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COMMITTEE D02 on PETROLEUM PRODUCTS, LIQUID FUELS, AND LUBRICANTS

Issued: 05.05.2020

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 04.30.2020 Sequence VI Conference Call.

The meeting was called to order at 1:02 PM Central Time by Chair Andrew Stevens.

1.0 The Agenda is Attachment 1.

2.0 Roll Call. Attendance is Attachment 2. There were no member changes.

3.0 Old Business

MOTION: Approve minutes from the 04.23.2020 conference call.
Rich, Jeff second. There was unanimous approval of the minutes.

3.1 The 04.23.2020 minutes are posted at:

http://www.astmtmc.cmu.edu/ftp/docs/gas/sequencevi/minutes/VIMinutes20200423ConferenceCall.pdf

4.0 New Business

4.1 There is an e-ballot for alternate fuel supplier procedure.

4.2 GM voted negative. This meeting was called to discuss the points for the negative.

There was discussion on the steps considered for the negative vote.
See Attachment 3 for the GM steps to consider. The FEI2 Severity Task Force Report is included as Attachment 4. This was discussed as Todd did an analysis of fuel response for the VIE test in particular comparing the Michigan to the Texas versions. There was a comment that engine differences override any differences in fuel batches.

There was further discussion of analysis of the fuel related to Item #1. DHA was discussed in detail.

Item #2 covered a desire for a history of fuel analysis. SwRI has records of DHA over the last few years. A discussion took place on comparing fuel economy not FEI response. Reference data only would be used. A motion was made to this effect:

MOTION: Review data to compare BL for different fuel batches.

Discussion on this motion indicated it might not resolve a difference as all data to be reviewed would be the same supplier. There was no further action, and the motion did not receive a second.

Discussion moved to Item #3. Unwashed gums should be performed on the fuel over a period of time.

MOTION: Monitor unwashed gums for VIE fuel.
Tim, Robert second.

This should be done before fuel ships. It was confirmed that when the large batch was made, the additive treatment was done as part of that batch, not as the truck leaves for delivery. There is a new specification being developed by the TGC Fuels Task Force.

It was noted the contract for the current fuel batch includes unwashed gums be done every quarter. Haltermann will review the contract and report back with that data.

There were still several items to cover, so the meeting adjourned and another will be scheduled to continue discussion of the items.

The meeting adjourned at 2:30 PM Central time.

Sequence VI Surveillance Panel Call Meeting Agenda
April 30, 2020 @ 2:00-3:30 EST

Webex Meeting Details Below Agenda

1. **Roll Call (start 2:05 EST)**

   1.1. SP Membership changes and additions

2. **Old Business**

2.1	Approve meeting minutes from 4/23/20 call	Andrew Stevens

3. **New Business**

3.1	GM Concerns with Alternative Fuel Supplier Proposal	Panel

4. **Next Meeting**

   4.1. SP Meeting: TBD

5. **Meeting Adjourned**

ASTM SEQUENCE VI

Name	Email	Company	Attend

VOTING MEMBERS

Ben Maddock	Ben.Maddock@AftonChemical.com	Afton	ATTEND
Brianne Hockkeppel	Brianne.Hockkeppel@bp.com	BP	
Kevin Brodwater	KBrodwater@chevron.com	Chevron	ROBERT
Haiying Tang	HT146@Chrysler.com	Chrysler	ATTEND
Tracey King	TKing@h-c-s-group.com	CS Group	ATTEND
Ron Romano	rromano@ford.com	Ford	ATTEND
Paul Rubis	paul.j.rubas@exxonmobil.com	ExxonMobil	ATTEND
Jim Carter	jcarter@gageproducts.com	Gage	ATTEND
Aleise Gauer	aleise.gauer@gm.com	GM	ATTEND
Prasad Tumati	ptumati@jhaltermann.com	Haltermann	ATTEND
Andy Ritchie	Andrew.Ritchie@infineum.com	Infineum	ATTEND
Adrian Alfonso	Adrian.Alfonso@intertek.com	Intertek	ATTEND
Andrew Stevens	andrew.stevens@Lubrizol.com	Lubrizol	ATTEND
Jason Bowden	jhbowden@ohtech.com	OHT	ATTEND
Jeff Hsu	j.hsu@shell.com	Shell	ATTEND
Dan Worcester	Dan.Worcester@swri.org	SwRI	ATTEND
Dan Lanctot	dlanctot@tei-net.com	TEI	ATTEND
Rich Grundza	reg@astmtmc.cmu.edu	TMC	ATTEND
Teri Kowalski	Teri.Kowalski@tema.toyota.com	Toyota	
Amol Savant	acsavant@valvoline.com	Valvoline	ATTEND

ASTM SEQUENCE VI

Name	Email	Company	Attend
Ed Altman	Ed.Altman@aftonchemical.com	Afton	
Bill Anderson	Bill.anderson@aftonchemical.com	Afton	
Bob Campbell	Bob.Campbell@aftonchemical.com	Afton	ATTEND
Lisa Dingwell	Lisa.Dingwell@AftonChemical.com	Afton	
Todd Dvorak	Todd.Dvorak@aftonchemical.com	Afton	ATTEND
Terry Hoffman	Terry.Hoffman@aftonchemical.com	Afton	
Christian Porter	Christian.Porter@aftonchemical.com	Afton	
Jeremy Styer	Jeremy.Styer@aftonchemical.com	Afton	
Clifford Salvesen	Clifford.R.Salvesen@exxonmobil.com	EM	
Jonathan VanScoyoc	VANSCJ@cpchem.com	CPChem	ATTEND
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Jerry Brys	Jerome.Brys@lubrizol.com	Lubrizol	
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Will O'Ryan	William.ORyan@Lubrizol.com	Lubrizol	ATTEND
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Ian Elliot	IanElliott@chevron.com	Oronite	
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Robert Stockwell	rsto@chevron.com	Oronite	ATTEND
Dan Engstrom	daniel.engstrom@swRI.org	SwRI	ATTEND
Travis Kostan	Travis.Kostan@swRI.org	SwRI	ATTEND

ASTM SEQUENCE VI

Name	Email	Company	Attend
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Chris Taylor	Chris.Taylor@vpracingfuels.com	VP Racing Fuels	

MOTION:				
Ben Maddock				
Brianne Hockkeppel				
Kevin Brodwater				
Haiying Tang				
Tracey King				
Ron Romano				
Clifford Salvesen				
Jim Carter				
Aleise Gauer				
Prasad Tumati				
Andy Ritchie				
Adrian Alfonso				
Andrew Stevens				
Jason Bowden				

ASTM SEQUENCE VI

Name	Email	Company	Attend

Jeff Hsu				
Dan Worcester				
Dan Lanctot				
Rich Grundza				
Teri Kowalski				
Amol Savant				

