

**HEAVY-DUTY ENGINE OIL CLASSIFICATION PANEL**  
OF  
ASTM D02.B0.02  
October 27, 2005  
Southwest Research Institute – San Antonio, TX

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**ACTION ITEMS**

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| <b>1. Publish monthly test registration report.</b>   | <b>ACC/RSI</b>                 |
| <b>2. Analyze FTIR Peak Height Round Robin values.</b>                                      | <b>FTIR Task Force</b>         |
| <b>3. Analyze ISB data for 100 hour sample viscosity and calculate 2 and 3 test limits.</b> | <b>Phil Scinto</b>             |
| <b>4. Final decision on C13 parameters and finish analysis.</b>                             | <b>Abdul Cassim and C13 SP</b> |
| <b>5. Issue revised ISM limits for PC-10 in time for November conference call.</b>          | <b>Cummins</b>                 |
| <b>6. Issue T-12 and ISB exit criteria ballots.</b>   | <b>Jim Mc Geehan</b>           |
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**MINUTES**

- 1.0 Call to order
  - 1.1 The Heavy Duty Engine Oil Classification Panel (HDEOCP) was called to order by Chairman Jim McGeehan at 8:30 a.m. on Thursday, October 27, 2005, in Building 209 at Southwest Research Institute.
  - 1.2 There were 19 members present and 27 guests present. The attendance list is shown as Attachment 2.
  
- 2.0 Agenda
  - 2.1 The agenda is included as Attachment 1. There were no changes to the agenda.
  
- 3.0 Minutes
  - 3.1 The minutes from October 12, 2005 were approved with no changes.
  
- 4.0 Membership
  - 4.1 Steve Goodier replaces Mike Lynskey for BP.
  - 4.2 Chairman McGeehan suggests that the HDEOCP vote first at the meeting in January before the NCDT meeting. The NCDT membership does not include ACC membership. The HDEOCP must approve all tests and limits before the NCDT votes to accept the outcome of the HDEOCP vote.
  - 4.3 The T-10 to T-9 ballot has been approved. The T-10 to T-6 vote is on the Subcommittee B ballot to be completed before the December meeting.
  
- 5.0 NCDT Report

- 5.1 The membership list of the NCDT was shown. See Attachment 3. The voting rules desire a consensus result. If that is not achievable, then the membership structure comes into play. There are 3 EMA members and 3 API members.
- 5.2 The NCDT conducted a conference call to discuss the request to include the CAT 1P in PC-10. See Attachment 4. There was not consensus, so the voting rules were followed and the vote was to accept the CAT 1N, 1P and C13 in the category. Concerns about the timeline were noted. This is where it became apparent that the ACC is not represented on the NCDT. There are 3 pistons deposit tests and 3 valve train wear tests in PC-10. The total number of tests for PC-10 is: 10 fired engine tests and 6 bench tests.
- 5.3 The NCDT timeline still shows January 2007 for first license. See Attachment 5. A breakthrough is needed to meet the timeline. The demonstration period is over when limits are set. The HDEOCP recommends the category to the NCDT which then sends it to the API. There has been little activity of pre-registered testing. The EMA wants to monitor the amount of demonstration testing. Some test work may be going on without pre-registration. Once the tests are declared ready, then more testing may happen. The expectation was that the tests would have been declared ready. RSI does supply a monthly report of the number of registered tests. That report will be published. The demonstration period is still 4 months beginning September 23, 2005. First license is still December 27, 2006.

#### 6.0 Matrix Status

- 6.1 John Zalar presented a summary of the matrix costs. See Attachment 6. The matrix included 8 lost tests at an estimated cost of \$279,000. The total cost of the PC-10 matrix is estimated to be \$5,532,000. These are just the direct testing costs.

#### 7.0 Mack T-12/T-11

- 7.1 Jim Rutherford presented the statisticians consensus analysis of the T-12 matrix. See Attachment 7. There are a few tiny issues to resolve, but the analyses are complete enough to present as finished. The first step was to look for cylinder outliers and to see if there are any profiles of wear biased by cylinder location. Cylinder 1 usually has higher wear. Profiles were found for Top Ring Weight Loss (TRWL) and Cylinder Liner Wear (CLW), but not Bearing Weight Loss (BWL). All the details of the analysis are contained in the attached icons in the original PowerPoint only (available separately). The data were modeled 3 ways; all the tests in a full model (26 tests), the tests on new rings only (19 tests) and the reduced model without stand within lab as an effect (19 tests). The significant effects for oil are CLW, Oil Consumption (OC), and Delta DIR from 250 hours to 300 hours (DIR250300). There is a significant effect for lab on CLW. With transformed parameters, the Ep is calculated around the Mack Merit values proposed at the time. The lead parameters are slightly less than 1, the CLW is well over 1. TRWL is the most challenged Ep at 0.50. OC is well over 1. Targets for reference oil acceptance are still needed. Two extreme ways to decide targets are: Least Square (LS) means and arithmetic means. The Root Mean Square Error (RMSE) from the model match pretty well with the arithmetic standard deviation except for liner wear due to the lab effect. There doesn't seem to be redundant parameters, but there is not ACC consensus yet.
- 7.2 Greg Shank presented a T-12 update. See Attachment 8. The T-12 Task Force met Wednesday, October 26, 2005. The task force voted that the T-12 is ready for inclusion in PC-10 and that the low SAP oil, PC-10E, be the reference oil for the T-12. There is an Operations and Hardware (O&H) level meeting scheduled for November 16, 2005 to investigate lab differences and try to tighten operations. Mack has updated the merit proposal. The weighting factors stayed the same, but the maximum, anchor points and minimum values have changed. More merit points are available for being better than the anchor and less merit points are available for being worse than the anchor. The TRWL precision is not too good, so the maximum and minimum parameters were relaxed some using 2 standard deviations. Mack Merit values using correlated BWL were also shown. These will not likely be used. The matrix results were calculated for merits using both

