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COMMITTEE D02 ON PETROLEUM PRODUCTS, LIQUID FUELS, AND LUBRICANTS

Issued: Jan. 13, 2017

Reply to: Dan Worcester
Southwest Research Institute
6220 Culebra Rd.
San Antonio, TX 78238
Phone: 210.522.2405
Email: dworcester@swri.org

These are the unapproved minutes of the 01.10.2017 Sequence VI Conference Call.

The meeting was called to order at 10:00 AM Eastern Time by Greg Miranda.

Agenda

The Agenda is the included as Attachment 1.

1.0 Roll Call

The Attendance list is Attachment 2. Katerina Pecinovsky replaces Dave Glaenzer as voting member for Afton.

2. **Approval of Meeting minutes from November 07 , 2016 Seq. VI SP meeting**

Motion #1: Approve the Surveillance Panel minutes.

2.1 Greg made the motion and Adrian seconded.

2.2 The vote received unanimous approval.

3. **Old Business and Update Item Review**

3.1 VID Extension taskforce update

Adrian noted that the VID continues. Lubrizol removed their VID. SwRI has one calibrated engine running.

3.2 VIE hardware taskforce update

There was discussion on the methods to introduce the GM kit engines. There will be a lab survey to see the number of stands available for support for this effort. There will also be a survey on the remaining OHT-2 engines. Adrian will send the survey for the stands. There are 79 OHT-2 engines remaining. OHT will send a survey for engines needed. Scott is working on the final parts list for another kit order. There will need to be a letter with pricing. Adrian will have a conference call Thursday 01.19.2017 to discuss these issues.

4. **New Business**

4.1 Proposal for revision of VIE stand/engine calibration requirements – Adrian Alfonso

The existing procedure requires a mini-calibration every 4-5 weeks with a new engine replacement. Dave Glaenzer recommended a calibration every 90 days as there are usually minimal or no adjustments on these calibrations

Motion [Adrian] This motion was tabled for a later meeting. Labs are to go back and review current calibration data for RPM, Torque, Fuel Flow, Exhaust Back Pressure and Air Fuel Ratio.
Related to this, the VIE procedure is out for ballot so any changes will require an information letter.

4.2 VIF Precision Matrix analysis review

Jo Martinez gave the Stats Group Presentation. See Attachment 3.

The analysis is based on 18 valid tests. Changes in baseline weighting could improve response, 8% for FEI 1 and 11% for FEI 2. There appears to be a change in engine hour response, there is a shift in separation of the reference oils, and the second test on engines has the mildest response. FEI 1 is best if compared to BLB 2 only, not BLB2 and BLA as is done on the VIE. FEI 2 also shows better response when compared only to BLA. Slide 4 shows the tests used for analysis. There needs to be more data, especially RO 1011 data as the second run on an engine. New engines would be preferred and the Stat Group could develop a test matrix. Dave noted that all of the matrix was on OHT-1 engines and all labs are now running the OHT-2 version. There is not a shift in response in the VIE at this point. Todd indicated labs might be able to get more runs per engine. Andy gave is response for the questions on Slide 16 as “no, no, no, yes, no, yes and Option 3”.

Greg felt more discussion is needed and a there is a Face to Face meeting planned in February. Jim recommended the meeting take place before the AOAP meeting so recommendations could be made.

5.0 Next Meeting.

5.1 Proposal: Face-to-Face meeting week of February AOAP meeting in San Antonio, TX

5.2 Objective: Finalize VIF discussion.

There will be another conference call 01.17.2017 at 10:00 AM Eastern Time to continue discussion.

Rich noted that there is a typo in the procedure that will be corrected with an information letter. Labs will need to prepare to offer stands for approval of the new BL-5 baseline oil. There is a quantity of BL-4 still available at TMC.

The meetings adjourned at 11:50 AM.

Sequence VI Surveillance Panel Conference Call Agenda
January 10, 2017 @ 10:00-12:00 EST

Audio Connection

Call-in Number: +1-415-655-0001
Conference Code: 190 653 723

Webex Meeting URL:
https://meetings.webex.com/collabs/#/meetings/detail?uuid=M034A11Q4KYXQ6LAPFHIXEA79X-20XT&rnd=309323.72794

1. **Roll Call (start 10:05 EST)**

   1.1. SP Membership changes and additions

2. **Approval of Meeting minutes from November 7, 2016 Seq. VI SP meeting**

3. **Old Business and Update Item Review**

   3.1. VID Extension taskforce update

   3.2. VIE hardware taskforce update

4. **New Business**

   4.1. Proposal for revision of VIE stand/engine calibration requirements – Adrian Alfonso

   4.2. VIF Precision Matrix analysis review

5. **Next Meeting**

   5.1. Proposal: Face-to-Face meeting week of February AOAP meeting in San Antonio, TX.
   5.1.1. Objective: Finalize VIF discussion.

6. **Meeting Adjourned**

ASTM SEQUENCE VI

Name	Email/Phone	Company	Attend
Adrian Alfonso **Voting Member**	Phone: (210) 838-0431 Adrian.Alfonso@intertek.com	Intertek	ATTEND
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Haiying Tang **Voting Member**	Phone: (248) 512-0593 HT146@Chrysler.com	Chrysler	
Dan Worcester **Voting Member**	Phone: (210) 522-2405 Dan.Worcester@swri.org	SwRI	ATTEND

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ASTM SEQUENCE VI

Name	Email/Phone	Company	Attend

VOTE				
Adrian Alfonso **Voting Member**				
Jason Bowden **Voting Member**				
Timothy Caudill **Voting Member**				
Tim Cushing **Voting Member**				
Rich Grundza **Voting Member**				
Jeff Hsu **Voting Member**				
Teri Kowalski **Voting Member**				
Dan Lanctot **Voting Member**				
Brian Marks **Voting Member**				
Greg Miranda **Voting Member**				
Katerina Pecinovsky **Voting Member**				
Andy Ritchie **Voting Member**				
Ron Romano **Voting Member**				
Clifford Salvesen **Voting Member**				
Kaustav Sinha **Voting Member**				
Haiying Tang **Voting Member**				
Dan Worcester **Voting Member**				

