To: API Lubricants Group
Cc: Lubricants Group Mailing List
API

BOI/VGRA Task Force Proposal 1 Sequence IIIH VGRA

On April 4, 2019 the Lubricants Standards Group (LSG) reviewed *"Table F-X – Groups I, II, III, and IV Viscosity Grade Read-Across: Sequence IIIH Test"*.

"Table F-X – Groups I, II, III, and IV Viscosity Grade Read-Across: Sequence IIIH Test" is given below and in the Electronic Ballot Attachment.

Table F-X – Groups I, II, III, and IV Viscosity Grade Read-Across: Sequence IIIH Test

Test Run On	0W-16	0W-20	0W-30	5W-20	5W-30	10W	10W-30	10W-40	15W-40	15W-50	20W	20W-40	20W-50	SAE 30	SAE 40	SAE 50
0W-16	NA	--	--	X	--	X	X	--	--	--	X	X	--	X	X	X
0W-20	X	NA	--	X	--	X	X	--	--	--	X	X	X	X	X	X
0W-30	X	X	NA	X	X	X	X	X	X	--	X	X	X	X	X	X
5W-20	--	--	--	NA	--	--	X	--	--	--	X	X	--	X	X	X
5W-30	--	--	--	X	NA	--	X	--	X	--	X	X	X	X	X	X
10W	--	--	--	--	--	NA	--	--	--	--	X	--	--	X	X	X
10W-30	--	--	--	--	--	--	NA	--	--	--	X	X	X	X	X	X
10W-40	--	--	--	--	--	--	X	NA	X	--	X	X	X	X	X	X
15W-40	--	--	--	--	--	--	--	--	NA	--	X	X	X	X	X	X
15W-50	--	--	--	--	--	--	--	--	X	NA	X	X	X	X	X	X
20W	--	--	--	--	--	--	--	--	--	--	NA	--	--	X	X	X
20W-40	--	--	--	--	--	--	--	--	--	--	--	NA	--	--	X	X
20W-50	--	--	--	--	--	--	--	--	--	--	--	X	NA	--	X	X
30	--	--	--	--	--	--	--	--	--	--	--	--	--	NA	X	X
40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NA	X
50	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NA

Notes:

1. X = read-across permitted for the viscosity grades identified based upon data and some applications of the technical principles approved by the BOI/VGRA Task Force and API Lubricants Group. Viscosity modifier content should not be higher than that in the oil tested.
2. A dash (--) means that read-across in not permitted; NA = not applicable
3. New viscosity grades and associated read-across are allowed if the requirements in F-1.x are met.
4. Tested formulations containing Group V stocks must contain an equal amount of the same Group V stock (e.g., ester) in the finished oil blended for application of viscosity grade read-across.

In support of this read across the BOI/VGRA Task Force provided the "Rationale and Data Overview" (Ballot Attachment 1, page 3) and "Additional Information" (Ballot Attachment 1, pages 5-10). The LSG discussed the BOI/VGRA Task Force Proposal and Supporting Information. Subsequently a Ballot Motion was made: "That the Table in Slide 2 and the Footnotes be Balloted by the Lubricants Group for acceptance into API 1509 Annex F to guide Sequence IIIH VGRA". (Ballot Attachment 1, Page 4)

The Ballot Motion is given below and on Attachment 1, page 4.

Motion

That the Table in Slide 2 and the Footnotes be Balloted by the Lubricants Group for acceptance into API 1509 Annex F to guide Sequence IIIH VGRA

Motion by: Rick Dougherty

Second by: Eric Kalberer

- Affirmative=16
- Negative=0
- Abstain=0

Motion Passes

Lubricants Group Members should use the API Ballot System to cast their vote and make comments. The Ballot Link is: http://Ballots.api.org. The Lubricants Group Member votes will be counted, and all received comments reviewed and considered before the ballot results are final.

Non-Lubricants Group Members should comment on the Ballot Motion using the Ballot system. The Ballot Link is: http://Ballots.api.org . All comments on the Ballot Motion will be reviewed before the ballot results are final.

This Ballot will close on May 10, 2019. All Votes and/or Comments must be received by that date. If approved the balloted change will be effective as of April 4, 2019.

