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MEMORANDUM: 04-021

DATE: April 28, 2004

TO: Mr. Ted Selby, Chairman ASTM D02.B0.07

FROM: Thomas Schofield & Richard Grundza

SUBJECT: TMC Bench Reference Test Monitoring from October 1, 2003 through March 31, 2004

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).

Calibration testing 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 and over a period of time)
(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) can be pooled across oils of different performance levels 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. 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 period into single precision and severity estimates for each test type, 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. Some of the oldest period comparison periods have been eliminated to keep the information succinct and relevant.

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 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/mem01-143.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: D02.B07 Bench Test Mailing List
J. Zalar (TMC)
ftp://ftp.astmtmc.cmu.edu/docs/bench/bo7semiannualreports/mem04-021.pdf

Distribution: Email

Attachment 1

ASTM Test Monitoring Center

Semiannual Report

ASTM D02.B07 Bench Reference Test Monitoring
From October 1, 2003 through March 31, 2004

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	13
Operationally Valid but Failed Acceptance Criteria	2
Operationally Invalid (initially reported as)	0
Operationally Invalid (after informed of failing calibration)	2
Total	**17**

Fail Rate of Operationally Valid Tests: 13.3%

Table 2 is a breakdown of the statistically unacceptable tests.

TABLE 2

Reason for Fail	No. of Tests
Area % Volatized @ 371°C Mild	2

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
4/1/02 through 9/30/02	16	13	0.34	-0.29
10/1/02 through 3/31/03	15	12	0.39	-0.47
4/1/03 through 9/30/03	14	11	0.36	-0.45
10/1/03 through 3/31/04	15	12	0.50	-0.42

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	-0.27
Lab B	2	-0.44
Lab D	1	0.10
Lab G	3	-1.06
Lab H	2	0.59
Lab S	2	-1.10

D6417: Estimation of Engine Oil Volatility by Capillary Gas Chromatography, continued

PRECISION AND SEVERITY

D6417 calibration testing precision is degraded this period and is slightly worse than target. Overall severity continues mild of target performance at about the same level as the prior two periods. Severity is represented graphically in Figure 1. A mild trend from last period continues into the start off the current, but then levels off. Two strongly mild data points (about 2.5 s each) influence the plot and the overall precision and severity.

Labs G and S are substantially mild this period; Lab S is consistently quite mild. The overall results by oil (Attachment 3A) shows oils 52 and 55 performing mild and oil 58 performing severe.

The fail rate of the operationally valid tests is higher than usual, with two statistically unacceptable tests reported this period (Lab A, Oil 55 and Lab G, Oil 52 with both tests mild). Also, Lab B reported two consecutive tests this period as operationally valid, only to determine instrument problems after being informed their TMC calibration results were statistically unacceptable.

TMC MEMORANDA

There were no TMC technical memos issued this report period for the D6417 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 (8 labs reporting):

TABLE 5

	No. of Tests
Statistically Acceptable and Operationally Valid	31
Operationally Valid but Failed Acceptance Criteria	1
Operationally Invalid (initially reported as)	1
Operationally Invalid (after informed of failing calibration)	1
Total	**34**

Fail Rate of Operationally Valid Tests: 3.1%

Table 6 is a breakdown of the statistically unacceptable tests.

TABLE 6

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

The single statistically unacceptable test this period was by Procedure B

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	-----
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
4/1/02 through 9/30/02	35	32	0.79	1.00
10/1/02 through 3/31/03	34	31	0.63	1.03
New Targets Effective 7/15/2003	102	99	0.70	-----
4/1/03 through 9/30/03	29	26	0.70	0.44
10/1/03 through 3/31/04	32	29	0.64	0.29

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	3	0	---	-0.81
Procedure B	27	24	0.62	0.43
Procedure C	2	0	---	0.08

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	6	-0.55
Lab B	5	0.12
Lab D	2	0.08
Lab F	4	-0.07
Lab G	6	1.12
Lab H	2	1.23
Lab I	3	0.70
Lab J	4	0.25

PRECISION AND SEVERITY

Effective September 26, 2000, the TMC began monitoring the three Noack procedures under the revised D5800 test method. Revised reference oil targets and acceptance bands for all three current reference oils (52, 55 and 58), based on 18-months of TMC reference data, became effective July 15, 2003.

Overall precision for the report period is directionally better than the new target precision. Overall severity is slightly severe of targets. Severity is graphically represented in Figures 2A and 2B. Figure 2B better illustrates some improvement in the severity trend following the revised oil targets timeline. Table 8 shows the severity of the Procedure B results alone is somewhat more severe (0.43 s) than the overall period severity (0.29 s), and the three Procedure A tests reported this period contribute substantially mild results to the overall severity estimate. There is insufficient data to determine a pooled precision for Procedures A & C results this period.

Failure rates for tests reported to the TMC as operationally valid but evaluated as statistically unacceptable has dropped from a range of 15.2% - 25.7% for the five report periods prior to the revised targets, down to a more reasonable 3.1% (1 test out of 32) this period. So, revising the acceptance bands seems to have helped to improve the fail rate considerably. It would seem the revised targets are indeed more accurate estimates of the reference oils' true performances in calibration monitoring, as hoped.

TMC MEMORANDA

There was one TMC technical memo issued this report period for the D5800 test method:

Report Packet Revision Notice D5800-20040205, February 16, 2004: Updated Report Packet Version 20040205, Effective March 22, 2004.

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	28
Operationally Valid but Failed Acceptance Criteria	9
Operationally Invalid (initially reported as)	0
Operationally Invalid (after informed of failing calibration)	0
Total	**37**

Fail Rate of Operationally Valid Tests: 24.3%

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	5

INDUSTRY PERFORMANCE

Table 12 shows the current Industry precision and severity for the Gelation Index test parameter for all operationally valid tests for the report period. (First calibration test completed 4/20/96.)

TABLE 12

Gelation Index	n	df	Pooled s	Mean Δ/s
Revised Targets Effective 20010702 (Oils 52, 53 & 62 targets unchanged, dropped oils 51 & 55)	107	104	3.53	-----
4/1/01 through 9/30/01	33	28	2.84	0.13
Revised Targets Effective 20011024 (Oils 52, 53 & 62 targets unchanged, added oil 58)	124	120	3.29	-----
10/1/01 through 3/31/02	30	26	4.76	-0.02
*4/1/02 through 9/30/02	32	28	2.15	0.43
*10/1/02 through 3/31/03	29	25	2.02	0.59
Revised Targets Effective 20030715 (Oils 58 & 62 targets unchanged, added oil 1009, dropped oils 52 & 53)	68	65	2.86	-----
4/1/03 through 9/30/03	27	22	2.30	0.06
10/1/03 through 3/31/04	37	34	5.86	1.73

*Excludes one data point as a rare event (for details, see the TMC's semiannual report for that period).

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	7	-0.49
Lab B	5	11.89
Lab D	5	-0.06
Lab G	5	-1.32
Lab H	2	0.68
Lab I	6	-0.06
Lab R	4	3.97
Lab S	3	-0.66

PRECISION AND SEVERITY

Effective July 15, 2003, new D5133 reference oils, targets and acceptance bands were implemented for TMC calibration monitoring. Oils 52 and 53 were dropped and oil 1009 was introduced using performance targets derived from an industry round-robin (targets for oils 58 & 62 continue without revision). Current GI reference oils are 58, 62 & 1009.

Last period's data was unusually favorable, with good overall precision and severity, and a low fail rate (3.7%). However, this period has exceptionally (unprecedented) poor performance, overall. Precision and severity are historically the worst we have seen for any period. However, three tests reported as operationally valid are clearly driving the overall poor performance.

Three statistically failing mild results this period are on oil 62 (from three different labs), and one mild result on oil 58. There is also a mix of statistically passing results on oil 62 that are both mild and severe of target, so there doesn't appear to be a problem with the oil, rather with the operation in the failing runs. Indeed, the same oil was reassigned to each lab and all four labs came back with passing results on the second calibration attempts.

All five severe results reported this period were on oil 58, from 4 different labs. At first the TMC became concerned that we had a severity problem with oil 58. However, additional data strongly suggests operational problems in running the test. Lab B reported a single result as operationally valid on oil 58 that was more than 40 s severe of target. Oil 58 is a non-gelling oil with a target GI of 5.8; the lab reported a result of 33.9, clearly indicating gelling when none is expected. An oil 58 rerun by the same lab, on the same instrument and head, yielded a second result nearly 20 s severe (again, reported as operationally valid). However, a screener (non-calibration) run on a different TMC oil also proved to be substantially severe, pointing to an instrument problem. Finally, after a complete clean-up of the instrument and a complete change of the methanol coolant, the lab ran oil 58 a third time and reported a result that was exactly on target (0.00 s), but, after further discussion, the lab revealed that result was from using a different head on the instrument! The rules established for instrument calibration allows this to be a passing calibration (the lab is looking at having the problem head rebuilt or replaced).

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

Meanwhile, the lab had run two additional calibrations on two other instruments using oils 58 and 1009, and both achieved passing calibrations on the first attempt. A follow-up discussion with the lab concluded that, while there were likely operational problems with the first two extremely severe calibration results, no definitive problem was uncovered, and therefore the extreme test results remain in the data set as operationally valid but statistically unacceptable. As expected, these two tests strongly influence the overall statistics.

Likewise, Lab R reported two severe (failing) results on TMC oil 58, one 10.7 s severe (again, reporting a strong gelation when none is expected) and the follow-up a more reasonable (but failing) 2.8 s severe, but the lab also achieved passing calibrations on two other instruments using oils 1009 and 62. (Lab R has yet to attempt another calibration on the problem instrument). Lab D reported an oil 58 result that was 4.6 s severe of target with a follow-up passing result on oil 1009. However, there are eight passing results this period on oil 58, both severe and mild of target, and one failing result mild of target. This range of data does not show a uniform trend that might suggest an oil performance (chemistry) problem, but rather suggests serious operational problems at some of the labs in question. In fact, the data and subsequent discussions strongly suggest that oil 58 is singly sensitive to instrument problems, and severe performance on oil 58 is (more likely) a strong early indicator of instrument operational problems. (Oil 58 is also used in D5800 volatility testing, and we have found it to be similarly sensitive to instrument problems in that test. And, the same oil formulation is used in one of the TMC MTEOS reference oils and seems to show a performance sensitivity to operational anomalies in that test relative to the other TMC reference oils.)

The TMC's QC program shows no problems (contamination or degradation) with any of the three TMC Gelation Index reference oils. The unused residual oil samples from the extreme results were returned to the TMC and confirmed by analysis. The supplier of oil 58 indicates there is no reason to believe that oil 58 will degrade, and doesn't believe the oil is capable of showing actual gelation properties. All indications so far are that GI testing is simply very operationally erratic this period. The Gelation Index Surveillance Panel Chair had indicated that new instrument heads (TAV-III) and software were available, but a survey of the monitored labs indicates they are all still using TAV-II heads, and no labs have made recent changes to their software, we are told. One issue that might be considered is that the TMC does not monitor head position, and the labs need only to achieve a passing calibration on any one head on a multi-head instrument for that instrument to be considered TMC calibrated.

Severity is graphically represented in Figures 3A & 3B (attached). Figure 3A & 3B are the same severity data plots, but figure 3A shows three-month time-lines while Figure 3B shows lines corresponding to the occurrence of various technical changes over the history of TMC monitoring. The figures illustrate the effects that the extreme mild results have on the severity estimate for the period.

Attachment 3A shows a breakdown of performance by oil. As would be expected, oil 58 performance for the period is strongly influenced by the anomalous results on that oil for the period.

TMC MEMORANDA

There were no TMC technical memos issued this report period for the D5133 test method.

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 (3 labs reporting):

TABLE 14

	No. of Tests
Statistically Acceptable and Operationally Valid	6
Operationally Valid but Failed Acceptance Criteria	1
Operationally Invalid (initially reported as)	0
Operationally Invalid (after informed of failing calibration)	1
Total	**8**

Fail Rate of Operationally Valid Tests: 14.3%

Table 15 is a breakdown of the statistically unacceptable tests.

TABLE 15

Reason for Fail	No. of Tests
Total Deposits Mild (Oil 71)	1

INDUSTRY PERFORMANCE

Table 16 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 16

Total Deposits	n	df	Pooled s	Mean Δ/s
Initial Round Robin Study	54	52	4.18	-----
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
4/1/02 through 9/30/02	7	5	4.22	1.26
10/1/02 through 3/31/03	5	3	5.44	0.50
4/1/03 through 9/30/03*	6	4	12.15	2.54
4/1/03 through 9/30/03*	5	3	3.84	1.33
10/1/03 through 3/31/04	7	5	7.61	-0.56

*Statistics with and without extreme result (8.58 s severe)

Table 17 shows the current severity for the Total Deposits parameter for each lab for all operationally valid tests in the report period.

