



Test Monitoring Center

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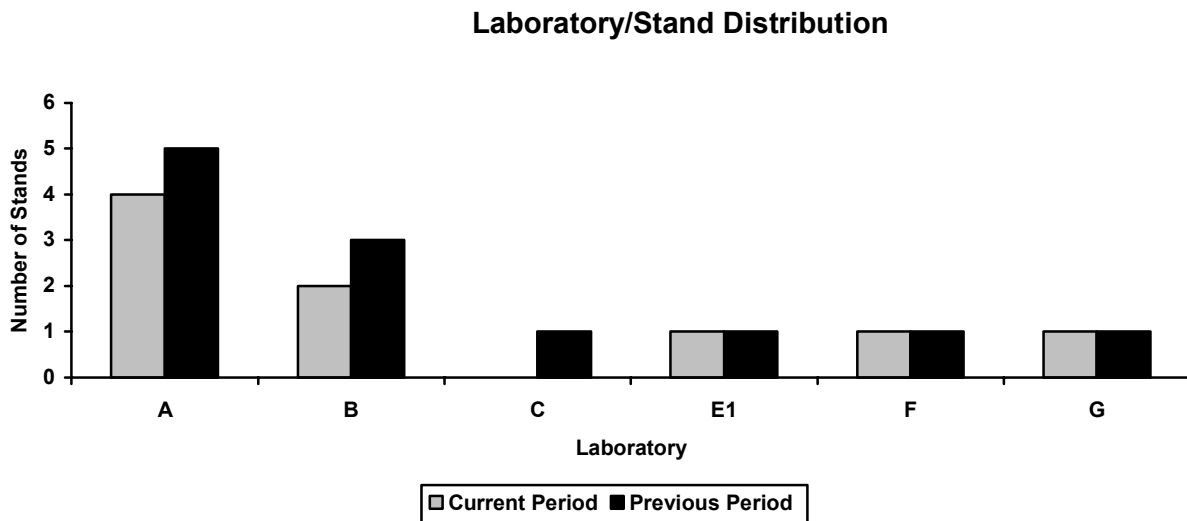
Memorandum: 04-097
Date: November 2, 2004
To: Bill Buscher, Chairman, Sequence IVA Surveillance Panel
From: Michael T. Kasimirsky *Michael T. Kasimirsky*
Subject: Sequence IVA Semiannual Report: April 1, 2004 through September 30, 2004

The following is a summary of Sequence IVA reference tests that were reported to the Test Monitoring Center during the period April 1, 2004 through September 30, 2004.

Lab/Stand Distribution

| | Reporting Data | Calibrated as of September 30, 2004 |
|-------------------------|----------------|-------------------------------------|
| Number of Laboratories: | 5 | 3 |
| Number of Test Stands: | 9 | 5 |

The following chart shows the laboratory/stand distribution:



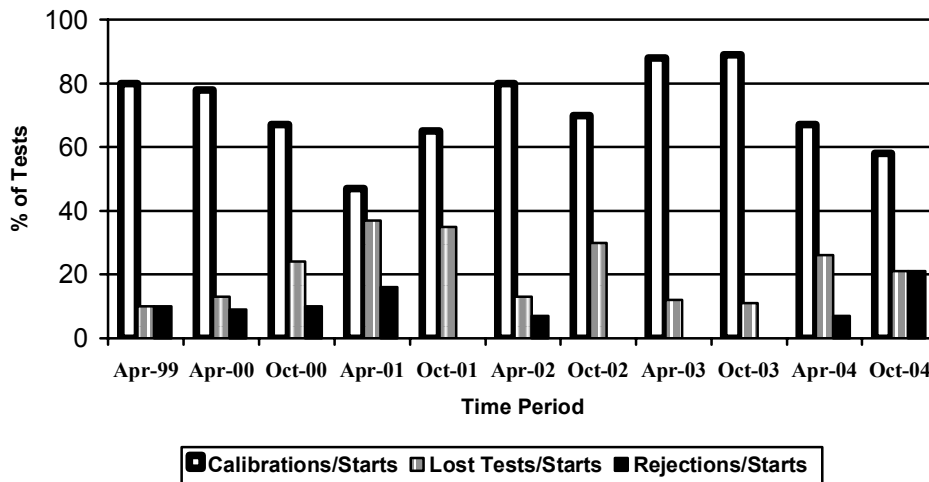
The following summarizes the status of the reference oil tests reported to the TMC:

| Calibration Start Outcomes | TMC Validity Codes | No. of Tests |
|---|--------------------|--------------|
| Operationally and Statistically Acceptable | AC | 9 |
| Failed Acceptance Criteria | OC | 3 |
| Stand Failed Reference Sequence – data pulled | MC | 0 |
| Operationally Invalid (Laboratory Judgment) | LC | 3 |
| Operationally Invalid (Lab & TMC Judgment) | RC | 1 |
| Aborted | XC | 0 |
| Total | | 16 |

| Donated & Industry Support Outcomes | TMC Validity Codes | No. of Tests |
|-------------------------------------|--------------------|--------------|
| Donated Tests | AG | 0 |
| Total | | 0 |

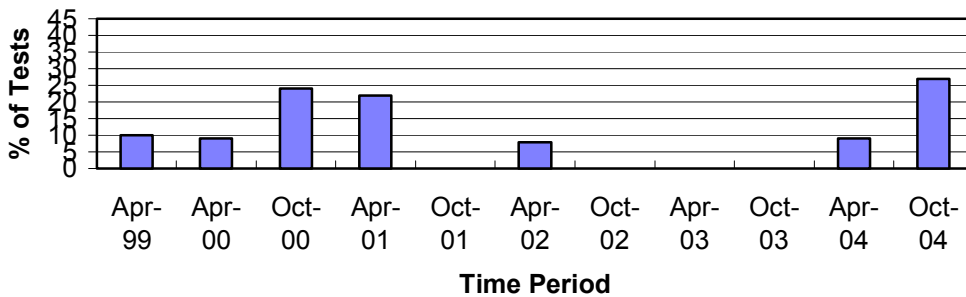
Calibrations per start, lost tests per start and rejection per start rates are summarized below:

Calibration Attempt Summary



The calibration per start rate has decreased since last period. The lost test rate is slightly lower than last period. The rejected test rate is at the highest level on record in the Sequence IVA test.

Rejected Test Rate



Three tests failed this period. All were conducted on reference oil 1006-2 and they were conducted on two test stands, each at a different laboratory.

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

There were three QI Deviations written this period. Two were written due to Coolant Out Temperature Control problems and one was written for Engine Speed control issues.

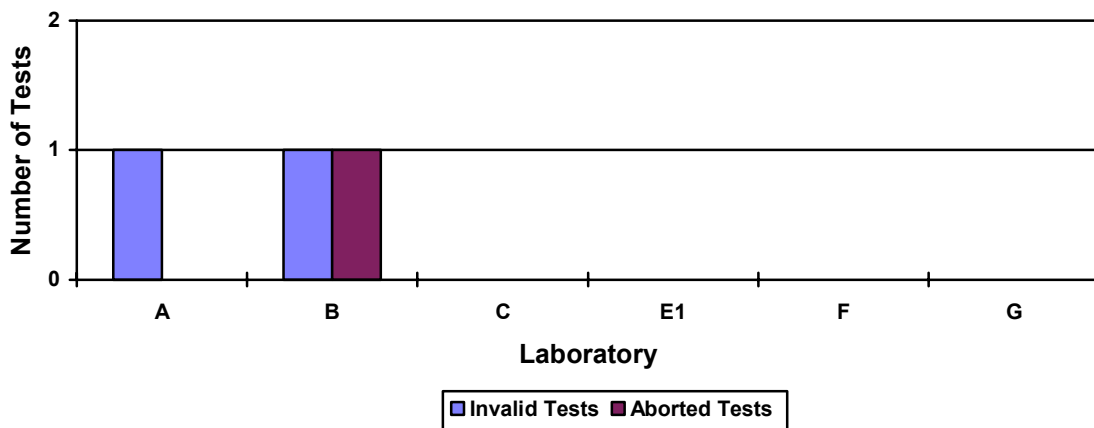
Two lab visits were performed this period. No major problems were found.

Lost Test Summary

Three 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 | Engine Oil Contaminated with Coolant | 1 | 1/0/0 |
| B | AFR Control Problems | 1 | 1/0/0 |
| | Driveline Problems | 1 | 0/1/0 |

Lost Test Distribution



Information Letters

Sequence IVA Information Letter No. 04-1, Sequence No. 11, dated July 19, 2004, was issued during the period and contained: Revised Camshaft Bore Measurement Requirements, New Solvent Specifications, Editorial Corrections, and Revised Precision Definitions.

