Sequence IV Surveillance Panel | MINUTES

REVISION DATE: 9/11/2017 2:45:00 PM

Relevant Test:	Sequence IVB
Note Taker:	Chris Mileti
Meeting Date:	08-08-2017
Comments:	Sequence IVB conference call to discuss preparations for upcoming prove-out testing.

1. AGENDA:

1.1. Agenda Items Provided by Bill Buscher:

1.1.1. Previous action item review.
1.1.2. Presentation on oil separator insulation trials.
1.1.3. Haltermann KA24E "green" fuel status.
1.1.4. Sequence IVB hardware status.
1.1.5. Keyence software upgrade status.
  1.1.5.1. Update from labs.
  1.1.5.2. Update from Metrology sub-team.
1.1.6. Procedural review status.
  1.1.6.1. Update on availability of latest draft of test procedure and engine assembly manual.
  1.1.6.2. Update from Sequence IVB Procedural Review sub-team.
1.1.7. Sequence IVB next steps.
1.1.8. Sequence IVB timeline review.
1.1.9. Motion and action item review.
1.1.10. Discuss next meeting.

2. REVIEW OF PREVIOUS BUSINESS AND ACTION ITEMS:

2.1. Oil Sampling Valve:

2.1.1. Lubrizol is evaluating whether a Swagelok valve will produce less foaming in oil samples than the original Golden Stand valve.
2.1.2. Lubrizol will monitor the performance of this valve during the upcoming prove-out testing.

2.2. Procedural Review Sub-Team:

2.2.1. This sub-team held a meeting last week.
2.2.2. The latest version of the procedure has been posted to the TMC website.
2.2.3. Lubrizol will eventually issue minutes from this meeting.

2.3. Oil Consumption Limit:

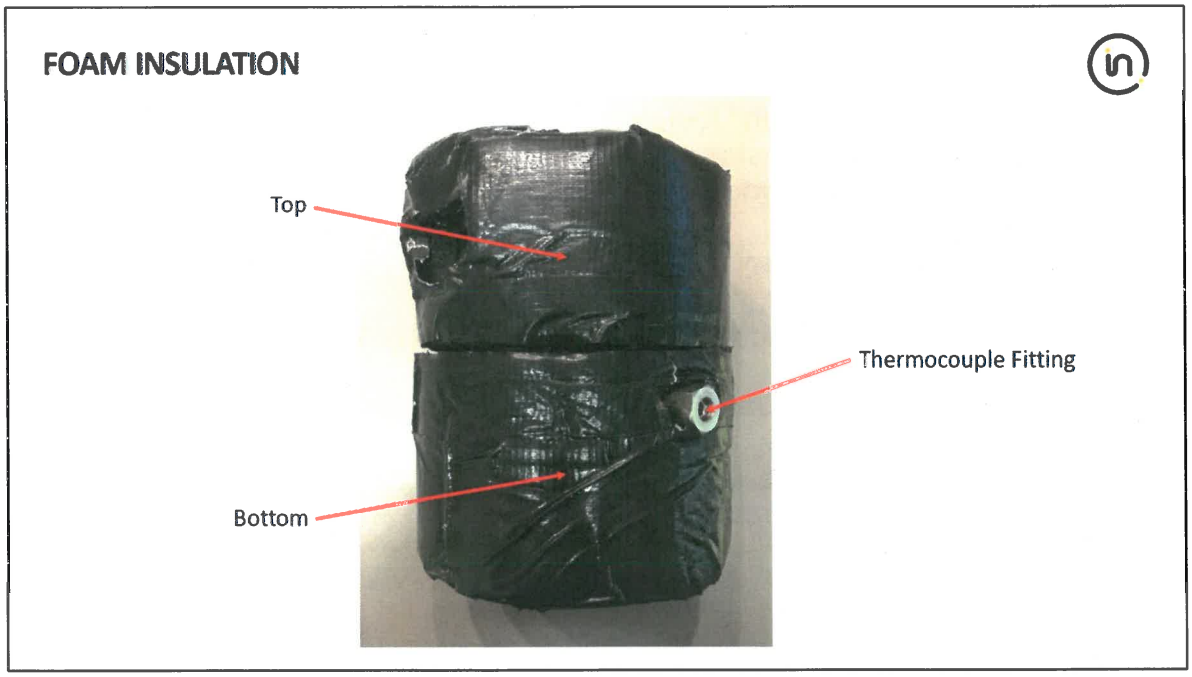
2.3.1. The Surveillance Panel has agreed to eventually set an oil consumption validity limit.

