HEAVY-DUTY ENGINE OIL CLASSIFICATION PANEL
OF
ASTM D02.B0.02
June 18, 2002
Fairmont –The Queen Elizabeth Hotel

ACTION ITEMS

1. Bring data on using CI-4 tests (1R, M-11 EGR, T-10) in place of CH-4 tests. All

MINUTES

1.0 Call to Order

1.1 Chairman Jim McGeehan called the meeting to order at 1:00 p.m. on June 18, 2002, in the Marquette Room of the Fairmont – Queen Elizabeth Hotel of Montreal, Canada. There were 10 members present or represented and there were approximately 45 guests present. The attendance list is shown as Attachment 2. Note: There were a large number of guests present who missed the attendance list because it was not passed from one side of the room to the other.

2.0 Agenda

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

3.0 Previous Meeting Minutes

3.1 The minutes from the December 3, 2001 meeting were approved as distributed and posted on the ASTM Test Monitoring Center web site.

4.0 Membership

4.1 Chairman McGeehan reviewed the membership list and corrected his slide after input from the audience. Matthew Urbanak will replace Aimin Huang for Shell. See Attachment 3.

5.0 Chairman's Comments

5.1 Chairman McGeehan thanked the group for their teamwork in bringing the CI-4 category in on time (See Attachment 4) and then asked for observations and thoughts about how the PC-9 process went and what we could do to help make the PC-10 process even better.

5.2 Lew Williams observed one of the key elements in delivering PC-9 was that all parties took a "what we could live with" approach, and worked out compromises.

5.3 Greg Shank noted that when issues arose, people expended the effort to meet and deal with them expeditiously and thus were able to keep close to the overall timeline. In response to a comment about early delivery of the tests, Greg said it was just the nature of the business…that production like hardware was never going to be available until close to actual production and consequently, not all problems would be known very far ahead of time.

5.4 Dave Stehouwer remarked that the spirit of the group was to work through the problems as they occurred and he encouraged the group to keep the dialog going during PC-10.

5.5 Tom Cousineau felt the “exit” ballots were a good process to help expose potential problems and Greg Shank added especially when no “abstentions” were allowed.

5.6 John Zalar noted his appreciation of people working to meet the timeline for PC-9 and his disappointment in how long it took to get the matrix oils blended and delivered.

5.7 Pat Fetterman observed that the T-10A test and the T-10 merit system were added at the last minute through extraordinary effort. He would have liked for those efforts to have started earlier.

6.0 Cummins M-11

6.1 Jeff Clark presented background and data on why the Cummins Surveillance Panel adopted a correction factor for the M-11EGR filter delta-P parameter. See Attachment 5.

7.0 APBF-DEC Program

7.1 Jim McGeehan informed the group of a government funded program looking at lubricant effects on emissions control systems (aftertreatment devices). See Attachment 6.

8.0 PC-10 Timeline

8.1 Greg Shank presented the EMA view of what the PC-10 timeline should look like. See Attachment 7.

8.2 John Shipinski asked about the possibility of an ash limit for PC-10 oils. The response indicated it would be mid-2004 before sufficient data would be available to know.

9.0 Demonstrating CH-4 Performance with CI-4 Tests

9.1 Don Marn presented data from T9 & T10 , M-11HST & M-11EGR tests on the same oil showing that the CI-4 (T-10 & M-11 EGR) tests were more severe than the CH-4 (T-9 & M-11 HST) tests, supporting the position that oils could be qualified for CH-4 by running the CI-4 tests with relaxed limits.

9.2 Greg Shank reminded the group that the CH-4 tests are still specified for ACEA categories and Pat Fetterman indicated Infineum had already presented data similar to the Lubrizol data.

9.3 The question was raised about using the 1R for the 1P also, but no data has appeared.

10.0 Award

10.1 Jim Bover, Chairman of Committee D.02, presented Jim McGeehan with an ASTM Award of Excellence for his and the panel’s efforts in delivering CI-4 on time.

11.0 Caterpillar Single Cylinder

11.1 Jim Wells notified the group that the SCOTE Surveillance Panel is considering a request to the HDEOCP to remove “Loss of Side Clearance” as a pass/fail parameter for the 1M-PC test, since it appears to be a random occurrence.

12.0 Next Meeting

12.1 The next meeting is planned for December 2002, in Anaheim.

13.0 Adjournment

13.1 The meeting was adjourned at approximately 2:25 p.m.

Submitted by:

Jim Wells
Secretary to the HDEOCP

ATTACHMENT 1

ASTM
SECTION D.02.BO.02
HEAVY-DUTY ENGINE OIL CLASSIFICATION PANELS

FAIRMONT-THE QUEEN ELIZABETH HOTEL-MONTREAL
June 18th 2002
2:00-4:00 PM

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

Desired Outcomes: **PC-10 Tests and Time-line**
Start the process: Funding etc

TOPIC	PROCESS	WHO	TIME
Agenda Review	• Desired Outcomes & Agenda	Group	2:00-2:05
Minutes Approval	• December 5th 2001	Group	2:05-2:10
Membership	• Changes • Chairman's comments	Group	2:10:2:15
Learning Look back	• API CI-4 • List +/-	Group	2:15-2:30
Cummins M11-EGR	• Effects of filter change • Surveillance panel recommendations accepted	John Zalar	2:30-2:45
APBF-DEC Program	• Objectives and time line • Influence on PC-10 requirements	Jim Mc Geehan	2:45-3:00
PC-10	• Process: funding; tests selection • Time line • PC-10 and DHD-2	Greg Shank	3:00-3:30
Older API categories :Test by test limits	• Alternate test limits for: • Cummins M11 EGR for M11HST • Mack T-10 for Mack T-9 • Cat 1R for Cat 1P • Process forward	Steve Kennedy Lew Williams	3:30-4:00

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  - D. Stehouwer, Cummins Inc.
  - B. Mesfin, Detroit Diesel Corporation
  - D. Tharp, Caterpillar Inc.
  - F. Bondarowicz, International Truck and Engine Corporation
  - K. Chao, John Deere
  - R. T. Stockwell, GM Powertrain Engineering Center
- **Oil and Additive Companies**
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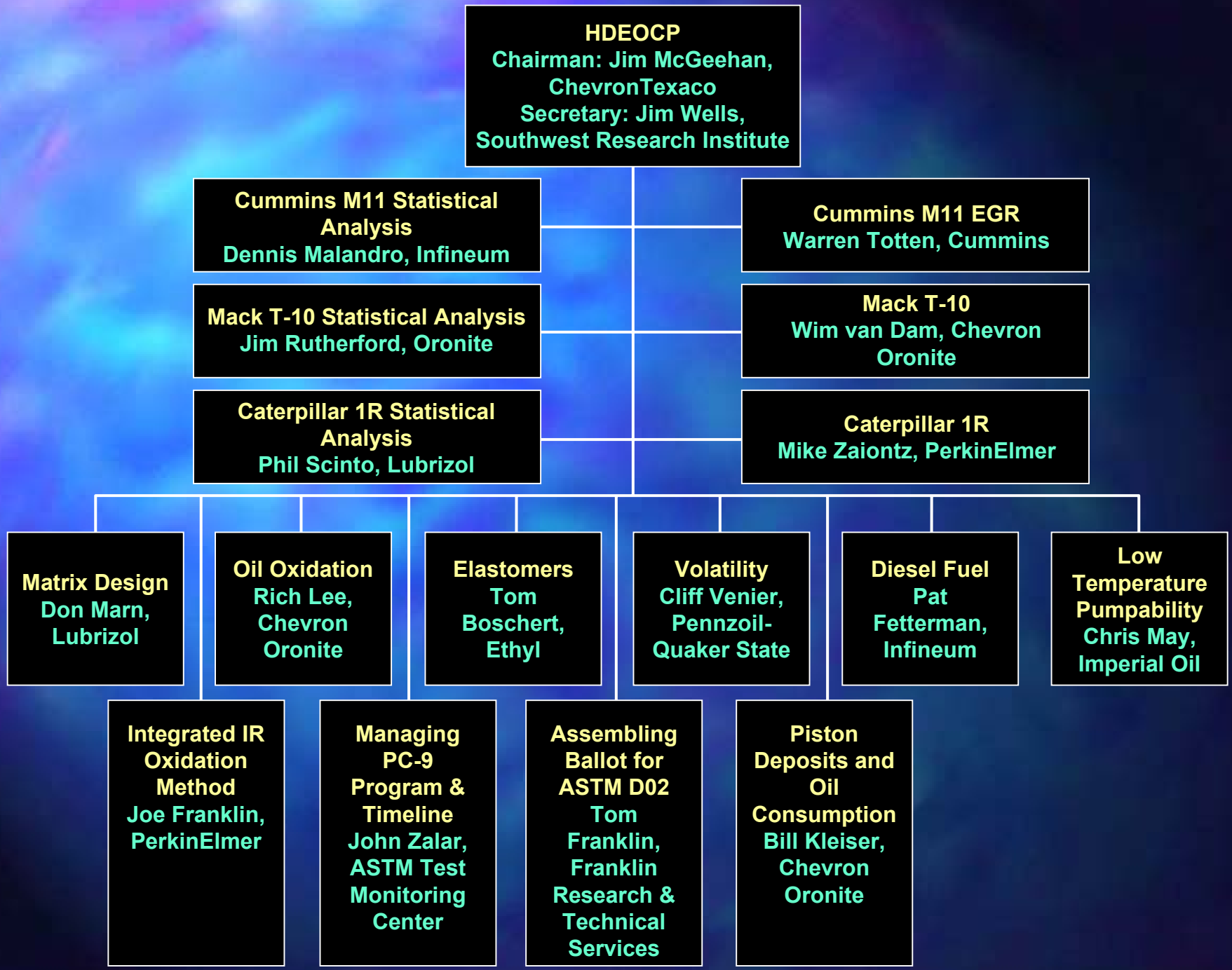
  - S. Kennedy, ExxonMobil
  - M. Urbanak, Shell Global Solutions, US
  - T. Cousineau, Ethyl Corporation
  - W. Kleiser, Chevron Oronite Company LLC
  - L. Williams, Lubrizol Corporation
  - P. Fetterman, Infineum USA

ATTACHMENT 3

The Team Membership and Task Forces Key to API CI-4 Success

ATTACHMENT 4, 1 OF 2


HDEOCP
Chairman: Jim McGeehan, ChevronTexaco
Secretary: Jim Wells, Southwest Research Institute
Cummins M11 Statistical Analysis
Dennis Malandro, Infineum
Cummins M11 EGR
Warren Totten, Cummins
Mack T-10 Statistical Analysis
Jim Rutherford, Oronite
Mack T-10
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Chris May, Imperial Oil
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Joe Franklin, PerkinElmer
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M11 EGR OIL FILTERS

Correction Factor Implementation

Presented By:
Jeff Clark
ASTM Test Monitoring Center

M11 EGR Oil Filter History

- **PC-9 Matrix:**
  - **Filters made without bead to maintain pleat spacing**
- **Post-Matrix:**
  - **Filters made with bead**
- **Performance differences found between filters**

Filter Plugging Results: Oil E

Units: kPa	N	Mean	Std. Dev.
Unbeaded	10	133	58
Beaded	12	67	14
Units: $\sqrt{\ }$	N	Mean	Std. Dev.
Unbeaded	10	11.28	2.54
Beaded	12	8.14	0.86

Filter Performance Differences

- **Filter Plugging Performance Change**
  - **Mean shift in mild direction**
  - **Large decrease in variation**
- **Concerns**
  - **Link with CI-4 development broken**
  - **Test loses ability to discriminate**
  - **“Poor” oils could pass**

Corrective Action / Expected Results

- **Corrective Action**
  - Implement a correction factor based upon the filter batch change
  - Correction Factor: +3.15 square root units added to oil filter plugging result
- **Expected Results**
  - Maintain integrity of CI-4
  - Improved precision and discrimination

Implementation of C.F.

