HEAVY-DUTY ENGINE OIL CLASSIFICATION PANEL

OF

ASTM D02.B0.02

February 19, 2004

DoubleTree Hotel – O'Hare, Rosemont, IL

ACTION ITEMS

1.	**Recommend PC-10 fuel supplier by 12/04.**	**PC-10 Fuel Source T. F.**
2.	**Accelerate Mack T-11 Test Procedure toward standard.**	**D02.B0**
3.	**Add Seq. IIIG as an alternative to Seq. IIIF in "C" categories.**	**D02.B0**
4.	**Data supporting consolidation of CAT single cylinder tests.**	**Any who have data**

MINUTES

1.0 Call to Order

1.1 Chairman Jim McGeehan called a meeting of the HDEOCP to order at 8:02 a.m. on February 19, 2004, in the DoubleTree Hotel of Rosemont, Illinois. There were 17 members present or represented and approximately 11 guests present. The attendance list is shown as Attachment 2.

2.0 Agenda

2.1 The published agenda (see Attachment 1) was reviewed with no suggested changes.

3.0 Previous Meeting Minutes

3.1 Chris Laroo wanted to clarify and expand on EPA considerations regarding dye colors for future fuels, as an amendment to paragraph 6.1 of the Dec. 9, 2003 HDEOCP minutes. His requested expansion is included here as Attachment 3.

3.2 Lew Williams moved and Dave Stehouwer seconded that the Dec. 9, 2003 minutes be approved as posted on the TMC web site and now amended. The motion passed via voice vote.

4.0 Membership

4.1 Michael Weismiller replaces Glen Mazzamaro of CIBA. See Attachment 4.

5.0 Chairman's Comments

5.1 Chairman McGeehan expressed his feelings that the CI-4 Supplement activity is sucking the air out of PC-10 efforts. His slides (Attachment 5) review what's been done, what needs to be done and the time available now versus what it has taken in the past. Ensuing discussion from the floor again emphasized proceeding with only those tests that are ready by the end of 2004.

6.0 PC-10 Matrix Funding

6.1 Steve Kennedy reported that the PC-10 Matrix Funding Task Force had met on Feb. 18, 2004. Due to the still large number of unknowns, they have not made much tangible progress. But, positions and strategies are being established to help speed the process when more is known about the matrix.

7.0 PC-10 Chemical Limits

7.1 Rick Finn reviewed the task force status (Attachment 6). Since they do not have much data yet, they have extended the data submission deadline to the end of March and they will try to meet in mid-April.

7.2 Mike Lynskey presented some slides (Attachment 7) covering a Castrol study of oil ash effects on diesel particulate filters.

8.0 PC-10 Fuel

8.1 Steve Kennedy proposed and Greg Shank seconded that a single source be chosen for PC-10 ULSD fuel. The fuel specification has already been developed, but the fuel and a source must be available by January 2005. The motion passed with 16 votes for, 0 against, 0 abstain.

8.2 Steve Kennedy proposed and Bill Runkle seconded that PC-9 fuel be carried forward for use in those PC-10 tests requiring 300 – 500 ppm Sulfur fuel. The motion passed via voice vote.

9.0 PC-10 Timeline

9.1 Bill Runkle reviewed the PC-10 timeline and noted that it is unchanged from the December meeting. See Attachment 8.

9.2 Lew Williams presented a timeline which adds a six month window after the matrix tests for technology demonstration (see Attachment 9) before limits for the tests are set. There was lots of discussion in regard to this potential addition. One idea that surfaced was to establish a range for parameter limits in June of 2005 and then finalize the limits in December. Discussion on this topic is sure to continue.

10.0 PC-10 Test Development

10.1 Cummins ISM

10.11 Warren Totten reported the initial ISM matrix tests are to start in March, using oil ISM(A) and reference oils 1004, 1005 & 870-2.

10.2 Cummins ISB

10.21 Warren also presented an update on the ISB test development. See Attachment 10.

10.3 Caterpillar C13

10.31 Abdul Cassim reported on the C13 test development status. Two tests have completed and four are in progress with scheduled completion by March 15. A Task Force meeting is planned for March 24 to review the data.

10.4 Mack T-12

10.41 Greg Shank reported on the T-12 test development and indicated they plan to generate about 5% soot in the oil and run with a 260 °F oil gallery temperature. See Attachment 11.

10.42 Since he already had the floor, Greg reviewed the T-11 status (see Attachment 15). He then proposed and Warren Totten seconded that the T-11 test be accepted as an ASTM procedure and moved forward to becoming a standard. The motion passed with 16 for, 0 against, 0 abstain. This will permit ACC to consider registration for T-11 candidate tests.

11.0 PC-10 Matrix Design Task Force

11.1 Chairman McGeehan asked for a volunteer to chair the Matrix Design Task Force. No one volunteered, but after some gentle arm twisting, Steve Kennedy agreed to accept the challenge.

12.0 Sequence IIIG for IIIF

12.1 Bill Kleiser made and Lew Williams seconded the following motion: A passing Sequence IIIG, GF-4 viscosity increase may be used as an alternative for a passing Sequence IIIF viscosity increase, anywhere the Sequence IIIF is required in a "C" category. After significant discussion, the motion passed with 13 votes for, 1 against and 2 abstains. This action now needs to move to D02.B0 for ballot approval of inclusion in D4485.

13.0 CI-4 Supplement

13.1 Steve Kennedy reported on the status of the CI-4 Supplement, see Attachment 12. Other than finalizing exactly what tests will be included, the major task remaining is to resolve the request for a 10 TBN new oil minimum. The next DEOAP meeting is scheduled for April 1, 2004.

13.2 Dave Stehouwer presented Cummins data behind their request for a 10 TBN minimum for the CI-4 Supplement oils. See Attachment 13. There was significant discussion after the presentation, but no apparent resolution.

14.0 Caterpillar Single Cylinder Tests

14.1 Abdul Cassim made a presentation on CAT single cylinder tests (see Attachment 14) and asked for any available data which might indicate newer tests could be substituted for older tests as an alternative. The CAT Surveillance Panel should ask RSI / ACC for data. CAT wants to get out of the older engine parts supply business.

15.0 Next Meeting

15.1 The previously scheduled meeting for April 15th has been postponed to May 18, 2004, still at the Rosemont DoubleTree Hotel.

16.0 Adjournment

16.1 The meeting was adjourned at 12:18 p.m.

Submitted by:

Jim Wells
Secretary to the HDEOCP

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

DoubleTree Hotel
February 19th 2004
8:00 am to 1:00 pm

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

Desired Outcomes: **PC-10 timing, tests, chemical limits.**

Note all presentations will be made from the computer to Focus projector. Bring discs or CD's for minutes.
Also need money for the rooms and other room items

TOPIC	PROCESS	WHO	TIME
Agenda Review	• Desired Outcomes & Agenda	Group	8:00-8:05
Minutes Approval	• December 9th 2003	Group	8:05-8:10
Membership	• Changes: Additions • Chairman's comments focusing on PC-10 in 2004	Jim Mc Geehan	8:10-8:20
Funding	• Status of funding for PC-10 matrix • Timing	Steve Kennedy	8:20-8:30
Chemical Limits	• Current status of information • Timing of closure of limits: April or June?	Pat Fetterman Jim Mc Geehan	8:30-8:45
NCDT report	• Time-line for program • Other activity	Bill Runkle	8:45-9:15
Coffee break	•		9:15-9:30
PC-10 Test Development report	• Cummins ISM • Cummins ISB • Caterpillar C13 • Mack T-12	Dave Stehouwer Abdul Cassim Greg Shank	9:30-11:00
Chairman for Matrix	• Need chairman for future precision and BOI matrix design	Jim Mc Geehan	11:00-11:15

TOPIC	PROCESS	WHO	TIME
Use of IIIG test for IIIF	• Passing results in IIIG meets IIIF requirements: discuss	Jim Mc Geehan	11:15-11:30
PC-10 test development	• Fast track oil categories process beyond API CI-4 and	Steve Kennedy	11:30-12:00
Mack T-11 test	• Acceptance of Mack T-11 as a ASTM test as it will be in API CI-4+	Greg Shank	12:00-12:30
Caterpillar single cylinder tests	• Support for single-cylinder tests and potential changes • Discussion	Abdul Cassim	12:30-12:55
New and old business			12:55-1:00
Next meeting April 15th	DoubleTree Hotel		

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I would like to make a change to the 12/8 meeting minutes in section 6.1, clarifying the fuel dye. Please strike the sentence on 15 ppm fuel being dyed yellow and replace it with the following fuel dye information:

6.1 "From 2007 to 2010, home heating fuel will be dyed yellow to prevent movement to the non-road sector. 500 ppm S fuel will be fungible (highway, non-road, locomotive, and marine) and non-road 500 ppm fuel will still be dyed red at point of sale for tax purposes. There will be no dye added to 15 ppm S highway fuel."

"For 2010 and beyond, the yellow dye will move to 500 ppm S fuel designated for locomotive and marine applications. Home heating oil will be not be dyed and will be the only remaining high S fuel in the market. Non-road 15 ppm fuel will still be dyed red at point of sale for tax purposes."

"It is also still possible that EPA will go to a *Designated Track* concept in the Tier 4 non-road final rule, that will eliminate the need for markers all together."

I had this corrected information at the meeting on the 9th, but never got a chance to present it. If these corrections could be added to the meeting minutes, it would be greatly appreciated.

HDEOCP Membership

	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 Kelly - International
6	Michael Weismiller - 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	Mary Graham-ConocoPhillips	

Focus on PC-10

James Mc Geehan
Chairman
Heavy-Duty Engine Oil Classification Panel

February 19, 2004
Chicago, Illinois

PC-10 Program Concerns

- API CI-4+ Taking All Resources From PC-10, Lack of Task-Force Meetings
- Potential Two Caterpillar Test Procedures at Two Different Sulfur Levels: Cost and Time
- Caterpillar Can Not Support SC Tests Due to Hardware Supply – Need to Develop One New Single Cylinder With Aluminum Piston
- Mack T-12 Not Available Until June 2004

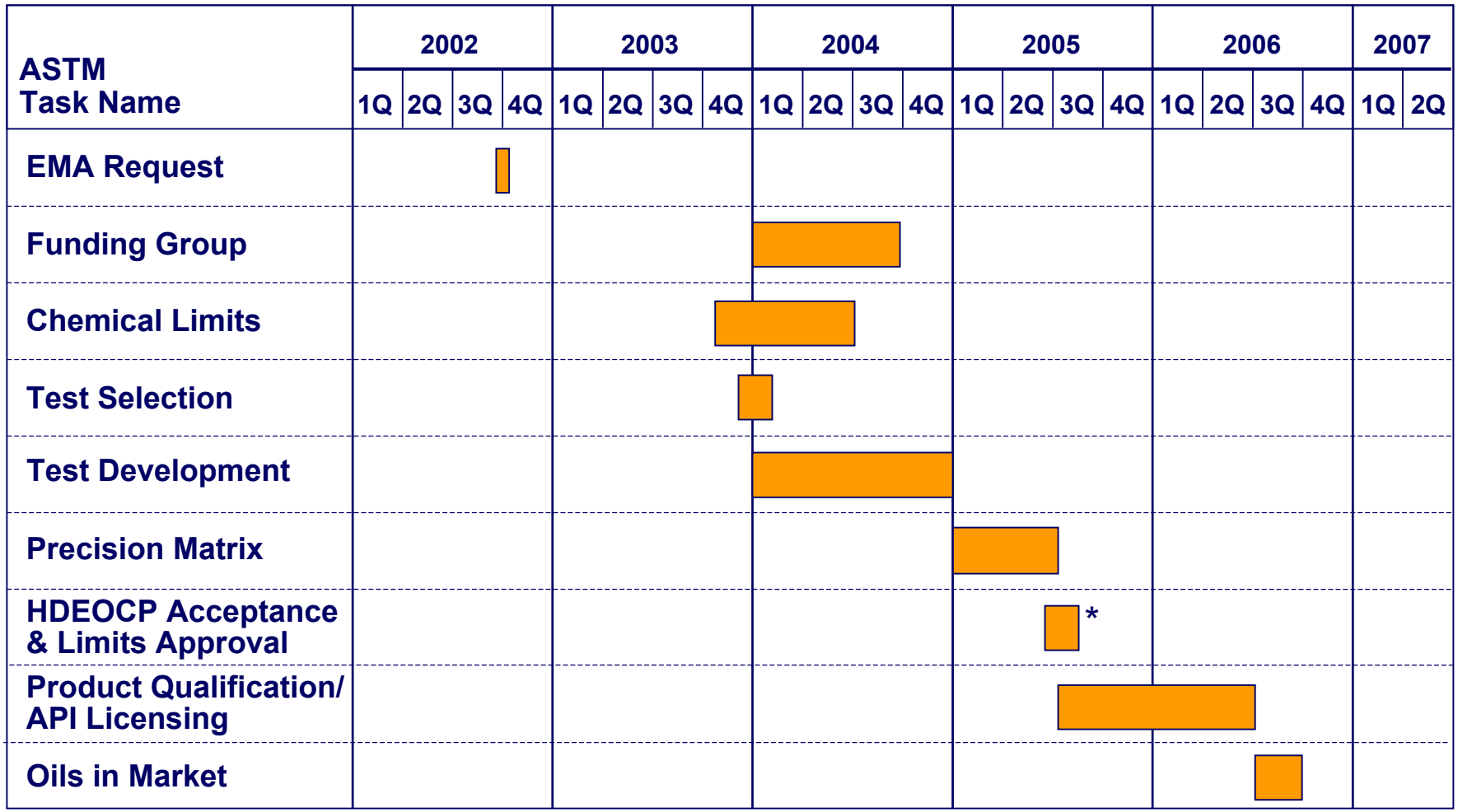
PC-10 Test Activity

- **Cummins ISM and ISB at Outside Labs With Test Procedures and Reference Oils**

Engine Oil Category "PC-7" Project Planning: Original Time Table

Calendar Year Quarters	1994			1995				1996				1997				1998
	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st
Category																
ASTM	■															
Estab. Funding	■	■														
Reference Oils																
Selection		♦														
Review & Eval.		■	■	■												
Modifications				♦												
Availability						♦										
Performance Tests																
Development		■	■	■	■											
Hardware Avail.						■										
Tests Go/No Go							♦									
Stat. Testing								■	■	■						
CMA Review										■	♦					
Write Res. Rpts.										■	♦					
Estab. Pass/Fail										♦						
Tests Available											♦					
Society Ballot											■					
Candidate Testing												■	■	■	■	
API Licens. Begins																♦

