


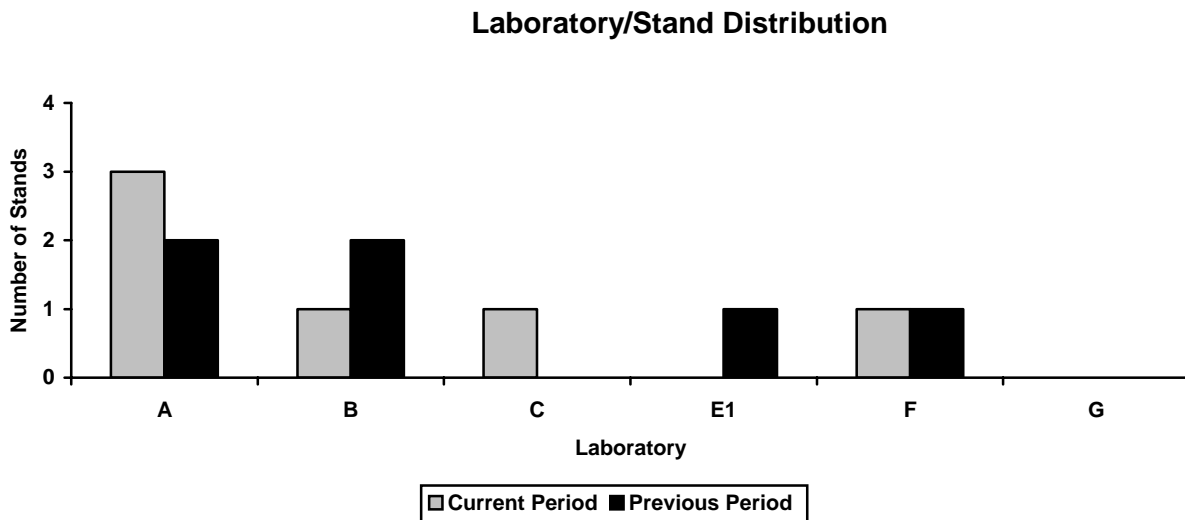
Memorandum: 06-011  
 Date: April 10, 2006  
 To: Bill Buscher, Chairman, Sequence IVA Surveillance Panel  
 From: Richard E. Grundza   
 Subject: Sequence IVA Semiannual Report: October 1, 2005 through March 31, 2006

The following is a summary of Sequence IVA reference tests that were reported to the Test Monitoring Center during the period October 1, 2005 through March 31, 2006.

Lab/Stand Distribution

	Reporting Data	Calibrated as of March 31, 2006
Number of Laboratories:	4	4
Number of Test Stands:	7	6

The following chart shows the laboratory/stand distribution:

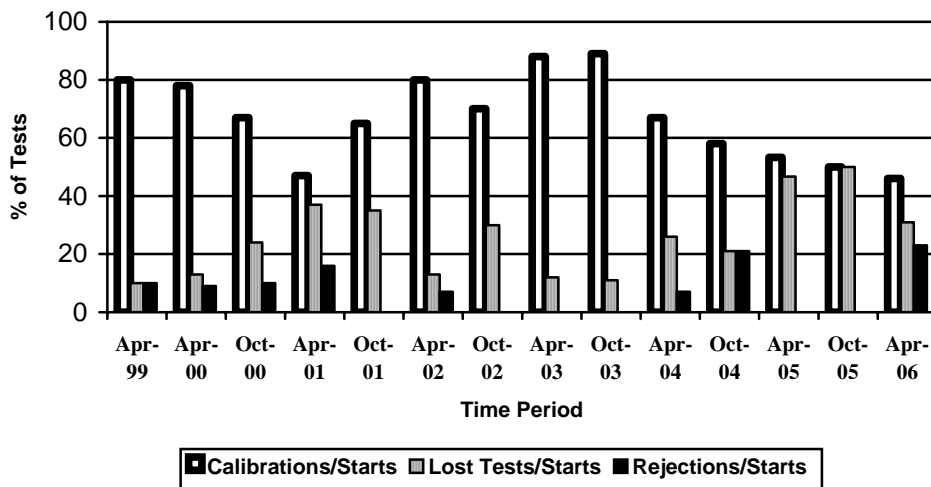


The following summarizes the status of the reference oil tests reported to the TMC:

Calibration Start Outcomes	TMC Validity Codes	No. of Tests
Operationally and Statistically Acceptable	AC	6
Failed Acceptance Criteria	OC	4
Operationally Invalid (Laboratory Judgment)	LC	1
Engine Abandoned	MC	2
Total		13

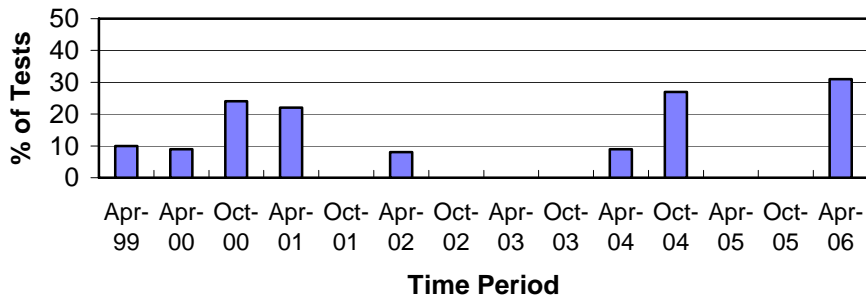
Calibrations per start, lost tests per start and rejection per start rates are summarized below:

### Calibration Attempt Summary



The calibration per start rate has decreased since last period. The lost test rate has decreased with respect to the last period. The rejected test per start rate has increased with respect to the previous period.

### Rejected Test Rate



There were four tests that failed acceptance criteria this period. One test failed for mild ACW. One test failed for a Shewhart Precision (Ri) alarm. The two remaining tests failed for stand EWMA Precision (Qi) alarms. Three of the four tests that failed were run using reference oil 1009, while the remaining test was run using oil 1007.

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. This QI Deviation addressed operational issues resulting from intake air pressure and torque control.

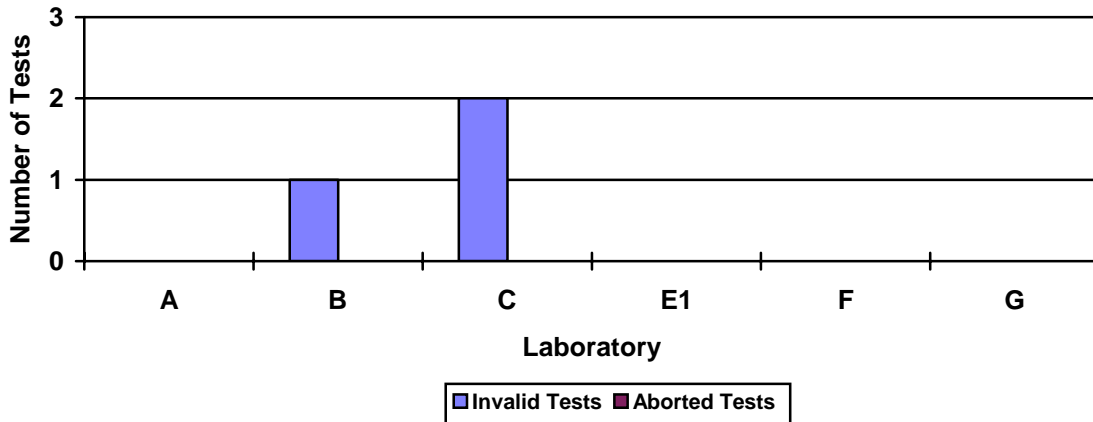
Two lab visits were performed this period. No significant discrepancies were observed during these visits.

