

Sequence IV Surveillance Panel | MINUTES

REVISION DATE: 9/11/2017 9:45:00 AM

Relevant Test:	Sequence IVA and IVB
Note Taker:	Chris Mileti
Meeting Date:	07-26-2017
Comments:	Conference call to discuss preparations for upcoming Sequence IVB prove-out testing.

1. AGENDA:

1.1. Agenda Provided by B. Buscher:

- 1.1.1. Previous action item review.
- 1.1.2. Motion on operational validity of (13) completed tests from the original Sequence IVB Precision Matrix.
- 1.1.3. Update from Haltermann on KA24E "green" fuel.
- 1.1.4. **Sequence IVB hardware status:**
 - 1.1.4.1. Update on chamfered Batch Code-C intake camshafts.
 - 1.1.4.2. Update on OHT oil pans with modified pick-up tube.
 - 1.1.4.3. Update from OHT and Toyota on the status of the next batches of critical hardware.
- 1.1.5. **Keyence Software:**
 - 1.1.5.1. Update from the labs and the Metrology Sub-Group.
- 1.1.6. Update on the ongoing procedure review.
 - 1.1.6.1. This includes an update on the availability of the latest draft procedure and the engine assembly manual.
- 1.1.7. Review the next steps for this test.
- 1.1.8. Review the proposed Sequence IVB timeline.
- 1.1.9. Motion and action item review.

2. REVIEW OF PREVIOUS BUSINESS AND ACTION ITEMS:

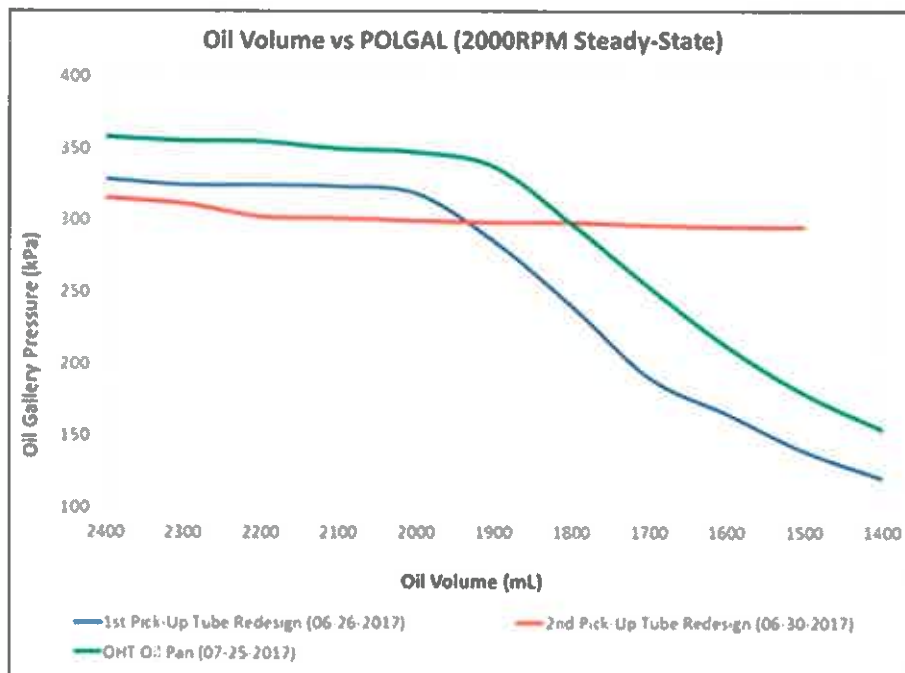
2.1. Intertek Experiments with Lubrizol Oil Pan:

- 2.1.1. Intertek continues to run experiments with the oil pan that Lubrizol modified with an oil well and sight glass.
- 2.1.2. **Water content:**
 - 2.1.2.1. One of the Surveillance Panel members suggested that Intertek run the Lubrizol oil pan using drain oil that already has water in it.
 - 2.1.2.2. They want to know if a significant concentration of water in the oil pan will impact aeration or bubble formation.
 - 2.1.2.3. Intertek agreed to conduct the proposed experiment using one of their end-of-test REO300 oil drains.
- 2.1.3. **Intertek's Comments on Lubrizol Oil Pan Design:**

