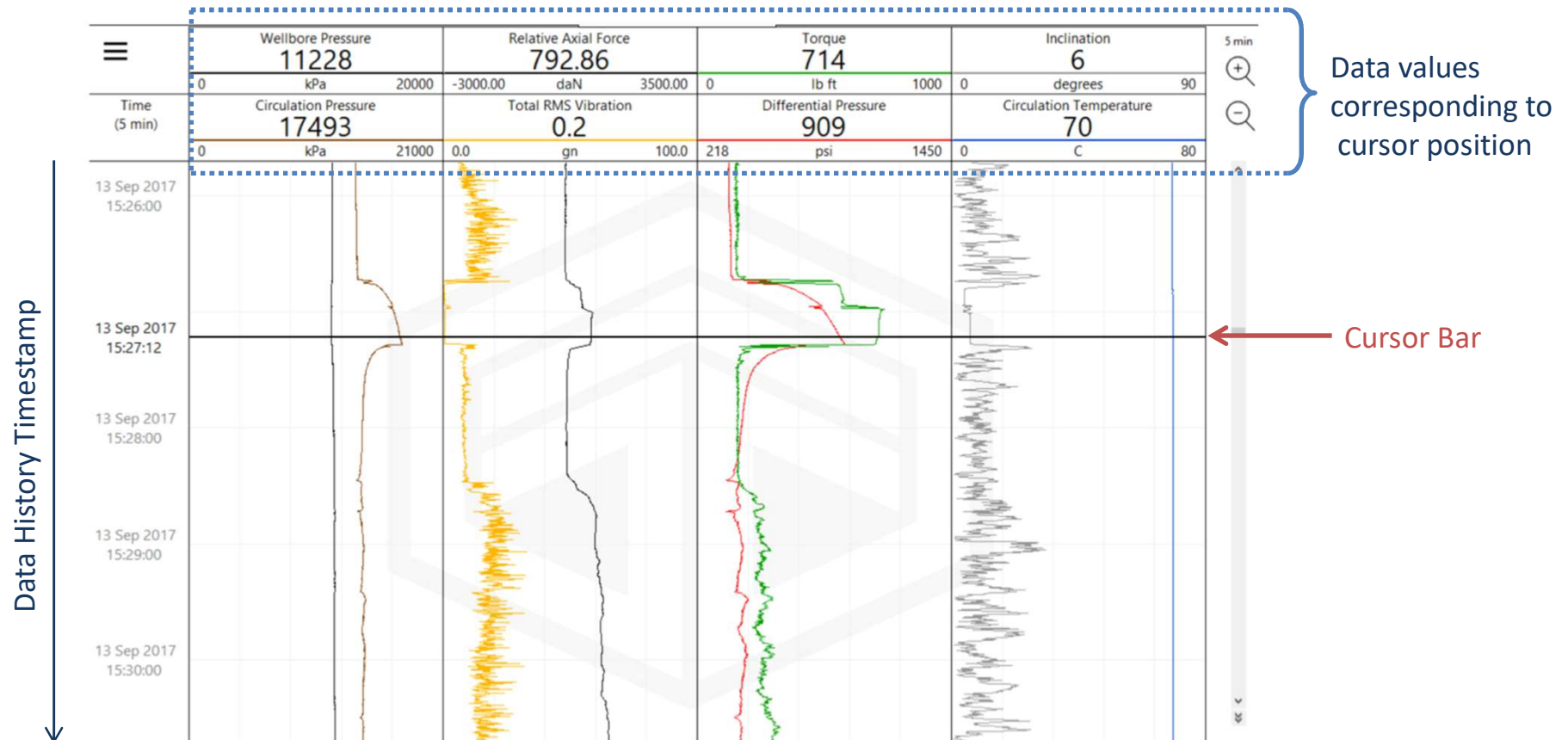


~ 3000 m



Coil-Link connected
to 2" e-coil providing
Downhole Measurements

Coil-Link Interface - What does the operator see?

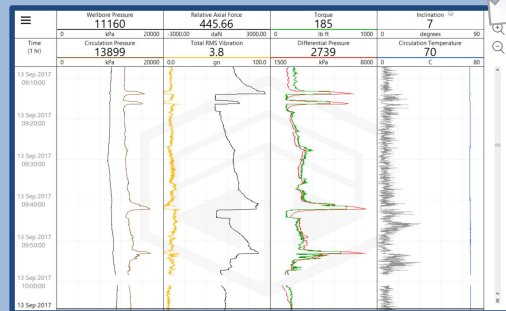


Real-time Data Merged and Compared

On-site
real-time
data acquisition



Timberstone Tools
software interface



STEP Software Interface
and Job Log



Data Merged for
Comparison



Real-time Downhole Data

Who Cares?

Your operators and engineers, the consultant, your customer

Real-time downhole data answers operational questions quickly with a higher level of certainty

What kind of questions can be answered?

Operational Questions

What is the precise bottom hole pressure right now?

How will this motor perform with this much N2?

Is the motor stalled?

How much weight and torque is on bit?

What is the differential pressure across the BHA?

Are our models correct – are they correctly predicting
what we are seeing here?

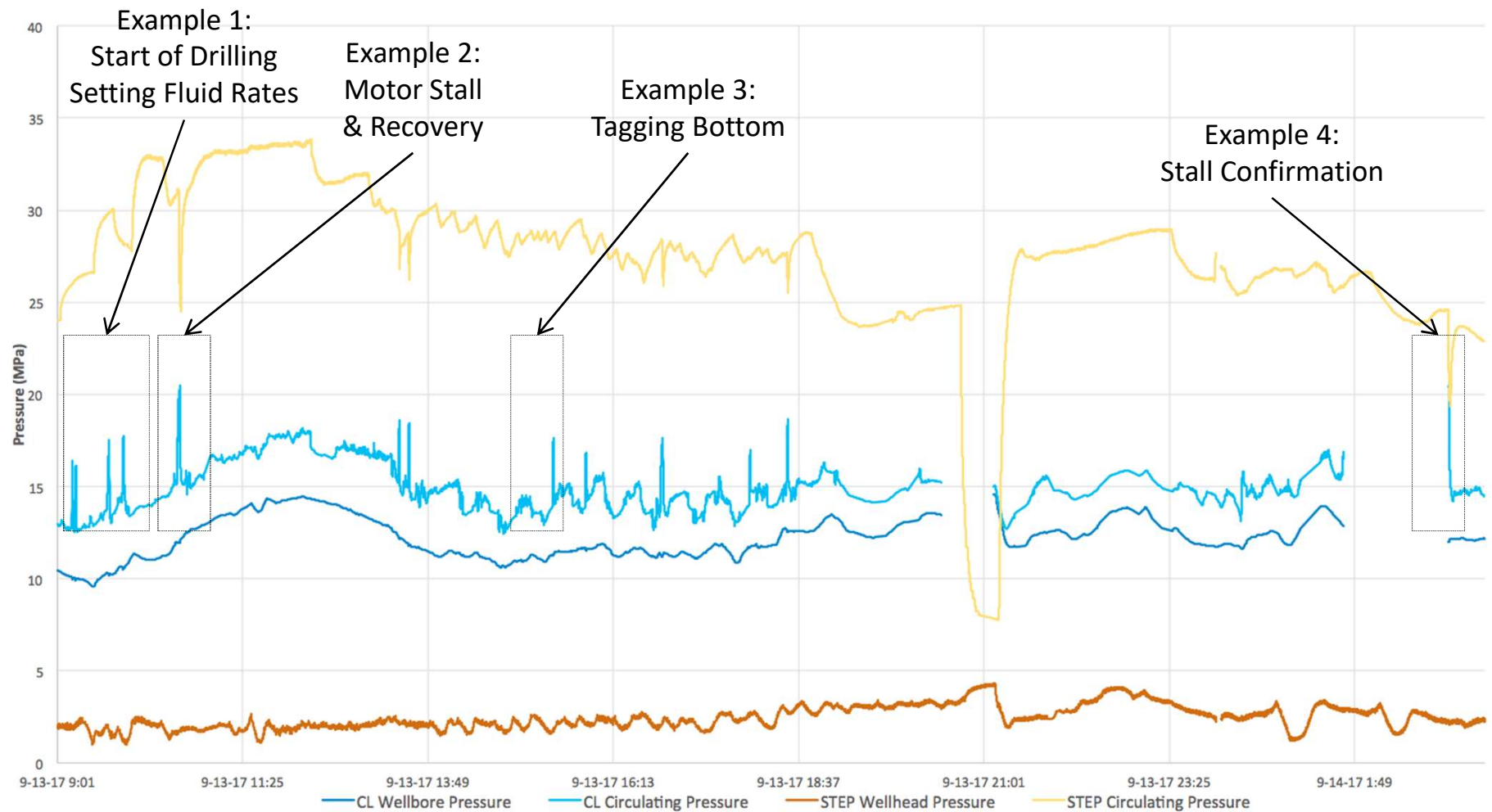
...

