

HEAVY-DUTY ENGINE OIL CLASSIFICATION PANEL
OF
ASTM D02.B0.02
January 13, 2005
Southwest Research Institute, San Antonio, Texas

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ACTION ITEMS

- | | |
|-------------------------------------------------------------|------------|
| 1. Piston temperature data, various current engines. | All |
| 2. T-10 / T-9 data. | All |
-

MINUTES

- 1.0 Call to Order
 - 1.1 Chairman Jim McGeehan called a meeting of the Heavy Duty Engine Oil Classification Panel (HDEOCP) to order at 9:00 a.m. on Thursday January 13, 2005 in the video-conference room of Building 189 at Southwest Research Institute (SwRI) in San Antonio, Texas. There were 18 members present or represented and approximately 26 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 Pat Fetterman moved that the minutes of the December 7, 2004 meeting be approved as circulated and posted on the TMC web site. Bill Runkle seconded the motion which passed via unanimous voice vote.
- 4.0 Membership
 - 4.1 No change in membership, see Attachment 3.
- 5.0 New Category Development Team
 - 5.1 Bill Runkle, chairman of the NCDT, reviewed the PC-10 timeline (Attachment 4).
 - 5.2 Bill presented the request by the EMA to include both the 1N and 1P tests in PC-10 (see Attachment 5). The NCDT took no action on the EMA request, but will reconsider after more piston temperature data on additional engines is made available.
- 6.0 Valve Train Wear Task Force
 - 6.1 In response to a request from the last meeting, Chairman McGeehan proposed that a task force be formed to review the three potential PC-10 valve train wear tests (ISM, ISB, RFWT) for wear redundancy. He proposed Mark Sarlo to lead the group and asked for group volunteers. Those volunteering to serve on the task force were: Bill Kleiser (or someone from Oronite), Dave Stehouwer, Pat Fetterman, Steve Kennedy, Heather

DeBaun, Tom Franklin, Jason Bowden, Keith Selby, Charlie Passut, Ron Buck, Jim McGeehan, Dave Duncan and Robert Stockwell.

7.0 Matrix Oils

7.1 John Zalar reported on the PC-10 matrix test oils status. The oil suppliers are now acquiring base oils and they expect to ship the finished oils to the TMC in February. Plans are for 6 drum quantities of four of the oils and 1300 gallon quantities of the remaining two featured oils. These oils are each to be blended as single batches, so TMC will not have to remix upon receipt. Thus, with an anticipated one week turnaround at TMC, the matrix oils could be shipped to the labs in early March.

8.0 PC-10 Matrix Design & Funding

8.1 Steve Kennedy reported on the matrix design and funding status (see Attachment 6).
8.2 A draft Memorandum of Agreement (MOA) for funding the matrix is circulating (see Attachment 7).

9.0 Test Development Status

9.1 Greg Shank reported on the T-12 development status (see Attachment 8).
9.2 Dave Stehouwer reported on the ISM status (see Attachment 9). The task force has decided to remove valve adjusting screws and bearing weight loss as potential pass/ fail parameters. They plan to present an M-11 EGR correlation by the next meeting. Dave thanked Jim Rutherford and Phil Scinto for all of the statistical analysis they provided on the ISM test data. Phil expressed concern about the small amount of reference oil data and dropping severity adjustments. There was some discussion on OFDP data.
9.3 Dave also reported on the ISB, see Attachment 9). Panel members emphasized the need for a well documented procedure and it was noted that the ISB could proceed to matrix testing when it is ready, but that does not necessarily mean it will become part of the category.
9.4 Abdul Cassim reported on C13 progress, see Attachment 10, and noted that the vertical scale of slide 2 is actual oil consumption with units of g/kW-h.

10.0 PC-10 Fuel

10.1 Dave Duncan expressed his concern that the Haltermann ultra low sulfur fuel being used by many labs prior to selection of ChevronPhillips as the PC-10 fuel supplier, was not representative of what a typical commercial 2007 fuel would probably look like. His analysis showed a much narrower boiling point range, very low aromatics and higher cetane for the Haltermann fuel than he thinks would be typical. Dave later submitted his analysis results as Attachment 11.

11.0 T-10 / T-9 Correlation

11.1 Greg Shank reviewed the only data accumulated so far, one run using oil 1005 in each test (see Attachment 12). There may be more data forthcoming and the panel wants to keep this on the agenda.

12.0 Next Meeting

12.1 The next meeting was agreed for February 23, 2005 in San Antonio, with a following meeting possibly on March 15, also in San Antonio. SwRI has reserved conference room 103 in Building 209 for the 2/23 meeting and the video-conference room in Building 189 for the 3/15 meeting, if desired.

13.0 Adjournment

13.1 The meeting was adjourned at 11:15 a.m.

14.0 Group Photo

14.1 At the request of Abdul Cassim, most of the group present gathered for a photograph after the meeting...see Attachment **13**.

Submitted by:

Jim Wells
Secretary to the HDEOCP

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

ATTACHMENT 1

SWRi, San Antonio, TX
January 13th, 2005
9:30 am-1:30 pm

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"> • Desired Outcomes & Agenda 	Group	9:30-9:05
Minutes Approval	<ul style="list-style-type: none"> • December 7th , 2004 	Group	9:35-9:40
Membership	<ul style="list-style-type: none"> • Changes: Additions • Comments 	Jim Mc Geehan	9:40-9:45
NCDT Report	<ul style="list-style-type: none"> • Review time line • Caterpillar IN/IP • Task-force on VTW tests in PC-10 • Time-line review 	Bill Runkle	9:45-10:15
Matrix Oils	<ul style="list-style-type: none"> • Status of blending and delivering matrix oils to labs. 	John Zalar (Program Manager)	10:15-10:30
Number of test stands and Funding	<ul style="list-style-type: none"> • Review matrix design • Funding and timing 	Steve Kennedy	10:30-10:45
Coffee break	<ul style="list-style-type: none"> • 		10:45-11:00
PC-10 Test Development report	<ul style="list-style-type: none"> • Mack T-12 • Caterpillar C13 • Cummins ISB • Cummins ISM • Exit-Criteria ballots remaining actions • New Exit-Criteria ballots: agree. 	Greg Shanks Dave Stehouwer Abdul Cassim Jim Mc Geehan	11:00-12:30
Correlation of Mack T-9 to Mack T-10	<ul style="list-style-type: none"> • Data review • Action required 	Greg Shank Group	12:30-1:00
Next Meeting	<ul style="list-style-type: none"> • Exit-Criteria ballots review. February 10th Chicago and final meeting for matrix March 2nd Chicago 		

HDEOCP Attendance

January 13, 2005

Attachment 2, Page 1 of 5

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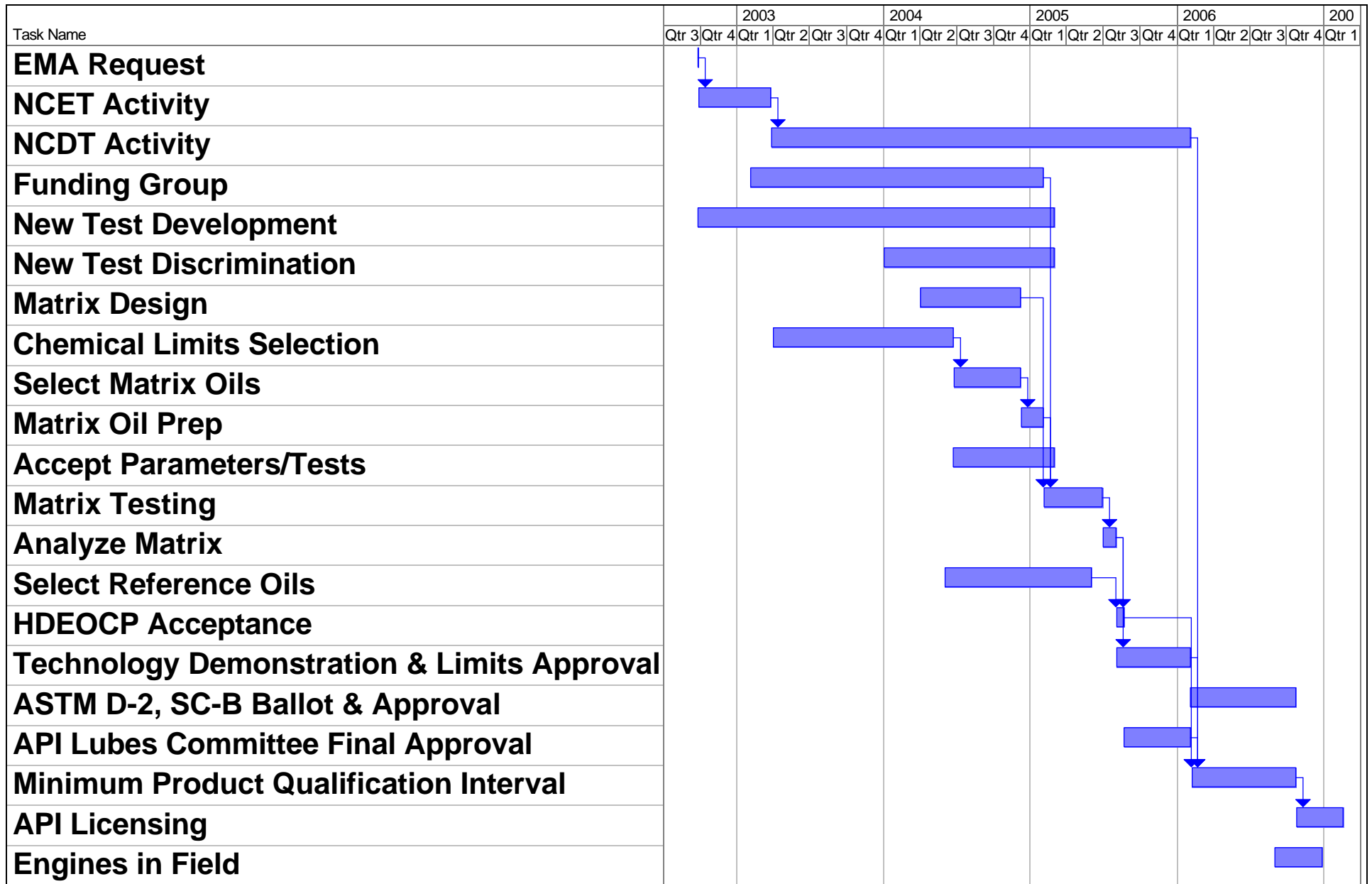
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Voting Members of ASTM HDEOCP

	Oil and Additive Companies	OEMs
1	Jim A. Mc Geehan - ChevronTexaco	Greg Shank - Mack Trucks
2	Steve Kennedy - ExxonMobil	Warren Totten - Cummins Inc.
3	Matthew Urbanak - Shell	Mesfin Belay - Detroit Diesel
4	Mike Lynskey - Castrol	Abdul Cassim - Caterpillar Inc.
5	Bill Runkle - Ashland	Heather DeBaun - International
6	Scott Harold - CIBA	Ken Chao - John Deere
7	Steven Herzog - RohMax	Robert Stockwell - GM Powertrain
8	Charles Passut - Ethyl	
9	Bill Kleiser - Oronite	
10	Lew Williams - Lubrizol	
11	Pat Fetterman - Infineum U.S.A.	
12	David Taber,- ConocoPhillips	
13		
14		





Project: PC-10 ACC-1 12072004 Date: Tue 1/11/05	Task		Milestone		External Tasks	
	Split		Summary		External Milestone	
	Progress		Project Summary		Deadline	

TO: Engine Lubricants Committee

CC: Susan Feingold Carlson

FROM: Roger Gault

DATE: January 13, 2005

RE: PC-10 NCDT Request

The Engine Manufacturers Association (EMA) requests a change in the performance requirements for the PC-10 engine oil category currently under development.

