MEETING MINUTES

HEAVY-DUTY ENGINE OIL CLASSIFICATION PANEL
OF
D02.B0.02
April 26, 2000
Holiday Inn – O'Hare International Hotel, Rosemont, IL

ACTION ITEMS

1. **Finalize test procedures, complete demonstration and discrimination data in preparation for start of matrix testing – 1Q, T-10 & M-11 EGR Task Forces.**

2. **Send EOT oil samples to Chris May for continued development of low temperature used oil rheology – Anyone with 5-10% soot one gallon samples.**

3. **Be prepared to discuss 1R & 3F as substitutes for the 1P & 3E at next meeting – All**

MINUTES

1.0 Call to Order

1.1 Chairman Jim McGeehan called the meeting to order at 7:33 AM on April 26, 2000, in the Holiday Inn O'Hare – International Hotel of Rosemont, IL. There were 12 members or representatives and approximately 33 guests present. The attendance list is shown as Attachment 2.

2.0 Agenda

2.1 The agenda for the meeting (Attachment 1) was reviewed and left unchanged. There was no report from the DEOAP / EMA.

3.0 Meeting Minutes

3.1 Chris May wanted section 10.1 of the February 23, 2000, meeting minutes to reflect that his task force is looking for oils that have 5% or higher soot content. With that change, the minutes of that meeting were approved as posted on the TMC website.

4.0 Membership

4.1 Tom Bowen was dropped from membership and Bill Buscher was moved to non-voting status per Chairman McGeehan.

5.0 Matrix Design Task Force

5.1 Don Marn presented the PC-9 Matrix Design TF report (Attachment 3) in which they recommended 6 oils for the matrix tests. The 6 oils would be blended from 2 base stocks (a Group I and a Group II) and 3 additive technologies. The recommendation for only 2 base stocks instead of 3 came from the TF assessment that the two Group II stocks volunteered were so close in properties that no useful information would be gained in testing them both. The reduced number of oils would also increase the confidence of results from the matrices. There was discussion about purchasing the only Group II base stock which had lower saturates, but the supplier of that base stock is planning to upgrade their equipment in the near future and then they would no longer produce the low saturates stock. Don indicated the base stocks could be available by the end of May.

5.2 Controversy arose over how many labs and stands were going to be available for the 1Q matrix based on what was reported on 4/25/00 in the Matrix Design TF meeting. Don Marn indicated that due to late replies, he had miscounted and there were actually 6 labs and 7 stands available and planning to participate. Thus, he felt the 1Q matrix should be 28 tests and this prompted discussion on why not use 3 base stocks / 9 oils then in the 1Q matrix.

5.3 Discussion on the number of stands / labs available for matrix testing continued and it was revealed that one of the two labs indicating JDQ-78A participation had not started on installation and would not until such time the test was actually included in an API or EMA specification. Then it would be 60 to 90 days before they would have an installation ready to run and the panel added it would take at least another month to produce the requested demonstration tests.

5.4 Don Marn moved and Charlie Passut seconded acceptance of the PC-9 Matrix Design TF recommendation to proceed with matrices of 24 tests each for the T-10 and M-11 EGR, 28 tests for the 1Q and 20 tests for the JDQ-78A, using 6 oils blended from 2 base stocks and 3 additive technologies. The vote was 3 for, 1 against and 5 abstains. In view of the weak support, it was decided to proceed with the Oxidation TF report and address the matrix recommendations again later.

6.0 Oxidation Task Force

6.1 Rich Lee gave the Oxidation TF report as shown in Attachment 4. They recommended using the 1Q deposits to measure the effects of thin film oxidation, the T-10 lead levels to measure the corrosive effects of oxidation and the T-10 IR analysis of oil samples as a precursor to oil thickening.

6.2 Bill Mitchell of Deere said that looking at viscosity increase is extremely important. He indicated that engine temperatures and power densities will continue to increase and thus the JDQ-78A test with its turbocharged, non-aftercooled, high piston ring belt engine is the ideal place to evaluate an oil's ability to resist viscosity increase due to oxidation.

6.3 Rich Lee moved and Lew Williams seconded acceptance of the Oxidation TF recommendation to use results from the 1Q and T-10 tests to establish an oil's ability to provide adequate oxidation protection. Ken Chao of Deere expressed concern that IR measurement of precursors does not give the same story as measuring viscosity increase. Glen Mazzamaro presented CMA concerns with the JDQ-78A (Attachment 5). Jim McGeehan noted that the T-10 sump temperature is now close to 260°F. The vote was 5 for, 2 against and 5 abstains.

7.0 T-10 Task Force

7.1 Greg Shank gave the T-10 TF report (Attachment 6) showing 11 engines delivered and several runs demonstrating discrimination – albeit with lower oil temperatures. He also included some Infineum data (Attachment 7) with his report, showing effects of the oil temperature change. Greg feels the test could be ready for matrix testing by July.

8.0 1Q Task Force

8.1 Dave Nycz gave a report on the 1Q test development (Attachment 8) and also announced a new test, the "1R". The 1R is essentially the "pre-Q" or the 1Q without EGR. The 1R is being proposed as part of a "worldwide" specification that EMA will unveil at the SAE meeting in Paris. The 1R proposes to use a ratio of "final" oil consumption to "initial" oil consumption where the initial OC is defined as the average OC for the first 252 hours and the final OC is the average of the OC at 468 and 504 hours.

9.0 M-11 EGR Task Force

9.1 Shawn Whitacre presented an M-11 EGR TF report (Attachment 9) indicating that the procedure had stabilized and that Cummins has data on four tests / three oils. Lab tests and inspections to continue in preparation for start of matrix testing.

10.0 Used Oil Pumpability

10.1 Chris May gave the "Low Temperature Rheology of Used Engine Oil" (LOTRUO) TF report. The group did receive T-8 EOT reference oil samples with ~5% soot from the TMC (oil 1004) and provided them to 11 volunteer labs for evaluation using MRV, CCS and Scanning Brookfield modified procedures. The CCS tests indicated the oil had thickened out of grade. In general, there seems to be sensitivity to oil sample history just prior to the rheometric test. The task force will address pre-test sample handling.

10.2 Jim McGeehan suggested that the Scanning Brookfield be extended to +25°C to capture higher temperature unexpected behaviors.

10.3 The TF still needs oil in the 5 to 10% soot range from various tests, with a minimum of one gallon samples.

11.0 PC-9 Timeline

11.1 Brent Shoffner presented the latest PC-9 timeline update (Attachment 11), showing an optimistic June, 2002 API license date for PC-9 oils.

12.0 Matrix Design Revisited

12.1 Don Marn moved that the PC-9 precision and base oil interchange matrices be designed to use six oils formulated from two base oils and three additive technologies with four tests on each of six stands for the 1Q, the T-10 and the M-11 EGR. Thus each test type matrix would consist of 24 tests. Various seconds. The motion passed with 6 for, 0 against and 5 abstains.

12.2 Lew Williams moved and Greg Shank seconded that the HDEOCP recommend that funding for the PC-9 matrices include up to 20% of the estimated project total for contingencies. The motion passed with 9 for, 0 against and 2 abstains.

13.0 New Business

13.1 Greg Shank proposed that the next meeting agenda include time to consider using the 1R for the 1P and the 3F for the 3E.

14.0 Adjournment

14.1 The meeting was adjourned at 11:40 AM on April 26, 2000. The next meeting is scheduled for 1:00 PM on June 27, 2000, at the Westin Hotel in Seattle, WA.

Submitted by,
Jim Wells
Secretary to The HDEOCP

APRIL 26, 2000

Holiday Inn O'Hare International
5440 North River Road
Rosemont IL (Tel. #847-671-6350)
7:30-12:00 Noon

Chairman/Secretary: **Jim McGeehan/Jim Wells**
Topic: **PC-9**

Desired Outcome:
- **Oil Oxidation Task-Force recommendations**
- **Matrix Design Task-Force recommendations**
- **Time Line To meet Introduction Date**

TOPIC	PROCESS	WHO	TIME
Agenda	• Review Agenda & Desired Outcome • Add/Chance	Group	7:30-7:45
Minutes Approval	• February 23, 2000 Minutes • Method of distributing minutes	Group	7:45-8:00
DEOAP/EMA/NCDT Recommendations	• Three technologies selected • Three base oils selected • Other issues • Discussion	Dan Larkin Steve Kennedy	8:00-8:30
Matrix Design	• API recommendations • Formulation matrix • Test matrix	Don Marn Ralph Cherrillo	8:30-9:15
Oxidation Task Force Recommendations	• Proposed selection of tests or test	Rich Lee	9:15-10:00
	• Coffee break • Room and coffee money	Group	10:00-10:30
Status of EGR tests	• Mack T-10 • Cat 1Q • Cummins M-11	Greg Shank Mike Quinn Shawn Whitacre	10:30-11:15
Oil Pumpability	• Method selected • Samples from reference oils • EGR engines or Mack T-8	Chris May	11:15-11:30
Timing line	• Status • Samples from EGR engines	Brent Shoffner	11:30-11:45
New Issues	• ?	Group	11:45-12:00
Room Cost	• Collect money for room and coffee	Group	11:50-12:00

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ATTENDANCE LIST

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PC-9 Matrix Design Task Force

Status Report

To

ASTM HDEOCP

Wednesday April 26, 2000
Holiday Inn O'Hare

Chicago, IL

PC-9 Matrix Design Task Force

Task Force Recommendation

Formulations Matrix (6 Test Oils)

- **Base Oils (Two)**
  - **Two Individual Base Stocks**
    - **One Group I and One Group II**
    - **Acceptable to the API BOI/VGRA Task Force**
- **Viscosity Grade (One)**
  - **SAE 15W-40**
- **Technologies (Three)**
  - **Three DI + VM Combinations**
  - **Selection Made by EMA April 11, 2000**

PC-9 Matrix Design Task Force

Task Force Recommendation

Formulations Matrix: **Six Oils**

Viscosity Grade - Base Oil →	Group I	Group II
Technology ↓		
A	X	X
B	X	X
C	X	X

PC-9 Matrix Design Task Force

Task Force Recommendation

PC-9 Test Matrices:

- **Statistical Matrix Designed for Each Test:**

  M11/EGR, T-10/EGR, 1Q/EGR, JDQ-78A

- **Designed to Provide:**
  - **Precision/BOI Guidelines along with Reference Oil/LTMS Data**
  - **Designs are essentially finalized**

- **Number of Tests:**
  - **M11/EGR = 24**
  - **T-10/EGR = 24**
  - **1Q/EGR = 24**
  - **JDQ-78A = 20**

- **For Each Proposed Statistical Test Matrix**
  - **Cost Estimates Developed**
  - **Project Timeline Developed**

