Sequence IVB Sub-Groups | MINUTES

REVISION DATE: 6/11/2018 8:14:00 AM

Relevant Test:	Sequence IVB
Note Taker:	Chris Mileti
Meeting Date:	05-29-2018
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. GENERAL DISCUSSION (BOTH SUB-GROUPS):

1.1. IVB Engine Information Template:

1.1.1. On May 22nd, Intertek provided the other four laboratories with a template to collect key engine information.

1.1.2. Lubrizol reviewed the template and does not see any problems or shortcomings with it.

1.1.3. Each lab will need to get approval from their internal and external customers before they can share this data with the Surveillance Panel.

1.2. Break-In and Aging Data (Intertek):

1.2.1. Intertek is summarizing the break-in and aging data from all their engines.

1.2.1.1. They are using a template that they can provide to the other four laboratories.

1.2.1.2. This template focuses on the following wear metals: *silicon, iron and aluminum*.

1.2.2. *Operational Data:*

1.2.2.1. *Should this sub-group review the operational data from break-in and aging cycles?*

1.2.2.2. *Comments from Lubrizol:*

1.2.2.2.1. The sub-group should initially focus on oil analysis data because it is easier to compile and compare.

1.2.2.2.2. Operational data can be reviewed later if necessary.

1.2.3. Intertek has identified stand-to-stand difference in oil level.

1.2.3.1. *Is this due to differences in the OHT oil pans?*

1.3. Procedure for Rebuilding an Engine after a Lobe Failure:

1.3.1. Intertek has completed approximately 70% of this rebuild procedure.

1.4. Surveillance Panel e-Ballots:

1.4.1. Two e-ballots were issued after the Surveillance Panel conference call last week.

1.4.2. The first e-ballot deals with retroactively approving certain hardware batches for candidate testing.

1.4.3. The second e-ballot deals with recommending a date that the ACC can use for retroactive registration.

1.4.4. Both e-ballots will be open through the end of this week.

1.5. Update on Action Item List (Lubrizol):

1.5.1. *The following action items have recently been marked as "complete":*

1.5.1.1. Procedure for selecting lifter grades based on valve clearance.
1.5.1.2. Procedure for adding a new fuel batch over an existing fuel batch.
1.5.1.3. OHT to supply clutch alignment tool to the labs.
1.5.1.4. Procedure for cleaning the blowby flow meter.
1.5.1.5. Develop a standardized test stand audit checklist.
1.5.1.6. Identify the minimum number of acceptable data points in a test file.

1.5.2. During the last sub-group conference call, OHT asked for feedback from each laboratory regarding their timing chain wedges.

1.5.2.1. Lubrizol provided feedback and photographs to OHT.

1.5.3. *Collecting Additional Data to Better Understand Iron Parameter:*

1.5.3.1. There are several items on the action item list related to collecting additional data to better understand the iron parameter.
1.5.3.2. Lubrizol will consolidate these into a single action item.

1.6. Update from Exxon:

1.6.1. They have recently analyzed two engines.

1.6.2. *Analysis of 1st Engine:*

1.6.2.1. This was the engine that was used to evaluate their high wear oil.
1.6.2.2. It experienced a camshaft lobe failure.
1.6.2.3. Exxon disassembled the engine and took photographs of its bottom end (including the bearings).
1.6.2.4. They will compile their findings and eventually share it with this sub-group.

1.6.3. *Analysis of 2nd Engine:*

1.6.3.1. This is the second engine that has experienced a lobe failure in their lab.
1.6.3.2. They flushed this engine and resumed testing.
1.6.3.3. The flush appears to have been successful.
1.6.3.4. They will inspect the lower end of the engine after it completes its 6th run.

1.7. TMC Draft Procedure for Iron Adjustment:

1.7.1. The TMC presented a draft procedure to the sub-group (***IVB fe Adj.docx***).

1.7.2. This draft procedure does not yet include instructions to perform repeat ICP measurements.

1.7.3. This draft is based on the procedure used for the Sequence IIIHB test.

1.7.3.1. Iron is substituted for phosphorous.

1.7.4. Some of the wording needs to be generic because not all oil formulations contain calcium.

1.7.4.1. The procedure needs to make an allowance for the lab to select the appropriate wear metal for the adjustment.

1.7.5. *Comments from Lubrizol:*

1.7.5.1. Lubrizol does not recall the statisticians doing any trials with the Sequence IIIGB or IIIHB to determine if performing an adjustment with different wear metals yields different overall adjustment factors.

