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Unapproved Minutes of the March 5, 2002 Sequence IIIF Surveillance Panel Meeting held in San Antonio, Texas

Chairman Nahumck called the meeting to order at 8:03am. A copy of the agenda (Attachment 1) was handed out and reviewed. OH Technologies, Inc. was thanked for sponsoring both the meeting room and lunch for the meeting attendees.

Secretary and Motion & Action Item Recorder – Jason Bowden will be Motion & Action Item Recorder. Since Frank Farber, who is now permanent secretary for this Surveillance Panel, is not in attendance Michael Kasimirsky volunteered to perform secretary duties for this meeting.

Membership changes – James Carter will now represent Halterman Products in place of Robert Rumford. An attendance sheet was circulated to the panel and is attached (Attachment 2).

Approval of November 15, 2001 Meeting Minutes – The minutes from the November 15, 2001 meeting were approved as issued, unanimously and without comment.

Removal of Action Items from November 15, 2001 meeting – The action items from the last meeting were reviewed. The following comments were noted:

- GM has received no additional high-wear components from candidate tests run in the IIIF.
- The new GF-3 Category reference oil is being procured at this time. 600 gallons were requested for IIIF testing use.

- The Sequence IIIF Test Procedure and Engine Assembly Manual were revised, as directed, and issued on or about March 1, 2001. The Light Duty Rating Task Force recommendations were incorporated in this revision, as directed.

TMC Test Status Update – Michael Kasimirsky presented the current industry control charts (Attachment 3). WPD is currently severe of target. This severity shift appears to be related to the introduction of reference oil 1006-2, but a concrete determination had not been made at this time. PVIS and APV are within limits. PV60 is mild of target and appears to have always been mild. The targets for this parameter should probably be reviewed to be sure that they are appropriate for this parameter.

Information Letter 02-1 was issued and contained Draft 4 of the Sequence IIIF test procedure. This new draft will be passed to Tom Verdura for final preparation for standard ballot. All future information letters will be written against this draft. The Information Letter and Procedure Draft are available for download from the TMC website at the following addresses:

ftp://tmc.astm.cmri.cmu.edu/docs/gas/sequenceiii/procedure_and_ils/il02-1.pdf
ftp://tmc.astm.cmri.cmu.edu/docs/gas/sequenceiii/procedure_and_ils/Draft%204.pdf

A new Sequence IIIF Engine Assembly Manual is also now available for download from the TMC website. It was issued in TMC Memo 02-11 and replaces all previous versions of the document. It incorporates all the changes requested at the previous meeting of the Surveillance Panel. It is available from the following address:

ftp://tmc.astm.cmri.cmu.edu/docs/gas/sequenceiii/procedure_and_ils/IIIF-EAM(version%202-22-02).pdf

Status of IIIF-HD test – The IIIF-HD test was reviewed. There was some discussion of revising the Sequence IIIF report form package to include the IIIF-HD data in one report. After some discussion, it was decided to leave the current report packages as they currently exist.

The IIIF-HD report form set was reviewed and the following changes were approved:

- Change name of IIIF-HD to IIIFHD in all occurrences.
- Move *Oil Consumption* and *Hot Stuck* Rings fields from pass/fail block to additional results block (form 4).
- Eliminate the stuck ring fields and the oil ring plugging fields (form 4).
- Eliminate the 79h NO_x reading (form 5).
- Eliminate the CCS & MRV fields (form 6).
- Eliminate the Blowby readings beyond 60h (form 7)
- Add the requirement for Iron, Copper, and Lead analysis of used oil samples to IIIFHD procedure.

These changes will be issued via an Information Letter updating Draft 4 of the test procedure. A new draft will be issued at that time since the IIIFHD portion of the test was not included in that draft.

Motion (Bill Nahumck/Pat Lang) Approve the changes to the IIIFHD procedure and report forms as discussed above. The motion passed unanimously by voice vote.

Update on the Camshaft Wear Investigation – Dwight Bowden presented his findings from his ongoing investigation into the Sequence IIIF wear situation. His presentation was handed out (Attachment 4), along with a summary of his 2002 runs made to date (Attachment 5).

Mr. Bowden presented his findings from his 2001 runs. Of the two tests run, one result gave acceptable wear and the other generated several high-wear positions. Both tests were run on reference oil 433-1 and both were run on unified engine build engines. He drew the following conclusions from that data:

- Possible initial wear after engine start.
- Plugged oil filter elements at approximately 40 hours (both tests).
- Possible engine block influence on wear (high wear correlation by position).

Mr. Bowden then turned the floor over to Charlie Leverett for his findings on this topic.

Mr. Leverett presented his findings from thirteen of his IIIF initial run wear experiments (Attachment 6). Mr. Leverett's conclusion is that there is not sufficient lubricant on the camshaft & lifter set for protection during the initial run, resulting in high-wear being generated very early in the test. He noted that they had found lifters that had grown in size during this experiment from material being welded onto the lifter foot from the camshaft lobe. He noted that all the post-test materials had been turned over to GM. He then turned the floor over to Pat Lang.

Mr. Lang presented his results on similar experiments to what Mr. Leverett had been working on (Attachment 7). He noted that in his chart that the first five tests were run on an SAE 5W-20 candidate engine oil that a customer supplied. Mr. Lang also concluded that the problem appeared to be insufficient lubrication at the camshaft-lifter interface on initial test start-up. Mr. Bowden noted that all of this work was done with the 2-piece Oil Filter Block Adapter fitting in place. Mr. Lang further noted that the cylinder head was not changed throughout his experiment. Mr. Lang then returned the floor to Mr. Bowden.

Mr. Bowden then went on with his presentation. He presented that the hardware supplier with the information generated by Mr. Leverett and Mr. Lang and the supplier commented that wear this early in the test was due to insufficient lubrication on initial assembly in his opinion. The supplier suggested a phosphate coating on the camshaft as a possible way to address the problem. The phosphate coating is designed to act as a "sponge" and hold oil on the camshaft-lobe interface during initial break-in of the parts. Mr. Bowden arranged to have some current IIIF camshafts phosphate coated and then run in IIIF testing. He then presented the results of these runs (Attachment 5). One of these runs is still running; Mr. Bowden will update his handout with the resulting data when it becomes available. {Revised spreadsheet is shown in Attachment 5.} His conclusion is that camshafts and lifters are not the root cause of the random and unexpected wear results in the Sequence IIIF test. He also concludes that the manganese phosphate coated camshafts eliminates the initial, uncontrolled wear failures following engine start and allows for a controlled, linear lifter wear format. He also noted that oil filter plugging and any possible engine block influence in wear performance identified in 2001 testing was not addressed in this activity.

Mr. Bowden also commented that OH Technologies, Inc. will not make it's hardware available for future IIIF or IIIG investigations unless it is part of a well-designed experimental program designed to investigate the current wear situation and come up with a solution.

Charlie Leverett and Sid Clark both thanked Mr. Bowden and OH Technologies, Inc. for it's significant efforts on this issue. Mr. Bowden thanked a long list of folks for their contribution to this effort and stressed that without their assistance it never would have happened.

Update on the Camshaft Wear Investigation – Sid Clark then presented the results of GM's investigation of Sequence IIIF wear performance. He presented some information on the initial development of the Sequence IIIF test and the wear materials chosen during that development process. He also commented on GM's use of motor-generator dynos during test development and how that relates to current engine starting speeds using the specified air starter.

Mr. Clark presented some information on a test run using the same camshaft and lifter set that Mr. Leverett used in his Experiment #9, presented earlier (Attachment 6). The camshaft and lifter set was removed from that engine, measured, cleaned, and then put into a new Sequence IIIG engine build and run in a 100-hour IIIG test. The test generated high wear on both the camshaft and lifter set in the IIIG test (Attachment 8). GM was pleased with the test results of this run and suggested it as a possible avenue of investigation. Mr. Clark discussed some differences between the IIIF engine design and the prior IIIE engine design and how it relates to wear performance.

Mr. Clark then reviewed the data Mr. Lang presented in his prior presentation on this topic. Mr. Clark also commented that GM does not consider linear wear performance, i.e. linearly increasing throughout the test, as an achievable nor desirable goal because wear needs to be driven by additive depletion, viscosity increase, and other factors related to test operations over time.

Mr. Clark then presented some data on post-test component analysis that GM is in the midst of performing. He reviewed some photographs taken at high magnification of several IIIF camshaft lobes on JB and MB camshafts, examining the various cast iron structures found in the parts that were examined (Attachment 9). Mr. Clark noted that the major difference found during GM's

metallurgy analysis of these two parts was a difference in carbide structure between the two camshaft batches. He noted the differences in retained austenite in the martensite structure of the two camshafts, along with a difference in carbide structures.

The discussion became heated at times. Chairman Nahumck commented that his review of the data presented so far lead him to believe that the problem did not seem to be driven by the metallurgy of the parts. He commented that the current IIIF camshaft is produced by the same methods and procedures used to manufacture the IIIE components. The IIIF components are controlled to at least the same level as the IIIE components, if not more controlled, and the IIIE had no such sensitivities with respect to wear performance.

Mr. Clark then presented some data on an experimental IIIF run which used an "oiling bar" in it. This "oiling bar" eliminates the balance shaft and replaces it with an o-ring sealed bushing that bypasses the balance shaft oil supply. This oil supply is fed into a stainless steel pipe that runs the length of the camshaft and has a 0.025" feed hole directly above each camshaft lobe. This supplies positive lubrication to the camshaft not only during initial priming but also during test operations.

Mr. Clark commented that GM does not support the use of a phosphate-coated camshaft in the IIIF test at this time. GM is not confident that a candidate test run using a camshaft with a phosphate coating will generate a failing wear result on a 0.03% Phos oil in the Sequence IIIF test. As a result they cannot support the phosphate coating at this time. He also commented that the rumors that GM is planning on using a double-length IIIF test as the IIIG test are baseless.

Mr. Bowden commented that OHT will *not* provide parts for further investigations unless there is a clear, stated goal, provided in advance, and the activity is to be conducted according to a clearly defined design of experiments, also provided in advance.

At this point, the meeting was stopped for a lunch break.

Update on the Camshaft Wear Investigation (cont.) – Chairman Nahumck attempted to summarize the data presented to this point on this topic. His personal opinion, based on the data presented during the meeting, was that there was some problem with initial wear in the Sequence IIIF test and if this problem is not addressed with some change to the test it will continue to plague the industry. He also had some concerns with the phosphate-coated camshaft in relation to EOT wear levels and also loss of wear discrimination. The oiling wand also presents it's own set of problems and issues with regards to introduction and possible impact on test results.

He also summarized some other issues confronting the panel on this topic. The first is the short timeline for introduction of the IIIG test as part of the GF-4 category. The next is that phosphate-coated camshafts may not be acceptable to GM without further investigation. Finally, he noted that we need a matrix to generate the data necessary to prove out whatever change we might make to fix this problem and move forward.

The discussion then turned towards possible solutions to the problem and also if the focus should be on the IIIF or IIIG test. Much discussion on this topic took place with no conclusions drawn. There was some discussion of IIIG introduction and the proposed timeline for introduction of it as part of the GF-4 Category. The current timeline calls for the IIIG test procedure to be completed by July 1, 2002, and that the precision matrix be completed by August 15, 2002.