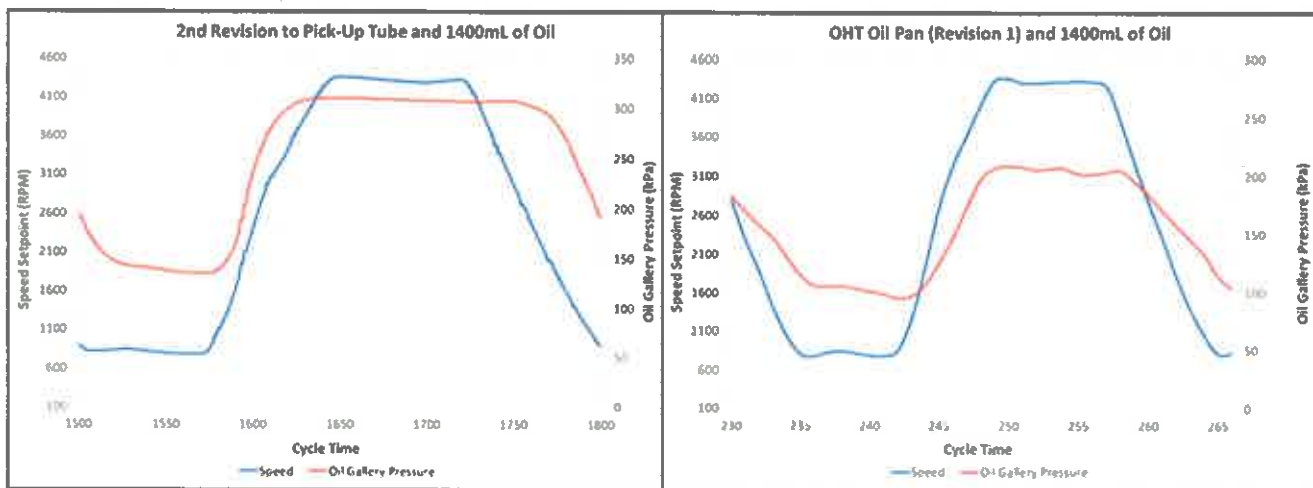
- 2.1.3.1. Intertek provided the Surveillance Panel with a spreadsheet (*IVB Oil Pressure Plots – Oil Level Trials.xls*) that contains oil pressure data collected with a stock IVB oil pan and the Lubrizol oil pan.
- 2.1.3.2. The Lubrizol oil pan design (with an oil well) significantly improves oil pressure at extremely low oil volumes (<1400mL).
- 2.1.3.3. The improvement offered by the Lubrizol oil pan design becomes less significant at higher oil volumes (~10kPa at 2400mL).
- 2.1.3.4. The stock IVB oil pan and the Lubrizol oil pan generate similar oil pressures at an oil volume of 3000mL.
- 2.1.3.5. It is unlikely that the oil volume of a Sequence IVB test will drop below 1800-2200mL with the larger initial oil volume of 3000mL.
 - 2.1.3.5.1. The Lubrizol oil pan does show a significant improvement in oil pressure within this range of volumes.
- 2.1.4. **Lubrizol's Comments about the Intertek Trial:**
 - 2.1.4.1. Intertek's findings mimic those of Lubrizol's earlier trials.
 - 2.1.4.2. The well underneath the pick-up tube offers a significant improvement in performance at oil volumes below 1600mL.
 - 2.1.4.3. However, it is unlikely that a test will ever approach such a low oil volume now that the initial oil charge has been increased.
 - 2.1.4.4. Thus, the OHT oil pan design should be adequate.
- 2.1.5. **Intertek's Videos of Oil Pan Sight Glass:**
 - 2.1.5.1. **2200mL Video:**
 - 2.1.5.1.1. The pick-up tube is submerged.
 - 2.1.5.1.2. The oil sump temperature thermocouple is also submerged.
 - 2.1.5.1.3. Intertek marked the far wall of the oil pan with ink lines.
 - 2.1.5.1.3.1. The ink lines indicate different oil volumes.
 - 2.1.5.1.3.2. Intertek calibrated these lines with water prior to installing the pan.
 - 2.1.5.2. **2000mL Video:**
 - 2.1.5.2.1. The top of the pick-up tube is starting to break the surface of the oil.
 - 2.1.5.2.2. Per the drawings of the new OHT design, the slots in the OHT oil pan will still be submerged at 2000mL.
 - 2.1.5.3. **Videos with less than 2000mL:**
 - 2.1.5.3.1. The top of the oil sump temperature thermocouple is above the surface of the oil.
 - 2.1.5.3.2. Intertek suggested incorporating a displacement block in the new OHT oil pan.
 - 2.1.5.3.3. There are clearly air bubbles in the oil – even with the well underneath the pick-up tube.

