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Committee D02 on PETROLEUM PRODUCTS AND LUBRICANTS

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Minutes of the ASTM Cummins ISM Test Development Task Force Held on September 5th, 2003 in Richmond, Virginia

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Call to order: The meeting was called to order at 8:30 am

Review of Agenda: attachment 1 shows a copy of the meeting agenda. There were no changes to the meeting agenda.

Review of Scope and Objectives: The chairman proposed a scope for the task force. One change made to the scope was to more clearly define what M11 test the ISM will be replacing. It is planned that the ISM could replace both the M11EGR and M11HST. In addition to this change a couple of minor grammatical changes were made to the scope. The revised scope, was then adopted by the ISM Task Force, and is shown as Attachment #2.

Review of Membership: As this was the first meeting of the ISM test development task force, the membership was not completely finalized prior to the meeting. Based on input received at the meeting, the official membership of the ISM test development task force will be as shown below.

Membership list for ISM Test Development Task Force

Name	Company
Bill Runkle	Valvoline
Bob Campbell	Ethyl
Dan Domonkos	Lubrizol
Daryl Baumgartner	Lubrizol --- Chairman.
Greg Shank	Mack

Jeff Clark	T.M.C.
Jim Moritz	Perkin Elmer
Mark Cooper	Chevron Oronite
Pat Fetterman	Infineum
Ron Buck	T.E.I.
Scott Richards	SwRI
Steve Kennedy	ExxonMobil
Warren Totten	Cummins

Other company representatives requested to be placed on the task force mailing list for the purposes of receiving routine updates. There were 22 people in attendance for this meeting. See attachment #3 for sign in sheet and company representation.

Overview of ISM test operations and hardware and discussion about equivalence:

Warren Totten gave a presentation that included a summary of the proposed ISM test operations as well as a breakdown on the parts and similarities of the ISM and M11 engine platforms. See Attachment #4 for Warren's complete presentation. Some of the key points that were made in the presentation are listed below.

- The ISM test is planned to replace the M11EGR and the M11HST. To do this the ISM test will have two sets of Pass/fail limits. One set should equate to the severity level of the M11EGR and the other set should equate to the severity level of the M11HST.
- The ISM is planned to be 200 hours in length and will run a similar cycle to that of the M11EGR.
- The target soot level for the ISM test is 5.0% at 150 hours
- The ISM will run on 500ppm sulfur fuel.
- The ISM test will use the double screen wire oil filters
- The new pistons used in the ISM are phosphated, however, we may be able to use the old style pistons in the ISM test.
- Warren presented a good summary of the similarities and differences in hardware between the M11 and ISM test engines.

Following Warren's presentation there were several questions asked about the current M11 test and the proposed ISM test. Some of these questions and responses are noted below:

Q: Are the EGR rates expected in the ISM the same as in the M11EGR?

A: The test will need to use a modified calibration table. The EGR rates may be a little different.

Q: Will we be able to generate wear in the ISM engine?

A: It is expected that the ISM engine will be able to differentiate wear performance. It may require looking at additional components such as top hat pieces or the sum of several components, but Cummins is open to recommendations that the Task Force will make based on the data.

Q: Will the ISM carry forward into PC10

A: Yes Cummins plans to have the ISM as part of PC10

Q: Can labs get additional rings and other parts for the current M11 tests?

A: No they are no longer available.

Q: Does Cummins have any data that they can share on the ISMs ability to generate wear?

A: Warren indicated that he did have some data but did not have it with him. He also indicated that he would make some data available to the Task Force.

Matrix Proposal:

Phil Scinto presented a proposal on how to move forward with a matrix that should help establish correlation with the M11EGR test and the M11HST test. The proposal was put forth as a “stage gate” type of approach to the matrix. This means that the matrix data is run and reviewed in segments and decisions to continue or stop the matrix are based on the results of each segment. As an example the first 4 tests in the proposed matrix are designed to demonstrate that the test can discriminate on wear. If after the first 4 tests, there is no discrimination, the matrix is halted. Phil’s complete presentation can be seen as attachment #5. There was some discussion that resulted after Phil’s presentation. Below are some of the key points that were made or discussed.

- Some voiced concern over the number of different reference oils in the planned matrix. They suggested that only 2 or 3 oils might give us a slightly better look at precision. The two statisticians present at the meeting debated this point briefly without resolution.
- The selection of oils for the matrix will be very important to insure that we can establish limits for both the M11EGR and M11 HST.
- There was some discussion about funding for the matrix and who would pay for the tests.