The panel brainstormed some ideas on how to correct IIIF and IIIG wear and following ideas were tossed out for discussion (the complete list is shown in Attachment 10):

1. Use increased spring loading on a phosphate-coated camshaft.
2. Pre-conditioned test components using the GM Engine Oil Supplement. This could be done on a specialized test rig.
3. Use of an oiling bar to replace the balance shaft in the test engine.
4. Use a camshaft with higher carbide content than the current camshaft batches.

The group was asked to offer up suggestions as to where the industry should proceed to investigate these issues. There was much discussion of what course of action should be taken, which test (IIIF versus IIIG) should be worked on, and how to fund this activity. No resolution was reached. The only consensus reached was that this is the Sequence IIIF Surveillance Panel and as

such the IIIF test needs to be the focus area. The Sequence IIIG test has not been released from the Test Sponsor and is not an ASTM activity at this point in time.

The Chairman proposed three possible options available to the panel at this time:

1. Do nothing.
2. Declare wear out of control. Possibly introduce the phosphate-coated camshaft as a result.
3. Introduce the phosphate-coated camshaft to the current IIIF test.

Discussion again shifted back to IIIG development. During the discussion, it was noted that there is an effective minimum limit of 0.08% Phosphorus for the GF-3 Category due to the requirement to run a Sequence VE test for oils below that level. The Sequence VE test is no longer available so one cannot effectively run a candidate oil for the GF-3 Category with less than 0.08% Phosphorus.

Motion (Charlie Leverett/Carl Stephens) Introduce the phosphate-coated camshaft into the Sequence IIIF test. This camshaft is a current-design IIIF camshaft with the addition of a manganese-phosphate coating (with appropriate process documentation) and no further changes. Introduce them with a reference oil test at the next normal reference in that laboratory (after the date of this Information Letter, assuming the letter is balloted to Subcommittee B prior to being issued) and at that time bring them into use laboratory-wide. Note this change in the test report. The motion passes 9-1-1. GM was the lone negative vote and TMC waived.

Charlie Leverett and Dave Glaenzer both offered to generate data on phosphate-coated camshafts to resolve the concerns GM expressed regarding that hardware. All parties present at the meeting were encouraged to do the same. This additional data will hopefully resolve GM's negative vote on the above motion.

O&H Subpanel Report – Pat Lang presented the O&H Subpanel report (Attachment 11). The main topic of discussion in his report was the topic of changing out oil filters and oil coolers during the test. This has become an issue in testing due to loss of oil temperature control related to plugging of these components.

Motion (Pat Lang/Carl Stephens) The oil filter and/or oil cooler may be changed once per test if the oil filter differential pressure is greater than 100 kPa or if oil temperature control is lost (assuming that the rest of the system is operating properly). The parts replacement can only be performed once per test (i.e. if a filter is changed at 30 hours, the oil cooler cannot be changed at 50 hours). The oil from the old oil filter has to be drained into the new oil filter prior to installation. No new test oil can be added as a result of this change. Finally, a note must be made in the test report that a change was made and what components were changed. This motion is effective today. The motion passed unanimously by voice vote.

Mr. Lang then presented some information on the ongoing O&H investigation of the Sequence IIIF oil bypass system. No conclusions have been reached on this activity at this time.

Mr. Lang also commented on the variations in the Kundinger Fluid Control racks. This subject has been an ongoing O&H activity. Work is continuing on determining a generic schematic for incorporation into the Sequence IIIF Test Procedure along with documenting the various valves and controllers used in the racks throughout industry.

CPD Report – Dwight Bowden presented the CPD report (Attachment 12). Mr. Bowden commented that the rejected camshafts would be used for destructive testing on the future phosphate-coated camshats, i.e. these rejected camshafts would be phosphate-coated and then used for destructive testing.

Scope & Objectives – Chairman Nahumck reviewed the Scope & Objectives for the Sequence IIIF Surveillance Panel (Attachment 13). The objective to have the IIIG test ready for inclusion in the GF-

4 Specification was revised to July 2002. Evaluation of the Sequence IIIF oil system was added as an objective for May 2002 as well.

There was no new business.

The meeting was adjourned at 4:43pm. The Motions & Action Items from this meeting, as recorded by Jason Bowden, are attached (Attachment 14).

Attachment	1
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Reference	

AGENDA

SEQUENCE IIIF SURVEILLANCE PANEL MEETING

San Antonio, Texas

March 5, 2002

1. **APPOINTMENT OF RECORDER OF ACTIONS/MOTIONS**
2. **AGENDA REVIEW**
3. **MEMBERSHIP CHANGES**
4. **APPROVAL OF MINUTES FROM NOVEMBER 15, 2001**
   (Available for viewing at the TMC website)
5. **REVIEW OF ACTION ITEMS**

SEQUENCE IIIF

1. **TMC TEST STATUS UPDATE – MIKE KASIMIRSKY**
   - **A. Highlights of the LTMS Control Charts**
   - **B. Test Procedure Status**
     CRC Manuals
   - **C. Assembly Manual Status**

2. **STATUS OF THE IIIF-HD TEST– BILL NAHUMCK**
   - **A. IIIF-HD Report Forms**

3. **UPDATE ON THE CAMSHAFT/LIFTER WEAR INVESTIGATION**
   - **A. OHT INVESTIGATION– DWIGHT BOWDEN**
   - **B. GM INVESTIGATION - SID CLARK**

4. **O&H SUBPANEL UPDATE – PAT LANG**
   - **A. Part Replacement Guidelines for Oil Filter Temperature Control Concerns**
   - **B. Variations in the Kundinger Racks**
   - **C. Report from the Procedure Review Task Force - PAT LANG**

5. **SEQUENCE IIIG DEVELOPMENT UPDATE – SID CLARK**

6. **OLD BUSINESS**
   - **A. Scope & Objectives**

7. **NEW BUSINESS**
   - **A. CPD Report**

ADJOURNMENT

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March 5, 2002 San Antonio, Texas

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Attachment	2
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Attachment	2
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Reference	

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March 5, 2002 San Antonio, Texas

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Attachment	2
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March 5, 2002 San Antonio, Texas

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Attachment 2
Page 5
Reference

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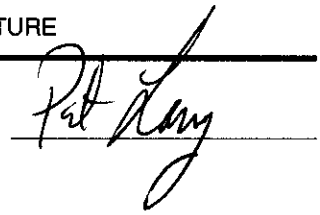
Patrick Lang Southwest Research Institute 6220 Culebra Road P.O. Box 28510 San Antonio, TX 78228 USA	210-522-2820 210-684-7523 plang@swri.edu O&H Subpanel Chairman	☑ IIIF SURV PANEL ☐ IIIF MAILING LIST ☑ O&H SUBPANEL ☐ O&H Mailing List	Present 
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Attachment 2
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Reference

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William M. Nahumck The Lubrizol Corporation 29400 Lakeland Boulevard Wickliffe, OH 44092 USA	440-347-2596 440-347-4096 wmn@lubrizol.com Surveillance Panel Chair	☑ IIIF SURV PANEL ☐ IIIF MAILING LIST ☑ O&H SUBPANEL ☐ O&H Mailing List	Present
Rick Oliver Registration Services Inc. 2805 Beverly Drive Flower Mound, TX 75022 USA	972-724-2136 210-341-4038 crickoliver@attbi.com	☐ IIIF SURV PANEL ☑ IIIF MAILING LIST ☐ O&H SUBPANEL ☐ O&H Mailing List	Present
Robert Olree GM Powertrain 30500 Mound Road m/c 480-106-160 Warren, MI 48090-9055 USA	810-947-0069 810-986-2094 robert.olree@gm.com	☐ IIIF SURV PANEL ☑ IIIF MAILING LIST ☐ O&H SUBPANEL ☑ O&H Mailing List	Present

Attachment 2
Page 7
Reference

ASTM SEQUENCE IIIF LIST

March 5, 2002 San Antonio, Texas

NAME / ADDRESS	PHONE / FAX / E-MAIL		SIGNATURE
John Pandosh Infineum USA LP 4335 Piedras West Suite 101 San Antonio, TX 78228 USA	210-732-8132 210-732-8480 John.Pandosh@Infineum.com	☐ IIIF SURV PANEL ☑ IIIF MAILING LIST ☑ O&H SUBPANEL ☐ O&H Mailing List	Present
Robert H. Rumford Specified Fuels & Chemicals, LLC 1201South Sheldon Road Channelview, TX 77530-0429 USA	281-457-2768 281-457-1469 rhrumford@specified1.com	☑ IIIF SURV PANEL ☐ IIIF MAILING LIST ☐ O&H SUBPANEL ☐ O&H Mailing List	Present
Jim Rutherford Chevron 100 Chevron Way Richmond, CA 94802 USA	510-242-3410 510-242-1930 jaru@chevron.com	☐ IIIF SURV PANEL ☑ IIIF MAILING LIST ☐ O&H SUBPANEL ☐ O&H Mailing List	Present
Philip R. Scinto The Lubrizol Corporation 29400 Lakeland Boulevard Wickliffe, OH 44092 USA	440-347-2161 440-347-9031 prs@lubrizol.com	☐ IIIF SURV PANEL ☑ IIIF MAILING LIST ☐ O&H SUBPANEL ☐ O&H Mailing List	Present PRS
Carl R. Stephens Ashland Oil Inc. 22nd & Front Streets Ashland, KY 41101 USA	606-329-5198 606-329-3009 crstephens@ashland.com	☑ IIIF SURV PANEL ☐ IIIF MAILING LIST ☑ O&H SUBPANEL ☐ O&H Mailing List	Present

Attachment	2
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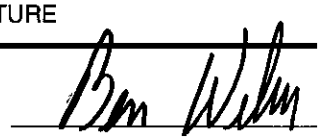
Reference	

ASTM SEQUENCE IIIF LIST

March 5, 2002 **San Antonio, Texas**

NAME / ADDRESS	PHONE / FAX / E-MAIL		SIGNATURE
Ben Weber Southwest Research Institute 6220 Culebra Road P.O. Box 28510 San Antonio, TX 78228 USA	210-522-5911 210-684-7530 bweber@swri.edu Sub-Committee D02.B01 Chair	☐ IIIF SURV PANEL ☑ IIIF MAILING LIST ☐ O&H SUBPANEL ☐ O&H Mailing List	Present 

SEQUENCE IIIF SURVEILLANCE PANEL MEETING
GUEST LIST
March 5, 2002
San Antonio, Texas

Attachment	2
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Reference	

NAME/ADDRESS	PHONE/FAX/EMAIL	SIGNATURE
Jason Bowden OH Technologies, Inc. P.O. Box 5039 Mentor, OH 44061-5039	440-354-7007 440-354-7080 jhbowden@ohtech.com	
Alex Boffa 100 Chevron Way Richmond CA 94805	510 242 5220 510 242 3173 abof@chevron.com	