1.7.6. *Comments from Afton:*

1.7.6.1. Certain elements are not ideal for adjustments because they can become depleted during a test.
1.7.6.2. The procedure should give some guidance on this so that the labs select the appropriate metal.

1.7.7. *Comments from Toyota:*

1.7.7.1. Calcium is the most appropriate metal to use for the adjustment.
1.7.7.2. Magnesium is the second best metal to use.

1.7.7.3. Boron is one of the wear metals that can become depleted.

1.7.8. *Recommendations for TMC Draft Proposal from Intertek:*

1.7.8.1. Intertek has updated the TMC draft with their proposed changes (in green).

1.7.8.1.1. The TMC has no issue with Intertek's recommendations.

1.7.8.2. Intertek will send out the updated document to all the sub-group members for their review.

1.7.8.3. <u>*Key Recommendations from Intertek:*</u>

1.7.8.3.1. Change "200HR" to "E.O.T".

1.7.8.3.1.1. The TMC replied that they are using different nomenclature to differentiate between adjusted and unadjusted iron measurements.

1.7.8.3.2. The word "adjusted" should be used any time iron is mentioned.

1.7.8.3.3. They recommended being consistent in the use of the "wear metal" and "detergent metal" terminology.

1.7.9. *Sequence IIIH 18-2 Information Letter:*

1.7.9.1. This information letter states that all S.O.T. and E.O.T. oil samples should be run sequentially and in duplicate.

1.7.9.1.1. Both measurements are to be averaged.

1.7.9.2. The TMC and Intertek agreed to add these changes (outlined in the 18-2 information letter) to the draft procedure before it is sent to the sub-group members for review.

1.7.10. *End-of-Test Drain Oils from Precision Matrix:*

1.7.10.1. Southwest, Lubrizol and Exxon have previously sent Intertek the E.O.T. oil samples from their Precision Matrix tests.

1.7.10.2. Afton sent Intertek the E.O.T. oil samples from their prove-out tests.

1.7.10.3. Intertek could analyze all these samples using the final iron adjustment procedure.

1.7.10.3.1. This would allow the statisticians to analyze the iron adjustment method without the complication of laboratory bias.

1.8. Metrology Action Items:

1.8.1. Lubrizol reminded the sub-group that there are several important "metrology" items on the action item list.

1.8.1.1. Several of these action items were identified over a year ago.

1.8.1.2. One of these action items is to conduct a round-robin with the latest version of the Keyence software that includes all five laboratories.

1.8.1.3. Another of these action items is to determine how to use the Keyence to screen lifters based on their profile.

1.8.1.3.1. Intertek supports revisiting the current lifter rejection criteria.

1.8.2. The sub-group agreed to convene regular metrology conference calls to address these action items.

1.9. Engine Health Checklist:

1.9.1. One of the action items is to develop an engine "health" checklist.

1.9.2. In theory, this "health" checklist would be used by a lab to determine if a used engine is suitable for continued testing.

1.9.3. Lubrizol agreed to take this action item.

1.9.4. Lubrizol requested that the remaining four labs provide it with any ideas or suggestions regarding this checklist.

1.10. Define a Camshaft Lobe Failure:

1.10.1. Intertek questioned how this definition should be approached.

1.10.1.1. *Should the definition of a camshaft lobe failure be based on an actual wear value?*

1.10.1.2. *Or should the definition be based on a technician's visual inspection?*

1.10.2. Intertek recently had a camshaft with two failed lobes.

1.10.2.1. The first failed lobe was worn down to the base circle.

1.10.2.2. The second failed lobe lost approximately 100µm of material from its nose.

1.10.2.3. Even though one lobe lost more material than the other, they were both easy to identify because of their scratched surfaces.