PC-9 Matrix Design Task Force

Proposed Stand/Lab Test Capacity For PC-9 Matrix Project

Calibration Requirements For Each Lab:

First Stand = 3 Tests / All Additional Stands = 2 Tests

	M-11/EGR	T-10/EGR	1-Q/EGR	JDQ-78A
Maximum Number of Stands	7	7	7	5
Number of Labs Participating	6	6	6	3

PC-9 Matrix Design Task Force

Potential Stand/Lab Test Capacity For PC-9 Matrix Project

Calibration Requirements For Each Lab:

First Stand = 3 Tests / All Additional Stands = 2 Tests

	M-11/EGR	T-10/EGR	1-Q/EGR	JDQ-78A
Maximum Number of Stands	6	6	6	4
Number of Labs Participating	4	5	5	2

PC-9 Matrix Design Task Force

3 Test Matrix Design For Precision and BOI

Using SAE 15W-40 Grade Formulations Matrix (6 Oils)

PC-9 Test:	M11/EGR		1Q/EGR		T-10/EGR		Total Cost	
	# Tests	$	# Tests	$	# Tests	$	# Tests	$
Number of Tests:	24	2.040	24	1.440	24	1.560	72	5.040
Project Cost (Funding Group)	**8**	**0.680**	**7**	**0.420**	**7**	**0.455**	**22**	**1.555**
*Calibration Requirements: 3 Tests for First Stand, 2 Tests for Additional Stands in Each Laboratory								

PC-9 Matrix Design Task Force

Proposed Timeline:

- **PC-9 Formulations Matrix**
  - **Technologies Selected** — *April 11, 2000*
  - **Technologies Available** — *May 15, 2000*
  - **Base Oils Available** — *June 7, 2000*
  - **Blends Prepared** — *August 2, 2000*

- **PC-9 Matrix Testing**

  (If the PC-9 Tests are Ready/Adopted at the June 2000 ASTM Meeting)
  - **Matrix Start** — *September 1, 2000*
  - **Matrix Completion** — *January 10, 2001*
  - **Data Evaluation Completed** — *February 16, 2001*

Oxidation Task Force
Report to the HDEOCP

Chicago

April 26th 2000

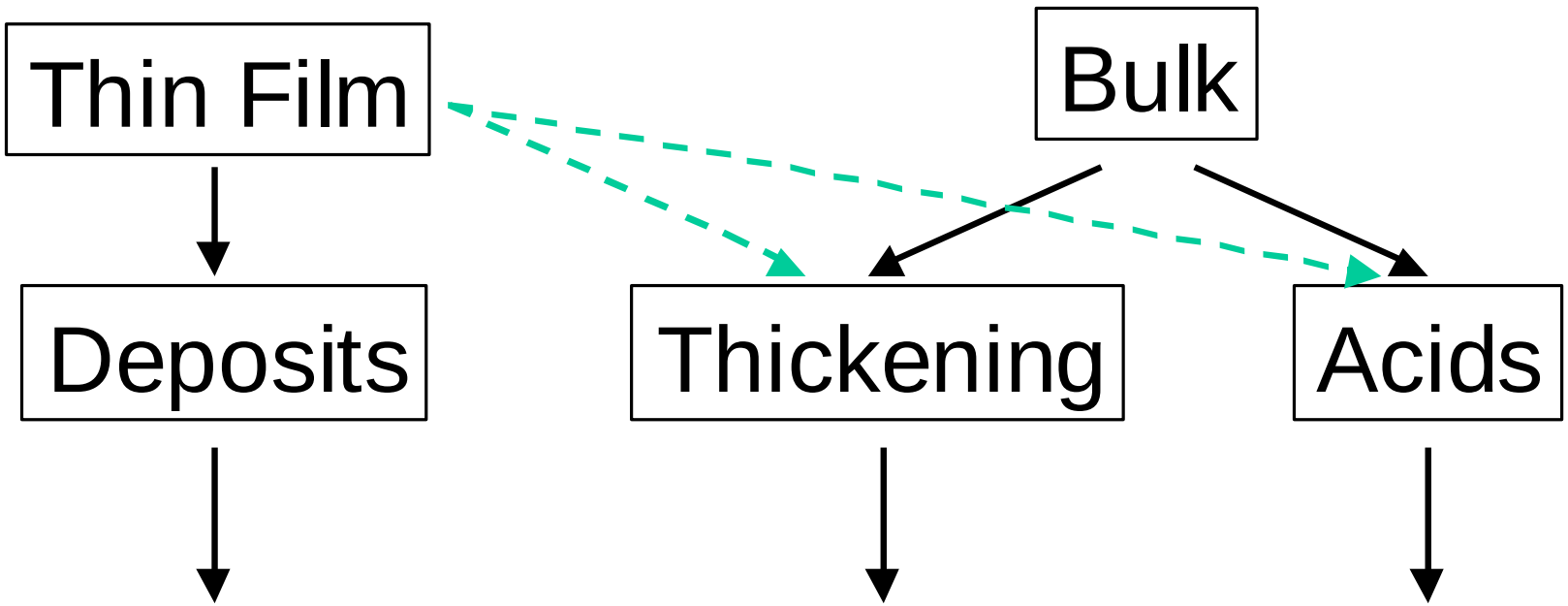
Rich Lee

Task Force

- 15 Members 4 API
  - 6 CMA
  - 3 EMA
  - 2 Independent Test Labs
- 5 Meetings
- Objective:

  To recommend test types to measure oxidation performance of API PC-9 oils

Oxidation Impacts



Factors Affecting Bulk Oil Oxidation - 1

- Bulk oil temperature
  - Sump and gallery temperatures
  - Residence time
- Peak temperature
  - Small volume from ring belt zone with highest temperatures
  - Larger volume from undercrown but lower temperatures
- Blowby gasses
  - Contribute significantly to oil oxidation
- EGR
  - EGR although reducing N0x hurts oxidation (CIBA & Infineum)

Factors Affecting Bulk Oil Oxidation - 2

- Wear metals
  - Catalyze oxidation process
- Soot
  - Can negatively affect oxidation (Infineum)
- Oil volume
  - Higher volume provides more antioxidant and TBN reserve
- Fresh oil additions
  - Provide a supply of antioxidants and TBN

Factors Affecting Bulk Oil Thickening

- Volatility losses
  - As the lighter fractions of the base stock, VII and additive package volatilize, the viscosity of the bulk oil increases.
- Soot
  - Soot particles from incomplete combustion can agglomerate in the oil and result in oil thickening as measured in the Mack T-7,8,8A & 8E.
- Bulk oil oxidation
  - Oxidation products polymerize in the oil causing thickening

Some Key Issues Reviewed

- Bench tests
  - PDSC
  - Panel Coker
  - Uniroyal Nitro Oxidation Test

  Insufficient supporting data
- EGR
  - Increases severity of oxidation
  - Can change response of oxidation inhibitors
- Volatility - Complex influence on oil thickening when combined with oxidation
- Seq. IIIF - Under redevelopment

Key Test Candidates

	John Deere JDQ-78A	Mack T-10
Pros	• Higher bulk oil temp. • Measures thickening • Combines the effects of oxidation and volatility	• Higher peak temperatures • Has EGR • Lower cost
Cons	• Significantly higher cost • No EGR • Timing impact (delay) on matrices and category	• Measures precursor to thickening • Lower bulk oil temperature • Significant soot related oil thickening

Recommendations to HDEOCP

1/ Thin Film Oxidation

Use the Caterpillar 1Q to measure piston deposits as an indicator of thin film oxidation.

Note: Special concern by some EMA members for undercrown deposit control

2/ Corrosive Wear Due to Oxidation

Use the Mack T-10 test measuring lead increase as a measure of corrosion

3/ Oil Thickening due to Oxidation

Use the Mack T-10 measuring oxidation products by integrated IR as the precursor to oil thickening

Results of Task Force Motions

Motion 1

To include the JDQ-78A test as the measure of oil thickening due to oxidation and volatility at bulk oil temperatures up to 275°F.

For 4 Against 7 Waive 4

Motion 2

To include the Mack T-10 test to measure oxidation using the integrated IR trace at 235°F minimum gallery oil temperature.

For 7 Against 1 Waive 6

Note: Letter received from EMA April 24th 2000 recommending use of the JDQ-78A.

Engine Manufacturers Association
401 North Michigan Avenue
Chicago, Illinois 60611-4267
312/644-6610
ema@sba.com
www.engine-manufacturers.org

April 23, 2000

Mr. Richard Lee
Chairman ASTM Oxidation Task Force
Oronite Additives Division
100 Chevron Way
Richmond, CA 94802-0627

Dear Rich:

Subject: Oxidation Test Procedure Recommendation

On behalf of the Engine Manufacturer Association Lubricants Committee I would like to thank you and your task force for their hard work and efforts in attempting to bring closure to the selection of test procedure(s) for oil oxidation resistance in PC-9. This has been a very difficult issue. Your task force has identified several facets of the oxidation process and have done a fine job in presenting each of those facets.

EMA has followed with interest the progress of your group, and have in fact, devoted substantial Committee time in discussing the proposals and data coming from the Task Force meetings. It is our continued view that there is no other industry test that can provide a performance identifier for high temperature oxidation as measured by viscosity increase, in combination with oil volatility, as well as the John Deere JDQ-78A test.

This test has the advantages that it is a diesel fueled test, has a current test procedure, and has hardware available for installation in any engine testing laboratory. EMA believes that the trend toward higher heat rejection characteristics of EGR / retarded injection timing engines of 2002 will require a need for good high temperature oxidation / volatility resistance of the engine oil. We feel the JDQ-78A provides that performance and should be advanced toward matrix testing to identify test precision and discrimination.

We hope that your Task Force will arrive at the same conclusion and take this recommendation to the ASTM HDEOCP. Thank you.