Proposed PC-10 Timeline



*Acceptance of PC-10 Limits – June 2005

Lubricants Chemical Limits for ACEA E6 and JASO DH-2

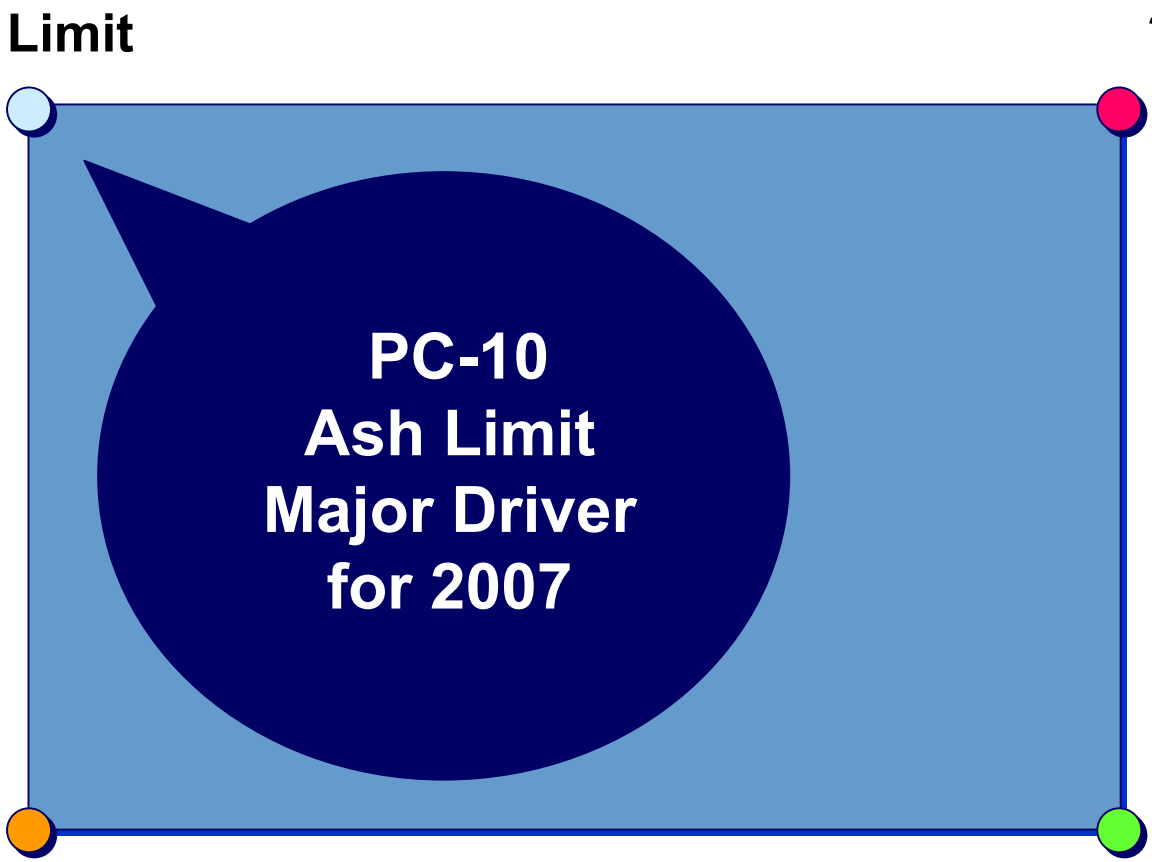
1.0% Ash (ACEA E6) - 2005
1.0% (JASO DH-2) - 2005

0.3% Sulfur (ACEA E6)
0.5% Sulfur (JASO DH-2)

13% Volatility (ACEA)

0.08% Phosphorus (ACEA E6)

High EGR and DPFs



PC-10 Multicylinder Engine Tests

	ISM	ISB	6.5L	C13	T-12	T-11	IIIG	7.3L
Valve Train Wear	✓	✓	✓					
Liner Wear					✓			
Ring Wear	✓				✓			
Bearing Corrosion					✓			
Oxidation Viscosity Inc.					✓		✓	
Oil Consumption				✓	✓			
Piston Deposit Control				✓				
Soot Viscosity Increase						✓		
Sludge	✓							
Filter Plugging	✓							
Aeration								✓

Proposed PC-10 Diesel Fuel Sulfur Levels for Each Test

Oil Category	PC-10	PC-10
Fuel Sulfur	500 ppm	15 ppm
Engine Test		
Caterpillar 1K	-	-
Caterpillar 1N	-	-
Caterpillar 1R	-	-
Caterpillar C-13 (CCV)		X
Cummins M11-EGR	-	-
Cummins ISM	X	-
Cummins ISB	-	X
Mack T-8	-	-
Mack T-12	-	X
Mack T-11	X	-
Sequence IIIF	-	-
Sequence IIIG (Sulfur 1,000 ppm)	-	-
GM 6.5 Liter Roller-Follower Test	X	-
Navistar 7.3L Aeration	X	-

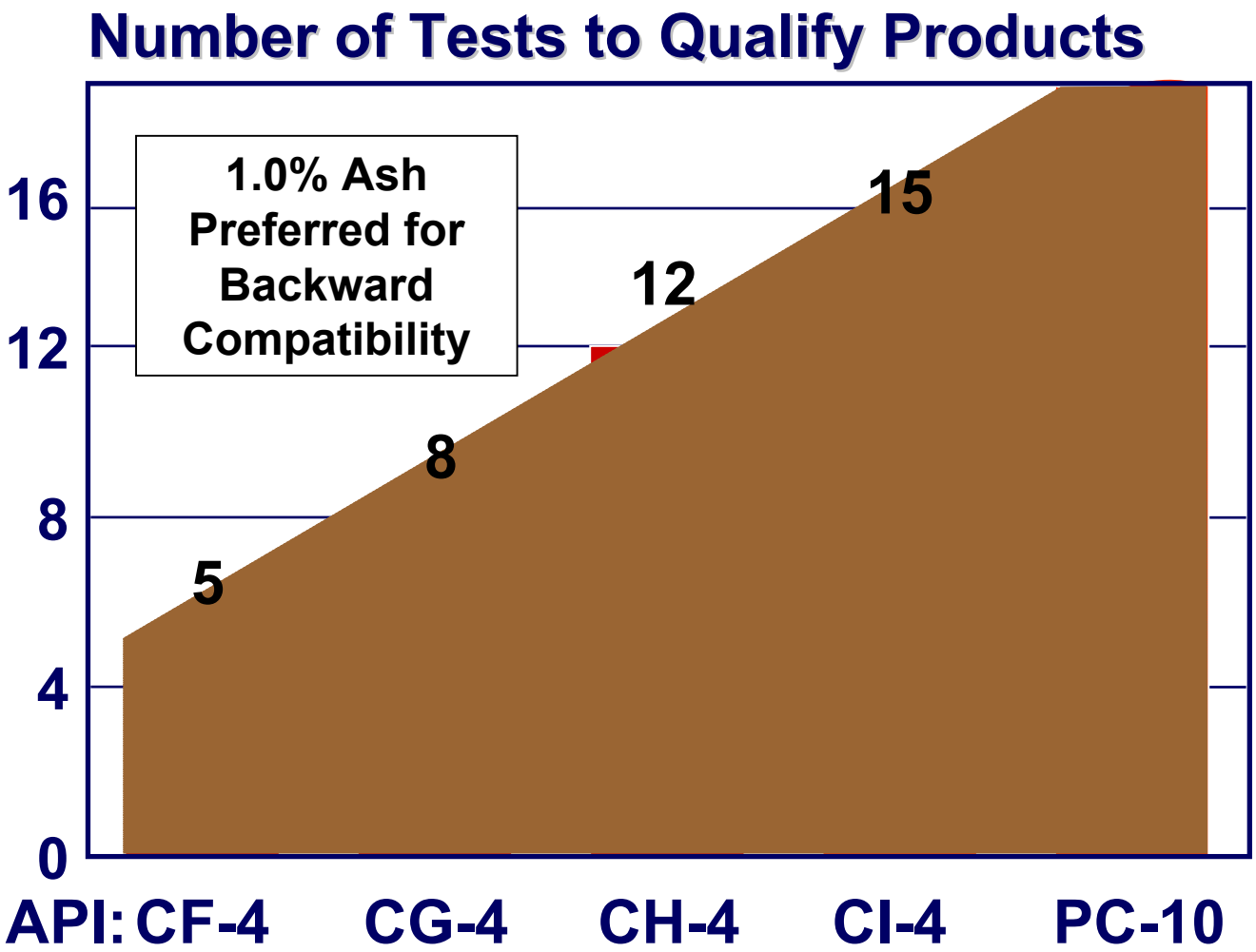
After-Treatment Compatibility

- DPF Will Be Used by 2005-2007 in Japan, Europe, and U.S.
- All Diesel Engines in U.S. Will Use DPF for 2007 to Meet Particulate Emissions
- PC-10 Should Be Driven by Sulfated Ash Limit to be Compatible With DPF

Motions to Date by HDEOCP

- Issued Chemical Limit Letter (August 22, 2003) With Limits to Be Frozen June 22, 2004. Exit-Criteria Ballot April 15th
- 13% Noack Volatility
- 90 Cycle Shear Stability
- Vamac Added to API CI-4 Seals
- 75% Membership Vote in HDEOCP to Move Forward With PC-10
- API CI-4 Supplement to Be Included in D 4485
- TMC Monitoring of API CI-4 Elastomer Tests

Customers Require One Oil



PC-10 Chemical Limits Task Force Update

February 19, 2004

Submissions

- Responses from 7 entities covering 34 oils
  - Short on Type 2 data
  - Short on Type 3 data
- Joint letter from ATC/ACC
  - Confirming that individual member companies would provide data separately
  - Encouraging any limits established to be based on sound and consistent data showing the technical need

Task List and Timeline for Task Force Activities

- Develop data input forms (Rick)
- Develop cover letter (Rick)
- Develop Distribution list for the letter
  - Greg S to supply a list for MECA
  - Jim M will handle API/ACC/EMA
  - Rick F will get a list for ACEA/Japan
- Send out letter/info request (Rick/Jim)
- Send out reminders of the 9/19/03 deadline (Rick/Jim)
- Information returned to EMA staff (by September 19)

Complete

- New Letter Extending Deadline to April 1
  - Encouraging more Type 2 data
  - Will issue by end of February
- Initial organization and review of the data (Abdul C, Bill K, Dave S and Mark R volunteered to do this)
  - Late March/early April
- Detailed review of the data and initial proposal for chemical limits by task force
  - Meeting dates proposed for April 14 (Chicago), April 27, May 11 and May 25
- Build consensus for chemical limits within task force by June ASTM meeting
  - Target end of May
  - Data "allowing"

Ahead

ATTACHMENT 6, 3 FO 3

Ash sensitivity study

- Work carried out in America
- Utilising a Detroit Diesel Series 60 engine
- Run for 200 hrs transient cycle (max power & max speed)
- CRT – Cordorite type

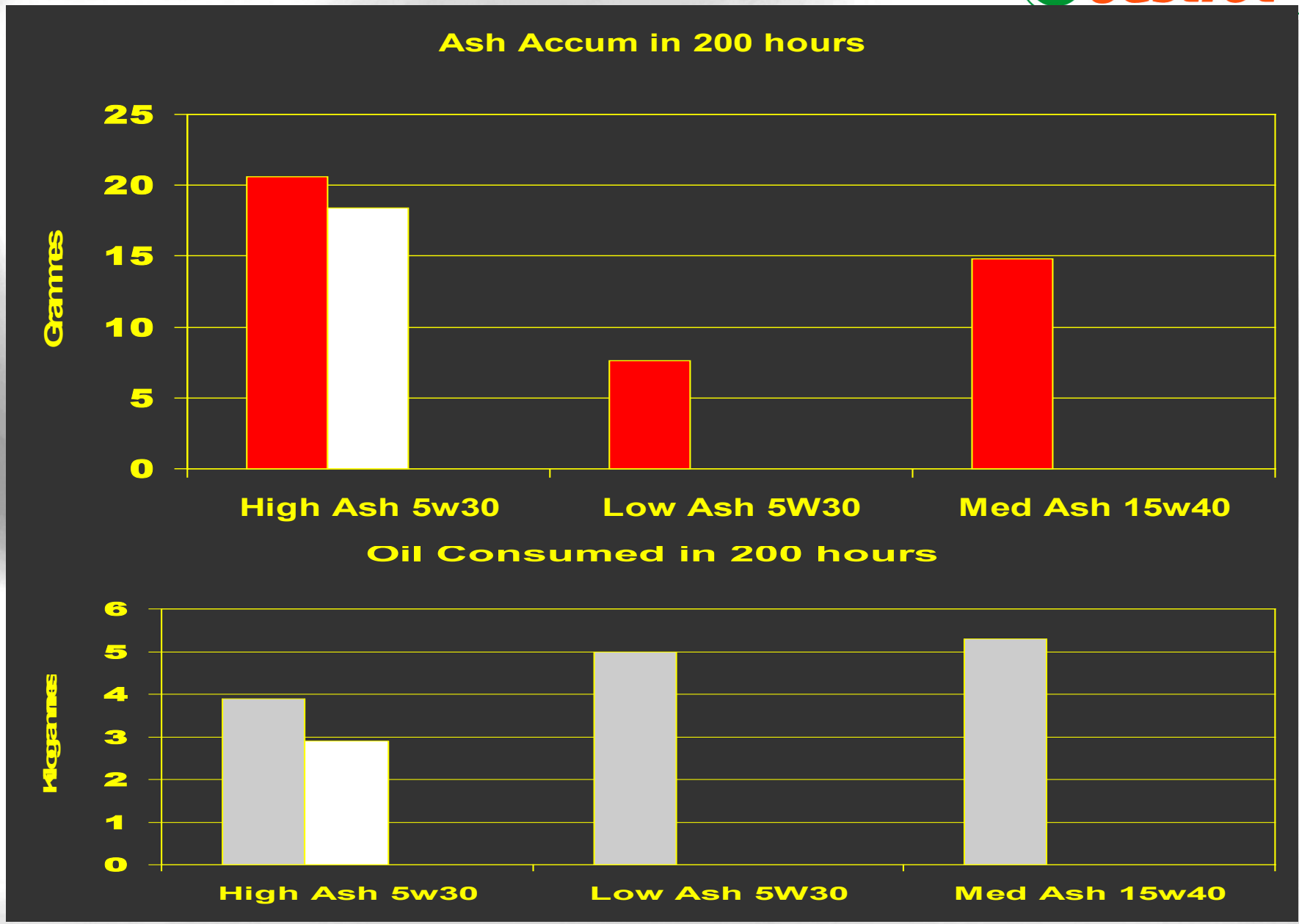
- Oil consumption monitored
- Weight of ash deposit calculated

- Candidates
  - 5W30 High Ash Top tier European
  - 15W40 Med Ash Market general American (CH-4)
  - 5W30 Low Ash Experimental low ash