2.4. OHT Update:

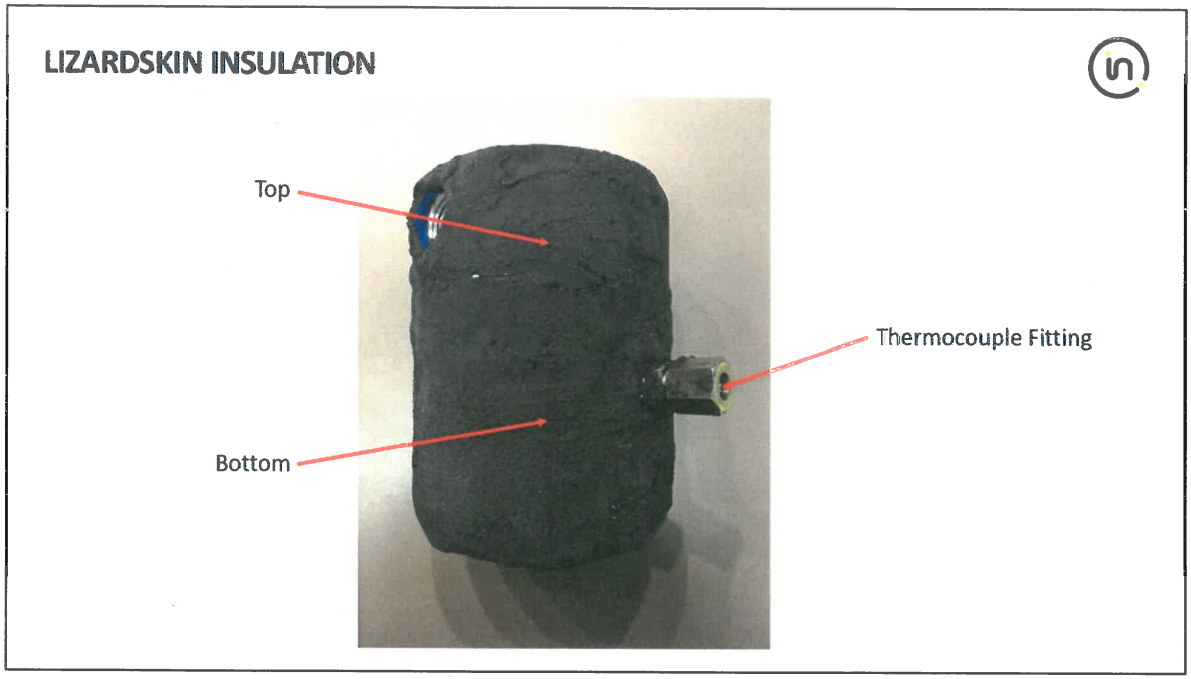
2.4.1. OHT is awaiting the delivery of additional camshafts.
2.4.2. They expect this delivery to arrive tomorrow.

2.5. Intertek Oil Separator Presentation:

2.5.1. Intertek reviewed the following PDF file: "*IVB Intertek Oil Separator Insulation Trials.pdf*".
2.5.2. Intertek is monitoring the blowby gas temperature in three locations: *between the valve cover and the oil separator, inside of the oil separator, and between the oil separator and the heat exchanger.*
2.5.3. ***Intertek conducted (4) different trials:***
  2.5.3.1. *Trial #1* – No insulation on oil separator
  2.5.3.2. *Trial #2* – Black insulation wrap around oil separator
  2.5.3.3. *Trail #3* – LizardSkin insulation around oil separator
  2.5.3.4. *Trail #4* – Cradin insulation around oil separator
2.5.4. Each trial was run for 25HRS and used Ford Motorcraft 5W-20 laboratory oil.
2.5.5. ***Slide #4 – Foam Insulation:***

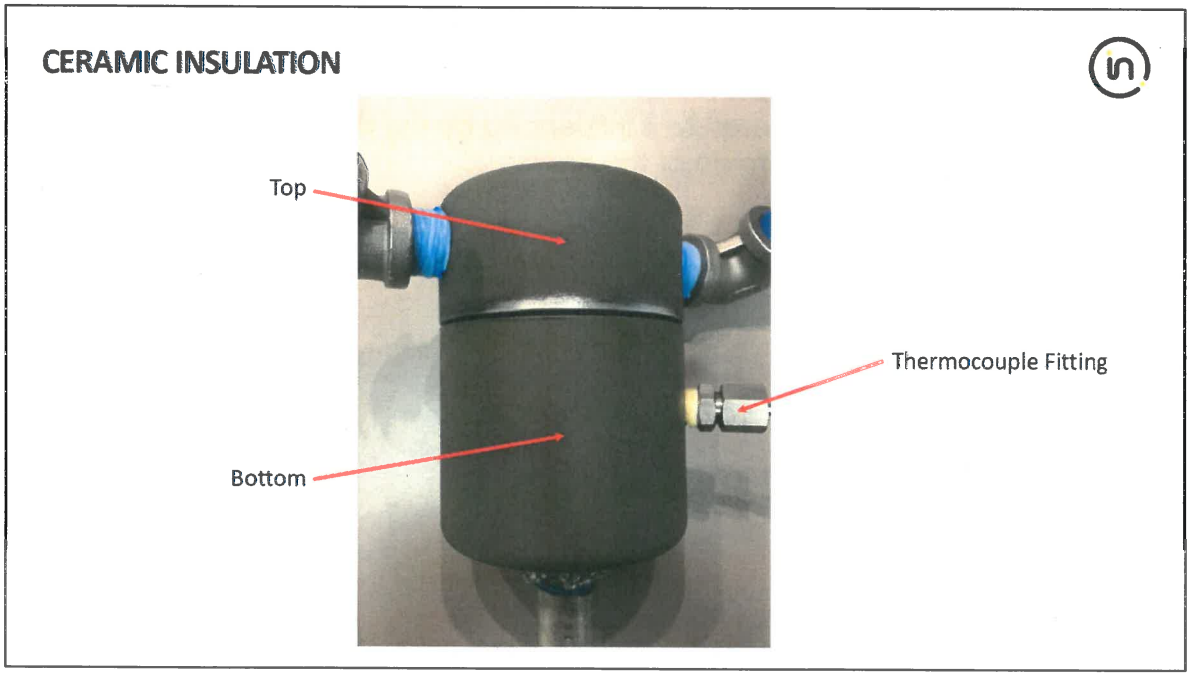


  2.5.5.1. The foam should be readily available at each lab.
  2.5.5.2. Intertek is recommending a two-piece sleeve for the oil separator.
2.5.6. ***Slide #5 – LizardSkin:***