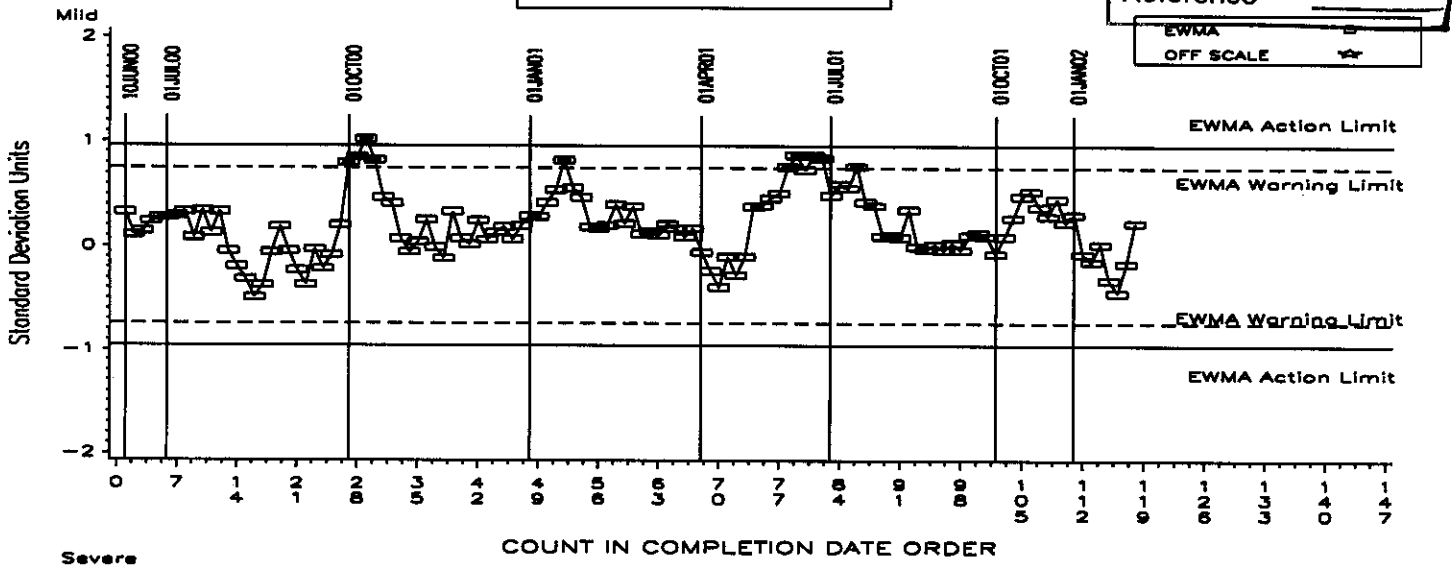
SEQUENCE IIIF INDUSTRY OPERATIONALLY VALID DATA

VISCOSITY INCREASE FINAL ORIG UNIT RES

Attachment 3
Page 1
Reference

EWMA
OFF SCALE ☆

LTMS Severity Analysis



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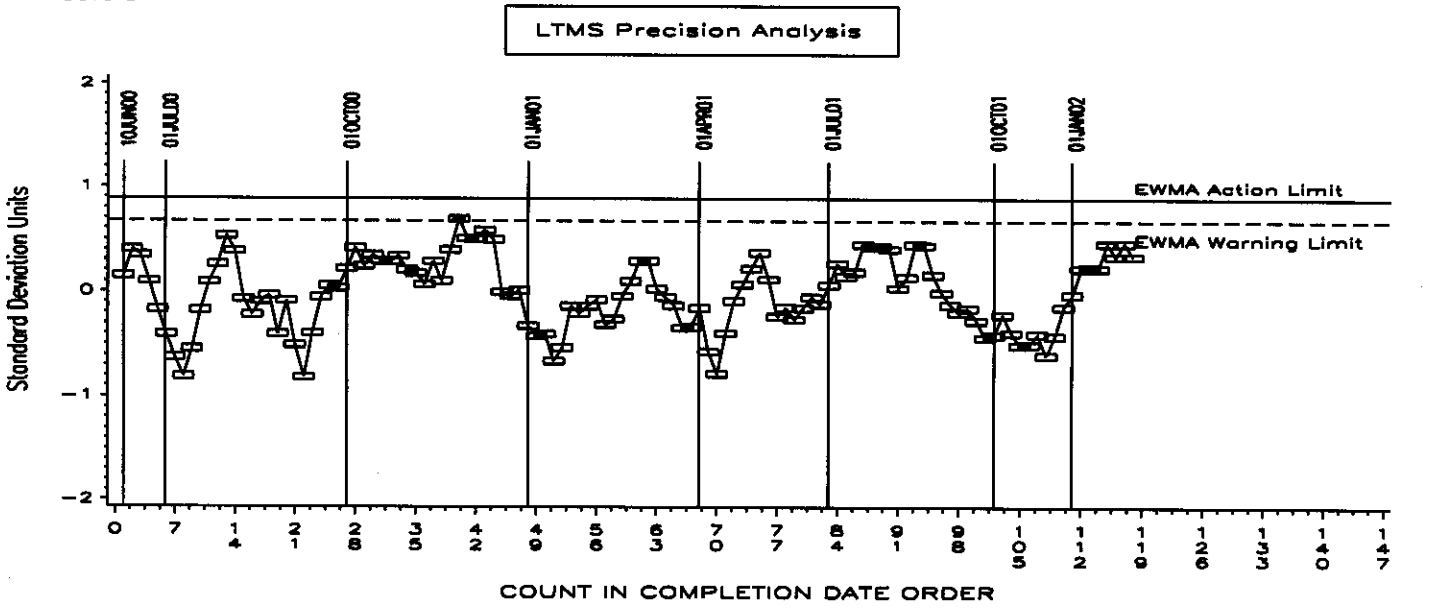

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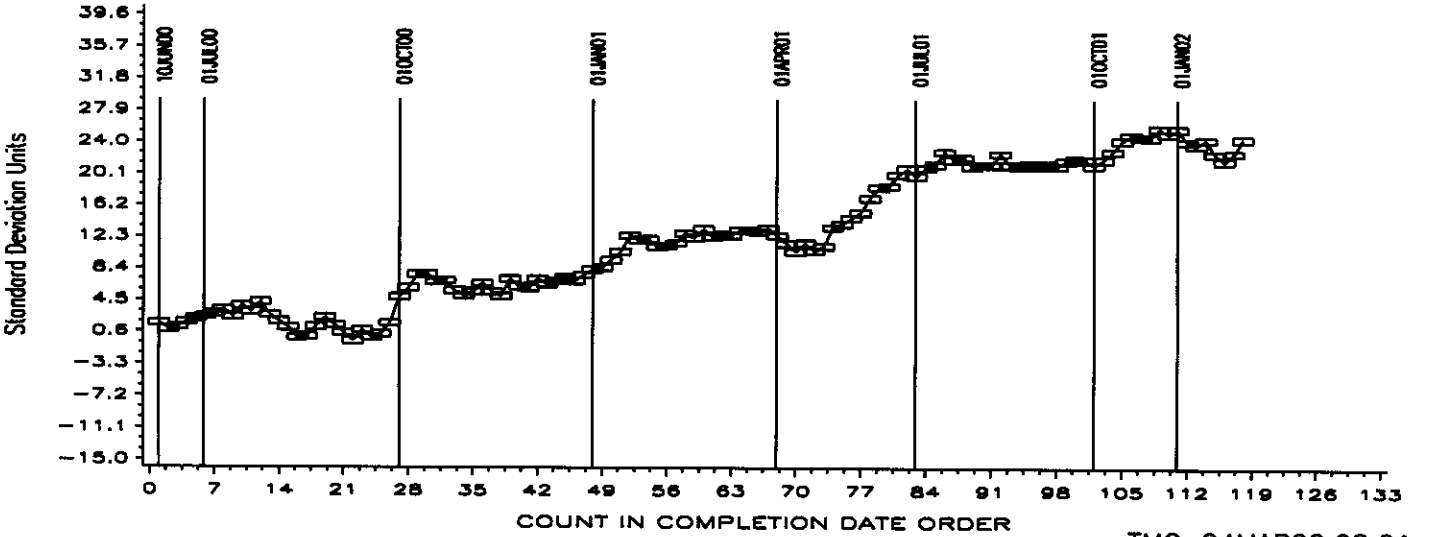

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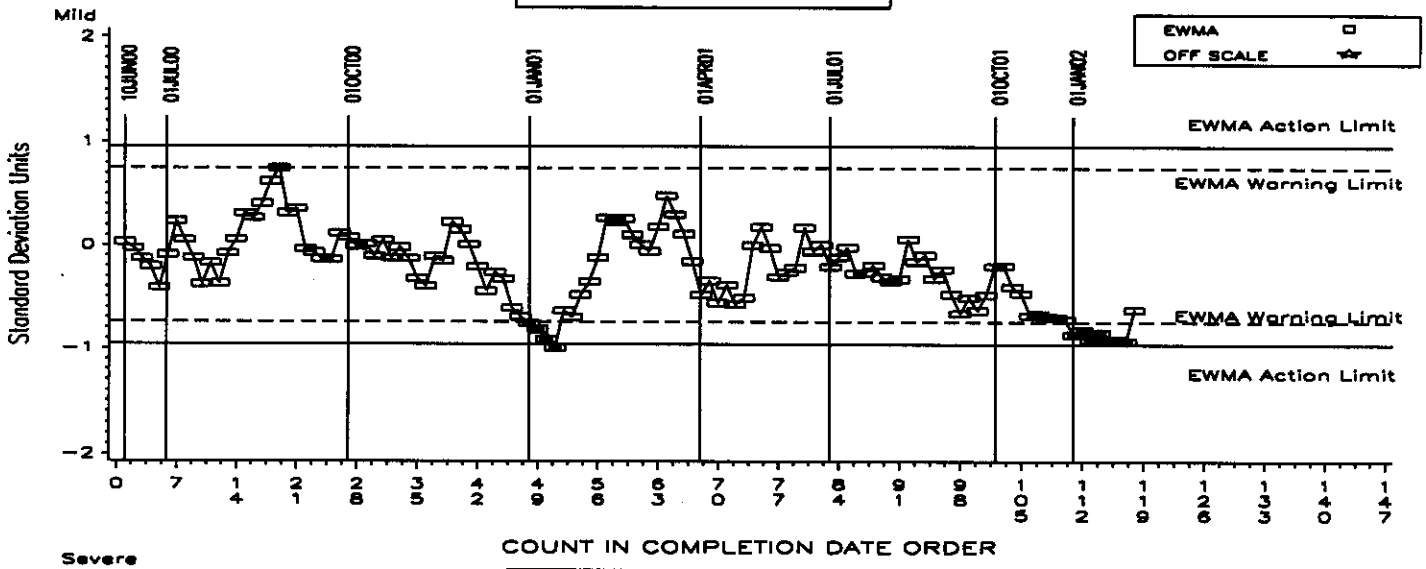
SEQUENCE IIIF INDUSTRY OPERATIONALLY VALID DATA