Get your answers when you need them.

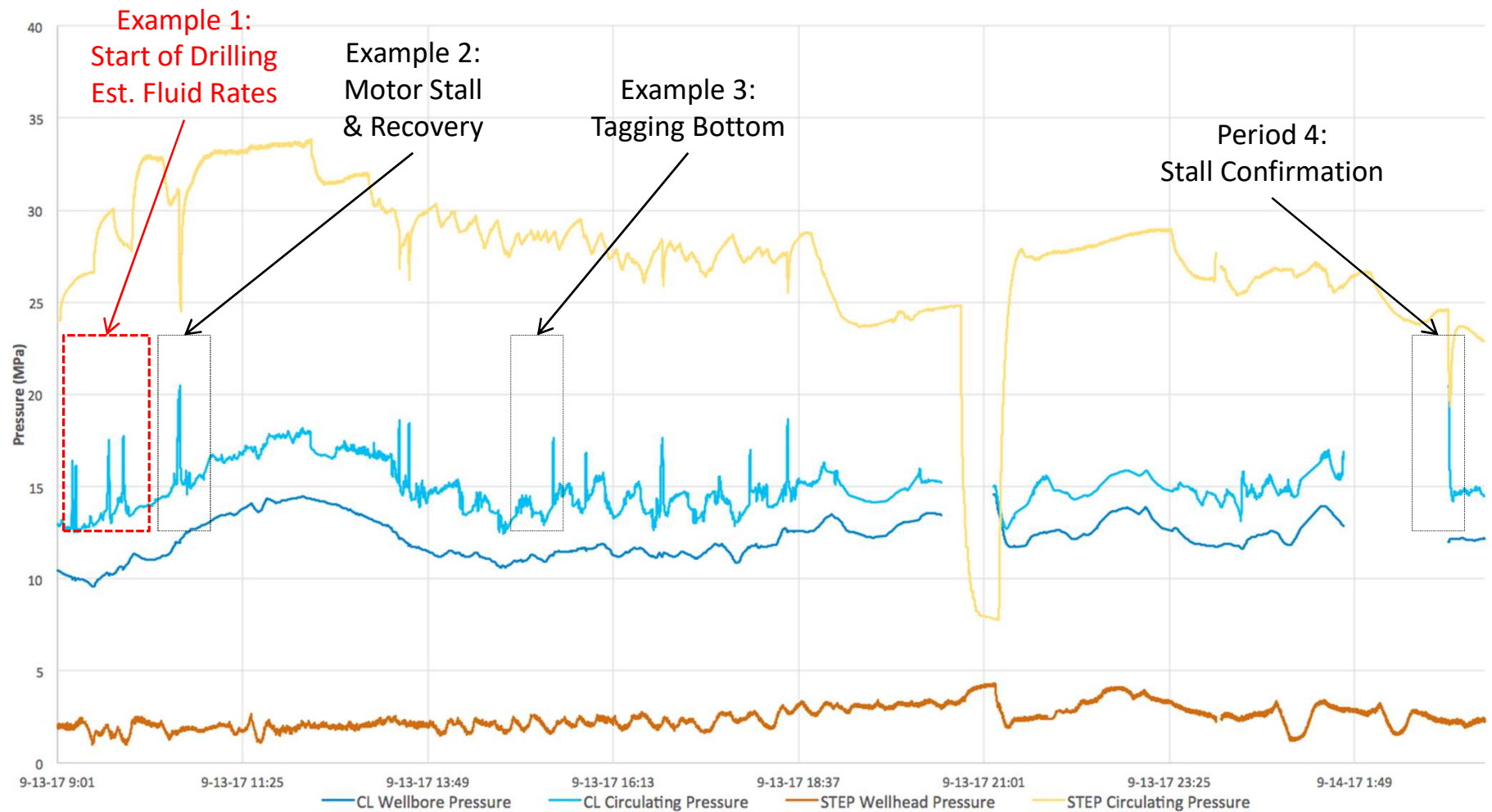
Have We Successfully Unloaded the Well? Are We Maintaining Underbalanced Conditions?



