

**HEAVY-DUTY ENGINE OIL CLASSIFICATION PANEL**  
**OF**  
**ASTM D02.B0.02**  
**February 23, 2005**  
**Southwest Research Institute, San Antonio, Texas**

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**ACTION ITEMS**

- |   |                     |
|---|---------------------|
| <b>1. Distribute additional T-12 data to panel, when available.</b> | <b>Jim McGeehan</b> |
| <b>2. Issue "Exit Ballot" on C13 matrix readiness.</b>              | <b>Jim McGeehan</b> |
| <b>3. Add "Oil D" to the C13 matrix oils.</b>                       | <b>PC-10 MDTF</b>   |
| <b>4. Issue "Exit Ballot" on T-10 limits for T-9.</b>               | <b>Jim McGeehan</b> |
- 

**MINUTES**

- 1.0 Call to Order
- 1.1 The Heavy Duty Engine Oil Classification Panel (HDEOCP) was called to order at 8:19 a.m. by Chairman Jim McGeehan on Wednesday, February 23, 2005 in conference room 103 of Building 209 at Southwest Research Institute in San Antonio, Texas. There were 19 members present or represented and there were approximately 27 guests present. The attendance list is shown as Attachment 2.
- 2.0 Agenda
- 2.1 The published agenda (Attachment 1) was reviewed and agreed upon.
- 3.0 Previous Meeting Minutes
- 3.1 Minutes of the January 13, 2005 meeting as circulated and posted to the TMC web site, were approved via voice vote on a motion to approve by Abdul Cassim and Dave Stehouwer.
- 4.0 Membership
- 4.1 There were no changes in membership.
- 5.0 Matrix Oils
- 5.1 John Zalar reported that these oils were scheduled to start arriving at TMC by the end of February.
- 6.0 PC-10 Matrix Design & Funding

- 6.1 Steve Kennedy reported that the PC-10 matrix Memorandum of Agreement (MOA) was out for review and that comments need to be returned by March 4, 2005, along with final test costs.
- 7.0 PC-10 Tests Development
  - 7.1 Greg Shank reported on the Mack T-12, see Attachment 3. The T-12 Task Force is still gathering data and Greg asked Jim McGeehan to distribute the additional data to the HDEOCP after their March 17 task force meeting.
  - 7.2 Dave Stehouwer reported on the Cummins ISM, see Attachment 4. Wim VanDam reviewed the request for soot correction on the crosshead and injector screw weight loss measurements. Industry statisticians have been asked to rework the ISM data taking into account soot corrections and lab severity. The task force plans to meet again on March 22, 2005 to review the adjusted data and work on ISM / M-11EGR correlation data.
  - 7.3 Dave also reported on the Cummins ISB, see Attachment 4. Concern was raised about the results from one of the labs, but the task force thinks the problems have been addressed. There was also concern that perhaps results should be corrected for soot level. The task force plans to meet in conjunction with the ISM meeting.
  - 7.4 Tom Franklin reported on the Caterpillar C13, see Attachment 5. The task force recommends proceeding to an exit ballot for matrix testing the C13 and they recommend including "Oil D" as a matrix oil. Greg Shank moved and Dave Stehouwer seconded that an exit ballot be issued to approve matrix testing the C13, once all operational data is posted to the TMC web site. The motion passed with 18 for, 0 against, 0 abstain. Rick Finn moved that the PC-10 Matrix Design Task Force add "Oil D" as one of the C13 matrix oils if that can be done without seriously compromising base oil interchange data. Robert Stockwell seconded the motion which passed with 18 for, 0 against, 0 abstain.
- 8.0 Piston Temperatures – 1N
  - 8.1 Heather DeBaun reviewed the additional piston temperature data, see Attachment 6. Greg Shank moved that based on this current piston temperature data, the 1N test should be included as part of PC-10. Ken Chao seconded the motion which passed with 17 for, 1 against, 0 abstain. Caterpillar assured the panel parts would remain available.
  - 8.2 Discussion then turned to whether the 1P test should be included in PC-10. This issue appears to presently be in the NCDT court.
- 9.0 Valve Train Wear Task Force
  - 9.1 Heather DeBaun has agreed to chair this task force in place of Mark Sarlo. Heather reviewed the volunteer members from the last meeting and Mark Cooper was designated as the Oronite member.
- 10.0 PC-10 Test Review
  - 10.1 Jim McGeehan reviewed the currently proposed tests for PC-10, see Attachment 7. Joe Franklin noted after the meeting that HTHS is method D4683, 90 cycle shear stability is method D7109 and volatility by GC is method D6417.
- 11.0 T-9 to T-10 Correlation

- 11.1 Greg Shank presented the T9 / T-10 data gathered to date, see Attachment 8. Greg moved and Lew Williams seconded that the proposed T-10 limits for qualifying an oil as passing the T-9 test be exit balloted. The motion passed with 18 for, 0 against, 0 abstain.
- 12.0 Dyed PC-9 Fuel
- 12.1 Jim Wells brought up the issue of using dyed PC-9 fuel and that nearly all of the surveillance panels had agreed to its use, with the switch to be a running change. The Cat Surveillance Panel agreed to the use of dyed fuel. However, Abdul Cassim presented a recently uncovered Cat position on the use of dyed fuel (see Attachment 9), but it contained no data with regard to effect on deposits. The RFWT had not yet met or addressed the issue. Tom Franklin moved to accept the use of dyed PC-9 fuel in older tests. Bill Runkle seconded the motion which passed with 16 for, 0 against, 2 abstain.
- 13.0 Next Meeting
- 13.1 The next meeting will be held on March 31, 2005 at the Embassy Suites in Rosemont, IL (Chicago) and will last into the afternoon.
- 13.2 Charlie Passut wants CF-4 to be on the agenda for the meeting.
- 14.0 Adjournment
- 14.1 This meeting was adjourned at 11:10 a.m. on February 23, 2005.

Submitted by:

Jim Wells  
Secretary to the HDEOCP

**Final Agenda**  
**ASTMSECTION D.02.BO.02**  
**HEAVY-DUTY ENGINE OIL CLASSIFICATION PANELS**

ATTACHMENT 1

**SWRi, San Antonio, TX**  
**February 23 , 2005**  
**8:00 am-12:00 noon**

**Chairman/ Secretary:** Jim Mc Geehan/Jim Wells  
**Purpose:** PC-10

**Desired Outcomes:** Select engine tests for matrix

TOPIC	PROCESS	WHO	TIME
Agenda Review	<ul style="list-style-type: none"> <li>• Desired Outcomes &amp; Agenda</li> </ul>	Group	8:00-8:05
Minutes Approval	<ul style="list-style-type: none"> <li>• January 13, 2005</li> </ul>	Group	8:05-8:10
Membership	<ul style="list-style-type: none"> <li>• Changes: Additions</li> </ul>	Jim Mc Geehan	8:10-8:15
Matrix Oils	<ul style="list-style-type: none"> <li>• Status of blending and delivering matrix oils to labs.</li> </ul>	John Zalar	8:15-8:30
Funding status	<ul style="list-style-type: none"> <li>• Review funding for matrix</li> </ul>	Steve Kennedy	8:30-8:45
PC-10 Test Development report	<ul style="list-style-type: none"> <li>• Mack T-12</li> <li>• Caterpillar C13</li> <li>• Cummins ISB</li> <li>• Cummins ISM</li> <li>• Exit-Criteria ballots and remaining actions.</li> </ul>	Greg Shanks Abdul Cassim Dave Stehouwer  Jim Mc Geehan	8:45-10:00
Coffee break	<ul style="list-style-type: none"> <li>•</li> </ul>		10:00-10:15
EMA's request on Cat SC tests.	<ul style="list-style-type: none"> <li>• Cat IN/Cat1P</li> <li>• Piston temperatures including Internal 6:0 Liter engine in Ford trucks</li> <li>• Discussion and recommendation</li> </ul>	Greg Shank Heather Debaun Group	10:15-11:00
VWT task-force	<ul style="list-style-type: none"> <li>• Chairman (Heather Debaun)</li> <li>• Charter/ Members</li> <li>• Goals and timing</li> </ul>	Jim Mc Geehan Heather Debaun	11:00-11:15
Review all PC-10 tests	<ul style="list-style-type: none"> <li>• Review all the existing tests in PC-10</li> </ul>	Jim Mc Geehan	11:15-11:30
Correlation of Mack T-9 to Mack T-10	<ul style="list-style-type: none"> <li>• Data review</li> <li>• Action required</li> </ul>	Greg Shank Group	11:30-11:50
Next Meeting	<ul style="list-style-type: none"> <li>• Decision on next meeting according to test development</li> </ul>	Group	11:50-12:00

## HDEOCP Attendance List

February 23, 2005

Attachment 2, Page 1 of 5

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February 23, 2005

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# Mack T12 Engine Test Update

February 23rd 2005



- Mack T-12
- Based on Mack T10 & Mack T11
  - With ULSD Fuel
  - Length - ~ 300 Hours
  - Two Phase Test
    - Phase 1 100 hr ( 4.0 % Soot )
- Phase 2 200 hr ( EOT of 6 % Soot )
  - Phase 2 260 F Oil Temp
- Increased EGR Flow (Heavy EGR)  
(35% Phase 1 – 15-% Phase 2)
- Precision Matrix Required



## •2 Production EGR Coolers ( Breadboard ) Replaces Tube Cooler

### *Now 90C IMT – Phase 1*

#### T12 Conversion Kits Sent to Labs

##### •T12 TASK FORCE –

Numerous Teleconferences,

Oct 20 Mtg in San Antonio – Meeting Nov 22<sup>nd</sup> @ ExxonMobil- Next Mtg Jan 12<sup>th</sup>  
in San Antonio - Meeting – Feb 22<sup>nd</sup> SWRI

•Test Procedure Ready - T12 Parts List Completed

•Completed 4 Test on 820-2 (T10 Ref Oil) 3 More Test in March

•Engines in 5 (820-2) Labs Running week of Jan 10<sup>th</sup>

•Reviewed Operational Data March 4

•Data for Initial Precision & Discrimination Review March 17th

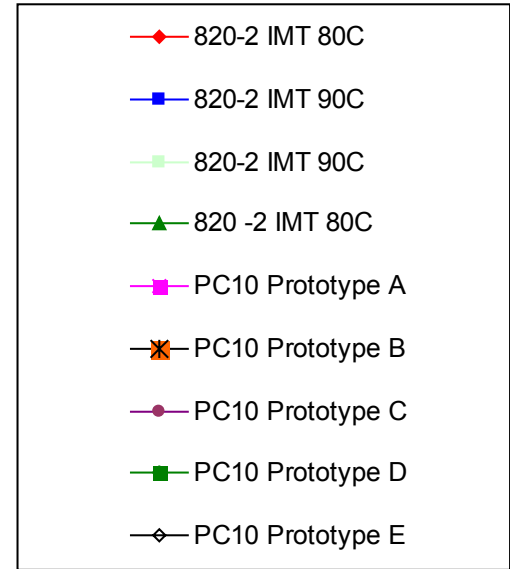
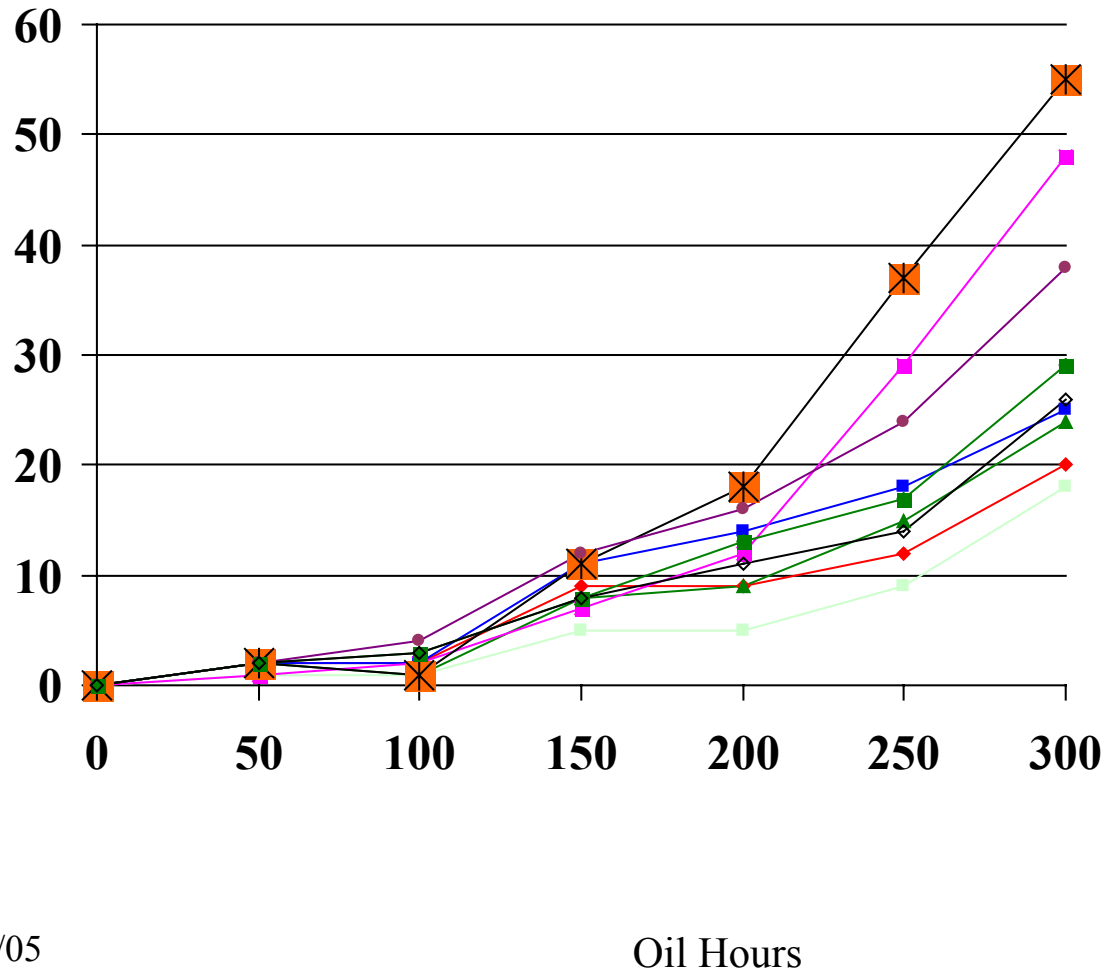
•Task Force Recommends the use of dyed PC 10 ULSD

