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MEMORANDUM: 02-025

DATE: May 2, 2002

TO: Mr. Ted Selby, Chairman ASTM D02.B07

FROM: Thomas Schofield & Richard Grundza

SUBJECT: TMC Bench Reference Test Monitoring from October 1, 2001 through March 31, 2002

We respectfully submit the TMC's ASTM D02.B07 Bench Reference Test Monitoring Semiannual Report, with statistical summaries broken down by test area (Attachment 1).

Precision and severity are monitored by comparing a recent period of reference test performance to "target" performance (as determined by the surveillance panels), and to performance over previous periods. The TMC monitors test precision by a pooled standard deviation (pooled s), and test severity by mean Δ/s, where:

Pooled s = Standard deviation pooled across reference oils
(i.e., The pooled precision of the test this period.)
Δ/s = [(Result) - (Target mean)] / (Target s)
(i.e., "How many standard deviations from the target mean is this test?")
Mean Δ/s = [Σ (Δ/s)] / n (across reference oils)
(i.e., "On average, how many standard deviations from the target mean are all the operationally valid calibration tests for each period?")

Notice that the period severity estimates (mean Δ/s) are independent of oil performances because the individual test results used to calculate mean Δ/s have all been normalized into (target) standard deviations (Δ/s) for each corresponding reference oil. Also, using a pooled s for precision simplifies the interpretation of precision across all reference oil performance levels. These two calculations (pooled s and mean Δ/s) allow us to combine all calibration performance levels for each test type into single precision and severity estimates for each period providing a means to compare current test performance (precision and severity) to target performance and to prior periods. Individual oil targets, and current performance summaries by oil**,** are also reported (Attachments 2 and 3).

The tables in Attachment 1 comparing current and previous period precision and severity have become too large to conveniently show all prior report periods. To keep the information succinct some of the older annual comparison periods have been eliminated.

The lab codes in this report are cross-referenced, as they were in previous reports. That is, in this report, Lab A represents the same lab in each section, which is the same as Lab A in previous reports, and should remain the same lab in future reports. (The initial TMC PCEOCP Bench Test Report, of November 8, 1996, did not cross reference the labs.)

Beginning with the last report period (April 1, 2001 through September 30, 2001), we are reporting on consecutive six-month intervals for all test areas, rather than one-year intervals for some test areas and six-month for others. For more information on this decision, please refer to the TMC's web page:

ftp://ftp.astmtmc.cmu.edu/docs/bench/bo7semiannualreports/mem02-025.pdf

All operationally valid test data and severity plots are available on the TMC's website. Please contact the TMC if you require further information.

Attachments

c: J. Zalar
M. Lane
ftp://ftp.astmtmc.cmu.edu/docs/bench/bo7semiannualreports/mem02-025.pdf
D02.B07 mailing list contacts notified by e-mail of ftp posting on the TMC's website.

Attachment 1

ASTM Test Monitoring Center

Semiannual Report

ASTM D02.B07 Bench Reference Test Monitoring
From October 1, 2001 through March 31, 2002

D6417: Estimation of Engine Oil Volatility by Capillary Gas Chromatography

STATUS

Table 1 summarizes the reference tests reported to the TMC this period (6 labs reporting):

TABLE 1

	No. of Tests
Statistically Acceptable and Operationally Valid	12
Operationally Valid but Failed Acceptance Criteria	1
Total	**13**

Fail Rate of Operationally Valid Tests: 7.7%

Table 2 is a breakdown of the statistically unacceptable tests.

TABLE 2

Reason for Fail	No. of Tests
Sample Area % Volatized Mild	1

INDUSTRY PERFORMANCE

Table 3 shows the current Industry precision and severity for the Sample Area % Volatized @ 371°C test parameter for all operationally valid tests for the report period. (First calibration test completed 10/5/00.)

TABLE 3

Area % Volatized @ 371°C	n	df	Pooled s	Mean Δ/s
Initial Round Robin Study	107	101	0.46	-----
10/5/00 through 3/31/01	18	15	0.50	1.42
4/1/01 through 9/30/01	16	13	0.54	0.65
10/1/01 through 3/31/02	13	10	0.44	-0.45

Table 4 shows the current severity for the Sample Area % Volatized @ 371°C parameter for each lab for all operationally valid tests for the report period.

TABLE 4

	n	Mean Δ/s
Lab A	5	-0.71
Lab B	2	0.20
Lab D	2	-1.35
Lab G	1	-0.55
Lab H	1	0.63
Lab U	2	-0.07

PRECISION AND SEVERITY

Precision has improved to near target this period. Overall severity has shifted to mild of target performance. Severity is represented graphically in Figure 1. The figure shows a large amount of variability in the results over the entire time, as evident by the sharp up and down pattern in the CUSUM plot. The figure shows a seven-test leveling period from November 2001 through early February 2002 followed by a strong mild trend.

Lab A, which had previously been performing substantially severe compared to the other labs, is now performing somewhat mild and in line with the performance of the other contributing laboratories.

The fail rate of the operationally valid tests is also back to what we would expect; last period it was an exceptionally high 18.8%. Because of the high fail rate and poor overall performance last period, B07 requested the EOVTSP to conduct a D6417 workshop. This workshop was conducted on January 29, 2002, with a follow-up round-robin matrix on the TMC's reference oils to look at resetting performance targets. As of this writing the round-robin is still pending and will be summarized and reported on separately.

TMC MEMORANDA

There were no TMC technical memoranda issued this report period for the D6417 test method.

D5480: Engine Oil Volatility by Gas Chromatography (VGC by D5480)

STATUS

There were no D5480 calibration tests reported to the TMC this period.

Figure 2 shows the severity of D5480 through the last reported calibration (completed 7/23/2001).

TMC MEMORANDA

There were no TMC technical memoranda issued this report period for the D5480 test method.

D5800: Evaporation Loss of Lubricating Oils by the Noack Method

STATUS

Table 5 summarizes the reference tests reported to the TMC this period (9 labs reporting):

TABLE 5

	No. of Tests
Statistically Acceptable and Operationally Valid	28
*Operationally Valid but Failed Acceptance Criteria	5
Operationally Invalid	1
Total	**34**

Fail Rate of Operationally Valid Tests: 15.2%

*All Statistically unacceptable test this period were by Procedure B

Table 6 is a breakdown of the statistically unacceptable tests.

TABLE 6

Reason for Fail	No. of Tests
Sample Evaporation Loss Mild	1
Sample Evaporation Loss Severe	4

INDUSTRY PERFORMANCE

Table 7 shows the current Industry precision and severity for the Sample Evaporation Loss test parameter for all operationally valid tests for the report period. (First calibration test completed 5/1/96.)

TABLE 7

Sample Evaporation Loss, mass %	n	df	Pooled s	Mean Δ/s
Initial Round Robin Study	180	175	0.51	-----
5/1/96 through 3/31/97	31	26	0.68	0.70
4/1/97 through 3/31/98	22	17	0.72	0.75
4/1/98 through 3/31/99	28	23	0.59	0.49
4/1/99 through 3/31/00	33	28	0.42	0.90
New Targets Effective 9/26/00	178	175	0.56	-----
4/1/00 through 3/31/01	47	42	0.69	0.98
4/1/01 through 9/30/01	35	32	0.61	1.21
10/1/01 through 3/31/02	33	30	0.66	0.79

Table 8 shows statistical comparisons by procedure for all operationally valid tests for the report period.

TABLE 8

Sample Evaporation Loss, mass %	n	df	Pooled s	Mean Δ/s
Procedure A	6	3	0.25	0.28
Procedure B	26	23	0.70	0.92
Procedure C	1	0	--.--	0.46

D5800: Evaporation Loss of Lubricating Oils by the Noack Method, continued

Table 9 shows the current severity for the Sample Evaporation Loss parameter for each lab for all operationally valid tests for the report period.

TABLE 9

	n	Mean Δ/s
Lab A	4	1.35
Lab B	5	1.01
Lab D	1	0.46
Lab G	7	1.88
Lab H	2	0.86
Lab I	2	0.48
Lab J	5	-1.05
Lab R	2	-0.05
Lab U	5	0.92

PRECISION AND SEVERITY

Effective September 26, 2000, the TMC began monitoring the three Noack procedures under the newest D5800 test method. Also effective September 26, 2000, new reference oils, targets and acceptance bands were implemented for TMC calibration monitoring. Oils 51, 53 and 54 were dropped, oil 58 was introduced and targets for oils 52 & 55 were revised.

Overall precision continues to run worse than target precision, and slightly worse than last period. Overall severity, while still severe of target, is notably improved. However, as Figures 3A and 3B illustrate, the overall severe trend actually continues unabated with a few mild results offsetting the more severe results in the severity (mean Δ/s) estimate for the period in Table 7. Figure 3B shows that a strong severe trend that started a long time before new targets were established continues right on through the effective date of the new performance targets and up to the present time. A leveling to target would have been expected after the performance targets were updated in September 2000.

Tests on oil 58 seem to be performing substantially more severe than oils 52 & 55 with oil 58 tests averaging 1.36 s severe of target mean (n = 13), oil 52 averaging 0.48 s severe of target (n = 11) and oil 55 averaging 0.34 s severe of target (n = 9). In fact, all four operationally valid but unacceptably severe tests reported this period were on oil 58. Attachment 3 shows a detailed comparison of the individual oil performances.

With an unusually high fail rate and numerous operational problems reported to the TMC last period, B07 requested the EOVTSP to conduct a D5800 workshop. This workshop was conducted on March 13 & 14, with an expected list of recommended practices and a round-robin matrix on the TMC's reference oils to follow. As of this writing the round-robin is still pending and will be summarized and reported on separately.

TMC MEMORANDA

There was one TMC technical memorandum issued this report period for the D5800 test method:
Memo 01-186, December 21, 2001, Test Operating Temperatures

D5133: Low Temperature, Low Shear Rate, Viscosity/Temperature Dependence of Lubricating Oils Using a Temperature Scanning Technique (Gelation Index or GI)

STATUS

Table 10 summarizes the reference tests reported to the TMC this period (8 labs reporting):

TABLE 10
Reference Tests

	No. of Tests
Statistically Acceptable and Operationally Valid	24
Operationally Valid but Failed Acceptance Criteria	6
Operationally Invalid	0
Total	**30**

Fail Rate of Operationally Valid Tests: 20.0%

Table 11 is a breakdown of the statistically unacceptable tests.

TABLE 11

Reason for Fail	No. of Tests
Gelation Index Mild	4
Gelation Index Severe	2

INDUSTRY PERFORMANCE

Table 12 shows the current Industry precision and severity for the Gelation Index and test parameter for all operationally valid tests for the report period. (First calibration test completed 4/20/96.) "Initial Tests" includes reference and donated tests; subsequent listings include only reference tests.

TABLE 12

Gelation Index	n	df	Pooled s	Mean Δ/s
Initial Tests 4/20/96 through 11/27/96	178	173	6.37	-----
4/20/96 through 3/31/97	60	55	5.40	-0.06
4/1/97 through 3/31/98	64	59	5.20	-0.12
4/1/98 through 3/31/99	68	63	6.67	-0.07
4/1/99 through 3/31/00	62	57	6.30	0.09
*4/1/00 through 3/31/01	65	60	5.93	-0.15
4/1/01 through 9/31/01	33	28	2.84	0.13
10/1/01 through 3/31/02	30	26	4.76	-0.02

*Excludes one data point as a rare event. See the TMC's December 2000 report for more information.

D5133: Low Temperature, Low Shear Rate, Viscosity/Temperature Dependence of Lubricating Oils Using a Temperature Scanning Technique (Gelation Index or GI), continued

Table 13 shows the current severity for the Gelation Index for each lab for all operationally valid tests for the report period.

TABLE 13

	n	GI Mean Δ/s
Lab A	8	-0.34
Lab B	6	0.43
Lab D	4	0.51
Lab G	4	0.63
Lab H	2	-1.00
Lab I	1	0.72
Lab R	3	-0.85
Lab U	2	-0.62

PRECISION AND SEVERITY

On June 18, 2001, the section decided to drop TMC oils 51 and 55 as GI reference oils, and add TMC oil 58. An industry-supported round-robin was run to establish performance targets and acceptance bands on TMC oil 58. The matrix was completed at the beginning of this report period and the first GI calibration on TMC oil 58 was reported on November 14, 2001, near the start of this report period. A TMC summary of the round-robin on oil 58 issued separately from this report. So, this period's data includes all four current GI reference oils: 52, 53, 58 and 62.

There is an unusually high number of statistically unacceptable (but reported as operationally valid) calibration tests this period, though there is no clear pattern to these failing tests (assorted labs and oils; a mix of mild and severe results). Overall gelation index precision, though worse than last period, remains considerably better than target. Overall severity is on target (mild bias). Severity is graphically represented in Figure 4 (attached).

