L-42 Surveillance Panel Meeting Minutes

Southwest Research Institute, San Antonio, TX and Virtual Meeting – Microsoft Teams

February 7, 2024

**Attendees**: voting members in **bold,** * indicates virtual attendance

N. Ariemma (Lubrizol)

R. Banas (Exxon Mobil)

**D. Beck (TMC)**

D. Bell (Afton)

T. Bender (Fuchs)

B. Campbell (Afton)

M. Caridi (BASF)

**J. Carowick (Cummins-Meritor)**

M. Charron (SwRI)

**A. Comfort (US Army)**

H. De La Fuente (Chevron Oronite)

J. Gingerich (Lubrizol)

**A. Goyal (BASF)**

H. Hahn (Chevron Oronite)

D. Horvath (Afton)

J. Huron (Chevron Oronite)

A. Jackson (Chevron Oronite)

B. Jordan (Shell)

**A. Lange (Intertek)**

M. M-Pouv (Tribodens)

J. Morris (Navistar)

**C. Mueller (SwRI)**

**T. Muransky (AAM)**

M. Portell (Intertek)

K. Rettman (Chevron Oronite)

**M. Sangpeal (Afton/C)**

E. Sattler (US Army)

**N. Schaup (LZ)**

A. Schweitzer (Shell)

D. Smith (Intertek)

A. Stone (Afton)*

C. Thomas (SwRI)

D. Uy (Shell)

W. Venhoff (Lubrizol)

**R. Warden (Chevron Oronite)**

**A. Zyski (Dana)**

**Call to Order**

**Review of Agenda**

The meeting agenda is attached.

**Review of Membership**

No changes required.

**Approval of Meeting Minutes**

Meeting minutes for approval:

- "20231108_SP" → November 8, 2023 – Surveillance Panel Meeting – Plymouth, MI

A motion was made to approve the meeting minutes as presented.
Motion: J. Carowick
Second: N. Schaup
All in favor, no objections, no abstentions.

**2023 Hardware Update**

One lab discovered a ring and pinion from an axle from the 2023 batch did not have corresponding match numbers after running the axle in an L-42 test. No adverse effects were observed. Dana was contacted, and they felt that this would not make any noticeable difference. No other labs have had this issue to date.

**Next Hardware Batch Order**

Labs were reminded that Dana has requested at least 9 months of lead time for the next hardware order. The November SP meeting will be the deadline for labs to have the quantity they plan to order calculated. All four labs plan to order hardware.

**Spring Plates**

One lab purchased new spring plates from a machine shop in Virginia. The same batch of steel from the previous order was still available at the shop. Labs plan to purchase more spring plates from the same shop soon.

**TMC 119 Reference Oil**

TMC 119 is nearly depleted. One additional drum has been ordered. Usage was higher than historical rates. L-42-1 development has also increased demand. D. Beck will reach out to the supplier to see if a second drum can be ordered.

A request was made of the TMC to share data that would show how critical oil quality parameters change from batch to batch and over time.

Anthony Lange will create a task force to define how reference oils will be qualified.

No additional TMC 119 should be used for L-42-1 development due to the limited quantities left in inventory.

**L-42-1 Development**

C. Mueller gave an update on SwRI's progress on electric L-42-1 test development. A four-reference test sequence was run, with average High Reference Oil scoring of 15 pinion, 10 ring (with correction factors applied). Low Reference Oil scoring was 34 pinion, 24 ring. 8 cycles of Conditioning 4 were run (four more than the current test method), and 15 cycles of Shock 2 (five more than the current method). All testing was done on 2023 hardware (MSPLO/P2AD01). Additional details can be found in the attached presentation.

M. Sangpeal gave an update on Afton's Regenerative AC Motor T-Rig test development. Two High Reference Oils were run, with average scoring of 29 and 19 (with correction factors applied). Low Reference Oil scoring was 85 and 55. Two J2360 approved oils were run, scoring performance was nearly identical to when they were run on the traditional L-42 test rig. One poor-performing oil was run. Scoring was less than the Low Reference Oil, but greater than the High Reference average. The test profile matches the current ASTM test method (in terms of repetitions and cycle length). All testing was done on 2023 hardware (MSPLO/P2AD01).

Afton will run one additional High Reference Oil test to complete the standard four-reference test sequence.

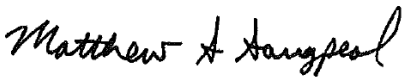
An L-42-1 Taskforce Meeting will be scheduled soon. Next steps will be determined in that meeting.

**New/Open Issues**
None.

**Adjournment**
A motion was made to adjourn.
Motion: M. Sangpeal
Second: N. Schaup
All in favor, no objections, no abstentions.

Meeting adjourned.

Respectfully submitted,



Matt Sangpeal
L-42 Surveillance Panel Chairman

# L-42 Surveillance Panel Meeting

ASTM D7452

Southwest Research Institute

San Antonio, TX

February 7, 2024

1:00 – 2:00 PM  CST

Passion for Solutions™

# Agenda

- **Call to Order**
- **Agenda**
- **Membership Review & Update**
- **Approval of Meeting Minutes**
  - "20231108 SP" – SwRI, Ann Arbor, MI
- **2023 Hardware Update**
- **Next Hardware Batch Order**
- **Spring Plates**
- **TMC 119 Reference Oil**
- **L-42-1 Development Updates**
- **New Issues**
- **Adjournment**

# L-42 SP Voting Members

- **Rob Banas:** Exxon Mobil
- **Dylan Beck:** TMC
- **Allen Comfort:** US Army
- **Arjun Goyal:** BASF
- **Troy Muransky:** AAM
- **Jessica Carowick:** Cummins-Meritor
- **Matt Sangpeal:** Afton Chemical (Chair)
- **Nick Schaup:** Lubrizol
- **Anthony Lange:** Intertek
- **Caroline Mueller:** SwRI
- **Amy Zyski:** Dana
- **Rebecca Warden:** Chevron-Oronite

# Approval of Meeting Minutes

## SP Meeting Minutes

- "20231108 SP" → November 11, 2023 – Surveillance Panel Meeting - SwRI, Ann Arbor, MI and Virtual Meeting via Microsoft Teams

# 2023 Hardware Update

- **Not all match numbers agree between ring and pinion at one lab**
  - Dana stated performance would not likely be affected
  - No mis-matches so far at Afton
- **Any other quality/performance issues?**

# Next Hardware Batch Order

- **Dana is requesting more lead time for next order**
  - 9 months vs 6 months
  - Should start next order one year ahead of need by date
  - Agree to revisit in November 2024

# Spring Plates

- **Some labs purchased new spring plates recently**
- **Update on delivery / quality of new plates?**

# TMC 119 Reference Oil

- **First batch of TMC 119 received in 2018**
  - One drum in total
- **Currently, 8 gallons remain in inventory**
- **Supplier has been requested to re-blend another batch**
  - ETA to TMC is ~1 month
- **TMC will run quality checks once oil is received**
- **Surveillance Panel will need to decide on approval process**

# L-42-1 Development Update February 2024

SOUTHWEST RESEARCH INSTITUTE®

Caroline Mueller

2/7/2024

# Where we left off…

- 1 high ref and 1 discrimination run presented in November 2023—passing results

- Action items:
  - Complete reference sequence with current L-42-1 settings **complete**
  - Share summary of operational conditions, highlighting differences from L-42 procedure **complete**

# Data Summary

| Test Number | Oil Code | Scoring %, Pinion | Scoring %, Ring | Notes | On L-42 Target? Y/N |
|---|---|---|---|---|---|
| 0023 | TMC 117 | 15 | 10 | C4 8 cycles, S2 15 cycles. 2023 hardware | Y |
| 0025 | TMC 117 | 16 | 10 | C4 8 cycles, S2 15 cycles. 2023 hardware | Y |
| 0026 | TMC 117 | 14 | 11 | C4 8 cycles, S2 15 cycles. 2023 hardware | Y |
| 0024 | TMC 119 | 34 | 24 | C4 8 cycles, S2 15 cycles. 2023 hardware | Y |
| **Average of High Refs** | | **15** | **10** | | **Y** |

Targets for pinion scoring % on TMC 117: *14-32*
correction factor +6 pinion, +4 ring
Targets for pinion scoring % on TMC 119: *2x most recent 117 run, including correction*

# Reminder: Operational Conditions

| *Test Phase* | *Dyno Setpoint (Input)* | *Output Speed(s)* | *Duration* | *Temperature* |
|---|---|---|---|---|
| Conditioning 1 | 60 lb-ft | 575 rpm | 10 mins | Ramp and hold 225 °F ±5 |
| Conditioning 2 | 60 lb-ft | 385/575 rpm | 4 cycles | Ramp and hold 225 °F ±5 |
| Conditioning 3 | 70 lb-ft | 815 rpm | 20 mins | Ramp and hold 225 °F ±5 |
| Conditioning 4 | 70 lb-ft | 670/815 rpm | 8 cycles | Ramp and hold 225 °F ±5 |
| Shock 1 | 60 lb-ft | 530/1050 rpm | 5 cycles | Start 200 °F ±5 |
| Shock 2 | 100 lb-ft | 530/630 rpm | 15 cycles | Start <280 °F |

Major operations different from D7452 are highlighted.

# Discussion & Next Steps

- **L-42-1 stand is on L-42 target for scoring severity**

- Next steps:
  - Further prove-out: group discussion
    - Initial suggestion: 4 market J2360 fluids + 2 fluids we know/expect to perform poorly
  - Resume procedure definition/specification writing

# Operational Data 0023-0026

# (Truncated)

# Test 01-0023

# Summary Data—Conditioning 01-0023

| Conditioning 1 | | | |
|---|---|---|---|
| **Input Torque [ft-lb]** | | **Input Speed [rpm]** | |
| *Target* | *60 ± 5* | *Target* | *2363* |
| Avg | 59.8 | Avg | 2361 |
| Min | 58.2 | Min | 2357 |
| Max | 61.8 | Max | 2364 |

| Conditioning 3 | | | |
|---|---|---|---|
| **Input Torque [ft-lb]** | | **Input Speed [rpm]** | |
| *Target* | *70 ± 5* | *Target* | *3350* |
| Avg | 70.0 | Avg | 3347 |
| Min | 68.5 | Min | 3344 |
| Max | 70.6 | Max | 3349 |

| Conditioning 2 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Peak Input Torque Drive [ft-lb]** | | **Peak Input Torque Coast [ft-lb]** | | **Maximum Input Speed [rpm]** | | **Minimum Input Speed [rpm]** | |
| *Target* | | *Target* | | *Target* | *2363* | *Target* | *1562* |
| Avg | 114.4 | Avg | -59.6 | Avg | 2365 | Avg | 1581 |
| Min | 113.2 | Min | -62.6 | Min | 2365 | Min | 1581 |
| Max | 115.5 | Max | -54.5 | Max | 2366 | Max | 1582 |

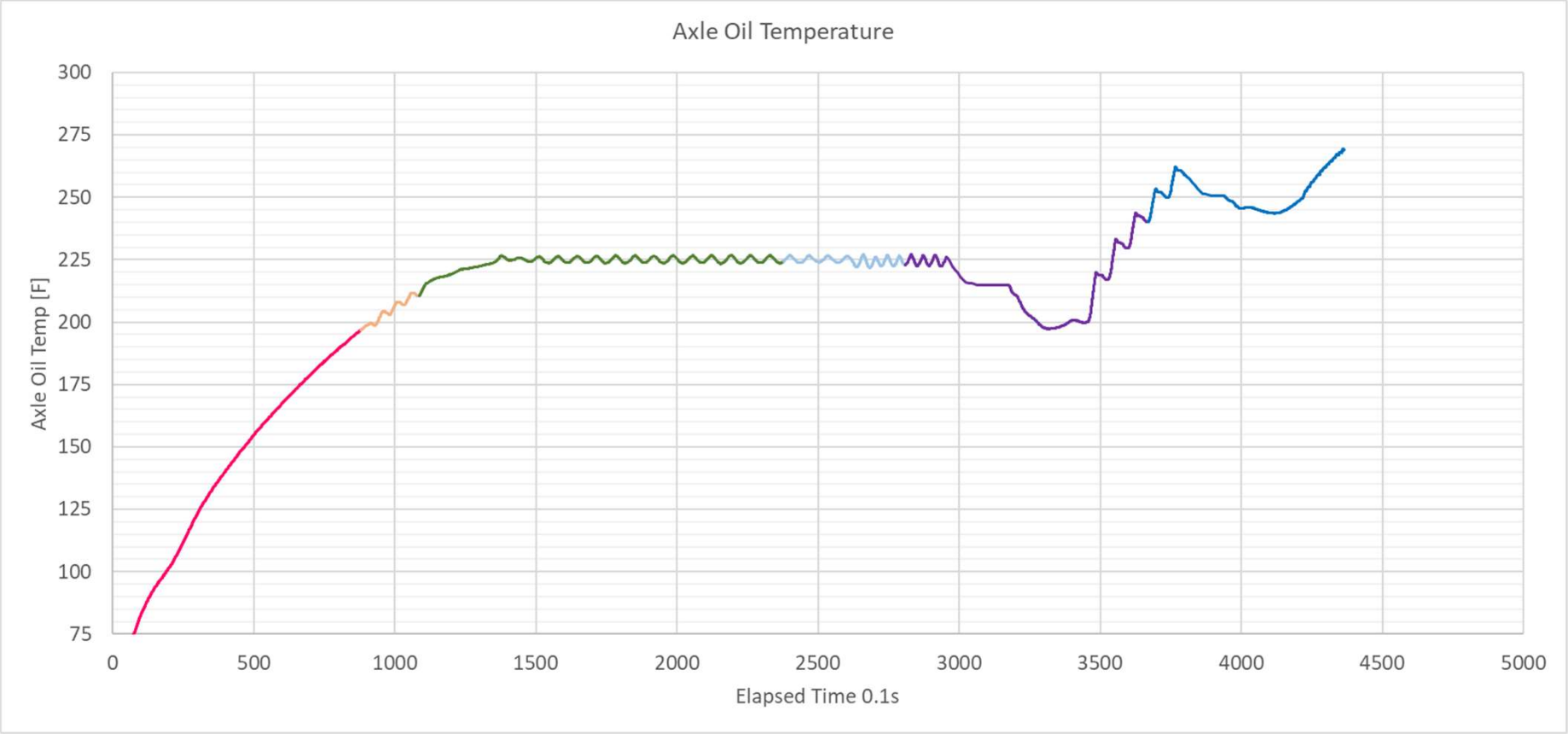
| Conditioning 4 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Peak Input Torque Drive [ft-lb]** | | **Peak Input Torque Coast [ft-lb]** | | **Maximum Input Speed [rpm]** | | **Minimum Input Speed [rpm]** | |
| *Target* | | *Target* | | *Target* | *3350* | *Target* | *2754* |
| Avg | 114.8 | Avg | -69.5 | Avg | 3351 | Avg | 2752 |
| Min | 114.3 | Min | -75.2 | Min | 3350 | Min | 2750 |
| Max | 115.3 | Max | -61.8 | Max | 3353 | Max | 2753 |

# Summary Data—Shocks 01-0023

| Shock 1 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Peak Input Torque Drive [ft-lb] | | Peak Input Torque Coast [ft-lb] | | Maximum Input Speed [rpm] | | Minimum Input Speed [rpm] | |
| *Target* | | *Target* | | *Target* | *4316* | *Target* | *2178* |
| Avg | 233.5 | Avg | -67.6 | Avg | 4348 | Avg | 2191 |
| Min | 232.6 | Min | -76.1 | Min | 4348 | Min | 2175 |
| Max | 235.5 | Max | -62.4 | Max | 4350 | Max | 2197 |

| Shock 2 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Peak Input Torque Drive [ft-lb] | | Peak Input Torque Coast [ft-lb] | | Maximum Input Speed [rpm] | | Minimum Input Speed [rpm] | |
| *Target* | | *Target* | | *Target* | *3083* | *Target* | *2178* |
| Avg | 237.0 | Avg | -235.2 | Avg | 2600 | Avg | 2192 |
| Min | 222.5 | Min | -239.7 | Min | 2596 | Min | 2172 |
| Max | 270.3 | Max | -208.6 | Max | 2602 | Max | 2201 |

# Temperature Data—01-0023



# Test 01-0024

# Summary Data—Conditioning 01-0024

| Conditioning 1 | | | |
|---|---|---|---|
| Input Torque [ft-lb] | | Input Speed [rpm] | |
| *Target* | *60 ± 5* | *Target* | *2363* |
| Avg | 59.9 | Avg | 2361 |
| Min | 54.4 | Min | 2357 |
| Max | 68.6 | Max | 2364 |

| Conditioning 3 | | | |
|---|---|---|---|
| Input Torque [ft-lb] | | Input Speed [rpm] | |
| *Target* | *70 ± 5* | *Target* | *3350* |
| Avg | 70.0 | Avg | 3346 |
| Min | 65.6 | Min | 3344 |
| Max | 73.5 | Max | 3349 |

| Conditioning 2 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Peak Input Torque Drive [ft-lb] | | Peak Input Torque Coast [ft-lb] | | Maximum Input Speed [rpm] | | Minimum Input Speed [rpm] | |
| *Target* | | *Target* | | *Target* | *2363* | *Target* | *1562* |
| Avg | 112.6 | Avg | -58.1 | Avg | 2366 | Avg | 1581 |
| Min | 112 | Min | -58.8 | Min | 2365 | Min | 1581 |
| Max | 112.9 | Max | -56.9 | Max | 2366 | Max | 1582 |

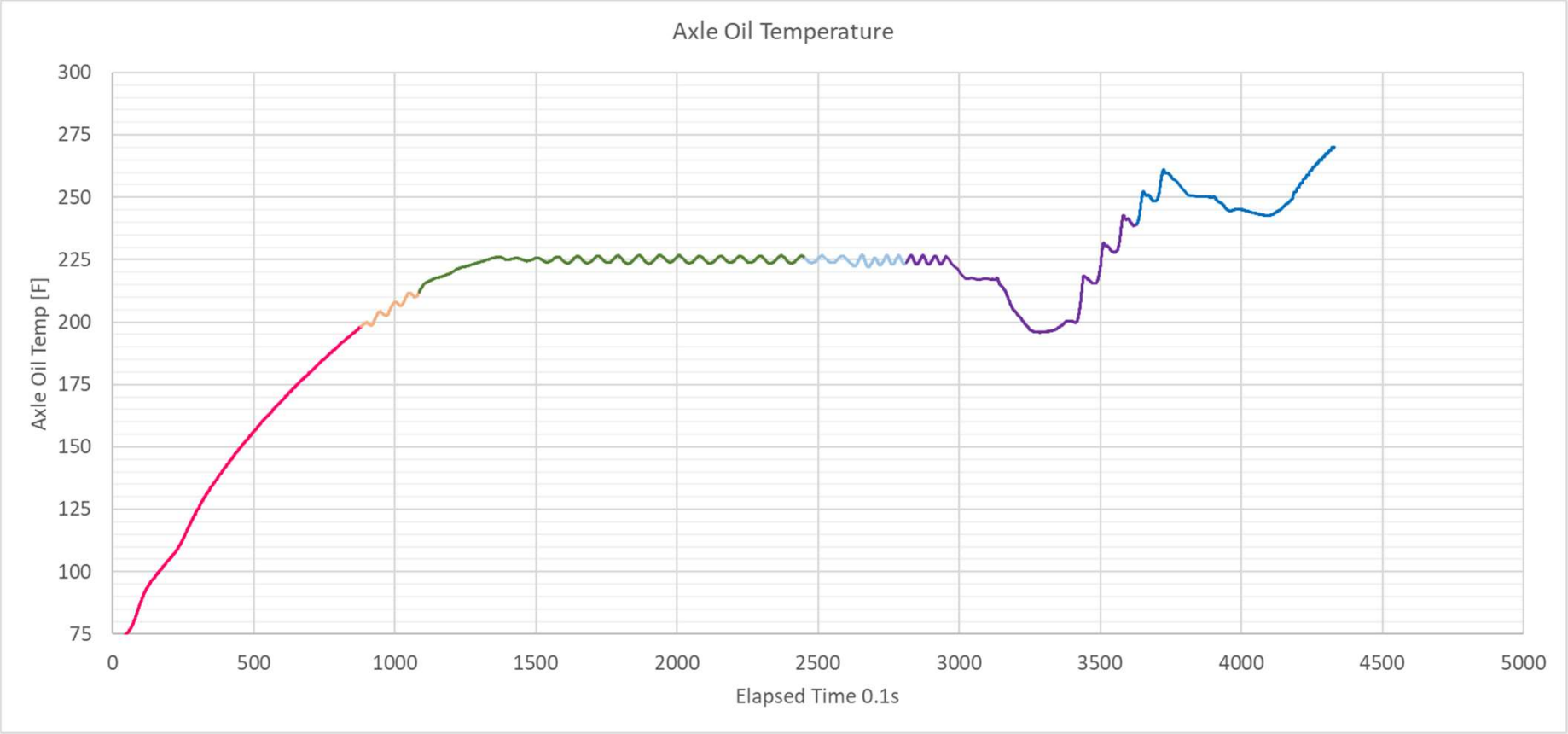
| Conditioning 4 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Peak Input Torque Drive [ft-lb] | | Peak Input Torque Coast [ft-lb] | | Maximum Input Speed [rpm] | | Minimum Input Speed [rpm] | |
| *Target* | | *Target* | | *Target* | *3350* | *Target* | *2754* |
| Avg | 114.6 | Avg | -65.6 | Avg | 3353 | Avg | 2752 |
| Min | 113.6 | Min | -77.0 | Min | 3348 | Min | 2750 |
| Max | 115.7 | Max | -57.6 | Max | 3355 | Max | 2753 |

# Summary Data—Shocks 01-0024

| Shock 1 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Peak Input Torque Drive [ft-lb] | | Peak Input Torque Coast [ft-lb] | | Maximum Input Speed [rpm] | | Minimum Input Speed [rpm] | |
| *Target* | | *Target* | | *Target* | *4316* | *Target* | *2178* |
| Avg | 235.5 | Avg | -64.7 | Avg | 4349 | Avg | 2192 |
| Min | 234.5 | Min | -70.7 | Min | 4348 | Min | 2174 |
| Max | 237.9 | Max | -60.9 | Max | 4354 | Max | 2197 |

| Shock 2 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Peak Input Torque Drive [ft-lb] | | Peak Input Torque Coast [ft-lb] | | Maximum Input Speed [rpm] | | Minimum Input Speed [rpm] | |
| *Target* | | *Target* | | *Target* | *3083* | *Target* | *2178* |
| Avg | 231.3 | Avg | -230.2 | Avg | 2599 | Avg | 2188 |
| Min | 224.4 | Min | -237.0 | Min | 2596 | Min | 2170 |
| Max | 248.5 | Max | -204.8 | Max | 2602 | Max | 2202 |

# Temperature Data—01-0024



# Test 01-0025

# Summary Data—Conditioning 01-0025

| Conditioning 1 | | | |
|---|---|---|---|
| **Input Torque [ft-lb]** | | **Input Speed [rpm]** | |
| *Target* | *60 ± 5* | *Target* | *2363* |
| Avg | 59.7 | Avg | 2360 |
| Min | 58.4 | Min | 2357 |
| Max | 61.2 | Max | 2363 |

| Conditioning 3 | | | |
|---|---|---|---|
| **Input Torque [ft-lb]** | | **Input Speed [rpm]** | |
| *Target* | *70 ± 5* | *Target* | *3350* |
| Avg | 70.0 | Avg | 3346 |
| Min | 51.8 | Min | 3343 |
| Max | 92.7 | Max | 3350 |

| Conditioning 2 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Peak Input Torque Drive [ft-lb]** | | **Peak Input Torque Coast [ft-lb]** | | **Maximum Input Speed [rpm]** | | **Minimum Input Speed [rpm]** | |
| *Target* | | *Target* | | *Target* | *2363* | *Target* | *1562* |
| Avg | 113.4 | Avg | -58.9 | Avg | 2367 | Avg | 1582 |
| Min | 112.8 | Min | -62.2 | Min | 2366 | Min | 1580 |
| Max | 113.7 | Max | -56.1 | Max | 2367 | Max | 1582 |

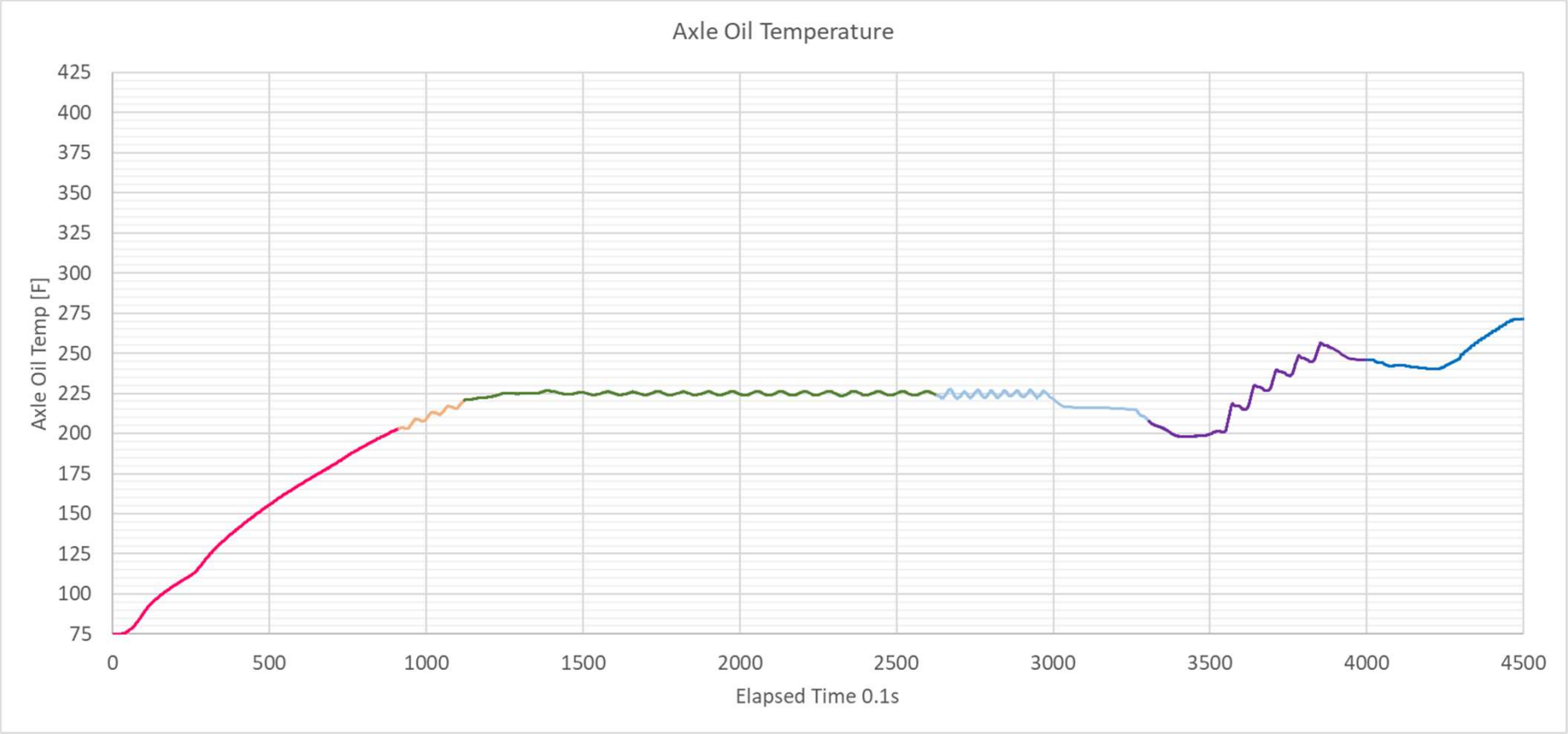
| Conditioning 4 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Peak Input Torque Drive [ft-lb]** | | **Peak Input Torque Coast [ft-lb]** | | **Maximum Input Speed [rpm]** | | **Minimum Input Speed [rpm]** | |
| *Target* | | *Target* | | *Target* | *3350* | *Target* | *2754* |
| Avg | 115.4 | Avg | -69.5 | Avg | 3352 | Avg | 2753 |
| Min | 114.4 | Min | -75.3 | Min | 3346 | Min | 2752 |
| Max | 116.2 | Max | -58.6 | Max | 3354 | Max | 2754 |

