Test Monitoring Center
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Memo: 00-130

Date: October 4, 2000

TO: Gordon Farnsworth, Chairman, Sequence VE Surveillance Panel

FROM: Richard E. Grundza

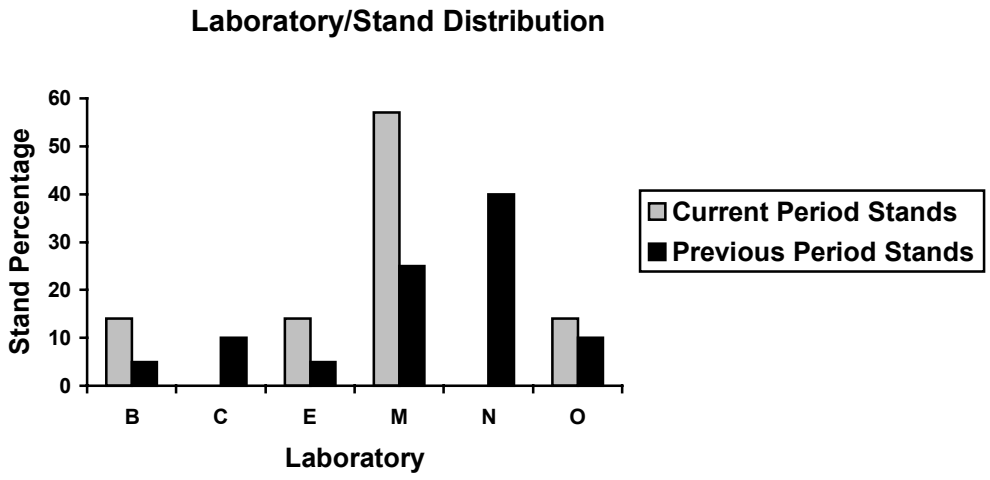
SUBJECT: Sequence VE Reference Test Status from April 1, 2000 through September 30, 2000

The following is a summary of Sequence VE reference tests that were completed during the period April 1, 2000 through September 30, 2000.

Lab/Stand Distribution

	Reporting Data	Calibrated as of 9/30/00
Number of Laboratories	5	4
Number of Stands	8	7

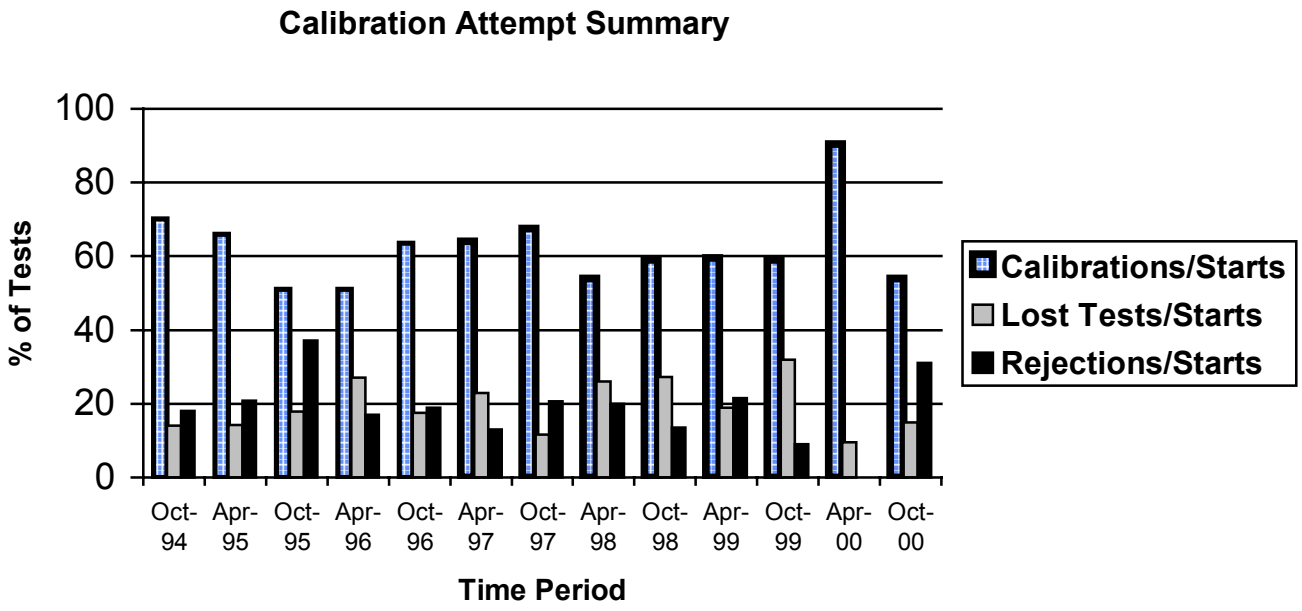
The following chart shows the laboratory/stand distribution:



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

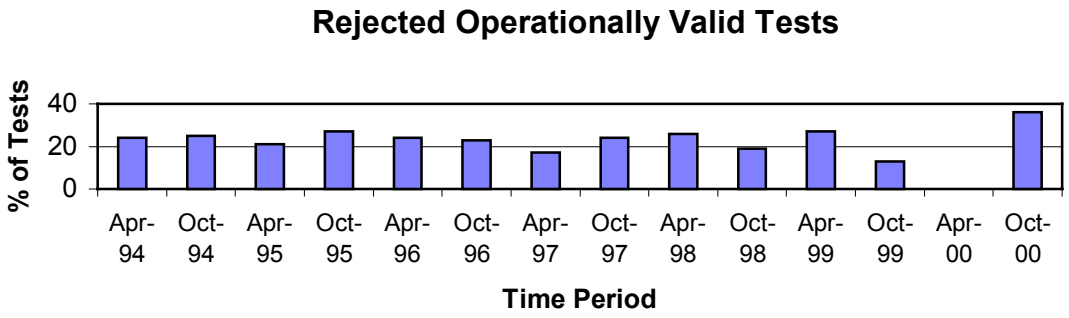
	TMC Validity Codes	No. of Tests
Operationally and Statistically Acceptable	AC	7
Operationally Valid, Statistically Unacceptable	OC	4
Operationally Invalid, Lab Judgment	LC	1
Aborted Test	XC	1
Total		13

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



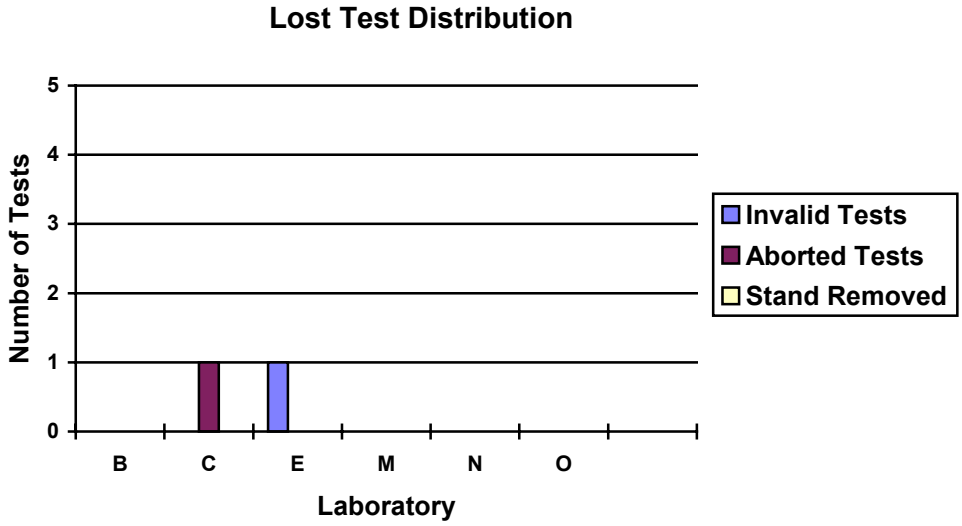
The calibration per start rate has decreased and is somewhat lower than the historical rate. The lost test per start and rejected test per start rates have increased with respect to the previous report period. The lost test per start rate compares favorably with the historical lost test rate, while the rejected test per start is much higher than the historical rate.

The following chart shows the percentage of operationally valid tests failing the acceptance criteria:



There were no instances of the application of "Engineering Judgment" in the interpretation of LTMS guidelines during this report period. A total of fourteen LTMS deviations have been granted during the life of the Sequence VE test.

There was one operationally invalid test. This test was determined to be invalid when the summation delta of the low blowby readings recorded during the test exceeded the procedural limit of 1.6. One test was aborted due to an engine build problem. Aborted and operationally invalid tests by laboratory are summarized with the following chart:



Severity and Precision

Based on the mean delta/s values and pooled standard deviation for the current period, a 95% confidence interval representing severity for the current period is given below in reported units. For RCS, AES, ACW and MCW, calculations were performed in transformed units, then converted to reported units. Pooled s and mean delta/s values for RCS, AES, MCW and ACW are shown in transformed units.

Variable	Pooled s All Oils	Mean Delta/s	Confidence Interval	Based on	Delta in Reported Units
RCS	0.940	-0.441	2.11 - 7.51	7.0	-1.35
AES	0.985	-0.418	7.75 – 9.14	9.0	-0.33
APV	0.334	-0.315	6.03 – 6.47	6.5	-0.11
AEV	0.373	-0.633	4.53 – 4.97	5.0	-0.23
ACW	2.805	-0.060	87.4 - 172.1	130	-3.8
MCW	4.428	-0.482	206 – 414	380	-80

The mean Δ/s for this period shows AES (-0.418), RCS (-0.441), AEV (-0.633) and APV (-0.315) were severe, MCW (-0.482) was mild and ACW (-0.060) was on or near target. Figures 1 through 6 are current industry severity and precision EWMA control charts and plots of summations Δ/s for RCS, AES, APV, AEV, MCW and ACW. Figures 7 through 9 compare the pooled standard deviation of the current period with previous periods.

