

HEAVY-DUTY ENGINE OIL CLASSIFICATION PANEL
OF
ASTM D02.B0.02
June 25, 2019
Sheraton Denver Downtown Hotel – Denver, CO

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ACTION ITEMS

MINUTES

- 1.0 Call to order
 - 1.1 The Heavy-Duty Engine Oil Classification Panel (HDEOCP) was called to order by Chairman Shawn Whitacre at 1:30 PM on Tuesday June 25, 2019 in the Plaza Ballroom D of the Sheraton Denver Downtown Hotel, Denver, CO.
 - 1.2 There were 15 members present and 74 guests present. The attendance list is included as Attachment **2**.
- 2.0 Agenda
 - 2.1 The agenda circulated prior (included as Attachment **1**) was not changed.
- 3.0 Minutes
 - 3.1 The December 12, 2018 minutes were approved as written.
- 4.0 Membership
 - 4.1 There were 4 membership changes. Gene Scanlon is taking over for Mary Dery of BASF. Steve Jetter replaces Shayna Butler for ExxonMobil. Patrick Holmes replaces Greg Shank of Volvo. Robert Stockwell acting for Chevron Oronite.
- 5.0 Existing Categories
 - 5.1 Update from Sean Moyer: **Attachment 3**.
 - 5.1.1 Candidate testing over the last six months is low. The number of calibrated stands in labs is unchanged with the exception of the COAT test. There are three labs and each lab has one COAT stand calibrated. CAT Aeration test is back on-line. The Surveillance Panel (SP) approved reference oil target update for oil 832-1 and the proposed a correction factor. All stands currently calibrated and available for testing.
 - 5.1.2 There is no update on Mack Volvo test T8 and T-11. Both are likely to be available through 2024 or longer.
 - 5.1.3 A T-12 piston skirt batch was out of spec. The manufacturer is currently working to fix the issues. The SP voted to reuse old skirts. The supplier of cylinder liners will not make new liners. The SP ordered the last batch to carry the test to 2026.

- 5.1.4 T-13 con rod bearings are different than previous. New batch of bearings contain no lead. No issues were found after testing.
- 5.1.5 ISM no issues, new batch of injector adjusting screws introduced.
- 5.1.6 ISB cam shaft has new batch. Taper was out of spec.. The SP voted to widen the taper spec. Reference tests proved that taper did not influence test.
- 5.1.7 RFWT no issues and is likely available through 2024 or longer
- 5.1.8 IIF/IIIG hardware depleted. The test is no longer being supported.
- 5.1.9 The EOAT is using the last available set of hardware. Oil temperature on runs higher w/ current EOAT engine. There is still no EOAT to COAT correlation remaining. Engine hardware is available for one more rebuild.

5.2 HDEOCP Parts Task force, Cory Koglin. **Attachment 4**

- 5.2.1 LSDRG requested a methodology similar to PCMO to track hardware. The goal is to provide a demonstration model based on the Mack tests. The group will need additional feedback to improve the model. Prediction of end of life test is desired. The model will help predict the timing needs of critical batch hardware. First focus is on T-11/T-12.
- 5.2.2 Angela Willis reviewed the model and explained what feeds the model. The chart in the attachment shows the usage rate and expectation life of the test. The model uses shared data between platforms to predict outcome. CPD report is given and translated to the table. The highlights are parts in yellow used in the draft model. Red are the skirts as they are critical parts due to 100% rejection rate. TEI provided update on rejected parts. Model does not include buffer parts or parts redistributed when industry runs low on some labs.
- 5.2.3 Conclusion: the model roughly predicts EOL for replacement test or industry action. Batch critical parts is a good feed for the model. The model will require more data and will continuously be adjusting. CPD feedback will be crucial. TEI only sees reference test and registered tests. Quarterly updates from CPD will be needed to refresh model. The goal is to either replace a test or supply new hardware. Future is to provide final number model once liners for T-12 are given. Next step is to update the panel in December.

5.3 COAT Update, Hind Abi-Akar. **Attachment 5**

- 5.3.1 COAT is now available for candidate testing. On May 15, 2019 the SP voted and finalized a correction factor and limits. Next step to be sent to D02.B. Matrix tests show reestablishment of discrimination. CF was established using the reference data generated by the labs. All changes were approved by unanimous vote of the SP. New charts are being created. SAs may be created. Labs are running candidate oils. Feedback shows no anomalies are present. Elisa Santos analyzed the data. Jim Gutzwiller helped with collecting data. Jim Moritz helped lead the changes on the COAT.
- 5.3.2 Backwards compatibility question: SP will start looking into this in the near future. First step was to get COAT test online.

5.4 Update on DD13 Scuffing Test, Suzanne Neal. **Attachment 6**

- 5.4.1 Test parts discussion. Rocker arms are not commercially available, they are not a critical component. Parts are to be re-used for the time being. Batch D liners are now being introduced. rejection rate is better than Batch C which was at 50%. Second rings are also being ordered. Critical Part Update; the pistons are the limiting factor. Introduction of part is being discussed to eliminate repeat reference testing. Alternative fuel supply being discussed. Ratings and Rater requirements are being discussed. SP decided to send parts to October 2019 workshop.

5.5 Update on Ford 6.7L Wear Test Development, Michael Deegan. **Attachment 7**

- 5.5.1 Recent work to standardize on soot generation rate is now complete. Oil filters were clogging causing them to bypass. Dual filter set up installed to resolve issue. Prove out testing on High Wear Oil (HWO) and Low Wear Oil (LWO) have been completed by independent labs. Statistician are getting involved to help find discrimination. Viscosity increase is also being looked at. Iron content over time may be helpful to predict wear outcome.
- 5.5.2 Next steps; soot windows are being evaluated. Develop a Precision Test Matrix by December 2019. Ford will need to manage funding and intends to release as ASTM procedure. Data dictionary at 80% complete. Procedure is still in draft form.

6.0 New Business

- 6.1.1 Joe Franklin: limits on new RO being introduced. RO 1006 has 6 months of quantity left. No re-blend was performed. New replacement oil is blended. New oil is similar to 1006 for seals test. The oil is also used in other elastomer testing outside the industry.
- 6.1.2 Elastomer group made significant changes to procedure so round robin will be required. Joe F to volunteer to calculate fixed limits rather than reference dependent limits.
- 6.1.3 Subcommittee 7, shear stability update. Analysis is desired to compare two clean methods. D6278 and D7109. Correlation between 30 cycle shear as part of 90 cycle shear method alignment D6278 and D7109. Question is, does the panel use 30 cycle data from D7109?

