HEAVY-DUTY ENGINE OIL CLASSIFICATION PANEL
OF
ASTM D02.B0.02
February 22, 2001
Holiday Inn – O'Hare International Hotel, Rosemont, IL

ACTION ITEMS

1.	**Resolve concerns with the 1Q test.**	**1Q Task Force**
2.	**Look at 1Q matrix redesign with different featured oil.**	**Matrix Design TF**
3.	**Confirm M-11 EGR rocker lever hardness readings.**	**TEI**
4.	**Decide on source of oil samples and test type for low temp. pumpability evaluation of highly sooted used oil.**	**HDEOCP**
5.	**3F for 3E in existing "C" categories.**	**3F/3E Task Force**
6.	**One gallon samples of all EOT matrix oils to Chris May.**	**Matrix Labs**
7.	**Save sufficient 75 hr T-10 & 250 hr M-11 EGR oil sample for MRV evaluations.**	**Matrix Labs**

MEETING MINUTES

1.0 Call to Order

1.1 Chairman Jim McGeehan called the meeting to order at 8:59 a.m. on February 22, 2001, in the Kitty Hawk room of the Holiday Inn – O'Hare International Hotel in Rosemont, IL. There were 12 members or representatives and approximately 18 guests present. The attendance list is shown as Attachment 2.

2.0 Agenda

2.1 The previously announced agenda for the meeting (Attachment 1) was reviewed and agreed to as distributed.

3.0 Meeting Minutes

3.1 The minutes from the December 5, 2000, meeting in Nashville were approved as posted on the TMC website.

4.0 Membership

4.1 Dwayne Tharp of Caterpillar will replace Mike Quinn and Dave Stehouwer of Cummins will replace Shawn Whitacre as members of the panel.

5.0 Mack T-10 Update

5.1 Greg Shank reported on T-10 matrix activities (Attachment 3) and indicated the Task Force had reviewed the data available from featured oil "A" and voted to continue the matrix. They are now estimating a mid-June completion date.

5.2 Jim McGeehan presented a graphical review of T-10 matrix results to date (Attachment 4).

6.0 Cummins M-11 EGR Update

6.1 Dave Stehouwer reported the M-11 EGR Task Force had reviewed available data on featured oil "E" and decided to continue the matrix (Attachment 5). They did make some changes before continuing, which may / may not effect the severity of the test. The rocker levers will now be screened for appropriate hardness of the crosshead wear pad and new cylinder blocks with beefier main bearing caps will be used to help reduce fretting between the caps and the block. They estimate matrix completion by mid-May.

6.2 Jim Wells expressed concern that it seemed highly unlikely that the wear pads in one set of rocker levers would all be in spec. on hardness when those in the other three sets varied widely – especially since the wear pads were probably all heat treated together before being assembled into the rocker levers. TEI will conduct further investigations into the hardness measurements of the assembled pads.

6.3 Jim McGeehan presented a graphical review of M-11 EGR results to date (Attachment 6).

7.0 CAT 1Q Update

7.1 Dave Nycz reported for the 1Q Task Force (Attachment 7) and indicated the 1Q matrix work was on hold until at least March 12, 2001, due to erratic results with oil "J". Four tests out of eight on that oil had aborted

with high oil consumption or scuffing. If investigation of the hardware and operating conditions does not reveal any discrepancies, CAT seems to be leaning toward declaring oil "J" to have inadequate deposit control. They may then ask that the matrix be redesigned with a different "featured" oil and possibly fewer total tests.

7.2 There was sentiment expressed that the Matrix Design Task Force needs to be involved if the 1Q matrix is redesigned and the criteria and data for selecting another "featured" oil should be made public.

7.3 Chairman McGeehan emphasized that the HDEOCP should agree with whatever changes are proposed by the Task Force, before the 1Q matrix continues.

8.0 Matrix Completion Timing

8.1 Greg Shank raised the question of what impact does the current situation have on completion of PC-9 matrix activities and potential API licensing date.

8.2 John Zalar presented (Attachment 8) a timeline showing the 1Q starting again on March 6 and licensing allowed by November, 2002.

9.0 Oxidation

9.1 Joe Franklin reported on the Integrated IR Task Force progress (Attachment 9). They have selected two integrated area under the curve methods to use for evaluating matrix oils.

9.2 Greg Shank presented data on two CH-4 "plus" oils run in extended length Sequence III F tests and asked that use of the III F test be kept in mind for PC-9 oxidation protection, just in case (Attachment 10).

9.3 Jim McGeehan reviewed the PC-9 oxidation protection scene (Attachment 11) and proposes that the Seq. III F test be used for bulk oil oxidation instead of integrated IR from the T-10. He plans to pursue this proposal at the next meeting with reinforcements.

10.0 Low Temperature Pumpability

10.1 Steve Kennedy presented the LOTRUO report for Chris May (Attachment 12) and asked that all the matrix labs be reminded to send their EOT one gallon samples to Chris.

10.2 Jim McGeehan put the T-10 and M-11 EGR soot accumulation slides back up and drew attention to the tight grouping at 75 hours for the T-10. Steve

Kennedy recommended using the 75 hr T-10 samples for evaluating used oil pumpability. Greg Shank felt both the 75 hr T-10 and the 250 hr M-11 EGR samples should be evaluated during the matrix. Thus, all matrix labs should try to retain enough of those two oil samples to allow MRV's to be run.

11.0 Elastomers

11.1 Charlie Passut presented the Elastomer Task Force report for Tom Boschert (Attachment 13).

12.0 Other PC-9 Tests

12.1 Greg Shank presented the EMA position for other tests to be included in PC-9. They seek no change in the CH-4 limits for the RFWT, the EOAT, the CBT and Shear and they would keep 1N limits at CG-4 levels. They seek volatility limits of 15% by Noack for all viscosity grades and a 3.3 cP minimum HTHS for Xw-30 vis. grade oils. For the T-8E, soot levels / windows would remain the same as for CH-4, but they are still evaluating kinematic versus MRV for viscosity measurement, along with possible limit changes.

13.0 Replacement Tests

13.1 Jim McGeehan reported for the Seq. III E / III F and L-38 / Seq. VIII Task Force. The group has not generated a position on the III E / III F yet – waiting on a couple more pieces of data.

13.2 They did make a recommendation with regard to using the Sequence VIII as an alternative to the L-38 for older active "C" categories (Attachment 14). Pat Fetterman moved to accept the recommendation and Ralph Cherrillo seconded the motion, which passed with 11 for, 0 against and 0 abstain. It will be incorporated in the next ballot for revision to D-4485.

14.0 Next Meeting

14.1 After much discussion, the next meeting will be held at the call of the chairman…probably on March 15th in Chicago or March 29th in Baltimore.

15.0 Adjournment

15.1 The meeting was adjourned at 12:16 p.m..

Submitted by:

Jim Wells
Secretary to the HDEOCP

ATTACHMENT 1

ASTM-HDEOCP

Holiday Inn O'Hare International, Rosemont
Phone#847-671-6350 (room rate $119.0)

February 22 2001
9:00 am-1:00 pm

Chairman/ Secretary: **Jim Mc Geehan/Jim Wells**

Purpose: **PC-9**

Desired Outcomes: **Feature oil performance in EGR tests**
Approvals for second oil

TOPIC	PROCESS	WHO	TIME
Agenda Review	• Desired Outcomes & Agenda	Group	9:00-9:05
Minutes Approval	• January 30th 2001	Group	9:05-9:10
Membership	• Changes	Group	9:10-9:15
Mack T-10	• Five tests on "Feature Oil" • Timing of matrix completion	Greg Shank	9:15-9:30
Cummins M11 EGR	• Five tests on "Feature Oil" • Timing of matrix completion	Dave Stehouwer	9:30-10:00
Caterpillar 1Q	• Five tests on "Feature Oil" • Resolution of high oil consumption • Discussion on timing	Dave Nycz Group	10:00-10:45
Oxidation	• Mack T-10 Integrated IR • EMA's back-up position: IIIF	Joe Franklin Greg Shank	10:45-11:15
Low Temp Pumpability	• Status of round-robin testing in Mack T-8E; Mack T-10 & Cummins M11 EGR	Chris May	11:15-11:45
Elastomers	• Status of Program	Tom Boschert	11:45-12:00
Other PC-9	Limits for all the other PC-9 tests in API CH-9	Greg Shank/Dan Larkin	12:00-12:30
IIIF/IIIE & L-38/VIII	Status of proposed limits and tests	Jim Mc Geehan	12:30-1:00

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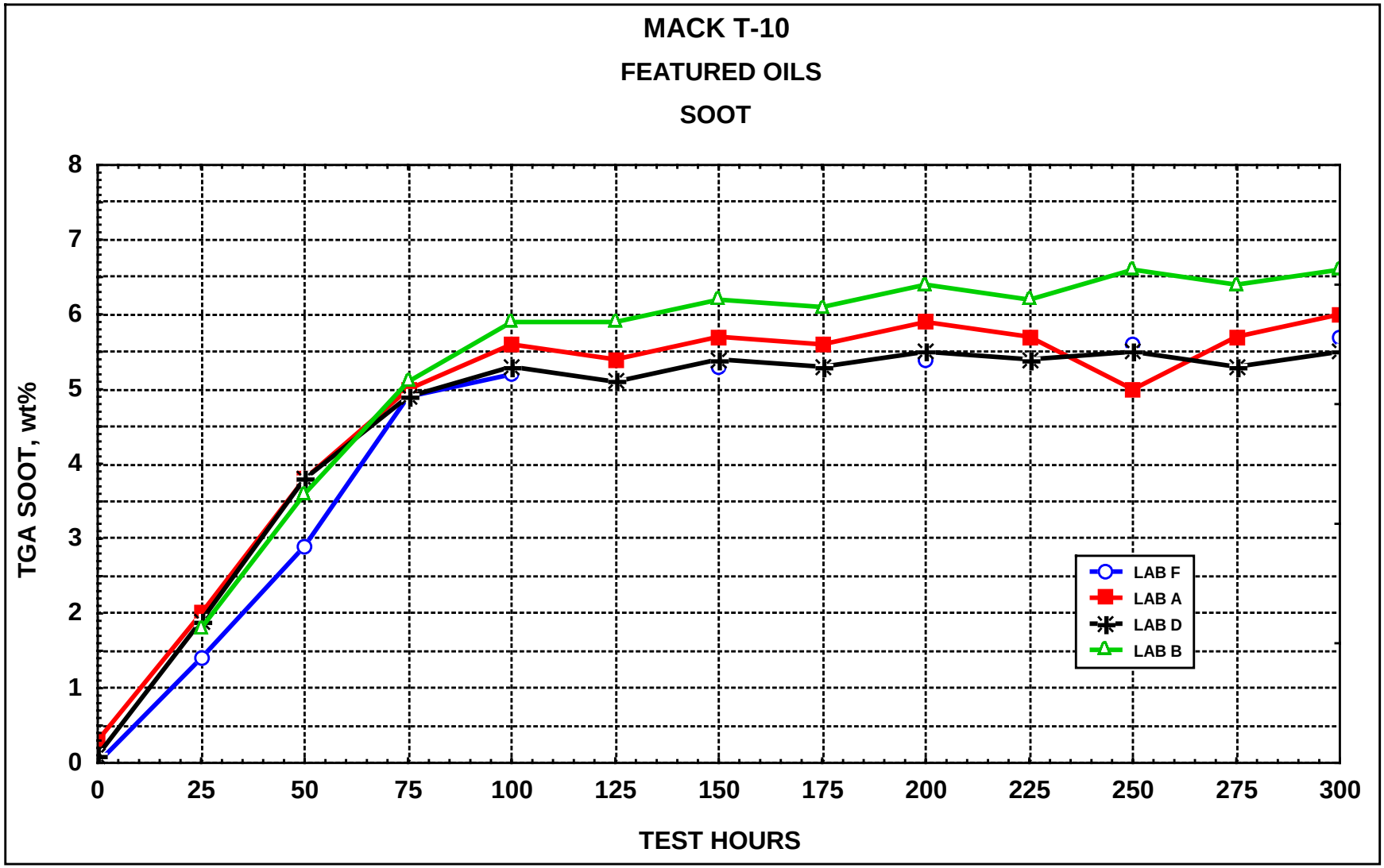
Mack T10 Test Matrix Update

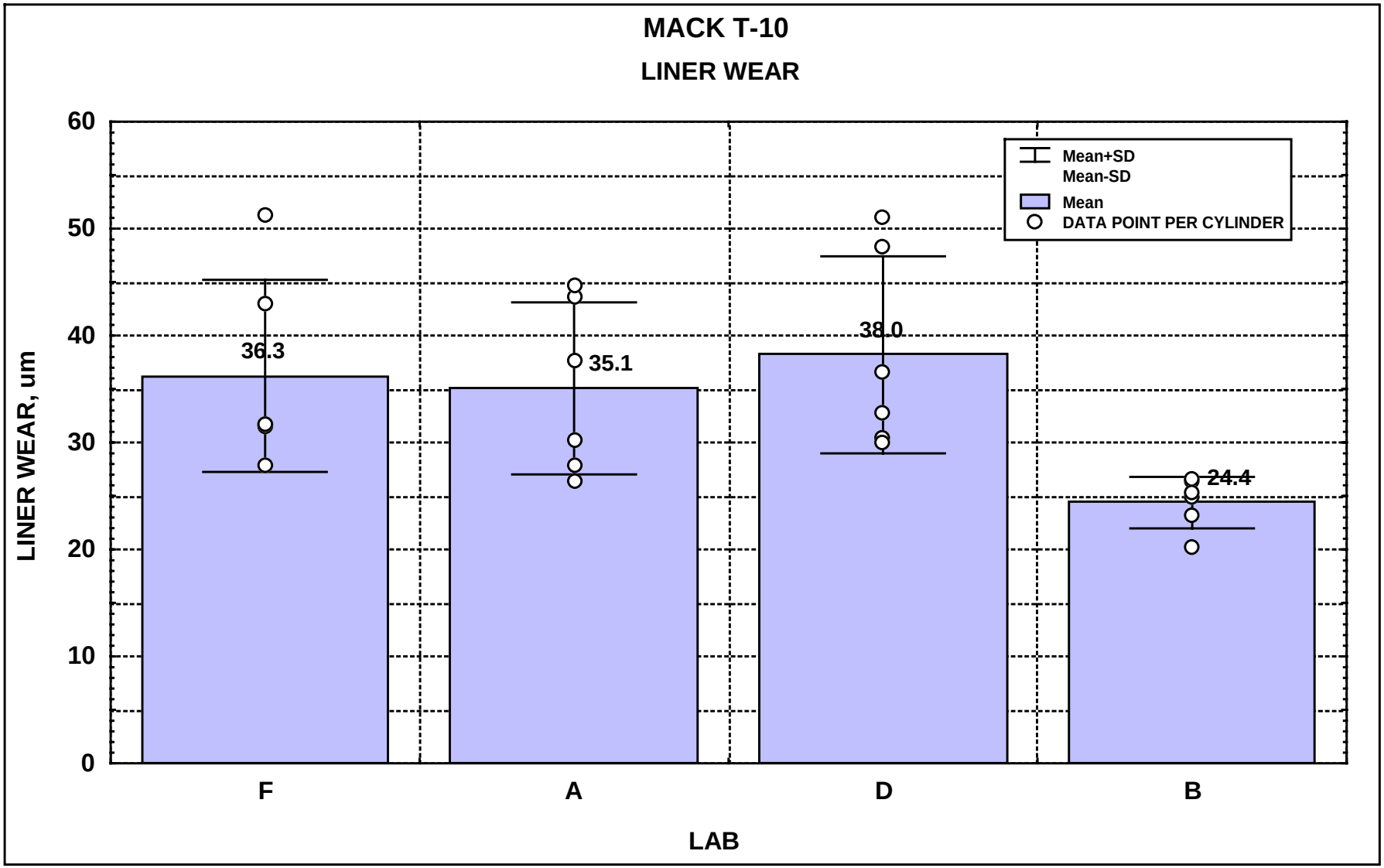
- **5 Labs - 7 Stands**
- **Oil A: 4 Test Finished / 2 Running / 1 To Start wk 2-19**
- **Task Force Reviewed Data(2/12) - Decided to Start 2nd Oil**
- **2nd Oil : 2 Test Started / 2 To Start wk 2-19**
- **Estimated Earliest T10 Matrix Completion Date June 15**

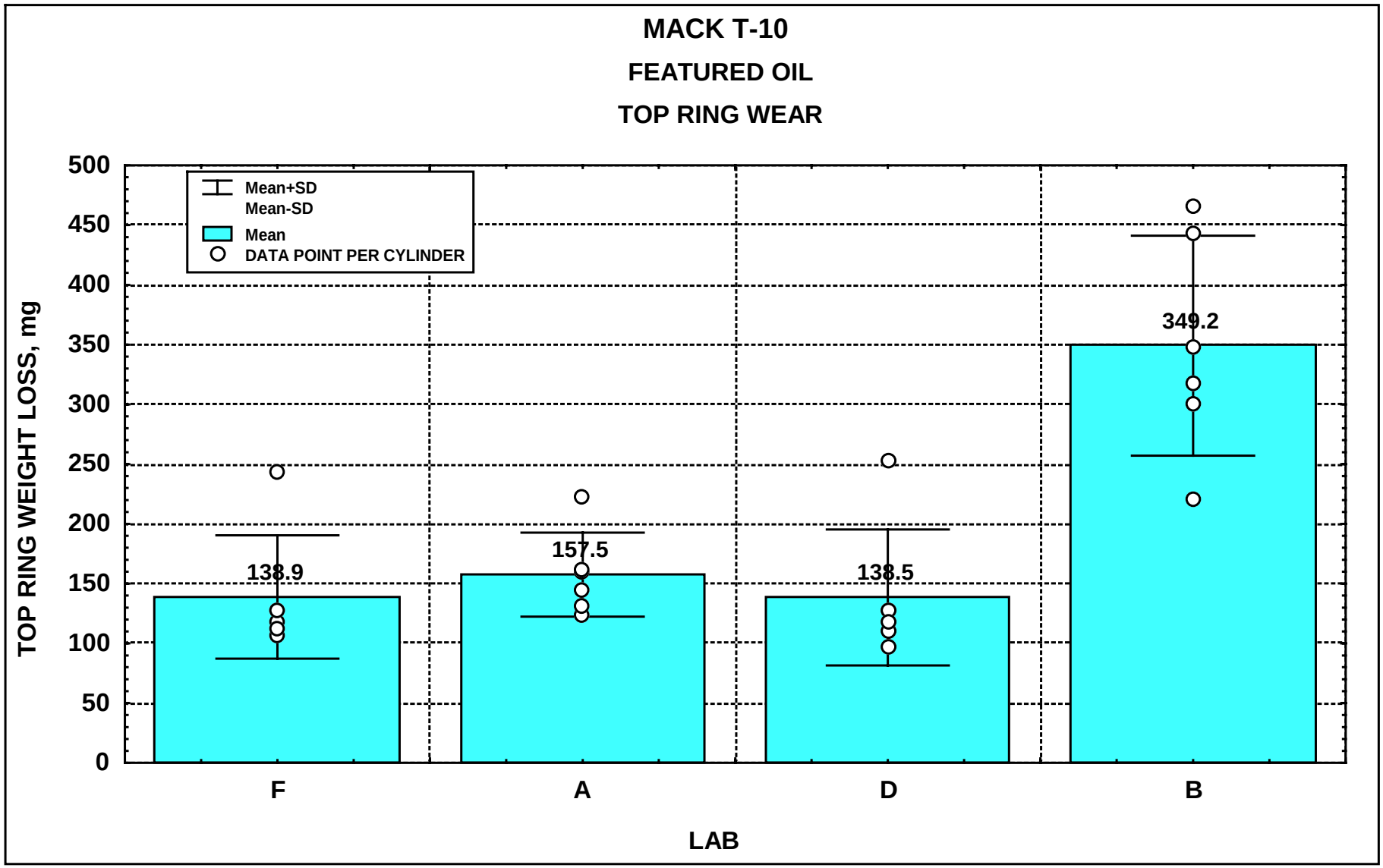
ATTACHMENT 3, 1 OF 2

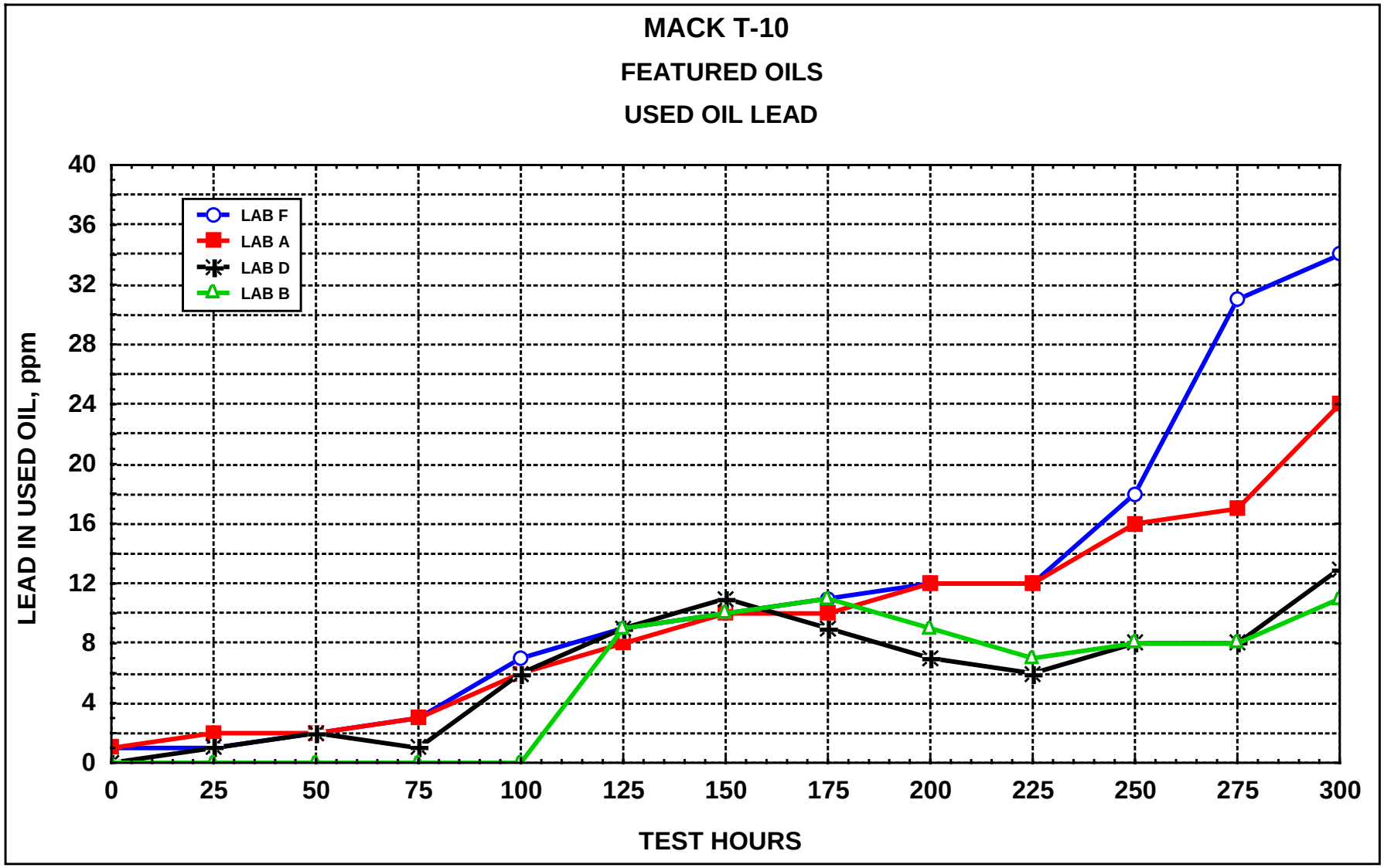
Greg Shank 2/20/01

T - 10 STATUS									
PC-9 MATRIX									
TEST TYPE	T-10	T-10	T-10	T-10	T-10	T-10	T-10	T-10	T-10
MATRIX LAB NO.	4	2	1	5	3	3	1	4	2
MATRIX STAND NO.	6	3	1	7	4	5	2	6	3
PC-9 OIL CODE	PC-9A	PC-9A	PC-9A	PC-9A	PC-9A	PC-9A	PC-9A	?	?
BASE OIL CODE	1	1	1	1	1	1	1	?	?
TECHNOLOGY CODE	X	X	X	X	X	X	X	?	?
MATRIX RUN NO.	1	1	1	1	1	1	1	2	2
START DATE	27-Nov-00	11-Dec-00	6-Dec-00	15-Dec-00	Started	Started	St wk 2/19	2-Feb-01	
EOT DATE	11-Dec-00	24-Dec-00	19-Dec-00	31-Dec-00				17-Feb-01	17-Feb-01
VALID	Yes	Yes	Yes	Yes				?	?
FAX BACK	Yes	Yes	Yes	Yes					
ASTM NOTIFIED	Yes	Yes	Yes	Yes					
RESULTS									
LINER WEAR	36.3	38.0	35.1	24.4				33.3	27.3
TOP RING WEIGHT LOSS	139	139	158	349				150	68.9
DELTA Pb	33	12	23	11				74	21
SOOT - 75 HR	4.9	4.9	5.0	5.1				4.9	5.0
SOOT - EOT	5.7	5.5	6.0	6.6				5.2	5.3
OIL CONSUMPTION	0.238	0.193	0.149	0.107				0.157	
EOT Silicon ppm	25	28	27	87				34	
EOT Aluminum ppm	3	4	4	14				5	


MACK T-10
FEATURED OILS
SOOT
TGA SOOT, wt%
TEST HOURS
0
1
2
3
4
5
6
7
8
0
25
50
75
100
125
150
175
200
225
250
275
300
LAB F
LAB A
LAB D
LAB B


MACK T-10
LINER WEAR
LINER WEAR, um
60
50
40
30
20
10
0
Mean+SD
Mean-SD
Mean
DATA POINT PER CYLINDER
36.3
35.1
38.0
24.4
F
A
D
B
LAB


MACK T-10
FEATURED OIL
TOP RING WEAR
Mean+SD
Mean-SD
Mean
DATA POINT PER CYLINDER
TOP RING WEIGHT LOSS, mg
500
450
400
350
300
250
200
150
100
50
0
138.9
157.5
138.5
349.2
F
A
D
B
LAB


MACK T-10
FEATURED OILS
USED OIL LEAD
LEAD IN USED OIL, ppm
TEST HOURS
LAB F
LAB A
LAB D
LAB B
0
4
8
12
16
20
24
28
32
36
40
0
25
50
75
100
125
150
175
200
225
250
275
300

Cummins M11 EGR Task Force
Meeting Summary

- **The task force reviewed the rocker pad hardness issue.**
  - **The task force agreed that the remaining matrix tests should be run on rocker arms that have been screened to a minimum pad hardness of 58 HRC. ACTION ITEM - Test Engineering**
- **The task force discussed test stand calibration and engine block issues.**
  - **Due to increased main bearing cap fretting on the older style blocks, the task force made the decision to replace the existing old style blocks with the newer style blocks with improved main bearing caps before proceeding with the matrix. Test Engineering will supply the labs with existing inventory ACTION ITEM - Test Engineering/Cummins**

D M Stehouwer
Cummins Inc

Cummins M11 EGR Task Force
Meeting Summary

- **The task force reviewed the data from 6 matrix tests.**
  - **The task force asked that average EGR rates, number of shutdowns, and oil filter differential pressure traces be placed on the TMC website for review. ACTION ITEM - TMC**
  - **The motion was made to postpone a decision to invalidate one of the tests until the next task force meeting. The motion passed unanimously.**
  - **The motion was made to continue the matrix under the guidelines set by the TMC. The motion passed unanimously.**
- **Timing?**
  - **M11 EGR Matrix should be complete by mid-May.**

Preliminary (Non-validated) Matrix Data

		Average (EOT)			Liner Wear	FDP (EOT)	EOT				
Oil Code	250-hr Soot (%)	CWL 9mg)	TRWL (mg)	ASR	(microns)	(kPa)	Fe	Pb	Cu	Cr	Al
CMIR-38927	9.1	23.1	104.1	9	8.2	486 (706)*	359	10	6	29	3
CMIR-38928	7.9	19.5	143.7	8.9	9	138 (204)*	310	4	6	29	3
CMIR-38931	8.20	23.4	112.82	9.1	6.4	159 (210)*	224	X	X	18	4
CMIR-38932	9.10	51.0	172.03	7.4	4.2	165 (204)*	341	3	6	25	2
CMIR-38933	8	28.8	115.52	8	5.3	231 (330)*	221	3	5	19	2
CMIR-38936	8.50	42.3	147	8.7	3.7	230 (407)*	338	>10	>10	23	>10

* corrected via M11 HST procedure

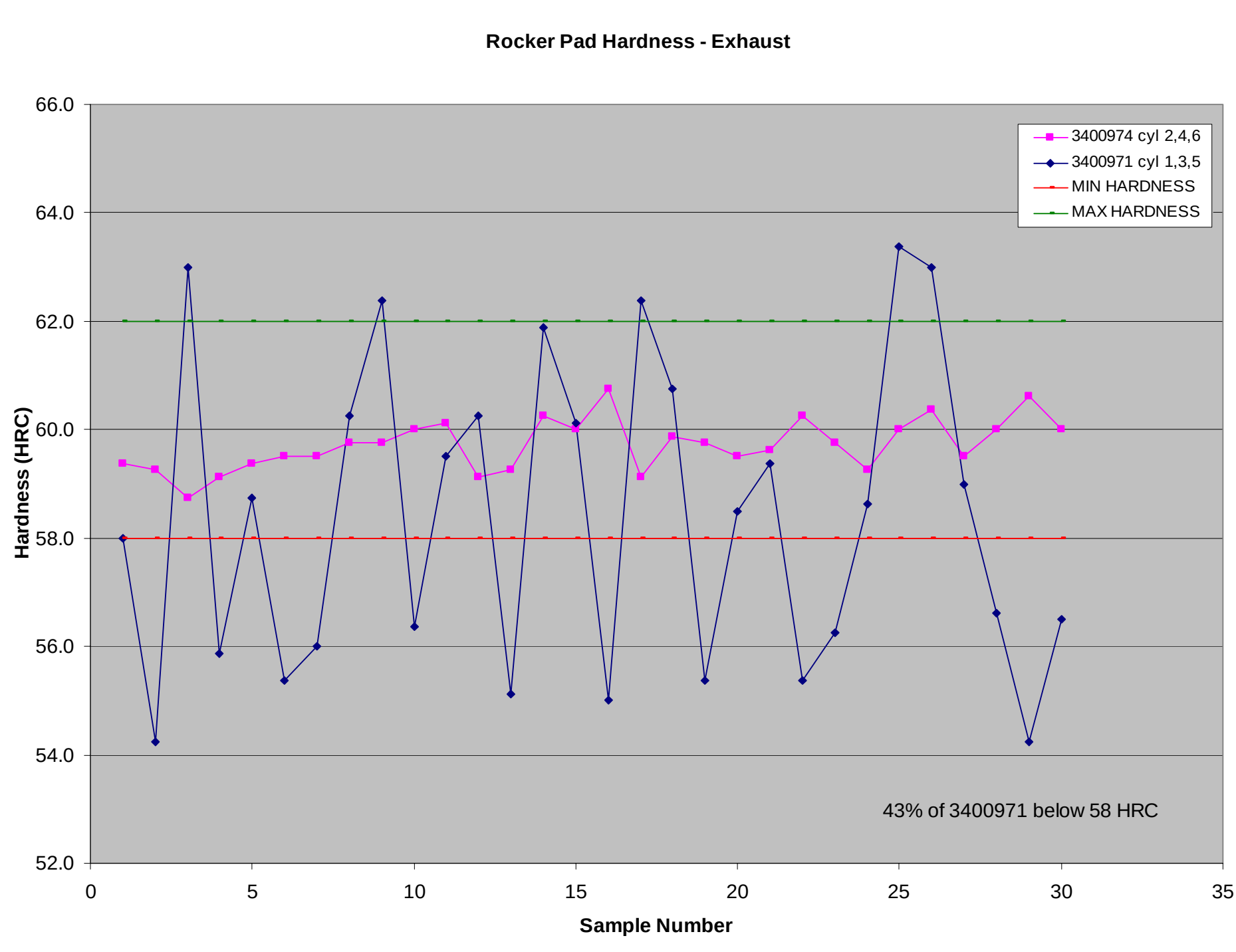
D M Stehouwer
Cummins Inc

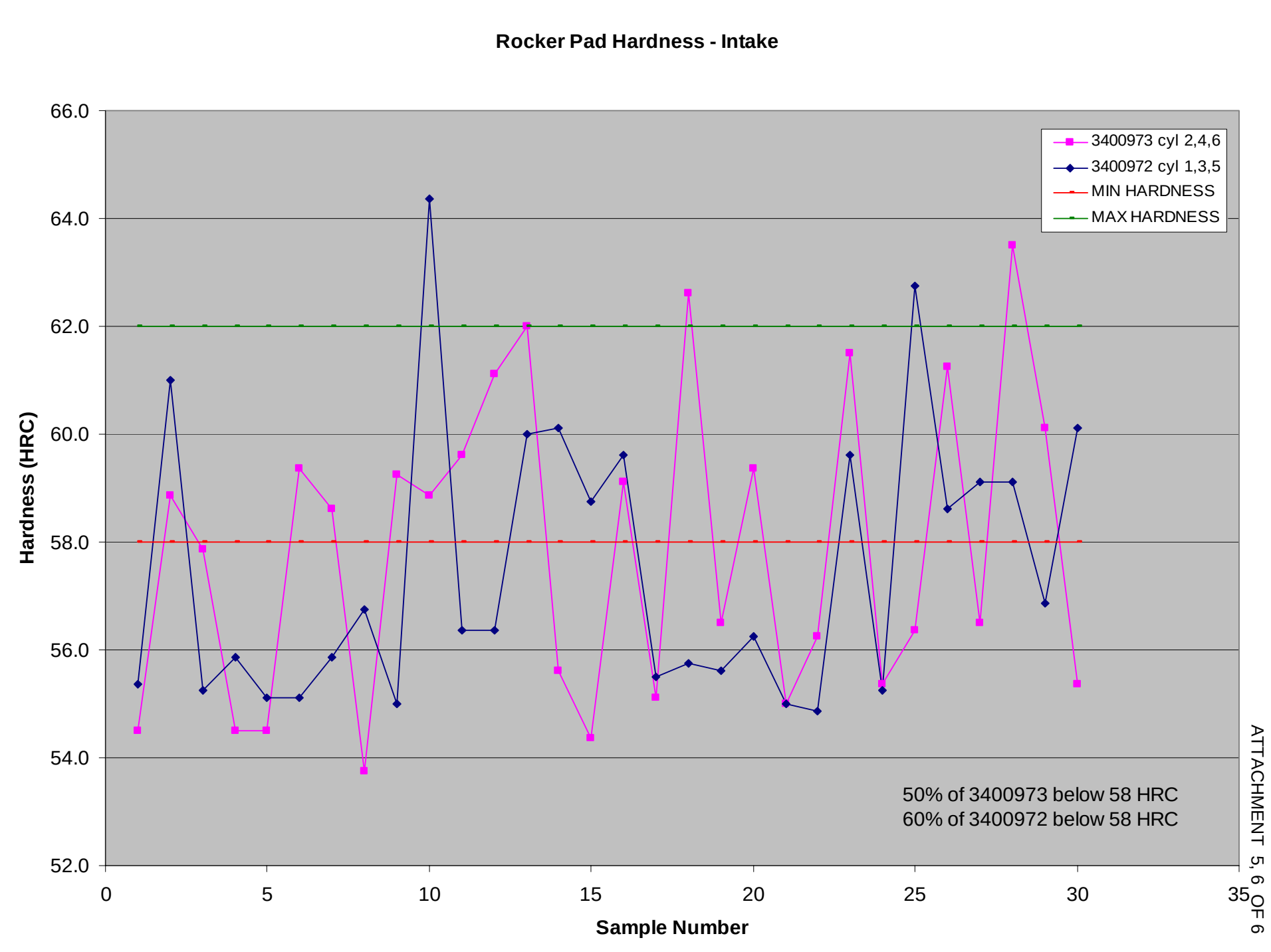
Crosshead Weight Loss

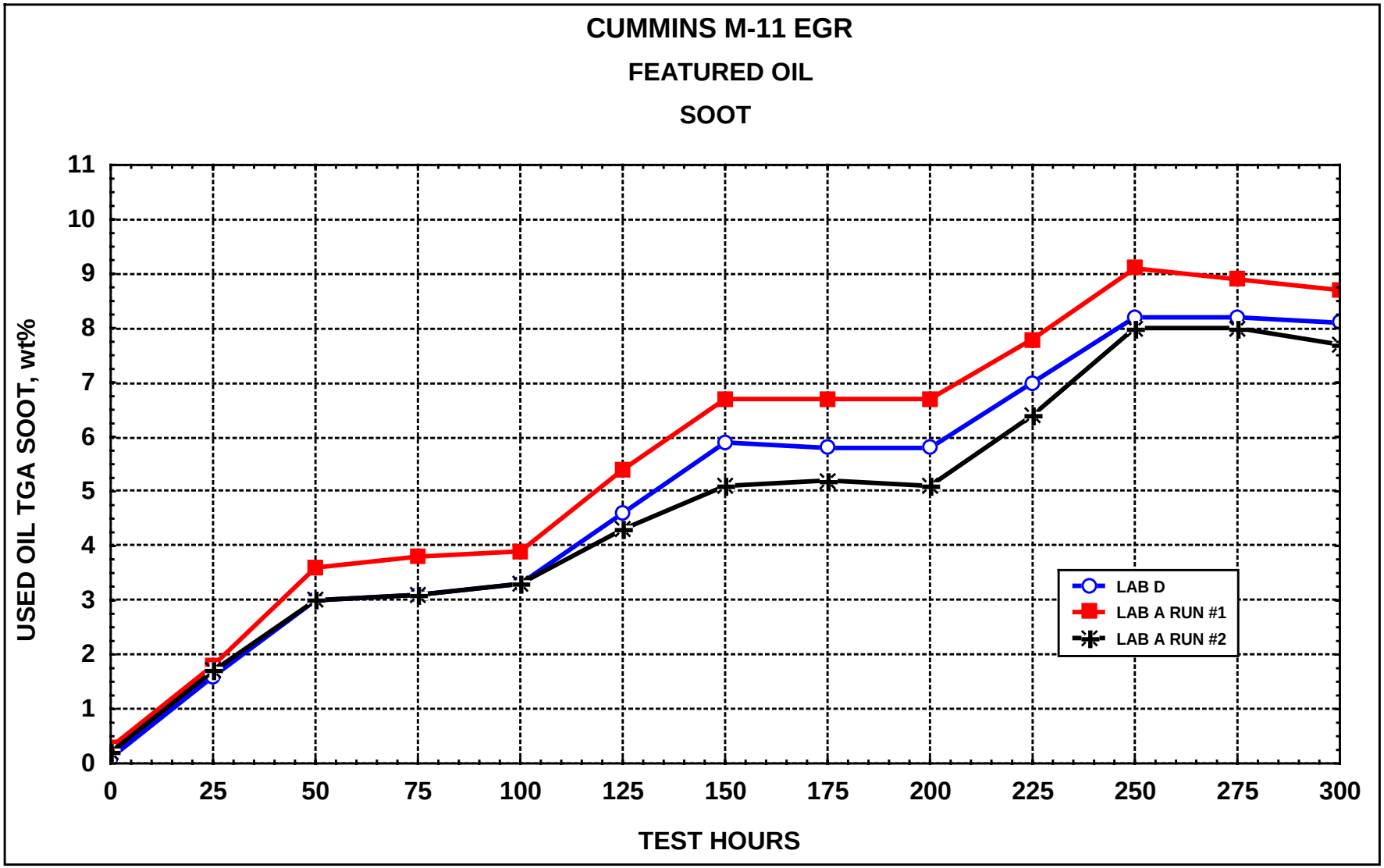
Screened by Rocker Hardness

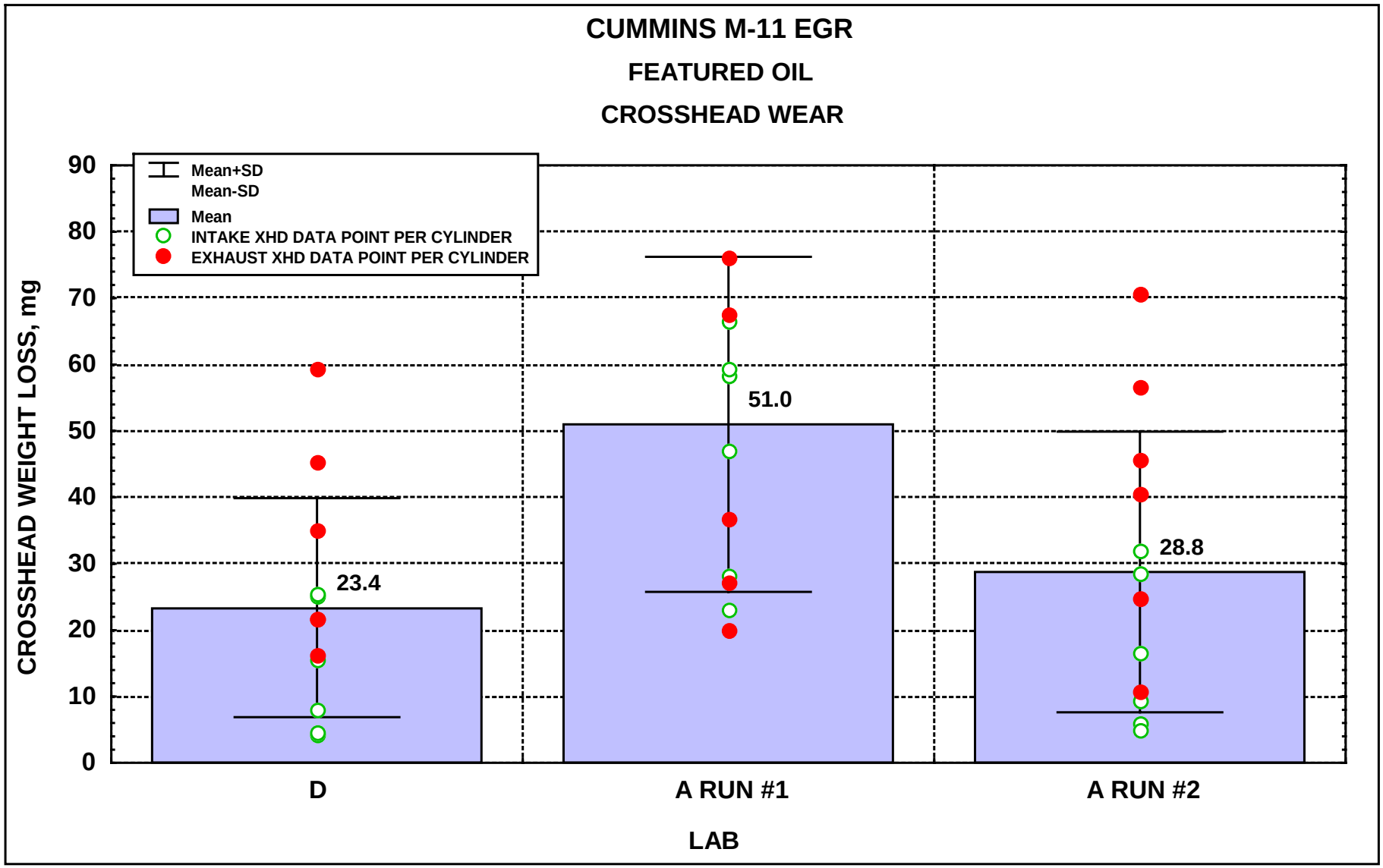
Oil Code	RAW AVERAGE	RAW Sdt Dev	Sorted Average	Sorted Sdt Dev	Soot % @ 250
CMIR 38927	20.71	7.84	19.42	7.44	9.1
CMIR 38928	17.66	9.47	17.70	9.62	7.9
CMIR 38931	23.39	16.49	19.90	14.79	8.2
CMIR 38932	51.02	25.24	38.08	16.26	9.1
CMIR 38933	28.77	21.15	13.11	9.99	8.0
CMIR 38936	42.28	35.60	40.47	21.69	8.5

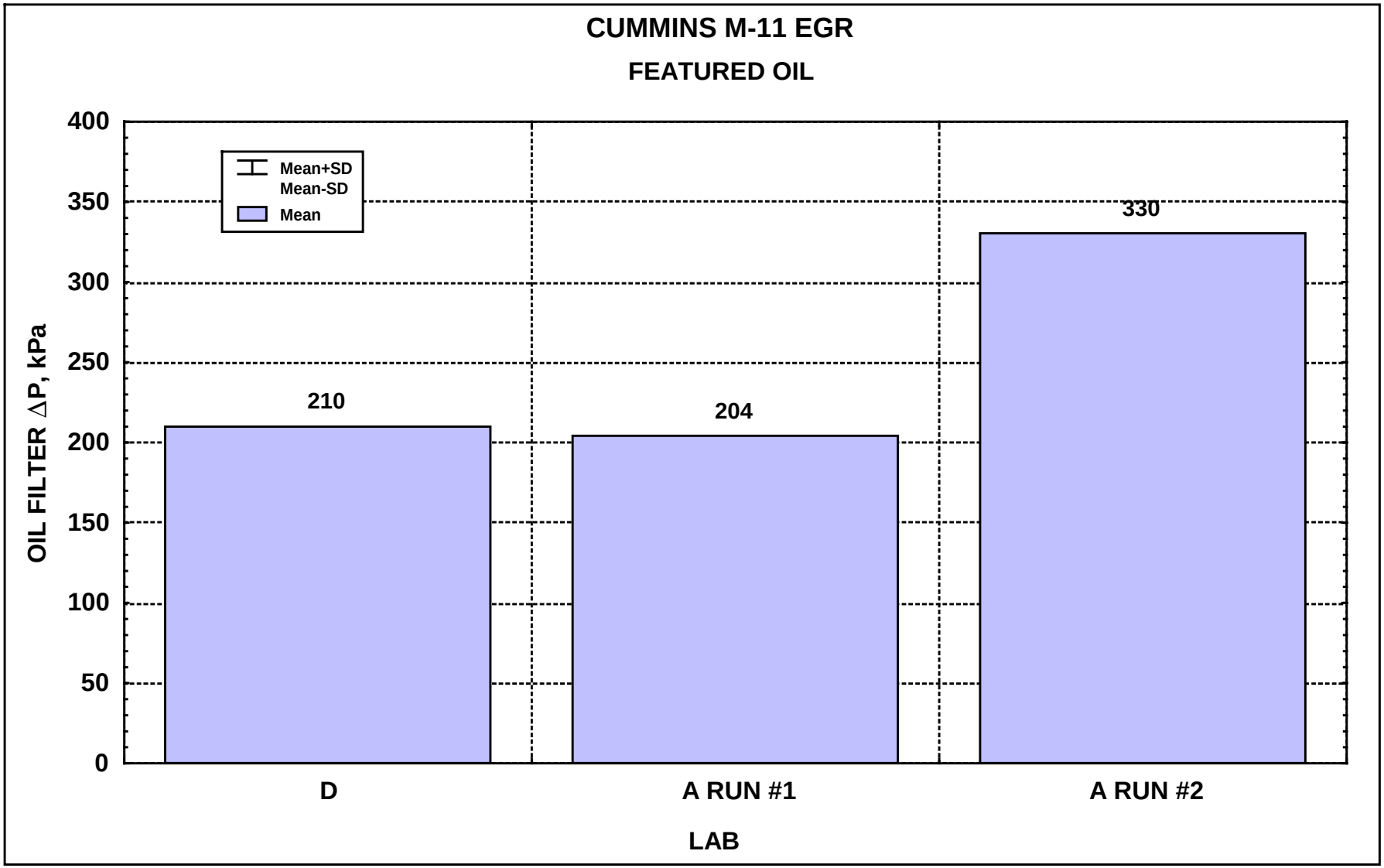
D M Stehouwer
Cummins Inc

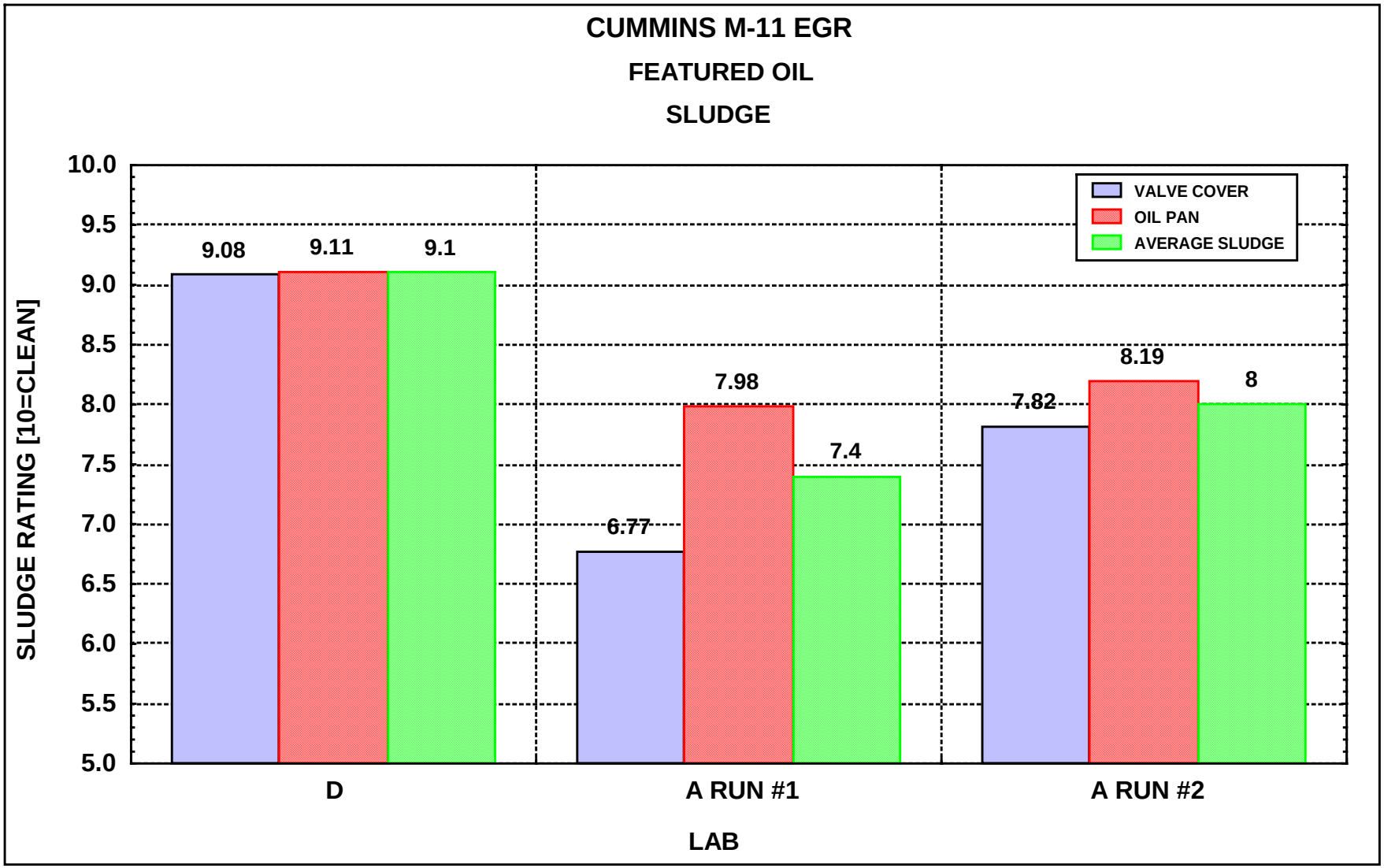

Rocker Pad Hardness - Exhaust
66.0
64.0
62.0
60.0
58.0
56.0
54.0
52.0
Hardness (HRC)
0
5
10
15
20
25
30
35
Sample Number
3400974 cyl 2,4,6
3400971 cyl 1,3,5
MIN HARDNESS
MAX HARDNESS
43% of 3400971 below 58 HRC


Rocker Pad Hardness - Intake
66.0
64.0
62.0
60.0
58.0
56.0
54.0
52.0
Hardness (HRC)
0
5
10
15
20
25
30
35
Sample Number
3400973 cyl 2,4,6
3400972 cyl 1,3,5
MIN HARDNESS
MAX HARDNESS
50% of 3400973 below 58 HRC
60% of 3400972 below 58 HRC


CUMMINS M-11 EGR
FEATURED OIL
SOOT
USED OIL TGA SOOT, wt%
TEST HOURS
0
1
2
3
4
5
6
7
8
9
10
11
0
25
50
75
100
125
150
175
200
225
250
275
300
LAB D
LAB A RUN #1
LAB A RUN #2


CUMMINS M-11 EGR
FEATURED OIL
CROSSHEAD WEAR
Mean+SD
Mean-SD
Mean
INTAKE XHD DATA POINT PER CYLINDER
EXHAUST XHD DATA POINT PER CYLINDER
CROSSHEAD WEIGHT LOSS, mg
90
80
70
60
50
40
30
20
10
0
23.4
51.0
28.8
D
A RUN #1
A RUN #2
LAB


CUMMINS M-11 EGR
FEATURED OIL
OIL FILTER ΔP, kPa
400
350
300
250
200
150
100
50
0
Mean+SD
Mean-SD
Mean
210
204
330
D
A RUN #1
A RUN #2
LAB


CUMMINS M-11 EGR
FEATURED OIL
SLUDGE
SLUDGE RATING [10=CLEAN]
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
VALVE COVER
OIL PAN
AVERAGE SLUDGE
9.08
9.11
9.1
6.77
7.98
7.4
7.82
8.19
8
D
A RUN #1
A RUN #2
LAB

1Q Test Report
for
PC-9

1. Test Results with matrix oil J
2. Surveillance Panel Decision
3. Action Plan

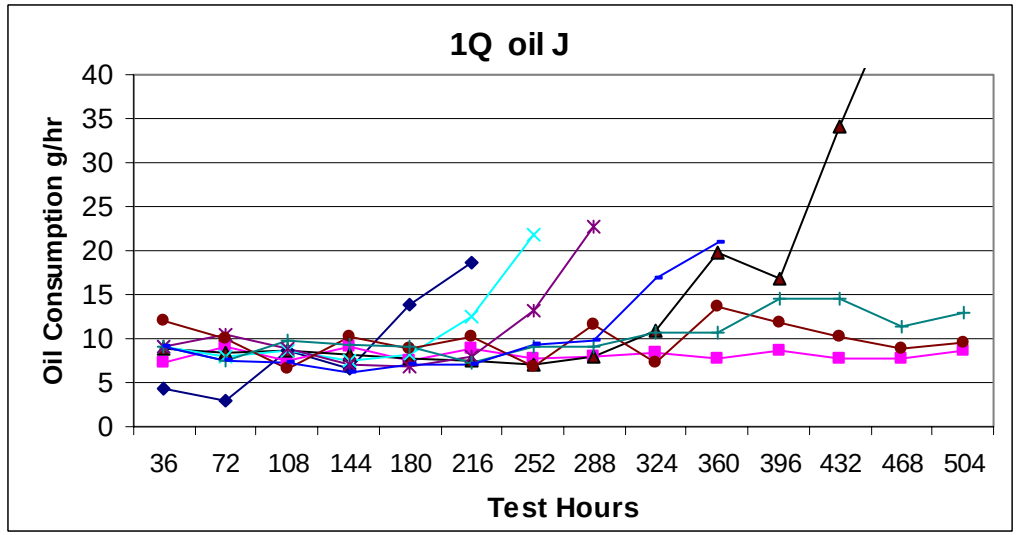
1Q Test Report for PC-9 matrix oil J

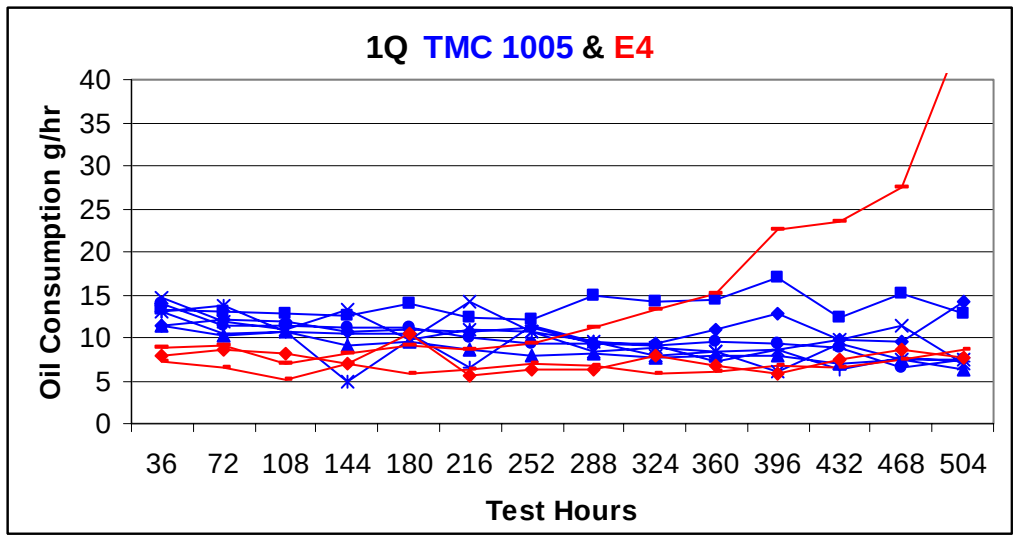
- 8 tests have been started with oil J
  - 3 completed 504 hours with oil control.
  - 1 completed 504 hours with high oil consumption and a scuff.
  - 3 lost oil control between 252 hours and 360 hours, one scuff.
  - 1 lost oil control and scuffed at 216 hours, (suspect fuel dilution).

ATTACHMENT 7, 2 OF 8

1Q Test Report for PC-9 matrix oil J

- Oil J showed typical initial oil consumption characteristics

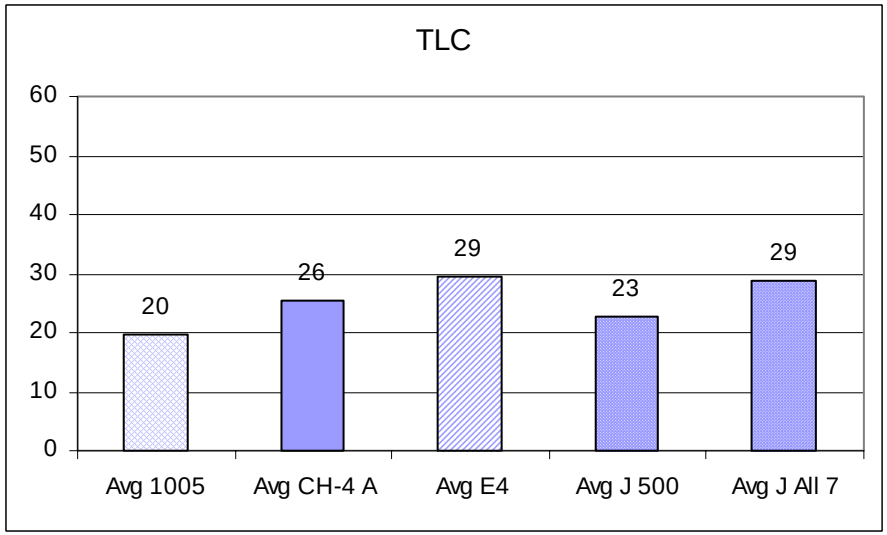


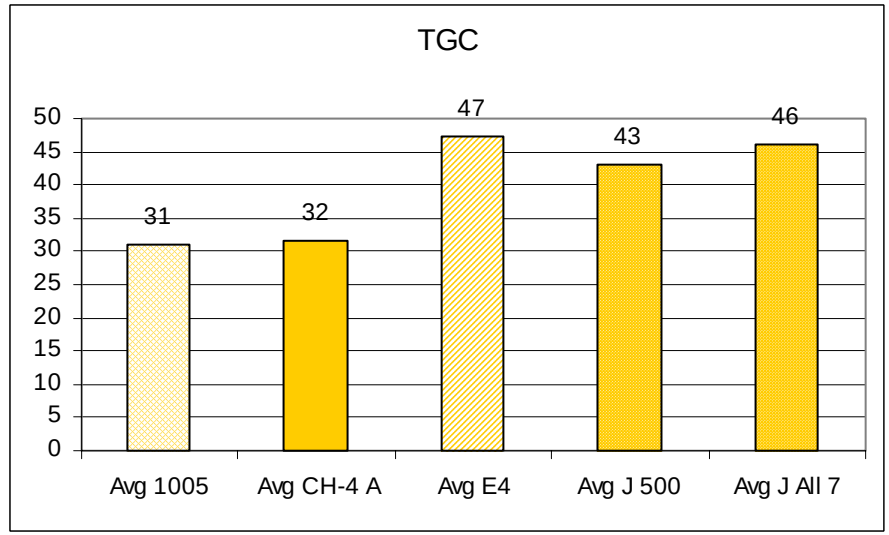


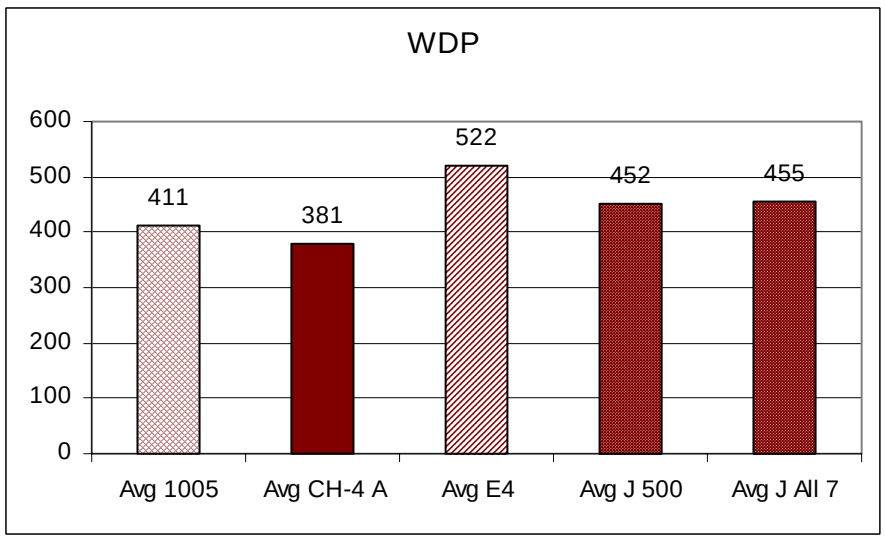
ATTACHMENT 7, 3 OF 8

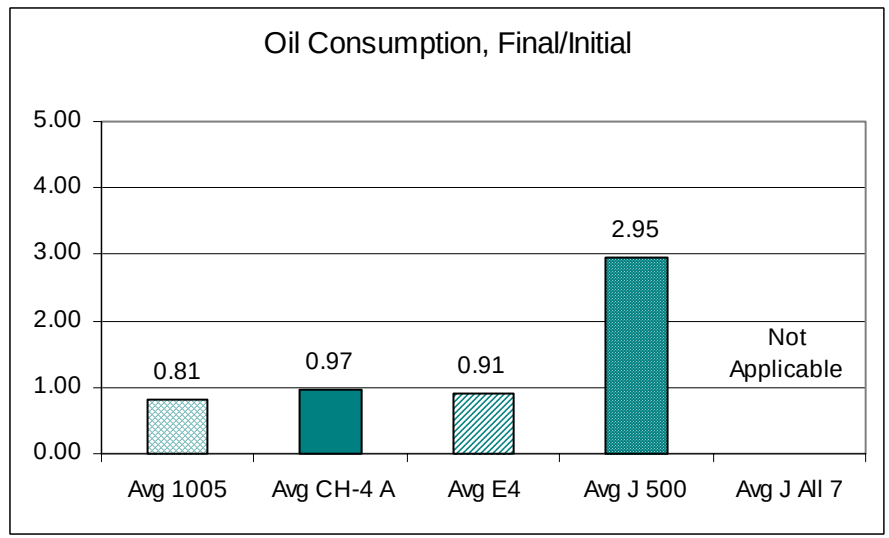
DS Nycz Caterpillar Inc.

1Q Test Report for PC-9 matrix oil J









ATTACHMENT 7, 4 OF 8

1Q Test Report for PC-9 matrix oil J

- Surveillance Panel Recommendation
  - "... the Caterpillar SCOTE Surveillance Panel has delayed the continuation of the Caterpillar 1Q PC-9 precision matrix pending an investigation into the probable root cause(s) of the test precision difference between 1005-1 and PC-9 matrix Oil J. The investigation has a target completion date of March 12, 2001. The motion passed, 8/1/0."

ATTACHMENT 7, 5 OF 8

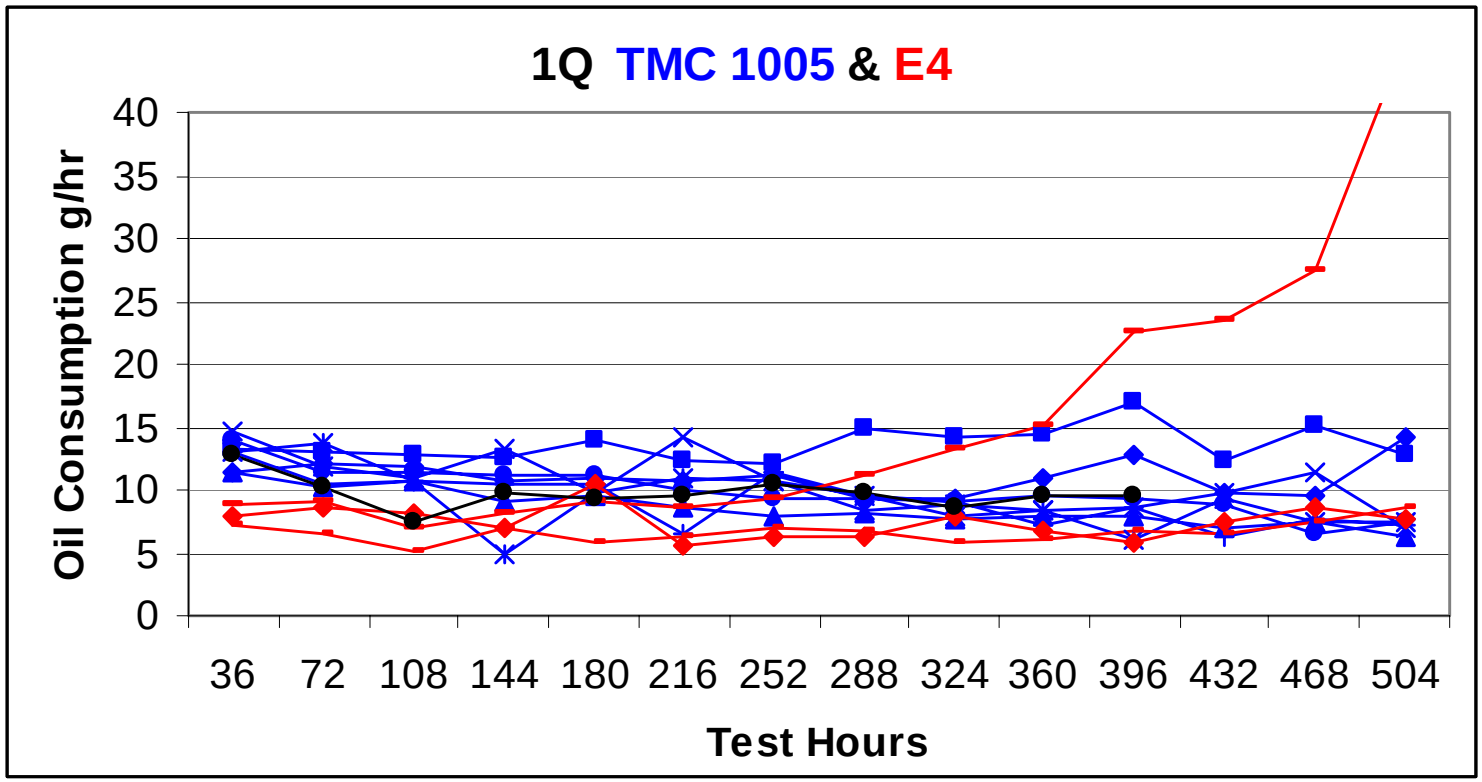
1Q Test Report for PC-9

- Action Plan
  - Caterpillar will
    - visually inspect all 8 pistons, ring sets, & cylinder liners
    - review all inspection data
    - re-measure any questionable parts
    - investigate deposit profiles on the pistons
  - Test Labs will
    - re-investigate test hardware and operating conditions
    - make a demonstration run on TMC 1005

ATTACHMENT 7, 6 OF 8

1Q Test Report for PC-9

- The demo run on TMC1005 has completed 396 hours with stable oil consumption



ATTACHMENT 7, 7 OF 8

1Q Test Report for PC-9

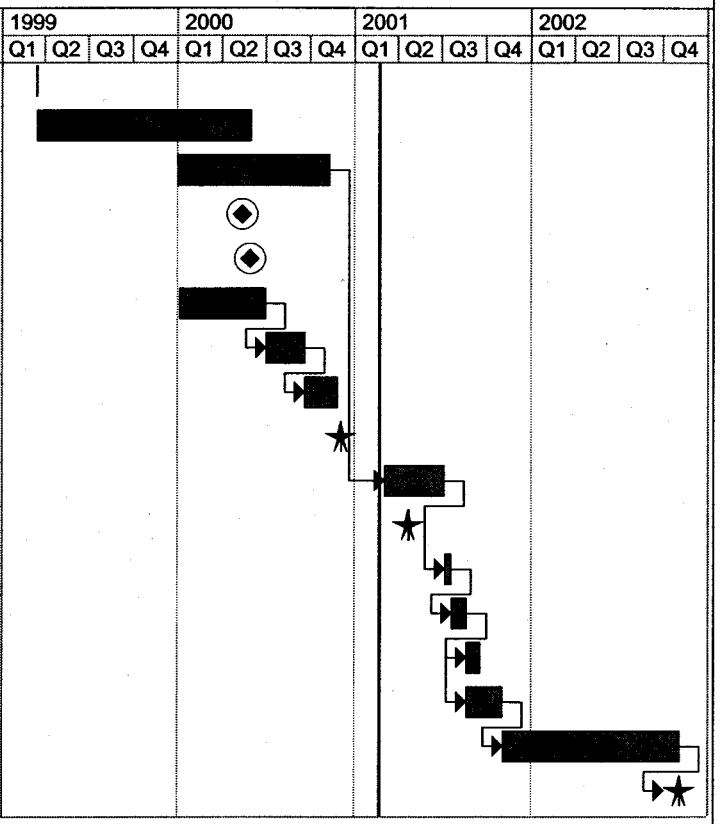
- Caterpillar Position
  - We are investigating 1Q hardware, operating conditions, and deposit profiles to determine the cause of high oil consumption with oil J.
  - However, at this point in time, it appears that oil J does not have adequate piston deposit control for EGR engines.
  - If the 1Q test conditions and hardware are determined acceptable by the surveillance panel, then the 1Q matrix should be re-started with a different feature oil for the 1Q test.

ATTACHMENT 7, 8 OF 8

Summary of Events Required for PC-9 Licensing

J. L. Zalar 2/22/01

ID	Task Name	Start	Finish
1	Define PC-9 Performance Parameters	3/16/99	3/16/99
2	Design Precison Matrix	3/17/99	5/31/00
3	PC-9 Funding MOA Signed	1/3/00	11/10/00
4	1Q & M11EGR Adequate for Oil Devel.	5/15/00	5/15/00
5	Finalize Base Oil Selections for Prec. Mtx	5/31/00	5/31/00
6	Finalize Additive Selections for Prec. Mtx.	1/6/00	6/30/00
7	Base Oils Recd. by Additive Companies	7/3/00	9/20/00
8	Blend Matrix Oils > TMC > Labs	9/21/00	11/27/00
9	Final Acceptance of New Engine Tests	12/5/00	12/5/00
10	PC-9 Matrix Testing *	3/6/01	7/6/01
11	PC-9 Demonstration Oil is Validated	4/24/01	4/24/01
12	Precision Matrix Data Analysis	7/9/01	7/20/01
13	HDEOCP Post Matrix Test Acceptance	7/23/01	8/21/01
14	ACC Registrations Allowed	8/22/01	9/18/01
15	Finalize Pass/Fail Criteria (Sub B Mtg)	8/22/01	11/2/01
16	New Product Development	11/5/01	11/4/02
17	API Licensing Allowed	11/5/02	11/5/02



* Last 1Q Stand

ATTACHMENT 8

Mack T-10 Integrated IR

Report on Oxidation measurement

2/22/01

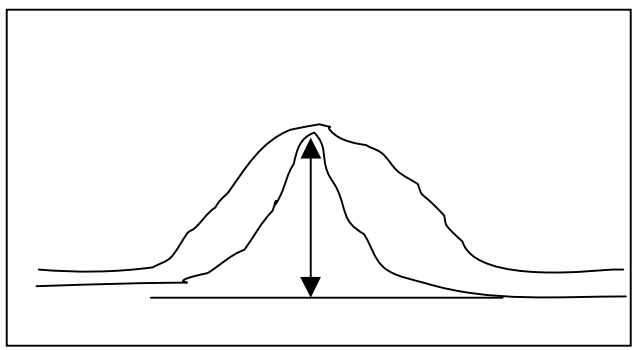
Joe Franklin

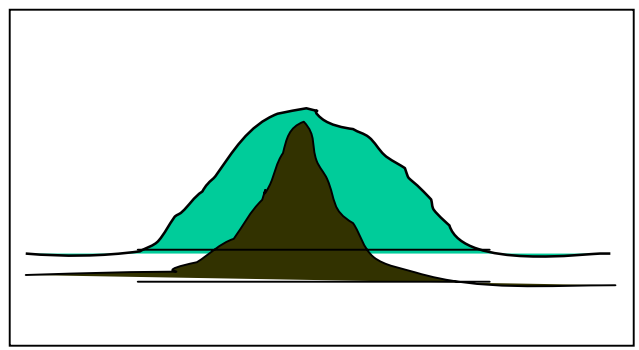
T10 Chemical Subgroup
Issues to address

- Oxidation measurement needed.
- Timing critical.
- Reproducible and valuable data from high soot samples.

Oxidation measurement needed

- Integrated area IR vs. Peak height.
  - Primary value of area - peak broadening.
    - Multiple oxidation components.



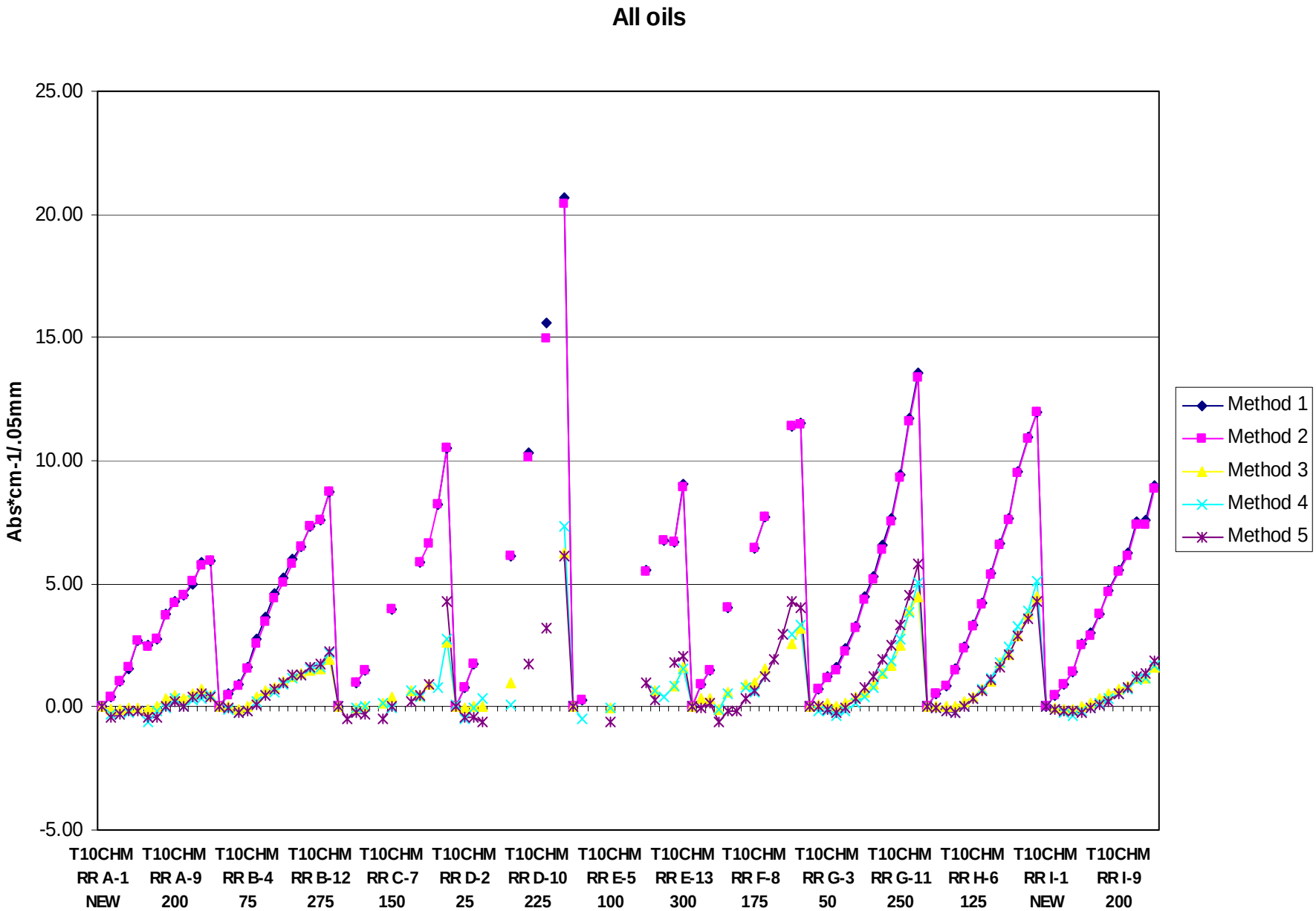


Timing critical

- Use readily available techniques.
  - Transmission cell (0.05mm BaF)
  - Standard detector
  - Dilution with fresh oil as needed to stay within linearity of detector. (measured for instrument)

Reproducible and valuable data from high soot samples

- Round Robin
  - 9 complete T10 tests including intermediates.
  - 4 suppliers
  - 1st set of data not reproducible
    - meeting to review - analysis techniques inconsistent
    - 5 proposed techniques.
  - 4 labs produced data.


All oils
Abs*cm-1/.05mm
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
T10CHM RR A-1 NEW
T10CHM RR A-9 200
T10CHM RR B-4 75
T10CHM RR B-12 275
T10CHM RR C-7 150
T10CHM RR D-2 25
T10CHM RR D-10 225
T10CHM RR E-5 100
T10CHM RR E-13 300
T10CHM RR F-8 175
T10CHM RR G-3 50
T10CHM RR G-11 250
T10CHM RR H-6 125
T10CHM RR I-1 NEW
T10CHM RR I-9 200
Method 1
Method 2
Method 3
Method 4
Method 5

T10 Chemistry Subgroup IR Round Robin

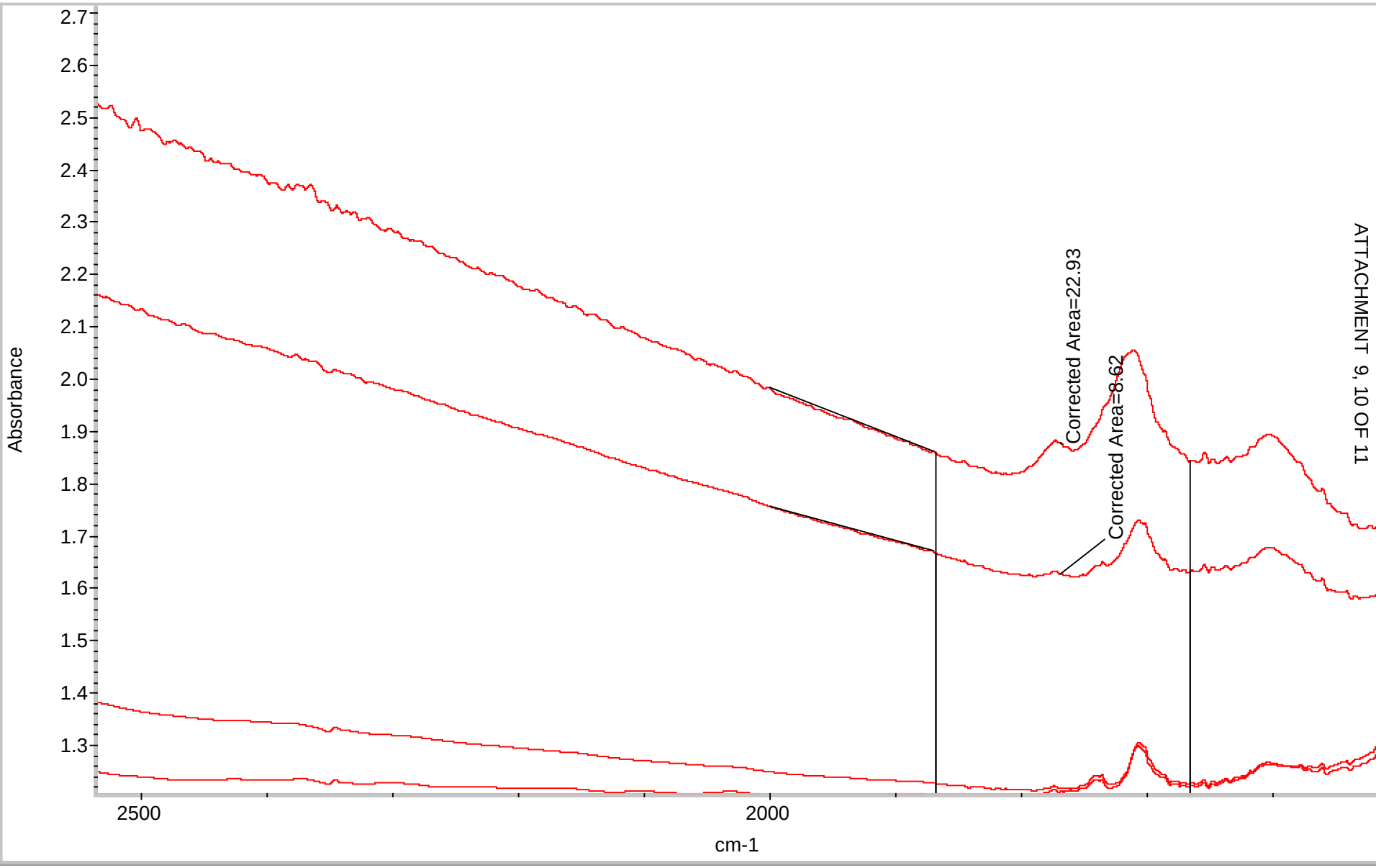
	Recalculation of Original data						
	Lab:	all					
Summary Statistics by method							
method		Method 1	Method 2	Method 3	Method 4	Method 5	
Reproducibility estimate (1 sigma)		**0.3338**	**0.3148**	**0.1866**	**0.2462**	**0.4628**	
sigma/range, %		**1.5%**	**1.4%**	**2.3%**	**2.6%**	**4.9%**	
Data range		21.91	21.91	8.26	9.63	9.46	
min		0.00	0.00	-0.63	-1.18	-1.18	
max		21.91	21.91	7.64	8.45	8.28	

	We decided to re-analyze the data in five ways:
Method 1	? Tangent Baseline correction/Fixed integration region (differential spectra)
	? Baseline calculated as a tangent to the 2000 - 1870 Region
	? Integrate between 1870 and 1665
	? Subtract spectra before calculations
Method 2	? Tangent Baseline correction/Fixed integration region (original spectra)
	? Baseline calculated as a tangent to the 2000 - 1870 Region
	? Integrate between 1870 and 1665
	? Calculations done on original spectra then subtract the integrals
Method 3	? Two Point baseline correction using a minimum (differential spectra)
	? Calculate baseline from point at 1665 and the minimum between 1750 and 1870
	? Integrate between the two baseline points
	? Subtract spectra before calculations
Method 4	? Two Point baseline correction using a minimum (Original spectra)
	? Calculate baseline from point at 1665 and the minimum between 1750 and 1870
	? Integrate between the two baseline points
	? Calculations done on original spectra then subtract the integrals
Method 5	? Two Point baseline correction using fixed points (Differential spectra)
	? Calculate baseline from point at 1665 and 1800
	? Integrate between the two baseline points
	? Subtract spectra before calculations

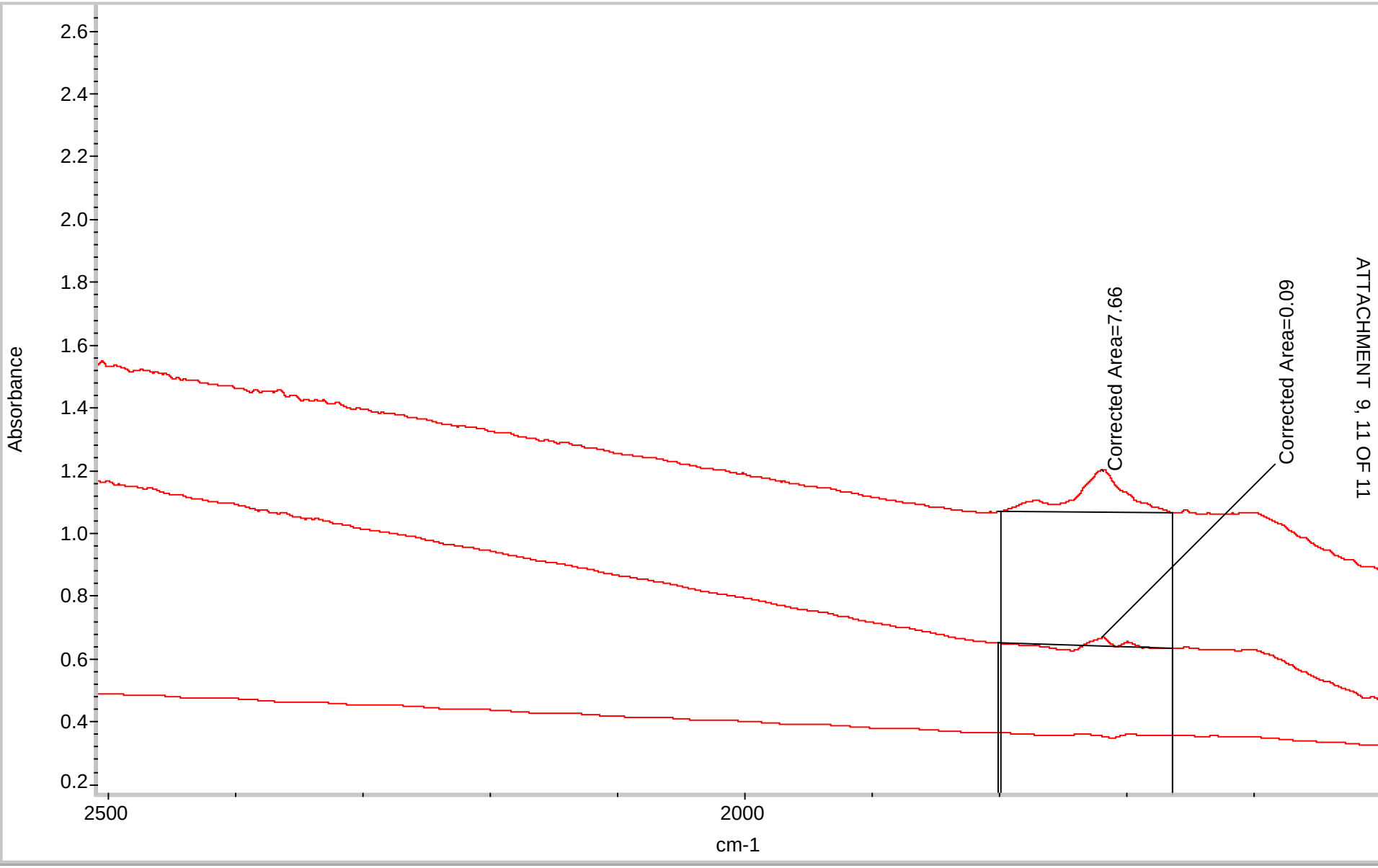
Method selection

- Method 2 and 5 will be run for the matrix.
- Method 2 best reproducibility.
- Method 5 ease of implementation.
- All methods discriminate appropriately based on expected oil performance.

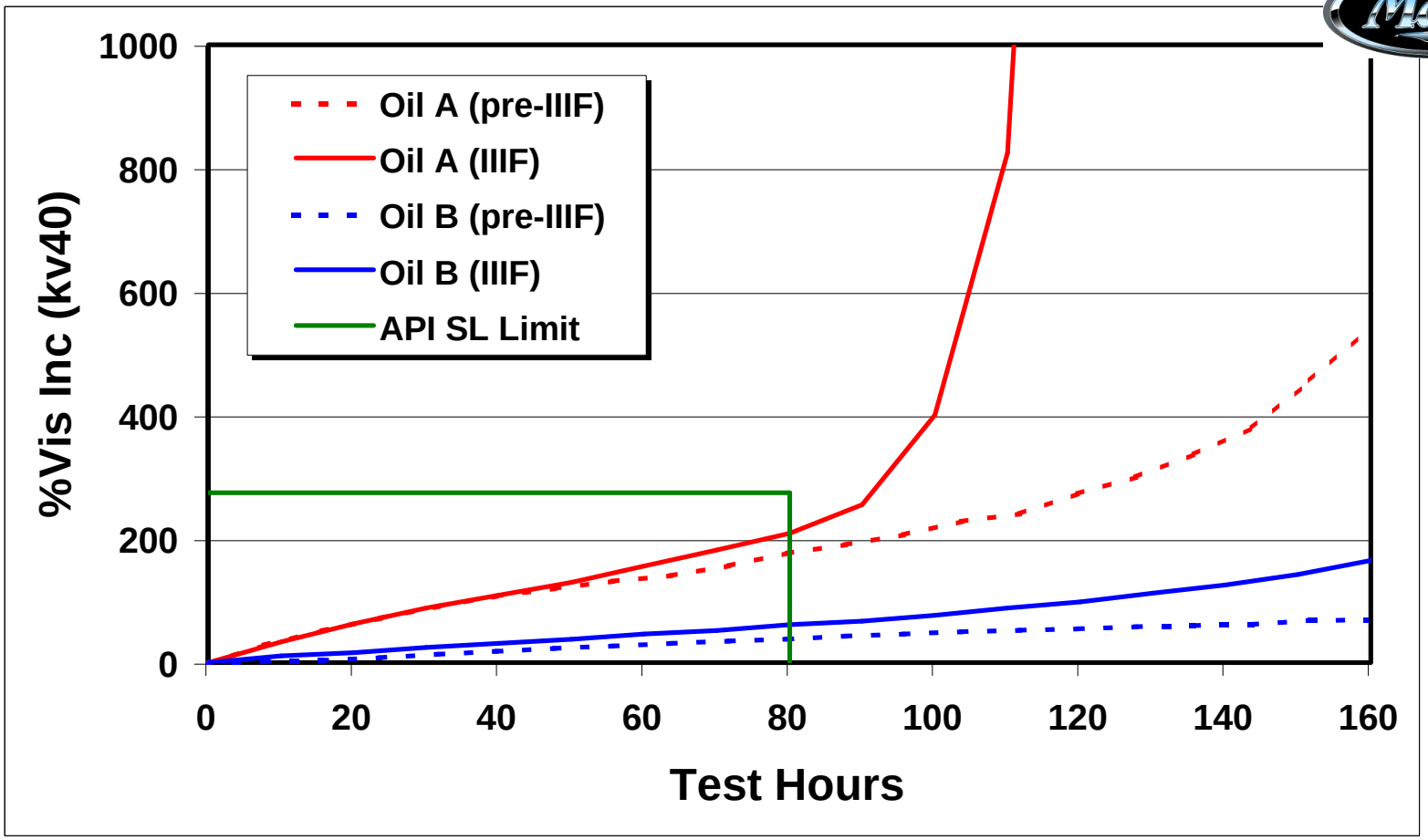
Method 2


Absorbance
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
2500
2000
cm-1
Corrected Area=22.93
Corrected Area=8.62
ATTACHMENT 9, 10 OF 11

Method 5


Absorbance
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
2500
2000
cm-1
Corrected Area=7.66
Corrected Area=0.09
ATTACHMENT 9, 11 OF 11

Sequence III Oxidation Data -- API CH-4 (Plus) Oils



% Viscosity Increase

	Seq. IIIE	pre-Seq. IIIF	Seq. IIIF @hrs		
	@64 hrs	@80 hrs	80	100	120
Oil A	40	180	209	401	2806
Oil B	-6	41	62	77	98

Sequence IIIF:

- More severe oxidation test than IIIE or preliminary version of IIIF
- May be a tool to differentiate heavy-duty oils, particularly at extended test length

ATTACHMENT 10

PC-9: Oxidation

- **Thin Film Oxidation: Use Cat 1Q to Measure Piston Deposits as an Indicator of Thin Film Oxidation**
- **Corrosive Wear Due to Oxidation: Measure Lead Increase as an Indicator of Oxidation and Corrosion in Mach T-10**
- **Oil Thickening Due to Oxidation: Use Integrated IR, Measure Oxidation as a Precursor to Oil Thickening in Mack T-10**

PC-9: Oxidation

- Caterpillar 1Q Test On Hold Due to High Oil Consumption in Some Labs
- In Four Labs the Mack T-10 Lead Varies Between 33 to 11 ppm
- Integrated IR for Oxidation, With 5.5-6.5% Soot in the Oil, Has Major Problems as an Accurate Predictor of Oxidation

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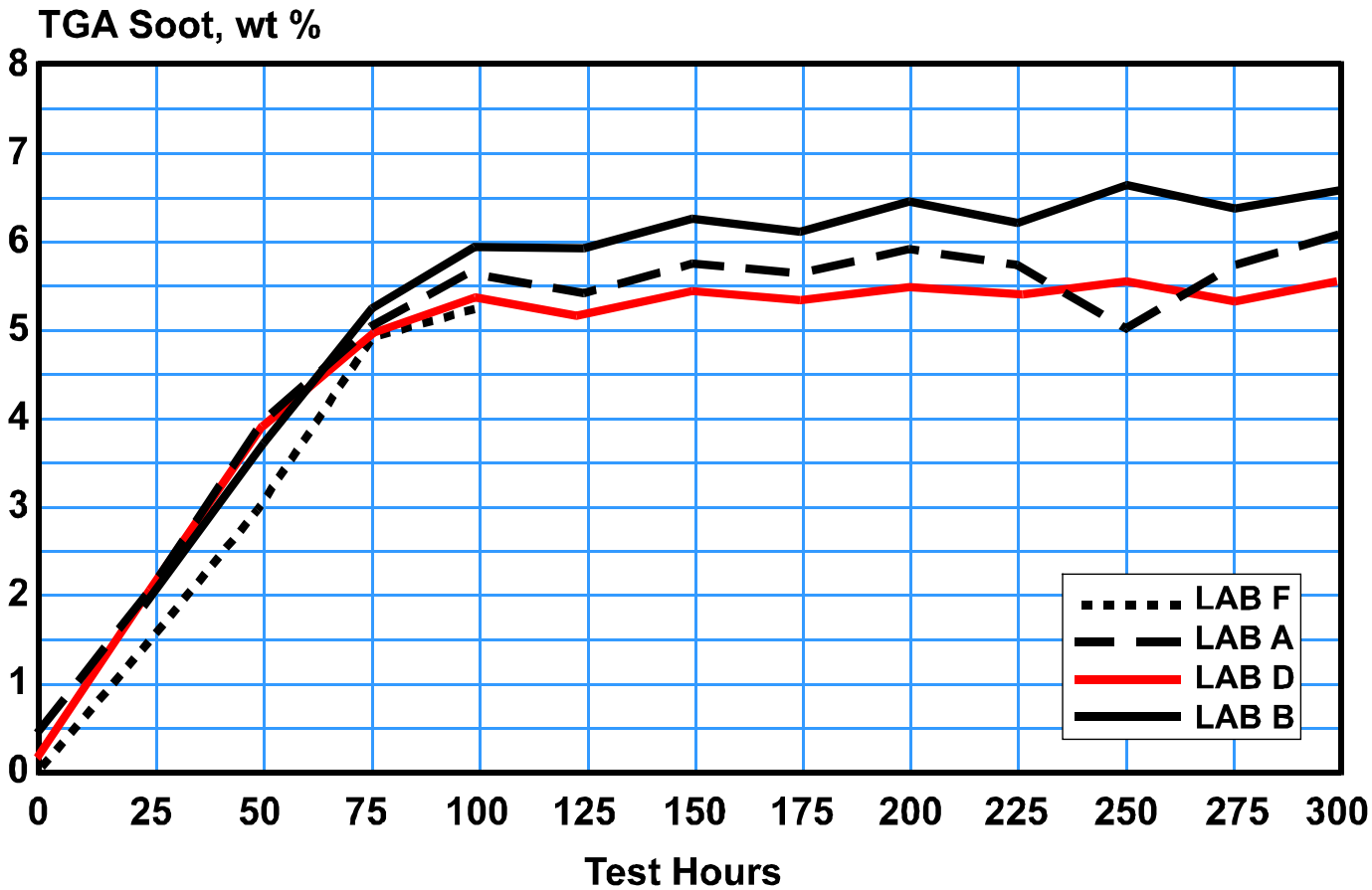
Mack T-10: TGA Soot Versus Engine Hours, Using Feature Oil A in Four Different Laboratories



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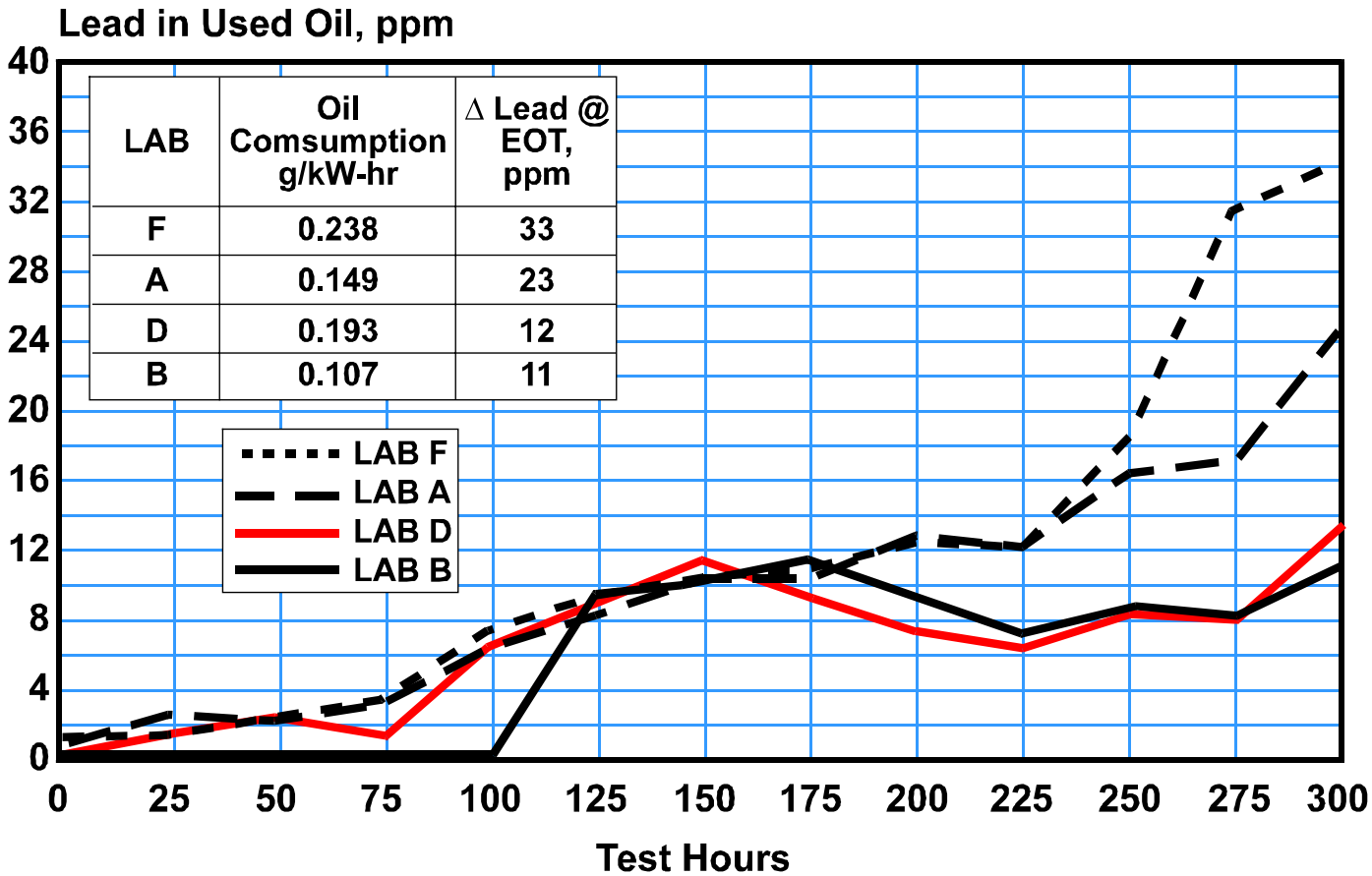
Products Company

Mack T-10: Used Oil Lead, Using Feature Oil A in Four Different Laboratories



LAB	Oil Comsumption g/kW-hr	Δ Lead @ EOT, ppm
F	0.238	33
A	0.149	23
D	0.193	12
B	0.107	11

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Integrated IR Method for Mack T-10

- At 6% Soot Levels, Sample Requires Dilution
- Sample Dilution Adds Complexity to the Analysis and Increases Uncertainty in Measure Values
- Sample Dilution With Fresh Oil is Especially Challenging Since Oils Don't Mix Well and Must Be Heated to Become Homogenous

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Integrated IR Method for Mack T-10

- **Soot Generated From Engine Tests is Itself Highly Oxidized. This Fact Makes it Especially Difficult to Separate Out the Individual Contributions to the 1720 cm^{-1} Carbonyl Stretching Band From Oil Oxidation, Additive Package (Succinimide Dispersant), and Soot.**

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Integrated IR Method for Mack T-10

- The Baseline Underneath the 1720 cm^{-1} Peak is Poorly Defined. If a Tangent Skim Method is Used Based on the Absorbances at 1665 and 1800 cm^{-1}, Then Negative Numbers Are Obtained Early in the Test Due to Additive Depletion Effects. But if the Baseline is Extrapolated From the Absorbances at 1870 and 2000 cm^{-1}, Then the Oil Oxidation Peak Includes Too Much Contribution From the Broad/Overlapping Absorbance Band Centered at 1600 cm^{-1} That Results From Soot-Quinone Structures

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Photoacoustic Fourier Transform Infrared Spectroscopy of Heavy Soot Diesel Oils

- Photoacoustic FTIR Can Measure Oxidation by Carbonyl Increase in Heavy Sooted Oils
- The Carbonyl Increase Should Be Viewed as Trend, Not as Quantitative Data
- Using Identical Samples, Photoacoustic FTIR Data Are Not Comparable
- Further Work is Not Recommended

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PC-9 Oxidation

- **Recommend That Sequence IIIF Be Considered for Bulk Oil Oxidation, Based on the Potential Problems With Integrated IR From Mack T-10**

ASTM HDEOCP Meeting - Chicago, IL

Feb. 22, 2001

UPDATE OF ASTM TASK FORCE ON LOW TEMPERATURE RHEOLOGY OF USED ENGINE OILS (LOTRUO)

C.J. May, K.O. Henderson

Current LOTRUO Activities

- **MRV Used Oil Round Robin**
  - ➢ **Data on 9 samples at two temperatures (-20/-25C) using two methods (D4684 or modified preheat) have been received**
    - – **9 labs reporting D4684 results (3 labs did not respond within time limits)**
    - – **5 labs reporting modified MRV method**
    - – **statistical analysis to be conducted using ASTM D2PP software**
    - – **expect to review results with working group within ~1 month**
- **Have begun to receive drain samples from PC-9 engine test precision matrix:**
  - ➢ **T10: 2 samples; M11 EGR : 3 samples ; 1Q: 1 sample**
  - ➢ **These samples (and others) will be useful in further assessing low temp. testing protocols on used oils**
  - ➢ **Does the HDEOCP require low temp. data on all matrix results?**

ASTM PC-9 Elastomer TF Report
To D02.B HDEOCP
February 22, 2001

- **A meeting of the task force was held in San Antonio Jan. 16**
  - A round robin will be conducted to help determine test precision and to be used for the standard in D11.15
  - Candidates for reference oils were chosen to be used in the round robin (Oils J, P, TMC 1006, and Matrix oil 9G). Potentially one or more of these will become Service Fluids
  - Results of the round robin would be used by statisticians to develop precision and means of using the data for limits within PC-9
- **Round Robin Status**
  - It appears that 8 labs will participate in the round robin
  - All 4 reference oils should all be available by the end of this week at the TMC for distribution for the round robin
  - Elastomers are available at OHT
  - There is still some more coordination work but the round robin should start next week
- **Procedure Status**
  - The procedure received additional modifications and is now in draft 6. It is being posted to the ASTM web site for comment while the round robin is being run.
    - Participating labs have access, some D11.15 members have access, if anyone else would like access please contact Tom Boschert at Tom_Boschert@ethyl.com
- **Timing**
  - The Round Robin should complete by end of March
  - Ballot to D11.15 by end of April
  - Ballot concludes and resolution in June D11.15 meeting
  - Next Task Force meeting – Late April/May – will try to coordinate with other HDEO meeting – evaluate data

Correlating the Sequence VIII to the CRC L-38 corrosion protection for HD approval categories

- Recommendation - Adopt current PCMO limits using ratios that provide equivalent limits to the current HD limits using the 25% increase determined from previous correlation work.

  - For CF-4, CF-2 and CF
    - 50 mg CRC L-38 BWL = 33.0 mg Sequence VIII BWL
  - For CG-4
    - 3 Test Limit of 50.0 mg CRC L-38 BWL = 33.0 mg Sequence VIII BWL
    - 2 Test Limit of 48.1 mg CRC L-38 BWL = 31.9 mg Sequence VIII BWL
    - 1 Test Limit of 43.7 mg CRC L-38 BWL = 29.3 mg Sequence VIII BWL

ATTACHMENT 14