RCS severity and precision EWMA charts were in control for most of the period, the exception being the last test reported during this period. This test caused a severity EWMA warning alarm to sound. The result was –3.540 Δ/s from target and may be a stand related issue. The summation Δ/s plot shows RCS having a slight severe trend, with the most recent test having a large impact on the summation Δ/s during this period.

As with the RCS control chart, the last test reported during this period caused an AES severity EWMA alarm to sound. With the exception of this one test, AES severity was in control for the remainder of the period. This alarm appears to be lab related and was caused by one test which was –3.594 Δ/s from target. The AES precision chart was in control for the period. The summation Δ/s plot shows that with the exception of the last test, severity was on or near target.

The APV severity EWMA was in control the entire period. Precision EWMA began the period in control, sounding a series of three warning and an action alarm during the middle of the period, coming back into control for the last four tests reported during the period. The alarms appear to be caused by severe results from one lab being reported with mild results from different labs. The summation Δ/s shows on or near target results for most of the period, with several severe results in the middle of the period.

AEV severity began the period in control and sounded a one test severity EWMA warning alarm. The alarm appears to be lab related, with three results from one lab –2.876, -3.540 and –1.487 Δ/s from target. Precision EWMA charts also began the period in control but quickly went into warning and action alarm. Seven of the eleven tests reported this period caused alarms. Finally, the precision EWMA alarms clear for the last two tests. These alarms are the result of a number of severe results being reported from one lab/stand mixed with mild results from other labs. The summation Δ/s plot shows severity on or near target for most of the period, with a short severe trend midway through the period.

The chart for MCW severity began the period with a continuation of a mild alarm event from the previous period. This alarm event continued for seven tests, before clearing for the remaining four tests reported during this report period. No one lab or stand appears to have caused this alarm. The precision EWMA chart has been in control for the period. The summation Δ/s plot shows a mild trend for most of the period.

With the exception of one warning alarm, ACW severity EWMA has been in control for the period. Precision EWMA control charts were in control the entire period. The summation Δ/s plot shows severity trending mild most of the period.

Pooled precision estimates show AES and RCS precision has degraded with respect to both the previous period and historical estimates. Precision for AEV and APV is directionally worse when compared to the previous period and has degraded significantly with respect with historical estimates. ACW and MCW are also directionally poorer when compared to the previous period, but have not degraded significantly with respect to the previous period and historical estimates. It should be noted that the sludge and wear estimates were heavily influenced by one result. When this result is removed, the precision estimates compare well with the previous period and historical estimates. Furthermore, with the exception of the mild severity alarms for the wear parameters, all the other alarms can be accounted for by results obtained from two stands in different laboratories.

Fuels and Reference Oils

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

Oil	TMC Inventory, in gallons	TMC Inventory, in tests	Laboratory Inventory, in tests	Estimated life
925-3	248	82	6	3+ years
927	8	2	1	frozen for IVA Test
927-1	152	50	10	3+ years
930	284	94	4	3+ years
930-1	265	88	0	3+ years
1002	4428	1476	4	3+ years
1006	1552	517	3	2+ years

Note: Oils 1002 and 1006 are used across multiple test areas, TMC inventory represents total amount of that oil on hand.

Information Letters

Information Letter 00-1 was issued on September 16, 2000. This information letter updated some of the definitions in the method to match those given in the D02.B Glossary of Terms and Their Definitions.

Information Memos

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

Memo	Date	Subject
00-38	4/6/00	Sequence VE Semi-Annual Report
00-59	5/4/00	Reference Oil Status Report, Month of April 2000
00-77	5/30/00	Updated Statistics (N=20) Reference Oil 1006
00-87	6/8/00	Reference Oil Status Report, Month of May 2000
00-101	7/6/00	Reference Oil Status Report, Month of June 2000
00-111	8/4/00	Reference Oil Status Report, Month of July 2000
00-113	8/4/00	Draft of Sequence VE Information Letter 00-1
00-120	9/7/00	Reference Oil Status Report, Month of August 2000

TMC Activities

During this report period, the TMC visited six laboratories. During these visits, the following deficiencies were noted:

1) Temperatures during stage transitions not meeting the procedural requirements.

In all cases, these deficiencies have been identified to the laboratory and the laboratory has documented that corrective action has been taken.

The following table compares the standard deviation used in the LTMS for severity adjustment calculations, which is a pooled estimate of precision based on oils 930 and 1002, with the current and historical pooled precision of the oils 1002, 1006 and 930.

Parameter	Severity Adjustment Standard Deviation (n = 43)	Historical Pooled Standard Deviation, Oils 930, 1006 and 1002 (n =304)	Current Period Pooled Standard Deviation, Oils 930, 1006 and 1002 (n = 6)
AES	0.594	0.691	1.184
RCS	0.528	0.578	1.149
AEV	0.239	0.258	0.442
APV	0.213	0.251	0.393
ACW	2.318	2.583	2.984
MCW	3.155	3.863	4.660

Summary

Calibration per start rate has decreased with respect to the previous period and historical rates. The rejected test per start and lost test per start rates have increased with respect to the previous period. When compared to the historical rates, the calibration per start rate is lower than the historical rate, while the rejected test per start rate is higher than the historical rate. The lost test per start rate compares well with historical rates. Precision, when compared to the previous period, has degraded significantly for AES and RCS, and is directionally poorer for all other parameters. When compared to historical estimates, precision has degraded significantly for AES, RCS, AEV and APV. AES, RCS, AEV, and APV all trended severe during this period, MCW was mild with ACW on or near target. The varnish precision EWMA alarms and the recent EWMA severity alarms for sludge, as well as the degradation in precision for these parameters, can be accounted for by results reported from two stands.

Attachments

c: Sequence VE Surveillance Panel
ftp://www.tmc.astm.cmri.cmu.edu/docs/gas/sequencev/semiannualreports/ve-10-2000
J. L. Zalar
F. M. Farber

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

Table 1 summarizes the mean and range of results, by oil, of all operationally valid reference oil tests reported to the TMC, through September 30, 2000, in transformed and reported units, where applicable.

Table 2 summarizes the mean and range of results, by oil, of all operationally valid reference oil tests reported to the TMC from April 1, 2000 through September 30, 2000, in transformed and reported units, where applicable.

Table 3 summarizes the mean and range of individual varnish part results, by oil, of all operationally valid dual plug reference oil tests reported to the TMC through September 30, 2000.

Table 4 summarizes the mean and range of individual sludge part results, by oil, of all operationally valid dual plug reference oil tests reported to the TMC through September 30, 2000.

Table 5 is the Sequence VE Industry Timeline

Figures 1 through 6 are the Industry control charts for the dual plug head results for AES, RCS, APV, AEV, ACW and MCW.

Figures 7 through 9 compare the pooled standard deviation of the dual plug head results for this ASTM reporting period with previous ASTM reporting periods, for AES and RCS, AEV and APV, and ACW and MCW, respectively.