Let's Look at 4 Interesting Examples During Drilling



Example 1: Start of Drilling & Establishing Fluid Rates

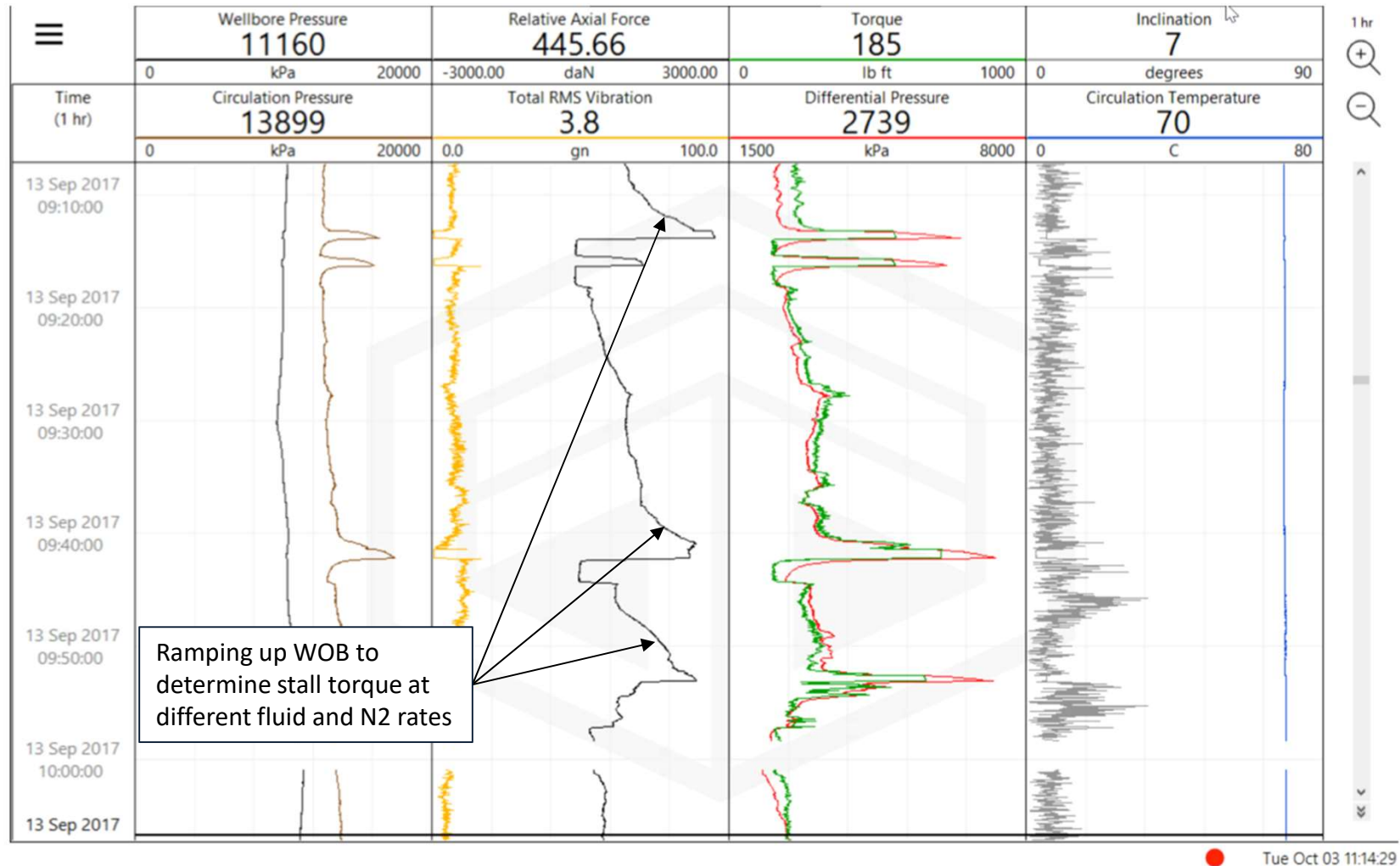


Example 1: Start of Drilling & Establishing Fluid Rates

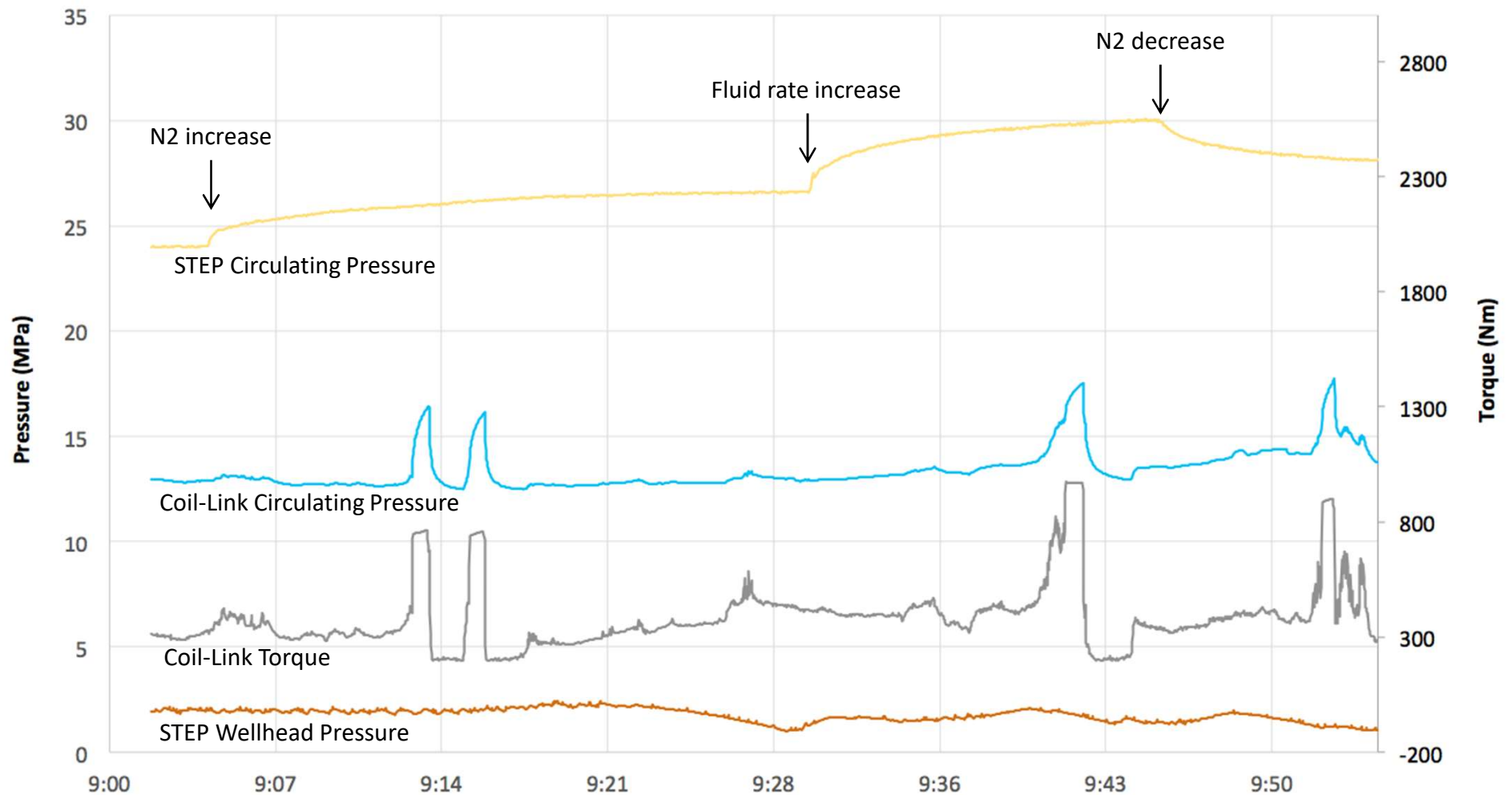
Questions:

- What are optimal fluid and N2 rates to stay underbalanced while giving the motor the hydraulic power it needs for drilling?
- What weight on bit is required to optimally use the torque we have available to avoid stalls?

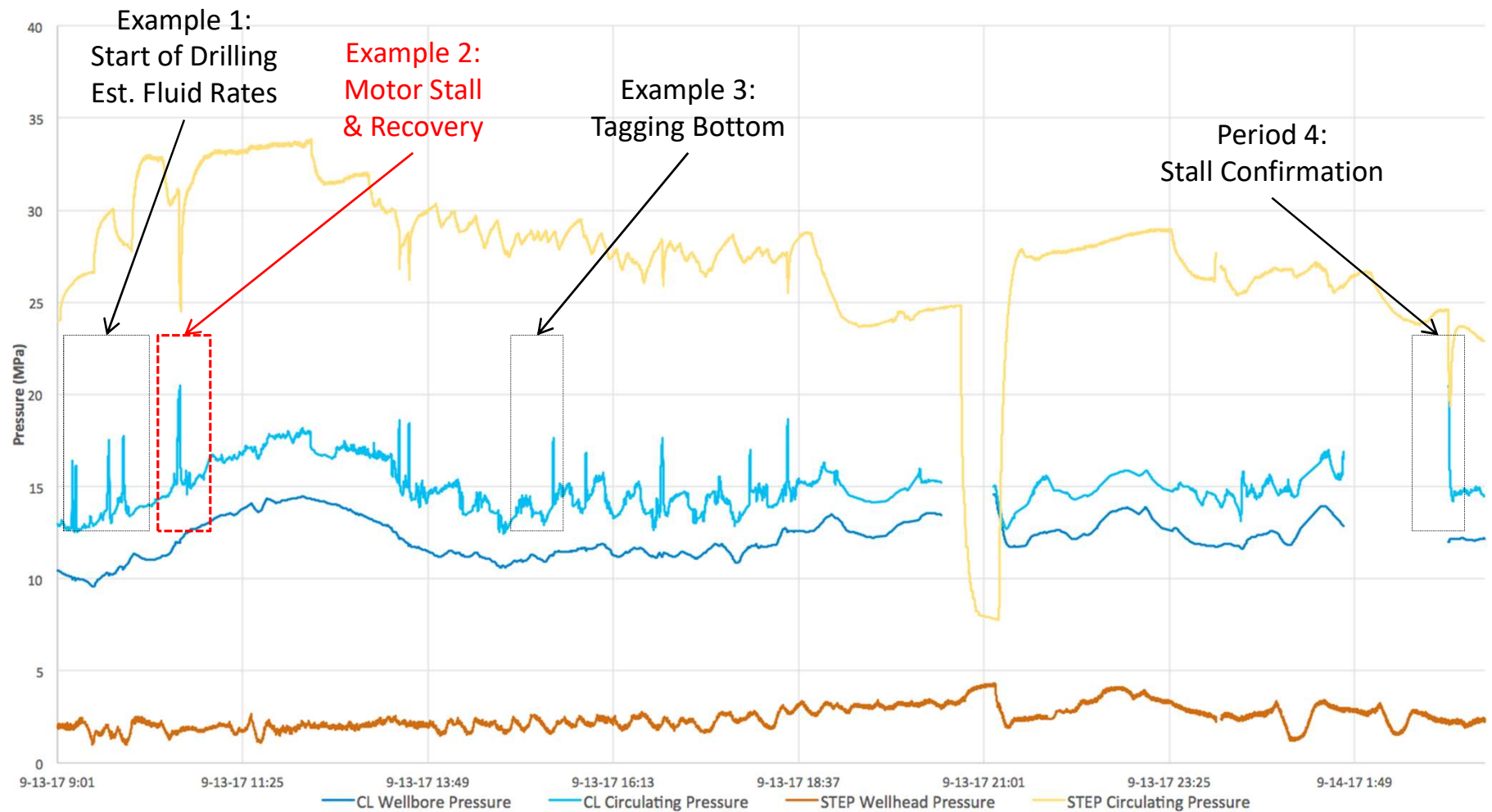
Example 1: Start of Drilling & Establishing Fluid Rates



Example 1: Start of Drilling & Establishing Fluid Rates



Example 2: Motor Stall & Recovery



Example 2: Motor Stall & Recovery

Stall Detection:

- Differential Pressure ↑
- Torque ↑
- Vibration ↓

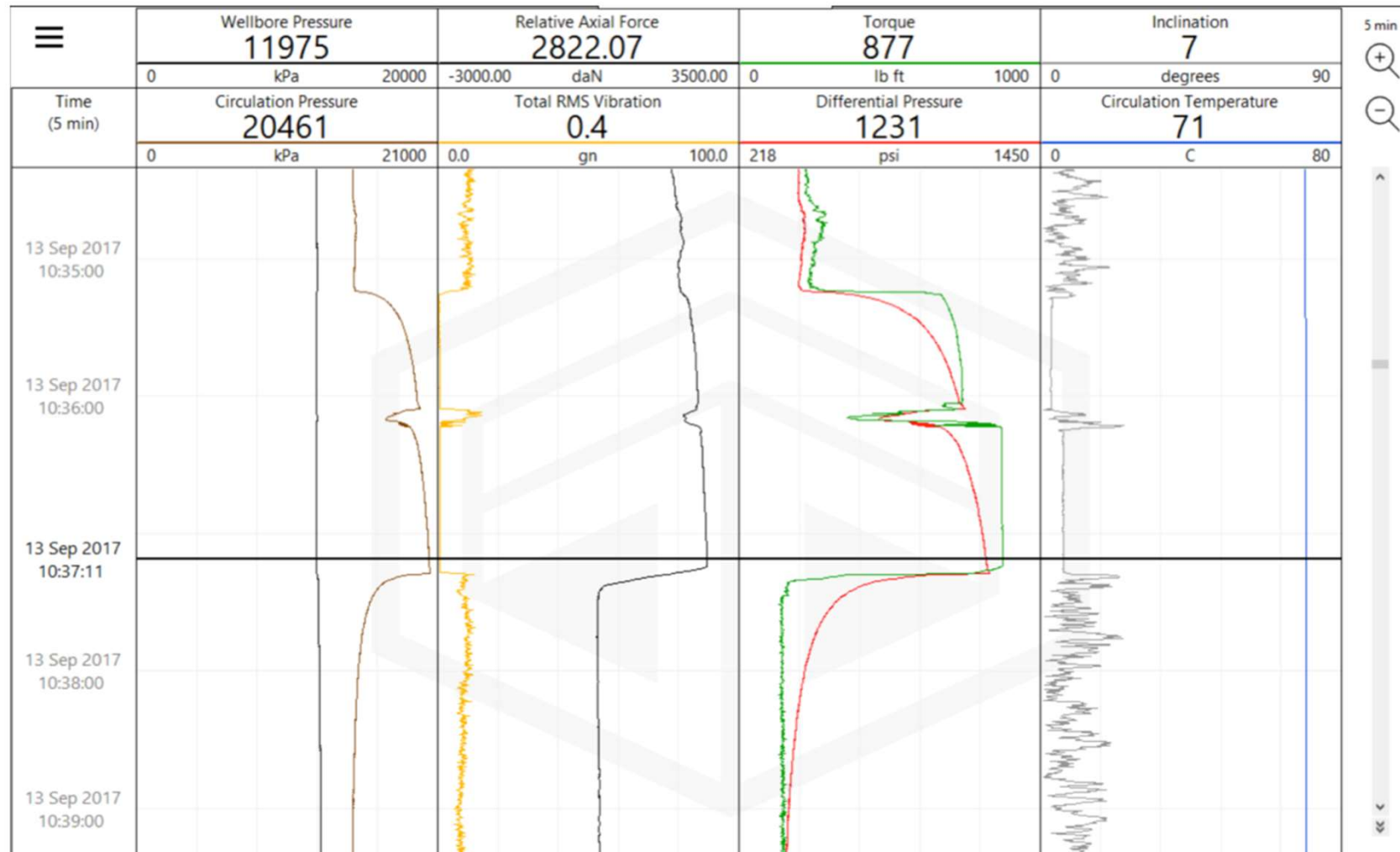
Stall Response:

- Stop Feed → Chew Through
- Cut Rates and Pull Back
- Resume Rates and Tag Bottom
- Mill Ahead

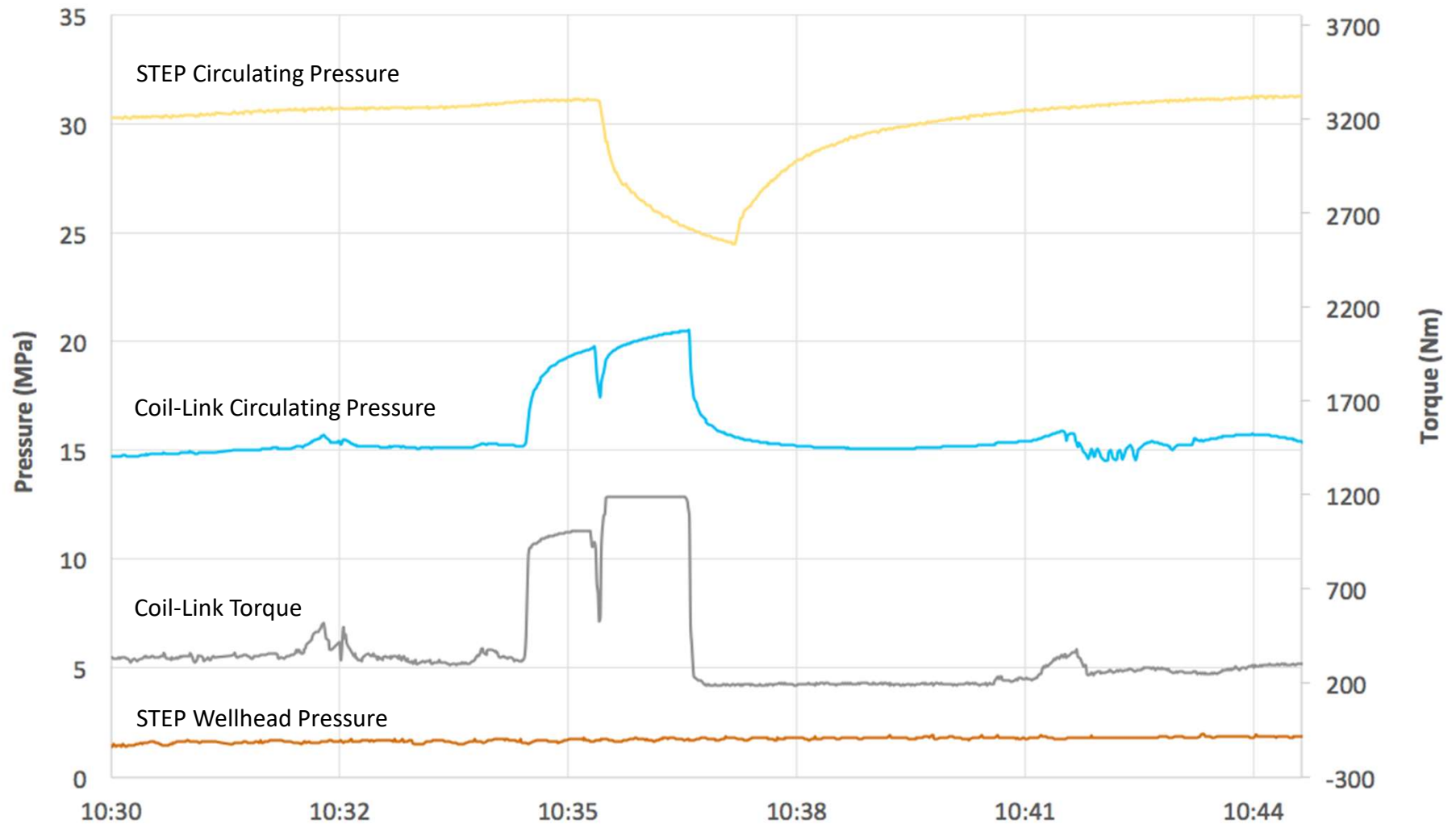
Questions:

- Are we stalled?
- Are we seeing clear indicators?

