100 Barr Harbor Drive ■ PO Box C700 ■ West Conshohocken, PA 19428-2959
Telephone: 610-832-9500 ■ Fax: 610-832-9555 ■ e-mail: service@astm.org ■ Website: www.astm.org

Committee D02 on PETROLEUM PRODUCTS AND LUBRICANTS

Chairman: W. JAMES BOVER, ExxonMobil Biomedical Sciences Inc, 1545 Route 22 East, PO Box 971, Annandale, NJ 08801-0971, (908) 730-1048, FAX: 908-730-1197, EMail: wjbover@erenj.com
First Vice Chairman: KENNETH O. HENDERSON, Cannon Instrument Co, PO Box 16, State College, PA 16804, (814) 353-8000, Ext: 0265, FAX: 814-353-8007, EMail: kenohenderson@worldnet.att.net
Second Vice Chairman: SALVATORE J. RAND, 221 Flamingo Drive, Fort Myers, FL 33908, (941) 481-4729, FAX: 941-481-4729
Secretary: MICHAEL A. COLLIER, Petroleum Analyzer Co LP, PO Box 206, Wilmington, IL 60481, (815) 458-0216, FAX: 815-458-0217, EMail: macvarlen@aol.com
Assistant Secretary: JANET L. LANE, ExxonMobil Research and Engineering, 600 Billingsport Rd, PO Box 480, Paulsboro, NJ 08066-0480, (856) 224-3302, FAX: 856-224-3616, EMail: janet_l_lane@email.mobil.com
Staff Manager: DAVID R. BRADLEY, (610) 832-9681, EMail: dbradley@astm.org

September 12, 2001

Reply to: Donald Lind
ASTM Test Monitoring Center
6555 Penn Avenue
Pittsburgh, PA 15206
Phone: 412-365-1034
Fax: 412-365-1047
Email: dml@tmc.astm.cmri.cmu.edu

Unapproved Minutes of the May 24, 2001 Sequence IVA Surveillance Panel Meeting Held in San Antonio, Texas

The meeting was called to order at 1:00 pm by Chairman Larry Bendele. A membership list was circulated for members and guests to sign in. It's shown in Attachment 1.

Membership Changes

Dave Glaenzer replaces Daryl Baumgartner as the Ethyl Corporation member.
Bob Rumford replaces Gil Clark as the Halterman Products member.
Barry Jecewski replaces Mike Riley as the Ford Motor Company member.

Agenda Review

Ben Weber is the new Action and Motion recorder.
Don Lind is the new Secretary.
The Agenda was accepted as attached (Attachment 2).
TGC report has been attached to the meeting minutes for review (Attachment 3).

Sequence IVA Surveillance Panel Meeting
May 24, 2001 San Antonio, TX

Meeting Minutes Status

November 15, 2000 Approved.

Review of Action Items From November 15, 2000 Meeting

Chairman Bendele presented and reviewed a list of action items from the November 15, 2000 meeting. (Attachment 4).

RSI Report

Rick Oliver from RSI presented the candidate severity and precision data for the report period October 1, 2000 through March 31, 2001 (Attachment 5). Note, RSI website URL has changed to http://www.registration-systems.com Username: acc Password rsi999.

TMC Reference Oil Report

TMC report can be found on the TMC ftp site.
ftp://tmc.astm.cmri.cmu.edu/docs/gas/sequenceiva/semiannualreports/

Mike Kasimirsky of the TMC presented the Semiannual Report for the test period of October 1, 2000 through March 31, 2001 (Attachment 6). Mike indicated that the industry began the period in a precision alarm and has been in and out of a precision alarm condition for much of the period. Severity, on the other hand, was within limits for much of the period however, when precision returned to within limits, the industry then experienced a severity alarm of six data points in the severe direction.

Mike stated that he has investigated the industry data set in an effort to determine a cause for the erratic wear results. The data was examined for differences in fuel batch, camshaft lot, cylinder head lot, rocker arm lot, laboratory, stand, as well as various interactions of these factors. The used oil analysis results for fuel dilution, copper content, and iron content were also examined for effects on ACW performance. The analysis showed no differences between fuel batches, camshaft lots, head lots, or rocker arm lots at a 95% confidence level. Analyzing the data for interactions between the three hardware categories also showed no significant differences between the various combinations. To date, no explanation for the wear anomalies have been found at this time. TheTMC report accepted.
(Motion 3)
(Motioner: Mike Kasimirsky, seconded by Carl Stephens).

Review Reference Oil 1006 Statistics

Larry Bendele made a presentation for revising reference oil 1006 test targets (Attachment 7). Chairman Bendele had also asked the TMC to prepare some possible target revisions based upon the LTMS data for consideration by the panel. Some possible targets, along with the current test targets, are shown in Table G, of the TMC report.

There was some discussion of using a statistical outlier test to remove the outlier data from the LTMS data set and then generate test targets from the resultant data set. Screening the LTMS data using this criteria results in one data point being excluded from the calculation.

Phil Scinto suggested that the test targets be based on rare event screened data and a lab pooled standard deviation. The panel agreed to revise reference oil 1006 test targets using a mean of 121.76 and a standard deviation of 12.5 based on the rare event screened data and a lab pooled standard deviation. This standard deviation will also be used for severity adjustment calculations.
(Motion 4)
(Motioner: Gordon Farnsworth, seconded by Bill Buscher, III).

The panel also discussed the re-blend of reference 1006. After some discussion the panel agreed to introduce the re-blend of 1006 using the test targets just approved with the previous motion until 10 tests are completed on the re-blend. Once 10 tests are completed new test targets will be generated. Further targets will be updated at 20 and 30 tests pending surveillance panel approval.
(Motion 5)
(Motioner: Dave Glaenzer, seconded by Gordon Farnsworth).

Review Test Program to Implement Additional Reference Oil 1007

Reintroduction of reference oil 1007 was a topic for discussion at the last meeting and the TMC was tasked with examining the available data on that oil and suggesting some possible test targets. Those proposals were issued to the Surveillance Panel in TMC Memorandum 01-004, issued on January 9, 2001.

After reviewing the data Phil Scinto suggested that the panel had three options. One option was to screen the "Matrix" and "Donated" test data for outliers, which excludes one data point, and develop test targets. Another option was to use all "Matrix" and "Donated" test data to develop test targets. The last option would be to not use 1007 as a reference oil.

Mark Hull stated that given the variability of reference oil 1007 data in other test areas, he was not in favor of using the oil for LTMS. However, if the panel wanted to use reference oil 1007, more data was needed.

After further discussion the panel agreed to reintroduce the use of reference oil 1007 using the "Matrix " and "Donated" tests, excluding the one outlier, for test targets. The test targets would be updated at 20 and 30 tests pending surveillance panel approval.
(Motion 6)
(Motioner: Gordon Farnsworth, seconded by Bill Busher, III).

The TMC was tasked with doing a comparison analysis on new reference oil 1007 data, including the "Donated" tests without the outlier result, versus the "Matrix" data for the November surveillance panel meeting.

Referencing Frequency

Dan Worcester presented wording for revising the reference frequency in Section 6.4 of the procedure. After discussion regarding different referencing frequencies the panel approved new wording for Section 6.4.
(Motion 9)
(Motioner: Dan Worcester, seconded by Bill Buscher, III).

Head Lot Code Numbering Scheme

Bill Busher III made a presentation on cylinder head lot numbering (Attachment 8). Bill stated that it appears Nissan does not provide lot numbers on the 1999 cylinder head box labels but they are hand written on the 1998 cylinder head boxes. Bill suggested that the lot numbers could be eliminated from the Sequence IVA Report Forms.

A motion was made to suspend reporting the cylinder head lot number in the test report. However, after much discussion the motioner and the seconder withdrew the motion.
(Motion 10)
(Motioner: Dwight Bowden, seconded by Carl Stephens).

The chairman was tasked with contacting Nissan about having the cylinder head lot number added to the long block engines and the separate cylinder pieces in a consistent and traceable manner.

Criteria for IVA Tests Being Deemed "Non-Interpretable"

Larry Bendele presented the current wording in Section 13.2.3 of the Sequence IVA Procedure (Attachment 9). After much discussion on the current wording the panel concluded that no changes were necessary.

Status of KA24E Fuel Supply

Bob Rumford from Haltermann Products reported on the KA24E test fuel, Batch No. 11769 (Attachment 10). The supplier reported that they have 28,588 gallons of fuel remaining, which is approximately a 6 month inventory. Bob's report was accepted.

Review Cam Shaft 2000 Round Robin

Larry Bendele presented the 2000 Cam Wear Measurement Round Robin data from six laboratories (Attachment 11). Two camshafts were measured in the Round Robin. Both cams had unworn edges making them examples of the most difficult cams to measure accurately.

John Pandosh commented that Lab D was consistently different. The panel agreed that a Cam Measurement Workshop was needed based on the inconsistency of the data. A workshop is scheduled for June 6, 2001 at Southwest Research Institute.

SwRI Metallurgical Presentation On Differences Between 1999 Cam Lot Codes

Bob Warke of SwRI presented a summary of SwRI metallurgical analysis of the two 1999 kit camshafts. (Attachment 12). Bob stated that one cam had normal wear and the other cam had very low wear. There appears to be no explanation why one cam performed differently than the other cam.

New Business

Mike Kasimirsky of the TMC stated that laboratories were using different formats to report the test number on the test report. After some discussion the panel agreed to follow the format of "stand-runs since last reference-total runs on stand".
(Motion 14)
(Motioner: Bill Buscher III, seconded by Dan Worcester)

Next Meeting

Next meeting is at the call of the chairman.

Adjourn

The meeting was adjourned at 5:30 pm.

MEMBERSHIP
ASTM IVA SURVEILLANCE PANEL

Attachment 1
Page 1
Reference

May 18, 2001

NAME	COMPANY-ADDRESS-PHONE-FAX-EMAIL	SIGNATURE
Bendele, Larry	SOUTHWEST RESEARCH INSTITUTE 6220 Culebra Road San Antonio, TX 78238-5166 Phone No.: 210-522-2824 Fax No.: 210-684-7530 Email: lbendele@swri.org	
Bowden, Dwight	OH TECHNOLOGIES, INC. 9300 Progress Parkway P.O. Box 5039 Mentor, OH 44061-5039 Phone No.: 440-354-7007 Fax No.: 440-354-7080 Email: dhbowden@ohtech.com	
Buck, Ron	TEST ENGINEERING, INC. 12718 Cimarron Path San Antonio, TX 78249 Phone No.: 210-690-1958 Fax No.: 210-690-1959 Email: rbuck@testeng.com	
Buscher III, Bill	SOUTHWEST RESEARCH INSTITUTE 6220 Culebra Road San Antonio, TX 78238-5166 Phone No.: 210-522-6802 Fax No.: 210-684-7523 Email: wbuscher@swri.edu	
Buscher, Jr., Bill	TEXACO GLOBAL PRODUCTS P.O. Box 112 Hopewell Jct, NY 12533 Phone No.: 914-897-8069 Fax No.: 914-897-8069 Email: buschwa@aol.com	
Clark, Gil	HALTERMANN CONSULTANCY 117 E. Church Street Lake Orion, MI 48362 Phone No.: 248-693-6434 Fax No.: 248-852-4957 Email: sdclark63@juno.com	
Farnsworth, Gordon	INFINEUM 1900 E. Linden Avenue P.O. Box 735 Linden, NJ 07036 Phone No.: 908-474-3351 Fax No.: 908-474-3637 Email: gordon.farnsworth@infineum.com	
Glaenzer, David	ETHYL CORPORATION 500 Spring St. P.O. Box 2158 23218-2158 Richmond, VA ~~23217-2158~~ Phone No.: 804-788-5214 Fax No.: 804-788-6358 Email: dave_glaenzer@ethyl.com	

MEMBERSHIP
ASTM IVA SURVEILLANCE PANEL

Attachment 1
Page 2
Reference

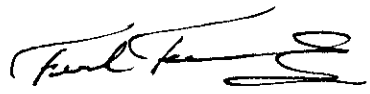
May 18, 2001

NAME	COMPANY-ADDRESS-PHONE-FAX-EMAIL	~~SIGNATURE~~
Hull, Mark	LUBRIZOL CORPORATION 29400 Lakeland Blvd. Wickliffe, OH 44092 Phone No.: 440-347-2748 / 440-943-1200 Fax No.: 440-943-9013 Email: mrh@lubrizol.com	MRH
Kasimirsky, Michael	ASTM TEST MONITORING CENTER 6555 Penn Avenue Pittsburgh, PA 15206 Phone No.: 412-365-1033 Fax No.: 412-365-1047 Email: mtk@tmc.astm.cmri.cmu.edu	Michael Kasimirsky
Montez, Alfredo	CHEVRON ORONITE COMPANY LLC 4502 Centerview Drive, Suite 210 San Antonio, TX 78228 Phone No.: 210-731-5604 Fax No.: 210-731-5699 Email: ammn@chevron.com	AM
Mosher, Mark	EXXONMOBIL RESEARCH & ENGINEERING Paulsboro Technical Center P.O. Box 480, 600 Billingsport Road Paulsboro, NJ 08066-0480 Phone No.: 856-224-2132 Fax No.: 856-224-3628 Email: mark.r.mosher@exxonmobil.com	MR Mosher
~~Riley, Mike~~ Barry Jecewsk	FORD MOTOR COMPANY 21500 Oakwood Blvd. EEE Bldg., MD#44 (Cube DN159) Dearborn, MI 48121-2053 Phone No.: 313-~~390-3059~~ 594-6943 Fax No.: 313-845-3169 Email: ~~mriley2@ford.com~~ BJECEWSK	Barry Jecewsk
Sagawa, Takumaru	NISSAN MOTOR COMPANY, LTD. 6-1, Daikoku-cho, Tsurumi-ku Yokohama, Japan (230) Phone No.: 011-81-45-505-8481 Fax No.: 011-81-45-505-8543 Email:	
Stephens, Carl	ASHLAND VALVOLINE 22nd and Front Streets Ashland, KY 41101 Phone No.: 606-329-5198 Fax No.: 606-329-3009 Email: cstephens@ashland.com	Carl Stephens
Worcester, Dan	PERKINELMER FLUIDS SCIENCES AUTOMOTIVE RESEARCH 5404 Bandera Road San Antonio, TX 78238-1993 Phone No.: 210-523-4659 or 684-2310 Fax No.: 210-523-4607 Email: Dan.worcester@perkinelmer.com	

NON-MEMBER MAILING LIST
ASTM IVA SURVEILLANCE PANEL

Attachment 1
Page 3
Reference

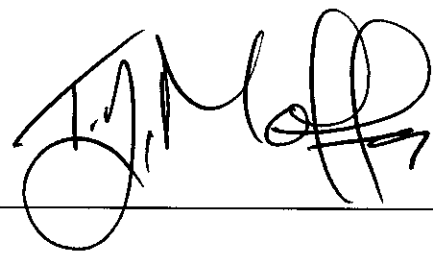
May 18, 2001

NAME	COMPANY-ADDRESS-PHONE-FAX-EMAIL	SIGNATURE
Bishop, Zack	CHEVRON ORONITE COMPANY LLC 4502 Centerview Drive, Suite 210 San Antonio, TX 78228 Phone No.: 210-731-5605 Fax No.: 210-731-5699 Email: zrbi@chevron.com	
Bond, Stacy	PERKINELMER FLUIDS SCIENCES AUTOMOTIVE RESEARCH 5404 Bandera Road San Antonio, TX 78238 Phone No.: 210-684-2310 / 210-647-9457 Fax No.: 210-523-4607 Email:	
Bowden, Jason	OH TECHNOLOGIES, INC. P.O. Box 5039 9300 Progress Pkwy. Mentor, OH 44061-5039 Phone No.: 440-354-7007 Fax No.: 440-354-7080 Email: jhbowden@ohtech.com	
Bryant, Don	LUBRIZOL CORPORATION 29400 Lakeland Blvd. Wickliffe, OH 44092 Phone No.: 216-943-1200 Fax No.: 440-943-9013 Email:	
Carlson, Jon	LUBRIZOL CORPORATION 14602 Huebner, Suite 116 PNB-198 San Antonio, TX 78230 Phone No.: 210-391-8838 (01/02/01) Fax No.: 210-522-0391 Email:	
Clark, Sidney L.	GM POWERTRAIN 30500 Mound Road 480-106-160 Box 9055 Warren, MI 48090-9055 Phone No.: 810-986-1929 Fax No.: 810-986-2094 Email: sidney.l.clark@gm.com	
Farber, Frank	ASTM TEST MONITORING CENTER 6555 Penn Avenue Pittsburgh, PA 15206 Phone No.: 412-365-1030 Fax No.: 412-365-1047 Email: fmf@tmc.astm.cmri.cmu.edu	
Fernandez, Frank	CHEVRON ORONITE COMPANY LLC 4502 Centerview Dr., Suite 210 San Antonio, TX 78228 Phone No.: 210-731-4381 / 210-731-5603 Fax No.: 210-731-5699 Email: ffer@chevron.com	

NON-MEMBER MAILING LIST
ASTM IVA SURVEILLANCE PANEL

Attachment 1
Page 4
Reference

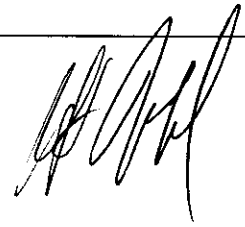
May 18, 2001

NAME	COMPANY-ADDRESS-PHONE-FAX-EMAIL	SIGNATURE
Ferner, Mark	PENNZOIL PRODUCTS COMPANY 1520 Lake Front Circle The Woodlands, TX 77380 Phone No.: 281-363-8053 Fax No.: 281-363-8002 Email:	
Galbraith, Robert	IMPERIAL OIL 453 Christina St. South P.O. Box 3002 Sarnia, Ontar, Canada N7T8C8 Phone No.: Fax No.: Email: rob.galbraith@iol.sprint.com	
Hsu, Jeffery	PENNZOIL-QUAKER STATE COMPANY 1520 Lake Front Circle (77380) P.O. Box 7569 The Woodlands, TX 77387 Phone No.: 281-363-8177 (1/10/01) Fax No.: 281-363-8002 (1/10/01) Email: JefferyHsu@PZLQS.com	
Ishikawa, Masa	INFINEUM USA L.P. 1900 East Linden Avenue Linden, NJ 07036 Phone No.: 908-474-2384 Fax No.: 908-474-3637 Email: masa.ishikawa@infineum.com	
Kelly, Jack	LUBRIZOL CORPORATION 29400 Lakeland Blvd. Wickliffe, OH 44092 Phone No.: 216-943-1200 Fax No.: Email: jack@lubrizol.com	
Moffa, John Please move to Voting Mbr list. Thanx	CASTROL INTERNATIONAL Whitchurch Hill Pangbourne, Reading Berkshire RG8 7QR, England Phone No.: 011-44-1-189-765-263 Fax No.: 011-44-1-189-84[redacted] 1095 Email: MoffaJ@Castrol.com	
Nakamura, K.	NISSAN MOTOR COMPANY, LTD. 6-1, Daikoku-cho, Tsurumi-ku Yokohama, Japan (230) Phone No.: 011-81-45-505-8481 Fax No.: 011-81-45-505-8543 Email:	
Oliver, Rick	REGISTRATION SYSTEMS INC. 2805 Beverly Drive Flower Mound, TX 75022 Phone No.: 972-724-2136 (Main Office: 210-341-2680) Fax No.: 210-341-4038 Email: crickoliver@home.com	

NON-MEMBER MAILING LIST
ASTM IVA SURVEILLANCE PANEL

Attachment 1
Page 5
Reference

May 18, 2001

NAME	COMPANY-ADDRESS-PHONE-FAX-EMAIL	SIGNATURE
Olree, Bob	GM POWERTRAIN 30003 Van Dyke Warren, MI 48090-9060 Phone No.: 810-492-2268 Fax No.: 810-575-2732 Email:	
Pandosh, John	INFINEUM 4335 Piedras Dr. West Suite 101 San Antonio, TX 78228 Phone No.: 210-732-8123 Fax No.: 210-732-8480 Email: john.pandosh@infineum.com	
Roby, Stephen	CHEVRON GLOBAL PRODUCTS 100 Chevron Way, #71-7348 P.O. Box 1627 Richmond, CA 94802-0627 Phone No.: 510-242-1273 Fax No.: 510-242-3758 Email: hrby@chevron.com	
Rumford, Robert Move to member replacing Gil Clark	HALTERMANN PRODUCTS P.O. Box 429 1201 S. Sheldon Road Channelview, TX 77530 Phone No.: 281-457-2768 Fax No.: 281-457-1469 Email: rhrumford@~~specified2.com~~ haltermann-usa.com	
Rutherford, Jim	CHEVRON ORONITE COMPANY LLC 100 Chevron Way, #60-1211 Richmond, CA 94802 Phone No.: 510-242-3410 Fax No.: 510-242-1930 Email: jaru@chevron.com	
Sciacchitano, Fran	INFINEUM 1900 East Linden Avenue P.O. Box 735 Linden, NJ 07036 Phone No.: 908-474-2573 Fax No.: 908-474-3363 Email: f.sciacchitano@infineum.com	
Scinto, Phil	LUBRIZOL CORPORATION 29400 Lakeland Blvd. Mail Drop 152-A Wickliffe, OH 44092 Phone No.: 440-347-2161 Fax No.: 440-347-9031 Email: prs@lubrizol.com	
Simkins, Russel	CONOCO INC. 1000 South Pine, 6617RW P.O. Box 1267 Ponca City, OK 74602 Phone No.: 580-767-6758 Fax No.: 580-767-4534 Email: russell.e.simkins@usa.conoco.com	

NON-MEMBER MAILING LIST
ASTM IVA SURVEILLANCE PANEL

Attachment 1
Page 6
Reference

May 18, 2001

NAME	COMPANY-ADDRESS-PHONE-FAX-EMAIL	SIGNATURE
Venier, C.G.	PENNZOIL PRODUCTS COMPANY P.O. Box 7569 The Woodlands, TX 77387 Phone No.: 281-363-8060 Fax No.: 281-363-8002 Email:	
Weber, Ben	SOUTHWEST RESEARCH INSTITUTE 6220 Culebra Road P.O. Drawer 28510 San Antonio, TX 78228-0510 Phone No.: 210-522-5911 Fax No.: 210-684-7523 Email: bweber@swri.org	Ben Weber
Ying, Lisa	INFINEUM 1900 E. Linden Avenue Linden, NJ 07036 Phone No.: 908-474-3335 Fax No.: 908-474-2298 Email:	
Zalar, John	ASTM TEST MONITORING CENTER 6555 Penn Avenue Pittsburgh, PA 15206 Phone No.: 412-365-1005 Fax No.: 412-365-1047 Email: jlz@tmc.astm.cmri.cmu.edu	
Zaweski, Ed	BP AMOCO 150 W. Warrenville Road Mail Code C-6 Naperville, IL 60563 Phone No.: 630-420-5026 Fax No.: 630-420-4866 Email: ed_f_zaweski@amoco.com	
Don Lind	Phone No.: 412-365-1034 Fax No.: Email: dnl@tmc.astm.cmri.cmu.edu	
BETO ARAIZA	T.E.I. 12718 Cimarron Path S.A. TX. 78249 Phone No.: 210.877.0222 Fax No.: 210.690.1955 Email: BARAIZA@Testing.com.	
	Phone No.: Fax No.: Email:	
	Phone No.: Fax No.: Email:	

Sequence IVA Surveillance Panel

San Antonio, TX
SwRI Cafeteria Meeting Room
May 24, 2001
1:00 p.m. - 5:00 p.m.

Attachment	2
Page	1
Reference	

A G E N D A

1. Membership Changes
2. Motion and Action recorder / Secretary
3. Approval of minutes November 15, 2000 meeting
   Thank you, Mark Mosher
4. Review Action Items from November meeting
5. TMC Reference Oil Report – Mike Kasimirsky
   Numerous LTMS alarms
6. RSI Candidate Precision Report Status – Rick Oliver
7. Review oil 1006 statistics (target and sigma)
8. Replacement frequency of Test Kit Hardware
   Referencing Frequency
   Year 2001 Nissan Kit orders
   Head Lot code numbering scheme
9. Review Test Program to Implement Additional Reference Oil (1007)
   Refer to TMC memorandum 01-004 dated Jan. 9, 2001
10. Criteria for IVA tests being deemed "non-interpretable"
11. Status of KA24E Fuel Supply
12. Review Cam Measurement 2000 Round-Robin
    Metrology Workshop scheduled for June 6, 2001 at SwRI
13. SwRI metallurgical presentation on differences between 1999 cam lot codes
    3:00 p.m. (Robert Warke - SwRI metallurgist)
14. Review test performance vs. test kit batch (lot codes)
    Experience with 2000 kit cams
15. Review objectives of Surveillance Panel
16. Old Business
    Coolant Flow Measurement of Jacketed RAC
17. New Business
18. Next Meeting
19. Adjourn

Technical Guidance Committee
April 18, 2001 meeting Highlights

Attachment	3
Page	1
Reference	

Rater Calibration:

A rater calibration procedure was agreed and details of the procedure are available from Zack Bishop.

- Raters classified by skill level (Category I or II)
- Attend at least one rating workshop per year (make-up sessions allowed in rare instances where attendance not possible)
- Maintain records of internal training classification

Precision for API Conformance Audit calculations:

The TGC recommendation is that "The LTMS Severity Adjustment standard deviation for the specific test type be used and that AMAP testing should only be scheduled during periods when the specific test is in control, as defined by the industry and laboratory LTMS precision charts".

Consensus ratings:

There was agreement that all test procedures should have consistent statements regarding consensus ratings. The statement agreed is "If multiple ratings are deemed necessary of a given part or parts, consensus rating may be used according to the following: The raters shall be from the same laboratory in question or an outside rater if required (no category 1 rater available in the lab). No averaging of ratings is permitted. Only one rating value is to be reported and is to be agreed to by the original rater involved. Any consensus rating shall be documented in the comment section of the test report.".

TMC Web Site:

The TGC approved a recommendation that all reference oil test data, valid or invalid, be posted on the TMC web site. The TMC will post this information as an Excel file.

GF-3 Category reference Oil:

The TGC agreed that a GF-3 reference oil should be pursued and introduced in all GF-3 sequence tests. Anyone wishing to provide an oil to the TMC should supply supporting test data to the TMC by June 1. The only current candidate is TMC 1008. The data for all reference candidates received will be blind coded and circulated to the TGC membership for review. One candidate will be selected.

Attachment	4
Page	1
Reference	

Unapproved Minutes of the Sequence IVA Surveillance Panel November 15th, 2000 – San Antonio, TX

ACTION ITEMS

1. All laboratories should respond to the batch code part number survey from the TMC.

2. Analyze all the valid TMC 1007 reference oil data for the mean and standard deviations (refer to item #9).

3. Southwest Research Institute agreed to finalize their metallurgical study on Sequence IVA camshafts and send the report to the Surveillance Panel members.

4. The Sequence IVA Surveillance Panel Chairman will request that Nissan produce larger cam batches.

5. The Sequence IVA Surveillance Panel Chairman will pursue better process control for the manufacture of the camshafts with Nissan.

6. A flame-hardened camshaft is an option.

7. When KA24E fuel is down to about 16,000 gallons or less, Haltermann will solicit the Sequence IVA laboratories to determine which laboratories are in danger of running out of fuel. Fuel will be sold/shipped to minimize the chance of a laboratory fuel outage.

8. Organize a workshop of Metrologists who measure Sequence IVA camshafts.

9. Send out the reference oil data for TMC 1007 (original tests and 2000 matrix tests) with a letter ballot for including it back into the LTMS.

