



Test Monitoring Center

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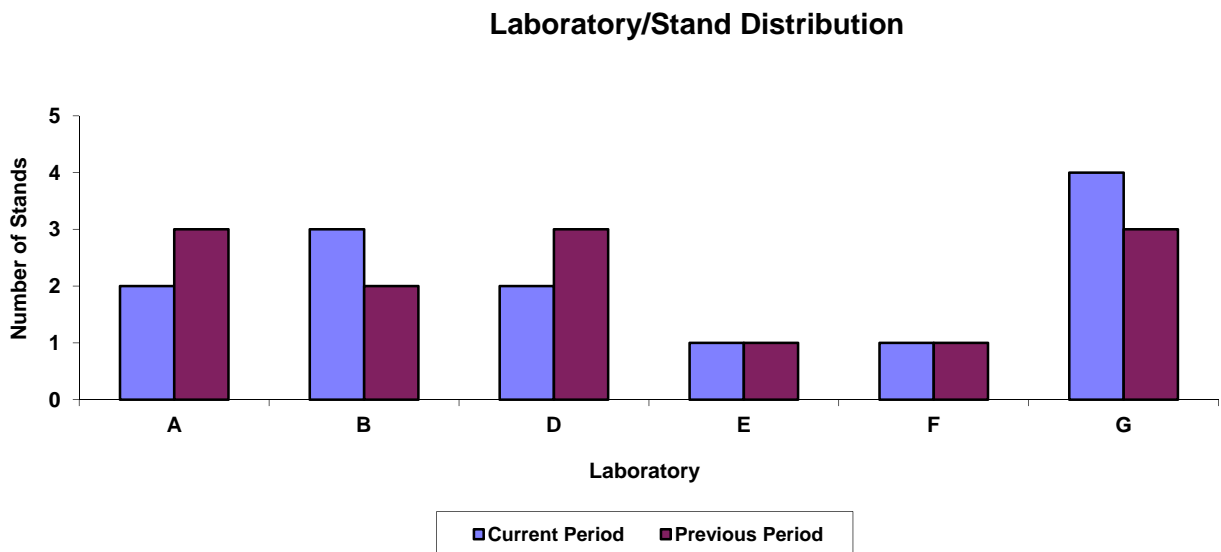
Memorandum: 11-041
Date: October 21, 2011
To: David Glaenzer, Chairman, Sequence III Surveillance Panel
From: Richard E. Grundza *R. E. Grundza*
Subject: Sequence IIIG/AB Semiannual Report: April 1, 2011 through September 30, 2011

The following is a summary of Sequence IIIG reference tests that were reported to the Test Monitoring Center during the period April 1, 2011 through September 30, 2011.

Lab/Stand Distribution

	Reporting Data	Calibrated as of September 30, 2011
Number of Laboratories:	6	5
Number of Test Stands:	13	16

The following chart shows the laboratory/stand distribution:

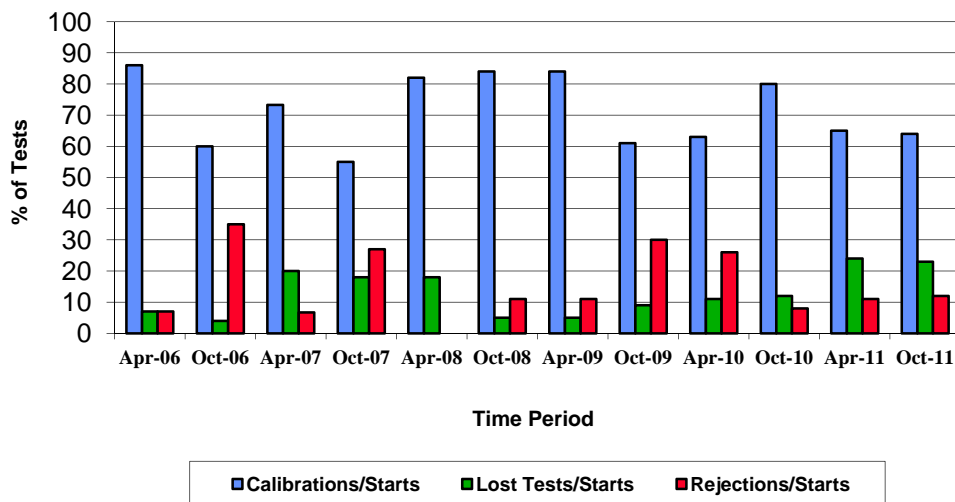


The following summarizes the status of the reference oil tests reported to the TMC:

Calibration Start Outcomes	TMC Validity Codes	No. of Tests
Operationally and Statistically Acceptable	AC	11
Failed Acceptance Criteria	OC	2
Donated Test	AG	4
Aborted	XC	4
Aborted Donated Test	XG	2
Total		23

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

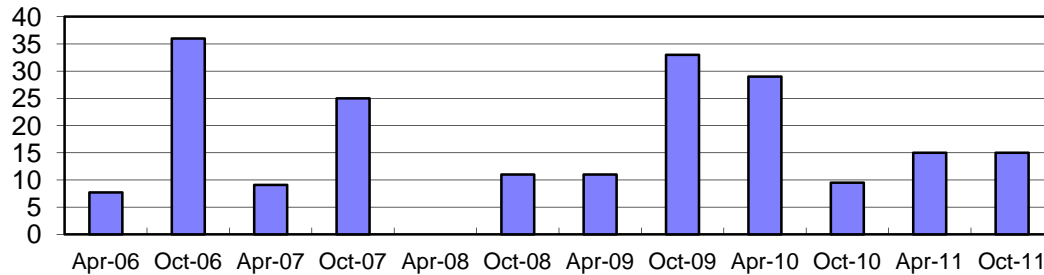
Calibration Attempt Summary



The calibration per start has decreased slightly with respect to the previous period, while the rejected test per start rates has decreased with respect to the previous period. The lost test per start rate has decreased slightly with respect to the previous period. A total of six donated tests were reported during the period. These tests were run on the engines built during the Unified Engine Build Workshop. These tests were all conducted using reference oil 434-1. Four tests were acceptable, while two results were aborted due to problems in maintaining oil temperature control.

Rejected Test Rate for Operationally Valid Tests

% of Tests



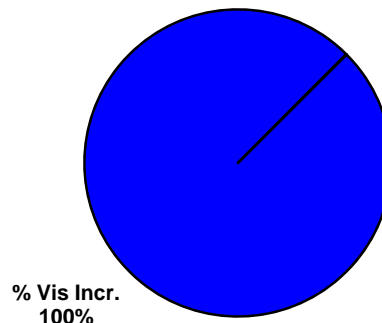
Time Period

Two tests failed the 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



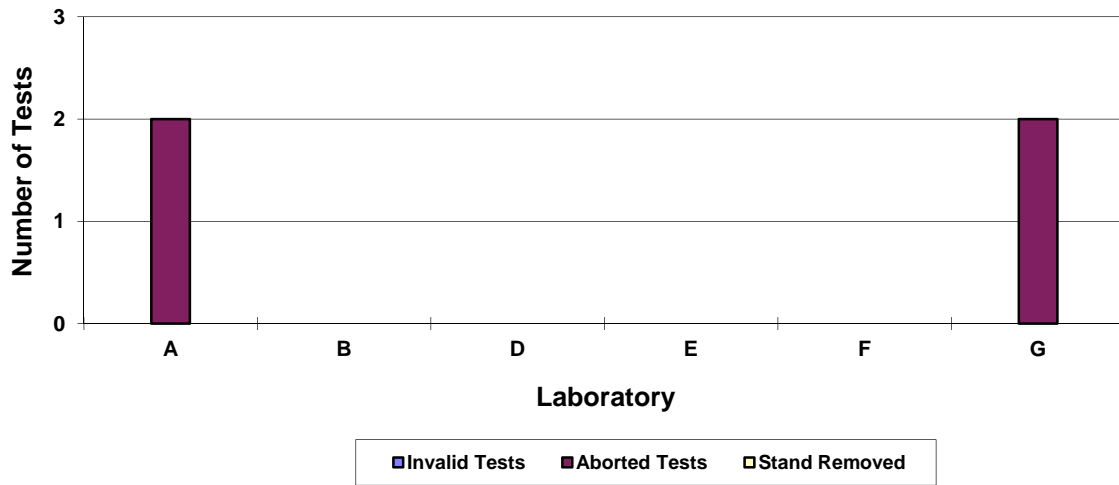
The failing results were obtained with reference oil 434-1. The failing results were obtained in different lab/stand combinations.

There were no LTMS Deviations written this period. Since its introduction in 2003, there have been five Sequence IIIG LTMS deviations.

Four calibration tests were lost this period. Reasons for terminating tests are tabulated below:

Reason test Terminated	Laboratory	# of Tests
Loss of Air-to-Fuel Ratio Control	A	1
Loss of Oil Temperature Control	A	1
Load Control Issues	G	1
Coolant Inlet and Outlet Thermocouples Switched	G	1

Lost Test Distribution



Information Letters

Three information letters were issued this report period. The subject of these letters is detailed in the Industry Timeline (See Figure 16).

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	0.748	0.708 (df=10)	111.3 % Viscosity Increase ¹
WPD	-0.754	0.279 (df=10)	-0.21 Merits
ACLW	-0.781	0.331 (df=10)	-13.7 μm^2
MRV ³	0.853	0.691 (df=4)	N/A (no appropriate baseline) ⁴
PHOS ⁵	-0.487	2.417 (df=10)	-1.18% ⁶

¹ At the GF-5 Pass Limit of 150% Viscosity Increase

² At the GF-5 Pass Limit of 60 μm

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.

⁵ Sequence IIIGB Test Parameter only

⁶ PHOS GF-5 Limit 79%

Average Δ/s Results, by Laboratory					
Laboratory	PVIS	WPD	ACLW	MRV ¹	PHOS
A	1.20	-0.55	-0.60	0.455	-0.69
B	0.30	-0.92	0.45	0.632	-2.14
D	0.06	-1.14	0.62	0.752	1.21
E	-1.60	-0.44	-1.61	-1.076	0.42
F	1.67	-0.74	-0.32	-	-0.87
G	1.22	-0.66	-2.21	1.359	-0.44

¹ Reference oil 435 data excluded from calculations

Percent Viscosity Increase (PVIS)

With the exception of two results, industry severity charts were in action or warning alarm the entire period. Precision was in warning or action alarm for the period. Three stands reported results $> 2.0 \Delta/s$ from target. Two of these results were obtained with reference oil 433-1 while the third was obtained with reference oil 435-2.1. The average Δ/s value for the period is 0.748 severe (see Figure 4). The pooled standard deviation for the period, 0.708, has degraded since last period (see Figure 7).

Weighted Piston Deposits (WPD)

Severity began the period in control before sounding a series of nine warning alarms and was in control at the end of the period. Precision was in control for the period (see Figure 2). The average Δ/s for the period, -0.754, was severe (see Figure 5). The pooled standard deviation for the period, 0.279, has improved when compared to previous period (see Figure 8). The summation Δ/s charts show a continuation of a long term severe trend which began around January of 2005.

Average Camshaft-plus-Lifter Wear (ACLW)

ACLW has been in severity and precision alarm for most of the period (see Figure 3), but both severity and precision were in control at the end of the period. Severity for the period was mild with an average Δ/s value of -0.781 (see Figure 6). The pooled standard deviation for the period, 0.331, has improved with respect to the previous period (see Figure 9). The large mild, excursions noted during the past two periods have decreased this period. There were three results beyond two standard deviations mild, none of which were more than three standard deviations mild.

During the May 2010 Surveillance Panel Meeting, the panel amended the LTMS to suspend the lower limit for ACLW, and would continue to review the industry data to reinstate it when the mild trend abates.

Mini Rotary Viscometer (MRV)

The MRV control charts are shown for informational purposes in Figure 10. Severity charts were in warning or action alarm the entire report period. The average Δ/s value for the period, 0.691, was severe for the period and is shown in Figure 11. The pooled standard deviation for the period, 0.853, has degraded, when compared to the last period and is shown in Figure 12.

Phosphorus Retention (PHOS)

PHOS severity was in control this report period and with the exception of one warning alarm, PHOS precision was in control for the period (see Figure 13). The average Δ/s value for the period, -0.487, was severe for the period and is shown in Figure 14. The pooled standard deviation for the period, 2.418, has degraded, when compared to the previous period and is shown in Figure 15.

QI Deviations

One QI Deviation was written this period. The QI deviation was for oil filter block temperature which fell below 0.00 at end of test. The negative QI value was caused by operator error, which involved initiating the data acquisition before all temperatures had stabilized, after a shutdown had occurred.

A total of ten QI deviations have been written to date.

Hardware

H and J pour code cams were noted in the reference tests data base this report period.

Reference Oils

Oil	Original Blend, in gallons	TMC Inventory, in gallons	Quantity Used past six months, gallons	TMC Inventory, in tests	Laboratory Inventory, in tests	Estimated life
434	550	4	5	1	3	< 1 year
434-1	660	253	72	63	8	2.5 years
435	550	3	0	0	0	< 1 year
435-1	660	577	83	144	4	3+ years ¹
435-2	550	474	76	118	10	3+ years
438	990	318	24	79	7	3+ years
1010	1100	767	73	141	3	3+ years ^{1,2}

¹ Suspended for use by the Surveillance Panel

² Multiple test area reference oil; total TMC inventory shown.

A new blend of oil 435, designated 435-2, has been obtained by the TMC. Four results were obtained on this oil during the period, and all results calibrated the associated lab/stand. A total of six results have been reported to date. Initial reference oil targets for this blend will be set when ten operationally valid tests are obtained on this blend.

Lab Visits

Three lab visits were conducted during this report period. Discrepancies identified during these visits included;

- 1) Humidity calibrations not documented/performed as per Test Method D 7320
- 2) No operation hours recording device installed on parts washer
- 3) Components in cooling system (filters) not listed in the Test Method.

These items have been communicated to the laboratories involved and correction actions have been completed and/or are pending.

REG/reg

Attachments

c: F. M. Farber, TMC
J. A. Clark, TMC
Sequence III Surveillance Panel
<ftp://ftp.astmtmc.cmu.edu/docs/gas/sequenceiii/semiannualreports/IIIG-10-2011.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 EWMA severity and precision control charts and also the CUSUM Δ/s plots of PHOS, annotated with date lines, using the same data set as the EWMA severity and precision control charts.
- Figure 14 is a bar chart of average Δ/s , by report period, for PHOS.
- Figure 15 is a bar chart of pooled standard deviation, by report period, for PHOS.
- Figure 16 is the Sequence IIIG/AB Timeline.

Figure 1
SEQUENCE IIIG INDUSTRY OPERATIONALLY VALID DATA



VISCOSITY INCREASE

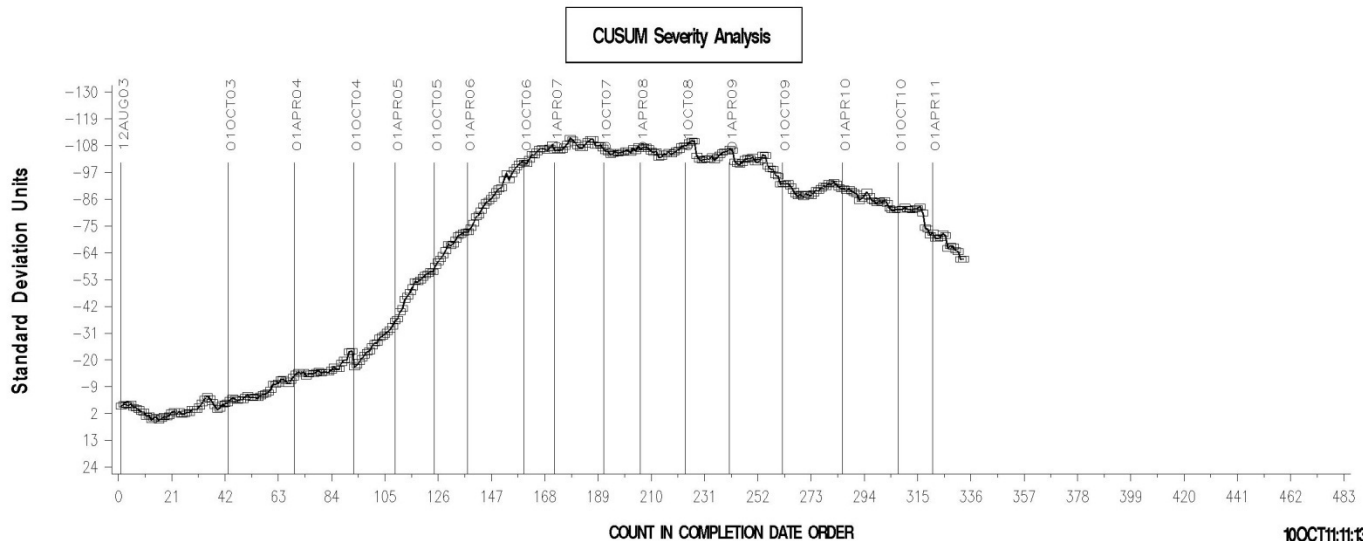
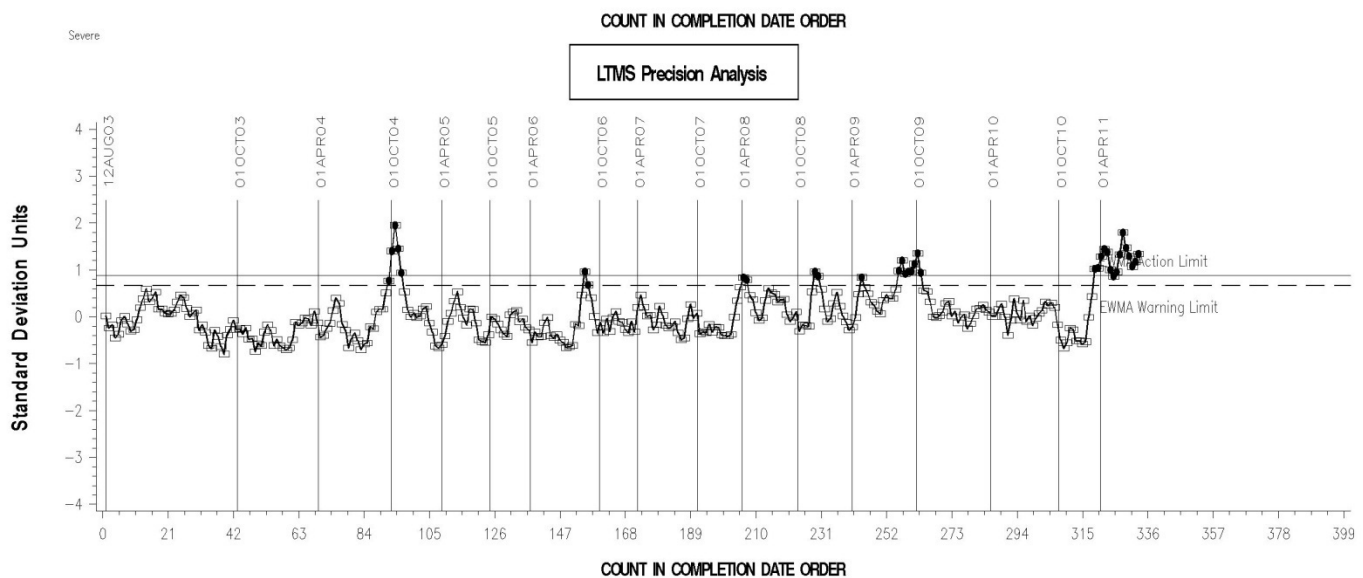
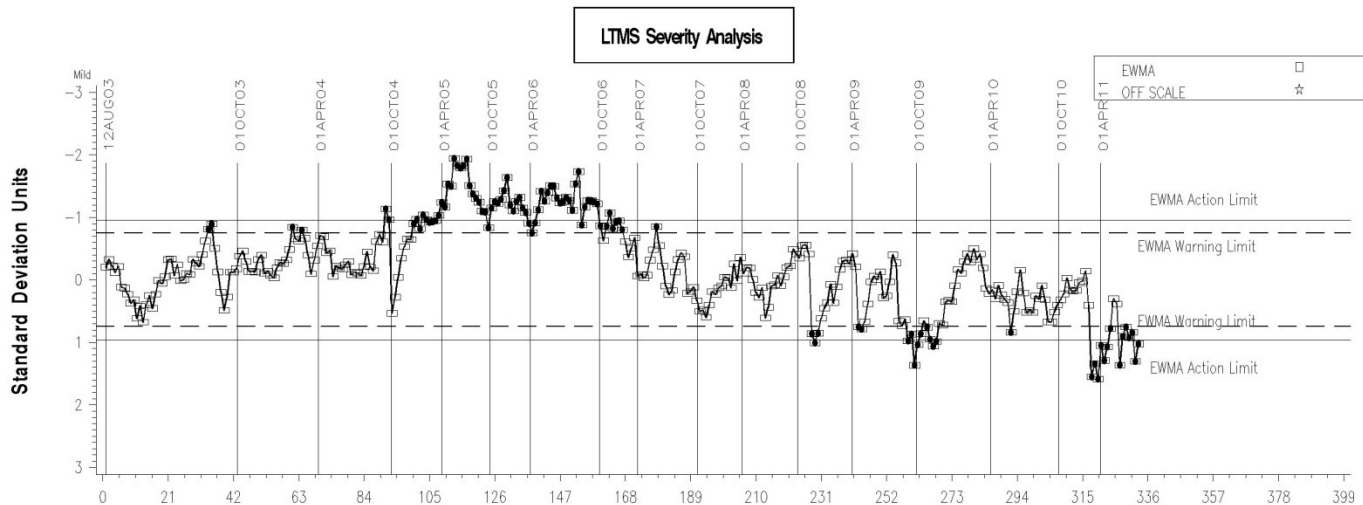


Figure 2
SEQUENCE IIIG INDUSTRY OPERATIONALLY VALID DATA



AVERAGE WEIGHTED PISTON DEPOSITS

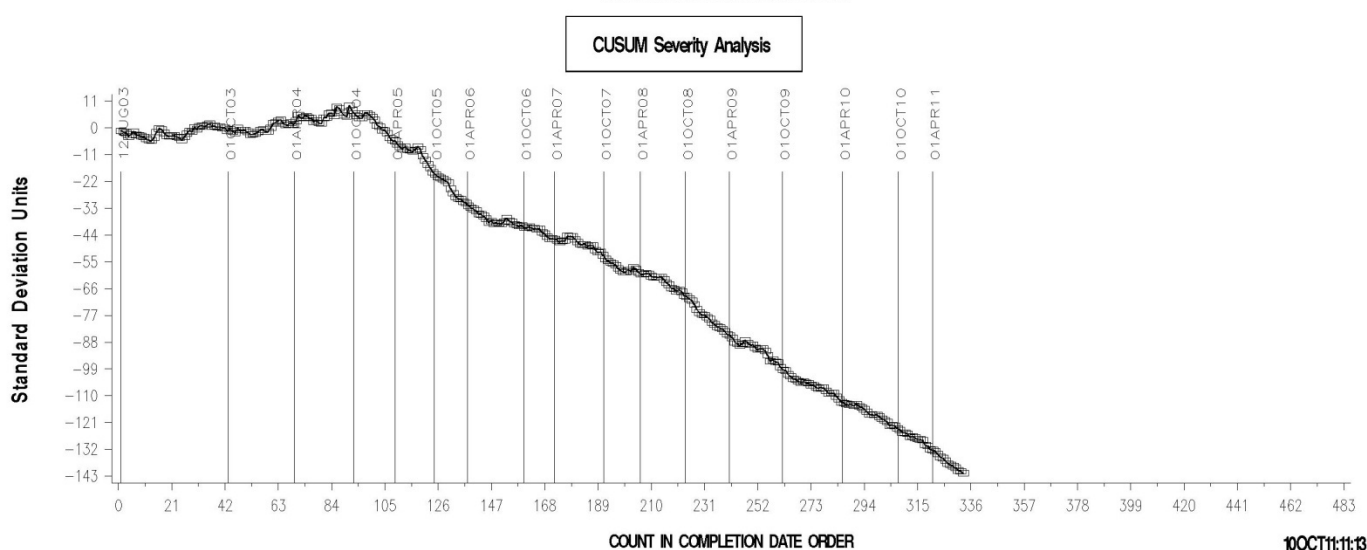
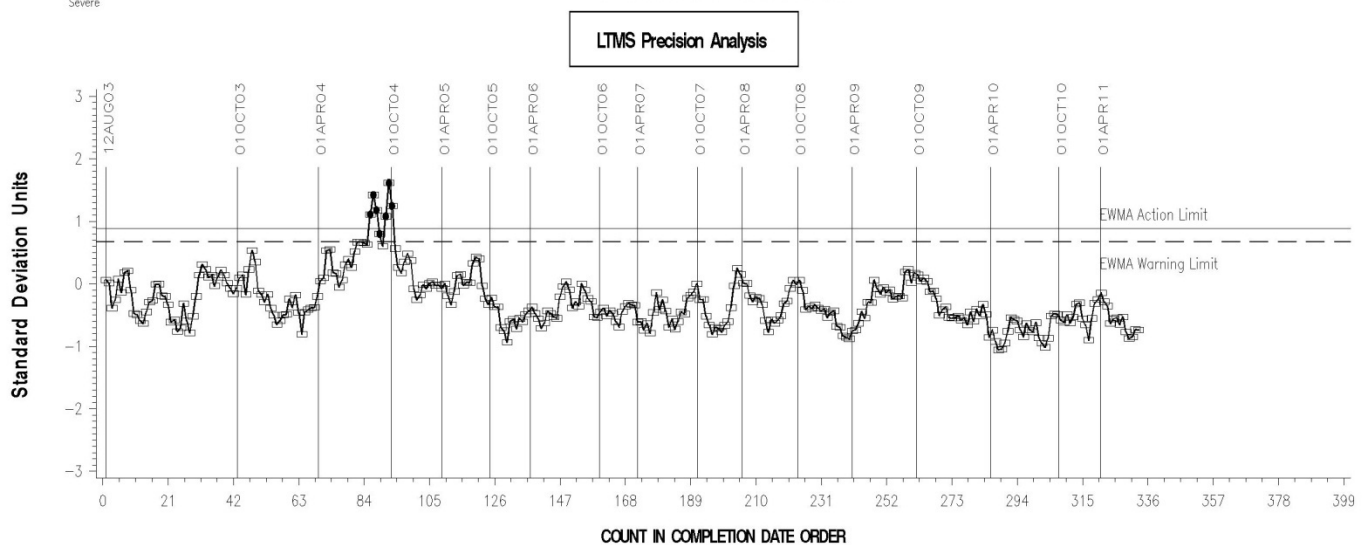
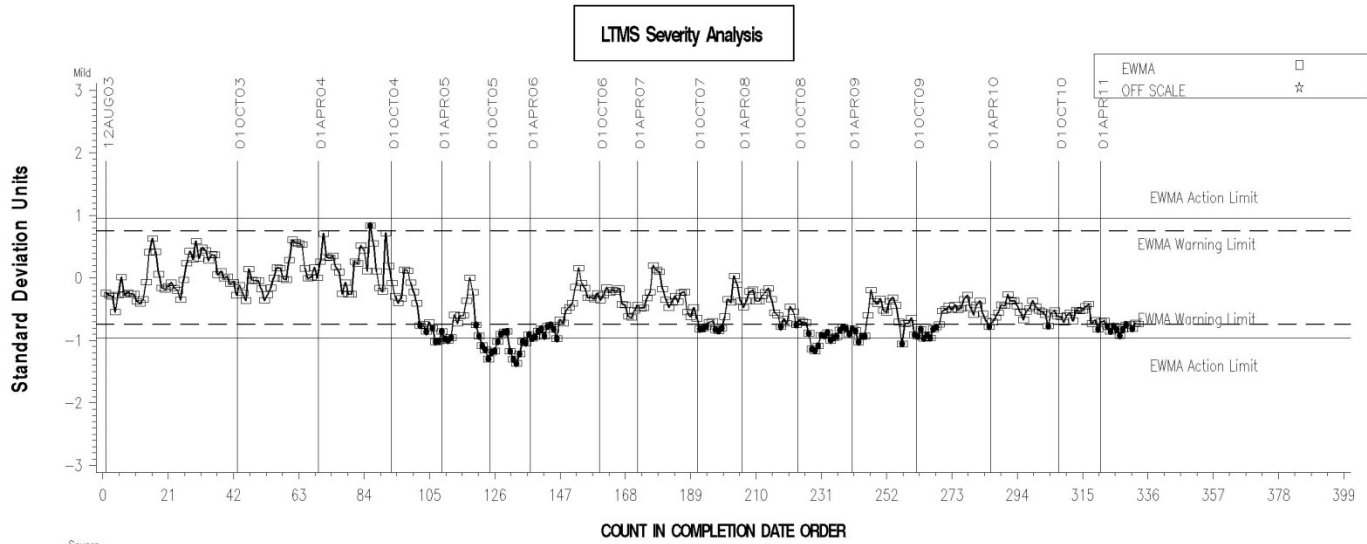


Figure 3
SEQUENCE IIIG INDUSTRY OPERATIONALLY VALID DATA



AVERAGE CAM + LIFTER WEAR

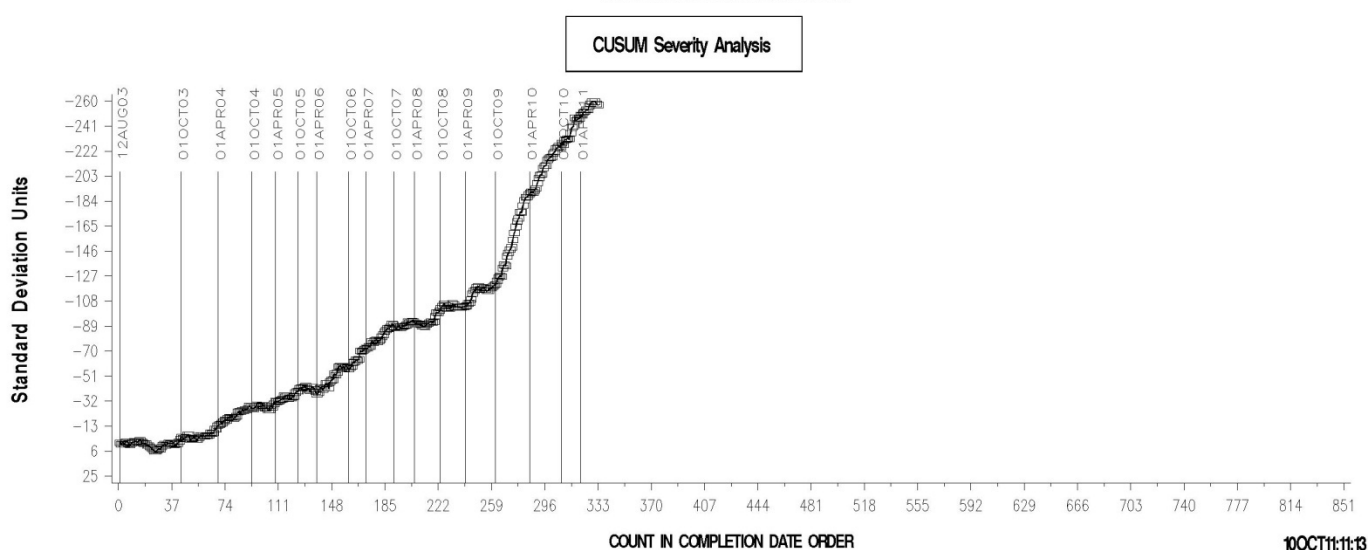
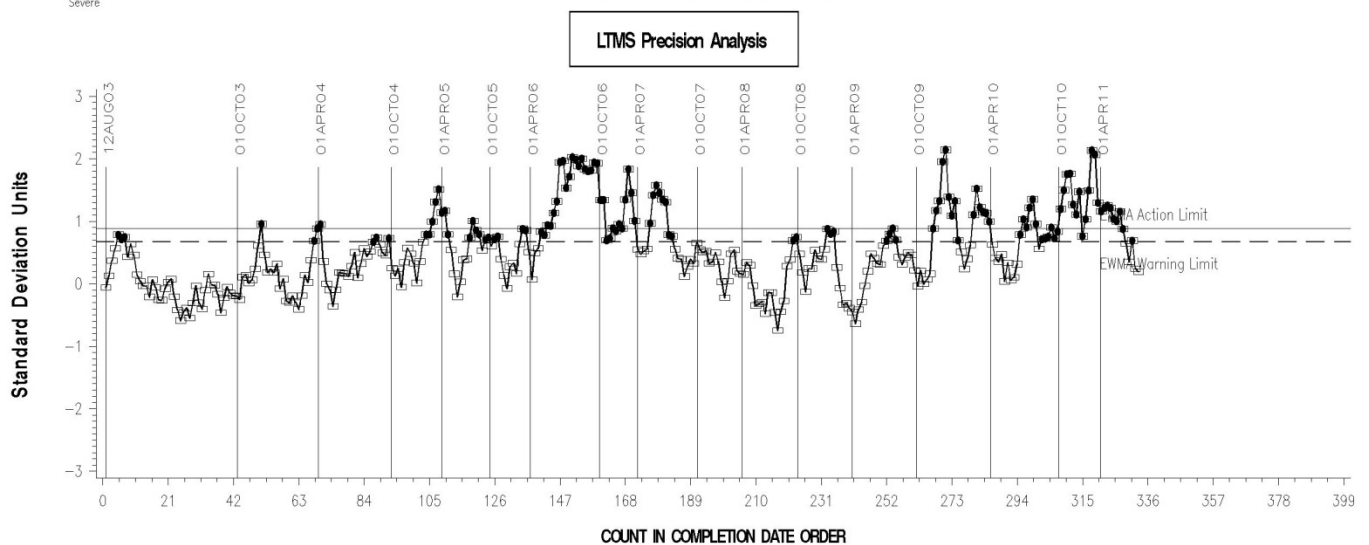
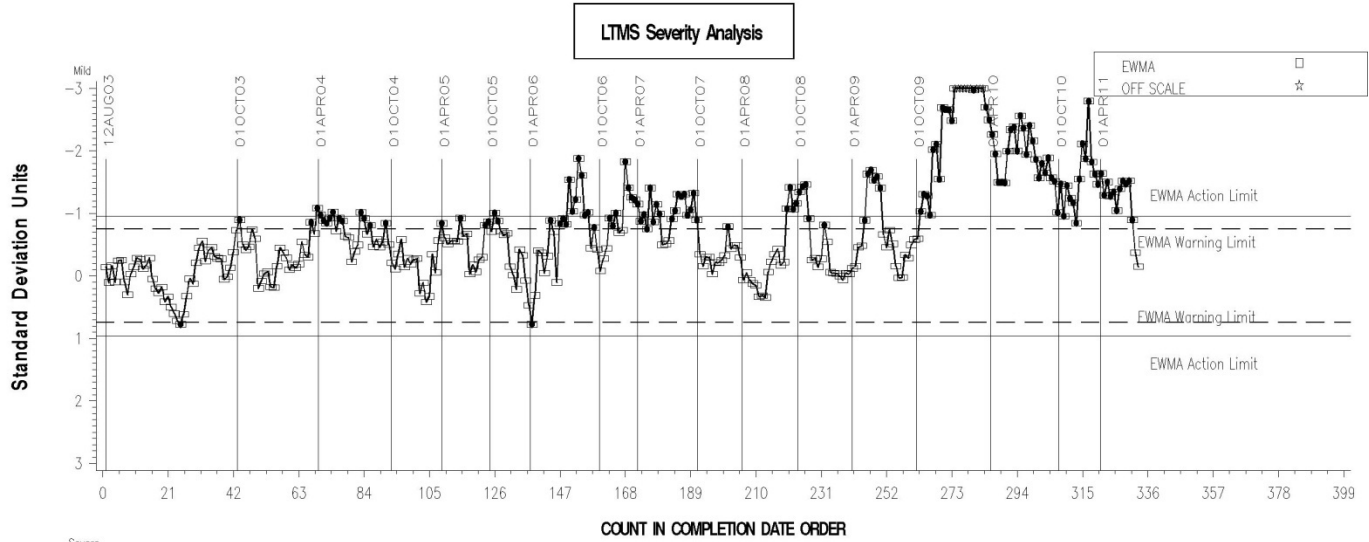


Figure 4-Percent Viscosity Increase Delta/s

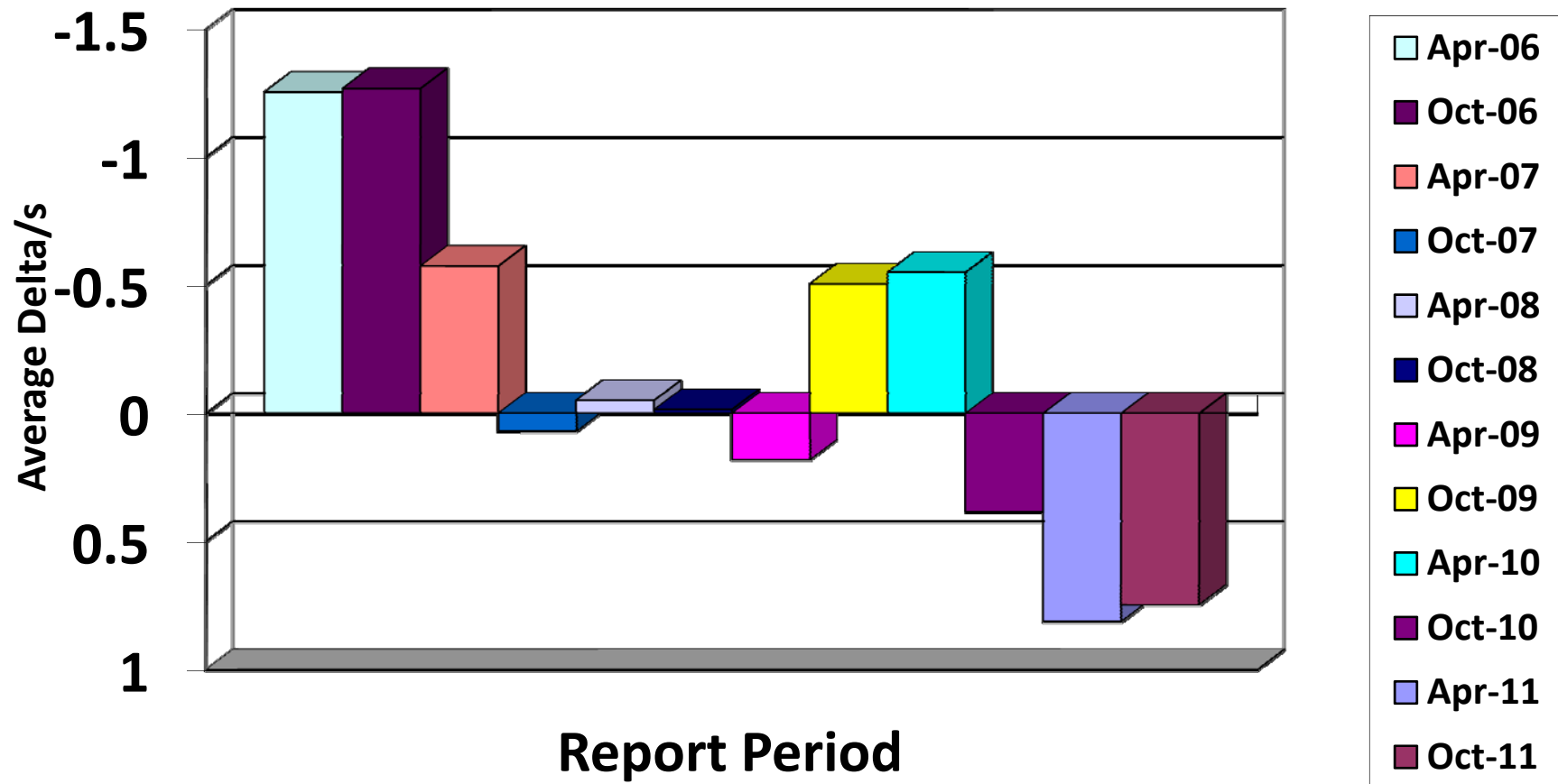


Figure 5-Weighted Piston Deposit Delta/s

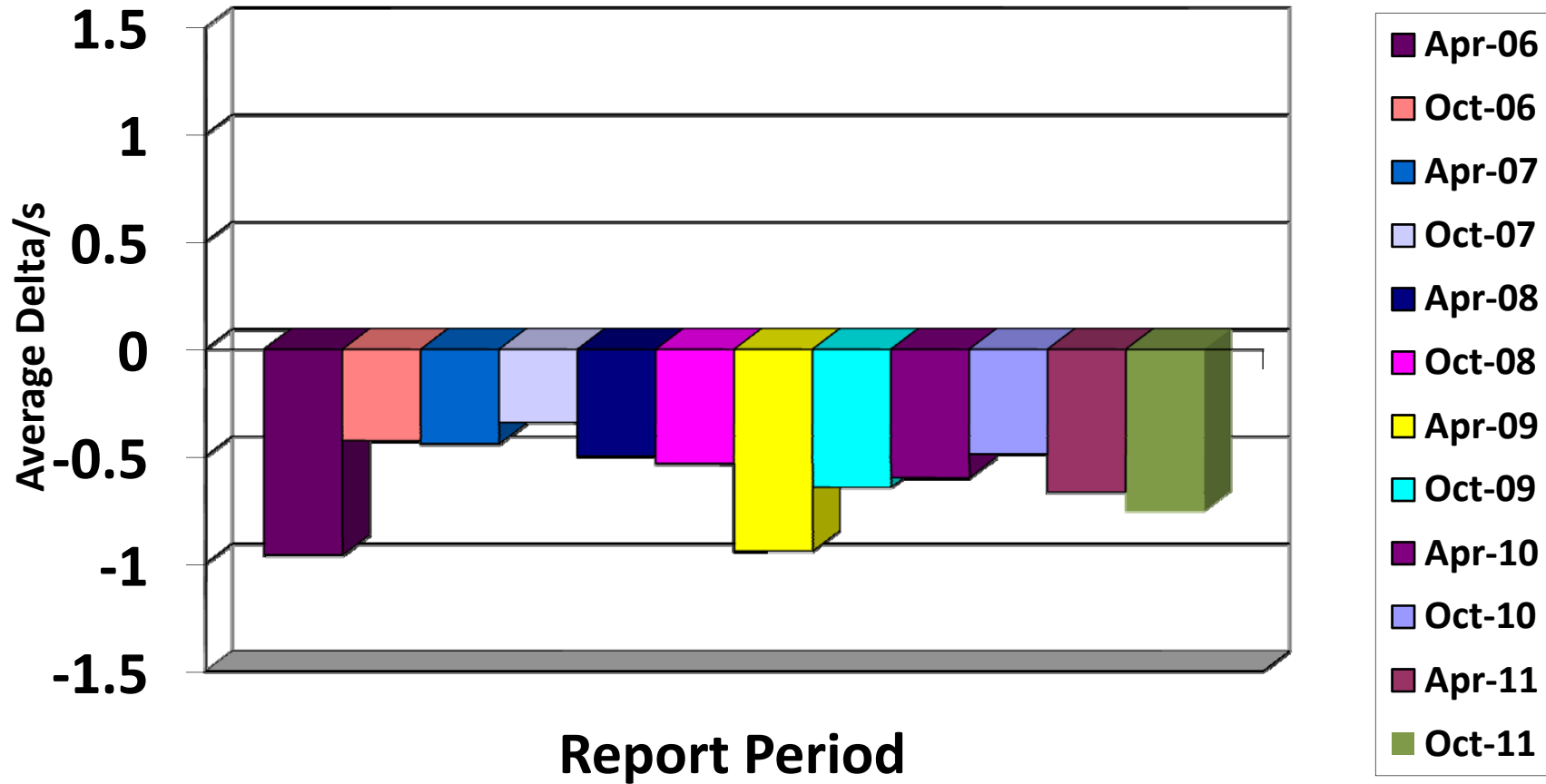


Figure 6-Average Cam and Lifter Wear Delta/s

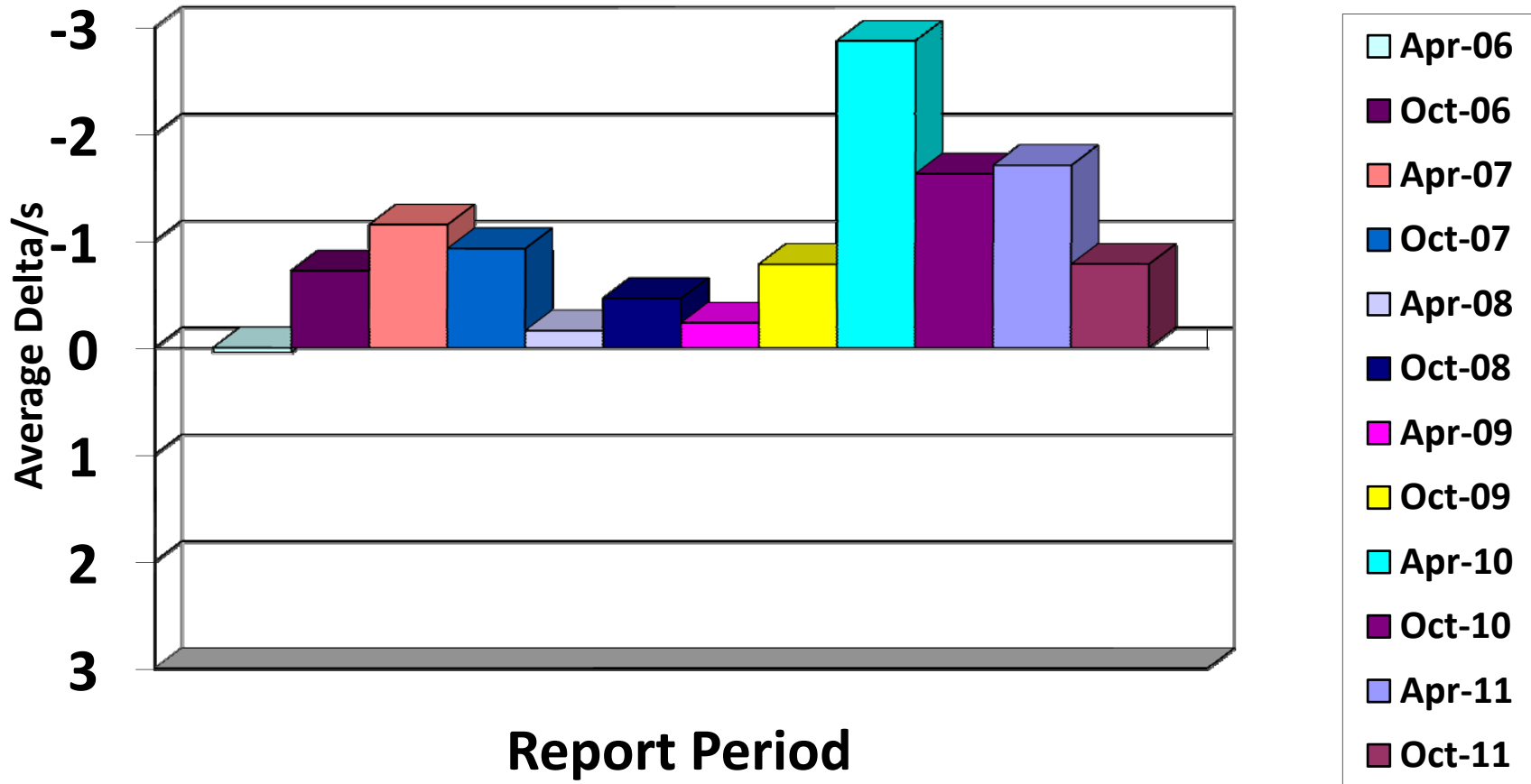


Figure 7-Percent Viscosity Increase Pooled s

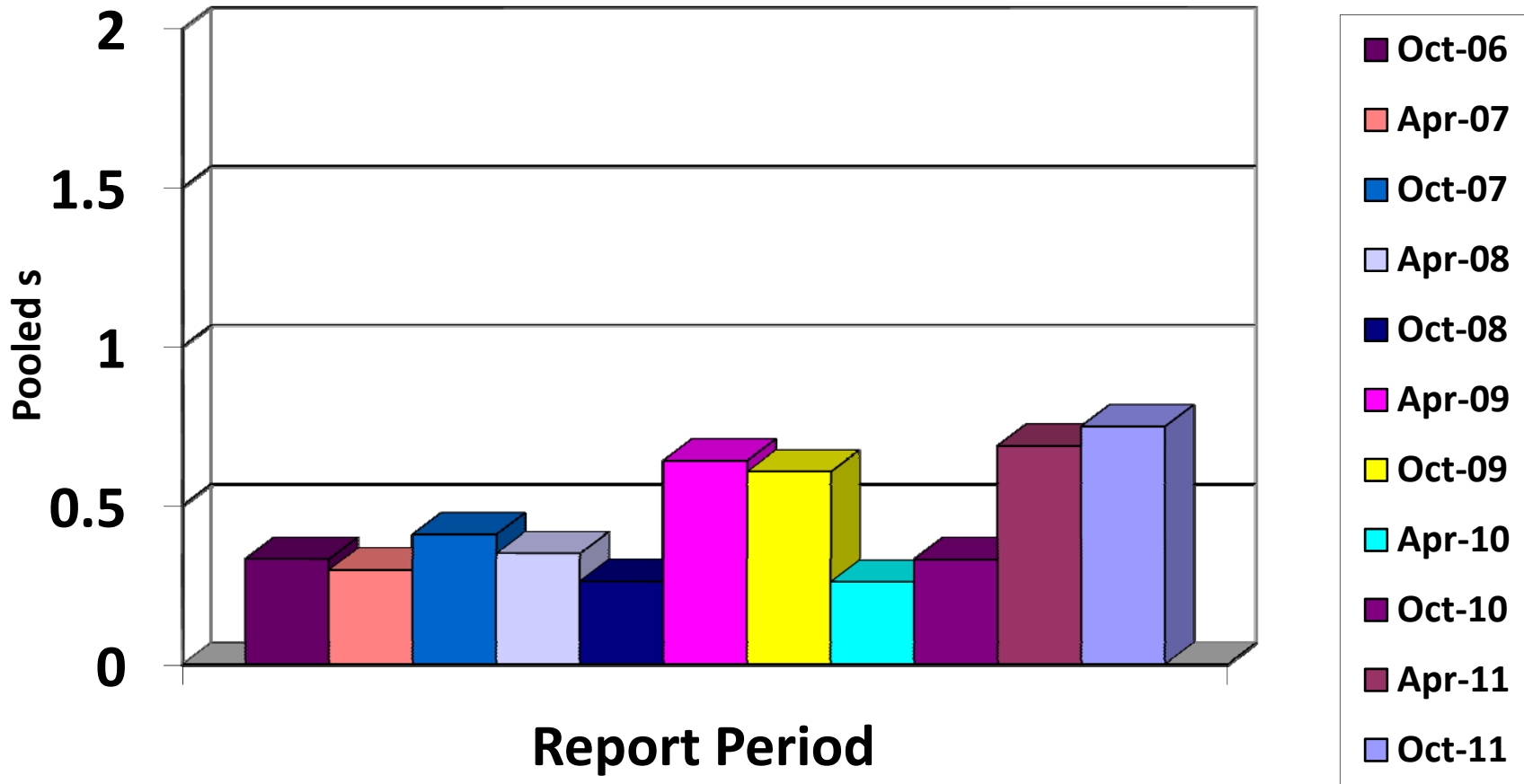


Figure 8-Weighted Piston Deposits Pooled s

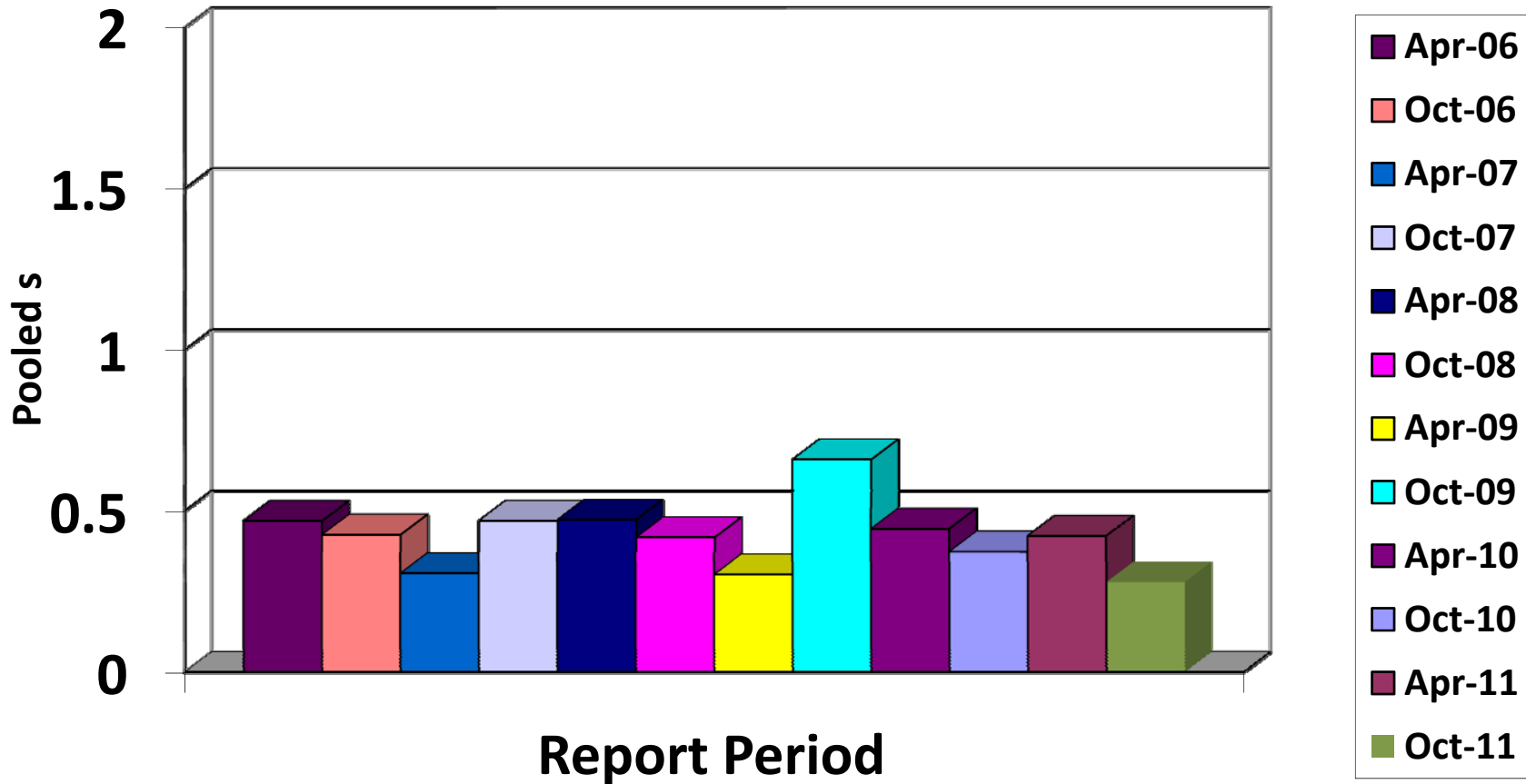


Figure 9-Average Cam and Lifter Wear Pooled s

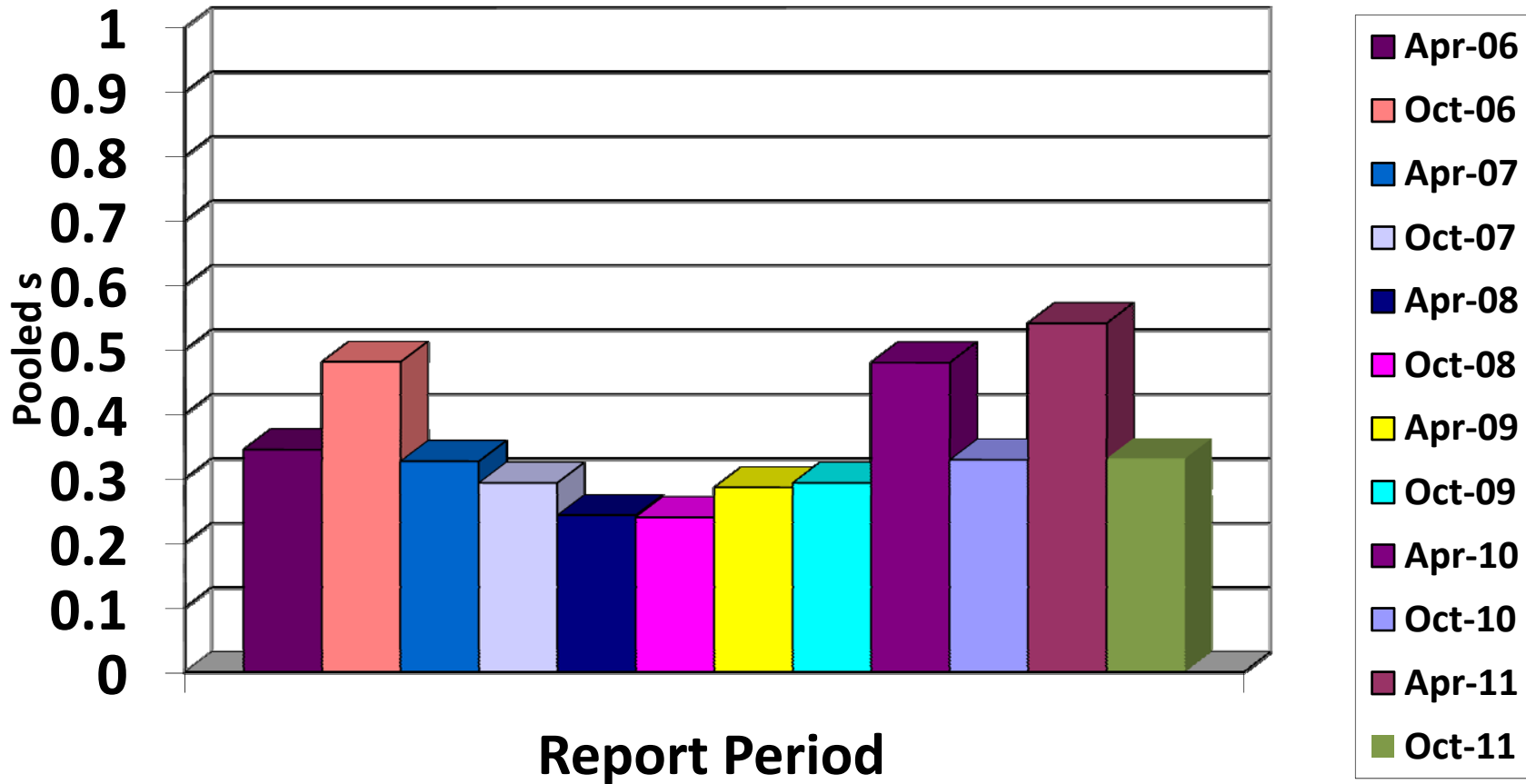


Figure 10

SEQUENCE IIIGA INDUSTRY OPERATIONALLY VALID DATA



MRV VISCOSITY RESULT

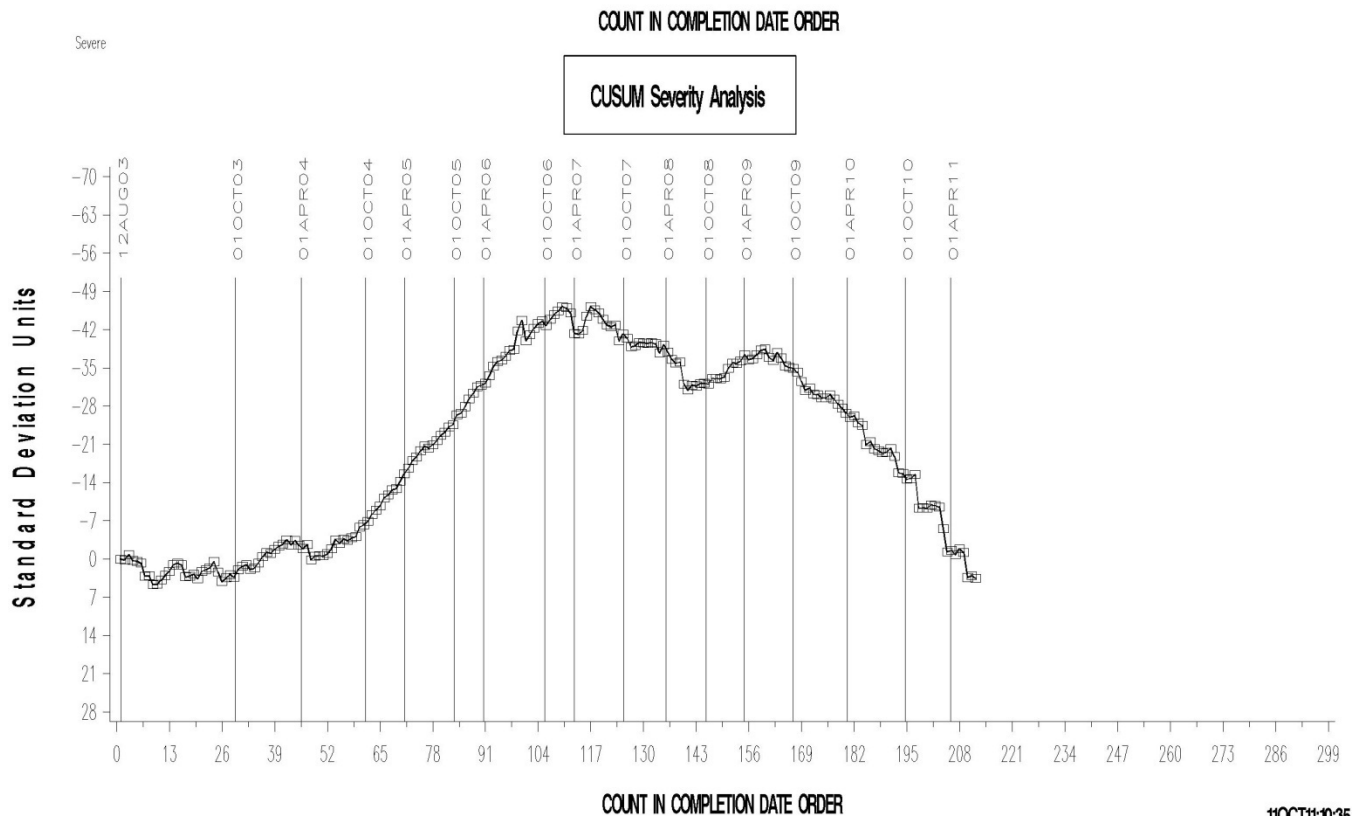
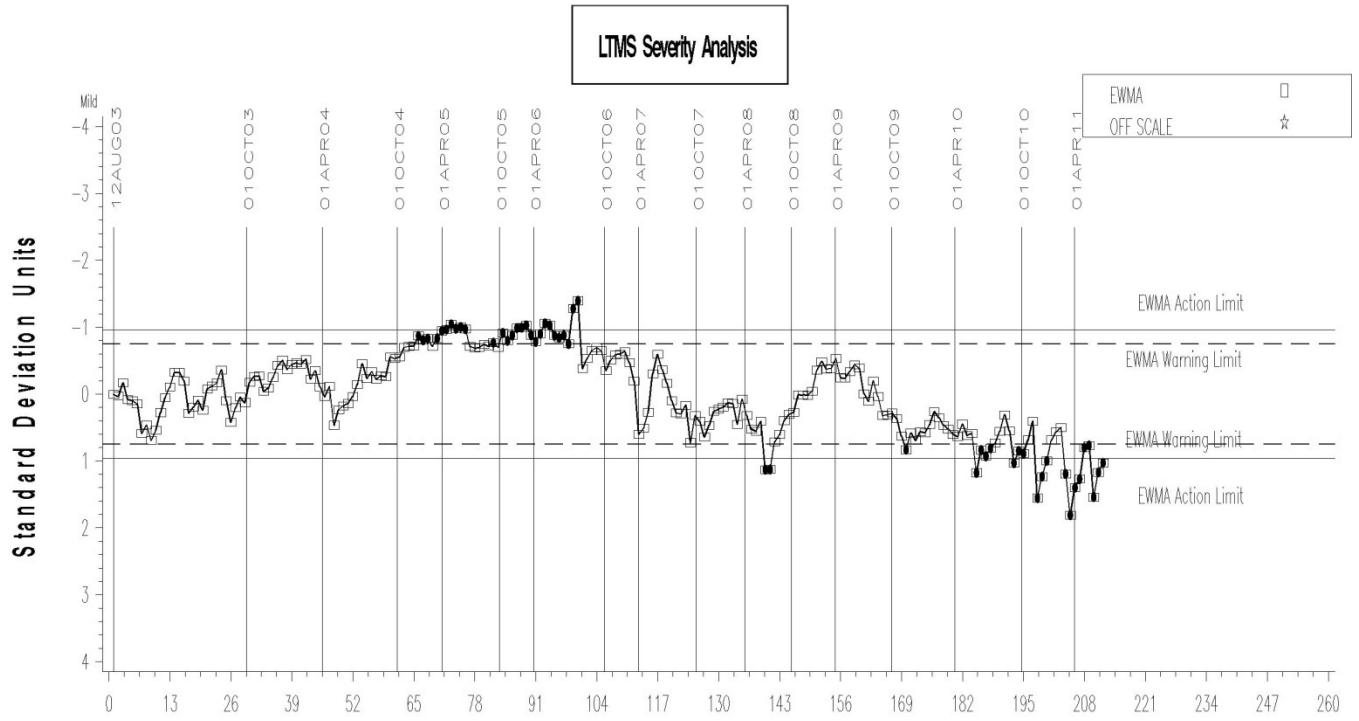


Figure 11-MRV Viscosity Delta/s

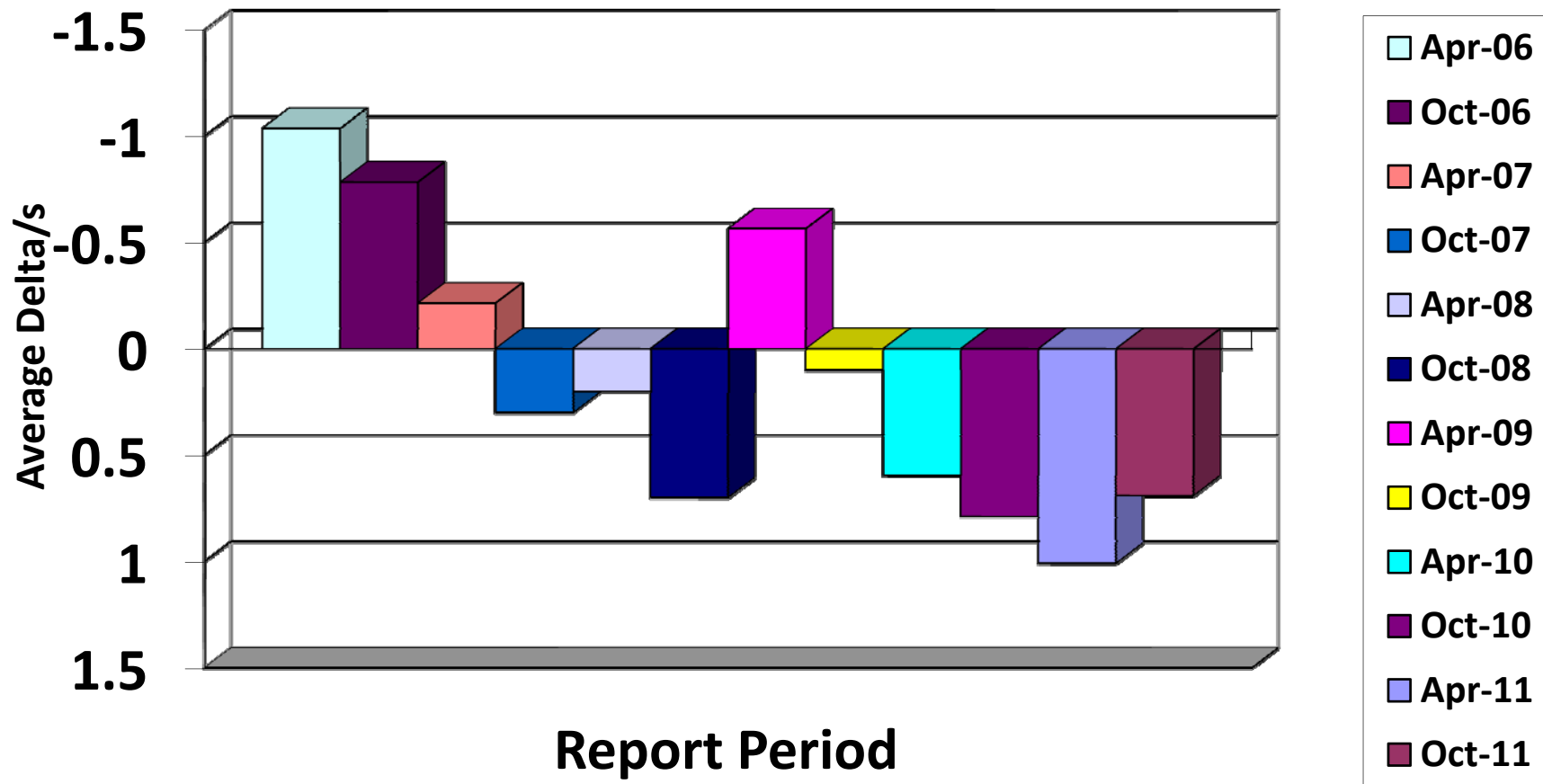


Figure 12-MRV Viscosity Pooled s

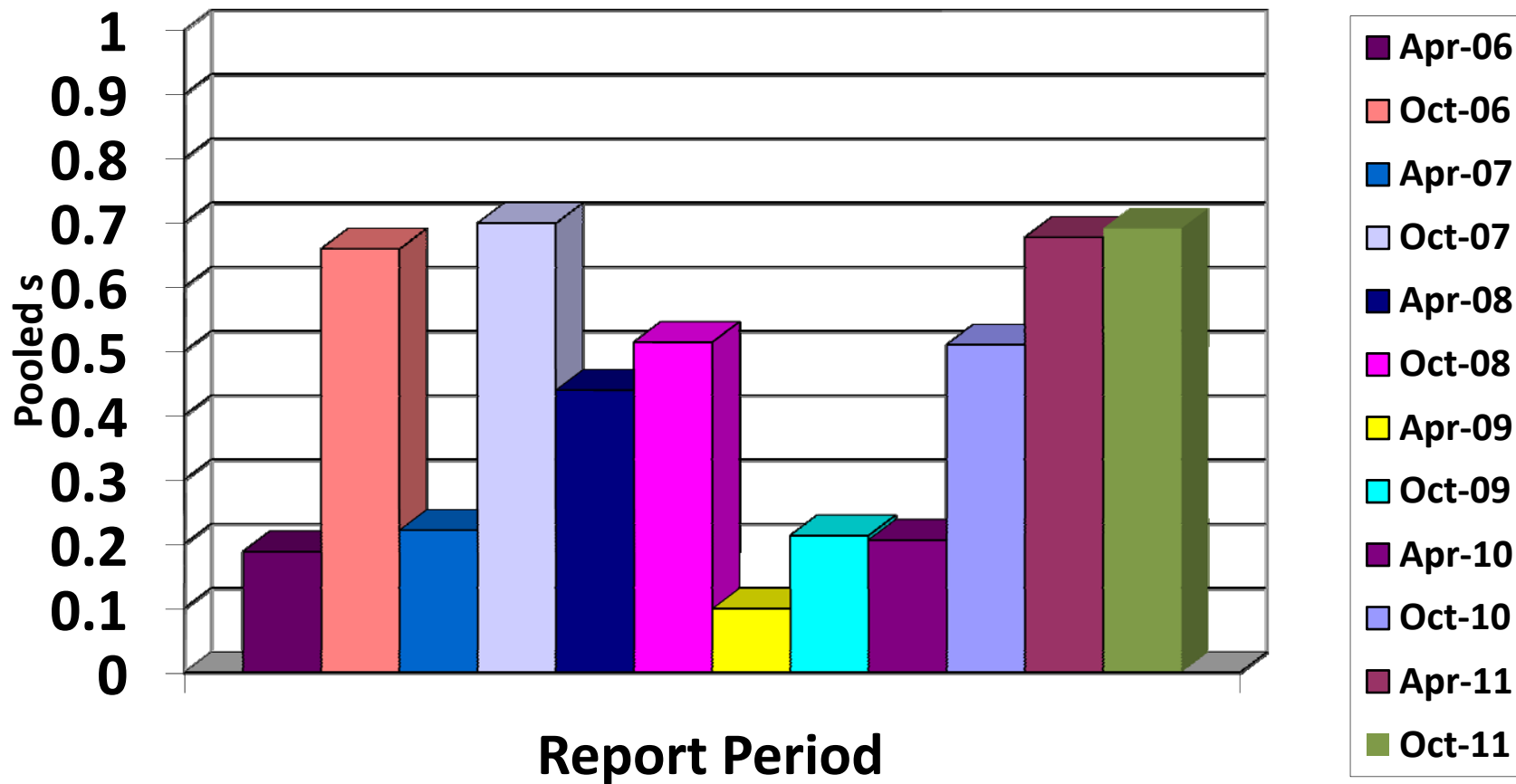


Figure 13
SEQUENCE IIIGB INDUSTRY OPERATIONALLY VALID DATA

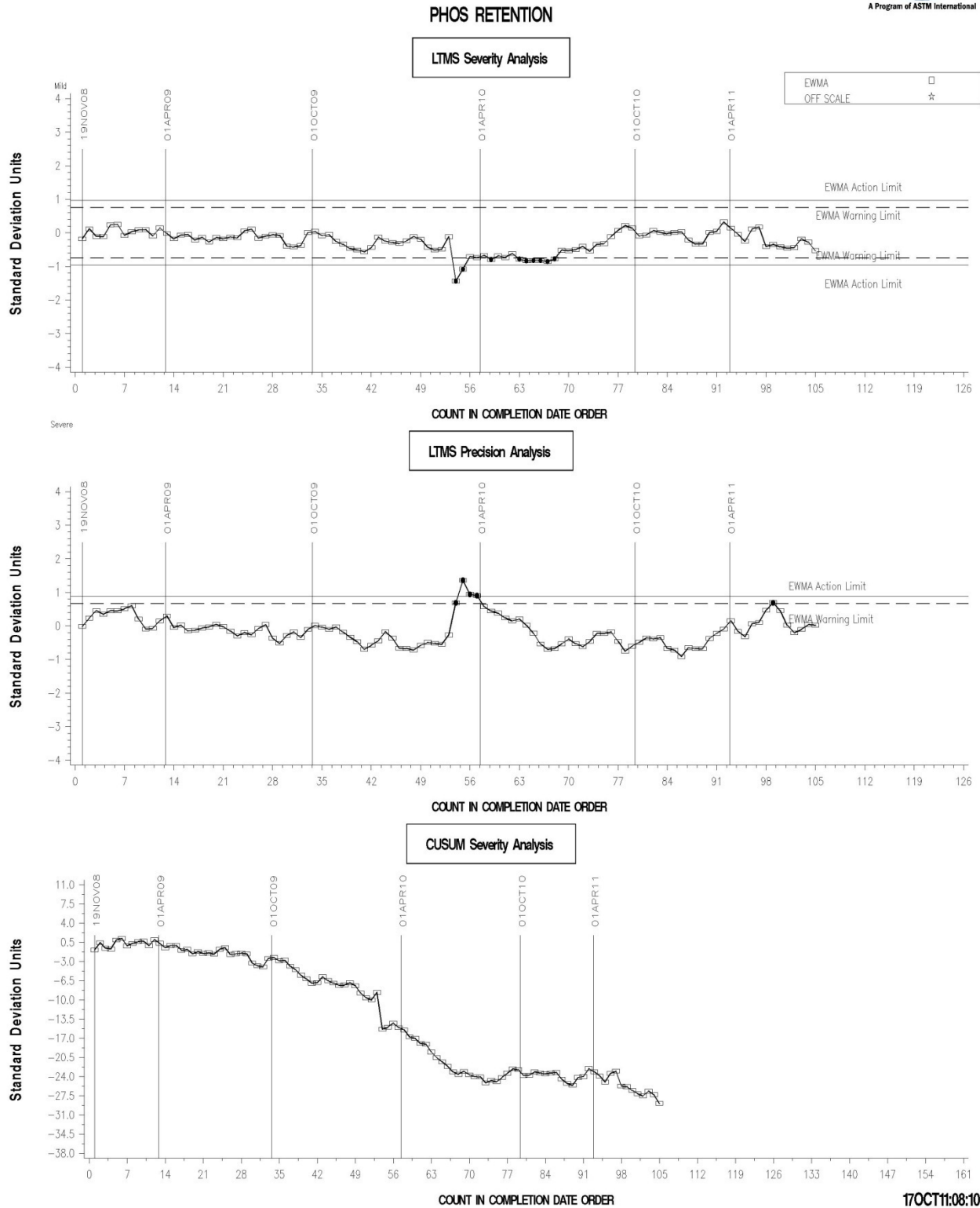


Figure 14-Percent Phosphorus Average Delta/s

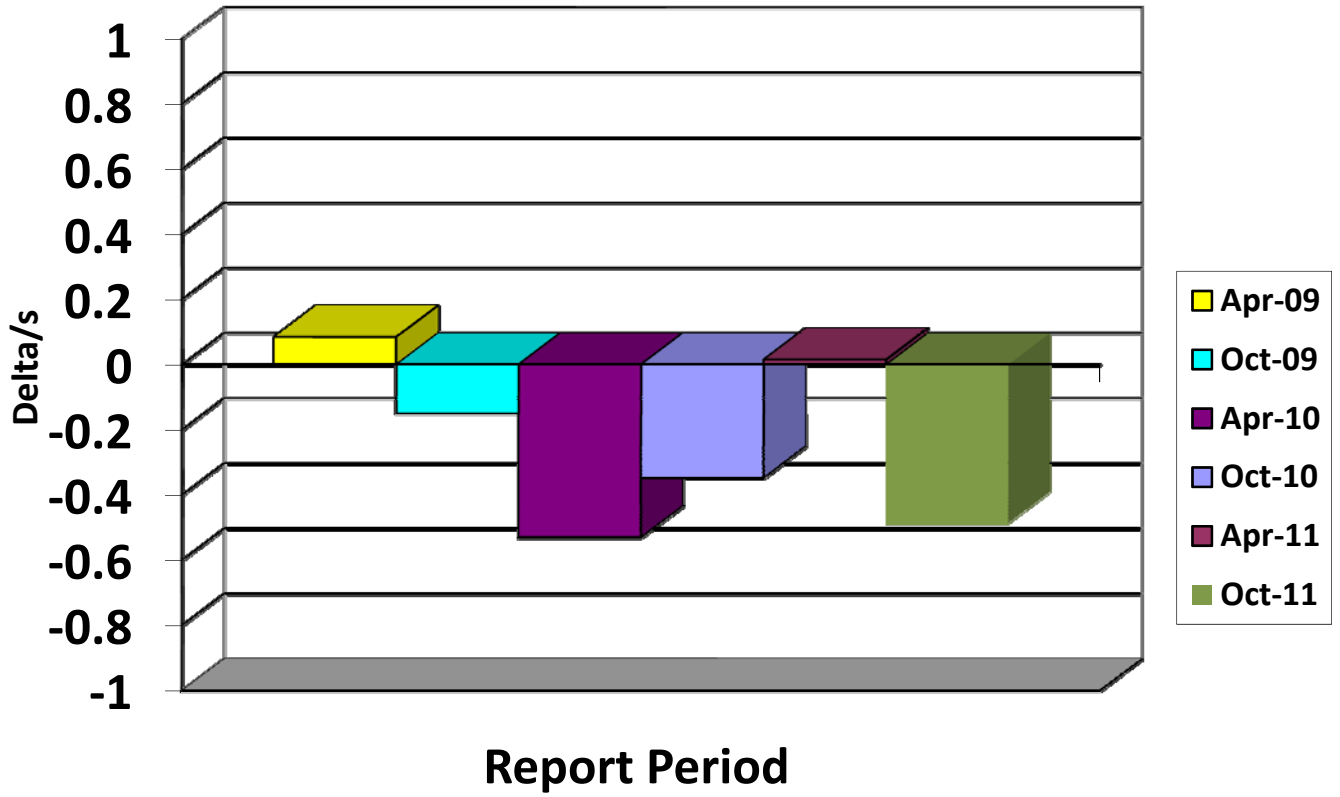


Figure 15-Percent Phosphorus Pooled s

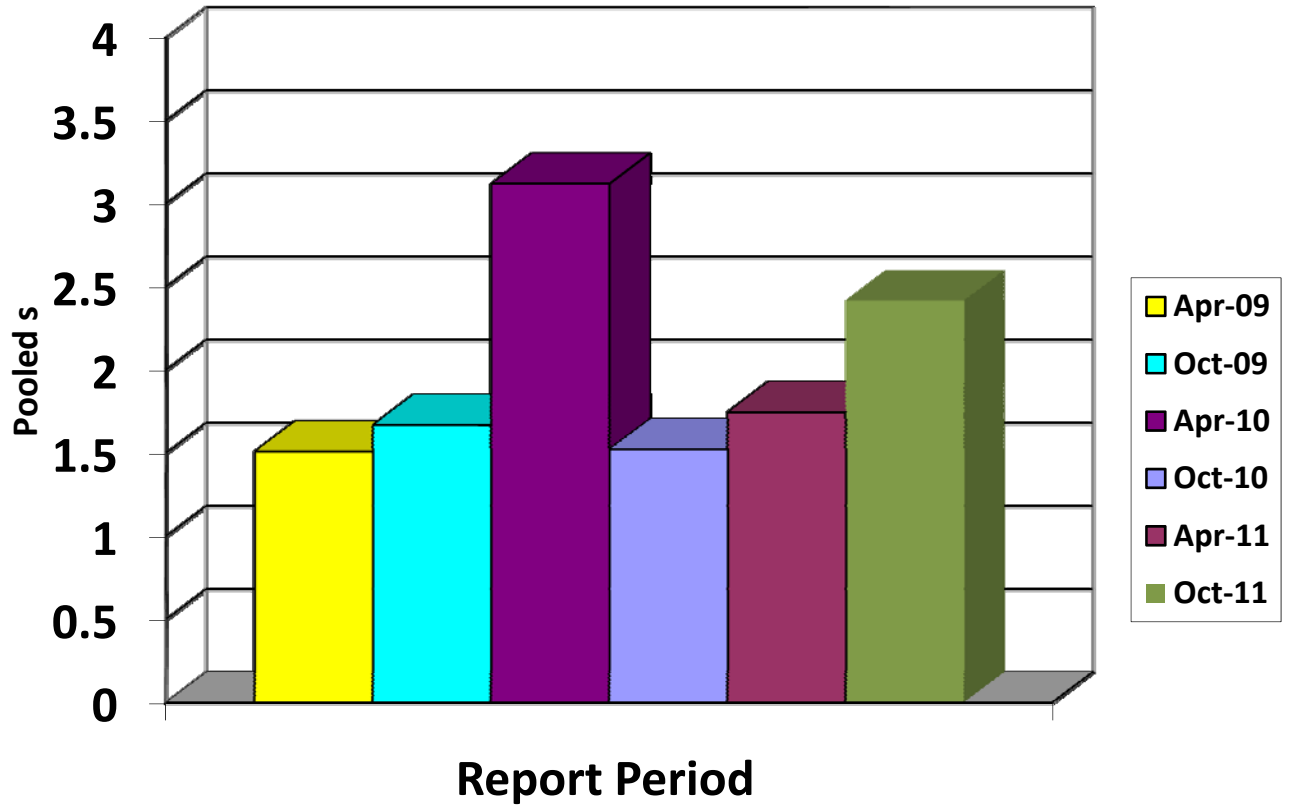


Figure 16 – Sequence IIIG/AB Timeline

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	
04/04/2006	Added requirement to monitor fuel at lab and revised aromatic content in fuel specification	06-1
08/18/2006	Procedure changes as a result of UEB and revised Table A4 to clarify units and test methods	06-2
10/03/06	Change in connecting rod (PMNS) and updated part numbers	06-3

10/08/06	First occurrence of powdered metal non-slotted connecting rods (PMNS)	
11/06/06	Changes in rater calibration requirements	06-4
3/19/07	Added IIIGVIS procedure to test method	07-1
4/01/07	Start of new cylinder head torquing procedures	
6/05/07	Revised designation of IIIGVIS to IIIGVS	07-2
6/05/07	Changed values in Table A4 to metric	07-2
6/05/07	Revised ring gap delta values and revised stand instrumentation calibration requirements	07-2
12/13/2007	Added substitute Rocker Cover Bushing to Test Method	07-3
12/13/2007	Change name of Rater Calibration workshop	07-3
12/13/2007	Added provisions to allow test stand to be calibrated as IIIF and IIIG	07-3
12/13/2007	Revised instrumentation calibration requirements	07-3
5/20/2008	Clarified definition of downtime during oil leveling and sampling	08-1
6/08/2008	1 st occurrence of BC-7 rings	
11/06/2008	Added IIIGB test procedure to test method	08-2
11/24/2008	Added Snap on torque wrench to test method	08-3
11/24/2008	Updated source of Perfect seal number 4 gasket sealer	08-3
11/24/2008	Addressed several editorial changes	08-3
3/09/2009	Added section addressing oil filter and cooler replacement	09-1
3/09/2009	Corrected conversion error in dry bulb temperature	09-1
5/28/2009	Added requirement to repeat fuel analysis when values are found out of spec	09-2
5/28/2009	Added requirement to report the results of all tests run to completion, regardless of validity	09-2
5/28/2009	Allowed use of new oil pan gasket	09-2
7/28/2009	Added industry correction factor for Phosphorus retention	09-3
8/13/2009	Dropped requirement to send hard copy test report to the TMC	09-4
10/12/2009	Added a tolerance to the bath temperature for cylinder head cleaning	09-5
10/12/2009	Corrected the part number for the cylinder head gaskets	09-5
10/12/2009	Deleted the requirement to clean cylinder heads with a brush	09-5
10/12/2009	Add a requirement to the have the cylinder hone load output and current checked annually by the manufacturer	09-5
11/18/2009	Corrected valve spring part number	09-6
11/18/2009	Corrected Annex reference in 10.8.10.1	09-6
11/18/2009	Allowed use of teflon tape and 1/16" thermocouple	09-6
11/18/2009	Revised U & L values used in QI calculation for condenser coolant temperature	09-6
4/27/2010	Corrected equation for Phosphorous retention calculation	10-1
5/22/2010	Additional criteria for oil filter replacement	10-2
5/22/2010	Increased oil consumption limit for interpretability of non-reference oil tests to 4.89 L	10-2
5/22/2010	Allowed use of real time measurement systems to verify AFR sensors	10-2
6/24/2010	Improvements to cam cleaning and measurement procedures	10-3
7/19/2010	Changed NOx measurements from mandatory to non mandatory	10-4
11/22/2010	Increased the time frame for conducting MRV on used oil sample from 168 hours to 504 hours	10-5
6/22/2011	Added additional oil filter change criteria	11-1
7/1/2011	Updated engine build practices as a result of Unified Engine Build	11-2
7/1/2011	Updated part numbers in Annexes A2.1 and A2.2	11-2
7/1/2011	Updated rating manual references in test method	11-2
8/22/2011	Added heat exchanger to engine oil cooling circuit	11-3