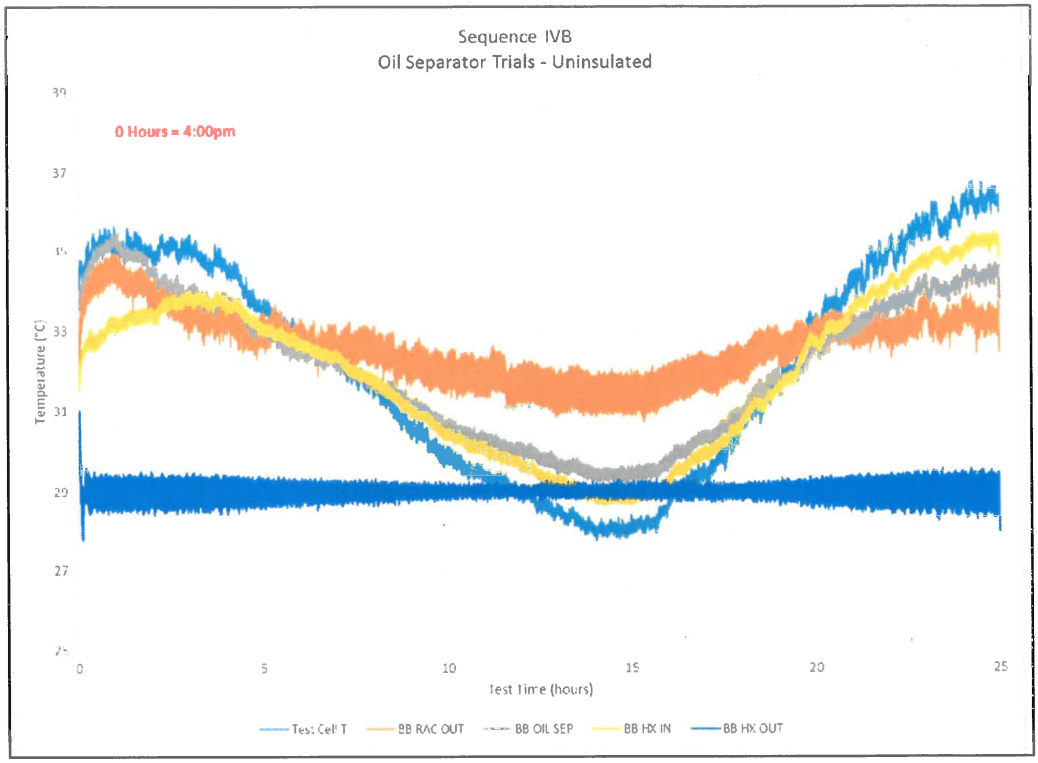
2.5.6.1. LizardSkin is a ceramic coating that is applied with a brush or spray can.
2.5.6.2. Two coats were necessary to achieve the desired thickness around the oil separator.

2.5.7. ***Slide #6 – Ceramic Insulation:***



2.5.7.1. This material is like the ceramic used on exhaust headers.
2.5.7.2. It provides a two-way thermal barrier.
2.5.7.3. The inside of the oil separator was treated as well.
2.5.7.4. Some of the material around the mating surface between the two halves of the oil separator was rubbed off when the threads were cleaned.
2.5.7.5. It was expensive to have this material applied (~$278.00/separator).

2.5.8. ***Slide #8 – Trial with Uninsulated Separator:***



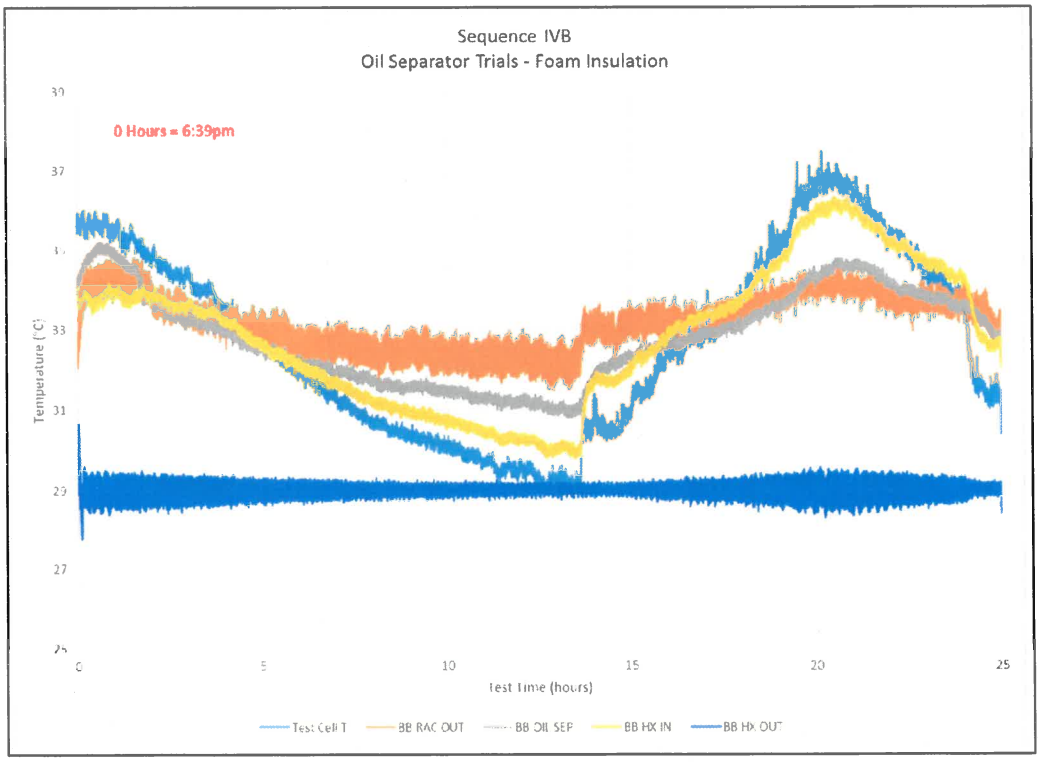
2.5.8.1. The light-blue line is the ambient temperature of the lab, which ranged between 28C-37C over two days.

