Daimler Surveillance Panel Meeting Minutes

May 30, 2018

12:30 PM – 2:30 PM CST

Call Participants:

Lubrizol - Patrick Joyce, Kevin O'Malley, John Loop, Greg Matheson
Southwest Research Institute – Jose Starling, Jim McCord, Travis Koston
Intertek – Jim Moritz, Josh Ward, Juan Vega
Daimler - Suzanne Neal, Greg Braziunas
Infineum - Jim Gutzwiller, Elisa Santos, David Brass,
Chevron Oronite – Mark Cooper, Josephine Martinez
TEI – Derek Grosch
TMC – Sean Moyer
Afton – Cory Koglin
ExxonMobil – Ray Burns

Unfinished Business

Review Operational Data - SP

Patrick from Lubrizol presented the operational data which focused on the two recently conducted Oil C runs at Intertek and Lubrizol on the new Batch C liners. Lubrizol's Oil C (866) run scuffed at 154 hours and Intertek's Oil C run completed 200 hours without scuffing. There was interesting differences noted in the CAC outlet temperature which correlate with EGR into intake manifold temperatures and EGR cooler "regeneration" events. Southwest had some higher temperatures seen on the coolant outlet temperature location. It was explained by Greg that there is a mixing effect that occurs at the elbow where this thermocouple is located so thermocouple location and depth is critical for this test point (Southwest will verify thermocouple location and adjust as necessary). Greg mentioned that EGR coolers are considered fouled when output EGR temperature reaches 200 C, so coolers with temperature output of 165 C as we are seeing in DD13 scuffing testing is normal. The remainder of the operational data was completed and no additional comments were made. It was mentioned that the operational data files will be uploaded to the TMC site for these recent runs.

Review Reference Oil Statistical Analysis – Kevin O'Malley

Kevin presented his analysis which included all the recent Batch C liner tests. It was mentioned that on average 866 yields higher hours to scuff than 864 when Batch C liners are used. Previously the oils did not significantly differ in their hours to scuff at the time oil targets were set. It was mentioned that an implementation of a simple correction factor won't properly compensate for oils that respond differently to hardware changes. It was asked if a transformation could be applied, but it was mentioned that it would be difficult to find a transformation that fits the data appropriately. This presentation will is attached to the meeting minutes for further review.

Batch C Liner Next Steps – SP

It was mentioned that Mahle in general is the only source for the liners. Suzanne mentioned that it may be a possibility to ask Federal Mogul to produce a batch of liners and have them hone them. Yet, Federal Mogul did not have experience honing the DD13 liners thus they were honed at Detroit Diesel in the past. It was mentioned that another possibility could be to have Mahle produce another batch of liners since they are the supply line moving forward. At the moment TEI has rejected about 500 batch C liners (out of 2,000) mainly due to being out of specification, swirl appearance issues or items such as rust/corrosion spots due to the shipment process. It was mentioned that Michael Teal (Detroit Diesel)

will take a look at some of the data and possibly some of the rejected liners and return an opinion of use on them. TEI stated there are about 1700 Batch B Top rings, so potentially next time the top rings and liners could be introduced together.

Suzanne stated that Daimler's position at this point is that there is a non-critical shift at the moment. They cannot define the shift as severe or mild but confirm that they have not seen such a large shift so that a passing oil is now failing and a failing oil is now passing over the load change point. They agree that additional data is needed but at this point the best method to acquire additional data is to approve the hardware and allow data to be generated via standard reference testing.

