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Committee D02 on PETROLEUM PRODUCTS AND LUBRICANTS

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Issued: June 15, 2015

Reply to: Dan Worcester
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6220 Culebra Rd.
San Antonio, TX 78238
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Email: dworcester@swri.org

These are the unapproved minutes of the 06.12.2015 Sequence VI Surveillance Panel call.

The meeting was called to order at 9:00 AM Central Time by Chairman Nathan Moles.

Agenda

The Agenda is the included as Attachment 1.

1.0 Roll Call

The Attendance list Attachment 2.

2.0 Approval of minutes

2.1 Approval of the minutes of the 06.02.2015 meeting.

2.2 The Secretary indicated the Toyota presentation was password protected. It is not in the minutes on the TMC site. The Secretary will work to correct this.

3.0 Action Item Review

3.1 OHT to report VID & VIE engine usage and expected depletion date of VID engines. This will be an on-going effort.

3.2 Labs reported VID engine inventory and expected depletion date of VID engines.
-Expected life of engines range from 2016 Q1 to 2018
Lab1: 2 engines
Lab2: 4 engines
Lab3: 4 engines
Lab4: 4 engines This will be an on-going effort.

3.3 SP chair and test sponsor to investigate what is needed to establish VID equivalent limits for VIE. This will be an on-going effort.

4.0 Old Business

4.1 List of items to be reviewed after the Precision Matrix
-Do we really need to run three RO tests to establish the new engine for LTMS?
-Discussion of reducing the new reference requirement to two oils, then a third oil run after a defined number of candidates.
-Discussion of using FEI 2 and FEI Sum for references to match candidate pass/fail criteria.
-Discussion of evaluating 80/20 ratio of BL before to after for FEI 1 and 10/90 for FEI 2.
-Should the acceptance bands value of 1.96 be rounded up? Due to the rounding on FEI 1 and 2 the actual pass limit is 1.91 and 1.92. This will be an on-going effort.

4.2 Discussion regarding Sequence VIE test ready to proceed with precision matrix. Chair to report results of vote at joint AOAP and PCEOCP meeting May 14th in Detroit.
-The Memorandum of Agreement must be signed and the test receive AOAP approval before the Precision Matrix begins.
-Lab visits required by TMC are completed.
-Labs must have two valid tests run on their stands to participate. 4 of 6 interested labs have data on the current version of the test (must use additized fuel). This will be an on-going effort.

4.4 There are several of items in the most current draft version of the Seq. VIE test procedure posted on the TMC website that need to be updated. Dave Glaenzer has agreed to reconvene the Task Force to review the procedure. This will be an on-going effort.

4.4 Update on the progress of 5W-30 Tech 1 in VIE testing. Afton will start the week of 06.22. SwRI test will complete the week of 06.15.

ACTION: SwRI requests the Stats Group to review 542-2 now that there are 20 valid tests on this oil. Jo Martinez will gather the data.

4.5 Engine hours needs to be addressed in the precision matrix and there is concern in the industry that the current design does not adequately address this. Alternate matrix designs have been requested. This will be an on-going effort. Statisticians will come up with the list of potential designs once all variables (engines, oils, etc.) have been decided.

5 New Business

5.1 There is a request to standardize the way the labs report data collected from the precision matrix to simplify analysis of results. There was discussion on this item. TMC has a secondary data file but it needs to be updated. Sending full data sets would be huge amounts of data. Charlie noted the Panel would need to find what labs can actually send and create a template.

5.2 Update on database for Sequence VIE fuel properties.

5.3 Update from task force, to investigate alternative Sequence VIE procedures that would improve 0W-16 response in the Sequence VIE test. - Charlie Leverett

(a) GM to look into the availability of FTP cycle temperature data from the VIE test engine (MY2012 Chevrolet Malibu LY7) to compare to similar data from the VID test engine (MY2009 Cadillac SRX LY7).

(b) Industry statisticians to review and report on the original reasoning for having a fixed reference oil sequence for calibrating new Sequence VID engine/stand combinations.

This is from the minutes of a conference call on 11/16/2010. There was no presentation included with the minutes.

4.) **New Business**:

4.1 Determine if we want to drop one of the current oils

• Determine the usage rates for all remaining oils

MOTION: [Guy Stubbs, Robert Stockwell, second] Use the same three existing reference oils for new engine introduction, then define usage rates for all reference oils.

0 for, 9 against, 4 waive. Motion fails.

• There was discussion on whether 4 reference oils were too many and what their level of assignment should be.

MOTION: [Dave Glaenzer, Mark Sutherland, second] Assign 542, 541 and 1010 in that order for new engine reference acceptance. All later reference testing would be 540, 542 and 1010 assigned randomly at a 33.3% frequency.

• 10 for, 0 against, 2 waive. Motion passes.

• This motion must wait two weeks to be implemented for LTMS review.

Effective date would be 12.01.2010 with the TMC report.

There was some discussion that the oil test order may affect the severity adjustment – which led to the formalized test order.

The order did not come from the stats group and was decided in the meeting.

Question to the labs: Does the order of oils impact the performance of the engine? If it does, leave it as it is but if not, random assignment is recommended.

(c) JAMA to share 0W-16 field data.

Afton will develop an 8 stage VIE test where additional stage 1A and 3A are 100°C oil temperature and 94°C coolant temperature. They will run a 0W-16 and 0W-20 oils. IAR will run the same VIS grade oils from the Toyota matrix and use the 8 stage version of the test. Ashland will review stage weighting. The Toyota presentation on VIE testing with lower oil and coolant temperatures is Attachment 3.

5.4 Lubrizol ILSAC presentation regarding prove out data. This is Attachment 4. This item was put on hold for members to review the presentation for the next meeting.

ACTION: TMC will request an updated BL-4 and FO-4 inventory to support production of the new BL-5 and FO-5 oils.

6 **Next Meeting will be at the Chair notification.**

The meeting adjourned at 10:33 AM.

Sequence VI Surveillance Panel Conference Call Agenda
June 12 @ 10-11AM EST

Call-in information is included below:

Call-in Number: 866-528-2256
Conference Code: 3744024

1.0) Roll Call

Do we have any membership changes or additions?

2.0) Approval of minutes

2.1) Approve the minutes from the June 2, 2015 Sequence VI Surveillance Panel.
ftp://ftp.astmtmc.cmu.edu/docs/gas/sequencevi/minutes/VIMinutes20150602.pdf

3.0) Action Item Review

3.1 OHT to report VIE engine usage and update on service engine order (345 additional engines being ordered). – OHT

3.2 Labs reported VID engine inventory and expected depletion date of VID engines.

-Expected life of engines range from 2016 Q1
Lab1: 2 engines
Lab2: 4 engines
Lab3: 4 engines
Lab4: 4 engines

3.3 SP chair and test sponsor to investigate what is needed to establish VID equivalent limits for VIE

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4.4 Update on progress of 5W-30 Tech1 in VIE testing.

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Statisticians will come up with the list of potential designs once all variables (engines, oils, etc.) have been decided.

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- Charlie Leverett

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(c) JAMA to share 0W-16 field data.

5.4 Lubrizol ILSAC presentation regarding prove out data.

6.) Next Meeting

Call of the chairman

Proposed date of 6/30, on site meeting?