10. Continue to investigate the nickel strike oil cooler as a potential test improvement.

11. The Sequence IVA Surveillance Panel Chairman will develop an objective for long-term improvement in Sequence IVA camshaft quality.

Attachment	5
Page	1
Reference	

Seq. IVA Semi-Annual Report
Six-Month Period Ending March 2001

SEQUENCE IVA STATUS OF REPORTED TESTS

STATUS	N	PERCENT
Operationally Non-Valid, Terminated	3	1.7
Operationally Non-Valid, Completed	2	1.1
Operationally Valid, Interpretable	172	97.2
Total Reported Tests	177	100.0

CAUSES FOR LOST TESTS	N
Engine Mechanical Problems	1
Support Equipment Problems	1
Sponsor Request	3

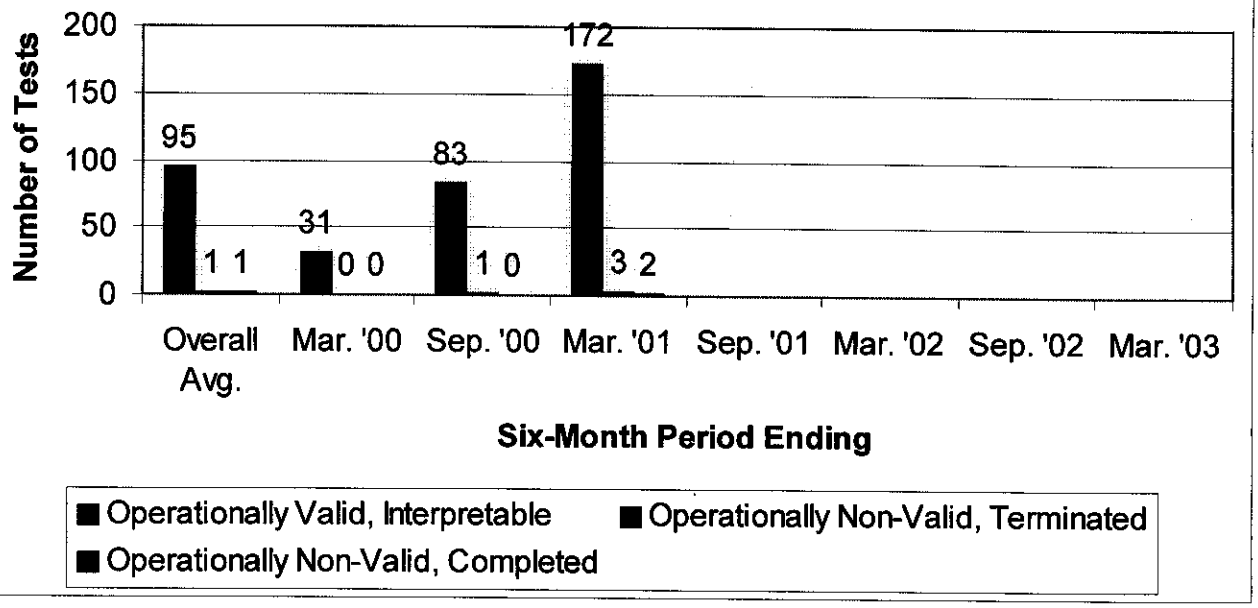
SEQUENCE IVA PRECISION

COMPONENTS OF REPLICATE DATA BASE	N
Number of Tests	15
Number of Oils	7
Number of Labs	4
Number of Stands	10
Number of Severity Adjusted Cam Wear	7

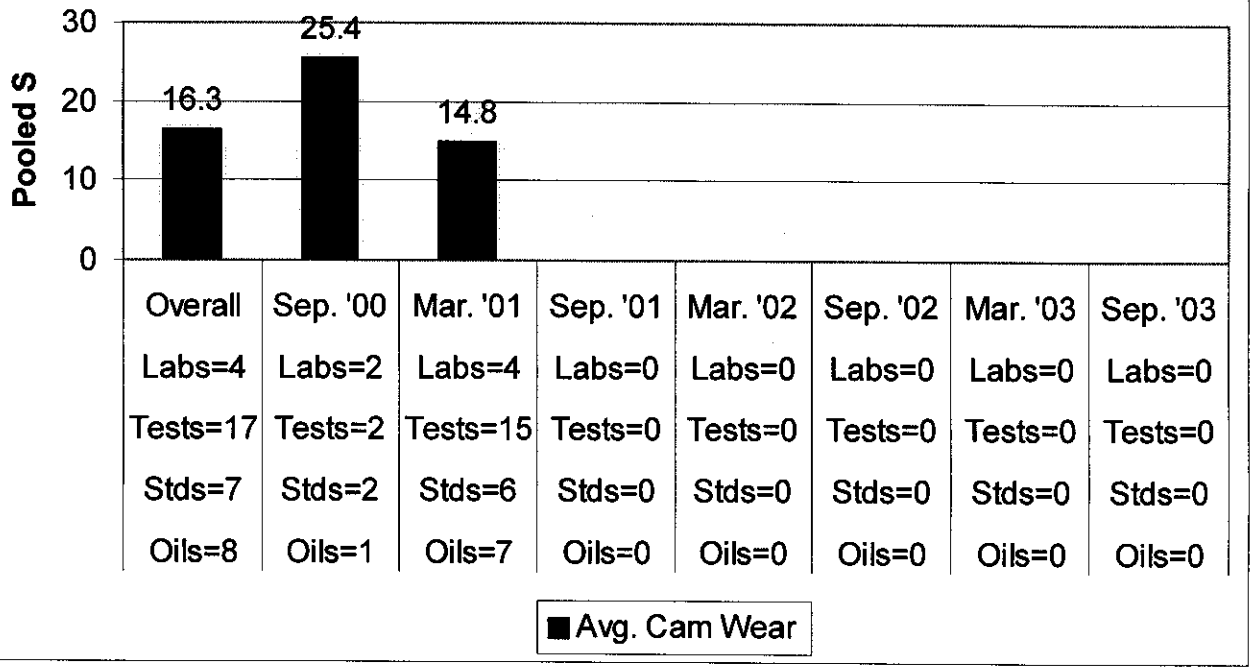
VARIABLE	Pooled s	R
Cam Wear, Non-Adjusted	17.7	49.7
Cam Wear, Adjusted	14.8	41.5

Attachment 5
Page 2
Reference

Seq. IVA
Status of Reported Tests



Seq. IVA Candidate Precision
Operationally Valid, Adjusted Data



Test Monitoring Center
6555 Penn Avenue
Pittsburgh, PA 15206-4489
(412) 365-1000

Attachment 6
Page 1
Reference

Memorandum: 01-051

Date: May 9, 2001

To: Larry M. Bendele, Chairman, Sequence IVA Surveillance Panel

From: Michael T. Kasimirsky

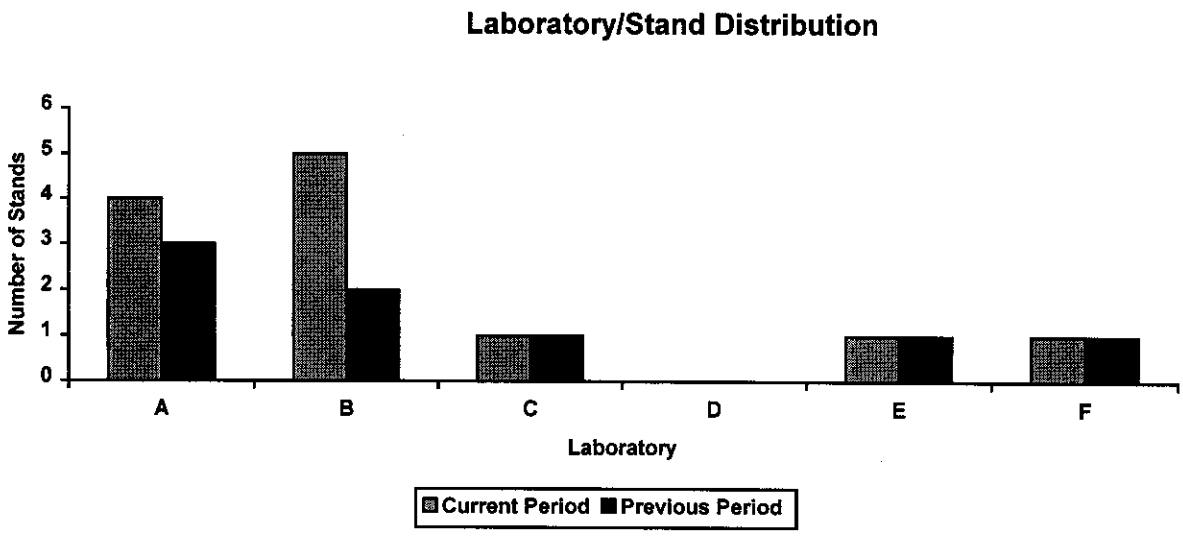
Subject: Sequence IVA Semiannual Report: October 1, 2000 through March 31, 2001

The following is a summary of Sequence IVA reference tests that were reported to the Test Monitoring Center during the period October 1, 2000 through March 31, 2001.

Lab/Stand Distribution

	Reporting Data	Calibrated as of March 31, 2001
Number of Laboratories:	5	4
Number of Test Stands:	12	8

The following chart shows the laboratory/stand distribution:



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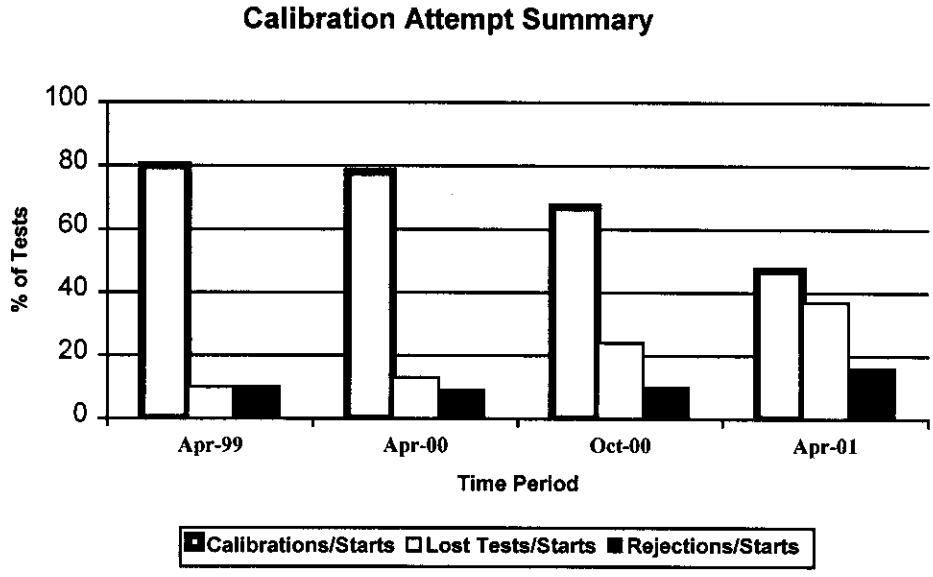
The following summarizes the status of the reference oil tests reported to the TMC:

Calibration Start Outcomes	TMC Validity Codes	No. of Tests
Operationally and Statistically Acceptable	AC	24
Failed Acceptance Criteria	OC	8
Stand Failed Reference Sequence – data pulled	MC	5
Operationally Invalid (Laboratory Judgment)	LC	10
Operationally Invalid (Lab & TMC Judgment)	RC	0
Aborted	XC	4
Total		51

Donated & Industry Support Outcomes	TMC Validity Codes	No. of Tests
Acceptable Decoded Runs	AG	1
Unacceptable Decoded Runs	OG	4
Invalid Decoded Runs	LG	0
Total		5

Calibrations per start, lost tests per start and rejection rates are summarized below:



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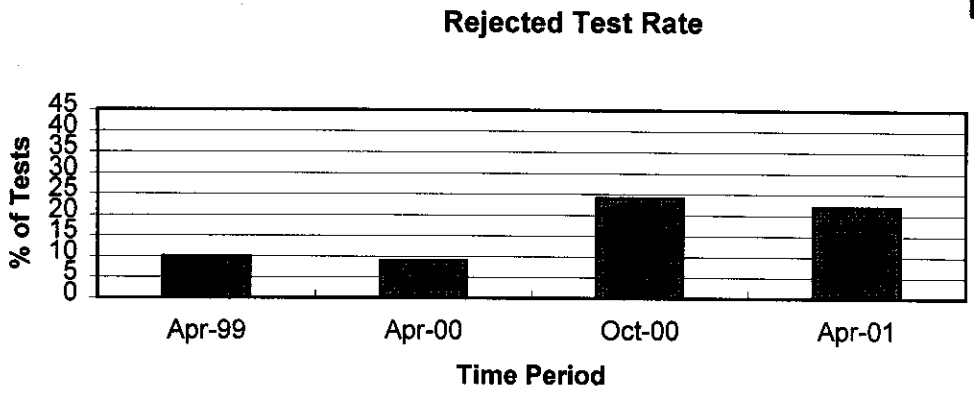
Reference



There were eight failing tests for the period; six failed due to Shewhart Severity alarms on ACW. Two were in the mild direction and four in the severe direction. One test failed due to Shewhart Precision Alarms at both the stand and lab level. The final failing test was due to an EWMA Precision Alarm at the stand level, an EWMA Precision Warning at the lab level, and Shewhart Precision Alarms at both the lab and stand level.

There were no LTMS Deviations this period. There has been one deviation from the LTMS since its introduction in 1999.

There were five QI Deviations written this period. One was written for coolant out temperature problems and four were written for exhaust backpressure control problems.

Lost Test Summary

Fourteen tests were lost this period. The causes are summarized in the following chart:

Lab	Reason for Lost Test	Number of Tests	Breakdown of Tests (LC/RC/XC)
A	Auxiliary Air Control Valve Set Wrong	1	1/0/0
B	Load Control Problems	1	1/0/0
	Oil Cylinder Head Temperature QI Results below zero	1	1/0/0
	Speed & Load Control	1	1/0/0
	Oil Cylinder Head Thermocouple inserted to incorrect depth	2	1/0/1
	Stand Pulled from LTMS	2	2/0/0
	Engine Overspeed on start-ups	1	1/0/0
	Stand Software Problems	1	0/0/1
	Driveline failure	1	0/0/1
C	Coolant Out Temperature, Intake Air Pressure, and Exhaust Backpressure QI Results below zero	1	1/0/0
	MAF Problems	1	1/0/0
E1	Engine Performance Problems	1	0/0/1

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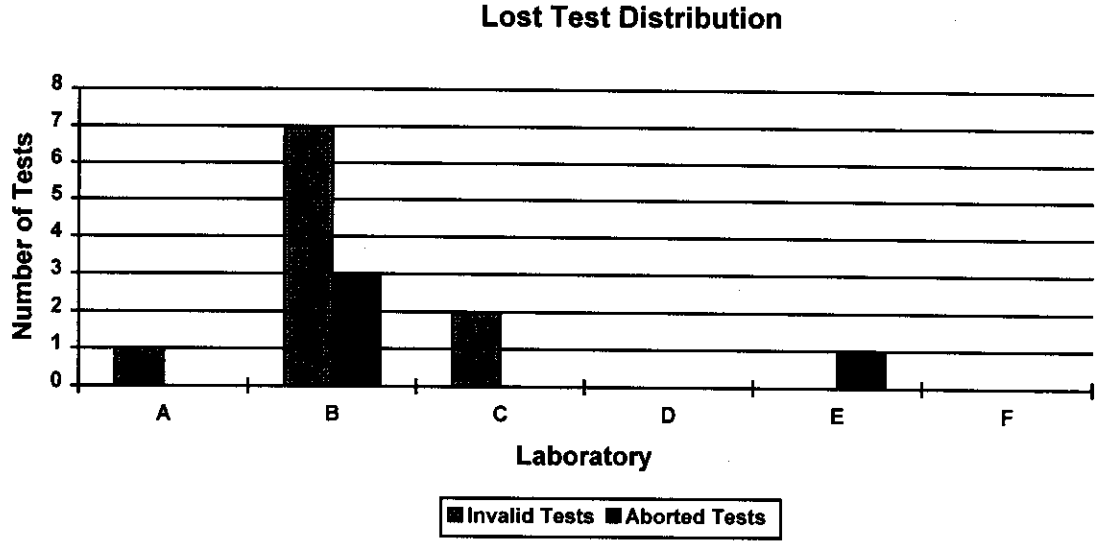

Information Letters

Sequence IVA Information Letter No. 00-4, Sequence No. 4, dated January 12, 2001, was issued during the period and contained a requirement that laboratories must successfully run a reference oil test on a camshaft lot before bringing that lot into use in the laboratory.

Severity and Precision Analysis

Below is a summary of the average Δ/s, pooled standard deviation, and average Δ in reported units for the tests reported during this period. Also below is a summary of the average Δ/s value, by parameter, for all laboratories reporting data during this period.

Industry Severity Summary			
Parameter	Average Δ/s	Pooled standard deviation (degrees of freedom)	Average Δ, in micrometers
ACW	0.124	14.74 (df=31)	1.83

ACW Results, by Laboratory	
Laboratory	Average Δ/s
A	-0.245
B	0.952
C	-0.378
D	-
E1	-1.466
F	-1.713

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Reference	

The industry began the period in a precision alarm. Since then, the industry has been in and out of a precision alarm condition for much of the period, finally clearing the alarm for the last 12 data points. Severity, on the other hand, was within limits for much of the period during those precision alarms, with only two data points being beyond the Warning limit. However, when precision returned to within limits, the industry then experienced a severity alarm of six data points in the severe direction. This is different from the previous problems the industry experiences with unexplained mild wear results.

The TMC has been investigating the industry data set in an effort to determine a cause for the erratic wear results seen in the Sequence IVA test. To that end, the data was examined for significant differences in ACW performance due to various factors. The data was examined for differences in fuel batch, camshaft lot, cylinder head lot, rocker arm lot, laboratory, stand, as well as various interactions of these factors. The used oil analysis results for fuel dilution, copper content, and iron content were also examined for effects on ACW performance. A summary of some of the means and standard deviations for these groups of data are shown in the tables below:

Table A – ACW Mean & Standard Deviations, by Fuel Batch

Fuel Batch[1]	N size	Mean	Standard Deviation
0011769	2	108.50	2.22
9701035	8	111.58	13.03
9903160	33	121.72	11.67
9910650	34	122.00	20.46

[1]One data point on a unique fuel batch not shown.

Table B – ACW Mean & Standard Deviations, by Camshaft Lot

Camshaft Lot[2]	N size	Mean	Standard Deviation
971103	14	122.53	11.12
971114	10	117.54	15.21
980929	5	118.98	9.38
981013	11	124.58	14.52
981015	6	118.86	11.74
98928	11	119.07	33.70
990628	8	123.40	12.46
N/A	7	121.70	8.16

[2]Six data points on unique camshaft lots not shown.

Table C – ACW Mean & Standard Deviations, by Cylinder Head Lot

Cylinder Head Lot	N size	Mean	Standard Deviation
960907	2	123.32	2.81
971001	20	118.75	12.75
981030	13	120.85	10.37
N/A	43	121.53	19.80

Table D – ACW Mean & Standard Deviations, by Rocker Arm Lot

Rocker Arm Lot[3]	N size	Mean	Standard Deviation
971001	22	122.29	11.93
981020	33	120.86	21.46
991029	8	123.40	12.45
N/A	12	118.49	11.29

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Reference	

[3]Three data points on unique rocker arm lots not shown.

Table E – ACW Mean & Standard Deviations, by Laboratory

LTMS Laboratory	N size	Mean	Standard Deviation
A	26	122.91	9.95
B	25	128.67	12.34
C	6	123.86	13.69
E1	12	105.00	25.62
F	9	111.48	12.19

Table F – ACW Mean & Standard Deviations, by Stand

LTMS Apparatus (LTMS Lab – LTMS Stand)	N size	Mean	Standard Deviation
A-1	8	126.67	9.63
A-2	8	119.50	8.07
A-3	7	118.30	10.33
A-4	3	132.69	6.63
B-1	3	125.78	6.15
B-1A	6	121.70	12.75
B-2	3	128.38	18.60
B-2A	5	131.72	9.29
B-3	6	132.54	15.25
B-3A	2	135.10	5.39
C-1	6	123.86	13.69
E-1	8	98.59	29.34
E1-1	4	117.80	8.41
F-1	9	111.48	12.19

The analysis showed no differences between fuel batches, camshaft lots, head lots, or rocker arm lots at a 95% confidence level. Analyzing the data for interactions between the three hardware categories also showed no significant differences between the various combinations, although the data for this analysis was quite limited since every lab has not run every hardware lot.

An analysis of laboratory differences did show some significant differences amongst some of the laboratories. The results showed that Lab B is significantly different at the 95% confidence level from both Labs E1 and F. Lab A was also found to be different from Lab E1 at the 95% confidence level.

However, the perception in industry is that camshaft lot is a significant factor in the current ACW situation, so this data was examined more closely, along with the laboratory differences mentioned above. In Figure A, all the data in the LTMS data set is plotted by camshaft lot, using different symbols for each laboratory. From this plot, there appears to be very little difference in the ACW performance of the various camshaft lots.

The LTMS data is further shown in Figure B (which has multiple pages), where the ACW results are plotted by laboratory, one camshaft lot per plot. The boxes on Figure B represent the mean and standard deviation of the data for that laboratory on that camshaft lot. Only camshaft lots with data from more than one laboratory are shown in Figure B. As a result, camshaft lots 971103, 971114, 981013, 981015, 98928, and 990628 are shown in Figure B. Several of these plots show a difference in performance for a particular camshaft lot at various laboratories, but the analysis did not show these differences to be significant. No explanation for these differences has been found at this time.

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Reference	

The used oil analysis data was also examined to see if fuel dilution, copper content, or iron content of the used oil samples was any indicator of wear performance. The first two, fuel dilution and copper content, were not found to be useful indicators of ACW performance in the Sequence IVA test. Iron content, as expected, was a significant indicator of wear performance, but beyond that did not yield any useful information.

To date, no explanation for the wear anomalies have been found at this time. There may be a laboratory and hardware interaction resulting in differing levels of severity on the same hardware, but no explanation for the cause of this interaction has been found at this time.

Along these same lines, the issue of test target updates has been an item of interest to the Surveillance Panel. The targets were due to be updated a while ago, but were not updated due to the precision alarms experienced by the industry. Chairman Bendele asked the TMC to prepare some possible target revisions based upon the LTMS data for consideration by the panel at the next meeting of the panel. Some possible targets, along with the current test targets, are shown in Table G, below:

Table G – Reference Oil 1006 Test Targets

Description	Mean	Standard Deviation	Effective Dates, if any
All Data	120.75	16.50	None
All Data, lab pooled standard deviation	120.75	14.56	None
Data Screened for Rare Events (1 found)	121.76	13.97	None
Rare Event Screened and lab pooled s	121.76	12.50	None
Original Targets	117.14	12.23	19991001 to 20000125
Current Targets	121.38	9.86	20000126 to present

No severity adjustments were applied to the data in generating the first two sets of targets shown in Table G. The first set of targets is a simple mean and standard deviation calculated from the data set. The second set of targets in Table G contains a standard deviation which was pooled across all laboratories, attempting to factor out any laboratory variations from the results obtained in the calculation. In both cases, the target means are very close to the current target while the standard deviation is significantly larger than the current or original target standard deviation. Industry control charts based upon these two sets of targets and the existing LTMS data set are shown in Figures C and D respectively. As expected, these targets reduce or eliminate the alarms currently shown in Figure 1.

There was also some discussion of using statistical outlier tests to remove the outlier data from the LTMS data set and then generate test targets from the resultant data set. From Table 1 of Standard Practice E178, the critical value for T for an upper 2.5% significance level (equivalent to a 5% significance level on a two-sided test) is found to be 3.297, meaning tests beyond 3.297 standard deviations from the mean can be excluded as rare events. Screening the LTMS data using this criteria results in one data point being excluded from the calculation. The third and fourth set of targets in the table are based on this new, reduced data set and were calculated in the same manner as the previous two sets of targets. As you can see, it had little effect on the results of the calculation. As a result, control charts using either of these two sets of test targets would fall somewhere between the current control chart and those shown in Figures C and D.

Reintroduction of reference oil 1007 was also a topic for discussion at the last meeting and the TMC was tasked with examining the available data on that oil and suggesting some possible test targets for that oil of the panel decides to reintroduce it into the LTMS. Those proposals were issued to the Surveillance Panel in TMC Memorandum 01-004, issued on January 9, 2001.

Hardware

Attachment	6
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Reference	

No hardware changes were made this period.