2.5.8.2. The dark blue line is the controlled measurement.

2.5.8.2.1. The controlled measurement improves as the blowby gas temperature approaches the set-point.

2.5.8.3. The blowby temperature is influenced by the ambient temperature (even when the blowby gas is still inside of the engine).

2.5.9. ***Slide #9 – Trial with Foam:***

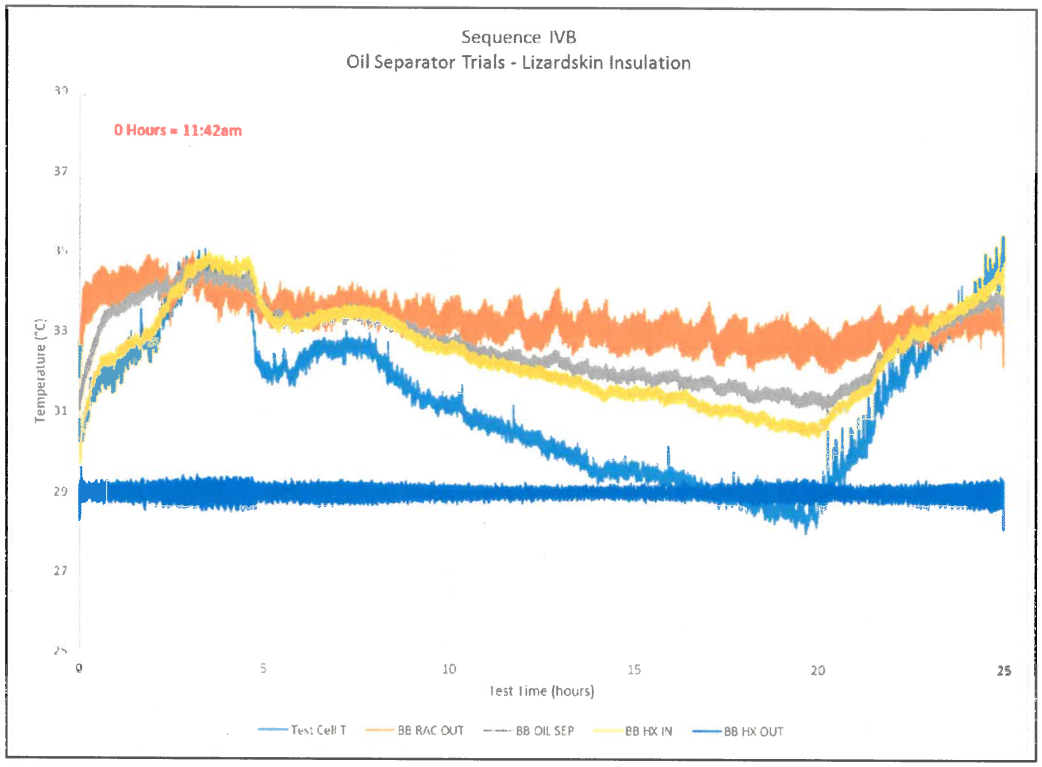


2.5.9.1. Ambient temperatures were like the first trial.

2.5.9.2. The anomaly at 14HRS may have been due to a weather front moving through San Antonio.

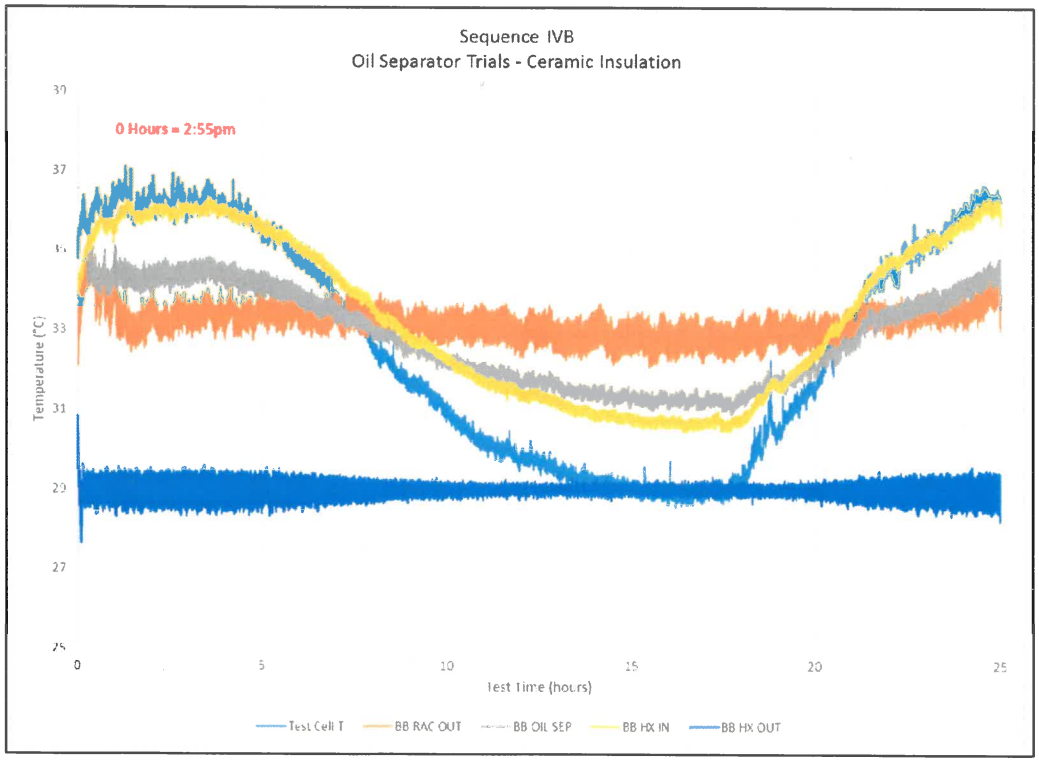
2.5.9.3. The foam insulation helped to bring all the measured blowby temperatures closer together.

