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

Memorandum: 04-101

Date: November 11, 2004

To: William M. Nahumck, Chairman, Sequence III Surveillance Panel

From: Michael T. Kasimirsky

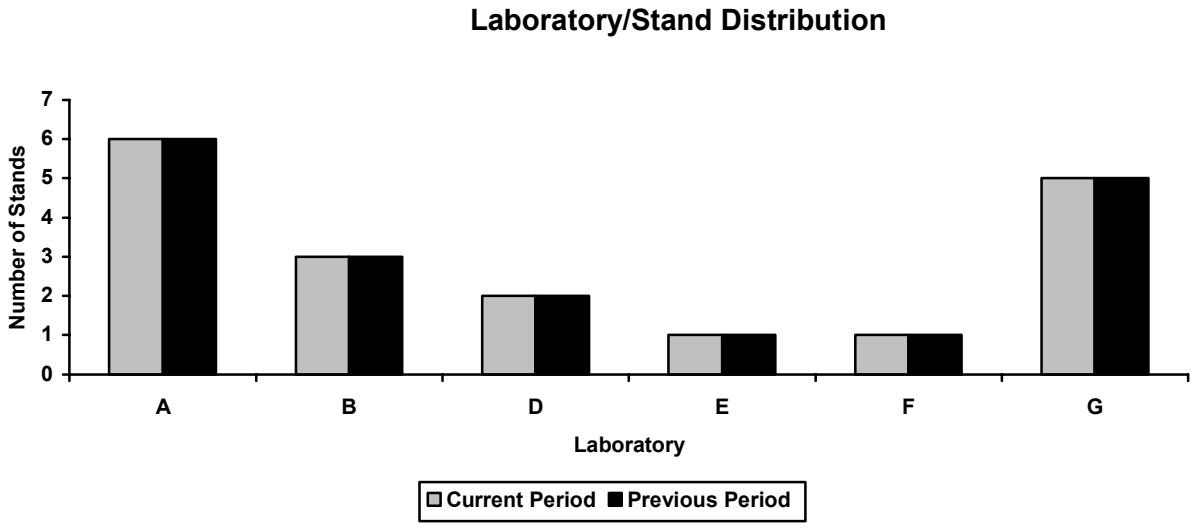
Subject: Sequence IIIG/IIIGA Semiannual Report: April 1, 2004 through September 30, 2004

The following is a summary of Sequence IIIG 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:	6	4
Number of Test Stands:	18	12

The following chart shows the laboratory/stand distribution:

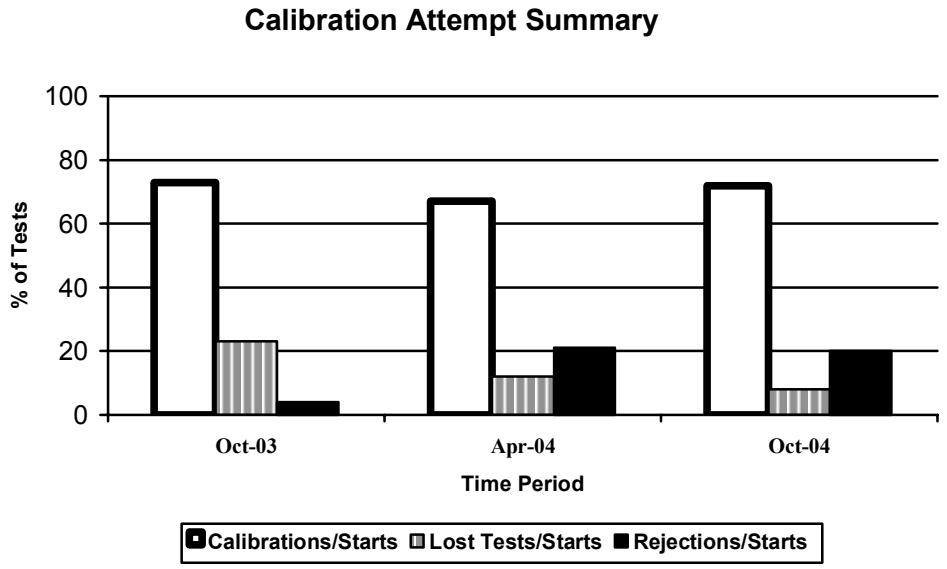


The following summarizes the status of the reference oil tests reported to the TMC:

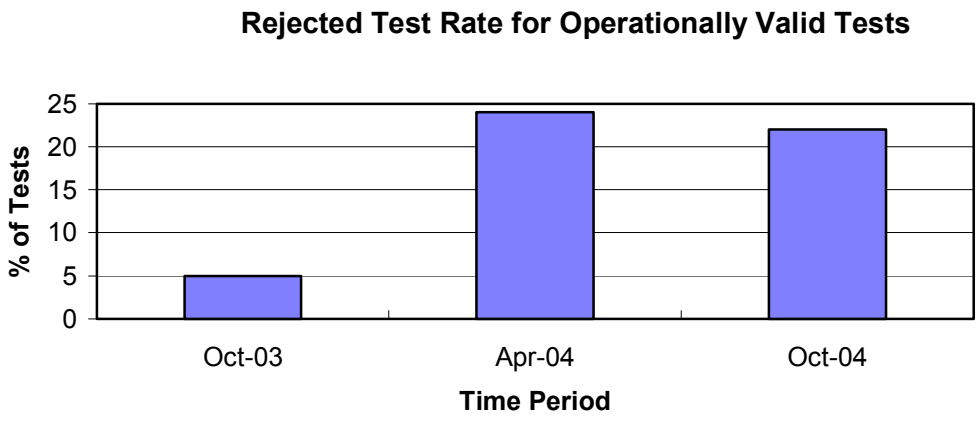
Calibration Start Outcomes	TMC Validity Codes	No. of Tests
Operationally and Statistically Acceptable	AC	18
Failed Acceptance Criteria	OC	5
Operationally Invalid (Laboratory Judgment)	LC	2
Operationally Invalid (Lab & TMC Judgment)	RC	0
Stand Problem – Data Pulled from LTMS	MC	0
Aborted	XC	0
Total		25

Donated & Industry Support Outcomes	TMC Validity Codes	No. of Tests
Decoded Oil – Stand Investigation	OG	2
Total		2

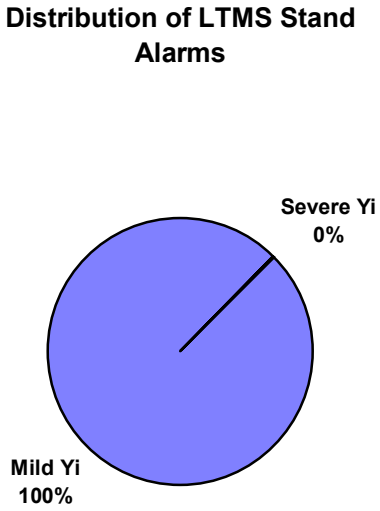
Calibrations per start, lost tests per start and rejection rates are summarized below:

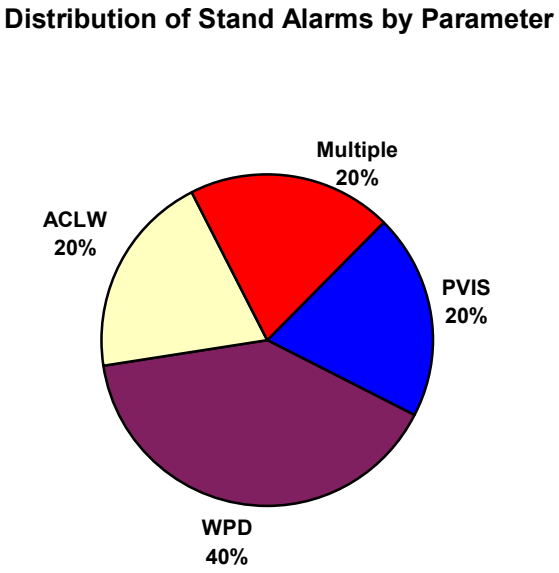


The calibration per start rate is slightly higher than last period. The lost test rate is slightly lower than last period. The rejected test rate is slightly lower than last period.