TMC MEMORANDA

There was one TMC technical memoranda issued this report period for the D5133 test method:

Memo 01-136, October 24, 2001, Reference Oil 58 Targets

D6335: Determination of High Temperature Deposits by Thermo-oxidation Engine Oil Simulation Test (TEOST)

STATUS

Table 14 summarizes the reference tests reported to the TMC this period (2 labs reporting):

TABLE 14

	No. of Tests
Statistically Acceptable and Operationally Valid	6
Operationally Valid but Failed Acceptance Criteria	0
Operationally Invalid	0
Total	**6**

Fail Rate of Operationally Valid Tests: 0.0%

INDUSTRY PERFORMANCE

Table 15 shows the current Industry precision and severity for the Total Deposits test parameter for all operationally valid tests for the report period. (First calibration test completed 2/13/96.)

TABLE 15

Total Deposits	n	df	Pooled s	Mean Δ/s
Initial Round Robin Study	54	52	4.18	-----
4/1/96 through 3/31/97	44	42	6.22	0.28
4/1/97 through 3/31/98	41	39	4.24	-0.10
4/1/98 through 3/31/99	36	34	5.68	-0.49
4/1/99 through 3/31/00	30	28	5.67	0.14
4/1/00 through 3/31/01	18	16	8.45	0.40
4/1/01 through 9/30/01	5	3	2.04	0.48
10/1/01 through 3/31/02	6	4	1.32	0.83

Table 16 shows the current severity for the Total Deposits parameter for each lab for all operationally valid tests in the report period.

TABLE 16

	n	Mean Δ/s
Lab A	3	0.79
Lab B	3	0.88

D6335: Determination of High Temperature Deposits by Thermo-Oxidation Engine Oil Simulation Test (TEOST), continued

PRECISION AND SEVERITY

Calibration testing has dropped significantly with the introduction of the MHT TEOST to replace TEOST-33C for GF-3/SL.

Overall precision is exceptionally good for the calibration tests this period and overall severity is severe of target. Both Labs A & B are performing comparably severe. The severity trends are graphically represented in Figure 5 (attached). The plot shows less erratic results since October 2000 with an increasing severe trend since July 2001.

TMC MEMORANDA

There were no TMC technical memoranda issued this report period for the D6335 test method.

TEOST MHT-4, Draft 17, 00.08.11: Determination of Moderately High Temperature Piston Deposits by Thermo-oxidation Engine Oil Simulation Test (MTEOS)

STATUS

Table 17 summarizes the reference tests reported to the TMC this period (8 labs reporting):

TABLE 17

	No. of Tests
Statistically Acceptable and Operationally Valid	39
Operationally Valid but Failed Acceptance Criteria	5
Operationally Invalid	9
Total	**53**

Fail Rate of Operationally Valid Tests: 11.3%

Table 18 is a breakdown of the statistically unacceptable tests.

TABLE 18

Reason for Fail	No. of Tests
Total Deposits Mild	4
Total Deposits Severe	1

INDUSTRY PERFORMANCE

Table 19 shows the current Industry precision and severity for the Total Deposits test parameter for all operationally valid tests for the report period. (First calibration test completed 9/6/00.)

TABLE 19

Total Deposits	n	df	Pooled s	Mean Δ/s
Initial Round Robin Study (1st half)	28	24	5.50	-----
9/6/00 through 3/31/01	52	48	6.67	-0.46
Updated Targets Effective 6/1/01	80	76	5.40	-----
4/1/01 through 9/30/01	34	30	5.61	-0.47
10/1/01 through 3/31/02	44	40	6.56	-0.44

Table 20 shows the current severity for the Total Deposits parameter for each lab for all operationally valid tests in the report period.

TABLE 20

	n	Mean Δ/s
Lab A	11	-0.29
Lab AB	1	0.94
Lab B	11	-0.25
Lab D	2	-0.83
Lab G	7	-0.57
Lab I	2	-0.83
Lab U	1	0.85
Lab V	9	-0.90

TEOST MHT-4, Draft 17, 00.08.11: Determination of Moderately High Temperature Piston Deposits by Thermo-oxidation Engine Oil Simulation Test (MTEOS), continued

PRECISION AND SEVERITY

Overall precision is worsening. Severity continues to trend moderately mild of target. Severity is presented graphically in Figure 6 where an overall mild slope is observed.

There were a high number of operationally invalid tests reported this period. In six out of the nine operationally invalid tests, the labs were unaware of an operational problem until a post-run check of the instrument was made after being advised of a failing TMC calibration result. One lab in particular had a hard time achieving initial calibration of their instrument; those initial failing results are withheld from the overall statistics for operationally valid tests.

A breakdown of the period calibration results by oil (Attachment 3) shows the precision for oil 433 (s = 9.18) to be significantly worse than target (s = 5.26) while the mean performance on oil 74 is, overall, 1.0 standard deviation mild of the target performance (oil 432 is performing 0.67 s mild of target and 432 is 0.72 s mild of target). Last period, precision on oil 433 (s = 4.91) was better than target (s= 5.26), while oil 1006 precision (s = 8.97) was significantly worse than target (s = 5.93).

TMC MEMORANDA

There were no TMC technical memoranda issued this report period for the MTEOS test method.

D6082: High Temperature Foaming Characteristics of Lubricating Oils

On June 18, 2001, the section agreed to suspend the use of TMC oil 1002 as a D6082 reference oil due to ongoing calibration precision and severity problems with that oil. It is unlikely that 1002 will be reintroduced into the monitoring system as the expected performance is extremely severe compared to GF-3/SL performance limits for this test method. A search for a more suitable replacement oil has been initiated. Please see last periods report for the final summary of calibrations on TMC 1002.

Note that TMC 1007 has a Foam Stability (one minute after disconnect) target mean performance of zero ml and a target precision (standard deviation) of zero ml. Any negative (mild) result for this parameter is unlikely and any positive result would be "infinitely" severe in standard deviations (Δ/s). For Foam Stability, it is preferable to simply note the number of non-zero occurrences in order to flag any severity trends.

Note that in June 2000, the High Temperature Foam Surveillance Panel had given approval for the TMC to stop collecting data for Total Volume Increase.

STATUS

Table 21 summarizes the reference tests reported to the TMC this period (5 labs reporting):

TABLE 21

	No. of Tests
Statistically Acceptable and Operationally Valid	11
Operationally Valid but Failed Acceptance Criteria	0
Operationally Invalid	1
Total	**12**

Fail Rate of Operationally Valid Tests: 0.0%

D6082: High Temperature Foaming Characteristics of Lubricating Oils, continued

TMC 1007 INDUSTRY PERFORMANCE

Tables 22 and 23 show the current industry precision and severity for the Foam Tendency and Foam Stability test parameters for all operationally valid tests on oil 1007 for the report period. (First calibration test on TMC 1007 completed 4/12/99.)

TABLE 22

1007 Foam Tendency, ml	n	Mean	s	Mean Δ/s
Initial Round Robin Study (targets)	28	65.71	19.28	-----
4/12/99 through 3/31/00	17	65.3	18.41	-0.02
4/1/00 through 3/31/01	14	67.5	11.22	0.09
4/1/01 through 9/30/01	9	71.1	14.53	0.28
10/1/01 through 3/31/02	11	64.5	15.07	-0.06

TABLE 23

1007 Foam Stability @ 1 min., ml	n	Mean	s	
Initial Round Robin Study	28	0.00	0.00	
4/12/99 through 3/31/00	17	No non-zero occurrences		
4/1/00 through 3/31/01	17	No non-zero occurrences		
4/1/01 through 9/30/01	9	No non-zero occurrences		
10/1/01 through 3/31/02	11	No non-zero occurrences		

Table 24 shows the current 1007 severity for the monitored result parameter for each lab for all operationally valid tests reported for the report period.

TABLE 24
TMC 1007

	n	Foam Tendency Mean Δ/s
Lab A	2	0.74
Lab B	4	-0.30
Lab D	2	0.48
Lab G	2	-1.07
Lab I	1	0.22

PRECISION AND SEVERITY

Foam Tendency precision on 1007 is somewhat worse than last period, but still better than the target precision. Severity is close to target (mild bias). There were no non-zero occurrences of Foam Stability on 1007; this would suggest Foam Stability precision is as expected. Foam Tendency severity is graphically represented in Figure 7 with some variability in the data but reasonably good overall leveling for the period.

TMC MEMORANDA

There were no TMC technical memoranda issued this report period for the D6082 test method.

D6557: Ball Rust Test (BRT)

Note that, for BRT, a positive Δ/s is mild, not severe (a higher AGV result is considered to be a more mild result while a lower AGV result is considered to be a more severe result.)

STATUS

Table 25 summarizes the reference tests reported to the TMC this period (4 labs reporting):

TABLE 25

	No. of Tests
Statistically Acceptable and Operationally Valid	109
Operationally Valid but Failed Acceptance Criteria	7
Operationally Invalid	1
Aborted	1
Total	**118**

Fail Rate of Operationally Valid Tests: 6.0%

Table 26 is a breakdown of the statistically unacceptable tests.

TABLE 26

Reason for Fail	No. of Tests
Average AGV Mild	5
Average AGV Severe	2

INDUSTRY PERFORMANCE

Table 27 shows the current Industry precision and severity for the Average AGV test parameter for all operationally valid tests for the report period. (First calibration test completed 8/15/00.)

TABLE 27

Average AGV	n	df	Pooled s	Mean Δ/s
Initial Round Robin Study (targets)	48	44	9.43	-----
8/15/00 through 9/30/00	28	25	10.50	0.38
10/1/00 through 3/31/01	112	109	8.48	0.42
4/1/01 through 9/30/01	156	153	8.90	0.36
10/1/01 through 3/31/02	116	113	12.46	0.67

Table 28 shows the current severity for the Average AGV parameter for each lab for all operationally valid tests for the report period.

TABLE 28

	n	Mean Δ/s
Lab A	52	0.59
Lab B	30	0.69
Lab G	21	0.36
Lab D	13	1.42

D6557: Ball Rust Test (BRT), continued

PRECISION AND SEVERITY

Precision this report period has degraded when compared to the target matrix and the previous period. Overall severity is trending mild of target. Severity is graphically represented in Figure 8 (attached). All labs are trending mild of target. There were three results from two labs, which were > 4 Δ/s from target. These results were all on reference oil 5A-3. When these results are removed, precision estimates improve from 12.46 to 10.42, which is more in line with the initial round robin estimates. The mild trend for this period also decreases from 0.67 Δ/s to 0.47 Δ/s when these three results are removed.

TMC MEMORANDA

There were no technical memoranda issued this report period nor were there any information letters issued this report period.

Engine Oil Filterability Test (EOFT)

STATUS

Table 29 summarizes the reference tests reported to the TMC this period (3 labs reporting).

TABLE 29

	No. of Tests
Statistically Acceptable and Operationally Valid	84
Operationally Valid but Failed Acceptance Criteria	0
Operationally Invalid	0
Total	**84**

Fail Rate of Operationally Valid Tests: 0.0%

INDUSTRY PERFORMANCE

Table 30 shows the current Industry precision and severity for the Average % Change in Flow (CIF) test parameter for all operationally valid tests for the report period. (First calibration test completed 5/4/00.)

TABLE 30

Average % CIF	n	df	Pooled s	Mean Δ/s
Initial Round Robin Study (targets)	24	22	5.76	-----
5/4/00 through 9/30/00	53	51	7.47	1.64
10/1/00 through 3/31/01	79	78	4.79	0.30
4/1/01 through 9/30/01	103	102	6.69	-0.08
10/1/01 through 3/31/02	84	83	5.67	-0.06

Table 31 shows the current severity for the Average % CIF parameter for each lab for all operationally valid tests for the report period.

TABLE 31

	n	Mean Δ/s
Lab A	29	0.13
Lab B	24	-0.50
Lab G	31	0.11

PRECISION AND SEVERITY

Precision this report period has improved when compared to the previous period and is comparable to the target matrix. Overall severity is on or near target. Labs A and G are trending slightly severe, while Lab B is trending mild. Severity is graphically represented in Figure 9 (attached).

At this time, only TMC 78 is being assigned as a TMC calibration oil. The panel is pursuing a replacement oil for TMC 77, which had been providing results significantly mild of target.

Engine Oil Filterability Test (EOFT), continued

TMC MEMORANDA

There were no technical memoranda issued this report period nor were there any information letters issued this report period.

Engine Oil Water Tolerance Test (EOWT): 0.6% Water Treat Level

STATUS

Table 32 summarizes the reference tests reported to the TMC this period (3 labs reporting):

TABLE 32

	No. of Tests
Statistically Acceptable and Operationally Valid	86
Operationally Valid but Failed Acceptance Criteria	2
Aborted	1
Total	**89**

Fail Rate of Operationally Valid Tests: 2.3%

Table 33 is a breakdown of the statistically unacceptable tests.

TABLE 33

Reason for Fail	No. of Tests
Average % Change in Flow Mild (Oil 77)	1
Average % Change in Flow Mild (Oil 78)	1

INDUSTRY PERFORMANCE

Table 34 shows the current Industry precision and severity for the Average % Change in Flow (CIF) test parameter for all operationally valid tests for the report period. (First calibration test completed 5/4/00.)