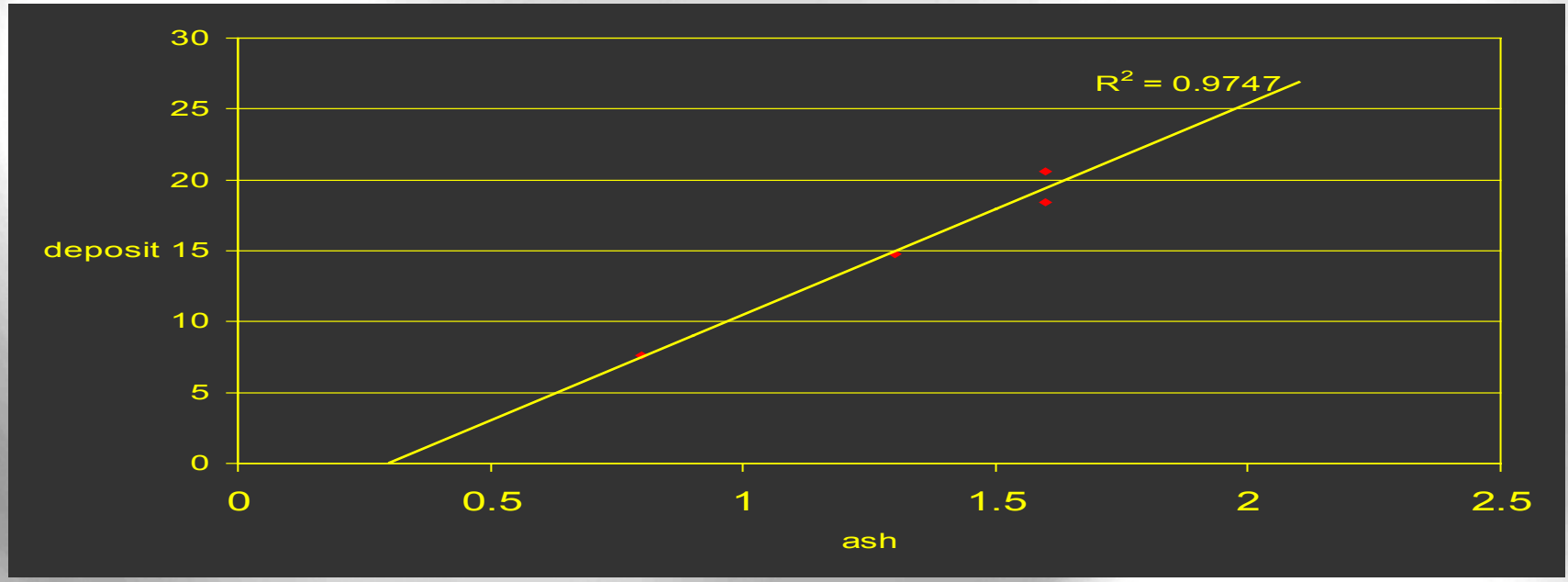
DPF work - Formulations

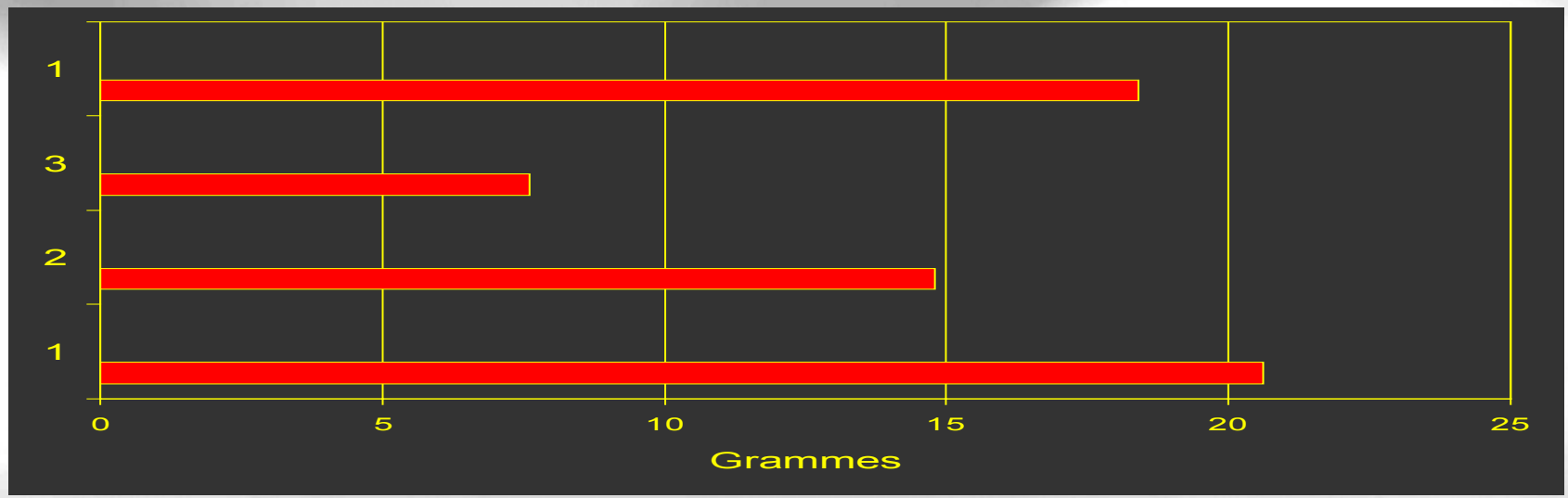
Lube number	1	2	3
Sulph. Ash	1.6	1.3	0.8
Phos	1260	1360	370
Sulphur	4010	5410	1290
Calcium	3200	3250	1770
Magnesium	370	11	350
Zinc	1380	1460	390

Ash Accumulation testing

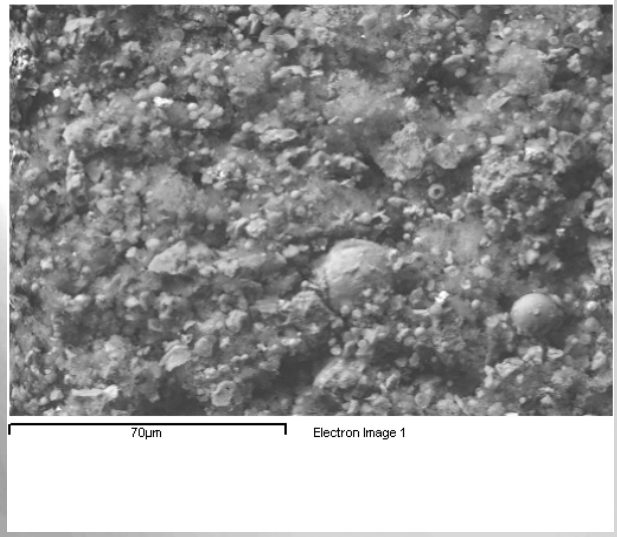


Ash Accumulation testing

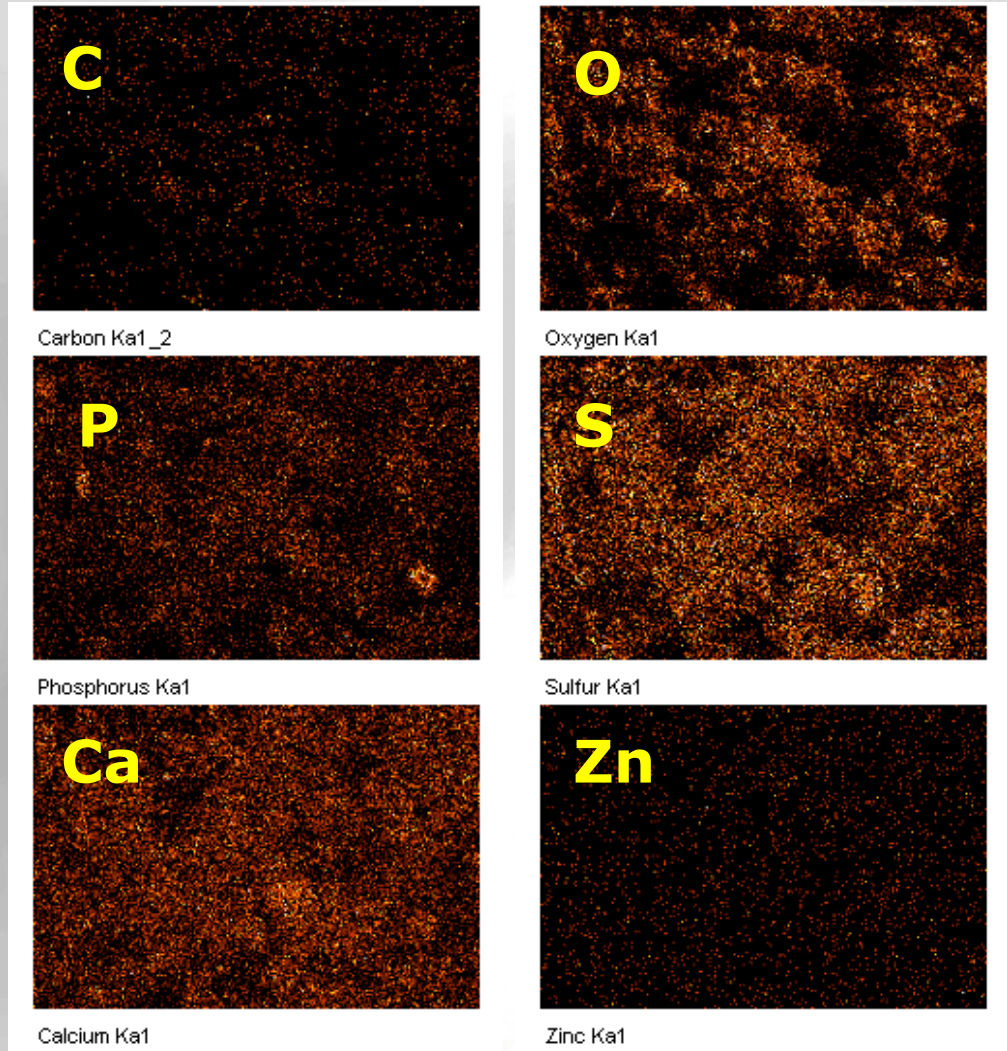




Elemental distribution in ash



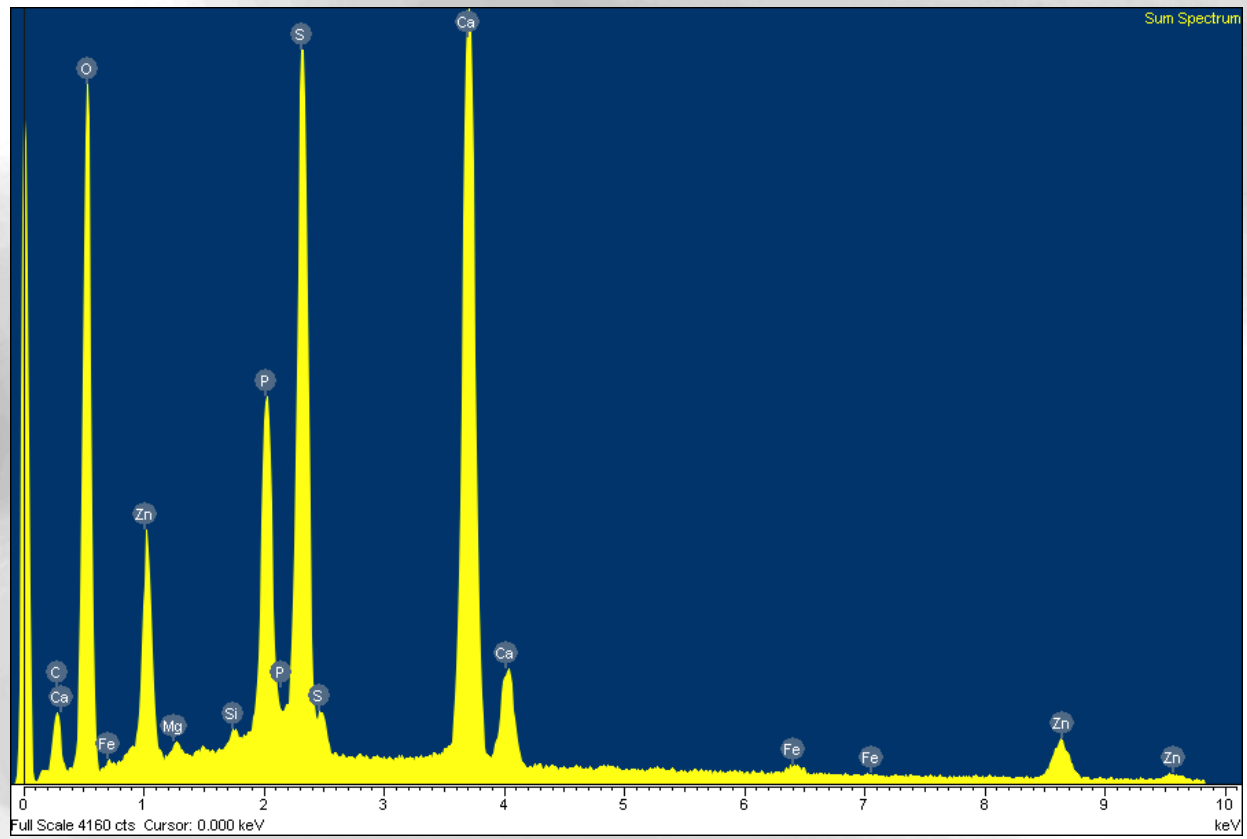
SEM micrograph of ash and individual elemental distribution maps



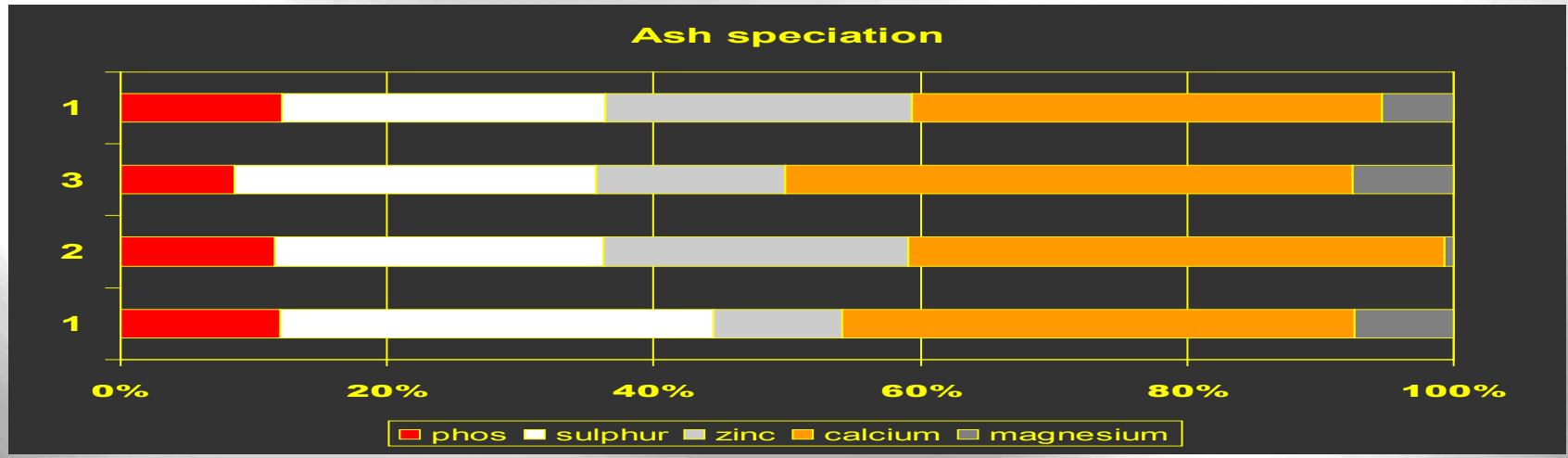
Lighter colour = more

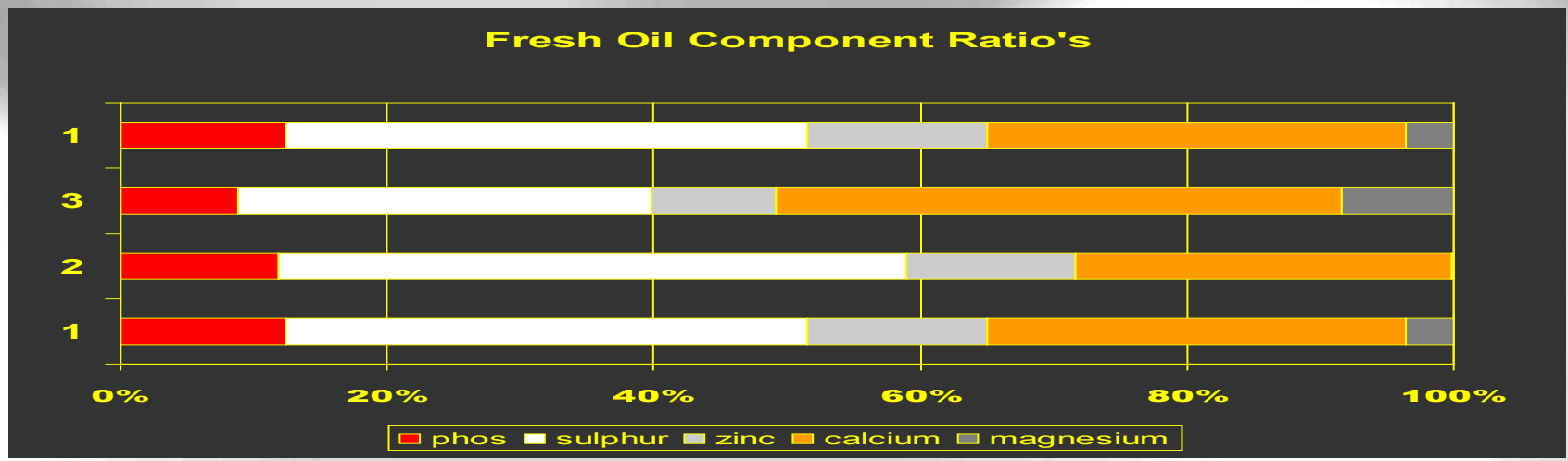
Ash analysis

Typical EDS spectrum of ash , used to calculate semi-quantitative composition



Ash Accumulation testing



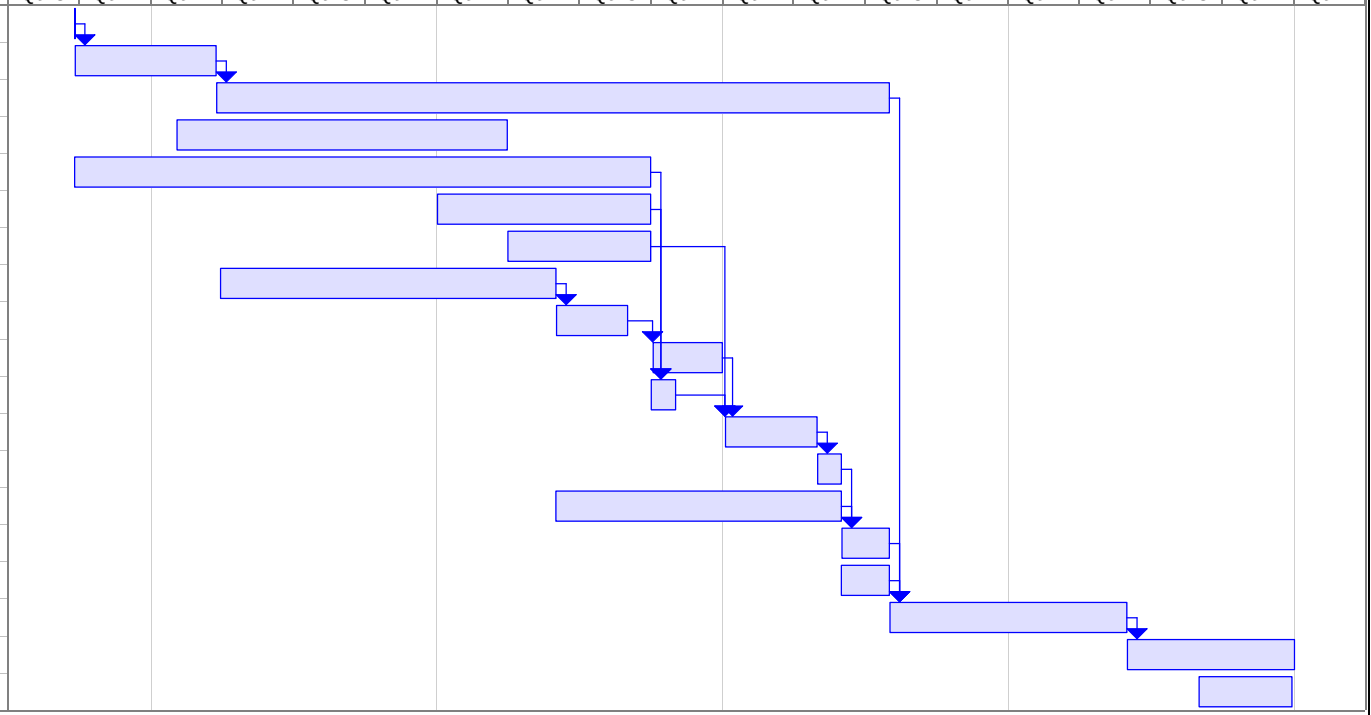


Conclusions & Questions

- Lubricant Sulphated Ash corresponds to trap deposits.
- Oil consumption does not appear to be related to deposit weight?
- Ratio's of ash speciation remained fairly constant to fresh oil component ratio's

- Testing confirmed pre-conceived ideas.

ID	Task Name
1	EMA Request
2	NCET Activity
3	NCDT Activity
4	Funding Group
5	New Test Development
6	New Test Discrimination
7	Matrix Design
8	Chemical Limits Selection
9	Select Matrix Oils
10	Matrix Oil Prep
11	Accept Parameters/Tests
12	Matrix Testing
13	Analyze Matrix
14	Select Reference Oils
15	HDEOCP Acceptance & Limits Approval
16	API Lubes Committee Final Approval
17	Minimum Product Qualification Interval
18	API Licensing
19	Engines in Field

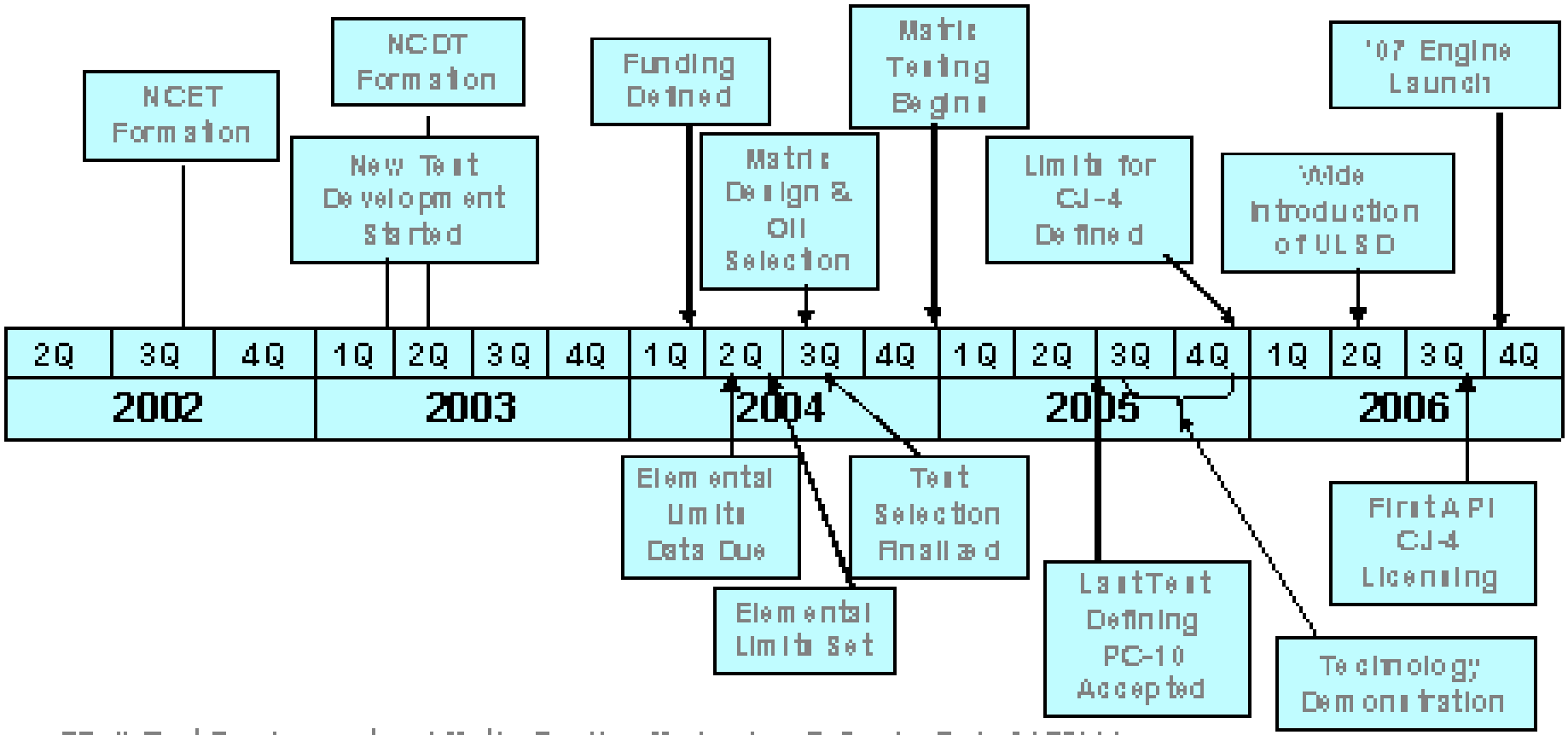


Project: PC-10
Date: Thu 1/8/04

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

ATTACHMENT 8

Proposed PC-10 Timeline



- PC-10 Test Development and Matrix Funding Mechanism Defined – End of 1Q2004
- Data on elemental limits due – 4/1/04
- Exit Ballot on Elemental Limits – 4/15/04
- Final definition of Elemental Limits – 6/22/04
- Matrix Design and Oil Selection – 3rd & 4th Qtr, 2004
- Matrix Testing Begins – 1Q, 2005
- Technology Evolution – 3Q, 4Q 2005
- Limits for CJ-4 Defined — Late, 2005
- ULSD Widely Available – 2Q, 2006
- First API CJ-4 Licensing – Fall, 2006
- 2007 Engine Launch – 3rd & 4th Qtr, 2006

ATTACHMENT 9

ISB Report Packet

Warren Totten

February 19, 2004

Chicago, IL

Scope

- Scope – To develop a lubricant performance test on a Cummins ISB test platform that can discriminate and provide a quality assessment of motor oils in a sliding tappet engine under cyclic conditions. The ISB test development will consider the following parameters for lubricant quality evaluation:

Primary Parameters	Secondary Parameters
Tappet Weight Loss	Push tube scuffing
Cam Lobe Wear	Sludge
Cam Journal Wear	Oil filter delta P
	Adjusting screw wt. loss
	Crosshead weight loss

Objectives

1. Draft of test procedure 12/03
   - **Preliminary draft completed 01/04**
   - **“ASTM-like” – in process**

2. Test engines to six labs 1/04
   - ExxonMobil, Lubrizol, SwRI, Valvoline
   - PerkinElmer and Ethyl engines 2/04

3. Initiate matrix design 1/04
   - **Preliminary proposal**

4. Begin matrix testing To meet API timing

Test Development

- The test method is derived from proven tests at Cummins and will have the same repeatability and discrimination
- Labs will receive 1 engine for shakedown and matrix testing
- Labs will receive all necessary parts for matrix testing
- This test will need to have completed matrix testing and be available to the industry by 3Q 2005

➢ Remember that sliding tappets will be used on the design of the 2007 engine

ISB Operating Conditions

- 2004 EPA Compliant ISB engine rated at 300 HP and 600 ft-lbs torque
  - 100 hours at 1600 RPM and 325 ft-lbs torque
    - 13 – 16 deg retarded timing to meet soot target
    - Soot target 3.5% at 100 hours
  - 250 hours engine wear cycle

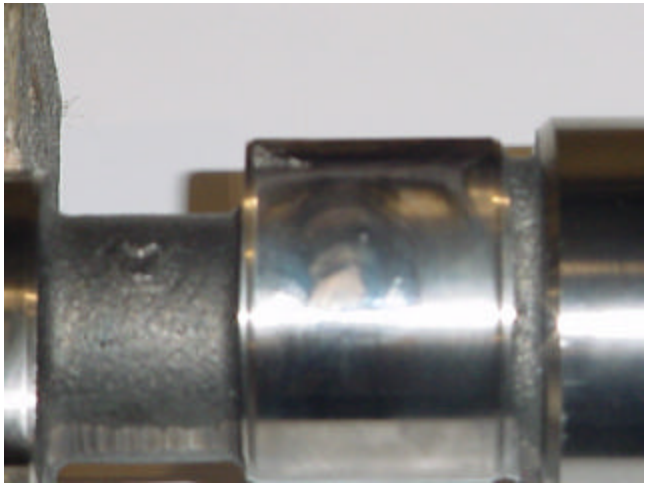
ISB Test Parameters

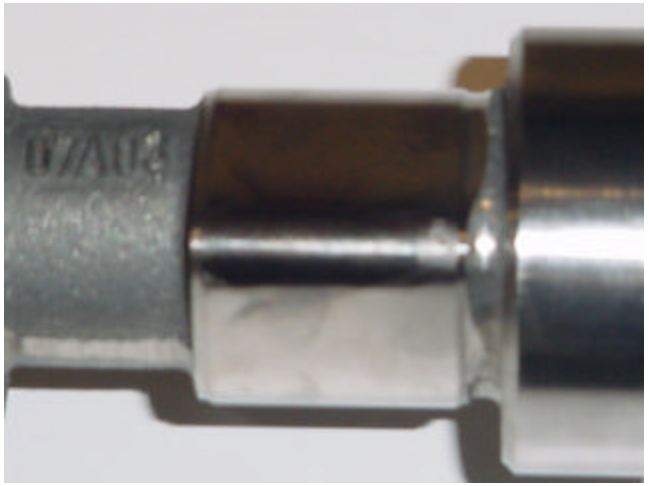
- Parameters to be rated
  - –Primary Parameters
    - •Tappet Wear
      - –mg wt loss
    - •Cam lobe wear
      - – mm wear
        - »ADCOLE measurement
        - »Cams will be pre and post measured by CPD
    - •Cam journal wear
      - – mm wear
        - »ADCOLE measurement

ISB Test Parameters

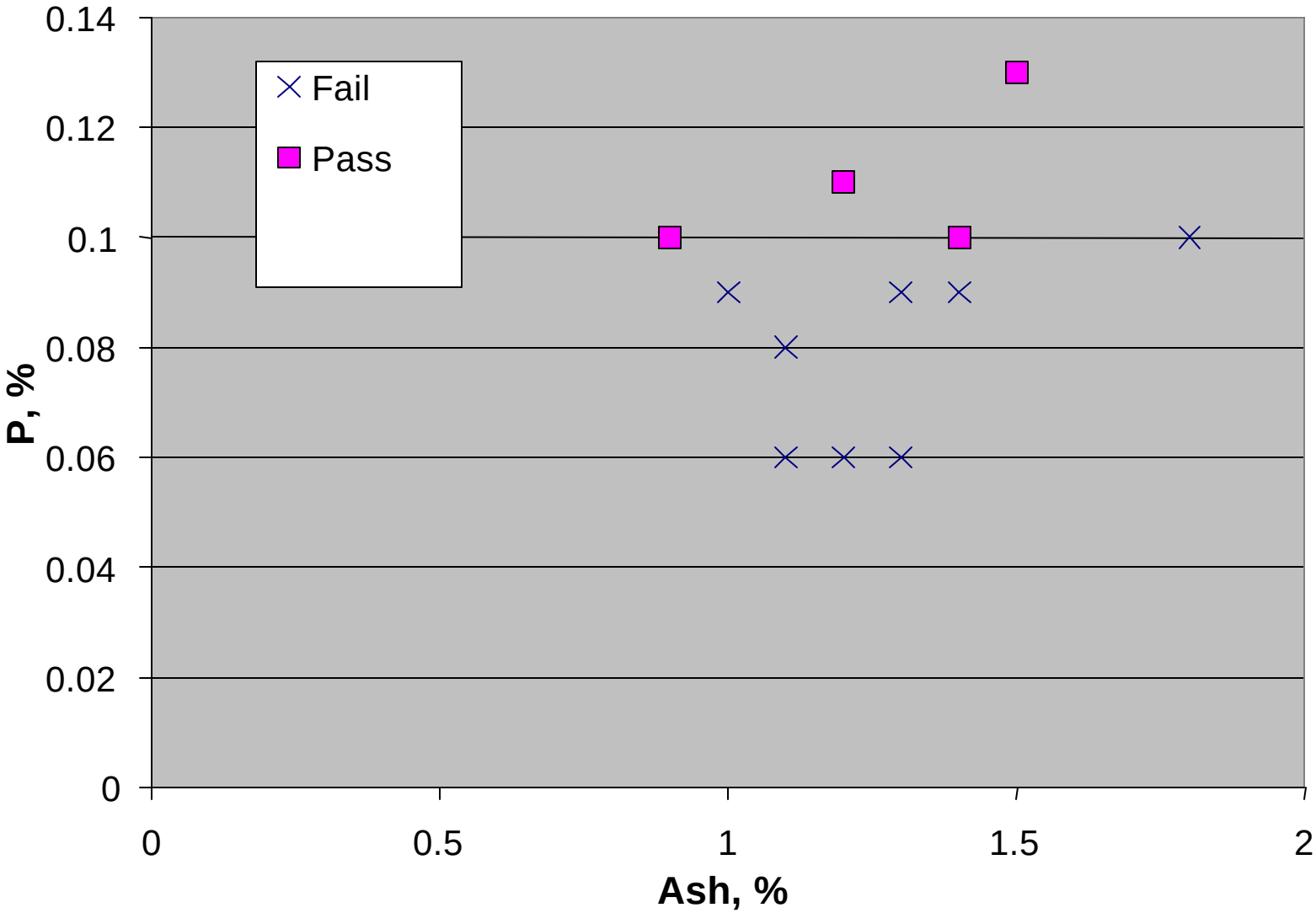
- Parameters to be rated
  - –Secondary Parameters
    - •Overhead wear
      - –Crosshead Weight Loss, mg loss
      - –Adjusting Screw Weight Loss, mg loss
      - –Push Tube Scuffing
    - •Other parameters
      - –Oil Filter Delta Pressure, kPa
      - –Sludge, rocker cover and oil pan

Cam and Tappets After Test

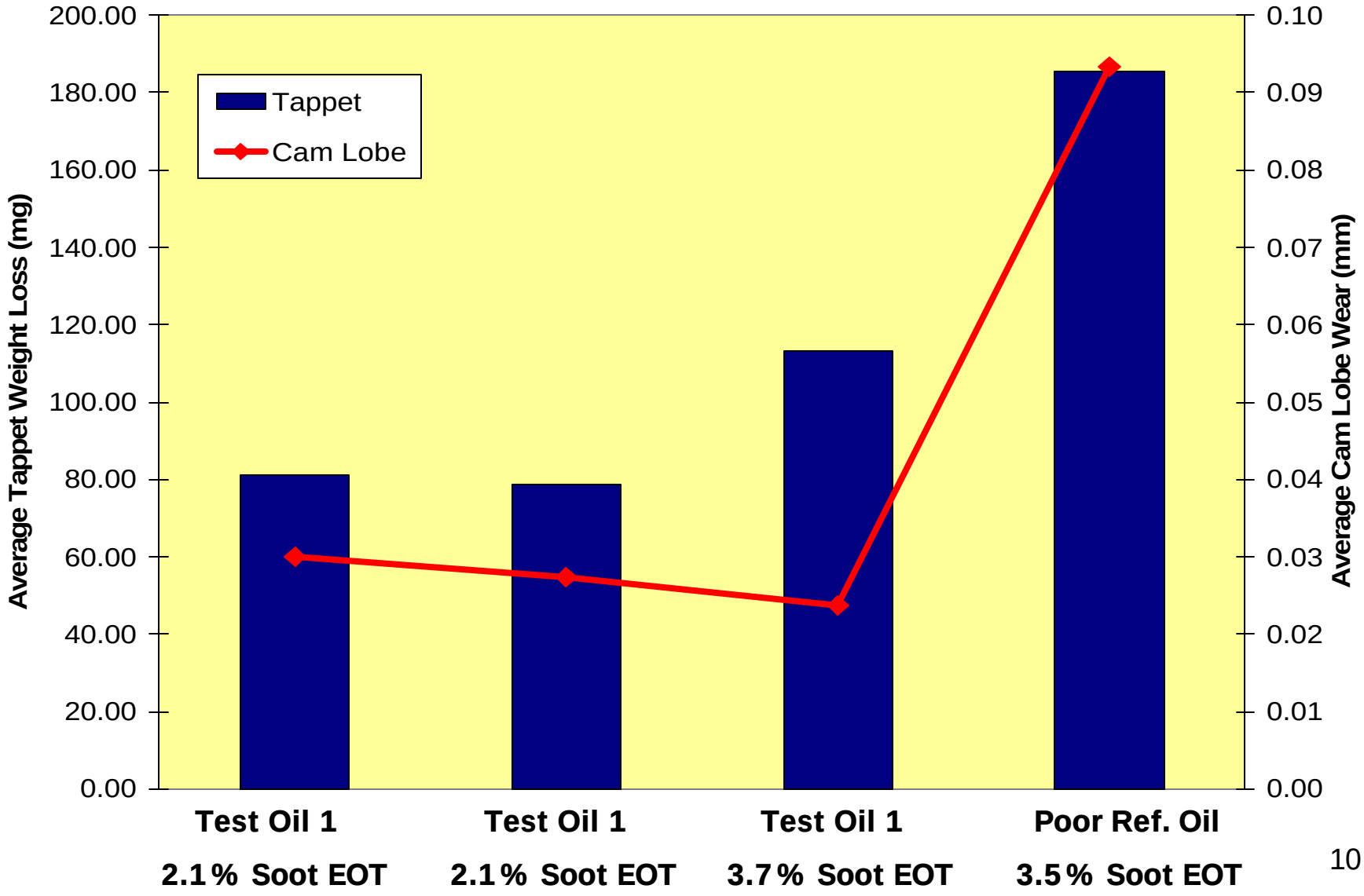




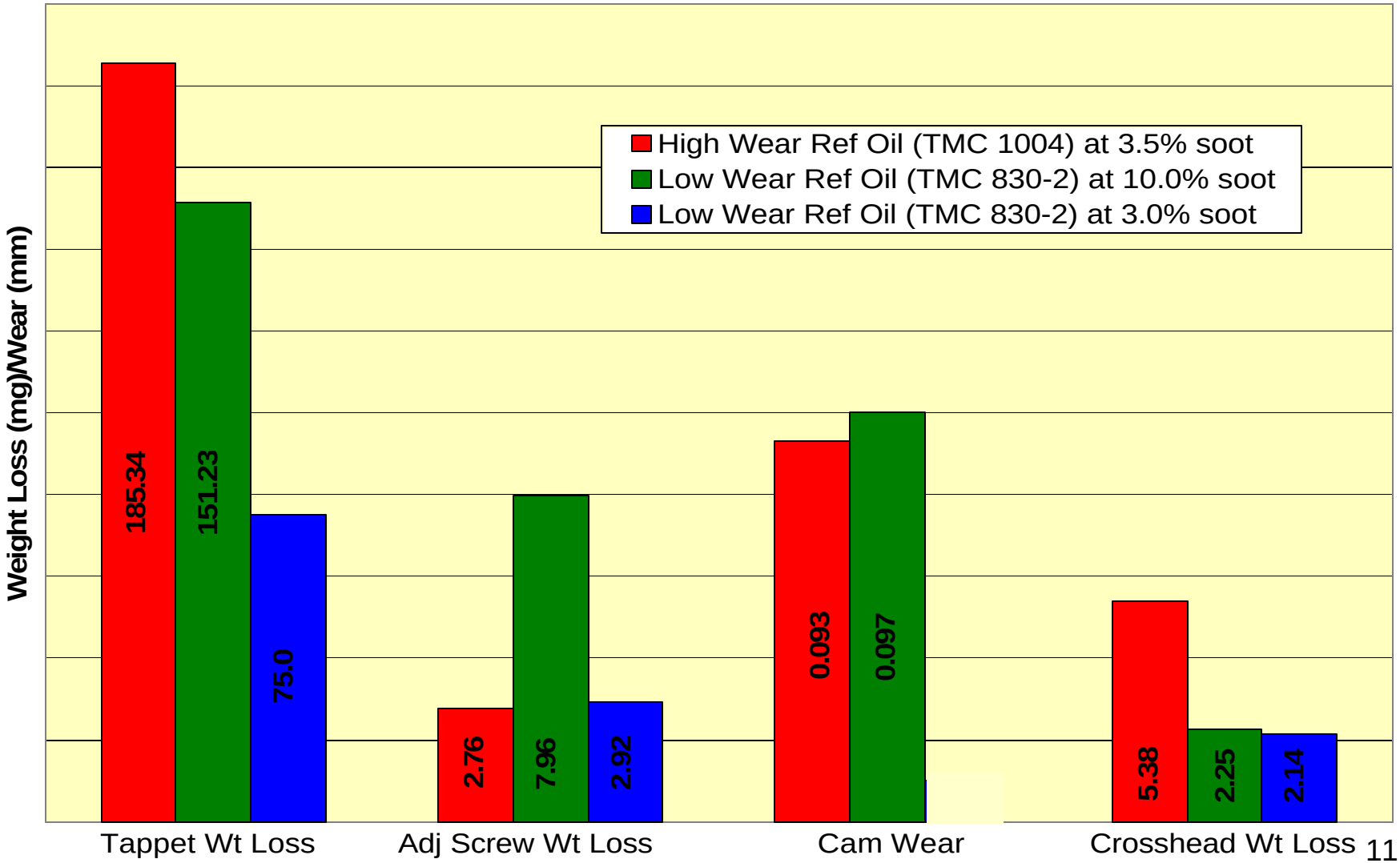
B Cam Test History



ISB '02 Repeatability / Discrimination



ISB ’02 Wear Data



Preliminary ISB Matrix Designs

Assumptions

- 3 DI/VI combinations, 3 base oils, and 1 Reference Oil
- Every factor level should be run at least 3 times to maintain Power, and at least 4 valid test results in each Matrix stand to account for bias
- At least 8 degrees of freedom (DF) to estimate test variability, and at least 6 repeats on identified Reference Oils
- Main effects and 2-Way Interactions (Except with Stand) are estimable
- No VGRA
- Decision rules for Industry Matrix Testing have been satisfied

Preliminary ISB Matrix Designs

Experimental Test Matrix Design Oils

- 9 matrix oils are formed. Note that PC-10A is the primary featured oil and
- PC-10H is the secondary featured oil.

	Technology		
Base Oil	X	Y	Z
Base Oil 1	PC-10A	PC-10D	PC-10G
Base Oil 2	PC-10B	PC-10E	PC-10H
Base Oil 3	PC-10C	PC-10F	PC-10J

Preliminary ISB Matrix Designs

Test Design 1

Stand 1	Stand 2	Stand 3	Stand 4
J	D	G	B
E	H	C	F
F	C	E	H
G	B	D	J
A	A	A	A
A	A	A	A

- 24 Runs
- BOI but No VGRA
- 8 Runs on One Reference Oil
- 12 df to Estimate Test Standard Deviation

Preliminary ISB Matrix Designs

Test Design 2

Stand 1	Stand 2	Stand 3	Stand 4
A	B	C	C
E	F	D	E
J	G	H	G
B	D	J	A
A	A	A	A

- 20 Runs
- BOI but No VGRA
- 6 Runs on One Reference Oil
- 8 df to Estimate Test Standard Deviation

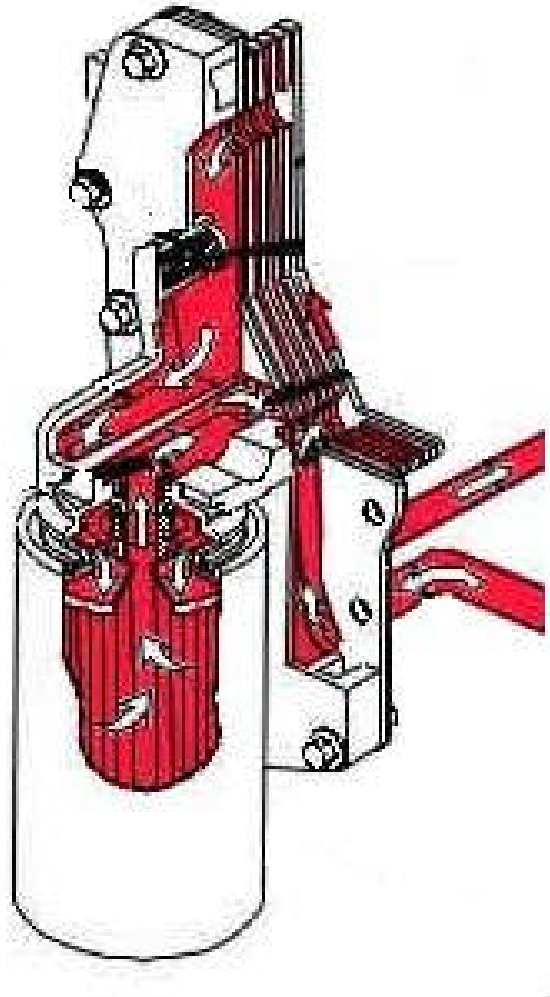
Preliminary ISB Matrix Designs

Test Design 3

Stand 1	Stand 2	Stand 3	Stand 4
A	B	C	C
E	F	D	E
J	G	H	G
B	D	J	A
A	A	A	A
H	H	H	H

- 24 Runs
- BOI but No VGRA
- 6 Runs on Primary Reference Oil and 5 Runs on Secondary Reference Oil
- 12 df to Estimate Test Standard Deviation

Hardware Modifications



Mack PC10 Engine Test Update

Ring & Liner Wear (Corrosive), Bearing Corrosion/Oxidation

- Mack T-12
- New Hardware (Piston / Liner / Ring)
- With ULSD Fuel ?????
- Length - ~ 300 Hours
- Increased EGR Flow (Heavy EGR)
- Precision Matrix Required
- Hardware Available 2nd QTR
- Test Procedure & Discrimination 4th QTR 04

ATTACHMENT 11, 2 OF 2

API CI-4 Supplement
DEOAP Report to the HDEOCP
February 19, 2004
Chicago, IL

API CI-4 Supplement

Status

- **DEOAP & Lubes Committee have agreed to establish a licensable supplemental category to address EMA concerns with CI-4**
  - **Requirements will be based on OEM tests and limits**
  - **Category will be established through a fast-track development process to be included in API 1509**
- **CI-4 supplement to include:**
  - **Mack T-11 for soot-viscosity control**
  - **Cat C13 for piston deposits**
  - **90 pass injector shear test to improve shear stability**
- **Potential timing for introduction**
  - **September 1, 2004 using parameters available on March 31, 2004.**

    -- OR --

  - **No later than March 31, 2005 depending on when requirements are defined**

API CI-4 Supplement

Status

- **Licensing requirements**
  - **Product must be CI-4 licensed**
  - **Must document acceptability in supplement engine tests**
    - **Meet limits & read-across guidelines published by OEM sponsor**
    - **OEM review & approval of data**
- **Issues / details to be finalized by DEOAP / API LC:**
  - **Resolution of EMA request to add 10 TBN minimum by D4739 to the supplement**
  - **Supplement name**
  - **Method of display**
  - **API1509 Appendix D revisions**
  - **Adjustments to API licensing forms**