AVERAGE WEIGHTED PISTON DEPOSITS FNL ORIG UNIT RES

Attachment 3
Page 2
Reference

LTMS Severity Analysis



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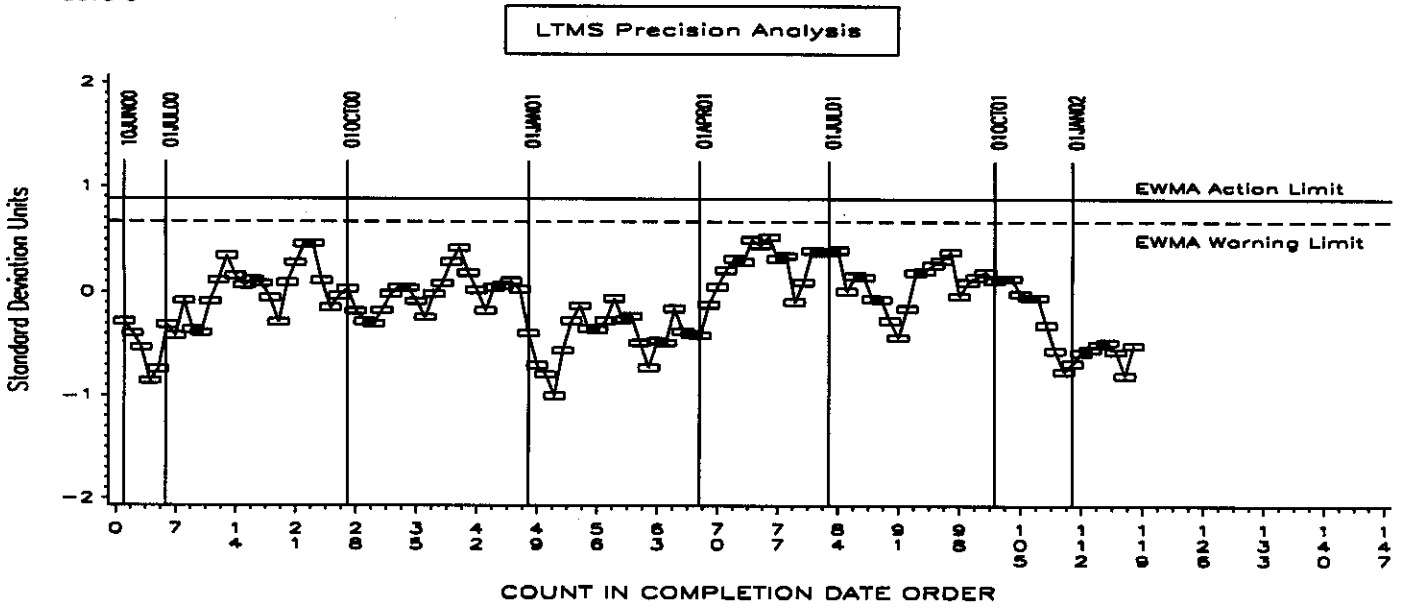

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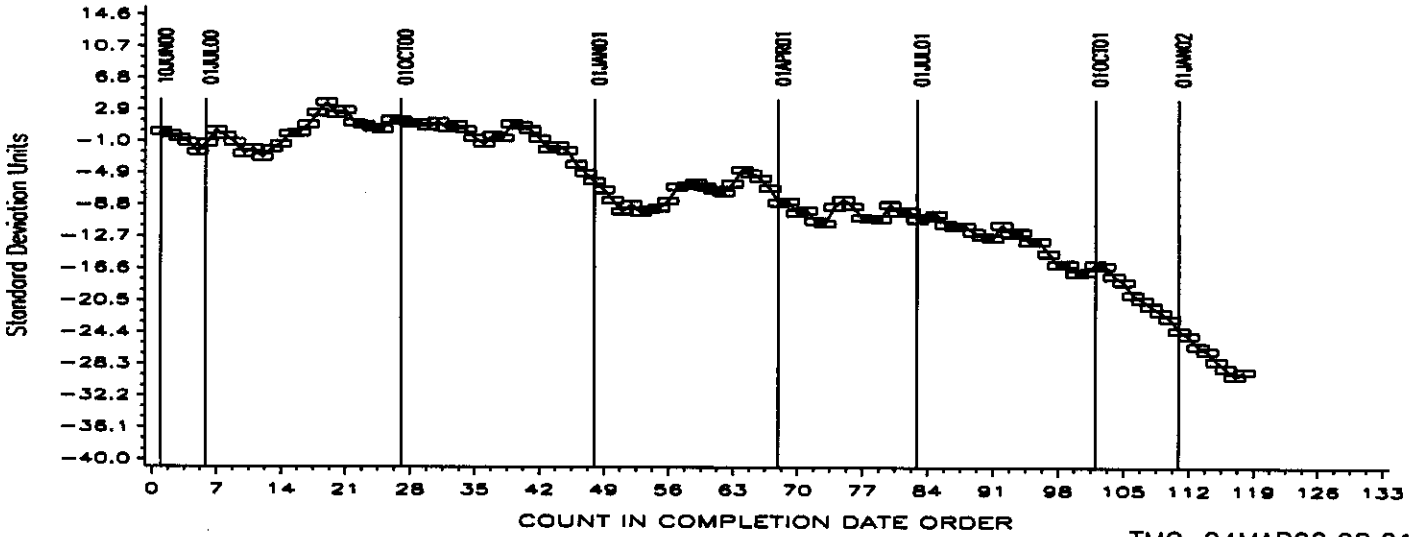

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SEQUENCE IIIF INDUSTRY OPERATIONALLY VALID DATA

AVERAGE PISTON SKIRT VARNISH FINAL ORIG UNIT RES

Attachment 3
Page 3
Reference

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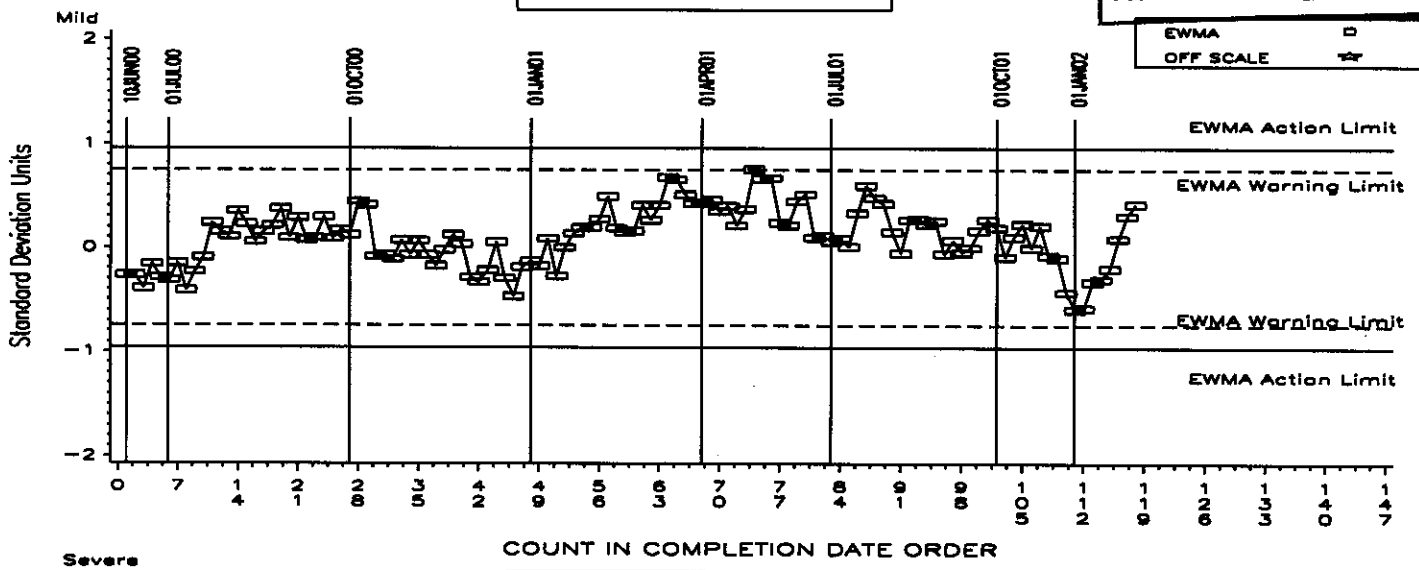

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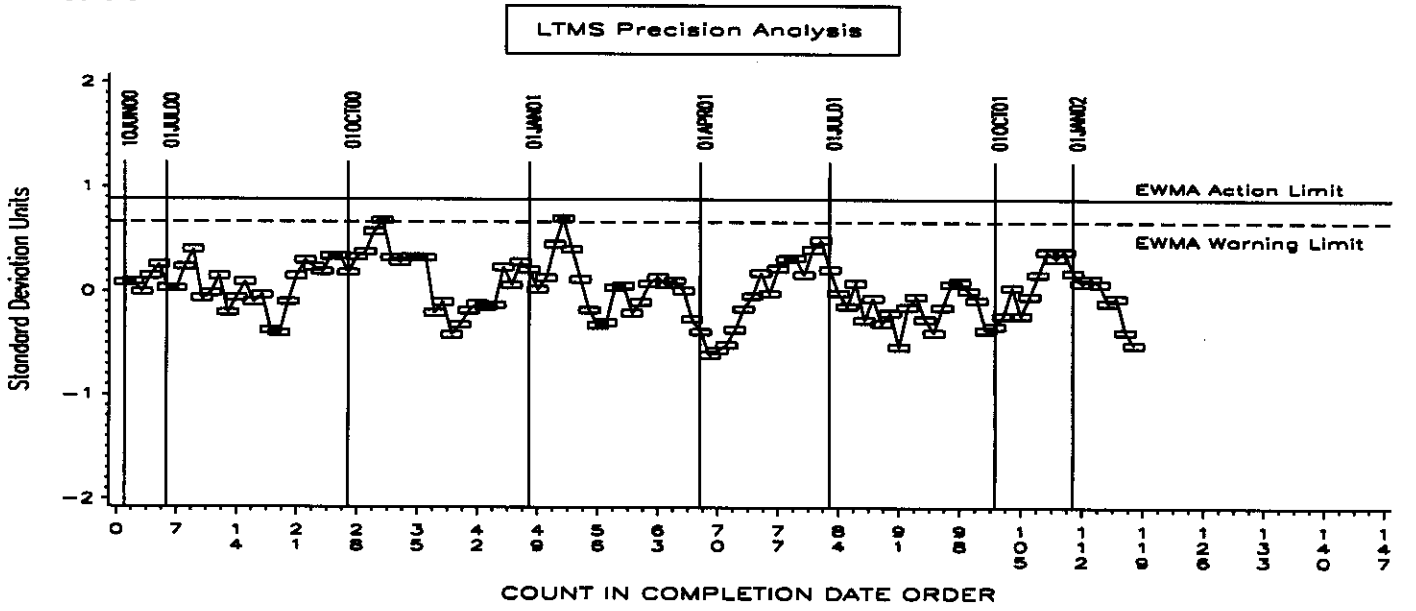

