



# Test Monitoring Center

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

Memorandum: 02-028  
Date: April 30, 2002  
To: Bill Buscher, Chairman, Sequence IVA Surveillance Panel  
From: Michael T. Kasimirsky *Michael T. Kasimirsky*  
Subject: Sequence IVA Semiannual Report: October 1, 2001 through March 31, 2002

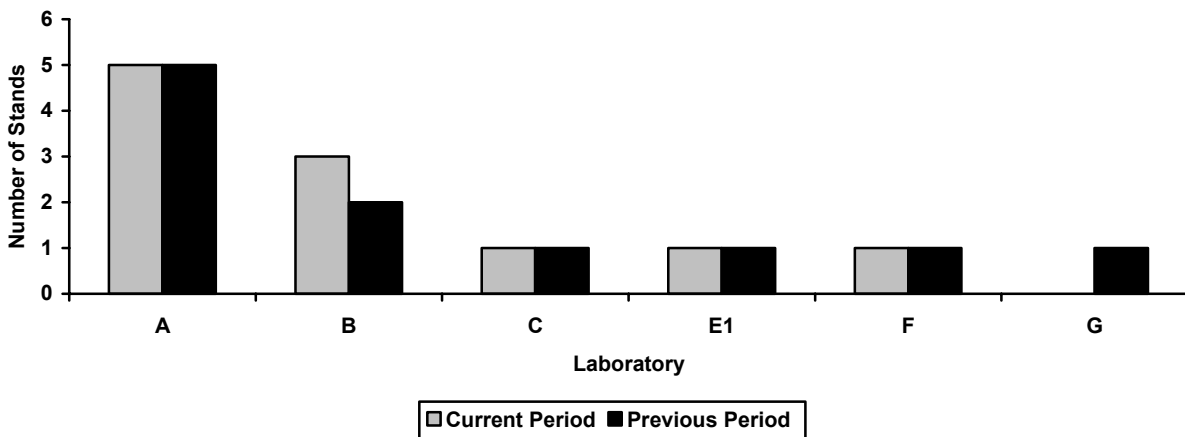
The following is a summary of Sequence IVA reference tests that were reported to the Test Monitoring Center during the period October 1, 2001 through March 31, 2002.

## Lab/Stand Distribution

	Reporting Data	Calibrated as of March 31, 2002
Number of Laboratories:	5	3
Number of Test Stands:	11	7

The following chart shows the laboratory/stand distribution:

### Laboratory/Stand Distribution



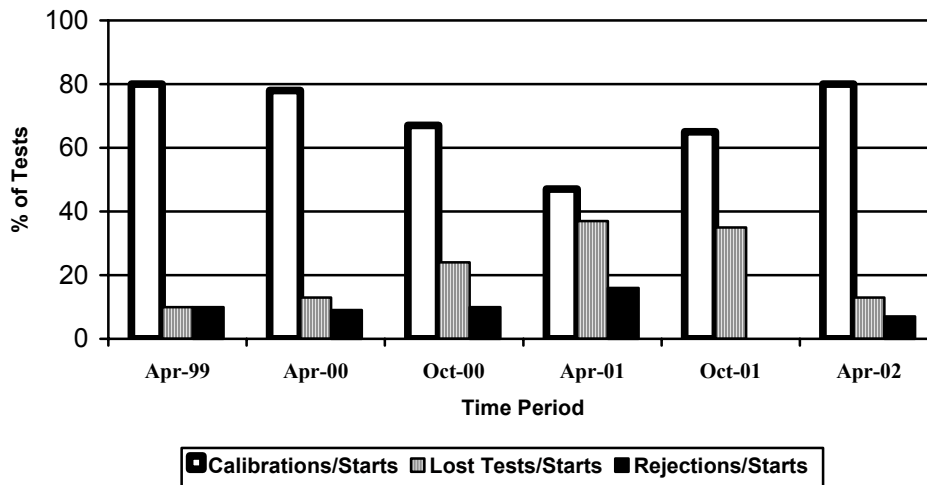
The following summarizes the status of the reference oil tests reported to the TMC:

Calibration Start Outcomes	TMC Validity Codes	No. of Tests
Operationally and Statistically Acceptable	AC	12
Failed Acceptance Criteria	OC	1
Stand Failed Reference Sequence – data pulled	MC	0
Operationally Invalid (Laboratory Judgment)	LC	1
Operationally Invalid (Lab & TMC Judgment)	RC	0
Aborted	XC	1
Total		15

