



Test Monitoring Center

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MEMORANDUM: 03-026
DATE: April 7, 2003
TO: Warren Totten, Chairman, Cummins Surveillance Panel
FROM: Jeff Clark
SUBJECT: M11 Calibration Testing for the April 2003 ASTM Report Period

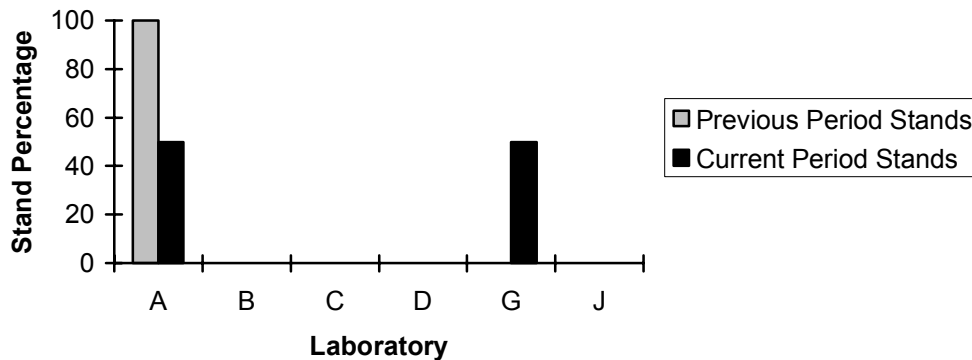
The following is a summary of M11 reference oil tests completed during the April 2003 ASTM report period, which began on October 1, 2002 and ended on April 1, 2003.

Lab / Stand Distribution:

	Reporting Data	Calibrated as of 3/31/03
Number of Laboratories	2	1
Number of Stands	2	1

The following chart shows the laboratory / stand distribution for tests completed this report period:

Laboratory / Stand Distribution

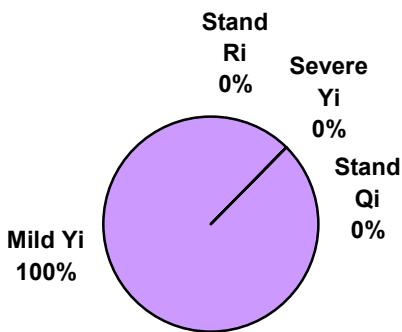


The following summarizes the status of the reference oil tests completed this ASTM report period:

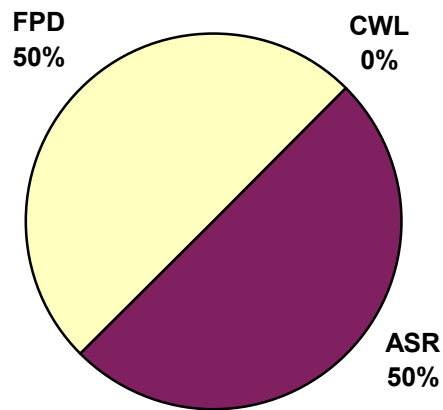
Test Status	TMC Validity Code	Number of Tests
Operationally and Statistically Acceptable	AC	1
Failed LTMS Acceptance Criteria	OC	1
Operationally Invalid	LC	0
Aborted	XC	0
Total		2

A detailed list of reasons tests failed the acceptance criteria is shown in Table 1 (attached). There were two LTMS stand alarms, on one test, for the current period. The following figures show the alarm and parameter distributions:

Distribution of LTMS Stand Alarms



Distribution of Stand Alarms by Parameter



“Engineering Judgment” was not applied in the interpretation of LTMS guidelines during this report period. A total of nine LTMS deviations have been issued during the life of the M11 test.

A detailed list of operationally invalid tests is shown in Table 2 (attached). Table 3 (attached) lists the reasons for aborted tests during this report period.

