

March 26, 2001

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ASTM Mack T-10 Task Force members and guests,

Here are the unconfirmed minutes of the March 22, 2001 meeting of the Mack T-10 Task Force in San Antonio, TX.
Please contact me regarding any questions or corrections to these minutes.

Regards,

Pat Fetterman

**UNCONFIRMED MINUTES IF THE
ASTM MACK T-10 TASK FORCE MEETING
SAN ANTONIO, TX
MARCH 22, 2001**

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Action Items

- 0.1** Joe Franklin and Scott Richards are to confer and establish the correct units for reporting oxidation results.
- 0.2** Joe Franklin is to contact the TMC for assistance in developing a precision statement for the Integrated I.R. oxidation techniques.
- 0.3** Joe Franklin is to keep the Chemicals subgroup active to develop a T-10 specific method for measuring TAN in used oil samples.
- 0.4** Jeff Clark is to remove all oil consumption data from the TMC website until a standardized method of reporting the data is developed.
- 0.5** Ken Goshorn recommended that all labs should standardize on Dow-Corning 732 Black silicone as the sealer to use when required.
- 0.6** Jeff Clark is to send averaged operational data for all runs to Jim Rutherford for statistical analysis of test results versus variations in operational parameters.
- 0.7** All labs with the capability are requested to measure exhaust gas NO_x during phase 2 operation along with the current CO₂ measurements.
- 0.8** All labs are to submit piston deposit data to Jeff Clark for posting. This will facilitate analysis of deposit data as a potential back-up for the IQ test.
- 0.9** Wim Van Dam is to send reference bore polish liners along with their outline traces to both PerkinElmer (first) and SwRI to allow raters a chance to calibrate themselves against European raters.

1. Call to Order/ Chairman's Comments/ Membership/ Attendance

The meeting was called to order at 9:00 am by the Chairman, Wim Van Dam. He reviewed a revised agenda which is similar to the agenda shown in attachment 1. (Final agenda not available, but topics are the same, only the order differs slightly) Wim encouraged the group to keep to a logical and focused progression in our analysis of the test data. Jim Moritz replaces Jim Collum as the Task Force member from PerkinElmer. Pat Fetterman circulated a corrected Membership/ Attendance list. The attendance list is shown in attachment 2.

2. Approval of Minutes From Previous Meetings

The minutes of the February 12 teleconference were approved as issued. Due to the late availability of the Minutes of the December 4, 2000 Task Force meeting, the approval of those minutes was delayed until old business.

3. Report from Chemicals Subgroup

Joe Franklin reported for the Chemicals Subgroup which he chairs. His presentation is shown in attachment 3. Joe reported that the group has completed a round robin test to evaluate five methods of evaluating the oxidation I.R. traces from the Mack T-10. These data have been reviewed with both the T-10 Task Force and the HDEOCP. The group has recommended that methods two and five should be used to evaluate the results from the T-10 matrix tests.

A draft test procedure has been issued, and a final draft is anticipated by March 30, 2001.

A discussion ensued covering some of the data and results thus far, a question as to how we select the final method, and whether or not everyone is capable of running the evaluation correctly. Scott Richards of SwRI was asked to add the evaluation of oxidation results to the "referee" used oil analysis work he is already performing.

There was a brief debate regarding how precision should be measured and pass/fail limits established.

Action items 1,2 and 3 stem from this report.

4. Review and Discussion of Matrix Test Results

Greg Shank reported on the Matrix results to date. His report is shown in attachment 4.

Although they have not all been verified and posted to the TMC website, eleven T-10 tests have completed and five more are running. Seven of these tests have completed on oil A, the featured oil for the T-10 test. Greg's analysis concentrated on just these seven tests. Of these seven tests, five appear similar, one appears low, and one appears high with respect to liner wear. Wim Van Dam suggested that we should concentrate on the "outliers" to see if we can identify operational variables leading to the differences.

An analysis of soot versus liner wear showed no correlation.

Looking at ring weight loss, Greg observed that the one very high result was accompanied by high silicon and high aluminum in the used oil. Ken Goshorn observed that the wear appears to be on the ring face rather than the flanks. There followed a discussion as to cause and effect over the silicon and ring weight loss which was not resolved.