7.) Meeting Adjourned

ASTM SEQUENCE VI

Name	Address	Phone/Fax/Email	Attendance
Jason Bowden Voting Member	OH Technologies, Inc.	Phone: 440-354-7007 jhbowden@ohtech.com	ATTEND
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Charlie Leverett Voting Member	Intertek Automotive Research	Phone: 210-647-9422 charlie.leverett@intertek.com	ATTEND
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Haiying Tang Voting Member	Chrysler	Phone: 248-512-0593 HT146@Chrysler.com	
Dan Worcester Voting Member	Southwest Research Institute	Phone: 210.522.2405 dan.worcester@swri.org	ATTEND

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Jo Martinez	jogm@chevron.com	Oronite	ATTEND
Valeriu Lieu		Oronite	

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Jim Linden	lindenjim@jlindenconsulting.com Phone: 248.321.5343	Toyota	ATTEND
Jeff Hsu		Shell	
Amol Savant		Ashland	ATTEND
Kevin O'Malley		Lubrizol	ATTEND
Chris Castanien		Nestles	ATTEND

ASTM SEQUENCE VI

Name	Address	Phone/Fax/Email	Attendance

TOYOTA

Engine Oil Temperature in Vehicle Test

June 12th, 2015

Toyota Motor Corporation

Observations of Sequence VIE

TOYOTA

- Sequence VIE has experienced difficulty to evaluate 0W-16 engine oil properly
  - Honda 0W-16 oil, Tech 1 0W-16
- 0W-20 performed better than higher viscosity grades as expected in Sequence VIE
  - Seq VIE Prove Out Data with TMC REOs
- Sequence VIE is supposed to provide correlation to Sequence VID
  - One of main objectives
- Sequence VID has shown fuel economy improvement to 0W-16 compared with 0W-20
  - Based on Toyota 0W-16 matrix work

Ideas for Improvement (without hardware change)

TOYOTA

1) Modification of Weight Factor

- Current wt factors have strong emphasis on high temperature stages
  - 115degC covers 95.6% of wt factors
- Will lose the correlation to the FTP

2) Modification of Oil / Coolant Temperatures at High Temp Stages

- Consortium selected Seq VID test stages based on the cluster analysis of vehicle test (FTP-75 + Highway). Speed, Load, and oil / coolant temperatures were chosen to cover the operational area. As a result, 115degC is higher than the maximum temp observed in the test.
- Lowering oil/coolant temperatures will enable VIE to evaluate 0W-16 as viscometric contribution.
  - SAE 2013-01-0297
- Oil/coolant temperatures can be set by other vehicle data to represent recent vehicle models.

Sequence VID / VIE Stage Conditions

TOYOTA

Seq VID / VIE Test Stage		1	2	3	4	5	6
Nominal Speed	rpm	2000	2000	1500	695	695	695
Load	Nm	105	105	105	20	20	40
Nominal Power	kW	21.99	21.99	16.49	1.46	1.46	2.91
Torque/L	Nm/L	29.2	29.2	29.2	5.6	5.6	11.1
Gallary Oil Temp	degC	115	65	115	115	35	115
Coolant Temp	degC	109	65	109	109	35	109
Weight Factor		0.3	0.032	0.31	0.174	0.011	0.172

Sequence VID Consortium Data

TOYOTA

Vehicle Test Data used for Setting Stage Conditions
Buick LaCrosse / V6-3.6L (LY7)

As oil temperature, approx 110degC was maintained all through highway mode.

