HEAVY-DUTY ENGINE OIL CLASSIFICATION PANEL

OF

ASTM D02.B0.02

September 21, 2005

Chicago O'Hare Crown Plaza – Rosemont, IL

ACTION ITEMS

1.	**Obtain the total cost of the PC-10 matrix.**	**John Zalar**
2.	**Obtain firm values for ISM merit system for PC-10 use.**	**Dave Stehouwer**
3.	**Send Mack T-10 test for T-6 in CF-4 ballot to Subcommittee B**	**Jim McGeehan**

MINUTES

1.0 Call to order

1.1 The Heavy Duty Engine Oil Classification Panel (HDEOCP) was called to order by Chairman Jim McGeehan at 8:05 a.m. on Wednesday, September 21, 2005, in the Kennedy Room of the Chicago O'Hare Crown Plaza Hotel, Rosemont, IL. There were 17
1.2 members present and 23 guests present. The attendance list is shown as Attachment **2.**

2.0 Agenda

2.1 The agenda shown (included as Attachment **1**) had changed since the last published one. Inclusion of a Mack and Sequence III test oxidation comparison was requested and agreed upon.
2.2 An emphasis was made to notice the "Next Meetings" item at the bottom of the agenda for October 12th and October 27th with the desire to complete exit criteria ballots at that time.

3.0 Minutes

3.1 The minutes of the June 21, 2005 meeting were approved as issued.

4.0 Membership

4.1 There were no membership changes.
4.2 Jim Moritz replaces Jim Wells as secretary of the panel.

5.0 Matrix Status

5.1 John Zalar presented his report on the progress of the matrix. See Attachment **3**. The T-12 and ISB tests are complete, but all data has not been submitted yet. The final C-13 test is set to finish 9/23/05. The matrix was run very efficiently, in that 87.7% of the starts completed as valid tests. The C13 had the most tests and only one test to re-run. The lab representatives were encouraged to take the message back to get the data reported. All 3 statisticians are "seasoned veterans". Phil Scinto has primary responsibility for the ISB,

Elisa Santos has the C13, and Jim Rutherford has the T12. All statisticians will analyze all test types and the group is to arrive at a consensus analysis. There is no date set yet for a meeting. The total cost of the PC-10 matrix isn't known yet, but it is needed.

6.0 Mack T-12/T-11

6.1 Greg Shank presented Jim Rutherford's preliminary analysis given at the September 9th, 2005 Richmond, VA Mack Surveillance Panel meeting. See Attachment **4**. The statisticians and the task force need to agree on what tests to include for the final analysis. This is still not a full data set; this is just a preliminary analysis. A Mack Surveillance Panel meeting is needed to work the details. Monday, October, 10th and Tuesday, October 11th are being considered. The labs need to do better at getting data submitted in a timely fashion.

6.2 Greg Shank also showed theT-12 Merits system "straw man" presentation from the Richmond meeting. See Attachment **5**. This is very preliminary. The existing T-10 system was explained for comparison. For the T12, the weighting factors have changed. The T-12 merit system may include FTIR oxidation. The anchor values are not limit proposals at this point. While the T-12 has much more EGR than the T-10, the effect seems to have been offset by the ULSD fuel, which is good news for the engine manufacturers. The Task Force needs to determine which oil will be the reference oil. Input from other groups on whether to tie back to the T-10 or use a low SAP oil is desired. To reference stands outside of the matrix, the 3 matrix oils are currently assigned uniformly and randomly. Mack may not be ready to propose limits by October 12th but probably by October 27th. October 27th is a key day. Mack can put proposed limits out between October 12th and October 27th.

6.3 Greg Shank presented a proposal to add an additional requirement to the T-11 test for PC-10. See Attachment **6**. The 12 cSt increase at 6% soot pass fail requirement will remain the same. Greg is worried about oils that curved around the pass fail limit. He is proposing a slope limit using the natural log of the viscosity increase. The slope values for various oils were shown. The results for the reference oil, 820-2, bounce around. Poor performing oils have a slope value greater than 0.8, marginal oils have slopes between 0.5 and 0.8, and the slope for good oils is less than 0.5. Instead of the slope calculation, another limit further out past 12 cSt and 6% soot could be added. This is only for PC-10. Input is needed on the best method.

6.4 The question about the T-12 as an oxidation test was raised. Greg Shank is asking for Sequence IIIG data on oils that have a Mack T-12 test. The Sequence IIIG will be available until 2009 and maybe longer. In the October meetings, an answer will be available. More data is needed to compare and resolve.

7.0 Cummins ISB

7.1 Dave Stehouwer presented the ISB results to date. See Attachment **7**. All matrix tests are finished, but all data has not been submitted. This is only a preliminary analysis today. The Cummins Surveillance Panel will review by early October and have a presentation to the HDEOCP by October 12th.

7.2 Phil Scinto gave his preliminary analysis. See Attachment **8**. This is just preliminary and unofficial since not all the data is in yet and this is just Phil's analysis so far, others haven't looked at it yet. Outlier screening criteria based on E178 was used on all wear measurements except Average Camshaft Wear (ACSW) since not all the individual cam lobe measurements were available at the time. Tappet Weight Loss (TWL) only had outlier tappets in 2 out of 13 tests. Crosshead Weight Loss (CWL) had outlier crossheads in 5 out of 13 tests. Valve Adjusting Screws (VAS) had outliers in 9 out of 13 tests. The cam wear by lobe is being collected. The relationship between wear and soot is inconsistent. Precision of the test is meeting expectations of ACC member companies with Ep > 1. To calculate Ep, divide maximum acceptable difference by the standard deviation. If the result is greater than 1, then the test is ok. A result less than 1 is not ok. Phil's early opinion is that the test proved discrimination before the matrix and that the precision is meeting all Ep

criteria. His concerns are the lab differences and apparent differences between stands. Dave Stehouwer stated that so far there is no consideration for a merit system for the ISB.

8.0 Caterpillar C13

8.1 Abdul Cassim gave a presentation included as Attachment **9**. Piston deposit tests have 4 requirements so the C13 is no different than those other tests. There are lab effects. There are oil and additive effects. Possible pass fail parameters are: Oil consumption, TLHC, TGC, TGF. These will be decided after completion of the matrix and of the analysis.

8.2 Elisa Santos showed a preliminary analysis of the C13 matrix. See Attachment **10**. The analysis so far includes 21 out of 26 tests plus 5 mini matrix tests. Lab A is mild on oil consumption and Lab F is severe on oil consumption. There is a weak correlation between some piston deposits. A slight correlation exists with oil consumption and deposits. Elisa will add stand within lab for the next round of analysis. The tighter band of points on the Pairwise correlation plots show better correlation. This is still using averages of all pistons for deposits, no outlier screening used yet. Using outlier criteria has begun and it doesn't seem to change it much. Precision estimates are: 8 for delta OC and 25 for OC% increase.

9.0 NCDT

9.1 Bill Runkle gave the NCDT timeline. See Attachment **11**. The current schedule shows API first license on December 26th 2006. The remaining lengthy tasks are the technology demonstration and limits approval step and the product qualification step. If limits could be set in January, then product qualification could start in January.

9.2 Three conference calls have been held looking at ways to shorten the timeline. Latest conference call was August 31st. The minutes of this call are included as Attachment **12**. A question of how much time would be saved if the C13 was not in category was asked. The ACC response is due by the end of September. The minimum time for product qualification is stated as 15 months. The EMA still supports the 1N test. As far as the 1P goes, data is still being requested. The EMA haven't seen enough data yet though. September 20th was the deadline for seeing more data to include a new test. No new data was presented. The EMA would like to keep it on the agenda for the next meeting. Adding the 1P would extend product qualification time and would raise test costs greatly. EMA member companies prefer the 1N over the 1P. Cat still wants the 1P. According to API rules, EMA endorsement would be needed to add a test to the category. If individual company requests, then it is like a request for a new category. Support for the 1P is needed by September 30th.

9.3 The EMA won't be able to meet the September 30th deadline to decide if the Sequence IIIG stays in the PC-10 category.

9.4 Valve Train Wear tests task force activity is ongoing. The task force may meet on October 11th.

9.5 The action items to investigate timeline reduction ideas were reviewed:

9.5.1 There was very little support for OEM test sponsor endorsement of technology so this idea has been removed from further consideration.

9.5.2 There is not yet enough data to decide to grant T12 read across to 100% group III and grant ISM/ISB read across to 100% group III. More tests are planned to get more data. These tests should be starting in a couple of weeks and should be complete by November. The tests involve running 100% group III oils in the T12 and ISB with 2 tests back to back in the same stand. This would have some effect on timeline reduction. BOI for the C13 would have the most effect. The BOI/VGRA Task Force is planning a meeting the week of October 31. The plan was to roll over VGRA from SCOTE tests to the C13.

9.5.3 The two tier license proposal only had support from one marketer, so this idea has been removed from further consideration.

9.5.4 Stand utilization will be monitored.

9.6 After September 21st, no new tests will be added to the PC-10 category. After that date, a new test will only be considered as a replacement of an existing test in the category.

10.0 PC-10 Oxidation

10.1 Pat Fetterman presented some data pertaining to oxidation. See Attachment **13**. In the CI-4 category, the T-10 lead parameter really determines oxidation, not the Sequence IIIF. This is very, very preliminary mix and match data. Testing used PC-10 prototype oils. The T-12 is the same or more severe than the T-10 on oxidation. High viscosity increase in Sequence III. Sequence IIIG has strong hate for group 1 base stocks. Including the Sequence IIIG will just raise costs. Oil A' in group II in T-10 was a very strong OEN premium pass. It is decent in T12. It had viscosity increase values of 66% in the IIIF and 337% in the IIIG. The Sequence IIIG is measuring things that aren't appropriate for heavy duty. Greg Shank encourages more data and it can be submitted to him.

11.0 Sulfated Ash Task Group Report

11.1 Eric Olsen of Oronite chaired the Sulfated Ash Task Group (SATG). His presentation is included as Attachment **14**. The recommendations of the task force are:
- 11.1.1 1.0% D874 Sulfated Ash, Non critical. There was no consensus for 1.0 or 1.00 (two decimals).
- 11.1.2 A new recommendation that D874 be determined using verified lab and stand according to ASTM-LTMS using the TMC. The LTMS will employ multiple reference oils; one for a daily check and 3 for periodic blind checks.
- 11.1.3 Drop MTAC, it is for ACC registered engine test and doesn't fit very well for ash.

11.2 Reproducibility is critical and is influenced by bias. Acceptance limits aren't impacted by using 1.00. Data submitted showed good repeatability indicating that bias between labs is the problem for reproducibility. Group is proposing new reference oil with pedigree to NIST SRM 1848 formulated as 15w-40 for 1.0% sulfated ash. Control limits set by round robin from participating labs.

11.3 Greg Shank motioned and Pat Fetterman seconded to accept the proposal from the SATG. A question was asked about how the daily checks would work. Joe Franklin explained that a set of report forms would be developed that shows the daily check with each candidate for that day, similar to the NOACK. The TMC has agreed to this and has already started getting ready. This would be similar to other bench tests and a Surveillance Panel will be created. There would be a range of oils lower and higher than 1.0% plus an oil at 1.0%. Another question was asked about using different chemistry in the 3 reference oils. The intent would be to use a range of chemistry. The desire is to use something the TMC has available. The call in fee is $470 per blind reference test run each quarter. Oil costs around $30 per sample. The daily check would replace the lab's own daily check sample. Dave Stehouwer is happy with this. If LTMS doesn't reduce precision, it can quantify bias. The vote is 16 for the motion, zero against the motion and 1 waive. The members of the task group were thanked for the amount of work that was done. Chairman McGeehan commented that task forces get created and deliver recommendations with much work behind the scenes for an easy discussion and decision at this panel. The group is to continue to improve this test. A letter has been generated emphasizing the need that this method be improved. One way to improve is to update the hardware of the test.

12.0 Cummins ISM: PC-10

12.1 Chairman McGeehan showed the ISM merit system proposal. See Attachment **15**. Input is still being solicited. Cummins will have a serious proposal with firm limits by October 12th to have a discussion, vote, and exit criteria ballot. Other tests with different appetites may preclude the vote on October 12th. The rest of the data and analysis from the PC-10 matrix may influence the limits. The '07 engines may need stronger performance; the PC-10 merit

anchors would be a performance improvement over the correlated values for a M11EGR. This should be balloted October 27th.

13.0 API CF-4

13.1 A letter has been sent to API asking to confirm the need for API CF-4. See Attachment **16**. The official response letter has not been received yet, but West Alexander has sent a letter stating that the API Lubricants Committee still needs API CF-4. See Attachment **17**. Chevron Oronite will keep their negative regarding the T-10 replacing the T-6. The next step is to move this on to Lyle Bowman for a subcommittee B ballot.

14.0 Fuel Sulfur measurement method.

14.1 Chris Laroo of the EPA stated that D2622, D5453, D7039 are acceptable methods for EPA compliance for ULSD. The appropriate Surveillance Panels and task forces will address this. No action is needed from the HDEOCP.

15.0 Next meetings

15.1 The Valve Train Wear Test Task Force (VTWTF) is tentatively planning a meeting late in the day October 11th.

15.2 The HDEOCP will meet October 12th in Chicago and October 27th in San Antonio. A meeting might be needed November 10th in Houston around the time of the NPRA. A meeting will be held December 6th at ASTM in Norfolk, VA.

16.0 The meeting was adjourned at 12:00 pm.

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

Crowne Plaza, Chicago O'Hare, Rosemont, IL (847-671-6350)
Wednesday September 21, 2005
8:00 am-1:00 pm

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

Desired Outcomes: **Complete PC-10 on time**

TOPIC	PROCESS	WHO	TIME
Agenda Review	• Desired Outcomes & Agenda	Group	8:00-8:10
Minutes Approval	• June 21 2005	Group	8:10-8:15
Membership	• Changes: Additions • Jim Moritz of PE new secretary	Jim Mc Geehan	8:15-8:20
Matrix Status	• Cummins ISB; Mack T-12; Caterpillar C13. • Timing of completion	John Zalar (Program Manager)	8:20-8:45
Mack T-12/T-11	• Mack T-12 analysis of data to-date • Mack T-11 proposal	Greg Shank	8:45-9:30
Cummins ISB	• Analysis of data to-date • Discussion	Dave Stehouwer Phil Scinto	9:30-10:00
Caterpillar C13	• Analysis of data to-date • Discussion	Abdul Cassim Elisa Santos	10:00-10:30
NCDT Report	• Mack T-12 or IIIG/IIIF for oxidations • Program timing and license..	Bill Runkle	10:30-11:00
Coffee break	• Collect room money!		11:00-11:15
Sulfated Ash Task-Force Report	• Precision of ASTM D 874: issues for PC-10 ash limits • Discussion/ Vote	Eric Olsen	11:15-11:45
Cummins ISM: PC-10	• Merit system and proposed limits. • Discussion/ Vote/Exit-Ballot	Group	11:45-12:15
API CF-4	• API Lubricants committee reply-need API CF-4	Jim Mc Geehan	12:15-12:30
Mack T-12	• Fuel sulfur method: ASTM D4294	Jim Moritz	12:30-12:45
Next Meetings	• October 12th Chicago • October 27th SWRi, San Antonio		12:45-1:00

HDEOCP CHICAGO, IL 9/21/05

	NAME	COMPANY	MEMBER
✓	JIM MORITZ	PE	NO
✓	W.A. RUNKLE	LUBRIZOL	YES
✓	ROBERT STOCKWELL	GM	YES
✓	CHRIS CASTANIEN	LZ	NO
✓	MATT URBANAK	SHELL	YES
	JIM MC GEEHAN	CHEVRON	YES
✓	Lewis Williams	Lubrizol	yes
✓	STEVEN HERZOG	ROHMAX USA, LP	YES
✓	Chris Laroo	EPA	No
✓	Heribert Nasch	ISP / EUROPE	NO
✓	Frank Fernandez	Chevron Oronite	YES
✓	DAVE STEHOUWER	CUMMINS	YES
✓	Steve Kennedy	ExxonMobil	yes
✓	Phil Scinto	LZ	NO
✓	Mesfin Belay	Detroit Diesel	yes
✓	Bill Place	Deere + Co.	No
✓	Scott Zechiel	DETROIT Diesel	NO
✓	HOWARD ROBINS	DANA CORPORATION	NO
✓	Joe Franklin	PE	No
✓	Scott HAROLD	CIBA	YES
✓	JOHN ZAKAR	ASTM TMC	NO
✓	HEATHER DEBAUN	INTERNATIONAL	YES
✓	ELISA SANTOS	Infineum	NO
✓	Joan Evans	INFINEUM	NO
✓	PAT FETTERMAN	INFINEUM	YES
✓	Ben Weber	SwRI	NO
✓	Bill Kleiser	ORONITE	yes
✓	Abdulhamid Cassim	CATERPILLAR	YES
✓	David Smith	API	NO
✓	Cathy Derlin	Afton Chemical	NO
✓	TOM COUSINEAU	AFTON CHEMICAL	NO
✓	Dan Pridemore	Afton Chemical	No

HDEOCP CHICAGO, IL 9/21/05

	Name	Company	Member
✓	Roger Gault	EMA	NO
✓	KEN CHAO	John Deere	Yes
✓	GREG SHANK	Volvo Powertrain N.A.	YES
✓	Con Buck	Test Engineering	NO
✓	BRAD CARTER	PERKINELMER	NO
✓	ERIC OLSEN	ORONITE	NO
✓	Jason Bowden	OH Technologies, Inc.	NO
✓	TED SELBY	SAVANT, Inc.	No

PC-10 Matrix Progress
9/21/05

Test Type	Planned Tests	Tests Started	Aborted / Invalid	Completed Tests[a]
T-12	16	20	4	15[b]
ISB	15	18	3	13[c]
C13	26	27	1	22[d]

[a] Operationally valid and reported to the TMC
[b] Final T-12 test has reached EOT
[c] Final two ISB tests have reached EOT
[d] Three out of four remaining C13 tests have reached EOT
Final C-13 test expected to reach EOT by 9/23

Mack T-12
Precision Matrix Preliminary Analyses

Presented to T-12 Task Force
September 8&9, 2005

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Observations

1. As of September 6, 30 tests in LTMS, 21 tests in Hardware.
2. One test missing ring and liner measurements.
3. One lab miscalculated TGAAVG.
4. From pictures, still looks like rings affected ring wear with one anomaly.
5. Matrix test outside soot window high on Pb 0 to 300. Maybe not a general trend. Doesn't appear to affect other performance criteria.
6. Pb relationship to UBWL still there but weaker.
7. First model using valid Hardware data: lab, stand within lab, oil, rings.
   - No transforms obvious.
   - Rings only significantly affect top ring weight loss.
8. Top Ring Weight Loss –
   – Only rings significant, not lab, stand, nor oil.
   – M: 95; N: 54
9. Cylinder Liner Wear – labs, stands, and oils significant, no big residuals
10. DPb0300, OC, & DPb250300 –
    - Lab, stand, and oil not significant.
    - One big residual for each (the same test for the Pb's)
11. E_p criterion met for oil consumption when using only new rings and for cylinder liner wear whether or not old rings are included.

Cylinder Liner Wear Analyses

D	CLWFNL LSMEAN	LSMEAN Number
0-2	21.7857828	1
C10B	14.1266919	2
C10E	16.8979040	3

TMSAPP	LTMSLAB	CLWFNL LSMEAN	LSMEAN Number
	A	23.5176768	1
	A	18.5941919	2
	B	18.5544192	3
	D	12.0294192	4
	F	19.6176768	5
	G	13.7441919	6
	G	22.9176768	7
	G	13.6176768	8

TMSLAB	CLWFNL LSMEAN	LSMEAN Number
	21.0559343	1
	18.5544192	2
	12.0294192	3
	19.6176768	4
	16.7598485	5

Least Squares Means for effect IND
Pr > |t| for H0: LSMean(i)=LSMean(j)
Dependent Variable: CLWFNL

i/j	1	2	3
1		<.0001	0.0051
2	<.0001		0.0998
3	0.0051	0.0998	

Least Squares Means for effect LTMSAPP(LTMSLAB)
Pr > |t| for H0: LSMean(i)=LSMean(j)
Dependent Variable: CLWFNL

i/j	1	2	3	4	5	6	7	8
1		0.4041	0.3605	0.0038	0.6814	0.0157	1.0000	0.0437
2	0.4041		1.0000	0.0078	0.9985	0.0492	0.5453	0.3927
3	0.3605	1.0000		0.0069	0.9974	0.0585	0.4993	0.3661
4	0.0038	0.0078	0.0069		0.0139	0.8905	0.0057	0.9932
5	0.6814	0.9985	0.9974	0.0139		0.0890	0.8180	0.2388
6	0.0157	0.0492	0.0585	0.8905	0.0890		0.0240	1.0000
7	1.0000	0.5453	0.4993	0.0057	0.8180	0.0240		0.0624
8	0.0437	0.3927	0.3661	0.9932	0.2388	1.0000	0.0624	

DPb0300, OC, & DPb250300 Analyses

IND	DPBFNL LSMEAN	LSMEAN Number
820-2	20.9304293	1
PC10B	30.6577020	2
PC10E	31.1273990	3

DPBFNL	LTMSLAB	LTMSAPP	IND	predicted_DPBFNL	residual_DPBFNL	student_DPBFNL	rstudent_DPBFNL
43	A	4	PC10E	28.5341	14.4659	2.45850	3.49231

IND	OCFNL LSMEAN	LSMEAN Number
820-2	70.2803662	1
PC10B	64.0712753	2
PC10E	68.4424874	3

OCFNL	LTMSLAB	LTMSAPP	IND	predicted_OCFNL	residual_OCFNL	student_OCFNL	rstudent_OCFNL
86.4	B	1	PC10E	71.6239	14.7761	2.34041	3.14937

IND	DPB2FNL LSMEAN	LSMEAN Number
820-2	8.7532828	1
PC10B	9.8441919	2
PC10E	12.9654040	3

DPB2FNL	LTMSLAB	LTMSAPP	IND	predicted_DPB2FNL	residual_DPB2FNL	student_DPB2FNL	rstudent_DPB2FNL
23	A	4	PC10E	14.1136	8.88636	2.57708	3.90347

Precision Analyses

	New and Old Rings		New Rings Only		MAD Survey Median
	S_{pp}	E_p	S_{pp}	E_p	
ΔPb0-300	7.9	0.57	10.4	0.43	4.5
ΔPb250-300	4.6	0.43	8.4	0.24	2
Cylinder Liner Wear	1.9	2.11	0.9	4.44	4
Top Ring Weight Loss	18.7	0.67	22.4	0.56	12.5
Oil Consumption	8.5	0.82	3.8	1.84	7

Mack T-12
Straw Man Merit Rating

Presented to T-12 Task Force
September 9, 2005

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Mack T-10 Merit Parameters

Criterion	EOT Delta Pb	250-300 Hour Delta PB	Cylinder Liner Wear	Top Ring Weight Loss	Oil Consumption
Weight	225	225	250	150	150
Maximum	35	12	32.0	158	65.0
Anchor	30	10	30	140	57
Minimum	5	0	12	50	25

Conversion from T-10 to T-12 Merit Parameters

	T-10					T-12				
	Min	Anchor	Max	820-2 Mean	820-2 sd	820-2 Mean	sd	Min	Anchor	Max
ΔPb0-300	5	30	35	25	0.2339	20.9	7.9	4	20	36
ΔPb250-30	0	10	12	9.0	3.5	8.8	4.6	-2	7	16
Cylinder Liner Wear	12	30	32.0	32.0	4.2	21.8	1.9	16	20	24
Top Ring Weight Loss	50	140	158	109	18	49.6	18.7	13	50	87
Oil Consumption	25	57	65.0	52.9	7.2	70.3	8.5	43	60	77

Mack T-12 Merit Parameters

Criterion	EOT Delta Pb	250-300 Hour Delta PB	Cylinder Liner Wear	Top Ring Weight Loss	Oil Consumption
Weight	200	200	250	200	150
Maximum	36	16	24	87	77
Anchor	20	7	20	50	60
Minimum	4	-2	16	13	43

		EOT Delta Pb	250-300 Hour Delta PB	Cylinder Liner Wear	Top Ring Weight Loss	Oil Consumption	Calculated Merit	**Final Merit**
On the border		20	7	20	50	60	1000	**1000**
Borderline Failures		**21**	7	20	50	60	988	**988**
		20	**8**	20	50	60	978	**978**
		20	7	**21**	50	60	938	**938**
		20	7	20	**51**	60	995	**995**
		20	7	20	50	**61**	991	**991**
One parameter can make up for another		**21**	**6**	20	50	60	1010	**1010**
		20	**8**	**19**	50	60	1040	**1040**
		20	7	**21**	**38**	60	1002	**1002**
		20	7	20	**51**	**59**	1003	**1003**
		19	7	20	50	**61**	1004	**1004**
Over Maximum Failures		37	7	20	50	60	788	**Fail**
		20	17	20	50	60	778	**Fail**
		20	7	25	50	60	688	**Fail**
		20	7	20	88	60	795	**Fail**
		20	7	20	50	78	841	**Fail**
55216	820-2	24	14	22	44	63	672	**672**
55213	820-2	25	11	20	30	76	799	**799**
55205	820-2	14	5	22	56	77	808	**Fail**
55217	820-2	12	6	22	42	64	1018	**1018**
55715	820-2	20	8	18	56	67	1020	**1020**
55722	820-2	20	7	15	45	60	1275	**1275**
56562	PC10B	40	17	11	41	65	782	**Fail**
55728	PC10B	34	12	15	44	62	980	**980**
56010	PC10B	30	8	9	31	61	1195	**1195**
55712	PC10B	24	8	15	46	60	1196	**1196**
55713	PC10E	43	23	17	35	57	678	**Fail**
55725	PC10E	25	8	11	106	62	841	**Fail**
55718	PC10E	18	7	13	36	63	1328	**1328**

Mack T-11 Analysis

Sept 9,2005

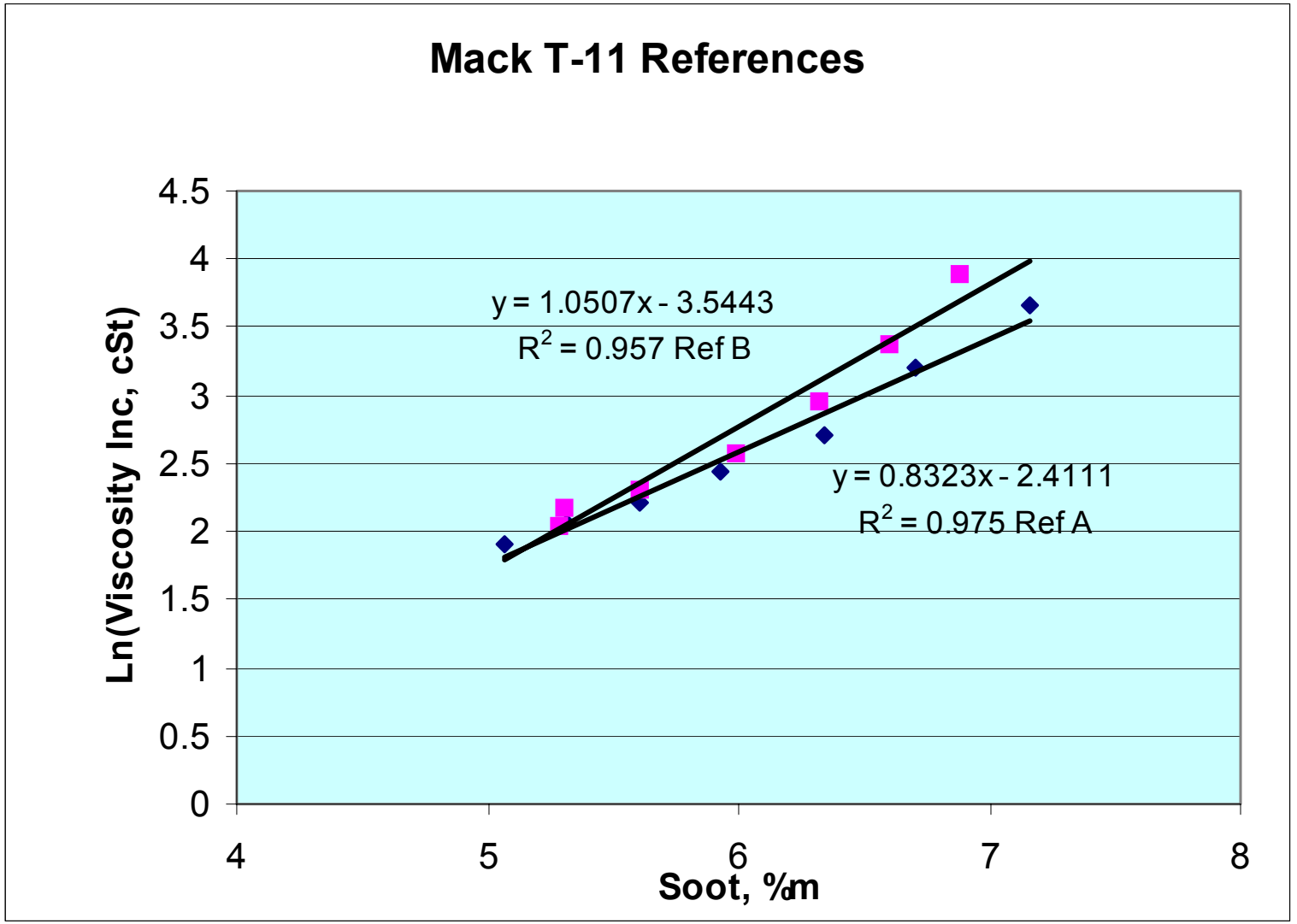
Mack T-11 Test Analysis

- The current T-11 test method provides protection from oils with excessive soot thickening
- The current reference oil 820-2 is a failing oil
- Some oils which give thickening rates similar to 820-2 can pass the T-11 test.
- The slope of the viscosity increase versus soot relationship can provide additional verification of oil performance

Mack T-11 Test Analysis

- The slope of the viscosity versus soot relationship was determined for several oils
- Results from 180 through 252 hours were plotted vs. the soot
- The natural log of the viscosity increase and the absolute viscosity measured by the rotational method at 100 C (decreasing) were both evaluated
- A linear least squares regression line was fitted to the data and the slopes of these lines were compared

Log of the Kinematic Viscosity Increase Reference tests on 820-2

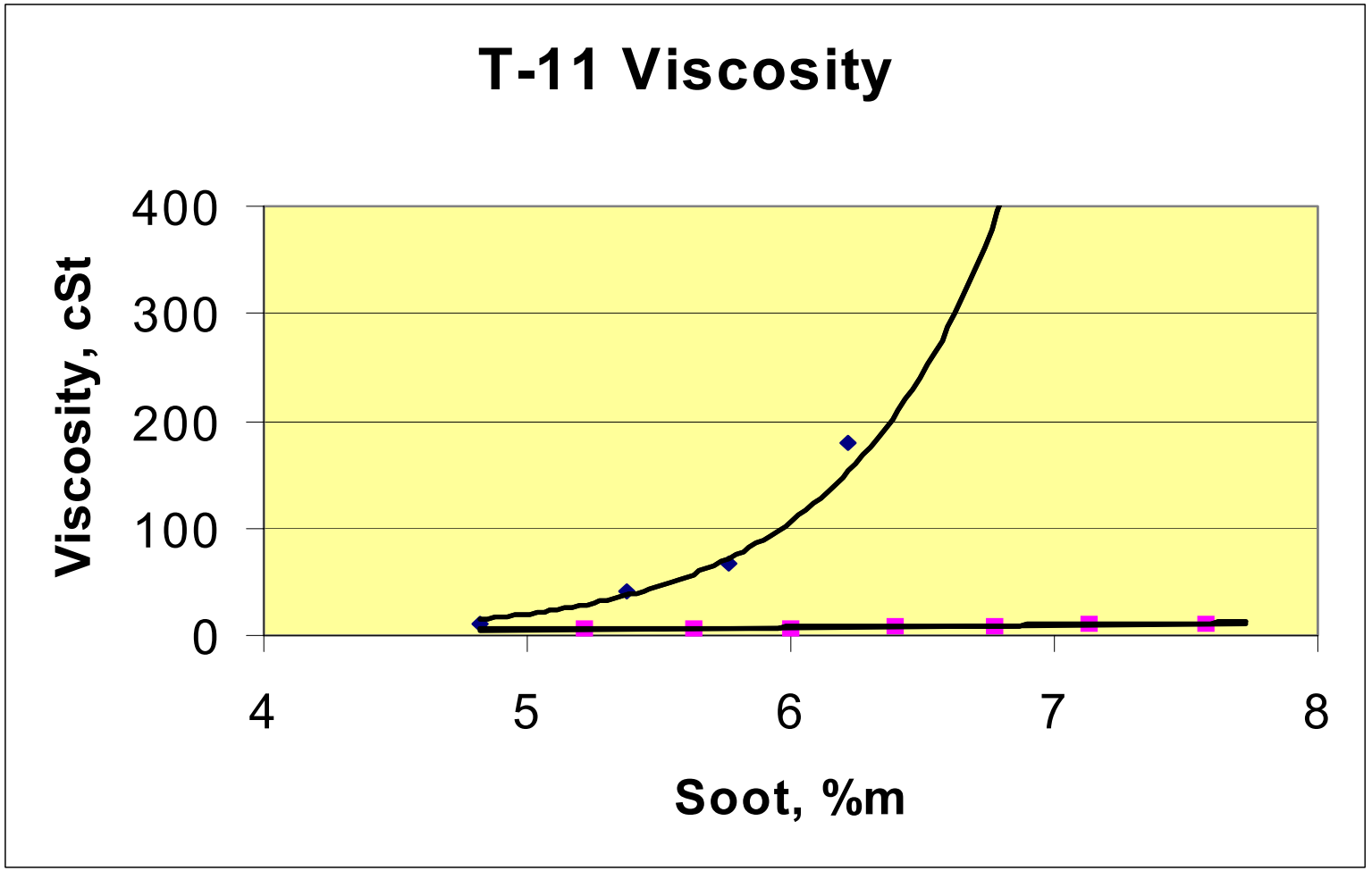


Recent T-11 Reference Tests. 820-2
Least Squares fit of the Log of the Viscosity Increase from 180 to 252 hours

Test Key	LAB	Slope	RSq
54659	A	0.3668	0.885
51960	D	1.0506	0.9577
49058	A	0.4901	0.9783
54198	G	0.5129	0.9491
50223	F	1.1325	0.9659
53889	G	0.5617	0.8547
49056	A	0.9726	0.9567
53812	G	1.0425	0.9778
53811	G	1.0879	0.984
52782	G	1.2245	0.939

Mack T-11 Tests Passing and Failing Oils

(Good Oil >7.6% soot @ 12 cSt, Poor Oil = 4.8% soot @ 12 cSt)



Mack T-11 Tests Passing and Failing Oils

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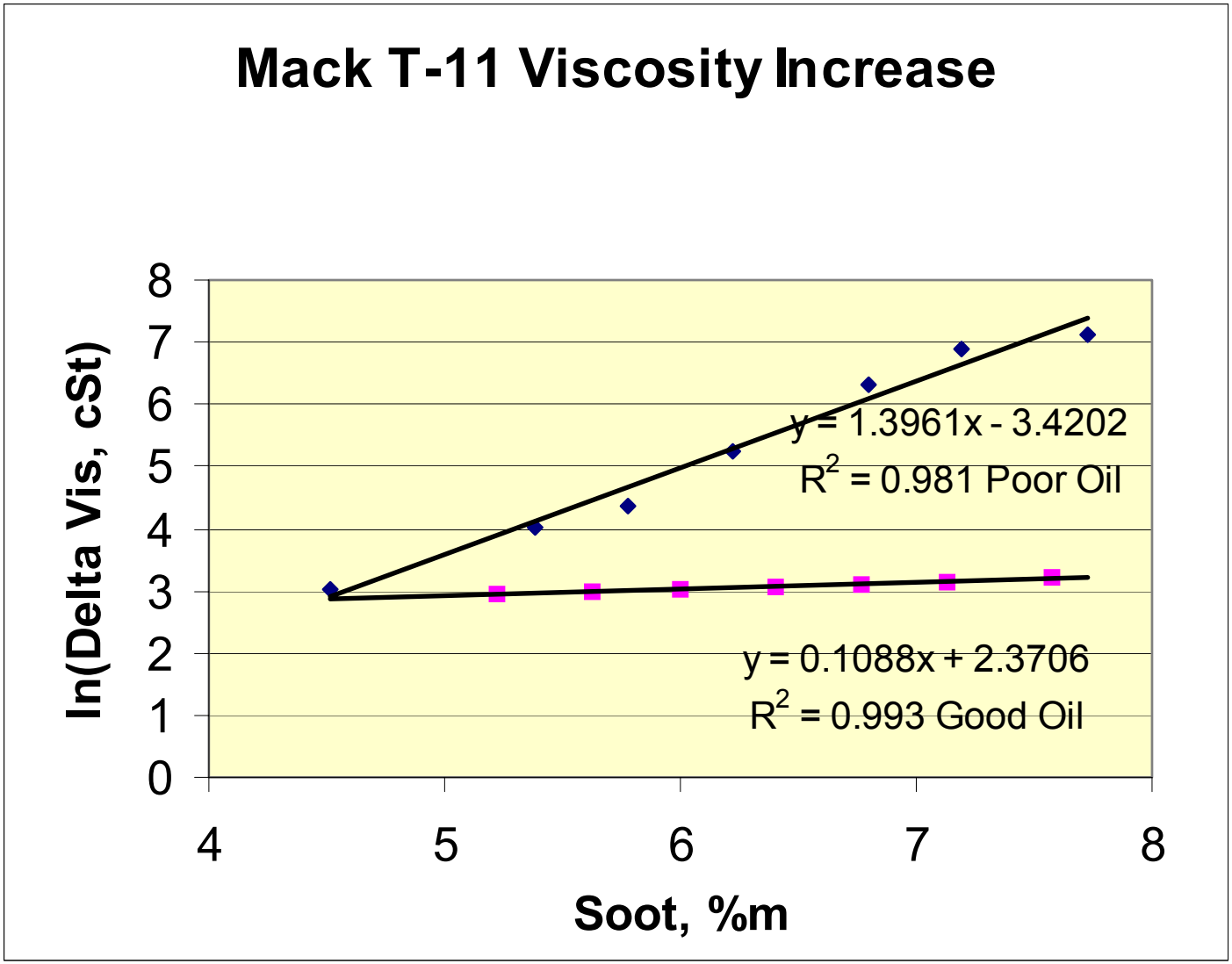
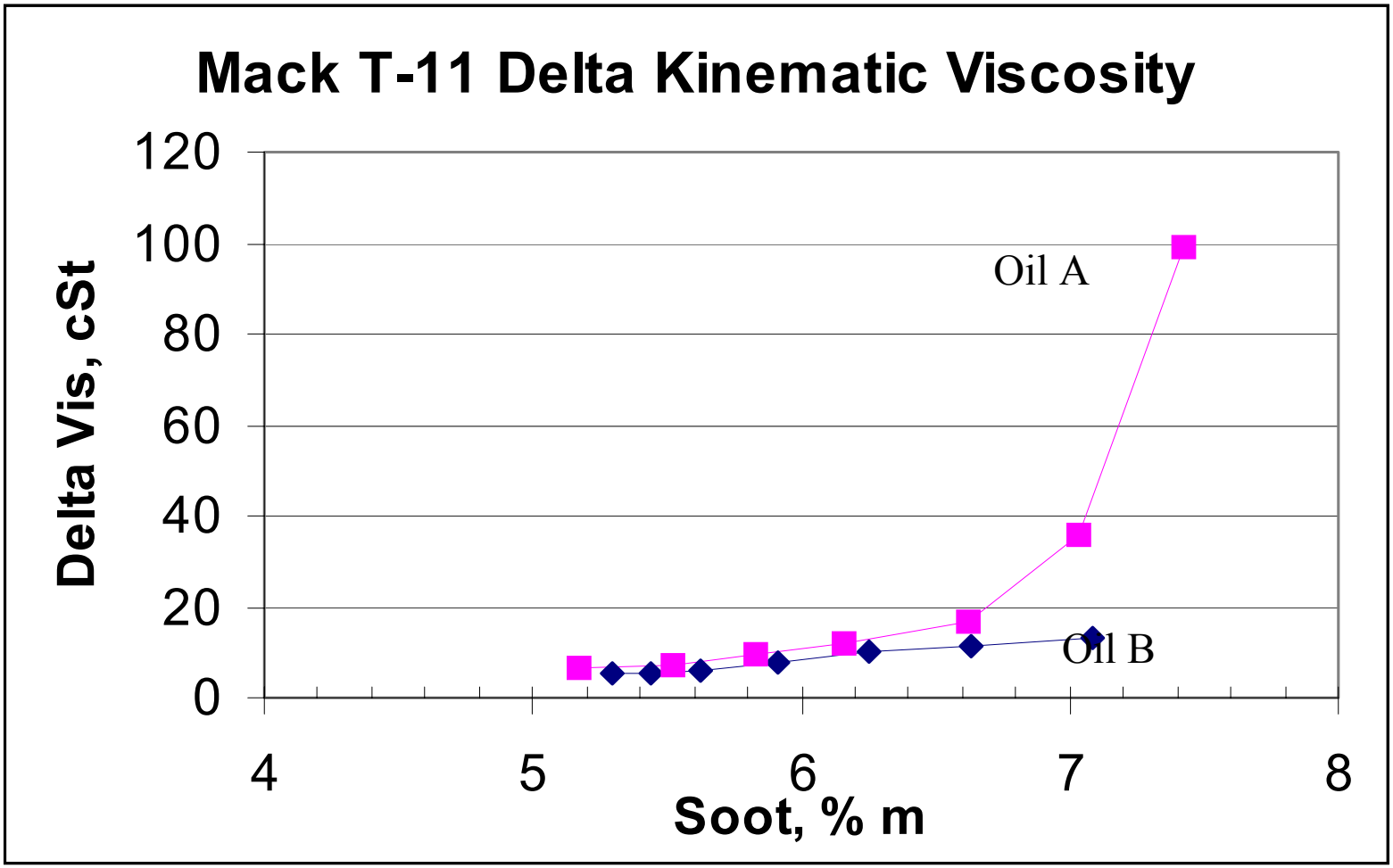


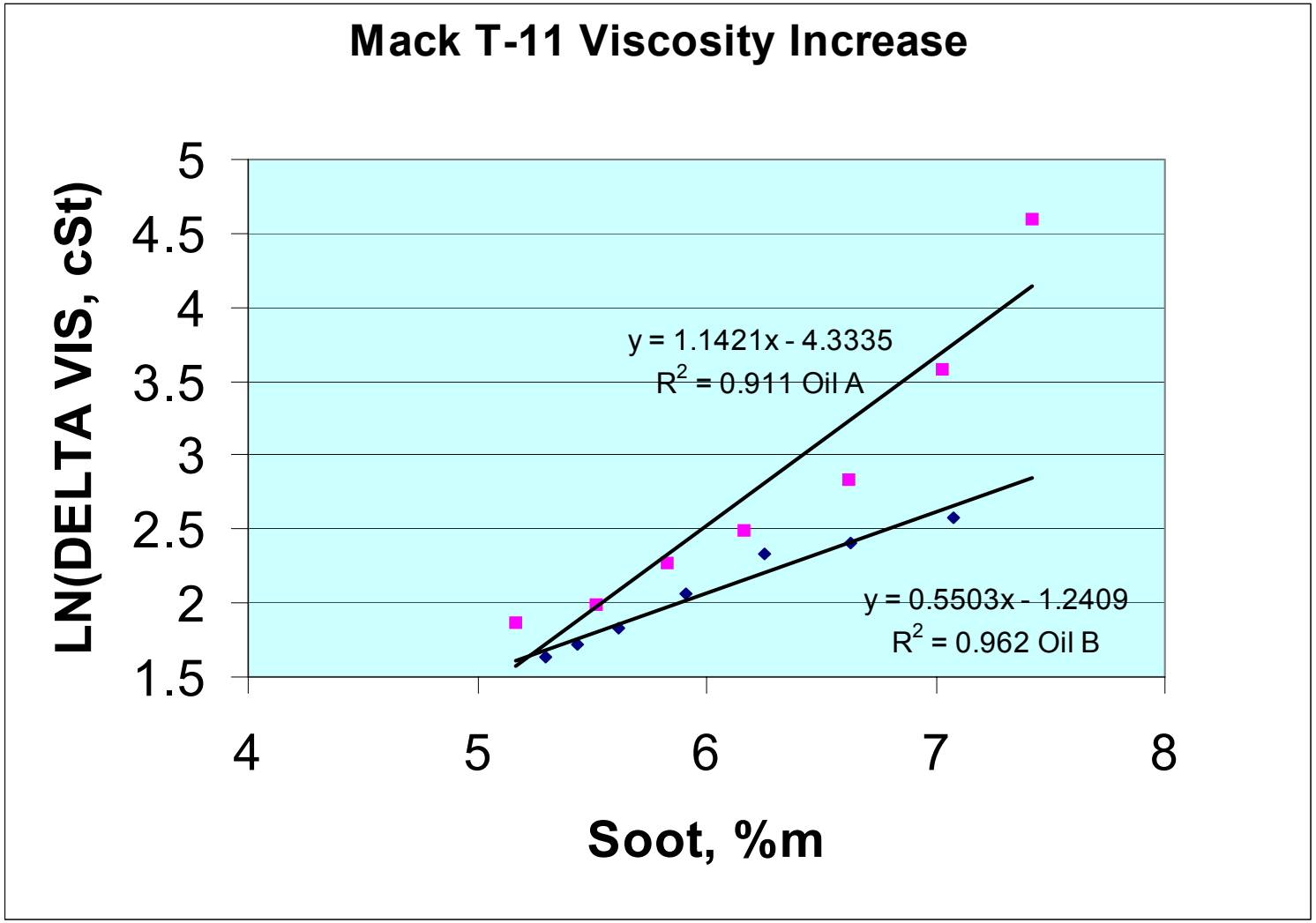
Mack T-11 Tests Passing Oils

(Oil A = 6.14% soot @ 12 cSt, Oil B = 6.83% soot @ 12 cSt)



Mack T-11 Tests Passing Oils

(Oil A = 6.14% soot @ 12 cSt, Oil B = 6.83% soot @ 12 cSt)



Slope of the Natural Log of the Kinematic Viscosity Increase with Soot

- Poor Oils > 0.8
- Marginal Oils 0.5 – 0.8
- Good Oils < 0.5

- Continue the current Pass/Fail Requirement At 12 cSt

ISB Cam and Tappet Test
Industry Report Packet

David Stehouwer

September 2005

ISB Matrix Data

ISB Matrix Results

DATE	TGA100	Cam Wear ACSW	Tappet WL ATWL	Outlier S OSATWL	Crosshead ACWL	Outlier S OSACWL	Adj Screw VASL	Outlier S OSVASL
20050713	3.4	32.8	63.7	63.7	1.3	1.3	1.6	0.79
20050804	3.4	45.7	106.9	106.9	2.4	2.3	1.9	1.69
20050624	3.4	41.3	98.4	98.4	2.9	2.8	1.2	1.18
20050629	3.2	27.1	72.8	72.8	1.8	1.5	2.2	2.18
		43.1	93.9		2.1		5.3	
Mean		**38.0**	**87.1**	**85.4**	**2.1**	**2.0**	**2.4**	**1.46**
SdDev		**7.8**	**18.2**	**20.5**	**0.6**	**0.7**	**1.7**	**0.60**
20050606	3.3	45.6	82.9	82.9	1.5	1.5	1.2	1.17
20050801	3.3	42.2	83.2	83.2	1.8	1.8	2.4	1.64
20050604	3.3	44.1	97.7	97.7	2.9	2.9	3.3	2.32
20050717	3.0	30.8	71.9	71.9	1.9	1.9	1.5	0.80
		39.4	64.6		2.3		1.9	
Mean		**40.4**	**80.1**	**83.9**	**2.1**	**2.0**	**2.1**	**1.48**
SdDev		**5.9**	**12.6**	**10.6**	**0.5**	**0.6**	**0.8**	**0.66**
20050627	3.3	26.5	44.4	44.4	1.5	1.3	2.3	2.13
20050715	3.3	42.0	73.1	73.1	2.6	2.4	3.3	2.70
20050711	3.3	35.3	67.4	65.2	1.9	1.9	1.4	1.27
20050730	3.2	32.3	46.0	43.6	2.1	2.1	1.5	1.23
20050805	3.3	34.3	48.9	48.9	1.9	1.9	1.1	1.07
Mean		**36.0**	**58.9**	**57.7**	**2.1**	**2.1**	**1.8**	**1.56**
SdDev		**4.2**	**13.4**	**13.8**	**0.3**	**0.3**	**1.0**	**0.76**

Next Steps

- **Preliminary Statistical Analysis to HDEOCP**
  - ✓ **September 21**
- **Review by ISB Surveillance Panel**
  - ✓ **Early October**
- **Presentation to HDEOCP**
  - ✓ **October 12**

Cummins ISB
Preliminary-Unofficial
Matrix Analysis

Phil Scinto

HDEOCP – Chicago

September 21, 2005

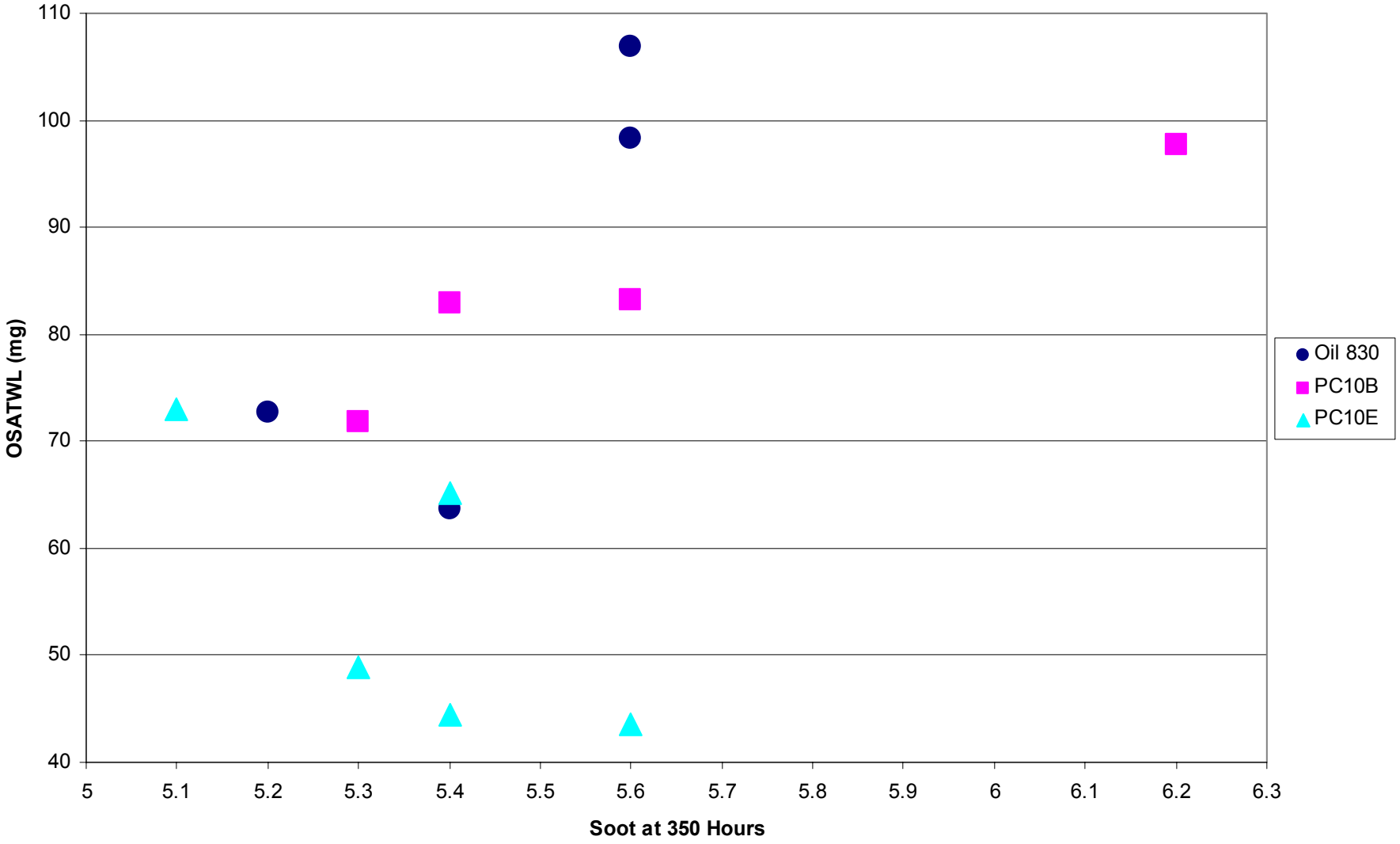
Analysis Summary

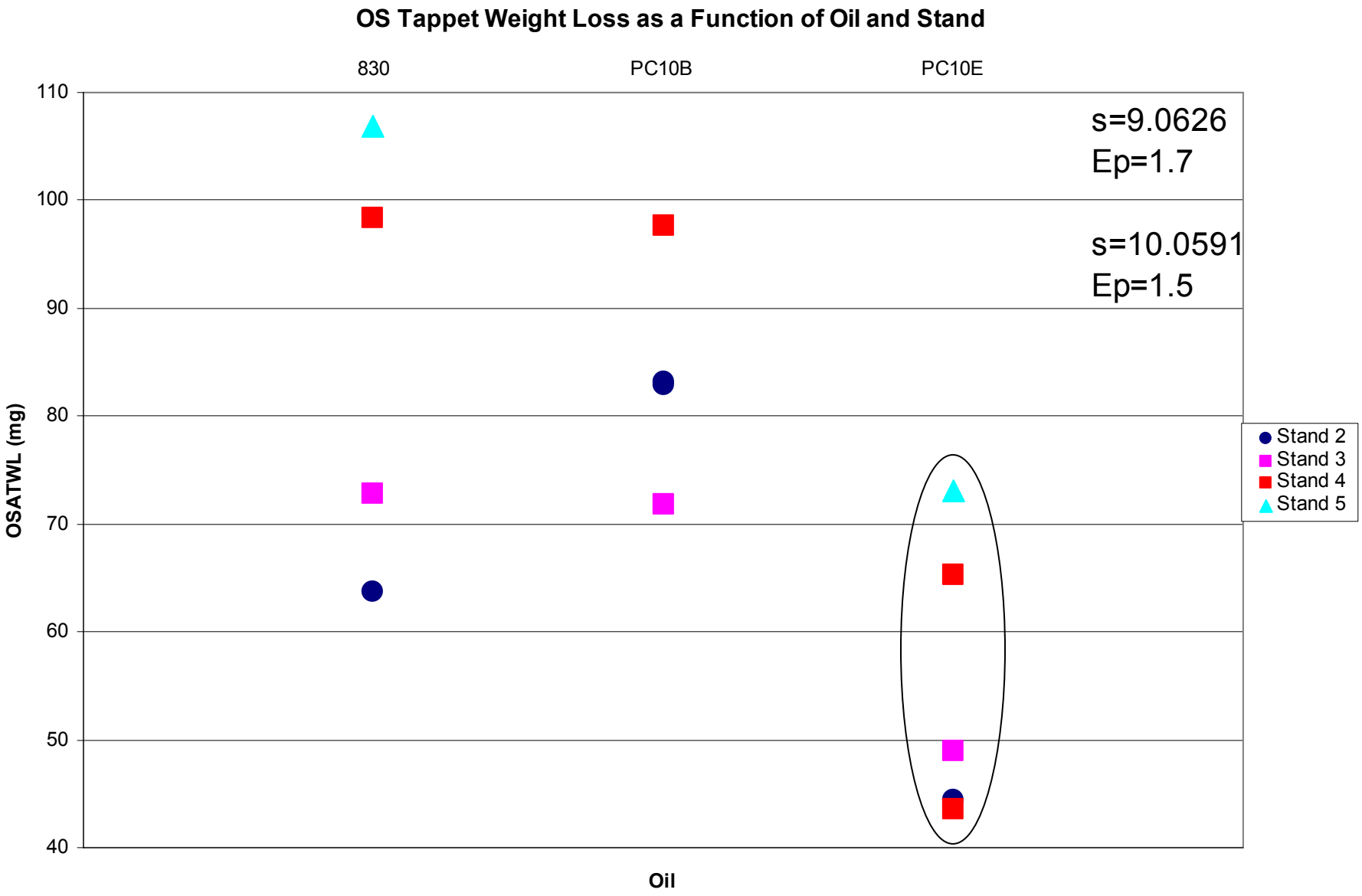
- 15 Valid Matrix Tests – Matrix Complete
  - 2 Results from Lab B Yet to be Uploaded
- E178 (95% CI) Used on Wear Results
  - Tappet Weight Loss – 2 of 13 Tests Affected
  - Crosshead Weight Loss – 5 of 13 Tests Affected
  - Valve Adjusting Screw – ***9 of 13 Tests Affected***
  - Cam Wear – Collecting Individual Cam Results
- Wear Relationship with Soot Inconsistent

Analysis Summary

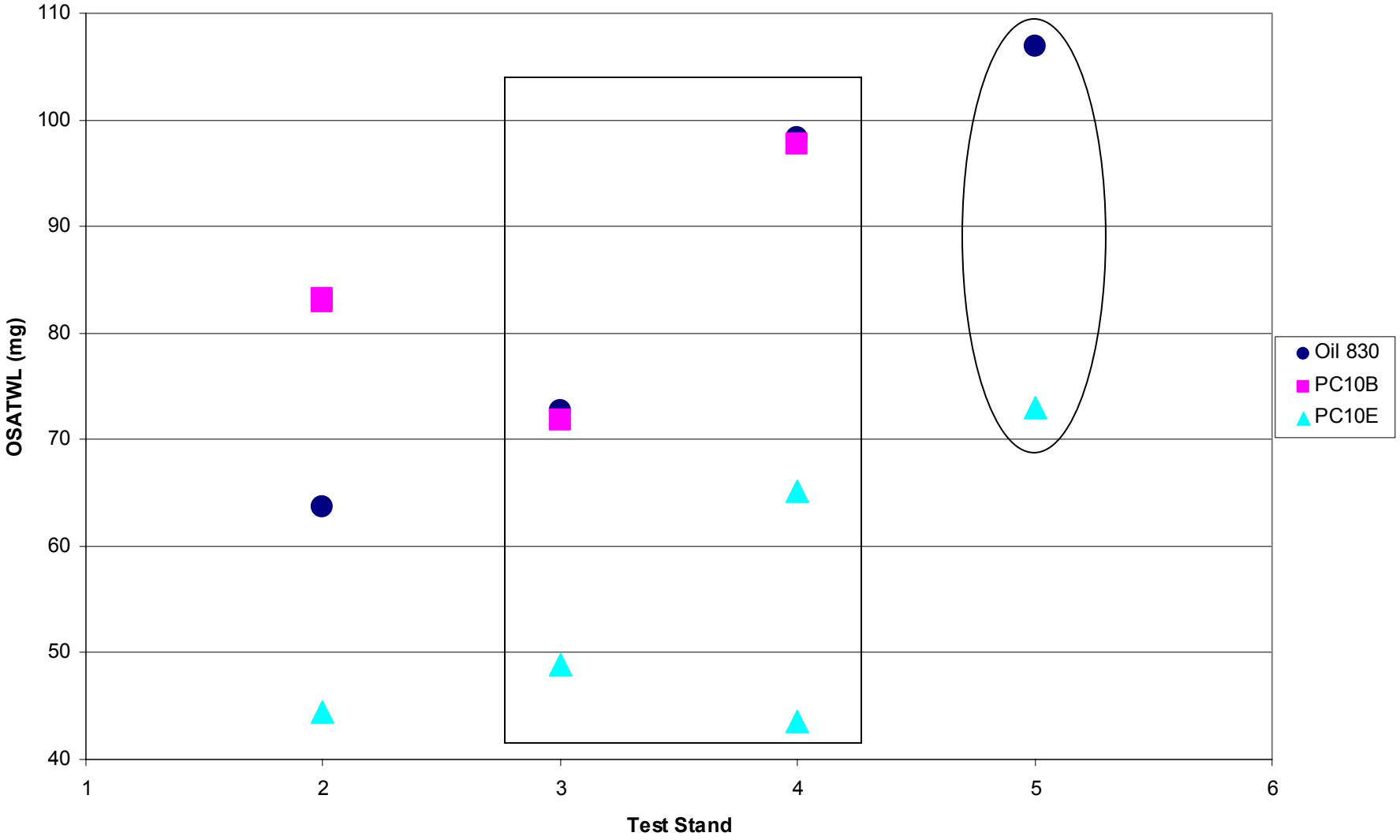
- Average Tappet Weight Loss
  - Oil Discrimination
  - Lab Differences and Stand within Lab Differences
- Average Crosshead Mass Loss
  - Lab Differences and Stand within Lab Differences
  - May Need a Natural Log Transformation
- Average Camshaft Wear
  - Lab Differences and Stand within Lab Differences
- Valve Adjusting Screw Weight Loss
  - No Discrimination
  - May Need a Natural Log Transformation

OS Tappet Weight Loss as a Function of Oil and Soot

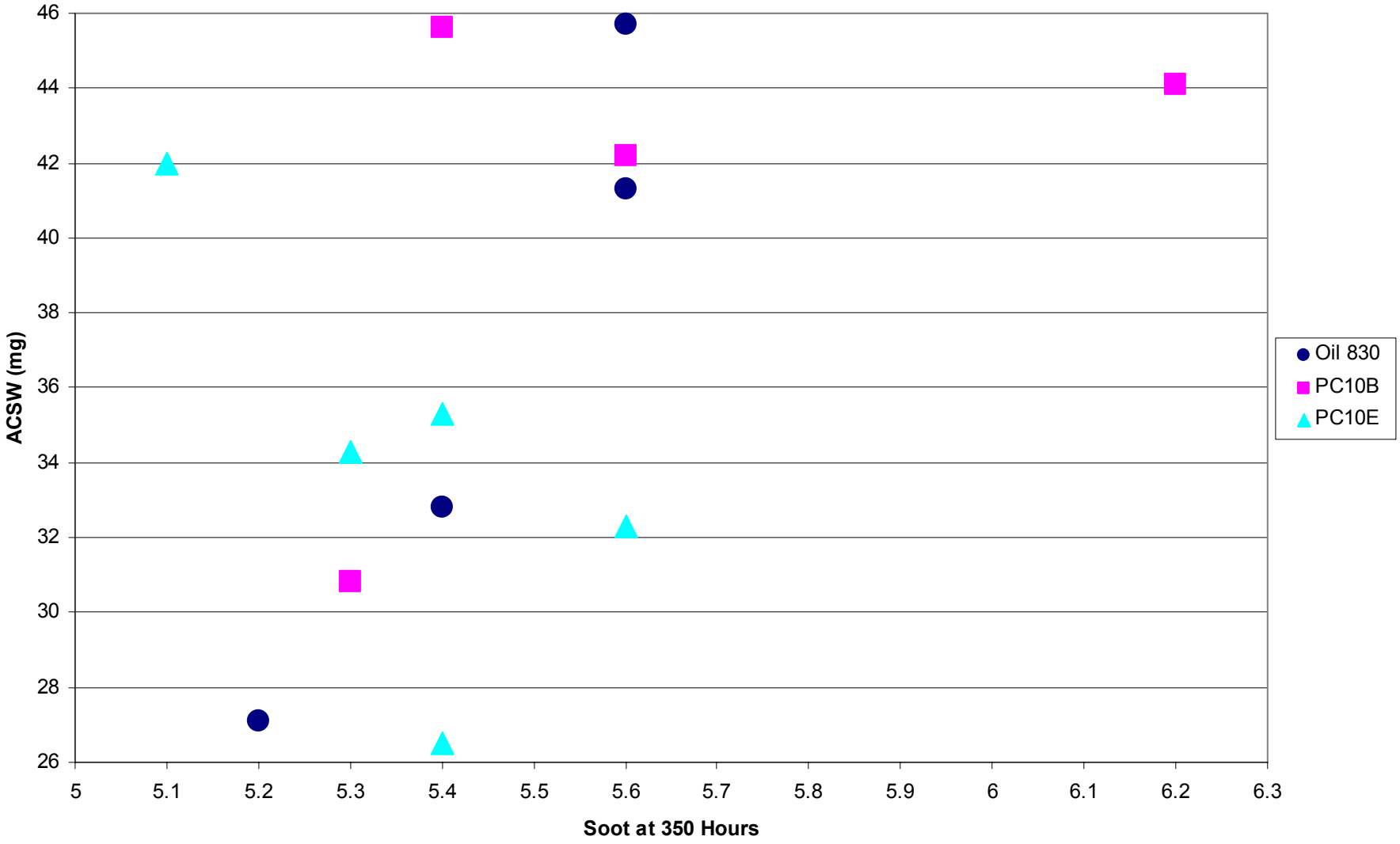


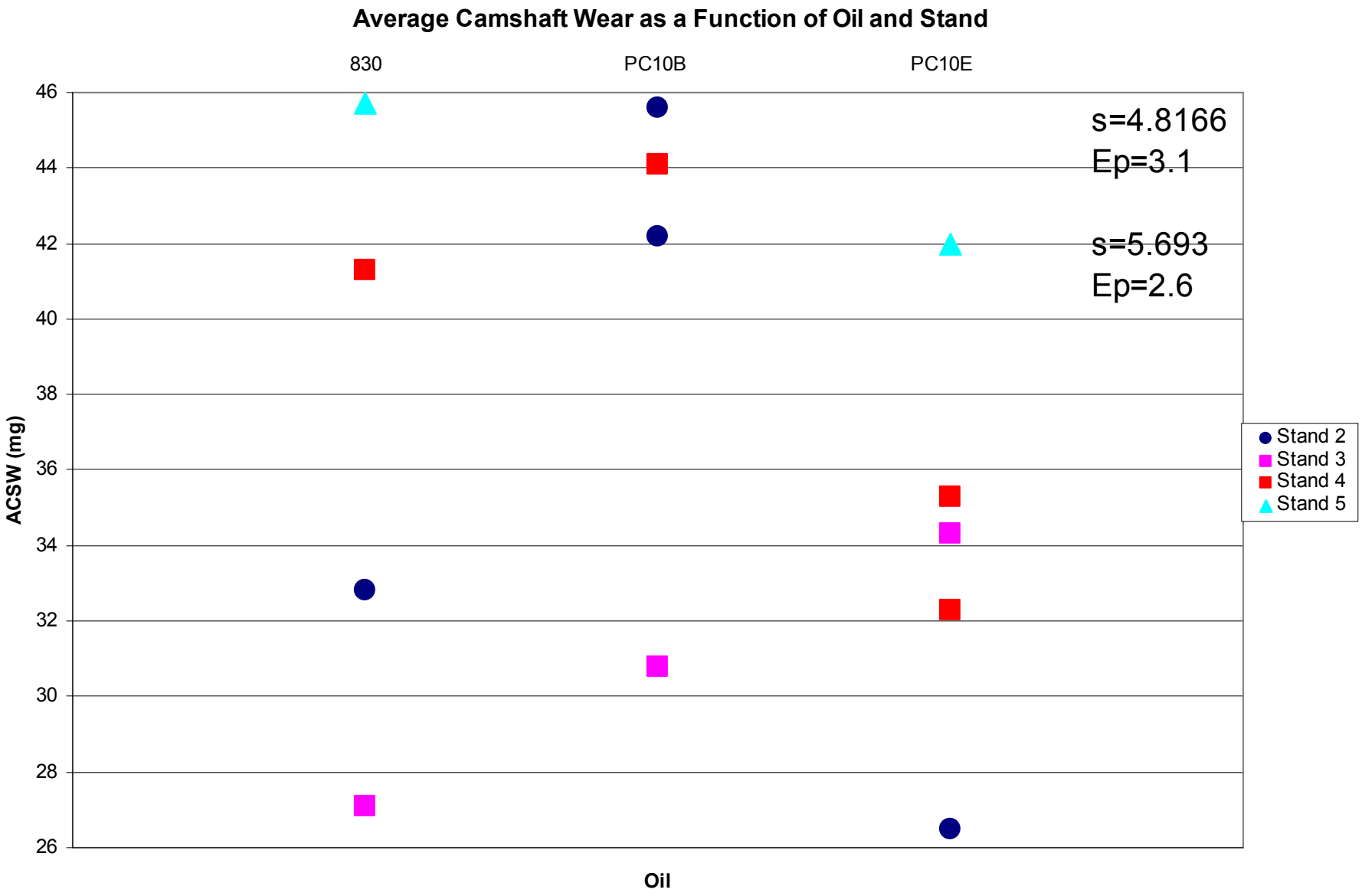

OS Tappet Weight Loss as a Function of Oil and Stand
830
PC10B
PC10E
110
100
90
80
70
60
50
40
OSATWL (mg)
s=9.0626
Ep=1.7
s=10.0591
Ep=1.5
Stand 2
Stand 3
Stand 4
Stand 5
Oil

OS Tappet Weight Loss as a Function of Stand and Oil

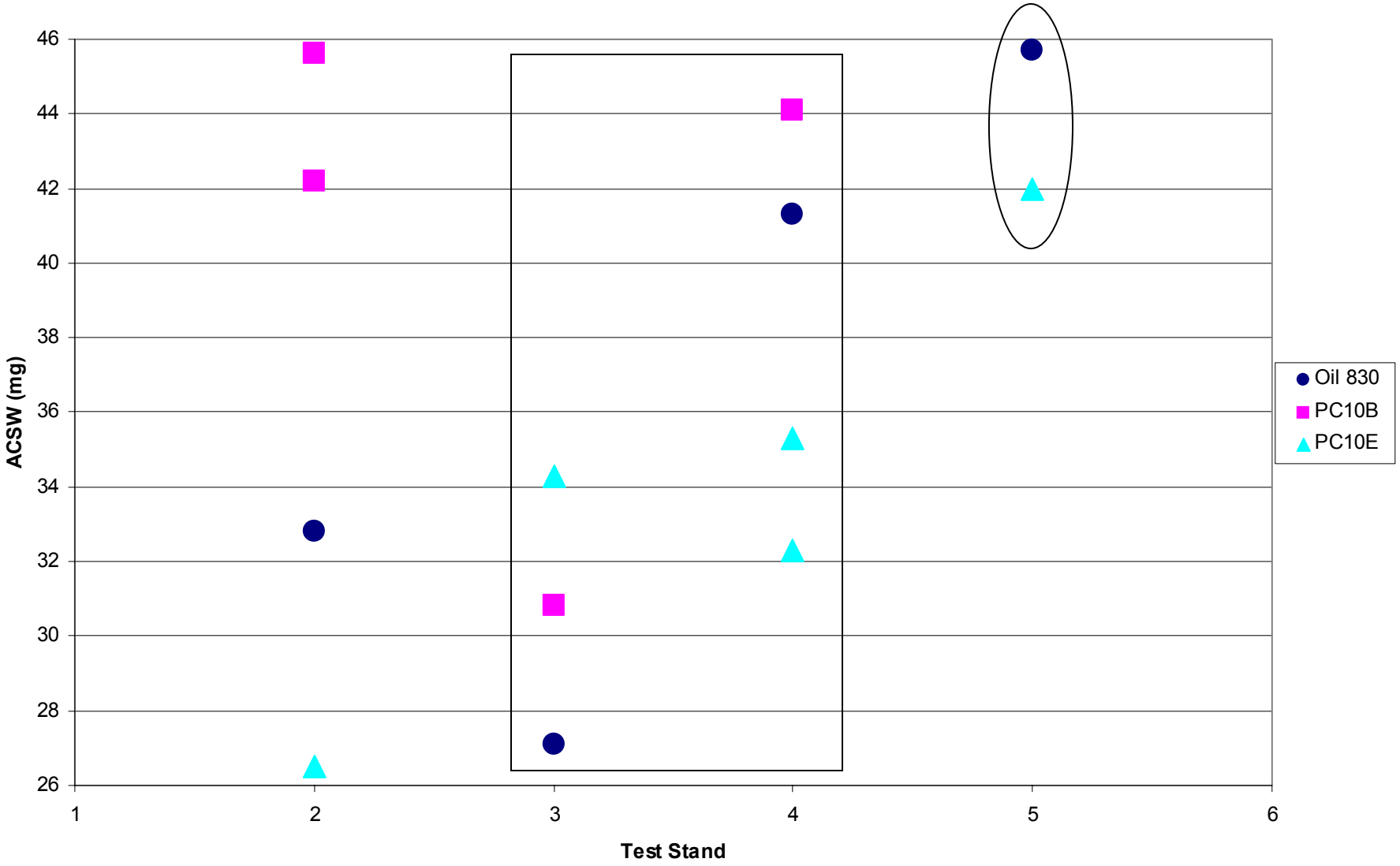


Average Camshaft Wear as a Function of Oil and Soot

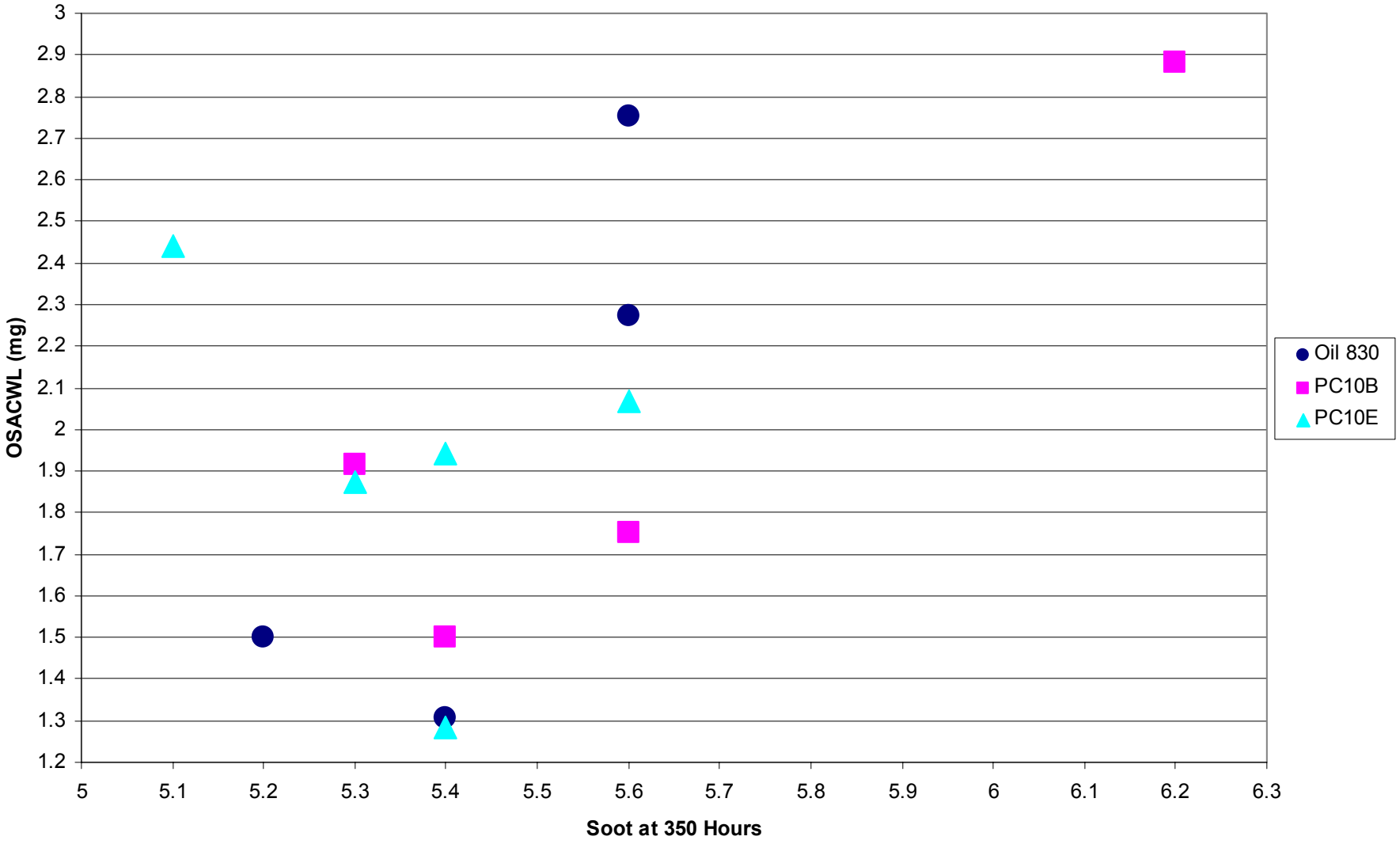


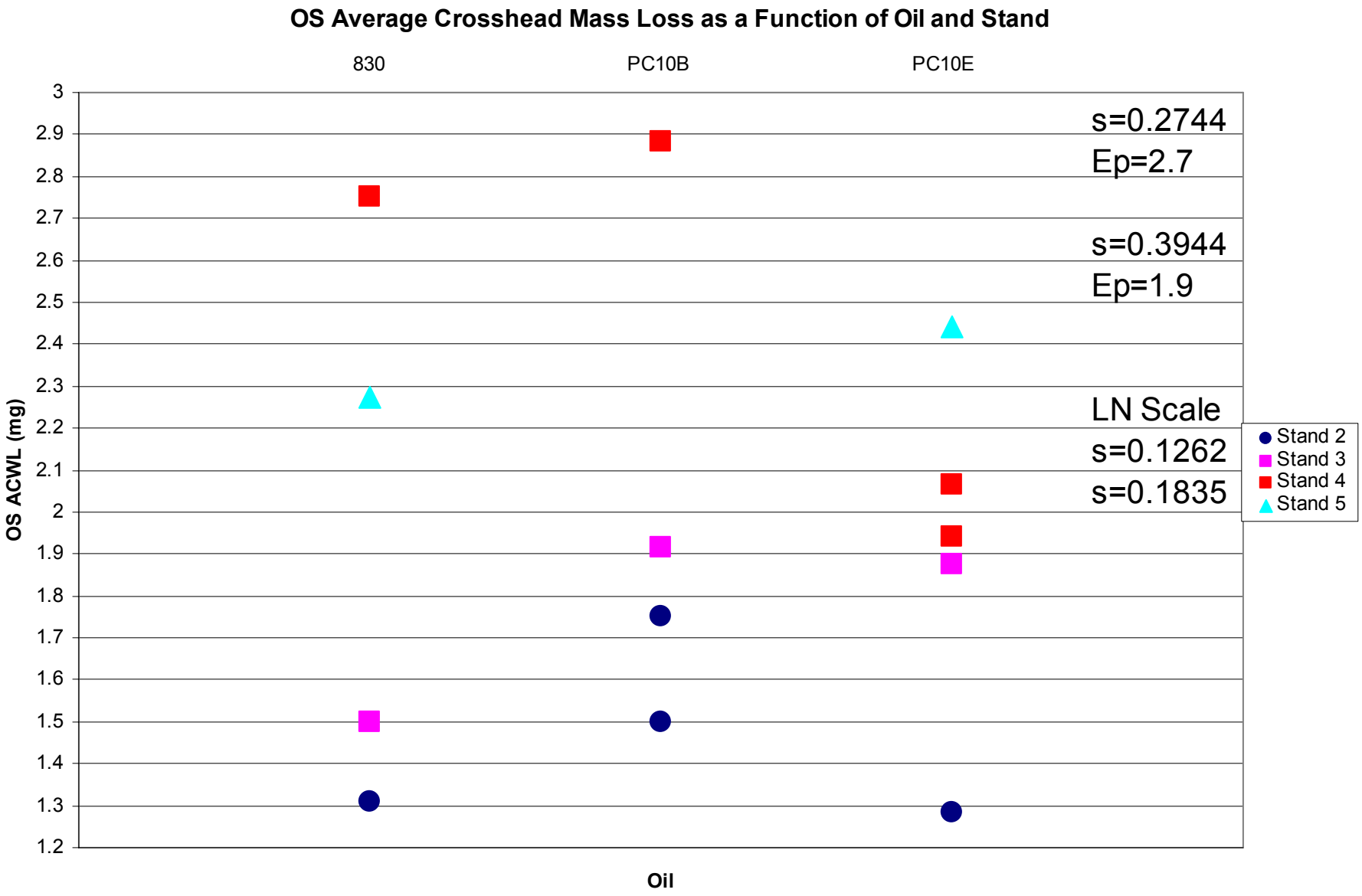

Average Camshaft Wear as a Function of Oil and Stand
830
PC10B
PC10E
46
44
42
40
38
36
34
32
30
28
26
ACSW (mg)
s=4.8166
Ep=3.1
s=5.693
Ep=2.6
Stand 2
Stand 3
Stand 4
Stand 5
Oil

Average Camshaft Wear as a Function of Stand and Oil

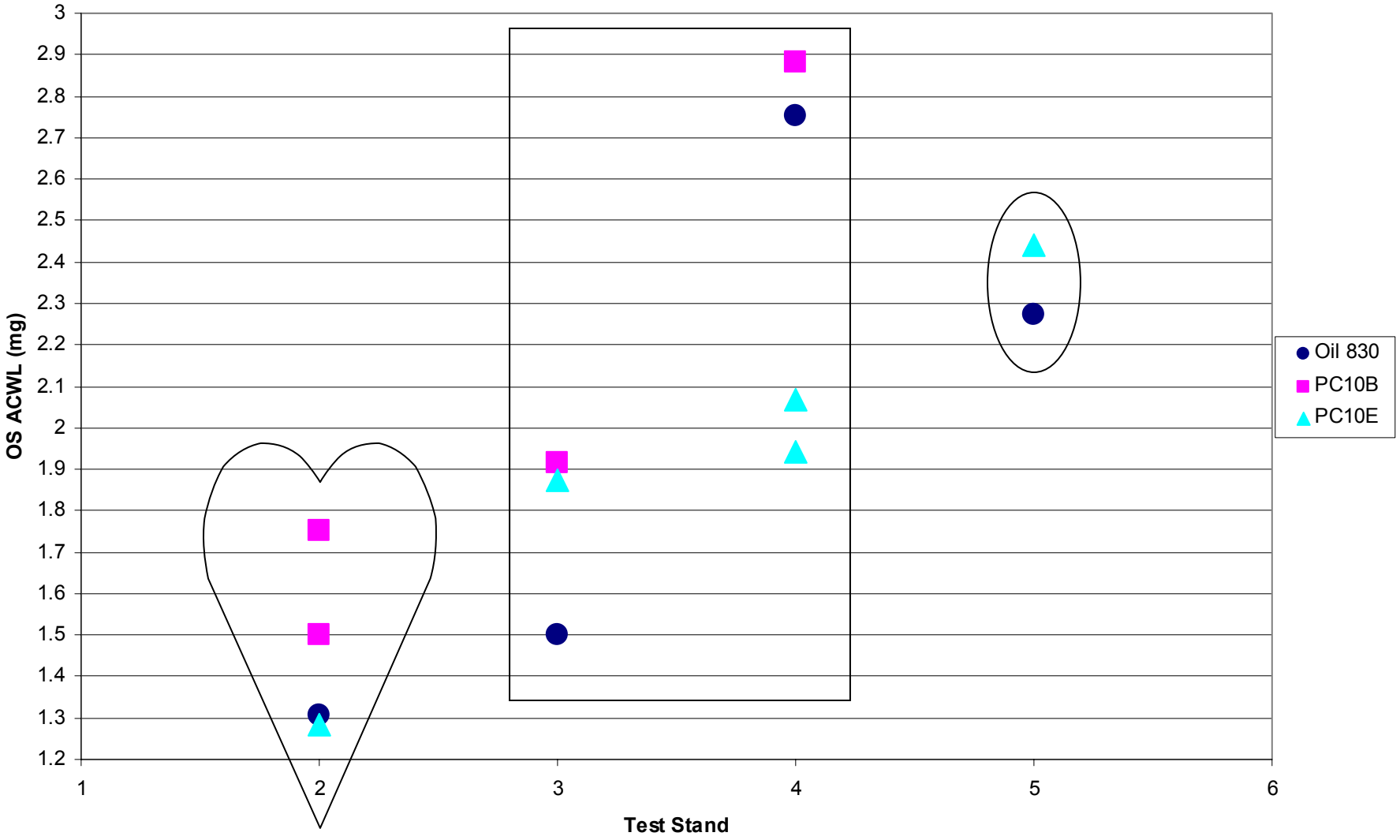


OS Average Crosshead Mass Loss as a Function of Oil and Soot

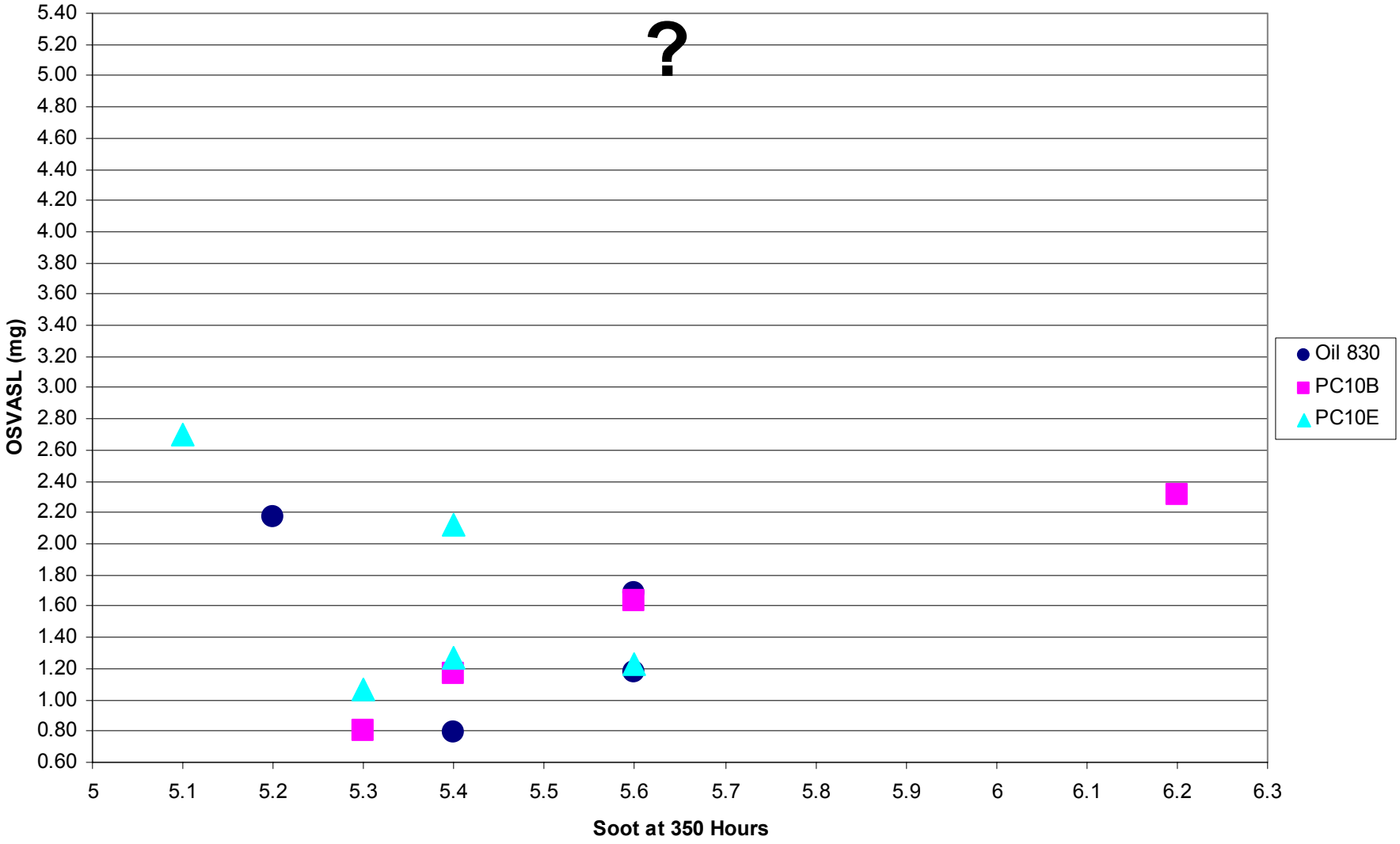


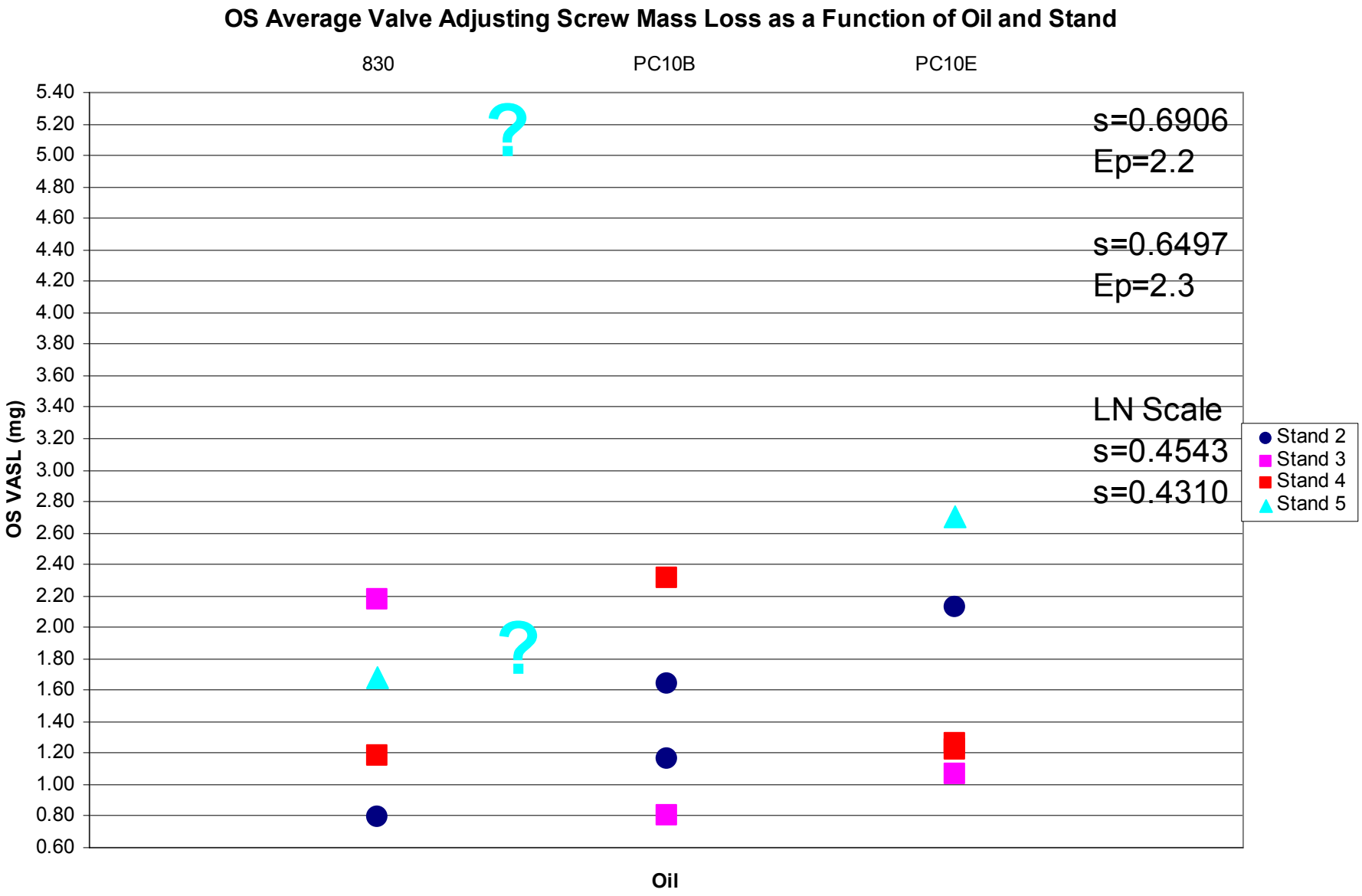

OS Average Crosshead Mass Loss as a Function of Oil and Stand
830
PC10B
PC10E
3
2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
OS ACWL (mg)
Oil
s=0.2744
Ep=2.7
s=0.3944
Ep=1.9
LN Scale
s=0.1262
s=0.1835
Stand 2
Stand 3
Stand 4
Stand 5

OS Average Crosshead Mass Loss as a Function of Stand and Oil

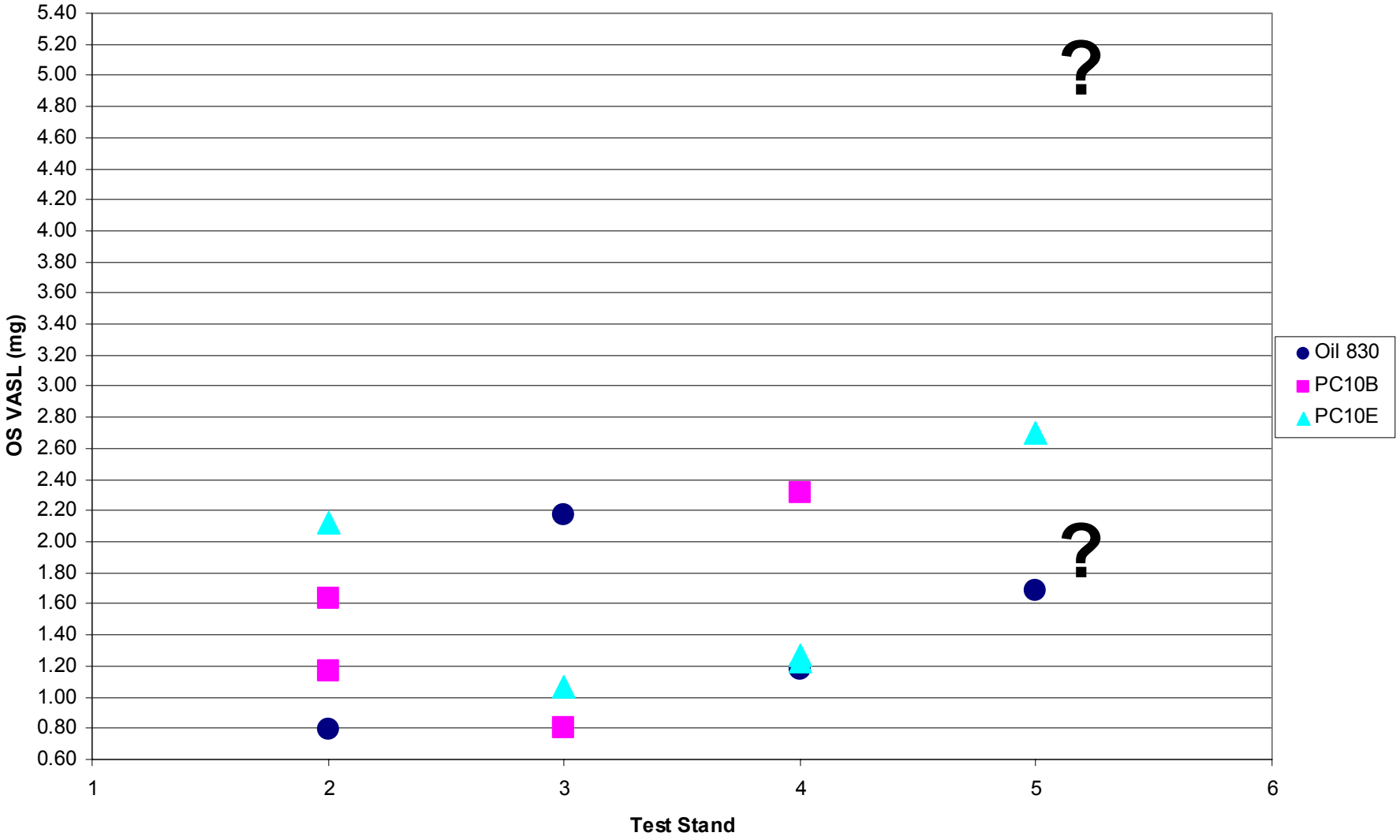


OS Average Valve Adjusting Screw Mass Loss as a Function of Oil and Soot




OS Average Valve Adjusting Screw Mass Loss as a Function of Oil and Stand
830
PC10B
PC10E
OS VASL (mg)
5.40
5.20
5.00
4.80
4.60
4.40
4.20
4.00
3.80
3.60
3.40
3.20
3.00
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
?
?
s=0.6906
Ep=2.2
s=0.6497
Ep=2.3
LN Scale
s=0.4543
s=0.4310
Stand 2
Stand 3
Stand 4
Stand 5
Oil

OS Average Valve Adjusting Screw Mass Loss as a Function of Stand and Oil



Caterpillar C13 Test Matrix Update

Fourth Round Started

1. 27 Tests started
2. 1 Test Aborted, Test restarted
3. 25 Completed
4. First round completed by June 21.
5. Second Round completed by July 21
6. Third Round completed by Aug 27
7. Last Round completion by Sept 23




C13 Test Status

Caterpillar Piston Deposit Test Requirements

1. No scuffed Pistons, Rings, Liners
2. No stuck Rings
3. No loss of Oil Consumption Control
4. No unacceptable Piston Deposits




Piston Deposit Test Issues.

No test is completely free from:

- Spread of results
- Outlier results
- Changes/Improvements/Reductions in:
  - Measurements,
  - Test Methods,
  - Data Collection




C13 Preliminary Matrix Observations.

Good repeatability on some oils

Discrimination on some parameters

Three PC-10 oils showing acceptable performance

Statistical Analysis show C13 behavior comparable to SCOTE data.

Laboratory Effects

Oil Effects (Base Oil, Additive)




Possible Pass/Fail Parameters

1. Oil Consumption
2. TLHC
3. TGC
4. TGF

Limits and Pass/Fail Criteria will be decided after completion of matrix and to best Protect OEMs needs




C13 matrix data
Preliminary Analysis

Revised

Elisa Santos
September 19th, 2005

Outline

- This is a Preliminary analysis
- Summary
- Data source
- Modeling
- Plots of the performance measures by Oil
- Summary of Discrimination for Lab and Oil
- Correlations
- Precision: C13 and 1P
- Additional plots for Delta OC and TGF
  - Oil and Lab discrimination - 95% simultaneous confidence intervals
  - By Technology
  - By Base Oil

Summary: Observations based on 21 out of 26 tests plus 5 mini matrix tests

- Lab differences
  - Based on Oil consumption (delta and OC % Inc.)
    - Lab F seems to be more severe than the other labs
    - Lab A seems to be more mild than the other labs
  - Deposits
    - Lab A seems to be more mild than Lab G
    - Other differences: slide 18 is a summary
- Lab discrimination and Oil discrimination seem to be somewhat consistent for both type of analysis: separating or combing oil D and PC10 G
- Summary of discrimination: presented on slides 18, 20 and 21
- Oil A and Oil D differences
  - Borderline for Delta OC and OC % Inc
  - Mix of Borderline and Significant for Delta OC, OC % Inc, TLHC, TGC and UWD when Oil D is combined with PC10G
- Precision: Preliminary C13 data set compared with 1P
- Correlations:
  - Greater than 85%:
    - ATGC x TGF
    - ATLC x ATLHC
    - AUWD X ATGC
  - Between 45 and 65%:
    - Delta OC x TGF
    - Delta OC x ATGC
    - ATGC x AWD
    - TGF x AWD
    - AUWD X ATLC

Between 65% and 85%
AUWD X AWD
AUWD X TGF
AUWD X ATLHC

Data Source: 08/31/05

- TMC file with 26 tests; 21 out of 26 valid matrix tests; 5 valid mini matrix tests
- Test 55017 was eliminated from the analysis because was operationally invalid.
- Test 55739 was aborted.
- The sample size is small and results should be interpreted with caution.

Number of tests per Lab

Lab	A	B	D	F	G
Tests	7	3	3	4	9

Number of tests per Lab/ Oil

	OILA	OILD	PC10A	PC10B	PC10C	PC10D	PC10E	PC10F	PC10G
A	1	0	0	1	0	2	1	1	1
B	0	0	1	0	0	0	1	0	1
D	0	0	1	1	0	0	0	0	1
F	0	1	0	1	0	1	1	0	0
G	1	2	1	1	1	0	1	2	0

Matrix Oil Key: Taken from Power point presentation of the ASTM HDEOCP Meeting March 31, 2005

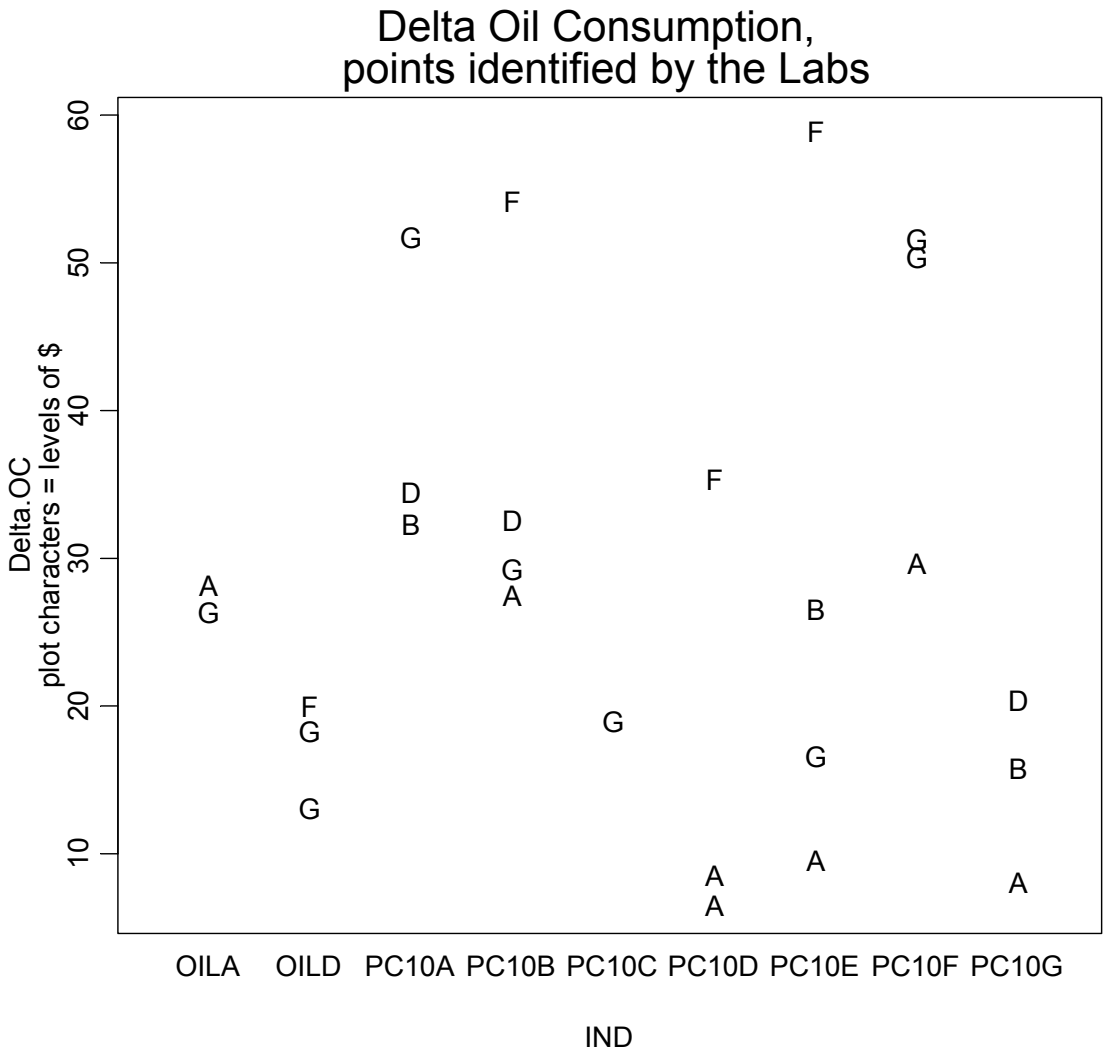
	Base Oil 1	Base Oil 2	Base Oil 3
Technology A	**PC-10A**	**PC-10B**	**PC-10C**
	C13	**C13, ISB, T12**	**C13**
Technology B	**PC-10D**	**PC-10E**	**PC-10F**
	C13	**C13, ISB, T12**	**C13**

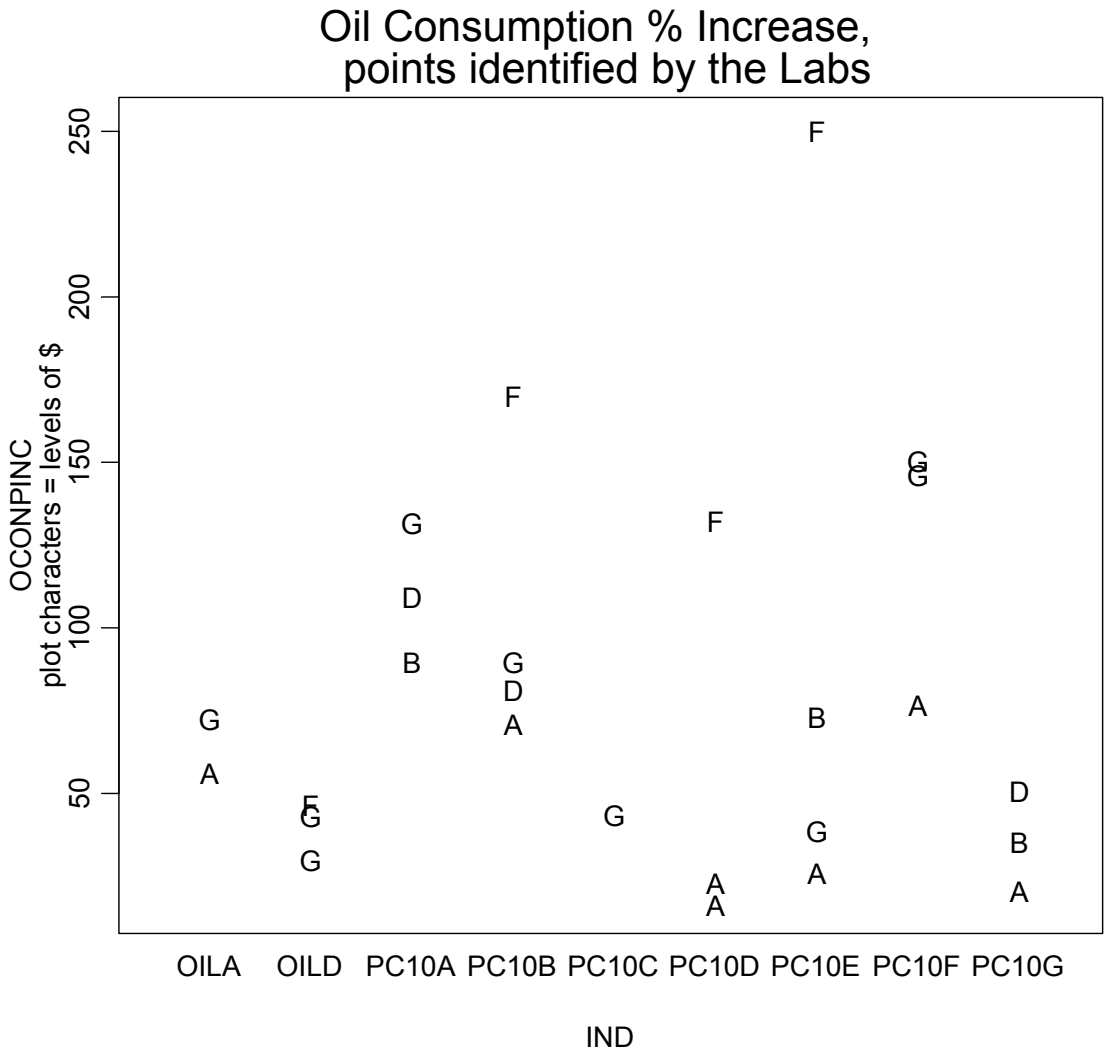
Notes: (1) Cat C13 to use PC-10B & PC-10E as the featured oils
(2) Both PC-10B and PC-10E to be available for ISB & T-12, but only one may be used

Modeling

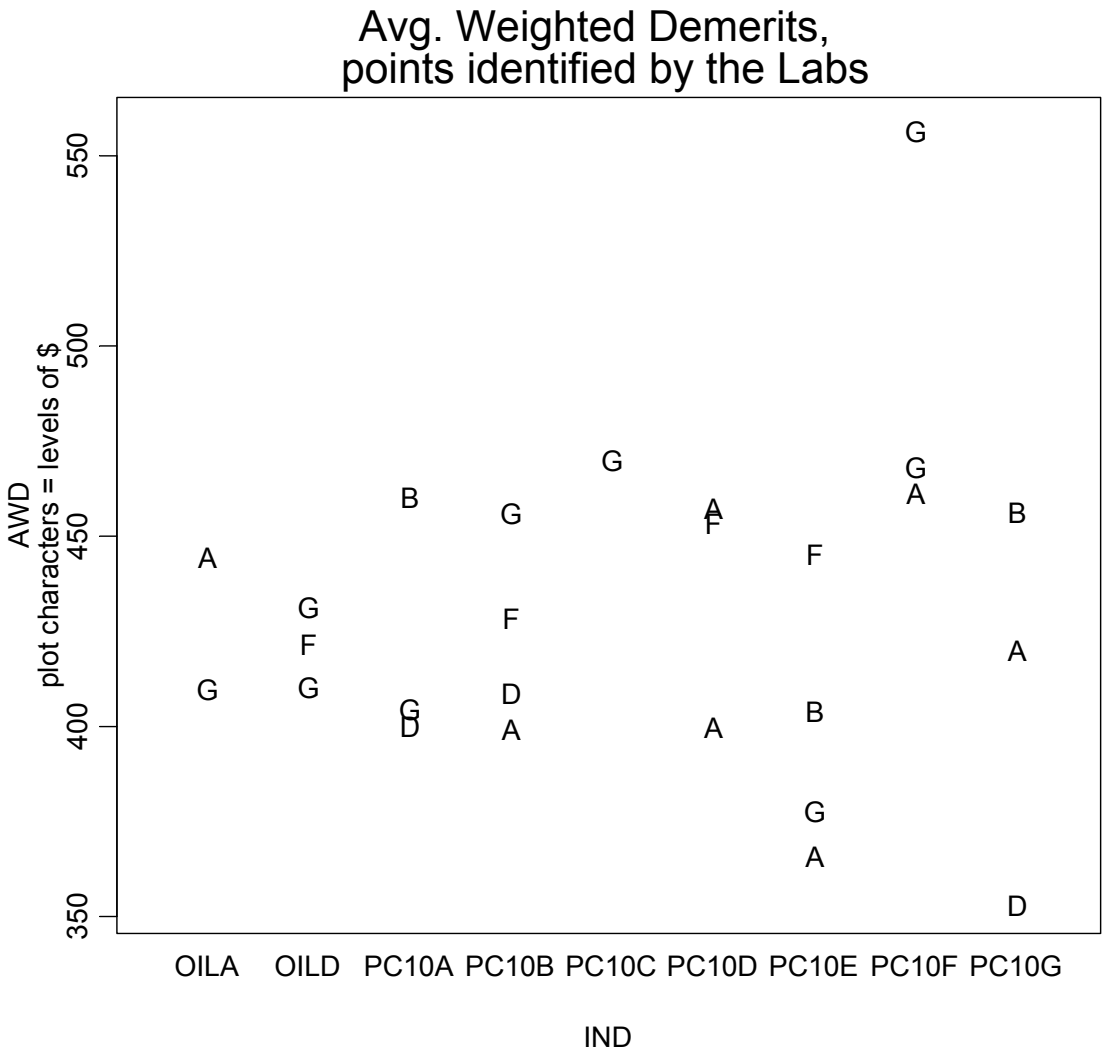
- The model used for the analysis includes Lab and Oil type
- The data set available today does not have enough tests, so that it can be analyzed using Base oil type and Technology type
- A transformation was used for oil consumption. The objective is to satisfy the assumptions of the model and be able to perform valid tests of hypothesis.
- The tests are corrected for multiple comparisons
  - With respect to the plots with confidence intervals: if the confidence intervals overlap then there are no significant differences between Labs (or Oils).

Plots of the performance measures by Oil

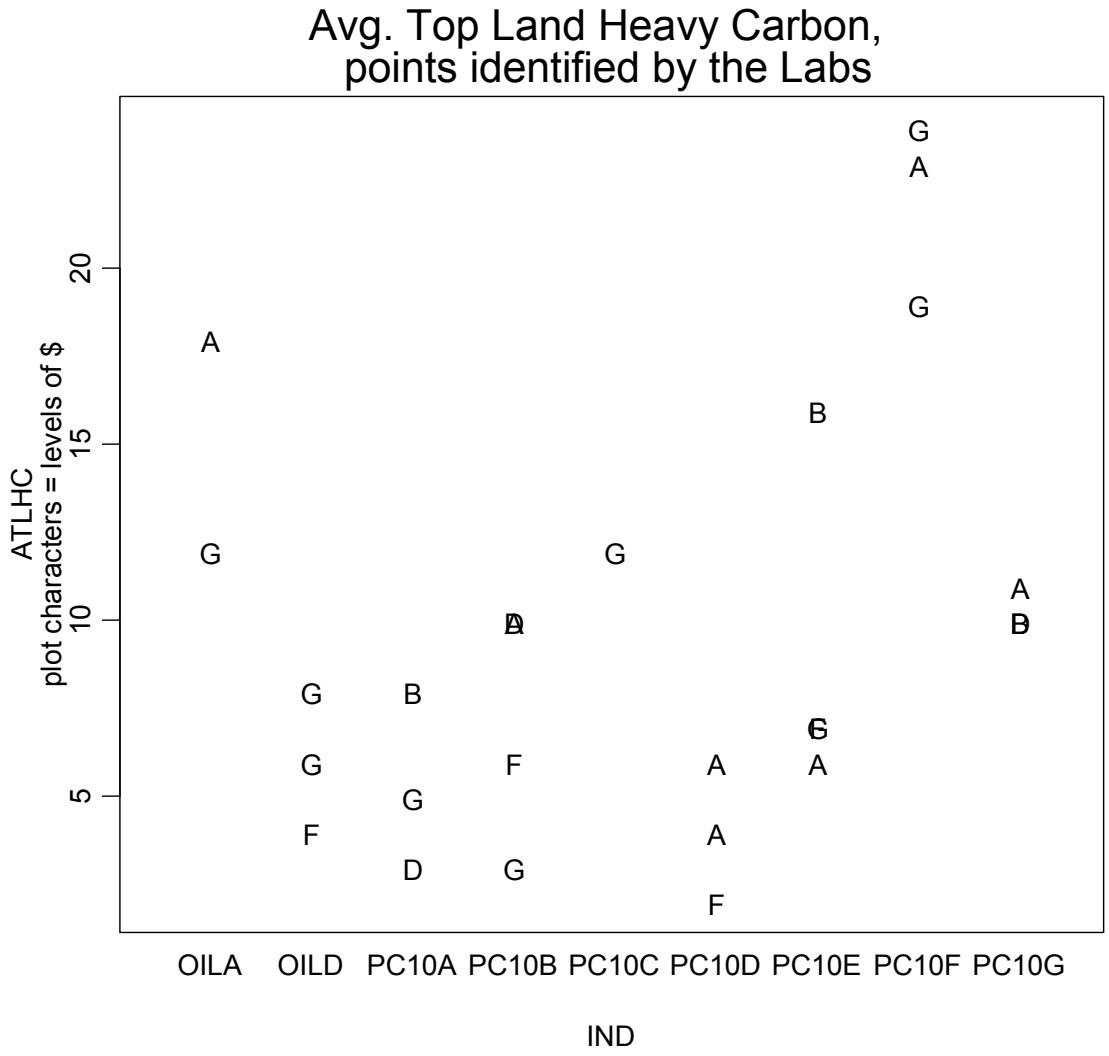


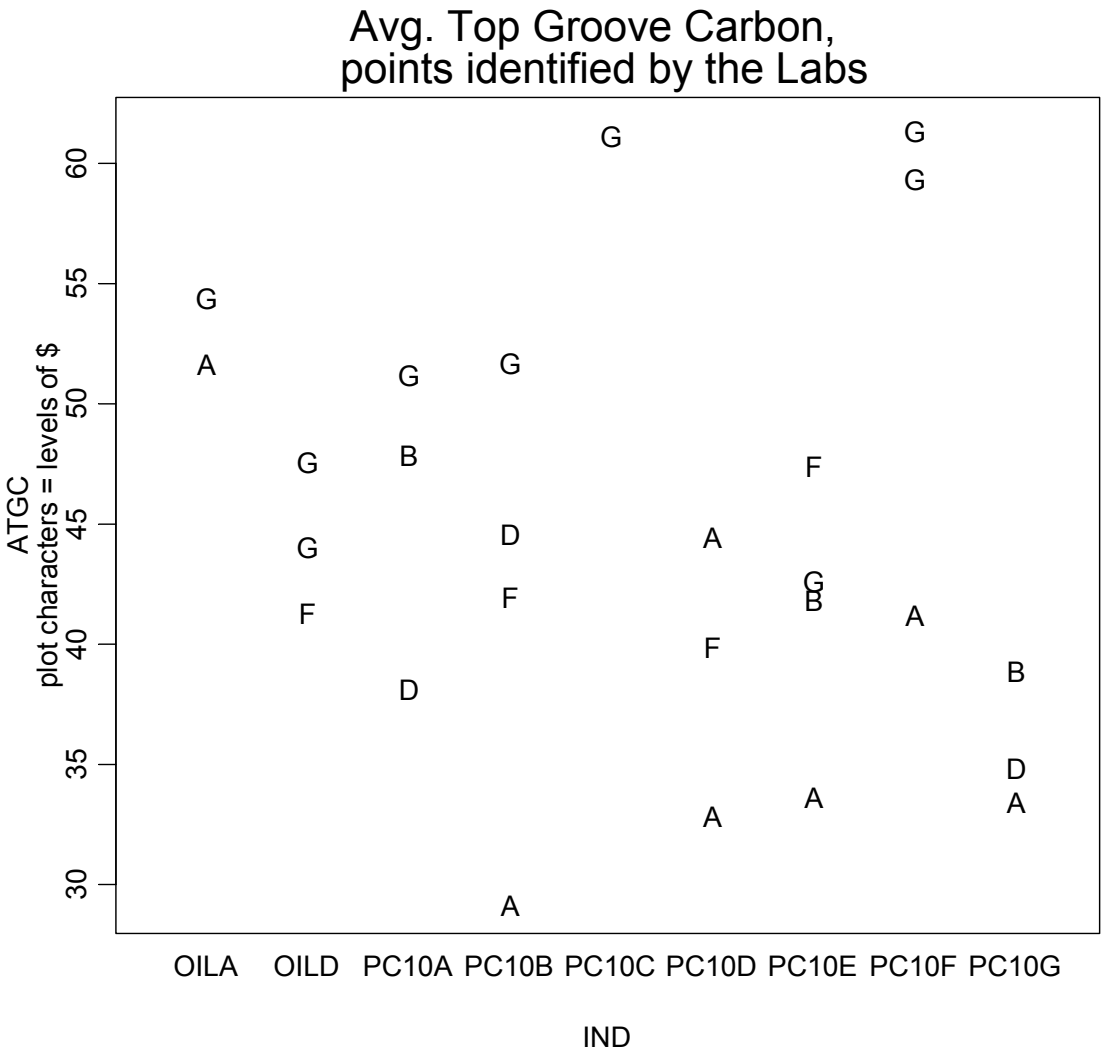


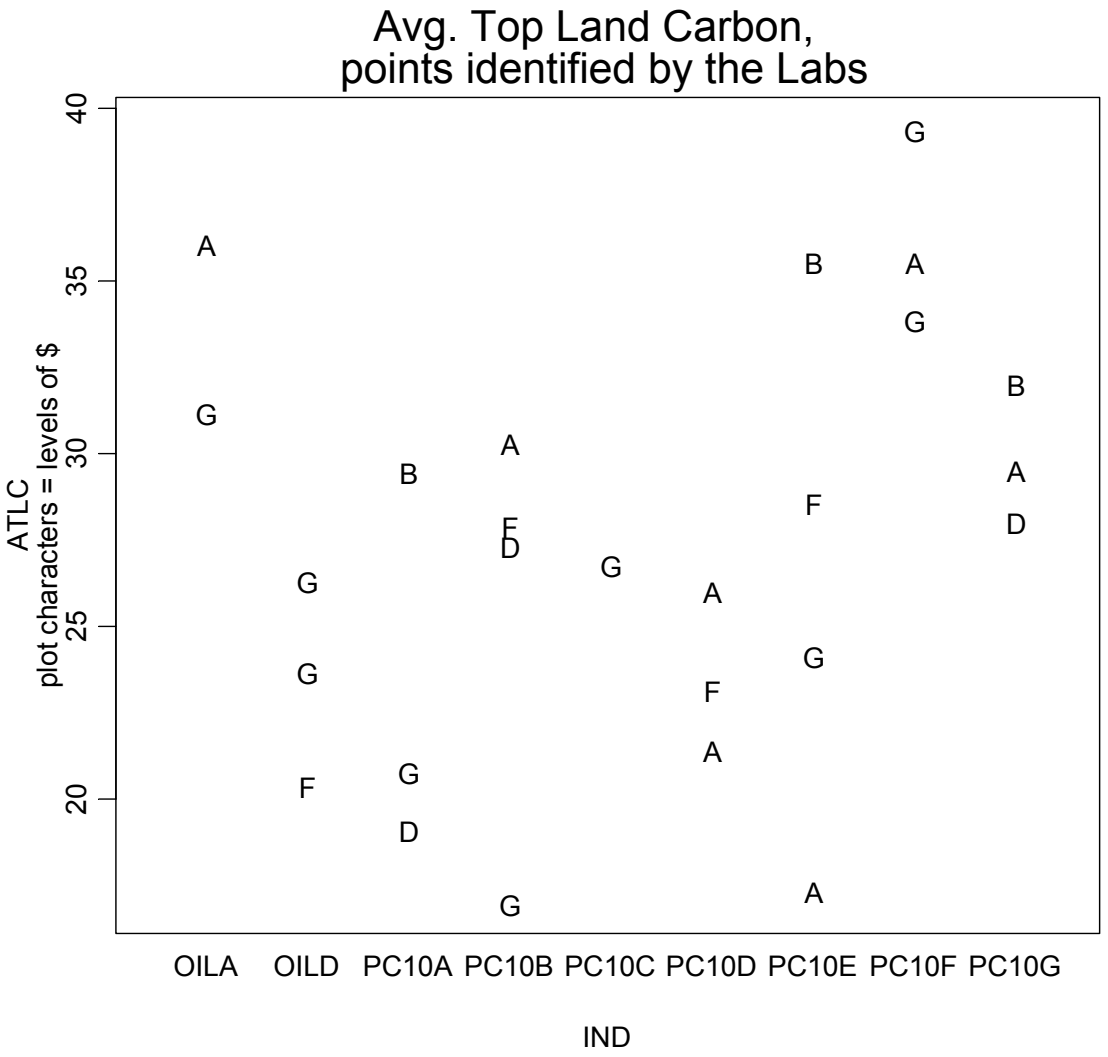
9

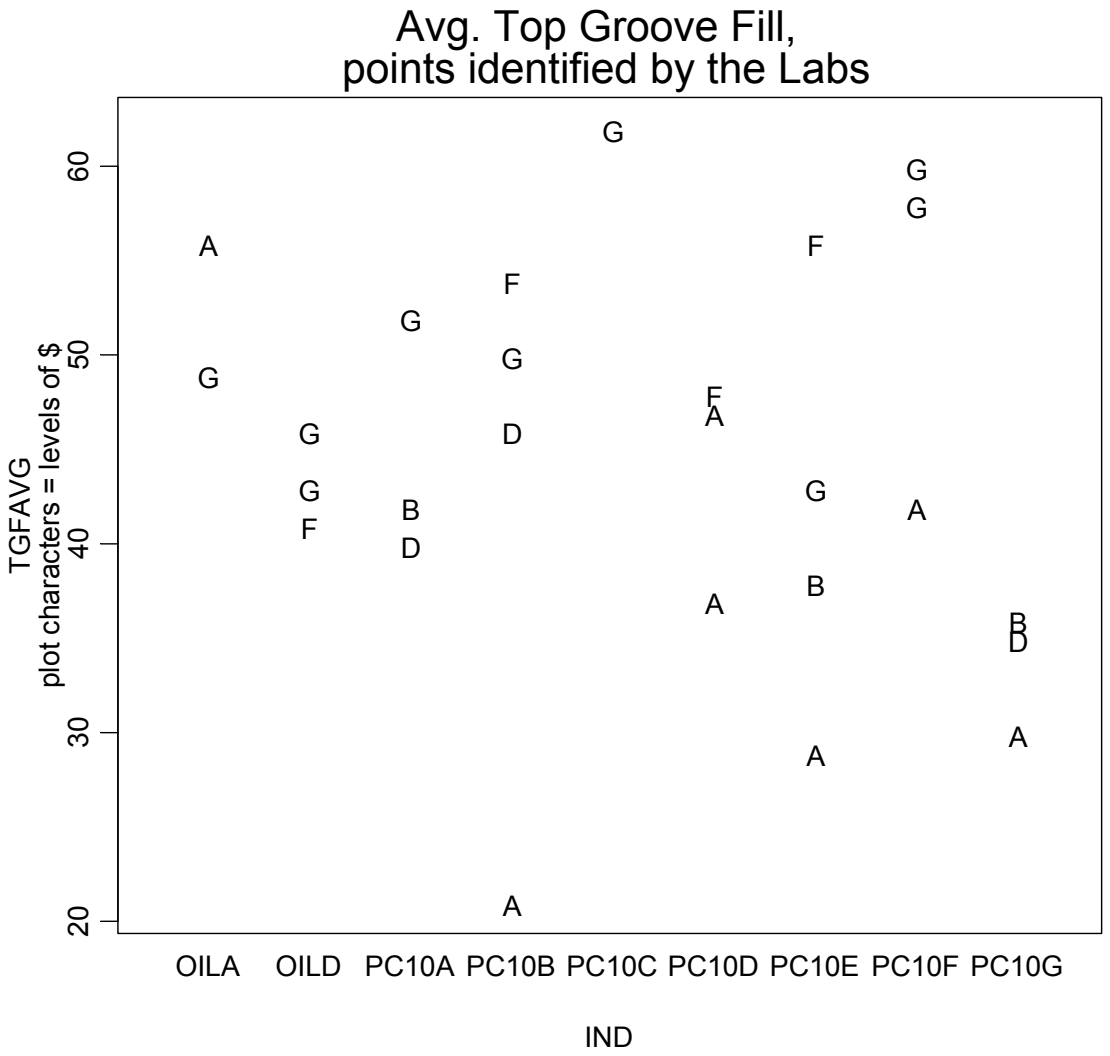


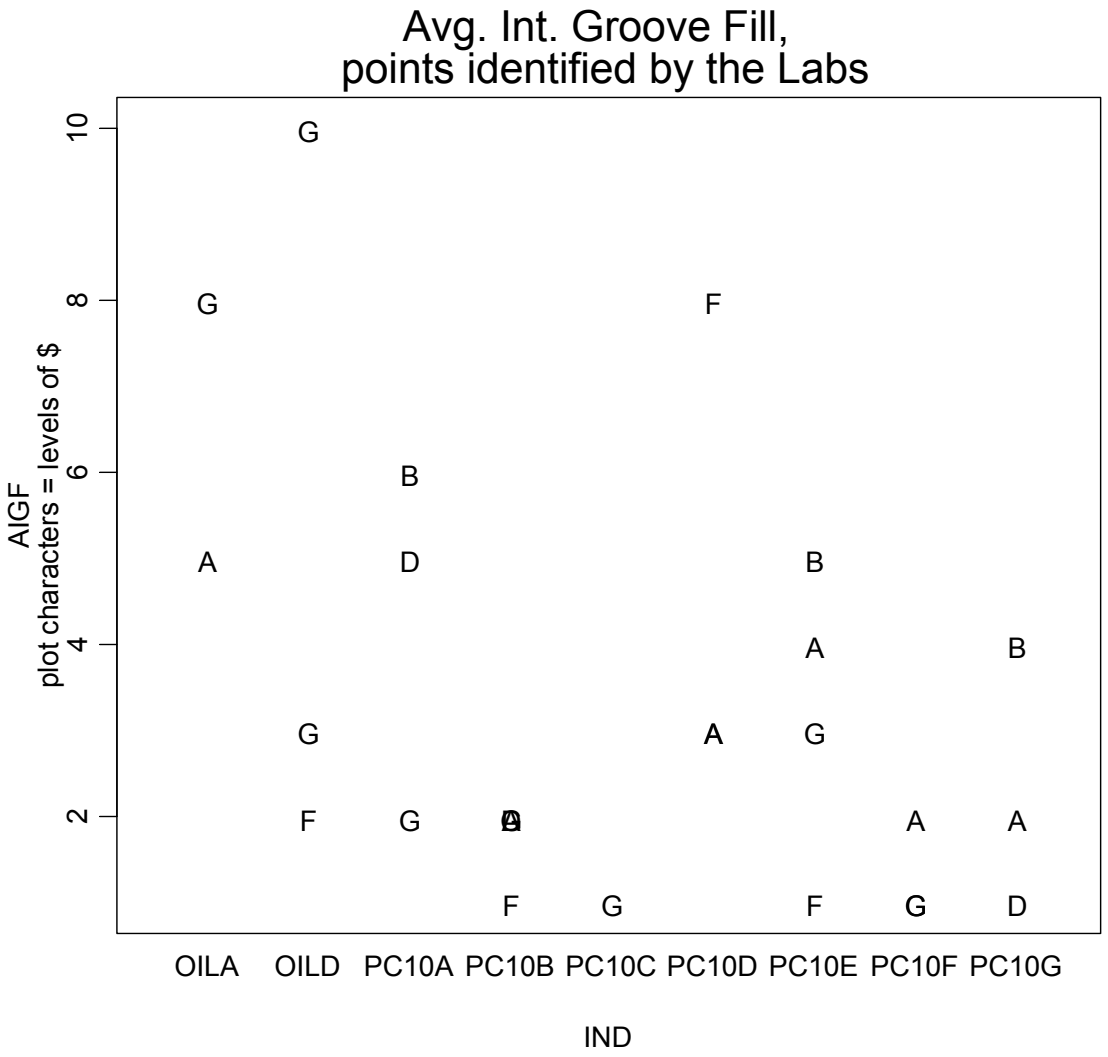
PC10E seems different from PC10F

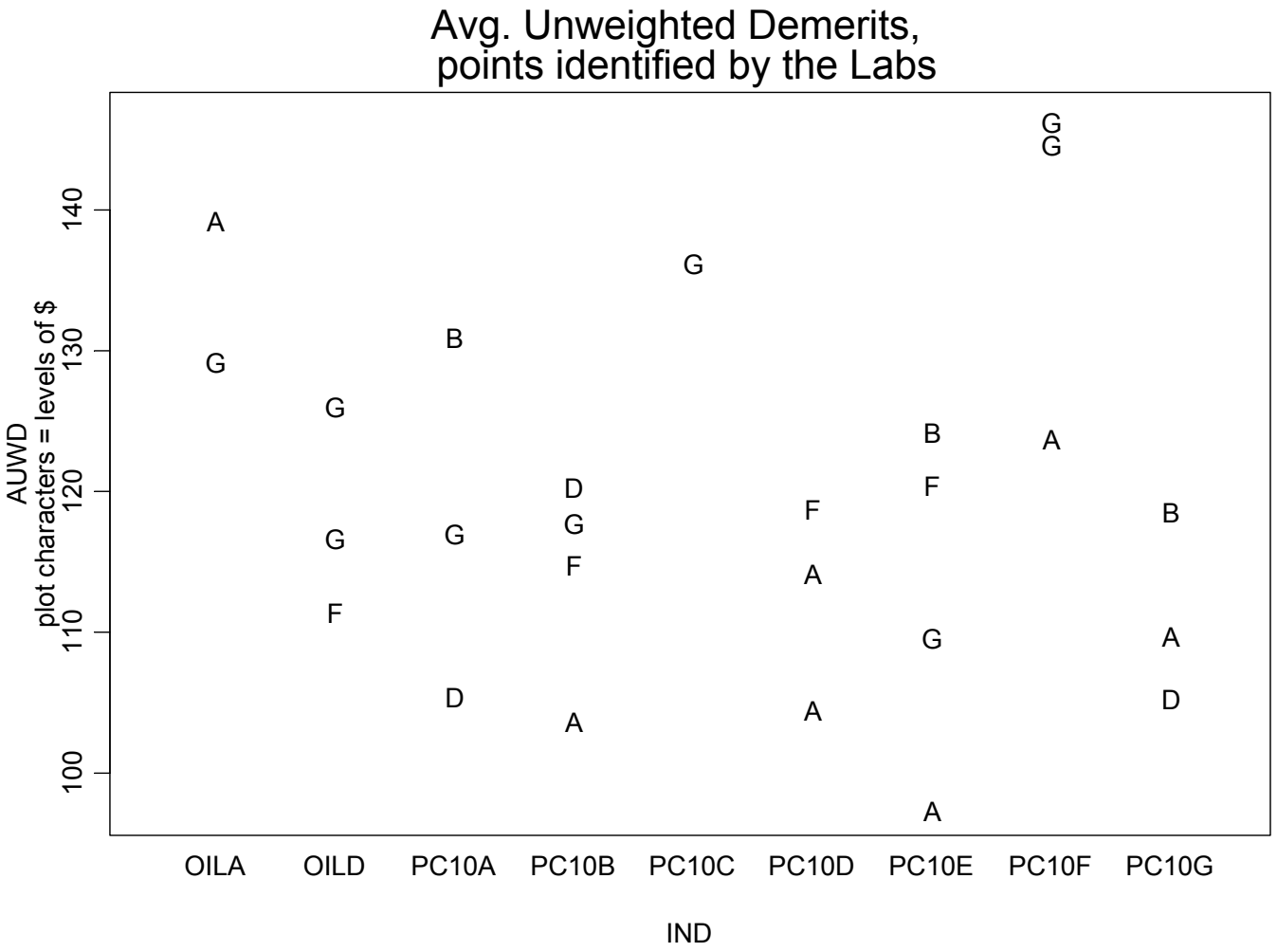












Summary of Discrimination for Lab and Oil

Lab differences

	Oil D separated from PC10 G									
	All data								Removing First PC10 E	
	Delta OC	OC % INC	TLHC	TGC	TLC	TGF	IGF	UWD	Delta OC	OC % INC
Discrimination										
Lab A - Lab B								X		
Lab A - Lab D										
Lab A - Lab F	X	X				X			X	X
Lab A - Lab G	Borderline	X		X		X			X	X
Lab B - Lab D										
Lab B - Lab F		X	Borderline				Borderline			Borderline
Lab B - Lab G			Borderline							
Lab D - Lab F		Borderline								Borderline
Lab D - Lab G										
Lab F - Lab G	X	X								X

	Oil D combined with PC10 G									
	All data								Removing First PC10 E	
	Delta OC	OC % INC	TLHC	TGC	TLC	TGF	IGF	UWD	Delta OC	OC % INC
Differences										
Lab A - Lab B								X		Borderline
Lab A - Lab D										Borderline
Lab A - Lab F	X	X				X			X	X
Lab A - Lab G	Borderline	Borderline		X		X		Borderline	Borderline	X
Lab B - Lab D										
Lab B - Lab F		X	X							
Lab B - Lab G			X		X					
Lab D - Lab F		Borderline								
Lab D - Lab G										
Lab F - Lab G	X	X								Borderline

Magnitude of the differences between Labs for LN(Delta OC) using all data

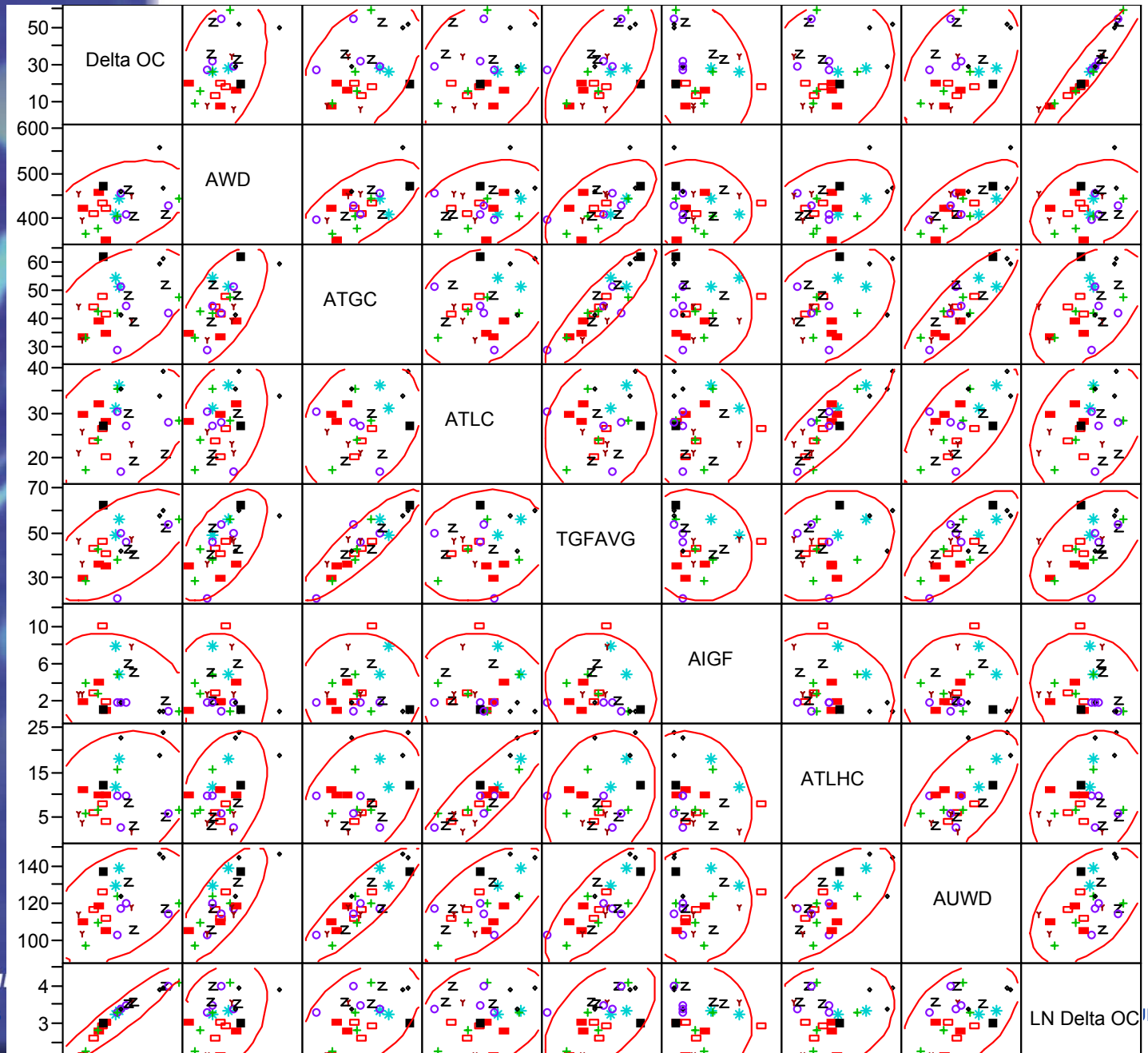
LTMSLAB A	3
LTMSLAB B	Plus 0.5
LTMSLAB D	Plus 0.5
LTMSLAB F	Plus 1.2
LTMSLAB G	Plus 0.5

	Oild D separated from PC10 G									
	All data								Removing First PC10 E	
	Delta OC	OC % INC	TLHC	TGC	TLC	TGF	IGF	UWD	Delta OC	OC % INC
Differences										
OIL A - OIL D	Borderline	Borderline							Borderline	Borderline
OIL A - PC10 A			X							
OIL A - PC10 B			Borderline							
OIL A - PC10 C										
OIL A - PC10 D			X							
OIL A - PC10 E								X		
OIL A - PC10 F			Borderline							
OIL A - PC10 G								Borderline		
OIL D - PC10 A	X	X							X	X
OIL D - PC10 B	X	X							X	X
OIL D - PC10 C										
OIL D - PC10 D										
OIL D - PC10 E										
OIL D - PC10 F	X	X	X		Borderline			X	X	X
OIL D - PC10 G										
PC10 A - PC10 B										
PC10 A - PC10 C										
PC10 A - PC10 D	Borderline								Borderline	
PC10 A - PC10 E										
PC10 A - PC10 F			X		X			X		
PC10 A - PC10 G	Borderline	Borderline							X	X
PC10 B - PC10 C										
PC10 B - PC10 D	Borderline								Borderline	
PC10 B - PC10 E										
PC10 B - PC10 F			X					X		
PC10 B - PC10 G										
PC10 C - PC10 D										
PC10 C - PC10 E										
PC10 C - PC10 F									Borderline	X
PC10 C - PC10 G										
PC10 D - PC10 E										
PC10 D - PC10 F	X	X	X		X			X	X	X
PC10 D - PC10 G										
PC10 E - PC10 F	Borderline	Borderline	X		X			X	X	X
PC10 E - PC10 G										
PC10 F - PC10 G	X	X	X		X			X	X	X

	Oil D combined with PC10 G									
	All data								Removing First PC10 E	
	Delta OC	OC % INC	TLHC	TGC	TLC	TGF	IGF	UWD	Delta OC	OC % INC
Differences										
OIL A - OIL D	X	Borderline	X	Borderline	Borderline			X	Borderline	
OIL A - PC10 A			X							
OIL A - PC10 B			Borderline							
OIL A - PC10 C										
OIL A - PC10 D	Borderline		X							
OIL A - PC10 E			Borderline					X		
OIL A - PC10 F			Borderline							
OIL A - PC10 G										
OIL D - PC10 A	X	X							X	X
OIL D - PC10 B	X	X							X	X
OIL D - PC10 C										
OIL D - PC10 D										
OIL D - PC10 E										
OIL D - PC10 F	X		X	X	X			X	X	X
OIL D - PC10 G										
PC10 A - PC10 B										
PC10 A - PC10 C			Borderline							
PC10 A - PC10 D	Borderline								Borderline	
PC10 A - PC10 E										
PC10 A - PC10 F			X		X			X		
PC10 A - PC10 G										
PC10 B - PC10 C										
PC10 B - PC10 D	X								Borderline	
PC10 B - PC10 E										
PC10 B - PC10 F			X		Borderline			X		
PC10 B - PC10 G										
PC10 C - PC10 D										
PC10 C - PC10 E										
PC10 C - PC10 F			Borderline							Borderline
PC10 C - PC10 G										
PC10 D - PC10 E										
PC10 D - PC10 F	X	X	X		X			Borderline	X	X
PC10 D - PC10 G										
PC10 E - PC10 F	X	X	X		X			X	X	X
PC10 E - PC10 G										
PC10 F - PC10 G										

Correlations

Correlations: all data available – 21 tests + 5 mini-matrix



Oil A * blue
Oil D □ red
PC10E + green
PC10B O purple
PC10G ■ red
PC10F ◊ black
PC10D Y brown
PC10A Z Black
PC10C ■ Black

Pairwise Correlations

Variable	by Variable	Correlation
AWD	Delta OC	0.3817
ATGC	Delta OC	0.4580
ATGC	AWD	0.6327
ATLC	Delta OC	0.2746
ATLC	AWD	0.3644
ATLC	ATGC	0.2692
TGFAVG	Delta OC	0.5756
TGFAVG	AWD	0.5993
TGFAVG	ATGC	0.8892
TGFAVG	ATLC	0.1812
AIGF	Delta OC	-0.2375
AIGF	AWD	-0.0965
AIGF	ATGC	-0.0397
AIGF	ATLC	-0.0562
AIGF	TGFAVG	-0.1103
ATLHC	Delta OC	0.2207
ATLHC	AWD	0.4118
ATLHC	ATGC	0.4105
ATLHC	ATLC	0.8740
ATLHC	TGFAVG	0.2491
ATLHC	AIGF	-0.1866
AUWD	Delta OC	0.4399
AUWD	AWD	0.7601
AUWD	ATGC	0.8702
AUWD	ATLC	0.6347
AUWD	TGFAVG	0.7531
AUWD	AIGF	0.0709
AUWD	ATLHC	0.6705
LN Delta OC	AWD	0.3352
LN Delta OC	ATGC	0.4616
LN Delta OC	ATLC	0.3050
LN Delta OC	TGFAVG	0.5268
LN Delta OC	AIGF	-0.1222
LN Delta OC	ATLHC	0.2531
LN Delta OC	AUWD	0.4745

Precision

Precision for C13: Preliminary results

Parameter	Precision based on the model
AWD	32.73
ATGC	5.02
ATLC	4.43
TGF	7.37
ATRWL	6.36
ATLHC	2.48
AIGF transf (-0.4)	0.14
AUWD	7.63

These estimates are calculated around the median: 27 for Delta OC and 73 for OC % Inc.

Parameters	Precision based on the model	Estimate of the Std. deviation: Original scale
LN Delta OC - all data	0.298	8.046
LN OC % Inc. - all data	0.347	25.331

* MAD survey results presented in slide 30

Precision for 1P:

ASTM TMC requirements for Engine Test Stand/Lab Calibration (Page 12-1)

Parameters	Mean	Standard Deviation
TGC	~ 29	7.74
TLC	28 to 31	13.15
Avg. OC LN (g/kW-h)	1.8	0.3238
WD	285 to 319	57.6

Calculated from all data: 103 tests: Chart = Yes

Parameters	Std. Deviation
TGC	7.68
TLC	9.15
WD	40.06

WD: There seems to be Lab differences for WD

OC-g/h: There seems to be Lab differences and Oil differences

Precision for 1P: Reference data

Latest data: 2003 to 2005; tests with Chart = Yes; 20 tests

Deposits:

LTMSLAB	Oil	N Rows	Mean(WD)	Std Dev(WD)	Mean(TGC)	Std Dev(TGC)	Mean(TLC)	Std Dev(TLC)
A	1004-3	3	283.17	30.66	27.33	6.36	32.25	17.06
A	1005-1	2	348.90	47.52	37.50	6.01	44.63	1.94
B	1004-3	4	307.28	56.24	34.38	10.78	26.88	2.67
B	1005-1	2	283.00	31.54	31.00	1.41	34.75	6.01
D	1005-1	3	276.47	11.27	28.75	5.81	33.17	8.38
F	1004-3	2	295.60	21.78	30.75	4.60	33.63	24.22
G	1005-1	4	334.68	40.61	32.63	10.68	27.06	9.81

Oil Consumption:

LTMSLAB	Oil	N Rows	Mean(OC)	Std Dev(OC)	Mean(ETOC)	Std Dev(ETOC)
A	1004-3	3	8.57	2.23	9.67	3.19
A	1005-1	2	9.15	1.06	11.70	0.71
B	1004-3	4	7.95	1.20	9.28	3.07
B	1005-1	2	8.65	0.21	9.05	0.64
D	1005-1	3	6.80	1.35	7.03	0.75
F	1004-3	2	8.25	1.20	9.25	1.34
G	1005-1	4	8.40	0.86	9.13	1.70

Speculating about the precision

- C13 is a six cylinder test and Deposits are averages of six ratings. The Standard deviation is expected to be reduced.
- How much reduction is reasonable to expect?
  I don't know…
- Reduced Std. Deviation 1 applies the factor of sqrt(6).
  - This reduction is expected if independence between the cylinders is assumed.
- Reduced Std. Deviation 2 applies the factor of sqrt(3).
  - This reduction is expected if the correlation is between the cylinders is assumed to be 0.2.

1P

Parameters	Std. Deviation	Reduced Std. Deviation 1	Reduced Std. Deviation 2
TGC	7.68	3.14	4.43
TLC	9.15	3.74	5.28
WD	40.06	16.35	23.13

29

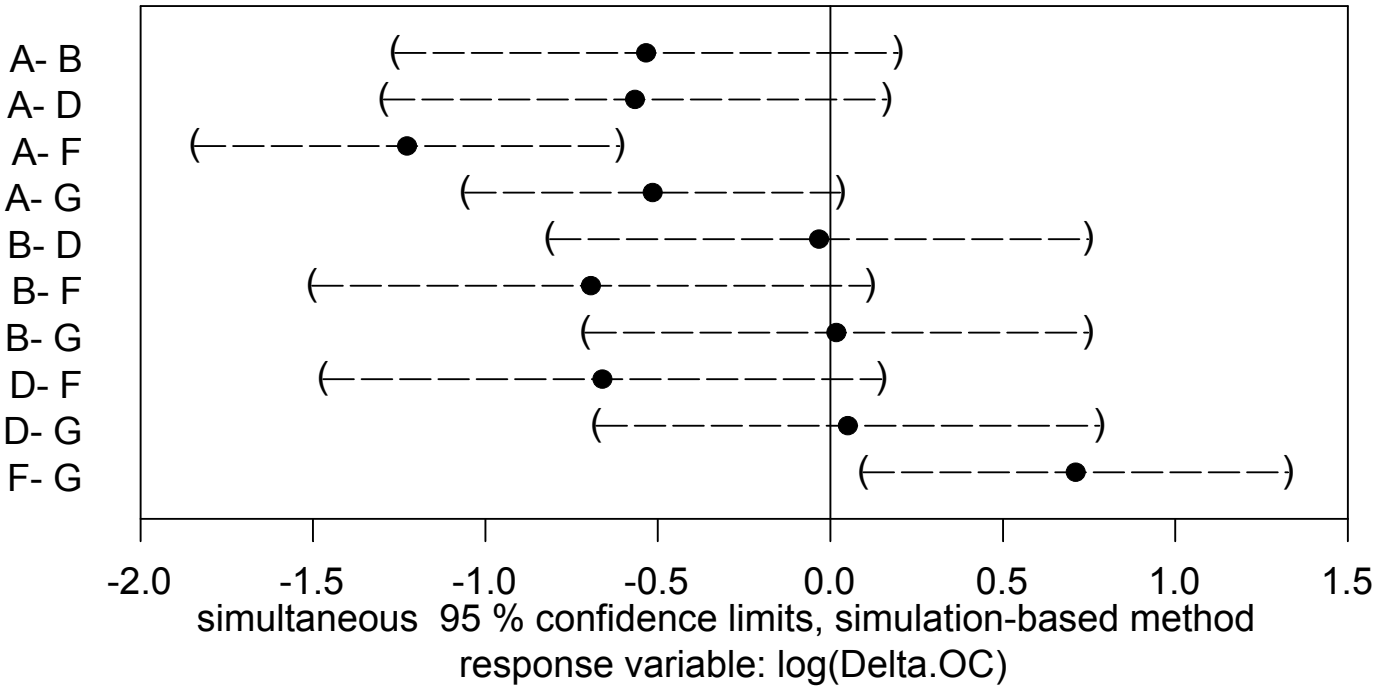
Maximum Accepted Difference

- "In this survey, we ask you to indicate the maximum acceptable difference between two test results on the same formulation."

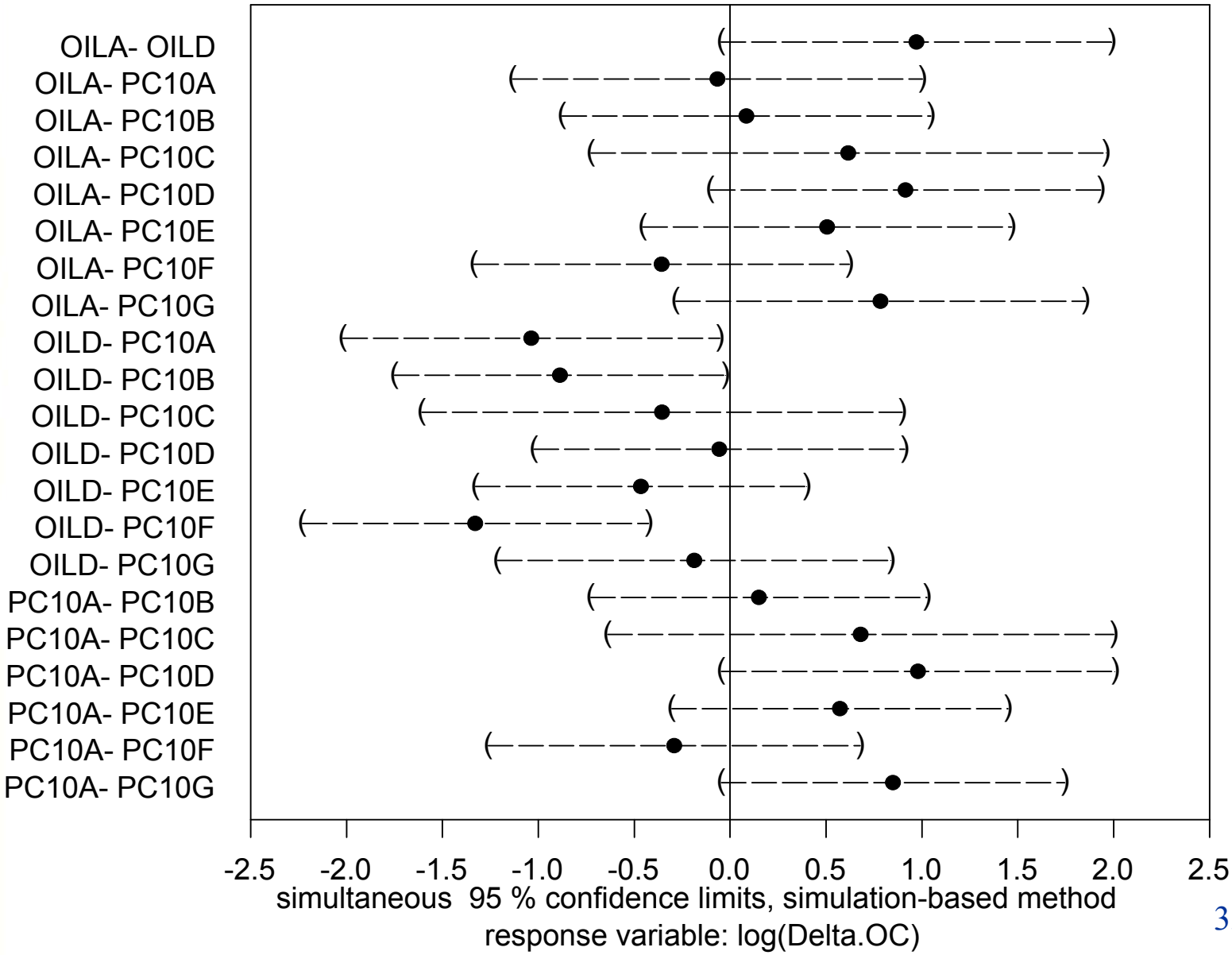
TEST	PARAMETER, units	MAXIMUM ACCEPTABLE DIFFERENCE	MEDIAN
Caterpillar C-13	Oil Consumption Percent Increase, %	N/A, 2.5, 3, 30	3
	Delta OC, g/hr	3, 4, 5, 10	4.5
	Average Top Groove Carbon (ATGC), Demerit	3, 5, 5, 20	5
	Average Top Land Carbon (ATLC), Demerit	2, 4, 5, 15	4.5
	Average Top Groove Fill (TGFAVG), %	3, 3, 6, 20	4.5
	Average Top Land Heavy Carbon (ATLHC), %	1.5, 3, 5, 10	4
	Piston Ring Loss of Side Clearance Intermediate (ALSCI), mm	Total loss of Side Clearance, N/A, ?, .005	?
	Weighted Demerits (WD)	15, 20, 30, 50	25

Additional plots

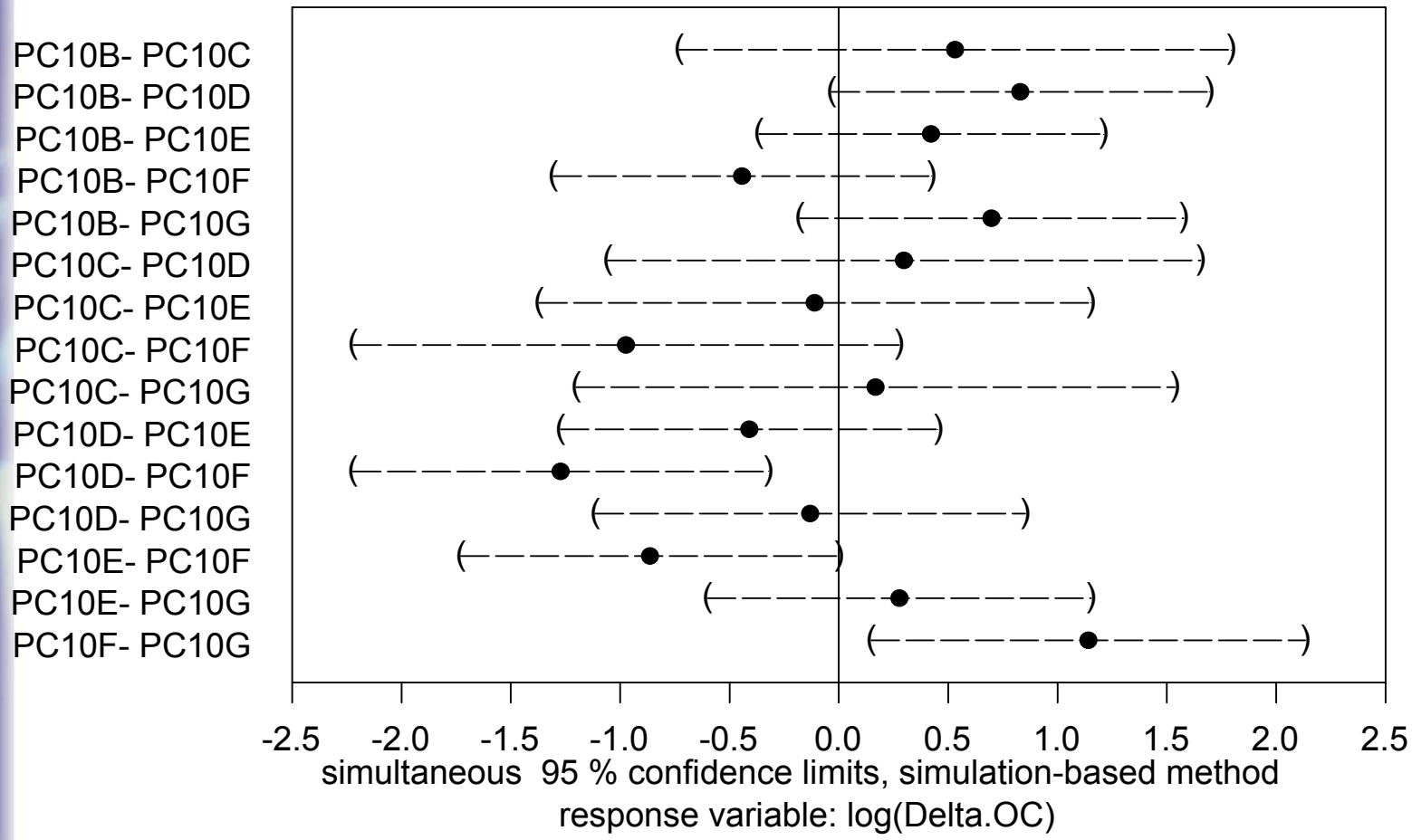
Delta OC: Preliminary Lab Discrimination



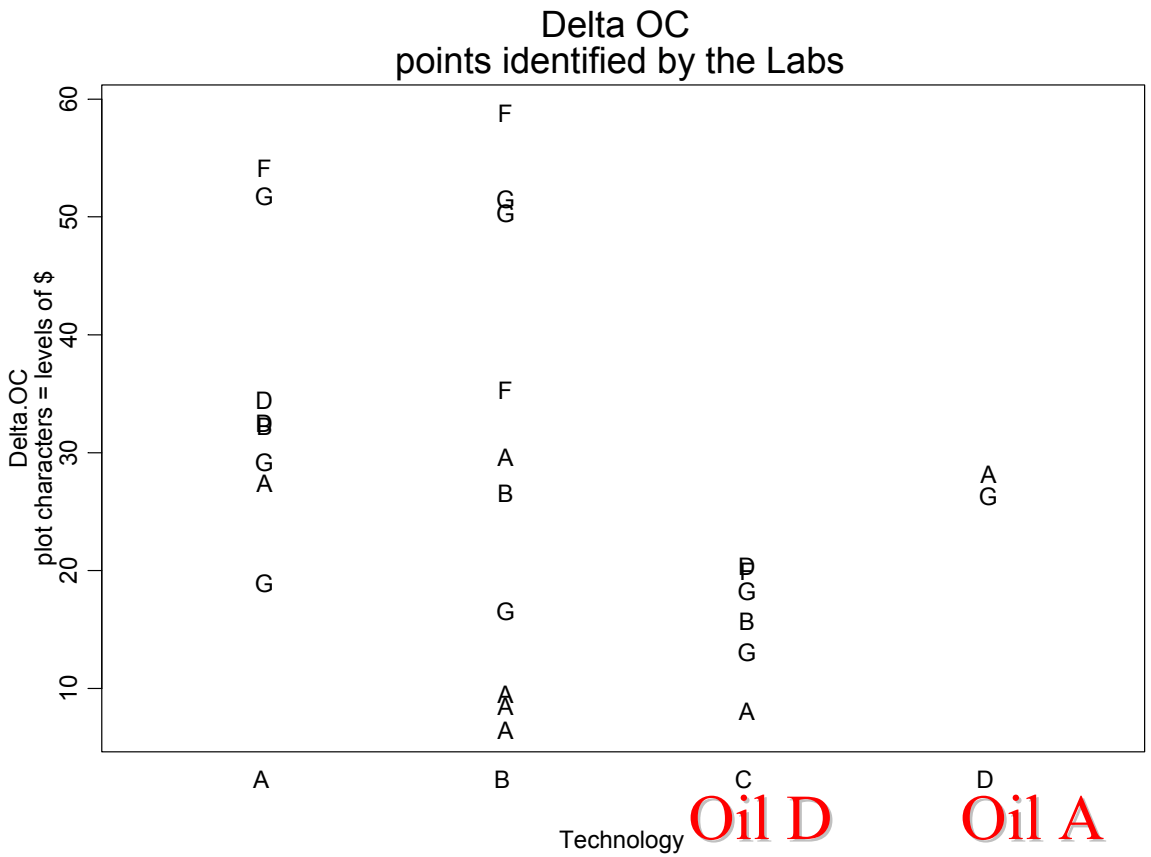
Delta OC: Preliminary Oil Discrimination



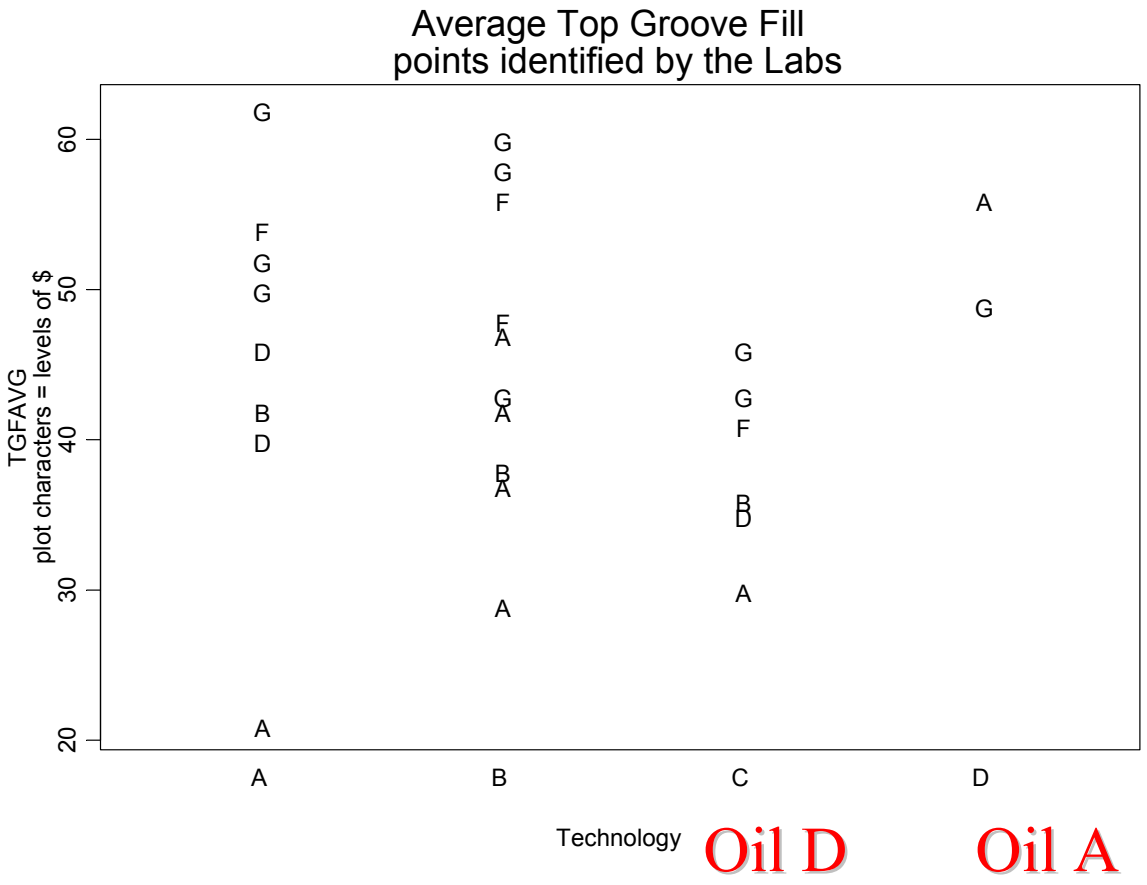
Delta OC: Preliminary Oil Discrimination



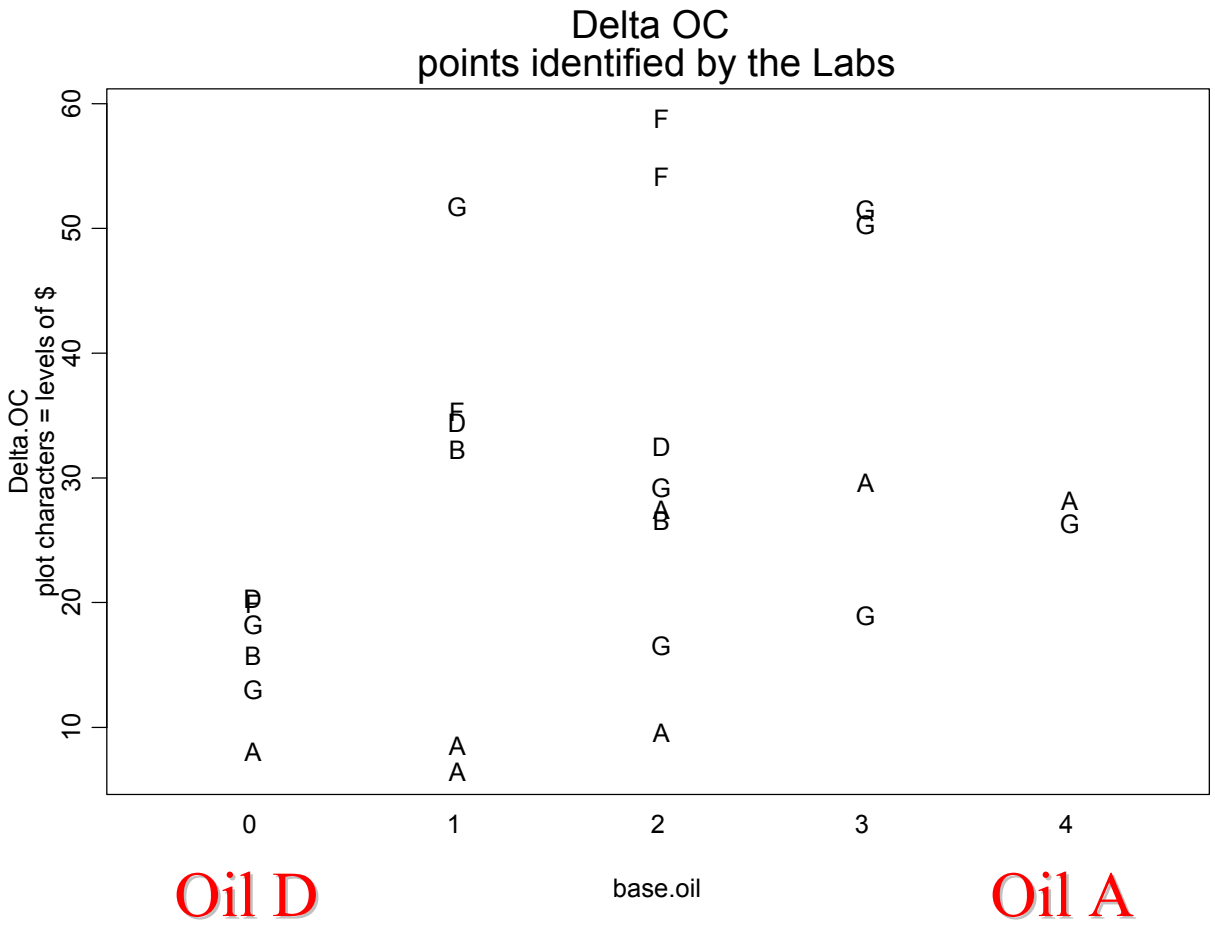
Delta OC by Technology



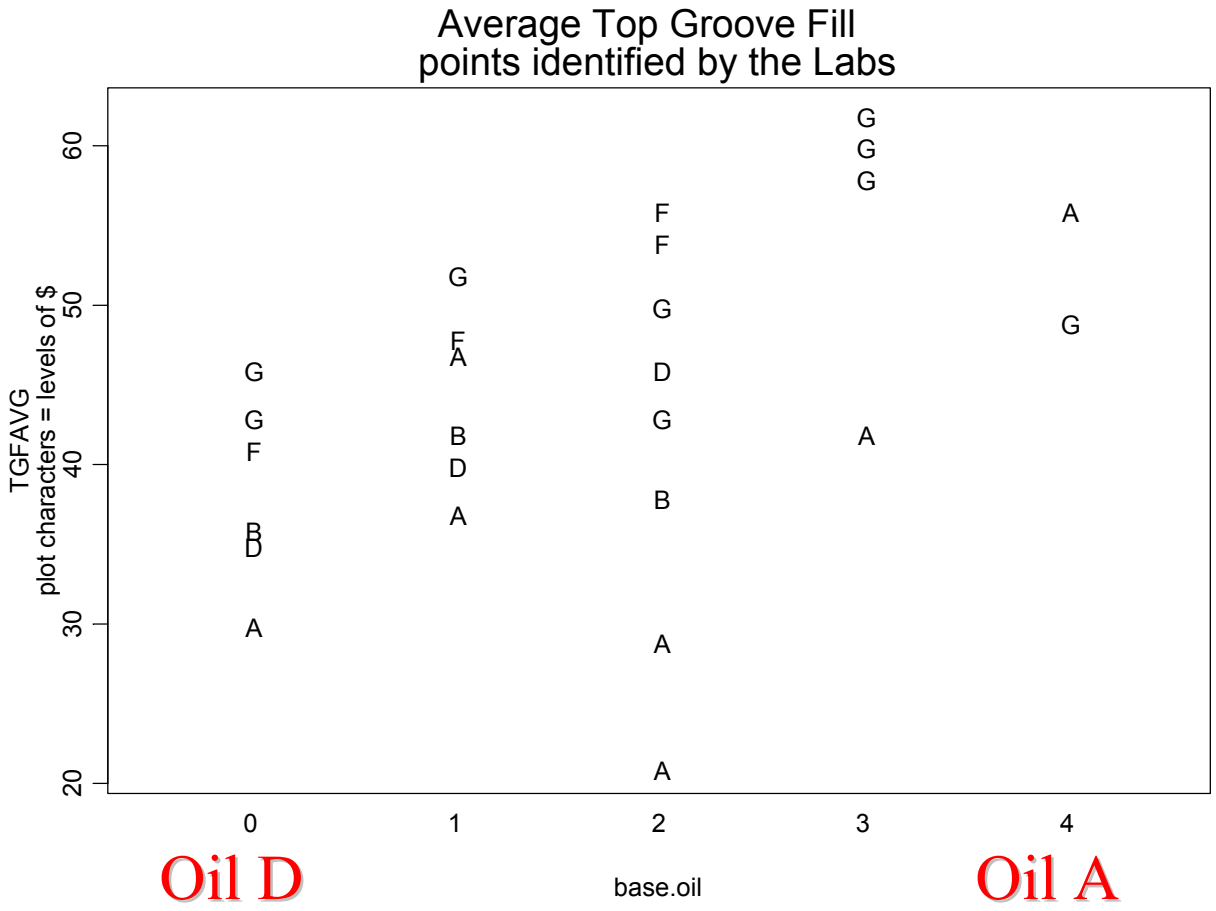
ATGF by Technology



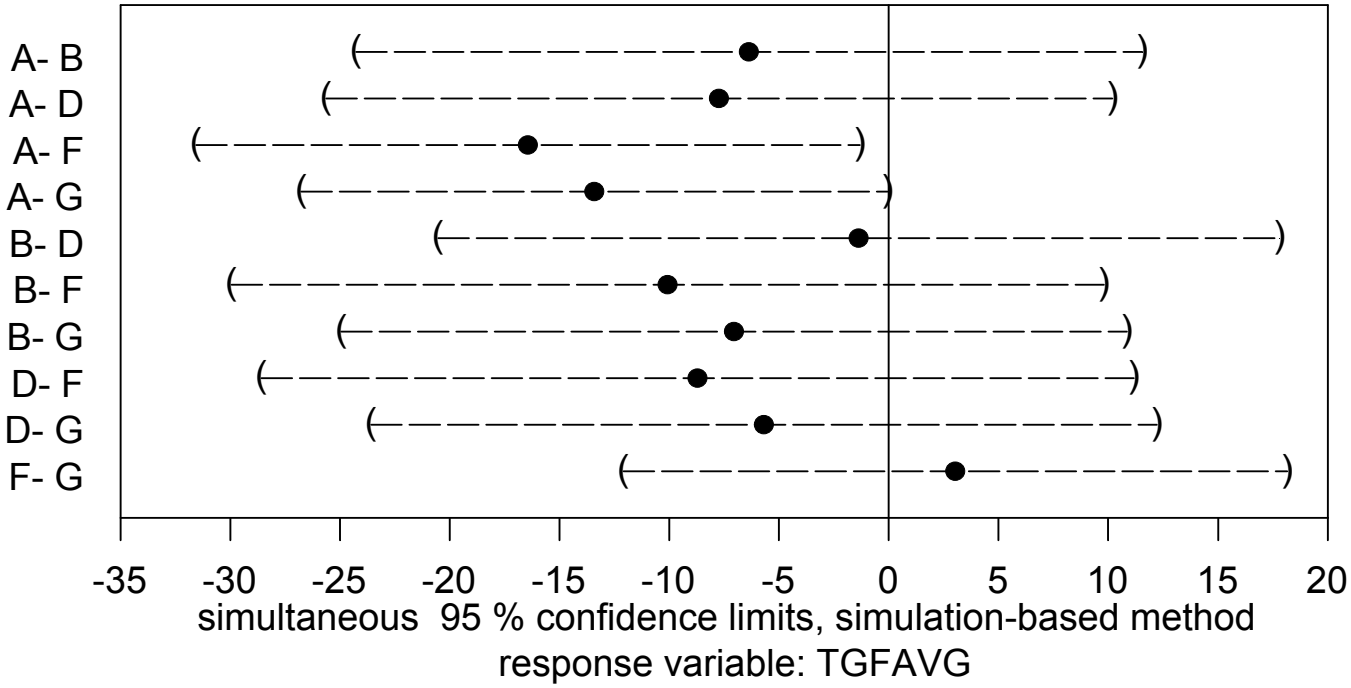
Delta OC by Base Oil



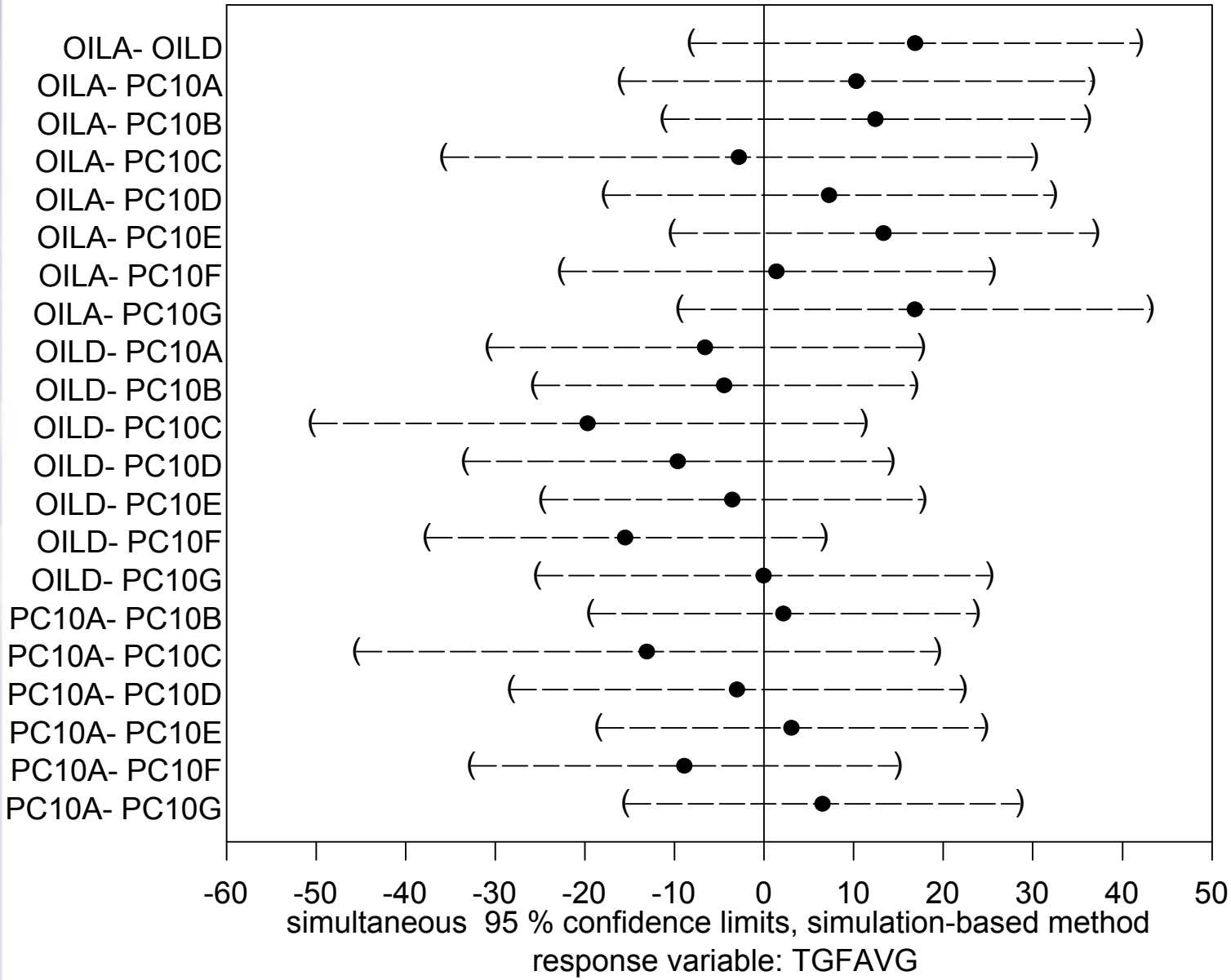
ATGF by Base Oil



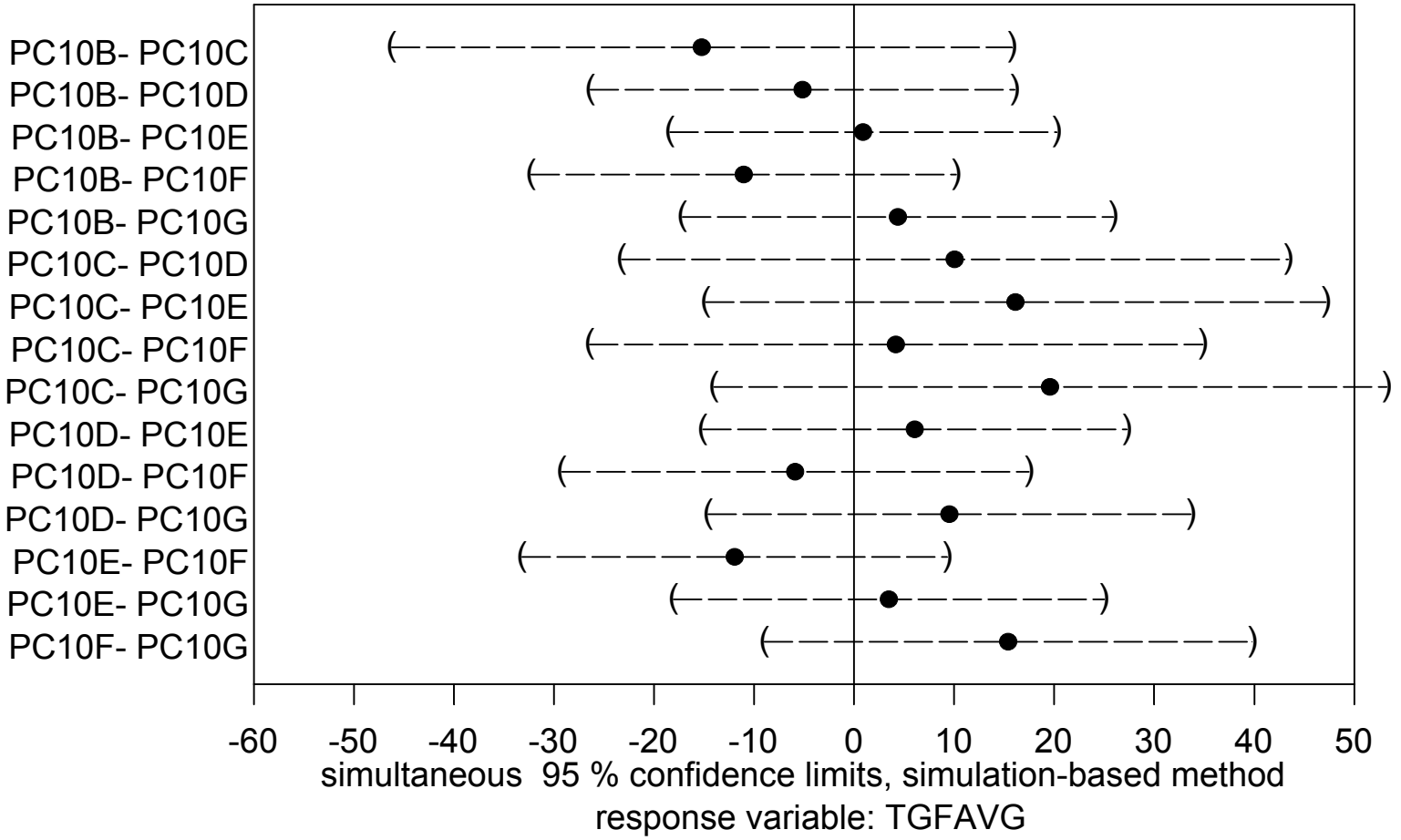
Top Groove Fill: Preliminary Lab Discrimination



Top Groove Fill: Preliminary Oil Discrimination

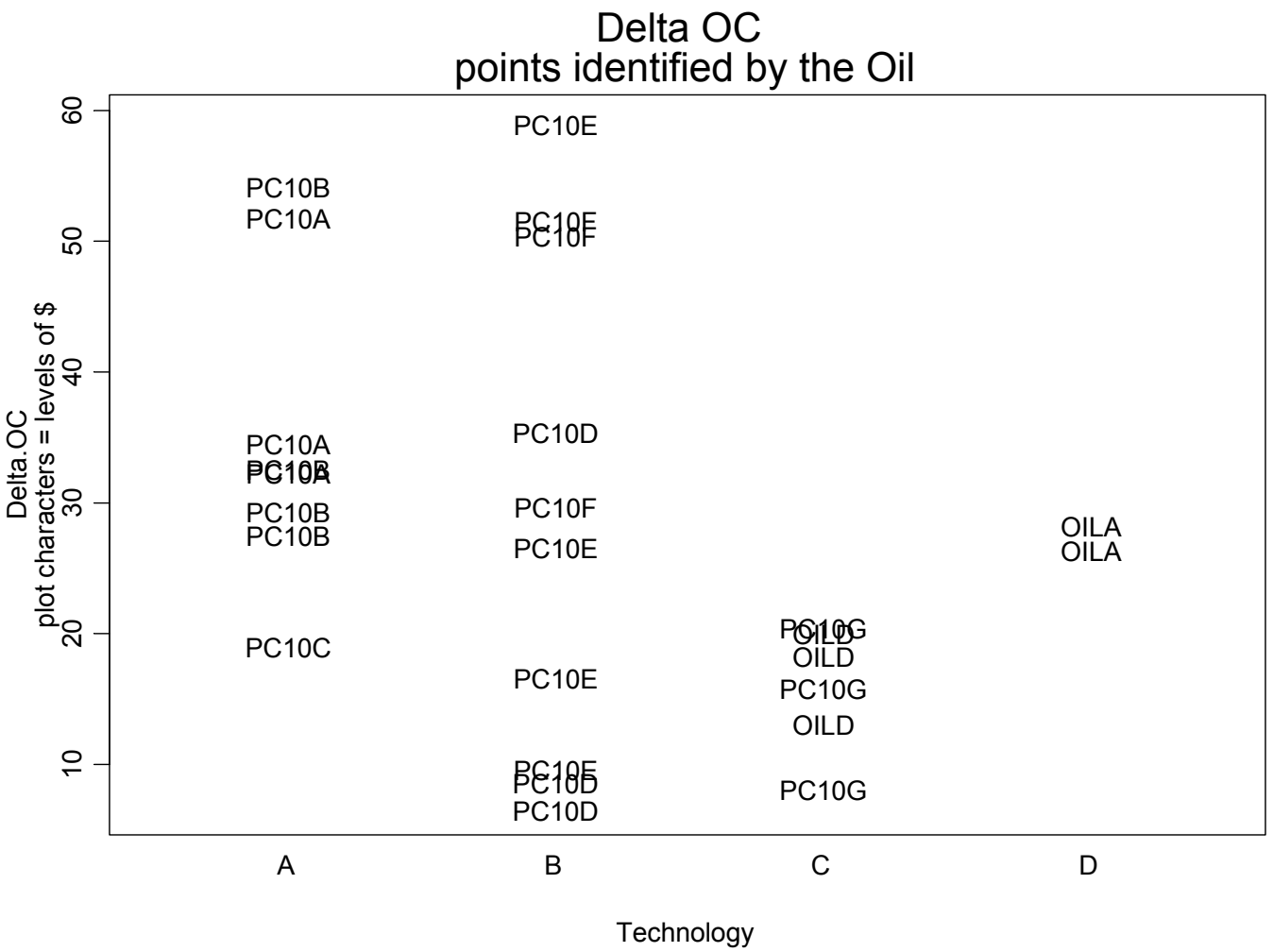


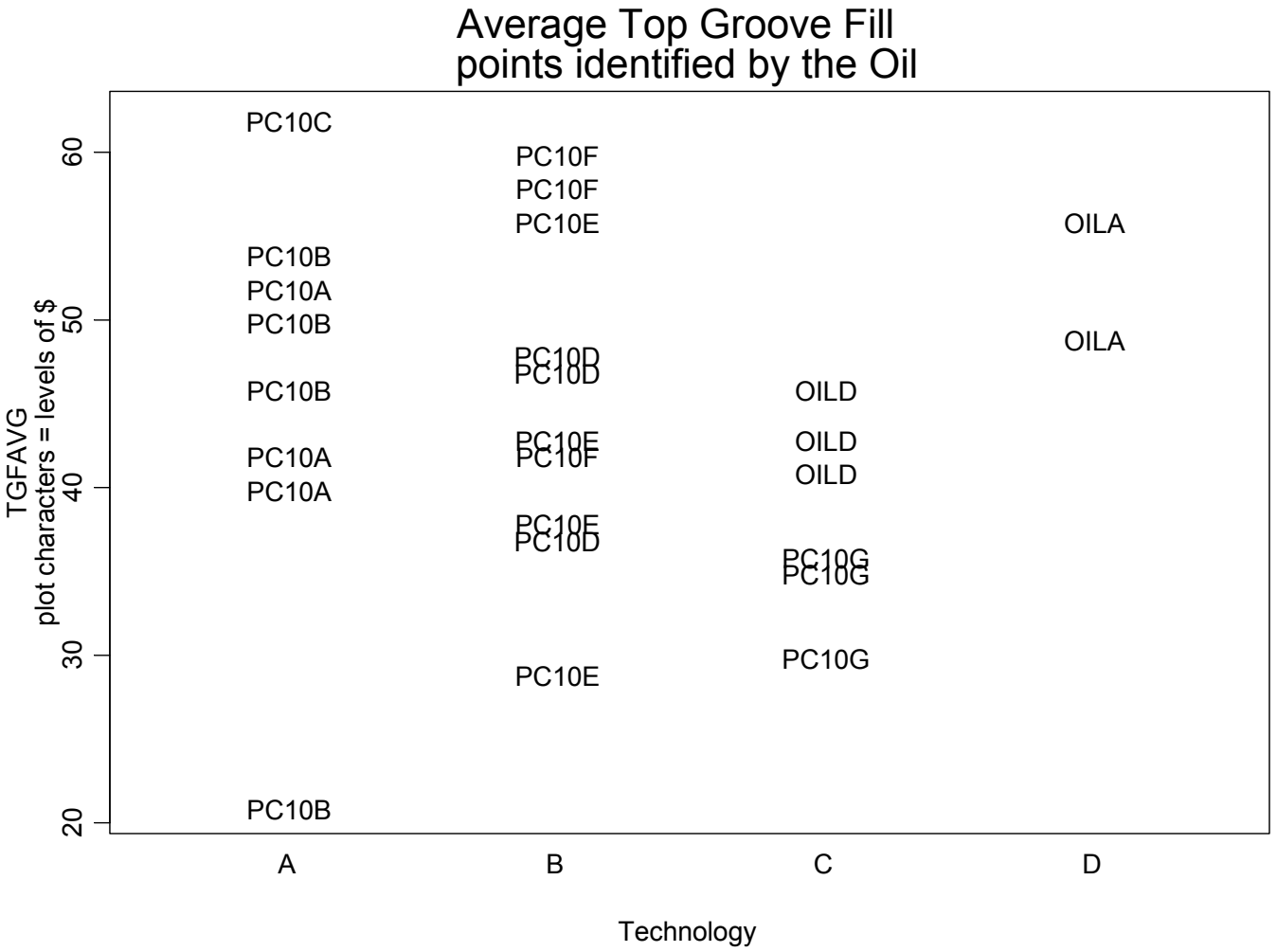
Top Groove Fill: Preliminary Oil Discrimination

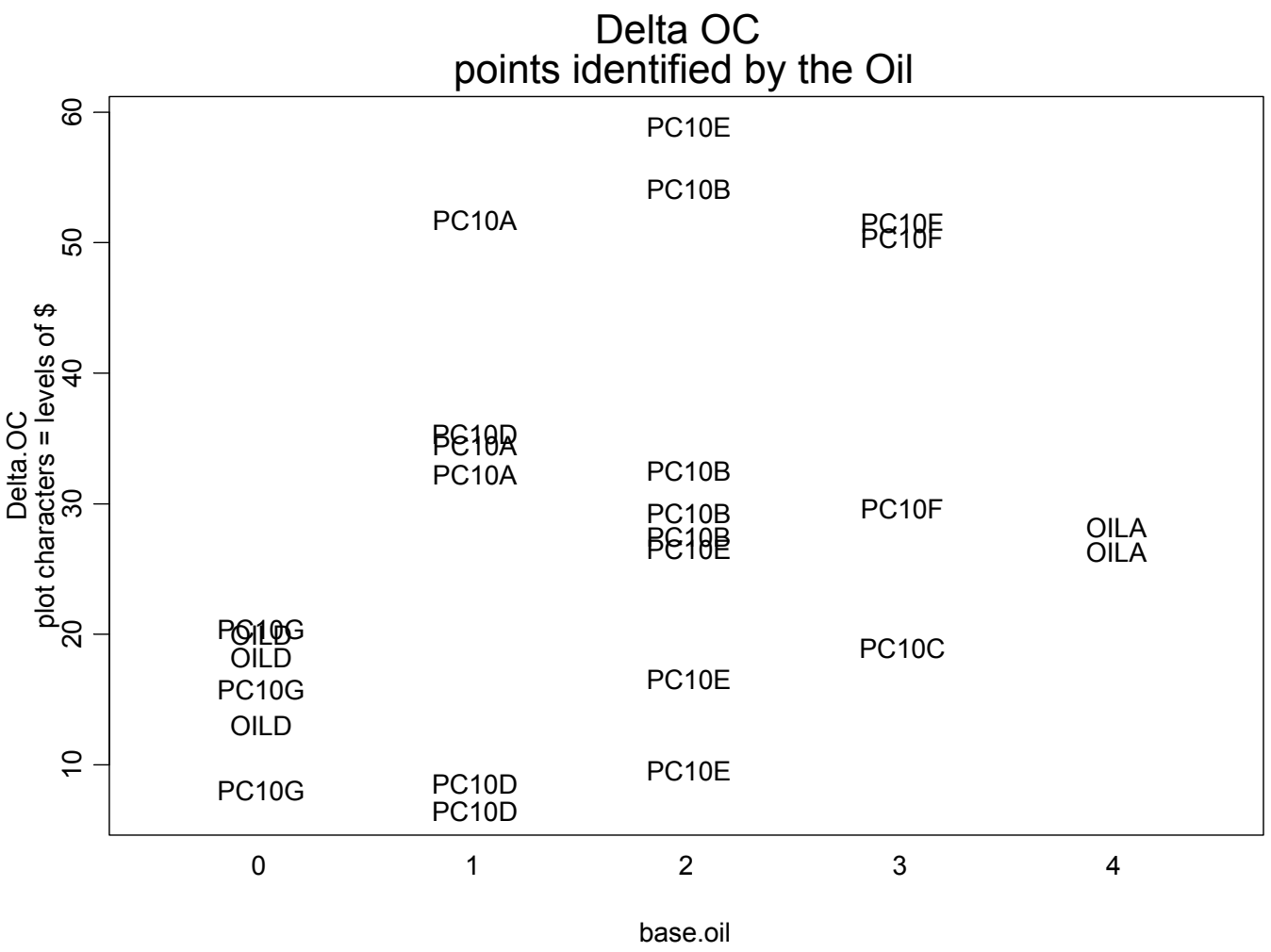


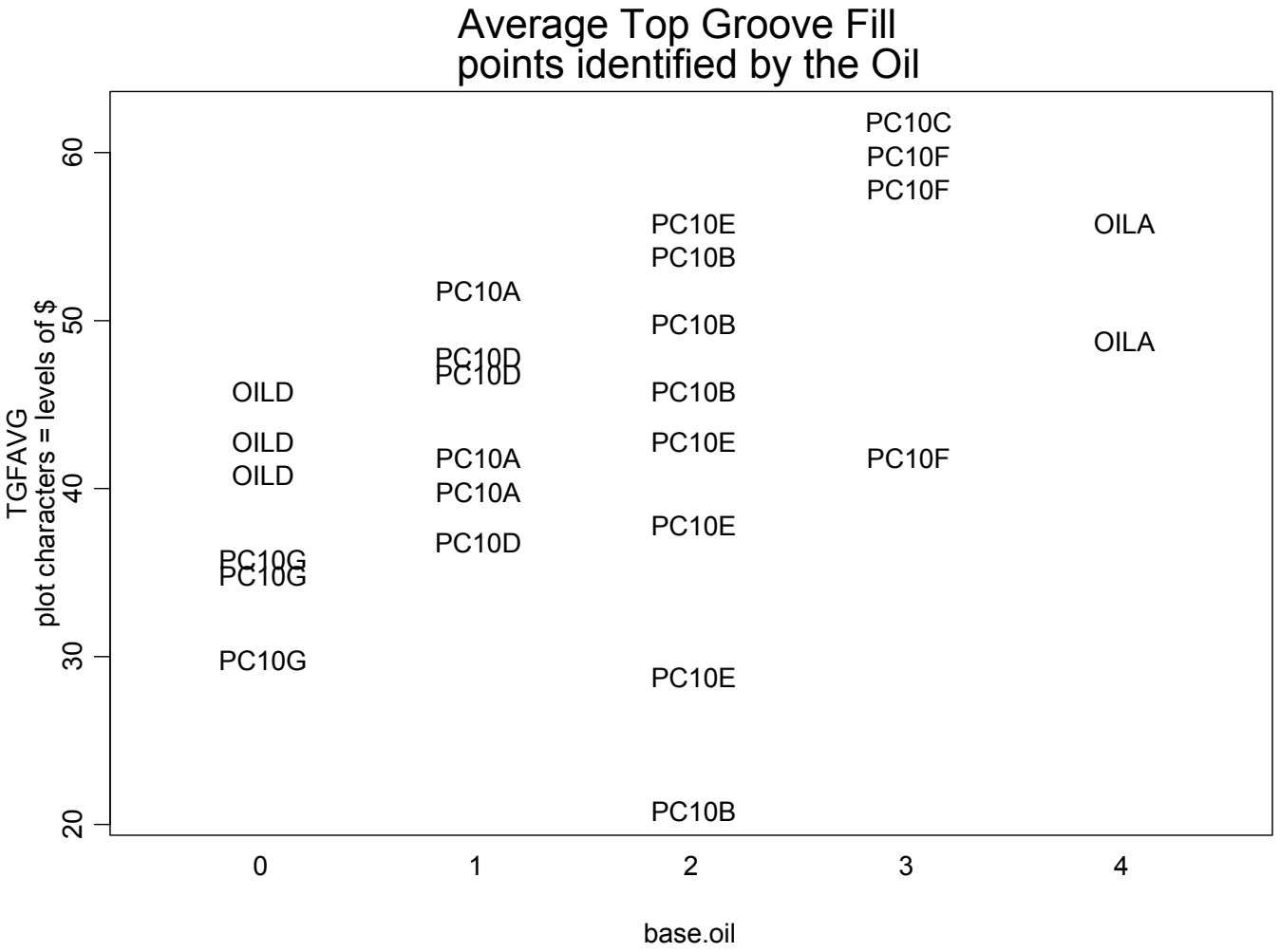
95 % simultaneous confidence intervals for TGF

	Estimate	Std.Error	Lower Bound	Upper Bound
OILA- OILD	16.900	5.91	-3.80	37.50
OILA- PC10A	10.300	6.91	-13.80	34.40
OILA- PC10B	12.400	6.26	-9.44	34.30
OILA- PC10C	-2.800	8.73	-33.30	27.70
OILA- PC10D	7.280	6.63	-15.90	30.40
OILA- PC10E	13.300	6.26	-8.53	35.20
OILA- PC10F	1.400	6.37	-20.90	23.70
OILD- PC10A	-6.560	5.10	-24.40	11.30
OILD- PC10B	-4.410	4.58	-20.40	11.60
OILD- PC10C	-19.700	7.81	-47.00	7.65
OILD- PC10D	-9.580	5.40	-28.40	9.29
OILD- PC10E	-3.510	4.58	-19.50	12.50
OILD- PC10F	-15.500	5.17	-33.50	2.60
PC10A- PC10B	2.140	5.68	-17.70	22.00
PC10A- PC10C	-13.100	8.47	-42.70	16.50
PC10A- PC10D	-3.020	6.66	-26.30	20.30
PC10A- PC10E	3.050	5.68	-16.80	22.90
PC10A- PC10F	-8.900	6.23	-30.70	12.90
PC10B- PC10C	-15.200	8.18	-43.80	13.30
PC10B- PC10D	-5.160	5.63	-24.80	14.50
PC10B- PC10E	0.909	5.13	-17.00	18.80
PC10B- PC10F	-11.000	5.61	-30.70	8.57
PC10C- PC10D	10.100	8.79	-20.60	40.80
PC10C- PC10E	16.100	8.18	-12.40	44.70
PC10C- PC10F	4.200	8.12	-24.20	32.60
PC10D- PC10E	6.070	5.63	-13.60	25.70
PC10D- PC10F	-5.880	6.18	-27.50	15.70
PC10E- PC10F	-11.900	5.61	-31.60	7.66









Summary of Discrimination for Lab and Oil screening for outliers

no outliers were identified for TLC & TGF

Lab differences

	Oil D separated from PC10 G									
	All data								Removing First PC10 E	
	Delta OC	OC % INC	TLHC	TGC	TLC	TGF	IGF	UWD	Delta OC	OC % INC
Discrimination										
Lab A - Lab B								X **X**		
Lab A - Lab D										
Lab A - Lab F	X	X				X	**X**		X	X
Lab A - Lab G	Borderline	X		X **X**		X			X	X
Lab B - Lab D										
Lab B - Lab F		X	Bd				**X**	X		Borderline
Lab B - Lab G			Bd							
Lab D - Lab F		Borderline								Borderline
Lab D - Lab G										
Lab F - Lab G	X	X					**X**			X

	Oil D combined with PC10 G									
	All data								Removing First PC10 E	
	Delta OC	OC % INC	TLHC	TGC	TLC	TGF	IGF	UWD	Delta OC	OC % INC
Differences										
Lab A - Lab B								X **X**		Borderline
Lab A - Lab D										Borderline
Lab A - Lab F	X	X				X	**X**		X	X
Lab A - Lab G	Borderline	Borderline		X **X**		X			Borderline	X
Lab B - Lab D										
Lab B - Lab F		X	X				**X**			
Lab B - Lab G			X		X					
Lab D - Lab F		Borderline								
Lab D - Lab G				**X**						
Lab F - Lab G	X	X								Borderline

	Oil D separated from PC10 G									
	All data								Removing First PC10 E	
	Delta OC	OC % INC	TLHC		TGC	TLC	TGF	IGF	UWD		Delta OC	OC % INC
Differences												
OIL A - OIL D	Borderline	Borderline									Borderline	Borderline
OIL A - PC10 A			X	**X**								
OIL A - PC10 B			Bd									
OIL A - PC10 C												
OIL A - PC10 D			X	**X**								
OIL A - PC10 E									X			
OIL A - PC10 F			Bd					**X**				
OIL A - PC10 G										**Bd**		
OIL D - PC10 A	X	X									X	X
OIL D - PC10 B	X	X									X	X
OIL D - PC10 C												
OIL D - PC10 D												
OIL D - PC10 E												
OIL D - PC10 F	X	X	X	**X**		Borderline			X	**Bd**	X	X
OIL D - PC10 G												
PC10 A - PC10 B												
PC10 A - PC10 C												
PC10 A - PC10 D	Borderline										Borderline	
PC10 A - PC10 E												
PC10 A - PC10 F			X	**X**		X			X	**Bd**		
PC10 A - PC10 G	Borderline	Borderline									X	X
PC10 B - PC10 C												
PC10 B - PC10 D	Borderline										Borderline	
PC10 B - PC10 E												
PC10 B - PC10 F			X	**X**					X	**Bd**		
PC10 B - PC10 G												
PC10 C - PC10 D												
PC10 C - PC10 E												
PC10 C - PC10 F											Borderline	X
PC10 C - PC10 G												
PC10 D - PC10 E												
PC10 D - PC10 F	X	X	X	**X**		X			Bd		X	X
PC10 D - PC10 G												
PC10 E - PC10 F	Borderline	Borderline	X	**X**		X			X	**X**	X	X
PC10 E - PC10 G												
PC10 F - PC10 G	X	X	X	**X**		X			X	**X**	X	X

	Oil D combined with PC10 G										Removing First PC10 E	
	All data											
	Delta OC	OC % INC	TLHC		TGC		TLC	TGF	IGF	UWD	Delta OC	OC % INC
Differences												
OIL A - OIL D	X	Borderline	X	**Bd**	Bd	**Bd**	Borderline			X **X**	Borderline	
OIL A - PC10 A			X	**X**								
OIL A - PC10 B			Bd	**Bd**								
OIL A - PC10 C												
OIL A - PC10 D	Borderline		X	**X**								
OIL A - PC10 E			Bd							X **X**		
OIL A - PC10 F			Bd	**Bd**					**X**			
OIL A - PC10 G												
OIL D - PC10 A	X	X									X	X
OIL D - PC10 B	X	X									X	X
OIL D - PC10 C												
OIL D - PC10 D												
OIL D - PC10 E												
OIL D - PC10 F	X		X	**X**	X		X			X **X**	X	X
OIL D - PC10 G												
PC10 A - PC10 B												
PC10 A - PC10 C			Bd									
PC10 A - PC10 D	Borderline										Borderline	
PC10 A - PC10 E												
PC10 A - PC10 F			X	**X**			X			X **Bd**		
PC10 A - PC10 G												
PC10 B - PC10 C												
PC10 B - PC10 D	X										Borderline	
PC10 B - PC10 E												
PC10 B - PC10 F			X	**X**			Borderline			X **X**		
PC10 B - PC10 G												
PC10 C - PC10 D												
PC10 C - PC10 E												
PC10 C - PC10 F			Bd									Borderline
PC10 C - PC10 G												
PC10 D - PC10 E												
PC10 D - PC10 F	X	X	X	**X**			X			Bd	X	X
PC10 D - PC10 G												
PC10 E - PC10 F	X	X	X	**X**			X			X **X**	X	X
PC10 E - PC10 G												
PC10 F - PC10 G												

Precision by cylinder

The numbers below may be compared to the precision for the 1P (slides 27 & 28)

WD:

- WD1= 79.4 WD2= 67.3 WD3= 60.27
- WD4= 54.2 WD5= 37.0 WD6= 48.7

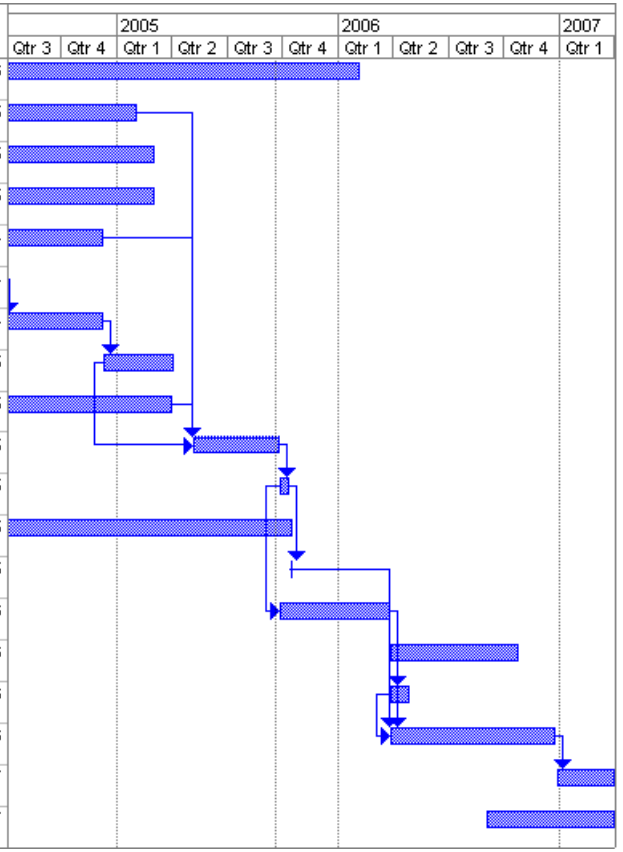
TGC: 2 outliers

- TGC1=11.38 TGC2= 7.23 TGC3= 8.10
- TGC4=8.69 TGC5= 6.44 TGC6=6.85

TLC: No outiers

- TLC1=11.21 TLC2=8.89 TLC3= 8.18
- TLC4=10.8 TLC5=5.65 TLC6= 7.84

Task Name	Start	Finish
NCDT Activity	Wed 3/26/03	Fri 2/3/06
Funding Group	Mon 2/3/03	Tue 2/1/05
New Test Development	Wed 9/25/02	Wed 3/2/05
New Test Discrimination	Fri 1/2/04	Wed 3/2/05
Matrix Design	Thu 4/1/04	Tue 12/7/04
Chemical Limits Selection	Mon 3/31/03	Tue 6/22/04
Select Matrix Oils	Wed 6/23/04	Tue 12/7/04
Matrix Oil Prep	Wed 12/8/04	Fri 4/1/05
Accept Parameters/Tests	Tue 6/22/04	Thu 3/31/05
Matrix Testing	Wed 5/4/05	Fri 9/23/05
Analyze Matrix	Mon 9/26/05	Mon 10/10/05
Select Reference Oils	Tue 6/1/04	Fri 10/14/05
HDEOCP Test Acceptance	Wed 10/12/05	Wed 10/12/05
Technology Demonstration & Limits Approval	Mon 9/26/05	Fri 3/24/06
ASTM D-2, SC-B Ballot & Approval	Mon 3/27/06	Mon 10/23/06
API Lubes Committee Final Approval	Mon 3/27/06	Wed 4/26/06
Minimum Product Qualification Interval	Mon 3/27/06	Fri 12/22/06
API Licensing	Tue 12/26/06	Mon 5/21/07
Engines in Field	Fri 9/1/06	Mon 5/21/07



DRAFT MINUTES
PC-10 New Category Development Team (NCDT) Teleconference
August 31, 2005

Bill Runkle, Chair

The PC-10 NCDT met by conference call on August 31, 2005, to discuss the following items related to PC-10 development:

- C-13 Status and Concerns
- Current ACC Position on Product Demonstration and Approval Periods
- Reconfirmation of EMA Withdrawal of Caterpillar 1P Requirement
- Inclusion, or not, of the Sequence IIIG
- Deadlines for Decisions on Valve Train Wear tests, the IIIG and the 1P

Progress on Action Items from the August 5, 2005, call was also reviewed.

Conference Call Attendees

Belay, Mesfin	Herzog, Steve	Richards, Scott
Carlson, Sue	Jetter, Steve	Runkle, Bill
Cassim, Abdul	Kennedy, Steve	Shank, Greg
Castanian, Chris	Kleiser, Bill	Smith, Dave
Chao, Ken	Laroo, Chris	Stehouwer, David
Cousineau, Tom	Lynskey, Mike	Stockwell, Robert
Evans, Joan	Morris, Doug	Williams, Lew
Ferrick, Kevin	Parsons, Gary	Urbanak, Matt
Fetterman, Pat	Passat, Charlie	Zalar, John
Fernandez, Frank	Place, Bill	

C-13 STATUS AND CONCERNS

The C-13 matrix testing may finish the 3rd week of September, three weeks ahead of the original estimate. This could allow 1st API licensing of PC-10 oils by the end of December 2006, provided no other factors cause delay. However, ACC voiced a number of concerns about the C-13 (see the next section of minutes) that, if they prove valid, would eliminate any time savings.

Since the C-13 is a time limiting step, it was questioned how much time would be saved if this test is not in the category. ACC indicated they will provide an estimate by the end of September.

ACTION: ACC will provide the NCDT with an estimate of how much time would be saved from the Technology Demonstration and Product Qualification Period if the C-13 is not a PC-10 test.

CURRENT ACC POSITION ON PRODUCT DEMONSTRATION AND APPROVAL PERIODS

Tom Cousineau summarized the current ACC position indicating that nothing has changed since June that would allow ACC to agree to reduce the 15 month Technology Demonstration and Product Approval Period in the PC-10 Timeline. ACC believes the uncertainty about including the Caterpillar 1P, the Sequence IIIG and up to three valve train wear tests plus unknown issues about the Caterpillar C13 that could affect the number of tests needed (how many parameters will be rated, the pass/fail ratio and inconclusive BOI data from results available to date) inhibits an informed decision at this time. They also believe it is premature to agree to set PC-10 test limits by January 15, 2006, as proposed in the August 5, 2005, NCDT call.

RECONFIRMATION OF EMA WITHDRAWAL OF CATERPILLAR 1P REQUIREMENT
EMA indicated that, in lieu of data being supplied to justify the need for the Caterpillar 1P test before their September 20, 2005, meeting, EMA will likely withdraw its request for this test. Any written withdrawal would be made only after this meeting.

ACTION: EMA will determine by September 21, 2005, whether to withdraw or keep the request to add the Caterpillar 1P test to PC-10.

INCLUSION, OR NOT, OF THE SEQUENCE IIIG
EMA will review Mack T-12 test results on September 20, 2005, to determine if this test alone is sufficient to measure oxidation protection and if so determine if the request for the Sequence IIIG in PC-10 can be withdrawn. The results of their analysis will be presented at the September 21, 2005, ASTM HDEOCP Meeting. Bill Runkle agreed to ask the HDEOCP Chair to add this item to the agenda for September 21, 2005.

EMA set a deadline of September 30, 2005, to resolve this issue. The NCDT concluded that if data are not available to support withdrawal of the Sequence IIIG by September 30, 2005, this test will not be a PC-10 requirement.

ACTION: Bill Runkle will request that discussion of the Mack T-12/Sequence IIIG issue be added to the September 21, 2005, HDEOCP agenda.

ACTION: EMA will determine by September 30, 2005, if the Sequence IIIG is necessary in PC-10 in addition to the Mack T-12 to measure oxidation resistance.

DEADLINES FOR DECISIONS ON VALVE TRAIN WEAR TESTS, THE IIIG AND THE 1P
As indicated above, the deadline for a decision on the Sequence IIIG test is September 30, 2005. EMA reported that the ASTM HDEOCP Valve Train Wear Test Task Force will make a decision by the HDEOCP meeting planned for the week of October 24.

The NCDT set a deadline of September 21, 2005, to consider any new test not in the original EMA PC-10 category request. This includes the Caterpillar 1P. After that date, a new test will be considered only if it is proposed to replace an existing test in the category.

REVIEW OF ACTION ITEMS FROM THE AUGUST 5, 2005, NCDT CALL

Ideas for a modified approach to allow first API licensing of PC-10 oil on October 1, 2006, that were developed at the June 30, 2005, NCDT meeting are again shown in Attachment 1. During the August 5, 2005, NCDT call, action items were set to further explore several of these ideas.

ITEM #2 - OEM test sponsor endorsement of technology (similar to CI-4 PLUS arrangement)

8/5 ACTION: Steve Kennedy and API will define the OEM liability requirement for use of OEM test sponsor endorsement of technology for licensing PC-10 oils.

STATUS: The API position was circulated to the NCDT on August 16, 2005. During this call, EMA indicated its members could not assume the added indemnification that would be required by API. Thus, this approach was removed from further consideration.

ITEMS #4 & 5 - Grant T-12 BOI reads to 100% Group III & Grant ISM/ISB BOI reads to 100% Group III

8/5 ACTION: Bill Runkle will refer these items to the API BOI/VGRA Task Force

STATUS: On August 22, 2005, Bill Runkle formally asked the BOI/VGRA Task Force to consider these items. It was reported that John Rosenbaum, BOI/VGRA Co-Chair, had forwarded this request to Task Force members for input and consideration.

ITEM #8 - Reduce number of engine tests in category

8/5 ACTION: EMA will provide the NCDT with their position regarding the Caterpillar 1P test for PC-10

8/5 ACTION: The PC-10 NCDT will evaluate the need for the valve train wear tests, the Sequence III and the Caterpillar 1P upon receipt of appropriate input

STATUS: Both items were discussed above

ITEM #9 - Different levels of licensing based on subset of critical tests.

8/5 ACTION: API will survey oil marketer members to determine if they would market PC-10 oils that were licensed based only on Stage 1 engine testing

STATUS: Kevin Ferrick reported that all but one oil marketer responded they would not market a PC-10 oil based only on Stage 1 testing. The one oil marketer that supported the idea would only agree to the option if certain conditions were met. Thus, this item was removed from further consideration.

ITEM # 11 - Monitor stand utilization to determine if product approval period can be shortened

8/5 ACTION: ACC will supply test stand utilization data when available

STATUS: Data are not yet available and this will be progressed as soon as data permit

OTHER JUNE 5, 2005, ACTION ITEMS

8/5 ACTION: ACC will provide their position on setting PC-10 test limits around January 15, 2006.

STATUS: Discussed above

8/5 ACTION: EMA will determine if there is any leeway in the October 1, 2006, date.

STATUS: EMA indicated that their request for first API licensing of PC-10 oils by October 1, 2006, is firm.

8/5 ACTION: The API DEOAP will carry forward to the API Lubricants Committee any modified PC-10 timeline for earlier first API licensing of PC-10 oils resulting from NCDT evaluations

STATUS: Not applicable at this time

OTHER BUSINESS
None indicated

NEXT MEETING
A conference call was scheduled for September 30, 2005, at 1:00 pm EST.

ACTION: API will finalize the arrangements for the conference call.

Mack T-10 / T-12 versus Sequence III Oxidation Tests

Reviewed with the HDEOCP, Chicago, IL
September 21, 2005

Preliminary Data Review

- Additive A in Group I stock –

	Mack T-10	Mack T-12		IIIF	IIIG
EOT Pb	25	54	Vis inc	100%	>1000%
250-300 Pb	6	18			
FTIR5	252	710			
URBWL	232	244			
Merits	1294	-			

Additive A’ (T-10) and additive A (T-12, IIIF/G) in Group II stock –

EOT Pb	14	27	66%	337%
250-300 Pb	7	12		
FTIR5	199	356		
URBWL	150	212		
Merits	1538	-		

D874 Sulfated Ash Compliance Task Group

Recommendations for PC10

Presentation for EMA, Chicago, 20 Sept 05

ASTM SACTG
Chartered 21 June 2005 HDEOCP

- Kishore Nadkarni, chair D02.03, Infineum
- Pat Fetterman, Infineum
- Lew Williams, Lubrizol
- Lowell Lefever, Lubrizol
- Joe Franklin, chair D02.B, Perkin Elmer
- Becky Grinfield, SwRI
- Dave Stehouwer, For Cummins
- Mesfin Belay, Detroit Diesel
- Eric Olsen, Oronite (SACTG chair)
- Plus countless others, behind the scenes

Proposals

- **1.0%** D874 sulfated ash, **Non-Critical**
  - **No consensus for two decimals**
- **NEW** – D874 determined with **verified lab/stand according to ASTM-LTMS** to reduce bias and improve precision
- LTMS will employ multiple TMC reference oils
  - One will be used for daily check (and logarithmic average plot)
  - Three oils for periodic blind checks (~90 days frequency)
- **Drop MTAC**
  - MTAC is for use with ACC registered engine tests in candidate data packages

D874 Precision

average of determinations	repeatibility	reproducibility
0.1	0.01	0.03
0.2	0.02	0.04
0.3	0.02	0.06
0.4	0.03	0.07
0.5	0.04	0.08
0.6	0.04	0.10
0.7	0.05	0.11
0.8	0.05	**0.12**
0.9	0.06	**0.13**
1.0	0.06	**0.14**
1.1	0.06	**0.15**
1.2	0.07	**0.16**
1.3	0.07	0.17
1.4	0.08	0.18
1.5	0.08	0.19
1.6	0.09	0.20
1.7	0.09	0.21
1.8	0.09	0.22
1.9	0.10	0.23
2.0	0.10	0.24

D3244 Type Limits

One test limits	Non-critical acceptance limit	Critical acceptance limit
Sulfated Ash (D874) – 1.00% Max.	1.08	0.92
Phosphorus (D4951) – 0.12% Max.	0.127	0.113
Sulfur (D4951) – 0.4% Max.	0.44	0.36
Sulfur (D2622) – 0.4% Max.	0.42	0.38

Two test limits	Non-critical acceptance limit	Critical acceptance limit
Sulfated Ash (D874) – 1.00% Max.	1.06	0.94
Phosphorus (D4951) – 0.12% Max.	0.125	0.115
Sulfur (D4951) – 0.4% Max.	0.43	0.37
Sulfur (D2622) – 0.4% Max.	0.42	0.38

Three test limits	Non-critical acceptance limit	Critical acceptance limit
Sulfated Ash (D874) – 1.00% Max.	1.05	0.95
Phosphorus (D4951) – 0.12% Max.	0.124	0.116
Sulfur (D4951) – 0.4% Max.	0.42	0.38
Sulfur (D2622) – 0.4% Max.	0.41	0.39

Example of D874 Reproducibility

TMC Ref oil 1005-1	Source of Data
1.11	ASTM Ref Oil Book 2004
1.02	average lab three
1.01	lab 3 determination #1
1	lab 3 determination #2
1.06	lab 3 determination #3
1.01	lab 3 determination #4
0.92	average lab four
0.89	lab 4 determination #1
0.92	lab 4 determination #2
0.94	lab 4 determination #3
0.94	lab 4 determination #4

New TMC reference oil for D874-00

- Pedigree links to NIST SRM 1848
  - Robust supporting data for metals content and D874
  - Formulated as 15w40 for 1.0% s-ash
- Available soon from TMC
  - Control limits will be established by round robin of participating laboratories

Closing Statement

- SACTG recommendations make the best of the capabilities of an old empirical method
  - 1.0% non-critical
  - D874 determined with verified lab/stand according to ASTM-LTMS to reduce bias and improve precision
  - Drop MTAC

D874-00, initial burn

Continue to heat with flame until smoke & fumes stop

Add H2SO4

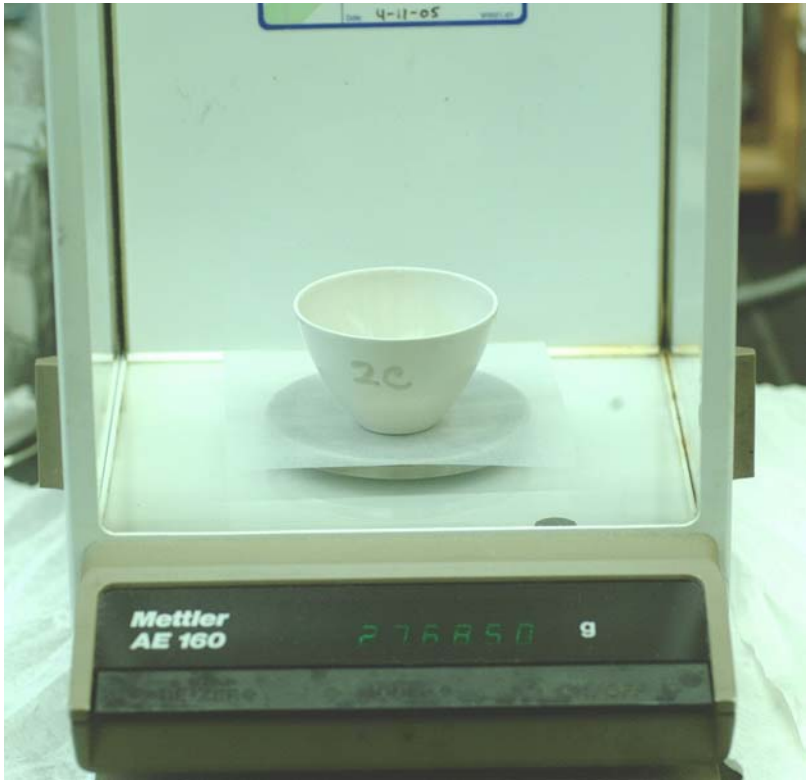
Heat at low temperature until fumes stop

Sample appearance after first burning

775C (1430 F) Muffle Furnace

5-Oct-05

Cool, then weigh residue



Partial list of Theoretical ash products

		theoretical sulfated ash reaction product			
element	mw	name	structure	MW	mass ratio reaction product to starting metal content
Zn	65.4	zinc oxide	ZnO	81.4	**1.24**
Zn	65.4	zinc sulfate	ZnSO4	161.4	**2.47**
Zn	65.4	zinc pyrophosphate	Zn2P2O7	304.7	**2.33**
Ca	40.1	calcium oxide	CaO	56.1	**1.40**
Ca	40.1	calcium sulfate	CaSO4	136.1	**3.40**
Ca	40.1	calcium phosphate	Ca2P2O7	254.1	**6.34**
Mg	24.3	magnesium oxide	MgO	40.3	**1.66**
Mg	24.3	magnesium sulfate	MgSO4	120.4	**4.95**
Mg	24.3	magnesium phosphate	Mg2P2O7	222.5	**9.16**

Proposals

- **1.0%** (or **1.00%**) D874 sulfated ash, **Non-Critical**
- **NEW** – D874 conducted using **verified lab/stand according to ASTM-LTMS** to reduce bias and improve precision
- Multiple TMC reference oils will be used
  - One will be used for daily check (and logarithmic average plot)
  - Three oils for periodic blind checks (~6 weeks frequency)
- **Drop MTAC**
  - MTAC is for use with registered tests in candidate data packages

APPENDIX

ASTM SACTG

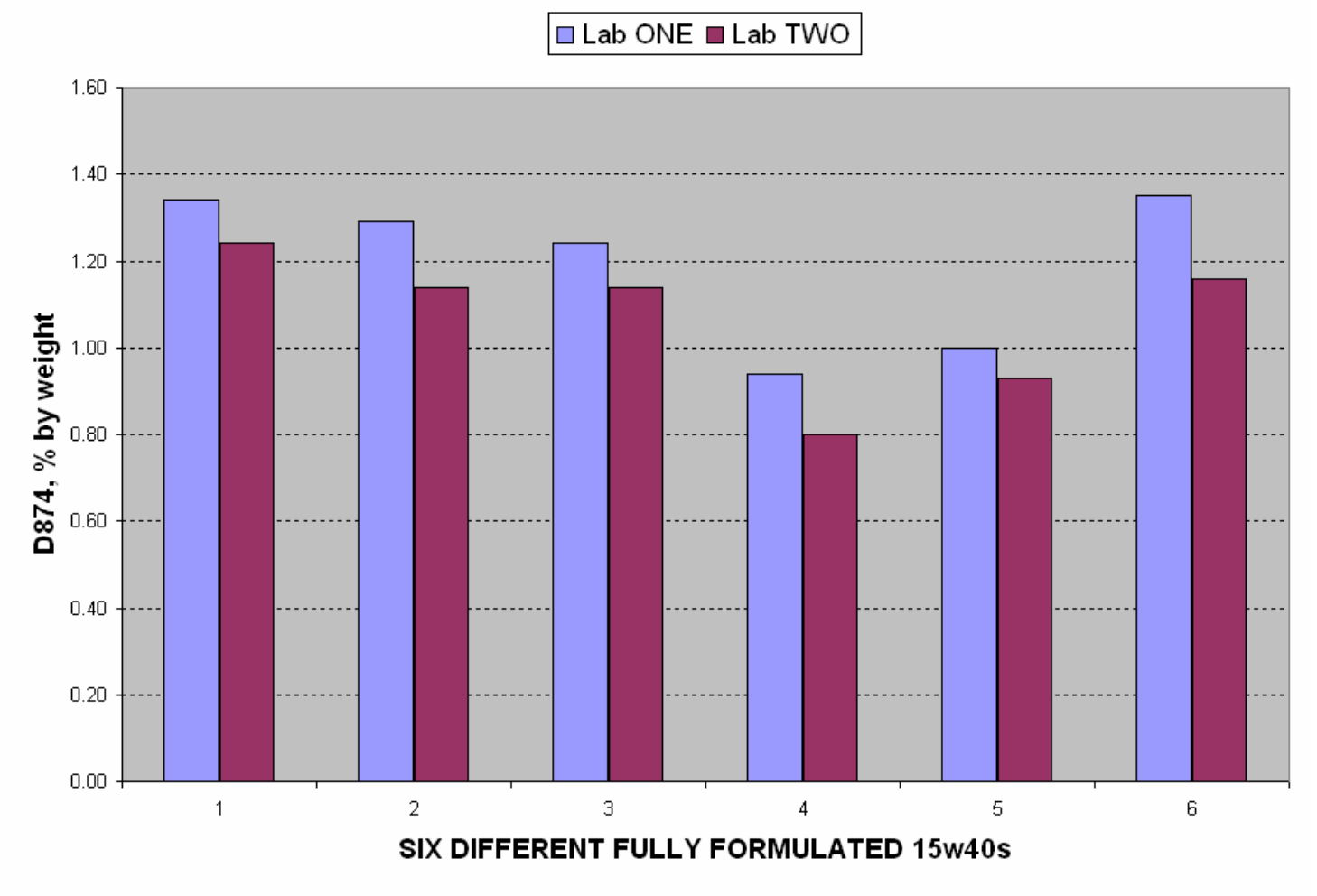
SACTG Objective

- **Recommend to the HDEOCP on or before 21 Sept 2005 how to resolve the contradictions among differing expectations for D874 compliance:**
  - **D874 as a non-critical specification (reference 15 June 2004 HDEOCP ballot results)**
  - **D874 as a critical specification (application of MTAC, 22 June class panel minutes) in context of the technical limitations of D874 (reference ASTM D874-00 and SAE 952548)**
- **First SACTG conference call held on July 28, 2005**

D874 Summary

- Bias between labs is the most difficult problem
  - Not a new issue
  - Control charts (2000, appendix X1) were an important step in the right direction

Some recent D874 results



Proposed Cummins ISM Merit Rating System

presented to

Cummins Surveillance Panel

Merit Rating System Terms

- Anchor – if an oil averaged exactly at the anchor for each criterion, it would be a borderline oil
- Maximum – limit of acceptable performance for an individual criterion
- Minimum – best possible performance for an individual criterion, or better number gives no better performance
- Weight -- relative contribution of individual criterion to total merit

Proposed Merit Rating System

- A result at or below the anchors for all five criteria would pass the test.

- If any of the five criteria results is above the maximum, the test fails.

- If results are below the maximums for all five criteria but one or more results is above the anchors, a mathematical system determines whether marginal numbers above the anchors are compensated by better than anchor results on other criteria.

Straw Man Parameters

Criterion	Crosshead Weight Loss	Top Ring Weight Loss	Oil Filter Delta P	Adjusting Screw Weight Loss	Sludge
Weight	225	150	250	225	150
Maximum	6.5	90	25	45	8.6
Anchor	5.0	65	12	30	9.0
Minimum	3.5	40	5	15	9.5

Multiple Test Acceptance Procedure

- Multiple test evaluation would consist of averaging the five individual criteria across multiple tests. The Cummins ISM Merit Rating System would be applied to the averages for the criteria.

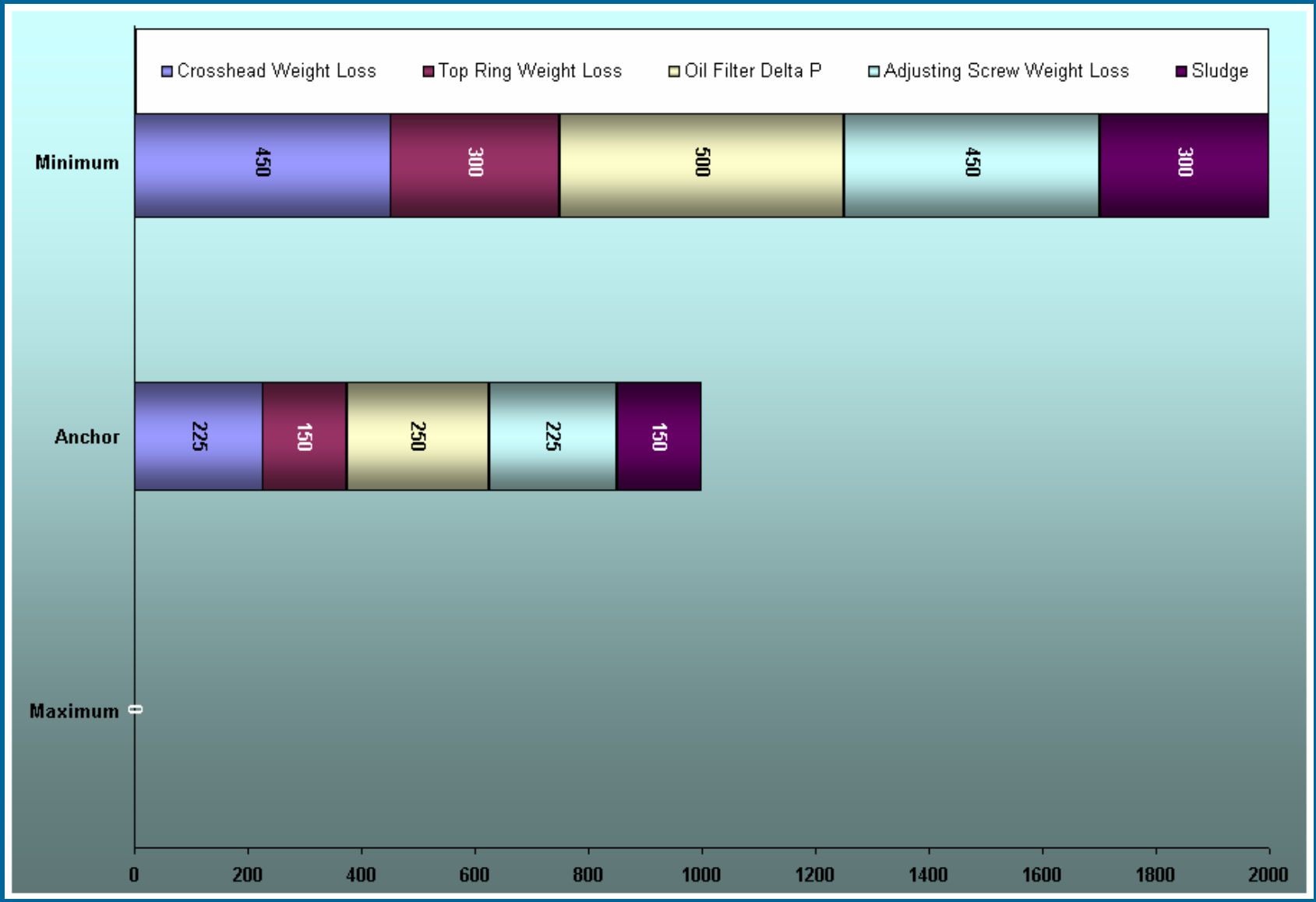
Examples Using Hypothetical Test Results

	Crosshead Weight Loss	Top Ring Weight Loss	Oil Filter Delta P	Adjusting Screw Weight Loss	Sludge	Calculated Merit	**Final Merit**
On the border	5.0	65	12	30	9.0	1000	**1000**
Borderline Failures	**6.6**	65	12	30	9.0	760	**Fail**
	5.0	**91**	12	30	9.0	844	**Fail**
	5.0	65	**26**	30	9.0	731	**Fail**
	5.0	65	12	**46**	9.0	760	**Fail**
	5.0	65	12	30	**8.5**	813	**Fail**
One parameter can make up for another	**6.0**	**40**	12	30	9.0	1000	**1000**
	5.0	**70**	**10**	30	9.0	1041	**1041**
	5.0	65	**15**	**20**	9.0	1092	**1092**
	5.0	65	12	**35**	**9.3**	1015	**1015**
	4.0	65	12	30	**8.8**	1075	**1075**
Beyond Limit Failure	**6.6**	40	5	15	9.5	1535	**Fail**
	3.5	**91**	5	15	9.5	1694	**Fail**
	3.5	40	**26**	15	9.5	1481	**Fail**
	3.5	40	5	**46**	9.5	1535	**Fail**
	3.5	40	5	15	**8.5**	1663	**Fail**

Values for Matrix Oil Tests

	Crosshead Weight Loss	Top Ring Weight Loss	Oil Filter Delta P	Adjusting Screw Weight Loss	Sludge	Calculated Merit	**Final Merit**
28402 1004-3	8.3	61	35	139	9.0	-1558	**Fail**
30048 1004-3	7.4	72	238	155	9.0	-5618	**Fail**
35313 1004-3	9.4	62	24	138	9.0	-1483	**Fail**
43672 1004-3	7.8	64	110	59	8.9	-1764	**Fail**
50254 1004-3	8.0	53	126	191	9.1	-3952	**Fail**
51225 1004-3	8.5	46	75	44	7.9	-1242	**Fail**
47644 830-2	5.7	57	9	20	9.2	1253	**1253**
50224 830-2	4.6	44	10	38	9.0	1134	**1134**
51799 830-2	4.4	56	12	34	9.1	1123	**1123**
52996 830-2	2.4	68	7	24	9.0	1470	**1470**
52997 830-2	**7.0**	34	11	25	9.1	988	**Fail**
54195 830-2	4.7	40	13	27	9.1	1245	**1245**
54204 830-2	4.9	78	**27**	41	8.8	397	**Fail**
50769 ISMA	5.9	76	10	**137**	8.6	-874	**Fail**
51224 ISMA	5.9	44	3	43	9.1	1087	**1087**

Potential Criteria Contributions



Benefits of Merit System

- More cost effective testing
- Consistent with reducing the time between ASTM acceptance and first date of API licensing
- Allows test developer to weight individual criteria
- Adds incentive for improved performance
- Flexibility in setting up system
- Easier to gain consensus on limits

Committee D-2 on PETROLEUM PRODUCTS AND LUBRICANTS

Chairman: N. DAVID SMITH, North Carolina Dept. of Agric., 2 West Edenton St., P.O. Box 27647, Raleigh, NC 27611 (919-733-3313) FAX: 919-715-0524
First Vice-Chairman: SUSAN E. LITKA, UOP Research Center, 50 East Algonquin Rd., P.O. Box 5016, Des Plaines, IL 60017-5016 (708-391-3390)
Second Vice-Chairman: KURT H. STRAUSS, 69 Brookside Rd., Portland, ME 04103 (207-773-4380) FAX: 207-775-6214
Secretary: KENNETH O. HENDERSON, Castrol North America, Automotive Div., 240 Centennial Ave., Piscataway, NJ 08854 (908-980-3630) FAX: 908-980-9519
Assistant Secretary: W. JAMES BOVER, Exxon Biomedical Sciences, Inc., Mettlers Rd., CN2350, East Millstone, NJ 08875-2350 (908-873-6318) FAX: 908-873-6009
Staff Manager: EARL R. SULLIVAN (610-832-9709)

July 20, 2005

Dear Mr. Alexander,

The API CF-4 category includes a Mack T-6 test with a merit rating of 90. However, there is no Mack T-6 test in the industry to date. Consequently, the ASTM-HDEOCP agreed on specific limits in the Mack T-10 to replace the Mack T-6.

An "Exit-Criteria" ballot on the proposed Mack T-10 limits had 19 affirmative votes and one negative by Chevron Oronite.

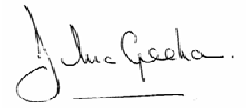
The limits accepted by the panel were:

- Liner Wear: 47 µm
- Top Ring Weight Loss: 180 mg

Oronite's position was that the Mack T-6 tests had different cycle, loads, rings, and liner than Mack T-10 and that the Mack T-6 had a piston deposit rating, which Mack T-10 does not have. In the past we have made similar changes to keep this category in place when the Cummins NCT 400 was replaced by two Caterpillar 1K tests.

We would like API's advice on whether your committee needs the API CF-4 category, understanding the technical challenges imposed with replacement tests, as described above.

Sincerely yours,



J. A. Mc Geehan
Chairman of Heavy-Duty Engine Oil Classification Panel

cc: Jim Wells, ASTM-HDEOCP Secretary
Lew Williams, ASTM-DO2.B Secretary

September 16, 2005

Dear Mr. McGeehan,

You requested reaffirmation by the API Lubricants Committee that the API CF-4 category was still needed; understanding the technical challenges imposed with replacement tests. In an August 11, 2005 teleconference, the Lubricants Committee approved by voice vote [8 For, 0 Against, 2 Abstains] to reaffirm to the ASTM HDEOCP the previous API Lubricants Committee request for a replacement test for the Mack T-6/T-9. Committee members also expressed the need for continued licensing of CF-4 oils.

Please provide a recommendation that would allowed continued licensing of CF-4 oils using technically feasible replacement test(s). If this request cannot be accommodated, please inform us.

Thanks for the effort of the HDEOCP regarding this matter.

Sincerely yours,

West Alexander, III
Chair API Lubricants Committee