HEAVY-DUTY ENGINE OIL CLASSIFICATION PANEL

OF

ASTM D02.B0.02

December 8 & 9, 2003

Hyatt Regency Hotel – Phoenix, Arizona

ACTION ITEMS

1.	**After treatment / lubricant effects data submitted by 1 April 2004.**	**All who have data**.
2.	**If / How to include CSR in PC-10 elastomer tests.**	**EMA / Elastomer TF**
3.	**Monitor CI-4 Elastomer tests.**	**TMC**
4.	**Add CI-4 Supplement to D4485.**	**Sub-comm. B**
5.	**Issue exit ballot on PC-10 Chemical Limits.**	**Jim McGeehan**

MINUTES

1.0 Call to Order

1.1 A supplementary session of the HDEOCP for its task forces was opened at 8:10 a.m. by chairman Jim McGeehan in the Phoenix Ballroom West of the Hyatt Regency Hotel of Phoenix, Arizona on December 8, 2003. No attendance was taken for these sessions, but there were approximately 40 people present at one time or another.

2.0 Agenda

2.1 An agenda for the Task Force sessions was reviewed and the Seals portion was moved to the top due to conflict with another meeting later in the morning. The published agenda is shown as Attachment 1.

3.0 Seals

3.1 Becky Grinfield reported on the progress of elevating the current elastomer tests to standards. A Vamac G specification has been established and OHG will be supplying the test parts. One reference fluid (SF 105) has been selected and is being used.

3.2 Rob French made a presentation (See Attachment 2) on a method to measure seal force retention called CSR (Compression Stress Relaxation). There is an ASTM standard (D6142) on CSR. During discussion following Rob's presentation, there was concern expressed about how this test could be used to evaluate oils, since it appears to be aimed at very long term seal force retention. It seems EMA, an OEM or the Elastomer Task Force will need to make a recommendation on whether to include CSR as a part of PC-10 elastomer tests and if so, how.

4.0 PC-10 Accomplishments to Date

4.1 Jim McGeehan listed what progress has been made toward PC-10 thus far. See Attachment 3.

5.0 PC-10 Category

5.1 Dave Stehouwer made a presentation for Greg Shank on EMA considerations for the PC-10 category. See Attachment 4.

6.0 Diesel Fuel Sulfur

6.1 Chris Laroo reported that the EPA now predicts 96% of refinery output for on highway diesel fuel will be ULSD by June of 2006. There apparently is some consideration being given to dyeing this less than 15 ppm S fuel yellow. See Attachment 5.

7.0 Chemical Limits

7.1 Pat Fetterman gave a report for Rick Finn on the Chemical Limits Task Force status. See Attachment 6. There has not been much information submitted thus far and much of what has, is not in the form requested. Thus, the EMA staff, which does not have expertise in the after treatment area, does not know how to appropriately handle the information that has been submitted. So, the Task Force is contemplating seeking permission from the data submitters to have the information reviewed by a small group of knowledgeable people, for the purpose of organizing and using the data while still protecting the anonymity of the sources. The Task Force also believes the timeframe for submitting data should be extended.

8.0 Backward Compatibility

8.1 Jim McGeehan raised the subject of backward compatibility for PC-10 oils and the OEM's agree that it is very desirable. But, potential limits on P, S, and ash may make it uneconomical to achieve. See Attachment 7.

9.0 Engine Tests

9.1 Dave Stehouwer reported on the ISM test status (See Attachment 8). Comments from the floor include a desire to use existing reference oils and concerns over the test's ability to discriminate on crosshead (valve bridge) wear. Cummins expects the CI-4 substitution matrix to be completed in the 2nd quarter of 2004.

9.2 Dave Stehouwer also reviewed the ISB test status (See Attachment 9). The primary wear measurement parameters being looked at are tappets, cam lobes and cam journals. They expect to have the procedure solidified and discrimination data available by June 2004.

9.3 Abdul Cassim reported on the C13 test program (See Attachment 10). CAT intends to have CI-4 Supplement test development work done by end of the 1st quarter in 2004 and the PC-10 test development work done by end of the 3rd quarter in 2004. First tests should start in mid-December, 2003. CAT also raised the possibility that the PC-10 test could have closed crankcase ventilation (CCV) and possibly some exhaust after treatment evaluation. Abdul indicated however, that evaluation of these two possibilities would be carried out in parallel to the deposit test development. The announcement of the possibility of these features (CCV & after treatment) being part of the PC-10 C13 test created quite a stir in the panel since for over nine months the direction has been toward chemical limits and no CCV.

10.0 PC-10 Timeline

10.1 Bill Runkle presented a PC-10 timeline which was then extensively remodeled during the meeting. See Attachment 11. Jim McGeehan also displayed a timeline he had compiled (See Attachment 12) and in the end, the two were in fair agreement. Main near term points are that chemical limit data need to be in by April 1, 2004 and chemical limits selected by the June 2004 meeting.

11.0 Base Stocks

11.1 Dave Stehouwer raised a concern about the sulfur level in engine oil base stocks…with its exhaust after treatment implications. API and the PCMO folks have just concluded a study on Group II base stock availability and there may be a possibility that study could be expanded to include needs for heavy duty.

12.0 Funding

12.1 Steve Kennedy reported that all the funding stakeholders have met, but not much has happened yet. The ACC is asking that new test development funding come from EMA and API.

13.0 Adjournment

13.1 The Supplementary session adjourned at 11:55 a.m. on December 8, 2003, after Dave Stehouwer had brought up what was agreed to be a DEOAP issue regarding the CI-4 Supplement.

14.0 Call to Order

14.1 Chairman Jim McGeehan called the HDEOCP meeting to order at 1:39 p.m. on December 9, 2003, in the Regency D Ballroom of the Hyatt Regency Hotel in Phoenix, Arizona. There were 17 members present or represented and approximately 55 guests present. The attendance list is shown as Attachment 13.

15.0 Agenda

15.1 The published agenda (Attachment 14) was reviewed and Becky Grinfield / Seals moved to the top because of meeting conflicts.

16.0 Previous Meeting Minutes

16.1 Dave Stehouwer moved and Lew Williams seconded a motion to accept the October 8, 2002 meeting minutes as distributed and posted on the TMC web site. The motion passed via unanimous voice vote. Subsequently, typos in paragraphs 8.1 and 8.2 have been brought to my attention. The third line of 8.1 should read…"an SAE seal" and the first line of 8.2 should read…"Becky Grinfield".

17.0 Membership

17.1 The membership list (Attachment 15) was reviewed and there were no changes.

18.0 Chairman's Comments

18.1 Chairman McGeehan again emphasized the need to deliver PC-10 on time.

19.0 Seals Status

19.1 Becky Grinfield did not repeat yesterday's report, but she and Terry Bates brought up the issue of TMC monitoring for the elastomer tests. Terry Bates moved that the TMC monitor the current test on four elastomers in CI-4. Greg Shank seconded the motion. During discussion an opinion was noted that if a new material were to be added for future categories, it would be easier to add if the current test was already being monitored. John Zalar responded when questioned, that in the past the TMC has levied something like a $5000.00 annual fee per lab for tests of this nature that the TMC monitors. Concern was voiced about the batch to batch variation of the elastomers, but since the candidate fluid results are compared to reference fluid results on coupons from the same

elastomer batch, there shouldn't be a problem. Also, TMC monitoring will help keep track of the variations. The motion passed with 11 votes for, 0 against and 6 abstains.

20.0 PC-10 Timeline

20.1 Bill Runkle displayed the revised timeline (Attachment 11) again and discussion focussed on when to freeze the chemical limits. The OEM's seemed to feel they could have their data in by April 1st. So, Charlie Passut moved and Abdul Cassim seconded a motion that the chemical limits be frozen at the June 22, 2004 HDEOCP meeting, with an exit ballot to be issued in mid-April. The motion passed with 16 for, 0 against and 0 abstain.

21.0 PC-10 Tests and Fuel Sulfur Levels

21.1 Jim McGeehan displayed his chart of proposed tests and fuel sulfur levels (See Attachment 16).

21.2 Greg Shank presented material from Mack indicating they intend to pursue a T-12 test, using a new engine, which will be available in the 2nd quarter of 2004, to replace the T-10 test. See Attachment 17. The new engine will have different cylinder kit components and materials and will run with up to 30% EGR.

21.3 The EMA has requested that the Sequence IIIG test be included as a PC-10 requirement, for oxidation protection. This raised concern by the panel over whether there would be sufficient Group II base stock available for both PCMO and HD lubricant needs. As a result of the previous day's discussions on this subject, it seems that API is already exploring the possibility of extending the Kline study on Group II availability.

21.4 Jim McGeehan was asked to add the "1N" and "CCV" to his slide of PC-10 tests. (Done)

22.0 DEOAP Report

22.1 Steve Kennedy presented a report from the DEOAP (Attachment 18) on the CI-4 Supplement status. This raised the question of whether the "Supplement" should be included in D4485. After considerable discussion, Steve Kennedy recommended that the CI-4 Supplement information be included in D4485. Pat Fetterman seconded the motion, which passed with 17 for, 0 against and 0 abstains.

22.2 Dave Stehouwer asked that the Cummins request for a minimum 10 TBN limit for the CI-4 Supplement be recorded as a point of information.

23.0 Next Meeting

23.1 The next meeting is provisionally set for February 19, 2004 in Phoenix and the one following that for April 15, 2004 in Chicago.

24.0 Adjournment

24.1 The meeting was adjourned at 3:45 p.m. on December 9, 2003.

Submitted by:

Jim Wells
Secretary to the HDEOCP

ATTACHMENT 1

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

Hyatt Regency Hotel, Phoenix
December 8th 2003
8:00-12:00 noon

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

Desired Outcomes: **Focus on PC-10 developments and issues**

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
Actions to date	• List	Jim Mc Geehan	8:05-8:15
PC-10 Charter	• Definition of category	Greg Shank	8:15-8:30
Diesel Fuel Sulfur	• On-highway and Off-highway for 2007 and 2010	Chris Laroo	8:30-8:45
Chemical Limits	• Status of request for data • Timing: essential time for decision	Rick Finn	8:45-9:15
Backward compatibility	• Discuss requirements	Group	9:15-9:45
PC-10 Time Line	• Review current status • Redefine time line	Bill Runkle Group	9:45-10:15
List engine test in category	• List all engine tests • List fuel sulfur levels for each test	Bill Runkle Group	10:15-10:45
Status of engine tests: data review	• Cummins ISM and ISB • Caterpillar C13 • Mack T-12 or T-10	David Stehouwer Abdul Cassim Greg Shank	10:45-11:30
Seals	• Status of Vamac addition to seals	Rebecca Grinfield	11:30-11:45
Funding	• Status	Steve Kennedy	11:45-12:00
Continue meeting	• In place of Cummins		

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ethylene/acrylic elastomer

Predicting Long-Term Sealing Performance with Compressive Stress Relaxation Testing

(Retention of Sealing Force)

R. S. French

DuPont Automotive

December 9, 2003

PC-10 Elastomers Compatibility

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ethylene/acrylic elastomer

What is the primary concern of the HDEOCP regarding elastomers used in the engine?