TABLE 1
SEQUENCE VE DUAL PLUG HEAD
OPERATIONALLY VALID DATA
DATA FROM APRIL 1, 2000 THROUGH SEPTEMBER 30, 2000

OIL CODE	TEST PARAMETER	N	MEAN	s	REPORTED RANGE
1006	RCS (-1(LN(9.65-RCS)))	3	-0.099	1.62	-1.954 TO 1.022
	RCS (MERITS*)		8.546		2.590 TO 9.290
	AES (-1(LN(9.65-AES)))		0.073	1.66	-1.652 TO 1.661
	AES (MERITS*)		8.720		4.430 TO 9.460
	Avg. Pist. Varnish		6.813	.364	6.560 TO 7.230
	Avg. Eng. Varnish		5.300	.390	5.070 TO 5.750
	MCW (Square Root)		8.168	5.95	4.472 TO 15.03
	MCW (micrometres*)		66.72		20.00 TO 226.0
	ACW (Square Root)		6.394	4.14	3.821 TO 11.17
	ACW (micrometres*)		40.89		14.60 TO 124.7
925-3	RCS (-1(LN(9.65-RCS)))	3	-1.415	.067	-1.459 TO -1.338
	RCS (MERITS*)		5.533		5.350 TO 5.840
	AES (-1(LN(9.65-AES)))		-0.633	.328	-0.936 TO -0.285
	AES (MERITS*)		7.767		7.100 TO 8.320
	Avg. Pist. Varnish		6.713	.159	6.530 TO 6.810
	Avg. Eng. Varnish		3.967	.163	3.840 TO 4.150
	MCW (Square Root)		6.738	3.92	3.742 TO 11.18
	MCW (micrometres*)		45.40		14.00 TO 125.0
	ACW (Square Root)		5.007	2.41	2.720 TO 7.517
	ACW (micrometres*)		25.07		7.400 TO 56.50
927	RCS (-1(LN(9.65-RCS)))	1	-1.987	.	-1.987 TO -1.987
	RCS (MERITS*)		2.360		2.360 TO 2.360
	AES (-1(LN(9.65-AES)))		-1.658	.	-1.658 TO -1.658
	AES (MERITS*)		4.400		4.400 TO 4.400
	Avg. Pist. Varnish		6.500	.	6.500 TO 6.500
	Avg. Eng. Varnish		5.100	.	5.100 TO 5.100
	MCW (Square Root)		18.65	.	18.65 TO 18.65
	MCW (micrometres*)		348.0		348.0 TO 348.0
	ACW (Square Root)		15.68	.	15.68 TO 15.68
	ACW (micrometres*)		245.9		245.9 TO 245.9
927-1	RCS (-1(LN(9.65-RCS)))	1	-1.974	.	-1.974 TO -1.974
	RCS (MERITS*)		2.450		2.450 TO 2.450
	AES (-1(LN(9.65-AES)))		-1.537	.	-1.537 TO -1.537
	AES (MERITS*)		5.000		5.000 TO 5.000
	Avg. Pist. Varnish		6.900	.	6.900 TO 6.900
	Avg. Eng. Varnish		5.100	.	5.100 TO 5.100
	MCW (Square Root)		17.92	.	17.92 TO 17.92
	MCW (micrometres*)		321.0		321.0 TO 321.0
	ACW (Square Root)		14.34	.	14.34 TO 14.34
	ACW (micrometres*)		205.7		205.7 TO 205.7
930	RCS (-1(LN(9.65-RCS)))	3	-0.045	.147	-0.199 TO 0.094
	RCS (MERITS*)		8.604		8.430 TO 8.740
	AES (-1(LN(9.65-AES)))		0.845	.215	0.598 TO 0.994
	AES (MERITS*)		9.220		9.100 TO 9.280
	Avg. Pist. Varnish		6.843	.421	6.440 TO 7.280
	Avg. Eng. Varnish		4.483	.488	4.130 TO 5.040
	MCW (Square Root)		8.326	2.83	5.831 TO 11.40
	MCW (micrometres*)		69.33		34.00 TO 130.0

ACW (Square Root)	5.800	.832	4.930	TO	6.588
ACW (micrometres*)	33.64		24.30	TO	43.40

* CALCULATED IN TRANSFORMED UNITS AND CONVERTED BACK TO REPORTED UNITS

10/03/00

TABLE 2
SEQUENCE VE DUAL PLUG HEAD
OPERATIONALLY VALID DATA
THROUGH SEPTEMBER 30, 2000

OIL CODE	TEST PARAMETER	N	MEAN	s	REPORTED RANGE
1002	RCS (-1(LN(9.65-RCS)))	122	-0.505	.516	-1.637 TO 0.734
	RCS (MERITS*)		7.992		4.510 TO 9.170
	AES (-1(LN(9.65-AES)))		0.367	.603	-1.244 TO 1.427
	AES (MERITS*)		8.957		6.180 TO 9.410
	Avg. Pist. Varnish		7.104	.222	6.620 TO 7.570
	Avg. Eng. Varnish		5.590	.272	4.230 TO 6.290
	MCW (Square Root)		14.09	3.22	4.243 TO 19.31
	MCW (micrometres*)		198.5		18.00 TO 373.0
	ACW (Square Root)		9.649	2.42	3.633 TO 15.21
	ACW (micrometres*)		93.09		13.20 TO 231.4
1006	RCS (-1(LN(9.65-RCS)))	52	-0.041	.736	-1.954 TO 1.022
	RCS (MERITS*)		8.609		2.590 TO 9.290
	AES (-1(LN(9.65-AES)))		0.575	.893	-1.792 TO 1.661
	AES (MERITS*)		9.087		3.650 TO 9.460
	Avg. Pist. Varnish		6.952	.276	6.460 TO 7.590
	Avg. Eng. Varnish		5.500	.246	4.940 TO 6.060
	MCW (Square Root)		9.140	4.40	4.359 TO 18.06
	MCW (micrometres*)		83.54		19.00 TO 326.0
	ACW (Square Root)		6.841	3.07	3.033 TO 13.55
	ACW (micrometres*)		46.80		9.200 TO 183.5
925-2	RCS (-1(LN(9.65-RCS)))	9	-1.452	.192	-1.658 TO -1.102
	RCS (MERITS*)		5.380		4.400 TO 6.640
	AES (-1(LN(9.65-AES)))		-0.426	.357	-0.944 TO 0.174
	AES (MERITS*)		8.119		7.080 TO 8.810
	Avg. Pist. Varnish		6.546	.184	6.300 TO 6.900
	Avg. Eng. Varnish		4.477	.227	4.160 TO 4.840
	MCW (Square Root)		6.367	3.37	3.162 TO 12.04
	MCW (micrometres*)		40.54		10.00 TO 145.0
	ACW (Square Root)		4.330	1.39	2.530 TO 6.411
	ACW (micrometres*)		18.75		6.400 TO 41.10
925-3	RCS (-1(LN(9.65-RCS)))	142	-1.207	.326	-1.970 TO -0.182
	RCS (MERITS*)		6.306		2.480 TO 8.450
	AES (-1(LN(9.65-AES)))		-0.431	.516	-1.850 TO 0.916
	AES (MERITS*)		8.111		3.290 TO 9.250
	Avg. Pist. Varnish		6.569	.222	5.730 TO 7.100
	Avg. Eng. Varnish		4.085	.277	3.580 TO 4.950
	MCW (Square Root)		6.463	3.03	2.236 TO 16.85
	MCW (micrometres*)		41.77		5.000 TO 284.0
	ACW (Square Root)		4.770	1.69	2.025 TO 12.28
	ACW (micrometres*)		22.76		4.100 TO 150.9
926-1	RCS (-1(LN(9.65-RCS)))	8	0.476	.469	-0.385 TO 1.050
	RCS (MERITS*)		9.029		8.180 TO 9.300
	AES (-1(LN(9.65-AES)))		1.280	.473	0.301 TO 1.772
	AES (MERITS*)		9.372		8.910 TO 9.480
	Avg. Pist. Varnish		6.963	.154	6.650 TO 7.160
	Avg. Eng. Varnish		5.570	.190	5.230 TO 5.850
	MCW (Square Root)		13.04	4.13	5.745 TO 17.89

MCW (micrometres*)	169.9		33.00	TO	320.0
ACW (Square Root)	8.091	2.75	4.648	TO	12.76
ACW (micrometres*)	65.47		21.60	TO	162.8

TABLE 2
SEQUENCE VE DUAL PLUG HEAD
OPERATIONALLY VALID DATA
THROUGH SEPTEMBER 30, 2000

OIL CODE	TEST PARAMETER	N	MEAN	s	REPORTED RANGE
927	RCS (-1(LN(9.65-RCS)))	22	-1.583	.489	-2.128 TO -0.049
	RCS (MERITS*)		4.781		1.250 TO 8.600
	AES (-1(LN(9.65-AES)))		-0.907	.744	-1.739 TO 0.916
	AES (MERITS*)		7.174		3.960 TO 9.250
	Avg. Pist. Varnish		6.780	.338	6.150 TO 7.600
	Avg. Eng. Varnish		4.994	.250	4.490 TO 5.510
	MCW (Square Root)		19.02	2.98	8.000 TO 21.73
	MCW (micrometres*)		361.6		64.00 TO 472.0
	ACW (Square Root)		13.55	2.77	5.523 TO 16.75
	ACW (micrometres*)		183.6		30.50 TO 280.4
927-1	RCS (-1(LN(9.65-RCS)))	6	-1.812	.177	-1.981 TO -1.509
	RCS (MERITS*)		3.529		2.400 TO 5.130
	AES (-1(LN(9.65-AES)))		-1.251	.274	-1.537 TO -0.820
	AES (MERITS*)		6.156		5.000 TO 7.380
	Avg. Pist. Varnish		6.970	.226	6.580 TO 7.200
	Avg. Eng. Varnish		5.110	.166	4.800 TO 5.270
	MCW (Square Root)		18.93	.721	17.92 TO 19.77
	MCW (micrometres*)		358.2		321.0 TO 391.0
	ACW (Square Root)		14.22	1.08	13.07 TO 15.83
	ACW (micrometres*)		202.2		170.9 TO 250.7
930	RCS (-1(LN(9.65-RCS)))	150	-0.278	.585	-1.920 TO 1.609
	RCS (MERITS*)		8.329		2.830 TO 9.450
	AES (-1(LN(9.65-AES)))		0.354	.700	-1.656 TO 1.470
	AES (MERITS*)		8.948		4.410 TO 9.420
	Avg. Pist. Varnish		6.991	.267	5.950 TO 7.820
	Avg. Eng. Varnish		4.846	.262	4.130 TO 5.700
	MCW (Square Root)		9.745	4.14	3.464 TO 19.13
	MCW (micrometres*)		94.96		12.00 TO 366.0
	ACW (Square Root)		6.815	2.53	2.470 TO 15.78
	ACW (micrometres*)		46.44		6.100 TO 248.9