TABLE 17

	n	Mean Δ/s
Lab A	2	0.59
Lab B	2	0.12
Lab G	3	-1.77

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-4 TEOST to replace TEOST-33C for GF-3/SL.

Overall precision is unusually poor this period with severity slightly mild (for the first time). Last period had one extreme test result strongly biasing the precision and severity. This period the data is generally imprecise with three tests reported at more than 1 s mild of targets and one result more than 1 s severe of targets. Severity is graphically represented in Figure 4.

TMC MEMORANDA

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

TEOST MHT-4, Version 2, 03.09.23: Determination of Moderately High Temperature Piston Deposits by Thermo-oxidation Engine Oil Simulation Test (MTEOS)

STATUS

Table 18 summarizes the reference tests reported to the TMC this period (5 labs reporting but only 4 labs reporting operationally valid tests):

TABLE 18

	No. of Tests
Statistically Acceptable and Operationally Valid	32
Operationally Valid but Failed Acceptance Criteria	3
Operationally Invalid (initially reported as)	0
Operationally Invalid (after informed of failing calibration)	2
Total	**37**

Fail Rate of Operationally Valid Tests: 8.6%

Table 19 is a breakdown of the statistically unacceptable tests.

TABLE 19

Reason for Fail	No. of Tests
Total Deposits Mild (Oil 433)	2
Total Deposits Severe (Oil 1006)	1

INDUSTRY PERFORMANCE

Table 20 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 20

Total Deposits	n	df	Pooled s	Mean Δ/s
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
4/1/02 through 9/30/02	47	43	6.74	-0.80
10/1/02 through 3/31/03	42	38	6.77	-0.78
4/1/03 through 9/30/03	27	23	6.02	-0.83
Updated Targets Effective 2/18/04	50	46	4.92	-----
10/1/03 through 3/31/04	35	31	9.40	-0.69*

*New oil performance targets and acceptance bands were implemented twice during the period; severity is estimated using the targets that were in effect at the time each test was reported.

Table 21 shows the current severity for the Total Deposits parameter for each lab for all operationally valid tests in the report period.

TABLE 21

	n	Mean Δ/s
Lab A	16	-0.51
Lab B	4	-1.44
Lab D	4	-0.87
Lab G	11	-0.61

TEOST MHT-4, Version 2, 03.09.23: Determination of Moderately High Temperature Piston Deposits by Thermo-oxidation Engine Oil Simulation Test (MTEOS), continued

PRECISION AND SEVERITY

Effective November 1, 2003, the monitored labs began using the "Version 2" test method for TMC calibrations (moving from the previous "Draft 17" version of the test method). All labs were asked to recalibrate all monitored instruments effective November 1 because of the expected (but still unexplained) performance shift on the reference oils due to the change in test method version. Three operationally valid tests were reported this period (prior to November 1) using the Draft 17, and 32 operationally valid tests were reported using Version 2. New reference oil performance targets and acceptance bands were also implemented on November 1 using data collected from a Subcommittee 6 round-robin. The use of oil 432 was suspended temporarily while an additional mini-round-robin was conducted to establish Version 2 performance of oil 432. For more information please see the TMC technical memos referenced below under TMC Memoranda.

Overall precision is as poor as we have seen for this method while severity is moderately mild of targets. Once again we see that calibration testing does not perform nearly as precisely as estimated by the controlled round-robin results. All four reporting labs are performing mild, and are mild on all oils (Attachment 3A). The surveillance panel might want to consider updating the oil performance targets after another six-month period of calibration data is collected.

As suggested by the overall poor precision this period, the test results reported to the TMC are unusually erratic in performance. To illustrate, the following is a breakdown of severity estimates for the 35 tests reported as operationally valid this period:

7 tests reported 0 to 1 s severe of targets
1 test reported 1 to 2 s severe of targets
1 test reported at 4.6 s severe of target (oil 1006)

12 tests reported 0 to 1 s mild of target
12 tests reported 1 to 2 s mild of target
1 test reported 3.2 s mild of target (oil 433)
1 test reported 5.8 s mild of target (oil 433)

The MTEOS severity trends are graphically represented in Figures 5A & 5B, with Figure 5B showing when the new performance targets were implemented. Note a brief leveling of severity shortly after the 11/03 New Targets, only to turn severe again.

As requested by the surveillance panel, the TMC is now capturing rod batch data.

TMC MEMORANDA

There were two TMC technical memos issued this report period for the MTEOS test method:

Memo 03-101, October 15, 2003, Test Method Update; Suspension of reference Oil 432; Revised Oil Targets
Memo 04-007, February 18, 2004, Revised Performance Targets for Reference Oil 432

D6082: High Temperature Foaming Characteristics of Lubricating Oils

On June 18, 2001, the section agreed to suspend the use of the severe performing TMC oil 1002 as a D6082 reference oil due to ongoing calibration precision and severity problems with that oil, and on June 17, 2002 the section voted to discontinue the use of 1002 altogether. On July 21, 2003 a severe performing "discrimination oil", TMC oil 66, was introduced to the monitoring system to be run by each participating lab once every six-months to show that each lab can discriminate a GF-3/SL passing oil (foam tendency) from a failing oil in the D6082 test method. The first discrimination test using oil 66 was completed on August 13, 2003. Because of apparent poor reproducibility of the D6082 test method on severe performing oils (greater than 100 ml foam tendency) in general, it was agreed that oil 66 discrimination results would not be statistically summarized by the TMC other than a count of the tests that do and don't meet the acceptance criteria.

Note that TMC reference oil 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" (indefinably) severe in standard deviations (Δ/s). Therefore, 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 22 summarizes the reference tests reported to the TMC this period (5 labs reporting):

TABLE 22

	No. of Tests
Statistically Acceptable and Operationally Valid	12
Operationally Valid but Failed Acceptance Criteria	0
Operationally Invalid (initially reported as)	0
Operationally Invalid (after informed of failing calibration)	0
Total	**12**

Fail Rate of Operationally Valid Tests: 0.0%

In addition to the calibration tests, there were four discrimination oil tests reported this period, all met the acceptance criteria for the discrimination oil.

D6082: High Temperature Foaming Characteristics of Lubricating Oils, continued

TMC 1007 INDUSTRY PERFORMANCE

Tables 23 and 24 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 23

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
4/1/02 through 9/30/02	12	62.5	14.22	-0.17
10/1/02 through 3/31/03	11	62.7	17.52	-0.15
4/1/03 through 9/30/03	12	65.8	9.96	0.01
10/1/03 through 3/31/04	12	62.5	10.55	-0.17

TABLE 24

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		
4/1/02 through 9/30/02	12	No non-zero occurrences		
10/1/02 through 3/31/03	11	No non-zero occurrences		
4/1/03 through 9/30/03	12	No non-zero occurrences		
10/1/03 through 3/31/04	12	No non-zero occurrences		

Table 25 shows the current 1007 severity for the monitored result parameter for each lab for all operationally valid tests reported for the report period.

TABLE 25
TMC 1007

	n	Foam Tendency Mean Δ/s
Lab A	2	0.22
Lab B	4	-0.56
Lab D	2	-0.04
Lab G	3	0.22
Lab I	1	-0.81

D6082: High Temperature Foaming Characteristics of Lubricating Oils, continued

PRECISION AND SEVERITY

Foam Tendency precision on 1007 is again quite good this period and severity is slightly mild of target. There were no non-zero occurrences of Foam Stability on 1007 suggesting Foam Stability precision is as expected. Foam Tendency severity is graphically represented in Figure 6. Additionally, all discrimination tests reported this period meet the acceptance criteria (that is, all reporting labs could discriminate oil 66 as a GF-3 failing oil).

TMC MEMORANDA

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

D6922-03 Standard Test Method for Determination of Homogeneity and Miscibility in Automotive Engine Oils

The TMC distributes six reference oils for D6922 testing. The TMC does not collect data or monitor any test results for this test at this time.

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

TABLE 26

	No. of Tests
Statistically Acceptable and Operationally Valid	69
Operationally Valid but Failed Acceptance Criteria	2
Aborted	4
Total	**75**

Fail Rate of Operationally Valid Tests: 2.8%

Table 27 is a breakdown of the statistically unacceptable tests.

TABLE 27

Reason for Fail	No. of Tests
Average AGV Severe	2

INDUSTRY PERFORMANCE

Table 28 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 28

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
4/1/02 through 9/30/02	138	135	11.38	0.76
10/1/02 through 3/31/03	143	140	7.76	0.69
4/1/03 through 9/30/03	119	116	10.95	0.27
10/1/03 through 3/31/04	71	68	10.21	0.14

Table 29 shows the current severity for the Average AGV parameter for each lab for all operationally valid tests for the report period.

D6557: Ball Rust Test (BRT), continued

TABLE 29

	n	Mean Δ/s
Lab A	30	-0.18
Lab B	15	0.74
Lab G	19	0.46
Lab D	7	-0.64

PRECISION AND SEVERITY

Precision this report period has improved slightly when compared to the previous period and is slightly worse than the target matrix. Overall severity is trending slightly mild of target. Severity is graphically represented in Figure 7 (attached). Labs B and G trended mild of target, while labs A and D trended severe.

TMC MEMORANDA

No technical memoranda were issued this report period.

Engine Oil Filterability Test (EOFT)

STATUS

Table 30 summarizes the reference tests reported to the TMC this period (3 labs reporting).

TABLE 30

	No. of Tests
Statistically Acceptable and Operationally Valid	62
Operationally Valid but Failed Acceptance Criteria	4
Total	**66**

Fail Rate of Operationally Valid Tests: 6.1%

Table 31 is a breakdown of the statistically unacceptable tests.

TABLE 31

Reason for Fail	No. of Tests
Difference between samples >11.4 (Oil 78)	2
Average % Change in Flow Mild (Oil 78)	2

INDUSTRY PERFORMANCE

Table 32 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 32

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
4/1/02 through 9/30/02	89	88	5.38	0.11
10/1/02 through 3/31/03	81	80	4.16	-0.27
4/1/03 through 9/30/03	71	70	3.70	0.02
10/1/03 through 3/31/04	66	65	8.68	-0.54

Table 33 shows the current severity for the Average % CIF parameter for each lab for all operationally valid tests for the report period.

TABLE 33

	n	Mean Δ/s
Lab A	30	-0.67
Lab B	15	-0.17
Lab G	21	-0.60

Engine Oil Filterability Test (EOFT), continued

PRECISION AND SEVERITY

Precision this report period has degraded when compared to the previous period and the target matrix. Overall severity trended mild for the period. All labs trended mild for the period. Severity is graphically represented in Figure 8 (attached).

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

TMC MEMORANDA

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

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

STATUS

Table 34 summarizes the reference tests reported to the TMC this period (3 labs reporting):

TABLE 34

	No. of Tests
Statistically Acceptable and Operationally Valid	86
Operationally Valid but Failed Acceptance Criteria	4
Total	**90**

Fail Rate of Operationally Valid Tests: 4.4%

Table 35 is a breakdown of the statistically unacceptable tests.

TABLE 35

Reason for Fail	No. of Tests
Average % Change in Flow Severe (Oil 77)	1
Average % Change in Flow Mild (Oil 78)	3

INDUSTRY PERFORMANCE

Table 36 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 36

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	-0.04
10/1/00 through 3/31/01	101	99	5.61	-0.17
4/1/01 through 9/30/01	123	121	6.28	0.05
10/1/01 through 3/31/02	88	86	6.12	-0.05
4/1/02 through 9/30/02	102	100	4.50	0.18
10/1/02 through 3/31/03	89	87	4.86	-0.08
4/1/03 through 9/30/03	93	92	3.89	0.01
10/1/03 through 3/31/04	90	88	5.12	-0.23

Table 37 shows the current severity for the Average % CIF parameter for each lab for all operationally valid tests for the report period.

TABLE 37

	n	Mean Δ/s
Lab A	49	-0.34
Lab B	19	-0.03
Lab G	22	-0.15

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

PRECISION AND SEVERITY

Precision has degraded when compared with the previous period, but compares well with the target matrix. Overall severity trended mild for the period. Severity is graphically represented in Figure 9 (attached). Labs A and G trended mild for the period. Lab B was on or near target.

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

STATUS

Table 38 summarizes the reference tests reported to the TMC this period (3 labs reporting):

TABLE 38

	No. of Tests
Statistically Acceptable and Operationally Valid	88
Total	**88**

Fail Rate of Operationally Valid Tests: 0.0%

INDUSTRY PERFORMANCE

Table 39 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 39

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
4/1/02 through 9/30/02	105	103	4.30	0.25
10/1/02 through 3/31/03	89	87	3.42	0.25
4/1/03 through 9/30/03	94	93	3.64	0.17
10/1/03 through 3/31/04	88	86	3.89	0.17

Table 40 shows the current severity for the Average % CIF parameter for each lab for all operationally valid tests for the report period.

