



A Program of ASTM International

Test Monitoring Center

<http://astmtmc.cmu.edu>

ASTM D02.B2 Semi-Annual Report Heavy Duty Reference Oil Testing

April 2014

Heavy Duty Testing

Executive Summary

- ▶ Reference Oils
 - 821-4
 - Reblend of 821 completed and accepted for shipment
- ▶ T12 V Batch liner approved
 - Larger production of liners to same specifications as previously approved U liner batch.

Calibrated Labs and Stands*

Test	Labs	Stands
1K	4	4
1N	4	7
1M-PC	1	1
1P	2	2
1R	1	2
C13	2	4
ISB	3	5
ISM	5	7
EOAT	1	1
RFWT	2	2
T-8/E	2	3
T-11	4	6
T-12	4	11
T-12A	4	12

*As of 03/31/2014

Test Monitoring Center

<http://astmtmc.cmu.edu>



A Program of ASTM International

Test Activity Levels

»» October 1, 2013 –

March 31, 2014

Test Monitoring Center

<http://astmtmc.cmu.edu>



A Program of ASTM International

CAT – SCOTE Tests

Test Status	Validity Code	1K	1N	1M-PC	1P	1R
Acceptable Calibration Test	AC	1	5	1	2	0
Failed Calibration Test	OC	0	0	0	0	0
Operationally Invalid	LC	0	1	0	1	0
Aborted	XC	0	1	0	0	0
Total		1	7	1	3	0

CAT - C13 Test

Test Status	Validity Code	C13
Acceptable Calibration Test	AC	2
Failed Calibration Test	OC	0
Operationally Invalid	LC	0
Aborted	XC	0
Total		2

Cummins Tests

Test Status	Validity Code	ISB	ISM
Acceptable Calibration Test	AC	3	6
Failed Calibration Test	OC	1	0
Operationally Invalid	LC	0	0
Aborted	XC	0	0
Total		4	6

Light Duty Diesel Tests

Test Status	Validity Code	EOAT	RFWT
Acceptable Calibration Test	AC	0	2
Failed Calibration Test	OC	0	0
Operationally Invalid	LC	0	0
Aborted	XC	0	0
Total		0	2

Mack Tests

Test Status	Validity Code	T-8/E	T-11	T-12	T-12A
Acceptable Calibration Test	AC	1 / 1	6	8	11
Failed Calibration Test	OC	0 / 0	0	3	0
Operationally Invalid	LC	1 / 1	0	0	0
Aborted	XC	3 / 3	0	4	4
Pending Tests	PC	0	0	0	0
Donated Test	AG	0	0	0	0
Information Test	NN	0	0	0	0
Total		5	6	15	15

Failed Tests

Test	Failed Parameter	Number of Tests
ISB	SEV ACW	1
T12	MILD CLW, SEV PB	1
T12	MILD CLW, SEV PB	1
T12	MILD CLW, SEV PB, SEV TRWL	1
Total		4

Lost Tests*

*Invalid and aborted tests

Test	Status	Cause
1N	Invalid	Bushing wear lead to high Copper
1N	Aborted	Exhaust backpressure valve failure
1P	Invalid	Piston scuffed
T8	Invalid	Missed soot window
T8	Aborted	Missed soot window
T8	Aborted	Missed soot window
T8	Aborted	High oil consumption
T12	Aborted	Valve Failure
T12	Aborted	High oil consumption safety concerns
T12	Aborted	Spun Rod bearing
T12	Aborted	High oil consumption safety concerns

Test Severity

»» October 1, 2013 –
March 31, 2014

Test Monitoring Center

<http://astmtmc.cmu.edu>



A Program of ASTM International

CAT Test Severity

▶ 1K

- WDK, TLHC, ETOC are in control. WDK near warning limit.
- TGF and TLHC
 - Within Chart Limits but near warning limit.
 - Long-term mild trend continuing
- BSOC in Warning Limit in the mild direction
 - Long-term mild trend continuing

- Charts shown in [Appendix 1.a.](#)

▶ 1N

- WDN and TLHC in action alarm
- TGF in control
- BSOC in warning alarm
- TGF, WDN, TLHC, and BSOC trending mild
- Severity trends are being evaluated by surveillance panel

- Charts shown in [Appendix 1.b.](#)

Test Monitoring Center

<http://astmtmc.cmu.edu>



A Program of ASTM International

CAT Test Severity

▶ 1M-PC

- Both parameters (TGF & WTD) are in control.
- TGF trending severe

- Charts shown in [Appendix 1.c.](#)

▶ 1P

- EOTOC is in warning limit (severe direction)
- OC, TGC, TLC and WD are in control.

- Charts shown in [Appendix 1.d.](#)

CAT Test Severity

▶ 1R

- BTOC and TLC are in control.
- WD, TGC and ETOC in precision alarm

- Charts shown in [Appendix 1.e.](#)

▶ C13

- TLC, TGC and OC are in control.
- R2TC in action alarm, extreme mild direction.

- Charts shown in [Appendix 1.f.](#)

Cummins Test Severity

▶ ISB

- ACSW is in action alarm severe direction
- ATWL in warning alarm in the mild direction

- Charts shown in [Appendix 1.g.](#)

▶ ISM

- CWL, FPD, IAS and ASR in control.
 - CWL trending mild.
 - FPD mild trend may be ending.
 - ASR possibly trending severe.

- Charts shown in [Appendix 1.h.](#)

Light Duty Diesel Test Severity

▶ EOAT

- AEOA in control.

- Charts shown in [Appendix 1.i.](#)

▶ RFWT

- AFW in control but trending mild and near warning alarm.

- Charts shown in [Appendix 1.j.](#)

Mack Test Severity

▶ T-8/E

- VI38 in warning alarm
- RV48 and RV2 are in control.

- Charts shown in [Appendix 1.k.](#)

▶ T-11

- SOOT, SOOT4 and SOOT5 in control chart limits.
- MRV in warning alarm severe direction
- MRV in warning precision alarm.

- Charts shown in [Appendix 1.l.](#)

Mack Test Severity

- ▶ T-12
 - CLW in action alarm mild direction with a continuing strong mild trend.
 - PB and PB2 are in action alarm in severe direction. Both in precision action alarm as well.
 - TRWL in action alarm in severe direction.
 - OC is in control.
- Charts shown in [Appendix 1.m.](#)

Mack Test Severity

- ▶ T-12A

- MRV is in action alarm in mild direction as well as precision action alarm.

- Charts shown in [Appendix 1.n.](#)

Test Precision

»» October 1, 2013 –
March 30, 2014

Test Monitoring Center

<http://astmtmc.cmu.edu>

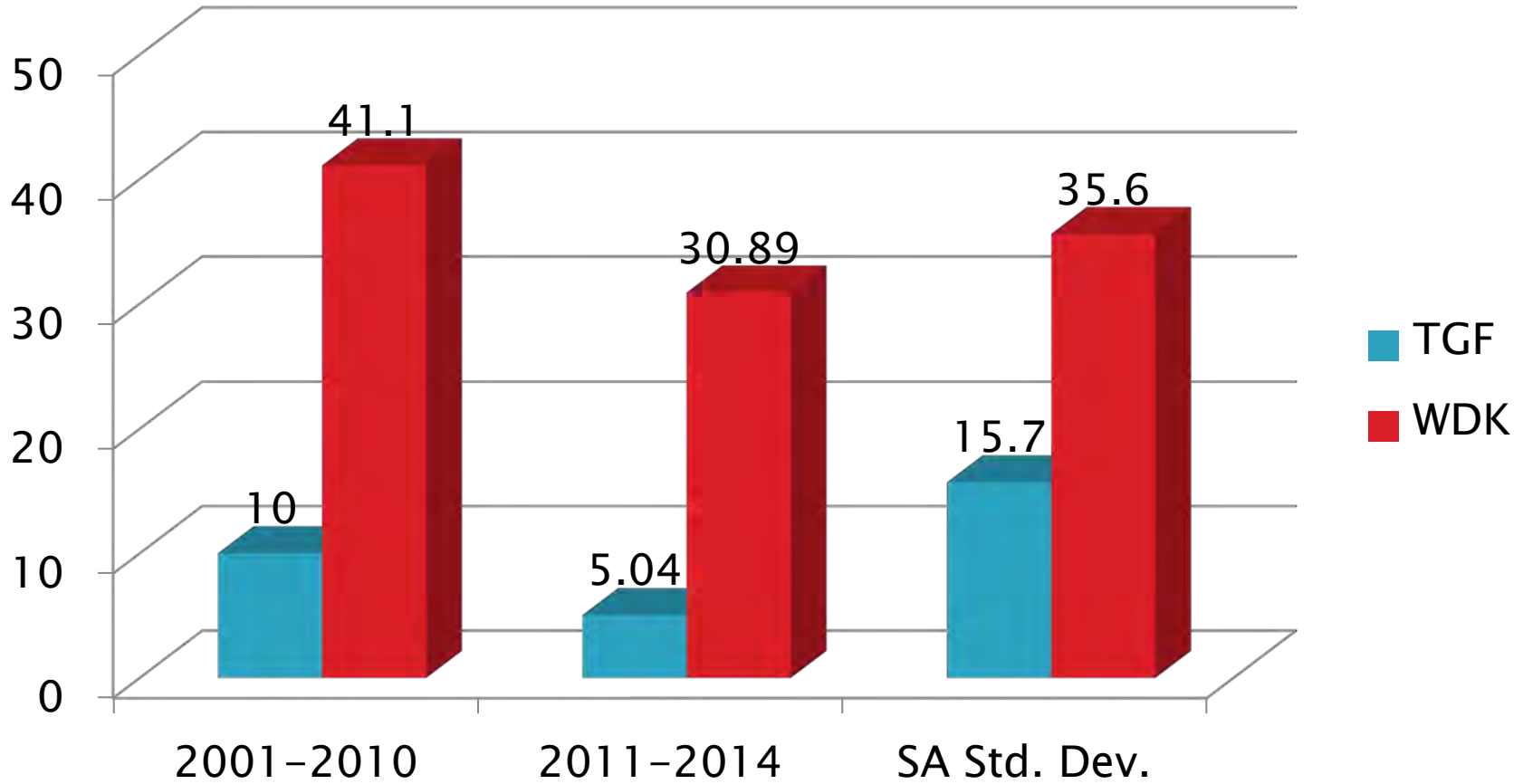


A Program of ASTM International

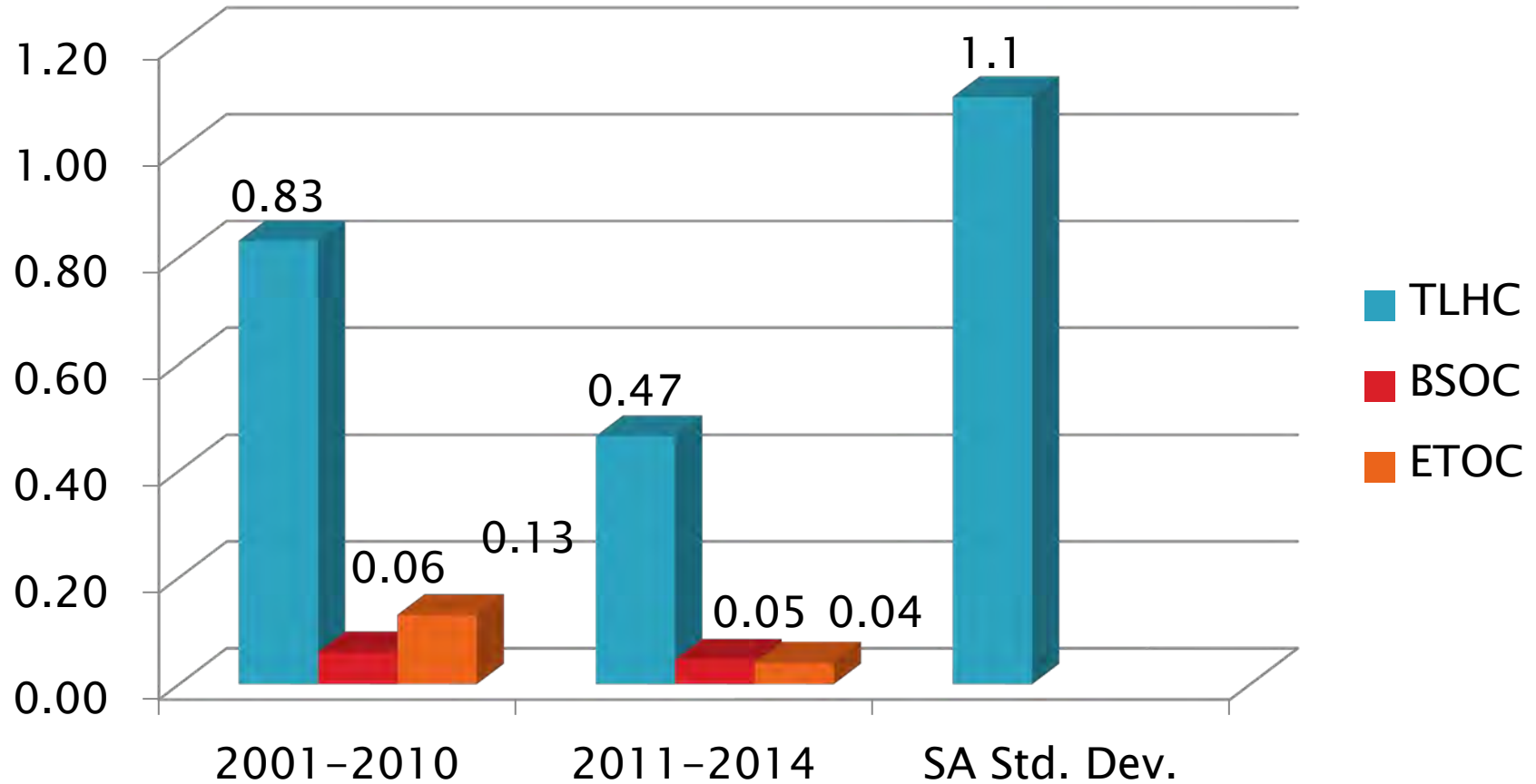
Test Precision Estimates

- ▶ Presented for years where sufficient data exist
- ▶ Precision estimates are shown with reference oil std. deviations, or where applicable, with Severity Adjustment std. deviations
- ▶ For several test types, precision estimates are not available due to low activity levels