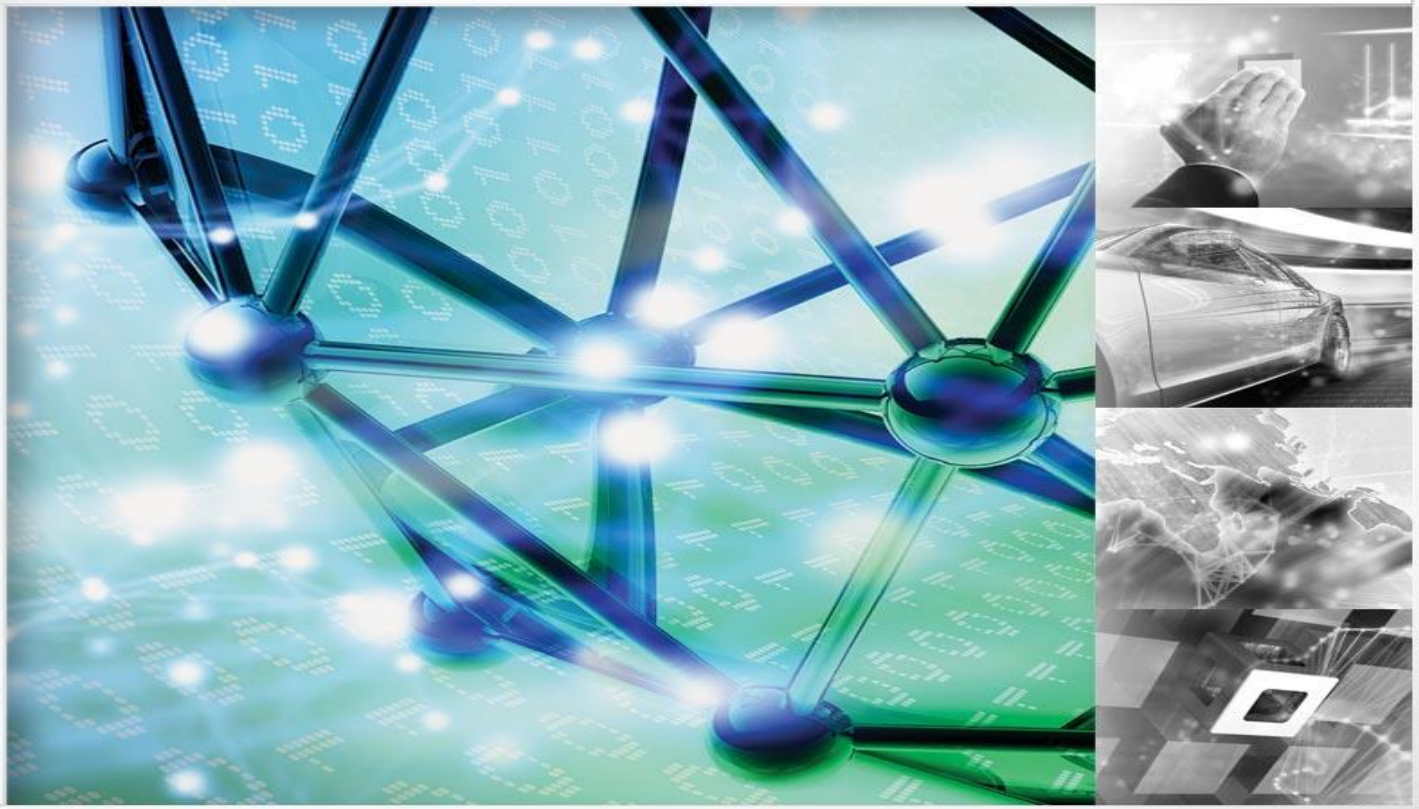
Suzanne Neal from Daimler ***made the motion to approve Batch C liners for use and chart reference oil tests accordingly with an LTMS effective date of May 30, 2018. Patrick Joyce from Lubrizol seconded the motion.***

Discussion took place first on how the original Batch C reference tests would be approved. It was mentioned by Sean that typically the calibration date of the reference is started on the day of the vote. The LTMS date for all reference tests on Batch C liners will be effective today. The Oil C (866) donated hardware runs utilizing batch C liners will not be chartable. It was asked if PNB liners would be acceptable for use moving forward if there were any left out there. Greg mentioned that in his point of view they would be acceptable for testing, but that it might be more suitable to keep in stock at TEI for future reference data. TEI mentioned that they did not have any usable PNB liners left in stock. With no further discussion regarding the motion voting proceeded.

