



COMMITTEE D02 on PETROLEUM PRODUCTS, LIQUID FUELS, AND LUBRICANTS

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SEQUENCE IX SURVEILLANCE PANEL

Date: 16 June 22

ATTENDANCE

SWRI	Christine Eickstead, Khaled Rais, Travis Kostan, Pat Lang
INTERTEK	Al Lopez, Jason Soto
LUBRIZOL	George Szappanos
AFTON	Ben Maddock
ORONITE	Robert Stockwell
INFINEUM	Doyle Boese, Andy Ritchie
TMC	Rich Grundza
GM	Khaled Zreik, Brad Cosgrove
OHT	Jason Bowden
TEI	Derek Grosch
APL	Timothy Hadaway
HALTERMAN	Prasad Tumati, Izabela Gabrel
BP	Tim Matthews, Nick Janssen

ATTACHMENTS:

- A: Meeting Agenda
- B: RO 221 Presentation
- C: Machined Pistons Presentation

MEETING:

1. **Attendance. See table above.**
2. **Chairman's Comments, Khaled.**
3. **Review and Acceptance of Minutes**
 - a. Last IX SP meeting was 23 Aug 2021.

MOTION 1: Approve meeting minutes from last meeting		
Proposed:	Khaled Rais	
Second:	Al Lopez	
Discussion:	None	
Questions:	None	
Votes:	<i>Waive:</i>	0
	<i>Negative:</i>	0
	<i>Approve:</i>	N/A
Outcome:	Motion passes unanimously	

4. **Review Action Item List, Khaled.**
5. **TMC Report, Rich Grundza.**
6. **Review RO 221 Performance, Christine.**

Christine – presents attachment B.

Discussion:

Al – Are end of life tests still reflected? Christine – Yes. All AC and OC tests are present in both oils' cusums.

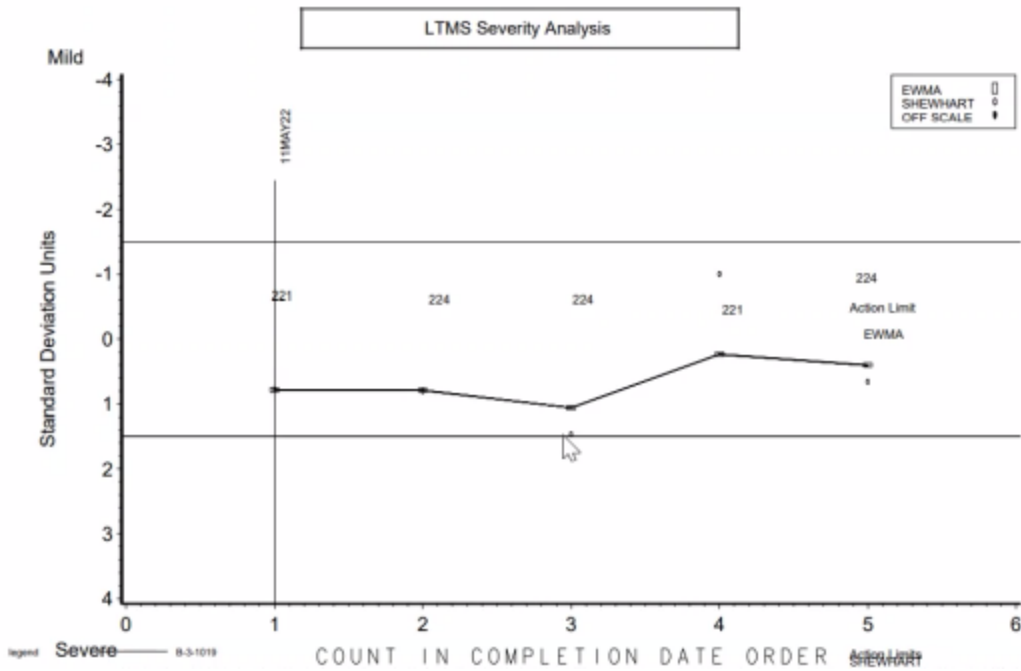
Rich – 221 falls off more at end of engine life, 224 doesn't do this as much. 221 shows moisture in the samples in storage at TMC. 224 is due for another blend, which will be 224-1. 224 is a new oil, so this is a bit less dicey than an older oil re-blend.

Rich – The stats group has done some work looking at pooled sigmas for this test, might that work impact this?

George – Hadn't noticed this trend yet, but was disappointed with recent RO 221 failure, had been happy with performance of engine up to this point.

George – Have adopted the extended new engine break-in at the suggestion of other labs.

Rich – Presents slides on RO 221 performance, see below.



Rich – Odd performance in oil later in engine life that may not have been happening prior to 2019. More room for it to move, therefore we see it move more? It is a higher event oil....

Christine - As an Industry, we have seen that, as engine gets older, will pass 224 but fail 221.

Christine – Should we do anything other than just watch this for now?

Rich – Are we failing engines too early with 221, or is 224 not showing us that an engine is going out?

Andy – Bottom line – we don't want oils with 221-type performance characteristics in the field. Christine – so worst case, an older engine passes 224, then runs a comparable 221 oil and gives it a passing result. Andy – yes.

Andy – Should just get rid of 221. Except that the test needs a failing oil as a RO.

Christine – Will try and factor engine life into this analysis for next discussion.

Pat – SwRI, as SP Chair, is doing due diligence here, noticing trends, and acting on them. Asks that Khaled keep this up front.

Action – Christine, Stats group, and TMC – work on engine life correlation

7. Fuel Supplier Report, Prasad Tumati

137000 gallons of EEE available, filling a lot of orders right now. Will complete by next week, still have significant volume remaining after all orders filled.

8. Old Business

Khaled – Regarding pistons, presents 16 June 22 presentation.

Machined pistons – SwRI has run these and reported the results. Previously discussed other labs running with machined pistons also but this hasn't happened yet. Lab availability?

George – In absence of BB engine, Lubrizol would be very interested in running machined pistons. Would also be very interested in running those tests for calibration. If we build an engine with these pistons and run 2-3 tests that come in on target, it would be good if those tests could be used for calibration.

Jason – Similar thoughts.

Khaled – Maybe we can approach the stats group with this proposal. If so, would the labs be willing to run these runs in next month?

Afton – Also interested in participating. Have a set of machined pistons, but not built into an engine yet.

Rich – Suggestions for conducting this: maybe do this whenever you need to change out an engine, so the lab doesn't invalidate any existing calibrations, etc. Unsure how soon after the matrix the Industry can grant calibration status. If all of the data looks good, can grant calibration status relatively soon.

Jason – IAR is willing to run, but is hesitate to install an engine with these pistons, run two tests, then have to pull the engine off and install one with regular pistons for calibration. So if can work out the timeline of granting cal. status, IAR can proceed.

Jason – Reminds the group that IAR got dealer pistons approved. IAR ran a lot of tests on those pistons, so something similar has been done before. Rich – clarifies – everyone can use dealer pistons if they bring them in on a reference.

Jason – yes, but the only prove-out data came from IAR. No other labs ran the dealer pistons as part of the prove-out.

Action - Khaled – Request matrix from the stats group and discuss cal. timing.

Pat – This takes time. Will need several tests from each lab, so each lab will be waiting on results from other labs. Once the matrix is designed, can collaborate on timing. Want to be mindful of the logistics in the labs, especially if a lab has only one test stand.

The Industry has approved pistons before with only a couple runs in a single lab – there was no official matrix for the dealer pistons' approval.

Doyle – Background – Is it true that one lab machined these pistons? Correct. How difficult is it to repeat the machining? Khaled – relatively easy. The process is quick and repeatable (there was a fixture made for the process). Doyle – Are there measurements that can be done to verify machining? Considering we should probably make these in a large batch for batch control purposes....

Al – How many have machined? Khaled, only what has been sent so far. Scoping batch only, not bulk batch.

The machining is done with a CNC program with a custom fixture. Al – Yes but one batch is one machining session.

Khaled – The pistons that have been delivered so far were technically machined at different times, so different batches?

Al – Ideally, we would run off all of the pistons in one batch and use these for the life of test.

Pat – This is only a potential solution, and there are lots of variables. But other routes, i.e. different manufacturing batches, have not proven successful so far.

Understand that not all pistons can be machined. Some fall out for clearance issues. Jason – this is true for new engines as well – pistons are larger with same size bores.

Al – How many do we plan on machining, and at what cost? Although as this is the only path we have, so cost may not be an issue. Jason – Depends on how many actually fall in spec. Al – So how many do we have that are in spec, that could be machined? Khaled – We only sampled before, but we can measure the rest of them.

Action - Khaled – Will look into price to machine the pistons. Will need to refresh quote.

Fuels task force – do people have time before ASTM meeting? Pat – stay away from the ASTM meeting, schedule the fuels task force meeting for after.

9. New Business

Any new items?

Al – One item in X is topic of non-critical hardware. Where are we with the IX with additional components that we need to build these things? X has a quote from FCS and labs are working to place own individual orders.

Christine has quote from FCS. Labs to see if they need anything from list.

Action - Christine - Send FCS quote to labs.

10. Summary of Aged Oil Results, Deegan.

Fresh Oil B – SwRI passed, George fails. But if apply repeatability, not outside normal range of results of this test. So no major issues with fresh oil B.

Cal period extensions – Khaled – SwRI ran the ref early, lost one candidate. Andy – This was the best thing to do for the matrix in terms of data rigor. So throw them a bone and give them one more candidate.