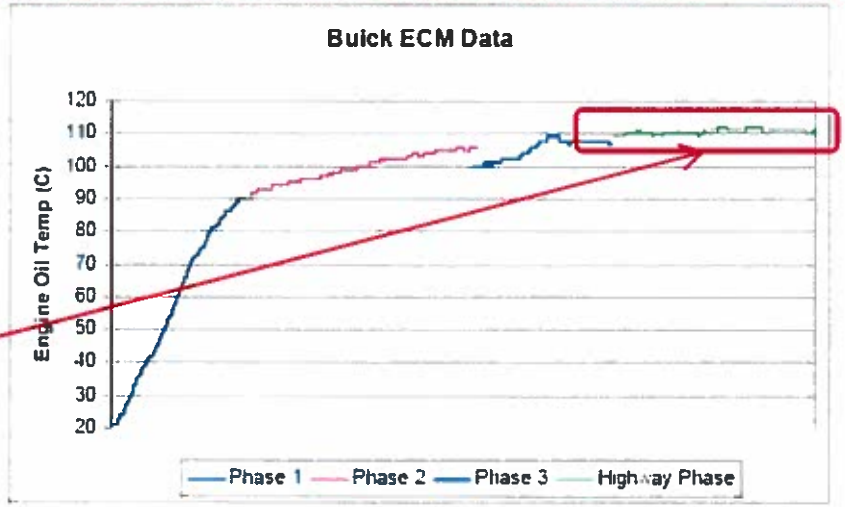


Figure 39. Engine Oil Sump Temperature During FTP and HWFET Tests

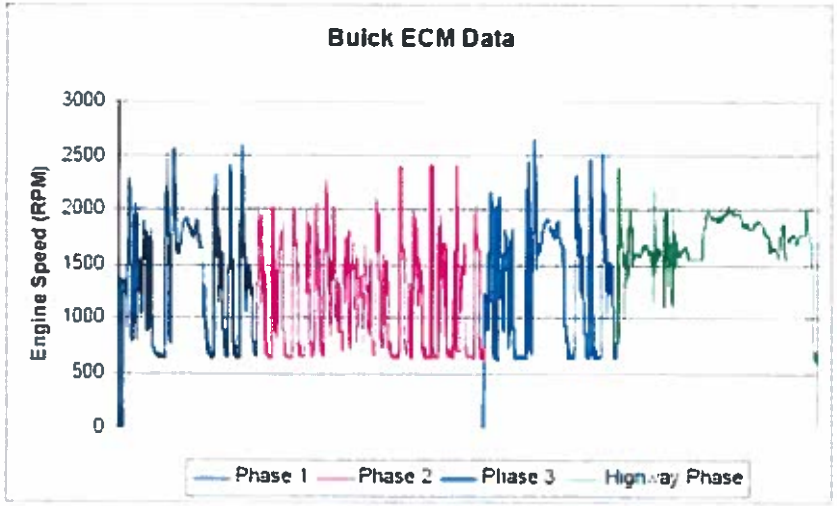


Figure 35. Engine Speed During FTP and HWFET Tests

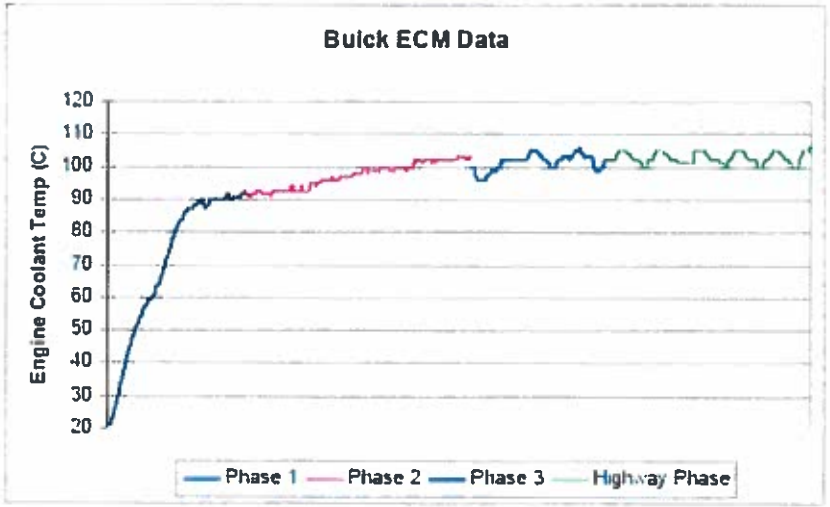


Figure 41. Engine Coolant Temperature During FTP and HWFET Tests

Sequence VID Consortium Data

TOYOTA

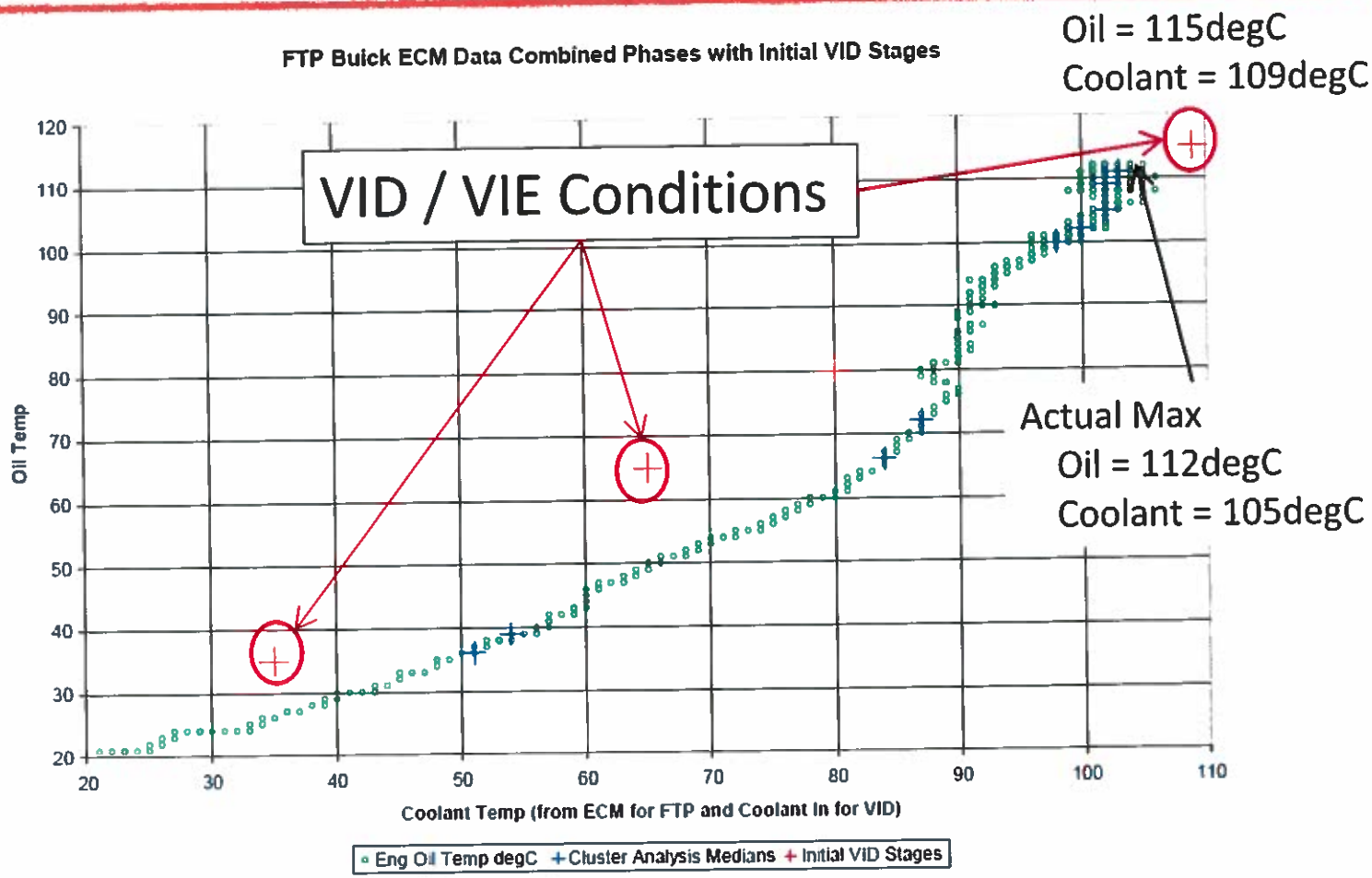
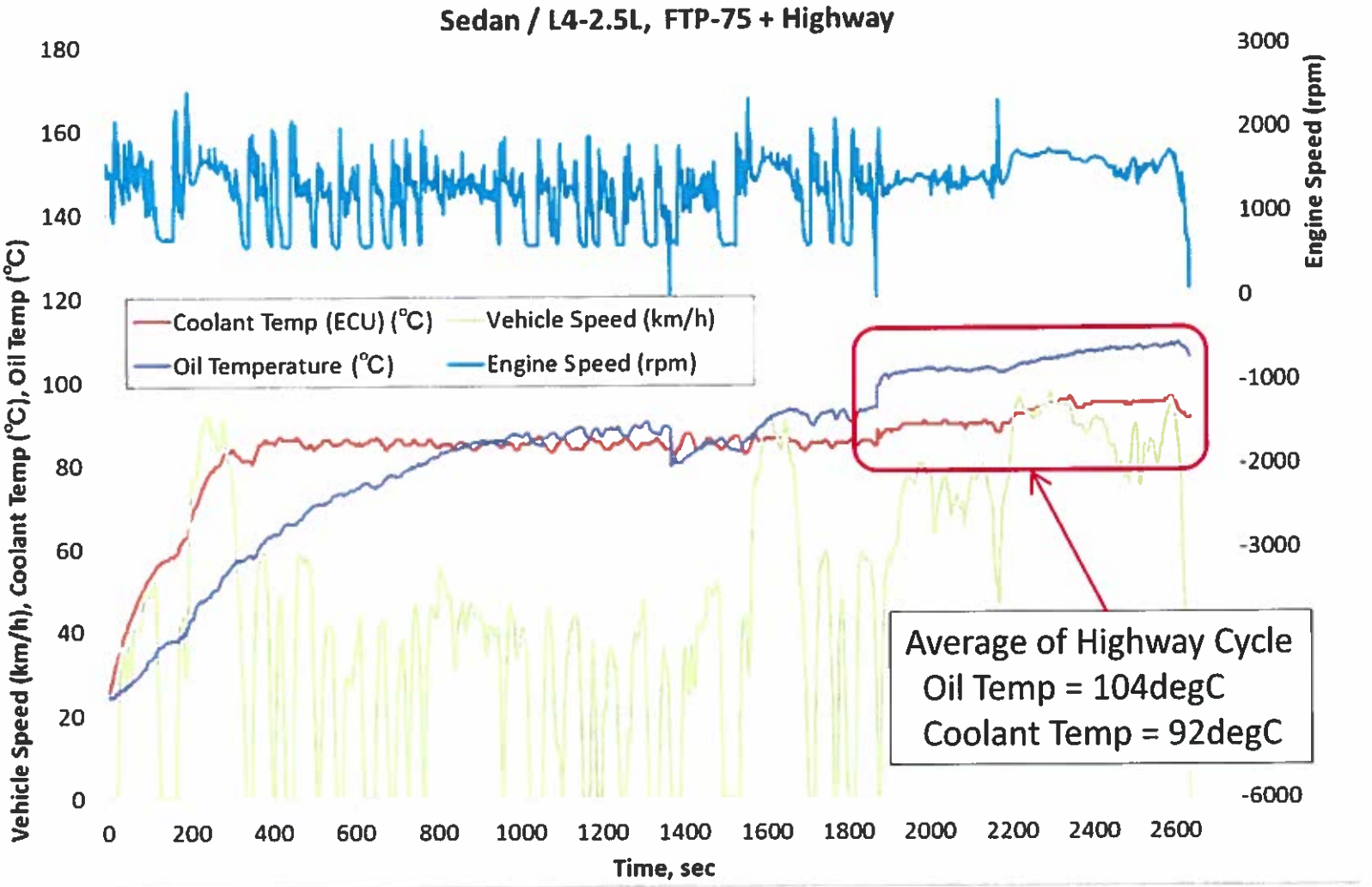