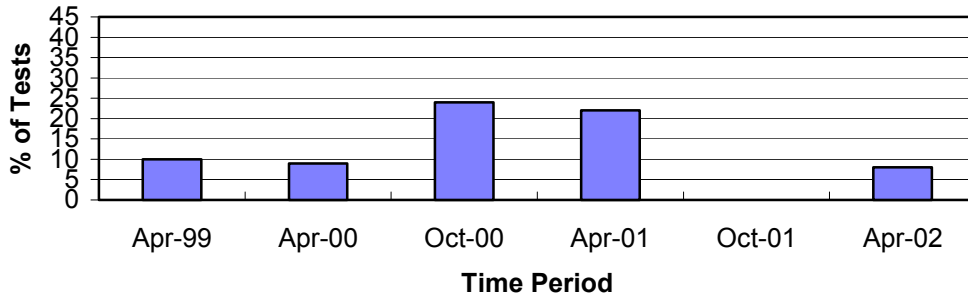
Donated & Industry Support Outcomes	TMC Validity Codes	No. of Tests
Acceptable Decoded Runs	AG	1
Acceptable Donated Tests (Reference oil 1006-2 test target generation)	NI	6
Invalid Decoded Runs	LG	0
Total		7

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

### Calibration Attempt Summary



**Rejected Test Rate**



One test failed this period for mild ACW.

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

There was one QI Deviation written this period on Coolant Outlet Temperature due to problems that the laboratory experienced with it's process water systems during a Sequence IVA test.

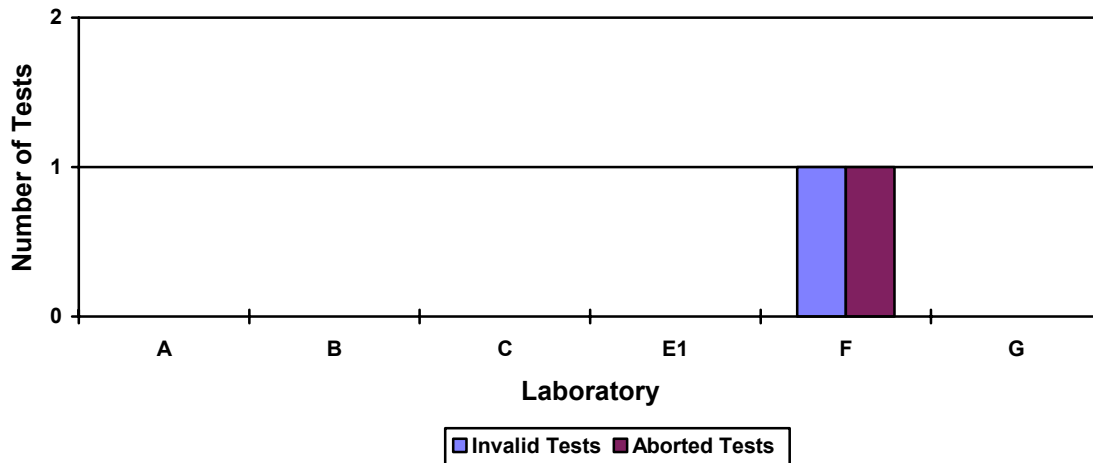
No lab visits were performed this period.

Lost Test Summary

Two 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)
F	Negative QI Results on Intake Air Pressure and Exhaust Back Pressure	1	1/0/0
	Test aborted due to severity concerns with test stand	1	0/0/1

### Lost Test Distribution



#### Information Letters

Sequence IVA Information Letter No. 02-1, Sequence No. 7, dated February 12, 2002, was issued during the period and contained a revised engine break-in specification and an updated draft standard of the Sequence IVA test procedure.

Sequence IVA Information Letter No. 02-2, Sequence No. 8, dated April 5, 2002, was issued since the last semiannual report and contained a revision to the camshaft measurement procedure.

