Test Monitoring Center
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Memorandum: 00-151

Date: October 23, 2000

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

From: Michael T. Kasimirsky

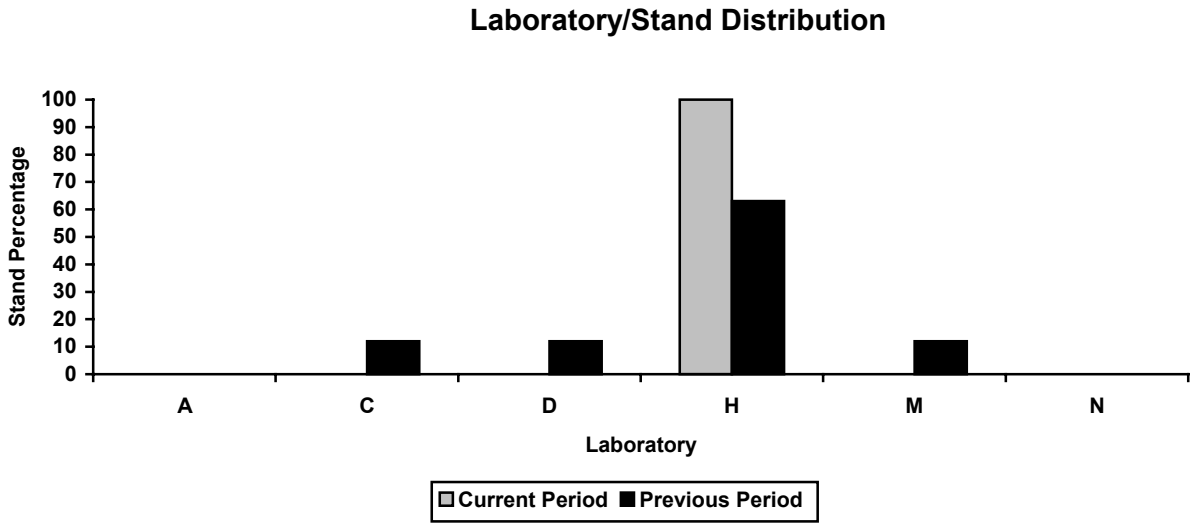
Subject: Sequence IIIE Semiannual Report: April 1, 2000 through September 30, 2000

The following is a summary of Sequence IIIE reference tests that were reported to the Test Monitoring Center during the period April 1, 2000 through September 30, 2000.

Lab/Stand Distribution

	Reporting Data	Calibrated as of September 30, 2000
Number of Laboratories:	1	1
Number of Test Stands:	1	1

The following chart shows the laboratory/stand distribution:

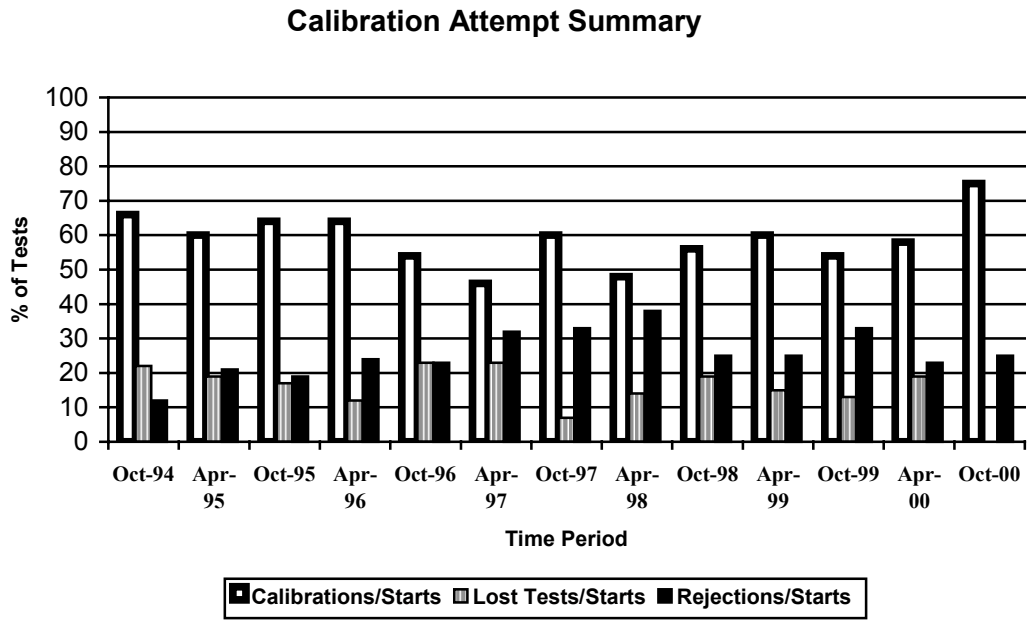


The following summarizes the status of the reference oil tests reported to the TMC:

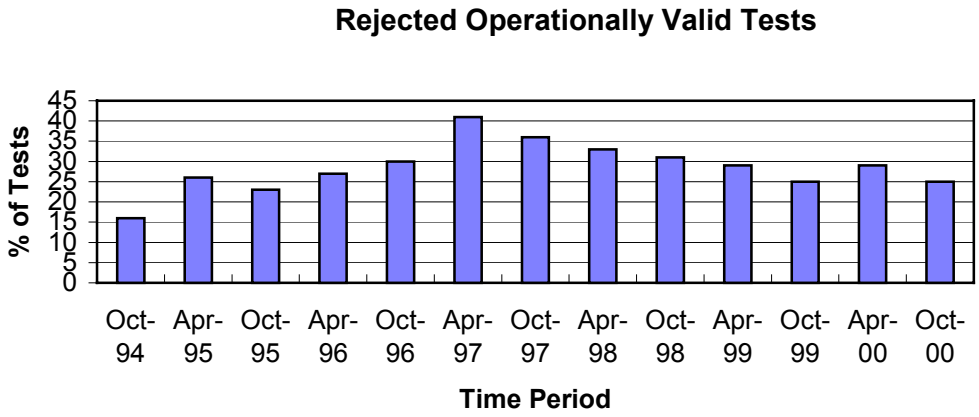
Calibration Start Outcomes	TMC Validity Codes	No. of Tests
Operationally and Statistically Acceptable	AC	3
Failed Acceptance Criteria	OC	1
Operationally Invalid (Laboratory Judgment)	LC	0
Stand Failed Reference Sequence – Data Pulled	MC	0
Operationally Invalid (Lab & TMC Judgment)	RC	0
Aborted	XC	0
Total		4

Donated & Industry Support Outcomes	TMC Validity Codes	No. of Tests
None		0
Total		0

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

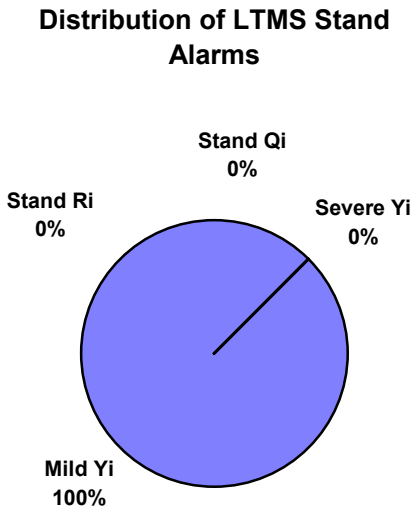


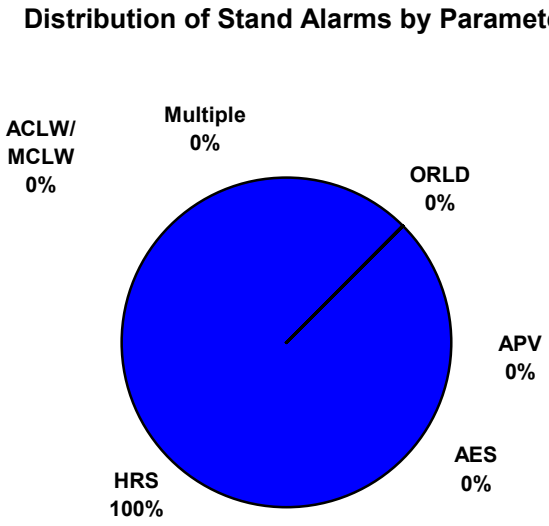
The calibration per start rate is slightly better than last period. The lost test rate is better than last period. The rejected test rate is slightly worse than last period. Given the reduced levels of test activity, none of these changes are significant.



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

The following charts summarize the reasons and breakdown by parameter for the failed test:

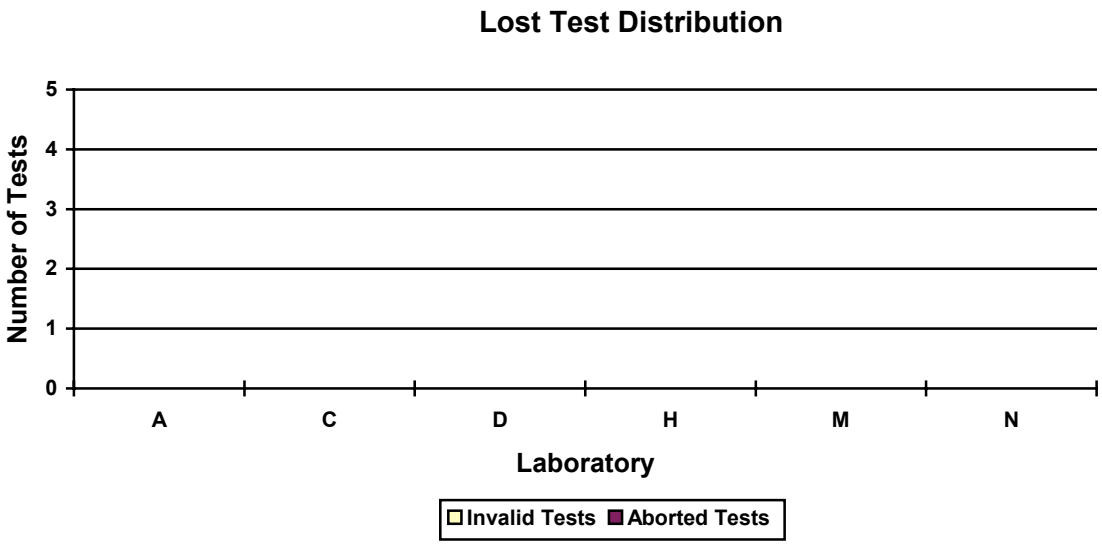




There were no LTMS deviations this period. There have been 13 deviations from the LTMS since its introduction in 1992. No applications of the 6X rule were made this period.

Aborts and Operationally Invalid tests by laboratory are summarized in the following charts:

Lab	Reason for Lost Test	Number of Tests	Breakdown of Tests (LC/RC/XC)
-	No lost tests	0	1/0/0



Information Letters

There were no Sequence IIIE Information Letters issued this period.

Sequence IIIE ASTM Standard Test Method Update

The Revised Sequence IIIE Standard, D5533-98$^{\varepsilon 1}$, which incorporates all the changes included in Information Letters through 98-1, is currently available from ASTM Headquarters.

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
HRS	1.29	3.31 (df=2)	4.3 hours
ACLW	0.582	0.376 (df=2)	7.3 µm[A]
APV	0.421	0.131 (df=2)	0.06 merits
AES	1.026	0.024 (df=2)	0.02 merits[B]
MCLW	0.196	0.354 (df=2)	4.6 µm[C]
ORLD	-0.972	0.103 (df=2)	-0.10 merits

[A] At the API SJ Pass Limit (30 µm)
[B] At the API SJ Pass Limit (9.20 merits)
[C] At the API SJ Pass Limit (64 µm)

Average Δ/s by Laboratory						
Laboratory	HOURS	ACLW	APV	AES	MCLW	ORLD
C	-	-	-	-	-	-
D	-	-	-	-	-	-
H	1.29	0.582	0.421	1.026	0.196	-0.972
M	-	-	-	-	-	-

Below is a summary of severity and precision of each parameter for the report period:

HOURS TO 375% VISCOSITY INCREASE (HRS)

The industry experiencing a severity alarm on HRS for the period (see Figures 1 and 7). Precision for the period is better than last period and is better than to the best historical performance of the Sequence IIIE test (see Figure 13). Given that all the data for the period is from one laboratory, this is not unexpected.

AVERAGE CAM PLUS LIFTER WEAR (ACLW)

The industry is within limits on ACLW for the period (see Figures 2 and 8). The pooled standard deviation has improved since the last period and is comparable to the best historical performance since the introduction of the test camshaft (See Figure 14).

AVERAGE PISTON SKIRT VARNISH (APV)

The industry is within limits for both severity and precision for the period on APV (see Figures 3 and 9). The pooled standard deviation for the period is comparable to the last several periods (see Figure 15).

AVERAGE ENGINE SLUDGE (AES)

The industry is within limits for both severity and precision for the period on AES (see Figures 4 and 10). The pooled standard deviation for the period is much better than last period and is comparable to the best periods of historical performance (see Figure 16). Given that all the data for the period is from one laboratory, this is not unexpected.

MAXIMUM CAM & LIFTER WEAR (MCLW)

The industry is within limits on MCLW for the period (see Figures 5 and 11). The pooled standard deviation has improved significantly since the last period (see Figure 14). Given that all the data for the period is from one laboratory, this is not unexpected.

OIL RING LAND DEPOSITS (ORLD)

The industry is within limits for both severity and precision for the period on ORLD (see Figures 6 and 12). The pooled standard deviation has improved significantly since the last period and is comparable to periods of best historical performance (see Figure 15). Given that all the data for the period is from one laboratory, this is not unexpected.

Hardware

No hardware changes were made this period.

Reference Oils

Oil	TMC Inventory, in gallons	TMC Inventory, in tests	Laboratory Inventory, in tests	Estimated life
402-1	273	18	1	remaining IIIE test life
424-1	27	6	0	Frozen for IIIF correlation
425-2	249	62	8	No longer used
404-1	22	5	0	remaining IIIE test life[1]
1002	4,428	1,107	0	remaining IIIE test life[2]
1006	1,552	388	2	No longer used[2]
476-4	614	153	19	No longer used[3]
403	359	89	4	remaining IIIE test life[4]

[1] To be assigned as necessary by TMC to investigate industry or laboratory problems.
[2] Multiple test area reference oil; total TMC inventory shown
[3] Former Discrimination Oil
[4] 10% usage oil; one run per lab per year minimum required

Reference oils supplies are sufficient to last the remaining life of the Sequence IIIE Test.

MTK/mtk

Attachments

c: F. M. Farber, TMC
Sequence IIIE Surveillance Panel

TABLES AND FIGURES

- Table 1 is a summary of hours to 375% viscosity increase, deposits, cam plus lifter wear and oil consumption for all operationally valid Sequence IIIE tests through the end of the period.

- Table 2 is a summary of camshaft and lifter wear for all operationally valid Sequence IIIE tests through the end of the period.

- Table 3 is a summary of sludge parts deposit ratings for all operationally valid Sequence IIIE tests through the end of the period.

- Table 4 is a listing of all operationally valid Sequence IIIE tests reported to the TMC during this report period.

Tables with the suffix "A" summarize operationally valid Sequence IIIE tests for this ASTM report period.

- Figures 1 through 6 are EWMA severity and precision control charts and also the CUSUM Δ/s plots of the six test acceptance parameters, annotated with date lines, using the same data set as the EWMA severity and precision control charts. Transformed units are used, when appropriate.

- Figures 7 through 12 are EWMA severity and precision control charts and also the CUSUM Δ/s plots of the six test acceptance parameters, annotated with date lines, using the same data set as the EWMA severity and precision control charts. Transformed units are used, when appropriate. Only the last 25 data points are shown on these charts.

- Figures 13 through 16 are bar charts of pooled standard deviation by report period for the six acceptance parameters.

- Figure 17 is the Sequence IIIE Timeline, created to track changes in test hardware and operations, current through October 23, 2000.

The CUSUM plots were derived using the targets issued January 1, 1992 and the latest version of test targets for any newly introduced reference oils (oils 1006, 1002, 404-1, 402-1, and 425-2).