Attachment 1

BOI/VGRA Task Force Proposal 1

Sequence IIIH BOI

Detroit

R. C. Dougherty

April 3, 2019

Sequence IIIH VGRA Read Table Proposal

Table F-X – Groups I, II, III, and IV Viscosity Grade Read-Across: Sequence IIIH Test

Test Run On	0W-16	0W-20	0W-30	5W-20	5W-30	10W	10W-30	10W-40	15W-40	15W-50	20W	20W-40	20W-50	SAE 30	SAE 40	SAE 50
0W-16	NA	--	--	X	--	X	X	--	--	--	X	X	--	X	X	X
0W-20	X	NA	--	X	--	X	X	--	--	--	X	X	X	X	X	X
0W-30	X	X	NA	X	X	X	X	X	X	--	X	X	X	X	X	X
5W-20	--	--	--	NA	--	--	X	--	--	--	X	X	--	X	X	X
5W-30	--	--	--	X	NA	--	X	--	X	--	X	X	X	X	X	X
10W	--	--	--	--	--	NA	--	--	--	--	X	--	--	X	X	X
10W-30	--	--	--	--	--	--	NA	--	--	--	X	X	X	X	X	X
10W-40	--	--	--	--	--	--	X	NA	X	--	X	X	X	X	X	X
15W-40	--	--	--	--	--	--	--	--	NA	--	X	X	X	X	X	X
15W-50	--	--	--	--	--	--	--	--	X	NA	X	X	X	X	X	X
20W	--	--	--	--	--	--	--	--	--	--	NA	--	--	X	X	X
20W-40	--	--	--	--	--	--	--	--	--	--	--	NA	--	--	X	X
20W-50	--	--	--	--	--	--	--	--	--	--	--	X	NA	--	X	X
30	--	--	--	--	--	--	--	--	--	--	--	--	--	NA	X	X
40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NA	X
50	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NA

Notes:

1. X = read-across permitted for the viscosity grades identified based upon data and some applications of the technical principles approved by the BOI/VGRA Task Force and API Lubricants Group. Viscosity modifier content should not be higher than that in the oil tested.
2. A dash (--) means that read-across in not permitted; NA = not applicable
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4. Tested formulations containing Group V stocks must contain an equal amount of the same Group V stock (e.g., ester) in the finished oil blended for application of viscosity grade read-across.

Rationale and Data Overview

Initial BOI/VGRA Testing Matrix

- Two additive technologies, and two base stock slates tested
- No cross-blending of VM/DI or base stock slate (unlike other BOI/VGRA matrices)
- Statisticians report indicated BOV to be a significant factor for VGRA with increasing BOV being beneficial
- Relative VM treat level was found to be statistically significant but with opposite directions for the two technologies (beneficial for Tech. 436; detrimental for Tech. 434)

Additional Data

- Three additional test results provided by supplier of TMC 436 corroborated the prior findings that increasing VM treat level appears beneficial to performance

Proposals Considered by Task Force

- Bracketing for each base stock slate, DI and VM
- Supplemental testing to simplify bracketing or to support directionality

Further Study by Task Force

- Beneficial PVIS performance for oils with Tech. 436 appear related to the shear stability of the VM used (50 SSI) relate to the more shear stable polymer used with Tech. 434 (25 SSI)
- Fundamental trend of PVIS increasing with time after certain point at which VM sheared consistent for both technologies
- Task Force reached consensus on read tables and technical principles based on increasing BOV and decreasing VM being beneficial; no equation of performance exists to determine reads where application of technical principles is not valid

Motion

That the Table in Slide 2 and the Footnotes be Balloted by the Lubricants Group for acceptance into API 1509 Annex F to guide Sequence IIIH VGRA