The Funding issue was primarily resolved when Cummins offered to supply parts for all of the matrix runs and also offered to pay for fuel for the first 4 runs. Based on this, all four labs present agreed to run the initial tests in support of the matrix.

To address the issue of reference oil selection, a Sub Group was established and tasked with the identification of proper oils for the ISM test matrix. Warren Totten will lead this group with TMC participation. Other membership in the group is to be determined by Warren.

Establish Lab Timing:

All labs present were asked when they would have their ISM engines up and running. Currently the only lab running the ISM in its test configuration is SwRI. All other labs estimated being ready by November of 2003.

In order to insure as much commonality between stand setups as possible a Sub Group was established and charged with defining as much as possible about stand setups. Jim Moritz will chair with participation from the other test labs and TMC.

Adjournment

The meeting was adjoured at approximately 10:30am.

These meeting minutes were compiled by Daryl Baumgartner of the Lubrizol Corporation. For comments or questions regarding the content, please feel free to contact him at:

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Cummins ISM Test Development Task Force
Meeting Agenda
September, 5th 2003
Richmond, VA

- | | |
|--|----------------|
| 1. Call to order | D. Baumgartner |
| 2. Review of membership | D. Baumgartner |
| 3. Review scope and objectives | Task Force |
| 4. Overview of ISM test operations | W. Totten |
| 5. Review of hardware for ISM | W. Totten |
| 6. Similarities between the ISM and M11 | W. Totten |
| 7. Discussion on equivalence | Task Force |
| 8. Develop matrix plan (based on item 6) | Task Force |
| 9. Establish lab timing | Task Force |
| 10. Review instillation at Ethyl | Task Force |

Scope and Objectives

Cummins ISM Test Development Task Force

9/5/03

Scope:

To develop a lubricant performance test on a Cummins ISM test platform that can discriminate and provide a quality assessment of motor oils in a similar manner as the current M11 test (That includes both the M11EGR and M11 HST). The ISM test development will consider the following parameters for lubricant quality evaluation:

Primary parameters:

Crosshead weight loss
Top ring weight loss
Injector screw scuffing/wt. Loss
Sludge
Filter delta P

Secondary parameters:

Liner Wear
Rocker hat wt. loss
bearing wear
Push tube scuffing
Intake and exhaust screw

In addition, the Task Force will provide guidance and documentation of the test development to the Cummins Surveillance panel. The task force will provide a written procedure for the ISM test and work within ASTM to insure that the ISM test procedure complies with ASTM standards. Once the test is developed to the satisfaction of the Cummins Surveillance Panel, the Test Development Task Force will be disbanded and the Cummins Surveillance Panel will oversee the ISM test.

Objectives:

1. Draft of test procedure 10/03
2. Finalize matrix plan 10/03
3. Begin matrix testing 11/03

ISM Test Development Task Force Membership and Mailing List 9/5/03


Members:

Name	Company	Contact info	Attendance
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ISM Task Force



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ISM Lubricant Quality Test

- **Objective:** To verify that the ISM engine hardware and procedure will have repeatable oil quality discrimination.
- **Cummins has donated engine hardware at 2 independent and 2 dependent labs**
 - ✓ SWRI, Lubrizol, and PerkinElmer have the new calibration required to run the test.
- **Cummins will supply all test parts needed for this matrix**

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Minimum Test Matrix

Lab 1	TMC 830-2	
Lab 2	TMC 830-2	
Lab 3		TMC 1005
Lab 4		TMC 1005

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ISM Operating Conditions

- **Test is intended as direct replacement of the M11 EGR**
 - ✓ Limits will be set to match current severity
 - ASTM D 4485 to be updated accordingly
- **Engine operational stages are the same as M11 EGR**
- **EGR rate is now controlled by on-engine valve and floats with operation**
 - ✓ Request has been made to have closed loop control based on intake manifold CO₂
- **Fuel is 500 ppm S (Phillips RD-9)**

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ISM Test Conditions			
Parameter	Unit	A (Soot)	B (Rated)
Stage Length	H	50	50
Engine Speed	r/min	1800	1600
Torque	N·m (lb·ft)	1300 (960)	1930 (1424)
Fuel Rate	Kg/hr (lb/hr)	58 (128)	64.4 (142)
Intake Manifold Air Temperature	°C (°F)	80 (176)	65.5 (150)
Coolant Out Temperature	°C (°F)	65.5 (150)	65.5 (150)
Oil Gallery Temperature	°C (°F)	115.5 (240)	115.5 (240)