2.5.10. ***Slide #10 – Trial with LizardSkin:***



2.5.10.1. This trial had the coolest ambient temperatures.

2.5.11. ***Slide #11 – Trail with Ceramic:***



2.5.11.1. The ceramic insulation increased the blowby temperatures outside of the engine.

2.5.11.2. Intertek is concerned by the oil analysis results from this trial.

2.5.12. ***Slide #18 – Comparison Table:***

COMPARISON TABLE

	Oil Separator Blowby Temperature				RAC to Oil Separator Blowby Delta Temperature			
	UNINSULATED Deg C	FOAM Deg C	LIZARDSKIN Deg C	CERAMIC Deg C	UNINSULATED Deg C	FOAM Deg C	LIZARDSKIN Deg C	CERAMIC Deg C
Min	29.20	30.79	31.02	30.90	-1.71	-2.12	-1.34	-1.82
Max	35.45	35.20	34.74	35.12	2.57	2.18	2.30	2.18
Average	32.08	32.81	32.73	32.83	0.54	0.38	0.60	0.36
Std. Dev	1.791	1.147	0.922	1.195	1.039	0.584	0.597	0.968

2.5.12.1. The biggest blowby temperature swings occurred when no insulation was used.

2.5.12.2. The smallest swing (i.e. standard deviation) in blowby temperature probably occurred with the LizardSkin.

2.5.12.2.1. This may have been because there was the least amount of variability in ambient temperature when the LizardSkin was used.

2.5.13. ***Slide #20 – Oil Analysis:***

OIL ANALYSIS

Insulation Method	UNINSULATED	FOAM	LIZARDSKIN	CERAMIC
D5185 Metals, ppm				
Ag	0	0	0	0
Al	2	2	2	2
B	151	156	159	160
Ba	0	0	0	0
Ca	2129	2155	2103	2112
Cd	0	0	0	0
Cr	0	0	0	0
Cu	0	0	0	0
Fe	11	4	3	3
K	0	0	0	0
Mg	19	11	9	8
Mn	0	0	0	0
Mo	20	17	16	16
Na	1	2	0	1
Ni	0	0	0	0
P	670	663	682	677
Pb	0	0	0	0
S	3080	3278	2894	3009
Sb	0	0	0	0
Si	31	15	11	9
Sn	2	2	0	0
Ti	0	0	0	0
V	0	0	0	0
Zn	753	752	748	740
D6304 Karl Fischer H2O Content, ppm	1280	1077	1023	1494
D3525 Fuel Dilution, %	10.3	9.3	9.6	12.5

2.5.13.1. Use of the foam and the LizardSkin resulted in an expected drop in water content.

2.5.13.2. The ceramic coating resulted in an unexpected increase in both water and fuel dilution.

2.5.13.2.1. Intertek does not believe that this increase is due to a measurement error.

2.5.14. ***Slide #21 – Conclusion:***

CONCLUSIONS

- **Conclusions:**
  - **Ambient temperature influences blowby temperature inside the test engine, inside the oil separator and inside the plumbing between blowby stack components**
  - **Insulation is beneficial**
  - **Insulation decreases ambient effect on blowby temperature inside the oil separator**
  - **The three insulation methods provide similar results, with the Lizardskin insulation appearing to be slightly better than the foam and ceramic insulation**
    - **Lizardskin performance over ceramic performance might be a result of ambient temperature swing**
  - **Ceramic insulation has the biggest potential to be the most consistent**

2.5.14.1. The (3) insulation methods provided similar results.

2.5.14.2. The LizardSkin may provide the greatest benefit.

2.5.15. ***Lubrizol's Comments:***

2.5.15.1. It would be interesting to run this experiment without the oil separator to measure the amount of water and fuel dilution.

2.5.15.2. Intertek stated that they already removed the engine from the stand.

2.5.15.3. Southwest ran a similar trial several weeks back.

2.5.15.3.1. They found no difference in water or fuel dilution between an uninsulated oil separator and running no oil separator at all.

2.5.16. Intertek feels that the oil separator needs to remain in place to avoid the clogging encountered at Lubrizol last year.

