



# Test Monitoring Center

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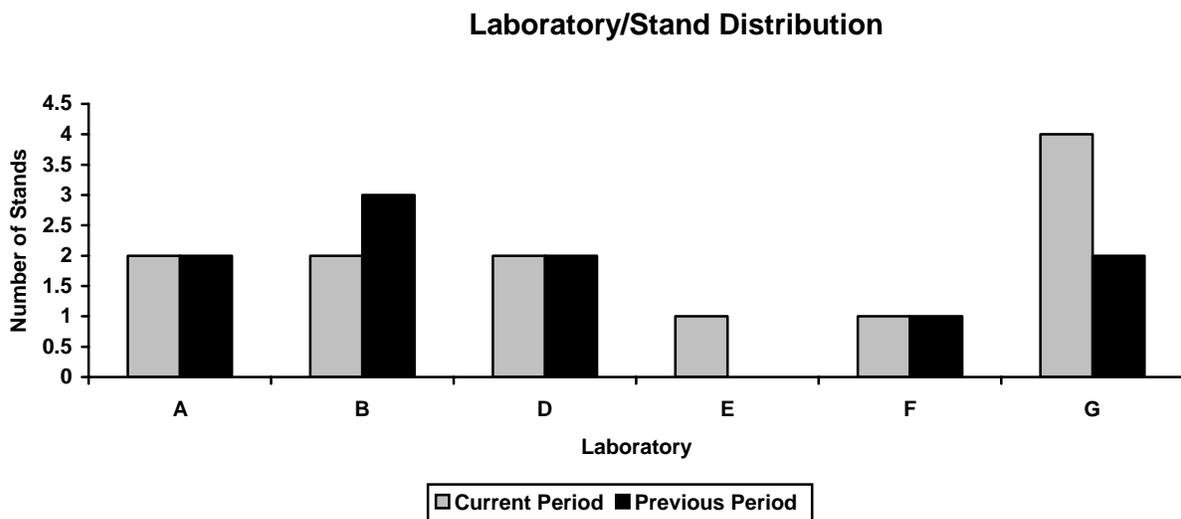
Memorandum: 06-024  
Date: April 14, 2006  
To: William M. Nahumck, Chairman, Sequence III Surveillance Panel  
From: Richard E. Grundza   
Subject: Sequence IIIG/IIIGA Semiannual Report: October 1, 2005 through March 31, 2006

The following is a summary of Sequence IIIG 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:	6	6
Number of Test Stands:	11	13

The following chart shows the laboratory/stand distribution:



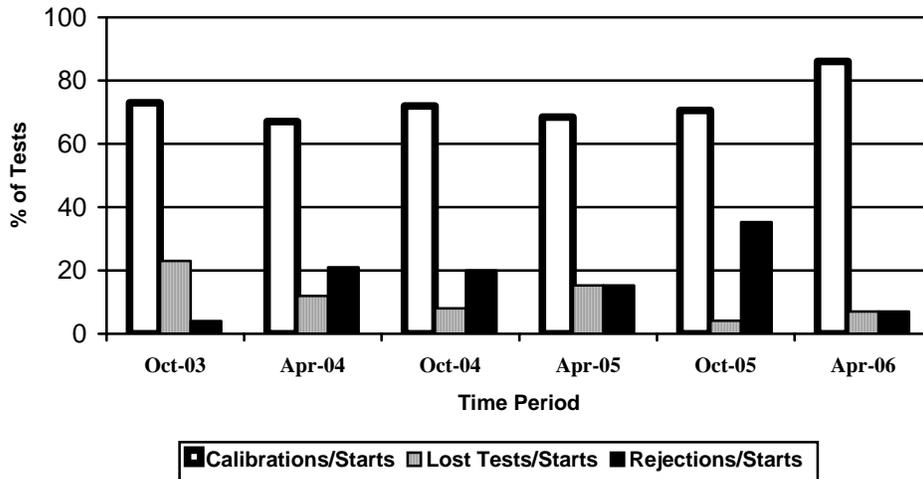
The following summarizes the status of the reference oil tests reported to the TMC:

Calibration Start Outcomes	TMC Validity Codes	No. of Tests
Operationally and Statistically Acceptable	AC	12
Failed Acceptance Criteria	OC	1
Operationally Invalid (Laboratory Judgment)	LC	1
Total		14

Donated & Industry Support Outcomes	TMC Validity Codes	No. of Tests
Donated Test, Unified Engine Build	AG	6
Operationally Invalid (Laboratory Judgment)	LG	1
Total		7

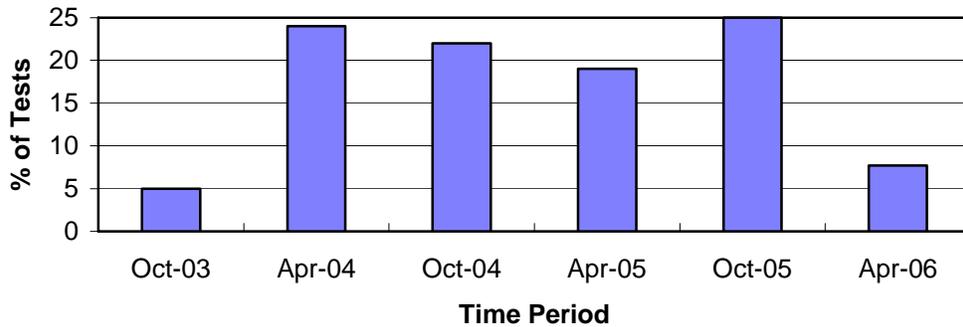
Calibrations per start, lost tests per start and rejection rates are summarized below:

### Calibration Attempt Summary



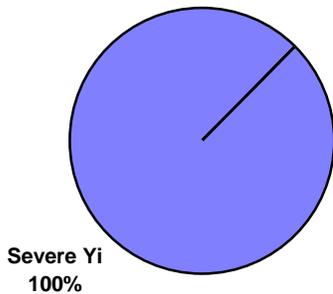
The calibration per start rate has improved with respect to last period. The lost test per start rate has increased slightly and the rejected test per start rate has decreased with respect to the previous period.

### Rejected Test Rate for Operationally Valid Tests

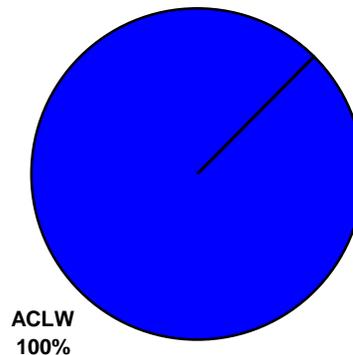


One test failed acceptance criteria during the period. The following charts summarize the reasons and breakdown by parameter for the failed test:

#### Distribution of LTMS Stand Alarms



#### Distribution of Stand Alarms by Parameter



There were no LTMS Deviations written this period. There have been no deviations from the LTMS since its introduction in August of 2003.

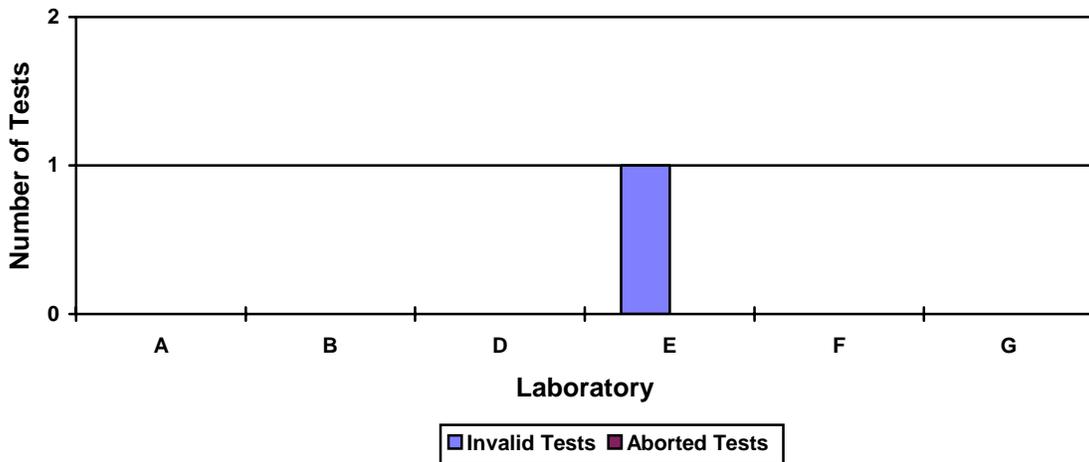
One Sequence IIIG lab visit was performed this period. No significant discrepancies were identified during this visit.