TABLE 34

Average % CIF	n	df	Pooled s	Mean Δ/s
Initial Round Robin Study (targets)	24	22	5.93	-----
5/4/00 through 9/30/00	34	32	6.25	-0.039
10/1/00 through 3/31/01	101	99	5.61	-0.173
4/1/01 through 9/30/01	123	121	6.28	0.047
10/1/01 through 3/31/02	88	86	6.12	-0.048

Table 35 shows the current severity for the Average % CIF parameter for each lab for all operationally valid tests for the report period.

TABLE 35

	n	Mean Δ/s
Lab A	35	-0.31
Lab B	22	-0.40
Lab G	31	0.50

PRECISION AND SEVERITY

Precision has improved slightly compared with the previous period and compares well with the target matrix. Severity is on or near target. Severity is graphically represented in Figure 10 (attached). Lab G is trending severe, while labs A and B are trending mild.

Engine Oil Water Tolerance Test (EOWT): 1.0% Water Treat Level

STATUS

Table 36 summarizes the reference tests reported to the TMC this period (3 labs reporting):

TABLE 36

	No. of Tests
Statistically Acceptable and Operationally Valid	87
Operationally Valid but Failed Acceptance Criteria	2
Aborted, Sample Mix Up	1
Total	**90**

Fail Rate of Operationally Valid Tests: 2.5%

Table 37 is a breakdown of the statistically unacceptable tests.

TABLE 37

Reason for Fail	No. of Tests
Average % Change in Flow Mild (Oil 77)	1
Average % Change in Flow Mild (Oil 78)	1

INDUSTRY PERFORMANCE

Table 38 shows the current Industry precision and severity for the Average % Change in Flow (CIF) test parameter for all operationally valid tests for the report period. (First calibration test completed 5/4/00.)

TABLE 38

Average % CIF	n	df	Pooled s	Mean Δ/s
Initial Round Robin Study (targets)	24	22	5.81	-----
5/4/00 through 9/30/00	33	31	6.98	0.12
10/1/00 through 3/31/01	99	97	5.85	-0.19
4/1/01 through 9/30/01	115	113	5.79	0.26
10/1/01 through 3/31/02	89	87	7.20	0.02

Table 39 shows the current severity for the Average % CIF parameter for each lab for all operationally valid tests for the report period.

TABLE 39

	n	Mean Δ/s
Lab A	36	-0.15
Lab B	22	-0.98
Lab G	31	0.93

PRECISION AND SEVERITY

Precision has degraded when compared to the previous period and historical rates. Industry data is trending on or near target. Lab G is trending severe, while labs A and B are trending mild this period. Severity is graphically represented in Figure 11 (attached).

Engine Oil Water Tolerance Test (EOWT): 2.0% Water Treat Level

STATUS

Table 40 summarizes the reference tests reported to the TMC this period (3 labs reporting):

TABLE 40

	No. of Tests
Statistically Acceptable and Operationally Valid	111
Operationally Valid but Failed Acceptance Criteria	3
Operationally Invalid	3
Total	**117**

Fail Rate of Operationally Valid Tests: 2.6%

Table 41 is a breakdown of the statistically unacceptable tests.

TABLE 41

Reason for Fail	No. of Tests
Average % Change in Flow Mild (Oil 78)	1
Average % Change in Flow Severe (Oil 78)	1

INDUSTRY PERFORMANCE

Table 42 shows the current Industry precision and severity for the Average % Change in Flow (CIF) test parameter for all operationally valid tests for the report period. (First calibration test completed 5/4/00.)

TABLE 42

Average % CIF	n	df	Pooled s	Mean Δ/s
Initial Round Robin Study (targets)	24	22	7.08	-----
5/4/00 through 9/30/00	31	29	5.63	-0.07
10/1/00 through 3/31/01	100	98	6.25	-0.16
4/1/01 through 9/30/01	114	112	6.57	0.22
10/1/01 through 3/31/02	89	87	5.75	-0.02

Table 43 shows the current severity for the Average % CIF parameter for each lab for all operationally valid tests for the report period.

TABLE 43

	n	Mean Δ/s
Lab A	36	-0.09
Lab B	22	-0.84
Lab G	31	0.65

PRECISION AND SEVERITY

Precision for this period has improved when compared to the previous period and has also improved when compared to the target estimates. Severity was on or near target for the period. Lab G was severe, lab B was mild and lab A was on or near target for the period. Severity is graphically represented in Figure 12 (attached).

Engine Oil Water Tolerance Test (EOWT): 3.0% Water Treat Level

STATUS

Table 44 summarizes the reference tests reported to the TMC this period (3 labs reporting):

TABLE 44

	No. of Tests
Statistically Acceptable and Operationally Valid	87
Operationally Valid but Failed Acceptance Criteria	2
Total	**89**

Fail Rate of Operationally Valid Tests: 2.2%

Table 45 is a breakdown of the statistically unacceptable tests.

TABLE 45

Reason for Fail	No. of Tests
Average % Change in Flow Severe (Oil 78)	2

INDUSTRY PERFORMANCE

Table 46 shows the current Industry precision and severity for the Average % Change in Flow (CIF) test parameter for all operationally valid tests for the report period. (First calibration test completed 5/4/00.)

TABLE 46

Average % CIF	n	df	Pooled s	Mean Δ/s
Initial Round Robin Study (targets)	24	22	5.79	-----
5/4/00 through 9/30/00	32	30	5.71	0.23
10/1/00 through 3/31/01	98	96	5.71	-0.01
4/1/01 through 9/30/01	122	120	6.46	0.34
10/1/01 through 3/31/02	89	87	5.82	0.31

Table 47 shows the current severity for the Average % CIF parameter for each lab for all operationally valid tests for the report period.

TABLE 47

	n	Mean Δ/s
Lab A	36	0.46
Lab B	22	-0.92
Lab G	31	1.01

PRECISION AND SEVERITY

Precision has improved when compared to the previous period and compares well with the target matrix. Severity trended severe of target for the period. Severity is graphically represented in Figure 13 (attached). Laboratories A and G are trending severe while B is trending mild for the period.

REFERENCE OIL SUPPLIES

There is adequate supply of PCEOCP Bench Test reference oils on hand at the TMC. Table 48 lists the PCEOCP bench test reference oils currently on hand at the TMC.

Table 48

Oil	For Tests	Quantity Left (gallons)	Quantity Used Last 12 Months (gallons)
5A-3	BRT	1787.6	0.5
51	D5480, GI	94.6	0.0
52	D5480, D6417, GI	83.2	6.0
53	D5480, GI	97.0	0.2
54	D5480	97.8	0.0
55	D6417, D5480, D5800	87.9	5.9
^57	Volatility Candidate	51.2	0.0
58	D6417, D5800, GI	141.0	6.8
62	GI	2.2	0.2
^66	D6082 Candidate	110	0.0
71	TEOST	5.7	0.2
72	TEOST	4.8	0.2
74	MTEOS	4.0	0.1
77	EOFT, EOWT	198.8	33.3
78	EOFT, EOWT	182.7	48.5
^80	BRT	26.5	0.0
81	BRT	20.5	1.3
**432	MTEOS	Adequate	-----
**433	MTEOS	Adequate	-----
^*1002	D6082	51.3	-----
*1006	BRT, MTEOS	46.1	-----
*1007	FOAM	15.8	-----

^Not selected as reference oil; TMC holding for further instructions from Surveillance Panel.
*One drum of oil is set aside for bench calibration testing; the TMC has a larger supply of this oil.
**Five gallon aliquot set aside for bench testing; hard to get an inventory reading on amount set aside.

REFERENCE OIL SUPPLIES, continued

Shipping aliquots are:

D6417	1 ml
D5480	4 ml
D5800	100 ml
GI	25 ml
MTEOS	17 ml
TEOST	125 ml
D6082	525 ml
EOFT	290 ml
EOWT	290 ml
BRT	30 ml

MISCELLANEOUS

The TMC posts monitored bench test calibration data on the Internet. Selected parameters from all operationally valid reference tests are posted on the TMC's World-Wide-Web page in real time. Lab identifications are coded on the TMC's web site as they are on the previous pages of this report. Also posted are statistics, CUSUM plots, reporting forms and data dictionaries and data from various matrix programs (like test development and reference oil selection matrix programs). The TMC encourages all interested parties to access and download the data, statistics and plots for individual studies and analyses. Likewise, you are encouraged to access the web site to download the most recent test reporting forms and data dictionaries. The TMC's web site address is http://www.astmtmc.cmri.cmu.edu/

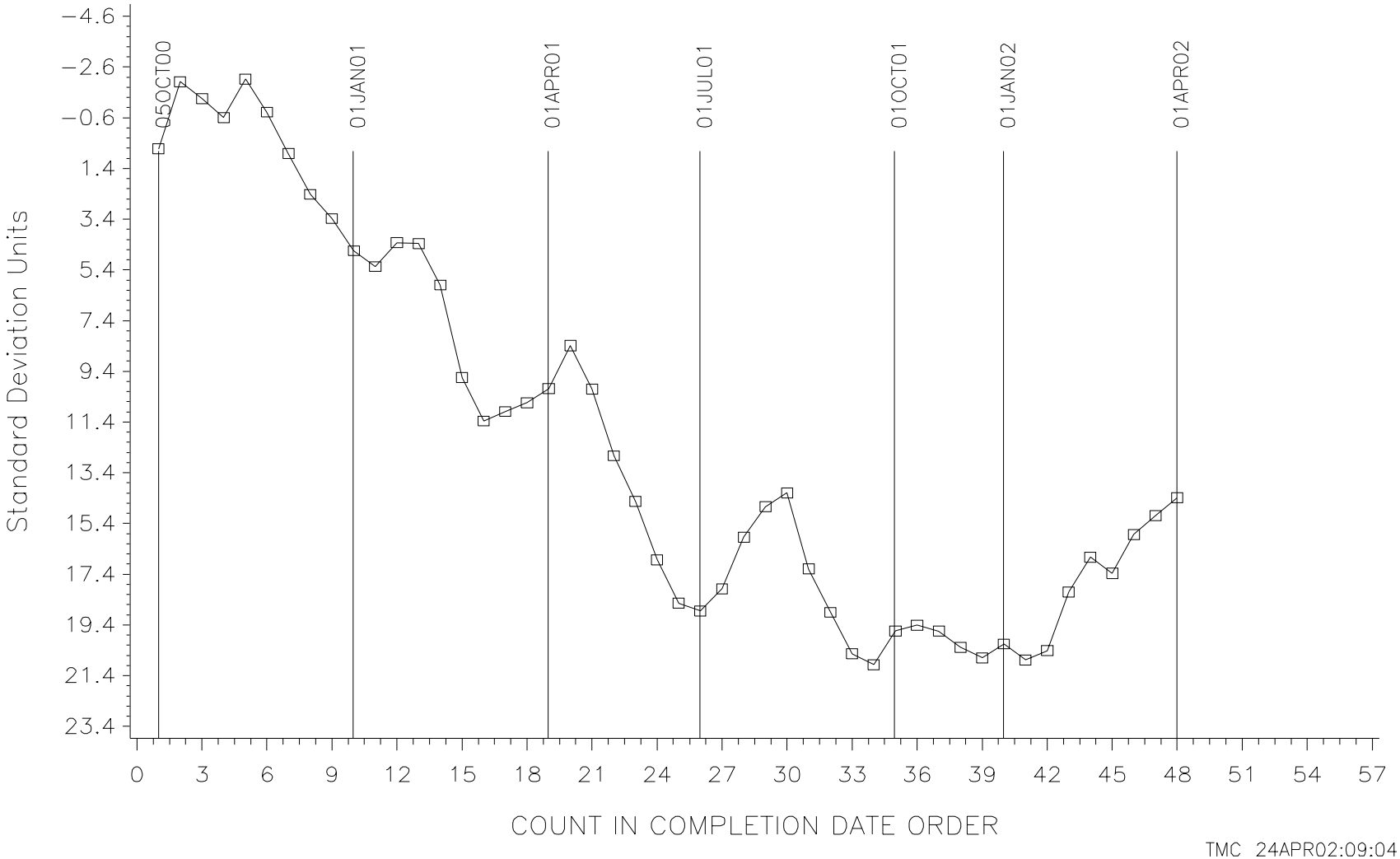
All currently monitored bench test data dictionaries and report form packages have been beta tested by the ASTM Data Communications Committee (DCC) and approved for electronic data transfer. If your lab should require additional information on this type of data reporting, please contact Tom Schofield at (412) 365-1011 or Rich Grundza at (412) 365-1031.