- Adopted by Cummins SP effective February 21, 2002
- Notice sent to HDEOCP
- M11EGR Information Letter 02-1 issued March 22, 2002
  - Cleared June ASTM ballot with no negatives or comments

Effect of C.F. on Reference Tests

Units: kPa	N	Mean	Std. Dev.
Unbeaded	10	133	58
Beaded C.F.	5	132	22
Units: $\sqrt{\ }$	N	Mean	Std. Dev.
Unbeaded	10	11.28	2.54
Beaded C.F.	5	11.46	1.00

M11 EGR Oil Filter Summary

- Introduction of beaded filter resulted in a change in test performance
- C.F. implemented to bring test performance back in line with PC-9 matrix
- Early reference results indicate that C.F. is impacting test as desired
  - Severity back to PC-9 levels
  - Improved precision / discrimination

The Influence of Lubricant Formulation on Emissions from a CIDI Engine: Basestock and Additive Effects

Shawn D. Whitacre
National Renewable Energy Lab
June 4, 2002

Future Car Congress 2002

Catalyst compatible lubricants

- 2007 HD standards and Tier 2 LD standards will require aftertreatment
- Growing concern over lube oil sulfur and ash
  - Potential to interfere with catalyst performance
  - NO_x adsorber poisoning
  - Diesel particle filter plugging
- APBF-DEC has established a multi-year project to quantify lubricant effects on emissions and catalyst performance

- ***Objective:*** Determine which, if any, lubricant derived emission components are detrimental to ECS performance or durability.

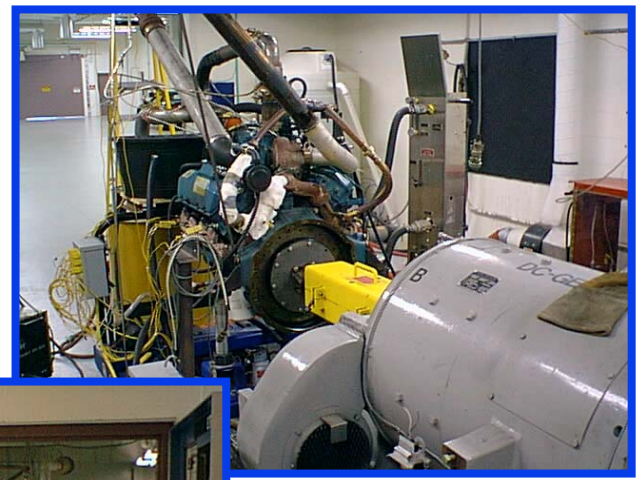
Workgroup Participants

- BP
- Caterpillar
- ChevronTexaco
- Chevron Oronite
- Ciba Specialty Chemicals
- Cummins, Inc.
- Equilon
- Ethyl Corporation
- ExxonMobil
- Infineum
- International
- John Deere
- Lubrizol
- Mack
- Marathon-Ashland Petroleum
- Motiva
- Pennzoil-Quaker State
- RohMax
- Shell Global Solutions
- Toyota
- Valvoline

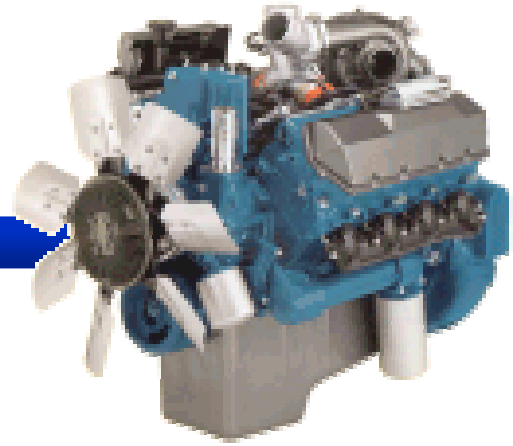
Test Laboratory

- Subcontractor: Automotive Testing Laboratories (East Liberty, OH)

- Principal Investigators:
  - Chris Tennant, Lisa Lanning
- Team members:
  - Michael Traver
  - Tom McDaniel
  - Brian Mace



Test Engine

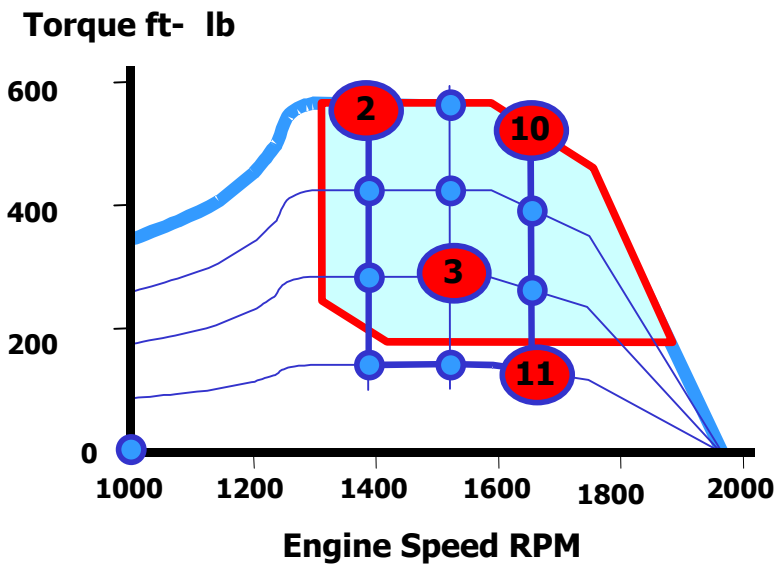


- 1999 International T444E
  - 7.3L OHV V-8
  - Direct injection, turbocharged w/ wastegate
  - 215 hp at 2400 rpm
  - 540 ft-lbs torque at 1500 rpm
  - Exhaust gas recirculation (retrofit)
  - Closed crankcase ventilation with filter
  - Lube system capacity: 18 quarts

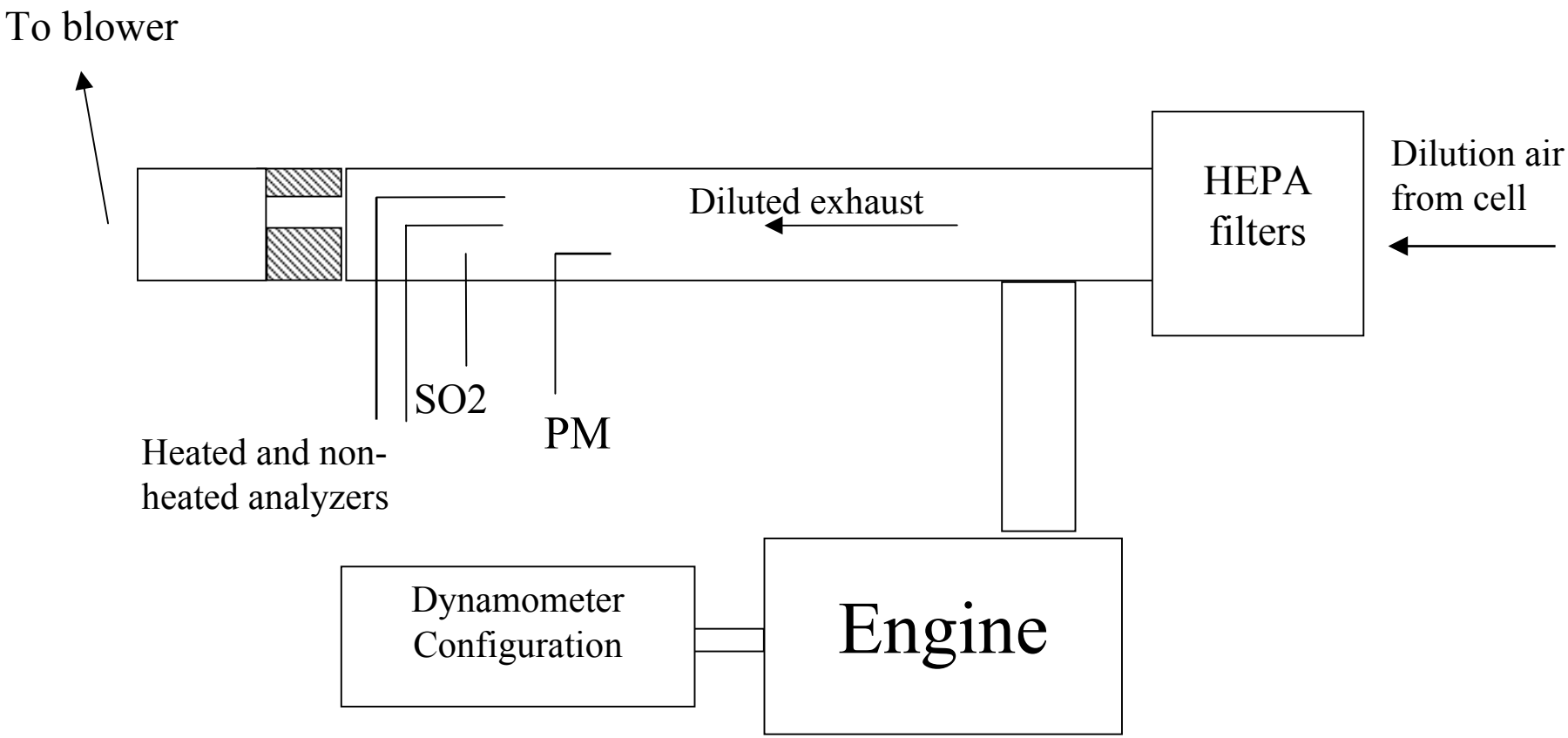
Emissions Measurements

- PM (three sample trains)
  - total weight
  - SOF and sulfate
  - metals
  - PAHs
- Four mode steady-state (OICA)

