

Good morning everyone,

Please find the unconfirmed minutes below of the November 11th, 2015 meeting held by the Volvo T-13 Task Force and followed by the Mack Surveillance Panel, held at ExxonMobil Research & Engineering in Paulsboro, NJ.

Please feel free to let me know if there are any changes or revisions needed. Thanks.

Attendees:

Afton – Bob Campbell, Christian Porter

ExxonMobil – Mike Alessi, Riccardo Conti, Cliff Salvesen

Intertek – Jim Mortiz, Luiz Garcia, Juan Vega

Infineum – Bob Salgueiro (Secretary), Jim Gutzwiller (by Phone), Elisa Santos, Pat Fetterman (by Phone)

Lubrizol – Jim Matasic, Kevin O'Malley

Oronite – Jim Rutherford, Mark Cooper (Chairman)

SwRI – Jim McCord, Bob Warden

TEI – Mark Sutherland

TMC – Sean Moyer, Jeff Clark

Volvo/Mack – Greg Shank

Volvo T-13 Task Force Meeting

A unanimous e-mail vote ended the Volvo T-13 Task Force activities. Mike Alessi (ExxonMobil) thanked the task force members for their contributions during the development of the Volvo T-13 oxidation test. Greg Shank (Volvo) thanked Mike for his leadership of the Task force.

Mack Surveillance Panel Meeting

The Surveillance Panel meeting was called to order at 08:40 AM, by Mark Cooper, Chairman of the Surveillance Panel. The agenda topics are listed below, with discussions and actions following.

Membership/Attendance

- Cliff Salvesen of ExxonMobil joined the Mack Surveillance Panel.
- Ray Burns of ExxonMobil attended and requested to be added to the distribution list.
- Juan Vega of Intertek attended and requested to be added to the distribution list.

Incorporation of T-13 into the Mack Surveillance Panel

- ***Jim Moritz (Intertek) motioned to include Volvo T-13 into the Mack Surveillance Panel. The motion was seconded by Bob Campbell (Afton). By unanimous acceptance, the motion carried.***

Review and Update the scope and objectives of the Mack Surveillance Panel

- The Scope and Objectives were updated to include the Volvo T-13, Mack T-12a, PC-11A (CK-4) and PC-11B (FA-4).
- There was a discussion after which periodic round robins for used oil analysis (of Soot, KV100, KV40, FTIR Pk Oxidation) and parts measurements were added to the objectives.
- A copy of the revised Scope and Objectives are attached.
- ***Greg Shank (Volvo) motioned to accept the updated scope and objectives. The motion was seconded by Mike Alessi (ExxonMobil). By unanimous acceptance, the motion carried.***

Updating Implementation Rules for Industry Correction Factors

- Mark Cooper (Oronite) presented some proposed revised rules that he had developed with the TMC. A copy of the proposed rules are attached.
- The proposed rule revisions were discussed. For hardware changes that were found to impact test results such that a calibration test fails severe or mild, and afterwards ICFs are added, shouldn't those affected calibration tests retroactively have the ICF applied which would bring them into calibration status? Also proposed is a two week waiting period for everyone to understand the impact of the proposed ICF, but sometimes a two week waiting period may be too long or too short of a period. TMC suggested ensuring that there is consistency in the implementation of changing the status of calibration. Implementation delay of 2 weeks can be shortened or waived with a unanimous vote of the Surveillance Panel to allow for urgent implementation.

Review of Mack T-12 Correction Factors with Recent Reference Tests

- Jim Rutherford (Oronite) presented Mack T-12 LTMC20151104 New Pistons and ICF Review. The document is attached for reference.
- Five more reference tests have been added since the last review.
- Looking at Industry Correction Factors calculated including the 5 new tests, Lead would not change much, but Liner wear and TRWL would be affected. One high liner wear result was charted, but the stand was subsequently converted and will not be run as a T-12 any longer, so it was decided that it should not be included going forward. If that stand will not see candidates, then that point (high liner wear) should be removed. The higher oil consumption data point was run on the new piston skirts but what to do with that point will be decided after the discussion on piston skirts.
- Jim will recalculate the correction factors without the high liner wear test and they will be reviewed in the afternoon.
- Proposed Industry Correction Factors were reviewed: a new correction factor will be calculated using batch A and B Pistons only, and with LTMS 20151104 (CMIR109182 removed) (slide 6).
- Since the data set is only 4 new tests and is a small data set. The Surveillance Panel decided to wait until more reference tests were available.