Lost Test Summary

One test was lost this period. The reason for the lost test is shown in the following table:

Lab	Reason for Lost Test	Number of Tests	Breakdown of Tests (LC/RC/XC)
E	Torque calibration error (full length)	1	1/0/0

**Lost Test Distribution**



Information Letters

Sequence IIIG Information Letter No. 05-2 Sequence No. 10, was issued during the period on November 29, 2005, and contained: Revisions to requirements for attendance to rater workshops and allows the use of torque wrench ETW-E180.

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 reported units
PVIS	-1.254	0.269 (df=10)	-42.9 % Viscosity Increase <sup>1</sup>
WPD	-0.959	0.470 (df=10)	-0.45 Merits
ACLW	0.043	0.345 (df=10)	0.89 $\mu\text{m}^2$
MRV <sup>3</sup>	-1.037	0.188 (df=8)	N/A (no appropriate baseline) <sup>4</sup>

<sup>1</sup> At the GF-4 Pass Limit of 150% Viscosity Increase

<sup>2</sup> At the GF-4 Pass Limit of 60 $\mu\text{m}$

<sup>3</sup> Sequence IIIGA Test Parameter only; Reference Oil 435 data excluded from calculations

<sup>4</sup> MRV does not have a specific GF-4 Pass Limit; Pass Limit is lack of Yield Stress.

Average $\Delta/s$ Results, by Laboratory				
Laboratory	PVIS	WPD	ACLW	MRV <sup>1</sup>
A	-0.12	-1.79	-1.84	-1.17
B	-1.56	-0.58	-1.52	-1.19
D	-1.98	-0.74	-0.41	-
E	-0.80	-0.32	-0.16	-1.09
F	-2.14	-1.30	0.51	-1.20
G	-1.27	-1.02	-0.09	-0.80

<sup>1</sup> Reference oil 435 data excluded from calculations

#### *Percent Viscosity Increase (PVIS)*

The industry has been in mild severity action alarm for most of the period. Precision has been in control the entire period (see Figure 1). The average  $\Delta/s$  value for the period, -1.254 is not quite as mild as the previous period (see Figure 4). Overall, severity has trended mild since the completion of the matrix. The pooled standard deviation for the period, 0.269, has improved slightly with respect to the previous period (see Figure 7).

#### *Weighted Piston Deposits (WPD)*

The industry has been in severe action alarm for most of the period (see Figure 2). The average  $\Delta/s$  value for the period, -0.959 is more severe than last period and is the most severe period on record (see Figure 5). Precision has been in control the entire period. The pooled standard deviation for the period, 0.469, is worse than last period, but compares well with historical estimates (see Figure 8).

#### *Average Camshaft-plus-Lifter Wear (ACLW)*

ACLW severity began the period mild, with a series of two warning and an action alarm, after which the charts return within control limits for the remainder of the period (see Figure 3). The average  $\Delta/s$  value for the period, -0.043 was on or near target and is shown in Figure 6. However, overall severity has trended mild since shortly after the matrix was completed. The precision charts start the period with two warning alarms. The charts come back into control for seven tests. Another alarm event of three warning alarms also occurred during the period before the charts return to within control limits at the end of the period. No one lab or stand appears to have caused these alarm events. The pooled standard deviation for the period, 0.345, has improved somewhat when compared to the last period and is shown in Figure 9.

#### *Mini Rotary Viscometer (MRV)*

The MRV control charts are shown for informational purposes in Figure 10. Industry has exceeded the EWMA mild warning limit the entire period, while precision has been in control the entire period. The average  $\Delta/s$  value for the period, -1.290, is milder than the previous period and is shown in Figure 11. The pooled standard deviation for the period, 0.188, has degraded when compared to the last period and is shown in Figure 12.

#### QI Deviations

One QI Deviations was written this period. There have been a total of two QI Deviations written since the test was introduced in August of 2003.

Hardware

Powdered metal connecting rods were used exclusively during this period. Ring Code BC-4 was used for six of the thirteen tests, BC-5 was used for five tests and BC-6 Ring Code was run on the last two tests reported this period. A Unified Engine Build was conducted this period, using the Ring Code BC-6 rings. The seven donated tests run this period were conducted on the Unified Engine Build engines. One of the donated tests was declared invalid by the laboratory due to a deep scratch noted in a cylinder wall at the end of test.

Reference Oils

Oil	TMC Inventory, in gallons	TMC Inventory, in tests (4 gal/test)	Laboratory Inventory, in tests	Estimated life
434	175	43	8	~ 4 years
435	261	65	6	~ 5 years
438	701	175	9	~10 years

REG/reg

## Attachments

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

Distribution: Electronic Mail

List of Figures

- Figures 1, 2, and 3 are EWMA severity and precision control charts and also the CUSUM  $\Delta/s$  plots of PVIS, WPD, and ACLW, annotated with date lines, using the same data set as the EWMA severity and precision control charts. Transformed units are used, when appropriate.
- Figures 4, 5, and 6 are bar charts of average  $\Delta/s$ , by report period, for PVIS, WPD, and ACLW.
- Figures 7, 8, and 9 are bar charts of pooled standard deviation, by report period, for PVIS, WPD, and ACLW.
- Figure 10 is EWMA severity and precision control charts and also the CUSUM  $\Delta/s$  plots of MRV, annotated with date lines, using the same data set as the EWMA severity and precision control charts. Transformed units are used.
- Figure 11 is a bar chart of average  $\Delta/s$ , by report period, for MRV.
- Figure 12 is a bar chart of pooled standard deviation, by report period, for MRV.
- Figure 13 is the Sequence IIIIG/IIIGA Timeline.