2.2. OHT Oil Pan:

- 2.2.1. OHT presented technical drawings for their proposed oil pan design.
- 2.2.2. They propose a slotted pick-up tube.
 - 2.2.2.1. The slots are 0.5-inches above the bottom of the oil pan.
 - 2.2.2.2. The tip of the pick-up tube is plugged.
- 2.2.3. **Lubrizol Trial with OHT Slotted Oil Pan Design:**
 - 2.2.3.1. The OHT slotted pick-up tube design behaved similarly to the original Lubrizol slotted pick-up tube design (that did not utilize the well).
 - 2.2.3.2. The chart below compares the oil pressure with Lubrizol's slotted design (blue), Lubrizol's oil-well design (red), and OHT's slotted design (green) under steady-state conditions.



2.2.3.3. The slotted designs (OHT slotted design is shown in right-side chart) do not seem to generate oil pressures that are as good as the oil-well design (shown in left-side chart) under dynamic conditions and extremely low oil volumes.



2.2.3.4. The slotted pick-up tube designs appear to exhibit a reduction in oil pressure when the oil volume drops below 1800-1900mL.

2.2.3.5. However, with the Sequence IVB's new initial oil charge of 3000mL, it is unlikely that the oil level will ever drop below 2000mL.

2.2.3.6. Thus, the OHT design will probably be sufficient at preventing oil pump starvation.

2.2.3.7. Lubrizol plans to run a more controlled and lengthy trial with the OHT oil pan this week.

2.2.4. Toyota's Comments on Lubrizol Trial:

2.2.4.1. Toyota agrees with Lubrizol's assessment that the Sequence IVB will no longer see the extremely low oil volumes that will prevent OHT's slotted pick-up tube design from working effectively.

2.2.4.2. The proposed oil pan modifications should reduce bore polishing and oil consumption.

2.2.5. Shell's Comments on Lubrizol Trial:

- 2.2.5.1. Shell is encouraged by these findings, and they agree with Lubrizol's assessment that the OHT oil pan will be adequate now that the initial oil charge has been increased.
- 2.2.5.2. *Is the surface area of the slots equivalent to the surface area of the opening on the stock pick-up tube?*
 - 2.2.5.2.1. OHT confirmed that the areas are equivalent.
- 2.2.5.3. *Is there a risk of the plug at the end of the pick-up tube becoming dislodged?*
 - 2.2.5.3.1. OHT stated that this is unlikely because the plug is press fit and welded.
- 2.2.5.4. *Is there a shift in the TAN-TBN cross-over with the 3000mL initial oil charge?*
 - 2.2.5.4.1. Intertek confirmed that the cross-over occurs approximately 10-15 hours later with the larger oil volume.
- 2.2.5.5. *Can we pull a vacuum in the oil pan to reduce aeration?*
 - 2.2.5.5.1. Intertek stated that this is a possibility, but cautioned that this could draw more blowby into the crankcase.
 - 2.2.5.5.2. Toyota added that the vacuum could increase the size of the oil bubbles.
- 2.2.6. Afton would still like to see OHT lower the slots on their pick-up tube design.
 - 2.2.6.1. OHT stated that they are still considering ways to fabricate the oil well proposed by Lubrizol.

