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LSPI AGING INDUSTRY CONFERENCE CALL

Date: 12 Oct 21

ATTENDANCE

SWRI	Christine Eickstead, Khaled Rais, Pat Lang
INTERTEK	Al Lopez, Jason Soto, Martin Chadwick
AFTON	Christian Porter
ORONITE	Robert Stockwell, Nicole Ketterer, Jo Martinez
INFINEUM	Doyle Boese, Charlie Leverett, Andy Ritchie
TMC	Rich Grundza
FORD	Mike Deegan
EXXON	Paul Rubas
GM	Brad Cosgrove, Meryn Hopp
SHELL	Jeff Hsu
HALTERMAN	Prasad Tumati
F C A GROUP	Haiying Tang

MEETING:

Martin presents stats group presentation on the precision matrix design for Aged Oil LSPI (attached):

Goal – demonstrate precision of test; secondary goal – identify discrimination between A and B, effect from age of CW engine, bias from running in different LSPI stand (while using same aging stand)

Would like to see all LSPI stands' calibration performance before running aged oils.

Run aging on all four samples, then run LSPIs back-to-back so run in same calibration interval so no different SAs in labs running 8 tests.

If we want to stop halfway through and analyze, will need to discuss how to do this: aging data first, then LSPI, run all four agings, then 2 LSPIs only? Etc.

Good idea if have enough EOT sample to send to one lab for chem. analysis, in addition to labs' analysis? Sample at EOT of aging, sample after charge for LSPI, IF enough oil…. Nice to have, not mandatory…?

Charlie – Made assumption that we will age all samples, do analysis, and then review before starting the LSPI runs.

Martin – Not our understanding; want to learn from aging analytical results, but the matrix is not contingent on this (the aging run procedure already established)

Andy – doesn't agree. We know there is variability in the aging process, and this will carry forward to LSPI results. We were cautious last time with good results – we looked at aged oil samples before running LSPI. If one is drastically different – may not use. Martin – Would like to run all samples but can add stage gate for analysis. If concern, run another aging run?

Andy – We are developing two ASTM standards, want to ensure we do both properly. Want to sign off on aging test before matrix?

Charlie – Don't expect to see difference between new and used engine.

Andy – other concern – timing. Aged oils need to be run through LSPI 2-3 weeks following the aging runs.

Martin – Possible to look at one aging stand at a time, can accommodate labs' schedules. All 24 tests do not have to start at same time. Important - do the four aged oils look similar within one lab? If so, proceed to LSPI.

Christian – Need to know what constitutes acceptably similar results to move forward?

Charlie – Can we use our previous analyses used to determine this?

Problem – Those chem analyses were all run in one lab, don't know what lab-to-lab variability we will see.

Martin – Hesitate to put any limits in place before runs. If concern about one aged oil, run another aging test (where will the $$ come from for this?). If remove one test from matrix, will hurt end analysis.

Charlie – other test type developments – always have sense check – hate to finish matrix and not be able to draw conclusions because of discrepancies in the aged oil results.

Andy – good compromise – each lab reviews data with group before LSPI runs.

Martin – power calc. slide in presentation:

Don't usually use two engines in one test, need to consider this calc. this time

Summary – if there is a big change, the matrix design should give us a good chance of spotting it. Not as strong of a chance of this with smaller changes.

Prove out data – suggests we have a good chance of seeing discrimination between the oils.

Martin – Still need two runs reported from prove out tests.

Deegan – One lab had one engine fail prior completing the LSPI run; this is all the data we will have.

Andy – What's the protocol if the oils break engine? Are we just assuming the oils won't break the engine?

Martin – Need valid test out of all runs or lose a lot of resolution in matrix; if lose a test, need to rerun it. If not same stand, use another referenced LSPI stand.

Robert – Need to accommodate that in the wording of how we agree to run this matrix.

Martin – Will need to discuss contingency at the time – if run fails, get together and discuss how to fill that hole, need all 24 runs.