Volvo T-13 Severity and Whether or Not to Adopt Correction Factors

- There was no presentation but Jim ran an analysis of the industry data live from his computer.
- FTIR Oxidation Peak Height was reviewed first. Oil PC-11A at Lab A which had a low Oxidation result had a higher oil gallery pressure than anything run in the matrix before or since. Bob Warden (SwRI) shared a graph of uncontrolled parameters with the Surveillance Panel and it appeared that the mild run, which was mild by 4 standard deviations, had higher oil pressure and different air handling characteristics than other runs. Bob Warden (SwRI) confirmed that the Analytical test results of a sample take from the oil drum matched previous PC-11A retains, confirming that the results were those of PC-11A. The Surveillance Panel agreed to review the operational data of the new tests to see if there was anything that might explain their results. Bob Campbell (Afton) asked what was the goal for the day. Jim Rutherford reiterated that the Surveillance Panel should discuss the various ways to address the differences between T-13 results run under Torque Control (TC) and those run under Fuel Flow Control (FFC). It was suggested that the panel be sure they are not missing anything in the controlled operational data before we think about applying an industry correction factor.
- Jim Gutzwiller (Infineum) noted how PC-11K and PC-11A had the same reported oil pressure but one is a SAE 10W-30 and one is a SAE 15W-40. During the Matrix there was a significant

variation in oil mist separator speed and oil gallery pressure. Checking Kinematic Viscosity at 100 deg C would verify if the right viscosity oil was run in the T-13. Oil analyticals confirmed the oils identities. The SP needed to decide whether or not to include the latest PC-11A results as they are very different than expected and the SP needed to understand why.

- The SP listed the steps that need to be completed:
 - Is there a severity shift and is it being moved by Torque Control vs Fuel Flow Control or something operationally that we've missed?
 - Consider if we should reset the Targets for TMC-823?
 - Consider PC-11 VGRA Matrix Results?
- When the Surveillance Panel considered the initial move from Torque Control to Fuel Flow Control the difference was so minute, that it should not be resulting in significant differences observed. Viewing a chart prepared by Kevin O'Malley (Lubrizol) which compared IR Peak Height and KV40 for TC vs FFC by Lab, doesn't seem to show a clear directionality of a severity shift. Not every oil responded the same way across all labs.
- Do we instead just need to update targets on TMC-823? Not all Labs have run TMC-823 yet. Elisa Santos (Infineum) did see a small difference when modeling PC-11A TC vs FFC data for Oxidation, but this difference is not seen KV40 nor is it seen looking at all the other matrix oils which were run under both TC and FFC.
- Bob Campbell (Afton) felt there was no difference in control modes and that the panel should consider setting new targets for TMC-823 instead. Then, discuss what do we do with test 111339-T13? Bob proposed to use the 5 results on TMC-823 to set new targets for TMC-823. Was the observed correlation only because of the 1 very mild VGRA test result on PC-11A, since the other oils going different directions between TC and FFC?
- The Surveillance Panel asked the statisticians to look at possible new targets for TMC-823. The surveillance Panel will then review the proposed targets for TMC-823. Jim Rutherford (Oronite) fit a model that had 5 Labs, 4 oils, from FFC and generated targets for the all the oils. The new targets calculated were based on fuel flow only.
- ***Jim Matasic (Lubrizol) motioned that the Mack Surveillance Panel accept the proposed targets for TMC-823, which after applying the two week waiting period, would have an implementation date of Nov 25th, 2015 and implementation would only apply to updating charts. The Motion was seconded by Greg Shank (Volvo).***
 - ***TMC-823 - FTIR Oxidation Peak Height Target 132.0 cm⁻¹ STDEV 9.0***
 - ***TMC-823 - Sqrt KV40 Inc: Target 8.963 % STDEV 0.725***
- Then, there was discussion around whether or not to include the latest two PC-11A tests on FFC. Jim Rutherford repeated the analysis using the two FFC results on PC-11A but the targets did not change significantly for oxidation or KV40. Recalculated Targets and Stdev with PC-11A FFC results in the model but not assuming PC-11A and TMC-823 are the same gave the following targets:
 - TMC-823 - FTIR Oxidation Peak Height Target 132.2 cm⁻¹ STDEV 9.6
 - TMC-823 - Sqrt KV40 Inc: Target 8.982 % STDEV 0.819
- ***Jim Matasic (Lubrizol) asked that his motion be modified to include test latest PC-11A Fuel Flow Control results and Greg Shank (Volvo) seconded the change.***
- The panel continued with further discussion continued. An alternative approach was to re-run the model assuming PC-11A and TMC-823 are the same. Not all oils showed the shift from TC to FFC. On average all the oils showed a similar "overall directionality" but some individual results went in different directions depending on lab. The T-13 pass/fail limits were based on both torque control and fuel flow control data. Precision was the desired target of improvement,

