



# Test Monitoring Center

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

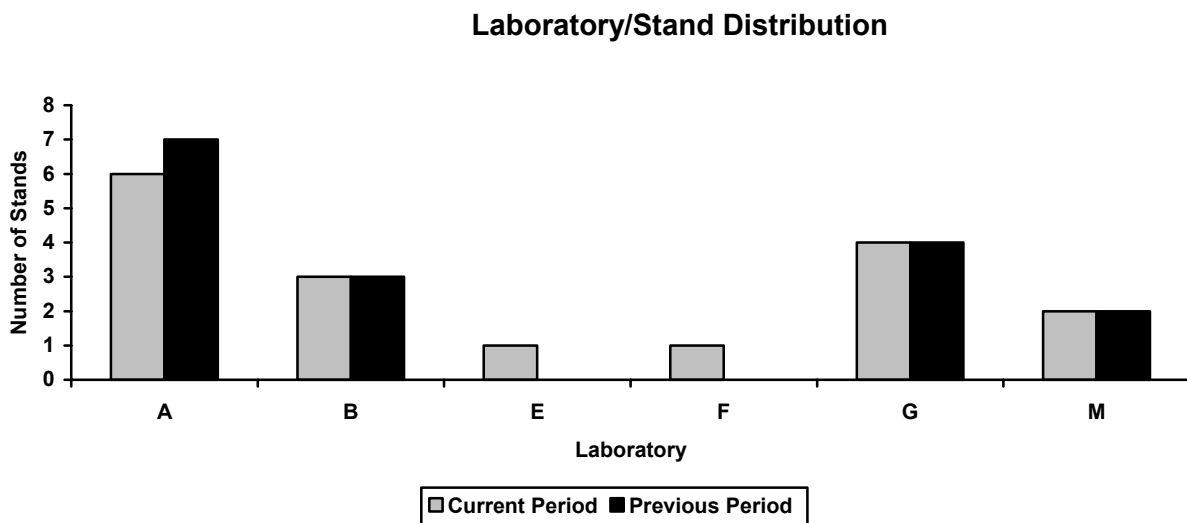
Memorandum: 01-153  
Date: November 1, 2001  
To: William M. Nahumck, Chairman, Sequence IIIF Surveillance Panel  
From: Michael T. Kasimirsky  
Subject: Sequence IIIF Semiannual Report: April 1, 2001 through September 30, 2001

The following is a summary of Sequence IIIF reference tests that were reported to the Test Monitoring Center during the period April 1, 2001 through September 30, 2001.

## Lab/Stand Distribution

	Reporting Data	Calibrated as of September 30, 2001
Number of Laboratories:	6	5
Number of Test Stands:	17	14

The following chart shows the laboratory/stand distribution:



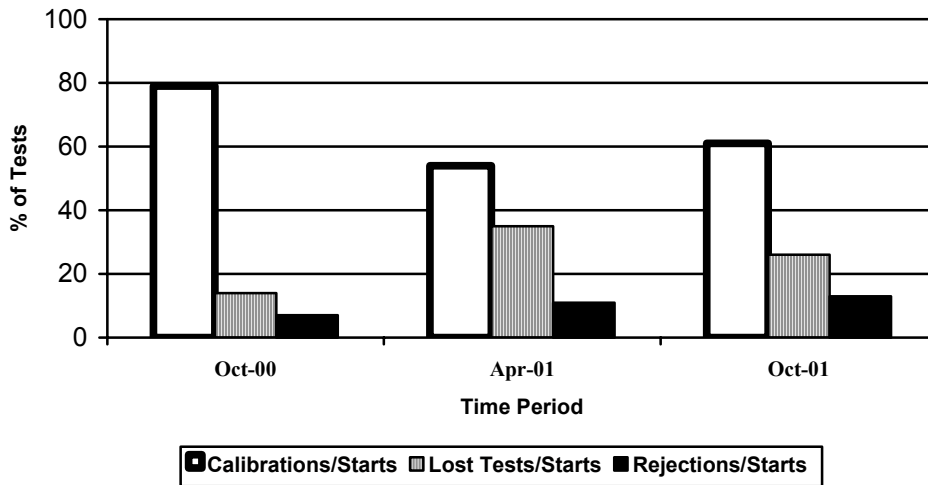
The following summarizes the status of the reference oil tests reported to the TMC:

Calibration Start Outcomes	TMC Validity Codes	No. of Tests
Operationally and Statistically Acceptable	AC	28
Failed Acceptance Criteria	OC	6
Operationally Invalid (Laboratory Judgment)	LC	7
Operationally Invalid (Lab & TMC Judgment)	RC	2
Stand Failed Reference Sequence – data pulled	MC	2
Aborted	XC	1
Total		46

Donated & Industry Support Outcomes	TMC Validity Codes	No. of Tests
Decoded Runs for Stand Shakedown	NI	1
Total		1

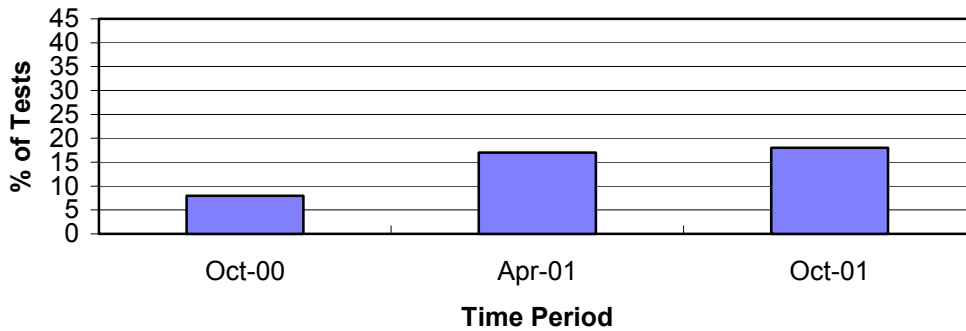
Calibrations per start, lost tests per start and rejection rates are summarized below:

### Calibration Attempt Summary



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

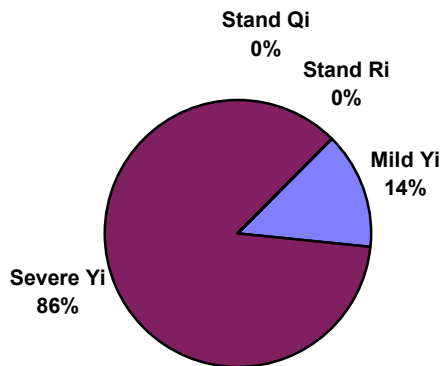
### Rejected Test Rate for Operationally Valid Tests



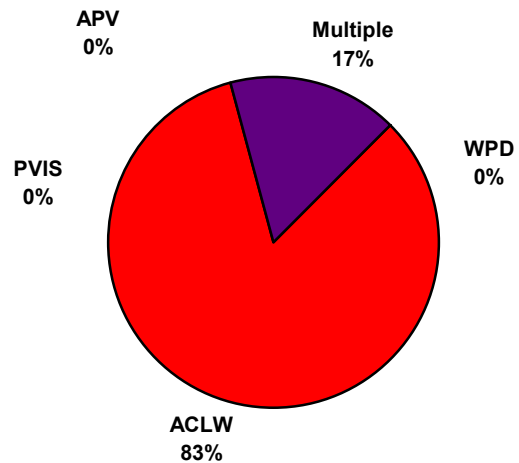
The rate of rejection of operationally valid tests has increased slightly from last period.

There were six failing tests for 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 was one LTMS Deviation written this period. There has been one deviation from the LTMS since its introduction in June of 2000.

During the period, the TMC visited two laboratories. Any discrepancies noted during these visits were identified to the laboratory and corrective action is being taken.

