HEAVY-DUTY ENGINE OIL CLASSIFICATION PANEL

OF

ASTM D02.B0.02

January 10, 2006

Southwest Research Institute – San Antonio, TX

ACTION ITEMS

1. Compile table of seals and pass limits **Dave Stehouwer**

2. Issue Exit Criteria Ballot for Seals **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 1:00 p.m. on Tuesday January 10, 2006, in Building 209 at Southwest Research Institute.

1.2 There were 18 members present and 34 guests present. The attendance list is shown as Attachment **2.**

2.0 Agenda

2.1 The agenda shown (included as Attachment **1**) had 2 additions for a seals update and a T-11 pumpability proposal.

3.0 Minutes

3.1 The minutes from the December 6, 2005 meeting were approved with a comment that the limits for a Sequence IIIG test have been determined.

4.0 Membership

4.1 There were no membership changes.

5.0 Delivering on time.

5.1 See Attachment **3**. Chairman McGeehan showed a table of 10 engine tests and 6 bench tests. The oil oxidation as measured by a IIIG was corrected. The Elastomer compatibility test (seals) has been assigned an ASTM number of D7216. The Mack T-12 test limits were modified since the exit ballot. Greg Shank pointed out that the changes resolved most of the negatives. The ISB and ISM limits were also modified after their exit ballots, but there were still concerns. Two additive companies were to talk with Cummins. The C13 limits were shown with an exit ballot to be discussed. The T-11 limits were presented with the exit criteria ballot to be discussed.

6.0 Exit Criteria Ballot Results

6.1 The table of ballot results was shown. See Attachment **4**. Steve Kennedy of ExxonMobil discussed their negative vote on the T-11. Any oil that passes the 6% limit will pass the 3.5% limit and feels that the 3.5% limit is meaningless. With 3 limits, they feel it makes more sense to express results as a viscosity increase at each of the 3 soot levels rather than minimum soot levels at set viscosity increases. As the only negative, ExxonMobil will "live with it". Lubrizol had a comment about what to do with the Correction Factor at 6.7% soot. Greg Shank suggests applying the 6% Correction Factor to the 6.7% data, but the Surveillance Panel will decide how to implement. Pat Fetterman said that since the 6.7% comes from the whole data set, it shouldn't have a correction applied at all. The Surveillance Panel will need to decide how to apply Severity Adjustments and Correction Factors to the test at the additional limits. Wim van Dam (chairman of the Mack Surveillance Panel) stated it will be on the Surveillance Panel agenda. The next meeting will be at the call of the chairman. Lubrizol also feels that the T-11 limits should be flipped using a maximum viscosity increase at a set soot level. Conventional thinking considers the T-11 as a 12 cSt maximum viscosity increase at 6% soot, not a 6% minimum soot at 12 cSt viscosity increase. Greg Shank **moved** to accept the T-11 at these limits for CJ-4. Lew Williams seconded. See Attachment **3**. The **motion passed** unanimously with 18 votes for, 0 against and 0 waives.

6.2 The negative votes from the C-13 ballot were discussed. Concerns included inconsistencies relating to the second ring top carbon on the way the data was collected. The presentation announcing this parameter stated that the data was not generated with the same methodology at all labs. There has since been a rating workshop. Some of the affirmative votes had comments. More concern about 2nd ring top carbon. Data from the workshop indicates better rating precision, but a shift more severe. The parameter did not have clear instructions during the matrix. If the workshop addresses this concern, then the voter is "ok" with the parameter, but if not, then will have to consider how to vote on the final vote. Concern about the anchor and maximum values in the merit system and the effect on the pass rate. Concern that the pass rate will be low. Second ring carbon technically flawed and would like to review TLC and TGC merit limits.

6.3 Abdul Cassim addressed the exit ballot concerns. See Attachment **5**. Abdul feels that the TLC and TGC carbon limits are already generous, so no room to move. Addressing concerns that the second ring parameter was not in the MOA and introduced late. The MOA required discrimination to be demonstrated on named parameters. After matrix completion, the parameters will be assigned by the Surveillance Panel. Second ring carbon was developed late to replace the Unweighted Deposits which was removed late in the process. Caterpillar had concerns over deposits lower than the top groove. Caterpillar has seen ring sticking and high levels of second ring carbon. A rating workshop was conducted recently to finalize rating methods. The rating workshop did improve the method but also indicated some difficulty rating the rings before the workshop. Limits were set liberally based on the matrix data and CAT's needs. 100% light carbon is undesirable. Rater comments were that these ratings were amongst the best they have rated, even better than more commonly accepted ratings.

6.4 Jim Gutzwiller showed the workshop data. See Attachment **6**. The Surveillance Panel has not seen the data yet. Two additive suppliers and CAT supplied rings for the workshop. (6 engine sets). One set of rings were created from the 6 engine sets. This set was used as a preliminary set for rating before discussion of the rating method. Two engine sets were rated after the initial discussion. The second day, 5 sets were rated after the discussion with no breaks for data analysis. One engine set was rated again, but was labeled a new set. Analysis of the matrix data is forthcoming and the C13 Surveillance Panel will meet by conference call to discuss. The ratings improved as a result of the workshop. A question was asked why the ratings are more severe as a result of the workshop. The answer is a clarification of heavy carbon. Some were calling heavy carbon as light carbon due to the polishing nature of the carbon. The raters would like to see more rings to evaluate as a round robin so they can improve the rating method. The reason for the question is that the pass/fail limits were set from the matrix data, but if the ratings are more severe, then the limits should be adjusted to account for the increase. The apparent shift is about 2.5 demerits.

6.5 Jim Rutherford has performed some analysis of the data. See Attachment **7**. Jim used ring sets A through G and preliminary set one. No real difference was evident between raters. This group of raters was able to see significant differences between the ring sets. Matrix only raters show better precision and may not have any outliers.

6.6 Chairman McGeehan went back to the table of C13 limits. Greg Shank **moved** to accept these limits for the C13 for CJ-4. Abdul Cassim seconded. Raising the limit of 22 from 17 and the cap from 28 to 33 is more than the shift of 2.5 from the raters as a result of the workshop. The rings CAT sent were the worst they have ever seen and were very caked with carbon. A standardized procedure is being adopted and appears to be improving the method. Abdul is happy with the work the raters have done and will not hold up the category. The voters who voted negative can "live with it". The **motion passed** unanimously with 18 votes for, 0 against and 0 waives.

7.0 Cummins ISM

7.1 Additive companies have had discussions with Cummins. The major issue was with the Injector Adjusting Screw Weight Loss (IASWL) maximum of 45 mg. Cummins can live with a maximum of 49 mg. The voters who voted negative are satisfied with 49 mg. Pat Fetterman **moved** to accept the ISM limits changing the maximum injector adjusting screw limit to 49 mg. Bill Kleiser seconded. See Page 3 of Attachment **8**. The **motion passed** unanimously with 18 votes for, 0 against and 0 waives.

8.0 Cummins ISB

8.1 The Average Camshaft Wear (ACW) pass limit was 50 micrometers and Cummins will move to 55 micrometers. The Tappet Weight Loss (TWL) will stay at 100 mg. The voters who voted negative are satisfied. Bill Kleiser **moved** to accept the ISB at the new limits including the change to 55 micrometers for ACW. Pat Fetterman seconded. See Page 5 of Attachment **8**. The **motion passed** unanimously with 18 votes for, 0 against and 0 waives.

9.0 Mack T-12

9.1 Greg Shank **moved** to accept the limits for the T-12 with the changes shown at the last meeting in Norfolk. Pat Fetterman seconded. See Attachment **3**. The **motion passed** unanimously with 18 votes for, 0 against and 0 waives.

10.0 Mack T-11

10.1 Greg Shank gave a Low Temperature Pumpability proposal for CJ-4. See Attachment **9**. The requirement would come from the 180 hour sample from the T-11, not the T-10A. The limits apply to 0W, 5W, 10W, and the 15W viscosity grades. For Yield Stress, use the Modified D4684 with a yield stress less than 35. Greg recommends that the BOI/VGRA Task Group use current T11 rules. For current read across, fresh oils would have a 20,000 cp maximum. No need for an exit criteria ballot, decide it here. Greg Shank **moved** to accept this proposal. Pat Fetterman seconded. The T-10A is not an alternative. The **motion passed** unanimously with 18 votes for, 0 against and 0 waives.

