

Sequence VH Surveillance Panel Meeting

Teams

Monday, September 22, 2025, 9:00 am – 10:30 am EDT

1.0) Attendance

Afton:	J. Lekavich, A. Stone
BP	B. Hochkeppel
Exxon	M. Shah
Ford:	M. Deegan, R. Zdrodowski
GM:	K. Zreik
Haltermann Solutions:	E. Hennessey, I. Mathur
Infineum:	J. Anthony, T. Dvorak
Intertek:	A. Lopez
Lubrizol:	T. Catanese
OHT:	J. Bowden
Oronite:	J. Martinez, R. Stockwell
Shell:	S. Demel
SwRI:	D. Engstrom, P. Lang
TMC:	D. Beck, S. Moyer, B. Transue
TEI:	D. Lancotot
Toyota:	V. Deshpande

2.0) Executive Summary

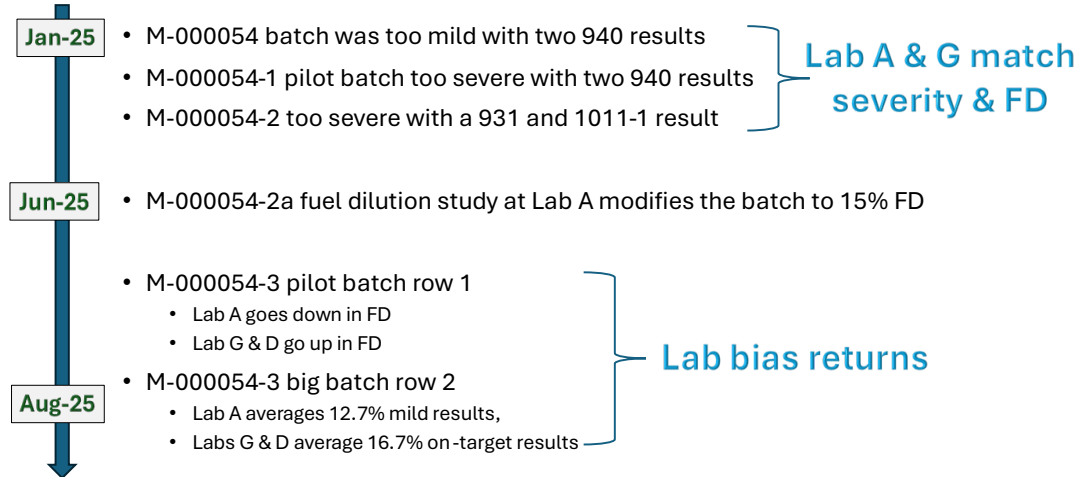
The precision matrix testing was paused in August to investigate AES bias between the labs. Lab A's results were much milder than results from Lab G and Lab D. Over the last month, Lab G and Lab A swapped engines, hardware, and made engine measurements. The SP members were updated on the progress, the next steps, and discussed the timeline to approve the M-Batch fuel for candidate testing.

3.0) Approval of Minutes

4.0) M-Batch Fuel Adjustment

4.1) The following O&H slides, summarizing the work performed by Labs G and A since the last SP meeting, were shared with the SP members,

Timeline



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Precision Matrix Status

- 2/3 complete with fuel batch approval
- Paused the matrix to explore lab bias

M-000054-3 Fuel Approval Matrix

A1	A2	G1	G2	D
940 (175651)	931 (193861)	940 (175644)	1011-1 (191485)	931 (190601)
931 (193862)	1011-1 (193857)	1011-1 (199200)	931 (191483)	1011-1 (190602)
1011-1	931	931	1011-1	931

Intertek Total Quality Assurance													
		Oil	AES	Yi	RCS	Yi	AEV	Yi	APV	Yi	OSCR	FD AVG	Oil Add
Pilot Blend Test	G	1011-1	8.71	0.491	9.42	-0.08	9.47	0.19	9.08	0.25	2	15.90	793
	D	931	7.92	-0.133	9.13	-0.643	8.7	-0.9	7.94	-0.683	80	15.60	925
Final Blend	A	931	8.84	1.4	9.38	-1.236	9.04	0.233	8.12	-0.383	1	12.10	730
	D	1011-1	8.75	0.561	9.46	-0.451	9.43	0	8.64	-0.667	6	16.40	
	G	1011-1	8.3	-0.228	9.4	0.097	9.68	1.19	9.24	0.583	2	16.69	500
	A	931	9.12	1.87	9.3	-1.02	9.02	0.17	8.22	-0.22	1	12.30	
	A	1011-1	9.47	1.82	9.6	-2.01	9.52	0.43	8.96	0.42	1	13.00	
	G	931	7.87	-0.217	8.86	-0.17	8.9	-0.233	7.64	-1.183	65	16.86	940
avg				0.6955		-0.68913		0.135		-0.23538			