• 820-2 Will be Part of Precision Matrix



# T12 Pb (ppm) Discrimination

P  
b

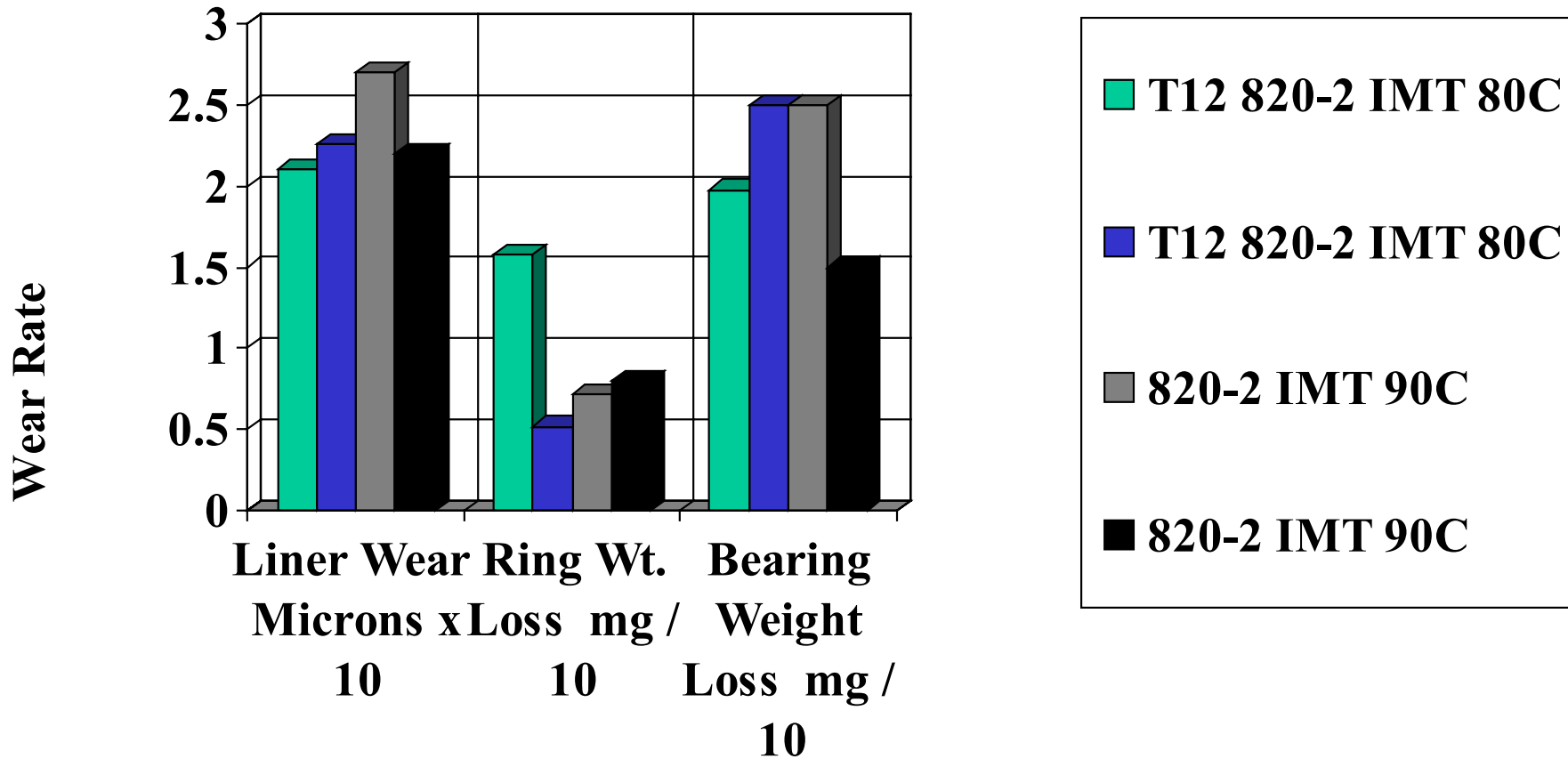


GLS 2/23/05



Mack Powertrain Division

# T12-820-2 vs. PC10 Prototype

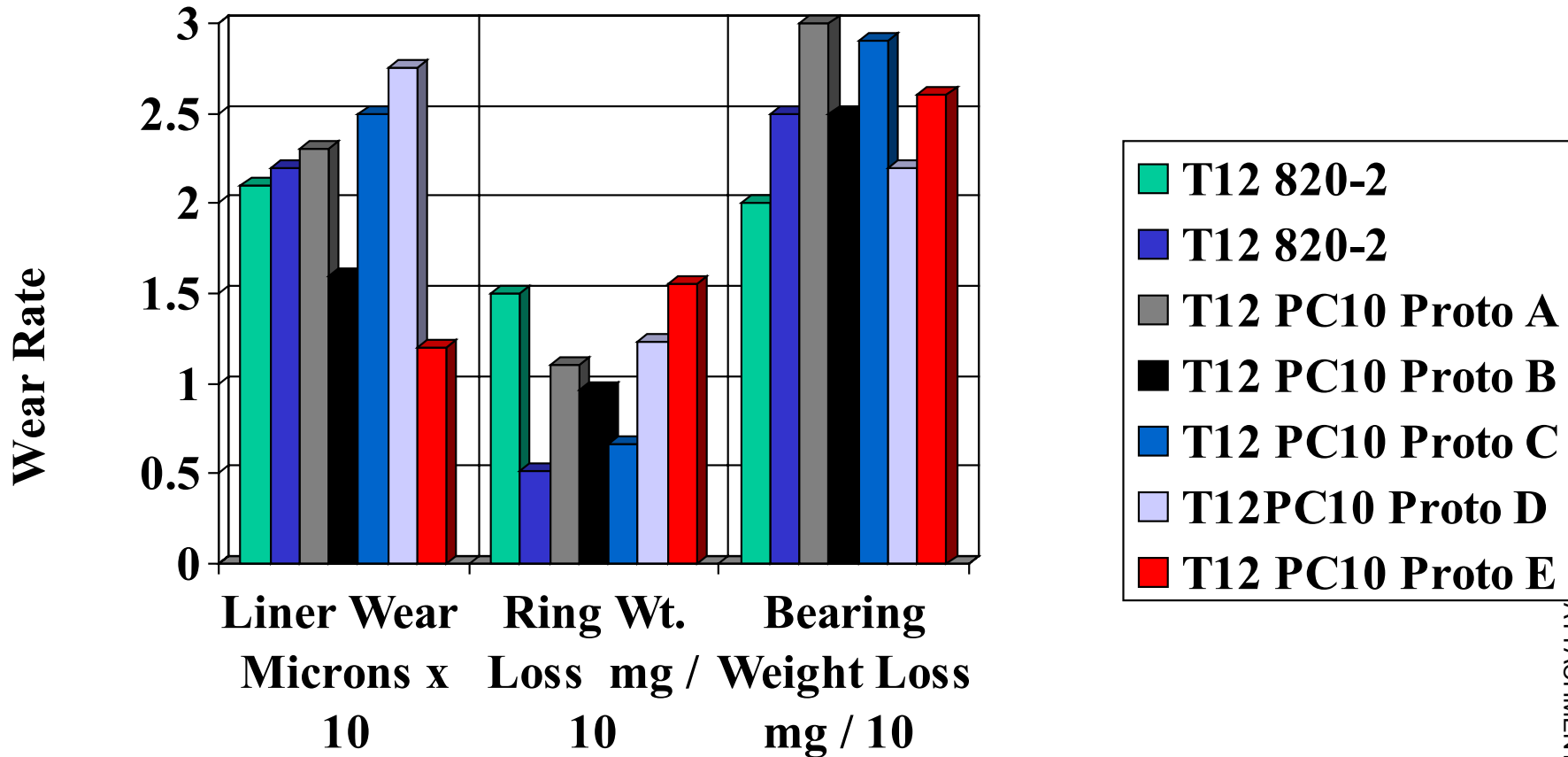


GLS Feb 18th 2005



Mack Powertrain Division

# T12-820-2 vs. PC10 Prototype



GLS Feb 18th 2005



Mack Powertrain Division

## T12 PC10 Engine Oil Test Development Schedule

	July	August	September	October	November	December	January	February
EGR Mapping	█	█						
Soot Mapping		█	█					
TBN Depletion Mapping			█					
Run Demonstration Test				█	█	█	█	█
Run Discrimination Test						█	█	█
Deliver Draft Procedure				█	█			
Deliver Procedure for Matrix Testing						█	█	█







# ISM Status

**Presentation to  
HDEOCP  
David M Stehouwer  
February 23, 2005**



## Brief overview of status of Test Development

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- | Matrix testing complete**
- | Initial matrix analysis complete**
- | Discrimination demonstrated on wear, and filter plugging.**
- | Sludge deposits also measured as part of the test**
- | Recommendation was made to HDEOCP that the test does show discrimination and that several other items such as outliers, soot correction, etc. would be soon finalized**



## January '05 meeting

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- : In January the panel met to try and resolve the pending items such as**
  - o Outlier screening**
  - o OFDP calculations**
  - o Soot corrections**
  - o M11EGR / HST correlations**