Severity and Precision:

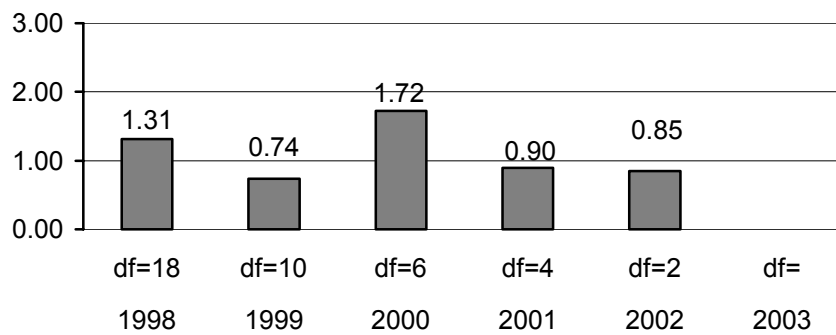
Figure 1 (attached) shows the current industry EWMA severity, EWMA precision, and cusum charts for Crosshead Weight Loss (CWL). CWL is currently within control chart limits. For this period, CWL is trending an average of 0.28 Δ/s severe. This is equivalent to 0.37 mg. For a history of CWL industry alarms, refer to the industry alarm log shown in Table 4 (attached).

Figure 2 (attached) shows the current industry EWMA severity, EWMA precision, and cusum charts for Filter Plugging Delta P (FPD). FPD is currently in an EWMA Action alarm for severity, in the mild direction. Since January 2001, FPD is trending an average of 0.99 Δ/s units mild. This is equivalent to 0.29 natural log units or 20 kPa at the CH-4 single test pass/fail limit. For a history of FPD industry alarms, refer to the industry alarm log shown in Table 5 (attached).

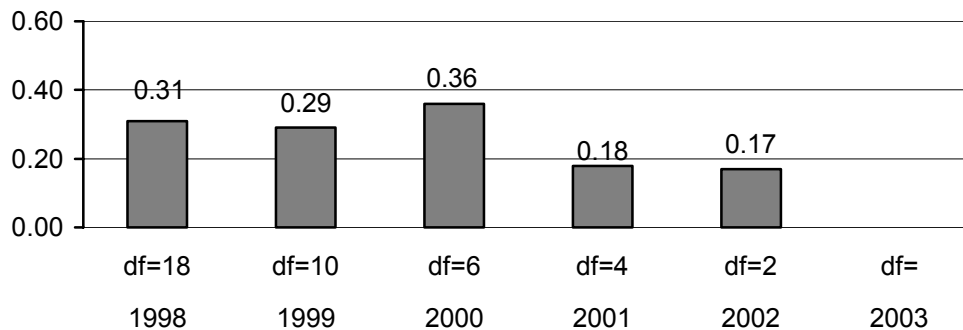
Figure 3 (attached) shows the current industry EWMA severity, EWMA precision, and cusum charts for Average Sludge Rating (ASR). ASR is currently within control chart limits. For this period, ASR is trending an average of 1.33 Δ/s mild. This is equivalent to 0.30 merits. For a history of FPD industry alarms, refer to the industry alarm log shown in Table 6 (attached).

Precision, as estimated by the pooled standard deviation, is shown in the following figures. Precision estimates are presented on an annual basis. The 2002 precision estimates for CWL, FPD, and ASR all show some improvement compared to historical levels. However, this may be due to the reduced number of degrees of freedom. Precision estimates for 2003 are not yet available due to low test activity.

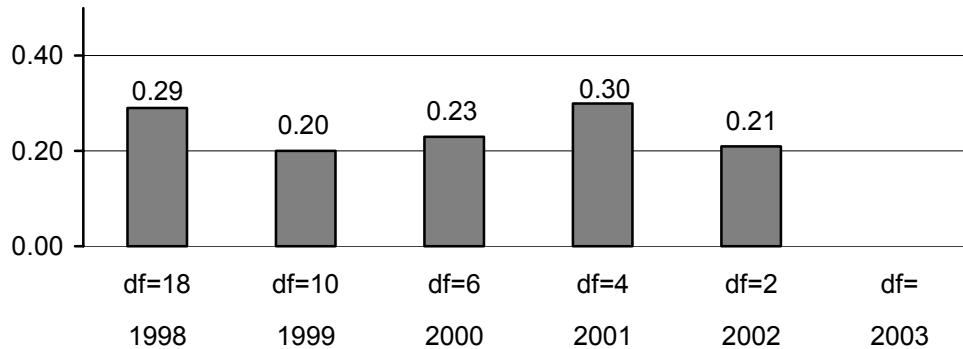
CWL Pooled Precision



FPD Pooled Precision



ASR Pooled Precision



Please note, that the degrees of freedom (df) equals $\Sigma(n \text{ observations per oil} - 1)$.