TABLE 40

	N	Mean Δ/s
Lab A	47	0.14
Lab B	19	-0.09
Lab G	22	0.71

PRECISION AND SEVERITY

Precision has changed little when compared to the previous period and is better than target estimates. Industry data is trending severe. Labs A and G trended severe, while lab B was on or near target this report period. Severity is graphically represented in Figure 10 (attached).

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

STATUS

Table 41 summarizes the reference tests reported to the TMC this period (3 labs reporting):

TABLE 41

	No. of Tests
Statistically Acceptable and Operationally Valid	88
Operationally Valid but Failed Acceptance Criteria	4
Total	**92**

Fail Rate of Operationally Valid Tests: 4.3%

Table 42 is a breakdown of the statistically unacceptable tests.

TABLE 42

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

INDUSTRY PERFORMANCE

Table 43 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 43

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
4/1/02 through 9/30/02	103	101	3.76	0.09
10/1/02 through 3/31/03	89	87	5.77	0.11
4/1/03 through 9/30/03	93	91	3.66	0.17
10/1/03 through 3/31/04	92	90	5.03	0.33

Table 44 shows the current severity for the Average % CIF parameter for each lab for all operationally valid tests for the report period.

TABLE 44

	N	Mean Δ/s
Lab A	51	0.32
Lab B	19	-0.07
Lab G	22	0.71

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

PRECISION AND SEVERITY

Precision for this period has degraded when compared with the previous period, but compares well with the target estimate. Severity was severe for the period. Labs A and G trended severe for the period, while lab B was on or near target for the period. Severity is graphically represented in Figure 11 (attached).

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

STATUS

Table 45 summarizes the reference tests reported to the TMC this period (3 labs reporting):

TABLE 45

	No. of Tests
Statistically Acceptable and Operationally Valid	87
Operationally Valid but Failed Acceptance Criteria	3
Total	**90**

Fail Rate of Operationally Valid Tests: 3.3%

Table 46 is a breakdown of the statistically unacceptable tests.

TABLE 46

Reason for Fail	No. of Tests
Average % Change in Flow Severe (Oil 78)	3

INDUSTRY PERFORMANCE

Table 47 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 47

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
4/1/02 through 9/30/02	108	106	4.69	0.56
10/1/02 through 3/31/03	89	87	5.09	0.50
4/1/03 through 9/30/03	94	92	3.29	0.55
10/1/03 through 3/31/04	90	88	3.74	0.52

Table 48 shows the current severity for the Average % CIF parameter for each lab for all operationally valid tests for the report period.

TABLE 48

	n	Mean Δ/s
Lab A	49	0.46
Lab B	19	0.27
Lab G	22	0.67

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

PRECISION AND SEVERITY

Precision has degraded 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 12 (attached). All laboratories trended severe of target during the period.

REFERENCE OIL SUPPLIES

There is adequate supply of B0.07 Bench Test reference oils on hand at the TMC. Tables 49A and 49B list the PCEOCP bench test reference oils currently on hand at the TMC.

Table 49A

Oil	For Tests	Quantity Left (gallons)	Quantity Used Last 12 Months (gallons)
^5A-3	BRT	1787.1	0.0
^51	GI	94.6	0.0
52	D6417, D5800, GI	70.4	0.7
^53	GI	96.8	0.0
^54	Obsolete Volatility	97.8	0.0
55	D6417, D5800	75.2	0.9
^57	Volatility Candidate	51.2	0.0
58	D6417, D5800, GI	127.2	1.8
62	GI	1.9	0.1
66	D6082 (Discrimination)	102.4	3.2
71	TEOST	4.3	0.2
72	TEOST	4.4	0.2
74	MTEOS	2.2	0.1
77	EOWT	142.2	28.0
78	EOFT, EOWT	95.2	37.2
^80	BRT	26.5	0.0
81	BRT	18.5	0.7
82	BRT	9.6	0.4
**432	MTEOS	Adequate	-----
**433	MTEOS	Adequate	-----
1006	BRT, MTEOS	43.5	1.5
*1007	FOAM	Est. 32	-----
**1009	GI	Adequate	-----

^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

Table 49B

Oil	For Tests	Quantity Left (gallons)	Quantity Used Last 12 Months (gallons)
HMA	H&M (D6922)	203.5	4.5
HMB	H&M (D6922)	207.5	4.5
HMC	H&M (D6922)	193.5	4.5
HMD	H&M (D6922)	201.5	4.5
HME	H&M (D6922)	186.5	4.5
HMF	H&M (D6922)	210.5	4.5

Shipping aliquots are:

D6417	1 ml
D5480	4 ml
D5800	100 ml
GI	25 ml
MTEOS	17 ml
TEOST	125 ml
D6082	525 ml
H&M	950 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, flatfile templates, data dictionaries and data from various round-robin 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 formats and data dictionaries. The TMC's web site address is www.astmtmc.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. Please contact Tom Schofield at (412) 365-1011 or Rich Grundza at (412) 365-1031 for more information.

Figure 1

D6417 VOLATILITY BY GC INDUSTRY OPERATIONALLY VALID DATA

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

CUSUM Severity Analysis

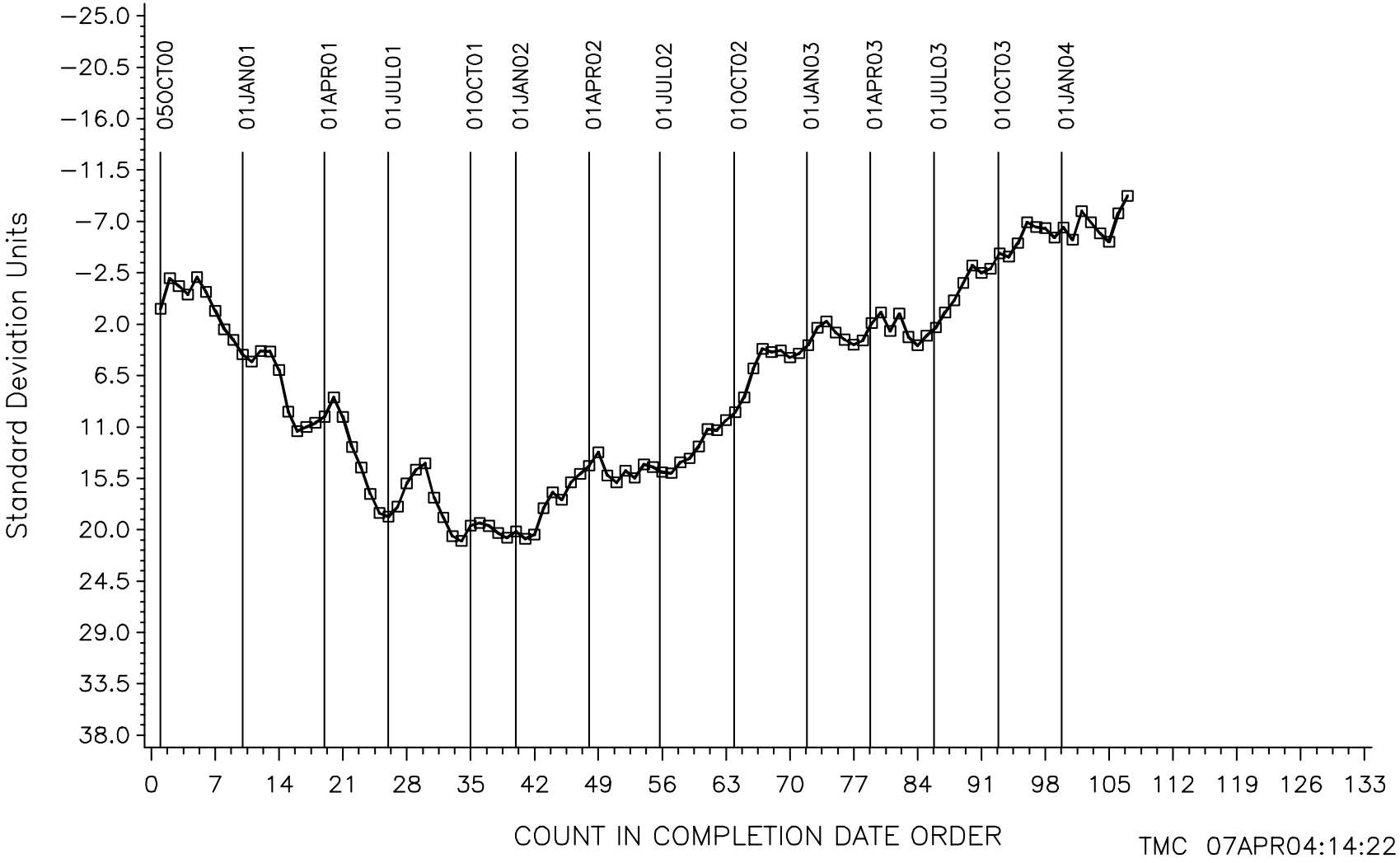


Figure 2A

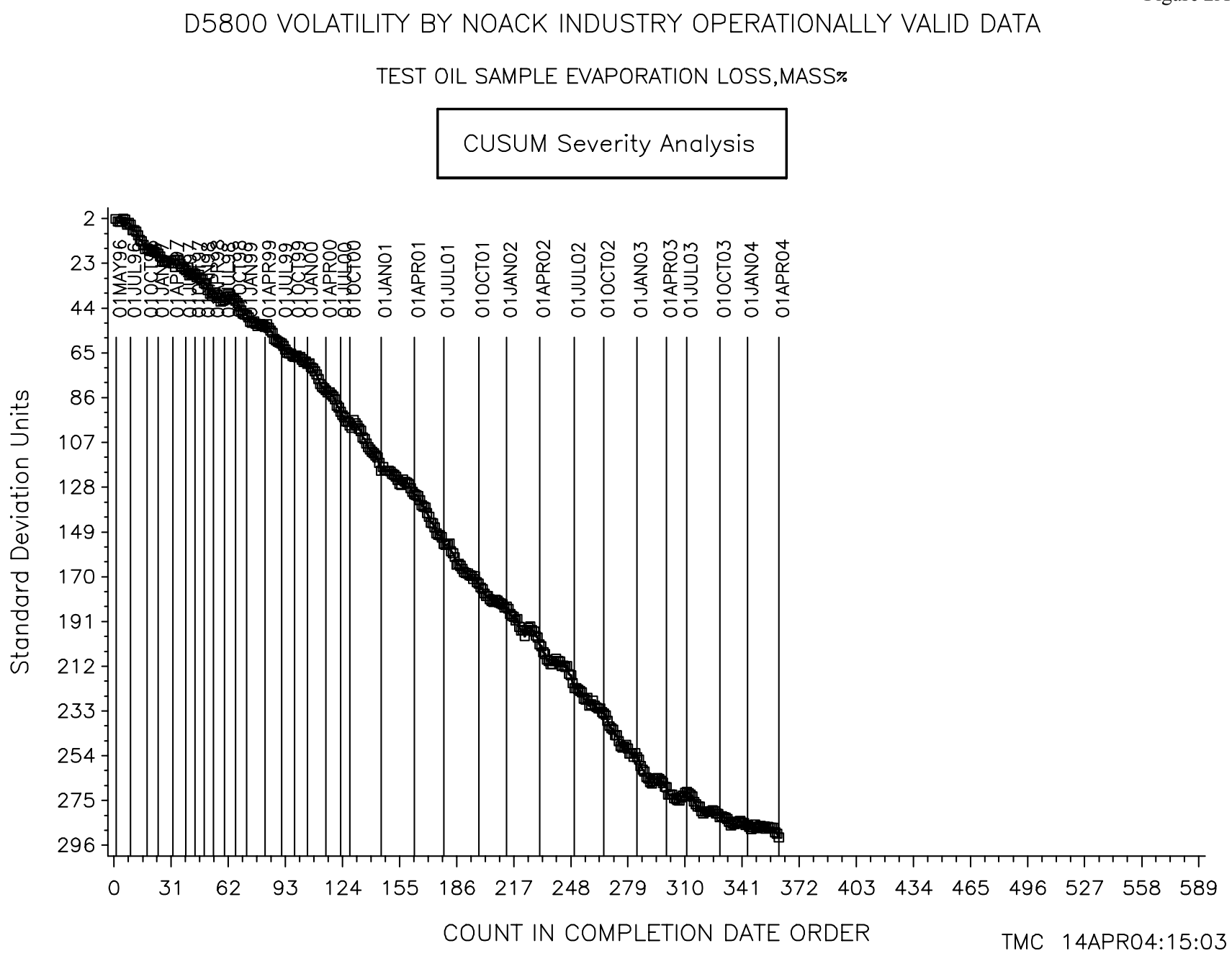
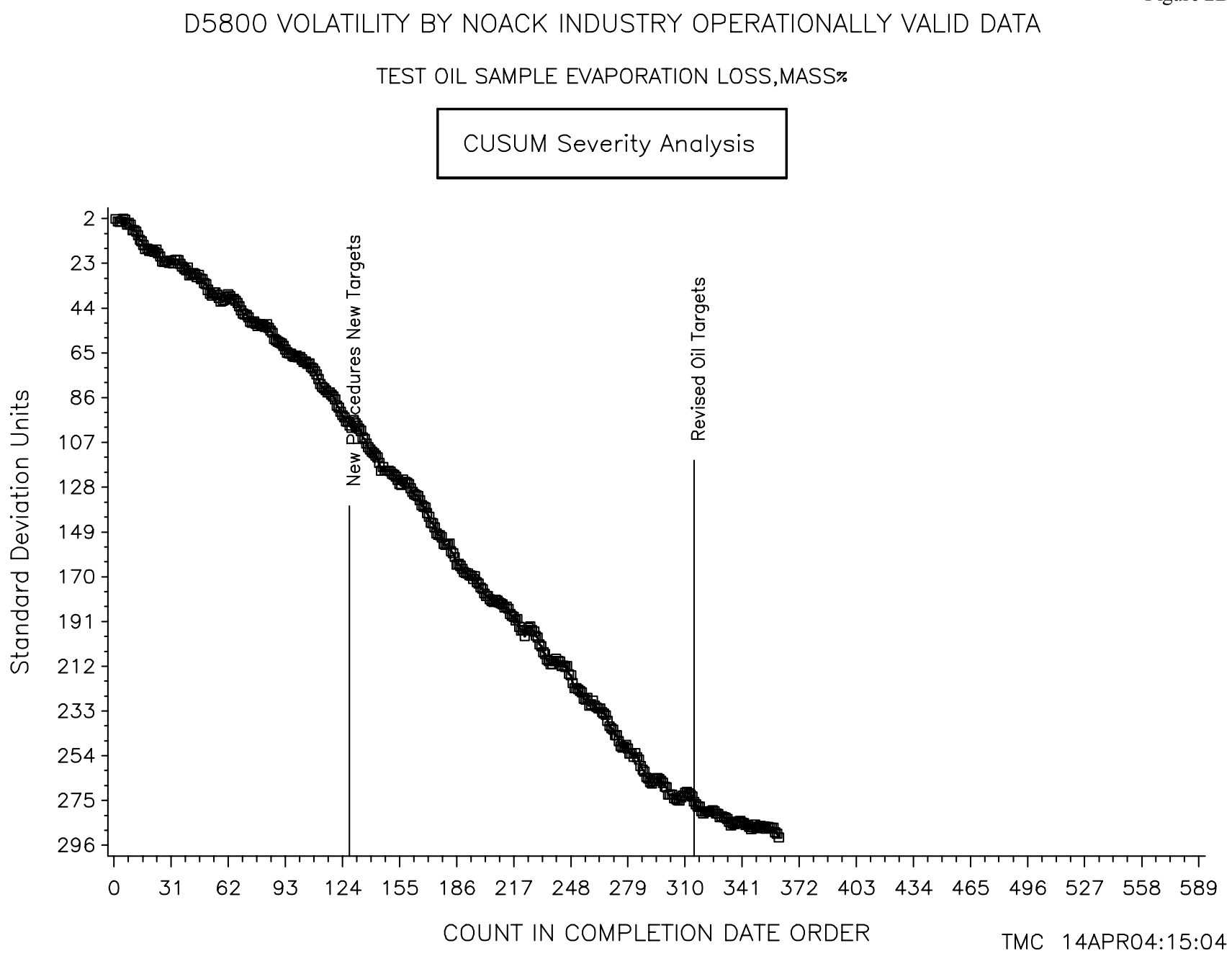

