Cummins Surveillance Panel Teleconference
October 19, 2017 10:00 – 12:00 EDT

Attendance:

Sean Moyer - TMC
Kevin O'Malley, Nick Ariemma, Patrick Joyce - LZ
Bob Campbell - Afton
Bob Salgueiro,Elisa Santos, Jim Gutzwiller - Infineum
Ray Burns - ExxonMobil
Jim Carroll, Jose Starling, Jim McCord - SwRI
Dan Lanctot - TEI
Jim Moritz, Josh Ward - Intertek
Mark Cooper, Jim Rutherford - Chevron Oronite

Agenda:

Discuss Changes to ISB LTMS, Oil Standard Deviations, Correction Factor Updates and Severity Adjustments

Kevin O'Malley reviewed background of what has been done to this point and the goal of the current meeting. Kevin made a presentation of slides (attached to these minutes) reviewing the data he used for the analysis as well as the results of the analysis.

Jim Moritz stated he does not believe that the options are not necessarily a package deal. Should the panel work on correction factors and adopt those first and then investigate incorporating LTMS changes.

Bob Campbell agree that the options don't need to be adopted simultaneously.

Patrick Joyce asked whether any of the models that Kevin used for developing correction factors indicated that no correction factors were needed or that significantly different correction factors are needed.

Bob Campbell asked whether the correction factor is just the difference between the model and the target means. Yes just the difference.

MOTION:
Patrick Joyce motioned (Seconded by Bob Campbell) that the correction factors that Kevin proposed (***multiply ATWL by 0.785*** and ***add -18.5 to ACSW***) be adopted effective for tests that finish on or after 10/19/2017. No opposed, No waives

Discussion moved to adoption of improved LTMS. Patrick Joyce asked whether adopting the new correction factors would affect the improved LTMS calculations. Kevin stated that indeed it would and he has not had the chance to rerun those numbers. Kevin reviewed the improved LTMS wording and a few things that would need to be reviewed before adopting it including standard deviations. Kevin went back to his presentation to look at the data for standard deviations and discussed the data that was included in his analysis of the standard deviations for ACSW.

Jim Moritz asked the group whether there was interest in changing oil standard deviations and pursuing adding severity adjustments to this test. Bob Campbell commented that he believes we should consider adding severity adjustments to the test. Patrick Joyce pointed out that there does seem to be more variability in the data from the original matrix test data.

There was discussion around which tests should be included in standard deviation calculations specifically if the 4 tests with high ACSW should be included or excluded. Should standard deviations even be changed or should we investigate what is causing the increased variability. The group started to coalesce around using the standard deviation of either all of the tests (option #2 8.9) or the data on just KDE hardware (Option #5 8.7) since they are in the same ballpark. It was determined that in order to implement these changes immediately the panel agreed these changes were an urgent enough matter to warrant forgoing the normal 2 week waiting period on LTMS changes (Sean was not sure whether the 2 week period applied to target updates or not).

MOTION:
Bob Campbell motioned and Jose Starling seconded to update the ACSW standard deviation from 5.0 to 8.7 effective today. No opposed, No waives

Discussion moved to standard deviation updates for ATWL. There did not seem to be as much desire to update the standard deviation for ATWL. Jim Rutherford asked why the logic for ATWL would be different than for ACSW.

Discussion moved to implementing improved LTMS. Kevin began to review the wording and the implications for improved LTMS. There was discussion about removing the “immediately” wording from the ei sections of the new document. After talking over the wording and reviewing editorial changes to the upfront ei section of the LTMS document forthcoming it was determined that the group would table the improved LTMS discussion for a later date.

Tentative date of next meeting will be November 1st, 2017 at 10 AM Eastern.

Meeting adjourned at 12:02 pm

Cummins ISB
LTMS Improvements & Correction Factor Evaluation

October 2017

Kevin O'Malley
Statistician
The Lubrizol Corporation

Lubrizol

Background

SUCCESS TOGETHER

- On June 14, 2017, the surveillance panel discussed ISB tappet severity and asked the Statistics Group to develop LTMS requirements incorporating LTMS improvements and report back to the panel

- The Statistics Group discussed various LTMS options:
  - Lab Based ISB Requirements
  - Comparison of the current versus improved LTMS calculations
  - Various standard deviation calculations

- In addition, the statistics group requested that the panel review the current oil standard deviation for average cam shaft wear and average tappet weight loss.