# Summary Data—Shocks 01-0025

| Shock 1 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Peak Input Torque Drive [ft-lb] | | Peak Input Torque Coast [ft-lb] | | Maximum Input Speed [rpm] | | Minimum Input Speed [rpm] | |
| *Target* | | *Target* | | *Target* | *4316* | *Target* | *2178* |
| Avg | 237.1 | Avg | -64.4 | Avg | 4349 | Avg | 2192 |
| Min | 235.6 | Min | -66.9 | Min | 4347 | Min | 2175 |
| Max | 239.4 | Max | -61.5 | Max | 4352 | Max | 2198 |

| Shock 2 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Peak Input Torque Drive [ft-lb] | | Peak Input Torque Coast [ft-lb] | | Maximum Input Speed [rpm] | | Minimum Input Speed [rpm] | |
| *Target* | | *Target* | | *Target* | *3083* | *Target* | *2178* |
| Avg | 239.4 | Avg | -228.9 | Avg | 2600 | Avg | 2191 |
| Min | 228.2 | Min | -235.0 | Min | 2597 | Min | 2172 |
| Max | 248.7 | Max | -204.2 | Max | 2602 | Max | 2206 |

# Temperature Data—01-0025



# Test 01-0026

# Summary Data—Conditioning 01-0026

| Conditioning 1 | | | |
|---|---|---|---|
| Input Torque [ft-lb] | | Input Speed [rpm] | |
| *Target* | *60 ± 5* | *Target* | *2363* |
| Avg | 59.7 | Avg | 2361 |
| Min | 58.6 | Min | 2357 |
| Max | 61.1 | Max | 2364 |

| Conditioning 3 | | | |
|---|---|---|---|
| Input Torque [ft-lb] | | Input Speed [rpm] | |
| *Target* | *70 ± 5* | *Target* | *3350* |
| Avg | 70.0 | Avg | 3346 |
| Min | 66.4 | Min | 3344 |
| Max | 71.2 | Max | 3349 |

| Conditioning 2 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Peak Input Torque Drive [ft-lb] | | Peak Input Torque Coast [ft-lb] | | Maximum Input Speed [rpm] | | Minimum Input Speed [rpm] | |
| *Target* | | *Target* | | *Target* | *2363* | *Target* | *1562* |
| Avg | 100.5 | Avg | -60.0 | Avg | 1789 | Avg | 1581 |
| Min | 59.8 | Min | -61.0 | Min | 60 | Min | 1581 |
| Max | 114.4 | Max | -58.9 | Max | 2366 | Max | 1582 |

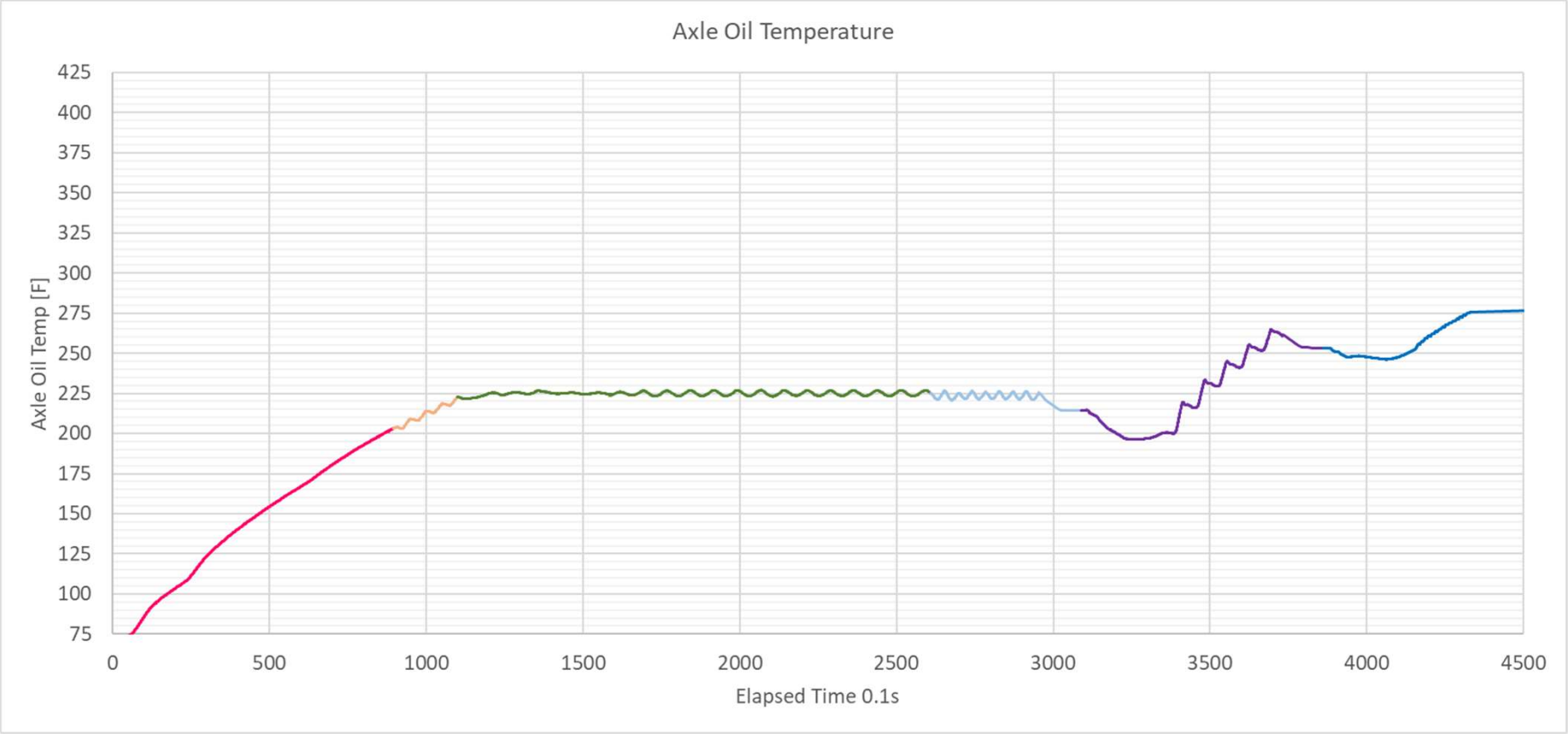
| Conditioning 4 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Peak Input Torque Drive [ft-lb] | | Peak Input Torque Coast [ft-lb] | | Maximum Input Speed [rpm] | | Minimum Input Speed [rpm] | |
| *Target* | | *Target* | | *Target* | *3350* | *Target* | *2754* |
| Avg | 115.9 | Avg | -68.6 | Avg | 3351 | Avg | 2752 |
| Min | 115.1 | Min | -74.3 | Min | 3345 | Min | 2750 |
| Max | 117.3 | Max | -62.5 | Max | 3354 | Max | 2753 |

# Summary Data—Shocks 01-0026

| Shock 1 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Peak Input Torque Drive [ft-lb] | | Peak Input Torque Coast [ft-lb] | | Maximum Input Speed [rpm] | | Minimum Input Speed [rpm] | |
| *Target* | | *Target* | | *Target* | *4316* | *Target* | *2178* |
| Avg | 237.6 | Avg | -66.6 | Avg | 4349 | Avg | 2192 |
| Min | 235.8 | Min | -69.6 | Min | 4348 | Min | 2175 |
| Max | 239.9 | Max | -64.6 | Max | 4350 | Max | 2197 |

| Shock 2 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Peak Input Torque Drive [ft-lb] | | Peak Input Torque Coast [ft-lb] | | Maximum Input Speed [rpm] | | Minimum Input Speed [rpm] | |
| *Target* | | *Target* | | *Target* | *3083* | *Target* | *2178* |
| Avg | 242.6 | Avg | -229.4 | Avg | 2600 | Avg | 2191 |
| Min | 225.7 | Min | -235.2 | Min | 2595 | Min | 2172 |
| Max | 262.8 | Max | -205.8 | Max | 2603 | Max | 2203 |

# Temperature Data—01-0026



# Reference: all ratings to date

| Test Number | Oil Code | EOT Date | Final Pinion Rating (Adjusted) | Final Ring Rating (Adjusted) | On L-42 Target? |
|---|---|---|---|---|---|
| 01-0003 | TMC 117 (High Ref) | 4/22/22 | 22% | 15% | Y |
| 01-0004 | TMC 113 (Disc. Oil) | 4/25/22 | 52% | 42% | Y |
| 01-0005 | TMC 117 (High Ref) | 6/16/22 | 30% | 18% | Y |
| 01-0006 | TMC 113 (Disc. Oil) | 6/17/22 | 46% | 36% | N |
| 01-0007 | TMC 117 (High Ref) | 6/20/22 | 30% | 20% | Y |
| 01-0008 | TMC 113 (Disc. Oil) | 6/20/22 | 43% | 33% | N |
| 01-0009 | TMC 117 (High Ref) | 9/27/22 | 33% | 18% | N |
| 01-0010 | TMC 113 (Disc. Oil) | 9/28/22 | 61% | 49% | N |
| 01-0012 | TMC 117 (High Ref) | 10/19/22 | 35% | 23% | N |
| 01-0011 | TMC 113 (Disc. Oil) | 10/19/22 | 60% | 48% | N |

# Reference: all ratings to date, continued

| Test Number | Oil Code | EOT Date | Final Pinion Rating (Adjusted) | Final Ring Rating (Adjusted) | On L-42 Target? |
|---|---|---|---|---|---|
| 01-0013 | TMC 117 (High Ref) | 7/26/23 | 16 | 11 | Y |
| 01-0014 | TMC 119 (Disc. Oil) | 7/26/23 | 28 | 18 | N |
| 01-0015 | TMC 117 (High Ref) | 7/29/23 | 19 | 12 | Y |
| 01-0016 | TMC 119 (Disc. Oil) | 7/30/23 | 28 | 28 | N |
| 01-0017 | TMC 117 (High Ref) | 8/7/23 | 18 | 12 | Y |
| 01-0018 | TMC 119 (Disc. Oil) | 8/7/23 | 35 | 26 | N |
| 01-0019 | TMC 119 (leftover 2023 pilot axle) | 9/25/23 | 28 | 18 | n/a |
| 01-0020 | TMC 117 (High Ref) | | Invalid | | |

# L-42-1 Development: Regen T-Rig

Matt Sangpeal
Afton Chemical
February 7, 2024

Passion for Solutions™

# Regenerative AC T-Rig

# Regenerative AC T-Rig

- **Rigid Axle Mounts (no spring plates)**
- **HBM T40B torque transducers**
- **Water cooled axle**
- **225 kW Input Motor**
- **180 kW Output Motors**

Afton CHEMICAL

Passion for Solutions™

# Test Details

| Run # | Description | CMIR | TMC Oil Code | Note | Axle Batch | Profile |
|---|---|---|---|---|---|---|
| 254 | Reference | 176818 | 117 | Pass Oil | MSPLO/P2AD01 (2023) | Engine Rig Data Setpoints |
| 255 | Reference | 176822 | 119 | Disc. Oil | MSPLO/P2AD01 (2023) | Engine Rig Data Setpoints |
| 256 | Reference | 176820 | 117 | Pass Oil | MSPLO/P2AD01 (2023) | Ramp Rate / Torque Setpoints |
| 257 | Reference | 184767 | 119 | Disc. Oil | MSPLO/P2AD01 (2023) | Ramp Rate / Torque Setpoints |
| 258 | 80W-90 | - | - | J2360 | MSPLO/P2AD01 (2023) | Ramp Rate / Torque Setpoints |
| 259 | 75W-80 | - | - | J2360 | MSPLO/P2AD01 (2023) | Ramp Rate / Torque Setpoints |
| 260 | Reference | 184759 | 117 | Pass Oil | MSPLO/P2AD01 (2023) | Ramp Rate / Torque Setpoints |
| 261 | 80W-90 | - | - | Poor Perf. | MSPLO/P2AD01 (2023) | Ramp Rate / Torque Setpoints |

# 100 Hz Setpoints from Engine-Driven Test Rig w/Reference Oils

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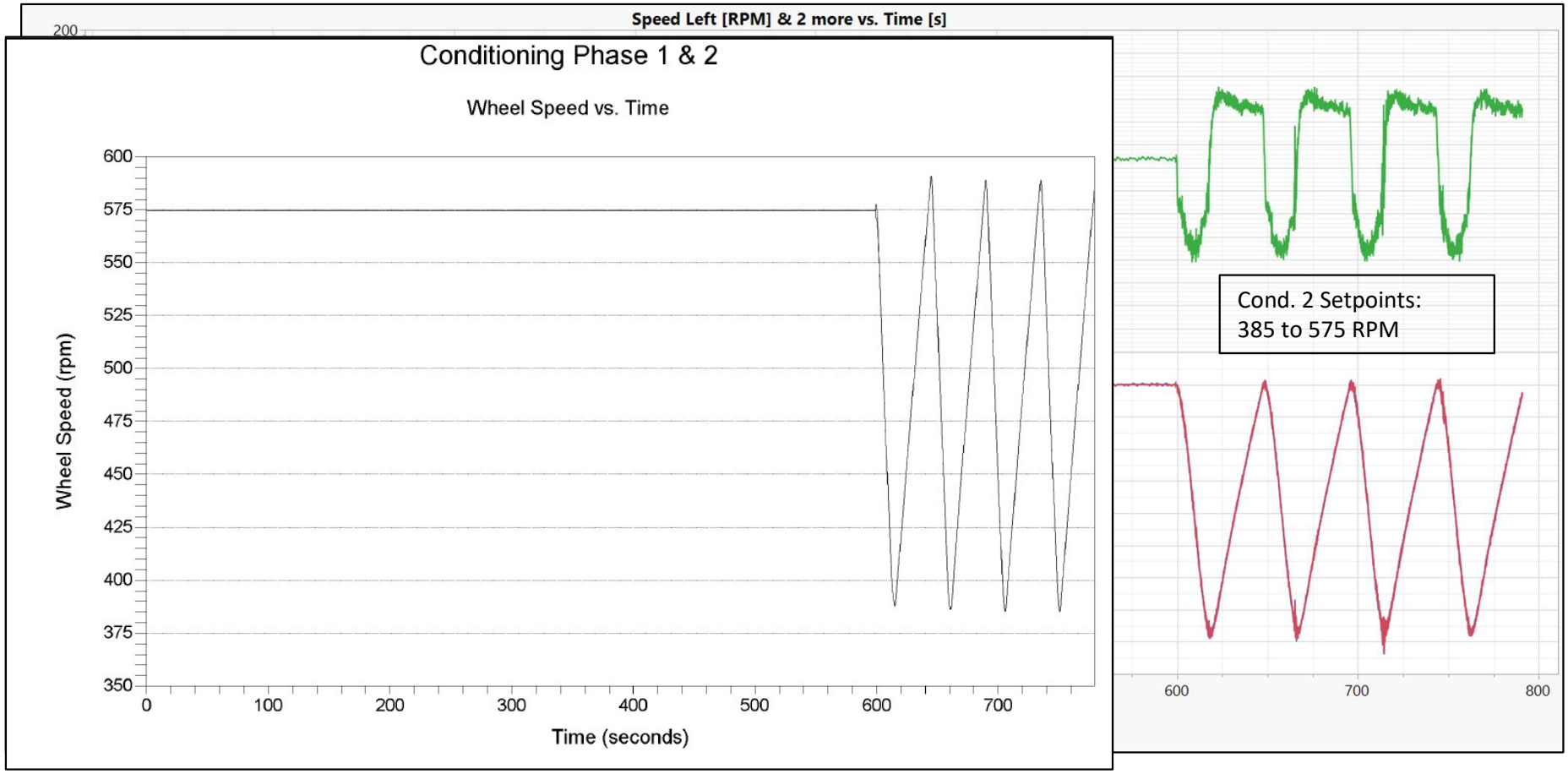
# 117 Conditioning Phase 1 & 2: Engine Setpoints

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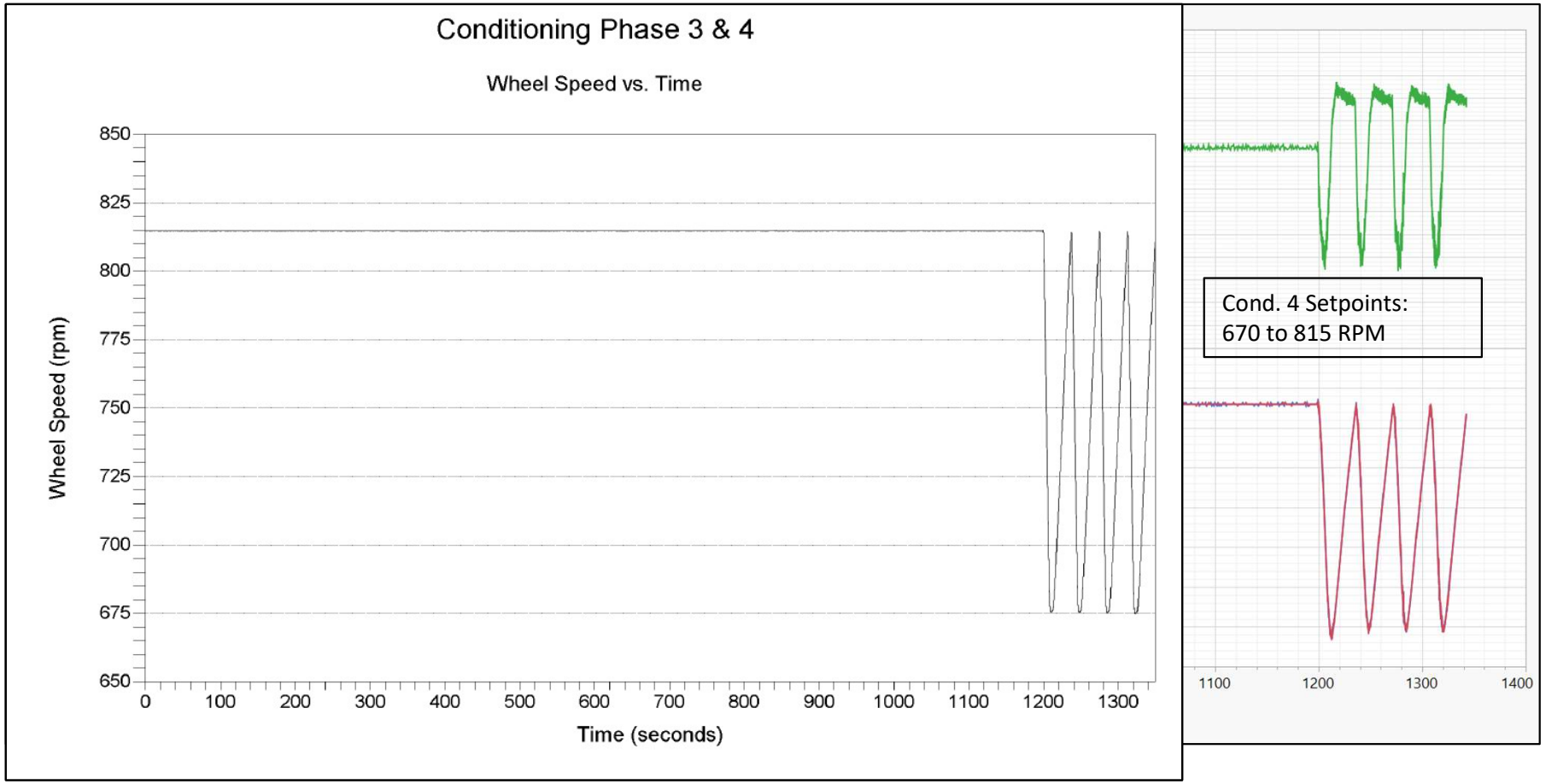
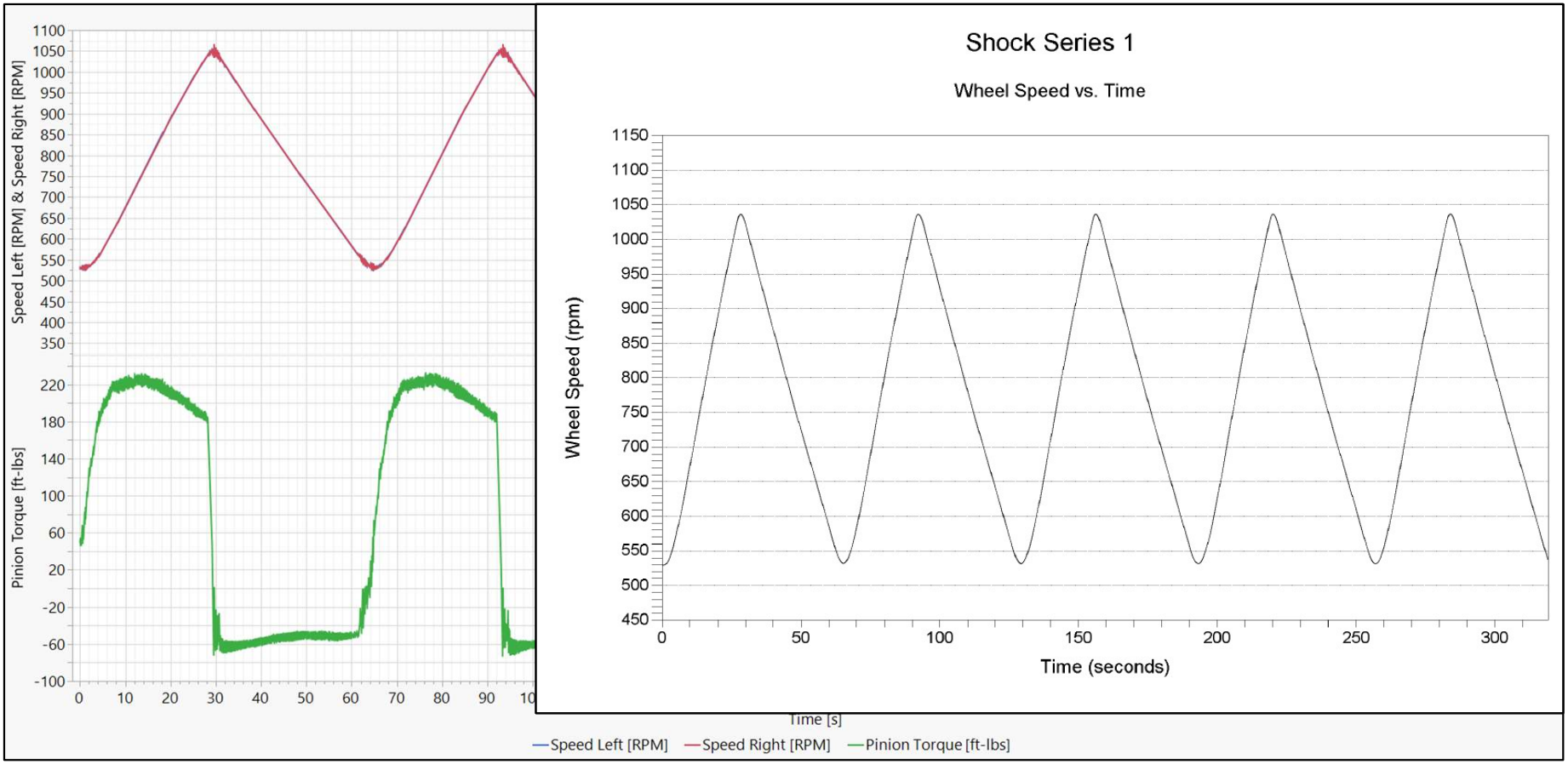
# 117 Conditioning Phase 3 & 4: Engine Setpoints



# 117 Shock I: Engine Setpoints

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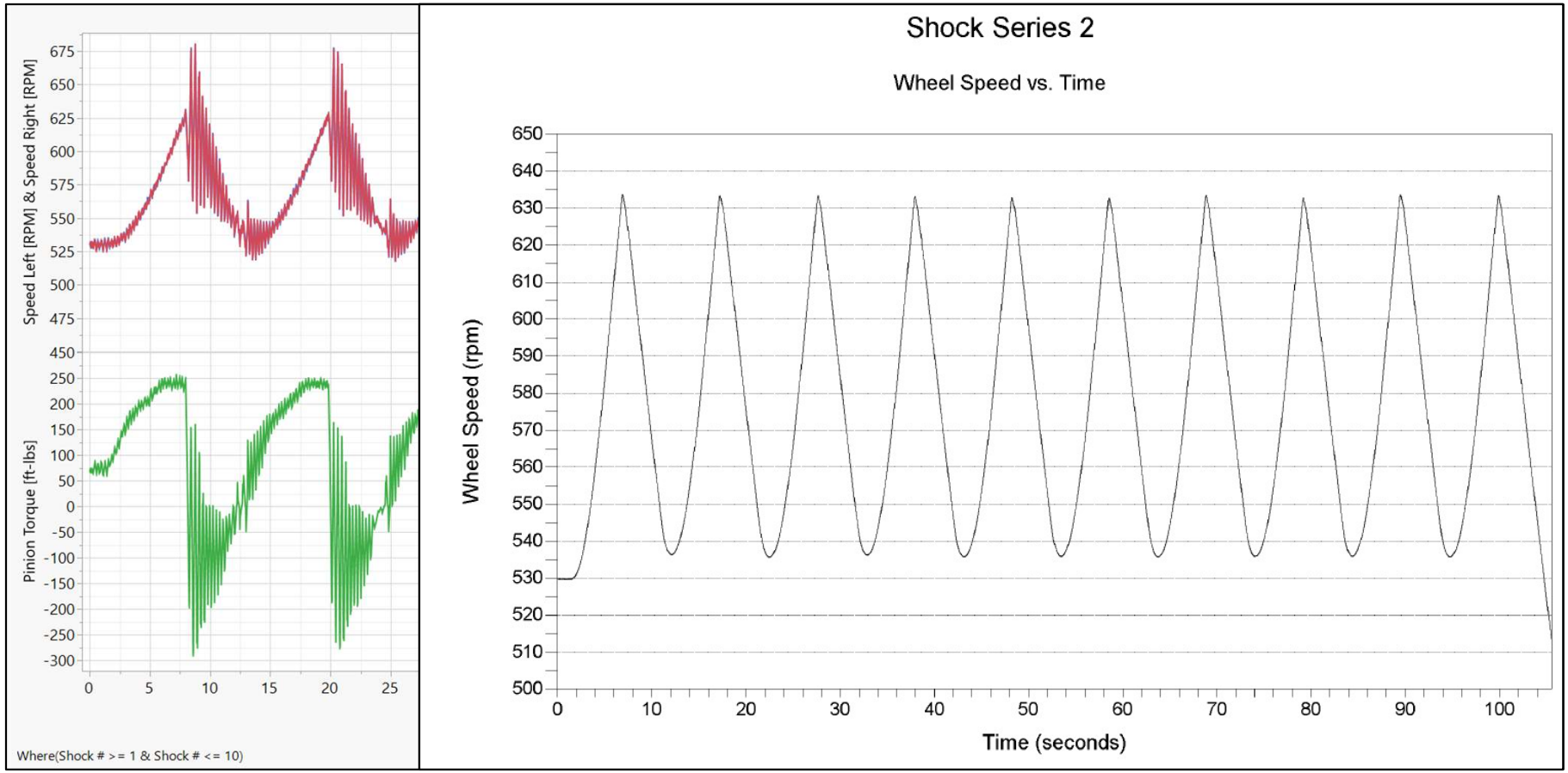
# 117 Shock II: Engine Setpoints