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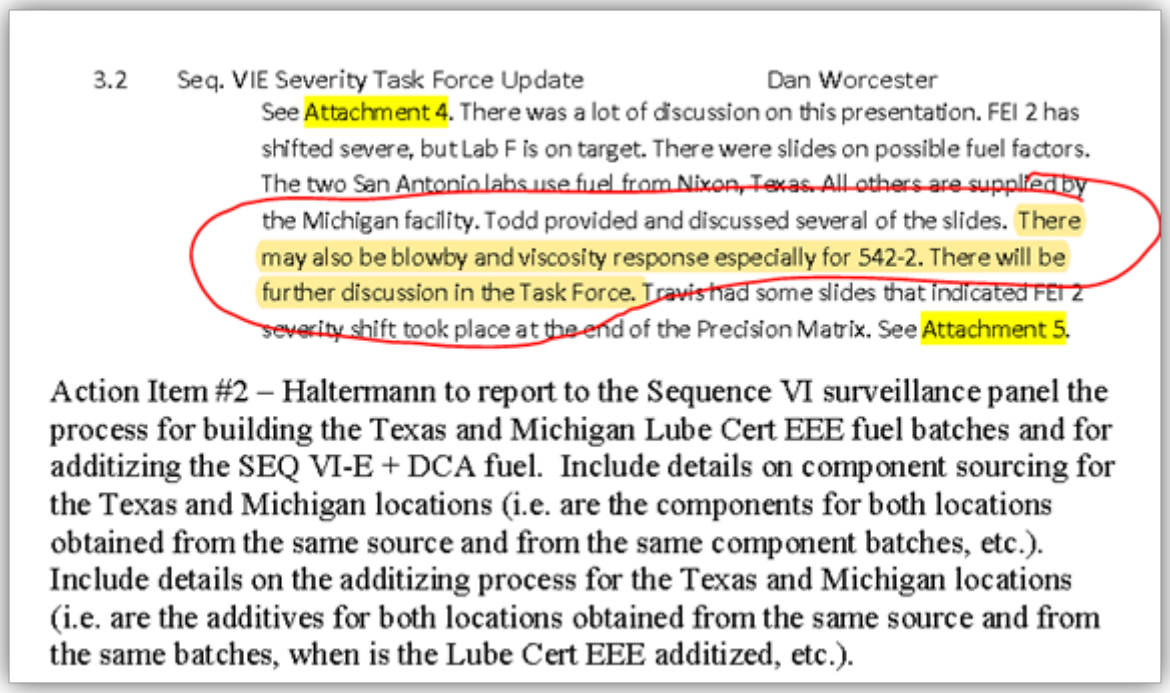
Rich Grundza				
Teri Kowalski				
Amol Savant				

April 30, 2020

30003 Fisher Brothers Road
Warren, MI 48093

1. If the test is run against reference and there is no prohibition or limitations on changing fuels from a reference run to a candidate run, then the precision matrices for the test should have incorporated this variable (two fuels at the ends of largest DHA fuel property spec range(s)). There is no way to know what impact changing fuel has without this analysis. There is no way to know how this potential change in fuels will impact stand severity either without data.

2. If a fuel parameter data collection process was instituted at the onset of the new Seq VI test, we would have the ability right now to utilize that information today to: 1.) better determine what parameters do/do not contribute to test variation, 2.) validate the fuel deliveries are meeting the requirements (trust but verify). In the highlighted section below: what were the findings of this? Was it blowby and response or was it fuel?



3.2 Seq. VIE Severity Task Force Update — Dan Worcester

See Attachment 4. There was a lot of discussion on this presentation. FEI 2 has shifted severe, but Lab F is on target. There were slides on possible fuel factors. The two San Antonio labs use fuel from Nixon, Texas. All others are supplied by the Michigan facility. Todd provided and discussed several of the slides. There may also be blowby and viscosity response especially for 542-2. There will be further discussion in the Task Force. Travis had some slides that indicated FEI 2 severity shift took place at the end of the Precision Matrix. See Attachment 5.

Action Item #2 – Haltermann to report to the Sequence VI surveillance panel the process for building the Texas and Michigan Lube Cert EEE fuel batches and for additizing the SEQ VI-E + DCA fuel. Include details on component sourcing for the Texas and Michigan locations (i.e. are the components for both locations obtained from the same source and from the same component batches, etc.). Include details on the additizing process for the Texas and Michigan locations (i.e. are the additives for both locations obtained from the same source and from the same batches, when is the Lube Cert EEE additized, etc.).

3. VIE development suffered from fuel related deposits issues. Is there any data supporting deposit variation with current modified test fuel? Deposit control additive which was added to solve deposit issues has not been measured since VIE inception and needs to be understood before entertaining an alternate fuel. The unwashed gums test should be performed on the test fuel for a period of time in order to understand its stability in the test labs fuel storage systems. Previous studies of ASTM Sequence III piston deposit composition have indicated the test fuel as the major contributor. Industry standard deposit tests Sequence

III and GMOD should be conducted with Sequence VI altered fuels to assess the deposit forming tendencies of the current and proposed test fuels.

4. According to Annex A18.8, you can mix up to 10% of one fuel into another fuel. 90/10 was recently implemented and there is not any data on this blending practice. There should be statistical analysis performed before this blending ratio is implemented.

5. Test standard deviation in the VIE is higher than it is in VID. VID was based on 100s of hours of actual vehicle fuel efficiency analysis. Adding additional variation in fuel pushes the test even further away from its intent in vehicle correlation.

6. In section A18.4 of the latest ballot stating "A18.4 If the criteria in both A18.3.1 and A18.3.2 are not satisfied for both FEI1 and FEI2, then conduct an additional four tests on another engine, followed by another ANOVA model. Continue this process until both criteria have been satisfied for both parameters." What was the criteria?

7. Section A18.7 of the ballot it states, "Each laboratory can choose which approved fuel to use for individual stands." What is the criteria for MTAC?

8. Section A18.5 of the ballot states "Run all tests on the same fuel used to calibrate the stand." Once a 90/10 mix of fuel is mixed there should be a calibration done with the mixture. Once that mixture runs out another calibration should be performed using the new batch of fuel.

9. Replicating the fuel economy (FE) performance of an internal combustion engine (ICE) measured in a given lab to any other lab equipped with another engine of the same design is as you know an incredibly difficult task. The many interactions of the engine hardware, state of the engine (tolerances, wear, metallurgy, etc…), combustion and crankcase ventilation gases, test fluids, lab operation and measurement variability, to name a few, all interact to impact the empirical measurements. Therefore, by definition, controlling as many of these variables is necessary for precise measurements. And while the proposed "A18 Alternate Fuel Approval Requirements" try to minimize the test measurement variability at the time of testing, adding additional approved test fuel sources will likely increase the test variation over time. Here are a couple practical issues with approving second sources of test fuels in D8114-2019b.
    a. Test fuels inherently age over time and change their response in tests; they oxidize, they weather (lose volatile hydrocarbons), they change on the molecular level depending on how they are stored. What is approved today, will be different tomorrow. If anti-oxidants are added to control oxidation during storage stability, small differences in type and concentration from one formulation to another will impact the engine test differently.
    b. Test fuels are purchased with a Certificate of Analysis to assure some level of blending repeatability, however unfortunately there is no known correlation between any known CofA test and the measurement of FE in an engine. There are many first order relationships, such as a fuel's energy content to ICE engine heat release that correlate to FE, but none of these have the precision necessary to qualify small lubricant formulation differences.
    c. Seemingly small changes from one test fuel supplier recipe to the next can impact the lubricant response, potentially unintentionally biasing the result. This is true of basefuel hydrocarbon components, oxygenates, and additives. Even if two test fuels pass the proposed Fuel Approval Requirements, the interaction of the detailed lubricant chemistry with multiple fuel chemistries is

likely to be different. For example, one fuel chemistry may favor one type of lubricant oxidation inhibitor, while another test fuel would favor another type.

Test fuel batches made to the same blending recipe are known to potentially have different responses in test engines. For this reason and those outlined above keeping a single source of test fuel, common to all lubricant FE qualification tests, has been and shall be the best practice.

10. Upon completion of an alternate fuel supplier's successful prove out testing statistical data analysis, ASTM needs to provide documentation to support the ILSAC / EPA guidance letter.

11. GM disagrees with the proposal of adding an alternate fuel supplier without going through the necessary steps of verifying the fuel to see if it's suitable for VIE. We wouldn't have a choice but to take appropriate steps to protect ourselves if this proposal passes.