- The elastomers used in gaskets, seals, and hoses will function reliably at the service temperatures of a HD Diesel engine.
- The elastomers used in gaskets, seals, and hoses will be compatible with the fluids they handle in service.
- The gaskets, seals, and hoses in the engine will not leak, and will maintain a seal over time under static and dynamic conditions.

PC-10 Elastomers Compatibility

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The PC-9 test protocol:

- Volume Swell after 336 hours
- Hardness Change after 336 hours
- Retention of Tensile Strength after 336 hours
- Retention of Elongation after 336 hours

Is this adequate assurance of reliability as defined in the last slide?

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ethylene/acrylic elastomer

What is Compressive Stress Relaxation (CSR)?

- CSR measures an elastomer's residual counter-force against compression over time, under simulated service conditions (heat and fluid), and under constant compressive deformation.
- It is a time progressive test combining compression set with heat / fluid aging to better simulate the actual service environment of seals.
- CSR data is a useful tool to predict the service life of a seal, and in evaluating potential for leaks at hose clamps.
- CSR data are now used as reference information in ranking materials for sealing applications at some automotive OEMs.

CSR Concept

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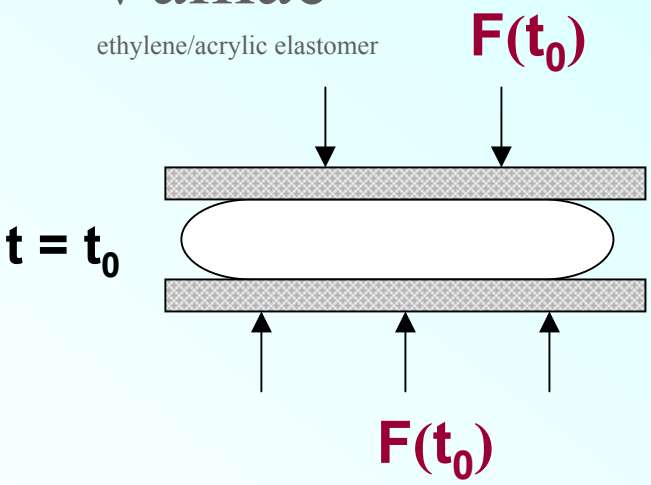
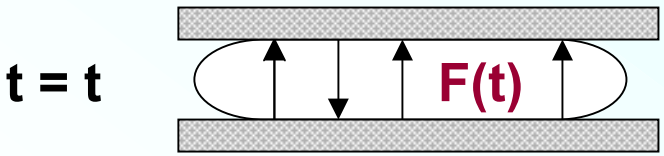
ethylene/acrylic elastomer



Elastomeric Material is Compressed

Compressive Energy Applied = Elastic (stored) + Viscous (dissipating)



Elastomeric material presses back

Counter Force, F(t) = Sealing Force

CSR (t) = F(t) / F(t_0)

CSR is typically plotted as a function of time

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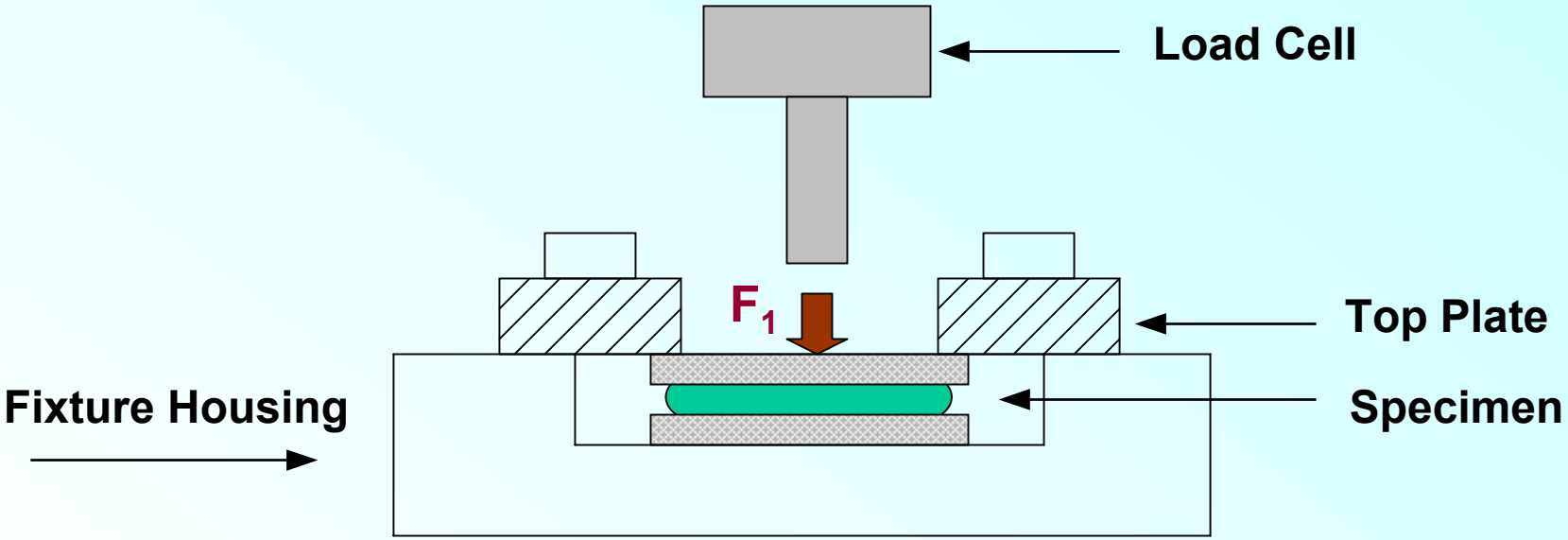
CSR Test Fixtures - Load Deflection



- Constant deformation of the elastomer (typically 25%) is maintained by the top plate during aging and measurement.
- The sample is loaded in the fixture, and force/deflection curve is generated to determine the counter-force in the specimen.
- Measurements are taken at specified time intervals to plot retention of sealing force over time

CSR Fixture

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ethyl

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CSR Test - Data Reporting

- Force readings are taken 3 times for each sample.
- The data are reported as percentage of the initial counter force

Force Retention **FR (t) = F(t) / F(t_0)**

- For FR(t), the median value of the 3 samples is used.
- It is generally accepted that a residual counter force at 10% of original is the lower limit for maintaining a static seal. Dynamic sealing applications are more complicated.
- For elastomers, positive fluid volume swell (5 - 10 %) can be helpful in maintaining the sealing force depending upon property changes.

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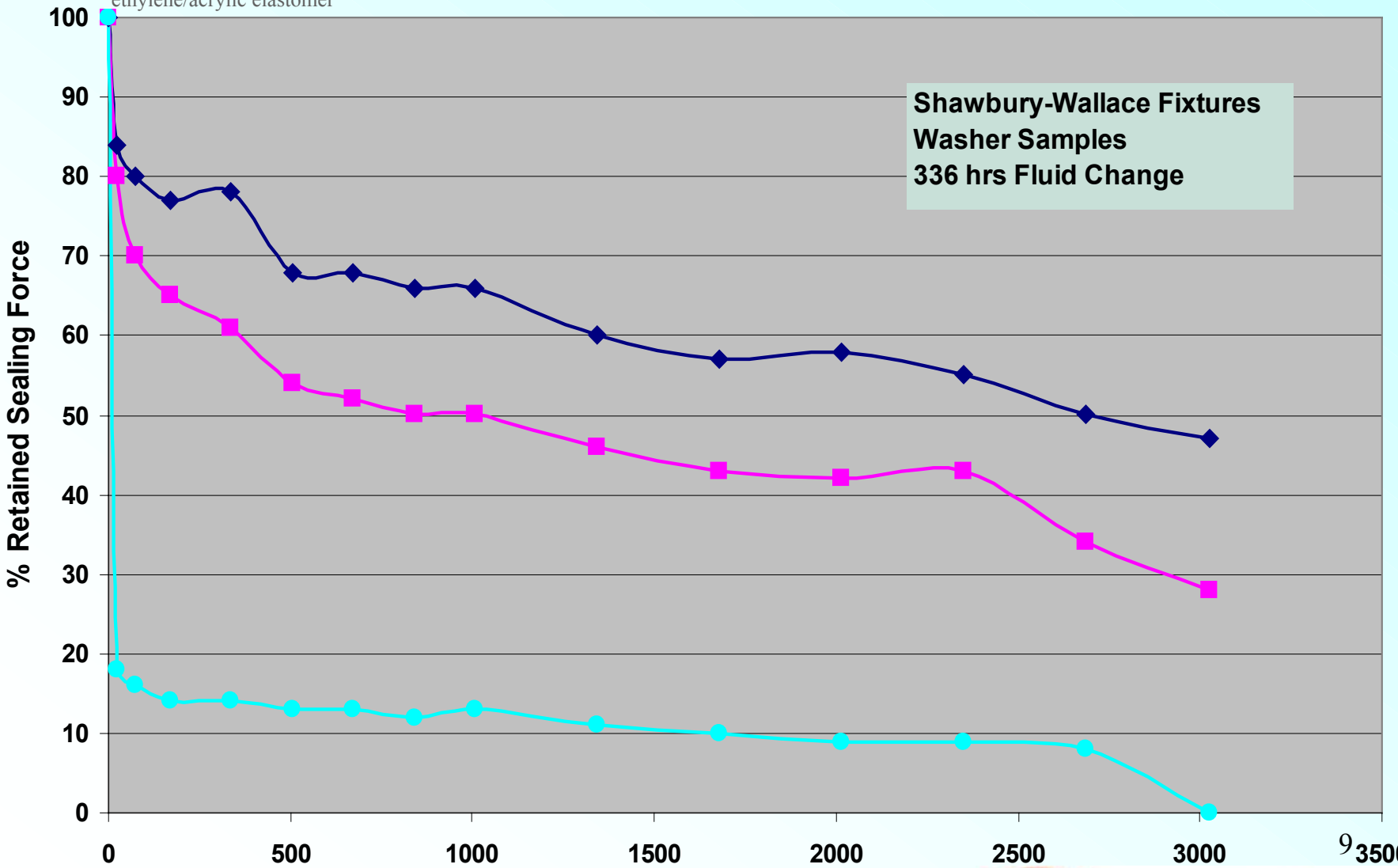
CSR Data - SF105 @ 150 °C



