Minutes of the Sequence VIF Task Force teleconference call

October 07, 2015 08:00 CDT

The seventh meeting of the Sequence VIF Task Force was called to order by Chairman Dan Worcester. The meeting Agenda is included as Attachment 1. Chairman Worcester opened the meeting with a few general comments about the upcoming face-to-face meetings scheduled for the Sequence VI Surveillance Panel, VIF Task force and Engine Rebuild TF to be held at the USCAR facility in Southfield, MI on October 27.

The meeting attendance roster is included as Attachment 2.

The minutes from the September 30, 2015 meeting were approved as written and are available on the ASTM-TMC web site. ftp://ftp.astmtmc.cmu.edu/docs/gas/sequencevi/minutes/VIFTaskForceMinutes20150930.pdf

Richard Grundza reported that ASTM oil RO 543 has completed about one-half of the analytical tests that are conducted by the TMC and he anticipates the oil ready for shipment to the labs the week of 10/12/2015. RO 543 is the 0W-16 oil that was designated oil 400 in the matrix of tests conducted in the Sequence VID by Toyota. David Glaenzer requested a summary of VID results from this oil be tabulated and provided for the minutes. Dan Worcester provided a copy of a presentation made by Toyota on 07/07/2015 included as Attachment 3 as well as an Excel spreadsheet of the data included as Attachment 4.

Both Southwest Research and Intertek Automotive Research indicated that they will have new engine break-in complete and be ready to start "Sense Check" testing the first week of November, 2015. There was some follow-up discussion pertaining to additional used oil analyses to be completed on the Candidate 2 oil samples during the Sense Check testing. Chairman Worcester will define which tests and test methods are to be used. The subject of obtaining additional samples during the oil aging was discussed and it was decided that no additional samples need be taken. At our last meeting, labs were queried if they noted any change in Sequence VIE engine performance following the testing of 0W-16 oils. IAR, SRI, LZ and Afton reported that they could pinpoint no specific indication of a change following 0W-16 testing.

Mark Adams questioned the relevance of the test in the real world. He cited temperatures, engine speed and choice of engine as not representative of what consumers see. He indicated he felt the test was being run at unrealistic conditions. Teri Kowalski explained that the test was being developed on an engine that is available and the time needed to develop a test with an engine designed for low viscosity oils is not available. Ron Romano explained some history of test development and the reasoning why conditions were selected as well as relevance to the Federal FTP cycle.

Having no further business, the meeting was adjourned at 08:40 CDT.

The next teleconference will be October 14 at 08:00 CDT.

Respectfully submitted,

David L. Glaenzer, Afton Chemical Corporation

Attachment 1

# GF-6B Sequence VIF Task Force

**Toll-free dial-in number (U.S. and Canada):**
**(866) 588-1857**
**International dial-in number:**
**(678) 373-4882**
**Conference code:**
**2894131**

## Scope

The ASTM Sequence VI Surveillance Panel requested a Task Force be formed to determine if the Sequence VIE could be used for 0W 16 oils. The TF will look at development of the VIF test using 100 °C oil temperature and 94 °C coolant temperature for stages 1, 3, 4, and 6.

## Objective

Review the Toyota proposal attached and work on selection of reference oils, stands to support testing, and running the Sense Check and test matrices.

The agenda for this meeting is shown below, if you have any additions please send them to me and Cc this distribution.

1.0 Chairman's Comments
2.0 Roll Call
3.0 Approval of Minutes from Meeting 09.30.2015
ftp://ftp.astmtmc.cmu.edu/docs/gas/sequencevi/minutes/VIFTaskForceMinutes20150930.pdf

4.0 Oil 543 is at TMC and will be tested then shipped to labs.
5.0 The matrix for VIF testing has been chosen. IAR and SwRI will update on start dates at each lab for the Sense Check.