7.0 Next meetings

- 7.1 The next meeting will be December 10, 2019 at the Marriott New Orleans in New Orleans, LA.

8.0 The meeting was adjourned at 2:45 pm.

AGENDA
D02.B0.02.1
Heavy-Duty Engine Oil Classification Panel
Tuesday, June 25, 2019 1:30pm MDT
Sheraton Denver Downtown Hotel
Denver, Colorado USA

- 1) Call to Order/Anti-trust statement**
- 2) Minutes** – Approval of Minutes from December 11, 2018 Meeting in Atlanta, GA USA
- 3) Membership**
 - a) Review current panel membership
- 4) Existing tests/categories**
 - a) Review of status of carry-over engine tests that support API CK-4, FA-4 and legacy categories (Cory Koglin, Afton; Sean Moyer, TMC)
 - b) Update on CAT Oil Aeration Test (Hind Abi-Akar, Caterpillar)
 - c) Update on DD13 Scuffing Test (Suzanne Neal, DTNA)
- 5) Old Business**
 - a) Update on Ford 6.7L Wear Test Development (Michael Deegan, Ford)
- 6) New Business**
- 7) HDEOCP Adjournment (transition to DEOAP)**

HDEOCP Attendance: June 25, 2019

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HDEOCP Attendance: June 25, 2019

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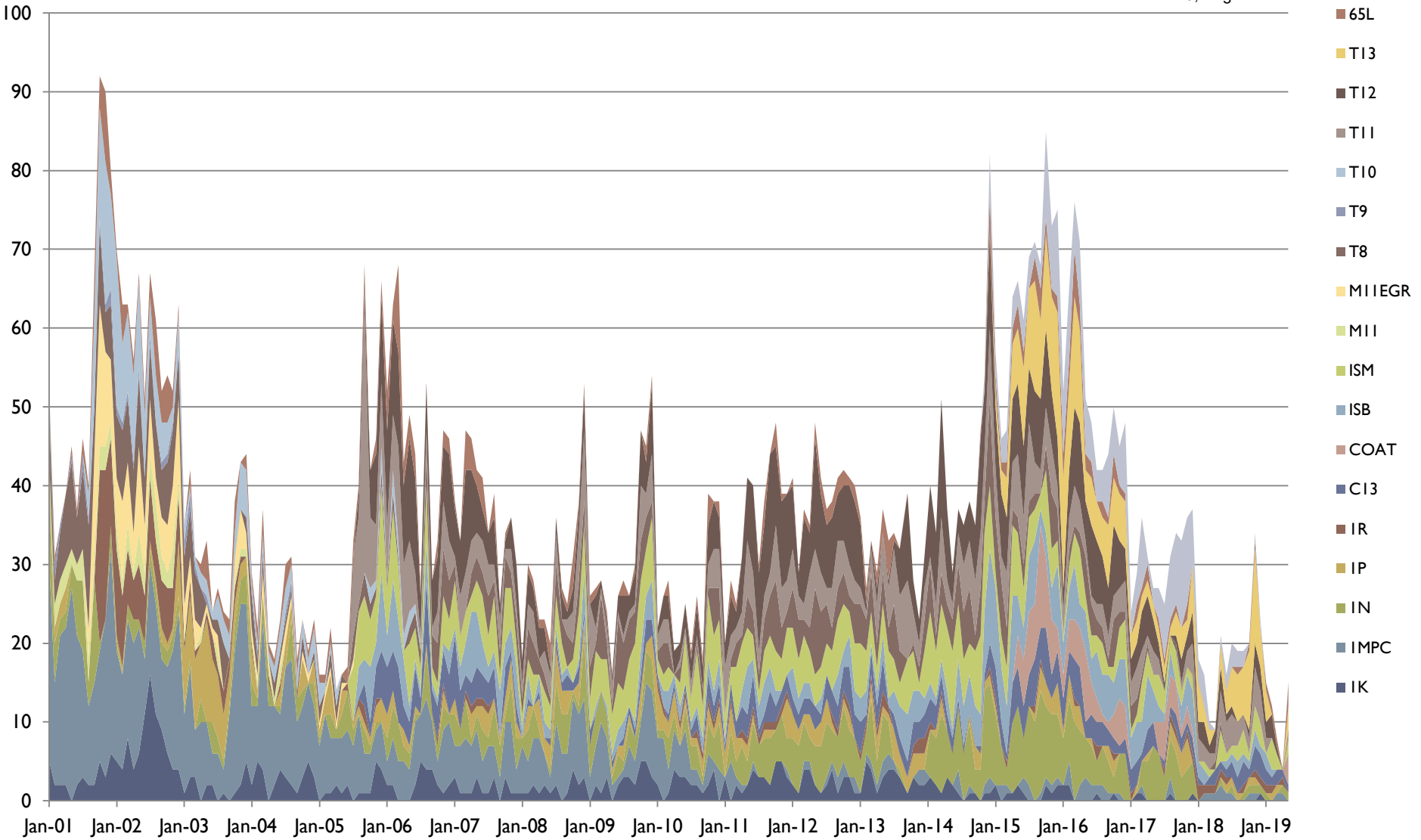
HDEOCP Attendance: June 25, 2019

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D02.B0.02 Maintenance Report

June 2019

ALL TEST CANDIDATE ACTIVITY



Calibrated Labs and Stands*

Test	Labs	Stands
IK	1	1
IN	3	4
IM-PC	0	0
IP	2	2
IR	1	1
CI3	2	2
ISB	0	0
ISM	4	4
EOAT	1	1
RFWT	1	1
T-8/E	2	2
T-11	3	4
T-12/T-12A	2/2	2/2
T-13	4	8
COAT	0	0
DDI3	3	4

*As of 03/31/2019

Availability of API CH-4 through CJ-4 Tests

Test	Hardware Issues	Availability Through 2024	Notes
IK/IN	Auxiliary components	Likely	Ongoing resolution of issues with stand auxiliary systems and miscellaneous components.
IP/IR	No current issues	Likely	None
CI3	No current issues	Likely	Engine block, injectors, turbos only available through reman.