- Upon review in September the surveillance panel requested an update of analyses with additional tests reported at that time along with updated correction factor estimates

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Data Considered

93 chart="Y" data up to 9/28/2017

+

Additional tests:

TESTKEY	LTMSLAB	IND	LTMSAPP	ENGINE	ENHOURS	VAL	LTMSDATE	CHART	ENKIT	COM1	COM2	COM3	COM4	TAPBID	CRHBID	CAMBID
106978-ISB	G	831-2	1	46560896	7910	AG	20150308	N	ISB-826	K CAM	D TAP		HARDWARE	D	D	K
106854-ISB	B	831-2	3	46562869	5280	AG	20150313	N	ISB-821	NEW CAM	NEW TAP			D	D	K
116611-ISB	G	831-3	6	440021	2593	OC	20161020	N	ISB-967	ATWL SEV				D	E	K
120532-ISB	G	831-3	5	49342610	1500	NN	20161029	N	ISB-969	STAND	INFO	RUN		D	E	K

106978 and 106854 were used in the prior severity analysis and correction factor calculations in 2015

116611 and 120532 are more recent non-chartable tests using the most recent hardware combination

Average Cam Shaft Wear

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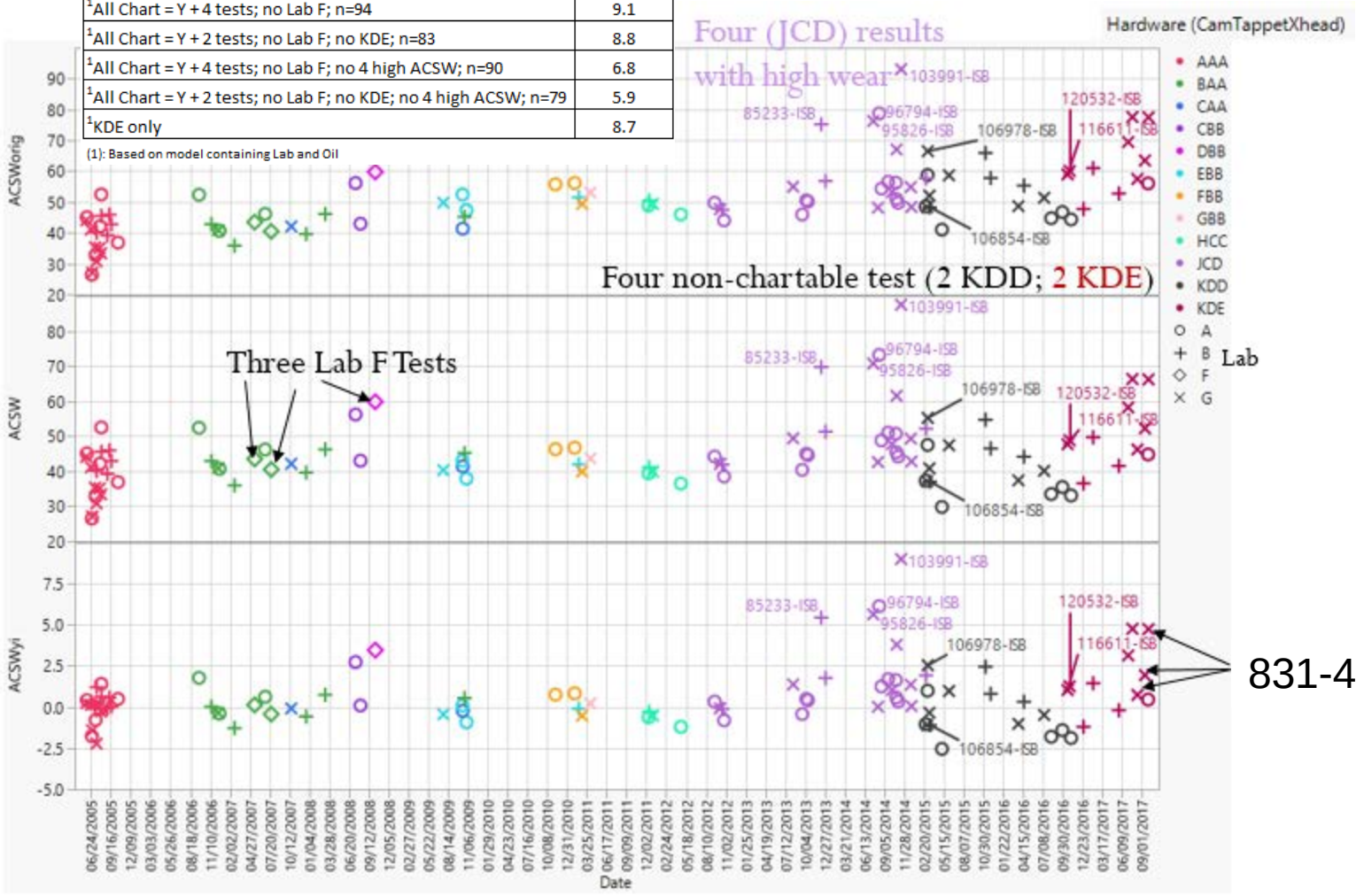
Option	Estimated Standard Deviation
Oil Target	5.0
[1]All Chart = Y + 4 tests; no Lab F; n=94	9.1
[1]All Chart = Y + 2 tests; no Lab F; no KDE; n=83	8.8
[1]All Chart = Y + 4 tests; no Lab F; no 4 high ACSW; n=90	6.8
[1]All Chart = Y + 2 tests; no Lab F; no KDE; no 4 high ACSW; n=79	5.9
[1]KDE only	8.7