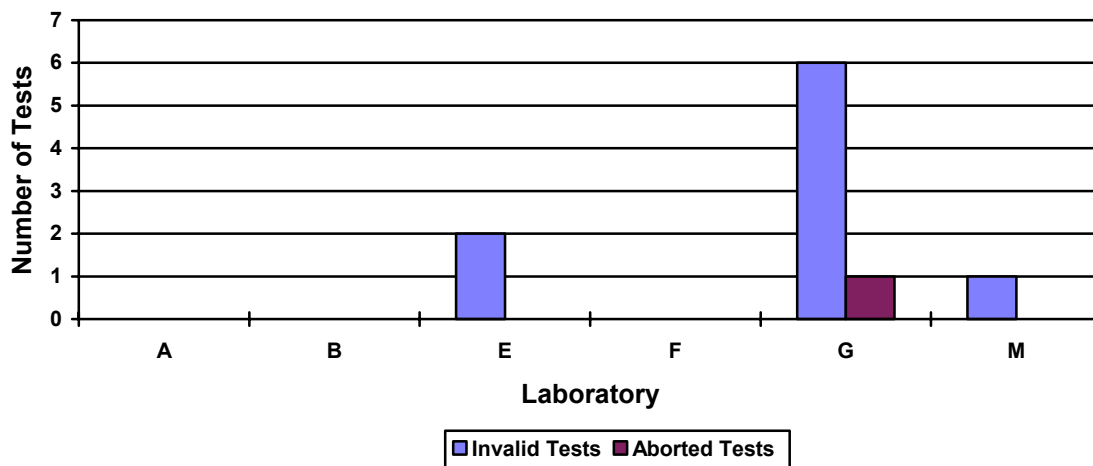
Lost Test Summary

Ten 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)
E	Assorted Stand Configuration Problems on a New Test Stand	1	1/0/0
	Oil Temperature Control Problem	1	1/0/0
G	Improper Condenser and Fuel Plumbing	2	2/0/0
	Coolant Temperature and Exhaust Back Pressure Problems	1	0/0/1
	AFR Problems & Potential Fuel Dilution Problems	1	0/1/0
	Oil Leveling	1	1/0/0
	Oil Temperature QI below zero	1	0/1/0
	Low Oil Level at 60h Oil Level	1	1/0/0
M	Temperature Calibration Error on Oil Filter Block Temperature	1	1/0/0

In addition, a total of two data points from one lab was pulled from the LTMS data set and given an “MC” validity code. Lab G pulled one stand from the system due to mild viscosity increase problems, resulting in the two pulled data points.

**Lost Test Distribution**



Information Letters

Sequence IIIF Information Letter No. 01-1, Sequence No. 4, dated September 18, 2001 was issued during the period and contained the Elimination of Condenser Coolant Flow as a QI Parameter, Elimination Of New Oil Addition At End Of Test, Revised Condenser Part Number, a Revised Parts Cleaning Material Part Number, a Revised Dipstick Calibration Curve, Revised MRV & CCS Procedures, Revised Viscosity Increase Calculation Procedures, and Revised QI U&L Values for Engine Speed & Condenser Coolant Out Temperature.

Sequence IIIF Information Letter No. 01-2, Sequence No. 5, dated September 18, 2001 was issued during the period and contained the New ACLW Parameter and revised requirements for Valve Train Lubrication During Engine Assembly.

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	0.250	0.017 (df=31)	35.0% Viscosity Increase <sup>1</sup>
APV	0.260	0.171 (df=31)	0.04 merits
WPD	-0.300	0.640 (df=31)	-0.19 merits

<sup>1</sup> At the GF-3 Pass Limit of 275% Viscosity Increase

Average $\Delta/s$ Results, by Laboratory			
Laboratory	PVIS	APV	WPD
A	0.31	0.23	-0.48
B	0.03	0.07	-0.31
E	0.69	-1.30	-0.88
F	-	-	-
G	0.02	0.74	-0.41
M	0.66	0.87	1.41

*Percent Viscosity Increase (PVIS)*

The industry experienced three severity alarms during the period (see figures 1, 4, and 7). The severity alarms were of two, two, and one data point in duration. The three alarms were driven by a single test result on reference oil 1006 which returned a result 2.3 standard deviations mild of target, resulting in a large severity shift in the industry control chart. Two mild but passing reference oil 1006 runs caused the first two-point alarm. The industry returned within limits for a single data point and then experienced the second two-point alarm due to a mild but passing test result on reference oil 1008. The industry returned within limits for three data points and then experienced a single-point alarm due to a single mild but passing test on reference oil 1006. No causes for the mild results were found and subsequent testing in industry cleared the alarms.

*Weighted Piston Deposits (WPD)*

The industry was within limits for both severity and precision for the period (see figures 2, 5, and 8). The industry has been more severe on this parameter than in the two preceding periods. The precision estimate for the period is slightly worse than previous periods, but was within limits on the industry control chart.

*Average Piston Skirt Varnish (APV)*

The industry was within limits for the period on both severity and precision with the exception of one single-point severity alarm (see figures 3, 6, and 9). The alarm was caused by a single mild failing reference oil test on reference oil 1006. The industry returned within limits with the next test result. Severity for the period has degraded compared to the previous two periods. Precision for the period has improved slightly compared to the previous two periods.

#### *Average Camshaft-plus-Lifter Wear (ACLW)/Screened Average Camshaft-plus-Lifter Wear (SACLW)*

Five of the six failing tests for the period failed due to poor ACLW performance. Of these five tests, two were on reference oil 1008 and three were on reference oil 433-1. No cause for the erratic wear performance in the Sequence IIF test has been found at this time.

Effective for all tests completed on or after September 8, 2001, the ACLW parameter was replaced with the SACLW parameter as the pass/fail measure of camshaft and lifter wear performance. This parameter is calculated by eliminating the positions that returned the maximum and minimum camshaft-plus-lifter wear results and calculating an average based upon the remaining 10 positions. Since this change, no reference oil tests have failed due to poor SACLW performance.

#### QI Deviations

There were six QI Deviations for the period. There have been 21 deviations from the QI Limits since the test was introduced in June of 2000.

Four deviations were written for Oil Filter Block Temperature control problems. All four tests were conducted on reference oil 1006 and this is a known problem with this oil. As the oil thickens, the filter goes into bypass mode and oil temperature control is lost.

Two deviations were written for Air-to-Fuel Ratio (AFR) control problems; one for Left AFR control problems and one for Right AFR control problems. Both deviations were written for tests at the same laboratory on the same test stand. The laboratory subsequently made some improvements to its control strategies, sampling frequencies, and filtering strategies to improve AFR control.

#### Percent Viscosity Increase at 60 Hours

At the last meeting of the Surveillance Panel, the issue of creating LTMS targets for percent viscosity increase at 60 hours was not decided. The Surveillance Panel tasked the Test Target Task Force with coming up with a set of recommendations for the panel to review. The targets are based upon the Task Forces recommendation of a Natural Log transformation for this parameter. This action has been completed and the recommended Test Targets are shown in the following table:

<i>Test Targets for Percent Viscosity Increase at 60 Hours</i>			
Oil	N size	Mean	Standard Deviation
1006	34	5.41732	0.230855
1008	38	4.21605	0.122356
433	19	3.31554	0.111867
433-1	6	3.41045	0.000897*

\* The Task Force recommends that reference oil 433-1 use the standard deviation for reference oil 433 until additional data is generated on this reference oil.

Another issue is what standard deviation to use for severity adjustment purposes. The Task Forces recommendation for that value is 0.17334.

The above items require formal approval by the Surveillance Panel so they can be incorporated into the LTMS.

#### Hardware

No hardware changes were made this period.

Reference Oils

Oil	TMC Inventory, in gallons	TMC Inventory, in tests (4 gal/test)	Laboratory Inventory, in tests	Estimated life
1006	46	11	18	depleted <sup>1</sup>
1006-2	5,342	1,335	14	To be Introduced <sup>1</sup>
1007	550	137	11	not currently used in IIIF <sup>2</sup>
1008	128	32	15	~1 year <sup>1</sup>
432	118	29	13	not currently used in IIIF
433	10	2	2	depleted
433-1	827	206	13	~3 years

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

<sup>2</sup> Not reblendable

The test targets on reference oil 1008 were updated and frozen during the period, based on 37 data points. The previous updated targets are listed below for comparison purposes:

Updated Reference Oil 1008 Test Targets		
Parameter	Mean	Standard Deviation
PVIS	0.0895442	0.0098604
APV	9.75	0.102
WPD	4.57	0.803

The data on this reference oil was adjusted using the severity adjustments, if any, generated as a result of the previous reference oil test. The new test targets, based upon this methodology, are shown below:

Final reference oil 1008 test targets		
Parameter	Mean	Standard Deviation
PVIS	0.0899551	0.0096670
APV	9.74	0.100
WPD	4.52	0.773

These new targets are effective for all tests completed on or after September 5, 2001.

Reference oil 1008 supplies at the TMC are also getting low. A reblend of this oil is being procured by the TMC at this time.

Reference oil 1006 has sufficient data for a target update at this time. However, the test targets for this oil present a problem in the LTMS. Using the current targets, there is no way for a test to be too severe on percent viscosity increase using this reference oil. The current targets, combined with the 8000 cSt upper limit on the viscosity measurement, result in a lower limit of approximately -1.0 for Shewhart Severity on this parameter, i.e. a test cannot generate a  $Y_i$  value lower than -1.0 on this reference oil. This undoubtedly has an impact on the Severity Adjustment system and the appropriateness of the adjustments it applies to candidate test results. The updated test targets in question, based on 35 data points, are shown below for your review.

Potential Updated Reference Oil 1006 Test Targets		
Parameter	Mean	Standard Deviation
PVIS	0.0167362	0.0086503

APV	9.23	0.213
WPD	3.32	0.327

A graphical comparison of these targets is shown in Figures A, B, C, and D, which are attached. The Surveillance Panel will need to decide what action, if any, is desired to address this problem and also if these new test targets will be implemented into the Sequence IIIF LTMS.

