Sequence IVB Sub-Groups | MINUTES

REVISION DATE: 5/19/2018 5:23:00 PM

Relevant Test:	Sequence IVB
Note Taker:	Chris Mileti
Meeting Date:	05-08-2018
Comments:	This was a back-to-back conference call with the two Sequence IVB Sub-Groups – ***IVB Procedure Review Sub-Group*** and ***IVB Precision/Operations Sub-Group***.

1. IVB PRECISION/OPERATIONS SUB-GROUP:

1.1. Opening Comments from Afton:

1.1.1. Katerina Pecinovsky will be moving to another area of the company.
1.1.2. Ben Maddock will be the new engineer that is transitioning into her role.

1.2. Comments from Surveillance Panel Chairman:

1.2.1. Last week, the LG Group issued a new motion to accept the Sequence IVB test into GF-6.
1.2.1.1. Toyota and ILSAC find this motion to be acceptable.
1.2.1.2. This motion may be approved by the AOAP panel this week.

1.2.2. *New Surveillance Panel Action Items:*

1.2.2.1. The Surveillance Panel will need to meet within the next 1-2 weeks.
1.2.2.2. The Panel needs to make a recommendation to the ACC regarding a registration date.
1.2.2.3. The Panel will need to approve whether retroactive registration can be granted to tests that used Batch-C and Batch-D camshafts.
1.2.2.4. The Panel will need to discuss the upcoming BOI/VGRA matrix.

1.2.3. *Goal of the IVB Precision/Operations Sub-Group:*

1.2.3.1. The purpose of this sub-group is to enhance the precision of this test.

1.3. Individual Laboratory Updates:

1.3.1. *Update from Intertek:*

1.3.1.1. *NO_X Analysis:*
1.3.1.1.1. Exhaust gas NO_X was an important parameter during the development of the Sequence VE, VG and IVA tests.
1.3.1.1.2. It may be useful to measure NO_X levels with the Sequence IVB.
1.3.1.1.3. However, they cautioned that the highly dynamic nature of the IVB test cycle may make this difficult.
1.3.1.1.4. They are currently running a trial with an ECM NO_X meter on IAR165.
1.3.1.1.5. This is the same sensor that is used on the Sequence III.
1.3.1.1.6. IAR165 is currently running its 2nd reference test to calibrate the stand.
1.3.1.1.7. The goal of this trial is to measure how much the NO_X level changes over a 200HR test, and determine how much drift there is from test-to-test.
1.3.1.2. *Analyze Blowby Gas Composition:*

1.3.1.2.1. Intertek proposes analyzing the IVB blowby gas using Gas Chromatography / Mass Spectrometry.
1.3.1.2.2. The Panel will need to decide how to sample this material.
1.3.1.2.3. It will also need to determine if the gas and/or the liquid will be analyzed.

1.3.1.3. *Hardware Magnetism:*

1.3.1.3.1. Intertek is measuring the change in magnetism of the camshafts and lifters from the start-of-test to the end-of-test.
1.3.1.3.2. They questioned whether this magnetism plays a role in camshaft lobe failures.
1.3.1.3.3. They have found that some E.O.T. lifters become so magnetized that they attract paperclips.
1.3.1.3.4. Afton commented that the ISM test focuses on magnetism because its pass/fail parameter is weight loss.
1.3.1.3.4.1. As a result, all critical hardware is degaussed before and after the test.

1.3.1.4. *Silicone Variation from Lab-to-Lab:*

1.3.1.4.1. Lubrizol uses a single OEM rocker arm cover for all its break-in cycles.
1.3.1.4.1.1. Lubrizol also tends to have the lowest silicone levels during break-in and aging.
1.3.1.4.2. Intertek has previously used a new rocker arm cover for all its break-in cycles.
1.3.1.4.2.1. This may be why Intertek's silicone typically peaks at a higher level (125-150ppm) than it does at Lubrizol.
1.3.1.4.3. They just ran a trial with a used OEM rocker cover (like Lubrizol does) and the peak silicone dropped to 104ppm.
1.3.1.4.4. Silicone may be leaching from the spark plug tube seals of the new OEM rocker arm covers.
1.3.1.4.5. In fact, silicone may be leaching from new spark plug tube seals that are installed in the OHT rocker arm cover.
1.3.1.4.5.1. The Surveillance Panel needs to investigate this further.

1.3.1.5. *Iron Content from Test-to-Test:*

1.3.1.5.1. They would like the Surveillance Panel to look at the cumulative iron of an engine over its full life cycle.
1.3.1.5.2. Does this cumulative iron correlate to oil consumption or the viscosity grades tested?
1.3.1.5.3. This analysis could help "lock down" the parts of the procedure that impact hardware longevity.