Afton abstains
Chevron Oronite Waives
Daimler Votes For the motion
Infineum Abstains but with comments: It was mentioned that they did demonstrate previously that there was multiple tests run on their technology that demonstrated a severity shift. There was also metallurgical differences shown between the PNB and Batch C liners that may affect how the test is running. In addition it was mentioned that we now are also seeing Oil C to be inconsistent with historical performance which we have no understanding about. They would also like to see more data generated via additional reference testing and will not hold up the voting process.
Intertek Votes for the motion
Lubrizol Votes for the motion
Southwest Votes for the motion
TEI Votes for the motion
TMC waives

The Motion passes with 5 votes for the motion and 4 abstains.

Next Meeting:
Next meeting date pending.



DD13 Scuffing Test
Liner Analysis

The Lubrizol Corporation

May 30 2018

Summary of Analyses

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- Data utilized include 26 chart = “Y” tests + 3 Liner Batch C tests (listed in Appendix)

- Statistically, we can’t simultaneously obtain independent estimates for Labs, Stands, Oils, Top Ring Batches, and Liner Batches.
  - This analysis assumes the effects of different stands and oil blends are negligible

- On average, Oil 866 yields higher Hours to Scuff than 864 when Batch C liners are used.
  - Previously, the oils did not significantly differ in their hours to scuff at the time oil targets were developed; 864 had directionally higher Hours to Scuff compared to 866 when PNB liners were utilized

- The implementation of a “simple” correction factor won’t adequately compensate for oils that respond differently to hardware changes.

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Hours to Scuff

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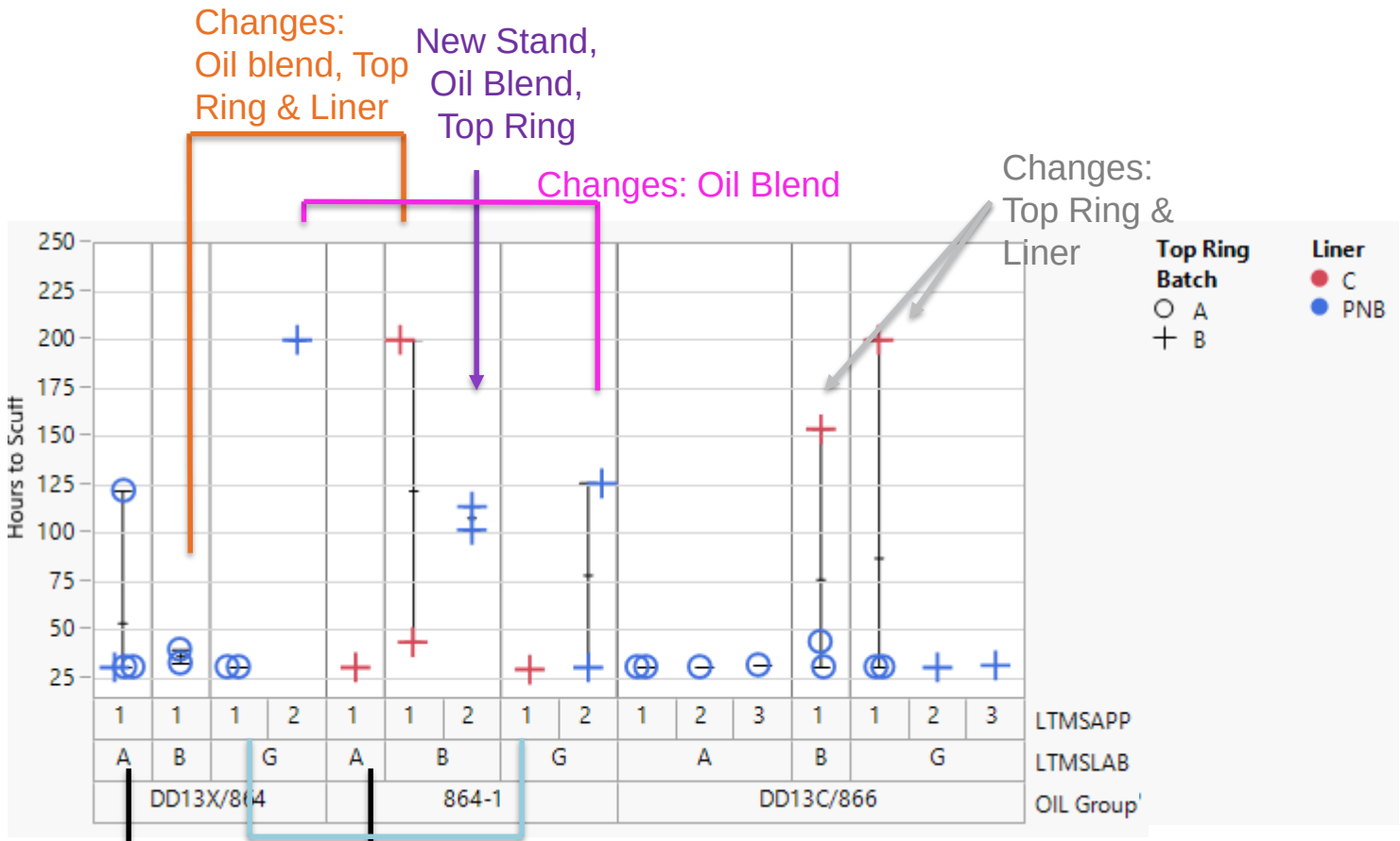
Past conversations have focused on Top Ring, Liner, and Oil Blend changes