Sequence
VIE FEI 2 Response Shift Task Force

SOUTHWEST RESEARCH INSTITUTE®

WINTER 2017

Task Force Members

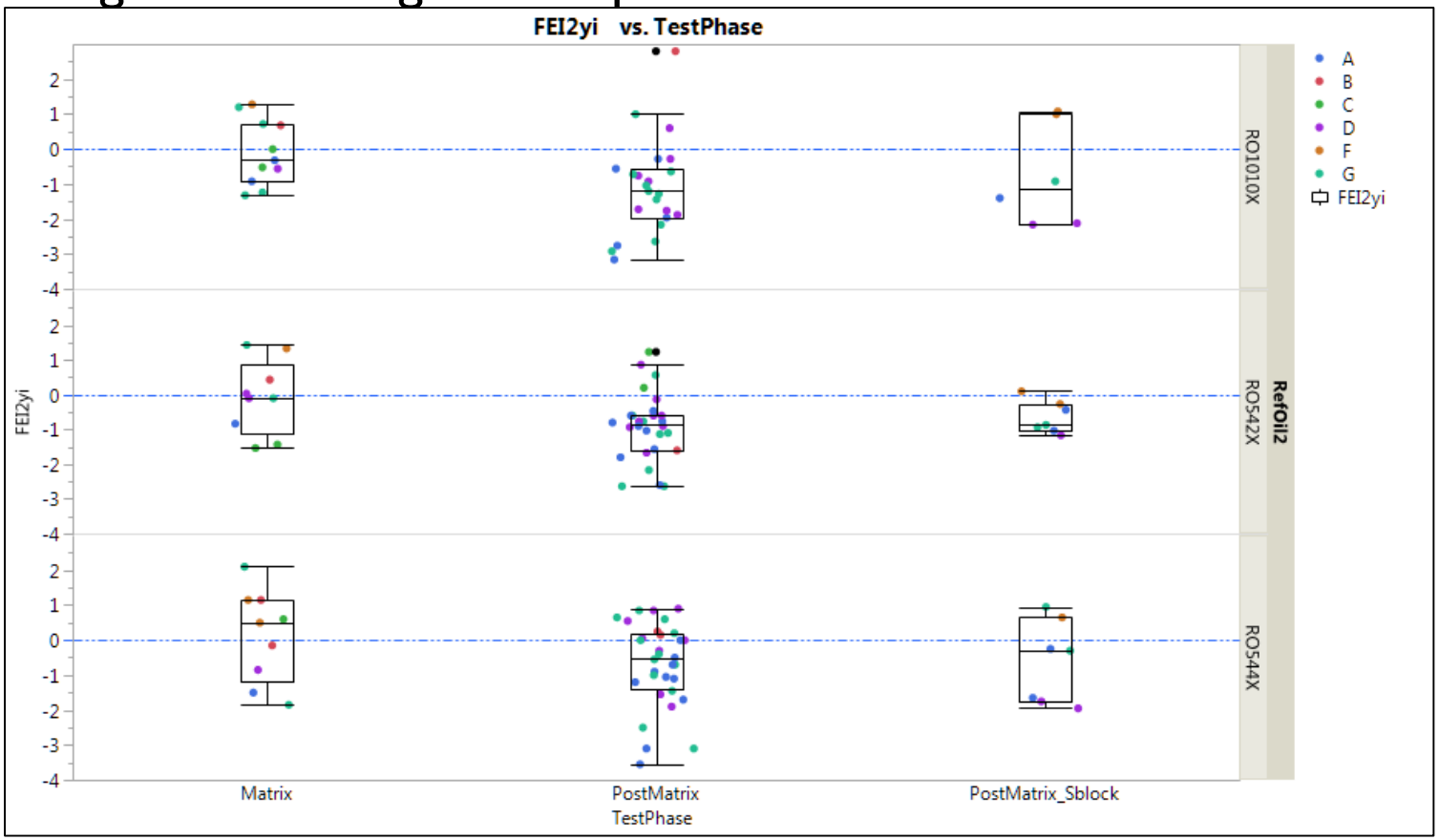
Adrian Alfonso	Intertek
Jerry Brys	Lubrizol
Bill Buscher	Intertek
Todd Dvorak	Afton
Rich Grundza	TMC
Charlie Leverett	Infineum
Katerina Pecinovsky	Afton
Cliff Salvesen	ExxonMobil
Andrew Stevens	Lubrizol
Amol Savant	Valvoline
Dan Worcester	SwRI

Task Force Scope

The Task Force will review data, chemical analysis for the 109 hour aging, and other factors for the VIE test looking for a root cause for a response shift affecting FEI 2.

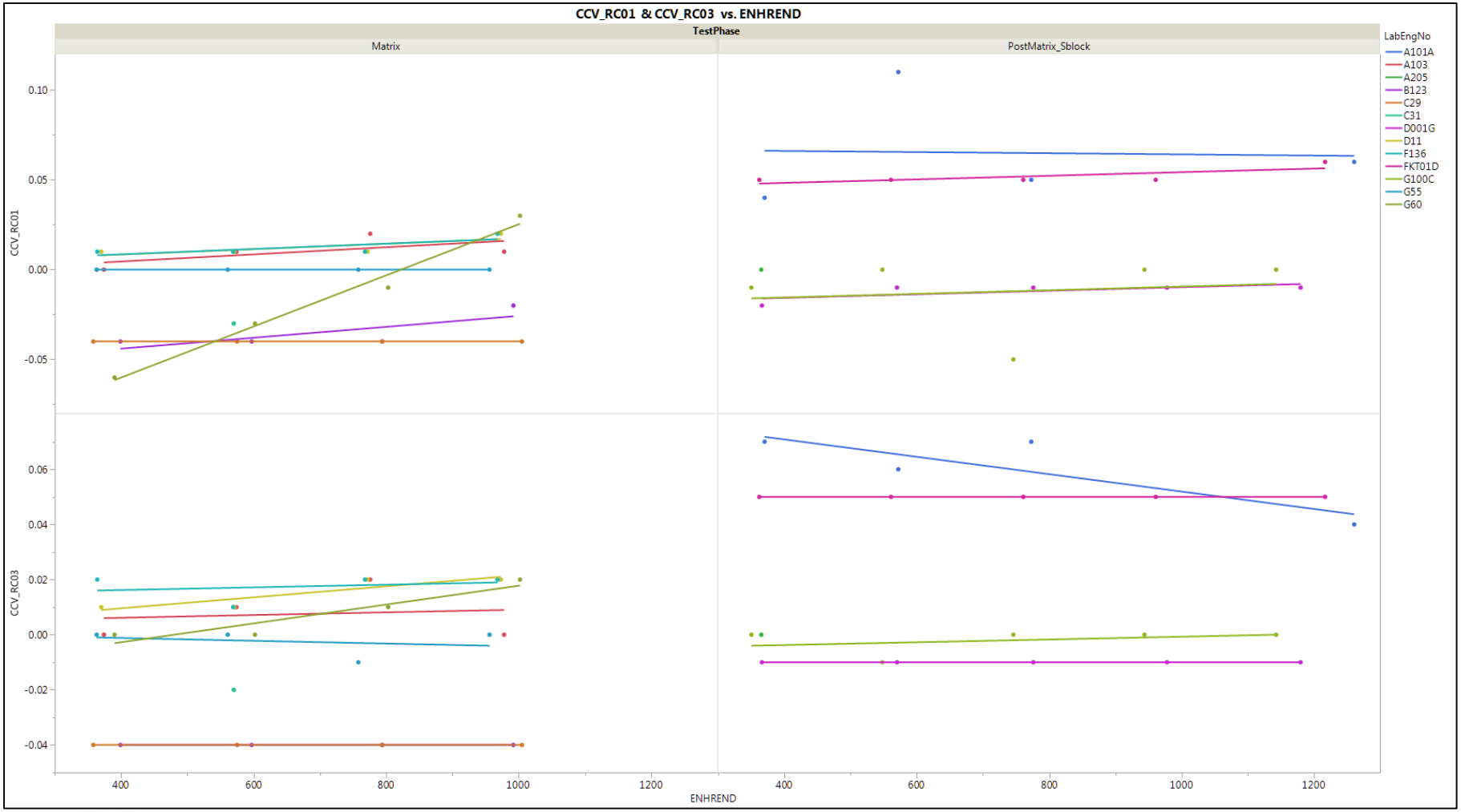
Review of VIE Data

- Plot of VIE $FEI2Y_i$ Chart provided by Todd Dvorak
  - Data suggests that the $FEI2Y_i$ performance has shifted severe of target - following the VIE precision matrix.