Greg observed that there seem to be three groups of used oil lead values, with three tests around 34 ppm, two around 22 ppm, and two around 12 ppm. Unlike the T-9, rod bearing weight loss does not appear to correlate with used oil lead.

A discussion of the significant spread in oil consumption data revealed that the labs were not all using the same method to calculate consumption. Action item 4 addresses this concern.

Scott Richards presented the SwRI analysis of the used oil from the various tests, and he confirmed the high silicon and aluminum results for the test with high ring weight loss. This led to a discussion to standardize the silicone sealer material among all test sites. Action item 5 addresses this concern.

Scott continued the used oil analysis with the following points:

-Copper shows significant variability and is roughly counter to lead i.e. high copper/low lead and vice versa. The source of copper was questioned as possible oil coolers or wrist pin bushings.

-Iron is fairly similar for all tests.

-Soot is fairly similar for all tests

-TBN loss is fairly similar for all tests.

-Peak oxidation numbers are similar for three tests and lower for two tests.

-Integrated I.R. technique 2 is similar for four tests and different for one test.

-Integrated I.R. technique 5 shows significant differences for all tests.

-Lead versus EOT TBN has an r-squared of 0.02.

-Lead versus peak I.R. has an r-squared of 0.59.

-Lead versus I.R. technique 2 has an r-squared of 0.5.

-Lead versus I.R. technique 5 has an r-squared of 0.94.

Greg questioned why we are seeing differences in oxidation...it's almost like there are three different operating conditions. Are there differences in temperature or EGR rates?

Wim suggested that we should tabulate each of the tests individually and list any issues and possible explanations for these issues.

5. Report of Operations and Hardware Subgroup

Jeff Clark distributed copies of the six minute operational data plots from key parameters for all of the tests. Jeff also posted these plots on the TMC website. Due to the size of these data files, they are not included as attachments to the minutes. Jeff had to leave the meeting early, so the review of the operational data was handled by Scott Richards and Greg Shank.

Scott noted that the operational data shows some variation in Venturi temperature across all of the runs. Intake CO₂ levels are reasonably consistent for stage one, but show quite a bit of variability in stage two. This was followed by a discussion regarding both the location and type of probe to be used as well as the correct span gasses. Consensus was that the T-10 should use the same gasses as the M11-EGR test.

Exhaust CO₂ was noted as somewhat better behaved than intake, and there were several correlation plots of Venturi temperature versus CO₂, Venturi temperature versus throttle by-pass voltage, and intake CO₂ versus throttle by-pass voltage.

Bob Campbell noted that he was seeing differences in sensor output varying with inlet air humidity/dew point. This led to an unanswered question from Scott Richards as to whether we need to re-evaluate the sensor selection.

Wim drew the group back to a test by test analysis of the data and issues which are detailed here:

SwRI test 1-

Observations

- High oxidation by method 5 during first 75 hours.
- Relatively high iron.

Possible explanations

- Check oxidation measurements.

SwRI test 2-

Observations

- Low copper.

Possible explanations

- None identified.

ExxonMobil Test 1-

Observations

- High lead and iron.
- Low copper.
- Retarded timing during first 75 hours.
- High oxidation by method 5.
- High oil consumption.

Possible explanations

- Broken oil control ring (check to see if there is deposit formation on the break surface)
- Check Exhaust Gas Temperature and delta temperature over coolers.

ExxonMobil test 2-

Observations

- High liner wear with normal soot.
- High lead.
- High oil consumption.

Possible explanations

- One cylinder had higher than typical valve deposits.
- Check build-up sheet.
- Piece of stainless steel broken from EGR crossover pipe. (Pictures included in attachment 5)
- Check venturi for indications of damage from the piece of spalled pipe.
- Check turbo turbine blades for damage.
- Check liners for signs of abrasive wear or debris plowing.
- Check piston tops for damage.

PerkinElmer

Observations

- High lead and iron
- High oxidation by both method 2 and method 5.
- Retarded timing during first 75 hours.

Possible explanations

- Low CO2 in phase two, check CO2 in current test.
- Revisit oxidation method 2 results.
- Possibly had leaks, crack in exhaust manifold.
- Evaluate exhaust gas temperature and delta temperature over EGR coolers.
- CO2 calibration might solve the problem. Standardize to having flow through the chamber from the 1/8 inch inlet to the 1/4 inch outlet.