Figure 50. Engine Oil and Coolant Temperatures Scatter Plot with Cluster Analysis Medians During FTP and HWFET Tests and Initial VID

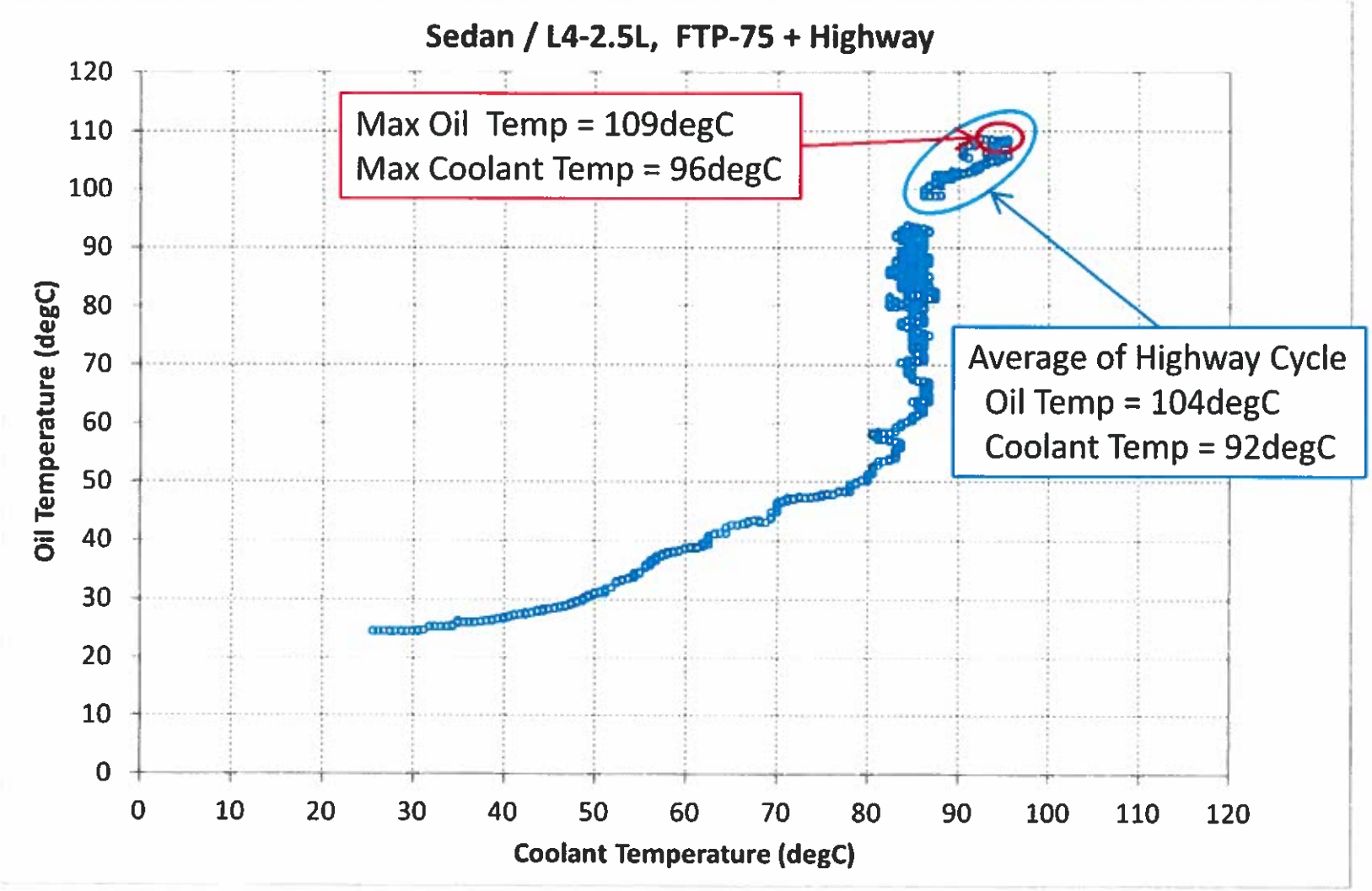
Example of Recent Vehicle Model

TOYOTA



Example of Recent Vehicle Model

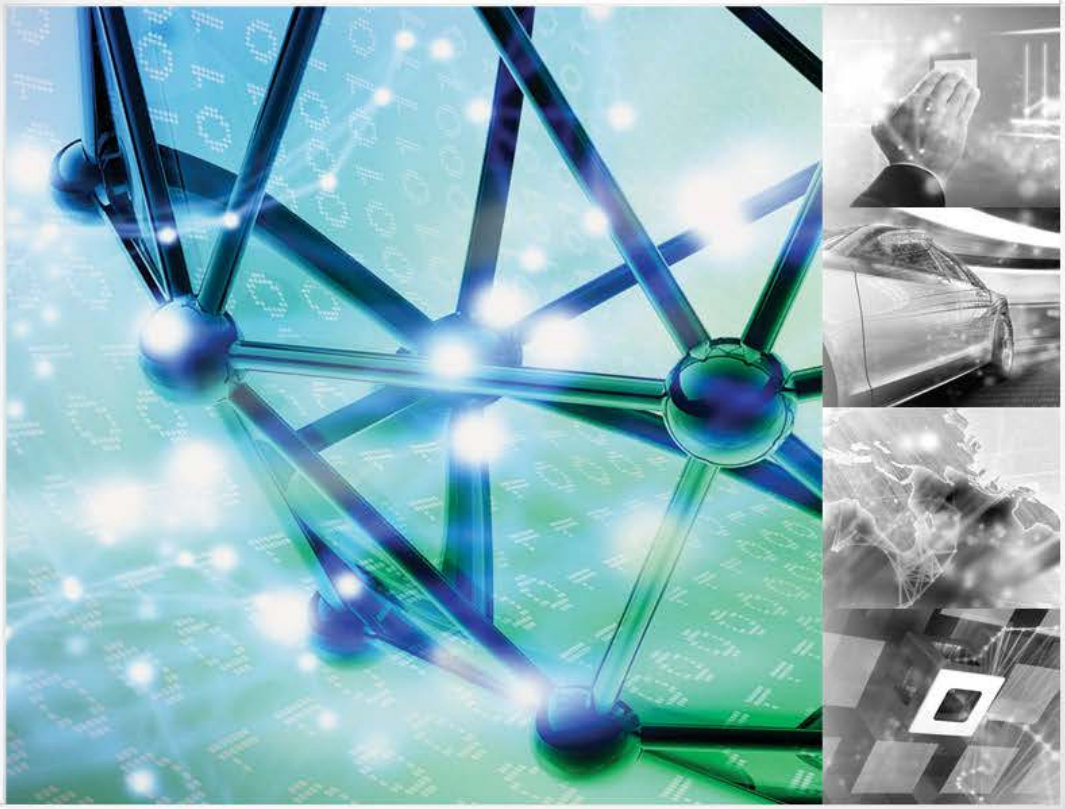
TOYOTA



Summary of Vehicle Test Data

TOYOTA

- Sequence VID Consortium Data
  - Buick LaCrosse V6 – 3.6L (LY7)
    - Highway cycle maintained oil temperature above 110degC all through the cycle
      - Max Oil Temp = 112degC Ave Oil Temp = approx 111degC
      - Max Coolant Temp = 105degC Ave Coolant Temp = approx 103degC
- Example of Recent Vehicles (from JAMA members)
  - Popular Mid Size Sedan, L4 – 2.5L
    - Highway cycle gradually increased oil and coolant temperatures
      - Max Oil Temp = 109degC Ave Oil Temp = 104degC
      - Max Coolant Temp = 96degC Ave Coolant Temp = 92degC
  - Anther OEM's comment
    - Their popular mid size sedan showed similar coolant temperatures
    - Oil temp data wasn't available, but it should be similar
- Oil / Coolant Temperatures for VIE high temperature stages can be lowered base on these data at the level of 5 – 10degC range from current conditions



Concerns with the Sequence VIE Prove-Out

Presentation to ILSAC

June 9, 2015

Lubrizol

Sequence VID Consortium Scope & Objectives

SUCCESS TOGETHER

The Sequence VID test development was done under the direction of the VID Consortium. They defined a clear scope & objectives (outlined below).