#### 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/MC/RC/XC)
B	Fresh Air Control	1	1/0/0/0
C	Engine Abandoned	2	0/2/0/0

### Lost Test Distribution



#### Information Letters

Sequence IVA Information Letter No. 05-3, Sequence No. 14, dated December 13, 2005, was issued during the period and contained: The addition of tolerances on the location of various measurement sensors, increased the number of runs allowed on heads and blocks, revised the schedule for oil cooler, pcv valve and coolant system cleaning and replacement, added limits on lost test data, changed fuel temperature control limits and revised torque control strategy. Sequence IVA Information Letter No. 06-1, Sequence No. 15, dated February 16, 2006, was issued during the period and contained: revisions to wear measurement techniques and addressed a number of editorial changes.

#### 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 report period. Also below is a summary of the average  $\Delta/s$  value, by parameter, for all laboratories reporting data during this report period.

Industry Severity Summary			
Parameter	Average $\Delta/s$	Pooled standard deviation (degrees of freedom)	Average $\Delta$ , in micrometers
ACW	-0.89	9.82 (df=9)	-11.1 $\mu\text{m}$

ACW Results, by Laboratory	
Laboratory	Average $\Delta/s$
A	-0.74
B	-0.865
C	-1.101
E1	N/A
F	-1.043
G	N/A

The industry was in severity action or warning alarm for the entire period (see Figure 1). No single stand or lab was responsible for these alarms, and all of the labs, on average, provided mild results. Industry precision was in control the entire period.

The industry was mild for the period (see Figure 2) with an average  $\Delta/s$  result of -0.89, which equates to -11.1  $\mu\text{m}$  in reported units. The pooled standard deviation for the period is 9.82  $\mu\text{m}$ , which is much worse than the last period, but compares well 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	7	1 month or less <sup>1</sup>
1006-2	4,681	1,170	9	3+ years <sup>1</sup>
1007 <sup>2</sup>	422	105	16	3+ years <sup>1</sup>
1009	757	189	7	3+ years <sup>1</sup>

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

<sup>2</sup> Cannot be reblended.

#### Summary

Calibration per start and lost test per start rates have decreased and the rejected test per start rate has increased with respect to the previous period. All rates compare with historical rates. ACW severity trended mild for the period. Pooled precision estimates show precision has degraded when compared with the previous period, but compares well with historical estimates.

REG/reg

#### Attachments

c: F. M. Farber, TMC  
Sequence IVA Surveillance Panel  
<ftp://astmtmc.cmu.edu/docs/gas/sequenceiv/semiannualreports/IVA-04-2006.pdf>