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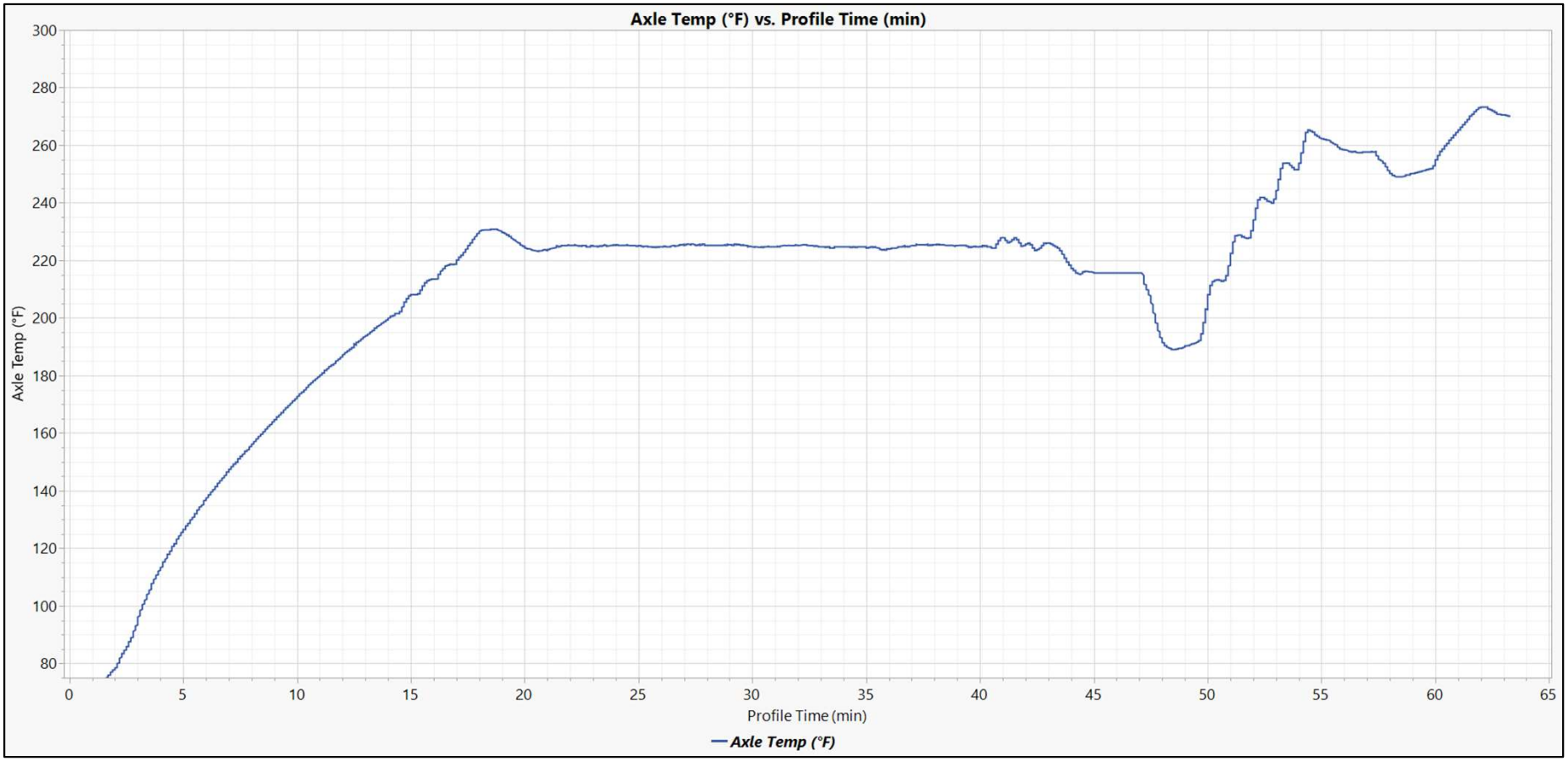
# 117 Oil Temp: Engine Setpoints

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# Operational Data: Engine Setpoints

| TMC 117 Oil | | | | |
|---|---|---|---|---|
| Operational Data | | | | |
| | Conditioning 1 | | Conditioning 3 | |
| | Wheel Speed (r/min) | Torques (lbf-ft) | Wheel Speed (r/min) | Torques (lbf-ft) |
| Maximum | 577 | 62 | 816 | 74 |
| Minimum | 574 | 57 | 814 | 67 |
| Average | 575 | 60 | 815 | 70 |

| TMC 119 Oil | | | | |
|---|---|---|---|---|
| Operational Data | | | | |
| | Conditioning 1 | | Conditioning 3 | |
| | Wheel Speed (r/min) | Torques (lbf-ft) | Wheel Speed (r/min) | Torques (lbf-ft) |
| Maximum | 576 | 62 | 816 | 73 |
| Minimum | 574 | 58 | 814 | 68 |
| Average | 575 | 60 | 815 | 70 |

| TMC 117 Oil | | | | | |
|---|---|---|---|---|---|
| Operational Data | | | | | |
| | | Conditioning 2 | | Conditioning 4 | |
| | | Wheel Speed (r/min) | Torques (lbf-ft) | Wheel Speed (r/min) | Torques (lbf-ft) |
| Drive Side | Maximum | 578 | 136 | 817 | 140 |
| | Minimum | 576 | 133 | 813 | 137 |
| | Average | 577 | 135 | 814 | 138 |
| Coast Side | Maximum | 381 | -48 | 674 | -59 |
| | Minimum | 368 | -51 | 669 | -63 |
| | Average | 376 | -49 | 672 | -61 |

| TMC 119 Oil | | | | | |
|---|---|---|---|---|---|
| Operational Data | | | | | |
| | | Conditioning 2 | | Conditioning 4 | |
| | | Wheel Speed (r/min) | Torques (lbf-ft) | Wheel Speed (r/min) | Torques (lbf-ft) |
| Drive Side | Maximum | 578 | 136 | 816 | 140 |
| | Minimum | 577 | 134 | 813 | 136 |
| | Average | 577 | 135 | 814 | 138 |
| Coast Side | Maximum | 380 | -50 | 673 | -58 |
| | Minimum | 367 | -52 | 669 | -64 |
| | Average | 376 | -51 | 672 | -62 |

| TMC 117 Oil | | | | |
|---|---|---|---|---|
| Lubricant Temperature Data | | | | |
| Phase | Specification | Average | Minimum | Maximum |
| Gear Conditioning (After reaching 215°F) | 225 ± 10°F | 224.1 | 216 | 228.1 |

| TMC 119 Oil | | | | |
|---|---|---|---|---|
| Lubricant Temperature Data | | | | |
| Phase | Specification | Average | Minimum | Maximum |
| Gear Conditioning (After reaching 215°F) | 225 ± 10°F | 225.3 | 223.1 | 227.8 |

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# Gear Loading Data: Engine Setpoints

| TMC 117 Oil | | | | | |
|---|---|---|---|---|---|
| Gear Loading Data | | | | | |
| Gear Side | | Shock Series 1 | | Shock Series 2 | |
| | | Wheel Speed (r/min) | Torques (lbf-ft) | Wheel Speed (r/min) | Torques (lbf-ft) |
| Drive | Maximum | 1062 | 232 | 679 | 254 |
| | Minimum | 1060 | 230 | 673 | 245 |
| | Average | 1061 | 231 | 676 | 249 |
| Coast | Maximum | 530 | -69 | 534 | -261 |
| | Minimum | 527 | -76 | 519 | -288 |
| | Average | 529 | -72 | 527 | -277 |

| TMC 119 Oil | | | | | |
|---|---|---|---|---|---|
| Gear Loading Data | | | | | |
| Gear Side | | Shock Series 1 | | Shock Series 2 | |
| | | Wheel Speed (r/min) | Torques (lbf-ft) | Wheel Speed (r/min) | Torques (lbf-ft) |
| Drive | Maximum | 1063 | 232 | 679 | 254 |
| | Minimum | 1060 | 230 | 675 | 244 |
| | Average | 1061 | 231 | 677 | 248 |
| Coast | Maximum | 530 | -70 | 534 | -271 |
| | Minimum | 526 | -77 | 519 | -290 |
| | Average | 528 | -75 | 526 | -281 |

| TMC 117 Oil | | | |
|---|---|---|---|
| Lubricant Temperature Data | | | |
| Phase | Specification | Start Value | Maximum |
| Shock Series 1 | 200 ± 5 °F | 192 | 265 |
| Shock Series 2 | < 280 °F | 252 | 272 |

| TMC 119 Oil | | | |
|---|---|---|---|
| Lubricant Temperature Data | | | |
| Phase | Specification | Start Value | Maximum |
| Shock Series 1 | 200 ± 5 °F | 185 | 261 |
| Shock Series 2 | < 280 °F | 246 | 270 |

| | |
|---|---|
| Current Engine Rig: | Shock 1: -74.2 lbf-ft<br>Shock 2: -333.5 lbf-ft |

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# Test Result Summary: Engine Setpoints

| TMC 117 Oil | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Test Date Started | Test Date Completed | Drive Side Scoring (%) | | Coast Side Scoring (%) | | | Coast Side Torque (lbf-ft) | |
| | | EOT Pinion | EOT Ring | EOT Pinion | EOT Ring | Shock Series 1 Ring | Shock Series 1 (Average) | Shock Series 2 (Average) |
| 20231211 | 20231211 | 0 | 0 | 16 | 8 | 0.0 | -72.4 | -277.0 |
| Conditioning 2 Test Time: 3 | | Conditioning 4 Test Time: 2 | | | End of Test Time: 15:39 | | Total Test Minutes: | 63 |
| Ring Batch: P2AD01 | | Pinion Batch: MSPLO | | | Latest Information Letter Run Against: | | N/A | |

*Correction Factors: Pinion = 6, Ring = 4

| TMC 119 Oil | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Test Date Started | Test Date Completed | Drive Side Scoring (%) | | Coast Side Scoring (%) | | | Coast Side Torque (lbf-ft) | |
| | | EOT Pinion | EOT Ring | EOT Pinion | EOT Ring | Shock Series 1 Ring | Shock Series 1 (Average) | Shock Series 2 (Average) |
| 20231213 | 20231213 | 0 | 0 | 41 | 29 | 0.0 | -74.7 | -280.7 |
| Conditioning 2 Test Time: 3 | | Conditioning 4 Test Time: 2 | | | End of Test Time: 11:09 | | Total Test Minutes: | 70 |
| Ring Batch: P2AD01 | | Pinion Batch: MSPLO | | | Latest Information Letter Run Against: | | N/A | |

| | |
|---|---|
| Current Engine Rig P/F: | Pinion: 20<br>Ring: 15 |

# EOT Pinion Photos: Engine Setpoints

TMC 117

TMC 119

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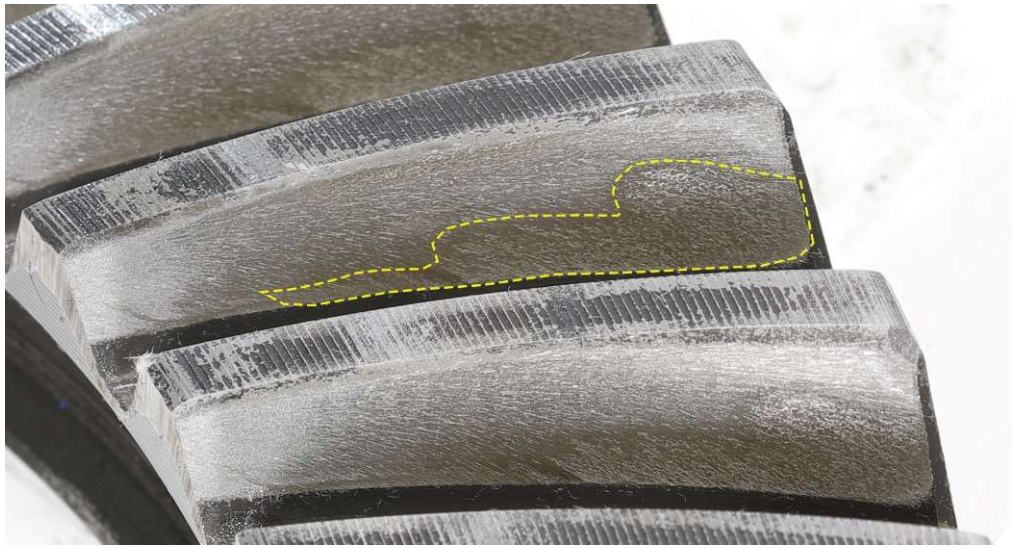
# EOT Ring Photos: Engine Setpoints

TMC 117

TMC 119



# Torque Setpoint / Ramp Rate w/Reference Oils

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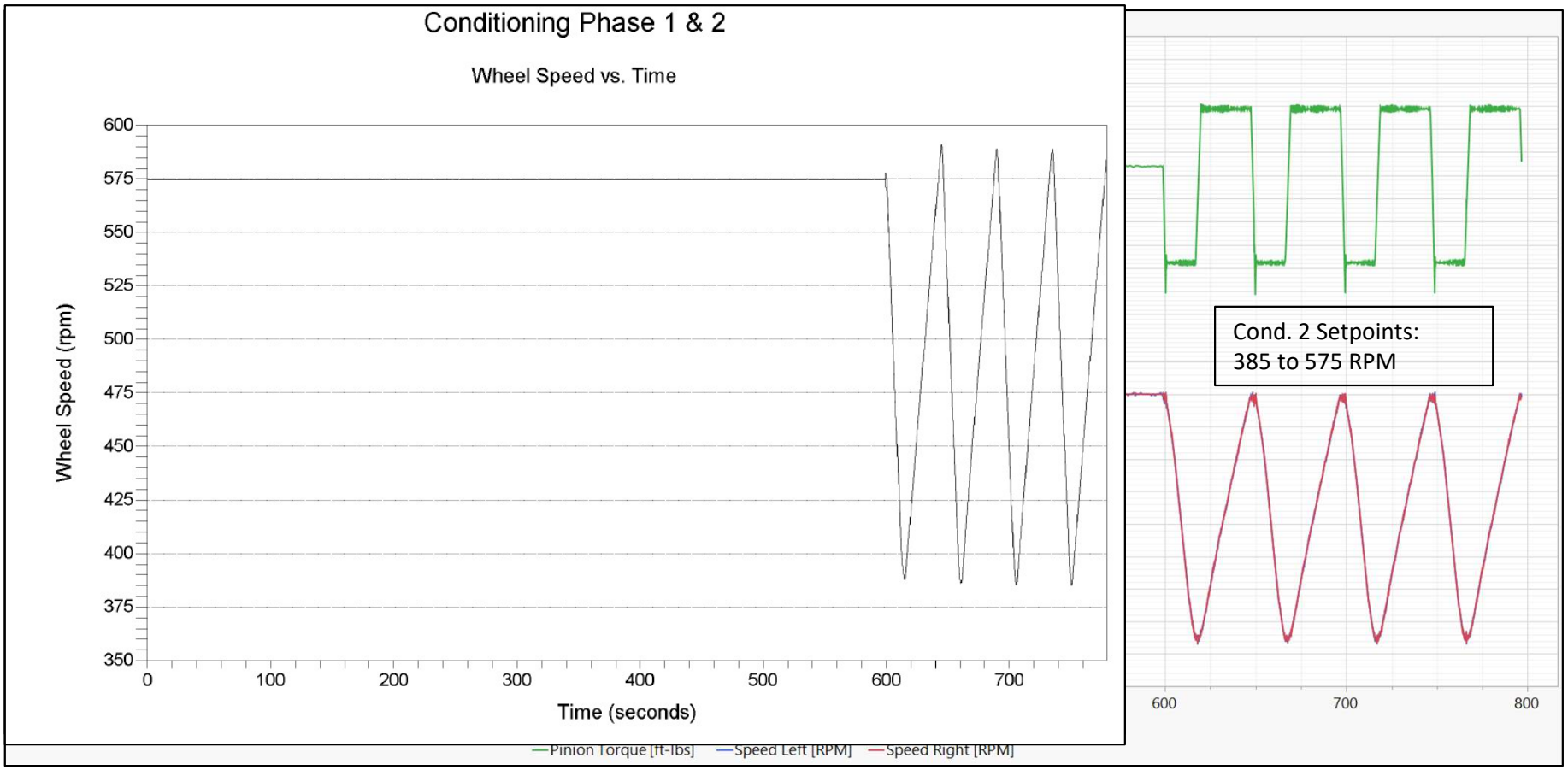
# 117 Conditioning Phase 1 & 2: Torque Setpoint / Ramp Rate

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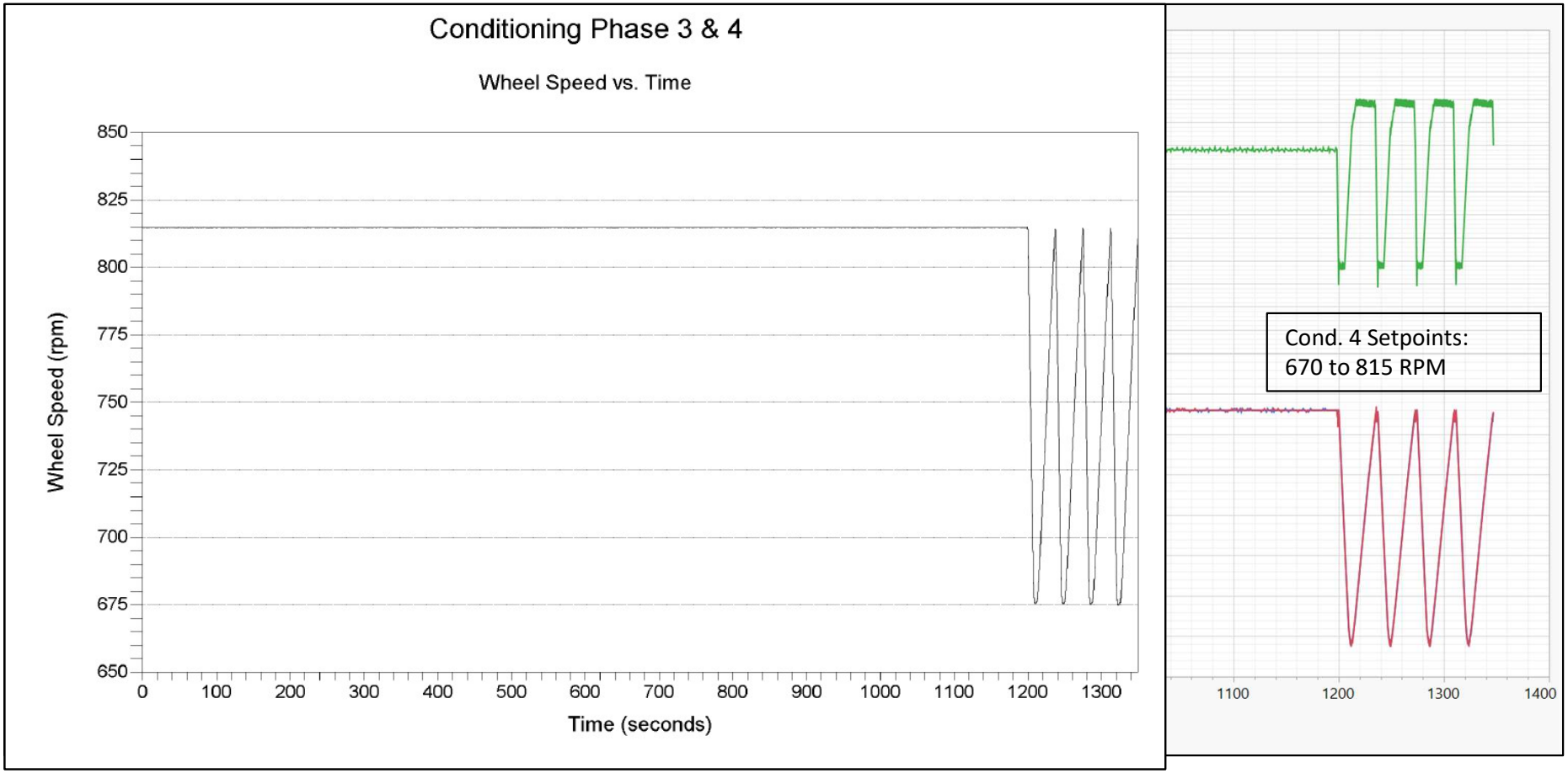
# 117 Conditioning Phase 3 & 4: Torque Setpoint / Ramp Rate

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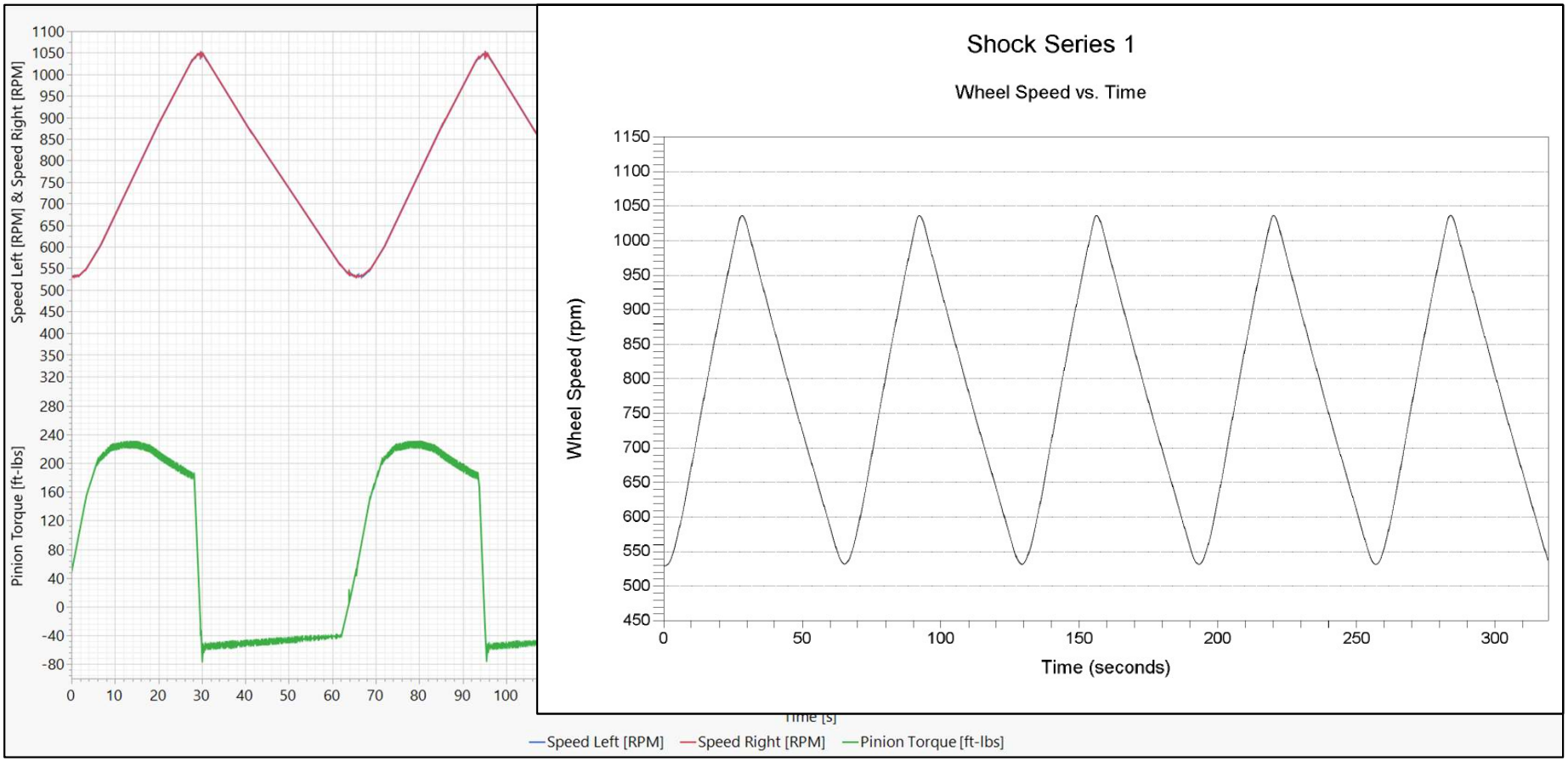
# 117 Shock I: Torque Setpoint / Ramp Rate

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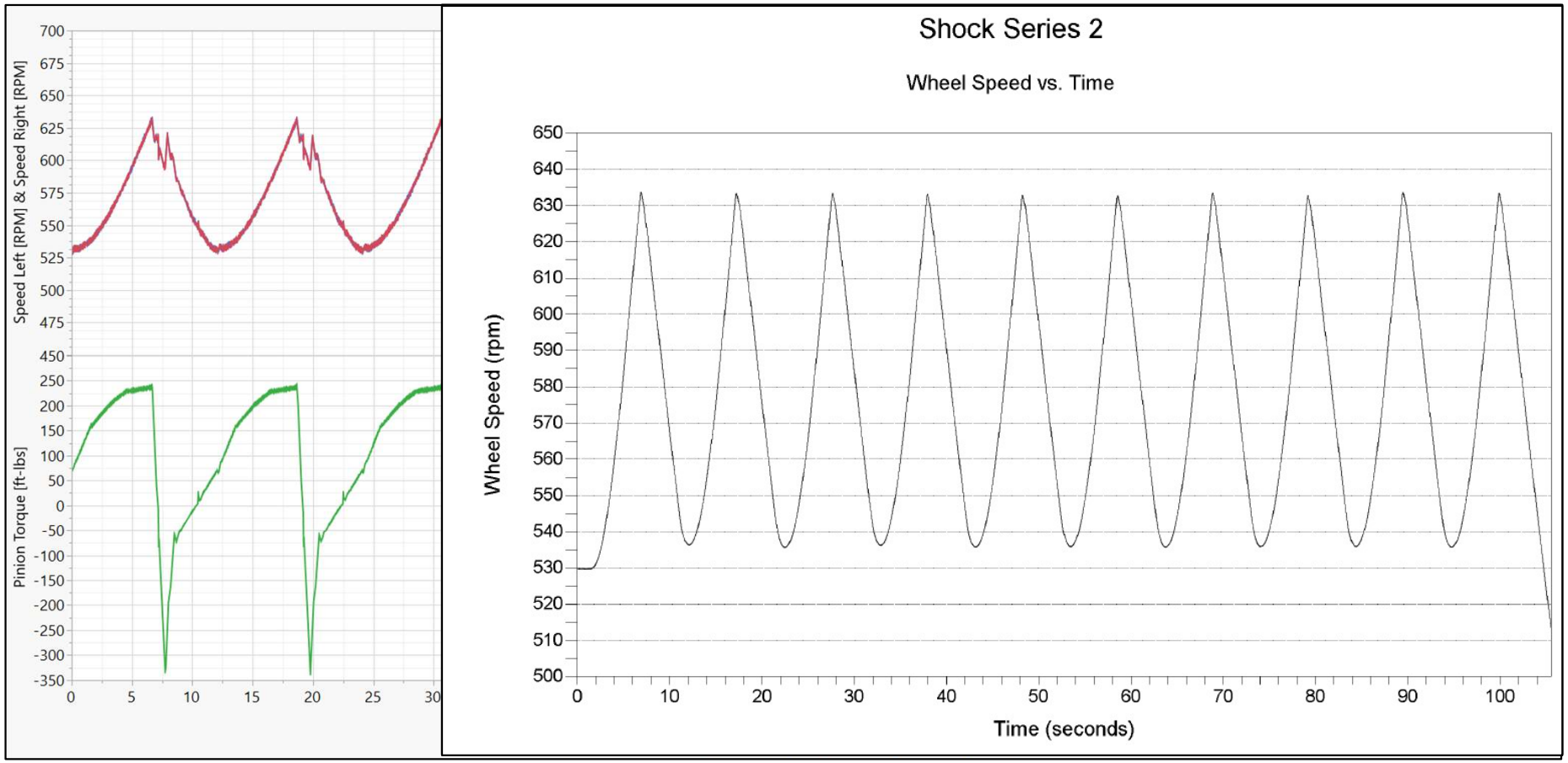
# 117 Shock II: Torque Setpoint / Ramp Rate