* CALCULATED IN TRANSFORMED UNITS AND CONVERTED BACK TO REPORTED UNITS

10/03/00
statsmon.SAS

SEQUENCE VE DUAL PLUG
ALL OPERATIONALLY VALID DATA
DATA REPORTED THROUGH SEPTEMBER 30, 2000

OIL CODE	VARNISH PART	N	MEAN	s	REPORTED RANGE
1002	AVERAGE PISTON	122	7.104	.222	6.620 TO 7.570
	ROCKER ARM COVER		3.594	.659	2.250 TO 5.540
	CAMSHAFT BAFFLE		7.197	.567	5.170 TO 8.550
	CYLINDER WALL (BRT)		2.916	.661	2.140 TO 8.290
	OIL PAN		7.175	.604	4.020 TO 8.520
1006	AVERAGE PISTON	52	6.952	.276	6.460 TO 7.590
	ROCKER ARM COVER		3.283	.724	1.720 TO 4.650
	CAMSHAFT BAFFLE		7.191	.389	5.890 TO 8.130
	CYLINDER WALL (BRT)		2.901	.315	2.300 TO 3.640
	OIL PAN		7.154	.490	5.380 TO 8.140
925-2	AVERAGE PISTON	9	6.546	.184	6.300 TO 6.900
	ROCKER ARM COVER		3.452	.642	2.280 TO 4.380
	CAMSHAFT BAFFLE		3.679	.810	2.330 TO 4.840
	CYLINDER WALL (BRT)		3.098	.147	2.880 TO 3.290
	OIL PAN		5.613	.295	5.310 TO 6.320
925-3	AVERAGE PISTON	142	6.569	.222	5.730 TO 7.100
	ROCKER ARM COVER		2.452	.572	1.410 TO 4.660
	CAMSHAFT BAFFLE		3.039	.874	1.380 TO 6.150
	CYLINDER WALL (BRT)		3.010	.382	2.240 TO 5.920
	OIL PAN		5.351	.406	4.410 TO 6.360
926-1	AVERAGE PISTON	8	6.963	.154	6.650 TO 7.160
	ROCKER ARM COVER		4.144	.638	3.400 TO 5.080
	CAMSHAFT BAFFLE		7.036	.642	6.120 TO 7.810
	CYLINDER WALL (BRT)		2.713	.270	2.280 TO 3.090
	OIL PAN		6.990	.574	6.280 TO 7.720
927	AVERAGE PISTON	22	6.780	.338	6.150 TO 7.600
	ROCKER ARM COVER		3.409	.792	2.080 TO 5.480
	CAMSHAFT BAFFLE		5.875	.811	3.870 TO 7.270
	CYLINDER WALL (BRT)		2.658	.396	1.940 TO 3.380
	OIL PAN		6.229	.461	5.460 TO 7.100
927-1	AVERAGE PISTON	6	6.970	.226	6.580 TO 7.200
	ROCKER ARM COVER		3.875	.543	3.330 TO 4.780
	CAMSHAFT BAFFLE		6.037	.439	5.350 TO 6.630
	CYLINDER WALL (BRT)		2.510	.454	1.810 TO 2.950
	OIL PAN		6.160	.460	5.470 TO 6.680
930	AVERAGE PISTON	150	6.991	.267	5.950 TO 7.820
	ROCKER ARM COVER		3.164	.705	1.780 TO 5.300
	CAMSHAFT BAFFLE		5.317	.690	3.370 TO 7.390
	CYLINDER WALL (BRT)		2.813	.407	1.920 TO 4.420
	OIL PAN		5.941	.574	4.650 TO 8.160

SEQUENCE VE DUAL PLUG
ALL OPERATIONALLY VALID DATA
DATA REPORTED THROUGH SEPTEMBER 30, 2000

OIL CODE	SLUDGE PART	N	MEAN (MERITS*)	s	REPORTED RANGE
1002	ROCKER ARM COVER	122	-.716 (7.954)	.424	4.51 TO 9.17
	CAMSHAFT BAFFLE		0.099 (9.094)	.405	6.19 TO 9.45
	FRONT SEAL HOUSING		0.589 (9.445)	.405	7.90 TO 9.75
	OIL PAN		-.099 (8.896)	.535	5.71 TO 9.50
	VALVE DECK		0.061 (9.059)	.620	3.60 TO 9.59
	UNDERSIDE OF BLOCK		0.242 (9.215)	.452	6.90 TO 9.65
1006	ROCKER ARM COVER	52	-.374 (8.546)	.585	2.59 TO 9.29
	CAMSHAFT BAFFLE		0.067 (9.064)	.643	4.23 TO 9.56
	FRONT SEAL HOUSING		0.537 (9.416)	.693	3.04 TO 9.75
	OIL PAN		-.017 (8.983)	.665	4.50 TO 9.51
	VALVE DECK		-.029 (8.970)	.772	1.30 TO 9.60
	UNDERSIDE OF BLOCK		0.263 (9.231)	.605	5.99 TO 9.67
925-2	ROCKER ARM COVER	9	-1.53 (5.375)	.176	4.40 TO 6.64
	CAMSHAFT BAFFLE		-.781 (7.817)	.637	4.97 TO 9.16
	FRONT SEAL HOUSING		-.313 (8.632)	.490	7.55 TO 9.25
	OIL PAN		-.091 (8.905)	.230	8.26 TO 9.16
	VALVE DECK		0.093 (9.089)	.652	6.77 TO 9.47
	UNDERSIDE OF BLOCK		0.406 (9.334)	.244	8.95 TO 9.53
925-3	ROCKER ARM COVER	142	-1.31 (6.289)	.292	2.48 TO 8.45
	CAMSHAFT BAFFLE		-.902 (7.535)	.595	2.06 TO 9.31
	FRONT SEAL HOUSING		-.442 (8.445)	.610	2.06 TO 9.72
	OIL PAN		-.336 (8.600)	.503	3.42 TO 9.48
	VALVE DECK		-.215 (8.760)	.583	3.09 TO 9.59
	UNDERSIDE OF BLOCK		0.233 (9.208)	.494	4.65 TO 9.65
926-1	ROCKER ARM COVER	8	0.008 (9.008)	.311	8.18 TO 9.30
	CAMSHAFT BAFFLE		0.486 (9.385)	.304	8.76 TO 9.51
	FRONT SEAL HOUSING		0.879 (9.585)	.346	9.30 TO 9.75
	OIL PAN		0.372 (9.311)	.302	8.66 TO 9.50
	VALVE DECK		0.663 (9.485)	.190	9.29 TO 9.60
	UNDERSIDE OF BLOCK		0.515 (9.402)	.114	9.25 TO 9.50
927	ROCKER ARM COVER	22	-1.66 (4.733)	.439	1.25 TO 8.60
	CAMSHAFT BAFFLE		-.875 (7.601)	.692	5.42 TO 9.53
	FRONT SEAL HOUSING		-.783 (7.812)	.892	1.28 TO 9.70
	OIL PAN		-.954 (7.404)	.619	4.58 TO 9.36
	VALVE DECK		-.883 (7.582)	.879	3.00 TO 9.35
	UNDERSIDE OF BLOCK		-.694 (7.999)	.647	4.90 TO 9.43
927-1	ROCKER ARM COVER	6	-1.87 (3.524)	.167	2.40 TO 5.13
	CAMSHAFT BAFFLE		-1.18 (6.754)	.152	6.07 TO 7.40
	FRONT SEAL HOUSING		-1.15 (6.857)	.674	2.64 TO 8.20
	OIL PAN		-1.14 (6.865)	.376	5.56 TO 8.33
	VALVE DECK		-1.40 (5.938)	.318	3.91 TO 7.54
	UNDERSIDE OF BLOCK		-.901 (7.537)	.213	6.95 TO 8.32

SEQUENCE VE DUAL PLUG
ALL OPERATIONALLY VALID DATA
DATA REPORTED THROUGH SEPTEMBER 30, 2000

OIL CODE	SLUDGE PART	N	MEAN (MERITS*)	s	REPORTED RANGE
930	ROCKER ARM COVER	150	-.541 (8.283)	.460	2.83 TO 9.45
	CAMSHAFT BAFFLE		-.053 (8.945)	.553	4.10 TO 9.53
	FRONT SEAL HOUSING		0.353 (9.297)	.546	5.26 TO 9.70
	OIL PAN		-.158 (8.829)	.589	3.69 TO 9.50
	VALVE DECK		-.015 (8.985)	.637	2.83 TO 9.59
	UNDERSIDE OF BLOCK		0.215 (9.194)	.516	5.81 TO 9.63