Specifically, EMA requests that the CAT 1P test be added to the requirements for this category. As you are aware, the category currently includes the CAT C13 and CAT 1N tests. Although both of those tests remain important to the category in terms of measuring piston deposits, they do not adequately protect engines that utilize an articulated steel piston with minimum side clearance piston rings. Such pistons are prevalent in current heavy-duty engines and are expected to be used by one or more manufacturers in 2007. Therefore, to assure that PC-10 oils not only meet the chemical limits required for 2007 and later-year aftertreatment technologies, but also address/protect both current and future engine hardware technologies, we ask that all three tests be required for PC-10. Because the 1P is a previously developed engine test, which need not be included in either a precision or BOI matrix, it should not add to the cost or time required to complete the category.

EMA understands and shares the interest of its fellow stakeholders in eliminating redundant tests from the category. To that end, EMA member companies have reviewed the available data to determine whether the C13 or 1P test could replace the 1N test, which has been included in the category to measure the deposits on aluminum piston engines. To date, however, the data indicates that aluminum piston engines may not adequately be protected by either the C13 or 1P. Obviously, if any of the piston deposit tests are determined to be redundant during the matrix and technology demonstration phases of PC-10 development, EMA would be happy to withdraw its request for inclusion of that test in the category.

EMA appreciates the NCDT's consideration of this request and its continued cooperation on this very important project.

EMADOCS: 6509.2

PC-10 Engine Test Matrix Funding, Design, and Oils

**ASTM HDEOCP Meeting
January 13, 2005
San Antonio, TX**

PC-10 Engine Test Matrix

Funding

- **Plan to fund the PC-10 matrix established**
 - ❖ ACC & API each contribute \$1MM in cash
 - ❖ EMA to provide \$350M in cash and >\$650M in-kind
- **Trade association funding (\$2.35MM) plus stand calibration testing allows acceptable designs**
 - ❖ Overall cost (minus EMA in-kind) \$4.2MM to \$4.5MM
 - ❖ Stand calibration tests \$1.89MM to \$2.14MM
 - ❖ Industry funded tests \$2.33MM
- **Draft MOA sent to potential matrix participants**

PC-10 Engine Test Matrix

Matrix Design

- Preliminary designs approved MDTF:

		Cat C13	Cummis ISB	Mack T-12
Matrix Outputs	Precision	Yes	Yes	Yes
	BOI	Yes	No	No
Number of Tests		26	14 to 16	14 to 16
Calibration		12	6 to 8	6 to 8
Funded		14	8	8
Number of Oils		6	2 or 3	2 or 3
Number of Stands		7	4	4
Number of Labs		5	2 to 4	2 to 4
Runs / Stand	First Stands	4	4	4
	Second Stands	3	3	3

- Final matrix selection to be based on additional criteria
 - ❖ Readiness / willingness of individual labs and stands
 - ❖ Agreed distribution across labs and test costs to industry
- PC-10 MDTF to remain in case additional input is needed

PC-10 Engine Test Matrix

Oil Selection

- API LC endorsed the following on Dec 1:
 - ❖ Use base stocks offered to blend 6 “15W-40” matrix oils
 - ❖ PC-10B & PC-10E (“Base Oil 2”) as featured oils for all new tests
 - ❖ Guidelines for blending Technologies with “Base Oil 3”
 - Target the same base oil viscosity (KV100 +/- 0.2 cSt) used to blend with “Base Oils 1 and 2”
 - Maintain nominal SAE 40 finished oil KV100 achieved with “Base Oils 1 and 2”

- **Matrix Oil Key**

	Base Oil 1	Base Oil 2	Base Oil 3
Technology A	PC-10A	PC-10B	PC-10C
	C13	C13, ISB, T12	C13
Technology B	PC-10D	PC-10E	PC-10F
	C13	C13, ISB, T12	C13

- Notes: (1) Cat C13 to use PC-10B & PC-10E as the featured oils
(2) Both PC-10B and PC-10E to be available for ISB & T-12, but only one may be used

PC-10 Engine Test Matrix

Oil Selection

- **Matrix Oil Assignments**

Test	No.	Codes
Caterpillar C13	6	PC-10A thru PC-10F PC-10B & PC-10E featured
Cummins ISB	2 or 3	TMC 830 (M11-EGR) PC-10B and/or PC-10E
Mack T-12	2 or 3	TMC 820 (T-10 & T-11) PC-10B and/or PC-10E

- **Options to accommodate required use of current TMC ref oils in precision-only matrices being considered**
 - ❖ 820 in T-12 / 830 in ISB
 - ❖ MDTF statistical group developed designs to use 3 matrix oils
 - ❖ Use of non-matrix calibration tests could help

PC-10 Engine Test Matrix

Next Steps

- **Draft MOA being circulated for comments**
 - ❖ **Single document to cover all 3 new tests**
 - ❖ **Each test matrix will start when declared ready**
 - ❖ **Includes stipulation that BOI for ISB & T-12 is finalized before precision testing can begin**
- **Selection of specific matrix designs**
 - ❖ **Will be impacted by the number of labs and stands**
 - ❖ **Labs asked to provide estimate of stand availability**
 - ❖ **Final oil selection and criteria for participation in precision only matrices to be determined**
- **Complete blending of matrix oils**

**Memorandum of Agreement
For Funding of the ASTM PC-10 Test Matrix Program**

PURPOSE

The purpose of this Memorandum of Agreement is to define the responsibilities of parties interested in the completion of the ASTM PC-10 Test Matrix Program and to ensure the program is completed in a cost-effective and timely manner.

The ASTM PC-10 Test Matrix (hereinafter the "Test Matrix" or "Matrix") will provide data on engine tests that are being considered for use in the establishment of a new diesel engine oil category. This category is based on the performance levels needed for model year 2007 and earlier vehicles. Successful completion of the Test Matrix should enable the development of a new service category.

The parties covered by this agreement include three (3) trade associations, ? (?) laboratories, and ASTM International. The trade associations (hereinafter the "Trade Associations") are the American Petroleum Institute (API), the American Chemistry Council (ACC), and the Engine Manufacturers Association (EMA). The test laboratories are PerkinElmer Automotive Research (PE), Southwest Research Institute (SwRI), and ? and are referred to hereinafter as the "Matrix Labs" or "Test Laboratories."

SCOPE

This agreement addresses only provisions for funding the testing specified in the ASTM PC-10 Test Matrix. The ASTM PC-10 Test Matrix will be designed by the ASTM Heavy Duty Engine Oil Classification Panel (hereinafter the "ASTM HDEOCP"). The Test Matrix will include the following tests and number of test runs:

PC-10 Tests	Number of Test Runs
Caterpillar C13	26
Cummins ISB	14
Mack T-12	14

The number of test stands, laboratories and test oils have been chosen by industry statisticians to deliver optimum results. This agreement covers all operationally valid engine tests, all results of which will be used in establishing the precision of the PC-10 engine tests. Caterpillar C13 results will also be used to establish base oil interchange (BOI) guidelines for the C13 test. There is no provision for contingency funding for rerunning invalid tests.

PC-10 Test Matrix Decision Criteria

The PC-10 Matrix Design Task Force (MDTF) will recommend a test matrix design based on the matrix's ability to provide statistically significant data on the precision of the new proposed PC-10 tests. The ASTM HDEOCP will review and decide whether to accept the recommended test matrix design based on the considerations provided

below. If it accepts the MDTF recommendation, the test program may proceed. If it does not, the HDEOCP will return the recommended test matrix design to the MDTF for changes, and the process will repeat until the HDEOCP accepts the MDTF recommendation.

The ASTM HDEOCP must formally declare the Caterpillar C13, Cummins ISB, and Mack T-12 tests suitable for matrix testing in terms of test procedure, materials supply, and the ability to discriminate between oils before testing commences.

More specific factors that the ASTM HDEOCP is expected to consider include the following:

- The test results generated in the engine test type have demonstrated discrimination in the most current test procedure to the satisfaction of the appropriate ASTM Surveillance and Classification Panels. Each oil used to demonstrate discrimination should have a minimum of two valid test results in the most current test procedure.
- Each Matrix Lab has run at least two operationally valid tests (shakedown runs are eligible) using the Test Matrix procedure. The appropriate ASTM Surveillance Panel will decide if these test results are satisfactory in terms of precision and relative agreement among labs.

Test Program Readiness Criteria

Before testing may begin and in addition to approving the test matrix design, the HDEOCP must determine that the following conditions are met:

- The lab inspection team has made a visit to each Matrix Lab and filed a report regarding the Matrix Lab's conformance to specifications that include, at a minimum, completed lab inspection checklists.
- Matrix Lab readiness, as summarized by the lab inspection team reports, is deemed satisfactory by the appropriate ASTM Surveillance and Classification Panels.
- The current batch supply of critical test parts used in the Test Matrix is sufficient to use in post-matrix testing beyond one reference cycle.
- The HDEOCP has identified a project manager for the test program using the procedure shown below under **Test Management**.
- The MOA has been signed by all participating parties.
- The API Base Oil Interchange (BOI)/Viscosity Grade Read Across (VGRA) Task Force and API Lubricants Committee have approved the application of the BOI

and VGRA guidelines for the Cummins M11EGR and Mack T-10 tests to the Cummins ISB and Mack T-12 tests.

AGREEMENT CONCERNING FUNDING AND RESOURCES

The Trade Associations and Test Laboratories agree to provide funds and resources to ASTM to support the engine test matrix for the proposed diesel engine oil category as prescribed by the ASTM HDEOCP:

a) Trade Associations

The Trade Associations agree to provide the following funds to ASTM for the PC-10 matrix-testing program:

- The API will provide up to \$1,000,000 to ASTM for the PC-10 matrix-testing program.
- The American Chemistry Council will provide up to \$1,000,000 to ASTM for the PC-10 matrix-testing program.
- The Engine Manufacturers Association will provide up to \$350,000 to ASTM for the PC-10 matrix-testing program. Note that EMA also agreed to provide more than \$650,000 in in-kind funding as detailed in the attached spreadsheet (see Attachment 1).

The Trade Associations will be individually responsible for prompt disbursement of funds to ASTM upon receipt of invoice with a targeted processing period of ten (10) business days. ASTM will invoice the Trade Associations for their share of the cost of each test in the test matrix as each is started or when ASTM and a Trade Association(s) mutually agree to an earlier invoicing date. "Started" is defined as when the ASTM HDEOCP has adopted each test and said that it is ready for use in the matrix.

The Trade Associations are not responsible for any claims, liabilities, or damages and are not responsible for any claims arising out of any and all aspects of the testing performed pursuant to this agreement.

In the unlikely event that the Matrix is terminated, testing stopped, and/or the category development canceled, any unspent monies would be returned to the Trade Associations in the same ratio as the funds were collected for each test.

(b) Test Laboratories

The Test Laboratories agree to provide the following resources to ASTM for use in the PC-10 Test Matrix.