11.0 Seals

11.1 Becky Grinfield indicated that VAMAC material has been tested since 2003. There has been more variability in this material, but the Central Parts Distributor (CPD) talked with the manufacturer and the latest batch should be better. The method has a new ASTM number: D7216 for CI-4 seals. VAMAC is not in D7216. Batches of seal material are controlled between the CPD and the manufacturer. Every candidate has a reference run on it simultaneously. The EMA is proposing to continue comparing to the 1006 reference oil with new limits for CJ-4. This is similar to the 4 other elastomers in CI-4. Engine manufacturers are using VAMAC in their seals. This should be an exit criteria item. Greg Shank **moved** to issue an exit criteria ballot. Robert Stockwell seconded. Dave Stehouwer is developing a

complete table of all the limits for all the seals. There was a **unanimous** voice vote to issue an exit criteria ballot.

12.0 ACC Report

12.1 The ACC report is included as Attachment **10**. After the Norfolk meeting with CAT's announcement of ECF-2 and ECF-3, ACC met to discuss impacts on the timeline. The C13 is still the rate limiting test. The ACC counts 10 calibrated C13 stands in the industry. CAT has offered up to 4 uncalibrated stands at their facility. The ACC code states that all testing for product approval must be conducted on calibrated stands. It is unlikely that anyone will use stands at CAT unless they are calibrated. The ACC is assuming 10 tests per month and a 40%-50% pass rate, which is 4 to 5 passes per month. There could be reasons that all 10 stands may not be utilized all the time. For CJ-4 only, 31 passes are required if full BOI/VGRA is granted. This can be complete by October 15th. The ECF-2 requirements are not fully defined, so passing C13 limits are unknown. The best case with CJ-4 and ECF-2 requires 74 passes, 43 additional passes for ECF-2. This would take 15 to 19 months to complete. Without VGRA, 88 passes are needed. Without any BOI/VGRA, 161 passes are needed, running into 2008. All CJ-4 and OEM specs need to be finalized. C13 capacity constraints will make it impossible for ECF-2 and CJ-4 simultaneously. Going back to best case with CJ-4 and ECF-2, will take 15 to 19 months and run into 2007.

12.2 Abdul Cassim presented plans to modify ECF-2 in response to ACC's concerns. See Attachment **11**. Industry concerns appreciated and addressed. The ECF-2 implementation date will be extended to first quarter 2007. ECF-2 is required for a "leave behind" oil for the rest of the world and off highway. The C13 limits in ECF-2 could be aligned with the PC-10 limits for the C13. This relieves pressure on the PC-10 timeline which can not be impacted. In lieu of a C13 laboratory test, field data meeting certain requirements will be acceptable. ECF-3 is bringing half of PC-10 forward by a few months. CAT is moving away from the self-certification of ECF-1. The timeline for ECF-2 does not change except for pushing out the implementation. ECF-3 can be used before ECF-2. A C12 bridge engine field test would be looked at, but not automatically accepted.

13.0 Timeline

13.1 Bill Runkle showed the NCDT timeline. See Attachment **12**. This version takes into account recent ACC concerns, but now ACC indicated that October 15th can be met. Provided no new parameters and specs are introduced, ACC still agrees to October 15th.

14.0 Full Table of Tests and Limits

14.1 Chris Castanien compiled all the limits. See Attachment **13**. There could be a T-11A test to generate the 180 hour sample only. The Surveillance Panel will consider it.

14.2 Fresh oil MRV is for BOI. The tiered limits for the T-11 will need to be added. The C13 ring and liner scuffing is for test interpretability, so it should not be listed as a pass/fail.

15.0 AOB

15.1 Greg Shank thanked all participants for the spirit of the meeting and for their efforts. Encourages everyone to use this category as a real spec, not a niche spec.

15.2 Greg Shank wants to start the T-10 to T-12 correlation at the meeting on January 26th. The whole issue of CJ-4 licensing CI-4 or CI-4+ needs to be addressed. Chairman McGeehan stated it looks like the category will be delivered on time.

16.0 Next meetings

16.1 January 26, 2006. Chicago, IL. Embassy Suites O'Hare.

17.0 The meeting was adjourned at 3:55 pm.

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

Southwest Research Institute, San Antonio, Texas
Tuesday, January 10th, 2006
1:00 pm-5:00 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	1:00-1:5
Minutes Approval	• December 6th , 2005	Group	1:05-1:10
Membership	• Changes: Additions • Delivering PC-10 on time!	Jim Mc Geehan	1:10-1:15
Mack T-12	• Mack T-12 final limits • Discussion and Vote	Greg Shank	1:15-2:00
Mack T-11	• Mack T-11 Exit-Ballot results • Discussion and vote	Jim Mc Geehan	2:00-2:45
Cummins ISB	• Cummins ISB Final limits • Discussion and vote	Dave Stehouwer	2:45-3:00
Cummins ISM	• Cummins ISM Final limits • Discussion and vote	Dave Stehouwer	3:00-3:30
Caterpillar C13	• Cat 13 Exit-Criteria ballot results • Discussion and vote	Jim Mc Geehan Abdul Cassim	3:30-4:15
ACC Report	• ACC's timing concerns and other issues • PAPIG-testing activity • Caterpillar C13 ECF-2/3 effects on test capacity and timing of PC-10	Lew Williams Joan Evans	4:15-4:30
Time-line	• Review time-line and effects of Cat ECF-2 on timing	Bill Runkle	4:30-4:45
New Business	•		4:45-5:00
Next Meetings	• January 26th 2007 in Chicago at Embassy Suites O'Hare Rosemont		

HDEOCP Meeting, January 10, 2006, San Antonio, TX

	Name	Company	Member
1	JIM MC GEEHAN	CHEVRON	✓
2	ABDUL H. CASSIM	CATERPILLAR	✓
3	John Rosenbaum	Chevron Base Oils	
4	JIM MORITZ	INTERTEK AR	NO
5	Frank Fernandez	Chevron Oronite	NO
6	Bernie Kinker	RohMax USA	proxy Sherzog
7	PAT FETTERMAN	INFINEUM	YES
8	JOHN EVANS	Infineum	NO
9	Jim GUTZWILLER	INFINEUM	NO
10	MATT VARBANAK	SHELL	YES
11	Alex Boffa	Oronite	NO
12	DAVID STEHOWER	CUMMINS	YES
13	STEVE GOODIER	B. P.	YES.
14	Bill Kleiser	Chevron Oronite Co. LLC	Yes
15	Steven Kennedy	Exxon Mobil	Yes
16	WIM VAN DAM	CHEVRON ORONITE	NO
17	Joe Franklin	Intertek Automotive Research	No
18	Cathy Devlin	Afton Chemical *	No *
19	TOM COUSINEAU	AFTON CHEMICAL	NO
20	RICK FINN	Infineum	NO
21	ROBERT STOCKWELL	GM	YES
22	CHRIS CASSIANERI	LUBRIZOL	NO
23	Lew Williams	"	Yes
24	Jim Rutherford	Chevron Oronite	No

* proxy for Charlie Passut.

HDEOCP Meeting, January 10, 2006, San Antonio, TX

	Name	Company	Member	
25	W.A. RUNKLE	THE LUBRIZOL CO.	YES	
26	Rob Morris	Chevron	No	
27	Mark Matson	Marathon Petroleum Co.	No	
28	BECKY GRINFIELD	SWRI	NO	
29	Andy Rahn	Infineum	NO	
30	Dan Pridemore	Afton	NO	mailing list
31	Scott Richardson	SWRI	No	
32	Jon Carlson	Lubrizol	No	
33	JOHN ZALAR	TMC	NO	
34	John Glaser	Intertek	No	
35	DAVID TABER	ConocoPhillips	yes	
36	ANNE KIM	SHELL CANADA	NO	mailing list
37	RAY FONK	CITGO PETROLEUM CORP	NO	
38	Allen Wallis	CITGO Petroleum Corp	No	
39	Rick Titel	BP Lubes USA	No	
40	David Smith	API	NO	
41	GARY PARSONS	Chevron ORONITE	NO	
42	Kevin Ferrick	API	No	
43	Larry Kuntschik	ILMA	No	
44	John FRick	CITGO	No	
45	Ken Chao	Deere & Company	Yes	
46	Mark Cooper	Chevron Oronite	No	
47	Ron Buck	TBI	NO	
48	BRAD CARTER	INTERTEK	NO	

HDEOCP Meeting, January 10, 2006, San Antonio, TX

	Name	Company	Member
49	Scott Zechiel	Detroit Diesel	Proxy for Belay
50	Roger Gault	EMA	Proxy for Heather DeBaun
51	Glenn Mazzamaro	Stellar Additive Services	NO
52	DAVID McFALL	LNG	NO
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10 Engine Tests and 6 Bench Tests