Ethyl

Observations

- Spike in copper at 150 hours.
- Slow down in lead accumulation rate at 150 hours.
- Low iron.
- Low oxidation peak.

Possible explanations

- High CO2- High EGR? Lower combustion temperature? Need to evaluate exhaust gas temperature.
- Shut down at 150 hours?
- Look at CO2 before and after 150 hours.
- Inspect bearings and bushings.
- Look at delta temperature over EGR coolers.

Lubrizol

Observations

- Low liner wear with high ring weight loss.
- High soot, 6.6%.
- High silicon and aluminum.
- Low lead.
- Low oxidation peak.
- Low oil consumption.
- High break-in copper and lead.

Possible explanations

- Injectors not working properly at EOT.
- High silicon from silicone sealant?
- Possible debris entering engine early in test? Rubbing pipes? Condensing in intake manifold? Check humidity.
- Check ring and liner surfaces in SEM to look for debris.
- Evaluate exhaust gas temperature and delta temperature over EGR coolers.

Additional data and analyses were suggested to help with the understanding of the tests. Action items 6 and 7 address these issues.

Wim noted that Jim Collum had vacated the job of Chairman, and he queried whether we need to replace him. The consensus of the Task Force was that there is no need for an O&H subgroup, and the Chairman's position does not need to be filled.

Ron Buck gave a verbal report from TEI with no handout. TEI has a new supply of small turbos, and there should be no shortages of any components for the T-10 test.

Ken Goshorn noted that the new engine at PerkinElmer needs to be retro-fitted with high pressure injectors. He also noted that there is a potential issue with the crosshead design, but the group expressed a desire to continue running with the "old" design and use service parts for the duration of the test.

TEI will look at changing the EGR cooler mounting arrangement to reduce cracking.

Ken and Greg noted that there will be changes in both the main bearing clearance and the design of the oil pump for future engines. The group elected to use the new design main bearings, but to ask TEI to determine the correct number and stockpile the current design oil pumps to use for the foreseeable future. TEI agreed to survey the labs for needs.

6. Scope and Objectives

Wim Van Dam reviewed the scope and objectives and noted that there is no change since our last meeting. We continue to be involved in item six, Monitor PC-9 Precision and BOI Matrix execution. Wim also noted that we should plan to review piston deposit data at our next meeting. Greg Shank interjected that all sites should submit piston deposit data to Jeff Clark for posting, as the T-10 piston deposit data could provide a back-up for the 1Q test in PC-9, should that test continue to have development problems. (Action item 8)

Wim also noted that we have not taken any action to look at bore polish in the T-10 liners. There was a brief discussion about the need for rater training, and action item 9 addresses the outcome of these discussions.

7. Old Business

The minutes of the December 4, 2000 T-10 Task Force meeting were approved as issued.

8. New Business/ A.O.B.

None

9. Next Meeting

The next meeting will be at the call of the Chairman, sometime after the five tests which are currently running have completed. Tentative timing is planned for either the week of April 16 or April 23, 2001. Jim Wells of SwRI graciously offered to, once again, host the meeting.

There being no further business, the meeting was adjourned at 2:52 pm by Chairman Van Dam.

Mack T-10 Task Force

**Revised Meeting Agenda
Thursday, March 22, 2001 9:00 am to Noon
SwRI, Large Conference Room Bldg. 138**

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|---|-----------------------------------|
| 1) Chairman's Comments and Membership | Wim Van Dam/ Pat Fetterman |
| 2) Approval of Minutes of December 4, 2000 meeting and February 12, 2001 teleconference | Pat Fetterman |
| 3) Update from Chemicals Subgroup | Joe Franklin |
| 4) Report from Operations and Hardware Subgroup
Review of 6 Minute Operational Data
Review of Hardware
TEI Report
New O&H Chair? | Jeff Clark/ Scott Richards |
| 5) Review and Discussion of Matrix Test Results | Greg Shank |
| 6) Scope and Objectives | Wim Vam Dam |
| 7) Old Business | |
| 8) New Business/ A.O.B. | |
| 9) Next Meeting | |