6.0 Next call October 14, 2015 at 8:00 AM Central Time.

Attachment 2

| Name | Affiliation | | 09/23/15 | | 09/30/15 | | 10/07/15 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Adrian Alfonso | Intertek | | P | | P | | P | | | | | |
| Amol C Savant | Ashland | V | | | P | | | | | | | |
| Andrew Ritchie | Infineum | V | | | P | | P | | | | | |
| Charlie Leverett | Intertek | | P | | P | | | | | | | |
| Chris Castanien | Nesteoil | V | | | | | | | | | | |
| Cliff Salvensen | ExxonMobil | | | | | | | | | | | |
| Cole Hudson | SwRI | V | | | | | | | | | | |
| Dan Worcester Jr. | Chairman, SwRI | | P | | P | | P | | | | | |
| David Glaenzer | Secretary, Afton Chemical | V | P | | P | | P | | | | | |
| Denny Gaal | ExxonMobil | | | | | | | | | | | |
| Doyle Boese | Infineum | | P | | P | | | | | | | |
| Eric Liu | SwRI | | P | | P | | | | | | | |
| Gordon Farnsworth | Infineum | | | | P | | P | | | | | |
| Guy Stubs | SwRI | | | | | | | | | | | |
| Jason Bowden | OH Technologies | V | P | | P | | P | | | | | |
| Jim Linden | Toyota | V | | | P | | | | | | | |
| Jo Martinez | Chevron | | P | | P | | P | | | | | |
| Kaustav Sinha | Chevron | V | P | | P | | P | | | | | |
| Kevin OMalley | Lubrizol | V | | | P | | P | | | | | |
| Mark Adams | Tribology Testing | | P | | P | | P | | | | | |
| Mark Mosher | ExxonMobil | V | | | P | | | | | | | |
| Martin Chadwick | Intertek | | | | | | | | | | | |
| Matthew Bowden | OH Technologies | | P | | P | | P | | | | | |
| Michael Conrad | Lubrizol | | P | | | | P | | | | | |
| Mike McMillan | Infineum | | P | | P | | | | | | | |
| Nathaniel Moles | Lubrizol | | P | | | | P | | | | | |
| Patrick Lang | SwRI | | | | | | | | | | | |
| Ray Burn | ExxonMobil | | | | | | | | | | | |
| Rich Grundza | ASTM Test Monitoring | V | P | | P | | P | | | | | |
| Robert Stockwell | Oronite | | | | P | | | | | | | |
| Ron Romano | Ford Motor Company | V | P | | | | P | | | | | |
| Satoshi Hirano | Toyota | | | | P | | P | | | | | |
| Teri Kowalski | Toyota | | | | P | | | | | | | |
| Timothy Cushing | General Motors | V | P | | P | | P | | | | | |
| Todd Dvorak | Afton Chemical | | P | | P | | P | | | | | |
| Tracy King | Haltermann | | | | | | | | | | | |
| Valerie Lieu | Chevron | | | | | | P | | | | | |
| William Buscher | Intertek | V | P | | P | | P | | | | | |
| Bob Campbell | Afton | | | | | | | | | | | |
| Mike Ragomo | ExxonMobil | | | | | | P | | | | | |
| Travis Kotan | SwRI | | | | P | | P | | | | | |

TOYOTA

# Sequence VID xW-16 FE Target Proposal for API SN / RC

Prepared for JAMA, ILSAC and AOAP

July 7th, 2015

Toyota Motor Corporation



## Agenda

TOYOTA

- Sequence VID Matrix for 0W-16 / 0W-20 Comparison
  - Objectives
  - Matrix Design
  - Test Result Summary
  - Statistical Analysis Result
- Conclusion and Proposal
  - 0W-16 Advantage based on Statistical Model
  - Proposal for API SN / RC xW-16

A 3
P 2 of 8

## Sequence VID Matrix

TOYOTA

- Objectives
  - Establish Sequence VID Fuel Economy Criteria for API SN / RC xW-16
    - Proposal based on statistically designed matrix
    - Based on market general GF-5 technologies
  - Mitigate the Delay of GF-6 Launch and Maximize the Utilization of Low Viscosity Technology
    - Meaningful and reasonable improvement with sooner introduction



## Sequence VID Matrix

TOYOTA

- Matrix Design (Total 24 Tests)
  - Additive Technologies
    - Market General GF-5 (DI Additive and VII)
    - Selected 3 out of 4 candidates anonymously
  - Viscosity Grades
    - 0W-16, 0W-20
  - Test Laboratory
    - 2 Independent Laboratories (Each 1 Fully Calibrated Test Stand)
      - 3 Engine Units were used as a result of high LOC in one of them
  - Test Repeats
    - 2 Repeat Tests on Each Combination

A3
P 3 of 8

## Sequence VID Matrix

TOYOTA

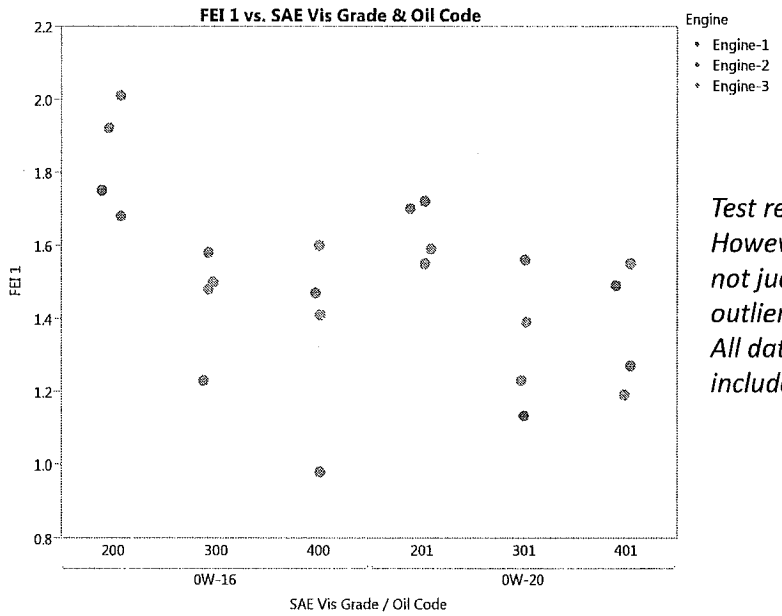
- Test Oil Code
  - Oil 200 0W-16 Additive Supplier 2
  - Oil 201 0W-20 Additive Supplier 2
  - Oil 300 0W-16 Additive Supplier 3
  - Oil 301 0W-20 Additive Supplier 3
  - Oil 400 0W-16 Additive Supplier 4
  - Oil 401 0W-20 Additive Supplier 4
- Statistical Analysis
  - ANOVA