There were five failing tests for the period. The following charts summarize the reasons and breakdown by parameter for the failed test:





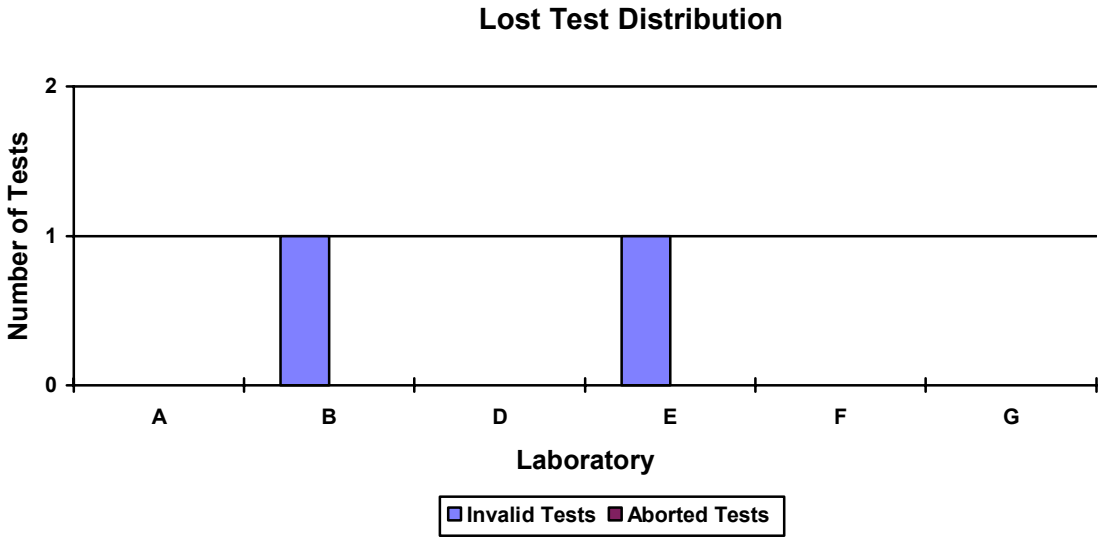
There were no LTMS Deviations written this period. There have been no deviations from the LTMS since its introduction in August of 2003.

Two Sequence IIIG lab visits were performed this period. No significant problems were found.

Lost Test Summary

Two tests were lost this period. The reasons for the lost tests are shown in the following table:

Lab	Reason for Lost Test	Number of Tests	Breakdown of Tests (LC/RC/XC)
B	Dynamometer Load Problem	1	1/0/0
E	Downtime	1	1/0/0



Information Letters

Sequence IIIG Information Letter No. 04-1, Sequence No. 5, was issued during the period on April 2, 2004, and contained: Revised Intake Manifold Gasket, and Additional Allowable Sealing Materials

Sequence IIIG Information Letter No. 04-2, Sequence No. 6, was issued during the period on June 24, 2004, and contained: Undercrown Rating Area Definition Clarification, Flow Meter Specifications, Editorial Corrections, MRV Reporting, and Amount of Test Oil Used for Camshaft & Lifter Lubrication

Sequence IIIG Engine Assembly Manual

A new version of the Sequence IIIG Engine Assembly Manual, dated 3-15-04, was issued via TMC Memorandum 04-014, dated April 2, 2004.

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 reported units
PVIS	-0.463	0.253 (df=20)	-16.6 % Viscosity Increase[1]
WPD	0.249	0.793 (df=23)	0.06 Merits
ACLW	-0.609	0.222 (df=20)	-5.3µm^2

Industry Severity Summary			
Parameter	Average Δ/s	Pooled standard deviation (degrees of freedom)	Average Δ, in reported units
MRV[3]	-0.233	0.348 (df=14)	N/A (no appropriate baseline)[4]

[1] At the proposed GF-4 Pass Limit of 150% Viscosity Increase
[2] At the proposed GF-4 Pass Limit of 60μm
[3] Sequence IIIGA Test Parameter only; Reference Oil 435 data excluded from calculations
[4] MRV does not have a specific GF-4 Pass Limit; Pass Limit is lack of Yield Stress.

Average Δ/s Results, by Laboratory				
Laboratory	PVIS	WPD	ACLW	MRV[1]
A	-0.20	0.31	-0.88	-0.11
B	-0.42	0.89	-0.34	-0.30
D	-0.84	-0.19	-0.03	-0.72
E	-0.17	1.22	-0.98	0.65
F	-1.37	1.08	-1.51	0.51
G	-0.32	-0.95	0.12	-0.70

[1] Reference oil 435 data excluded from calculations

Percent Viscosity Increase (PVIS)

The industry began the period within limits for both severity and precision, but has recently experienced a two-point severity alarm and is currently in a precision alarm (see Figure 1). These two alarms were caused by two failing reference oil tests on one stand at one laboratory. These two tests were run on 438 and 434 and generated Y_i results of -3.25 and 6.52, respectively. Subsequent tests have calibrated the stand in question and there is no indication that these industry alarms are illustrating a larger industry problem. The average Δ/s value for the period, -0.463, is milder than last period and is shown in Figure 4. The pooled standard deviation for the period, 0.253, is slightly better than last period and is shown in Figure 7.

Weighted Piston Deposits (WPD)

The industry exceeded the limits for both severity and precision during the period (see Figure 2). The single-point severity alarm and two four- and three-point precision alarms were caused by two failing reference oil tests on different stands at two different laboratories. Both tests were run on reference oil 438 and generated Y_i results of 3.74 and 4.45 respectively. Both stands have successfully calibrated on subsequent reference oil test runs. The average Δ/s value for the period, 0.249, is milder than last period and is the mildest period we have on record (see Figure 5). The pooled standard deviation for the period, 0.793, is worse than last period and is the worst precision estimate on record for WPD in the Sequence IIIG test (see Figure 8).

Average Camshaft-plus-Lifter Wear (ACLW)

The industry has exceeded the EWMA Severity Mild Warning Limit repeatedly during the period and has exceeded the EWMA Precision Warning Limit twice during the period (see Figure 1). These alarms seem to be driven primarily by four test results, on four different test stands in three different laboratories, on reference oils 435 (-3.09, -2.73, and –-3.12 Y_i respectively) and 438 (-2.07 Y_i). One of these tests (-2.73 Y_i result on reference oil 435) was deemed acceptable under the Special K Criterion for

laboratories with active severity adjustments. No cause for these mild tests has been found and subsequent testing (when applicable) has resulted in stand calibration for all the aforementioned stands. The average Δ/s value for the period, -0.609, is much milder than last period and is shown in Figure 6. The pooled standard deviation for the period, 0.222, is slightly better than last period and is shown in Figure 9.

Mini Rotary Viscometer (MRV)

The MRV control charts are shown for informational purposes in Figure 10. As you can see, the industry has exceeded the EWMA Severe Warning Limit several times with the most recent test results. Precision, with the exception of a single-point alarm, has been within limits for the period. The average Δ/s value for the period, -0.233, is less severe than last period and is shown in Figure 11. The pooled standard deviation for the period, 0.348, is worse than last period and is shown in Figure 12.

QI Deviations

There was one QI Deviation written this period. There has been a total of one QI Deviation written since the test was introduced in August of 2003.

Hardware

Powdered metal connecting rods came into widespread use during the period. These connecting rods use a different fastener than the previous cast connecting rods and require the use of different fastener torque specifications as a result. The connecting rods do not appear to have had any effect on test severity with their introduction.

Reference Oils

Oil	TMC Inventory, in gallons	TMC Inventory, in tests (4 gal/test)	Laboratory Inventory, in tests	Estimated life
434	258	64	12	~ 4 years
435	294	73	15	~ 5 years
438	751	187	11	~10 years

On May 26, 2004, the Sequence III Surveillance Panel approved a motion to revise the test targets on all three reference oils based upon all the data available to date in the LTMS. As part of the motion, the panel also approved a plan to update the targets for all three reference oils again when 30 and 35 data points become available on each oil. As a result of this motion, the test targets for 434 were revised once during the period and the targets for reference oils 435 and 438 were revised twice during the period. The revised targets are shown in the tables below:

Updated Reference Oil 434 (N=23), effective June 1, 2004		
Parameter	**Mean**	**Standard Deviation**
PVIS	4.7269	0.3859
WPD	4.80	0.96
ACLW	3.4657	0.1993
MRV	10.7881	0.45550

Updated Reference Oil 435 (N=26), effective June 1, 2004		
Parameter	**Mean**	**Standard Deviation**
PVIS	5.2333	0.2924
WPD	3.59	0.51
ACLW	3.5044	0.2256
MRV	N/A*	N/A*

*MRV results for 435 use the calculated Yi value for PVIS in the MRV control charts

Updated Reference Oil 438 (N=25), effective June 1, 2004		
Parameter	**Mean**	**Standard Deviation**
PVIS	4.5761	0.1877
WPD	3.20	0.35
ACLW	2.8799	0.1864
MRV	9.8405	0.16998

Updated Reference Oil 438 (N=30), effective September 1, 2004		
Parameter	**Mean**	**Standard Deviation**
PVIS	4.5706	0.1768
WPD	3.20	0.33
ACLW	2.8814	0.2082
MRV	9.8277	0.16646

Updated Reference Oil 435 (N=31), effective October 1, 2004		
Parameter	**Mean**	**Standard Deviation**
PVIS	5.1838	0.3096
WPD	3.59	0.58
ACLW	3.4985	0.2342
MRV	N/A*	N/A*

*MRV results for 435 use the calculated Yi value for PVIS in the MRV control charts

MRV Severity Adjustments

On the May 18/26, 2004 teleconference, the Sequence III Surveillance Panel decided to temporarily stop applying severity adjustments to MRV results in the Sequence IIIGA test. As you know,

the original proposal for severity adjusting the MRV parameter called for using the Y_i result for PVIS in place of the calculated Y_i result for MRV for any tests conducted on reference oil 435. This was done because reference oil 435 sometimes generates Yield Stress, making the MRV viscosity results meaningless. This "Y_i Exchange" has been determined to be unacceptable and as a result, severity adjustments on the MRV parameter are not used until a new system can be determined. To date, the TMC has received the following data on reference oil 435:

TESTKEY	LTMSLAB	LTMSAPP	LTMSDATE	LTMSTIME	VAL	MRV	MRVTEMP	PVIS	YSTRESS
47905	G	3	20030812	00:11	AO	84800	-30	163.4	105
47888	A	3	20030812	00:12	AO	84500	-30	172.2	50
47906	G	5	20030812	00:19	AO	210700	-30	279	315
47889	A	1	20030812	00:20	AO	300200	-30	222.2	80
47891	A	3	20030812	00:25	AO	91900	-30	176.4	20
47908	G	2	20030812	00:27	AO	400000	-30	304.8	315
47907	G	5	20030812	00:30	AO	294000	-30	230.2	175
47890	A	2	20030812	00:39	AO	110100	-30	167.7	60
47892	A	4	20030812	00:48	AC	158700	-30	214.1	90
47918	B	2	20030812	00:51	AC	71200	-30	143.3	35
47927	F	1	20030812	00:53	AC	88790	-30	154.7	<175
47919	B	1	20030812	00:54	AC	999999	-30	286.8	NM
47909	G	4	20030812	00:55	AC	400000	-30	313.6	315
48579	G	5	20030831	02:33	AC	68600	-30	135.8	105
47945	E	1	20031025	00:22	OC	71927	-25	247.1	245-
47938	D	1	20031123	21:43	AC	29341	-25	178.7	20
48587	A	2	20031126	16:02	AC	247800	-30	225.6	280
48580	G	3	20040111	23:32	AC	145400	-30	185.1	175
47920	B	3	20040117	03:46	OC	42500	-30	116.3	NM
49512	G	1	20040218	04:45	AC	44300	-30	129.8	NM
49067	D	2	20040223	21:45	AC	199362	-30	189.7	8
51017	G	4	20040323	07:18	OC	278800	-30	272.5	280
49076	A	6	20040324	13:32	AC	52700	-30	141	NM
51018	G	4	20040331	06:48	AC	45600	-30	131	NM
50457	A	7	20040404	17:37	AC	48700	-30	133.9	70
49074	B	2	20040409	18:14	AC	58800	-30	165.9	NM
47947	E	1	20040728	03:45	OC	30022	-25	172.5	70-1
51027	A	4	20040815	20:59	OC	171300	-30	191.5	210
51752	G	4	20040822	06:23	AC	38300	-30	124.9	35
47928	F	1	20040906	21:04	OC	31157	-25	91	<35
52628	A	5	20040908	19:45	AC	50300	-30	132.6	70

As you can see, only 7 of the 31 data points generated to date did not generate Yield Stress (reported as either "NM" or "<35" in the *YSTRESS* column; the "8" result may also indicate a lack of Yield Stress as well), meaning that most of the reference oil 435 data isn't suitable for use in determining a laboratory severity adjustment. No other proposals have been offered up for the Surveillance Panel's consideration at this time.

MTK/mtk

Attachments

c: F. M. Farber, TMC
Sequence III Surveillance Panel
ftp://ftp.astmtmc.cmu.edu/docs/gas/sequenceiii/semiannualreports/IIIG-10-2004.pdf

Distribution: Electronic Mail

List of Figures

- Figures 1, 2, and 3 are EWMA severity and precision control charts and also the CUSUM Δ/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 Δ/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 Δ/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 Δ/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 IIIG/IIIGA Timeline.

Figure 1

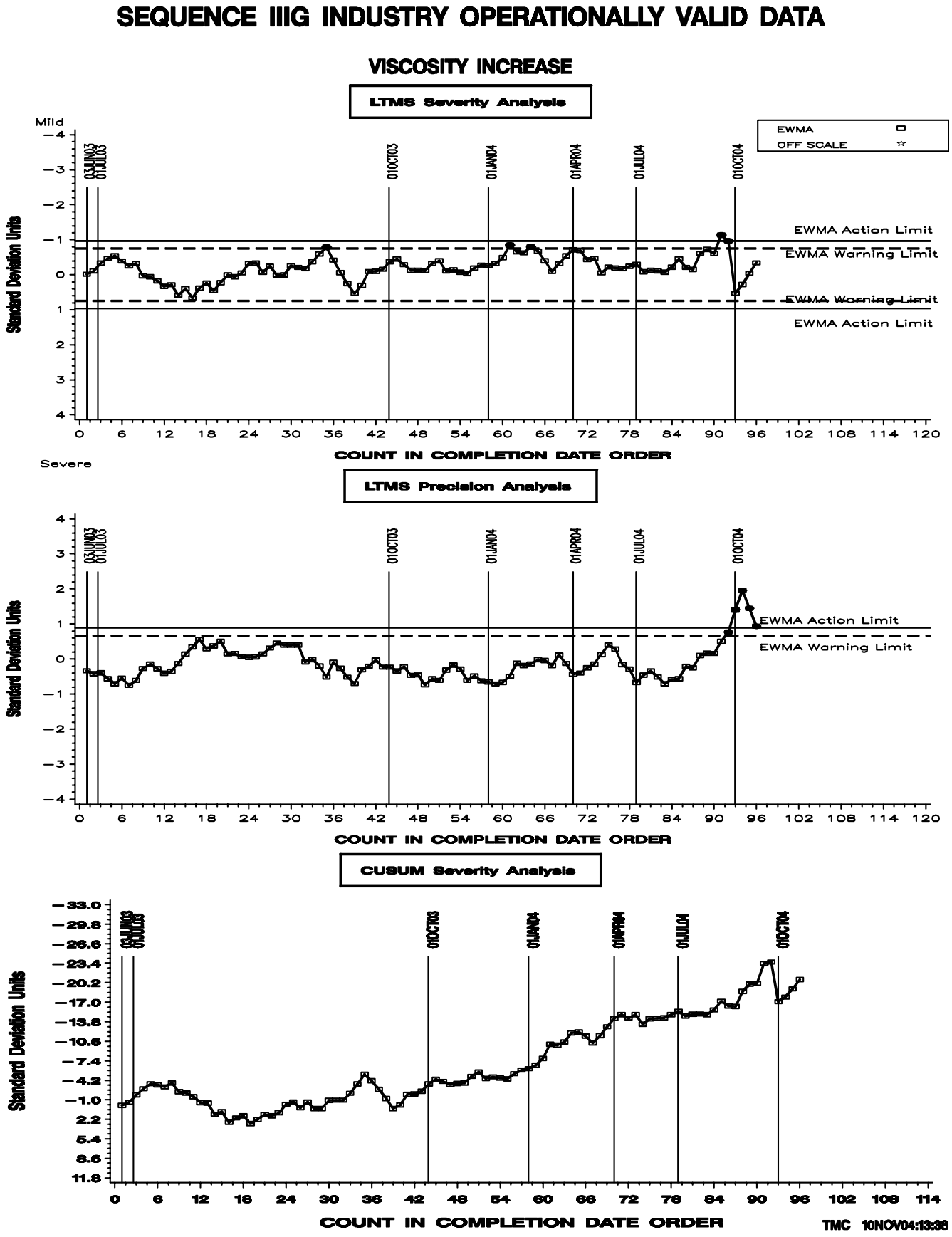

SEQUENCE IIIG INDUSTRY OPERATIONALLY VALID DATA
VISCOSITY INCREASE
LTMS Severity Analysis
Mild
Severe
Standard Deviation Units
EWMA
OFF SCALE
EWMA Action Limit
EWMA Warning Limit
EWMA Warning Limit
EWMA Action Limit
03JUN03
01JUL03
01OCT03
01JAN04
01APR04
01JUL04
01OCT04
COUNT IN COMPLETION DATE ORDER
LTMS Precision Analysis
CUSUM Severity Analysis
TMC 10NOV04:13:38

Figure 2

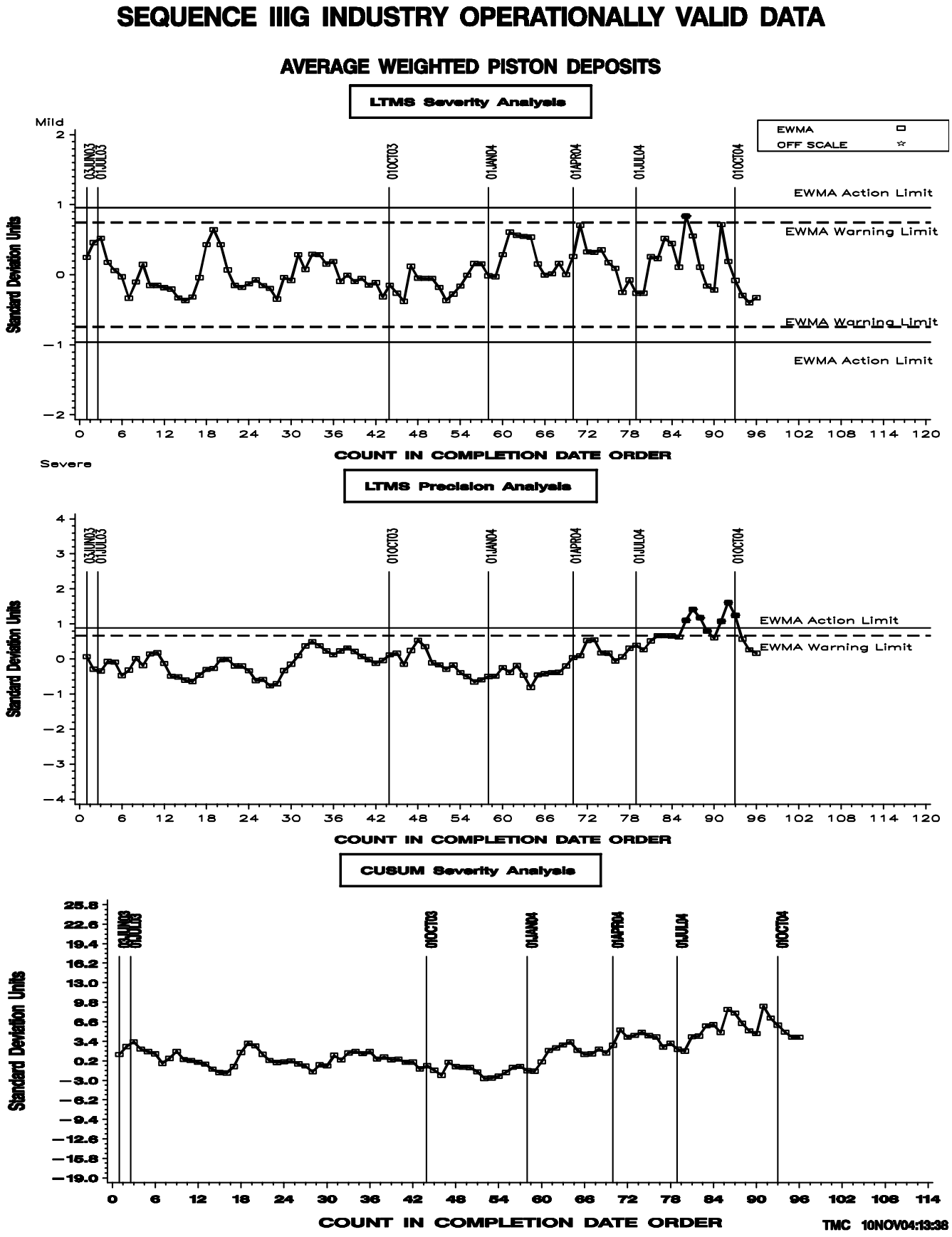

SEQUENCE IIIG INDUSTRY OPERATIONALLY VALID DATA
AVERAGE WEIGHTED PISTON DEPOSITS
LTMS Severity Analysis
Mild
Severe
EWMA
OFF SCALE
EWMA Action Limit
EWMA Warning Limit
EWMA Warning Limit
EWMA Action Limit
Standard Deviation Units
03JUN03
01JUL03
01OCT03
01JAN04
01APR04
01JUL04
01OCT04
COUNT IN COMPLETION DATE ORDER
LTMS Precision Analysis
EWMA Action Limit
EWMA Warning Limit
CUSUM Severity Analysis
TMC 10NOV04:13:38

Figure 3

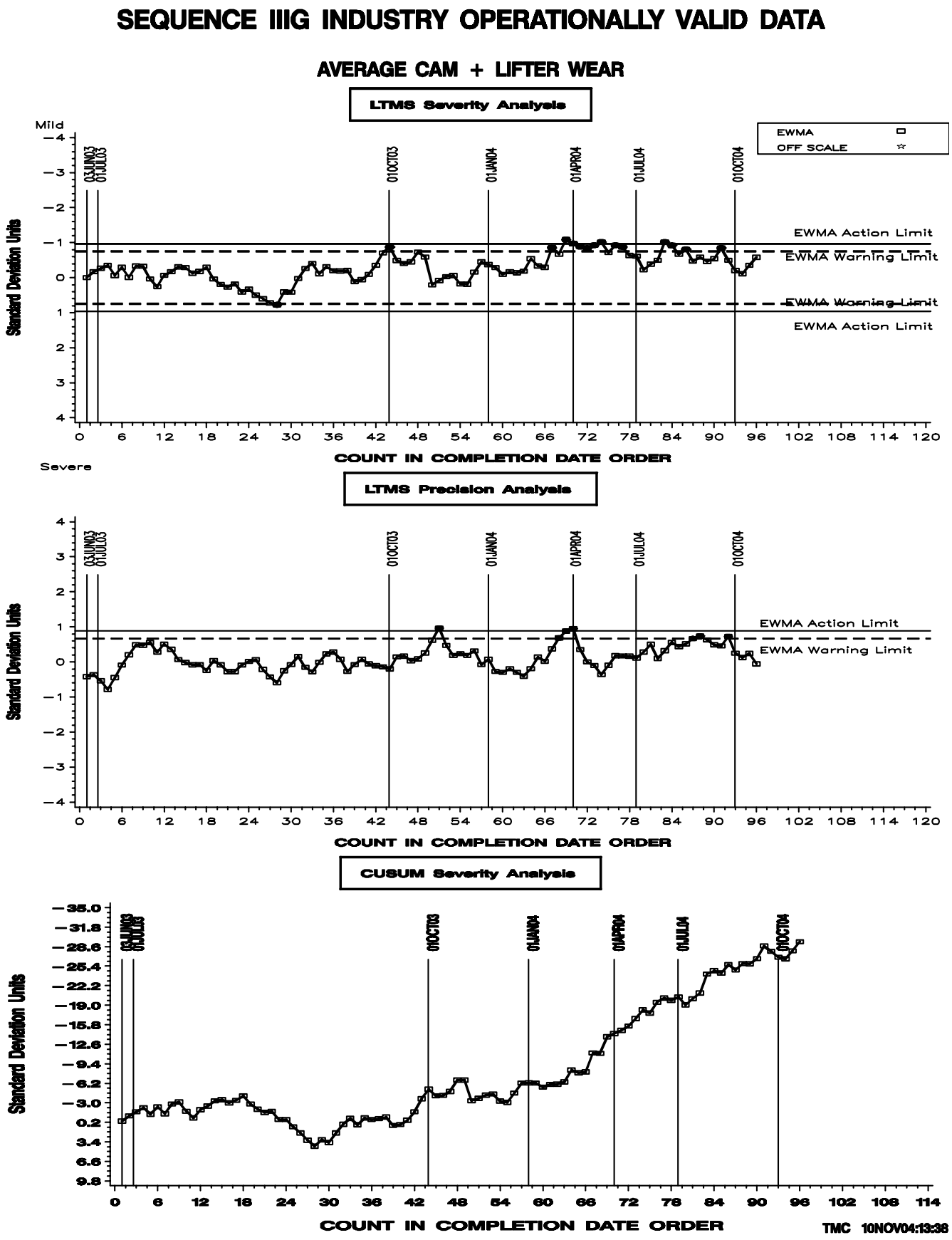

SEQUENCE IIIG INDUSTRY OPERATIONALLY VALID DATA
AVERAGE CAM + LIFTER WEAR
LTMS Severity Analysis
Mild
Severe
EWMA
OFF SCALE
EWMA Action Limit
EWMA Warning Limit
EWMA Warning Limit
EWMA Action Limit
03JUN03
01JUL03
01OCT03
01JAN04
01APR04
01JUL04
01OCT04
Standard Deviation Units
COUNT IN COMPLETION DATE ORDER
LTMS Precision Analysis
CUSUM Severity Analysis
TMC 10NOV04:13:38

Figure 4 - Percent Viscosity Increase, Average Delta/s

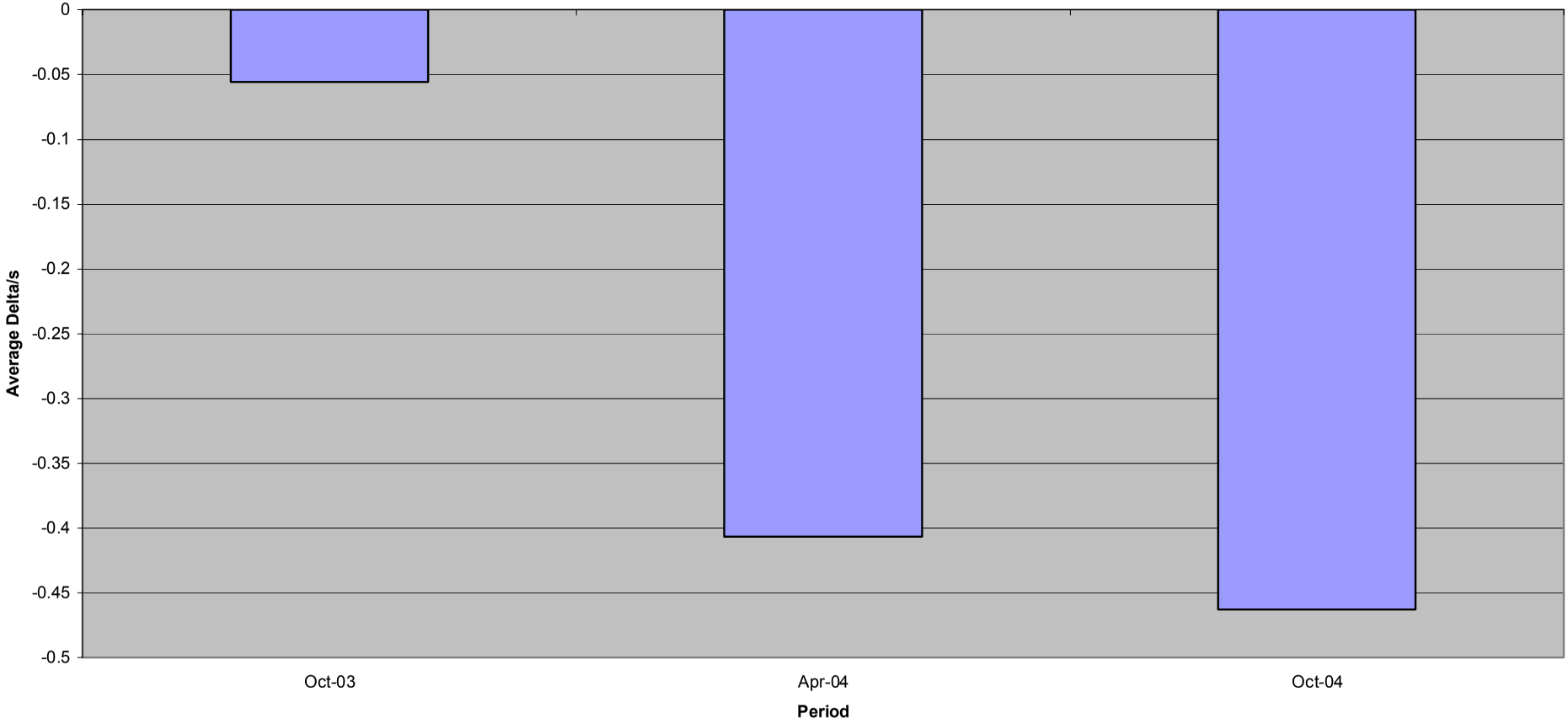


Figure 5 - Weighted Piston Deposits, Average Delta/s

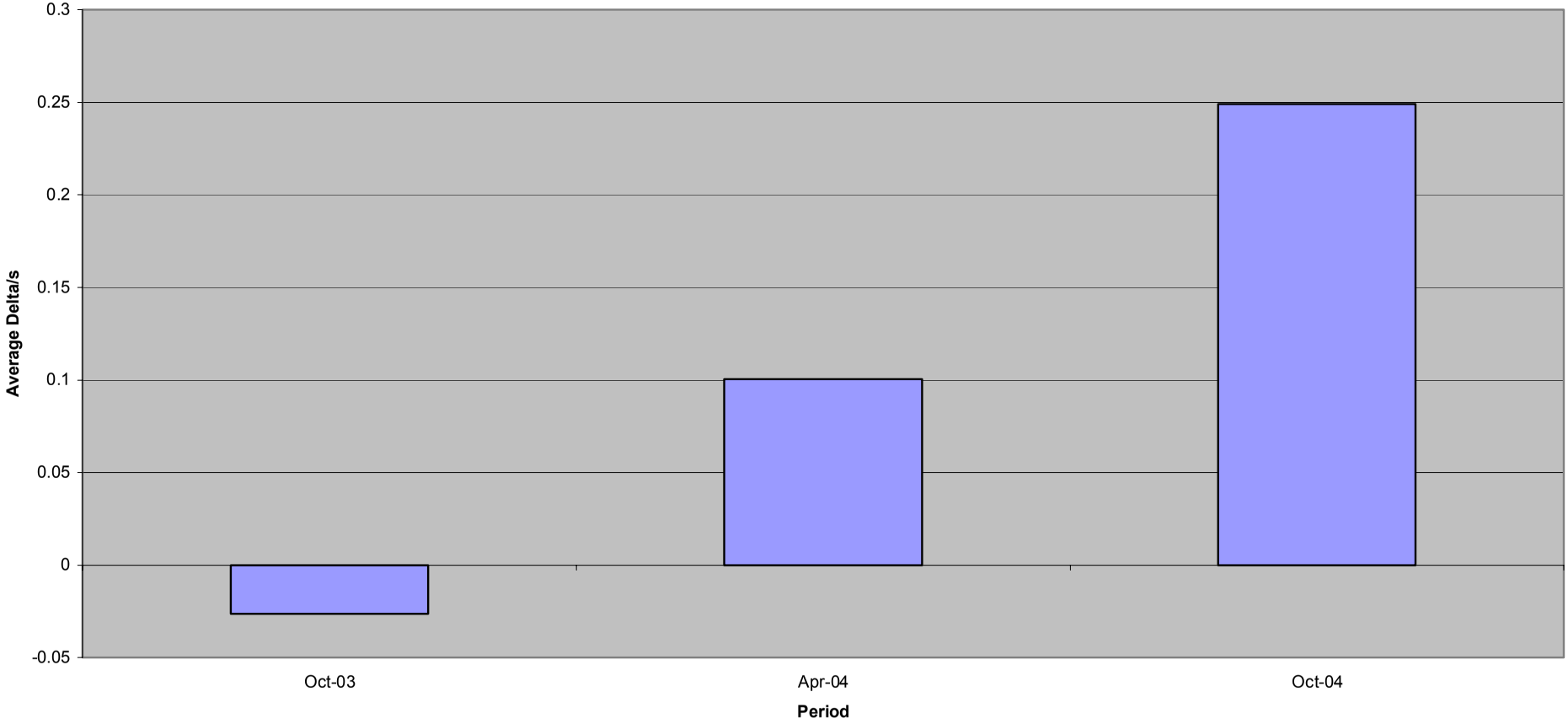


Figure 6 - Average Camshaft plus Lifter Wear, Average Delta/s

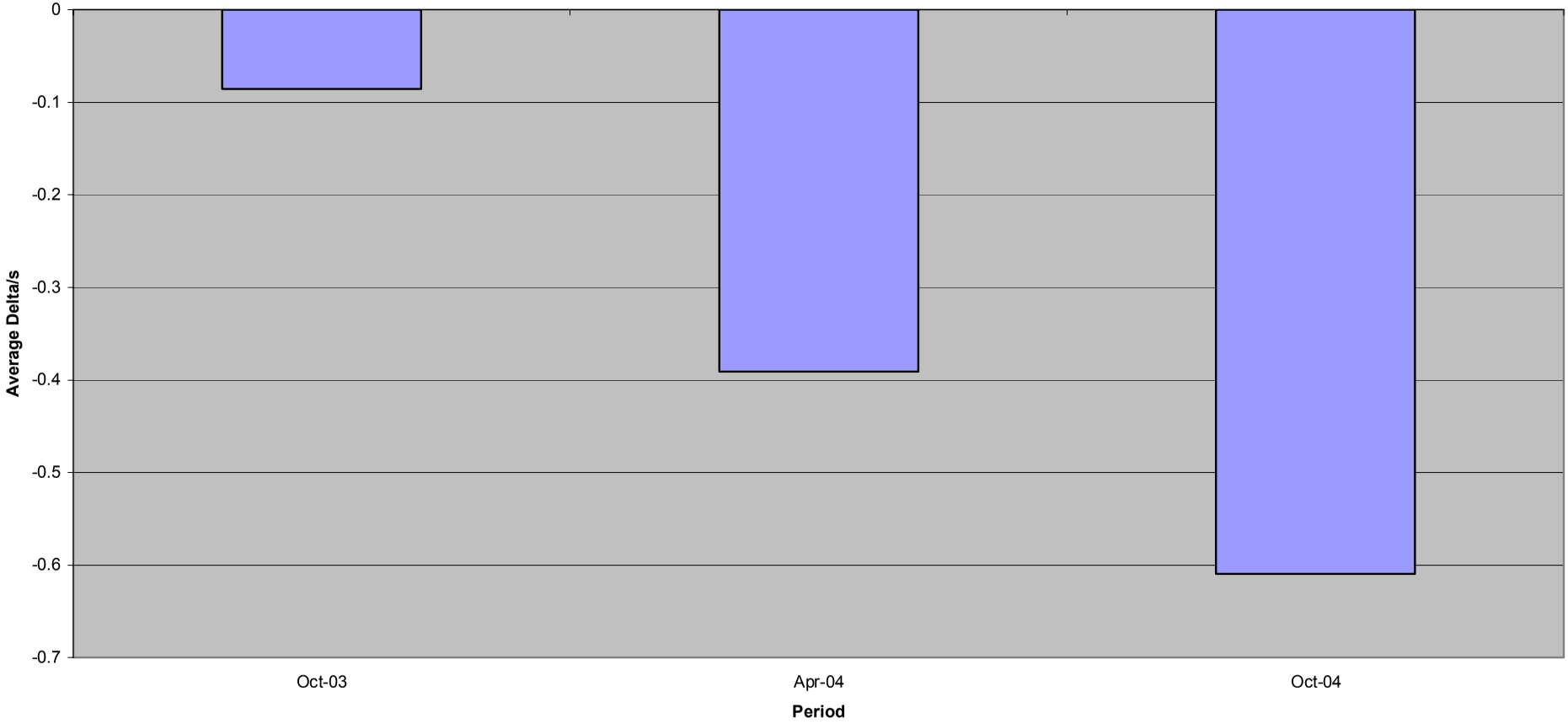


Figure 7 - Percent Viscosity Increase, Pooled Standard Deviation

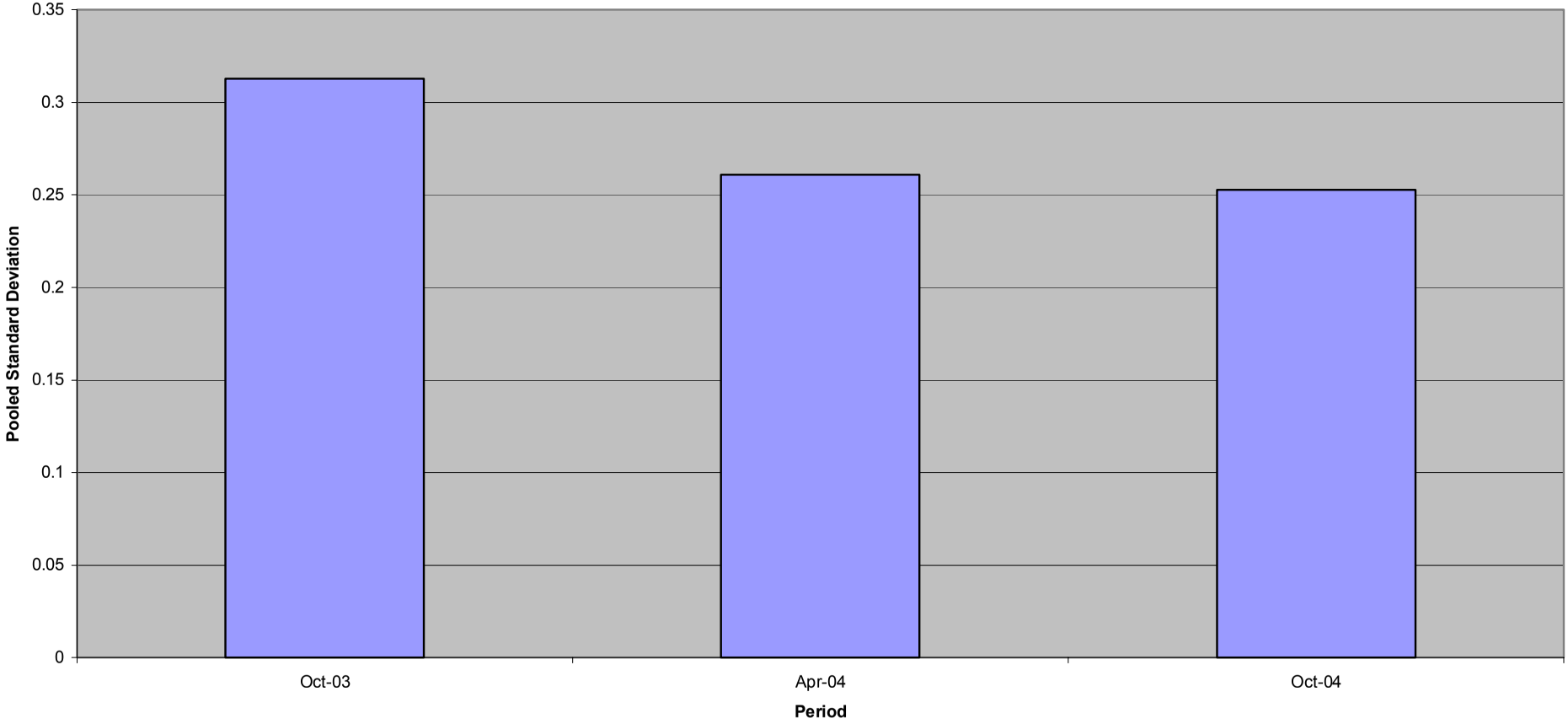


Figure 8 - Weighted Piston Deposits, Pooled Standard Deviation

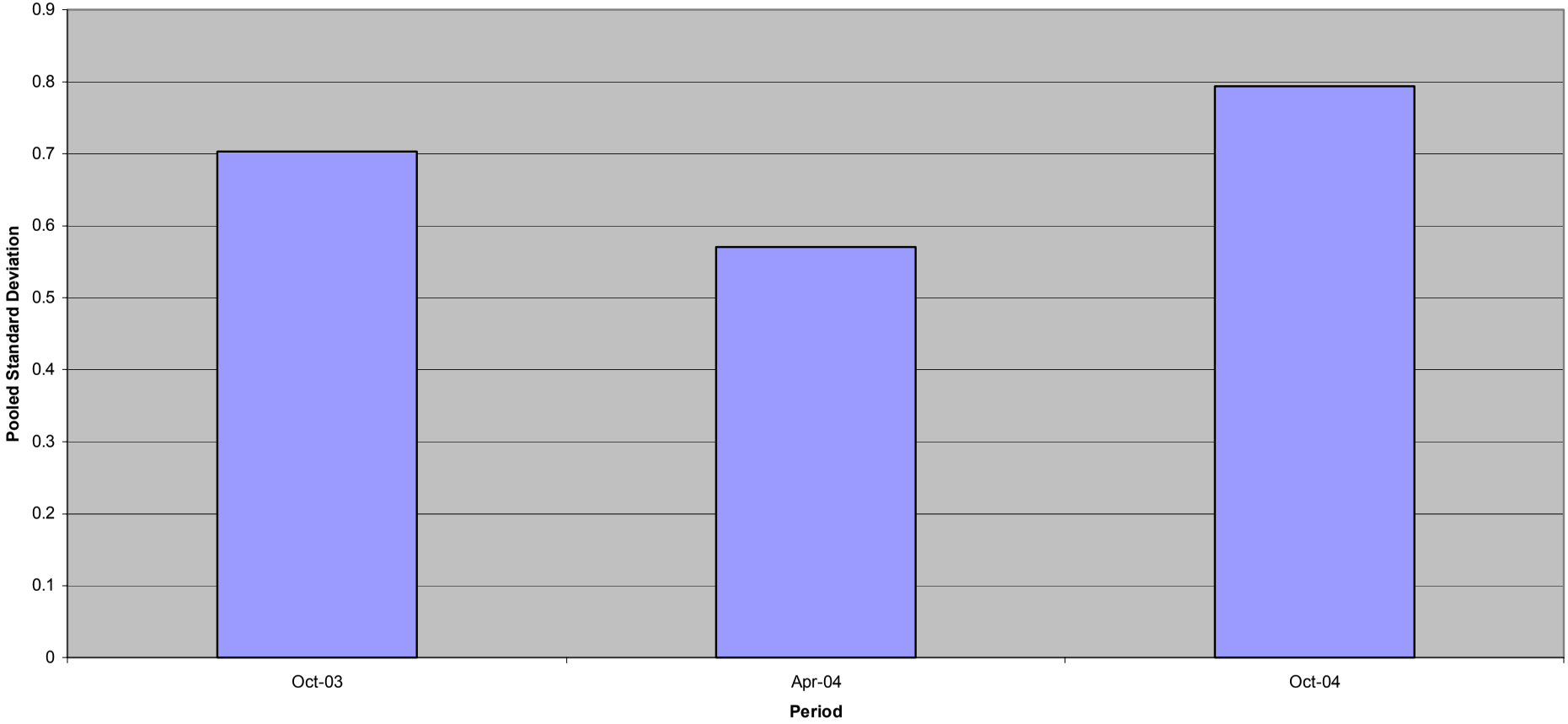


Figure 9 - Average Camshaft plus Lifter Wear, Pooled Standard Deviation

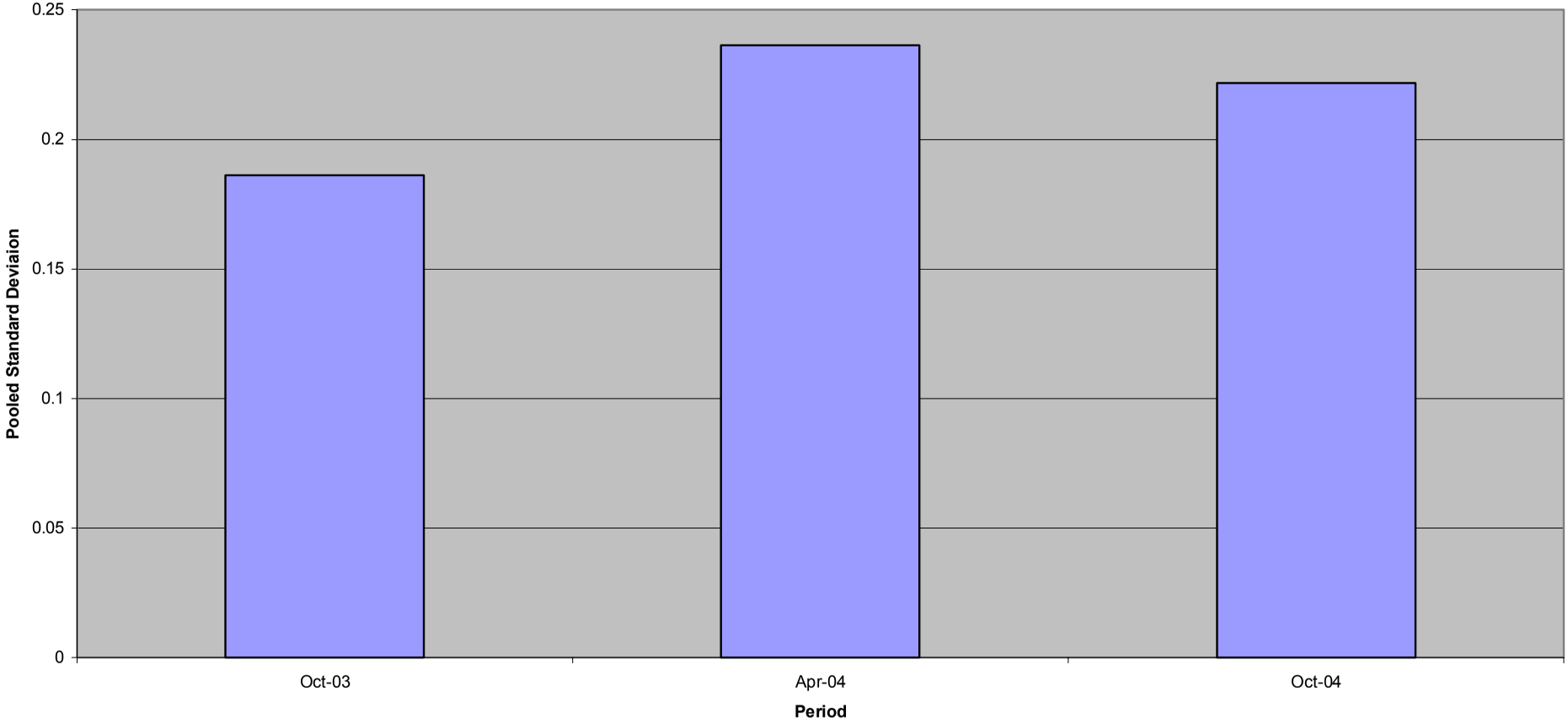


Figure 10

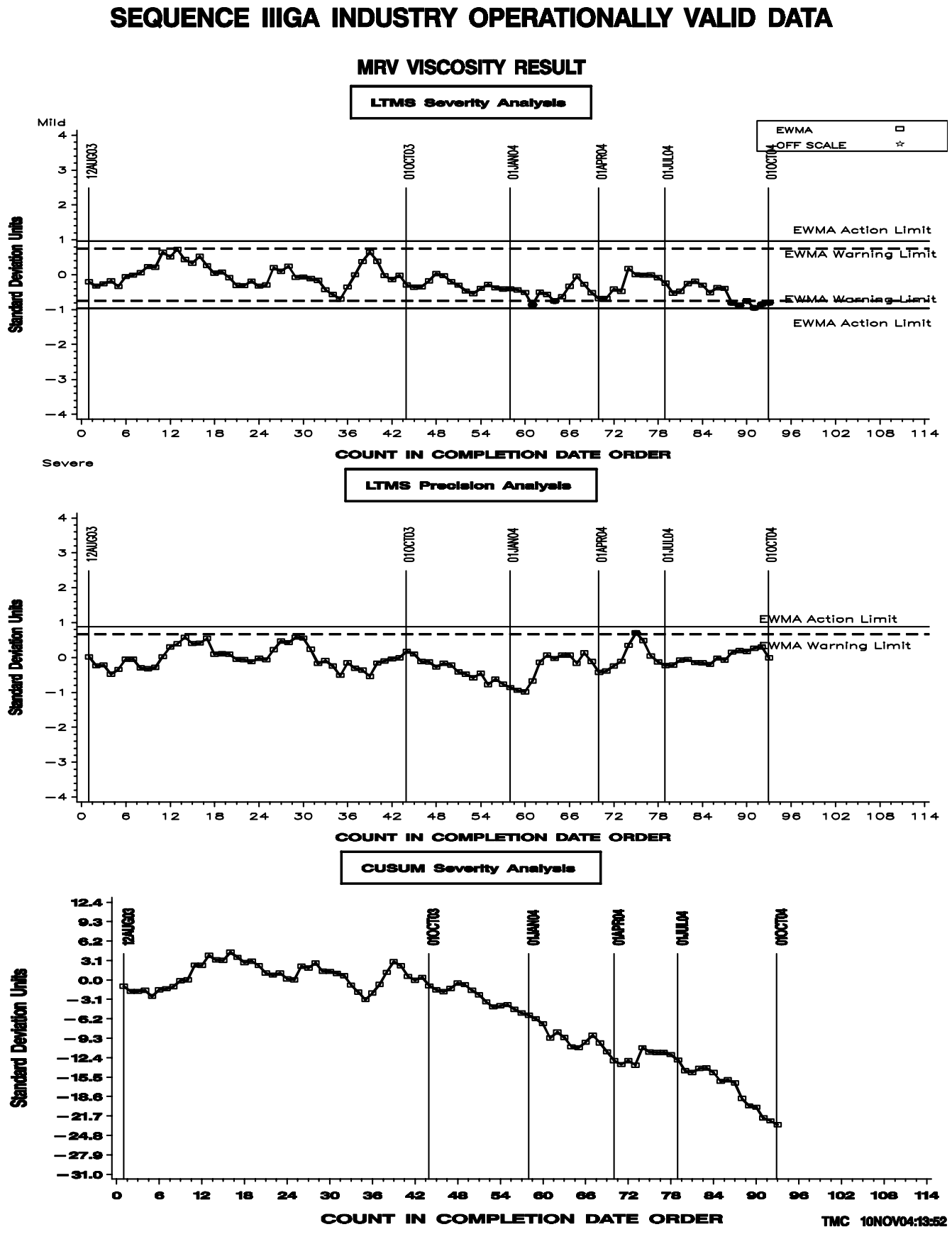

SEQUENCE IIIGA INDUSTRY OPERATIONALLY VALID DATA
MRV VISCOSITY RESULT
LTMS Severity Analysis
Mild
EWMA
OFF SCALE
12AUG03
01OCT03
01JAN04
01APR04
01JUL04
01OCT04
EWMA Action Limit
EWMA Warning Limit
EWMA Warning Limit
EWMA Action Limit
Standard Deviation Units
COUNT IN COMPLETION DATE ORDER
Severe
LTMS Precision Analysis
EWMA Action Limit
EWMA Warning Limit
Standard Deviation Units
COUNT IN COMPLETION DATE ORDER
CUSUM Severity Analysis
Standard Deviation Units
COUNT IN COMPLETION DATE ORDER
TMC 10NOV04:13:52

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

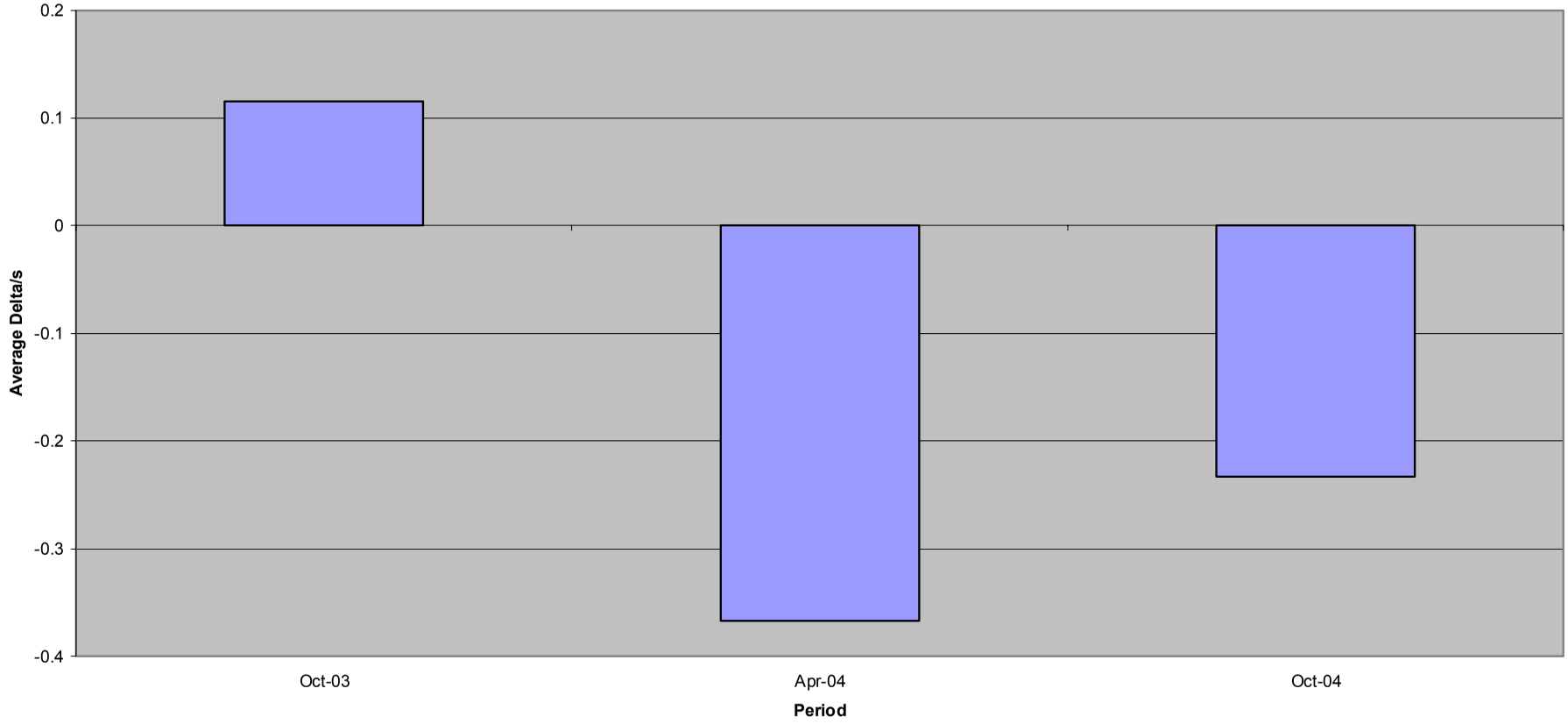


Figure 12 -Mini Rotary Viscometer result, Pooled Standard Deviation

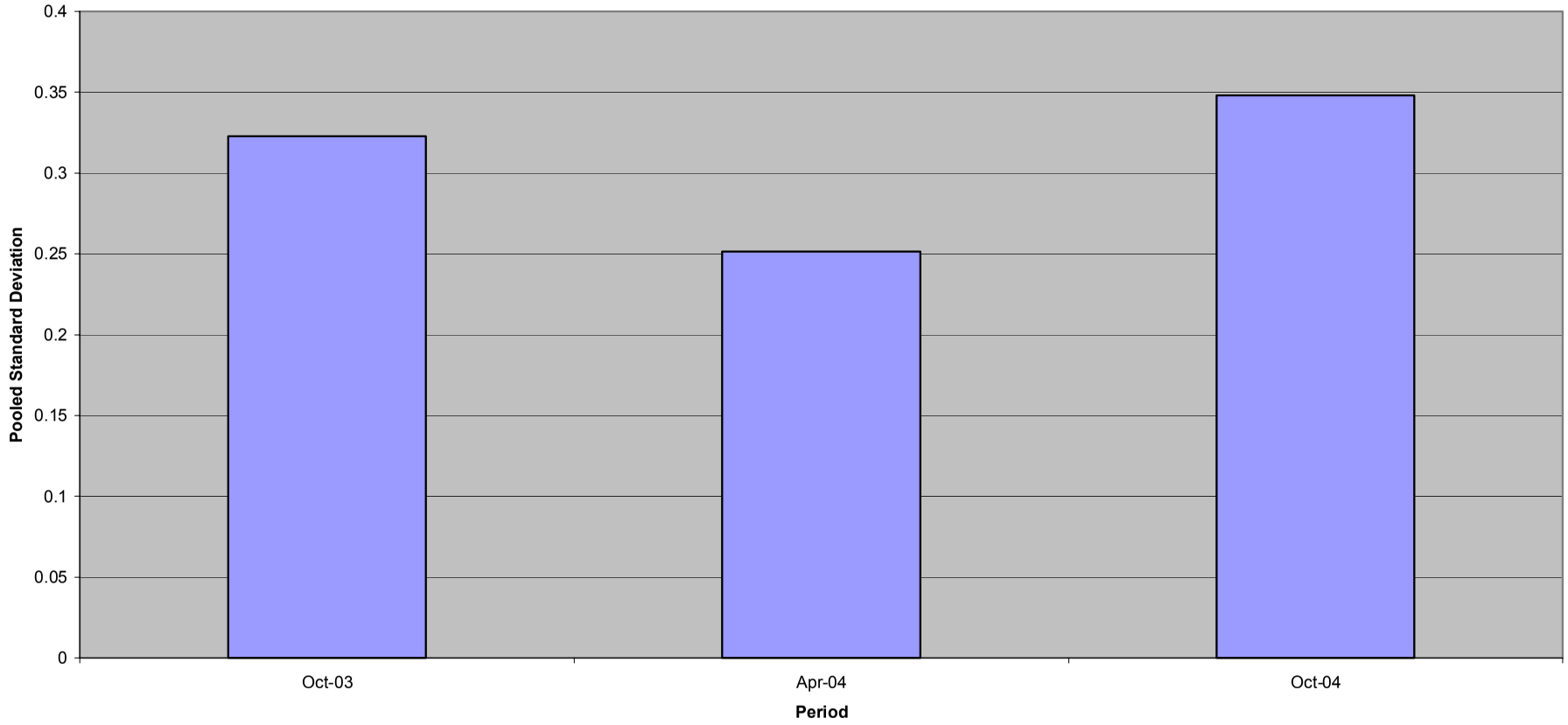


Figure 13 – Sequence IIIG/IIIGA Timeline

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
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