Figure 1

# SEQUENCE IIIG INDUSTRY OPERATIONALLY VALID DATA

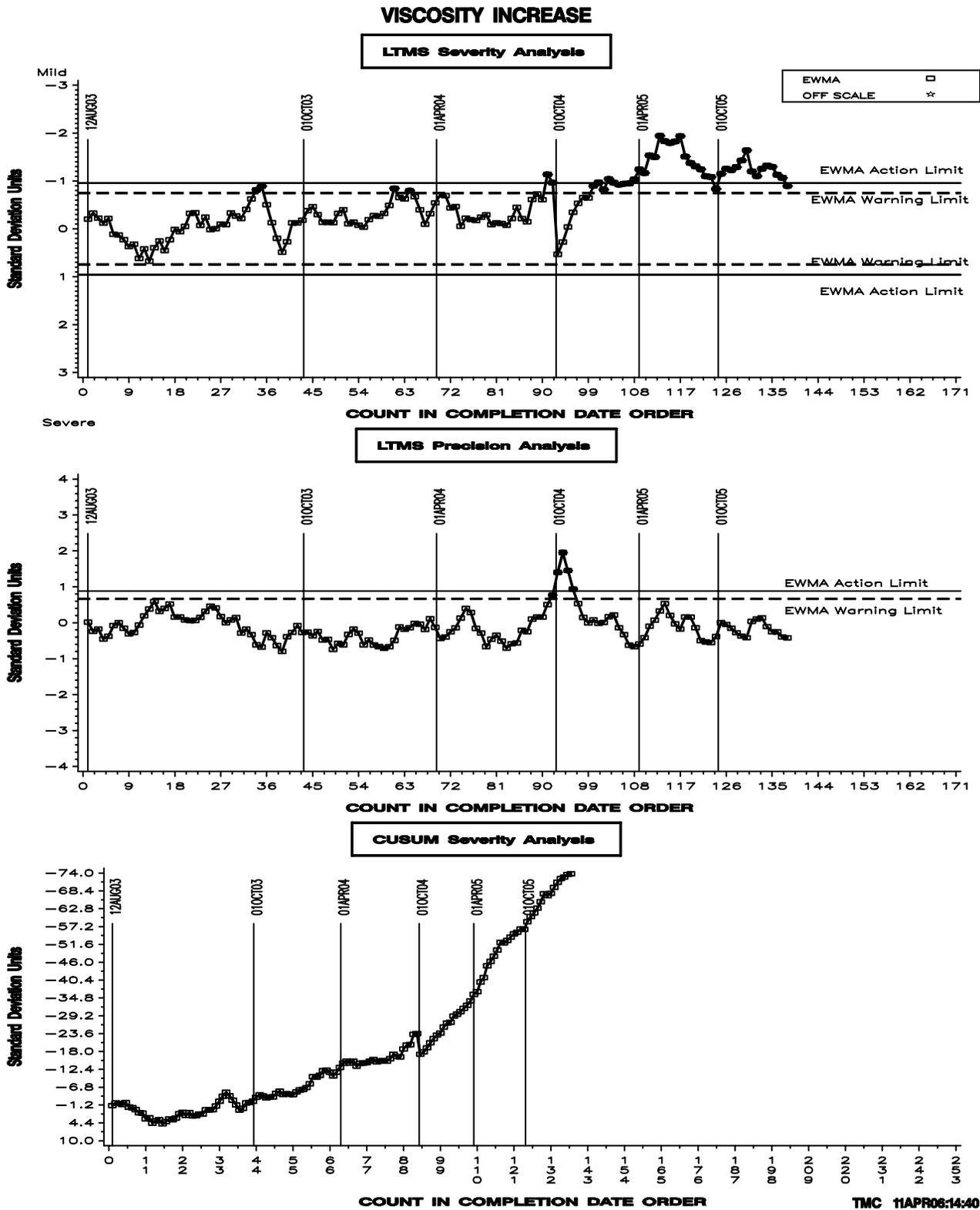


Figure 2

# SEQUENCE IIIG INDUSTRY OPERATIONALLY VALID DATA

## AVERAGE WEIGHTED PISTON DEPOSITS

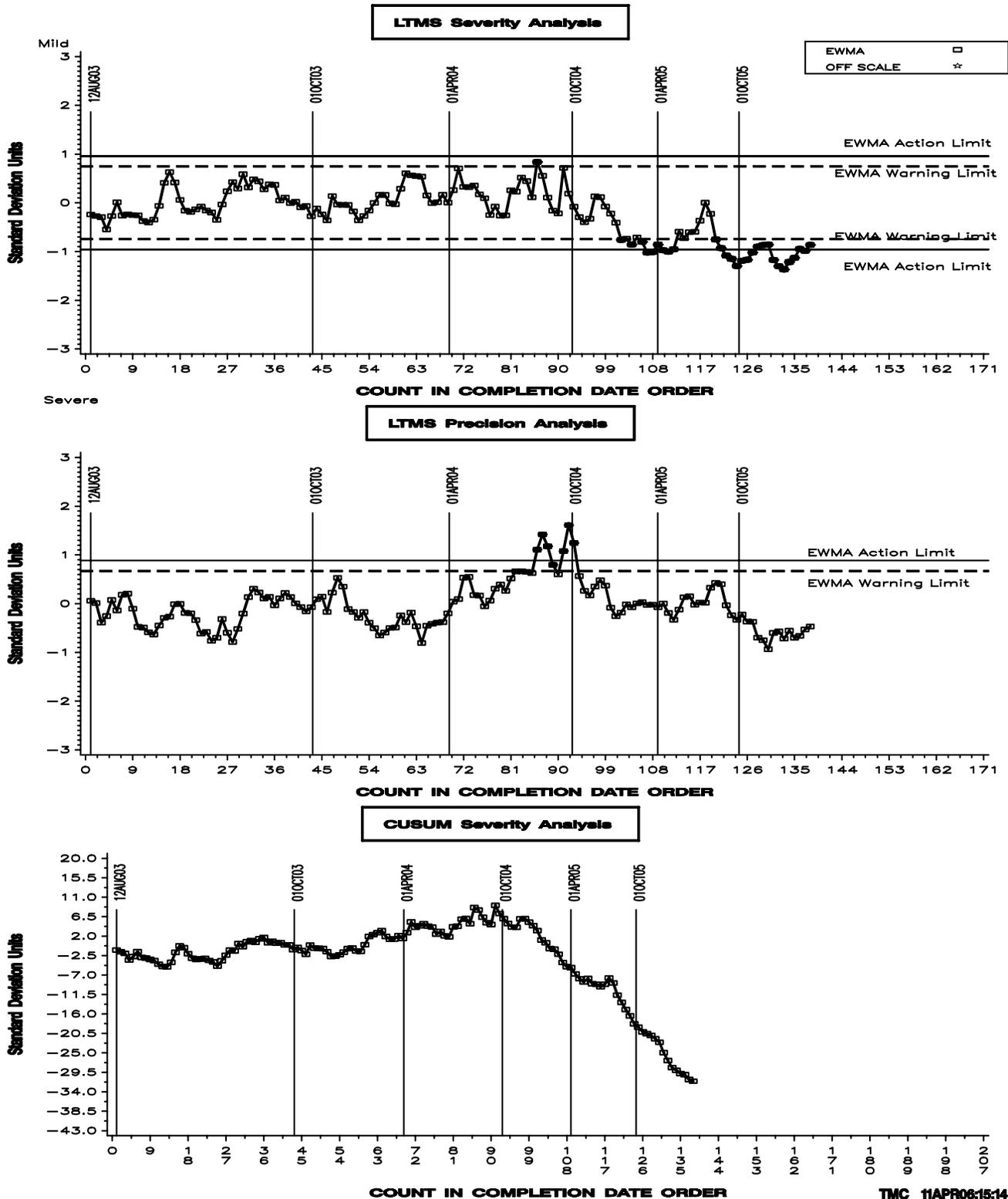