2.5.16.1. Lubrizol noted that it is seeing less emulsion now that the blowby set-point has been increased to 29C.

2.5.16.2. The heat exchanger clogging occurred when the blowby set-point was 24C.

2.5.17. ***Engine Insulation:***

2.5.17.1. The results of the Intertek trial show a relationship between ambient temperatures and blowby temperatures.

2.5.17.2. *Should insulation be added to the oil pan and front cover?*

2.5.17.3. It may be possible to apply the ceramic coating to the outside of the oil pan and front cover.

2.5.17.4. This issue will be revisited after the Precision Matrix.

2.5.18. ***Afton's Comments:***

2.5.18.1. They have no idea why the ceramic coating would generate a higher water content.

2.5.18.2. However, they are not very concerned by the unexpected finding.

2.5.19. ***Intertek's Comments:***

2.5.19.1. The black, ½-inch foam is the simplest insulation option.

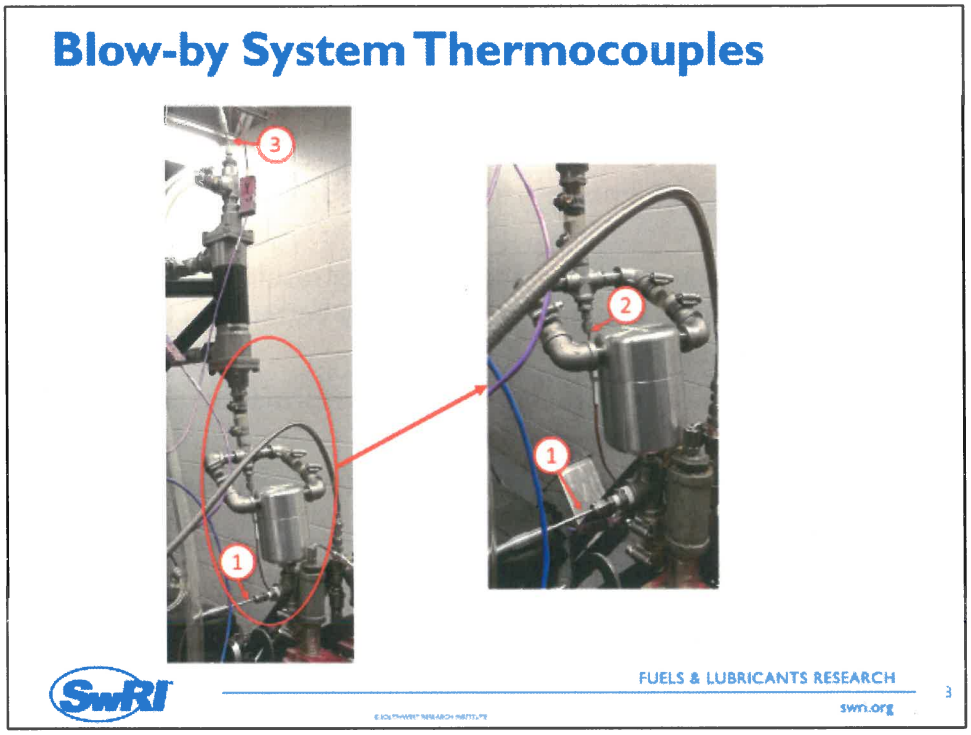
2.5.19.2. Intertek made a two-piece insulator for the oil separator that is held in place with black tape.

2.5.19.3. They installed a thermocouple inside of the oil separator that will not be mandated in the procedure.

2.6. SWRI Blowby Oil Separator Coolant Loop Trial:

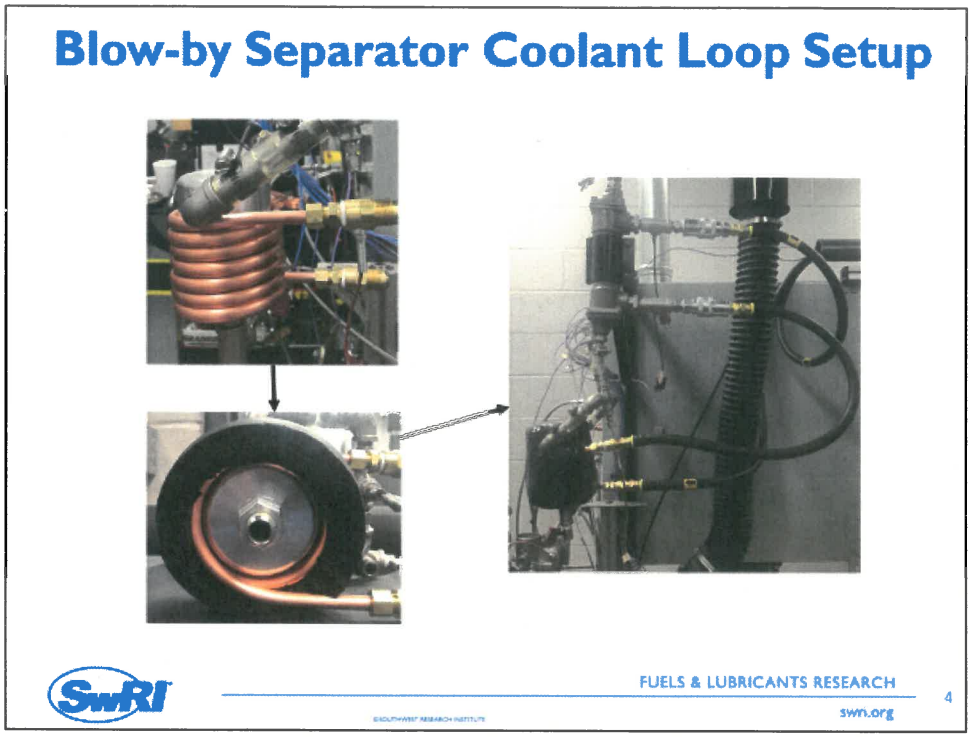
2.6.1. Southwest reviewed the following PDF file: "*SwRI_IVB_20170808.pdf*".

2.6.2. ***Slide #3:***



2.6.2.1. SWRI is using a similar set-up as Intertek, except that SWRI does not have a thermocouple inside of their oil separator.