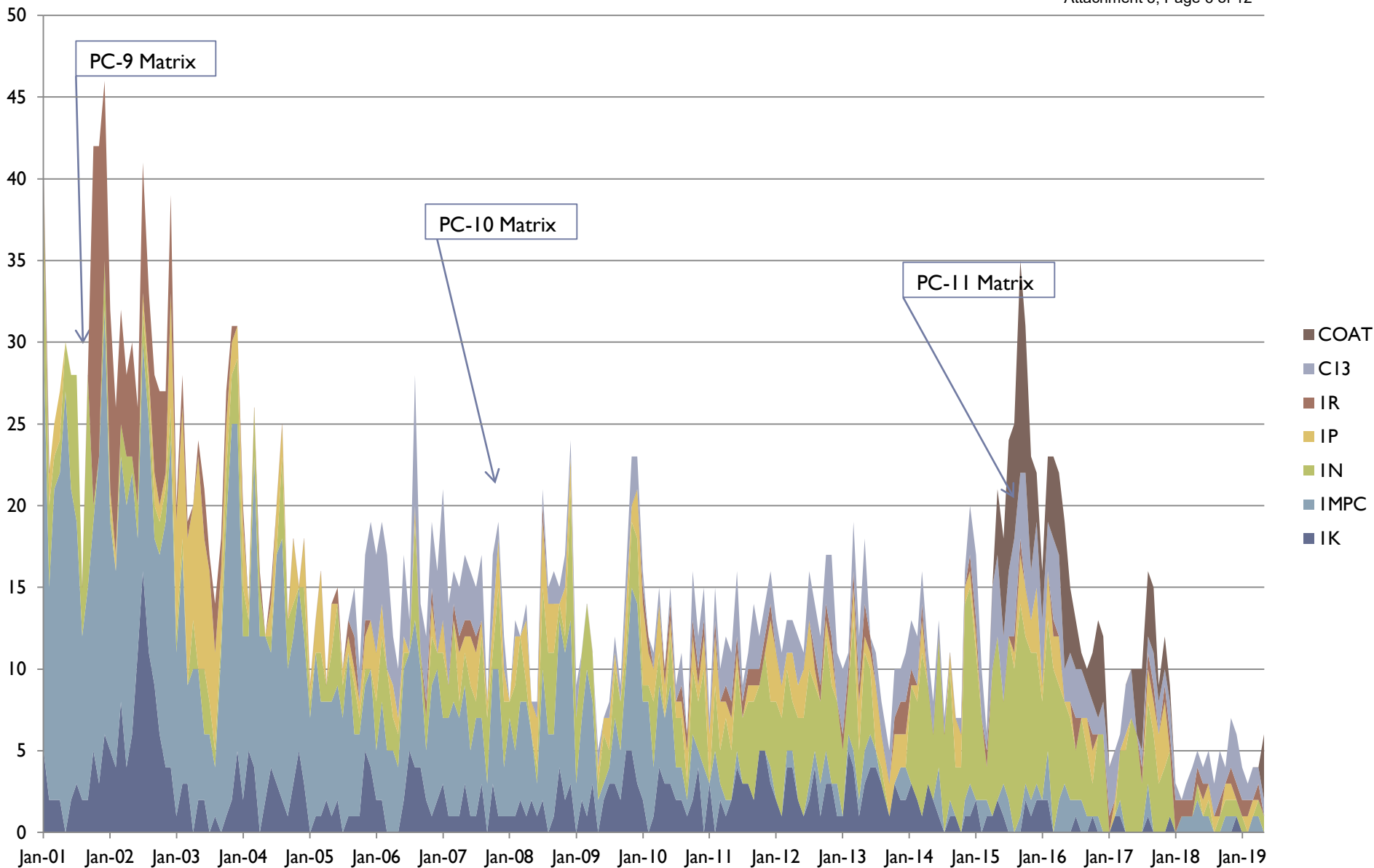
Additional Caterpillar Test Issues

➤ **Caterpillar Oil Aeration Test**

- Aeration test procedure improvement complete. Surveillance panel approved reference oil target update for 832-I and industry correction factor. All stands currently calibrated and available for testing.



