HEAVY-DUTY ENGINE OIL CLASSIFICATION PANEL

OF

ASTM D02.B0.02

November 11, 2004

The DoubleTree Hotel – Rosemont, IL

ACTION ITEMS

1. Recommend T-10 limits for T-9 performance. (Left Over)	**Mack Surv. Panel & EMA**
2. Exit Ballot on ISM inclusion in PC-10	**Jim McGeehan**
3. Continue data collection and discussion of 1P v 1K/1N	**Infineum and Others**
4. Discuss 820 as a T-12 matrix oil.	**Interested parties**

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 8:09 a.m. on November 11, 2004 in the DoubleTree Hotel of Rosemont, Illinois. There were 18 members present or represented and approximately 17 guests present. The attendance list is shown as Attachment **2**.

2.0 Previous Meeting Minutes

2.1 The minutes of the September 29, 2004 meeting were amended per Tom Cousineau as follows: The first sentence of section 7.21 should have the words “in the field” added to its end, to clarify the source of Cummins concern. In section 8.4, the “CF” should be “CF-4”.

2.2 Dave Stehouwer moved that the minutes of the 9/29/04 meeting be approved as amended, seconded by Heather DeBaun. The amended minutes were approved by unanimous voice vote.

3.0 Membership

3.1 Mary Graham of ConocoPhillips sent a letter conveying her resignation from the HDEOCP and requesting that David Taber of ConocoPhillips take her place. Mr. Taber was introduced and welcomed, with thanks to Mary for her participation.

4.0 Agenda

4.1 The published agenda (Attachment **1**) was reviewed and Becky Grinfield requested an earlier slot for travel considerations.

5.0 Elastomer Compatibility Test Method

5.1 Becky Grinfield reviewed concerns with the Elastomer Test Method (see Attachment **3**). Presently, the specification limits contained in D4485 are adjusted by the method to produce "acceptance" limits, which reflect current test variability. Becky proposed: 1.) To accept the concept of an Annex to D4485 (see Attachment **3A**), which explains how the elastomer specification limits are adjusted, forming the "acceptance" limits. The annex would take the place of an extensive footnote. 2.) To allow the Elastomer Surveillance Panel to finalize the wording of the proposed annex and then move it forward for "B" ballot. Lew Williams seconded the motion, which passed via unanimous voice vote.

5.2 Becky also reviewed data obtained by the surveillance panel and the TMC on the performance of Vamac, along with potential specification limits for Vamac (see Attachment **4**).

6.0 PC-10 NCDT

6.1 Bill Runkle presented the NCDT report on PC-10 (see Attachment **5**) and noted that the API LC wants the category delayed if necessary, to include the C13 unless Caterpillar withdraws the C13 as a service requirement.

7.0 PC-10 Matrix Funding and Design

7.1 Steve Kennedy reported that Funding Task Force had agreed to sufficient in-kind contributions from the engine manufacturers to permit the full $1,000,000 contributions each from the ACC and API. The total contributions from the ACC, API, EMA and test laboratories will allow a precision plus BOI matrix to be run for the C13 and precision only matrices for the ISB andT-12 tests. See Attachment **6**.

8.0 Matrix Oils

8.1 Greg Shank noted that EMA has selected two additive technologies for use in blending the matrix oils. See Attachment **7**.

9.0 1P – 1K/1N Comparison

9.1 Bill Kleiser reviewed 1P/1K data from the same oils and concluded that passing the 1P test insured passing the 1K test (see Attachment **8**).

9.2 Charlie Passut reviewed more 1P/1K data (see Attachment **9**) with much the same observation…passing the 1P, an oil would pass the 1K.

9.3 Both Bill and Charlie felt there was insufficient 1P/1N data to analyze.

9.4 Joan Evans agreed to send more 1P data to Jim McGeehan and this item will be on the December meeting agenda.

10.0 PC-10 Test Development Updates

10.1 Greg Shank reported on T-12 progress and displayed some 820-2 results (see Attachment **10**). He indicated there will soon be four or five labs with T-12 installations and there will be at least six stands. There was some discussion on the use of 820-2 as a matrix oil, so this topic will be part of the December agenda.

10.2 Dave Stehouwer reported on the ISM and ISB (see Attachment **11**). The ISM Task Force feels the test has shown the ability to discriminate with sufficient precision on wear and filter plugging, to proceed with an exit ballot before the December meeting. Dave proposed and Greg Shank seconded a motion that an exit ballot on including the ISM in PC-10 be conducted before the December meeting. The motion passed via unanimous

voice vote. For the ISB, the task force expects four tests to complete by Dec. 6, using oils 1004 and 830.

10.3 Abdul Cassim reporting on C13 progress, indicated the task force has decided to stop using simulated CCV, but to keep using ULSD fuel (see Attachment **12**). The task force is still working on developing discrimination data.

10.4 Joan Evans requested that the decision on including a Sequence III test (F or G) in PC-10 be postponed until sufficient T-12 data is accumulated (see Attachment **13**). An e-mail from Bill Nahumck (Attachment **14**) indicates there should be sufficient Seq. III parts available to support testing through at least 2008. Jim Mcgeehan also requested that decision on a PC-10 oxidation test be postponed until more data is available from the C13 and T-12 tests (see Attachment **15**).

10.4.1 Joan Evans moved and Bill Kleiser seconded a motion that the HDEOCP wait to decide on an oxidation test for PC-10 until data becomes available from other tests under development. The motion passed with 17 for, 0 against and 0 abstain.

11.0 PC-10 Fuel Supplier Selection

11.1 Jim wells reported for the PC-10 Fuel Supplier Selection Task Force (see Attachment **16**). The task force recommended Supplier 2 and Abdul Cassim seconded the recommendation. Supplier 2, who is ChevronPhillips, was accepted via unanimous voice vote.

12.0 Other Business

12.1 Abdul Cassim updated the panel on the status of 1P cylinder liners (see Attachment **12**). Cat expects to have a new supplier on board by the second quarter of 2005.

13.0 Next Meeting

13.1 The next meeting is scheduled for December 7, 2004 in Tampa, FL. There might be an additional session on Dec.6, if needed. Following the meeting in Tampa will be a meeting in San Antonio on Jan. 13, 2005.

14.0 Adjournment

14.1 This meeting of the HDEOCP was adjourned at 11:53 a.m.

Submitted by:

Jim Wells,
Secretary to the HDEOCP

ATTACHMENT 1

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

Double-Tree Hotel, 540 North River Road (847-292-9100)
November 11th 2004
8:00 am-1:00 pm

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

Desired Outcomes: **PC-10 timing, tests, matrix oils funding.**

TOPIC	PROCESS	WHO	TIME
Agenda Review	• Desired Outcomes & Agenda	Group	8:00-8:05
Minutes Approval	• September 29th , 2004	Group	8:05-8:10
Membership	• Changes: Additions • Comments	Jim Mc Geehan	8:10-8:20
PC-10 Timing and Tests	• Review time line • Engine tests status: Cat1P/IN/IK	Bill Runkle	8:20-8:45
Funding	• Status of funding.	Steve Kennedy	8:45-9:15
Matrix Oils	• Precision and BOI matrix • Timing of availability of matrix oils • OEM reference oils for limit setting	Steve Kennedy Greg Shank	9:15-9:45
Coffee break	• Collect money for room coffee.		9:45-10:00
PC-10 Test Development report	• Mack T-12 • Cummins ISB • Cummins ISM • Caterpillar C13 • Seq IIIG-or IIIF for oil oxidation. • Review all the tests in category • Exit-Criteria ballot on specific engine tests: Review results Dec 6th 04	Greg Shanks Dave Stehouwer Abdul Cassim Jim Mc Geehan	10:00-11:30
Elastomer Test Method and Acceptance limits for API CI-4	• Current procedure for limits and proposal for D4485 • Vote on recommendation	Becky Grinfield	11:30-12:15
New/Old business	•		12:15-1:00
Next meeting	• Dec 6 and 7th Tampa, Marriott, FL		

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ATTACHMENT 3

Jim Wells

From: BatesTerryW@aol.com

Sent: Monday, October 18, 2004 2:39 AM

To: jbfoodie@attbi.com; Mc Geehan, James (JIAM); tom.franklin@perkinelmer.com

Subject: Elastomer test method_Acceptance Limits

Lyle/Jim/Tom

I propose sending the following e-mail to Becky Grinfield who is chairperson of the Elastomer Test Method Surveillance Group to keep her informed as to developments with the acceptance limits issue. Grateful if you could check that my understanding is correct to ensure we are all singing out of the same hymnbook.
****
Becky

The situation re acceptance limits is currently as follows:

1. Some members of D02.B0.10 (Standards Acceleration) do not consider it appropriate to have the acceptance limits as a mandatory part of the Elastomer Test Method. This is because the purpose of an ASTM test method is to produce a result. The acceptance limits effectively adjust (i.e. relax) the specification limits to take account of test variability. (The candidate oil must conform to the acceptance limits not the specification limits.) As such, the acceptance limits are a specification matter and should be covered in a specification (such as D 4485) and not in a test method. If we persist in including the acceptance limits in an Annex (which is mandatory) to the Test Method we will certainly get negative votes which will most likely be regarded by Subcommittee B as persuasive.

2. If the acceptance limits are not included as a mandatory part of the Elastomer Test Method, then they are currently in limbo in both ASTM and API. Thus they are not mentioned in D 4485 and API 1509 says "pass the elastomer limits specified in D 4485".

3. There are two options to ensure that the acceptance limits are properly covered in D 4485 (and hence in API 1509):

a) add an annex (mandatory) to D 4485 describing how to derive the acceptance limits from the specification limits

b) add an Appendix (non-mandatory) to the Elastomer Test Method describing how to derive the acceptance limits from the specification limits and add a footnote to Table 3 in D 4485 making the Appendix in the Test Method a mandatory part of D 4485.

4. With a view to implementing option 3a, an edited version of Appendix X1 of draft 15 of the Elastomer Method has been written as the first draft of an Annex for D 4485. A statistician appointed by the HDEOCP will use this as the basis for a second draft which will be presented to the HDEOCP on Nov. 11.

5. As I understand the situation, items to be discussed by the HDEOCP on Nov. 11 may include whether or not to allow the user the choice between using the experiment specific value for the reference oil or the industry average. Other items may also be raised.

6. In any event, the HDEOCP meeting on Nov. 11 will hopefully reach a decision on how best to proceed. One option might be for a ballot of the HDEOCP as precursor to a Subcommittee B ballot.

7. I propose delaying a ballot of the Elastomer Test Method until it is more clear what will happen with respect to the acceptance limits and D 4485. In principle we could still include the acceptance limits as a non-mandatory Appendix which could serve to complement the D 4485 Annex if the latter is more concise than our current Appendix X1.

Terry

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A10. PROCEDURE FOR THE ADJUSTMENT OF ELASTOMER SPECIFICATION LIMITS TO TAKE ACCOUNT OF TEST VARIABILITY

A10.1 Background

A10.1.1 This annex describes a statistical method for adjusting the elastomer specification limits shown for the CI-4 category in Table 3 to take account of the inherent test variability. The need to take account of the inherent test variability arises because batch-to-batch, sheet-to-sheet and within-sheet variations in the properties of the reference elastomers (the four elastomers specified in Table 3, noted above) can be sufficiently large that they complicate making a decision as to whether or not a test oil has passed the elastomer compatibility specification.

A10.1.2 The adjusted specification limits are referred to as the acceptance criteria (see A10.4). The latter in fact being the specification limits adjusted for an amount to account for test variability. For a candidate oil to be in conformance with the specification limits, the candidate-oil results shall lie within the range defined by the acceptance criteria.

A10.1.3 The statistical method for determining the acceptance criteria uses updated information about the industry test variability relevant to the time frame in which the candidate oil is tested. The TMC provides the updated information which is based on test results obtained by different test laboratories with different batches of reference elastomers on the same TMC 1006 reference oil.

A10.2 Specification Limits

The elastomer specification limits are shown for the CI-4 category in Table 3. (These are reproduced in Table A10.4.3.1 at the end of this annex for comparison purposes.) The specification involves sixteen criteria. These criteria are the specified limits for the four elastomer types [nitrile (NBR), silicone (VMQ), polyacrylate

(ACM) and fluoroelastomer (FMK)], with changes in four properties (volume, Durometer A hardness, tensile strength and elongation at break). Acceptable performance in any particular criterion (e.g., nitrile volume change) is defined as satisfying the acceptance limits.

The acceptance limits are bounded by an adjusted specification limit at each end in some cases, and an adjusted specification limit at one end and an adjusted mean *Ref* value limit on the other end. (*Ref* stands for the mean value for the reference oil TMC 1006, which is run in parallel with the candidate oil as a control for every experiment.)

A10.3 Inherent Test Variability

To determine whether a candidate oil's performance is consistent with that defined by the specification limits given in Table 3, the inherent variability of the test, as indicated by the standard deviation estimates of the four reference elastomers and the four performance parameters, needs to be accounted for. Table A10.3 shows examples of the standard deviation estimates, as reported by the TMC. The standard deviation estimates, applicable at the time the test oils are evaluated, can be obtained from the TMC website (www.astm.tmc.cmu.edu/refdata/bench/alastomer_pc-9/).

TABLE A10.3 Example of Total and Within-Laboratory Standard Deviation Estimates for the Four Reference Elastomers[A]

Elastomer		% volume change	Hardness change	% change in tensile strength	% change in elongation
Nitrile (NBR)	Total	0.91	1.84	7.67	7.66
Nitrile (NBR)	Within-Lab	0.91	1.51	7.44	7.66
Silicone (VMQ)	Total	2.33	2.59	5.40	9.98
Silicone (VMQ)	Within-Lab	2.30	1.57	5.37	9.97
Polyacrylate (ACM)	Total	0.83	1.92	10.19	11.20
Polyacrylate (ACM))	Within-Lab	0.81	1.90	10.17	11.11
Fluoroelastomer (FKM)	Total	0.16	2.40	5.59	10.48
Fluoroelastomer (FKM)	Within-	0.13	1.82	5.27	8.44

	Lab				

[A]Applicable for the period March 1, 2004 to March 15, 2004, as reported on the TMC website (see www.astm.tmc.cmu.edu/refdata/bench/alastomer_pc-9/).

A10.4 Acceptance Limits

The *acceptance* limits are determined as the specification limits adjusted (in absolute value) by an amount to account for the test variability.

A10.4.1 *Calculation of Fixed (i.e the numerical limits) Acceptance Limits*

A10.4.1.1 Calculate the standard error of the test oil mean, se, by dividing the appropriate Total standard deviation estimate, $\sigma_{T,}$ by the square root of the number of observations in the sample:

$$se = \sigma_T / \sqrt{N}$$

where N is the number of observations and is generally six.

A10.4.1.2 Multiply the standard error of the test oil mean by 2.0.

A10.4.1.3 Add or subtract the result to or from the respective upper or lower Specification Limits to obtain the Fixed Acceptance Limit(s).

A10.4.2 *Calculation of Variable (i.e.when Ref is one of the limits) Acceptance Limits*

A10.4.2.1 Calculate the standard error of the test oil mean, se, by dividing the appropriate Within-Lab standard deviation estimate, $\sigma_{T,}$ by the square root of the number of observations in the sample:

$$se = \sigma_T / \sqrt{N}$$

where N is the number of observations and is generally six.

A10.4.2.2 Multiply the standard error of the test oil mean by 2.8.

A10.4.2.3 Add or subtract the result to or from *Ref* (the mean result obtained with TMC 1006, run in parallel with the test oil) to obtain either the upper or lower Variable Acceptance Limit, respectively.

A10.4.3 *Acceptance limits for all parameters.* Table A10.4.3 shows an example of the calculated acceptance limits for all thirty-two parameters.

TABLE A10.4.3 An Example of Acceptance Limits (i.e,, accounting for test variability) for the Four Reference Elastomers) Applicable for the Period March 1, 2004 to March 5, 2004 [A]

Elastomer	Change in volume, %	Change in hardness, Points	Change in tensile strength, MPa	Change in elongation at break, %
Nitrile	(5.7, -3.7)	(8.5, -6.5)	(16.3, Ref - 8.5)	(16.3, Ref – 8.8)
Silicone	(Ref + 2.6, - 4.9)	(7.1, Ref -1.8)	(14.4, -49.4)	(28.1, -38.1)
Polyacrylate	(5.7, -3.7)	(9.6, -6.6)	(26.3, -23.3)	(19.1, -44.1)
Fluoroelastomer	(5.1, -2.1)	(9.0, -7.0)	(14.6, Ref - 6.0)	(18.6, Ref – 9.6)

[A] Based on specification limits given in Table 3 (D 4485) and standard deviation estimates shown in Table A10.3..

A10.4.3.1 The following Table A10.4.3.1 provides the specification limits (identical to Table 3 in D 4485) for comparison with the above acceptance limits.

TABLE A10.4.3.1 Specification Limits for the Elastomer Test Method as part of the CI-4 Category (i.e,. not accounting for test variability)[A]

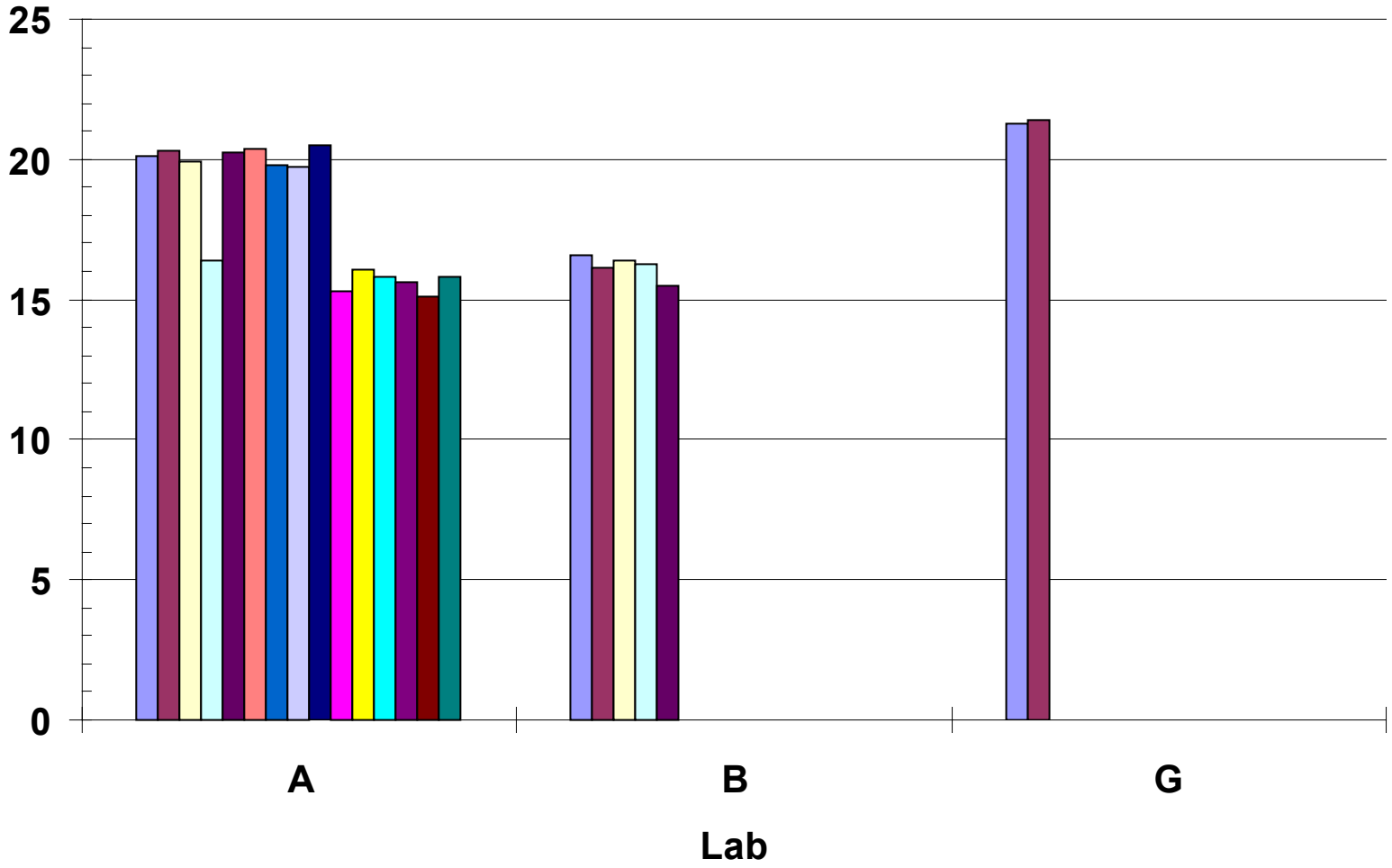
Elastomer	Change in volume, %	Change in hardness, Points	Change in tensile strength, MPa	Change in elongation at break, %
Nitrile (NBR)	(+5, -3)	(+7, -5)	(+10, Ref)	(+10, Ref)
Silicone (VMQ)	(Ref, -3)	(+5, Ref)	(+10, -45)	(+20, -30)
Polyacrylate (ACM)	(+5, -3,	(+8, -5)	(+18, -15)	(+10, -35
Fluoroelastomer (FKM)	(+5, --2)	(+7, -5	(+10, Ref)	(+10, Ref)

[A] "Ref" is the mean value for the reference oil TMC 1006.