Reference Oils

Oil	TMC Inventory, in gallons	TMC Inventory, in tests	Laboratory Inventory, in tests	Estimated life
1006	498	124	28	3+ years[1]
1007[2]	619	154	9	3+ years[1]

[1] Multiple test area reference oil; total TMC inventory shown
2 Cannot be reblended

MTK/mtk

Attachments

c: F. M. Farber, TMC
Sequence IVA Surveillance Panel
ftp://tmc.astm.cmri.cmu.edu/docs/gas/sequenceiv/semiannualreports/IVA-04-2001.pdf

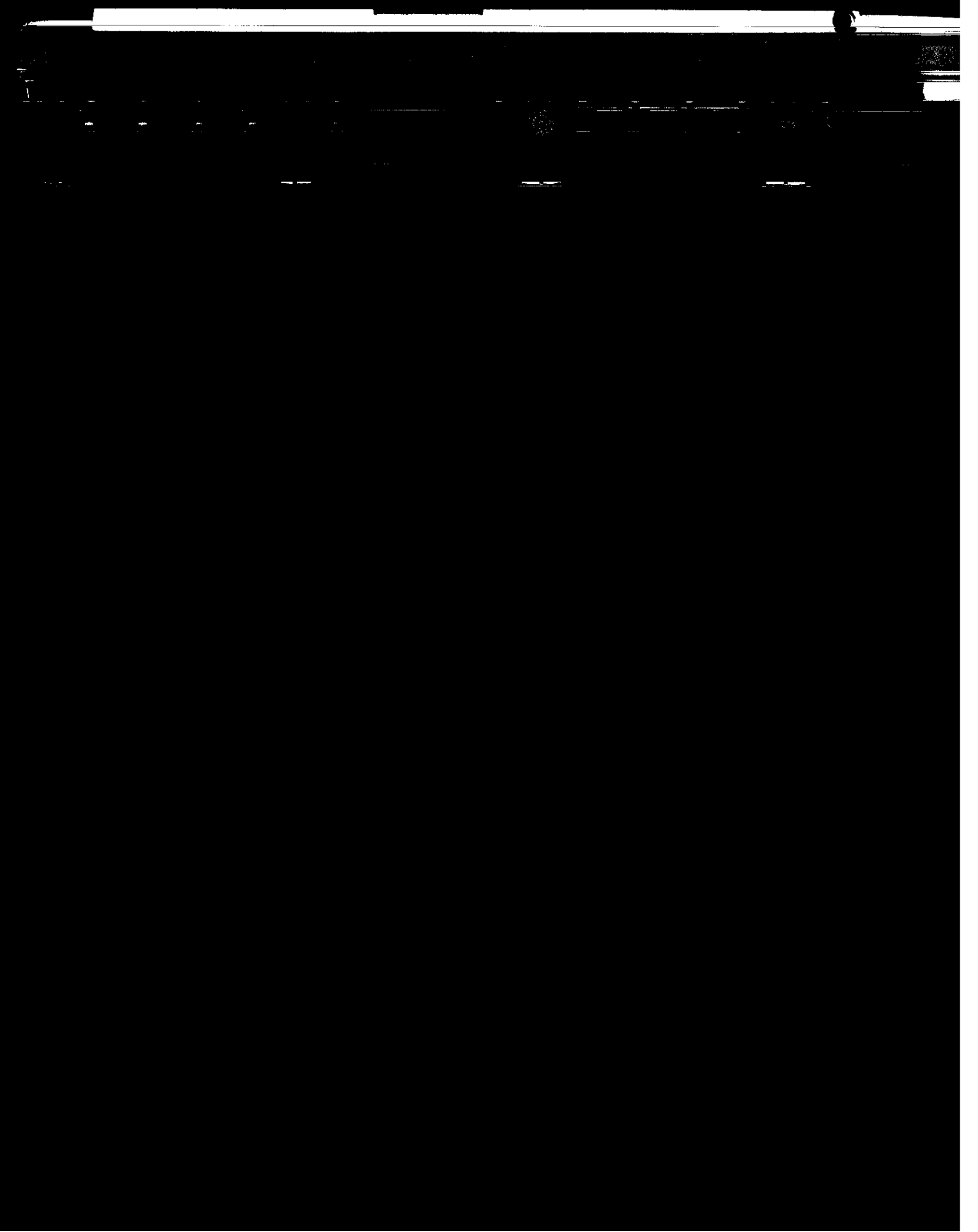
Attachment	6
Page	9
Reference	

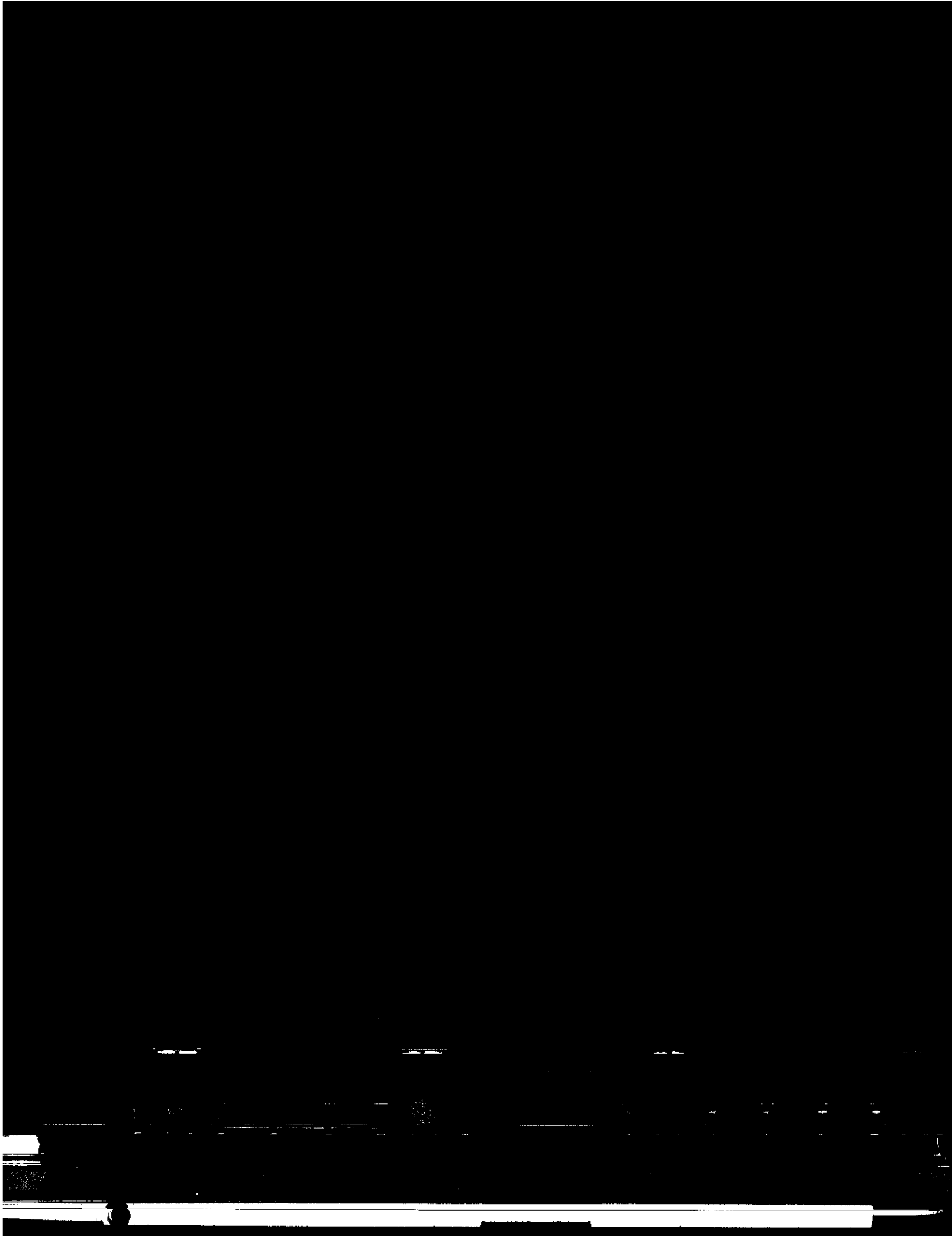
List of Figures

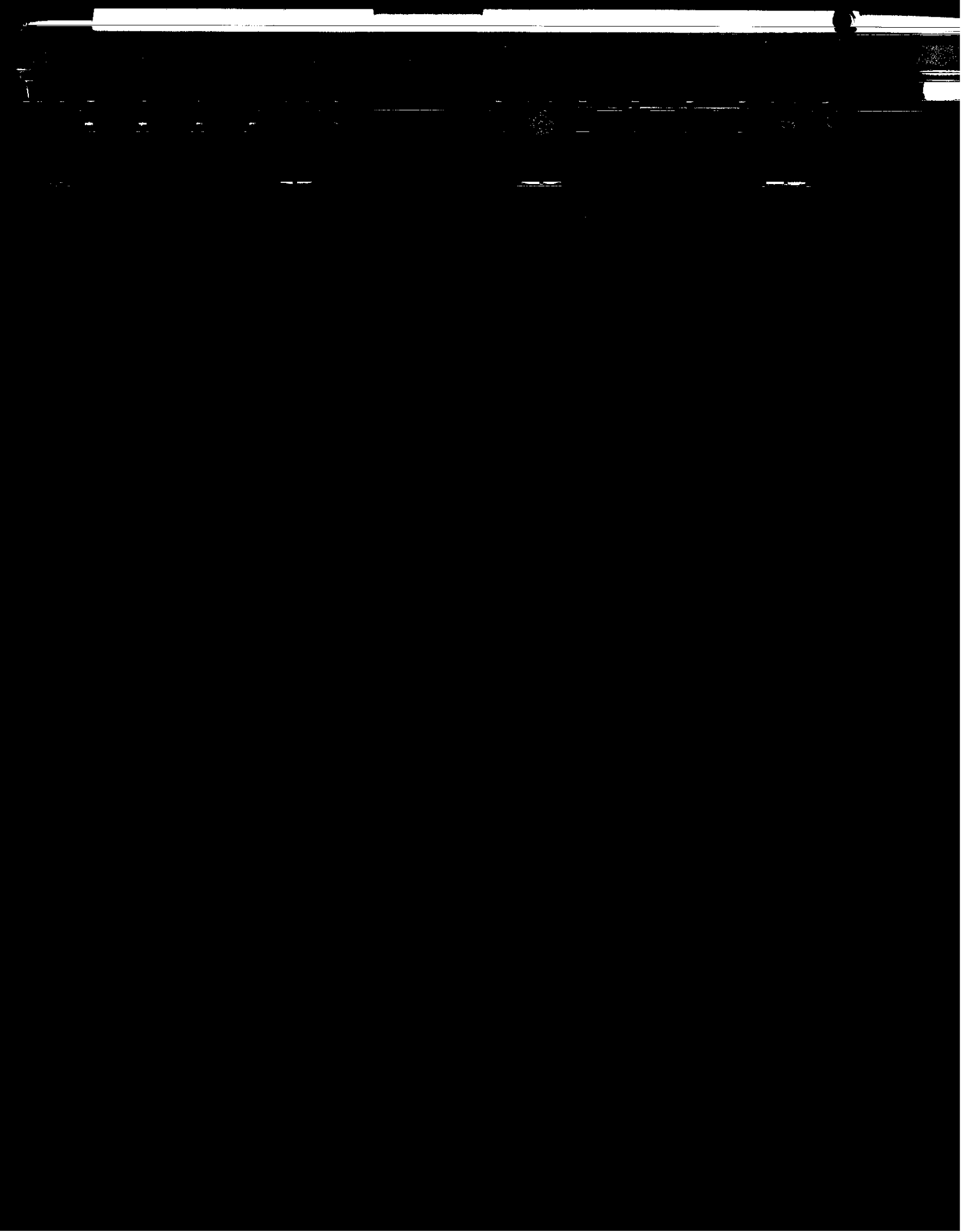
- Figure 1 graphically presents the Industry control charts for ACW and also the CUSUM delta/s plot (by count in completion date order) of average camshaft wear for operationally valid tests.
- Figure 2 graphically presents a historic perspective for ACW mean delta/s by report period.
- Figure 3 graphically presents a historic perspective for ACW pooled standard deviations by report period.
- Figure 4 is the Sequence IVA Timeline, created to track changes in test hardware and operations.

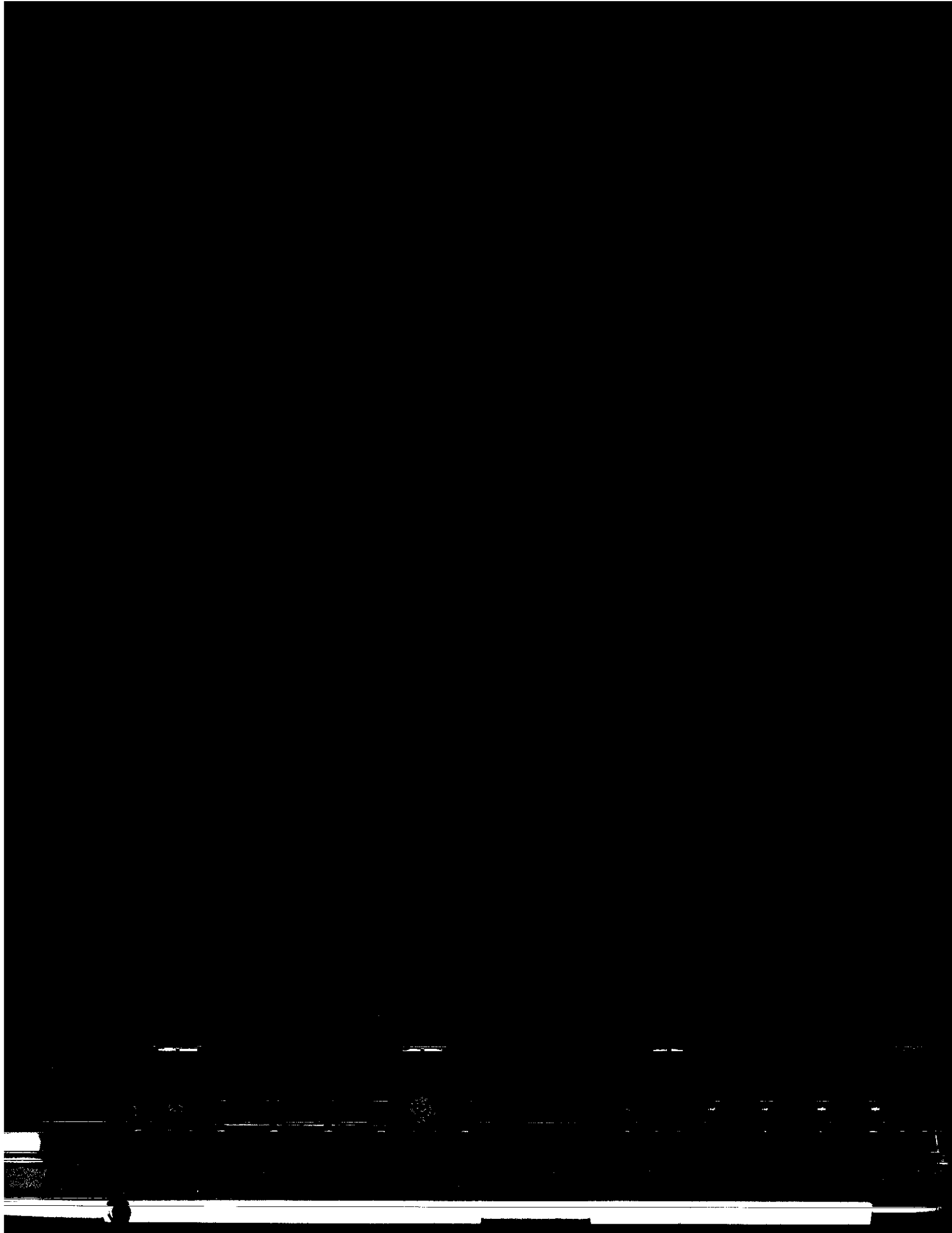
The following tables and figures refer to the Severity and Precision Analysis section of this report:

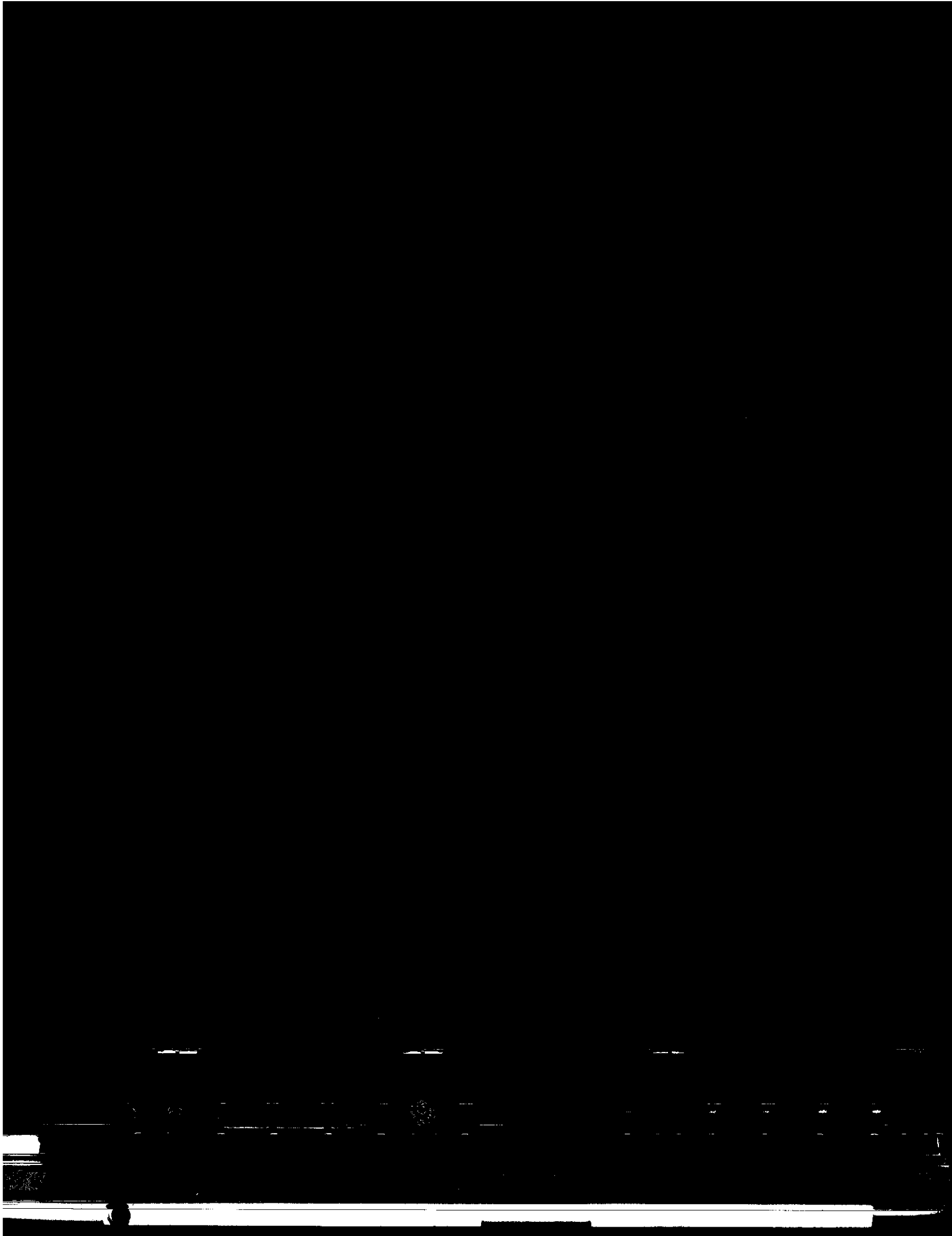
- Table A contains the N size, mean, and standard deviation of the ACW results for all data in the LTMS Data set, calculated by fuel batch.
- Table B contains the N size, mean, and standard deviation of the ACW results for all data in the LTMS Data set, calculated by camshaft lot number.
- Table C contains the N size, mean, and standard deviation of the ACW results for all data in the LTMS Data set, calculated by head lot number.
- Table D contains the N size, mean, and standard deviation of the ACW results for all data in the LTMS Data set, calculated by rocker arm lot number.
- Table E contains the N size, mean, and standard deviation of the ACW results for all data in the LTMS Data set, calculated by LTMS laboratory code.
- Table F contains the N size, mean, and standard deviation of the ACW results for all data in the LTMS Data set, calculated by LTMS laboratory and stand code.
- Table G contains two possible sets of test targets based on the current LTMS data set as well as the current and original test targets used for reference oil 1006 in the Sequence IVA test.
- Figure A shows all LTMS data, plotted by camshaft lot number, using different symbols for each laboratory.
- Figure B (6 plots total) shows individual test results, plotted by laboratory, with one camshaft lot per plot. Also shown on the plot are boxes, which represent the mean and standard deviation (plotted as the mean plus and minus one standard deviation), for that lab's data on that hardware. Only camshaft lots with runs from more than one lab are shown.
- Figure C is the industry control chart, plotted using the first set of targets in Table G.
- Figure D is the industry control chart, plotted using the second set of targets in Table G.

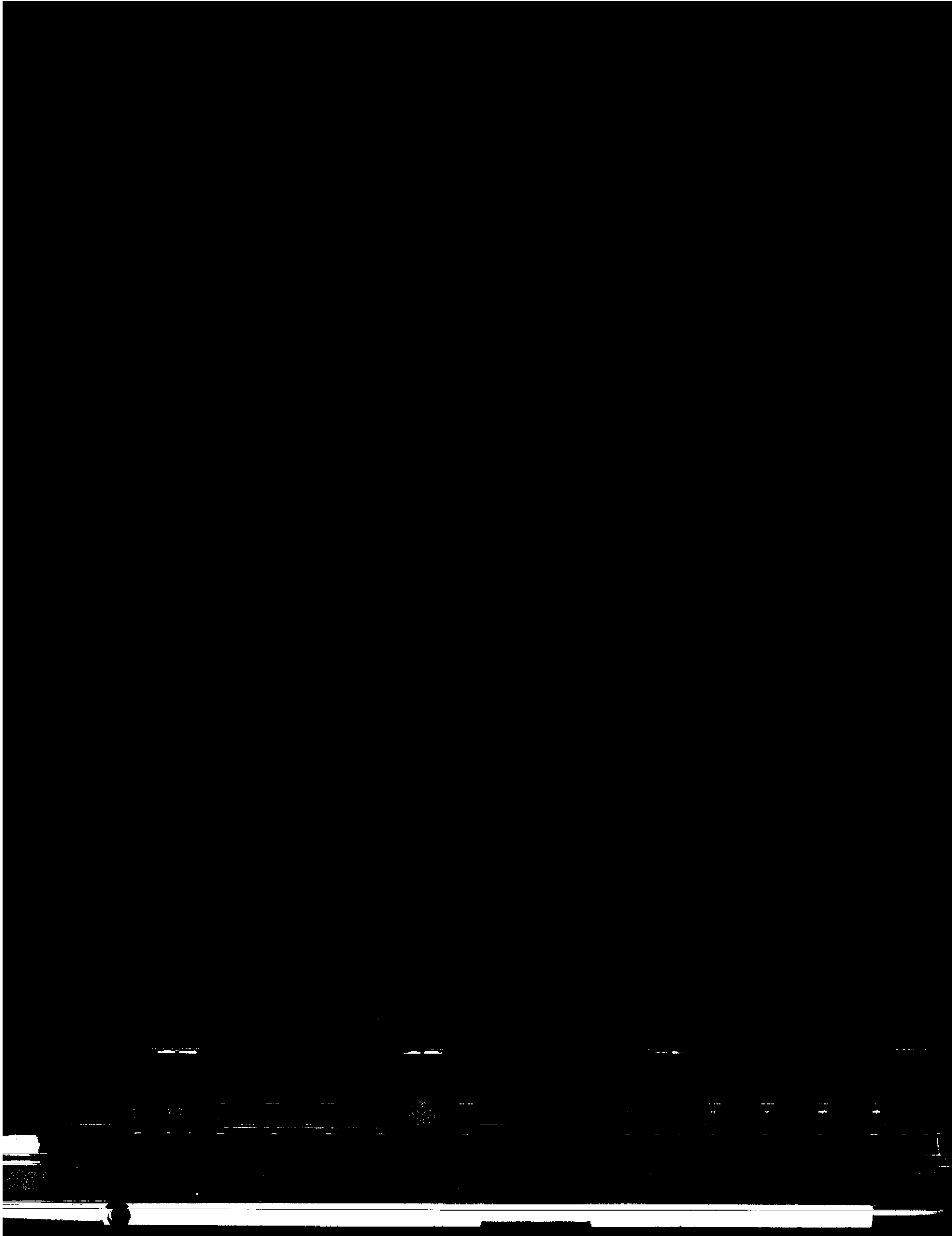








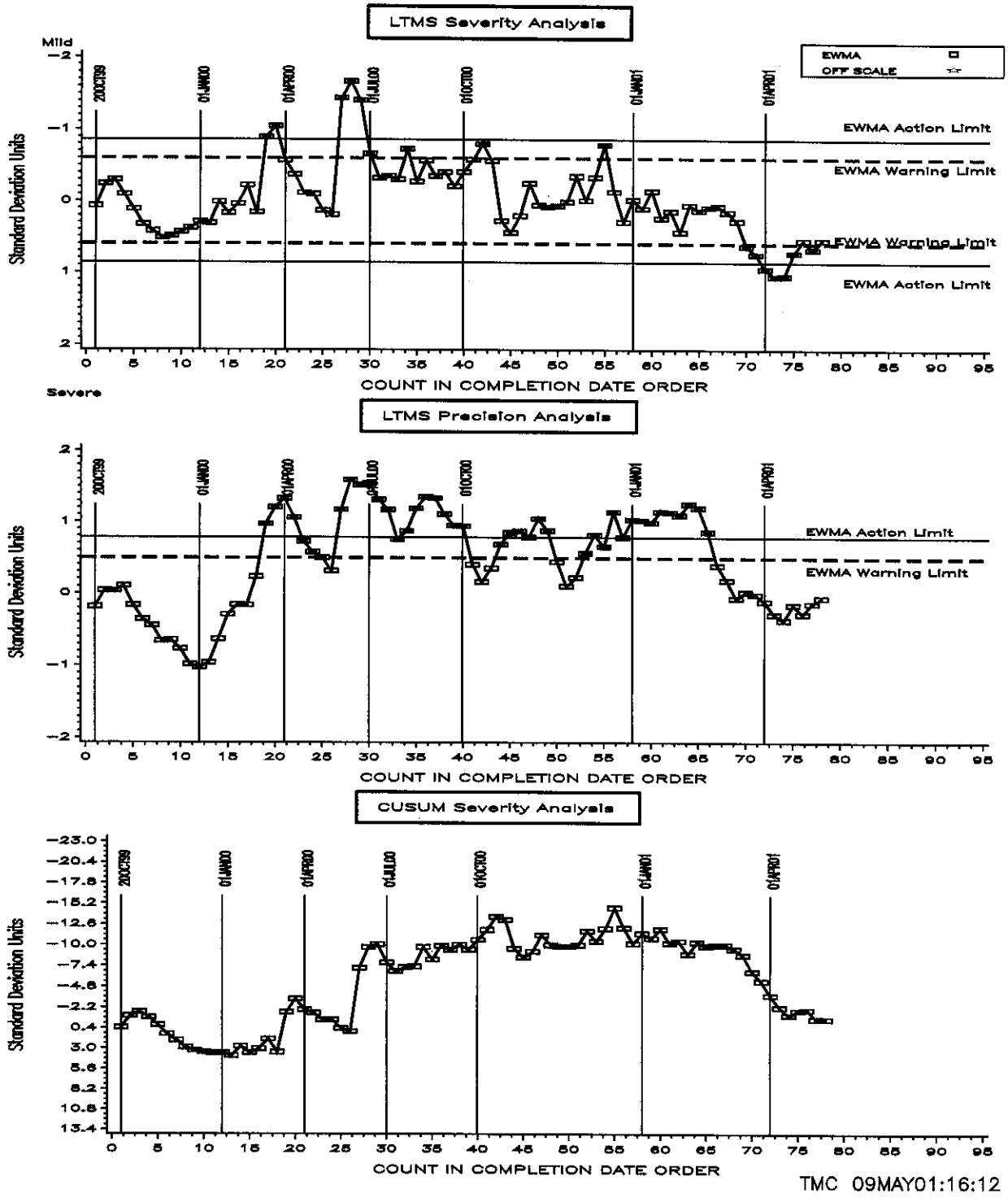




Attachment 6
Page 10
Reference Figure 1

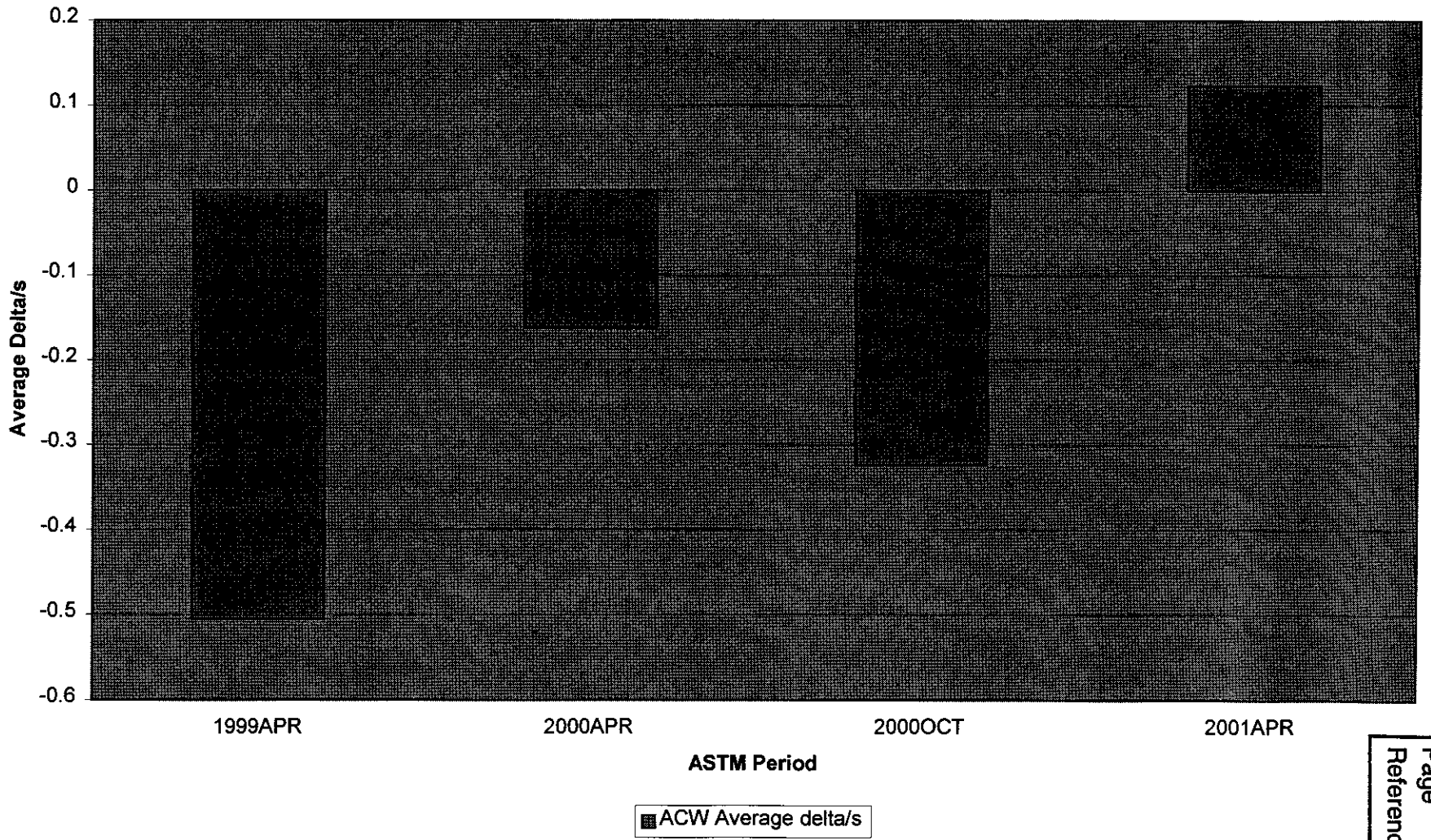
SEQUENCE IVA INDUSTRY OPERATIONALLY VALID DATA