Sequence IIIE Reference Oil Acceptance Parameter Summary

All Operationally Valid Tests Through September 30, 2000

OIL	N	TEST PARAMETER	MEANS TRANS	ORIG	s	MIN	MAX
1002	202	Hours to 375		79.9	1.703	74.8	83.1
		Avg. Engine Sludge	0.89	9.59	0.129	9.43	9.75
		Avg. Piston Varnish		9.09	0.151	8.62	9.46
		Ring Land Deposits		3.79	0.774	2.51	6.29
		Avg. Cam + Lifter Wear	2.177	8.8	0.353	3.9	39.2
		Max. Cam + Lifter Wear	2.785	16	0.613	7	135
		Oil Consumption		2.81	0.317	2.05	4.05
1006	11	Hours to 375		69.5	7.893	57	80.1
		Avg. Engine Sludge	0.717	9.51	0.106	9.41	9.58
		Avg. Piston Varnish		8.83	0.317	8.15	9.16
		Ring Land Deposits		3.3	0.817	2.35	5.17
		Avg. Cam + Lifter Wear	1.649	5.2	0.298	2.8	7.4
		Max. Cam + Lifter Wear	2.275	10	0.482	6	38
		Oil Consumption		3.56	0.302	3.07	4.16
400	25	Hours to 375		57.7	5.479	50.2	68.8
		Avg. Engine Sludge	0.522	9.41	0.149	9.23	9.53
		Avg. Piston Varnish		8.69	0.383	7.68	9.28
		Ring Land Deposits		4.06	0.857	2.69	6.25
		Avg. Cam + Lifter Wear	2.911	18.4	0.719	4	109.6
		Max. Cam + Lifter Wear	3.762	43	1.058	10	419
		Oil Consumption		3.35	0.394	2.63	4.22
402	128	Hours to 375		62.2	8.022	44	78.9
		Avg. Engine Sludge	0.504	9.4	0.184	9.01	9.6
		Avg. Piston Varnish		8.84	0.247	7.86	9.27
		Ring Land Deposits		6.5	1.301	3.04	8.56
		Avg. Cam + Lifter Wear	3.746	42.4	1.174	5.2	812.9
		Max. Cam + Lifter Wear	4.797	121	1.44	11	3805
		Oil Consumption		2.84	0.417	2	4.17
402-1	154	Hours to 375		63	7.831	47.4	78.8
		Avg. Engine Sludge	0.48	9.38	0.16	9.06	9.61
		Avg. Piston Varnish		8.96	0.17	8.48	9.32
		Ring Land Deposits		7.49	0.941	4.52	9.41
		Avg. Cam + Lifter Wear	4.053	57.5	0.599	10.3	221.5
		Max. Cam + Lifter Wear	4.855	128	0.641	16	802
		Oil Consumption		2.81	0.391	1.77	4.02
403	85	Hours to 375		43.9	6.825	25.2	61.7
		Avg. Engine Sludge	-0.091	8.9	0.504	5.85	9.54
		Avg. Piston Varnish		8.34	0.41	7.28	9.12
		Ring Land Deposits		2.93	0.687	1.28	4.56
		Avg. Cam + Lifter Wear	4.886	132.4	0.694	14.8	624.4
		Max. Cam + Lifter Wear	5.879	357	1.061	25	4328
		Oil Consumption		3.48	0.596	1.6	5.17

Sequence IIIE Reference Oil Acceptance Parameter Summary

All Operationally Valid Tests Through September 30, 2000

OIL	N	TEST PARAMETER	MEANS TRANS	MEANS ORIG	s	MIN	MAX
404	28	Hours to 375		48.9	5.046	33	57.7
		Avg. Engine Sludge	0.209	9.19	0.32	8.13	9.46
		Avg. Piston Varnish		8.66	0.407	7.61	9.22
		Ring Land Deposits		3.17	0.843	1.78	4.68
		Avg. Cam + Lifter Wear	2.913	18.4	0.451	6.4	51.4
		Max. Cam + Lifter Wear	3.491	33	0.571	10	104
		Oil Consumption		4.31	0.432	3.58	4.91
404-1	66	Hours to 375		57.9	8.342	40	74.8
		Avg. Engine Sludge	0.452	9.36	0.231	8.75	9.59
		Avg. Piston Varnish		9.03	0.212	8.47	9.38
		Ring Land Deposits		4.46	0.883	2.45	5.97
		Avg. Cam + Lifter Wear	2.451	11.6	0.454	4	40.2
		Max. Cam + Lifter Wear	3.23	25	0.596	6	127
		Oil Consumption		3.88	0.508	2.55	4.84
424	17	Hours to 375		72.6	3.214	67.8	77.3
		Avg. Engine Sludge	0.717	9.51	0.088	9.43	9.59
		Avg. Piston Varnish		8.93	0.238	8.46	9.19
		Ring Land Deposits		2.77	0.642	1.83	3.92
		Avg. Cam + Lifter Wear	2.871	17.7	0.317	10.2	31.1
		Max. Cam + Lifter Wear	3.3	27	0.309	18	46
		Oil Consumption		3.08	0.361	2.6	3.94
424-1	110	Hours to 375		74.3	4.828	47.1	79.2
		Avg. Engine Sludge	0.698	9.5	0.152	9	9.61
		Avg. Piston Varnish		9.02	0.23	7.88	9.45
		Ring Land Deposits		3.31	0.708	1.56	5.18
		Avg. Cam + Lifter Wear	2.328	10.3	0.36	1.9	24.7
		Max. Cam + Lifter Wear	2.945	19	0.516	7	96
		Oil Consumption		3.2	0.464	2.3	4.55
425	12	Hours to 375		51.7	3.817	48	57.8
		Avg. Engine Sludge	0.199	9.18	0.361	8.64	9.52
		Avg. Piston Varnish		8.64	0.384	8.03	9.24
		Ring Land Deposits		2.11	0.376	1.48	2.77
		Avg. Cam + Lifter Wear	2.679	14.6	0.577	5.1	40.9
		Max. Cam + Lifter Wear	3.475	32	0.825	13	297
		Oil Consumption		3.72	0.461	3.08	4.5
425-1	57	Hours to 375		51.5	7.087	40	66.1
		Avg. Engine Sludge	0.148	9.14	0.557	6.22	9.61
		Avg. Piston Varnish		8.65	0.33	7.89	9.27
		Ring Land Deposits		2.37	0.626	1.23	4.25
		Avg. Cam + Lifter Wear	2.393	11	0.522	1.9	52.1
		Max. Cam + Lifter Wear	3.064	21	0.705	8	358
		Oil Consumption		3.79	0.592	2.63	5.27

Sequence IIIE Reference Oil Acceptance Parameter Summary

All Operationally Valid Tests Through September 30, 2000

OIL	N	TEST PARAMETER	MEANS TRANS	MEANS ORIG	s	MIN	MAX
425-2	46	Hours to 375		51.7	4.701	42.1	60.3
		Avg. Engine Sludge	0.305	9.26	0.217	8.42	9.47
		Avg. Piston Varnish		8.73	0.284	8.19	9.2
		Ring Land Deposits		2.88	0.64	1.96	4.66
		Avg. Cam + Lifter Wear	2.09	8.1	0.416	3.8	21.8
		Max. Cam + Lifter Wear	2.887	18	0.706	5	86
		Oil Consumption		3.55	0.575	1.02	4.51
476-4	57	Hours to 375		37.8	6.139	25.6	56.8
		Avg. Engine Sludge	-0.403	8.5	0.469	6.05	9.5
		Avg. Piston Varnish		8.34	0.412	7.31	9.05
		Ring Land Deposits		2.43	0.688	1.2	4.23
		Avg. Cam + Lifter Wear	2.51	12.3	0.426	5.3	29.8
		Max. Cam + Lifter Wear	3.215	25	0.573	9	94
		Oil Consumption		3.72	0.776	1.1	5.36

Sequence IIIE Reference Oil Acceptance Parameter Summary

Operationally Valid Tests April 1, 2000 Through September 30, 2000

OIL	N	TEST PARAMETER	MEANS TRANS	MEANS ORIG	s	MIN	MAX
1002	2	Hours to 375		81.3	0.919	80.6	81.9
		Avg. Engine Sludge	1.036	9.65	0.02	9.64	9.65
		Avg. Piston Varnish		9.06	0.141	8.96	9.16
		Ring Land Deposits		2.92	0.057	2.88	2.96
		Avg. Cam + Lifter Wear	2.38	10.8	0.228	9.2	12.7
		Max. Cam + Lifter Wear	2.636	14	0.101	13	15
		Oil Consumption		2.9	0.537	2.52	3.28
402-1	2	Hours to 375		75.6	4.596	72.3	78.8
		Avg. Engine Sludge	0.654	9.48	0.027	9.47	9.49
		Avg. Piston Varnish		9.14	0.12	9.05	9.22
		Ring Land Deposits		6.89	0.134	6.79	6.98
		Avg. Cam + Lifter Wear	3.94	51.4	0.48	36.6	72.2
		Max. Cam + Lifter Wear	4.89	133	0.49	94	188
		Oil Consumption		2.65	0.014	2.64	2.66

Sequence IIIE Reference Oil Camshaft and Lifter Wear Summary

All Operationally Valid Tests Through September 30, 2000

OIL	N	WEAR PART	MEAN TRANS	ORIG	s	MIN	MAX
1002	202	Cam Wear Avg.	.	0.3	0.885	0	6
		Lifter Wear Avg.	.	8.8	3.996	3	38
		Cam & Lifter Avg.	2.177	8.8	0.353	3.9	39.2
		Cam & Lifter Max.	0.401	1.5	0.62	1	13
1006	11	Cam Wear Avg.	.	0.2	0.603	0	2
		Lifter Wear Avg.	.	5.5	1.128	4	7
		Cam & Lifter Avg.	1.649	5.2	0.298	2.8	7.4
		Cam & Lifter Max.	0.22	1.2	0.491	1	3
400	25	Cam Wear Avg.	.	6.8	3.613	1	15
		Lifter Wear Avg.	.	16	19.255	1	95
		Cam & Lifter Avg.	2.911	18.4	0.719	4	109.6
		Cam & Lifter Max.	1.335	3.8	1.112	1	41
402	128	Cam Wear Avg.	.	25.5	69.916	0	471
		Lifter Wear Avg.	.	65.5	87.681	3	531
		Cam & Lifter Avg.	3.746	42.4	1.174	5.2	812.9
		Cam & Lifter Max.	2.395	11	1.538	1	380
402-1	154	Cam Wear Avg.	.	9.8	37.719	0	253
		Lifter Wear Avg.	.	66.2	37.198	9	191
		Cam & Lifter Avg.	4.053	57.5	0.599	10.3	221.5
		Cam & Lifter Max.	2.507	12.3	0.678	1	80
403	85	Cam Wear Avg.	.	42.8	66.156	0	308
		Lifter Wear Avg.	.	129.7	64.405	6	385
		Cam & Lifter Avg.	4.886	132.4	0.694	14.8	624.4
		Cam & Lifter Max.	3.557	35.1	1.078	2	432
404	28	Cam Wear Avg.	.	7.4	3.633	0	13
		Lifter Wear Avg.	.	12.1	8.196	4	40
		Cam & Lifter Avg.	2.913	18.4	0.451	6.4	51.4
		Cam & Lifter Max.	1.033	2.8	0.643	1	10
404-1	66	Cam Wear Avg.	.	0.4	0.682	0	3
		Lifter Wear Avg.	.	11.9	6.254	4	37
		Cam & Lifter Avg.	2.451	11.6	0.454	4	40.2
		Cam & Lifter Max.	0.748	2.1	0.682	1	12
424	17	Cam Wear Avg.	.	6	2.784	2	12
		Lifter Wear Avg.	.	11.5	5.198	5	25
		Cam & Lifter Avg.	2.871	17.7	0.317	10.2	31.1
		Cam & Lifter Max.	0.846	2.3	0.355	1	4

Sequence IIIE Reference Oil Camshaft and Lifter Wear Summary

All Operationally Valid Tests Through September 30, 2000

OIL	N	WEAR PART	MEAN TRANS	ORIG	s	MIN	MAX
424-1	110	Cam Wear Avg.	.	1.3	2.13	0	9
		Lifter Wear Avg.	.	8.8	3.396	1	23
		Cam & Lifter Avg.	2.328	10.3	0.36	1.9	24.7
		Cam & Lifter Max.	0.492	1.6	0.537	1	9
425	12	Cam Wear Avg.	.	6.7	3.143	0	11
		Lifter Wear Avg.	.	9.3	8.013	3	32
		Cam & Lifter Avg.	2.679	14.6	0.577	5.1	40.9
		Cam & Lifter Max.	1.026	2.8	0.892	1	29
425-1	57	Cam Wear Avg.	.	3.8	3.239	0	11
		Lifter Wear Avg.	.	7.9	6.11	1	40
		Cam & Lifter Avg.	2.393	11	0.522	1.9	52.1
		Cam & Lifter Max.	0.622	1.9	0.758	1	35
425-2	46	Cam Wear Avg.	.	0.5	0.809	0	3
		Lifter Wear Avg.	.	8.2	3.687	2	19
		Cam & Lifter Avg.	2.09	8.1	0.416	3.8	21.8
		Cam & Lifter Max.	0.588	1.8	0.711	1	8
476-4	57	Cam Wear Avg.	.	3.5	3.295	0	11
		Lifter Wear Avg.	.	9.1	4.951	2	28
		Cam & Lifter Avg.	2.51	12.3	0.426	5.3	29.8
		Cam & Lifter Max.	0.72	2.1	0.652	1	9

Sequence IIIE Reference Oil Camshaft and Lifter Wear Summary

Operationally Valid Tests April 1, 2000 Through September 30, 2000

OIL	N	WEAR PART	MEAN TRANS	MEAN ORIG	s	MIN	MAX
1002	2	Cam Wear Avg.	.	0	0	0	0
		Lifter Wear Avg.	.	11	2.828	9	13
		Cam & Lifter Avg.	2.38	10.8	0.228	9.2	12.7
		Cam & Lifter Max.	0	1	0	1	1
402-1	2	Cam Wear Avg.	.	1	1.414	0	2
		Lifter Wear Avg.	.	54	24.042	37	71
		Cam & Lifter Avg.	3.94	51.4	0.48	36.6	72.2
		Cam & Lifter Max.	2.544	12.7	0.49	9	18

Sequence IIIE Reference Oil Sludge Rating Summary

All Operationally Valid Tests Through September 30, 2000

OIL	N	SLUDGE PART	TRANS	ORIG	s	MIN	MAX
1002	202	Front Cover Deflector	1.072	9.66	0.23	9.45	9.85
		Right Rocker Cover	0.835	9.57	0.14	9.41	9.75
		Left Rocker Cover	0.864	9.58	0.144	9.4	9.75
		Right Rocker Cover Baffle	0.852	9.57	0.155	9.43	9.75
		Left Rocker Cover Baffle	0.875	9.58	0.147	9.43	9.75
1006	11	Front Cover Deflector	0.817	9.56	0.209	9.32	9.67
		Right Rocker Cover	0.688	9.5	0.094	9.4	9.56
		Left Rocker Cover	0.691	9.5	0.082	9.43	9.56
		Right Rocker Cover Baffle	0.692	9.5	0.116	9.42	9.6
		Left Rocker Cover Baffle	0.722	9.51	0.103	9.45	9.6
400	25	Front Cover Deflector	0.581	9.44	0.271	9.22	9.7
		Right Rocker Cover	0.487	9.39	0.144	9.19	9.5
		Left Rocker Cover	0.524	9.41	0.154	9.23	9.52
		Right Rocker Cover Baffle	0.511	9.4	0.147	9.25	9.5
		Left Rocker Cover Baffle	0.533	9.41	0.146	9.25	9.52
402	128	Front Cover Deflector	0.618	9.46	0.287	9	9.8
		Right Rocker Cover	0.47	9.37	0.161	9.1	9.55
		Left Rocker Cover	0.504	9.4	0.172	9.11	9.59
		Right Rocker Cover Baffle	0.463	9.37	0.198	8.74	9.57
		Left Rocker Cover Baffle	0.492	9.39	0.209	8.96	9.6
402-1	154	Front Cover Deflector	0.547	9.42	0.254	8.75	9.75
		Right Rocker Cover	0.455	9.37	0.164	9.05	9.56
		Left Rocker Cover	0.48	9.38	0.163	9.05	9.6
		Right Rocker Cover Baffle	0.46	9.37	0.165	9	9.6
		Left Rocker Cover Baffle	0.48	9.38	0.168	9	9.57
403	85	Front Cover Deflector	-0.644	8.1	0.863	2.05	9.57
		Right Rocker Cover	0.208	9.19	0.385	6.68	9.57
		Left Rocker Cover	0.187	9.17	0.485	3.96	9.57
		Right Rocker Cover Baffle	0.235	9.21	0.32	6.75	9.54
		Left Rocker Cover Baffle	0.219	9.2	0.396	5.74	9.52
404	28	Front Cover Deflector	-0.092	8.9	0.712	3.59	9.57
		Right Rocker Cover	0.358	9.3	0.133	9.07	9.45
		Left Rocker Cover	0.384	9.32	0.163	8.94	9.45
		Right Rocker Cover Baffle	0.344	9.29	0.193	8.66	9.47
		Left Rocker Cover Baffle	0.364	9.3	0.165	9	9.5
404-1	66	Front Cover Deflector	0.449	9.36	0.423	7.83	9.73
		Right Rocker Cover	0.466	9.37	0.216	9.07	9.65
		Left Rocker Cover	0.489	9.39	0.217	9	9.65
		Right Rocker Cover Baffle	0.444	9.36	0.194	8.86	9.55
		Left Rocker Cover Baffle	0.461	9.37	0.204	8.86	9.57