1.3.2. *Update from Southwest:*

1.3.2.1. They conducted some trials with the external blowby system shortly after the Precision Matrix.

1.3.3. *Update from Lubrizol:*

1.3.3.1. Their stand has been committed to internal testing over the last month.
1.3.3.2. Lubrizol would eventually like to perform some trials with the external blowby system and one-way check valve.

1.3.4. *Update from Afton:*

1.3.4.1. Their stand has recently been devoted to internal testing.
1.3.4.2. They eventually want to focus on "gray" areas of the procedure (i.e. cylinder head changes, new cylinder head break-in, etc.).

1.4. Engine Management:

1.4.1. *Comments from Afton:*

1.4.1.1. Afton would like this sub-group to discuss engine management.

1.4.1.2. This includes discussing whether an engine-based LTMS system should be used.
1.4.1.3. There is a lot of candidate data being generated on engines that have never run a reference oil.
1.4.1.3.1. Can this data still be used if the Surveillance Panel switches to an engine-based LTMS system?
1.4.1.4. This group also needs to establish alignment on how to handle camshaft lobe failures.

1.4.2. *Comments from Intertek:*

1.4.2.1. They feel strongly that there will not be an engine-based LTMS system.
1.4.2.2. The procedure needs strict rules regarding engine "health".
1.4.2.2.1. Excessive engine wear can impact test severity.
1.4.2.3. This group needs to define a camshaft lobe failure.
1.4.2.3.1. Intertek has reconditioned several camshaft lobe failure engines since the Precision Matrix.
1.4.2.3.2. They use a rebuild procedure that was agreed upon by the Surveillance Panel but has not yet been documented.
1.4.2.4. <u>*Cumulative Iron Limit:*</u>
1.4.2.4.1. Should this group recommend placing a cumulative iron limit on engine life?
1.4.2.4.2. They recommend two separate cumulative iron limits:
1.4.2.4.2.1. Maximum iron accumulated over the engine's life.
1.4.2.4.2.2. Maximum end-of-test iron for a single test.
1.4.2.4.3. An engine would be deemed unusable if it exceeds either of these limits.

1.4.3. *Comments from Lubrizol:*

1.4.3.1. It is premature to dismiss the possibility of an engine-based LTMS system.
1.4.3.2. Lubrizol agrees with Afton's suggestion that this sub-group should initially focus on engine management and camshaft lobe failures.

1.4.4. *Comments from Toyota:*

1.4.4.1. A correlation between engine hours and test severity can occur.
1.4.4.2. The important question to ask is, "why is this engine hour effect occurring?".
1.4.4.3. This group needs to investigate all likely causes.
1.4.4.3.1. For example, excessive bore wear can lead to high oil consumption.
1.4.4.3.2. High oil consumption can, in turn, result in accelerated oil degradation.
1.4.4.4. Monitoring cumulative iron levels may be useful.
1.4.4.4.1. This parameter can be used to predict when issues like excessive bore wear can impact oil consumption.

1.5. Upcoming Reference Tests:

1.5.1. The calibration period for most of the Sequence IVB stands is ending soon.
1.5.2. *Should the labs calibrate with engines that have a high number of hours on them?*
1.5.2.1. Southwest, Lubrizol and Intertek all offered to use older engines for their calibration tests in June.
1.5.3. This group will also need to discuss the upcoming BOI/VGRA matrix.
1.5.3.1. Stands that will be included in BOI/VGRA testing will need to be calibrated before the matrix starts.

1.6. Cylinder Head Changes:

1.6.1. *Comments from Toyota:*

1.6.1.1. Cylinder head changes were originally introduced to address valve seat wear and tappet bore wear.
1.6.1.2. A cylinder head change also provides an opportunity to inspect cylinder bores.

1.6.1.3. One option is to perform cylinder head changes after 4-runs, and then run the engine block for a total of 8-runs.

1.6.2. *Comments from Intertek:*

1.6.2.1. Intertek did something similar a few months ago.

1.6.2.2. That engine had to be decommissioned during its 7th run.

1.6.2.2.1. The engine suffered a camshaft lobe failure at 145HRS.

1.6.2.3. Intertek has started the practice of bore scoping engines between tests that used poor performing oils.

1.7. Afton's Calibration Status:

1.7.1. Buscher believes that Afton's two prove-out tests will be sufficient to calibrate their stand.

1.7.2. This calibration will extend through August.

1.8. External Blowby System:

1.8.1. *Comments from Toyota:*

1.8.1.1. The purpose of the external blowby system is to improve blowby control.

1.8.1.2. During the DOE matrix, there was minimal lab-to-lab variation.

1.8.1.3. However, recent testing has shown that there is more lab-to-lab variation.

1.8.1.3.1. They are questioning whether the external blowby system is playing a role in this.

1.8.1.4. A previous report published by Chevron (*Gasoline-Engine Camshaft Wear: The Culprit is Blow-By*) found a correlation between NO_X level, oil degradation and sludge formation.