#### Severity and Precision Analysis

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

Industry Severity Summary			
Parameter	Average $\Delta/s$	Pooled standard deviation (degrees of freedom)	Average $\Delta$ , in micrometers
ACW	-0.778	11.81 (df=10)	-9.19

ACW Results, by Laboratory	
Laboratory	Average $\Delta/s$
A	-0.593
B	-0.336
C	-0.687
E1	-0.696
F	-2.029
G	-

The industry experienced a severity alarm of ten data points during the period (see Figure 1). This alarm was initiated by a test on reference oil 1006 which generated mild failing results. Seven of the remaining nine tests in the alarm were mild of target but within the Shewhart Severity limits. In addition, all five laboratories reporting data for the period have been mild of target, on average. The mild results do not appear to be driven by test hardware or fuel batch as there are several different batches of hardware and fuel represented in the ten mild test results. The ten data points also include data on both reference oil 1006 and 1007 so it does not appear to be driven by a particular reference oil either. To date, no specific cause for the mild test results has been identified. Subsequent testing has since cleared the alarm. Severity for the period is the mildest obtained to date in the Sequence IVA test while precision is comparable to historical performance (see Figures 2 & 3).

### Hardware

No hardware changes were made this period.

During the period, the various test engineers involved in Sequence IVA testing activity discussed via email and also via teleconference the subject of rocker arm cover coolant flow rates. As you know, rocker arm cover coolant flow rate is not controlled in the Sequence IVA test at this time. While there is a control valve in the system, it merely acts as a fixed metering orifice in the Sequence IVA cooling system. Laboratories have reported varying levels of coolant flow through the rocker cover and the reasons for these varying flow rates were the subject of discussion. Several laboratories had noted that they were having trouble reaching the ~3.5 L/min flow rate that other laboratories had been observing. The reasons for these lower flow rates were investigated and the following factors were found to most influence the rocker arm cover flow rate: calibration problems with the system, extra plumbing fittings in the system causing flow restrictions, and in at least one case a bad research valve was found to be the culprit. The TMC was tasked with reviewing the calibration procedures and records for rocker cover flow during lab visits and with monitoring the rocker arm cover flow data on reference oil tests. Beyond that, no further action on this issue, specifically controlling rocker arm cover coolant flow rates using the research valve, is planned.

### Reference Oils

Oil	TMC Inventory, in gallons	TMC Inventory, in tests	Laboratory Inventory, in tests	Estimated life
1006	46	11	17	1 month or less <sup>1</sup>
1006-2	5,246	1,311	15	3+ years <sup>1</sup>
1007 <sup>2</sup>	509	127	16	3+ years <sup>1</sup>

<sup>1</sup> Multiple test area reference oil; total TMC inventory shown.

<sup>2</sup> Cannot be re-blended.

At the November 15, 2001 meeting of the Sequence IVA Surveillance Panel, the panel approved a plan to run a series of donated tests on reference oil 1006-2 for the purposes of test target generation. This data would be used to set the initial test targets on this reference oil. The targets would subsequently be updated when 10, 20, and 30 total data points became available and frozen after the final update.

Preliminary results showed that this reference oil was generating results significantly milder than the previous blend of this oil, both in Sequence IVA testing as well as in other test areas. Chairman Bendele expressed concern over the potential test targets resulting from this preliminary data set and asked that this issue be reviewed before going forth with the previously approved plan. The TMC generated test targets based upon the six available donated tests, both with and without severity adjustments applied. These

targets were distributed and discussed during a conference call of laboratory engineers that was previously scheduled for discussion of Rocker Arm Cover cooling issues held on January 31, 2002. The general consensus of the Chairman and the laboratory engineers was to introduce this reference oil using the severity adjusted target mean generated from the donated test data but to use the current standard deviation for reference oil 1006 for the initial targets. The targets would then be updated at 10, 20, and 30 data points as previously planned. Since this plan deviated from the plan originally approved by the Surveillance Panel, panel approval was necessary before it could be implemented.

On February 1, 2002, an E-ballot was sent out to the Surveillance Panel asking for approval of this revised plan. The ballot was approved on February 8, 2002, with a final tally of eight votes for the plan, no votes against the plan, and three members who responded but abstained from voting. The approved test targets for reference oil 1006-2 are shown in the following table, along with the latest targets for reference oil 1006 for comparison purposes:

Reference Oil	Mean	Standard Deviation
1006-2	88.74	12.50
1006	121.76	12.50

The TMC currently has a total of eight data points on reference oil 1006-2 and will be processing a test target update when an additional two data points become available.