Sincerely,

Danny E. Larkin

Danny E. Larkin
Chairman, EMA Lubricants Committee

cc:
J. McGeehan, Chair HDEOCP
S. Kennedy, Chair PC-9 NCDT
EMA LC

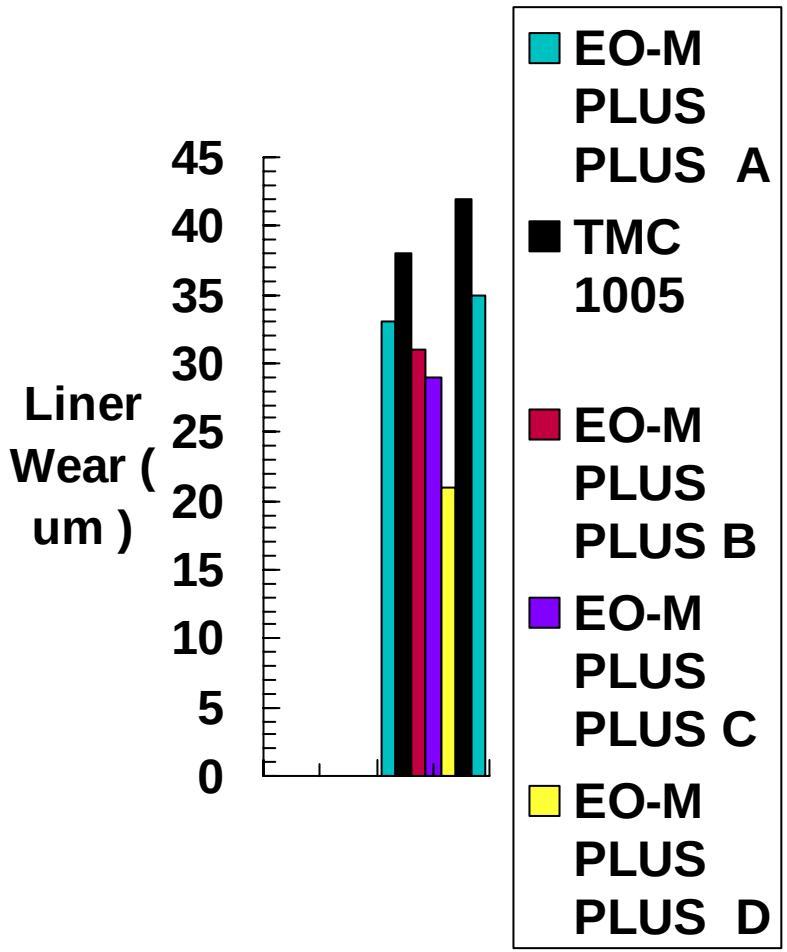
"CMA has strong concerns about the potential for inclusion of the John Deere test at this time. These concerns relate to the costs and timing impacts. Preliminary data show that adding the John Deere test would cost the industry at least $30M. It is our considered opinion that the John Deere test would become the rate limiting step in the development of PC-9 and that, if it is included, it would be unlikely that PC-9 would be developed in time for the oils to be in place by October 1, 2002. CMA wishes for our concerns to be included in the record of the meeting."

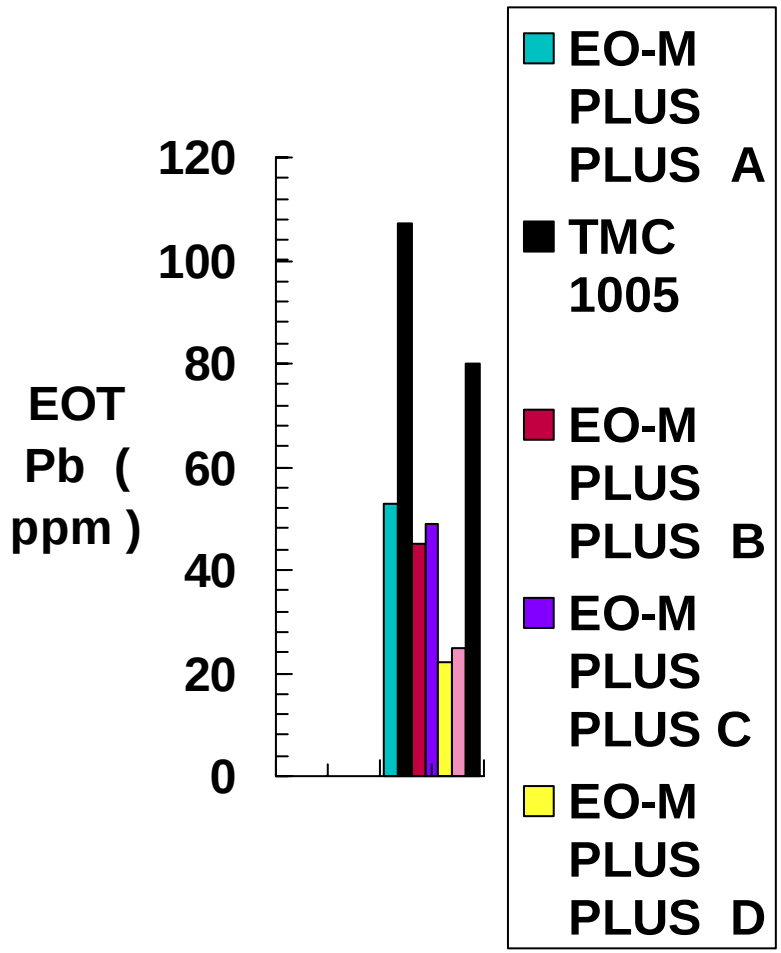
ATTACHMENT 5

Mack T 10 Report
HDEOCP April 26, 2000

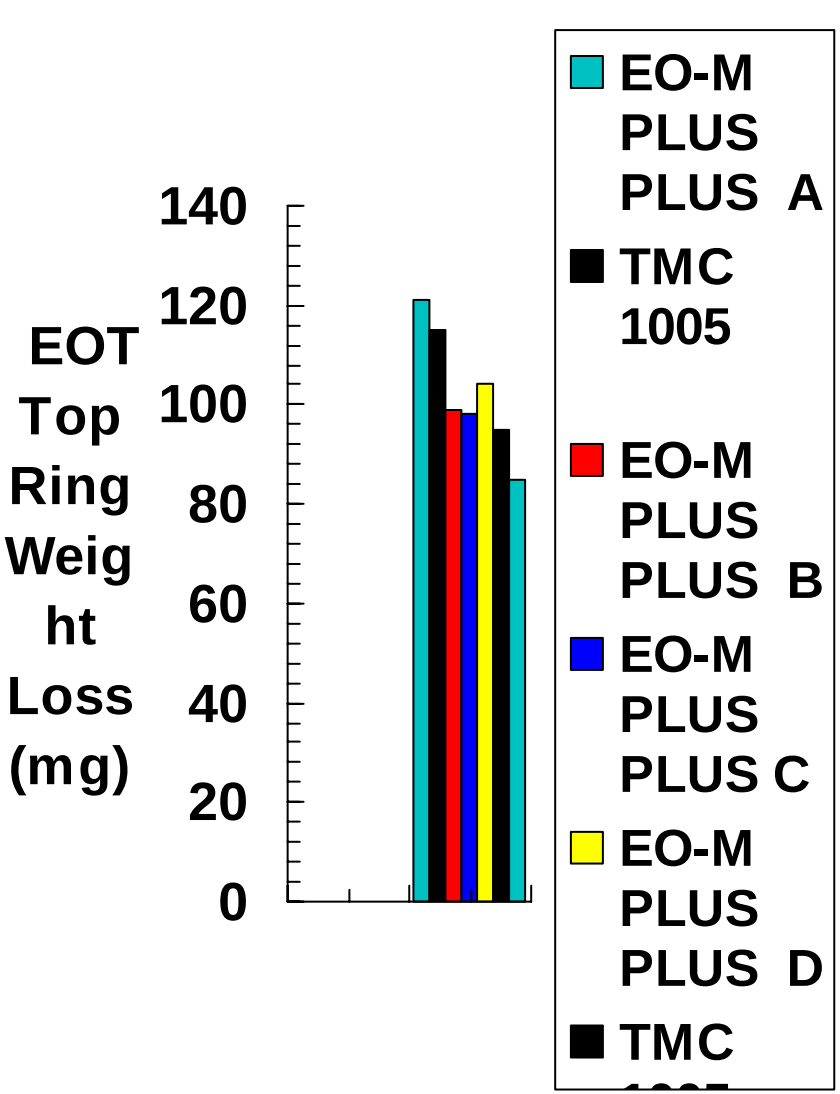
- Engine Availability - 11 Delivered
- Intial Test Procedure - Nov 99
- Discrimination - Begin Jan 2000
  Data to Industry April 26
- Test Procedure Changes
- Test Plan
- Ready for Matrix July 2000