CATERPILLAR CANDIDATE ACTIVITY

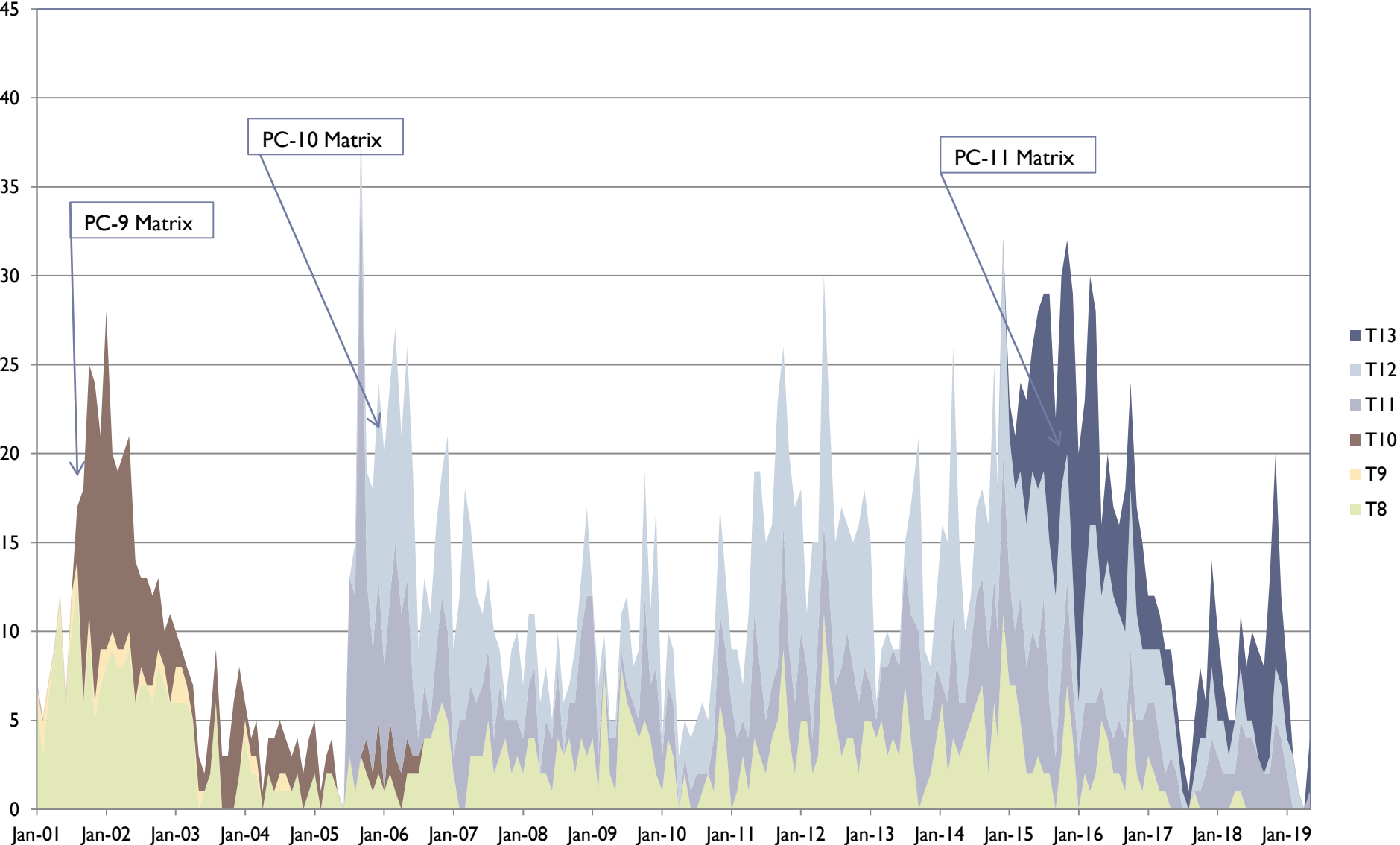


Availability of API CH-4 through CJ-4 Tests

Test	Hardware Issues	Availability Through 2024	Notes
T-8	No current issues	Likely	Engine block supply limited. Final liner batch ordered to take test to 2026
T-11	No current issues	Likely	Engine production ended 2006. Finite number of engine blocks. Engine build life issues with oil consumption. Final liner batch ordered to take test to 2026
T-12	Piston Skirts	Likely	Piston skirt batch out of spec. Rework in progress and temporary re-use of skirts allowed by panel. Final liner batch ordered to take test to 2026
T-13	Connecting rod bearings	Likely	New connecting rod batch tested and approved for use.



MACK CANDIDATE ACTIVITY

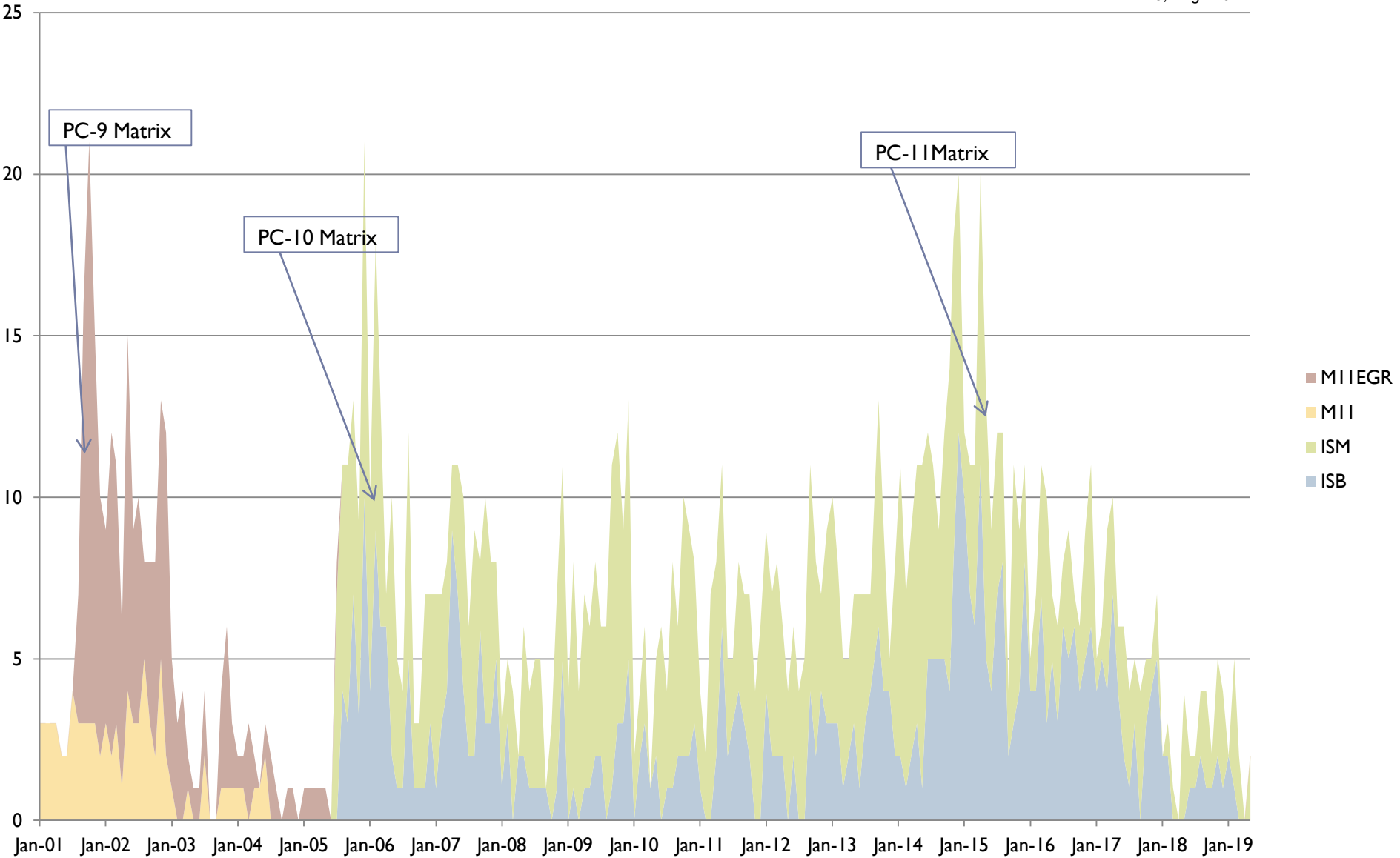


Availability of API CH-4 through CJ-4 Tests for PC-11

Test	Hardware Issues	Availability Through 2024	Notes
ISM	None	Likely	Injector Adjusting Screw new batch approved for use.
ISB	Camshafts	Likely	New camshaft batch secured and tests run. New camshafts approved for use with wider taper spec. Taper measurements indicated taper did not affect test results.