D6417 INDUSTRY OPERATIONALLY VALID DATA

Figure 1

SAMPLE AREA % VOLATIZED @ 371'C ... 700'F (Area %

CUSUM Severity Analysis



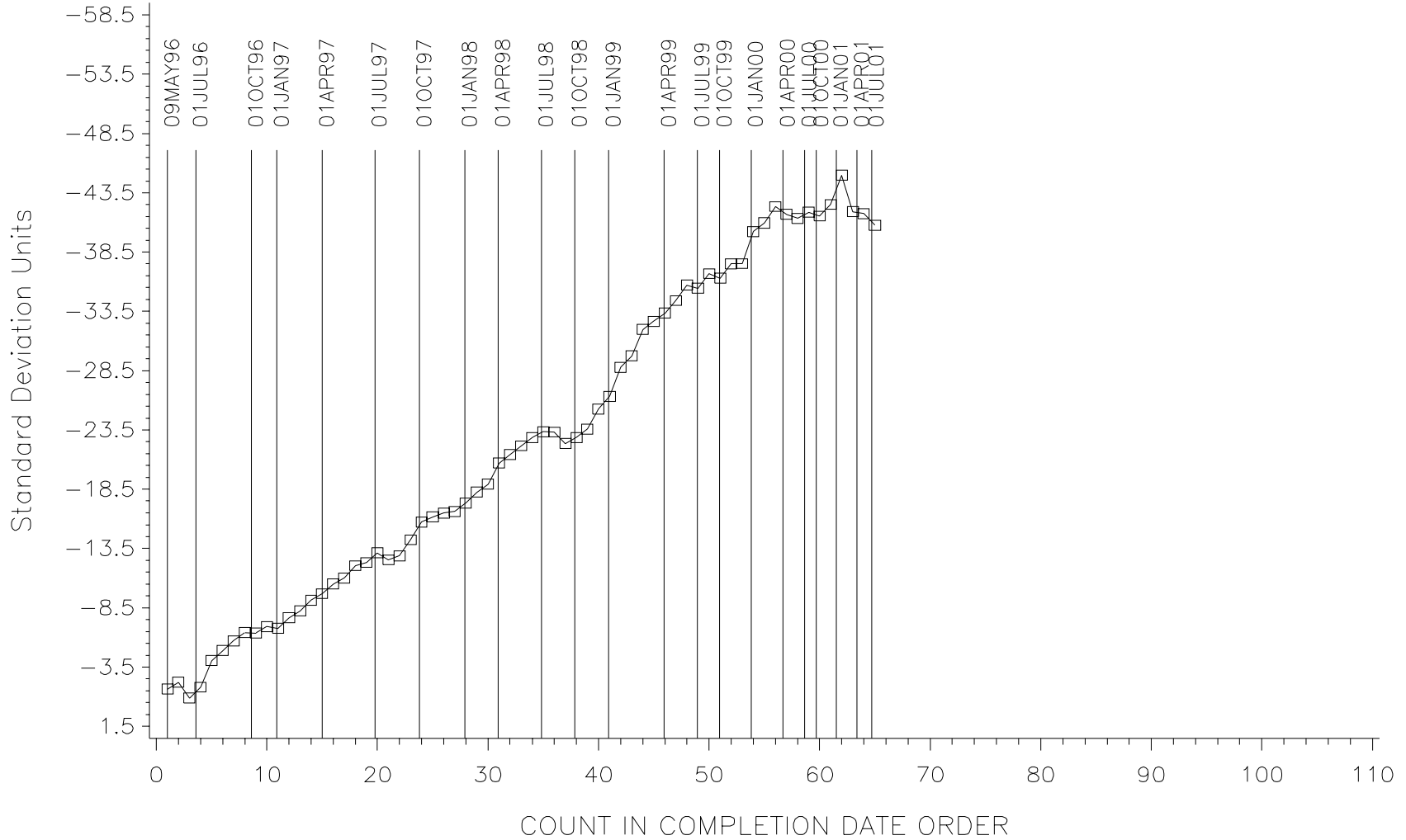
TMC 24APR02:09:04

VGC–D5480 INDUSTRY OPERATIONALLY VALID DATA

Figure 2

SAMPLE MASS % VOLATIZED @ 371'C ... 700'F (MASS %)

CUSUM Severity Analysis



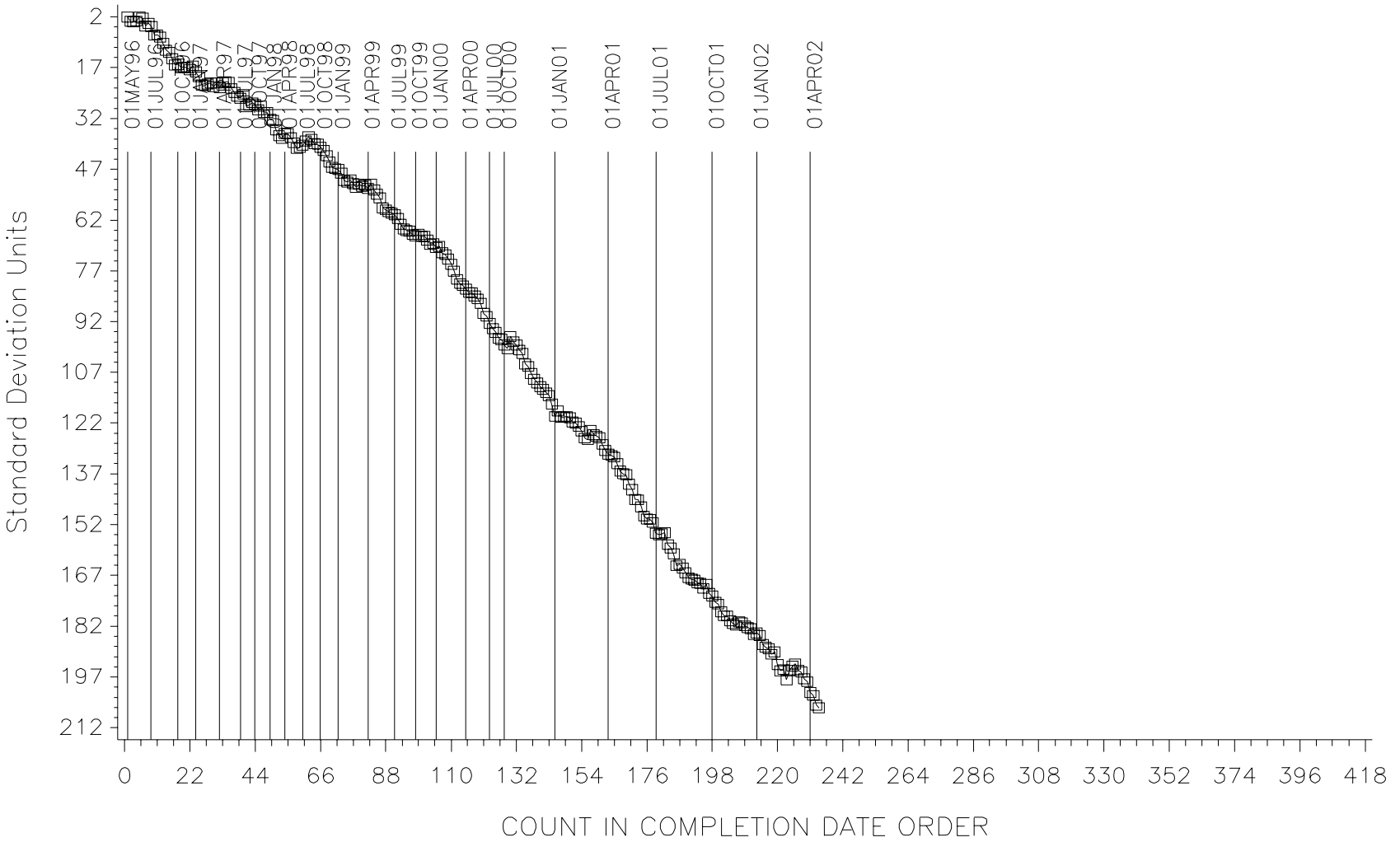
TMC 24APR02:10:25

D5800 INDUSTRY OPERATIONALLY VALID DATA

Figure 3A

TEST OIL SAMPLE EVAPORATION LOSS (MASS %)

CUSUM Severity Analysis



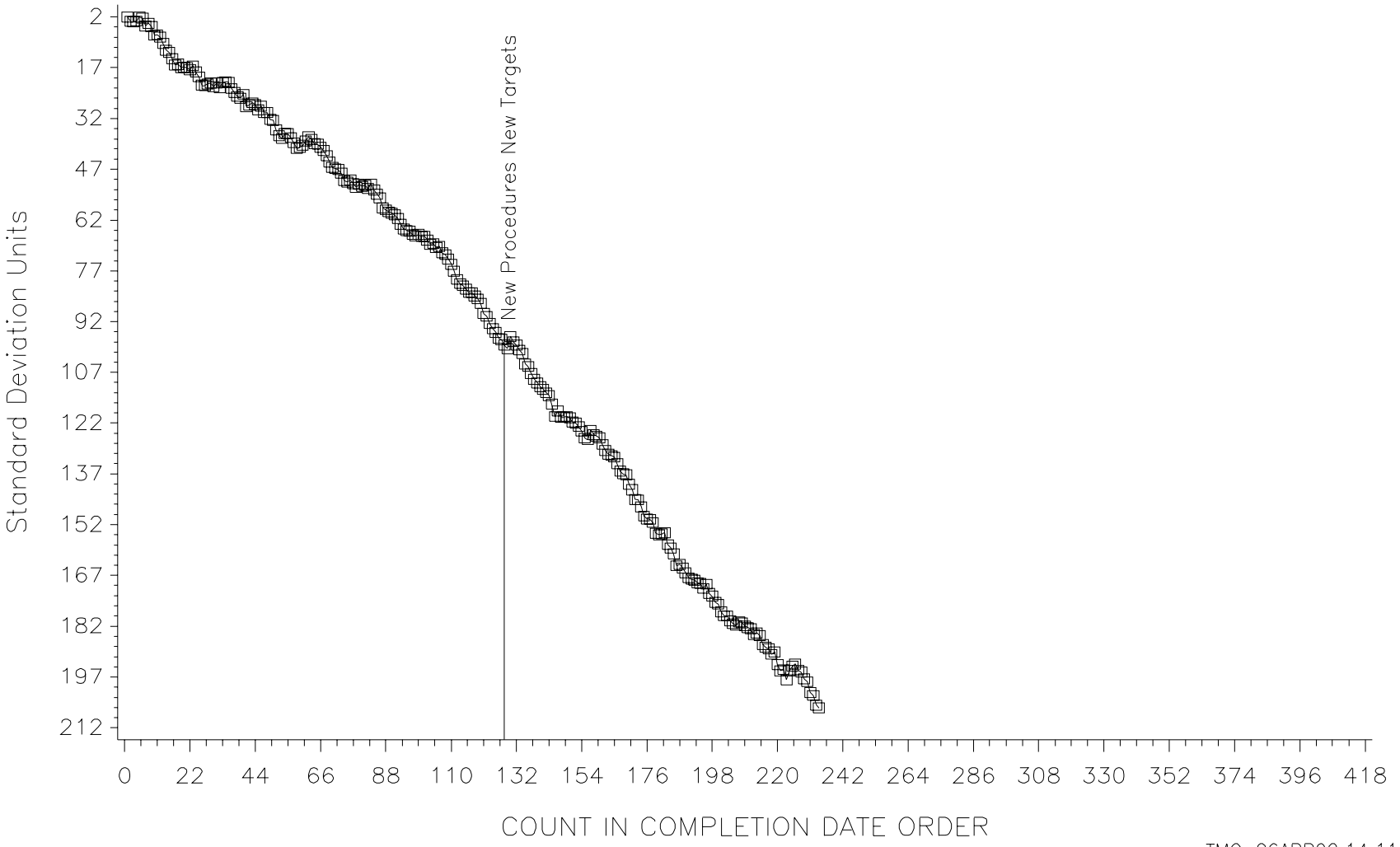
TMC 26APR02:14:13

D5800 INDUSTRY OPERATIONALLY VALID DATA

Figure 3B

TEST OIL SAMPLE EVAPORATION LOSS (MASS %)