150 hr soot: 5.0% target

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ISM Test Parameters	
<ul style="list-style-type: none"> ■ Parameters to be rated ✓ Primary Parameters <ul style="list-style-type: none"> → Crosshead wear ⇒ Intake and Exhaust ⇒ mg wt loss → Injector Adjusting Screw Wear <ul style="list-style-type: none"> ⇒ None permitted ⇒ mg wt loss → Ring Wear <ul style="list-style-type: none"> ⇒ mg wt loss → Filter Plugging <ul style="list-style-type: none"> ⇒ Increase in kPa across filter ⇒ Using double wire screen filters → Engine Sludge 	

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ISM Test Parameters	
<ul style="list-style-type: none"> ■ Parameters to be rated ✓ Secondary Parameters <ul style="list-style-type: none"> → Bearing Wear <ul style="list-style-type: none"> ⇒ mg wt loss → Rocker Lever Wear <ul style="list-style-type: none"> ⇒ mg wt loss "rocker hat" → Liner Wear <ul style="list-style-type: none"> ⇒ average liner wear trace (microns) → Push Tube Scuffing <ul style="list-style-type: none"> ⇒ None → Intake and Exhaust Adjusting Screw Wear <ul style="list-style-type: none"> ⇒ No Scuffing ⇒ mg wt loss 	

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What is different?	
<ul style="list-style-type: none"> ■ Hardware <ul style="list-style-type: none"> ✓ Electronic control module CM870 instead of ECMB <ul style="list-style-type: none"> → Simplicity and reliability ✓ New pistons <ul style="list-style-type: none"> → Same design without bushing → Phosphorus coating - pistons are black <ul style="list-style-type: none"> ⇒ Industry has requested the use of current pistons → "Old" pistons can be used with new configuration ✓ Cylinder head improved to resist valve "beat-in" ✓ Cylinder liners <ul style="list-style-type: none"> → Induction hardened ✓ Oil ring <ul style="list-style-type: none"> → Nitrided for improved wear 	

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What is different?

- **Hardware**
 - ✓ New rocker levers (ball and socket type)
 - ✓ Intake system
 - EGR system with EGR valve and venturi
 - Variable Geometry Turbo

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What is the same?

- **Hardware**
 - ✓ Croseheads
 - ✓ Engine block
 - ✓ Top and second ring
 - ✓ Remainder of CPD rebuild parts
- **Same Celect Fuel System**
 - ✓ Improved fuel injectors
- **Performance Design Limits Unchanged**

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Field Data

- **Adjusting screw scuffing becomes a concern because wear causes increase in valve lash**
 - ✓ Potential to create increase in emissions
 - ✓ Potential for decrease in engine power
- **Filter Plugging remains an issue**
 - ✓ Some oil formulations exhibit higher filter plugging even at low soot levels
- **Valve train wear and power cylinder wear will always be of concern**
- **Use of one oil for mixed fleets desired by customers**

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Action Plan

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Cummins ISM

Proposed Testing Plan to
 Determine Correlation with the
 M11-EGR

- Cummins ISM Test Plan**
- Test in Stages
 - Use Decision Points
 - Use a Range of Oils – Quality Determined by Test Results/Models
 - Reference Oil
 - Poor
 - Borderline
 - Good
 - Great

Cummins ISM Test Plan

STAGE1	Lab 1	Lab 2	Lab 3	Lab 4
Oil				
Poor	√	√		
Great			√	√

- Cummins ISM Test Plan**
- Is there Discrimination?
 - No: Stop the Matrix
 - Is the Discrimination Similar to the M11 EGR?
 - No: Stop the Matrix

Cummins ISM Test Plan

STAGE2	Lab 1	Lab 2	Lab 3	Lab 4
Oil				
Borderline		√		√
Good	√		√	

- Cummins ISM Test Plan**
- Is the Correlation Similar to the M11 EGR?
 - No: Stop the Matrix
 - Somewhat: Run the Reference Oil Twice in Each Lab (8 Tests)
 - Yes: Run the Reference Oil Once in Each Lab (4 Tests)

- Cummins ISM Test Plan**
- Summary
 - Minimum Number of Tests for a Successful Matrix: 12
 - Maximum Number of Tests for a Successful Matrix: 16
 - Minimum Number of Tests for Comfort: 4