

GF-6B Sequence VI Low Viscosity Task Force

Tuesday, June 2, 2015, 9:30 – 11:00 CDT

Minutes and Action Items:

1.0 Roll Call membership changes

Attending/Present: Afton – Dave Glaenzer, Greg Guinther
Ashland – Amol Savant
ASTM TMC – Rich Grundza
GM – Bruce Matthews
Intertek – Charlie Leverett, Adrian Alfonso, Bill Buscher
Lubrizol – Nathan Moles, Jerry Brys
OHT – Jason Bowden
Oronite – Kaustav Sinha, Jo Martinez
SwRI – Dan Worcester, Guy Stubbs
Toyota – Jim Linden, Teri Kowalski

2.0 Chairman's opening comments – Bill Buscher has agreed to take minutes and record action items.

Agreed.

3.0 Open Discussion on Scope and Objective.

Scope and Objectives were approved as written.

4.0 Review differences in the engines

Engine: VID vs. VIE

VID is a 2009 model Year and the VIE is a 2012 Model year engine, some differences in the two are:

- Valve and valve seat material changes
- Polymer bearings ('12) vs bimetal ('09)
- Revised thrust rings on the camshaft
- Changed oil pump to increase flow
- Changed flow rate of piston undercrown cooling/flow rate
- Block machining changes which included main oil gallery increased capacity
- Others? (I have ask Tim to see if I have anything missing)

This will go on New Business for next call.

5.0 Brain Storming the objective

Proposals presented to the task force for consideration:

1) Evaluate a Toyota VID matrix oil (0W-16 oil with the highest VID response) on a standard VIE test.

- Intertek offered to donate a test, stand availability ≈ 1.5 weeks.
- Objective would be to evaluate a different additive technology to confirm if the VIE test has a problem differentiating 0W-16 oils from other viscosity grades.

- If the VIE test on the Toyota VID matrix oil doesn't provide good response, then the test confirms the VID and VIE tests have different responses for 0W-16 oils and we need a test different than the current VIE test for GF-6B.
 - If the VIE test on the Toyota VID matrix oil provides good response, then further investigation is needed on why some additive technologies show response and some do not in the current VIE test.
- 2) Evaluate a modified VIE test with lower oil temperatures (100°C versus 115°C) for the high temp. stages.
 - Afton presented a proposal (see attached) to add two stages with modified oil and coolant temperatures to the current VIE test.
 - Modified test would have Stage 1A (current VIE conditions, Stage 1B (100°C oil temp. and 94°C coolant temp.), Stage 3A (current VIE conditions and Stage 3B (100°C oil temp. and 94°C coolant temp.).
 - Stages 1A and 3A would be used for calculating FEI results for GF-6A tests and Stage 1B and 3B would be used for calculating FEI results for GF-6B tests, but all VIE tests, for both GF-6A and GF-6B, would be conducted the same.
 - Afton offered to donate two tests, one on a 0W-16 oil and one on a 0W-20 oil, both oils with the same additive technology, stand availability ≈ 6 weeks.
 - If pursued, task force would need to select what oils/additive technology to use.
 - 3) Evaluate different stage weighting to improve the current VIE test's response for 0W-16 oils.
 - Ashland offered to further evaluate.
 - 4) Evaluate extending VID engine life with ultrasonic cleaning, which, if successful, could allow for use of the VID test in GF-6B.
 - Lubrizol offered to further investigate.

6.0 Review of action items

- 1) Toyota (Teri/Jim) to inform Charlie of the ILSAC discussion / outcome (6/9/15) on the VIE test. Charlie will then send it to the task force members.
- 2) Toyota (Teri/Jim) to select which matrix oil (0W-16) to run a standard VIE test on.
- 3) Ashland (Amol) to evaluate different stage weighting, using the TMC VIE database, and present at next task force conference call.
- 4) Lubrizol (Nathan) to distribute Lubrizol's presentation and/or data on ultrasonic cleaning of used VID test engines.
- 5) Charlie to schedule next conference call for ≈ 1 week from now.

7.0 Schedule for next conference call.

To be schedule for ≈ 1 week from now.