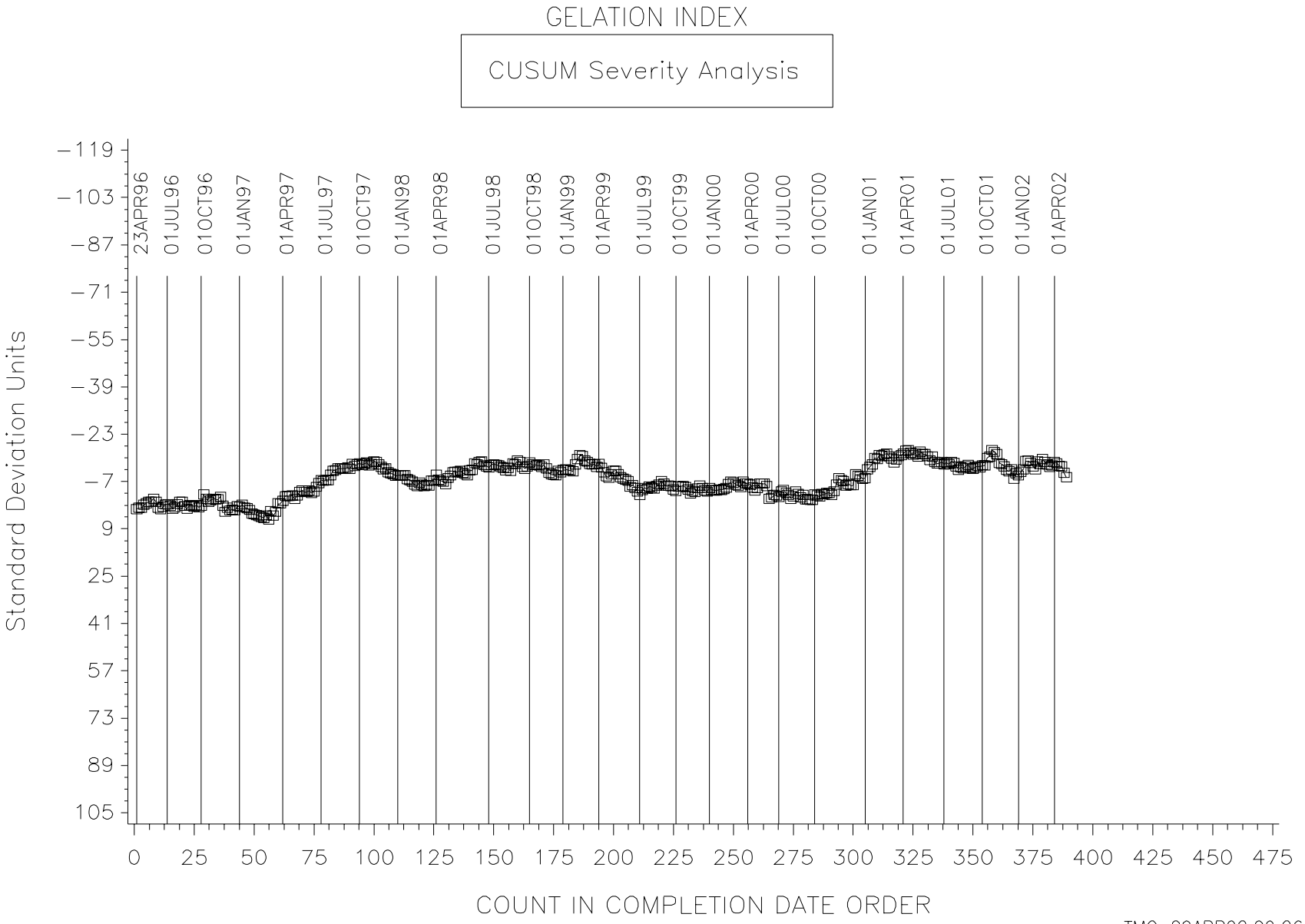
CUSUM Severity Analysis



TMC 26APR02:14:11

GELATION INDEX INDUSTRY OPERATIONALLY VALID DATA

Figure 4



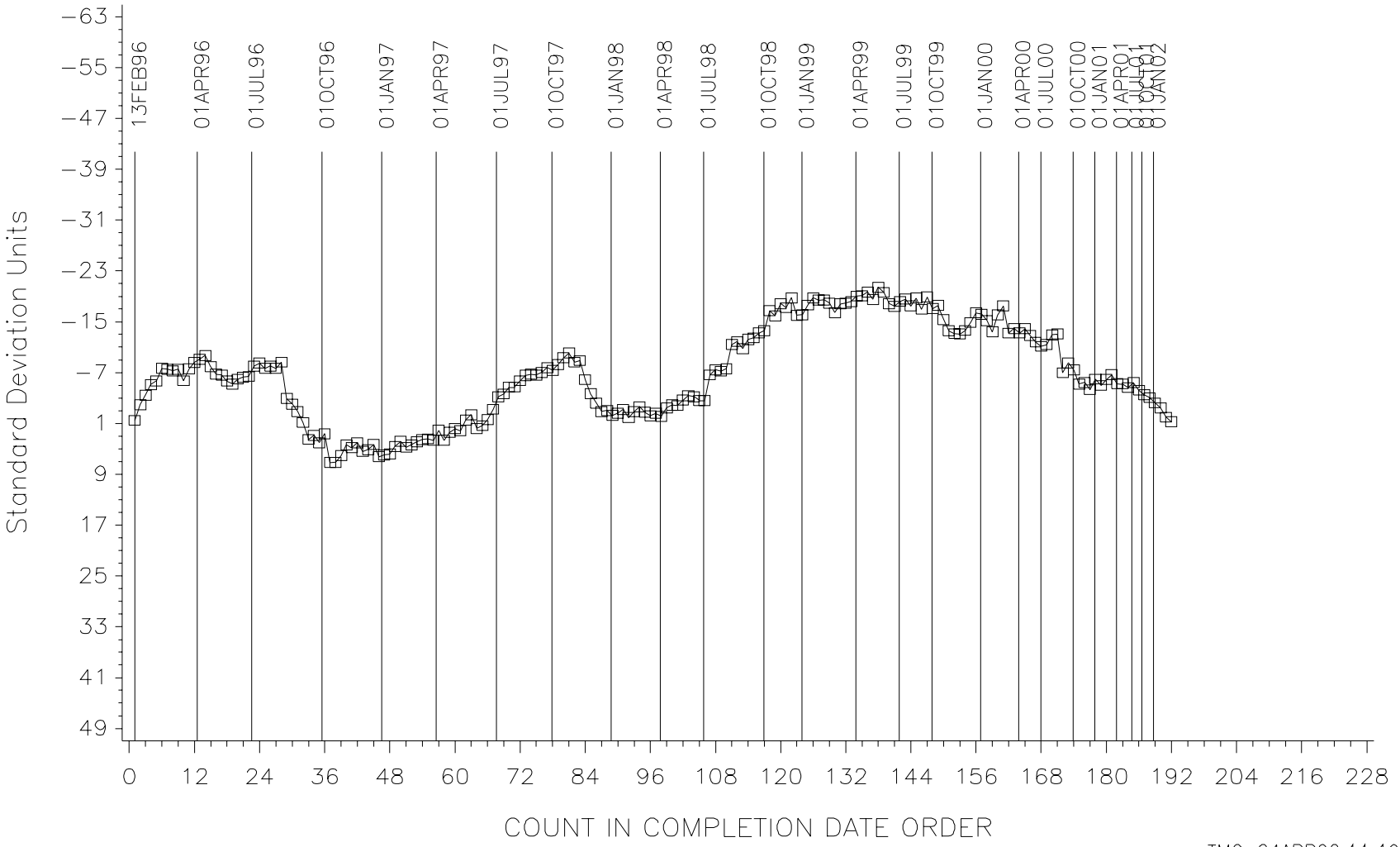
TMC 29APR02:09:26

TEOST INDUSTRY OPERATIONALLY VALID DATA

Figure 5

TOTAL DEPOSITS (mg)