Performance Criteria	Fuel Sulfur, Wt %/ppm	Test	PC-10 2006
Engine Tests			
Aluminum Piston Deposits, Oil Consumption	0.05	Caterpillar 1N ASTM D 6750	1
Forged Steel Piston Oil Consumption / Deposits	0.05	Caterpillar 1P ASTM D 6681	2
Oil Consumption and Piston Deposit	15 ppm	Caterpillar C-13	3
Viscosity Increase Due to Soot at 6.0%*	0.05	Mack T-11 ASTM D 7156	4
Ring, Liner Bearing Wear & Oil Consumption	15 ppm	MackT-12	5
Valve Train Wear, Filter ΔP and Sludge	.05	Cummins ISM	6
Valve Train Wear	15 ppm	Cummins ISB	7
Roller-Follower Valve Train Wear	0.05	GM 6.5-L RFWT ASTM D 5966	8
Aeration	0.05	Navistar EOAT ASTM D 6894	9
Oil Oxidation	0.10	See III G (SM) or IIIF-CI-4(D 6984)	10
Bench Tests			
Foam Sequence I, II, III	–	ASTM D 892 (non opt. A)	1
Volatility	–	Noack D 5800	2
Elastomer Compatibility		EOEC (DXXXX) plus Vamac	3
High Temperature/High Shear		Viscosity After Shear D 4683	4
Corrosion		HTCBT 135°C D 6594	5
Shear Stability – 90 Cycles	–	Bosch Injector ASTM D 7109	6
Total Number of Engine and Bench Tests			***16***

T12 Proposal PC 10 Exit Ballot

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	35	15	24	105	85
Anchor	25	10	20	70	65
Minimum	10	0	12	35	50

1000

Mack Merit 1000 min

- NO FTIR Parameter

Estimated MTAC Limits

- **Tappet wear limit**
  - **Target limit 100 mg weight loss.**
  - **MTAC limits are: 100 /108 / 112 mg for 1/2/3 tests**
- **Cam wear limit**
  - **Target limit 55 µm wear by Mitutoyo snap gauge.**
  - **MTAC limits are: 55 / 59 / 61 um for 1/2/3 tests**
- **Statisticians need to verify MTAC Limits.**

ISM Merit System for PC-10

- **Motion: Accept the ISM Merit System as summarized here.**

Criterion	Crosshead Weight Loss	Top Ring Weight Loss	Oil Filter Delta P	Adjusting Screw Weight Loss	Sludge	Total Merits
Weight	350	0	150	350	150	1000
Maximum	7.1	100	19	45	8.7	
Anchor	5.7		13	27	9.0	
Minimum	4.3		7	16	9.3	
Average	5.3	58.9	11.3	24.6	9.0	
St Dev	1.42	15.64	5.93	11.03	0.15	

Final Proposed Merit System

- **Following merit system currently planned for presentation to class panel for exit ballot…**

Parameter	Limit	Cap	Max Merit	Weight
Delta OC	25	31	10	300
TLC	30	35	15	300
TGC	46	53	30	300
2RTC	22	33	5	100

T11 Proposal for PC10 (CJ-4)

Visc 12 cSt Inc.
TGA Soot 6.0 min
Std .25 COV 4.2

Visc 15 cSt Inc.
TGA Soot 6.7 min
Std .26 COV 4.3

Visc 4 cSt Inc.
TGA Soot 3.5 min.
Std .27 COV 4.3

ASTM-HDEOCP EXIT CRITERIA BALLOT for:

- **Caterpillar C13** **BOTH DUE: January 4, 2006**
- **Mack T11**

Company	Name	Mack T 11 Affirmative	Mack T 11 Negative	Caterpillar C13 Affirmative	Caterpillar C13 Negative
Afton Chemical	Charles Passut	X		X *	
BP	Steven Goodier	X *			
Caterpillar Inc	Abdul Cassim	X		X	
Chevron Oronite LLC	Wm. Kleiser	X		X *	
Chevron	Jim Mc Geehan	X			X *
Ciba Specialty Chemicals	Scott Harold	X		X	
Comcast	David Stehouwer	X		X	
ConocoPhillips	David E. Taber	X		X	
Cummins	Warren Totten				
DDC	Mesfin Belay	X		X	
Dana Corporation	Howard Robins	X		X	
Deere & Co	Ken Chao	X		X	
EMA	Roger Gault	X		X	
ExxonMobil	Steven Kennedy		X *	X	
GM	Robert Stockwell	X *		X *	
Infineum	Pat Fetterman	X *		X *	
Int'l Truck & Engine	Heather DeBaun	X		X	
Lubrizol	Lewis Williams	X *		X *	
PerkinElmer	Thomas M. Franklin				
RohMax USA	Steven Herzog	X *		X	
Shell	Matthew Urbanak				
Valvoline	Wm. Runkle Jr.	X			X *
Volvo Power Train	Greg Shank	X		X	
Shell	Mattwhe Urbank	X			X
	Totals	**20**	**1**	**17**	**3**

*** = Comments attached** **Thursday Jan 5, 2006**

The two negatives in C13 focus only on the second ring rating.

C13 Exit Ballot Concerns

- Majority of concerns expressed on Negative and Affirmative ballot responses were related to 2RTC parameter and fall into two areas

1. Process of arriving at new parameter
    - Not included in MOA
    - Introduced late in process
    - Link to field/engine performance issues/protection not established
2. Variability of matrix ratings used to establish limits




2RTC Concerns – Process of Arriving at Parmeter

1. The MOA specifically required DISCRIMINATION to be demonstrated on named parameters which were imposed by ACC before allowing the C13 test to proceed , all of which were done successfully.
2. After the Matrix completion, the MOA states “The test discrimination parameters, pass-fail criteria and methods of evaluation will be assigned by the appropriate ASTM Surveillance Panel or Test Development Task Force”. The MOA did not exclude new parameters from being introduced.




2RTC Concerns – Process of Arriving at Parmeter

3. 2RTC was developed late in process to replace UWD which was removed from the test late in the process due to concerns with correlation to other deposit parameters making it redundant.
    - SP asked that new parameter be sought by Caterpillar that was related to field or other engine experience that addressed any additional needs not captured by TCG and TLC
    - Caterpillar had concerns over deposits lower that the top groove as it related to ring sticking & loss of side clearance
4. 2RTC does not show redundancy to other rated parameters




2RTC Concerns – Process of Arriving at Parmeter

5. 2RTC addresses an area of the piston/ring that Caterpillar believes relates to potential field issues with ring sticking
    - Field engines with Ring Sticking can exhibit heavy deposits on the top face of the 2nd ring on multiple cylinders
    - Previous C12 Bridge engine testing (650 hr/cyclic) did show high 2RTC deposits on a run that had a 30% Cold Stuck Ring (Est. 2RTC rating – 38)
    - Rings from two field engines (that has experienced ring sticking) were rated as part of the recent rating workshop. Average 2RTC values was: 25, (100% stuck, 52 and 67)




2RTC Concerns – Variability in Matrix Data

1. A Ring Rating Workshop was held recently to determine if 2RTC can be rated consistently and to finalize the final rating procedures
2. Pre-calibration workshop showed rater variances similar to the overall range experienced in the matrix
3. Post-calibration workshop showed improvement in consistency of ratings
   - Appears that future rating of this parameter should be similar to other deposit ratings in terms of consistency
   - Magnitude of differences between pre and post calibration ratings not very large (unlikely that matrix results would be very different if more consistent procedure would have been used)
4. Limits were set very liberally based on the Matrix data relative to area of concern (due to variability inherent in dataset)
   - 100% Light carbon not desirable
   - Incidence of Heavy carbon highly undesirable




PRELIMINARY DATA

- Second Ring Topside Rating workshop was held in San Antonio January 4&5, 2006
- Two additive suppliers and Cat supplied rings for the workshop (6 engine sets).
- Reviewed the rating definitions and area to be evaluated
- Wednesday – After rating each set of rings the data was reviewed by the group
- Thursday – Ring sets B, C, D, E and G (blind) were rated with no breaks for data analysis

PRELIMINARY DATA

- Raters will issue a list of recommendations that will be forwarded to the C13 Surveillance Panel
- Statisticians have not had time to evaluate the data generated at the workshop.
- TMC will perform analysis and Precision (Yi) calculations for each rater/parameter
- C13 Surveillance Panel will schedule a conference call when all the statistical analysis have been completed