which was achieved by the switch from TC to FFC, so if the test is slightly milder than before that should not influence the limits as balloted. TMC-823 targets need to be set going forward. If PC-11A tests are to be judged, wouldn't we use the same targets as TMC-823 because everything we have seems to suggest they are the same? Unless there's a technical reason to eliminate the two newest PC-11A results, then they should be included in the TMC-823 calculations.

Jim Rutherford then proceeded to recalculate the targets and Stdev with PC-11A FFC results in the model assuming PC-11A and TMC-823 are the same:

- TMC-823 - FTIR Oxidation Peak Height Target 127.4 cm⁻¹ STDEV 11.1
- TMC-823 - Sqrt KV40 Inc: Target 8.610 % STDEV 0.929

- ***Jim Matasic (Lubrizol) proposed his motion be further updated to reflect the new TMC-823 targets calculated assuming TMC-823 = PC-11A. Greg Shank (Volvo) seconded the change. The final motion after all changes was as follows:***

Jim Matasic (Lubrizol) motions that the Mack Surveillance Panel accept the proposed targets for TMC-823, which after applying the two week waiting period, would have an implementation date of Nov 25th, 2015 and implementation would only apply to updating charts. The Motion was seconded by Greg Shank (Volvo).

- TMC-823 - FTIR Oxidation Peak Height Target 127.4 cm⁻¹ STDEV 11.1
- TMC-823 - Sqrt KV40 Inc: Target 8.610 % STDEV 0.929

The motion carried with 8 Approves, 1 Waive (TMC) and no Objections.

Surveillance Panel Review of Operational Data for T-13 VGRA PC-11A Results

- Throttle position from Lab A has less resolution than Lab G. Coolant in temperature was tight and consistent. For Oil Sump temperature, Lab G lost their thermocouple signal. Dew Point was reported for Lab G but not for Lab A. Intercooler out temperature was directionally lower for Lab G than Lab A. Compressor out temperature was a little lower for Lab G than Lab A. Room Temperature was recorded and very similar between Lab G and A. Directionally, Humidity seemed to impact test results, so each lab should be measuring Dew Point. Blow-by was very consistent between the two labs. Intake manifold pressure was similar between these two labs.
- Nothing appeared clearly abnormal in a comparison of the operational data between these two results, at this point, there was no reason to exclude either result.

TEI Volvo/Mack CPD Report

- Piston Crowns batch "C" went into kits after kit #181987 and "D" batch crowns are on order but manufacturer is indicating a delay in supply.
- T-11/T-12 Batch "P" main bearings going into kits after kit #182107 have a rejection rate of 75% based on damaged backs and scratches and nicks
- T-11/T-12 Injector Lines is such a low volume, no supplier want to pickup supply of new ones
- Volvo/Mack Reman is down to 53 blocks. Reman wants to sell 7/8 basic engines not blocks. 7/8 basic engines are about \$20K more than bare blocks. Once the supply of these engines is exhausted there are not more available.
- T-11/T-12 1000 Piston Skirts arrived in March 2015, manufactured in 1 batch by Federal-Mogul, and have a 50% rejection rate for small pits, nicks and/or scratches. TEI agreed to measure the parts but need to know what to measure.
- T-12/T-13 Stained Rings – Oronite studied the rings, Volvo/Mack says the rings are OK to use. Mark Cooper (Oronite) will forward the analysis to the Surveillance Panel.