Vamac Elastomer

Volume Change, %

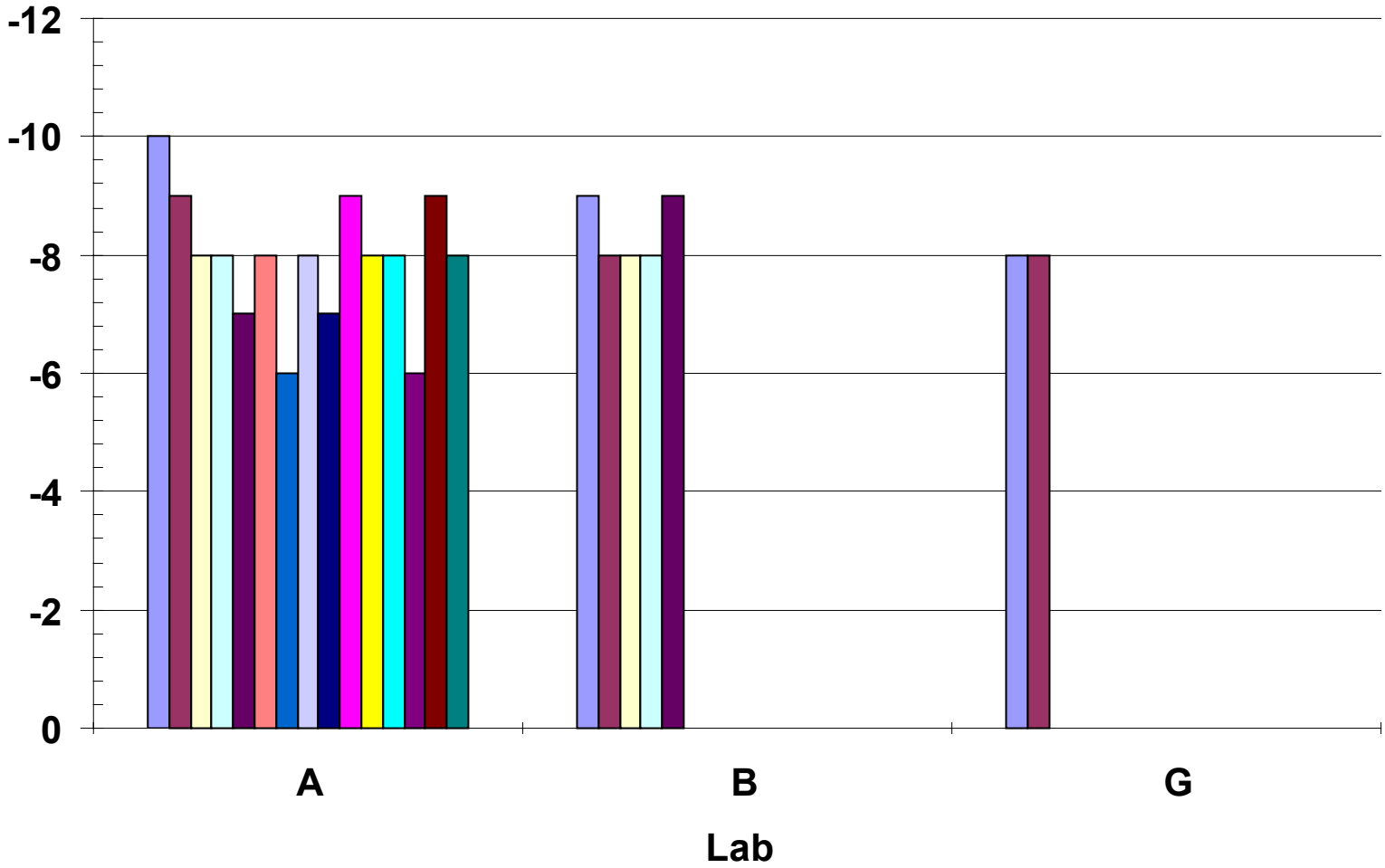
TMC 1006-1



Vamac Elastomer

Hardness Change, Points

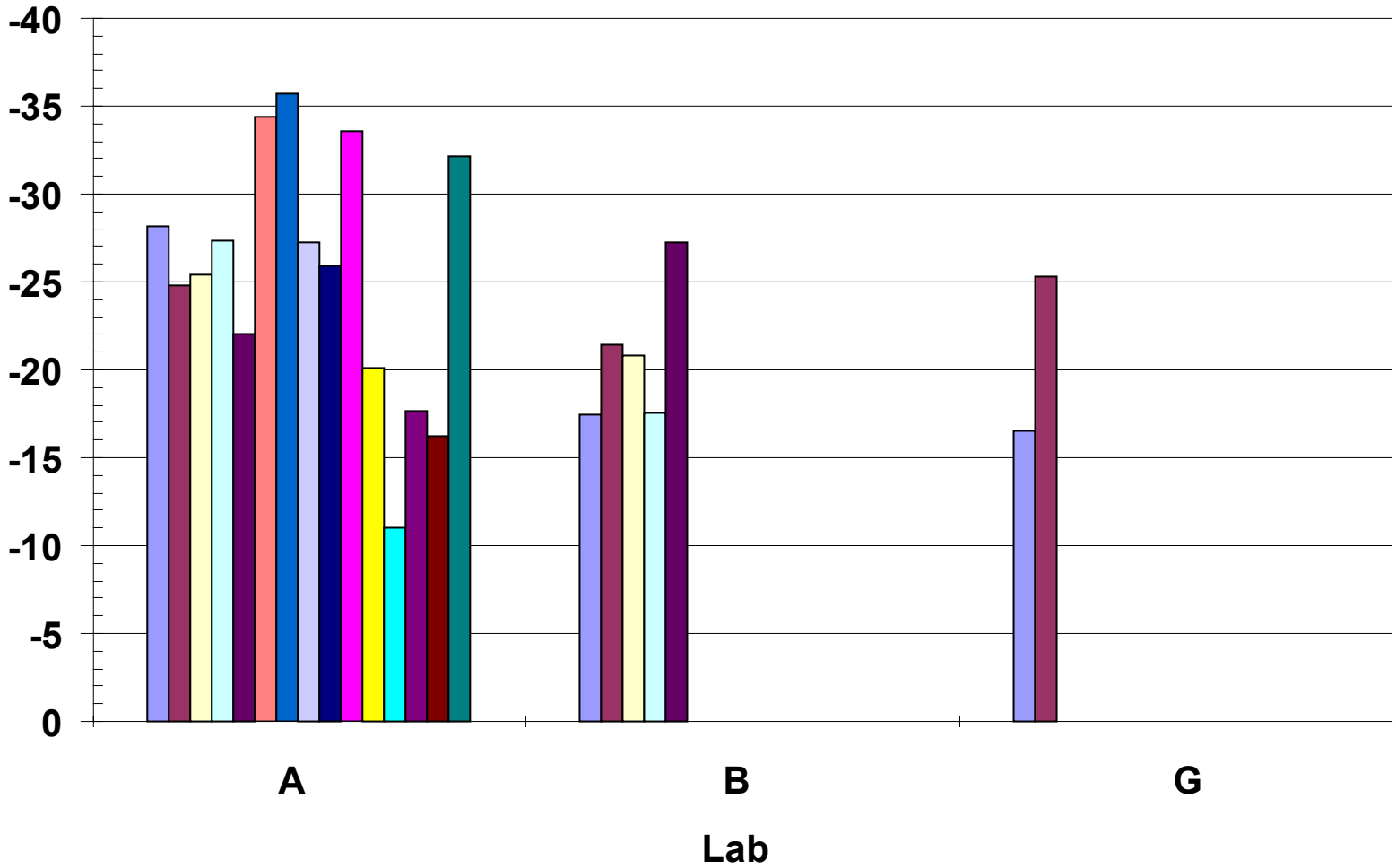
TMC 1006-1



Vamac Elastomer

Tensile Strength Change, %

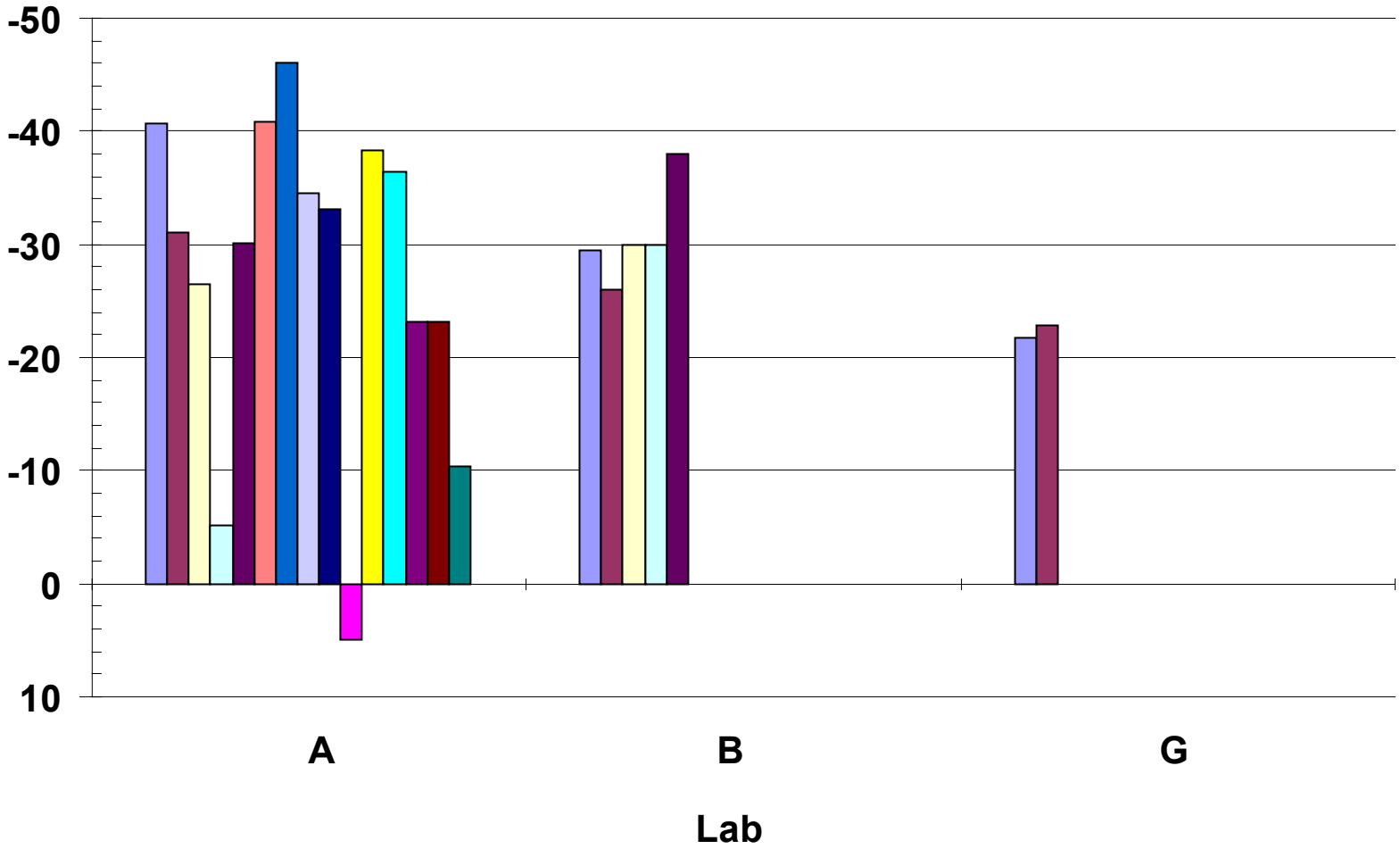
TMC 1006-1



Vamac Elastomer

Elongation Change, %

TMC 1006-1



Vamac Elastomer

TMC 1006-1

n=22

	95% LCL	Mean	95% UCL
Volume Change, %	16.9	17.9	19.0
Hardness Change, Points	-8.5	-8.0	-7.6
Tensile Strength Change, %	-26.9	-24.0	-21.1
Elongation Change, %	-33.2	-27.8	-22.5

Engine Oil Elastomer Compatibility

Average Results by Elastomer Type

TMC 1006-1

	Nitrile	Polyacrylate	Fluoroelastomer	Silicone	Vamac
Volume Change, %	0.7	1.7	-27.5	-50.9	17.9
Hardness Change, Points	0.8	-1.5	0.7	-18.1	-8.0
Tensile Strength Change, %	0.6	7.3	-69.3	-58.6	-24.0
Elongation Change, %	26.4	-18.5	-13.6	-23.2	-27.8

PC-10 NCDT STATUS REPORT

ASTM HDEOCP MEETING
DOUBLETREE HOTEL O'HARE
CHICAGO, IL
November 11, 2004

ATTACHMENT 5, 1 OF 8

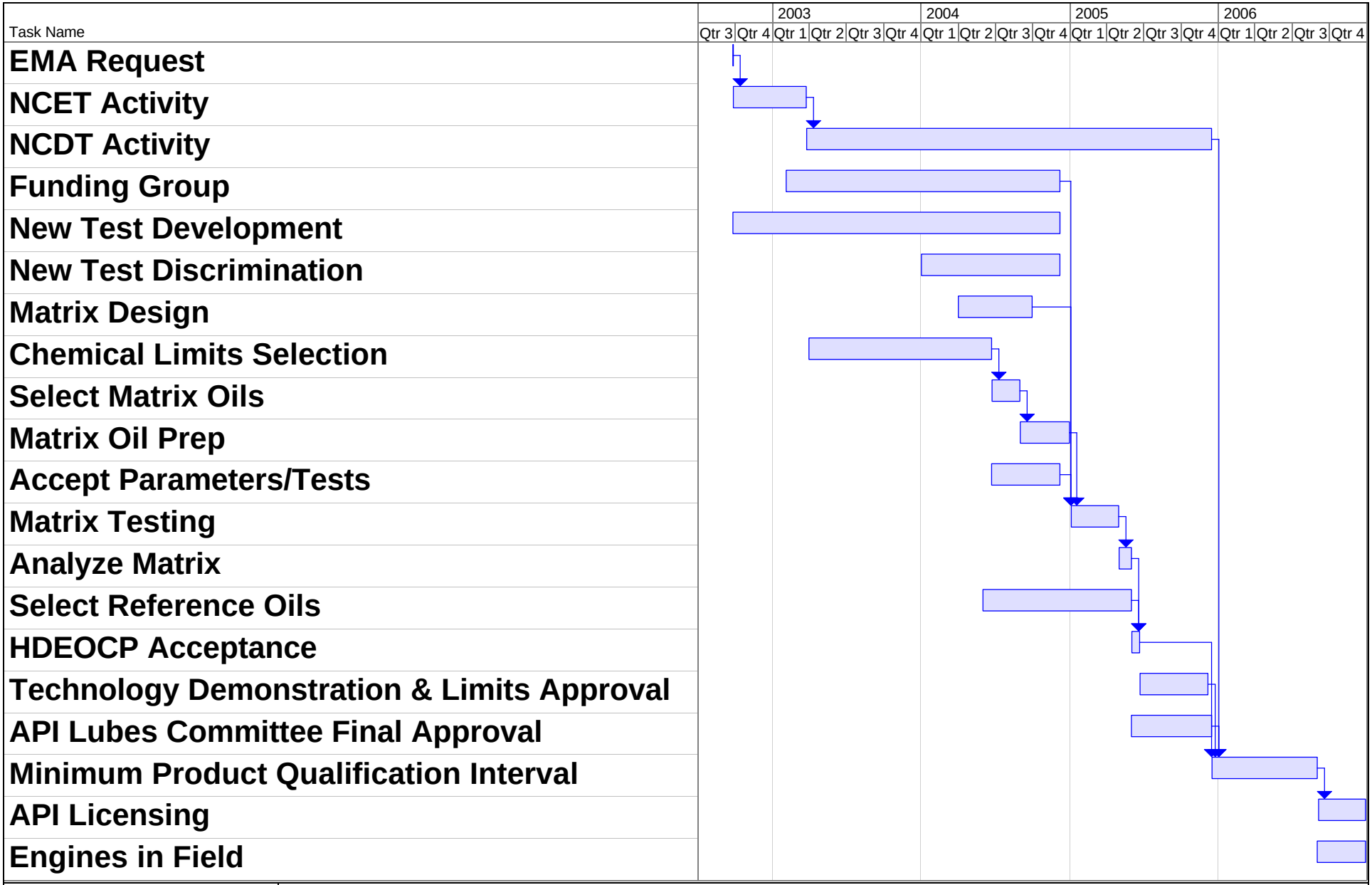
Heavy-Duty Engine Oils
API Lubes Committee Meeting
November 8, 2004

Topics:

(1) PC-10 Development

(2) PC-10 Timeline

(3) PC-10 Matrix Funding



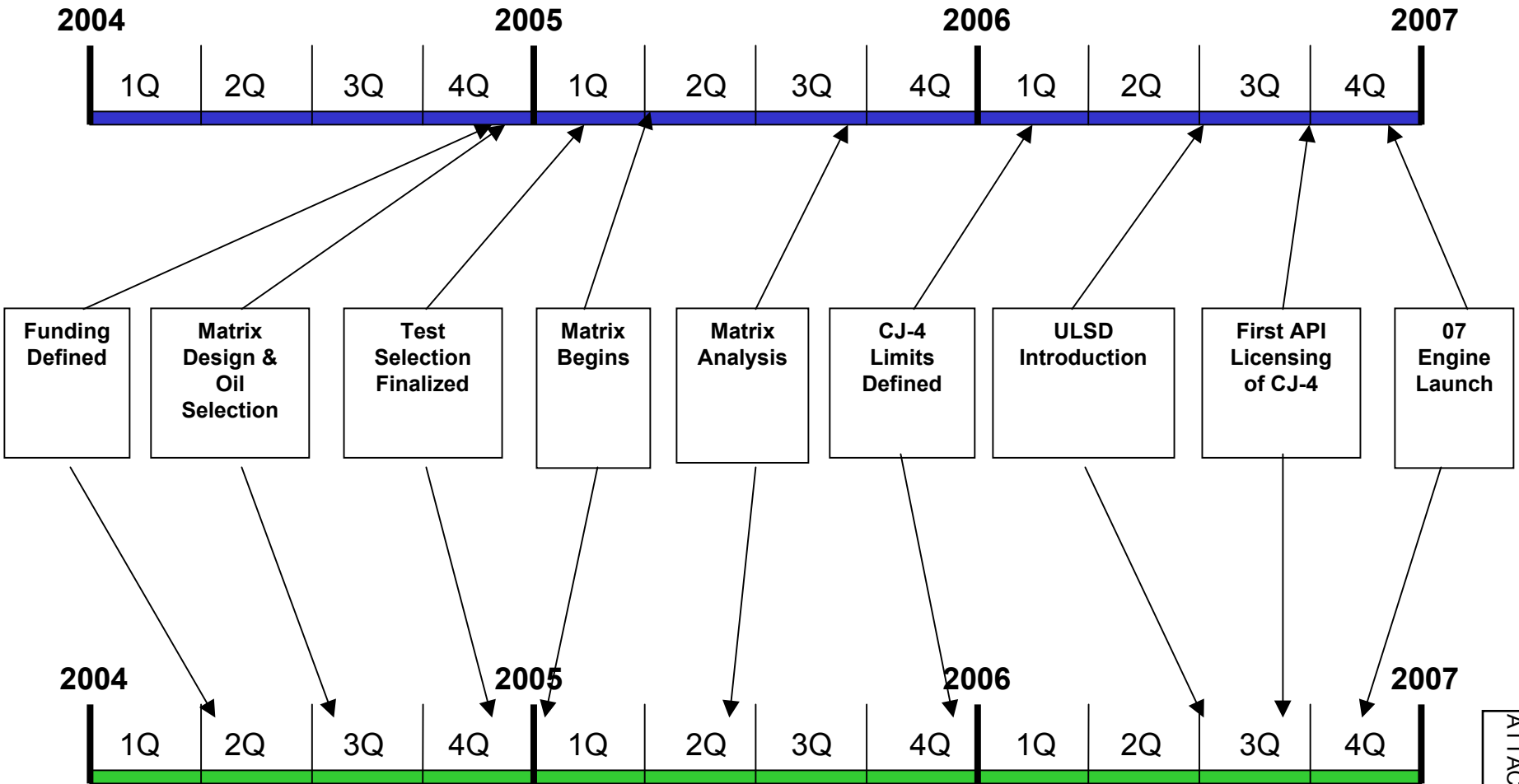
Project: PC-10 ACC-1 09212004
Date: Tue 9/21/04

Task		Milestone		External Tasks	
Split		Summary		External Milestone	
Progress		Project Summary		Deadline	

PC-10 Development

- Cummins ISB will be ready for matrix by 12/04.
- Mack T-12 may not be ready by 12/04.
- T-12 may be ready by 01/05.
- Caterpillar C-13 will probably not be ready by 12/04.
- C-13 will probably not be ready by 01/05.
- Caterpillar 1P/1N/1K issue awaits EMA support, prior to NCDT consideration.
- Matrix oil Status?

Best Guess PC-10 Timeline (10/11/04)



Proposed PC-10 Timeline

ASTM HDEOCP Meeting
November 11, 2004

PC-10 Matrix Funding

Overview

- **Current PC-10 development requires three Precision matrices and one BOI matrix.**
  - **Cat C13 requires Precision & BOI.**
  - **Cummins ISB, and Mack T-12 require Precision only.**
  - **Cummins will specify BOI for ISB, based on M-11 EGR.**
  - **Mack will specify BOI for T-12, based on T-10.**
- **API & ACC have agreed to match up to $ 1MM of EMA funding.**
- **EMA funding in cash and kind will be counted.**

Lubes Committee Guidance Needed

- **Position on dealing with timeline slippage.**
  - **Go forward with only tests that are ready for 1/1/2005 matrix start.**
  - **Reduce technology demonstration period.**
  - **Reduce qualification period.**
  - **Delay first license.**
- **API-LC: Proceed with matrix, as ready. Delay category completion to allow inclusion of C-13, if needed, unless withdrawn by Caterpillar as a service requirement. Delay of matrix completion will delay first license.**

Lubes Committee Guidance Needed

- **Procedure for T-12 & ISB BOI.**
  - **OEM input required.**
  - **BOI/VGRA Task Force requirements.**
- **API LC: Accepted in principle. BOI/VGRA TF will work out details with EMA.**
- **Acceptance of funding commitment.**
  - **EMA in kind.**
  - **Separate MOUs.**
- **API LC: Accepted**

PC-10 Matrix Funding & Design TF

ASTM HDEOCP Meeting

November 11, 2004

Chicago, IL

PC-10 Engine Test Matrix

Funding Group

- **Preliminary plan to fund the PC-10 matrix established at the October 20 meeting**
  - **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 likely to allow acceptable designs**
  - **Projected overall cost** **$4.2MM to $4.5MM**
  - **Stand calibration tests** **$1.89MM to $2.14MM**
  - **Industry funded tests** **$2.33MM**
- **Final approval for funding pending**
  - **ACC to confirm support for the proposal**
  - **API LC endorsed the plan pending AAC decision**

PC-10 Engine Test Matrix

Matrix Design Task Force

- **Preliminary designs that meet criteria below identified**

		Cat C13	Cummis ISB	Mack T-12
Matrix Outputs	Precision	Yes	Yes	Yes
	BOI	Yes	No	No
Number ot Tests		26	14 to 16	14 to 16
Calibration		12	6 to 8	6 to 8
Funded		14	8	8
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 will remain in place to see if additional input is needed**

PC-10 Engine Test Matrix

Next Steps

- **Industry agreement on the plan to limit BOI to the Cat C13; precision only for the Cummins ISB & Mack T-12**
- **Finalize selection of oils for the matrix**
  - **EMA to choose 2 PC-10 technologies for Cat C-13; select base oils**
  - **Identify & accept matrix oils for the Cummins ISB & Mack T-12**
  - **Matrix oil blending**
- **Trade association confirmation of the plan to fund matrix testing; complete MOA before testing starts**
- **Selection of specific matrix designs**

PC-10 Engine Test Matrix

Preliminary Matrix Designs

Engine Test	Cat C-13	Cummins ISB / Mack T-12		
		Case 1	Case 2	Case 3
Matrix Type	Precision / BOI	Precision Only		
No. of Stands	7	4	4	4
No. of Labs	5	2	3	4
No. of Oils	6	2	2	2
Total No. of Tests	26	14	15	16
No. of Tests/Oil	6,4,3	7	7,8	8
Detectable Difference in s of variable and using t	3.02	1.95	1.86	1.78
Detectable Difference in s of variable and MC	4.22	1.95	1.86	1.78
Comparing reference oils only	2.81			
No. of Tests/Stand	4,3,4,3,4,4,4	4,3,4,3	4,3,4,4	4,4,4,4
Detectable Difference in s of variable and using t	2.67	2.78	2.75	2.52
Detectable Difference in s of variable taking the multiple comparison into account for several sample size combinations	3.85 3.57 4.12	3.63 3.36 3.88	3.55 3.29	3.23
No. of Tests/ Lab	7,7,4,4,4	7,7	7,4,4	4,4,4,4
Detectable Difference in s of variable and using t	2.19	1.95	2.26	2.52
Detectable Difference in s of variable taking the multiple comparison into account for several sample size combinations	2.93 2.50 3.30	1.95	2.66 3.00	3.23
Degrees of Freedom				
Oil	5	1	1	1
Stand (Lab)	2	2	1	0
Lab	4	1	2	3
Mean	1	1	1	1
Error	14	9	10	11
Total	26	14	15	16
95% CI for Sigma, Width^	0.84	1.14	1.06	0.99

PC-10 Engine Test Matrix

Matrix Cost Calculator

- Enter assumptions in cells with blue text
- Sheet will display the number and cost for individual PC-10 matrices and the total test cost

Inputs	Cat C13	Cummis ISB	Mack T-12
Number ot Tests	26	14	14
$1,000 per Test	95	50	75
No. of Labs / First Stands	5	2	2
No. of Calibrations per 1st Stand	2	2	2
No. of Second Stands	2	2	2
No. Calibrations per 2nd Stand	1	1	1

Outputs	Cat C13	Cummis ISB	Mack T-12	Total Cost
Labs	5	2	2	
Stands	7	4	4	
No. of Tests				
Total	26	14	14	
Calibration	12	6	6	
Funded	14	8	8	
Cost ($1,000)				
Total	2,470	700	1,050	4,220
Calibration (Labs)	1,140	300	450	1,890
Funded (Trade Assoc)	1,330	400	600	2,330

	Cash	In-Kind	Contrib.
EMA	350	657	1007
ACC	1000	--	1000
API	1000	--	1000
Total Trade Association	2350	657	3007

Matrix Lubricant Selection

EMA has selected two lubricants for the PC-10 Matrix

- Two different VI technologies
- Variation in SAP levels
- Good level of engine data

Chevron ORONITE

Comparison of Caterpillar 1P and 1K Oronite Experience

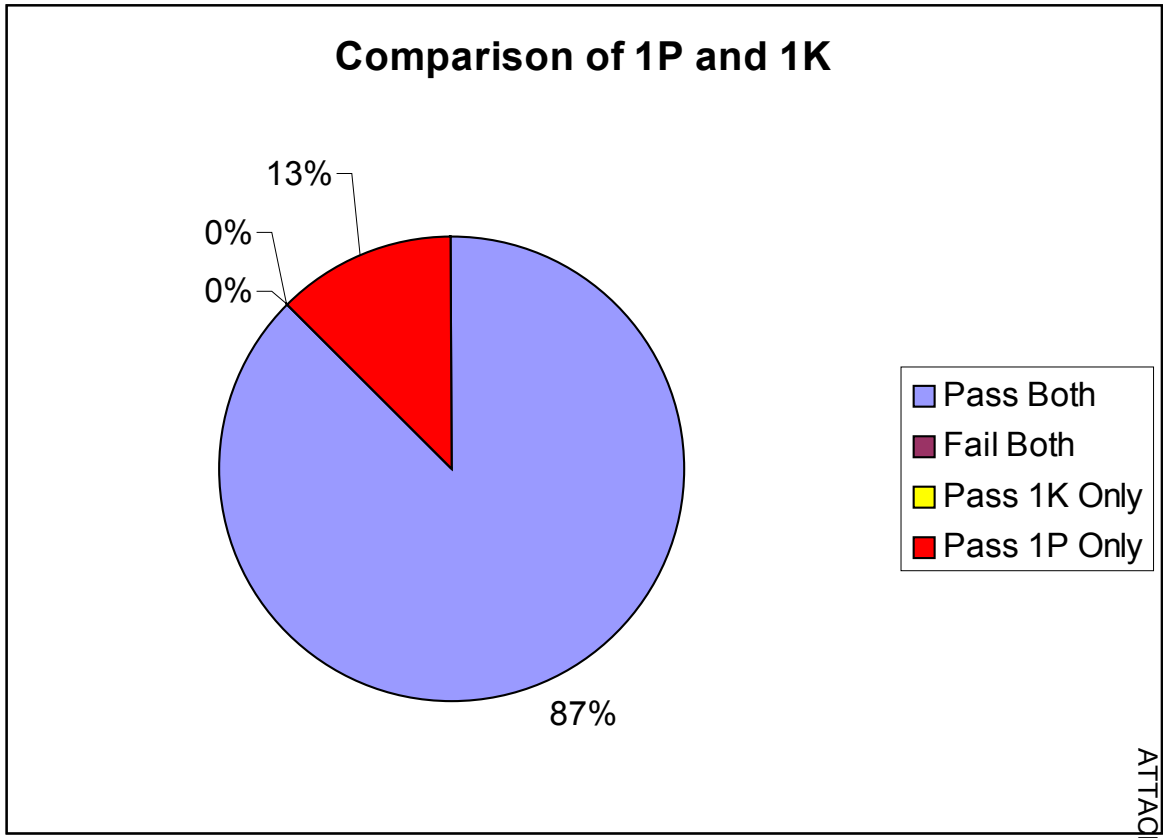
November 11th 2004

Methodology

- Comparison of Caterpillar 1P and 1N: Insufficient number of pairs
- Comparisons of Caterpillar 1P and 1K test results
  - Same oil formulation in each test
  - For each oil where the Caterpillar 1P passed, the Caterpillar 1K also passed
  - ~75% of the oils were API CH-4 quality
  - ~ 25% were API CI-4+ quality
  - Covering a range of 1.3% to 1.6% sulfated ash
  - Both 15W-40 (87%) and 10W-30 (13%) included
  - Group I and Group II base oils
- The data were analyzed for correlation between parameters
  - No correlation with *weighted* total demerits
  - No correlation of corresponding lands and grooves
  - *Some* correlation exists for non-corresponding locations
- The data support the conclusion that passing 1P performance will insure passing 1K performance
  - 1P is more severe

1P and 1K Pass/Fail Analysis

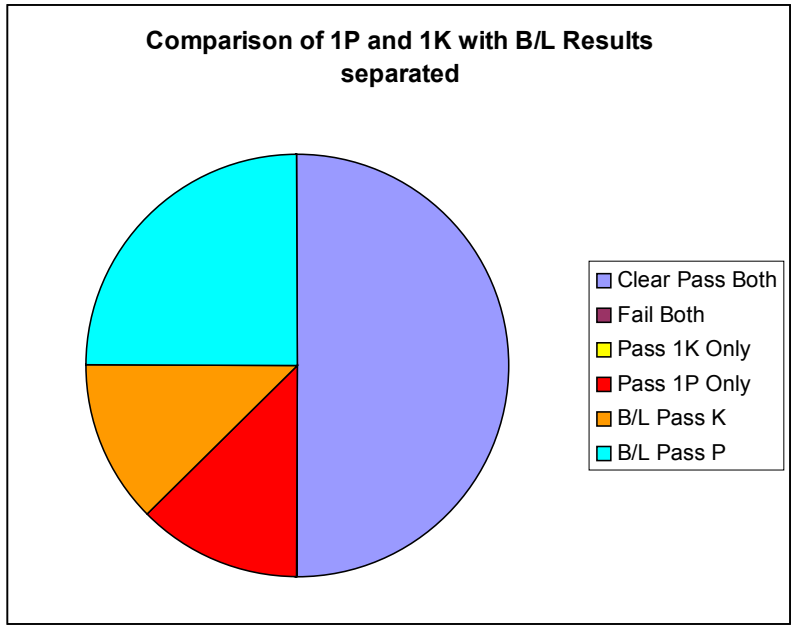
- Analysis based on 1 test pass limits
- All oils that passed 1P also passed 1K
- All Oils that failed 1P passed 1K



ATTACHMENT 8, 3 OF 4

1P and 1K Pass/Fail Analysis

- Separate results on the pass/fail limit
- Twice as many 1P results are borderline as 1K results