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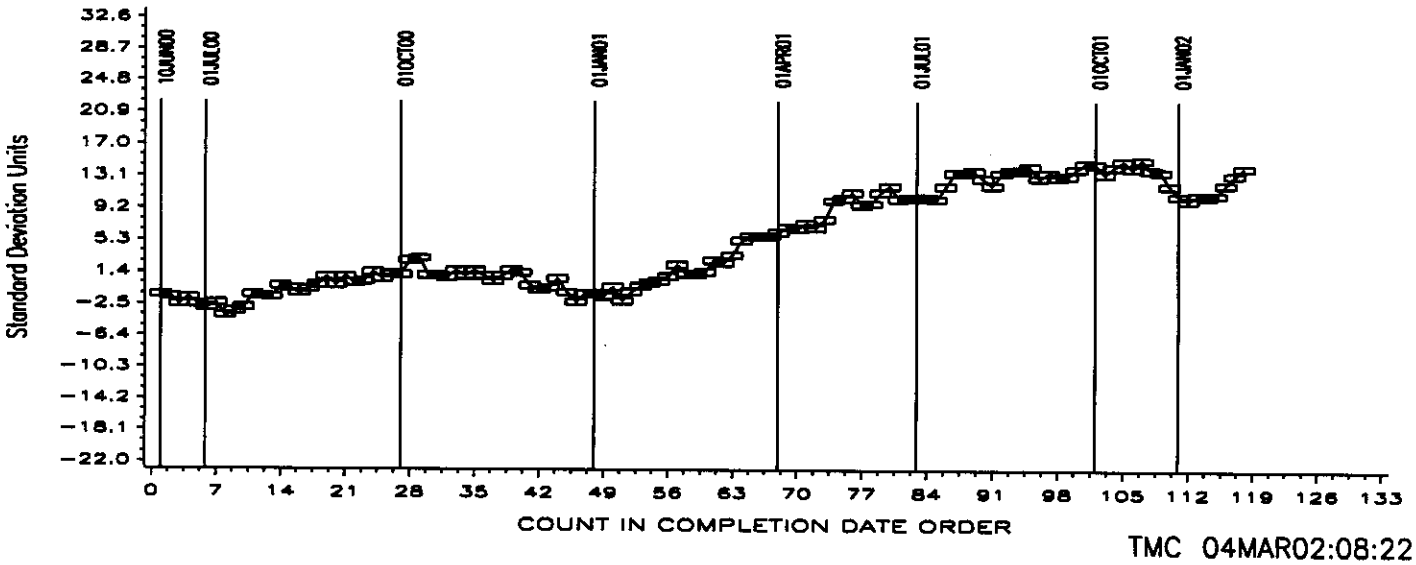

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SEQUENCE IIIF INDUSTRY OPERATIONALLY VALID DATA

% VISCOSITY INCREASE ● 060 HOURS

Attachment 3
Page 4
Reference

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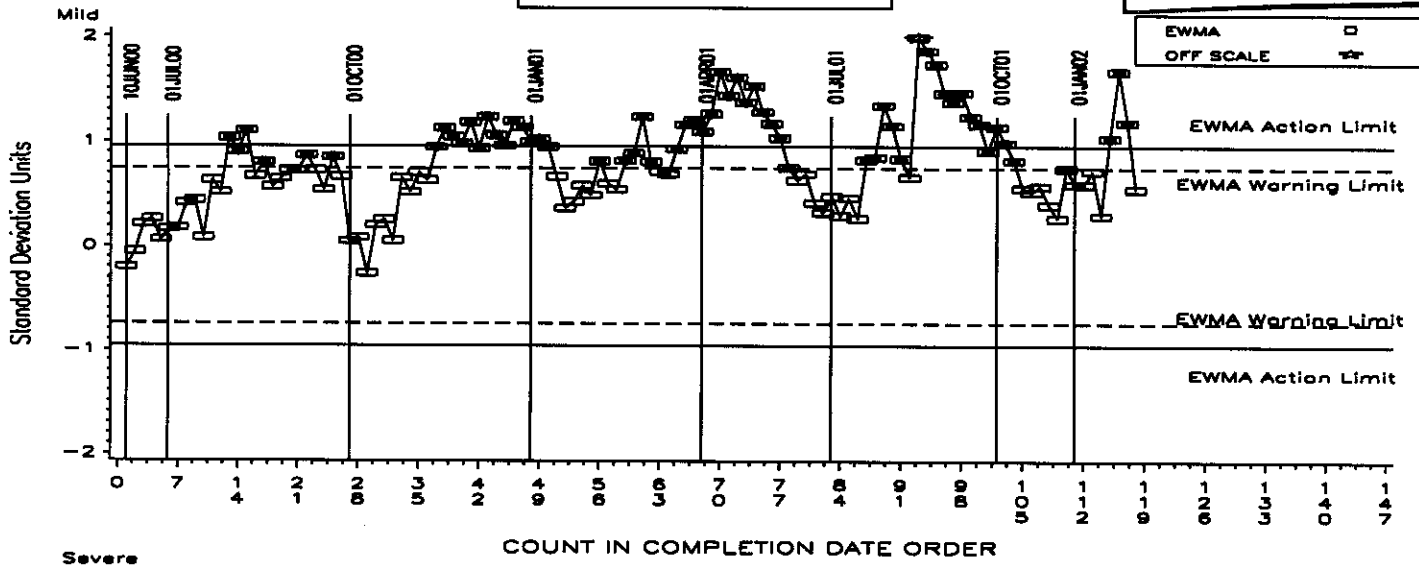

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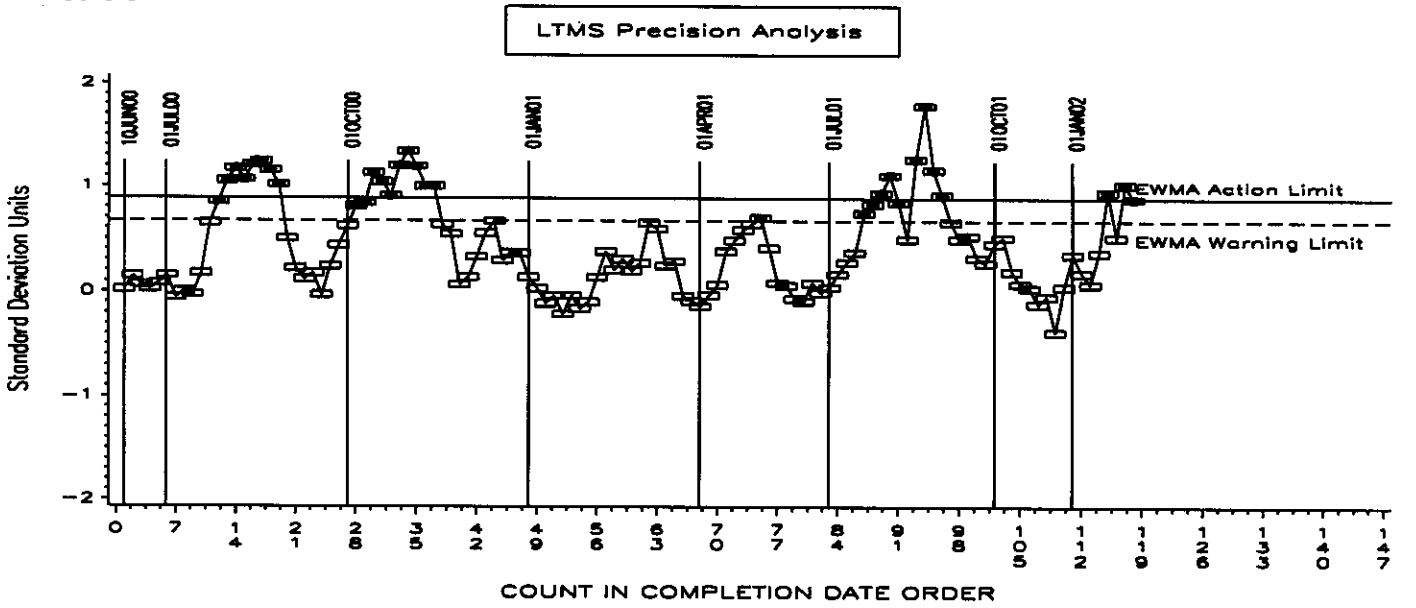

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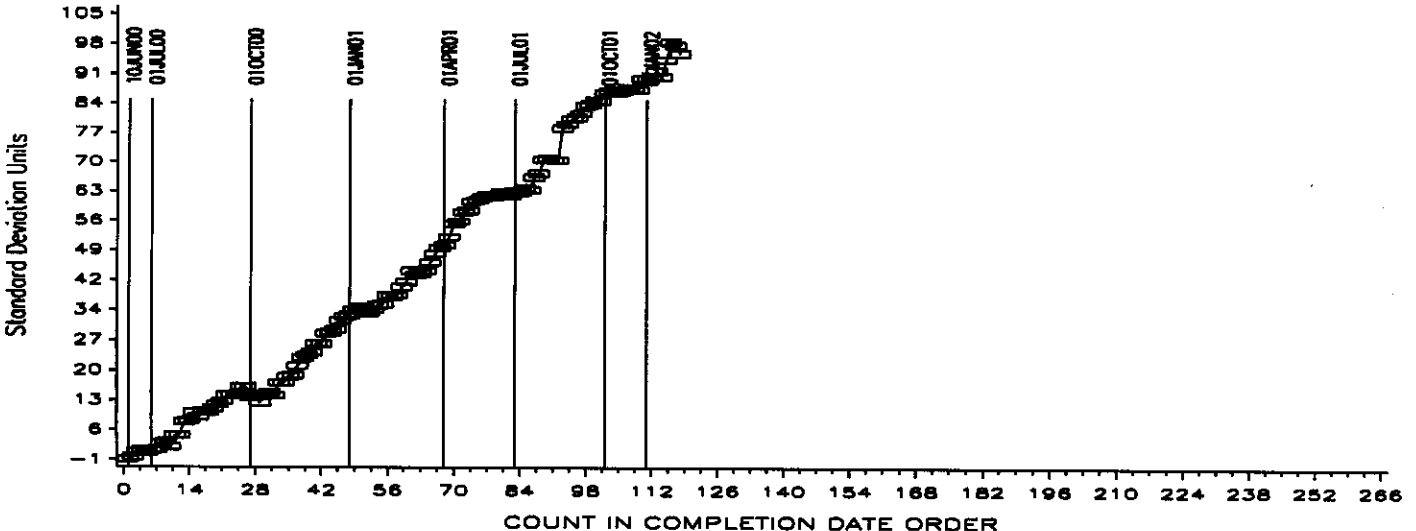

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Attachment	4
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Camshaft and Lifter Wear Study

Dwight H. Bowden
OH Technologies, Inc.
March 5, 2002

Attachment	4
Page	2
Reference	

Order of Presentation

- OHT 10/2002 Test Configuration and Results
- PerkinElmer Wear Screener Results - Charlie Leverett
- Southwest Research Wear Screener Results - Pat Lang
- OHT 2002 Test Configuration and Results

OHT 2001 Test Configuration

- Two tests, two Laboratories
- Unified engine build
- Test Oil = RO 433-1
- Lifter fill chamber w/ test oil
- All components assembled with test oil
- Bypass blocked in oil cooler and oil filter adapter (GM)
- IIIE/IIIF Oil Filter Adapter and IIIF Connector
- Racor 40 micron filter w/ remote oil filter adapter
- .1520" Thrust Plate and Cam Bolt Torque of 100 nm + 90 Degrees Torque