CUMMINS CANDIDATE ACTIVITY



Availability of API CH-4 through CJ-4 Tests for PC-11

Test	Hardware Issues	Availability Through 2024	Notes
RFWT	None	Likely	<p>Long term supply of test parts at CPD.</p> <p>6.5 L engine no longer in production at AM General, but available through supply network.</p> <p>Injection pump still available.</p>
Seq III F/III G	Hardware depleted	No	None
EOAT	Using last known hardware	No	<p>Oil Temperature runs higher w/ current EOAT engine. Still no official EOAT / COAT correlation. Engine hardware available for one rebuild.</p>

B2 Action Items

- **No Action Items**
- **Comments**



HDEOCP Parts Task Force

Denver, CO

6-25-2019

Agenda

- Background
- Model
- Conclusions

TF Summary

- DEC 2018: LSDRG requested adoption of similar PCMO methodology to understand viability of current API HDEO tests and hardware
 - Cory Koglin-Afton
 - Angela Willis-Willis Advanced Consulting/PCEOCP Chair
 - Sean Moyer-TMC
 - Mark Sutherland/Derek Grosch-TEI
- Task Force met 5 times since December
- June 2019: Present draft model to HDEOCP

TF Goals

- Short Term
 - June 2019: work on providing first draft model using Volvo tests
 - December 2019: Continue to refine model based on feedback + additional information
- Long Term/Continuous
 - Prediction of the need for a replacement test or action by industry because of parts end of life
 - Prediction of timing need for new parts order of critical parts
 - Provide additional granularity and detail on HD test part status at Industry level

Background

- HD Parts model is Significantly different than PCMO model
 - HD does not rely on banking of hardware (like PCMO)
 - Parts orders are out of sync
 - Ex. Piston orders not lined up with rings
 - Inspection fallout differences between parts
- TEI is Central Parts Distributor (CPD) for Volvo, Detroit, Cummins tests
- Caterpillar is their own CPD

HD Test Status

- Since December 2018
 - T8/T11/T12 liners:
 - Supplier no longer making parts
 - Tests no longer supported for future categories
 - ISB camshaft order
 - Original 280 received
 - 89 of 100 inspected failed, so batch was stopped
 - New batch ordered and accepted-testing to resume
 - T13 main bearing order
 - Different than original batch roughness
 - 2nd order placed, parts tested and deemed acceptable for use
 - Testing resumed
-
- HD Parts task force agreed T8/T11/T12 End of life liner supply provides best starting point
 - Recent T13 and ISB issue: More frequent discussions needed at SP level

What Feeds the Model?

- 👁️ T8, T11, T12, T13
- 👁️ “# of Runs” in past 12 months (candidate, reference, valid, invalid)
- 👁️ TEI Inventory Status from latest CPD report
 - 👁️ Calculate # of rebuilds (with application of weight factors when parts shared across tests)
 - 👁️ Determine critical part - use # of rebuilds for forecast

What Feeds the Model?

Test	Valid	Invalid/Aborted	Tests run per year	Tests run per month	Weight factor when T8,T11,T12 share parts	Weight factor when T11, T12 share parts	# of Runs per Build
T8	15	2	17	1.4	0.2	1.0	11.0
T11	36	2	38	3.2	0.5	0.6	7.0
T12	20	2	22	1.8	0.3	0.4	1.0
T13	56	9	65	5.4	1.0	1.0	1.0
		Total tests for T8,T11,T12	77				
		Total tests for T11,T12	60				

- 👁️ Runs based on most recent 12 mos. report
- 👁️ # of Runs per build based on Surveillance Panel determination

What Feeds the Model?

Parts Inventory /Rebuilds Available - Latest as of May 2019

Part Description	Qty /Kit	Test Type	Part Number	Batch/ Date	In Stock	~Reject %	Total available	# rebuilds available	T8 Rebuild Allotment	T11 Rebuild Allotment	T12 Rebuild Allotment	Comment
Cylinder Liner	6	T8, T11, T12	509GC471	V	277	10%	249	41	9	20	12	Rebuild allotments based on weight factors in "Data Feeding Model" tab. Used for forecast for T11,T12. Will receive one more batch by Oct/Nov
Piston Crown	6	T11, T12	240GC5125M	F	500	1%	495	82		52	30	
Piston Skirt	6	T11, T12	240GC5119M	B	1,680	100%	0	0		0	0	Isolated issue: Being addressed - TEI to update
Piston Assembly	6	T8	215SB232A	n/a	11	0%	11	1.83				Used for forecast for T8
Top Ring	6	T8, T11, T12	349GC3107	X	1,075	5%	1021	170	38	84	49	
				V	4	0	4	0				
2nd Ring	6	T8, T11, T12	349GC3108	W	403	5%	383	63	14	31	18	
Oil Ring	6	T8, T11, T12	350GC343	W	403	5%	383	63	14	31	18	
Connecting Rod Bearings	6	T8, T11, T12	*20705743	Y	1,449	15%	1232	205	45	101	59	Best case for T8,T11,T12
Main Bearings (full sets)	1	T8, T11, T12	*25503508	P	213	15%	181	181	40	89	52	
Cylinder Liner	6	T13	21334768	B	1116	2%	1094	182				Best case for T13
Piston	6	T13	**21330684	n/a	120	50%	60	10				Used in forecast for T13
Top Ring	6	T13	**21330684	n/a	120	10%	108	18				
2nd Ring	6	T13	**21330684	n/a	120	10%	108	18				
Oil Ring	6	T13	**21330684	n/a	120	10%	108	18				
Connecting Rod Bearings	6	T13	**20580558	B	156	10%	140	23				Not Batched
Main Bearing (full sets)	1	T13	**20530916	n/a	26	10%	23	23				

- Highlighted parts in yellow were used in this draft model
- Highlighted parts in red shows piston skirt issue - isolated issue where entire batch was rejected (TEI has been providing updates)
- Highlighted parts in green show parts least limited (just for informative purposes)

First Draft of Model

(# of runs/rebuild) x # of rebuilds

previous month runs available - (runs/month)

Test	May 2019	June 2019	July 2019	August 2019
T8	20.2	18.8	17.3	15.9
T11	142	138.5	135.3	132.1
T12	12	9.9	8.0	6.2
T13	10	4.6	(0.8)	

- Based on inventory at TEI only
 - Does not include any buffer held at independent labs
 - Does not take into account rework of parts
- Predicts four months - due to frequency CPD report is updated
 - Will have an end-of-life model for T8, T11, and T12 based on final batch of cylinder liners