Figure 3

# SEQUENCE III G INDUSTRY OPERATIONALLY VALID DATA

## AVERAGE CAM + LIFTER WEAR

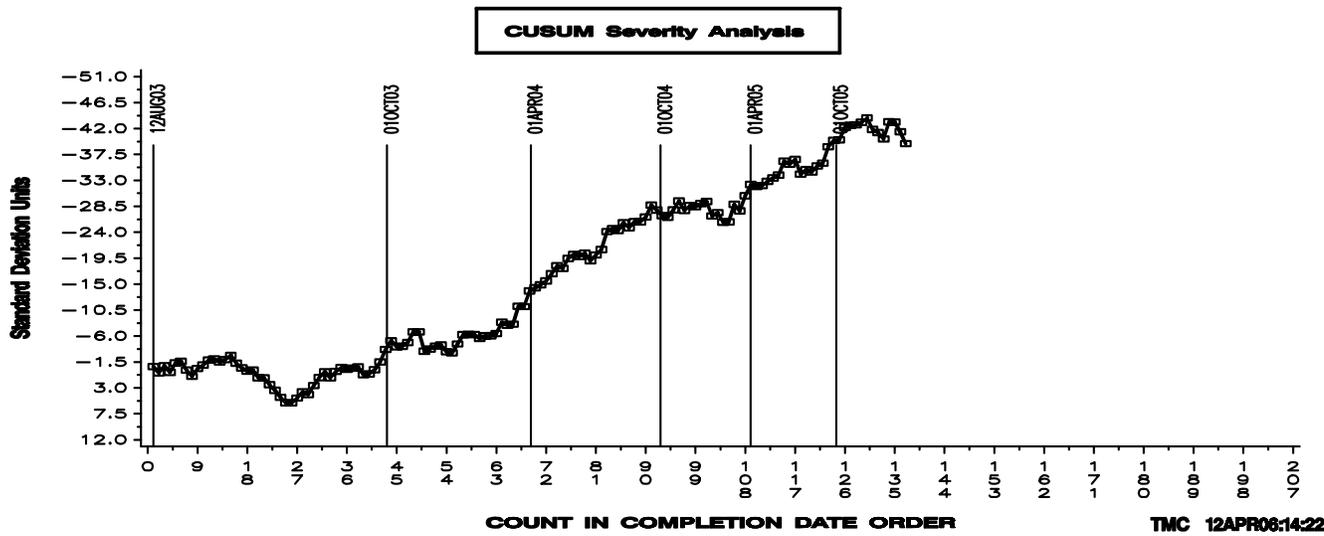
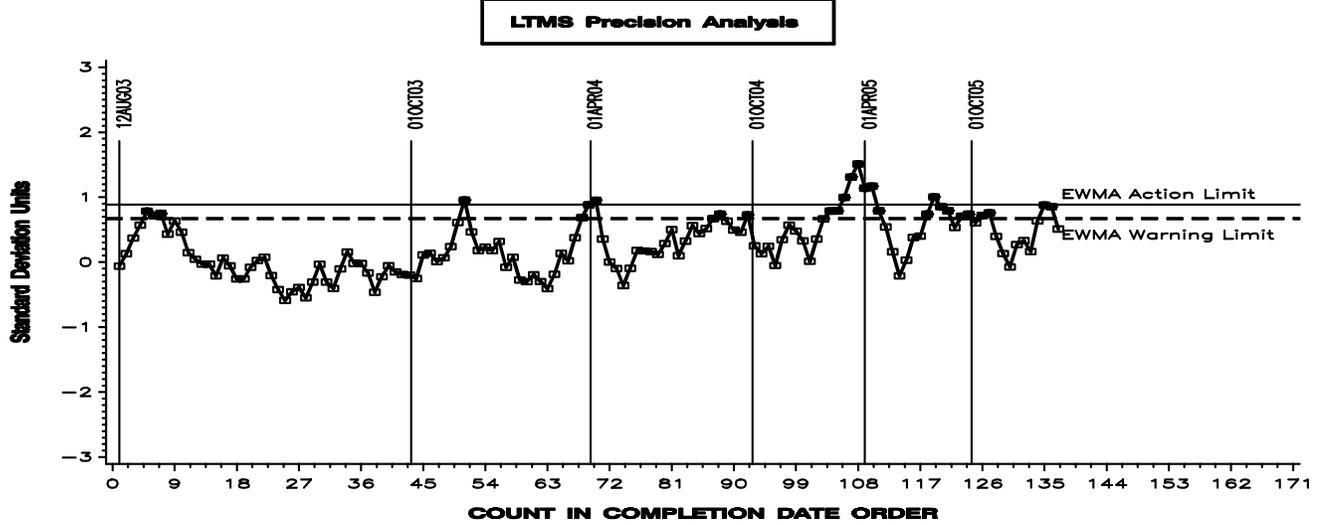
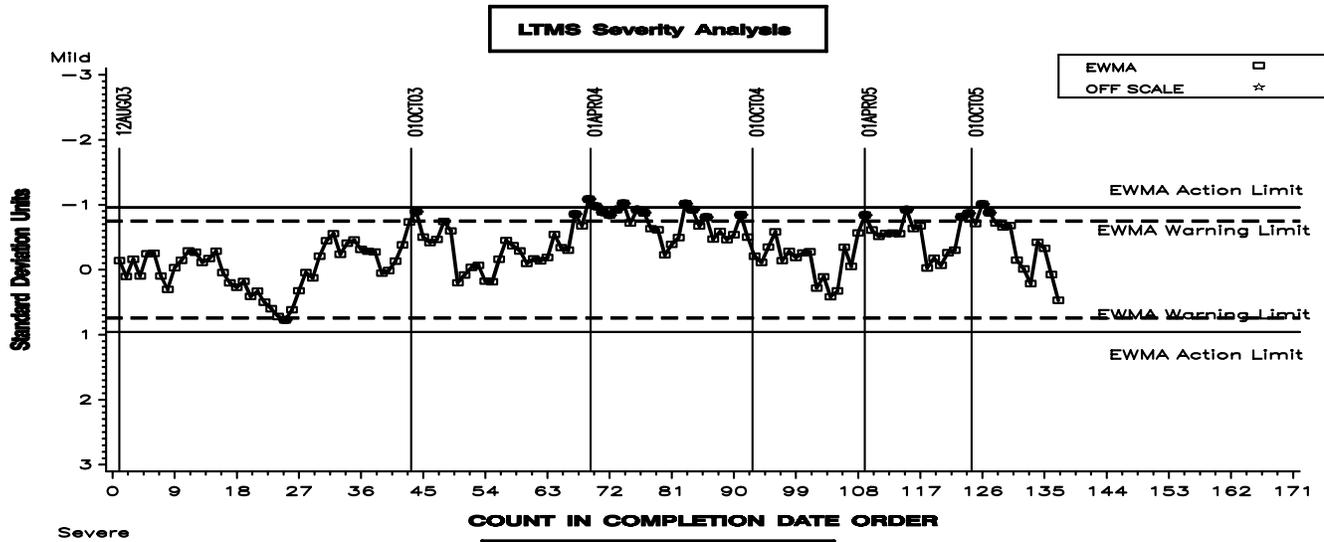