- T-13 Rod Bearings show wide range of rod bearing surface finishes. Currently screening out the rough ones with 50% rejection rate. TEI has 991 “bad” sets out of 3000 from the original order. Another batch will need to be placed soon.
- T-13 Thrust Washers are begin rejected at 50% for nicks, dings, or scratches because the packing is not tight allowing the stacked thrust washers to move around in packaging
- T-13 Oil Rings should not have the Red Dot as they are the wrong model year and should not be used. Bob Campbell asked if it was possible that the test labs may be receiving piston oil rings that are mis-marked.
- T-13 Piston oil hole chamfer – two different piston oil holes. Greg will ask Chris Cauley (Volvo) to look into it.
- Volvo/Mack Kit Parts Inventory – There were no parts availability issues currently.

Mack T-11/T-12 Piston Skirt Failures Discussion

- There appears to be a possible dimensional issue with the skirts that is causing them to rub against the liner.
- As a stop gap action the Surveillance Panel had previously passed a Motion allowing labs to reuse piston skirts until the root cause could be identified.
- Juan Vega (Intertek) presented an analysis of new and old skirts they had, measuring the piston skirts in 3 locations which is attached.
 - Although the data set included pistons that rubbed and/or had high oil consumption but there was not clear indicator as to cause.
- Although some pistons have internal voids which were observed by SwRI after doing CT scans on pistons, analysis of an Intertek piston which was starting to crack, was cracking in an area nowhere near the void.
- SwRI said that some of the pistons they received are too big based on the print spec plus the allowable tolerance.
- Pistons skirts measured at the top with a measurement greater than 4.859 in (123.418 mm) have signs of rubbing.
- Afton’s analysis showed pin bores were off by 3 degrees. Lubrizol confirmed that getting pins in these new skirts is more difficult than previously. The skirt analysis also showed that the skirt was skewed/asymmetrical to the top.
- Rubbing is being observed on the thrust side.
- 5119M is the part number TEI orders
- Federal Mogul part number P5634 is stamped on the piston skirts it is possible the wrong ones are being sent (production vs test specific)
- Need to verify if the prints are different. TEI will ask Federal-Mogul.
- The Labs will send their data on the piston skirts to TEI.

Mack T-12 Injection Timing

- Afton noticed that the injection timing is different today then several years ago. They have to run much more retarded injection timing to achieve the targeted soot levels vs timing used in the past. It was speculated that possibly the new cylinder heads may be different in flow characteristics than the old ones. Possibly, high swirl flow heads relative to the low swirl heads. It was noted by the panel but no further action was taken at this time.

D4485 Ballot Tiered Limits for T-13

- T-13 outlier provision was not included in the ballot.

- Oronite will include in their Ballot comments that that in Table A5.1 Outlier Test Determination Values, the T-13 needs to be added.

Valve Issues in the T-13

- Lubrizol has experienced a valve breaking in the T-13. Volvo acknowledged it was a field issue. SwRI also confirmed they've seen the issue as well. Intertek reported that they had received valve springs that were very rusty. Afton confirmed they too had received rusty valve springs which they reject and ship back.

New T-12 Rod Bearings

- SwRI is running the new batch of T-12 Main bearings on a Reference test.
- Do we need to coordinate references? At least none of the labs should run a reference on the old rod and main bearings. Connecting Rod bearings are "Y" batch and Main Bearings a "P" batch. Should the panel run their next references on these parts? TMC suggested a call early next week (Tuesday Nov 17th, 2015) to decide on how to bring these new batches in. Labs should bring in how much of the old bearing qualities they still have in stock.