They met their objectives by following rigorous test development practices

Scope

Develop an engine dynamometer-based fuel economy test for ILSAC GF-5 that will replace the ILSAC GF-4 Sequence VIB fuel economy test. The new test should represent both viscometric and friction modifier oil effects on the fuel economy of current and future North American and Japanese engines.

Objectives

1) *The test should be responsive to both viscometric and friction modifier effects in oils.*
2) *Ideally, the test should show improved test precision over the current Sequence VIB fuel economy test. This will be quantified by showing that the new test has a lower standard deviation of fuel economy improvement.*
3) *Develop a VID engine test based on operating conditions mapped proportionally to FTP-75 and Highway Fuel Economy Tests, and which generally agrees with the FTP fuel economy data generated by the Consortium. Other data may be considered, as appropriate. The test should emulate aging observed during mileage accumulation at Xk miles from the FTP program, discriminate between Oil Z and the other matrix oils based on viscosity effects, and determine FM effects.*

From *Consortium to Develop a new Sequence VID Fuel Efficiency Test for Engine Oil – Final Report*; Issued Oct 15, 2008

Lubrizol

Is this really “Prove Out” Data?

SUCCESS TOGETHER

Data Concerns

- Data used in the analysis is not designed but observational and therefore have a lot of correlation among the variables
  - Engines did not run the same mix of oils
  - Many engines have limited tests
- High percentage of the tests were run in early engine hours
  - In most cases there’s a lack of randomization of oil order in new engines
- Most of the data in higher hours are with 542
- FM carry-over effects could not be accounted for in this data

5

This is NOT how other GF-6 new test development is being done

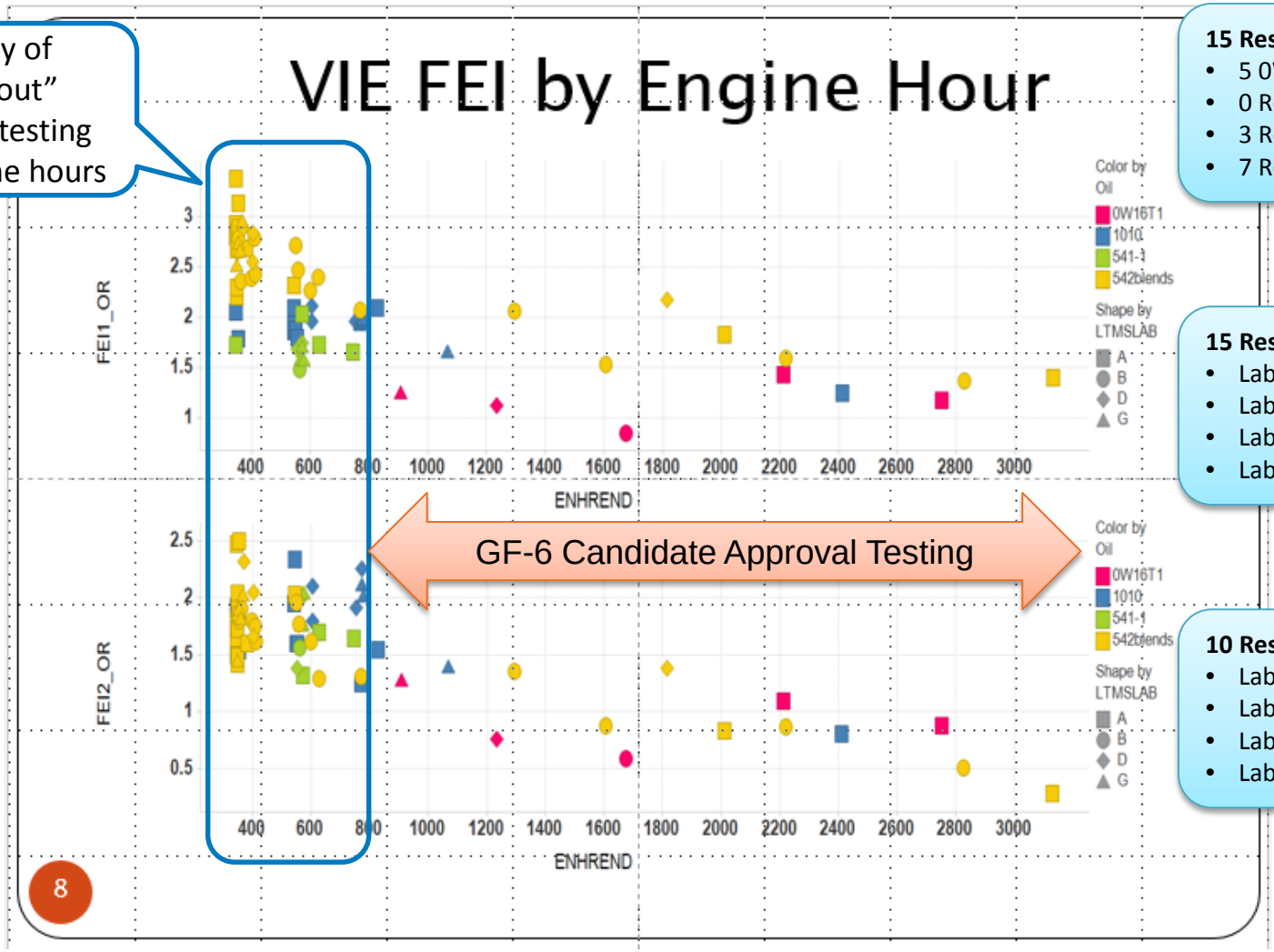
Base Slide from May 14, 2015; Sequence VIE Update Presentation

Lubrizol

Data Spread of VIE "Prove Out"

SUCCESS TOGETHER

Majority of "Prove-out" reference testing ≤ 800 engine hours



15 Results > 800Hrs:
- 5 0W-16
- 0 Ref Oil 541
- 3 Ref Oil 1010
- 7 Ref Oil 542

15 Results > 800Hrs:
- Lab A: 6 tests
- Lab B: 5 tests
- Lab D: 2 tests
- Lab G: 2 tests

10 Results >1500 Hrs:
- Lab A: 5 tests
- Lab B: 4 tests
- Lab D: 1 tests
- Lab G: none

Base Slide from Feb 23, 2015; Sequence VIE Prove-Out Analysis Presentation

Lubrizol

Proof of Discrimination is biased by the lack of Statistical Design

SUCCESS TOGETHER

VID Data and VIE Comparison (542 and 1010 only)