AVERAGE CAM WEAR



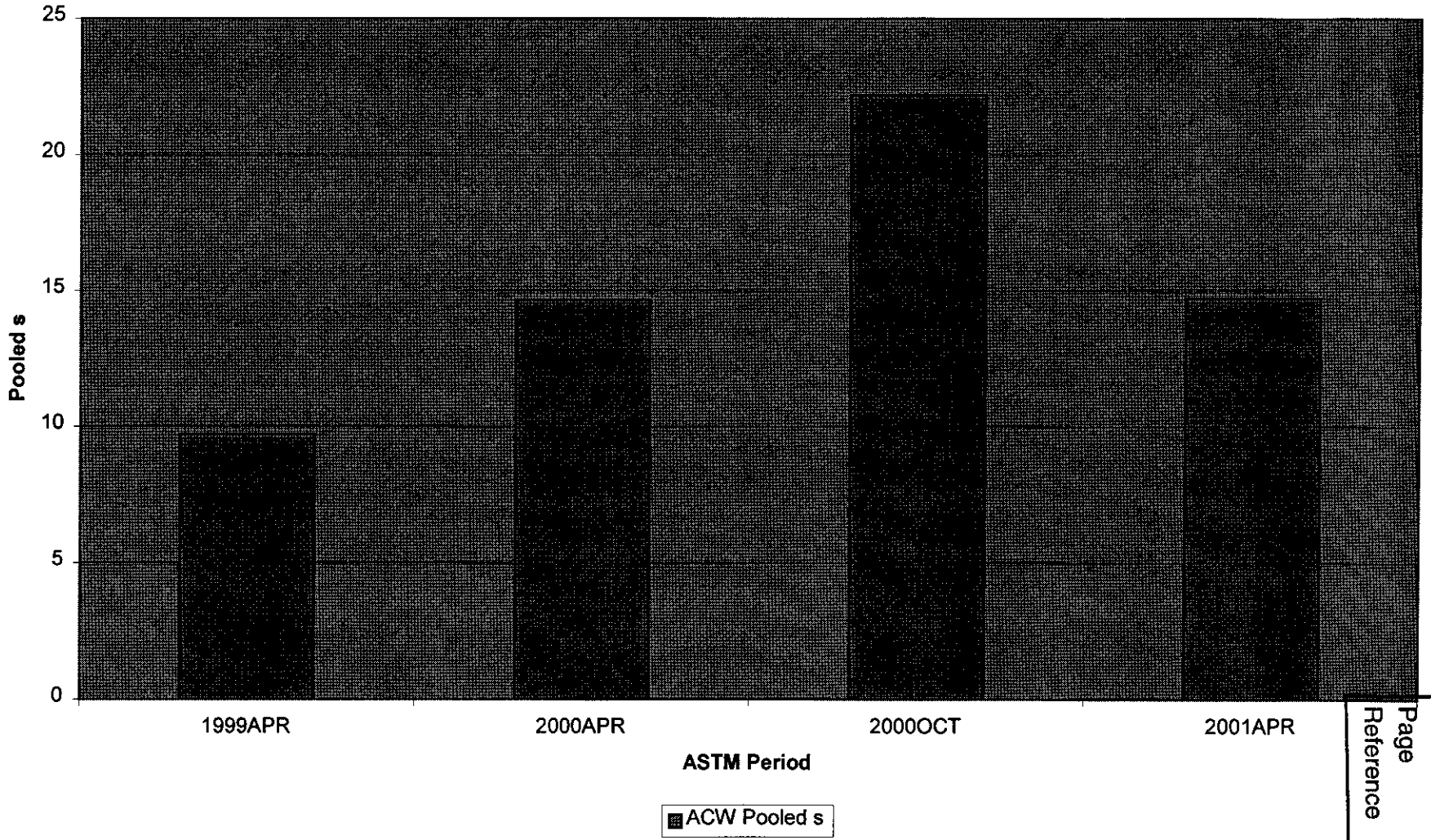
TMC 09MAY01:16:12

Figure 2 - Sequence IVA Reference Oil Data
Average Camshaft Wear



Attachment 6
Page 11
Reference

Figure 3 - Sequence IVA Reference Oil Data
Average Camshaft Wear



Attachment 6
Page 12
Reference

Attachment 6
Page 13
Reference

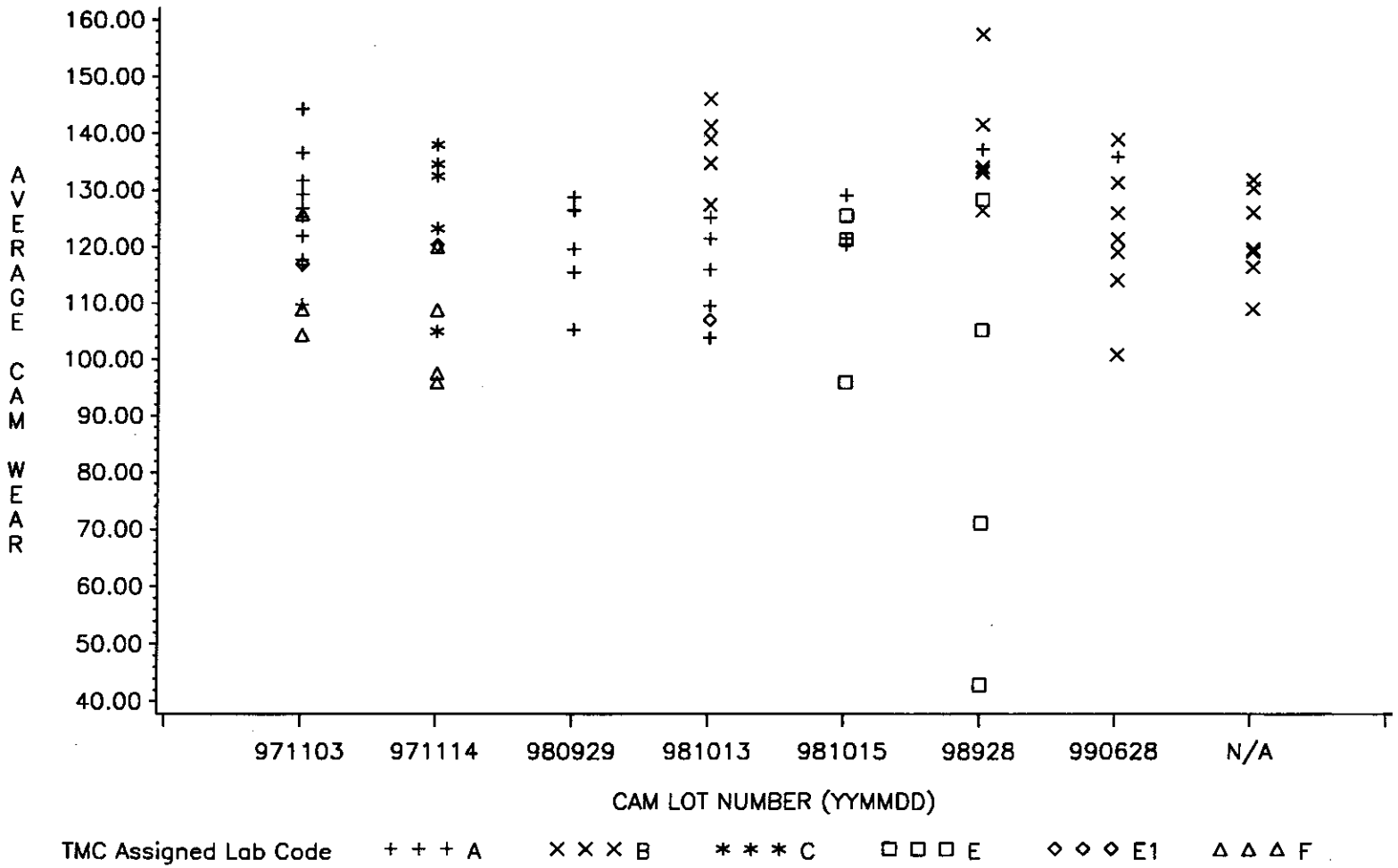
Figure 4 - Sequence IVA Timeline

Date	Topic	Information Letter
2/10/1999	SEQUENCE IVA TEST LTMS ESTABLISHED BY SURVEILLANCE PANEL	
11/17/1999	CALIBRATION STATUS RESUMED	
2/16/2000	DRAFT 4 OF TEST PROCEDURE ISSUED. INCORPORATED JACKETED ROCKER COVER, CONTROLLED FLOW OF FRESH AIR TO ROCKER COVER, AND OIL CYLINDER HEAD AS OIL TEMPERATURE CONTROL POINT.	00-1
8/1/2000	REVISED DATA DICTIONARY AND REPORT FORM SET (VERSION 20000126) GOES INTO EFFECT.	00-2
6/12/2000	REVSED DOUBLE-FLUSH COOLANT CONTROL REQUIREMENTS EFFECTIVE	00-3
6/12/2000	REVISED ENGINE STARTING PROCEDURE EFFECTIVE	00-3
6/12/2000	ELIMINATE THE REQUIREMENT FOR LINEAR RAMPING OF TRANSIENT PARAMETERS	00-3
6/12/2000	REVISED OIL SAMPLING PROCEDURE	00-3
6/12/2000	REVISED DOUBLE-FLUSH OIL DRAIN REQUIREMENT	00-3
6/12/2000	REVISED COMPRESSION TEST REQUIREMENTS	00-3
6/12/2000	NEW CAMSHAFT CLEANING REQUIREMENTS	00-3
1/24/2001	CAMSHAFT LOT RESTRICTIONS	00-4

Figure A

Sequence IVA Reference Oil Data

Individual Lab Data, Plotted By Camshaft Lot



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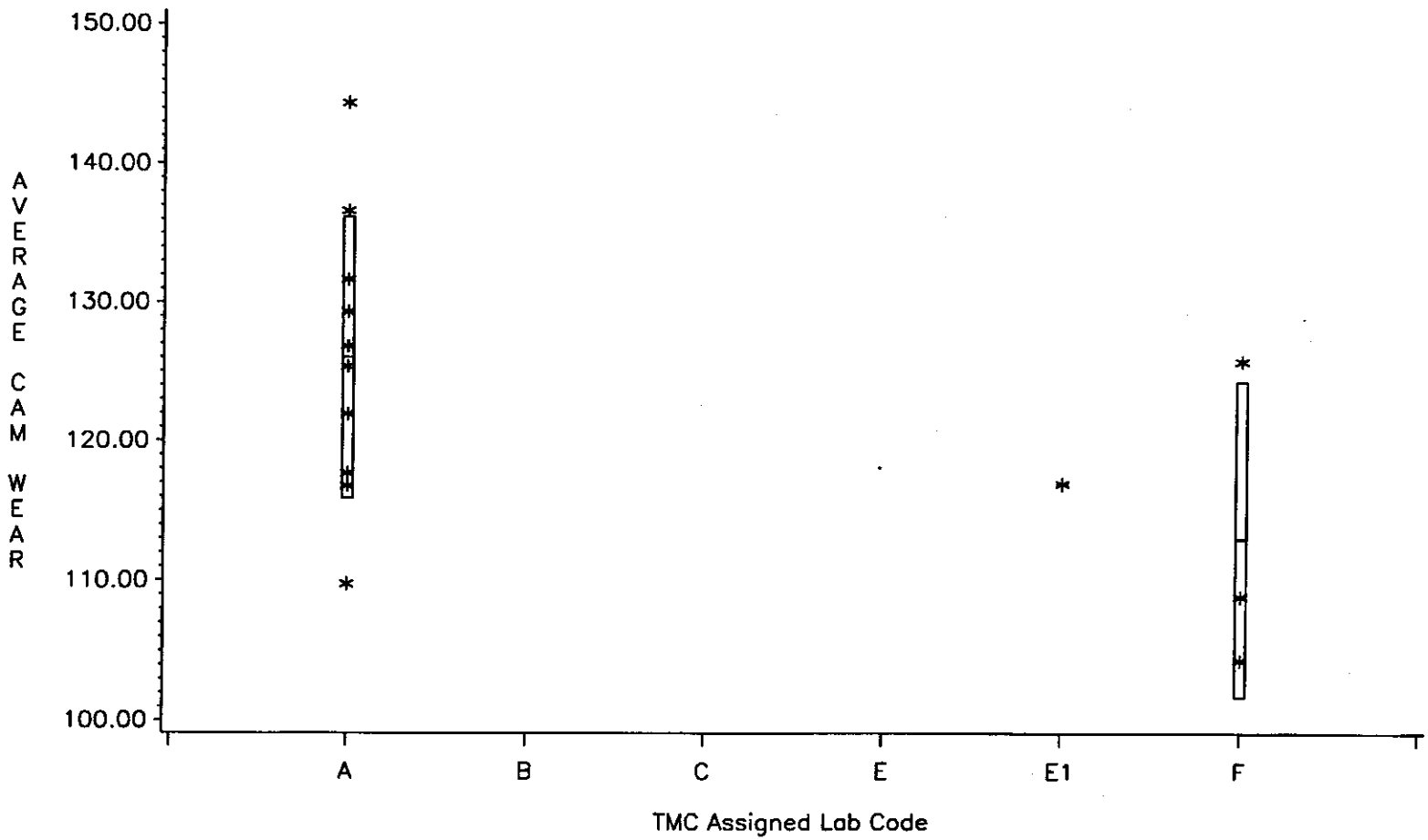
Page 14
Reference

Figure B

Sequence IVA Reference Oil Data

Individual Camshaft Lot Data, Plotted By Laboratory

CAM LOT NUMBER (YYMMDD)=971103



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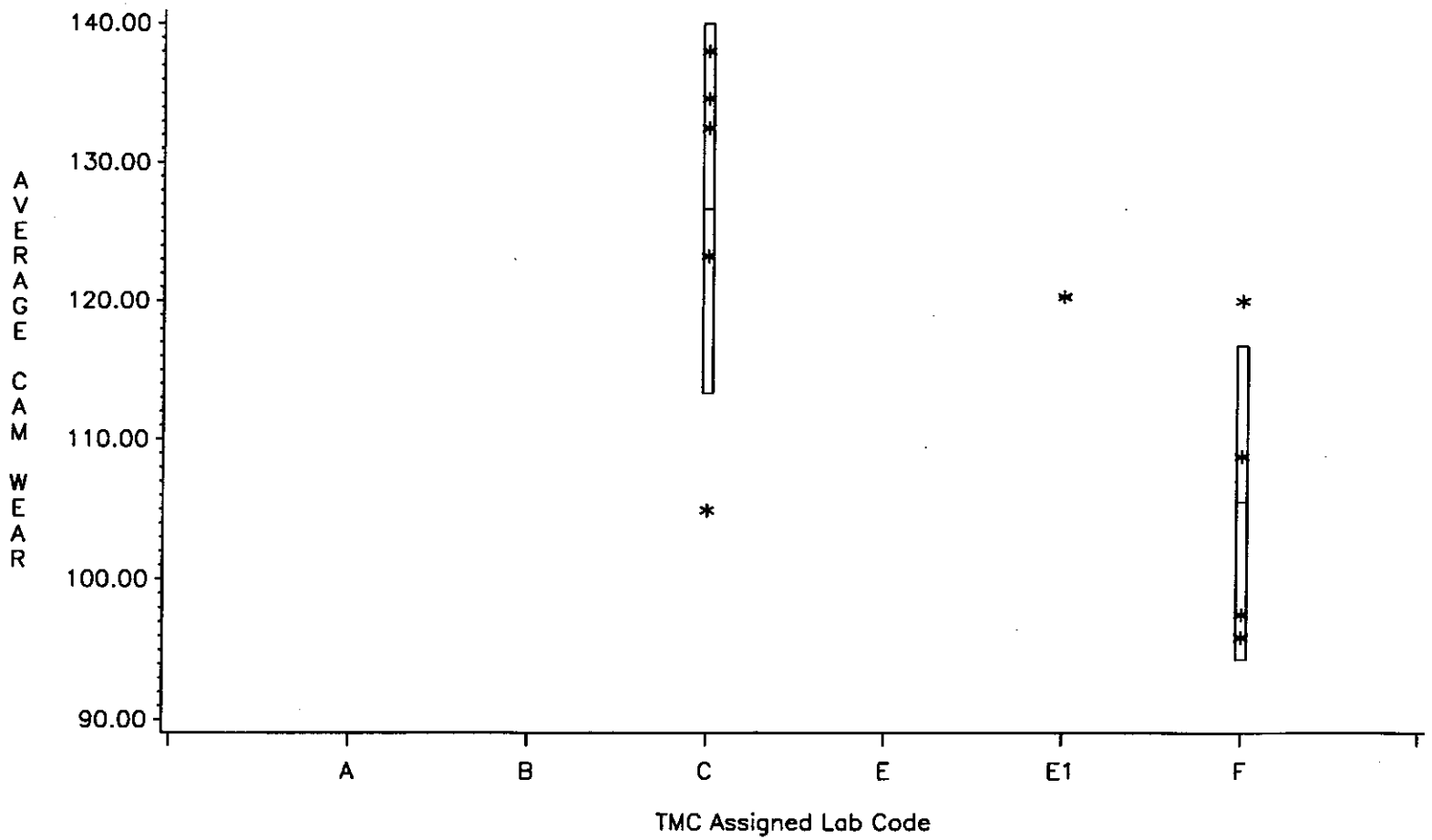
Page
Reference

Figure B

Sequence IVA Reference Oil Data

Individual Camshaft Lot Data, Plotted By Laboratory

CAM LOT NUMBER (YYMMDD)=971114



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Reference

Figure B

Sequence IVA Reference Oil Data

Individual Camshaft Lot Data, Plotted By Laboratory

CAM LOT NUMBER (YYMMDD)=981013

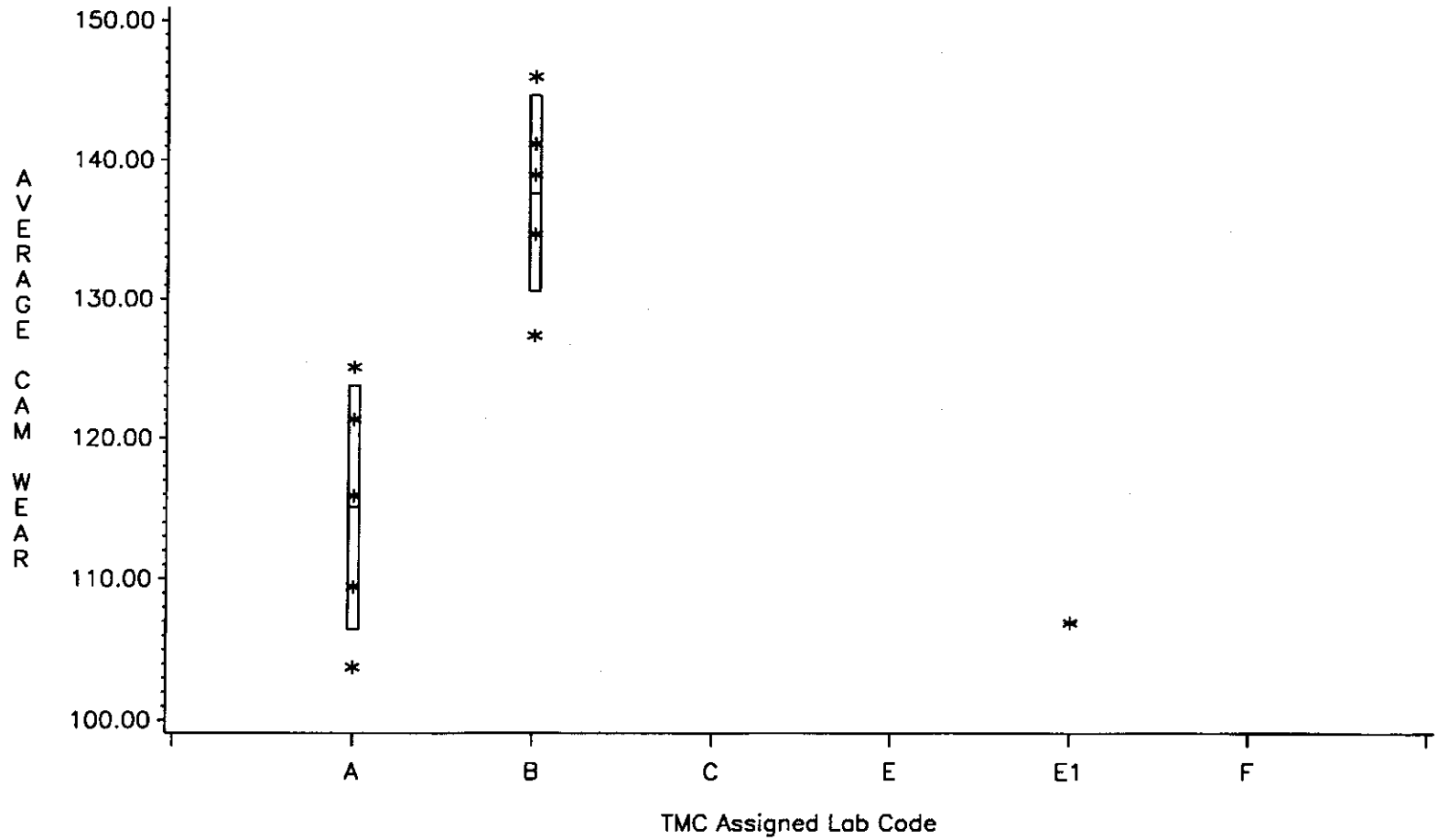

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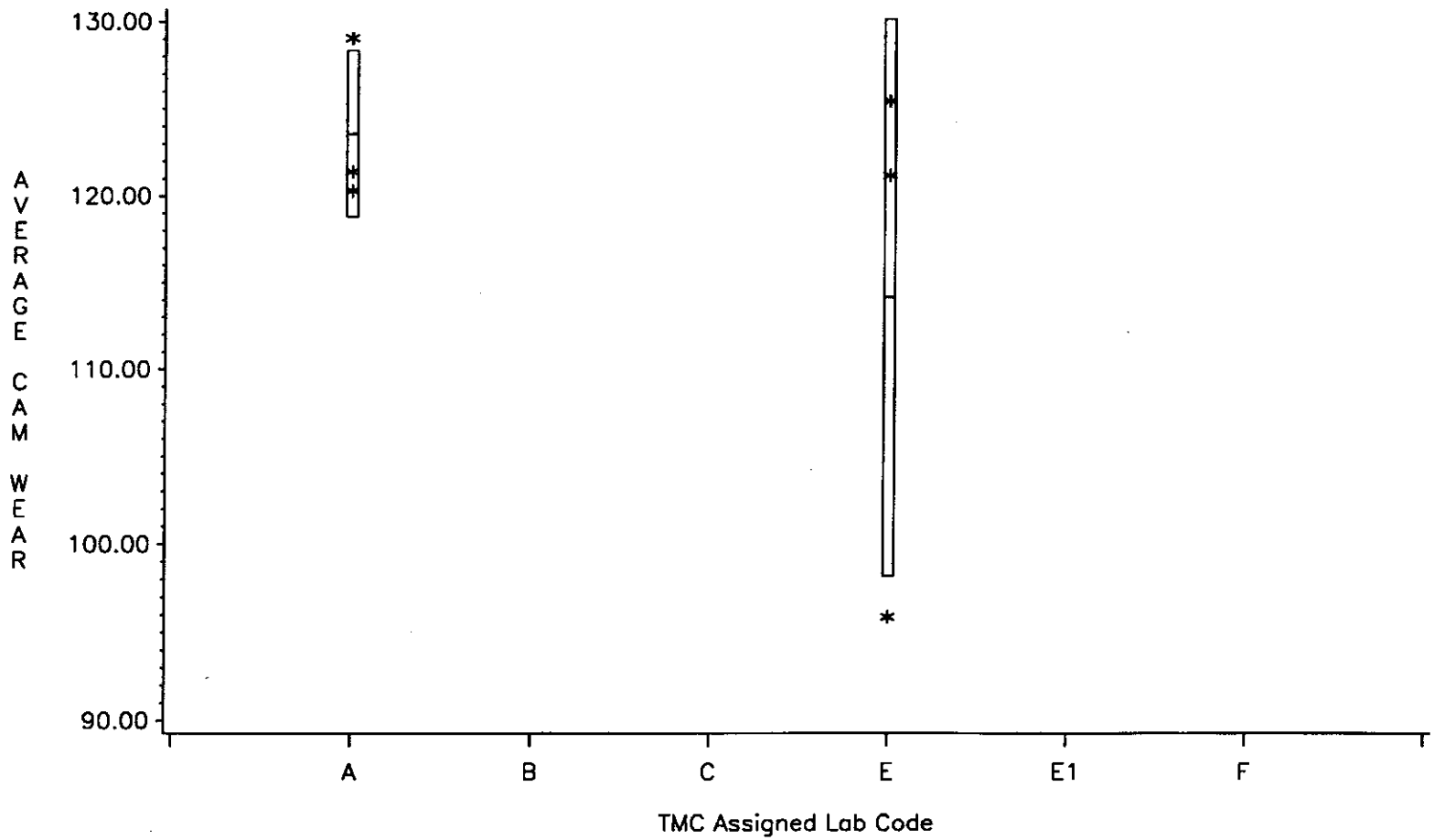
Figure B