CAT 1N/1K Comparison with CAT 1P

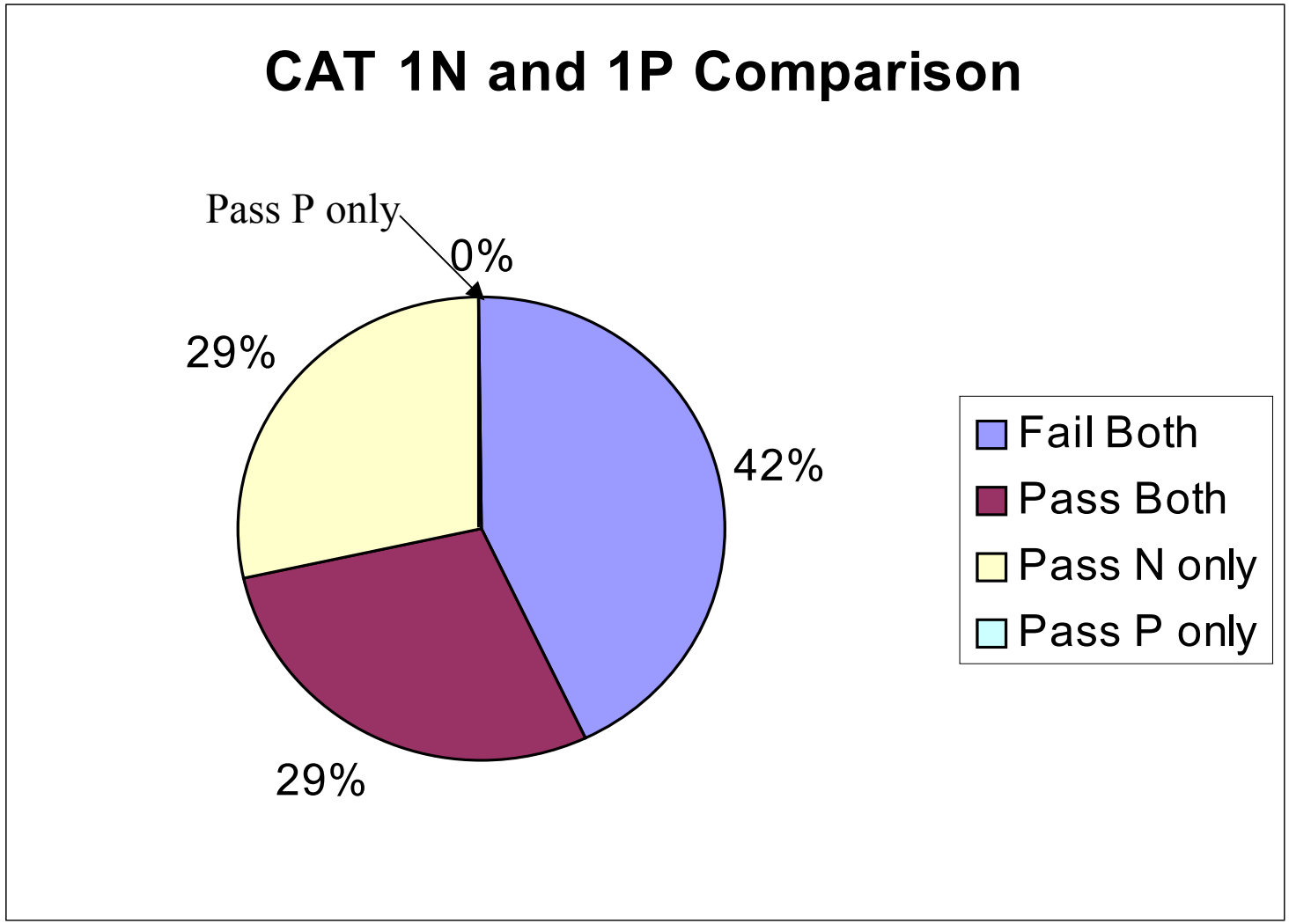
HDEOCP

November 11, 2004

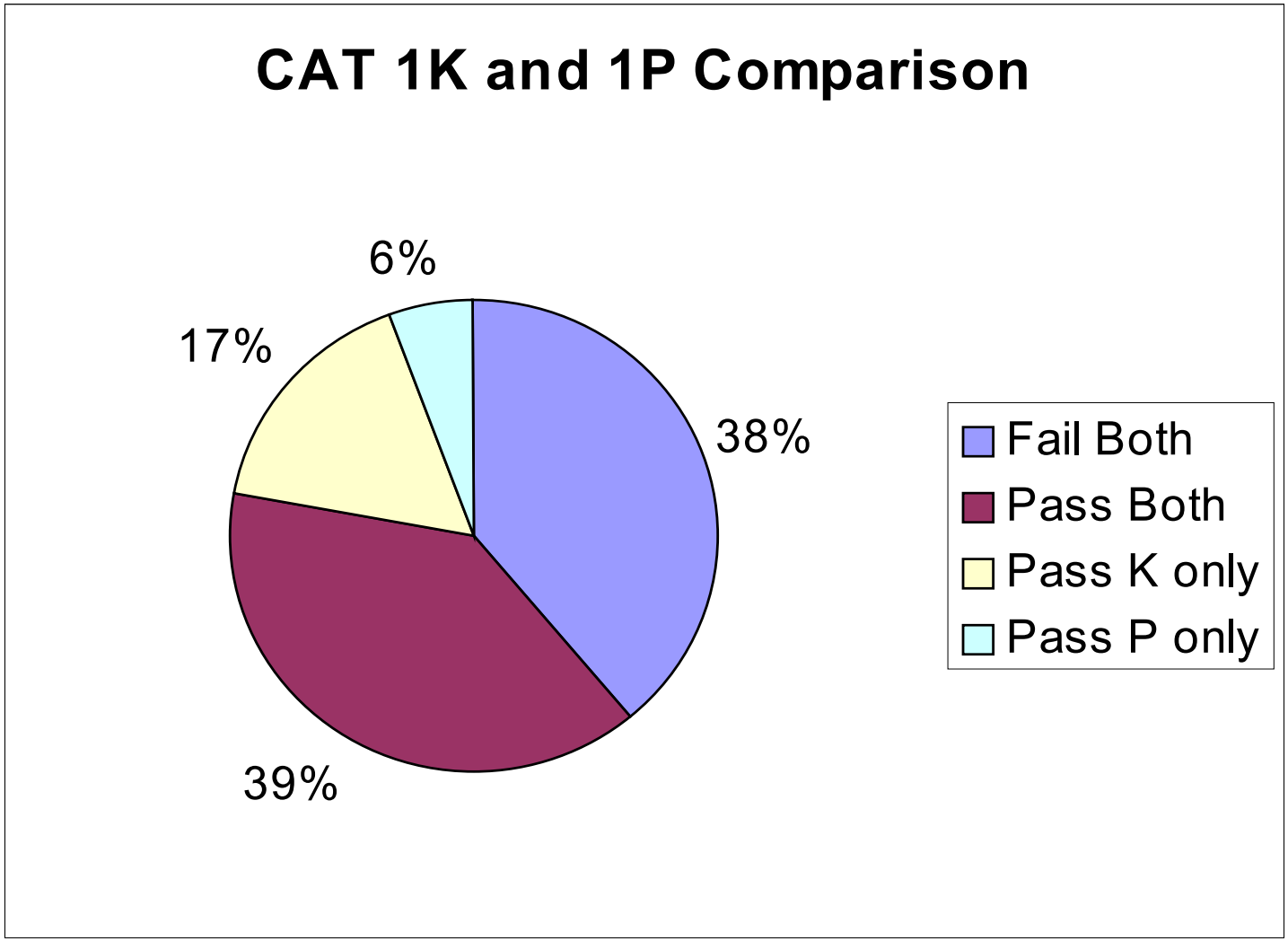
Correlation of Single Cylinder CAT Tests

- The number of direct comparisons of the CAT 1K to the CAT 1P is significantly higher than the CAT 1N to the CAT 1P.
- No significant positive correlation exists between the 1K/1N groove and land ratings and the corresponding 1P groove and land ratings.
- The CAT 1P is more sensitive than the 1K/1N to Oil Consumption failures.
- Overall passing results show the CAT 1P to be more severe than the 1K/1N

1N vs. 1P


CAT 1N and 1P Comparison
Pass P only
0%
29%
42%
29%
Fail Both
Pass Both
Pass N only
Pass P only

1K vs. 1P


CAT 1K and 1P Comparison
6%
17%
38%
39%
Fail Both
Pass Both
Pass K only
Pass P only

Summary

- Single test parameters from the CAT 1P do not correlate with the 1N or 1K.
- The CAT 1P can be used to screen oils for the 1N and 1K.

Mack PC 10 Engine Test Update

November 11, 2004

•Mack T-12

•Ring, Liner, Rod Bearing Wear / Corrosive Wear / Oxidation / OC

•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 – 15-20% Phase 2)

•Precision Matrix Required

•Hardware (External)

•Same as T10 Except – VGT Turbo replaces small T10 Turbo
Two Production EGR Coolers (Breadboard) Replaces Tube Cooler
EGR on/off Valve

Hardware (Internal)

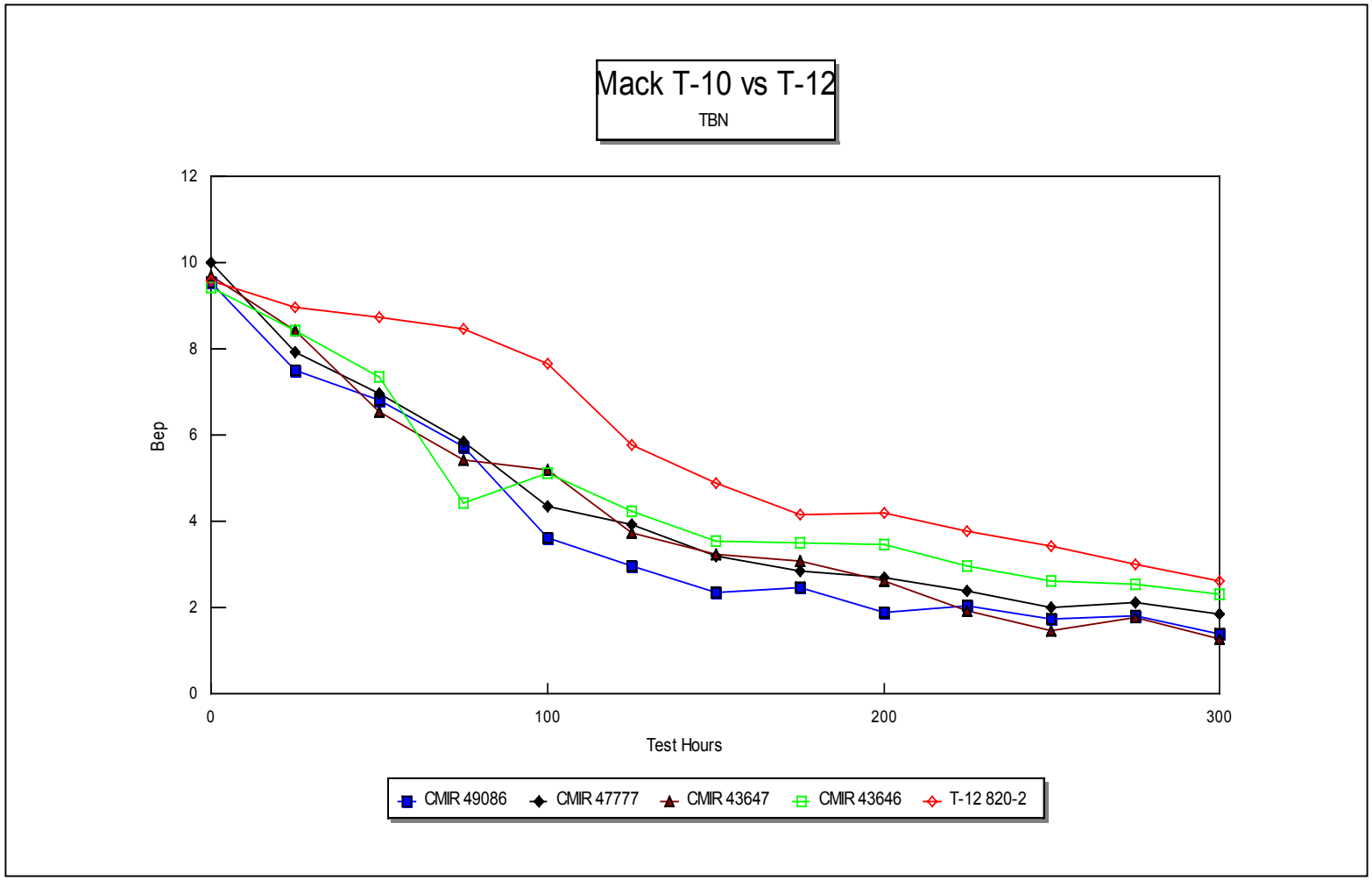
T11 Power Cylinder (T10 Top Ring) & T11 Heads
New Nozzles & Spray Angle

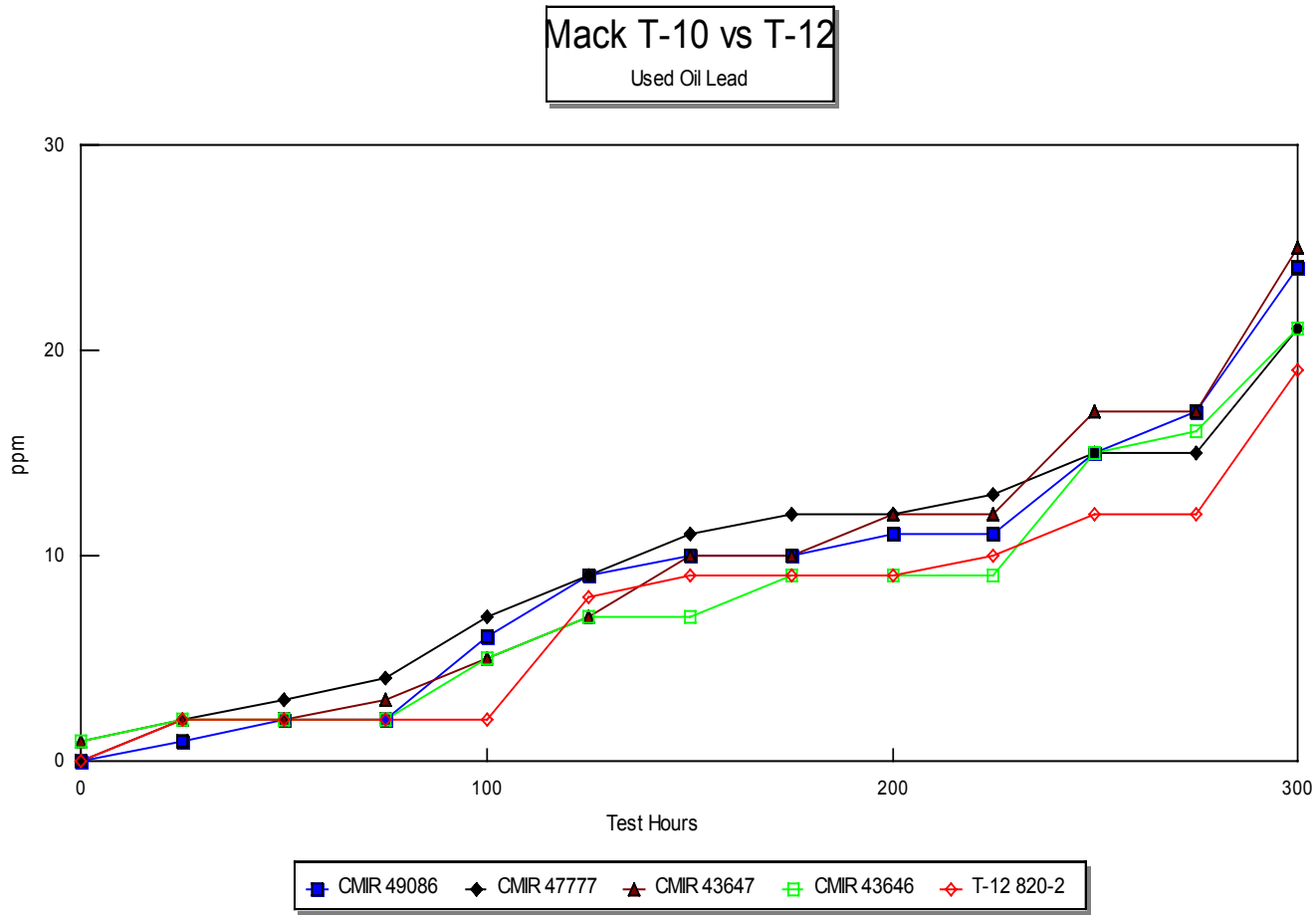
– T12 Conversion Kits Sent to Labs

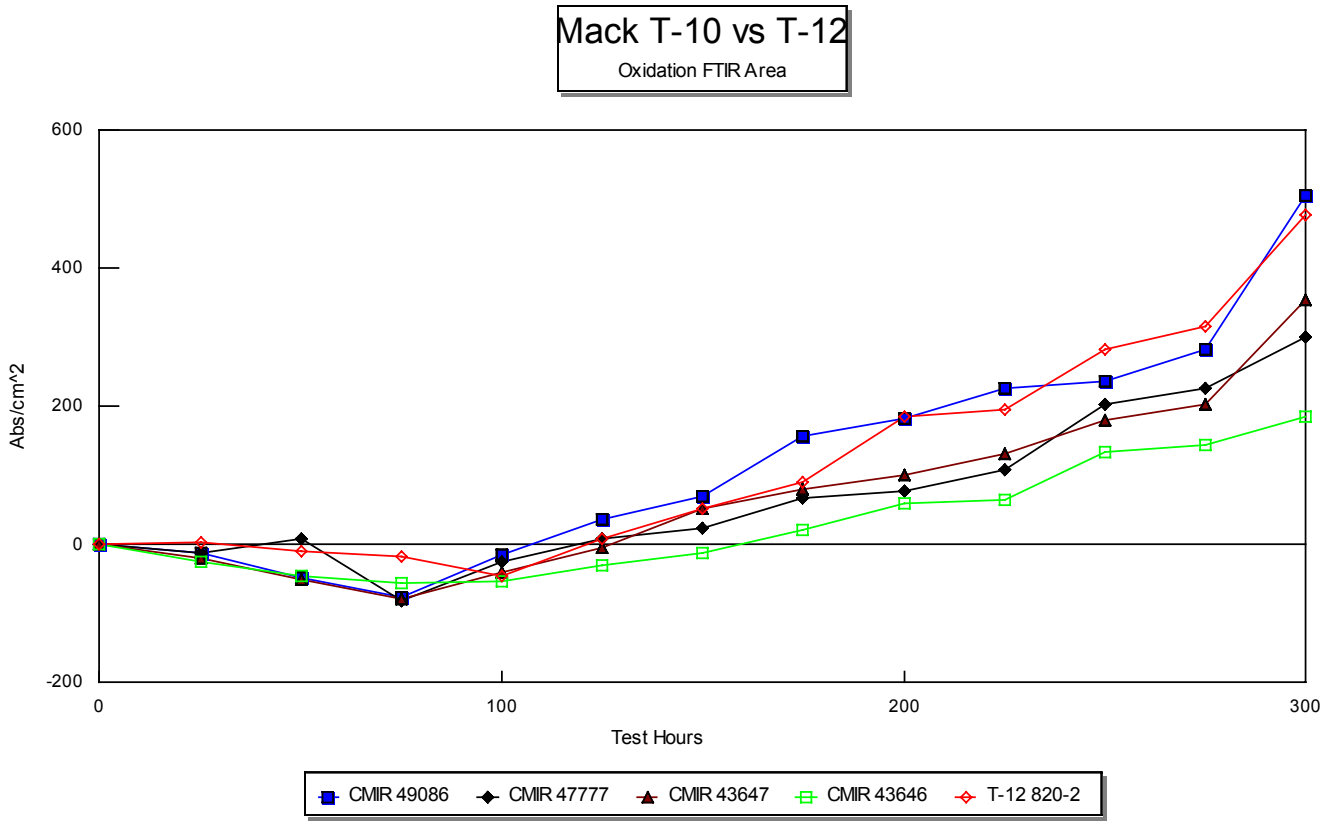
•T12 TASK FORCE – Numerous Teleconferences, Oct 20 Mtg in San Antonio –
Next Meeting Nov 22nd @ ExxonMobil

•Draft Procedure # 2 Now Available, T12 Parts List Completed

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

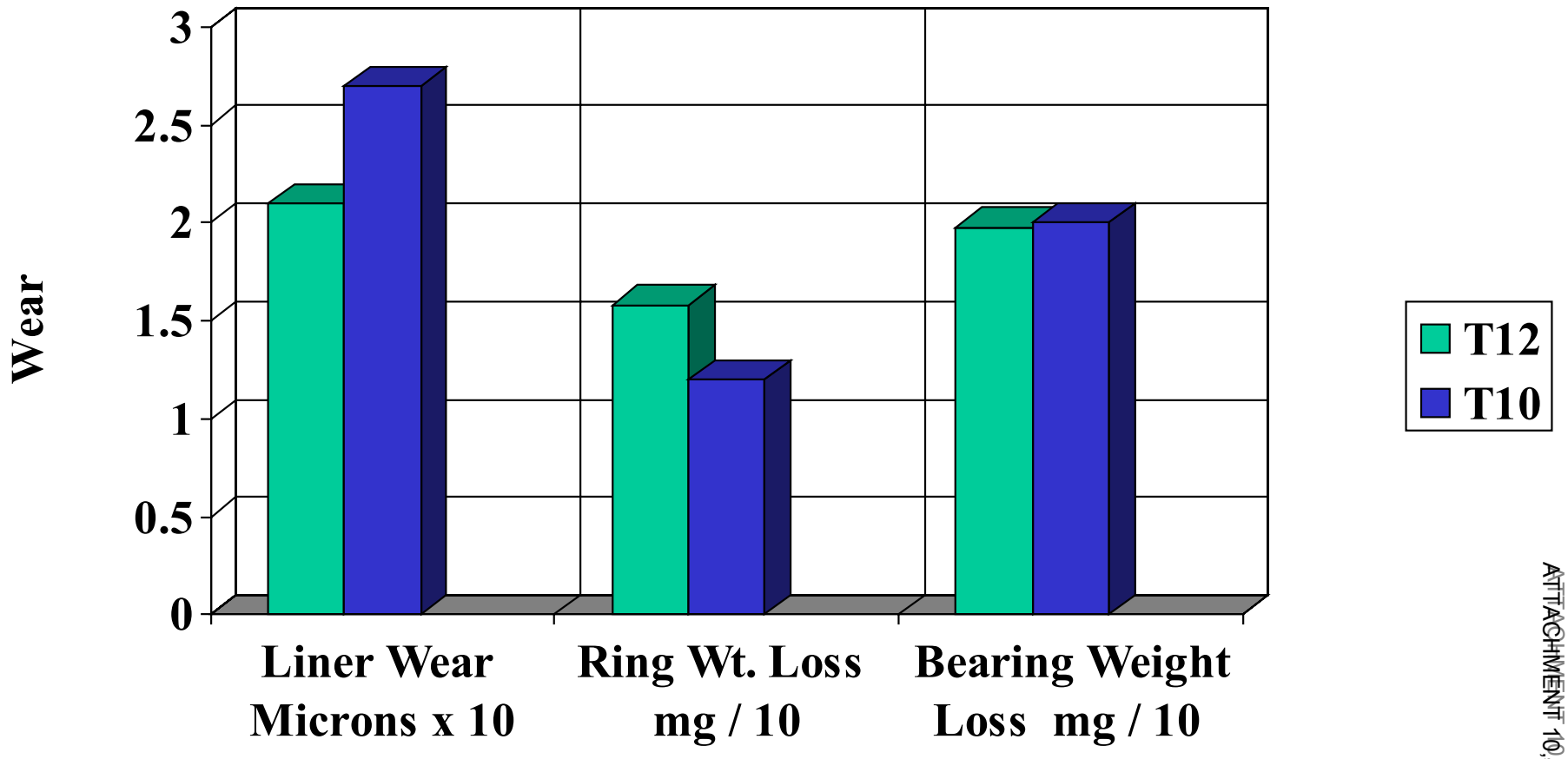

Mack T-10 vs T-12
TBN
Bep
12
10
8
6
4
2
0
0
100
200
300
Test Hours
CMIR 49086
CMIR 47777
CMIR 43647
CMIR 43646
T-12 820-2