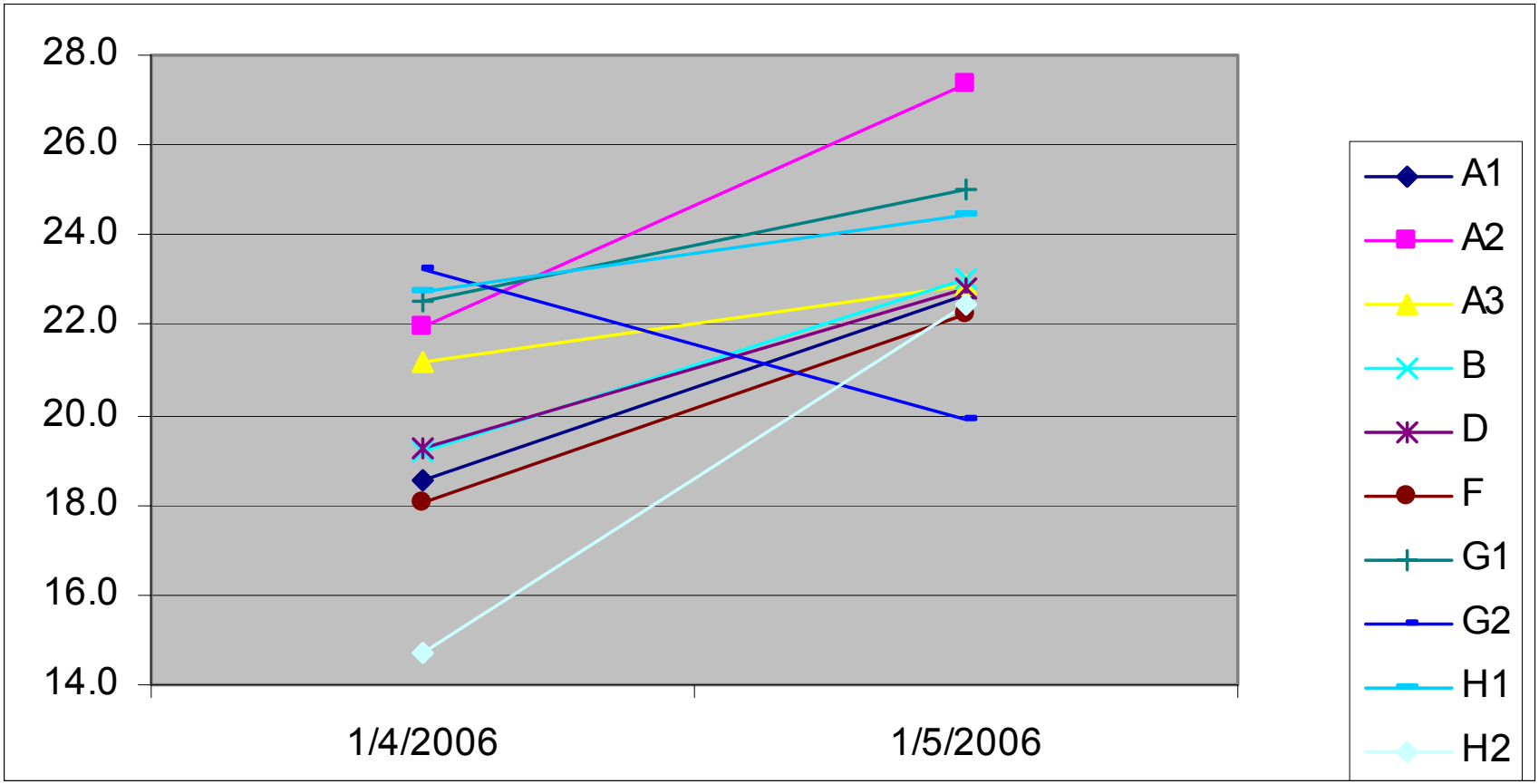
All Raters - Average 2RTC Rating

	Lab	Prelim 1	G Jan 4	A	B	C	D	E	G Jan 5
	A1	18.4	18.5	31.9	12.9	17.7	25.4	36.9	22.6
	A2	27.3	22.0	29.0	13.1	22.8	31.2	40.9	27.3
	A3	30.9	21.2	33.7	16.7	16.3	27.3	32.5	22.9
	B	27.4	19.2	28.9	12.1	15.3	23.2	33.4	23.0
	D	17.0	19.3	25.5	13.7	18.0	20.3	30.2	22.8
	F	28.8	18.1	32.4	11.2	18.0	23.1	29.6	22.2
	G1	24.1	22.5	32.7	15.0	18.0	23.6	33.9	25.0
	G2	25.1	23.2	27.7	11.0	15.3	21.8	29.0	19.9
	H1	15.3	22.7	31.0	10.2	30.0	32.3	34.2	24.4
	H2	16.9	14.7	29.4	11.5	23.1	31.0	36.4	22.5
Maximum		30.92	23.21	33.71	16.67	29.96	32.33	40.94	27.33
Minimum		15.34	14.73	25.48	10.22	15.25	20.31	28.96	19.88
Range		15.57	8.48	8.23	6.45	14.71	12.02	11.98	7.46
Average		23.11	20.15	30.22	12.72	19.46	25.92	33.71	23.28
STDev.		5.70	2.67	2.57	1.98	4.57	4.30	3.70	1.97

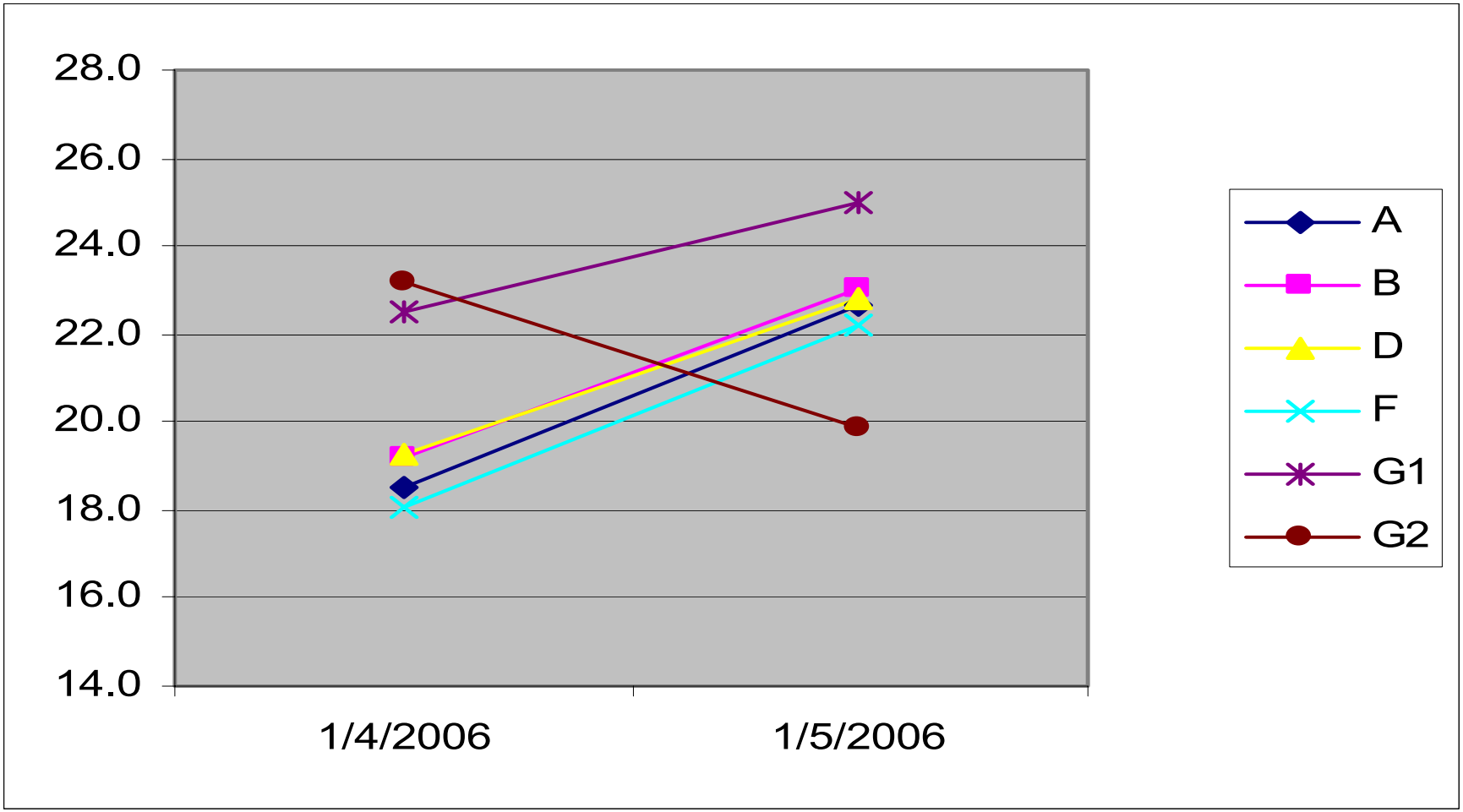
Matrix Raters - Average 2RTC Rating

	Lab	Prelim	G Jan 4	A	B	C	D	E	G Jan 5
	A1	18.4	18.5	31.9	12.9	17.7	25.4	36.9	22.6
	B	27.4	19.2	28.9	12.1	15.3	23.2	33.4	23.0
	D	17.0	19.3	25.5	13.7	18.0	20.3	30.2	22.8
	F	28.8	18.1	32.4	11.2	18.0	23.1	29.6	22.2
	G1	24.1	22.5	32.7	15.0	18.0	23.6	33.9	25.0
	G2	25.1	23.2	27.7	11.0	15.3	21.8	29.0	19.9
Maximum		28.75	23.21	32.73	14.96	18.04	25.38	36.94	25.02
Minimum		17.00	18.08	25.48	10.96	15.25	20.31	28.96	19.88
Range		11.75	5.13	7.25	4.00	2.79	5.06	7.98	5.15
Average		23.46	20.15	29.85	12.63	17.06	22.89	32.17	22.60
STDev.		4.78	2.17	2.96	1.54	1.38	1.70	3.09	1.65