Figure 4 - Percent Viscosity Increase, Average Delta/s

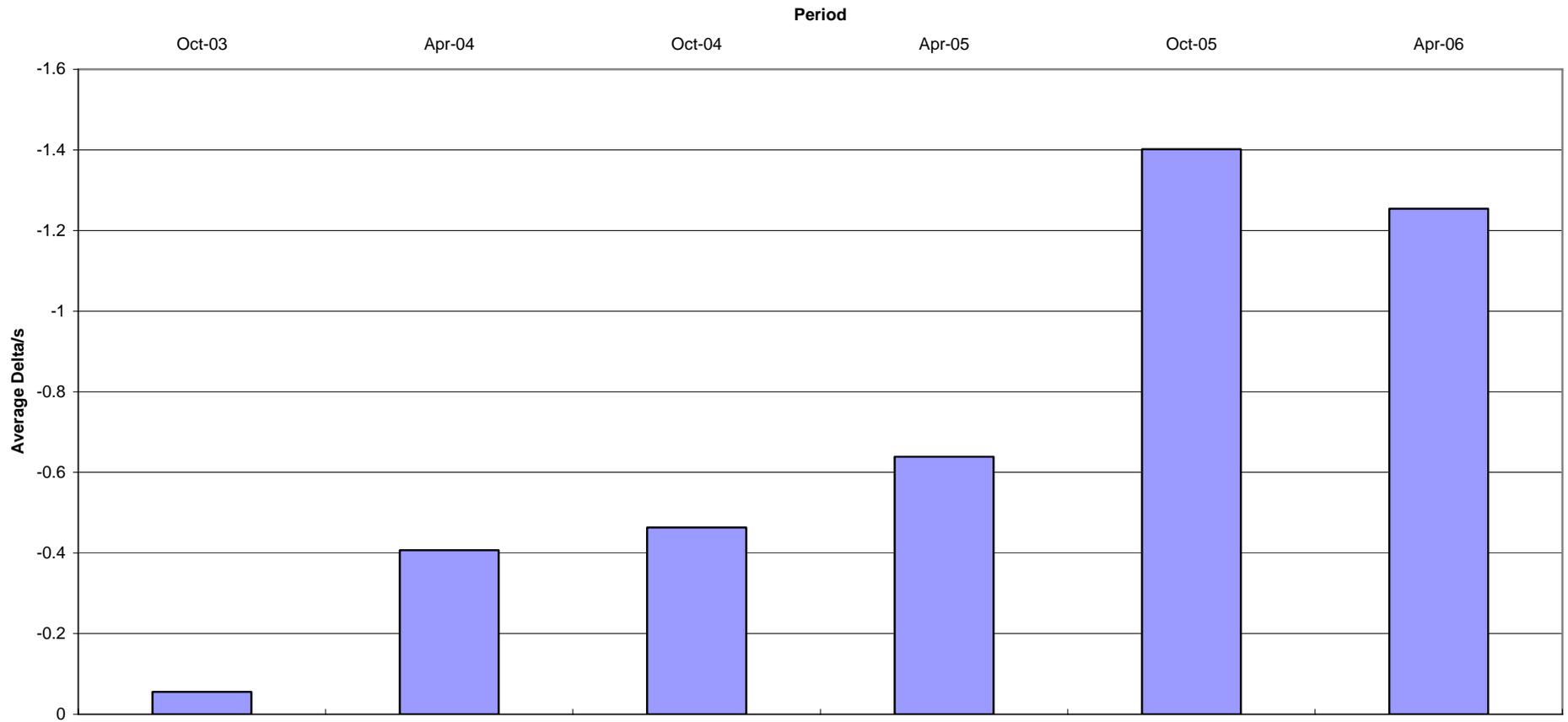


Figure 5 - Weighted Piston Deposits, Average Delta/s

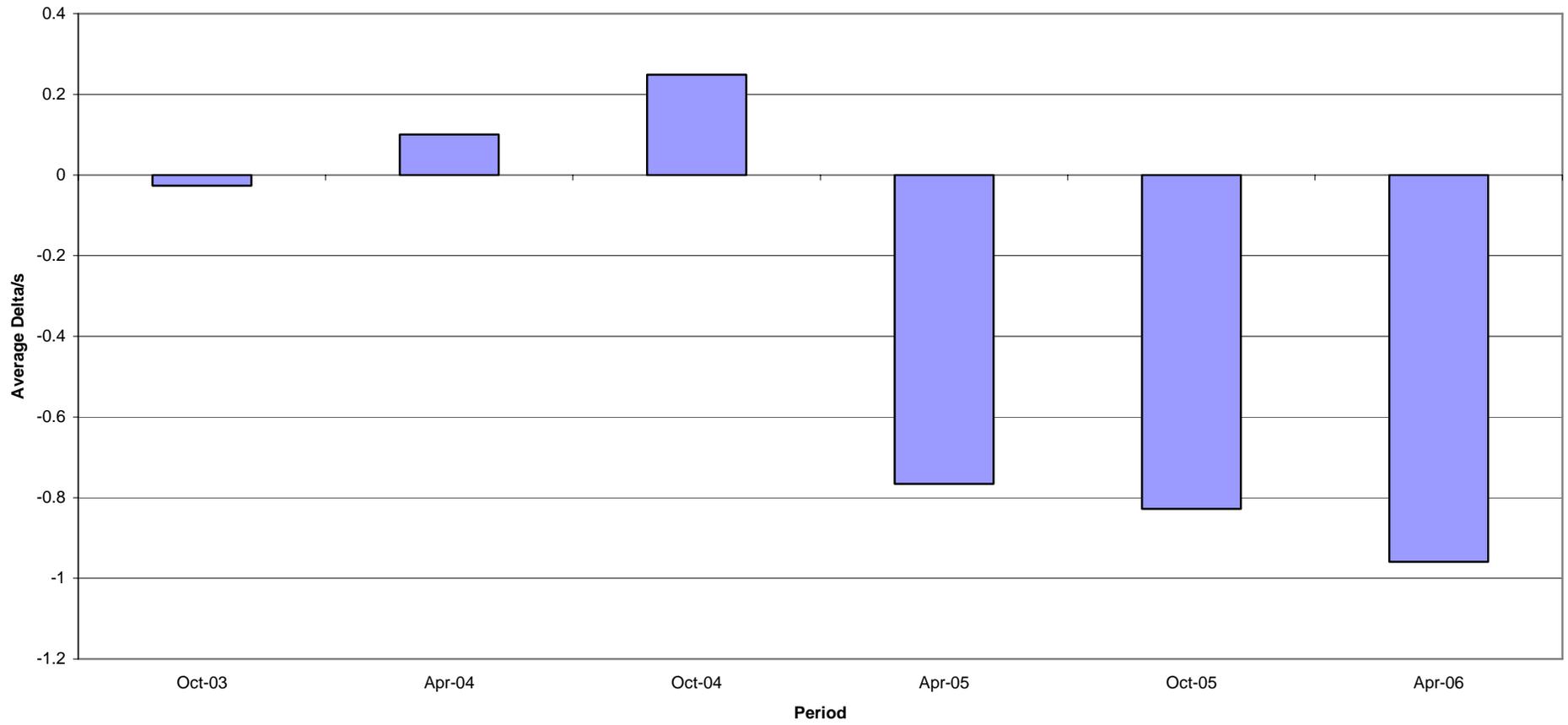


Figure 9 - Average Camshaft plus Lifter Wear, Pooled Standard Deviation

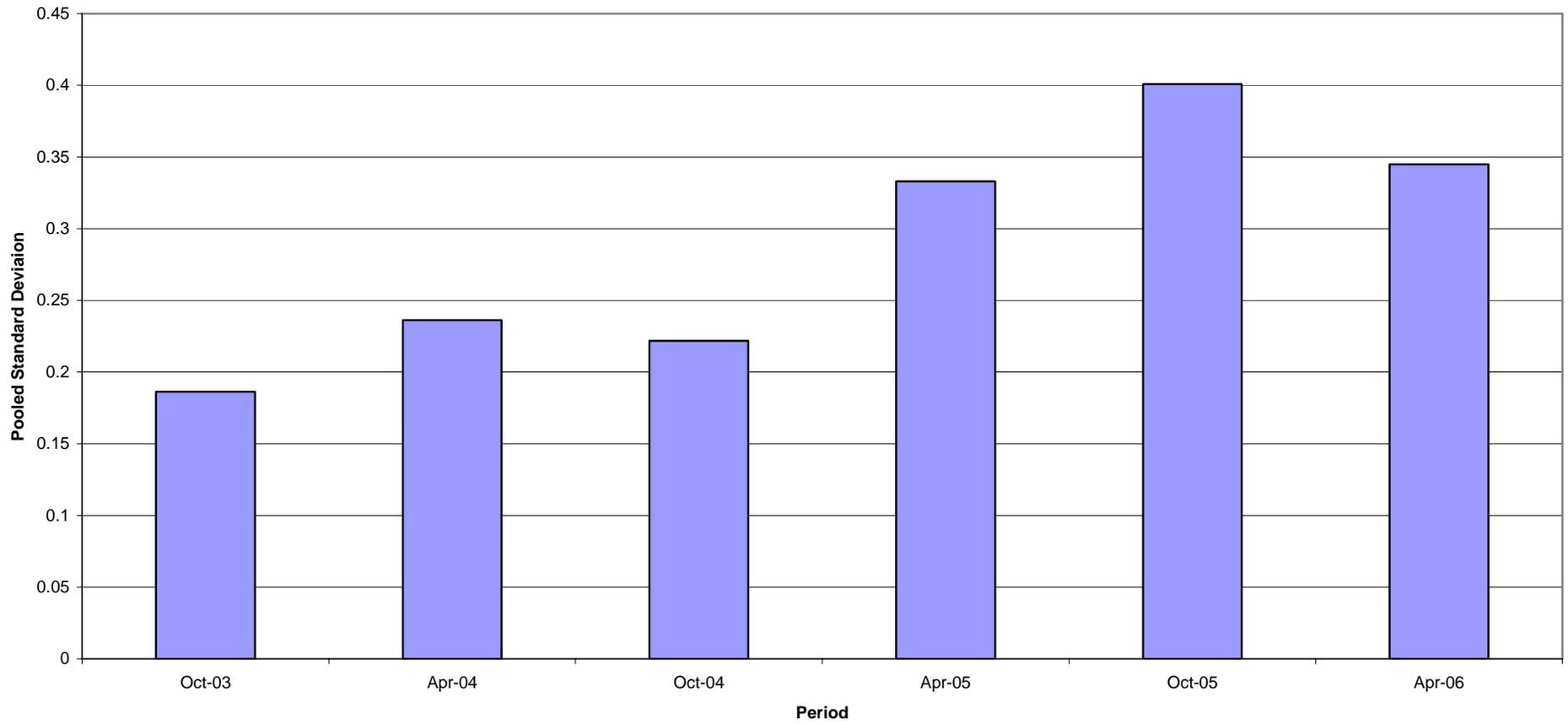


Figure 7 - Percent Viscosity Increase, Pooled Standard Deviation

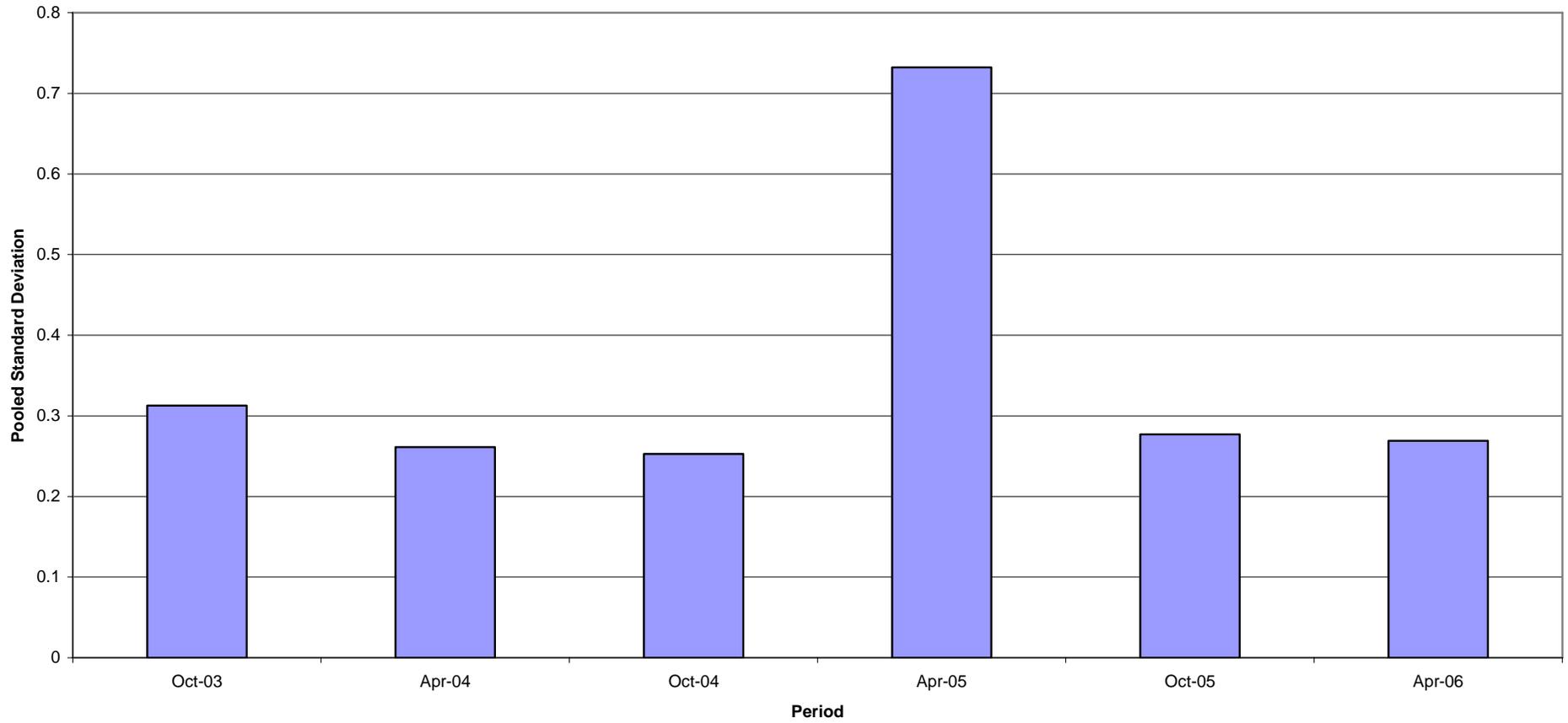


Figure 8 - Weighted Piston Deposits, Pooled Standard Deviation

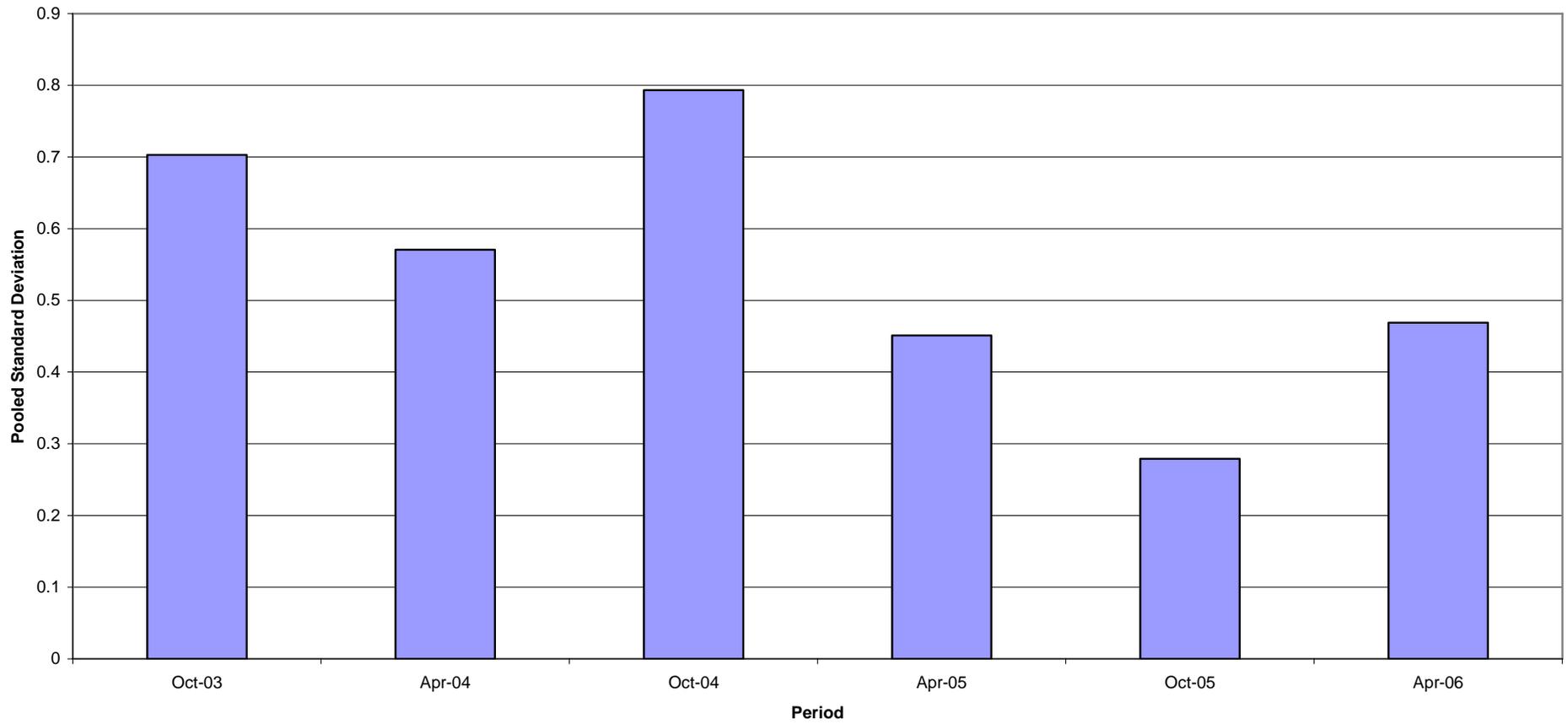


Figure 6 - Average Camshaft plus Lifter Wear, Average Delta/s

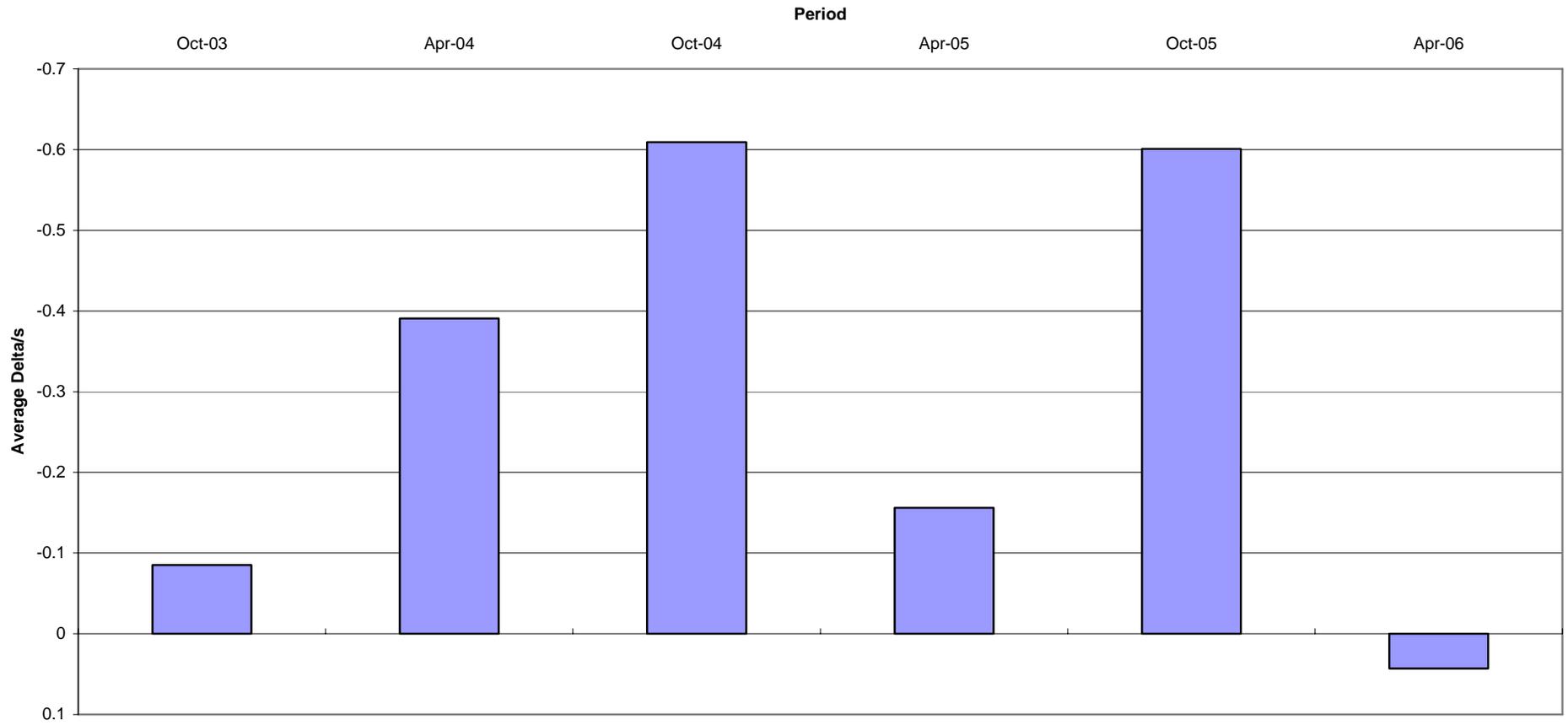


Figure 10

# SEQUENCE IIIGA INDUSTRY OPERATIONALLY VALID DATA

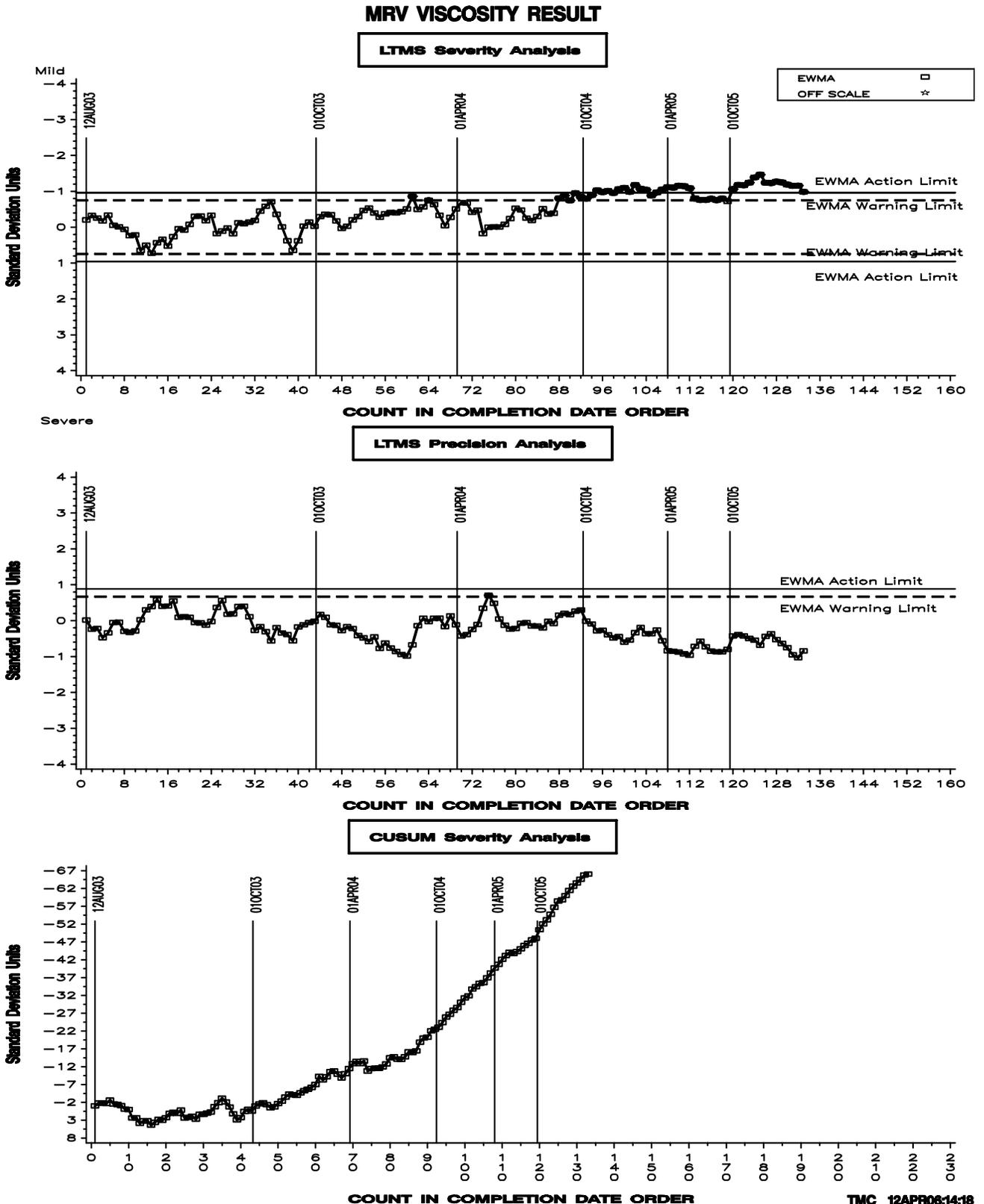


Figure 11 - Mini Rotary Viscometer result, Average Delta/s

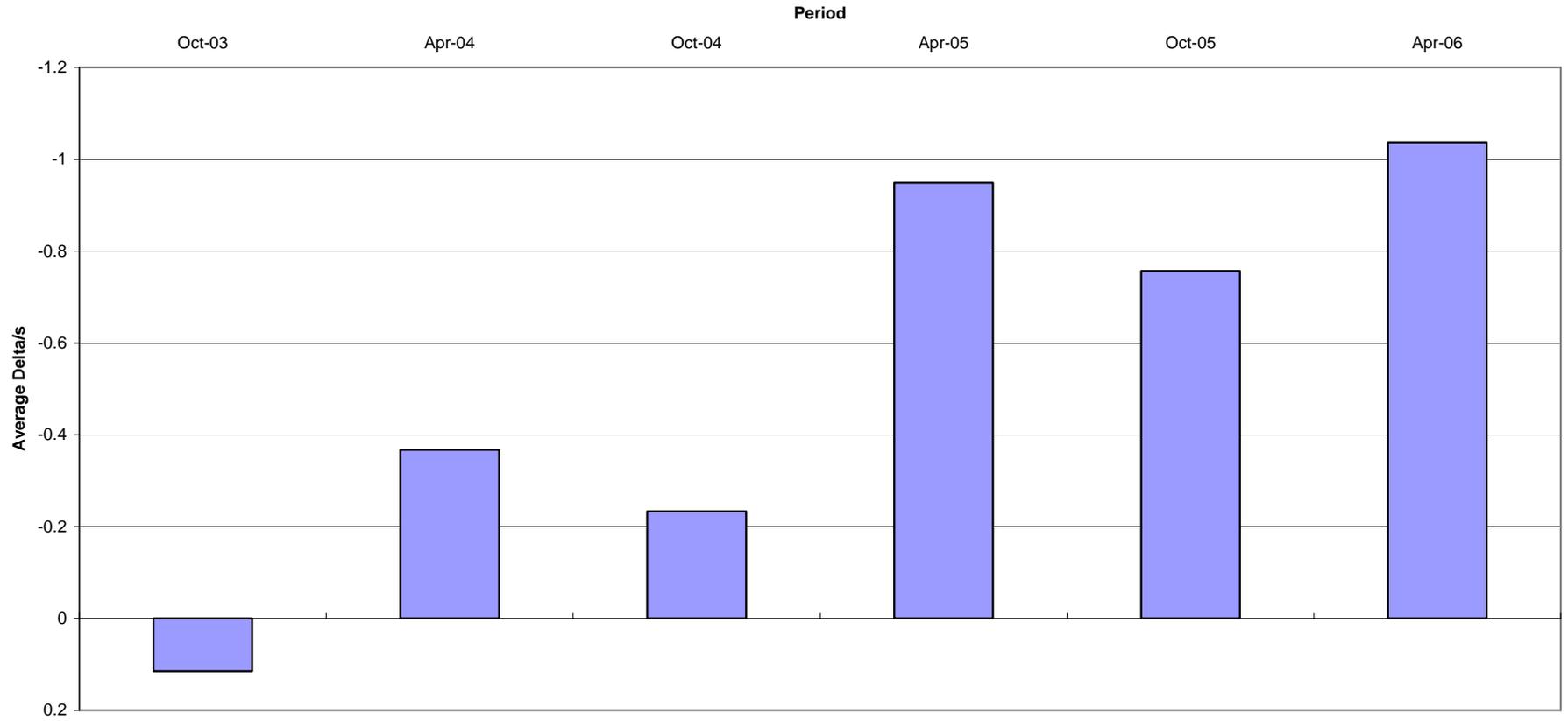