- NO_x
- SO_2
- Hydrocarbons
- CO



Test Cell Layout



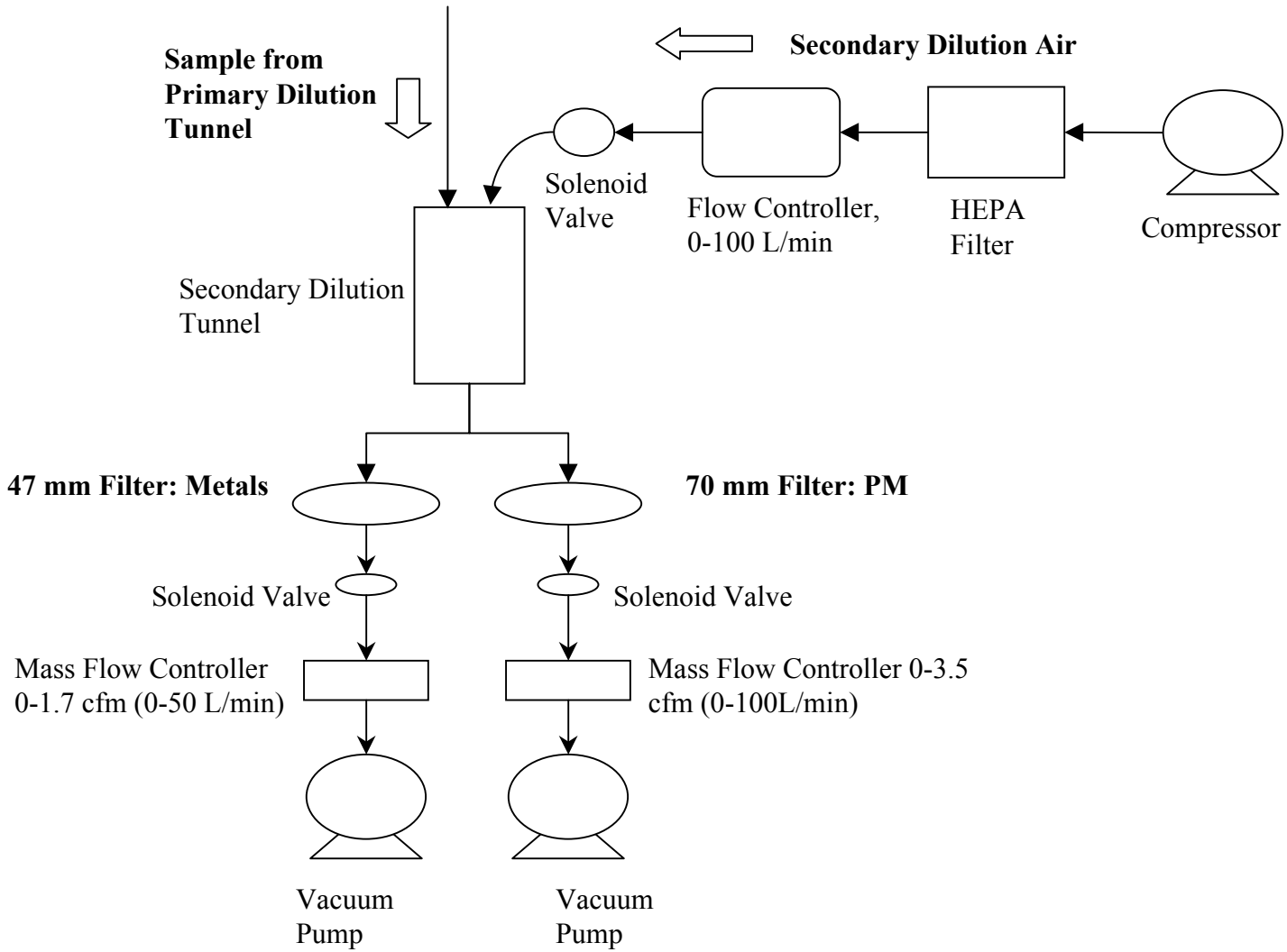
Particulate Matter Sample Collection

- Train #1: PM mass (ATL/ORNL)
  - 70 mm Pallflex 'Emfab' (glass fiber w/bonded PTFE)
  - analysis for sulfate and soluble organic fraction (ORNL)

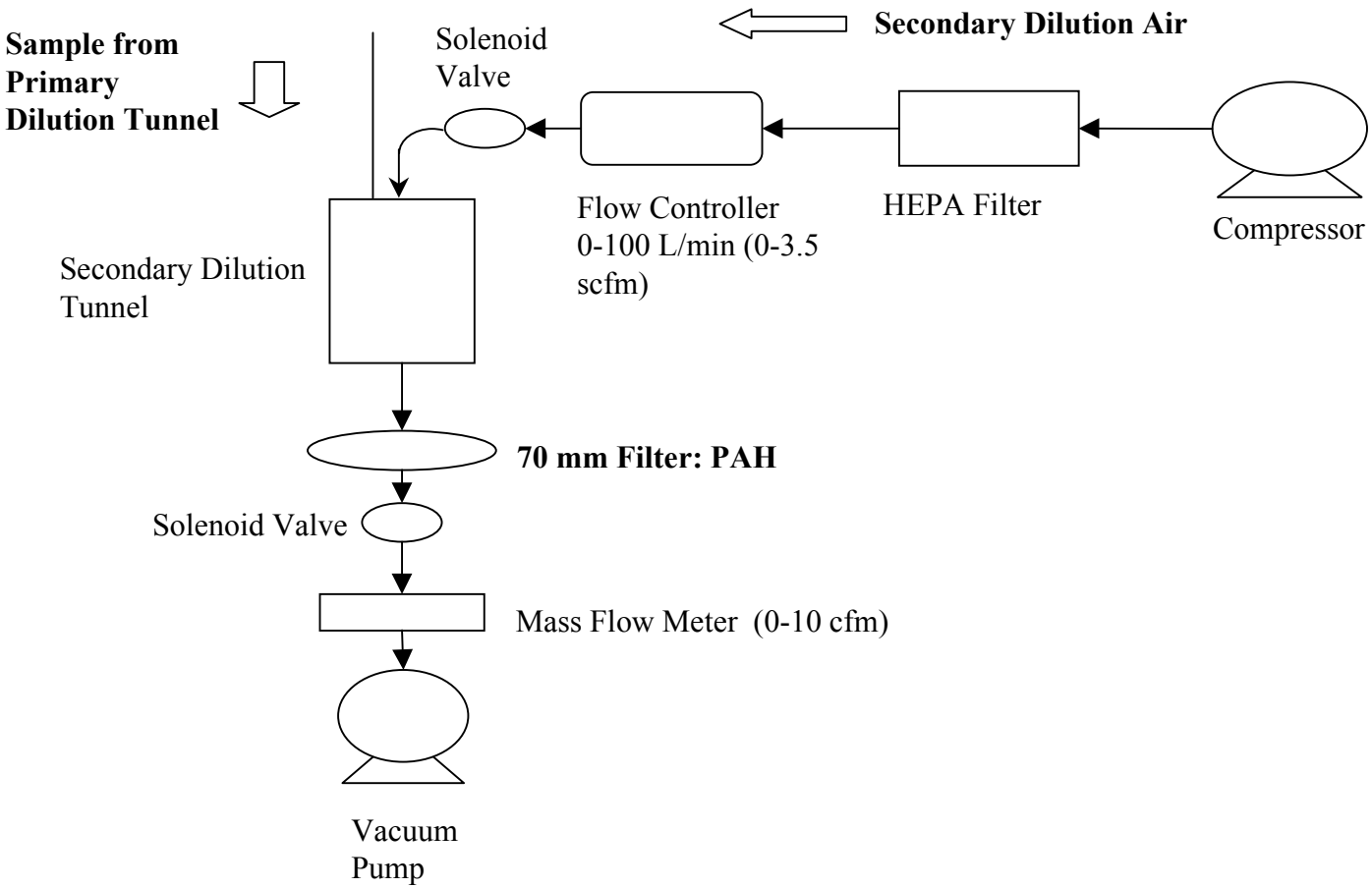
- Train #2: PM Metals
  - 47 mm Gelman 'Teflo' (PTFE w/ PMP support)
  - determined by x-ray fluorescence (DRI)

- Train #3: Poly-cyclic Aromatic Hydrocarbons (PAH)
  - 70 mm Pallflex 'Fiberfilm' (glass fiber w/bonded TFE)
  - Determined by GC-MS (SwRI)

Sample Train 1&2 Configuration



PM Sample Train 3 Configuration



SO_2 Analysis - Overview

- SO_2 measured via impingement in aqueous hydrogen peroxide (wet chemistry method)
  - SO_2 converted to SO_4
- Modeled after EPA methods 6, 8, 16
- Post-test quantification of SO_4 concentration using ion chromatograph yields SO2 emission rate (exhaust flow measured)

Additive Systems Selected

Element	a	b	c	d	e	f	g	h	i	j	k	l	r
Ash Level (%)	1.2	0	1.2	1.5	1.85	0.75	1.4407	1.4016	0.6	1.4	0.3	0.23	1.35
S	0	5	4950	4500	6590	2785	3246	2921	4226	2224	20	725	4454
Ca	3484	0	3950	800	4770	1820	3130	3130	1748	4128	870	415	3412
Zn	0	0	0	1900	1560	860	1319	865	0	0	0	225	1269
N	0	950	2000	1200	970	1286	1182	1137	0	1560	2235	1457	855
P	0	670	600	1700	1420	760	1201	788	0	0	0	587	1156
B	1099	0	0	300	150	60	1235	143	0	0	985	176	0
Cl	100	0	<100	200	0	126	0	0	100	18	0	60	80
Mo	0	0	0	0	170	0	0	284	0	0	0	0	0
Mg	0	0	<50	1700	0	0	277	277	0	0	0	0	0

Reference Oil Duplicate test

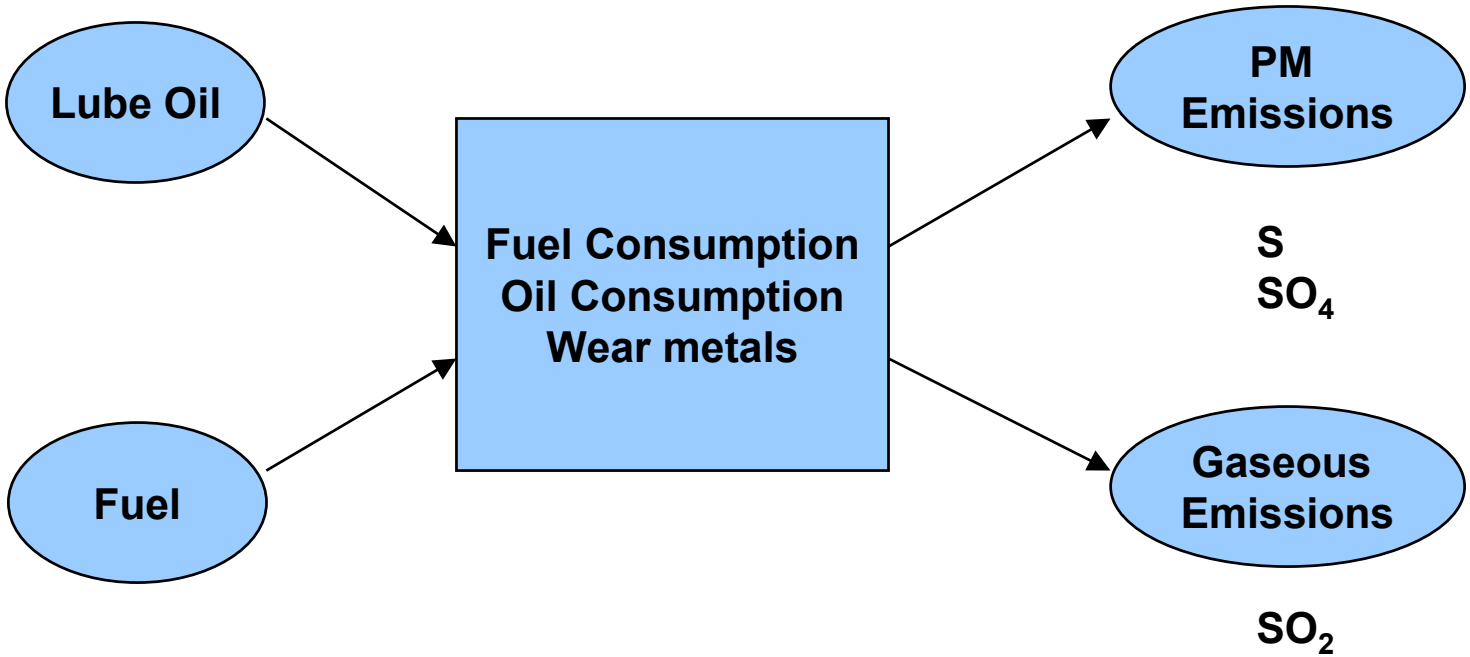
Additives supplied by:

Ciba, Chevron Oronite, Ethyl, Infineum, Lubrizol

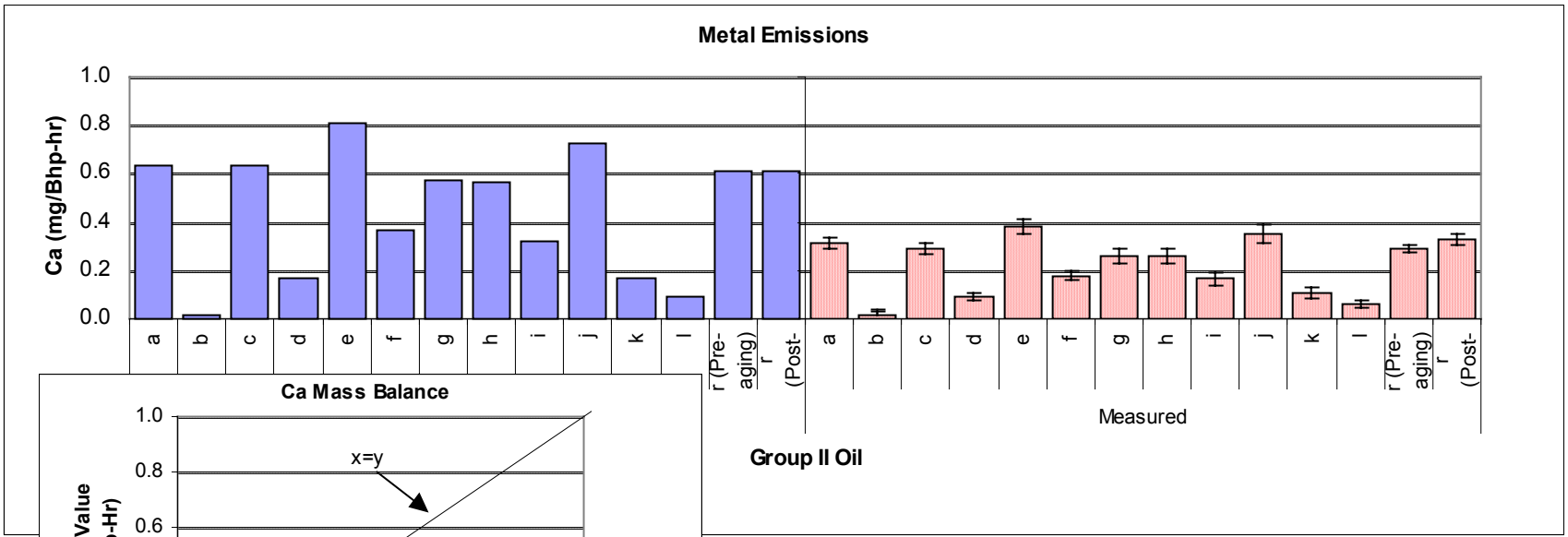
Base Oils Selected

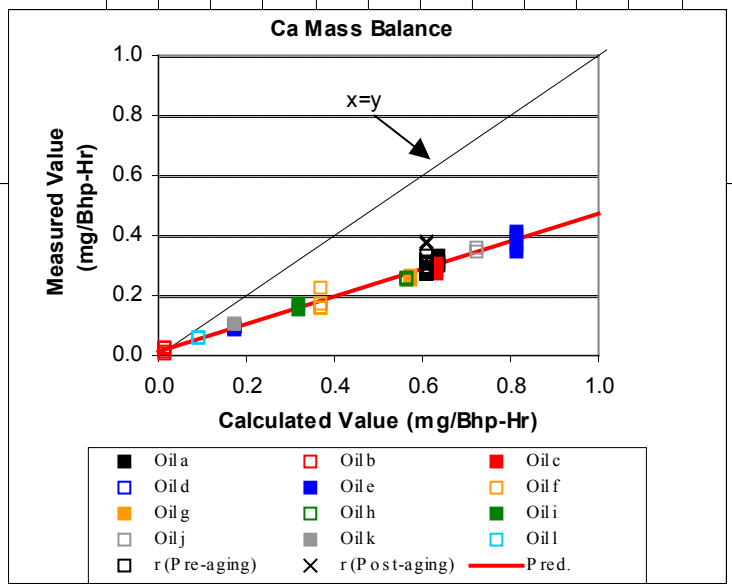
- Group I: Valero (Paulsboro)
  - 4800-5600-ppm S, 75% saturates
- Group II: Excel (Lake Charles)
  - <20-ppm S, >99% saturates
- Group III: Motiva (Houston)
  - <5-ppm S, >99% saturates
- Group IV: BP
  - PAO (poly-alpha olefin, synthetic)
  - 0 sulfur
  - 5% ester for additive solubility

Material Balance



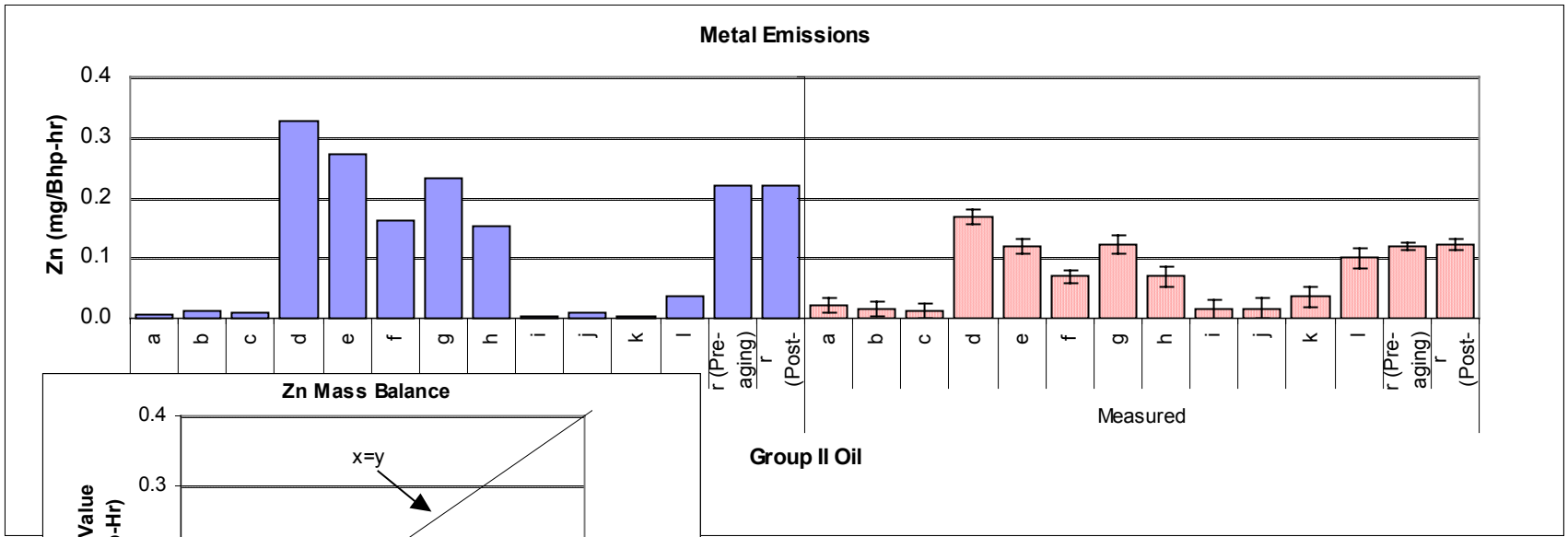
Ca in PM Emissions

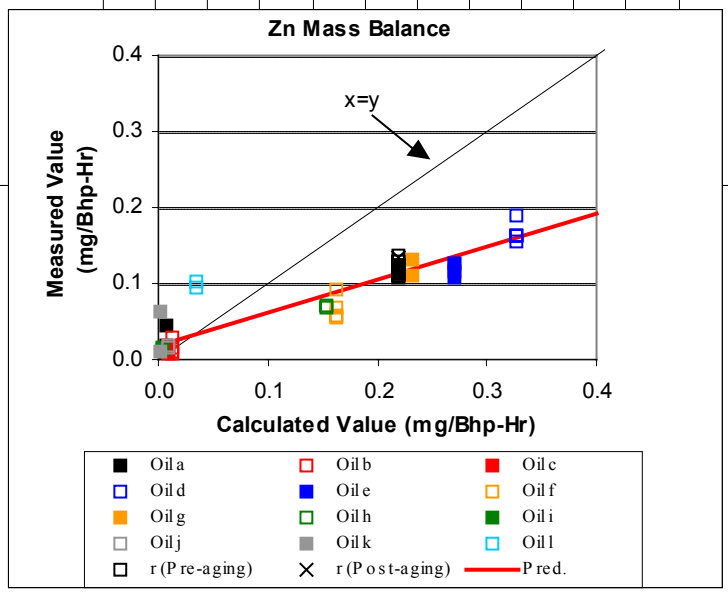




- Ca emissions directly correlated with concentration in oil
- No apparent composition effects
- 46% recovery rate

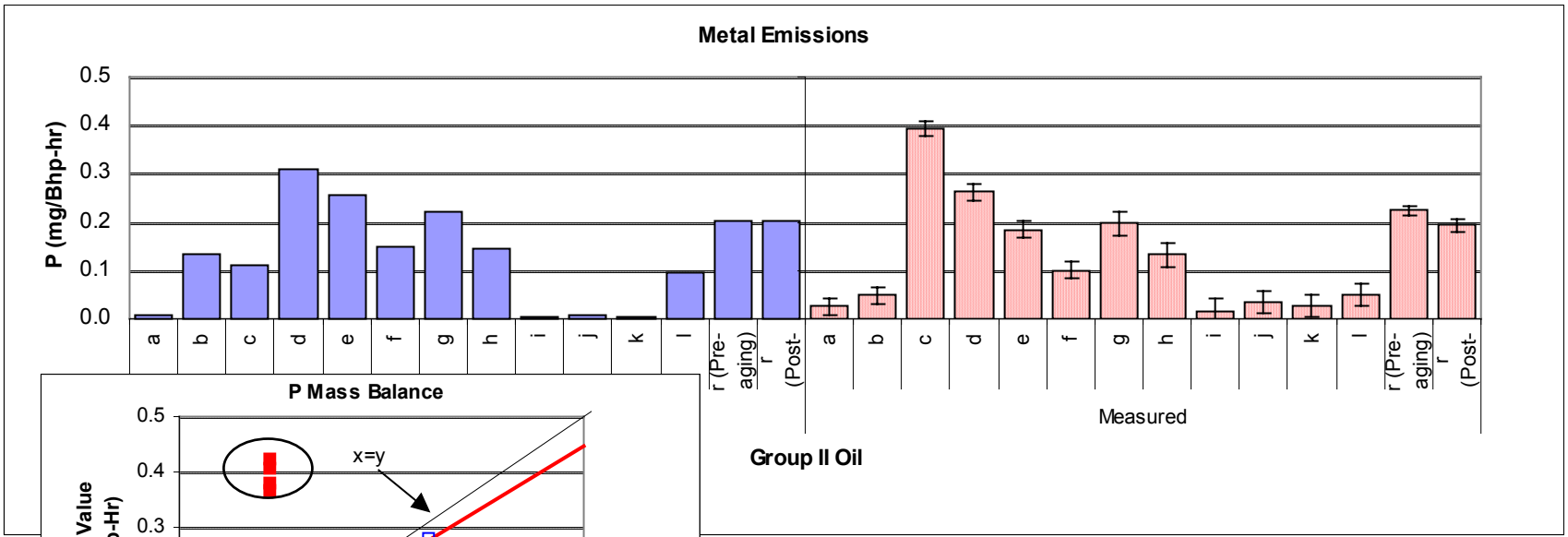
Zn in PM Emissions

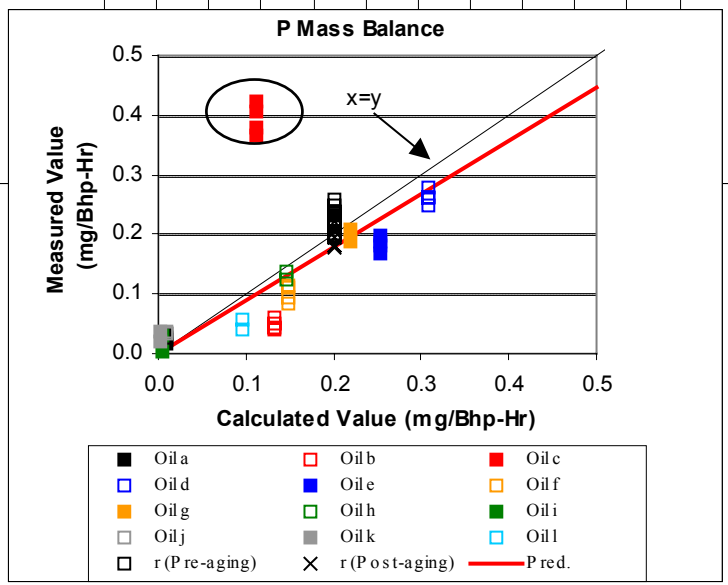




- Zn emissions directly correlated with concentration in oil
- Possible composition effects
- 43% recovery rate