Mack T-10 vs T-12
Used Oil Lead
30
20
10
0
ppm
0
100
200
300
Test Hours
CMIR 49086
CMIR 47777
CMIR 43647
CMIR 43646
T-12 820-2


Mack T-10 vs T-12
Oxidation FTIR Area
600
400
200
0
-200
Abs/cm^2
0
100
200
300
Test Hours
CMIR 49086
CMIR 47777
CMIR 43647
CMIR 43646
T-12 820-2

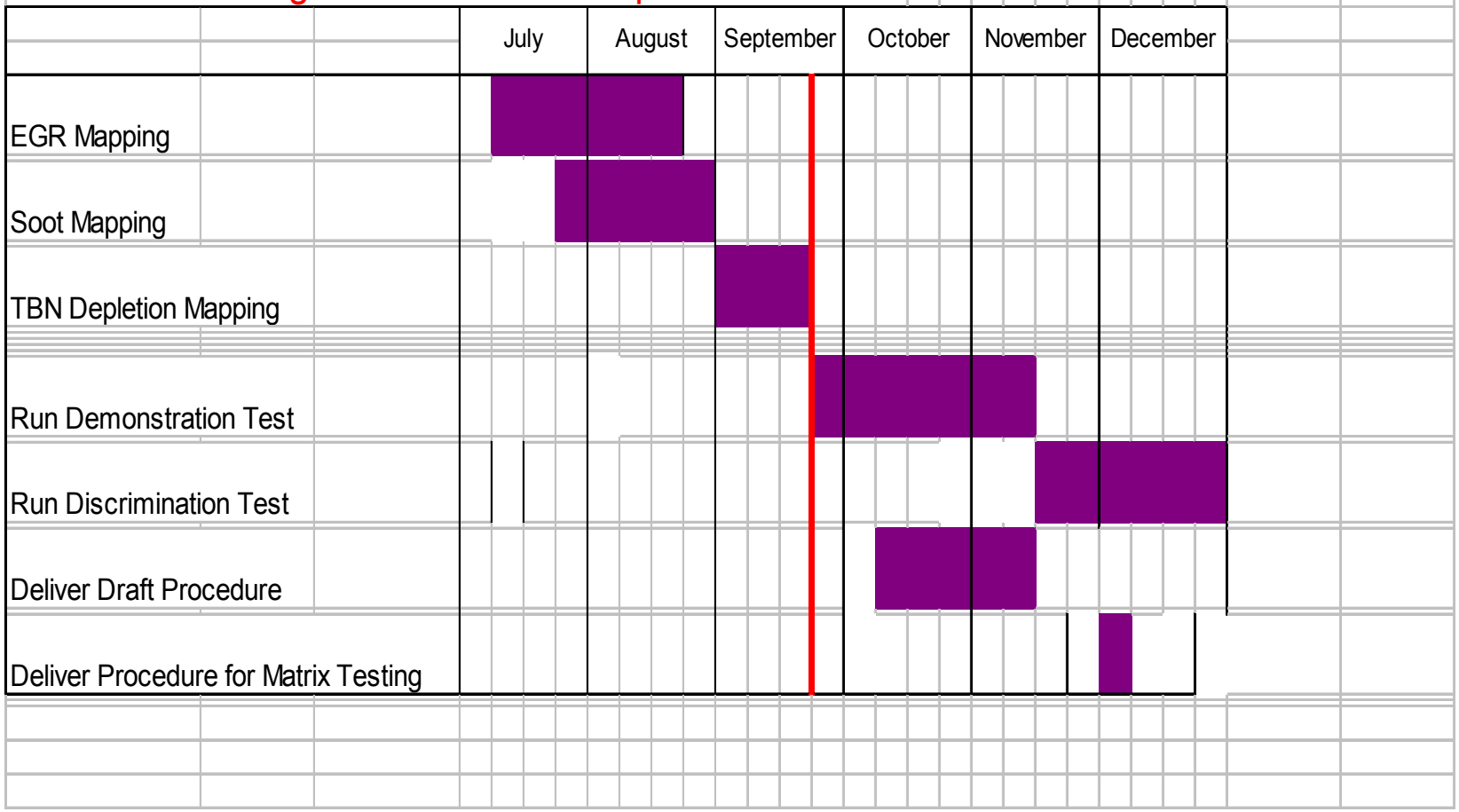
Wear T12 vs T10

820-2 Ref Oil



GLS Nov 11th 04

T12 PC10 Engine Oil Test Development Schedule



Status of ISM Test Development
Nov. 9, 2004

D M Stehouwer

To HDEOCP

Nov. 11, 2004

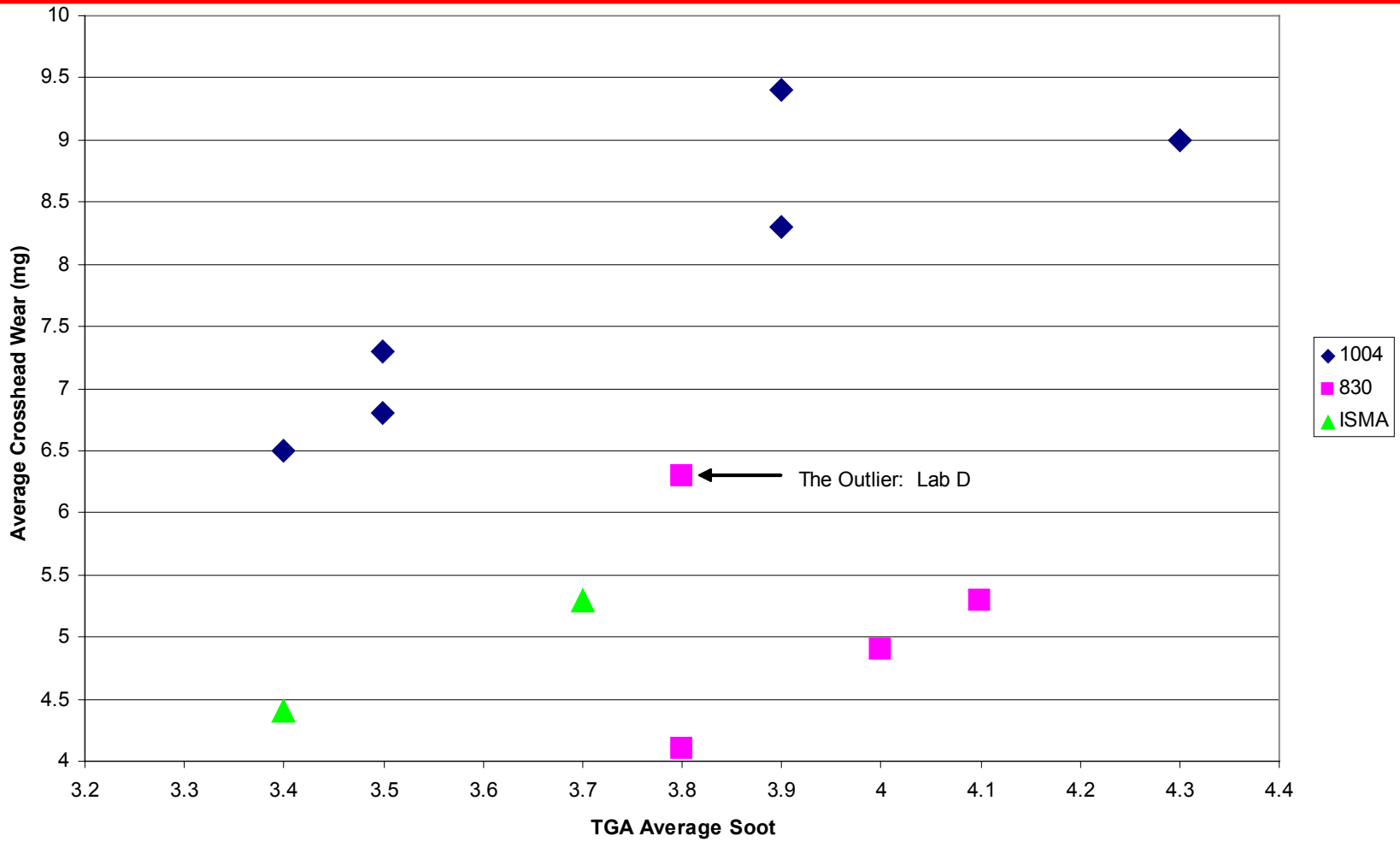
Conclusions from Surveillance Panel

- **Is ISM test ready for PC 10 carry-forward?**
  - **Statistical analysis from 12 test matrix complete**
    - **Test does discriminate between oils**
      - **Crosshead Weight Loss**
        - » **soot correction needed**
      - **Filter plugging (modified calculation)**
      - **Sludge (rater calibrations)**
    - **Precision is good**
- **Is ISM ready to set limits for M11 EGR?**
  - **Crosshead Weight Loss**
    - **soot correction needed**
  - **Filter plugging (modified calculation)**
  - **Sludge (rater calibrations)**

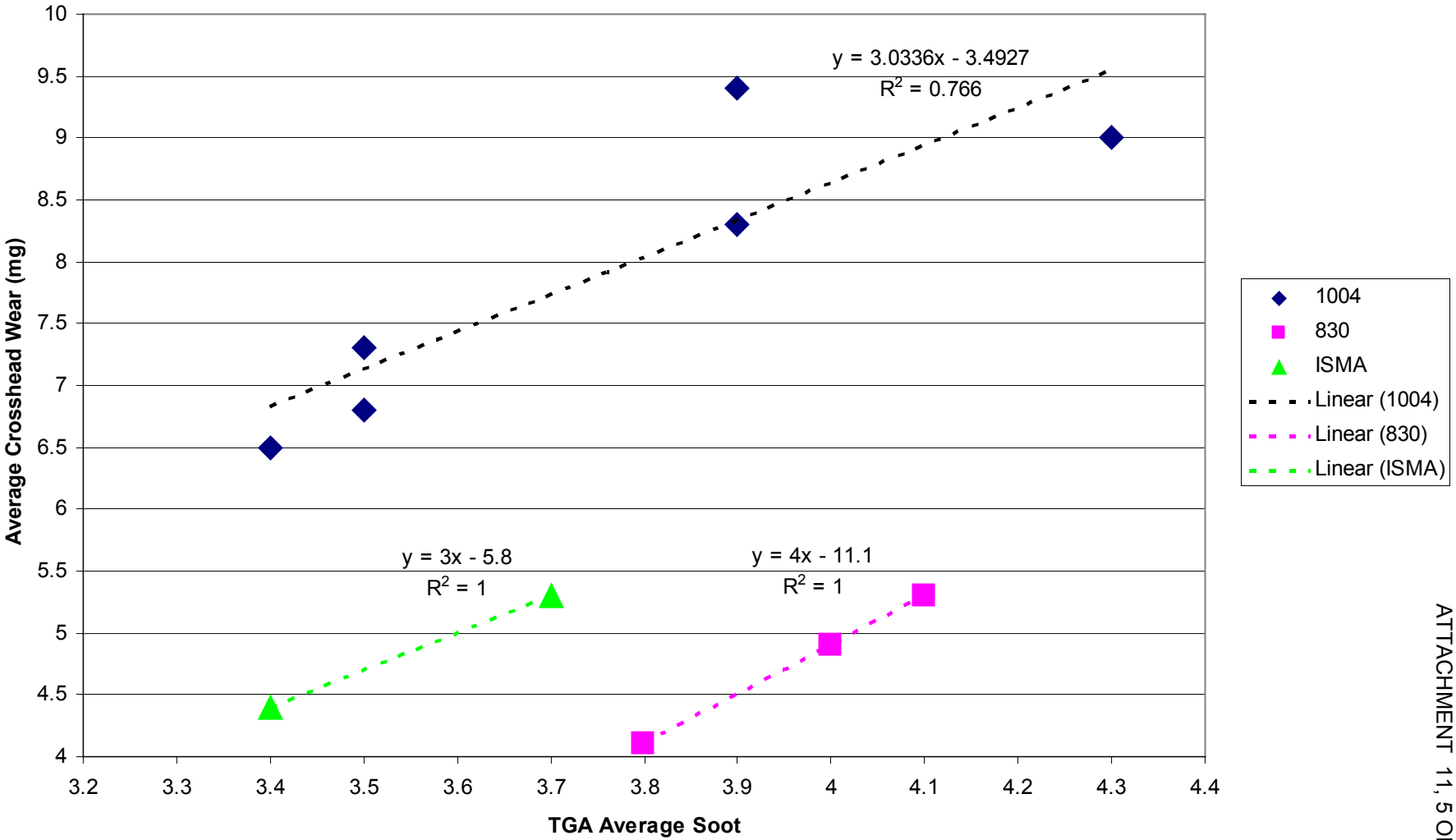
Recommendation

- **It is the opinion of the ISM Development Task Force and the Cummins Surveillance Panel that the ISM test does show the ability to differentiate oils with acceptable precision on wear and filter plugging, however items such as soot correction, outlier screening, correlation to M11 EGR, and the actual OFDP calculation still need to be finalized.**
- **Passed by unanimous vote of Cummins Surveillance Panel / ISM Task Force**

