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Unapproved Minutes of the November 16, 2018
Sequence IV Surveillance Panel Conference Call.

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The meeting was called to order by Chairman Buscher at 10:00 AM Central Time.

A list of attendees is included as attachment 2.

A copy of the agenda is included as attachment 1.

The panel discussed testing protocols to generate sufficient data with using the additional 50 hour cyclic break-in. After reviewing upcoming laboratory referencing needs, it was determined that there could be as many as three reference tests results on reference oil 1012 and two on reference oil 300 by December 13th, BOI-VGRA meeting. The panel agreed to run the three tests on reference oil 1012 and then meet to

review those results before starting the two 300 reference tests. If the panel agreed that the data on 1012 was reasonable, then the two tests on reference oil 300 and an additional test on 1012 would be started. The panel would again meet to review those results and determine if the break in procedure is providing the desired results or if additional changes were required to address the difference in performance between engine runs 1 and 2. The panel agreed to this approach.

The panel reviewed the status of the lifter round robin being conducted. Three laboratories had completed post-test measurements on the lifters and the lifters were being shipped to SwRI from another lab.

The panel also briefly reviewed the BOI-VGRA task force report, included as Attachment 3.

The panel reviewed the chairman's report to AOAP (Attachment 4), and in general agreed with actions to be taken and what had been completed to date.

The meeting was adjourned at 11:30 AM.

The next meeting will be at the call of the chair, when additional reference test data is available.

From: Bill Buscher Intertek
To: [Alfonso Lopez Intertek](#); ["Lang, Patrick M."](#); ["Clark, Sidney L."](#); ["SATOSHI HIRANO"](#); ["Teri Kowalski \(TEMA TTC\)"](#); ["lindenjim@lindenconsulting.com"](#); ["t-sagawa@mail.nissan.co.jp"](#); ["stephen.fields@nissan-usa.com"](#); ["Romano, Ron \(R.\)"](#); ["Tang Haiying \(FCA\) \(haiying.tang@fcagroup.com\)"](#); ["Jeff Betz"](#); ["Mark Sutherland"](#); ["Dan Lancot"](#); ["dhbowden@ohotech.com"](#); ["Jason Bowden \(jbowden@OHTech.com\)"](#); ["Matthew Bowden"](#); ["fmf@astmtmc.cmu.edu"](#); ["jac@astmtmc.cmu.edu"](#); ["Rich Grundza"](#); ["Rieth, Ryan"](#); ["Ritchie, Andrew"](#); ["Ed Altman@afonchemical.com"](#); ["Bob.Campbell@afonchemical.com"](#); ["Brys, Jerome"](#); ["tcaudill@valvoline.com"](#); ["Jeff Hsu"](#); ["Hapithom@aol.com"](#); ["BuschWA@aol.com"](#); ["Mike McMillan"](#); ["Chris Castanien \(Chris.Castanien@nesteoil.com\)"](#); ["Amol Savant"](#); ["Kevin OMalley@lubrizol.com"](#); ["ray.seiz@infineum.com"](#); [Martin Chadwick Intertek](#); ["Dvorak, Todd"](#); ["Martinez, Jo G. \(jogm\)"](#); ["Doyle Boese"](#); ["Affinito, Ricardo E"](#); ["Lochte, Michael D."](#); ["Stockwell, Robert T"](#); ["Mileti, Christopher"](#); ["Meryn.hopp@gm.com"](#); ["John Glaser Intertek"](#); ["Mourhatch, Ramoun"](#); ["Kostan, Travis G."](#); ["Rais, Khaled"](#); ["Karin.Haumann@shell.com"](#); ["Mark Adams"](#); ["Salvesen, Clifford R"](#); ["James Matasic"](#); ["Hosseini, Seyedeh Mahboobeh"](#); ["Tarry, Preston"](#); ["Charlie"](#); ["Calcut, Brent"](#); [Carlton Coker Intertek](#); ["Collins, Chet A."](#); ["Overaker, Mark"](#); ["ptumati@jhaltermann.com"](#); ["Meier, Adam Robert"](#); ["Bob Proctor \(rproctor@oh.hra.com\)"](#); ["angela.p.willis@gm.com"](#); ["Joshua Frederick"](#); ["darryl.purificati@petrocanadalsp.com"](#); ["Maddock, Ben"](#); ["Matthew Bowden"](#); ["chris.castanien@neste.com"](#); ["Chen, Min"](#); ["Michael P. Raney"](#); ["Aleise Gauer"](#); ["Garellick, Ken"](#); ["McLaughlin, Michael"](#); [King, Tracey](#)

Subject: Purpose of 11/16/18 Sequence IV Surveillance Panel WEBEX Conference Call
Date: Thursday, November 15, 2018 5:04:00 PM
Attachments: [11-13-2018 BOI-VGRA Meeting Presentation.pdf](#)
[IVB Update to AOAP 20181114.pptx](#)

Sequence IV Surveillance Panel Members,

The purpose of the 11/16/18 Sequence IV Surveillance Panel WEBEX Conference Call is to review the Sequence IVB discussions that took place at this week's BOI/VGRA Task Force and AOAP meetings and make sure that the majority of the surveillance panel is in agreement, prior to the BOI/VGRA matrix labs proceeding with starting the reference tests.

See slide 23 in the attached BOI/VGRA meeting presentation, slides 5 – 7 in the attached IVB update to the AOAP and my notes from the BOI/VGRA Task Force meeting, which are included below.

- **DISCUSSED AND AGREED UPON BY THE BOI/VGRA TASK FORCE:**
 - After reviewing and understanding the Seq. IV Surveillance Panel's approach to resolving the FEWMEOT vs engine run order phenomenon, the BOI/VGRA Task Force has agreed to and requested the following:
 - It is acceptable for the BOI/VGRA matrix labs to conduct their ASTM REO 300 reference tests on their BOI/VGRA matrix stands.
 - This will provide the Seq. IV Surveillance Panel the necessary ASTM REO 300 data on new run 1 engines with the revised break-in procedure.
 - If, after reviewing the 8 run 1 reference tests (4 reference tests using ASTM REO 300 (BOI/VGRA stand reference tests) and 4 reference tests using ASTM REO 1012 (each lab's next routine stand reference test)), the Seq. IV Surveillance Panel decides to make further changes to the break-in procedure, the BOI/VGRA Task Force will require the BOI/VGRA matrix stands to be re-referenced on engines using the further revised break-in procedure and ASTM REO 300-1.
 - If the switch from ASTM REO 300 to 300-1 must occur for referencing the BOI/VGRA matrix stands, then the BOI/VGRA Task Force will request that a sufficient amount of data first be generated on ASTM REO 300-1 to determine its equivalency to ASTM REO 300.
 - The BOI/VGRA matrix will not start, until the Seq. IV Surveillance Panel reports






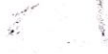

- that all aspects of the Sequence IVB test procedure, including the new engine break-in procedure, are finalized and not subject to further changes.
- o Seq. IV Surveillance Panel needs to meet ASAP to be updated on these BOI/VGRA matrix discussions and to ensure that the 8 run 1 reference tests are expedited.