Reference Oils and Hardware:

The following table shows the current M11 reference oil test targets:

Parameter	Oil	N	Mean (cSt)	S
CWL	1005-1	30	4.5300	1.3190
FPD	1005-1	30	4.8061	0.2935
ASR	1005-1	30	8.4000	0.2250

A new crosshead design was introduced into production for the M11 engine in 1999. Use of the new crossheads was approved in April 1999 following a series of tests, both candidate and calibration, that were run with both types of crossheads. These split tests showed no significant difference in wear between the crosshead designs. However, once M11 testing began on the new crossheads, a severity shift occurred that led to the introduction of a correction factor for CWL, as shown in the table below.

Parameter	Correction Factor (mg)	Effective Date
CWL	-1.8250	20000307

A new rocker arm design has been introduced to the M11 as well. At the September 1999 meeting, the M11 Surveillance Panel approved a plan to run M11 tests using both styles of rocker arms. This study was similar to the one that was done for the new crosshead design. At the conclusion of the study, no significant difference was found in crosshead wear between the two populations of rocker arms. There was, though, a significant difference in the standard deviation between the two styles of rocker arms. This necessitated an update to the outlier screening criteria, which is covered in M11 Information Letter 02-1. Effective January 28, 2002, the new design rocker arms are approved for use in testing, using the updated outlier screening methodology.

Information Letters:

No information letters were issued this period.

Quality Index:

No Quality Index deviations were issued this period. For the history of the M11 test, two Quality Index deviations have been issued.

TMC Laboratory Visits:

One TMC laboratory visit was conducted this ASTM report period and two deficiencies were noted: the auxiliary oil system return line location was different than the specified location; and incorrect set points were used for stand instrumentation calibration.

Additional Information:

Table 7 contains the M11 Timeline, which details changes to the test since January 1, 1997.

The M11 database, for operationally valid calibration tests, can be accessed on the TMC's web site at <http://www.astmtmc.cmu.edu>.

JAC/jac/mem03-026.jac.doc

Attachments

c: J.L. Zalar, TMC
F.M. Farber, TMC
M11 Surveillance Panel
<ftp://ftp.astmtmc.cmu.edu/docs/diesel/cummins/semiannualreports/M11-04-2003.pdf>