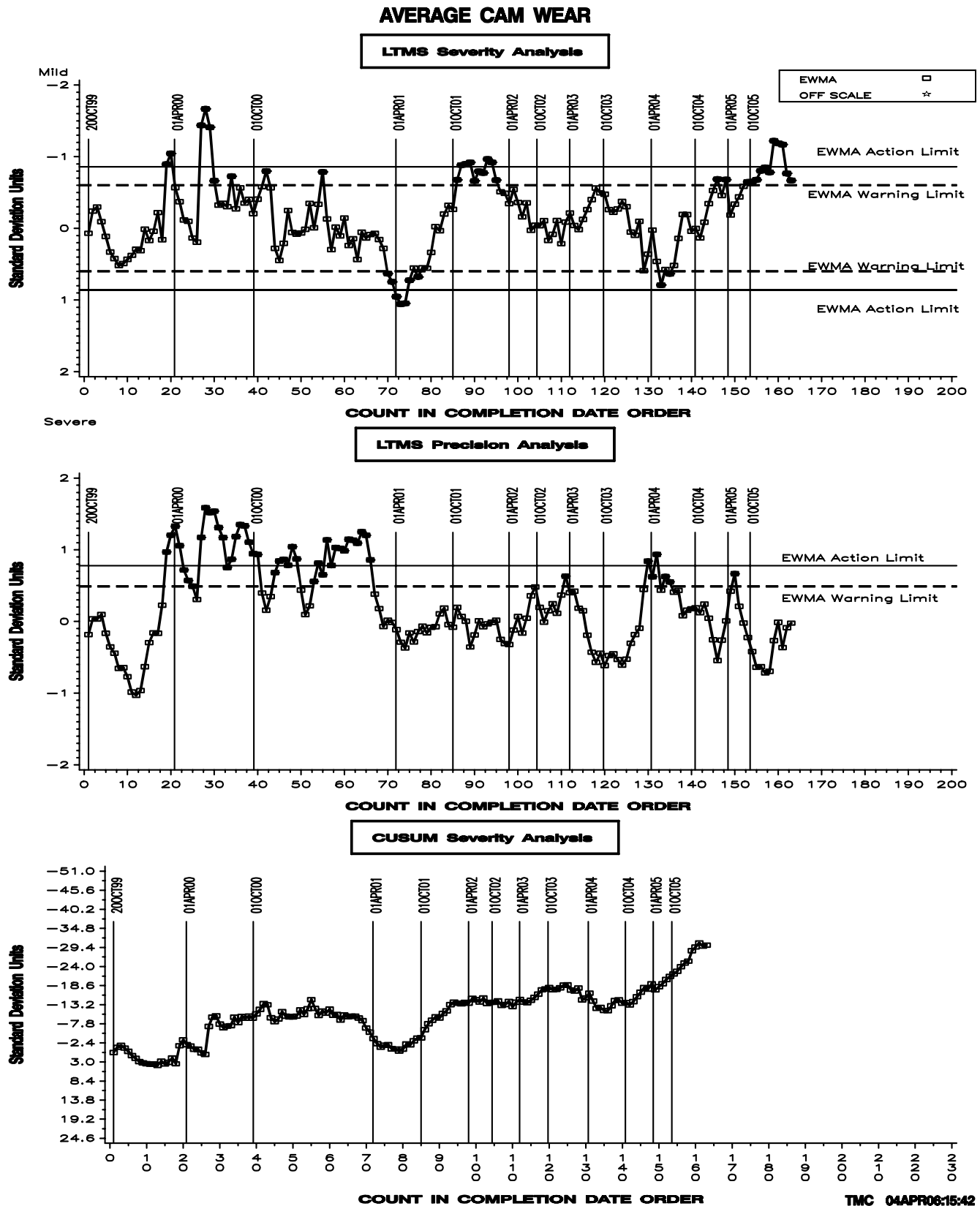
Distribution: Electronic Mail

List of Figures

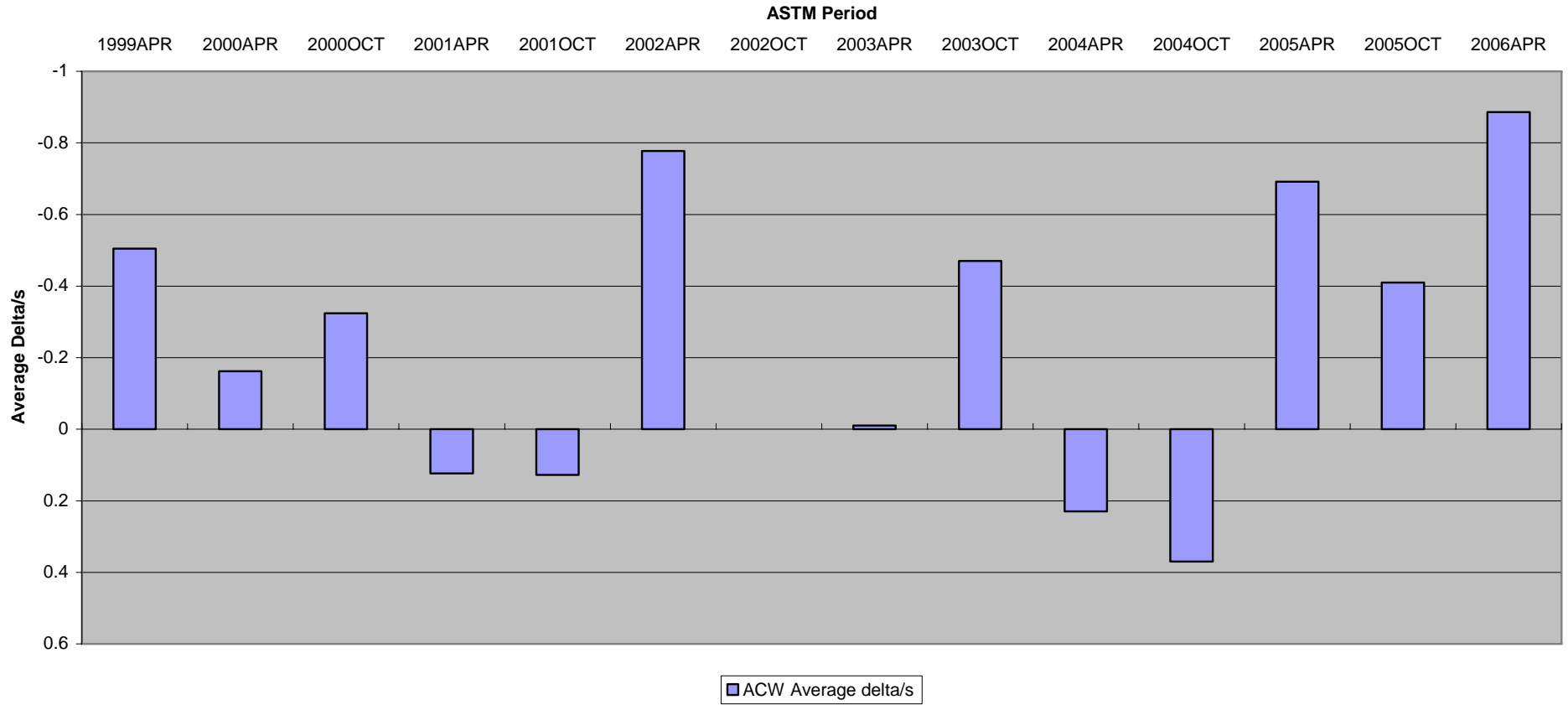
- Figure 1 graphically presents the Industry control charts for ACW and also the CUSUM delta/s plot (by count in completion date order) of average camshaft wear for operationally valid tests.
- Figure 2 graphically presents a historic perspective for ACW mean delta/s by report period.
- Figure 3 graphically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