VIF Precision Matrix Analysis

Statistics Group

January 11, 2017

Statistics Group

- Arthur Andrews, ExxonMobil
- Doyle Boese, Infineum
- Jo Martinez, Chevron Oronite
- Kevin O'Malley, Lubrizol
- Martin Chadwick, Intertek
- Richard Grundza, TMC
- Lisa Dingwell, Afton
- Todd Dvorak, Afton
- Travis Kostan, SwRI

Summary

- Analyses include the results of 18 valid precision matrix tests which reflects the surveillance panel's decisions
- Simulations suggest a change in baseline weighting could improve test precision (estimated standard deviation decreases as much as 0.02% (8% reduction) for FEI1; 0.02% (11% reduction) for FEI2)
- Analyses indicate that engines may not differentiate oils similarly
- These data suggest that second run tests may be the highest. In particular, higher than first run tests. This could have implications on the engine hours corrections, engine calibration, and/or severity adjustments
- It is not clear, based on the data obtained, whether a nonlinear type of engine hours correction or lack of consistency in oil discrimination across the engines and engine life or combination of these effects exists

Input is needed from the surveillance panel for analysis to proceed – some options are provided

PM Data for Analysis

- Precision Matrix (PM):
  - On 11-7-16 the surveillance panel passed a motion to include 18 tests in the statistical analysis.

Run Order	EOT Engine Hours	SwRI #1		SwRI #2		IAR #1		IAR #2	
1	350	Stage 1 Sense Check	543 112952-VIF	Stage 2 Sense Check	1011 112953-VIF	Stage 1 Sense Check	542-2 112957-VIF	Stage 2 Sense Check	1011 112955-VIF Baseline Shift
2	550		542-2 112951-VIF		542-2 116037-VIF		543 112958-VIF		543 113824-VIF
3	750		542-2 113818-VIF		1011 112954-VIF		543 113823-VIF		1011 112956-VIF
4	950		543 113819-VIF		543 113820-VIF		542-2 113822-VIF EBP Calibration Shift 542-2 113231-VIF		542-2 116030-VIF
5	1150	1011 117508-VIF		543 113821-VIF Worn Throttle Controller 543 [illegible]-VIF		1011 116832-VIF		542-2 116031-VIF Baseline Shift	
6	1350	543 117626-VIF		1011 117509-VIF		543 113825-VIF		1011 117495-VIF	
7	1550	542-2 116038-VIF		542-2 117511-VIF		1011 117496-VIF		543 117494-VIF	
8	1750	1011 117510-VIF				542-2 117493-VIF			

Excluded From Analysis

LZ	
Additional Testing	1011 118268-VIF
	543 118267-VIF
	542-2 119631-VIF
	1011 119628-VIF

Test Reported | Under Review | Invalid

- Table is from Frank Faber's 6-21-16 matrix update plus 4 additional tests

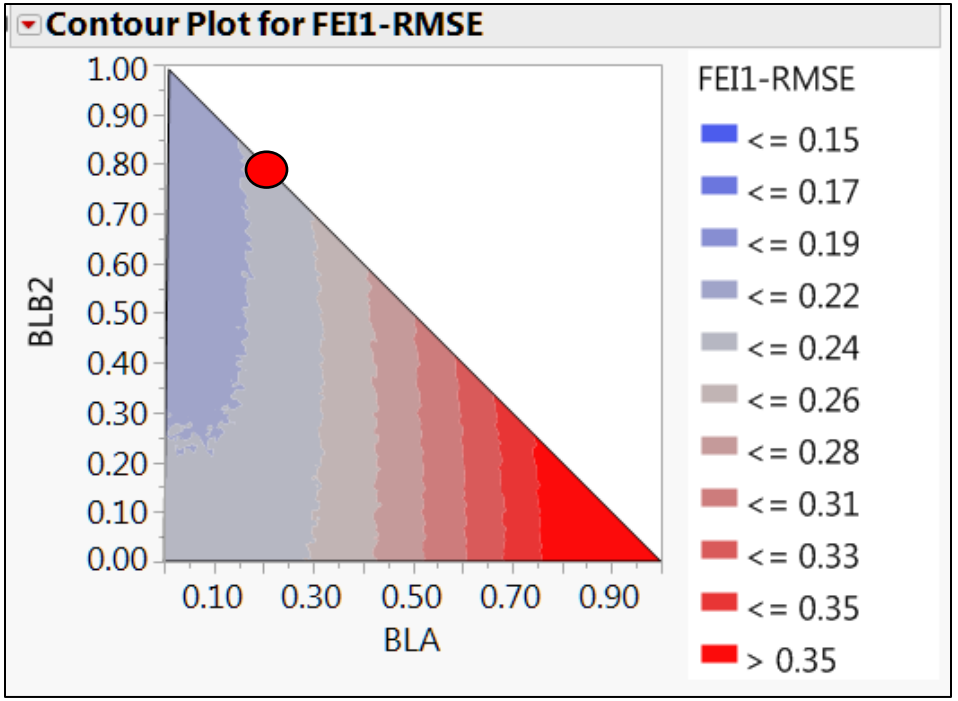
Evaluating Baseline Weight Scenarios

- Excel Program developed to evaluate 10,000 different weight combinations of BLB1, BLB2, and BLA
- Excel based prediction model for precision (RMSE) included Lab, Eng(Lab), Oil, and EngHr factors
- All BL weight combinations summed to a value of 1.0
- For those runs that included a BLB3, BL weights were applied to BLB2 & BLB3 in lieu of BLB1 & BLB2
- Results are shown on the following slides