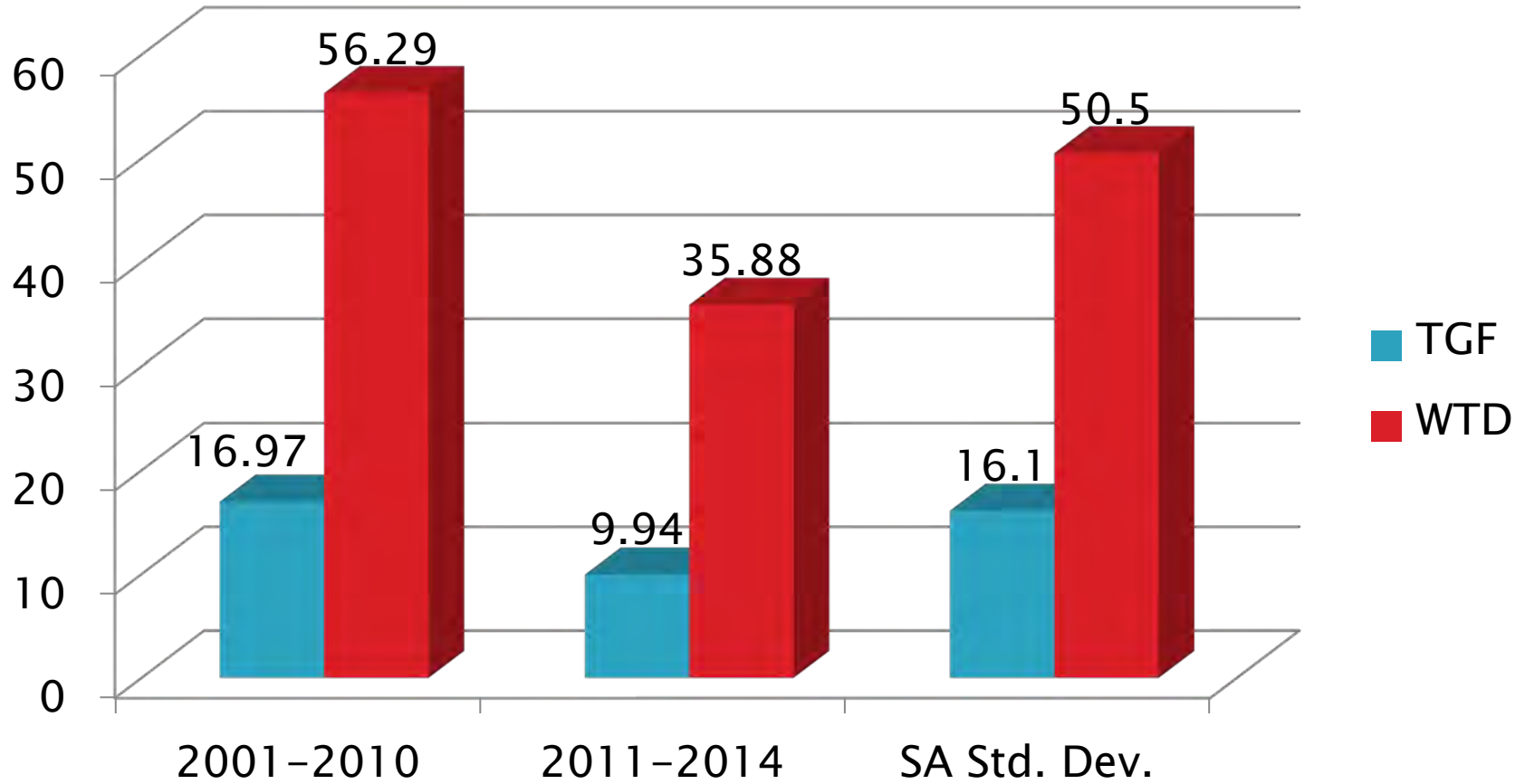
1 K Precision Estimates



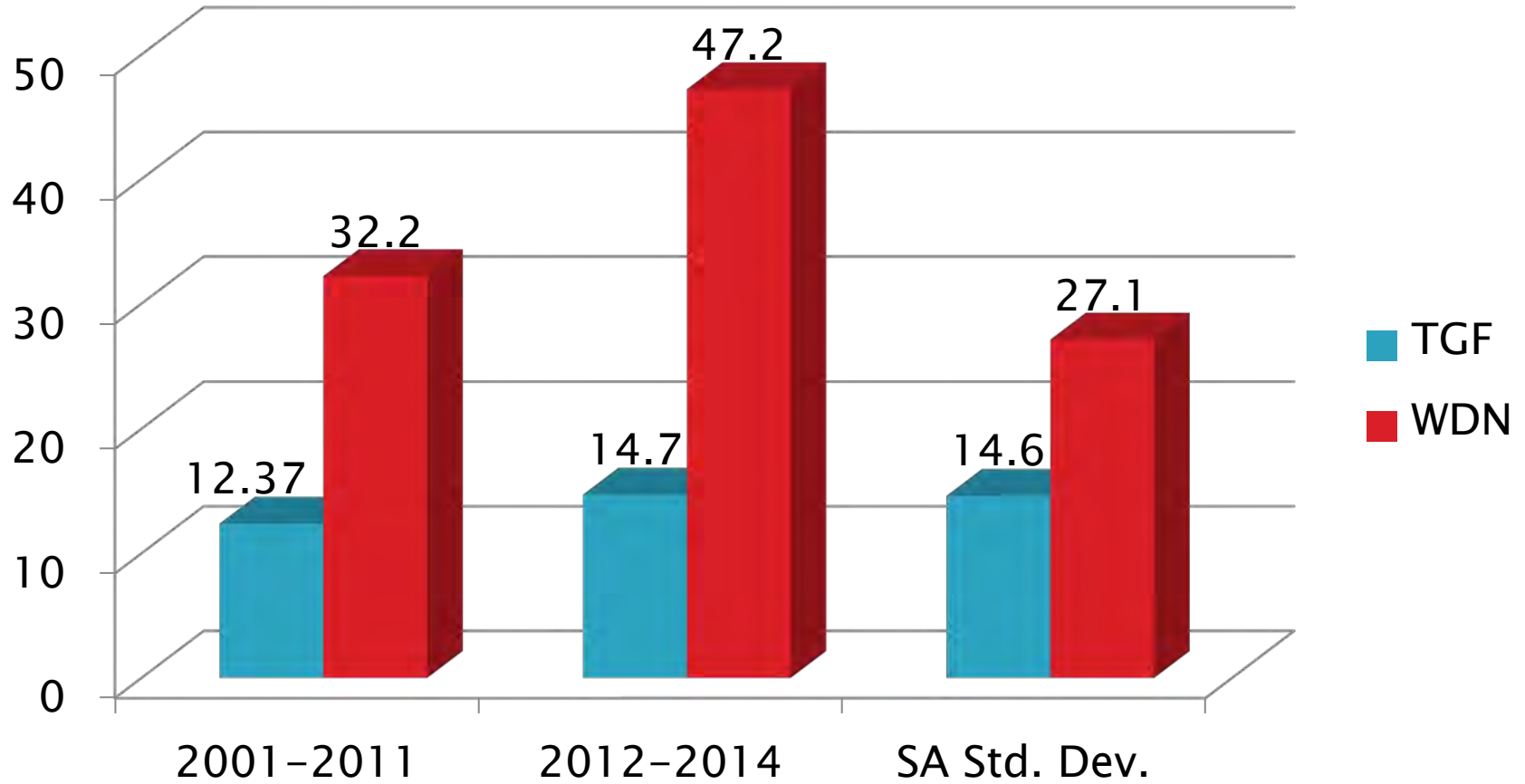
1 K Precision Estimates



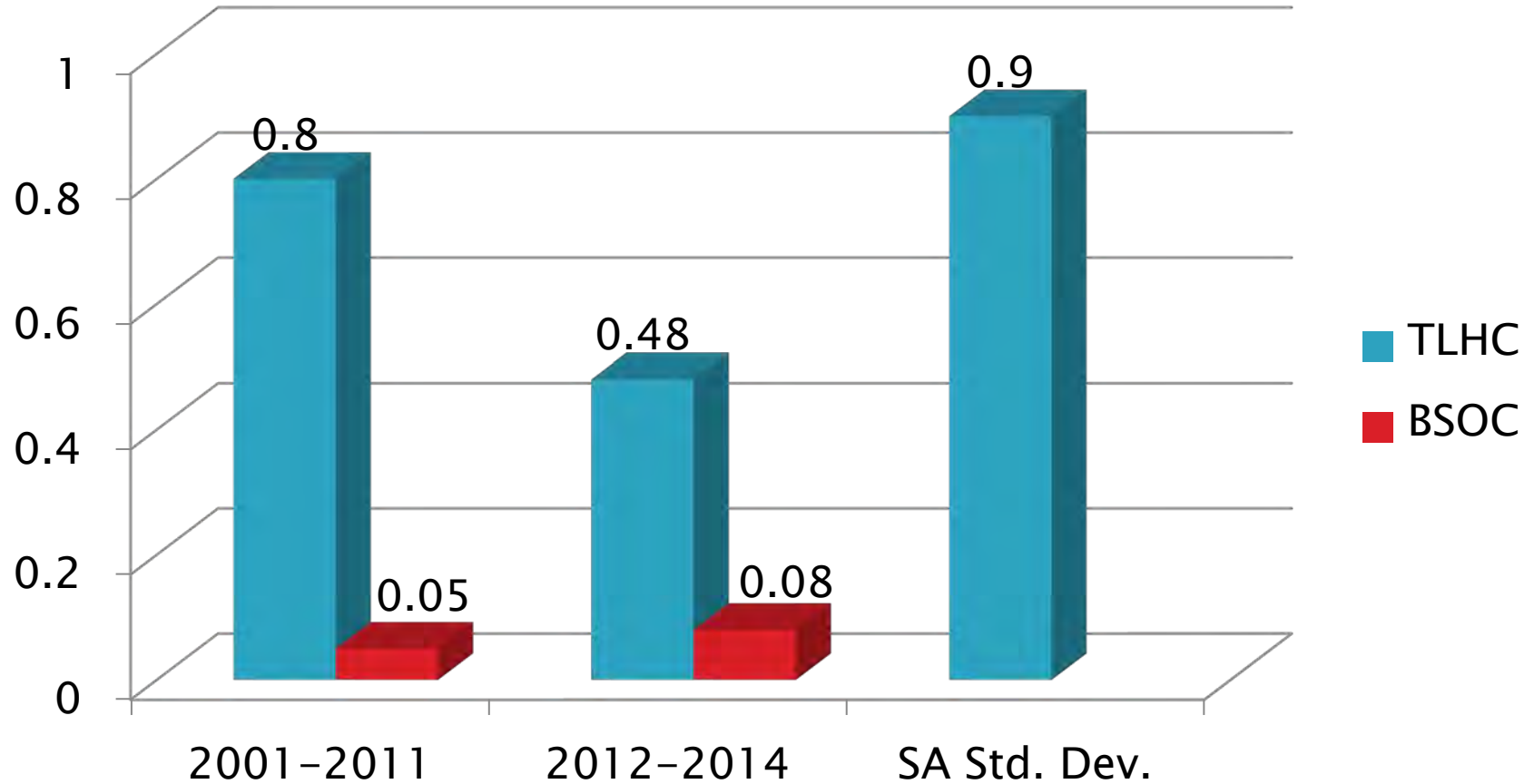
1 MPC Precision Estimates



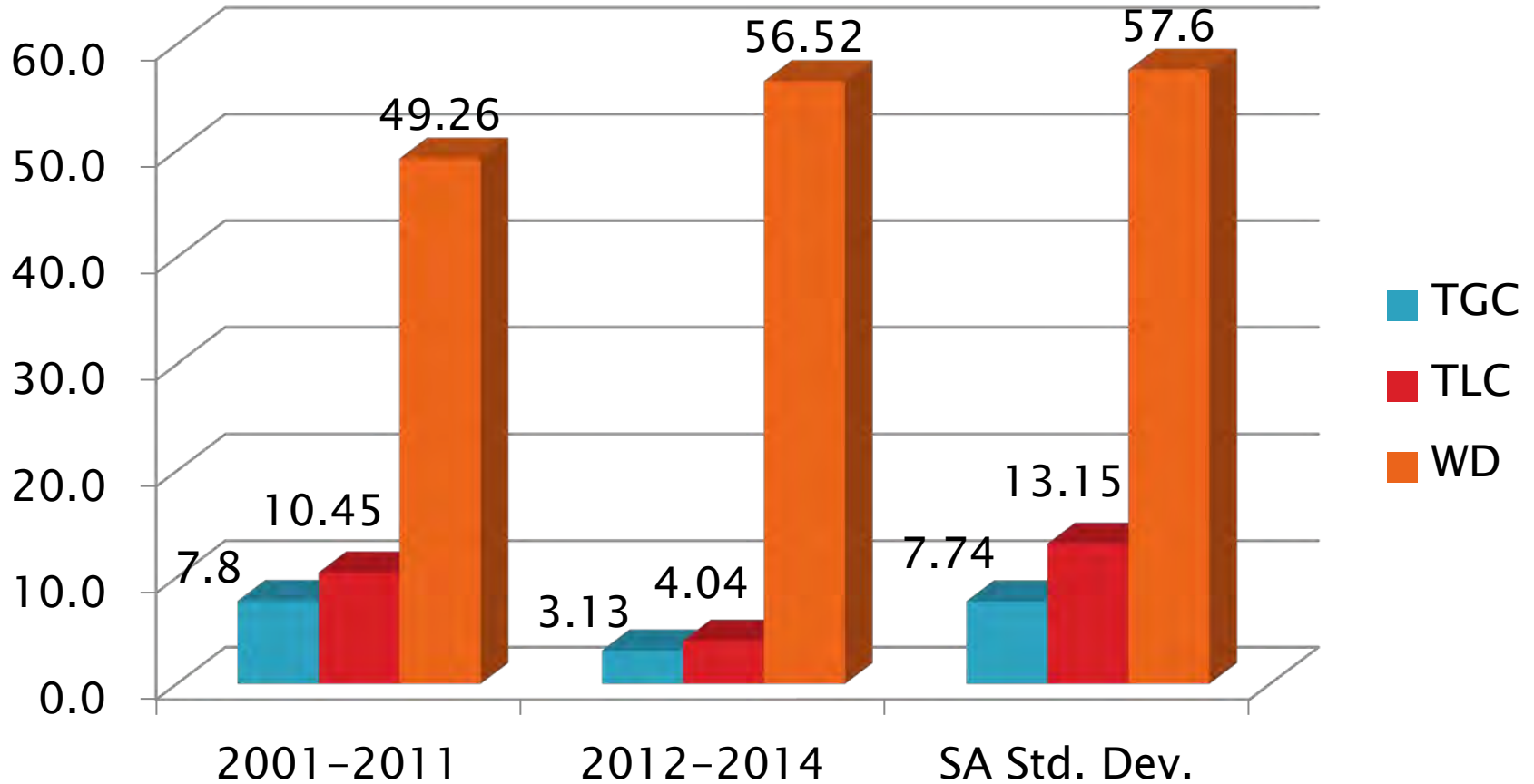
1 N Precision Estimates



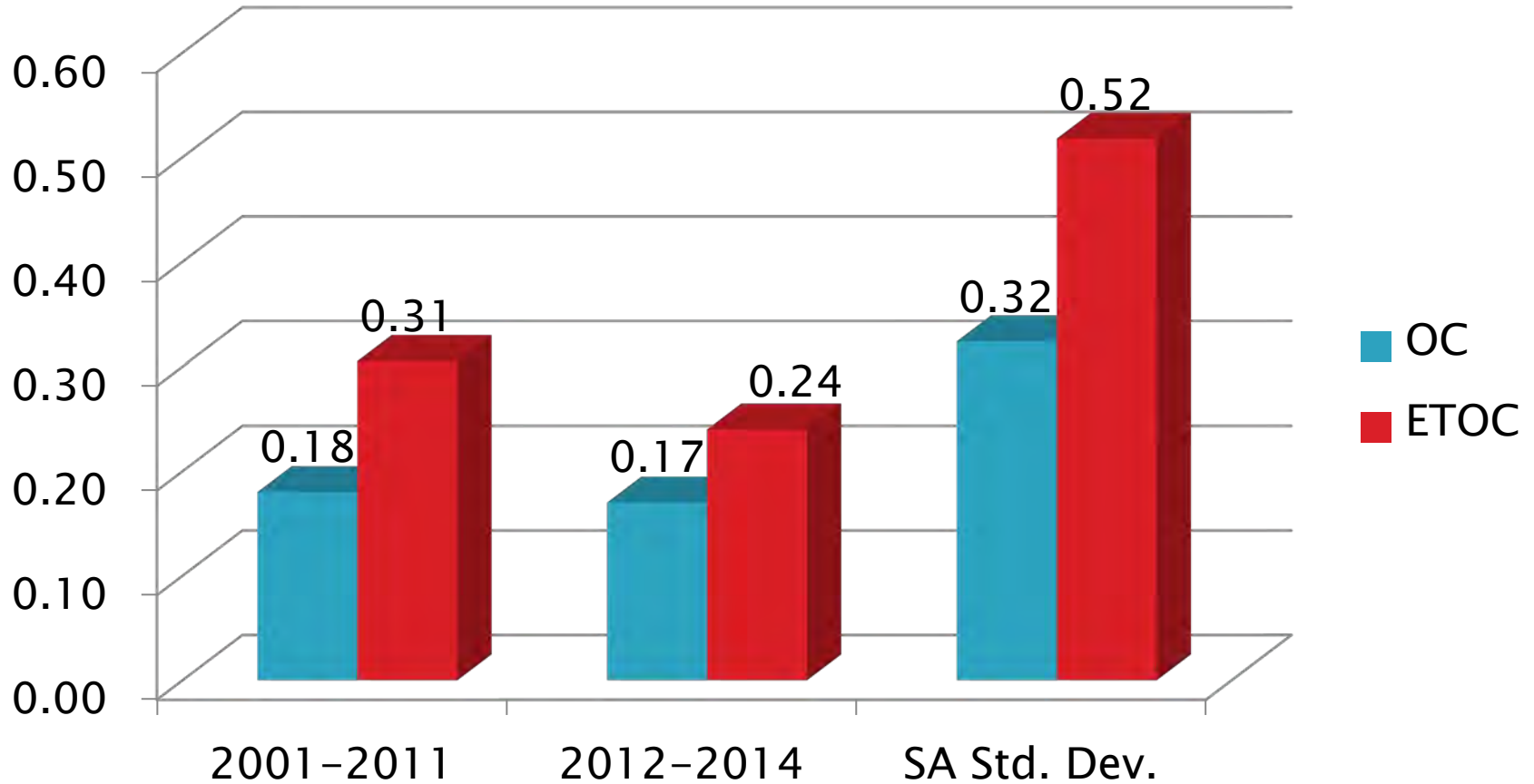
1 N Precision Estimates



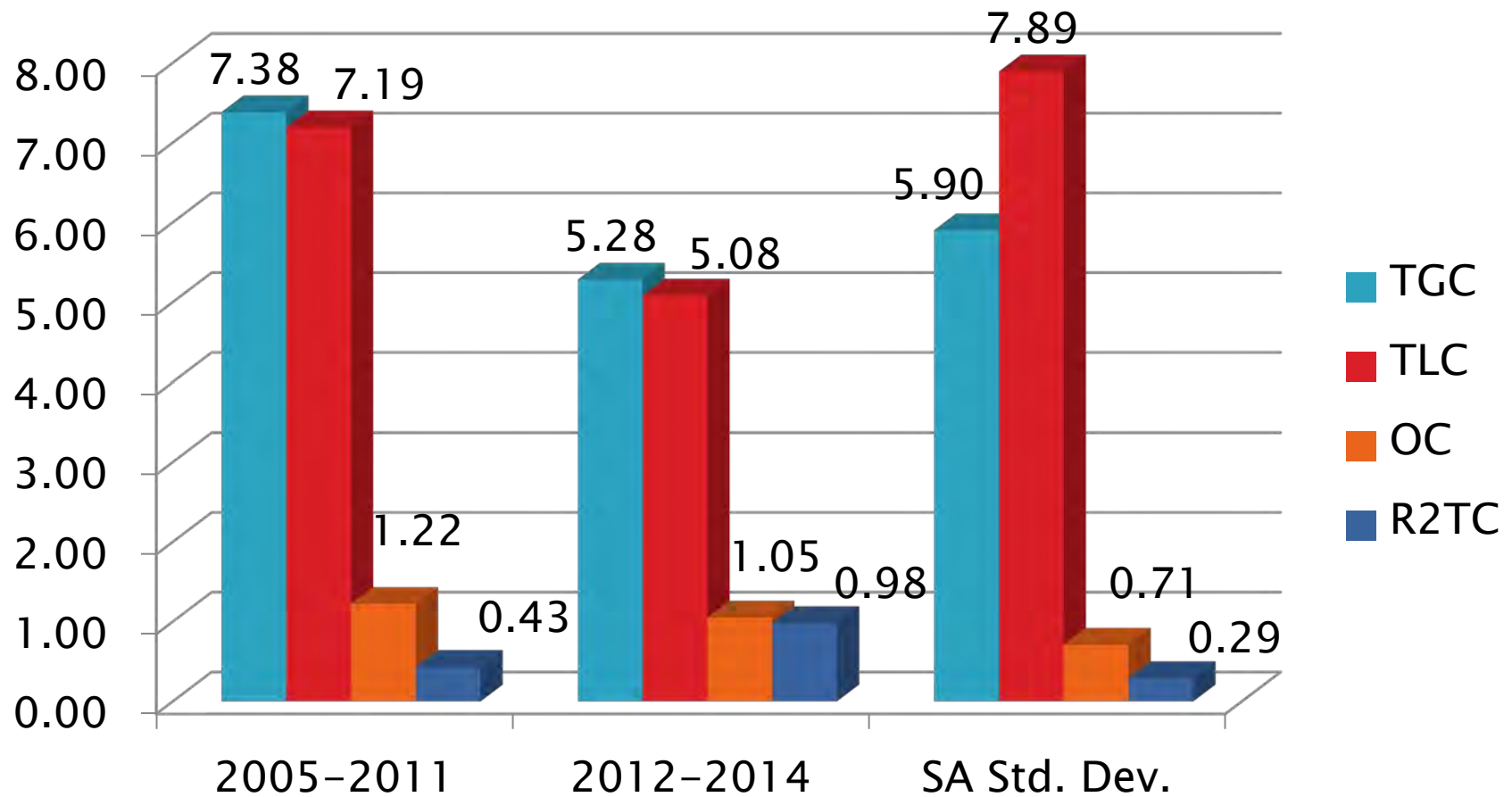
1P Precision Estimates



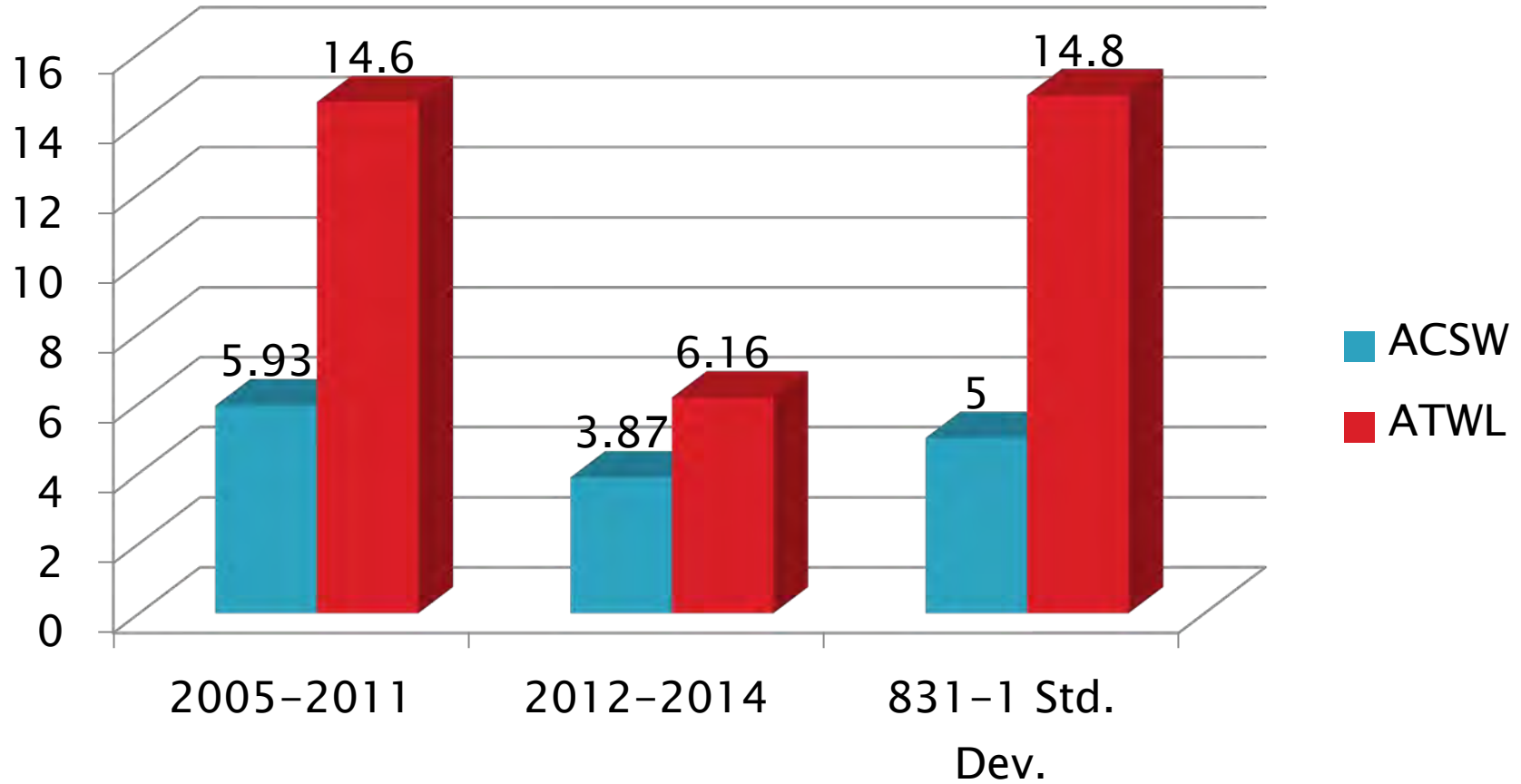
1 P Precision Estimates



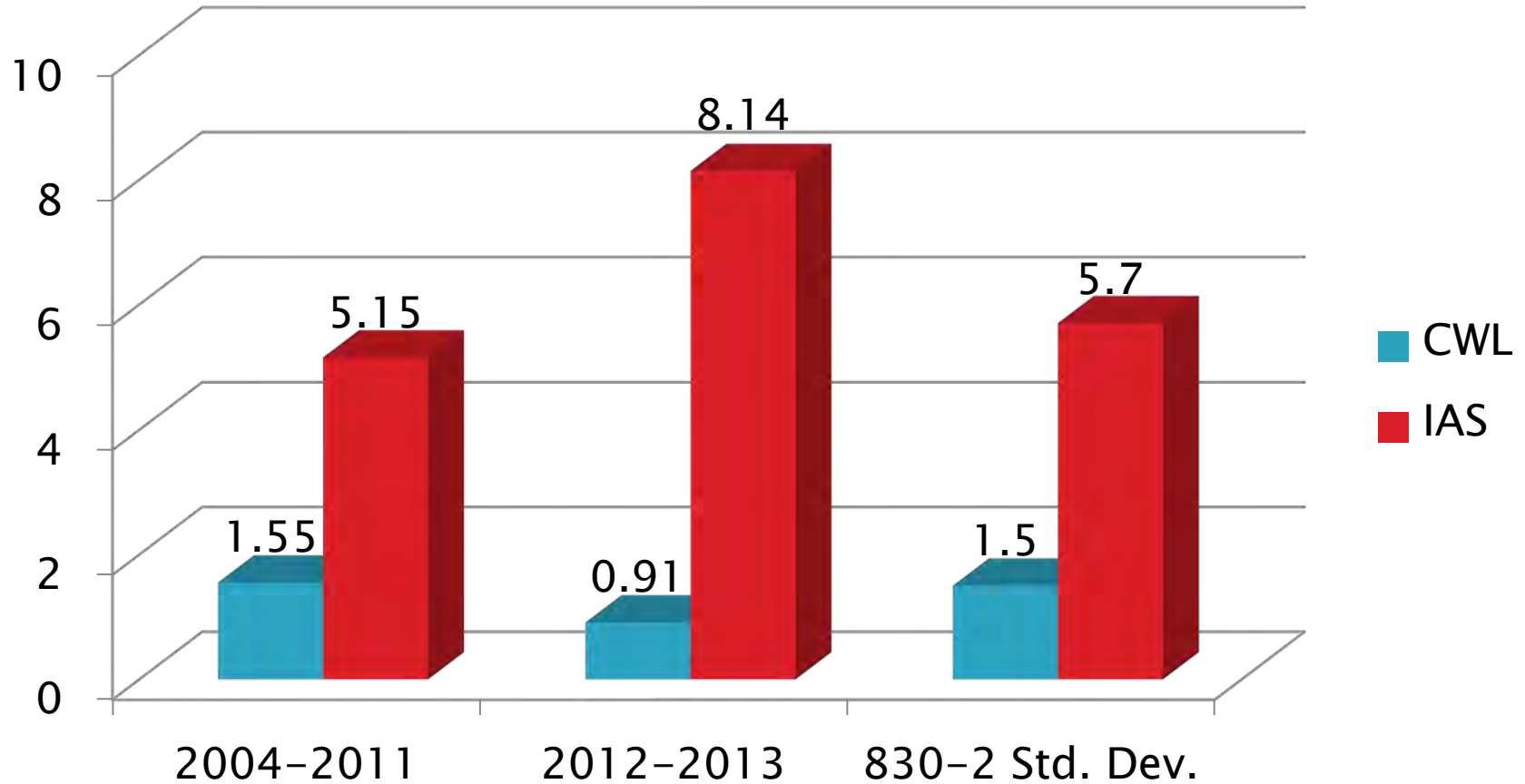
C13 Precision Estimates



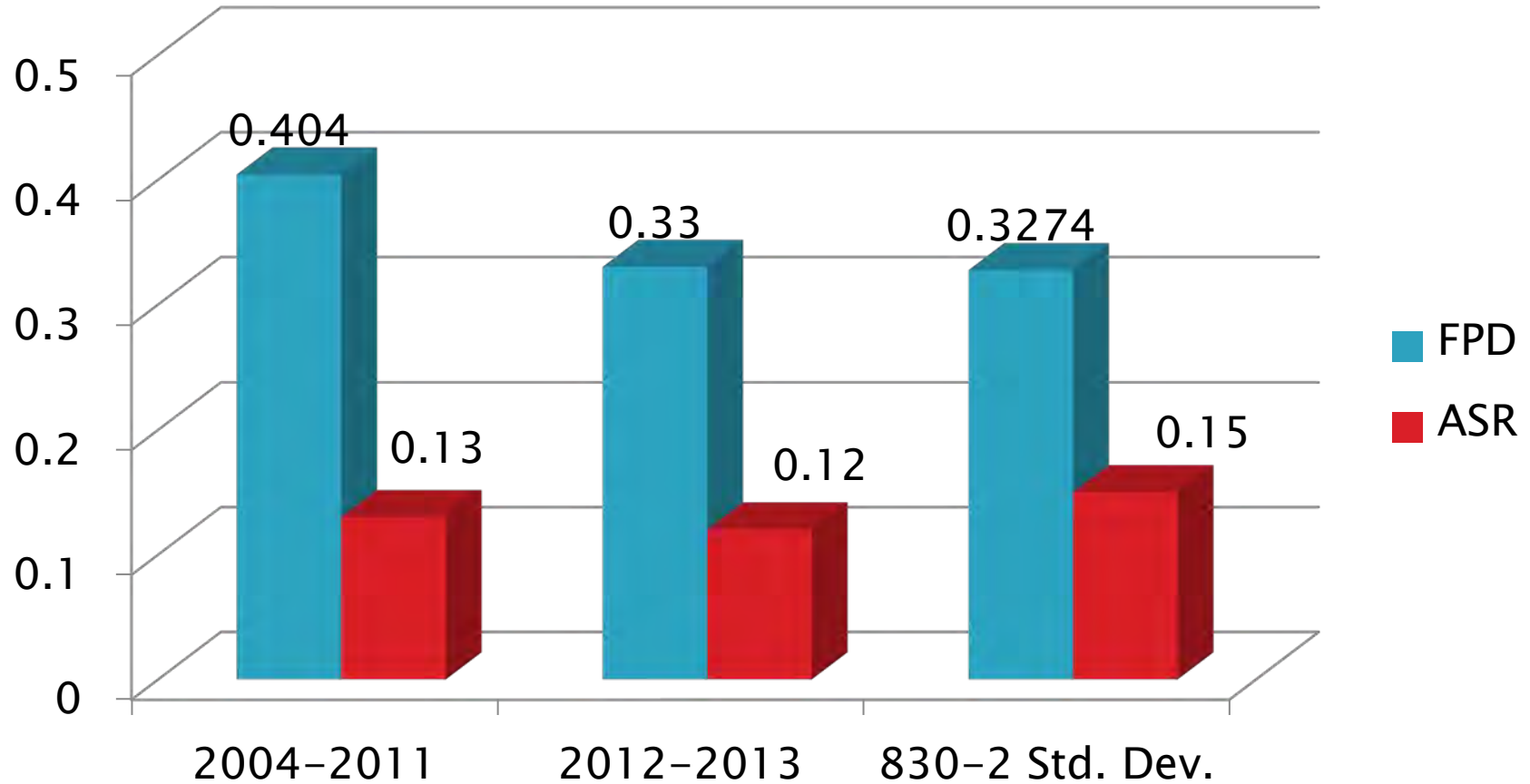
ISB Precision Estimates



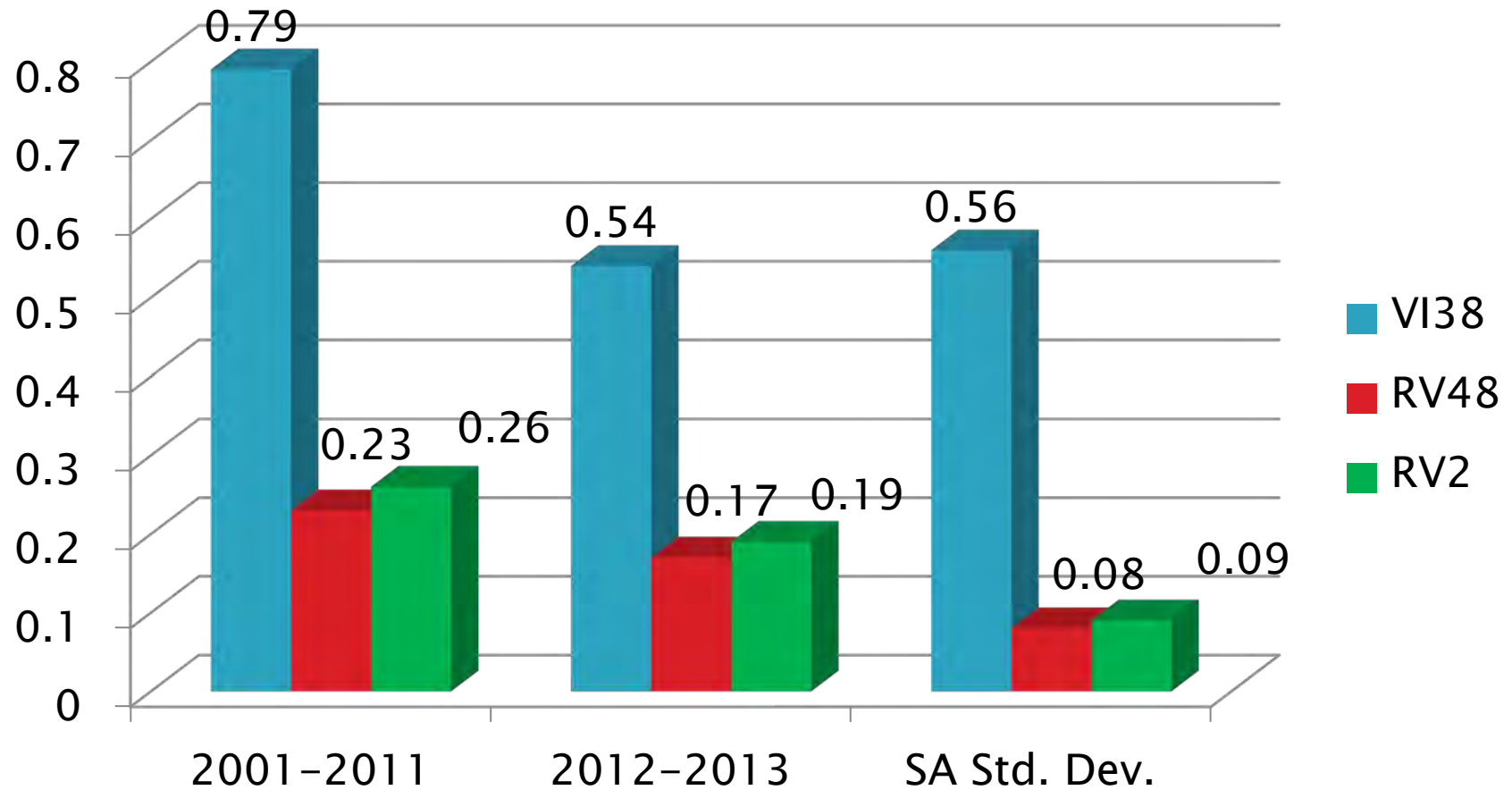
ISM Precision Estimates



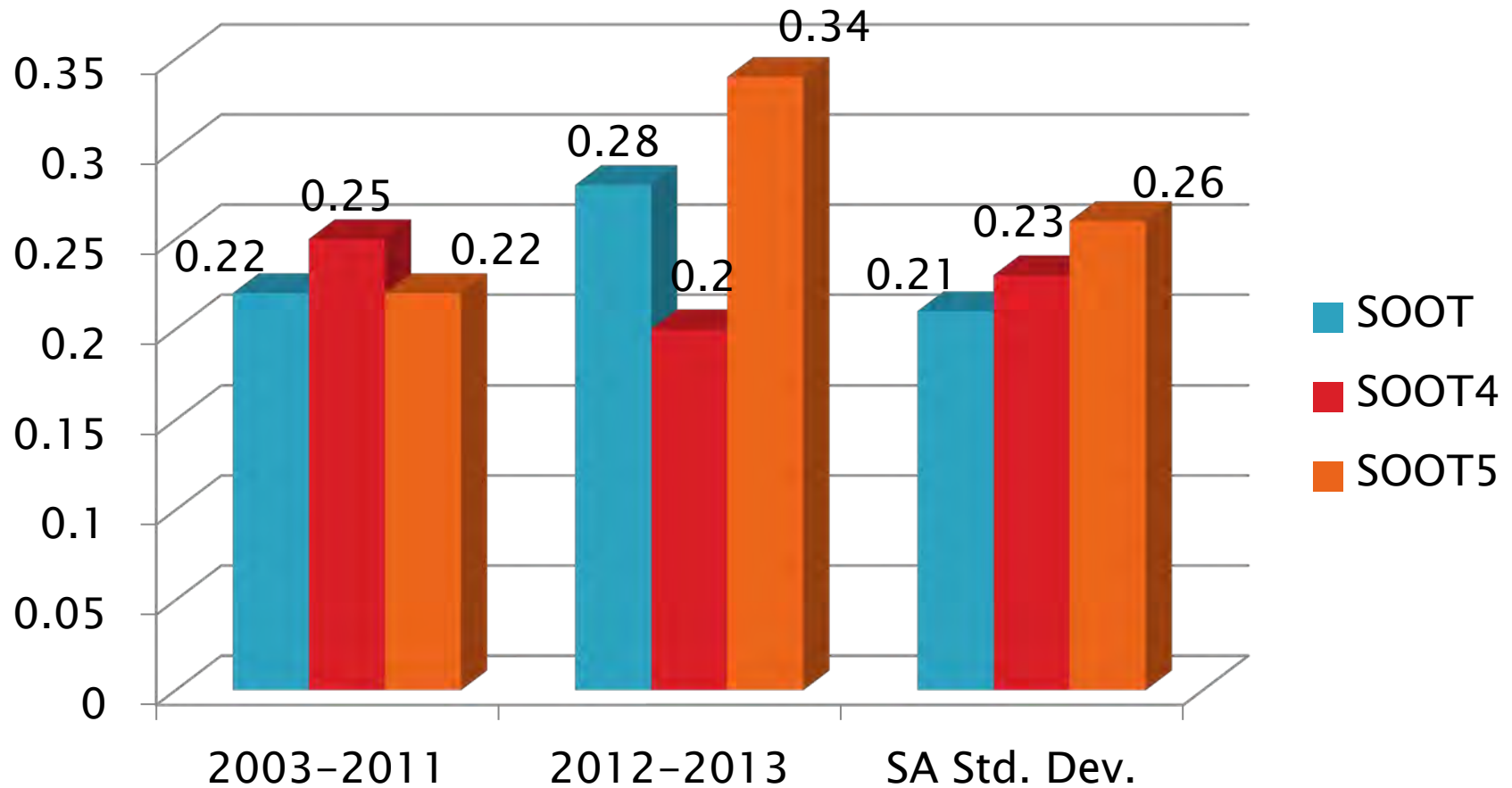
ISM Precision Estimates



T-8/E Precision Estimates

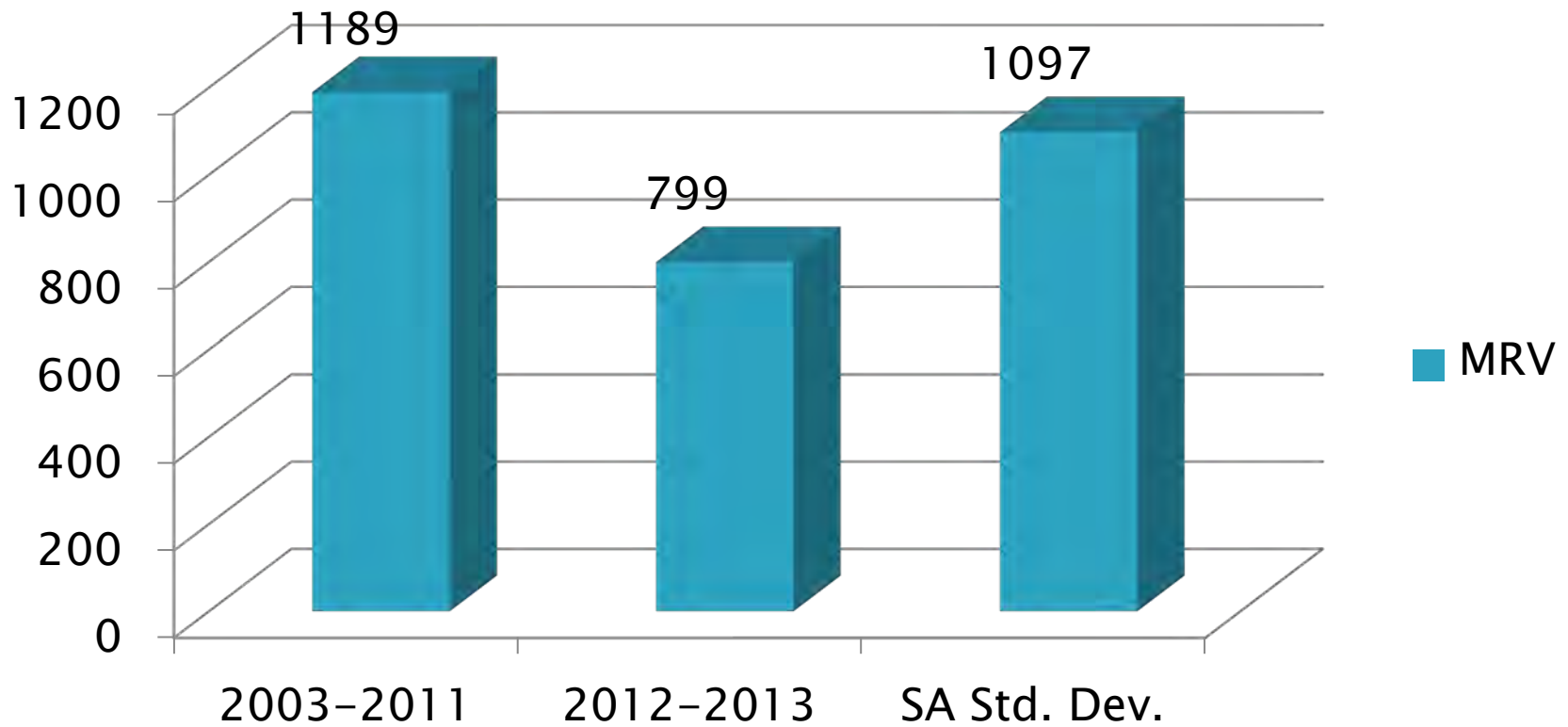


T-11 Precision Estimates

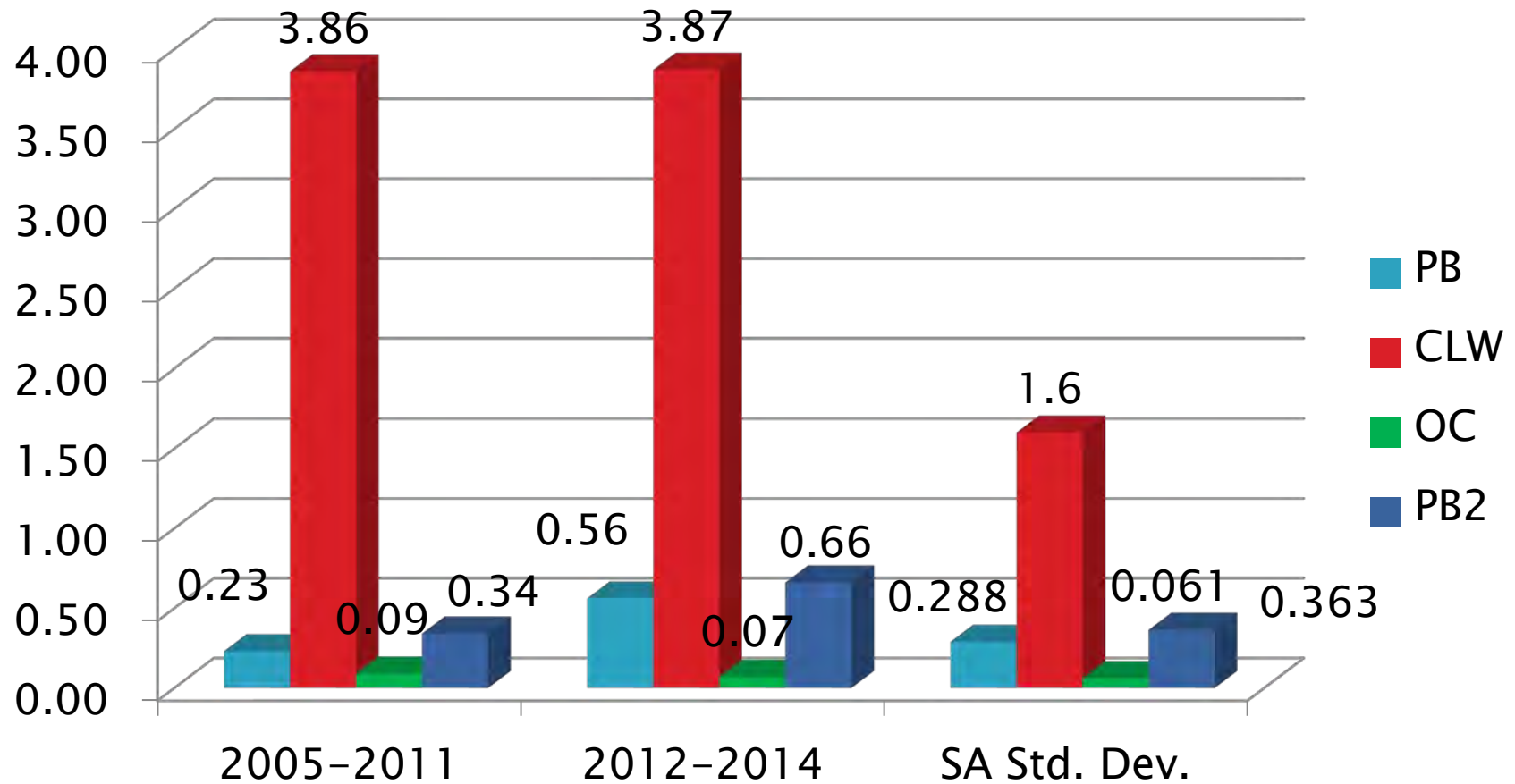


T-11 Precision Estimates

MRV

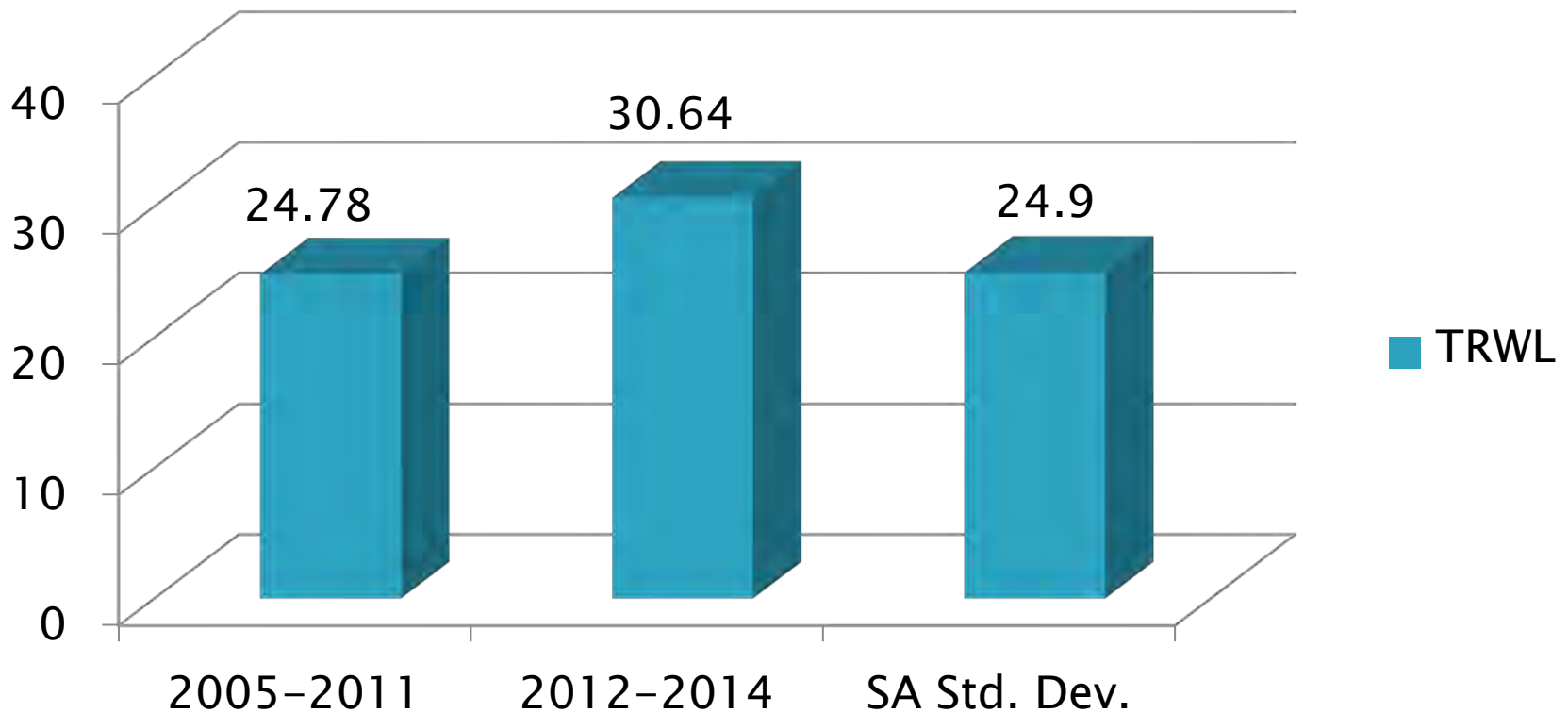


T-12 Precision Estimates



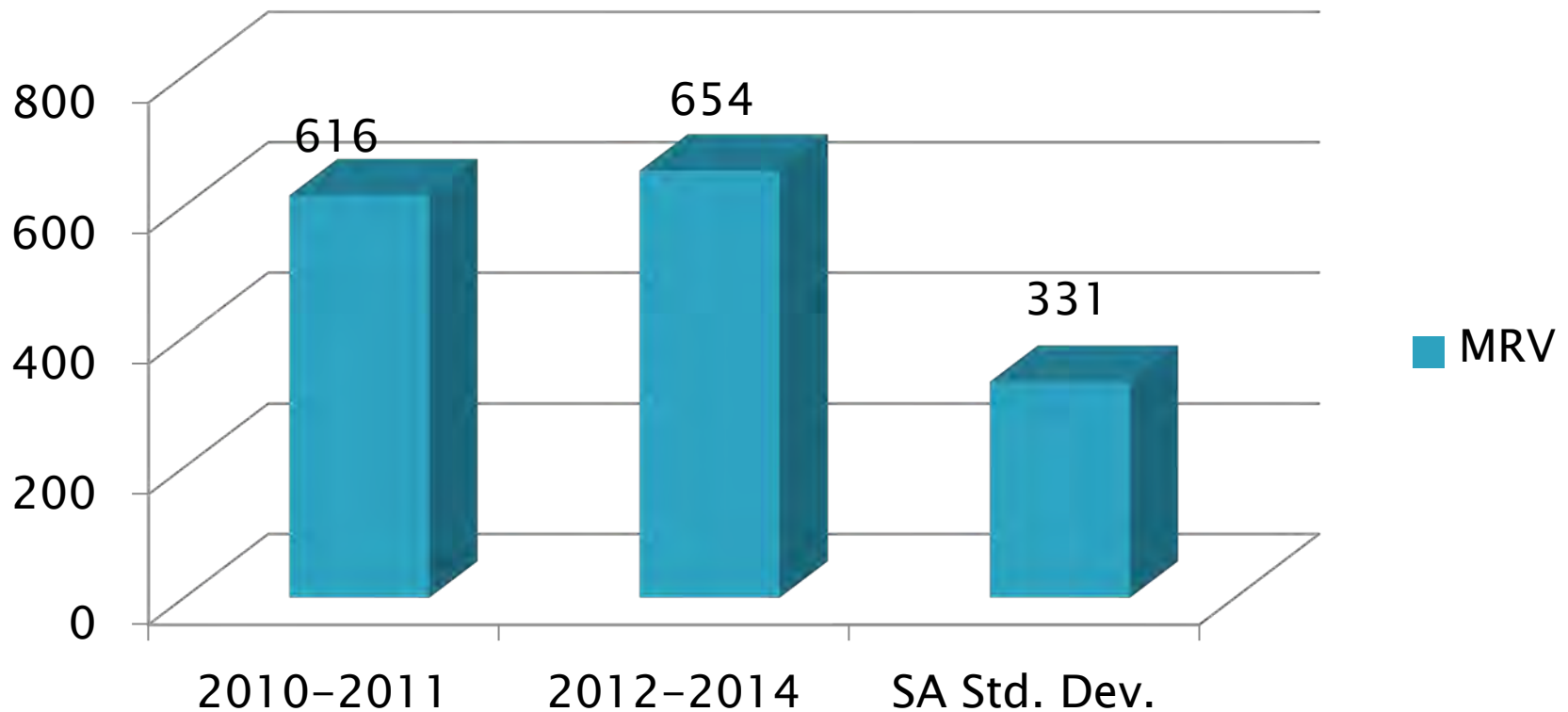
T-12 Precision Estimates

TRWL



T-12A Precision Estimates

MRV



Information Letters

»» October 1, 2013 –
March 31, 2014

Test Monitoring Center

<http://astmtmc.cmu.edu>



A Program of ASTM International

Information Letters*

Test	Date	IL	Topic
ISM	11/22/2013	13-1	New IAS Correction Factors and Reporting Methods and Corrected References for Rating Manual
C13	12/17/2013	13-2	New Piston Second Ring Cleaning Procedure and Oil Filter Part Number Update
T12	3/21/2014	14-1	Procedure Update - Calibration of New Engines and T12A Flexibility
T8	3/25/2014	14-1	T-8 Use of Rebuilt Injection Pumps and Sourcing

[Return to Executive Summary](#)

*Available from TMC Website

Test Monitoring Center
<http://astmtmc.cmu.edu>



A Program of ASTM International

Reference Oil Inventory

»» Actions, Re-blends, Inventories
and Estimated Life

Test Monitoring Center

<http://astmtmc.cmu.edu>



A Program of ASTM International

Reference Oil Reblends

- ▶ T12 Re-blend
 - Re-blend completed as 821-4. Available for testing.
- ▶ 1005-4 Re-blend being pursued

[Return to Executive Summary](#)

Reference Oil Inventory Estimated Life

Oil	Tests	Original Blend Amount	Quantity Shipped in last 6 months	TMC Inventory	Lab Inventory	Estimated Life
809-1	1K, 1N	9134	50	2388	126	5+ years
811-2	1K, 1N	1732	30	1194	50	5+ years
822-1	1R, T-10A, T-11	560	0	16	56	~.25 years
822-2	1R, T-10A, T-11	4386	280	4106	196	5+ years
821-3	T-12	1500	340	94	100	~.75 years
821-4	T-12	4495	0	4495	0	5+ years