D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA
TEST OIL SAMPLE EVAPORATION LOSS,MASS%
CUSUM Severity Analysis
Standard Deviation Units
2
23
44
65
86
107
128
149
170
191
212
233
254
275
296
01MAY96
01JUL96
01APR99
01JUL99
01JAN00
01APR00
01JUL00
01JAN01
01APR01
01JUL01
01OCT01
01JAN02
01APR02
01JUL02
01OCT02
01JAN03
01APR03
01JUL03
01OCT03
01JAN04
01APR04
0
31
62
93
124
155
186
217
248
279
310
341
372
403
434
465
496
527
558
589
COUNT IN COMPLETION DATE ORDER
TMC 14APR04:15:03

Figure 2B


D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA
TEST OIL SAMPLE EVAPORATION LOSS,MASS%
CUSUM Severity Analysis
Standard Deviation Units
2
23
44
65
86
107
128
149
170
191
212
233
254
275
296
New Procedures New Targets
Revised Oil Targets
0
31
62
93
124
155
186
217
248
279
310
341
372
403
434
465
496
527
558
589
COUNT IN COMPLETION DATE ORDER
TMC 14APR04:15:04

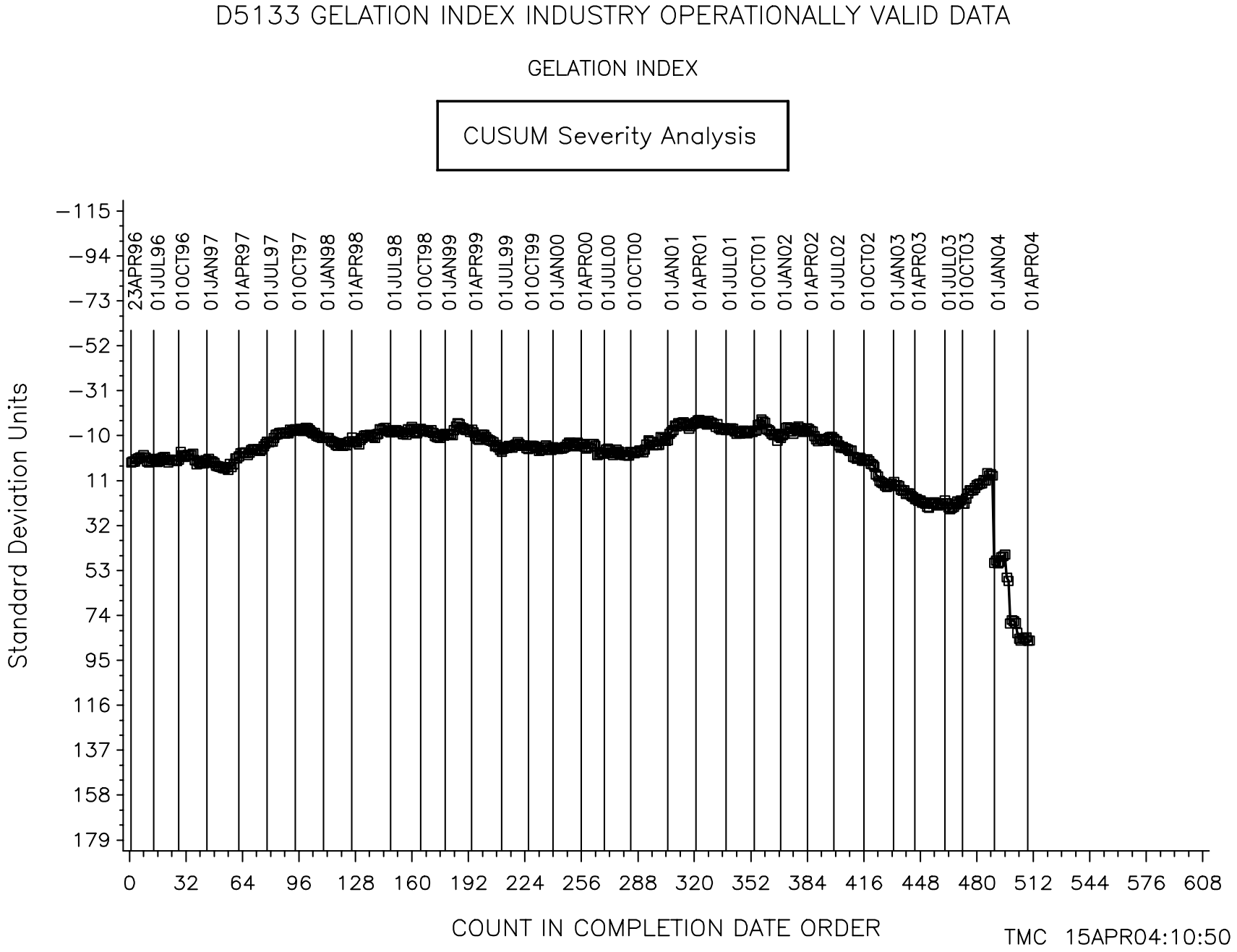
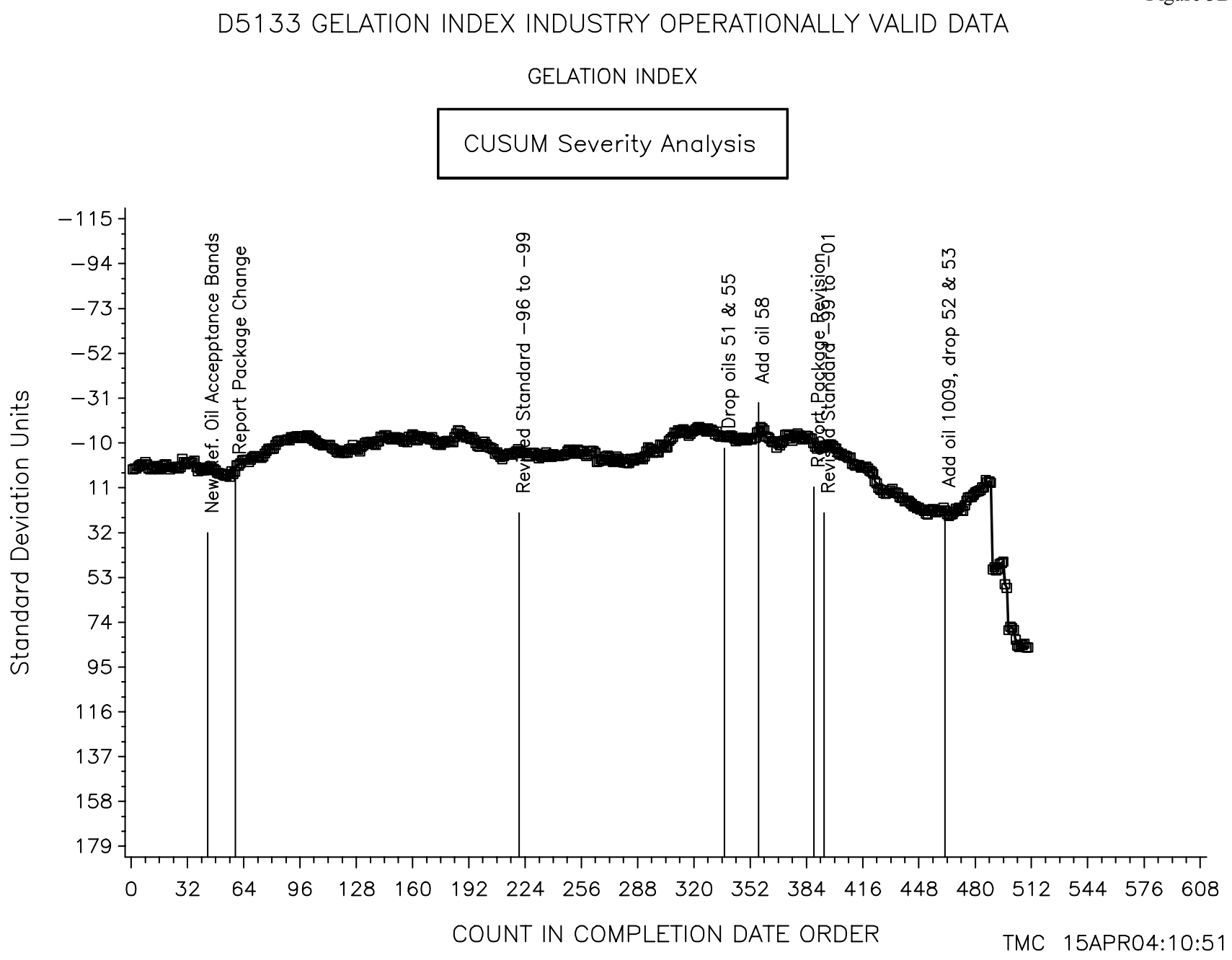

D5133 GELATION INDEX INDUSTRY OPERATIONALLY VALID DATA
GELATION INDEX
CUSUM Severity Analysis
Standard Deviation Units
−115
−94
−73
−52
−31
−10
11
32
53
74
95
116
137
158
179
23APR96
01JUL96
01OCT96
01JAN97
01APR97
01JUL97
01OCT97
01JAN98
01APR98
01JUL98
01OCT98
01JAN99
01APR99
01JUL99
01OCT99
01JAN00
01APR00
01JUL00
01OCT00
01JAN01
01APR01
01JUL01
01OCT01
01JAN02
01APR02
01JUL02
01OCT02
01JAN03
01APR03
01JUL03
01OCT03
01JAN04
01APR04
0
32
64
96
128
160
192
224
256
288
320
352
384
416
448
480
512
544
576
608
COUNT IN COMPLETION DATE ORDER
TMC 15APR04:10:50