Table 5
Sequence VE Industry Timeline

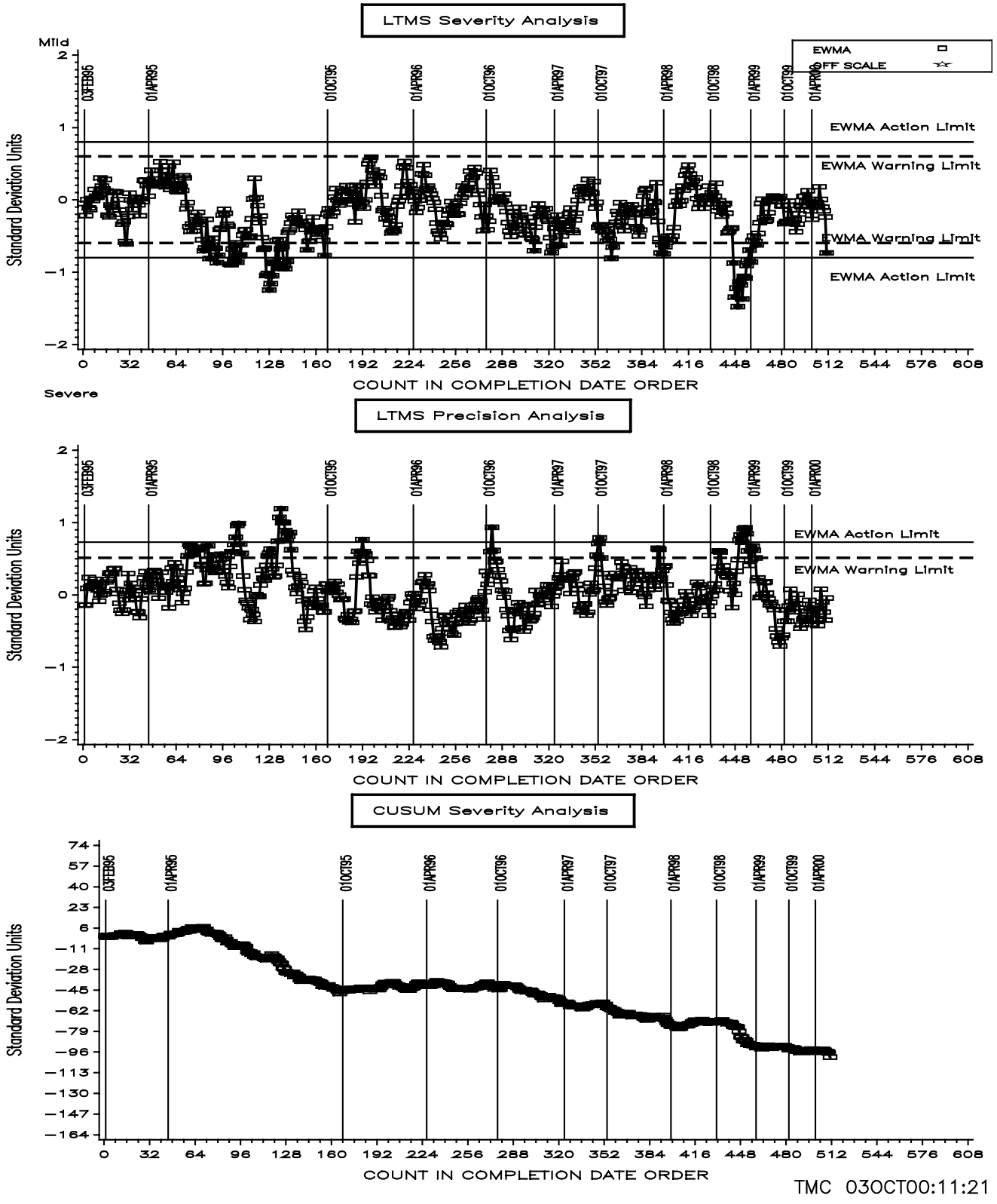
19950201	95-3	Start of Dual Plug VE Testing
19950515		Targets For Oil 925-3 and 930 Updated
19950523	95-5	Sludge Rating Sites Revised on Cylinder Head
19950523	95-5	Oxygen limits in test method were incorrect
19950524	95-4	AEV Correction Factor Approved (Candidates only)
19950601		Targets For Oil 1002 and 930 Updated
19950901		Reground followers introduced.
19960901	95-5	Data dictionary version 19950530 implemented
19951003		Targets for 1002; 925-3 and 930 Updated
19951101	95-6	Increased Aliphatic naphtha concentration to 50%
19951101	95-6	Added requirements to change honing oil & filter 1/15 Hrs
19951101	95-6	Changed cylinder head calibration rig calibration requirements
19951101	95-6	Allowed Torque to Yield bolts to be used twice
19951101	95-6	Corrected errors in footnote 14 and renumbered footnotes
19960101	95-7	Instituted program to monitor test fuel stored at labs
19951003	95-7	Revised pooled s for severity adjustment calculations
19960515	96-2	Implemented industry correction factors for ACW and MCW
19960901	96-1	Standard orifice mount; clean orifice daily; standard correction calculation
19960901	96-1	Revised stage 1 to 2 RAC temperature Ramp
19960901	96-1	Calibration Frequency Changes and requirements
19960901	96-1	Specified Follower Installation Tool
19960901	96-1	Coolant Flush Cart Calibration
19960901	96-1	Pre-lube engine when downtime exceeds 8 hours
19960901	96-1	Require the use of OHTA-007-1 adapter
19960901	96-1	Required use of lifter fill chamber for VE lifters
19960901	96-1	Standardized separator height at 5.5±0.25 in
19960901	96-1	Standardized sample probe distance 2.75±0.25" from exh man flange
19960901	96-1	Required pressurized engine coolant system at 10 psig
19960901	96-1	Specified engine coolant out temperature measurement at 1"
19960901	96-1	Clarified what is a shutdown and reporting requirements
19960901	96-1	Deleted retention requirements for excess oil at oil leveling
19960901	96-1	Corrected errors; footnote 2; table 3; section 9.3.1 and Fig A3.25
19961001	96-2	Forms and Data Dictionary Change, Version 19960726
19961001	96-2	Added requirement to identify sampling technique used for sampling of lab fuel supply
19961119	97-1	Humidity Calibration Requirements Added
19961119	97-1	Clean Blowby Orifice weekly
19970101	97-1	Changed AFR probe location
19970310	97-2	Changed Cam Wear measurements (Avg, Max and individual lobes) to micrometres
19970310	97-2	Forms and data dictionary changes to accompany wear measurement units, Version 19970130
19970429	97-3	Corrected typo errors in 8.3.5, 9.3.2 and 13.2.2.1. Changed Nalcool to Pencool 2000
19970820	97-4	Added requirements to flow test fuel injectors, prior to each test
19970820	97-4	Changed calibration frequency for fuel flow measurement device from every 3rd test to every reference
19971124	97-5	Changed field length for DELACW and DELMCW, Moved notes 29 and 31 into text of procedure
19971118	97-6	Allowed removal of piston staining and deleted Annex A13.
19980611	98-1	Machining of 0.5 mm pistons, Calibration frequency Changes
19980709		Test Target Update, Reference oil 1006 (N=20)
19980611	99-1	Machining of 0.5 mm pistons, Calibration frequency Changes
19990224		Test Target Update, Reference oil 1006 (N=30)
19990615	99-2	Added Procedure for re-using cylinder heads, deleted requirement to identify cams with lobes <50C

19991216	99-3	Revised method to allow use of non-kit parts obtained from Ford Dealers, for other than parts listed in the Origin of Significant Parts Sheet (Form A7.12)
20000916	00-1	Revised definitions to match D02.B Glossary of Terms and Their Definitions