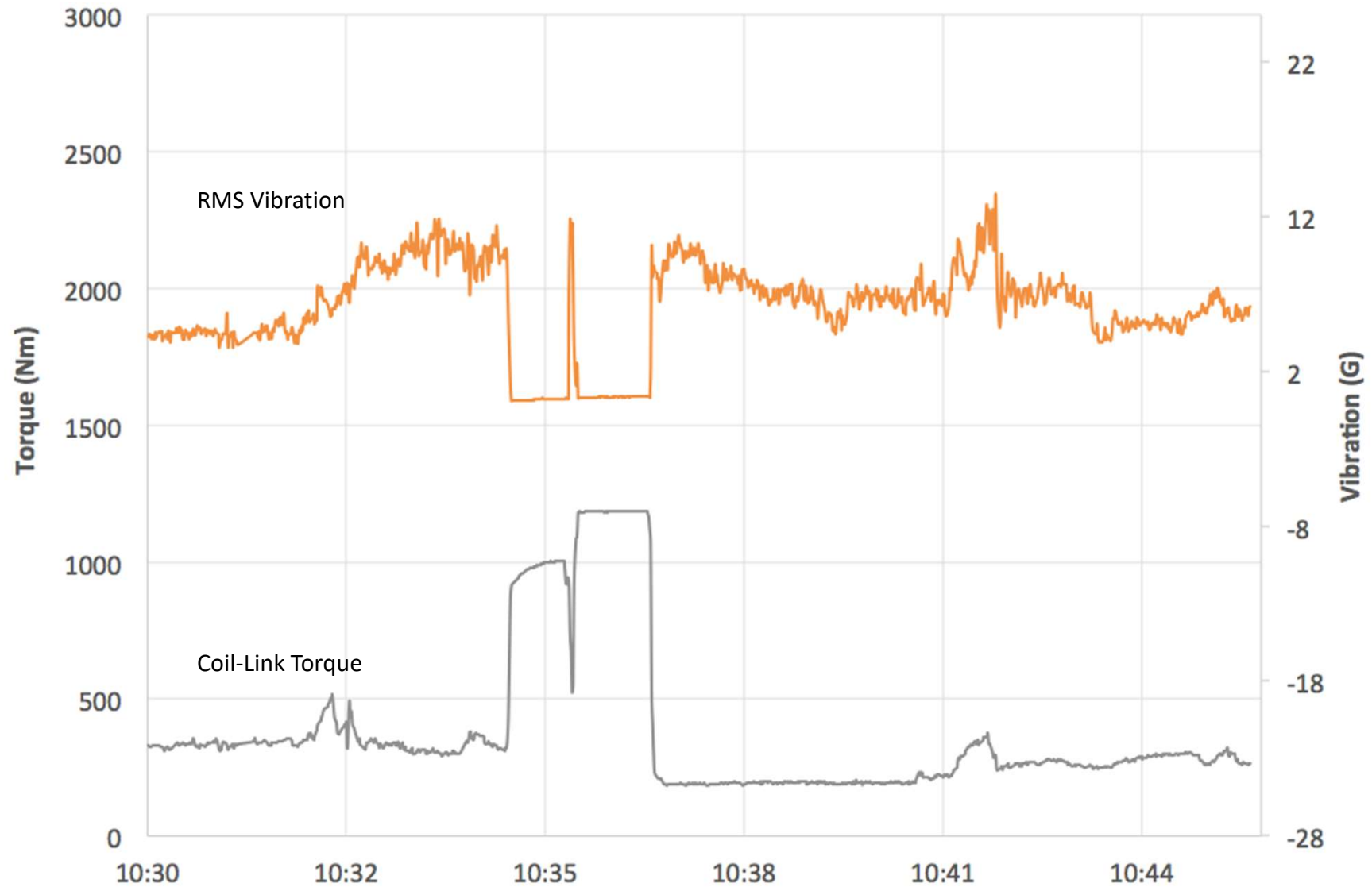
Example 2: Motor Stall & Recovery



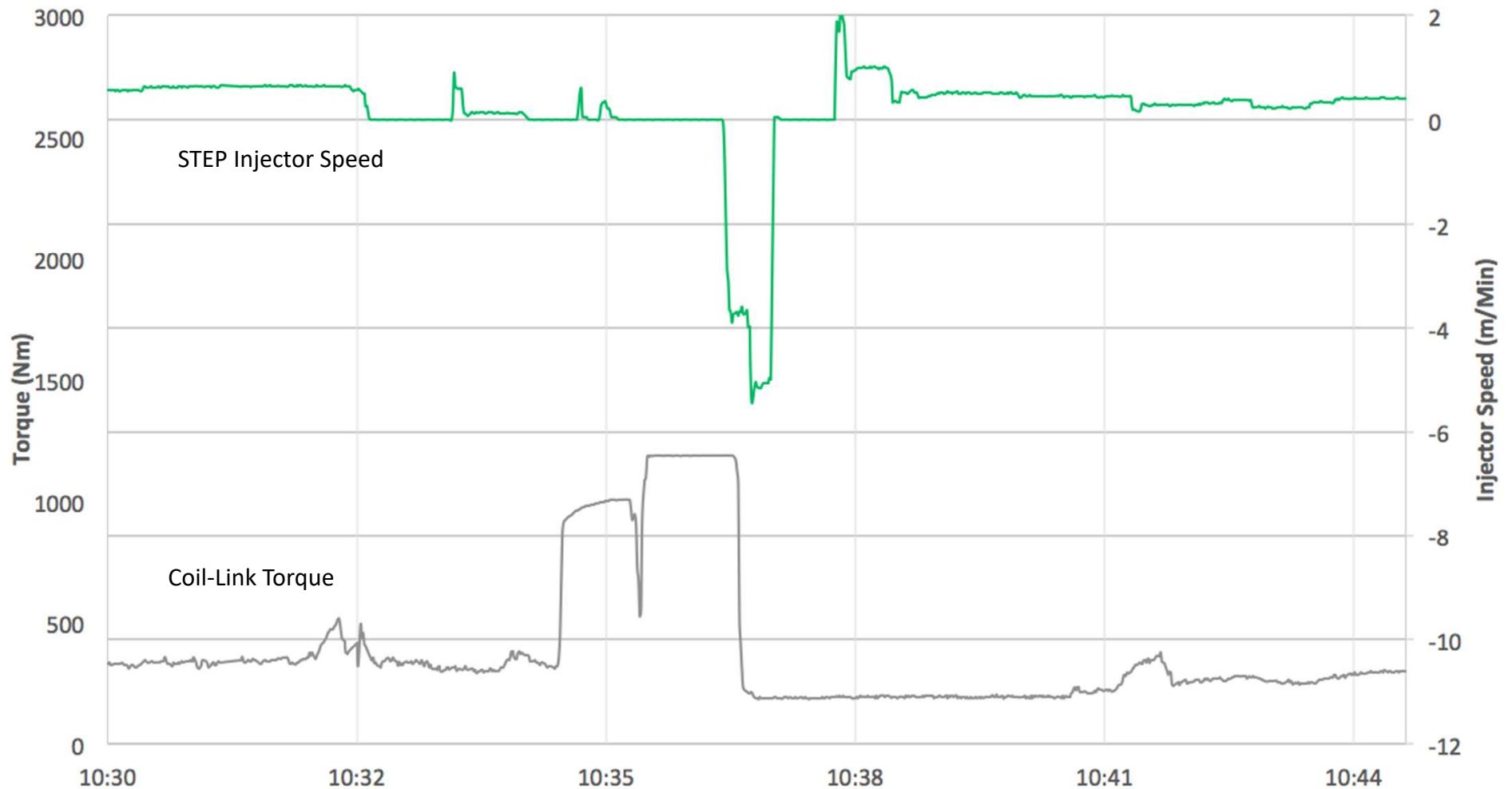
Example 2: Motor Stall & Recovery



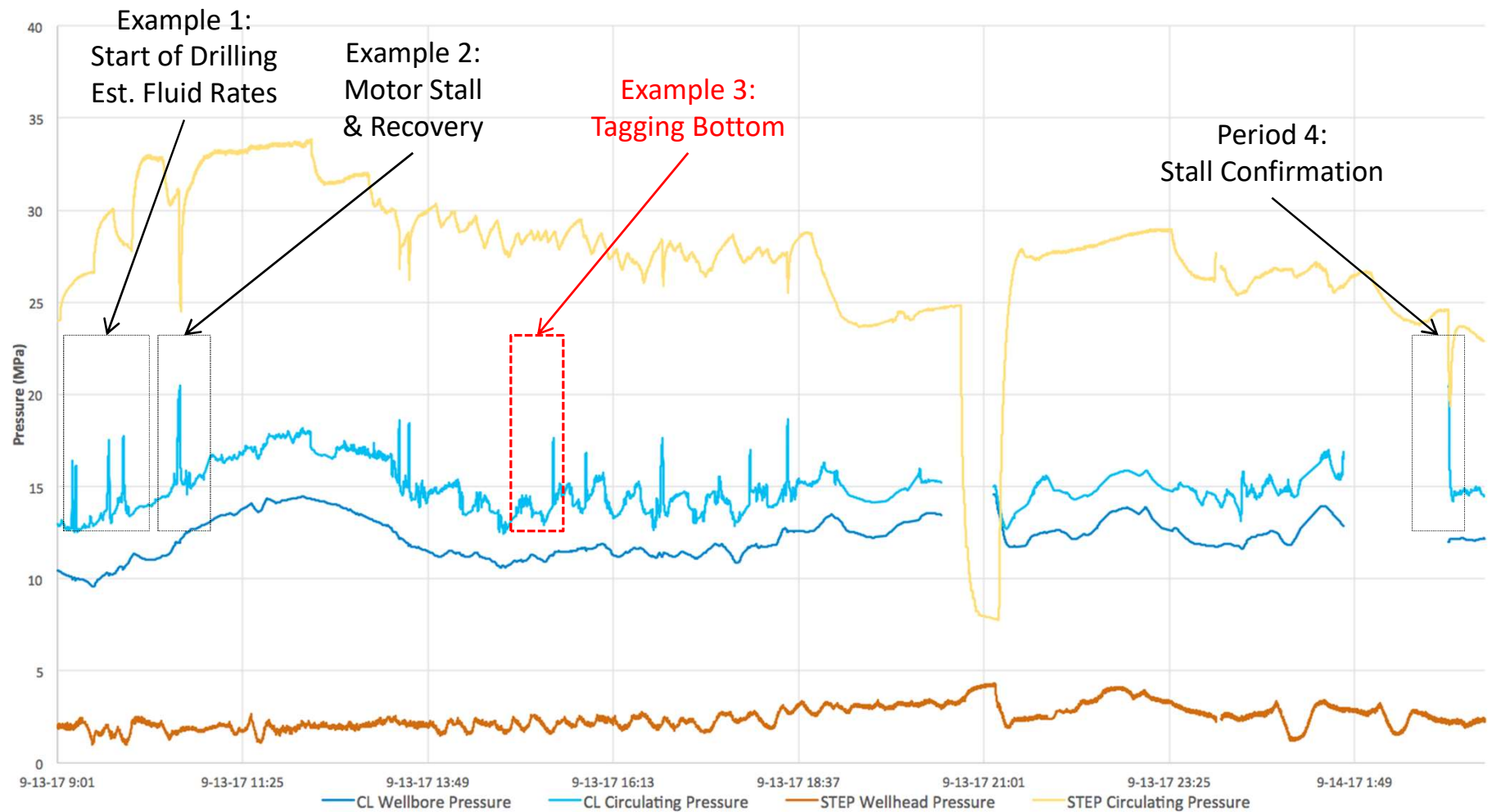
Example 2: Motor Stall & Recovery