Figure 3B


D5133 GELATION INDEX INDUSTRY OPERATIONALLY VALID DATA
GELATION INDEX
CUSUM Severity Analysis
Standard Deviation Units
−115
−94
−73
−52
−31
−10
11
32
53
74
95
116
137
158
179
New Ref. Oil Accepptance Bands
Report Package Change
Revised Standard −96 to −99
Drop oils 51 & 55
Add oil 58
Report Package Revision
Revised Standard −99 to −01
Add oil 1009, drop 52 & 53
0
32
64
96
128
160
192
224
256
288
320
352
384
416
448
480
512
544
576
608
COUNT IN COMPLETION DATE ORDER
TMC 15APR04:10:51

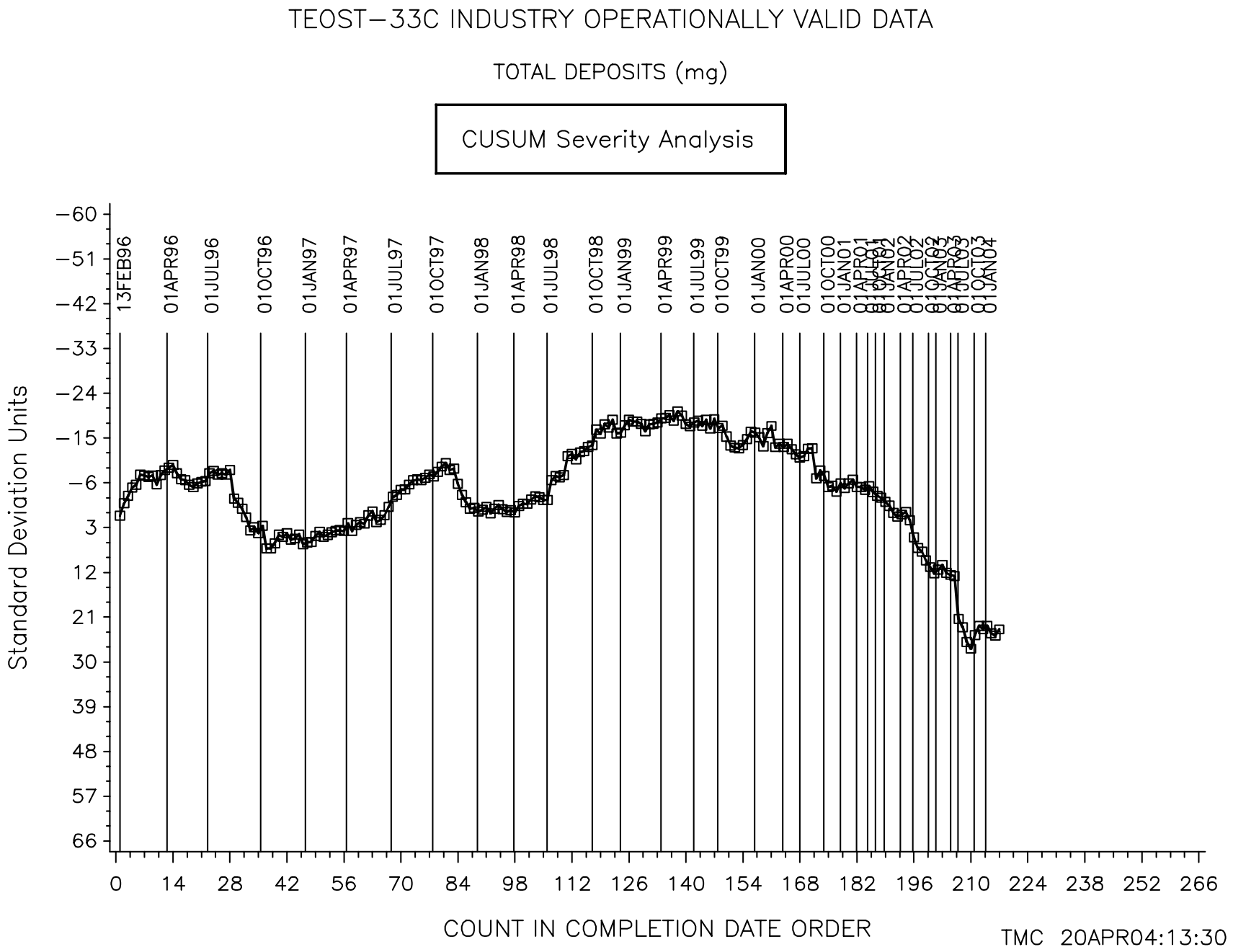
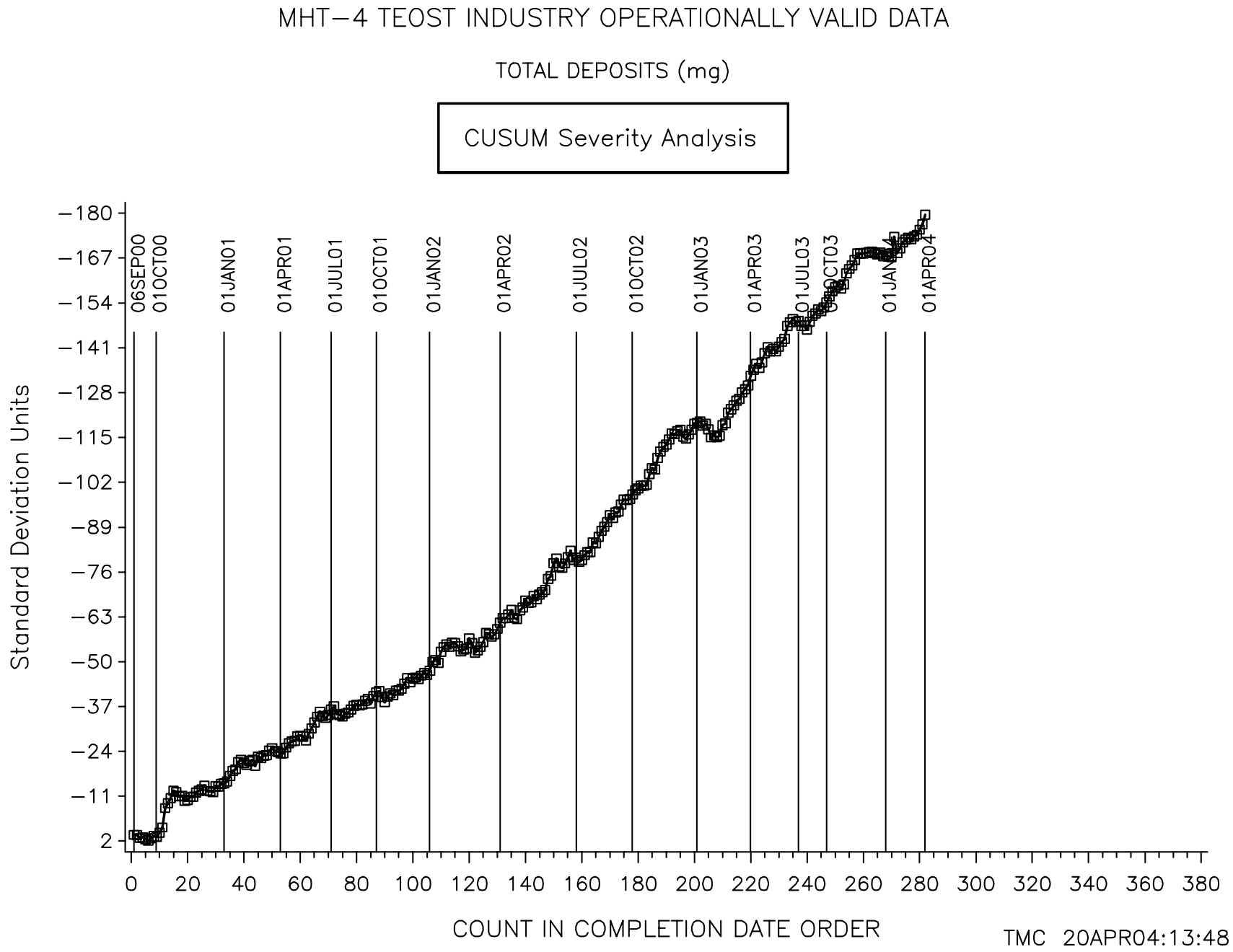

TEOST–33C INDUSTRY OPERATIONALLY VALID DATA
TOTAL DEPOSITS (mg)
CUSUM Severity Analysis
Standard Deviation Units
−60
−51
−42
−33
−24
−15
−6
3
12
21
30
39
48
57
66
13FEB96
01APR96
01JUL96
01OCT96
01JAN97
01APR97
01JUL97
01OCT97
01JAN98
01APR98
01JUL98
01OCT98
01JAN99
01APR99
01JUL99
01OCT99
01JAN00
01APR00
01JUL00
01OCT00
01JAN01
01APR01
01JUL01
01OCT01
01JAN02
01APR02
01JUL02
01OCT02
01JAN03
01APR03
01JUL03
01OCT03
01JAN04
0
14
28
42
56
70
84
98
112
126
140
154
168
182
196
210
224
238
252
266
COUNT IN COMPLETION DATE ORDER
TMC 20APR04:13:30

Figure 5A


MHT−4 TEOST INDUSTRY OPERATIONALLY VALID DATA
TOTAL DEPOSITS (mg)
CUSUM Severity Analysis
Standard Deviation Units
−180
−167
−154
−141
−128
−115
−102
−89
−76
−63
−50
−37
−24
−11
2
06SEP00
01OCT00
01JAN01
01APR01
01JUL01
01OCT01
01JAN02
01APR02
01JUL02
01OCT02
01JAN03
01APR03
01JUL03
01OCT03
01JAN04
01APR04
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
COUNT IN COMPLETION DATE ORDER
TMC 20APR04:13:48

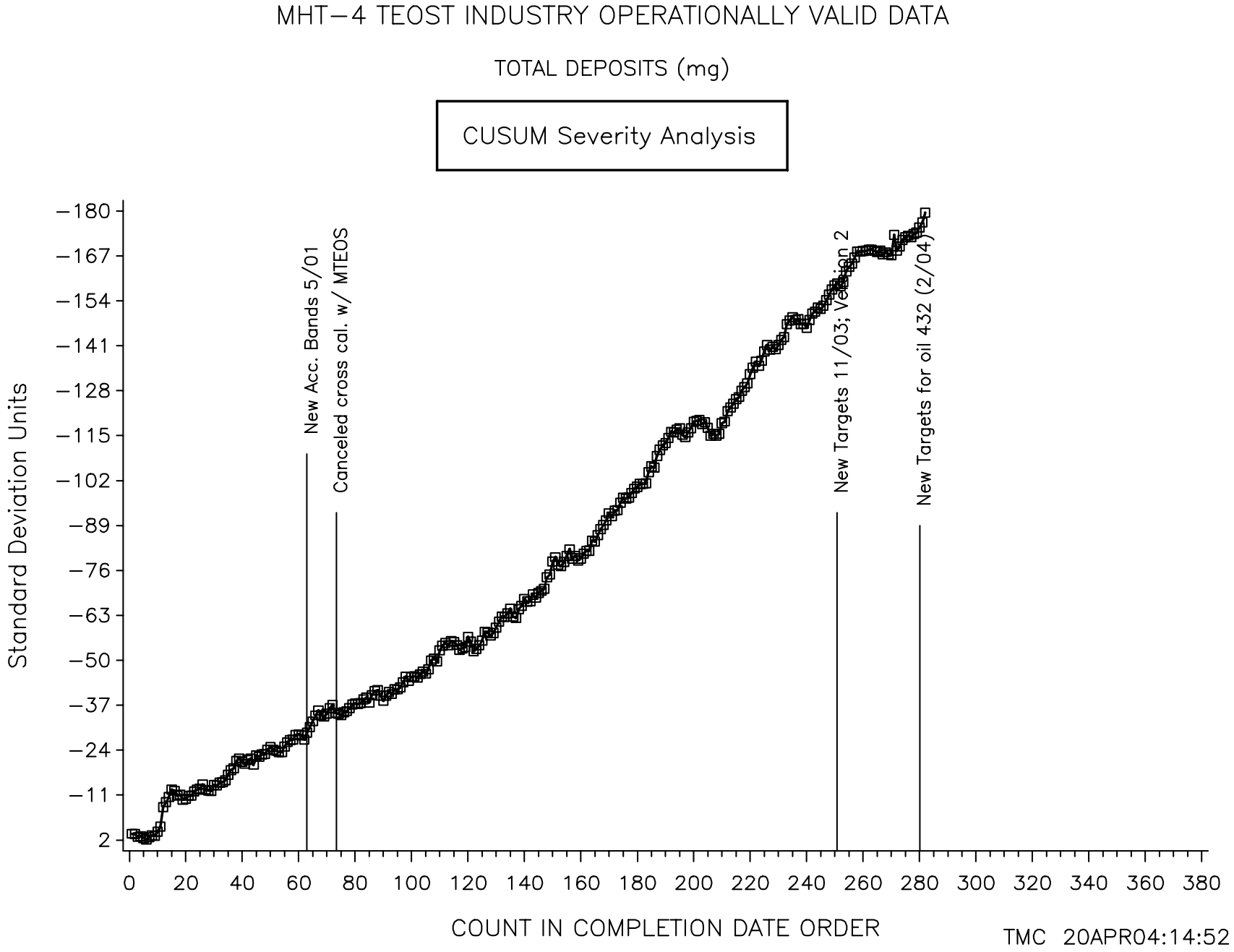

MHT−4 TEOST INDUSTRY OPERATIONALLY VALID DATA
TOTAL DEPOSITS (mg)
CUSUM Severity Analysis
Standard Deviation Units
−180
−167
−154
−141
−128
−115
−102
−89
−76
−63
−50
−37
−24
−11
2
New Acc. Bands 5/01
Canceled cross cal. w/ MTEOS
New Targets 11/03; Version 2
New Targets for oil 432 (2/04)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
COUNT IN COMPLETION DATE ORDER
TMC 20APR04:14:52