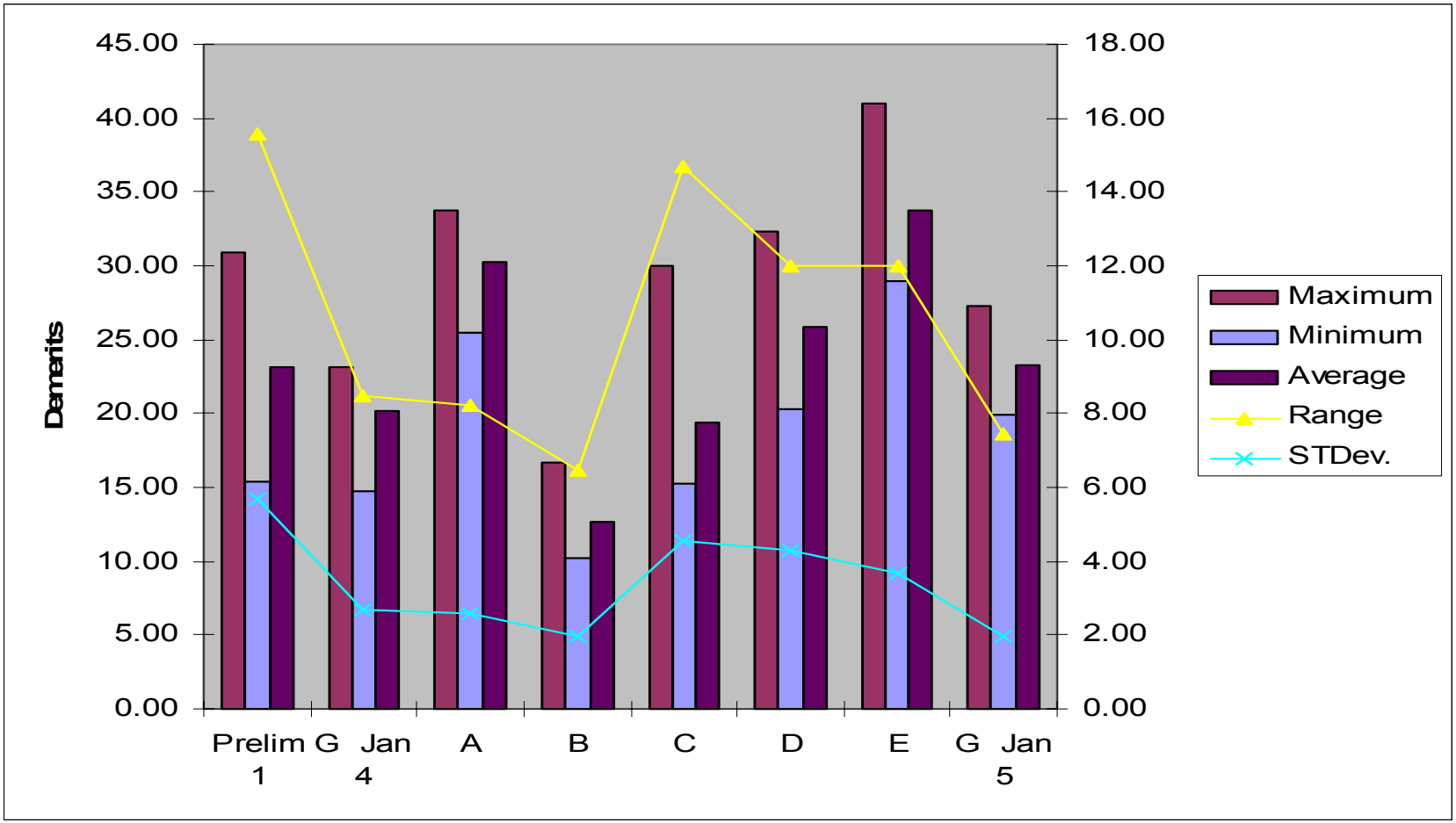
All Raters – Ring Set G – Pre vs. Post



Matrix Raters – Ring Set G – Pre vs. Post



All Raters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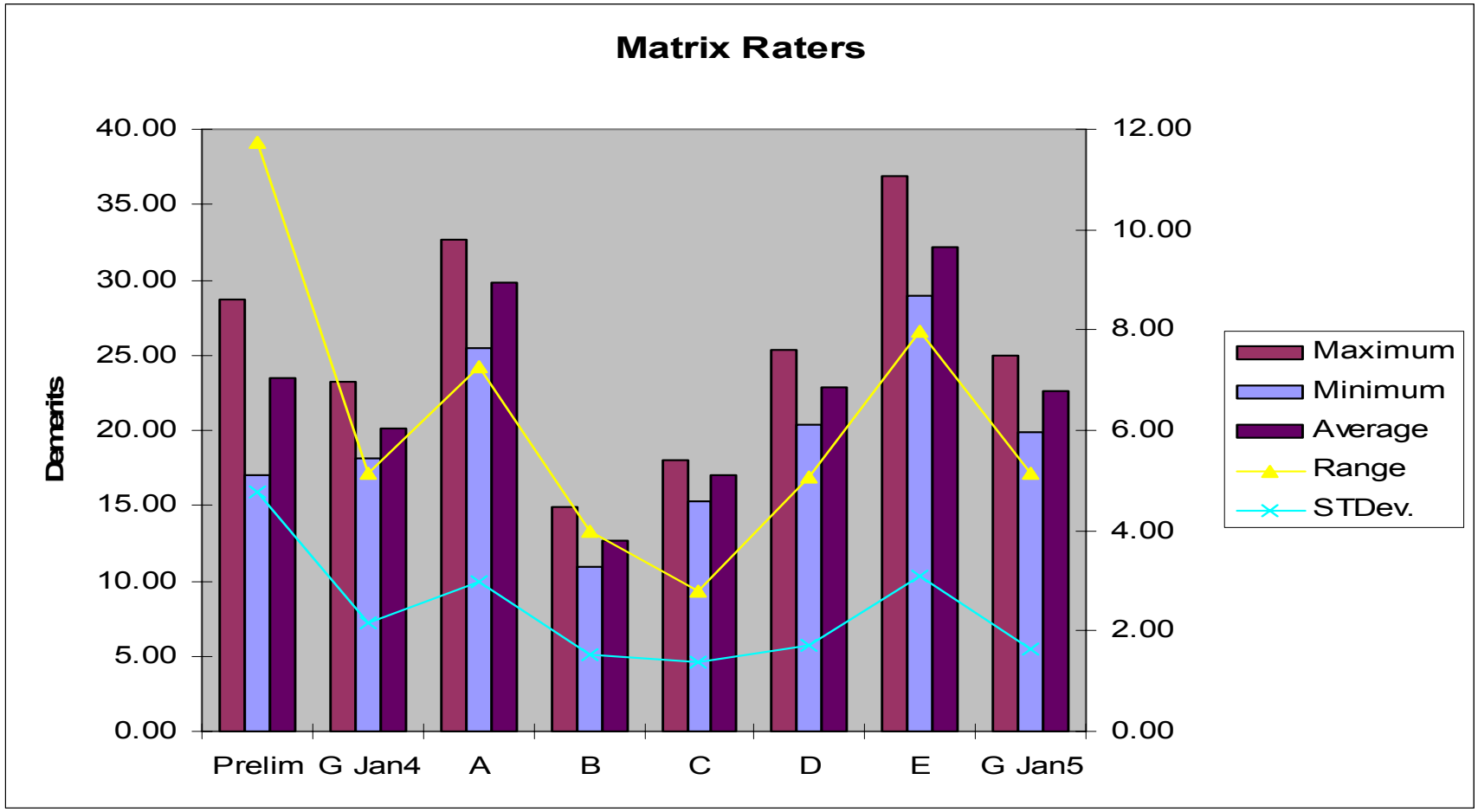
Prelim G 1
Jan 4
A
B
C
D
E
G
Jan 5
Maximum
Minimum
Average
Range
STDev.