SEQUENCE VE INDUSTRY OPERATIONALLY VALID DATA

Rocker Cover Sludge – Merits

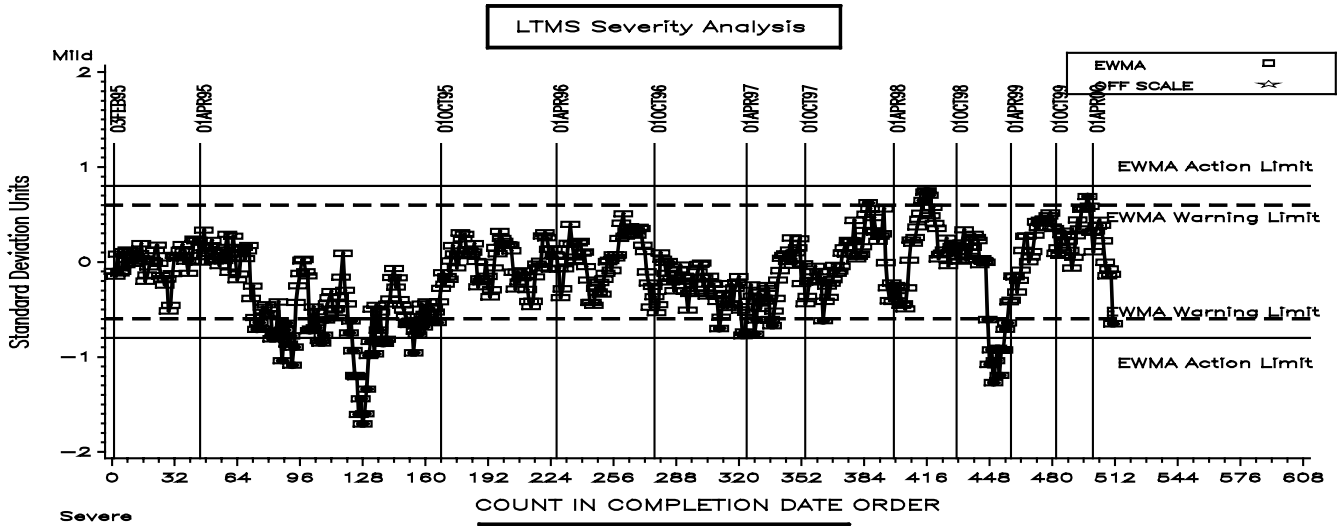
Figure 1

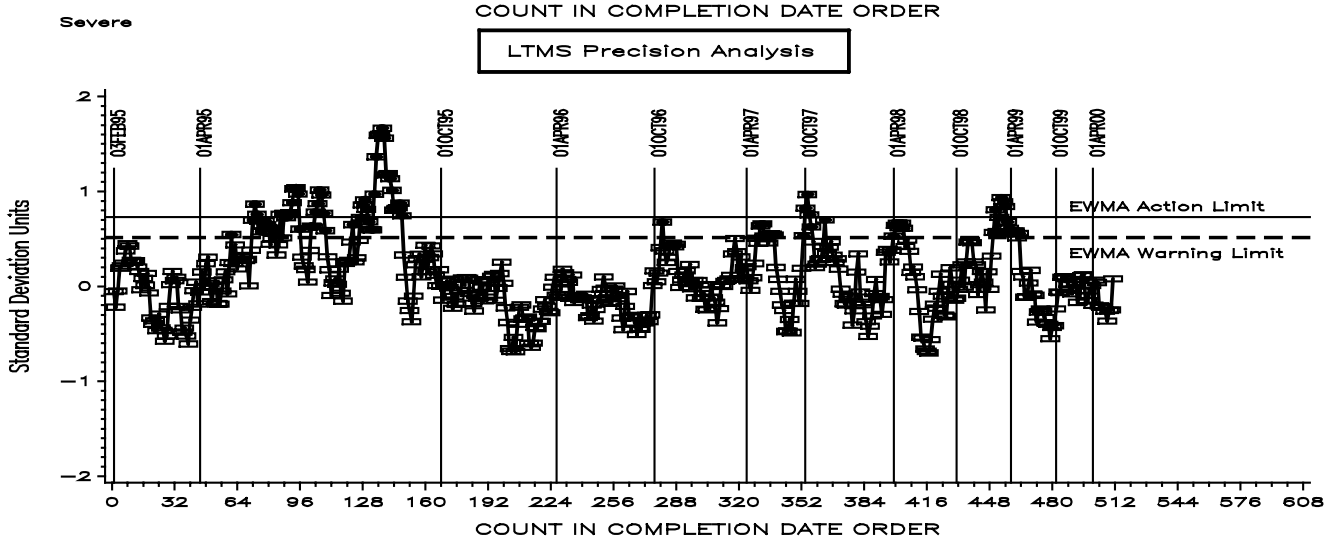


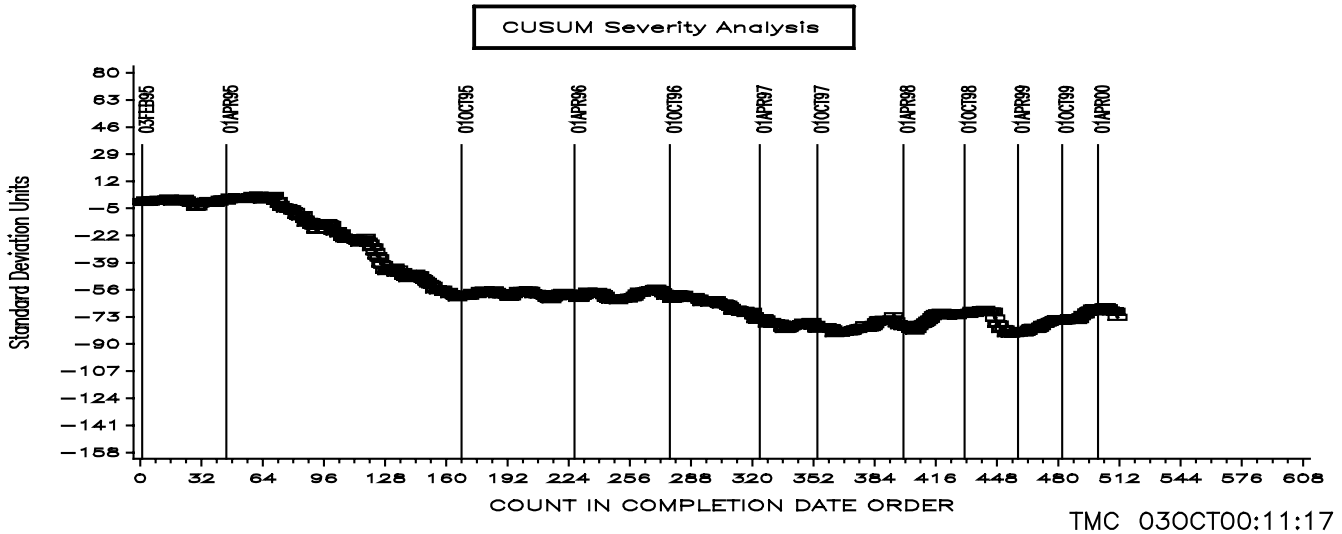
SEQUENCE VE INDUSTRY OPERATIONALLY VALID DATA

Average Engine Sludge — Merits

Figure 2







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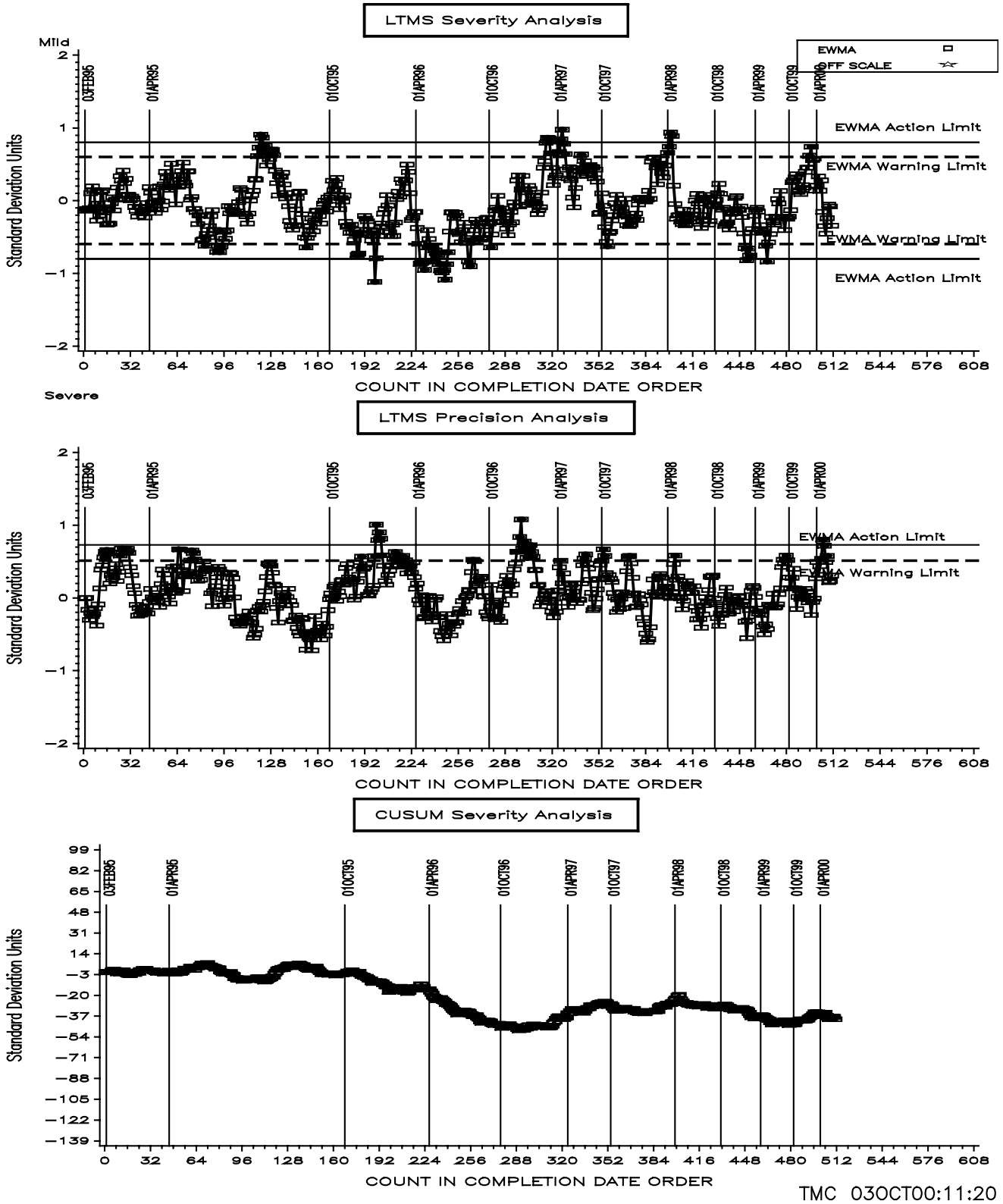
SEQUENCE VE INDUSTRY OPERATIONALLY VALID DATA