Figure 6

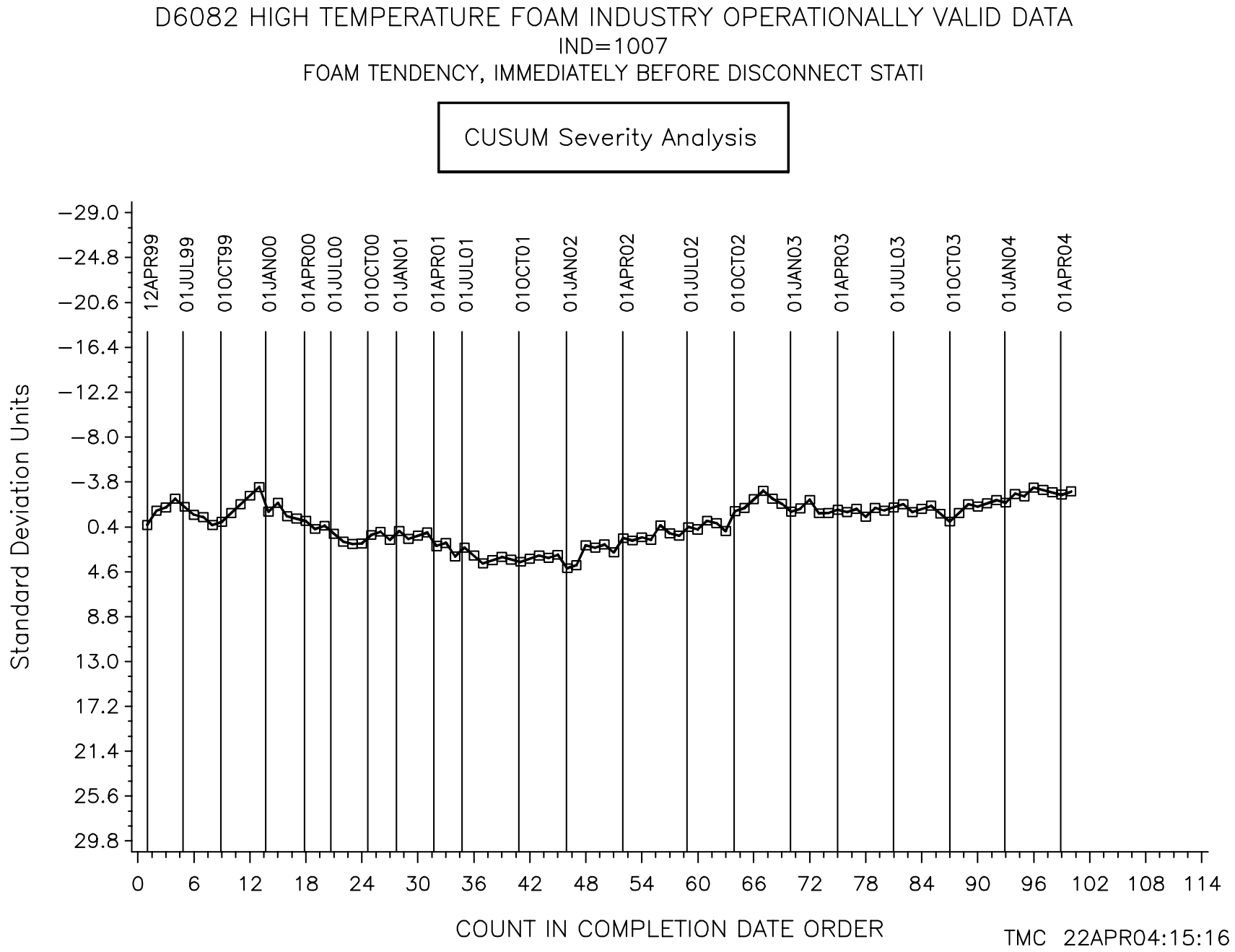
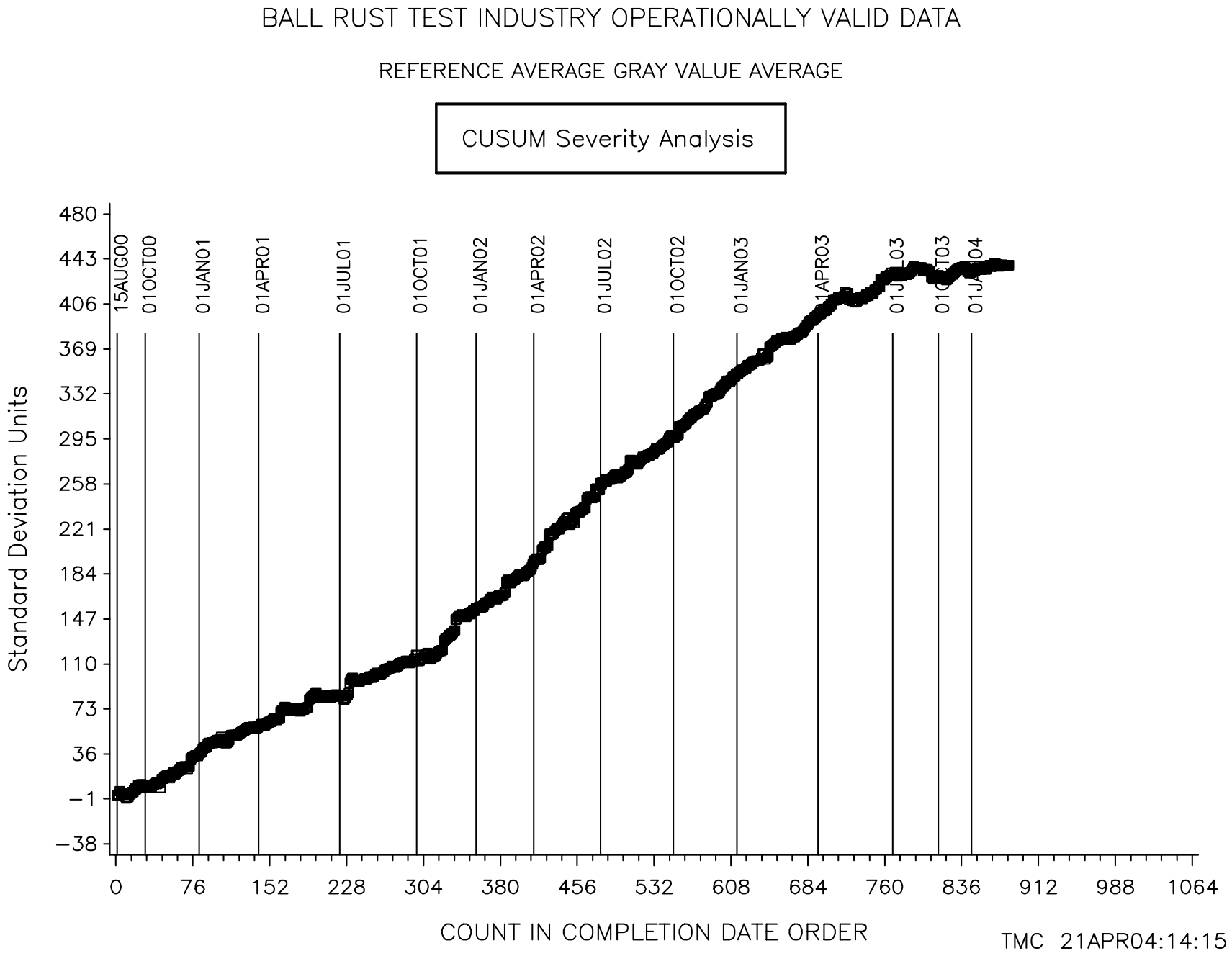
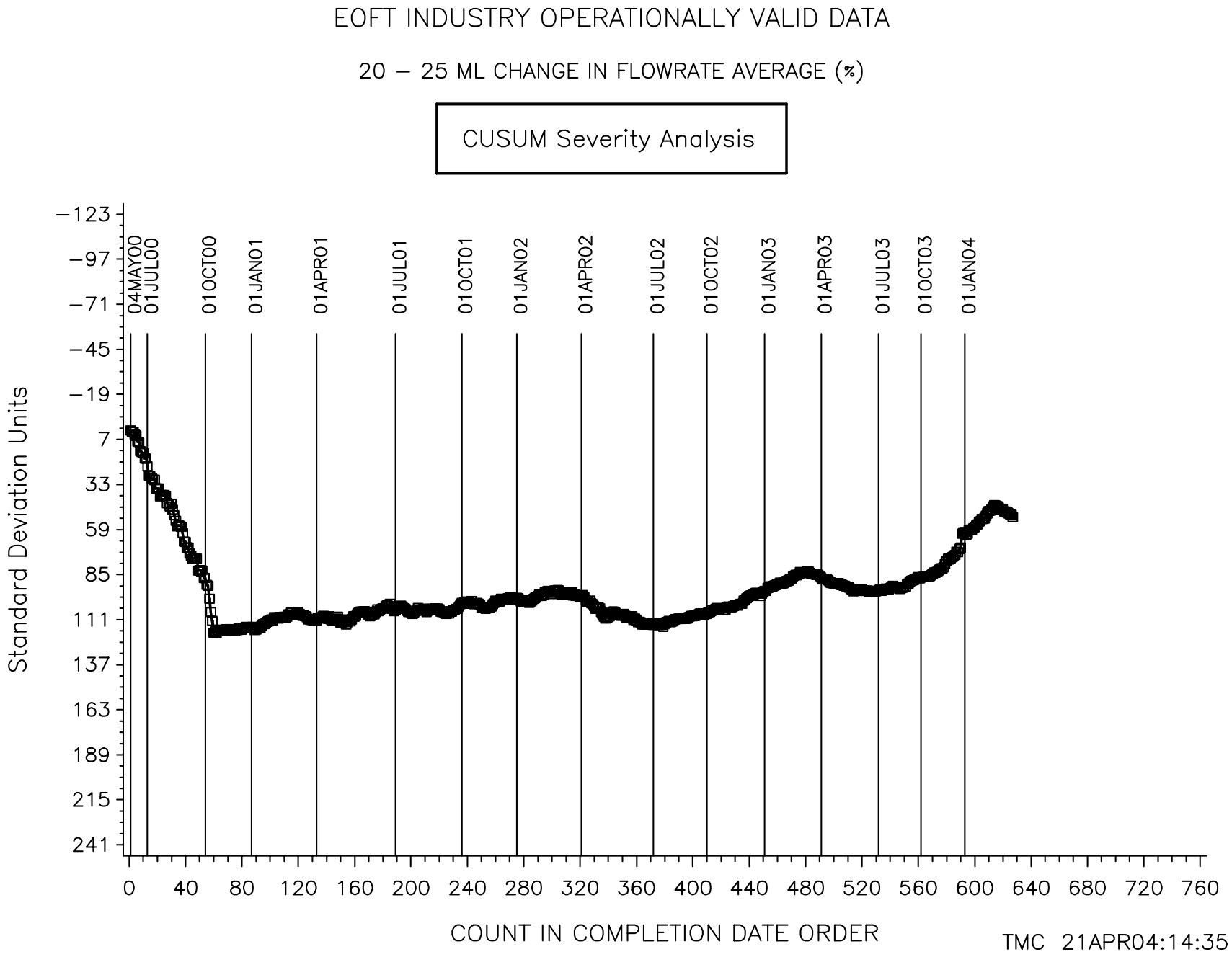