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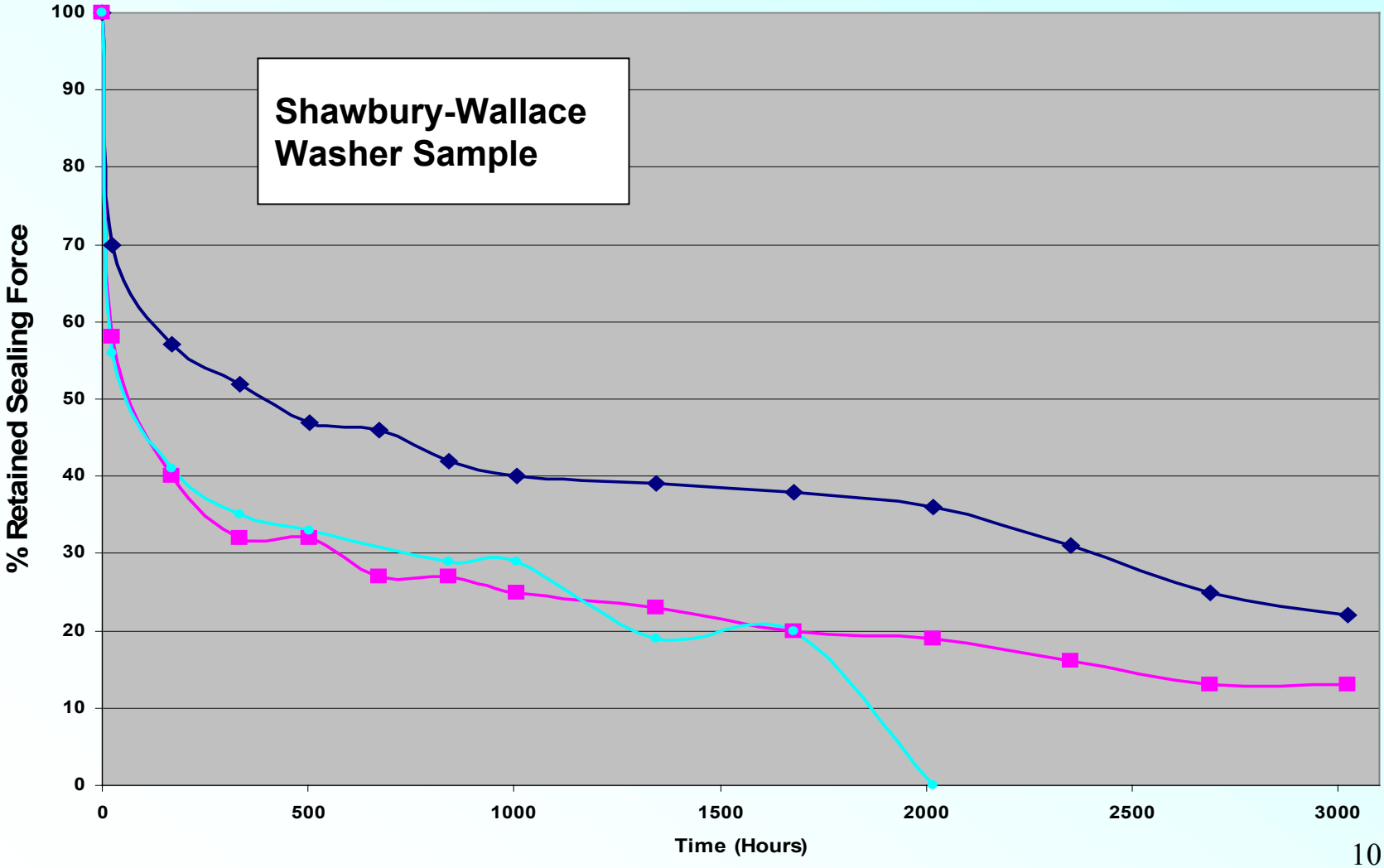
CSR in Motorcraft 0W-30 Oil @ 150 °C



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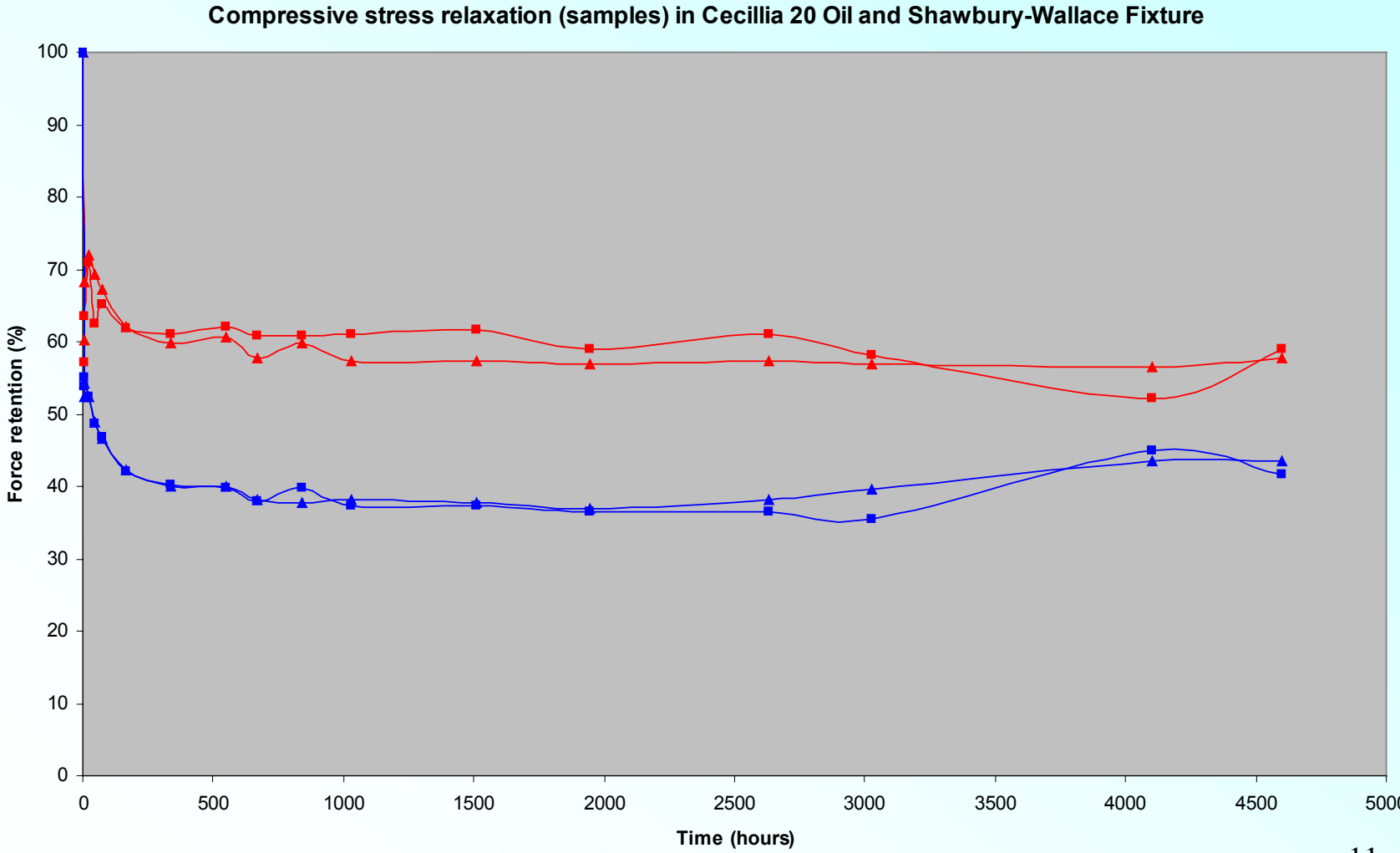
CSR Data - Cecilia 20 @ 150 °C



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GM and Ford Dry Heat CSR Test Temp.

Elastomer	GMNA 3922TP	Ford Proposal
FKM (fluoroelastomer, Viton®)	**150 °C**	**190 °C**
FVMQ (fluorosilicone)	**150 °C**	**190 °C**
VMQ (silicone)	**150 °C**	**190 °C**
AEM (Vamac®, ethylene acrylic)	**150 °C**	**150 °C**
ACM (polyacrylate)	**150 °C**	**150 °C**
EPDM (ethylene propylene)	**150 °C**	**135 °C**
HNBR (hydrogenated nitrile)	**150 °C**	**135 °C**
ECO (epichlorohydrin)	**125 °C**	**135 °C**
CSM (chlorosulfonated PE, Hypalon®)	**125 °C**	**135 °C**
NBR (nitrile)	**125 °C**	**121 °C**
TPE	**125 °C**	**- - -**

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Conclusions

- Compressive Stress Relaxation is the most representative test for predicting sealing performance over time under end use environment.
- CSR maintains compression of the sample during the entire evaluation period, and function, not uncompressed size, is the determining factor.
- Test conditions can be tailored to meet specific application needs (e.g., temperature cycling, oil changing, oil aeration, etc.)
- Automotive OEMs are now requiring CSR test data as reference info in new material specifications for seals and gaskets.
- **ASTM** and **ISO** procedures for Compression Stress Relaxation provide guidelines for developing specifications :
  - ASTM D6147
  - ISO 3384

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

Diesel Engine Oil Category Development: Considerations for the Next Category

HDEOCP Working Groups

Phoenix

December 8, 2003

EMA/API/ACC Concerns

- **Availability of new oils on the market**
  - **To meet immediate needs**
  - **To meet 2007 emission standards**
- **Flexibility to accommodate change / refinement**
- **Funding**
  - **Test development**
  - **Matrix testing for BOI / VGRA**
  - **Structure**
- **Worldwide acceptance of categories**
- **Value to, and consensus among, stakeholders**

EMA Observations

- **Great value in API system**
- **Time and resources are major concern for all**
- **Engine manufacturers committed to make new lower emitting engines available for 2007**
  - **EPA standards take effect**
  - **Aftertreatment deployment will begin**
  - **Engine oils are critical to manufacturers' meeting those standards**
- **Flexibility and innovation needed in process development**
  - **Combine features of all proposals**
  - **Adjust to hardware development and still meet timeline**
  - **Deadlines have been met before, they'll be met again by all stakeholders working together**

EMA Observations

- **OEM specifications**
  - **Require less process to develop but lack universal API "CX" reference**
  - **May force fleet owners to purchase multiple oils**

    This is not acceptable
- **Chemical limits offer an efficient alternative to engine/aftertreatment performance testing for the short term**

2007 On Highway Emission Stds Aftertreatment Category – PC10

- **Requires vital new tests including**
  - **Cummins ISB cam wear**
  - **Mack T12 ring and liner wear, bearing corrosion**
  - **Caterpillar C13 deposit control, oil consumption, (CCV?)**
  - **GM Sequence IIIG oxidation stability**
- **Aftertreatment deployment will begin**
- **Chemical limits**
  - **Efficient alternative to engine/aftertreatment performance tests**
  - **Balance hardware and aftertreatment needs**
- **Backward compatibility / suitability needs to be defined**
  - **ExxonMobil proposal regarding chemical limits and 500 ppm sulfur fuel presents an interesting concept to explore**
  - **Other test consolidation may be appropriate**

A Way Forward

- **OEMs**
  - **Introduce new tests**
    - **Cummins ISB to protect overhead valve train with low P oils**
    - **Caterpillar C13 for deposit control, oil consumption, and possibly CCV**
    - **Mack T12 for ring and liner wear, bearing corrosion**
    - **GM Sequence IIIG for oxidation stability**
  - **Develop tests**
    - **Demonstrate test discrimination**
    - **Propose limits**

A Way Forward (cont.)