Reference oil 433 has been depleted in industry, with only four samples of that oil remaining. The TMC has frozen these four samples for any future needs the panel may have for this remaining supply of this reference oil.

At the May 23, 2001 meeting of the Sequence IIIF Surveillance Panel, the panel approved a plan to run a series of simultaneous reference oil tests on oil 433-1 for the purposes of both stand calibration and test target generation. The initial targets for reference oil 433-1, based on the five data points from the matrix, are shown below:

Initial Reference Oil 433-1 Test Targets		
Parameter	Mean	Standard Deviation
PVIS	0.1700213	0.0433403
APV	9.31	0.242
WPD	4.28	0.826

No severity adjustments were applied to the data prior to target generation. Future updates to the targets will be severity adjusted according to past practice. The Surveillance Panel has approved a plan to update these targets when the TMC has 10, 20, and 30 data points on this reference oil. These new targets are effective for all tests completed on or after August 15, 2001.

MTK/mtk

Attachments

c: F. M. Farber, TMC  
 Sequence IIIF Surveillance Panel  
<ftp://tmc.astm.cmri.cmu.edu/docs/gas/sequenceiii/semiannualreports/IIIF-10-2001.pdf>



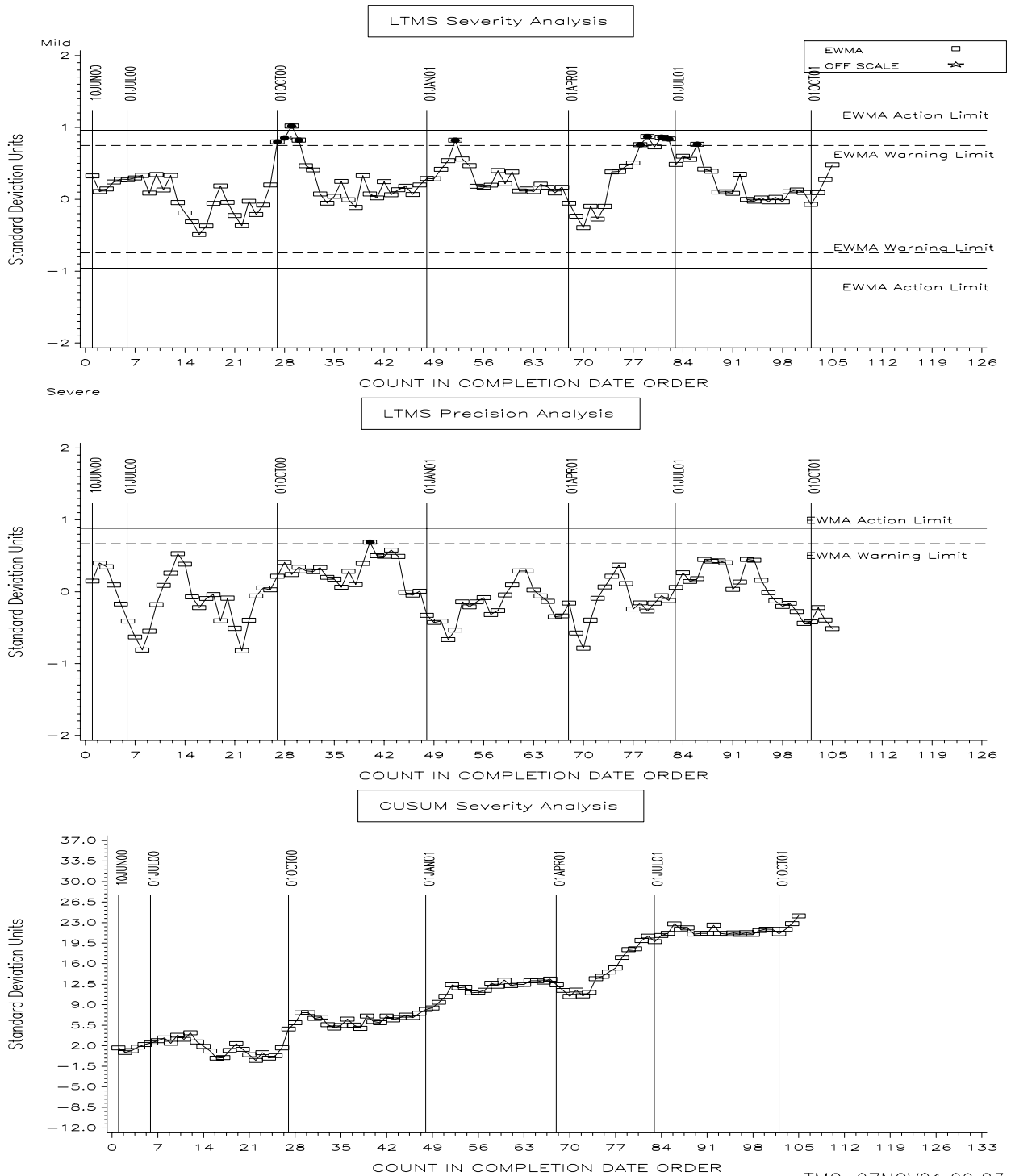
List of Figures

- Figures 1, 2, and 3 are EWMA severity and precision control charts and also the CUSUM  $\Delta/s$  plots of PVIS, WPD, and APV, 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 APV.
- Figures 7, 8, and 9 are bar charts of pooled standard deviation, by report period, for PVIS, WPD, and APV.
- Figure 10 is the Sequence IIIIF Timeline.
- Figure A is the proposed reference oil 1006 test targets for Viscosity Increase, in transformed units.
- Figure B is the proposed reference oil 1006 test targets for Viscosity Increase, in original units.
- Figure C is the proposed reference oil 1006 test targets for Weighted Piston Deposits, in reported units.
- Figure D is the proposed reference oil 1006 test targets for Average Piston Varnish, in reported units.

# SEQUENCE IIIF INDUSTRY OPERATIONALLY VALID DATA

VISCOSITY INCREASE FINAL ORIG UNIT RES

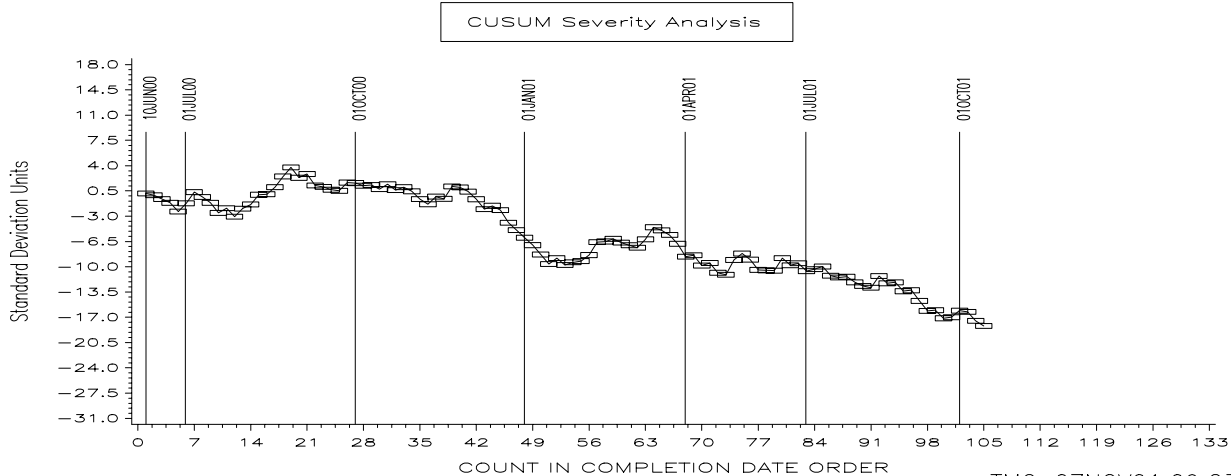
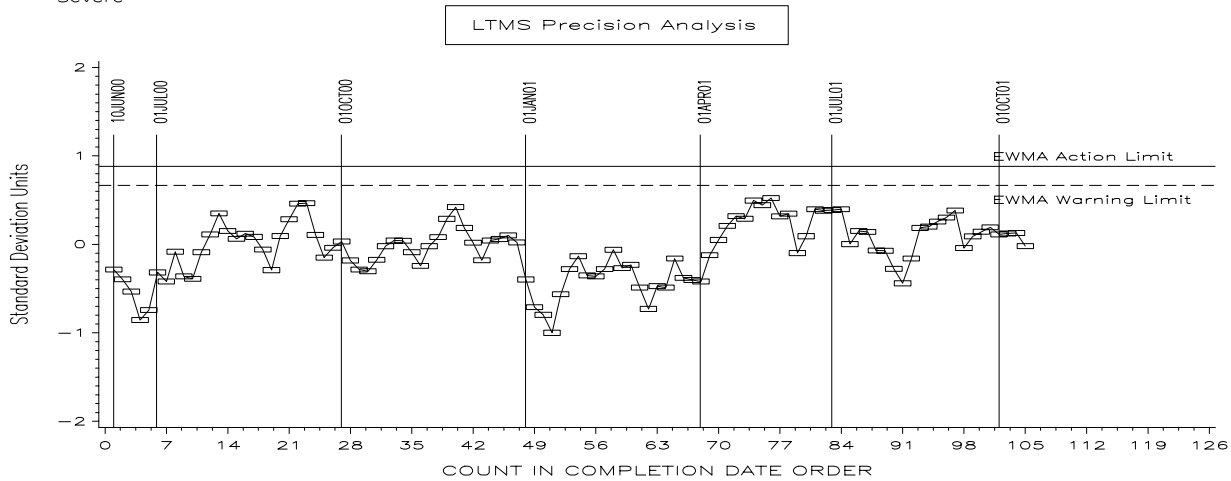
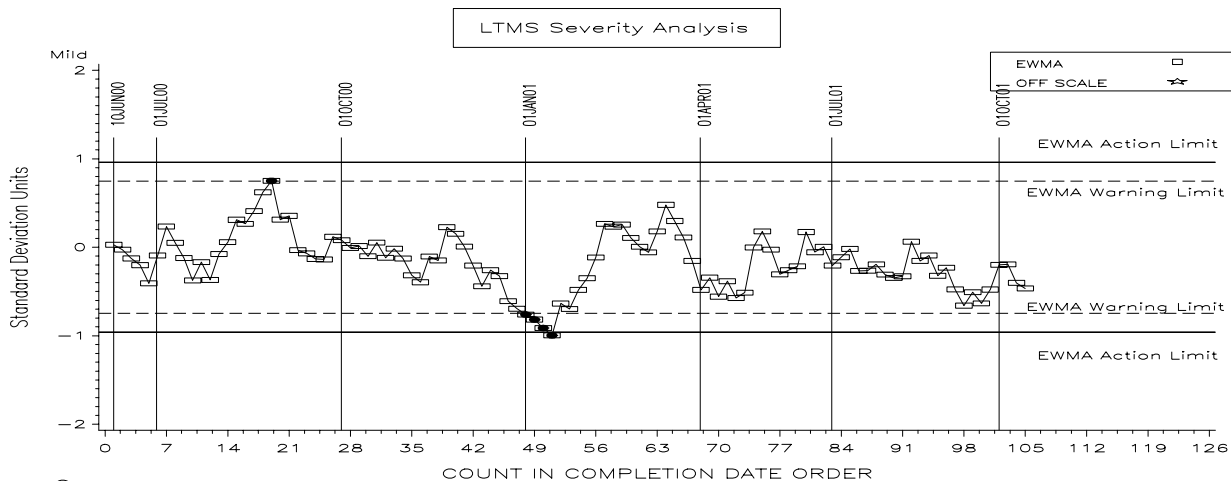
Figure 1