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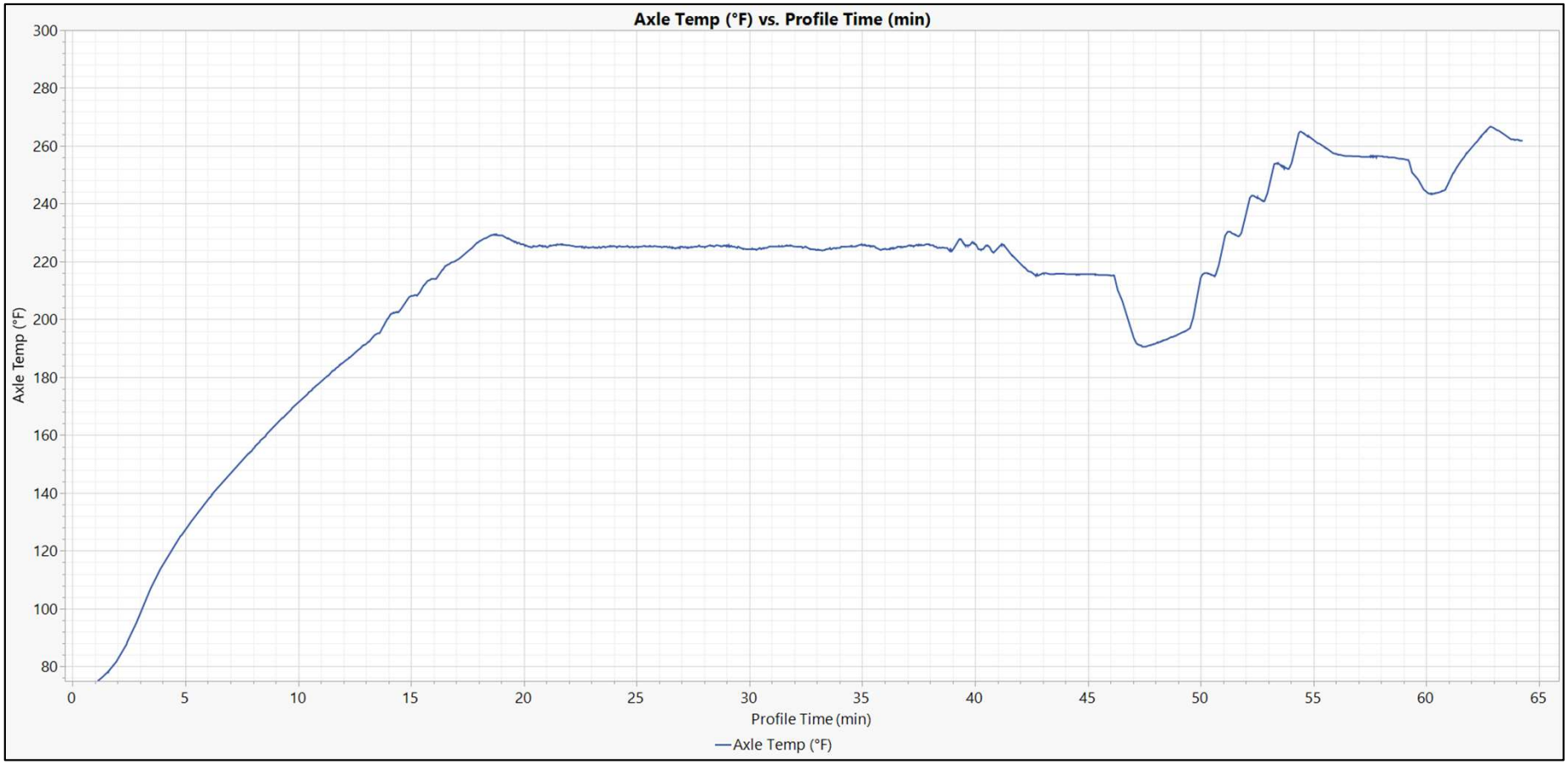
# 117 Oil Temp: Torque Setpoint / Ramp Rate

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# Operational Data: Torque Setpoint / Ramp Rate (Hi Ref)

| TMC 117 Oil | | | | |
|---|---|---|---|---|
| Operational Data | | | | |
| | Conditioning 1 | | Conditioning 3 | |
| | Wheel Speed (r/min) | Torques (lbf-ft) | Wheel Speed (r/min) | Torques (lbf-ft) |
| Maximum | 576 | 61 | 816 | 73 |
| Minimum | 574 | 58 | 814 | 67 |
| Average | 575 | 60 | 815 | 70 |

| TMC 117 Oil (Run 2) | | | | |
|---|---|---|---|---|
| Operational Data | | | | |
| | Conditioning 1 | | Conditioning 3 | |
| | Wheel Speed (r/min) | Torques (lbf-ft) | Wheel Speed (r/min) | Torques (lbf-ft) |
| Maximum | 576 | 62 | 817 | 73 |
| Minimum | 574 | 57 | 814 | 67 |
| Average | 575 | 60 | 815 | 70 |

| TMC 117 Oil | | | | | |
|---|---|---|---|---|---|
| Operational Data | | | | | |
| | | Conditioning 2 | | Conditioning 4 | |
| | | Wheel Speed (r/min) | Torques (lbf-ft) | Wheel Speed (r/min) | Torques (lbf-ft) |
| Drive Side | Maximum | 575 | 125 | 816 | 123 |
| | Minimum | 574 | 124 | 814 | 123 |
| | Average | 575 | 124 | 815 | 123 |
| Coast Side | Maximum | 386 | -75 | 670 | -74 |
| | Minimum | 384 | -76 | 670 | -77 |
| | Average | 385 | -75 | 670 | -75 |

| TMC 117 Oil (Run 2) | | | | | |
|---|---|---|---|---|---|
| Operational Data | | | | | |
| | | Conditioning 2 | | Conditioning 4 | |
| | | Wheel Speed (r/min) | Torques (lbf-ft) | Wheel Speed (r/min) | Torques (lbf-ft) |
| Drive Side | Maximum | 575 | 125 | 815 | 124 |
| | Minimum | 574 | 124 | 814 | 124 |
| | Average | 575 | 125 | 815 | 124 |
| Coast Side | Maximum | 386 | -74 | 670 | -74 |
| | Minimum | 385 | -76 | 670 | -76 |
| | Average | 385 | -75 | 670 | -75 |

| TMC 117 Oil | | | | |
|---|---|---|---|---|
| Lubricant Temperature Data | | | | |
| Phase | Specification | Average | Minimum | Maximum |
| Gear Conditioning (After reaching 215°F) | 225 ± 10°F | 224.1 | 216 | 229.4 |

| TMC 117 Oil (Run 2) | | | | |
|---|---|---|---|---|
| Lubricant Temperature Data | | | | |
| Phase | Specification | Average | Minimum | Maximum |
| Gear Conditioning (After reaching 215°F) | 225 ± 10°F | 225.5 | 215.1 | 229 |

# Operational Data: Torque Setpoint / Ramp Rate (Disc. Ref)

| TMC 119 Oil | | | | |
|---|---|---|---|---|
| Operational Data | | | | |
| | Conditioning 1 | | Conditioning 3 | |
| | Wheel Speed (r/min) | Torques (lbf-ft) | Wheel Speed (r/min) | Torques (lbf-ft) |
| Maximum | 576 | 61 | 816 | 73 |
| Minimum | 574 | 58 | 814 | 67 |
| Average | 575 | 60 | 815 | 70 |

| TMC 119 Oil | | | | | |
|---|---|---|---|---|---|
| Operational Data | | | | | |
| | | Conditioning 2 | | Conditioning 4 | |
| | | Wheel Speed (r/min) | Torques (lbf-ft) | Wheel Speed (r/min) | Torques (lbf-ft) |
| Drive Side | Maximum | 576 | 125 | 815 | 124 |
| | Minimum | 574 | 123 | 814 | 123 |
| | Average | 575 | 124 | 815 | 123 |
| Coast Side | Maximum | 386 | -74 | 670 | -74 |
| | Minimum | 385 | -77 | 670 | -77 |
| | Average | 385 | -75 | 670 | -75 |

| TMC 119 Oil | | | | |
|---|---|---|---|---|
| Lubricant Temperature Data | | | | |
| Phase | Specification | Average | Minimum | Maximum |
| Gear Conditioning (After reaching 215°F) | 225 ± 10°F | 224.4 | 215.1 | 231 |

# Gear Loading Data: Torque Setpoint / Ramp Rate (Hi Ref)

| TMC 117 Oil | | | | | |
|---|---|---|---|---|---|
| Gear Loading Data | | | | | |
| Gear Side | | Shock Series 1 | | Shock Series 2 | |
| | | Wheel Speed (r/min) | Torques (lbf-ft) | Wheel Speed (r/min) | Torques (lbf-ft) |
| Drive | Maximum | 1049 | 228 | 632 | 241 |
| | Minimum | 1048 | 228 | 631 | 239 |
| | Average | 1048 | 228 | 631 | 241 |
| Coast | Maximum | 530 | -74 | 530 | -332 |
| | Minimum | 529 | -75 | 529 | -336 |
| | Average | 529 | -74 | 529 | -334 |

| TMC 117 Oil (Run 2) | | | | | |
|---|---|---|---|---|---|
| Gear Loading Data | | | | | |
| Gear Side | | Shock Series 1 | | Shock Series 2 | |
| | | Wheel Speed (r/min) | Torques (lbf-ft) | Wheel Speed (r/min) | Torques (lbf-ft) |
| Drive | Maximum | 1049 | 228 | 632 | 241 |
| | Minimum | 1048 | 227 | 631 | 240 |
| | Average | 1048 | 228 | 631 | 240 |
| Coast | Maximum | 530 | -72 | 531 | -329 |
| | Minimum | 529 | -74 | 530 | -333 |
| | Average | 529 | -73 | 530 | -332 |

| TMC 117 Oil | | | |
|---|---|---|---|
| Lubricant Temperature Data | | | |
| Phase | Specification | Start Value | Maximum |
| Shock Series 1 | 200 ± 5 °F | 197 | 264 |
| Shock Series 2 | < 280 °F | 245 | 266 |

| TMC 117 Oil (Run 2) | | | |
|---|---|---|---|
| Lubricant Temperature Data | | | |
| Phase | Specification | Start Value | Maximum |
| Shock Series 1 | 200 ± 5 °F | 196 | 262 |
| Shock Series 2 | < 280 °F | 243 | 264 |

| | |
|---|---|
| Current Engine Rig: | Shock 1: -74.2 lbf-ft<br>Shock 2: -333.5 lbf-ft |

# Gear Loading Data: Torque Setpoint / Ramp Rate (Disc. Ref)

| TMC 119 Oil | | | | | |
|---|---|---|---|---|---|
| Gear Loading Data | | | | | |
| Gear Side | | Shock Series 1 | | Shock Series 2 | |
| | | Wheel Speed (r/min) | Torques (lbf-ft) | Wheel Speed (r/min) | Torques (lbf-ft) |
| Drive | Maximum | 1049 | 228 | 632 | 240 |
| | Minimum | 1049 | 227 | 631 | 239 |
| | Average | 1049 | 227 | 631 | 240 |
| Coast | Maximum | 530 | -74 | 530 | -331 |
| | Minimum | 530 | -75 | 530 | -336 |
| | Average | 530 | -74 | 530 | -334 |

| TMC 119 Oil | | | |
|---|---|---|---|
| Lubricant Temperature Data | | | |
| Phase | Specification | Start Value | Maximum |
| Shock Series 1 | 200 ± 5 °F | 197 | 272 |
| Shock Series 2 | < 280 °F | 252 | 279 |

| | |
|---|---|
| Current Engine Rig: | Shock 1: -74.2 lbf-ft<br>Shock 2: -333.5 lbf-ft |

# Test Result Summary: Torque Setpoint / Ramp Rate

| TMC 117 Oil | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Test Date Started | Test Date Completed | Drive Side Scoring (%) | | Coast Side Scoring (%) | | | Coast Side Torque (lbf-ft) | |
| | | EOT Pinion | EOT Ring | EOT Pinion | EOT Ring | Shock Series 1 Ring | Shock Series 1 (Average) | Shock Series 2 (Average) |
| 20240104 | 20240104 | 0 | 0 | 36 | 24 | 0.0 | -74.5 | -333.5 |
| Conditioning 2 Test Time: 3 | | Conditioning 4 Test Time: 2 | | End of Test Time: 11:56 | | | Total Test Minutes: | 64 |
| Ring Batch: P2AD01 | | Pinion Batch: MSPLO | | Latest Information Letter Run Against: | | | N/A | |

| TMC 117 Oil (Run 2) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Test Date Started | Test Date Completed | Drive Side Scoring (%) | | Coast Side Scoring (%) | | | Coast Side Torque (lbf-ft) | |
| | | EOT Pinion | EOT Ring | EOT Pinion | EOT Ring | Shock Series 1 Ring | Shock Series 1 (Average) | Shock Series 2 (Average) |
| 20240130 | 20240130 | 0 | 0 | 22 | 14 | 0.0 | -73.5 | -332.4 |
| Conditioning 2 Test Time: 3 | | Conditioning 4 Test Time: 2 | | End of Test Time: 10:00 | | | Total Test Minutes: | 63 |
| Ring Batch: P2AD01 | | Pinion Batch: MSPLO | | Latest Information Letter Run Against: | | | N/A | |

*Correction Factors: Pinion = 6, Ring = 4

| TMC 119 Oil | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Test Date Started | Test Date Completed | Drive Side Scoring (%) | | Coast Side Scoring (%) | | | Coast Side Torque (lbf-ft) | |
| | | EOT Pinion | EOT Ring | EOT Pinion | EOT Ring | Shock Series 1 Ring | Shock Series 1 (Average) | Shock Series 2 (Average) |
| 20240105 | 20240105 | 0 | 0 | 85 | 55 | 0.0 | -74.3 | -334.0 |
| Conditioning 2 Test Time: 3 | | Conditioning 4 Test Time: 2 | | End of Test Time: 09:28 | | | Total Test Minutes: | 63 |
| Ring Batch: P2AD01 | | Pinion Batch: MSPLO | | Latest Information Letter Run Against: | | | N/A | |

| | |
|---|---|
| Current Engine Rig P/F: | Pinion: 20<br>Ring: 15 |
| TMC 117 Average: | Pinion: 29<br>Ring: 19 |

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# EOT Pinion Photos: Torque Setpoint / Ramp Rate

TMC 117

TMC 119

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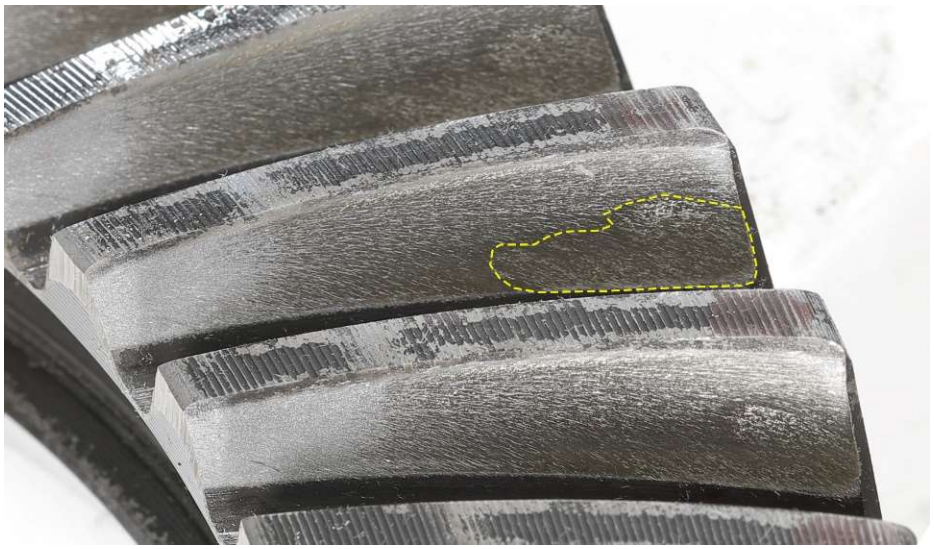
# EOT Pinion Photos: Torque Setpoint / Ramp Rate

TMC 117

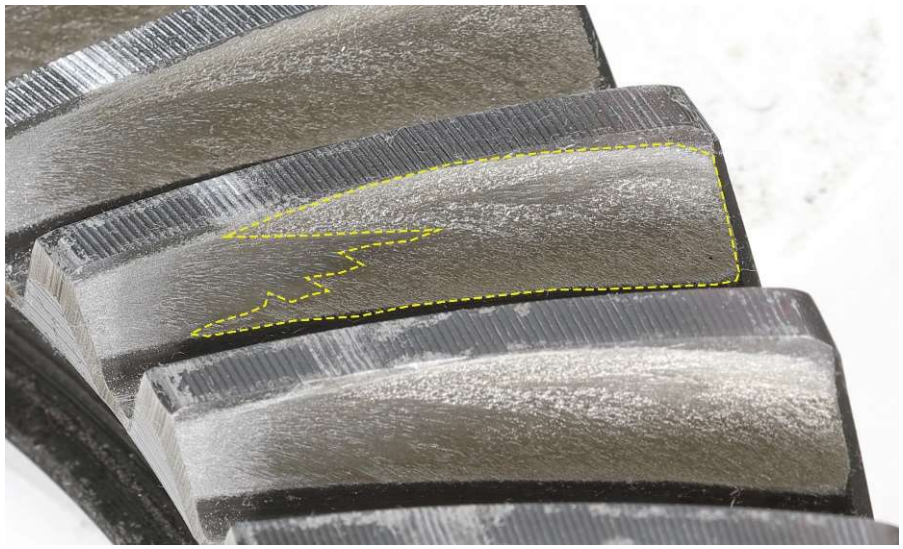
TMC 117 (Run 2)

# EOT Ring Photos: Torque Setpoint / Ramp Rate

TMC 117



TMC 119



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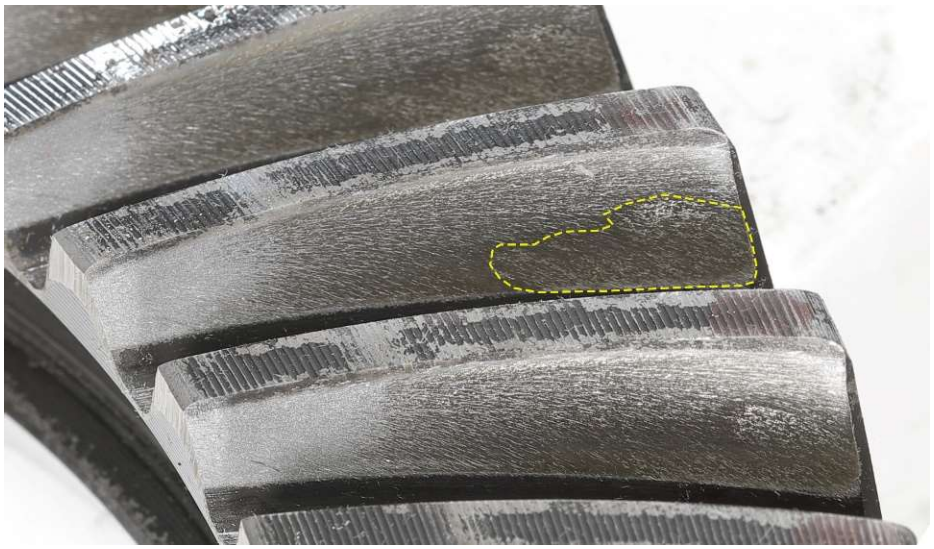
# EOT Ring Photos: Torque Setpoint / Ramp Rate

TMC 117



TMC 117 (Run 2)

# Torque Setpoint / Ramp Rate w/J2360 Oils

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# Operational Data: Torque Setpoint / Ramp Rate

| 80W-90 Mineral Oil, J2360 | | | | |
|---|---|---|---|---|
| Operational Data | | | | |
| | Conditioning 1 | | Conditioning 3 | |
| | Wheel Speed (r/min) | Torques (lbf-ft) | Wheel Speed (r/min) | Torques (lbf-ft) |
| Maximum | 576 | 63 | 816 | 73 |
| Minimum | 574 | 58 | 814 | 67 |
| Average | 575 | 60 | 815 | 70 |

| 75W-80 Synthetic, J2360 | | | | |
|---|---|---|---|---|
| Operational Data | | | | |
| | Conditioning 1 | | Conditioning 3 | |
| | Wheel Speed (r/min) | Torques (lbf-ft) | Wheel Speed (r/min) | Torques (lbf-ft) |
| Maximum | 576 | 62 | 816 | 73 |
| Minimum | 574 | 57 | 814 | 66 |
| Average | 575 | 60 | 815 | 70 |

| 80W-90 Mineral Oil, J2360 | | | | | |
|---|---|---|---|---|---|
| Operational Data | | | | | |
| | | Conditioning 2 | | Conditioning 4 | |
| | | Wheel Speed (r/min) | Torques (lbf-ft) | Wheel Speed (r/min) | Torques (lbf-ft) |
| Drive Side | Maximum | 576 | 125 | 815 | 124 |
| | Minimum | 574 | 125 | 815 | 123 |
| | Average | 575 | 125 | 815 | 124 |
| Coast Side | Maximum | 386 | -72 | 670 | -76 |
| | Minimum | 385 | -76 | 670 | -78 |
| | Average | 386 | -75 | 670 | -77 |

| 75W-80 Synthetic, J2360 | | | | | |
|---|---|---|---|---|---|
| Operational Data | | | | | |
| | | Conditioning 2 | | Conditioning 4 | |
| | | Wheel Speed (r/min) | Torques (lbf-ft) | Wheel Speed (r/min) | Torques (lbf-ft) |
| Drive Side | Maximum | 576 | 125 | 816 | 124 |
| | Minimum | 575 | 125 | 814 | 124 |
| | Average | 575 | 125 | 815 | 124 |
| Coast Side | Maximum | 386 | -75 | 670 | -75 |
| | Minimum | 384 | -77 | 670 | -77 |
| | Average | 385 | -76 | 670 | -76 |

| 80W-90 Mineral Oil, J2360 | | | | |
|---|---|---|---|---|
| Lubricant Temperature Data | | | | |
| Phase | Specification | Average | Minimum | Maximum |
| Gear Conditioning (After reaching 215°F) | 225 ± 10°F | 224.1 | 215.1 | 229.4 |

| 75W-80 Synthetic, J2360 | | | | |
|---|---|---|---|---|
| Lubricant Temperature Data | | | | |
| Phase | Specification | Average | Minimum | Maximum |
| Gear Conditioning (After reaching 215°F) | 225 ± 10°F | 225.3 | 215.3 | 228.5 |

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# Gear Loading Data: Torque Setpoint / Ramp Rate

| 80W-90 Mineral Oil, J2360 | | | | | |
|---|---|---|---|---|---|
| Gear Loading Data | | | | | |
| Gear Side | | Shock Series 1 | | Shock Series 2 | |
| | | Wheel Speed (r/min) | Torques (lbf-ft) | Wheel Speed (r/min) | Torques (lbf-ft) |
| Drive | Maximum | 1049 | 227 | 631 | 240 |
| | Minimum | 1048 | 227 | 631 | 239 |
| | Average | 1048 | 227 | 631 | 240 |
| Coast | Maximum | 530 | -74 | 531 | -331 |
| | Minimum | 530 | -76 | 529 | -335 |
| | Average | 530 | -75 | 530 | -333 |

| 75W-80 Synthetic, J2360 | | | | | |
|---|---|---|---|---|---|
| Gear Loading Data | | | | | |
| Gear Side | | Shock Series 1 | | Shock Series 2 | |
| | | Wheel Speed (r/min) | Torques (lbf-ft) | Wheel Speed (r/min) | Torques (lbf-ft) |
| Drive | Maximum | 1049 | 228 | 632 | 241 |
| | Minimum | 1048 | 227 | 631 | 240 |
| | Average | 1048 | 228 | 631 | 240 |
| Coast | Maximum | 530 | -73 | 530 | -331 |
| | Minimum | 529 | -75 | 529 | -335 |
| | Average | 530 | -74 | 530 | -333 |

| 80W-90 Mineral Oil, J2360 | | | |
|---|---|---|---|
| Lubricant Temperature Data | | | |
| Phase | Specification | Start Value | Maximum |
| Shock Series 1 | 200 ± 5 °F | 196 | 276 |
| Shock Series 2 | < 280 °F | 258 | 284 |

| 75W-80 Synthetic, J2360 | | | |
|---|---|---|---|
| Lubricant Temperature Data | | | |
| Phase | Specification | Start Value | Maximum |
| Shock Series 1 | 200 ± 5 °F | 197 | 265 |
| Shock Series 2 | < 280 °F | 245 | 265 |

| | |
|---|---|
| Current Engine Rig: | Shock 1: -74.2 lbf-ft<br>Shock 2: -333.5 lbf-ft |

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# Test Result Summary: Torque Setpoint / Ramp Rate 80W-90

| 80W-90 Mineral Oil, J2360 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Test Date Started | Test Date Completed | Drive Side Scoring (%) | | Coast Side Scoring (%) | | | Coast Side Torque (lbf-ft) | |
| | | EOT Pinion | EOT Ring | EOT Pinion | EOT Ring | Shock Series 1 Ring | Shock Series 1 (Average) | Shock Series 2 (Average) |
| 20240126 | 20240126 | 0 | 0 | 14 | 7 | 0.0 | -74.8 | -333.3 |
| Conditioning 2 Test Time: 3 | | Conditioning 4 Test Time: 2 | | End of Test Time: 10:40 | | | Total Test Minutes: 64 | |
| Ring Batch: P2AD01 | | Pinion Batch: MSPLO | | Latest Information Letter Run Against: N/A | | | | |

Previous L-42 Data on Same Oil

| Test Date Started | Test Date Completed | Drive Side Scoring (%) | | Coast Side Scoring (%) | | | Coast Side Torque (lbf-ft) | |
|---|---|---|---|---|---|---|---|---|
| | | EOT Pinion | EOT Ring | EOT Pinion | EOT Ring | Shock Series 1 Ring | Shock Series 1 (Average) | Shock Series 2 (Average) |
| 20190128 | 20190128 | 0 | 0 | 13 | 7 | 0.0 | -73.3 | -276.6 |
| Conditioning 2 Test Time: 4 | | Conditioning 4 Test Time: 2 | | End of Test Time: 15:00 | | | Total Test Minutes: 63 | |
| Ring Batch: P8AD078X | | Pinion Batch: C1L925 | | Latest Information Letter Run Against: 16-1 | | | | |

**Stand Reference Oil Test History In Chronological Order**

| | Test Date Started | Test Date Completed | Stand Run No. | CMIR No. | TMC Oil No. | Drive Side Scoring (%) | | Coast Side Scoring (%) | | | Coast Side Torque (lbf-ft) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | EOT Pinion | EOT Ring | EOT Pinion | EOT Ring | Shock Series 1 Ring | Shock Series 1 (Average) | Shock Series 2 (Average) |
| Discrimination [A] | 20190122 | 20190122 | 2083 | 130178 | 113 | 0 | 0 | 85 | 45 | 0 | -74.6 | -288.2 |
| Calibration Sequence Passing Tests Only [B] | 20190110 | 20190110 | 2080 | 132920 | 117 | 0 | 0 | 14 | 9 | 0 | -84.1 | -274.1 |
| | 20190110 | 20190110 | 2081 | 132921 | 117 | 0 | 0 | 17 | 10 | 0 | -81.1 | -274.1 |
| | 20190110 | 20190110 | 2082 | 132922 | 117 | 0 | 0 | 18 | 9 | 0 | -70.8 | -302.0 |
| **Passing Reference Oil Test Average** | | | | | | | | 16 | 9 | 0 | -78.7 | -283.4 |

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# Test Result Summary: Torque Setpoint / Ramp Rate 75W-80

| 75W-80 Synthetic, J2360 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Test Date Started | Test Date Completed | Drive Side Scoring (%) | | Coast Side Scoring (%) | | | Coast Side Torque (lbf-ft) | |
| | | EOT Pinion | EOT Ring | EOT Pinion | EOT Ring | Shock Series 1 Ring | Shock Series 1 (Average) | Shock Series 2 (Average) |
| 20240126 | 20240126 | 0 | 0 | 15 | 9 | 0.0 | -74.1 | -333.5 |
| Conditioning 2 Test Time: 3 | | Conditioning 4 Test Time: 2 | | End of Test Time: 14:42 | | | Total Test Minutes: | 63 |
| Ring Batch: P2AD01 | | Pinion Batch: MSPLO | | Latest Information Letter Run Against: N/A | | | | |

Previous L-42 Data on Same Oil

| Test Date Started | Test Date Completed | Drive Side Scoring (%) | | Coast Side Scoring (%) | | | Coast Side Torque (lbf-ft) | |
|---|---|---|---|---|---|---|---|---|
| | | EOT Pinion | EOT Ring | EOT Pinion | EOT Ring | Shock Series 1 Ring | Shock Series 1 (Average) | Shock Series 2 (Average) |
| 20190125 | 20190125 | 0 | 0 | 13 | 6 | 0.0 | -70.3 | -288.4 |
| Conditioning 2 Test Time: 4 | | Conditioning 4 Test Time: 2 | | End of Test Time: 13:06 | | | Total Test Minutes: | 62 |
| Ring Batch: P8AD078X | | Pinion Batch: C1L925 | | Latest Information Letter Run Against: 16-1 | | | | |

**Stand Reference Oil Test History In Chronological Order**

| | Test Date Started | Test Date Completed | Stand Run No. | CMIR No. | TMC Oil No. | Drive Side Scoring (%) | | Coast Side Scoring (%) | | | Coast Side Torque (lbf-ft) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | EOT Pinion | EOT Ring | EOT Pinion | EOT Ring | Shock Series 1 Ring | Shock Series 1 (Average) | Shock Series 2 (Average) |
| Discrimination [A] | 20190122 | 20190122 | 2083 | 130178 | 113 | 0 | 0 | 85 | 45 | 0 | -74.6 | -288.2 |
| Calibration Sequence Passing Tests Only [B] | 20190110 | 20190110 | 2080 | 132920 | 117 | 0 | 0 | 14 | 9 | 0 | -84.1 | -274.1 |
| | 20190110 | 20190110 | 2081 | 132921 | 117 | 0 | 0 | 17 | 10 | 0 | -81.1 | -274.1 |
| | 20190110 | 20190110 | 2082 | 132922 | 117 | 0 | 0 | 18 | 9 | 0 | -70.8 | -302.0 |
| **Passing Reference Oil Test Average** | | | | | | | | 16 | 9 | 0 | -78.7 | -283.4 |