1.8.1.4.1. Is a similar situation happening with the IVB test?

1.8.1.4.2. If so, NO_X could be the source of the variation between laboratories.

1.8.1.5. Intertek agreed that this group should focus on blowby gas and the blowby system.

1.8.2. *Comments from Intertek:*

1.8.2.1. Precision during the Precision Matrix was not as good as it was during the DOE Matrix.

1.8.2.2. Most of the changes made to the test between these two matrices improved repeatability.

1.8.2.3. The corrosive aspect of this test is probably more severe now than during the DOE Matrix.

1.8.2.4. <u>*They would like to revisit two changes to the procedure that were made somewhat recently:*</u>

1.8.2.4.1. Controlling exhaust backpressure during all stages instead of just during Stage 2.

1.8.2.4.2. Coolant flow direction through the engine.

1.8.3. *NOX Level on IAR165:*

1.8.3.1. Intertek has been monitoring NO_X on IAR165.

1.8.3.2. NO_X appears to peak during the transition.

1.8.3.3. NO_X also appears to climb as the test progresses.

1.8.3.3.1. It is currently above 4000ppm.

1.9. Format for Sub-Group Meetings Moving Forward:

1.9.1. Lubrizol sent out a complete action item list prior to this conference call.

1.9.1.1. Intertek will update this list with action items from their notes.

1.9.2. Lubrizol proposed having Intertek send out an agenda a day before each meeting.

1.9.3. Lubrizol will send out an updated action item list and minutes from the previous week's meeting.

1.9.4. Lubrizol recommended that this sub-group should try to address 3-5 action items each week.
1.9.5. During next week's meeting, Buscher will focus exclusively on this action item list so that this sub-group can develop a strategy to move forward.

1.10. Oil Charge:

1.10.1. Southwest would like this sub-group to consider going back to the original initial oil charge for this test.
1.10.1.1. The new, larger oil charge may no longer be needed because of the redesigned oil pan.
1.10.2. *Are people willing to risk problems related to aeration?*

2. TEST PROCEDURE SUB-GROUP:

2.1. Opening Comments from Southwest:

2.1.1. They plan to use Lubrizol's action item list to drive the agendas for this sub-group.
2.1.2. This sub-group needs to review Section 4 of the procedure.
2.1.2.1. Section 4 contains the rebuild instructions for engines that have experienced a camshaft lobe failure.
2.1.2.2. This is the most important action item for this sub-group.

2.2. Cylinder Head Changes:

2.2.1. *Comments from Afton:*
2.2.1.1. They want cylinder head changes to be an urgent action item for this sub-group as well.
2.2.1.2. Cylinder head swaps are not clearly explained in the procedure.
2.2.1.3. *When will they be done?*
2.2.1.4. *What hardware should be used?*
2.2.1.5. *How will silicone be mitigated?*
2.2.2. Intertek noted that the cylinder head rebuild kit does include all the accessory hardware that is needed.
2.2.3. Lubrizol cautioned against mixing the test-specific intake valve springs with the "pointy" stock intake camshafts.

2.3. Extended Periods of Downtime:

2.3.1. Lubrizol considers extended downtime to be more than 4-hours.
2.3.2. *Comments from Intertek:*
2.3.2.1. Intertek can accept Lubrizol's definition for extended downtime.
2.3.2.2. They remove the rocker arm cover and pour drain oil over the lifters and camshafts.
2.3.2.3. They place a stock cover over the engine until they are ready to start it back up.
2.3.3. *Comments from Southwest:*
2.3.3.1. Section 11.3.4.1 of the procedure deals with downtime periods over 30-minutes.
2.3.3.2. They can modify this section to increase the duration of downtime.
2.3.4. *Comments from Afton:*
2.3.4.1. This section of the procedure should not use the word "permissible".
2.3.4.2. The wording needs to clearly state that these instructions must be followed.

2.4. Permissible Data File Length:

2.4.1. *Comments from Afton:*

2.4.1.1. The data acquisition requirements for this test are unusual and hardware intensive.

2.4.1.2. The lengths of the data sets posted in the TMC database are all different.

2.4.1.3. *How many data points can be missing before a data set is deemed invalid?*

2.4.2. *Comments from TMC:*

2.4.2.1. There are guidelines in the DACA-II document that deal with missing data.

2.4.2.2. In general, files cannot be missing more than 1% of their required length.

2.4.2.2.1. That is 7200 data points in the case of the IVB test.

2.5. OHT Update:

2.5.1. OHT would like each lab to send them information on the material and dimensions of the timing chain wedges currently in use.

2.5.2. The clutch alignment tool will be available soon.

Action Items	Person responsible	Completion Date

Follow-up Notes/Updates	Initials	Date Added

Attendees	Organization	Contact Information