2.3. Oil Consumption:

2.3.1. Afton's Comments:

- 2.3.1.1. This test needs an oil consumption limit.
 - 2.3.1.1.1. Shell agrees with Afton's assertion.
- 2.3.1.2. Customers will want to be sure that the oil pick-up tube is full of oil.
- 2.3.1.3. A test with a high oil consumption should be deemed invalid and not non-interpretible.

2.3.2. Southwest proposed an oil consumption limit of 850g.

2.3.3. Intertek's Comments:

- 2.3.3.1. The Sequence IVB test now utilizes (7) samples that are each 2oz/60mL.
- 2.3.3.2. Southwest's proposed limit would invalidate 25% of the previous Sequence IVB tests.
- 2.3.3.3. They would like the proposed oil consumption limit to be made a Surveillance Panel action item.
- 2.3.3.4. This limit can be set at the end of the upcoming prove-out testing.

2.3.4. Afton is amenable to making this an action item if it is addressed before the end of the Precision Matrix.

2.4. Motion to Approve Revised OHT Oil Pan:

2.4.1. Intertek proposed the following motion: *"The Sequence IV Surveillance Panel approves the OHT alternate design, plugged and slotted pick-up tube, as an additional modification to the OHT modified oil pan (P/N OHTIVB-022-1). The purpose of this modification is to reduce exposure of the suction port of the pick-up tube and air ingestion, which leads to engine oil aeration."*

2.4.1.1. This motion listed above is a reworded version of the original motion proposed by Intertek.

2.4.1.2. The rewording was done at the request of Chevron and Shell.

2.4.2. Shell seconded the motion after the wording was changed.

2.4.3. The motion passed with (13) approvals, (0) negatives and (2) waives.

2.4.3.1. **Approvals:** Intertek, OHT, GM, Toyota, TEI, Lubrizol, Haltermann, Afton, Southwest, Infineum, Exxon, Chevron, and Shell.

2.4.3.2. **Waives:** TMC and Valvoline

2.4.3.3. **No Votes:** BP, Chrysler, Nissan and Ford

2.4.4. OHT's Comments on the Approved Motion:

2.4.4.1. OHT is currently modeling an oil pan displacement block.

2.4.4.1.1. This modification has a relatively short lead-time.

2.4.4.2. OHT is also modeling an oil well below the pick-up tube.

2.4.4.2.1. This modification has the longest lead-time.

2.4.4.3. The slotted pick-up tube design has the shortest lead-time, and that is why OHT decided to use it for the oil pan.

2.4.4.4. Now that this motion is approved, they will start modifying the existing oil pans in their inventory and at the labs.