FEI1				FEI2			
VID Data		VIE Prove-Out		VID Data		VIE Prove-Out	
Oil	LS Mean	Oil	LSMean	Oil	LS Mean	Oil	LSMean
542blends	1.52	542blends	2.49	542blends	0.82	542blends	1.64
1010	1.35	1010	1.92	1010	1.07	1010	1.82
s	0.12	s	0.22	s	0.15	s	0.11

VIE Prove-Out Oil Discrimination
FEI1: 542blends > 1010

FEI2: 1010 > 542blends

VID Data Oil Discrimination
FEI1: 542blends > 1010

FEI2: 1010 > 542blends

Oil	# of VIE Tests with Engine Hours ≤ 800	# of VIE Tests with Engine Hours > 800
542	6	2
542-1	24	3
542-2	0	2
1010	14	3
Total	44	10

VIE Analysis is heavily biased by data on low engine hours

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Base Slide from May 14, 2015: Sequence VIE Update Presentation

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FEI1 (Combined Oils 542, 542-1, 542-2)

SUCCESS TOGETHER

VID

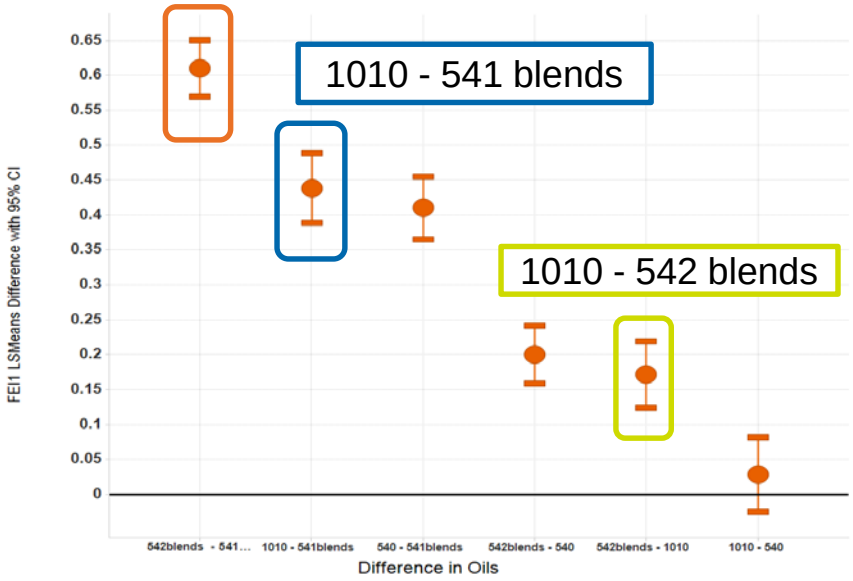
- Model: s = 0.12
- Oils [542, 1010, 541, 540]
- Labs [A, B, C, D, F, G]
- Engine(Lab)

Oil	LS Mean
542blends	1.52
1010	1.34
540	1.32
541blends	0.91

542 blends - 541 blends

1010 - 541 blends

1010 - 542 blends



VIE

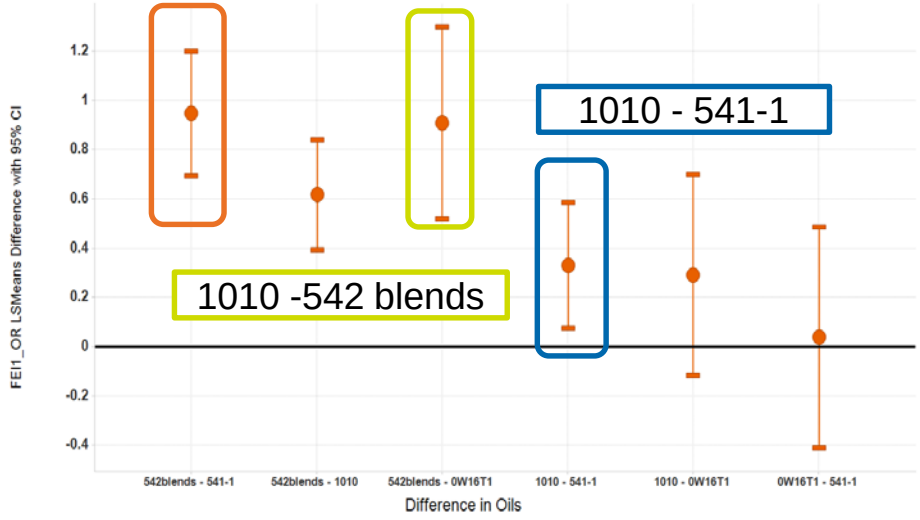
- Model: s = 0.21
- Engine Hours [linear]
- Oils [542, 1010, 541-1, 0W16T1]
- Labs [A, B, D, G]
- Engine(Lab)

Oil	LS Mean
542blends	2.48
1010	1.86
0W16T1	1.57
541-1	1.53

542 blends - 541-1

1010 - 541-1

1010 -542 blends



Crossing the zero line means oil pair does not discriminate

Note: VID is calculated across engine life; VIE is biased to new engines

Combined Data from Feb 23, 2015; Sequence VIE Prove-Out Analysis Presentation; Slides 6 & 14

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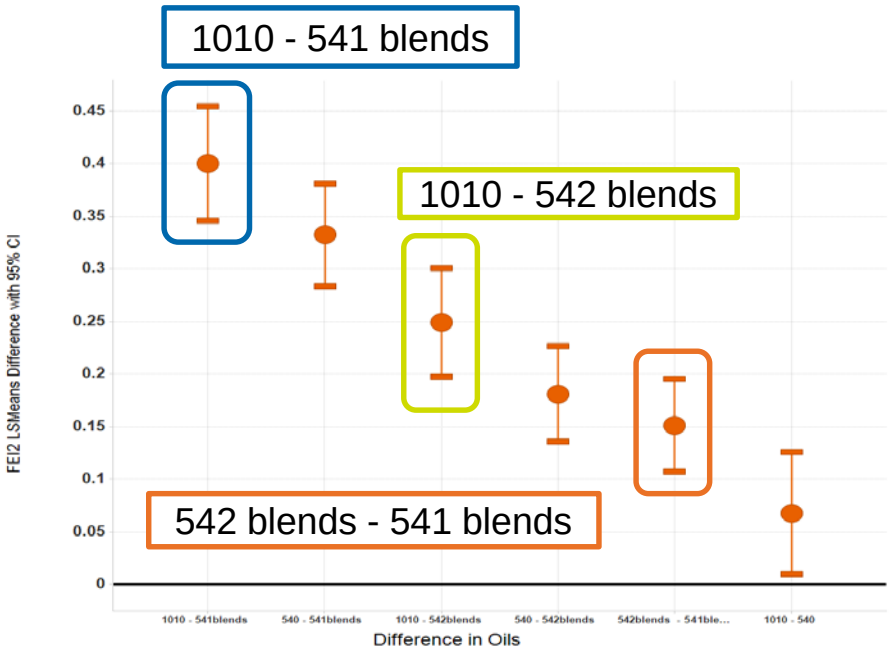
FEI2 (Combined Oils 542, 542-1, 542-2)

SUCCESS TOGETHER

VID

- Model: s = 0.13
- Oils [542, 1010, 541, 540]
- Labs [A, B, C, D, F, G]
- Engine(Lab)