Figure 12 -Mini Rotary Viscometer result, Pooled Standard Deviation

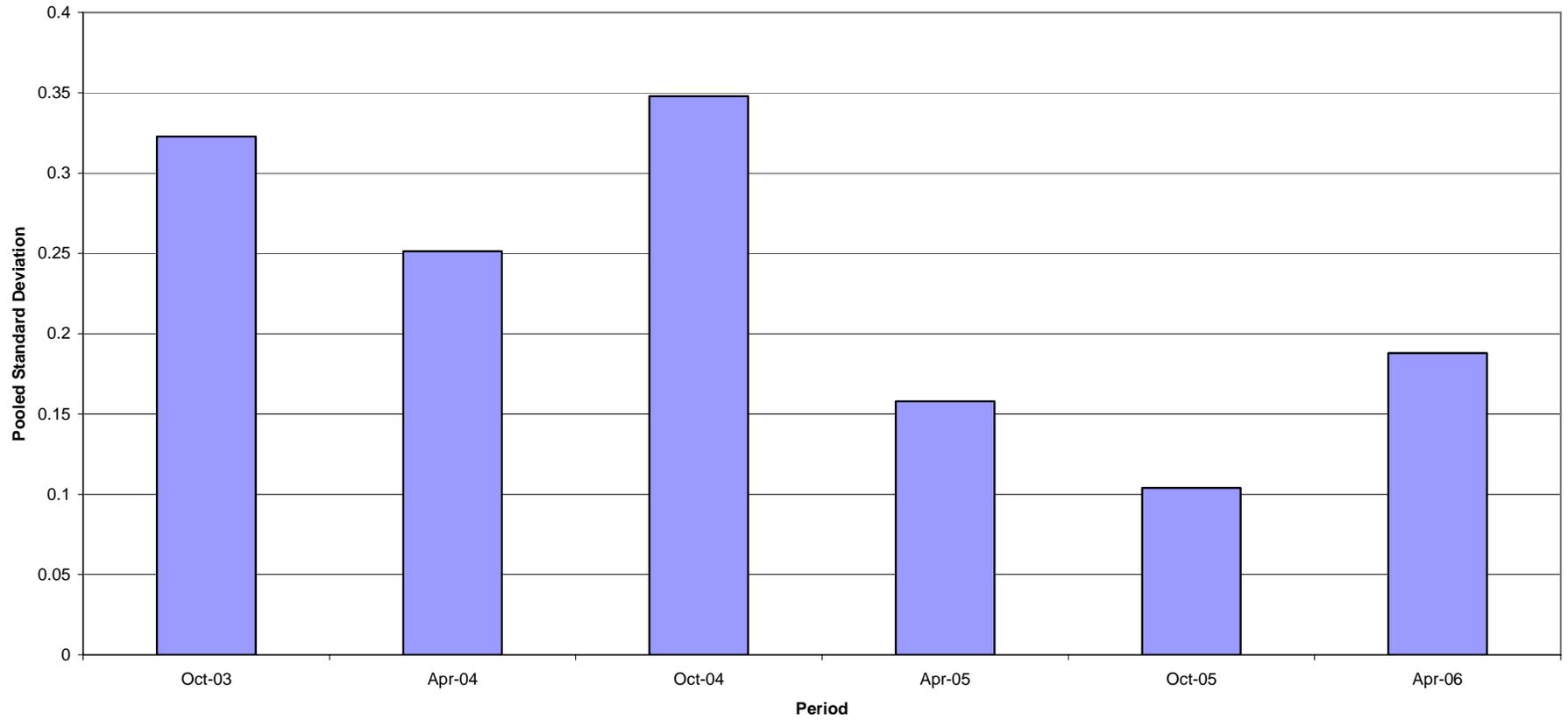


Figure 13 – Sequence IIIG/IIIGA Timeline

Effective Date	Topic	Info Letter
8/19/2003	Draft Sequence IIIG Test Procedure Issued	03-1
9/9/2003	Revised Valve Spring Load Specifications	03-2
9/23/2003	Revised Test Numbering Methodology	03-3
10/29/2003	Revised Fuel Pressure Specification	03-4
10/29/2003	Automatic Parts Cleaning Machine Maintenance Requirements Added	03-4
10/29/2003	Main Bearing Bore Mandrel Made Optional	03-4
10/29/2003	Piston Ring Cleaning Requirements	03-4
10/29/2003	Additional Allowable RTV Sealing Compound Allowed	03-4
10/29/2003	Main Bearing Cap Bolt Replacement Specifications	03-4
10/29/2003	Revised Camshaft Measurement Procedure	03-4
10/29/2003	Revised Camshaft Lubrication & Installation Procedure	03-4
10/29/2003	Revised Oil Consumption Reporting Procedure	03-4