Evaluating Baseline Weight Scenarios

- Plot of RMSE vs. baseline (BL) weight combinations for FEI1 shown below:
  - RMSE of weights can be interpreted from plot- if BL weights sum to 1.0
  - VID & VIE FEI1 Baseline weights are 80% & 20% (shown in red circle)
  - VIF test precision can be improved with weight factor of 1.0 for BLB2

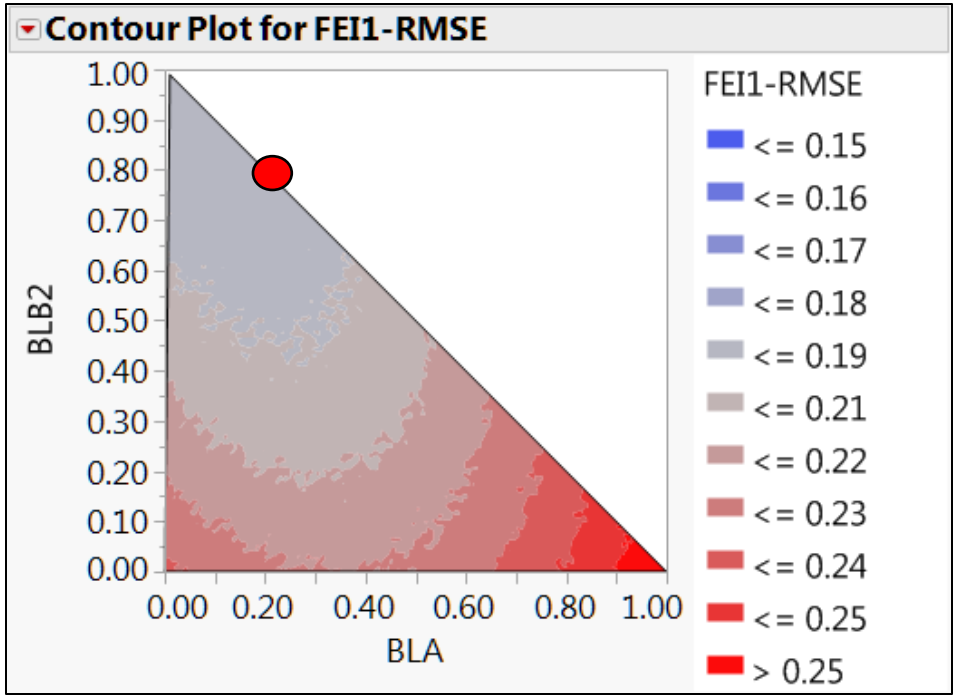
VIF Precision - BL Weights			
BLB1	**BLB2**	**BLA**	**FEI1-RMSE**
0	0.8	0.2	0.2225
0	1	0	0.2050



Evaluating Baseline Weight Scenarios

- Plot of RMSE vs. BL weight combinations for FEI1-with 1st run data deleted is shown below *(n = 14)*
  - VID & VIE FEI1 Baseline weights are 80% & 20% (shown in red circle)
  - Traditional BL weights appear to be better suited for this reduced data set
  - BL shifts tend to be higher during first run tests & may affect the BL weights and RMSE

VIF Precision - BL Weights			
BLB1	**BLB2**	**BLA**	**FEI1-RMSE**
0	0.8	0.2	0.1896
0	1	0	0.1912

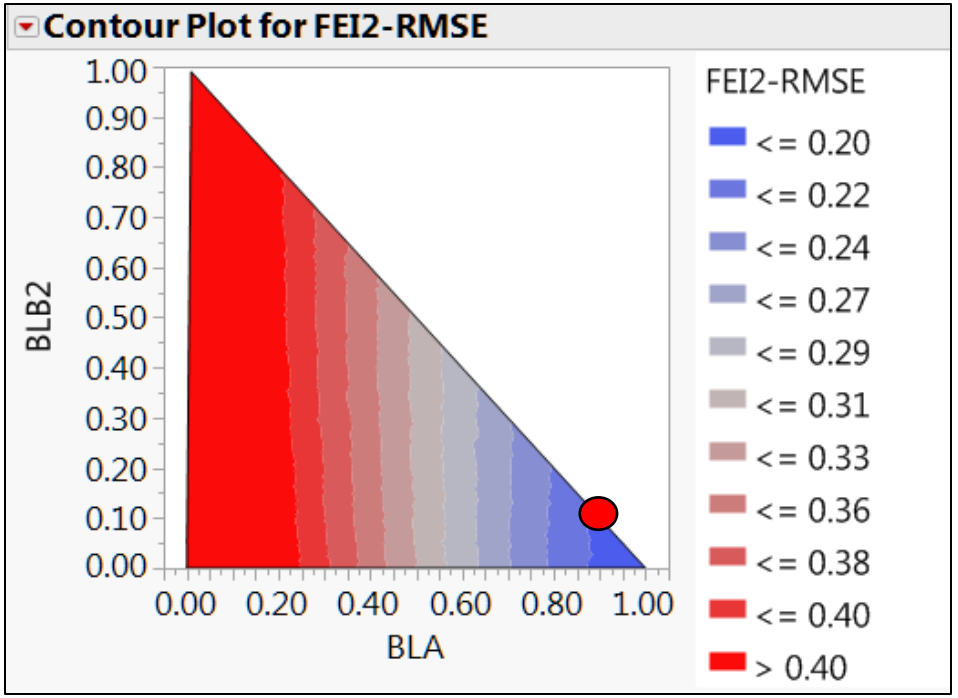


Evaluating Baseline Weight Scenarios

- Plot of RMSE vs. baseline weight combinations for FEI2 shown below
  - RMSE of weights can be interpreted from plot- if BL weights sum to 1.0
  - VID & VIE FEI2 Baseline weights are 10% & 90% (shown in red circle)
  - Test precision can be decreased with other BL weighting combinations