830-2	ISM	3786	125	757	251	3.7 years
831-1	C13, ISB	1300	0	0	51	~ .5 years
831-2	C13, ISB	880	90	612	235	5+ years
873-2	1M-PC	1650	10	177	50	5+ years
1005-3	1P, 1R, EOAT, RFWT, T-8/E	2000	7	8	150	~ 1 year
1005-4	1P, 1R, EOAT, RFWT, T-8/E	2000	296	1023	401	2.5 years

LTMS Deviations

»» October 1, 2013 –
March 31, 2014

Test Monitoring Center

<http://astmtmc.cmu.edu>



A Program of ASTM International

LTMS Deviations

- No LTMS Deviations in Current Period

Historical Count of HD LTMS Deviations

Test	LTMS Deviations
1M-PC	2
1N	2
T-8/E	2
T-10A	1
T-12	1

Quality Index Deviations

»» October 1, 2013 –
March 31, 2014

Test Monitoring Center

<http://astmtmc.cmu.edu>



A Program of ASTM International

Quality Index Deviations

- ▶ No deviations during this reporting period.

Quality Index Deviations

Historical Count of HD Quality Index Deviations

Test	Qi Deviations
1P	12
1R	1
ISM	3
C13	1
T-10A	1
T-11	3
T-12	5

TMC Laboratory Visits

»» October 1, 2013 –

March 31, 2014

Test Monitoring Center

<http://astmtmc.cmu.edu>



A Program of ASTM International

TMC Lab Visits

- ▶ No HD lab visits during the reporting period.

Test Area Timelines

»» October 1, 2013 –
March 31, 2014

Test Monitoring Center

<http://astmtmc.cmu.edu>



A Program of ASTM International

Test Area Timeline Additions*

Test	Date	Topic	IL/Memo
T12	20131021	BATCH V LINERS APPROVE FOR USE	
ISM	20131119	NEW IAS MASS LOSS CORRECTION FACTORS	13-1
C13	20131217	NEW PISTON SECOND RING CLEANING PROCEDURE AND OIL FILTER PART NUMBER UPDATE	13-2
T12	20140321	CALIBRATION OF NEW ENGINES AND T12A FLEXIBILITY	14-1
T8	20140325	USE OF REBUILT INJECTION PUMPS AND SOURCING	14-1

[Return to Executive Summary](#)

*As of 9/30/2013

Test Monitoring Center
<http://astmtmc.cmu.edu>



A Program of ASTM International

Additional Information

»» October 1, 2013 –
March 31, 2014

Test Monitoring Center

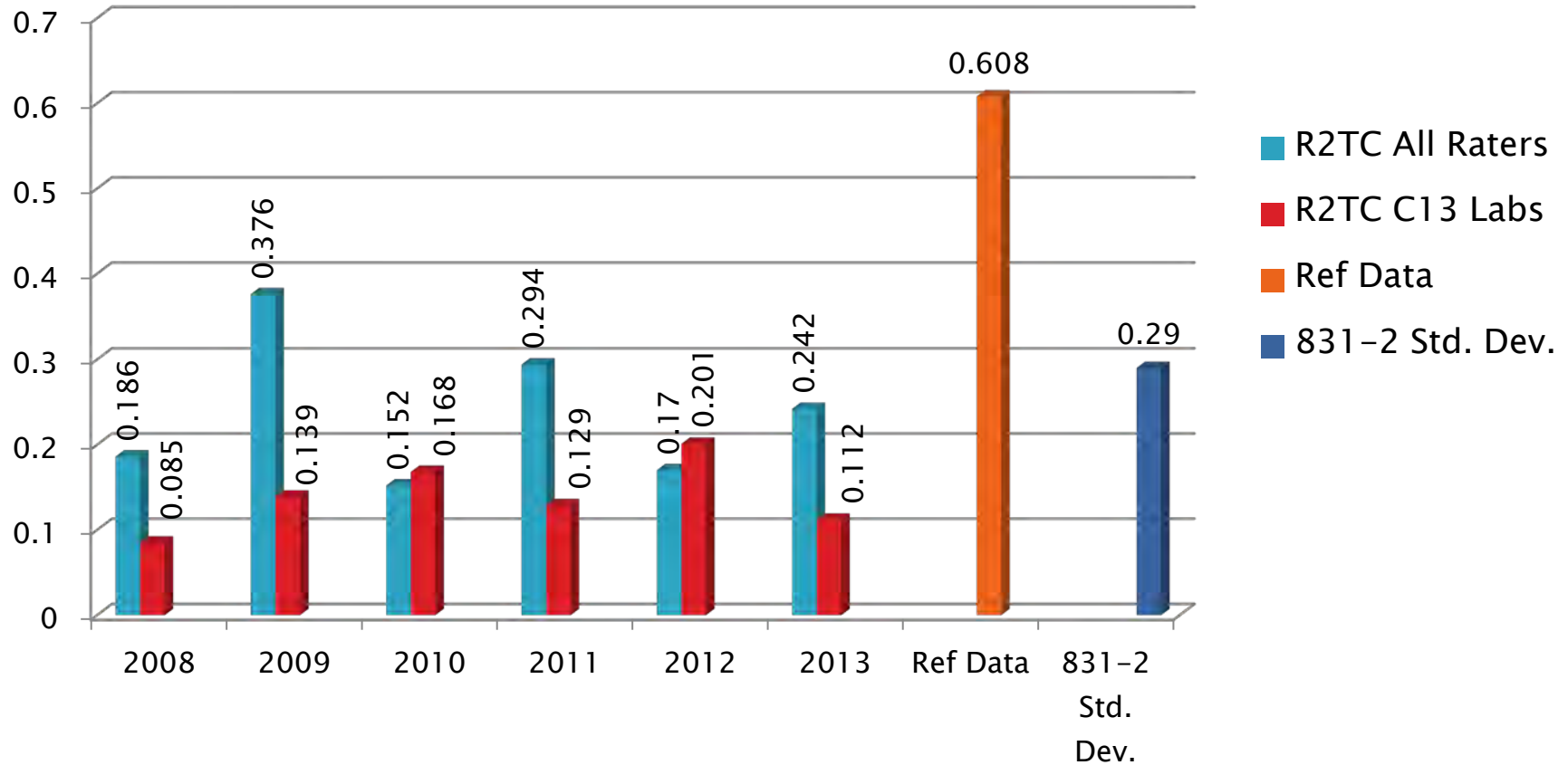
<http://astmtmc.cmu.edu>



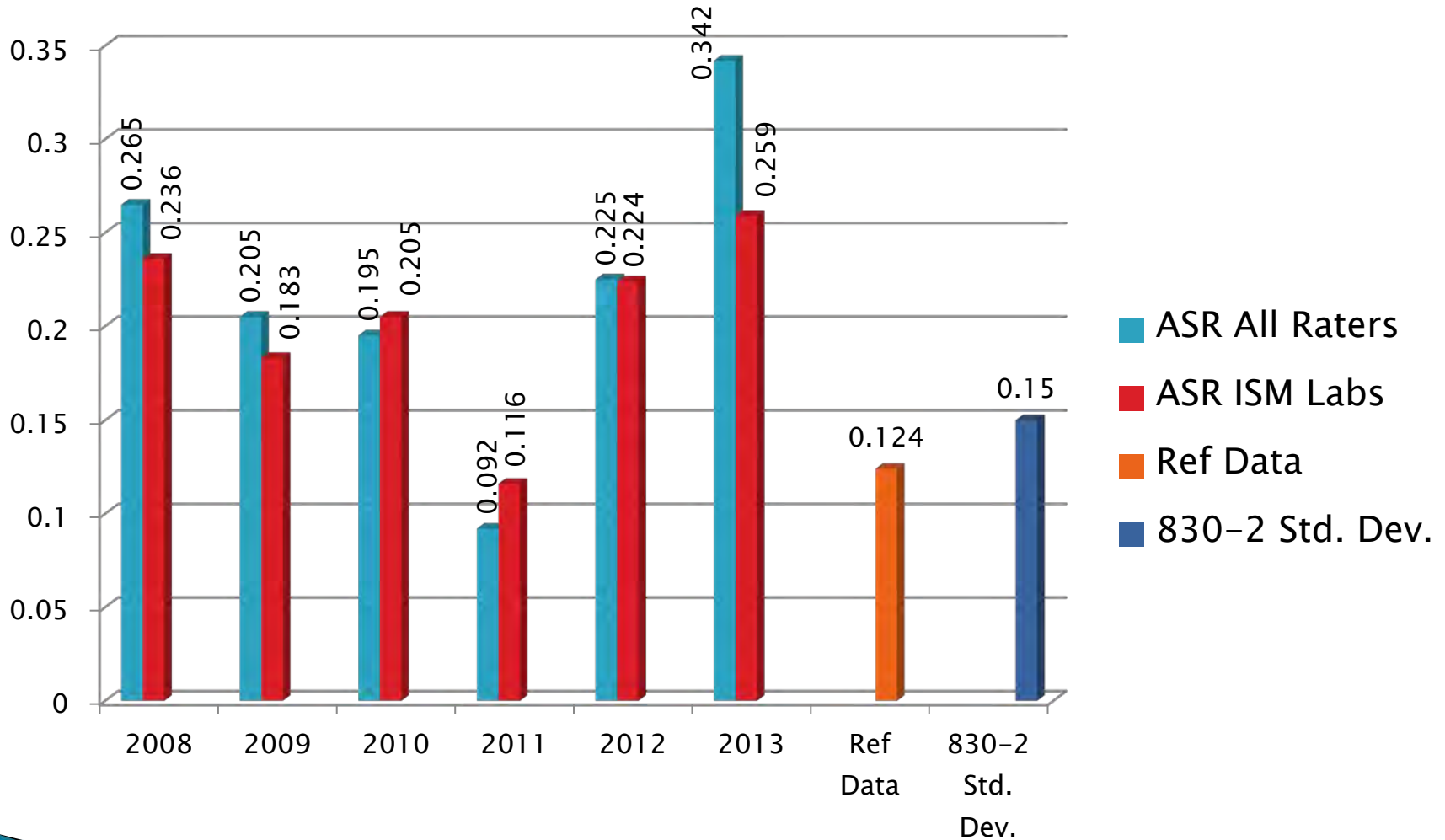
A Program of ASTM International

C13 2nd Ring Carbon Rating Precision Estimates

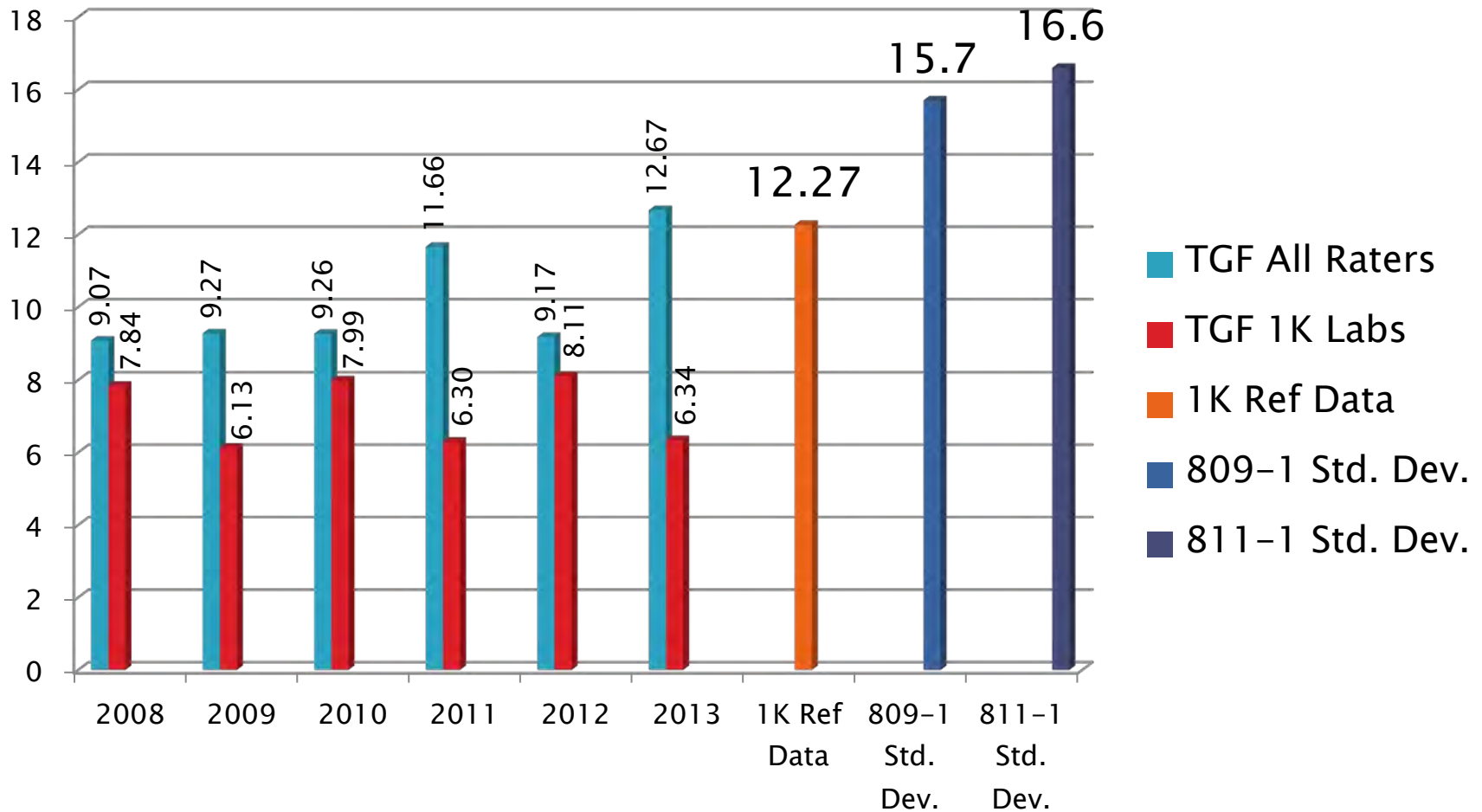
R2TC



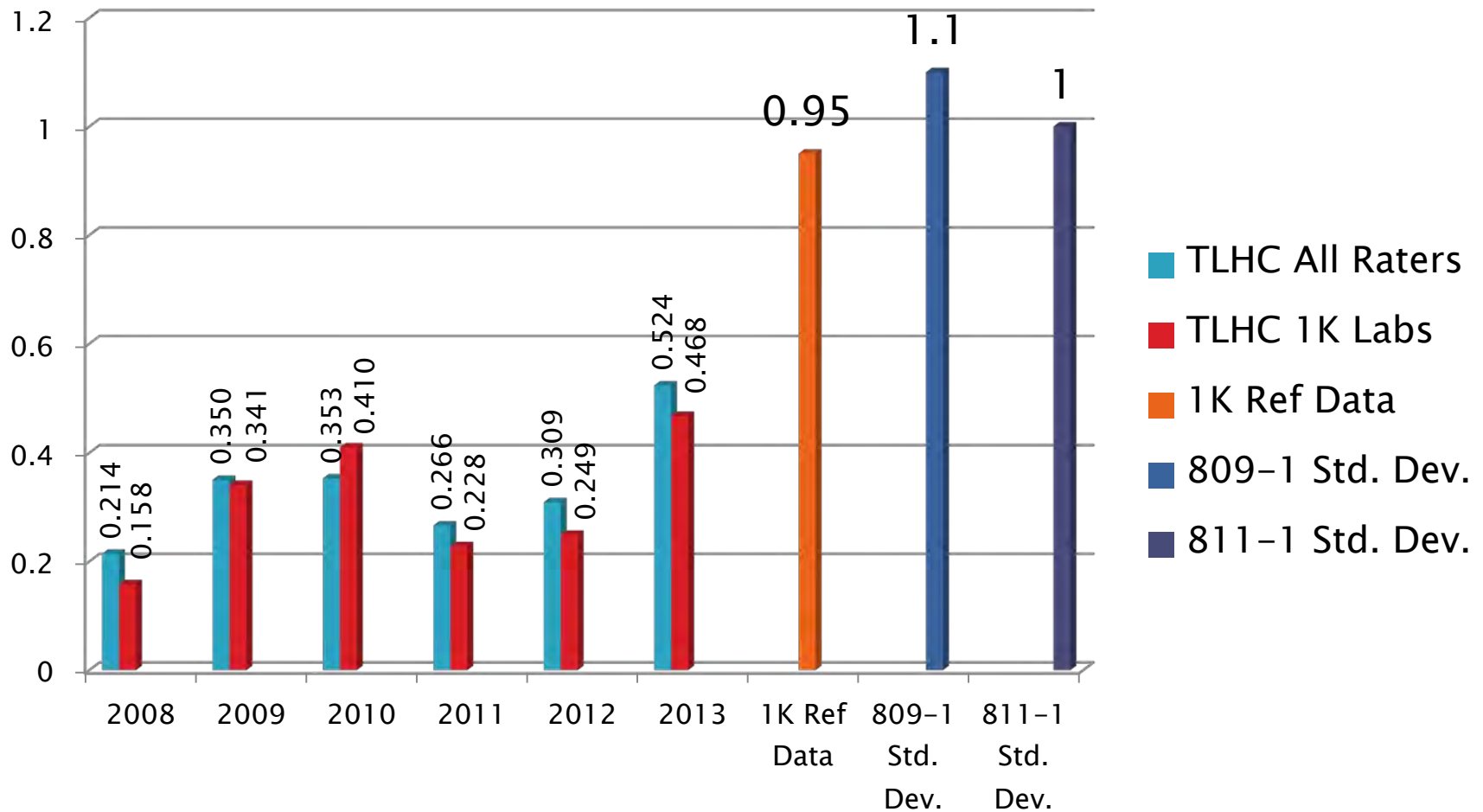
ISM Sludge Rating Precision Estimates



Deposit Rating Precision Estimates



Deposit Rating Precision Estimates



Additional Information

- ▶ Available on TMC Website:
 - Oil Assignment Request and Test File Upload
 - Live Reference Test Data Bases
 - Surveillance Panel Meeting Minutes
 - Test Area Alarm Logs
 - Complete Test Area Timelines
 - LTMS Manual
- ▶ www.astmtmc.cmu.edu