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# EOT Pinion Photos: Torque Setpoint / Ramp Rate

80W-90

75W-90

# EOT Ring Photos: Torque Setpoint / Ramp Rate

80W-90

75W-80

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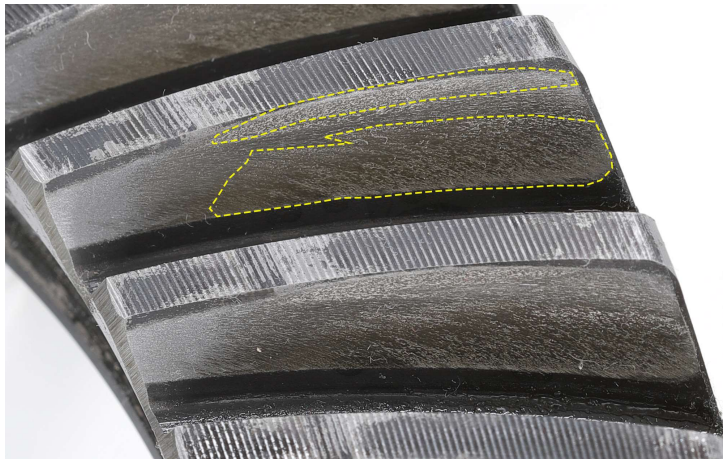
# Late Development

- Non-reference oil with known poor performance
- Run yesterday, rated this morning
- Pinion: 67, Ring: 61



| Poor Performing 80W-90 | | | | | |
|---|---|---|---|---|---|
| Gear Loading Data | | | | | |
| Gear Side | | Shock Series 1 | | Shock Series 2 | |
| | | Wheel Speed (r/min) | Torques (lbf-ft) | Wheel Speed (r/min) | Torques (lbf-ft) |
| Drive | Maximum | 1049 | 227 | 631 | 239 |
| | Minimum | 1049 | 226 | 631 | 239 |
| | Average | 1049 | 226 | 631 | 239 |
| Coast | Maximum | 530 | -74 | 530 | -332 |
| | Minimum | 529 | -75 | 530 | -335 |
| | Average | 530 | -74 | 530 | -334 |

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# Summary / Conclusions / Next Steps

# Summary

- T-Rig with AC regenerative motors
- Rigid axle mounts (no spring plates)
- Same quantity of Conditioning 2/4 and Shock I/II sweeps as current L-42 test method
- Minimum torque magnitudes comparable to current fired-engine stand
- Good discrimination between Hi and Low reference oils
- Comparable Hi Ref repeatability to engine stand (need more data points)
- Two J2360 oils pass as expected
- Poor-performing non-ref oil ranks as expected

| Run # | Description | CMIR | TMC Oil Code | Note | Axle Batch | Profile | Pinion Scoring [%] | Ring Scoring [%] | Shock I Avg Tq [lbf-ft] | Shock II Avg Tq [lbf-ft] |
|---|---|---|---|---|---|---|---|---|---|---|
| 254 | Reference | 176818 | 117 | Pass Oil | MSPLO/P2AD01 (2023) | Engine Rig Data Setpoints | 16 | 8 | -72.4 | -277.0 |
| 255 | Reference | 176822 | 119 | Disc. Oil | MSPLO/P2AD01 (2023) | Engine Rig Data Setpoints | 41 | 29 | -74.7 | -280.7 |
| 256 | Reference | 176820 | 117 | Pass Oil | MSPLO/P2AD01 (2023) | Ramp Rate / Torque Setpoints | 36 | 24 | -74.5 | -333.5 |
| 257 | Reference | 184767 | 119 | Disc. Oil | MSPLO/P2AD01 (2023) | Ramp Rate / Torque Setpoints | 85 | 55 | -74.3 | -334.0 |
| 258 | 80W-90 | - | - | J2360 | MSPLO/P2AD01 (2023) | Ramp Rate / Torque Setpoints | 14 | 7 | -74.8 | -333.3 |
| 259 | 75W-80 | - | - | J2360 | MSPLO/P2AD01 (2023) | Ramp Rate / Torque Setpoints | 15 | 9 | -74.1 | -333.5 |
| 260 | Reference | 184759 | 117 | Pass Oil | MSPLO/P2AD01 (2023) | Ramp Rate / Torque Setpoints | 22 | 14 | -73.5 | -332.4 |
| 261 | 80W-90 | - | - | Poor Perf. | MSPLO/P2AD01 (2023) | Ramp Rate / Torque Setpoints | 67 | 61 | -74.1 | -333.8 |

# Conclusions

- **Regen T-Rig shows comparable scoring performance to traditional L-42 test stand**
- **Spring plates are not need to replicate scoring performance**
- **Torque ‘Ringing’ has minimal or no impact on EOT scoring**
  - Initial ‘Hit’ seems to be the driving factor for scoring
  - How many ‘Hits’ are needed?

# Next Steps

- **Afton**
  - Run additional fluids with known poor performance
  - Run one more Hi-Ref to complete 4-ref sequence
- **Setup L-42-1 Task Force Meeting**
  - Align on path going forward
  - Define test procedure
  - Define test oil matrix
    - J2360 oils
    - Fail oils (non-reference)
  - Outline responsibilities
- **Do other labs want to begin running on their stands?**

# New Issues

- ?

Thanks!

# Appendix: TMC 119 100 Hz Operational Data

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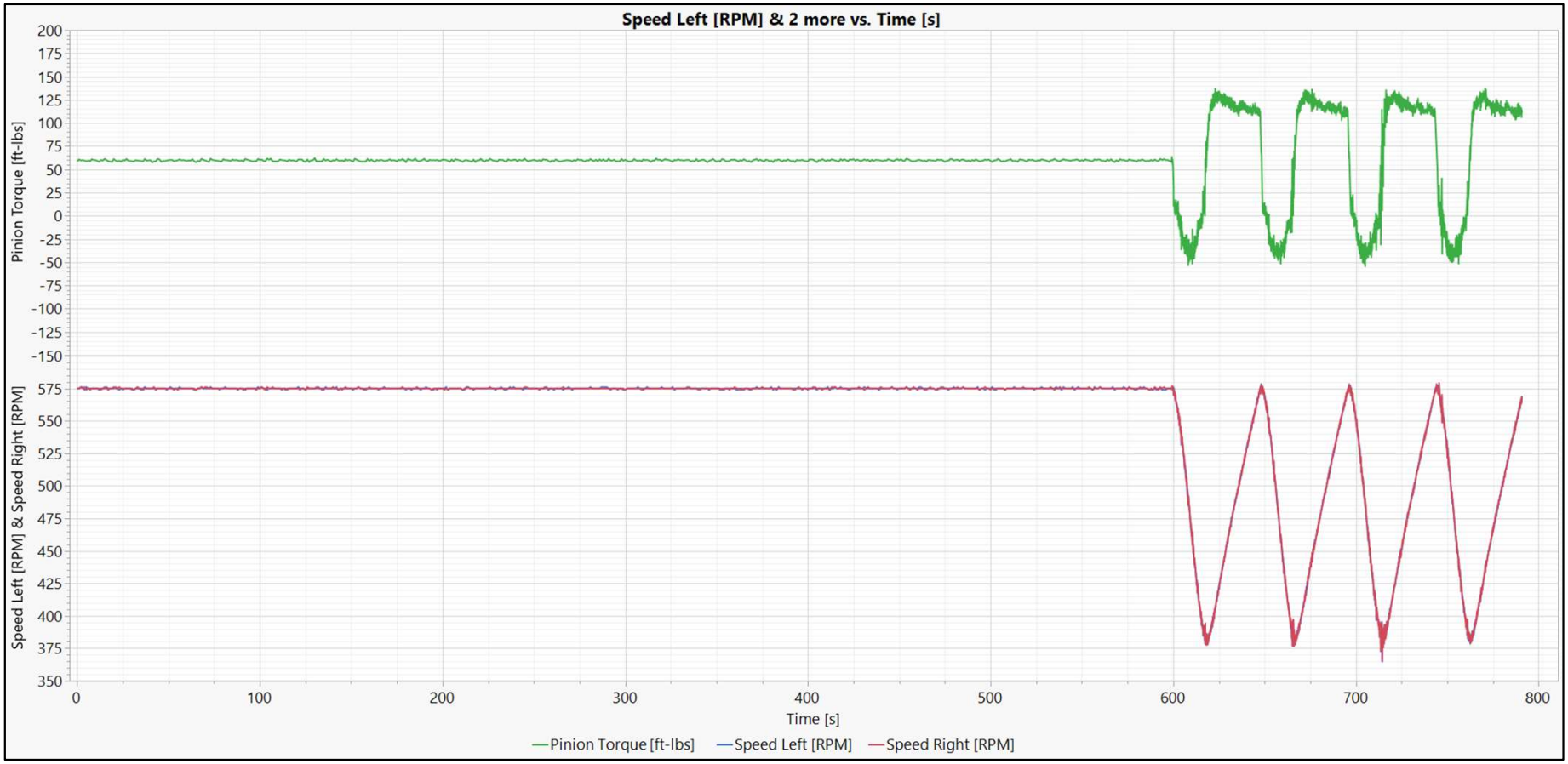
# 119 Conditioning Phase 1 & 2: Engine Setpoints

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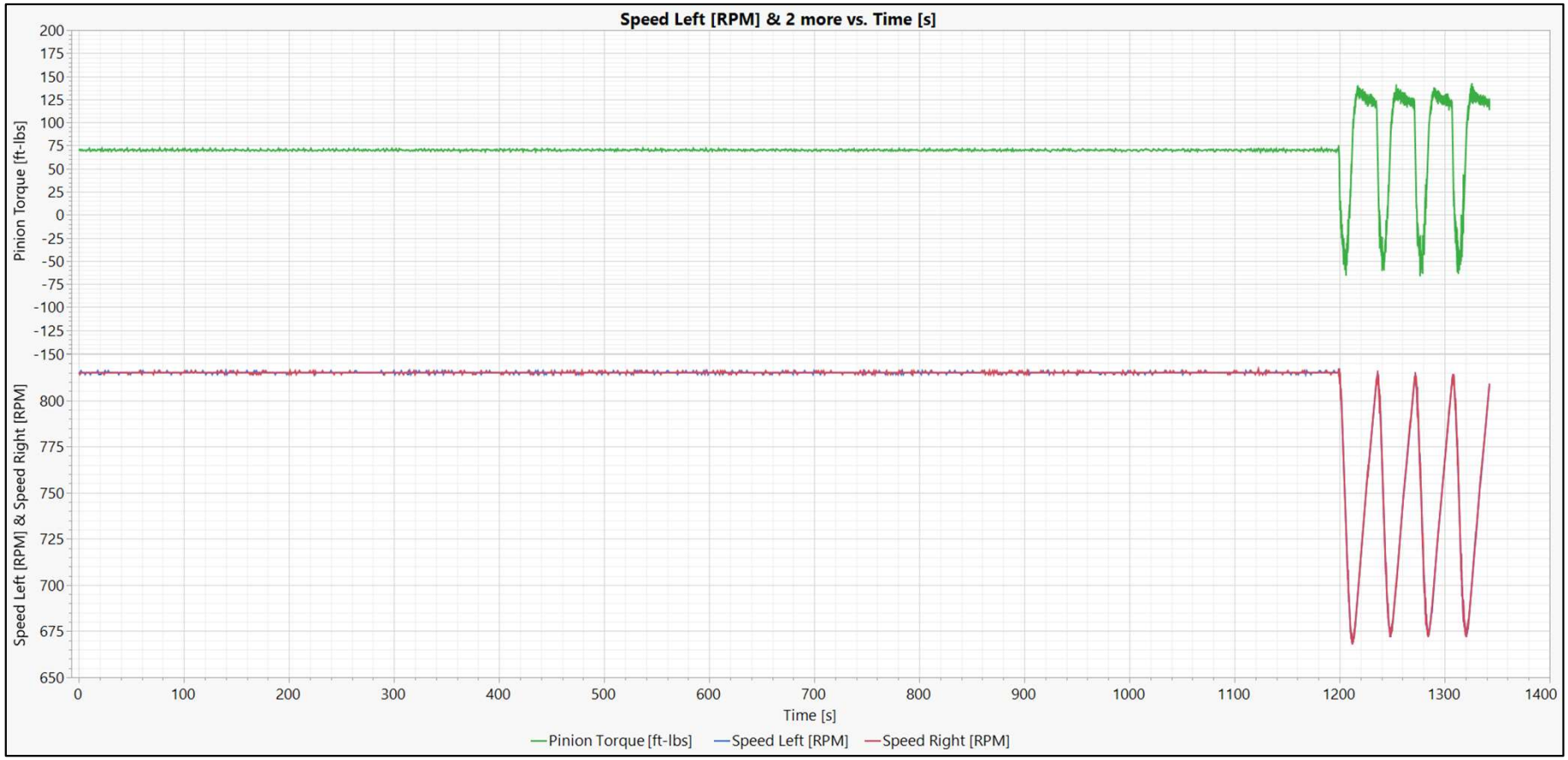
# 119 Conditioning Phase 3 & 4: Engine Setpoints

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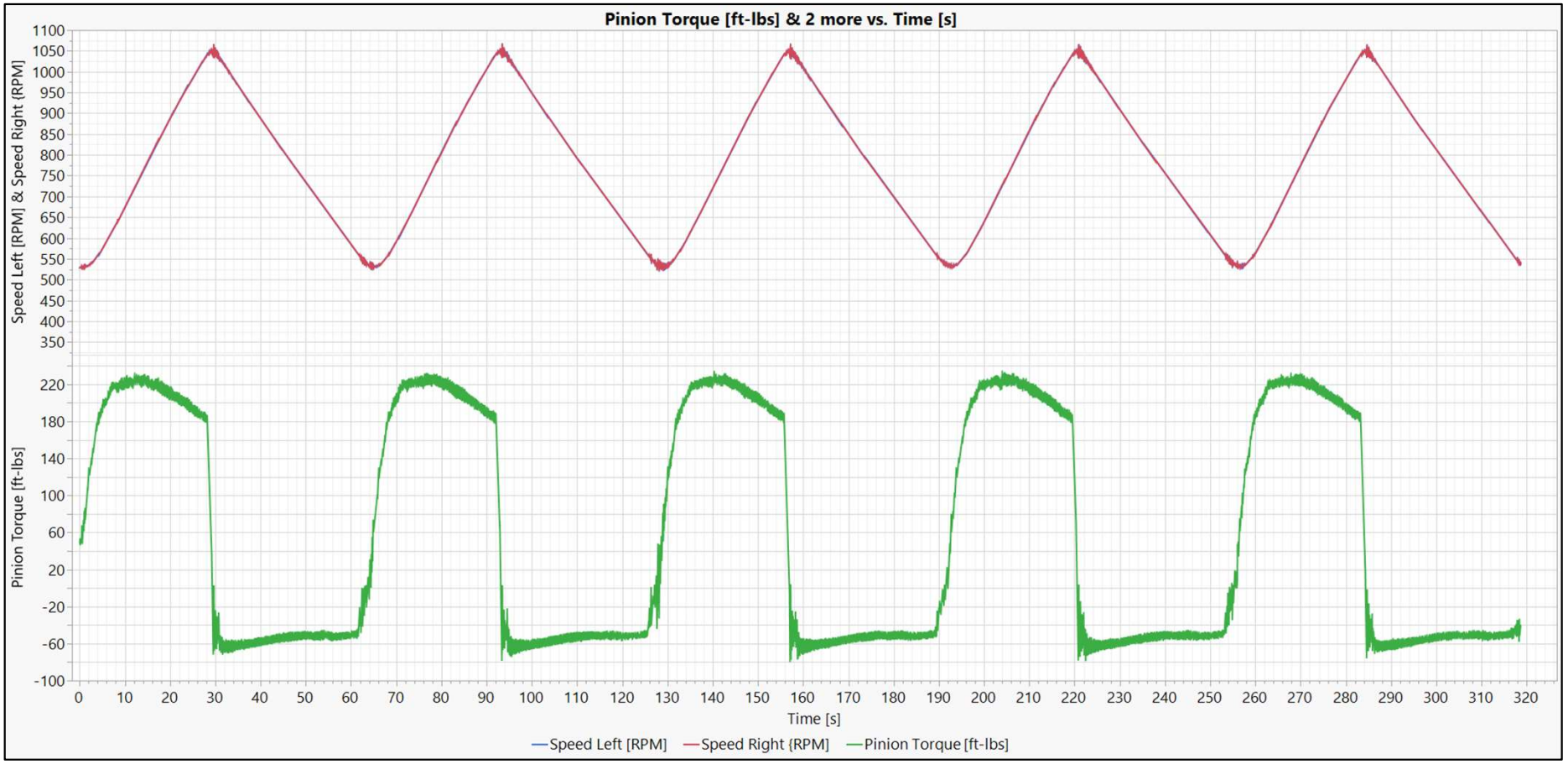
# 119 Shock I: Engine Setpoints

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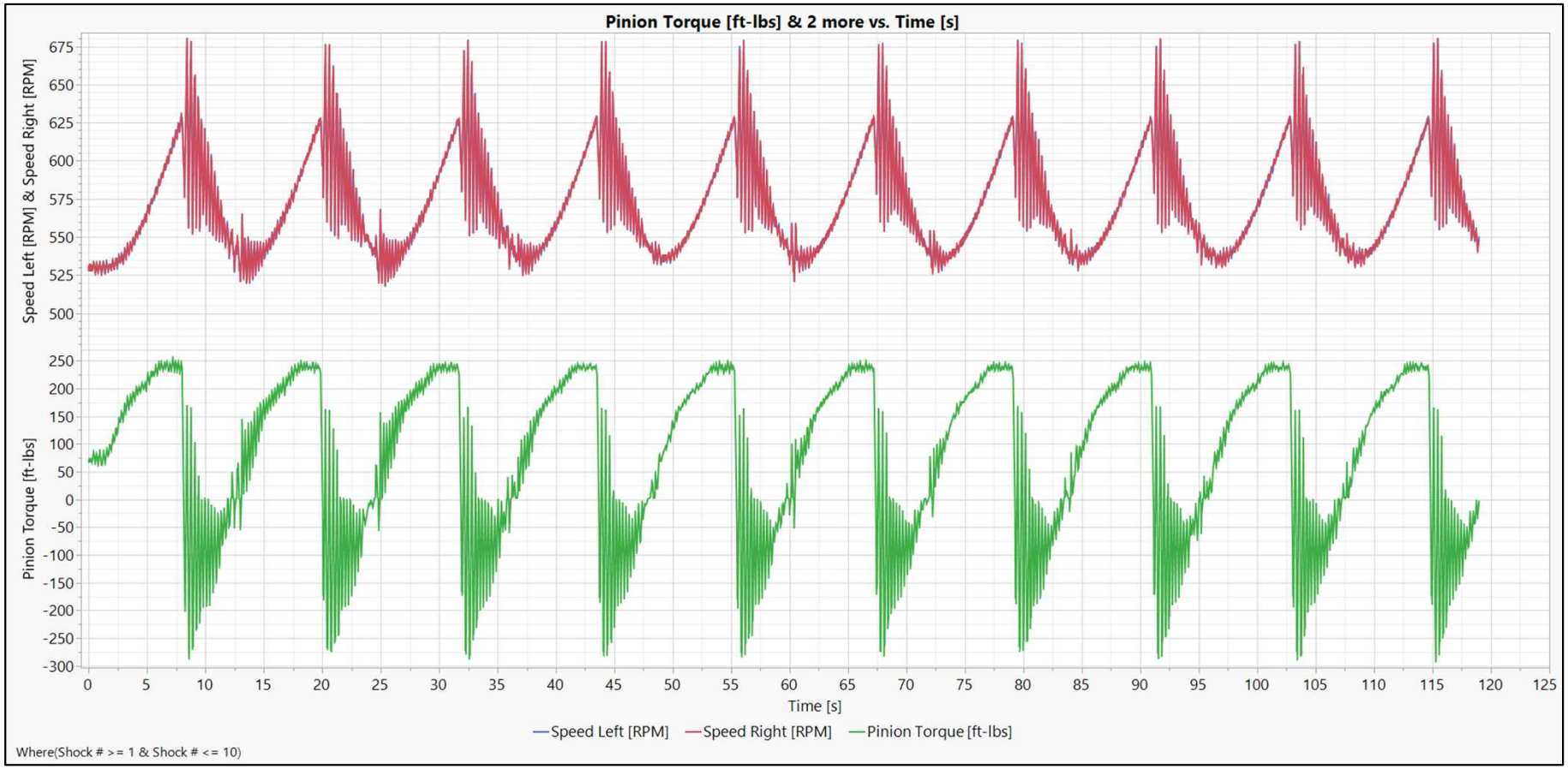
# 119 Shock II: Engine Setpoints

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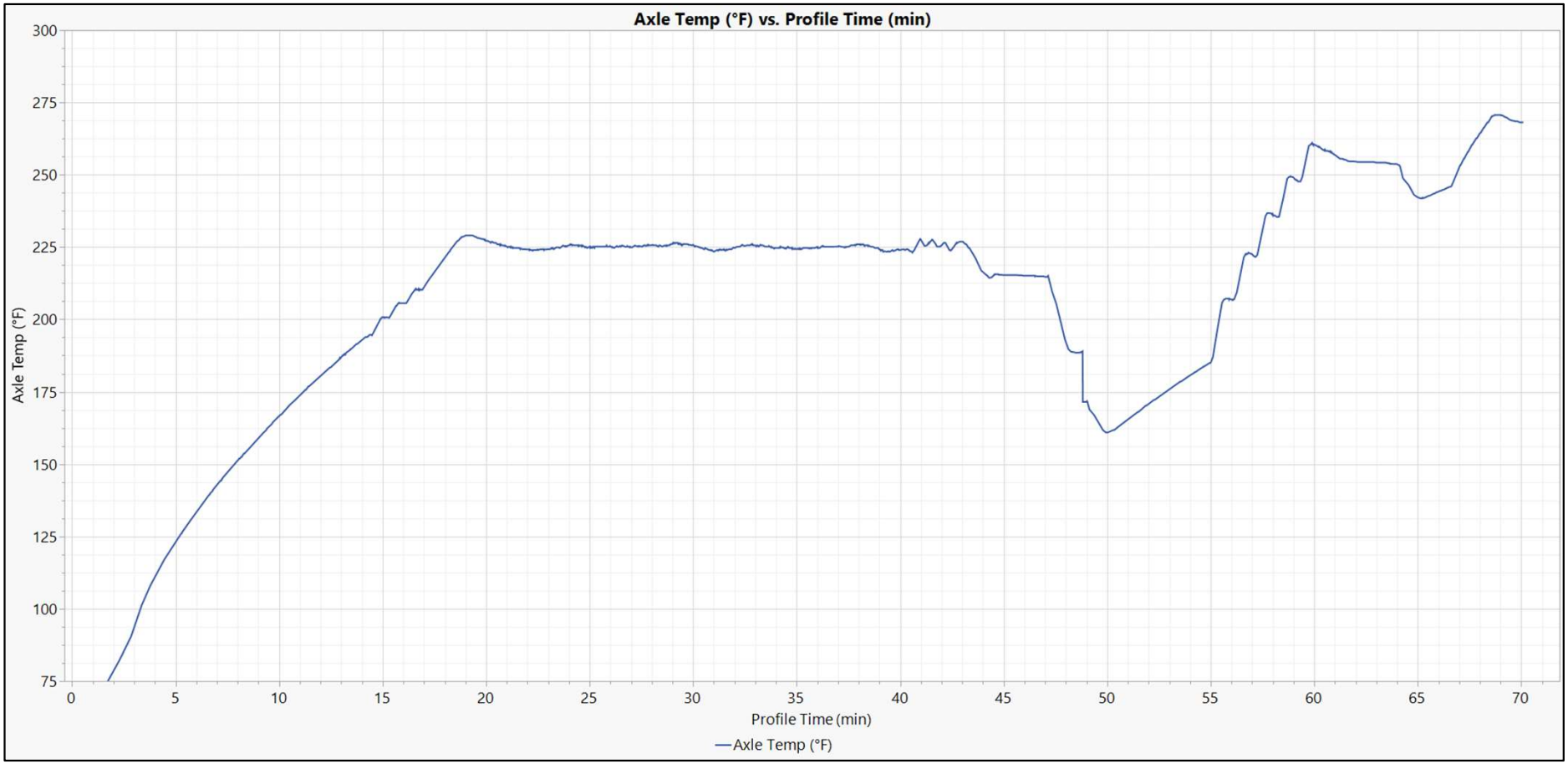
# 119 Oil Temp: Engine Setpoints

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# Appendix: TMC 119 Torque Setpoint / Ramp Rate Operational Data

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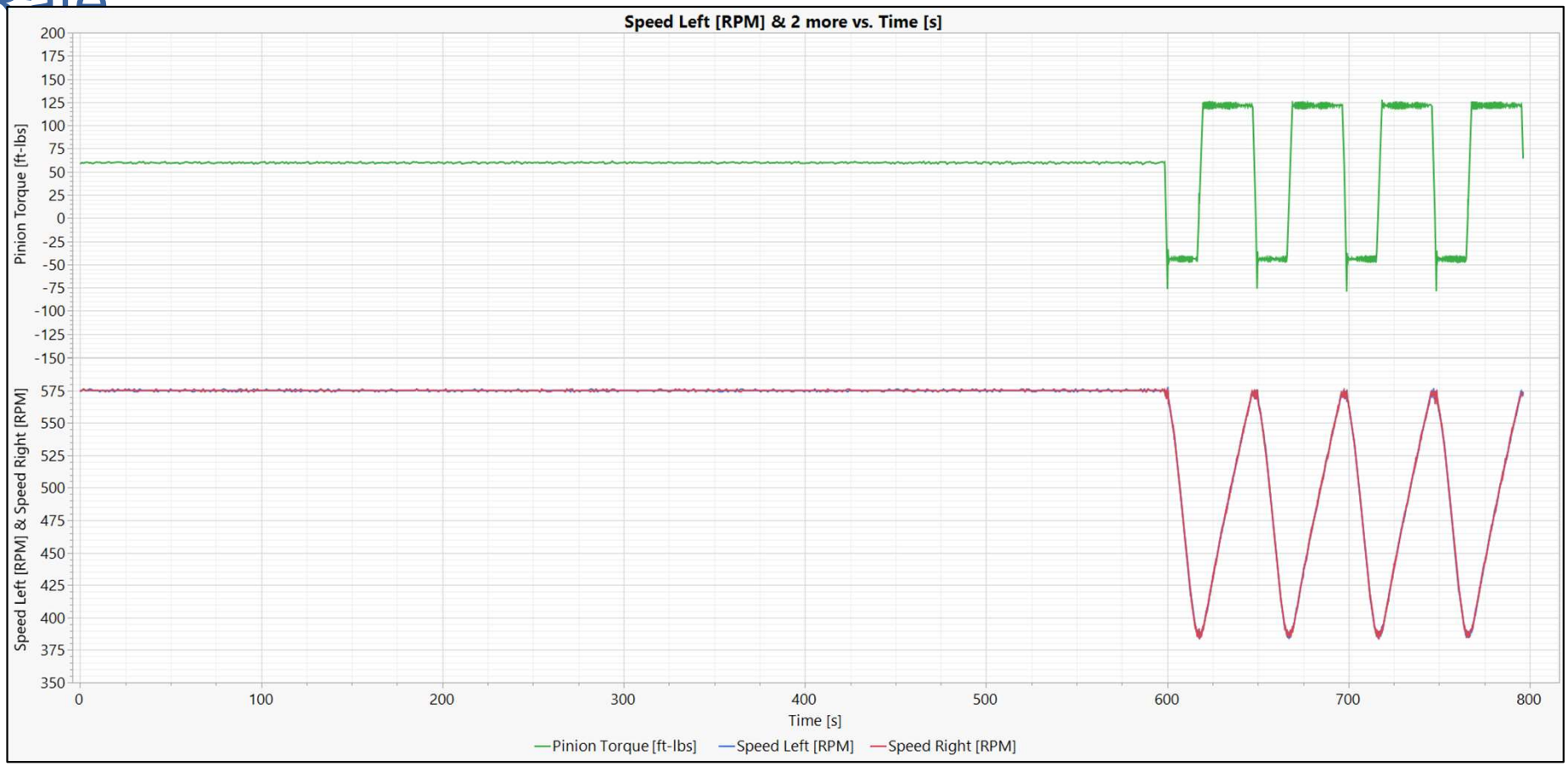
# 119 Conditioning Phase 1 & 2: Torque Setpoint / Ramp Rate