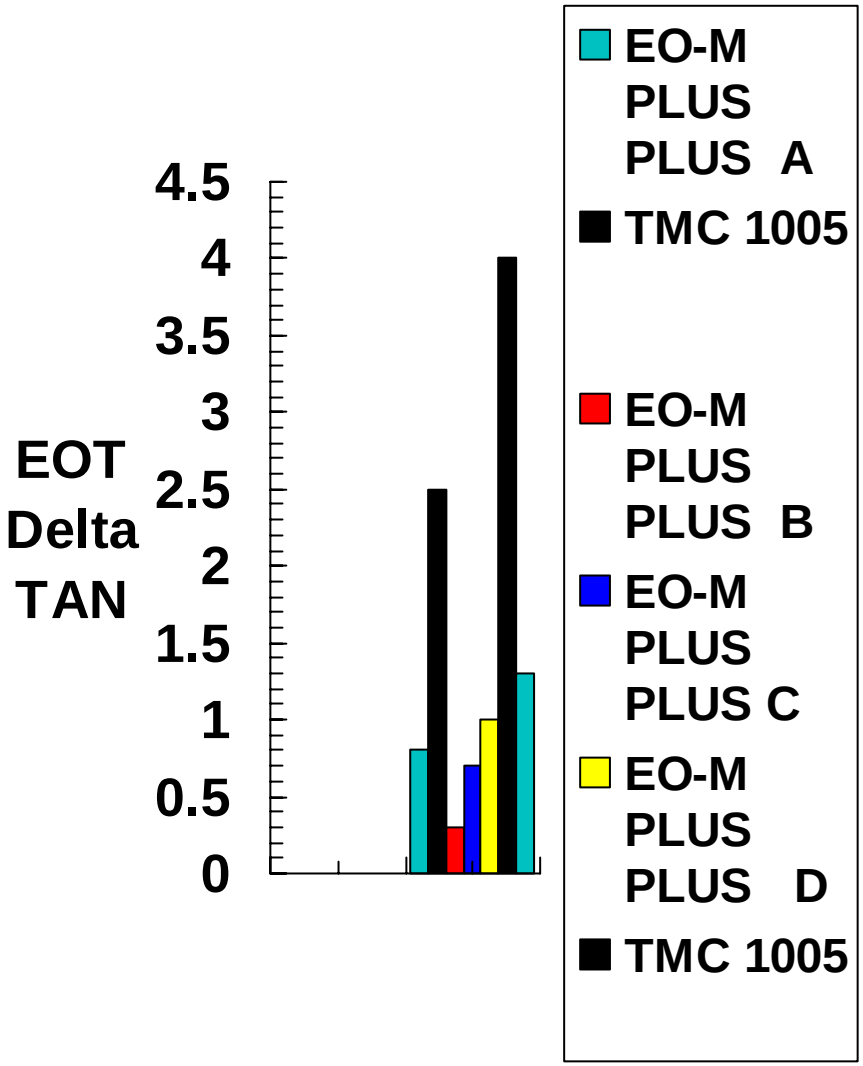
T 10 EGR Test Discrimination



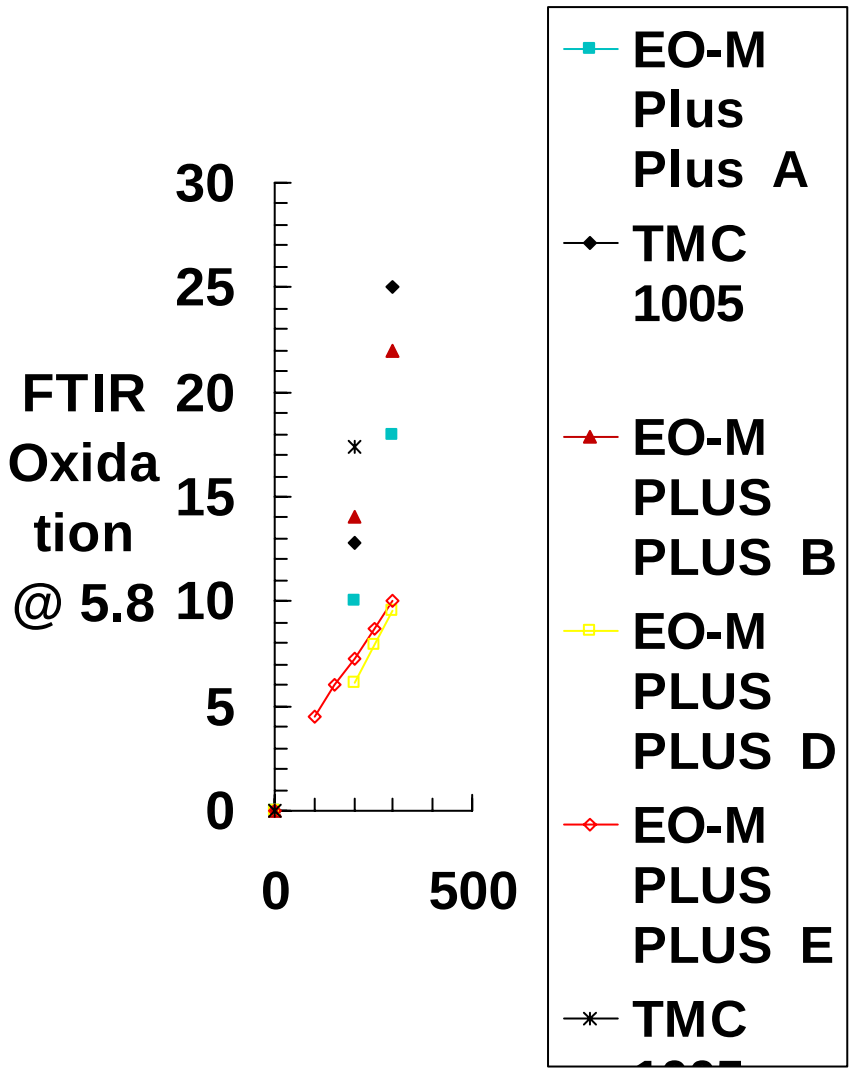


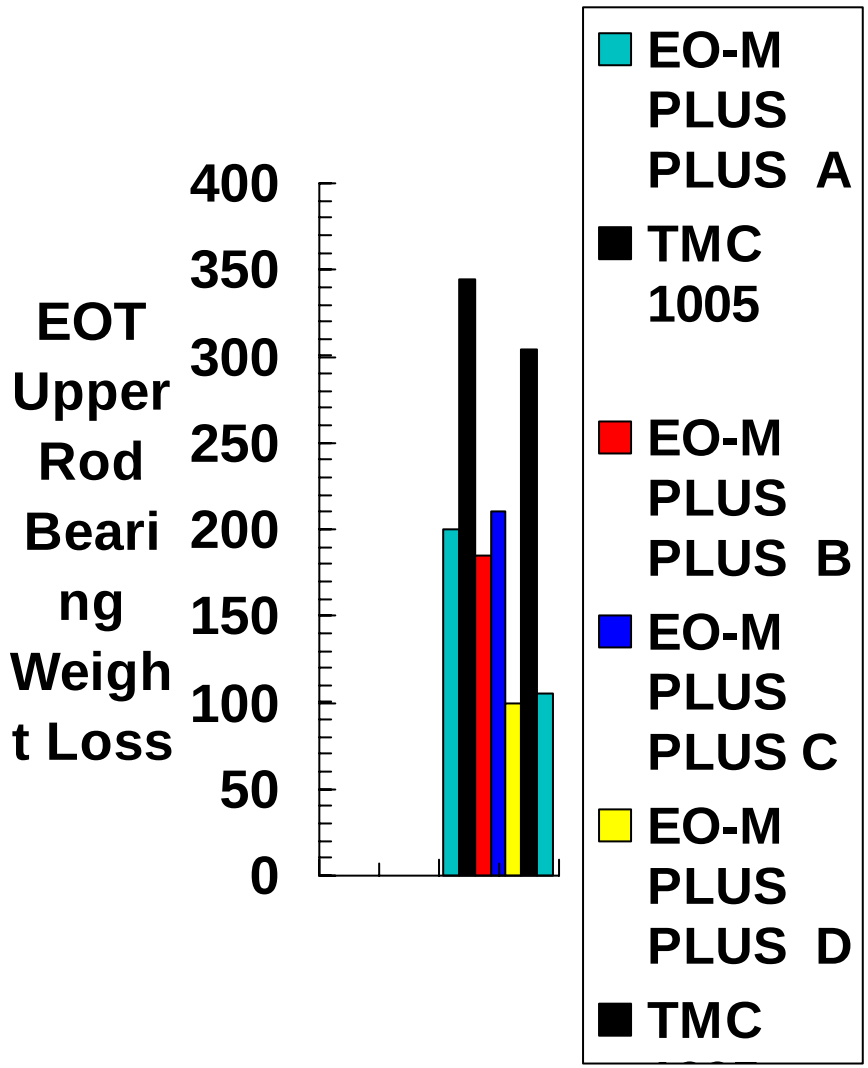
T 10 EGR Test Discrimination





T 10 EGR Test Discrimination





Mack T 10
Test Procedure Changes

- Phase 1
  No Oil add @ 50 Hr. -
  Previously a 3 lb. add @ 50 hrs.

- Phase 2
  5 lb. oil add every 50 hrs (100-300)
  Previously a 3 lb add every 50 hrs.

- Phase 2
  Oil Gallery Temp was 225 F(248Sump)
  Has been increased : 235 F(260Sump)

Summary Comparison

Gallery Temp (F)	Liner Wear (Microns)	Corrected Liner Wear (Microns)	Top Ring Wt Loss (mg)	Upper Bearing Wt Loss (mg)	EOT Lead (ppm)
225	36.4	23.4	91.48	160.98	18
235	22.6	22.6	98.07	295.82	52

ATTACHMENT 7

1Q Test Update
for
PC-9

1. 1Q results with EGR
2. Predicted Response
3. Test Stand Status

1Q Test Update for PC-9

- 1Q results with EGR

		Piston Deposits			Oil Consumption			Soot and Wear Metals				
					Initial	Final	Ratio					
Test Type	Oil Type	TLC %	TGC %	WDP	g/hr	g/hr	F/I	TGA - %	Fe	Cr	Cu	Pb
Pre-1Q Mean	TMC 1005	18	30	298	9.1	8.4	0.9	0.6	38	2		3
1Q (EGR)	TMC 1005	36	31	388	11.2	11.8	1.1	1.6	74	7	21	9
1Q (EGR)	CH-4 oil A	40	37	333	13.2	13.8	1.0	2.9	133	7	19	6

1Q Test Update for PC-9

- Predicted 1Q Response
  - The pre-1Q has been re-named the 1R test for the World Wide Heavy Duty oil spec.
  - 19 valid 1R runs completed
    - 5 with TMC 1005 (1.0% ash)
    - 14 with commercial and candidate oils (1.5% average ash)
  - 1R Piston Deposits
    - Piston deposits were not directly related to ash content.
    - Three runs ended with excessive deposits.

1Q Test Update for PC-9

- Predicted 1Q Response
  - 1R Oil Consumption
    - None of the runs lost oil control in the first 252 hours.
    - Two runs lost oil control in the last 72 hours because of upper piston deposits.
    - Oil consumption limits were based on:
      - initial oil consumption 0 to 252 hour average
      - final oil consumption 468 & 504 hour average
      - ratio of final / initial

1Q Test Update for PC-9

- Predicted 1Q Response
  - Conclusions
    - The 1R test has demonstrated the capability to measure piston deposits on higher ash oils without a pre-mature loss of oil consumption.
    - Since the 1Q with EGR uses identical hardware, the response to oil performance should be similar.

1Q Test Update for PC-9

- Test Stand Status
  - 7 1Q test stands, in 6 labs, are now equipped with EGR hardware.
  - The labs are validating operating conditions and preparing for initial runs.
  - Initial runs with TMC 1005 will be completed by the end of May 2000.
  - The successful completion of these runs will confirm 1Q readiness for the ASTM matrix.

M11-EGR Task Force Report
HDEOCP

March 26, 2000

Chicago, IL

M11 EGR Hardware Status

- M11 EGR Test Stands
  - Cummins: 1 stand, 4 tests complete
    - TMC 1005 (2 tests)
    - CRO-3 (1 test)
    - Candidate package (1 test)
  - 7 other stands installed
- No procedural changes since last meeting