Average Piston Varnish — Merits

Figure 3



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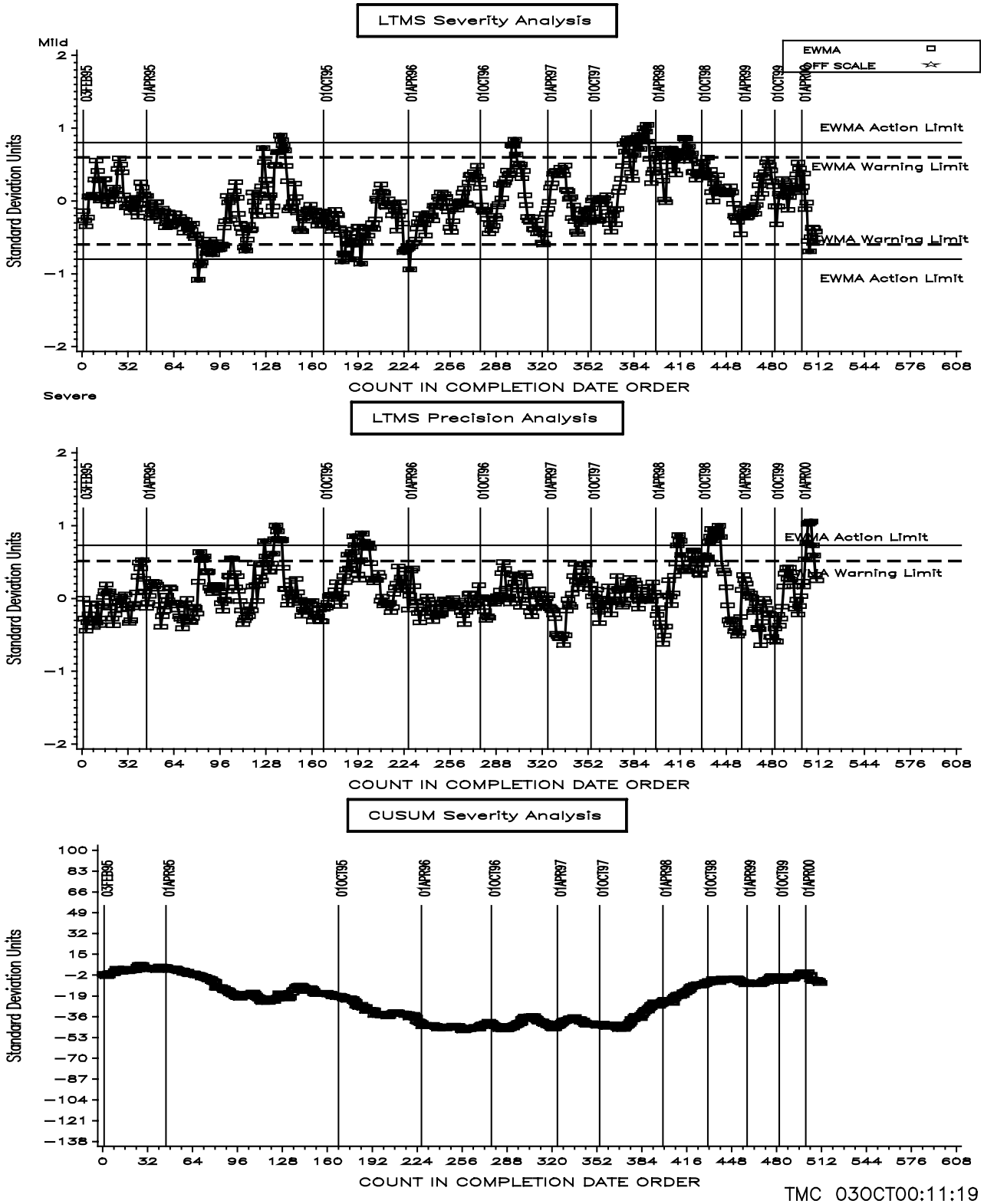
SEQUENCE VE INDUSTRY OPERATIONALLY VALID DATA

Average Engine Varnish — Merits

Figure 4



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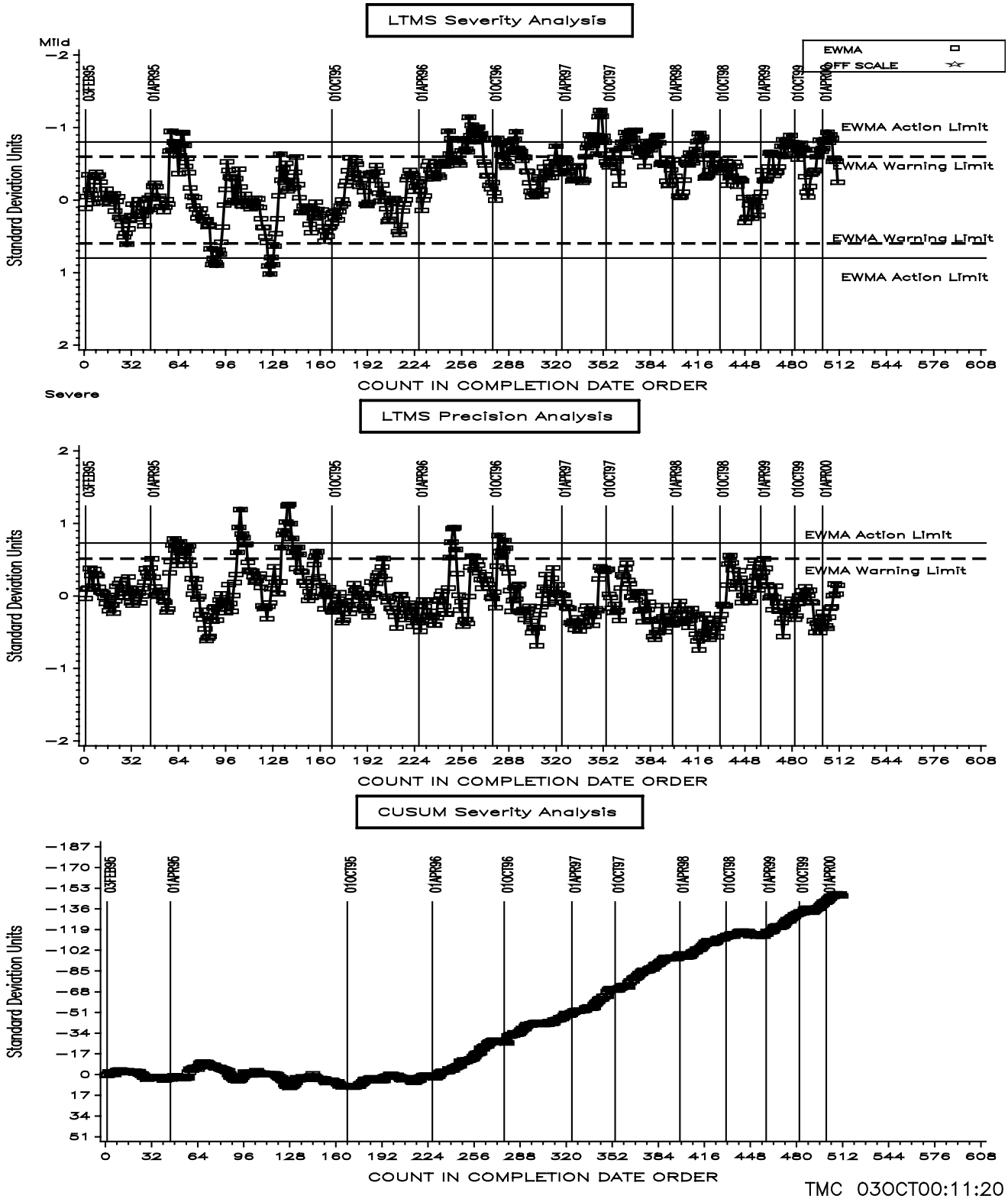
SEQUENCE VE INDUSTRY OPERATIONALLY VALID DATA

Maximum Camshaft Wear (Micrometers)

Figure 5



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SEQUENCE VE INDUSTRY OPERATIONALLY VALID DATA

Average Camshaft Wear (Micrometers)