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 | 0.37 | 13.02 (df=8) | 4.8 μm |

| ACW Results, by Laboratory | |
|----------------------------|--------------------|
| Laboratory | Average Δ/s |
| A | 1.03 |
| B | -1.54 |
| C | - |
| E1 | -1.37 |
| F | -1.31 |
| G | 1.05 |

The industry has exceeded both the severity and precision limits for the period (see Figure 1). The two single-point severity alarms and the two- and three-point precision alarms were caused by a single laboratory attempting to calibrate a new test stand. This stand generated three failing reference oil test results (3.34, 2.20, and 2.10 Δ/s , respectively) on reference oil 1006-2, prior to generating acceptable results and calibrating the test stand. No cause for these failing test results was found. The most recent single-point precision alarm was caused by a single failing reference oil test, on reference oil 1006-2, at another laboratory. Subsequent testing has cleared the alarm and this alarm also appears to have been driven by the failing reference oil test results outlined above.

The industry was severe for the period (see Figure 2) with an average Δ/s result of 0.37, which equates to 4.8 μm in reported units. The pooled standard deviation for the period is 13.02 μm , which is comparable to last period and in line with overall historical performance (see Figure 3).

Hardware

No hardware changes were made this period.

Reference Oils

| Oil | TMC Inventory, in gallons | TMC Inventory, in tests (4gal/test) | Laboratory Inventory, in tests | Estimated life |
|-------------------|------------------------------|--|-----------------------------------|------------------------------|
| 1006 | 43 | 10 | 10 | 1 month or less ¹ |
| 1006-2 | 4,774 | 1,193 | 9 | 3+ years ¹ |
| 1007 ² | 494 | 121 | 11 | 3+ years ¹ |
| 1009 | 834 | 208 | 6 | 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://astmtmc.cmu.edu/docs/gas/sequenceiv/semiannualreports/IVA-10-2004.pdf>

Distribution: Electronic Mail

List of Figures

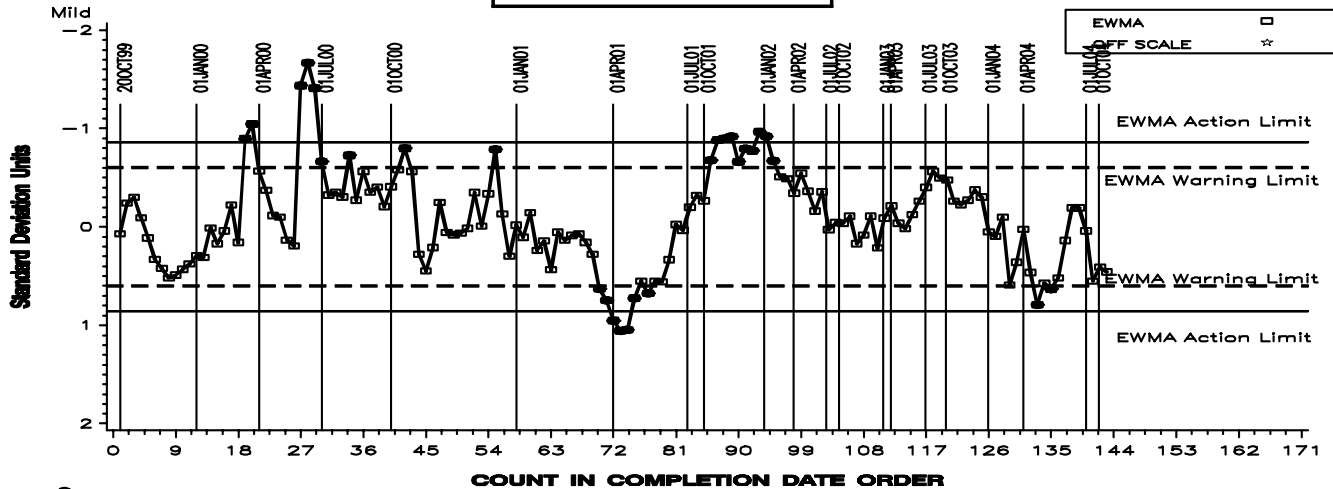
- Figure 1 graphically presents the Industry control charts for ACW and also the CUSUM delta/s plot (by count in completion date order) of average camshaft wear for operationally valid tests.
- Figure 2 graphically presents a historic perspective for ACW mean delta/s by report period.
- Figure 3 graphically 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.