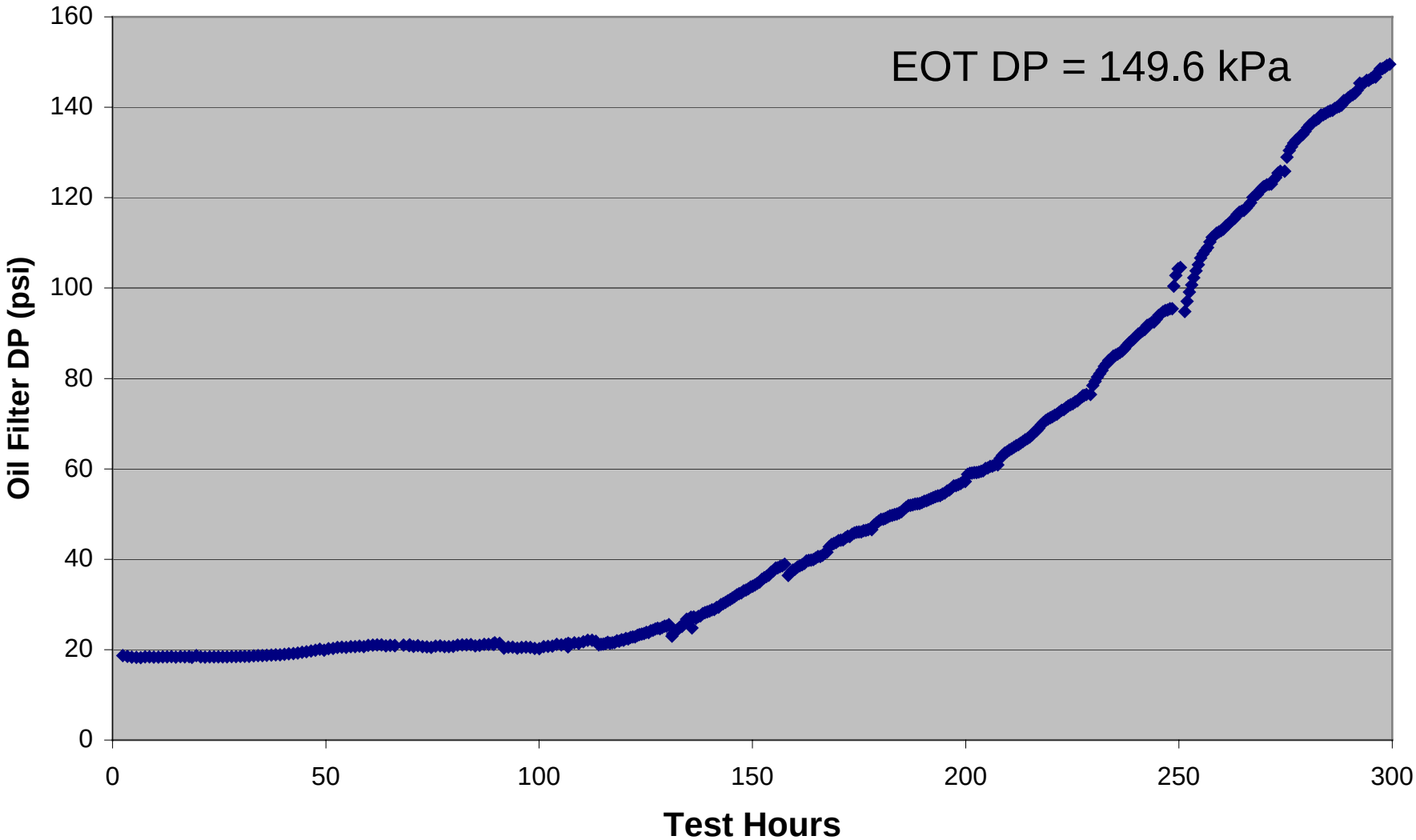
Test Results

- TMC 1005:
  - Crosshead wear: 34.2 mg
  - Oil Filter DP: 150 kPa (at 300 hrs)
  - Sludge: 9.2 valve cover, 8.9 oil pan

- CRO-3
  - Crosshead wear: 54.9 mg
  - Oil Filter DP: 101.3 kPa (at 300 hrs)
  - Sludge: 8.42 valve cover

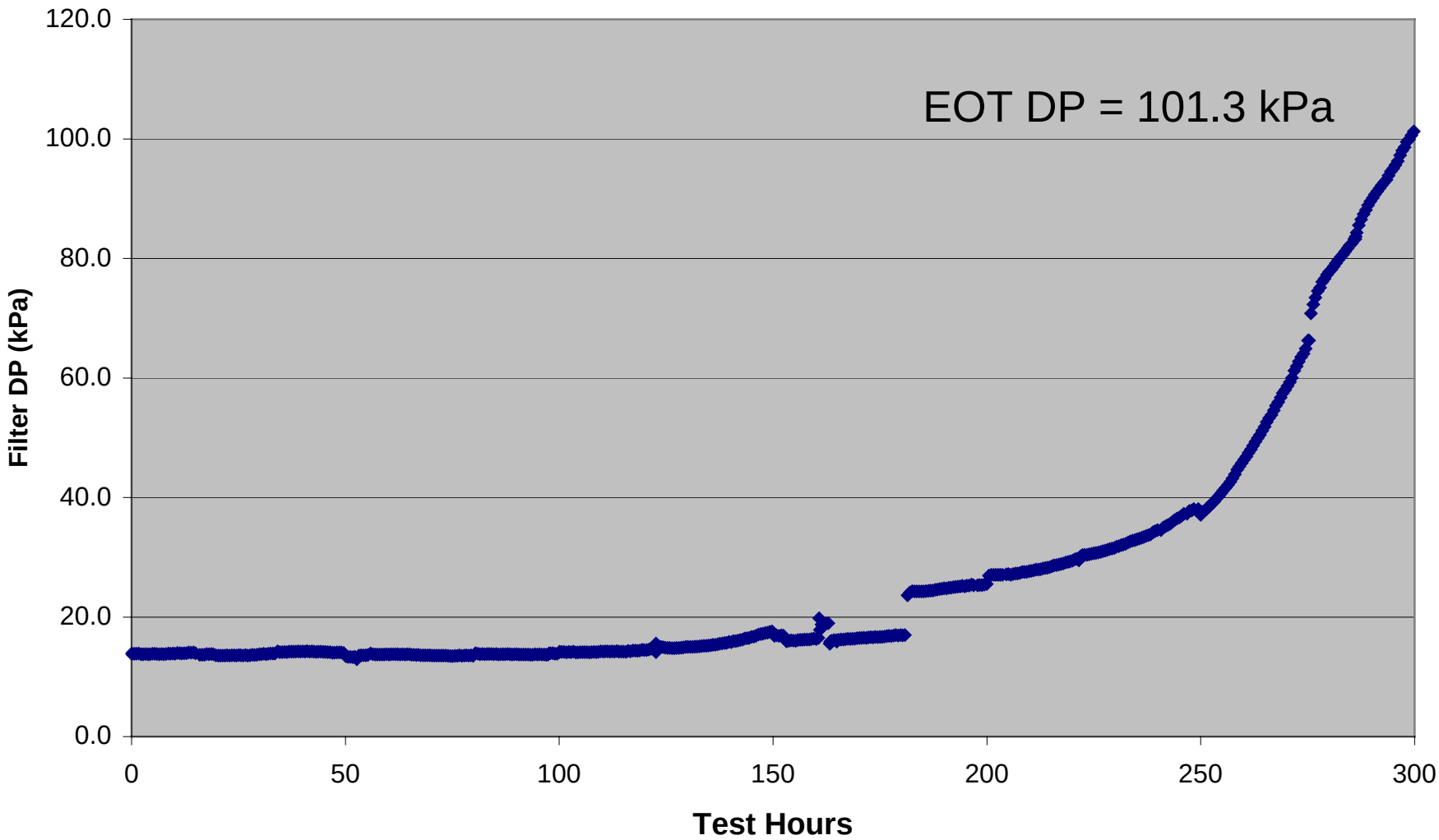
Oil Filter Pressure Drop

TMC 1005



Oil Filter Pressure Drop

CRO-3



Next Steps

- Repeat test of one of the oils
- Continue candidate evaluations

ASTM HDEOCP Mtg

Apr. 26, 2000 - Chicago, IL

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

C.J. May, K.O. Henderson, F.W. Girshick

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Recent LOTRUO Activities

- **At Feb.23rd meeting, we received clarification on key issues for the HDEOCP with respect to highly sooted diesel engine oils:**
  - ➢ **D4684 (TP-1) MRV data at current 'W' grade test temperature (fresh oil) and 5°C higher**
  - ➢ **CCS viscosity of used oil also of interest**
  - ➢ **Understand Scanning Brookfield performance**
- **We requested gallon quantities of relevant used oil samples, to allow our task force to begin its work**
  - ➢ **Recognized that used oils from PC-9 engine tests may not be available yet; focus on available T-8 ref. Oil drains**

Recent LOTRUO Activities

- **TMC provided samples of TMC 1004 end-of-test T8 oils to us in mid-March**
  - ➢ **3 x 1 gal. Samples, reported soot levels 4.7-5.2% by TGA**
  - ➢ **Preliminary analysis by two labs indicated 2 of the 3 samples were very similar ➡ these 2 were combined to provide a significant amount of oil for study by an expanded working group (11 labs) for MRV, Scanning Brookfield and CCS evaluation (5798-2101)**
- **Working group members have provided rapid turn around for this *preliminary* assessment**
  - ➢ **Equipment manufacturers also doing some step-out analysis of the samples using modified MRV and SBR**

Working Group Members Providing Data on Used Oil Sample(s)

Cannon Instrument (K. Henderson)

Chevron (J. Ziemer)

Citgo Petroleum (R. Sauer)

Conoco (S. McQueen)

Ethyl Petroleum Additives (M. Devlin)

Imperial Oil (C. May)

Infineum U.S.A. (F. Girshick)

Oronite (K. Hope)

Pennzoil (R. Worsham)

RohMax (A. Flamberg)

Savant (T. Selby)

LOTRUO Activities (Cont'd)

- **Limited analysis of 5798-2101 by D5293 Cold Crank Simulator indicates 'W' grade viscosity change:**

	CCS, mPa-s @ -10°C	CCS, mPa-s @ -15°C	CCS, mPa-s @ -20°C
TMC 1004*	---	3280 / 3310*	---
5798-2101			
No. labs reporting	3	3	1
Avg. Value	3,220	5,730	12,310
Std. Dev.	150	160	---

*** data on TMC 1004-2 / 1004-3 from TMC 'brown book', 12/98**

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LOTRUO Activities (Cont'd)

- **D4684 MRV data from 10 labs providing a preliminary assessment of test precision on 5798-2101**

	Vis., cP @ -20C	Y. Stress, Pa @ -20C	Vis., cP @ -25C	Y. Stress, Pa @ -25C
TMC 1004*	9,600 / 11,500	<35	---	---
5798-2101				
No. labs reporting	10	10	10	9
Avg. Value	19,700	<35	55,300	4 labs <35 5 labs <70
Std. Dev., % of mean (cP)	6.3 (1,190)	---	9.0 (6,260)	---
Stated D4684 precision	4.3%	---	6.3%	---