ISM Matrix Average Crosshead Wear as a Function of Soot



ISM Matrix Average Crosshead Wear as a Function of Soot
Outlier Lab Removed

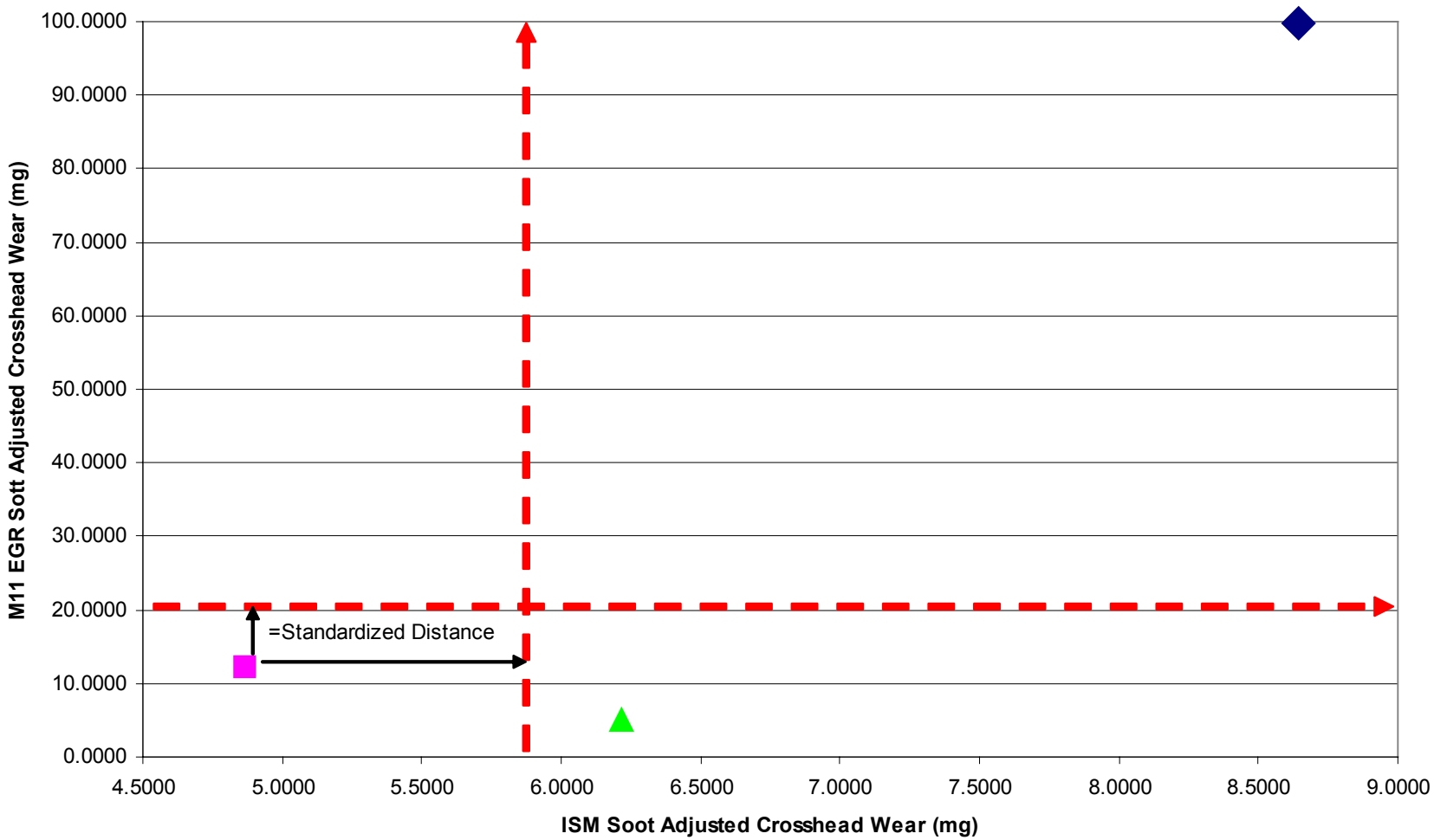


Cross Head Weight Loss

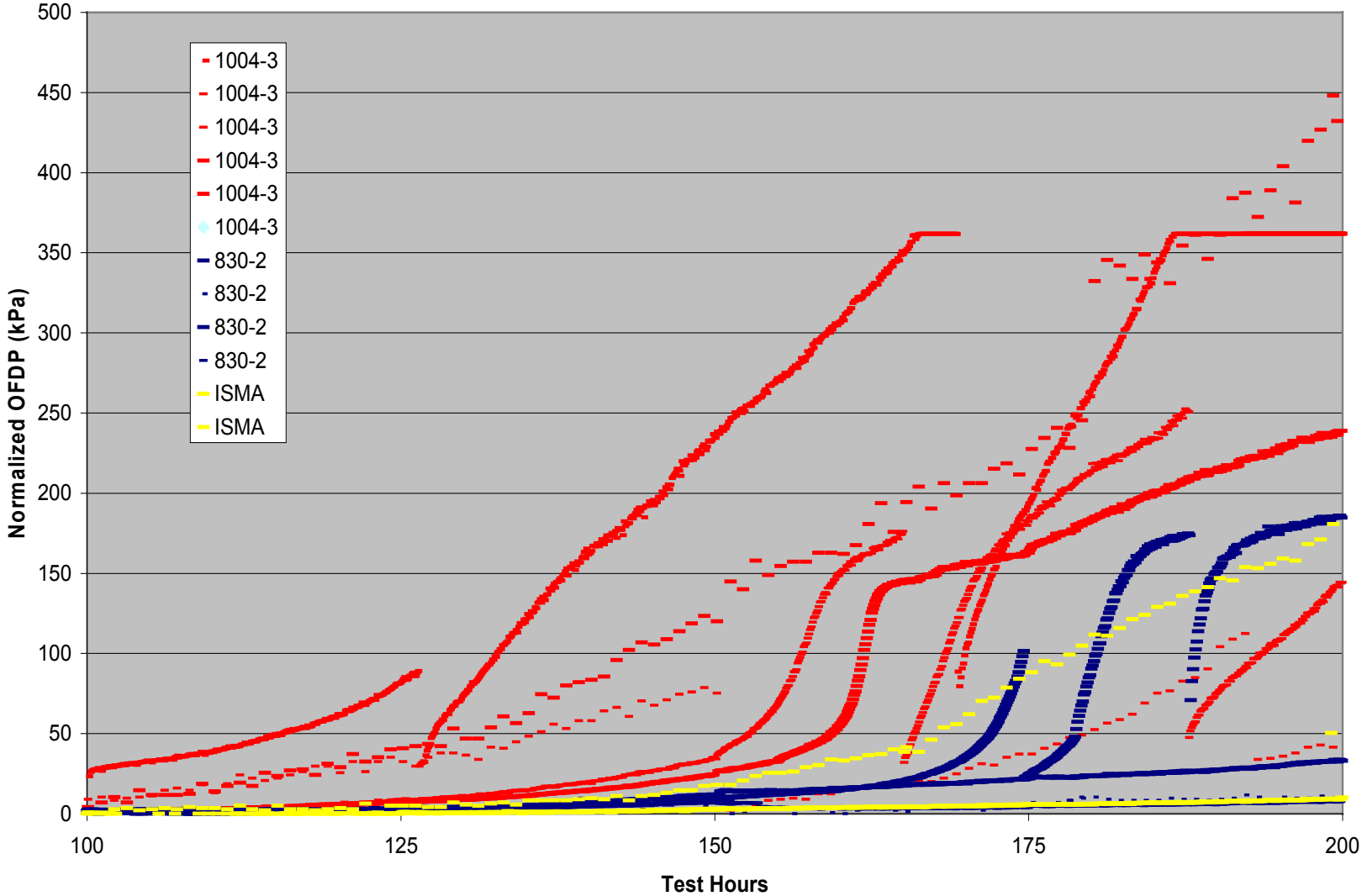
- **Model Fit: CWL=f(Lab, Oil, Average Soot)**
  - **No Lab Differences**
    - **Lab G 0.84 Mild if Fit Procedure Change Instead of Soot**
  - **All 3 Oils Statistically Significantly Different**
  - **CWL Increases 3.0332 per 1% Avg Soot**

Crosshead Weight Loss			
	Oil 1004	Oil 830	Oil ISMA
LS Mean @ 4% Soot	8.6385	4.8680	6.3605
Mean @ 4% Soot	8.6416	4.8678	6.2149
StdDev @ 4% Soot	0.5784	0.1477	0.0070
Mean @ New Soot	8.9000	4.7667	***6.8767***
StdDev @ New Soot	0.5568	0.6110	NA
M11 EGR Target	99.8000	12.2000	5.1000

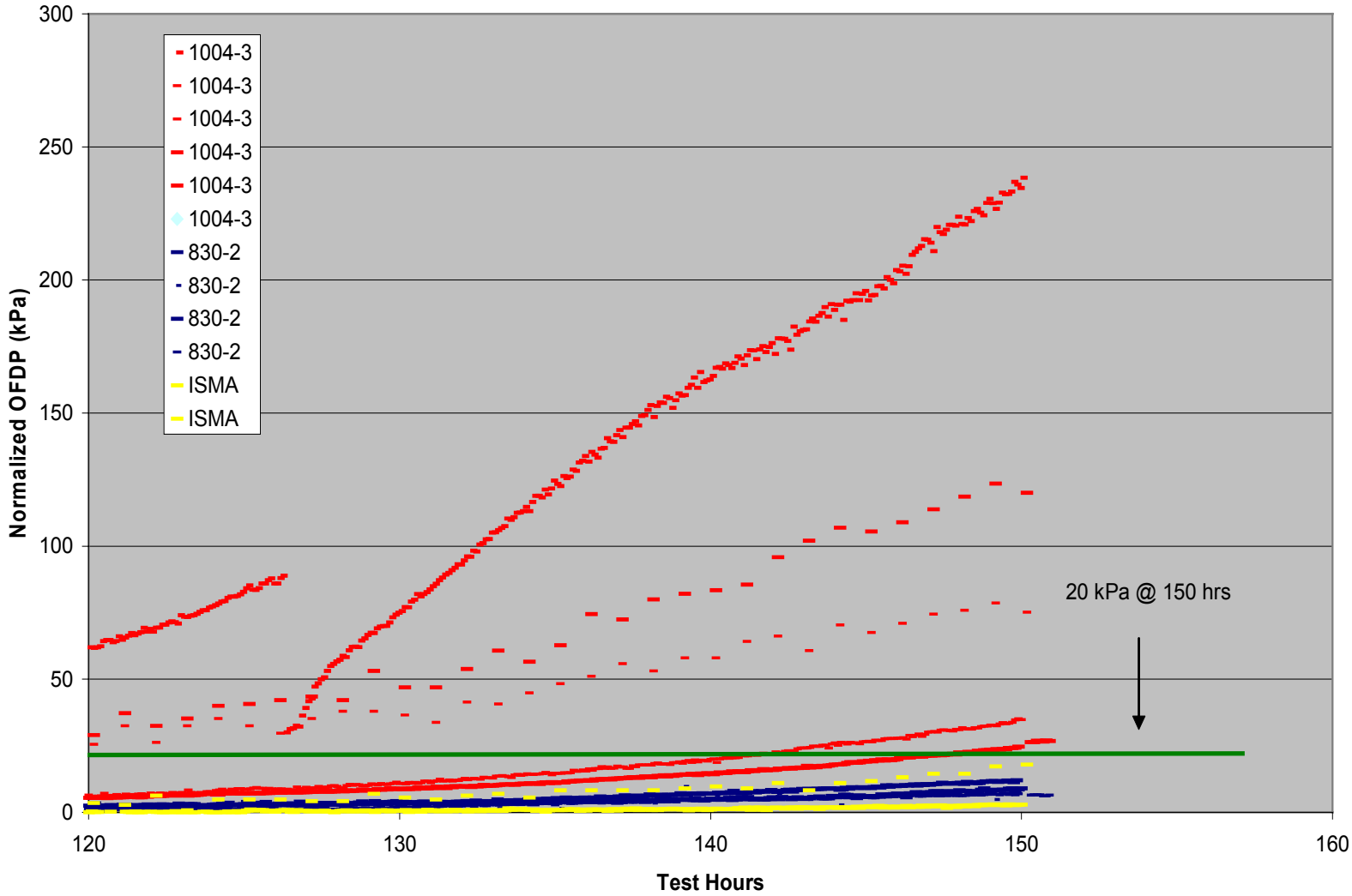
M11 EGR Crosshead Wear as a Function of ISM Crosshead Wear
Oil Averages



OFDP


Normalized OFDP (kPa)
500
450
400
350
300
250
200
150
100
50
0
100
125
150
175
200
Test Hours
1004-3
1004-3
1004-3
1004-3
1004-3
1004-3
830-2
830-2
830-2
830-2
ISMA
ISMA

OFDP


1004-3
1004-3
1004-3
1004-3
1004-3
1004-3
830-2
830-2
830-2
830-2
ISMA
ISMA
Normalized OFDP (kPa)
300
250
200
150
100
50
0
120
130
140
150
160
Test Hours
20 kPa @ 150 hrs

Recommendation

- **It is the opinion of the ISM Development Task Force and the Cummins Surveillance Panel that the ISM test does show the ability to differentiate oils with acceptable precision on wear and filter plugging, however items such as soot correction, outlier screening, correlation to M11 EGR, and the actual OFDP calculation still need to be finalized.**

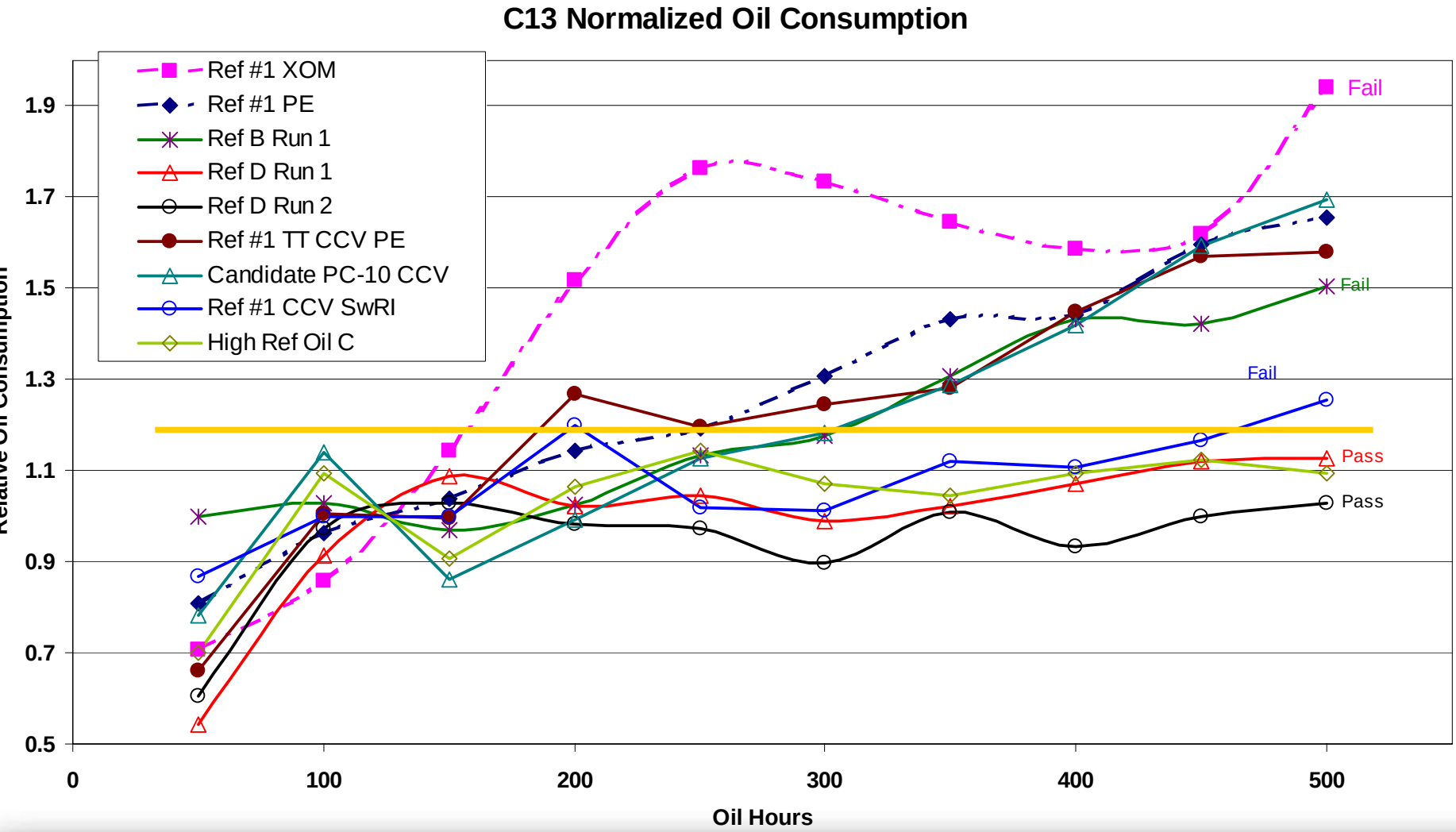
Next Steps

- Re-do statistics
  - Agreed upon outlier rejection criteria
  - Soot corrections
  - OFDP revised calculations
    - i.e. @ 150 hrs.
  - 4 more reference runs
- Target to have data by mid-January
- Proposed CI-4 limits relate 830 values & St Dev from M11 EGR limits
- PC-10
  - CHWL, ASWL
  - OFDP
  - Sludge
  - TRWL
  - Used Oil Properties
  - Merit system ?

ISB Status

- Four Test Mini Matrix in progress
- Finish runs and analyze data for Dec ASTM meeting

Caterpillar C13 Test Update



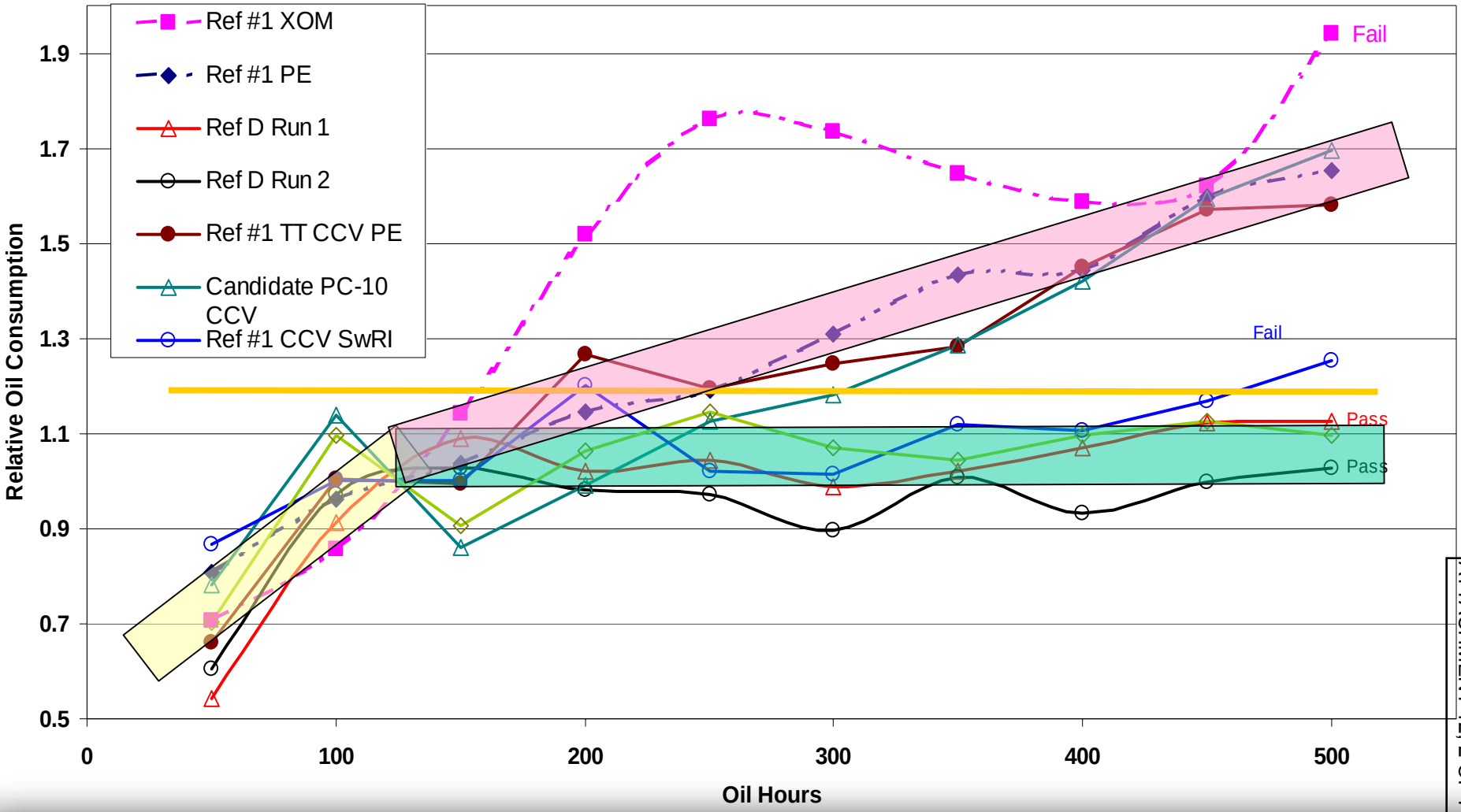
ATTACHMENT 12, 1 OF 7




CATERPILLAR®

Caterpillar C13 Test Update

C13 Normalized Oil Consumption

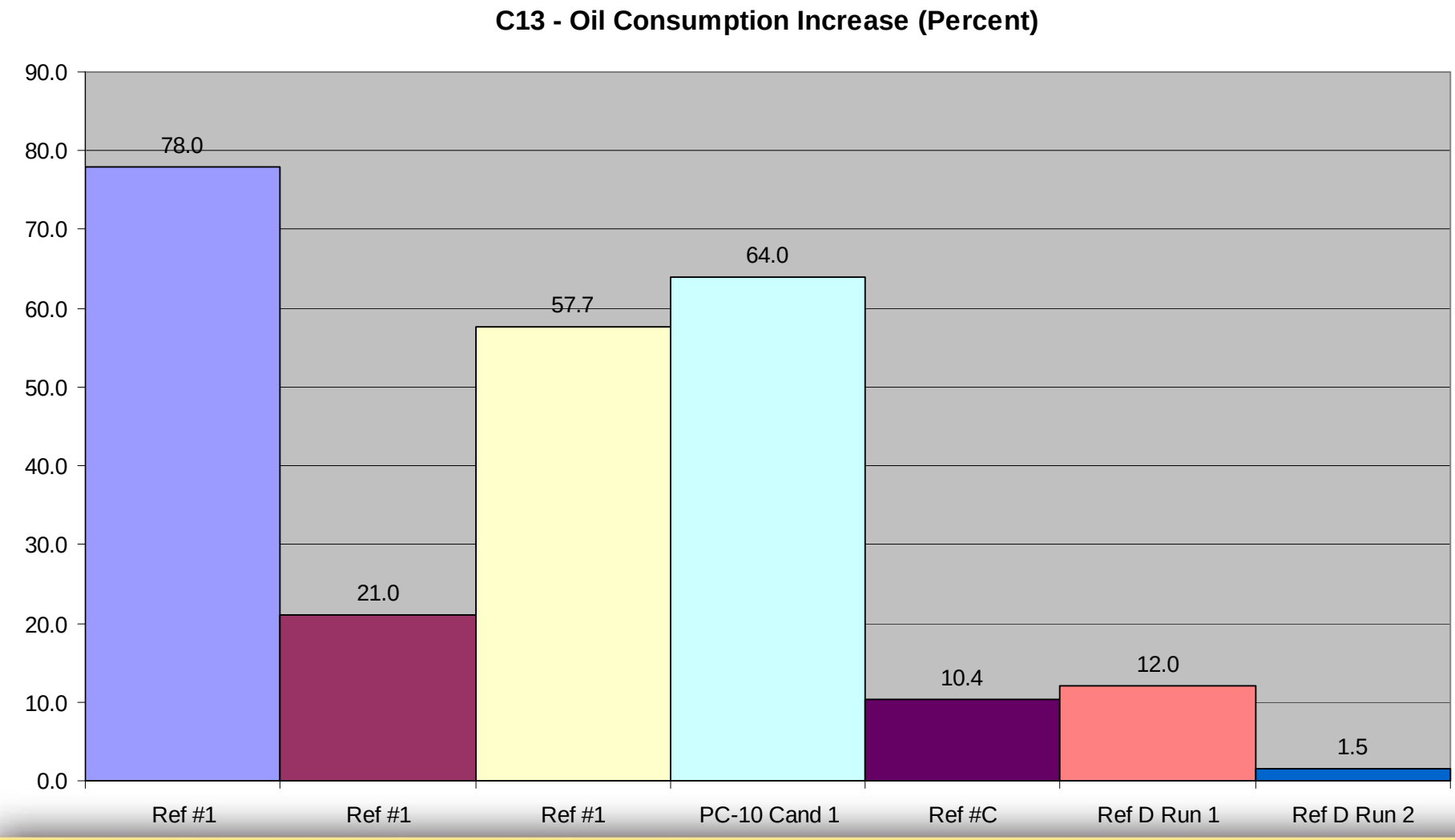


ATTACHMENT 12, 2 OF 7




CATERPILLAR®

Caterpillar C13 Test Update



ATTACHMENT 12, 3 OF 7




CATERPILLAR®

Caterpillar C13 Test Update

Oil	Oil Consumption	Piston Deposits	Loss of 2nd Ring Side Clearance
Ref #1 SwRI	Fail	Fail	All
Ref #1 PE	Fail	Fail	2 Sluggish
PC-10 Cand 1	Fail	Fail	3, 1 Stuck
High Ref C	Pass	Fail	All
Ref Oil D	Pass	Pass	None




Caterpillar C13 Test Update

Oil	Oil Oxidation at 500 hrs	TBN	TAN
Ref #1 SwRI	494	2.3	4.2
Ref #1 PE	535	3.0	4.8
PC-10 Cand 1	779	2.5	6.4
High Ref C	1087	0.1	3.8
Ref Oil D	1154	2.2	5.5




Caterpillar C13 Test Update

Turbo fouling discrimination of oils is possible on the C13.