VIF Precision - BL Weights				
BLB1	**BLB2**	**BLA**	**FEI2-RMSE**	**EngHr Factor**
0	0.1	0.9	0.1971	Yes
0	0	1	0.1753	Yes
0	0	1	0.1775	No[1]

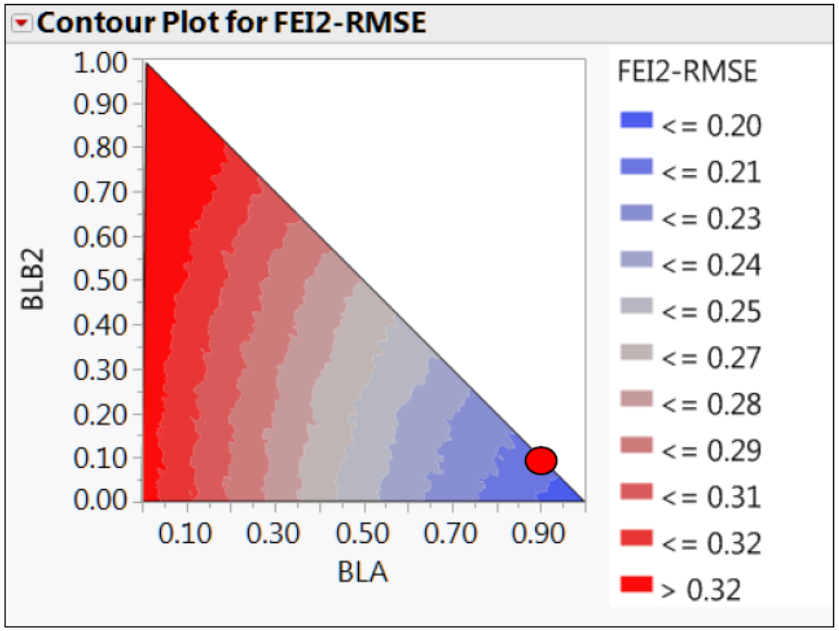
Note 1: Plot shown at right includes engine hour factor



Evaluating Baseline Weight Scenarios

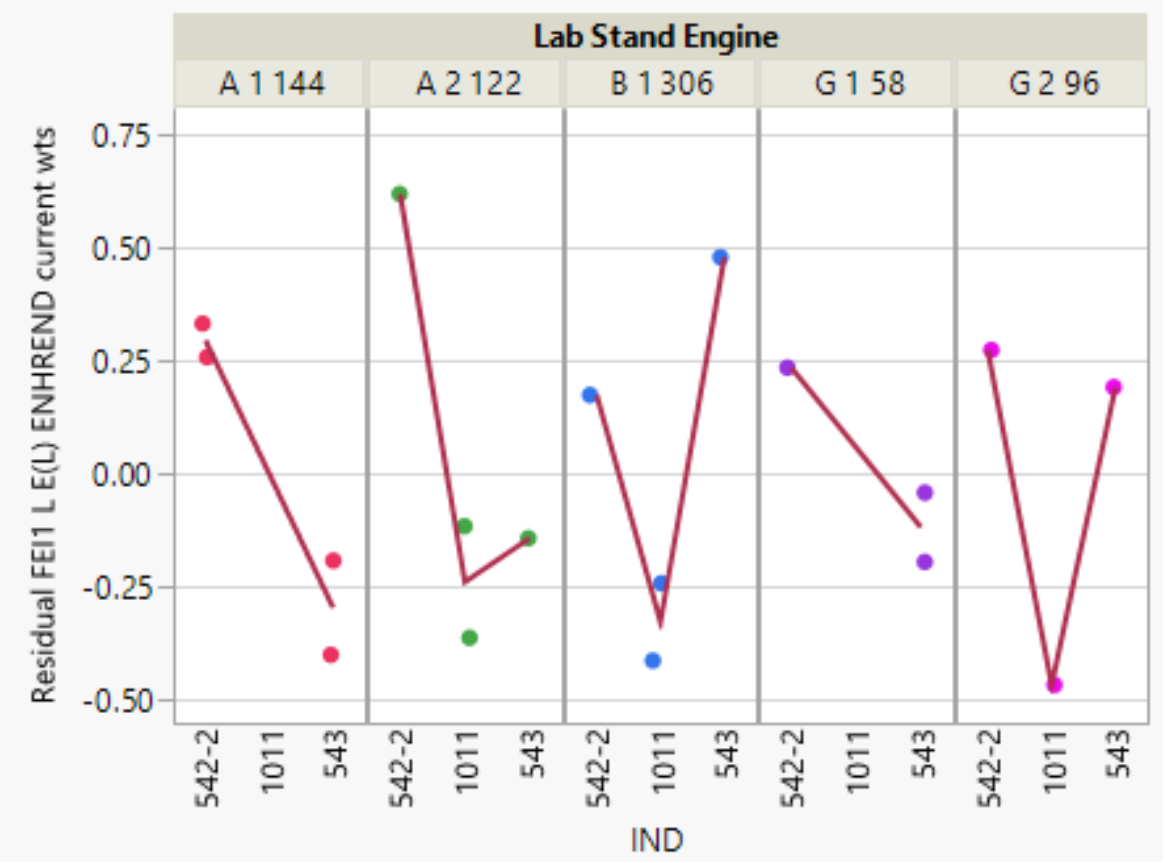
- Plot of RMSE vs. BL weight combinations for FEI2-with 1st run data deleted is shown below *(n = 14)*
  - VID & VIE FEI1 Baseline weights are 10% & 90% (shown in red circle)
  - Precision can be slightly improved with revised BL weights