	Caterpillar C13		Cummins ISB		Mack T-12	
Lab	Lab Financed Runs	ACC/API/EMA Financed Runs	Lab Financed Runs	ACC/API/EMA Financed Runs	Lab Financed Runs	ACC/API/EMA Financed Runs

PerkinElmer						
SwRI						

To maintain confidentiality of pricing information, the full and final prices paid to a lab are shown only on that lab's copy and the master copy kept by API.

- **PerkinElmer** will provide to ASTM, at no charge, the pertinent data and results of ? (?) Caterpillar C13, ? (?) Cummins ISB, and ? (?) Mack T-12 tests for the PC-10 matrix. PerkinElmer also commits to conduct ? (?) Caterpillar C13, ? (?) Cummins ISB, and ? (?) Mack T-12 tests for the PC-10 matrix at the full and final price of _____.
- **Southwest Research Institute** will provide to ASTM, at no charge, the pertinent data and results of ? (?) Caterpillar C13, ? (?) Cummins ISB, and ? (?) Mack T-12 tests for the PC-10 matrix. Southwest Research also commits to conduct ? (?) Caterpillar C13, ? (?) Cummins ISB, and ? (?) Mack T-12 tests for the PC-10 matrix at the full and final price of _____.

All tests submitted by the Test Laboratories must be operationally valid. Operational validity of engine tests will be determined by the testing laboratory using guidance from the ASTM Test Monitoring Center (hereinafter the "ASTM TMC") and input from the Project Manager using guidelines established by appropriate ASTM Surveillance Panels prior to the start of each matrix. Matrix tests that are determined to be operationally invalid will be re-run at the cost of the test laboratory. The Test Laboratories are not responsible for performing any testing beyond what is stated above.

TEST MANAGEMENT

ASTM and the appropriate ASTM committees agree to act as the fund and test administrators for the PC-10 matrix. The responsibilities of ASTM and the ASTM committees are as follows:

- ASTM will act as the fund-dispersing agency for the PC-10 matrix. API, ACC, and EMA will be invoiced as described above in **Agreement Concerning Funding and Resources, section (a), second paragraph**, according to the contribution level of each association. ASTM will disburse funds to the Test Laboratories on a per test basis.
- ASTM HDEOCP will be responsible for the management of the PC-10 matrix testing. The PC-10 New Category Development Team (hereinafter the "PC-10 NCDT") and API/EMA Diesel Engine Oil Advisory Panel (hereinafter the "DEOAP") will provide oversight and guidance to the ASTM HDEOCP on all issues pertaining to funding, timing or revisions to the initial matrix design. The PC-10 NCDT and DEOAP will get appropriate direction from API, ACC, and EMA. If the PC-10 NCDT and DEOAP

revise the matrix after commencement of the testing, the PC-10 NCDT Chair and DEOAP Co-Chairs will immediately communicate with and obtain concurrence to the changes by all parties in this agreement.

- The Chair of the ASTM HDEOCP in consultation with the PC-10 NCDT Chair and DEOAP Co-Chairs is responsible for identifying a project manager who will be responsible for the technical oversight and direction of the project. The project manager will also be responsible for reporting the status of the program to the Chair of the ASTM HDEOCP with copies to Trade Association staff, the Test Laboratories, the PC-10 NCDT, and the DEOAP.

TEST SCHEDULE

The testing covered by this agreement begins when each of the three tests—Caterpillar C13, Cummins ISB, and Mack T-12—have been formally affirmed "ready for matrix testing" by the ASTM HDEOCP and all other conditions shown above under **Scope** have been met.

The targeted completion date for each engine test for the ASTM PC-10 test matrix is ? months after its commencement date. The commencement date is the date that the first test begins. Extension of the timing past this targeted completion date must be approved by the PC-10 NCDT and DEOAP.

COMPLETION OF TESTING & TEST REPORTS

The Test Laboratories will immediately communicate Matrix test results to the ASTM TMC, the Trade Association staff person designated by each association and the ASTM HDEOCP Chair. All reports shall become the property of the parties to this agreement. Each party shall have the right to use the report in any manner it deems appropriate. ASTM will return any funds unspent for any reason to API, ACC, and EMA based on their originally contributed percentages.

MISCELLANEOUS TERMS

- The parties express their continued support for the development of future diesel engine oil categories.
- The Trade Associations express their continued support for the API Engine Oil Licensing and Certification System and agree to promote its use for as long as the system remains fully functional.
- The Test Laboratories shall not be responsible for any use made by any other party of the data and test results provided by the Test Laboratories nor liable for the consequences of any such use.

- This document represents the final written understanding of all of the terms of this agreement and is a complete statement of those terms.
- This agreement will be executed in ? counterparts, and each counterpart shall constitute an original instrument, but all such separate counterparts shall constitute only one and the same instrument. Each party will sign a separate copy of the same document. Each copy shall be considered as an original document and all signed copies together shall be the same document.
- This agreement, and all rights, duties and responsibilities herein, shall not become effective until all parties have executed this agreement.
- The parties express their continued support for the development of laboratory stand calibration based on acceptable test results from matrix runs.

American Petroleum Institute

American Chemistry Council
(On behalf of ACC PAPTG)

By: _____

By: _____

By: _____

Date: _____

Date: _____

ASTM International

Engine Manufacturers Association

By: _____

By: _____

Date: _____

Date: _____

PerkinElmer Automotive Research

Southwest Research Institute

By: _____

By: _____

Date: _____

Date: _____

Mack T12 Engine Test Update

January 13th 2005



Mack Powertrain Division

- 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



•Hardware (External)

Same as T10 Except – VGT Turbo replaces

small T10 Turbo

2 Production EGR Coolers (Breadboard) Replaces Tube Cooler-Test with 3 ?

•80 C EGR Coolant Inlet Temp
EGR on/off Valve

•Hardware (Internal)

T11 Power Cylinder (**T10 Top Ring**) & T11 Heads
New Nozzles & Spray Angle

– T12 Conversion Kits Sent to Labs

•T12 TASK FORCE – Numerous Teleconferences, Oct 20 Mtg in San Antonio –
Meeting Nov 22nd @ ExxonMobil- Next **Mtg Jan 12th** in San Antonio

•Next Meeting – Feb 22nd Chicago

•Test Procedure Available, T12 Parts List Completed

•Completed Test on 820-2 (T10 Ref Oil) , 2nd Test to Complete Mid November

•Engines in 4 Labs Running week of Jan 10th

•Task Force Recommends the use of dyed PC 10 ULSD

•Task Force Recommends 820-2 Should be Part of Precision Matrix



Mack Powertrain Division

Lubrizol- 2 Coolers – 80 hrs with NO sign of fouling

**Perkin-Elmer – 2 Coolers 100 hrs live test (820-2) – Cleaned Coolers @ 77 hrs (Ni 1ppm)
2nd Stand with 3 Coolers – wk of Jan 24th**

Afton – Start 3 Coolers wk of Jan 10th 100 hrs

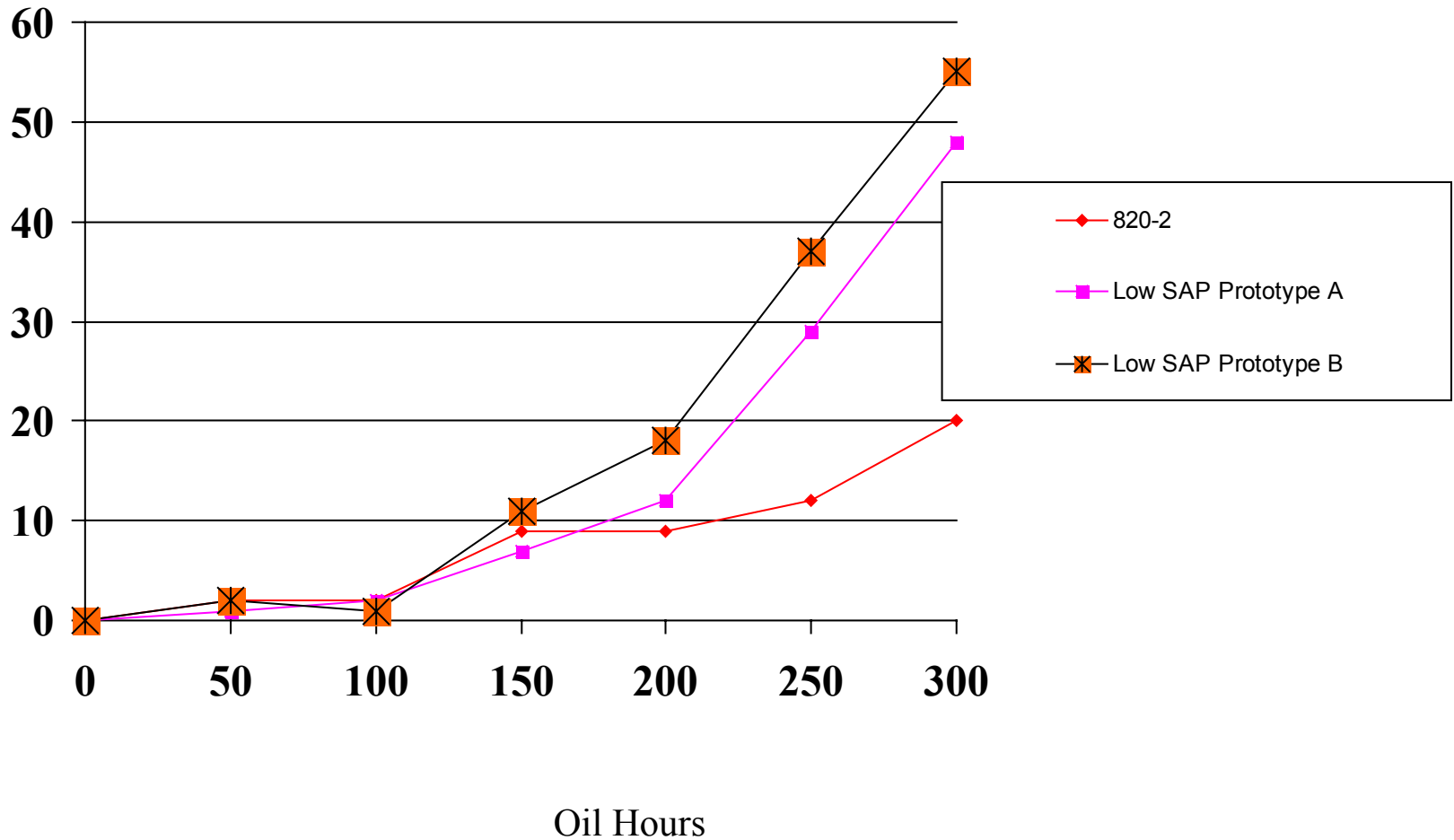
ExxonMobil – Start 3 Coolers wk of Jan 17th – Live Test