*** data on TMC 1004-2 / 1004-3 from TMC 'brown book', 12/98**

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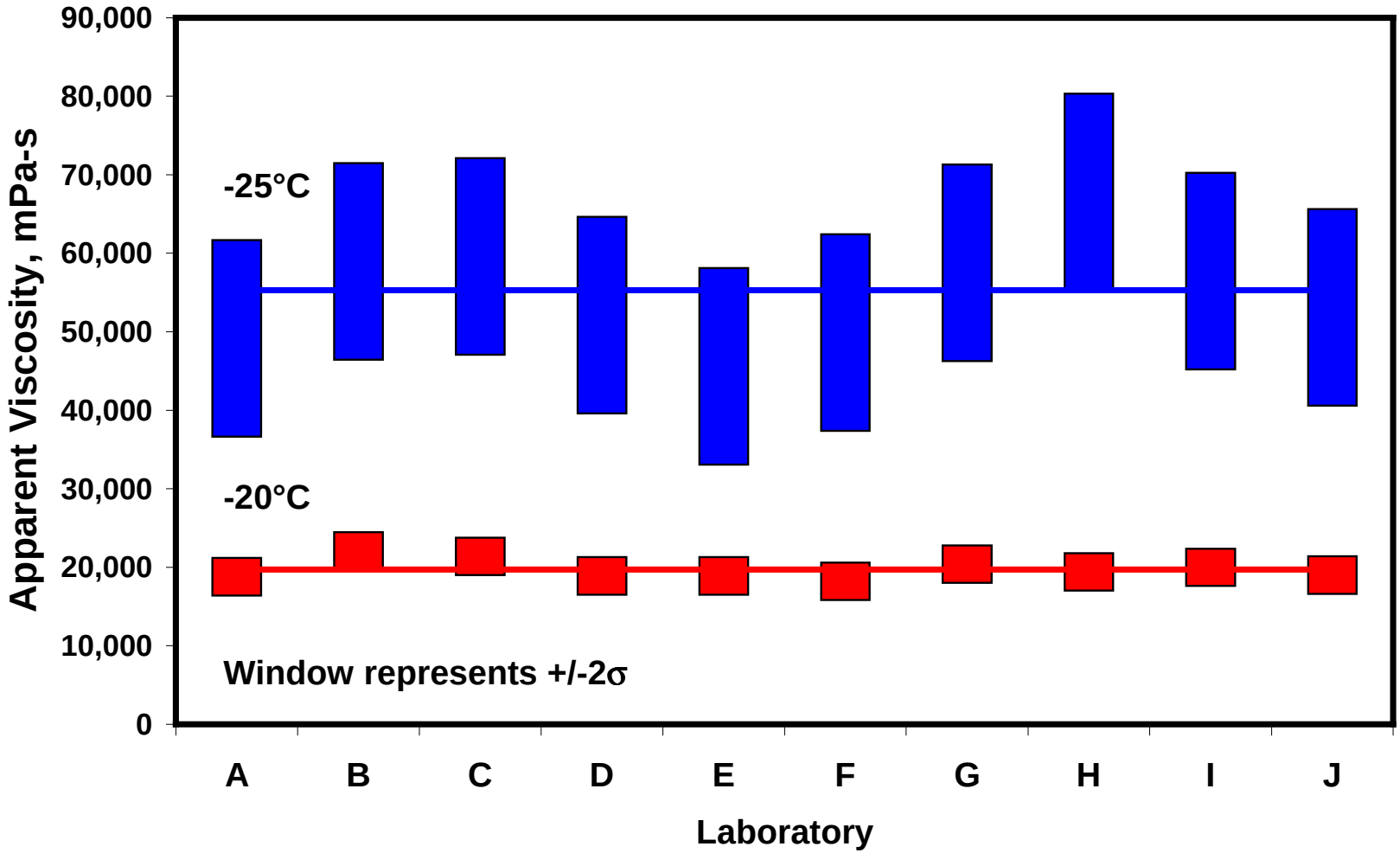
5798-2101 Sooted Oil MRV TP-1 Summary



- ***Limited data suggest test <u>repeatability</u> reasonably good***

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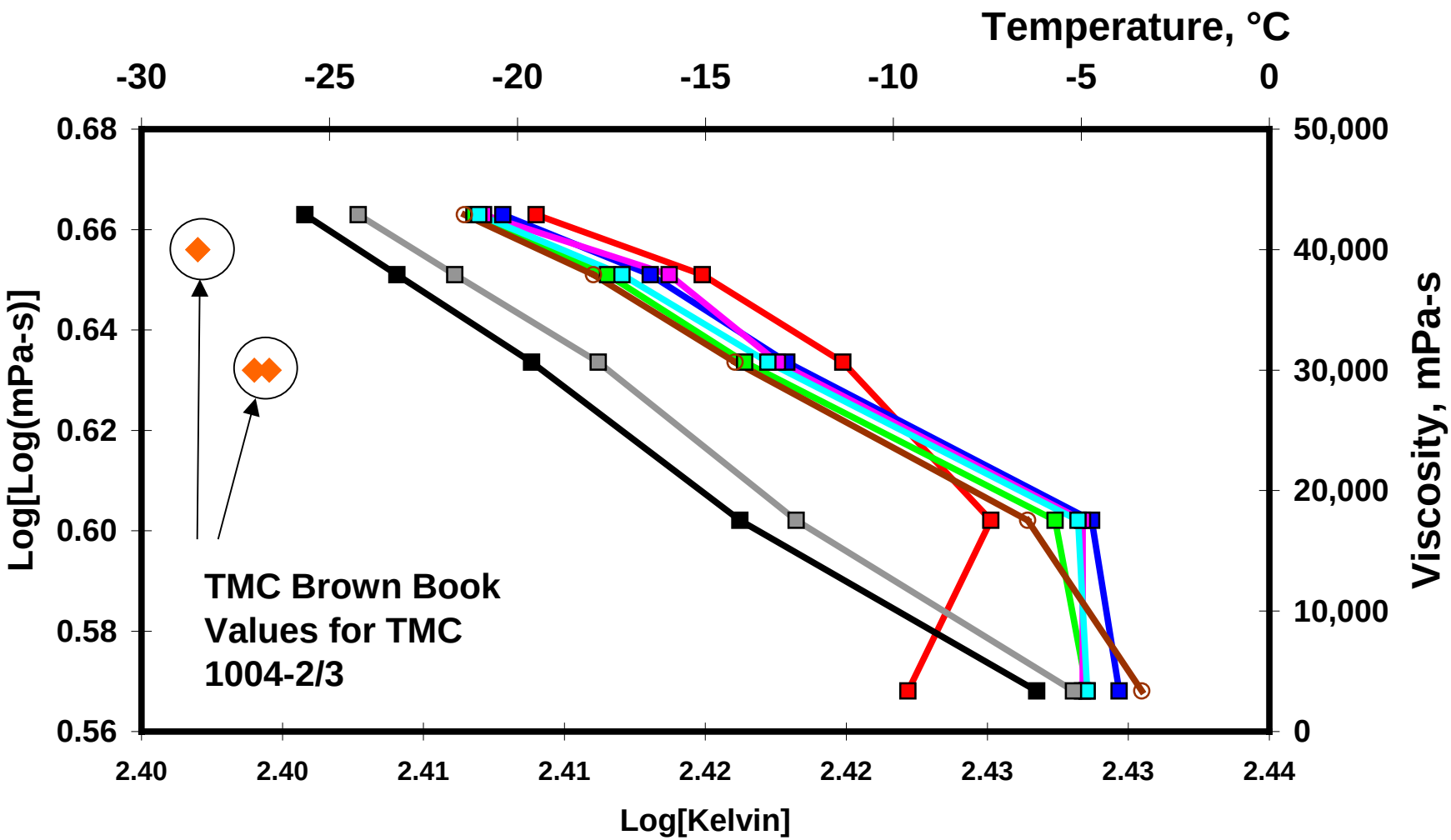
LOTRUO Activities (Cont'd)

- **D5133 Scanning Brookfield analysis with standard 90°C preheat and no preheat, indicates good G.I. precision**

	Standard Preheat		No Preheat	
	Gelation Index	Gel Index Temp. (°C)	Gelation Index	Gel Index Temp. (°C)
TMC 1004*	N.R.		---	---
5798-2101				
No. labs reporting	9	9	5	5
Avg. Value	5.1	-13.3	4.9	-14.2
Std. Dev.	1.0	0.5	0.4	0.4

5798-2101 Sooted Oil SBT With Standard Pre-Heat



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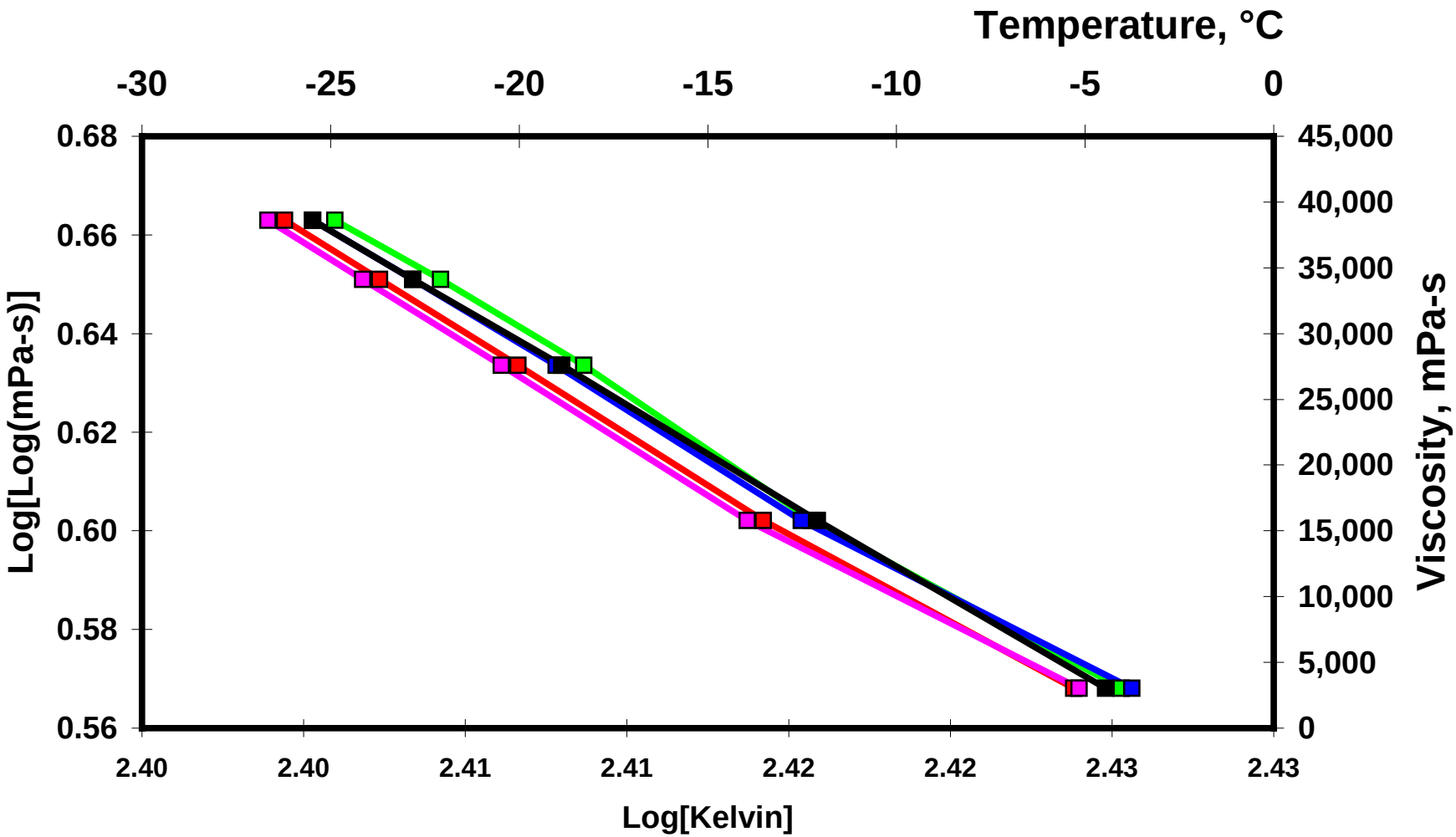
5798-2101 Sooted Oil SBT Without Pre-Heating