D6082 HIGH TEMPERATURE FOAM INDUSTRY OPERATIONALLY VALID DATA
IND=1007
FOAM TENDENCY, IMMEDIATELY BEFORE DISCONNECT STATI
CUSUM Severity Analysis
Standard Deviation Units
−29.0
−24.8
−20.6
−16.4
−12.2
−8.0
−3.8
0.4
4.6
8.8
13.0
17.2
21.4
25.6
29.8
12APR99
01JUL99
01OCT99
01JAN00
01APR00
01JUL00
01OCT00
01JAN01
01APR01
01JUL01
01OCT01
01JAN02
01APR02
01JUL02
01OCT02
01JAN03
01APR03
01JUL03
01OCT03
01JAN04
01APR04
0
6
12
18
24
30
36
42
48
54
60
66
72
78
84
90
96
102
108
114
COUNT IN COMPLETION DATE ORDER
TMC 22APR04:15:16

Figure 7


BALL RUST TEST INDUSTRY OPERATIONALLY VALID DATA
REFERENCE AVERAGE GRAY VALUE AVERAGE
CUSUM Severity Analysis
Standard Deviation Units
480
443
406
369
332
295
258
221
184
147
110
73
36
−1
−38
15AUG00
01OCT00
01JAN01
01APR01
01JUL01
01OCT01
01JAN02
01APR02
01JUL02
01OCT02
01JAN03
01APR03
01JUL03
01OCT03
01JAN04
0
76
152
228
304
380
456
532
608
684
760
836
912
988
1064
COUNT IN COMPLETION DATE ORDER
TMC 21APR04:14:15

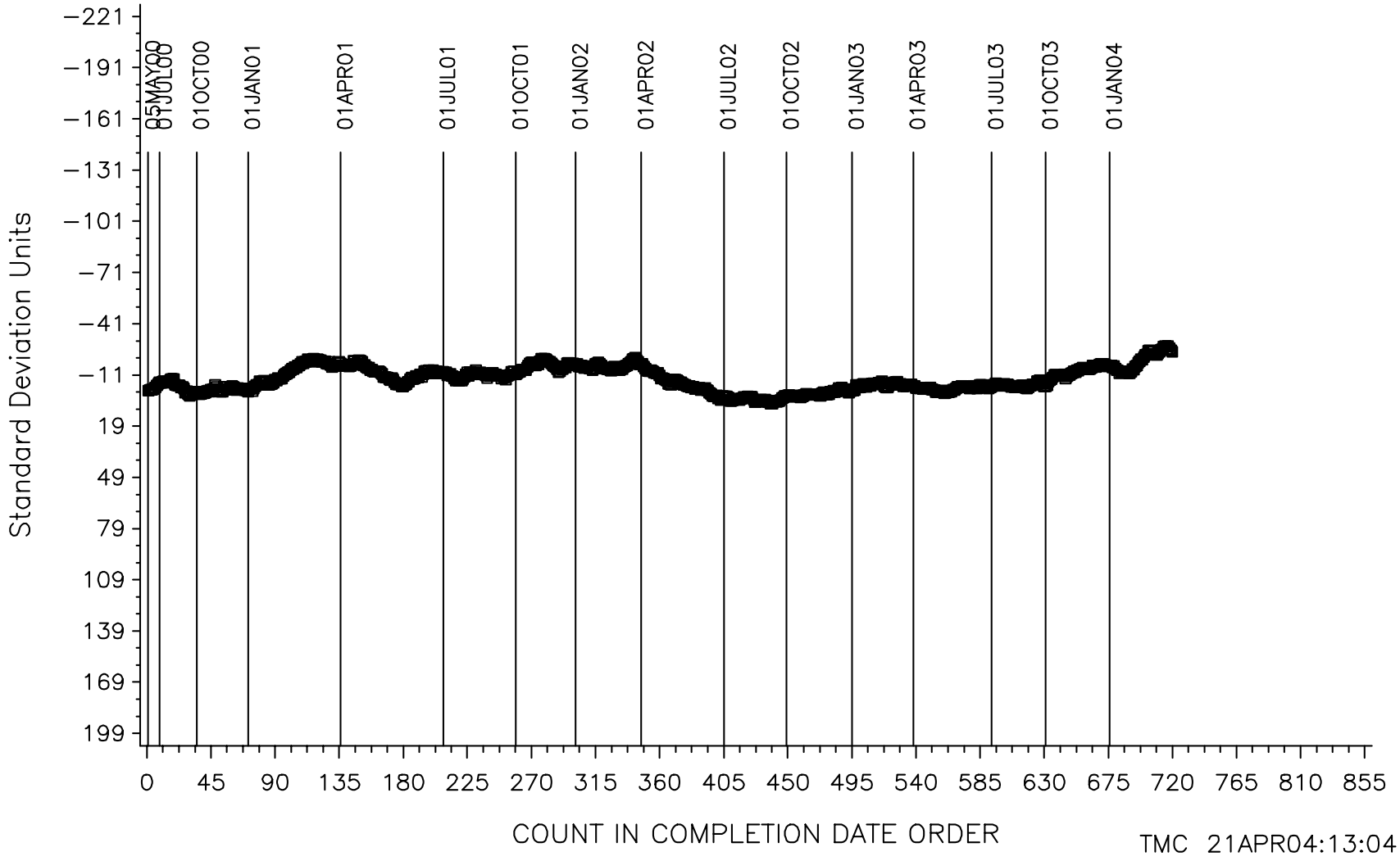

EOFT INDUSTRY OPERATIONALLY VALID DATA
20 – 25 ML CHANGE IN FLOWRATE AVERAGE (%)
CUSUM Severity Analysis
Standard Deviation Units
−123
−97
−71
−45
−19
7
33
59
85
111
137
163
189
215
241
04MAY00
01JUL00
01OCT00
01JAN01
01APR01
01JUL01
01OCT01
01JAN02
01APR02
01JUL02
01OCT02
01JAN03
01APR03
01JUL03
01OCT03
01JAN04
0
40
80
120
160
200
240
280
320
360
400
440
480
520
560
600
640
680
720
760
COUNT IN COMPLETION DATE ORDER
TMC 21APR04:14:35

EOWT INDUSTRY OPERATIONALLY VALID DATA

0.6% Treat Rate

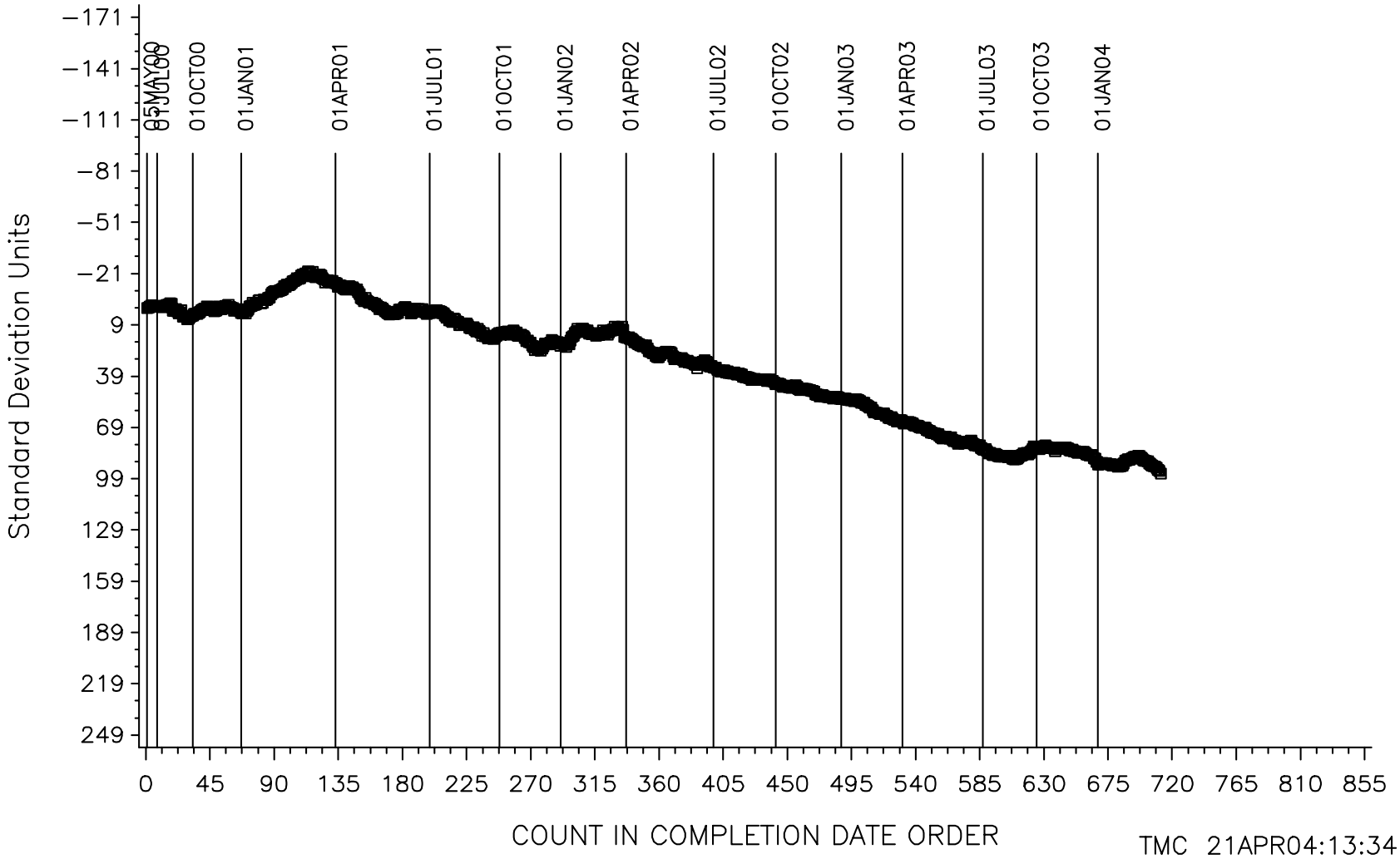
TEST RUN 20 – 25 ML CHANGE IN FLOWRATE AVERAGE

CUSUM Severity Analysis



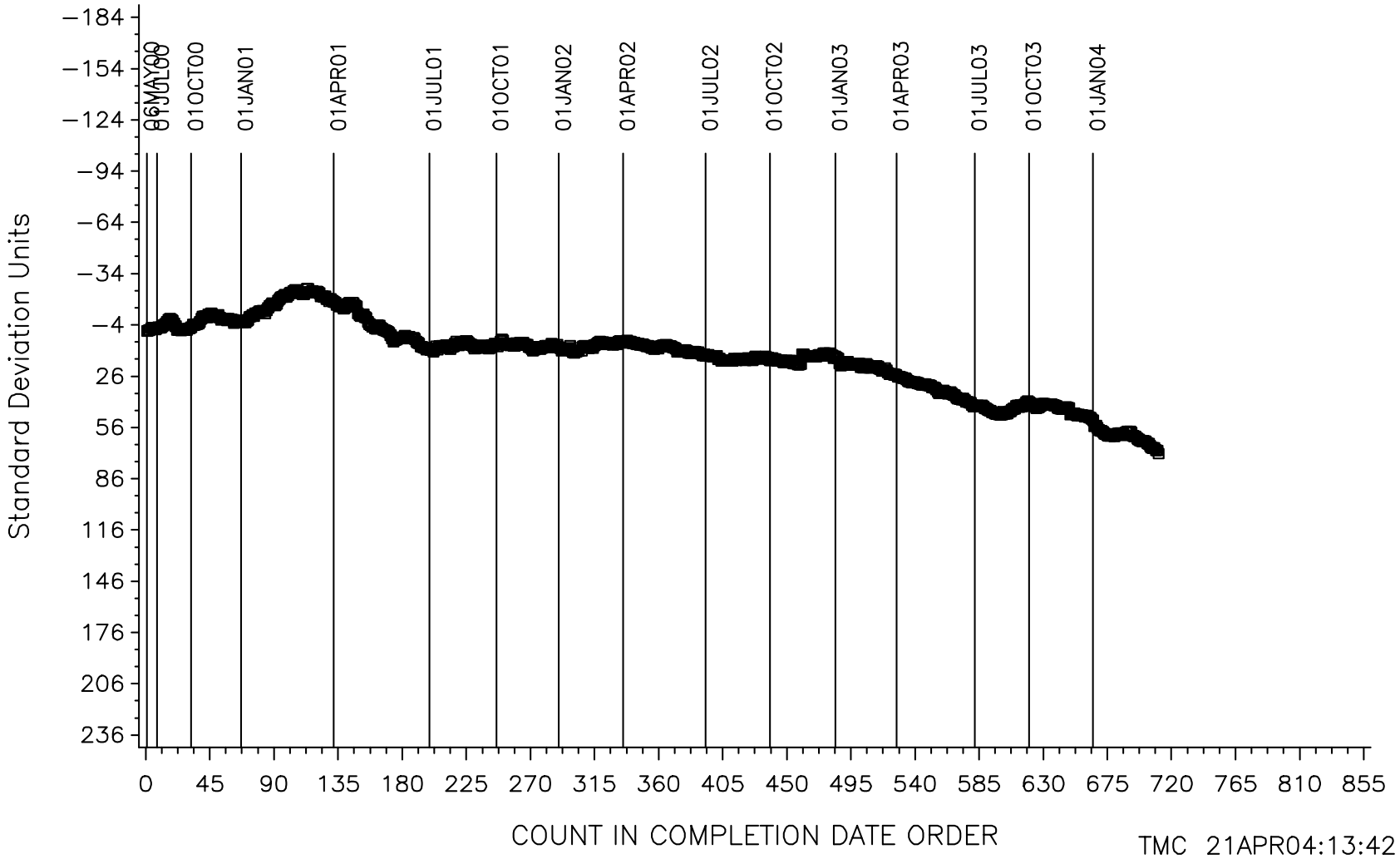
EOWT INDUSTRY OPERATIONALLY VALID DATA
1.0% Treat Rate
TEST RUN 20 – 25 ML CHANGE IN FLOWRATE AVERAGE