Distribution: Email

Table 1
Summary of Reasons for Rejected Tests

	No. of Tests
FPD mild, ASR mild	1

Table 2
Summary of Reasons for Invalid Tests

	No. of Tests
No invalid tests this period	-

Table 3
Summary of Reasons for Aborted Tests

	No. of Tests
No aborted tests this period	-

FIGURE 1

M11 INDUSTRY OPERATIONALLY VALID DATA

CROSSHEAD WEIGHT LOSS

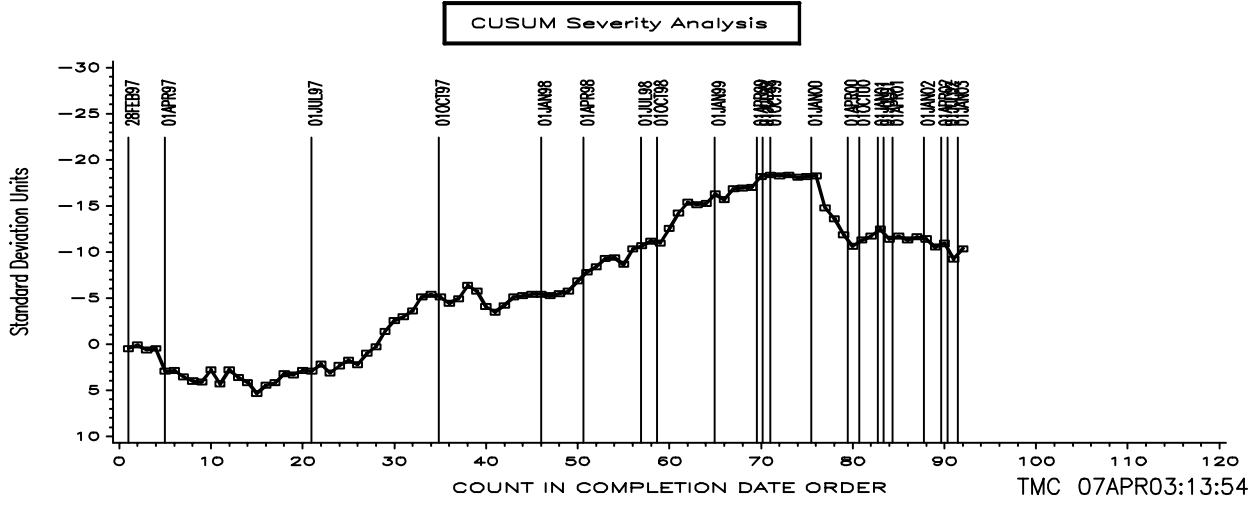
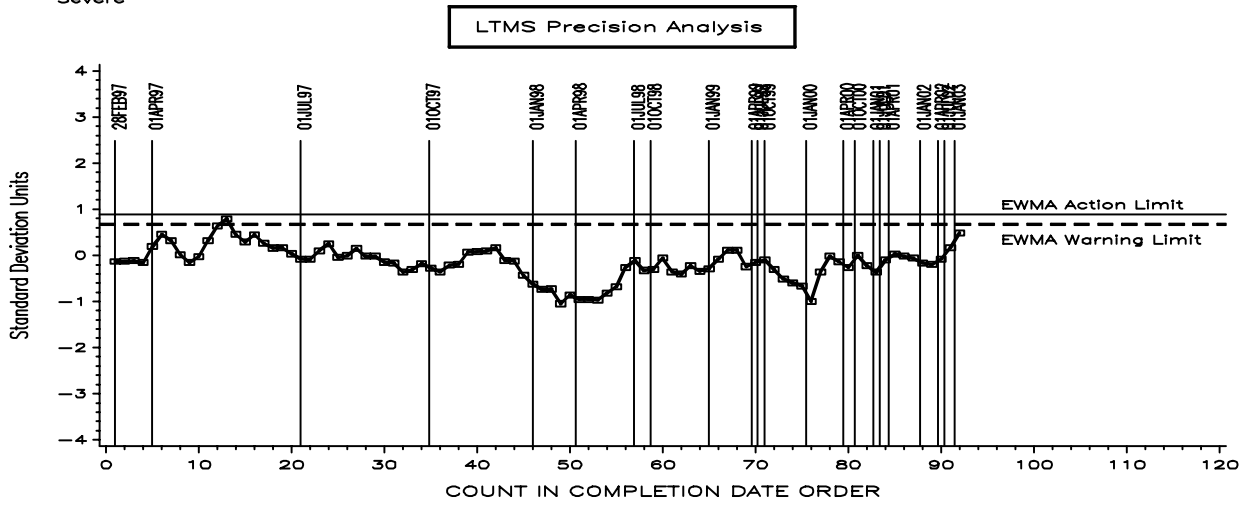
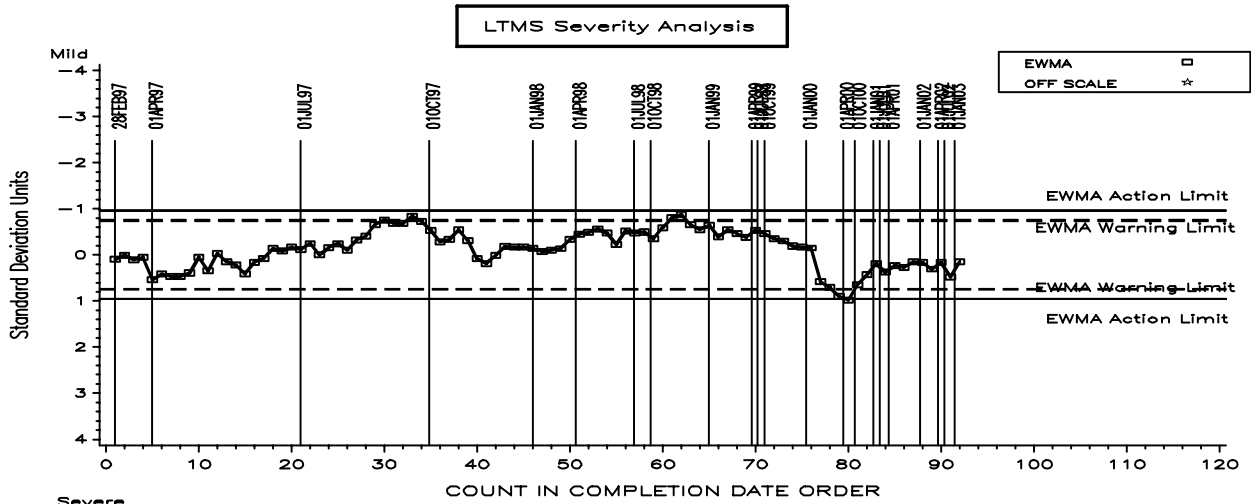