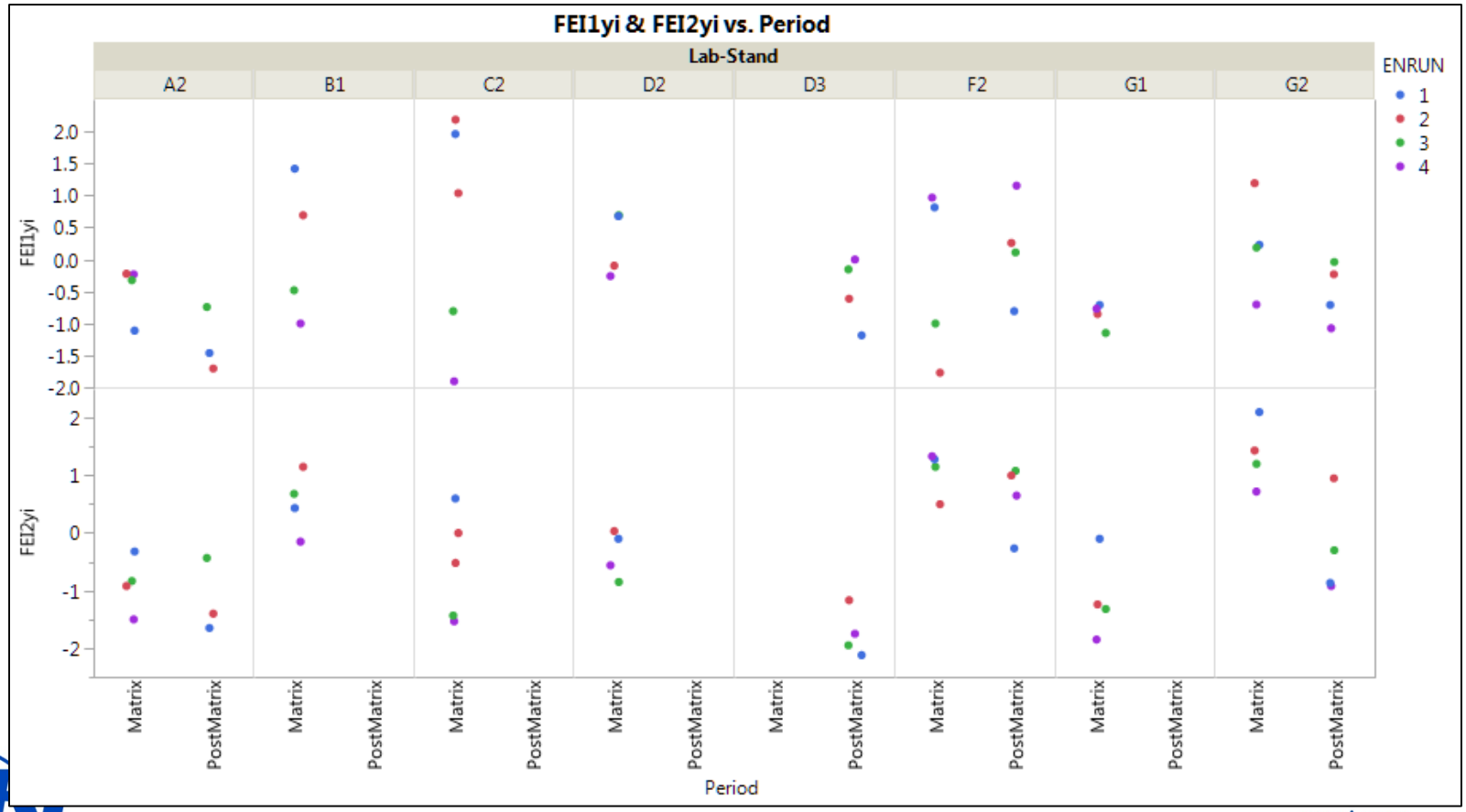
Review of VIE Data

Crankcase pressure is higher with PostMatrix SBEngines



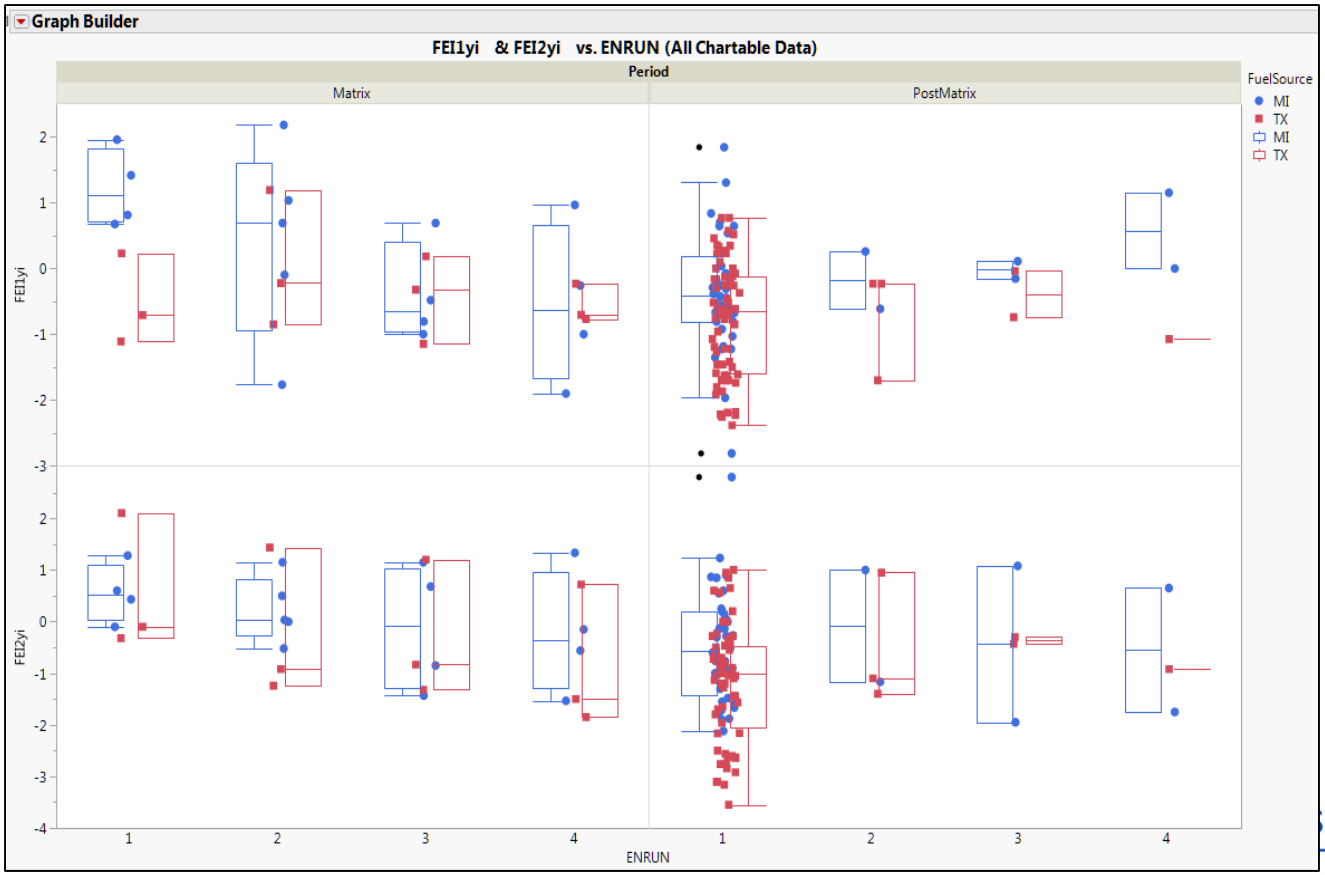
Lab-Stand Comparison of PM and PPM Test Severity