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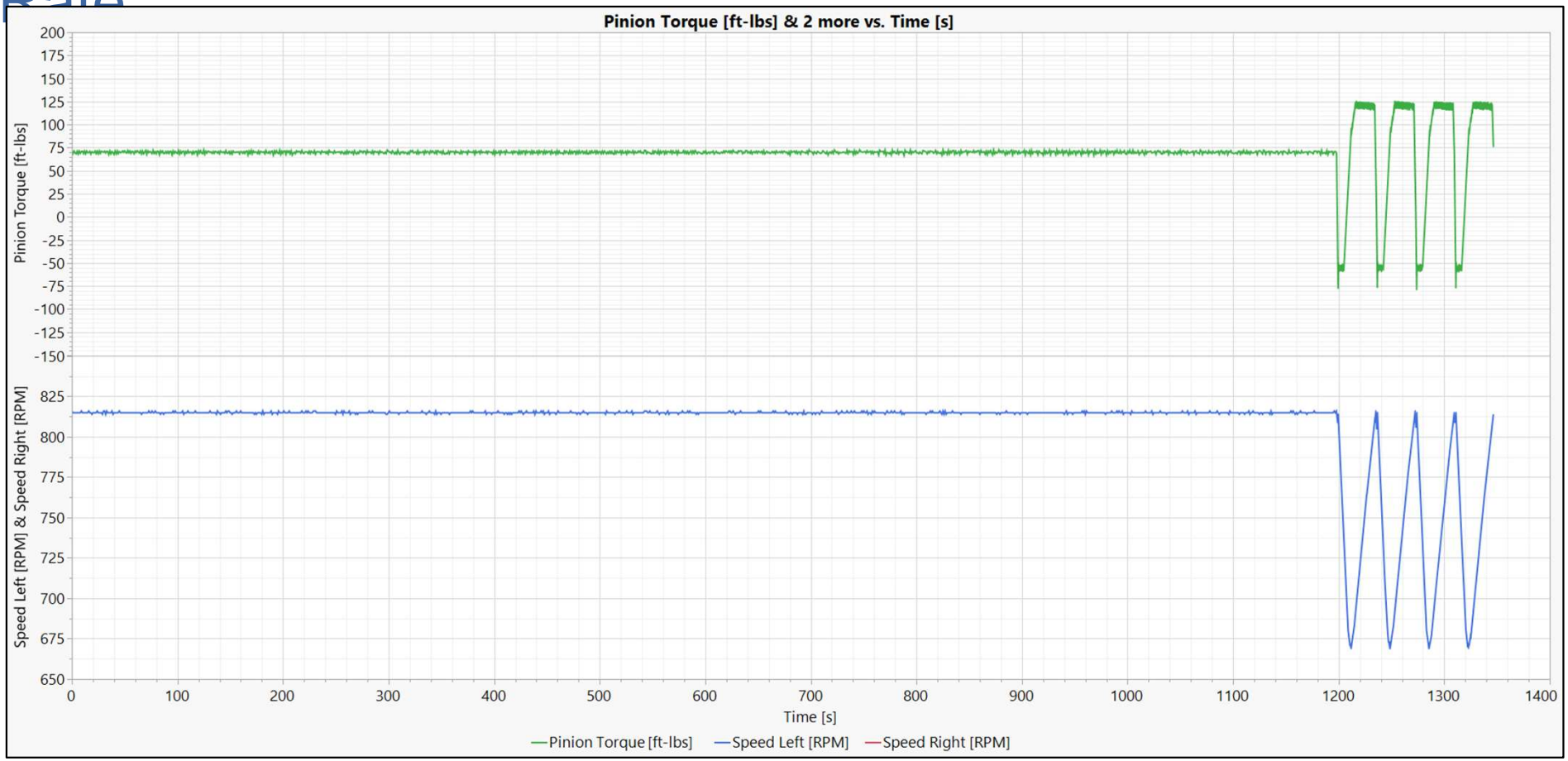
# 119 Conditioning Phase 3 & 4: Torque Setpoint / Ramp Rate

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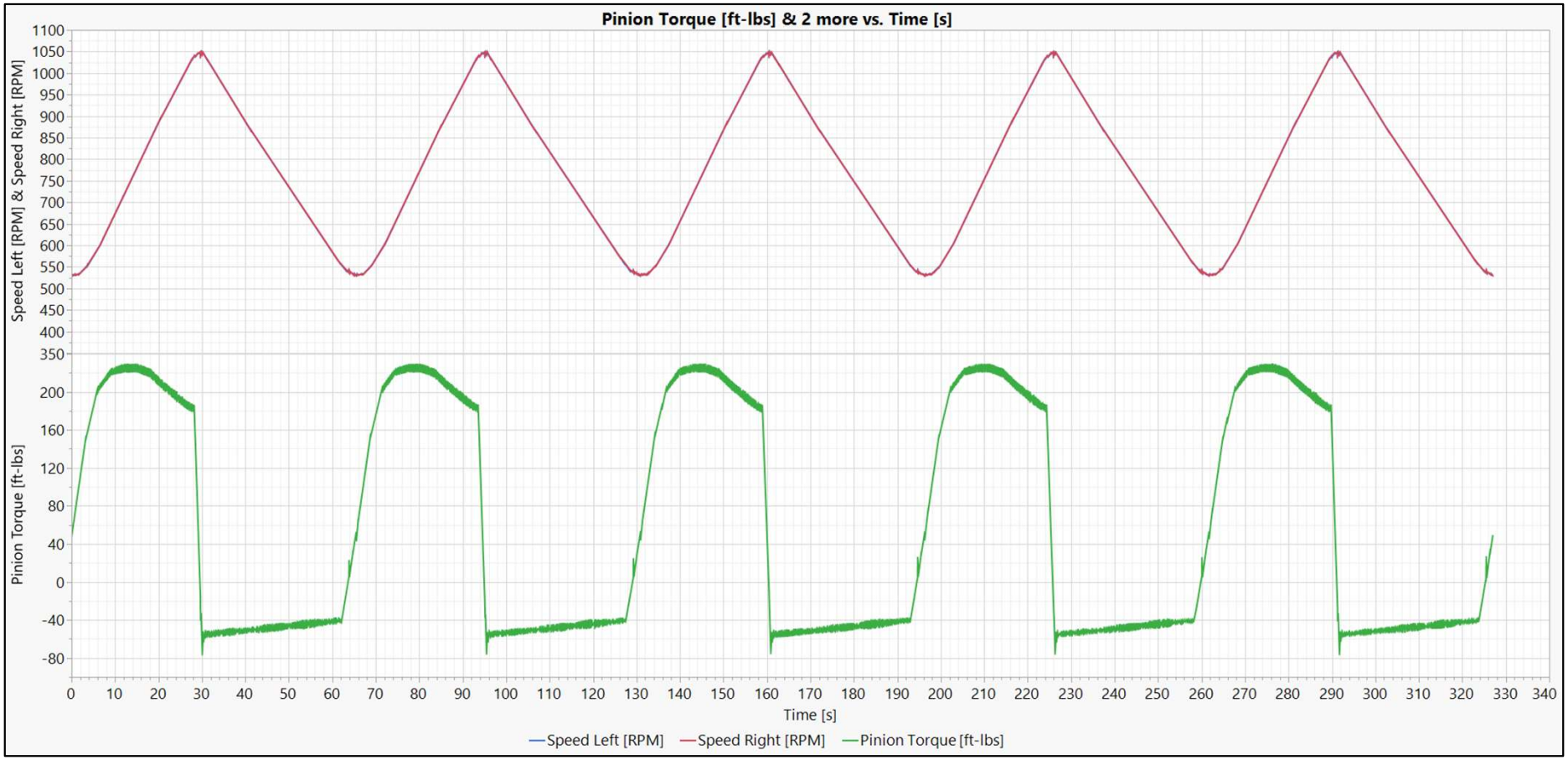
# 119 Shock I: Torque Setpoint / Ramp Rate

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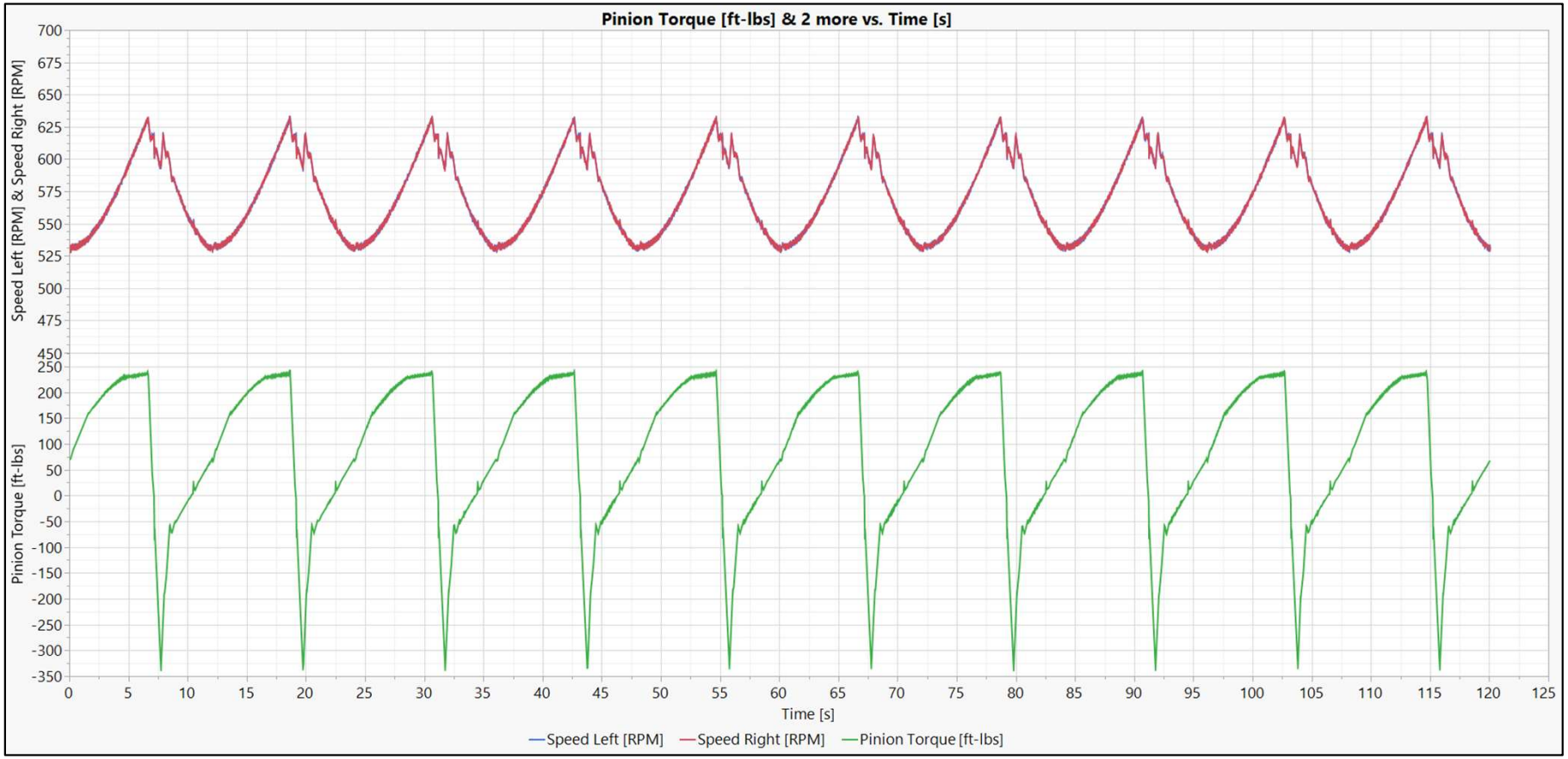
# 119 Shock II: Torque Setpoint / Ramp Rate

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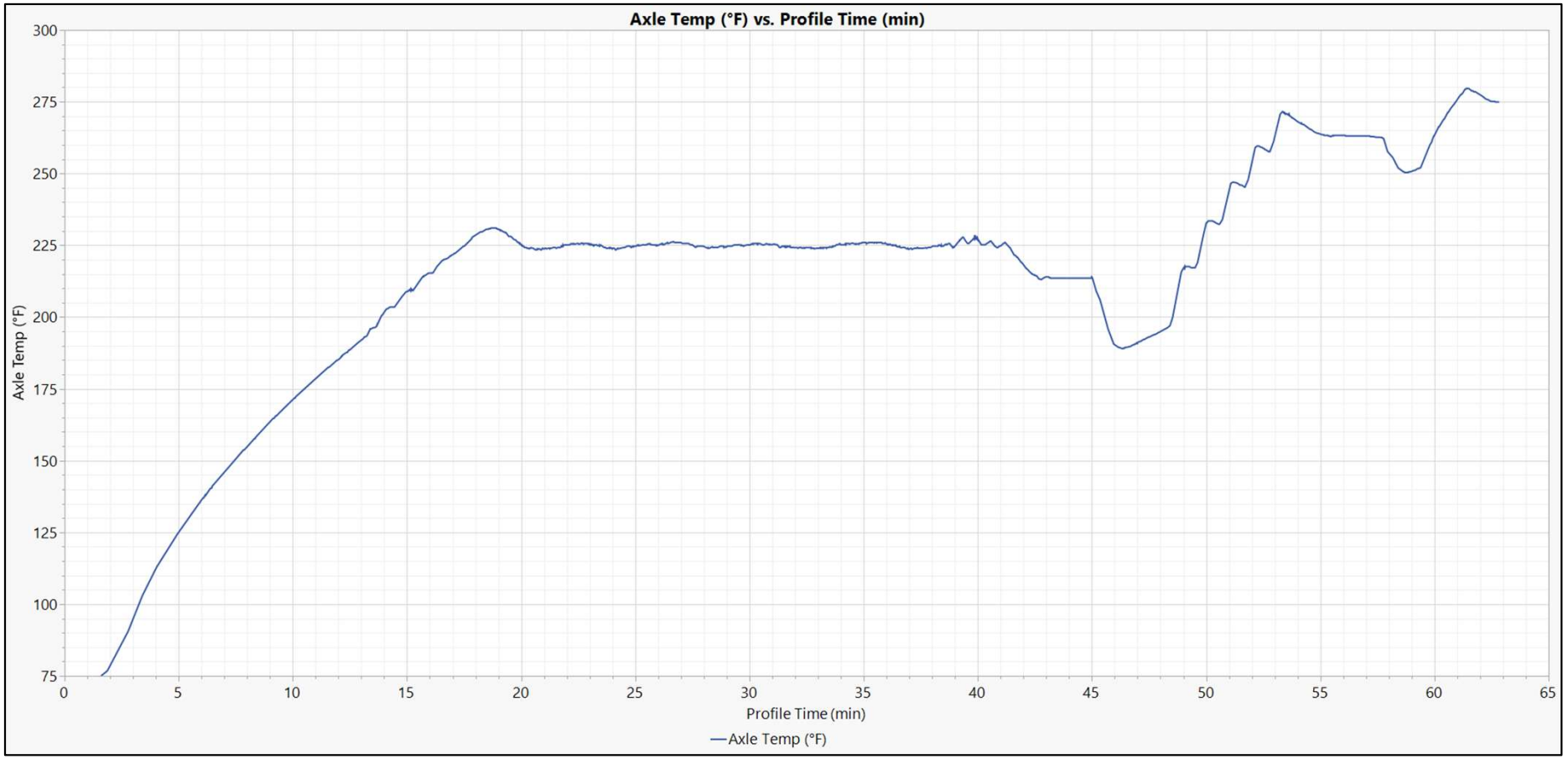
# 119 Oil Temp: Torque Setpoint / Ramp Rate



# Appendix: 80W-90 Torque Setpoint / Ramp Rate Operational Data

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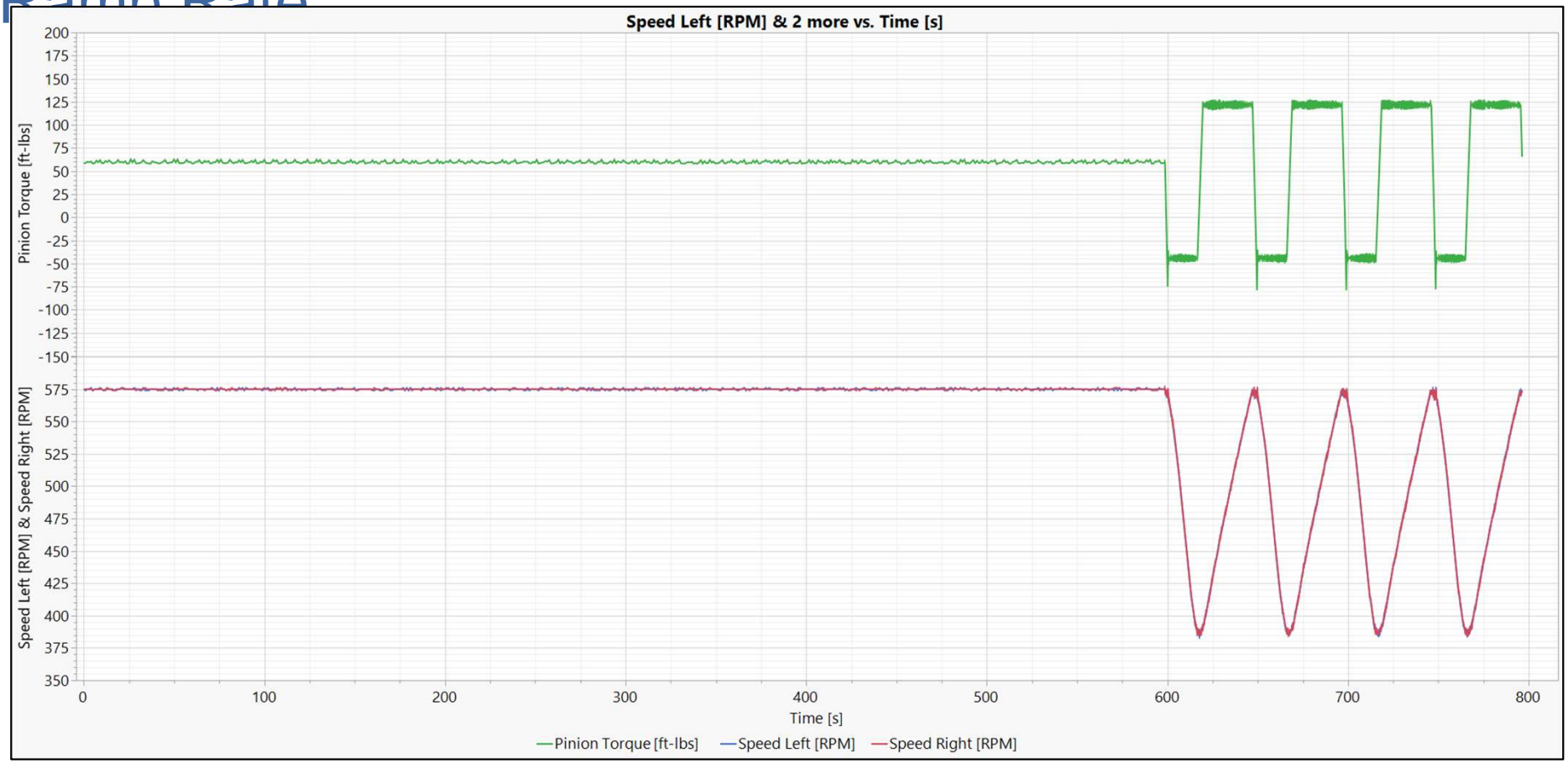
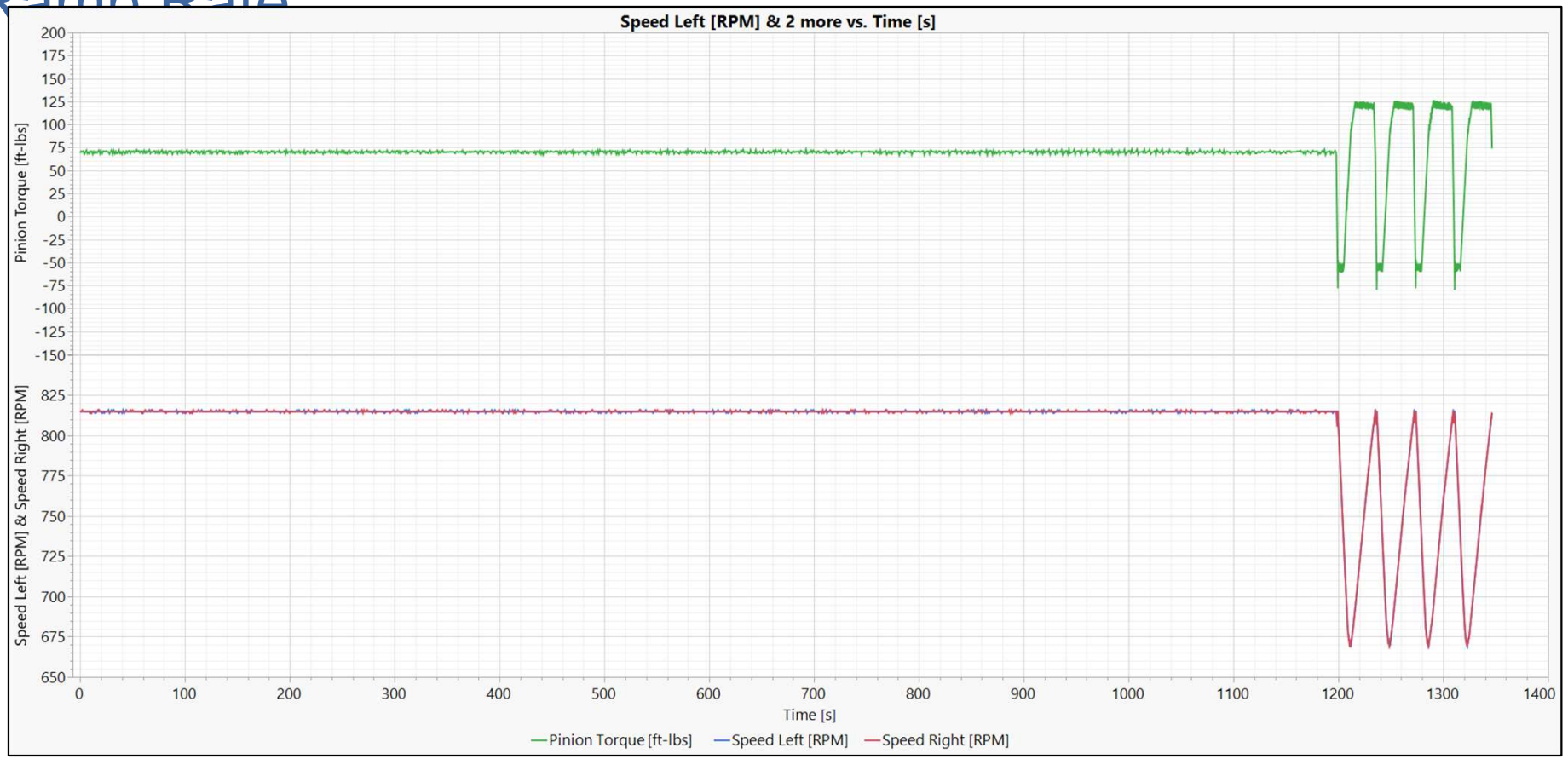
# 80W-90 Conditioning Phase 1 & 2: Torque Setpoint / Ramp Rate



# 80W-90 Conditioning Phase 3 & 4: Torque Setpoint / Ramp Rate

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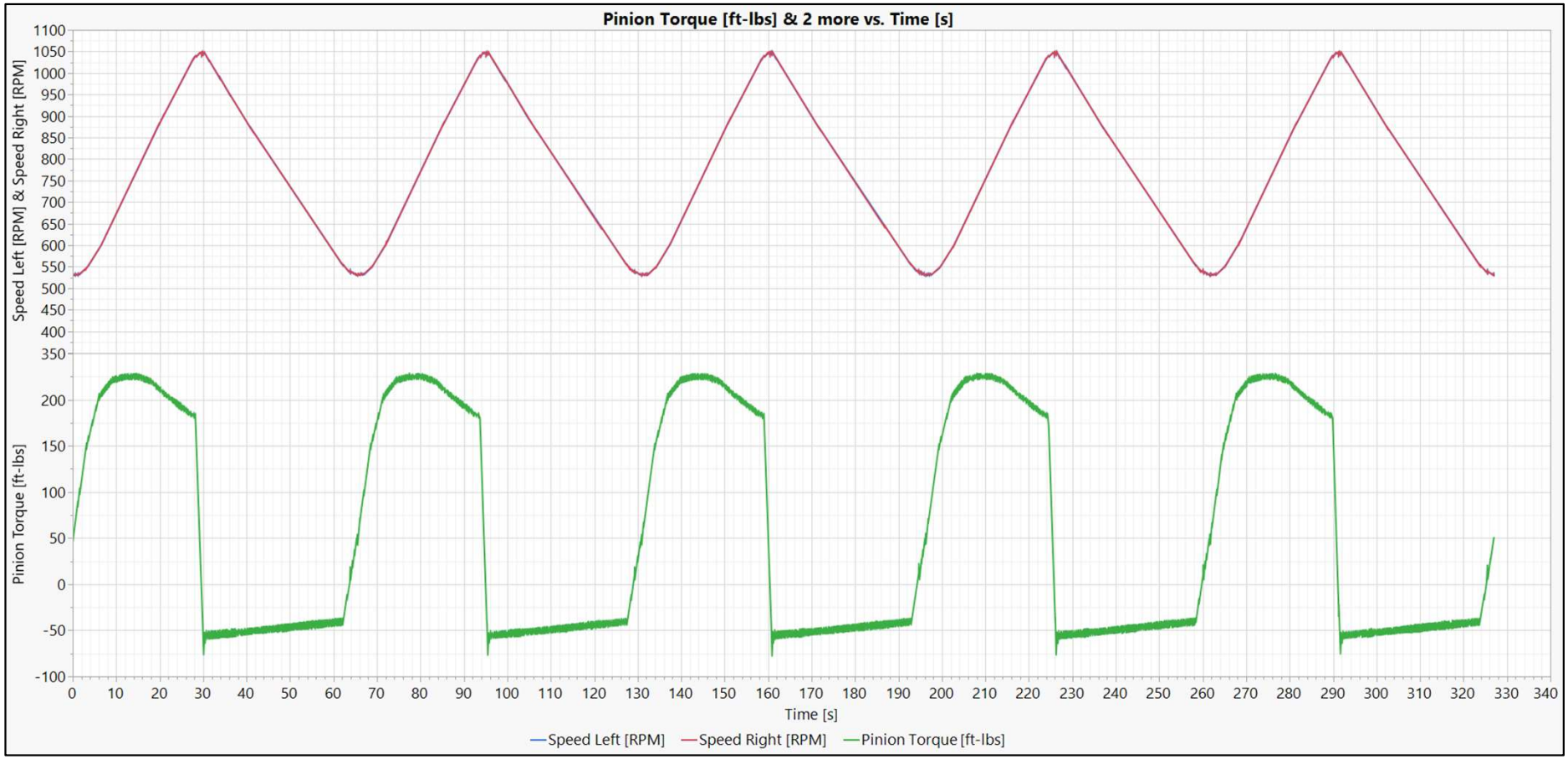
# 80W-90 Shock I: Torque Setpoint / Ramp Rate

