Precision Matrix Follow-Up Pt. 2 | MINUTES

Revision Date *5/22/2017 11:04:00 AM*

Relevant Test:	Sequence IVB
Note Taker:	Chris Mileti
Meeting Date:	05-19-2017
Lubrizol Attendees:	Matasic, Mileti and O'Malley
Comments:	Second meeting to review the investigations that were started after the Precision Matrix was placed on hold.

1. DISCUSSION:

a) Opening Remarks from Intertek:

i) Intake lifter wear has been the main critical parameter during most of the development of this test.
   (1) Initially, average intake lifter area loss was the main measurement.
   (2) Recently, the focus has shifted to average intake lifter volume loss.
   (3) The correlation between the area loss and volume loss measurements has been strong.

ii) The average intake lifter volume loss is measured with the Keyence unit.
   (1) The end-of-test measurements are currently being collected both with and without talc.
   (2) There are still lab-to-lab differences with the Keyence measurements (especially when talc is used).

iii) The variation in the results of REO1011 appears to be lower when talc is used.

iv) The application of talc has very little impact on the results from REO300.

v) There appears to be a bias in the results from Stand A2.

vi) Two new Precision Matrix tests from SWRI have been added to the database.
   (1) The operational data from these two tests has not yet been reviewed for validity.
   (2) All of the remaining Precision Matrix tests have been deemed valid.

vii) 200HR Iron Content:
   (1) The iron curves correlate somewhat with the wear results.
   (2) Ring and liner wear can skew this correlation.

viii) Operational Data:
   (1) Certain operational parameters have been highlighted in yellow for further review:
      (a) Exhaust backpressure
      (b) AFR
      (c) Blowby flow
      (d) Fuel flow
      (e) Intake manifold pressure

b) Oil Consumption:

i) There is variability in oil consumption across all three oils.

ii) Oil consumption is calculated by weight, yet the initial oil charge is established by volume.

iii) There is inherent variability in setting the initial oil charge by volume.

iv) The Surveillance Panel should consider setting the initial oil charge by weight.

(1) This is how it is done for the Sequence V test.
(2) This method is generally accepted as being more accurate.
(3) This would be considered an enhancement to the procedure and not a change to the procedure.

v) Lubrizol's Comments:

(1) Lubrizol agrees that it would be an improvement to set the initial oil charge by weight and not by volume.
(2) The procedure should continue to calculate the oil consumption by weight.
(a) Dipstick measurements are too subjective.
(3) Afton and SWRI echoed Lubrizol's comments.

vi) Ashland's Comments:

(1) Ashland disagreed with Lubrizol and felt that the initial oil charge should continue to be set by volume.
(2) Lab-to-lab variability could be reduced by having one of the central parts distributors supply a specific Sequence IVB flask.
(3) OHT noted that they are already looking into possible flask designs.

vii) TMC's Comments:

(1) The TMC measured the density of the three Sequence IVB reference oils and distributed the measurements via email (*Jeff Clark, 5/18/2017 at 3:07PM EST*).

Reference Oil	**Density (g/ml) @ 60°F ASTM D1298**	**2400 mL Mass (g)**
REO300	0.8587	2060.88
REO1011	0.8456	2029.44
REO1012	0.8358	2005.92

viii) Toyota's Comments:

(1) One option would be to request a density for each candidate oil that is tested.
(2) This will yield even more accurate weight measurements.
(3) ASTM D1298 can be used to get the density.

ix) Motion to change the procedure so that the initial oil charge is set by weight and not volume:

(1) Toyota, Lubrizol and Exxon all stated that the initial weight should be set on the higher end of the acceptable range to help mitigate the possible aeration issue.
(2) Intertek made the motion, and the motion was seconded by Lubrizol.
(3) Motion: "*Modify the Sequence IVB procedure to require that the test oil charge be set by weight instead of volume. Set the initial oil charge at 2100g*."
(4) The motion passed with no negative votes.
(5) Ashland waived.

x) The remaining Precision Matrix tests will be run with a 2100g initial oil charge.

c) Coolant Temperature Differential:

i) Coolant Temperature Differential = $\Delta T = T_{COOLANT,\ OUTLET} - T_{COOLANT,\ INLET}$

ii) Afton's Comments:

(1) There is a clear lab bias in the coolant temperature differential.
(2) Why is this bias there, and what does it mean?
(3) Afton investigated this issue and found that there is a discrepancy in how the various Sequence IVB documents describe the coolant system plumbing.

(a) The Golden Stand installation document and the Sequence IVB "procedure" contradict each other on this topic.
(b) This issue is extremely confusing because both documents are posted on the TMC website.

(4) Afton confirmed that Lubrizol and SWRI have the same coolant system plumbing.
(a) The coolant is entering the engine in the tube mounted along the exhaust side of the engine.