SEQUENCE IIIF INDUSTRY OPERATIONALLY VALID DATA

AVERAGE WEIGHTED PISTON DEPOSITS FNL ORIG UNIT RES

Figure 2



SEQUENCE IIIF INDUSTRY OPERATIONALLY VALID DATA

AVERAGE PISTON SKIRT VARNISH FINAL ORIG UNIT RES

Figure 3

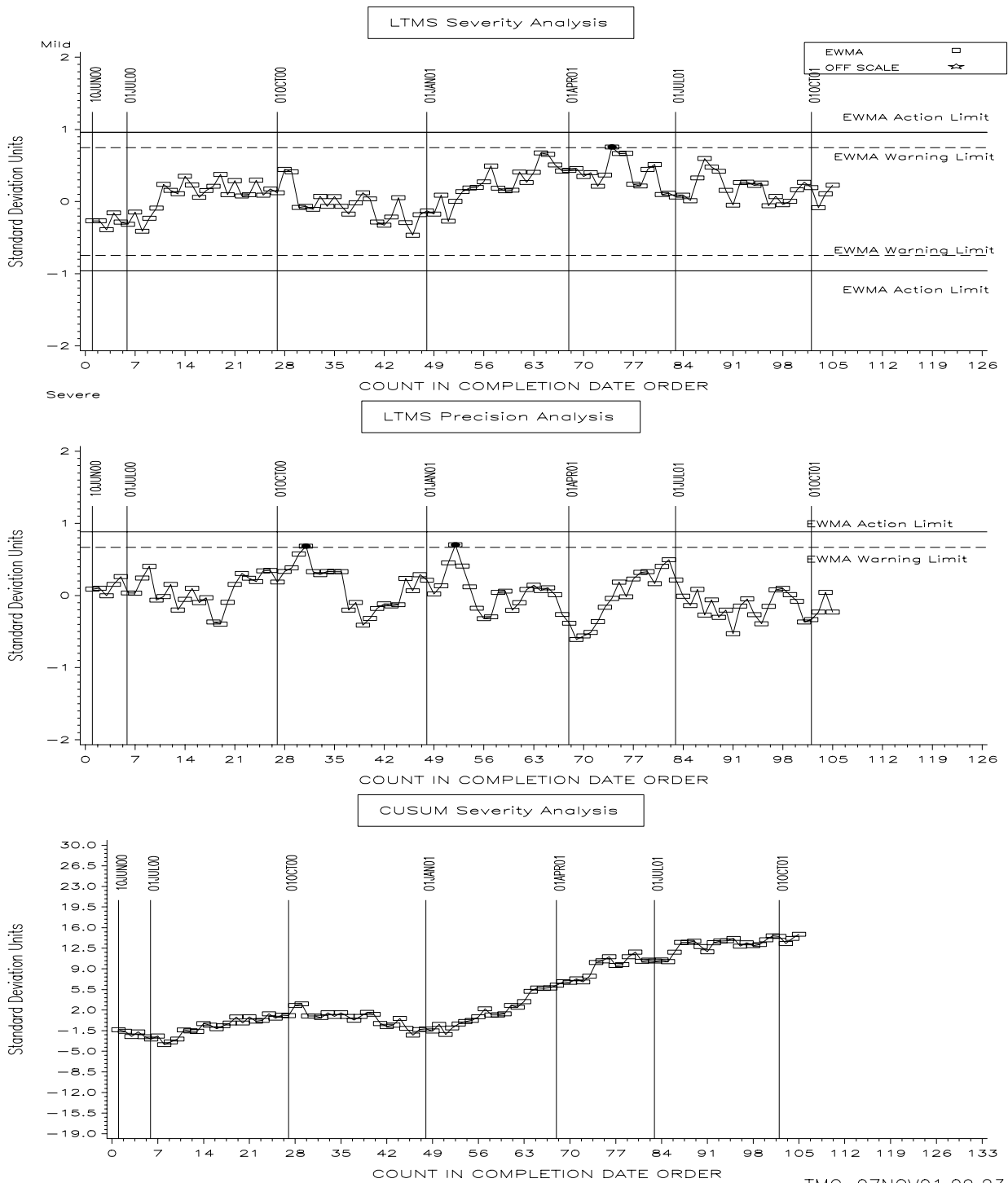


Figure 4 - Percent Viscosity Increase, Average Delta/s

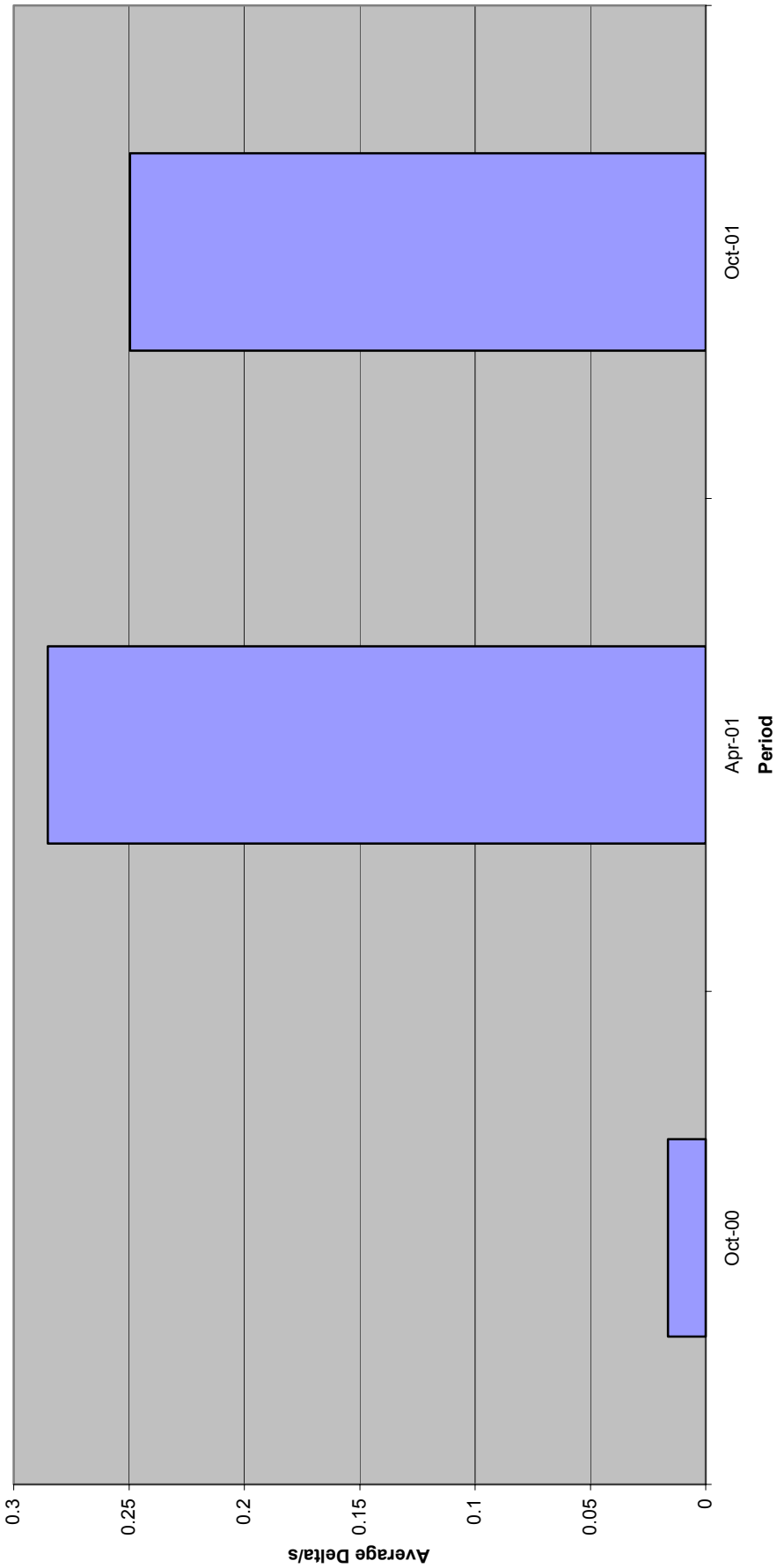


Figure 5 - Weighted Piston Deposits, Average Delta/s

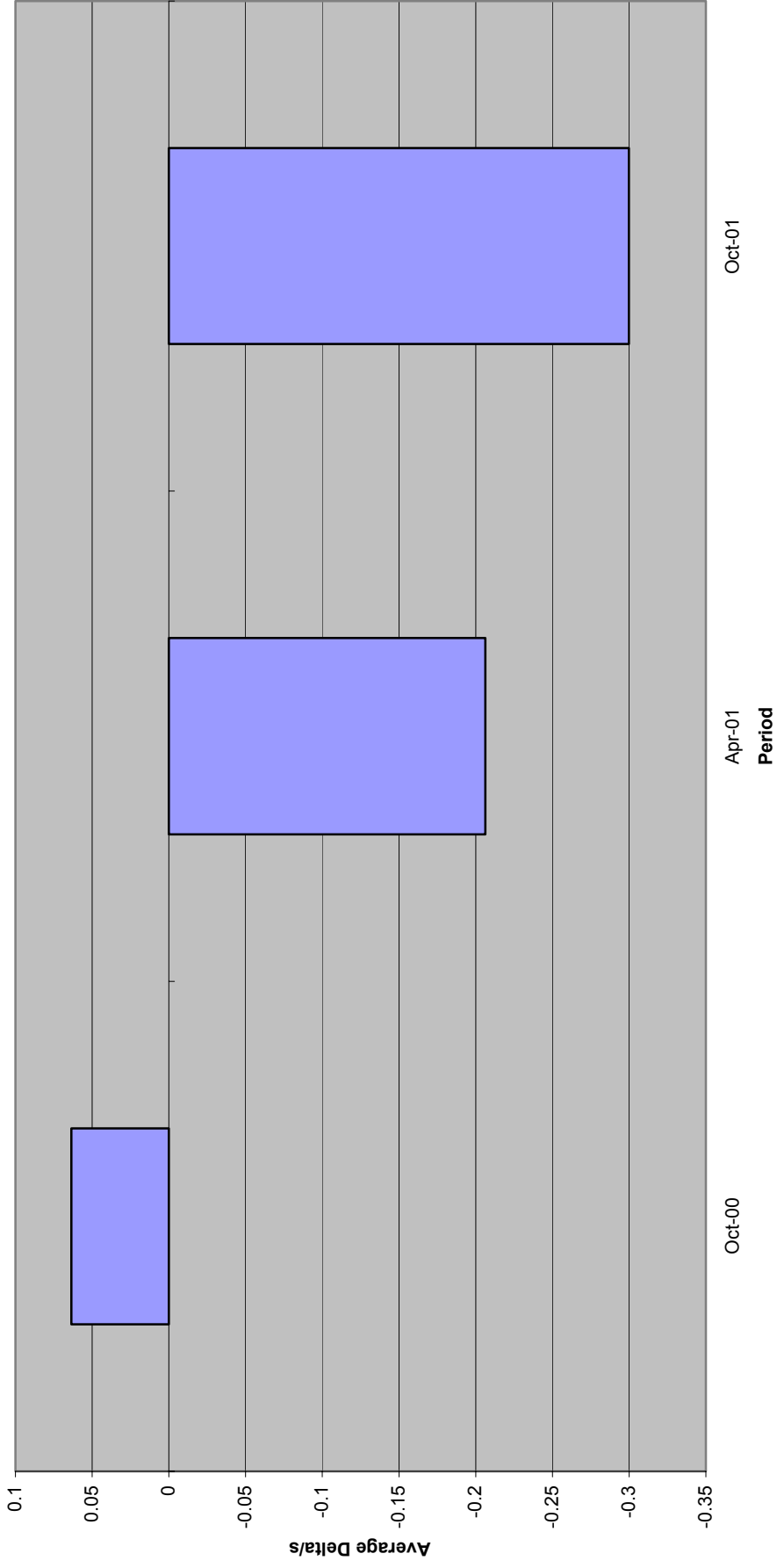


Figure 6 - Average Piston Varnish, Average Delta/s

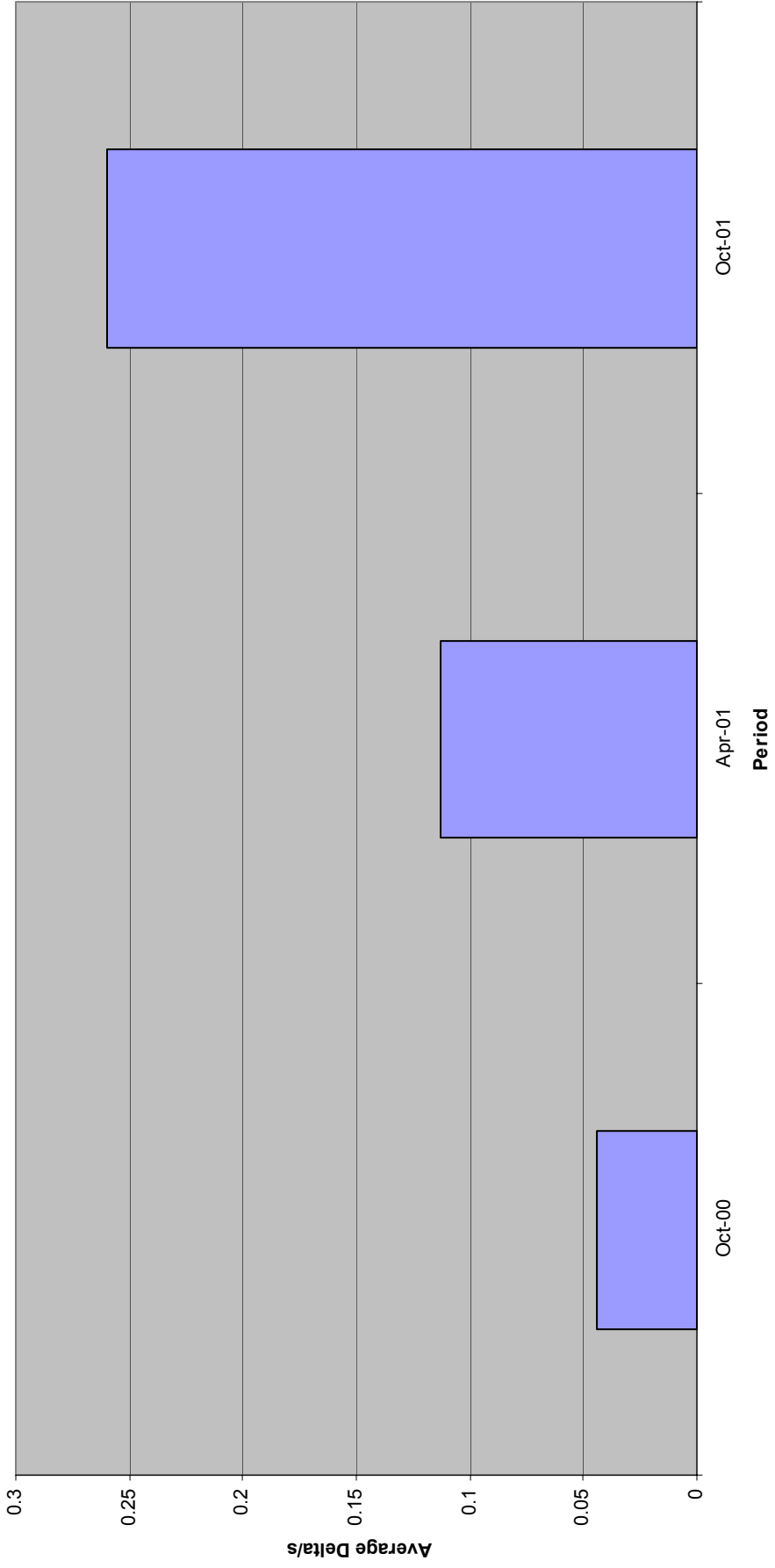


Figure 7 - Percent Viscosity Increase, Pooled Standard Deviation

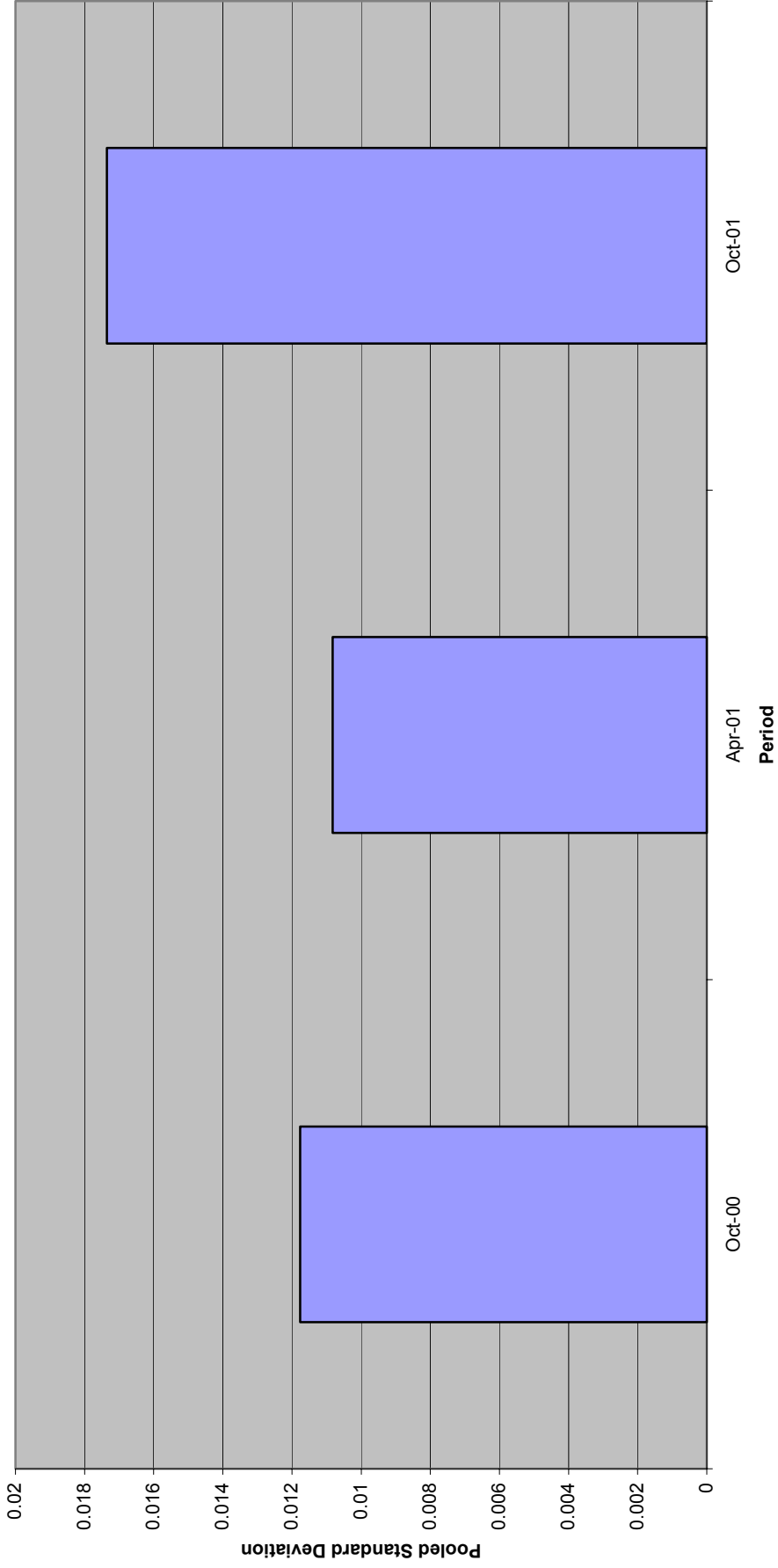




Figure 8 - Weighted Piston Deposits, Pooled Standard Deviation

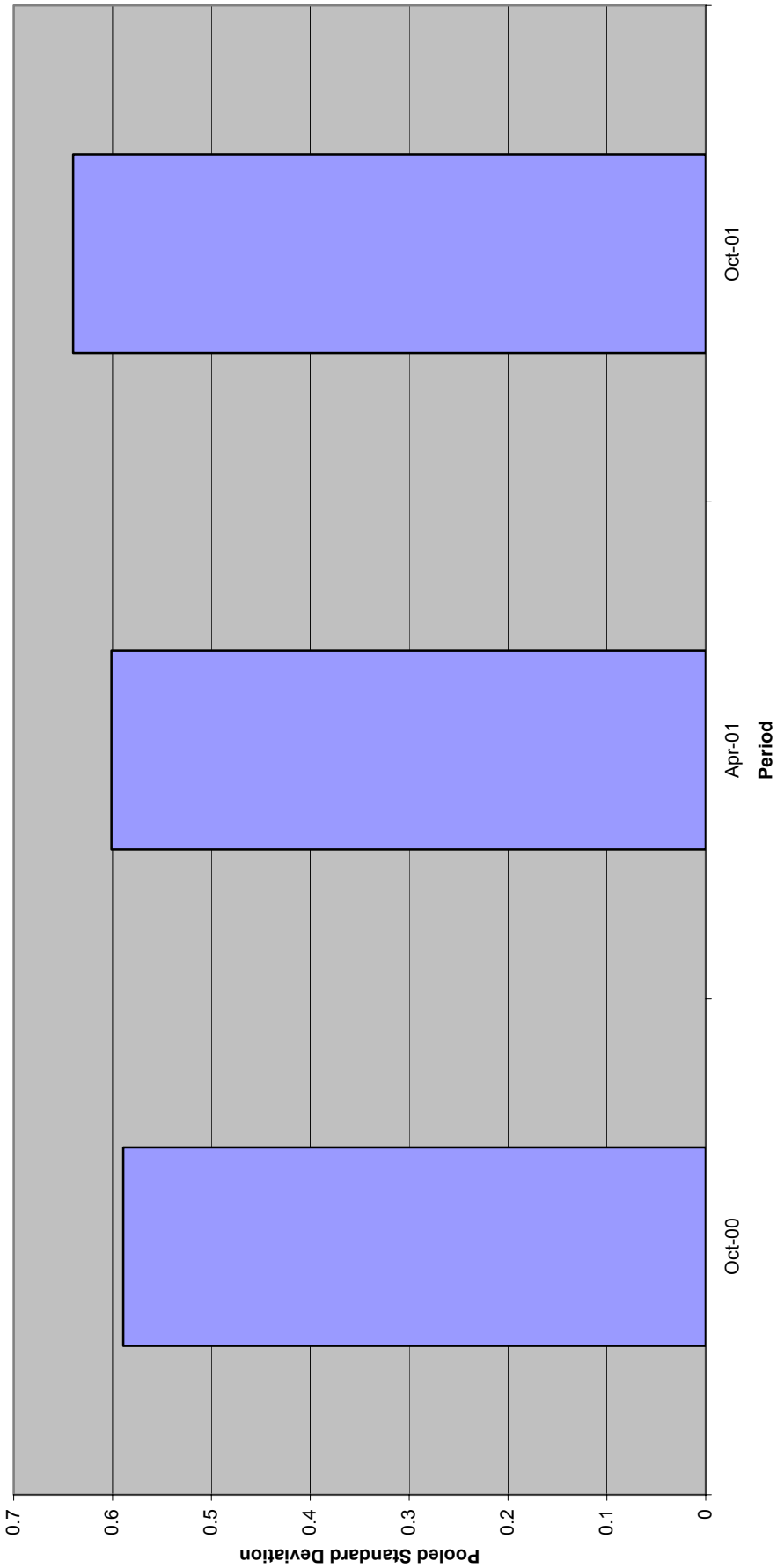