MTK/mtk

Attachments

c: F. M. Farber, TMC  
Sequence IVA Surveillance Panel  
<ftp://ftp.astmtmc.cmu.edu/docs/gas/sequenceiv/semiannualreports/IVA-04-2002.pdf>

Distribution: Electronic Mail

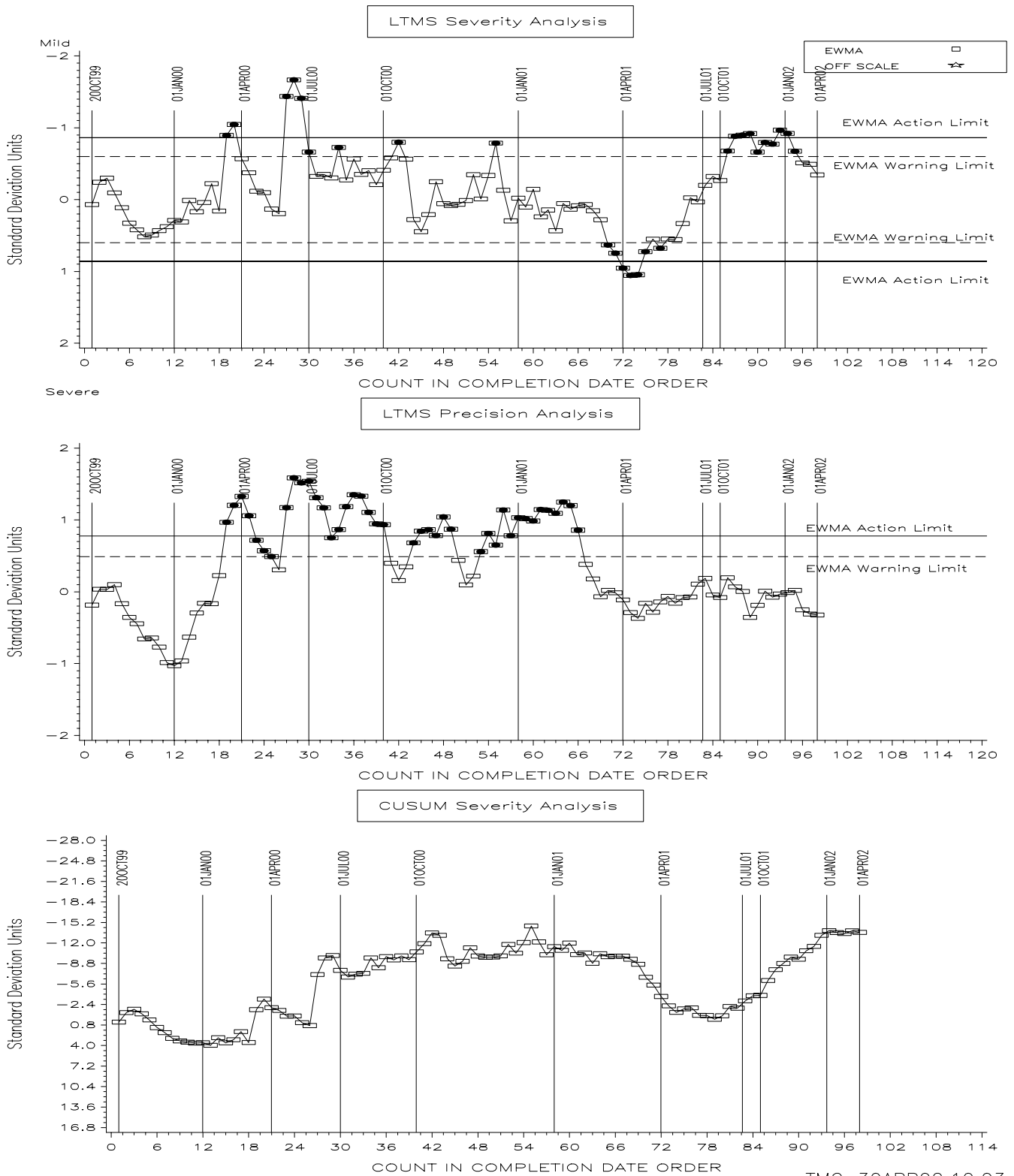
List of Figures

- 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.