Sequence IVA Reference Oil Data

Individual Camshaft Lot Data, Plotted By Laboratory

CAM LOT NUMBER (YYMMDD)=981015



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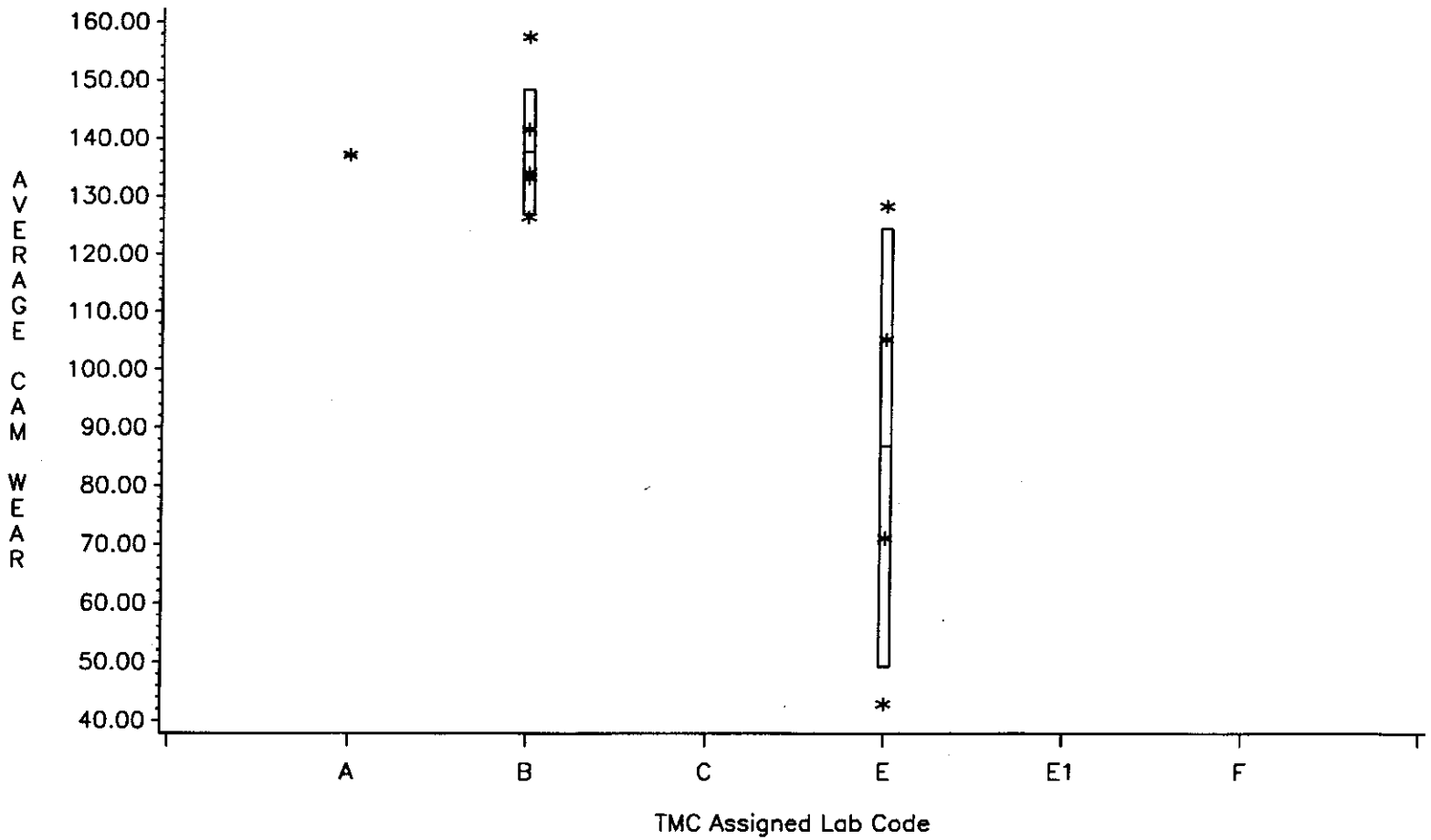
Reference

Figure B

Sequence IVA Reference Oil Data

Individual Camshaft Lot Data, Plotted By Laboratory

CAM LOT NUMBER (YYMMDD)=98928



Attachment 6
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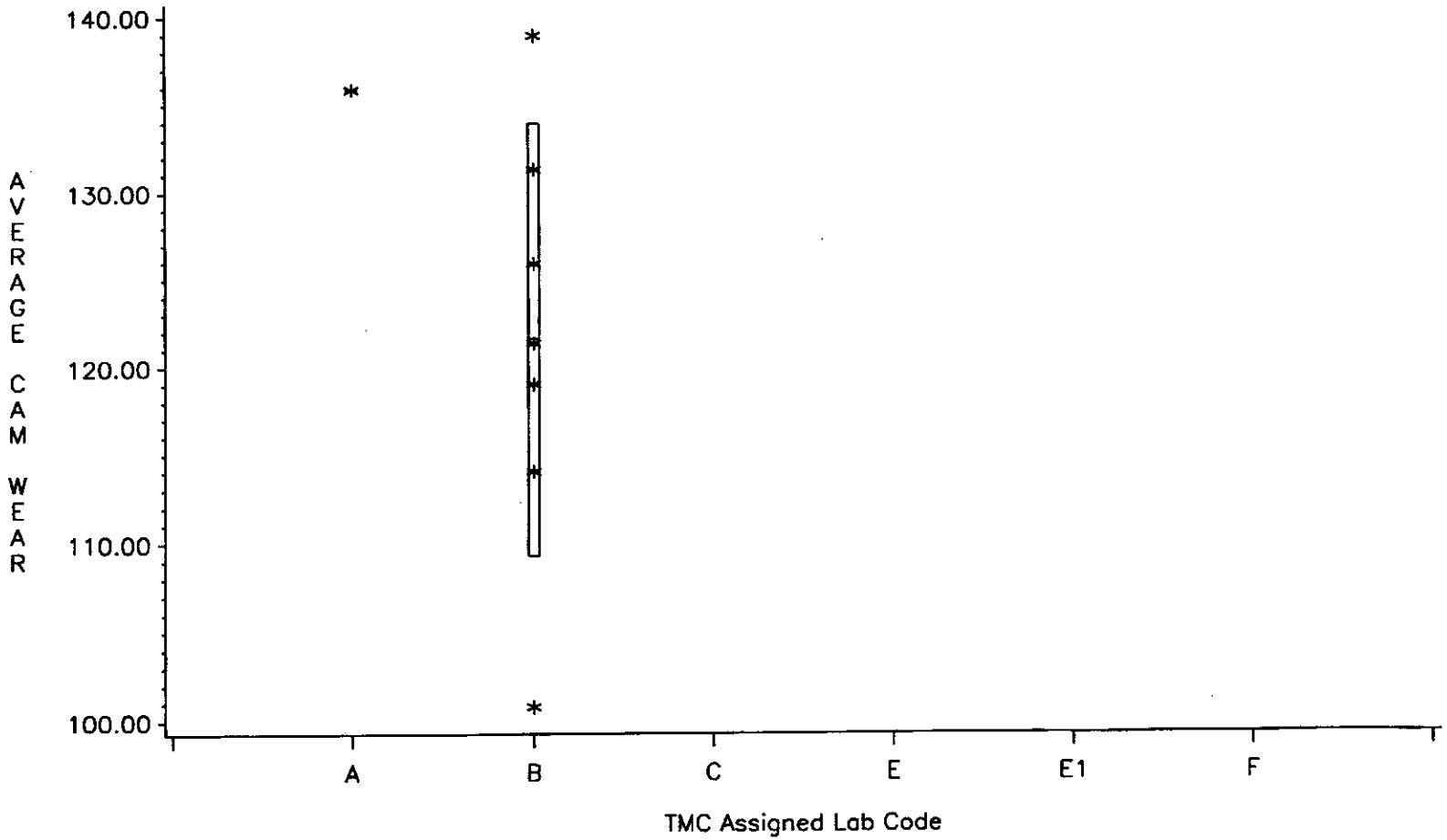
Reference

Figure B

Sequence IVA Reference Oil Data

Individual Camshaft Lot Data, Plotted By Laboratory

CAM LOT NUMBER (YYMMDD)=990628

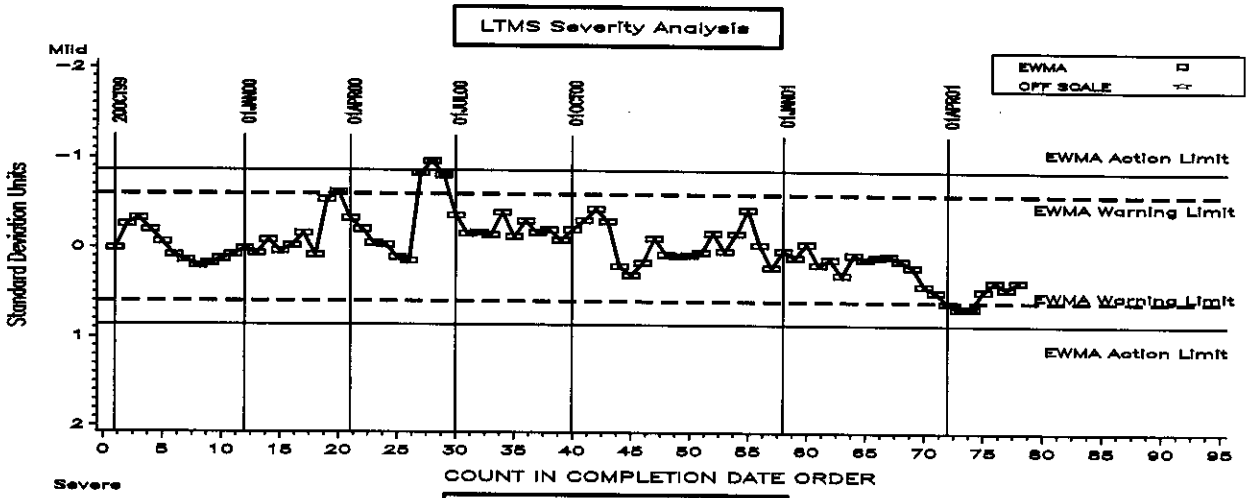


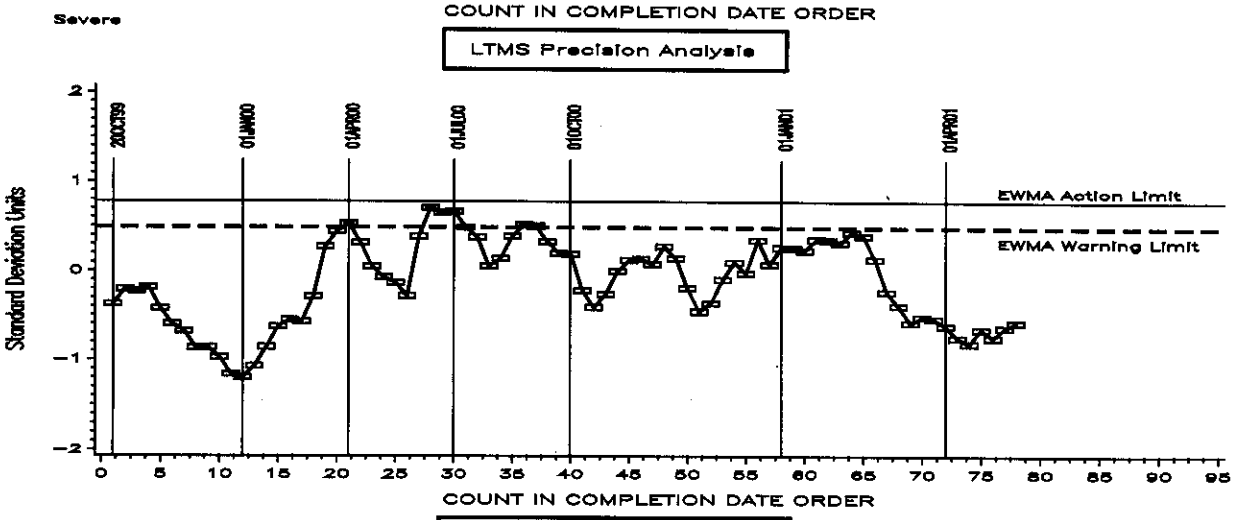
Attachment 6
Page 20
Reference

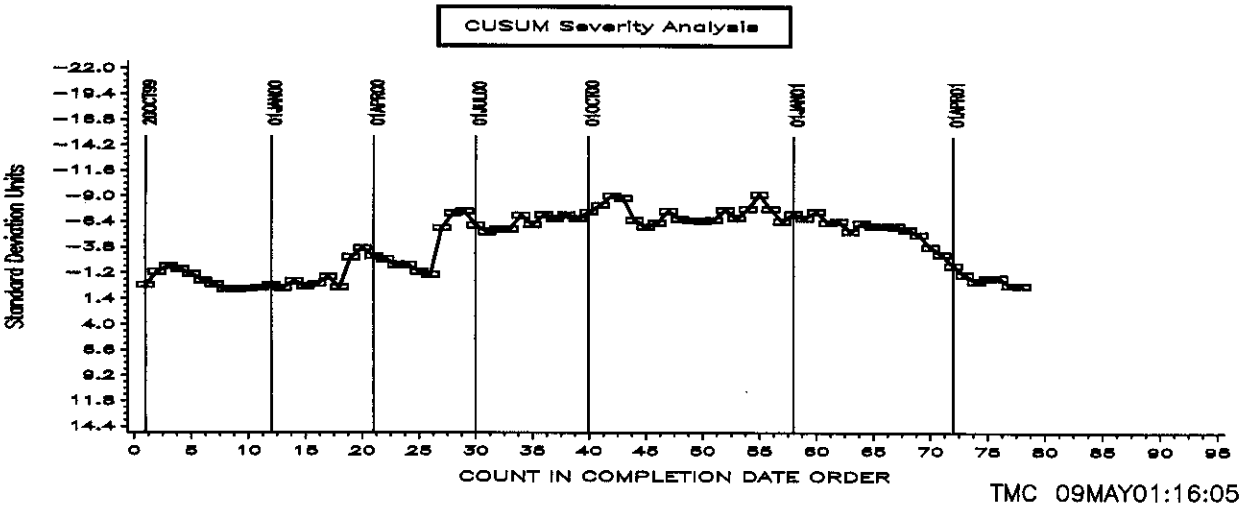
Attachment 6
Page 21
Reference Figure C

SEQUENCE IVA INDUSTRY OPERATIONALLY VALID DATA

Plot using new mean and 16.50 standard deviation
AVERAGE CAM WEAR





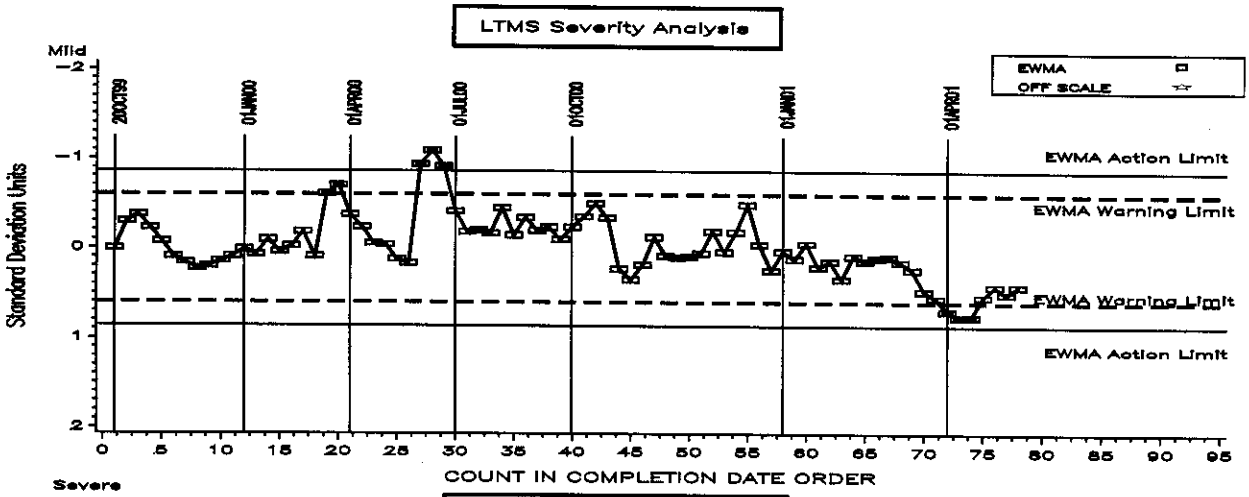


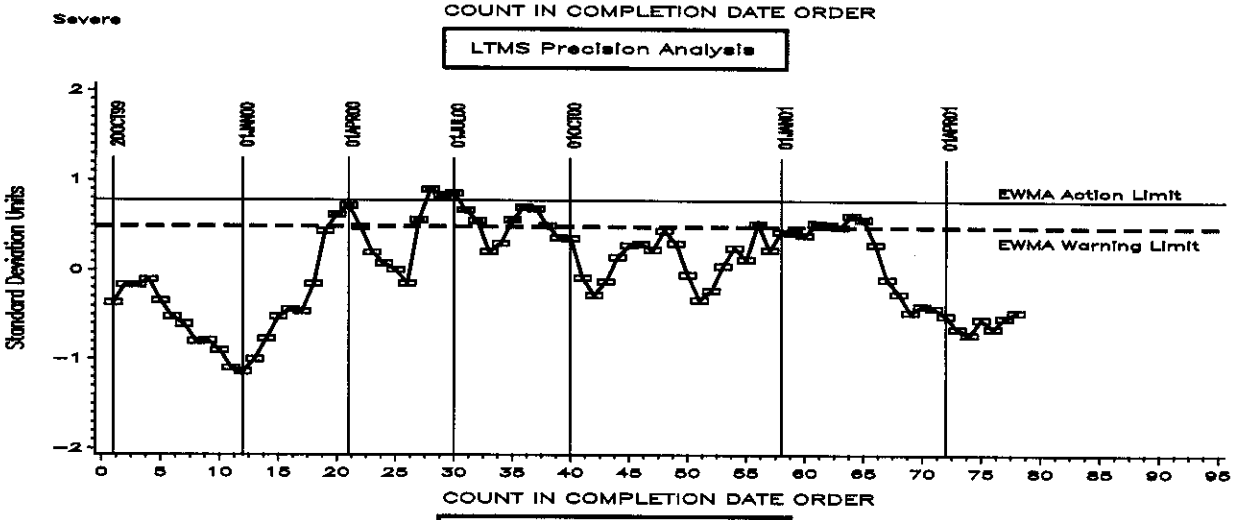
TMC 09MAY01:16:05

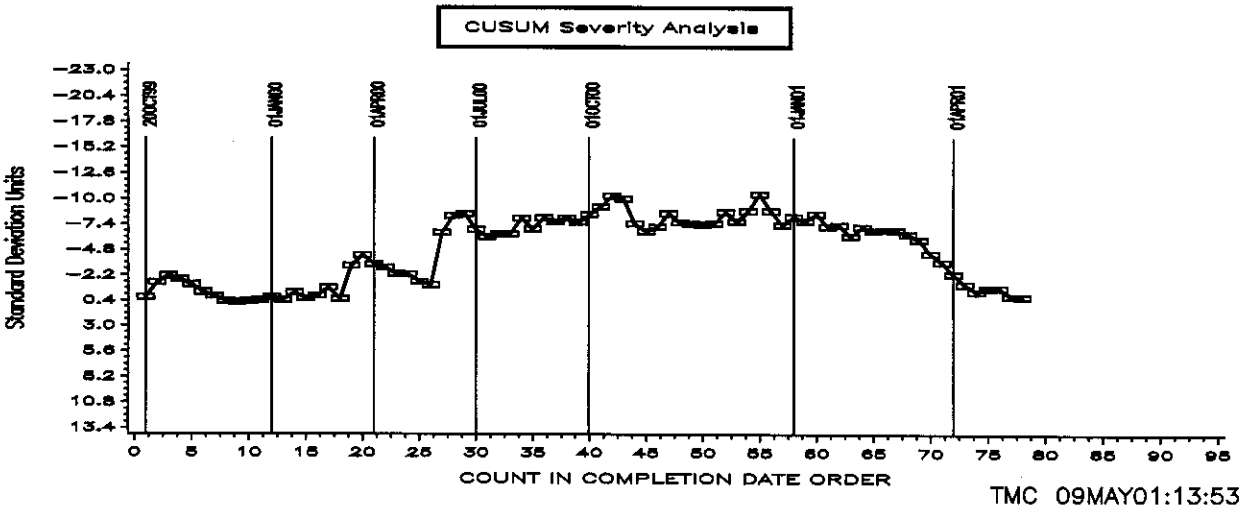
Attachment 6
Page 22
Reference Figure D

SEQUENCE IVA INDUSTRY OPERATIONALLY VALID DATA

Plot using new mean and 14.56 standard deviation
AVERAGE CAM WEAR







TMC 09MAY01:13:53

Attachment	7
Page	1
Reference	

Revising Test Targets for the Sequence IVA

Presented by SwRI

May 7, 2001

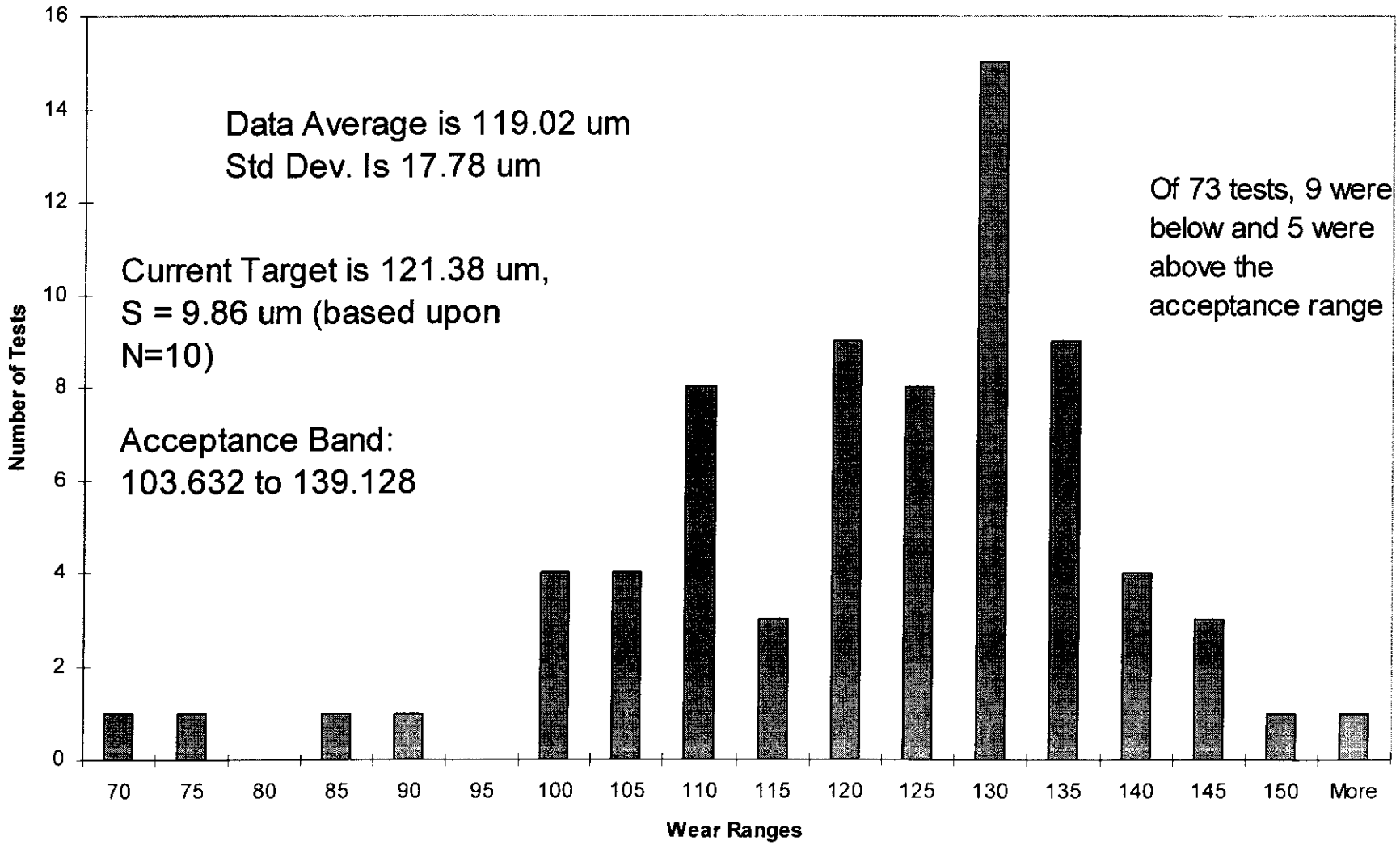
Attachment	7
Page	2
Reference	

Histogram of LTMS for Oil 1006

- Following is a histogram chart showing the distribution of the 73 LTMS operationally valid tests on oil 1006 listed in the TMC database.
- It is noted that 9 tests were listed below the 1.8s current acceptance range; 5 tests were listed above the 1.8s acceptance range.