API CI-4 Supplement

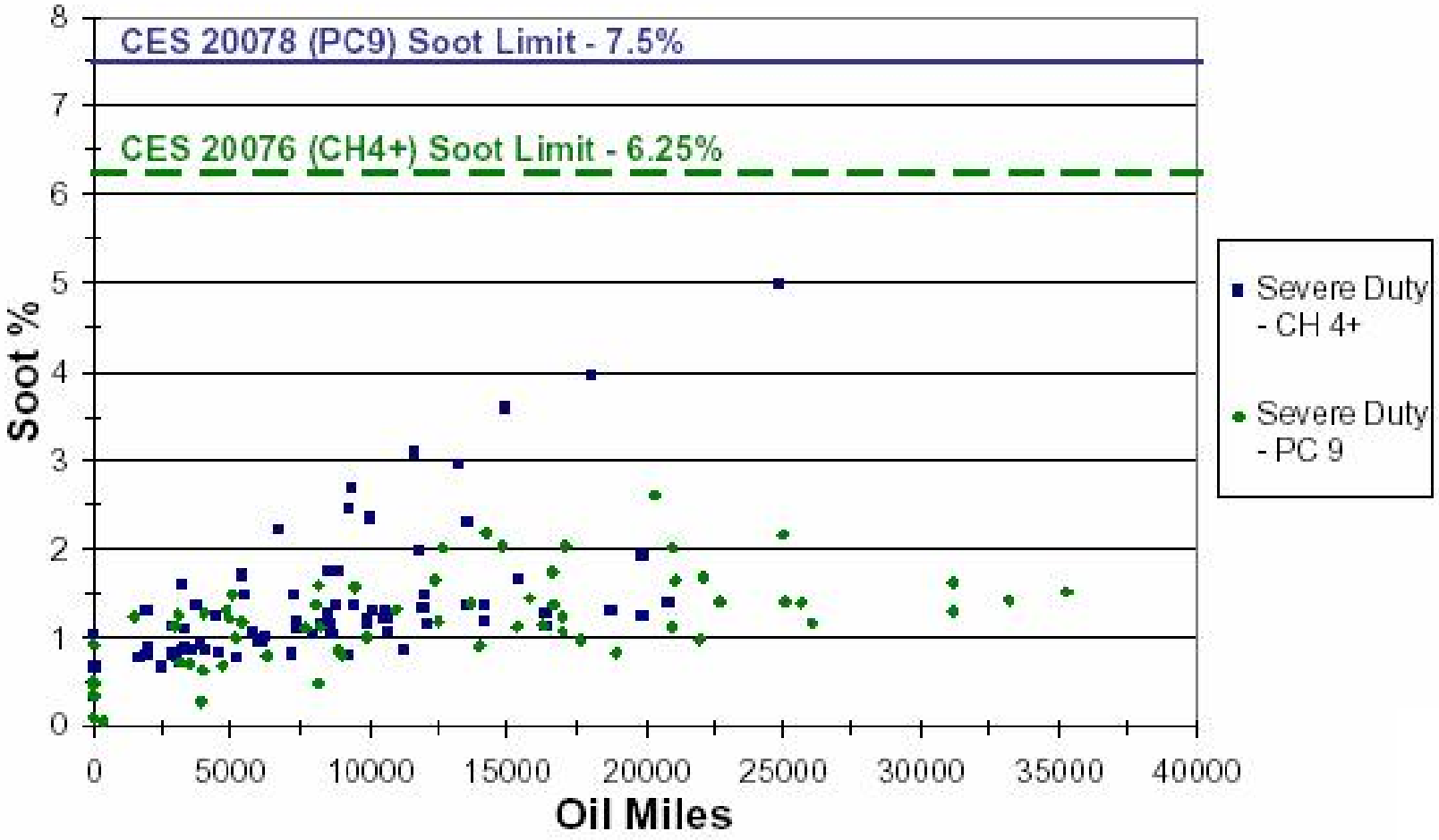
ASTM in the Process

- **Key roles in test development & monitoring**
  - **ASTM Surveillance Panel or Test Development Task Force deems engine test suitable for use and requests TMC monitoring**
  - **Test development will be done within ASTM Task Force**

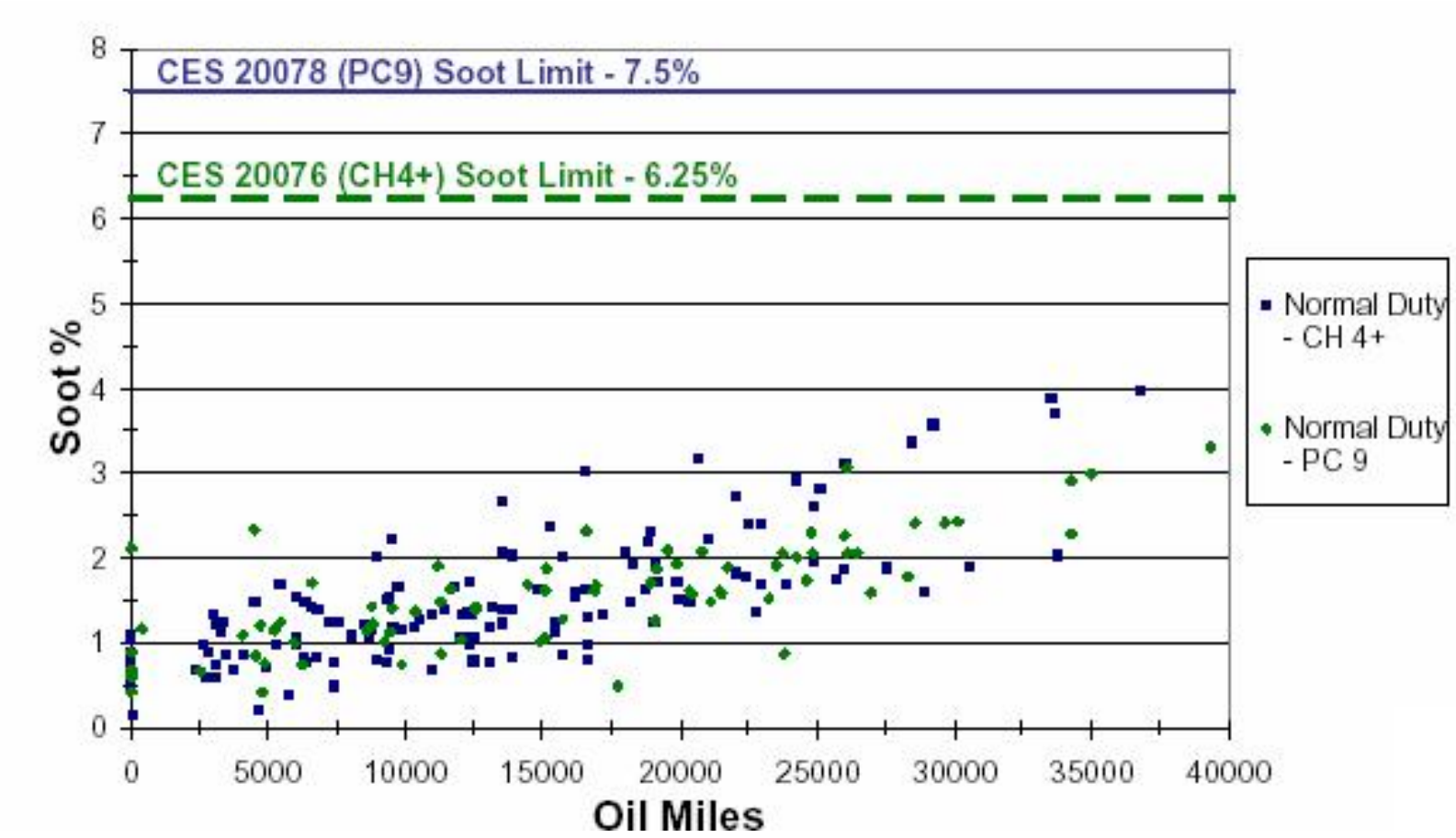
Engine Data Overview

- **EGR Engines are not soot limited**
- **EGR vs non-EGR depletes TBN much faster**
- **Current drain intervals are TBN limited**
- **Reductions in TBN from current levels would threaten ability to maintain drain intervals.**

ISX Severe Duty Soot



ISX Normal Duty Soot



Engine Data Overview

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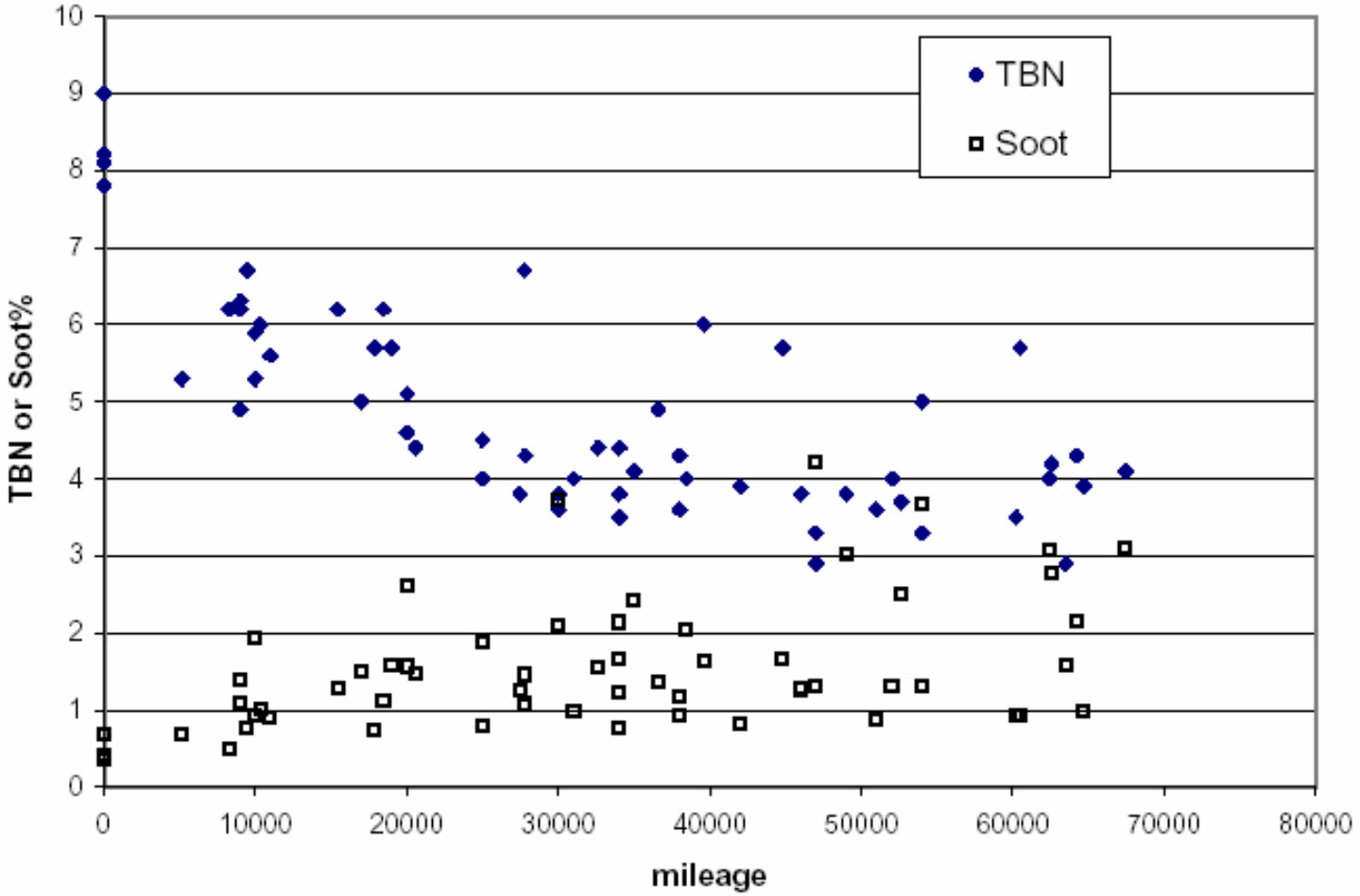
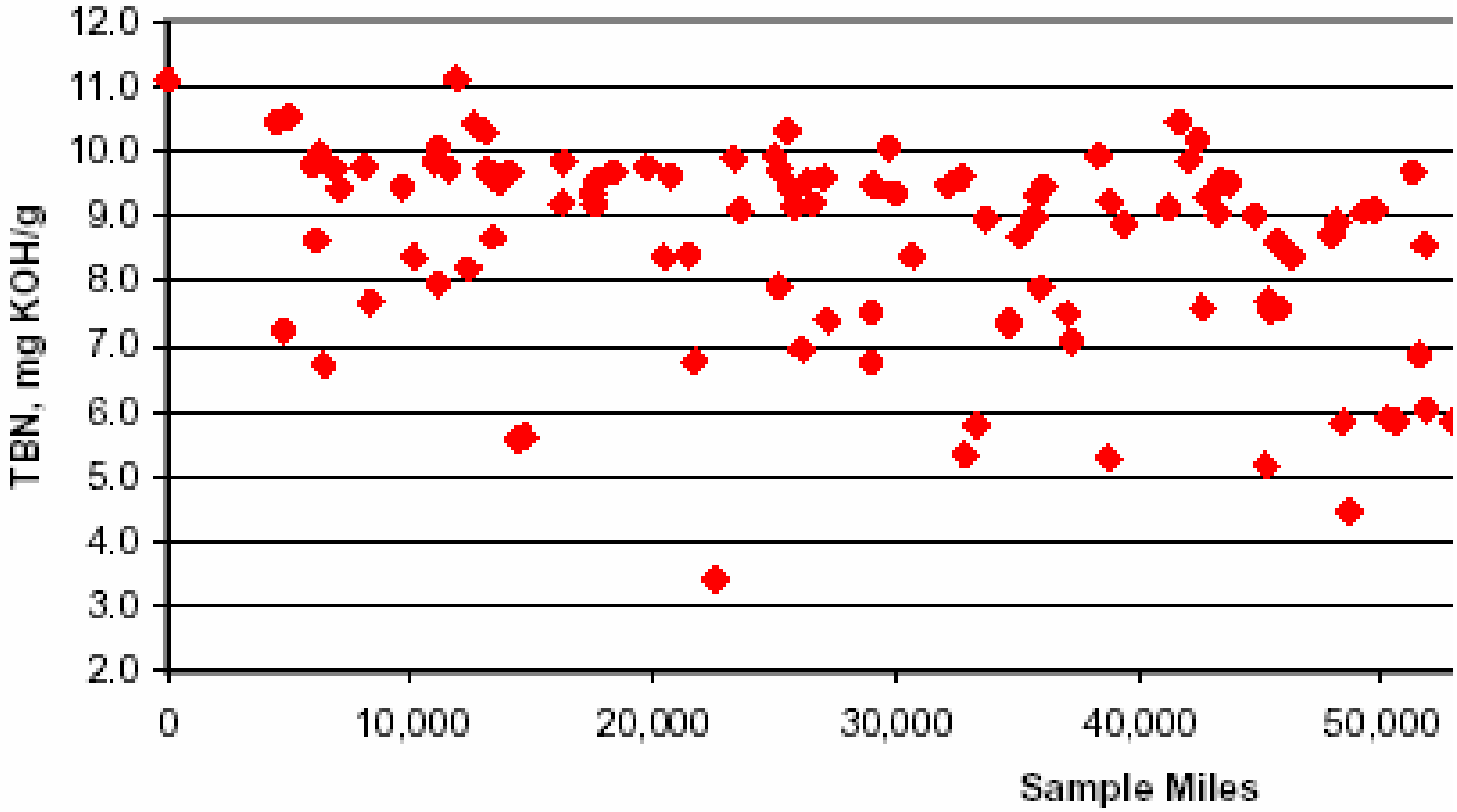
Pre-EGR HD Normal Duty