Question is do the members need a Turbo test?

Pistons Deposit complication without discrimination with Closed CCV

TF decided to remove CCV but retain ULSDF




Caterpillar 1P Update

1P liner change of supplier by 2nd qtr 04.

Funding to sort out surface profile to improve test reliability

Surv Panel, Labs agree to help in this work.

Early data and studies prevent 1M-PC situation repeat

New Piston temperature test at CAT show C13 temps much lower than previous, Top land 230 °C, 2G 130 °C.




Suggested Approach to Meeting the Oxidation Test Requirements of PC-10

Presented at

ASTM HDEOCP Meeting

Chicago, IL

November 11, 2004

Background on HD Categories and Oxidation Tests

- **For many years the API C Categories did not contain a specific test to measure oil oxidation and viscosity increase**
- **API Categories CD through CF-4 relied on L-38 bearing weight loss as an indirect estimate of oxidation via bearing corrosion**
  - HD engines use oil coolers
  - Relatively low specific power output and sump temperatures
- **Increasing power output and sump temperatures drove the desire to have a diesel oxidation test**
  - No suitable diesel test could be identified

Background on HD Categories and Oxidation Tests (cont.)

- **API CG-4 adopted the Sequence IIIE light duty oxidation test as a surrogate for ensuring some level of oxidation capability**
  - No other cost effective measure of oxidation capability available
  - Test was run anyway to support BOI licensing of the S category for universal oils
- **Sequence IIIE upgraded to Sequence IIIF in API CI-4**
  - Recognized higher levels of oxidation due to EGR
  - Test options considered included John Deere 6646 and Mack T-10 IR
  - Belief at the time was that the Sequence IIIF provided a margin of safety for oxidation protection beyond the Mack T-10

API CI-4 Experience

- **Passing a Mack T-10 at the API CI-4 performance limits is more restrictive than passing the Sequence IIIF viscosity increase at the ILSAC GF-3 limit**
  - **So in effect, the Mack T-10 diesel test has been functioning as the limiting oxidation test in API CI-4**
- **ACC member companies do not support redundant tests or parameters, and in retrospect, API CI-4 should have been defined with no Sequence III requirement**
  - Moot point as IIIF was run to support API S Category licensing of universal oils
- **The Sequence IIIG is dramatically more severe than the Sequence IIIF and if included in PC-10 it may restrict base stock and additive formulation options**

Correlation Among Mack T-10 Test Parameters

Infineum

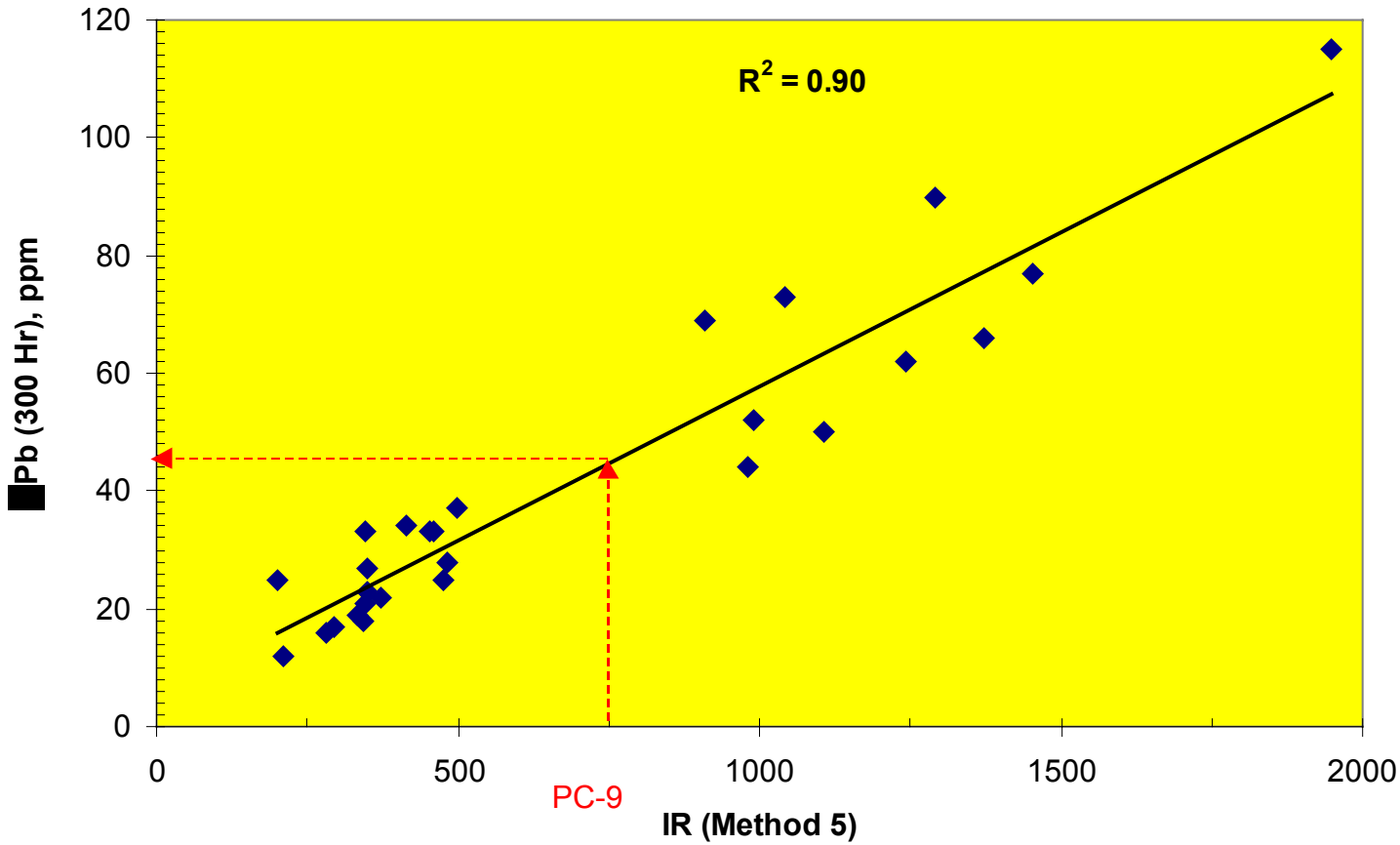
- **PC-9 limits for the Mack T-10 test:**

Average Cylinder Liner Wear	32 μM Max
Average Top Ring Weight Loss	158 mg Max
Delta Lead at EOT (300 Hrs)	35 ppm Max
Delta Lead between 250-300 Hrs	14 ppm Max
Oil Consumption in Phase II	65 g/hr Max
Oxidation by Integrated IR	rate and report--considered 750 Absorbance Units Max

- **Data on the following graph shows that three of these 6 parameters, *Delta Lead (300 Hrs), Delta Lead (250-300 Hrs) and Integrated IR*, are highly correlated with R^2 ~0.9**

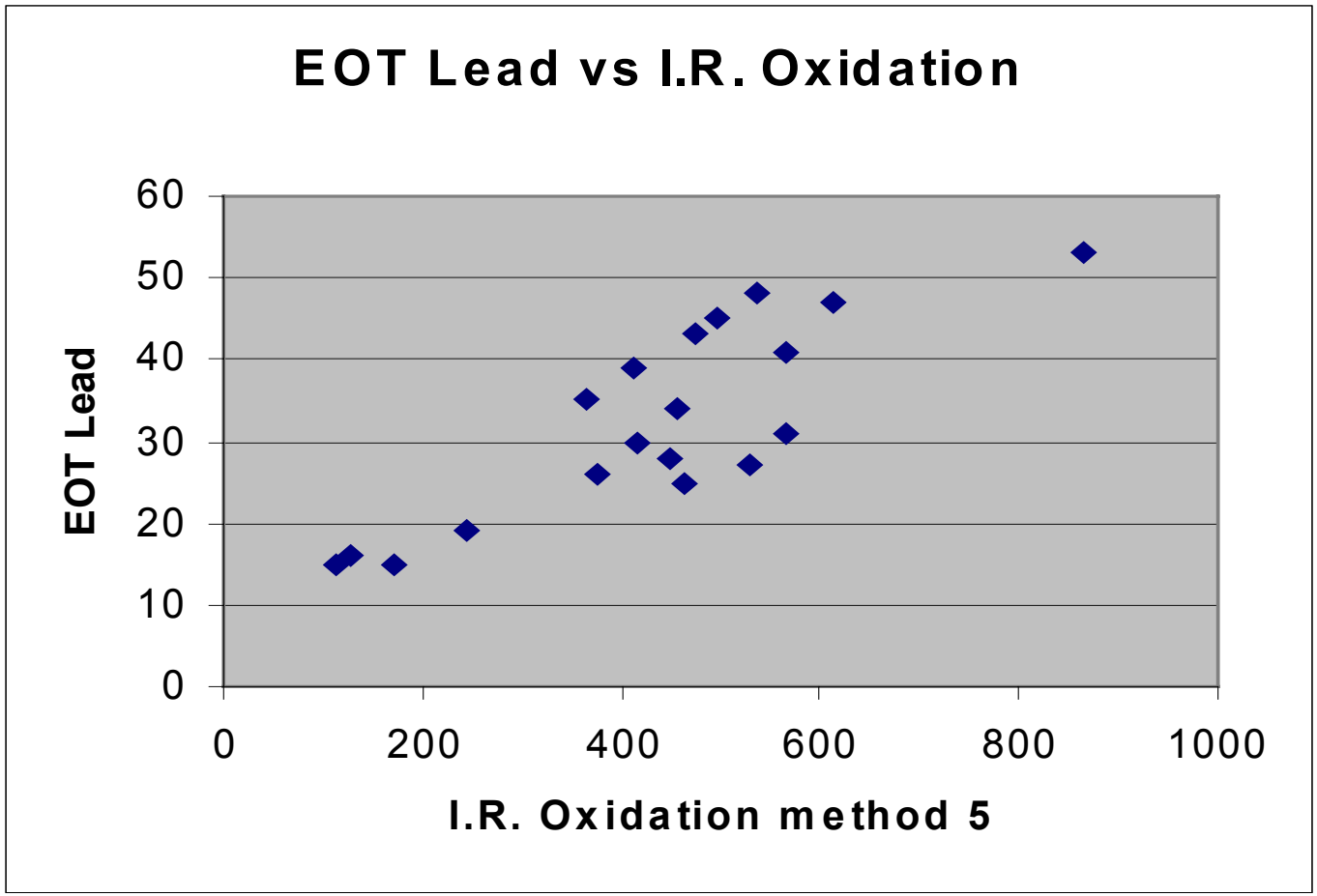
ΔPb (300 Hr) Strongly Correlates with IR

(*Matrix Data – 27 Points; One Outlier Excluded)*

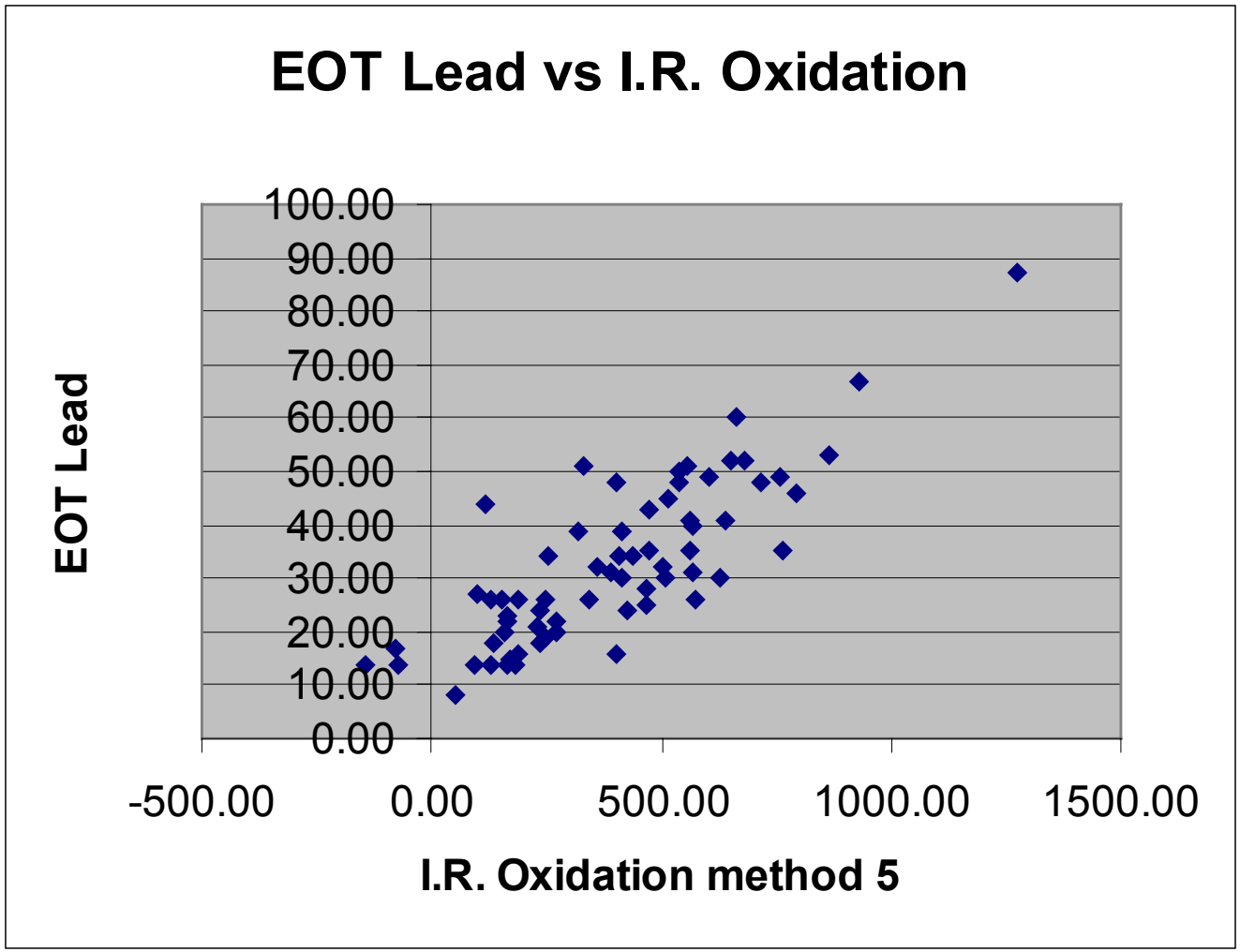


At PC-9 limit consideration, EOT Pb is limiting parameter not IR oxidation.