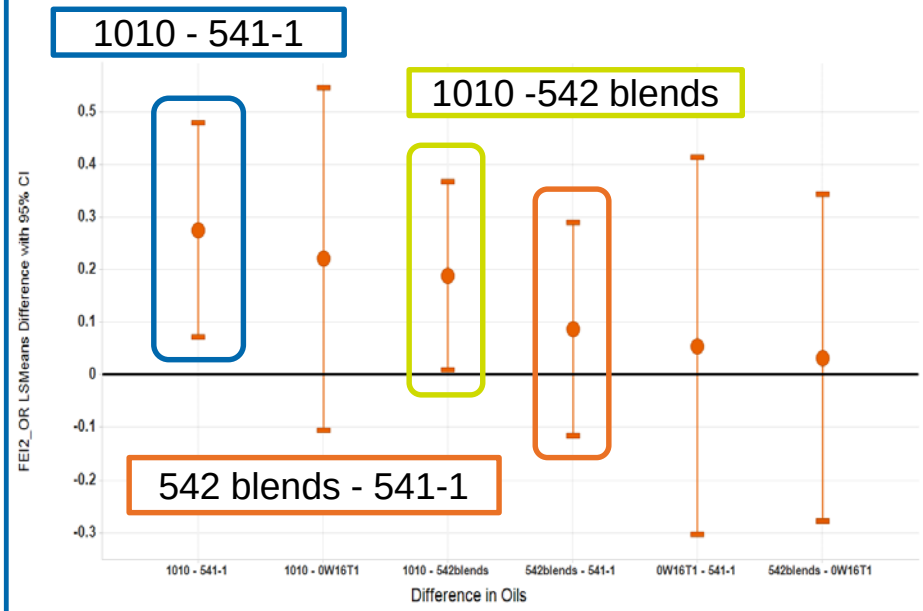
Oil	LS Mean
1010	1.07
540	1.01
542blends	0.83
541blends	0.67



VIE

- Model: s = 0.16
- Engine Hours [linear]
- Oils [542, 1010, 541-1]
- Labs [A, B, D, G]
- Engine(Lab)

Oil	LS Mean
1010	1.79
542blends	1.60
0W16T1	1.57
541-1	1.51



Crossing the zero line means oil pair does not discriminate

Note: VID is calculated across engine life; VIE is biased to new engines

Combined Data from Feb 23, 2015; Sequence VIE Prove-Out Analysis Presentation; Slides 7 & 15

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VID Matrix Design covered the full Engine Life

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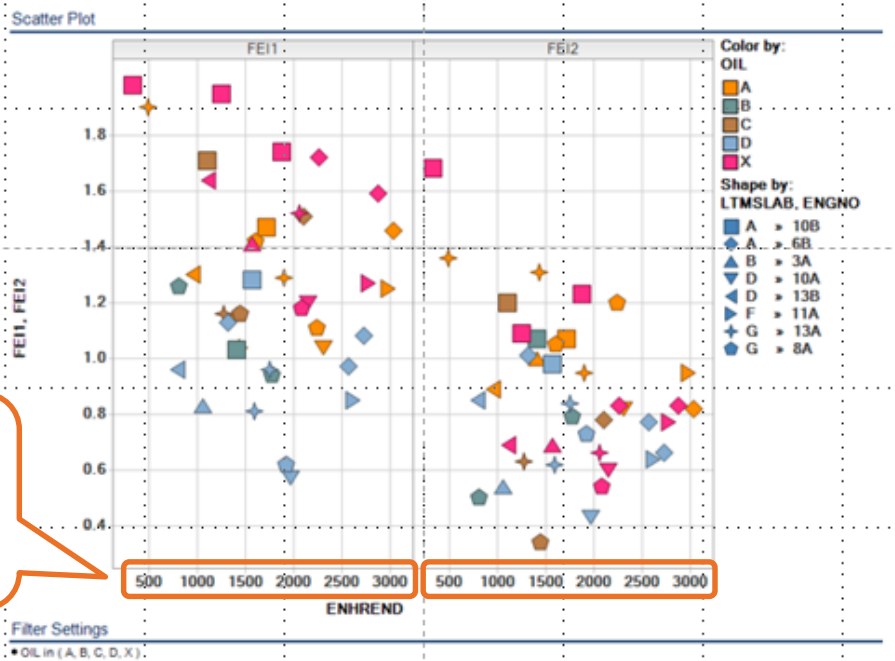
VID Precision Matrix

FEI by Engine Hours



Engine life evenly spread
From <500 to >3000 hours

12

6

Base Slide from Feb 23, 2015; Sequence VIE Prove-Out Analysis Presentation

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Consequences of Insufficient Prove-Out data

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- What is important for a “Ready for Matrix” vote?
  - A test needs to show:
    - Repeatability
    - Reproducibility
    - Discrimination
- Has the Sequence VIE “prove-out” data shown this?
  - Maybe for new engines…
    - Yes, for FEI 1
    - Limited, for FEI 2
  - For the life of the engine?
    - Unknown….
- Why is this an issue?

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FEI1 Comparison of Reference Oils 542 and 1010

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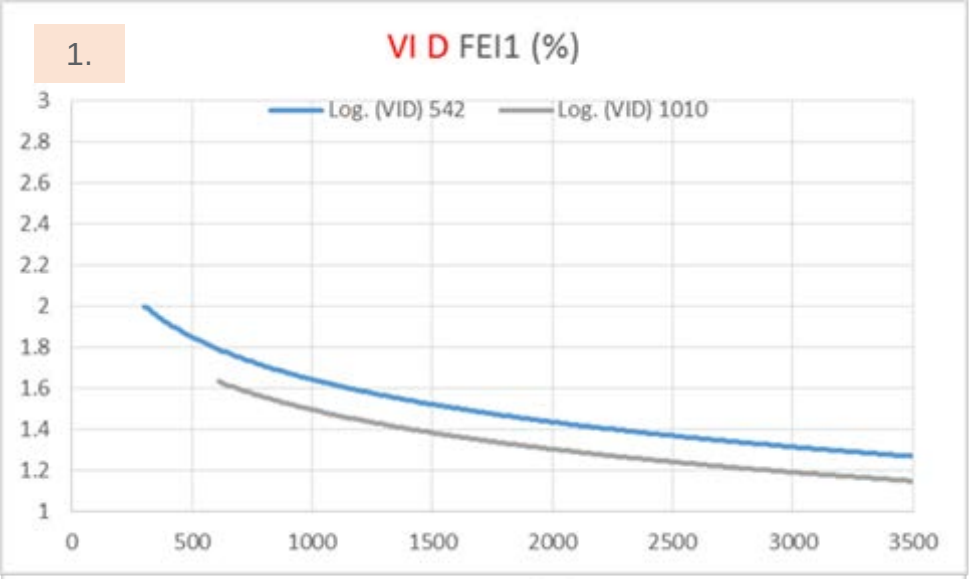
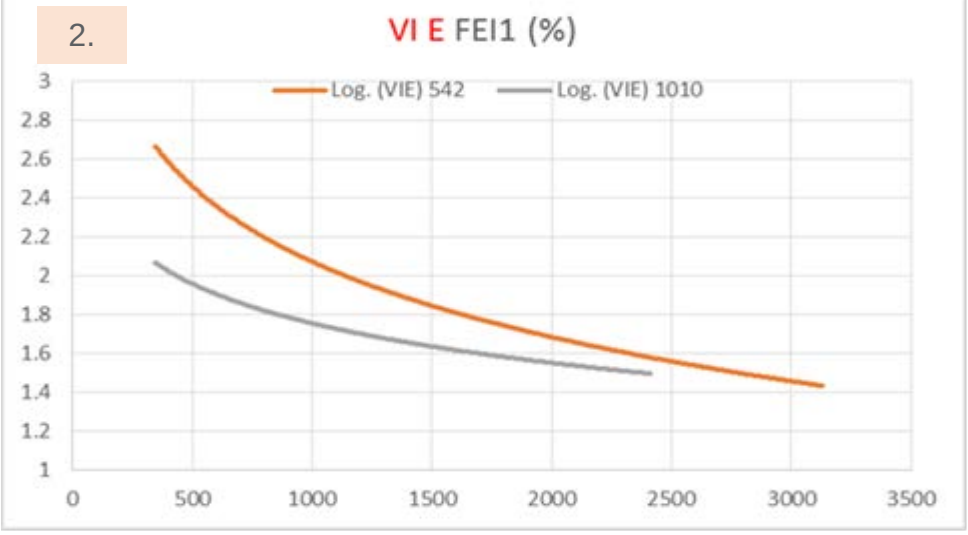
1.



