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

Memorandum: 04-038

Date: April 28, 2004

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

From: Michael T. Kasimirsky

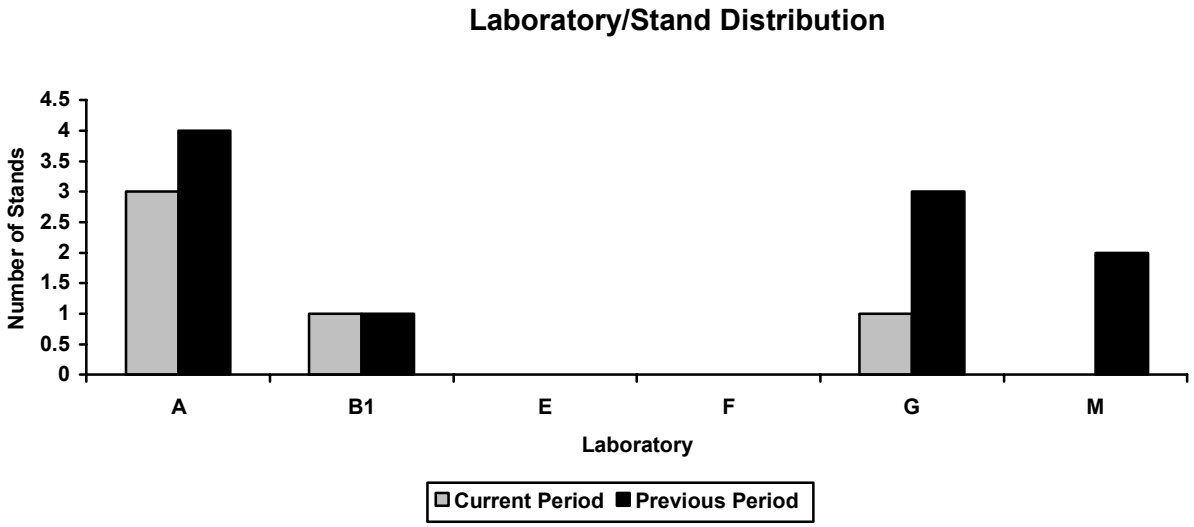
Subject: Sequence IIIF Semiannual Report: October 1, 2003 through March 31, 2004

The following is a summary of Sequence IIIF reference tests that were reported to the Test Monitoring Center during the period October 1, 2003 through March 31, 2004.

Lab/Stand Distribution

| | Reporting Data | Calibrated as of March 31, 2004 |
|---|---|---|
| Number of Laboratories: | 3 | 2 |
| Number of Test Stands: | 5 | 3 |

The following chart shows the laboratory/stand distribution:

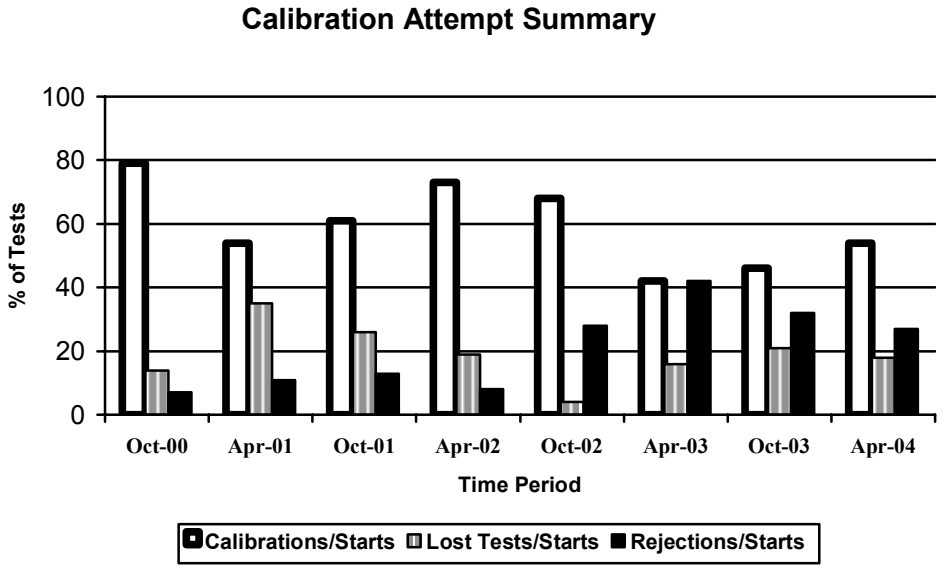


The following summarizes the status of the reference oil tests reported to the TMC:

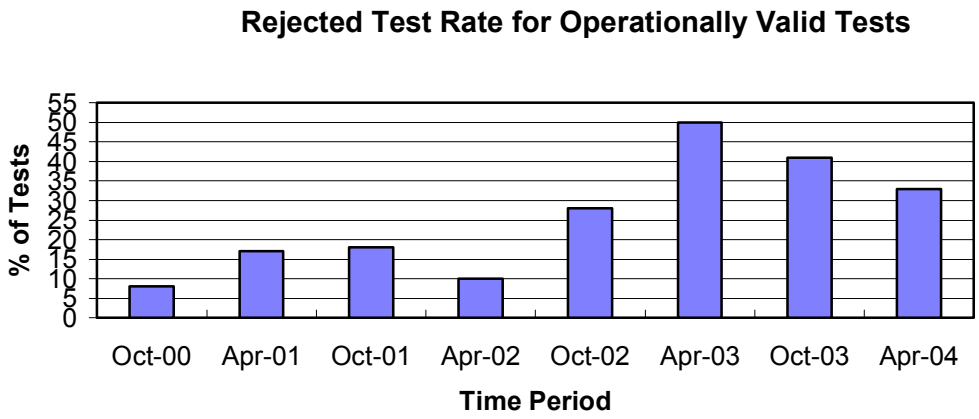
| Calibration Start Outcomes | TMC Validity Codes | No. of Tests |
|---|---|---|
| Operationally and Statistically Acceptable | AC | 6 |
| Failed Acceptance Criteria | OC | 3 |
| Operationally Invalid (Laboratory Judgment) | LC | 2 |
| Operationally Invalid (Lab & TMC Judgment) | RC | 0 |
| Stand Failed Reference Sequence – data pulled | MC | 0 |
| Aborted | XC | 0 |
| Total | | 11 |

| Donated & Industry Support Outcomes | TMC Validity Codes | No. of Tests |
|---|---|---|
| Decoded Oil for Test Development Work | NI | 1 |
| Total | | 1 |

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

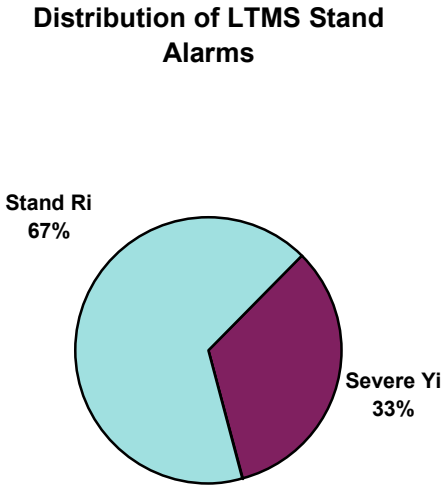


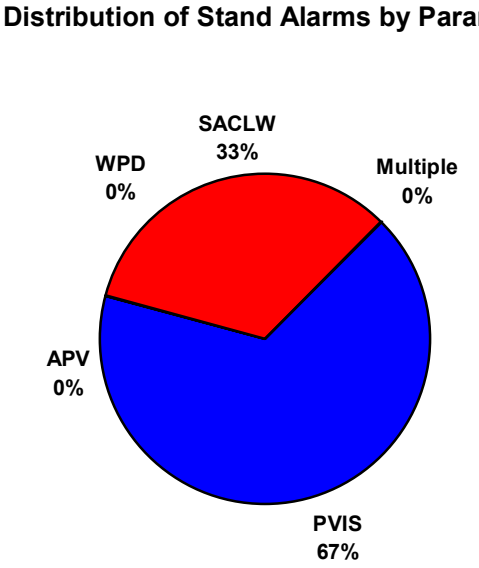

The calibration per start rate is higher than last period. The lost test rate is slightly lower than last period. The rejected test rate is lower than last period. Overall testing activity has dropped significantly so these changes should be viewed with that information in mind.