SWRI - Continue Running 2 Coolers until 3 Cooler data avail

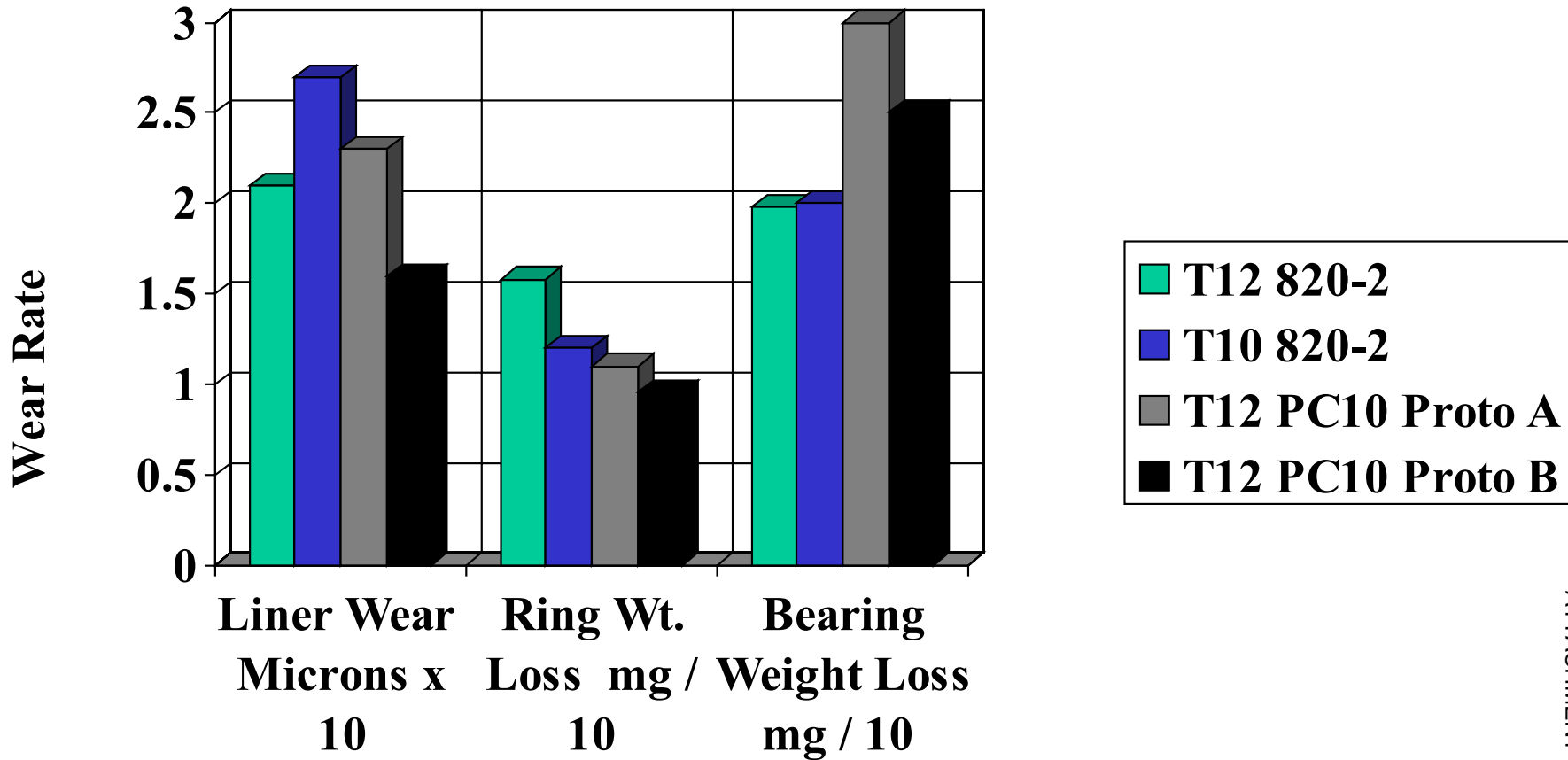


T12 Pb (ppm) Discrimination

P
b



Wear / T12 vs. T10 820-2 T12-820-2 vs. PC10 Prototype



GLS JAN 12TH 2005



Mack Powertrain Division

T12 PC10 Engine Oil Test Development Schedule

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



Status of ISM / ISB Test Development

1/13/05

D M Stehouwer
To HDEOCP

Conclusions from Surveillance Panel

- **Several elements of the ISM test were approved to carry forward to PC-10**
 - **Data from 3 additional tests added to statistical analysis**
 - **Outlier criteria defined for individual parts**
 - **Panel voted to move forward with:**
 - **Wear: Crosshead and adjusting screw**
 - **OFDP @ 150 hrs**
 - **Sludge**

Conclusions from Surveillance Panel

- **Wear: Crosshead and adjusting screw**
 - 830 and 1004 discrimination statistically significant
 - Outlier rejection approved @ 95% for Intake & Exhaust Crossheads, and Inj. Adj. Screws
 - Soot Correction not needed within the window of operation which will go forward
- **OFDP**
 - 150 hr data
 - Natural log transformation
 - 830 and 1004 discrimination statistically significant
 - No soot correction
- **Sludge**
 - No transformations needed
 - Ratings equivalent to M11-EGR

Conclusions from Surveillance Panel

- **Voted to remove Valve Adj. Screw and Rod Bearing wt. loss from further analysis and the procedure.**

ISM Action Items

- **Surveillance Panel will continue to evaluate crosshead wear and injector adjusting screw data**
 - One more test due
- **SP will address lab severity issues**
- **SP will address correlation with M11 EGR**

Executive Summary

- **Both Levels of Soot Data Used in Analysis**
 - **Crosshead Wear, Sludge, Oil Filter Delta Pressure, Injector Screw, Valve Adjusting Screw, Bearing Wear**
- **Soot Correction for CWL and IAS Possible**
- **Oil Discrimination on Some Parameters**
- **Lab A has Significantly Higher Oil Consumption and Some Lower Sludge Ratings**
- **Lab D has Significantly Higher CWL**
- **Lab B has Significantly Higher BWL**
- **Outlier Criteria a Possibility, but NOT Used in Conjunction with Soot Correction**

ISM Matrix

Stage: Avg Soot	Lab A	Lab G	Lab B	Lab D
ISMA	1: 3.7% 2: None	1: 3.4% 2: None	1: None 2: None	1: None 2: None
1004-3	1: 3.5% 2: 4.3%	1: 3.4% 2: 3.9%	1: 3.5% 2: 3.9%	1: None 2: None
830-2	1: None 2: 4.0%	1: None 2: 3.8% 2: 3.8%	1: None 2: 4.1% 2: 3.7%	1: None 2: 3.8% 2: 4.0%

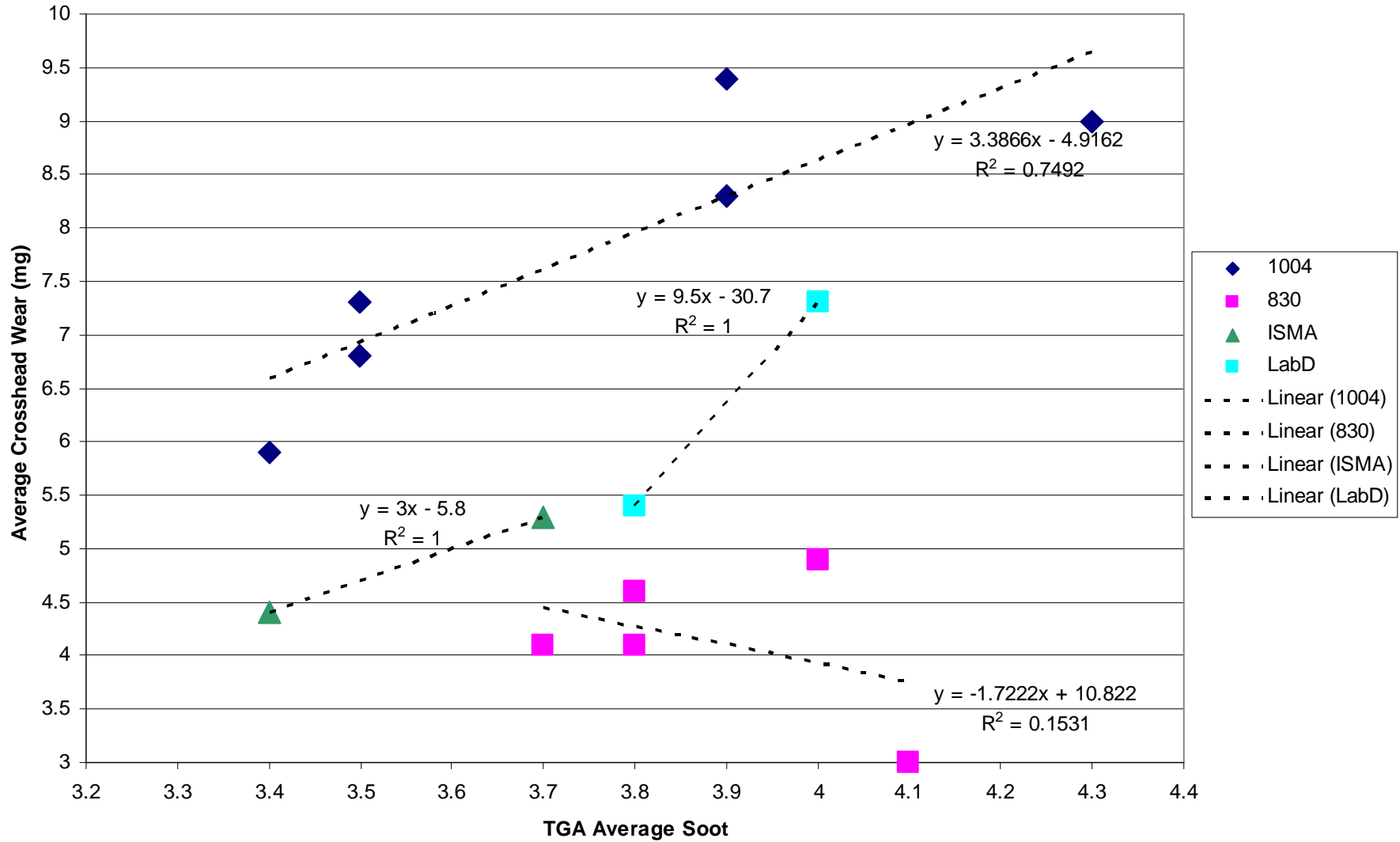
Cross Head Weight Loss

- **Model Fit: $CWL=f(\text{Lab, Oil, Average Soot})$**
 - Lab D Severe
 - All 3 Oils Statistically Significantly Different
 - CWL Increases 3.15 per 1% Avg Soot
- **With Outlier Criteria (95% and 99%)**
 - **Model Fit: $CWL=f(\text{Lab, Oil, High vs Low Soot Target})$**
 - Lab D Severe (Not Different from A with 95% Outlier Criteria)
 - All 3 Oils Statistically Significantly Different (ISMA:1004 Tukey p-value=0.06 with 95% Outlier Criteria)
 - **CWL Higher at Higher Soot Target, BUT CANNOT Establish Linear CWL:Soot Relationship**