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Hours to Scuff

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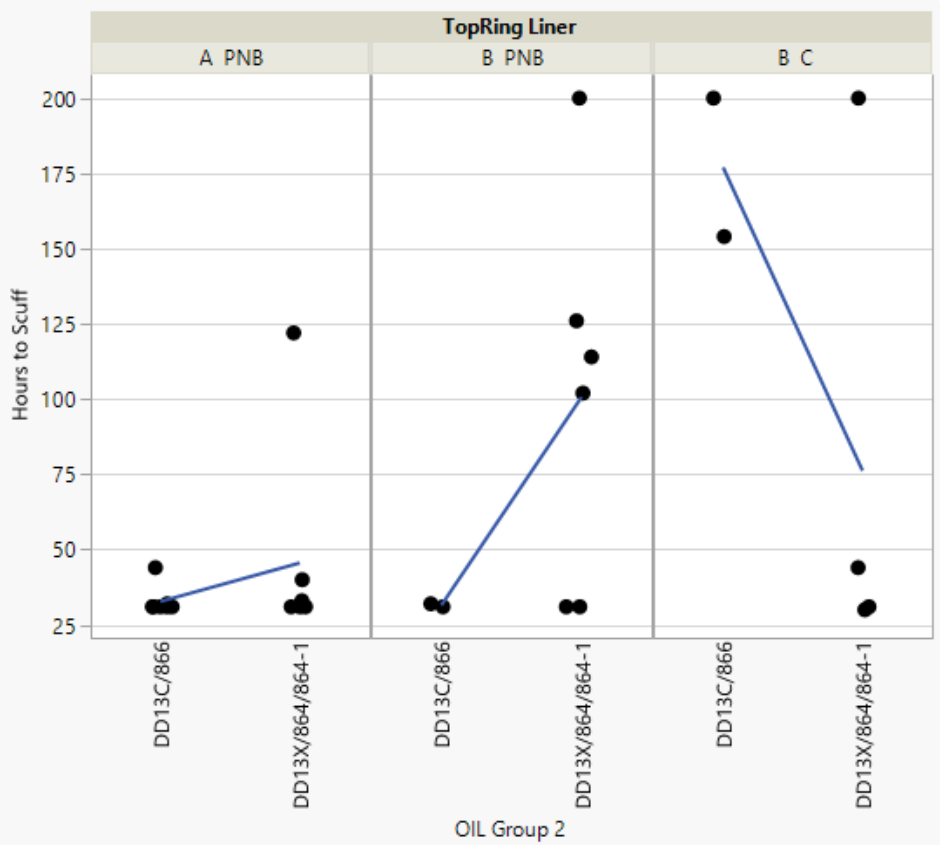
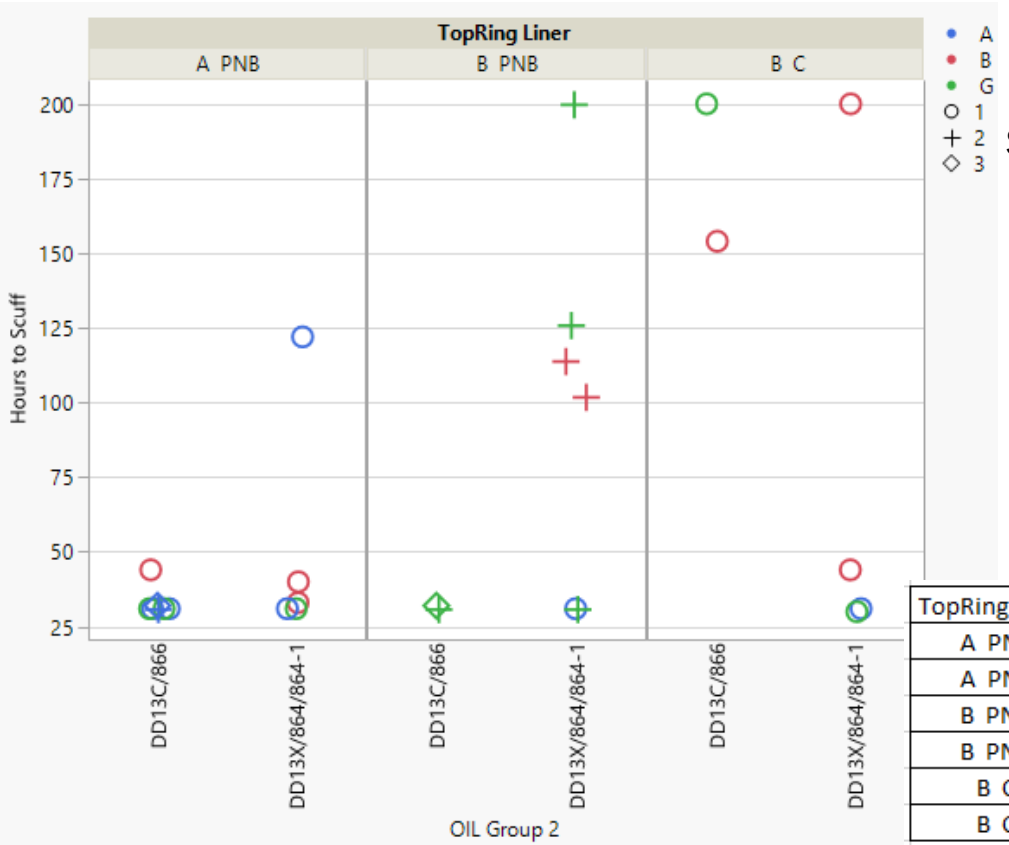
Batch C liners: 866 > 864

PNB liners: 864 yields directionally higher hours to scuff than 866

When oil targets were set, there was no significant difference between the oils





TopRing Liner	OIL Group 2	# of Tests	Avg Hours to Scuff
A PNB	DD13C/866	8	33
A PNB	DD13X/864/864-1	7	46
B PNB	DD13C/866	2	32
B PNB	DD13X/864/864-1	6	101
B C	DD13C/866	2	177
B C	DD13X/864/864-1	4	76