Figure 9 - Average Piston Skirt Varnish, Pooled Standard Deviation

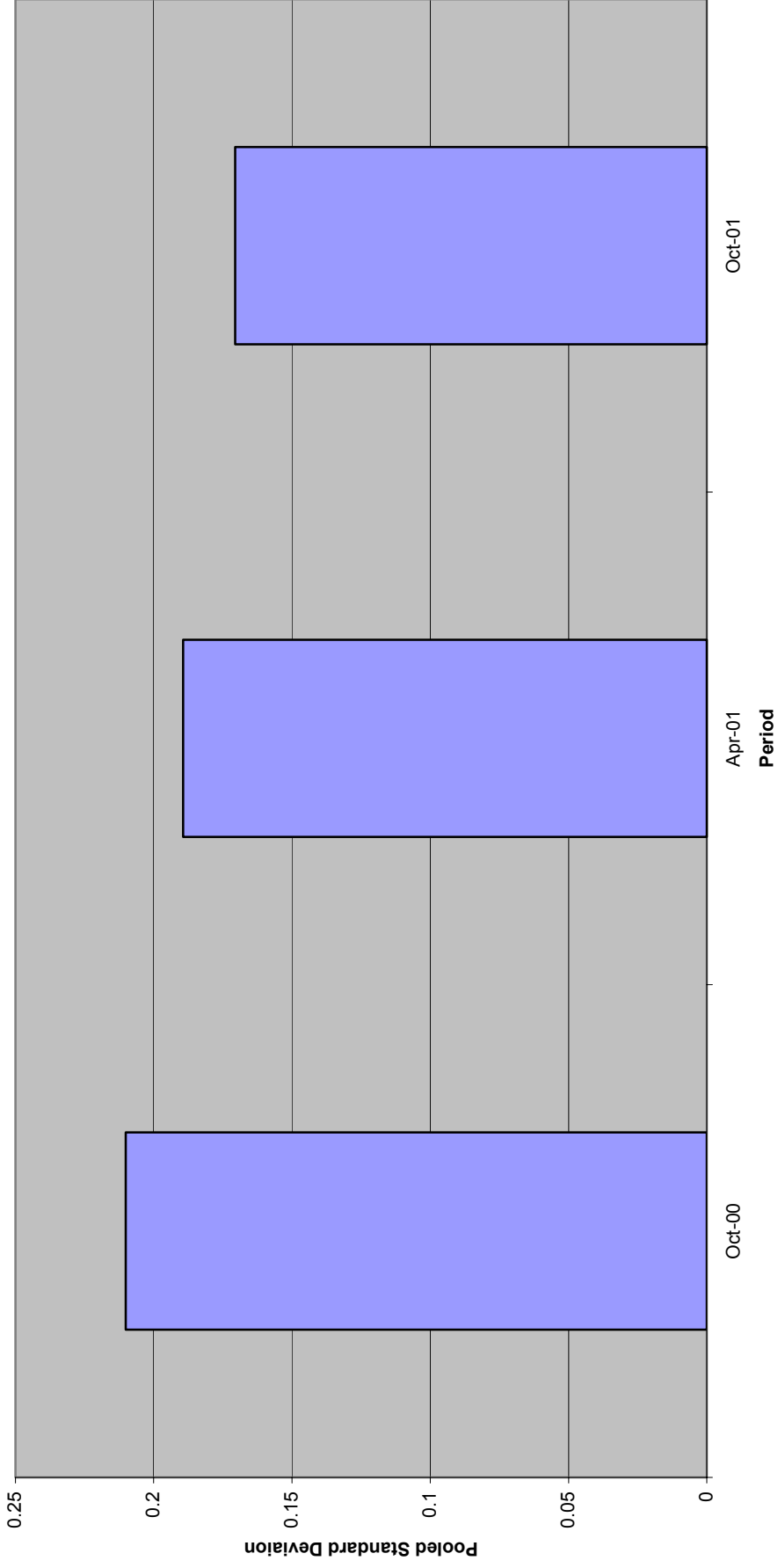


Figure 10 – Sequence IIIF Timeline

Date	Topic	Information Letter
6/10/2000	IIIF Test Released from Redevelopment	
6/10/2000	Revised Ring Sticking definitions implemented	00-2
7/25/2000	Oil Consumption as a test validity criteria dropped	00-2
8/28/2000	First occurrence of LC camshafts in LTMS data	
9/8/2000	Draft 3 of the Sequence IIIF Test Procedure released	00-1
9/27/2000	MRV & CCS Testing of used oil samples added	00-2
9/27/2000	Valve train assembly using build up oil implemented	00-2
10/4/2000	New QI U&L Values implemented	00-2
10/8/2000	First occurrence of Valve train assembly using build up oil in LTMS	00-2
12/6/2000	Oil Consumption as a test interpretability criteria added	00-3
4/25/2001	First occurrence of MB camshafts in LTMS data	
5/23/2001	Condenser Flow QI requirements dropped	01-1
5/23/2001	New oil addition at EOT dropped	01-1
5/23/2001	Condenser part number corrected	01-1
5/23/2001	Revised dipstick calibration curve implemented	01-1
5/23/2001	Revised MRV & CCS test procedures	01-1
5/23/2001	Upper limit of 8000cSt for viscosity measurements established	01-1
5/23/2001	Reexamination of Engine Speed and Condenser Coolant Out Temperature QI U&L values performed; no changes made	01-1
9/8/2001	Screened Average Cam-plus-lifter Wear (SACLW) replaces Average Cam-plus-lifter Wear (ACLW) as pass/fail parameter	01-2
9/8/2001	Valve train assembly using test oil reintroduced into IIIF test	01-2
9/12/2001	First occurrence of engine builds using test oil for valvetrain lubrication in LTMS	