(1): Based on model containing Lab and Oil



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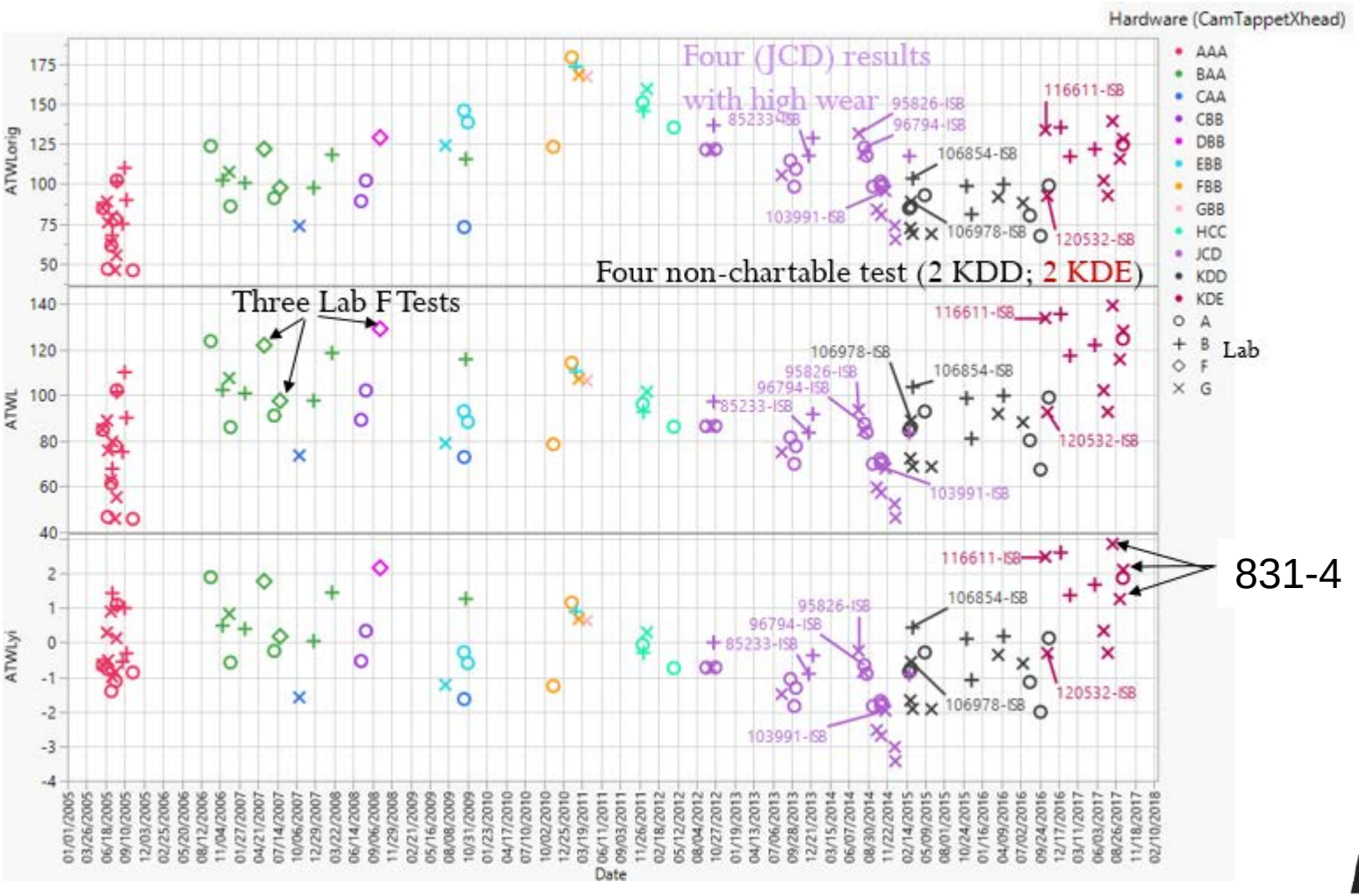
Average Tappet Weight Loss