1.10.3. Intertek also had a recent camshaft lobe failure that made it to the end of the test.

1.10.3.1. The lobe had lost approximately 200µm of material from its nose.

1.10.4. *Comments from Lubrizol:*

1.10.4.1. Put a threshold value in place and do not use a visual rating system.

1.10.4.2. Lubrizol generally sees lobe wear that is under 10µm (when there is no lobe failure).

1.10.4.2.1. As a result, a 50µm threshold would be an appropriate starting point.

1.10.4.3. Intertek agrees with Lubrizol's suggestion.

1.10.5. *Comments from Afton:*

1.10.5.1. *How does a lab decide whether an engine needs to be flushed or rebuilt after a lobe failure?*

1.10.5.2. *What if the lobe is just slightly scuffed?*

1.10.6. *Comments from Lubrizol:*

1.10.6.1. In most cases, a flush is probably appropriate.

1.10.6.2. Lubrizol noted that Exxon has collected data that supports the effectiveness of flushes after a lobe failure.

1.10.6.3. Exxon confirmed that their post-failure flush was successful.

1.10.6.3.1. They plan to share some of this data with the sub-group.

1.10.6.3.2. They cannot share all the data because the test used a candidate oil.

1.10.7. *Comments from Intertek:*

1.10.7.1. The main area of damage after a full lobe failure (i.e. the nose is worn down to the base circle) is the center main bearing.

1.10.7.2. This type of lobe failure appears to generate enough wear debris to put the Oberg filter into bypass.

1.10.7.2.1. This allows the debris to make it past the filter.

1.10.7.3. Even though this debris damages the center main bearing, it appears to have little impact on the cylinder walls and oil pump.

1.10.7.4. *<u>Intertek experimented with "post lobe failure" engine flushes early in test development:</u>*

1.10.7.4.1. They determined that most of the wear debris remains on the valve deck.

1.10.7.4.2. At the time, they poured EF-411 onto the valve deck and let the debris flow into the oil pan.

1.10.7.4.3. The OHT oil pan, which retains very little oil when the plug is removed, allowed most of this debris to drain out of the engine.

1.10.7.5. Bearing wear was significantly reduced after the aeration problem was resolved.

1.10.8. *Comments from Exxon:*

1.10.8.1. They have confidence that flushing an engine (after a camshaft lobe failure) is acceptable.

1.10.8.2. They also agree that most engine wear and damage was significantly reduced after the aeration problem was resolved.

1.10.9. *Comments from Intertek:*

1.10.9.1. The independent labs have previously had up to four camshaft lobes fail during a single test.

1.10.9.2. However, this is no longer the case.
1.10.9.3. The independent labs now rarely encounter more than two camshaft lobes that fail during a single test.

1.11. Further Discussion About Engine Flushes After Lobe Failures:

1.11.1. *Comments from Afton:*

1.11.1.1. *Should there be a maximum iron validity limit for the first test run after an engine flush?*
1.11.1.1.1. Exxon, Lubrizol and Intertek all support the idea of an iron validity criteria.
1.11.1.1.2. This will be added as an action item.

1.11.2. *Comments from Lubrizol:*

1.11.2.1. The sub-group should take an action item to document a formal flush procedure.
1.11.2.1.1. This procedure can then be implemented on a trial basis.
1.11.2.1.2. Intertek supports adding this as an action item.
1.11.2.1.3. Exxon agreed to document their flush procedure and provide it to the sub-group for review.
1.11.2.1.4. Lubrizol recommended using a lobe wear of 20µm to trigger the requirement for a flush.
1.11.2.2. Lubrizol suggested running four flushes with EF-411.
1.11.2.2.1. Oil samples can be taken after each flush to track "flush effectiveness".
1.11.2.3. The other four labs agree that four flushes are appropriate.
1.11.2.3.1. However, the other labs do not want to use EF-411.
1.11.2.3.2. They want a fully formulated fluid to be used for the flushes.

1.11.3. *Comments from Intertek:*

1.11.3.1. They have photographs that show lobes and lifters with different levels of wear/damage.
1.11.3.2. They will provide these photographs to the sub-groups.

1.11.4. *Comments from Afton:*

1.11.4.1. *What if a camshaft lobe failure is not apparent?*
1.11.4.2. The labs will not be able to start another test until the metrology measurements are available to confirm that there was not a lobe failure.

1.11.5. *Comments from Toyota:*

1.11.5.1. Lobe wear more than 10-12µm should be visible.
1.11.5.2. Lobe wear above 10µm leaves a different surface texture on a Sequence IVA camshaft.

1.12. The sub-group agreed to move the meeting time up by 1-hour for all future conference calls.

Action Items	Person responsible	Completion Date

Follow-up Notes/Updates	Initials	Date Added

Attendees	Organization	Contact Information