Example 2: Motor Stall & Recovery



Example 3: Tagging Bottom

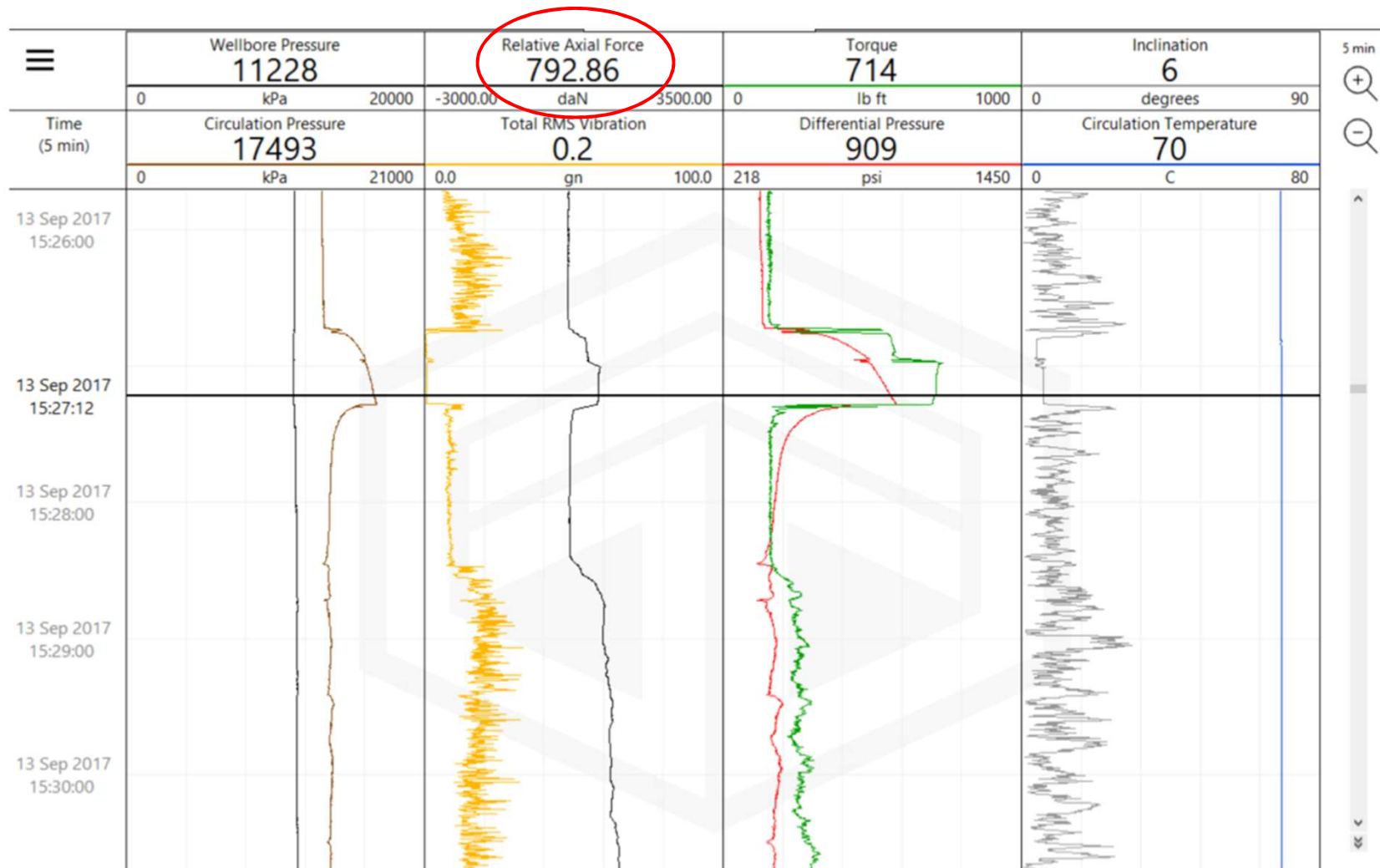


Example 3: Tagging Bottom

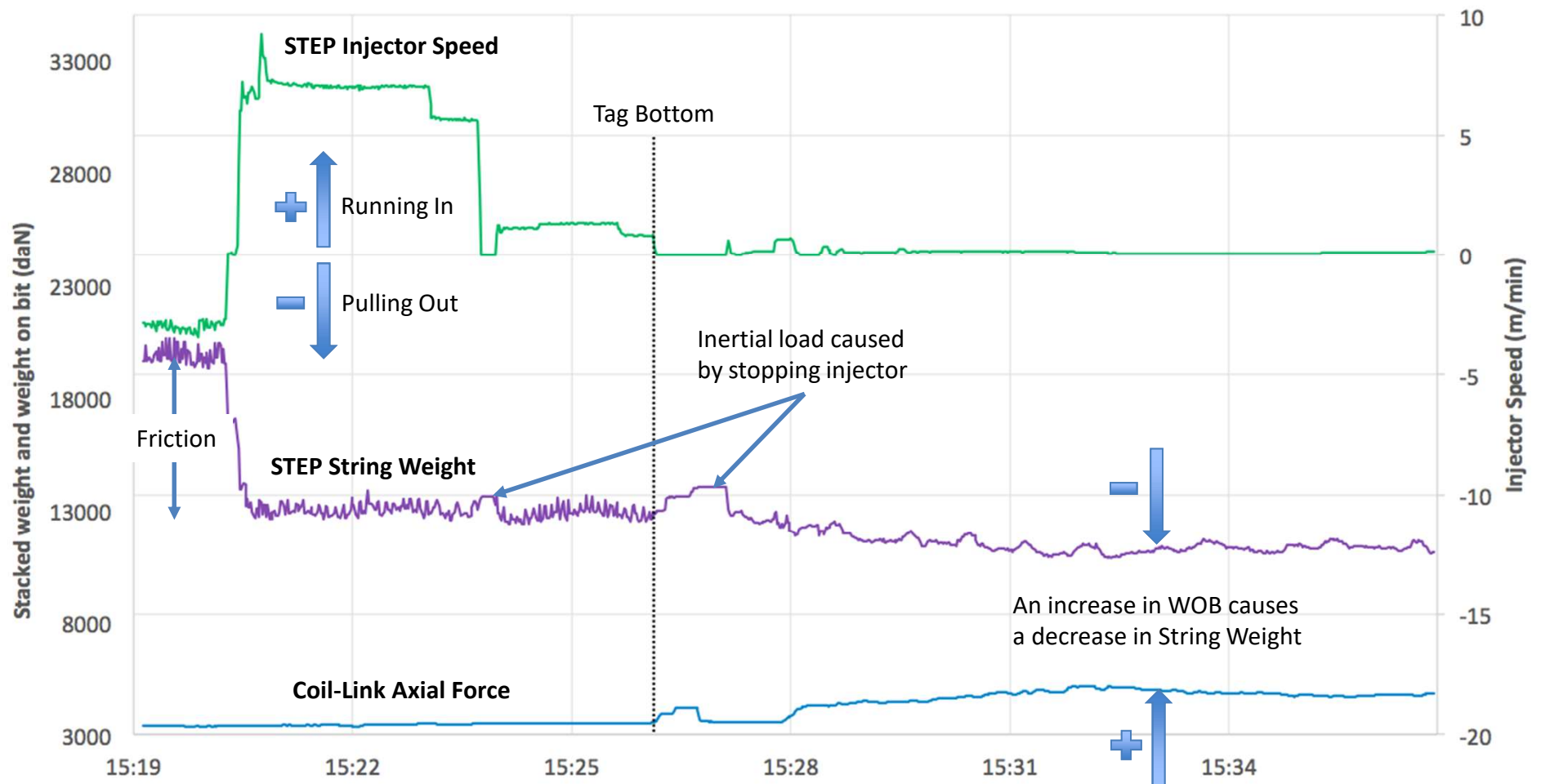
Question:

- Have I tagged bottom?