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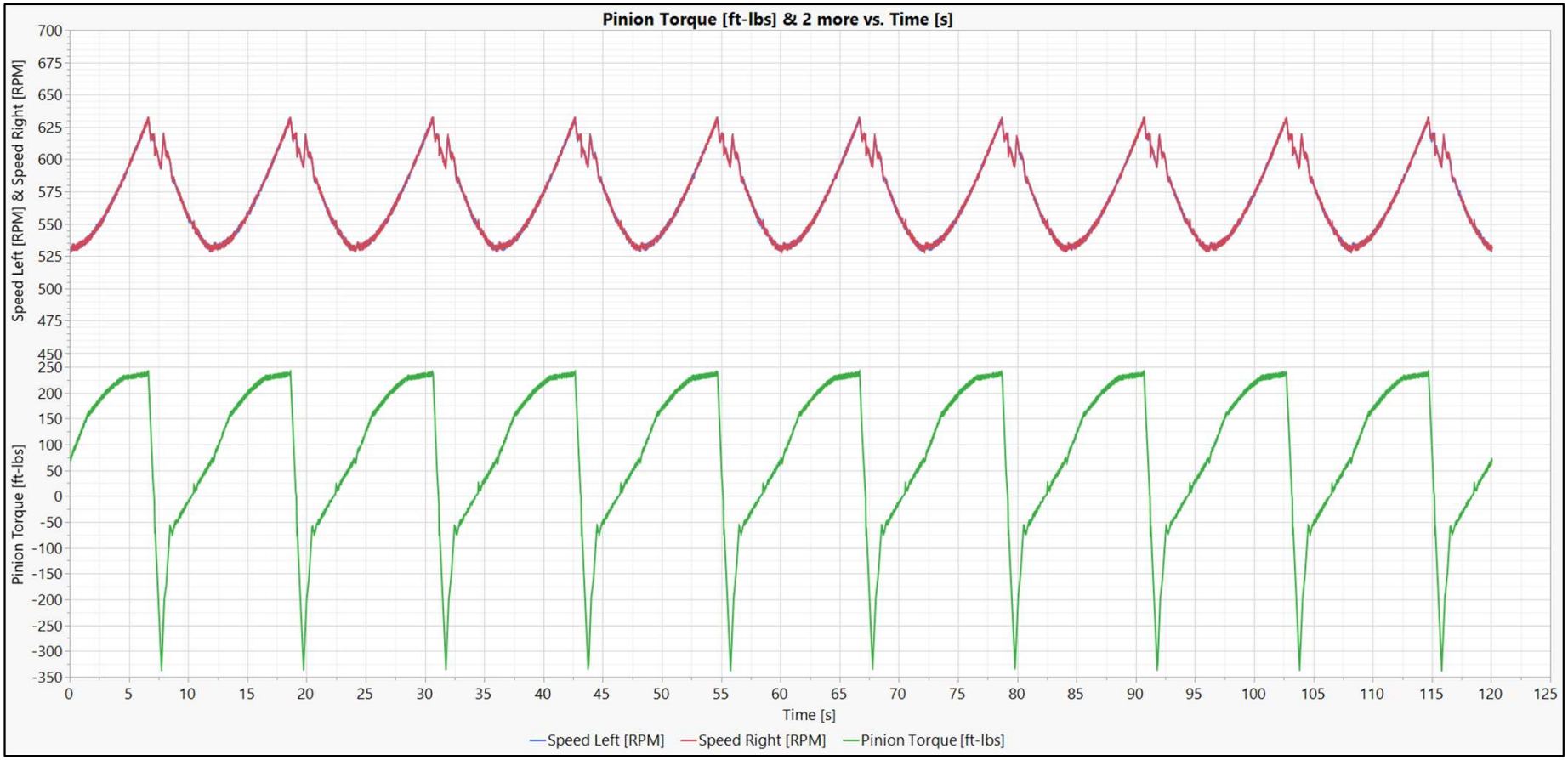
# 80W-90 Shock II: Torque Setpoint / Ramp Rate

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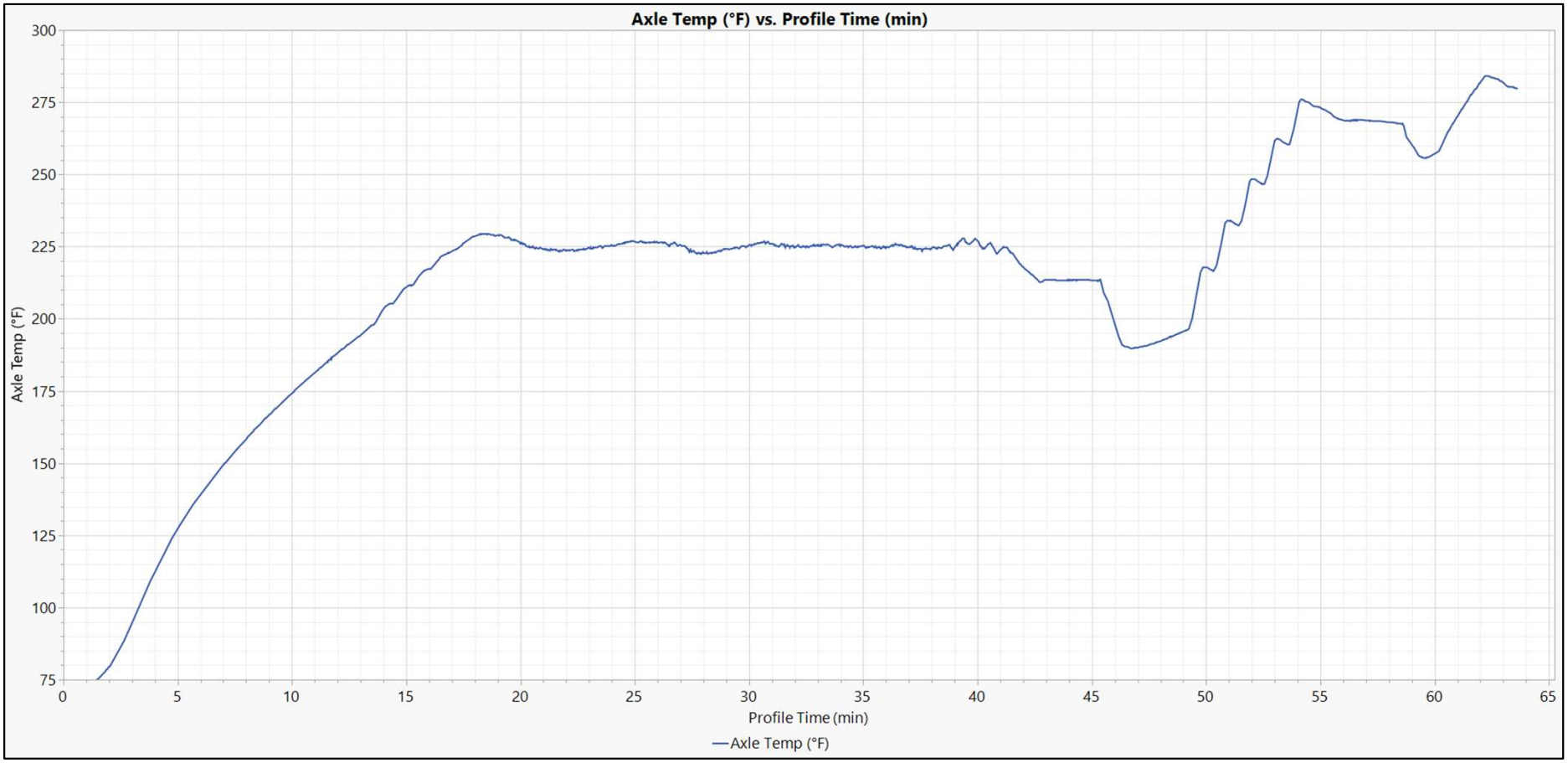
# 80W-90 Oil Temp: Torque Setpoint / Ramp Rate

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# Appendix: 75W-80 Torque Setpoint / Ramp Rate Operational Data

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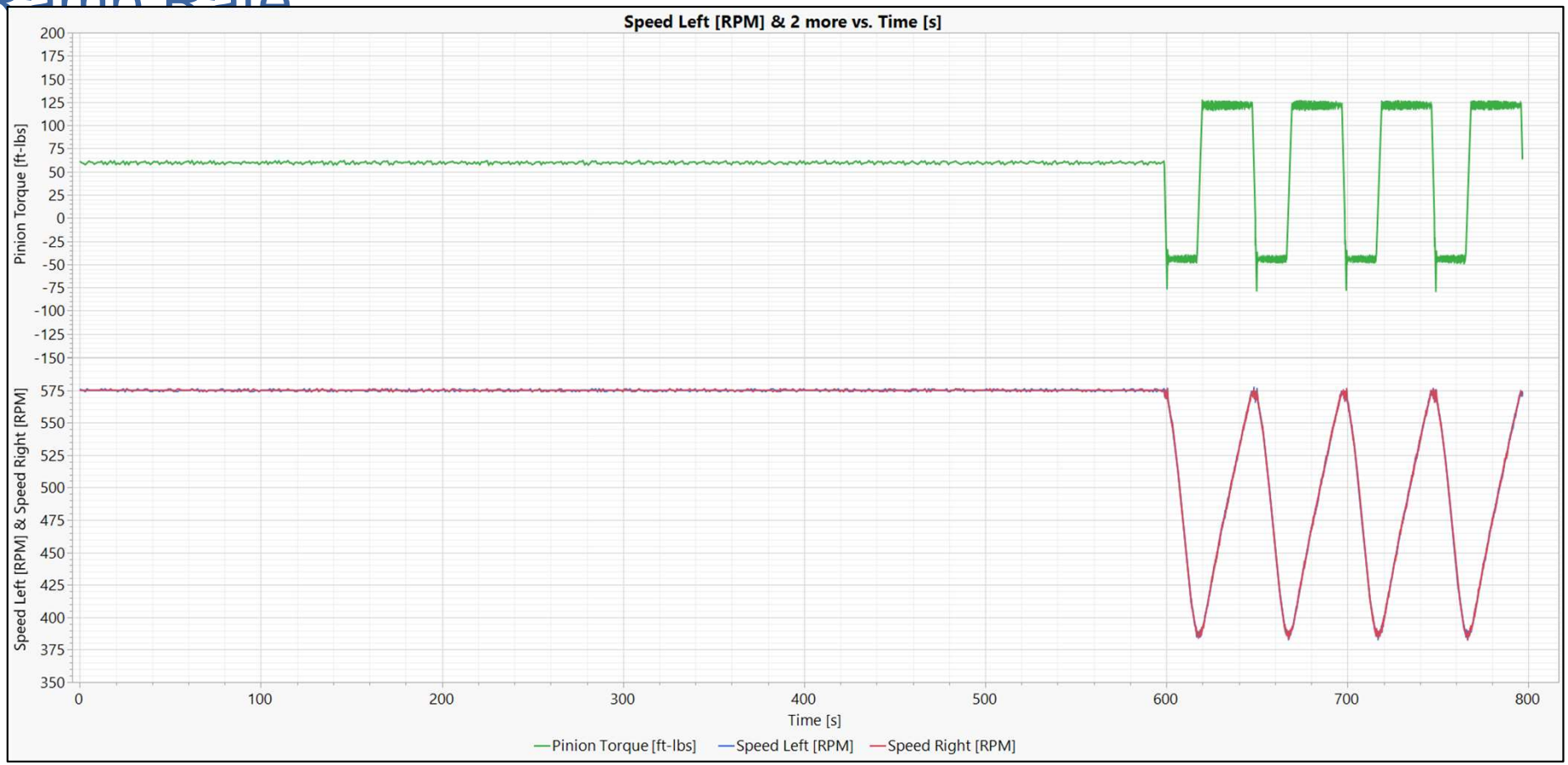
# 75W-80 Conditioning Phase 1 & 2: Torque Setpoint / Ramp Rate

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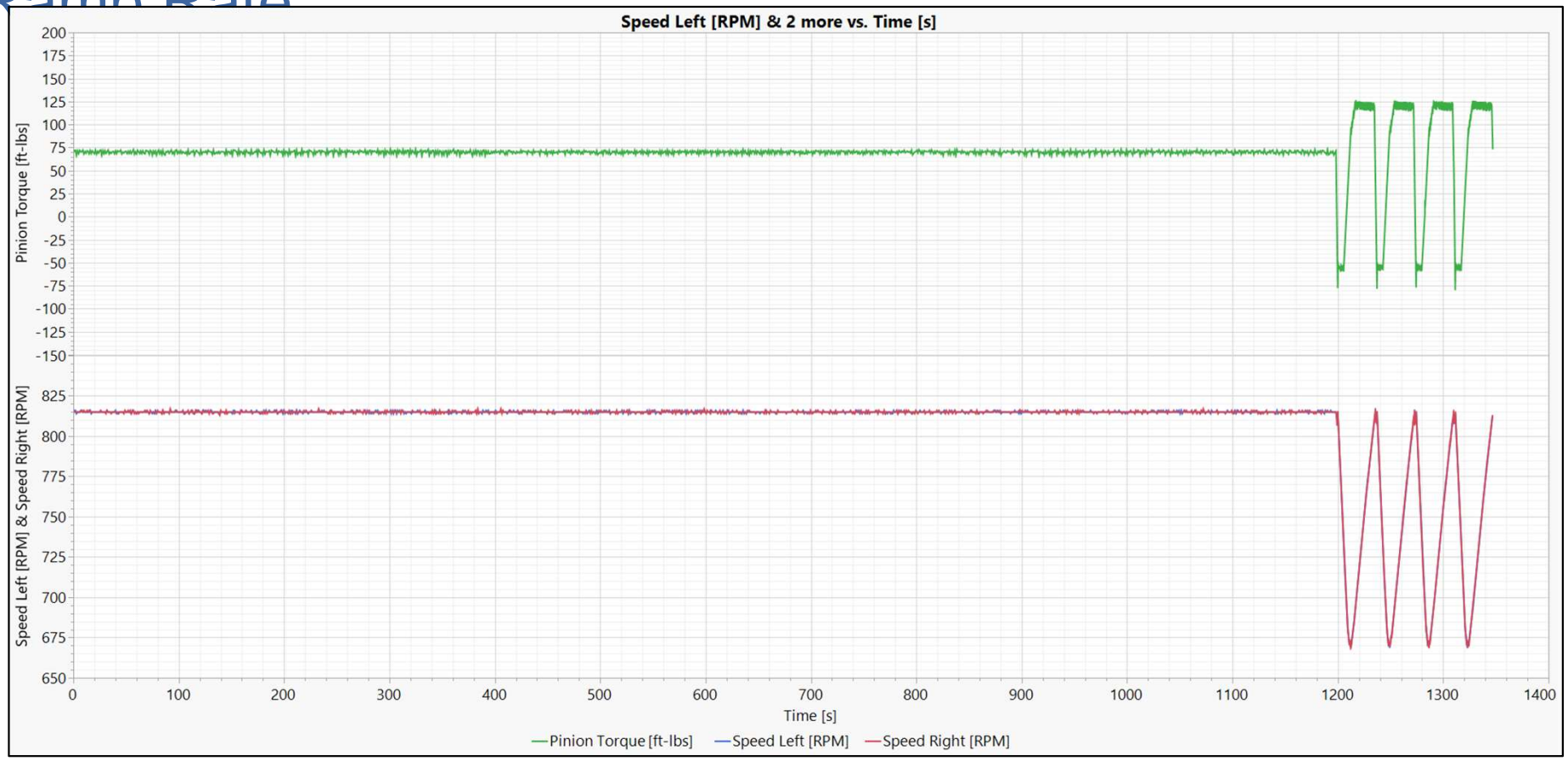
# 75W-80 Conditioning Phase 3 & 4: Torque Setpoint / Ramp Rate

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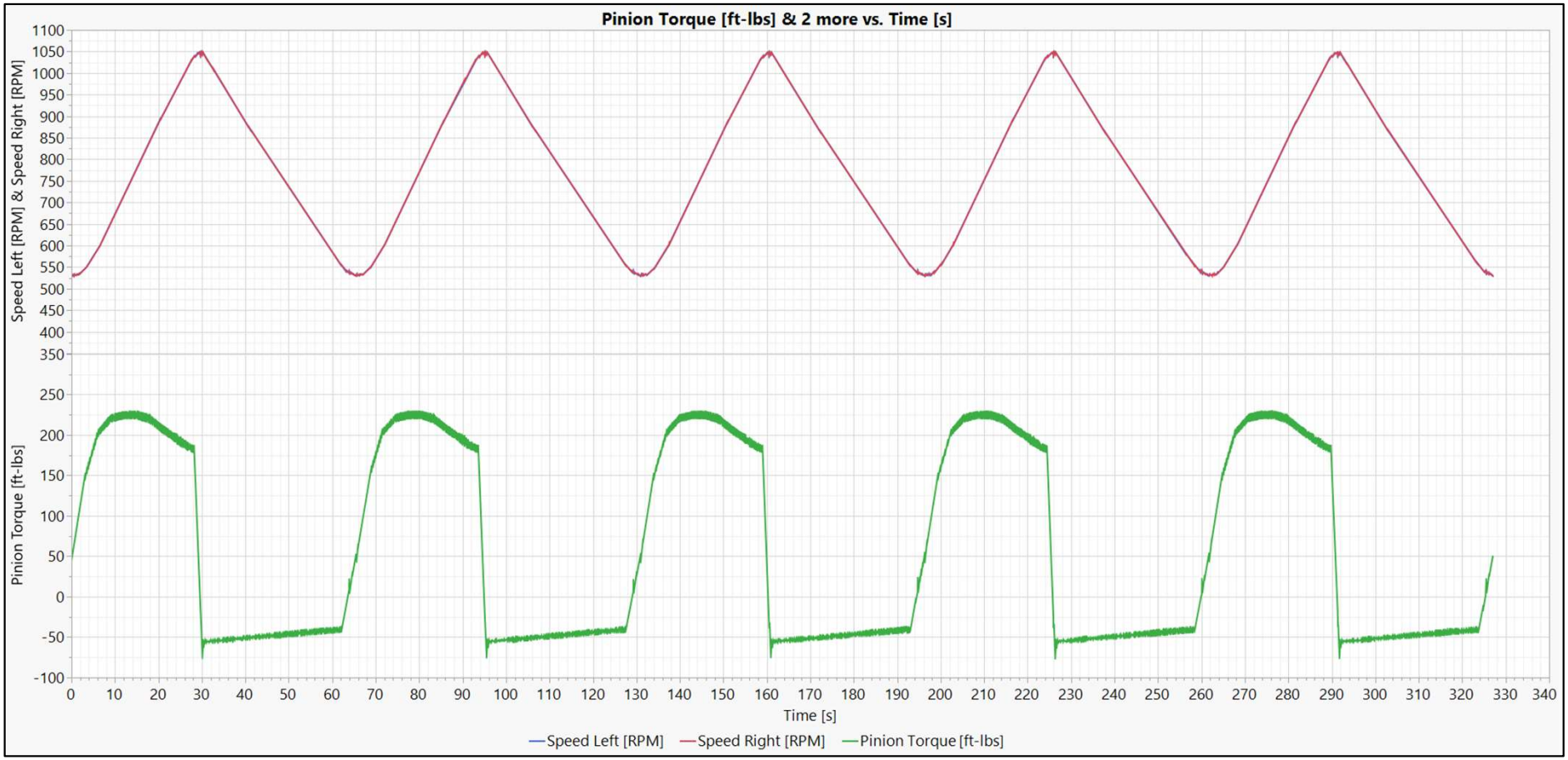
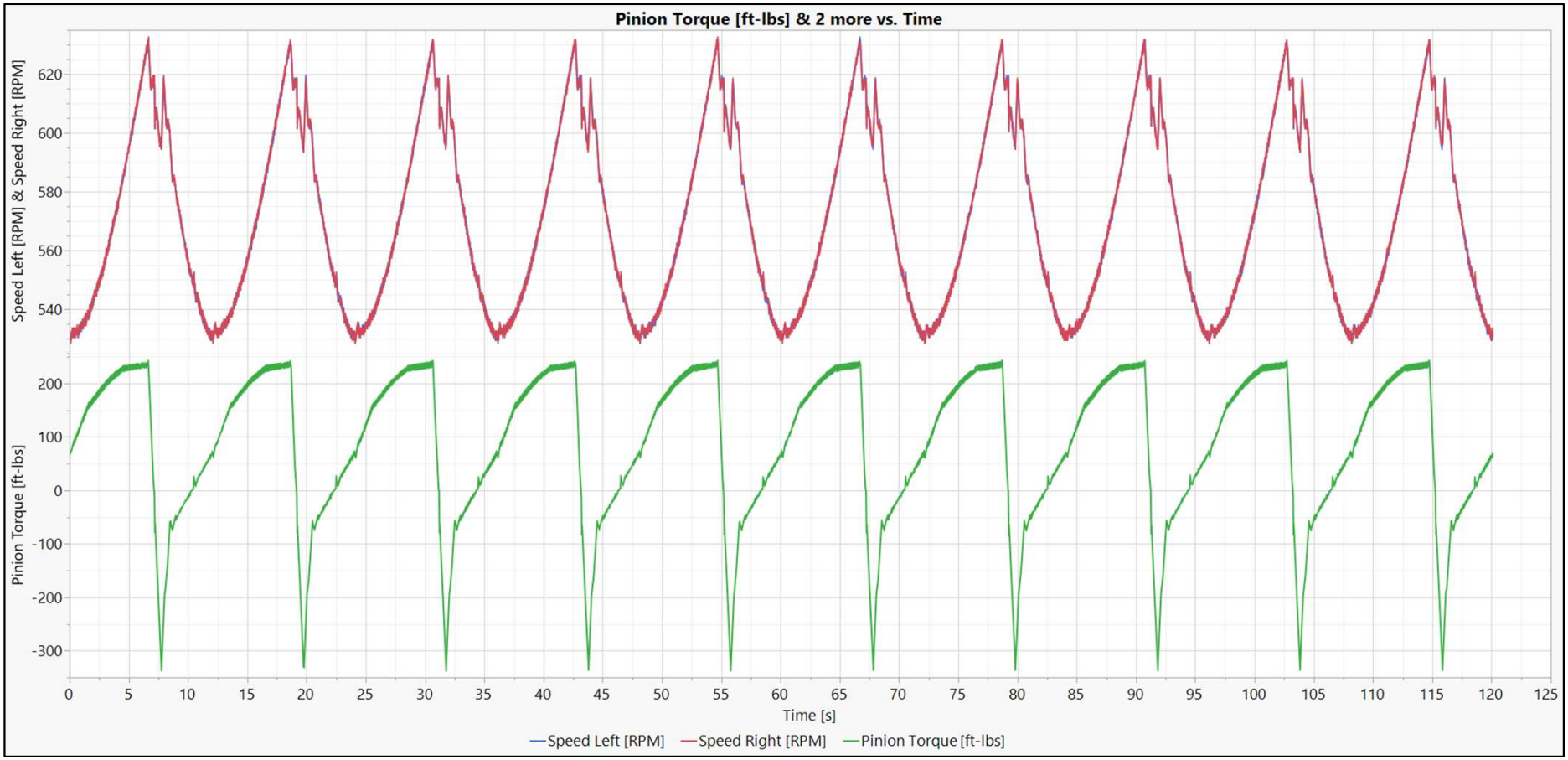
# 75W-80 Shock I: Torque Setpoint / Ramp Rate



# 75W-80 Shock II: Torque Setpoint / Ramp Rate

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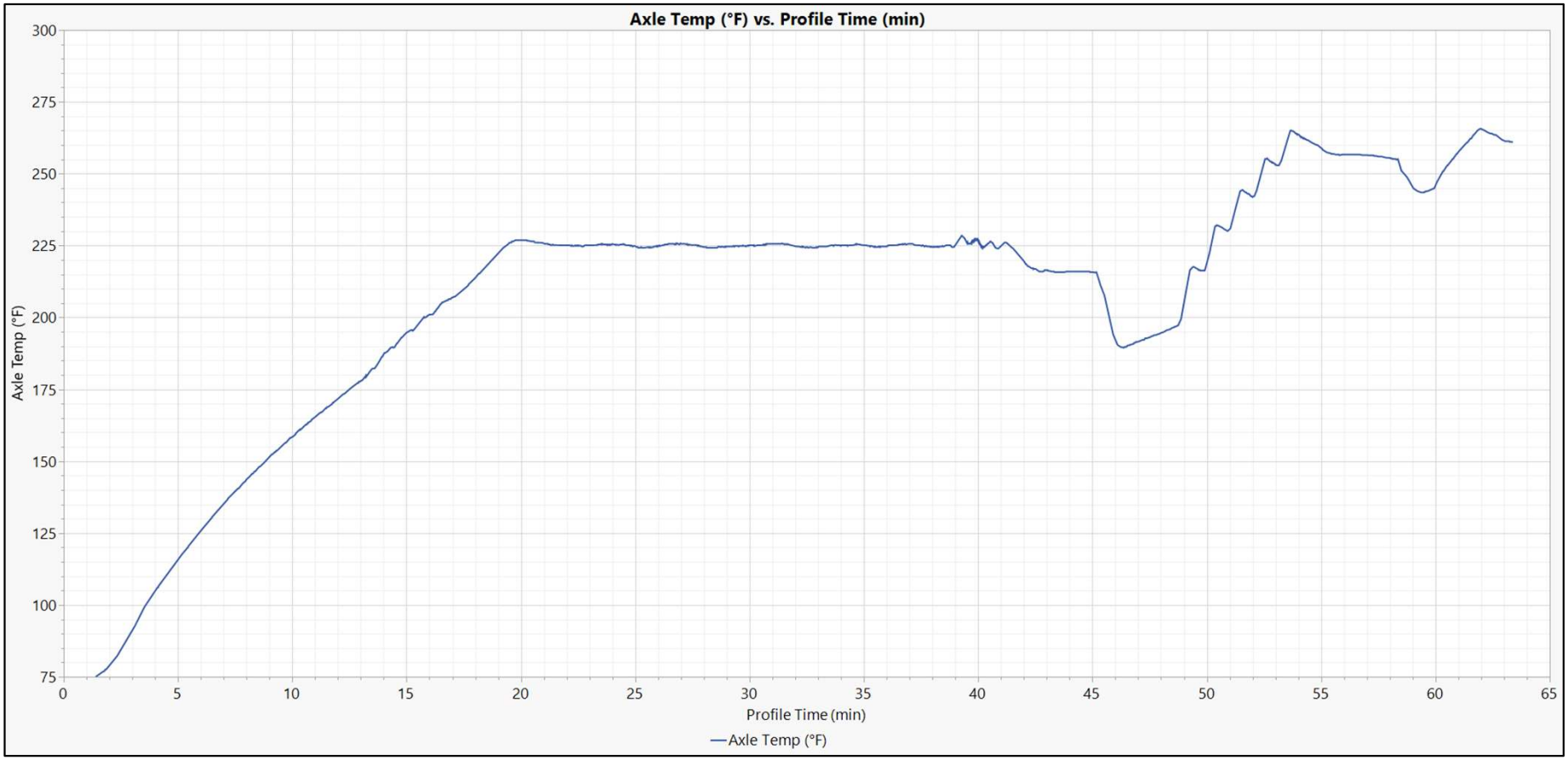
# 75W-80 Oil Temp: Torque Setpoint / Ramp Rate

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# Appendix: TMC 117 Run 2 Torque Setpoint / Ramp Rate Operational Data

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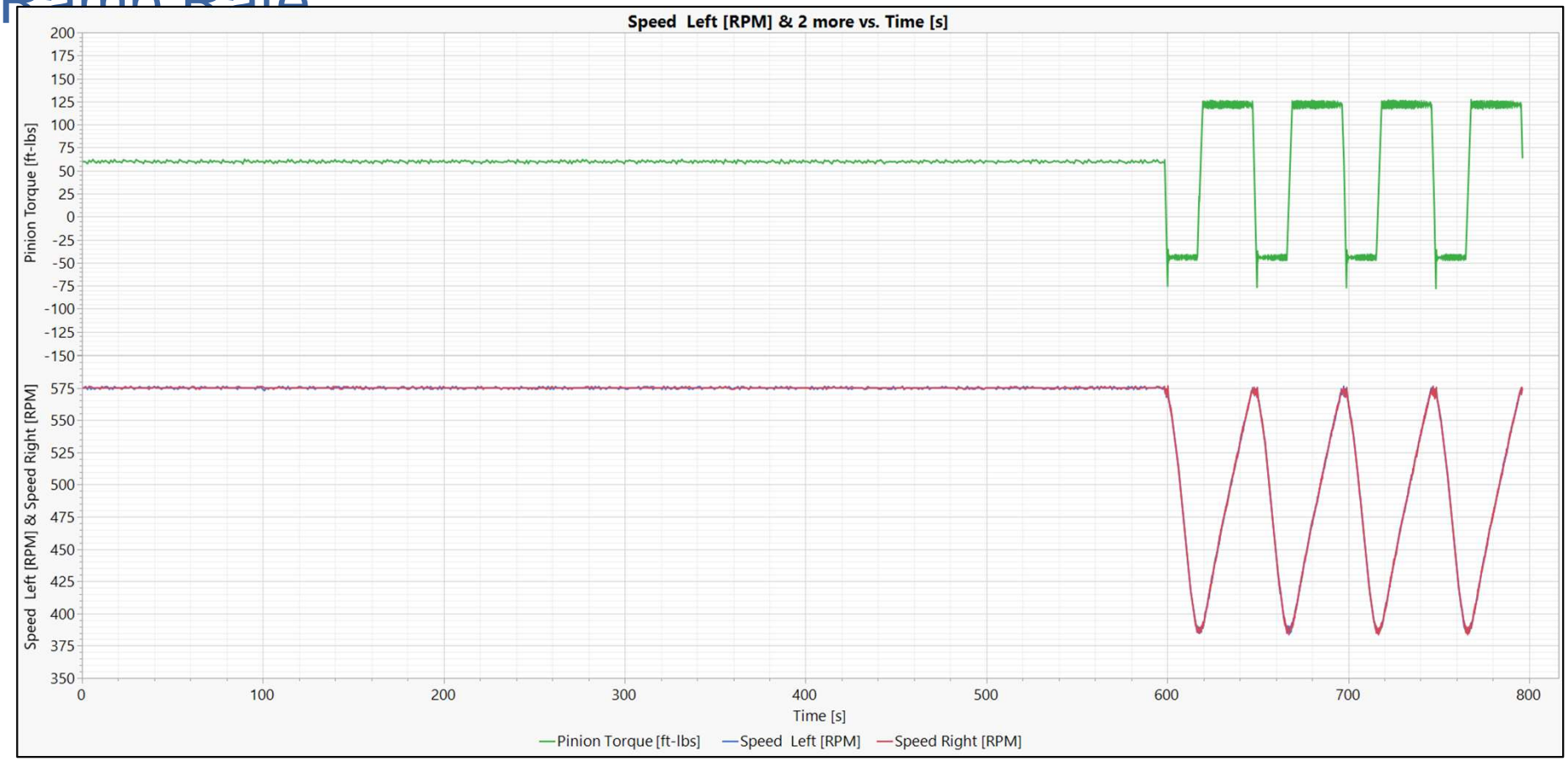
# 117 Run 2 Conditioning Phase 1 & 2: Torque Setpoint / Ramp Rate