- Plot of Precision Matrix and Short Block Post Matrix data by Lab-Stand combination
  - General trend of test being more severe during PostMatrix



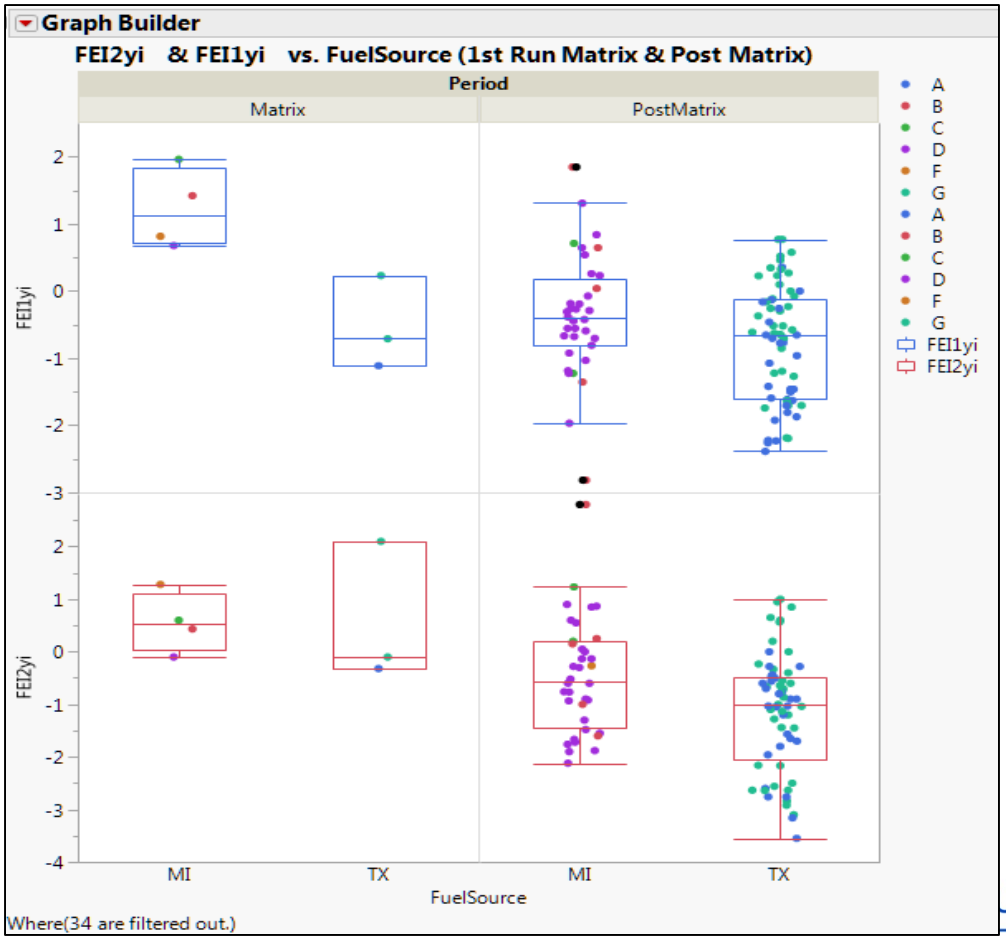
VIE Analysis of Fuel Source Analysis

- Plot of all chartable FEI_Yi data by test run, period (Matrix vs. PostMatrix) and fuel source (Texas vs. Michigan)
  - Plot may suggest difference in FEI2_Yi during PostMatrix)



VIE Analysis of Fuel Source Analysis

- Plot of all chartable FEI_Yi 1st run data by Fuel Source and Period



VIE Analysis of Fuel Source Analysis

- Analysis of FEI1 chartable PM and SBM data
  - Analysis suggests fuel source is significant.
    - Fuel source confounded with test laboratory

Response FEI1_OR

Whole Model

Actual by Predicted Plot

Residual by Predicted Plot

Summary of Fit

RSquare	0.868613
RSquare Adj	0.823449
Root Mean Square Error	0.241403
Mean of Response	1.841818
Observations (or Sum Wgts)	44

Analysis of Variance

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|	VIF
Intercept	2.0857973	0.119807	17.41	<.0001*	.
RefOil[RO1010-1]	-0.042199	0.05231	-0.81	0.4258	1.4545655
RefOil[RO542-2]	0.6232552	0.055366	11.26	<.0001*	1.4680865
ENHREND	-0.000403	0.000169	-2.39	0.0230*	1.0624665
LTMSLAB [A]:Eng_2[ENG101A]	0.0495838	0.136006	0.36	0.7178	2.2147037
LTMSLAB [C]:Eng_2[ENG29]	-0.067018	0.122399	-0.55	0.5878	1.2328292
LTMSLAB [D]:Eng_2[ENG001G]	0.0407069	0.135007	0.30	0.7650	2.5021777
LTMSLAB [F]:Eng_2[ENG136]	-0.205149	0.135231	-1.52	0.1391	2.5105006
LTMSLAB [G]:Eng_2[ENG100C]	0.1535584	0.169852	0.90	0.3727	3.9604634
LTMSLAB [G]:Eng_2[ENG55]	0.0714538	0.120395	0.59	0.5570	1.989868
FuelSource[MI]	0.0756464	0.037917	2.00	0.0546	1.0653179
Period[Matrix]	0.1524663	0.1037	1.47	0.1513	7.2974641

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
RefOil	2	2	9.2765911	79.5928	<.0001*
ENHREND	1	1	0.3324074	5.7041	0.0230*
Eng_2[LTMSLAB]	6	6	0.3620312	1.0354	0.4209
FuelSource	1	1	0.2319524	3.9803	0.0546
Period	1	1	0.1259715	2.1617	0.1513

RefOil | ENHREND | Eng_2[LTMSLAB] | Period

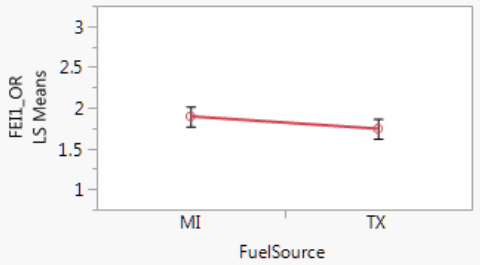
FuelSource

Leverage Plot

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
MI	1.8936224	0.05958571	1.91440
TX	1.7423295	0.06007136	1.74632

LS Means Plot



VIE Analysis of Fuel Source Analysis

- Analysis of FEI2 chartable PM and SBM data
  - Analysis suggests fuel source is not significant.