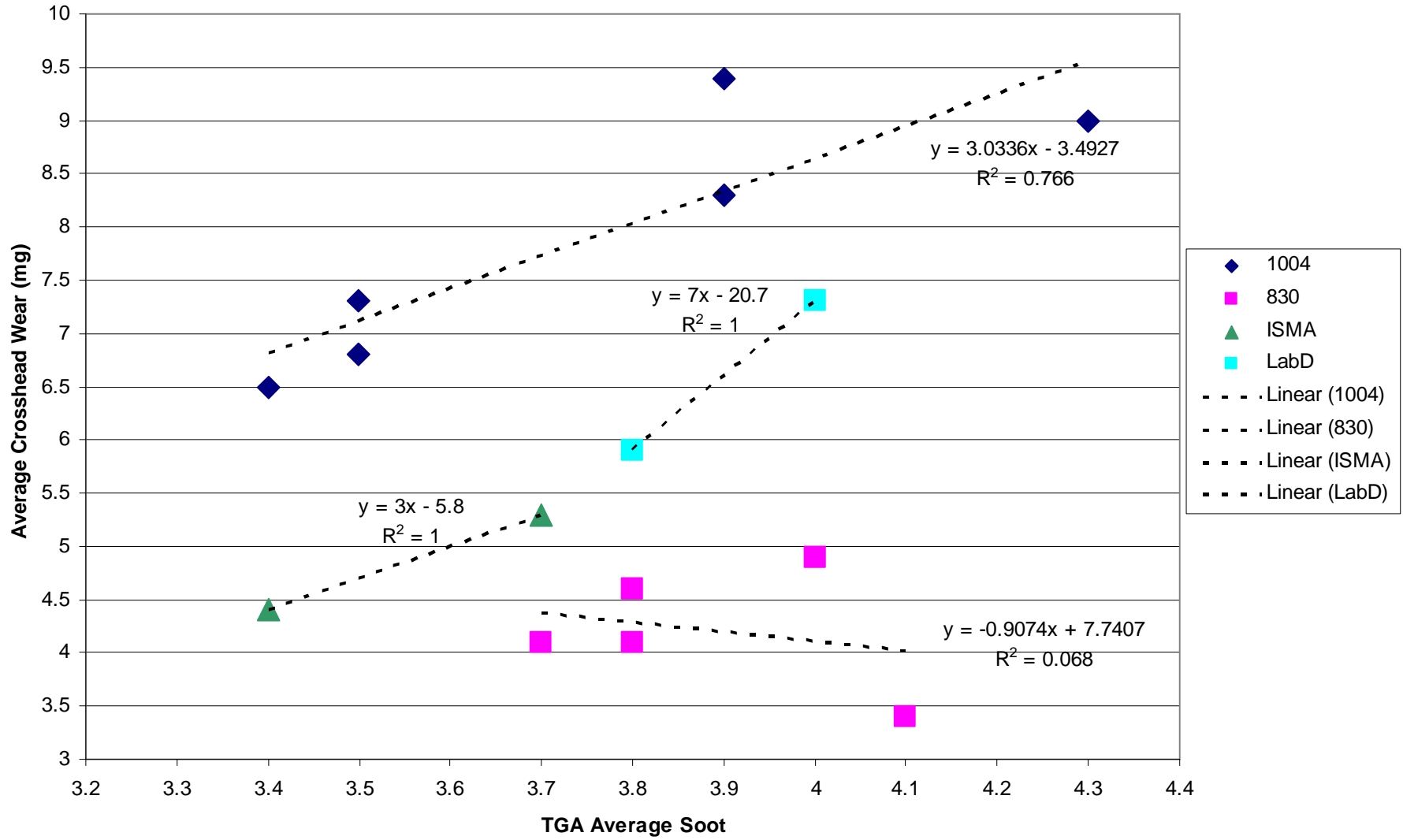
Cross Head Weight Loss

Crosshead Weight Loss			
At New Soot Level			
95% Outlier Criteria	Oil 1004	Oil 830	Oil ISMA
CWL LS Mean	9.4283	4.7652	7.5191
CWL Mean	8.9000	4.7714	7.0833
CWL StdDev	0.5704	1.3462	0.6364
CWL LS Mean (Lab D*)	8.9000	4.2369	6.9908
CWL Mean (Lab D*)	8.9000	4.1400	7.0833
CWL StdDev (Lab D*)	0.5704	0.7232	0.6364
Pooled s from Model	0.7472		
M11 EGR Target	99.8000	12.2000	5.1000
Crosshead Weight Loss			
At New Soot Level			
99% Outlier Criteria	Oil 1004	Oil 830	Oil ISMA
CWL LS Mean	9.4742	4.8774	7.3734
CWL Mean	8.9000	4.9000	6.8833
CWL StdDev	0.4351	1.3153	0.6364
CWL LS Mean (Lab D*)	8.9000	4.3032	6.7992
CWL Mean (Lab D*)	8.9000	4.2200	6.8833
CWL StdDev (Lab D*)	0.4351	0.5718	0.6364
Pooled s from Model	0.5674		
M11 EGR Target	99.8000	12.2000	5.1000

ISM Matrix Average Crosshead Wear as a Function of Soot
Two-Sided 95% Outlier Screening



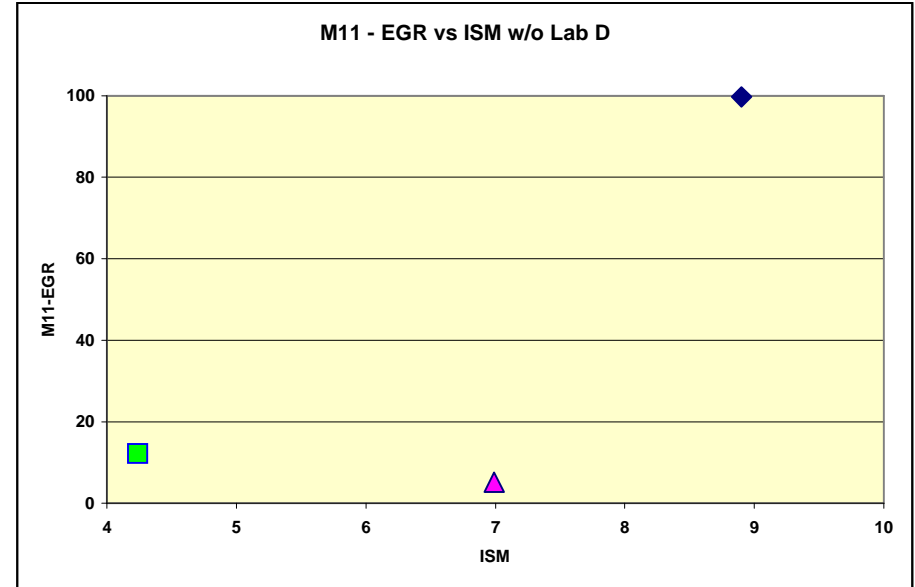
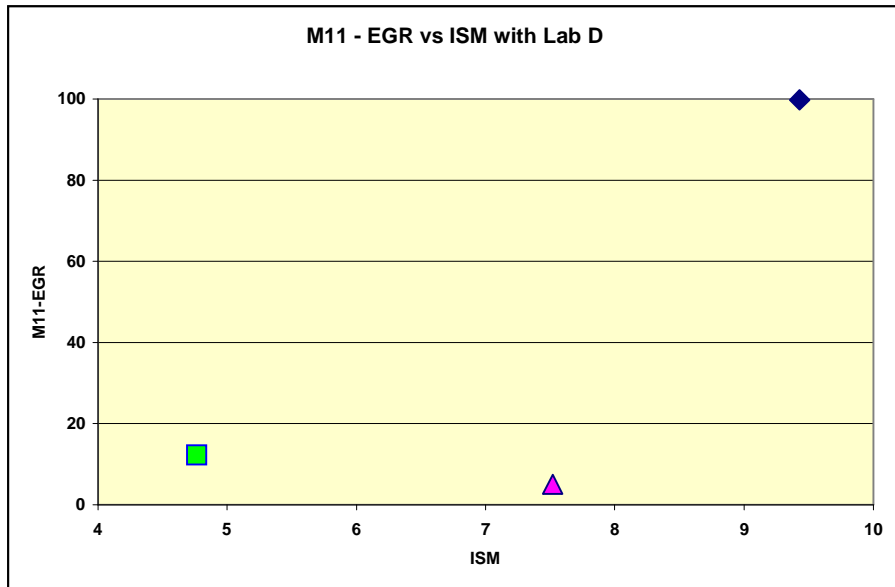
ISM Matrix Average Crosshead Wear as a Function of Soot
Two-Sided 99% Outlier Screening



Cross Head Weight Loss

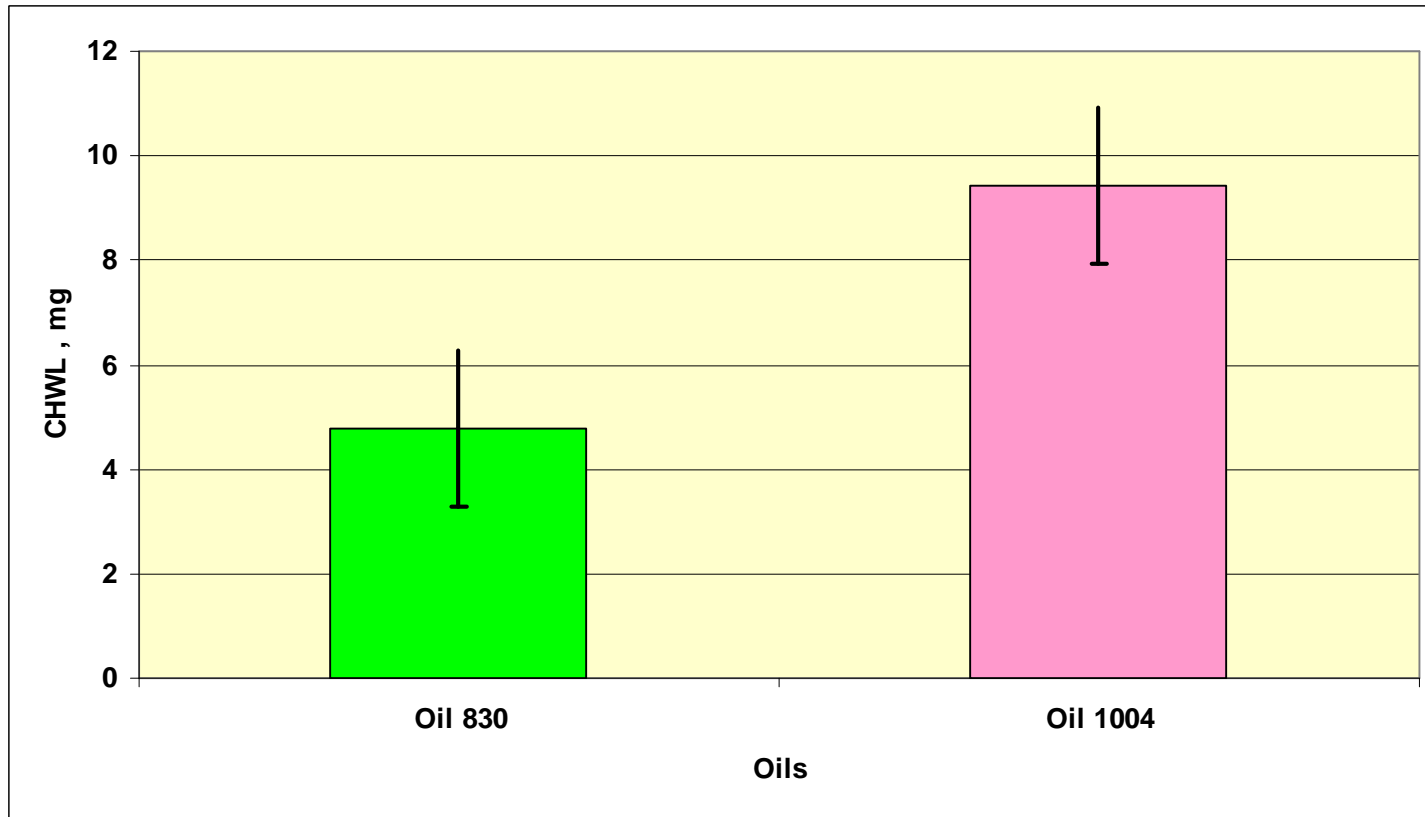
- **Within the band of soot values expected and the high condition going forward, and with outlier rejection, there is no need for a soot correction**
- **Good discrimination is maintained**
- **Repeat analysis with values in current soot window**