Figure 1

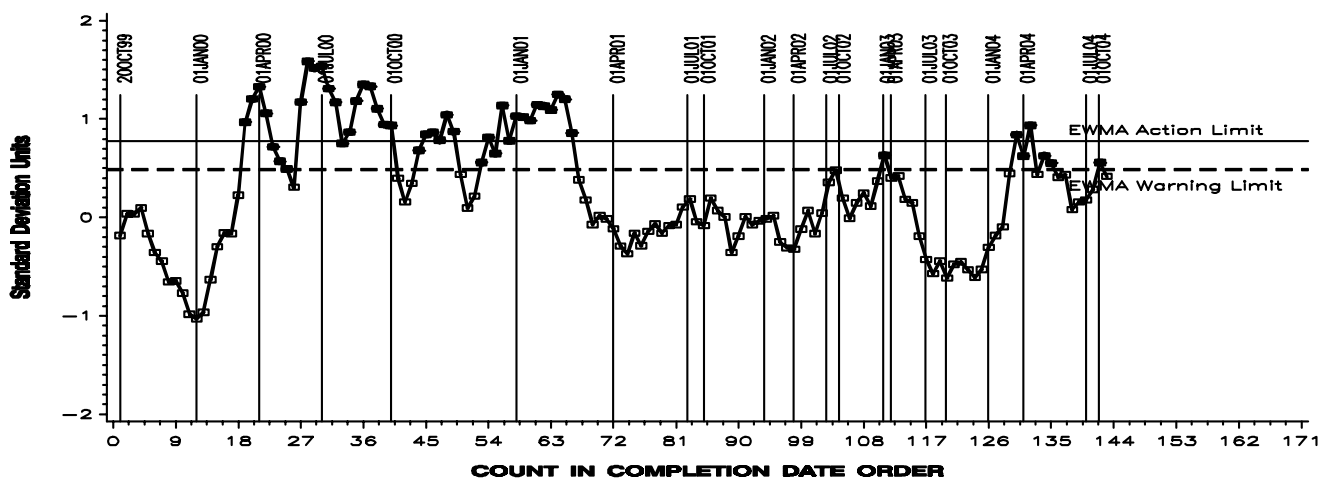
SEQUENCE IVA INDUSTRY OPERATIONALLY VALID DATA