A Program of ASTM International



A Program of ASTM International

Test Monitoring Center

<http://astmtmc.cmu.edu>

Appendix 1 Heavy Duty Reference Oil Testing Control Charts October 2013

Appendix 1.a

1 K Control Charts

» Severity, Precision, and CuSum

Top Groove Fill

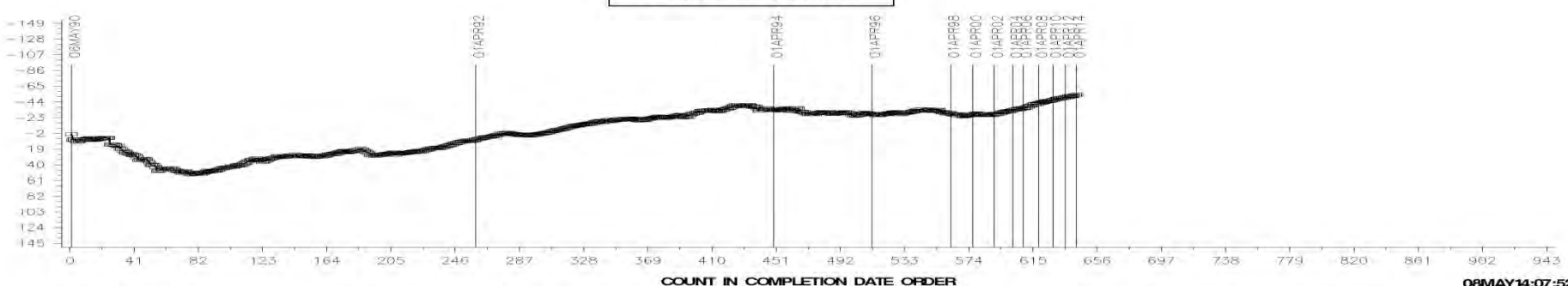
LTMS Severity Analysis



LTMS Precision Analysis



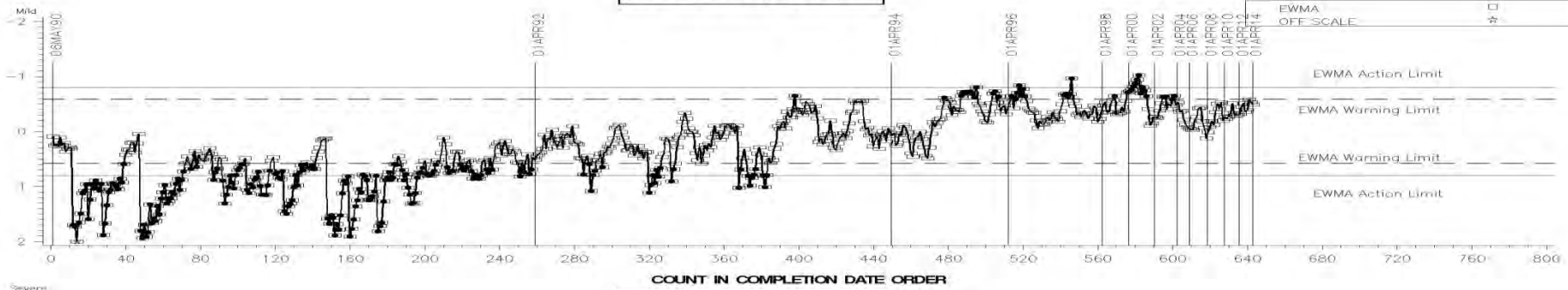
CUSUM Severity Analysis



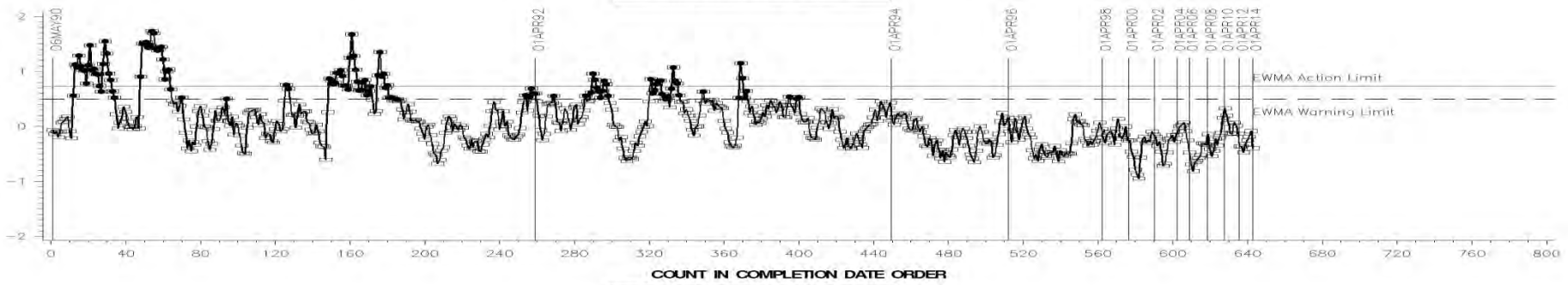
08MAY14:07:52

Weighted Total Demerits

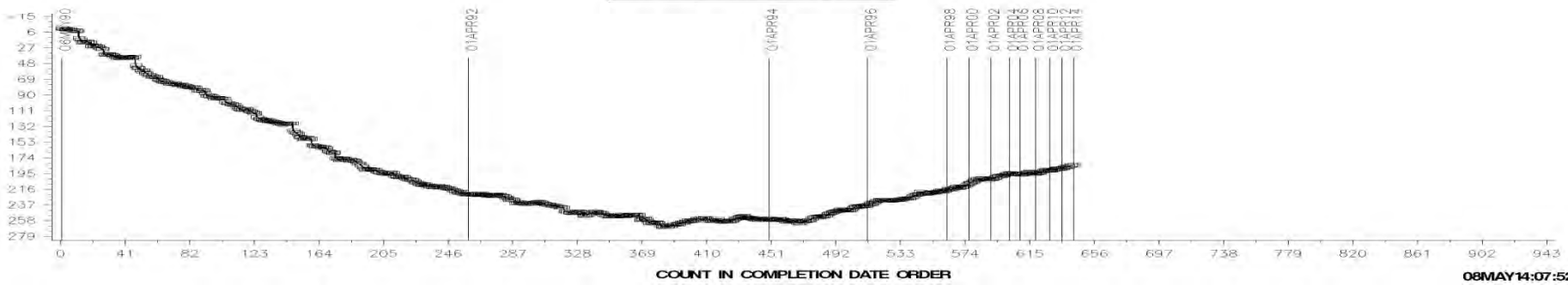
LTMS Severity Analysis



LTMS Precision Analysis



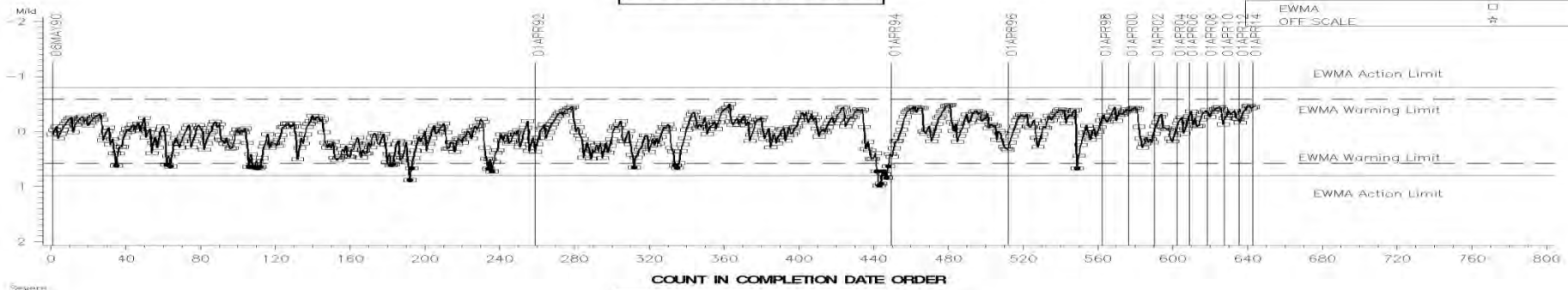
CUSUM Severity Analysis



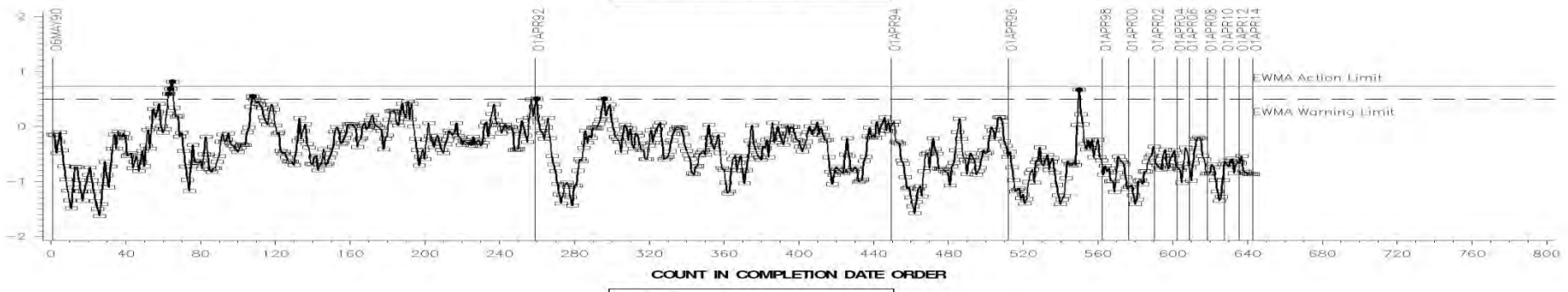
08MAY14:07:52

FINAL TRANSFORMED TOP LAND HEAVY CARBON

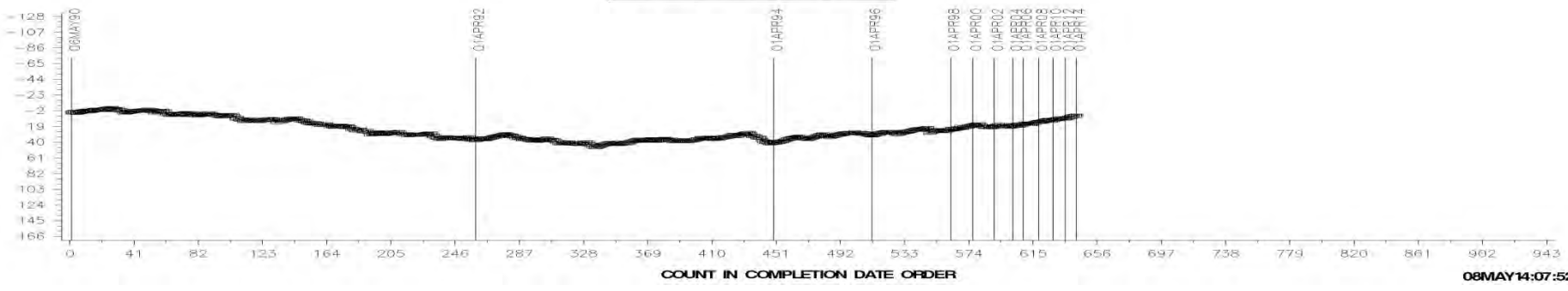
LTMS Severity Analysis



LTMS Precision Analysis



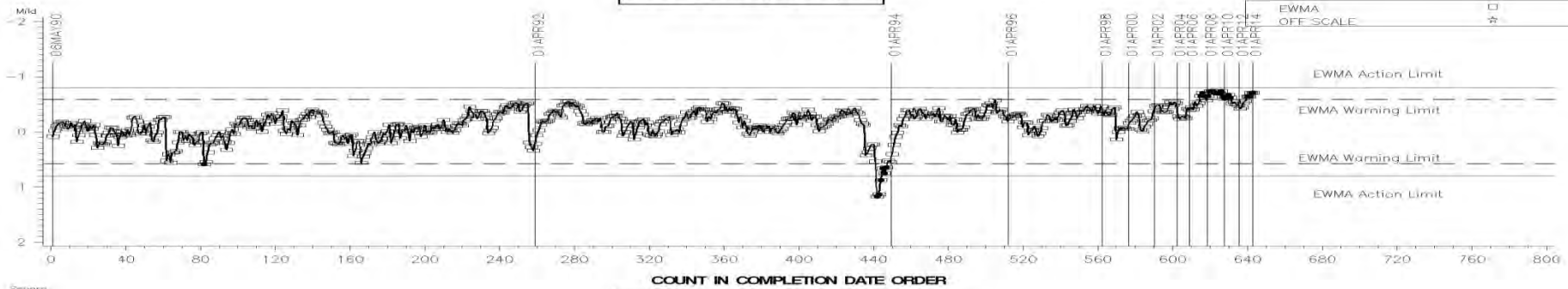
CUSUM Severity Analysis



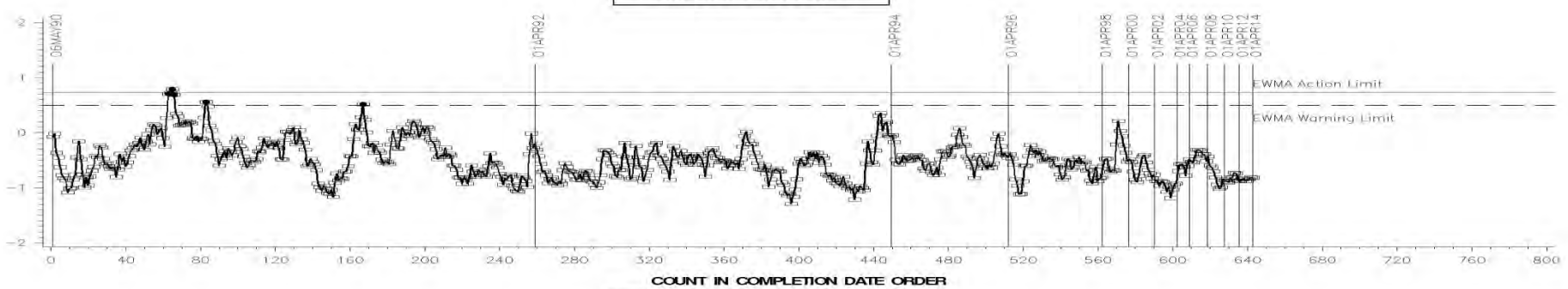
08MAY14:07:52

BSOC

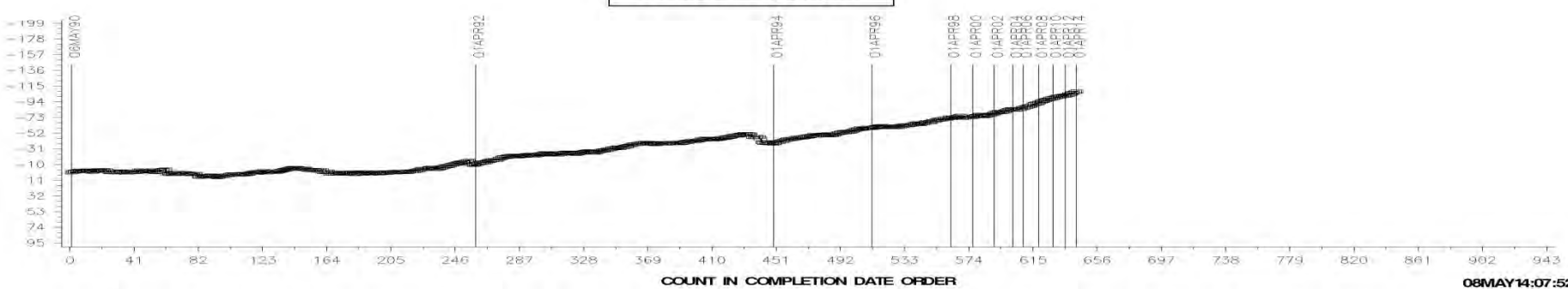
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



08MAY14:07:52

EOTOC

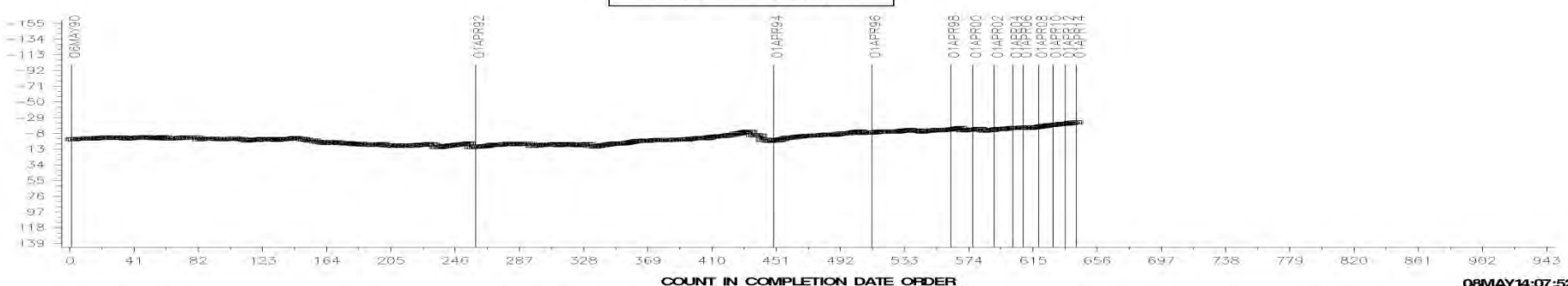
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



08MAY14:07:52

[Return](#)

Test Monitoring Center
<http://astmtmc.cmu.edu>

Appendix 1.b

1 N Control Charts

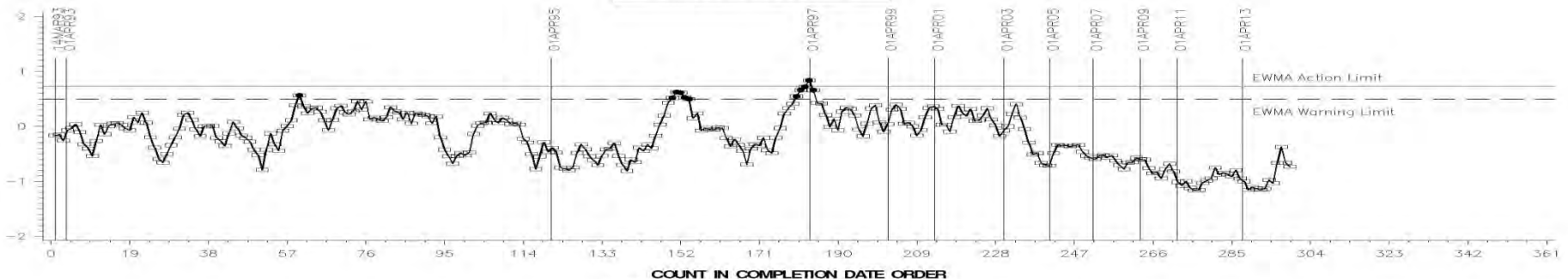
» Severity, Precision, and CuSum

Top Groove Fill

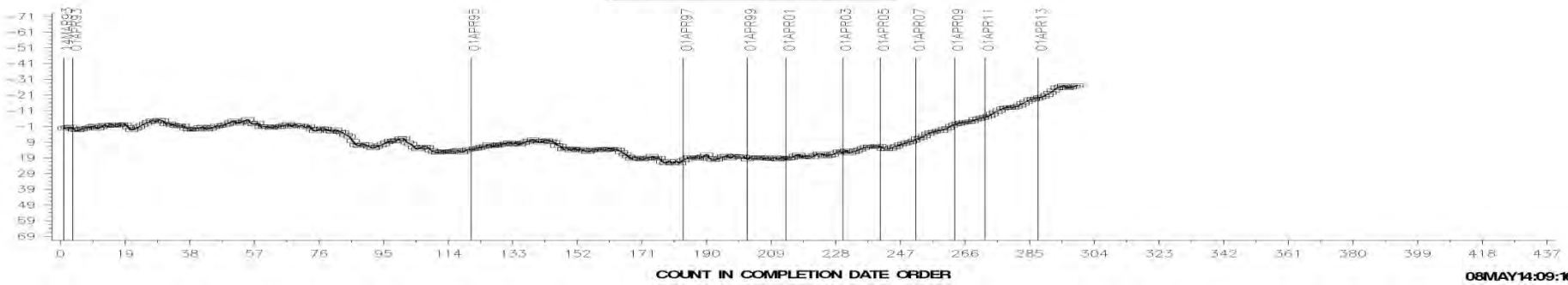
LTMS Severity Analysis



LTMS Precision Analysis



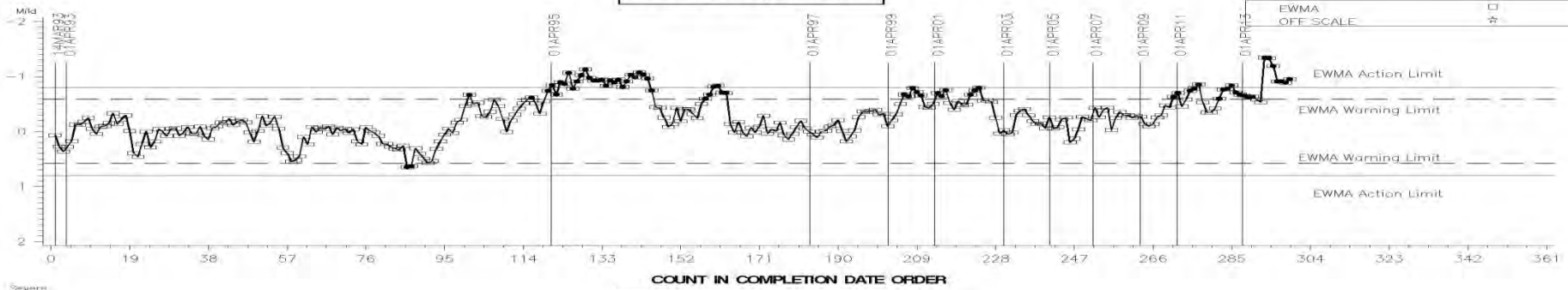
CUSUM Severity Analysis



08MAY14:09:16

Weighted Total Demerits

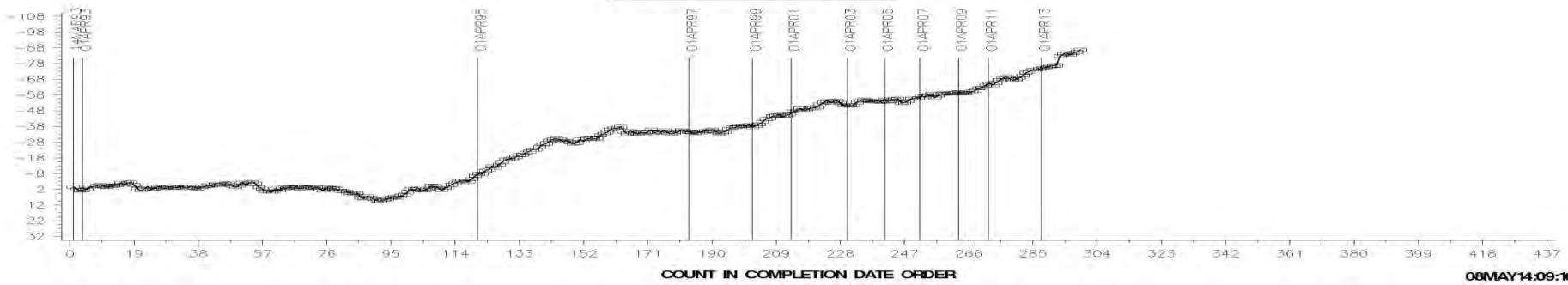
LTMS Severity Analysis



LTMS Precision Analysis



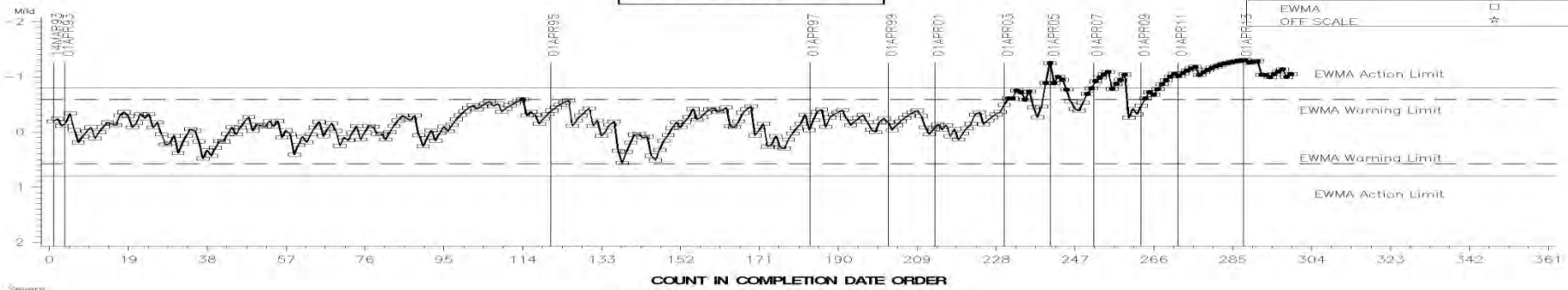
CUSUM Severity Analysis



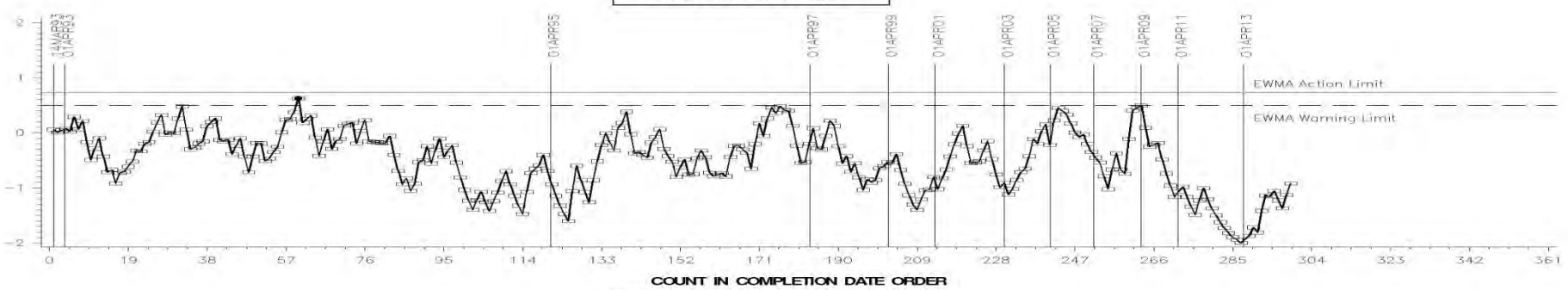
08MAY14:09:16

FINAL TRANS. TOP LAND HEAVY CARBON

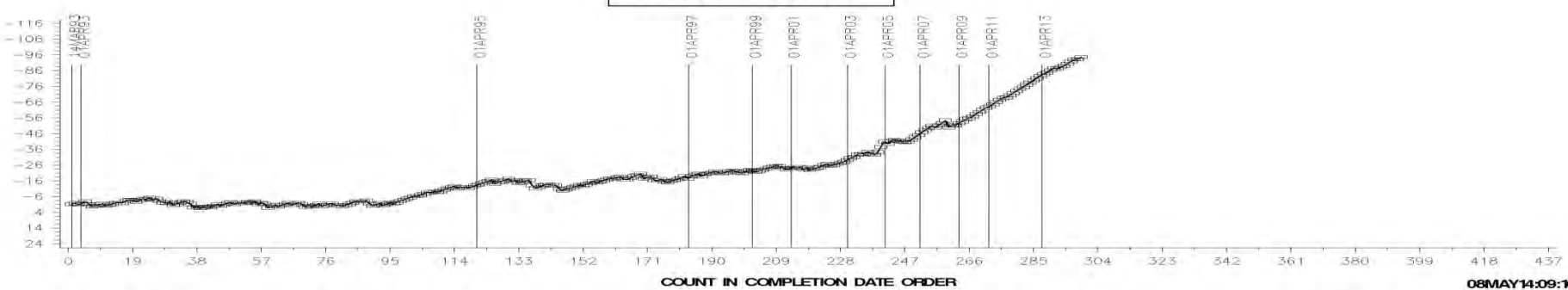
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



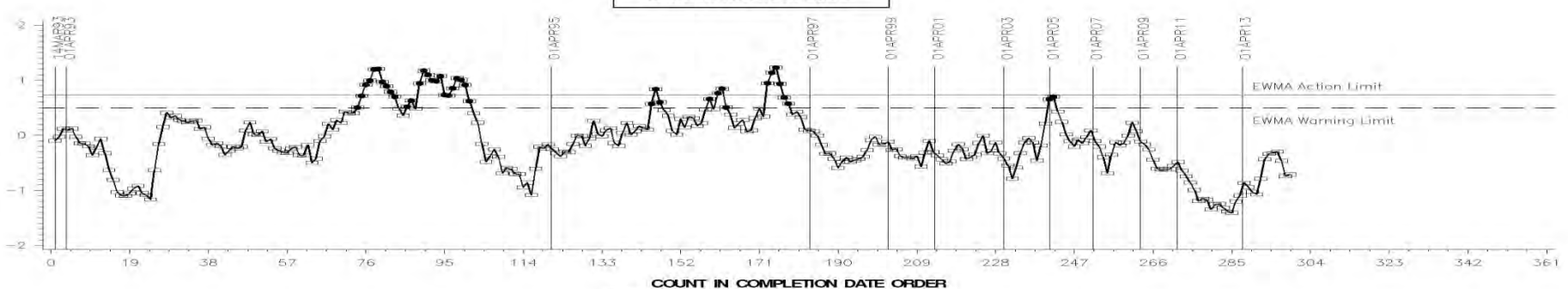
08MAY14:09:16

BSOC

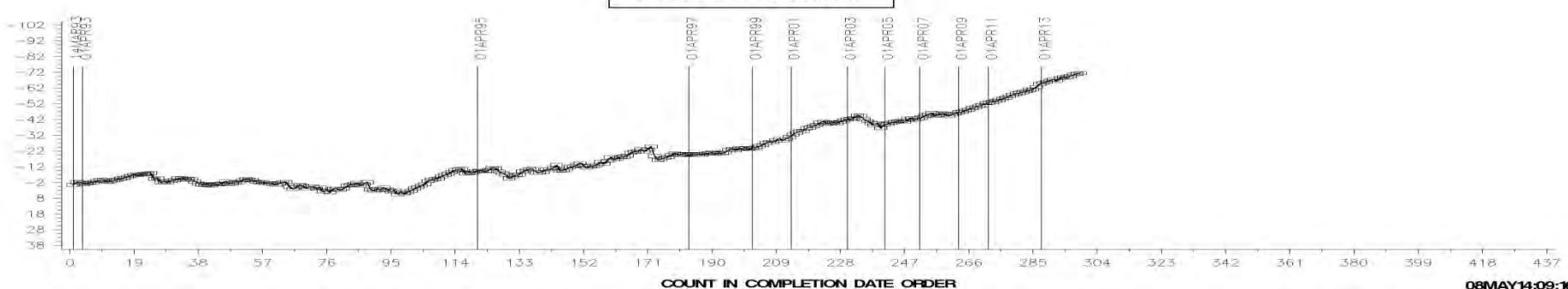
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