Afton Presentation to Sequence VIE Task Force

A case for lower measurement temperatures

June 9, 2015

Passion for Solutions™

Summary of Where We Are Today

- ▶ The standard Sequence VID test appears to have shown some discrimination of SAE 0W-16 low-viscosity oils relative to SAE 0W-20
- ▶ The Sequence VIE test appears to lack discrimination of these grades
- ▶ Afton has documented in SAE papers and presentations to industry the discrimination-improving benefit of lowered measurement temperature in Stages 1, 3, 4 & 6
 - ▶ Changing from 115C to 100C
- ▶ In support of a position to improve the discrimination of the Sequence VIE test, Afton has shown that average vehicle oil temperature during fully-operational driving is about 100°C for the range of vehicles we have tested
- ▶ Some automakers are now asking about the possibility of changing the Sequence VIE test to improve discrimination

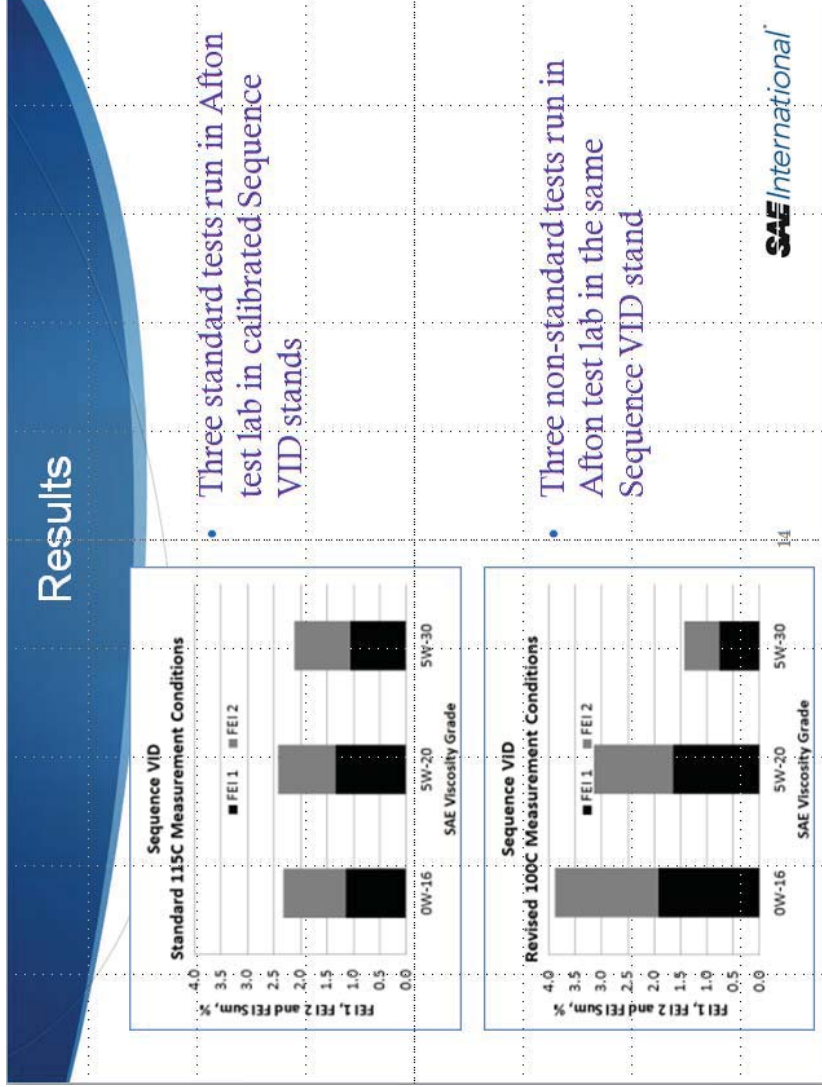


2015 © Afton Chemical Corporation, All Rights Reserved. Not to be copied, shared, or reproduced in any media without the express written permission of Afton Chemical Corporation.