Option	Estimated Standard Deviation
Oil Target	14.8
[1]All Chart = Y + 4 tests; no Lab F; n=94	14.0
[1]All Chart = Y + 2 tests; no Lab F; no KDE; n=83	12.6
[1]KDE only	15.1

(1): Based on model containing Lab and Oil



831-4

Discussion Topics

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- Incorporation of LTMS improvements into ISB
- Standard deviation update
  - Note: if the standard deviation is updated and LTMS improvements are incorporated it is recommended that the oil standard deviation for 831 also be used for the severity adjustment standard deviation
  - Options:

ACSW Option	Estimated Standard Deviation
Oil Target	5.0
[1]All Chart = Y + 4 tests; no Lab F; n=94	9.1
[1]All Chart = Y + 2 tests; no Lab F; no KDE; n=83	8.8
[1]All Chart = Y + 4 tests; no Lab F; no 4 high ACSW; n=88	6.8
[1]All Chart = Y + 2 tests; no Lab F; no KDE; no 4 high ACSW; n=79	5.9
[1]KDE only	8.7

(1): Based on model containing Lab and Oil

ATWL Option	Estimated Standard Deviation
Oil Target	14.8
[1]All Chart = Y + 4 tests; no Lab F; n=94	14.0
[1]All Chart = Y + 2 tests; no Lab F; no KDE; n=83	12.6
[1]KDE only	15.1

(1): Based on model containing Lab and Oil

- Correction factor update

Current

All test using batch D tappets and batch K cams	Multiply ATWL by 1; Add -11.3 to ACSW

Proposed

All Tests using Batch K Cams with Batch D Tappets and Batch E Crossheads	Multiply ATWL by 0.785; Add -18.5 to ACSW

Proposed CFs based on model including lab (lab F included in model, but not used to estimated CF, oil (blends not combined, but PC10B renamed 831), and hardware (combined term for cam, tappet, and crosshead batches used); no transformation utilized; model estimate for KDE (averaging over labs and 831 oil blends) compared against 831 oil target

- Does the panel want to investigate the incorporation of LTMS improvements into the ISM?

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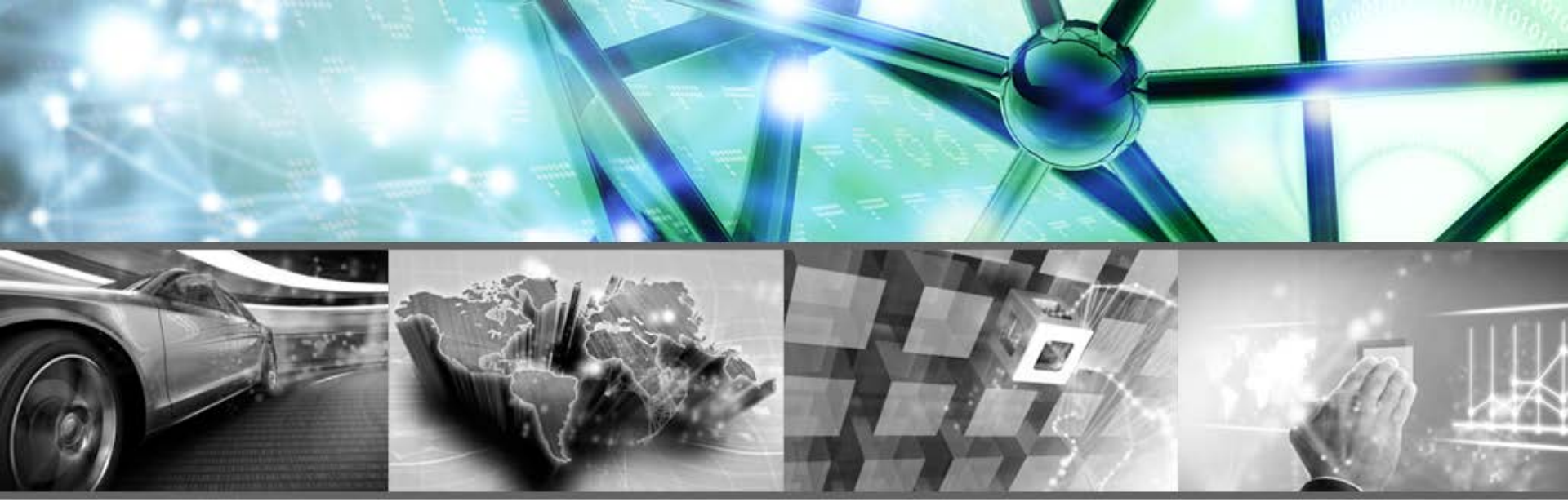

SUCCESS TOGETHER

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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