08MAY14:09:16

Return

Test Monitoring Center

<http://astmtmc.cmu.edu>



A Program of ASTM International

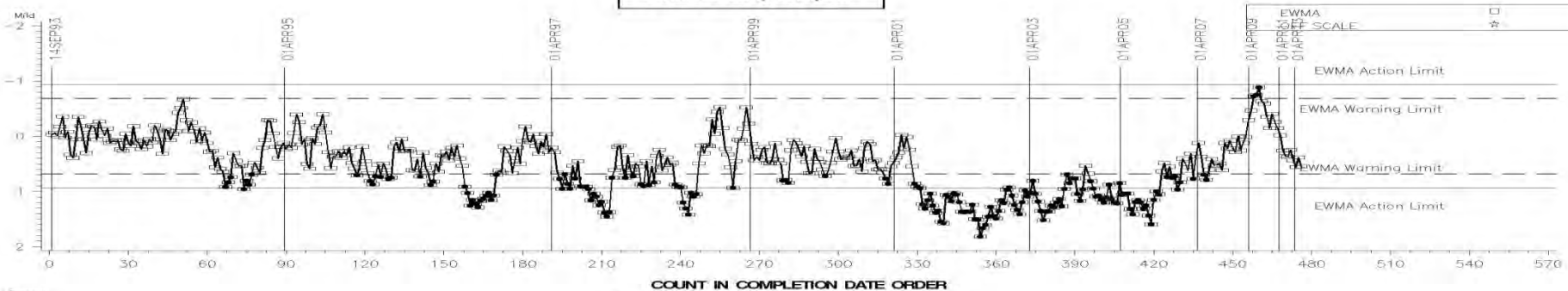
Appendix 1.c

1 M-PC Control Charts

» Severity, Precision, and CuSum

FINAL TOP GROOVE FILLING

LTMS Severity Analysis



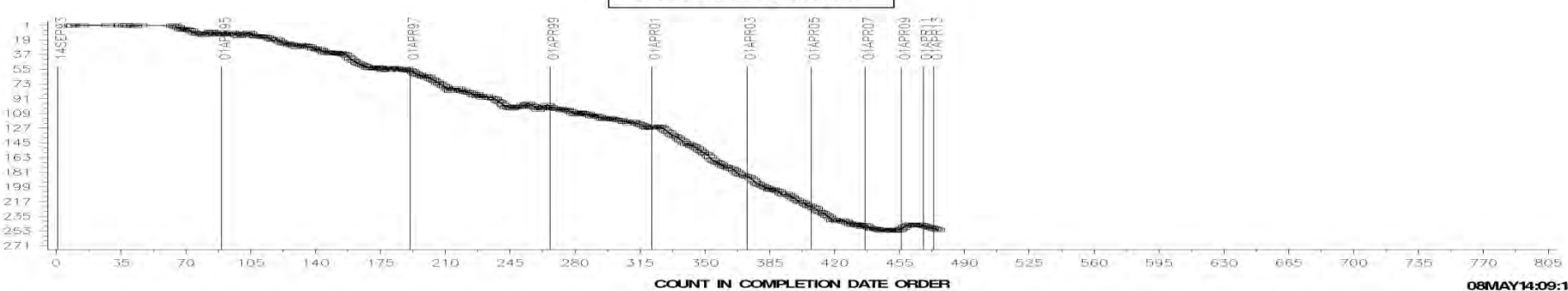
COUNT IN COMPLETION DATE ORDER

LTMS Precision Analysis



COUNT IN COMPLETION DATE ORDER

CUSUM Severity Analysis

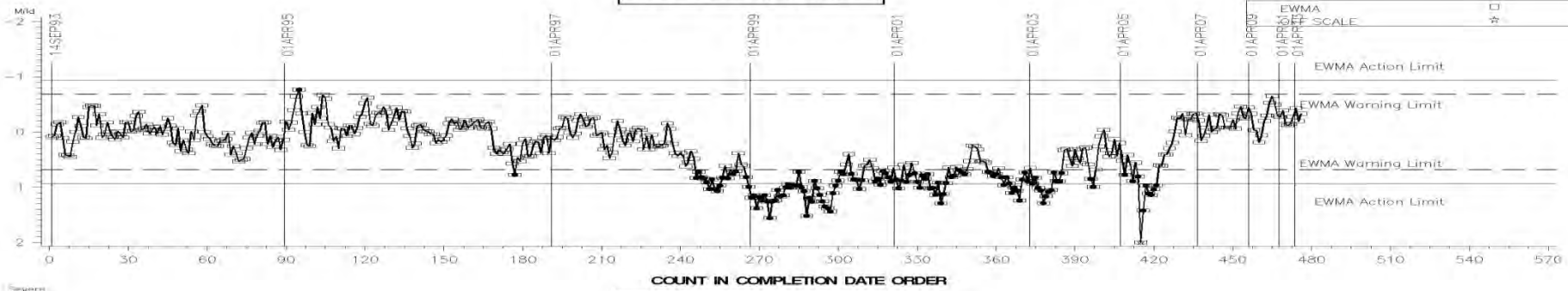


COUNT IN COMPLETION DATE ORDER

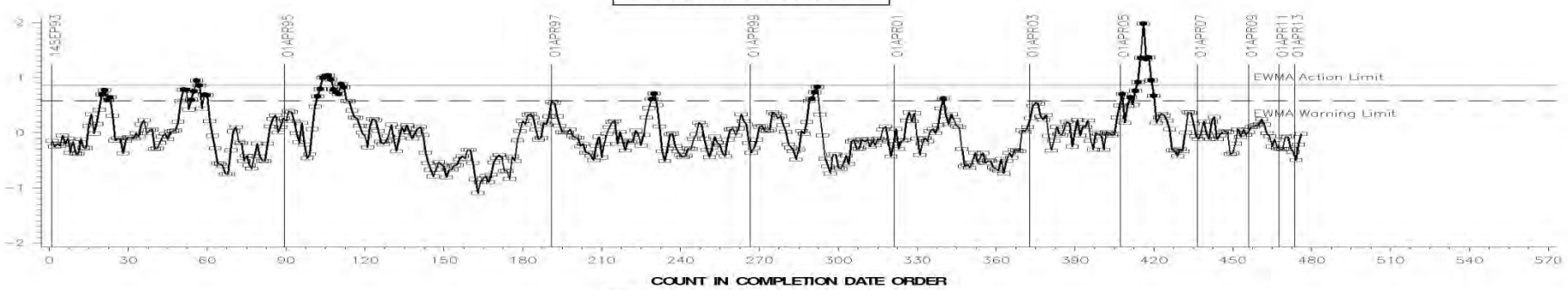
08MAY14:09:15

Weighted Total Demerits

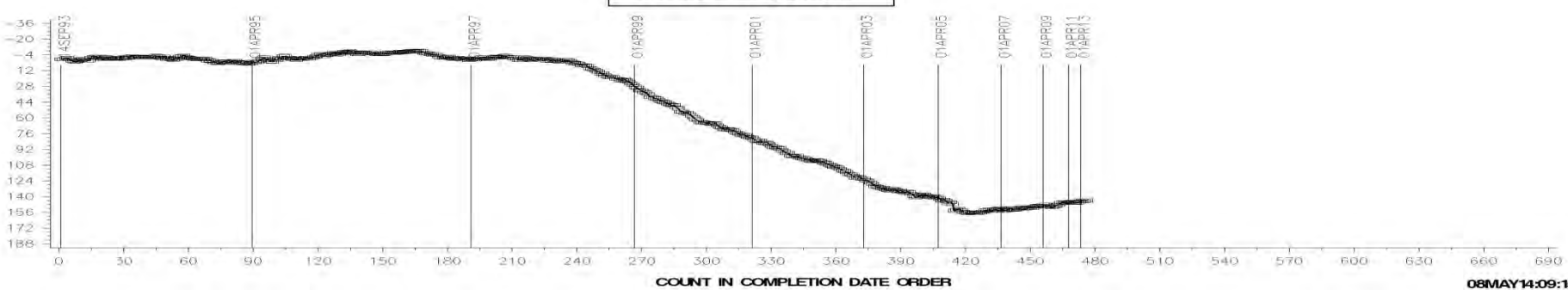
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



08MAY14:09:15

[Return](#)

Test Monitoring Center

<http://astmtmc.cmu.edu>



A Program of ASTM International

Appendix 1.d

1 P Control Charts

» Severity, Precision, and CuSum

Test Monitoring Center

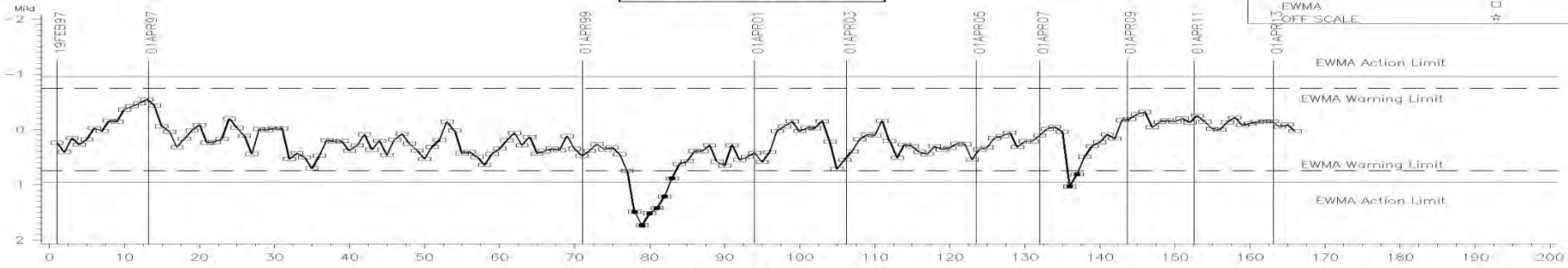
<http://astmtmc.cmu.edu>



A Program of ASTM International

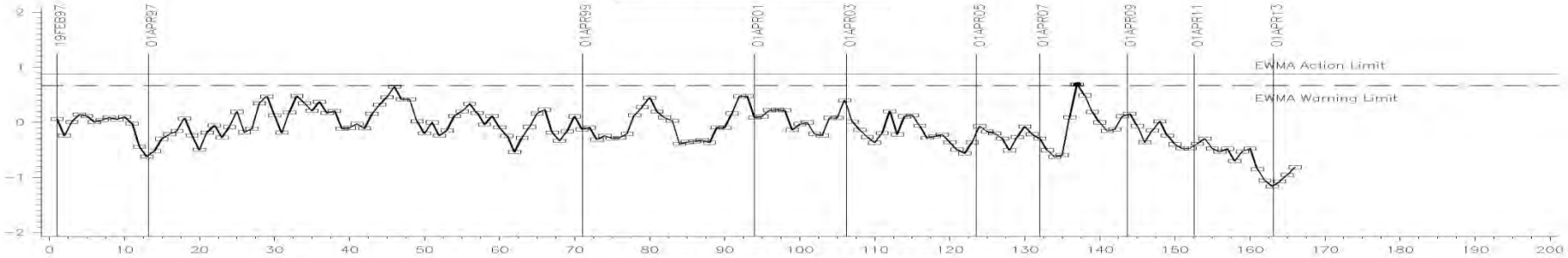
TOP GROOVE CARBON

LTMS Severity Analysis



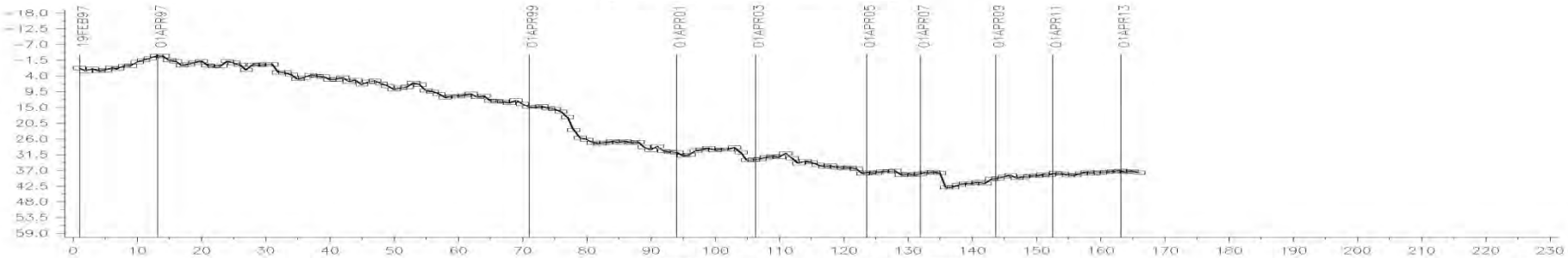
COUNT IN COMPLETION DATE ORDER

LTMS Precision Analysis



COUNT IN COMPLETION DATE ORDER

CUSUM Severity Analysis



COUNT IN COMPLETION DATE ORDER

08MAY14:09:17

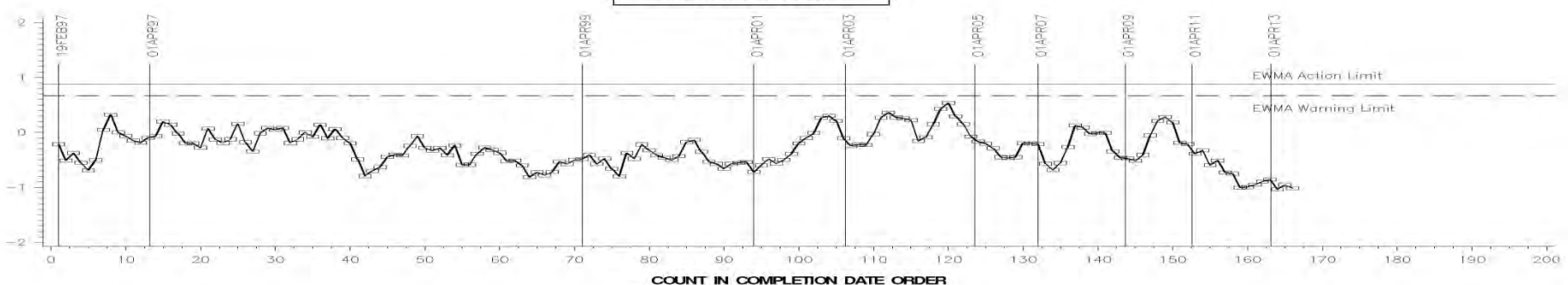
TOP LAND CARBON

LTMS Severity Analysis



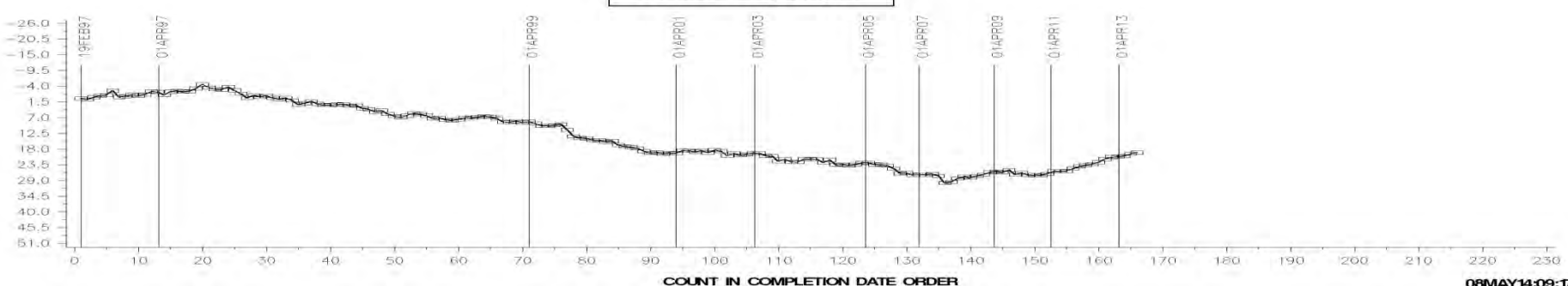
COUNT IN COMPLETION DATE ORDER

LTMS Precision Analysis



COUNT IN COMPLETION DATE ORDER

CUSUM Severity Analysis

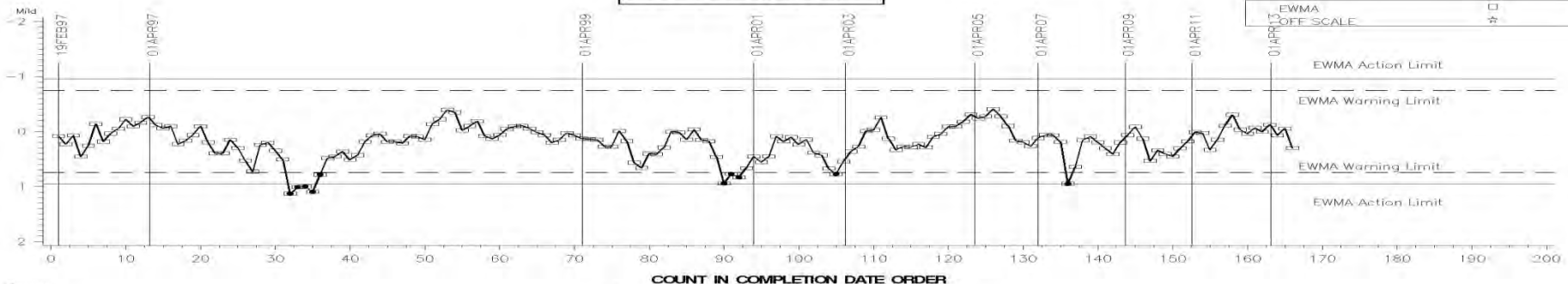


COUNT IN COMPLETION DATE ORDER

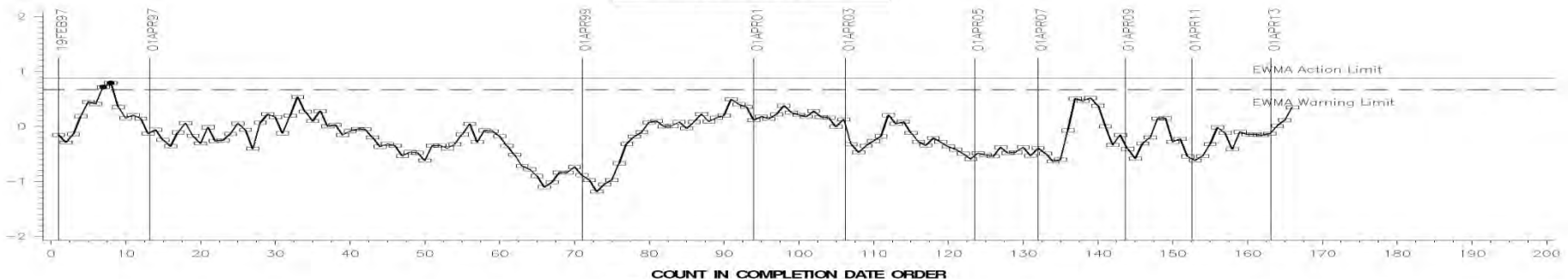
08MAY14:09:17

WEIGHTED TOTAL DEMERITS

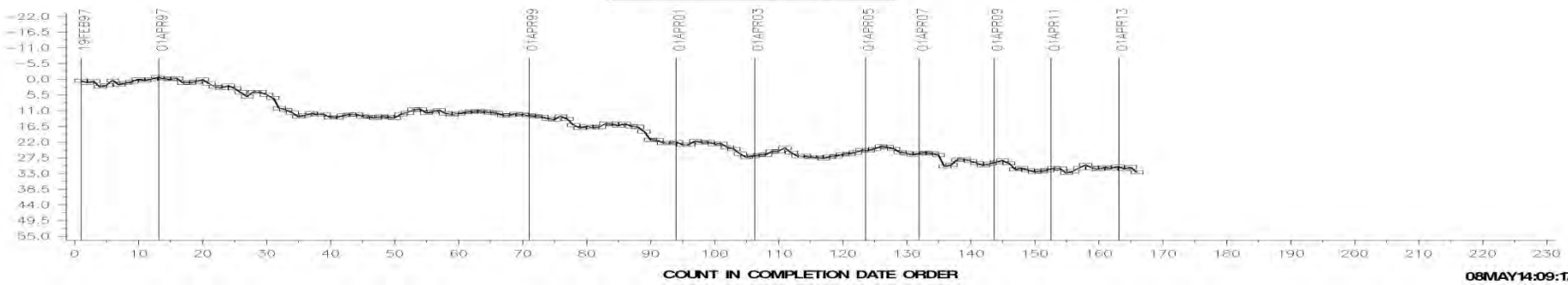
LTMS Severity Analysis



LTMS Precision Analysis



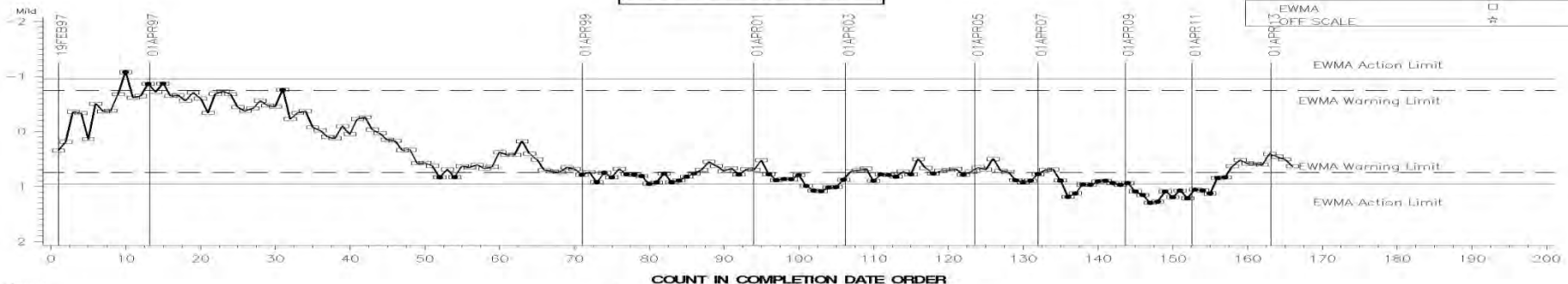
CUSUM Severity Analysis



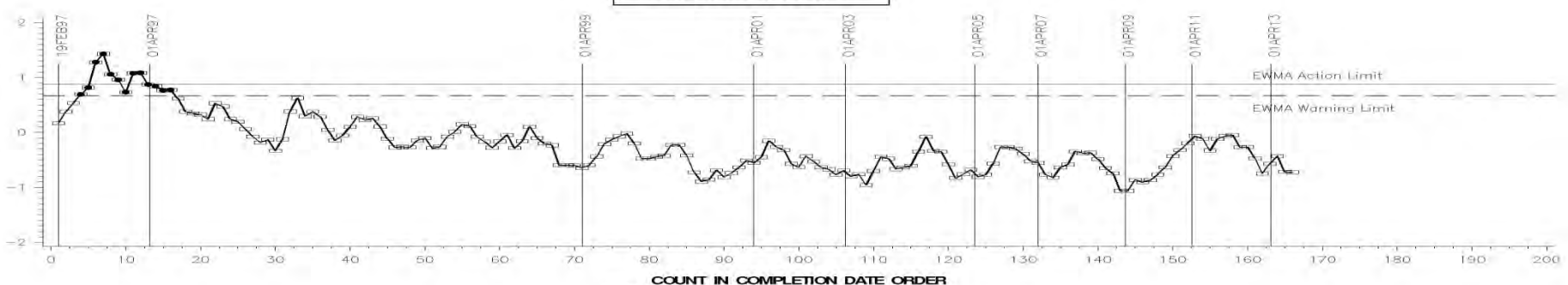
08MAY14:09:17

OIL CONSUMPTION

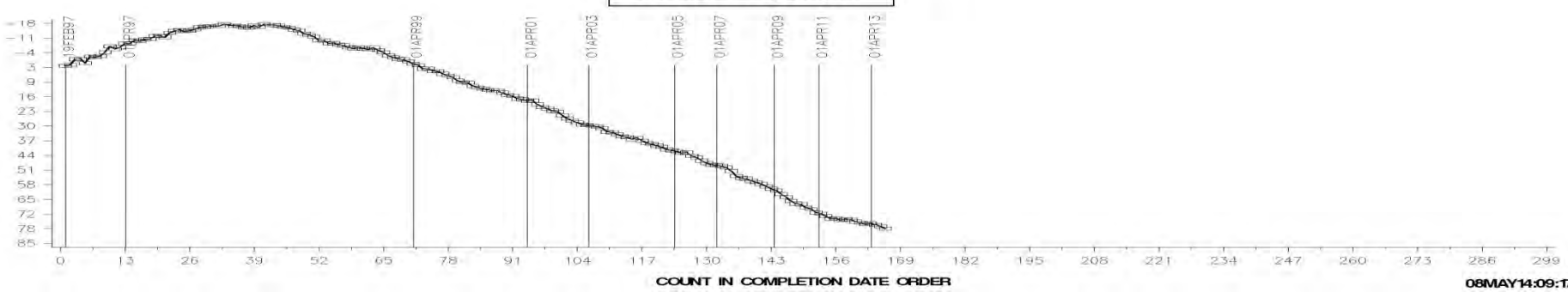
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



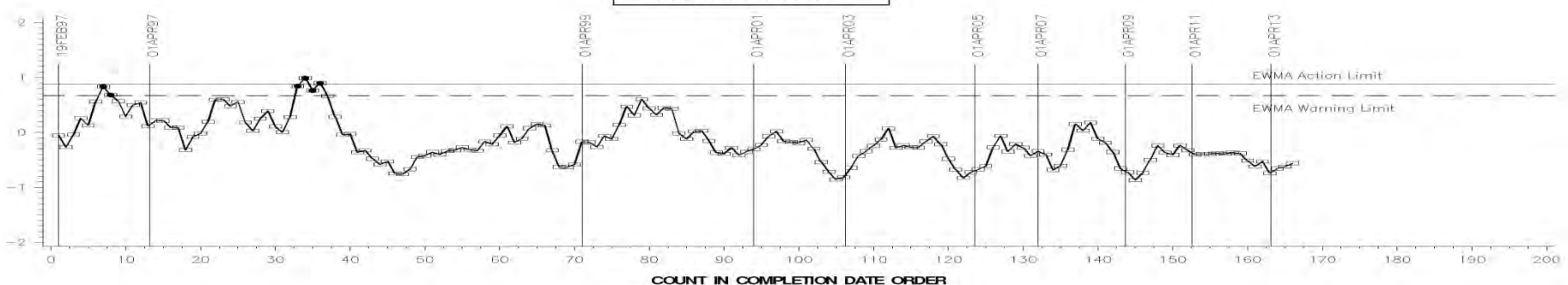
08MAY14:09:17

EOTOC

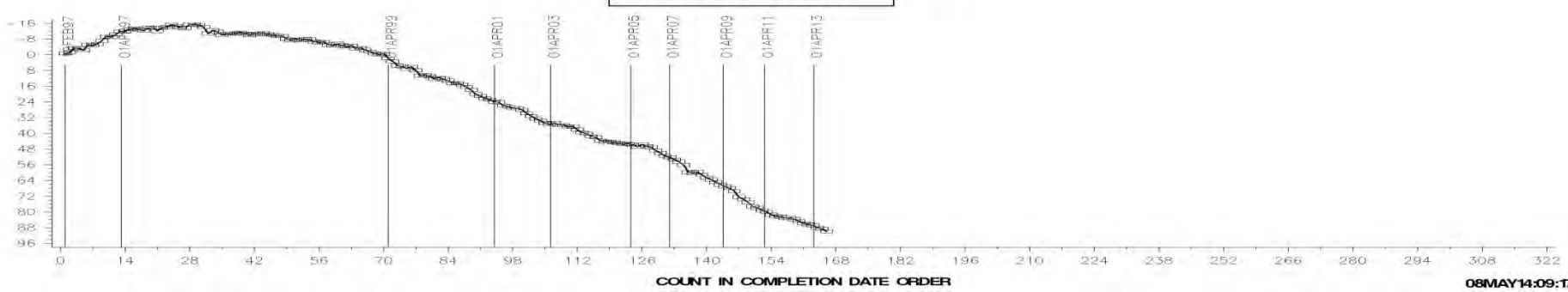
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



08MAY14:09:17

[Return](#)

Appendix 1.e

1 R Control Charts

» Severity, Precision, and CuSum

Test Monitoring Center

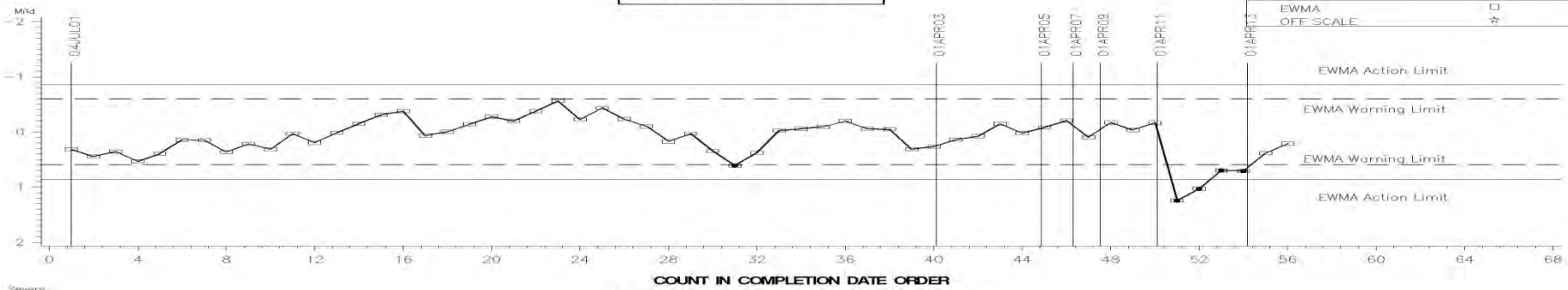
<http://astmtmc.cmu.edu>



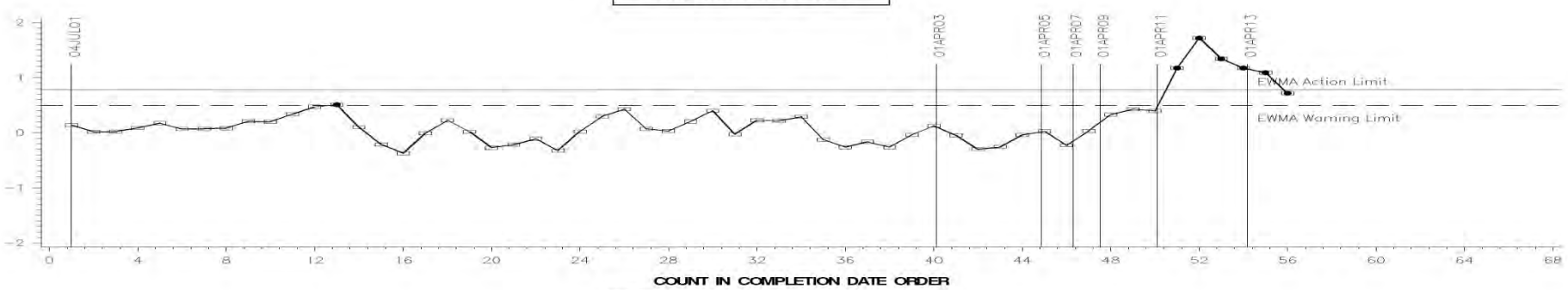
A Program of ASTM International

FINAL WEIGHTED TOTAL DEMERITS (DEMERITS)