Passion for Solutions™

From SAE 2013-01-0297

Afton has demonstrated that the discrimination power of the Sequence VID test can be improved through the use of more realistic measurement temperatures



Current Measurement Stages

Stage #	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
Speed, rpm	2000	2000	1500	695	695	695
Power, kw	22	22	16.5	1.5	1.5	2.9
Oil Temp, C	115	65	115	115	35	115
Coolant In Temp, C	109	65	109	109	35	109
Stage Weight	0.300	0.032	0.310	0.174	0.011	0.172

Weights: >95% at 115°C

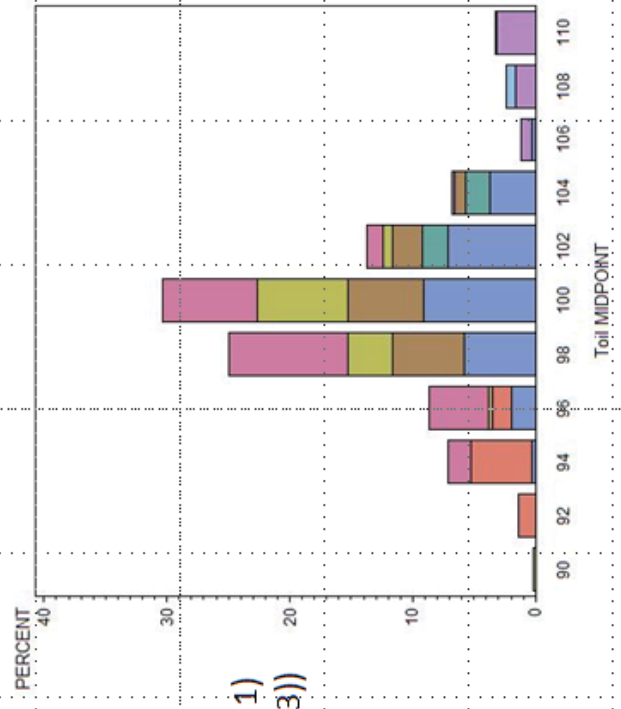


From October 9, 2012 Presentation to ILSAC

Vehicle Operation – Oil Temperature Studies Using Afton’s A-CAFE Test

Normal Operating Oil Temperature is far below 115°C which is used in >95% of VID measurement stages

Oil Temperature Distribution of Vehicles During Real-World Operation Over 500,000 Miles of Operation, Summarized



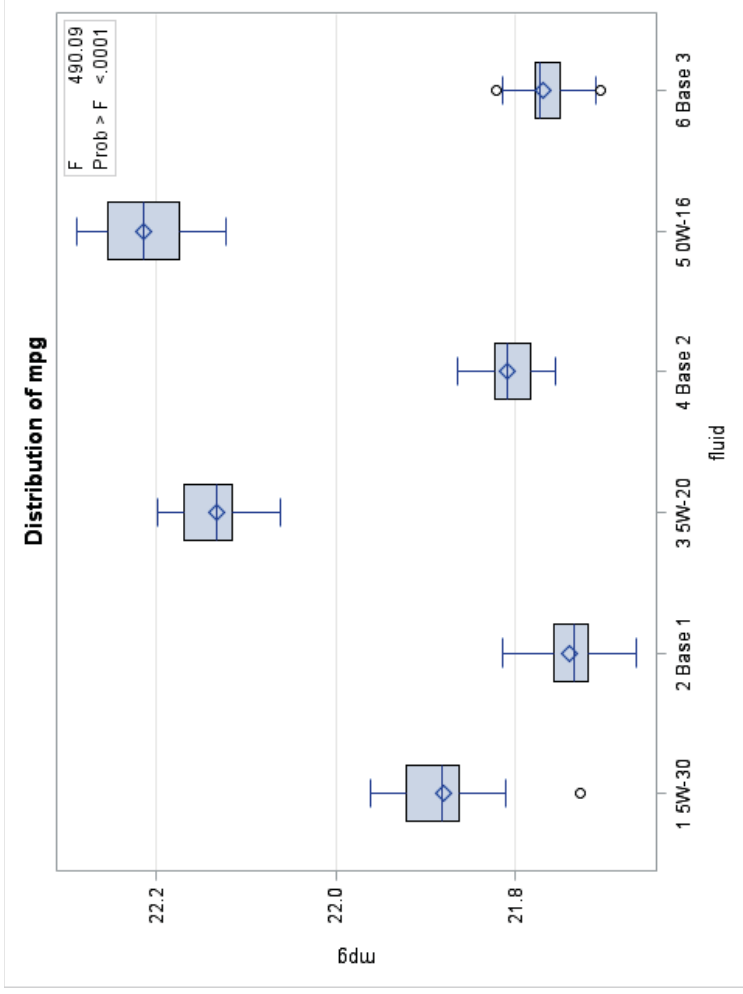
Vehicle List

- NA V8 (OEM 1)
- NA V6 (OEM 1 & 2)
- NA I-4 (Turbo GDI – OEM 1)
- DE I-4 (Turbo GDI – OEM 3))
- JA I-4 (OEM 4)
- JA I-4 (OEM 4)
- JA I-4 (Hybrid – OEM 4)