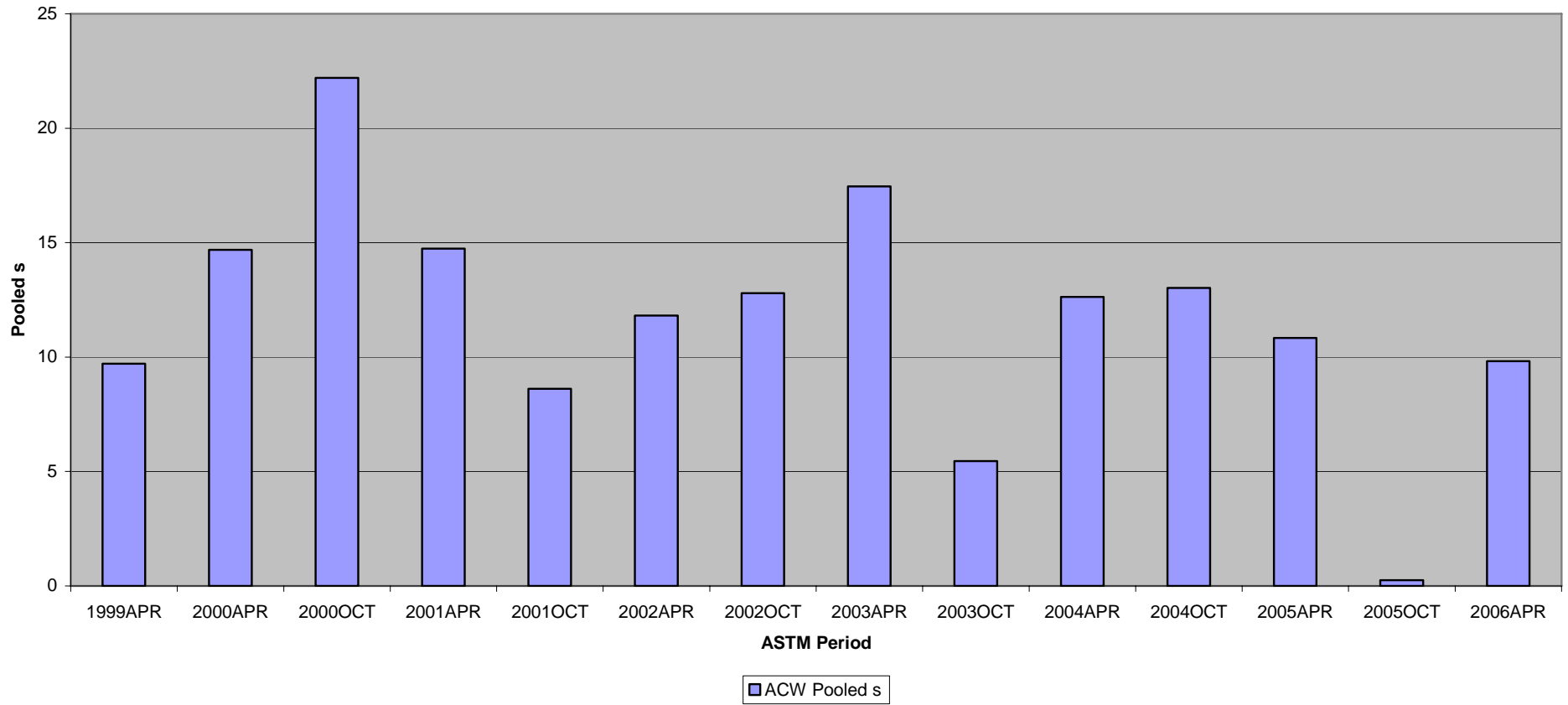


**Figure 2 - Sequence IVA Reference Oil Data  
Average Camshaft Wear**





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



<b>Figure 4 - Sequence IVA Timeline</b>		
<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
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
11/19/2004	REVISED REPLACEMENT CRITERIA FOR CYLINDER HEADS AND ENGINES	05-1
11/19/2004	CLARIFIED SOLVENT SPECIFICATION REQUIREMENTS	05-1
11/19/2004	REVISED QI U&L VALUES FOR COOLANT OUTLET TEMPERATURE	05-1
11/19/2004	REVISED CALIBRATION FREQUENCY FOR INSTRUMENTATION CHANNELS	05-1
11/19/2004	ADDED SECTIONS AND ANNEX TO DEFINE ROLE OF TMC AND EXTEND CALIBRATION PERIODS FOR DONATED TEST PROGRAMS	05-1
6/8/2005	UPDATED PRECISION ESTIMATE	05-2
12/13/2005	ADDED TOLERANCES TO MEASUREMENT DEVICE LOCATIONS	05-3
12/13/2005	INCREASED NUMBER OF RUNS ALLOWED ON BLOCK AND HEADS	05-3
12/13/2005	ADDED/REVISED SCHEDULE FOR OIL COOLER, PCV VALVE AND COOLANT SYSTEM CLEANING/REPLACEMENT	05-3
12/13/2005	ADDED LIMITS ON LOST OPERATIONAL DATA	05-3
12/13/2005	REVISED FUEL TEMPERATURE CONTROL LIMITS	05-3
12/13/2005	REVISED TORQUE CONTROL STRATEGY	05-3
02/16/2006	REVISED WEAR MEASUREMENT TECHNIQUES	06-1
02/16/2006	ADDRESSED EDITORIAL CHANGES	06-1