Sequence IIIE Reference Oil Sludge Rating Summary

All Operationally Valid Tests Through September 30, 2000

OIL	N	SLUDGE PART	TRANS	ORIG	s	MIN	MAX
424	17	Front Cover Deflector	0.984	9.63	0.19	9.5	9.73
		Right Rocker Cover	0.667	9.49	0.133	9.32	9.6
		Left Rocker Cover	0.682	9.49	0.124	9.33	9.59
		Right Rocker Cover Baffle	0.648	9.48	0.136	9.27	9.55
		Left Rocker Cover Baffle	0.666	9.49	0.143	9.25	9.57
424-1	110	Front Cover Deflector	0.894	9.59	0.27	8.6	9.75
		Right Rocker Cover	0.667	9.49	0.134	9.21	9.62
		Left Rocker Cover	0.706	9.51	0.141	9.27	9.63
		Right Rocker Cover Baffle	0.627	9.47	0.183	8.9	9.67
		Left Rocker Cover Baffle	0.646	9.48	0.194	9	9.7
425	12	Front Cover Deflector	-0.198	8.78	0.738	6.65	9.53
		Right Rocker Cover	0.321	9.27	0.223	8.76	9.49
		Left Rocker Cover	0.349	9.29	0.234	8.84	9.52
		Right Rocker Cover Baffle	0.426	9.35	0.195	9.08	9.55
		Left Rocker Cover Baffle	0.442	9.36	0.189	9.08	9.53
425-1	57	Front Cover Deflector	-0.121	8.87	0.889	3.8	9.67
		Right Rocker Cover	0.213	9.19	0.477	6.54	9.6
		Left Rocker Cover	0.239	9.21	0.492	6.76	9.6
		Right Rocker Cover Baffle	0.323	9.28	0.423	6.55	9.6
		Left Rocker Cover Baffle	0.351	9.3	0.419	6.55	9.63
425-2	46	Front Cover Deflector	0.199	9.18	0.249	8.05	9.52
		Right Rocker Cover	0.265	9.23	0.24	8.35	9.47
		Left Rocker Cover	0.283	9.25	0.257	8.27	9.48
		Right Rocker Cover Baffle	0.414	9.34	0.23	8.52	9.53
		Left Rocker Cover Baffle	0.427	9.35	0.258	8.52	9.55
476-4	57	Front Cover Deflector	-1.2	6.68	0.681	3.55	9.53
		Right Rocker Cover	-0.053	8.95	0.62	4.5	9.5
		Left Rocker Cover	0.02	9.02	0.574	6.07	9.5
		Right Rocker Cover Baffle	0.112	9.11	0.376	6.92	9.5
		Left Rocker Cover Baffle	0.192	9.17	0.375	6.75	9.5

Sequence IIIE Reference Oil Sludge Rating Summary

Operationally Valid Tests April 1, 2000 Through September 30, 2000

OIL	N	SLUDGE PART	TRANS	ORIG	s	MIN	MAX
1002	2	Front Cover Deflector	1.459	9.77	0.361	9.7	9.82
		Right Rocker Cover	0.961	9.62	0.166	9.57	9.66
		Left Rocker Cover	0.957	9.62	0.092	9.59	9.64
		Right Rocker Cover Baffle	0.983	9.63	0.094	9.6	9.65
		Left Rocker Cover Baffle	0.954	9.61	0.219	9.55	9.67
402-1	2	Front Cover Deflector	0.755	9.53	0.03	9.52	9.54
		Right Rocker Cover	0.666	9.49	0.096	9.45	9.52
		Left Rocker Cover	0.645	9.48	0.04	9.46	9.49
		Right Rocker Cover Baffle	0.608	9.46	0.065	9.43	9.48
		Left Rocker Cover Baffle	0.598	9.45	0	9.45	9.45

Sequence IIIE Reference Data

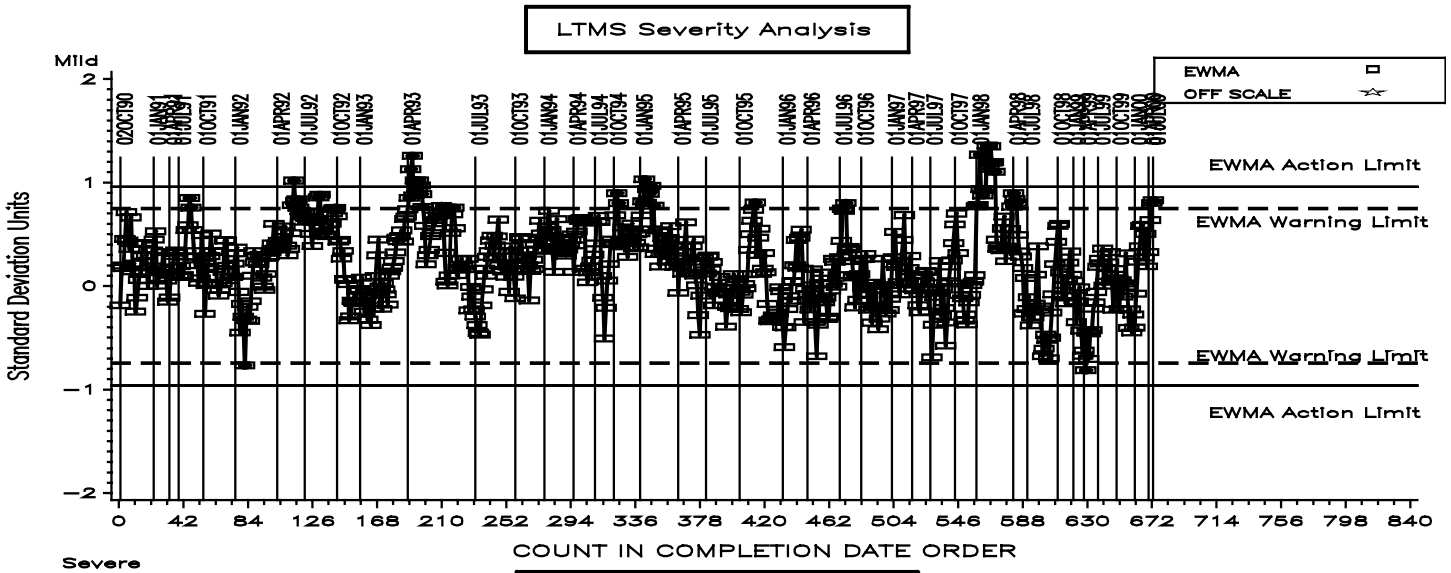
Operationally Valid Tests April 1, 2000 Through September 30, 2000

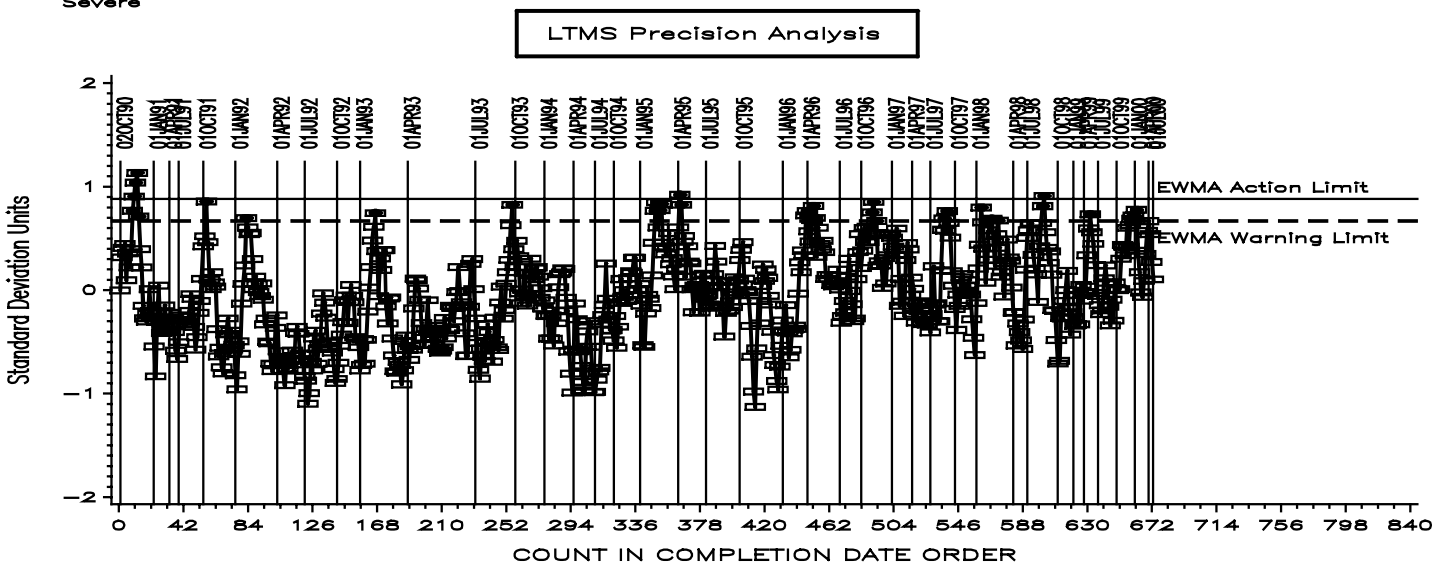
Date Completed	Oil	Hours to 375	Oil Consump.	ACLW	MCLW	AES	APV	ORLD
200004	402-1	78.8	2.66	72.2	188	9.47	9.05	6.98
200004	1002	80.6	3.28	9.2	13	9.64	8.96	2.96
200005	1002	81.9	2.52	12.7	15	9.65	9.16	2.88
200007	402-1	72.3	2.64	36.6	94	9.49	9.22	6.79

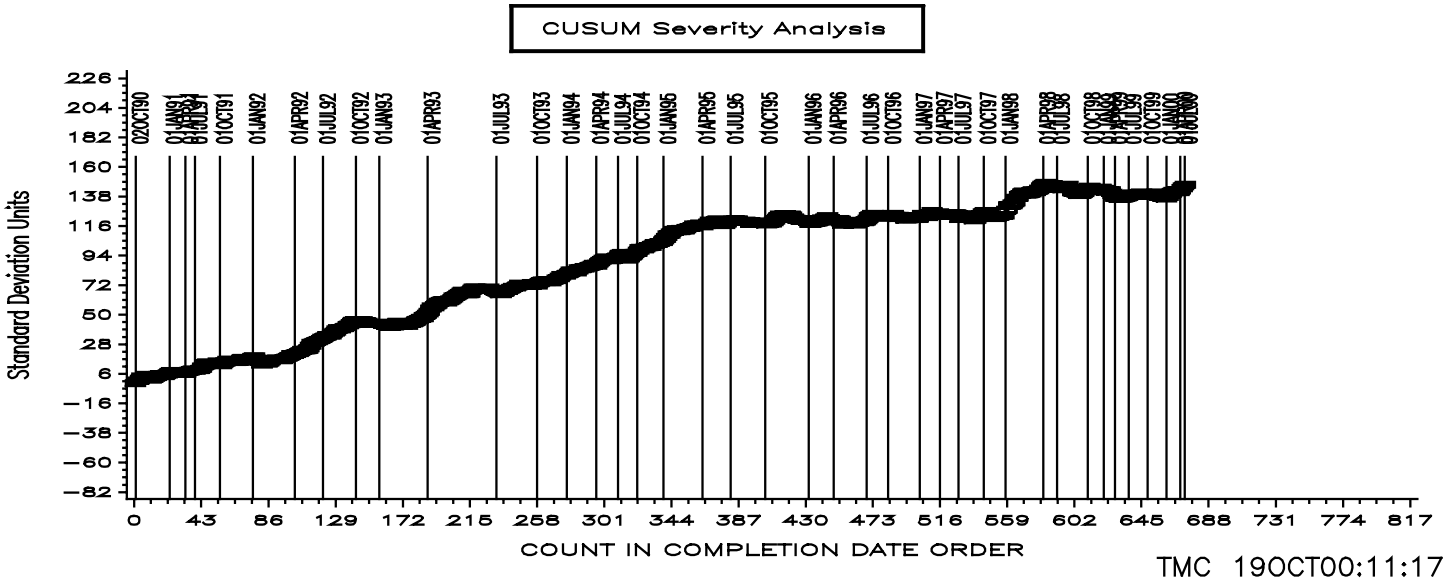
IIIE INDUSTRY OPERATIONALLY VALID DATA

Hours to 375% Viscosity Increase

Figure 1







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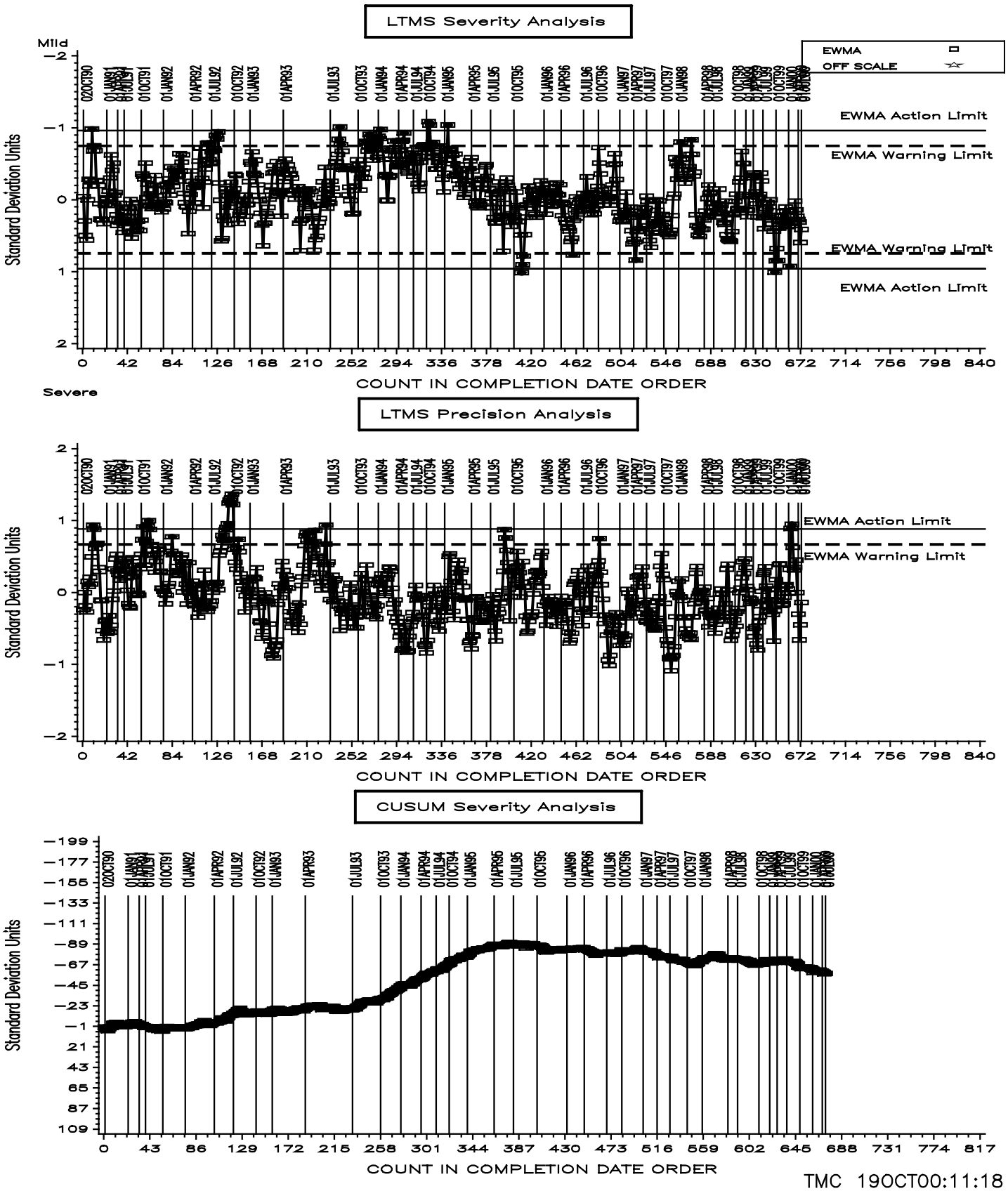
IIIE INDUSTRY OPERATIONALLY VALID DATA