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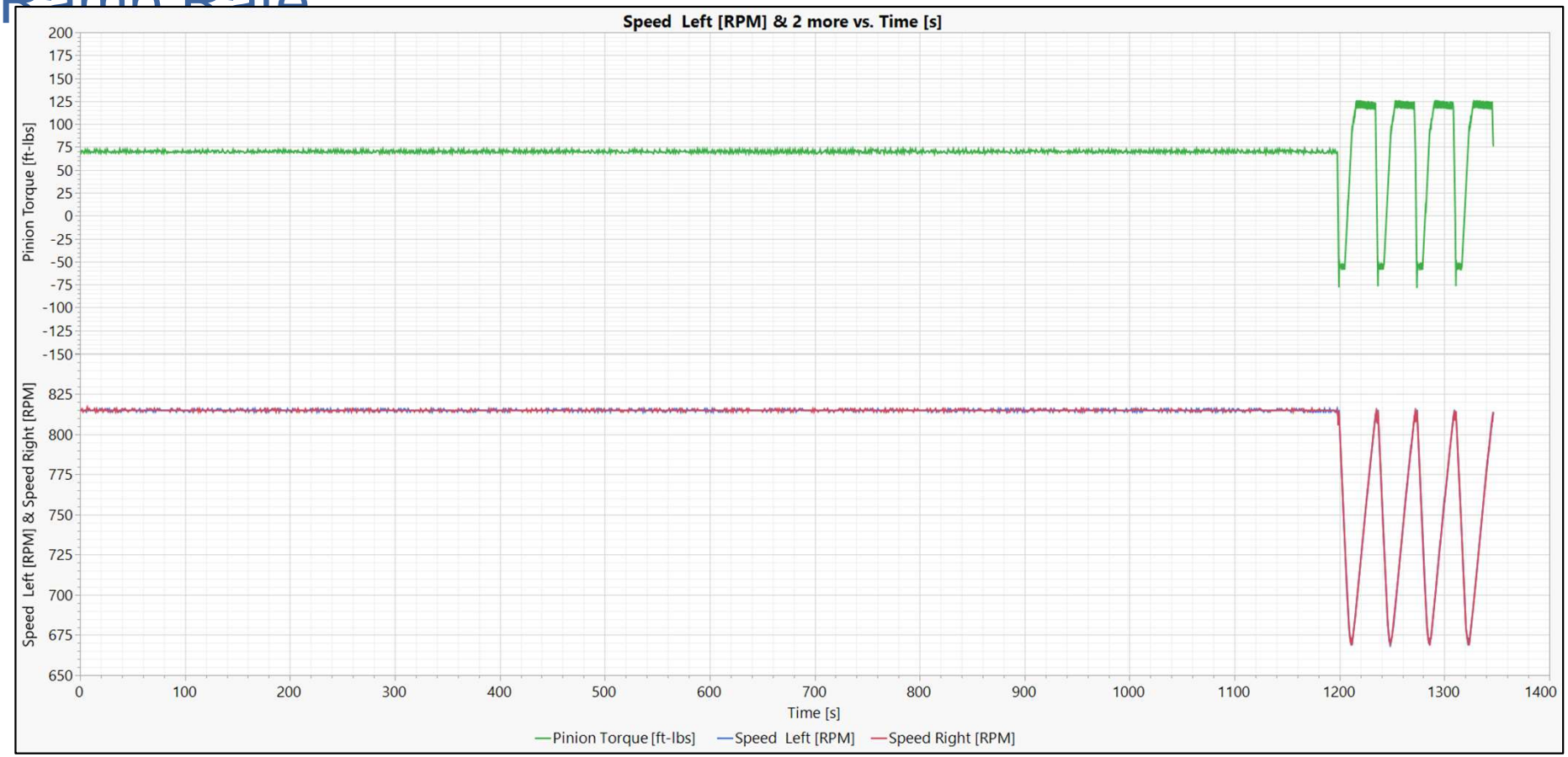
# 117 Run 2 Conditioning Phase 3 & 4: Torque Setpoint / Ramp Rate

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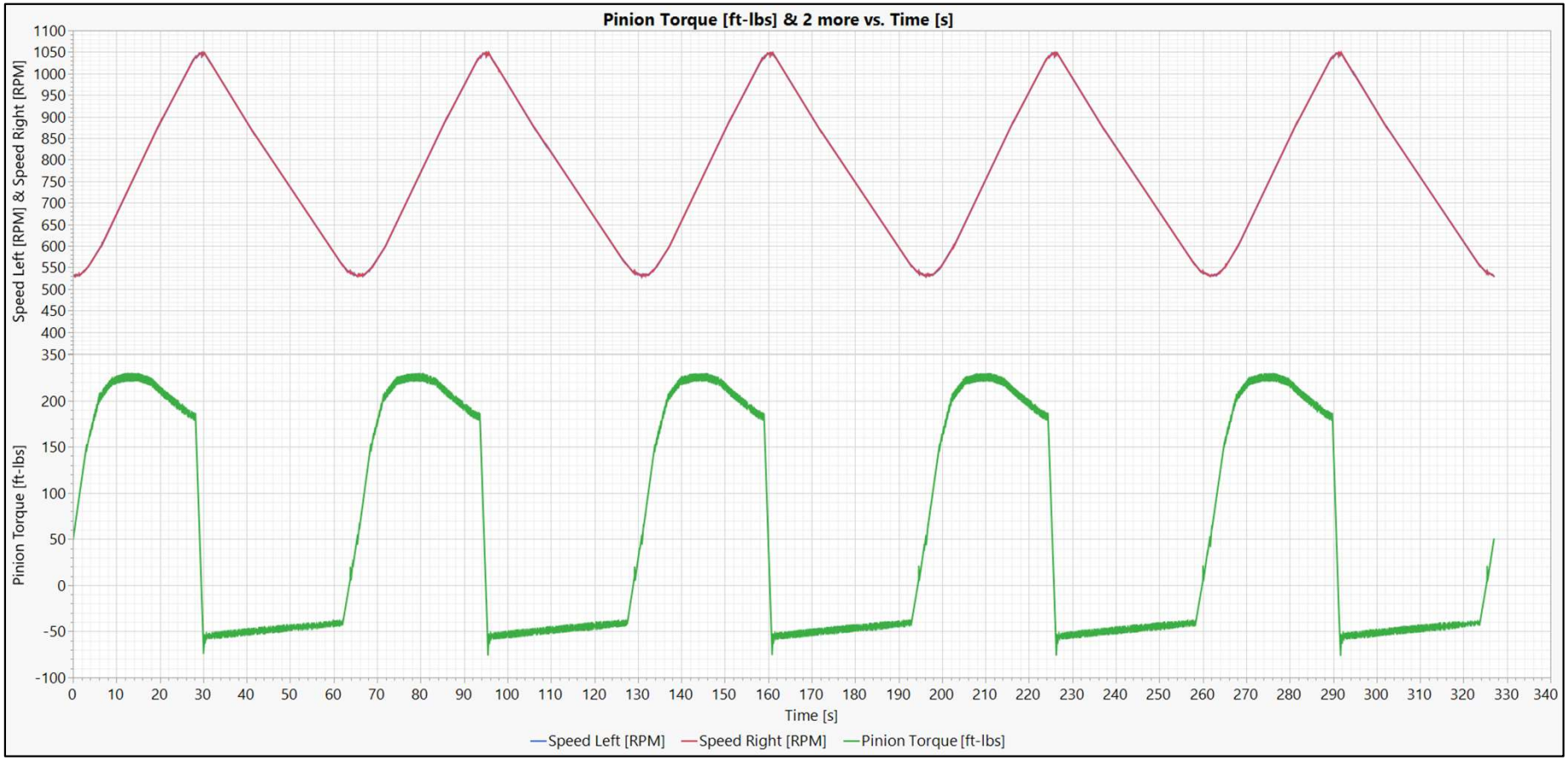
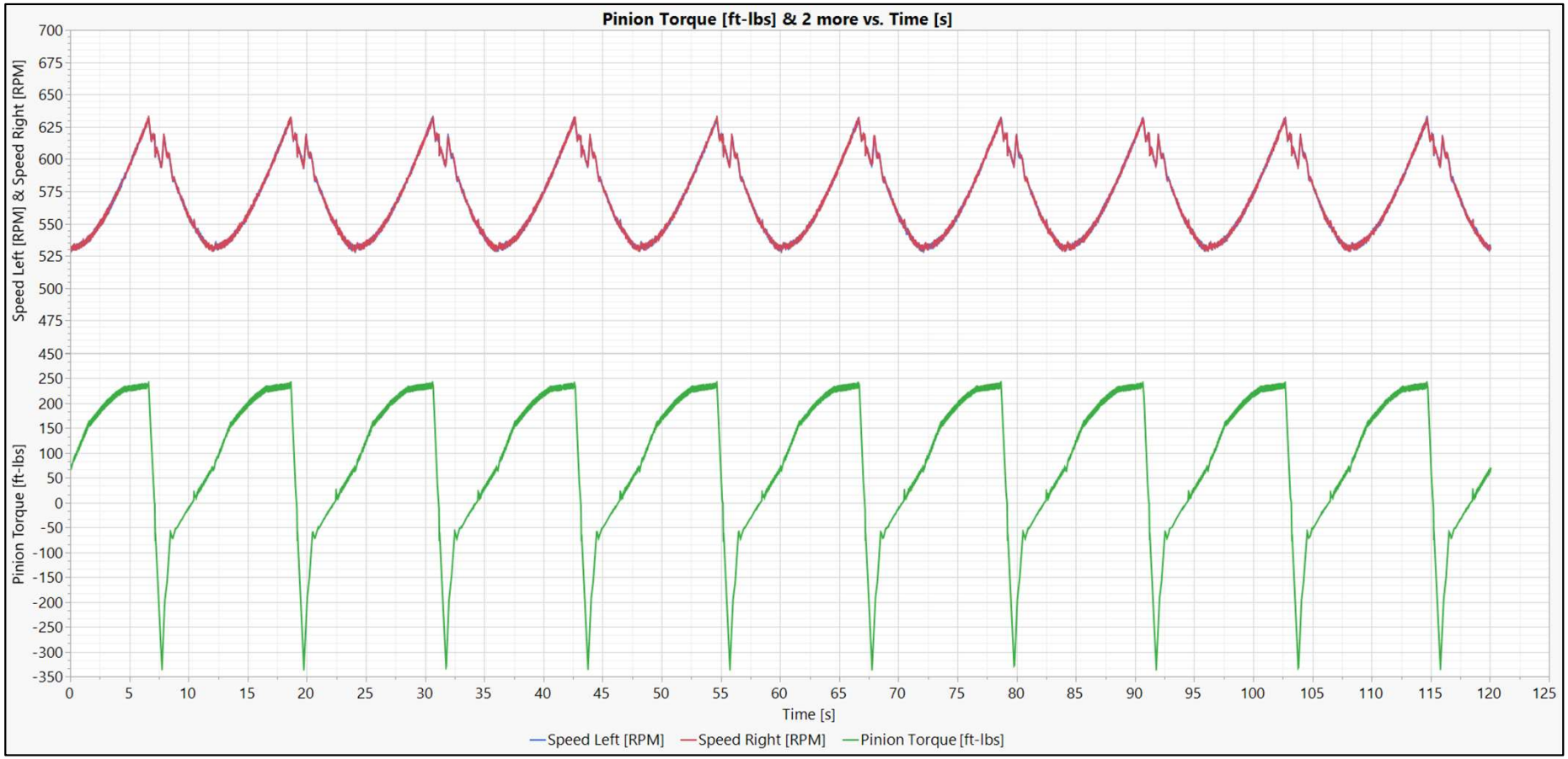
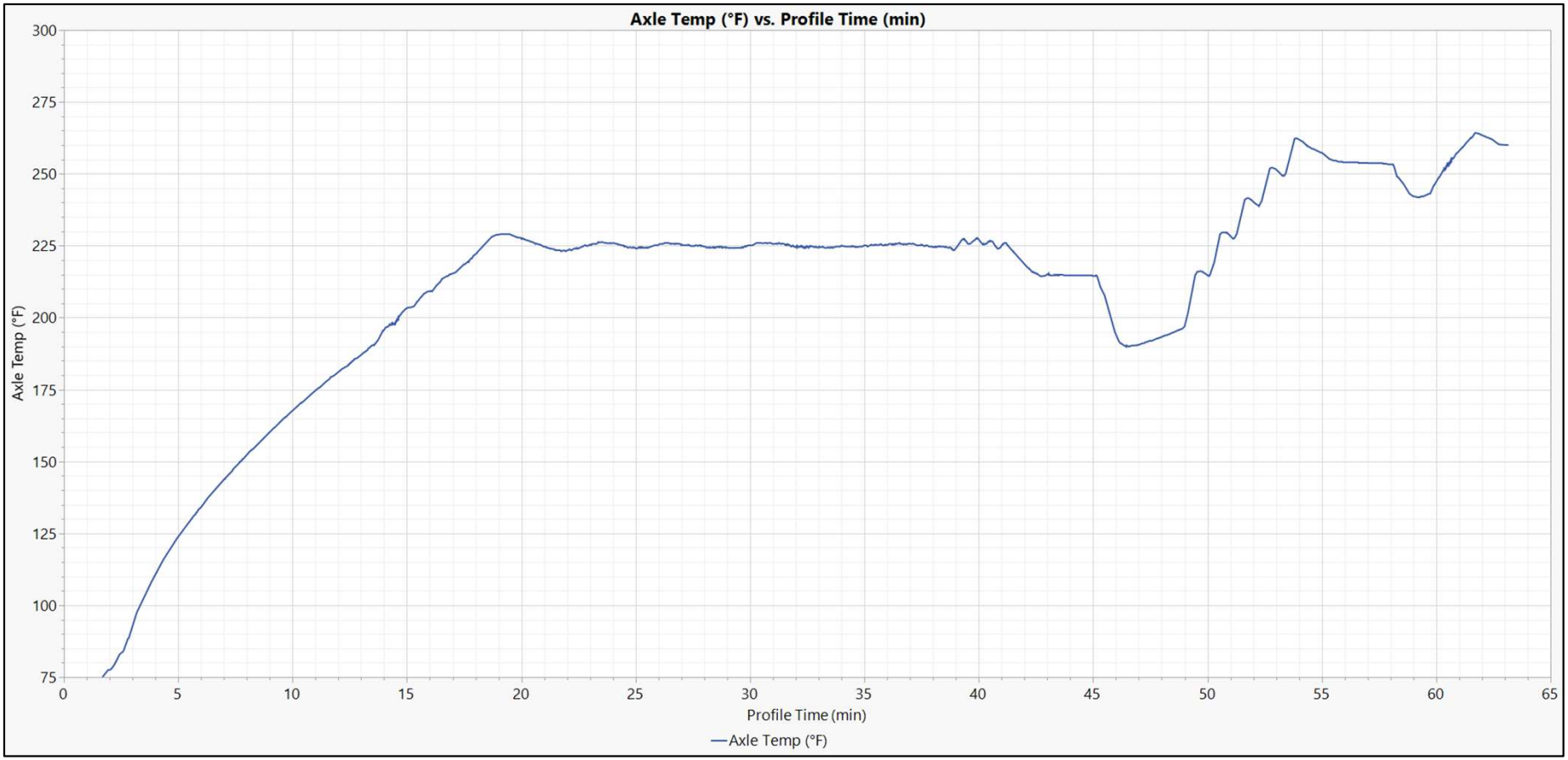
# 117 Run 2 Shock I: Torque Setpoint / Ramp Rate



# 117 Run 2 Shock II: Torque Setpoint / Ramp Rate



# 117 Run 2 Oil Temp: Torque Setpoint / Ramp Rate

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# L-42 Surveillance Panel Membership/Attendance
## Southwest Research Institute, San Antonio, TX and Microsoft Teams Virtual Meeting
## February 7, 2024

| Present | Name | Voting Non-Voting | Company Name Company Address | Contact information | |
|---|---|---|---|---|---|
| | Aguirre, Nancy | NV | Intertek Automotive Research | Phone: | |
| | | | 5404 Bandera Rd.<br>San Antonio, TX 78238 | E-mail: | nancy.aguirre@intertek.com |
| NA | Ariemma, Nick | NV | The Lubrizol Corporation | Phone: | |
| | | | 29400 Lakeland Boulevard<br>Wickliffe, OH 44092 | E-mail: | Nick.Ariemma@Lubrizol.com |
| | Banas, Rob | V | ExxonMobil Product Solutions | Phone: | 770-833-5920 |
| | | | 535 Thomas Lane<br>Waleska, GA 30183 | E-mail: | rob.a.banas@exxonmobil.com |
| DB | Beck, Dylan | V | ASTM Test Monitoring Center | Phone: | 724-355-1854 |
| | | | 203 Armstrong Drive<br>Freeport, PA 16229 | E-mail: | djb@astmtmc.org |
| | Bell, Don | NV | Afton Chemical | Phone: | 804-788-6332 |
| | | | 500 Spring St.<br>Richmond, VA 23219 | E-mail: | don.bell@aftonchemical.com |

# L-42 Surveillance Panel Membership/Attendance
## Southwest Research Institute, San Antonio, TX and Microsoft Teams Virtual Meeting
## February 7, 2024

| Present | Name | Voting Non-Voting | Company Name Company Address | Contact information | |
|---|---|---|---|---|---|
| TB | Bender, Tobias | NV | Fuchs Lubricants | Phone: | 708-737-1681 |
| | | | 17050 Lathrop Ave Harvey, IL 60426 | E-mail: | Tobias. Bender@fuchs.com |
| | Burgman, Maxim | NV | Fuchs Lubricants | Phone: | 248-846-3120 |
| | | | 17050 Lathrop Ave Harvey, IL 60426 | E-mail: | maxim.burgman@fuchs.com |
| | Camposo, Lucas | NV | Evonik | Phone: | 215-706-5809 |
| | | | 723 Electronic Dr Horsham, PA 19044 | E-mail: | lucas.camposo@evonik.com |
| MC | Caridi, Margaret | NV | BASF | Phone: | 914-785-2336 |
| | | | 500 White Plains Rd Tarrytown, NY 10591 | E-mail: | margaret.caridi@basf.com |
| JC | Carowick, Jessica | V | Cummins-Meritor | Phone: | 248-872-3055 |
| | | | 2135 W. Maple Rd Troy, MI 48084 | E-mail: | Jessica.LaBond@cummins.com |

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|---|---|---|---|---|---|
| | Cereghino, Brian | NV | IPAC Inc. | Phone: | |
| | | | | E-mail: | bcereghino@ipac-inc.com |
| MC | Charron, Michael | NV | Southwest Research Institute | Phone: | 832-444-2180 |
| | | | 6220 Culebra Rd.<br>San Antonio, TX 78238 | E-mail: | michael.charron@swri.org |
| | Clark, Jeff | NV | ASTM Test Monitoring Center | Phone: | 412-365-1032 |
| | | | 203 Armstrong Drive<br>Freeport, PA 16229 | E-mail: | jac@astmtmc.org |
| A.C. | Comfort, Allen | V | US Army DEVCOM | Phone: | 586-282-4225 |
| | | | | E-mail: | allen.s.comfort.civ@army.mil |
| | Drlja, Kristijan | NV | The Lubrizol Corporation | Phone: | 440-391-6374 |
| | | | 29400 Lakeland Boulevard<br>Wickliffe, OH 44092 | E-mail: | krdr@lubrizol.com |

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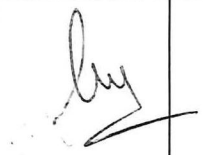
|---|---|---|---|---|---|
|  | Gingerich, Jason | NV | The Lubrizol Corporation | Phone: | 440-391-0101 |
| | | | 29400 Lakeland Boulevard<br>Wickliffe, OH 44092 | E-mail: | Jason.Gingerich@lubrizol.com |
|  | Goyal, Arjun | V | BASF | Phone: | 914-785-2083 |
| | | | 500 White Plains Rd<br>Tarrytown, NY 10591 | E-mail: | arjun.goyal@basf.com |
| | Grundza, Rich | NV | ASTM Test Monitoring Center | Phone: | 412-365-1031 |
| | | | 203 Armstrong Drive<br>Freeport, PA 16229 | E-mail: | reg@astmtmc.org |
| | Haynes, Troy | NV | IPAC Inc. | Phone: | |
| | | | | E-mail: | thaynes@ipac-inc.com |
|  | Horvath, Dan | NV | Afton Chemical | Phone: | 248-514-2551 |
| | | | 2000 Town Center, Suite 1160<br>Southfield, MI 48075 | E-mail: | dan.horvath@aftonchemical.com |

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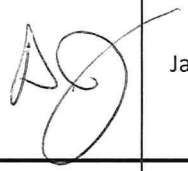
|  | Jackson, Alexander | NV | Chevron Oronite | Phone: | 510-367-7541 |
| | | | 4502 Centerview, Suite 210 San Antonio, TX 78228 | E-mail: | alexmjack@chevron.com |
|  | Jordan, Brad | NV | Shell | Phone: | 804-516-1238 |
| | | | 2084 Ditchley Rd Kilmarnock, VA 22482 | E-mail: | brad.jordan@shell.com |
| | Joy, Tisha | NV | BASF | Phone: | 914-785-2206 |
| | | | | E-mail: | tisha.joy@basf.com |
| | Kanga, Percy | NV | Exxon Mobil (Retired) | Phone: | |
| | | | | E-mail: | |
| | Kostan, Travis | NV | Southwest Research Institute | Phone: | 210.522.2407 |
| | | | | E-mail: | travis.kostan@swri.org |

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|---|---|---|---|---|---|
| | Lange, Anthony | V | Intertek Automotive Research | Phone: | 210-634-1103 |
| | | | 5404 Bandera Rd.<br>San Antonio, TX 78238 | E-mail: | anthony.lange@intertek.com |
| | Morris, Jeanelle | NV | Navistar | Phone: | 331-332-1661 |
| | | | 2701 Navistar Dr<br>Lisle, IL 60532 | E-mail: | jeanelle.morris@navistar.com |
| | Mosher, Donna | NV | BASF | Phone: | 269-217-1715 |
| | | | 100 Park Ave<br>Florham Park, NJ 07932 | E-mail: | donna.mosher@basf.com |
| | Mueller, Caroline | V | Southwest Research Institute | Phone: | 210-522-2671 |
| | | | 6220 Culebra Rd.<br>San Antonio, TX 78238 | E-mail: | caroline.louis@swri.org |
| | Muransky, Troy | V | AAM | Phone: | 734-564-8406 |
| | | | 1840 Holbrook<br>Detroit, MI | E-mail: | troy.muransky@aam.com |

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|---|---|---|---|---|---|
| | Neil, Suzanne | NV | Daimler Trucks/Detroit Diesel | Phone: | |
| | | | | E-mail: | suzanne.neal@daimler.com |
| | Portell, Michael | NV | Intertek Automotive Research | Phone: | 210-896-8012 |
| | | | 5404 Bandera Rd.<br>San Antonio, TX 78238 | E-mail: | michael.portell@intetek.com |
| MS | Sangpeal, Matt | V/Chair | Afton Chemical | Phone: | 804-788-5364 |
| | | | 500 Spring St.<br>Richmond, VA 23219 | E-mail: | matt.sangpeal@aftonchemical.com |
| ES | Sattler, Eric | NV | CCDC-GVSC | Phone: | 586-282-2272 |
| | | | Warren, MI | E-mail: | eric.r.sattler.civ@army.mil |
| NS | Schaup, Nick | V | The Lubrizol Corporation | Phone: | 616-710-2546 |
| | | | 29400 Lakeland Boulevard<br>Wickliffe, OH 44092 | E-mail: | Nick.Schaup@Lubrizol.com |

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|---|---|---|---|---|---|
|  | Schweitzer, Addison | NV | Shell | Phone: | 346-549-2481 |
| | | | | E-mail: | Addison.Schweitzer@shell.com |
|  | Uy, Dairene | NV | Shell | Phone: | 281-544-6781 |
| | | | | E-mail: | dairene.uy@shell.com |
|  | Warden, Rebecca | V | Chevron Oronite | Phone: | 830-865-6771 |
| | | | 4502 Centerview, Suite 210<br>San Antonio, TX 78228 | E-mail: | Rebecca.Warden@chevron.com |
| | Yucebilgic, Fatih | NV | Fuchs Lubricants | Phone: | 708-539-0252 |
| | | | 17050 Lathrop Ave<br>Harvey, IL 60426 | E-mail: | fatih.yucebilgic@fuchs.com |
| | Zarins, George | NV | AAM | Phone: | 586-854-8810 |
| | | | 1840 Holbrook<br>Detroit, MI | E-mail: | george.zarins@aam.com |

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|---|---|---|---|---|---|
| | Zreik, Khaled | NV | General Motors | Phone: | 248-977-9214 |
| | | | 823 Joslyn Ave<br>Pontiac, MI 84340-2925 | E-mail: | khaled.zreik@gm.com |
|  | Zyski, Amy | V | Dana Incorporated | Phone: | 419-887-3432 |
| | | | 3939 Technology Dr<br>Maumee, OH 43537 | E-mail: | amy.zyski@dana.com |
| | Bob Campbell | NV | | Phone: | |
| | | | | E-mail: | |
| | Mahdi M-Pour | NV | Tribodens | Phone: | |
| | | | | E-mail: | |
| | WES VENHOFF | NV | LUBRIZOL | Phone: | |
| | | | | E-mail: | WES.VENHOFF@LUBRIZOL.COM |

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| Present | Name | Voting Non-Voting | Company Name Company Address | Contact information | |
|---|---|---|---|---|---|
| CT | Connor Thomas | NV | SwRI | Phone: | |
| | | | | E-mail: | connor.thomas@swri.org |
| HH | Hyeok Hahn | NV | Chevron | Phone: | 408-507-2848 |
| | | | | E-mail: | hyeok.hahn@chevron.com |
| DSB | Dale Smith | NV | Intertek | Phone: | 412 855 6854 |
| | | | | E-mail: | dale.smith@intertek.com |
| MP | Micheal Portell | NV | Intertek | Phone: | 210-896-8012 |
| | | | | E-mail: | micheal.portell@intertek.com |
| | John Huron | NV | Chevron Oronite 4502 Centerview, Suite 210 San Antonio, TX 78228 | Phone: | (210) 731-5609 |
| | | | | E-mail: | john.huron@chevron.com |
| | Hector De La Fuente | NV | Chevron Oronite 4502 Centerview, Suite 210 San Antonio, Tx 78228 | | HDELAFUENTE@CHEVRON.COM |

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| Present | Name | Voting Non-Voting | Company Name Company Address | Contact information | |
|---|---|---|---|---|---|
| | Kevin Rottmann | NV | Chevron Oronite Company<br>4502 Commerce, Ste 210 | Phone: | 210-778-9358 |
| | | | San Antonio, TX 78228 | E-mail: | Kevin.Rottmann@Chevron.com |

Virtual Amanda Stone

After