ISX98/99

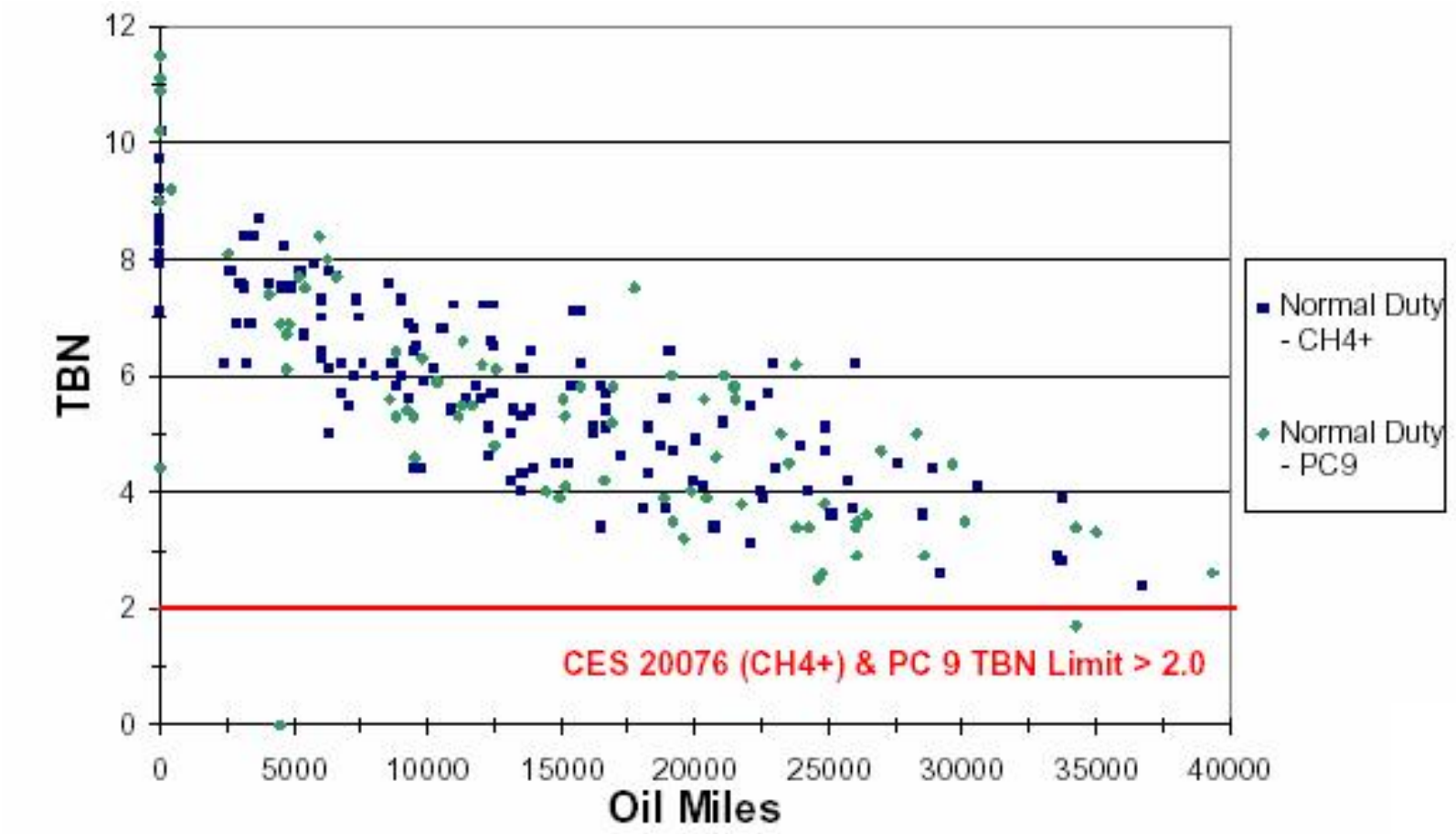


Pre-EGR HD Normal Duty

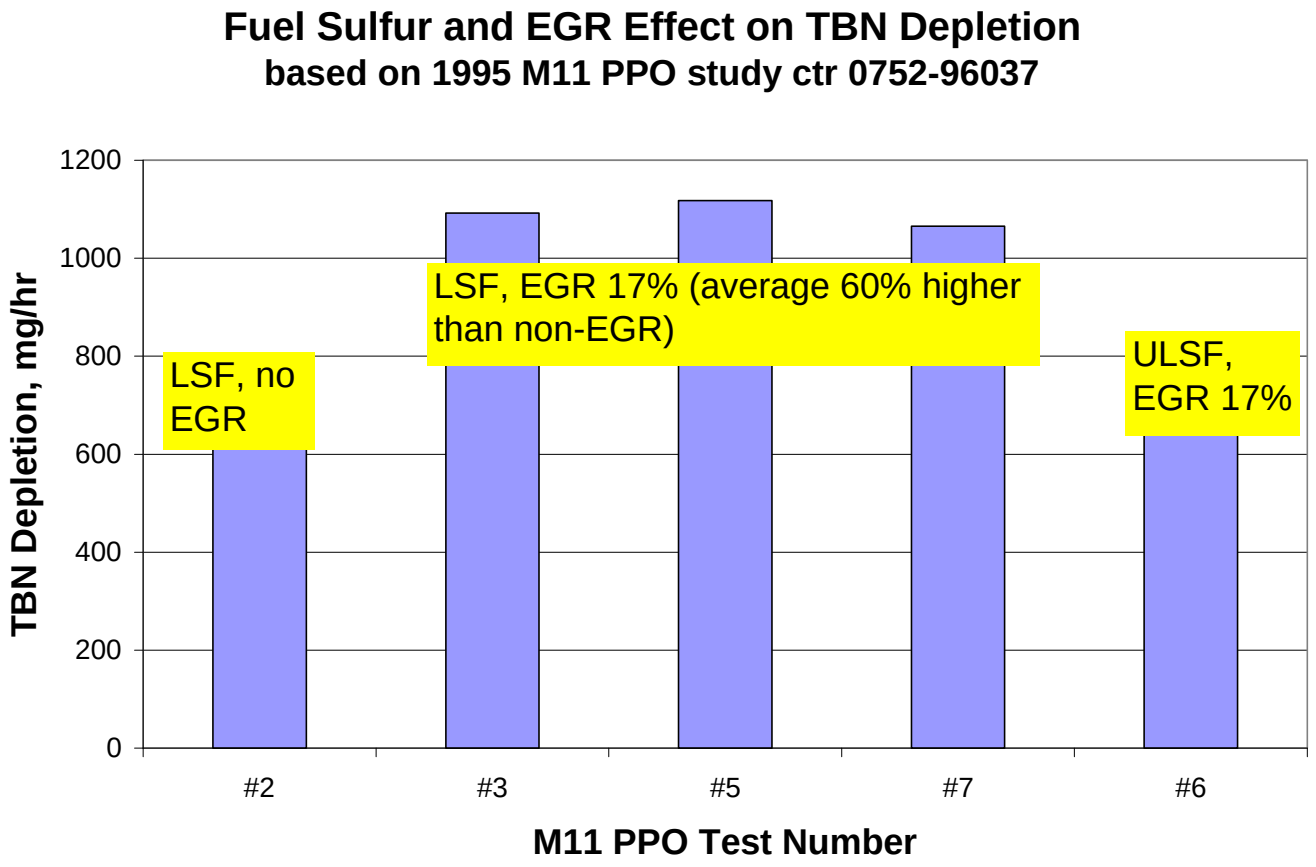
ISX98/99



ISX Normal duty TBN



EGR Effect on TBN Depletion



TBN depletion rate is determined by correcting for oil consumption, oil volatility, and time. Data produced in 1996 using CG-4 Premium Blue

Engine Data Overview

- EGR Engines are not soot limited
- EGR vs non-EGR depletes TBN much faster
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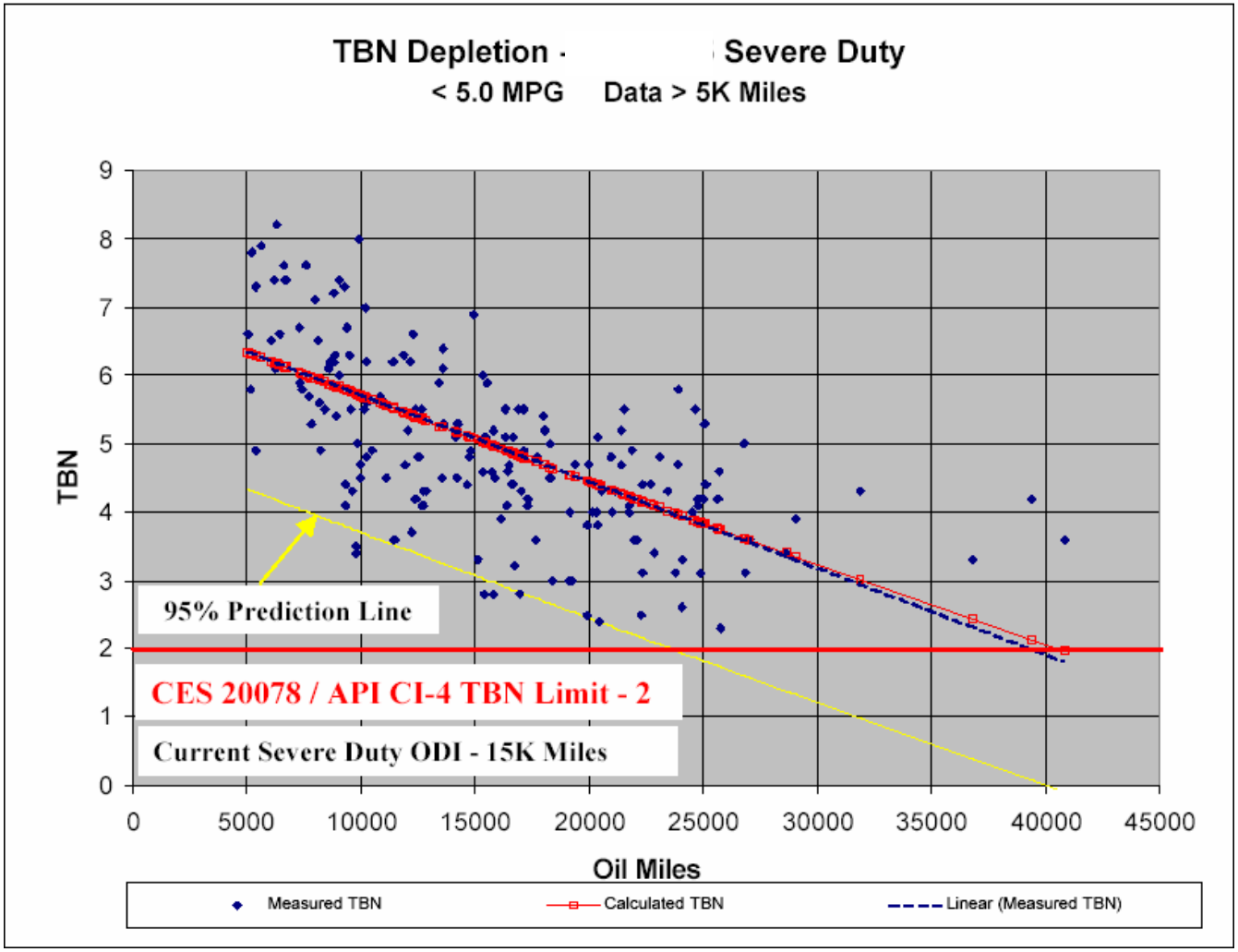
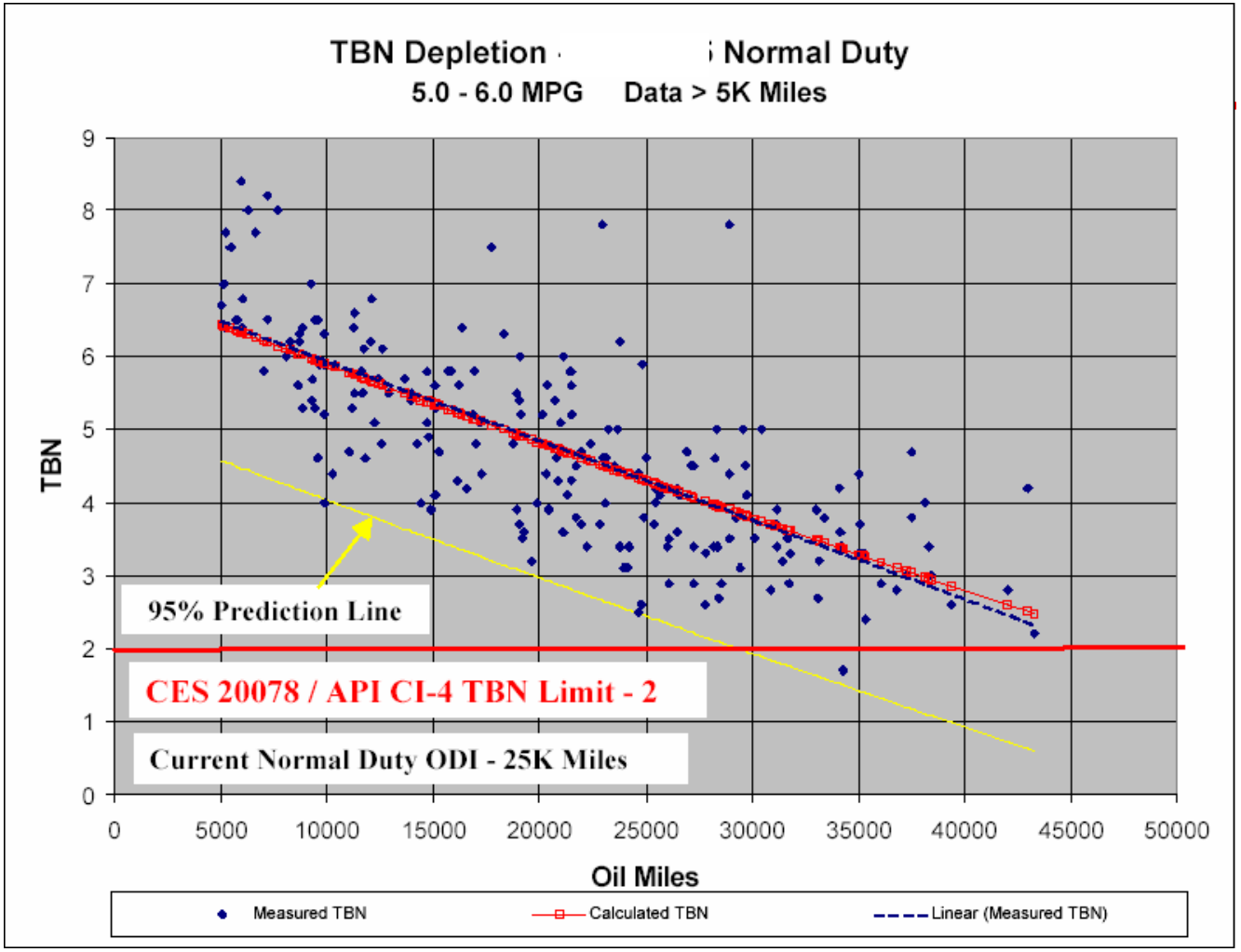
- Reductions in TBN from current levels would threaten ability to maintain drain intervals.