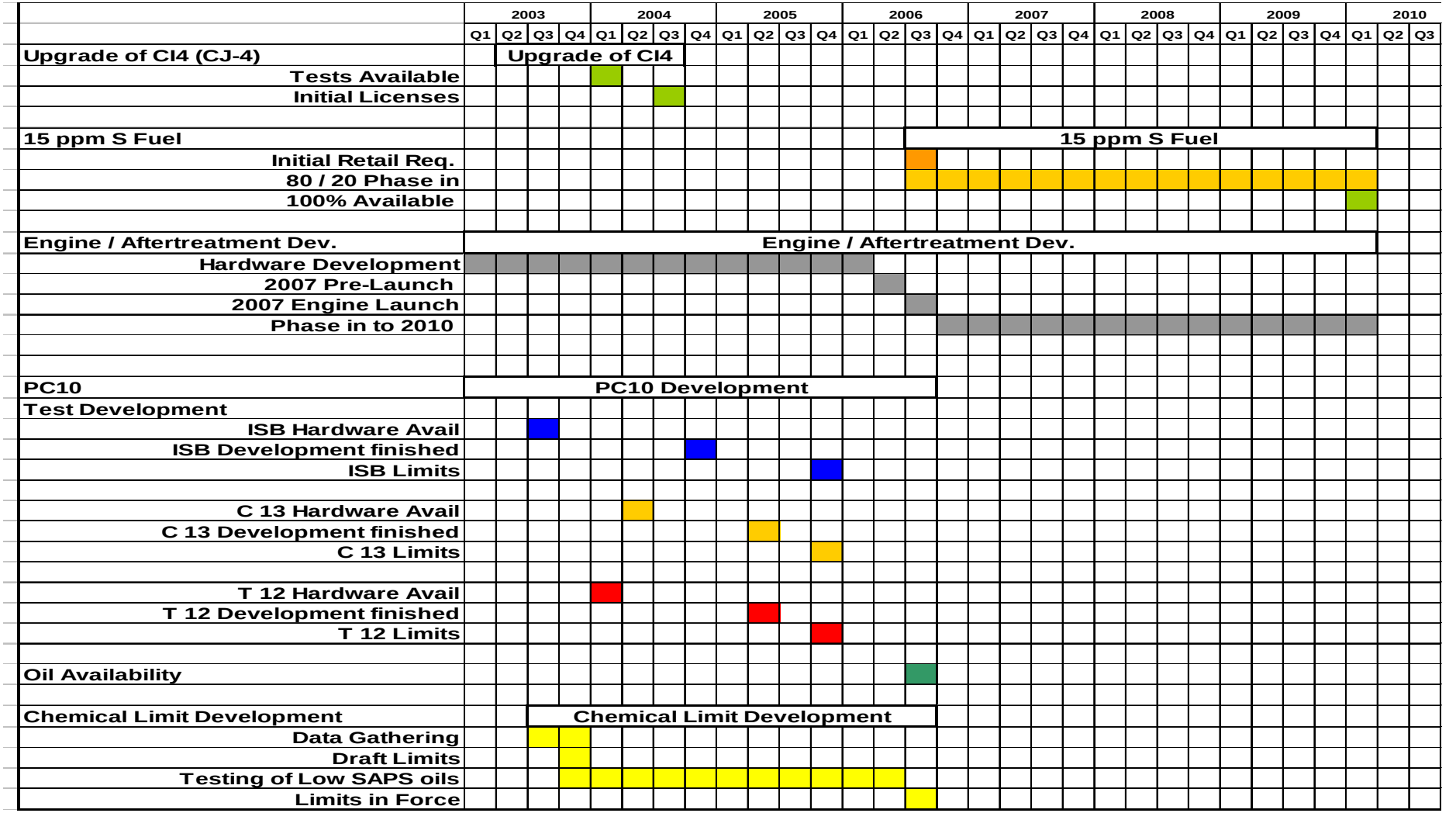
- **ASTM**
  - **Develops chemical limits for 2006**
    - **Expect minimal changes to existing mechanical elements-bearing, valves, cams, etc.**
    - **Chemical limits that balance aftertreatment device protection and engine requirements**
  - **Addresses test robustness**
    - **Assures precision through HDEOCP and surveillance panels**
    - **Develops matrix to quantify test discrimination and lab repeatability**
    - **BOI / VGRA carried forward and improved over time with data collected**

      (early approved formulations remain valid until reformulated)
  - **No "B" ballot required**

A Way Forward (cont.)

- **DEOAP**
  - **Determines timing for new category introduction**
  - **Establishes funding structure**
  - **Affirms consensus of test limits**
  - **Defines backward compatibility**
  - **Obsoletes old categories**

Timeline


2003
2004
2005
2006
2007
2008
2009
2010
Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3
Upgrade of CI4 (CJ-4)
Upgrade of CI4
Tests Available
Initial Licenses
15 ppm S Fuel
15 ppm S Fuel
Initial Retail Req.
80 / 20 Phase in
100% Available
Engine / Aftertreatment Dev.
Engine / Aftertreatment Dev.
Hardware Development
2007 Pre-Launch
2007 Engine Launch
Phase in to 2010
PC10
PC10 Development
Test Development
ISB Hardware Avail
ISB Development finished
ISB Limits
C 13 Hardware Avail
C 13 Development finished
C 13 Limits
T 12 Hardware Avail
T 12 Development finished
T 12 Limits
Oil Availability
Chemical Limit Development
Chemical Limit Development
Data Gathering
Draft Limits
Testing of Low SAPS oils
Limits in Force

Fuel Program Update

Heavy-Duty Engine Oil Classification Panel

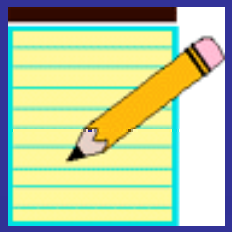
Chris Laroo

US EPA Office of Transportation and Air Quality

December 8, 2003

Presentation Overview

- Program Implementation
  - Highway Diesel
- Programs in Development
  - Nonroad Diesel
  - Locomotive and Marine

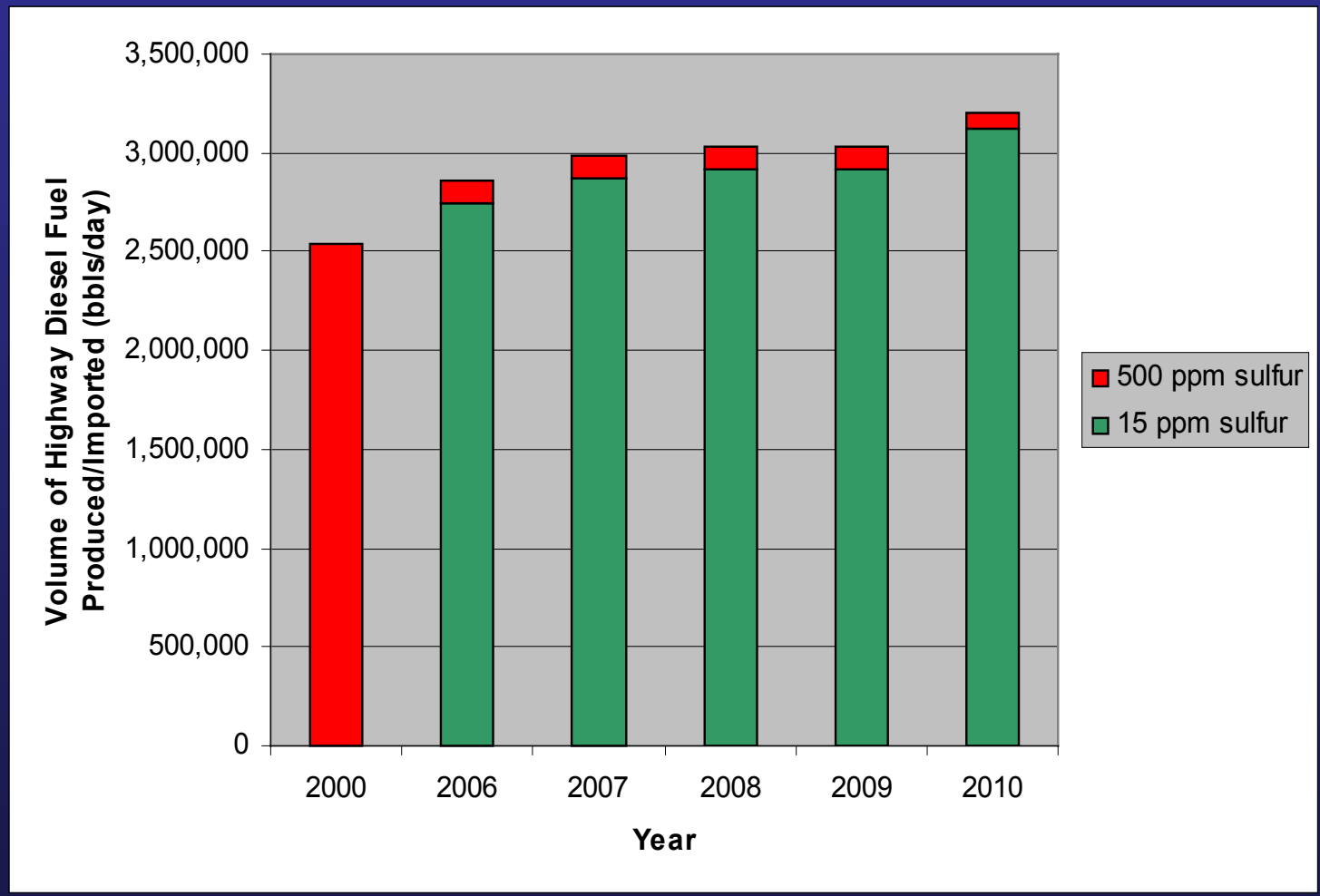


Progress Toward 2007:
Highway Diesel Fuel Status

- *Summary and Analysis of the Highway Diesel Fuel 2003 Pre-compliance Reports*
  - Analysis of reports submitted by ~120 refineries
  - Published October 29, 2003

- 3 major findings:
  - Industry is on target to comply with the 15 ppm sulfur highway diesel fuel requirements on time
  - 15 ppm sulfur highway diesel fuel will be widely available
  - Highway diesel fuel supply will be sufficient to cover demand