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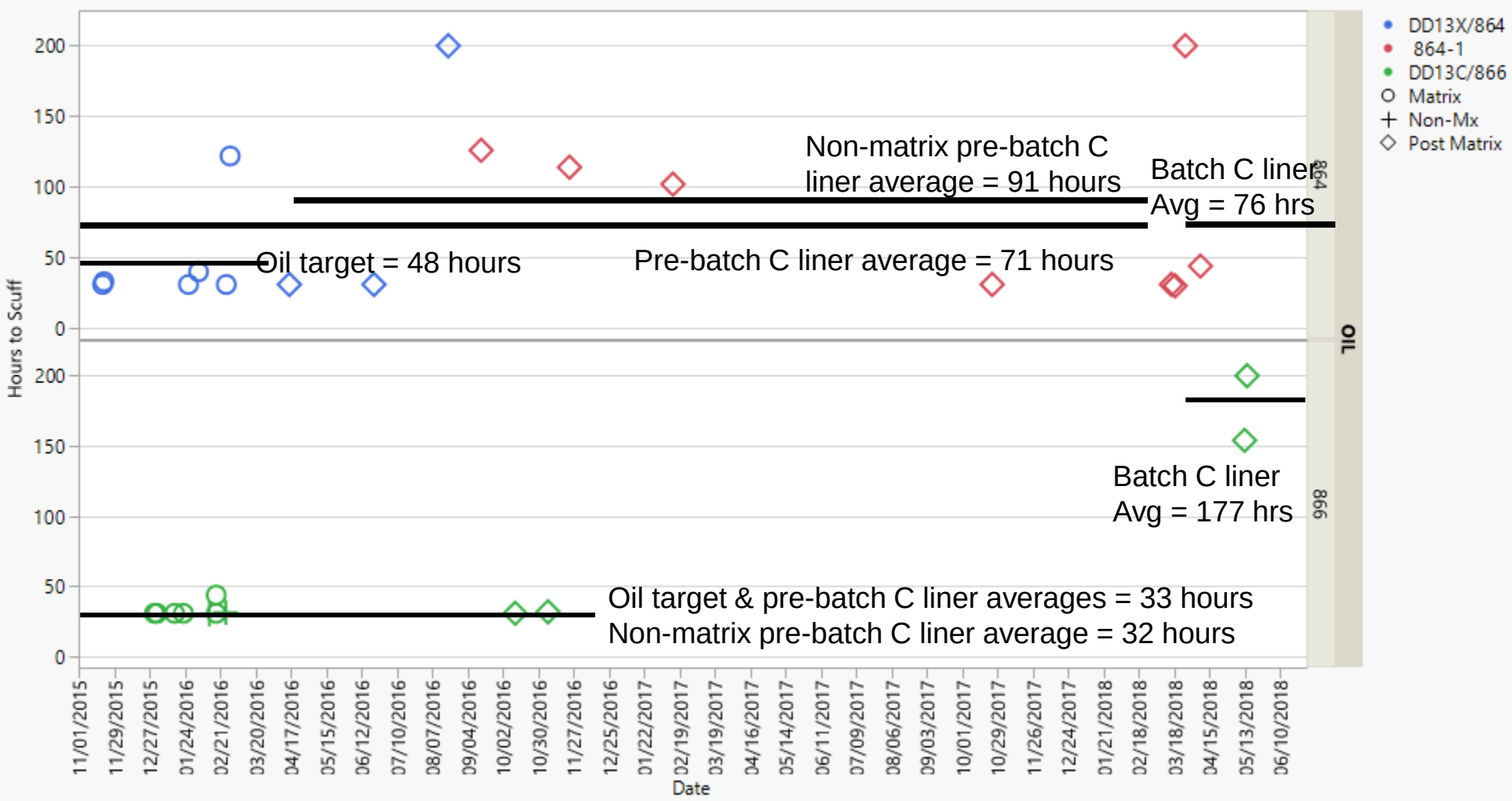
Appendix