VIF Precision - BL Weights			
BLB1	**BLB2**	**BLA**	**FEI2-RMSE**
0	0.1	0.9	0.2059
0	0.0	1.0	0.1910



Oil Discrimination Consistency – FEI1

- Engines do not appear to separate oils the same way, but caution should be used when basing conclusions on limited data.
- Similar differences are observed when baseline weights are used which improve test precision as shown in previous slides (100% BLB2 chosen as a representative)

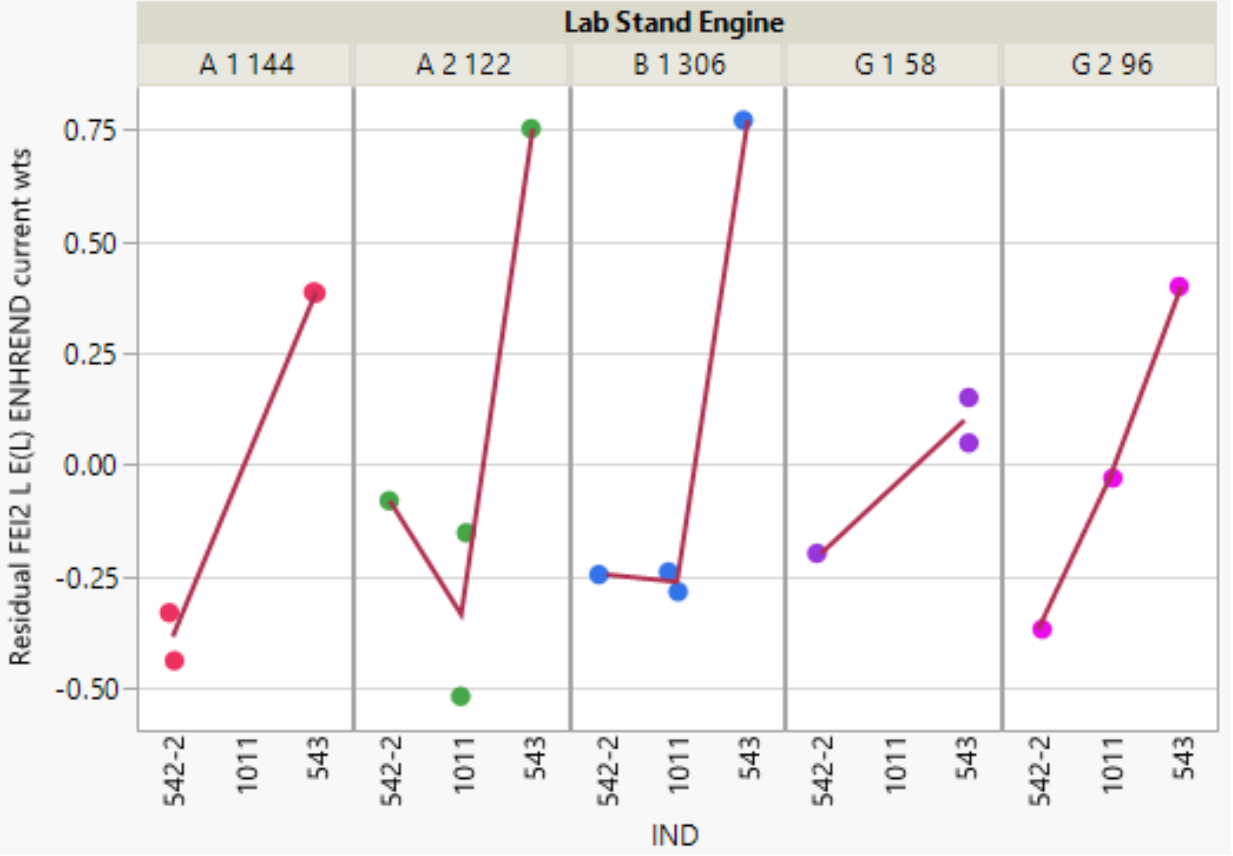


Plot assumes current/historical baseline weights: 80%BLB2 and 20% BLA

Residuals are based on models with LTMSLAB, ENGNO(LTMSLAB), and ENHREND effects

Oil Discrimination Consistency – FEI2

- Engines do not appear to separate oils the same way, but caution should be used when basing conclusions on limited data.
- Similar differences are observed when baseline weights are used which improve test precision as shown in previous slides (100% BLA chosen as a representative)