Relation of M11-EGR and ISM



Crosshead Wt Loss Discrimination

- High soot level
- CHWL +/- 2 sigma

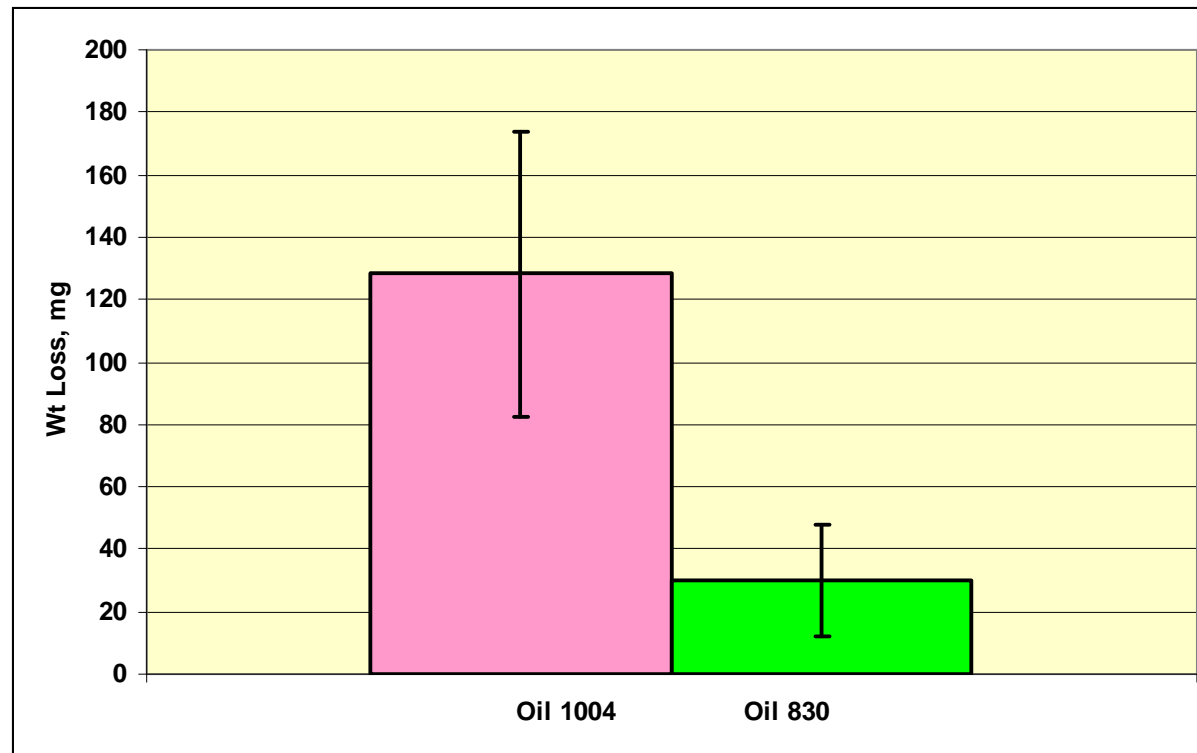


Injector Adjusting Screw Weight Loss

- **Model Fit: $AVGIAS=f(\text{Lab, Oil, Average Soot})$**
 - **No Lab Differences**
 - **Oil 830 Statistically Significantly Different**
 - **Oil 830 Marginally Statistically Significantly Different from Oil ISMA (Tukey p-value=0.07)**
 - **AVGIAS Increases 111.74 per 1% Avg Soot**
- **Repeat analysis with values from current soot window**

Injector Adjusting Screw Weight Loss

Injector Screw Wt Loss at New Soot Level	1004	830
IS LS Mean	128.3	30.2
StdDev	22.8	8.9

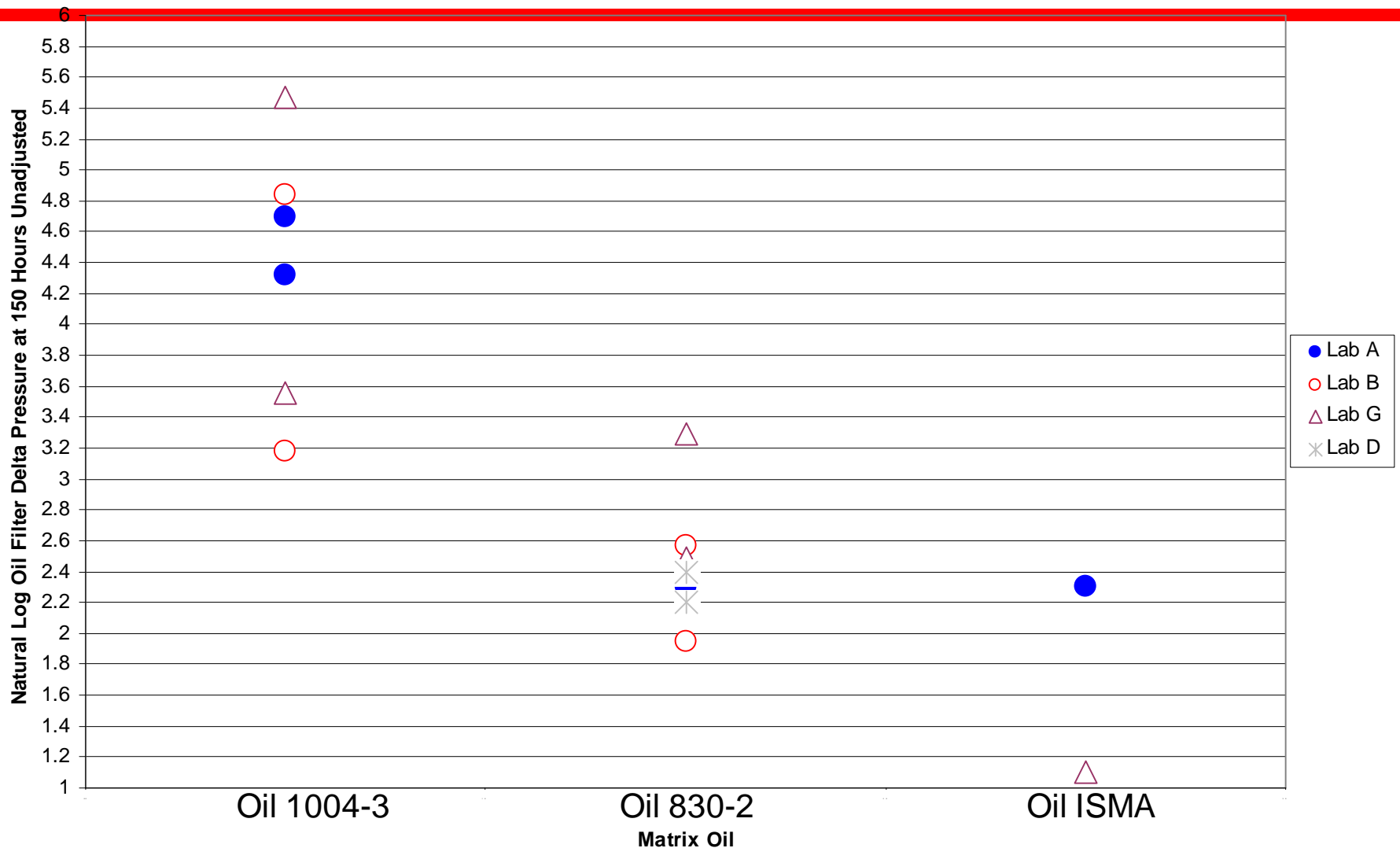


Oil Filter Delta Pressure

- **Model Fit: FDP=f(Lab, Oil)**
 - **No Lab Differences**
 - **Oil 830 Marginally Statistically Significantly Different from Oil 1004 (Tukey p-value=0.07)**

Oil Filter Delta Pressure	Oil 1004	Oil 830	Oil ISMA
FDP LS Mean	100.5075	12.4675	-1.7325
FDP Mean	101.3333	12.7143	6.5000
FDP StdDev	78.0197	6.6009	4.9497
Pooled s from Model	56.1800		
M11 EGR Target	182.0000	141.9000	144.0000

ISM Matrix Oil Filter Delta Pressure as a Function of Lab and Oil



ISM Action Items

- **Surveillance Panel will continue to evaluate crosshead wear and injector adjusting screw data**
 - One more test due
- **SP will address lab severity issues**
- **SP will address correlation with M11 EGR**

ISB Test Development Progress

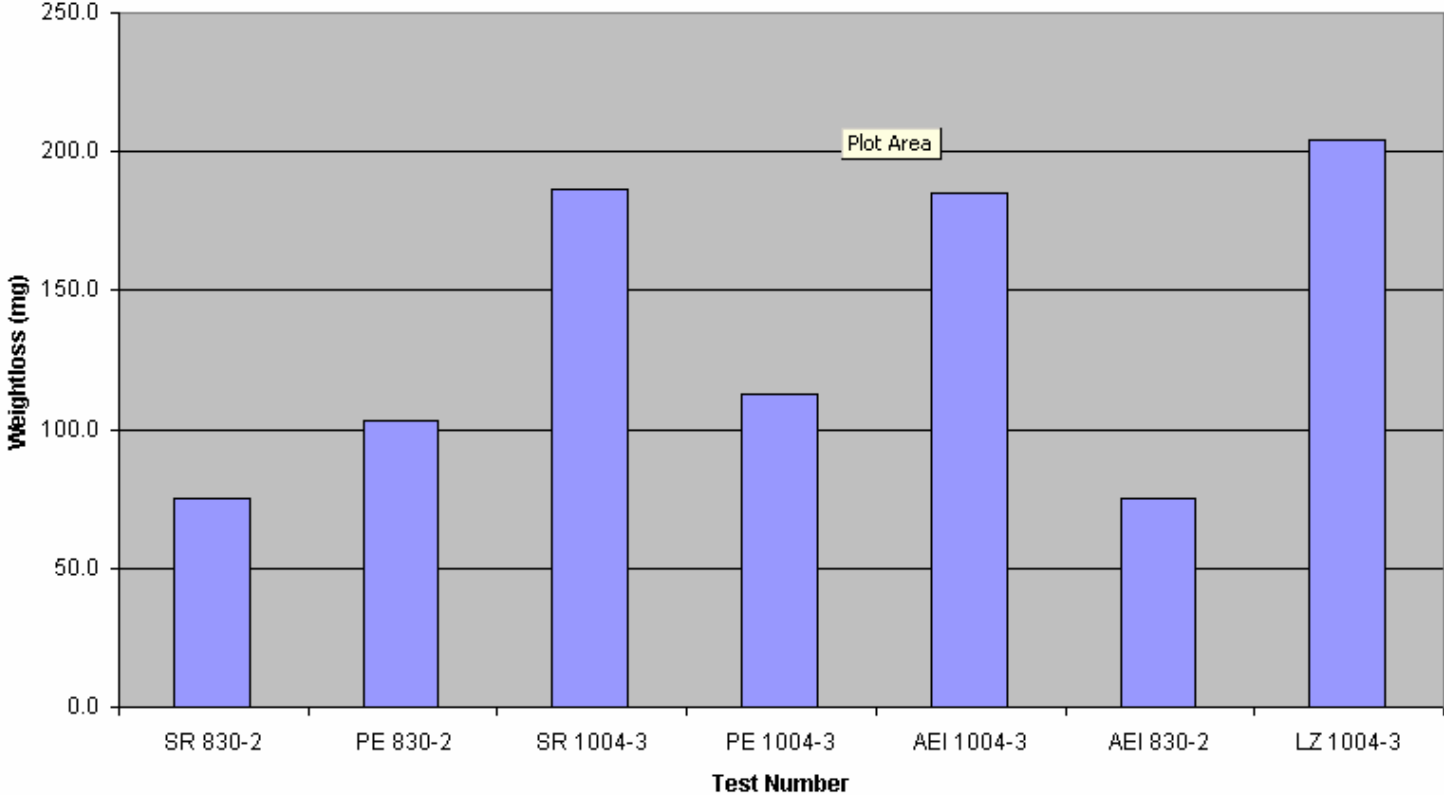
- **Labs and Engines**
- **Procedure**
- **Special Parts and Cam Measurement**
- **Modifications to Hardware and or Procedure**
- **Move Forward to Matrix**