Projected Highway Diesel Fuel Production



Nonroad Proposal Overview

- Same systems approach as the highway program
- Engine standards represent reductions of >95% PM and ~90% NO_x - Starting in 2011, fully phased in by 2014
- Enhanced testing requirements to ensure in-use emissions reductions
- 500 ppm maximum sulfur nonroad, locomotive and marine diesel fuel in 2007
- 15 ppm sulfur nonroad diesel fuel in 2010

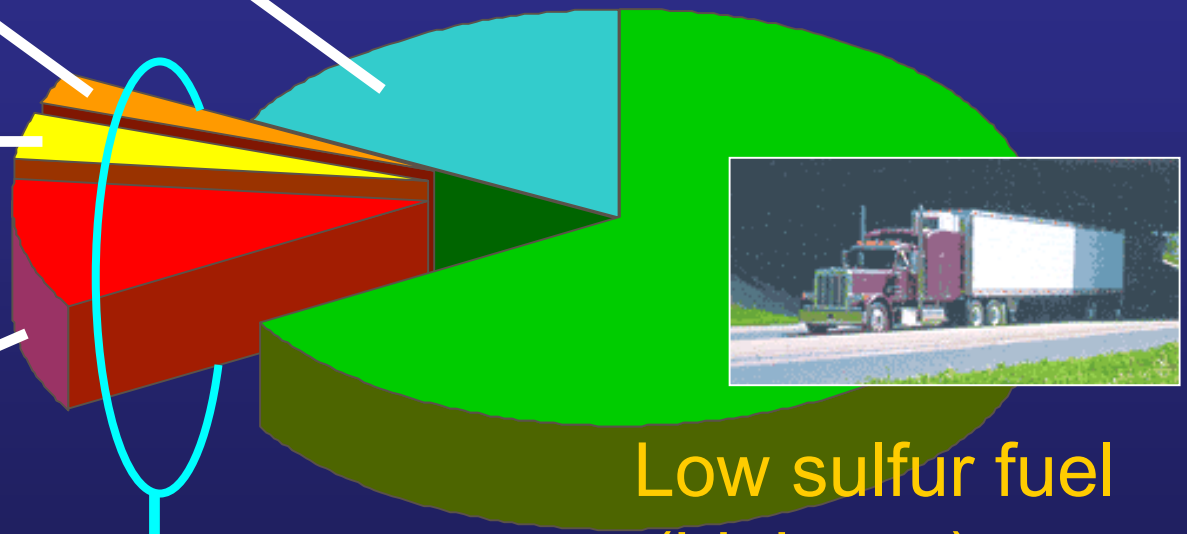
Distillate Fuels

Marine 2.5%

Home heating, etc. 17%
not covered

Locomotive 3.5%

Nonroad equipment 10%



Low sulfur fuel (highway) 67%
regulated since 1993

Covered by the proposal

Nonroad Feedback

- Published May 23, 2003
- 3 Public Hearings (NY, Chicago, LA)
- Comment Period Closed August 20
- ~150,000 Written Comments
- ~120 Substantive
  - States, Enviros, Labor, Farming, Fuel Industry, Engine/Equip Industry, Construction, Mining, Rail
- Overall Very Positive
- Widespread support for Standards and Timing
- Many comments received on
  - Large engine standards
  - Fuel program design
  - 15 ppm sulfur standard for locomotive and marine diesel fuel
- Comments received on many other specific technical issues
- Plan to issue FRM ~next April

Locomotive and Marine Diesel Standards

- Considering systems approach for future marine diesel and locomotive standards modeled after land-based nonroad
- Loco/marine diesel fuel sulfur control options discussed in the land-based nonroad proposal
  - Recent nonroad proposal would extend 500 ppm fuel sulfur cap to locomotive and marine diesel engines
  - Considering extending 15 ppm sulfur cap as well
  - Ocean going vessels (Category 3, >30 l/cyl) must use low-sulfur fuel (<15,000 ppm) or use SO_x scrubbers in designated SOx Emission Control Areas in the United States
- Next Steps: ANPRM planned for Spring 2004 within the same timeframe as the nonroad diesel FRM

For More Information…

- 2007 Highway Diesel Program:
  - http://www.epa.gov/otaq/diesel.htm
- Nonroad Diesel Proposal:
  - Copy of proposal and supporting documents are available from: www.epa.gov/nonroad/
  - Submitted comments are available at: www.epa.gov/epahome/edocket/

PC-10 Chemical Limits Task Force

December 8, 2003

Proposed Agenda

- Agenda review
- Approve meeting minutes, June 16 meeting
- Secretary volunteer ?
- Review summary of plan and timing that was established earlier this year
- Review data submissions to-date
- Discuss and decide revised timing for the key Task Force activities and deliverables
- Next Steps
- Next Meeting

PC-10 Chemical Limits Task Force - Plan

- **Any necessary chemical limits for S, P, SASH**
  - Balance engine durability, after-treatment system durability and ODI. Engine durability is top priority
  - Apply broadly to all engines, allow backward compatibility of PC-10 lubricants, based on best judgment from analysis of data supplied by Industry, and focus on the needs of 2007 emissions controlled engines
- **Solicit, then analyze data from the Industry related to:**
  - Engine durability at lower constitutional amounts of sulfated ash, phosphorus and sulfur
  - Exhaust system durability as a function of constitutional amounts of sulfated ash, phosphorus and sulfur
  - Engine durability as a function of oil drain interval at lower constitutional amounts of sulfated ash, phosphorus and sulfur
- **Timing driver - input to the design of the reference oils that will be used in the PC-10 engine test matrix**.
  - Recommendation in place about 3 months ahead of the start of the matrix, slated for late 1Q04. Timing to be adjusted if the PC-10 test matrix timing slips

Data Submissions

- Responses from 8 entities
  - Type 1 data – 10 oils
  - Type 2 data – 7 oils
  - Type 3 data – 1 oil
  - Lacking DPF data
- Some data provided in summary form (not the underlying data points) that might prove difficult to analyze

Task List and Timeline from June Meeting

- 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

Ahead

- New Letter Extending Deadline? April 1, 2004-drop dead!
- Some help for EMA staff on data aggregation?
- Initial organization and review of the data (Abdul C, Bill K, Dave S and Mark R volunteered to do this)
- Detailed review of the data and initial proposal for chemical limits by task force-target for June HDEOCP final acceptance.
- Build consensus for chemical limits within task force in early November. Now revised to April-June 2004.

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

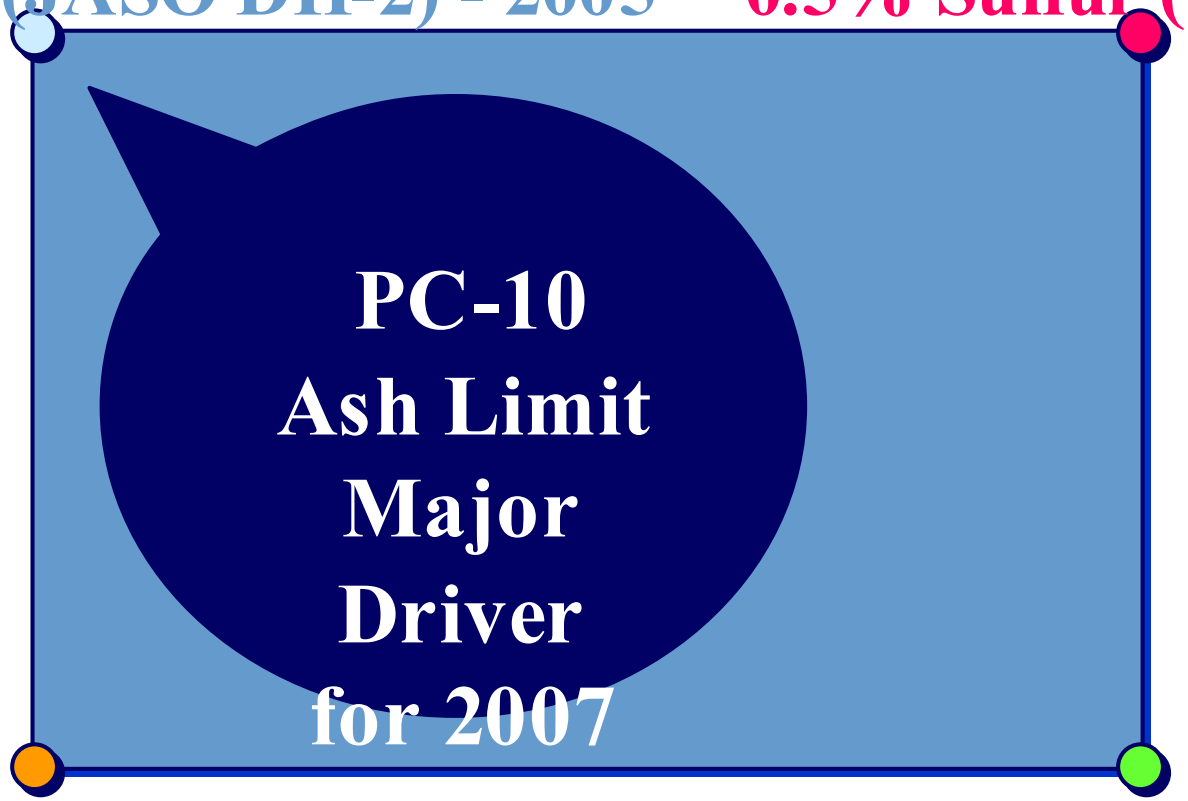
Lubricants Chemical Limits for ACEA E6 and JASO DH-2

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)

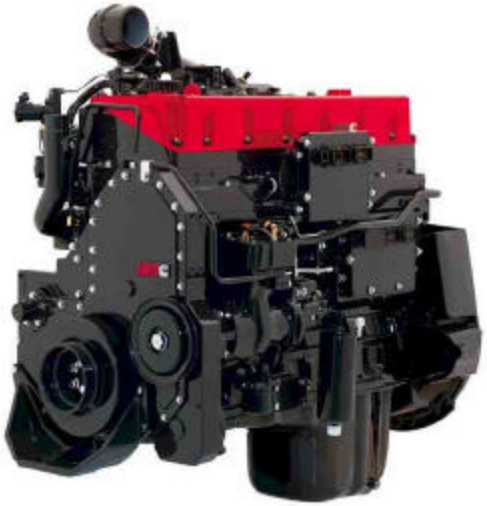
0.08% Phosphorus (ACEA E6)

ISM Task Force Report
HDEOCP

Warren Totten

December 9, 2003

Phoenix, AZ



Scope

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

Primary Parameters	Secondary Parameters
Crosshead weight loss	Liner wear
Top Ring weight loss	Rocker hat weight loss
Sludge	Push tube scuffing
Oil filter delta P	Bearing wear
	Intake and Exhaust screws

Scope

- In addition to insuring the continuation of API categories CH-4 and CI-4 the following parameters, in addition to those incorporated from ASTM D6975 and D4485, will be added for PC-10.