- Motion by: Rick Dougherty
- Second by: Eric Kalberer

  - Affirmative=16
  - Negative=0
  - Abstain=0

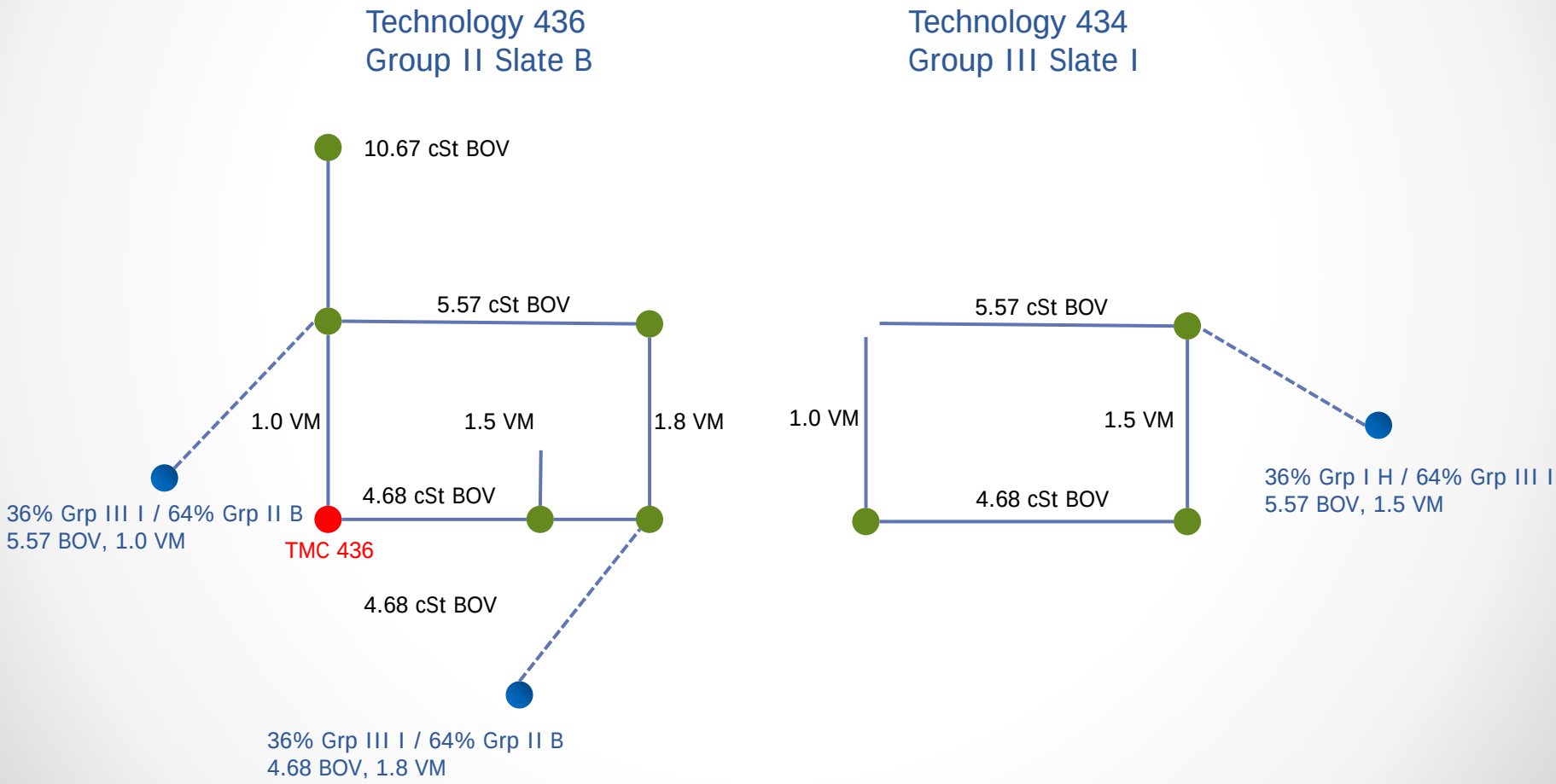
Motion Passed

BOI/VGRA Task Force Proposal #1
Sequence IIIH BOI

Additional Information

Sequence IIIH BOI/VGRA Matrix Design

Includes 3 supplemental test results provided by supplier of TMC 436



Statisticians' Report: Aug. 29, 2018

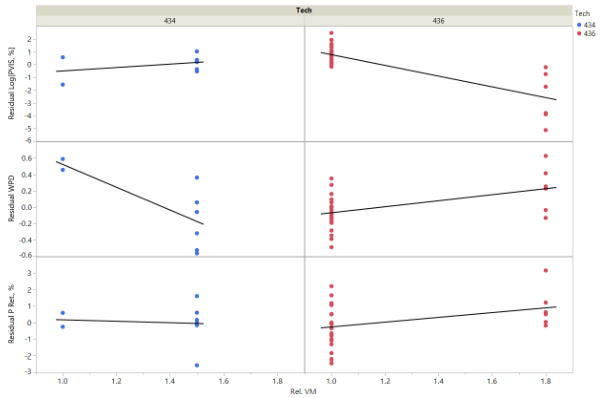
Does not include 3 supplemental test results provided by supplier of TMC 436

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

3

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.