ISB Engines at Labs

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

Mini-Matrix Data

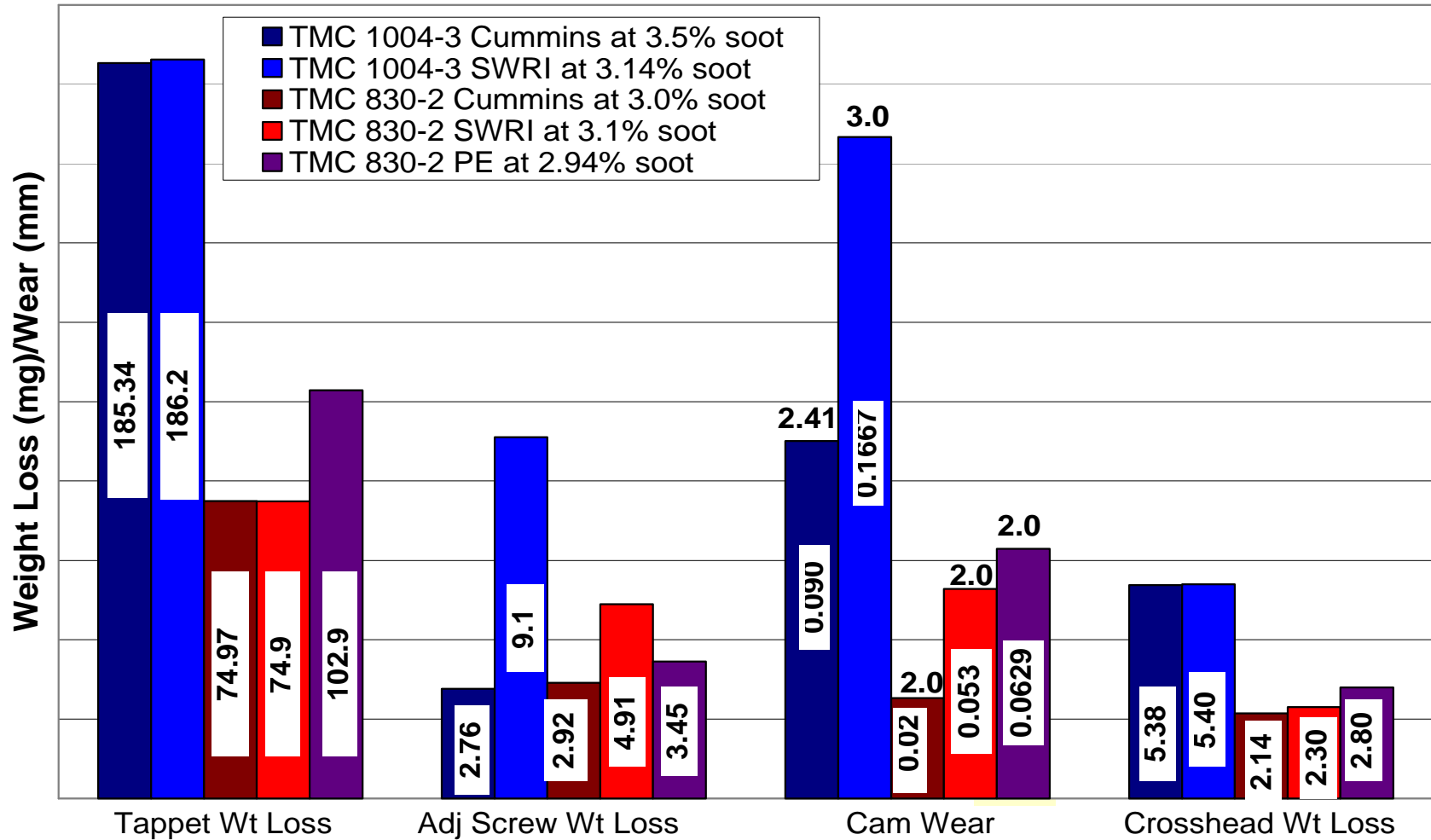
Slider Tappet AVG Weightloss



ISB Camshaft and Tappet Data

Discrimination/Repeatability

ISB Cam Cycle Test Data



ISB Status / Summary

- **Warren to Supply Updated Procedure in ASTM Format**
- **Discrimination maintained with Mini-Matrix**
 - Complete Cam wear data
 - Lab process / severity issues
- **Lab operational data review**
- **Build and Hardware Workshop Feb 1**
- **Matrix Design**

Caterpillar C13 Test Criteria

500 hour – Steady State Test Cycle

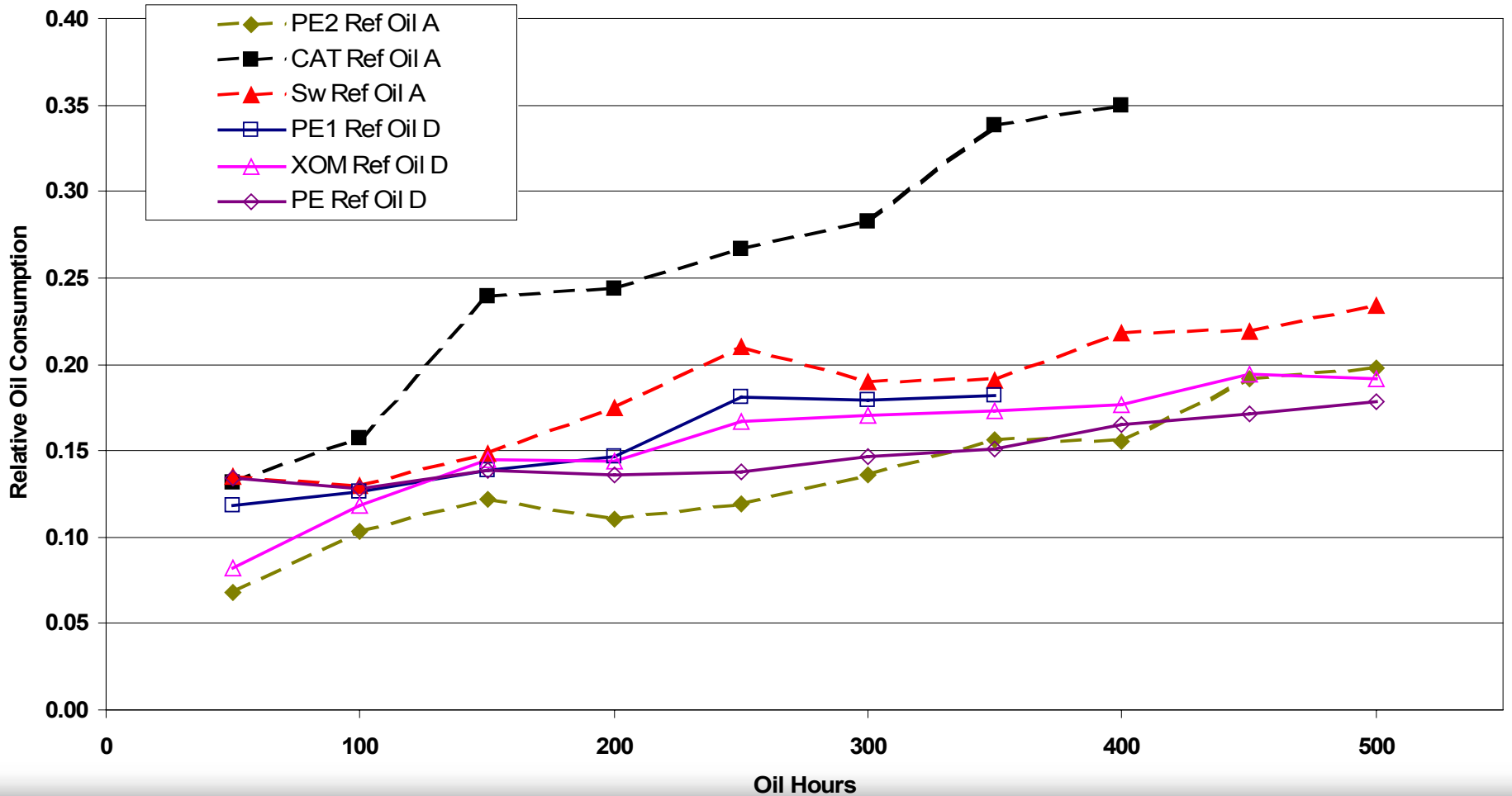
Test Pass/Fail Criteria:

- No Loss of Oil Consumption Control
<20% or lower? (based on average of EOT vs SOT)
- Last 150 hours stable Oil Consumption
- No stuck rings/Loss of ring side clearance