Attachment	7
Page	3
Reference	

Sequence IVA
LTMS Results on Oil 1006
(all valid data since Oct. 1999)



Statistical Test for Outliers

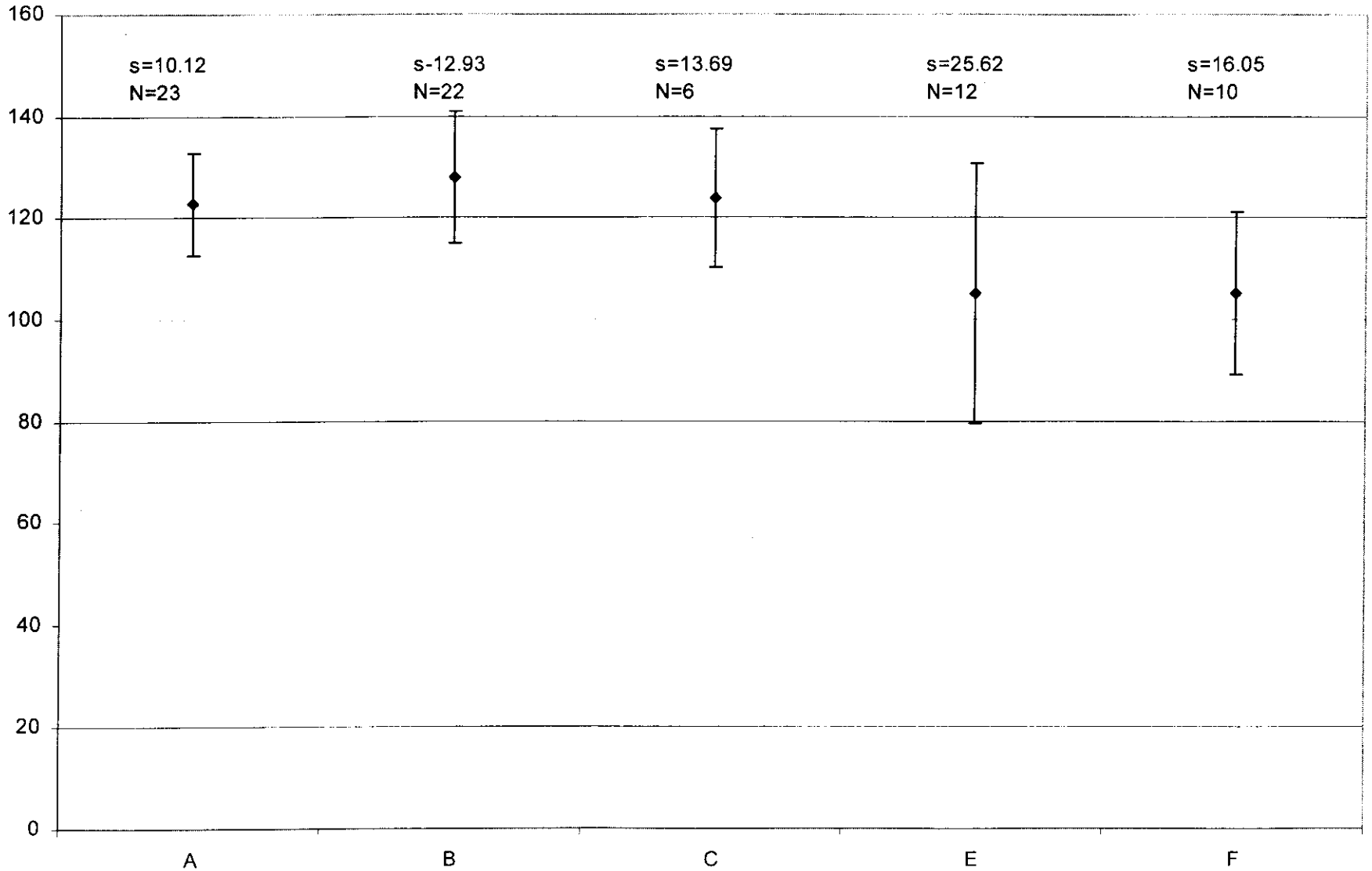
- Using an s=17.78, a statistical test to point out potential outliers resulted in only one LTMS test being identified (42.86 um result)
- If one were to have a good reason to remove this one statistical outlier, then the LTMS database average is 120.07 um, and s=15.42

Laboratory Comparisons

- The following chart shows the standard deviation of 1006, by laboratory, using the LTMS database.
  - Lab A average is 122.70 with s of 10.12
  - Lab B average is 127.89 with s of 12.93
  - Lab C average is 123.85 with s of 13.69
  - Lab E average is 104.99 with s of 25.62
  - Lab F average is 104.96 with s of 16.05

Attachment	7
Page	6
Reference	

Sequence IVA
Laboratory Comparisons



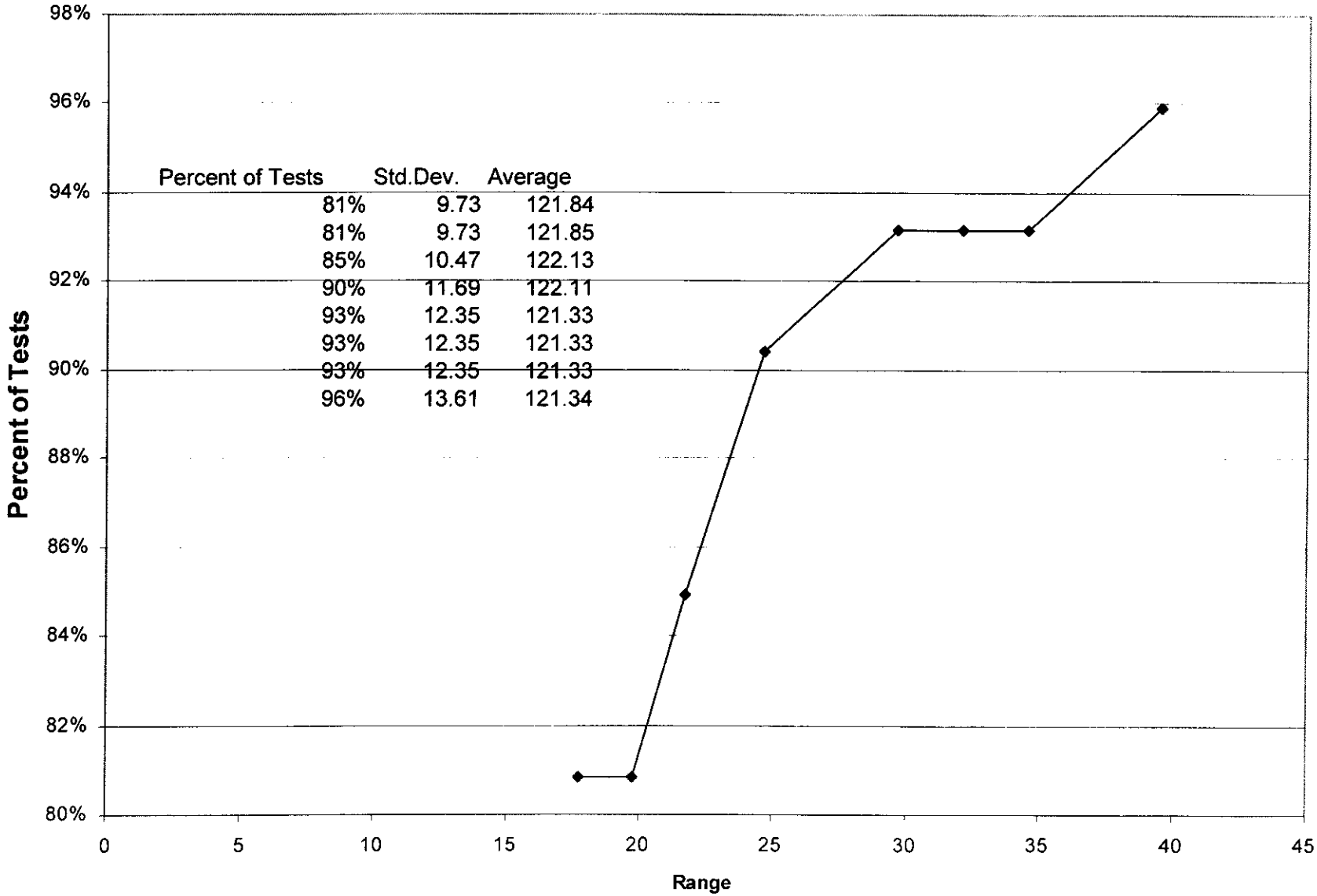
Weeding Tests from LTMS

- The following graph shows the resulting standard deviation and target when tests on the "fringe" (those tests beyond 35 um from current target) are excluded.
  - Entirely subjective exercise
  - Notice how the curve flattens out around 93%
    - is this telling us something??

Attachment 7
Page 8
Reference

Percent of Tests Within a Certain Range from Current 121.38 um Target

Percent of Tests	Std.Dev.	Average
81%	9.73	121.84
81%	9.73	121.85
85%	10.47	122.13
90%	11.69	122.11
93%	12.35	121.33
93%	12.35	121.33
93%	12.35	121.33
96%	13.61	121.34



What If?

- What would be the target and standard deviation if one only included 93% of the tests that are in the LTMS database?
- new target would be 121.33, and new "s" is 12.35
  - versus existing target is 121.38 with "s" being 9.86

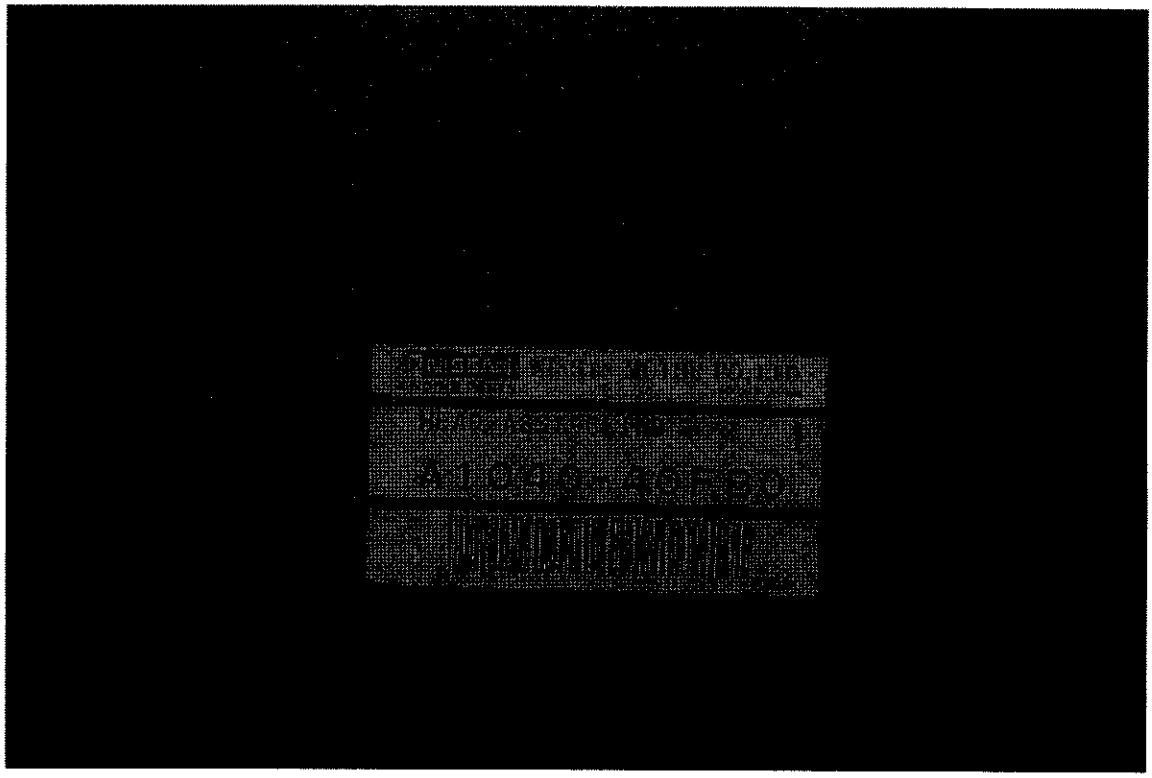
Recommendation

- SwRI believes that the current target is correct (near 121.38 um)
- The LTMS data indicates that the original, conservative sigma of 9.86 is too low
  - Should be reset to a sigma of 12.35??
  - Perhaps TMC can give guidance at upcoming meeting. Their semi-annual report will address this.
- All LTMS control charts (and Severity Adjustments) should be recalculated using a new sigma

Attachment 8
Page 1
Reference

Sequence IVA

1999 Cylinder Head



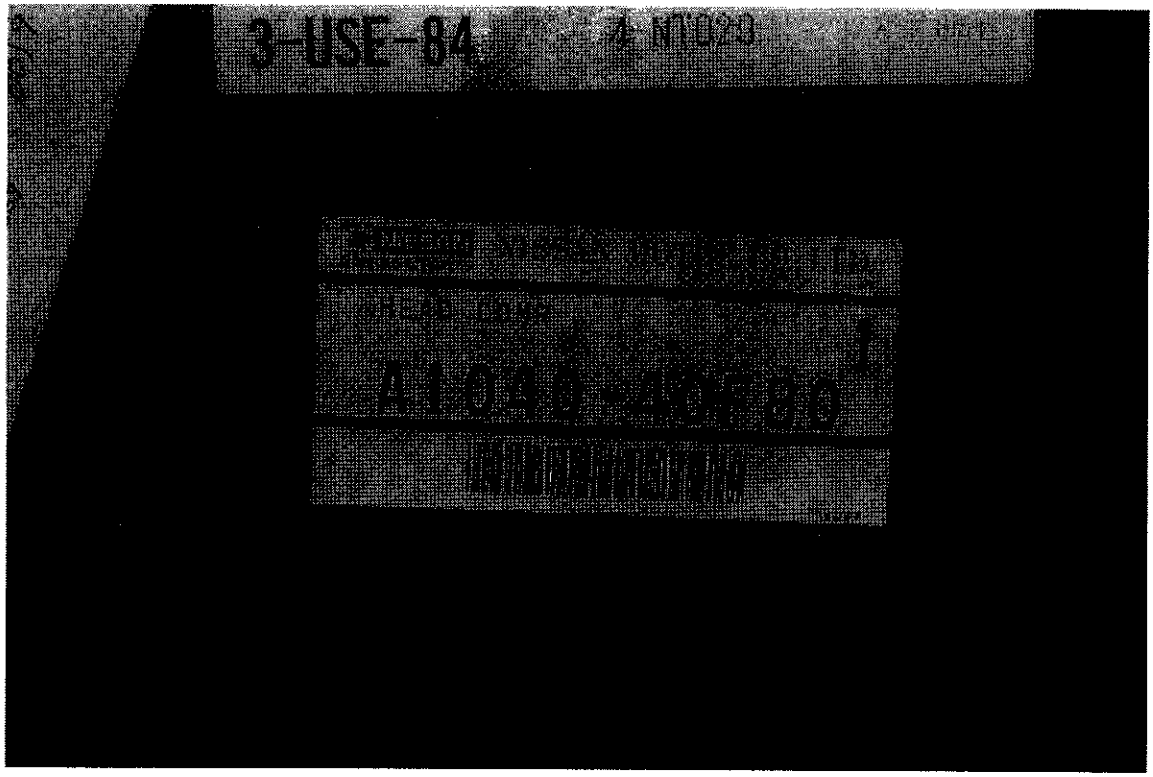
- It appears that Nissan did not provide lot numbers on 1999 cylinder head box labels.

Attachment	8
Page	2
Reference	

Sequence IVA

Cylinder Head Lot Number

1998 Cylinder Head



- The individual cylinder head assemblies are assigned lot numbers, but the cylinder heads that are part of the KA24E engine assemblies do not have lot numbers assigned.

- Currently SwRI uses the lot number that is assigned to the individual cylinder head assemblies for both the individual cylinder head assemblies and the cylinder heads that are part of the KA24E engine assemblies for that particular year's parts order (ie. For all cylinder heads from the 1998 parts order SwRI uses lot number 981030).

No.	Parts number	Name		1998				1999		2000
1	A0102 76P01	ENG ASSY-BARE	Date of delivery	98.8.31	98.9.30	98.10.21	98.10.30	99.7.30		00.9.18
			Number of deliver	12	13	13	1	35		14
			Lot numbaer	980820	980915	981001	981001	981008		000809
2	A1040 40F80	HEAD COMPL	Date of delivery	98.11.16				99.8.23		00.10.25
			Number of deliver	33				41		20
			Lot numbaer	981030				990719 and 99072		001023
3	A3020 40F01	CAM	Date of delivery	98.11.16	98.11.16	98.11.16	98.11.16	99.10.8	99.10.27	00.10.25
	(A3020 40F01 is included in 13000 40F85.)		Number of deliver	125	125	125	105	200	252	256
			Lot numbaer	980928	980929	981013	981015	990628 or 990729		000927
4	A3257 40F06	ROCKER-VALVE	Date of delivery	98.11.16				99.10.8	99.10.27	00.10.25
	(Number of delivery is number of 13000 40F85.)		Number of deliver	480				200	252	256
	(A3257 40F06 is included in 13000 40F85.)		Lot numbaer	981020				990928	991025	000825

*1:Cams were delivered. But lot numbers were not added.

Attachment 8
Page 3
Reference

Attachment 9
Page 1
Reference

Non-Interpretable Test Parameter(s)

Sequence IVA

13.2.3 Fuel Dilution

Measure the mass percent fuel dilution of the used oil sample at 100 hours. Fuel dilution typically ranges from 3.5% to 7.0%. If the fuel dilution exceeds 7.0%, then the valvetrain wear test results may not be interpretable.

Haltermann
PRODUCTS

Attachment	10
Page	1
Reference	

KA24E FUEL REPORT

WEEK OF 5/21/2001

SALEABLE GALLONS AT HATLTERMANN PRODUCTS	28,588
GALLONS SHIPPED SIX MONTH PERIOD 10/1/2000-3/30/01	26,435
AVERAGE USAGE PER MONTH	4,406
NUMBER OF MONTHS OF INVENTORY ON HAND	6

1201 South Sheldon Road P.O. Box 429 Channelview, TX 77530-0429
T 281-457-2768 F 281-457-1469 CS 800-969-2542

PRODUCT INFORMATION

Haltermann PRODUCTS

RESPONSIBLE CARE
ISO 9001 CERTIFIED

T (281) 457-2768 F (281) 457-1469

PRODUCT: KA24E TEST FUEL
PRODUCT CODE: HF008

Batch No.:	0011769	0011769
Tank No.:	682	682
Date sampled:	4/2/01	1/6/01
Date tested:	4/2/01	1/6/01

TEST	METHOD	UNITS	RESULTS	RESULTS
Distillation - IBP	ASTM D86	°F	89	87
5%		°F	115	113
10%		°F	128	127
20%		°F	150	150
30%		°F	179	180
40%		°F	210	212
50%		°F	225	227
60%		°F	234	234
70%		°F	242	243
80%		°F	260	261
90%		°F	315	319
95%		°F	343	343
Distillation - EP		°F	392	387
Recovery		vol %	97.8	97.9
Residue		vol %	1.0	1.0
Loss		vol %	1.2	1.1
Gravity	ASTM D4052	°API	59.1	58.9
Reid Vapor Pressure	ASTM D323	psi	8.9	9.1
Lead	ASTM D3237	g/gal	<0.01	<0.01
Oxidation Stability	ASTM D525	minutes	>1440	>1440
Gum content, washed	ASTM D381	mg/100mls	<1	<1
Gum content, unwashed	ASTM D381	mg/100mls	1	1

Attachment 10
Page 2
Reference

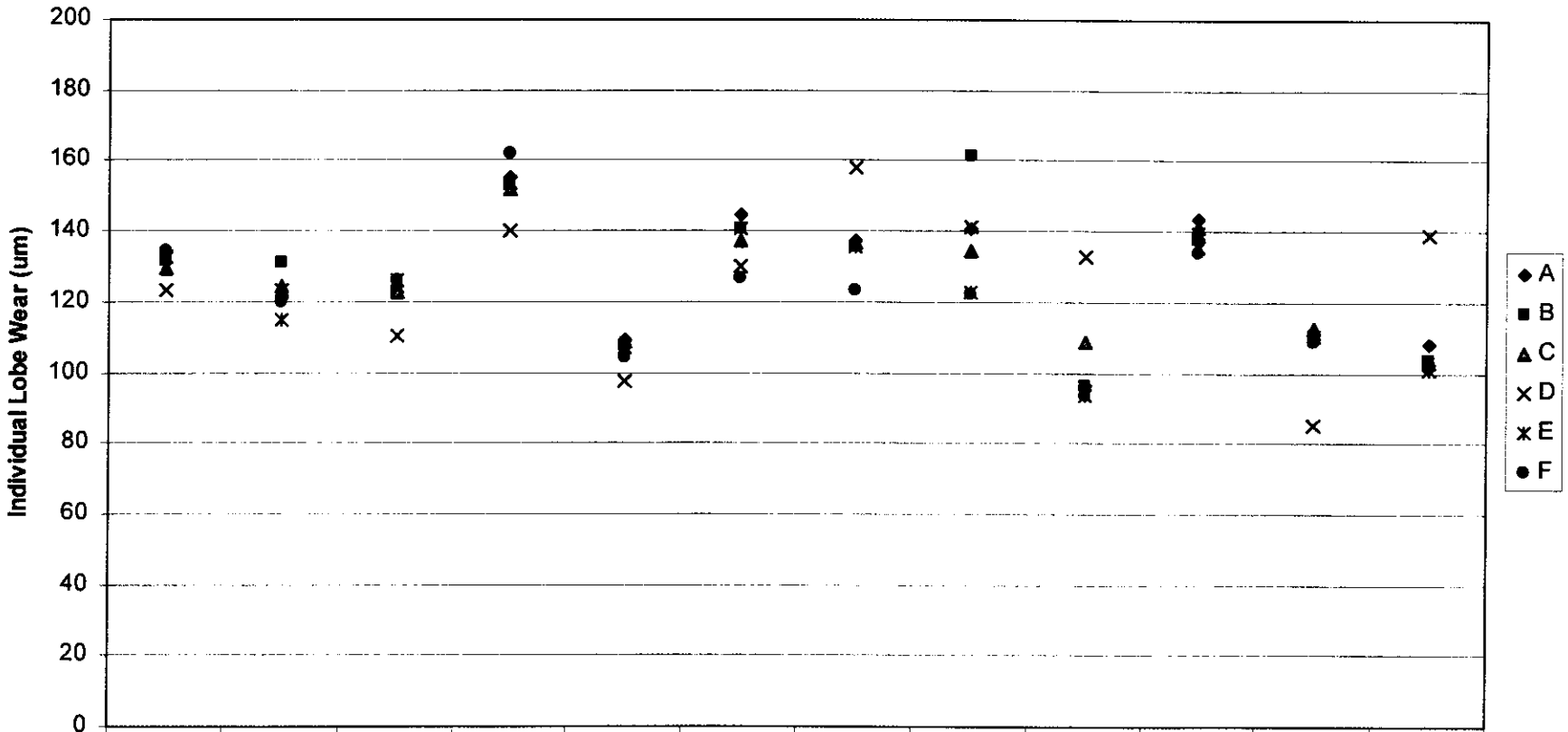
Sequence IVA

YEAR 2000

Measurement Round-Robin

Attachment	11
Page	2
Reference	

Cam A

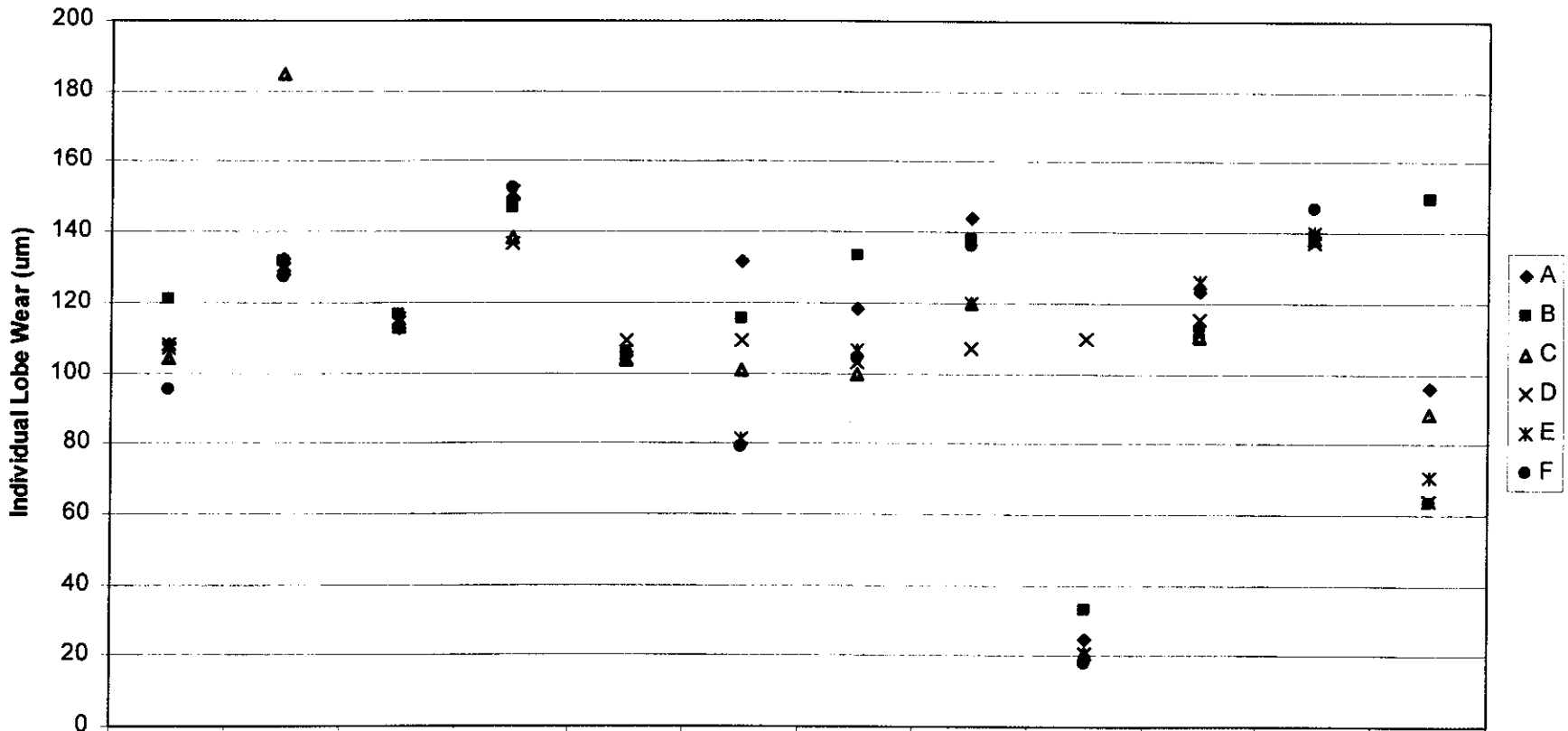


	1	2	3	4	5	6	7	8	9	10	11	12
◆ A	134.00	121.28	122.76	154.98	109.36	144.38	137.07	140.46	96.56	143.52	110.03	108.40
■ B	131.68	131.28	122.45	153.04	107.44	140.70	135.61	161.43	96.62	138.08	109.14	103.87
▲ C	129.60	124.53	122.47	151.65	108.80	137.18	136.44	134.56	108.61	141.24	112.39	102.81
× D	123.18	123.22	110.58	140.06	97.41	130.22	157.82	141.23	133.01	135.56	85.12	138.69
✱ E	132.75	114.65	126.11	153.54	106.96	140.70	135.39	122.65	93.76	139.72	110.32	101.07
● F	134.60	119.88	126.17	161.99	104.13	126.47	123.46	122.39	93.82	133.94	108.91	101.21