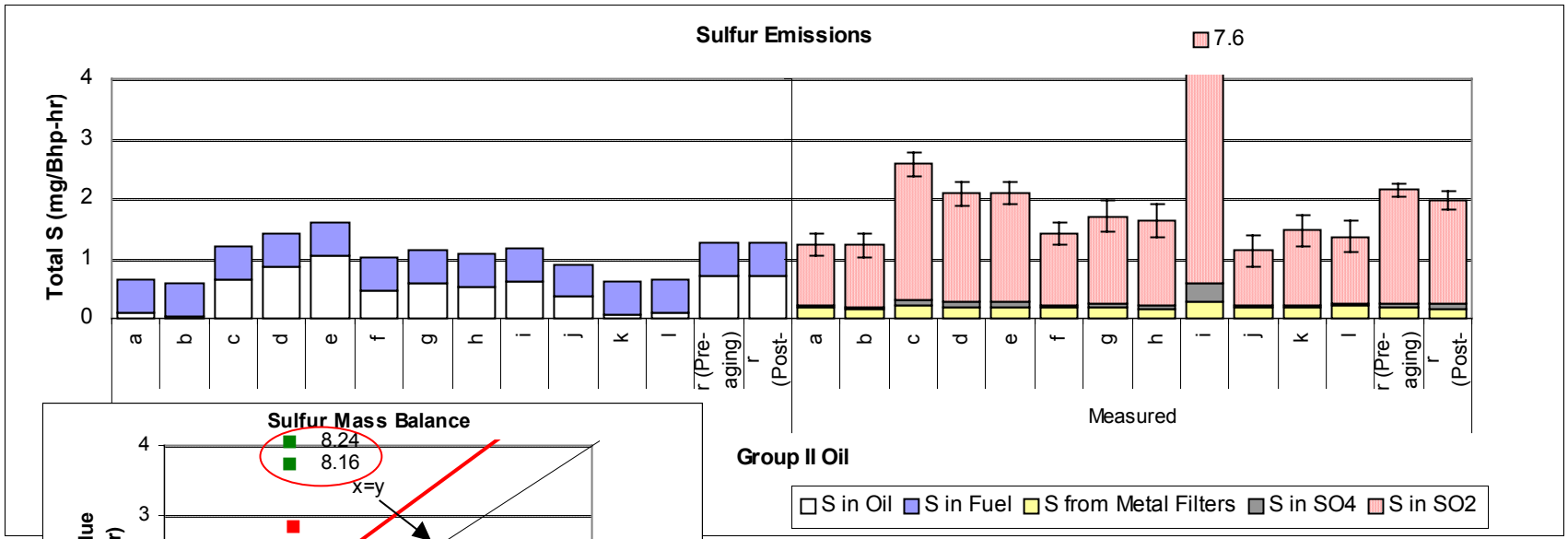
P in PM Emissions

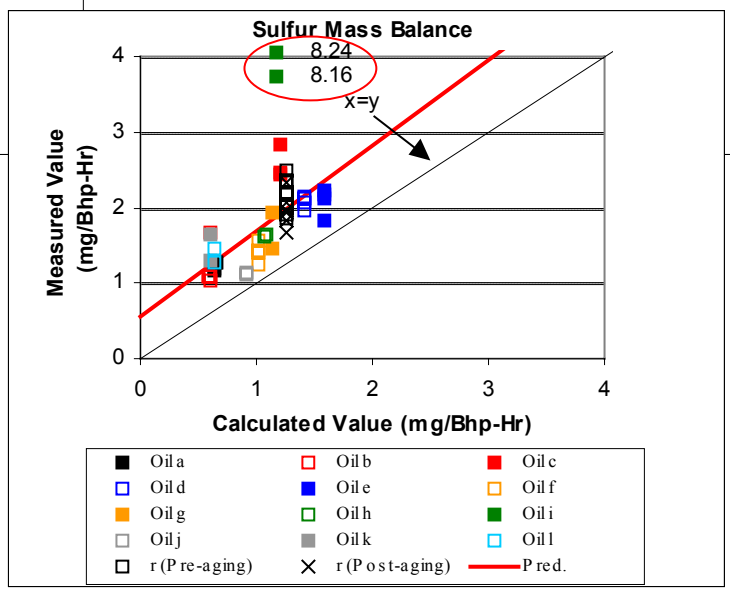




- P emissions directly correlated with concentration in oil
- Oil C significantly deviates
- 90% recovery rate (excl. Oil C)

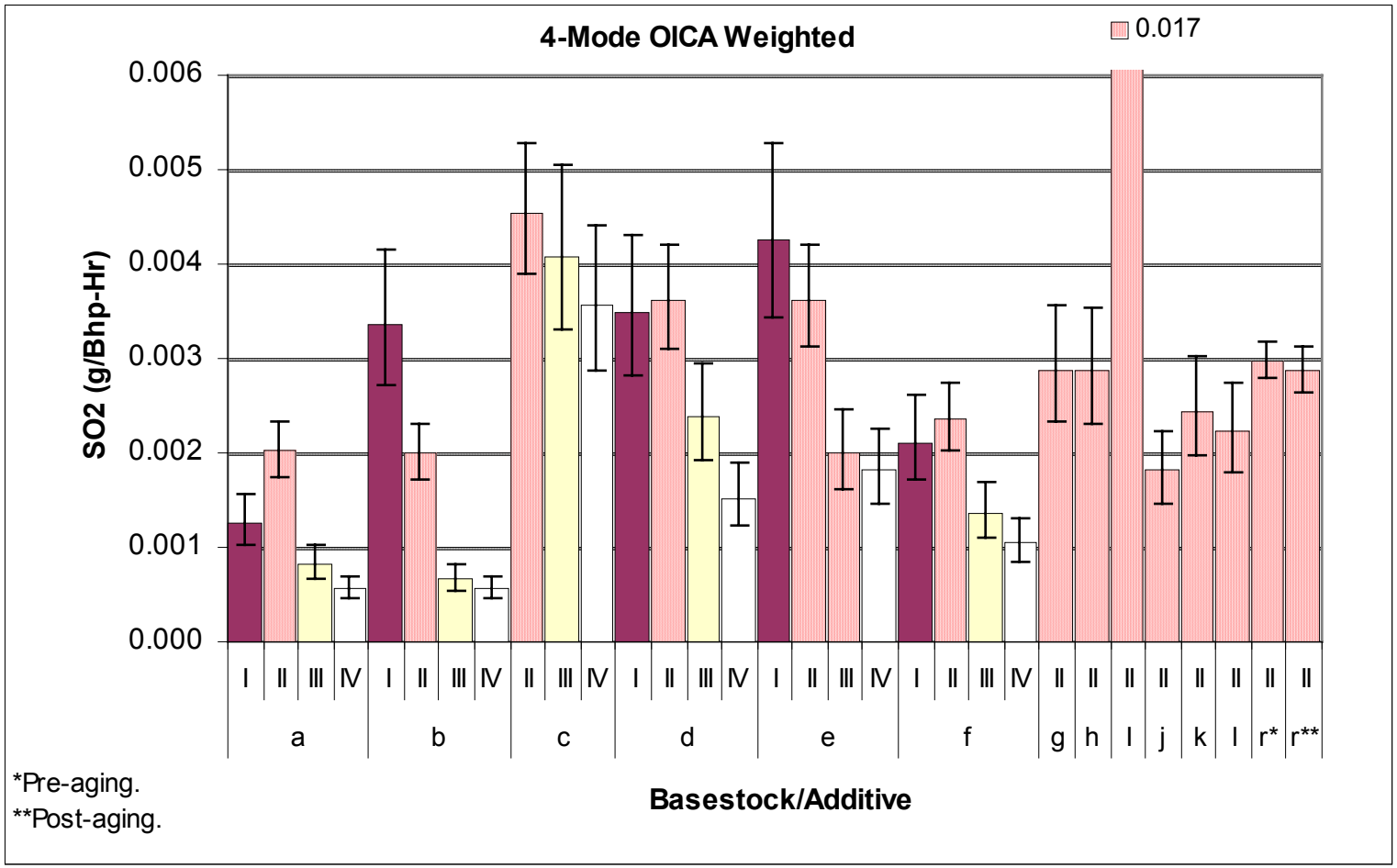
Sulfur in Emissions





- S emissions directly correlated with concentration in oil
- Oil l significantly deviates
- 113% recovery rate (excl. Oil l)
  – uncertainty in fuel S level

Base Oil and Additive Effects on SO_2 Emissions



Summary

- Preliminary results show the effects of oil composition on selected emissions, including metals and sulfur
- Results indicate that emissions from certain formulations deviate from those using more traditional chemistry
- Data from all additive/basestock combinations are currently being analyzed and will be reported in late summer.
- Phase II will focus on development of a rapid catalyst aging protocol to determine lubricant effects on durability

Acknowledgements

- Special thanks to:
  - Oil and additive suppliers
  - International Truck and Engine
  - APBF-DEC Lubricants Project Workgroup
  - U.S. Department of Energy (John Garbak and Steve Goguen)
  - Battelle (Hsing-Chuan Tsai and John Orban) for statistical analysis

  - **APBF-DEC Funding Partners**: ACC, API, CARB, DOE, EMA, MECA, SCAQMD

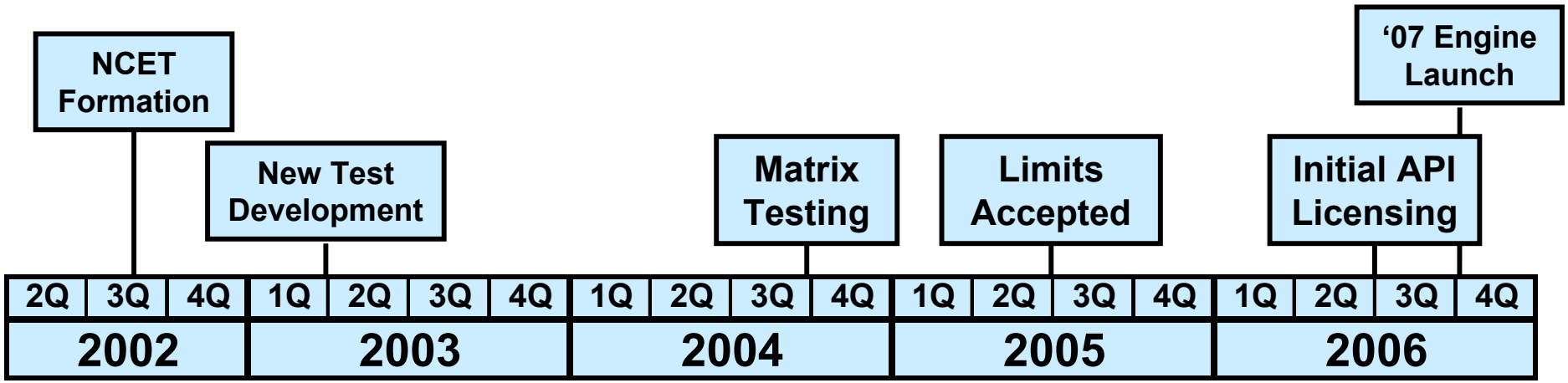
PC 10 Discussion

Introduction of Low Sulfur Fuel and PC 10 Oils
June 2006

Required Test to Industry June 2004 ?
Matrix Testing Start Jan. 2005
Finish Matrix Testing June 2005
Test Accepted by ASTM & ACC 6/2005
No B Ballot on Limits

Heavy-Duty Engine Oils

- **Projected Timeline for PC-10**



- **Category will be very challenging; development process needs to begin soon**

Active API HD Categories

Any Modifications Required or Desired?