Average Cam + Lifter Wear

Figure 2



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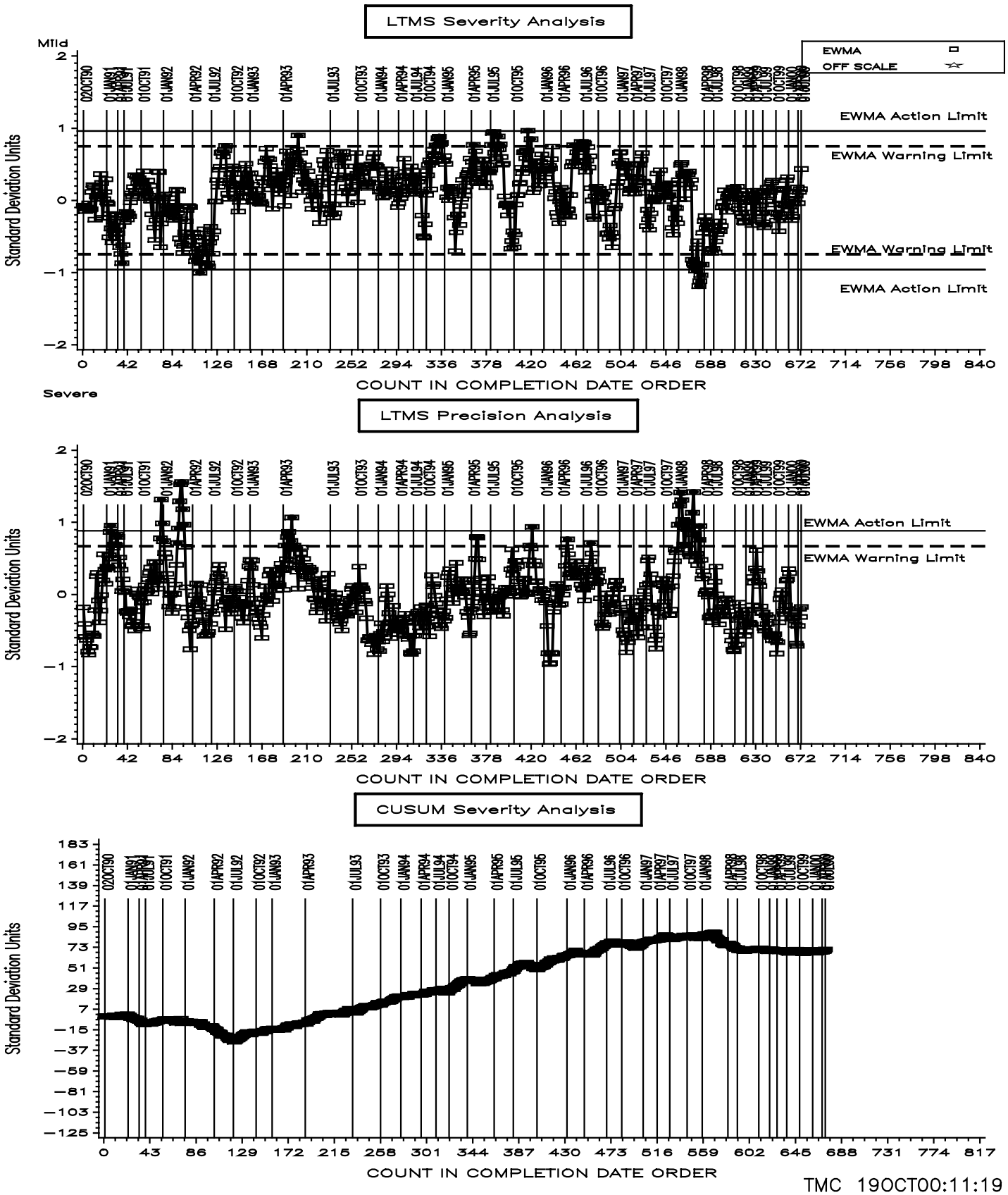
IIIE INDUSTRY OPERATIONALLY VALID DATA

Average Piston Skirt Varnish

Figure 3



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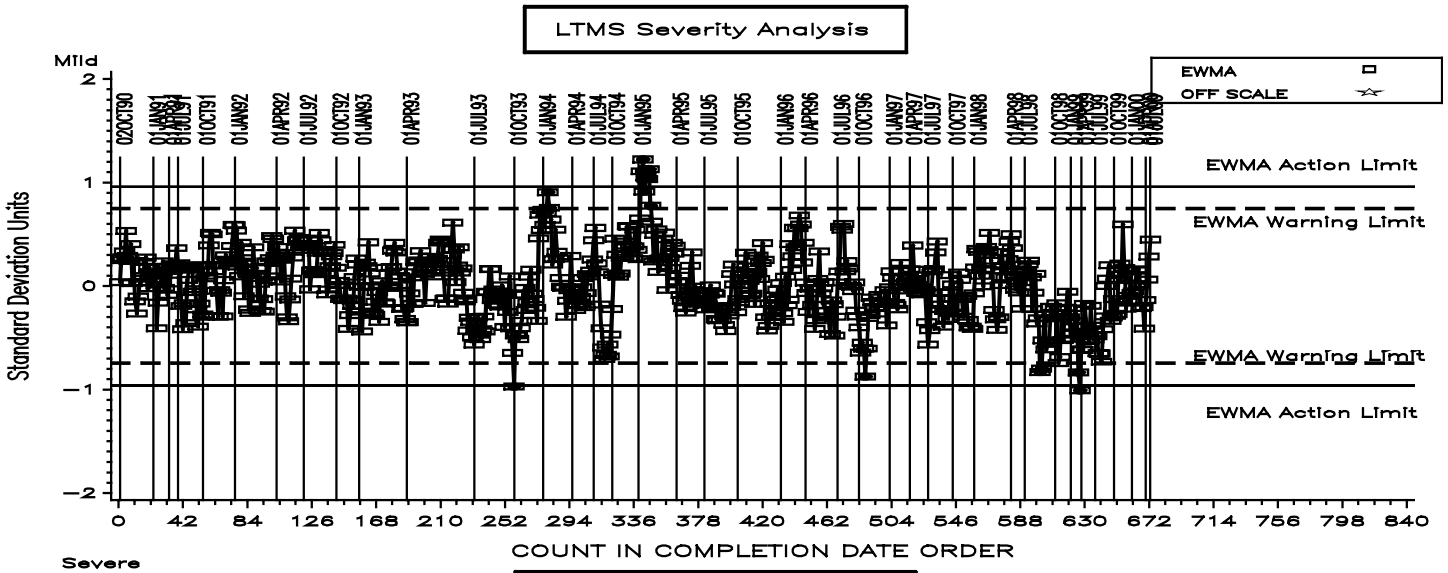
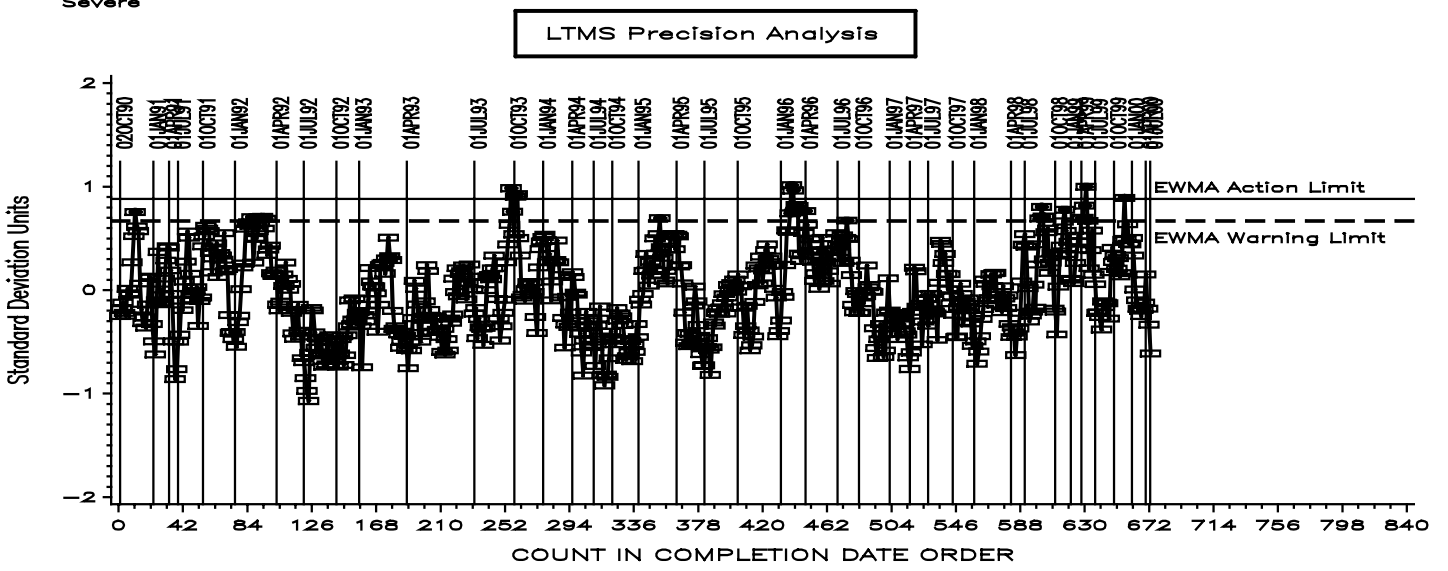
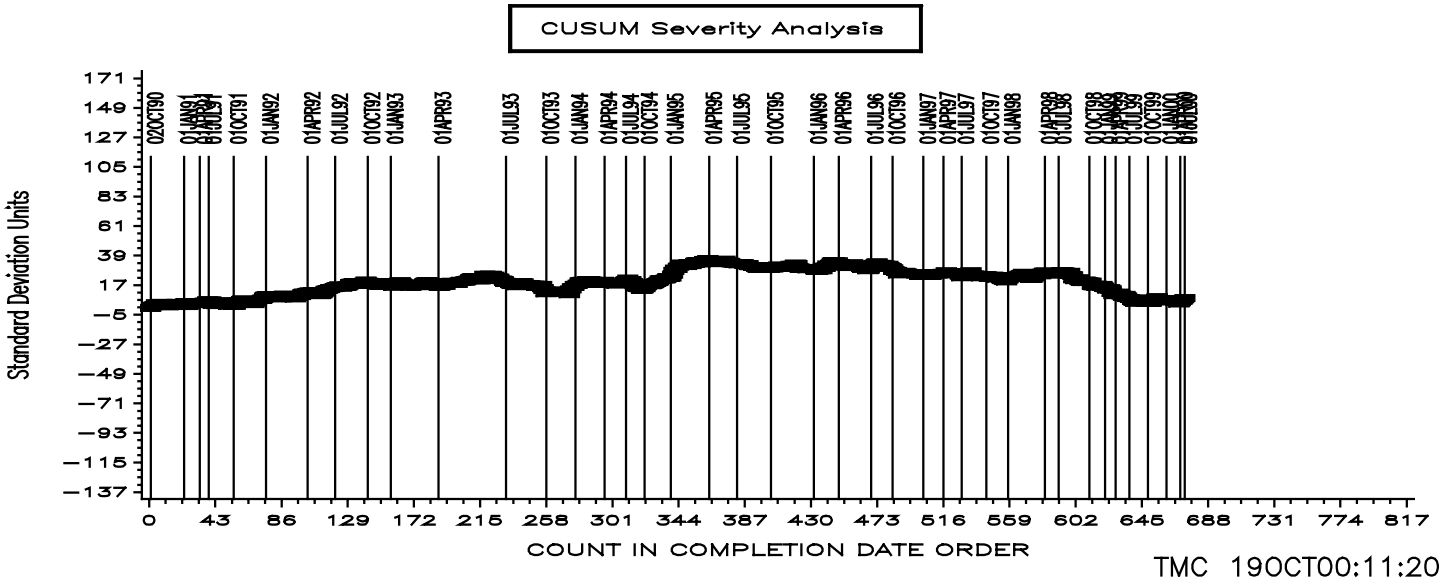
IIIE INDUSTRY OPERATIONALLY VALID DATA

Average Engine Sludge

Figure 4







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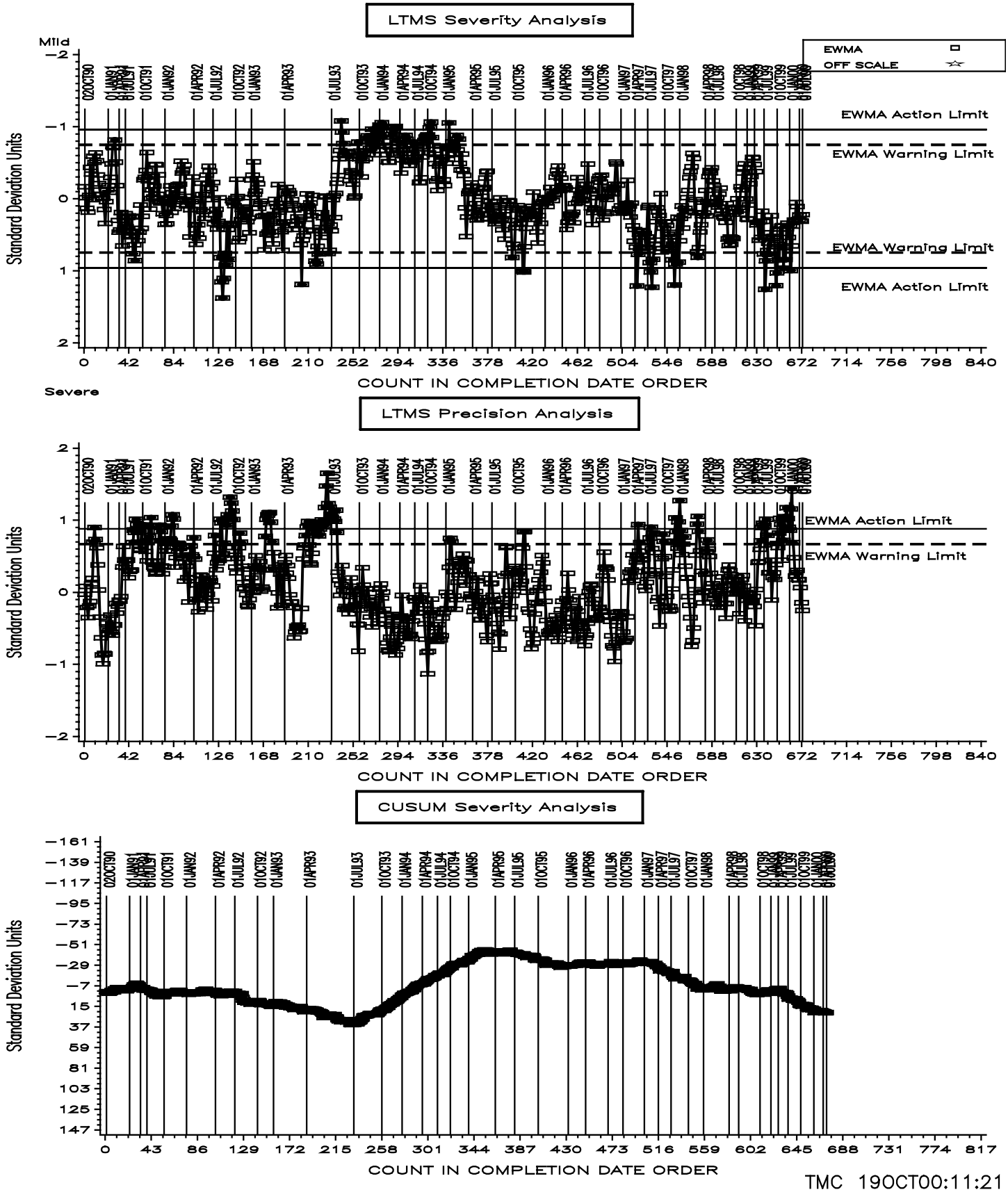
IIIE INDUSTRY OPERATIONALLY VALID DATA