Lobe Number

Attachment	11
Page	3
Reference	

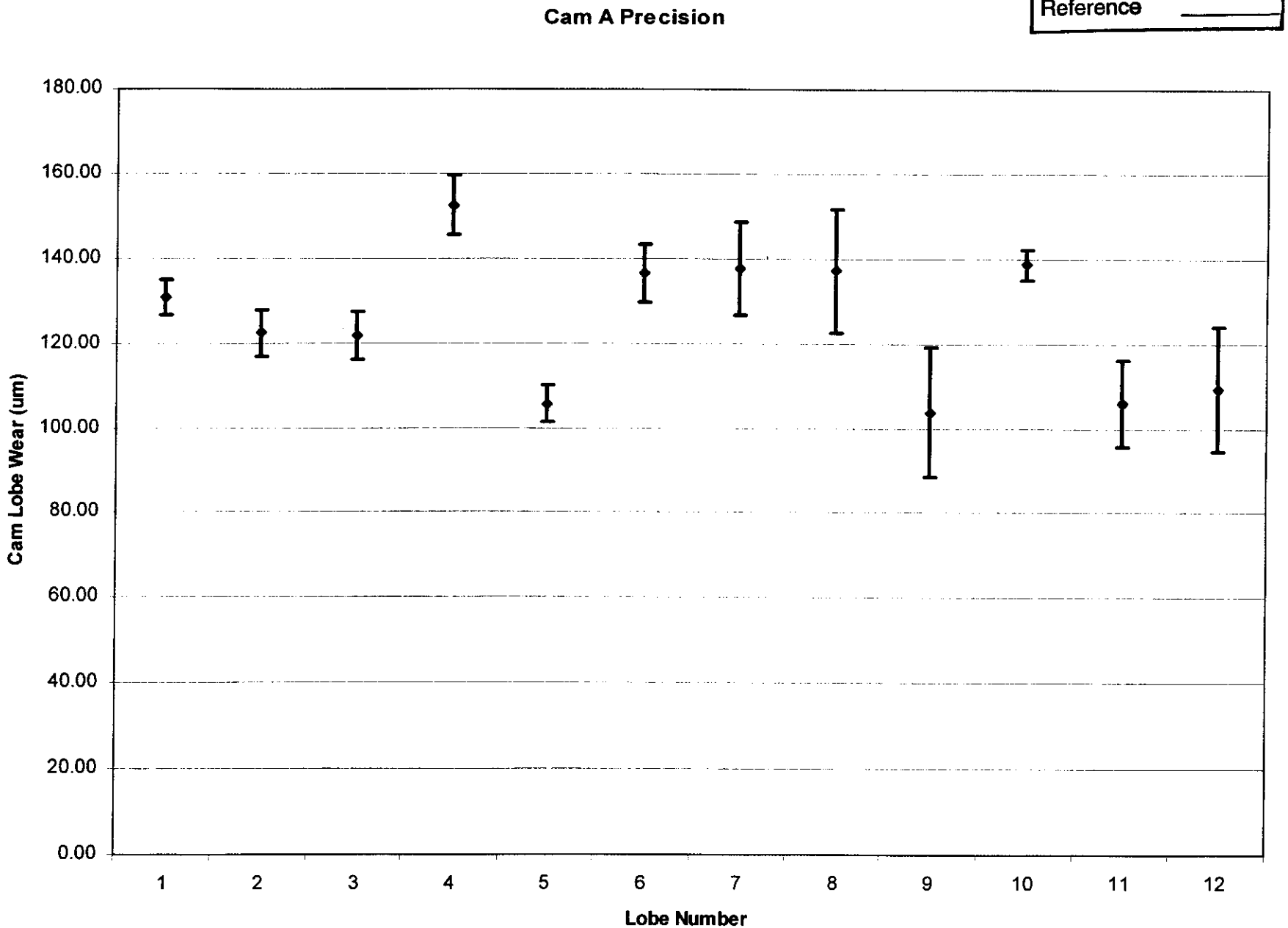
Cam B



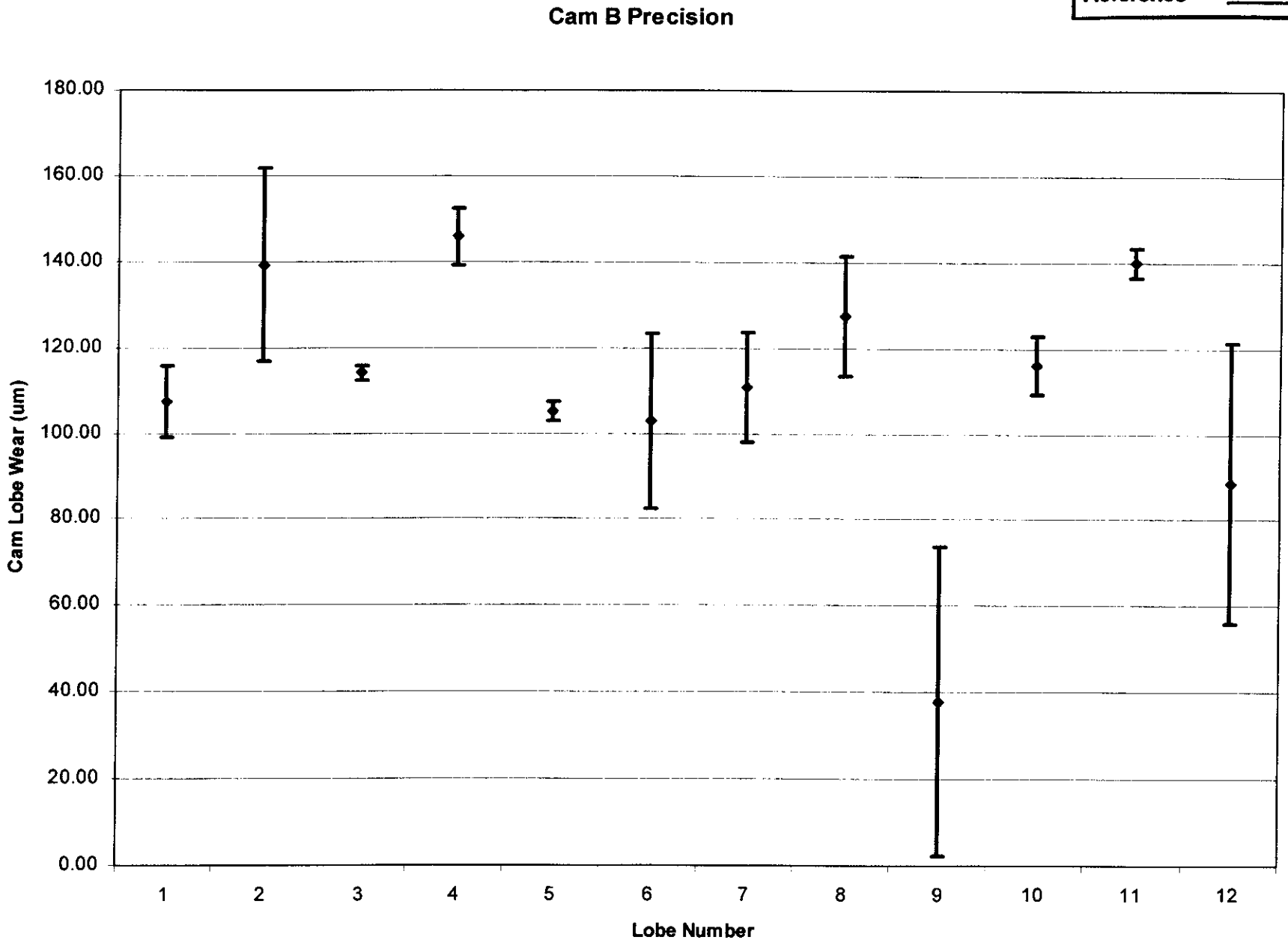
	1	2	3	4	5	6	7	8	9	10	11	12
◆ A	108.28	132.01	112.44	149.24	104.92	131.62	118.20	143.93	24.79	123.22	139.19	95.59
■ B	121.04	131.83	116.37	146.58	102.83	115.28	133.51	138.08	33.23	109.88	138.93	149.65
▲ C	104.23	185.10	112.92	138.58	103.54	101.12	99.84	119.94	20.78	110.46	138.49	88.65
× D	107.92	129.39	114.18	136.71	109.34	109.22	102.85	107.15	110.04	115.19	137.07	64.04
✱ E	106.82	130.38	115.48	151.28	103.99	81.02	106.51	119.92	20.87	125.86	139.81	70.61
● F	95.49	127.14	112.84	152.33	106.15	78.89	104.36	136.29	17.77	112.49	146.59	63.27

Lobe Number

Attachment 11
Page 4
Reference



Attachment	11
Page	5
Reference	



Attachment 11
Page 6
Reference

Position	Cylinder	Lobe Number	14° BTC Wear, µm	10° BTC Wear, µm	4° BTC Wear, µm	0° (Nose) Wear, µm	4° ATC Wear, µm	10° ATC Wear, µm	14° ATC Wear, µm	Lobe Wear, µm	Nominal Value
Intake	1	1	0.83	0.73	7.57	6.25	0.13	0.11	0.42	16.04	107.76
		3	-0.02	0.19	1.00	0.74	1.31	-1.85	1.90	3.28	114.23
	2	4	-0.74	-0.51	-0.48	0.49	0.93	0.85	0.88	1.43	147.97
		6	-1.12	0.31	2.88	7.76	4.90	1.14	-7.73	8.13	122.89
	3	7	1.79	2.90	3.51	2.79	0.86	-1.74	1.09	11.19	109.30
		9	-1.76	-1.37	-1.28	-0.94	-1.01	-0.49	0.48	-6.36	37.58
	4	10	1.48	1.45	0.51	0.53	-0.03	-2.41	0.47	2.00	117.84
		12	1.64	1.26	1.83	1.50	1.91	-0.22	-4.50	3.41	89.73
Exhaust	1	2	-6.47	-0.76	-0.21	-0.13	0.42	0.23	0.49	-6.43	139.52
	2	5	0.41	-0.66	0.58	0.49	0.30	-0.46	-0.52	0.13	105.62
	3	8	3.19	5.31	3.40	3.17	1.01	1.17	-0.51	16.74	130.45
	4	11	-1.09	-0.96	-0.05	-0.57	0.20	0.75	0.54	-1.17	140.00

Attachment	11
Page	7
Reference	

Position	Cylinder	Lobe Number	14° BTC Wear, µm	10° BTC Wear, µm	4° BTC Wear, µm	0° (Nose) Wear, µm	4° ATC Wear, µm	10° ATC Wear, µm	14° ATC Wear, µm	Lobe Wear, µm	Nominal Value
Intake	1	1	-2.81	-1.94	-2.99	-3.30	-1.08	-0.42	0.26	-12.27	107.76
		3	0.52	0.82	0.73	0.26	-0.32	-3.03	-0.37	-1.39	114.23
	2	4	1.23	1.20	1.80	0.98	0.82	-0.96	-0.72	4.36	147.97
		6	-2.72	-2.49	-4.24	-4.60	-9.91	-13.16	-6.89	-44.00	122.89
	3	7	-0.15	-0.23	-0.31	-1.17	-0.94	-2.10	-0.03	-4.94	109.30
		9	-2.52	-2.63	-3.34	-4.23	-3.60	-2.54	-0.96	-19.81	37.58
	4	10	-0.88	0.04	0.19	-0.58	-0.03	-3.48	-0.61	-5.35	117.84
		12	0.69	-0.24	-1.10	-5.18	-6.49	-7.34	-6.79	-26.46	89.73
Exhaust	1	2	-3.89	-12.11	1.16	1.37	0.85	0.37	-0.13	-12.38	139.52
	2	5	0.96	1.29	0.08	-0.01	0.11	-0.73	-1.16	0.53	105.62
	3	8	1.66	0.56	0.64	-0.26	0.63	0.80	1.81	5.84	130.45
	4	11	2.60	1.85	0.90	0.65	0.20	0.42	-0.03	6.60	140.00

Attachment	11
Page	8
Reference	

Position	Cylinder	Lobe Number	14° BTC Wear, µm	10° BTC Wear, µm	4° BTC Wear, µm	0° (Nose) Wear, µm	4° ATC Wear, µm	10° ATC Wear, µm	14° ATC Wear, µm	Lobe Wear, µm	Nominal Value
Intake	1	1	0.77	-0.60	-1.99	-1.38	1.16	0.78	0.31	-0.94	107.76
		3	-0.21	0.11	-0.37	0.21	0.59	1.32	-0.41	1.25	114.23
	2	4	-0.03	0.35	0.62	-0.40	0.07	2.12	0.58	3.31	147.97
		6	-4.00	-3.28	-5.24	-2.46	-6.20	-6.57	-14.13	-41.87	122.89
	3	7	-2.01	-2.43	-2.10	-0.52	-0.06	4.18	0.15	-2.79	109.30
		9	-3.01	-2.70	-3.23	-3.29	-2.23	-1.55	-0.71	-16.71	37.58
	4	10	0.75	0.69	1.73	0.73	1.19	4.88	-1.95	8.02	117.84
		12	-0.73	-0.15	-0.59	-6.45	-4.00	-4.78	-2.41	-19.12	89.73
Exhaust	1	2	-6.15	0.84	-1.86	-2.30	-0.45	0.33	0.45	-9.14	139.52
	2	5	-0.56	0.20	-0.52	0.10	0.20	-0.06	-0.98	-1.63	105.62
	3	8	-1.43	-0.67	-2.60	-1.70	0.32	0.75	-5.20	-10.53	130.45
	4	11	-1.66	-1.69	-0.20	0.11	1.06	0.66	1.53	-0.18	140.00

Position	Cylinder	Lobe Number	14° BTC Wear, µm	10° BTC Wear, µm	4° BTC Wear, µm	0° (Nose) Wear, µm	4° ATC Wear, µm	10° ATC Wear, µm	14° ATC Wear, µm	Lobe Wear, µm	Nominal Value
Intake	1	1	2.08	2.00	0.25	-0.41	-1.11	-1.21	-1.45	0.16	107.76
		3	-0.39	0.67	-0.45	-0.24	-1.70	4.17	-2.12	-0.05	114.23
	2	4	-1.10	0.14	0.22	-1.21	-2.40	-4.52	-2.40	-11.26	147.97
		6	13.78	9.70	2.96	-6.81	-6.64	-14.39	-12.27	-13.67	122.89
	3	7	0.82	-1.10	-1.48	-2.06	-3.29	1.43	-0.77	-6.45	109.30
		9	11.84	12.33	14.04	14.37	11.72	8.44	-0.27	72.46	37.58
	4	10	0.08	-1.04	-0.24	-3.07	-1.91	0.09	3.44	-2.65	117.84
		12	-0.49	-0.12	-2.14	4.00	-3.52	-4.85	-8.29	-15.41	89.73
Exhaust	1	2	-6.97	0.33	0.42	-0.09	-1.20	-1.14	-1.48	-10.13	139.52
	2	5	-0.57	0.87	-0.75	-1.22	-0.59	2.05	3.94	3.72	105.62
	3	8	-3.23	-7.53	-2.50	-3.09	-1.12	-2.46	-3.37	-23.30	130.45
	4	11	1.56	1.25	-0.38	-0.23	-1.17	-1.65	-2.31	-2.92	140.00

Position	Cylinder	Lobe Number	14° BTC Wear, µm	10° BTC Wear, µm	4° BTC Wear, µm	0° (Nose) Wear, µm	4° ATC Wear, µm	10° ATC Wear, µm	14° ATC Wear, µm	Lobe Wear, µm	Nominal Value
Intake	1	1	-0.63	0.22	-2.36	-1.21	0.25	0.18	0.02	-3.53	107.76
		3	0.52	-1.26	-0.34	-0.92	0.01	0.63	0.05	-1.31	114.23
	2	4	0.06	-1.12	-1.46	0.01	0.53	1.54	1.31	0.87	147.97
		6	-4.57	-3.07	1.25	-0.96	12.96	30.35	46.71	82.66	122.89
	3	7	-2.51	-2.16	-2.23	-1.68	2.67	-0.16	0.15	-5.92	109.30
		9	-2.68	-3.05	-3.10	-3.31	-2.51	-2.00	-0.16	-16.80	37.58
	4	10	-2.72	-2.00	-1.83	-0.20	0.36	-1.02	0.03	-7.38	117.84
		12	-0.01	-0.36	0.57	4.16	8.40	15.02	23.95	51.73	89.73
Exhaust	1	2	30.18	14.07	0.09	0.76	0.31	0.00	0.17	45.58	139.52
	2	5	-0.25	-0.95	-0.22	-0.01	0.13	-0.22	-0.55	-2.07	105.62
	3	8	-2.92	-2.30	-1.89	-0.99	-1.43	-0.57	7.88	-2.22	130.45
	4	11	-1.29	-0.73	-0.19	0.04	-0.02	0.23	0.45	-1.50	140.00

Position	Cylinder	Lobe Number	14° BTC Wear, µm	10° BTC Wear, µm	4° BTC Wear, µm	0° (Nose) Wear, µm	4° ATC Wear, µm	10° ATC Wear, µm	14° ATC Wear, µm	Lobe Wear, µm	Nominal Value
Intake	1	1	-0.25	-0.43	-0.49	0.04	0.65	0.56	0.44	0.52	107.76
		3	-0.42	-0.54	-0.57	-0.04	0.10	-1.26	0.94	-1.79	114.23
	2	4	0.58	-0.08	-0.70	0.13	0.03	0.96	0.34	1.27	147.97
		6	-1.37	-1.19	2.40	7.07	4.89	2.65	-5.71	8.74	122.89
	3	7	2.05	3.02	2.60	2.63	0.78	-1.61	-0.57	8.90	109.30
		9	-1.89	-2.58	-3.11	-2.59	-2.35	-1.88	1.60	-12.79	37.58
	4	10	1.31	0.84	-0.34	2.59	0.43	1.95	-1.40	5.38	117.84
		12	-1.08	-0.39	1.43	1.95	3.72	2.19	-1.96	5.86	89.73
Exhaust	1	2	-6.72	-2.38	0.42	0.38	0.06	0.21	0.52	-7.51	139.52
	2	5	0.03	-0.77	0.85	0.65	-0.12	-0.60	-0.73	-0.70	105.62
	3	8	2.73	4.63	2.96	2.86	0.59	0.33	-0.62	13.48	130.45
	4	11	-0.13	0.28	-0.07	-0.01	-0.28	-0.43	-0.17	-0.80	140.00

Attachment	12
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Reference	

Metallurgical Investigation of Anomalous Camshaft Lobe Wear Behavior in Sequence IVA Valve Train Lubricant Test: Progress Report #1

Robert W. Warke, Manager
Michael A. Cauchy, Engineer
Materials Characterization Section
Southwest Research Institute

Test Results: Normal Wear

Camshaft Lobe Wear

Laboratory: SR	Test Number: 80-6-101	Oil Code: CMIR-37324
Formulation/Stand Code: ----		

7-point measurement method

Position	Cylinder	Lobe Number	14° BTC Wear, μm	10° BTC Wear, μm	4° BTC Wear, μm	0° (Nose) Wear, μm	4° ATC Wear, μm	10° ATC Wear, μm	14° ATC Wear, μm	Lobe Wear, μm
Intake	1	1	19.21	19.10	22.44	22.88	20.66	12.24	7.90	124.33
		(3)	15.30	14.32	17.79	25.65	32.81	24.71	3.93	134.51
	2	4	11.18	13.02	16.73	19.59	15.81	10.47	3.80	90.60
		6	14.43	14.26	16.77	21.09	25.39	9.44	7.99	109.39
	3	7	13.03	16.65	24.76	29.48	25.31	10.40	2.60	122.23
		9	1.56	7.12	12.06	17.87	20.33	10.54	3.02	72.50
	4	10	8.30	13.22	24.33	23.12	14.41	7.62	3.56	94.56
		(12)	8.78	12.84	24.96	30.17	30.82	17.50	4.60	129.67
	Max. of Intake		19.21	19.10	24.96	30.17	32.81	24.71	7.99	134.51
	Avg. of Intake		11.47	13.82	18.98	23.73	23.18	12.66	4.68	109.72
Exhaust	1	(2)	2.33	10.75	19.27	22.50	19.12	17.11	10.64	101.72
	2	5	2.38	16.32	11.00	8.08	6.36	17.39	16.18	77.71
	3	(8)	5.16	18.30	18.65	17.06	18.00	17.97	17.96	111.10
	4	11	20.63	16.45	17.57	20.08	18.42	18.31	21.75	134.21
	Max. of Exhaust		20.63	18.30	19.27	22.50	19.12	18.31	21.75	134.21
	Avg. of Exhaust		7.62	15.46	16.12	16.93	15.48	17.94	16.63	106.18
Over-all Maximum			20.63	19.10	24.96	30.17	32.81	24.71	21.75	134.51
Over-all Average			10.19	14.36	18.69	21.46	20.61	14.56	8.66	108.54

Note: Plus direction is before top center of cam nose

Attachment	12
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Reference	

Results Summary

Laboratory: SR	Test Number: 80-5-101	Oil Code: CMIR-37324
Formulation/ Stand Code: ----		

Laboratory Oil Code:	LO-147811	Fuel Batch:	98-03160	SAE Grade:	5W-30
Date Started:	20000808	Date Completed:	20000810	Test Length:	100
Time Started:	13:22	Time Completed:	18:42	TMC Oil Code ^	1006
Lab Engine Number:	1997-011				
Cam Lot Number:	990628	Head Lot Number:	971001	Rocker Arm Lot Number:	991029

Average Camshaft Wear

Original Unit Result, µm	108.54
Transformed Result	108.54
Industry Correction Factor	0.000
Corrected Transformed Result	108.540
Severity Adjustment (non-reference oil tests only)	0.000
Final Transformed Result	108.54
Final Original Unit Result, µm	108.54

Additional Camshaft Lobe Wear Measurements

Intake Lobe	Maximum, µm	134.91
	Average, µm	109.72
Exhaust Lobe	Maximum, µm	134.21
	Average, µm	106.18
Nose	Maximum, µm	30.17
	Average, µm	21.46

Additional Information

Total Oil Consumption @ EOT, g	-90
Fuel Dilution @ EOT, %	4.80
Fuel Consumption @ EOT, kg	153.31
Fe by ICP @ EOT, ppm	109
Corr. Blowby, L/min @ hour 5	7.90
Corr. Blowby, L/min @ hour 100	7.94

Most Recent Stand Reference Oil History*

Test Number	80 0 98A		
Oil Code	CMIR-36918		
Date Completed	20000711	TMC Oil Code	1006
Final Average Camshaft Wear, µm	136.55		

Test Results: Mild Wear

Camshaft Lobe Wear

Laboratory: SR	Test Number: 80-4-100	Oil Code: CMIR-37323
Formulation/Stand Code: ----		

7-point measurement method

Position	Cylinder	Lobe Number	14° BTC Wear, µm	10° BTC Wear, µm	4° BTC Wear, µm	0° (Nose) Wear, µm	4° ATC Wear, µm	10° ATC Wear, µm	14° ATC Wear, µm	Lobe Wear, µm
Intake	1	1	7.56	10.69	11.49	13.41	11.31	2.86	1.87	59.19
		3	7.22	9.85	10.37	12.38	10.63	1.56	1.96	53.97
	2	4	3.97	6.29	13.17	11.80	5.00	3.28	3.13	46.64
		6	3.14	6.92	13.12	13.18	8.53	1.80	2.14	46.83
	3	7	7.14	11.35	14.04	13.85	13.58	2.44	2.75	65.15
		9	7.64	10.12	10.75	12.15	5.74	3.81	3.60	53.81
	4	10	4.43	10.71	14.69	13.50	11.95	2.98	3.13	61.37
		12	5.95	11.63	13.00	12.97	7.19	2.38	2.95	56.07
	Max. of Intake		7.64	11.63	14.69	13.85	13.58	3.81	3.60	65.15
	Avg. of Intake		5.88	9.70	12.58	12.90	9.99	2.64	2.69	55.38
Exhaust	1	2	4.22	3.97	3.86	7.37	7.00	7.62	5.46	39.50
	2	5	5.11	3.73	5.54	6.46	8.64	8.40	2.13	40.13
	3	8	4.21	4.25	10.10	12.66	12.12	8.24	4.88	56.36
	4	11	4.21	5.72	5.03	4.84	7.52	7.86	4.70	39.88
	Max. of Exhaust		5.11	5.72	10.10	12.56	12.12	8.40	5.46	56.36
	Avg. of Exhaust		4.44	4.42	6.16	7.81	8.82	8.03	4.29	43.97
Over-all Maximum			7.64	11.63	14.69	13.85	13.58	8.40	5.46	65.15
Over-all Average			5.40	7.94	10.44	11.21	8.93	4.43	3.22	51.58

Note: Plus direction is before top center of cam nose

Results Summary

Laboratory: SR	Test Number: 80-4-100		Oil Code: CMR-37323
Formulation/ Stand Code: ----			

Laboratory Oil Code:	LO-147610	Fuel Batch:	99-03180	SAE Grade:	N/A
Date Started:	20000728	Date Completed:	20000801	Test Length:	100
Time Started:	17:42	Time Completed:	21:07	TMC Oil Code [A]	1006
Lab Engine Number:	1997-011				
Cam Lot Number:	980729	Head Lot Number:	971001	Rocker Arm Lot Number:	991029

Average Camshaft Wear

Original Unit Result, µm	51.58
Transformed Result	51.58
Industry Correction Factor	0.000
Corrected Transformed Result	51.580
Severity Adjustment (non-reference oil tests only)	0.000
Final Transformed Result	51.58
Final Original Unit Result, µm	51.58

Additional Camshaft Lobe Wear Measurements

Intake Lobe	Maximum, µm	66.15
	Average, µm	55.38
Exhaust Lobe	Maximum, µm	56.36
	Average, µm	43.97
Nose	Maximum, µm	13.85
	Average, µm	11.21

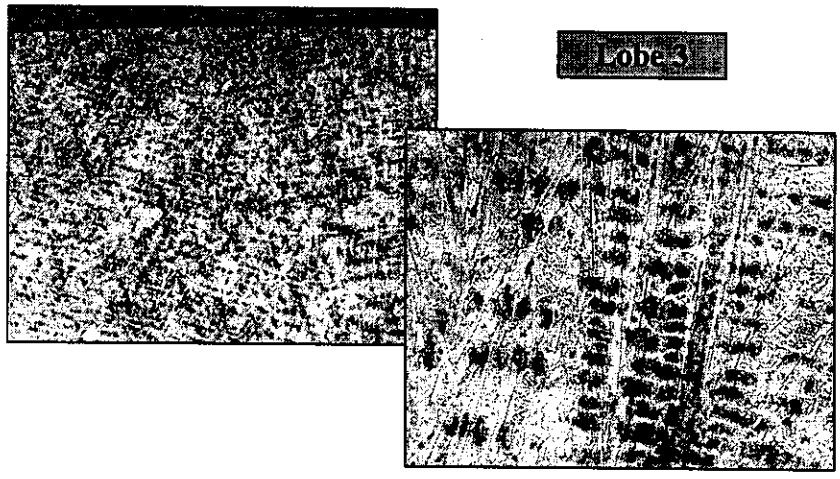
Additional Information

Total Oil Consumption @ EOT, g	-85
Fuel Dilution @ EOT, %	4.20
Fuel Consumption @ EOT, kg	141.85
Fe by ICP @ EOT, ppm	55
Corr. Blowby, L/min @ hour 5	7.46
Corr. Blowby, L/min @ hour 100	7.92

Most Recent Stand Reference Oil History

Test Number	80 -0 -98A		
Oil Code	CMR-35918		
Date Completed	20000711	TMC Oil Code	1006
Final Average Camshaft Wear, µm	136.56		

Metallography of Normal Wear (002) Camshaft



Attachment	12
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Reference	

Metallography of Mild Wear (001) Camshaft

Pearlite Fractions

Shaft	Lobe	Count	Vol%
002	2	2851/13269	21%
002	3	3190/9943	32%
002	8	4233/15804	27%
002	12	3694/13488	27%
001	2	2855/11389	25%
001	4	3019/11840	25%
001	7	3168/13803	23%
	001 (mild wear) average:		24%
	002 (normal wear) average:		26%

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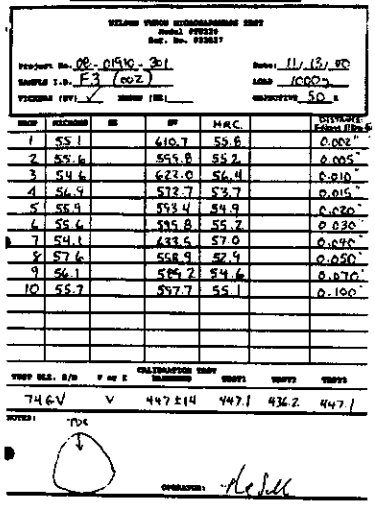
Reference	

Chemical Analyses

Element	002	001
C	3.53	3.46
Si	1.91	1.98
Mn	0.61	0.61
P	0.172	0.161
S	0.015	0.019
Cr	0.65	0.67
Mo	0.01	0.02
Ni	0.08	0.08
Cu	0.08	0.08
V	0.01	0.01
B	<0.0005	<0.0005
Pb	0.001	0.001

Hardness Traverses

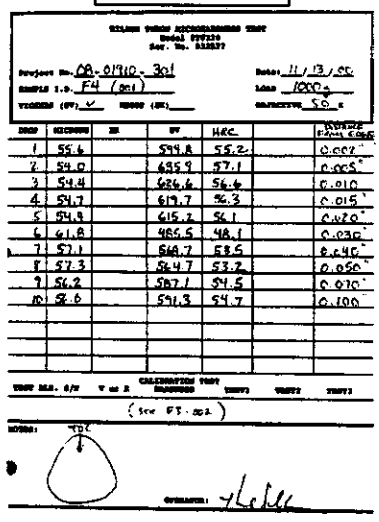
Normal Wear



1	55.1		610.7	55.6		0.002"
2	55.6		595.8	55.2		0.005"
3	54.6		622.0	56.4		0.010"
4	56.9		572.7	53.7		0.015"
5	56.9		593.4	54.9		0.020"
6	55.6		595.8	55.2		0.030"
7	54.1		633.5	57.0		0.040"
8	57.6		558.9	52.9		0.050"
9	56.1		589.2	54.6		0.070"
10	55.7		597.7	55.1		0.100"