2.



Log Plot of Uncorrected Reference Oil data

1. Comparison of 542 and 1010 in VID
   - Note: parallel lines → similar responsiveness drop off over the life of the engine
2. Comparison of 542 and 1010* in VIE
   - Note: the lines are not parallel; responsiveness drop off is different for the two oils

** Based on only 3 high engine hour 1010 test results – more data is required to confirm if lines converge*

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FEI1 Comparison of Reference Oils 542 and 1010

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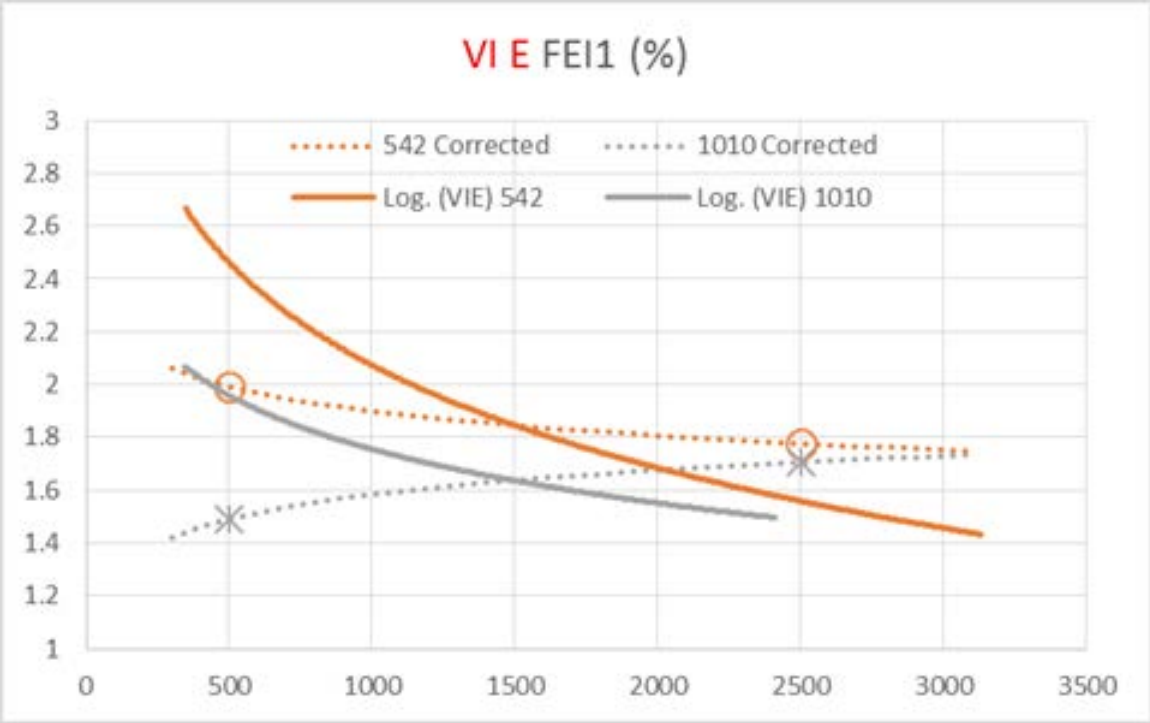

By applying a VID-type engine hour correction to both oils (based on the 542/1010 reference oils data we currently have) - the two reference oils show discrimination at early engine hours, but lose that discrimination as the engine ages

The oils would maintain discrimination if engine aging impact was the same for both oils as with the VID

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Recommended Path Forward

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Because of the lack of reference oil data at higher engine hours, we are concerned that there may be issues with the test's ability to discriminate oils as the engine ages. Lubrizol would prefer not waste Industry Precision Matrix Funding on test development

- Recommendations
  - Run a minimum of 5 more tests on Oil 1010 on older engines (>1500 hours)
  - Run a minimum of 3 tests on Tech1 0W-16 in newer engines (<800 hours)
    - *Lubrizol is willing to run the 0W-16 on a new engine*
  - Run at least 1 reference Oil Repeat in the same engine per matrix lab
- A Fit-for-Purpose Vote could get these Repeatability, Reproducibility, Discrimination issues out in the open

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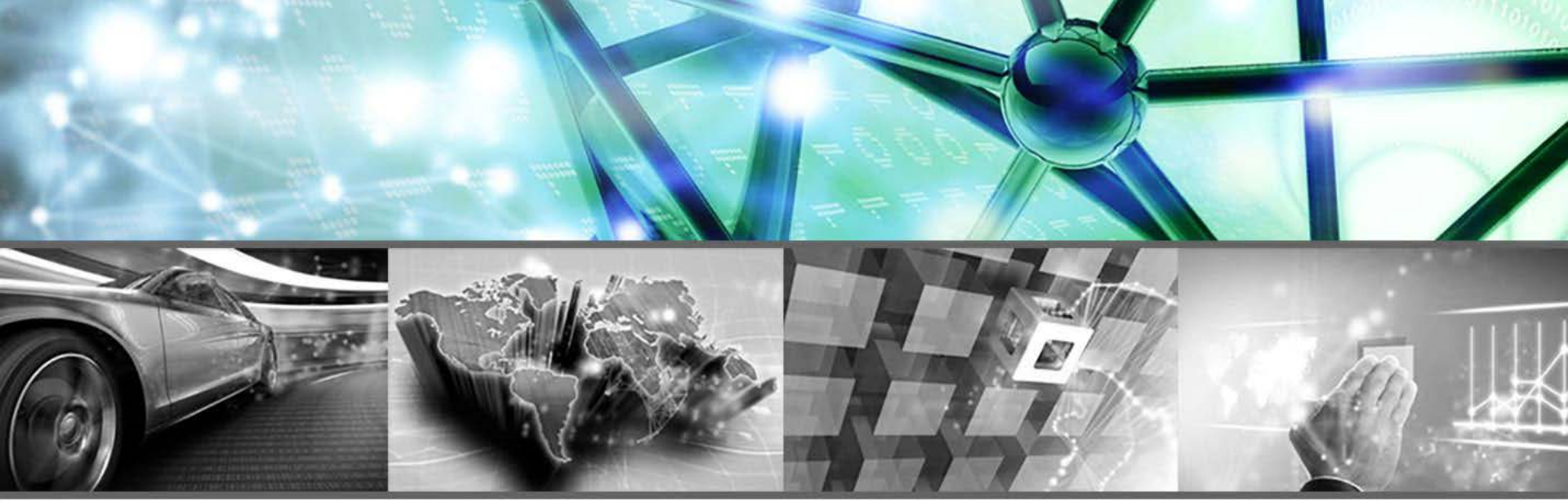

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Working together, achieving great things

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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