MOTION 2: To extend the calibration period by one candidate test for labs participating in the matrix that referenced one test early.

Proposed: Ben Maddock

Second: Mike Deegan

Discussion: None

Questions: None

Votes: *Roll Call:*

<i>Company</i>	<i>Voter</i>	<i>Approve</i>	<i>Waive</i>	<i>Disapprove</i>
SwRI	Khaled Rais	■		
IAR	Jason Soto	■		
Lubrizol	George Szappanos	■		
Afton	Ben Maddock	■		
Oronite	Robert Stockwell	■		
Infineum	Andy Ritchie	■		
TMC	Rich Grundza	■		
Ford	Mike Deegan	■		
GM	Tim Cushing	■		
BP	Nick Janssen	■		
Halterman	Prasad Tumati	■		
OHT	Jason Bowden		■	
TEI	Derek Grosch		■	
<i>Totals:</i>		11	2	0

Outcome: The motion passes.

11. Next Meeting:

Maybe week of 18th maybe? If have fuels meeting week of 11th?

12. Meeting adjourned.

AGENDA

ASTM D8291 Sequence IX Surveillance Panel (WebEx)

Khaled Rais – Chairman

Thursday, June 16, 2022– 10:00 AM to 11:30 AM (CST)

<https://swri.webex.com/swri/j.php?MTID=m248d3edc9d06b6ee0647ef977bc9f248>

1. Attendance
2. Chairman's Comments
3. Review & Acceptance of Minutes
 - 3.1. Acceptance of the Aug 23rd, 2021 WebEx meeting minutes.
4. Review Action Item List (Khaled Rais)
5. TMC Report (Rich Grundza)
 - 5.1. Review of current LTMS charts
6. Review RO 221 Performance
7. Fuel
 - 7.1. Fuel supplier report (Prasad)
8. Old Business
 - 8.1. Hardware status of the Sequence IX (machined pistons): timeline and approval procedure
 - 8.2. Alternate Fuel Task Force to resume
9. New Business
10. Summary of Aged Oil LSPI Results
 - 10.1. Extension of matrix stand reference periods by 1 test
11. Next Meeting: Will be at the call of the chairman.

Sequence IX

REFERENCE OIL ANALYSIS

SOUTHWEST RESEARCH INSTITUTE®

Christine Eickstead
June 2022



BACKGROUND

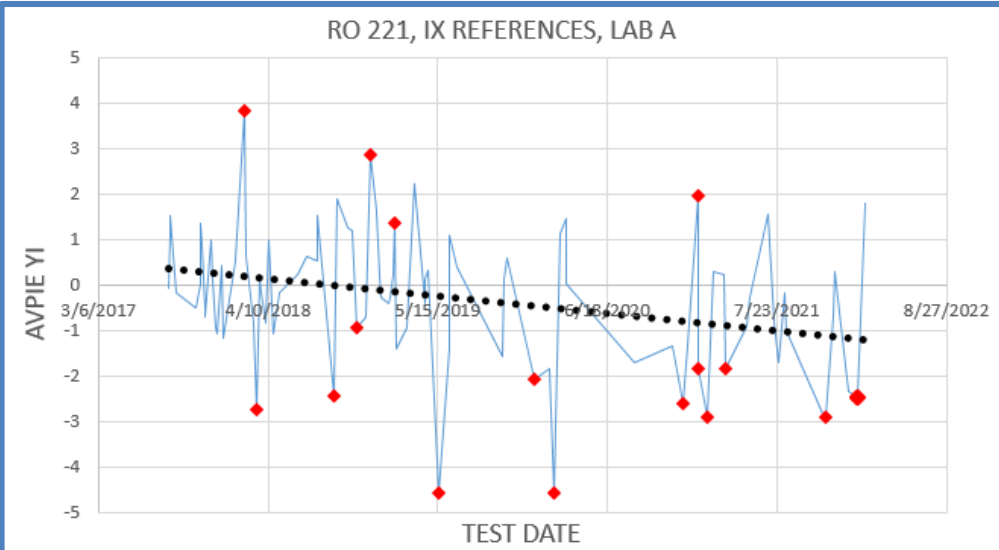
- SwRI noticed an internal mild trend on RO 22I resulting in difficulty passing references. Is this an Industry-wide or internal trend only?
- Analyzed Industry-wide RO 22I data, all together and by lab.
- Analyzed Industry-wide RO 224 data for comparison, all together and by lab.

RO 224 CUSUM, ALL LABS

- Inflection point present around May 2019. Performance of oil milder after this point.



RO 221 PERFORMANCE

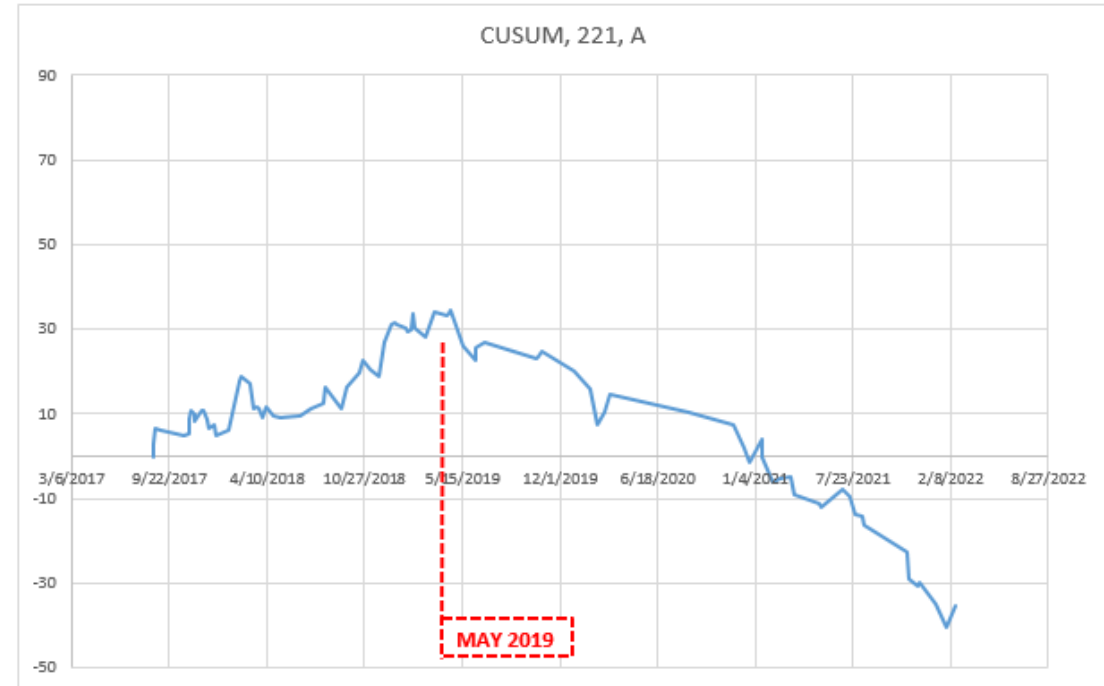
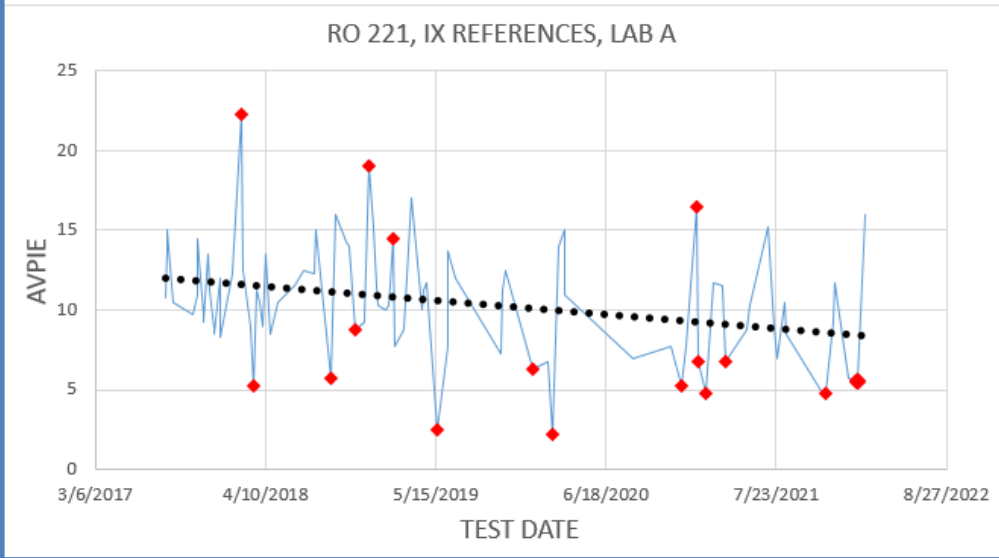


LAB A:

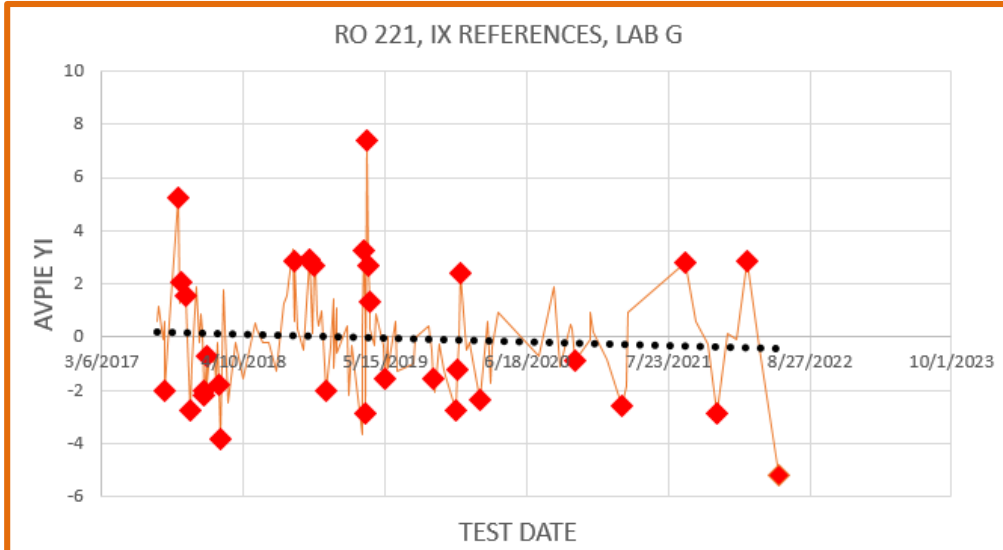
Runs: 88

Fails: 17

Fail %: 19.3



RO 221 PERFORMANCE

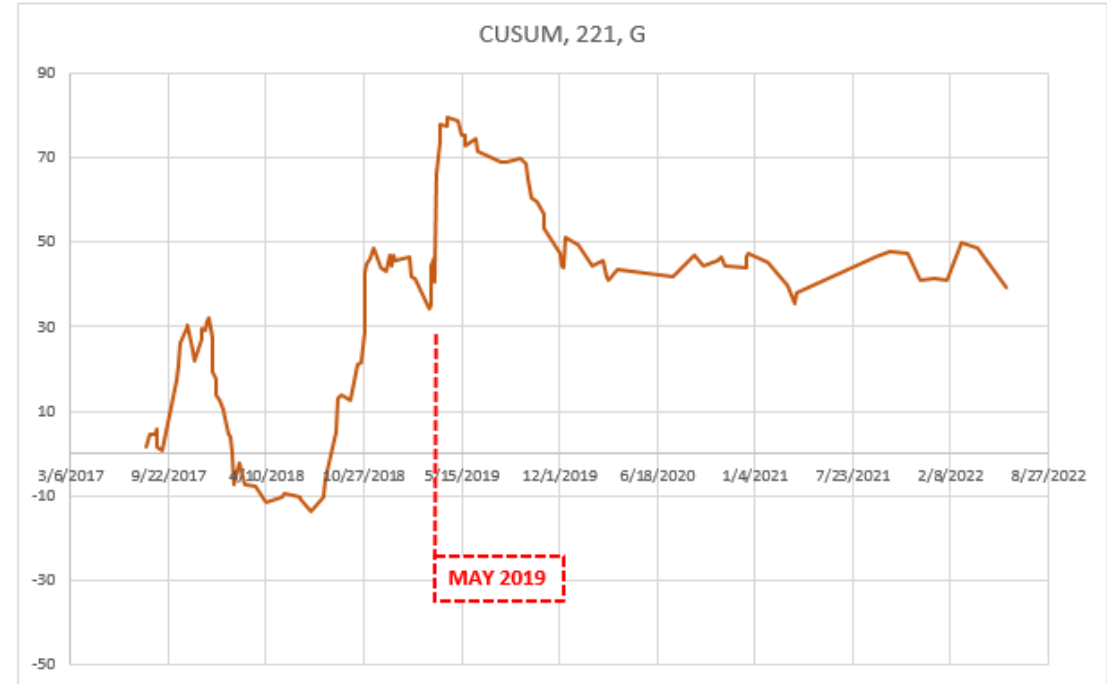
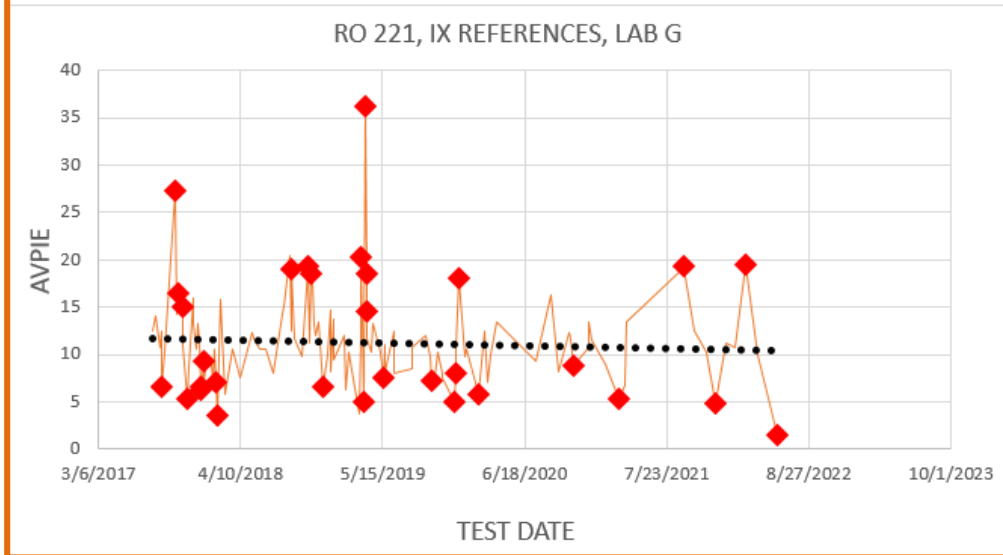


LAB G:

Runs: 124

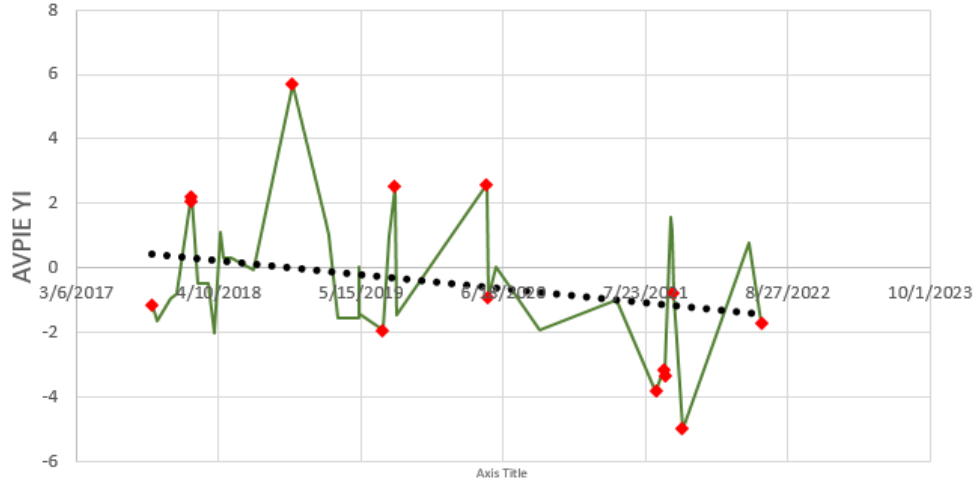
Fails: 34

Fail %: 27.4



RO 221 PERFORMANCE

RO 221, IX REFERENCES, LAB B



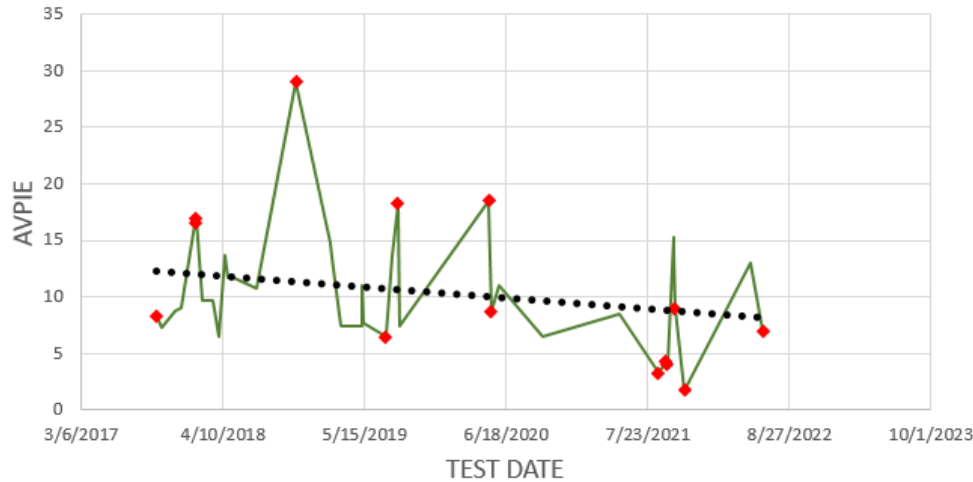
LAB B:

Runs: 38

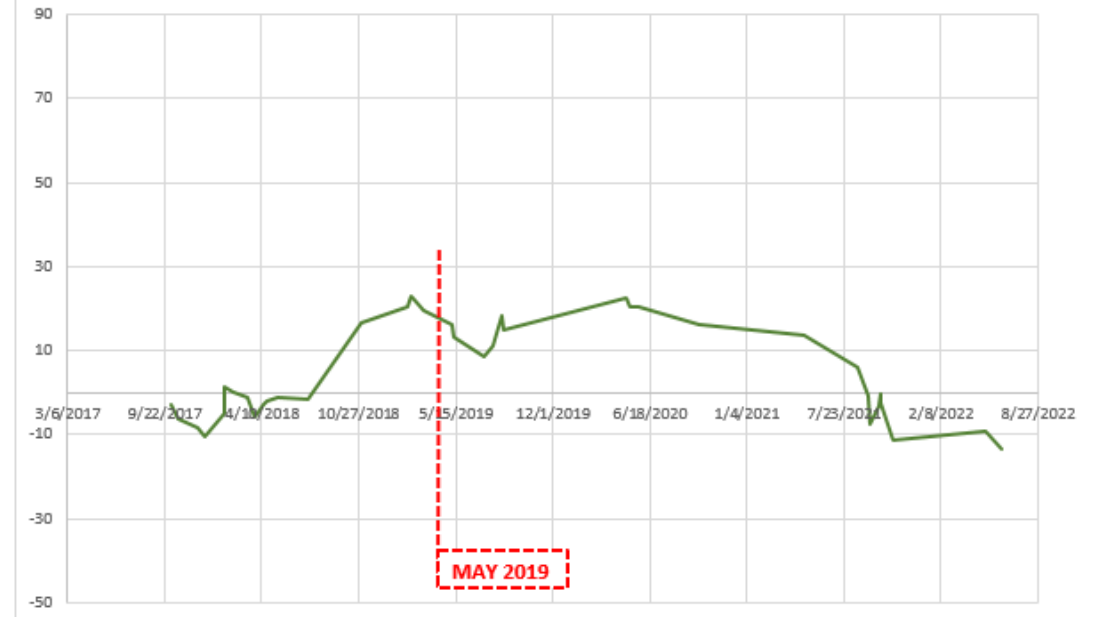
Fails: 14

Fail %: 36.8

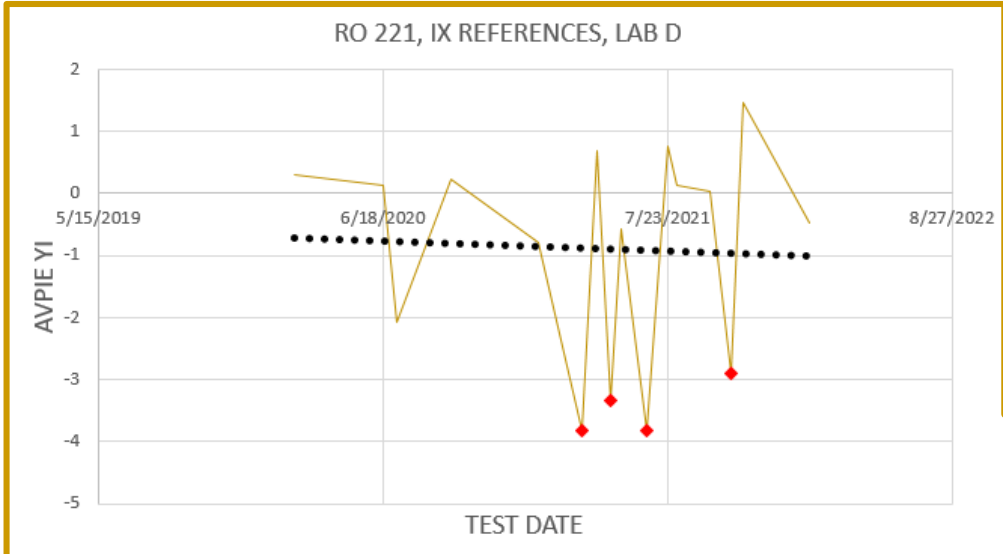
RO 221, IX REFERENCES, LAB B



CUSUM, 221, B



RO 221 PERFORMANCE

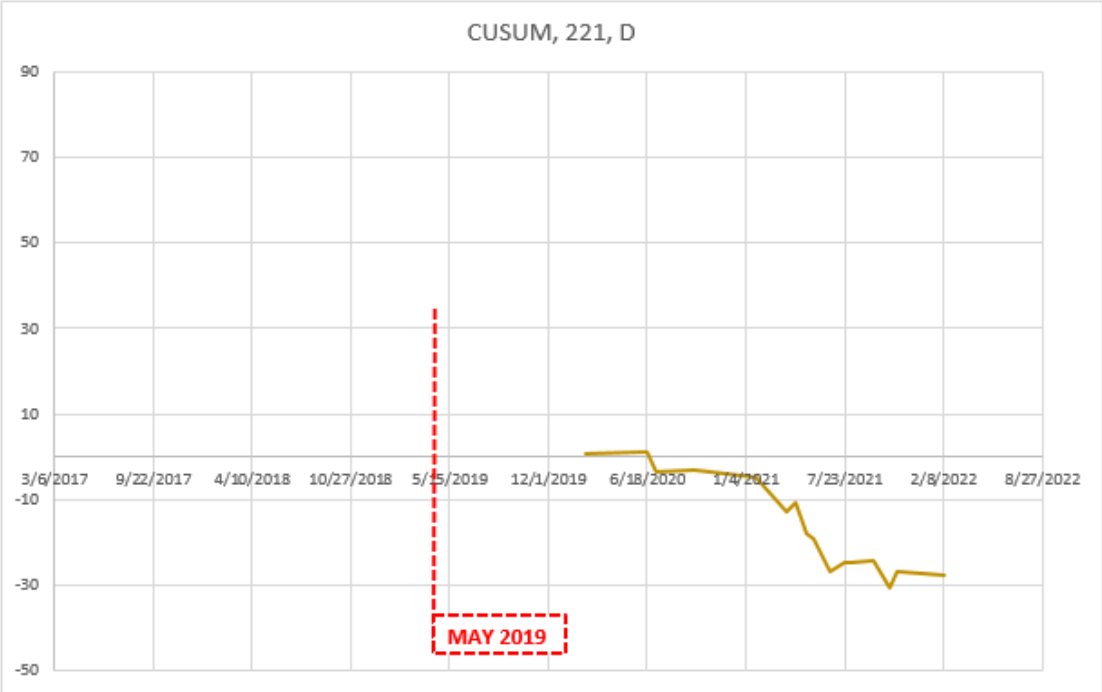
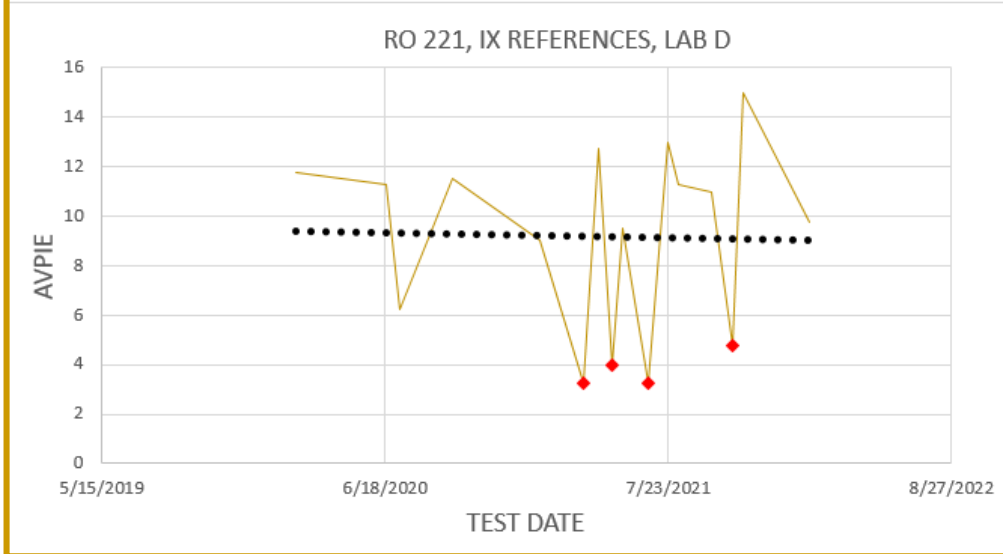


LAB D:

Runs: 16

Fails: 4

Fail %: 25.0



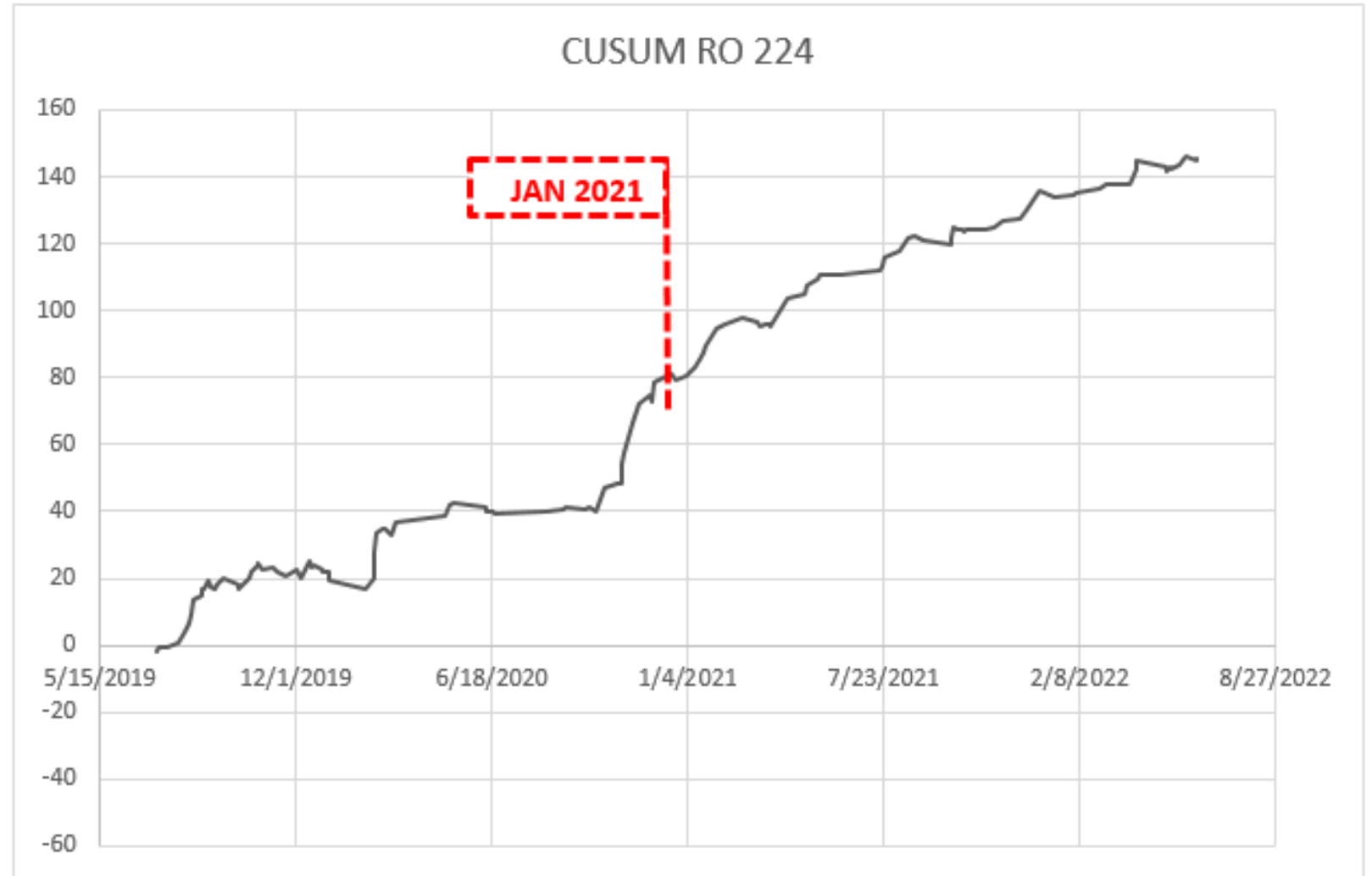
RO 221 OBSERVATIONS

- Inflection point in overall RO 221 CUSUM around May 2019.
- Inflection point in lab-by-lab RO 221 CUSUMs *around* May 2019 (for all labs running at that time).
- Failure rates are somewhat consistent across labs.

LAB	FAILURE RATE, RO 221
A	19.5
G	27.4
B	36.8
D	25.0

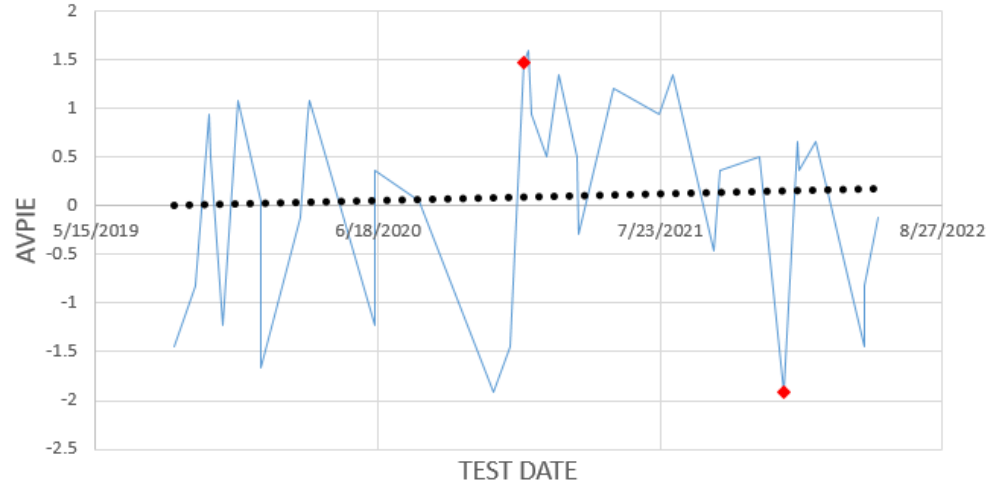
RO 224 CUSUM, ALL LABS

- No significant inflection point present in overall CUSUM



RO 224 PERFORMANCE

RO 224, IX REFERENCES, LAB A



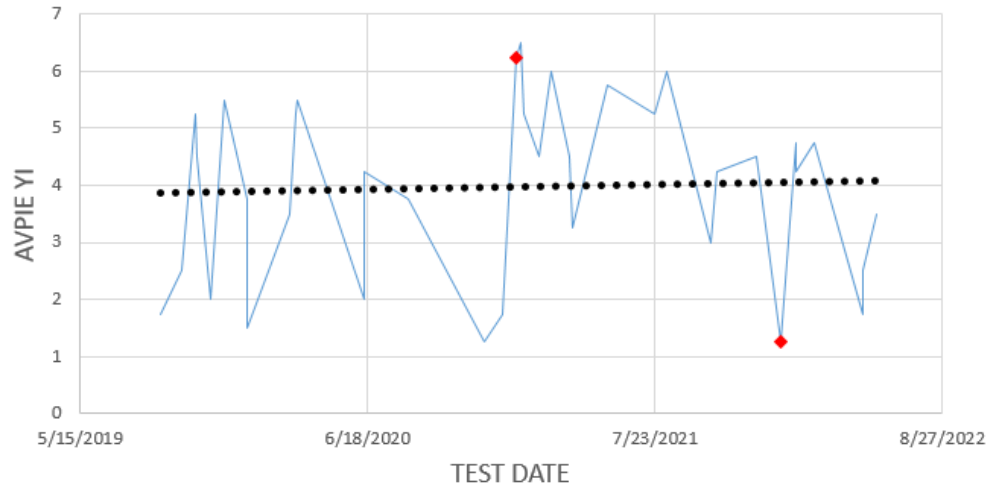
LAB A:

Runs: 37

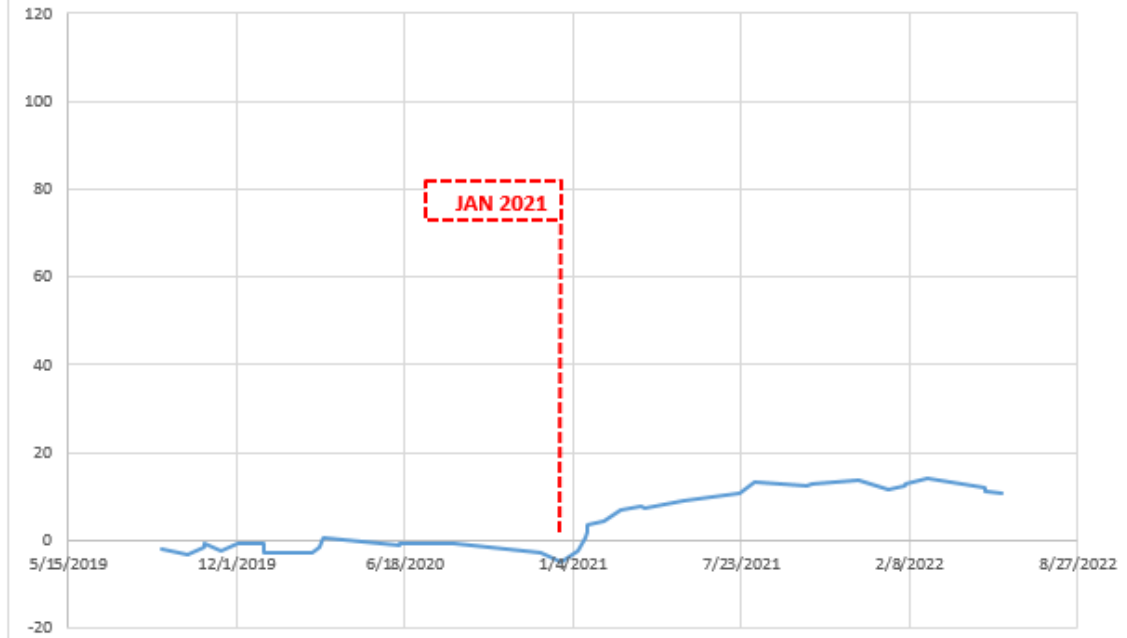
Fails: 2

Fail %: 5.4

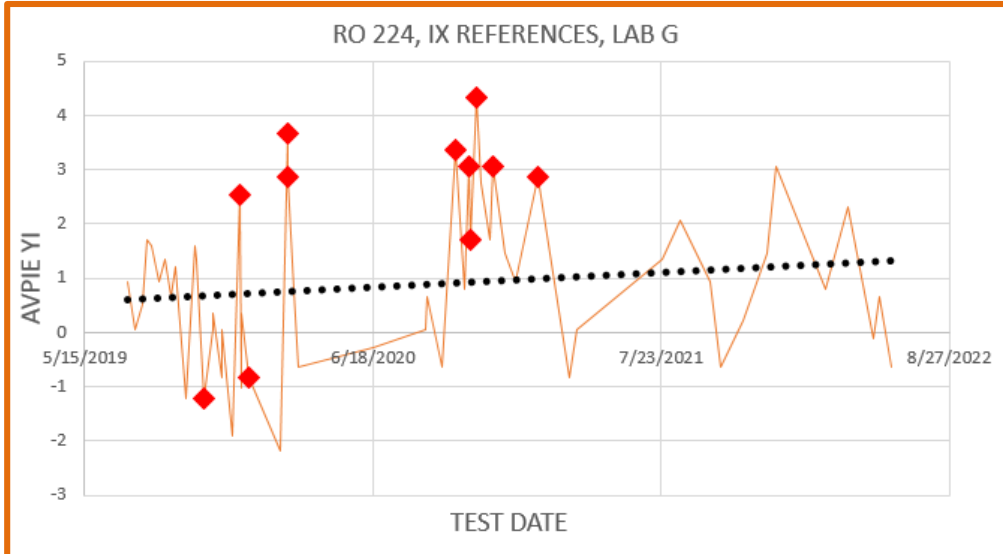
RO 224, IX REFERENCES, LAB A



CUSUM, 224, A



RO 224 PERFORMANCE

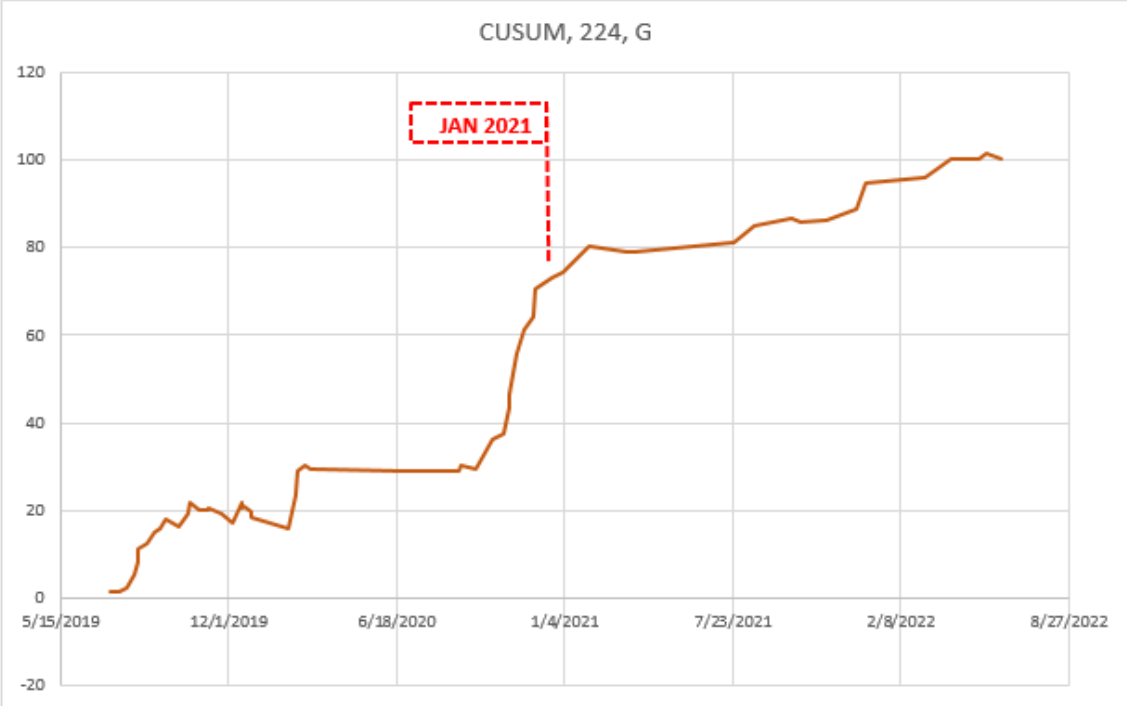
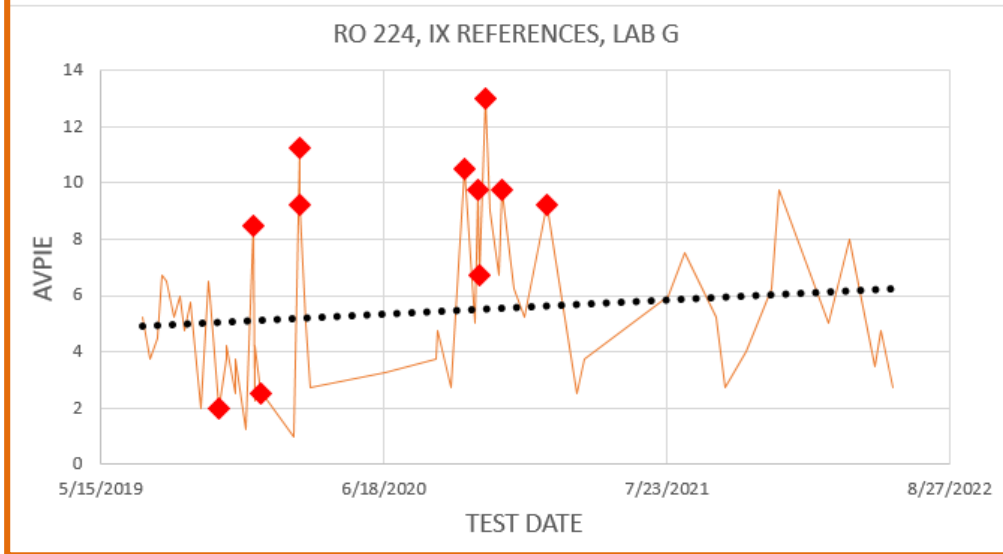


LAB G:

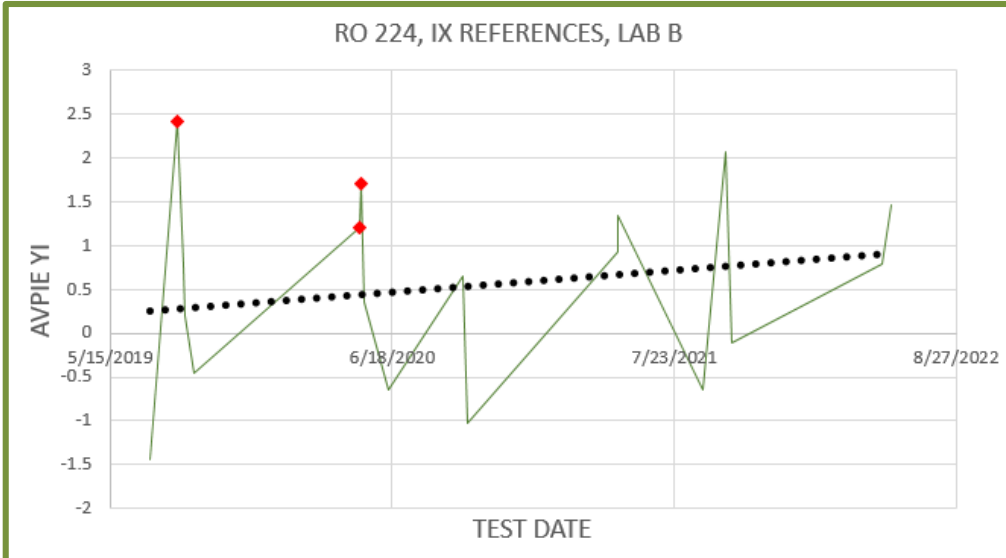
Runs: 58

Fails: 11

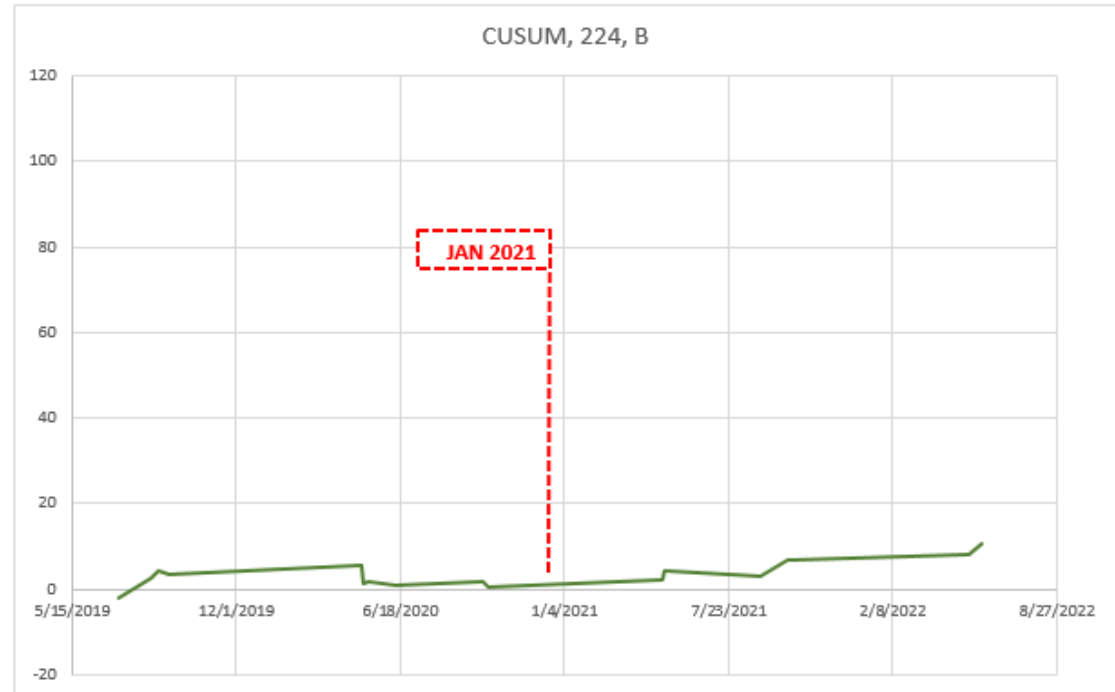
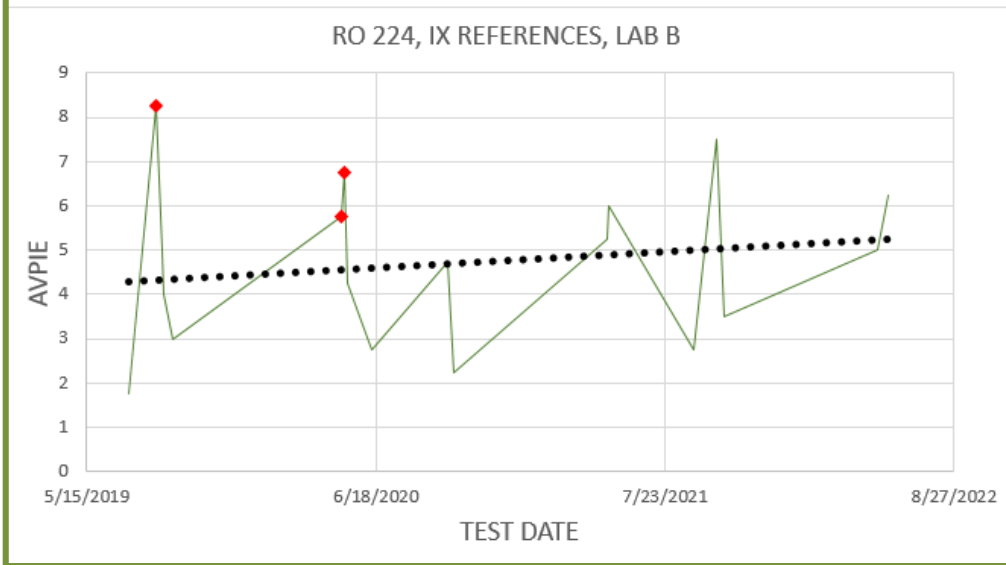
Fail %: 19.0



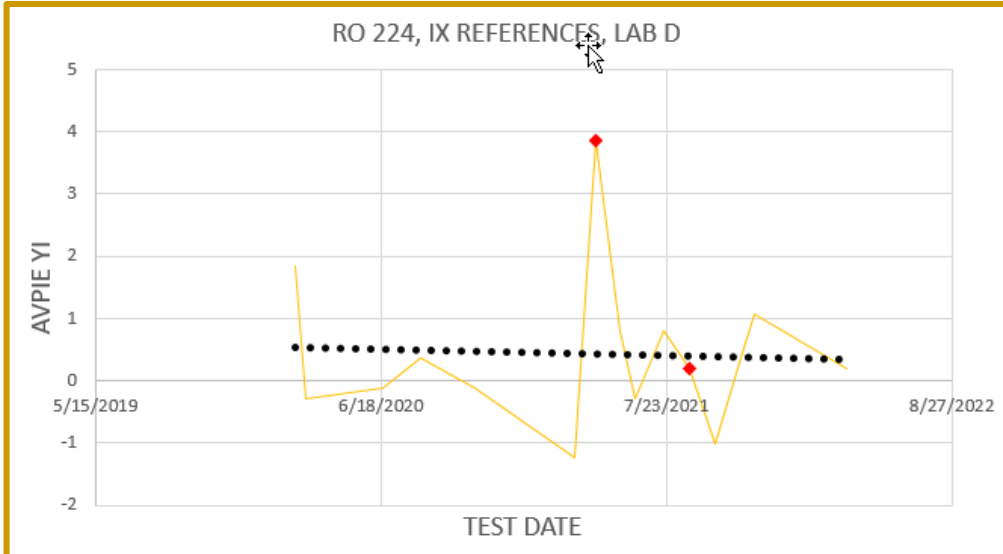
RO 224 PERFORMANCE



LAB B:
 Runs: 18
 Fails: 3
 Fail %: 16.7

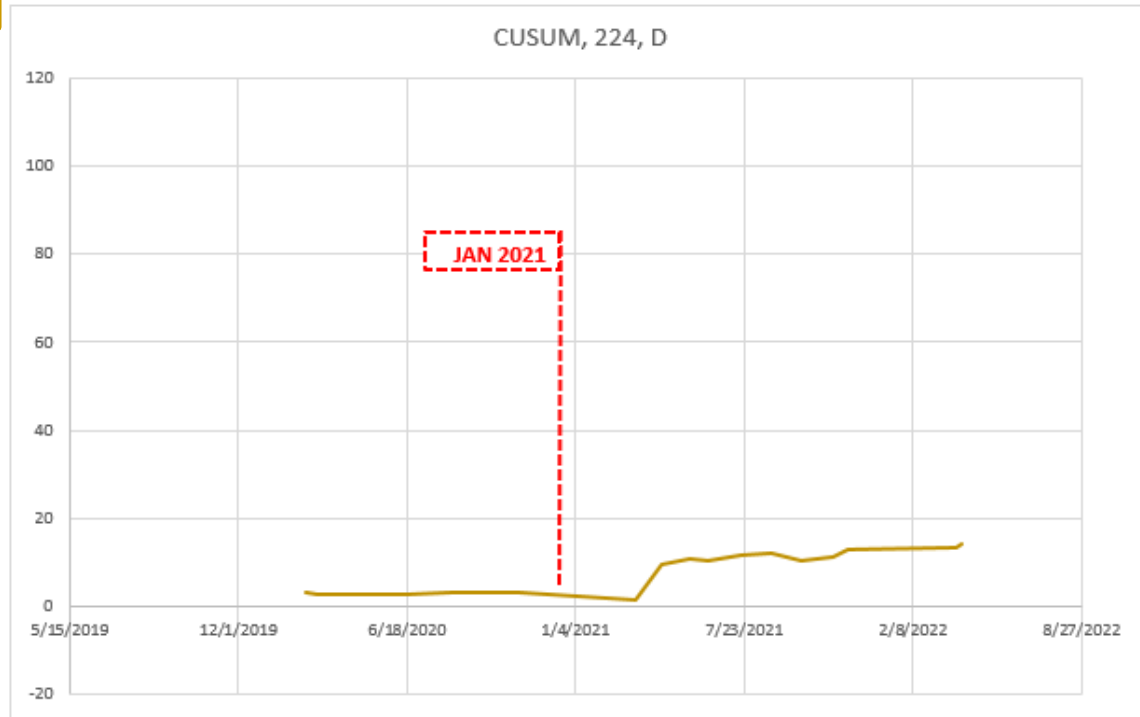
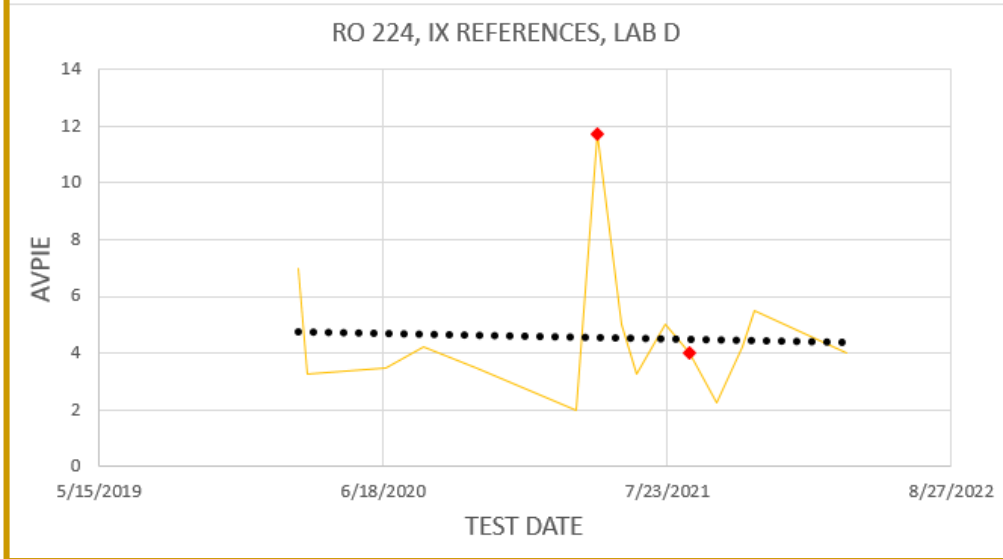


RO 224 PERFORMANCE



LAB D:

Runs: 18
 Fails: 2
 Fail %: 11.1



RO 224 OBSERVATIONS

- No significant inflection point in overall CUSUM.
- Inflection points present in individual lab CUSUMs (*around Jan 2021*).
- Overall trend is towards the severe side.

- Failure rates are somewhat consistent across labs.