Attachment	4
Page	4
Reference	

OHT 2001 Test Results

	Test #1		Test #2	
Position	Cam	Lifter	Cam	Lifter
1	0	19	101	117
2	0	16	0	12
3	0	19	113	130
4	0	21	0	15
5	0	20	0	19
6	0	17	0	13
7	0	20	0	14
8	0	21	14	30
9	0	20	76	87
10	0	23	100	111
11	0	17	51	60
12	0	19	64	75
	ACLW = 19.3		ACLW = 56.9	
	SACLW = 19.3		SACLW = 54.1	

OHT 2001 Test Result Items

- Possible initial wear after engine start
- Plugged oil filter elements at approximately 40 hours (both tests)
- Possible engine block influence on wear (high wear correlation by position)

Attachment	4
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Reference	

PerkinElmer Screener Results

Southwest Research Screener Results

Purpose of 2002 Tests

- Validate that manganese phosphate coating eliminates initial/break-in wear failures at start
- Validate that manganese phosphate coating eliminates lobe wear and permits uniform, controlled (linear) lifter wear that is dependent on oil quality
- Validate OHT3F-081-1, Stud, Oil Cooler/Oil Filter Adapter

OHT 2002 Test Configuration

- Seven tests, two Laboratories
- Test Oil = .03 Phos, 1006-2, 433-1
- Test Lifter = ACI and Steel
- Lifter fill chamber w/ test oil
- All components assembled with test oil
- Bypass blocked in oil cooler
- Oil filter adapter (GM) bypass valve **not blocked**
- OHT3F-081-1, Stud w/ .500" ID
- PF-47 Oil Filter
- .1520" Thrust Plate and Cam Bolt Torque of 100nm + 90 Degrees Torque

Conclusions

- Camshafts and lifters (steel and ACI), either by design or batch, are not the root cause of random and unexpected wear
- Manganese phosphate coating eliminates initial, uncontrolled wear failures following engine start and allows for a controlled, linear lifter wear format
- Observed that steel lifters have uncontrolled wear using high load springs, manganese phosphate camshafts in GPS IIIF test configuration
- Oil filter plugging and possible engine block influence on wear performance identified in 2001 testing not addressed in this activity

Attachment	5
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Reference	

2002 OHT Sponsored Test Sequence and Results

Test	1	2	3	4	5	5 + 20 HRS	6	6 + 80 HRS	7	7 + 80 HRS
Laboratory	PE	PE	PE	SW	PE		PE		SW	
Oil	.03 Phos	.03 Phos	1006	.03 Phos	.03 Phos		433-1		1006-2	
Camshaft	IIIF Phos	IIIF Phos	IIIF Phos	IIIF Phos	IIIF Phos		IIIF Phos		IIIF Phos	
Lifter Type	ACI	ACI & Steel	Steel	ACI	ACI		ACI		ACI	
Spring Type	IIIF/Low	Production/High	Production/High	Production/High	Production/High		Production/High		Production/High	
Hours	80	80	73	80	80	100	80	160	80	160
Wear Results										TEST STOPPED AFTER 80 HRS
Lobe(s) Worn	0	8	12	0	0	0	0	4	11	
		Steel = 6 ACI = 2								
Lifter Wear, Max.	19	1275	1611	36	27	35	26	45	23	
		Steel = 1275 ACI = 104								
Lifter Wear, Min.	9	16	123	18	9	11	17	26	13	
		Steel = 76 ACI = 16								
ACLW	14	493	1283	24	17	21.8	21.3	36.08	24.08	
		Steel = 914 ACI = 72								
Screened Average Cam + Lifter Wear	14.5	388.8	1268	23.4	16.7	21.6	21.3	36	24.3	
Screened Average Cam + Lifter Wear (Avg. Of 4)		Steel = 763 ACI = 27								

Wear by Position	Cam	Lifter	Cam	Lifter	Cam	Lifter	Cam	Lifter	Cam	Lifter	Cam	Lifter	Cam	Lifter	Cam	Lifter	Cam	Lifter	Cam	Lifter
1	0	17	272	38	622	1600	0	18	0	27	0	35	0	17	2	35	3	18		
2	0	12	1	28	548	1611	0	20	0	19	0	24	0	19	1	30	3	19		
3	0	15	***738***	***1275***	654	453	0	26	0	22	0	25	0	22	3	44	6	23		
4	0	18	0	31	800	161	0	28	0	23	0	27	0	26	0	45	6	22		
5	0	17	***505***	***104***	1231	447	0	25	0	20	0	26	0	23	0	33	4	23		
6	0	14	0	26	488	359	0	20	0	10	0	14	0	19	0	26	5	16		
7	0	14	***844***	***580***	700	1092	0	20	0	9	0	11	0	20	0	30	0	21		
8	0	19	0	22	298	192	0	36	0	17	0	26	0	23	0	43	8	23		
9	0	12	0	16	1010	186	0	27	0	14	0	17	0	23	0	37	5	19		
10	0	11	***327***	***96***	577	306	0	22	0	16	0	22	0	19	0	30	2	13		
11	0	9	***482***	***114***	936	131	0	21	0	11	0	15	0	23	0	32	3	18		
12	0	15	***342***	***76***	867	123	0	25	0	15	0	20	0	22	3	39	8	21		
			Denotes Steel Lifter Positions																	
AVERAGE OIL SUMP TEMPERATURE, DEGREES C	161.7		162.4		162.8		161.2		162.4				SEE ATTACHED PLOT				163			

Attachment	G
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Reference	

IIIF Wear Experiments

Experiment #	1	2A	3B	4C	5D	6E	7F	9	9A	11	11A	12	12A
Thrust Washer	1530	1520	1520	1520	1520	1520	1530	1520	1520	1520	1520	1520	1520
Cam ID	MB	MB	MB	MB	MB	MK	MK	MK	Phos MK	MK	Phos MK	MK	Phos MK
C & L Lube	Test Oil	EF-411	EF-411	SAE 30W	SAE 30W	SAE 30W	EF-411	EOS	EF-411	Vaseline	EF-411	Test Oil	Test Oil
Cool Flush	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No
Run Time	10 min.	10 Min.	10 Min.	10 Min.	4 Min.	10 Min.	10 Min.	10 Min.	10 Min.	10 Min.	10 Min.	10 Min.	10 Min.
Avg C & L Wear	68.5	0	47.5	393	42.4	522	168.8	0	0	456	0	33.83	0
Failed Lobes	5	0	2	11	2	12	8	0	0	11	0	1	0
Fe 3 minutes	N/A	N/A	N/A	21 ppm	3 ppm	27 ppm	24 ppm	4 ppm	7 ppm	37 ppm	7 ppm	2 ppm	5 ppm
Fe 9 minutes	19 ppm	4 ppm	6 ppm	66 ppm	N/A	62 ppm	44 ppm	5 ppm	6 ppm	60 ppm	9 ppm	10 ppm	5 ppm
Note #					1	2		3		4	5	6	6

Notes:
1. Safety shutdow occurred 4 minutes into timing run.
2. Pumped up lifters in vacuum chamber
3. EOS is a GM new engine break-in product
4. Run in different stand
5. Phosphate cam used had 6 minute dip
6. Test Oil Changed to 0.03 Phos 5W 30.

Attachment	7
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SwRI IIIF/IIIG Wear Screener

Cam Lobe Wear Only

Run Number		1	2	3	4	5	6	7
Engine Operation		10 minute run	5 Sec cranking	Ramp to 2000 rpm	10 minute run	Manual rotation	10 minute run	Repeat of test 6
Camshaft ID		MK-1225	***MK-1234***	***MK-1234***	***MK-1234***	MK-1278	MK-1212	MK-1505
Test Oil *		~~5W-20~~	~~5W-20~~	~~5W-20~~	~~5W-20~~	~~5W-20~~	15W-40	15W-40
Cam/lifter pre-lube		test oil	test oil	test oil	test oil	test oil	test oil	test oil
Notes		A	B	C	D	E	F	G
Cam Lobe	Springs							
1	180	0	0	0	0	0	0	0
2	180	0	0	0	0	0	0	0
3	180	230	0	0*	379	0	0	0
4	205	266	0	0	405	0	374	0
5	205	232	0	0	0	339	0	0
6	180	0	0	0	0	0	0	0
7	205	157	0	0	181	260	0	0
8	205	0	0	0	388	587	0	0
9	180	192	0	0	147	0	0	0
10	205	360	0	0	235	0	0	0
11	205	162	0	0	515	405	409	0
12	180	0	0	0	0	0	0	0

Notes:

A) Ran 10 minute timing run (baseline with this oil).
B) Engine cranked by air starter at 400 RPM for 5 seconds.
C) Using the same cam as test 2, engine started, ramped to 2000 RPM then was shut down immediately.
D) Using the same cam/lifters that were used in tests 2 and 3, the engine was started and run 10 minutes.
E) New cam/lifters, engine rotated manually 30 revolutions w/valve train assembled, lifters removed and lubed with test oil again, put back in the engine and rotated another 30 revolutions. Engine was then started and run 10 minutes.
F) Switched to a 15W-40 HD reference oil to understand if there is an SAE viscosity grade influence.
G) Run to see if test number 6 would repeat.
Max lifter wear from all tests was 4 micrometers.
* Lobe and lifter showed a visual indication of some distress

* All "5W-20" tests in chart actually run with a [~~0.03 Phos 5W-30 engine oil~~] 5W-20 candidate oil that a customer supplied.

PML 2/20/02

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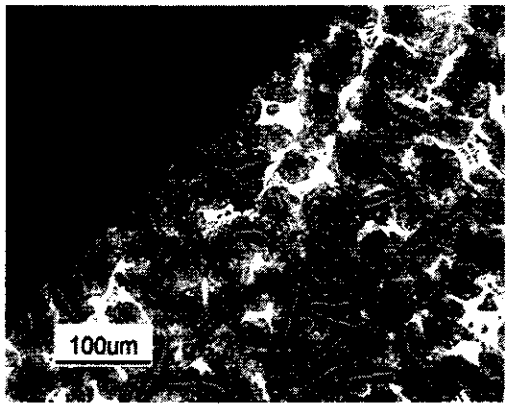
Sequence IIIG Development (Data Presented at the Sequence IIIF Meeting 03/05/02)