## Sequence VID Matrix

TOYOTA

- Test Result Summary : FEI1

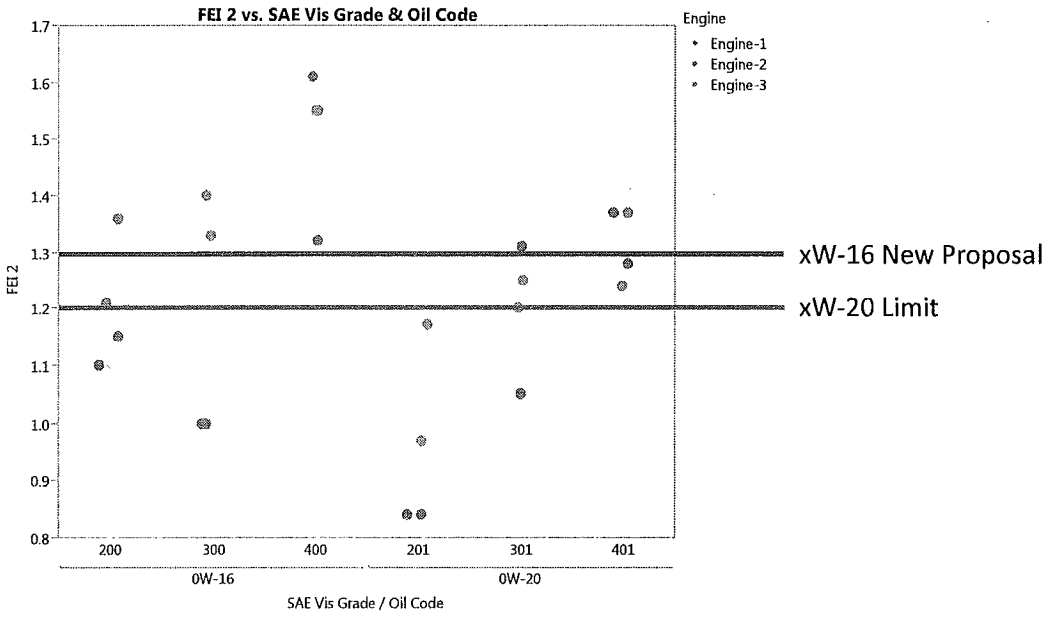



*Test results certainly varied. However, no data point was not judged statistically as outlier.*
*All data points were included in the model.*

## Sequence VID Matrix

TOYOTA

- Test Result Summary : FEI2

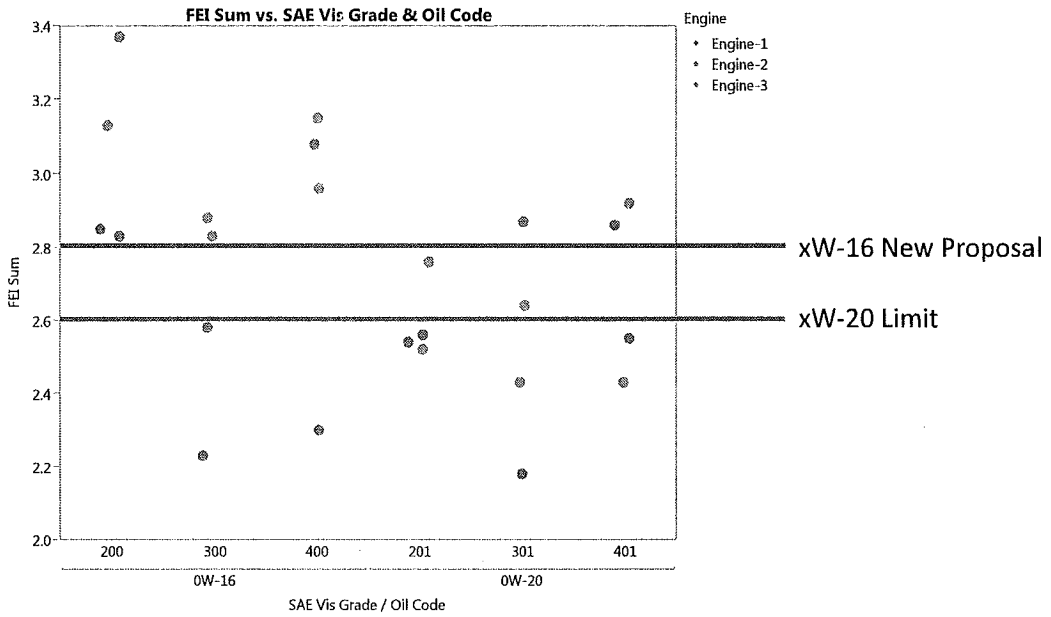





## Sequence VID Matrix

TOYOTA

- Test Result Summary : FEI Sum



## Sequence VID Matrix

TOYOTA

- Statistical Model
  - Since 3 engines were involved in the matrix tests, simple averages will receive different weightings in terms of oil/engine combination.
  - The statistical model was constructed to measure the performance difference between 0W-16 and 0W-20 at equal weighting.
  - Terms in the model
    - **Viscosity grade** (categorical variables with 2 levels)
    - **Oil (Viscosity Grade)** (nested variable with 4 levels)
    - **Engine** (categorical variables with 3 levels)
  - Other observations
    - Engine hours effect was not found (Current Seq VID engine hour correction is working well for Seq VID).
    - No oil and engine interaction was incorporated.