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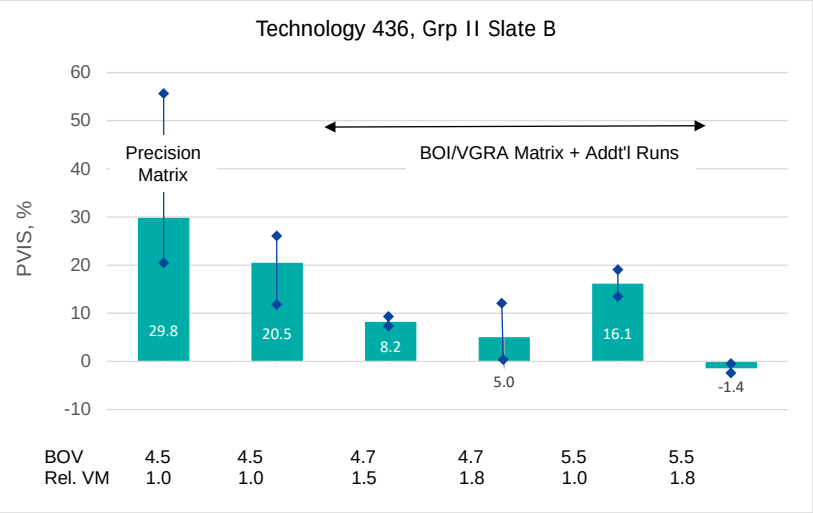
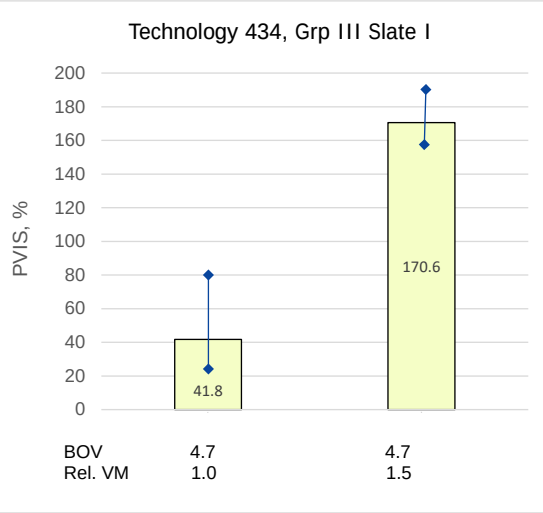
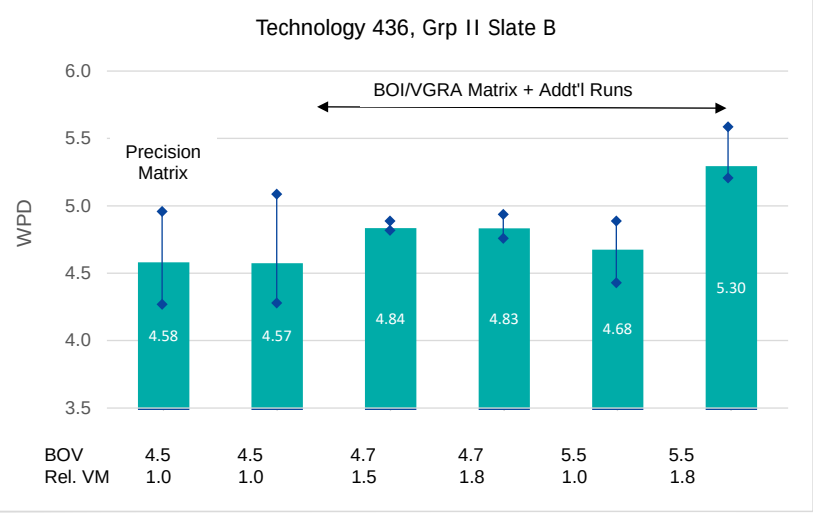
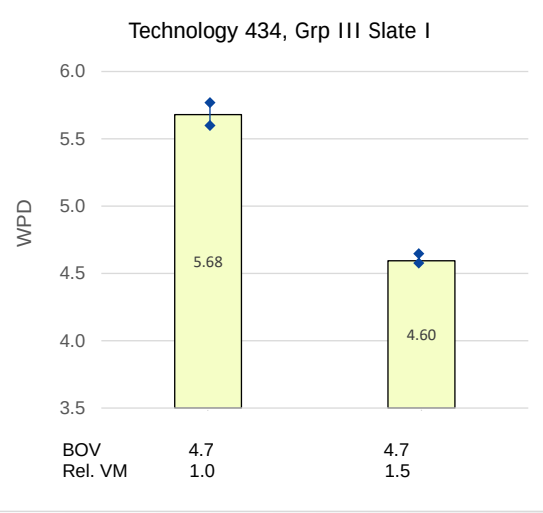
Impact of Relative VM Treat