Figure A

# Sequence IIF Reference Oil 1006 Test Target Data Set and Shewhart Bands

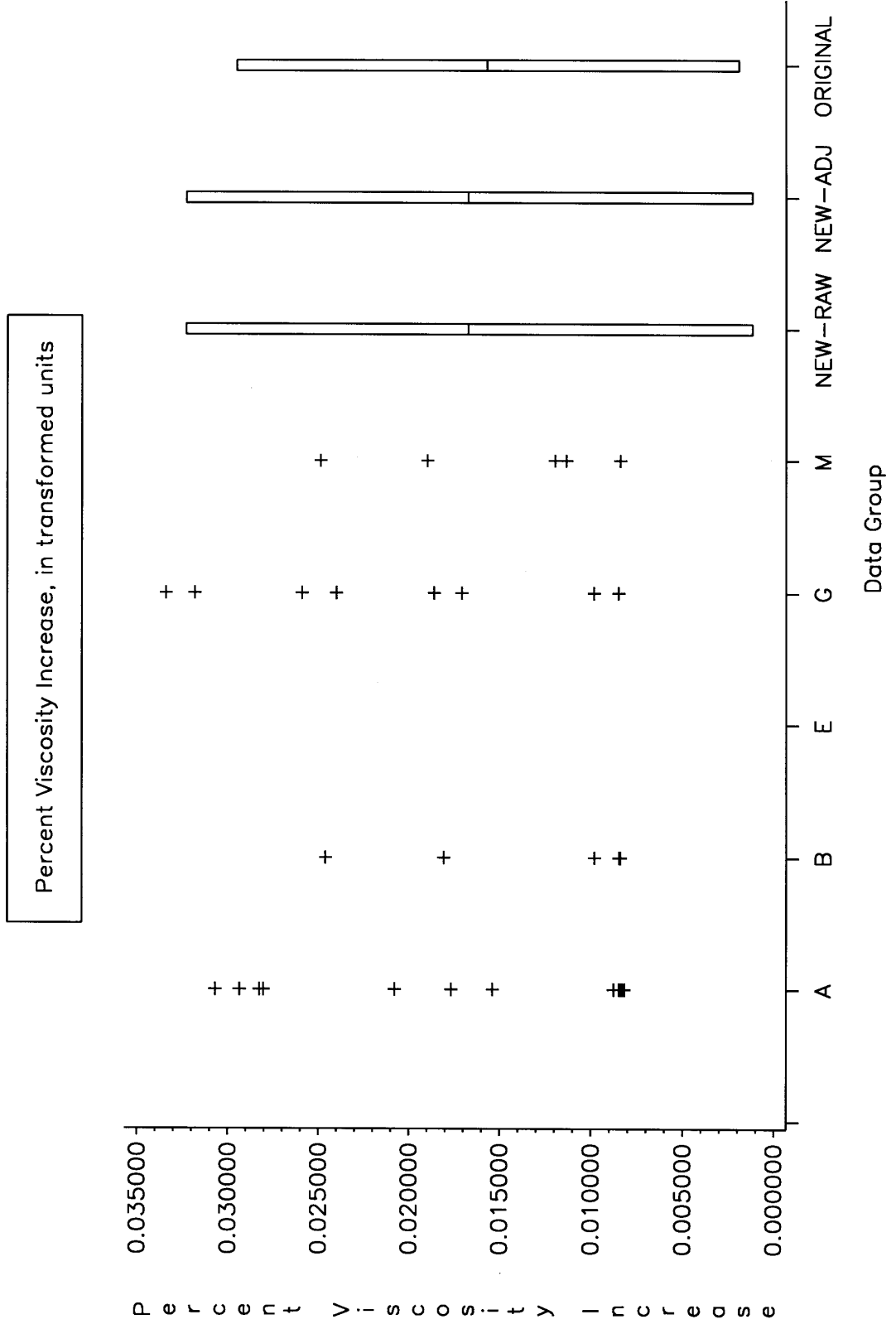


Figure B

# Sequence IIF Reference Oil 1006 Test Target Data Set and Shewhart Bands

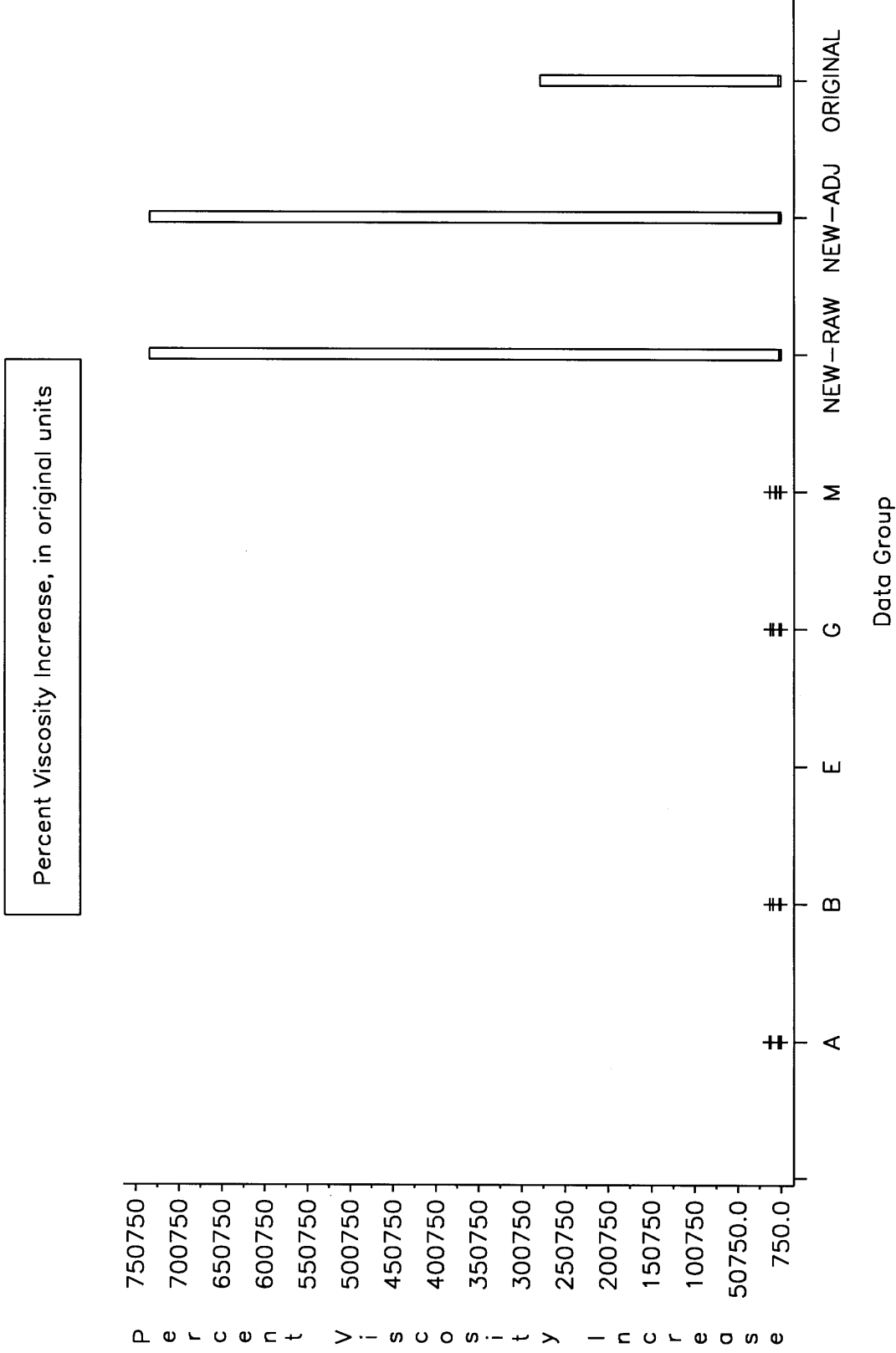


Figure C