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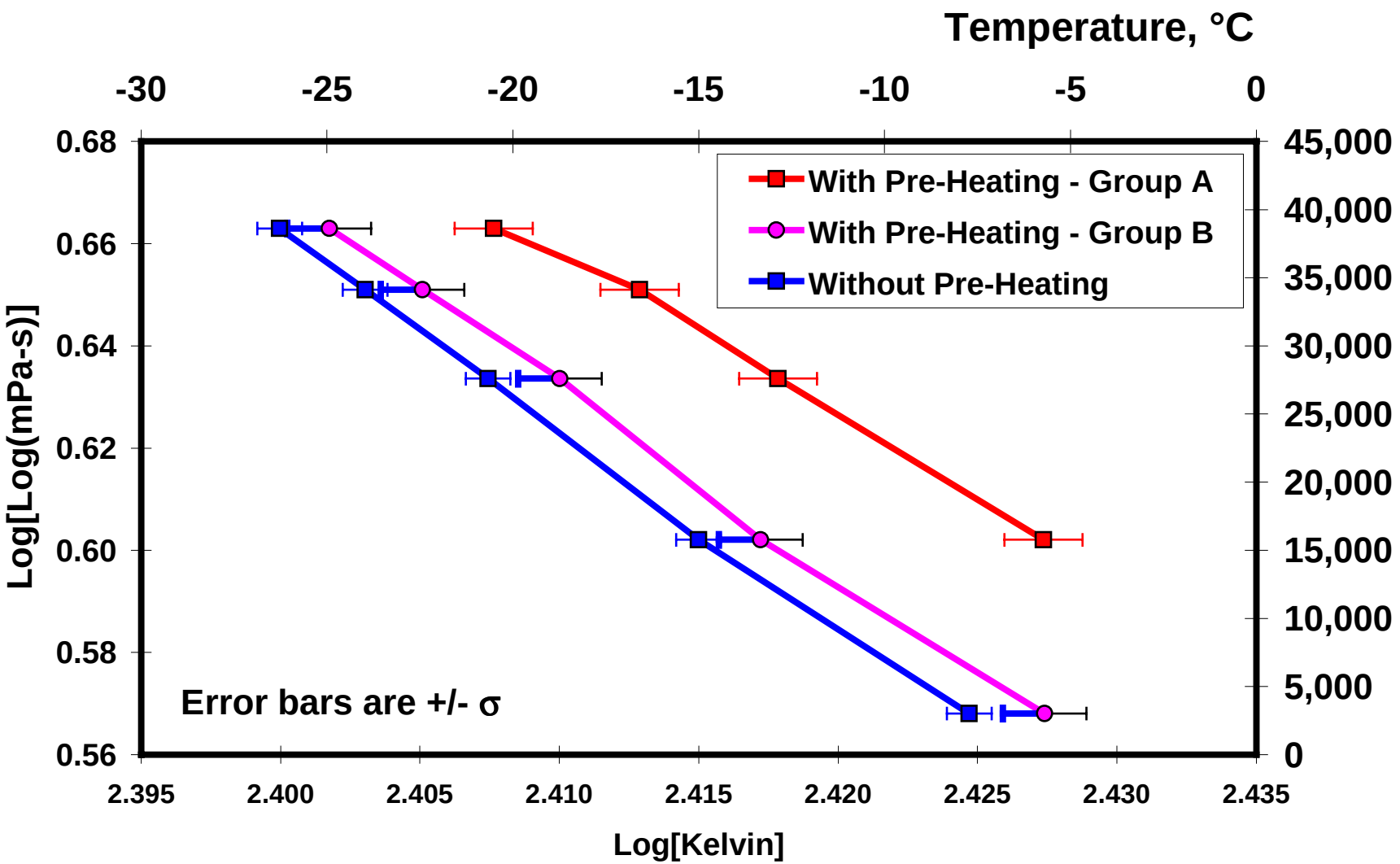
5798-2101Sooted Oil: Summary SBT Data



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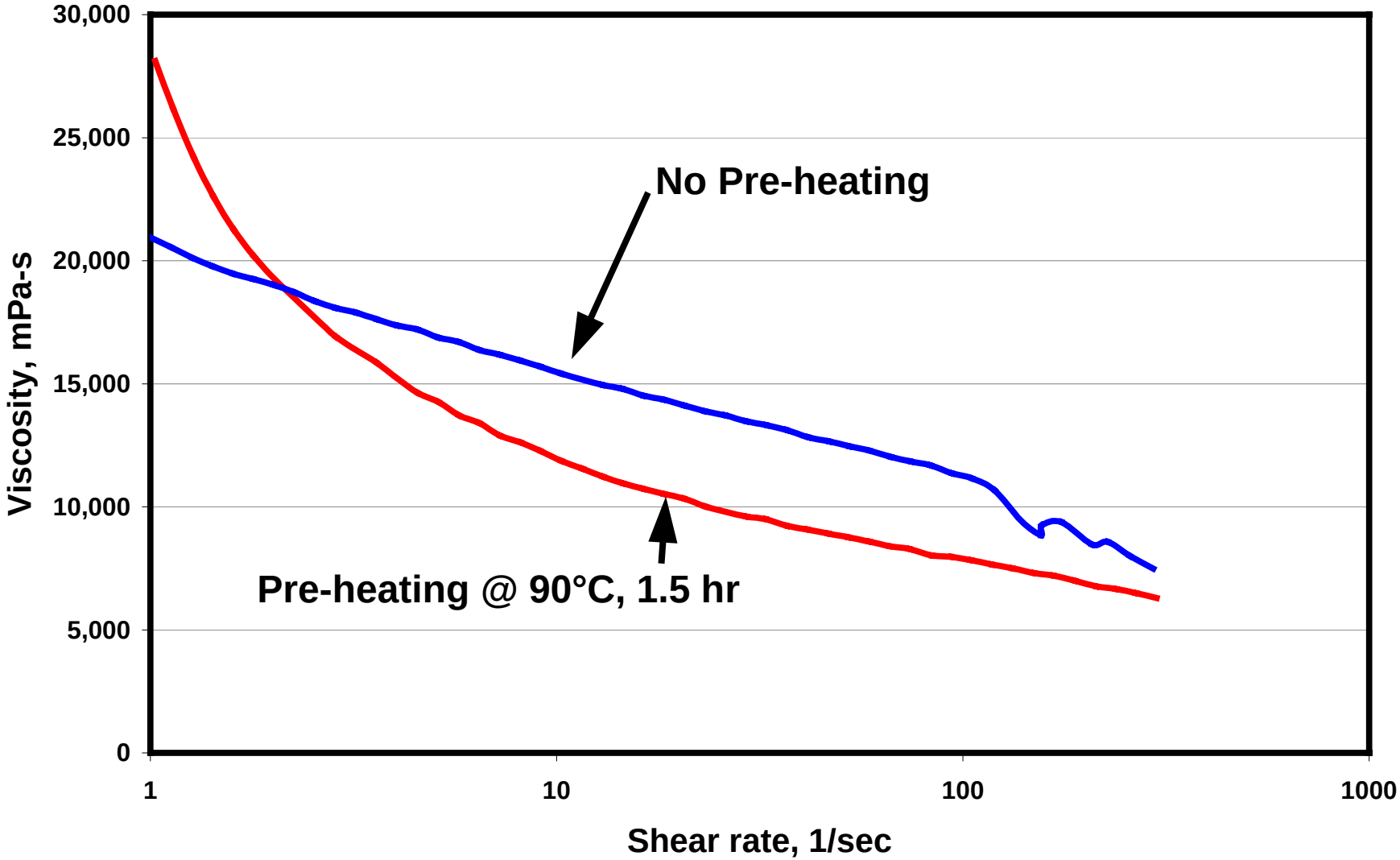
Rheometric Analysis of 5798-2101 @ -20°C



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Summary

- **Good progress made on preliminary evaluation of moderately sooted used oil (~5% soot)**
  - ➢ **CCS measurements indicate end-of-drain TMC 1004 has thickened out-of-grade, i.e. would be classed as 20W**
  - ➢ **TP-1 MRV testing at -20C (20W) and -25C (15W) suggests precision poorer than fresh oil D4684**
  - ➢ **Scanning Brookfield shows good precision for Gelation Index and Gelation Index Temperature, but appears to be two populations of viscosity-temperature data with standard preheat; SBR without preheat shows good precision, different viscosity-temperature behaviour**
  - ➢ **Rheometric analysis confirms sensitivity of oil to preheat, particularly at low shear rates**

Summary (Cont'd)

- **Equipment Manufacturers evaluating modified methods**
  - ➢ **Cannon has developed software for MRV testing without preheat and alternate rotor for lower shear stress measurements ⇨ some preliminary testing conducted on 5798-2101**
  - ➢ **Savant has used new 'extended range' Scanning Brookfield in some preliminary testing of 5798-2101**

Next Steps

- **Working group ‘meeting’ to review data, discuss testing protocol refinements/modifications (May ‘00)**
- **Evaluate second TMC used oil (sl. Higher MRV and CCS viscosity)**
- **Testing of used oils at higher soot contents**
  - ➢ **Anonymous donor of higher sooted oil**
  - ➢ **End-of-test drain samples from emerging PC-9 tests??**
- **Anticipate lots of data for review at June ASTM meeting (with the continued assistance of this group)!**