Regards,

William A. Buscher III
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November 16, 2018

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Sequence IVB Development Update

AOAP
November 14, 2018

Teri Kowalski
William A Buscher III

Summary of Activity Since 10/11/18

- Sequence IV Surveillance Panel met on 10/18/18 and 10/25/18
 - Anticipated progress was made
 - Reviewed and updated the Sequence IVB Appendix K checklist on 10/25/18
 - Next meeting TBD, probably sometime during the week after Thanksgiving
- Industry Statisticians Group met on 10/12/18, 10/16/18, 10/24/18, 10/30/18, 11/1/18, 11/6/18 and 11/8/18
 - Next meeting TBD (waiting on additional data collection)
- Sequence IVB Precision Improvement and Sequence IVB Procedure Review sub-groups met on 10/30/18 and 11/6/18
 - Next meeting is scheduled for 11/27/18
- Sequence IVB Sequence IVB Metrology sub-group last met on 9/14/18
 - Next meeting TBD (waiting on completion of Round Robin 4)

-
- Surveillance Panel received a presentation from ACC PAPTG on 9/26/18
 - Surveillance Panel reviewed the ACC PAPTG presentation on 10/4/18
 - Surveillance Panel chair provided an initial surveillance panel response to the ACC PAPTG on 10/16/18
 - ACC PAPTG manager replied to the Sequence IV surveillance panel on 10/17/18
 - Surveillance Panel reviewed and updated the surveillance panel response to the ACC PAPTG on 10/25/18
 - Surveillance Panel chair provided an updated surveillance panel response to the ACC PAPTG on 10/25/18

Surveillance Panel's Primary Focus

Action Items Believed to be Critical to Starting
ACC Registration and the BOI/VGRA Matrix

- Industry Statisticians Group analysis of FEWMEOT data (N = 44) revealed an engine run order effect on FEWMEOT severity
 - Run 1 is severe, but not statistically different than run 3+
 - Run 2 is mild, but not statistically different than run 3+
 - Run 1 is severe compared to run 2, and run 1 and 2 are statistically different
 - Runs 3+ are not statistically different from each other
- Oil consumption and FEWMEOT data indicate the phenomenon is a break-in effect
 - New engines are not completely broken in at run 1
- Two options to consider for resolution
 - Mathematical solution = engine hour correction factor applied only to runs 1 and 2
 - Engineering solution = revise break-in
- Industry Statisticians Group and Surveillance Panel agree an engineering solution is the better approach

Resolution of FEWMEOT vs Engine Run Order **TOYOTA**

- **Completed:**

- FEWMEOT database (N = 44) for Industry Statisticians Group
- Industry Statisticians Group analysis of FEWMEOT data (N = 44)
- Surveillance Panel review of the FEWMEOT statistical analysis
- Industry Statisticians Group and Surveillance Panel agreement on pursuing an engineering solution instead of a mathematical solution
- Surveillance Panel motion to revise the break-in procedure for new engines
 - Added start of test flushing procedures and 50 hours of runtime on test conditions, using ASTM REO 1012, at the completion of the 50 hour aging portion of the current break-in/aging cycle
- Surveillance Panel action item to generate 8 run 1 reference tests, 4 reference tests using ASTM REO 300 (BOI/VGRA stand reference tests) and 4 reference tests using ASTM REO 1012 (each lab's next routine stand reference test)
 - These 8 run 1 reference tests will be used to evaluate the effectiveness of the revised break-in procedure

Resolution of FEWMEOT vs Engine Run Order **TOYOTA**

- **Completed:**

- BOI/VGRA Task Force reviewed the Surveillance Panel's approach to resolving the FEWMEOT vs engine run order phenomenon
- BOI/VGRA Task Force agreed to instruct the ASTM TMC to release ASTM REO 300 for BOI/VGRA matrix stand referencing, with stipulations

- **In Process:**

- Labs conducting 8 run 1 reference tests
 - Timing: Currently in process
- Industry Statisticians Group analysis of 8 run 1 reference tests
 - Timing: Once 8 run 1 reference tests have been completed
- Surveillance Panel review of 8 run 1 reference test statistical analysis, and either confirmation that the revised break-in procedure is adequate or that further revisions to the break-in procedure should be considered
 - The only additional revisions to the break-in procedure that the Surveillance Panel agreed to consider, would be additional runtime on test conditions
 - Timing: Once 8 run 1 reference tests have been completed

- **Completed:**

- FEWMEOT measurement procedure
- Sub-group and Surveillance Panel review of proposed FEWMEOT measurement procedure and approval to conduct this procedure on all precision matrix 2 EOT oil samples
- FEWMEOT analysis/measurements, at a single lab (Intertek) and at original labs on all precision matrix 2 and post-precision matrix reference oil EOT oil samples
- FEWMEOT database (N = 44) for Industry Statisticians Group
- Surveillance Panel/Industry Statisticians Group meeting for initial review of FEWMEOT database, and to request and prioritize analysis
- Surveillance Panel motion to approve final FEWMEOT measurement procedure
- FEWMEOT measurement implementation into all Sequence IVB testing
- Preliminary FEWMEOT statistical analysis and surveillance panel review

- **Completed:**

- Industry Statisticians Group development of a proposed engine hour correction factor
- Industry Statisticians Group analysis of FEWMEOT data (N = 44), both with and without the application of an engine hour correction factor
- Industry Statisticians Group development of FEWMEOT LTMS, both with and without the application of an engine hour correction factor
- Surveillance Panel review and motions to approve FEWMEOT statistical analysis, LTMS (**no detergent metal ratio adjustment used, no engine hour correction factor used, cap the severity adjustments for FEWMEOT at $\pm 100\text{ppm}$**) and implementation
- FEWMEOT LTMS implementation on 11/1/18