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

There were three failing tests for the period. The following charts summarize the reasons and




breakdown by parameter for the failed test:

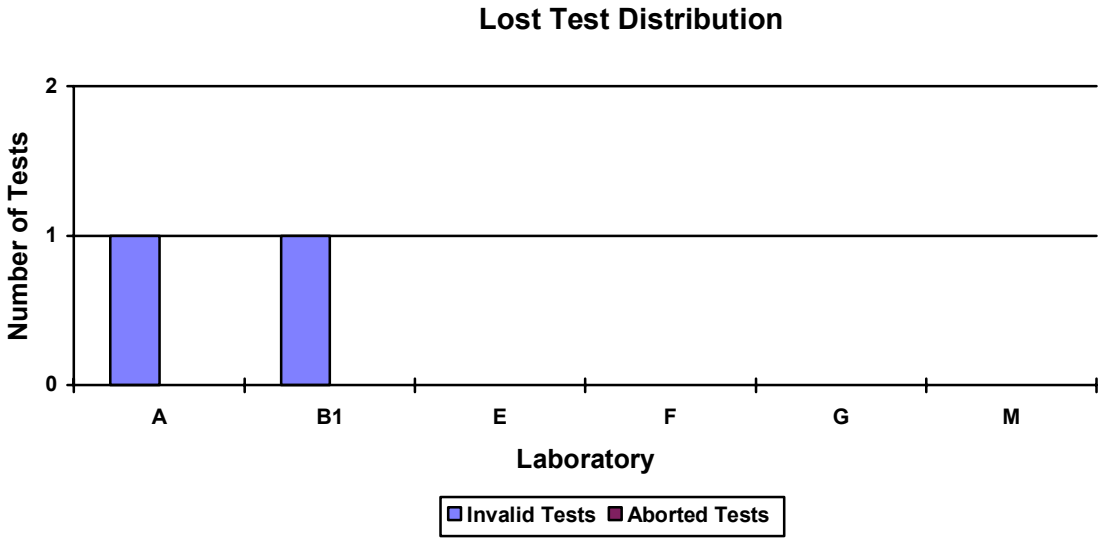
There were no LTMS Deviations written this period. There have been four deviations from the LTMS since its introduction in June of 2000.

No Sequence IIIF lab visits were performed this period.

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) |
|---|---|---|---|
| A | Bad Ignition Voltage | 1 | 1/0/0 |
| B1 | Low Fuel Pressure | 1 | 1/0/0 |




Information Letters

Sequence IIIF Information Letter No. 03-3, Sequence No. 13, was issued during the period on November 7, 2003, and contained the following topics: Revised Fuel Pressure Specification, Automatic Parts Washing Machine Maintenance Requirement, Revised Main Bearing Bore Mandrel Procedure, Piston Ring Cleaning Requirements, Additional Allowable RTV Sealing Compound, Main Bearing Cap Bolt Replacement Specification, Revised Camshaft Measurement Procedure, Revised Camshaft Lubrication & Installation Procedure, Revised Oil Consumption Reporting Procedure, Fluid Conditioning Module Equipment Specifications, Revised Camshaft Measurement Equipment Specifications, Rating Workshop Attendance Requirement, and Editorial Corrections.

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 | -0.438 | 0.022 (df=6) | -114.5% Viscosity Increase[1] |
| APV | 0.087 | 0.292 (df=6) | 0.03 Merits |
| WPD | -0.008 | 0.755 (df=6) | -0.01 Merits |
| PV60[2] | 0.141 | 0.223 (df=6) | 9.4% Viscosity Increase[3] |

[1] At the GF-3 Pass Limit of 275% Viscosity Increase

[2] Not a pass/fail parameter in the Sequence IIIF test; Sequence IIIFHD use only

[3] At the CH-4 Pass Limit of 295% Viscosity Increase @ 60 Hours; Sequence IIIFHD use only.

| Average Δ/s Results, by Laboratory | | | | |
|---|---|---|---|---|
| Laboratory | PVIS | APV | WPD | PV60 |
| A | -1.02 | -0.25 | -0.34 | 0.57 |
| B1 | 1.03 | 0.25 | 0.11 | -1.35 |
| E | - | - | - | - |
| F | - | - | - | - |
| G | 0.13 | 1.76 | 1.75 | 0.52 |
| M | - | - | - | - |

*Percent Viscosity Increase (PVIS)*

With the exception of a single-point action alarm, the industry was within limits for precision during the period (see Figure 1). This alarm appears to have been driven by a severe result in one test stand (-3.65 $Y_i$ result). Industry performance was on the severe side of target for the period, with an average Δ/s value of -0.438 for the period (see Figures 1 & 5), however this appears to be driven largely by the test mentioned above, as the remaining tests are all within ±1.15 $Y_i$ of target. Precision for the period has degraded significantly this period but is still comparable to historical performance (see Figure 9).

*Weighted Piston Deposits (WPD)*

The industry was within limits on both severity and precision for the period (see Figure 2). The industry was essentially on-target for the period, with an average Δ/s value of –0.008, or -0.01 merits (see Figure 6). Precision for the period degraded with a pooled standard deviation of 0.755 (see Figure 10) making it the least precise period in history.

*Average Piston Skirt Varnish (APV)*

The industry was within limits on both severity and precision for the period (see Figure 3). The industry was 0.03 Merits mild for the period with an average Δ/s value of 0.087 (see Figure 7), which reverses the severe trend of the last two periods. Precision has degraded over last period, with a pooled standard deviation of 0.292, which is the largest precision estimate on record for this parameter (see Figure 11).

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

One test failed during the period on SACLW. It was run on reference oil 433-1 and used a "PE" batch code camshaft. Four of the 12 lobes had wear values over 250µm on this test (of the remaining eight lobes, one lobe measured 25µm and the other seven measured zero wear). No cause for this failure has been found at this time.

*Percent Viscosity Increase at 60 Hours*

The industry control chart for PV60 is shown in Figure 4. The average Δ/s and pooled standard deviation for this period, and previous report periods, are shown in Figures 8 and 12 respectively. This parameter is not a pass-fail parameter in the Sequence IIIF test and is used only in Sequence IIIFHD testing. Therefore, the industry control charts are presented for information purposes only and any alarms shown on those charts do not require action by the Sequence IIIF Surveillance Panel. A review of Figure 4 shows that the industry has run within limits after being consistently severe of target on this parameter.

QI Deviations

There were no QI Deviations written this period. There have been a total of 25 QI Deviations written since the test was introduced in June of 2000.

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 | 44 | 11 | 8 | Not currently used in IIIF[1] |
| 1006-2 | 4,886 | 1,221 | 13 | ~3+ years[1] |
| 1007 | 494 | 123 | 11 | Not currently used in IIIF[2] |
| 1008 | 29 | 7 | 8 | No longer shipped[1] |
| 1008-1 | 1,980 | 495 | 6 | ~3+ years[1] |
| 1009 | 891 | 222 | 13 | Not currently used in IIIF[1] |
| 432 | 118 | 29 | 13 | Not currently used in IIIF |
| 433 | 10 | 2 | 2 | No longer shipped |
| 433-1 | 600 | 150 | 12 | ~3+ years |

[1] Multiple test area reference oil; total TMC inventory shown
[2] Not reblendable

Introduction of the GF-3 Category Oil, Reference Oil 1009, has been tabled indefinitely.

During the period the TMC received sufficient data to generate final test targets on Reference Oil 1006-2. The updated targets for reference oil 1006-2, based on these 30 data points, are shown in the following table:

| *Final Reference Oil 1006-2 Test Targets* | | |
|---|---|---|
| *Parameter* | *Mean* | *Standard Deviation* |
| PVIS | 0.0440739 | 0.0102981 |
| WPD | 3.94 | 0.448 |
| APV | 9.35 | 0.223 |
| PV60 | 5.46088 | 0.16663 |

These new targets are effective for all tests completed on or after January 22, 2004.

During the period the TMC received sufficient data to generate final test targets on Reference Oil 433-1. The updated targets for reference oil 433-1, based on these 31 data points, are shown in the following table:

| *Final Reference Oil 433-1 Test Targets* | | |
|---|---|---|
| *Parameter* | *Mean* | *Standard Deviation* |
| PVIS | 0.1635099 | 0.0302263 |
| APV | 9.30 | 0.300 |
| WPD | 4.59 | 0.697 |
| PV60 | 3.55500 | 0.229905 |

These new targets are effective for all tests completed on or after February 24, 2004.

MTK/mtk

Attachments

c: F. M. Farber, TMC
Sequence IIIF Surveillance Panel
ftp://ftp.astmtmc.cmu.edu/docs/gas/sequenceiii/semiannualreports/IIIF-04-2004.pdf

Distribution: Electronic Mail

List of Figures

- Figures 1, 2, 3, and 4 are EWMA severity and precision control charts and also the CUSUM Δ/s plots of PVIS, WPD, APV, and PV60, annotated with date lines, using the same data set as the EWMA severity and precision control charts. Transformed units are used, when appropriate.

- Figures 5, 6, 7, and 8 are bar charts of average Δ/s, by report period, for PVIS, WPD, APV, and PV60.