Response FEI2_OR

Whole Model

Actual by Predicted Plot

Residual by Predicted Plot

Summary of Fit

RSquare	0.634647
RSquare Adj	0.509057
Root Mean Square Error	0.223663
Mean of Response	1.601364
Observations (or Sum Wgts)	44

Analysis of Variance

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|	VIF
Intercept	1.7865754	0.111003	16.09	<.0001*	.
RefOil[RO1010-1]	0.1591073	0.048466	3.28	0.0025*	1.4545655
RefOil[RO542-2]	0.0498451	0.051298	0.97	0.3385	1.4680865
ENHREND	-0.000311	0.000156	-1.99	0.0555	1.0624665
LTMSLAB [A]:Eng_2[ENG101A]	0.0891297	0.126011	0.71	0.4845	2.2147037
LTMSLAB [C]:Eng_2[ENG29]	-0.200763	0.113404	-1.77	0.0862	1.2328292
LTMSLAB [D]:Eng_2[ENG001G]	-0.071605	0.125086	-0.57	0.5710	2.5021777
LTMSLAB [F]:Eng_2[ENG136]	-0.043949	0.125294	-0.35	0.7281	2.5105006
LTMSLAB [G]:Eng_2[ENG100C]	0.0383168	0.15737	0.24	0.8092	3.9604634
LTMSLAB [G]:Eng_2[ENG55]	0.2709102	0.111548	2.43	0.0210*	1.989868
FuelSource[MI]	0.0347819	0.03513	0.99	0.3296	1.0653179
Period[Matrix]	0.0971397	0.09608	1.01	0.3196	7.2974641

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
RefOil	2	2	1.0083526	10.0785	0.0004*
ENHREND	1	1	0.1976136	3.9503	0.0555
Eng_2[LTMSLAB]	6	6	0.9441128	3.1455	0.0154*
FuelSource	1	1	0.0490376	0.9803	0.3296
Period	1	1	0.0511350	1.0222	0.3196

RefOil | ENHREND | Eng_2[LTMSLAB] | Period

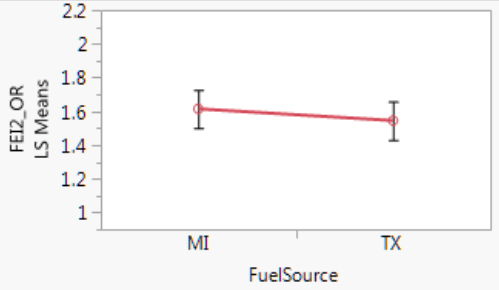
FuelSource

Leverage Plot

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
MI	1.6148582	0.05520690	1.61520
TX	1.5452943	0.05565686	1.58316

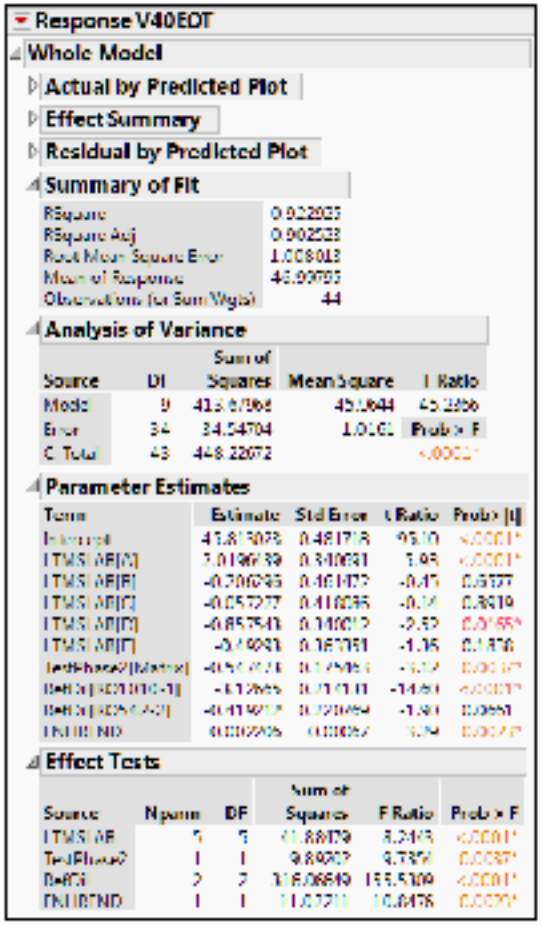
LS Means Plot

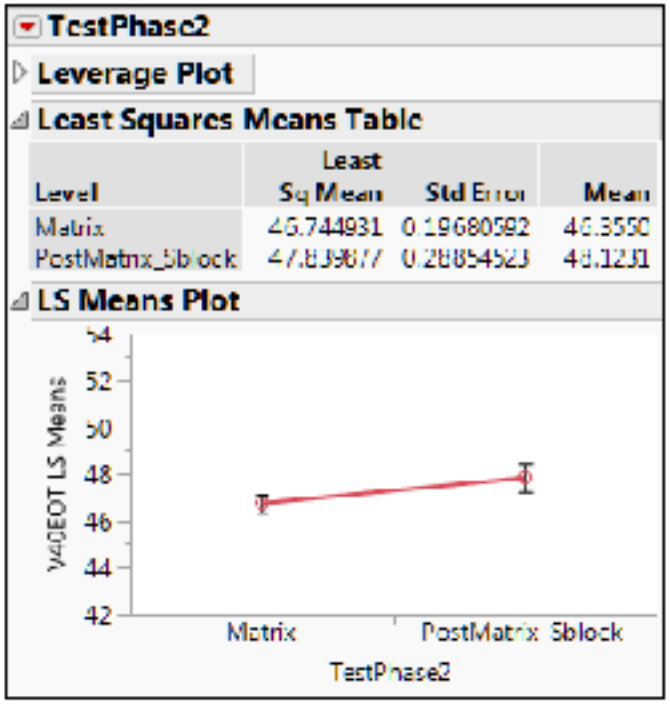


Review of VIE Data

Analysis of VIE Reference Oil Viscosity Data

- KV40 EOT Oil Analysis (PM n = 28[1] & n = 16 SBM)
  - Analysis suggests significant increase in KV40 EOT viscosity between the 2 test phases (PM-EOT-KV40 < SBM-EOT-KV40)