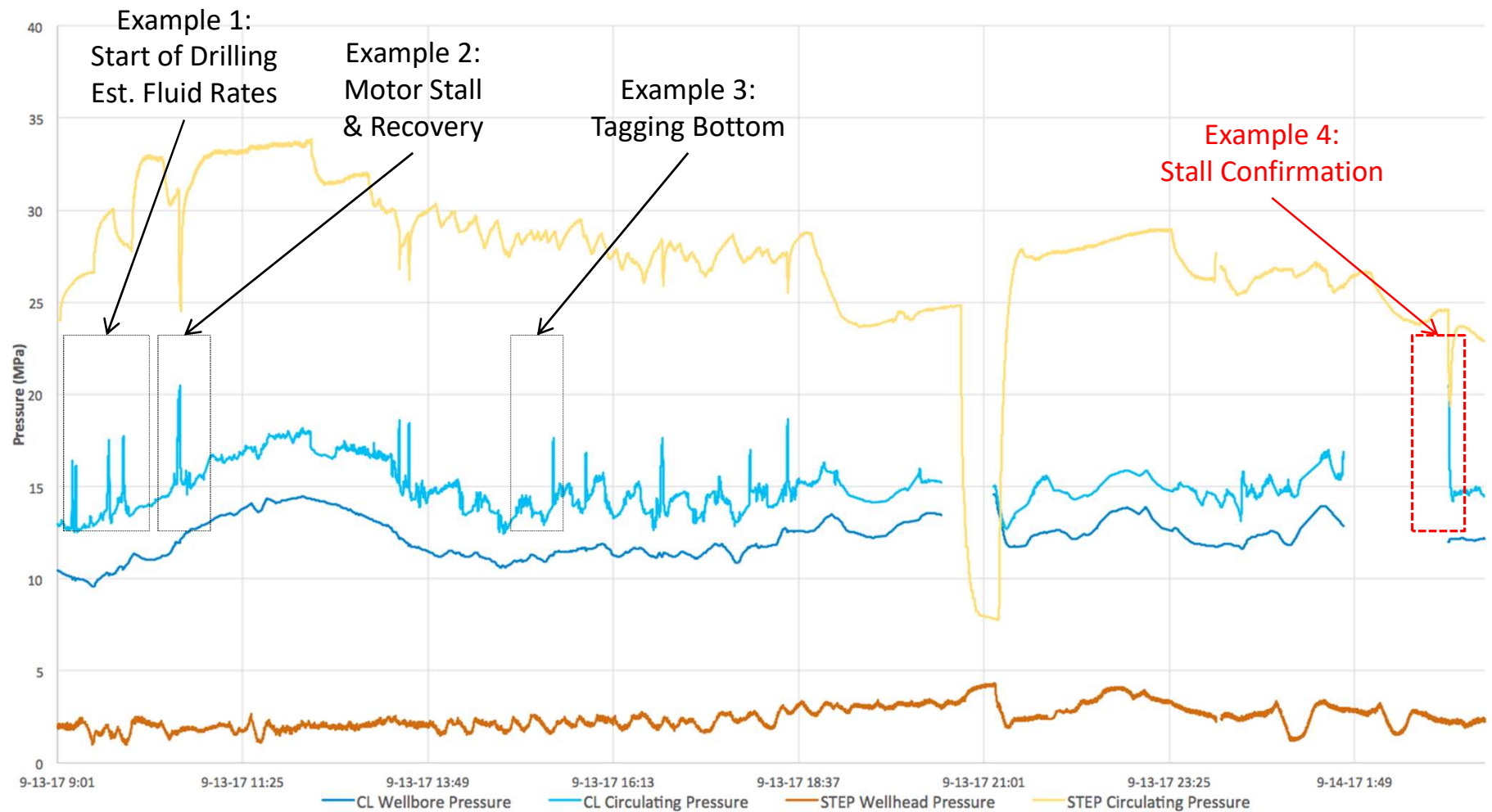
Example 3: Tagging Bottom



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Example 4: Stall Confirmation



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Scenario:

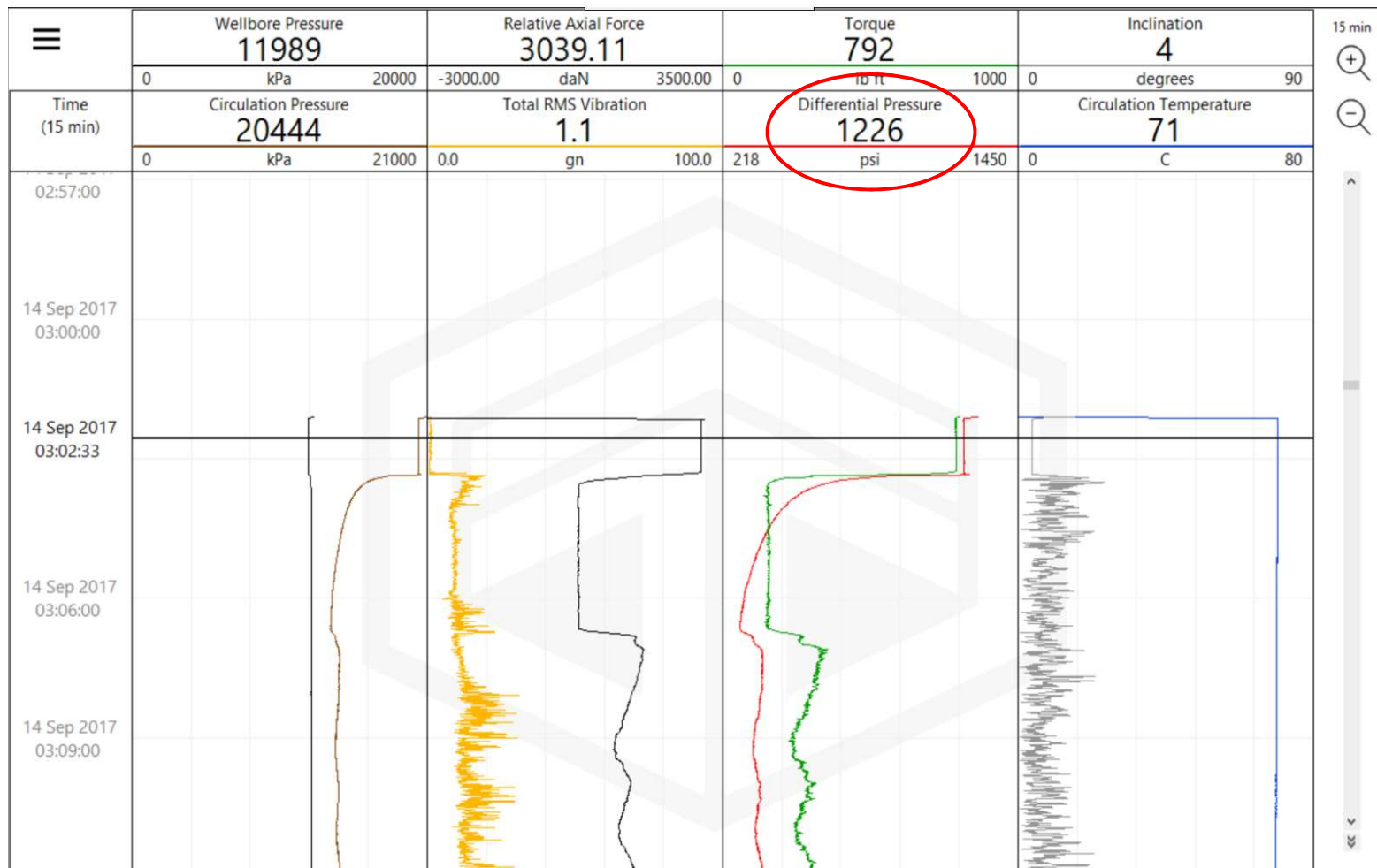
- Coil-Link is off
- Drilling seems dialed in
- Then ROP and string weight are slightly reduced

Question: Are we stalled?