Hours to Scuff Over Time



Data Utilized

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TESTKEY	LTMSDATE	LTMSLAB	LTMSAPP	VAL	CHART	IND	Liner	Top Ring Batch	HRS2	Hours to Scuff
116652-DD13	20151120	G	1	AC	Y	DD13X	PNB	A	35	31
116656-DD13	20151121	B	1	AC	Y	DD13X	PNB	A	32	33
116648-DD13	20151231	A	1	AC	Y	DD13C	PNB	A	32	31
116653-DD13	20160102	G	1	AC	Y	DD13C	PNB	A	31	31
116657-DD13	20160116	B	1	AC	Y	DD13C	PNB	A	31	31
116654-DD13	20160123	G	1	AC	Y	DD13C	PNB	A	31	31
116649-DD13	20160127	A	1	AC	Y	DD13X	PNB	A	32	31
116658-DD13	20160204	B	1	AC	Y	DD13X	PNB	A	40	40
120064-DD13	20160212	A	2	AC	Y	DD13C	PNB	A	31	31
116659-DD13	20160218	B	1	AC	Y	DD13C	PNB	A	44	44
116650-DD13	20160218	A	1	AC	Y	DD13C	PNB	A	32	31
120065-DD13	20160225	A	3	AC	Y	DD13C	PNB	A	32	32
116655-DD13	20160226	G	1	AC	Y	DD13X	PNB	A	31	31
116651-DD13	20160229	A	1	OC	Y	DD13X	PNB	A	122	122
117347-DD13	20160416	A	1	AC	Y	DD13X	PNB	A	31	31
118393-DD13	20160622	A	1	AC	Y	864	PNB	B	31	31
119058-DD13	20160820	G	2	OC	Y	864	PNB	B	200	200
119743-DD13	20160915	G	2	OC	Y	864-1	PNB	B	126	126
120881-DD13	20161012	G	2	AC	Y	866	PNB	B	31	31
120882-DD13	20161107	G	3	AC	Y	866	PNB	B	32	32
121505-DD13	20161124	B	2	OC	Y	864-1	PNB	B	114	114
121506-DD13	20170214	B	2	AC	Y	864-1	PNB	B	102	102
119744-DD13	20171025	G	2	AC	Y	864-1	PNB	B	31	31
121501-DD13	20180316	A	1	PC	Y	864-1	C	B	31	31
134325-DD13	20180319	G	1	PC	N	864-1	C	B	30	30
134612-DD13	20180327	B	1	PC	Y	864-1	C	B	200	200
134613-DD13	20180408	B	1	PC	Y	864-1	C	B	44	44
135907-DD13	20180513	B	1	AG	N	866	C	B	154	154
121891-DD13	20180515	G	1	NI	N	866	C	B	200	200

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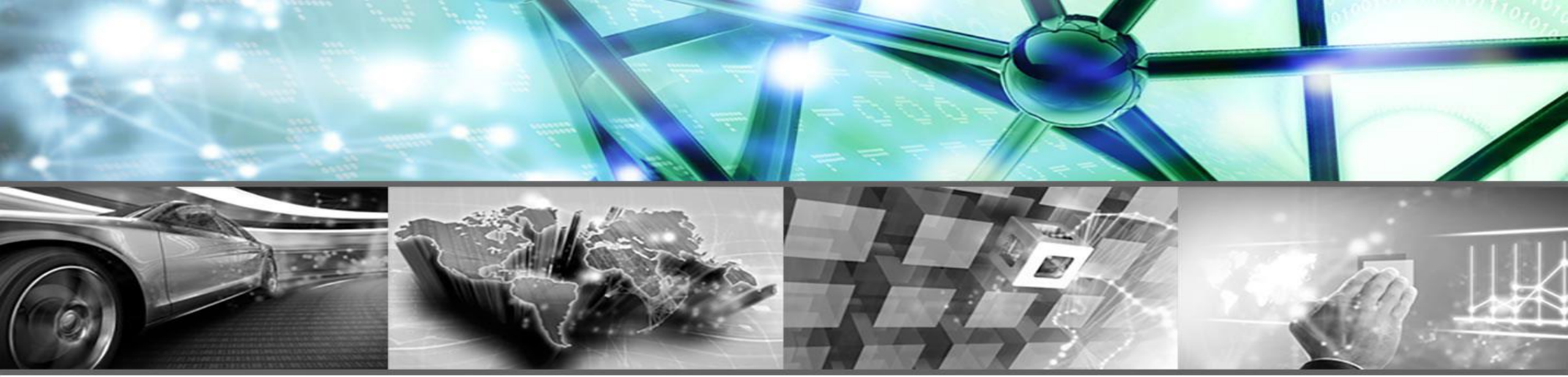

SUCCESS TOGETHER

Working together, achieving great things

When your company and ours combine energies, great things can happen. You bring ideas, challenges and opportunities. We'll bring powerful additive and market expertise, unmatched testing capabilities, integrated global supply and an independent approach to help you differentiate and succeed.

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