Vehicle Testing of 2012 Malibu using A-CAFE Sequence LY7 Engine

- 📈 **A-CAFE: Afton Continuous Aging Fuel Economy**
- 📈 **Fully-operational temperature, repeated cycles**
- 📈 **Testing conducted using ARTEMIS cycle (SAE 2012-01-1619)**
- 📈 **Testing conducted in October and November, 2012**



- Base = Seq VI BL
- 5W-30 = Dealer SF oil
- 5W-20 = Dealer SF oil
- 0W-16 = Afton "GF-5"

- Statistical separation of test oils at 99% CL
- From Baseline
- From each other



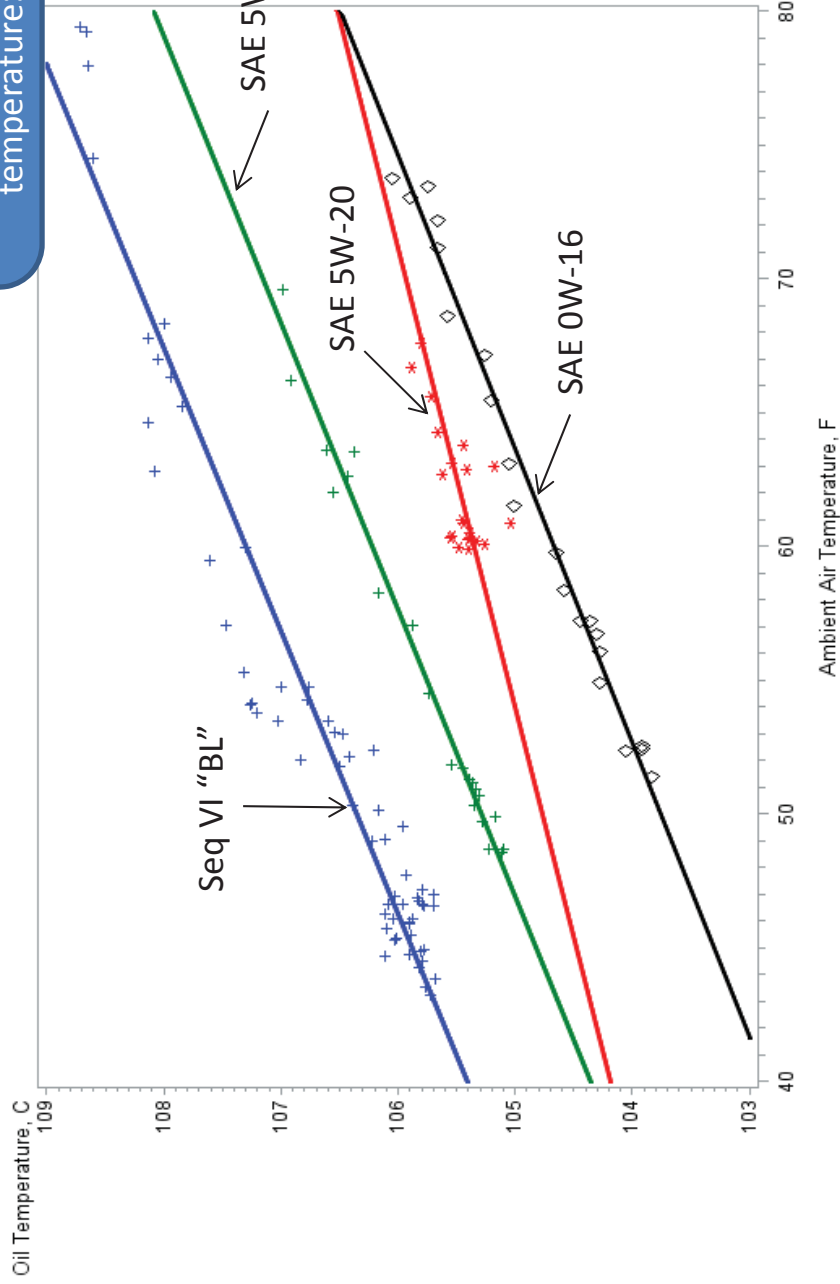
2015 © Afton Chemical Corporation, All Rights Reserved. Not to be copied, shared, or reproduced in any media without the express written permission of Afton Chemical Corporation.