Matrix Raters



2nd Ring Rated Area

Second Ring Top Carbon Raters Workshop January, 2006 Data Analyses

January 9, 2006

Jim Rutherford
(510) 242-3410
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Summary

- No significant interaction between raters and ring sets.
- Only marginally significant difference among raters as a group. No pairwise significant differences among raters. One rater had two "outlier" ratings (Studentized residual greater than 3 in absolute value).
- The majority of pairwise differences between ring sets were significant. Generally stronger significance when restricted to matrix raters.

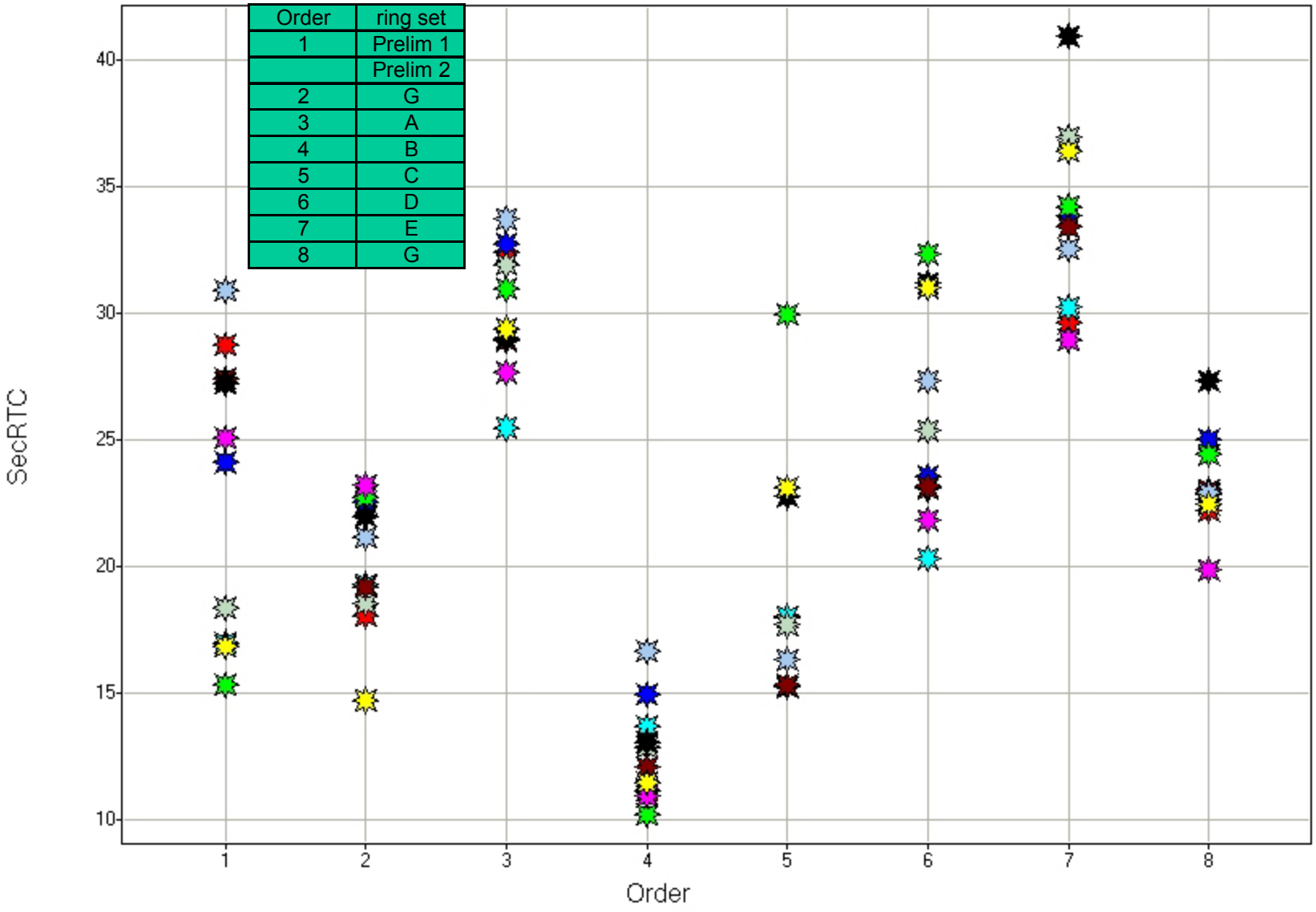
For the statisticians, here are analyses:


Microsoft Word Document


Microsoft Word Document

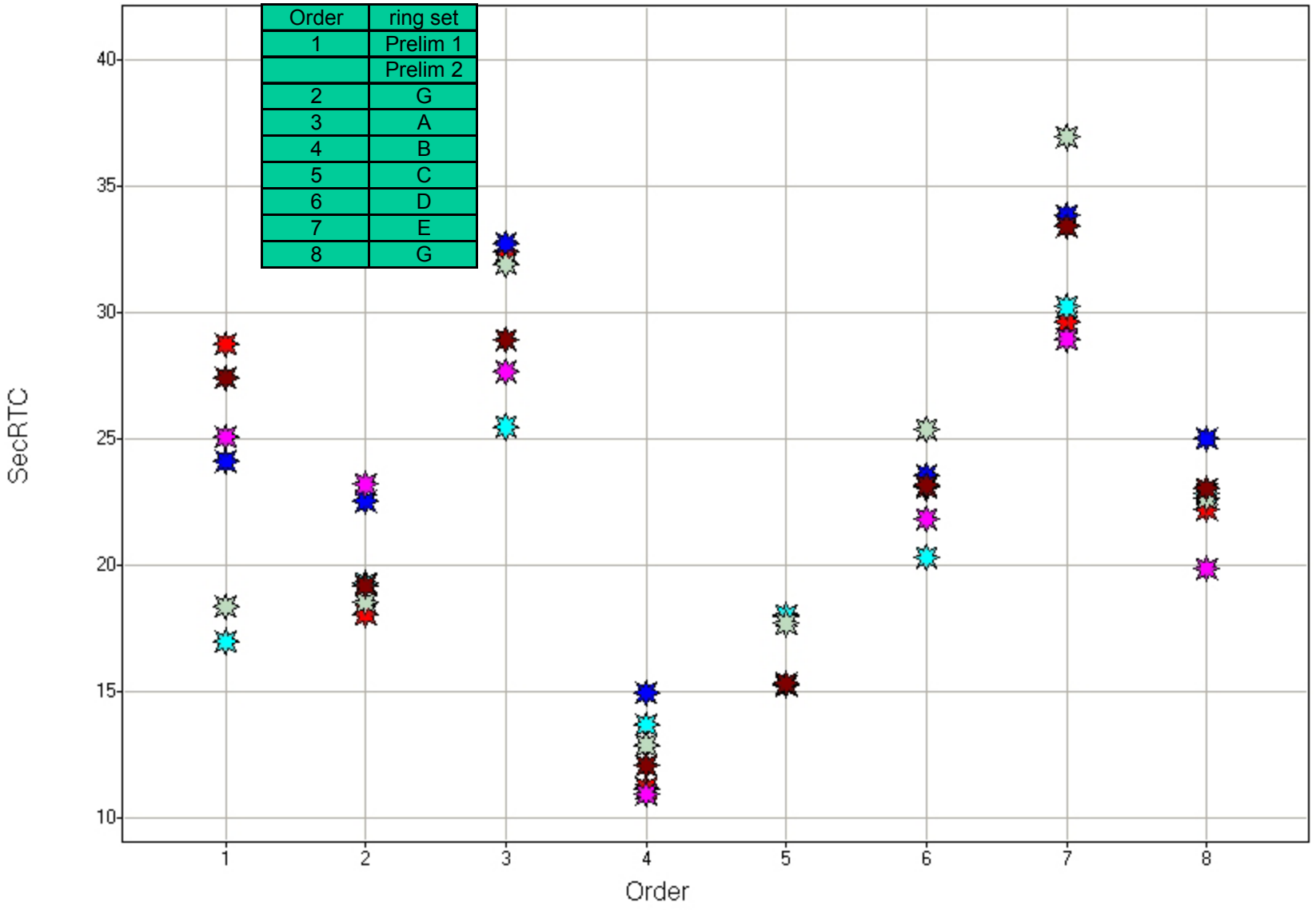
Rating by Ring Set Order – Raters by Colors – All Raters