# Sequence IIF Reference Oil 1006 Test Target Data Set and Shewhart Bands

Weighted Piston Deposits, in reported units

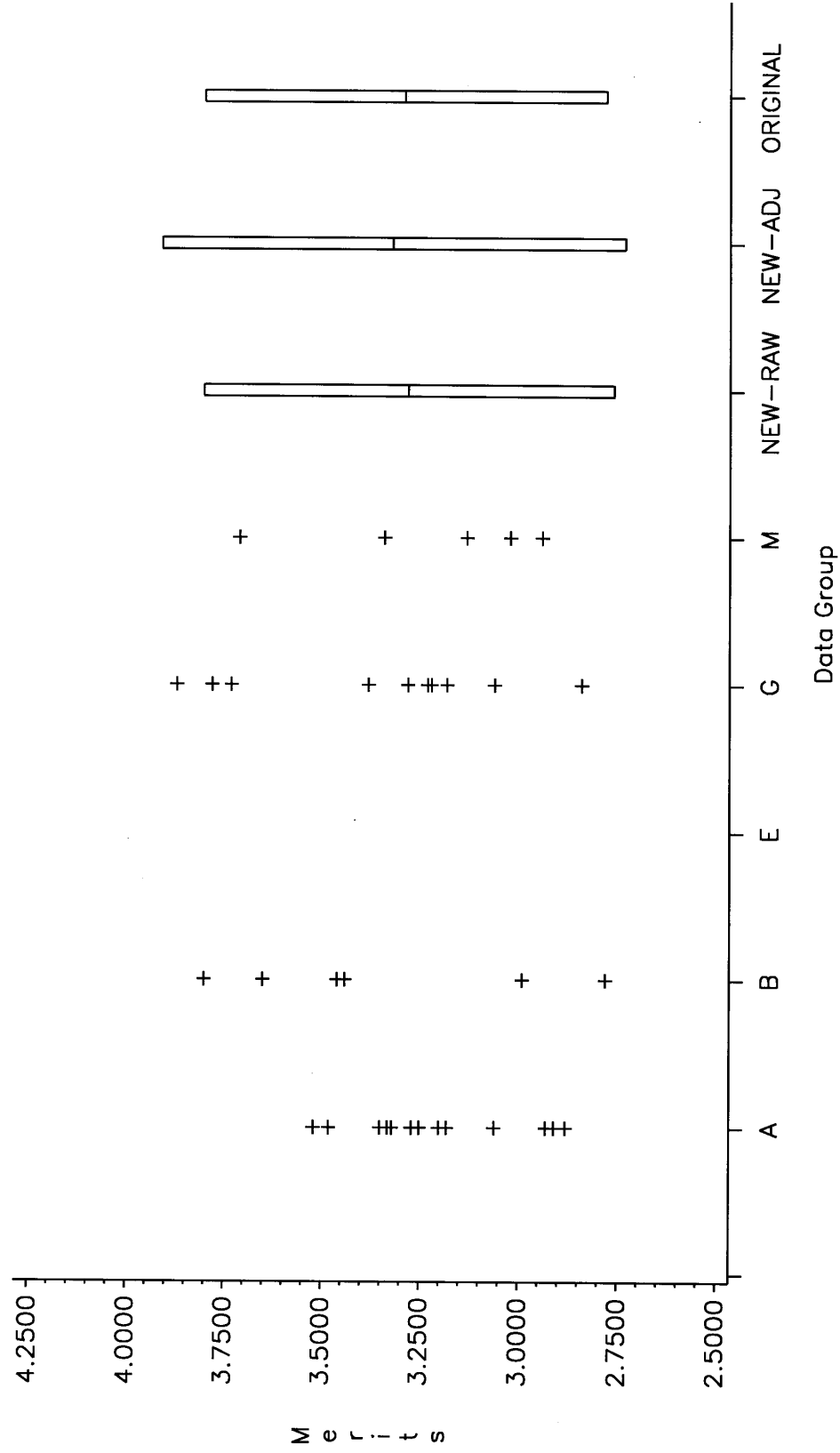


Figure D

# Sequence IIIF Reference Oil 1006 Test Target Data Set and Shewhart Bands

Average Piston Varnish, in reported units