- **All opened action items completed**

- **Completed:**

- 1) Definition of a lobe failure (**>20 μ m**)
 - 2) Test interpretability and/or test validity criteria for camshaft lobe failure (**non-interpretable**)
 - 3) Engine Assembly Manual Section 4 (reconditioning after a lobe failure)
 - 4) Stand maintenance after a lobe failure procedure
 - 5) Engine health checklist
- Sub-group review of items 1 – 5 listed above and approval of implementation of items 1 – 5 listed above at the labs
 - Implementation of items 1 – 5 listed above at the labs
 - Surveillance Panel motions to approve items 1 – 5 listed above
 - Single master database (N = 159) for Industry Statisticians Group

- **All opened action items completed**

- **Completed:**
 - Oil consumption data collection
 - Sub-group review of oil consumption data
 - Test interpretability and/or test validity criteria for oil consumption (**validity limit = 1,000g max**)
 - Surveillance Panel motion to approve oil consumption validity limit
 - Implementation of oil consumption validity limit at the labs
 - Single master database (N = 159) for Industry Statisticians Group
 - Preliminary oil consumption (reference oils only) statistical analysis and surveillance panel review
- **All opened action items completed**

- **Completed:**

- Surveillance Panel motion to reduce the maximum number of allowable runs per engine from 12 to 6
- Updated the ASTM draft procedure and engine assembly manual with all of the revised and additional material generated by the sub-groups and approved by the surveillance panel
 - Updated ASTM draft procedure and engine assembly manual are posted on the ASTM TMC website

Surveillance Panel's Secondary Focus

Continuous Improvement Action Items Believed NOT to be Critical to Starting ACC Registration and the BOI/VGRA Matrix

- **Completed:**

- Engine break-in and aging data collection
- Engine life/history data collection
- Lobe failure data collection
- Single master database (N = 159) for Industry Statisticians Group
- Surveillance Panel motion to reduce the maximum number of allowable runs per engine from 12 to 6

- **In Process:**

- Statistical analysis of single master database, including all data listed above
 - **Timing:** Full analysis currently in process
- Surveillance Panel review and motions to approve changes and/or additions to most recent engine life guidelines and criteria, and implementation
 - **Timing:** Once full analysis is completed
- Implementation of revised engine life guidelines and criteria at the labs
 - **Timing:** Once full analysis is completed

- **Completed:**

- Test stand audit checklist
- Extended downtime procedure
- Blowby flow meter cleaning procedure
- Fuel monitoring and handling procedures
- Lifter grade selection procedure
- Revisions to ANNEX A.5 of the Sequence IVB ASTM draft procedure (lifter screening)
 - Procedure development/revision, sub-group review, surveillance panel review, motions and approval (if necessary) and implementation has occurred for all items listed above
- Design for a 4th Keyence lifter measurement Round Robin
- Round Robin 4 pre-test measurements at all five labs
- Donated test at Intertek on Round Robin 4 lifters, using ASTM REO 300-1

- **In Process or To Start:**

- Round Robin 4 post-test measurements at all five labs (**progressing**)
 - Will analyze and review data, once available
- Updating the data dictionary and test report forms (**almost completed**)
- In depth review of the final ASTM draft procedure and engine assembly manual (**started on 11/6/18**)
- Developing a Keyence calibration/verification procedure
- Investigating Keyence monitoring in LTMS
- Reviewing and potentially updating QIs
- Additional in-depth review of precision matrix 2 operational data
- Continue to pursue an improved understanding of test severity and test precision drivers

- Intake Camshafts
 - Batch Code D
 - This is the precision matrix 2 hardware batch
 - Reserved 30 runs of hardware for BOI/VGRA matrix and BOI/VGRA stand reference testing
 - Depleted for candidate and non-matrix stand reference testing
 - Batch Code E
 - Candidate and non-matrix stand reference testing have transitioned
- Exhaust Camshafts
 - Batch Code E
 - This is the precision matrix 2 hardware batch
 - Depleted for all testing
 - Batch Code G
 - Reserved 30 runs of hardware for BOI/VGRA matrix and BOI/VGRA stand reference testing
 - Candidate and non-matrix stand reference testing have transitioned

- Lifters
 - Batch Code A, B and C
 - Mixture of these batches are the precision matrix 2 hardware batch
 - BOI/VGRA matrix and BOI/VGRA stand reference testing will use same batch mixture
 - Candidate and non-matrix stand reference testing will continue to use same batch mixture
- Engines and Cylinder Heads
 - Batch Code 1
 - A few engines and/or cylinder heads remaining in lab inventory
 - Almost depleted for Candidate and non-matrix stand reference testing
 - Batch Code 2
 - This is the precision matrix 2 hardware batch
 - BOI/VGRA matrix and BOI/VGRA stand reference testing will use this batch
 - Candidate and non-matrix stand reference testing will continue to use this batch

BOI/VGRA Task Force Meeting

R. C. Dougherty

November 13, 2018

Review of Lubricants Standards Group Ballots

Lubricants Standard Group Ballots

September LG Meeting

- Ballot 4625: Sequence VIF BOI
- Ballot 4626: Revision to Section F.1.2 (Annex F)
- Ballot 4627: Revision to Section E.3.2.5 (Annex E)
- Ballot 4628: Revision to Section E.2.2.4 (Annex E)

Ballot results to be reviewed Nov. 14th

October LG Meeting

- Ballot 4648: D6278 as Alternate to Seq. VIII Stripped Viscosity (Annex F)
- Ballot 4649: D6278 as Alternate to Seq. VIII Stripped Viscosity (Annex E)
- Ballot 4650: Sequence X BOI
- Ballot 4651: Sequence X VGRA
- Ballot 4652: New VGRA Technical Principles table (Seq. X)

Ballots to close Nov. 30th

Lubricants Group Proposal #1

Sequence IIIH BOI

Sequence IIIH BOI Recommendation

Incorporate following text and table in Annex E

E.2.2.4.x For Sequence IIIH and IIIHB tests required for interchanging the base stock, specific requirements are given in Table E-xx.