- Figures 9, 10, 11, and 12 are bar charts of pooled standard deviation, by report period, for PVIS, WPD, APV, and PV60.

- Figure 13 is the Sequence IIIF Timeline.

Figure 1

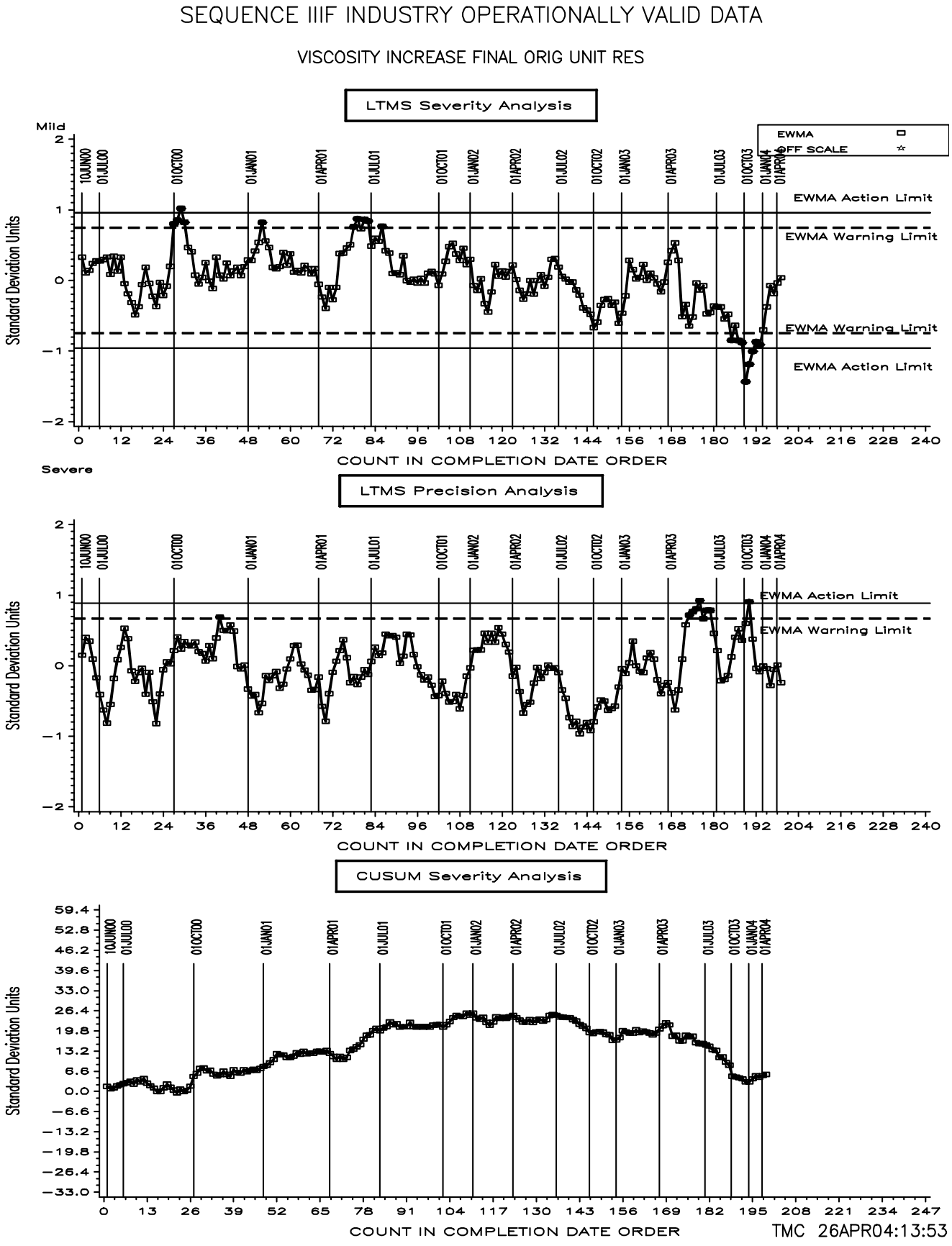

SEQUENCE IIIF INDUSTRY OPERATIONALLY VALID DATA
VISCOSITY INCREASE FINAL ORIG UNIT RES
LTMS Severity Analysis
Mild
Severe
EWMA
OFF SCALE
EWMA Action Limit
EWMA Warning Limit
EWMA Warning Limit
EWMA Action Limit
Standard Deviation Units
COUNT IN COMPLETION DATE ORDER
LTMS Precision Analysis
EWMA Action Limit
EWMA Warning Limit
Standard Deviation Units
COUNT IN COMPLETION DATE ORDER
CUSUM Severity Analysis
Standard Deviation Units
COUNT IN COMPLETION DATE ORDER
TMC 26APR04:13:53

Figure 2

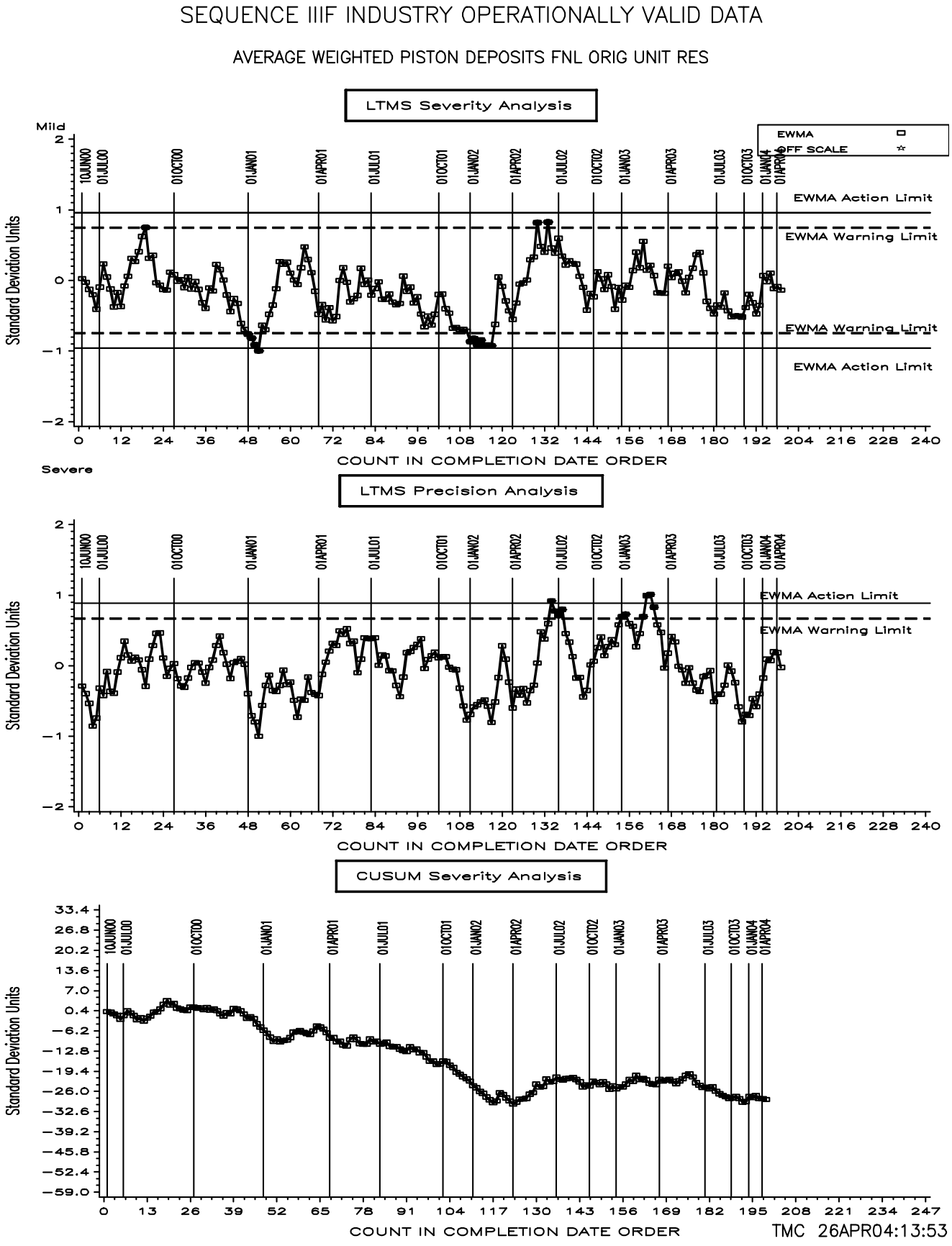

SEQUENCE IIIF INDUSTRY OPERATIONALLY VALID DATA
AVERAGE WEIGHTED PISTON DEPOSITS FNL ORIG UNIT RES
LTMS Severity Analysis
Mild
Severe
EWMA
OFF SCALE
EWMA Action Limit
EWMA Warning Limit
EWMA Warning Limit
EWMA Action Limit
Standard Deviation Units
COUNT IN COMPLETION DATE ORDER
LTMS Precision Analysis
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 26APR04:13:53

Figure 3

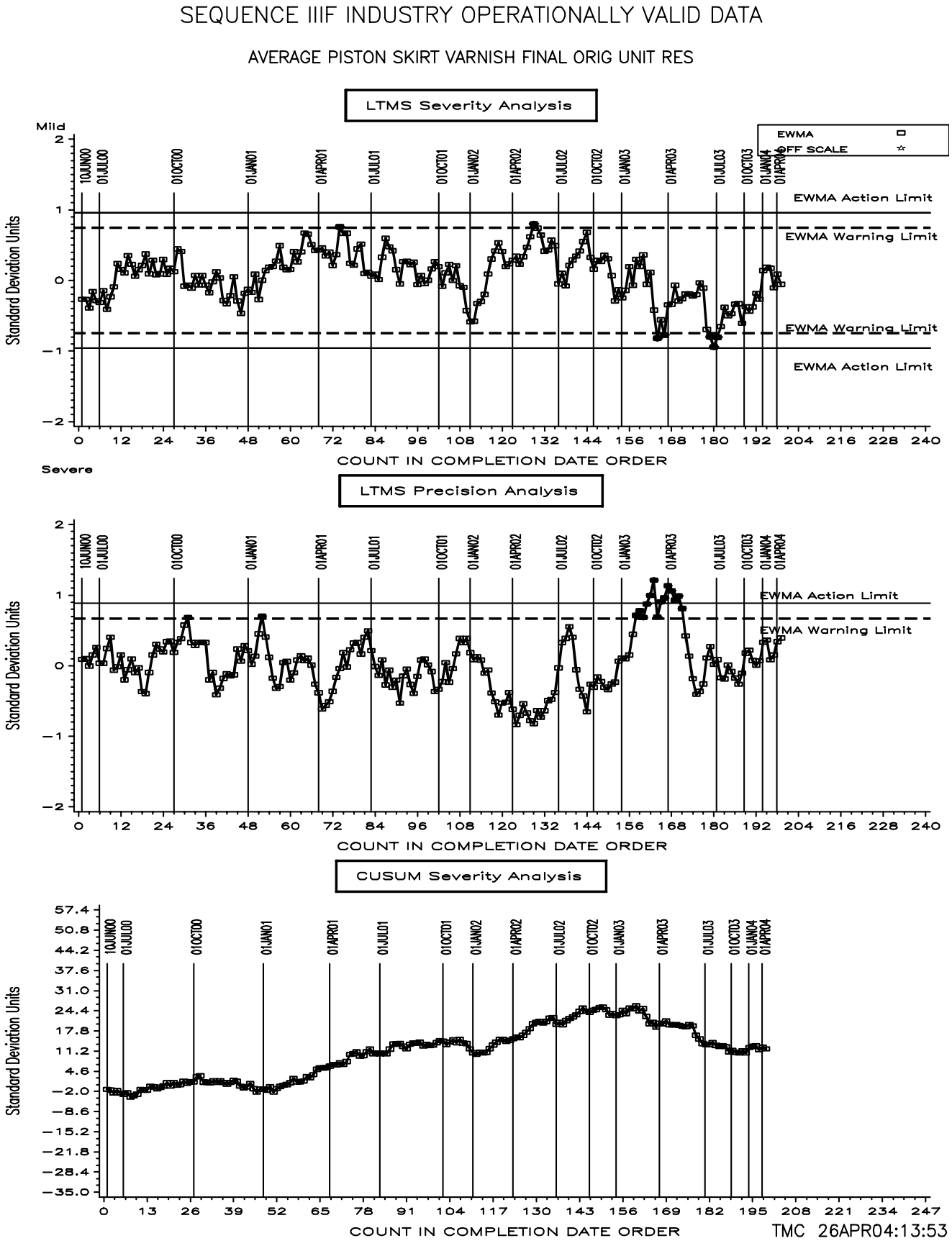

SEQUENCE IIIF INDUSTRY OPERATIONALLY VALID DATA
AVERAGE PISTON SKIRT VARNISH FINAL ORIG UNIT RES
LTMS Severity Analysis
Mild
Severe
EWMA
OFF SCALE
EWMA Action Limit
EWMA Warning Limit
EWMA Warning Limit
EWMA Action Limit
Standard Deviation Units
COUNT IN COMPLETION DATE ORDER
LTMS Precision Analysis
CUSUM Severity Analysis
TMC 26APR04:13:53

Figure 4

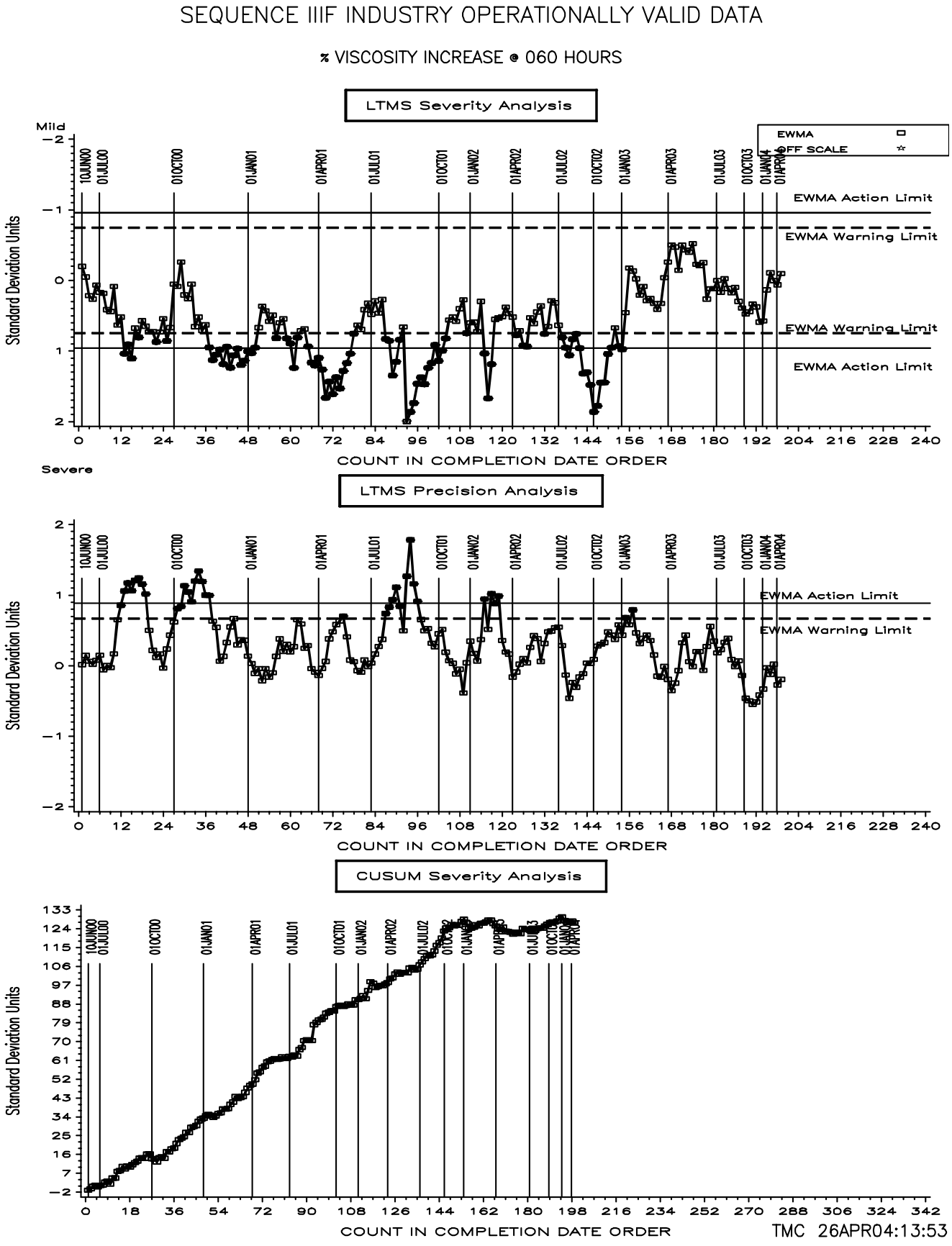

SEQUENCE IIIF INDUSTRY OPERATIONALLY VALID DATA
% VISCOSITY INCREASE @ 060 HOURS
LTMS Severity Analysis
Mild
Severe
EWMA
OFF SCALE
EWMA Action Limit
EWMA Warning Limit
EWMA Warning Limit
EWMA Action Limit
Standard Deviation Units
COUNT IN COMPLETION DATE ORDER
LTMS Precision Analysis
EWMA Action Limit
EWMA Warning Limit
Standard Deviation Units
COUNT IN COMPLETION DATE ORDER
CUSUM Severity Analysis
Standard Deviation Units
COUNT IN COMPLETION DATE ORDER
TMC 26APR04:13:53

**Figure 5 - Percent Viscosity Increase, Average Delta/s**

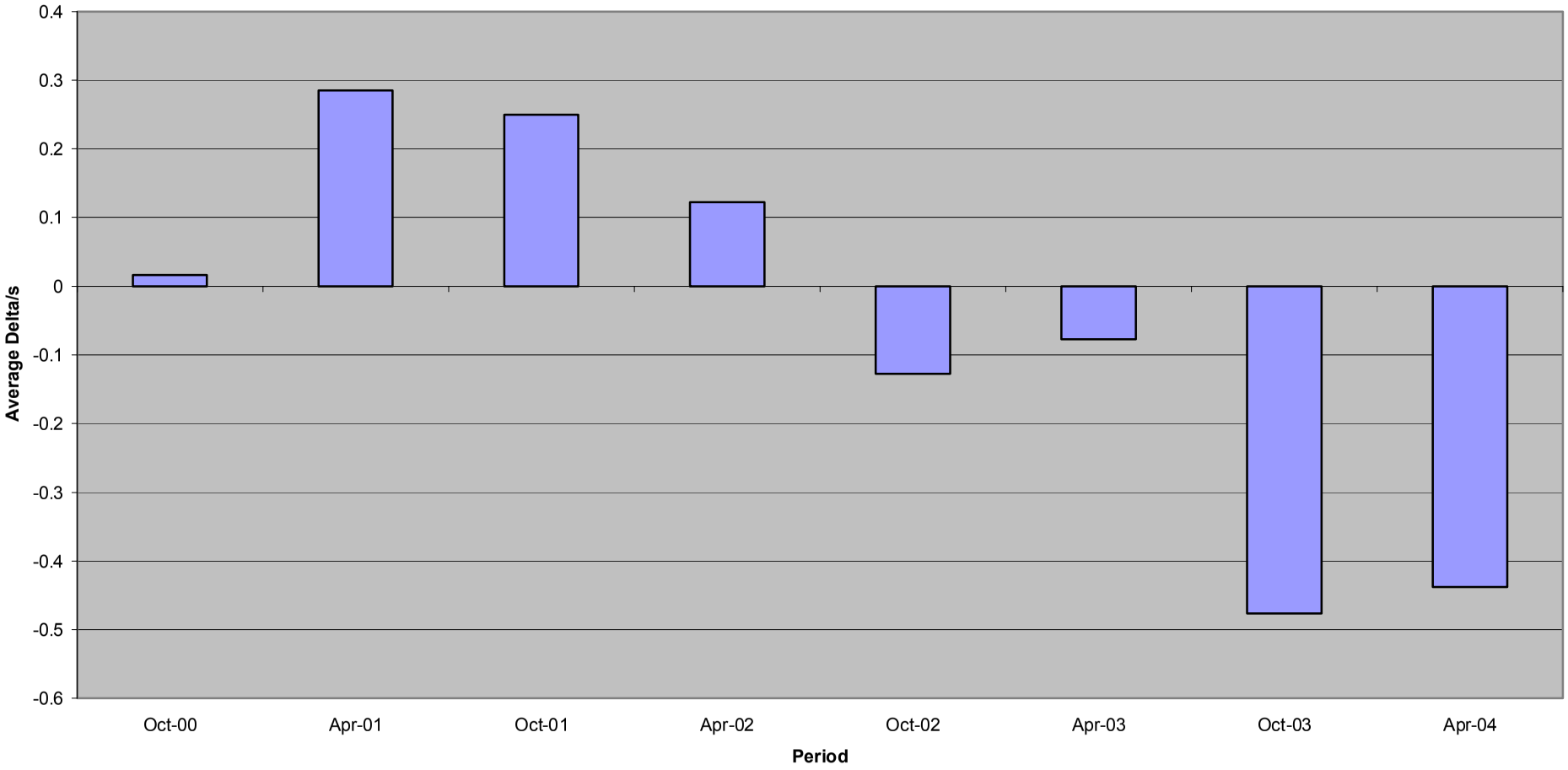


**Figure 6 - Weighted Piston Deposits, Average Delta/s**

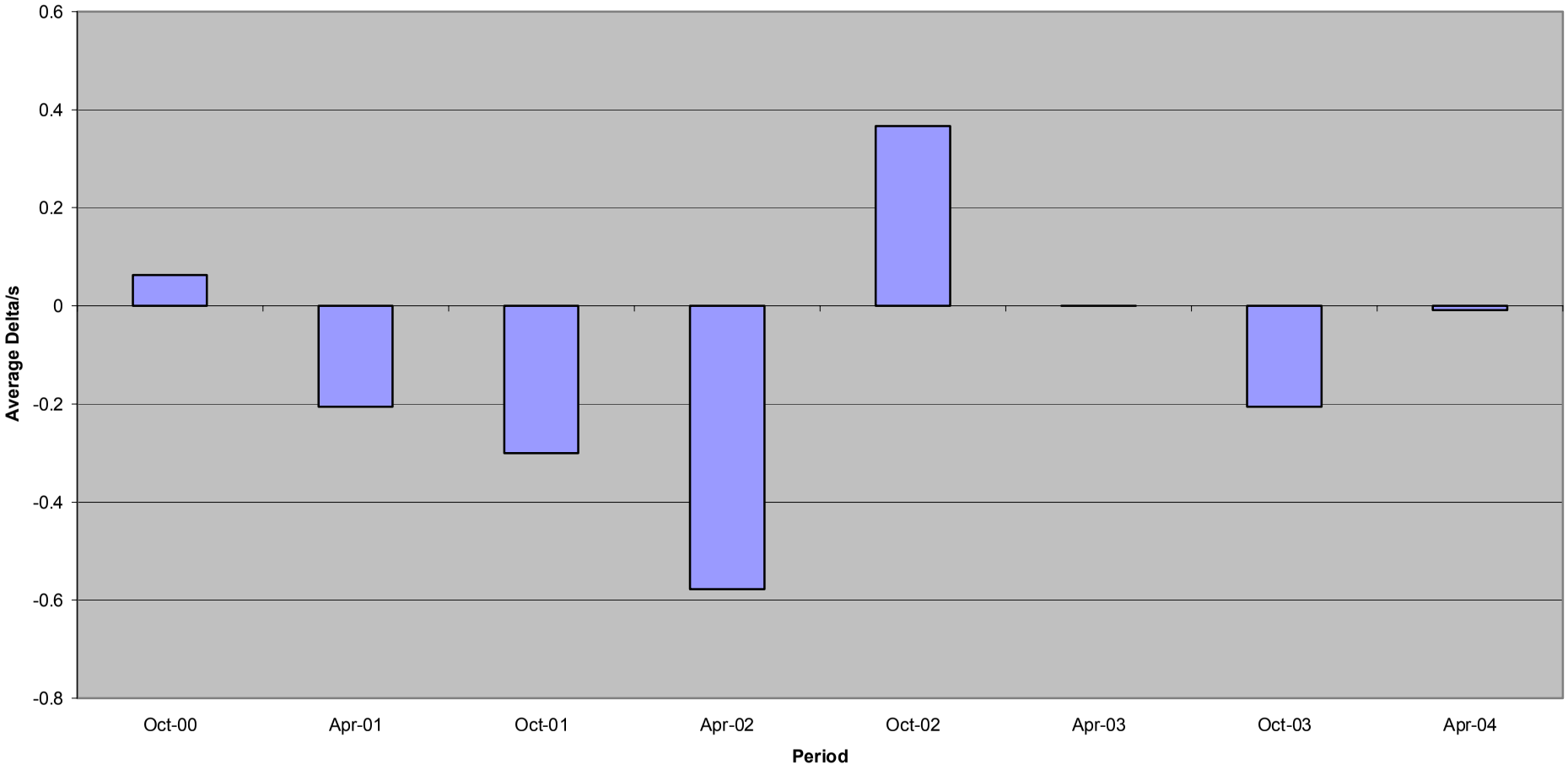


**Figure 7 - Average Piston Varnish, Average Delta/s**

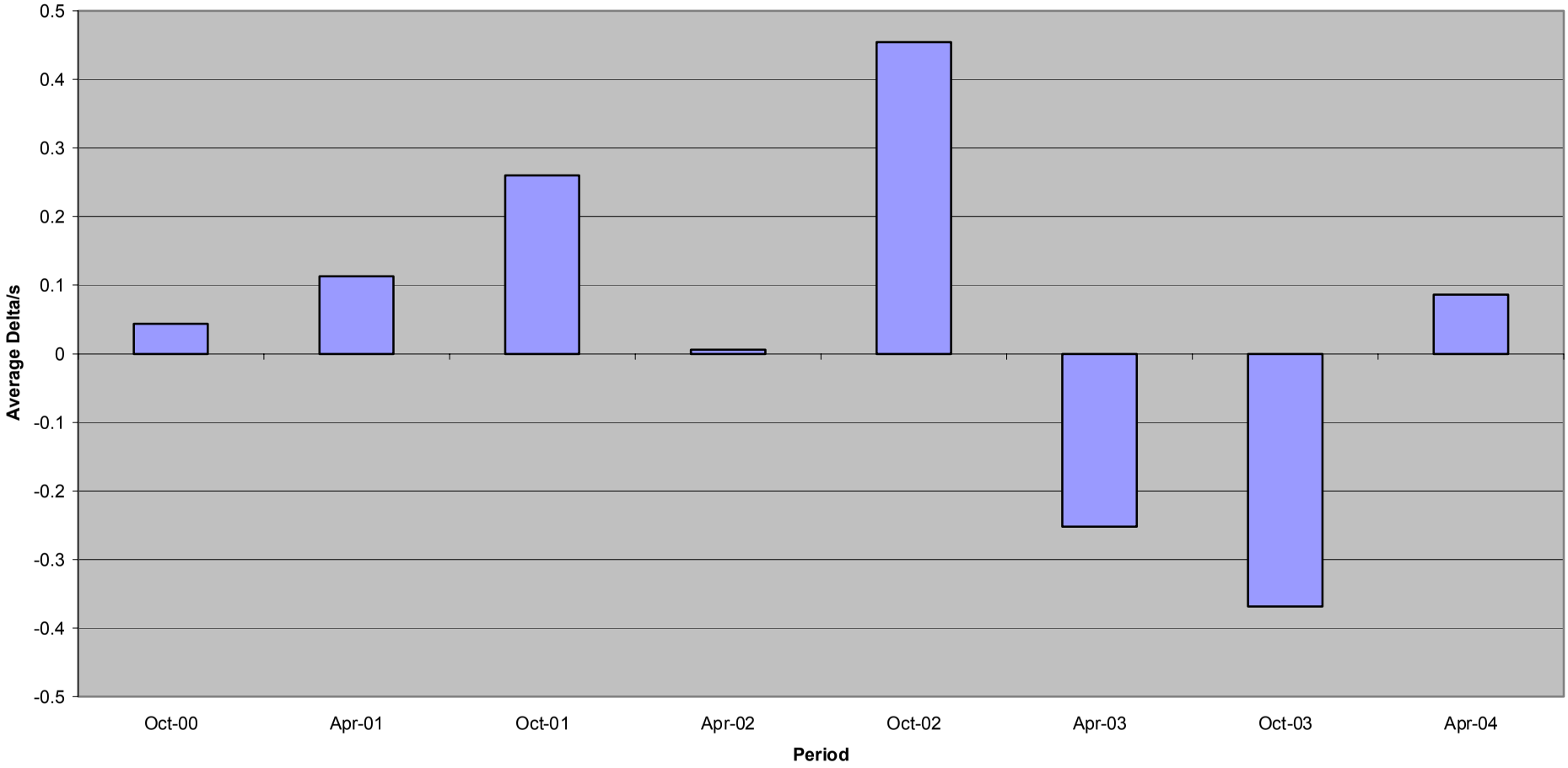


**Figure 8 - Percent Viscosity Increase @ 60 Hours (Sequence IIIFHD), Average Delta/s**

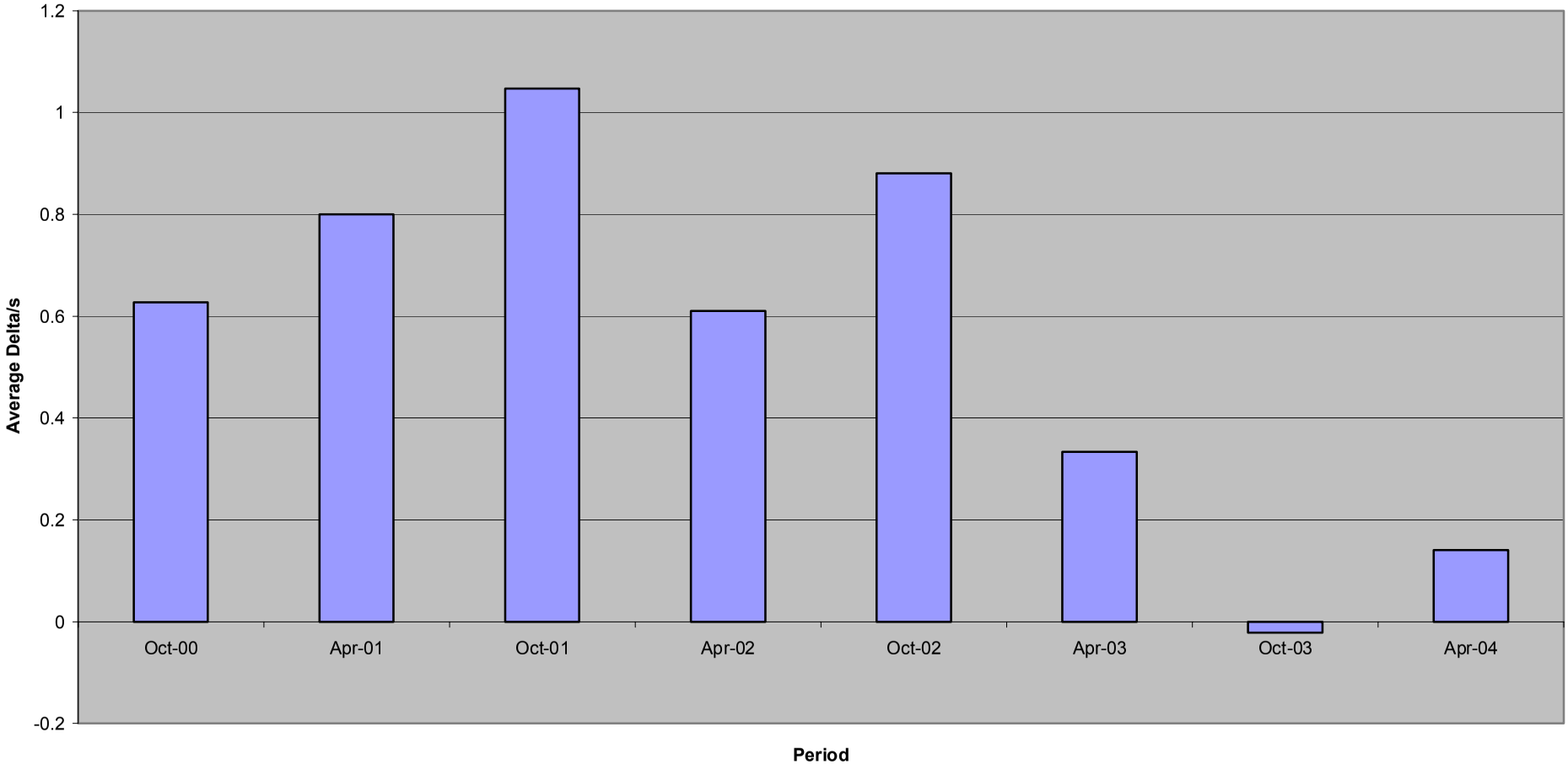


**Figure 9 - Percent Viscosity Increase, Pooled Standard Deviation**

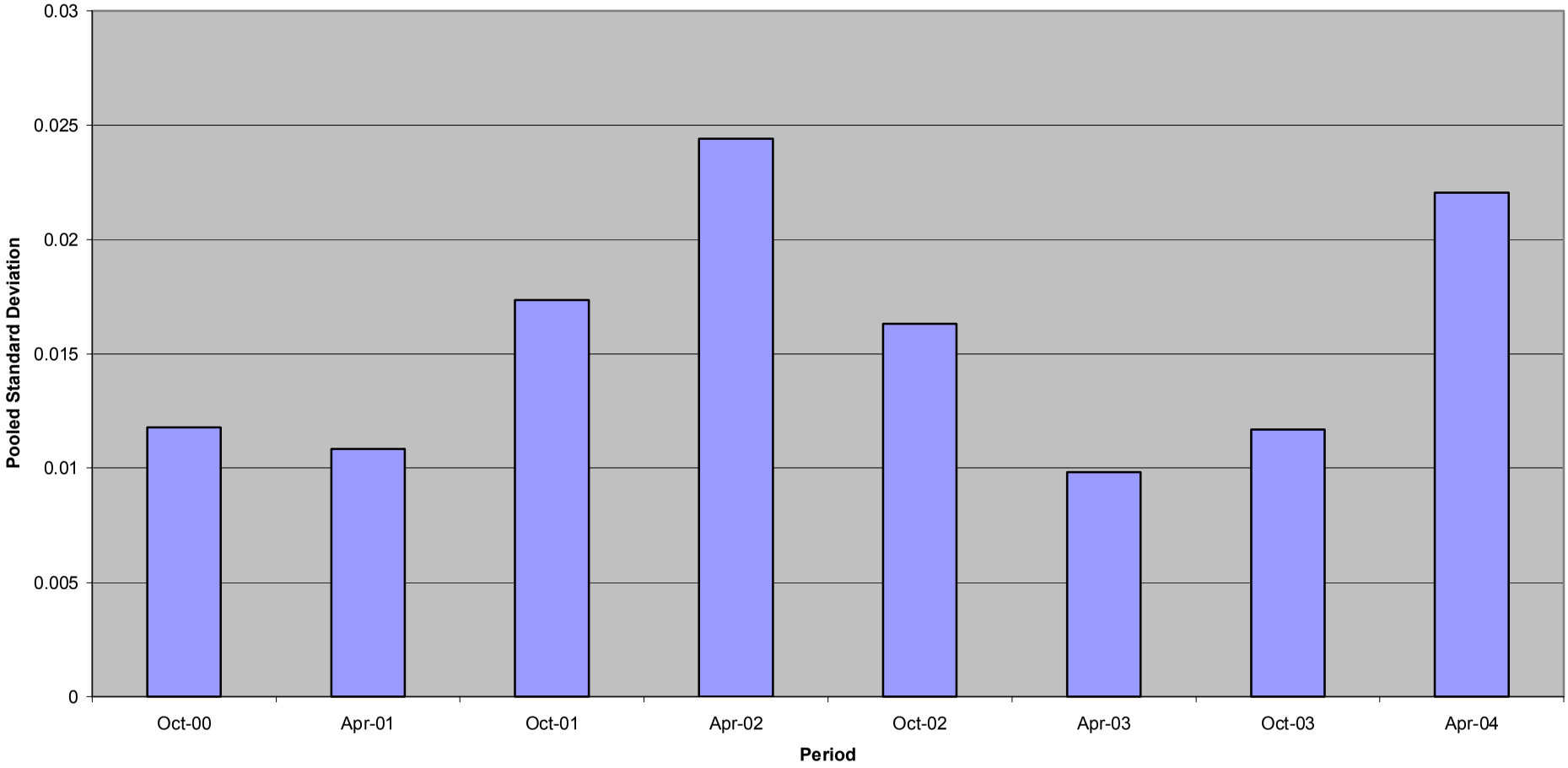


**Figure 10 - Weighted Piston Deposits, Pooled Standard Deviation**

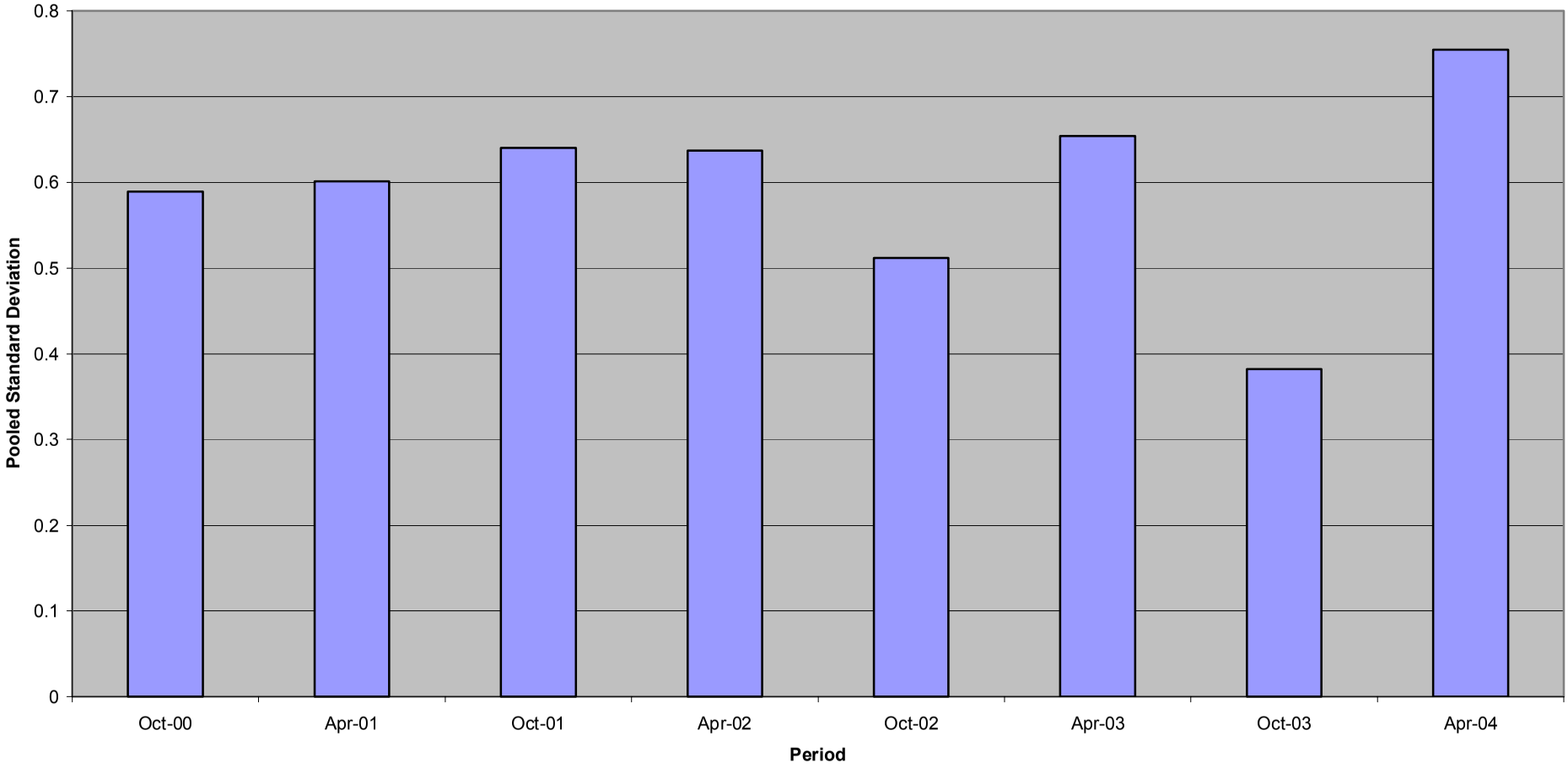


**Figure 11 - Average Piston Skirt Varnish, Pooled Standard Deviation**

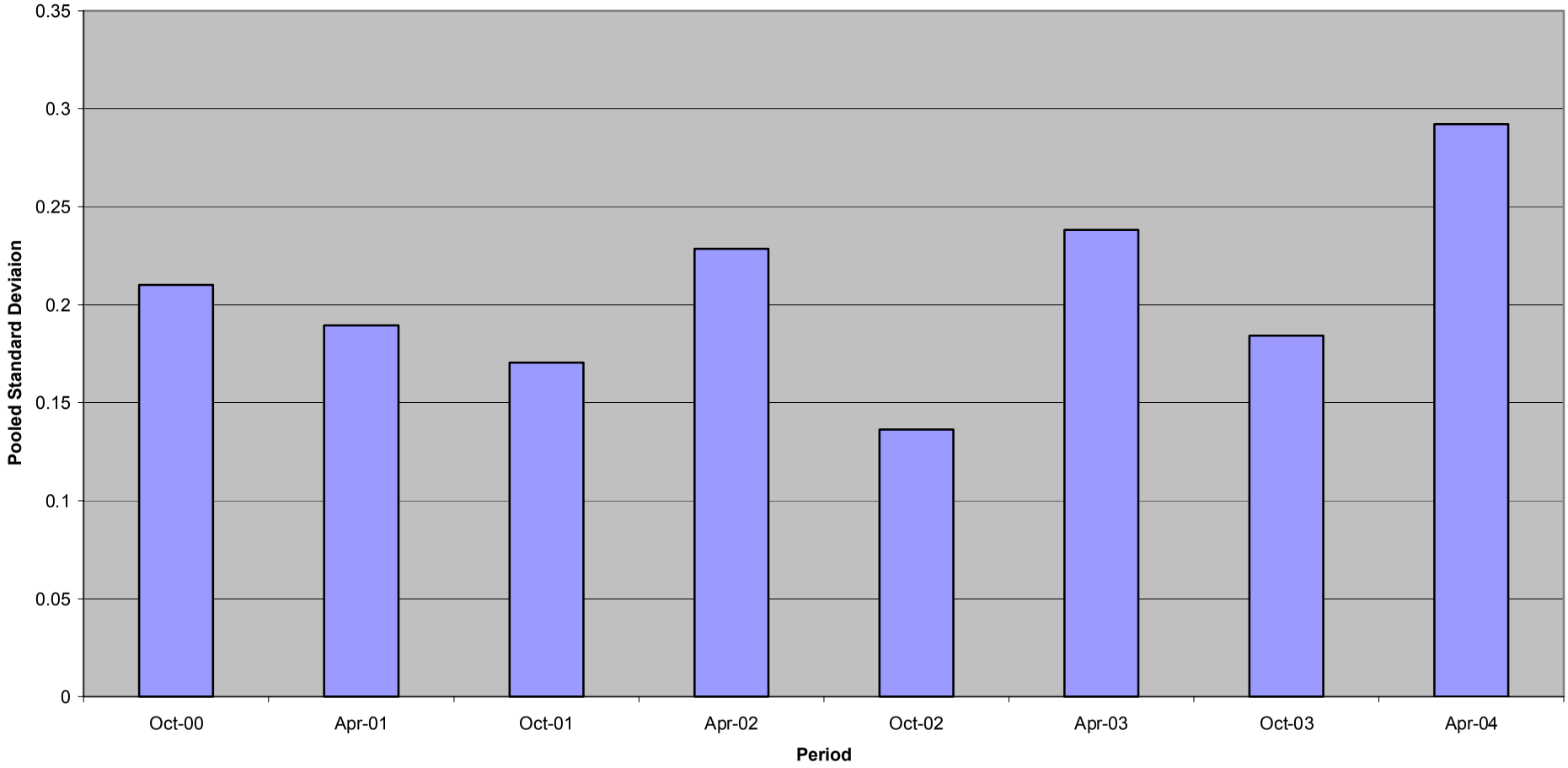


**Figure 12 - Percent Viscosity Increase @ 60 Hours (Sequence IIIFHD), Pooled Standard Deviation**

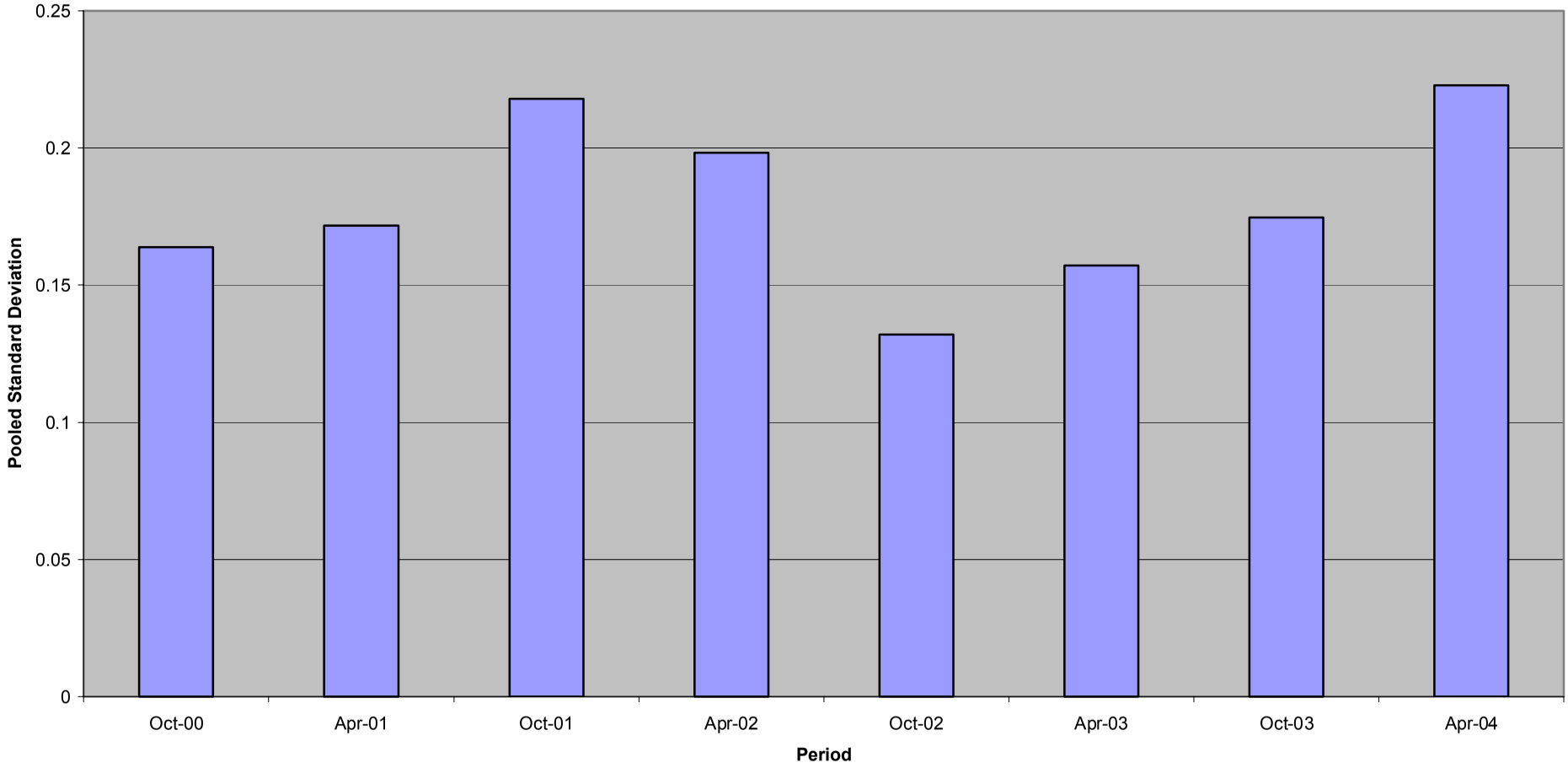


Figure 13 – Sequence IIIF Timeline

| Date | Topic | Information Letter |
|---|---|---|
| 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 | |
| 11/28/2001 | Sequence IIIF-HD Test Procedure Published | 01-3 |
| 3/1/2002 | Revised Sequence IIIF Test Procedure Published | 02-1 |
| 3/15/2002 | Sequence IIIFHD Test Procedure added to Revised Sequence IIIF Test Procedure. Editorial changes to IIIF Test Procedure also made and do | 02-2 |
| 4/23/2002 | Oil Filter and Oil Cooler Replacement Guidelines issued | 02-3 |
| 6/1/2002 | External Oil Bypass Valve System & Modified Oil Filter Adapter | 02-4 |
| 12/15/2003 | New Honing Procedure approved and added to Assembly Manual | |
| 5/30/2003 | New Oil Filter | 03-1 |
| 6/30/2003 | New Front Cover and Oil Filter Housing | 03-1 |
| 6/30/2003 | Sequence IIIG Dipstick | 03-1 |
| 6/30/2003 | Calibrated Flask for Initial Oil Charge | 03-1 |
| 12/31/2003 | New Solvent Specifications | 03-1 |
| 10/29/2003 | Revised Fuel Pressure Specification | 03-3 |
| 10/29/2003 | Automatic Parts Washing Machine Maintenance Requirement | 03-3 |
| 10/29/2003 | Main Bearing Bore Mandrel Procedure made optional | 03-3 |
| 10/29/2003 | Piston Ring Cleaning Requirements | 03-3 |
| 10/29/2003 | Additional Allowable RTV Sealing Compounds | 03-3 |
| 10/29/2003 | Main Bearing Cap Bolt Replacement Specification | 03-3 |
| 10/29/2003 | Revised Camshaft Measurement Procedure | 03-3 |
| 10/29/2003 | Revised Camshaft Lubrication & Installation Procedure | 03-3 |
| 10/29/2003 | Revised Oil Consumption Reporting Procedure | 03-3 |
| 10/29/2003 | Fluid Conditioning Module Equipment Specifications | 03-3 |
| 10/29/2003 | Revised Camshaft Measurement Equipment Specifications | 03-3 |
| 10/29/2003 | Rating Workshop Attendance Requirement | 03-3 |
| 4/13/2004 | Revised Intake Manifold Gasket | 04-1 |
| 4/13/2004 | Additional Allowable Sealing Materials | 04-1 |