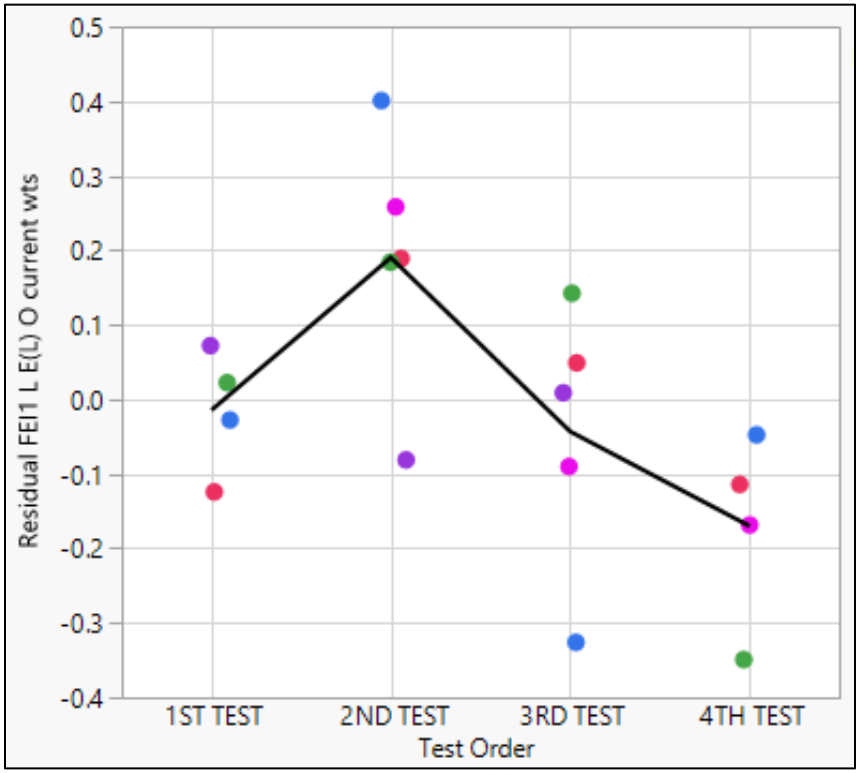


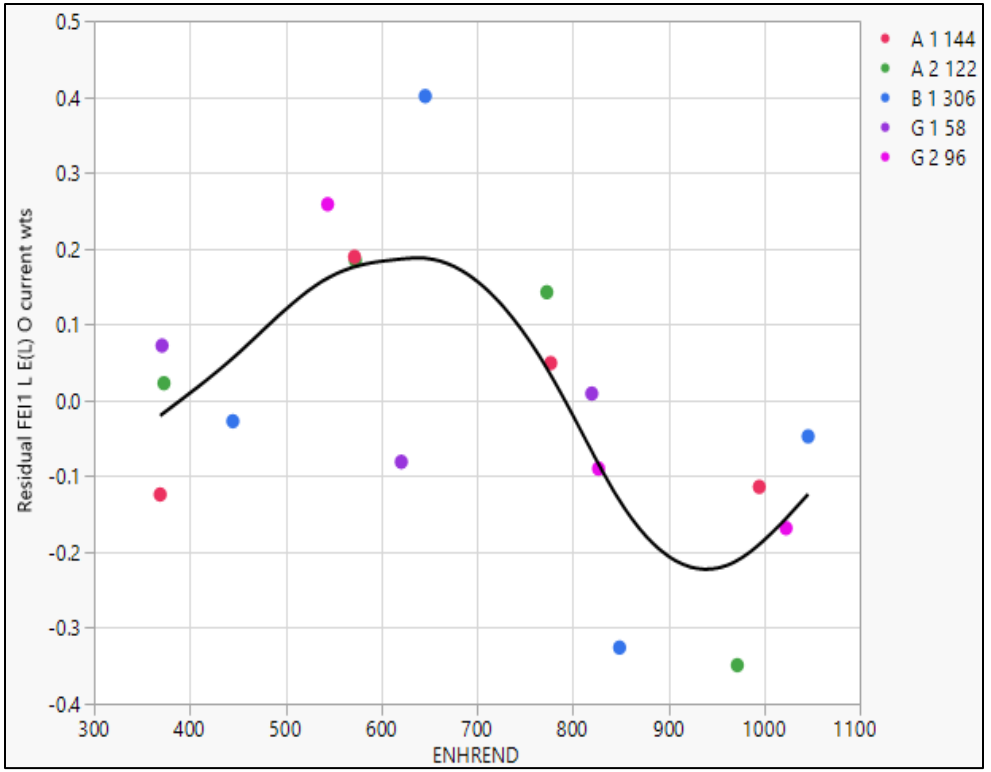
Plot assumes current/historical baseline weights: 10%BLB2 and 90% BLA

Residuals are based on models with LTMSLAB, ENGNO(LTMSLAB), and ENHREND effects

Engine Hours Effect– FEI1

- The second tests run within engines are generally the highest (in particular, higher than the first test). This could have implications on the engine hours correction used and/or engine calibration/severity adjustments.
  - Engine hour corrections in this situation are viable – See Appendix for one possibility
- Similar effect is observed when baseline weights are used which improve test precision as shown in previous slides (100% BLB2 chosen as a representative)