methods. Volvo would like to stay with lead and not use bearing weight loss. Bearing weight loss does not capture any other corrosion or source of lead. The minimum total merit value for a pass would be 1000. There is some dissatisfaction with FTIR area Method 5, so FTIR peak height value is being considered in its place. The existing round robin data will be investigated for FTIR peak height repeatability. FTIR area is off the table for the T-12, but peak height is not. Greg Shank **motioned** that these proposed merit limits be sent out for exit ballot. Bill Kleiser seconded. FTIR is not on this exit ballot, but is still being considered. If FTIR is desired, a separate exit ballot would be issued. The proposed reference oil passes 50% of the time and fails 50% of the time, so it is a borderline oil. The **motion passed** unanimously with 19 votes for, 0 against and 0 waives.

7.3 The T-11 limits and slope item on the agenda will be discussed at a later date.

## 8.0 Cummins ISB

8.1 Phil Scinto presented the ISB analysis. See Attachment **9**. This analysis is “mostly official”, there are minor decimal differences to resolve, but the conclusions are complete. The analysis included 17 valid tests; 15 matrix tests and 2 tests on stands outside the matrix. The parameters analyzed are: Average Tappet Weight Loss (ATWL), Average Camshaft Wear (ACSW), and Average Crosshead Weight Loss (ACHWL). Outlier screening was used and there are no wear profiles in the ISB. Currently, there are soot corrections for ATWL and ACHWL. Cam shaft wear may possibly be corrected for stage B average torque. The reported torque is a snapshot of the torque during the 6 second long step of the cycle. There are no transformations needed at these wear levels. All 3 wear parameters meet the ACC precision requirements, except ATWL between stand and labs. The models have somewhat confounding parameters: stand, stage B average torque and soot. Some feel that correcting for an operational parameter (torque) is not ideal. If the stand differences are real and they can't be fixed, then more references may be necessary. The Surveillance Panel is not favoring running more references. The referencing rules for the ISB test are 12 candidate tests or 12 months for the first 2 reference periods, then 12 tests or 18 months after that. The table of Ep values shows acceptable values except the ATWL reproducibility between stand and labs. Within a stand, the repeatability is good. In most cases, the LS means and arithmetic means are close to each other. ATWL is a function of lab, stand within lab, oil, and average soot. ACSW is a function of lab, stand within lab, and oil. The stand within lab effect is eliminated if the ACSW is corrected for stage B average torque. ACHWL is a rate and report parameter and is a function of lab, oil, and average soot.

8.2 Dave Stehouwer presented the Cummins report on pass/fail limits. See Attachment **10**. PC-10E was proposed and rejected as the reference oil, because it didn't show much sensitivity. An oil that shows more sensitivity would be a better choice, but the oil has not been selected yet. Cummins is proposing a 75 mg pass limit for ATWL. For ACSW in the field, Cummins has used in internal rating method and has some Adcole cam wear results data. Using limited data from the matrix on Adcole and Mitutoyo, the service limit correlates to a 30 µm pass limit for cam wear. The labs are to send the matrix cams to Cummins for the visual rating and get all the Adcole data together so a better correlation can be developed. Since some T-11 to ISB data is coming in, but not complete yet, Cummins is proposing a placeholder viscosity limit of stay in grade at the 100 hour soot window level of 3.0% to 3.5% soot. The matrix data was not analyzed for that yet, but will need to be. Dave Stehouwer **motioned** that an exit criteria ballot be issued for the ISB test with the proposed limits. Bill Kleiser seconded. The viscosity analysis will be performed and should be complete in time for the exit criteria ballot. The ballot will include the analysis. The viscosity result should be soot adjusted back to 3.0%. The **motion passed** unanimously with 19 votes for, 0 against and 0 waives.