Primary Parameters	Secondary Parameters
Injector adjusting screw wt. loss	Liner wear
Push tube scuffing	Rocker hat weight loss
	Bearing wear
	Intake and Exhaust screws

Objectives

Objectives:

1. Draft of test procedure — 10/03 (similar to ASTM D 6975)
2. Finalize matrix plan — 10/03 (complete)
   - 4 initial tests planned for discrimination
     - Two tests on TMC 1004
     - Two tests on an “excellent” reference (commercial oil)
3. Begin matrix testing — 11/03 (delayed)
   - Matrix testing has been delayed and the ISM O&H Panel has been meeting via teleconference on a weekly basis to resolve pending issues.
4. Review first 4 tests and make decision to continue — 1Q 2004

ISM O&H Activity Summary

- Familiarize test engineers with new engine management software
- Review and insure operating conditions
  - Labs to run power sweep and test conditions to verify
- OEM availability for one on one troubleshooting increased
- Verify sensor locations as per ASTM D6975 where applicable
- Labs to prepare and pre-measure test kits to reduce timing
- TMC to ship TMC 1004 and “Excellent” oil to labs
- Target matrix start for beginning of January 2004

ISM Test Conditions:

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

150 hr soot: 5.5% - 6.0%

ATTACHMENT 8, 6 OF 15

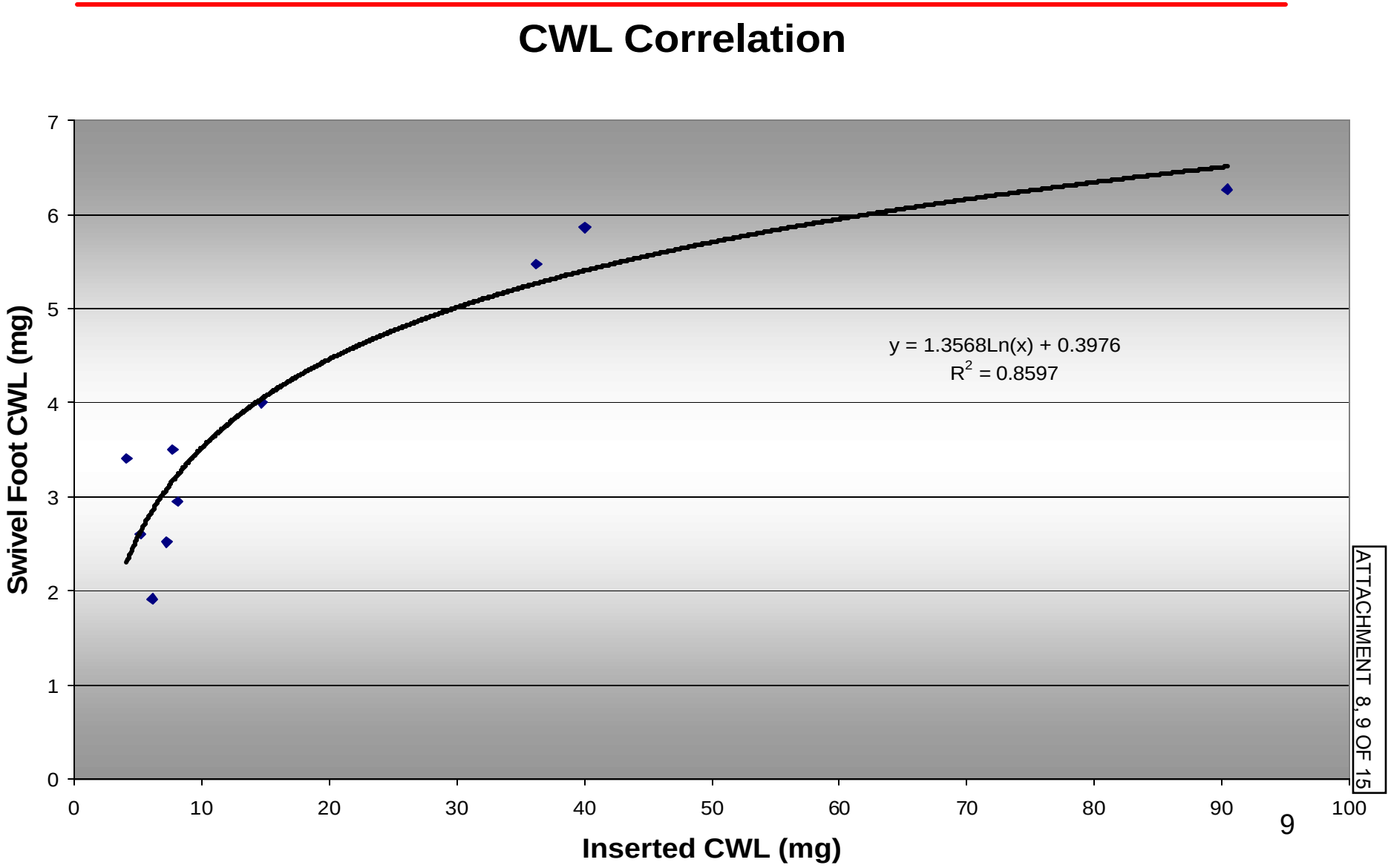
9/5/03 Task Force Mtg. Summary

- ISM test is planned to replace the M11 EGR and M11 HST.
  - The ISM test will have two sets of limits
    - **1 set for alternate pass/fail in the M11 HST**
    - **1 set for alternate pass/fail in the M11 EGR**
- The ISM test is proposed to be 200 hours in length and run on a similar cycle to the M11 EGR test
- Target level soot is 5.5% at 150 hours
- The ISM test will run on 500 ppm S fuel and use double wire screen filters

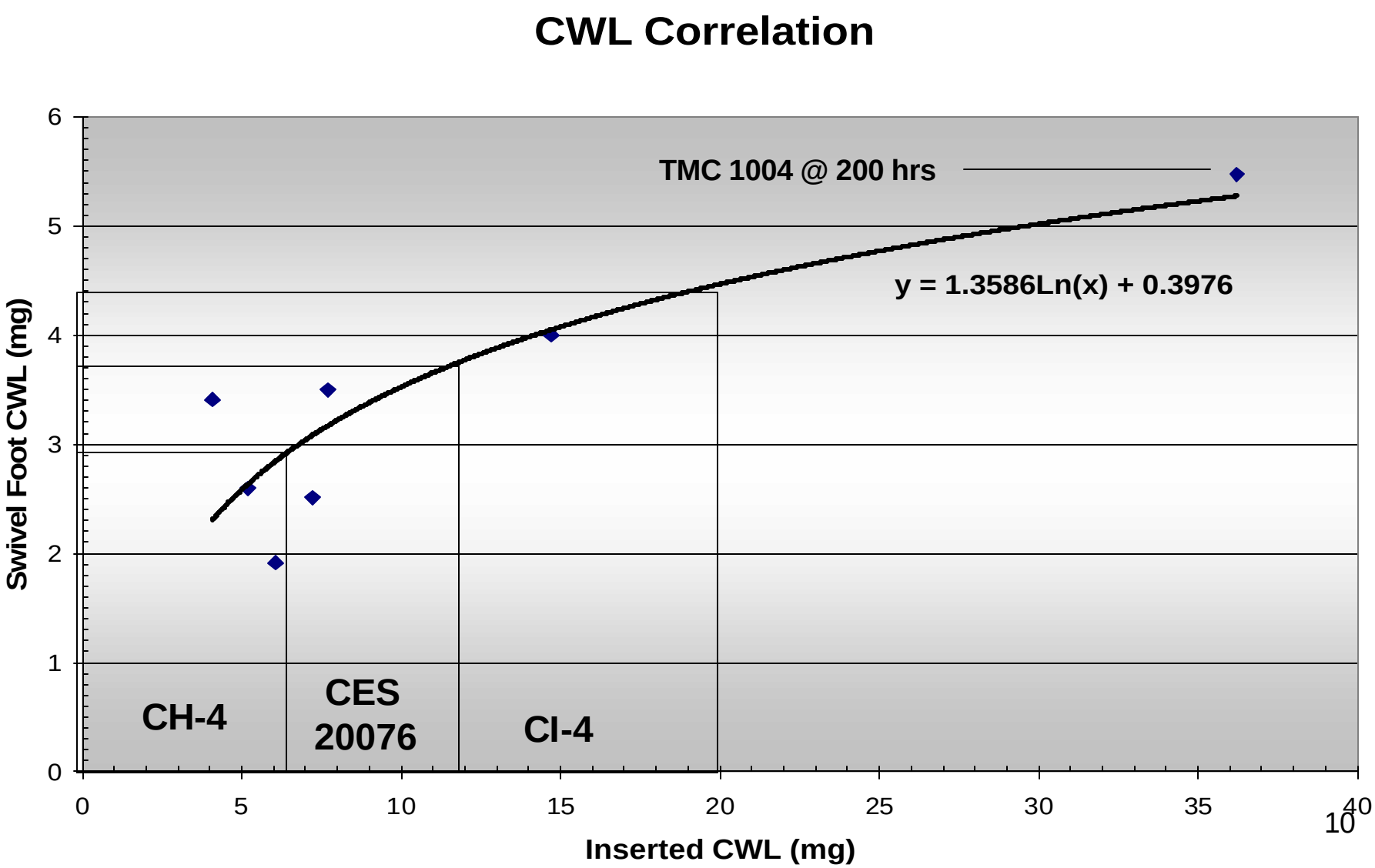
Comments and Questions

- The ISM test will be carried forward into PC 10
  - Cummins will request oil data in the ISM test
- Can the labs get additional rebuild parts for the M11 HST/EGR?
  - Current parts availability will not carry through the hardware matrix and PC 10.

Swivel Foot Rockers vs Inserted Rockers



Swivel Foot Rockers vs Inserted Rockers



Proposed Matrix

- Test in Stages
- Use Decision Points
- Use a range of oils
  - TMC 1004, TMC 1005, TMC 830-2, and “Excellent” oil to be based upon commercial technology (CI-4)
  - Covers M11 HST and M11 EGR range
- Stage 1
  - First four tests will test two poor oils and two excellent oils in four labs. Cummins will provide funding for parts and fuel for these tests.