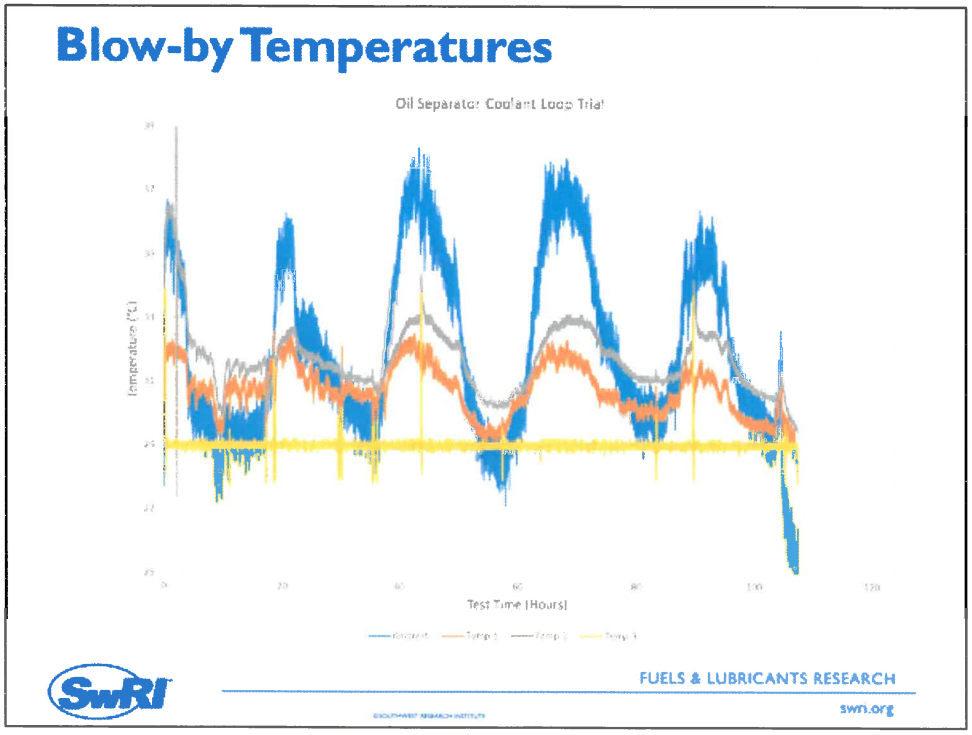
2.6.3. ***Slide #4:***



2.6.3.1. They wrapped copper tubing around their oil separator, and then wrapped foam insulation around the copper tubing.

2.6.3.2. Flow was diverted from the blowby heat exchanger and through this copper tubing.

2.6.4. ***Slide #5:***

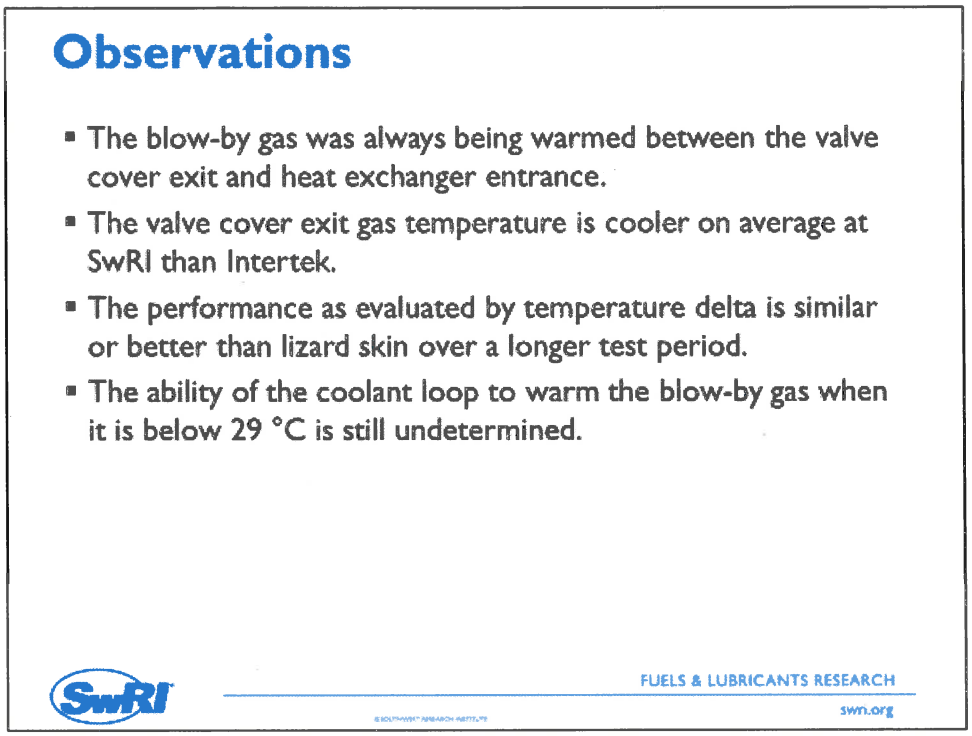


2.6.4.1. The SWRI encountered temperature swings that were like those at Intertek.

2.6.4.2. The gray line is the temperature of the blowby gas as it enters the heat exchanger.

2.6.4.3. The only unusual observation was the heat exchanger still appeared to be cooling the blowby gas even when the ambient temperature was lower than the temperature of the blowby gas as it exited the heat exchanger.

2.6.5. ***Slide #7:***



2.6.6. ***Intertek's Comments:***

2.6.6.1. The two San Antonio labs are currently under the hottest temperatures that any of the labs [probably] will encounter.