TABLE 4
M11 CROSSHEAD WEIGHT LOSS INDUSTRY ALARM LOG

May 26, 1997 to June 4, 1997 (Precision)

One test sounds warning alarm. No industry related problem.

July 28, 1997 to August 27, 1997 (Severity, Mild Direction)

Two of five tests sound warning alarms. No industry related problem.

November 28, 1998 to December 27, 1998 (Severity, Mild Direction)

Two tests sound warning alarms. No industry related problem.

March 30, 2000 to November 5, 2000 (Severity, Severe Direction)

Two tests sound warning alarms. No industry related problem.

Updated 4/7/03

FIGURE 2 M11 INDUSTRY OPERATIONALLY VALID DATA

FILTER PLUGGING DELTA P

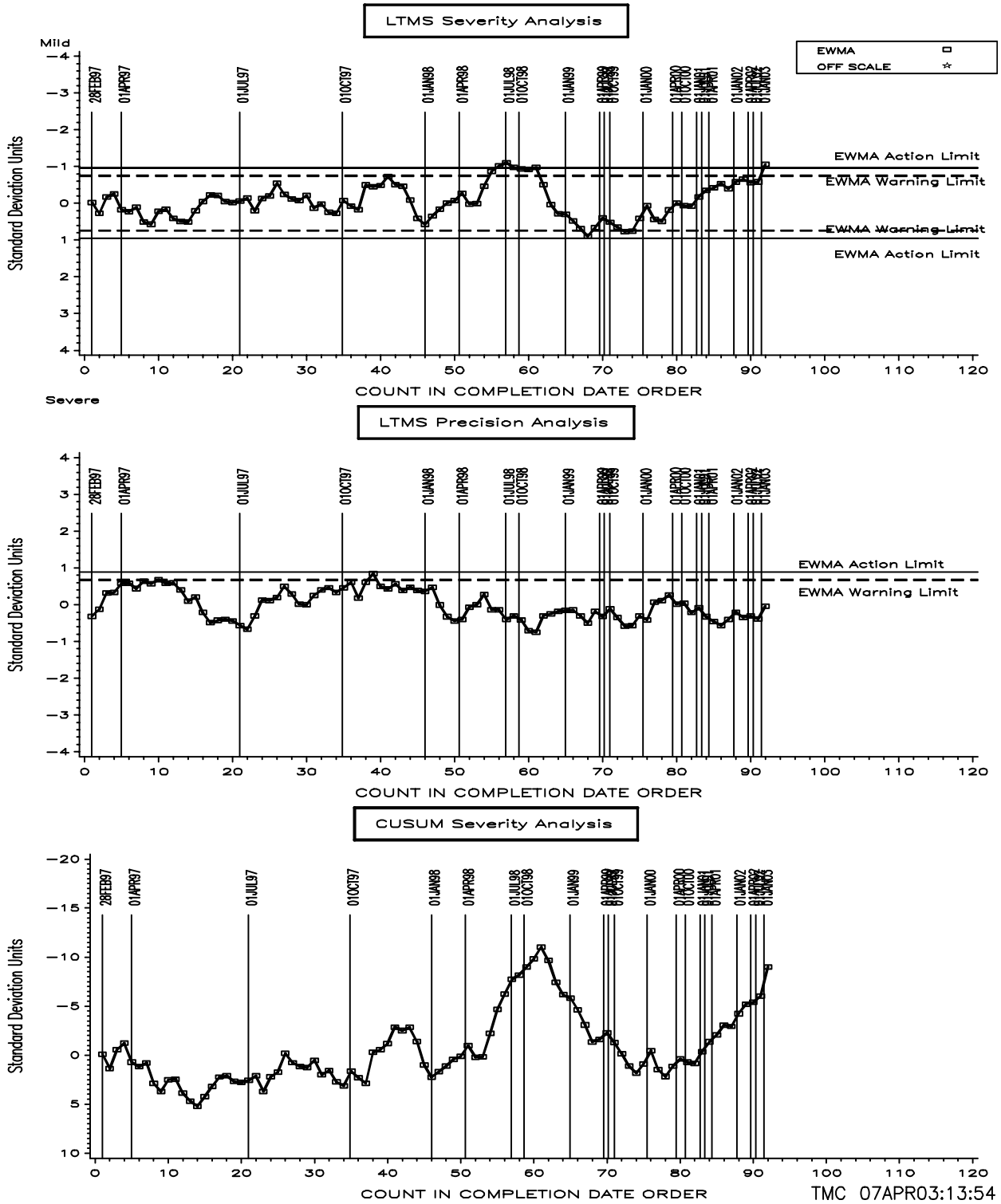


TABLE 5
M11 FILTER PLUGGING DELTA P INDUSTRY ALARM LOG

May 5, 1997 to May 12, 1997 (Precision)

One test sounds warning alarm. No industry related problem.

October 31, 1997 to November 7, 1997 (Precision)

One test sounds warning alarm. No industry related problem.

June 14, 1998 to December 12, 1998 (Severity, Mild Direction)

Alarms sounded due to a series of mild tests. Data accumulation was slow, making it difficult to establish a cause. Lab effects, reference oils, fuel, and filter design changes were all investigated as possible causes. No correlation was found between these factors and the mild trend; however, none of these factors were ruled out. Test targets were updated effective December 8, 1998. Alarm cleared December 12, 1998.

March 14, 1999 (Severity, Severe Direction)

One test sounds warning alarm. No industry related problem.

December 14, 1999 to December 31, 1999 (Severity, Severe Direction)

Two tests sound warning alarms. No industry related problem.

March 17, 2003 to Date (Severity, Mild Direction)

One test sounds an action alarm. While Filter Plugging has been trending mild since January of 2001, it is unclear if alarm has sounded due to industry trend or the most recent test, which was almost three standard deviations mild. To date, no action has been taken by the Surveillance Panel.