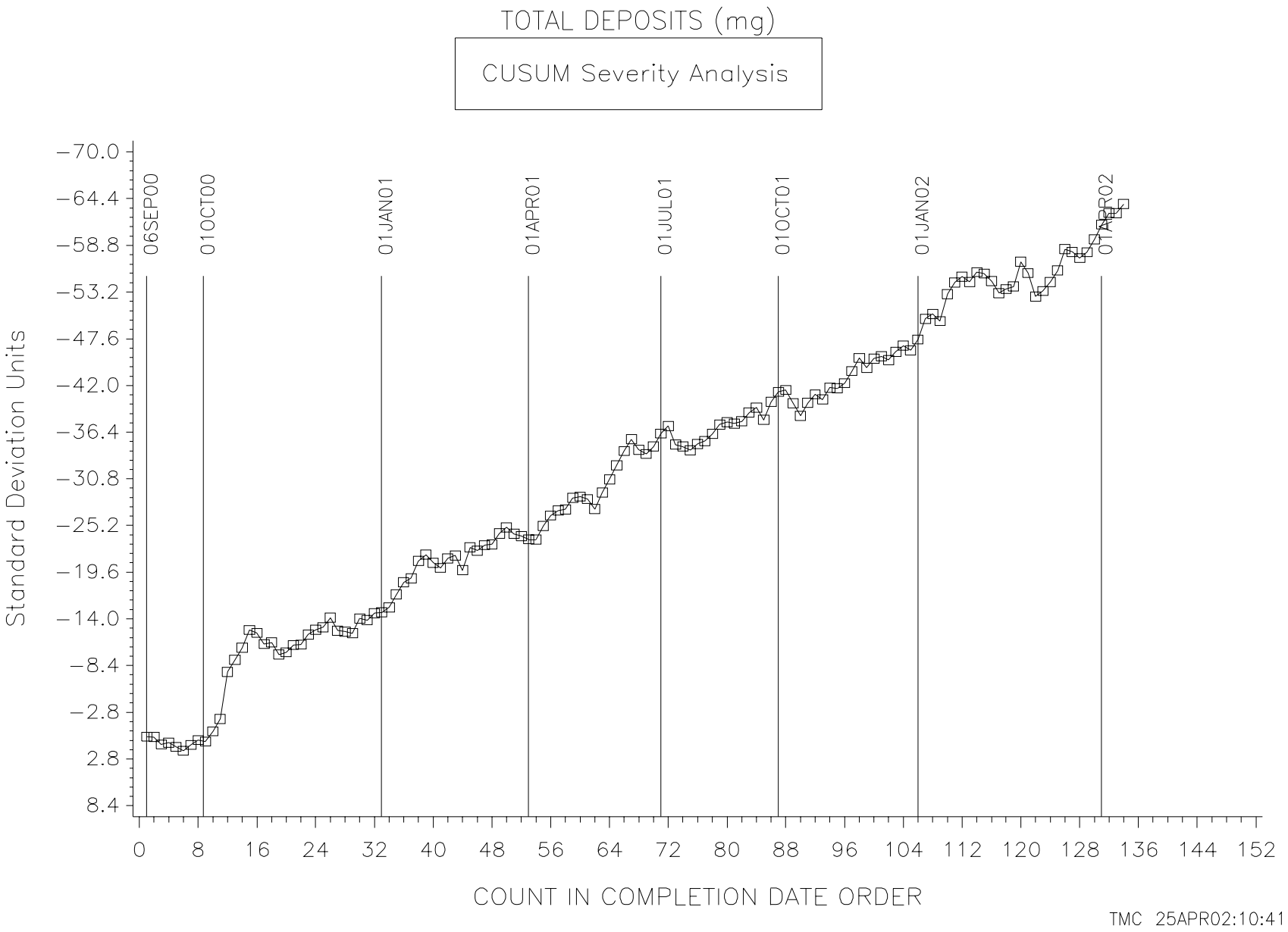
CUSUM Severity Analysis



TMC 24APR02:11:19

MHT TEOST INDUSTRY OPERATIONALLY VALID DATA

Figure 6



TMC 25APR02:10:41

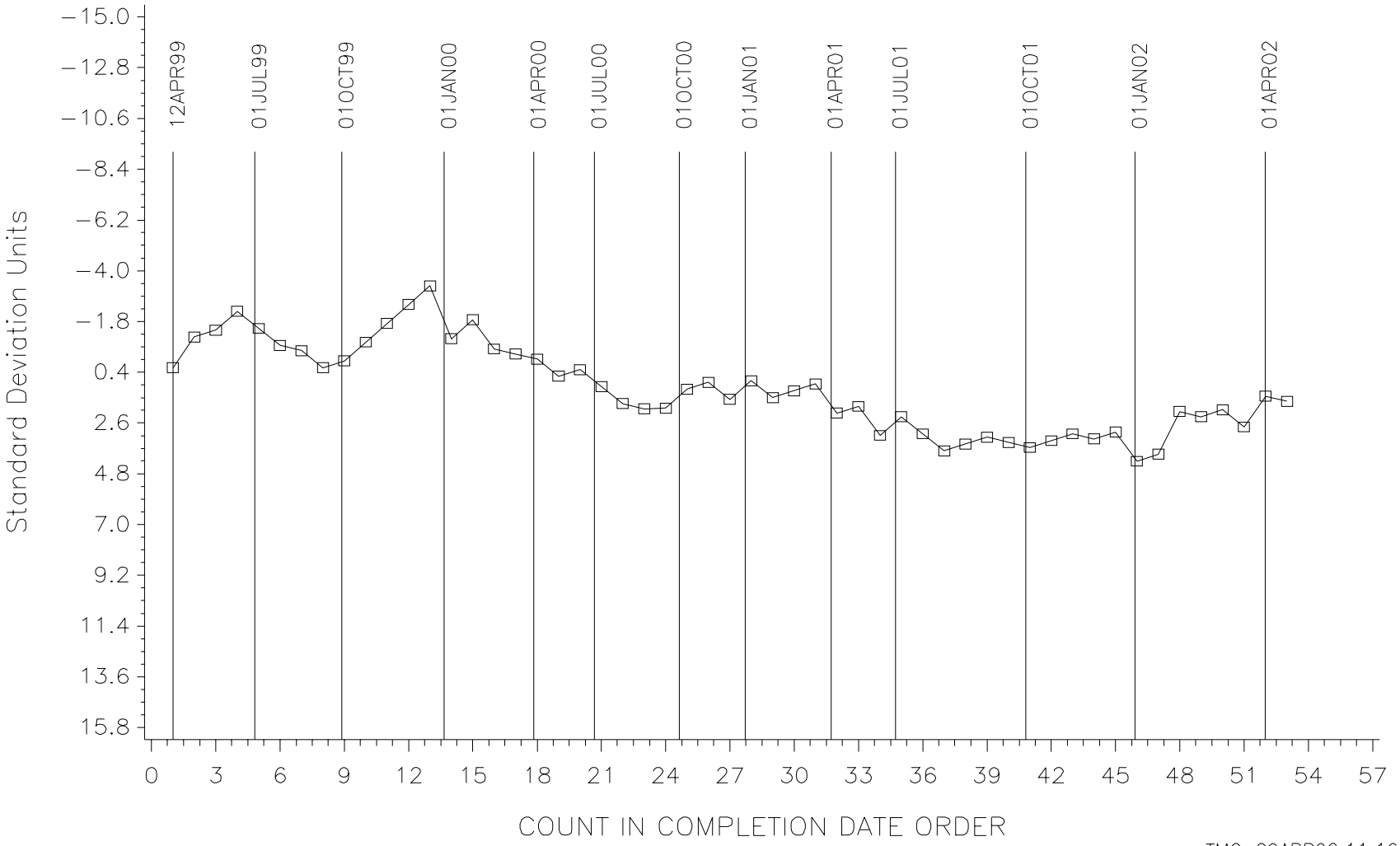
Figure 7

D6082 INDUSTRY OPERATIONALLY VALID DATA

Oil 1007 Only

FOAM TENDENCY, IMMEDIATELY BEFORE DISCONNECT STATI

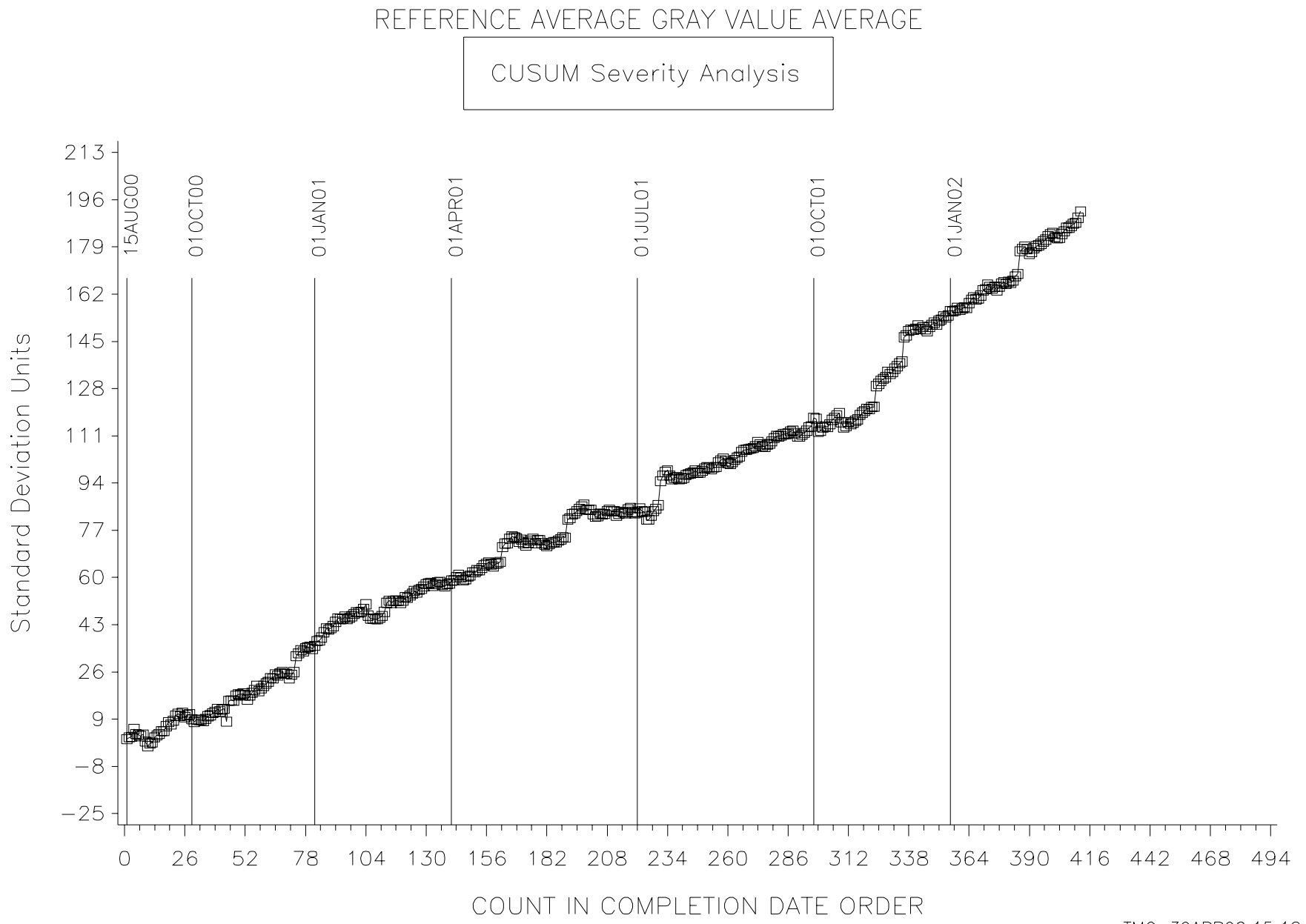
CUSUM Severity Analysis



TMC 29APR02:11:16

BALL RUST TEST INDUSTRY OPERATIONALLY VALID DATA

FIGURE 8



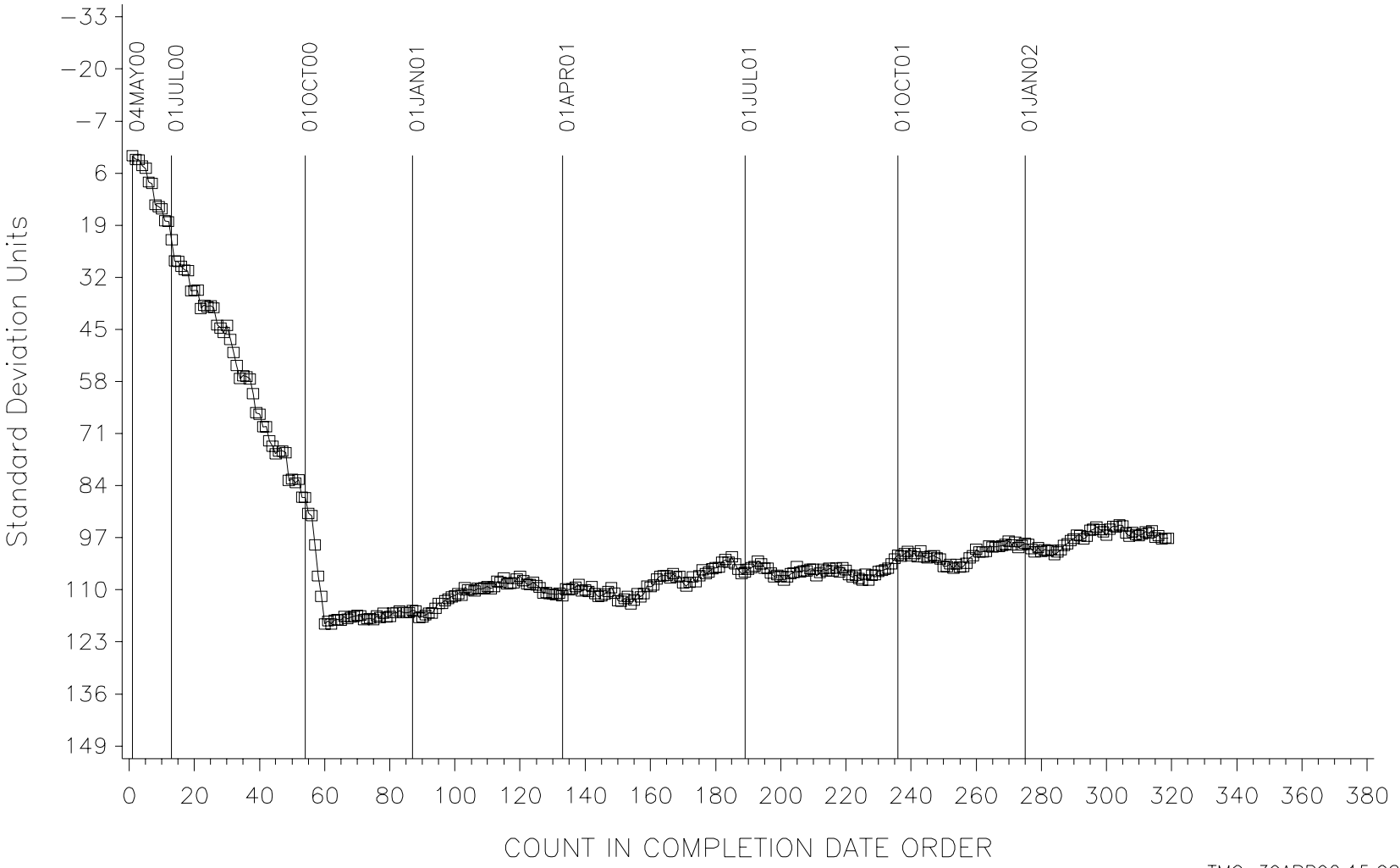
TMC 30APR02:15:18

EOFT INDUSTRY OPERATIONALLY VALID DATA

FIGURE 9

20 – 25 ML CHANGE IN FLOWRATE AVERAGE (%)

CUSUM Severity Analysis



TMC 30APR02:15:28

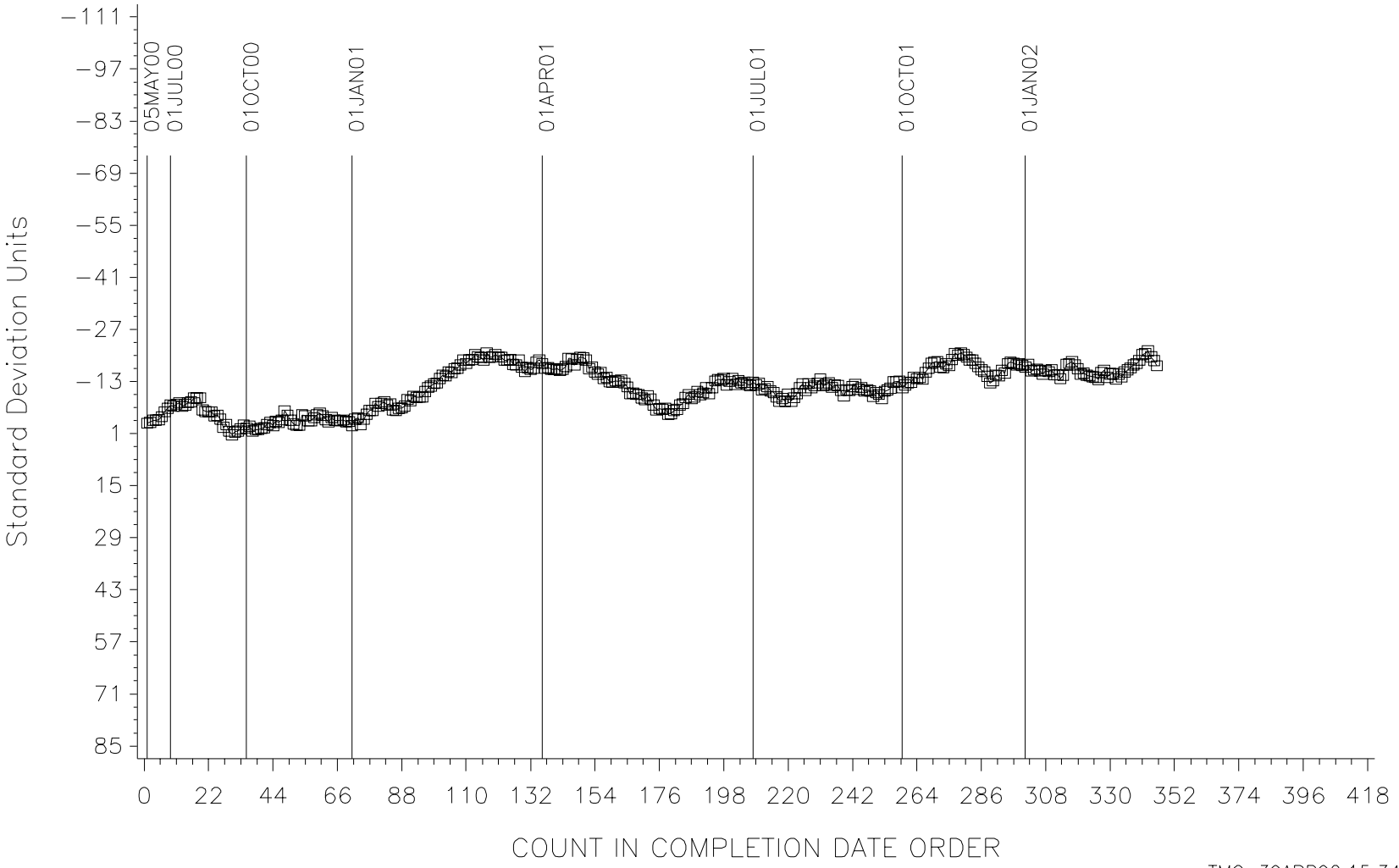
FIGURE 10

EOWT INDUSTRY OPERATIONALLY VALID DATA

0.6% Treat Rate

TEST RUN 20 – 25 ML CHANGE IN FLOWRATE AVERAGE (%)