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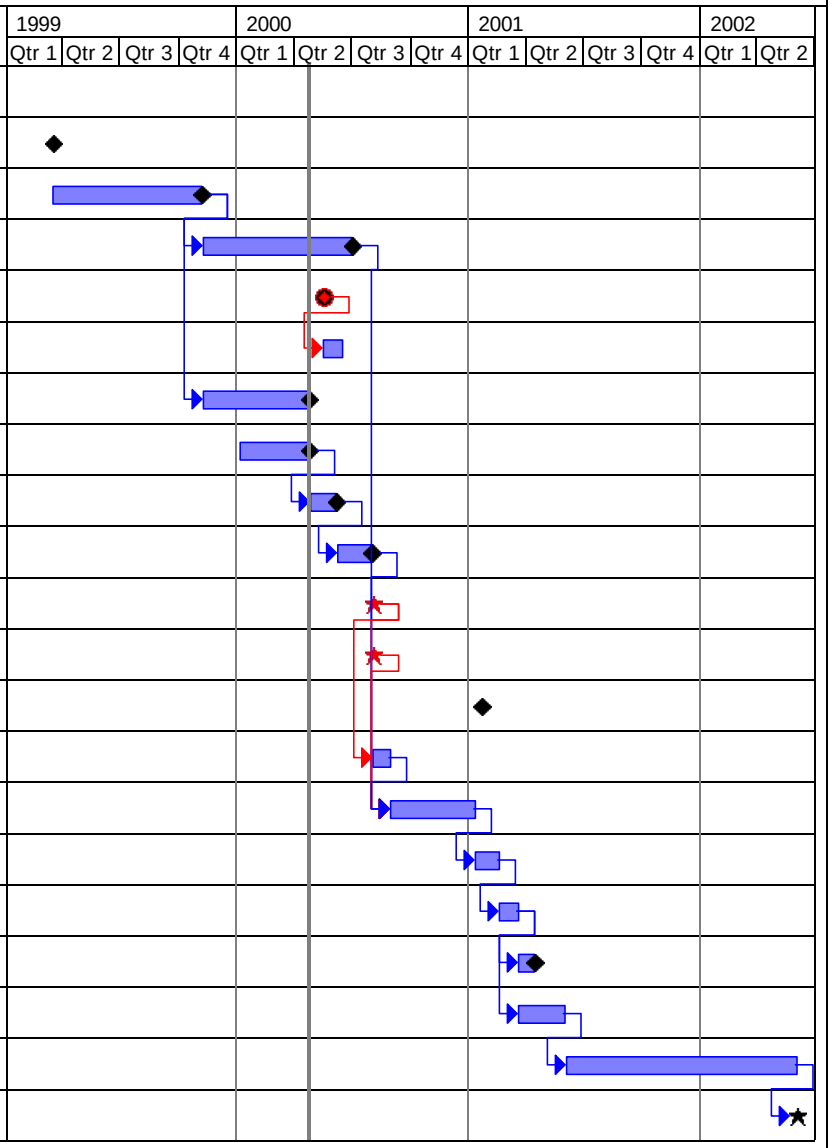
Summary of Events Required for PC-9 Licensing

Brent Shoffner 4/26/2000

ID	Task Name	Start	Finish
1			
2	Define PC-9 Performance Parameters	03/16/99	03/16/99
3	Design Prec. Mtx. Appr. API Lubes Comm	03/17/99	11/08/99
4	PC-9 Funding MOU Signed	11/09/99	07/03/00
5	1Q & M11EGR adequate for oil devel.	05/15/00	05/15/00
6	Identify Test Oils (with validation)	05/16/00	06/14/00
7	Finalize Base Oil selections for Prec. Mtx.	11/09/99	04/25/00
8	Finalize Additive selections for Prec. Mtx.	01/06/00	04/25/00
9	Base Oils Recd by Additive Companies	04/26/00	06/07/00
10	Blend Prec. Mtx. Oils>TMC>Labs	06/08/00	08/02/00
11	Final Acceptance of New Engine Tests *	08/02/00	08/02/00
12	Final Acceptance of Test Parameters	08/02/00	08/02/00
13	PC-9 Demonstration Oil is Validated	01/22/01	01/22/01
14	Pre-Matrix Activities	08/03/00	08/30/00
15	PC-9 Precision Matrix Testing	08/31/00	01/10/01
16	Precision Matrix Data Analysis	01/11/01	02/16/01
17	HDEOCP Post Matrix Test Acceptance	02/19/01	03/20/01
18	CMA Registrations Allowed	03/21/01	04/17/01
19	Finalize Pass/Fail Criteria (Sub B Mtg)	03/21/01	06/01/01
20	New Product Development	06/04/01	06/03/02
21	API Licensing Allowed	06/04/02	06/04/02

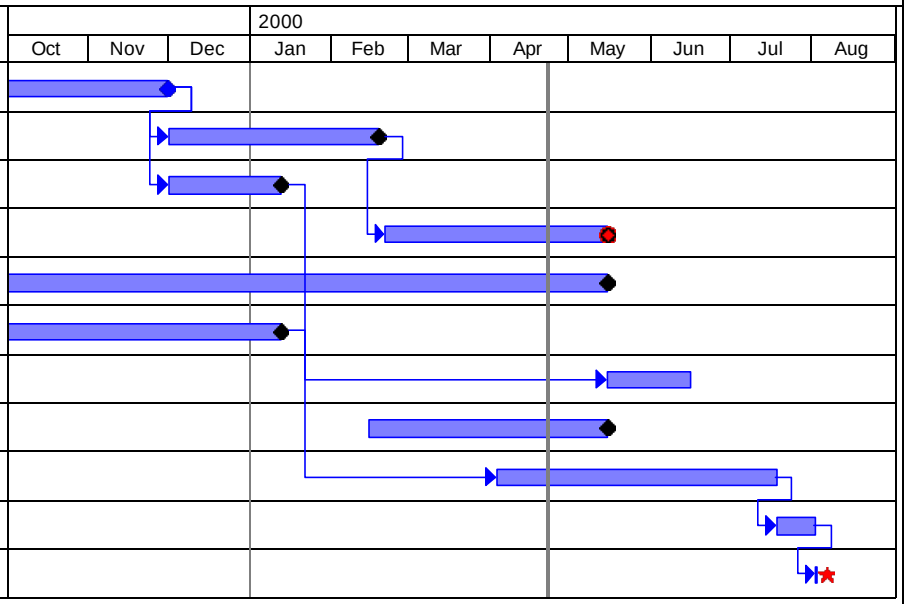


* Acceptance of each engine test (by HDEOCP) for discrimination and preliminary precision prior to starting the precision matrix.

Time Line for the 1Q Test

Brent Shoffner - 4/13/2000

ID	Task Name	Start	Finish
1	Design EGR Hardware	03/01/99	11/30/99
2	Produce and ship test kits to labs	12/01/99	02/18/00
3	Specify Installation/Prelim. Procedure	12/01/99	01/12/00
4	Install test kits	02/21/00	05/15/00
5	Write final procedure	03/01/99	05/15/00
6	Develop EGR rate measurement	03/01/99	01/12/00
7	Lab Visits	05/15/00	06/15/00
8	Discr. Oils Available at the labs	02/15/00	05/15/00
9	Run Discrimination Tests	04/03/00	07/17/00
10	Data Analysis	07/18/00	08/01/00
11	HDEOCP Approves Proof of Concept*	08/02/00	08/02/00

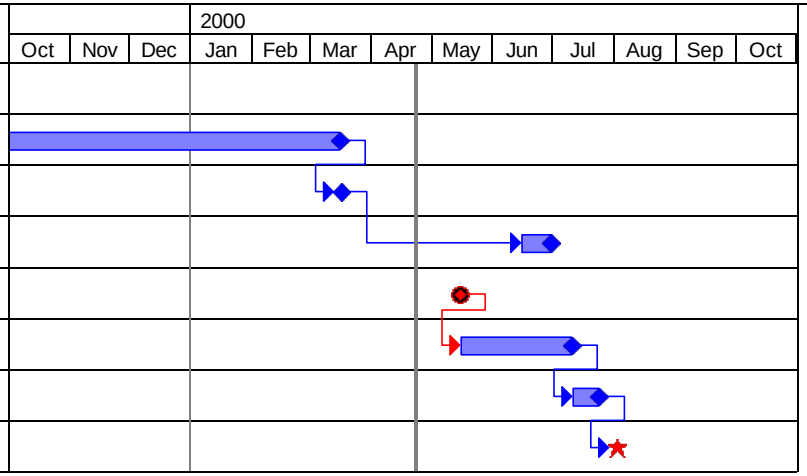


* Contingent on HDEOCP Meeting Date

Time Line for the M11 EGR Test

Brent Shoffner - 04/26/00

ID	Task Name	Start	Finish
1	Initial Kits/Parts Available	04/21/99	04/21/99
2	Develop Procedure	04/22/99	03/15/00
3	Procedure Available	03/16/00	03/16/00
4	Lab Visits for Precision Matrix	06/15/00	06/30/00
5	Procedure Adequate	05/15/00	05/15/00
6	Run Preliminary Tests & Report Data**	05/16/00	07/10/00
7	Data Analysis	07/11/00	07/24/00
8	HDEOCP Approves Proof of Concept*	08/02/00	08/02/00

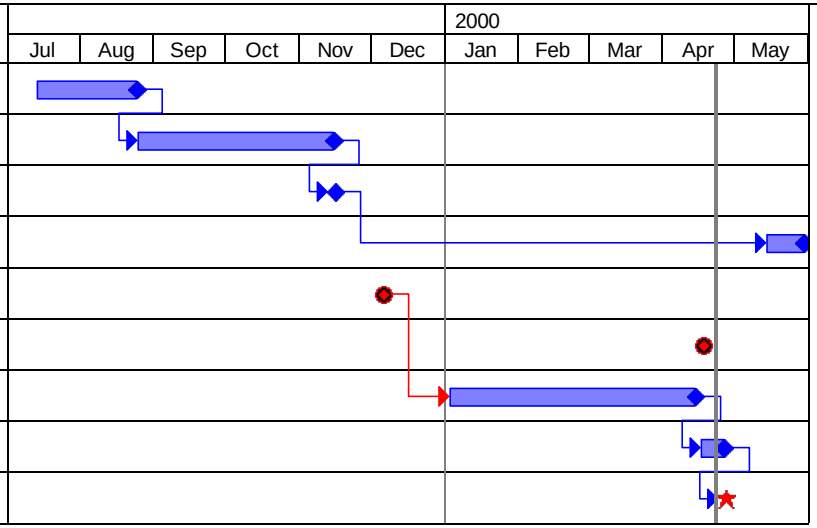


* Contingent on HDEOCP Meeting Date
** Will include TMC 1005-1

Time Line for the T-10 Test

Brent Shoffner - 4/26/00

ID	Task Name	Start	Finish
1	Final Kits/Parts Available (1 per lab)	07/14/99	08/24/99
2	Install engines and run shakedown	08/25/99	11/15/99
3	Procedure Available	11/16/99	11/16/99
4	Lab Visits for Precision Matrix	05/15/00	05/30/00
5	Procedure Adequate	12/06/99	12/06/99
6	Oil Gallery Temp 225F to 235F	04/18/00	04/18/00
7	Run Preliminary Tests & Report Data**	01/03/00	04/14/00
8	Data Analysis	04/17/00	04/26/00
9	HDEOCP Approves Proof of Concept*	04/27/00	04/27/00



* Contingent on HDEOCP Meeting Date
** Will include TMC 1005-1