Category	Application	Tests with Potential Issues	
CF	4-cycle IDI	1M-PC	(Severity Shift)
CF-2	2-cycle	1M-PC 6V-92TA	(Severity Shift) (Availability)
CF-4	4-cycle DI (1991)	Alternates in Place	
CG-4	4-cycle DI (1994)	Alternates in Place	
CH-4	4-cycle DI (1998)	Mack T-9 Cummins M11-HST Caterpillar 1P	(Economic Viability) (Economic Viability) (Economic Viability)
CI-4 (9/02)	4-cycle DI w/EGR	None	

LUBRIZOL

Fluid technologies for a better world™

Heavy Duty Engine Oil Classification Panel

Queen Elizabeth Hotel

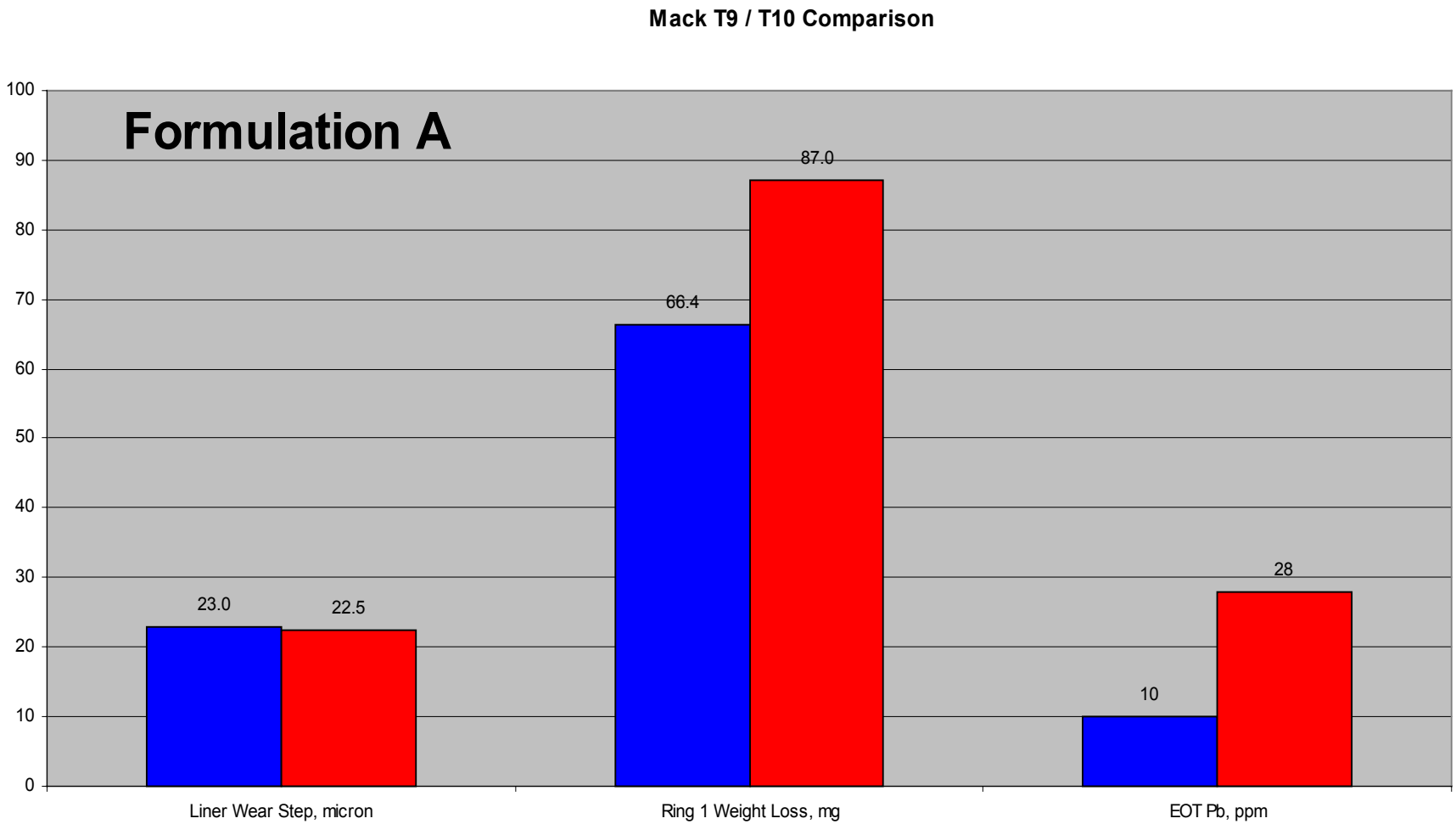
Montreal

June 18, 2002

CH-4 Performance

Based on CI-4 Tests

EGR Backward Compatibility



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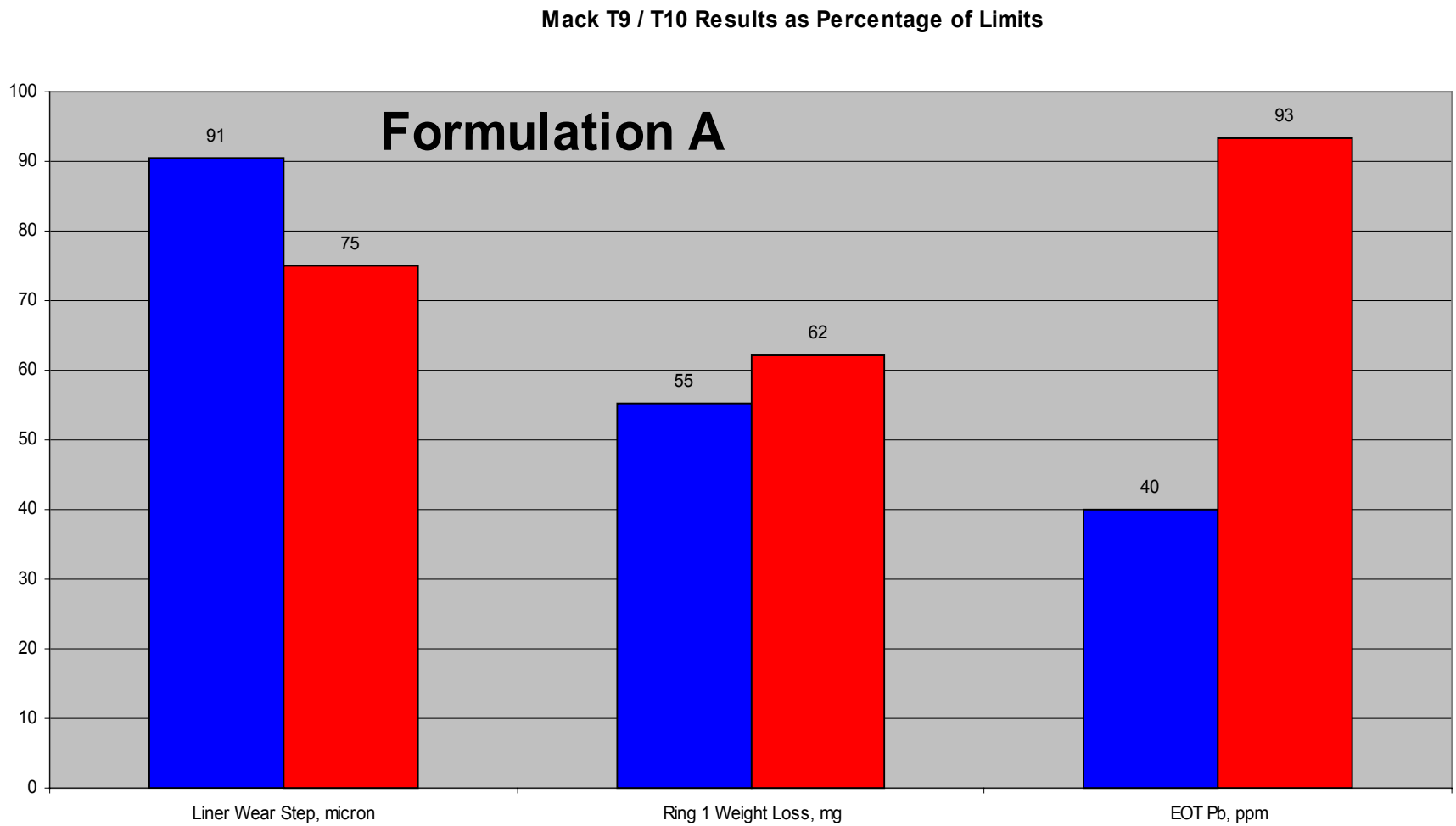
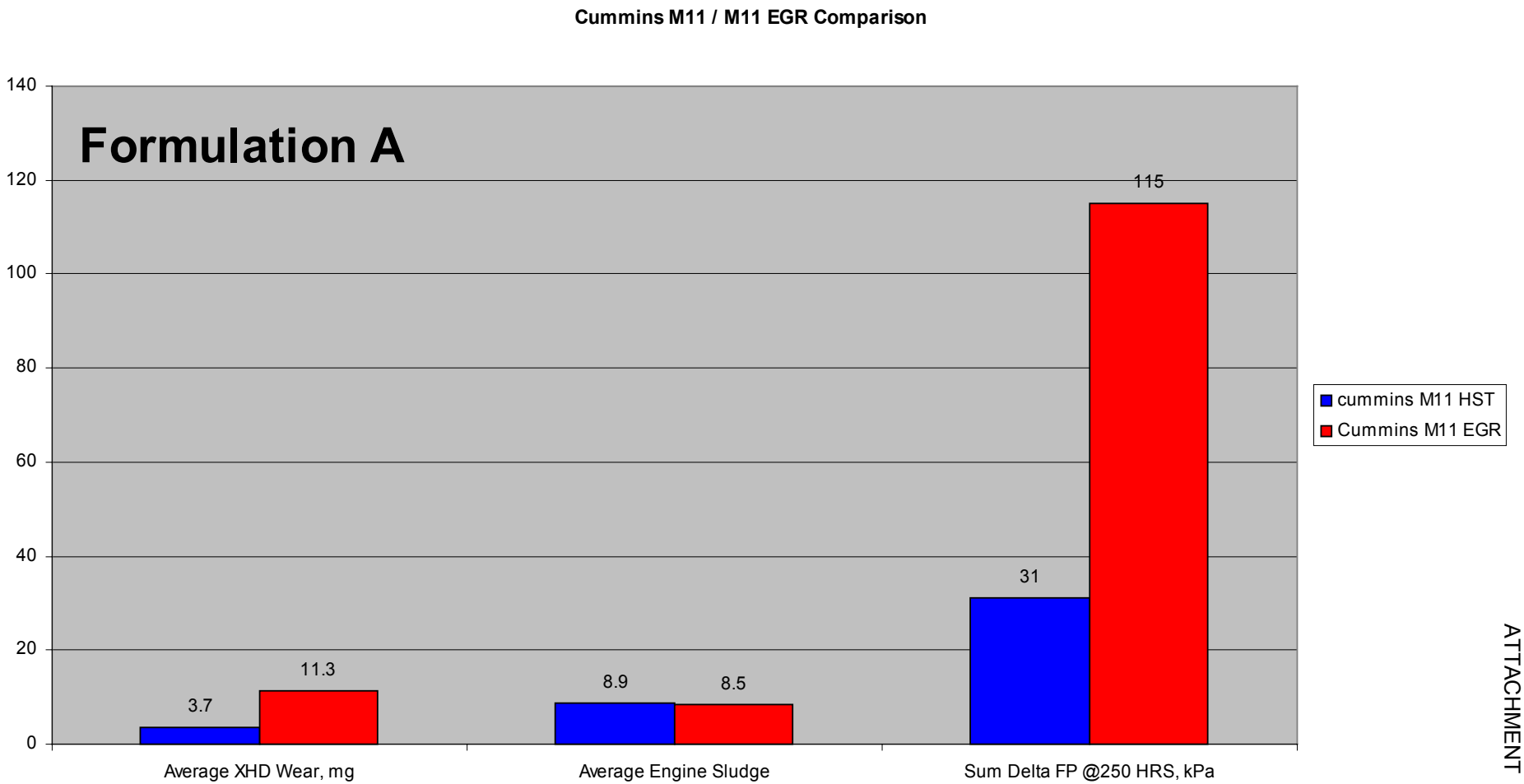
EGR Backward Compatibility