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VH Engine Swap Experiment

Date	Description	Fuel Dilution	
		Lab A	Lab G
7/7 - 8/21, 2025	Average of 3 runs for each lab	12.7%	16.8%
8/21-25, 2025	Labs trade engines, each built with 3rd run blocks	18.2%	11.4%
8/25-27, 2025	Lab G installs Lab G intake manifold and injectors on Lab A engine	N/A	13.0%
9/2-6, 2025	Labs swap assembled heads and head gaskets	15.8%	12.3%

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VH Engine Swap Results

Swapping engines and parts eliminated the following sources of the lab bias,

- Lab instrumentation
- Operating conditions
- Test Fuel
- Intake manifold
- Fuel injectors
- Cylinder heads
- Camshafts

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VH Engine Short Block Measurements

- It seemed that the difference in fuel dilution was the in short block build
- Lab G took Lab A's engine to Lab A and both engines were disassembled side-by-side with engineers and builders from both labs present to take compare parts and take measurements
- Findings from teardown,
 - Piston-to-Bore clearance
 - Lab G > Lab D >> Lab A
 - Hone Surface Finish
 - Ra: Lab D > Lab G > Lab A
 - CV: Lab G > Lab D >> Lab A

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VH Lab Bias Investigation Next Steps

1. To test the if piston-to-bore clearance affects fuel dilution and severity, Lab A will build an engine with piston-to-bore clearances on the high side of the VH spec, similar to Lab G's
2. SwRI will run a 48-hour test with RO931 to measure fuel dilution, if the fuel dilution increases, the test will run to completion to verify AES rating.

4.2) Summary of the Lab Bias Investigation to date,

- Lab operations, fuel, instrumentation, engine components were eliminated as sources of the bias
- The labs performed a component measurement round robin to verify parts were measured the same and the labs were practically identical
- The only differences found were,
 - Lab G's piston-to-bore clearance was greater than Lab A's (both are in spec)
 - Lab G's hone was rougher on average than Lab A's. There is no hone roughness specification and both labs honed their blocks to procedure
- **THE LAB OPERATION AND THE ENGINE BUILDS WERE EXAMINED IN GREAT DETAIL AND FOUND NO DEVIATIONS FROM PROCEDURE**

- Lab A will build an engine similar to Lab G's and perform a fuel dilution experiment which may complete 216 hours if there is an increase in fuel dilution to verify fuel dilution impact on AES

4.3) Lab Bias Investigation Discussion by the SP

- **Hone Discussion:**

- IAR and LZ are concerned that only one of the differing parameters, piston-to-bore clearance, is being considered, not the hone, which is not being given enough attention
- IAR noted that Lab A used an engine with 216 hours, which may have had higher piston-to-bore clearance from wear, for the M-Batch-3 scoping tests that resulted in 15.5% FD.
- LZ showed the hone measurements from the M-Batch tests
 - The hone crevice volume was discussed.
 - Infineum asked how CV is calculated.
 - Afton questioned if the hone data was correct because of the large variability shown in table.
 - LZ explained that the values are correct, and the measurements are that variable.
- Lab A expressed concerns about moving the hone with a calibrated stand, considering it risky.
 - IAR believes making changes during the precision matrix is an opportunity improve the test at the beginning of new fuel batch.
 - Infineum agreed that controlling factors is typically preferred, but since the lab bias has been present for years, it not just a fuel matrix problem. Infineum believes the recorded build differences could be used to correct data, including changing hones.
 - Lab A was assured by the SP and TMC that the results of the experiment would not affect the stand's calibration status
- Afton asked if the first three runs of Lab A should be used and whether the other two labs can continue.
 - Lab A confirmed all tests are within specification.
 - Lab A's previous tests will likely be included in the final precision matrix calculations.
 - For statistical analysis, the data can be used without a correction factor, as offsets can be managed.
- It was suggested that Lab A could use this experiment's result as part of precision matrix, since the engine build and other conditions are being run within test specs.
- The SP panel agreed to table the discussion until Lab A's results were available.

- **Next Steps & Lab Plans:**

- The SP suggested Labs G and D move forward with the precision matrix testing since all previous tests are valid, and IAR agreed.

- Lab G expects to complete the matrix in 10 days (possibly Lab D as well).
- Fuel approval timeline
 - IAR believes the worst-case scenario for Lab A's experiment is no change in results and Lab A completes the precision matrix in 3 weeks.
 - If Lab A's changes successfully move AES close to target, the matrix will likely be completed in 4 weeks.

6.0) Old Business

7.0) New Business

9.0) Meeting Adjourned

- Meeting adjourned at 10:30 am EDT
- The next meeting is scheduled for October, 6 2025 at 9:00am EDT