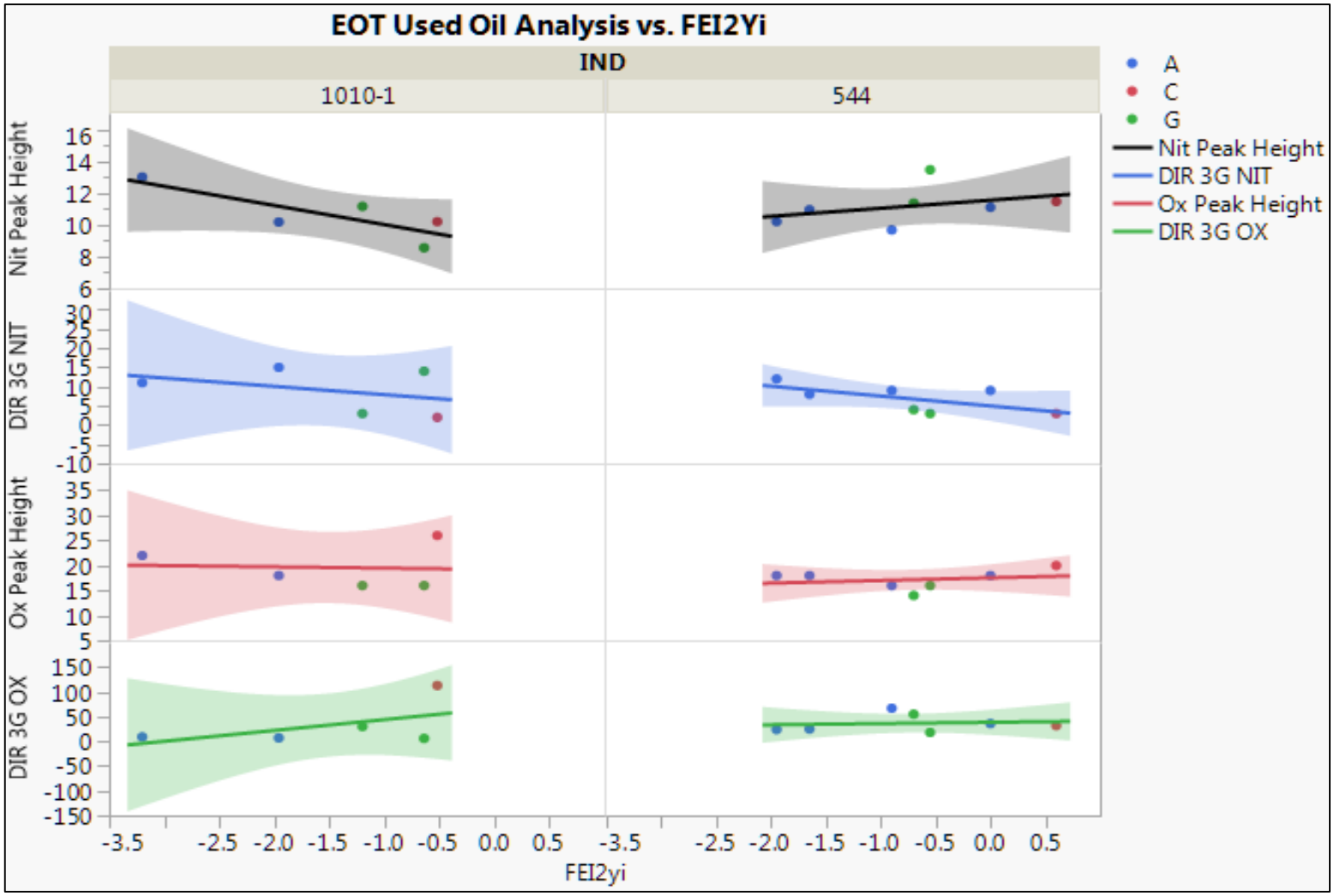


Note 1: One observation missing PM EOT viscosity data

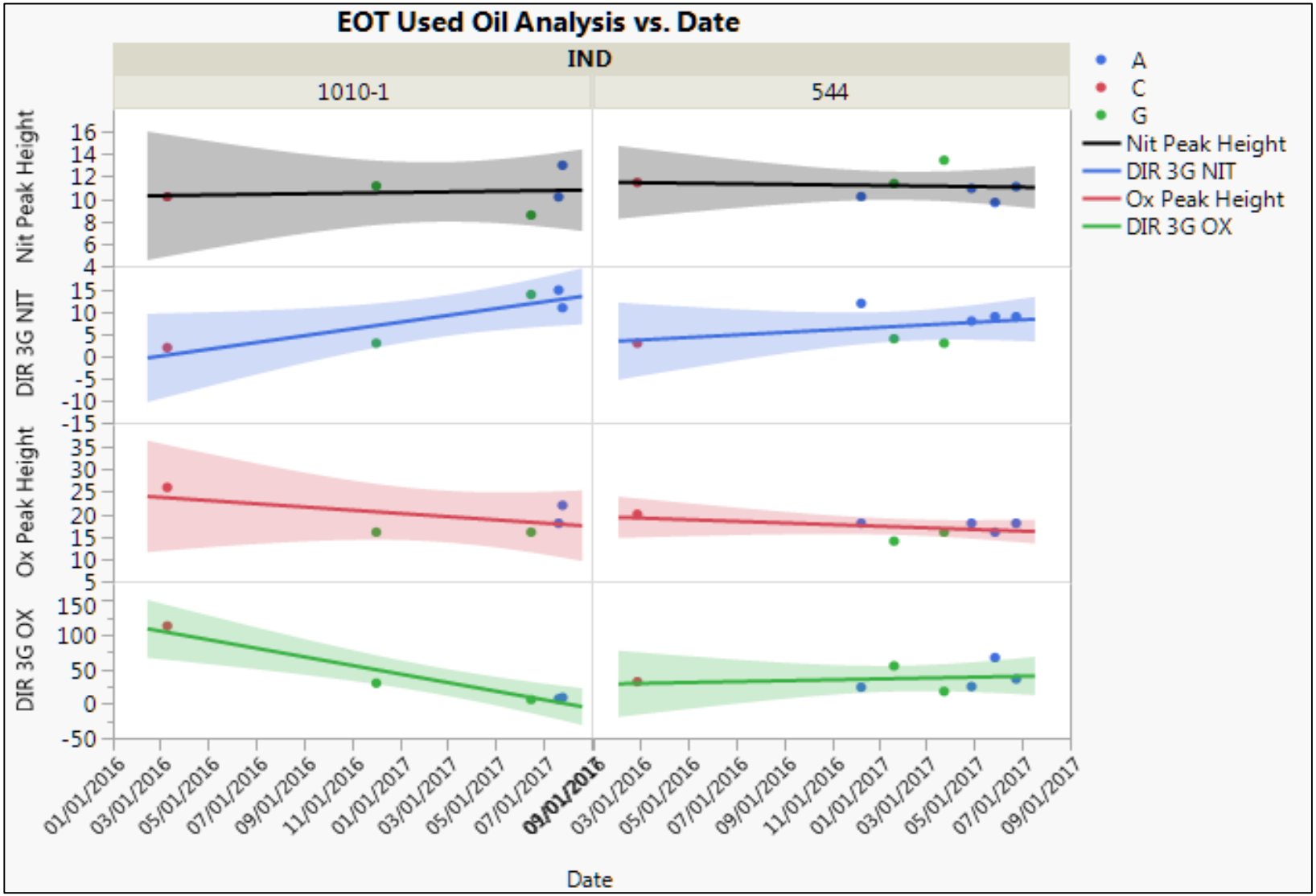
Afton CHEMICAL

Passion for Solutions™

FEI 2Yi CHEM DATA



EOT CHEM DATA by OIL



Engines

- OHT-1 engines were used for the Precision Matrix.
- Labs moved to OHT-2 engines in 2016.
- GM Short Block Kit engines are approved, and labs are running.
- All Labs will switch over this Fall.

Fuel Batches

- Haltermann to report to the Sequence VI surveillance panel the process for building the Texas and Michigan Lube Cert EEE fuel batches and for additizing the SEQ VI-E + DCA fuel. Include details on component sourcing for the Texas and Michigan locations (i.e. are the components for both locations obtained from the same source and from the same component batches, etc.). Include details on the additizing process for the Texas and Michigan locations (i.e. are the additives for both locations obtained from the same source and from the same batches, when is the Lube Cert EEE additized, etc.).

Fuel Batches

EEE Lube Cert blending

The components used in the EEE Lube Cert blending process (at both the Nixon and Sterling locations) are sourced from the same suppliers. This has been our standard practice since we place the Nixon tanks into service.

Seq.VI DCA additive

Original MOC for this additive was created on 09/03/2013. HS purchased 2 drums of this material in 2013 to start the project.

HS purchased an additional 7 drums in 2014 and four more drums in 2016.

The additive used when producing the Seq.VI fuel, HF-2003, has been and continues to be sourced from the same supplier.

The HF-2003 is additized at the rack at both locations.

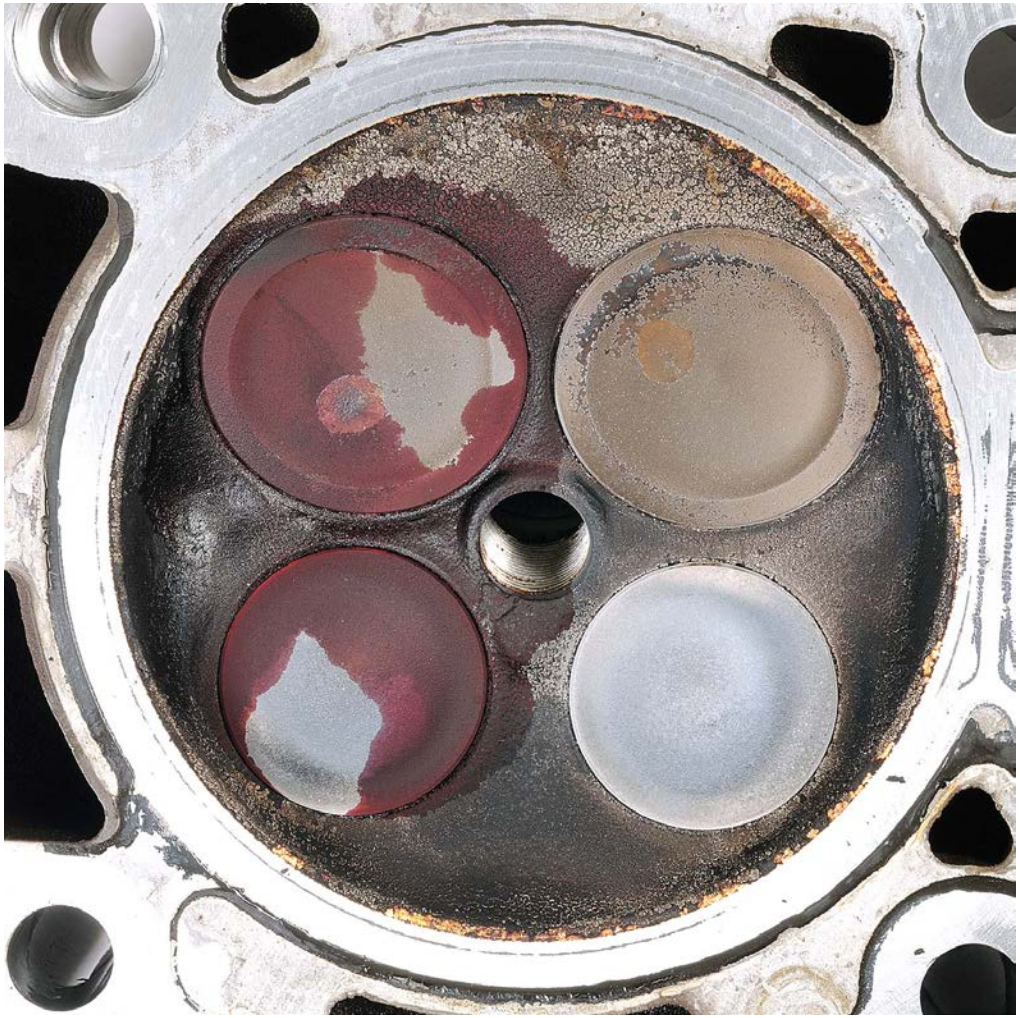
Action

- Amol has created Power Points comparing a pass and a fail engine.
- Those are posted at:
  - http://www.astmtmc.cmu.edu/ftp/refdata/gas/VIE/plots/

APPENDIX

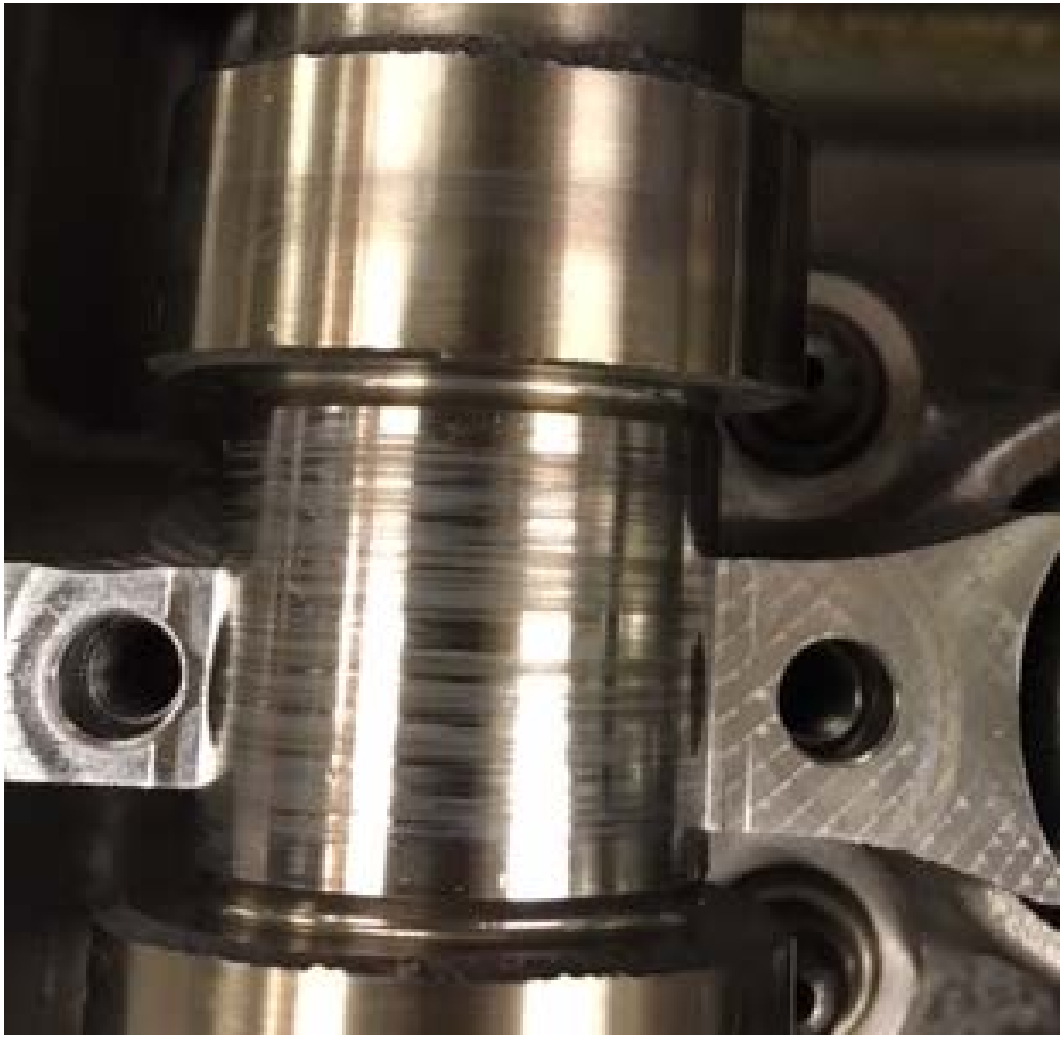
PHOTOS

VIE SwRI Valves



VIE IAR Piston Deposits

VIE Afton Journal Wear



VIE Valvoline Bore Polish