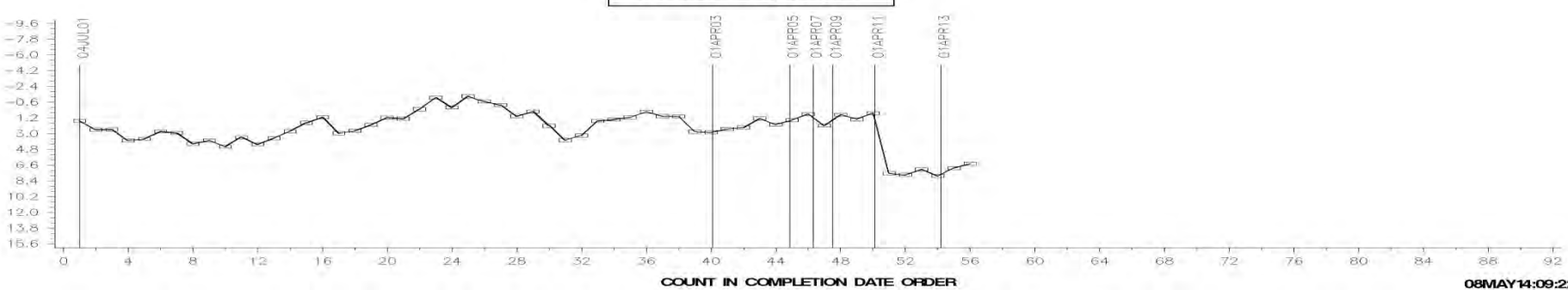
LTMS Severity Analysis



LTMS Precision Analysis



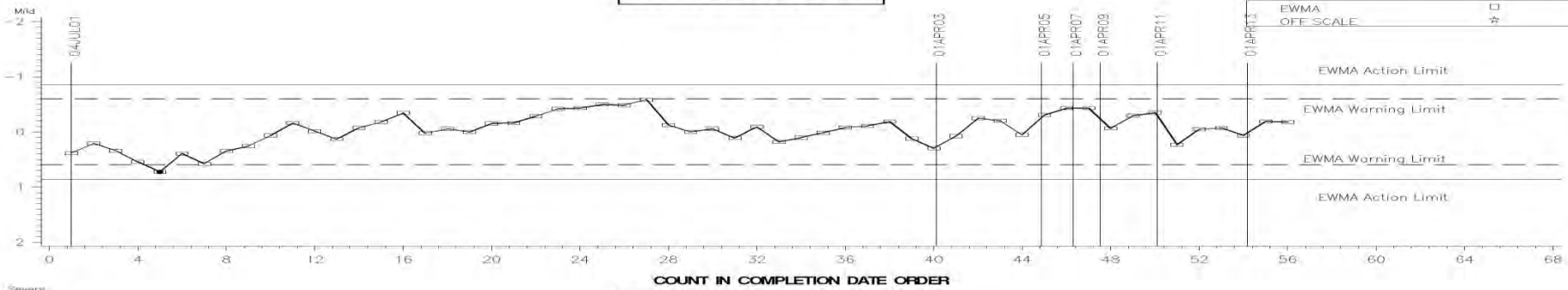
CUSUM Severity Analysis



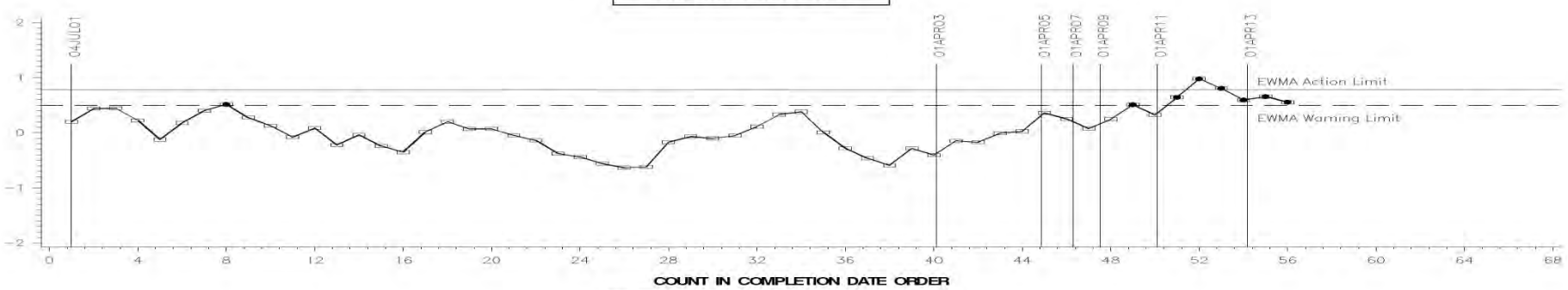
08MAY14:09:22

FINAL TOP GROOVE CARBON (DEMERITS)

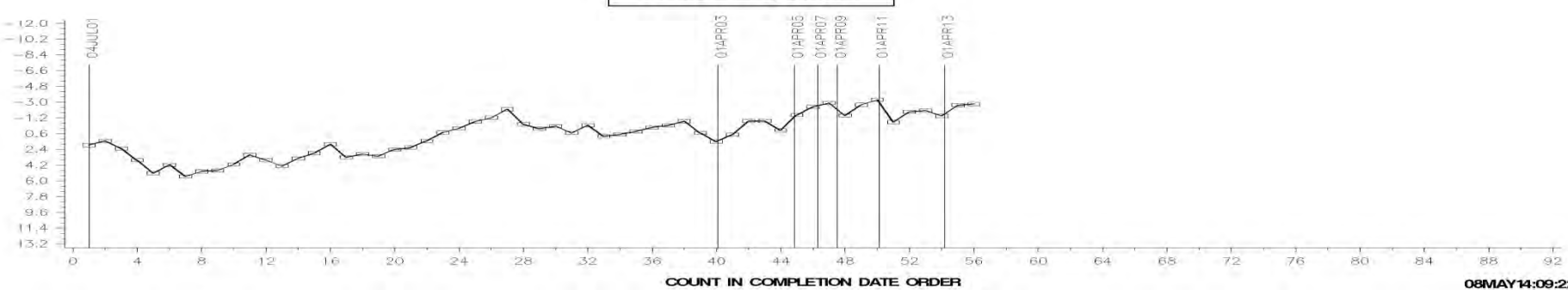
LTMS Severity Analysis



LTMS Precision Analysis



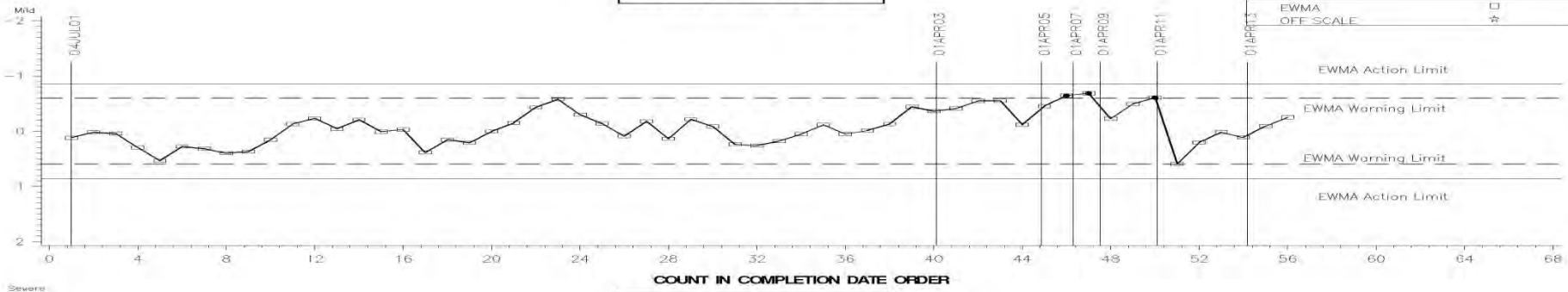
CUSUM Severity Analysis



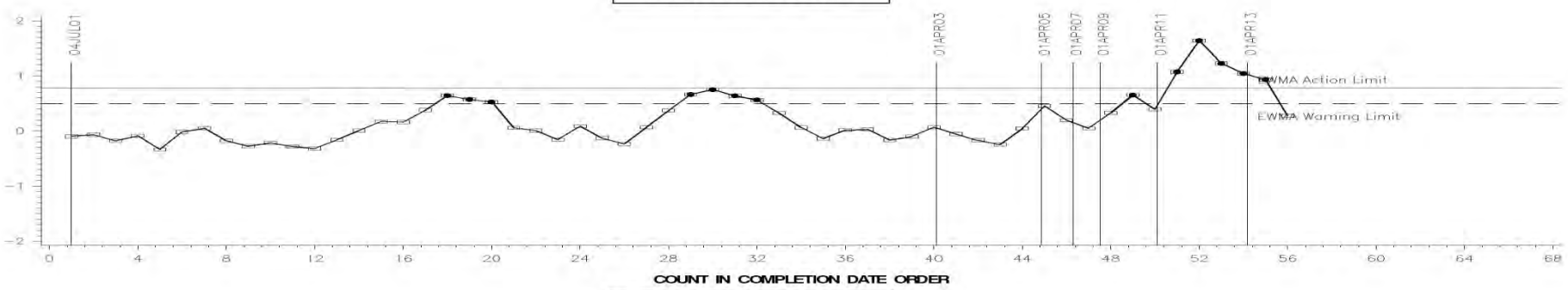
08MAY14:09:22

FINAL TOP LAND CARBON (DEMERITS)

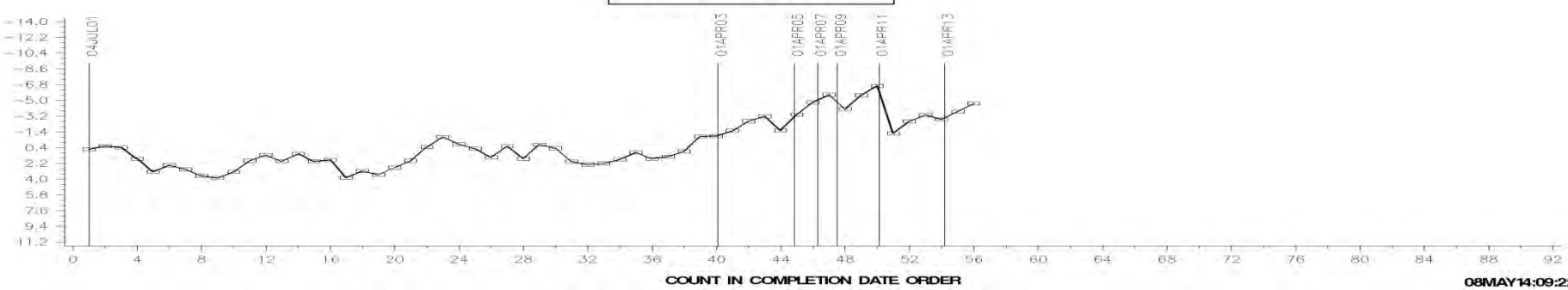
LTMS Severity Analysis



LTMS Precision Analysis

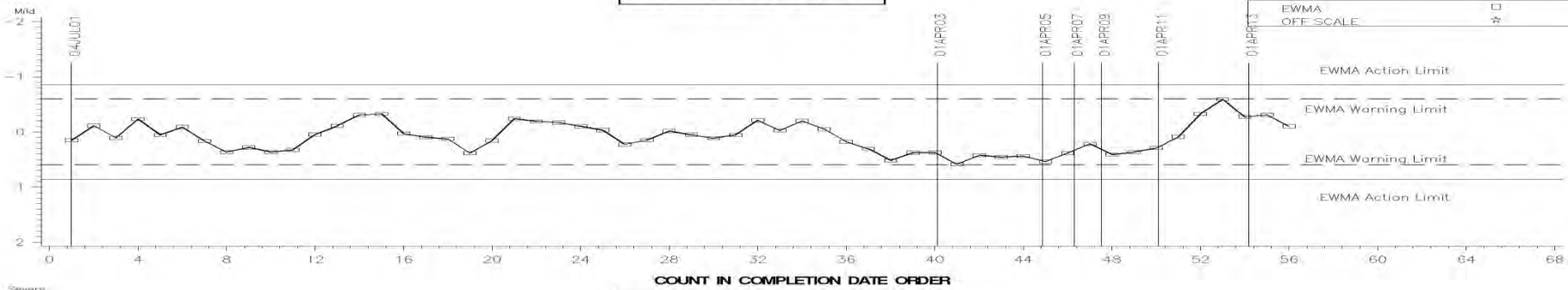


CUSUM Severity Analysis

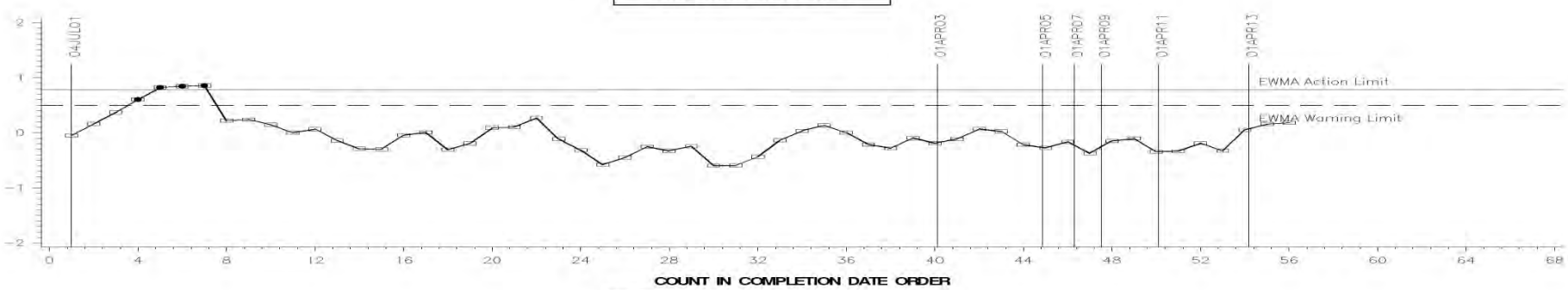


08MAY14:09:22

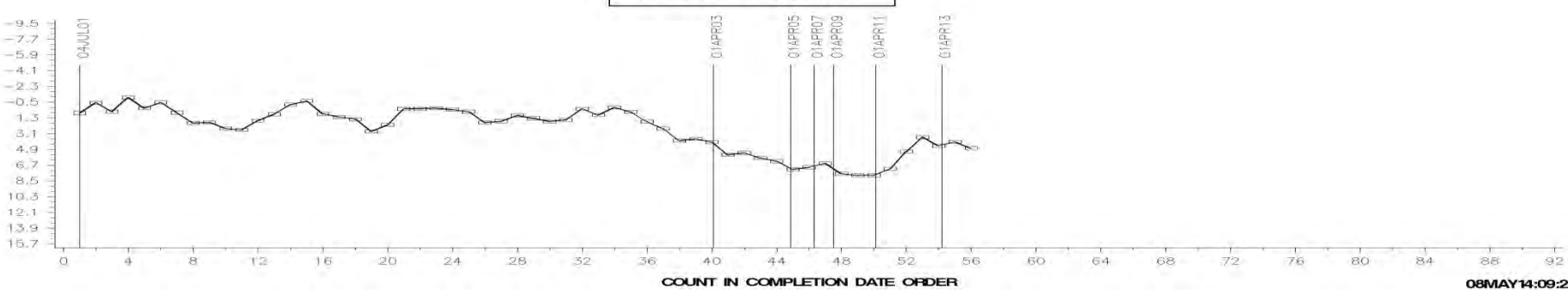
LTMS Severity Analysis



LTMS Precision Analysis



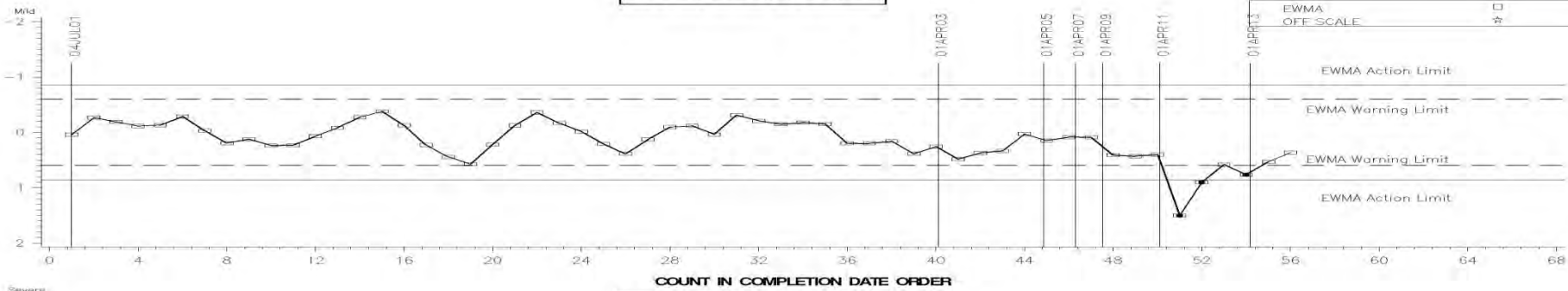
CUSUM Severity Analysis



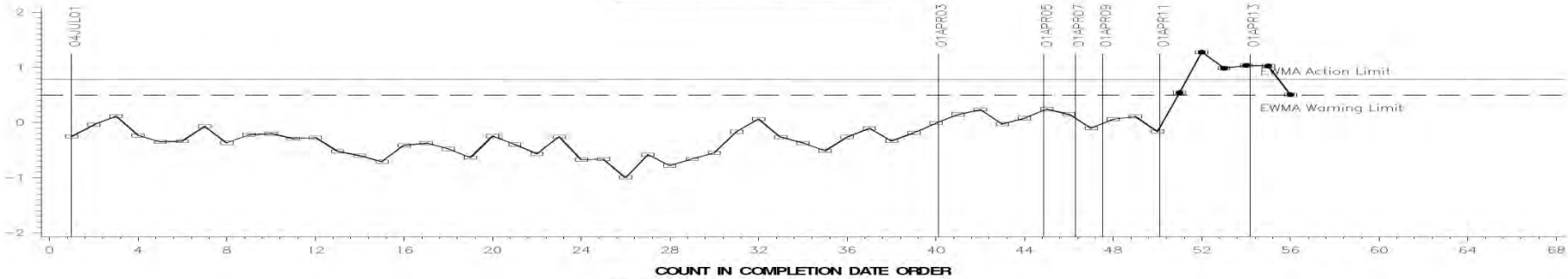
08MAY14:09:22

FINAL EOTOC (g/h)

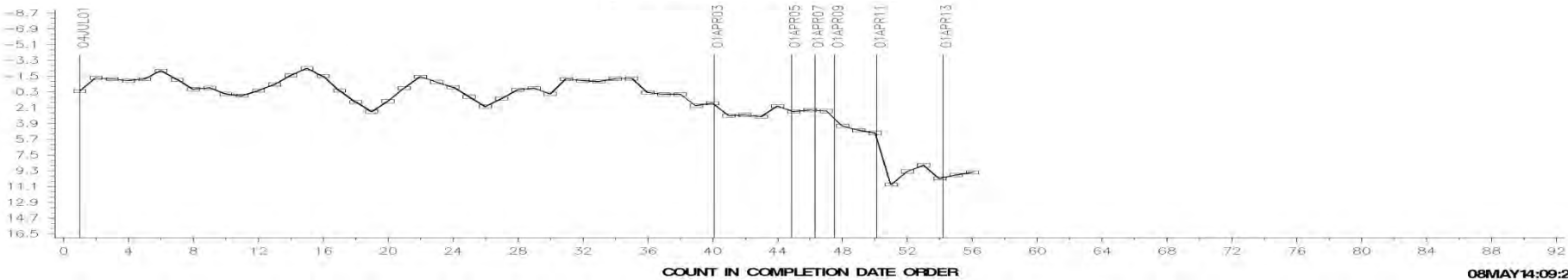
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



08MAY14:09:22

[Return](#)