Lab/Run#	Viscosity	Test Oil	Spring Load	Fe @ Initial	% Vis. Inc.	Avg. Wear	WPD	PSV	Oil Cons.	Comments:
SR/01	5W-30	433-1	180	21	6467	132	2.21	7.87	4.43	High B/B .042/.038 ring gap EF-411 build 180lb. Springs
SR/02	5W-30	433-1	180	4	287	28	2.62	7.96	3.85	.025/.042 ring gap - Test oil build - 180lb. springs
PE/01	5W-30	433-1	180	5	130	37	2.82	8.32	4.09	.025/.042 ring gap - Test oil build - 180lb. springs
SR/03	5W-30	403 Reformulated	180	4	TVTM	14	1.6	8.2	TVTM	.025/.042 ring gap - Test oil build - 180lb. springs
SR/04	5W-30	1006 Reformulated	180	6	1077	27	2.36	8.62	3.61 @ 80h	.025/.042 ring gap - Test oil build - 180lb. springs
SR/05	5W-30	0.03 Phos.	180	17	105	105	3.92	8.4	3.74	.025/.042 ring gap - Test oil build - 180lb. springs
SR/06	5W-30	0.03 Phos.	180	16	156	267	2.85	7.79	3.7	.025/.042 ring gap - Test oil build - 180lb. springs
PE/02	5W-30	0.05 Phos.	180	3	130	26	3.16	8.69	3.78	.025/.042 ring gap - Test oil build - 180lb. springs
PE/03	5W-30	0.05 Phos.	205	19	133	153	3.32	8.52	3.99	.025/.042 ring gap - Test oil build - 205lb. springs
PE/04	5W-30	0.095 Phos.	205	4	176	16	3.23	8.84	4.55	.025/.042 ring gap - Test oil build - 205lb. springs
SR/07	0W-30	GM-1	205	5	106	57	4.64	9.17	2.71	.025/.042 ring gap - Test oil build - 205lb. springs
PE/05	5W-20	Proto-type GF-4	205	5	110	53	2.64	7.52	4.47 @ 77.8h	EOT @ 77.8 h. Low Oil Level / Lifter Collapse
PE/06	5W-20	GF-3	205	29	149	337	2.16	7.18	4.66 @ 76.8h	EOT @ 76.8 h. Low Oil Level / Lifter Collapse
SR/08	5W-20	GF-3	205	42	587	270	2.52	7.53	4.63	.025/.042 ring gap - Test oil build - 205lb. springs
PE/07	5W-30	0.03 Phos.	205	1	5601	483	2.52	8.76	4.98	EOS Initial run-in (3F engine w/5W-20) then 100H 3G
SR09	5W-30	0.03 Phos.	205	4	293	49.6	3.27	8.48	4.12	Oiling Bar

Sequence III Camshaft Metallography Study



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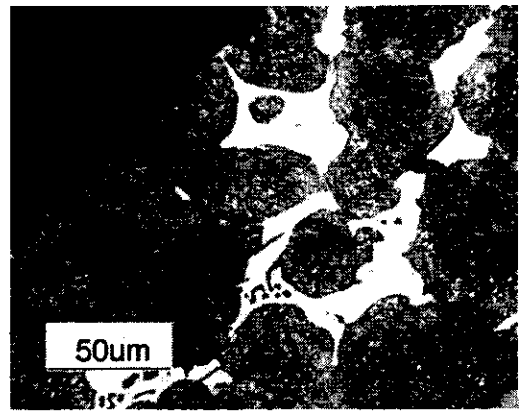
Sequence III Camshaft Metallography Study



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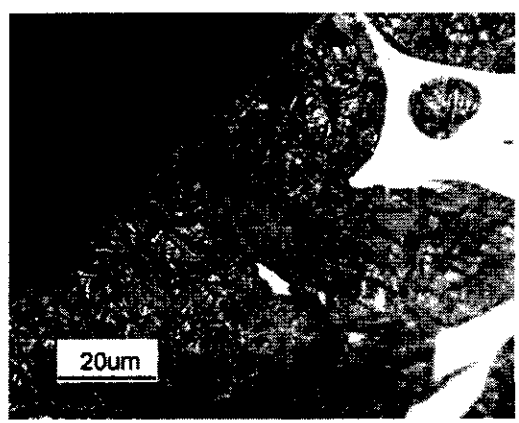

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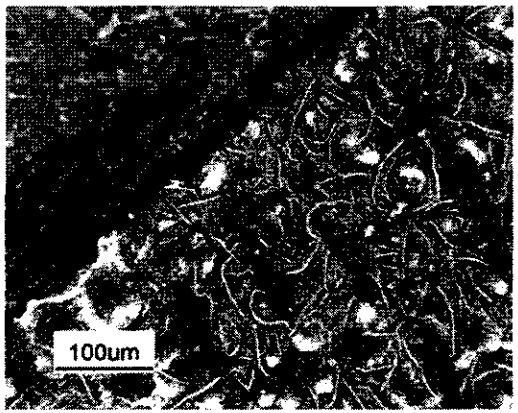
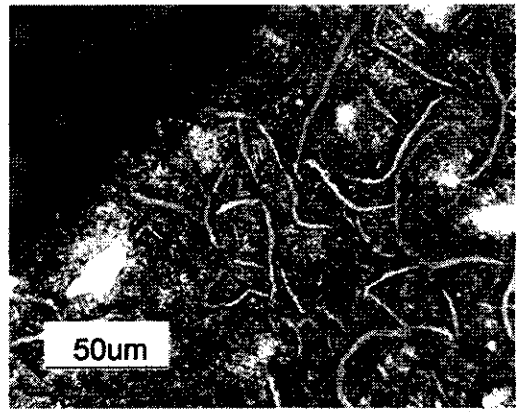
Attachment 9
Page Reference 1

Sequence III Camshaft Metallography Study



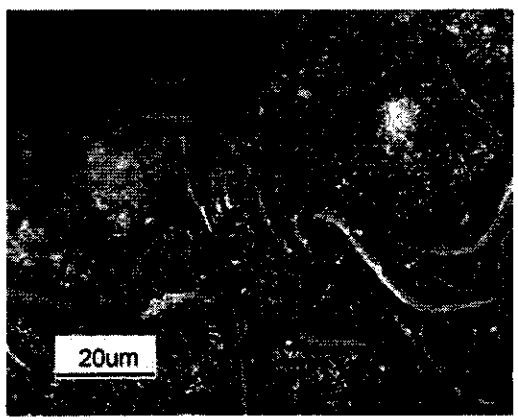
MB @ 200X

Sequence III Camshaft Metallography Study



MB @ 500X

Sequence III Camshaft Metallography Study



MB @ 1000X

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Suggested items for a IIIG Design of Experiments/Matrix

1. IIIG spring loading (205#) with Phosphated camshaft
2. Preconditioned Test Components using EOS/Test Rig/Variable spring rates
3. Oiling Bar
4. Higher carbide camshafts
5. Special High Load Springs (> 205#) with phosphated camshaft
6. define a 0.03%P reference oil
7. steel lifters
8. new OHT 1 piece oil filter adapter
9. oiling bar thru the first hour
10. run both ends of the spectrum for parameters or parts or conditions (Ying/Yang)
11. oil cooler configuration
12. alternative additive chemistry/level
13. filter type and size
14. flying flush with a break-in oil
15. additional wear measurements
16. Use of IIIF or IIIG?

Operations and Hardware Subpanel Update

A) Part replacement guidelines when experiencing oil temperature control problems in an IIIF test.

1) Procedure does not address whether or not the oil filter and cooler are allowed to be changed out during an IIIF test.

2) Currently have two scenarios that are associated with loss of oil temperature control:

    a) Oil pressure differential across the oil filter is high enough that the system goes into bypass (typically associated with high cam/lifter wear).
    b) Loss of oil temperature control when there is not a sufficient differential oil pressure across the oil filter. This is an unknown area that is currently under investigation.

A conference call was held on February 5, 2002, participants were Bill Nahumck, Jason Bowden, Adam Bowden, Charlie Leverett, Sid Clark, Dave Glaenzer and Pat Lang. After a lengthy discussion, the following recommendation was requested to be presented to the Sequence IIIF Surveillance Panel:

***RECOMMENDATION*:**

During the operation of a Sequence IIIF test, it is allowable to change out the oil cooler and oil filter one time. The guidelines for the change are as follows:

A) The oil filter differential pressure is at least 100 kPa. or oil temperature control is lost and you have confirmed that the rest of your oil temperature control circuit is operating properly.
B) The replacement can only be done during one shut down session, i.e., if you only replace one of the two components during a shut down, you can't shut it down later to change the other.
C) Pour the oil from the old filter into the new filter.
D) No new test oil can be added.
E) Document in the comment section of the test report that the change was made.

B) O&H Is Further Investigating Oil Bypass In The IIIF Engine

1) Some work has been done on measuring oil temperature and pressure at a different location in the oil circuit to help understand the effects of oil bypass in the IIIF engine.
2) Data has been generated to study the OHT3F-081-1 one-piece oil filter adapter (see plots).

C) Variations in the Kundinger Fluid Control Rack.

1) A conference call took place on January 24, 2002 discussing how to handle the current variations in the Kundinger Fluid Conditioning Rack.

The group agreed on the following:

A) The module would be specified by performance, not specific components.
B) A schematic will be put into the test procedure to define the general configuration (shape and size) of the fluid conditioning rack.
C) The procedure will state combinations of valves, positioners and meters that have proven to work but are not necessarily required. This will allow a non-experienced laboratory to get an indication on what brand components that have been proven to work.
D) Laboratories will need to prove performance of components that are substituted for the originals.

D) Procedural Review Task Force

The Test Monitoring Center and Test Developer have been busy incorporating the procedural changes that were approved at the November meeting.

a) The TMC sent out Memorandum 02-011, dated February 28, 2002 informing the industry that the approved revisions have been incorporated into the IIIF Engine Assembly Manual.

b) The TMC issued Information Letter 02-1, dated March 1, 2002 stating that Draft 4 of the IIIF procedure incorporated the approved procedural changes and is now available on the TMC website.

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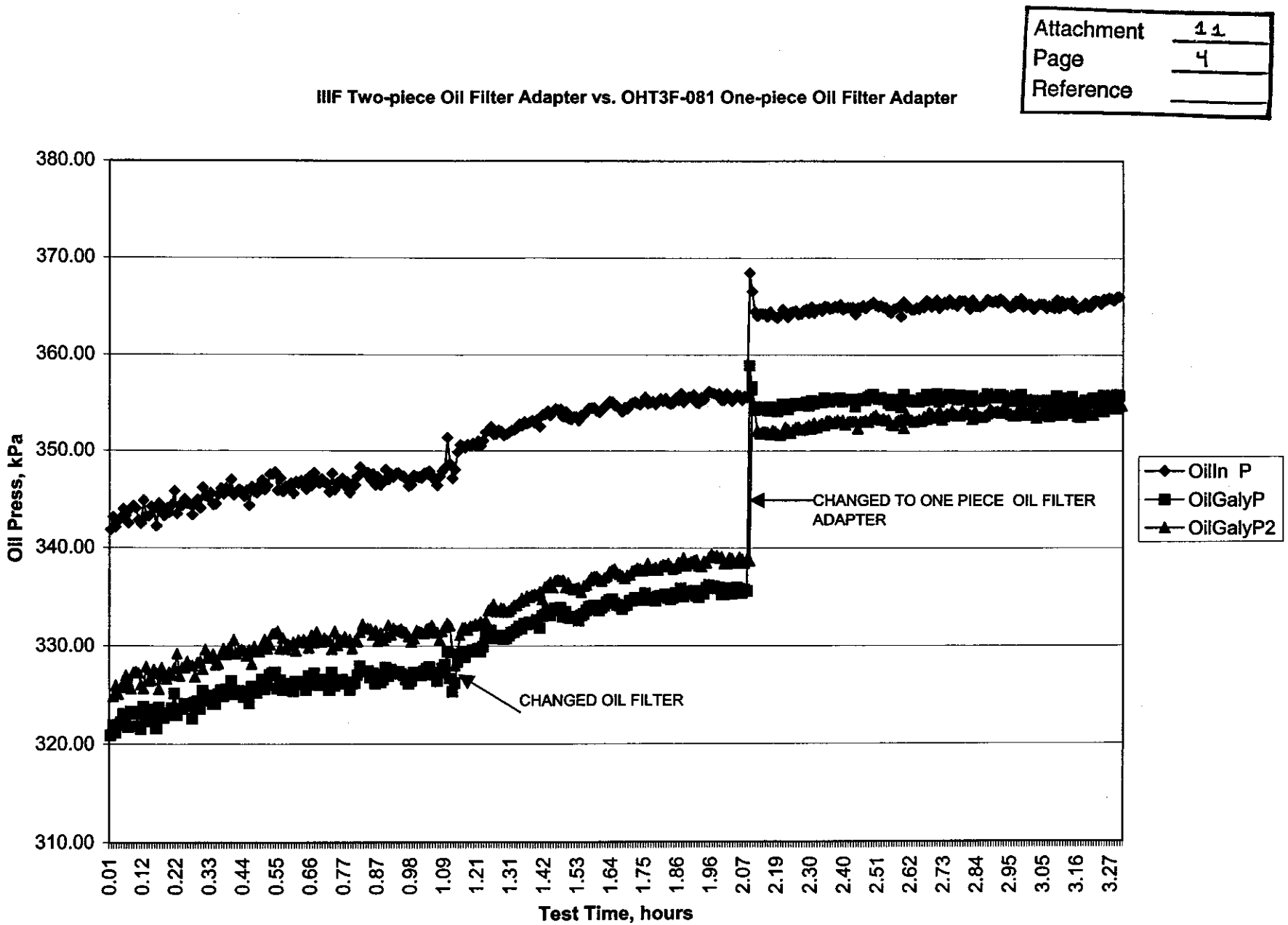
Reference	