Maximum Cam + Lifter Wear

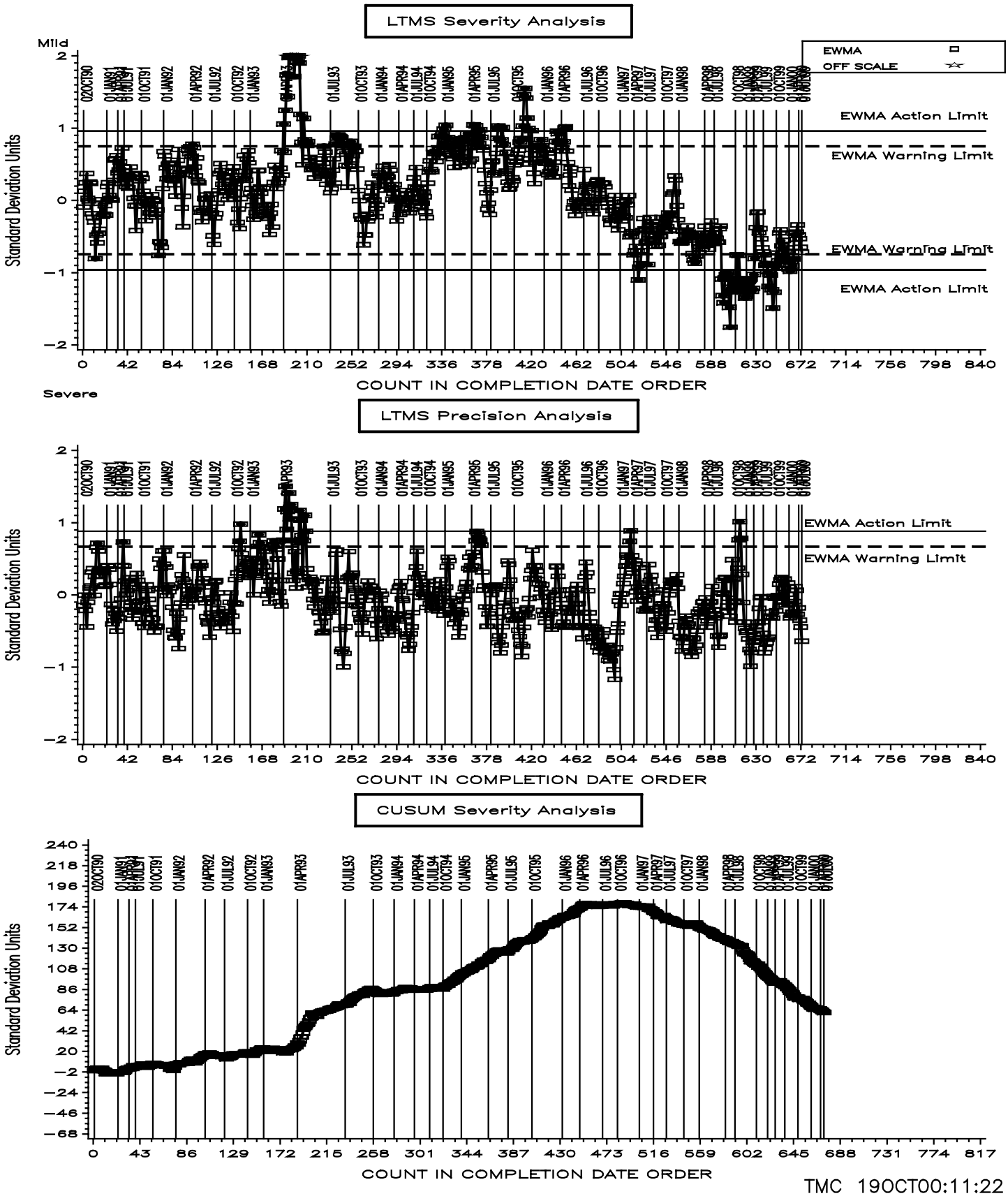
Figure 5



IIIE INDUSTRY OPERATIONALLY VALID DATA

Average Oil Ring Land Deposits

Figure 6



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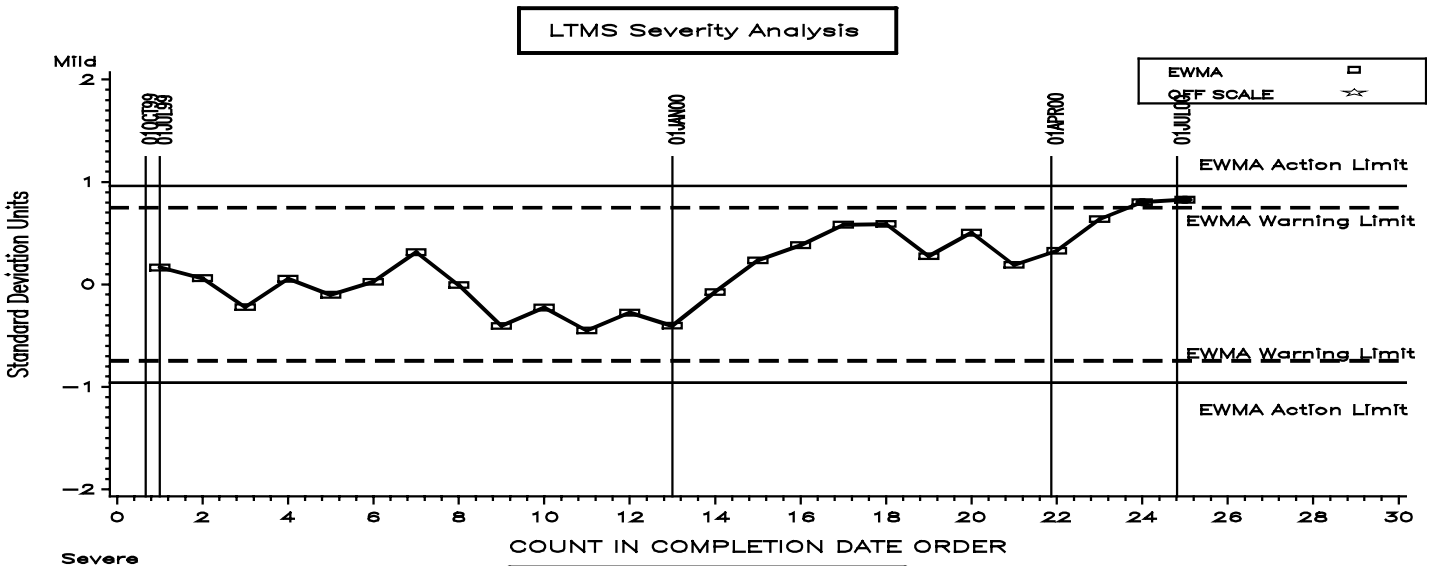
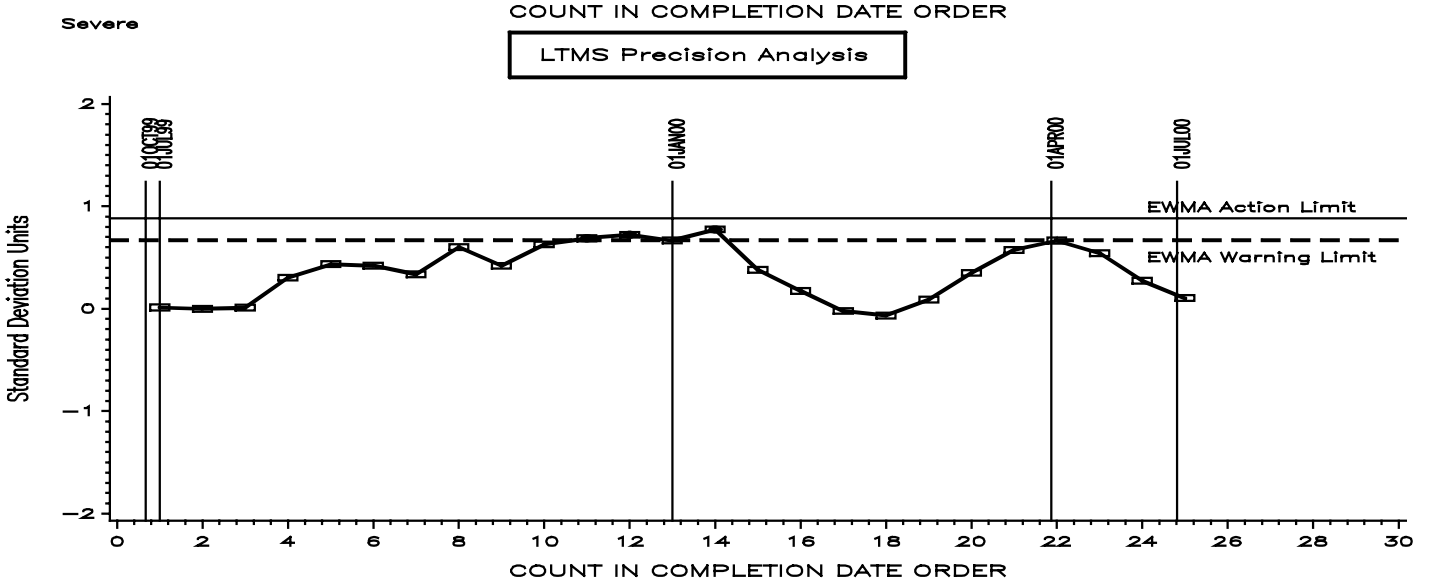
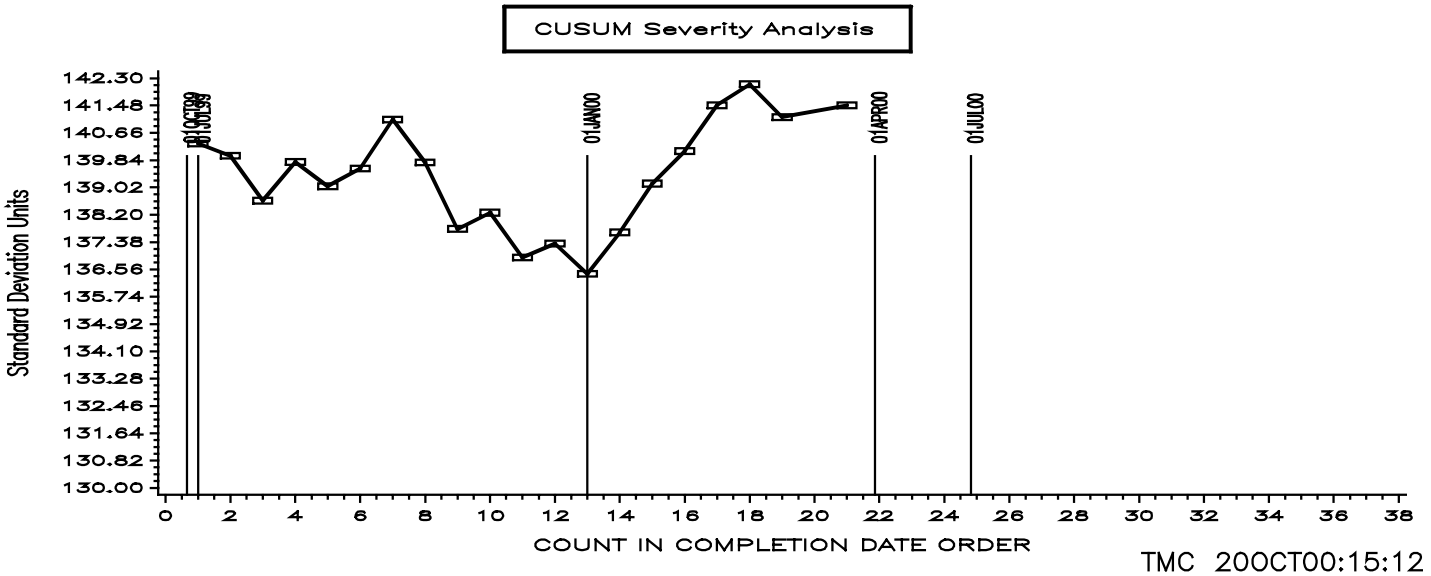
IIIE INDUSTRY OPERATIONALLY VALID DATA

Hours to 375% Viscosity Increase

Figure 7







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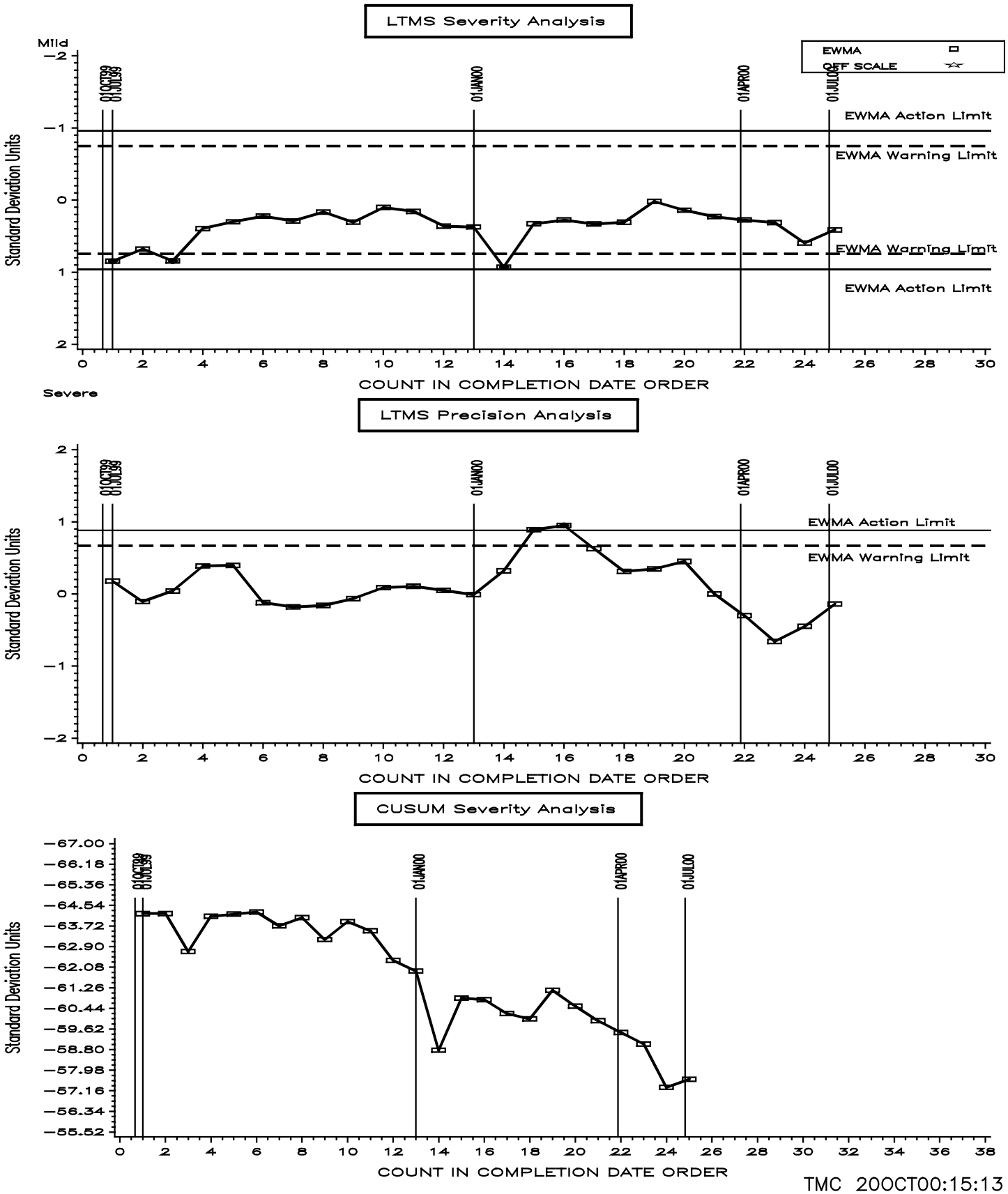
IIIE INDUSTRY OPERATIONALLY VALID DATA

Average Cam + Lifter Wear

Figure 8



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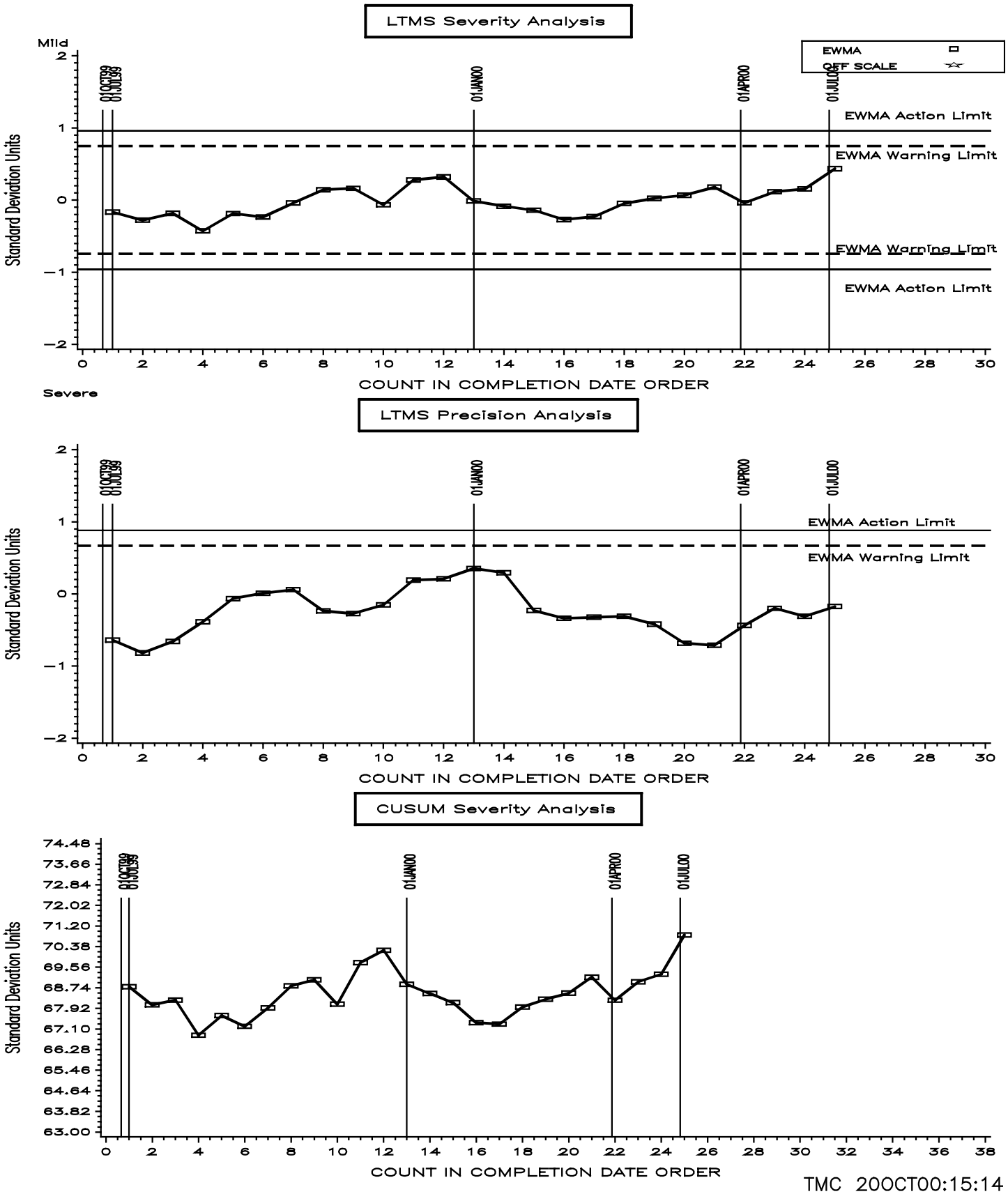
IIIE INDUSTRY OPERATIONALLY VALID DATA