LAB	FAILURE RATE, RO 224
A	5.4
G	19.0
B	16.7
D	11.1

COMPARISON, ROs 221 vs. 224

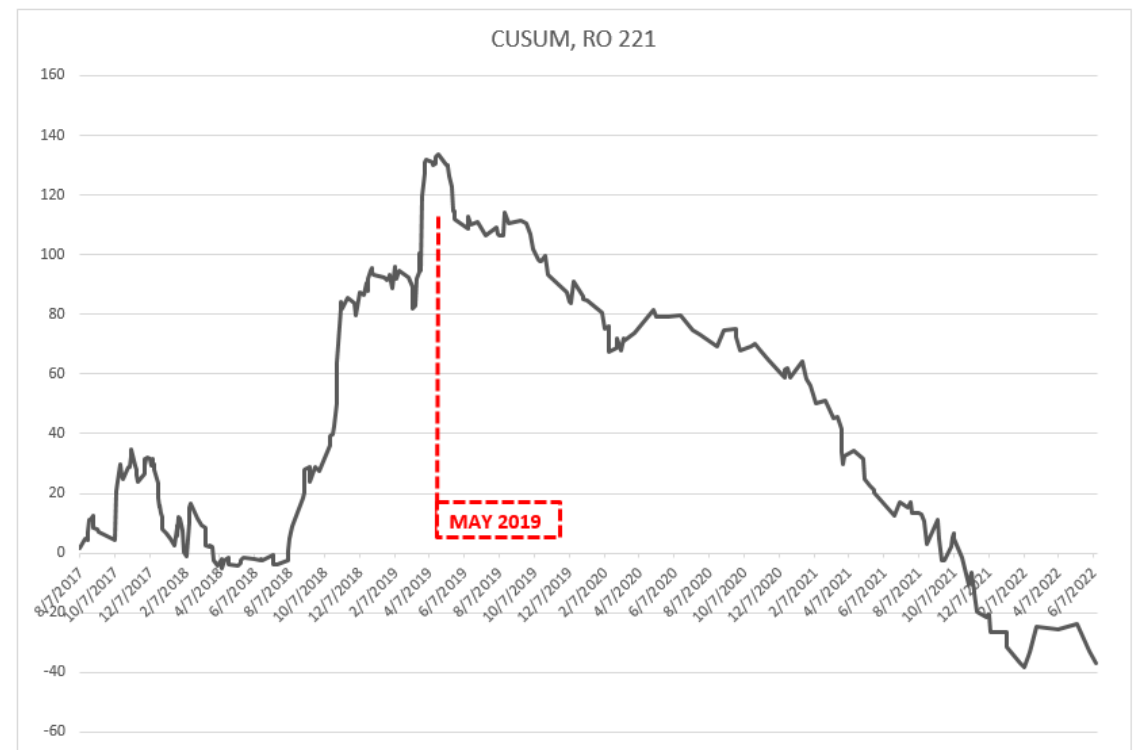
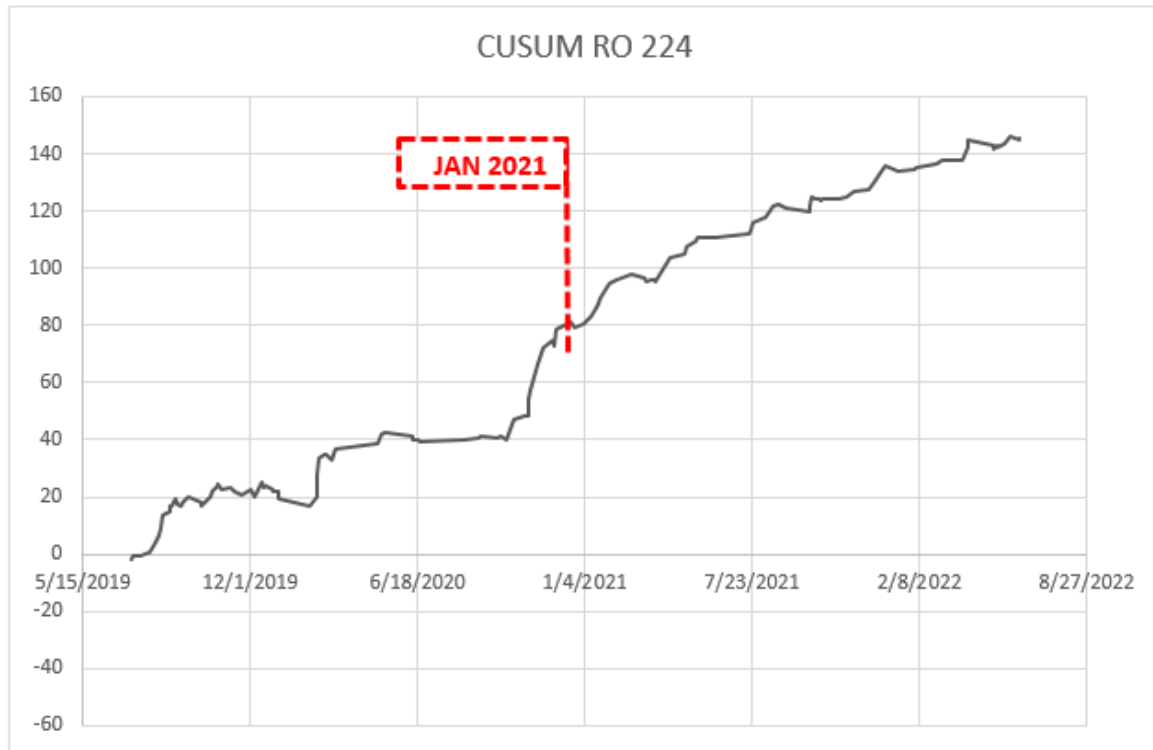
- All labs fail RO 221 at a higher rate than RO 224.

LAB	FAILURE RATE, RO 221	FAILURE RATE, RO 224
A	19.5	5.4
G	27.4	19.0
B	36.8	16.7
D	25.0	11.1



COMPARISON, ROs 221 vs. 224

- Performance of RO 224 has been consistently severe of target for the life of the oil.
- The performance of RO 221 has changed from steady/severe to mild across all labs.
 - This may not be actionable yet, but something to keep an eye on.



Sequence IX Piston Machining

SOUTHWEST RESEARCH INSTITUTE®

Khaled Rais

6/16/2022



FUELS & LUBRICANTS RESEARCH

BB Pistons vs 2019 BB Pistons

- Additional pistons were ordered in 2019 (2019-BB) since we do not have enough BB and dealer pistons (AAI / ABI) to last the life of the test especially with ACEA testing
- The latest pistons (2019-BB) have significant differences from the batch that is currently being used for testing.
- There is a small difference in average skirt diameter but it was found that it is possible to fit most 2019-BB pistons in engines while maintaining the piston-to-bore clearance spec.
- The piston crowns of the two batches differ in terms of surface and overall shape which slightly impacts compression ratio and is suspected to impact mixing.
- Four tests were conducted at the two independent labs and the 2019-BB pistons were severe of the BB reference oil targets

BB Pistons vs 2019 BB Pistons



BB

2019-BB

2019-BB Pistons Tests

- Four tests were conducted on the 2019-BB pistons at the two independent labs and all were very severe

Lab	CMIR	Oil	Target	AVPIE
SwRI	145077-IX	221	10.94	18.25
SwRI	143123-IX	224	3.68	5.25
IAR	144484-IX	221	10.94	27.25
IAR	147982-IX	224	3.68	9

Gasket Change for Compression Ratio



CJ5Z-6051-B
(0.895 mm)



CB5Z-6051-A
(1.33 mm)

- The initial compression ratio with BB pistons is ~ 9.28 and 2019-BB pistons shifted the compression ratio to ~ 9.39
- A thicker OEM remanufacture gasket was found that shifts compression ratio to ~ 9.04
- A reduction of in-cylinder pressure was expected to reduce severity

Gasket Test

- A larger reman gasket (CB5Z-6051-A) was tested with the 2019-BB pistons to reduce the compression ratio in hopes of bringing the severity closer to the BBs’.
- The thicker gasket was installed in the original 2019-BB piston engine at SwRI and resulted in increased AVPIE

Pistons	Gasket	Gasket Thickness	CR*	AVPIE
Target (BB)	CJ5Z-6051-B	0.895 mm	9.28	10.94
2019-BB	CJ5Z-6051-B	0.895 mm	9.39	16.75
2019-BB	CB5Z-6051-A	1.33 mm	9.04	23.50

*Approximate compression ratio

Piston Modification

- Since the gasket failed to reduce the 2019-BB piston severity, machining to bring the shape more in-line with the BBs was discussed.
- At SwRI, we got some pistons scanned and CNC machined and were able to nearly match the bulk shape but not the surface finish



2019-BB

BB

2019-BB Machined

Modified Piston Test

- A single test on oil 221 has been conducted with the modified pistons at SwRI
- Four additional machined pistons are still available at SwRI

Pistons	Lab	Gasket	CR*	Oil	AVPIE
Target (BB)	-	CJ5Z-6051-B	9.28	221	10.94
2019-BB	SwRI	CJ5Z-6051-B	9.39	221	16.75
2019-BB Machined	SwRI	CJ5Z-6051-B	9.39	221	11.25

*Approximate compression ratio

- **Next Steps: a 224 test at SwRI, and two tests on another engine at another lab?**

New batch of Pistons

- A new batch of pistons was machined at SwRI and shared with IAR, Afton, and APL
- Two on-target tests were conducted at SwRI

Pistons	CMIR	Oil	Target	AVPIE
2019-BB Machined	169254	221	10.94	9
2019-BB Machined	166512	224	3.68	3.25

- **Next Steps: tests at other labs? A formal matrix?**