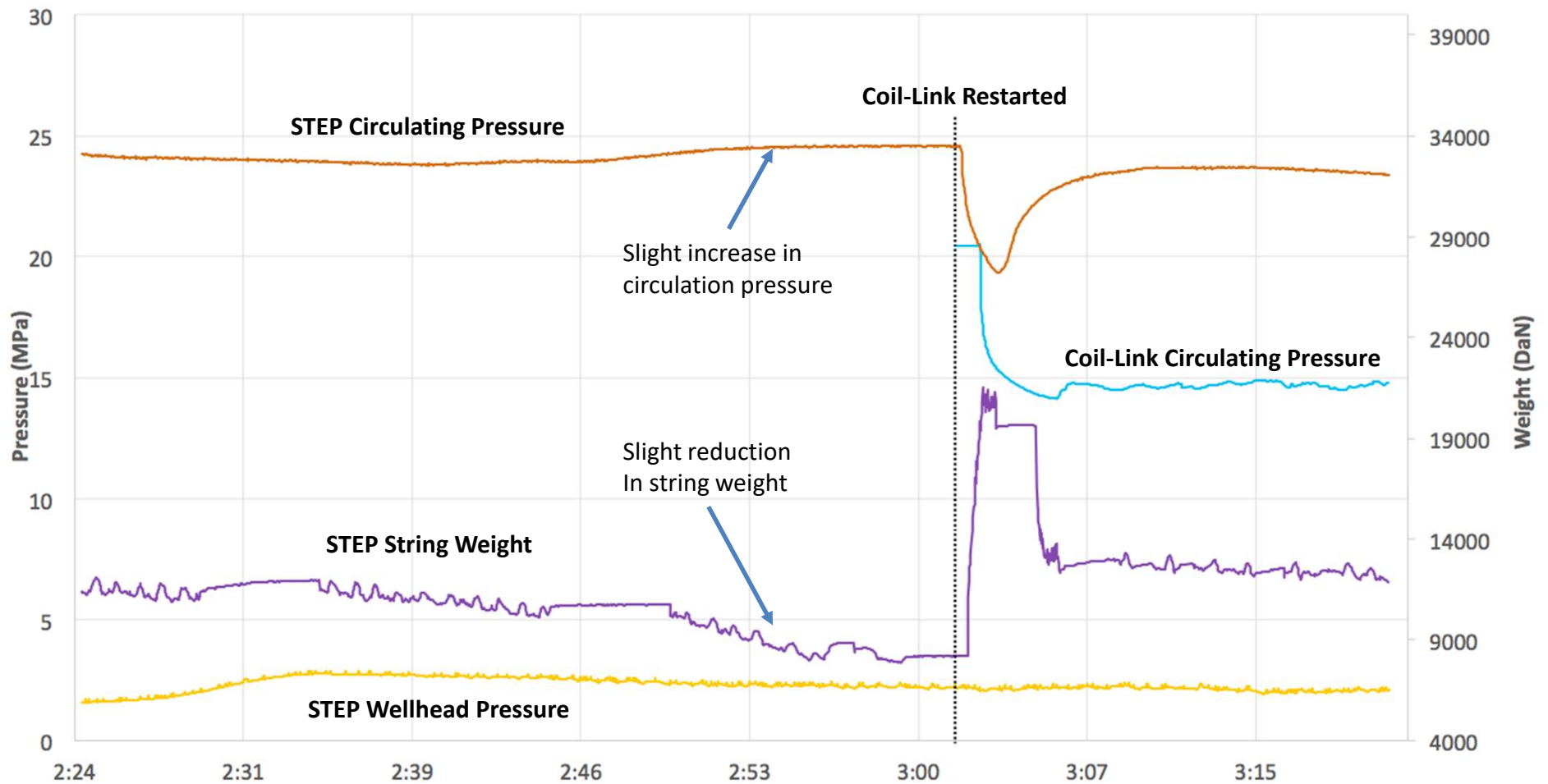
Action: Turn on Coil-Link to confirm

Answer: Yes, and way over pressure across the motor

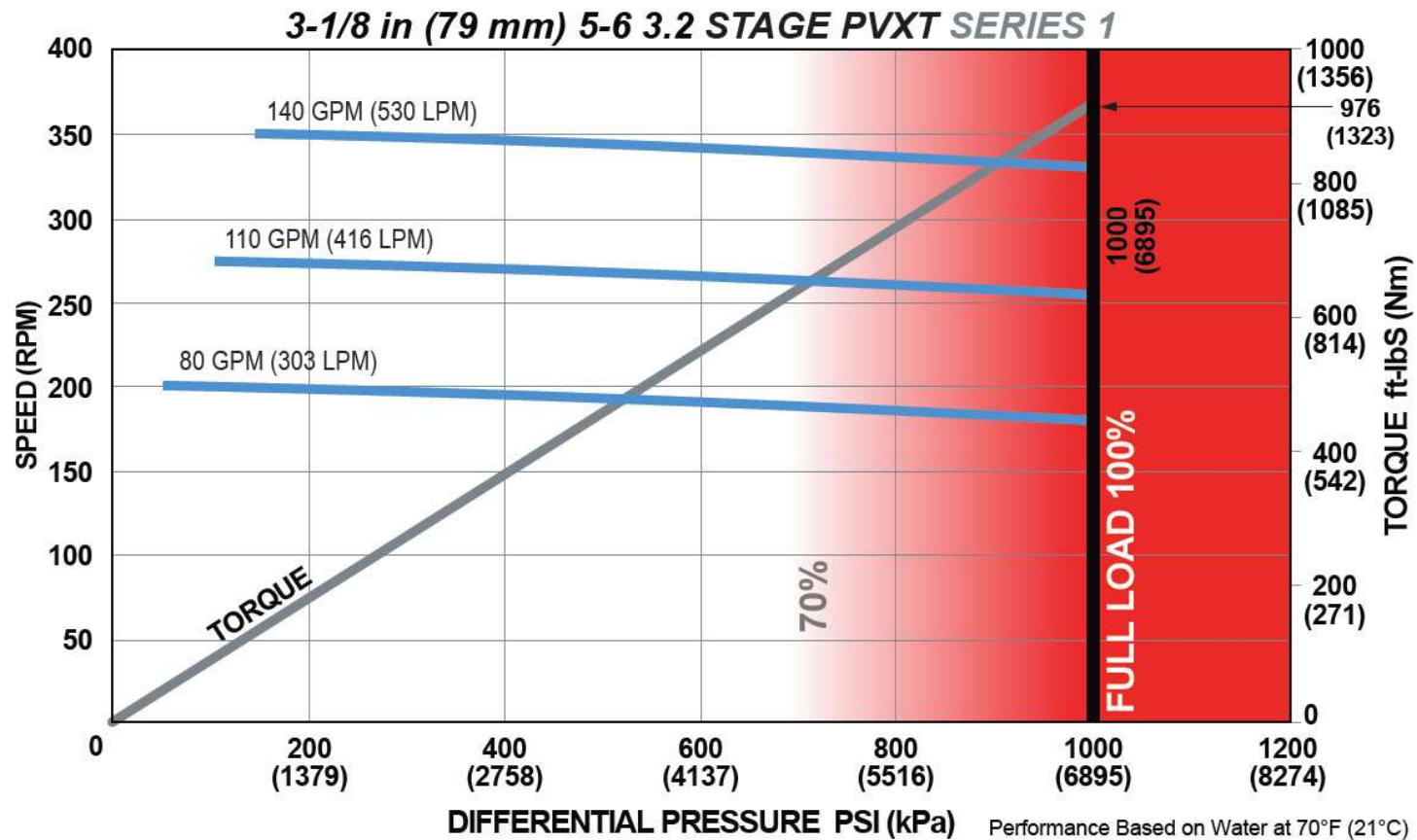
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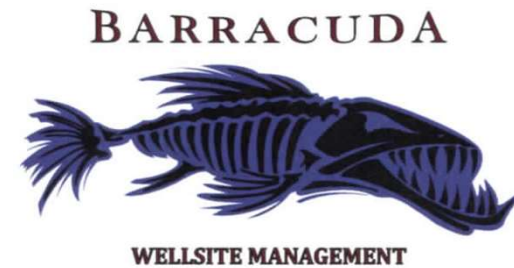


Example 4: Stall Confirmation



Possible damage may occur when motor is run higher than 70% of Maximum Differential Pressure.

Acknowledgements



Thank you – Questions?

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