  - o Redundant parameters**
  - o Transforms**



## ISM Status

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- : ISM ready to carry forward for PC10**
- : As a guideline for formulators:  
Performance of PC 10 candidates should be equal to or better than 830.**
  - ü A Merit system is also being considered
  - ü Limits for backward compatibility will be discussed at March 22 meeting
- : OEM feels that ISM should have soot correction**
  - ü Historically all the M11 tests have needed correction
  - ü Data over broad range supports correction
  - ü Presentation by Chevron Oronite



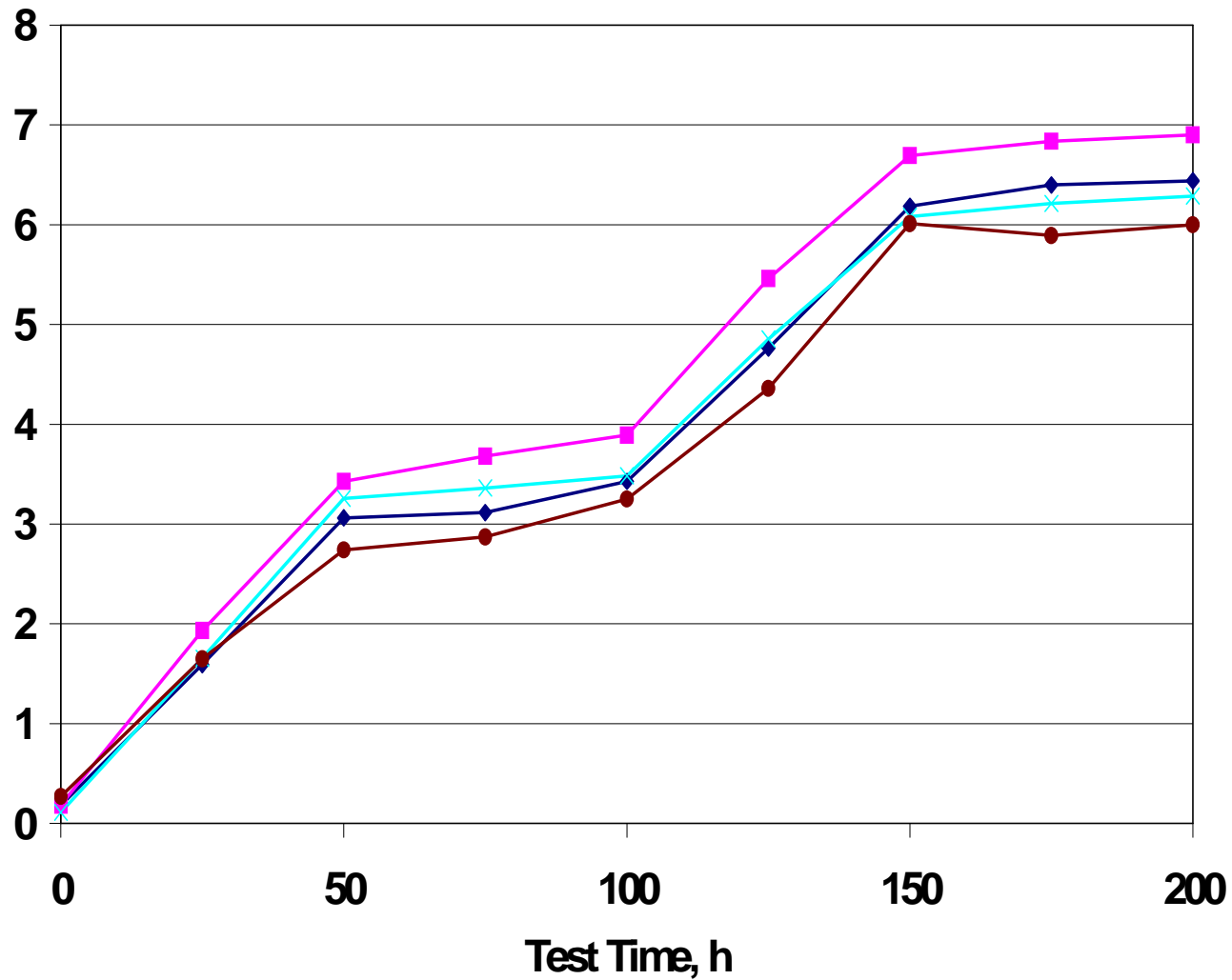
## Wear Normalization for Soot in the Cummins ISM Test

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- ! **Soot impact significant for XHW and IASW**
  - ü Average soot range 3.4 to 4.3 %
  - ü True for complete data set w or wo outlier screening
  - ü True for complete data set w or wo outlying test
- ! **Soot impact trend for reduced data set with higher soot window tests**
  - ü Average soot range for smaller reference test data set 3.7 to 4.3 %
  - ü Range too small to reveal a significant soot impact
- ! **M11 engine tests have always had a soot normalization**
  - ü ISM is the same basic engine
  - ü ISM soot normalization necessary for establishing M11EGR/ISM correlation
  - ü Average soot range can range from 3.7 to 4.5 %
- ! **Recommendations**
  - ü Apply a normalization for XHW (linear) and IASW (exponential)
  - ü Adopt a 50 h soot window