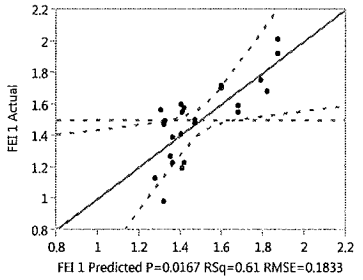


## Sequence VID Matrix

TOYOTA

- FEI1 Model

**Actual by Predicted Plot**




Least Square Mean is the measured viscosity grade performance for an average Additive Technology and Engine.

| Level | | Least Sq Mean |
|---|---|---|
| 0W-16 | A | 1.5392767 |
| 0W-20 | A | 1.4382704 |

Levels not connected by same letter are significantly different.

| Level | - Level | Difference | Std Err Dif | Lower CL | Upper CL | p-Value |
|---|---|---|---|---|---|---|
| 0W-16 | 0W-20 | 0.1010063 | 0.0755507 | -0.059154 | 0.2611665 | 0.1999 |

**Summary of Fit**

| | |
|---|---|
| RSquare | 0.609314 |
| RSquare Adj | 0.438389 |
| Root Mean Square Error | 0.183339 |
| Mean of Response | 1.499167 |
| Observations (or Sum Wgts) | 24 |

**Parameter Estimates**

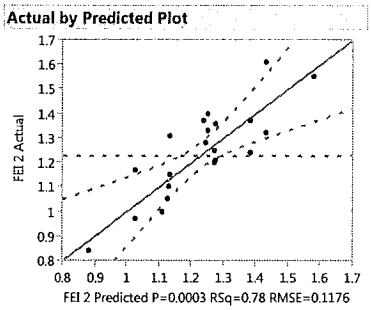
| Term | Estimate | Std Error | t Ratio | Prob>\|t\| | VIF |
|---|---|---|---|---|---|
| Intercept | 1.4887736 | 0.040039 | 37.18 | <.0001* | . |
| SAE Vis Grade[0W-16] | 0.0505031 | 0.037775 | 1.34 | 0.1999 | 1.0188679 |
| SAE Vis Grade[0W-16]:Oil Code[200] | 0.2891667 | 0.074848 | 3.86 | 0.0014* | 1.3333333 |
| SAE Vis Grade[0W-16]:Oil Code[300] | -0.110314 | 0.080954 | -1.36 | 0.1919 | 1.5597484 |
| SAE Vis Grade[0W-20]:Oil Code[201] | 0.1971541 | 0.077621 | 2.54 | 0.0218* | 1.4339623 |
| SAE Vis Grade[0W-20]:Oil Code[301] | -0.122327 | 0.075551 | -1.62 | 0.1250 | 1.3584906 |
| Engine[Engine-1] | -0.037075 | 0.063377 | -0.58 | 0.5667 | 2.1459644 |
| Engine[Engine-2] | -0.009151 | 0.06973 | -0.13 | 0.8972 | 2.1637841 |

*Oil 400 and Oil 401 are embedded in "Intercept". All 24 results are incorporated in this model.*

# Sequence VID Matrix

TOYOTA

- FEI2 Model




| Summary of Fit | |
|---|---|
| RSquare | 0.77881 |
| RSquare Adj | 0.682039 |
| Root Mean Square Error | 0.117565 |
| Mean of Response | 1.227917 |
| Observations (or Sum Wgts) | 24 |

**Parameter Estimates**

| Term | Estimate | Std Error | t Ratio | Prob>\|t\| | VIF |
|---|---|---|---|---|---|
| Intercept | 1.2042138 | 0.025675 | 46.90 | <.0001* | . |
| SAE Vis Grade[0W-16] | 0.070173 | 0.024223 | 2.90 | 0.0105* | 1.0188679 |
| SAE Vis Grade[0W-16]:Oil Code[200] | -0.093333 | 0.047996 | -1.94 | 0.0696 | 1.3333333 |
| SAE Vis Grade[0W-16]:Oil Code[300] | -0.117296 | 0.051911 | -2.26 | 0.0332* | 1.5597484 |
| SAE Vis Grade[0W-20]:Oil Code[201] | -0.201525 | 0.049774 | -4.05 | 0.0009* | 1.4339623 |
| SAE Vis Grade[0W-20]:Oil Code[301] | 0.0445126 | 0.048446 | 0.92 | 0.3718 | 1.3584906 |
| Engine[Engine-1] | -0.050818 | 0.04064 | -1.25 | 0.2291 | 2.1459644 |
| Engine[Engine-2] | -0.044969 | 0.044714 | -1.01 | 0.3295 | 2.1637841 |

| Level | | Least Sq Mean |
|---|---|---|
| 0W-16 | A | 1.2743868 |
| 0W-20 | B | 1.1340409 |

Levels not connected by same letter are significantly different.

| Level | - Level | Difference | Std Err Dif | Lower CL | Upper CL | p-Value |
|---|---|---|---|---|---|---|
| 0W-16 | 0W-20 | 0.1403459 | 0.0484465 | 0.0376440 | 0.2430478 | 0.0105* |