Passion for Solutions™

Average Oil Temperature vs Ambient Temperature ARTEMIS Urban and Rural Driving


- Oil temperature varies with ambient temperature and viscosity grade
- Range at 70°F ambient of oil temperature: 105 – 108°C


2012 Chevrolet Malibu with LY7 V6 Engine
Oil Temperature Trends During ARTEMIS Driving




2015 © Afton Chemical Corporation, All Rights Reserved. Not to be copied, shared, or reproduced in any media without the express written permission of Afton Chemical Corporation. *Passion for Solutions™*


Afton Recommendation

- 
Afton suggests the following solution:
 - ▶ Decrease measurement temperatures for Stages 1 & 3 only
 - ▶ Leaves “boundary” stages 4 & 6 alone
 - ▶ This will allow for the inclusion of more real-world temperatures into the measurement regime

- 
To show proof-of concept, Afton is willing to run back-to-back tests on 0W-20 and 0W-16
 - ▶ BUT, since the test is controlled by a computer, Stages 1 & 3 can be programmed to be measured at 100 and 115C

	Stage 1a	Stage 1b	Stage 2	Stage 3a	Stage 3b	Stage 4	Stage 5	Stage 6
RPM	2000	2000	2000	1500	1500	695	695	695
Power, kw	22	22	22	16.5	16.5	1.5	1.5	2.9
Oil Temp, C	115	100	65	115	100	115	35	115
Cooling In, C	109	94	65	109	94	109	35	109
Stage Weight	0.300	0.300	0.032	0.310	0.310	0.174	0.011	0.174

- 
 With the Panel's concurrence, we would do this for BLB 1&2, CAN1, CAN2, and BLA

- 
Afton successfully tried this experiment in 2012 with “VIE” engine
 - ▶ FEI Sum 0W-16: 2.91 FEI Sum 0W-20: 2.37
 - ▶ 100 hour aging, 100 C aging temperature, 5.4L oil charge



2015 © Afton Chemical Corporation, All Rights Reserved. Not to be copied, shared, or reproduced in any media without the express written permission of Afton Chemical Corporation.

Passion for Solutions™

Conclusion

- ▲ **If this proves to be successful, this could be incorporated into the precision matrix to follow, with minimal delay**
 - ▲ We estimate that it adds about 20 hours to the test
- ▲ **Afton favors having only ONE test protocol for the Seq VIE**
- ▲ **Afton favors transitioning from the Seq VID to the Seq VIE as quickly as possible**



TOYOTA

Toyota Sequence VID Matrix Update and Proposal for Seq VIE Improvement

June 2nd, 2015

Toyota Motor Corporation

- Potential Delay of GF-6 OW-16 Introduction
 - Toyota has proposed to add RC for API SN OW-16 to mitigate the risk
 - Toyota has completed Seq.VID matrix to compare OW-16 and OW-20 (3add techs x 2 labs x 2 vis grades x 2 tests = 24 tests)
 - Data will be shared
- Correlation between Seq.VID and Seq.VIE, especially for OW-16
 - Some JAMA members have run Seq.VID on their own OW-16 products and seen benefit by lowering vis grade from OW-20 to OW-16.
 - JAMA members are confident that OW-16 will provide fuel economy benefit over OW-20 in the real market.
 - We should improve the precision, correlation, and discrimination of Seq.VIE to make it good fuel economy measurement tool in order to deliver true FE benefit through GF-6.