Average Piston Skirt Varnish

Figure 9



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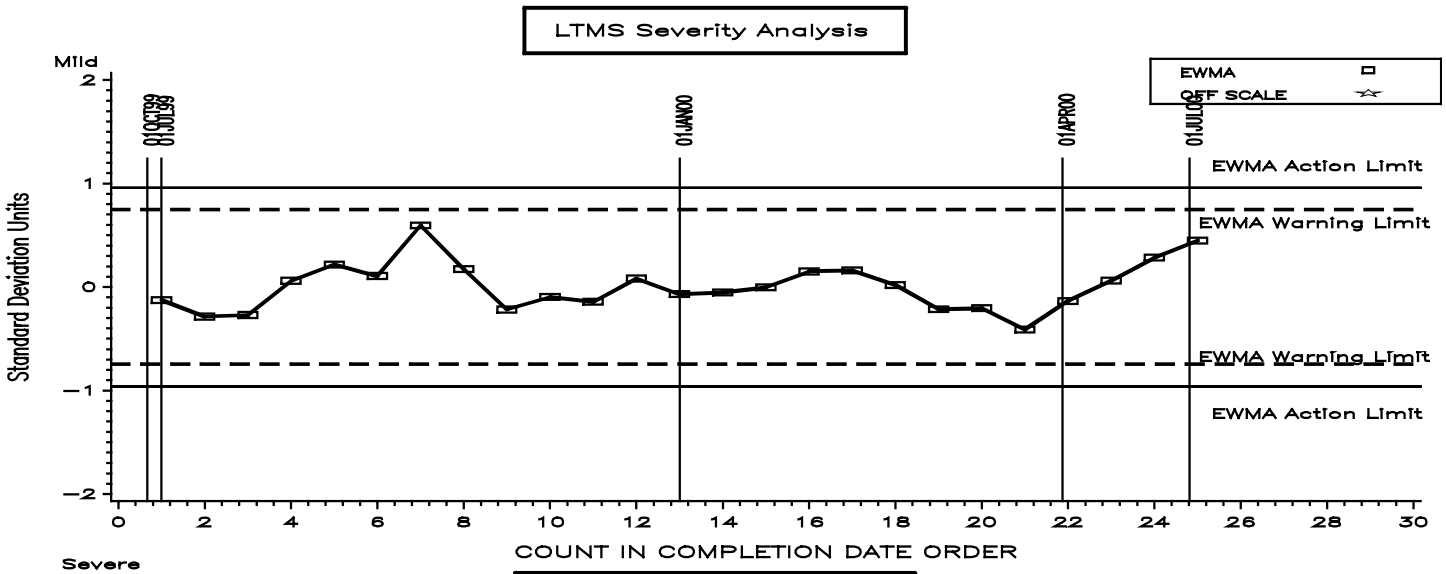
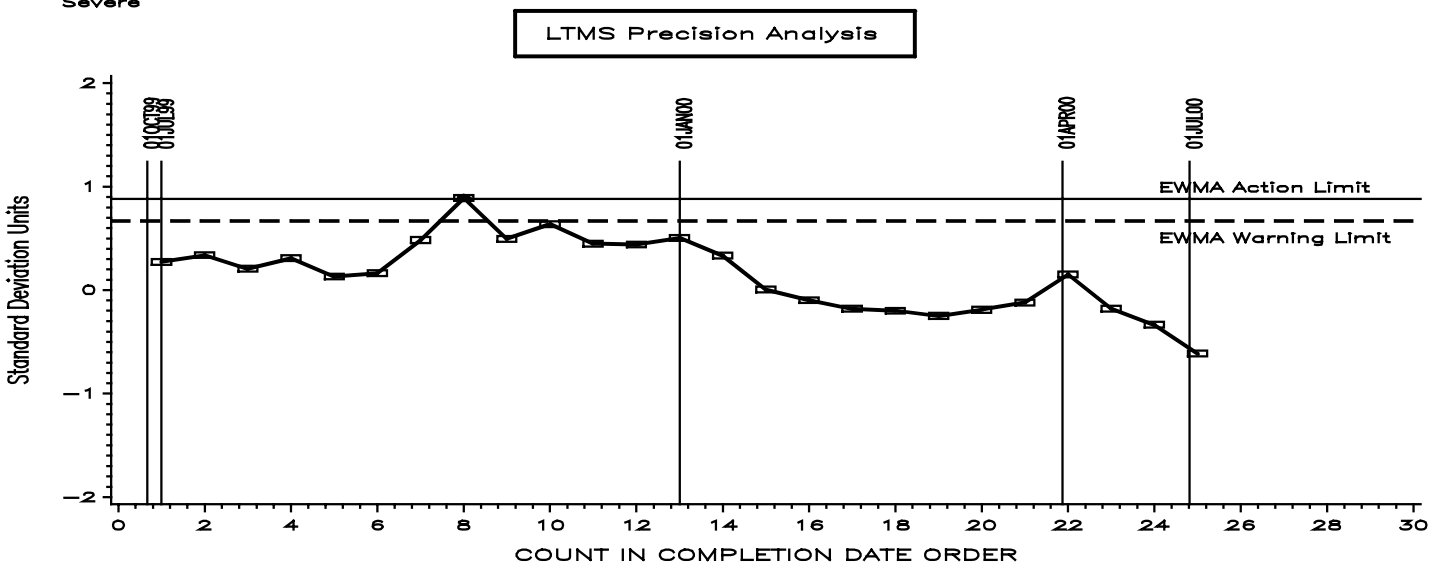
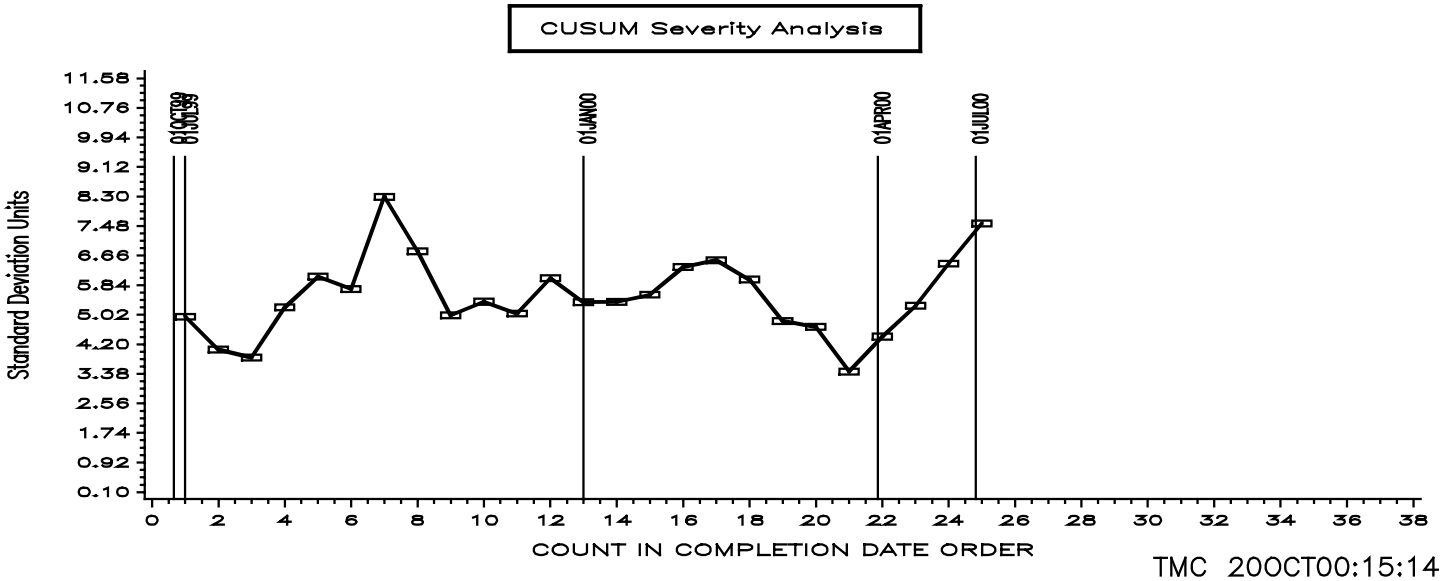
IIIE INDUSTRY OPERATIONALLY VALID DATA

Average Engine Sludge

Figure 10







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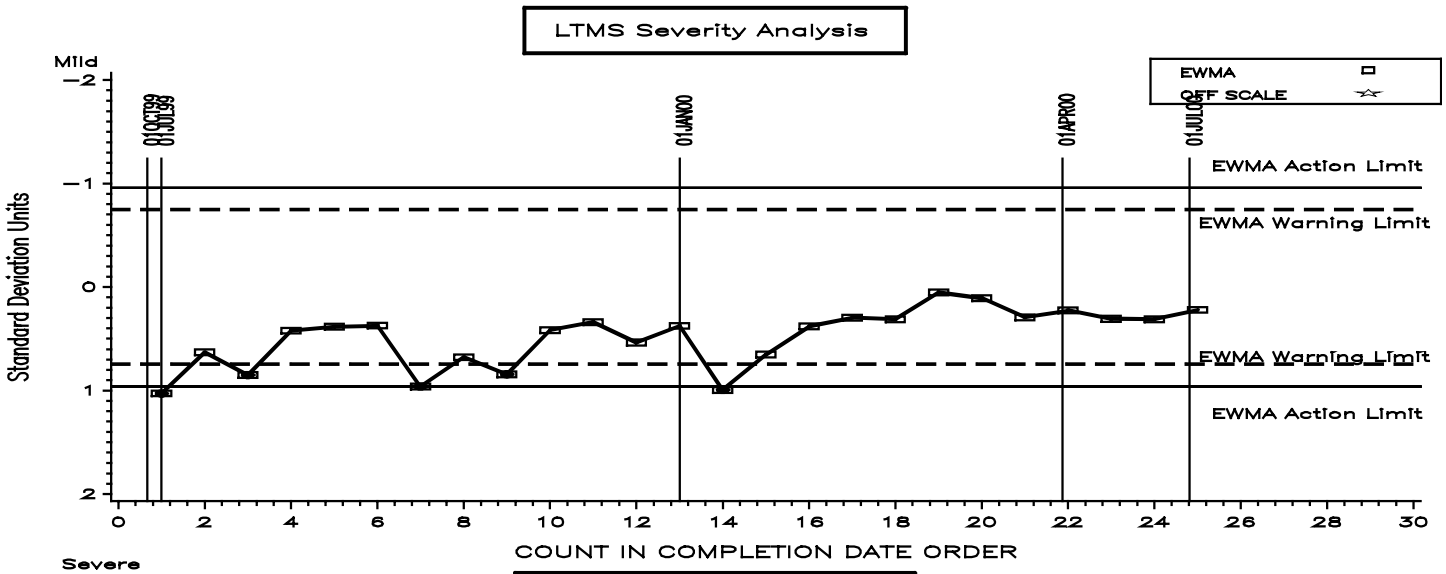
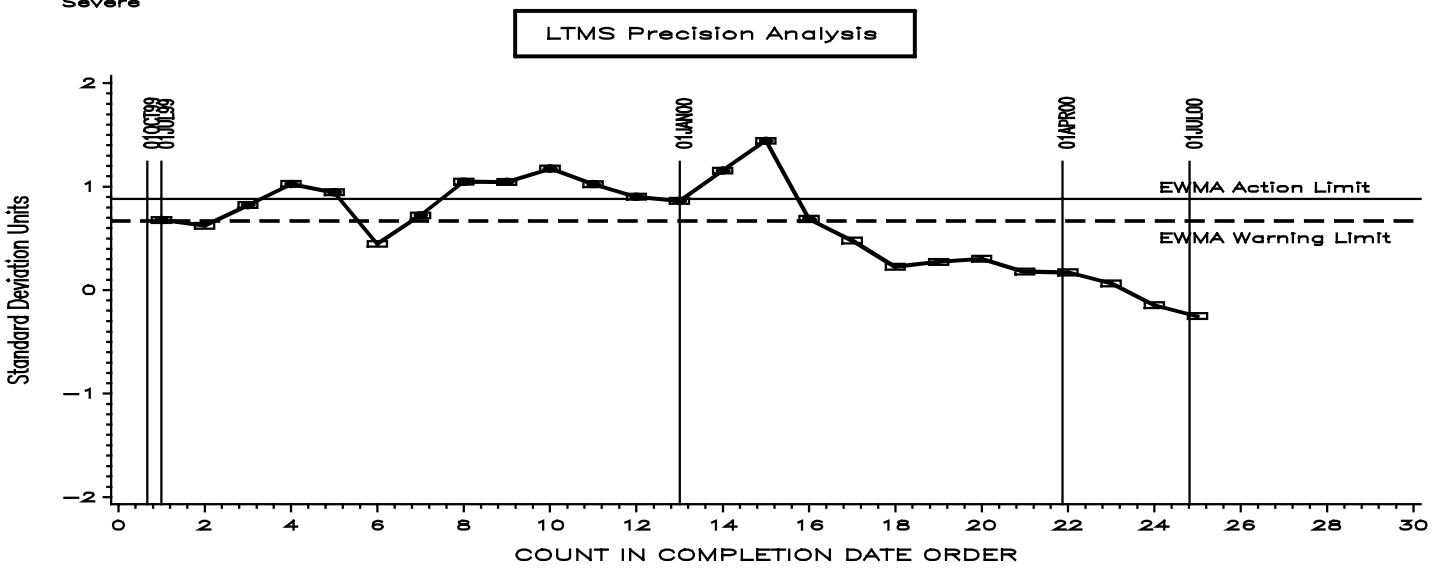
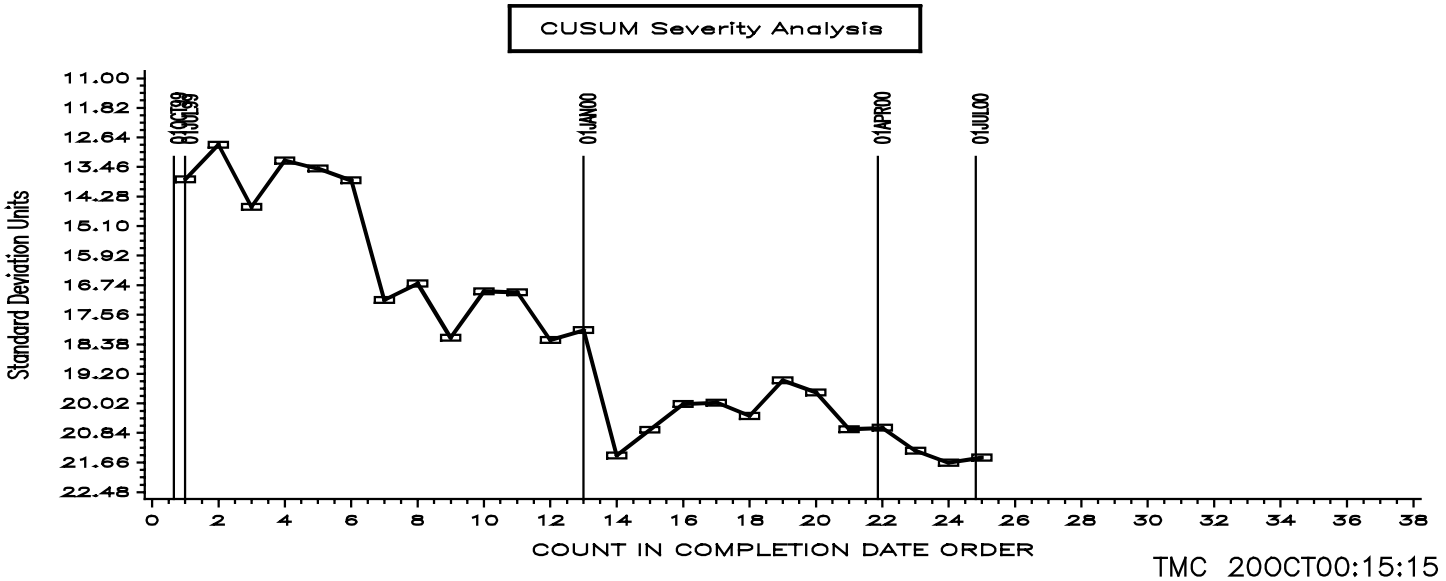
IIIE INDUSTRY OPERATIONALLY VALID DATA