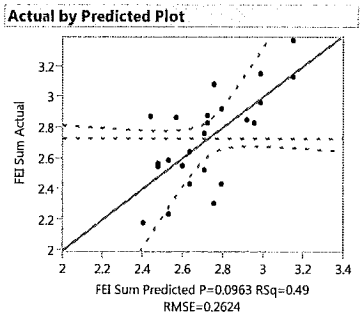
For **FEI2**, 0W-16 showed **0.14%** FE improvement over 0W-20 with **p-Value of 0.0105**. **Statistically significant.**



# Sequence VID Matrix

TOYOTA

- FEI Sum Model




| Summary of Fit | |
|---|---|
| RSquare | 0.485379 |
| RSquare Adj | 0.260233 |
| Root Mean Square Error | 0.262423 |
| Mean of Response | 2.727083 |
| Observations (or Sum Wgts) | 24 |

**Parameter Estimates**

| Term | Estimate | Std Error | t Ratio | Prob>\|t\| | VIF |
|---|---|---|---|---|---|
| Intercept | 2.6929874 | 0.05731 | 46.99 | <.0001* | . |
| SAE Vis Grade[0W-16] | 0.1206761 | 0.05407 | 2.23 | 0.0403* | 1.0188679 |
| SAE Vis Grade[0W-16]:Oil Code[200] | 0.1958333 | 0.107134 | 1.83 | 0.0863 | 1.3333333 |
| SAE Vis Grade[0W-16]:Oil Code[300] | -0.22761 | 0.115873 | -1.96 | 0.0671 | 1.5597484 |
| SAE Vis Grade[0W-20]:Oil Code[201] | -0.004371 | 0.111103 | -0.04 | 0.9691 | 1.4339623 |
| SAE Vis Grade[0W-20]:Oil Code[301] | -0.077814 | 0.10814 | -0.72 | 0.4822 | 1.3584906 |
| Engine[Engine-1] | -0.087893 | 0.090715 | -0.97 | 0.3470 | 2.1459644 |
| Engine[Engine-2] | -0.054119 | 0.099808 | -0.54 | 0.5951 | 2.1637841 |

| Level | | Least Sq Mean |
|---|---|---|
| 0W-16 | A | 2.8136635 |
| 0W-20 | B | 2.5723113 |

Levels not connected by same letter are significantly different.

| Level | - Level | Difference | Std Err Dif | Lower CL | Upper CL | p-Value |
|---|---|---|---|---|---|---|
| 0W-16 | 0W-20 | 0.2413522 | 0.1081396 | 0.0121064 | 0.4705980 | 0.0403* |

For **FEI Sum**, 0W-16 showed **0.24%** FE improvement over 0W-20 with **p-Value of 0.0403**. **Statistically significant.**

## Conclusion and Proposal

TOYOTA

- Conclusion
  - 0W-16 showed statistically significant improvement over 0W-20 as average of 3 additive technologies and 3 test engines involved in the test matrix.
  - 0.24% improvement for FEI Sum and 0.14% improvement for FEI2 are achieved.
  - If 2.8% and 1.3% are chosen for the FEI Sum and FEI2 for xW-16, 9 test results out of 24 runs are passing results in this matrix.
    - xW-20 : 2.6% min / 1.2% min (FEI Sum / FEI2)
    - xW-16 : 2.8% min / 1.3% min (FEI Sum / FEI2)



## Conclusion and Proposal

TOYOTA

- Proposal for API SN / RC
  - Toyota proposes to add Sequence VID requirement to the API SN / RC xW-16 grade with following criteria.

    FEI Sum : 2.8% min (+0.2% improvement over xW-20)
    FEI2 : 1.3% min (+0.1% improvement over xW-20)

  - Toyota does not request any stretch target for this proposal for following reasons.
    - It will not be appropriate to request stretch target, since this is the addition of new requirement in the middle of the category life.
    - With this proposal. Toyota believes that xW-16 can be formulated by utilizing existing market general GF-5 technologies readily available in the market, as demonstrated in this matrix.
    - Sooner introduction with reasonable performance will be more beneficial for consumers in the market, rather than late introduction with difficult target.

# Appendix : All Sequence VID Results

TOYOTA

| Oil Code | SAE Vis Grade | Lab | Test Run Order within Laboratory | Comp Date | Stand | Engine | ENGINE HOURS @ END OF TEST | Final FEI Sum | Final FEI 1 | Final FEI 2 | FEI Sum w Eng Hr Adjst | FEI 1 w Eng Hr Adjst | FEI 2 w Eng Hr Adjst | FEI 1 w/o S.A. | FEI 2 w/o S.A. | LTMS S.A. for FEI 1 | LTMS S.A. for FEI 2 | Engine Hours Adjustment | Engine Hours Adjustment 2 | LOC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 200 | 0W-16 | X | 1 | 12/17/2014 | Stand-A | Engine-1 | 1114 | 2.85 | 1.75 | 1.10 | 2.84 | 1.80 | 1.04 | 1.90 | 1.14 | -0.05 | 0.06 | -0.10 | -0.10 | 1200 |
| 200 | 0W-16 | X | 8 | 4/9/2015 | Stand-A | Engine-2 | 988 | 2.83 | 1.68 | 1.15 | 2.57 | 1.58 | 0.99 | 1.72 | 1.12 | 0.10 | 0.16 | -0.14 | -0.13 | 800 |
| 201 | 0W-20 | X | 3 | 1/6/2015 | Stand-A | Engine-1 | 1474 | 2.54 | 1.70 | 0.84 | 2.53 | 1.75 | 0.78 | 1.77 | 0.80 | -0.05 | 0.06 | -0.02 | -0.02 | 1200 |
| 201 | 0W-20 | X | 7 | 2/5/2015 | Stand-A | Engine-1 | 2125 | 2.56 | 1.72 | 0.84 | 2.55 | 1.77 | 0.78 | 1.69 | 0.70 | -0.05 | 0.06 | 0.08 | 0.08 | 1600 |
| 300 | 0W-16 | X | 9 | 4/16/2015 | Stand-A | Engine-2 | 1145 | 2.58 | 1.58 | 1.00 | 2.32 | 1.48 | 0.84 | 1.58 | 0.93 | 0.10 | 0.16 | -0.10 | -0.09 | 900 |
| 300 | 0W-16 | X | 11 | 5/5/2015 | Stand-A | Engine-2 | 1485 | 2.23 | 1.23 | 1.00 | 1.97 | 1.13 | 0.84 | 1.15 | 0.86 | 0.10 | 0.16 | -0.02 | -0.02 | 1000 |
| 301 | 0W-20 | X | 4 | 1/13/2015 | Stand-A | Engine-1 | 1630 | 2.18 | 1.13 | 1.05 | 2.17 | 1.18 | 0.99 | 1.17 | 0.98 | -0.05 | 0.06 | 0.01 | 0.01 | 1200 |
| 301 | 0W-20 | X | 10 | 4/24/2015 | Stand-A | Engine-2 | 1304 | 2.87 | 1.56 | 1.31 | 2.61 | 1.46 | 1.15 | 1.52 | 1.21 | 0.10 | 0.16 | -0.06 | -0.06 | 800 |
| 400 | 0W-16 | X | 2 | 12/25/2014 | Stand-A | Engine-1 | 1293 | 2.30 | 0.98 | 1.32 | 2.29 | 1.03 | 1.26 | 1.09 | 1.32 | -0.05 | 0.06 | -0.06 | -0.06 | 1300 |
| 400 | 0W-16 | X | 6 | 1/27/2015 | Stand-A | Engine-1 | 1948 | 3.08 | 1.47 | 1.61 | 3.07 | 1.52 | 1.55 | 1.46 | 1.50 | -0.05 | 0.06 | 0.06 | 0.05 | 1400 |
| 401 | 0W-20 | X | 5 | 1/20/2015 | Stand-A | Engine-1 | 1791 | 2.86 | 1.49 | 1.37 | 2.85 | 1.54 | 1.31 | 1.51 | 1.28 | -0.05 | 0.06 | 0.03 | 0.03 | 1400 |
| 401 | 0W-20 | X | 12 | 5/13/2015 | Stand-A | Engine-2 | 1642 | 2.55 | 1.27 | 1.28 | 2.29 | 1.17 | 1.12 | 1.16 | 1.11 | 0.10 | 0.16 | 0.01 | 0.01 | 1200 |
| 200 | 0W-16 | Y | 1 | 12/2/2014 | Stand-B | Engine-3 | 958 | 3.37 | 2.01 | 1.36 | 3.46 | 2.10 | 1.36 | 2.25 | 1.50 | -0.09 | 0.00 | -0.15 | -0.14 | 900 |
| 200 | 0W-16 | Y | 5 | 1/30/2015 | Stand-B | Engine-3 | 2060 | 3.13 | 1.92 | 1.21 | 3.44 | 2.06 | 1.38 | 1.99 | 1.31 | -0.14 | -0.17 | 0.07 | 0.07 | 1100 |
| 201 | 0W-20 | Y | 4 | 12/23/2014 | Stand-B | Engine-3 | 1431 | 2.76 | 1.59 | 1.17 | 2.85 | 1.68 | 1.17 | 1.71 | 1.20 | -0.09 | 0.00 | -0.03 | -0.03 | 1200 |
| 201 | 0W-20 | Y | 7 | 2/12/2015 | Stand-B | Engine-3 | 2374 | 2.52 | 1.55 | 0.97 | 2.83 | 1.69 | 1.14 | 1.58 | 1.03 | -0.14 | -0.17 | 0.11 | 0.11 | 1300 |
| 300 | 0W-16 | Y | 6 | 2/5/2015 | Stand-B | Engine-3 | 2217 | 2.83 | 1.50 | 1.33 | 3.14 | 1.64 | 1.50 | 1.55 | 1.41 | -0.14 | -0.17 | 0.09 | 0.09 | 900 |
| 300 | 0W-16 | Y | 12 | 3/20/2015 | Stand-B | Engine-3 | 3160 | 2.88 | 1.48 | 1.40 | 3.19 | 1.62 | 1.57 | 1.42 | 1.38 | -0.14 | -0.17 | 0.20 | 0.19 | 1200 |
| 301 | 0W-20 | Y | 2 | 12/9/2014 | Stand-B | Engine-3 | 1115 | 2.64 | 1.39 | 1.25 | 2.73 | 1.48 | 1.25 | 1.58 | 1.35 | -0.09 | 0.00 | -0.10 | -0.10 | 900 |
| 301 | 0W-20 | Y | 11 | 3/13/2015 | Stand-B | Engine-3 | 3004 | 2.43 | 1.23 | 1.20 | 2.74 | 1.37 | 1.37 | 1.19 | 1.20 | -0.14 | -0.17 | 0.18 | 0.17 | 1300 |
| 400 | 0W-16 | Y | 3 | 12/16/2014 | Stand-B | Engine-3 | 1273 | 2.96 | 1.41 | 1.55 | 3.05 | 1.50 | 1.55 | 1.57 | 1.61 | -0.09 | 0.00 | -0.07 | -0.06 | 900 |
| 400 | 0W-16 | Y | 10 | 3/6/2015 | Stand-B | Engine-3 | 2846 | 3.15 | 1.60 | 1.55 | 3.46 | 1.74 | 1.72 | 1.57 | 1.56 | -0.14 | -0.17 | 0.17 | 0.16 | 1200 |
| 401 | 0W-20 | Y | 8 | 2/19/2015 | Stand-B | Engine-3 | 2531 | 2.92 | 1.55 | 1.37 | 3.23 | 1.69 | 1.54 | 1.56 | 1.42 | -0.14 | -0.17 | 0.13 | 0.12 | 1300 |
| 401 | 0W-20 | Y | 9 | 2/27/2015 | Stand-B | Engine-3 | 2688 | 2.43 | 1.19 | 1.24 | 2.74 | 1.33 | 1.41 | 1.18 | 1.27 | -0.14 | -0.17 | 0.15 | 0.14 | 1300 |

| | FEI Sum | FEI2 |
|---|---|---|
| xW-16 Proposal | >=2.8 | >=1.3 |

- 9 results out of 24 runs are passing for proposed xW-16 limits.
- This will be good passing rate, considering recent Seq VID statistics.

| Oil Code | SAE Vis Grade | Lab | Test Run Order within Laboratory | Comp Date | Stand | Engine | ENGINE HOURS @ END OF TEST | Final FEI Sum | Final FEI 1 | Final FEI 2 | FEI Sum w Eng Hr Adjst | FEI 1 w Eng Hr Adjst | FEI 2 w Eng Hr Adjst | FEI 1 w/o S.A. | FEI 2 w/o S.A. | LTMS S.A. for FEI 1 | LTMS S.A. for FEI 2 | Engine Hours Adjustment | Engine Hours Adjustment 2 | LOC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 200 | 0W-16 | X | 1 | 12/17/2014 | Stand-A | Engine-1 | 1114 | 2.85 | 1.75 | 1.10 | 2.84 | 1.80 | 1.04 | 1.90 | 1.14 | -0.05 | 0.06 | -0.10 | -0.10 | 1200 |
| 200 | 0W-16 | X | 8 | 4/9/2015 | Stand-A | Engine-2 | 988 | 2.83 | 1.68 | 1.15 | 2.57 | 1.58 | 0.99 | 1.72 | 1.12 | 0.10 | 0.16 | -0.14 | -0.13 | 800 |
| 201 | 0W-20 | X | 3 | 1/6/2015 | Stand-A | Engine-1 | 1474 | 2.54 | 1.70 | 0.84 | 2.53 | 1.75 | 0.78 | 1.77 | 0.80 | -0.05 | 0.06 | -0.02 | -0.02 | 1200 |
| 201 | 0W-20 | X | 7 | 2/5/2015 | Stand-A | Engine-1 | 2125 | 2.56 | 1.72 | 0.84 | 2.55 | 1.77 | 0.78 | 1.69 | 0.70 | -0.05 | 0.06 | 0.08 | 0.08 | 1600 |
| 300 | 0W-16 | X | 9 | 4/16/2015 | Stand-A | Engine-2 | 1145 | 2.58 | 1.58 | 1.00 | 2.32 | 1.48 | 0.84 | 1.58 | 0.93 | 0.10 | 0.16 | -0.10 | -0.09 | 900 |
| 300 | 0W-16 | X | 11 | 5/5/2015 | Stand-A | Engine-2 | 1485 | 2.23 | 1.23 | 1.00 | 1.97 | 1.13 | 0.84 | 1.15 | 0.86 | 0.10 | 0.16 | -0.02 | -0.02 | 1000 |
| 301 | 0W-20 | X | 4 | 1/13/2015 | Stand-A | Engine-1 | 1630 | 2.18 | 1.13 | 1.05 | 2.17 | 1.18 | 0.99 | 1.17 | 0.98 | -0.05 | 0.06 | 0.01 | 0.01 | 1200 |
| 301 | 0W-20 | X | 10 | 4/24/2015 | Stand-A | Engine-2 | 1304 | 2.87 | 1.56 | 1.31 | 2.61 | 1.46 | 1.15 | 1.52 | 1.21 | 0.10 | 0.16 | -0.06 | -0.06 | 800 |
| 400 | 0W-16 | X | 2 | 12/25/2014 | Stand-A | Engine-1 | 1293 | 2.30 | 0.98 | 1.32 | 2.29 | 1.03 | 1.26 | 1.09 | 1.32 | -0.05 | 0.06 | -0.06 | -0.06 | 1300 |
| 400 | 0W-16 | X | 6 | 1/27/2015 | Stand-A | Engine-1 | 1948 | 3.08 | 1.47 | 1.61 | 3.07 | 1.52 | 1.55 | 1.46 | 1.50 | -0.05 | 0.06 | 0.06 | 0.05 | 1400 |
| 401 | 0W-20 | X | 5 | 1/20/2015 | Stand-A | Engine-1 | 1791 | 2.86 | 1.49 | 1.37 | 2.85 | 1.54 | 1.31 | 1.51 | 1.28 | -0.05 | 0.06 | 0.03 | 0.03 | 1400 |