### Soot Content, %

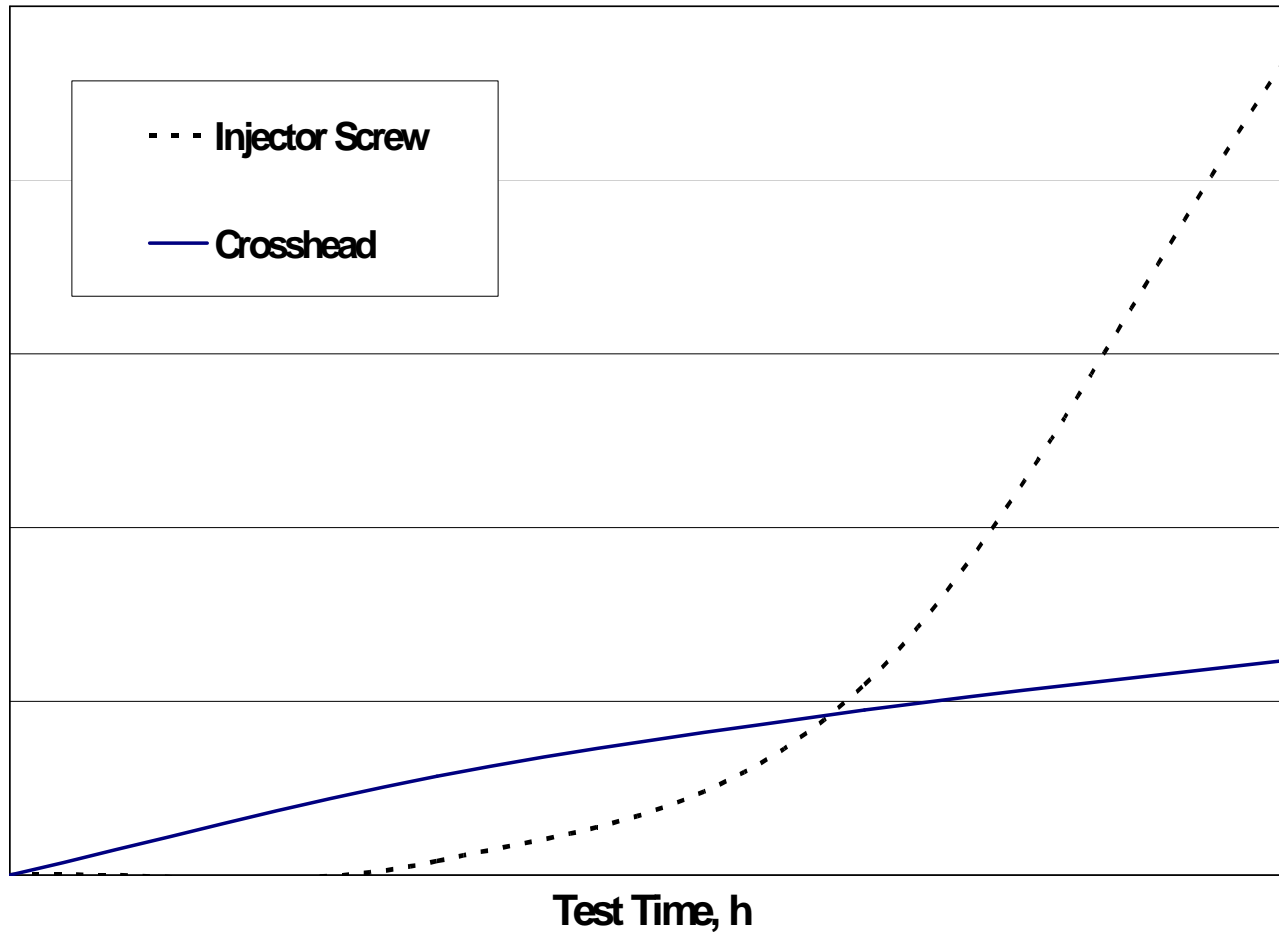


David M Stehouwer, Cummins Inc.



## Wear versus Time Linear for XHW and Exponential for IASW

Component Weight Loss, mg





## Current timing for the ISM Development

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- | **3/22/05 -- Discuss Reference status of stands**
- | **3/22/05 – M11EGR correlation**
  - ü **TMC to solicit data as a neutral party?**
  - ü **Data to TMC by 3/14**
- | **5/05 – Test procedure issued**
- | **6/05 – Initial development complete – ISM to be monitored by the Surveillance Panel and task force disbanded.**





## ISM Action Items

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- | TMC to solicit data to help establish ISM / M11 EGR correlation**
  - ü Due to TMC for distribution to Task Group by March 14
- | Task Group meeting in Columbus March 22.**
  - ü Examine matrix data with and without soot correction
  - ü Recommend limits for M11 EGR correlation to HDEOCP
  - ü Resolve stand calibration issues



# **ISB Status Report**

**Presentation to  
HDEOCP  
David M Stehouwer  
February 23, 2005**



# ISB Status

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- | **Severity issues at one lab were linked to a control problem and exhaust back pressure issues.**
  - ü Source was identified
  - ü Corrective action is in place
  - ü Another run is planned
- | **Build workshop was held Feb 8, 9**
  - ü Several issues identified and addressed in Task Group
  - ü Evaluate use of longer cam pin
    - o Decrease ADCOLE measurement time (48 hr turn around)
- | **Draft 1 Procedure completed**
  - ü Task Group reviewing
  - ü Incorporating details from build workshop