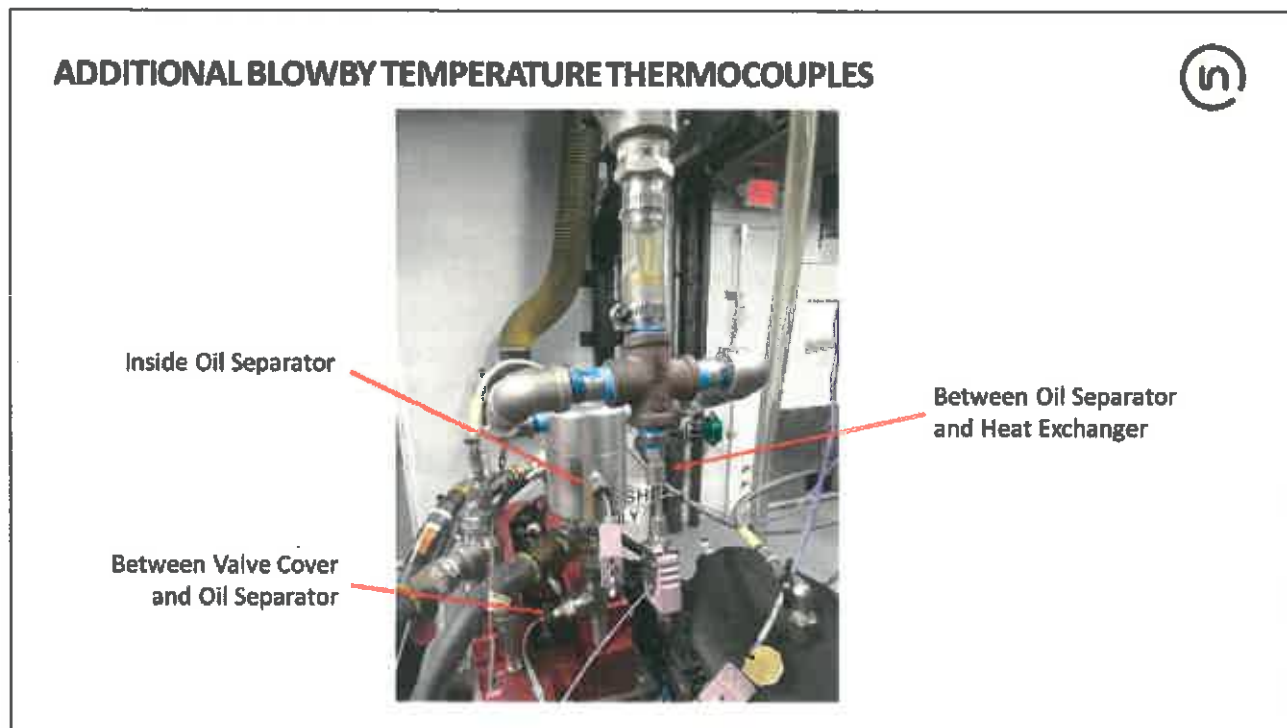
2.4.4.4.1. They will also start fabricating (6) additional oil pans.

3. NEW BUSINESS:

3.1. Intertek Presentation on Oil Separator:

3.1.1. Intertek reviewed a presentation titled, "IVB Intertek Oil Separator Trials.pptx".

3.1.2. **Slide #2:**



3.1.2.1. Intertek added a thermocouple between the oil separator and the heat exchanger.

3.1.2.2. They also added a thermocouple inside of the oil separator.

3.1.2.3. They plan to run several trials with this configuration.

3.1.3. **Slide #3:**

PLAN



- Install additional blowby temperature thermocouples and evaluate uninsulated oil separator and three (3) different insulation methods
- Run at test conditions to obtain blowby temperature data with the 4 different methods
 - Considering running each trial for 25 hours to obtain data over the course of one full day and to evaluate the H₂O content of the 25 hour used oil sample
 - Would follow the same procedure as the original Intertek blowby temperature / H₂O content trials
- Three insulation methods to be evaluated:
 - Standard dense black insulation wrap with 1 side sticky
 - LizardSkin's ceramic thermal insulation coating
 - <http://www.lizardskin.com/car-ceramic-insulation.html>
 - Cradin Industries' thermal barrier ceramic coating
 - <http://www.cradin.com/top-posts/product/>

3.1.3.1. Intertek will collect blowby temperature data using the (4) different thermocouples.

3.1.3.2. They will also evaluate three different insulation methods (listed in the slide).

3.1.3.3. The LizardSkin ceramic thermal insulation coating will require a detailed procedure if the other labs are to use it.

3.1.3.4. The Cradin Industries ceramic coating is designed for exhaust headers.

3.1.3.4.1. The vendor would apply the ceramic coating and not the labs (which will eliminate concerns about application consistency).