| 401 | 0W-20 | X | 12 | 5/13/2015 | Stand-A | Engine-2 | 1642 | 2.55 | 1.27 | 1.28 | 2.29 | 1.17 | 1.12 | 1.16 | 1.11 | 0.10 | 0.16 | 0.01 | 0.01 | 1200 |
| 200 | 0W-16 | Y | 1 | 12/2/2014 | Stand-B | Engine-3 | 958 | 3.37 | 2.01 | 1.36 | 3.46 | 2.10 | 1.36 | 2.25 | 1.50 | -0.09 | 0.00 | -0.15 | -0.14 | 900 |
| 200 | 0W-16 | Y | 5 | 1/30/2015 | Stand-B | Engine-3 | 2060 | 3.13 | 1.92 | 1.21 | 3.44 | 2.06 | 1.38 | 1.99 | 1.31 | -0.14 | -0.17 | 0.07 | 0.07 | 1100 |
| 201 | 0W-20 | Y | 4 | 12/23/2014 | Stand-B | Engine-3 | 1431 | 2.76 | 1.59 | 1.17 | 2.85 | 1.68 | 1.17 | 1.71 | 1.20 | -0.09 | 0.00 | -0.03 | -0.03 | 1200 |
| 201 | 0W-20 | Y | 7 | 2/12/2015 | Stand-B | Engine-3 | 2374 | 2.52 | 1.55 | 0.97 | 2.83 | 1.69 | 1.14 | 1.58 | 1.03 | -0.14 | -0.17 | 0.11 | 0.11 | 1300 |
| 300 | 0W-16 | Y | 6 | 2/5/2015 | Stand-B | Engine-3 | 2217 | 2.83 | 1.50 | 1.33 | 3.14 | 1.64 | 1.50 | 1.55 | 1.41 | -0.14 | -0.17 | 0.09 | 0.09 | 900 |
| 300 | 0W-16 | Y | 12 | 3/20/2015 | Stand-B | Engine-3 | 3160 | 2.88 | 1.48 | 1.40 | 3.19 | 1.62 | 1.57 | 1.42 | 1.38 | -0.14 | -0.17 | 0.20 | 0.19 | 1200 |
| 301 | 0W-20 | Y | 2 | 12/9/2014 | Stand-B | Engine-3 | 1115 | 2.64 | 1.39 | 1.25 | 2.73 | 1.48 | 1.25 | 1.58 | 1.35 | -0.09 | 0.00 | -0.10 | -0.10 | 900 |
| 301 | 0W-20 | Y | 11 | 3/13/2015 | Stand-B | Engine-3 | 3004 | 2.43 | 1.23 | 1.20 | 2.74 | 1.37 | 1.37 | 1.19 | 1.20 | -0.14 | -0.17 | 0.18 | 0.17 | 1300 |
| 400 | 0W-16 | Y | 3 | 12/16/2014 | Stand-B | Engine-3 | 1273 | 2.96 | 1.41 | 1.55 | 3.05 | 1.50 | 1.55 | 1.57 | 1.61 | -0.09 | 0.00 | -0.07 | -0.06 | 900 |
| 400 | 0W-16 | Y | 10 | 3/6/2015 | Stand-B | Engine-3 | 2846 | 3.15 | 1.60 | 1.55 | 3.46 | 1.74 | 1.72 | 1.57 | 1.56 | -0.14 | -0.17 | 0.17 | 0.16 | 1200 |
| 401 | 0W-20 | Y | 8 | 2/19/2015 | Stand-B | Engine-3 | 2531 | 2.92 | 1.55 | 1.37 | 3.23 | 1.69 | 1.54 | 1.56 | 1.42 | -0.14 | -0.17 | 0.13 | 0.12 | 1300 |
| 401 | 0W-20 | Y | 9 | 2/27/2015 | Stand-B | Engine-3 | 2688 | 2.43 | 1.19 | 1.24 | 2.74 | 1.33 | 1.41 | 1.18 | 1.27 | -0.14 | -0.17 | 0.15 | 0.14 | 1300 |

| | FEI Sum | FEI2 |
|---|---|---|
| **xW-16 Proposal** | >= 2.8 | >= 1.3 |
| 200 | 3.05 | 1.21 |
| 201 | 2.60 | 0.96 |
| 300 | 2.63 | 1.18 |
| 301 | 2.53 | 1.20 |
| 400 | 2.87 | 1.51 |
| 401 | 2.69 | 1.32 |

Attachment 4