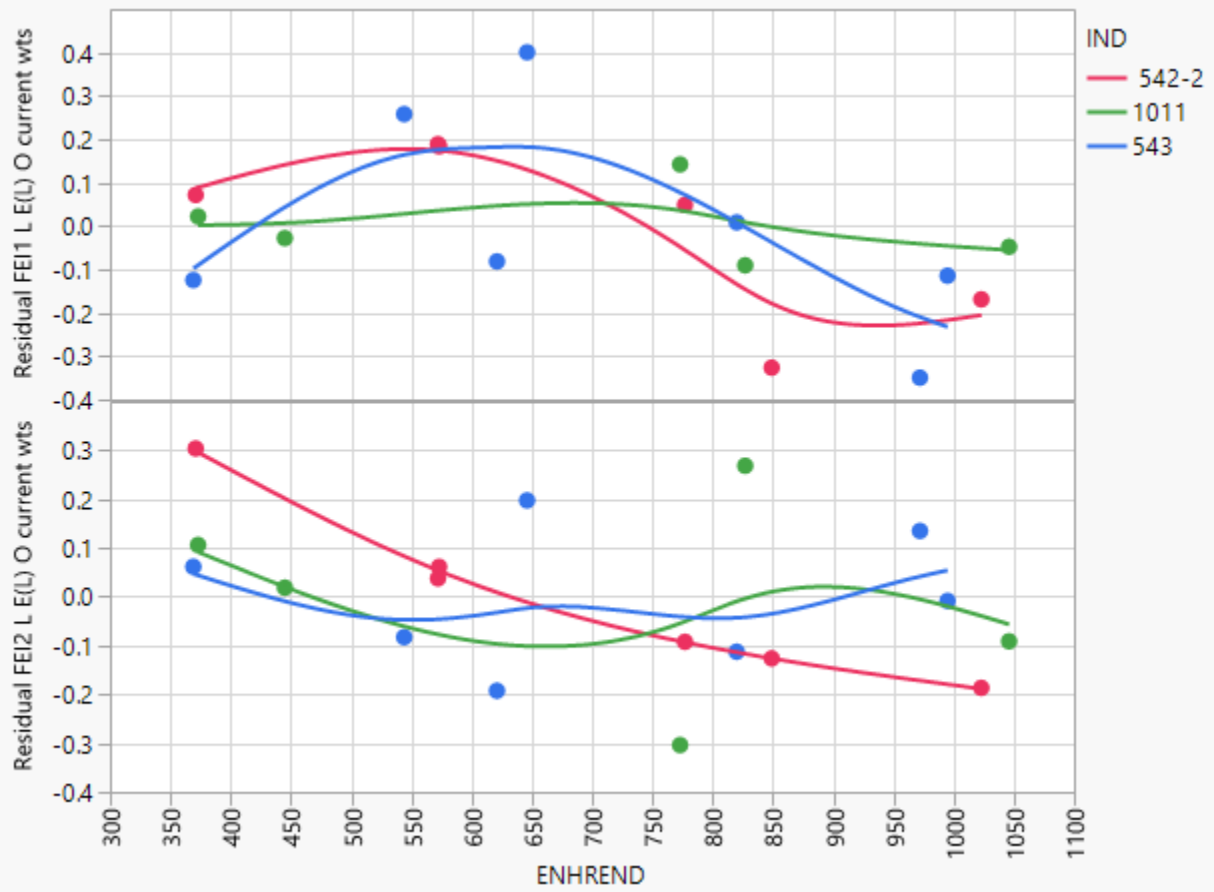


Plots assume current/historical baseline weights: 80%BLB2 and 20% BLA

Residuals are based on models with LTMSLAB, ENGNO(LTMSLAB), and Oil effects

FEI2 - Engine Hours Effect

- For FEI2, 542-2 tends to have a different engine hours effect compared to the other oils
- Although the engine hour effects for oils in FEI1 don't significantly differ, it should be pointed out that the results of the second tests within engines have an influence on the observed engine hours trend. In particular, there is lack of 1011 data in this range of engine hours.



Similar FEI2 effect is observed when baseline weights are used which improve test precision as shown in previous slides (100% BLA chosen as a representative)

Plots assume current/historical baseline weights: 80%BLB2 and 20% BLA

Residuals are based on models with LTMSLAB, ENGNO(LTMSLAB), and Oil effects

Evaluating Different FEI1 Modeling Scenarios

- Different FEI1 models[1] were evaluated by changing the Base Line Weights, Engine Hour effect coding, and elimination of 1st run test data.
  - For the full data set (*n=18*), the minimum RMSE corresponds to BL weights of 1.0 and 0.0 for BLB2 and BLA, respectively.
  - For the reduced data set (no first run data n=14), the minimum RMSE corresponds to the traditional BL weights of 0.8 and 0.2 for BLB2 and BLA, respectively.
  - A table of the various scenarios that were evaluated is provided below.

	Model	N Size	BLB2 Weight	BLA Weight	Model RMSE	Piece-Wise EngHr	EngHr *p* value	LSMeans			*Contrast Significant (p ≤ 0.05)*		
								RO_1011 (A)	RO_542-2 (B)	RO_543 (C)	A - B	A - C	B - C
	FEI1	18	0.8	0.2	0.2225	No	0.132	1.45	2.23	1.88	Yes	Yes	Yes
	FEI1	18	0.8	0.2	0.1965	Yes (Hrs=646)	0.031	1.47	2.22	1.87	Yes	Yes	Yes
No First Run	FEI1	14	0.8	0.2	0.1896	No	0.018	1.55	2.15	1.90	Yes	No	No
	FEI1	18	1.0	0.0	0.2050	No	0.001	1.47	2.22	1.89	Yes	Yes	Yes
	FEI1	18	1.0	0.0	0.1866	Yes (Hrs=646)	0.003	1.51	2.21	1.87	Yes	Yes	Yes
No First Run	FEI1	14	1.0	0.0	0.1912	No	0.009	1.52	2.08	1.87	Yes	No	No

[1] *Models are based on LTMSLAB, ENGNO(LTMSLAB), and Engine Hour factors (Regular vs. Piecewise)*

Evaluating Different FEI2 Modeling Scenarios

- Different FEI2 models[1] were evaluated by changing the Base Line Weights, Engine Hour effect coding, and elimination of 1st run test data.
  - For the full data set (*n=18*), the minimum RMSE corresponds to BL weights of 0.0 and 1.0 for BLB2 and BLA, respectively.
  - For the reduced data set (no first run data n=14), the minimum RMSE corresponds to BL weight of 1.0 for BLA.
  - A table of the various scenarios that were evaluated is provided below.

	Model	N Size	BLB2 Weight	BLA Weight	Model RMSE	Piece-Wise EngHr	EngHr *p* value	LSMeans RO_1011 (A)	LSMeans RO_542-2 (B)	LSMeans RO_543 (C)	*Contrast Significant (p ≤ 0.05)* A - B	A - C	B - C
	FEI2	18	0.1	0.9	0.1971	No	0.208	1.41	1.52	2.25	No	Yes	Yes
	FEI2	18	0.1	0.9	0.2057	Yes (Hrs=646)	0.380	1.42	1.52	2.24	No	Yes	Yes
No EngHrs	FEI2	18	0.1	0.9	0.1941	No Hr Factor	N/A	1.37	1.42	2.26	No	Yes	Yes
No First Run	FEI2	14	0.1	0.9	0.2059	No	0.658	1.36	1.42	2.26	No	Yes	Yes
	FEI2	18	0.0	1.0	0.1753	No	0.569	1.40	1.52	2.24	No	Yes	Yes
	FEI2	18	0.0	1.0	0.1771	Yes (Hrs=646)	0.720	1.40	1.52	2.39	No	Yes	Yes
No EngHrs	FEI2	18	0.0	1.0	0.1775	No Hr Factor	N/A	1.37	1.45	2.27	No	Yes	Yes
No First Run	FEI2	14	0.0	1.0	0.1910	No	0.837	1.45	1.45	2.27	No	Yes	Yes