# SEQUENCE IVA INDUSTRY OPERATIONALLY VALID DATA

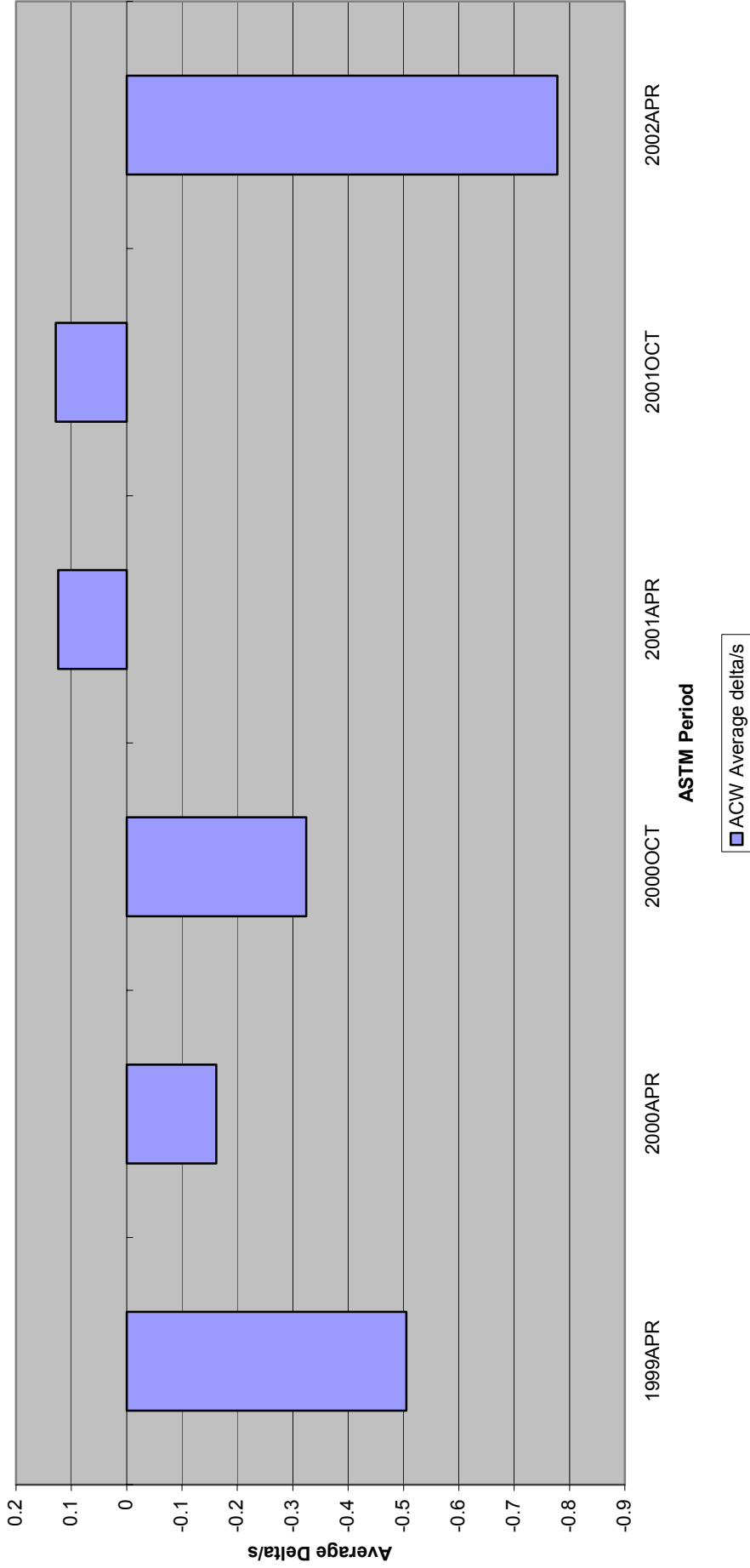
## AVERAGE CAM WEAR

Figure 1

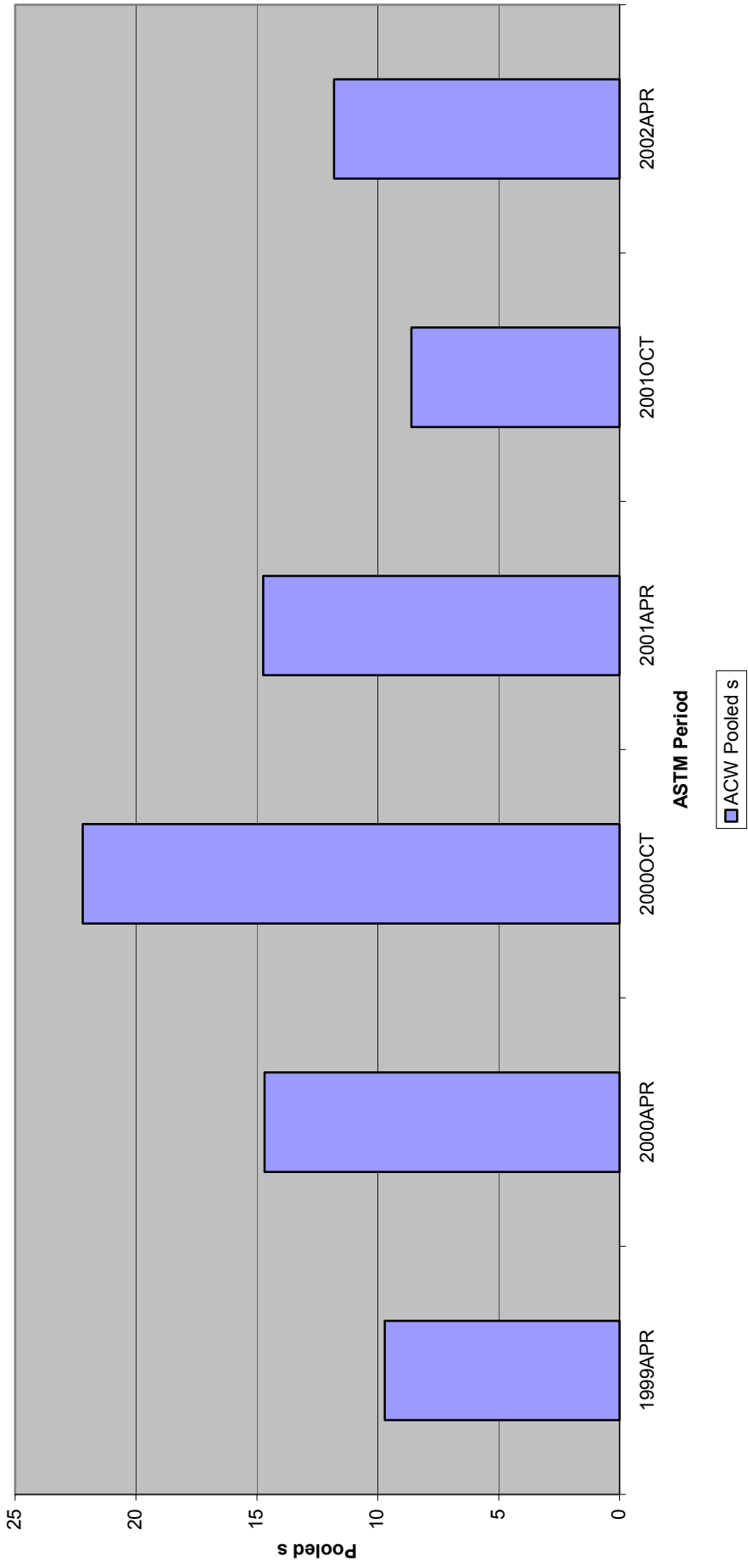




**Figure 2 - Sequence IVA Reference Oil Data  
Average Camshaft Wear**



**Figure 3 - Sequence IVA Reference Oil Data  
Average Camshaft Wear**



**Figure 4 - Sequence IVA Timeline**

<b>Date</b>	<b>Topic</b>	<b>Information Letter</b>
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	REVISED 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
7/22/2001	ROCKER COVER COOLANT FLOW MEASUREMENT & REPORTING	01-1
5/24/2001	REVISED CYLINDER HEAD AND TEST ENGINE REPLACEMENT REQUIREMENTS	01-2
5/25/2001	REVISED TEST NUMBERING REQUIREMENTS	01-2
2/12/2002	REVISED ENGINE BREAK-IN SPECIFICATIONS	02-1
2/12/2002	UPDATED DRAFT STANDARD OF SEQUENCE IVA TEST PROCEDURE RELEASED	02-1
4/5/2002	REVISED CAMSHAFT MEASUREMENT PROCEDURES	02-2