Infineum Data on T-10 Lead Corrosion: Delta Lead and IR Oxidation are highly correlated



Industry Data on T-10 Lead Corrosion



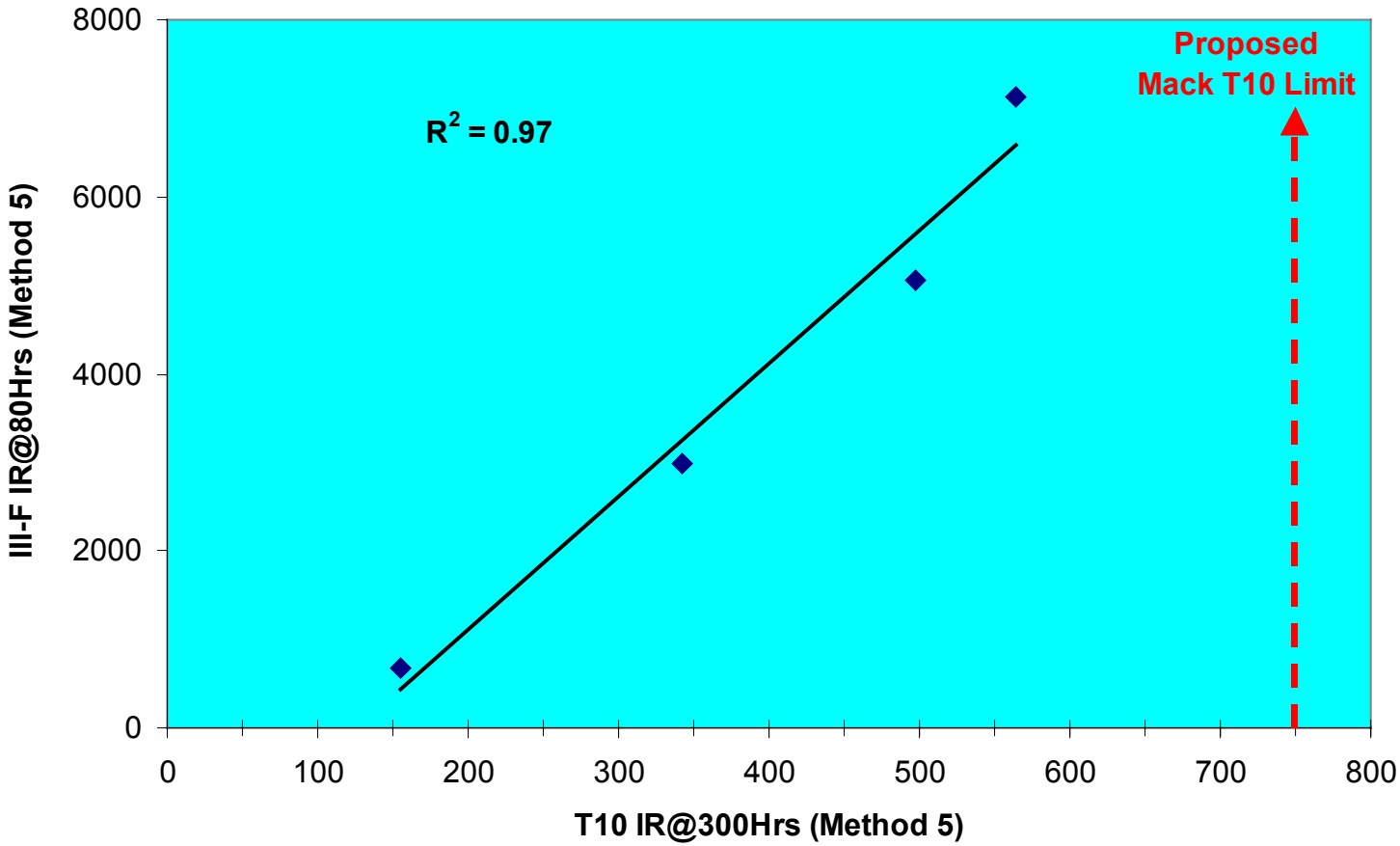
PC-9 Oils: Oxidation responses in Sequence III-F and Mack T-10 tests

- **Infineum has found 4 oil formulations with "matched pairs" of Sequence III-F and Mack T-10 tests**
  - ie, both tests run on identical oils

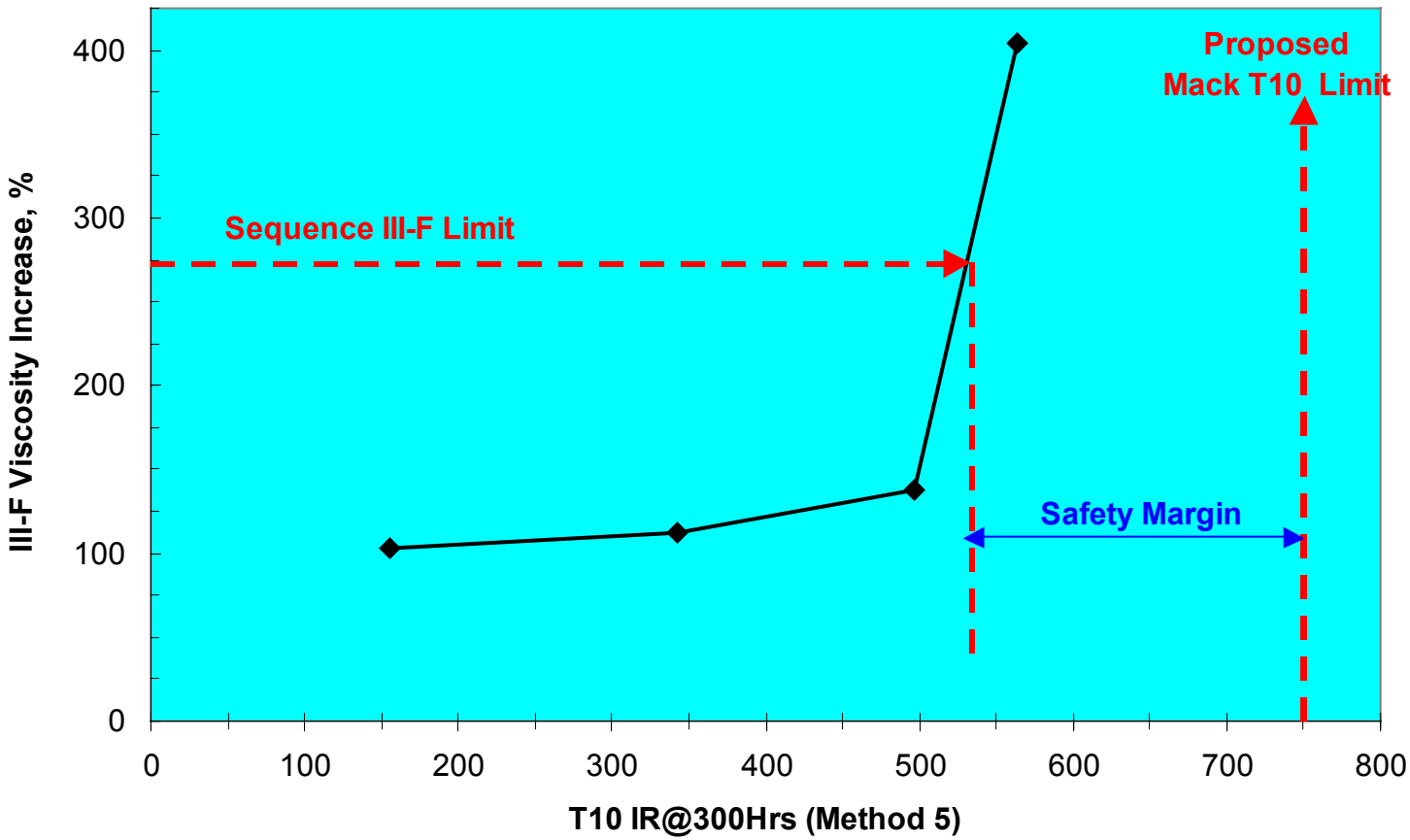
- **Results from these 4 pairs clearly show that oxidation responses in the two tests are highly correlated**
  - At an I.R. oxidation limit of 750 absorbance units, the Sequence III-F is shown to be a more severe test of oxidation than the Mack T-10 test evaluated .
  - However, both T-10 EOT lead and 250-300 hr delta lead limits actually drive T-10 I.R. oxidation to a range of 400-500 absorbance units which makes the **T-10 more restrictive than a passing IIIF**
  - The I.R. oxidation limit for EO-N Premium Plus (and PP 03) is 250 absorbance units which further reduces the oil's oxidation in the Sequence IIIF.

Seq.III-F IR shows Strong Correlation with Mack T-10 IR

(Infineum PC-9 Development Data)



PC-9: T-10 IR can be used as limiting oxidation parameter

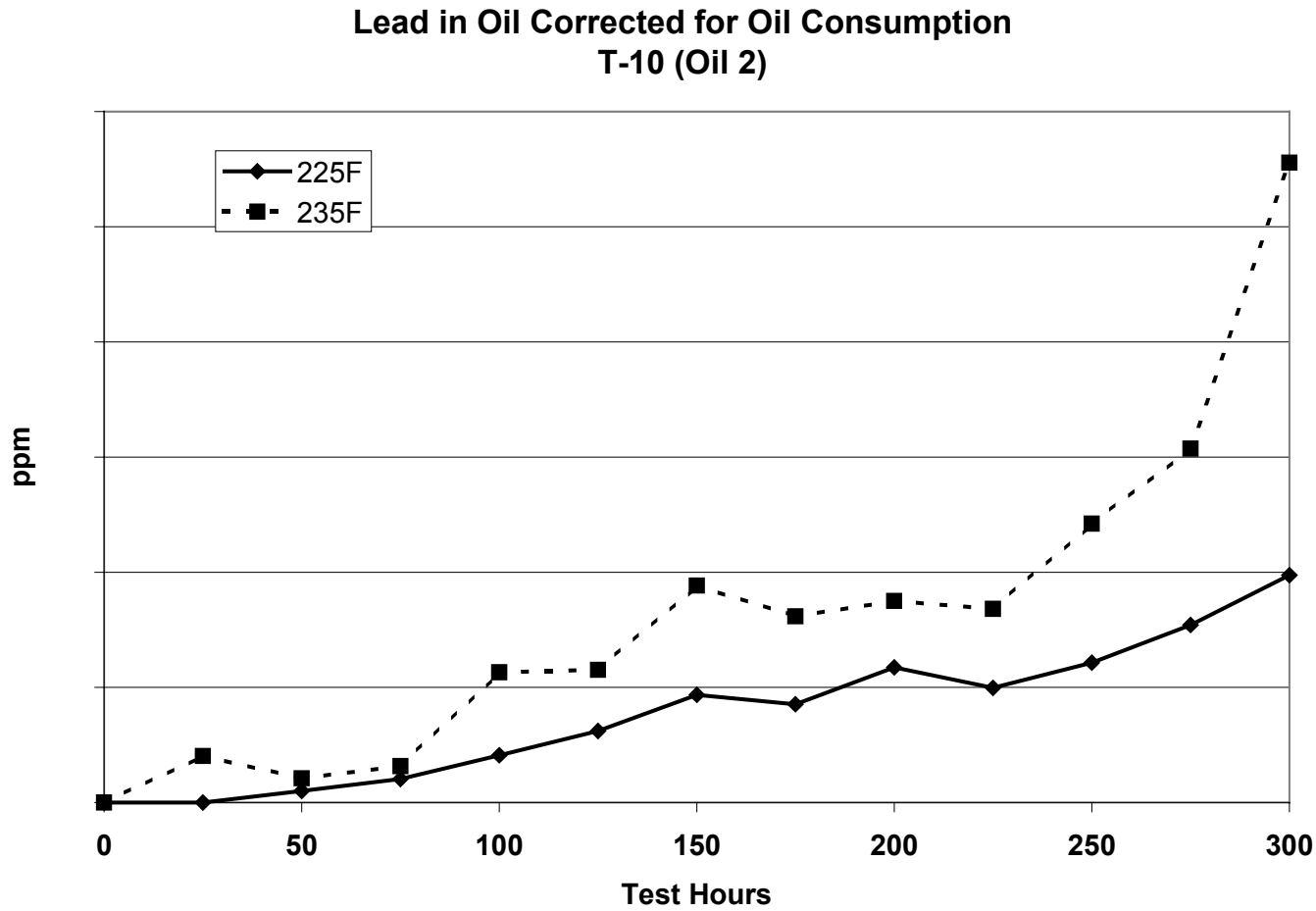


T-10 IR of 400-500 corresponding to 30 ppm Pb (p/f) is more restrictive than the current Vis Incr p/f for the IIIF for CI-4

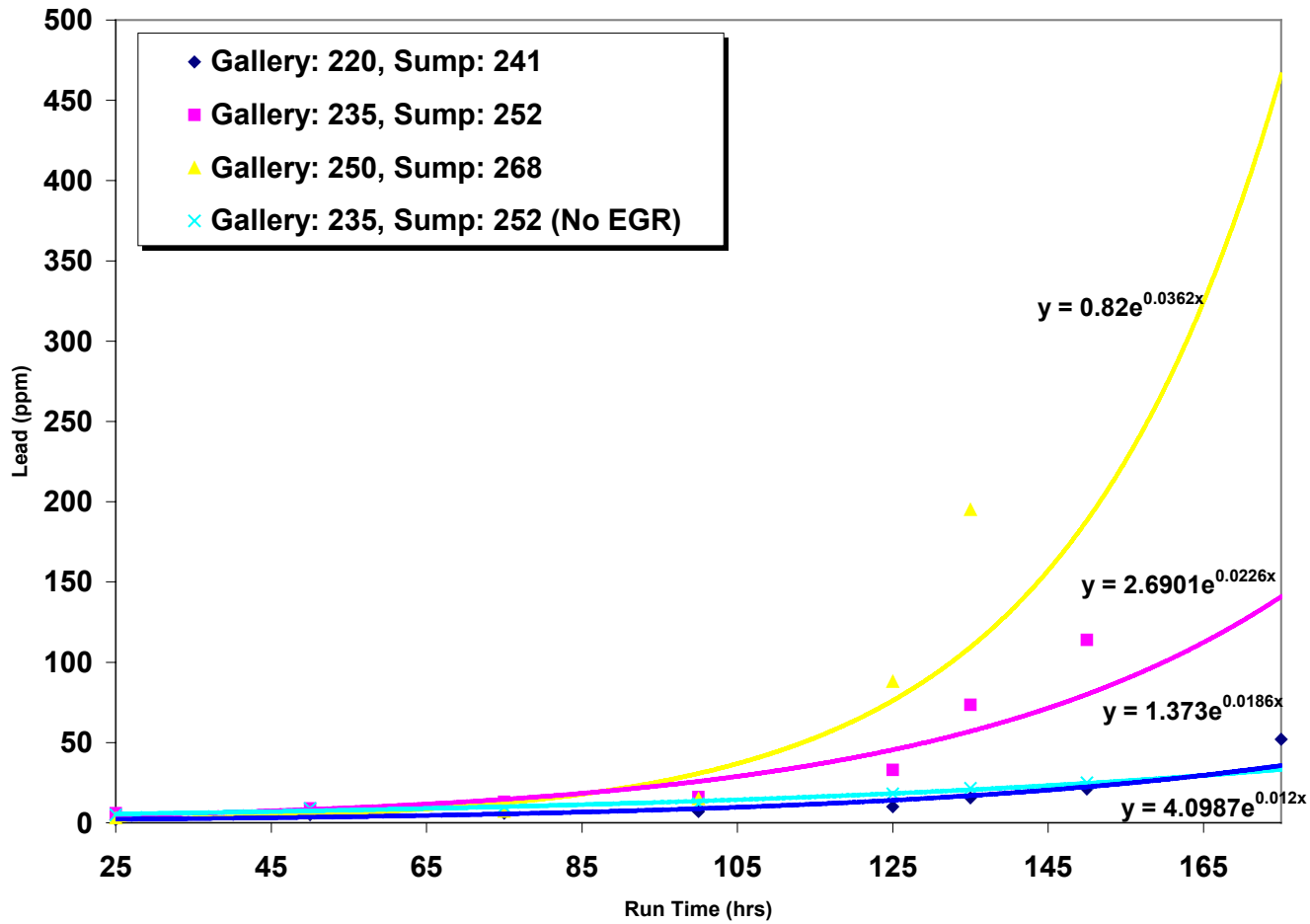
A Single Oxidation test for PC-10

- **The Mack T-12 is still under development**
- **The sump temperature for the Mack T-12 will be 10 °F higher than the Mack T-10**
  - Should be a more severe oxidative test
- **The Mack T-12 may provide adequate oxidation protection for API PC-10**

T-10: Lead (correlates to IR oxidation) Increases with Increased Temperature



Oxidation is Critical in T-10 –>T-12 Sump = 260



Summary

- **Past uses of the Sequence III in API C Categories were necessary as better tests did not exist**
  - Sequence III provided the desired level of protection against oxidation and viscosity increase
- **Experience has shown the Mack T-10 defines the oxidation benchmark for API CI-4**
  - Making the Sequence IIIF redundant
- **The Mack T-12 is still under development and is likely to be more severe than the T-10**
  - sump temperature increases 10 deg F from T-10 which implies roughly a 40% increase in oxidation rate and even greater lead severity
  - New bearings may change lead versus oxidation response

Recommendations

- **Do not make any decision regarding a Sequence III test for PC-10 until the Mack T-12 is more fully developed and its antioxidant severity is understood**
- **Assess if the Sequence III is a redundant test for PC-10: If the Mack T-12 is at least as severe as the T-10, use it as the oxidation test for PC-10 and do not include any Sequence III test**
- **Allow oil marketers to decide whether to license universal oils as API SL or SM**
  - Either a Sequence IIIF or a IIIG will still be run to support S category BOI claims
  - Avoiding API SM reduces the potential for misapplication where ILSAC GF-4 oils are required

ATTACHMENT 14

Jim Wells

From: Nahumck, William [WMN@Lubrizol.com]
Sent: Monday, October 04, 2004 3:16 PM
To: Mc Geehan, James (JIAM)
Cc: sidney.l.clark@gm.com; Dwight Bowden; Williams, Lewis
Subject: Projected Life of Sequence IIIF and IIIG

Dear Jim,

I have received the request from the HDEOCP (via Lew Williams) to provide some projection of the Sequence IIIF and /or Sequence IIIG test life so that you may weigh all options for the upcoming PC-10 category. Based on information recently provided by GM Powertrain and OHTechnologies, our primary central parts distributors, the Surveillance Panel has been given assurances that the engine used for this test will remain viable thru 2008 at this time. This is also true for all of the specialized, non-production parts made specifically for either test. This timeline is always subject to change, but none are anticipated at this time. Build out quantities can be considered an option if PC-10 requires either test to have a longer life than what is currently projected or an earlier cessation of production is announced. This will take some capital investment (individual labs would likely be reluctant to "absorb" buying and holding excess inventory) to make sure adequate parts supplies are available.

I hope this satisfies your concerns and needs for the HDEOCP members. Please do not hesitate to notify me if you need more information or additional clarification.

William Nahumck

Sequence III Surveillance Panel Chairman
The Lubrizol Corp. Phone: 440-347-2596
Fax: 440-347-2377 E-Mail: wmn@lubrizol.com

Focus on PC-10

James Mc Geehan
Chairman
Heavy-Duty Engine Oil Classification Panel

November 11th 2004

PC-10 Oxidation Tests Selection

- Need to determine the diesel oxidation characteristic's of Cat.13 and Mack T-12 tests before considering a gasoline test.
- Cat.13 IR oxidation (Method 5) indicates high levels of oxidations, equal or higher than Mack T-10 .
- Mack T-12 development producing oxidation as indicated by lead increases
- Establish diesel oxidation characteristic's at the end of matrix testing, and then decide on proper tests for diesels engines. (Cat C13/Mack T-12)

PC-10 Fuel Supplier Selection Task Force

MEMBERS

- Mesfin Belay
- Pat Fetterman
- Tom Franklin
- Jim Wells

JMW 11/11/04

PC-10 Fuel Supplier Selection Task Force

Supplier	Meets Proposed Fuel Spec.	Fuel Batch Certified	Price Index (BASE)	Off Road Dye Charges	PC-10 ULSD Spec. Premium	Transport	Total	Comments
1	Yes	Yes 250,000 gallons, min	Platt's LS #2D	No	$1.25 per gallon	$0.09 per gallon	Base + $1.34 per gallon	Change monthly
2	Yes	Yes 500,000 gallons, min.	Platt's LS #2D	No	$0.325 per gallon	$0.24/gl Trailer $0.14/gl Tank car	Base + $0.565 or $0.465	Change with each batch
3	No							

ATTACHMENT 16, 2 OF 3

JMW 11/11/04

PC-10 ULSD Fuel Specification

Property	Specification	Test Method
Additives	Lubricity additive only	
Distillation Range, ºF		
90%	560 - 630	ASTM D 86
Specific Gravity	0.840 – 0.855	ASTM D 4052
API Gravity	34 – 37	ASTM D 4052
Corrosion, 3 h at 50 ºC	1 max	ASTM D 130
Sulfur, ppm	7 – 15	ASTM D 5453
Flash Point, ºF	130 min	ASTM D 93
Pour Point, ºF	0 max	ASTM D 97
Cloud Point, ºF	Report	ASTM D 2500
Viscosity at 40 ºC, cSt	2.0 – 2.6	ASTM D 445
Ash, weight %	0.005 max	ASTM D 482
Carbon Residue on 10% Bottoms	0.35 max	ASTM D 524
Net Heat of Combustion	Report	ASTM D 3338
Water and Sediment, volume %	0.05 max	ASTM D 2709
Total Acid Number	0.05 max	ASTM D 664
Strong Acid Number	0 max	ASTM D 664
Cetane Index	Report	ASTM D 976
Cetane Number	43 – 47	ASTM D 613
Accelerated Stability, mg/100 ml	1.5 max	ASTM D 2274
Composition		
Aromatics, wt %	26 – 31.5	ASTM D 5186
Olefins, vol %	Report	ASTM D 1319
Saturates, vol %	Report	ASTM D 1319
HFRR, microns	520 max	ASTM D 6079