Additionally, once five passing IIIHB test have been demonstrated on a unique technology in a single additive package (DI) at a constant treat rate, then no additional Sequence IIIHB testing is required for that unique technology

Table E-xx – Sequence IIIH and IIIHB Tests Required for Interchanging the Base Stock

Base Stock in Original Test Oil	Interchange Base Stock				
	Group I	Group II	Group III	Group IV	Group V
Group I	Required	Required	≤ 30% Not Required ----- > 30% Required	Required	Required
Group II	Required	Required	≤ 30% Not Required ----- > 30% Required	Required	Required
Group III	Required	Required	Required	Required	Required
Group IV	Required	Required	Required	Not Required provided the interchange Group IV meets the original manufacturer's specifications in all physical and chemical properties	Required
Group V	Required	Required	Required	Required	Required

Lubricants Group Proposal #1

Sequence IIIH BOI

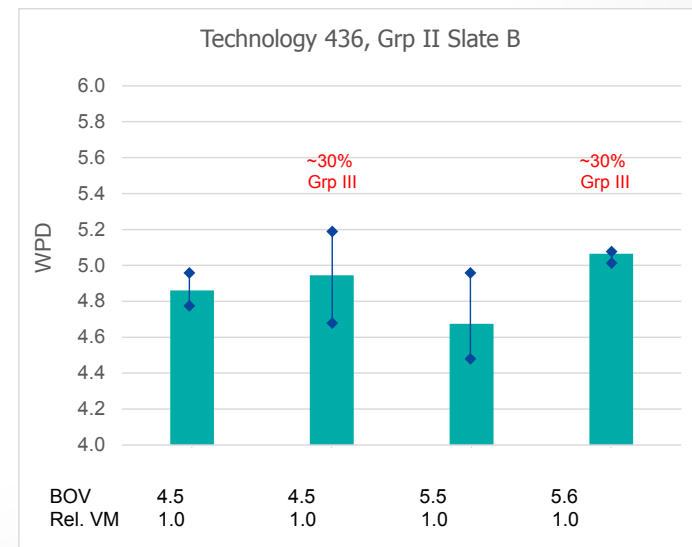
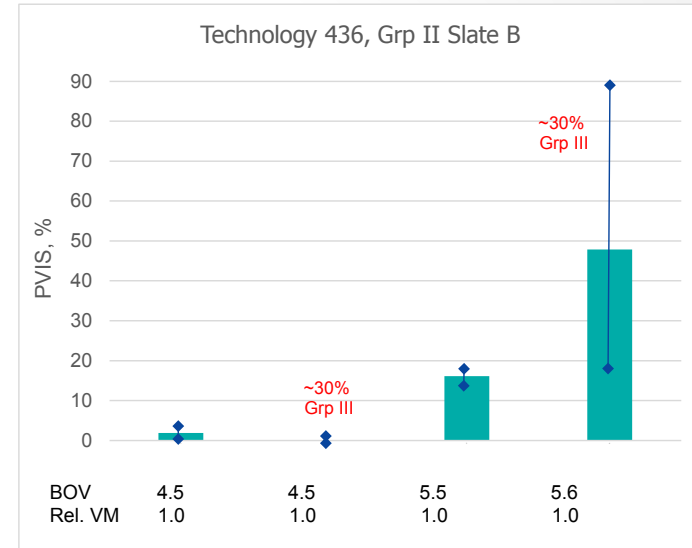
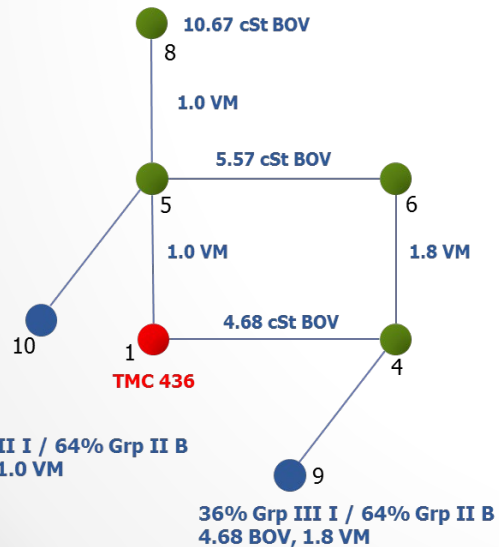


Additional Information

Sequence IIIH: Grp III → Grp II BOI

- Test program evaluated directly 30% substitution of Grp III into Grp II (fully formulated oil basis)
- Two {BOV,VM} levels evaluated

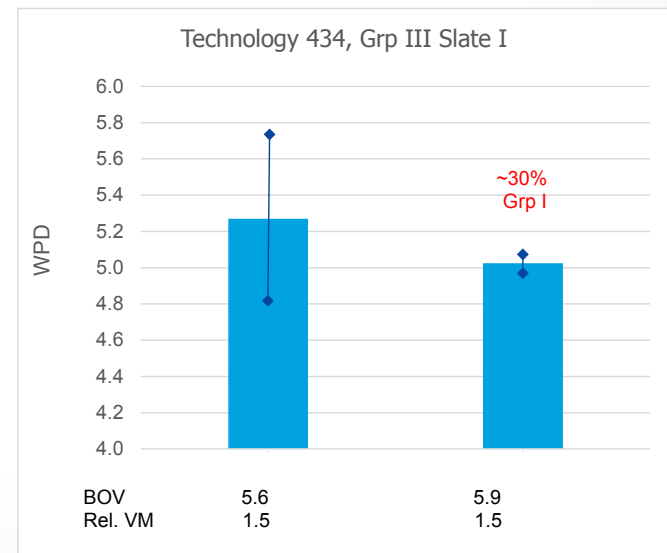
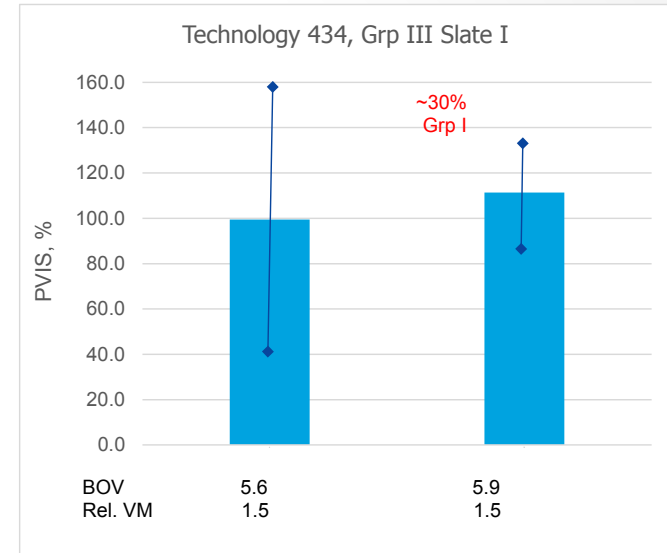
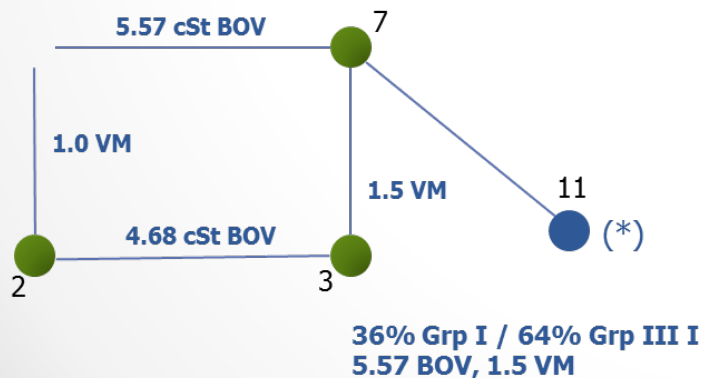
Grp II Slate B, Tech 436



Sequence IIIH: Grp III → Grp I BOI

- Test program evaluated 30% substitution of Grp III into Grp I (fully formulated oil basis) by testing the inverse
- Concern was that full Grp I formulation might not be capable of completing the test
- One {BOV,VM} levels evaluated

Grp III Slate I, Tech 434



Sequence IIIH: Statisticians Report

Executive Summary

- Technology is statistically significant for all parameters
- BOV is statistically significant for WPD
 - *Linear effect may not be capturing the trend in the data*
- Relative VM within Technology is statistically significant for PVIS and WPD
 - *Evidence of opposite slopes between Technologies*
- BO Group is not statistically significant for all parameters
 - *Swapping Group II with 30% Group III (Tech 434) or Group III with 30% Group I (Tech 436) is not statistically significant*
- Lab and Stand within Lab are not statistically significant for all parameters

Lubricants Group Proposal #2

Sequence IIIH VGRA

Sequence IIIH VGRA Recommendation

Incorporate following text and table to Annex F

Groups I, II, III and IV Viscosity Read-Across: Sequence IIIH Test

Bracketing two passing formulations for a given technology may be used to waive additional viscosity grade testing. VGRA is allowed, if the candidate's viscosity modifier treat falls within the range of the two passing formulations and the base stock blend kinematic viscosity @ 100°C is equal to or higher than both oils used in the bracket, considering the precision of the test method. (This approach applies to formulations using base oils containing Group I, Group II, Group III and Group IV base stocks. Oils containing Group V base stocks must contain an equal amount of the same base stock in the finished oil blend for application of viscosity grade read-across.)

Example:

	Matrix Oil 1	Matrix Oil 2	Candidate Oil A	Candidate Oil B	Candidate Oil C
Base Oil Viscosity @ 100°C, cSt	4.6	6.3	9.0	6.0	6.0
Viscosity Modifier Treat	3.5	9.0	7.0	11.5	7.0
Dxxx Seq. IIIH	Pass	Pass			
Test Required?			No	Yes	Yes
Reason			Formulation base oil viscosity is higher than both Matrix oils and fails within the range of viscosity modifier treat	Formulation base oil viscosity is only higher than one Matrix oil and does not fail within the range of viscosity modifier treat	Formulation base oil viscosity is only higher than one Matrix oil, but does fail within the range of viscosity modifier treat

Lubricants Group Proposal #2

Sequence IIIH VGRA



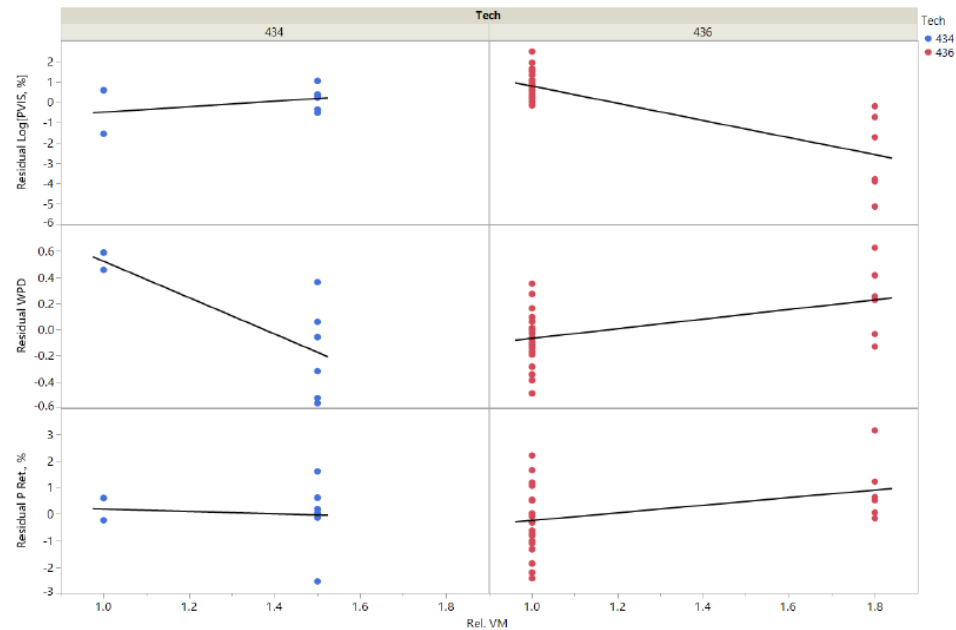
Additional Information

Executive Summary

- Technology is statistically significant for all parameters
- BOV is statistically significant for WPD
 - *Linear effect may not be capturing the trend in the data*
- Relative VM within Technology is statistically significant for PVIS and WPD
 - *Evidence of opposite slopes between Technologies*
- BO Group is not statistically significant for all parameters
 - *Swapping Group II with 30% Group III (Tech 434) or Group III with 30% Group I (Tech 436) is not statistically significant*
- Lab and Stand within Lab are not statistically significant for all parameters

Sequence IIIH: Statisticians Report (cont.)

VM Effect within Technology



Linear effect of Relative VM on LnPVIS and WPD has opposite directions (slopes) between Technologies. The differences in slopes may be due to the VM type or treat rate which are confounded with Technology.

Sequence IIIH: Statisticians Report (cont.)

Model Regression Summary

Term	P-values		
	LnPVIS	WPD	PRet
Tech	<.0001	0.05	<.0001
BOV100 (Calc)	0.42	<.0001	0.69
Rel. VM within Tech	<.0001	0.00	0.18
BO Group within Tech	0.28	0.97	0.37
Lab	0.89	0.14	0.12
Stand within Lab	0.47	0.23	0.78

Statistically significant (p-value \leq 0.05)

Lubricants Group Proposal #3

Sequence IIIH, IIIHB VGRA Technical Principles
(2 ballots)

Sequence IIIH, IIIHB VGRA Technical Principles Recommendation #3a

Incorporate following in Annex F

Table F-y – Technical Principles for New Viscosity Grades and Read Across
 (Applies to oils with HTHS¹⁵⁰ ≥ 2.3 mPa·s)

Passenger Car Motor Oils		IIIH	IIIHB
a	Detergent (dispersant)-inhibitor (DI) content of the read-across viscosity grade shall be equal to or higher than that of the original viscosity grade. The increase in DI is limited to the maximum allowed by the ACC Code	✓	✓
b	Base stock blend kinematic viscosity at 100°C of the read-across viscosity grade must be equal to or higher than that of the original viscosity grade, considering the precision of the test method	✓	NA

Sequence IIIH VGRA Technical Principles Recommendation #3b

Incorporate following changes to Table F-1
Ballot ID 4358 (Feb., 2018)

Table F-1 – Technical Principles for New Viscosity Grades and Read Across
 (Applies to oils with HTHS¹⁵⁰ ≥ 2.6 mPa·s)

Passenger Car Motor Oils		IID	L-38/VIII	IIIE/IIIF/ IIIG	IIIGA (Note 2)	IIIGB/ IIICB	IIIH	IVA	VE	VG	VIA/VIB/ VID
a	Detergent (dispersant)- inhibitor (DI) content of the read-across viscosity grade shall be equal to or higher than that of the original viscosity grade. The increase in DI is limited to the maximum allowed by the ACC Code	✓	✓	✓	✓	✓	✓	✓	✓	✓	Note 3
b	Base stock blend kinematic viscosity at 100°C of the read-across viscosity grade must be equal to or higher than that of the original viscosity grade, considering the precision of the test method	NA	NA	✓	✓	NA	✓	✓	✓	✓	Note 3
c	The viscosity modifier (VM) content of the read-across viscosity grade must be equal to or lower than that of the original viscosity grade	NA	NA	Note 4	Note 4	NA	Note 4	✓	✓ or Note 5	✓ or Note 5	Note 3

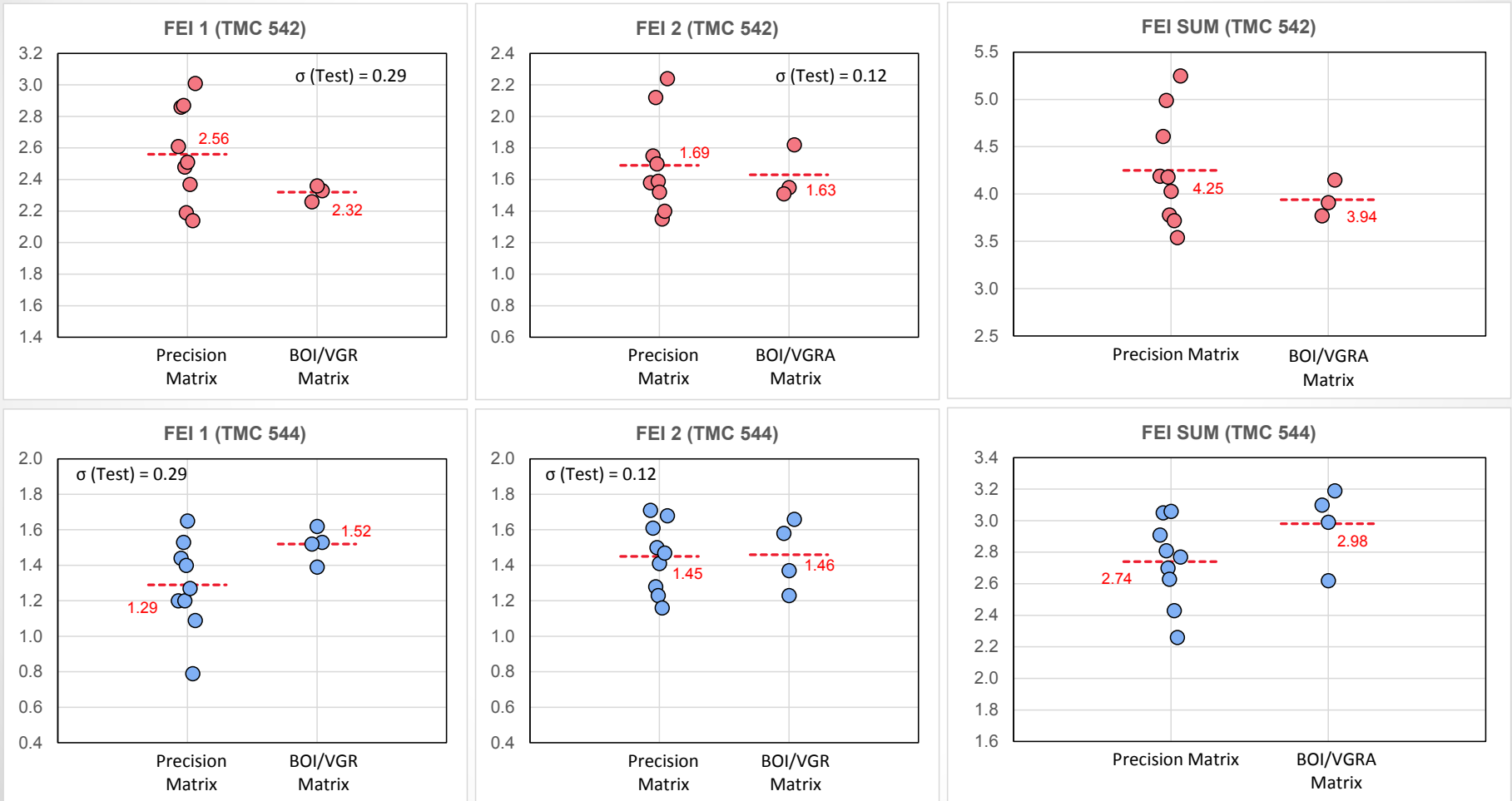
Sequence IIIH VGRA Technical Principles Recommendation (cont.)

Note: BOI/VGRA Task Forces intends to make a recommendation to the Lubricants Group to eliminate the reference to the Sequence IIIH in Table F-1 nominal 12 months before first allowable use of API SP / GF-6

BOI/VGRA Status Update

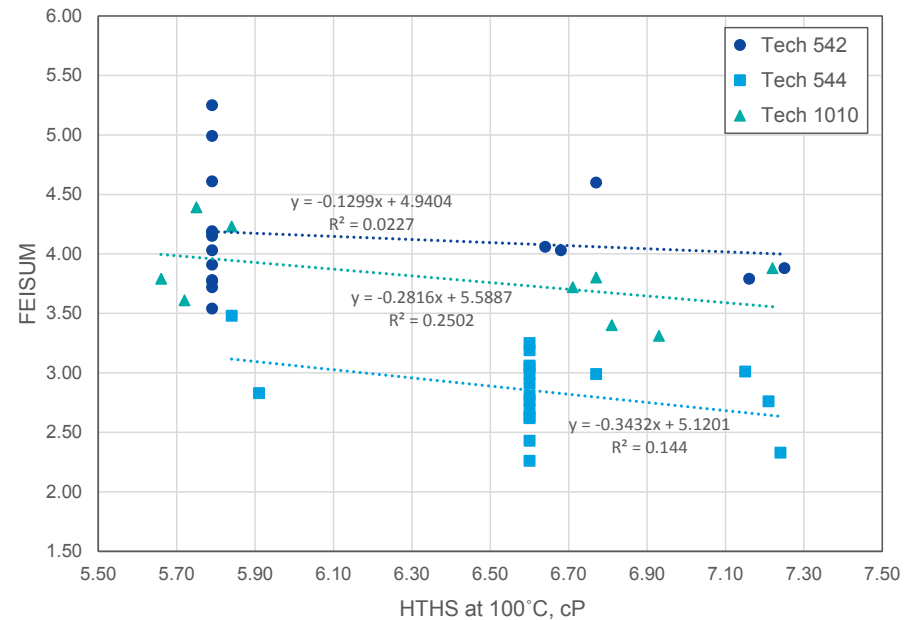
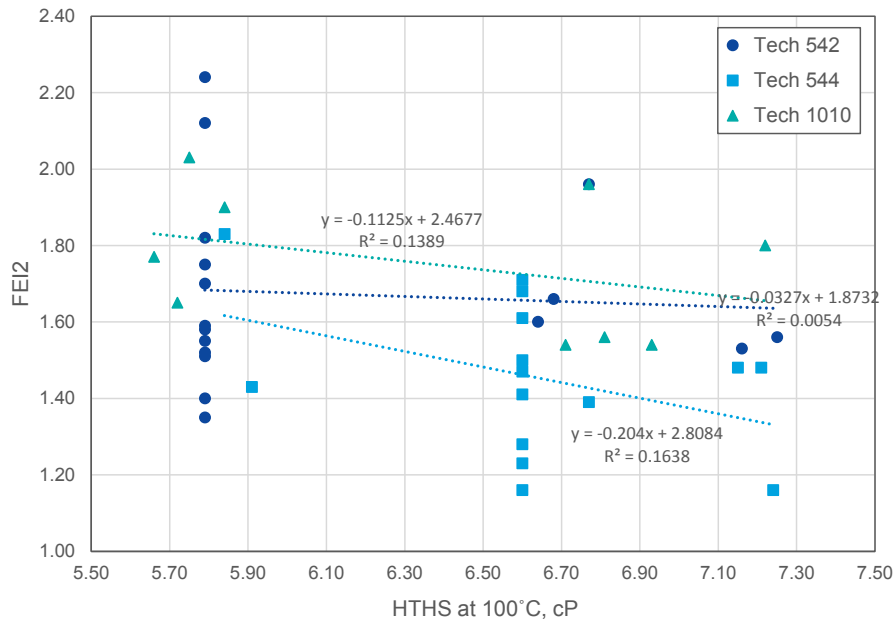
Sequence VIE: Reference Oil Performance

Tests completed and severity adjustments confirmed by TMC and Stats Group



Sequence VIE: FE Trends

All data included (precision matrix, BOI/VGRA matrix + references)



- FEISUM difference between 0W-20 and 10W-30: 0.28 – 0.47%
- FEISUM difference in proposed GF-6A specification: 1.1%

Sequence IVB

- Awaiting final assessment of break-in procedure
- Scott Parke email (11/2/18)

There are exactly enough cans of oil 300 remaining to calibrate the 4 boi-vgra matrix test stands. 4 cans. these cans have been marked to prevent any other use for them.

Rich Grundza will report back to the surveillance panel that these oils are off limits for any other use and that the break-in procedure will need to be finalized by the surveillance panel before any stands can be referenced for boi-vgra testing.

While it would have been nice if the oil 300 boi-vgra reference tests could have done double duty proving out the extended break-in, the oil is simply too valuable and limited a commodity to allow it to be put at risk. The labs will have to accept that refining the break-in procedure is a test development cost separate and apart from the boi-vgra referencing.

Recap of Sequence IIIH BOI Options

Single Technology Matrix

- N + 2 tests
- Statistical criteria applied to model of performance
- Spread requirement

“Single Technology BOI”

- Infineum proposal
- Bracketing approach – 2^N tests (?); codification required

Sequence IIIH Base Oil Parameters Of Potential Impact

Fundamental Properties of Potential Impact

Properties	Example Measurement Technique
Total Aromatics	UV (prop, D2008), HPLC (D7419), D2007
Multi-Ring Aromatics (2R+, 3R+)	UV (prop, D2008)
Mean Boiling Point	D2887, D6352, prop
Boiling Point Distribution (e.g. T ₉₀ -T ₁₀)	D2887, D6352, prop
Paraffin/Naphthene Ratio	Supercritical Fluid Chromatography, other
Saturates branching characteristics	2DGC, GCMS, ¹³ C NMR
Total Sulfur*	D2622
Aliphatic/Thiophenic Sulfur Ratio*	Prop
Basic Nitrogen*	Prop

* Base oils using Gp base stocks

Surrogate Properties of Potential Impact

Properties	Example Measurement Technique
Total Aromatics	D7419, D2007
Viscosity Index	D2270
Viscosity	D445
Noack Volatility	D5800

EM plans testing to evaluate parameters of potential impact with experimental design focused on fundamental properties

ExxonMobil

Included in Base Stock Manufacturers interest group deck (11-12-18)

N = number of base oil parameters of import

VGRA requires a minimum of 1 additional test for each option (to bracket or discern directionality)

Sequence VH BOI

Sequence VH Incremental Testing Update

Oil	BOI/VGRA Oil 13	Test Oil A	BOI/VGRA Oil 16	Test Oil B
Additive Technology	1009	1009	1011	1011
Grp II Slate K LN	15		75	
Grp II Slate K MN	85		25	
Grp II LN		67		95
Grp II HN		33		5
BOV _{100r} , cSt	6.07	5.95	4.83	4.81
Saturates (D7419), %	> 99.8	95.3	> 99.8	95.0
Saturates (D2007), %	99.0	92.9	99.0	92.7
Sequence VH Severity Adjusted Results				
AES	6.95		8.93	
AEV	8.91		9.51	
APV	8.45		8.88	
RES	9.24		9.31	

Test Oil A running at SwRI for testing with prior fuel batch; Test Oil B next in queue

- EM planning testing to support Grp IV BOI
- 2 technologies
 - Grp II vs. Grp IV (1 tech)
 - Grp III vs. Grp IV (1 tech)

Sequence VH BOI Read Table Recommendation

Oct. LG meeting

Table E-XX Sequence VH - Tests required for Interchanging the Base Stocks

Base Stock in Original Test Oil	Interchange Base Stock				
	Group I	Group II	Group III	Group IV	Group V
Group I	Not Required if Base Oil Viscosity at 100°C ≥ Original, and both Original and Candidate Base Oil Saturates ⁽¹⁾ ≥ 83%, and Sulfur ≤ 0.13% Required	Not Required if Base Oil Viscosity at 100°C ≥ Original and Original Base Oil Saturates ≥ 83%, and Sulfur ≤ 0.13% Required		Required	Required
Group II		Required		Required	Required
Group III				Required	Required
Group IV	Required	Required	Required	Not Required provided the interchange Group IV meets the original manufacturer's specifications in all physical and chemical properties	Required
Group V	Required	Required	Required	Required	Required

No data to support

Impact of Grp I saturates and sulfur

Impact of hydroprocessed base oil saturates

Read extensions to Grp IV

Testing In Progress

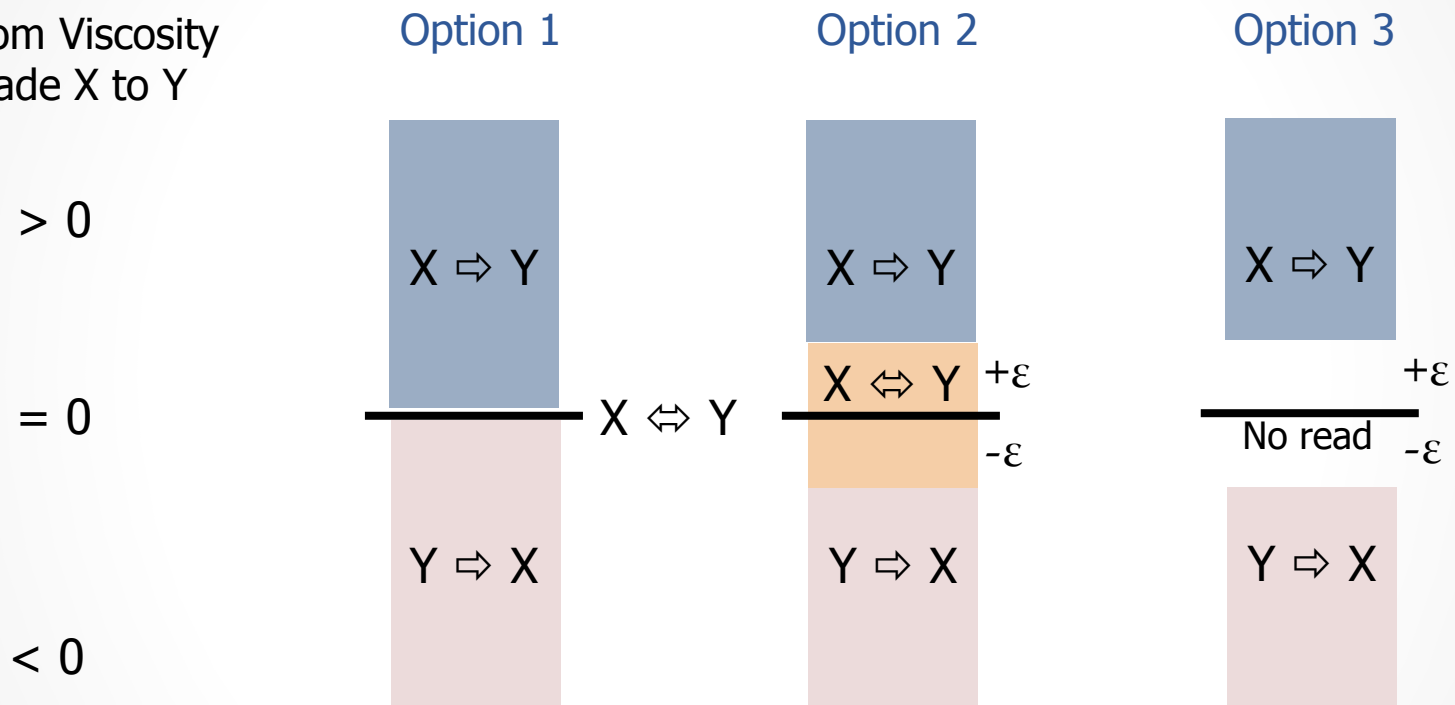
Testing Planned for 4Q18

⁽¹⁾ By ASTM D2007

Sequence VH VGRA

Performance Model Use for VGRA Reads

Performance Model for Read From Viscosity Grade X to Y



Preference	4	2	2
Acceptable	4	5	1
Not Acceptable		1	4

Oil Marketer Input

Question:

The methodology we used supports reads from 10W-40 → 5W-30 and from 15W-40 → 10W-30, which are the reverse direction of the reads for the Seq. VG. The question to oil marketers is whether if these guidelines were accepted by the industry, would you require testing in lower viscosity grades, or would you accept the reads per the read table? In other words, if an addco presented a CDP with a passing result in a 10W-40 grade, would you accept this result as being sufficient to waive testing in a 5W-30 grade? If your organization would not accept this read, what would be your proposal?

For the VH, Shell's preference is for the one-way reads and would accept the reads from 10W-40 – 5W-30 as well as from 15W-40 – 10W-30. Shell does not prefer, but would not prevent the adoption of the two-way reads in the table due to the use of the VH test to support previous categories where those reads were unavailable.

Eric Kalberer, Shell

Oil Marketer Input (cont.)

In general, Chevron's position is not to second guess codified industry guidelines. We will not require our ACC partners to run a test that is already supported by BOI/VGRA R/A guidelines.

Matthew Ansari, Chevron

If these guidelines were accepted by the industry, we don't see an issue accepting the reads 10W-40 to 5W-30 and 15W-40 to 10W-30 on Sequence VH.

Brian Humphrey, Petro Canada

ExxonMobil would take no exception to 10W-40 → 5W-30 and 15W-40 → 10W-30 VGRA reads if those were recommended by the BOI /VGRA Task Force and would not require incremental testing.

Dennis Gaal, ExxonMobil