3.2. Reimbursement to Intertek and Southwest for 1st Precision Matrix:

3.2.1. Thirteen tests were completed during the original Precision Matrix.

3.2.2. The Surveillance Panel was not aware of the impact of fuel sulfur on test severity when the matrix was started.

3.2.3. The Surveillance Panel also agreed at the time that the tests were operationally valid.

3.2.4. TMC needs documentation regarding test validity before reimbursement payments can be released.

3.2.5. The ACC wants documentation summarizing the results of the investigation into the issues with the original Precision Matrix.

3.2.6. Toyota plans to use private funding for the 2nd Precision Matrix.

3.2.6.1. Haltermann will donate fuel.

3.2.6.2. OHT will donate critical hardware.

3.2.7. Affon's Comments:

3.2.7.1. The report provided to the ACC will need to document that the coolant flow directions were different.

3.2.7.2. There was also no approved procedure prior to the start of the matrix.

3.2.7.3. The prior test stand inspections were not as thorough as they should have been.

3.2.8. Toyota's Comments:

3.2.8.1. This group needs to keep in mind that the Surveillance Panel did approve the start of the 1st Precision Matrix.

3.2.9. TMC's Comments:

3.2.9.1. The "lessons learned" report that has been requested by the ACC should not hold up this vote to reimburse the labs.

3.2.10. Valvoline's Comments:

3.2.10.1. For the Precision Matrix tests to be deemed valid, they must be valid in the absolute sense.

3.2.10.2. The tests that had the coolant flow issues should not be included in this statement.

3.2.11. Chevron's Comments:

3.2.11.1. The Surveillance Panel members thought that these tests were operationally valid during the time of the lab inspections.

3.2.11.2. However, these members may not feel the same way now.

3.3. Motion to Approve Laboratory Reimbursements for 1st Precision Matrix:

3.3.1. Intertek proposed the following motion: *"The Sequence IV Surveillance Panel agrees that the (13) full length tests that were completed for the original Sequence IVB Precision Matrix were operationally valid, based on test procedures and information known to the Precision Matrix labs at the time that the tests were conducted. The (13) tests include test numbers 102-0-53, 165-0-19, 18-0-32, 20-0-47, 102-0-54, 165-0-21, 18-0-33, 20-0-48, 102-0-55, 165-0-22, 18-0-34, 20-0-49 and 102-0-56."*

3.3.2. This motion was seconded by Southwest.

3.3.3. Initial Vote:

3.3.3.1. The initial vote included (7) approves, (0) negatives and (8) waives.

3.3.3.2. Approving votes: Intertek, Shell, Toyota, TEI, Southwest, Infineum and Chevron

3.3.3.3. Waives: OHT, TMC, GM, Lubrizol, Haltermann, Afton, Exxon and Valvoline

3.3.3.4. The results of this vote were somewhat unique in that there were more "waives" than "approves".

3.3.4. Final Vote Tally:

3.3.4.1. TMC changed its final vote from a "waive" to an "approve".

3.3.4.2. The final vote tally was (8) approves, (0) negatives and (7) waives.

3.4. Haltermann Fuel Status:

3.4.1. They have completed the re-blend of the KA24E Sequence IVB fuel.

3.4.2. This fuel is being stored in both Michigan and Houston.

3.4.2.1. They may consolidate storage locations in the future.

3.4.3. Lab Status:

3.4.3.1. Intertek, Southwest and Lubrizol have taken delivery of the fuel.

3.4.3.2. Afton has ordered their shipment.

3.4.3.3. Exxon is cleaning the tank that they plan to use for fuel storage.

3.4.3.3.1. Exxon has 20,000 gallons of existing KA24E fuel that is near the upper limit of the new sulfur specification.

3.4.3.3.2. The consensus among the Surveillance Panel members is that Exxon should be able to use this fuel for future reference and candidate testing (because it is within the new sulfur specification).