Proposals from JAMA Members

TOYOTA

- JAMA members support to evaluate OW-16 Tech 1 Oil on Seq.VID for correlation work
 - JAMA members have confirmed that OW-16 provides FE benefit in Seq.VID and their own products
 - Seq.VIE should have reasonable correlation and capability to measure the benefit of OW-16
- Toyota can provide our Seq.VID matrix oil for Seq.VIE correlation work
 - Toyota's VID matrix includes 3 additive technologies representing current GF-5 products in the industry and the comparison between OW-16 and OW-20 (Total 24 tests data)
 - Approx. 20 – 25gals of each test oil are still available
 - If additive suppliers agree, Toyota can provide these oils for further correlation work

Toyota Sequence VID Matrix Study

TOYOTA

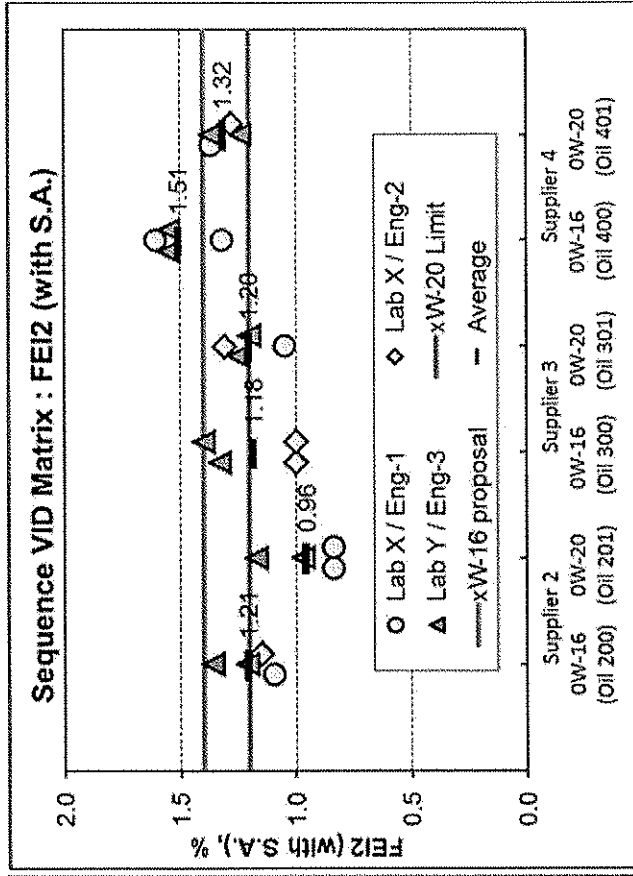
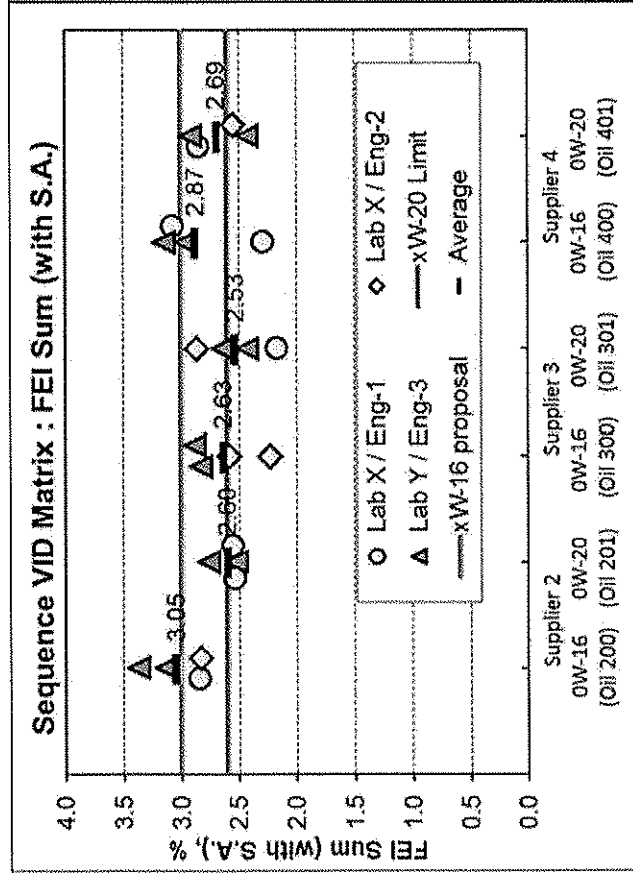
- Matrix Design
 - 3 Additive Technologies (GF-5 Market General) from Major Additive Suppliers
 - Selected as anonymously
 - Viscosity Grade
 - 0W-16 vs 0W-20
 - Base Stock
 - 4cSt Group-3 100%
 - 2 Test Laboratories
 - Calibrated Test Engine and Test Stands are utilized
 - 2 Repeat Tests on Each Test Oil