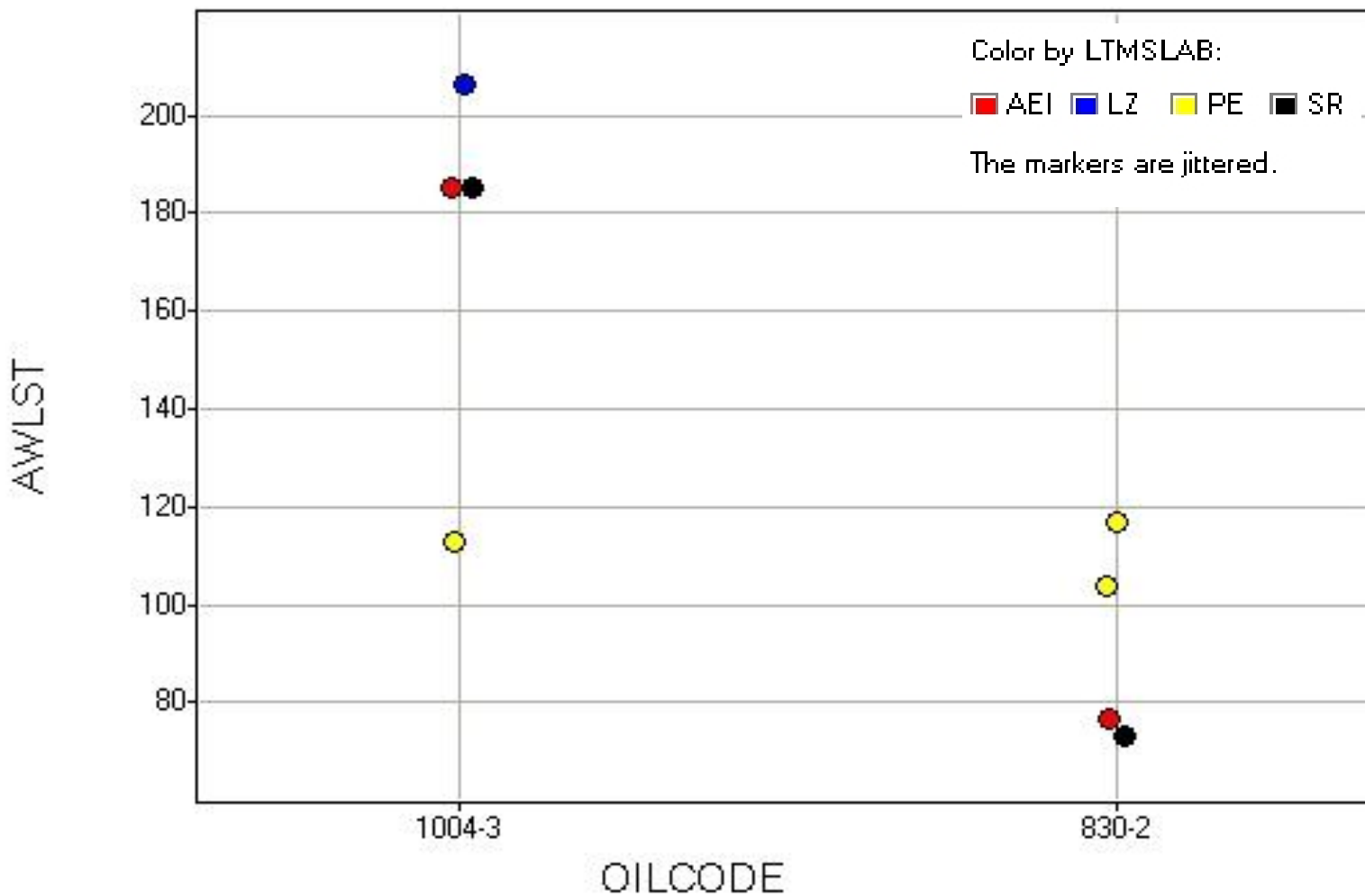
# ISB Engines at Labs

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- ! **SwRI @ San Antonio, Completed 830-2 and 1004-3**
- ! **PE @ San Antonio, Completed three 830-2 and one 1004-3**
- ! **Lubrizol @ Wickliffe, Completed 1004-3 one 830-2 pending**
- ! **ExxonMobil @ Paulsboro, Preparing to Run Reference Oil**
- ! **Valvoline, Ashland, May Run Older Engine Configuration**
- ! **Afton, Richmond, Waiting on Engine, Waiting on Cell Space**

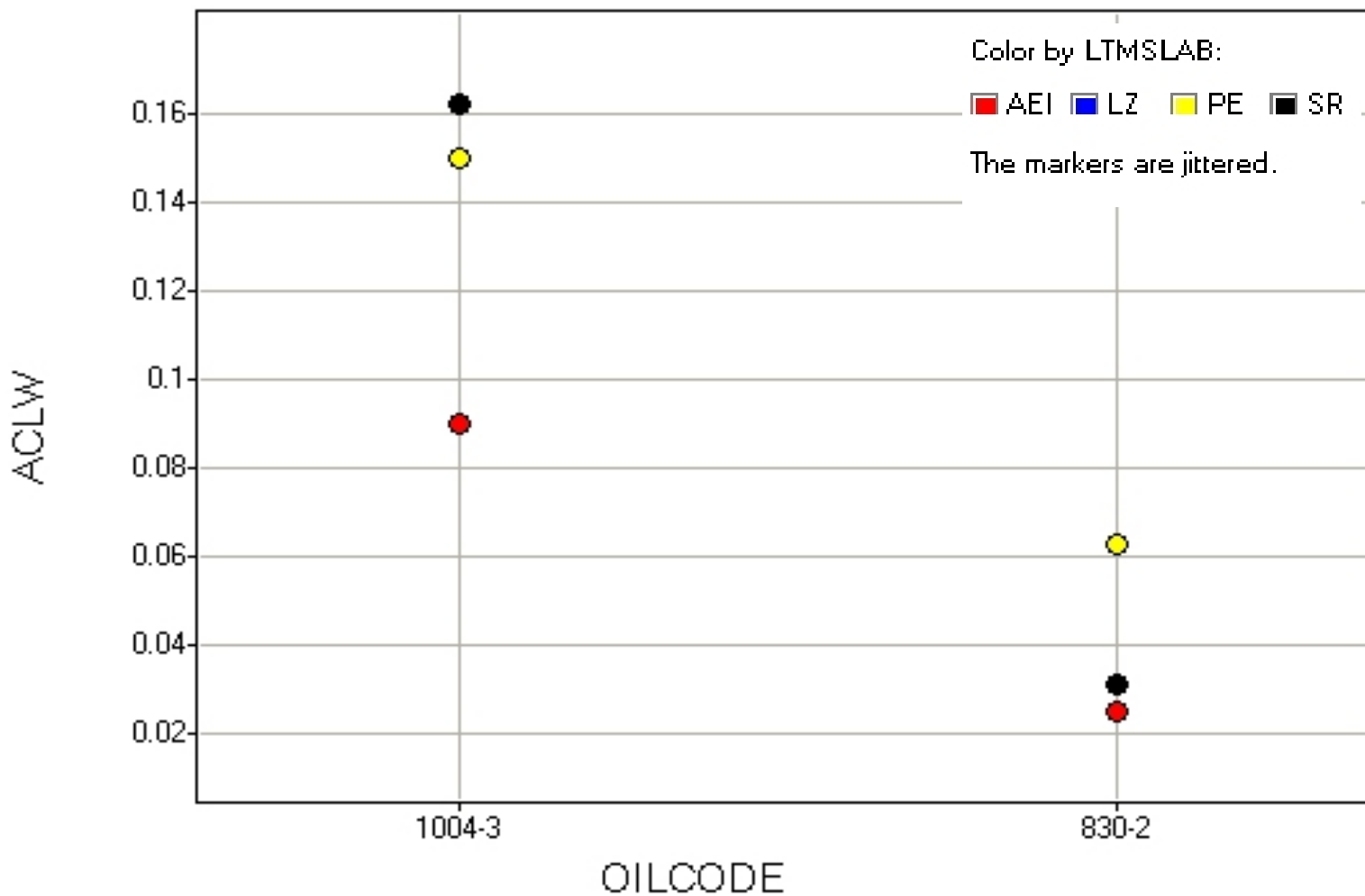


# Tappet Wt Loss





# Cam Lobe Wear



David M Stehouwer, Cummins Inc.