3.5. OHT Hardware Status:

3.5.1. Intertek and Southwest have both received the new intake camshafts.

3.5.1.1. OHT will send (1) additional camshaft to Southwest to use with their 2nd high-event camshaft lobe failure oil.

3.5.2. OHT is ready to ship the new hardware to Lubrizol.

3.5.3. OHT has (10) more intake camshafts being machined.

3.5.4. Batch-D Intake Camshafts:

3.5.4.1. OHT has received all critical components.

- 3.5.4.2. They are waiting on direction from the Surveillance Panel before they start modifying hardware.
- 3.5.4.3. Intertek responded that this direction should be available after the prove-out testing.

3.6. Keyence Software Update:

- 3.6.1. Intertek and Lubrizol have already installed the software upgrades.
- 3.6.2. This upgrade is not necessary at Exxon because they purchased their macroscope with the latest version of the software.
- 3.6.3. Southwest has purchased the software but not yet installed it.
- 3.6.4. **Metrology Conference Call Last Week:**
 - 3.6.4.1. All (5) laboratories participated in the call.
 - 3.6.4.2. Intertek and Lubrizol are working on new templates for the Generation-2 software.
 - 3.6.4.3. The new templates will be presented at the workshop.
- 3.6.5. **Upcoming Metrology Workshop:**
 - 3.6.5.1. *The following topics will be covered in this workshop:*
 - 3.6.5.1.1. Settings and templates for Generation-2 software.
 - 3.6.5.1.2. Rejection criteria for lifters.
 - 3.6.5.1.3. PDI versus Keyence wear measurements.

3.7. Timeline Review (Intertek):

- 3.7.1. The original timeline has already slipped by several weeks.
- 3.7.2. Another 1-2 weeks will be needed to sort out the remaining issues with oil pans and oil separators.
- 3.7.3. All laboratories will need to break-in and pacify their new engines.
- 3.7.4. Prove-out testing is expected to begin the week of August 14th.

Action Items	Person responsible	Completion Date

Follow-up Notes/Updates	Initials	Date Added

Attendees	Organization	Contact Information

Sequence IV Surveillance Panel

July 26, 2017

8:30AM – 10:30AM

Conference Call

Motions and Action Items

As Recorded at the Meeting by Bill Buscher

1. Action Item – At conclusion of the prove-out testing the Sequence IV surveillance panel will set an oil consumption validity limit.
2. Motion – The Sequence IV surveillance panel approves the OHT alternate design, plugged and slotted pick-up tube, as an additional modification to the OHT modified oil pan (p/n OHTIVB-022-1). The purpose of this modification is to reduce exposure of the suction port of the pick-up tube and air ingestion, which leads to engine oil aeration.
Bill Buscher / Jeff Hsu / Pass 13 – 0 – 2
3. Action Item – Continuous improvement will be applied to this modification, in the future.
4. Action Item – OHT to expedite machining and modification of six additional OHT modified oil pans (p/n OHTIVB-022-1) with the alternate design
5. Motion – The Sequence IV surveillance panel agrees that the 13 full length tests that were completed for the original Sequence IVB precision matrix were considered to be operationally valid, based on test procedures and information known to the precision matrix labs at the time that the tests were conducted. The 13 tests include test numbers 102-0-53, 165-0-19, 18-0-32, 20-0-47, 102-0-54, 165-0-21, 18-0-33, 20-0-48, 102-0-55, 165-0-22, 18-0-34, 20-0-49 and 102-0-56.
Bill Buscher / Khaled Rais / Passed 8 – 0 – 7
6. Action Item – OHT to send one additional chamfered Batch Code C intake camshaft to SwRI, once additional camshafts are available, so that they can conduct a test on a second candidate oil that experienced intake camshaft lobe failures.

**MEMBERSHIP
SEQUENCE IV SURVEILLANCE PANEL**

July 26, 2017

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**MEMBERSHIP
SEQUENCE IV SURVEILLANCE PANEL**

July 26, 2017

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**MEMBERSHIP
SEQUENCE IV SURVEILLANCE PANEL**

July 26, 2017

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SEQUENCE IV SURVEILLANCE PANEL**

July 26, 2017

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July 26, 2017

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