Maximum Cam + Lifter Wear

Figure 11







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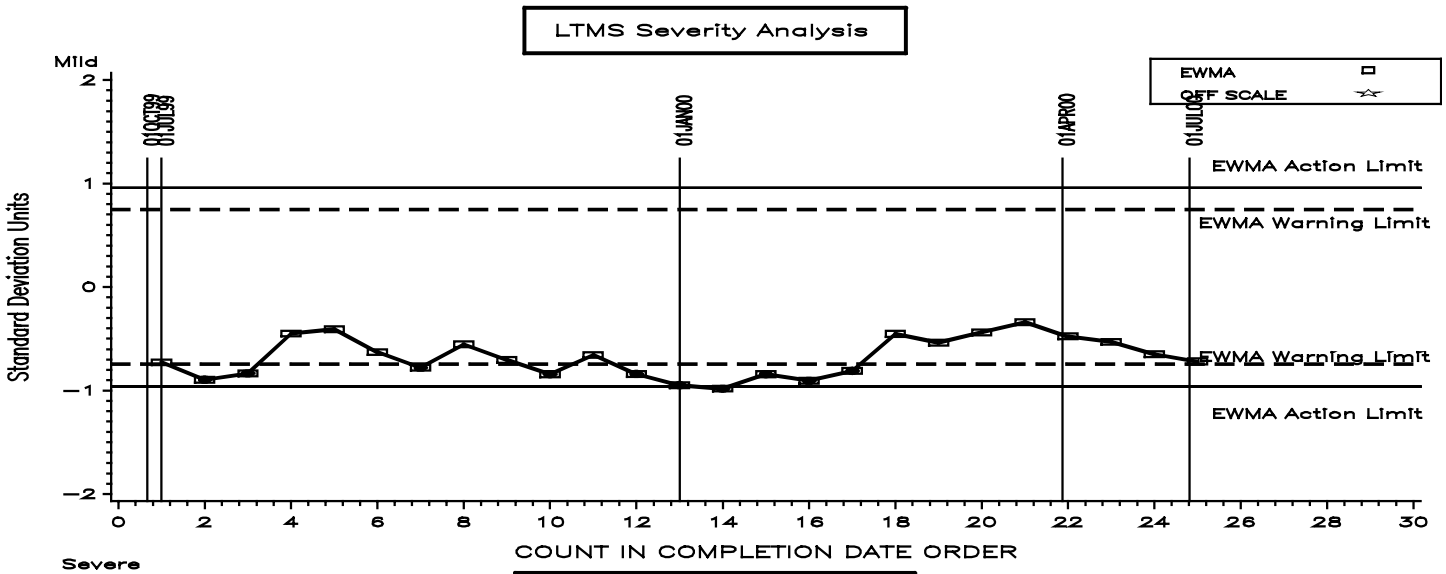
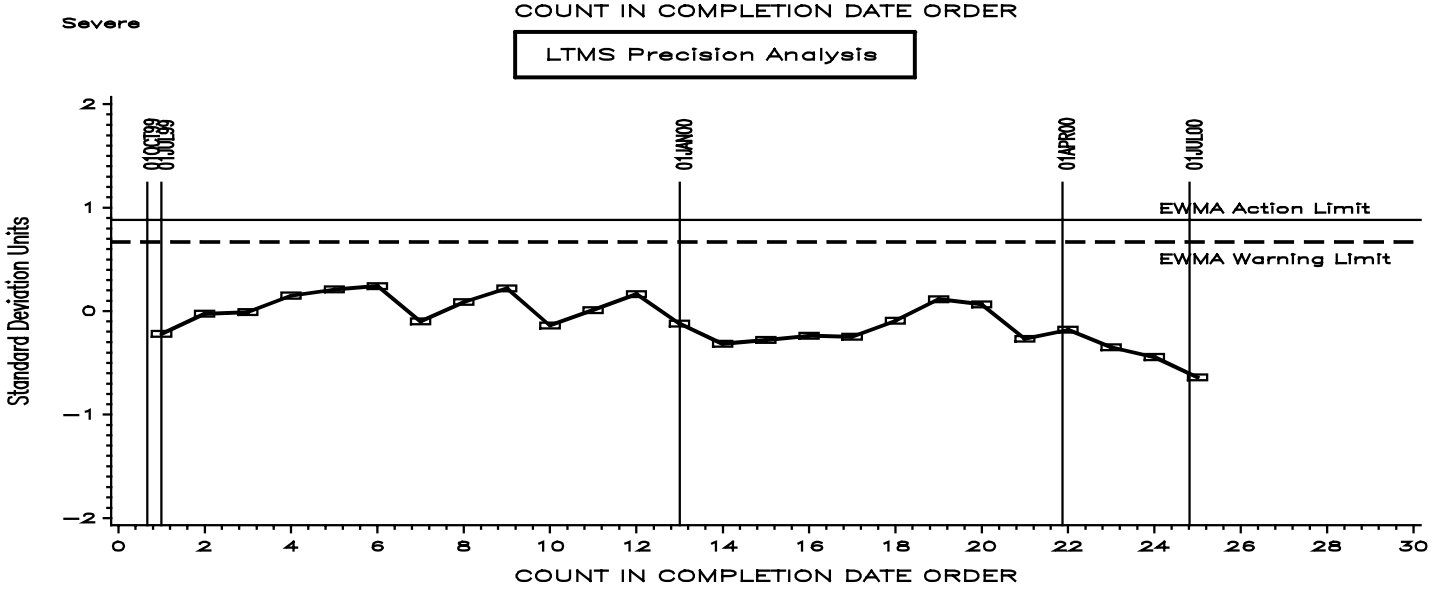
IIIE INDUSTRY OPERATIONALLY VALID DATA

Average Oil Ring Land Deposits

Figure 12





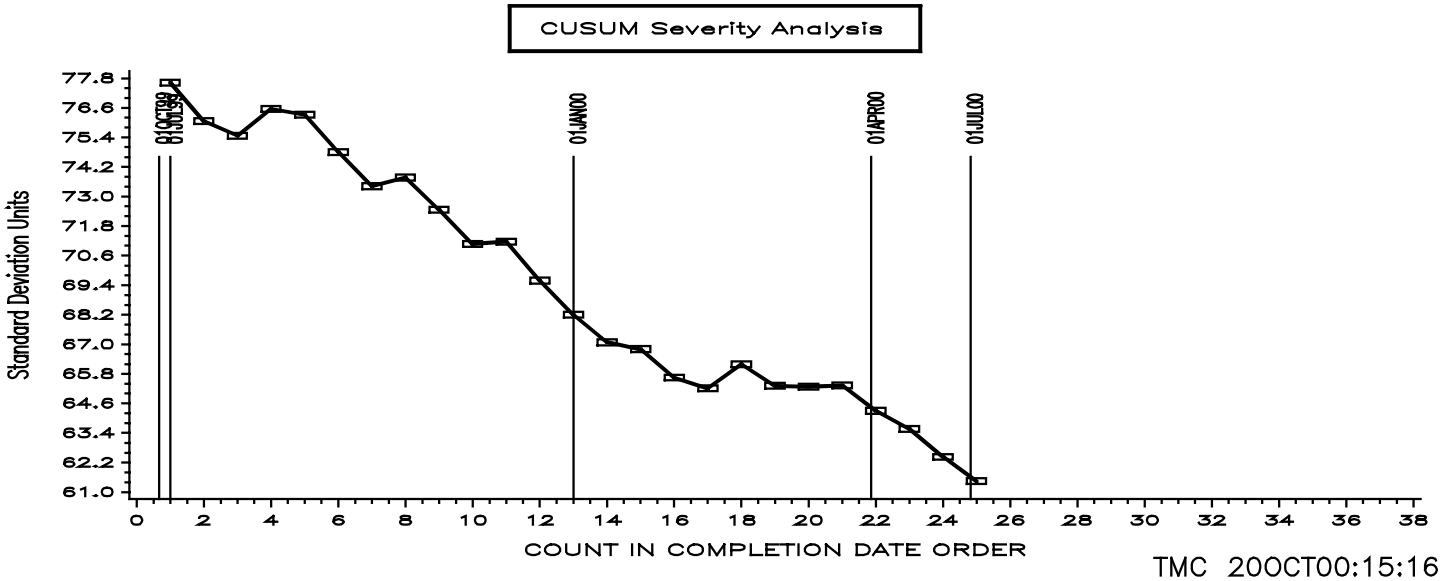


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Figure 13 - HRS Pooled Standard Deviation by ASTM Period