CUSUM Severity Analysis



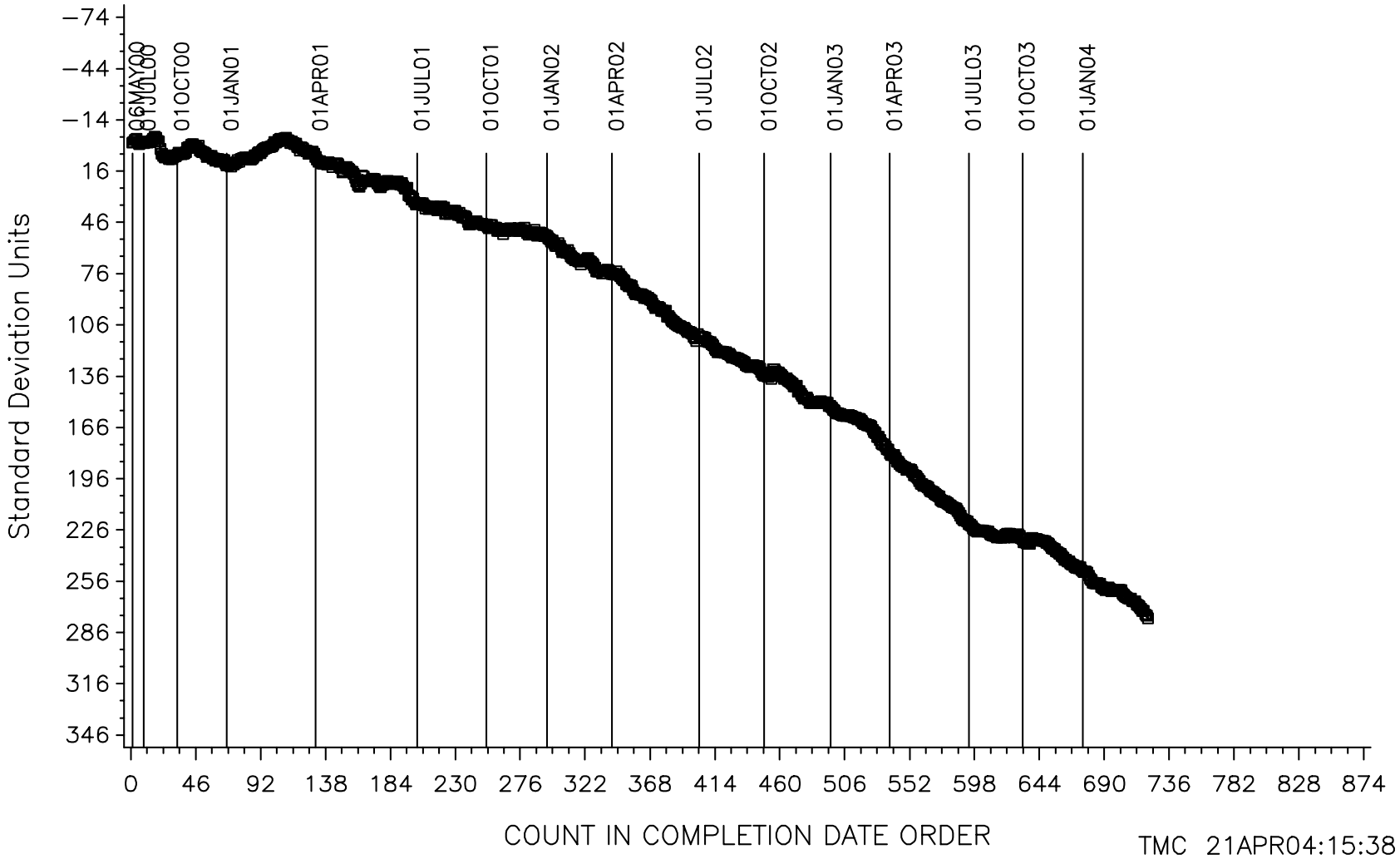
EOWT INDUSTRY OPERATIONALLY VALID DATA
2.0% Treat Rate
TEST RUN 20 – 25 ML CHANGE IN FLOWRATE AVERAGE

CUSUM Severity Analysis



EOWT INDUSTRY OPERATIONALLY VALID DATA
3.0% Water Treat Rate
TEST RUN 20 – 25 ML CHANGE IN FLOWRATE AVERAGE

CUSUM Severity Analysis



Test	Oil Code	Parameter	n	Mean	sR	Acceptance Bands * 95% Lower	Acceptance Bands * 95% Upper
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
D5800	52	mass % volatility loss	33	13.75	0.61	12.6	14.9
New Targets	55	mass % volatility loss	32	17.09	0.76	15.6	18.6
7/21/2003	58	mass % volatility loss	37	15.20	0.72	13.8	16.6
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)	14	13.59	3.97	5.8	21.4
Version 2, 03.09.23	432	Total Deposit wt. (mg)	8	45.18	2.73	39.8	50.5
New Targets	433	Total Deposit wt. (mg)	14	42.10	5.34	31.6	52.6
20031101/20040218	1006	Total Deposit wt. (mg)	14	42.43	6.10	30.5	54.4
GI by	58	Gelation Index	17	5.8	0.69	4.4	7.2
D5133	62	Gelation Index	35	17.0	3.90	9.4	24.6
New Targets	1009	Gelation Index	16	7.3	0.68	6.0	8.6
7/15/2003							
D6082	1007	Tendency (ml)	28	65.71	19.28	28	103
(HT FOAM)	1007	Stability (ml)	28	0.00	0.00	0	0
D6082	66 (DISCRIM)	Tendency (ml)	--	-----	-----	>100	-----
(HT FOAM)	66 (DISCRIM)	Stability (ml)	--	-----	-----	0	0
BRT by	81	Average AGV	12	112	14.00	85	140
(D6557)	82	Average AGV	12	48	12.50	25	70
D02-1483	1006	Average AGV	12	128	7.21	114	142
	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			10/1/02 - 3/31/03				4/1/03 - 9/30/03				10/1/03 - 3/31/04			
			n	Mean	sR	n	Mean	sR	Mean Δ/s	n	Mean	sR	Mean Δ/s	n	Mean	sR	Mean Δ/s
D6417	52	Area % Volatized	18	6.97	0.31	2	6.6	0.21	-1.03	5	6.9	0.48	-0.23	8	6.7	0.39	-0.75
	55	Area % Volatized	18	11.68	0.51	7	11.2	0.51	-0.91	4	11.0	0.14	-1.33	4	11.4	0.79	-0.65
	58	Area % Volatized	18	5.61	0.30	6	5.7	0.19	0.24	5	5.6	0.33	0.03	3	5.8	0.12	0.74
D5800	52	% volatility loss	33	13.75	0.61	12	13.8	0.55	0.29	11	13.9	0.53	0.40	8	13.8	0.46	0.04
**	55	% volatility loss	32	17.09	0.76	9	17.2	0.61	1.21	12	16.9	0.81	0.38	12	17.3	0.79	0.24
	58	% volatility loss	37	15.20	0.72	13	15.3	0.71	1.59	6	15.3	0.74	0.63	12	15.6	0.58	0.51
TEOST	71	Deposit wt. (mg)	27	51.79	4.79	3	51.7	6.66	-0.01	2	62.2	5.44	2.16	5	48.1	8.33	-0.78
(D6335)	72	Deposit wt. (mg)	27	26.72	3.46	2	31.1	0.28	1.27	4	36.2	13.68	2.73	2	26.7	3.39	-0.01
MTEOS	1006	Deposit wt. (mg)	14	42.43	6.10	14	31.4	8.72	-0.52	4	39.0	1.81	0.75	13	37.7	10.91	-0.59
***	432	Deposit wt. (mg)	8	45.18	2.73	8	41.8	6.62	-1.70	10	44.7	3.34	-1.12	2	42.8	0.35	-1.51
	433	Deposit wt. (mg)	14	42.10	5.34	13	47.2	5.00	-0.59	7	41.4	9.09	-1.70	10	37.7	11.46	-0.82
	74	Deposit wt. (mg)	14	13.59	3.97	7	13.5	4.95	-0.63	6	14.7	6.75	-0.41	10	11.6	3.76	-0.51
GI	~~52~~	~~Gelation Index~~	~~35~~	~~4.5~~	~~0.24~~	~~7~~	~~4.6~~	~~0.20~~	~~0.36~~	~~3~~	~~4.3~~	~~0.10~~	~~-0.83~~	--	----	----	----
(D5133)	~~53~~	~~Gelation Index~~	~~37~~	~~44.7~~	~~4.64~~	~~5~~	~~47.0~~	~~3.73~~	~~0.50~~	~~6~~	~~47.3~~	~~2.12~~	~~0.55~~	--	----	----	----
****	58	Gelation Index	17	5.8	0.69	8	6.6	1.00	1.09	9	5.8	0.95	-0.03	12	10.1	8.68	6.27
	62	Gelation Index	35	17.0	3.90	9	18.5	2.21	0.37	6	18.1	4.15	0.27	12	14.5	5.51	-0.64
	1009	Gelation Index	16	7.30	0.68	--	-----	-----	-----	3	7.2	0.60	-0.20	13	7.1	0.54	-0.27
D6082	1007	Tendency (ml)	28	65.71	19.28	11	62.7	17.52	-0.15	12	65.8	9.96	0.01	12	62.5	10.55	-0.17

**D5800 Targets Adjusted 10/2/00; new oils selected; new procedures approved; targets adjusted again 7/21/03
***MTEOS Targets Adjusted 6/1/01; adjusted again 11/1/03 (SC9 RR2)
****GI: Added oil 1009 and dropped oils 52 & 53 7/15/03; added 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			4/1/02 - 9/30/02			10/1/02 - 3/31/03			4/1/03 - 9/30/03			10/1/03 - 3/31/04		
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	30	123.0	9.11	38	126.0	5.09	44	123.5	7.76	17	125.8	5.57
	5A-3	Average AGV	12	76	6.47	38	89.7	15.52	23	85.9	14.43	14	87.6	16.30	---	---	---
	81	Average AGV	12	112	14.00	70	121.3	9.38	82	124.6	5.98	60	119.9	11.46	38	120.7	11.81
	82	Average AGV	12	48	11.50	---	---	---	---	---	---	1	55.0	0.00	16	41.6	9.74
EOFT	77	Avg. % CF	12	-45.55	4.36	0	-----	-----	0	-----	-----	0	-----	-----	0	-----	-----
	78	Avg. % CF	12	15.74	6.87	89	16.5	5.39	81	13.9	4.16	71	15.8	3.70	66	12.1	8.68
EOWT	77	0.6 H2O Avg. %CF	12	-24.90	5.68	61	-24.5	4.15	48	-24.5	4.15	51	-23.6	3.77	49	-26.6	4.76
	77	1.0 H2O Avg. %CF	12	-17.94	5.45	52	-16.4	4.17	47	-16.2	2.49	47	-15.4	3.48	42	-16.7	3.06
	77	2.0 H2O Avg. %CF	12	-17.96	8.47	47	-16.7	3.87	36	-15.1	5.21	49	-14.2	3.55	51	-14.9	4.63
	77	3.0 H2O Avg. %CF	12	-18.23	6.83	50	-16.9	5.70	46	-16.2	4.53	42	-16.3	3.01	42	-16.5	3.69
EOWT	78	0.6 H2O Avg. %CF	12	10.87	6.16	41	13.0	5.00	41	10.5	5.41	42	9.4	5.00	41	10.0	5.52
	78	1.0 H2O Avg. %CF	12	7.54	6.15	52	8.9	4.42	42	8.6	4.23	47	6.8	4.42	46	8.3	4.52
	78	2.0 H2O Avg. %CF	12	5.17	5.33	56	5.4	3.67	53	4.9	6.12	44	4.5	3.67	41	6.8	5.48
	78	3.0 H2O Avg. %CF	12	-0.54	4.52	58	3.4	3.59	43	2.6	5.64	52	2.9	3.59	48	2.9	3.78