TBN Depletion for Severe Duty



TBN Depletion for Normal Duty

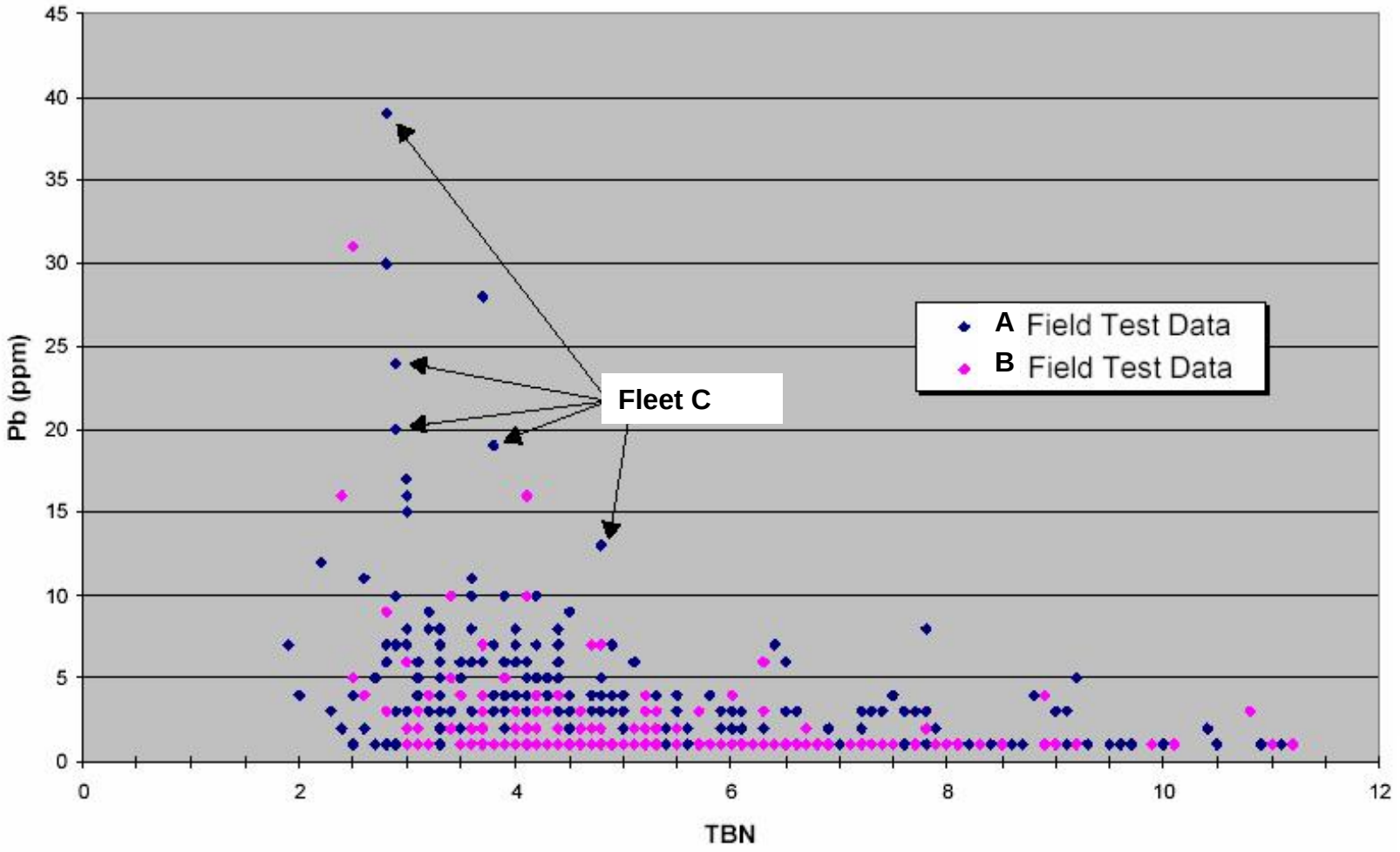


Engine Data Overview

- EGR Engines are not soot limited
- EGR vs non-EGR depletes TBN much faster
- Current drain intervals are TBN limited
- **Reductions in TBN from current levels would threaten ability to maintain drain intervals.**

Low TBN Causes Bearing Distress

Summary for all duty cycles



Caterpillar Piston Deposit Engines

Performance Parameters (API)	Year Introduced	Caterpillar Test	Piston Configuration	Injection	Fuel Sulfur (%)
CF	1994	1M-PC	Al	PC	0.50
CF-4	1990	1K	Al	DI	0.50
CG-4	1994	1N	Al	DI	0.05
CH-4	1998	1P,1K	Art-Steel/Al	DI	0.05
N/A (EGR)	N/A	1Q	Art-Steel/Al	DI	0.05
CI-4	2002	1R+(1K or 1N)	Art-Steel/Al	DI	0.05
ECF-2	2003	C-12	Art-Steel/Al	DI	0.05
PC-10	2006	C-13	Art-Steel/Al	DI	15 ppm

Rationalization of Caterpillar Piston Deposit Engines for PC-10/Old API Categories

Performance Parameters (API)	Test Length (hrs)	Load Factor (g/min Fuel Cons)	Caterpillar Test	Piston Configuration	Injection	Fuel Sulfur (%)
CF	240	135	1M-PC	Al	PC	0.50
CG-4	252	185	1N	Al	DI	0.50
CH-4	360	185	1P	Art-Steel/Al	DI	0.05

Note: If API CH-4 is retained then need 1P test

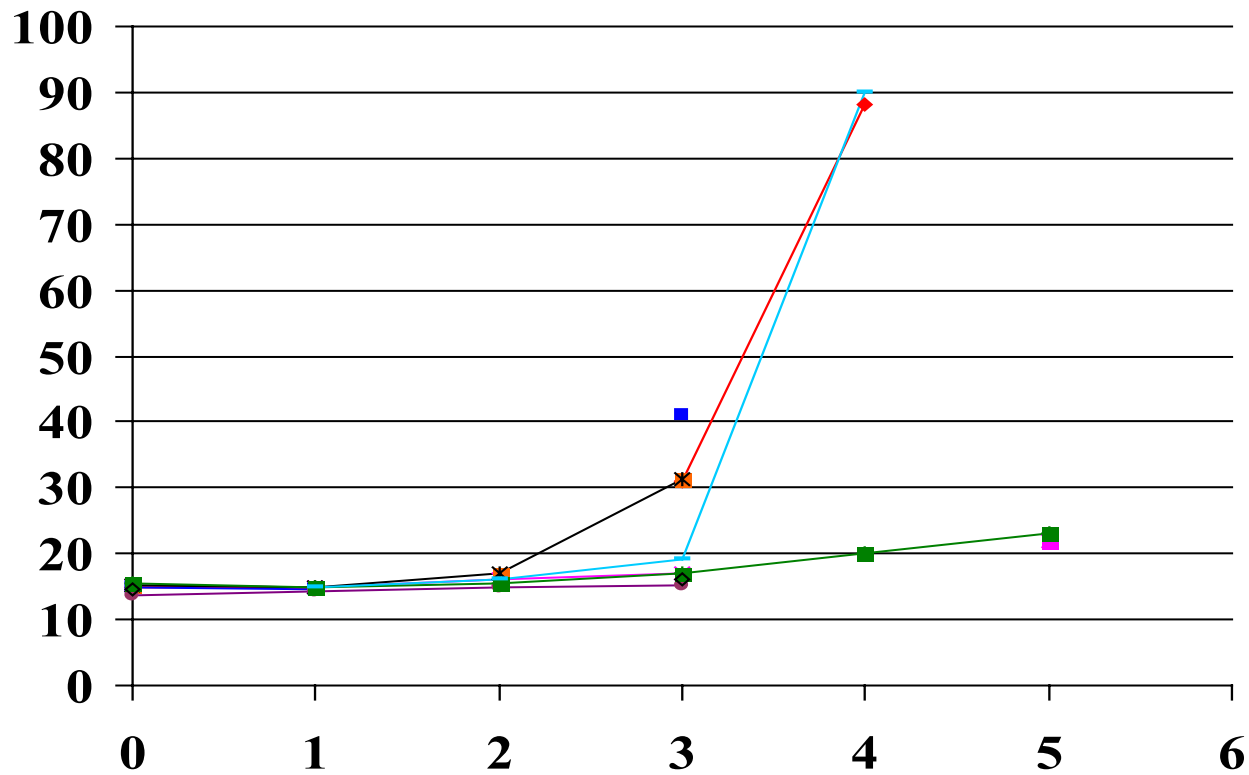
Caterpillar Piston Deposit Engines for PC-10

Performance Parameters	Test Length (hrs)	Load Factor (g/min Fuel Cons)	Caterpillar Test	Piston Configuration	Injection	Fuel Sulfur (%)
Based on 1 P engine	252	185	1S	Al	DI	0.50
			C-13	Art-Steel/Al	DI	15 ppm

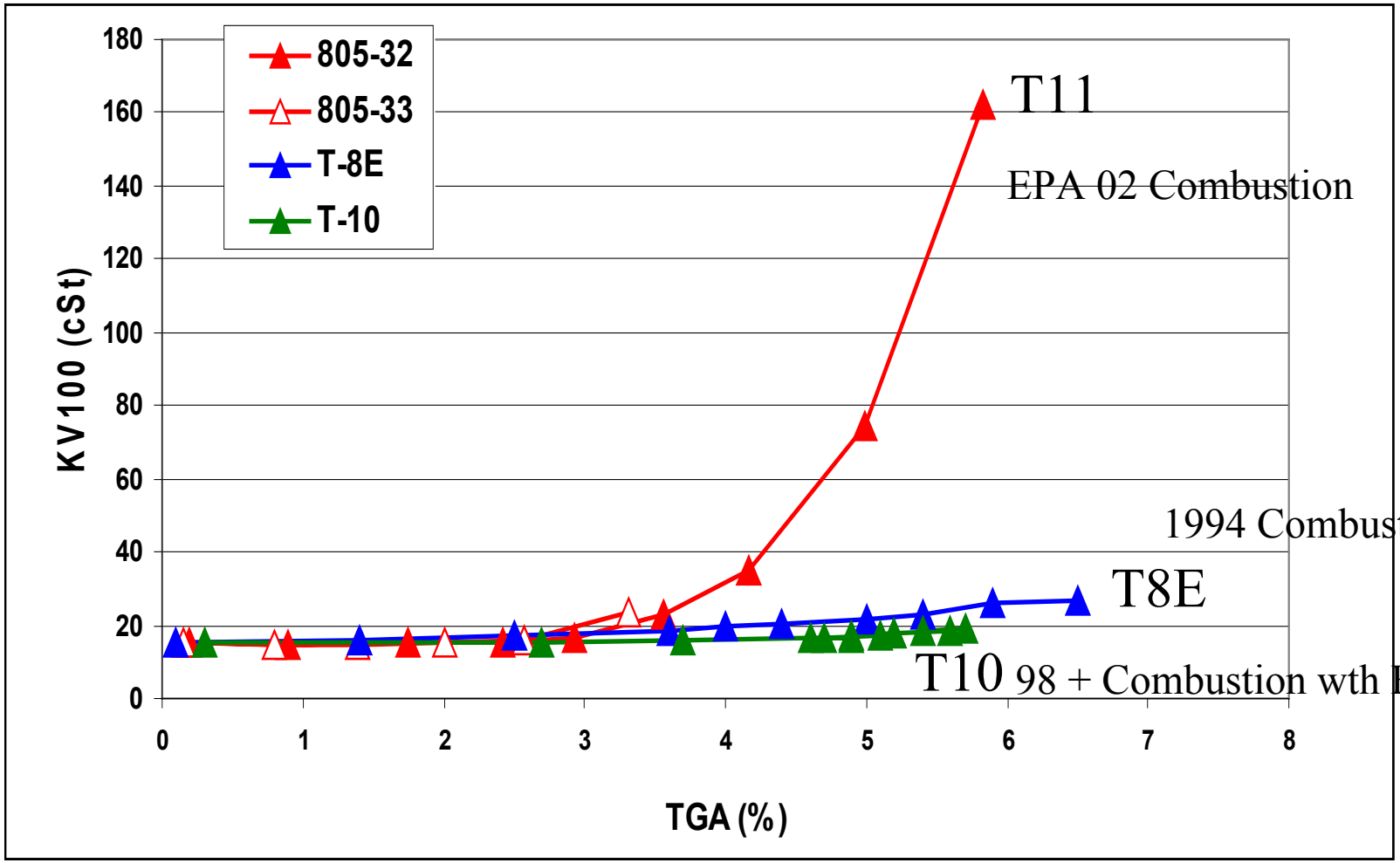
Engine	Piston	Injection	Performance Parameters	Test Length (hrs)	Fuel Usage per Oil Drain Interval	Load Factor (g/min Fuel Cons)	E-Model
1M-PC	Al	PC	CF	240	70	135	
1K	Al	DI	CF-4	252	70	185	
1N	Al	DI	CG-4	252	80	185	
1P	Art-Steel	DI	CH-4	360	90	185	
1Q	Art-Steel	DI					
1R	Art-Steel	DI	CI-4	504	105	240	

EPA 02 Field Test

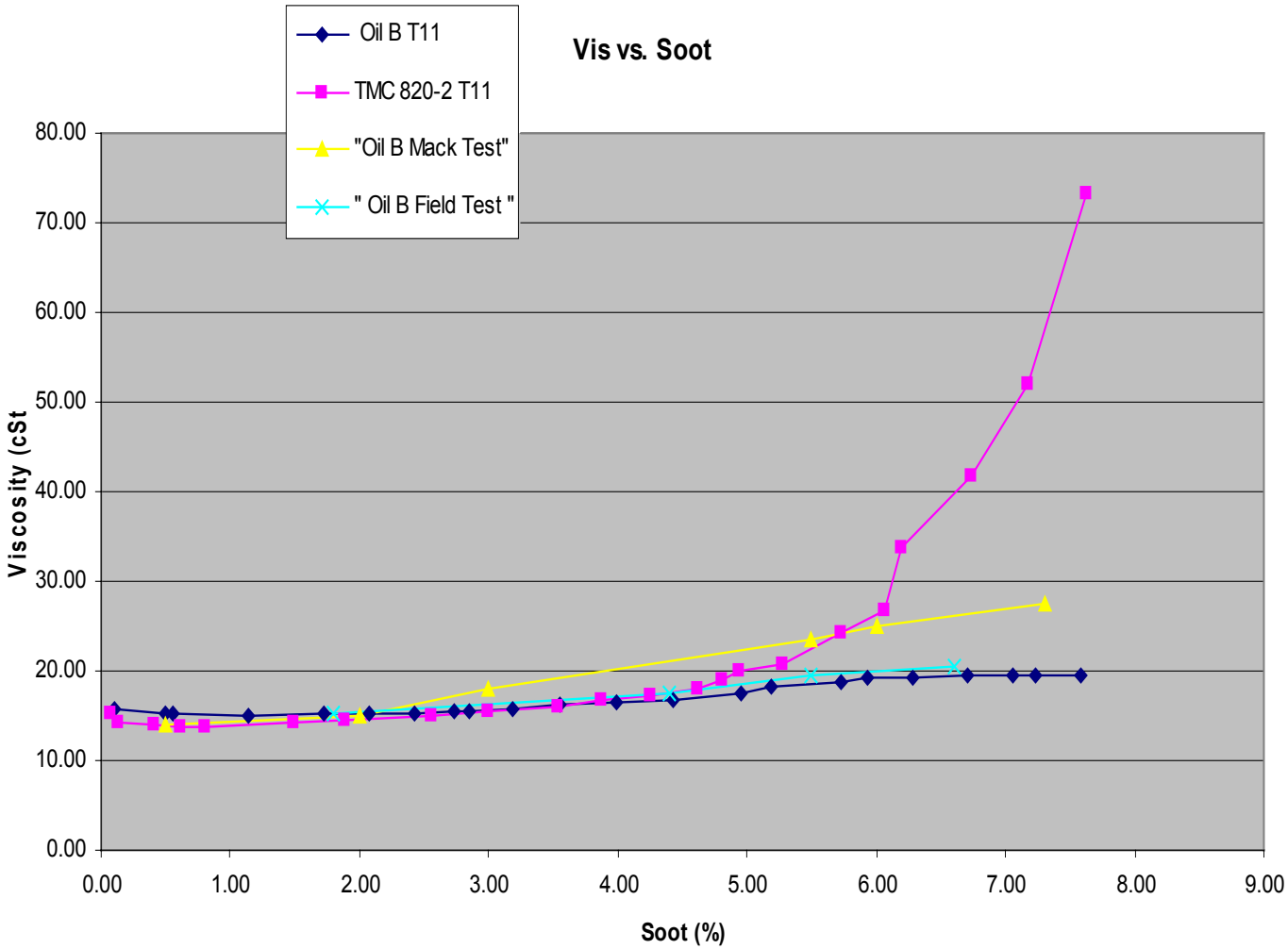
Visc @ 100 C



% TGA Soot



ATTACHMENT 15, 2 OF 5


Oil B T11
TMC 820-2 T11
"Oil B Mack Test"
" Oil B Field Test "
Vis vs. Soot
Viscosity (cSt
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
Soot (%)

- Soot vs Visc Solution

- Mack T11 - Test Developed

  Good Precision

  Field Correlation

Mack T 11

Feb 12th Surveillance Declared Test Ready

Request HDEOCP Acceptance

Ask ACC for Registration Approval