## 9.0 Caterpillar C13

9.1 Abdul Cassim presented his C13 summary. See Attachment **11**. There is no correlation between oil consumption and piston deposits. Base oil effects by parameter and technology show Group III effects. The Ep values are all greater than 0.6 with Top Land carbon (TLC) and Top Land Heavy Carbon (TLHC) greater than 1. The C13 Surveillance Panel met Tuesday, October 25, 2005. The C13 data analysis is almost complete. Further data review was requested. The Surveillance Panel agreed on 5 pass/fail parameters including oil consumption. The Surveillance Panel is waiting on CAT's choice of lower piston deposit parameter(s) instead of Unweighted Demerits (UWD). That action is to be complete by November 4, 2005. There have been reports of lower piston deposit concerns on the C13, this shows that a parameter is possible there. There is a desire to ensure that upper and lower deposits behave independently. The possible parameters are no piston, ring, or liner scuffing and no hot stuck rings. The scuffing requirement will be a non-interpretable parameter. The additional parameters are: no loss of oil consumption control, no unacceptable piston deposits in the form of excessive TLC, Top Groove Carbon (TGC) and a parameter farther down the piston such as 2<sup>nd</sup> groove deposits. The schedule is to identify the lower piston parameters by November 2, 2005 and complete outlier screening methods for an LTMS by November 5, 2005. A pass/fail limits proposal based on the new parameter and reference oil selection are still needed. The originally proposed limits need to be updated. There are stand and lab differences, but no corrections yet. Some differences have been observed in the operational data and stand set-up. Those are being resolved. The issuance of an exit criteria ballot needs to happen before the December meeting. Once the Surveillance Panel and CAT resolve the parameters and issue limits, then the HDEOCP will have a teleconference to review so that an exit criteria ballot can be issued before the December 6th meeting.

#### 10.0 ACC Report

10.1 Joan Evans presented the ACC timing report. See Attachment **12**. Using an assumption of ten C13 stands and one month per test, 10 tests per month will be available. The ACC thinks that a best case scenario of 36 passing tests are needed if full BOI/VGRA guidelines are granted that roll over from the CAT 1R to the C13 by 01/01/2006. This would take seven to twelve months to complete. The BOI task force has investigated the use of boundaries for base oil parameters to improve the read across methods. The middle case scenario requires 73 passes if only C13 BOI guidelines are granted and would take 15 to 24 months to complete. The worst case is 223 passes without any BOI/VGRA guidelines and would take 4 to 6 years to complete. Proposed solutions will be handled through the BOI/VGRA task force. If full guidelines are granted, then December 26<sup>th</sup> is possible. This is very dependant on pass/fail limits and pass/fail rates.

#### 11.0 Cummins ISM

11.1 The Cummins ISM exit criteria ballot returns show 9 negatives and 10 affirmatives. See Attachment **13**. Some concerns are listed. The limits are set too far from 830-2 performance. Could not find evidence of discrimination data on Top Ring Weight Loss (TRWL). Did not know there would be a performance improvement need. Since it was a designed experiment, the precision is known and the merit SYSTEM has values too close together that don't seem to be statistically based. Thought limits would be closer to 830 for backward compatibility. Test redundancy. Other limits need to be known too. Redundant wear tests. The ISB has better wear separation than the ISM. This is a step change in severity, thought that the severity would be the same. Would like to see more data on the TRWL since it has been added back. ISM was introduced as a replacement test to the M11EGR. Had it been brought in as a new test, many more tests would have been run and more data would have been available for the other parameters. New limits would fail 830-2 40% of the time, when it is supposed to be a passing oil. With the amount of variability of TRWL and Injector Adjusting Screw Weight Loss (IASWL) and the fail safe idea of sludge and Oil Filter Plugging (OFDP), then merits aren't needed. Use straight limits with tiered

limits for multiple tests instead. Proposed limits are a substantial upgrade when originally proposed as a replacement test. Supposed to be a CI-4 replacement at CI-4 limits.

- 11.2 The Cummins response is included as Attachment **14**. Cummins has stated that the ISM would have its own limit in PC-10. The PC-10 performance should be based on 830-2 and not on correlation with M11EGR. A 7.5 mg CHWL maximum limit will not be acceptable to Cummins. New data has expanded the 830 data set, so Cummins will look again. Backward compatibility refers to use of high sulfur fuel and its impact on wear, filter plugging and TBN retention. It does not mean the same limits. Cummins will accept staying with traditional limits and not using a merit system. Cummins will issue a revision for the November conference call. Cummins to review merit values anyway and may adjust the merit maximums based on statistics of the test so that if a result takes off it won't be a fail.
- 12.0 Review of all tests in PC-10
  - 12.1 Chairman McGeehan stated that there are 10 engine tests and 6 bench tests to approve a fluid for PC-10. Charlie Passut **motioned** that the 1P be allowed as an alternative to a 1R at CH-4 limits for CI-4. Abdul Cassim seconded. The **motion carried** with 17 votes for, 0 votes against, and 2 waives.
- 13.0 Other Business
  - 13.1 ILMA representative Larry Kuntschik expressed concern that the timeline is too short for the independents. If ACC is comfortable, than ILMA is comfortable. If ACC is concerned, then ILMA is concerned.
  - 13.2 Two and three test pass limits for the ISB are needed on the exit ballot.
  - 13.3 The EMA position is still that this must be complete with oils available by October 2006.
- 14.0 Next meetings
  - 14.1 Conference call week of November 14<sup>th</sup>.
  - 14.2 December 5<sup>th</sup> and 6<sup>th</sup>
  - 14.3 Week of January 23<sup>rd</sup>.
- 15.0 The meeting was adjourned at 11:45 am.