- Total 24 tests Matrix
 - 0W-16 : Oil 200, Oil 300, Oil 400
 - 0W-20 : Oil 201, Oil 301, Oil 401

Toyota VID Matrix Results

TOYOTA

Sequence VID Test Results Summary (with Severity Adjustment)

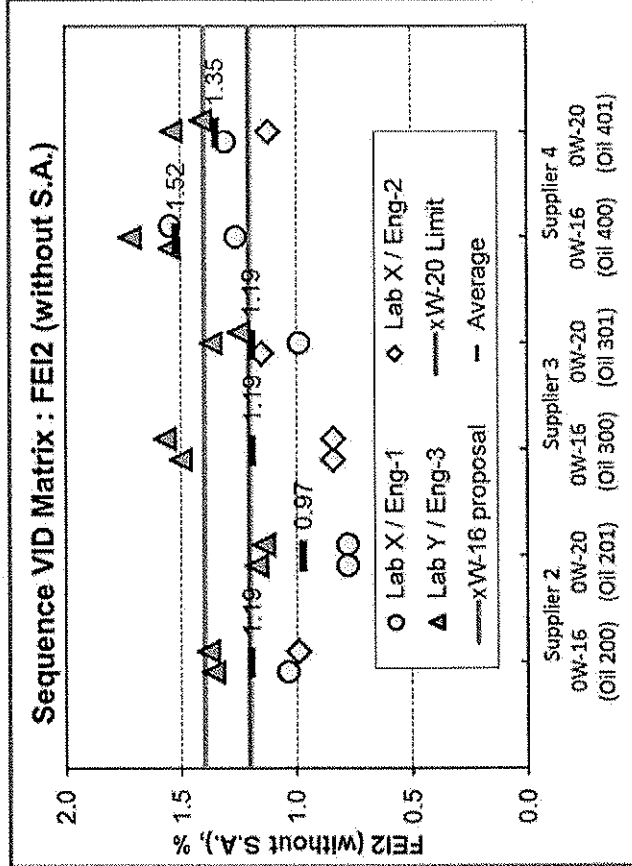
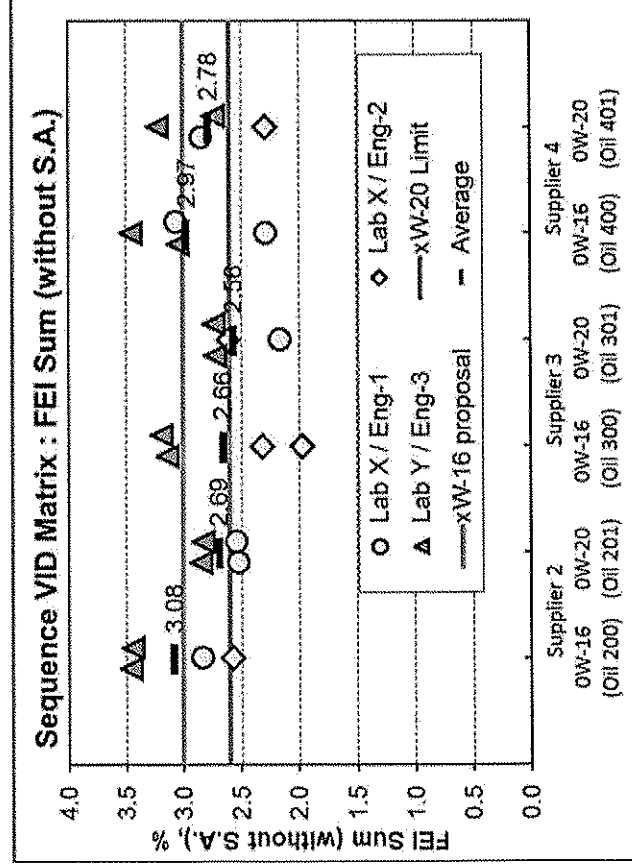


- Laboratory X had to change test engine in the middle of matrix and used 2 engines
- Laboratory X showed more severe results and wider variation compared with Labo Y
- As overall, OW-16 showed better fuel economy than that of OW-20
- Toyota's proposal for xW-16 (3.0% for FEI Sum and 1.4% for FEI2) seems achievable

Toyota VID Matrix Results

TOYOTA

Sequence VID Test Results Summary (without Severity Adjustment)