## ISB Action Items

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- : Motion from CSP: ISB Test should use dyed low S PC-10 fuel.**



# **C13 Development Task Force**

Report to the HDEOCP

February 23, 2005

Tom Franklin

PerkinElmer Automotive Research



# C13 – Matrix Ready?

## The Task Force Position

- ⇒ Discrimination Testing
- ⇒ Lab/Stand Visits
- ⇒ Test Procedure
- ⇒ Hardware Supply
- ⇒ Matrix Participation (stands) Requirements
- ⇒ Outstanding Needs

# Discrimination Testing

- ⇒ Six Test Mini-matrix – as described by Caterpillar - Task Force does not support the validity of one of the six tests
- ⇒ Conclusions supported by statistical analyses using six or five tests
- ⇒ Task Force concerned that the level of discrimination may not be sustainable

# Summary

## Courtesy of Jim Rutherford

- ⇒ Five tests with two oils in an assortment of labs.
- ⇒ Simple t-tests for most of the result variables.
- ⇒ ATGC, ATLC, and TGA\_H500 had significant ( $p < 0.05$ ) oil differences
- ⇒ OCONPINC, TGFAVG, and FEWMH500 had marginally significant ( $0.05 < p < 0.10$ ) oil differences
- ⇒ Adding sixth test from Caterpillar didn't change much.
  - The only test for oil difference that changed substantially was IRINH500 – strange result. Looks like different units for some measurements.
- ⇒ **If this test continues and it has averages over cylinders we will probably have to have cylinder outlier procedures.**
- ⇒ After outlier screening, oil difference for TGF is no longer significant.
- ⇒ ALSCT oil difference is significant with or without outlier screening.
- ⇒ ALSCI and ALSCO did not have significant oil differences

# Lab Visits

- ⇒ Team formed – Jeff Clark, leader
- ⇒ Three labs visited, no significant discrepancies
- ⇒ Two more labs scheduled for mid-March

# Test Procedure

- ⇒ Fully developed in ASTM format
- ⇒ Draft #5 due out next week to correct loose ends discovered in the lab visits and adopted by the Task Force on 2/21
- ⇒ Procedure is ready to be incorporated into an ASTM Research Report and subsequently given to a Facilitator to process as a Standard

# Hardware Supply

- ⇒ Caterpillar to be the CPD
- ⇒ Critical parts (PRL) from production with reduced tolerances on critical parameters
- ⇒ 1Y parts system to be used
- ⇒ Matrix hardware in production, sufficient hardware is in-hand for the matrix
- ⇒ Five year parts supply to be in place by the end of 2006

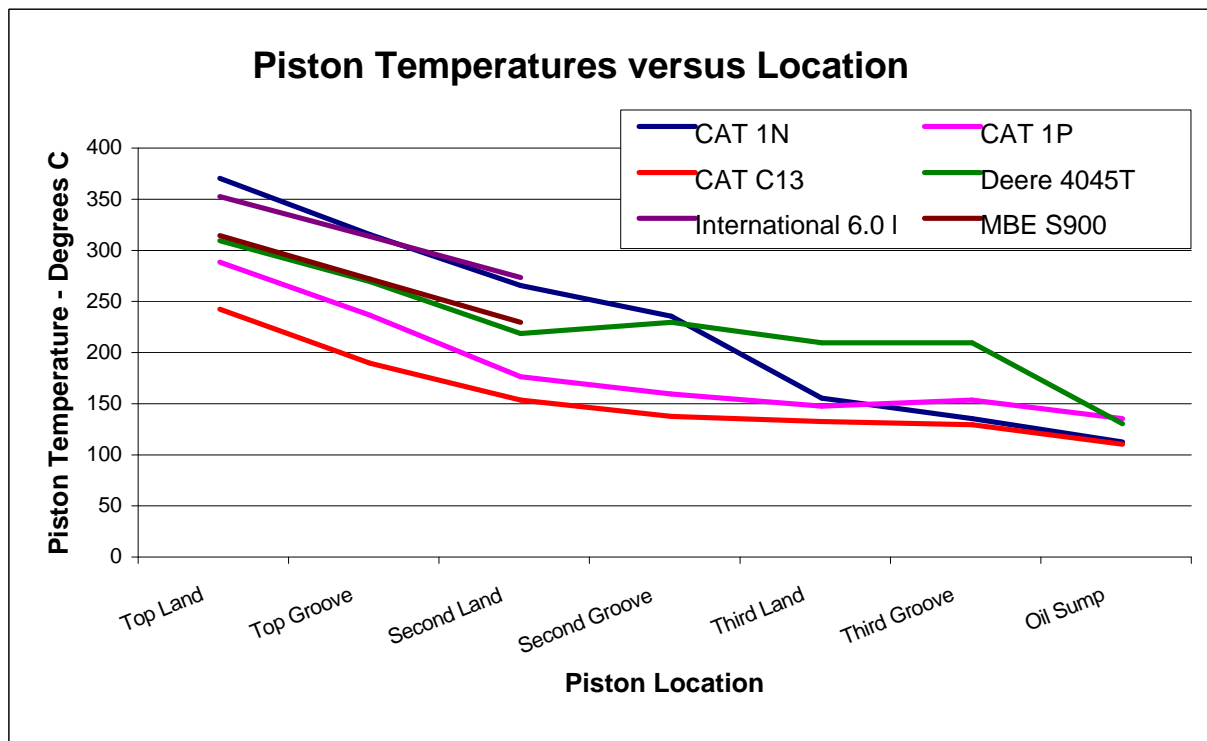
# Matrix Participation Req'm'ts

- ⇒ MOA Draft followed
- ⇒ Task Force agreed that any lab/stand combination that has generated two valid C13 tests with either PC-9 or PC-10 fuel is acceptable

# Outstanding Needs

- ⇒ Task Force supports moving the C13 to Matrix (vote 9-2-1)
- ⇒ However, the Task Force remains concerned that the level of demonstrated discrimination may not be sustainable.
- ⇒ The Task Force highly recommends that an oil or oils be included in the matrix to further support the conclusion that the test discriminates.





# PC-10 Performance Requirement: Engine Tests

Performance Criteria	Fuel Sulfur, Wt %	Engine Tests	PC-10 2006
Aluminum Piston Deposits, Oil Consumption	0.05	Caterpillar 1N	X
Viscosity Increase Due to Soot at 6.0%	0.05	Mack T-11	X
Roller-Follower Valve Train Wear	0.05	GM 6.5-Liter PC – Diesel	X
Aeration	0.05	Navistar HEUI 7.3-Liter EOAT	X
Valve Train Wear, Filter ΔP and Sludge	.05	Cummins ISM	X
Valve Train Wear	15 ppm	Cummins ISB	X
Oil Consumption and Piston Deposit	15 ppm	Caterpillar C-13	X
Ring, Liner Bearing Wear & Oil Consumption	15 ppm	MackT-12*	X
Oil Oxidation	0.10	See III G or III F or Neither	X
Steel Piston Oil Consumption / Deposits	0.05	Caterpillar 1P	X

\*Low Temperature Pumpability Test (ASTM D 4684) (MRV TP-1) / Mack T-10A?