2.6.6.2. Intertek can see laboratory temperatures as low as 15C in the winter.

2.6.7. ***OHT's Comments:***

2.6.7.1. They will contact insulation vendors as a follow-up to the trials at Intertek and SWRI.

2.6.8. ***Comments by Lubrizol and Toyota:***

2.6.8.1. Both Lubrizol and Toyota stated that the foam should be used because it provides the simplest solution.

2.6.8.2. This issue can be revisited after the Precision Matrix if the foam is deemed to be inadequate.

2.7. What about the exposed Tygon hoses (Toyota)?

2.7.1. ***Intertek's Comments:***

2.7.1.1. These lines are not currently insulated.

2.7.1.2. The initial focus was on the oil separator because it is a large mass of aluminum.

2.7.1.3. The external blowby system could benefit from foam around the plumbing.

2.7.1.4. Keep in mind that the temperature of the rocker arm cover coolant is 19C, which is considerably cooler than the temperature of the blowby gas.

2.7.2. ***Lubrizol's Comments:***

2.7.2.1. It is easy to add foam to the heat exchanger and plumbing.

2.7.2.2. Lubrizol used foam insulation on its blowby heat exchanger last summer when the blowby temperature set-point was 24C.

2.7.2.3. This insulation was used to prevent frost from forming on the heat exchanger and dripping on the rocker arm cover.

2.7.3. ***Afton's Comments:***

2.7.3.1. The foam insulation will need to be removed each time the external blowby system is cleaned.
2.7.3.2. It will be easier to wrap several large pieces of foam around the entire system.

2.8. Haltermann Fuel Update:

2.8.1. The new sulfur specification for the KA24E fuel will affect the Sequence IVA and VIII tests.
2.8.2. The remaining [small-blend] batches of KA24E fuel at each of the labs can be used for Sequence IVA testing.
2.8.2.1. The labs can also use these fuel batches for IVB testing if they meet the new sulfur specification.
2.8.3. No future KA24E fuel batches will be "blend-to-order".
2.8.4. ***Toyota's Comments:***
2.8.4.1. The new sulfur specification will not affect the Sequence VIII because this engine has higher operating temperatures.
2.8.4.2. Intertek noted that they have not seen any severity shift with Sequence IVA or VIII test results when high sulfur fuel was used.

2.9. OHT Hardware Update:

2.9.1. Some chamfered intake camshafts have been sent to the labs.
2.9.2. Six oil pans have been modified with slotted pick-up tubes (a.k.a. Iteration #1).
2.9.3. The Iteration #2 oil pans will have displacement blocks.

2.10. Keyence Software Updates:

2.10.1. All the labs are now using the Generation-2 Keyence software.
2.10.2. SWRI recently hosted their Keyence representative for onsite training.
2.10.2.1. All the laboratories participated via conference call.
2.10.3. Intertek and Lubrizol have created a small dataset of measurements using various software settings.
2.10.3.1. The statisticians are reviewing this dataset now.
2.10.4. ***Metrology Workshop:***
2.10.4.1. The Metrology Workshop has been scheduled for August 15th.
2.10.4.2. The labs will need to make several key decisions regarding templates and software settings during this meeting.
2.10.5. ***Prove-Out Testing:***
2.10.5.1. Lubrizol and Intertek will collect prove-out measurements using both the new and the old software.
2.10.5.2. The biggest change in software settings will be with the end-of-test measurements.

2.11. Update on Procedure Review:

2.11.1. SWRI posted the latest draft to the TMC website yesterday.
2.11.2. The group will convene again next Thursday to continue reviewing the document.
2.11.3. Lubrizol reiterated that each lab will be expected to audit their own stands against the procedure once it is finalized.

2.12. Next Steps:

2.12.1. Two stands at each San Antonio lab will be assigned to the Precision Matrix.
2.12.2. One stand at Lubrizol, Afton and Exxon will be used for Industry testing.
2.12.3. The high-event lobe failure oil will only be run at the two San Antonio labs.

2.12.3.1. These labs will be limited in the information that they can release to the Industry regarding the results from this oil.

2.12.4. ***Intertek's Status:***

2.12.4.1. They have started their engine break-ins.

2.12.4.2. Their first test will start on Friday.

2.12.5. ***Lubrizol's Status:***

2.12.5.1. Lubrizol just installed its new engine.

2.12.5.2. Lubrizol is conducting a thorough procedural audit of its work instructions and test stand programming.

2.12.5.3. Engine break-in will start early next week.

2.12.6. ***SWRI's Status:***

2.12.6.1. SWRI started their engine break-in on Monday.

2.12.6.2. They are currently conducting internal stand audits.

2.13. Updated Timeline:

2.13.1. The timeline will need to be pushed back one week.

2.13.2. Buscher would still like to present to the AOAP at their September 14th meeting.

Action Items	Person responsible	Completion Date

Follow-up Notes/Updates	Initials	Date Added

Attendees	Organization	Contact Information

Sequence IV Surveillance Panel

Conference Call
August 8, 2017
8:30 a.m. - 10:30 a.m.

AGENDA

1. Previous action item review
2. Presentation on oil separator insulation trials
3. Haltermann KA24E Green fuel status:
4. Sequence IVB hardware status:
5. Keyence VR-3000 3D Measurement System software upgrade status:
    i. Update from labs
    ii. Update from metrology sub-group
6. Procedural review status:
    i. Update on availability of latest draft of test procedure and engine assembly manual
    ii. Update from Sequence IVB procedural review sub-group
7. Sequence IVB next steps
8. Sequence IVB timeline review
9. Motion and action item review
10. Next meeting
11. Adjourn