Order	ring set
1	Prelim 1
	Prelim 2
2	G
3	A
4	B
5	C
6	D
7	E
8	G



Rating by Ring Set Order – Raters by Colors – Matrix Raters

Order	ring set
1	Prelim 1
	Prelim 2
2	G
3	A
4	B
5	C
6	D
7	E
8	G



Report to HDEOCP
ISM Merit System Revised Limits
ISB Revised Limits

Warren Totten

David Stehouwer

January 10, 2006

ISM Merit System for PC-10

Criterion	Crosshead Weight Loss	Top Ring Weight Loss	Oil Filter Delta P	Adjusting Screw Weight Loss	Sludge	Total Merits
Weight	350	0	150	350	150	1000
Maximum	7.1	100	19	45	8.7	
Anchor	5.7		13	27	9.0	
Minimum	4.3		7	16	9.3	
Average	5.3	58.9	11.3	24.6	9.0	
St Dev	1.42	15.64	5.93	11.03	0.15	

Revised ISM Merit System for PC-10

Criterion	Crosshead Weight Loss	Top Ring Weight Loss	Oil Filter Delta P	Adjusting Screw Weight Loss	Sludge	Total Merits
Weight	350	0	150	350	150	1000
Maximum	7.1	100	19	49	8.7	
Anchor	5.7		13	27	9.0	
Minimum	4.3		7	16	9.3	
Average	5.3	58.9	11.3	24.6	9.0	
St Dev	1.42	15.64	5.93	11.03	0.15	

ISB Proposed MTAC Limits

- **Tappet wear limit**
  - **Target limit 100 mg weight loss.**
  - **MTAC limits are: 100 /108 / 112 mg for 1/2/3 tests**
- **Cam wear limit**
  - **Target limit 50 µm wear by Mitutoyo snap gauge.**
  - **MTAC limits are: 50 / 54 / 56 um for 1/2/3 tests**
- **Statisticians need to verify MTAC Limits.**

ISB Revised MTAC Limits

- **Tappet wear limit**
  - **Target limit 100 mg weight loss.**
  - **MTAC limits are: 100 /108 / 112 mg for 1/2/3 tests**
- **Cam wear limit**
  - **Target limit 55 µm wear by Mitutoyo snap gauge.**
  - **MTAC limits are: 55 / 59 / 61 um for 1/2/3 tests**
- **Statisticians need to verify MTAC Limits.**

Low Temperature Pumpability (CJ-4)

Used oil sample from T11 180 hrs. (5% Soot)

Used oil Limit @ -20 C 25,000 mPa s max.

Fresh Oil Limit @ -20 C 20,000 mPa s max.

Limits applied to 0W, 5W, 10W, 15W Visc. Grades

Yield Stress Oils use Modified D4684 < 35

Recommend BOI/VGRA Task Group use Current T11 Rules

American Chemistry Council Good Chemistry Makes It Possible

ACC Evaluation of CJ-4 Category Timing

January 10, 2006

American Chemistry Council Good Chemistry Makes It Possible

C13 Testing Estimates

- Input from four additive companies
  - Oronite, Lubrizol, Infineum, Afton Chemical
  - Assumes C13 is rate limiting test
- Each company estimated passing tests required; ACC compiled the data

American Chemistry Council Good Chemistry Makes It Possible

C13 Stand Assumptions

- Ten calibrated C13 stands available in the industry
  - Labs are unlikely to install more stands
- Caterpillar has offered up to four uncalibrated stands at their facilities

American Chemistry Council Good Chemistry Makes It Possible

Unreferenced C13 Stands

- ACC PAPTG member companies follow the ACC Code of Practice, which states: *"All engine testing for product approval must be conducted using only equipment and facilities current in monitoring by and calibration with the ASTM Test Monitoring Center (TMC) and meeting the requirements for test stand/laboratory calibration in Appendix A".*
- Uncalibrated stands do not satisfy criteria for COP approval.

American Chemistry Council Good Chemistry Makes It Possible

C13 Assumptions

- Ten calibrated C13 stands available
- One month per test → ten tests per month in the industry
- 40% to 50% pass rate

➔ Four to five passes per month assuming all 10 stands utilized

American Chemistry Council Good Chemistry Makes It Possible

C13 Testing for CJ-4 Only

- 31 passes required if full BOI/VGRA guidelines are granted

➔ Six to eight months to complete, October 2006 timing should be met

American Chemistry Council Good Chemistry Makes It Possible

ECF-2 Uncertainties

- ECF-2 requirements not fully defined
- Passing C13 limits unknown
  - ECF-2 limits may be higher than PC-10 limits
  - Higher ECF-2 limits may lower pass rate
- BOI/VGRA guidelines unknown
- Certification process unknown
- June 2006 timing reported at December ASTM meeting

American Chemistry Council Good Chemistry Makes It Possible

API CJ-4 & ECF-2, Best Case

- 74 passes required
  - CJ-4, 31 passes
  - ECF-2, 43 additional passes, with BOI/VGRA

➔ 15 to 19 months to complete all programs

American Chemistry Council Good Chemistry Makes It Possible

API CJ-4 & ECF-2, Mid Case

- 88 passes required
  - CJ-4, 31 passes
  - ECF-2, 57 additional passes, with BOI only

➔ 18 to 22 months to complete, July, 2007 at the earliest

American Chemistry Council Good Chemistry Makes It Possible

API CJ-4 & ECF-2, Worst Case

- 161 passes required
  - CJ-4, 31 passes
  - ECF-2, 130 additional passes, no BOI/VGRA

➔ 32 to 40 months to complete, September, 2008 at the earliest

American Chemistry Council Good Chemistry Makes It Possible

Conclusion

- All CJ-4 and associated OEM specs need to be finalized
- C13 capacity constraints will make it impossible for ECF-2 and CJ-4 to both complete in the timeframe requested
- All classes of oil marketers will be affected

ECF-2 Update

1. Industry concerns appreciated and addressed

2. ECF-2 implementation date will be extended to first quarter 2007
   - Required as best leave behind oil for Rest of World, Off-Hwy
   - Gives time for C13 field data to be collected by Oil marketers (C13 field data may be acceptable to Caterpillar for qualification of oils against ECF-2)

3. If currently balloted C13 Limits for PC-10 are accepted, limits for C13 test in ECF-2 could be aligned with PC-10 which will be released in June, No claims allowed before 1st Qtr 2007

4. Above actions relieves pressure on PC-10 timeline which must not be impacted



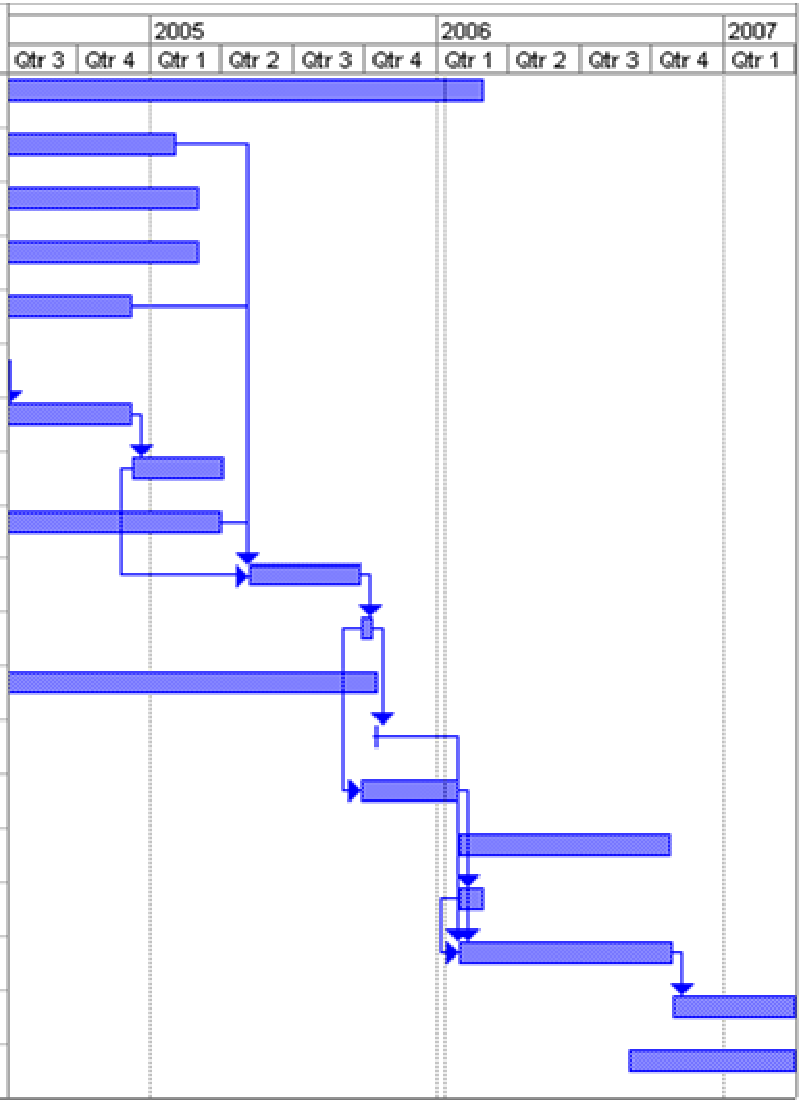

ECF-2 Update

A passing 500-hour Caterpillar C13 test on a referenced stand is required for the fully formulated engine oil.