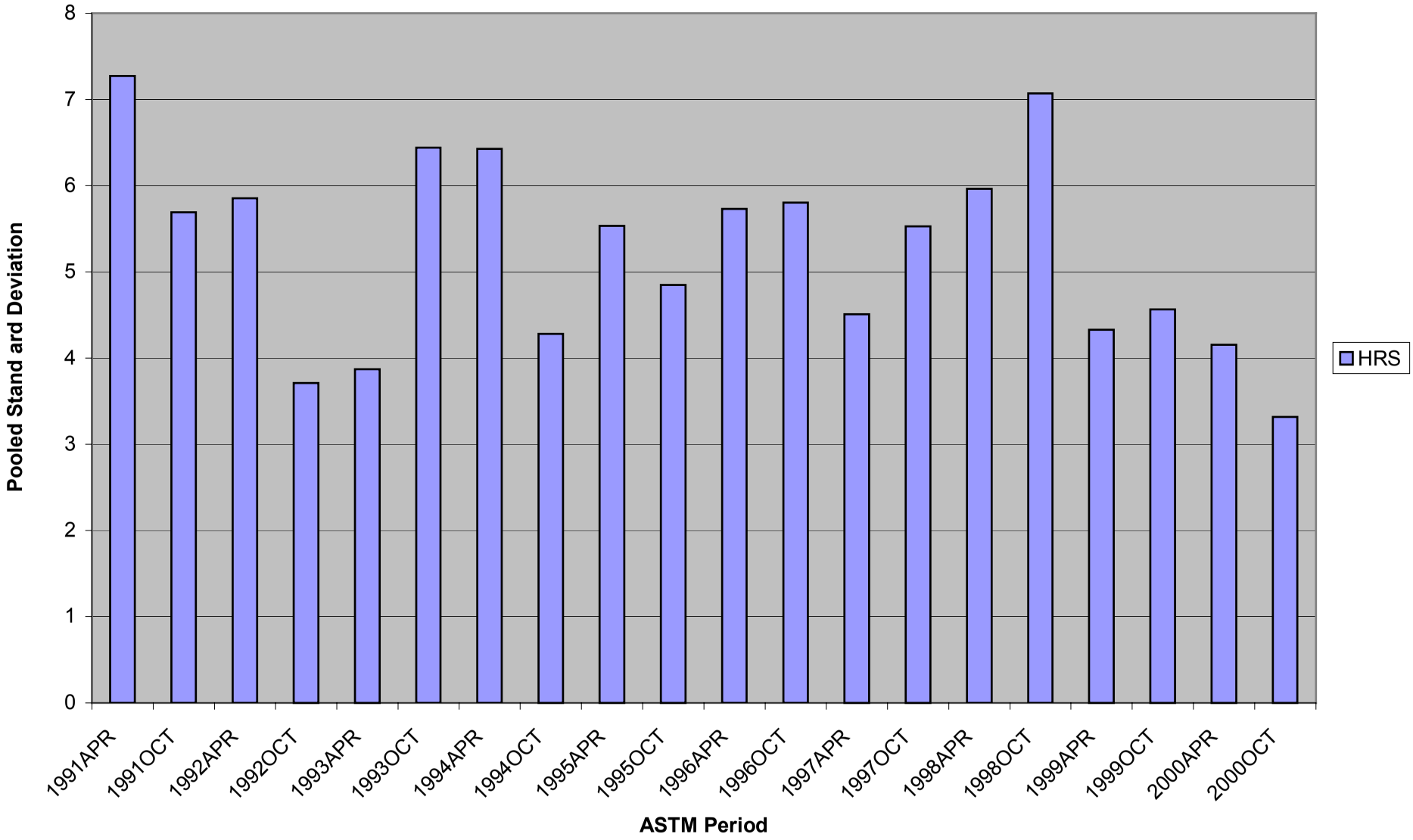

Figure 14 - ACLW & MCLW Pooled Standard Deviation by ASTM Period

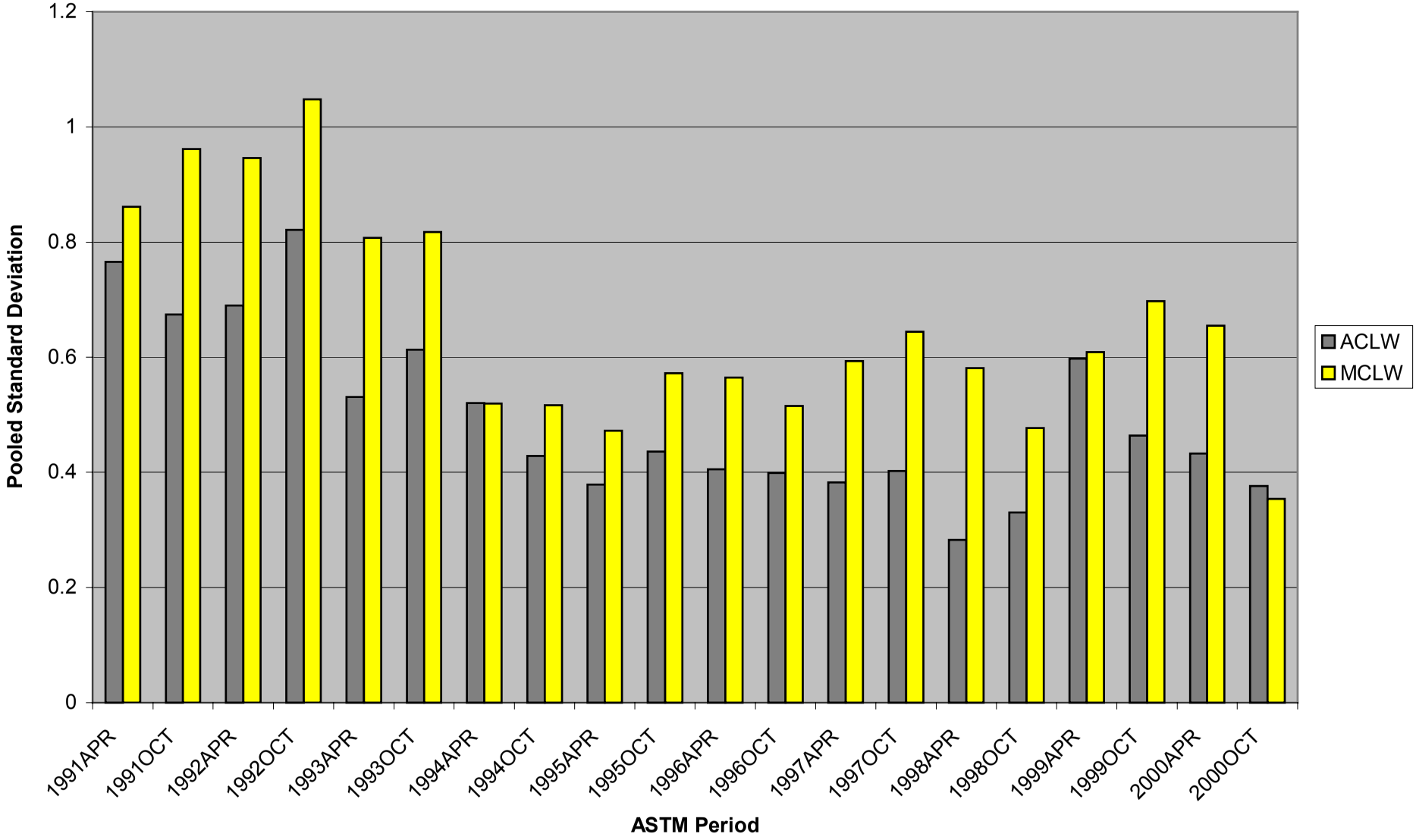

Figure 15 - APV & ORLD Pooled Standard Deviation by ASTM Period

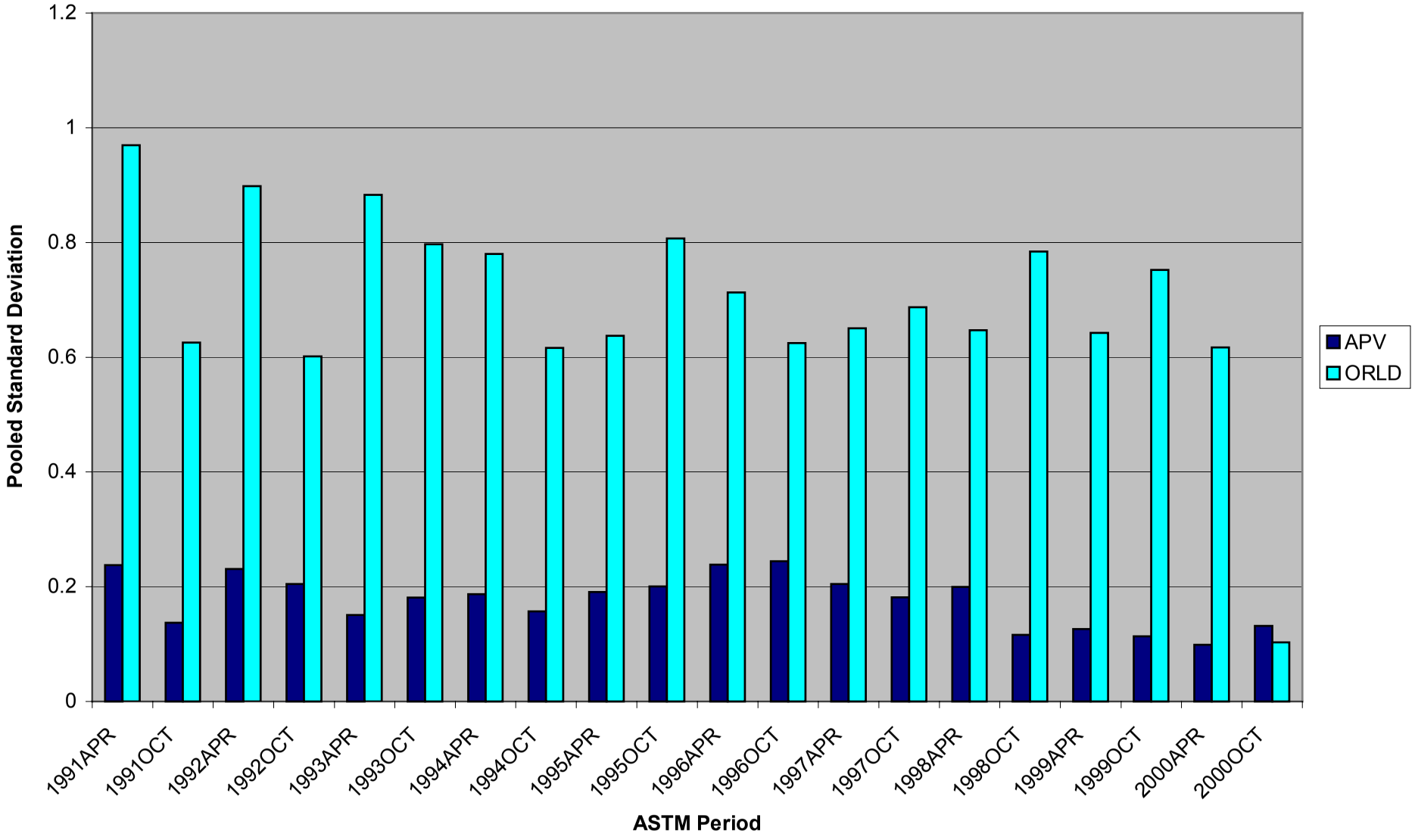

Figure 16 - AES Pooled Standard Deviation by ASTM Period

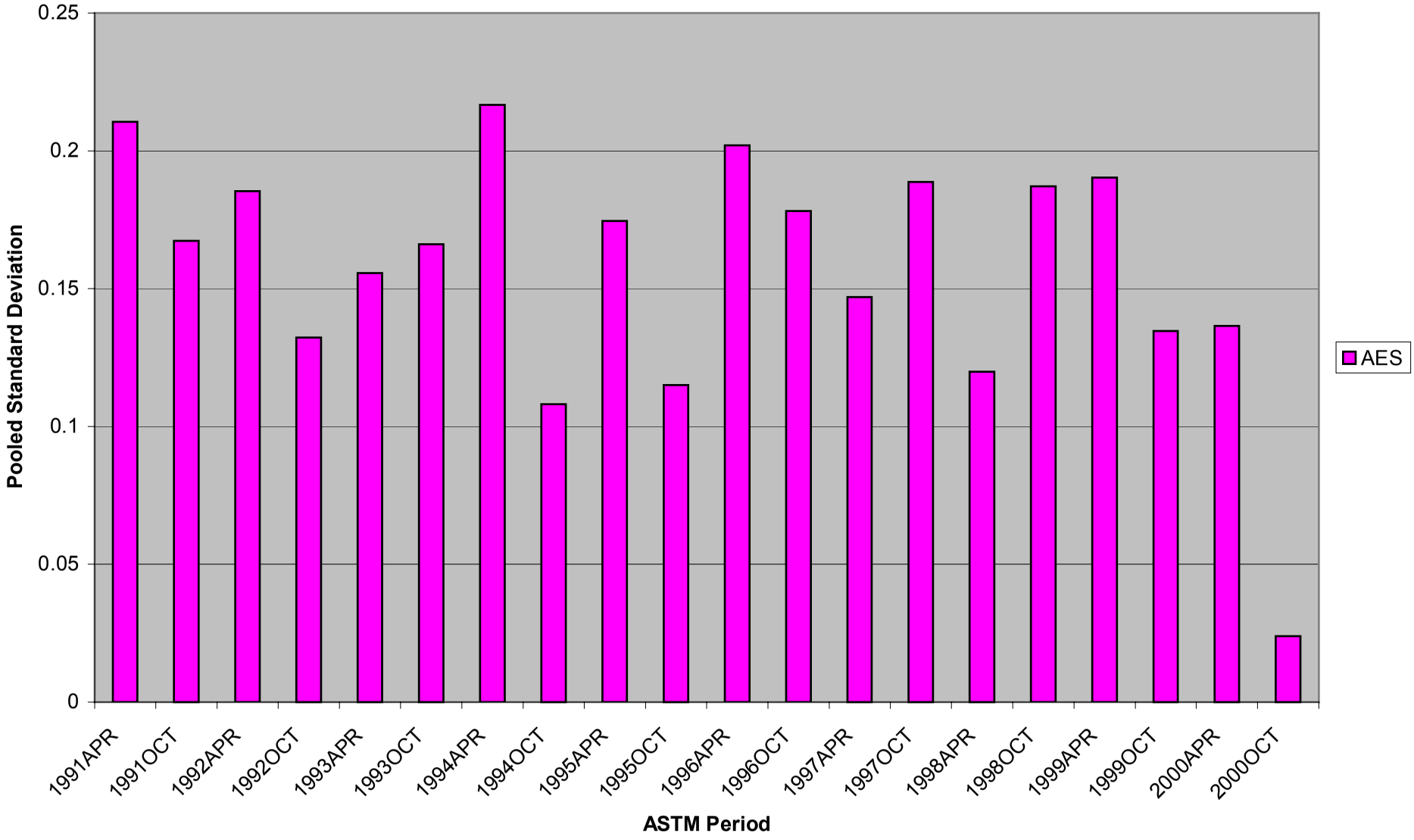

Figure 17	Sequence IIIE Timeline	Page 1 of 3
Date	Topic	Information Letter
1/1/1992	Hours to 375% viscosity increase implemented into IIIE testing	61
1/1/1992	Severity adjustments implemented into IIIE testing	61
2/2/1992	First occurrence of CPD rocker shafts in reference data	
2/24/1992	First occurrence of BC1 pistons in reference data	
3/28/1992	Cylinder head sealing compound implemented into IIIE testing	62
3/30/1992	Severity adjustment Lambda modification	62
3/30/1992	Deviation percentage & operational validity criteria required	62
4/1/1992	Main bearing torque+angle method implemented	62
4/13/1992	First occurrence of Batch 48 GMR 995 Test Fuel in reference data	
6/1/1992	CPD harmonic balancer & timing indicator required	63
6/1/1992	LTMS control charting system revisions take effect. "k" value reduced from 2.24 to 1.96 and AES & ORLD severity adjustments added	64
6/17/1992	CPD harmonic balancer recalled	
7/1/1992	Supplemental Piston Photos - Set A required	65
9/1/1992	Oil 404-1 introduced into reference system	
9/1/1992	Mid-limit operation required	62
9/1/1992	Model 555 duty cycle controller required	63
9/8/1992	First occurrence of BC2 pistons in reference data	
9/8/1992	First occurrence of BC1 rings in reference data	
9/27/1992	First occurrence of BC2 rings in reference data	
11/1/1992	Precision rocker shafts required	66
12/15/1992	Valve load measurement apparatus calibration procedures required before and after each head build session	66
12/15/1992	Nalcool 2000 coolant additive package mandatory	66
12/15/1992	Lifter fill chamber use mandatory	66
12/15/1992	External oil system volume & flow checks required before every reference test	66
12/15/1992	All rated parts must be handled with gloved hands	66
12/15/1992	BC2 piston APV correction factor of +0.20 merits implemented	67
12/15/1992	ACLW & MCLW correction factor for "F113" pour code camshafts. Correction factor applies to all candidates runs using F113 camshafts	68
1/1/1993	Consensus rating procedure for rating of test parts implemented into IIIE rating methods	69
1/1/1993	Standardized report form package/data dictionary required for reporting reference results	93-3
1/7/1993	Oil 1002 introduced into reference system	
4/1/1993	BC2 APV correction reduced to +0.14 merits and extended to BC3 pistons	93-1
4/3/1993	First occurrence of BC3 pistons in reference data	
4/3/1993	First occurrence of BC3 rings in reference data	
4/15/1993	Oil 1002 targets updated after 21 tests	
5/1/1993	Test camshaft required for all IIIE testing. "D value" measurement no longer permitted	93-2
5/10/1993	First occurrence of L217 pourcode camshafts B1in reference data	
5/20/1993	Aerosol sealing compound for head gaskets to be used instead of thinned brush on version	93-2
5/20/1993	Vacuum requirement for lifter fill chamber	93-2
5/20/1993	External oil system no longer required to be recalibrated if heat exchanger or heat exchanger core replaced.	93-2
5/20/1993	New organic solvent approved for use in wiping pistons during APV rating	93-2
5/20/1993	Valve train loading procedure required for all engine builds	93-2
5/21/1993	Oil 402-1 introduced into reference system	
5/24/1993	Oil 404-1 targets updated after 20 tests	
5/31/1993	IIIE Ring Land Deposit Rating Aid required for rating ORLD	93-2
6/23/1993	First occurrence of BC4 rings in reference data	
7/1/1993	Oil 402-1 targets updated after 11 tests	
7/15/1993	Oil 1002 targets updated & frozen after 35 tests	
7/18/1993	First occurrence of C329 pourcode camshafts in reference data	
7/26/1993	Laboratory "35 test limit" removed. 120 day reference period defined as beginning on LTMS date and LTMS time of reference test	93-4

Figure 17	Sequence IIIE Timeline	Page 2 of 3
Date	Topic	Information Letter
8/31/1993	Sequence IIIE Engine Rebuilder Workshop	
9/1/1993	2" coolant flow orifice required	93-2
9/1/1993	Redesigned intake air horn required	93-2
9/2/1993	First occurrence of BC4 pistons in reference data	
9/15/1993	B-H-J torque plates mandatory. Torque-to-yield fasteners also required. New cylinder head and connecting rod torquing procedures mandatory.	93-5
9/23/1993	APV correction factor of +0.14 merits extended to BC4 pistons and future batches unless data proves otherwise	93-6
9/28/1993	First occurrence of "D" lifters in reference data	
10/1/1993	Batch 49 of GMR 995 Test Fuel rejected	
10/1/1993	Oil 404-1 targets updated & frozen after 30 tests	
11/12/1993	First occurrence of BC56 rings in reference data	
12/10/1993	First occurrence of Batch 50 GMR 995 Test Fuel in reference data	
1/14/1994	Non-interpretable wear 6X rule implemented	94-1
1/14/1994	Thrust washer discarding criteria implemented	94-1
1/14/1994	Plastigage usage prohibited & bearing clearance specifications removed from test procedure	94-1
1/14/1994	Valve train loading procedure revised prohibiting engine rotation after final valve train loading	94-1
1/14/1994	Intake manifold torquing specifications corrected	94-1
1/14/1994	Ring gapping procedure revised to allow rings to be fit with or without torque plates installed	94-1
1/14/1994	Blowby configuration; calibration cleaning and maintenance procedures implemented	94-1
1/14/1994	Cam bearing installation tool implemented	94-1
1/20/1994	Belleville Washer becomes a Critical Part	94-2
1/21/1994	Revised test numbering and referencing requirements changes take effect	94-1
3/2/1994	First occurrence of H313 pourcode camshafts in reference data	
3/10/1994	IID breather tube required for IIIE testing	63
3/15/1994	Oil 402-1 targets updated & frozen after 30 tests	
5/31/1994	Nalcool 2000 coolant additive dosage reduced	94-2
5/31/1994	Revised honing procedures prohibiting the use of solvents to clean honing materials and also prohibiting the introduction of solvents into the honing machine	94-2
6/30/1994	Intake manifold flush during jacket flush mandatory after this date	94-2
6/30/1994	Revised block cleaning procedure requiring all bushings bearings and oil gallery plugs be removed prior to cleaning mandatory after this date	94-2
6/30/1994	Honing mats required for honing machines used to hone IIIE blocks by this date	94-2
6/30/1994	New organic solvent the only permissible solvent after this date	94-2
6/30/1994	Main bearing bore mandrel use mandatory	94-2
9/27/1994	First occurrence of BC5 pistons in reference data	
9/27/1994	First occurrence of BC78 rings in reference data	
9/27/1994	Sequence IIIE Engine Rebuilder Workshop II	
11/30/1994	Revised carb air inlet adapter & gasket mandatory after this date	94-2
2/6/1995	First occurrence of B422 camshafts in reference data	
2/15/1995	Revised ACLW & MCLW Test Targets for Reference Oil 1002 effective for all tests completed on or after this date	
3/15/1995	Sequence IIIE Standard Test Method D5533 implemented into use	
5/22/1995	Replacement GM silicone sealer allowed for use	95-1
5/24/1995	Oil 425-2 introduced into reference system	
8/3/1995	First occurrence of Batch 51 GMR 995 Test Fuel in reference data	
8/31/1995	Glycol specification changed from Dow Regular Grade to glycol meeting ASTM Specification E1119-92 for Industrial Grade Ethylene Glycol	95-1
8/31/1995	Test precision table in Test Method D5533 revised	95-1
8/31/1995	APV & ORLD rating procedure wording revised to reflect actual practices	95-1
8/31/1995	MTAC 6X rule removed from Test Method D5533	95-1
8/31/1995	Discrimination run requirement corrected to one test per stand per year	95-1
8/31/1995	Connecting rod bolt torquing procedure corrected in Test Method D5533 to reflect correct torque-plus-angle method	95-1
8/31/1995	New design timing chain allowed for use in IIIE testing	95-1
8/31/1995	Crankshafts; connecting rods;engine blocks; and bearing kits reclassified as CPD special test parts	95-1
9/15/1995	"Honing fluid; filter and mat change requirements implemented	95-1
10/1/1995	Camshaft bearing clearance verification using stainless steel balls required	95-1
10/1/1995	Oil filter block thermocouple specification changed to 3 in. from 2 in.	95-1
10/9/1995	First occurrence of BC9 rings in reference data	
10/18/1995	Oil 425-2 targets updated after 13 tests	
10/30/1995	Valve load measurement apparatus enhancements required	95-1
11/6/1995	First occurrence of E523 pourcode camshafts in reference data	
11/6/1995	First occurrence of BC6 pistons in reference data	

Figure 17	Sequence IIIE Timeline	Page 3 of 3
Date	Topic	Information Letter
11/29/1995	Revised Data Dictionary and Standardized Report Form Set required	95-1
1/16/1996	TMC address change	96-1
2/6/1996	First occurrence of BC10 rings in reference data	
5/14/1996	Aftermarket coolant jacket freeze plugs alloowed for use in Sequence IIIE test engines.	96-2
6/25/1996	First occurrence of BC7 pistons in reference data	
6/28/1996	Zero wear test reporting procedure	96-1
6/28/1996	Revised Data Dictionary and Standardized Report Form Set required	96-1
7/8/1996	Oil 425-2 targets updated and frozen after 32 tests	
9/7/1996	First occurrence of Batch 52 GMR 995 Test Fuel in reference data	
12/18/1996	Blowby configuration, cleaning, and maintenance procedures omitted from D5533 added to sta	96-2
12/18/1996	Recommend replacement of oil heat exchanger cores after tests with high wear and/or high viscosity increase.	96-2
12/18/1996	Procedure for cleaning rust from number 3 main and connecting rod bearings prior to installation in a Sequence IIIE test engine implemented.	96-2
12/18/1996	SPS Torque Sensor I wrench usage clarification implemented into Sequence IIIE testing.	96-2
12/18/1996	Editorial corretions of Section 7.6.8 and footnote 55 in Test Method D5533.	96-2
2/16/1997	Revised parts cleaning procedures implemented into Sequence IIIE testing.	96-2
3/17/1997	Camshaft loading fixture calibration and use procedure inplemented into Sequence IIIE	96-2
3/17/1997	First occurrence of BC11 rings in reference data	
3/21/1997	First occurrence of H607 pourcode camshafts in reference data	
5/19/1997	Reference Oil 425-2 removed from LTMS	
7/20/1997	First occurrence of Batch 54 GMR 995 Test Fuel in reference data	
7/22/1997	Nalcool 2000 Name Change	97-1
7/28/1997	First occurrence of Batch 53 GMR 995 Test Fuel in reference data	
11/20/1997	Oil 1006 introduced into LTMS based on 9 data points	
11/20/1997	Top and bottom compression ring gaps required to be be the same for all six pistons	98-1
11/28/1997	First occurrence of Batch 55 GMR 995 Test Fuel in reference data	
1/20/1998	First occurrence of Batch 56 GMR 995 Test Fuel in reference data	
2/17/1998	Test Numbering Editorial Correction	98-1
2/17/1998	Revised Bias Statement in Test Method D5533	98-1
3/31/1998	Laboratories required to report compression ring gaps for all reference oil tests.	98-1
3/31/1998	Revised Report Forms & Data Dictionary Version 19980403	98-1
3/31/1998	First occurrence of Batch 57 GMR 995 Test Fuel in reference data	
5/18/1998	Reference Oil 1006 removed from LTMS	
6/15/1998	Oil 402-1 targets for ORLD revised.	
7/13/1998	First occurrence of Batch 58 GMR 995 Test Fuel in reference data	
11/25/1998	First occurrence of Batch 59 GMR 995 Test Fuel in reference data	
3/19/1999	First occurrence of Batch 60 GMR 995 Test Fuel in reference data	
8/16/1999	First occurrence of Batch 61 GMR 995 Test Fuel in reference data	
12/21/1999	First occurrence of Batch 62 GMR 995 Test Fuel in reference data	
1/11/2000	First occurrence of Batch 63 GMR 995 Test Fuel in reference data	
3/7/2000	First occurrence of Batch 64 GMR 995 Test Fuel in reference data	
4/15/2000	First occurrence of Batch 65 GMR 995 Test Fuel in reference data	