(5) Intertek has the coolant entering in the back of the cylinder head.

iii) Intertek's Comments:

(1) SWRI and Intertek did review this during the recent stand inspections.
(2) Their coolant flow system has not changed since 2014.

iv) Lubrizol's Comments:

(1) The Surveillance Panel needs to review all of the documents related to this test procedure to identify inconsistencies.
(2) SWRI has taken this as an action item.
(3) The Precision Matrix should not have started until this review was completed.
(4) Stand inspections are not as effective as they could be because a standardized checklist is not being utilized.
(a) This checklist needs to be more comprehensive than the TMC checklist.
(b) A "secretary" also needs to be designated to document all of the group's comments and findings.

v) Exxon's Comments:

(1) The test documentation that is posted on the TMC website is not appropriate.
(2) This documentation does not follow typical ASTM protocols.
(3) Instead, this documentation is just a packet of excerpts from Lubrizol, SWRI and Intertek work instructions.

vi) Afton's Comments:

(1) It is not appropriate to push coolant into the cylinder head and not the water pump inlet.

vii) Toyota's Comments:

(1) It appears that the OHT part number naming conventions are correct.
(2) Toyota will confirm how the coolant system is plumbed in the vehicle and report back the Surveillance Panel.
(3) One option would be to finish the Precision Matrix and then make a decision about the validity of the existing data.

viii) Leverett's Comments:

(1) The Surveillance Panel needs to review and approve the procedure before it does any additional stand inspections.
(2) No further action should be taken until the documentation is finalized.

ix) Comments from Lubrizol and Afton:

(1) A full update on these issues must be given to all of the signatories of the MOA document.
(2) Lubrizol will create a checklist document that the labs can use to organize information and photographs showing the configuration of their Golden Stands.
(a) This will be done in about a week.
(3) The labs can then audit their own stands and return the completed checklist to Lubrizol.
(4) Lubrizol will then compile all of the results so that the Surveillance Panel can focus exclusively on differences between the stands.
(a) This should make the stand inspection process more efficient and effective.
(5) Lubrizol is also willing to become the de facto secretary for the Surveillance Panel.

x) The results of the stand audits will be reviewed in San Antonio between June 6th and June 8th.

d) SWRI Presentation on "High Sulfur" Fuel Batches:

i) Slide #2:

(1) The San Antonio labs have recently used three different fuel batches.

(2) Two different fuel batches were used during prove-out testing, and a single fuel batch is being used during the Precision Matrix.

ii) Slide #5:

(1) There is only a single data point available with REO1011 from the prove-out testing.

(2) As a result, we do not know where "the stake in the ground" was with this oil.

iii) Slide #6 through Slide #8:

(1) There is a substantial difference in TBN between the fuel batches.

iv) Slide #9:

(1) The data may indicate that the sulfur does not impact all three oils equally.

(a) However, it should be noted that there is still not enough data available to draw conclusions.

v) Slide #11:

(1) There is a difference in oil consumption between prove-out and Precision Matrix testing on (3) of the (4) stands.

vi) Slide #15:

(1) SWRI again noted that there is no guarantee that the high sulfur level is effecting all of the oils in the same way.

(a) A larger data set will be needed to confirm this.

(2) It will be difficult to apply correction factors to the fuel if it does not impact all of the reference oils in the same way.

(3) The reference oils still appear to discriminate with the high sulfur fuel.

(4) Additional tests will need to be added to the Precision Matrix if the decision is made to continue testing with a different fuel batch [that presumably has lower sulfur].

vii) Toyota requested that the statisticians design a revised Precision Matrix that utilizes the existing data, but has provisions to introduce a second [low sulfur] fuel batch.

(1) Basically, the revised design will need to accommodate sulfur as a variable.

e) Discussion about Camshaft Lobe Failures:

i) Toyota stated that this issue is a valid concern.

ii) It is not clear why recent candidate oils are more susceptible to lobe failures than the reference oils.

(1) Could it be due to the fact that recent candidate oils have been of a lower viscosity?

iii) Haltermann's Comments:

(1) Haltermann feels that it can achieve a ±15ppm range around any sulfur target established by the Surveillance Panel.

(2) Is there enough data to suggest the level at which this test is sensitive to the sulfur in the fuel? Is it 15ppm… 30ppm?

iv) Afton's Comments:

(1) It appears that the Surveillance Panel is setting itself up for a fuel batch approval system like the one used for the Sequence V.

(a) This is not ideal.

(2) Is there something besides sulfur that is driving this severity?

v) Haltermann's Comments:

(1) The sulfur compound is added to this fuel separately.

(2) It is adjusted using a different method than is used for the Triple-E or Sequence V fuels.

vi) Lubrizol's Comments:

(1) Lubrizol has noticed more corrosion or varnish along the perimeter of the intake lifters since it started using these high sulfur fuel batches.

(a) Could this corrosion/varnish be inhibiting lifter rotation?

(2) The latest test conditions may have made the Sequence IVB more sensitive to fuel chemistry.

(a) The external blowby system is forcing a larger volume of water and condensed fuel back into the rocker arm cover.

(3) The statisticians need to look at all of the fuel parameters – and not just sulfur.

(a) It should also be noted that we have not confirmed that the fuel is the main cause of the severity shift.

vii) Afton noted that one option would be to use a fuel with no added sulfur.

viii) Haltermann stated that they could probably go as low as 5ppm.

(1) Toyota is concerned that the test may become too mild at such a low sulfur level.

ix) Infinium is not comfortable using a sulfur additive with this test.

(1) This exposes the fuel to differences in the additive itself.

Action Items	Person responsible	Completion Date

Follow-up Notes/Updates:	Initials	Date Added