In lieu of a C13 laboratory test, at least three C13 engines units each having a documented oil consumption (≤0.15 oil to fuel ratio) and oil analysis history covering at least 300 000 miles in-field severe duty service (≥50% Load Factor from ECM) and at least one set of qualifying piston deposit data on the same oil having nominally covered 500 000 miles, will be considered acceptable.




Task Name	Start	Finish
NCDT Activity	Wed 3/26/03	Mon 2/27/06
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	Thu 1/26/06
ASTM D-2, SC-B Ballot & Approval	Fri 1/27/06	Mon 10/23/06
API Lubes Committee Final Approval	Fri 1/27/06	Mon 2/27/06
Minimum Product Qualification Interval	Fri 1/27/06	Wed 10/25/06
API Licensing	Thu 10/26/06	Mon 5/21/07
Engines in Field	Fri 9/1/06	Mon 5/21/07



Requirement	PC-10/CJ-4
Mack T-12 EGR Engine Test	
Mack Merit Rating, min.	1,000
Cylinder Liner Wear (Avg. 6 cylinders, 12 locations)	20
Top Ring Weight Loss (Avg. of 6 Cylinders)	70
End of Test Lead	25
Delta Lead 250 - 300 hrs.	10
Oil Consumption (Phase II)	65
Mack T-11 Engine Test	
Minimum TGA % Soot **@ 4.0 cSt** increase @ 100° C	3.5%
Minimum TGA % Soot **@ 12.0 cSt** increase @ 100° C	6.0%
Minimum TGA % Soot **@ 15.0 cSt** increase @ 100° C	6.7%
Mack T-11A Used MRV TP-1	
180 hour T-11 Drain MRV (-20C for 0W, 5W, 10W, 15W), mPa max.	25,000
Fresh oil MRV (-20C for 0W, 5W, 10W, 15W), mPa max. (for read only)	20,000
Cummins ISM EGR Engine Test	
Cummins Merit Rating, min.	1,000
Crosshead Avg. Wt. Loss	5.7
Top Ring Weight Loss	100
Oil Filter Differential Pressure @ 150 hr.	13
Average Engine Sludge / CRC Merits @ EOT	9.0
Average Valve Adjusting Screw Weight Loss, mg.	27
Cummins ISB EGR Engine Test	
Average Slider Tappet Weight Loss, mg, max.	100/108/112
Average Cam Lobe Wear, µm, max.	55/59/61
Average Crosshead Weight Loss, max.	R&R
Caterpillar C13 Deposit/Oil ConsumptionTest	
CAT Merit Rating, min.	1,000
Oil Consumption Delta (125=>475 hours), g/hr.	25
Top Groove Carbon	46
Top Land Carbon	30
Second Ring Top Carbon	22
Hot-stuck piston ring	NONE
Caterpillar 1N	
Weighted Demerits, max.	286.2/311.7/323.0
Top Groove Fill, max.	20/23/25
Top Land Heavy Carbon, max.	3/4/2005
Oil Consumption (0-252 hrs) g/kwh, max.	0.5
Piston/ring/liner scuffing	NONE
Piston ring stick	NONE
Caterpillar 1P	
Weighted Demerits, max.	350/378/390
Top Groove Carbon, max.	36/39/41
Top Land Carbon, max.	40/46/49
Oil Consumption (0 to 360 hrs) g/hr, max.	12.4
Final OC (312-360 hrs), max.	14.6
Piston/ring/liner scuffing	NONE
Sequence IIIF Engine Test	
EOT Kinematic Viscosity / % Increase @ 40° C, max.	275%
Sequence IIIG Engine Test (alternative to IIIF)	
EOT Kinematic Viscosity / % Increase @ 40° C, max.	150%
Roller Follower Wear Test D 5596	
Average pin wear, mils, max.	0.30

Requirement		PC-10/CJ-4
Chemical Limits (non-critical)		
Sulfated Ash, max.		1.0%
Phosphorus, weight %, max.		0.12%
Sulfur, weight %, max.		0.4%
Bench Tests		
Corrosion ASTM D 6594 (135° C, HTCBT)		
	Cu, max.	20
	Pb, max.	120
	Sn, max.	50
	Copper strip, max.	3
Shear Stability ASTM D 6278		
Kinematic Viscosity after 90 pass Shearing cSt @ 100° C, min.	XW-30 / XW-40	9.3/12.5
Volatility ASTM D 5800 (NOACK)		
Evaporative Loss @ 250° C, max.	[Viscosities other than 10W-30]	13%
Evaporative Loss @ 250° C, max.	[10W-30]	15%
D 6894 (EOAT)		
Aeration, Volume %, max.		8.0%
Foaming ASTM D 892 (NO Option A)		
Foaming / Settling	Sequence I	10/0 ml max.
	Sequence II	20/0 ml max.
	Sequence III	10/0 ml max.
Seal Compatability Tests		
Nitrile		
Volume Change (ASTM D 471)		+5 / -3
Hardness (ASTM D 2240)		+7 / -5
Tensile Strength (ASTM D 412)		+10 / -TMC 1006
Elongation (ASTM D 412)		+10 / -TMC 1006
Silicone		
Volume Change (ASTM D 471)		+TMC 1006 / -3
Hardness (ASTM D 2240)		+5 / -TMC 1006
Tensile Strength (ASTM D 412)		+10 / -45
Elongation (ASTM D 412)		+20 / -30
Polyacrylate		
Volume Change (ASTM D 471)		+5 / -3
Hardness (ASTM D 2240)		+8 / -5
Tensile Strength (ASTM D 412)		+18 / -15
Elongation (ASTM D 412)		+10 / -35
FKM		
Volume Change (ASTM D 471)		+5 / -2
Hardness (ASTM D 2240)		+7 / -5
Tensile Strength (ASTM D 412)		+10 / -TMC 1006
Elongation (ASTM D 412)		+10 / -TMC 1006
Vamac G		
Volume Change (ASTM D 471)		+TMC 1006 / -3
Hardness (ASTM D 2240)		+5 / -TMC 1006
Tensile Strength (ASTM D 412)		+10 / -TMC 1006
Elongation (ASTM D 412)		+10 / -TMC 1006

PC-10/CJ-4 Merit Systems

Mack T-12 EGR Engine Test

PC-10/CJ-4	Cylinder Liner Wear	Top Ring Wt. Loss	Delta Pb Final	Delta Pb 250-300 hr.	Oil Consumption
Weight	250	200	200	200	150
Maximum	24	105	35	15	85
Anchor	20	70	25	10	65
Minimum	12	35	10	0	50

Caterpillar C13 Deposit/Oil ConsumptionTest

PC-10/CJ-4 1000	Delta Oil Consumption	Ave. Top Land Carbon	Ave. Top Groove Carbon	2nd Ring Top Carbon
Weight	300	300	300	100
Maximum	31	35	53	33
Anchor	25	30	46	22
Minimum	10	15	30	5

ISM EGR Engine Test

PC-10/CJ-4 1000	Crosshead Ave. Wt. Loss	Top Ring Weight Loss	Oil Filter Pressure Delta	Ave. Engine Sludge	Ave. Valve Adj. Screw Wt. Loss
Weight	350	0	150	150	350
Maximum	7.1	100	19	8.7	49
Anchor	5.7		13	9	27
Minimum	4.3		7	9.3	16

Notes:

Maximum - At the Maximum you get zero merit points. Performance worse than the Maximum for any parameter is an automatic FAIL

Anchor - At the Anchor you receive merit points equal to the Weight

Minimum - At the Minimum you receive merit points equal to twice the Weight. There are no additional points for better performance than the minimum.