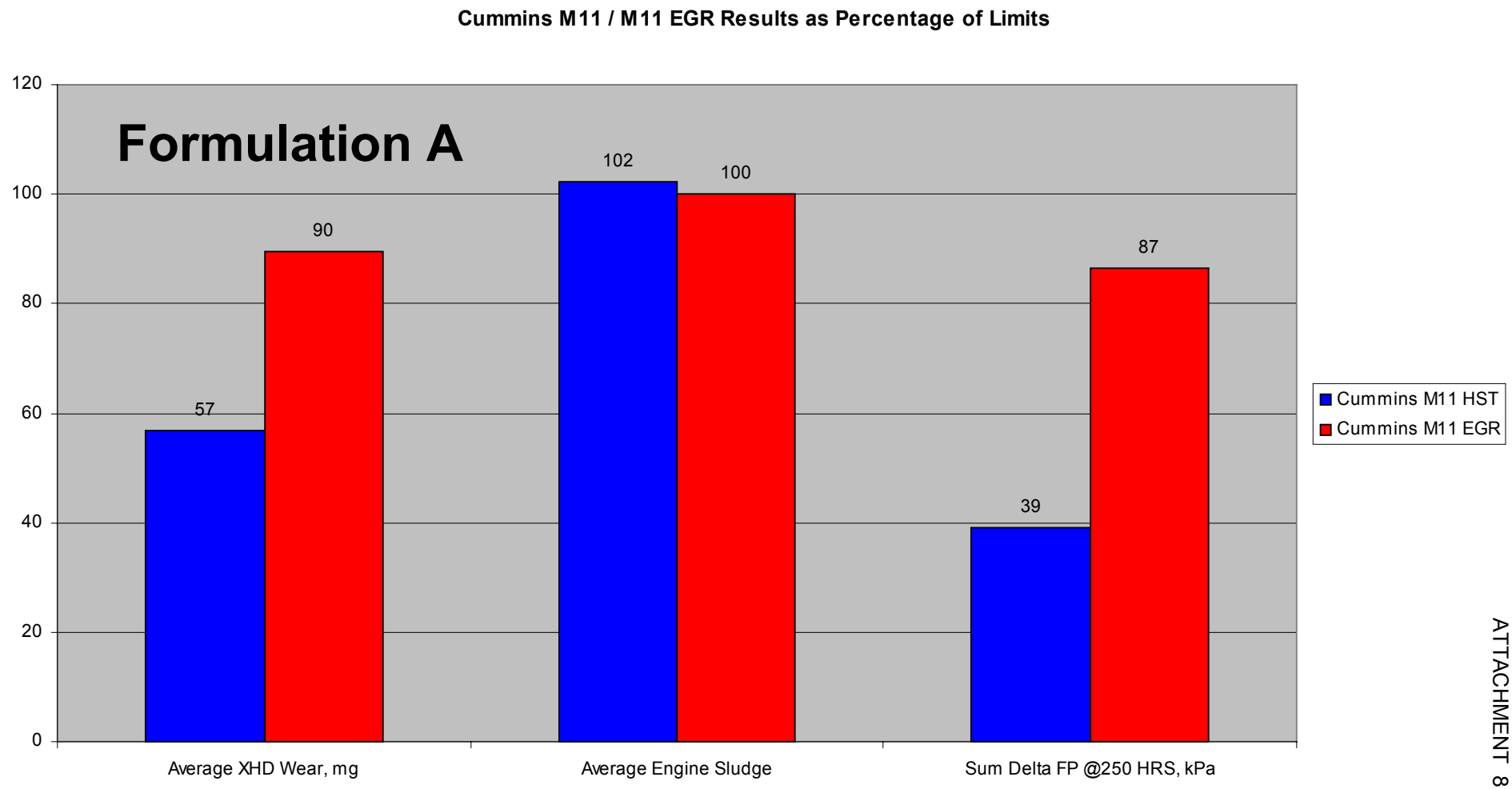


LUBRIZOL

EGR Backward Compatibility



EGR Backward Compatibility



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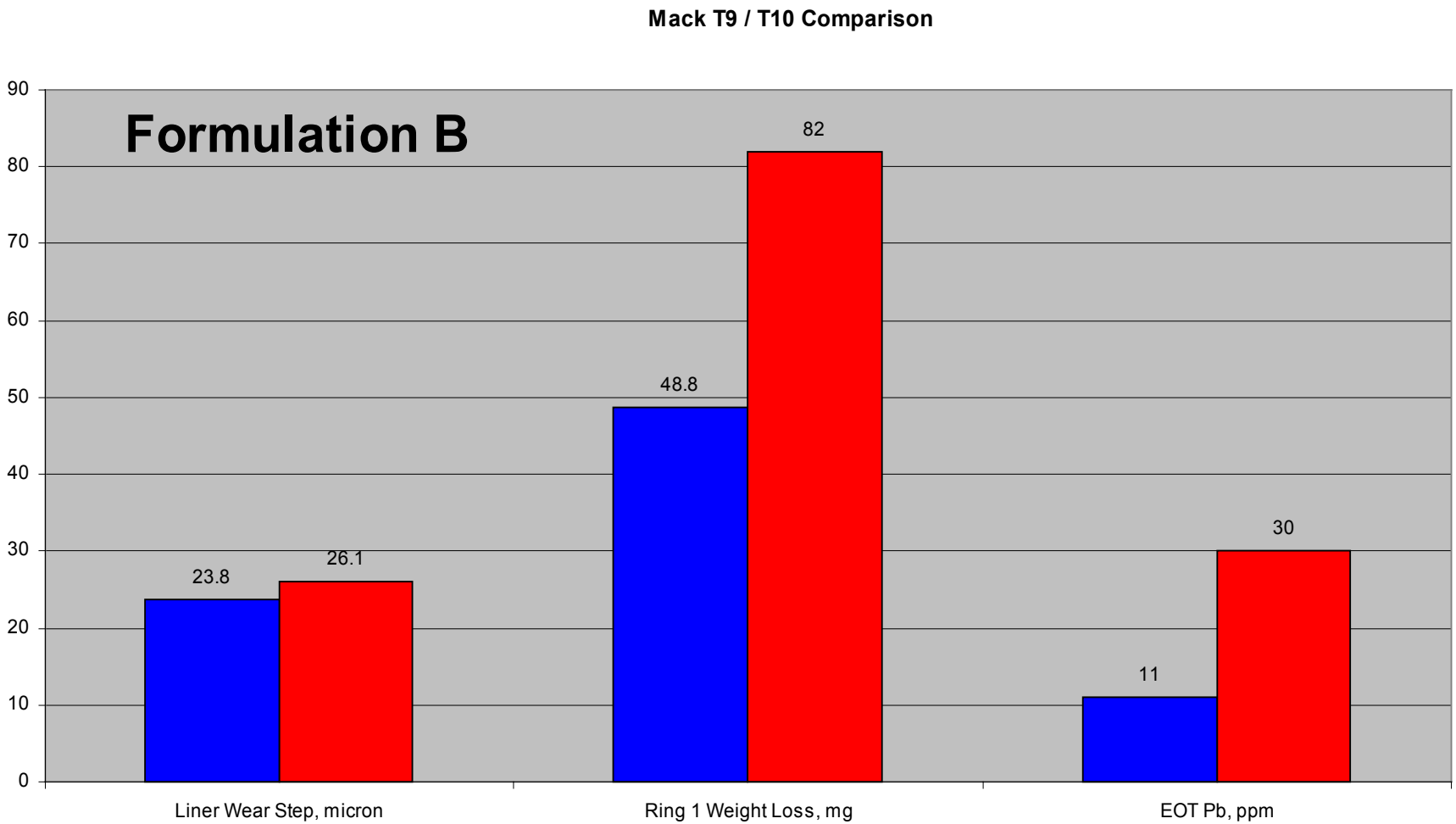
EGR Backward Compatibility



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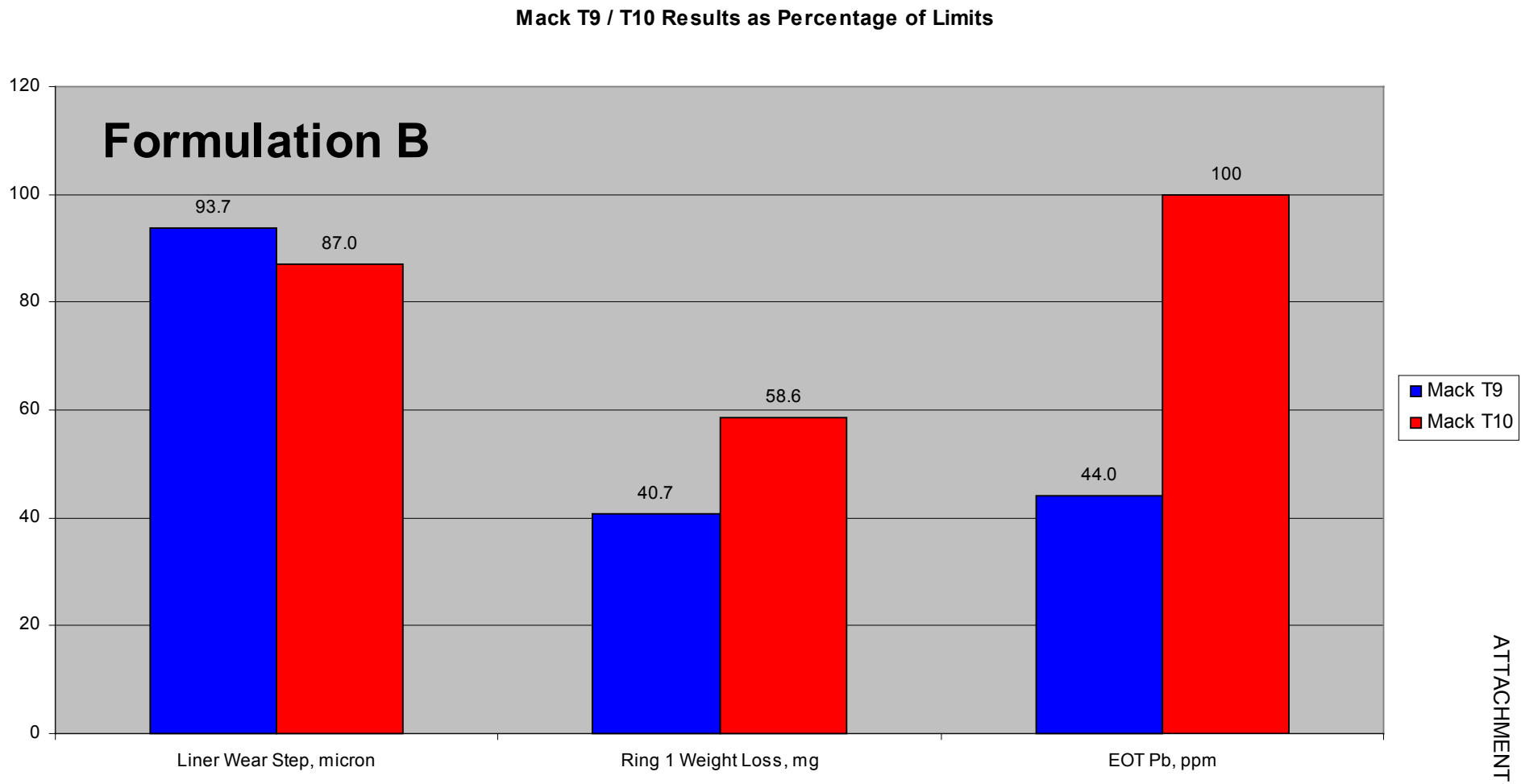
EGR Backward Compatibility