Additional data provided by TMC 436 supplier included
Points represent data extremes



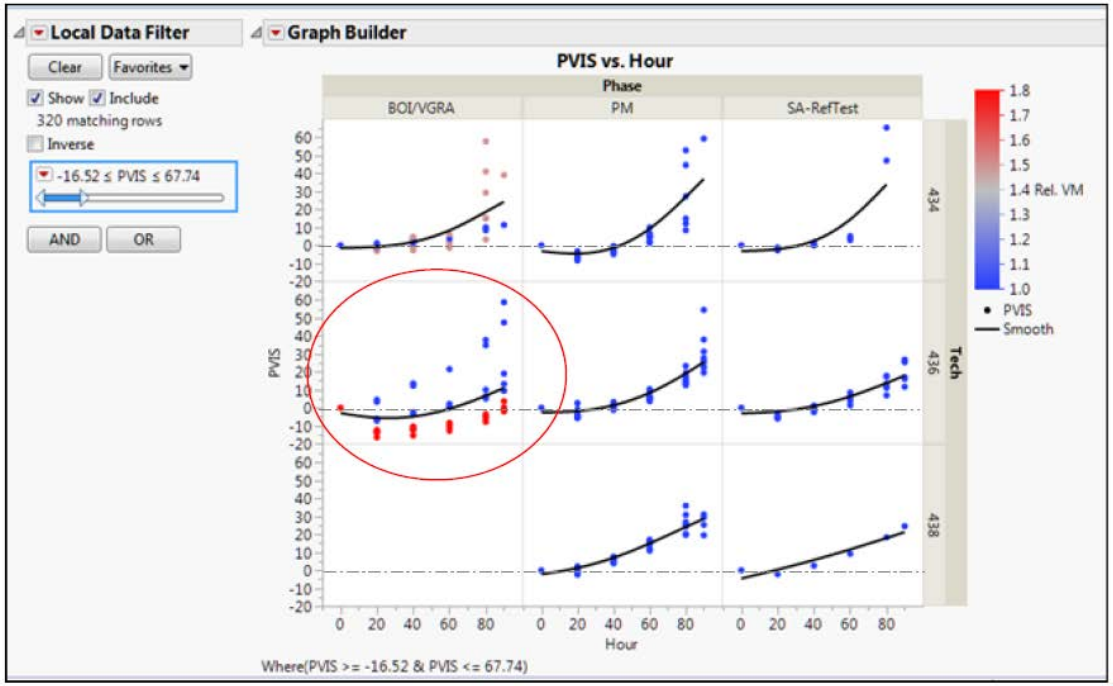






Sequence IIIH VGRA Commentary

Hourly PVIS plot suggests a larger drop in PVIS for Tech/VM 436 for higher relative VM levels



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Hypothesis:

- PVIS "valley" for 436 technology caused by VM shearing
- Could extrapolate to conclusion that more VM reduces PVIS before oil breaks, i.e., deeper valley