AVERAGE CAM WEAR

LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis

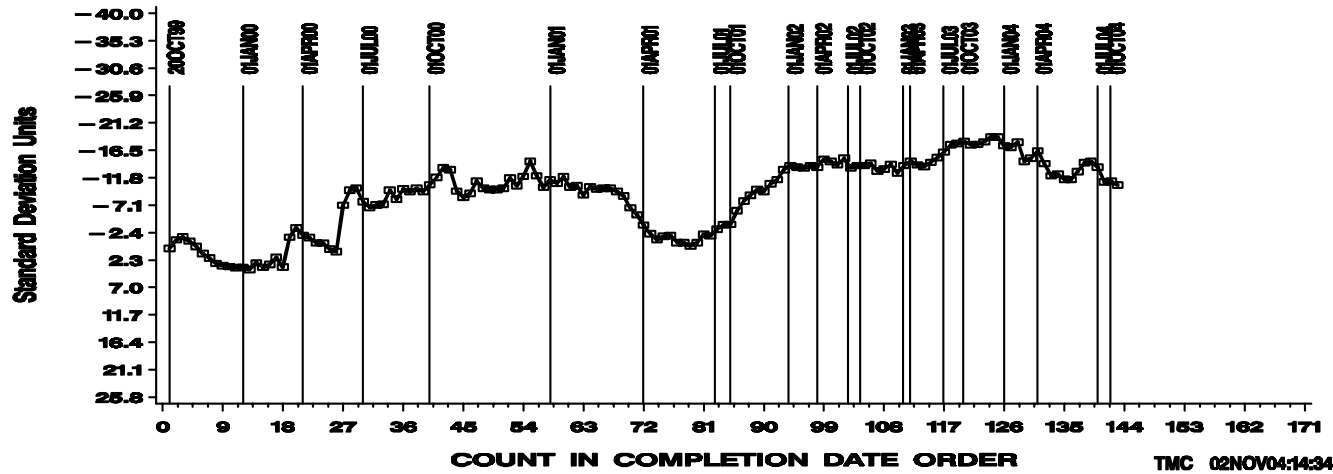


Figure 2 - Sequence IVA Reference Oil Data
Average Camshaft Wear

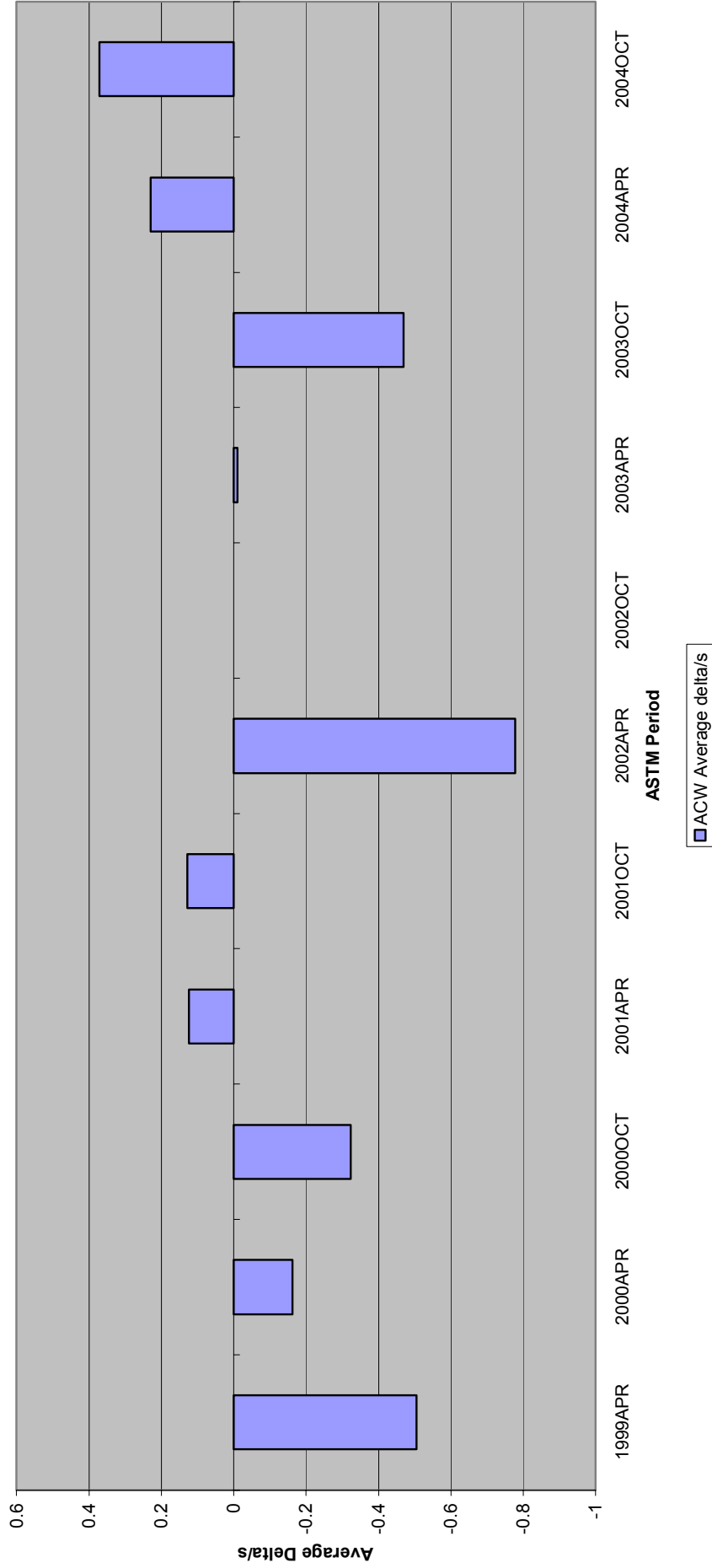
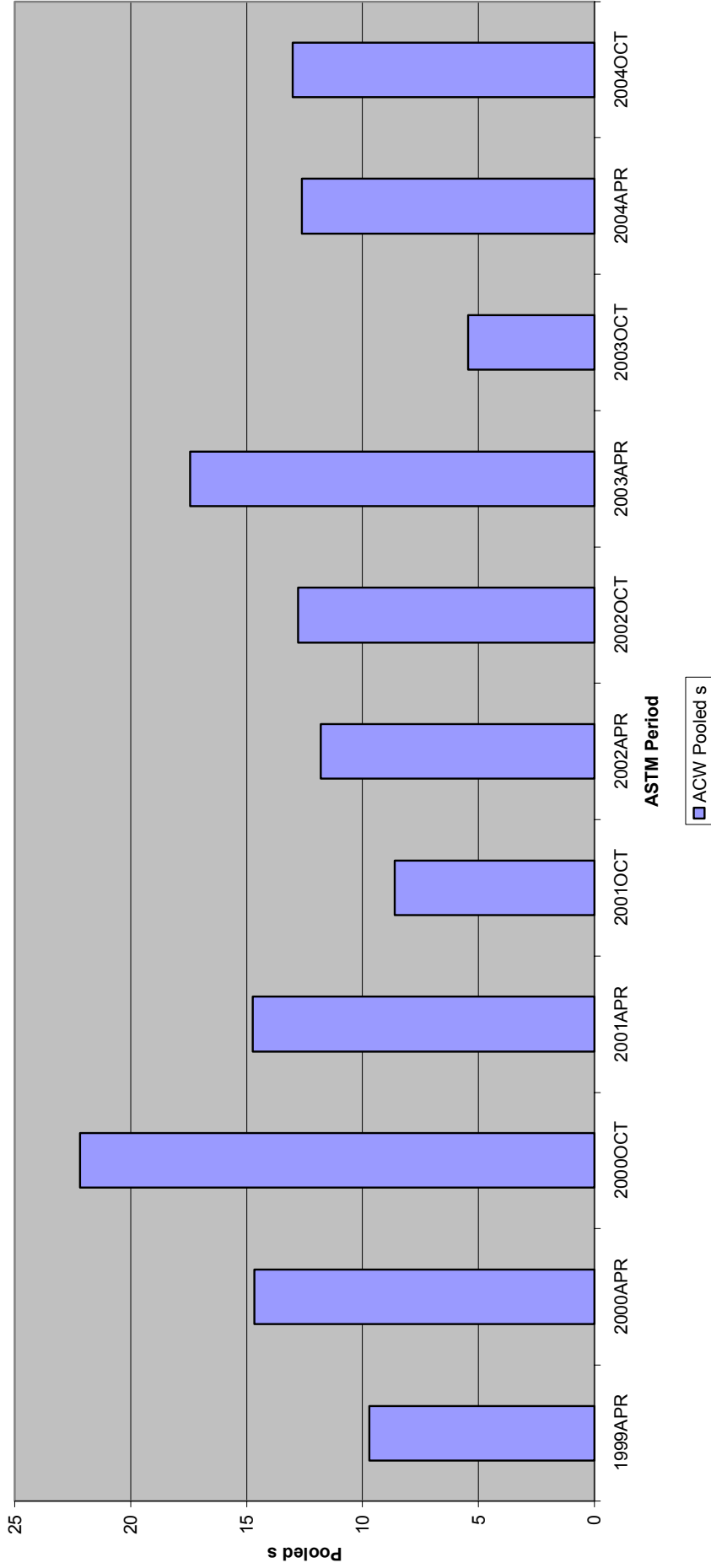


Figure 3 - Sequence IVA Reference Oil Data
Average Camshaft Wear



| Figure 4 - Sequence IVA Timeline | | |
|---|---|---------------------------|
| 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 | 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 |
| 5/14/2002 | STAND CALIBRATION REQUIREMENT REVISIONS | 02-3 |
| 5/14/2002 | STAND INSTRUMENTATION CALIBRATION REQUIREMENT REVISIONS | 02-3 |
| 6/1/2002 | REVISED OIL SAMPLE TAP LOCATION | 02-3 |
| 12/16/2002 | LUBRICATION OF CAMSHAFT DURING INSTALLATION | 02-4 |
| 5/11/2004 | CAMSHAFT BEARING BORE MEASUREMENTS ELIMINATED EXCEPT FOR INITIAL ENGINE BUILD | 04-1 |
| 6/2/2004 | NEW SOLVENT SPECIFICATIONS | 04-1 |
| 7/19/2004 | REVISED PRECISION DEFINITIONS | 04-1 |