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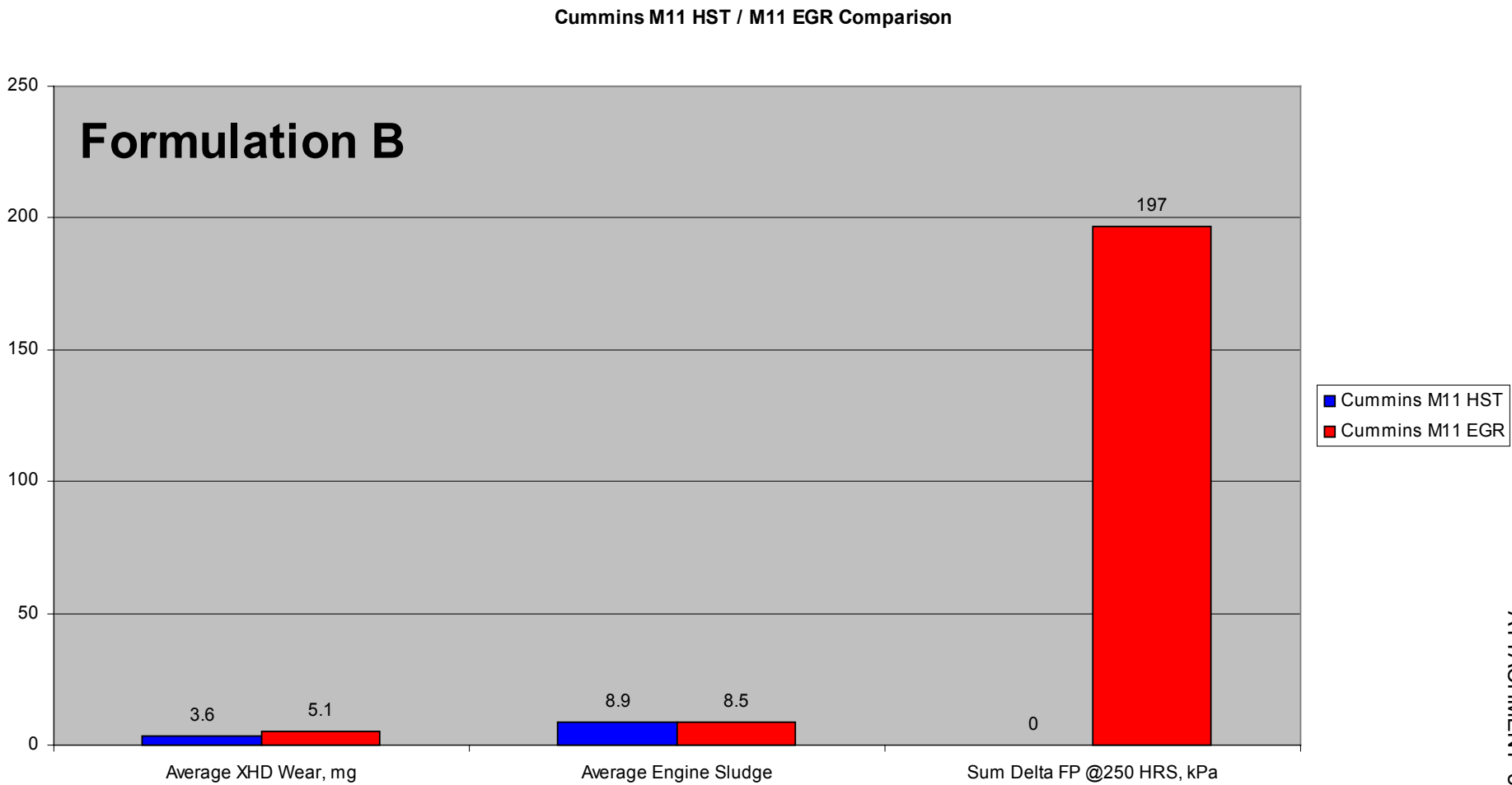
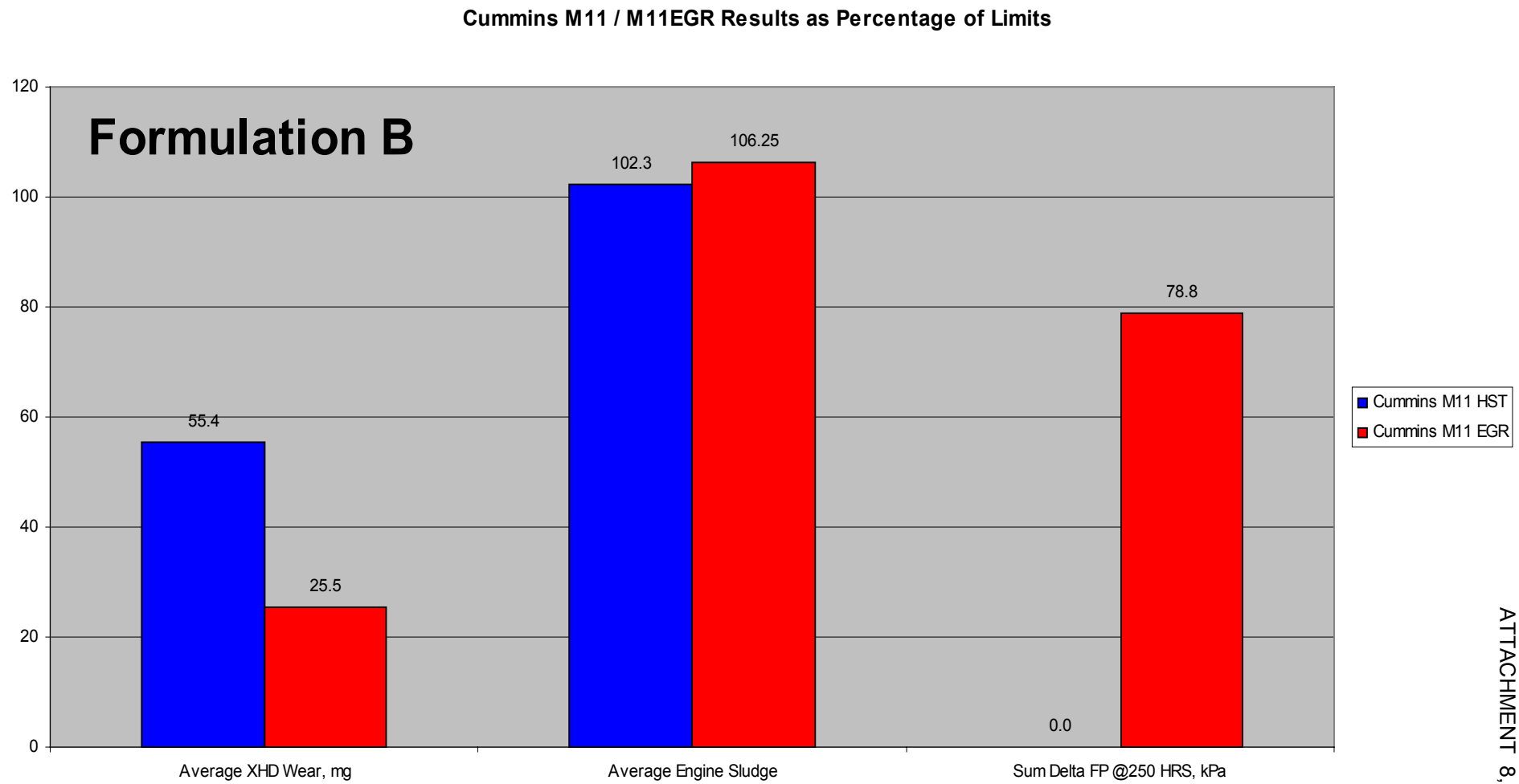


EGR Backward Compatibility



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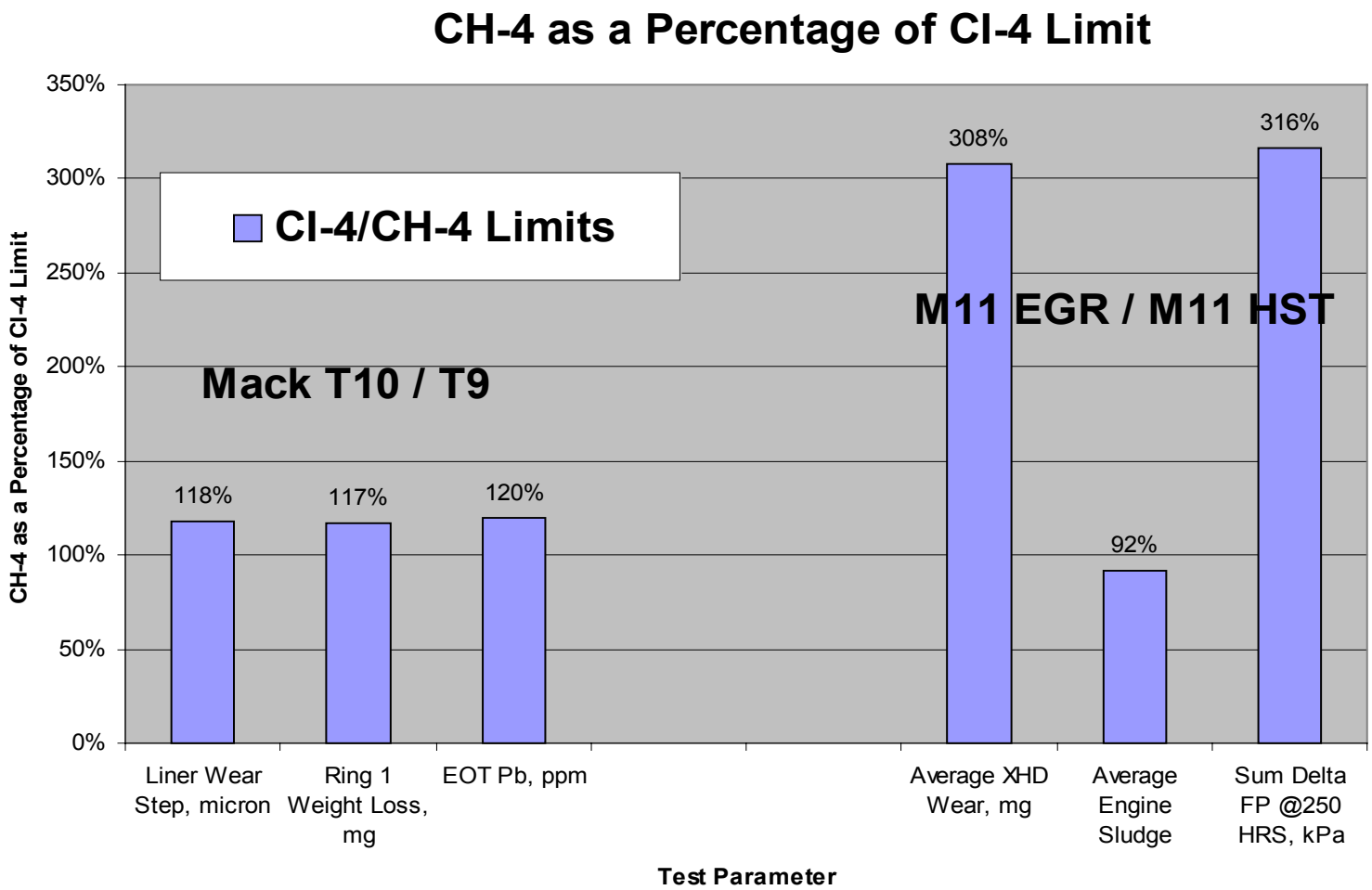
EGR Backward Compatibility



EGR Backward Compatibility

- Performance observed in the new EGR tests is more severe than their non-EGR predecessors
- Lubrizol offers the following for consideration
  - "The Mack T-10 and Cummins M11-EGR tests may be used to qualify oils for API CH-4 using relaxed limits that recognize the increased severity of CI-4 tests compared to the T-9 and M11 HST tests used to define CH-4.

CH-4 Limits proposal follows: