



# Test Monitoring Center

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MEMORANDUM: 04-012  
DATE: April 1, 2004  
TO: Gordon Farnsworth, Chairman, Sequence VG Surveillance Panel  
FROM: Richard E. Grundza  
SUBJECT: Sequence VG Reference Test Status from October 1, 2003 through March 31, 2004

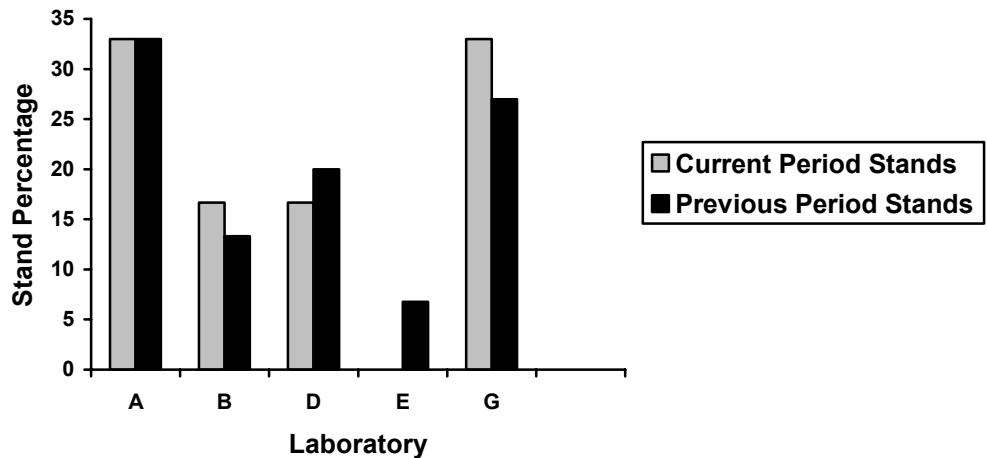
The following is a summary of Sequence VG reference tests that were completed during the period October 1, 2003 through March 31, 2004.

## Lab/Stand Distribution

	Reporting Data	Calibrated as of 3/31/04
Number of Laboratories	4	4
Number of Stands	12	10

The following chart shows the laboratory/stand distribution:

### Laboratory/Stand Distribution

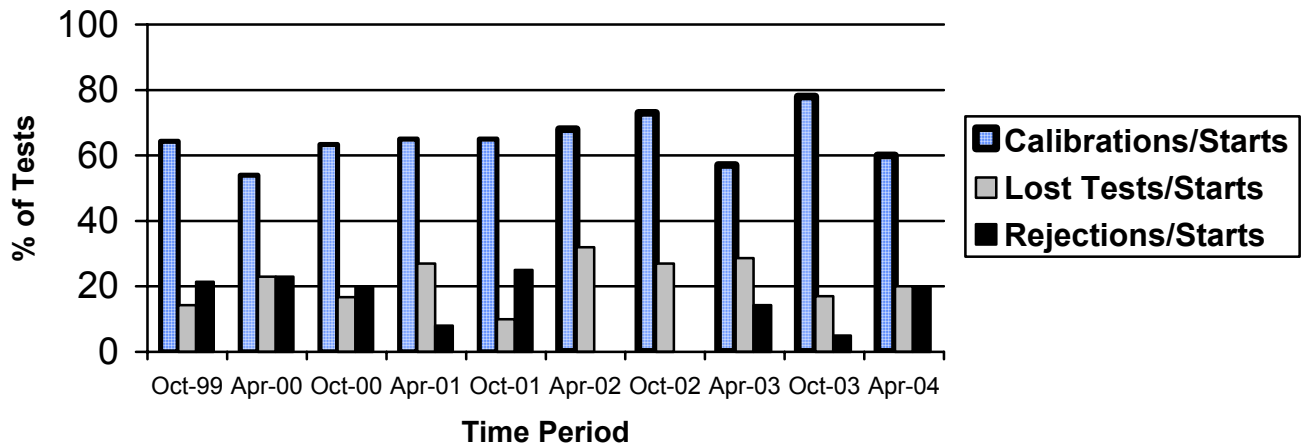


The following summarizes the status of the reference oil tests reported to the TMC:

	TMC Validity Codes	No. of Tests
Operationally and Statistically Acceptable	AC	12
Failed Acceptance Criteria	OC	4
Operationally Invalid, Lab Judgment	LC	3
Aborted	XC	1
<b>Total</b>		<b>20</b>

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

### Calibration Attempt Summary

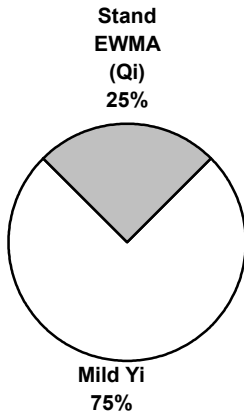


The calibration per start rate has decreased with respect to the previous period and compares well with the historical rate. The lost test per start and rejected test per start rates have increased with respect to the previous period. Both rates compare well with historical rates.

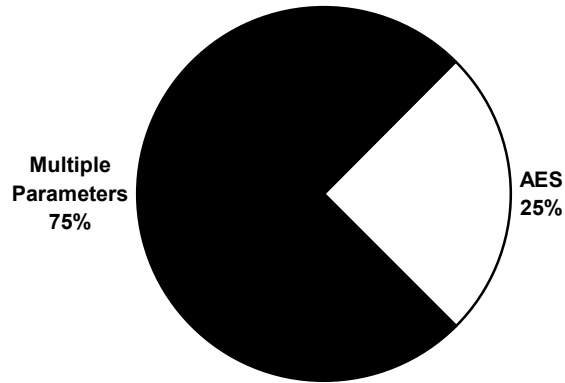
The following table lists the reasons for statistically invalid tests this period.

Reason for Statistical Failure	Number of Tests
Mild AES, Severe AEV	1
Mild AES	1
Mild AES, RAC, OSCR and APV	1
Stand Precision EWMA alarm, AES	1

**Distribution of LTMS Stand Alarms**



**Distribution of Stand Alarms by Parameter**



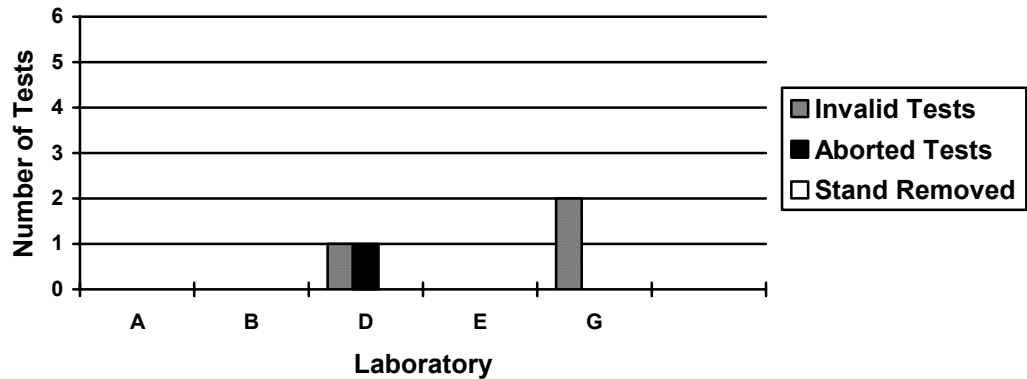
There was one LTMS deviation written during this report period. A total of six LTMS deviations have been written to date.

The following table lists the reasons for operationally invalid tests this period.

Reason	Number of Tests
Oil Contamination due to improper oil heat exchanger cleaning	1
Control problems, new stand	1
Piston staining, flawed surface	1
Intake air temperature calibration shift, low fuel dilution	1

Aborted and operationally invalid tests by laboratory are summarized with the following chart:

**Lost Test Distribution**



Severity and Precision

Based on the mean delta/s values and pooled standard deviation for the current period, 95% confidence intervals representing severity for the current period are given below in reported units.

<u>Variable</u>	<u>Pooled s All Oils</u>	<u>Mean Delta/s</u>	<u>Confidence Interval</u>	<u>Based on</u>	<u>Delta in Reported Units</u>
RAC	0.200	0.401	7.97 - 8.19	8.0	0.08
AES	0.394	0.683	7.86 - 8.28	7.8	0.27
APV	0.182	0.163	7.43 - 7.63	7.5	0.03
AEV	0.110	-0.161	8.82 - 8.94	8.9	-0.02
OSCR	0.587	-0.410	11.1 - 21.6	20	-4.5

The mean  $\Delta/s$  for this period shows AEV (-0.161) was severe, while RAC (0.401), AES (0.683), APV (0.163) and OSCR (-0.410) were mild. Figures 1 through 5 are current industry severity and precision EWMA control charts and plots of summations  $\Delta/s$  for AES, RAC, AEV, APV, and OSCR.

Industry control charts for AES show that AES severity began the period in control for the first three tests before sounding a series of three warning alarms. The charts cleared for a test before sounding another two warning alarms and then clearing for three tests. A third alarm event of two warning alarms sounded before the charts came back into control for the remaining two tests in the period. The alarms were caused by three tests from two labs on different oils. These tests were 2.194, 2.087 and 2.339  $\Delta/s$  from target, respectively. AES precision was in control for the period. The industry summation  $\Delta/s$  plot for AES shows severity trended mild for the period.

RAC severity and precision charts were in control for the period. The industry summation  $\Delta/s$  plot for RAC shows severity trended mild for the period.

Industry control charts for AEV severity and precision were in control the entire period. The summation  $\Delta/s$  plot for AEV reflect a slight severe trend during the period.

Industry control charts for APV severity were in control the entire period. APV precision began the period in warning alarm, but returned in control for the remainder of the period. The summation  $\Delta/s$  plot for APV shows a slight mild trend for the period.

OSCR severity and precision were in control the entire period. The summation  $\Delta/s$  plot for OSCR shows OSCR trending mild for the period.

Figures 6 and 7 chart the pooled precision estimates for all monitored parameters, by ASTM report period. Figure 6 shows AES and RAC have shown little change with respect to the previous period while OSCR precision has improved with respect to the previous period. Precision AES and RAC parameters compares well with historical rates. OSCR precision is the best since the inception of the test. Figure 7 shows precision for APV has improved slightly with respect to the previous period, whereas AEV precision has degraded slightly with respect to the previous period. Both parameters precision compares well with historical estimates.

The following table compares the standard deviation used in the LTMS for severity adjustment calculation, which is a pooled estimate of precision based on oils 925-3, 1006, and 1007, with the current pooled precision of the oils 1006, 1007, 1009 and 925-3.

Parameter	Severity Adjustment Standard Deviation (n = 30)	Pooled Standard Deviation, Oils 925-3, 1006, 1007 and 1009 (n = 16)
AES	0.51	0.39
RAC	0.24	0.20
AEV	0.10	0.11
APV	0.18	0.18
OSCR	0.828	0.587

#### Fuels and Reference Oils

Reference oil quantities available at the laboratories and TMC as well as estimated life of these oils, are tabulated below.

Oil	TMC Inventory, in gallons	TMC Inventory, in tests	Laboratory Inventory, in tests	Estimated life
925-3	150	50	8	3+ years
1006	0	0	3	< 1 year
1006-2	4967	1655	7	3+ years
1007	483	151	5	3+ years
1009	958	319	6	3+ years

Note: Oils 1006, 1006-2, 1007 and 1009 are used across multiple test areas, TMC inventory represents total amount of that oil on hand.

#### Information Letters

Information Letter 04-1 was issued March 10, 2004. This information letter increased the length of time a non reference oil test may be started from within 171 days of the reference oil completion date to 180 days. This information letter also made editorial changes to the precision statement and added a footnote to Table 8 to show that OSCR results are transformed.

Information Memos

The following memos were issued by the TMC during this period.

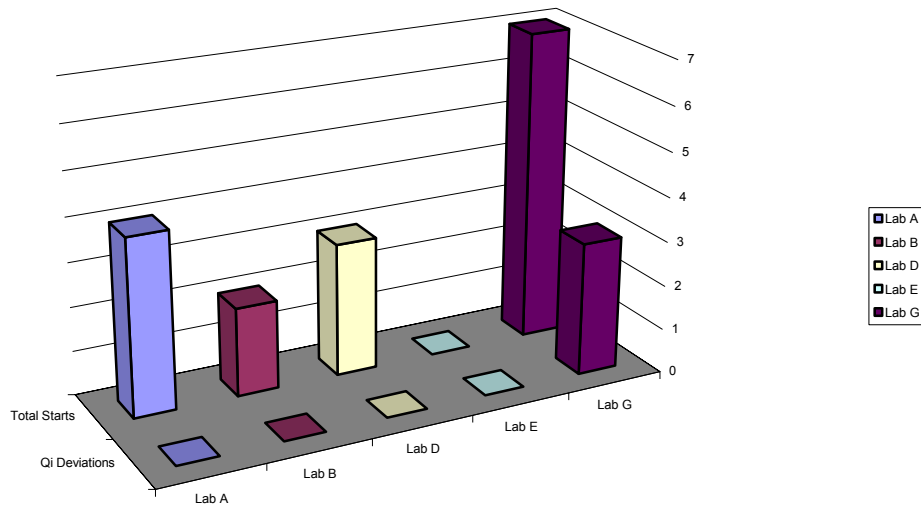
<u>Memo</u>	<u>Date</u>	<u>Subject</u>
03-089	09/30/03	Sequence VG Semi-Annual Report
04-001	05/15/03	Target Update, Reference Oil 1009 (n = 20)
04-008	02/17/04	Target Update, Reference Oil 1009 (n = 20)

Laboratory Visits

During this report period, the TMC visited three labs. Any discrepancies noted during these visits were identified to the laboratory and corrective action was being taken.

QI Deviations

The following charts the number of QI deviations reviewed by the Test Monitoring Center for this report period, by laboratory.



The following tabulates the parameter(s) where QI deviations were written.

Reason	Number of Tests
Manifold Absolute Pressure and Exhaust Backpressure QI	1
Coolant Pressure	1
Manifold Absolute Pressure	1

Three QI deviations were written this period. In one case, the coolant pressure deviation was caused by an operator trying to add coolant while the test was running. A second deviation was written for manifold absolute backpressure QI which was caused by problems with the transducer and throttle controller. The third deviation was written for both exhaust back pressure and manifold absolute pressure. The exhaust backpressure was the result of an exhaust leak, while the manifold absolute pressure was caused by a problem with the throttle controller.

### Summary

The calibrations per start rate has decreased with respect to the previous period and compares well with historical rates. The lost test per start and rejected tests per start rates have increased with respect to the previous period and compare well with historical rates. AEV was severe, while AES, RAC, APV and OSCR trended mild for the period. Precision AES, AEV and RAC is essentially unchanged when compared to the previous period, while OSCR and APV precision have improved. Precision for all parameters compares well with historical estimates.

REG/reg

Attachments

c: Sequence VG Surveillance Panel

J. L. Zalar

F. M. Farber

<ftp://ftp.astmtmc.cmu.edu/docs/gas/sequencev/semiannualreports/vg-04-2004.pdf>

Distribution: Email

Listing of Tables and Figures Included as Part of This Report to the Sequence VG Surveillance Panel

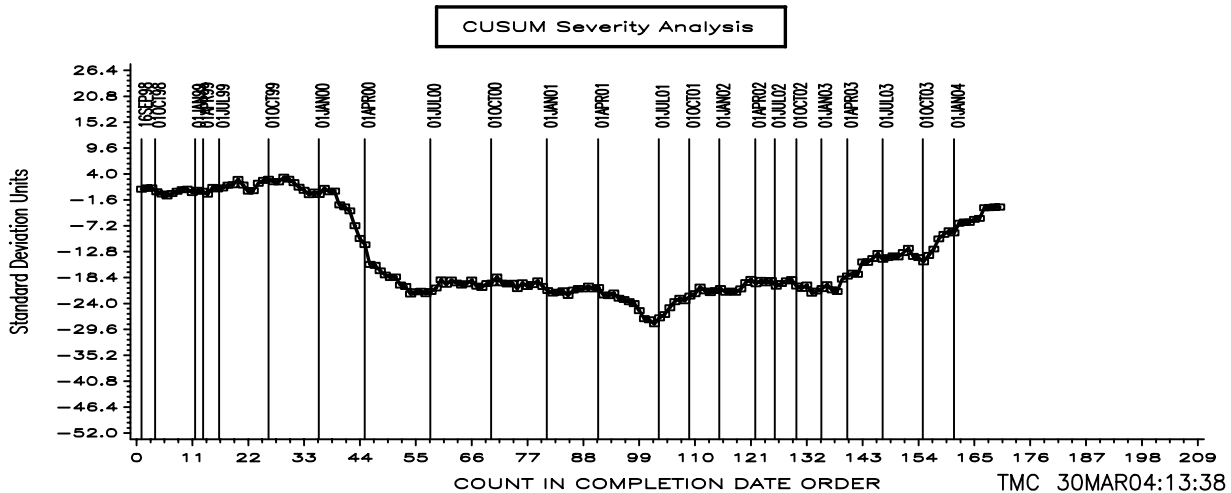
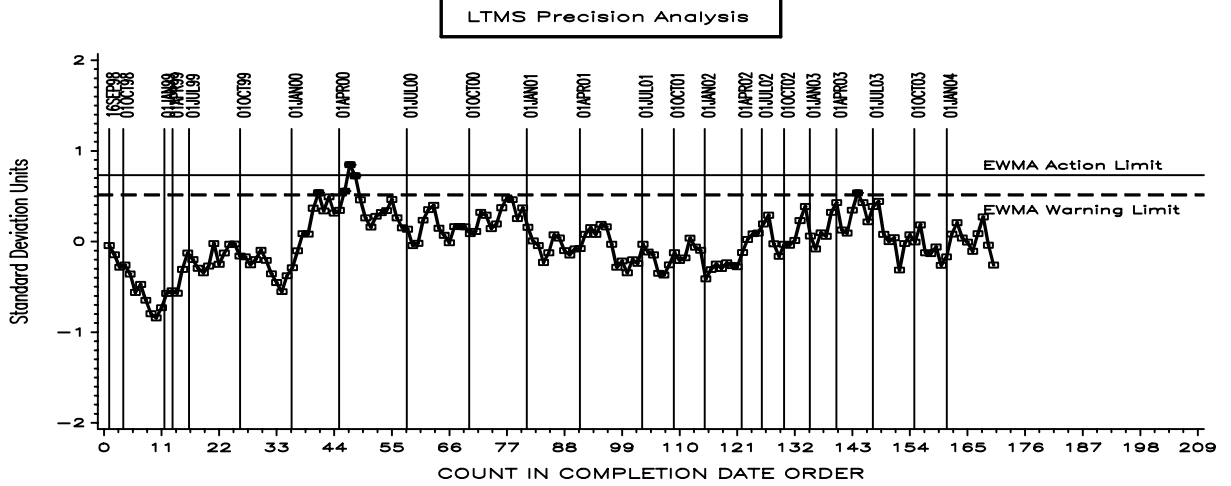
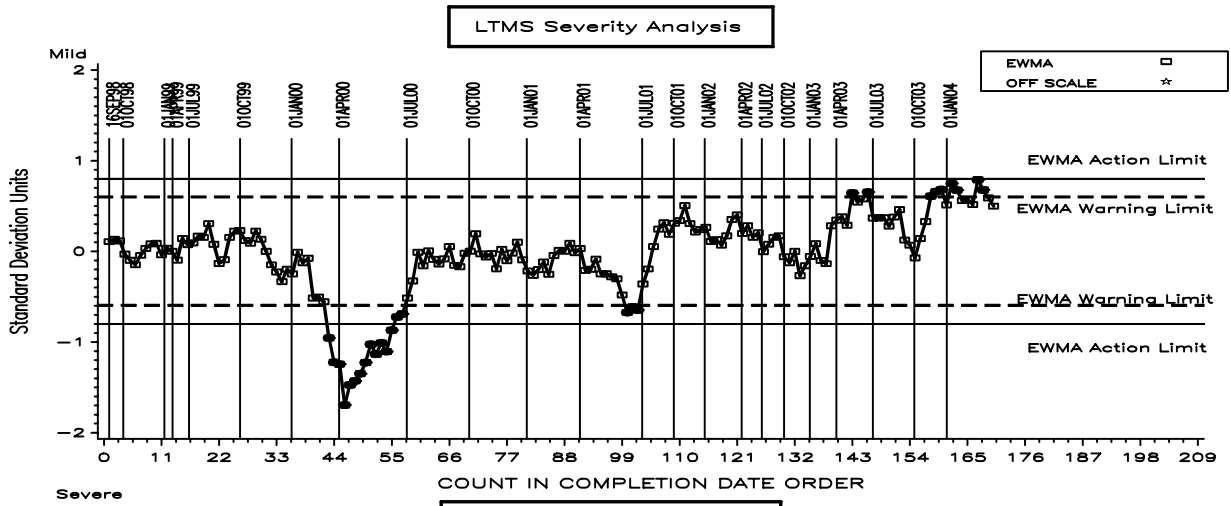
Figures 1 through 5 are the Industry control charts for AES, RAC, AEV, APV and OSCR.

Figures 6 and 7 compare pooled precision estimates from this report period with previous periods.

Figure 8 is the Industry Timeline.



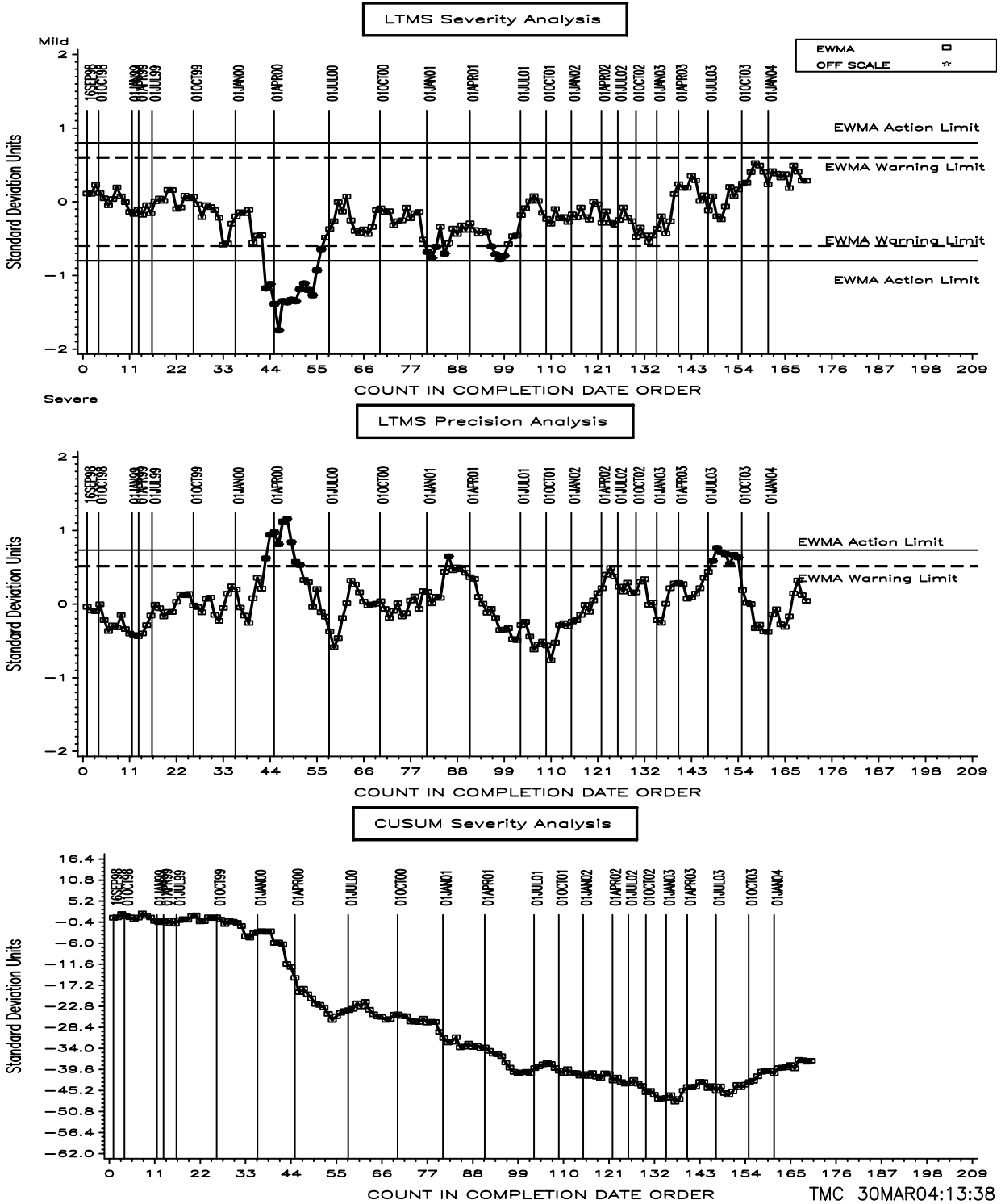
AVERAGE ENGINE SLUDGE



# SEQUENCE VG INDUSTRY OPERATIONALLY VALID DATA

Figure 2

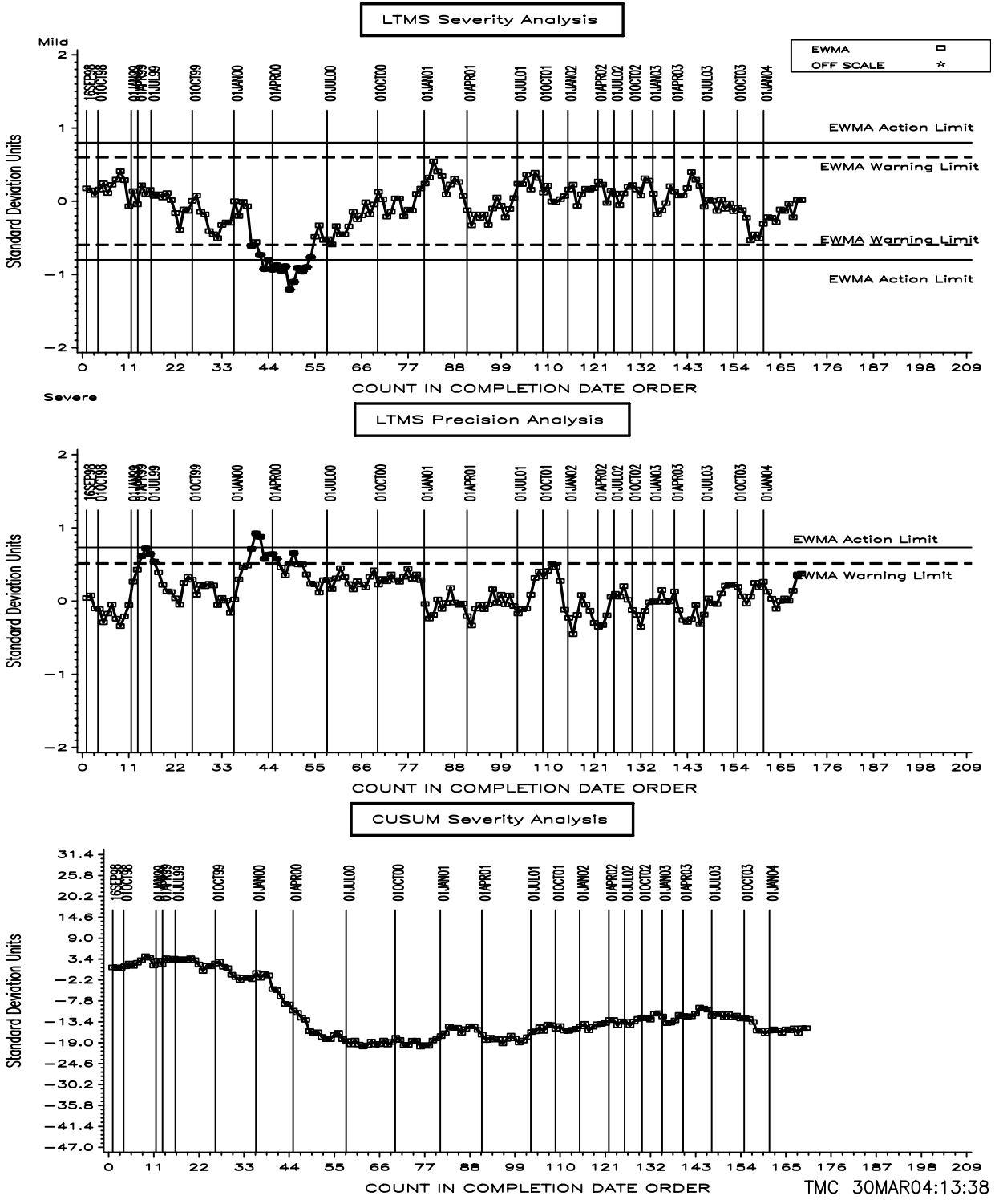
## AVERAGE ROCKER COVER SLUDGE



# SEQUENCE VG INDUSTRY OPERATIONALLY VALID DATA

Figure 3

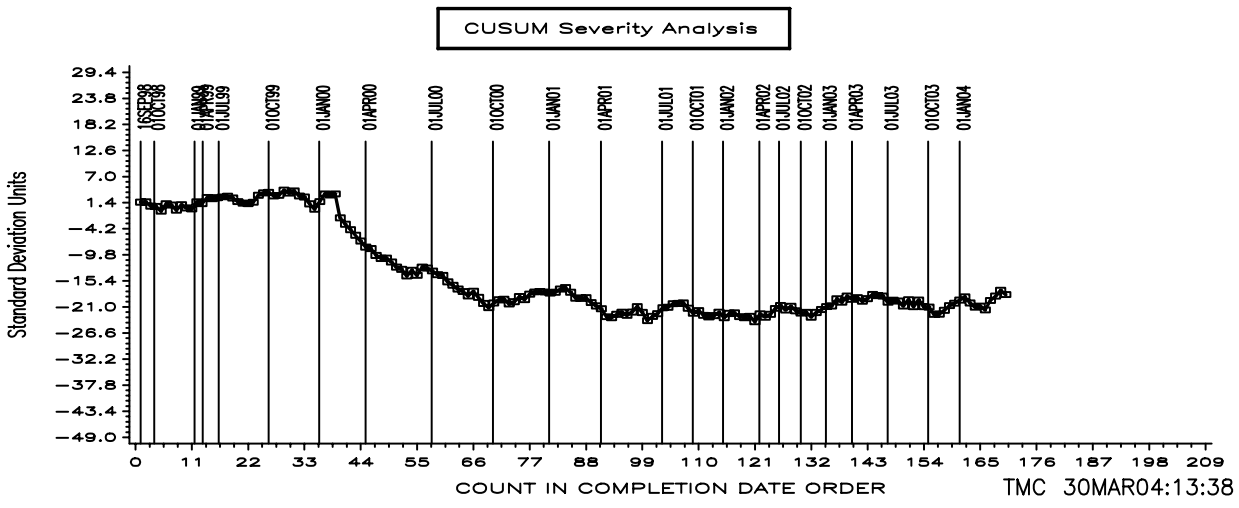
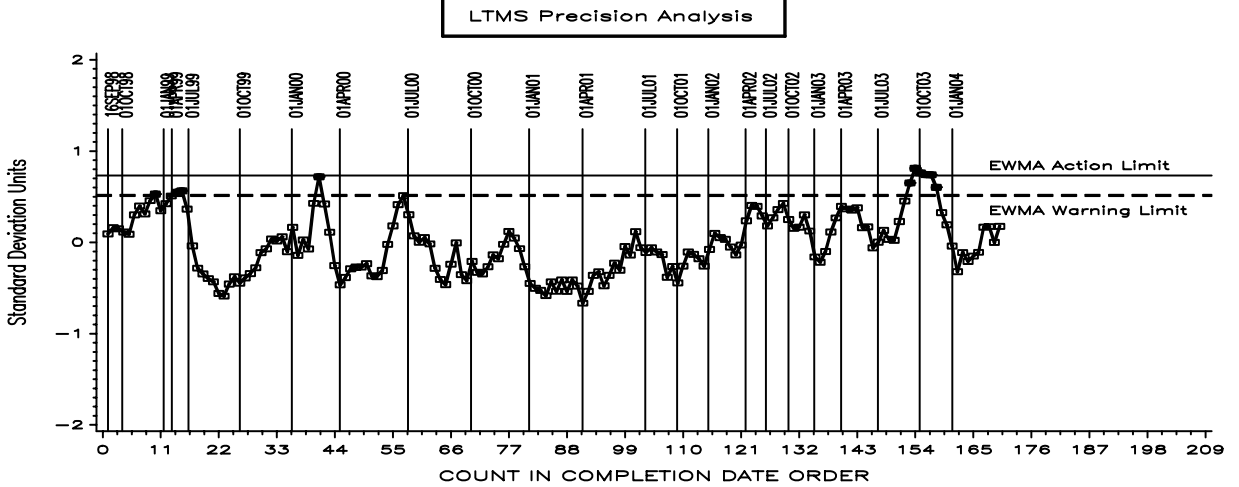
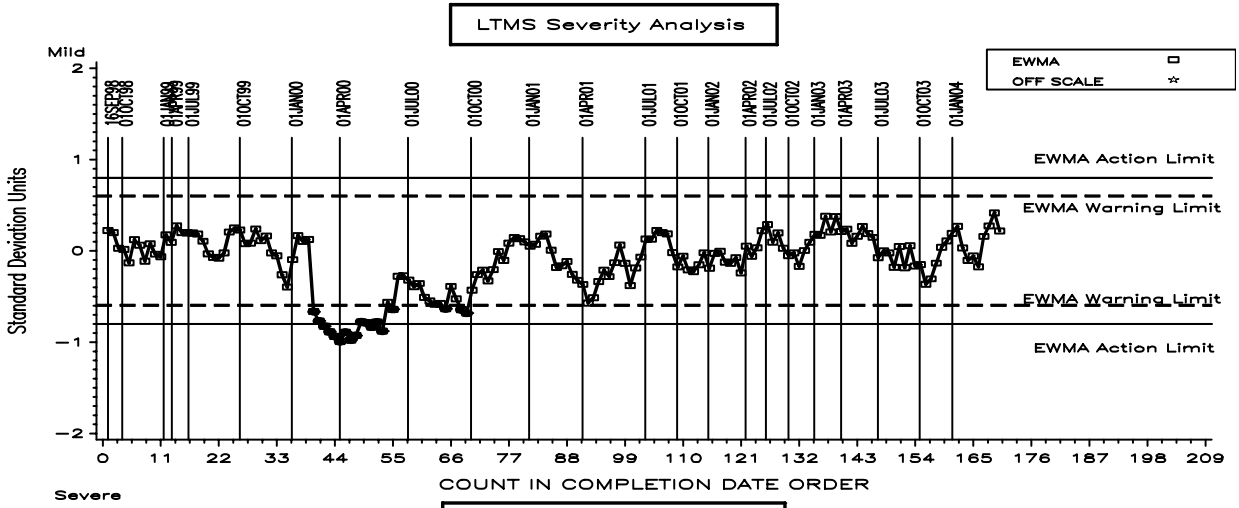
AVG. ENG. VARN. 3-PART FINAL RESULT APV + BAFFLES



SEQUENCE VG INDUSTRY OPERATIONALLY VALID DATA

Figure 4

AVG PISTON SKIRT RATING



OIL SCREEN SLUDGE

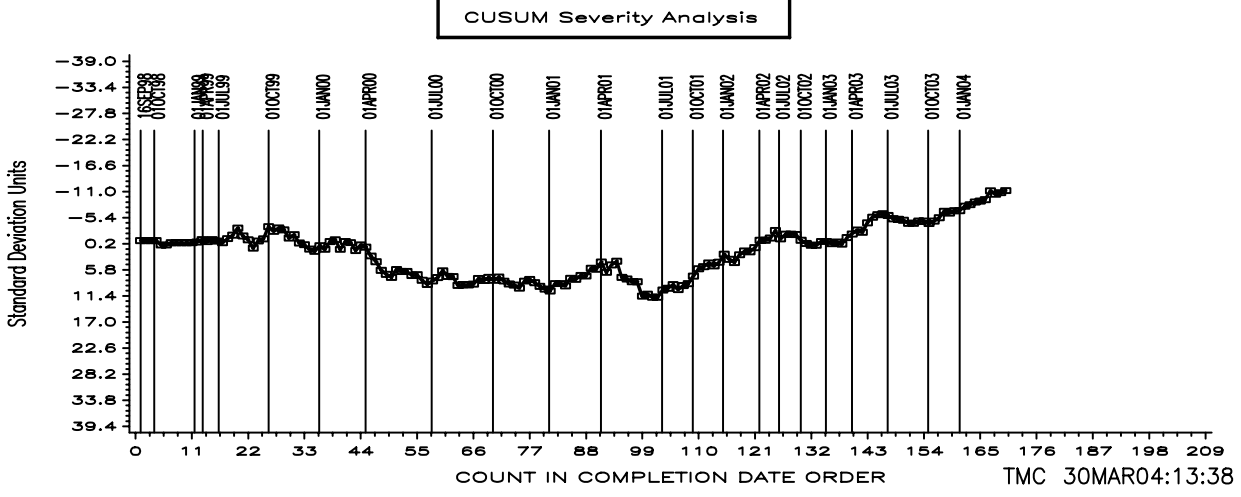
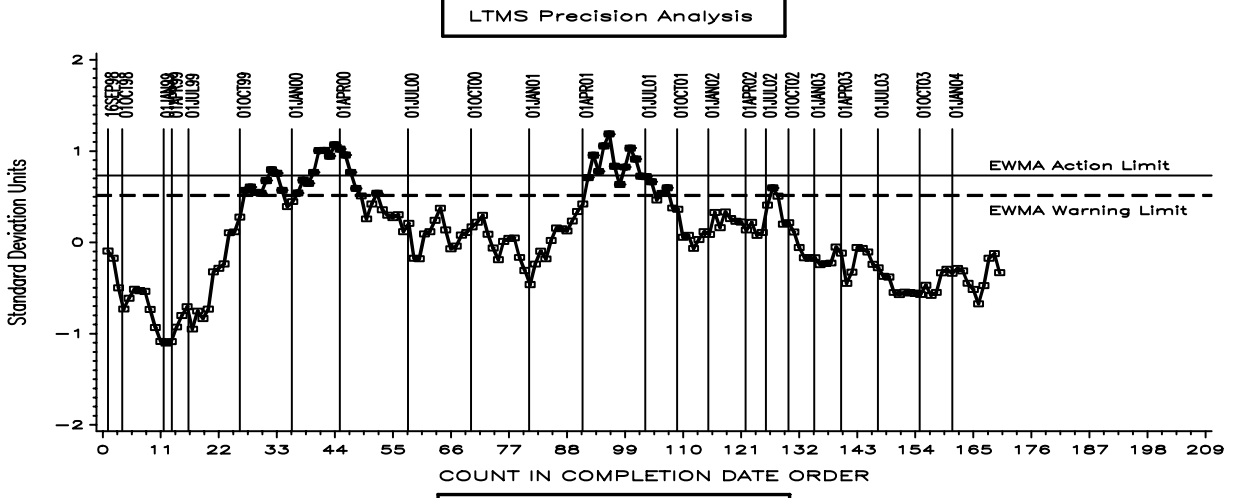
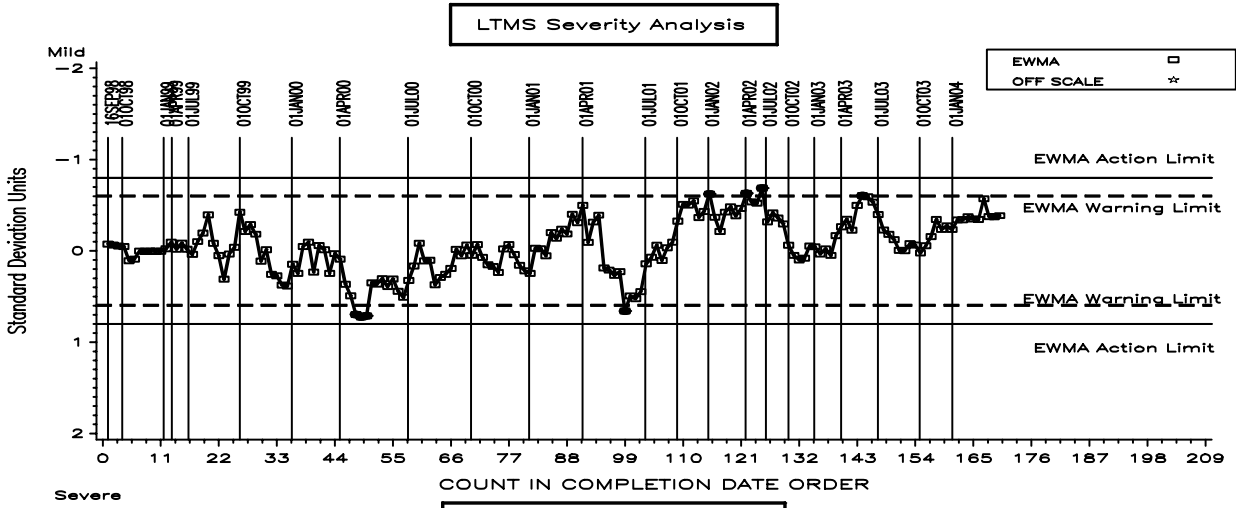


Figure 6

### Comparison of Pooled Precision Estimates By ASTM Report Period

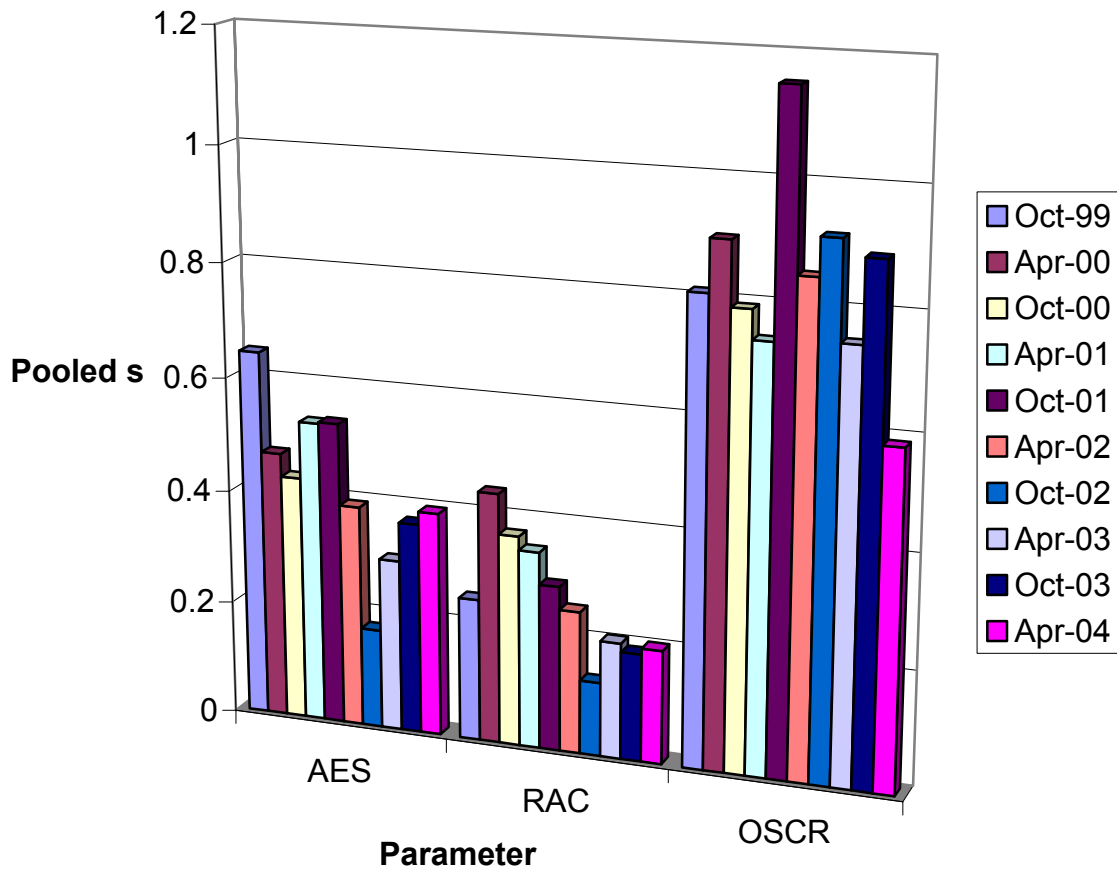
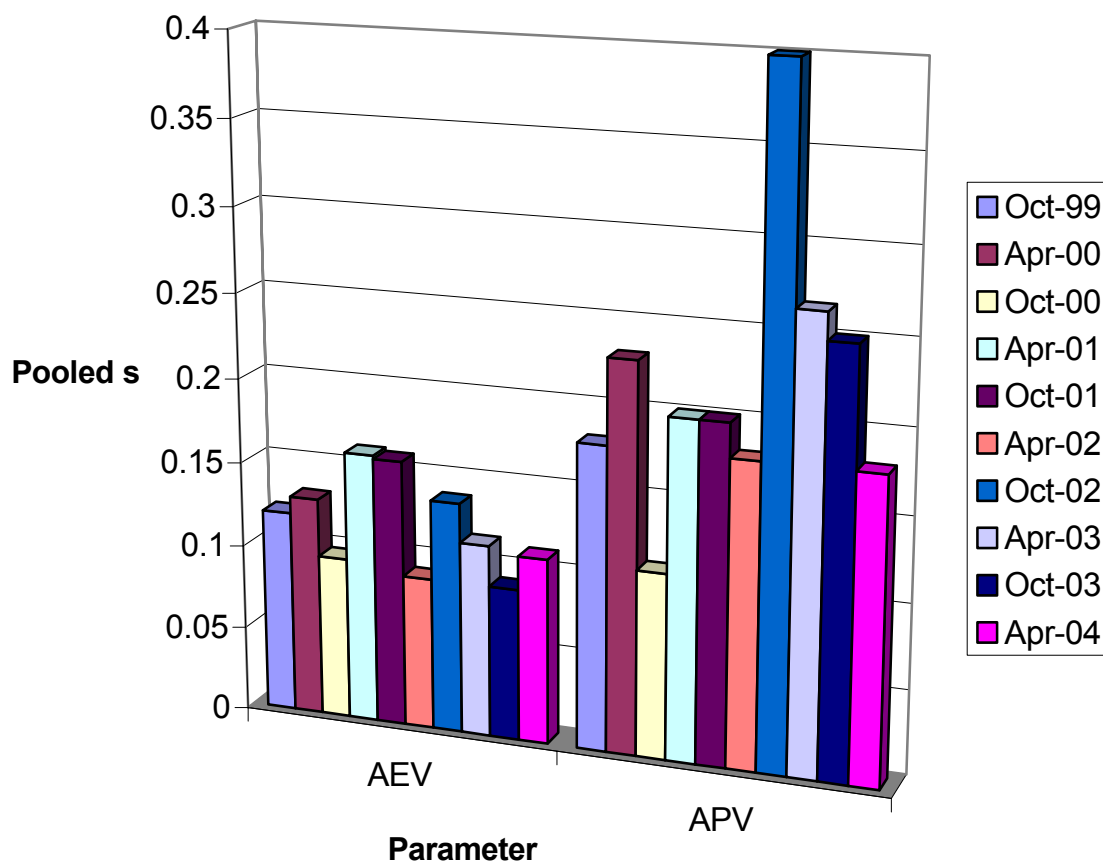


Figure 7

### Comparison of Pooled Precision Estimates By ASTM Report Period



## Sequence VG Industry Timeline

19980901		Matrix testing begins
19990211		Sequence VG Test approved, matrix stands charted and calibrated where applicable
19990503	99-1	Information Letter 99-1 issued, adding ring weight loss, bore wear and pin wear measurements; as well as other procedural changes
19990615	99-2	Numerous procedure updates as identified in Information Letter 99-2
19990830		In conjunction with approval of VG fuel batch 996416, new test targets were published for oils 1006 and 1007
19990830		Batch 996416 was approved for qualified testing at 8/13/99 Surveillance Panel meeting.
19991025	99-3	Revised Exhaust Backpressure limits for stages I and II to 102 and 106 kPa, respectively
19991025	99-3	Deleted rating of Underside of Block sludge and revised report forms and data dictionary accordingly
19991025	99-3	Added Section 11 to document stand referencing requirements
19991025	99-3	Added Section 16 and Annex A14, which give precision and bias statements
19991025	99-3	Updated listing of kit parts given in Sections 7.2 and 7.3 and Annex A5
19991025	99-3	Revised the type of oil filter and screen size, Sections 7.4.9 and 8.3.2.2 and A3.8 changed to reflect this
19991115		Update reference oil targets for oils 1006 and 1007 (n=10), also revised severity adjustment standard deviation
20000215	00-1	Revised Exhaust Backpressure Limits for stages I and II to 104 and 107 kPa, respectively
20000215	00-1	Deleted varnish ratings for cam baffles, oil pan, timing chain cover and rear seal housing.
20000215	00-1	Revised Form 8 to not allow value to be entered for oil added at cycle 54 and deleted form 7.
20000802	00-2	Added Oil Ring Clogging Rating, changed follower pin wear measurement from all 8 cylinders to cylinder 8 only Changed bore wear measurements from all cylinders to cylinders 1 and 8.
20000802	00-2	Changed from ring weight loss to ring gap increase on cylinders 1 & 8.
20000802	00-2	transformation for oil screen clogging. Deleted photos for cam baffles, timing chain cover rear seal housing varnish.
20000802	00-2	Report forms and Data dictionary changes, version 20000713
20001101	00-3	Revised Section 13.4.1. Report forms and Data dictionary changes, version 20000831
20010115	01-1	Changed analysis method for water in fuel, deleted Section 7.1.1, enhanced the measurement techniques for bore wear, oil screen clogging, pin wear and top ring gap increase, changed RAC inlet temperature ramp for stage III to I, removed ring chamfer measurements, changed calibration frequency for temperature and pressure measurement sensors. Changed dipstick calibration procedure, dropped stage I blowby measurements, dropped 0.5% O2 calibration gas, modified fuel injector flow requirements and updated Appendix X2.
20010320	01-2	This information letter was issued against Test Method D6593 to incorporate information letters not included in the initial issue of the method and to correct the precision statement in the method.



20010320	01-3	This information letter dropped the requirement to measure benzene in the fuel, defined a process for consensus rating and no longer requires analysis of used oil for TBN, vis @100 °C and pentane insolubles.
20011114	02-1	This information letter dropped the requirement to measure NOx, monitor Power Qi, addressed rating changes recommended by the Light Duty Rating Task Force and allow adjustments to blowby flow rates during the first 48 hours of the test.
20020301	02-2	This information letter replaced CO, CO2 and O2 measurements with Lambda measurement.
20020408	02-3	Revised references to CRC manuals 12 and 14 with CRC manual 20.
20020515	02-4	This information letter allowed use of power supply for EEC and Lambda sensor power, replaced Rocker Arm cover varnish with cam baffle varnish, revised lambda sensor calibration frequency and dropped requirement to measure bore wear.
20020809		Test Targets, Reference oil 1009, n = 3.
20021023		Test Targets, Reference oil 1009, n = 5.
20021025	02-5	Removed remedial statements from test method and addressed other editorial changes.
20030128		Test Targets, Reference oil 1006-2, n = 10.
20030227	03-1	Removed requirement to include photographs of rated parts in final test report.
20030227	03-2	Corrected Table 6, Section 12.1.1.2 and 12.1.1.6 to remove exhaust gas analysis value and replace with appropriate Lambda values
20030515		Test Targets, Reference oil 1009, n = 10.
20030710		First Test on Romeo Hardware completes.
20030905	03-3	Change solvent from aliphatic naphtha to a solvent meeting ASTM D235, Type II, Class C specification
20030905	03-3	Procedure changes to accomplish build activities and parts required for using Romeo engine for Sequence VG testing.
20030905	03-3	Corrected Section 16.1.1 and modified A7.1 to add ACC Conformance Statement.
20040105		Test Targets, Reference oil 1006-2, n = 20.
20040217		Test Targets, Reference oil 1009, n = 20.
20040109	04-1	Change in calibration period from last candidate start within 171 days to last candidate start within 180 days of reference oil test completion.
20040109	04-1	Editorial changes to precision statement, revised table 8 to reflect that oil screen clogging has a log transformation.