Al – Matrix is trying to prove if run one LSPI stand vs another makes a difference – why does this matter? Martin - Don't understand how the aged oil effect and LSPI stands affect each other. Al – Not seeing the point of this. Have all the data from new oil LSPI in multiple stands, why do we need to prove this for aged oils? Jo – Running in many stands – trying to get coverage of as many stands as possible, will aid in setting up the eventual LTMS.

Doyle – Not even sure how we would design it differently, if we took that element out. If eight tests conducted in same stand, that would cover two ref periods (with two different SAs) which complicates matters also….

Doyle - Actually works out better to include this requirement vs. introducing new variable (multiple SAs).

Andy – What are the fresh oil targets for oils A and B? Martin – both passing oils when fresh (2-3?).

Martin – There are no fresh oil runs in this matrix, will have fresh oil data from prove-out runs.

Martin – Can get data from TMC website (UOLSPI, spreadsheet from (Rich)). Martin will add to chart in presentation and resend to group.

Deegan – Will send spreadsheet to Martin.

Stats group done. Discuss:

Jo – Means for fresh oils: A = 1.6, B=3.3 events.

Andy – Assigning ref oils before and after tests, going to be random or do we want to use same RO for matrix? Rich – will do whatever group wants.

Martin – Stats group did not discuss, can and get back to group with recommendation.

Andy – Case for 224's use exclusively: 221 = more risk of damage. 224 more likely to show severity shifts mild and severe. 221 will only show mild shift.

Rich – Might respectfully disagree with previous comments, but 224 is closer to passing limits, so no problem either way.

Andy – Let's get stats group input. Action – stats group to discuss. Martin will send note to group.

Andy – Having same RO before and after gives better chance of catching drift.

Martin – Might give us false precision estimate, if we take a variable away.

Deegan – Next steps?

Martin – Need vote on matrix? Andy – Not hearing any negatives… unanimous vote?

Deegan – Voice vote: Any negatives? No. Any waives? No. Additional discussion? No.

Stats questions – Use single RO? Any recommendations on if we kill an engine, how to fill that data point hole….

Martin to send note to stats group. Will depend on specific circumstances, need to handle on a case-by-case basis.

Deegan – One more meeting needed at least to discuss funding.

How much oil of each are we going to need?

Rich – Should we issue oil through TMC? Would require timing to get the process set up… but can use blind RO system through TMC. Deegan – Should do this. Any objections? Christian – We know the order, being blind doesn't make a difference, having a testkey will make reporting smoother though.

Rich – We do have a data dictionary in place. Don't have separate used oil LSPI test itself, only for aging. Assume will use current LSPI data dictionary. Al – Maybe add supplemental chem. page? Rich – Yes. Can add chem. sheet from aged to LSPI report for each iteration. Could use aging EOT data as zero hour sample data for LSPI. Could do revision to add supplemental sheet to report, then take it out when matrix is complete. Rich – Can work on this later this week. Call this LSPIA?

Labs – Look at current data dictionary to see if needs to be updated.

Deegan –Labs are working on cleaning up procedure for aging, can put updated version on website within week?

Pat – For the aging portion, if we use one stand, will likely take a month+. Just be aware, there is concern about how long an aged oil sits before LSPI.

Martin – Could run 4 aged, then 4 LSPIs, then 4 aged, then 4 LSPIs. Although 3-4 weeks not a huge concern for group

Pat – Will eventually need a hard limit on the time allowed between aging and LSPI. Don't know answer right now, but will need to define this.

Deegan – Get stats input, have another SP meeting to discuss funding. Have another SP meeting this time next week? Procedure changes, stats group input, then work through funding.

Khaled to send out meeting notice for 19th, 1:00 – 2:30.

Jo – prove-out data, one lab hasn't shown any data at all. Christian will get the Afton data reported. Jo - In the past, all labs have been required to show prove-out data before matrix.

Meeting topics covered, meeting adjourned.