Proposals from JAMA Members (1/2)

TOYOTA

- Characteristics of Sequence VID Test
 - Seq.VID was designed to emphasize the measurement capability of friction modifier, and resulted in significant contribution from high temperature stages (Oil Temp = 115degC, 95.6%).
 - As a trade-off, Seq.VID became less sensitive to viscosity effect.
- Potential Modifications of Sequence VIE
 - VIE has lost the response to 0W-16, but has maintained the response to 0W-20.
 - SAE Paper 2013-01-0297 reported that lowering oil temperature from 115degC to 100degC for high temp stages provided better discrimination between viscosity grades (0W-16, 5W-20, and 5W-30).
 - Modification of oil temperature at high temperature stages may recover the response to 0W-16 and improve the correlation with Seq.VID.
 - This is just one idea. We are open for any ideas and discussions.

SAE 2013-01-0297 : Modification of FE Measurements TOYOTA

Table 2. Sequence VID Fuel Economy Measurement Stages

Stage #	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
Speed, rpm	2000	2000	1500	695	695	695
Power, kw	22	22	16.5	1.5	1.5	2.9
Oil Temp, C	115	65	115	115	35	115
Coolant In Temp, C	109	65	109	109	35	109
Stage Weight	0.300	0.032	0.310	0.174	0.011	0.172

Oil Temperatures were modified to 100degC for Stage 1, 3, 4, and 6.

Improved discrimination among 0W-16, 5W-20, and 5W-30.

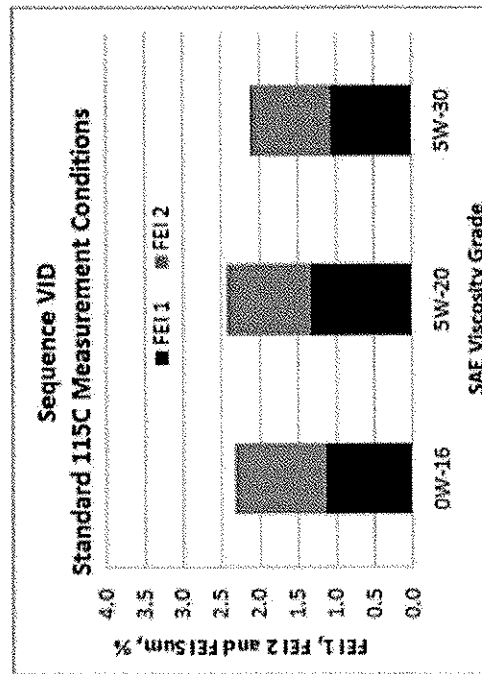
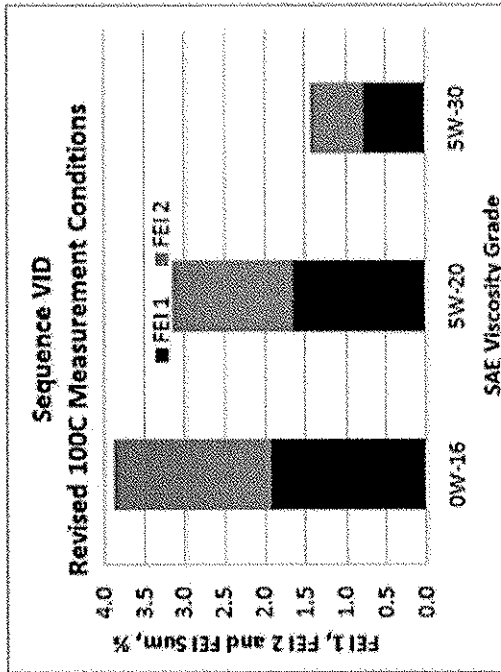


Figure 9. Sequence VID Results Under Modified Test Conditions

Figure 8. Sequence VID Results Under Standard Test Conditions

Proposals from JAMA Members (2/2)

TOYOTA

- Next Sequence VI Surveillance Panel
 - Need to work on the VIE improvement as soon as possible
 - Propose to hold the SP meeting monthly basis until the issue is fixed
 - Next SP should be held early July
- JAMA members will provide further information and data to support Seq.VIE improvement
 - Toyota will update the matrix result with statistical analysis
 - Other JAMA members are reviewing their internal data to see if there is any useful information