HD Parts Model Conclusions

- End Of Life (EOL) scenario best fit for model
 - Prediction of the need for a replacement test or action by industry
 - Ex. T8/T11/T12
- Batched critical parts scenario decent fit for model
 - Prediction of need or timing for new parts order of critical parts
 - Larger inventories of batched parts, longer lead time parts, etc.
- Continuous production scenario not a great fit for model
 - non-batched, small inventoried parts relatively easy to obtain
 - Difficulty predicting part shortages or high rejections of a normally available part

Next Steps

- Draft model has been completed for Volvo Tests
 - T8/T11/T12
 - Update once 'final' liner batch manufacturing and initial inspections are complete
 - Total liners (#) x rejection rate (%) = Total number of tests available
 - TEI is currently purchasing additional critical parts to match liners to take the tests to EOL
 - T13
 - Current model suggests pistons will be the next limiting factor and will run out in July-However these parts are production, readily available, non-batched and can be obtained in 2 days
 - Liners are the limiting factor as these are larger inventory of batched parts-rerun model to predict when next batch will be needed
- Task Force recommends continuing to work on refining model and incorporate additional test types, determining how the model can be used for each
 - DD13, ISB, ISM, C13, Cat 1x-single cylinder



COAT Update

Hind Abi-Akar
Caterpillar Inc.

ASTM, HDEOCP

Denver, June 25, 2019



COAT – End of Provisional Licensing May 15, 2019

- The Caterpillar Surveillance Panel agreed that the Caterpillar Aeration test is available for “Candidate Oil” testing starting Monday May 13th, 2019.
- Test stand calibrations became active Monday May 13, 2019.
 - The decision was based on extensive test improvements, matrix testing and data analysis that showed reestablishing of discrimination

Letter sent to D02.B0 chairman and to API



COAT – Surveillance Panel Meeting, May 10, 2019

Established an industry correction factor:

- Allows taking known reference oil performance from the improved Caterpillar Aeration Test back to original target levels.
 - This correction factor will be applied to all candidate oil testing, starting Monday May 13th, 2019.

All panel votes were unanimous



COAT – Surveillance Panel Meeting, May 10, 2019

Established the following LTMS elements necessary for determining lab calibration status:

- Starting new charts for upgraded MM system for the two reference oils TMC832-1 and TMC833-1
- Applying existing target for TMC833-1 and a new target for TMC 832-1 (i.e.10.23%)
- Applying a common standard deviation for LTMS calculations, equal to 0.2774
- Applying the selected standard deviation (equal to 0.2774) to obtain the lab severity adjustments

All panel votes were unanimous



Test lab perspective

- Labs are running candidate oil tests
- General input is that tests are running well and results show no unusual behavior
- SP will keep monitoring the test

Surveillance Panel will start working on backwards compatibility and EOAT replacement

DAIMLER

ASTM D8074 – DD13 Scuffing Test – Update
Suzanne Neal & Patrick Joyce
Tuesday June 25th, 2019

Daimler Trucks



Agenda

Test Parts

- Exhaust Rocker Arm Availability – Suzanne/TEI
- Critical Parts Quantities – TEI
- Liner and Second Ring New Batch Status – Suzanne/TEI

Alternate Fuel Supplier Request – Surveillance Panel

Ratings and Rater Requirements – Patrick

Exhaust Measurement Location Procedure Clarification – Sean Moyer

Next Meeting: Planned for the week of July 7th, 2019

Exhaust Rocker Arm Availability

- Rocker Arms: Update: (June 14th, 2019)
 - New part number for rocker arms. Parts are not commercially available yet.
 - Panel made a motion to continue with re-using parts to a defined measurement criteria until parts become commercially available.

Liner and Second Ring

“D” Batch Liners:

- Initial rejection rates for Batch “D” liners:
 - 11 of the 39 liners were rejected based on the current specs, improved rejection rate compared to “C” Batch Liners




Second Rings:

- Order placed on April 23rd, 2019 - 3000 pieces received

Referencing:

- Referencing will be coordinate to bring in the new Batch “D” liners and second rings.

Critical Part Update

Part	Batch	Qty	Approx. Time Left (years)
Top Ring	B	1,050	2.2 
2nd Ring	A	0	0.0
	B	3,000	6.3
Oil Ring	A	710	1.5 
Piston	A	627	1.3 
Liner	C	0	0.0
	D	4000 liners ~3000 liners with rejection rate	8.3 ~6.3 with rejection rate

Team is reviewing remaining part availability to prepare appropriately for ordering more parts and next round of referencing. (see arrows)

Alternative Fuel Supplier

Request from Haltermann to be an alternative fuel supplier for the DD13 Scuffing Test:

- Panel Discussion
- Feedback Overview:
 - Bob Campbell (Afton) – to schedule OEM/Chair meeting (Q3 2019) heavy duty meeting to discuss the topic at a high level and outline general questions that need to be addressed.
 - After Q3 2019, Panel will re-visit request.

Ratings and Rater Requirements – Patrick

☐ Separate Presentation

- See document attached to meeting invite (Thursday, April 04, 2019 2:30 PM-4:30 PM) from Patrick Joyce
- Document Name: “2017 Daimler SP Rater Workshop DD13 Data Summary”
- Panel decided to send parts to the October 2019 workshop or have a separate rating workshop.
- Team will re-discuss this topic in the next Surveillance Panel meeting.

Ford 6.7L Valve Train Wear (VTW) Test Update ASTM June 2019

Team Members:

Patrick Joyce, Nick Ariemma (Lubrizol)/Ron Romano, Michael Deegan (Ford)/Andrew Smith (Intertek)/Robert Warden (SwRI)

6.7I VTW Test Development: Why

- Implemented due to CK-4 800ppm Phosphorus Wear results
 - 6.7I Valvetrain showed higher wear than CJ-4 oils.
 - Phosphorus was one of the differences between the oils.
 - Testing CK-4 with same CJ-4 phosphorus PPM showed passing wear results.
- Ford/Lubrizol/Intertek/SwRI agree to develop ASTM Test Method.
 - Using soot as the mechanism to create the Valvetrain Wear.