Proposed Matrix

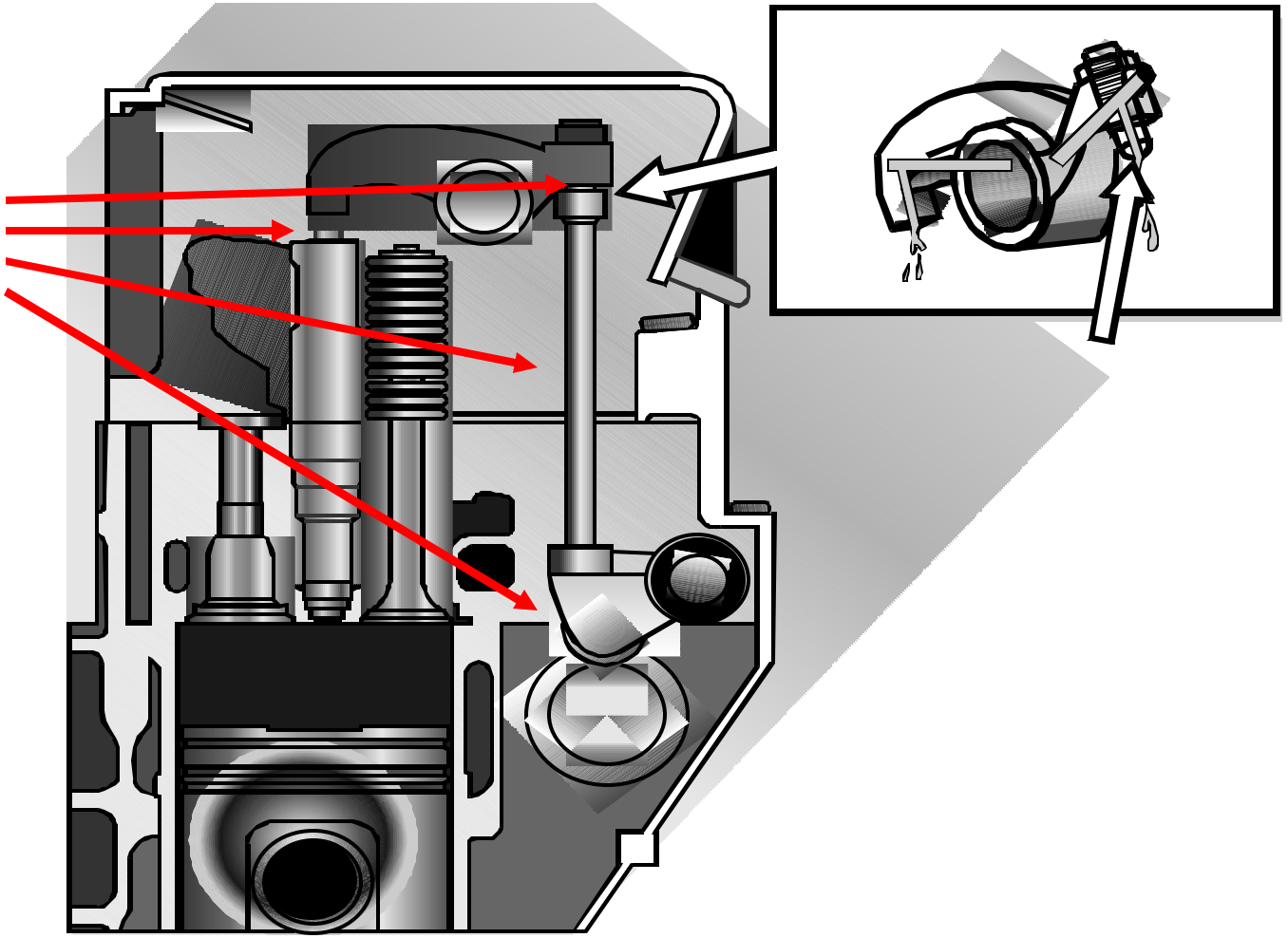
- Is there discrimination?
  - No? Stop the matrix
- Is the discrimination similar to the M11 EGR?
  - No? Stop the matrix
- Stage 2
  - 2 borderline oils and 2 good oils in four labs. Cummins will provide parts for these tests.
- Is the correlation similar to the M11 EGR?
  - No? Stop the matrix
  - Somewhat? Run the reference oil twice in each lab
  - Yes? Run the reference oil once in each lab

Matrix Summary

- Minimum number of tests for a successful matrix: 12 tests
- Maximum number of tests for a successful matrix: 16 tests
- Minimum number of tests for comfort: 4

Injector Adjusting Screw Wear (PC 10)

ISM engine test will also insure good oil performance for other valve train components. This parameter will only be added for PC10 requirements.



*Drawing courtesy of Jim McGeehan, ChevronTexaco (SAE 1999-01-1525)

Injector adjusting screw weight loss

CH4/SJ Oil	CG-4/SJ Oil	CG-4/SJ Oil
21 mg wear	64 mg wear	145 mg wear

*Photo and data courtesy of Jim McGeehan, ChevronTexaco (SAE 1999-01-1525)

ISB Task Force Report
HDEOCP

Warren Totten

December 9, 2003

Phoenix, AZ

ATTACHMENT 9, 1 OF 12

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

Objectives:

1. Draft of test procedure 12/03
2. Test engines to six labs 1/04
3. Initiate matrix design 1/04
   - Full matrix required for BOI/VGRA
4. Begin matrix testing ?
   - Matrix must be finished by 3Q 2005

B Product Evolution

1997

Established Product
Over 2 Million put in Service
Great Reliability & Durability

B Mechanical

2002

4 Valve Head with Centered Injection
Full Authority Electronic Fuel System
No Adjust Overhead

ISB

Common Rail Fuel System
Rear Gear Train
Cooled EGR Emissions Control

ISB '02

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 Operating Conditions

1.	Run at low idle		1.0 sec
2.	Ramp up to rated speed (2600 RPM) and full load (600 ft-lbs) within	2.5 sec	
3.	Run at rated speed and full load	6.0 sec	
4.	Lug the engine to low idle within		2.0 sec
5.	Low idle		1.0 sec
6.	Ramp up to torque peak speed (1600 RPM) and 75% rated torque within		2.5 sec
7.	Lug the engine to low idle within		2.0 sec
8.	Ramp up to torque peak speed (1600 RPM) and 75% rated torque within		2.5 sec
9.	Lug the engine to low idle within		2.0 sec
10.	Ramp up to torque peak speed (1600 RPM) and 75% rated torque within		2.5 sec
11.	Lug the engine to low idle within		2.0 sec
12.	Run at low idle		1.0 sec

ISB Test Conditions

Parameter	Unit	A (Soot)	B (Wear Cycle)
Stage Length	H	100	250
Engine Speed	r/min	1600	Variable
Torque	N·m (lb·ft)	(325)	Variable
Fuel Rate	Kg/hr (lb/hr)	(43)	Variable
Intake Manifold Air Temperature	°C (°F)	(110)	(110)
Coolant Out Temperature	°C (°F)	(200)	(200)
Oil Sump Temperature	°C (°F)	(205)	(205)

100 hr soot: 3.5 % target

ATTACHMENT 9, 8 OF 12

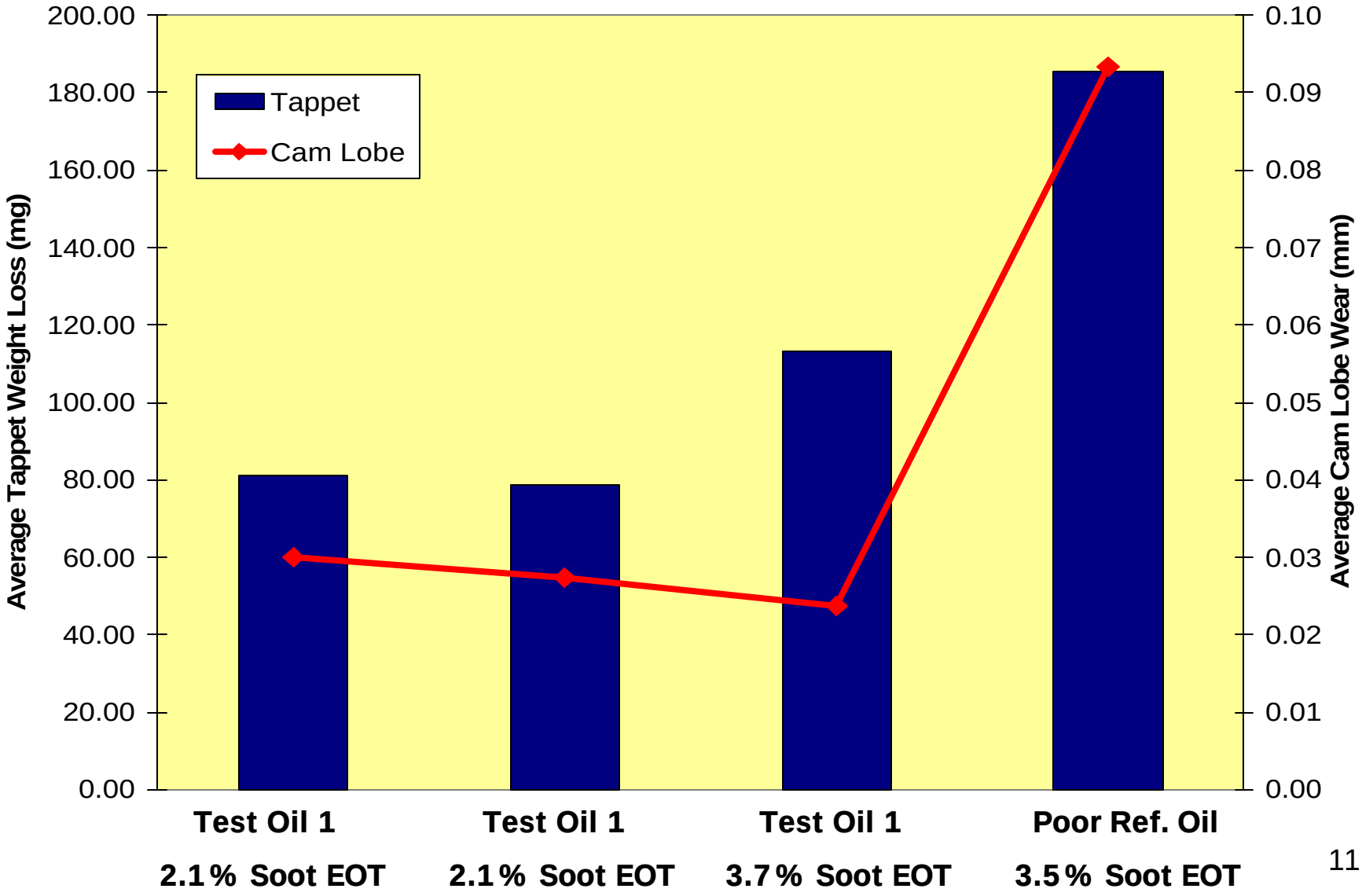
ISB Test Parameters

- 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

ISB '02 Repeatability / Discrimination



9/5/03 Task Force Mtg. Summary

- Reviewed ISB operation and hardware
- Q&A on performance and operation
- Established lab timing
- The ISB test will run on 15 ppm S fuel
- Developed scope and objectives
- Solicited membership
- Mark Sarlo of Southwest Research is the TF Chair

CAT C13 Oil Test Engine Program - Dec 8, 03

- C13 Engine Availability has been resolved.
- C13 will be used for ECF-2 & PC-10.
- Expect to be ready for CI-4 upgrade end 1st Qtr 04 to meet CI-4 Supplement.
- PC-10 test will follow on after CI-4 supplement completion – CCV and after-treatment? Planned completion 3rd Qtr 04