Updated 4/7/03

FIGURE 3
M11 INDUSTRY OPERATIONALLY VALID DATA
AVERAGE SLUDGE RATING

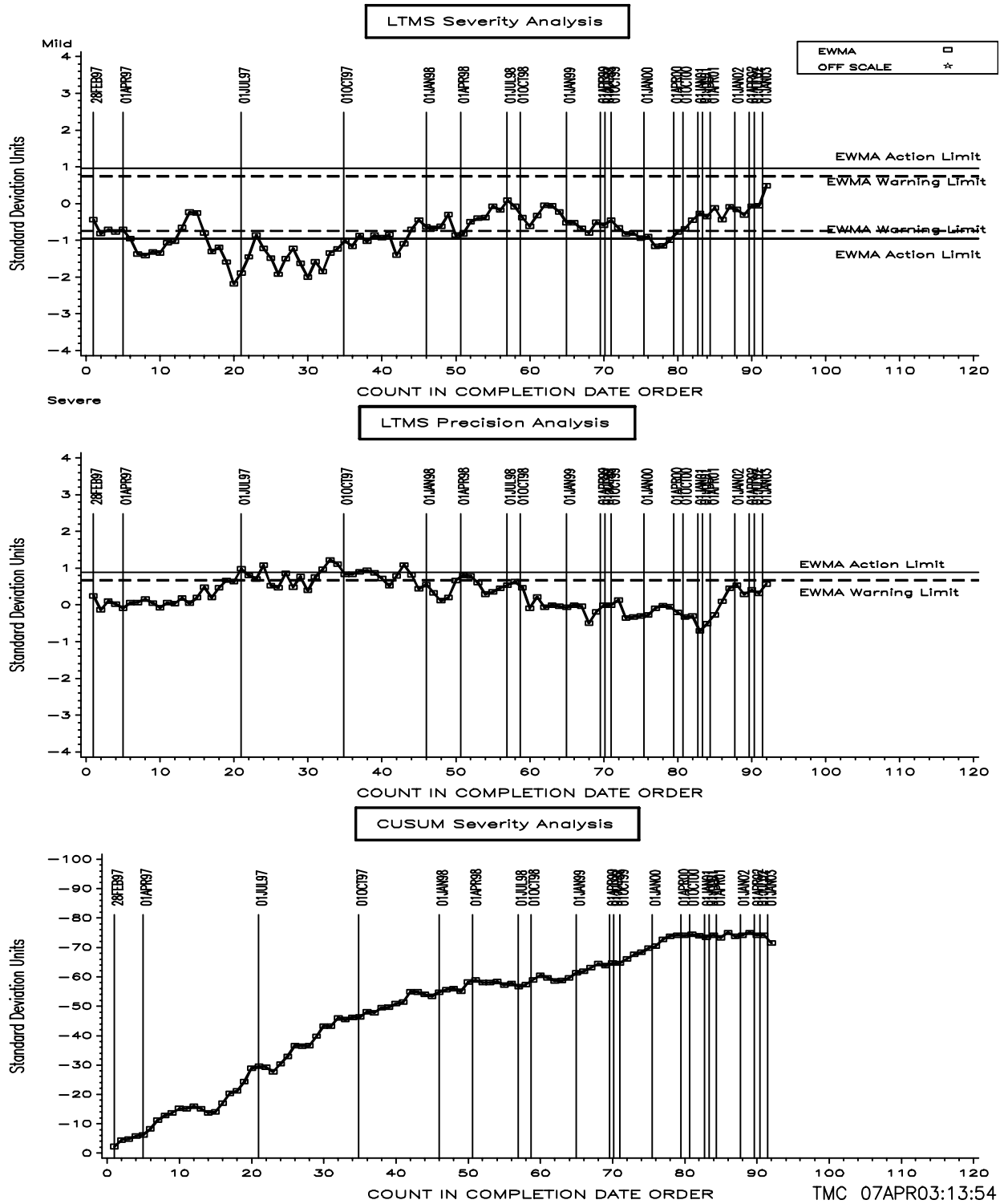


TABLE 6
M11 AVERAGE SLUDGE RATING INDUSTRY ALARM LOG

March 1, 1997 to November 29, 1997 (Severity, Severe Direction)

Alarms caused by laboratories running at two different severity levels on the matrix tests. Original test targets were set using data from the mild labs. The severity difference was believed to be a difference in sludge rating. Rating workshops were held to resolve the rating differences. The difficulties in rating sludge depths from A to BC were determined to be the cause of the rating differences. Alarms cleared on November 29, 1997.

June 28, 1997 to December 21, 1997 (Precision)

Alarms caused by laboratories running at different severity levels on the matrix tests. See the severity alarm description above. Alarms cleared on December 21, 1997.