SwRI February, 2002

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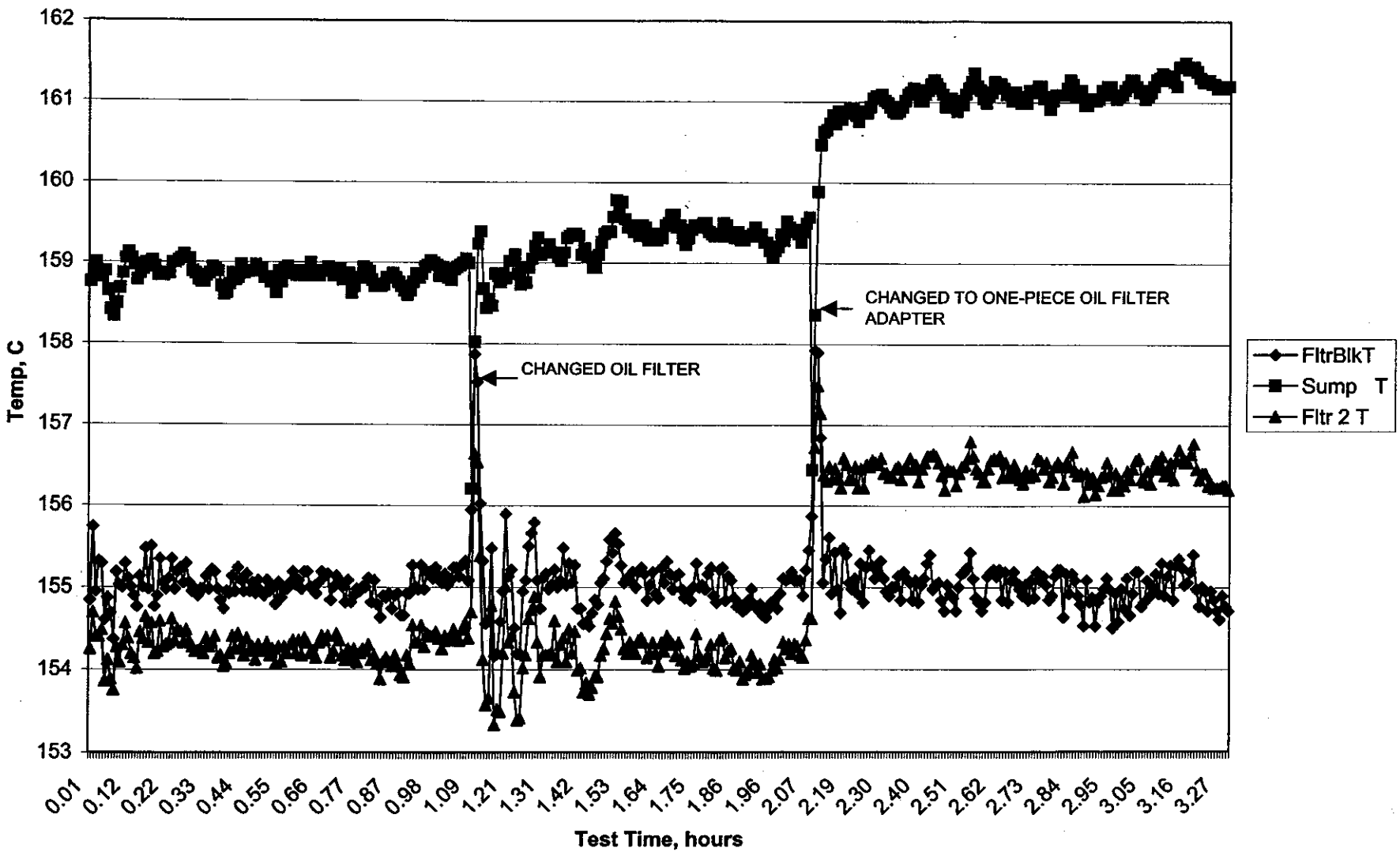
IIIF Two-piece Oil Filter Adapter vs. OHT3F-081 One-piece Oil Filter Adapter



SwRI February, 2002

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CENTRAL PARTS DISTRIBUTOR REPORT
OH Technologies, Inc.

Sequence IIIF Surveillance Panel Meeting

San Antonio, Texas

March 5, 2002

1.) Rejections from 10/20/2001 to 02/27/2002:

Camshaft / 28 Pieces

Pitted Lobes / 7 Pieces
Scratched, Nicked Lobes / 14 Pieces
Thread Condition / 2 Pieces
Journal Size / 2 Pieces
Thrust Surface Condition / 2 Pieces
Defective Grind / 1 Piece

Material replaced

2.) Technical Memos Issued

Technical Memo 6, Dated 11/20/01

Revised Part Numbers, Modified Oil Coolers and Camshaft Thrust Plates

Camshaft Serialization

3.) Batch Code Changes

Piston Rings Batch Code 8 (Grades 12, 34 & 56)

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Date: 20 Nov 01

To: ASTM Sequence IIIF Testing Laboratories

From: Dwight H. Bowden / OH Technologies, Inc.

Re: IIIF CPD Technical Memo 6
Revised Part Numbers, Modified Oil Coolers and Camshaft Thrust Plates
Camshaft Serialization (MB & MK)

Cc: Mr. Sid Clark / General Motors Powertrain
Mr. Michael Kasimirsky / Test Monitoring Center

Revised Part Numbers, Modified Oil Coolers and Camshaft Thrust Plates

1.) Please be advised of the following new part numbers:

OHT3F-030-2 Cooler, Oil, Modified (Bypass closed)
OHT3F-011-2 Plate, Camshaft Thrust, .1520"

Camshaft Serialization

2.) The MB cam batch represented an approximate total cast or pour of 1500 pieces. This pour of cams was machined in two lots of approximately 750 each, the last lot taken to completion in October 2001.

In error, the cam supplier serialized the second machine lot with the letter designation of MK.

MB and MK camshafts are from the same casting lot.

If there are any questions or comments regarding the aforementioned item, please do not hesitate to call.

THE ASTM SEQUENCE IIIF SURVEILLANCE PANEL

SCOPE & OBJECTIVES

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SCOPE

The Sequence IIIF Surveillance Panel is responsible for the surveillance and continual improvement of the Sequence IIIF test documented in ASTM Standard DNNNN-XX as update by the Information Letter System. Data on test precision and laboratory versus field correlation will be solicited and evaluated at least every six (6) months. The Surveillance Panel is to provide continual improvement of rating techniques, test operation, test monitoring and test validation through communication with the Test Sponsor, ASTM Test Monitoring Center, Operations and Hardware Subpanel, the Central Parts Distributor, ASTM B0.01 Passenger Car Engine Oil Classification Panel, ASTM Light Duty Rating Task Force, ASTM Committee B0.01, CMA Monitoring Agency and CRC Motor Rating Methods Group. Actions to improve the process will be recommended when appropriate based on input to the Surveillance Panel from one or more of the previously stated groups. Develop updated test procedures when necessary and review the correlation with previous test procedures. This process will provide the best possible Sequence III Type Test Procedure for evaluating automotive lubricant performance with respect to the lubricant's ability to prevent oil thickening, varnish formation, oil consumption and engine wear.

OBJECTIVES	TARGET DATE
1. Identify a 15W-40 HDD, CH-4 oil for the IIIF reference system	On hold
2. Assembly Manual Revision System	March 2002
3. Control System Clarification	May 2002
4. Issue Draft 4 of the Sequence IIIF Test Method	March 2002
5. Resolution of the unexplained, random wear in the IIIF Test Method	March 2002
6. Revise the IIIF Test Method for elevation to ASTM Standard	March 2002
7. Develop the IIIG test for inclusion in the ILSAC GF-4 Specification	July 2002
8. Introduction of the GF-3 Category Reference Oil	May 2002
9. Evaluate and Introduce a Revised Oil Cooling System	May 2002

William M. Nahumck, Chairman
Sequence IIIF Surveillance Panel

Updated March 5, 2002
San Antonio, Texas

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Action Items and Motions

Date: 3/5/02

Motions:

1. Motion #1: Dwight Bowden / Pat Lang. Accept minutes from November 15, 2001. PASSED

2. Motion #2: Bill / Pat. Accept changes to IIIFHD report and procedure. PASSED

3. Motion #3: Charlie Leverett / Carl Stephens – Given the knowledge that a .08 phos. limit for oil is in place for the GF-3 and there is no VE test available. Introduce the phosphate-coated camshaft into the IIIF test. Introduce them with the next reference oil test after the laboratory receives the material. The phosphate camshaft is nothing more than the current IIIF camshaft with Manganese Phosphate coating. The supplier will keep all proper documentation with regards to this camshaft. 9-1-1

   This motion will be preballotted. Labs will provide any data obtained to GM.

4. Motion #4: Charlie / Carl. During the operation of the Sequence IIIF test, it is allowable to change out the oil cooler and oil filter one time. The guidelines for the change are as follows:
   A.) The oil filter differential pressure is at least kPa. Or oil temperature control is lost and you have confirmed that the rest of your oil temperature control circuit is operating properly.
   B.) The replacement can only be done during one shut down session, i.e., if you only replace one of the two components during the shut down, you can't shut it down later to change the other.
   C.) Pour the oil form the old filter into the new filter.
   D.) No new test oil can be added.
   E.) Document in the comment section that the change was made.
   Effective date 3/5/02. PASSED

Action Items

Action #1: TMC and Bill Nahumck will make changes to the IIIFHD Report forms and Procedure.

Action Item #2: O&H will investigate the oil and temp control system including the OHT3F-081-1 one-piece oil filter adapter fitting. Get sump temperature data from OHT 7 tests.

Action Item # 3: O&H Panel will continue deriving solutions to the variations in the Kundinger Fluid Control Racks.