[1] *Models are based on LTMSLAB, ENGNO(LTMSLAB), and Engine Hour factors (Regular, Piecewise, and none)*

Questions for the Surveillance Panel

- Should we treat the 1st run results differently than the remaining tests?
- Should we change the baseline weights?
- Should we pursue a non-linear engine correction factor?
- Should we consider tests beyond the first 4?
- Should we consider FEI2, exclusively?
- Should additional testing be pursued to understand which effect(s) are "real" (oil discrimination consistency across engines, oi discrimination across engine hours, and test order)?

Options:

1. In the opinion of the SP the VIF data indicates performance that was not taken into account during the matrix design. Additional test development or additional test data designed to better quantify these differences is necessary. The industry will consider redevelopment or the stats group will provide additional matrix runs in an attempt to help clarify the current concerns.

   - Absolute Minimum (Engine 1: 542-2, 1011 and Engine 2: 543, 1011); 3 or 4 runs per engine is better

   - Preferred (3 to 5 engines; 6 to 8 runs per engine; revised break-in?)

2. In the opinion of the SP the VIF may perform in a fundamentally different manner from the VIE. The analysis should take this into account and minimize the variability of the available VIF data set by considering different BL weights, engine hour correction calculation methods, run limitations, etc. with the understanding that individual data points will carry significant weight in determining these changes due to the small data set available.

3. In the opinion of the SP the VIF should be similar to the VIE and any disagreement between the VIE methods of analyzing the results with the VIF matrix data is caused by the small data set available for analysis. The VIF analysis should proceed using the same BL weights, engine hour correction calculation methods, run limitations, etc. as the VIE used.

   - Engine referencing should include two tests

   - Gather 5th run (6th if we allow 3 candidates) data similar to the VIE

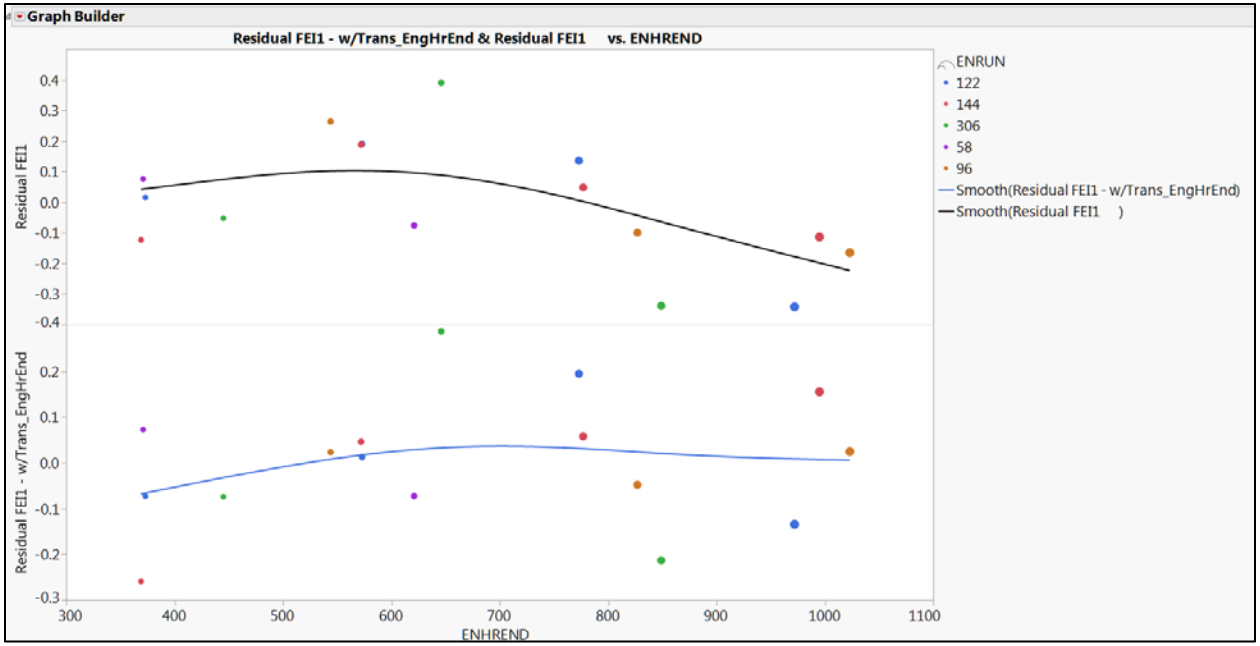
   - Revisit assumptions with more data

APPENDIX

Engine Hours Effect – FEI1

- Based on a [1]residual analysis, piecewise engine hour adjustment may be a viable alternative for FEI1.
  - If EngHrEnd > 646 then *Trans_EngHrEnd = (EngHrEnd – 646)*
  - If EngHrEnd ≤ 646 then *Trans_EngHrEnd = 0*

		VIF Precision - BL Weights			
Trans_EngHrEnd at 646	**EngHrEnd *p* value**	**BLB1**	**BLB2**	**BLA**	**FEI1-RMSE**
No	0.132	0	0.8	0.2	0.2225
No	0.001	0	1	0	0.2050
Yes	0.031	0	0.8	0.2	0.1965
Yes	0.003	0	1	0	0.1866



[1]Residuals are based on models with LTMSLAB, ENGNO(LTMSLAB), and Oil effects