CAT C13 Oil Test Engine Program– Dec 8, 03

- C13 oil test engines status.
  - All Production Hardware
  - Test cycle defined
  - Operating Conditions defined
  - Ref Oils defined
  - 14 available Engines at this time.
  - 6 Engines at labs
  - 2 ready to begin test by 17 Dec 03
  - Team defined




CAT C13 Oil Test Engine Program– Dec 8, 03

- C13 oil test engines Data status.
  - Early deposit concerns with commercial oils in field, similar to C12
  - Engine desensitized to deposits, oil consumption
  - Tests being conducted on oils known to be worst for deposits – need for failing ECF-1 oils.
  - Possible other handles for tweaks:

    Hardware, Injection timing, Oil, Operating conditions

CCV effects on deposits to be determined

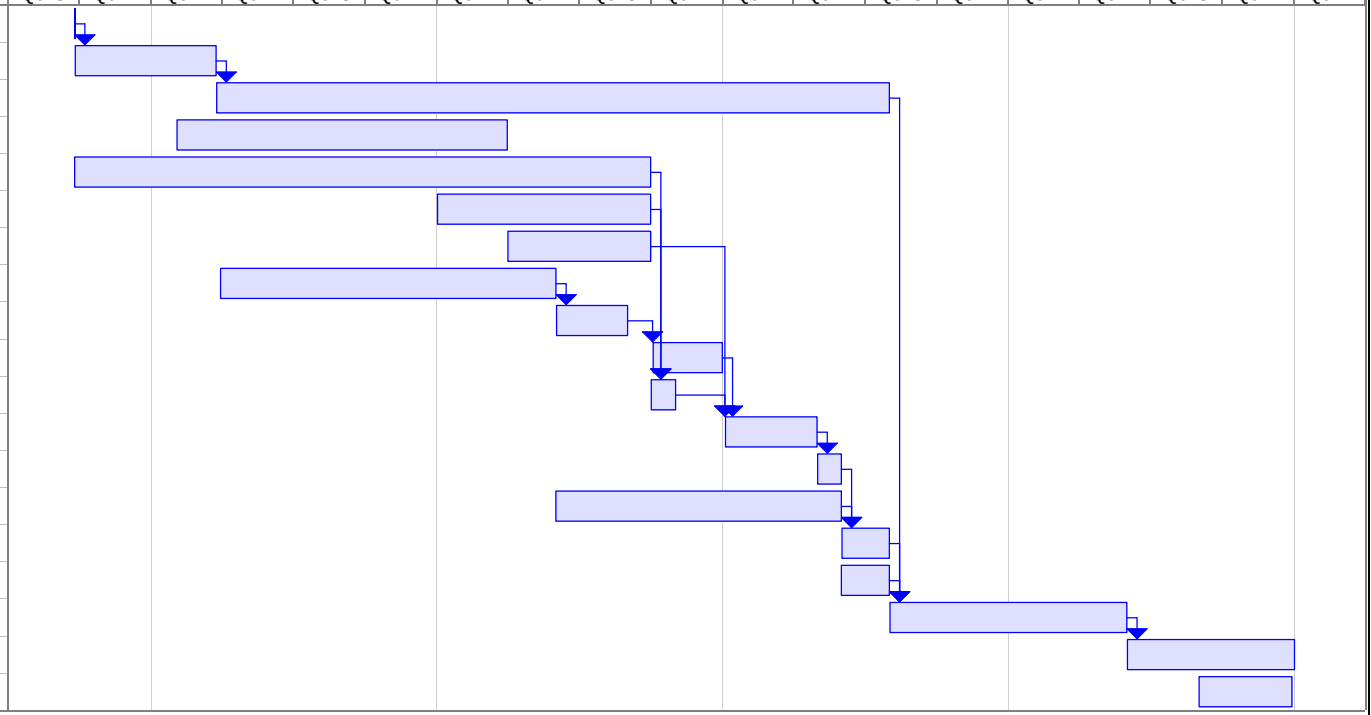



CAT C13 Oil Test Engine Program - Dec 8, 03

ECF-1	ECF-2	PC-10
Completed June '03	Apr '04	June '06
CAT 1P	C-13	C-13
500 ppm	500 ppm	500 or 15 ppm (Depending on Severity)




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

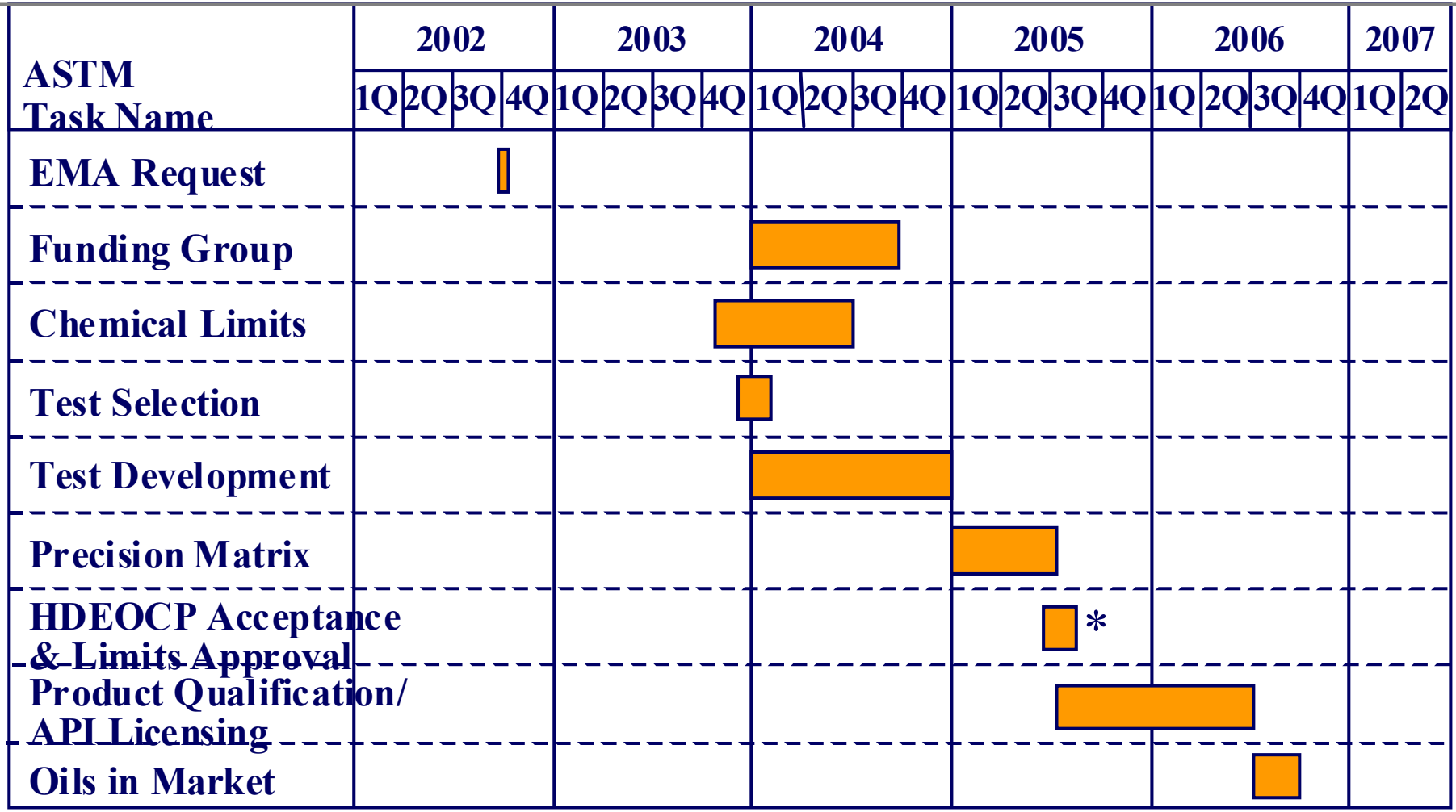


Project: PC-10
Date: Thu 1/8/04

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

ATTACHMENT 11

Proposed PC-10 Timeline



* Acceptance of PC-10 Limits – June 2005

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

Hyatt Regency Hotel, Phoenix, AZ
December 9th 2003
2:00-4:15 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	2:00-2:05
Minutes Approval	• October 8th 2003	Group	2:05-2:10
Membership	• Changes: Additions • Chairman's comments focusing on PC-10 in 2004	Jim Mc Geehan	2:10-2:20
Summary reports on Monday Dec 7th meeting and actions	• PC-10 charter • Chemical limits: Timing dead-line • Fuel Sulfur levels for on-highway • Time-line for PC-10 program • Tests in PC-10 and fuel sulfur levels for each test • Status of tests development • Status of seal development for Vamac • Funding	Greg Shank Rick Finn Chris Laroo Bill Runkle Steve Kennedy Rebecca Grinfield	2:20-4:00
DEOAP report	• Fast track oil categories process beyond API CI-4 and PC-10	Steve Kennedy	4:00-4:15

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	

PC-10 Tests

Oil Category	CI-4	PC-10
Fuel Sulfur	500 ppm	15 (500) ppm
Chemical Limits	-	X
Engine Test		
Caterpillar 1K	X	-
Caterpillar 1N (500 ppm)	-	X
Caterpillar 1R	X	-
Caterpillar C-13 (CCV)	-	X
Cummins M11-EGR	X	-
Cummins ISM (500 ppm)	-	X
Cummins ISB	-	X
Mack T-8	X	-
Mack T-12	X	X
Mack T-11(500 ppm)	-	X
Sequence IIIF	X	-
Sequence IIIG (0.10%s)	-	X
GM 6.5 Liter Roller-Follower Test	X	X
Navistar 7.3L Aeration *	X	X
Bench Test List (Seals, Etc.)	X	X

Proposed 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								✓

Mack PC10 Engine Test Update

ATTACHMENT 17, 1 OF 2

Ring & Liner Wear (Corrosive), Bearing Corrosion

- 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

DEOAP Report

CI-4 Supplement

- **DEOAP & Lubes Committee have agreed to establish a licensable supplemental category to address EMA concerns with 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**
- **Timeline**
  - **Target for first licensing is September, 2004 (could be adjusted based on test availability)**
  - **Tests ready by March 31, 2004 will be included in the supplement**

ATTACHMENT 18, 1 OF 2

DEOAP Report

CI-4 Supplement

- **Licensing requirements**
  - **Product must be CI-4 licensed**
  - **Must document acceptability in supplements engine tests**
    - **Meet limits & read-across guidelines published by OEM sponsor**
    - **OEM review & approval of data**
- **Details to be finalized by DEOAP / API LC:**
  - **Supplement name**
  - **Method of display**
  - **API1509 Appendix D revisions**
  - **Adjustments to API licensing forms**

ATTACHMENT 18, 2 OF 2