CUSUM Severity Analysis



TMC 30APR02:15:34

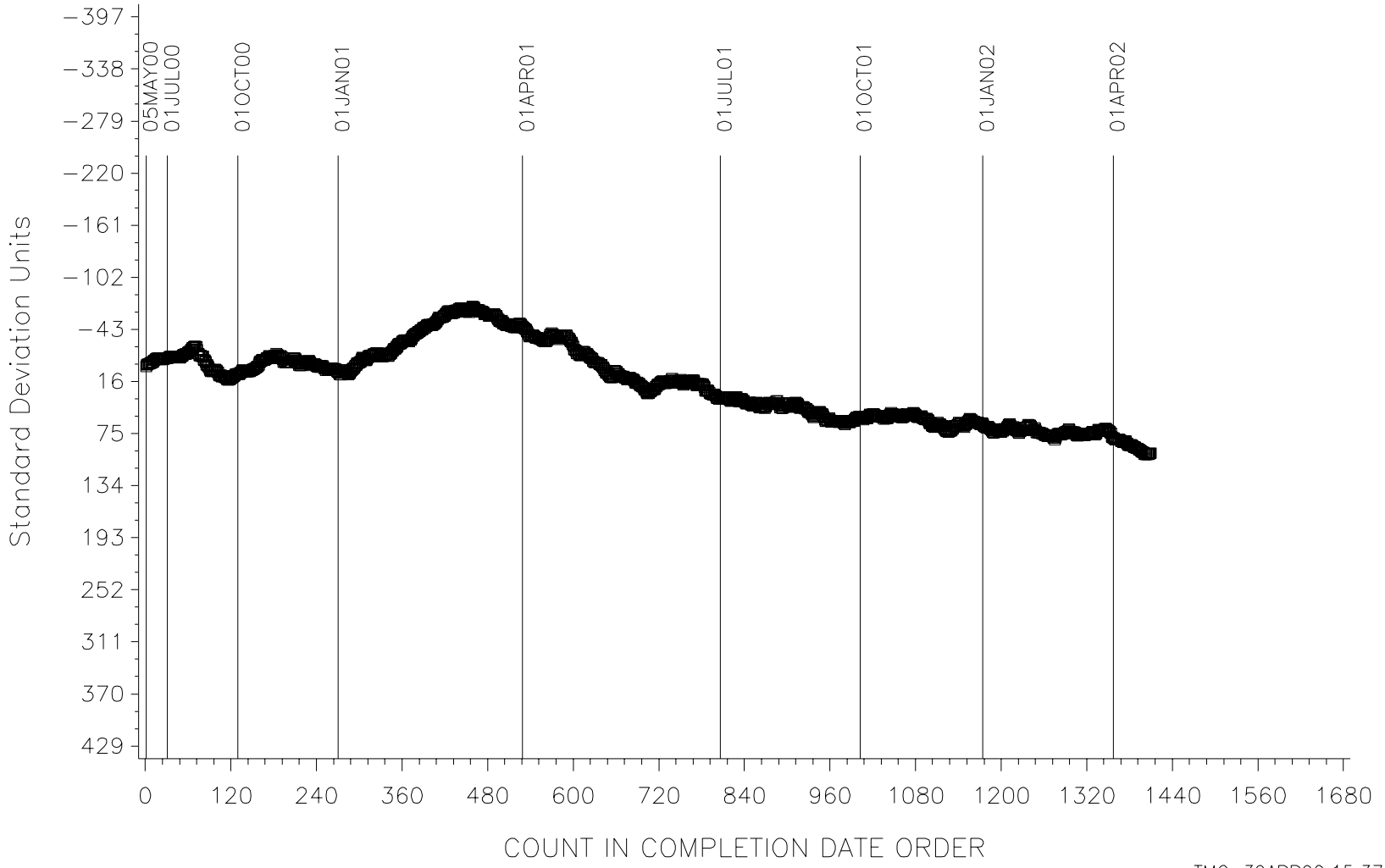
EOWT INDUSTRY OPERATIONALLY VALID DATA

1.0% Treat Rate

TEST RUN 20 – 25 ML CHANGE IN FLOWRATE AVERAGE (%)

Figure 11

CUSUM Severity Analysis



TMC 30APR02:15:37

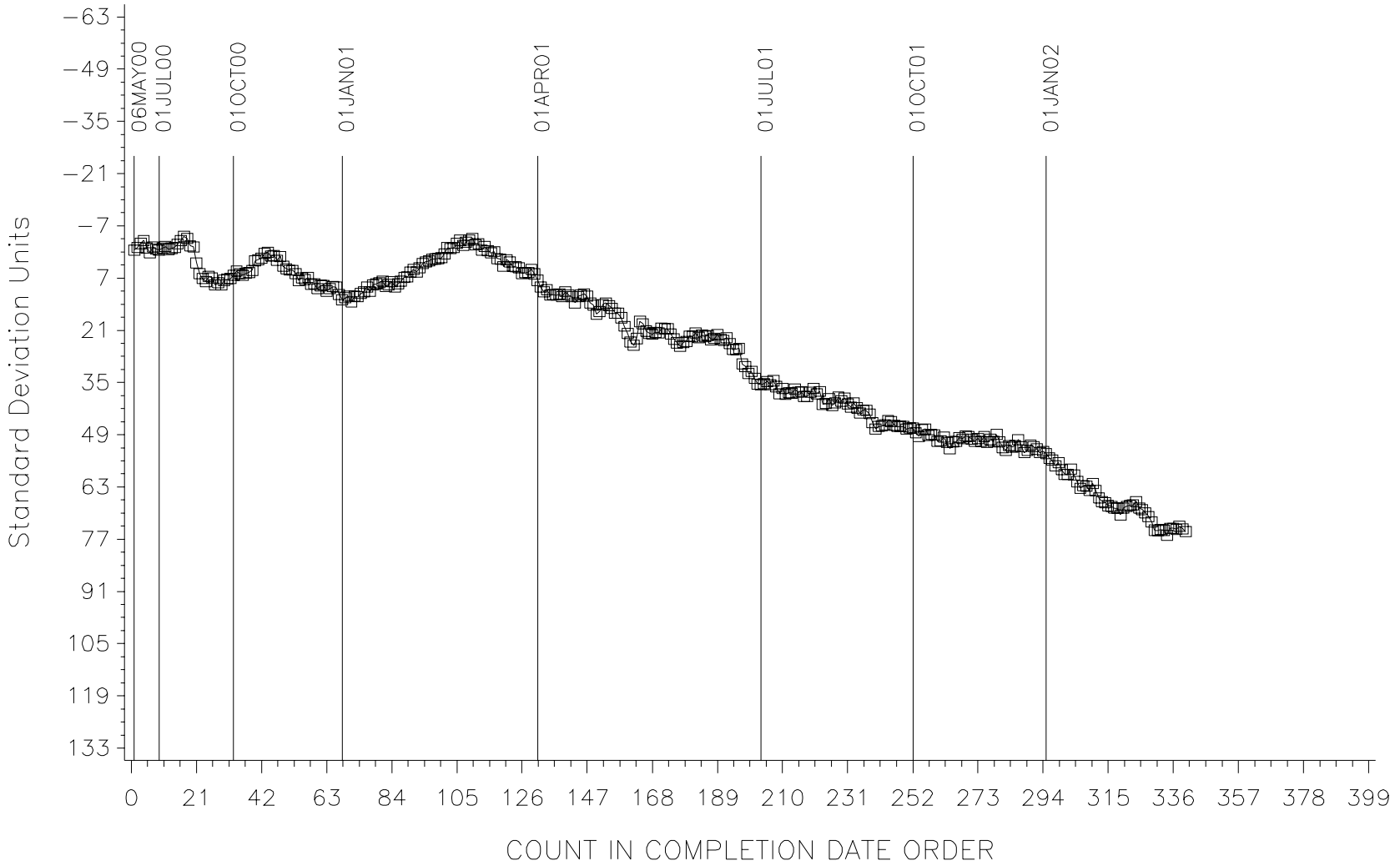
Figure 12

EOWT INDUSTRY OPERATIONALLY VALID DATA

2.0% Treat Rate

TEST RUN 20 – 25 ML CHANGE IN FLOWRATE AVERAGE (%)

CUSUM Severity Analysis



TMC 30APR02:15:52

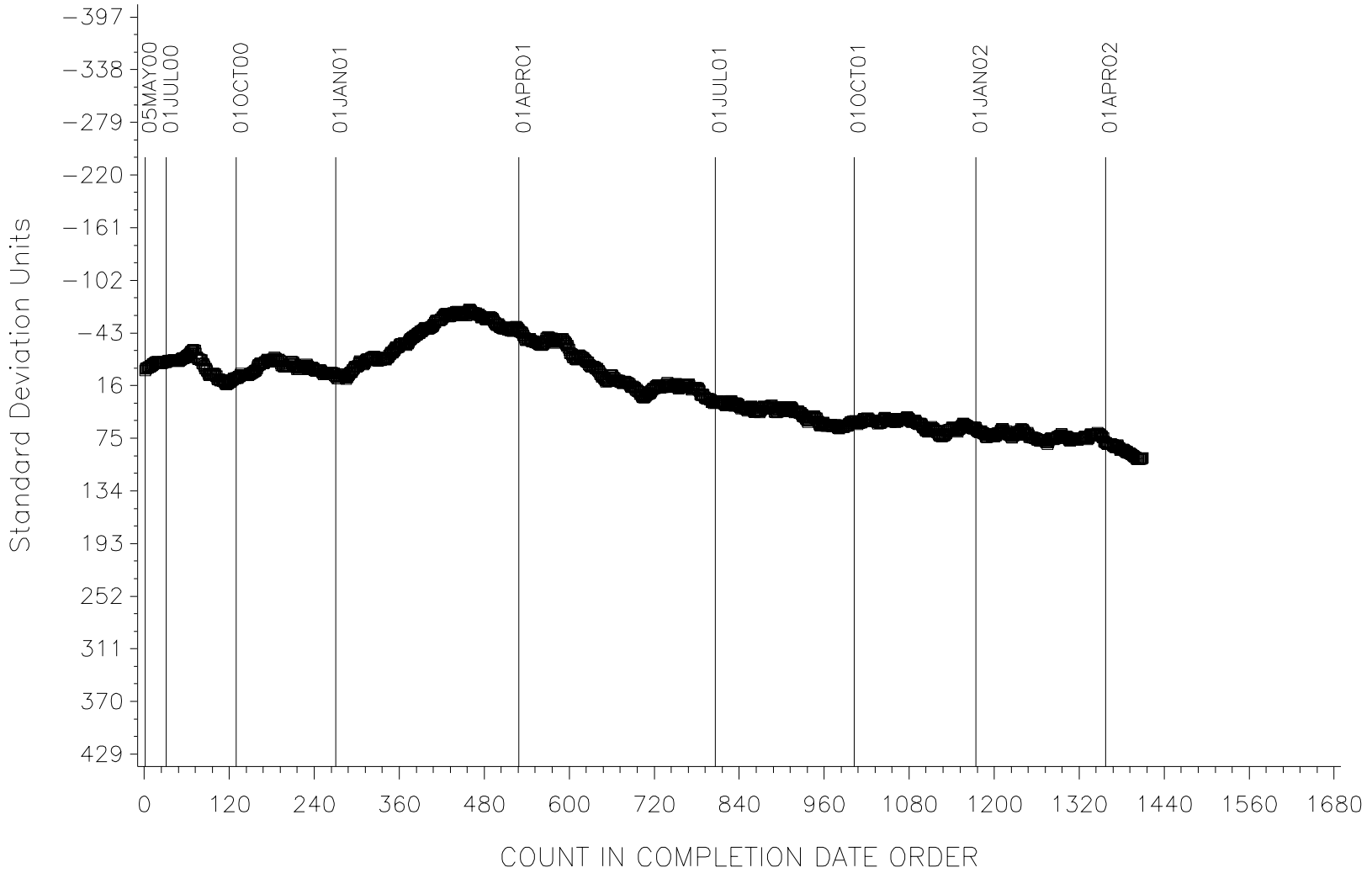
EOWT INDUSTRY OPERATIONALLY VALID DATA

Figure 13

3.0% Treat Rate

TEST RUN 20 – 25 ML CHANGE IN FLOWRATE AVERAGE (%)