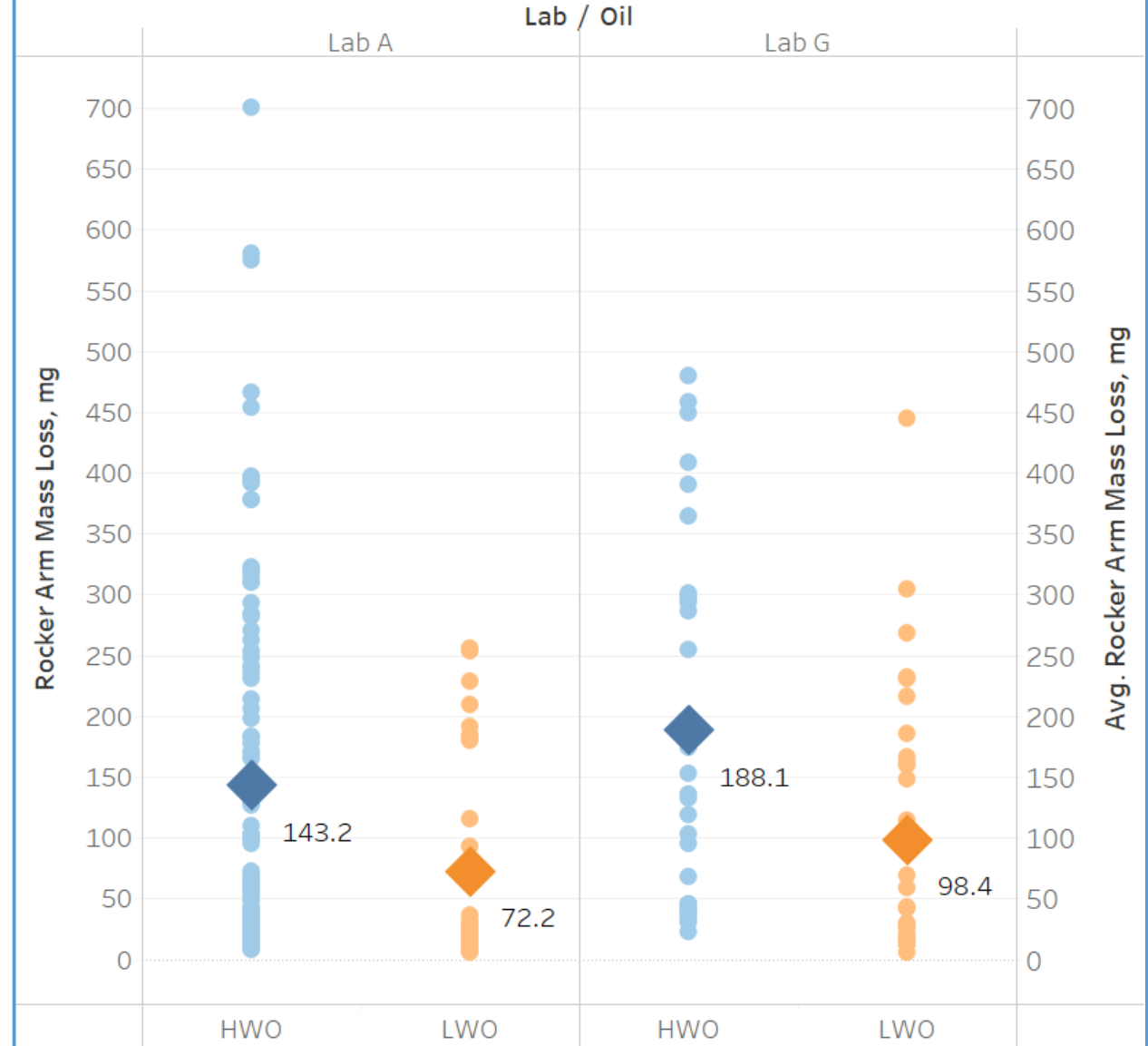
6.7 VTW Test Development: Status

- Completed Soot Generation Investigation
 - Soot Generation controlled by adjusting Coolant Temp Signal to PCM which in turn changes Fuel Injection Timing.
- Resolved Filter Bypass Issue:
 - Dual Filter set up installed.
- Proveout Testing at All Labs.
 - Intertek & SwRI have completed First Proveout tests on HWO & LWO.
 - Tests hit the proposed soot windows.
 - Test results, including engine operation characteristics, were comparable between the two labs. See following pages for results.

Test Development Data relative to latest (4) Tests.

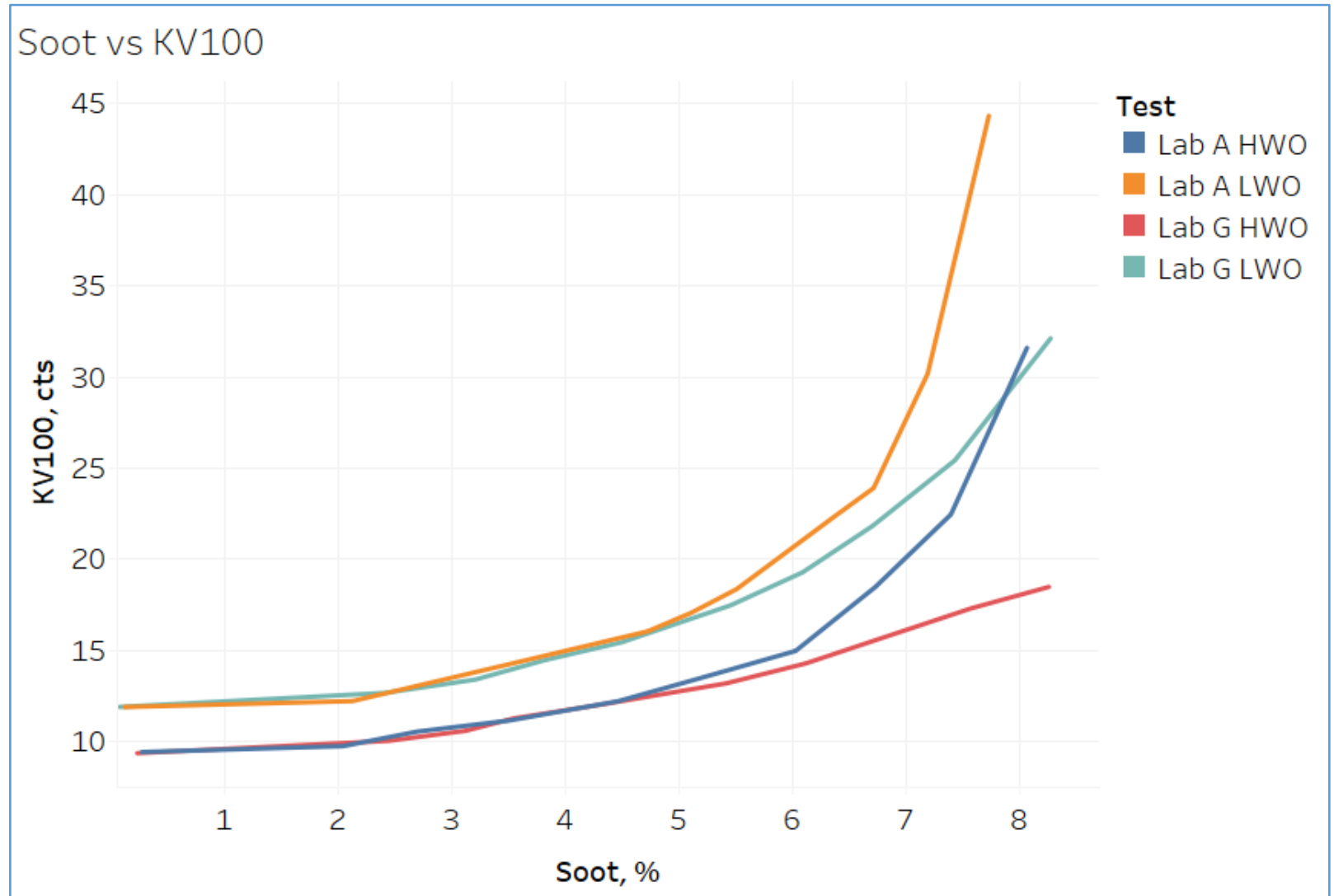
- HWO – “PC11B”
 - Blue
 - 3.0 HTHS150
 - 800 ppm phosphorus
- LWO – CJ-4 Factory Fill
 - Yellow
 - 3.5 HTHS150
 - 1100 ppm phosphorus
- Average Rocker Arm Mass appears to have the best chance of discrimination based on:
 - (2) of each LWO/HWO run on latest test procedure at SwRI and Intertek.
 - Both labs within Soot Window Limits.
 - Both Labs within Operational Limits.
- Statisticians reviewing for Discrimination Test on Data.