Figure 6

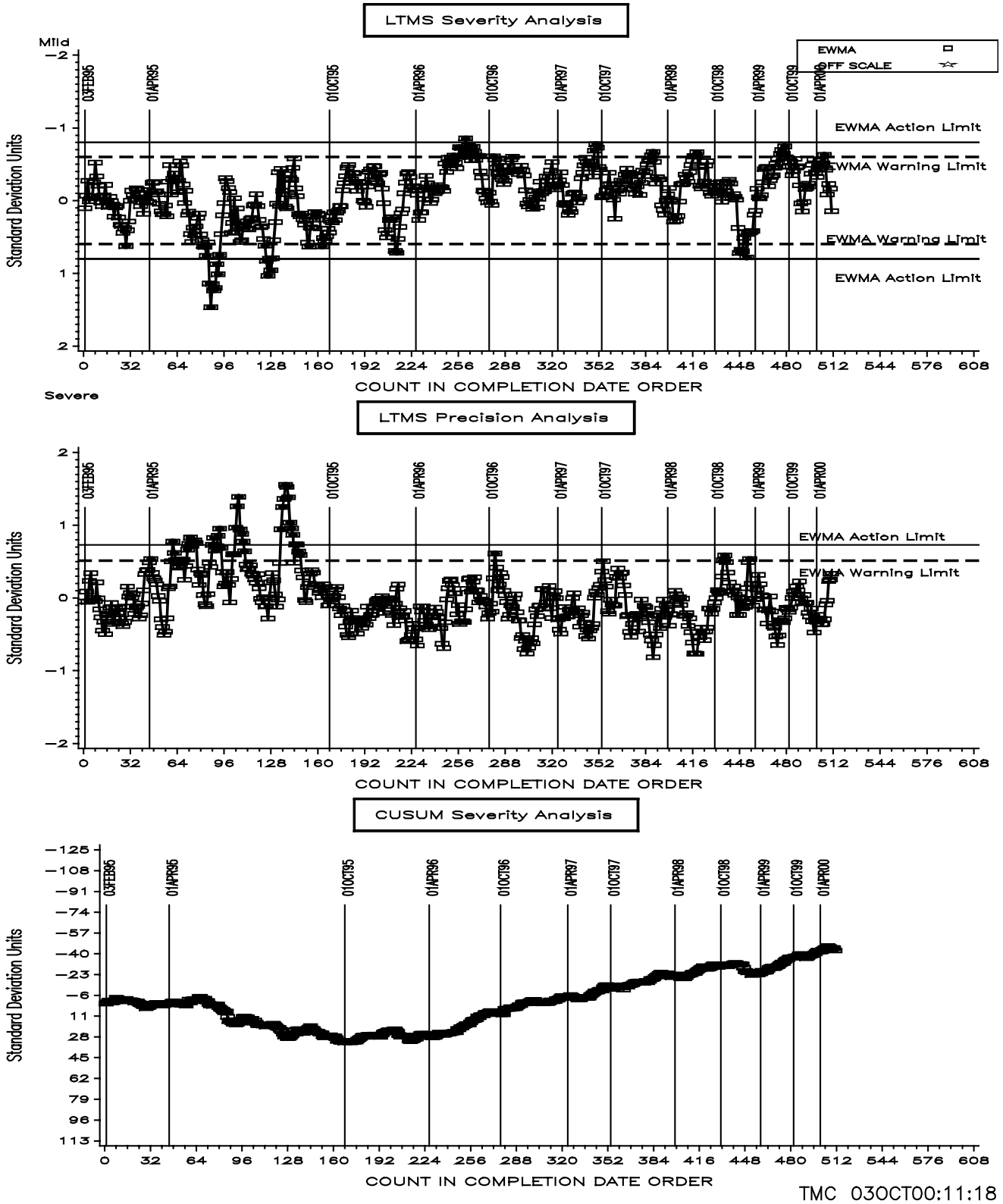

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Figure 7

Sequence VE
Sludge Precision Estimates by Report Period

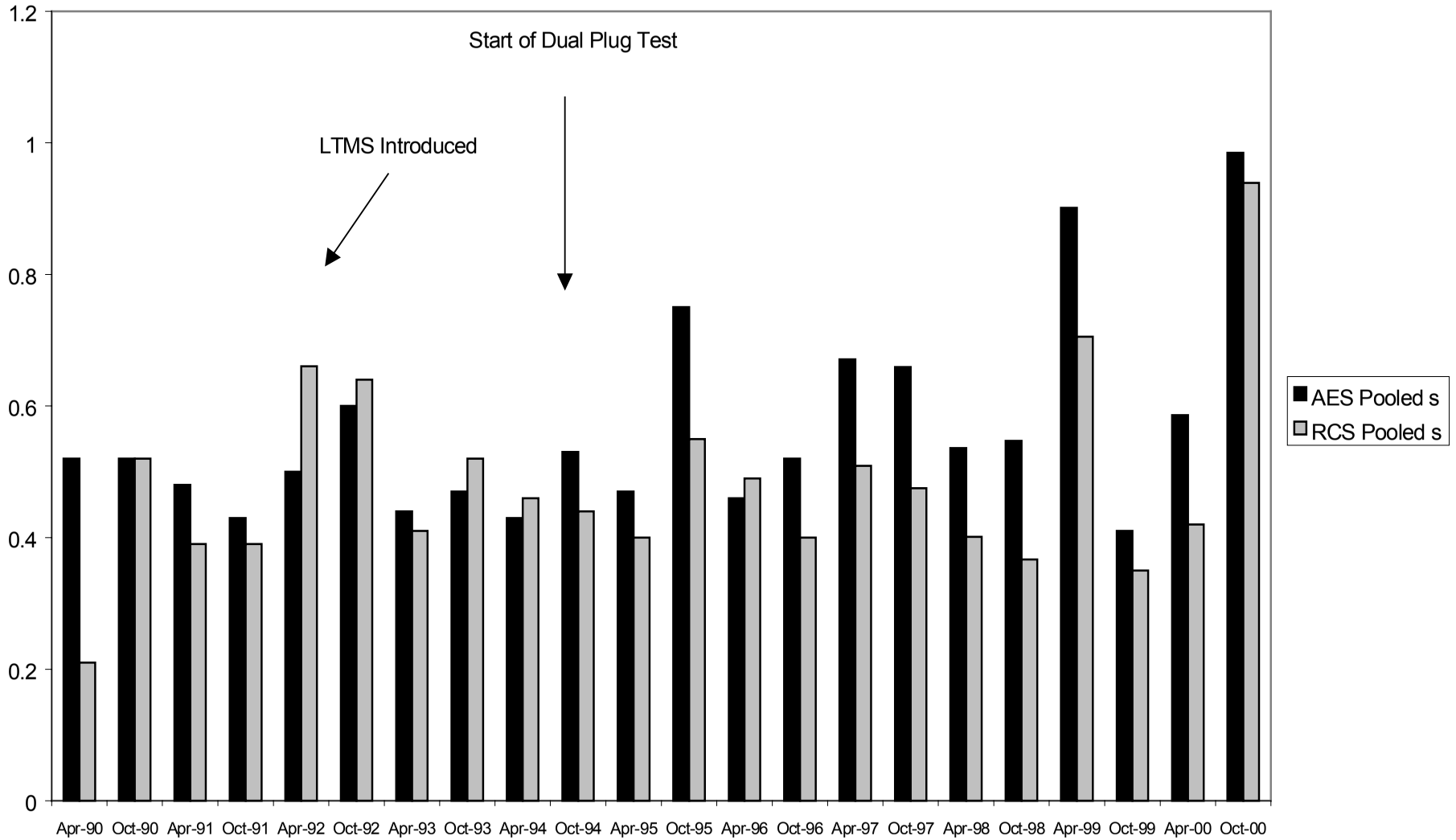

Figure 8

Sequence VE
Varnish Precision Estimates by Report Period

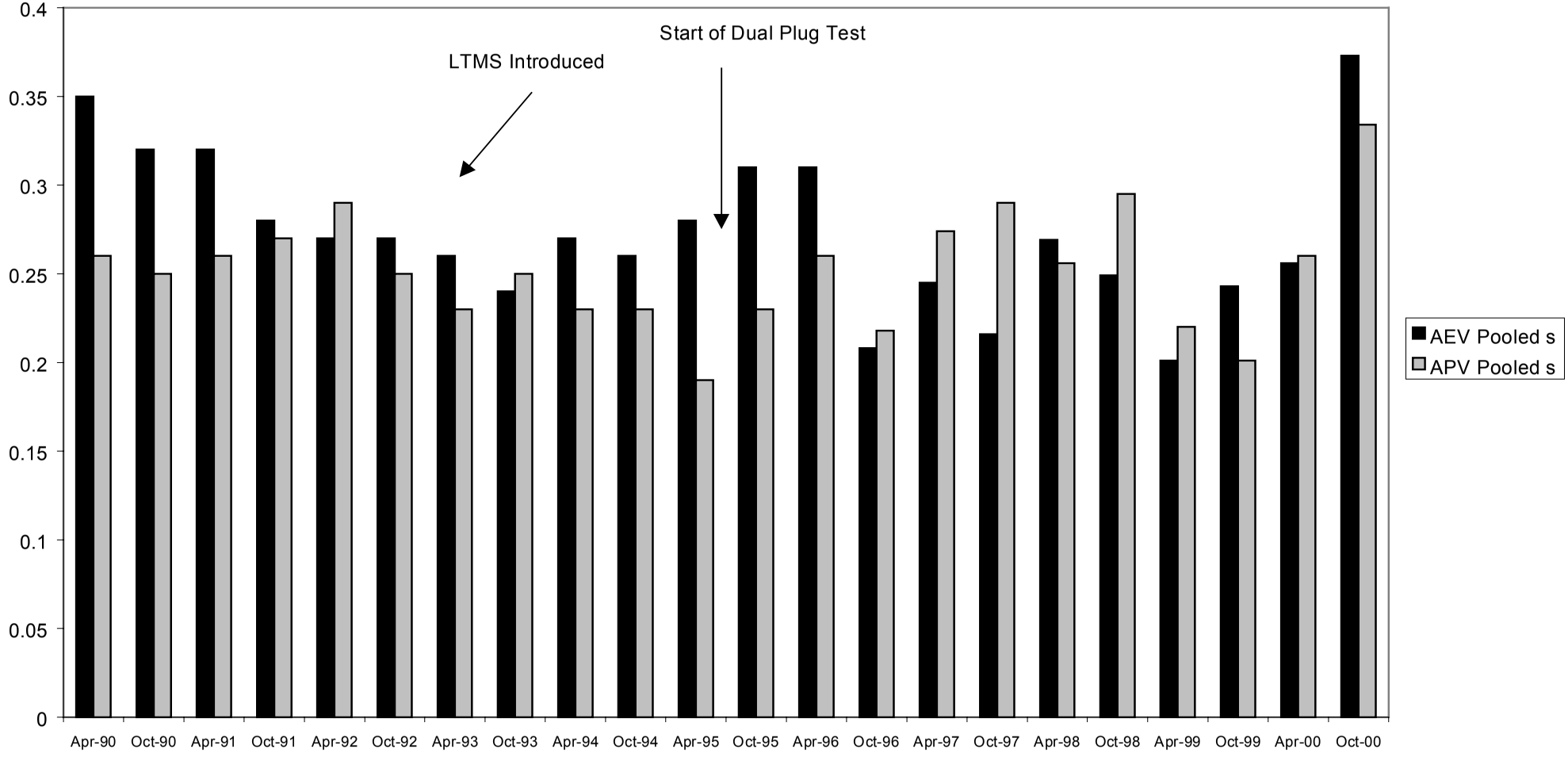

Figure 9

Sequence VE
Wear Precision Estimates by Report Period