CUSUM Severity Analysis



TMC 30APR02:15:49

Attachment 2

TMC Monitored Bench Tests
Reference Oil Test Targets and Acceptance Bands

Test	Oil Code	Parameter	n	Mean	sR	Acceptance Bands * 95% Lower	95% Upper
VGC by	51	area % volatility loss	48	13.07	0.66	11.8	14.4
D2887	52	area % volatility loss	48	6.88	0.43	6.0	7.7
Extended	53	area % volatility loss	48	17.92	0.76	16.4	19.4
	54	area % volatility loss	48	19.16	0.87	17.5	20.9
	55	area % volatility loss	48	11.56	0.71	10.2	13.0
D6417	52	area % volatility loss	18	6.97	0.31	6.4	7.6
	55	area % volatility loss	18	11.68	0.51	10.7	12.7
	58	area % volatility loss	18	5.61	0.30	5.0	6.2
VGC by	51	mass % volatility loss	10	11.85	0.47	10.9	12.8
D5480	52	mass % volatility loss	11	6.22	0.23	5.8	6.7
(New Targets	53	mass % volatility loss	10	16.74	0.66	15.4	18.0
Effective	54	mass % volatility loss	10	17.89	0.68	16.6	19.2
12/7/1999)	55	mass % volatility loss	11	10.71	0.29	10.1	11.3
D5800	52	mass % volatility loss	59	13.61	0.49	12.6	14.6
New Targets	55	mass % volatility loss	60	16.39	0.66	15.1	17.7
9/26/00	58	mass % volatility loss	59	14.46	0.52	13.4	15.5
TEOST by	71	Total Deposit wt. (mg)	27	51.79	4.79	42.4	61.2
D6335	72	Total Deposit wt. (mg)	27	26.72	3.46	19.9	33.5
MTEOS by	74	Total Deposit wt. (mg)	20	16.84	5.28	6.5	27.2
Draft 17 00.08.11	432	Total Deposit wt. (mg)	18	50.13	4.88	40.6	59.7
New Targets	433	Total Deposit wt. (mg)	18	50.28	5.26	40.0	60.6
6/1/01	1006	Total Deposit wt. (mg)	24	34.53	5.93	22.9	46.2
	~~51~~	~~Gelation Index~~	~~35~~	~~63.3~~	~~12.01~~	~~39.8~~	~~86.8~~
GI by	52	Gelation Index	35	4.5	0.24	4.0	5.0
D5133	53	Gelation Index	37	44.7	4.64	35.6	53.8
	~~55~~	~~Gelation Index~~	~~36~~	~~22.3~~	~~4.84~~	~~12.8~~	~~31.8~~
	58	Gelation Index	17	5.8	0.69	4.4	7.2
	62	Gelation Index	35	17.0	3.90	9.4	24.6
~~D6082~~	~~1002~~	~~Tendency (ml)~~	~~32~~	~~410.63~~	~~58.78~~	~~295~~	~~526~~
~~(HT FOAM)~~	~~1002~~	~~Stability (ml)~~	~~32~~	~~37.81~~	~~45.41~~	~~0~~	~~127~~
D6082	1007	Tendency (ml)	28	65.71	19.28	28	103
(HT FOAM)	1007	Stability (ml)	28	0.00	0.00	0	0
BRT by	81	Average AGV	12	112	14.00	85	140
D02-1483	1006	Average AGV	12	128	7.21	114	142
(D6557)	5A-3	Average AGV	12	76	6.47	63	89
EOFT by	77	Δ Flowrate (%)	12	-45.55	4.36	-54.10	-37.00
(Draft 6)	78	Δ Flowrate (%)	12	15.74	6.87	2.27	29.21
EOWT by	77	0.6% H20 Δ Flowrate (%)	12	-24.90	5.68	-36.03	-13.77
(Draft 5)	77	1.0% H20 Δ Flowrate (%)	12	-17.94	5.45	-28.62	-7.26
	77	2.0% H20 Δ Flowrate (%)	12	-17.96	8.47	-34.56	-1.36
	77	3.0% H20 Δ Flowrate (%)	12	-18.23	6.83	-31.62	-4.84
EOWT by	78	0.6% H20 Δ Flowrate (%)	12	10.87	6.16	-1.20	22.94
(Draft 5)	78	1.0% H20 Δ Flowrate (%)	12	7.54	6.15	-4.51	19.59
	78	2.0% H20 Δ Flowrate (%)	12	5.17	5.33	-5.27	15.62
	78	3.0% H20 Δ Flowrate (%)	12	-0.54	4.52	-9.40	8.32

TMC Monitored Bench Tests – Individual Reference Oil Statistics
(Operationally Valid tests Only)

Test	Oil Code	Parameter	Targets n	Targets Mean	Targets sR	4/1/00 - 3/31/01 n	4/1/00 - 3/31/01 Mean	4/1/00 - 3/31/01 sR	4/1/01 - 9/30/01 n	4/1/01 - 9/30/01 Mean	4/1/01 - 9/30/01 sR	10/1/01 - 3/31/02 n	10/1/01 - 3/31/02 Mean	10/1/01 - 3/31/02 sR	Mean Δ/s
D6417	52	Area % Volatized	18	6.97	0.31	6	7.1	0.71	8	7.2	0.49	3	6.9	0.15	-0.12
	55	Area % Volatized	18	11.68	0.51	5	11.8	0.50	2	12.2	0.49	6	11.2	0.57	-0.84
	58	Area % Volatized	18	5.61	0.30	7	5.9	0.21	6	5.8	0.61	4	5.6	0.29	-0.12
VGC by	51	% volatility loss	10	11.85	0.47	1	10.7	-----	1	12.3	-----	-----	-----	-----	-----
D5480	52	% volatility loss	11	6.22	0.23	2	6.2	0.14	-----	-----	-----	-----	-----	-----	-----
*	53	% volatility loss	10	16.74	0.66	1	16.1	-----	-----	-----	-----	-----	-----	-----	-----
	54	% volatility loss	10	17.89	0.68	1	18.1	-----	1	18.0	-----	-----	-----	-----	-----
	55	% volatility loss	11	10.71	0.29	2	11.2	0.49	-----	-----	-----	-----	-----	-----	-----
D5800	52	% volatility loss	59	13.61	0.49	13	14.2	0.58	12	14.0	0.60	11	13.8	0.60	0.48
**	~~53~~	~~% volatility loss~~	~~36~~	~~22.30~~	~~0.55~~	~~2~~	~~22.6~~	~~0.35~~	-----	-----	-----	-----	-----	-----	-----
	~~54~~	~~% volatility loss~~	~~36~~	~~23.54~~	~~0.67~~	~~3~~	~~24.5~~	~~0.36~~	-----	-----	-----	-----	-----	-----	-----
	55	% volatility loss	60	16.39	0.66	15	16.9	0.73	10	17.1	0.54	9	16.6	0.58	0.34
	58	% volatility loss	59	14.46	0.52	15	14.8	0.80	13	15.4	0.67	13	15.2	0.75	1.36
TEOST	71	Deposit wt. (mg)	27	51.79	4.79	9	52.4	11.36	2	50.0	2.83	3	55.6	0.29	0.79
(D6335)	72	Deposit wt. (mg)	27	26.72	3.46	9	29.1	3.69	3	30.4	1.50	3	29.8	1.84	0.88
MTEOS	1006	Deposit wt. (mg)	24	34.53	5.93	17	34.0	6.13	5	35.7	8.97	14	36.1	5.11	0.26
***	432	Deposit wt. (mg)	18	50.13	4.88	13	46.5	9.87	8	46.8	6.26	11	46.9	5.98	-0.67
	433	Deposit wt. (mg)	18	50.28	5.26	11	47.4	5.63	11	46.2	4.91	12	46.5	9.18	-0.72
	74	Deposit wt. (mg)	20	16.84	5.28	11	15.0	2.20	10	15.1	3.43	7	11.5	4.01	-1.01
GI	~~51~~	~~Gelation Index~~	~~35~~	~~63.3~~	~~12.01~~	~~12~~	~~60.3~~	~~6.22~~	~~2~~	~~66.0~~	~~7.99~~	-----	-----	-----	-----
(D5133)	52	Gelation Index	35	4.5	0.24	9	4.4	0.12	12	4.4	0.15	4	4.3	0.13	-1.04
****	53	Gelation Index	37	44.7	4.64	13	47.7	6.88	10	48.1	3.43	7	47.6	5.90	0.63
	~~55~~	~~Gelation Index~~	~~36~~	~~22.3~~	~~4.84~~	~~15~~	~~20.2~~	~~7.46~~	~~2~~	~~16.8~~	~~3.61~~	-----	-----	-----	-----
	58	Gelation Index	17	5.8	0.69	-----	-----	-----	-----	-----	-----	9	5.9	1.18	0.11
	62	Gelation Index	35	17.0	3.90	16	16.2	4.71	7	18.4	2.67	10	16.3	6.41	-0.19
~~D6082~~	~~1002~~	~~Tendency (ml)~~	~~32~~	~~410.63~~	~~58.78~~	~~17~~	~~495.6~~	~~232.46~~	~~5~~	~~514.0~~	~~159.31~~	-----	-----	-----	-----
	~~1002~~	~~Stability (ml)~~	~~32~~	~~37.81~~	~~45.41~~	~~17~~	~~182.9~~	~~225.47~~	~~5~~	~~128.0~~	~~182.13~~	-----	-----	-----	-----
D6082	1007	Tendency (ml)	28	65.71	19.28	14	67.5	11.22	9	71.1	14.53	11	64.5	15.08	-0.06

* D5480 Targets Adjusted 12/7/99 per direction of the Volatility Surveillance Panel
**D5800 Targets Adjusted 10/2/00; new oils selected; new procedures approved
***MTEOS Targets Adjusted 6/1/01 per direction of TEOST Surveillance Panel (based on completed Matrix 6 data)
****GI Added new oil 58 10/24/01; dropped oils 51 & 55 7/2/01

Attachment 3B

TMC Monitored Bench Tests – Individual Reference Oil Statistics
(Operationally Valid tests Only)

			Targets			4/1/00 - 9/30/00			10/1/00 - 3/31/01			4/1/01 - 9/30/01			10/1/01 - 3/31/02		
Test	Oil Code	Parameter	n	Mean	sR	n	Mean	sR	n	Mean	sR	n	Mean	sR	n	Mean	sR
BRT	1006	Average AGV	12	128	7.21	7	123.1	5.30	26	123.7	6.79	39	124.4	5.77	29	125.0	5.19
	5A-3	Average AGV	12	76	6.47	7	82.0	12.03	31	81.6	13.72	38	83.4	12.60	28	87.6	15.69
	81	Average AGV	12	112	14.00	14	121.0	11.50	55	121.0	6.06	79	117.8	7.99	59	121.2	13.22
EOFT	77	Avg. %CF	12	-45.55	4.36	26	-32.4	8.56	5	-18.5	7.03	0	----	----	0	----	----
	78	Avg. %CF	12	15.74	6.87	27	17.9	6.24	74	15.1	4.64	103	15.2	6.67	84	15.3	5.67
EOWT	77	0.6 H2O Avg. %CF	12	-24.90	5.68	18	-25.6	6.19	53	-23.8	4.71	63	-24.8	5.64	47	-24.6	5.45
	77	1.0 H2O Avg. %CF	12	-17.94	5.45	15	-17.4	6.72	45	-17.8	5.25	59	-16.3	5.71	41	-17.3	6.70
	77	2.0 H2O Avg. %CF	12	-17.96	8.47	17	-18.1	6.26	50	-17.0	6.72	56	-16.1	6.25	47	-17.9	5.34
	77	3.0 H2O Avg. %CF	12	-18.23	6.83	16	-21.7	4.96	48	-18.4	6.19	60	-17.7	6.44	46	-17.0	5.46
EOWT	78	0.6 H2O Avg. %CF	12	10.87	6.16	16	11.2	6.32	48	8.6	6.46	60	11.4	6.90	41	9.9	6.80
	78	1.0 H2O Avg. %CF	12	7.54	6.15	17	8.4	7.21	54	5.3	6.30	56	8.9	5.87	48	7.1	7.61
	78	2.0 H2O Avg. %CF	12	5.17	5.33	14	4.5	4.74	50	2.8	5.75	58	6.4	6.85	42	4.9	6.18
	78	3.0 H2O Avg. %CF	12	-0.54	4.52	16	3.8	6.37	50	-0.6	5.22	62	2.2	6.48	43	1.5	6.18