Aged Oil LSPI Precision Matrix Draft

Statistics Group

October 12, 2021

Statistics Group

- Doyle Boese, Infineum
- Jo Martinez, Chevron Oronite
- Martin Chadwick, Intertek
- Richard Grundza, TMC
- Taylor Lagler, Lubrizol
- Todd Dvorak, Afton
- Travis Kostan, SwRI

Initial Precision Matrix Proposal

Below is the current recommendation from the statistics group for the aged oil LSPI precision matrix. It consists of 24 total tests.

Lab A		Lab B	Lab D	Lab G	
LSPI Stand 1	LSPI Stand 2	LSPI Stand 1	LSPI Stand 1	LSPI Stand 1	LSPI Stand 2
Oil A CW Eng.#1	Oil B CW Eng. #1	Oil A CW Eng.#1	Oil B CW Eng. #2	Oil A CW Eng.#2	Oil B CW Eng. #2
Oil B CW Eng. #2	Oil A CW Eng. #2	Oil B CW Eng. #2	Oil A CW Eng. #1	Oil B CW Eng. #1	Oil A CW Eng. #1
Oil B CW Eng. #1	Oil A CW Eng. #1	Oil B CW Eng. #1	Oil A CW Eng. #2	Oil B CW Eng. #2	Oil A CW Eng. #2
Oil A CW Eng. #2	Oil B CW Eng. #2	Oil A CW Eng. #2	Oil B CW Eng. #1	Oil A CW Eng. #1	Oil B CW Eng. #1

Additional Details and Requests:

- Aging is done on a single fixed chainwear stand in each lab, though 2 different engines are used.
- "CW Eng. #1" should be a new chainwear engine.
- "CW Eng. #2" were preferably be on rebuild #4 or later.
- Prior to start of LSPI testing, existing stand-engine combinations to be reviewed by Stats Group
- Aging would be completed on all four samples - followed by consecutive LSPI testing immediately after an acceptable reference in each LSPI stand.
- If the SP desires analysis part way through the matrix, a discussion would need to take place on the best way to run the testing prior to the analysis.
- Perform "aged" oil analysis in the testing lab and in a common lab where sample quantity allows. Consider taking "aged" oil samples after aging, after LSPI flush, and/or after LSPI testing.

Power Calculations

Power (α=0.05)	Effect Size		
Factor (n-size per level)	1s	1.5s	2s
LSPI Stand (4)			
within A or G (4)	0.27	0.51	0.76
CW Engine Age (New vs Old)	0.63	0.93	0.99
CW Engine Hours	0.44	0.78	0.95
Lab			
B vs D (4)	0.26	0.52	0.76
A/G vs B/D (4,8)	0.34	0.63	0.87
A vs G (8)	0.47	0.80	0.96
Oil (12)	0.63	0.93	0.99

- Power represents the probability the matrix would detect a significant difference assuming a real difference equal to the effect size existed.

- At the α=5% significance, there is a probability of 0.27 that this matrix would identify a LSPI stand within lab as statistically significant - if the difference is (1) standard deviation. This increases to a probability of 0.76 if the difference between two LSPI stands in a lab is two standard deviations.
- At the α=5% significance, the probability this matrix would identify a significant difference between Oil A and B if the actual difference is only (1) standard deviation is 0.63 and it increases to 0.99 if the difference is (2) standard deviations.

Prove Out Data

- RMSE of adjusted prove out data (0.2572) is lower than the severity adjustment standard deviation for the Sequence IX of 0.3775.
  - Model is IND Only
- The difference between aged oils means is 4+ s using the RMSE of the five runs and 2.9 s when using the Sequence IX SA s.

Summary of Fit

RSquare	0.879507
RSquare Adj	0.839343
Root Mean Square Error	0.257156
Mean of Response	2.108721
Observations (or Sum Wgts)	5

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
AAGED	1.6693150	0.14846907	1.66931
BAGED	2.7678308	0.18183673	2.76783

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	2.2185729	0.117375	18.90	0.0003*
IND[AAGED]	-0.549258	0.117375	-4.68	0.0184*