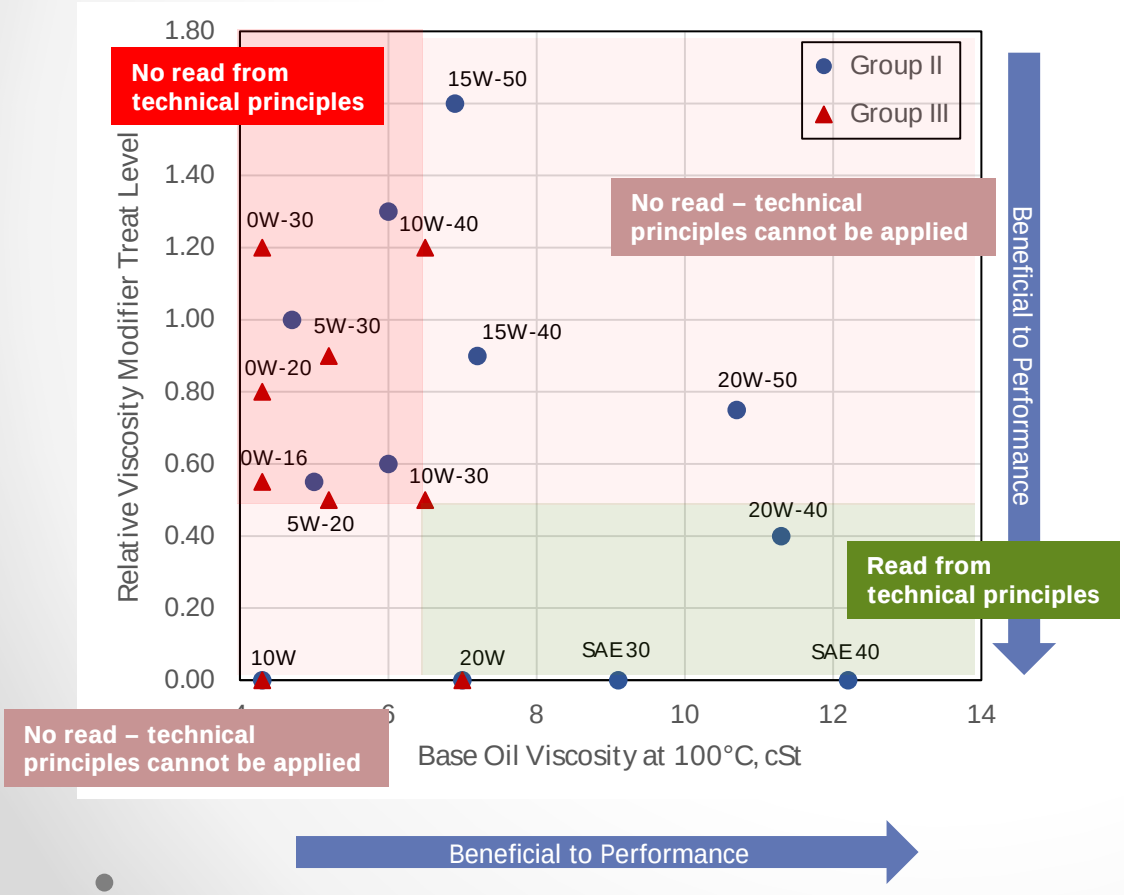
Per TMC: TMC 434 VM SSI: 25; TMC 436 VM SSI: 50

Task Force Consensus

VGRA read table reading up in BOV and down in VM concentration

Basic Approach (from Seq. VH VGRA)

10W-30 Example



Beneficial to Performance

	Grp II		Grp III		
	BOV	Rel. VM	BOV	Rel. VM	Source
0W-16			4.3	0.55	Afton
0W-20			4.3	0.80	Afton
0W-30			4.3	1.20	Afton
10W	4.3	0	4.3	0	Infineum
5W-20	5.0	0.55	5.2	0.50	Afton
5W-30	4.7	1.00	5.2	0.90	Afton
10W-30	6.0	0.60	6.5	0.50	Afton
10W-40	6.0	1.30	6.5	1.20	Afton
20W	7.0	0	7.0	0	Infineum
15W-40	7.2	0.90			Afton
15W-50	6.9	1.60			EM
20W-40	11.3	0.40			Infineum
20W-50	10.7	0.75			EM
SAE 30	9.1	0			Afton
SAE 40	12.2	0			Afton
SAE 50	16.3	0			Afton