March 8, 1998 to May 29, 1998 (Severity, Severe Direction)

Two tests sound warning alarms. No industry related problem.

March 8, 1998 to June 4, 1998 (Precision)

Three tests sound warning alarms. No industry related problem.

March 14, 1999 (Severity, Severe Direction)

One test sounds warning alarm. No industry related problem.

December 14, 1999 to November 5, 2000 (Severity, Severe Direction)

A series of tests sound industry action alarms. An M11 Surveillance Panel sanctioned sludge-rating workshop was held in late April 2000 in an attempt to resolve alarms and a small task group was also formed to investigate possible sludge severity changes that are not related to rating differences. The group did not find any causes of the severe trend, and it is difficult to determine if the sludge workshop had any impact on severity. The alarms cleared in November 2000.

Updated 4/7/03

Table 7
M11 Timeline

Date	Info. Letter	Topic
19970424,		DATA ACQUISITION MINIMUM FREQUENCY CHANGED FROM 2 MINUTES TO 6 MINUTES
19970424,		COOLANT PRESSURE, INLET AIR TEMPERATURE AND PRESSURE CHANGED TO NON-CONTROLLED PARAMETERS
19970424,		INTAKE MANIFOLD BOOST PRESSURE SPEC SET AT +/- 5KPA OF REFERENCE TEST AVERAGE ON STAGES 1 AND 3
19970623,		FRONT GEAR HOUSING ADDED TO CRITICAL PARTS LIST
19971007,		150 HOUR CANDIDATE SOOT MINIMUM RAISED FROM 4.3% TO 4.5%
19971007,		OIL 1004-3 REMOVED AS REFERENCE OIL
19971007,		NEW STAND CALIBRATION WITH 1 TEST APPROVED
19980408,		OUTLIER SCREENING CI CHANGED FROM 99% TO 95%
19980408,		FILTER PLUGGING DELTA P CALCULATION MODIFIED
19980408,		SLUDGE RATING TEMPLATE MODIFIED
19980408,		ONE INJECTION TIMING CHANGE ALLOWED DURING FIRST 100 HOURS
19980408,		INTAKE MANIFOLD BOOST PRESSURE CHANGED TO A NON-CONTROLLED PARAMETER FOR ALL FOUR STAGES
19980408,		OIL 1005 TWENTY FIVE TEST TARGETS
19980408,		OIL 1005-1 INTIAL TARGETS, BASED ON 1005 RESULTS
19980521,		REFERENCE OIL 1005-1 INTRODUCED
19980614,		NEW OIL FILTER DESIGN INTRODUCED
19980731,	98-1	REPORT FORMS AND DATA DICTIONARY VERSION 19980604
19981208,		OIL 1005-1 TEN TEST TARGETS
19990421,	99-1	VISCOSITY MEASUREMENTS MAY BE DONE ACCORDING TO EITHER D 445 OR D 5967, ANNEX 3
19990421,		NEW CROSSHEAD DESIGN APPROVED FOR ALL M11 TESTING
19990621,		OIL 1005-1 TWENTY TEST TARGETS
19990709,	99-1	REPORT FORMS AND DATA DICTIONARY VERSION 19981110
19991128,	99-1	QUALITY INDEX IMPLEMENTED FOR DETERMINING OPERATIONAL VALIDITY
20000131,		FIRST REFERENCE TEST RESULT RUN AS SPLIT TEST WITH OLD AND NEW ROCKER ARM DESIGN
20000307,		CROSSHEAD WEIGHT LOSS CORRECTION FACTOR OF -1.8250 MG TO BE ADDED TO ALL TESTS ON NEW CROSSHEAD DESIGN
20000418,	01-1	OUTLIER SCREENING CRITERIA MODIFIED
20010811,		OIL 1005-1 THIRTY TEST TARGETS
20020128,	02-1	NEW ROCKER ARMS APPROVED FOR TESTING. CWL OUTLIER METHOD UPDATED ACCORDINGLY