6.7L Rocker Arm Weight Loss Averages



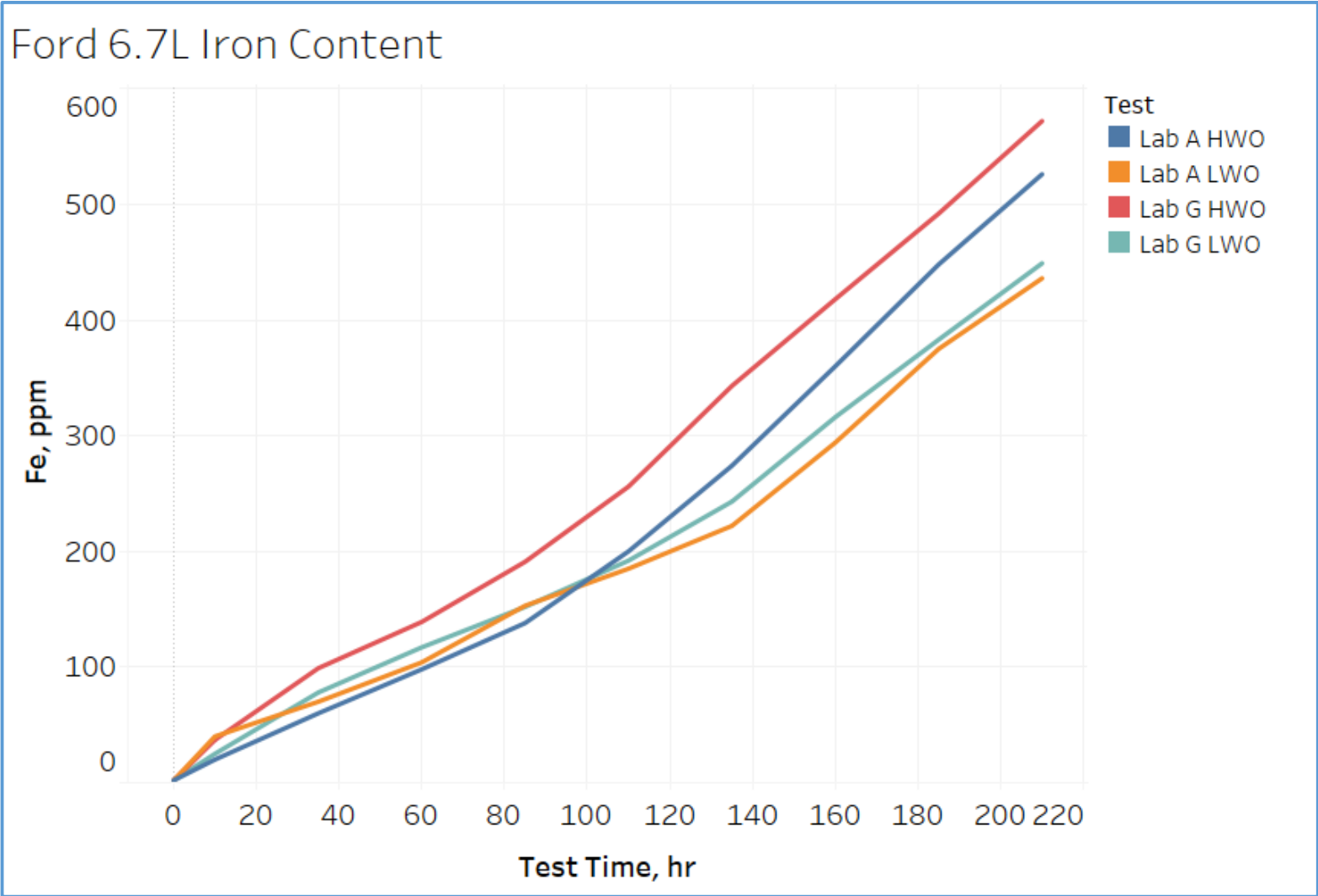
Test Development Data: Soot Content vs Viscosity

- Results with regard to Oil Viscosity to %TGA Soot.
- Labs consistent with soot vs Viscosity including HWO & LWO up to ~6% soot.



Test Development Data: Fe vs. Test Hours

- HWO Fe > 500ppm.
- LWO Fe < 450ppm.
- Labs consistent with HWO & LWO Fe content.
- May be useful for predicting failure before end of test.



6.7 VTW Test Development Next Steps

- Resolve Soot Window Tolerances.
- Determine Statistical Model for Pass/Fail Criteria. ECD: July 2019
- Develop a Precision Matrix Test. ECD: December 2019
 - Funding.
 - Memorandum of Understanding.
 - Task Force needed.
- ASTM Test procedure with report forms and data dictionary are planned to be complete by year end.