10/29/2003	Fluid Conditioning Module Equipment Specifications	03-4
10/29/2003	Revised Camshaft Measurement Equipment Specifications	03-4
10/29/2003	Rating Workshop Attendance Requirement	03-4
11/4/2003	Elimination of CCS & MRV from IIIG test (creation of IIIGA test)	03-4
12/15/2003	New Honing Technique approved and added to Assembly Manual	
1/20/2004	Elimination of transform from ACLW results on oil 438 in LTMS; other oils still transformed	
1/20/2004	New Pooled s for ACLW SA calculation, based upon 434 and 435 only	
3/23/2004	Transform put back on 438 ACLW results, for all data. Control charts recalculated and effective today	
4/2/2004	Revised Intake Manifold Gasket	04-1
4/2/2004	Additional Allowable Sealing Materials	04-1
5/12/2004	Undercrown Rating Area Definition Clarification	04-2
5/12/2004	Flow Meter Specifications	04-2
5/12/2004	Editorial Corrections to Draft 2D	04-2
5/12/2004	MRV Reporting	04-2
5/12/2004	Amount of Oil Used for Camshaft & Lifter Lubrication	04-2
8/4/2004	First Occurrence of Powdered Metal Rods	
8/22/2004	First Occurrence of BC-4 rings	
11/4/2004	Powdered Metal Connecting Rod Torque Specifications	04-3
11/4/2004	New Front and Rear Main Seals	04-3
11/4/2004	New Oil Pan Gaskets	04-3
11/4/2004	New Exhaust Valves	04-3
11/4/2004	Editorial Change to Precision Statements	04-3
1/7/2005	Updated Precision Statements	05-1
1/7/2005	Engine Build Worksheets	05-1
1/7/2005	Clarification of Solvent Specifications	05-1
1/7/2005	Provisions for Adjustment to Calibration Period for Donated Oil Test Programs	05-1
8/8/2005	First occurrence of BC-5 rings	
11/29/2005	Revision to requirements for attendance to rater workshops	05-2
11/29/2005	Allows the use of torque wrench ETW-E180	05-2
3/29/2006	First occurrence of BC-6 rings	