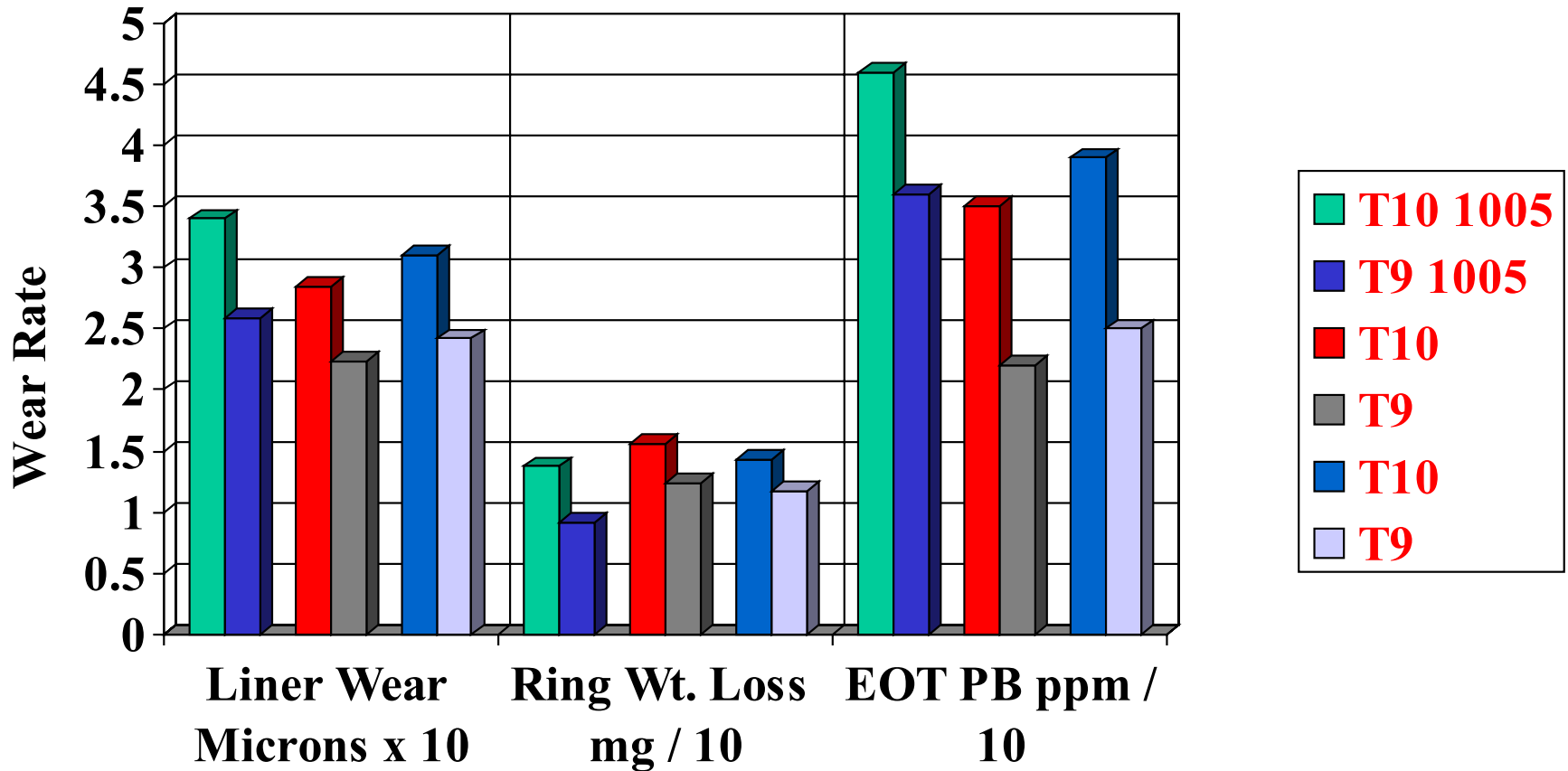
Yet to Be Decided



# PC-10 Performance Requirement: Bench Tests

<b>Performance Criteria</b>	<b>Bench Tests</b>	<b>PC-10 2006</b>
<b>Foam</b>	<b>Bench Test Sequence I, II, III</b>	<b>X</b>
<b>Elastomer Compatibility</b>	<b>D-471, Ref. Oils</b>	<b>X</b>
<b>High Temperature/High Shear</b>	<b>Bosch Injector</b>	<b>X</b>
<b>Shear Stability – 90 Cycles</b>	<b>Bosch Injector ASTM D 3945</b>	<b>X</b>
<b>Volatility</b>	<b>Noack D 5800 or Distillation D 2887</b>	<b>X</b>
<b>Corrosion</b>	<b>HTCBT (135°C) ASTM D 6594</b>	<b>X</b>

# Wear / T10 vs. T9



GLS Jan 12<sup>th</sup> 2005



Mack Powertrain Division

Name of Function and Date

Model Data								
T9 Pb	T10 Pb	T9 LWS	T10 LWS	T9 TRWL	T10 TRWL		Base Oil Group	Viscosity Grade
11.462	35.376	22.607	24.204	84.877	106.433		I	15W-40
6.679	24.909	22.607	28.609	84.877	114.278		II	15W-40
8.811	29.553	23.658	24.666	84.87	109.344		I	15W-40
4.791	20.997	23.658	29.012	84.87	117.126		II	15W-40
5.316	21.775	24.81	25.17	70.93	111.423		I	15W-40
2.378	15.571	24.81	29.473	70.93	119.16		II	15W-40
3.688	17.877	24.81	23.3	70.933	112.67		I	15W-40
1.36	12.833	24.81	27.578	70.933	120.381		II	15W-40
15.256	36.499	21.303	28.317	89.699	104.493		I	15W-40
9.548	25.546	21.303	32.761	89.699	112.379		II	15W-40
11.379	35.177	23.658	24.719	84.869	107.819		I	15W-40
6.669	24.875	23.658	29.096	84.869	115.634		II	15W-40



## Limit Recommendations

**CH 4 T9 - T10**

**Liner Wear (um)**

**T9 – 25.4 T10 – 30, 32,33**

**Top Ring Weight Loss (mg)**

**T9 – 120 T10 – 145,154,158**

**EOT Delta Lead (ppm)**

**T9 – 25 T10 – 40,45,47**



# Caterpillar Dyed Fuel Update

3406E tested with 30 ppm dyed<sup>1</sup> and un-dyed fuel showed:

- 9% increase in EPA C1 cycle particulates
- 2% increase in NO<sub>x</sub>+HC on EPA C1 test cycle
- No difference on EPA Transient smoke
- Piston deposit measurements not recorded but expect that deposits would increase.

<sup>1</sup> (Unisol Liquid Red B-50 Dye)

# Caterpillar Dyed Fuel Update

## **Caterpillar uses NON-DYED/CLEAR diesel fuel for use in testing because:**

- Commercial grade fuels differ in quality and specifications.
- Uniformly calibrate test equipment to assure accurate, repeatable data results and performance analysis.
- Permits efficient storage and handling of the fuel for multiple testing programs.
- The potential long-term detrimental effects on oil and engine life is unknown and requires a significant amount of time and resources to quantify.
- Today, federal law requires the use of a clear, low-sulfur fuel in all heavy duty on-highway applications to assure compliance with emissions standards. 1998 - 4 million gallons of diesel fuel costing approximately \$x million.
- Caterpillar receives a rebate for the taxes paid on this fuel.



## Caterpillar Dyed Fuel Update

Test Labs and the TMC should use a similar approach to Caterpillar and continue to use **undyed** fuel and address refunds on fuel which is allowed in other states (eg Illinois).