746V	V	447±14	447.1	436.2	447.1

Mild Wear



1	55.6		599.8	55.2		0.002"
2	54.0		635.9	57.1		0.005"
3	54.8		624.6	56.6		0.010"
4	54.7		619.7	56.3		0.015"
5	54.9		615.2	56.1		0.020"
6	61.8		486.5	48.1		0.030"
7	57.1		648.7	58.5		0.040"
8	57.3		644.7	58.2		0.050"
9	56.2		587.1	54.5		0.070"
10	58.6		591.3	54.7		0.100"

(see 83-002)

Attachment	12
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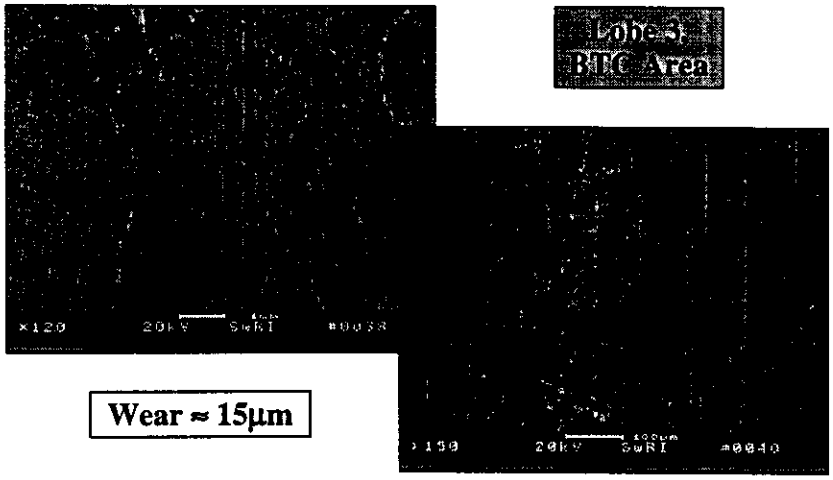
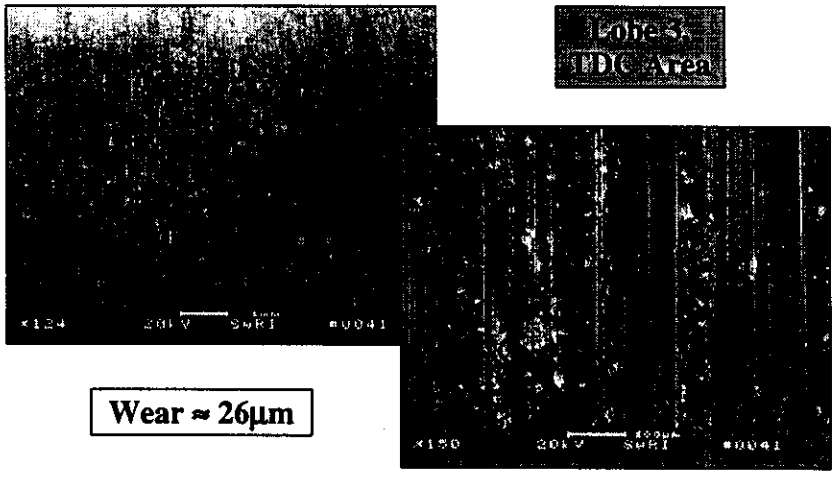
Reference	

SEM of Normal (002) Wear Surface



Wear ≈ 15µm

SEM of Normal (002) Wear Surface



Wear ≈ 26µm

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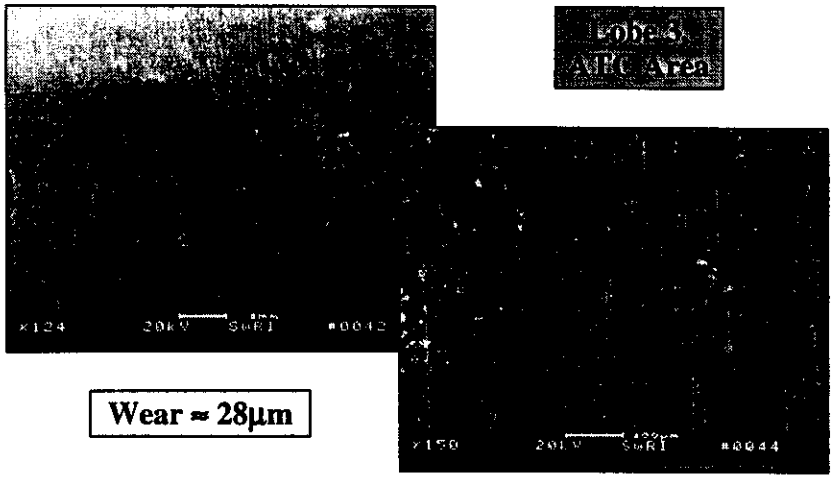
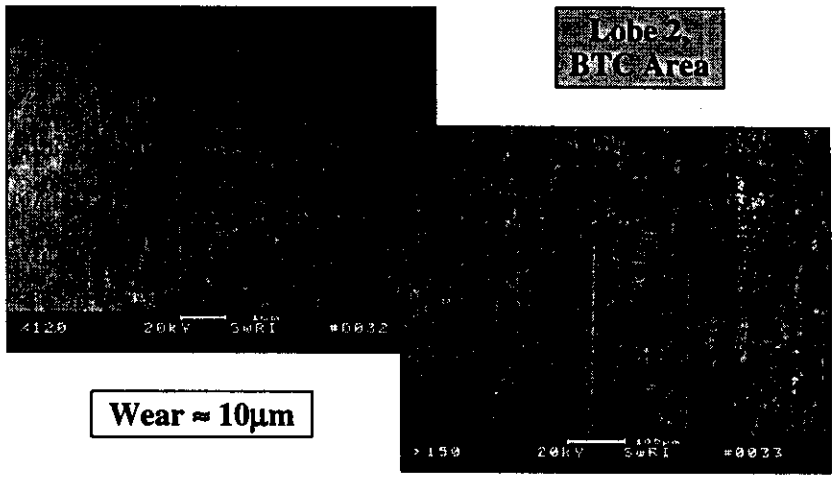
SEM of Normal (002) Wear Surface



SEM of Normal (002) Wear Surface



Attachment	12
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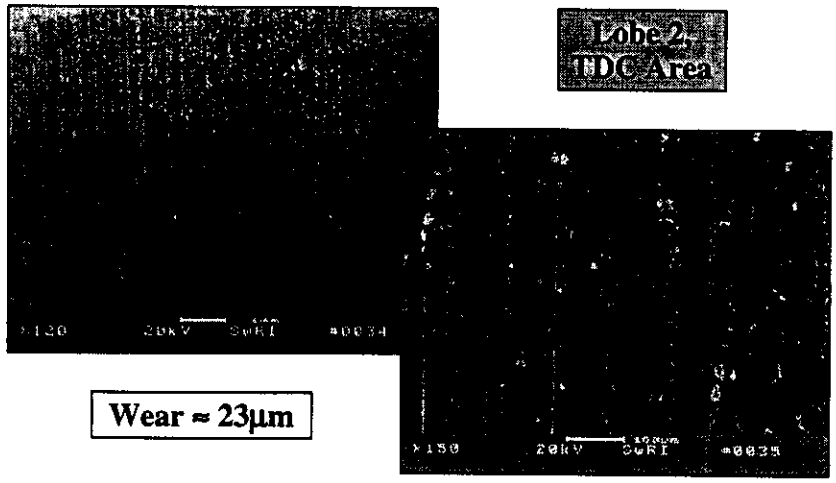
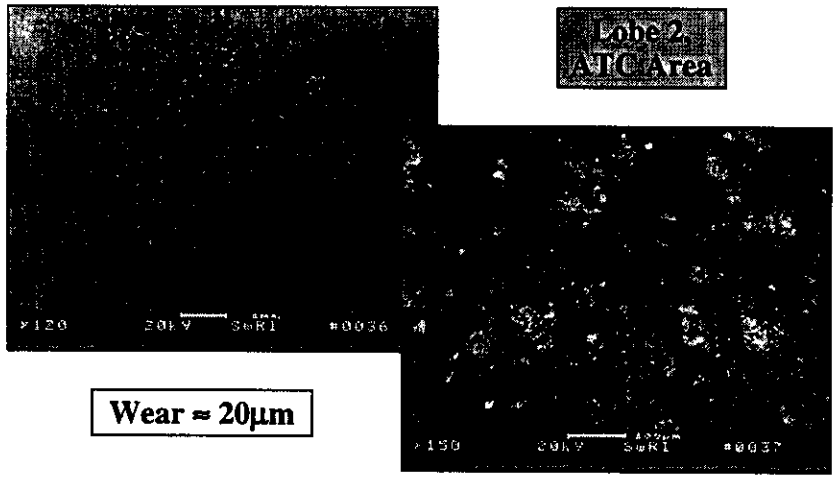
Reference	

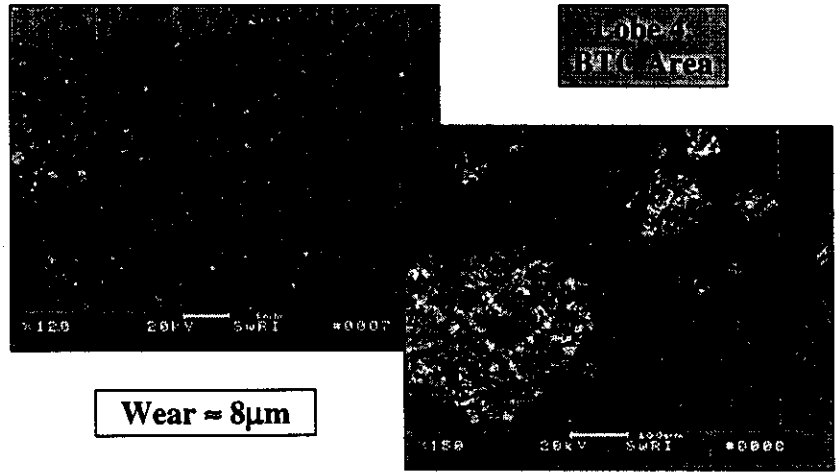
SEM of Normal (002) Wear Surface



SEM of Normal (002) Wear Surface

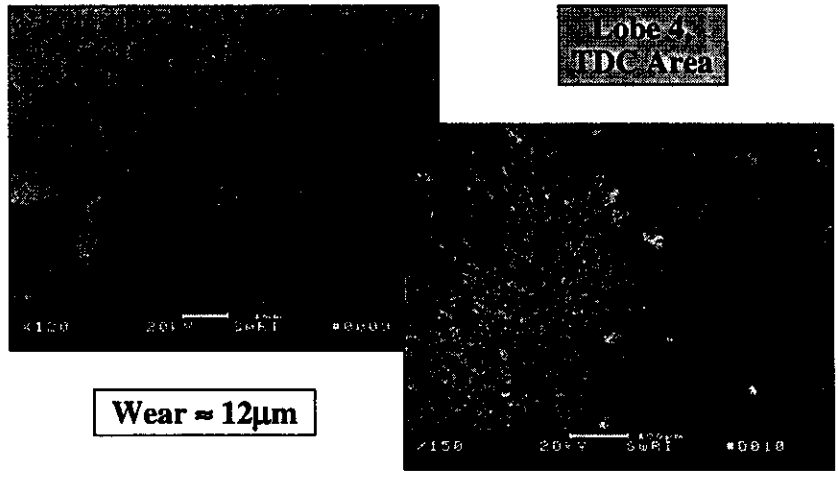


SEM of Mild (001) Wear Surface



Wear ≈ 8μm

SEM of Mild (001) Wear Surface



Wear ≈ 12μm

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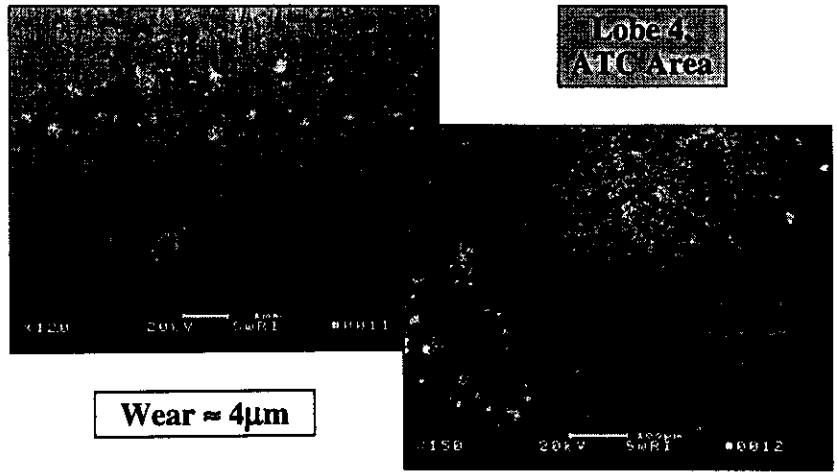
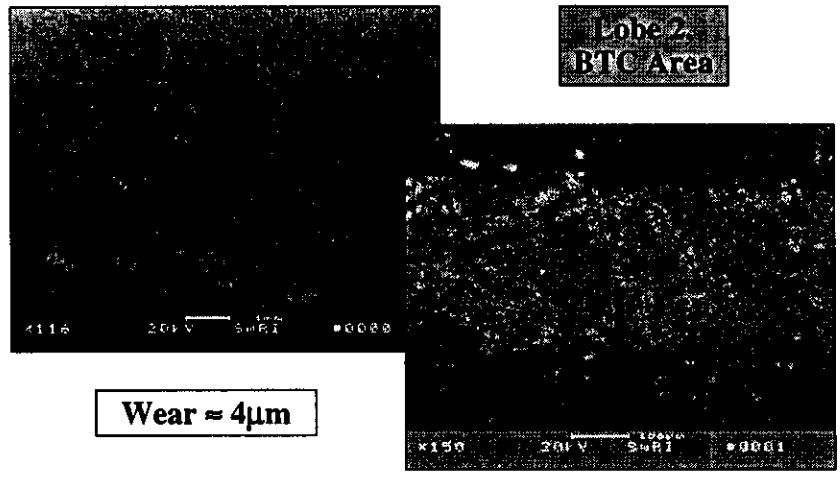
Reference	

SEM of Mild (001) Wear Surface



SEM of Mild (001) Wear Surface



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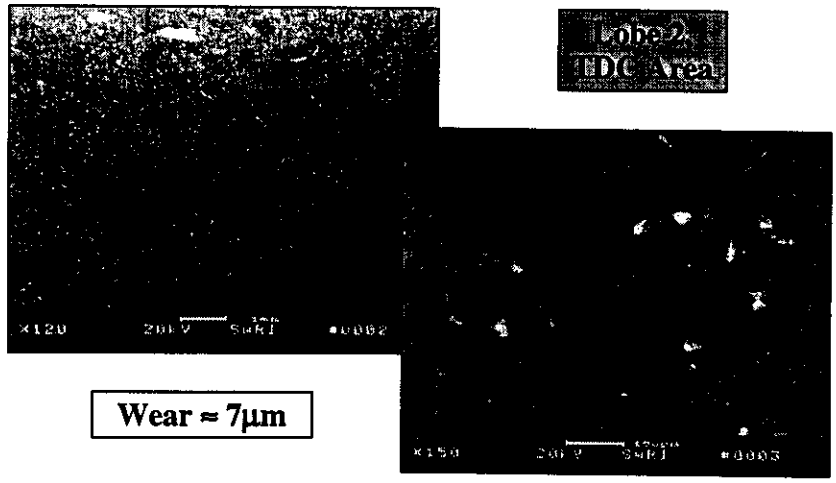
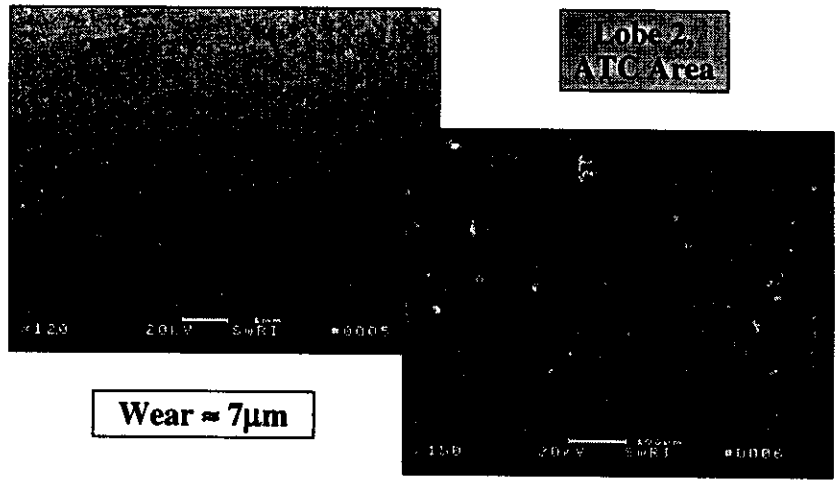
Reference	

SEM of Mild (001) Wear Surface



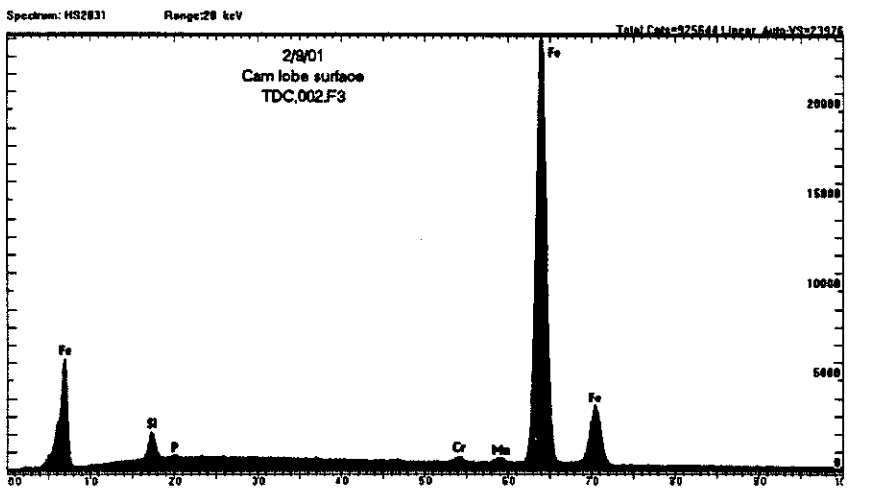
Wear ≈ 7μm

SEM of Mild (001) Wear Surface

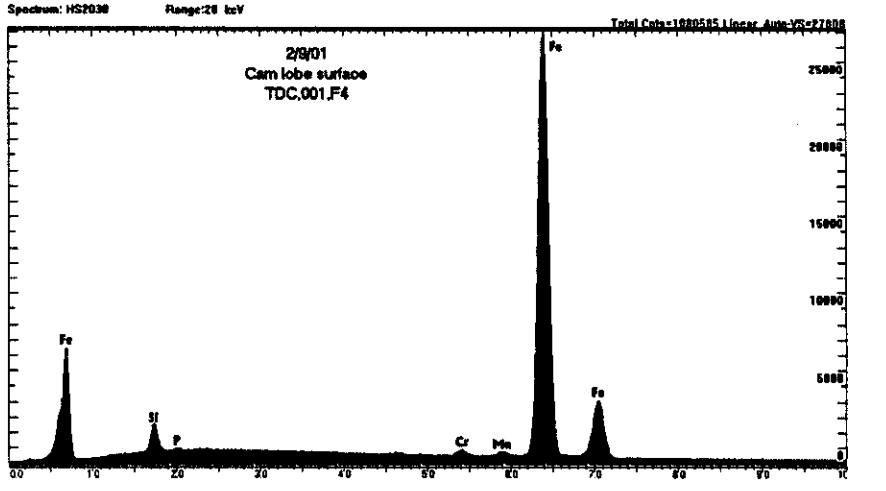


Wear ≈ 7μm

EDS of Normal (002) Wear Surface



EDS of Mild (001) Wear Surface



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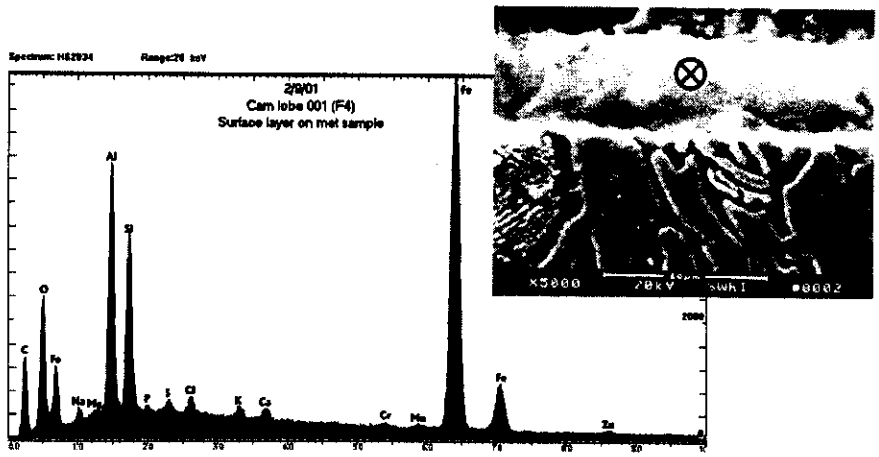
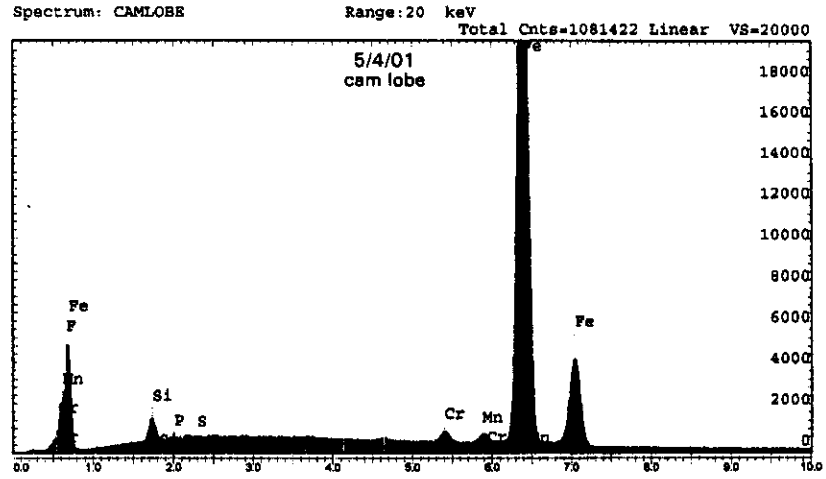
EDS of Mild (001) Wear Cross-Section



EDS of As-Received Lobe Surface, Mild Wear Lot



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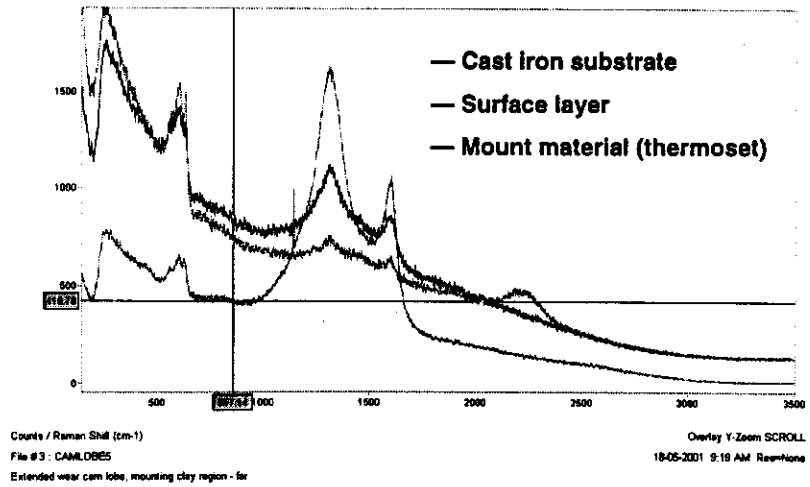
Reference	

Raman Spectrum of Mild (001) Wear Cross-Section



Conclusions and Future Work

- Microstructural and compositional differences cannot account for observed differences in wear rate.
- Raman spectroscopy shows promise as a means to identify surface layer.
- Surface layer did not appear on a virgin camshaft from mild wear lot.
- Auger spectroscopy will be used to study conditions giving rise to formation of surface layer.

May 24, 2001 Sequence IVA Surveillance Panel Meeting
San Antonio, Texas
Motions and Actions Items as Recorded at the Meeting

1. [Action Item] Bring over the April 2001 TGC action items into the Sequence IVA active action item list.
2. [Motion made by Bill Buscher, III and seconded by Gordon Fransworth] The panel unanimously accepted the RSI report.
3. [Motion made by Mike Kasimirsky and seconded by Carl Stephens] The panel unanimously accepted the TMC report.
4. [Motion made by Gordon Farnsworth and seconded by Bill Buscher, III] The Surveillance Panel agreed that the statistics for 1006 should now be set at a mean of 121.76 and a standard deviation of 12.50. Effective for all tests that complete on or after May 25, 2001. This standard deviation will also be used for lab severity adjustment calculations. Passed unanimously.
5. [Motion made by Dave Glaenzer and seconded by Gordon Farnswoth] TMC will introduce the re-blend of 1006 using the current limits of 1006 from motion 4 until 10 tests are completed, at which time new targets will be generated for the re-blend 1006. Further targets will be updated at 20 & 30 tests. Passed unanimously.
6. [Motion made by Gordon Farnsworth and seconded by Bill Buscher, III] Reintroduce the use of 1007. Reset the targets using data from the "MATRIX" and "DONATED" data excluding the one outlier listed in the TMC report, which produces 11 data points with a mean of 92.12 and a standard deviation 16.76. The targets will again be updated when 20 and 30 calibration tests are completed. The motion passed by a vote of 6-1-5. Effective today.
7. [Action Item] The TMC will issue 1006 and 1007 at a 50/50 mixture.
8. [Action Item] For the upcoming November meeting, compare the new 1007 data including the "donated" tests without the outlier versus the older "matrix" data.
9. [Motion made by Dan Worcester and seconded by Bill Buscher, III] Effective 5/24/01, on all calibrated IVA stands, re-word section 6.4 to read: A new engine short block assembly is utilized for 16 tests, and a new kit cylinder head assembly is utilized for a total of eight calibration or non-reference tests. A new head will be installed for the first (1st) and ninth (9th) calibration or non-reference test on that short block. The break-in procedure is conducted prior to the start on any test with a new head installed. One test will be considered to be 100 hours in length, less break-in. Shortened or extended length tests will count as single or multiple tests run on the head and block. Effective today. Passed unanimously.
10. [Motion made by Dwight Bowden and seconded by Carl Stephens] Suspend reporting the cylinder head lot number in the test report. You must put "N/A" in the report form for now. The motioner and seconder later withdrew the motion.
11. [Action Item] The Chairman will contact Nissan about having the cylinder head lot number added to the long block engines and the separate cylinder head pieces in a consistent and traceable manner.
12. [Action Item] A metrology workshop will be held on June 6, 2001 at SwRI.
13. [Action Item] The Surveillance Panel Chairman is looking for assistance and volunteers to help him and the facilitator with producing the ASTM Test Method.
14. [Motion made by Bill Buscher, III and seconded by Dan Worcester] Test numbering will follow the format of stand-runs since last reference-total runs on stand.