Caterpillar C13 Test Update

C13 Raw Oil Consumption

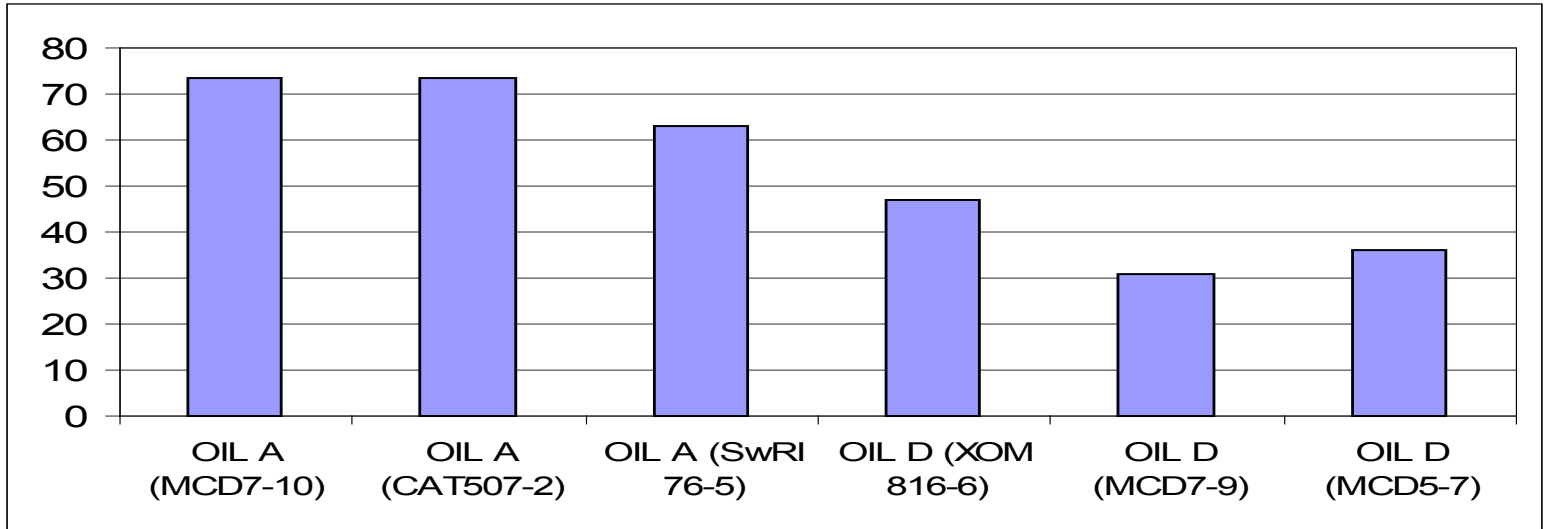


ATTACHMENT 10, 2 OF 7



Caterpillar C13 Test Update

January 12, 2005



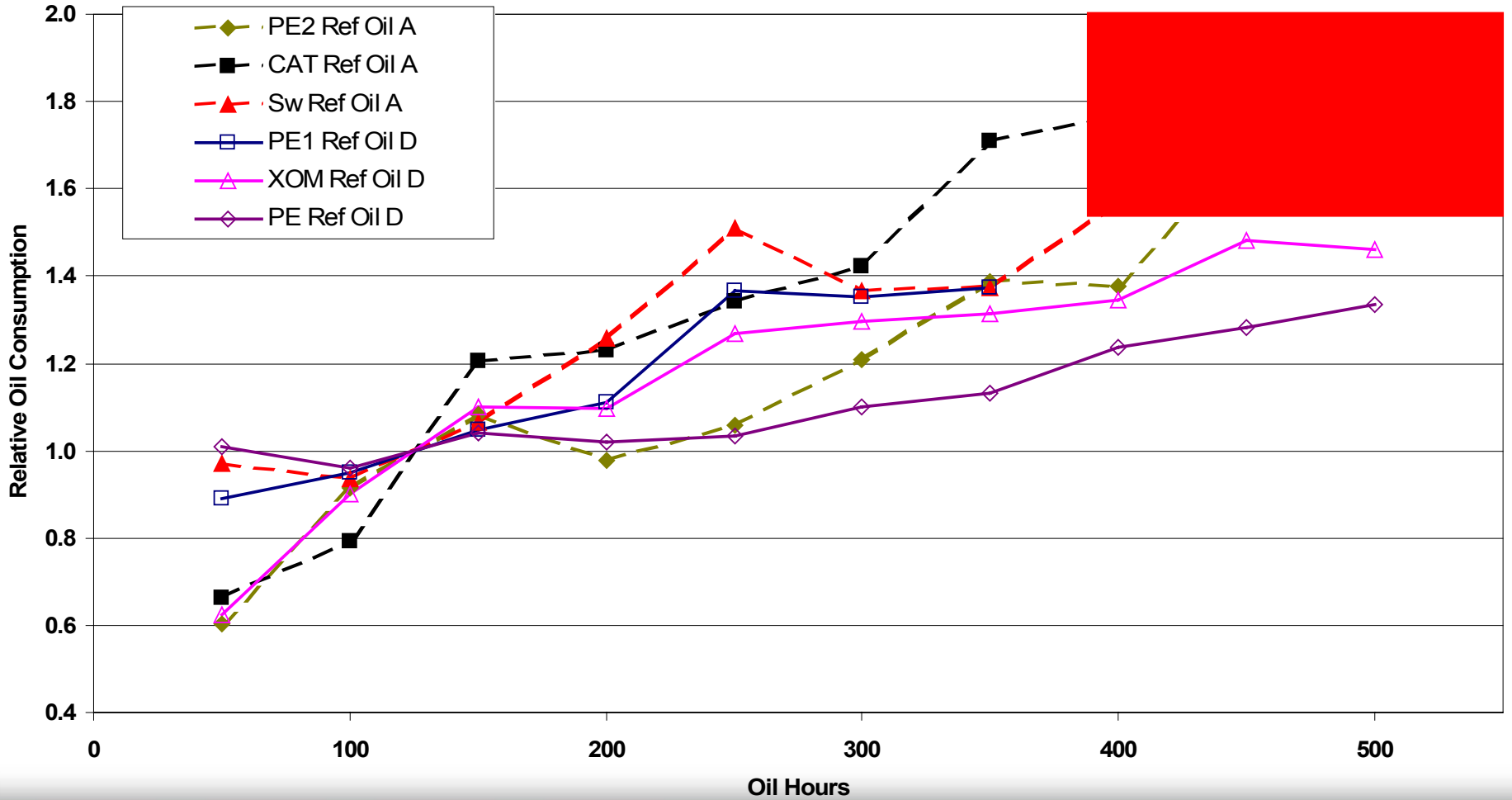
<u>Oil</u>	<u>Test Hours</u>	<u>Oil Cons Inc</u>
Oil A (MCD7-10)	500	73.3
Oil A (CAT507-2)	400	73.6
Oil A (Sw76-5)	500	62.9
Oil D (XOM816-6)	500	47.1
Oil D (MCD7-9)	500	30.7
Oil D (MCD5-7)	350	36.2

ATTACHMENT 10, 3 OF 7



Caterpillar C13 Mini-matrix Test Status

C13 Normalized Oil Consumption



ATTACHMENT 10, 4 OF 7



No CCV, ULSDF Tests, Second Ring

<u>Oil</u>	<u>RSC # (max loss)</u>	<u>TLC (Ave)</u>
Oil A (MCD7-10)	0 (0.02)	31
Oil A (CAT507-2)		
Oil A (Sw76-5)	3 (0.06)	36
Oil D (XOM816-6)	0 (0.04)	20
Oil D (MCD7-9)	1 (0.06)	24
Oil D (MCD5-7)		

ATTACHMENT 10, 5 OF 7



Cat Single vs Multi- Cylinder

- 1P and C13 needed for PC-10
- 1K/1N supportable but not at expense of 1P
- 1P covers 1K/1N due to greater severity (Afton, Oronite data confirm this)



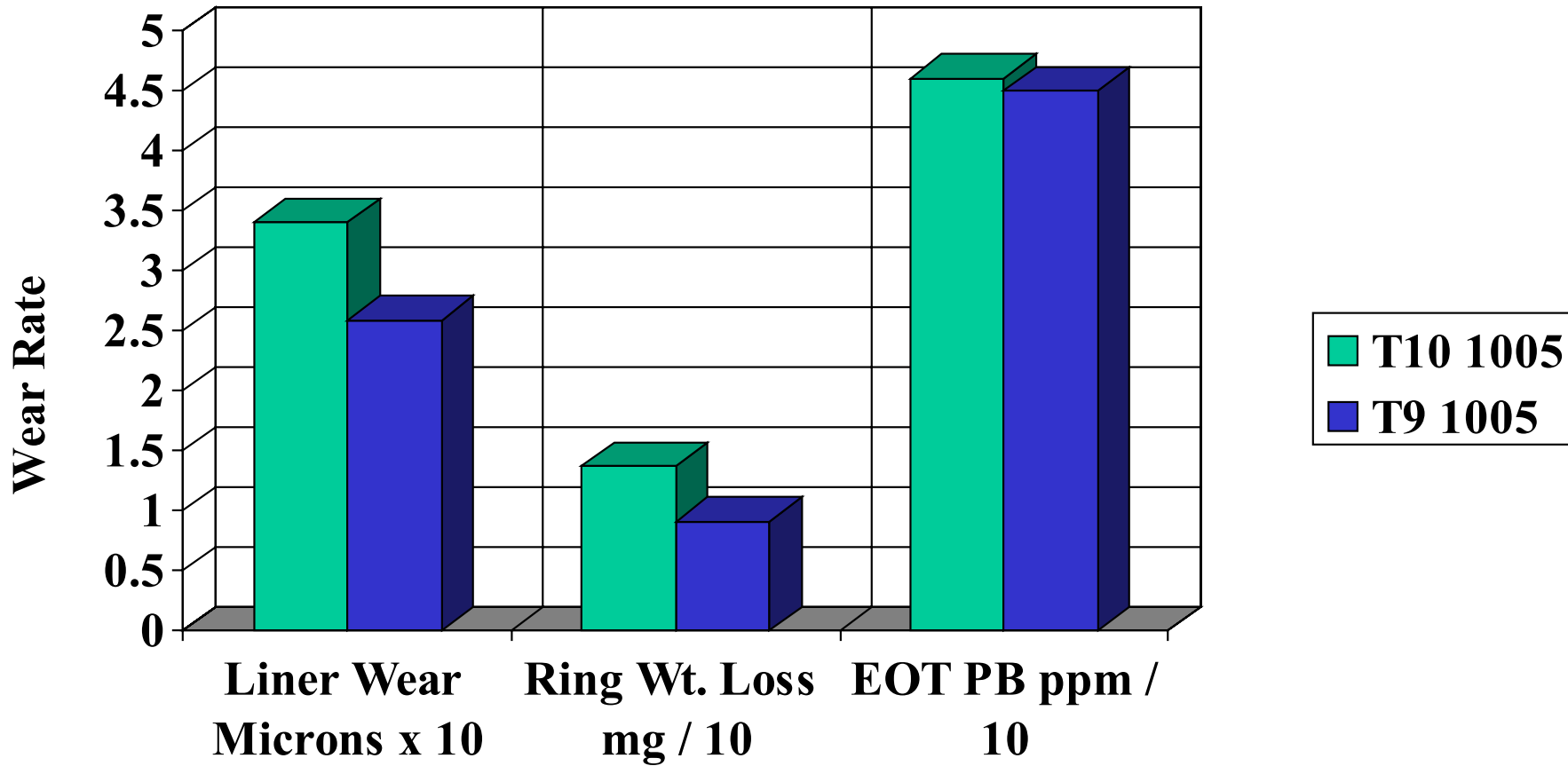
Cat Single vs Multi- Cylinder Avg. Temperatures (°C)

	TL	TG	2L	2G	3L	3G	Oil
1N	365	310	260	230	150	130	107
1P	283	231	171	154	142	148	130
C13	237	184	148	132	127	124	105



		PC-9	LSRD-4	EC-ULS	Chevron Phillips Diesel UL Sulfur type (Desce)	
Lot No.	4APPC901	RJ1321LS13	SK0921LS01	3LPULD01		
API gravity	35.76	34.8	37.1	39.23		
KV40	2.51	2.8	3.4	2.41		
IBP C	163	192	249	198.3		
	50% 260	268	268	253		
	90% 316	319	310	311.7		
FBP C	349	334	330	350.8		
Cetane No.	44.5	47.4	57.3	NA		
Cetane Index D976	47		51	51.2		
Cetane Index D4737	NA	NA	56.2	NA		
Aromatics	32.6	28.7	1	27.6		
Sulfur	432	400	12	0.5		
					ATTACHMENT 11	

Wear / T10 vs. T9 1005



GLS Jan 12th 2005



Mack Powertrain Division