Test Monitoring Center

<http://astmtmc.cmu.edu>



A Program of ASTM International

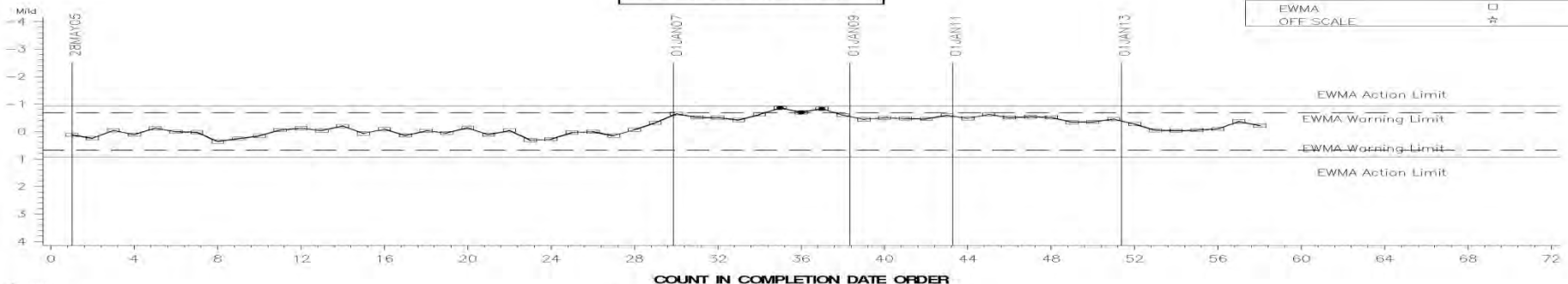
Appendix 1.f

C13 Control Charts

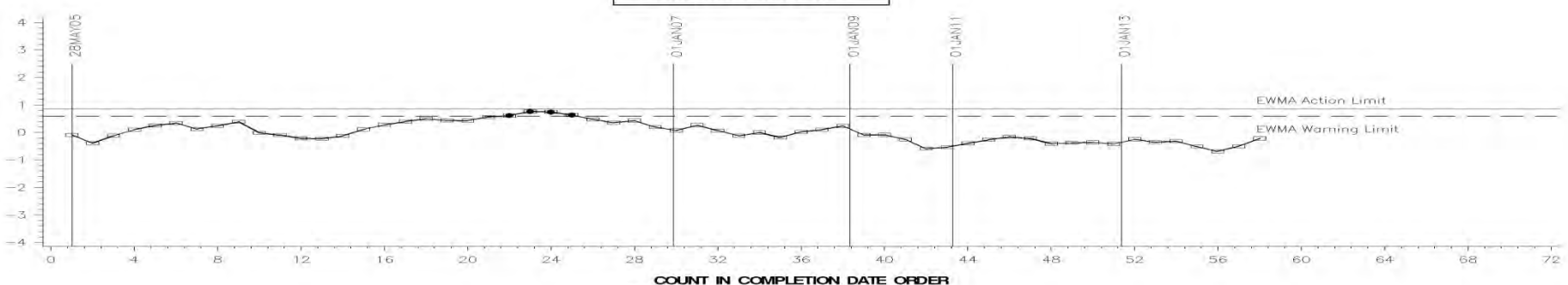
» Severity and CuSum

TOP LAND CARBON AVG. — FINAL RESULT

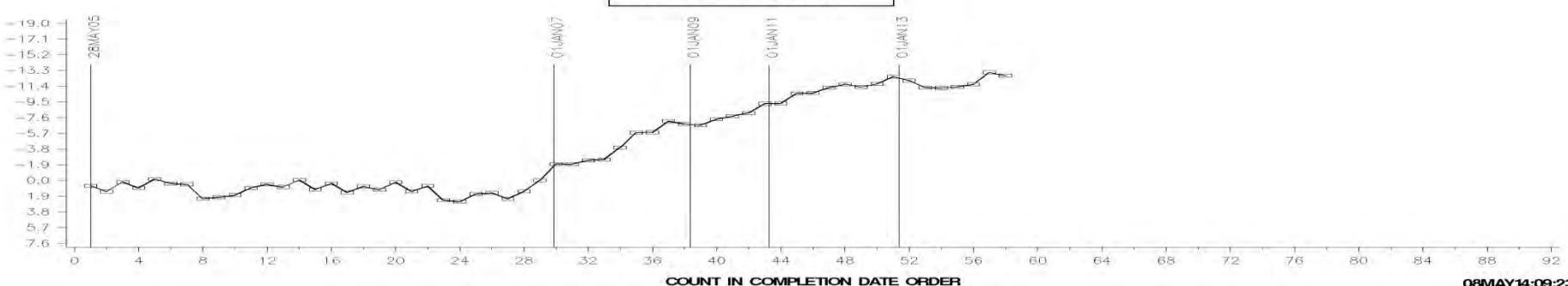
LTMS Severity Analysis



LTMS Precision Analysis

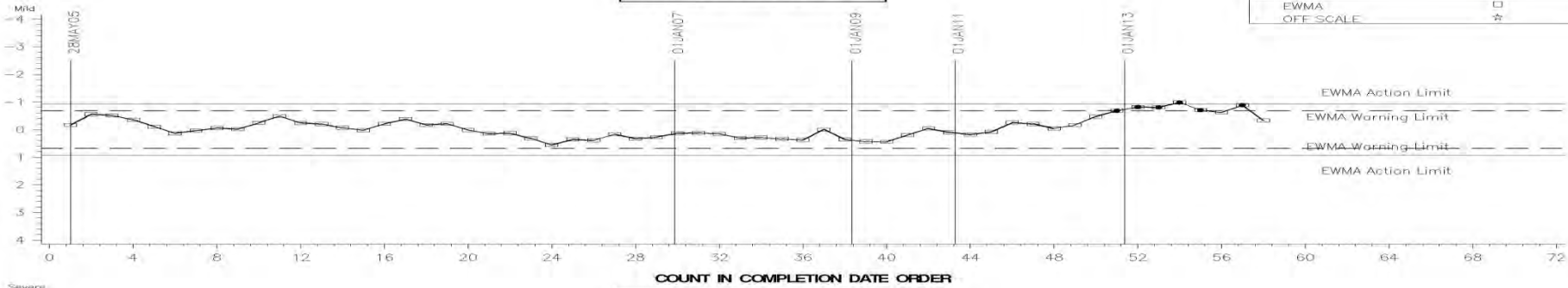


CUSUM Severity Analysis

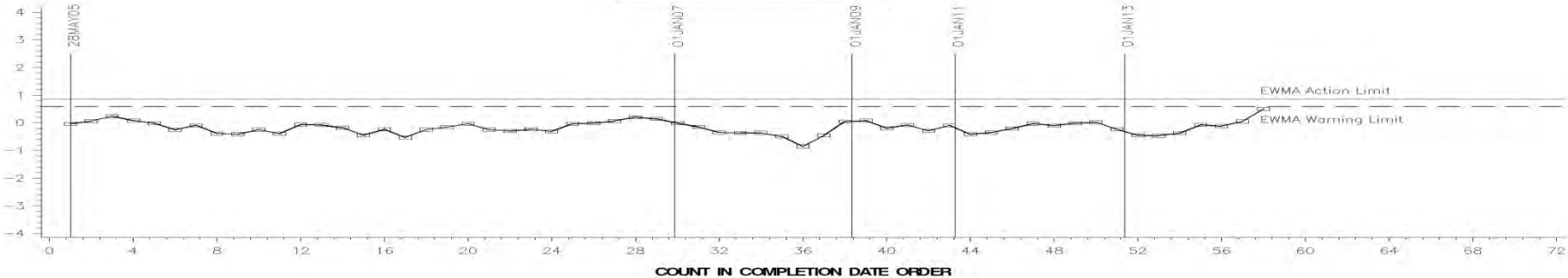


08MAY14:09:23

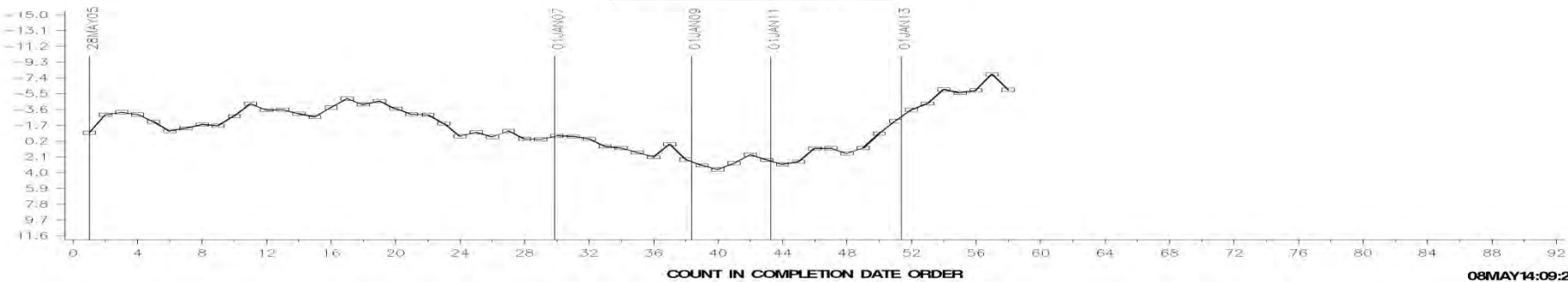
LTMS Severity Analysis



LTMS Precision Analysis



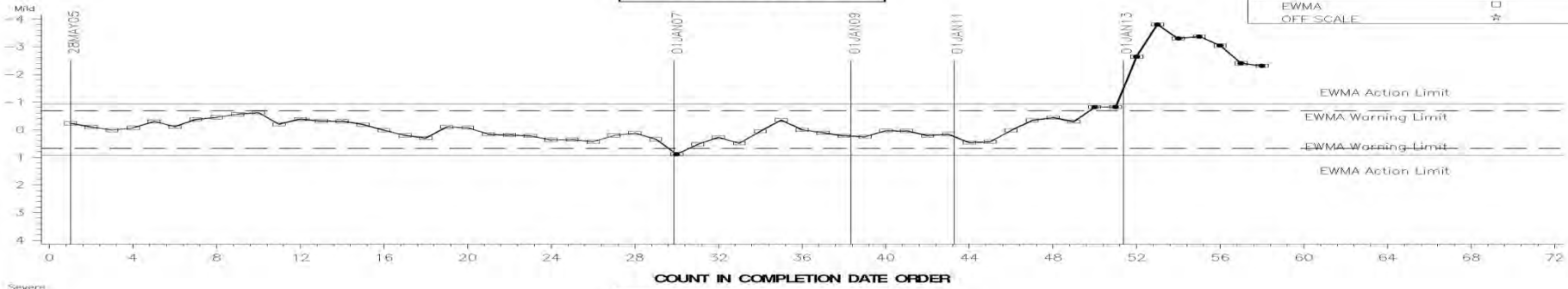
CUSUM Severity Analysis



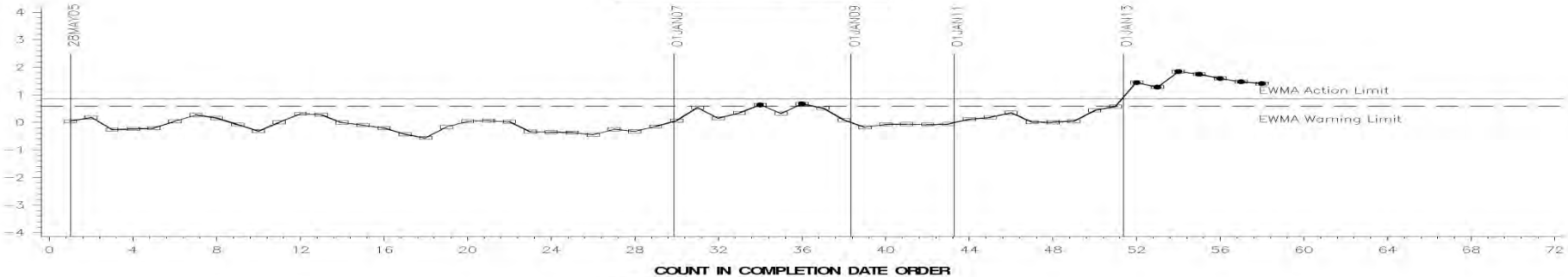
08MAY14:09:23

2ND RING TOP CARBON AVG. — FINAL RESULT

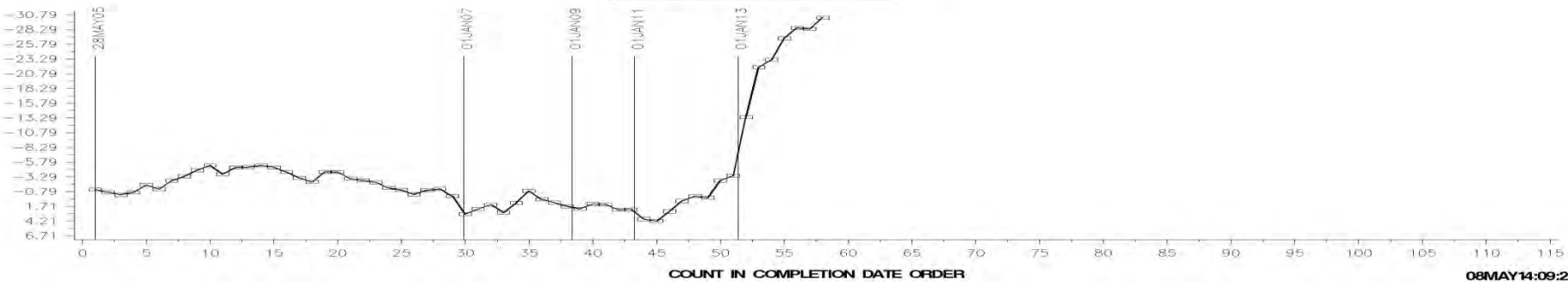
LTMS Severity Analysis



LTMS Precision Analysis



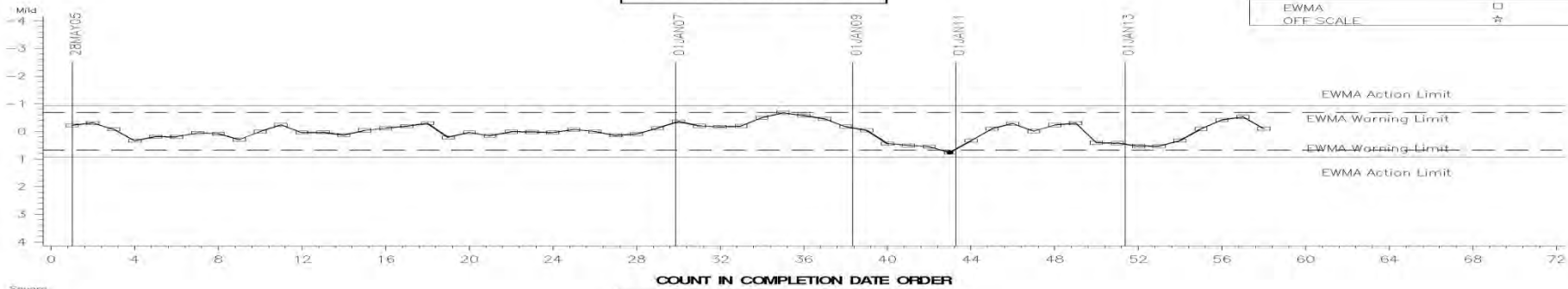
CUSUM Severity Analysis



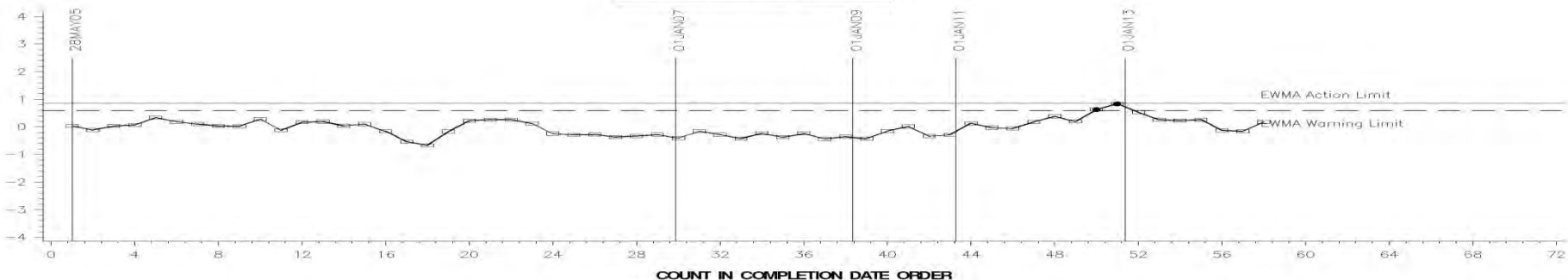
08MAY14:09:23

OIL CONS. DELTA - FINAL RESULT

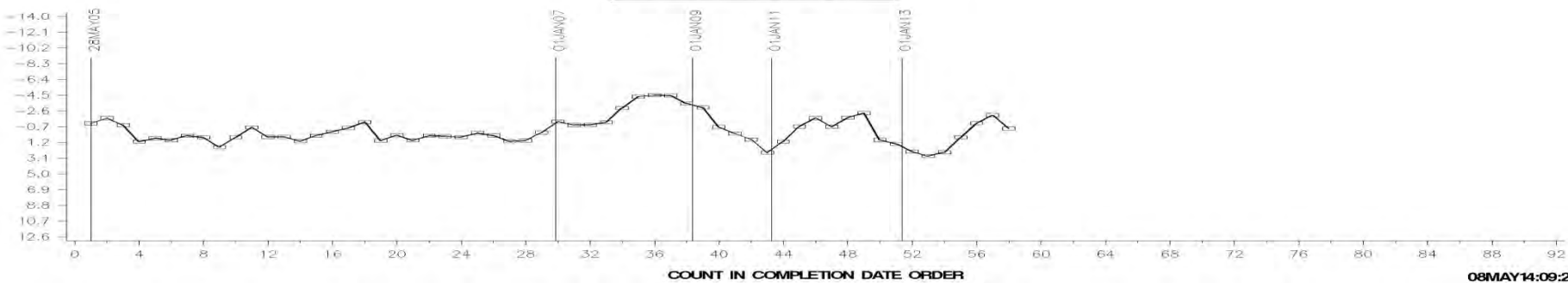
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



08MAY14:09:23

[Return](#)

Test Monitoring Center

<http://astmtmc.cmu.edu>



A Program of ASTM International

Appendix 1.g

ISB Control Charts

» Severity and CuSum

Test Monitoring Center

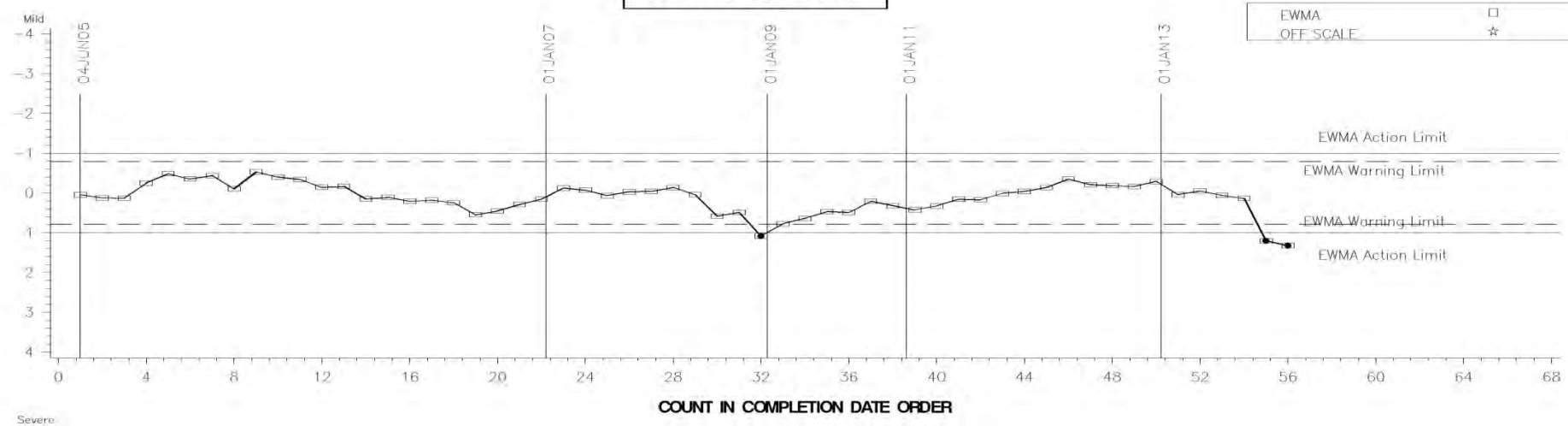
<http://astmtmc.cmu.edu>



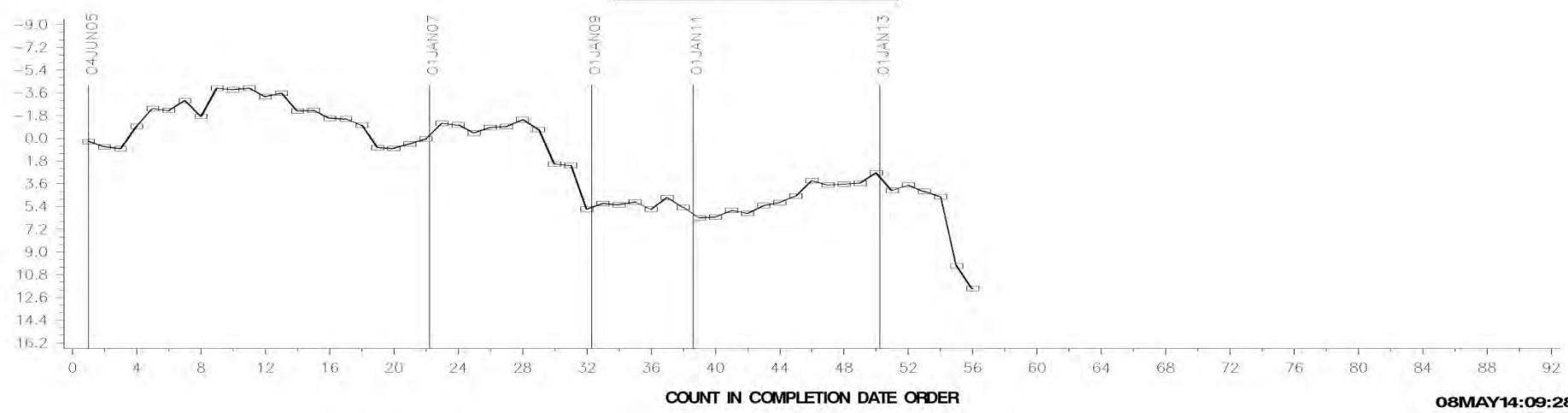
A Program of ASTM International

AVERAGE CAMSHAFT WEAR

LTMS Severity Analysis



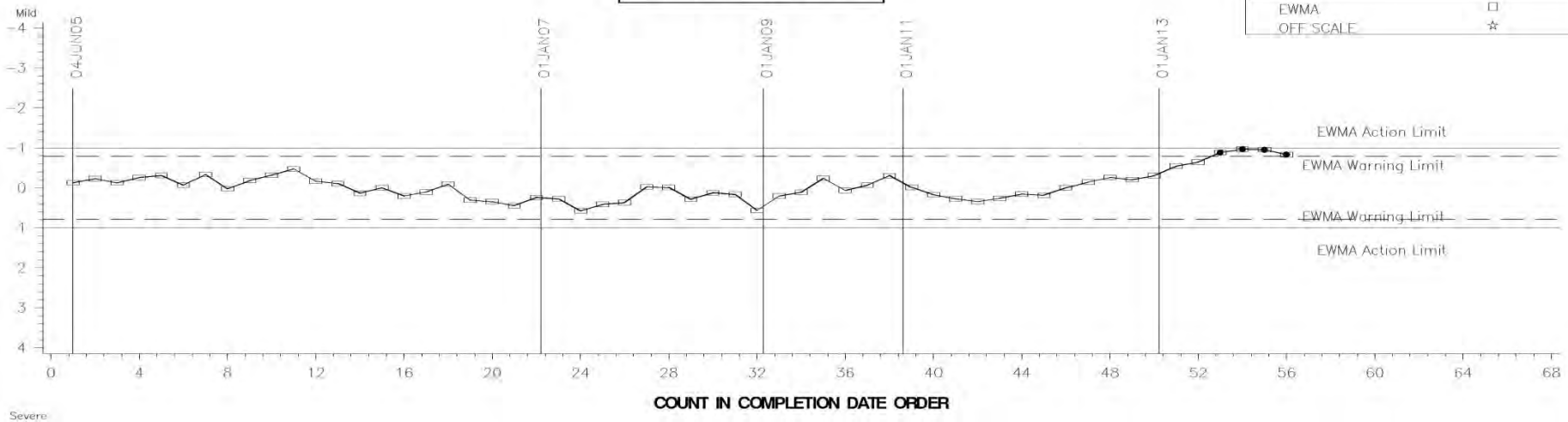
CUSUM Severity Analysis



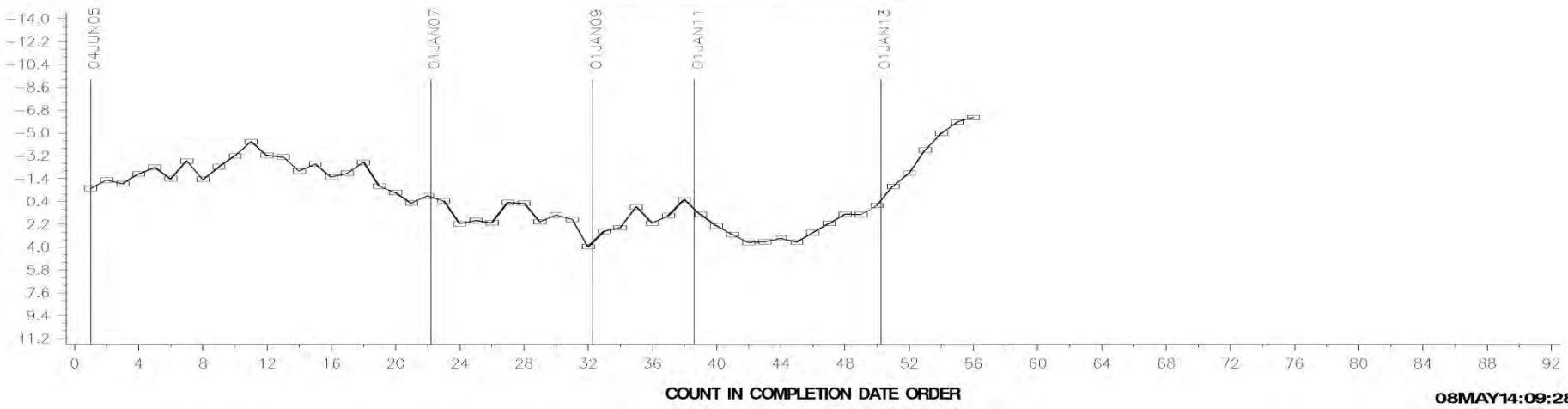
08MAY14:09:28

AVERAGE TAPPET WEIGHT LOSS

LTMS Severity Analysis



CUSUM Severity Analysis



08MAY14:09:28

[Return](#)

Appendix 1.h

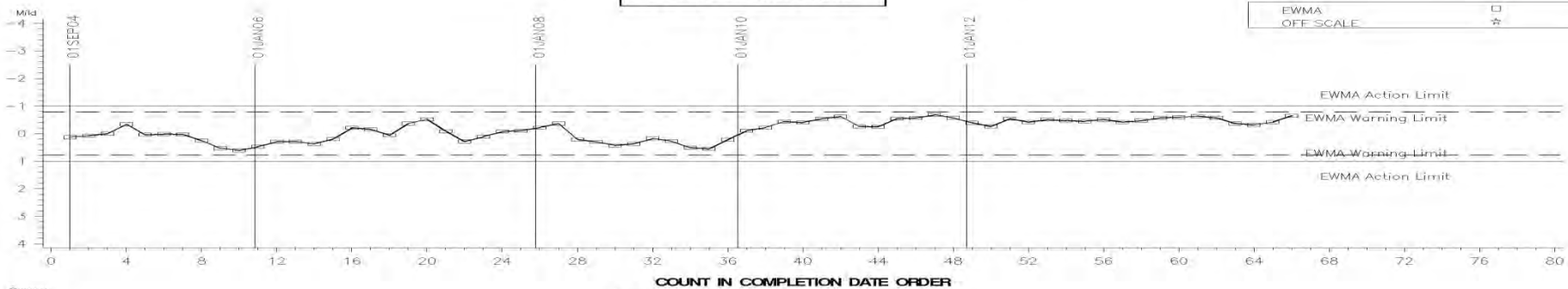
ISM Control Charts

» Severity and CuSum

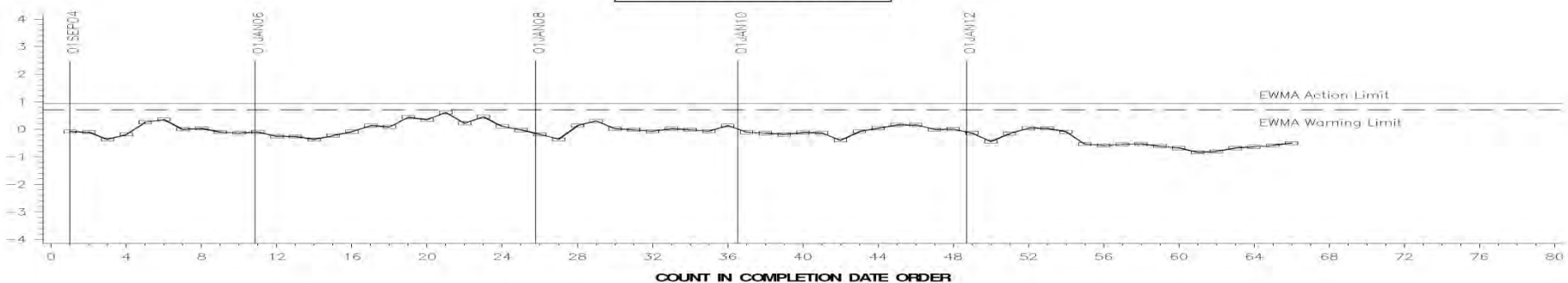
ISM INDUSTRY OPERATIONALLY VALID DATA

CROSSHEAD WEIGHT LOSS ADJUSTED TO 3.9 % SOOT

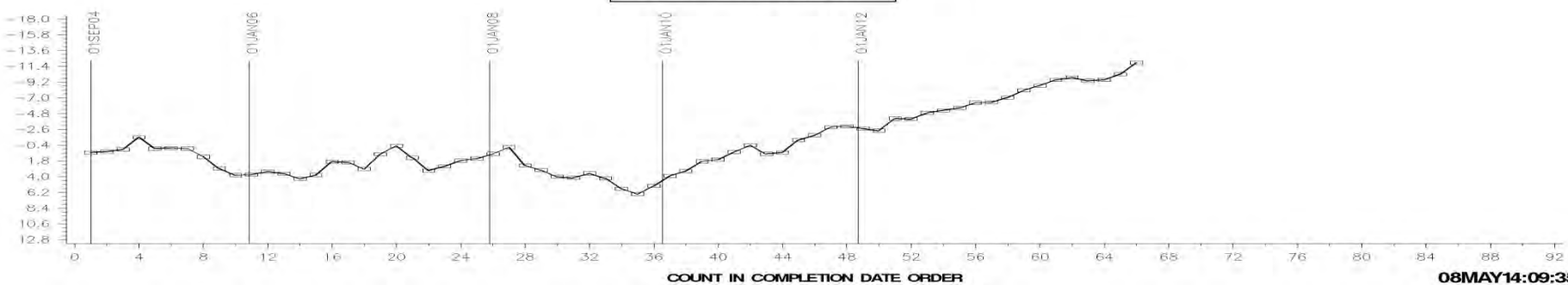
LTMS Severity Analysis



LTMS Precision Analysis



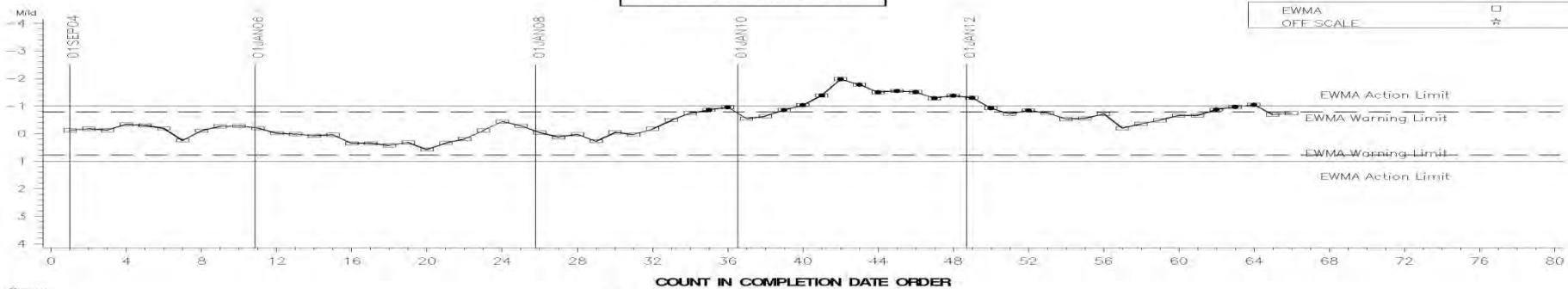
CUSUM Severity Analysis



08MAY14:09:35

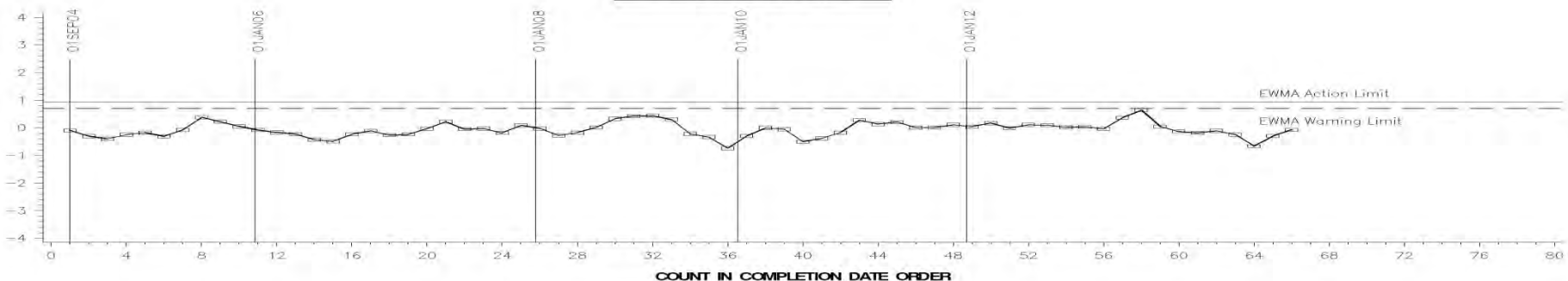
FILTER PLUGGING DELTA P

LTMS Severity Analysis



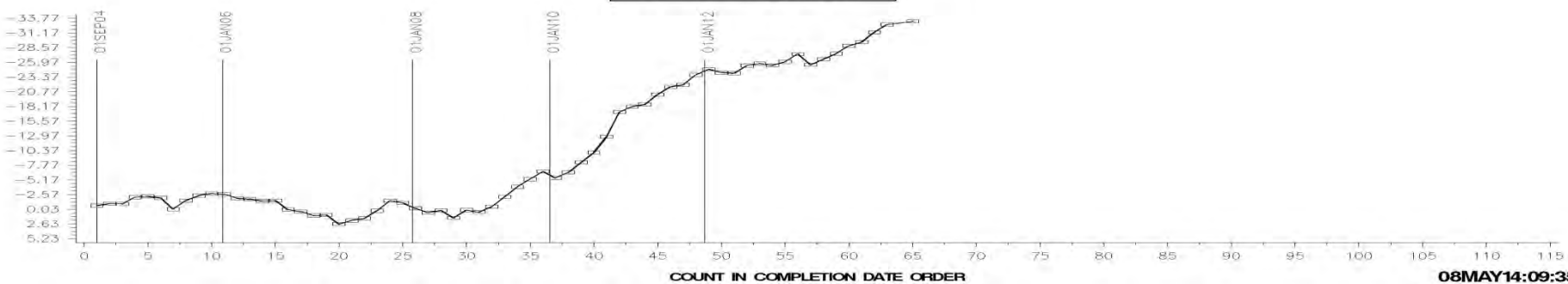
COUNT IN COMPLETION DATE ORDER

LTMS Precision Analysis



COUNT IN COMPLETION DATE ORDER

CUSUM Severity Analysis



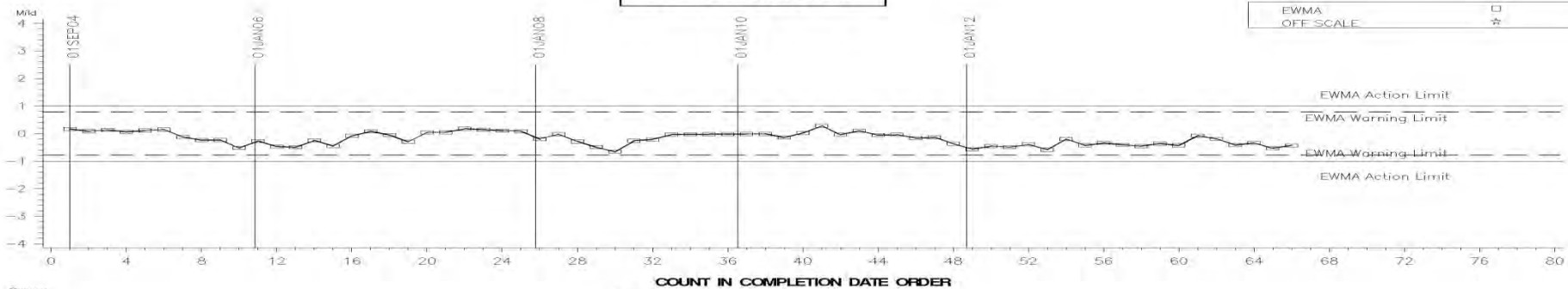
COUNT IN COMPLETION DATE ORDER

08MAY14:09:35

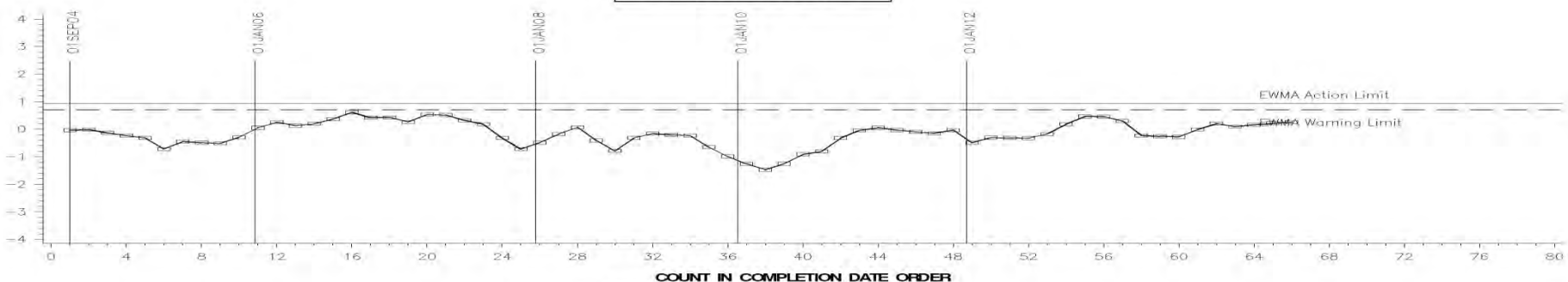
ISM INDUSTRY OPERATIONALLY VALID DATA

AVERAGE SLUDGE RATING

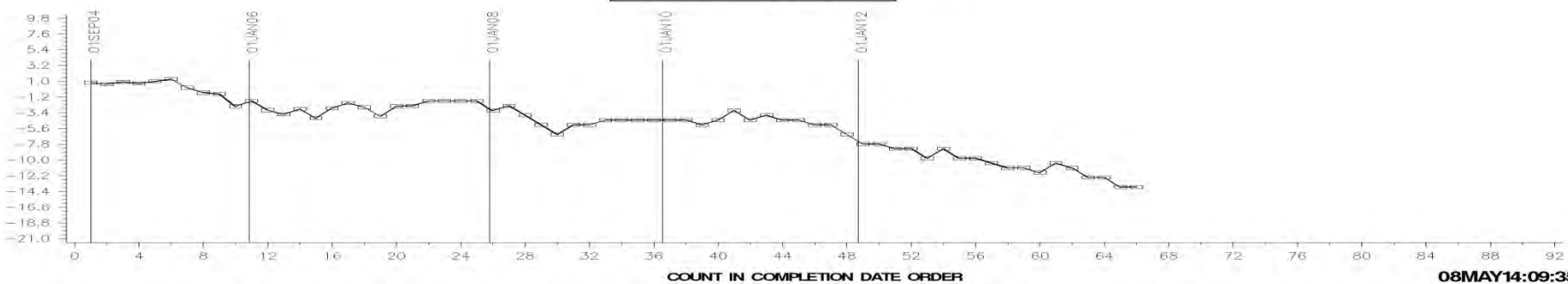
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis

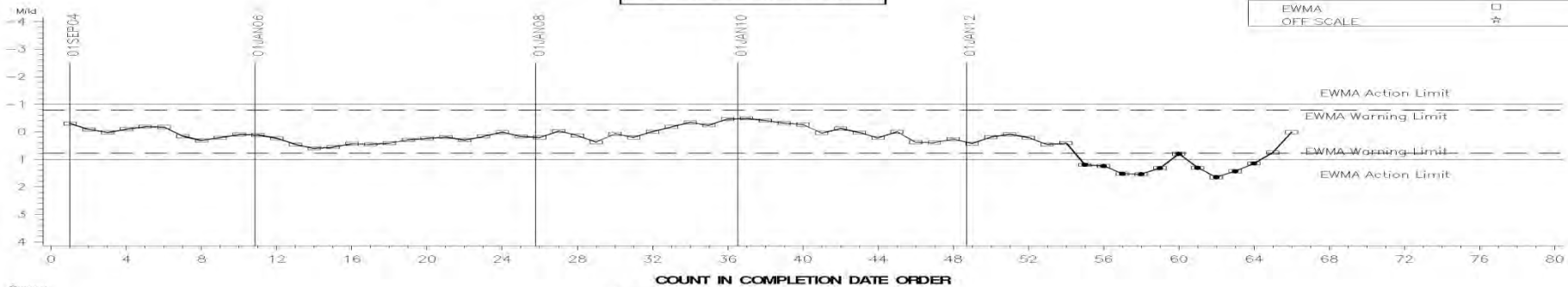


08MAY14:09:35

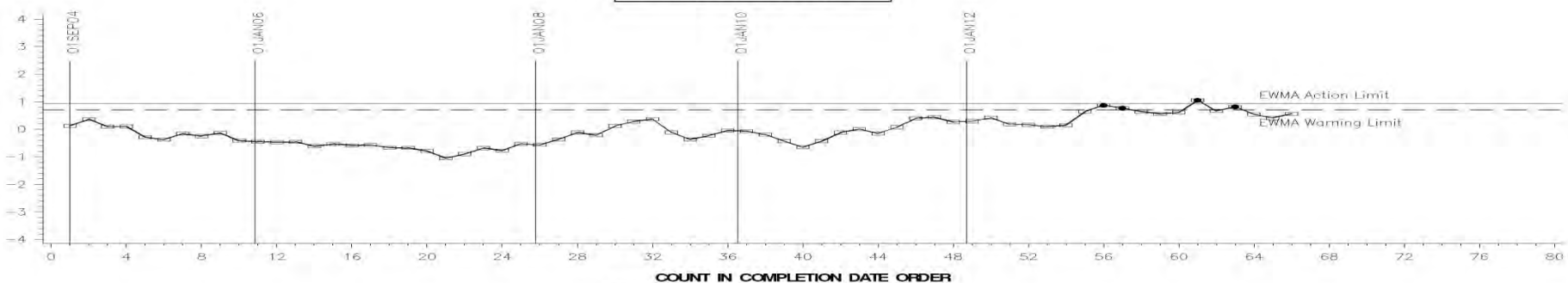
ISM INDUSTRY OPERATIONALLY VALID DATA

INJECTOR SCREW WEIGHT LOSS ADJUSTED TO 3.9% SOOT

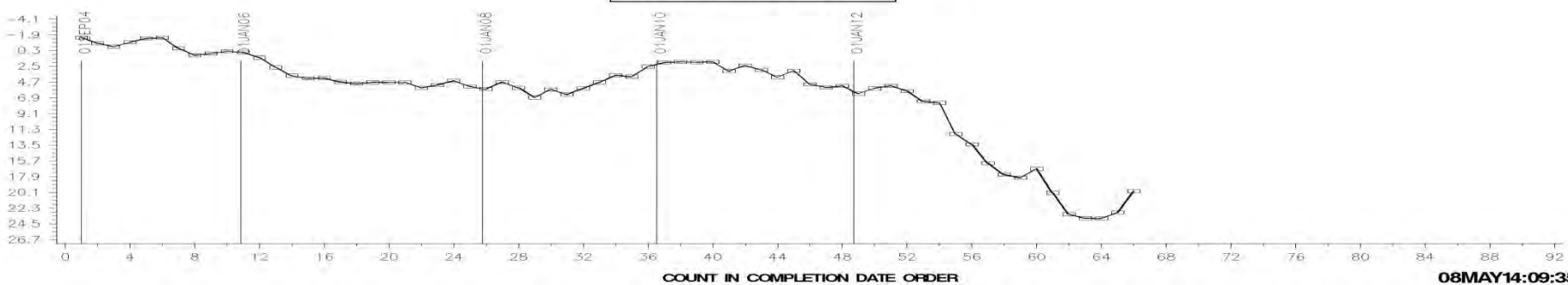
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



08MAY14:09:35

[Return](#)

Test Monitoring Center

<http://astmtmc.cmu.edu>



A Program of ASTM International

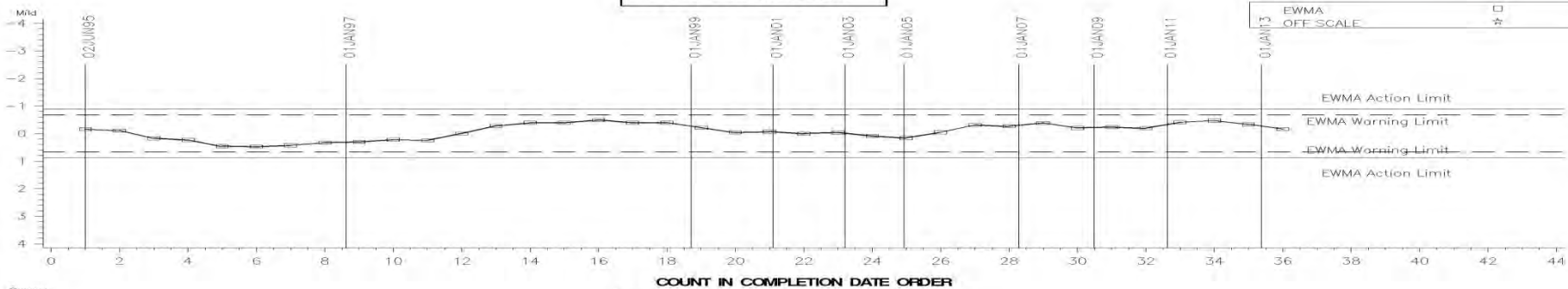
Appendix 1.i

EOAT Control Charts

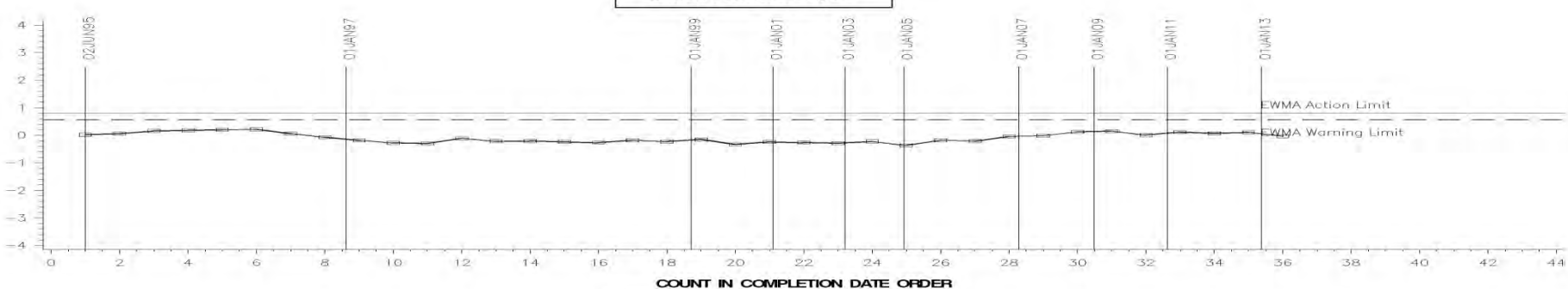
» Severity, Precision, and CuSum

ENGINE OIL AERATION

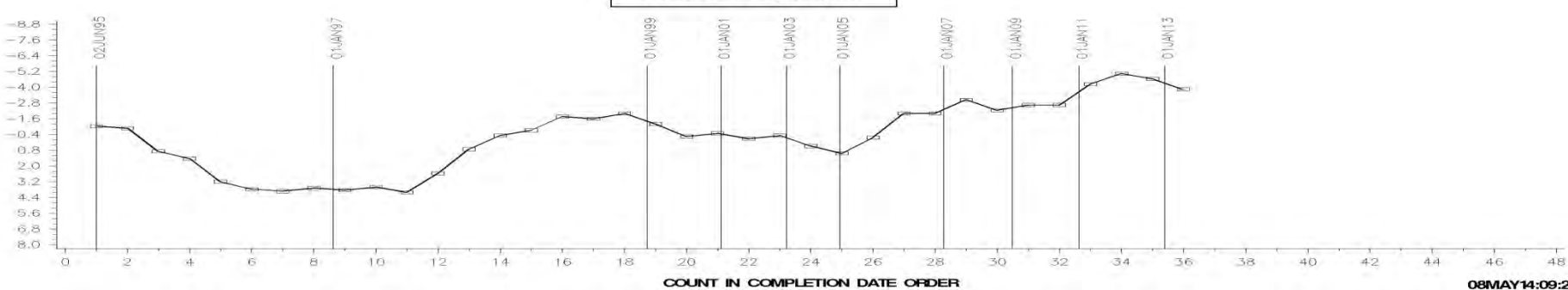
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



08MAY14:09:24

[Return](#)

Test Monitoring Center

<http://astmtmc.cmu.edu>



A Program of ASTM International

Appendix 1.j

RFWT Control Charts

» Severity, Precision, and CuSum

Test Monitoring Center

<http://astmtmc.cmu.edu>

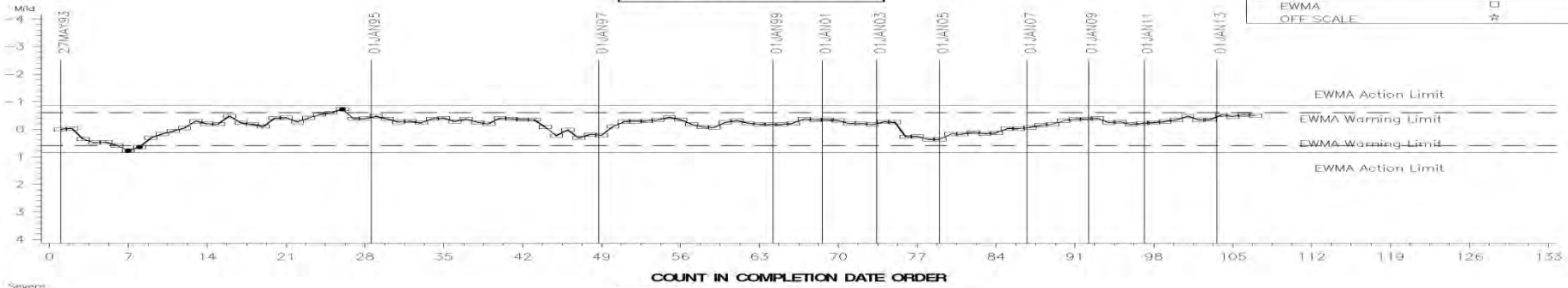


A Program of ASTM International

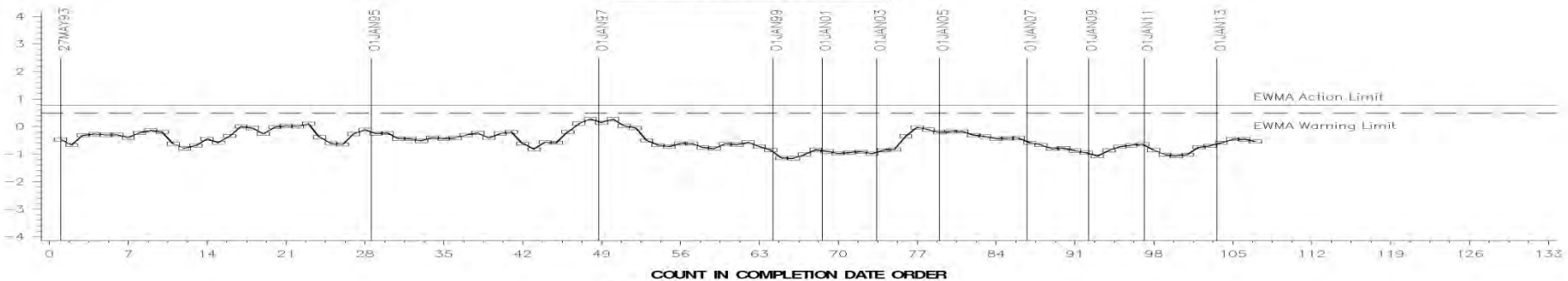
RFWT INDUSTRY OPERATIONALLY VALID DATA

Average Follower Wear

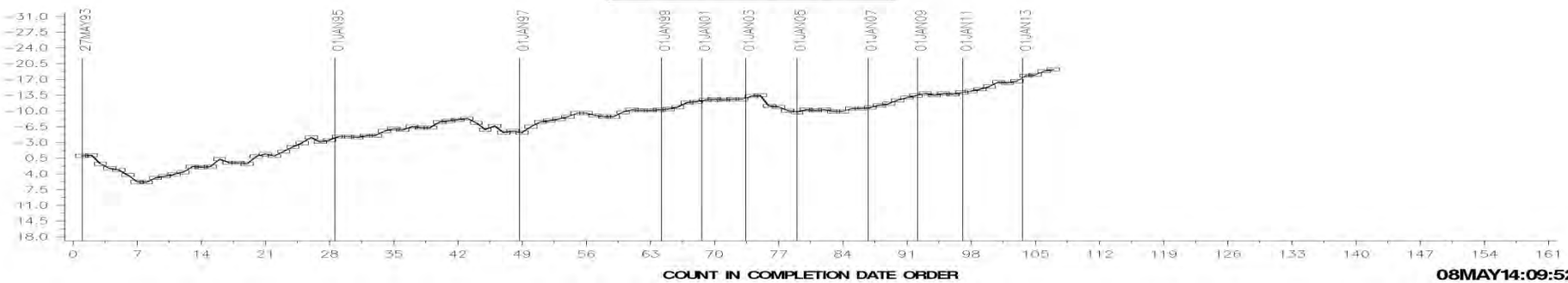
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



08MAY14:09:52

[Return](#)

Test Monitoring Center

<http://astmtmc.cmu.edu>



A Program of ASTM International

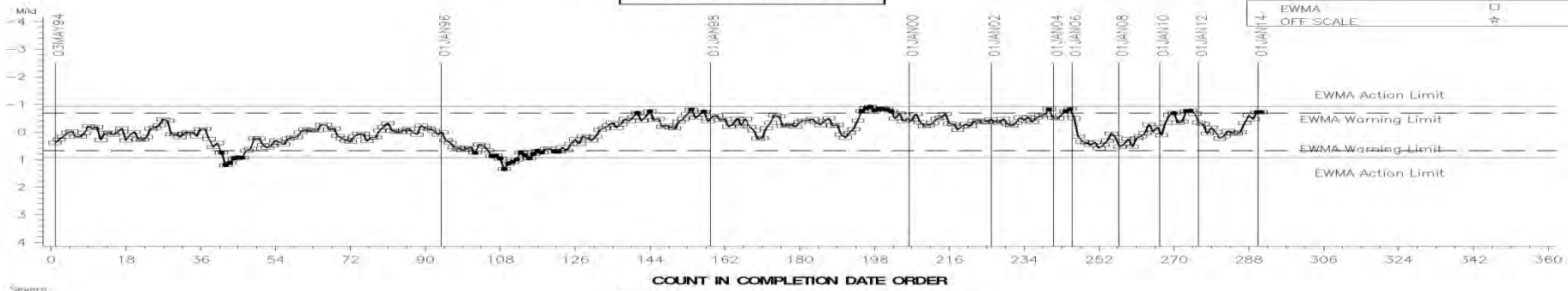
Appendix 1.k

T-8/T-8E Control Charts

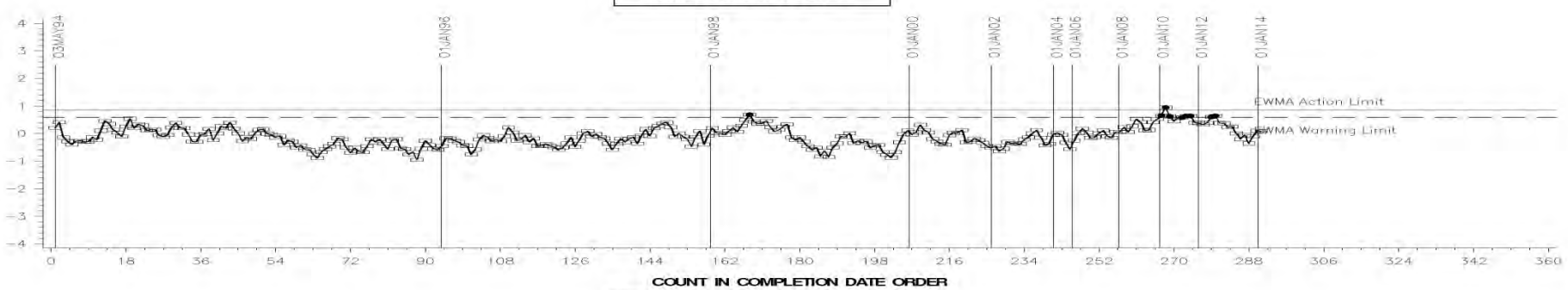
» Severity, Precision, and CuSum

FINAL REFERENCE VISCOSITY AT 3.8% TGA SOOT LEVEL

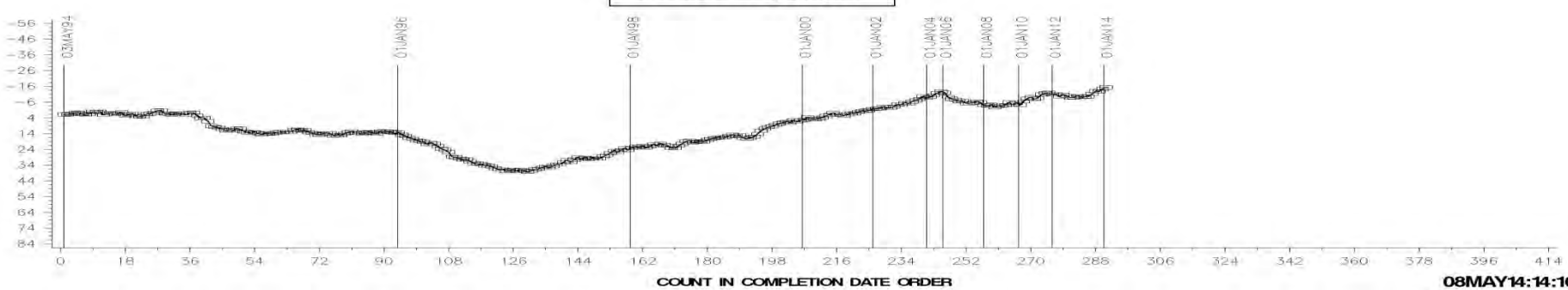
LTMS Severity Analysis



LTMS Precision Analysis



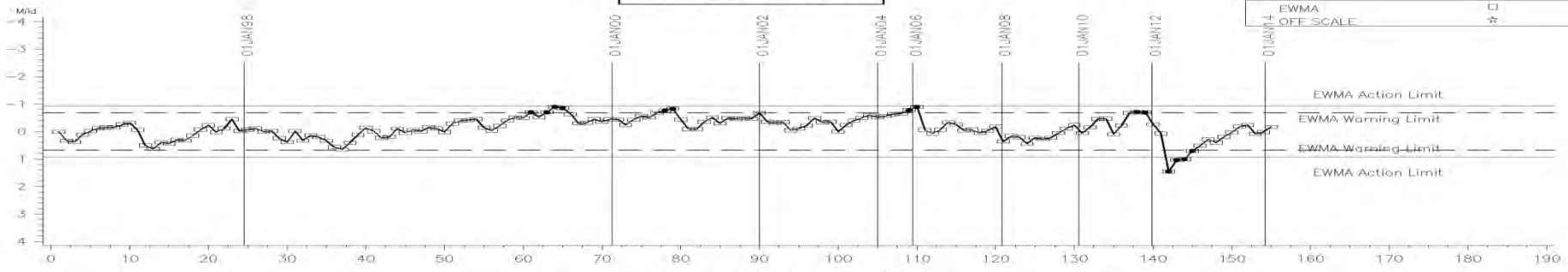
CUSUM Severity Analysis



08MAY14:14:16

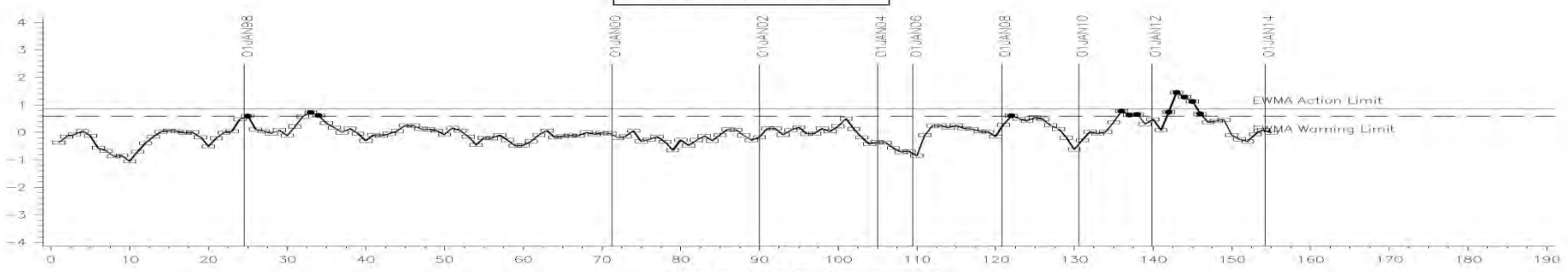
FINAL RELATIVE VISCOSITY (50% LOSS)

LTMS Severity Analysis



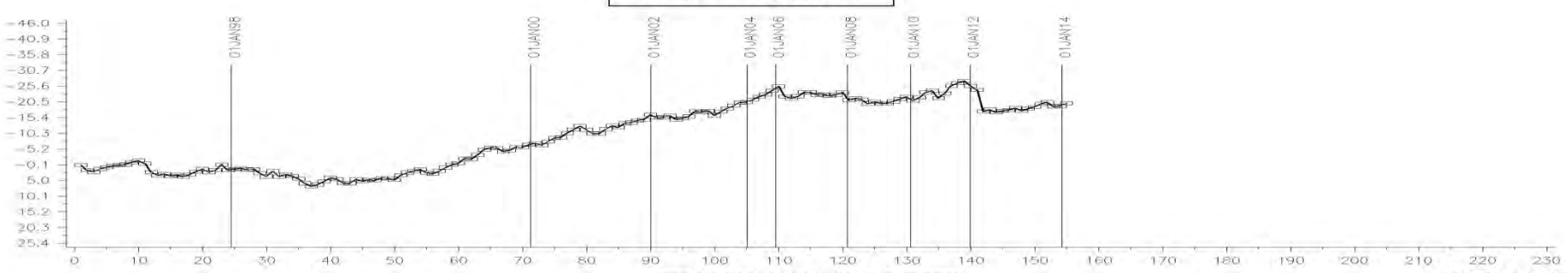
COUNT IN COMPLETION DATE ORDER

LTMS Precision Analysis



COUNT IN COMPLETION DATE ORDER

CUSUM Severity Analysis

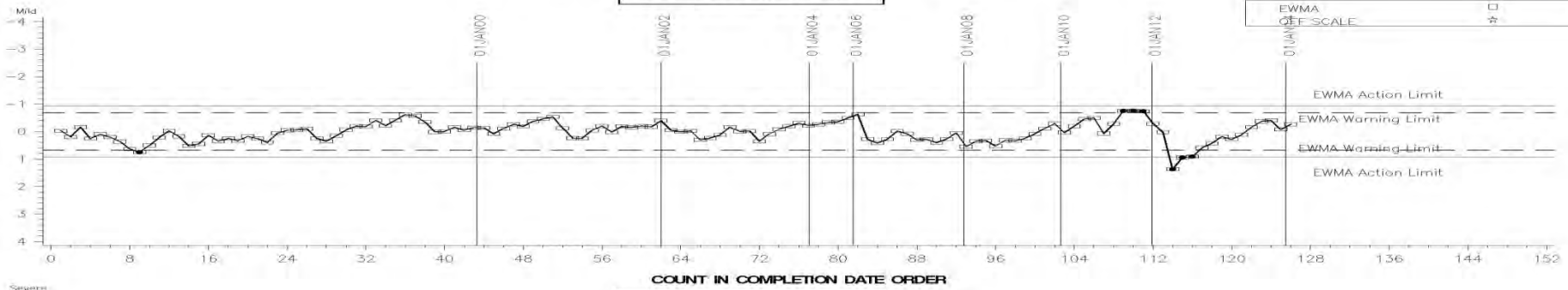


COUNT IN COMPLETION DATE ORDER

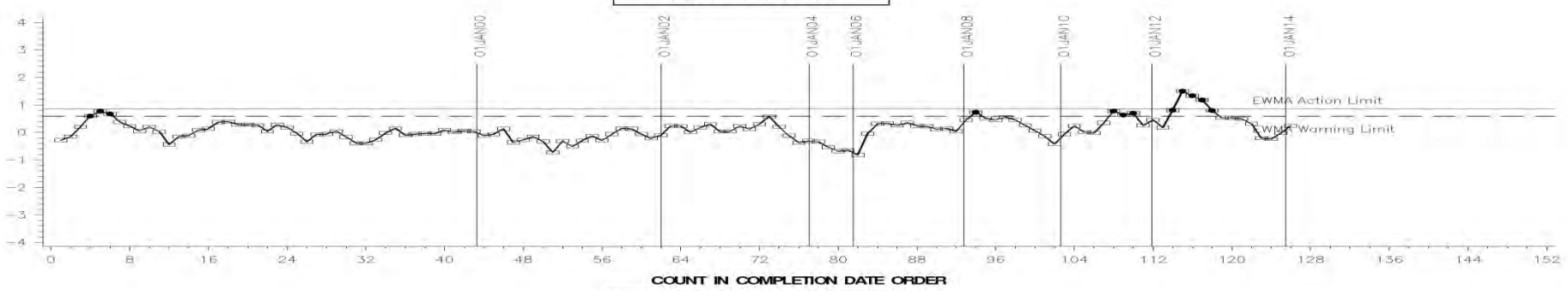
08MAY14:14:16

FINAL RELATIVE VISCOSITY (100% LOSS)

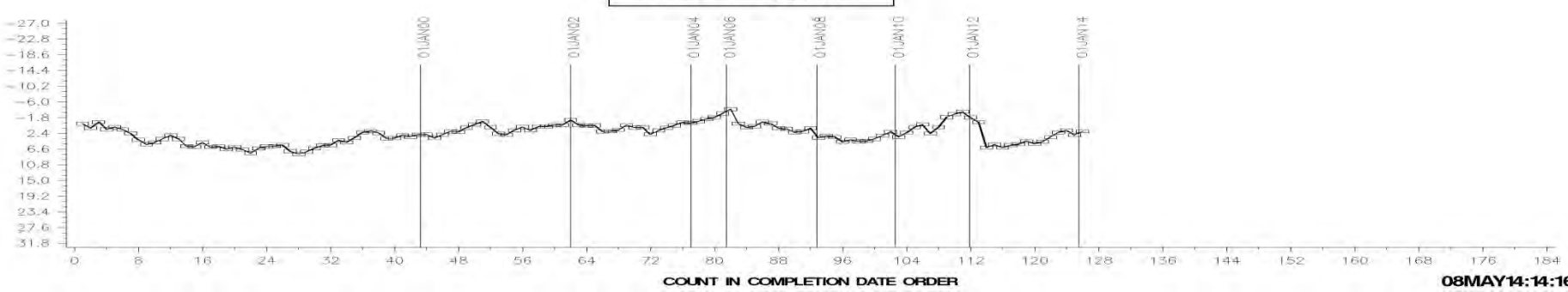
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



08MAY14:14:16

[Return](#)

Appendix 1.1

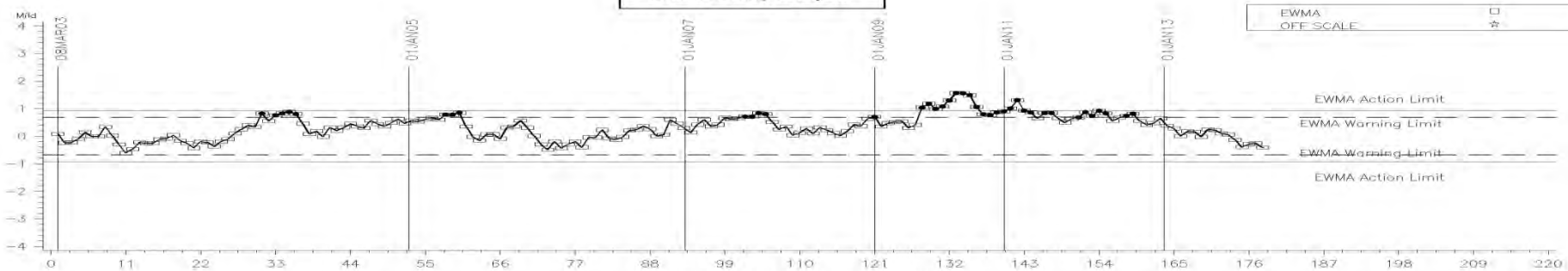
T-11 Control Charts

» Severity, Precision, and CuSum

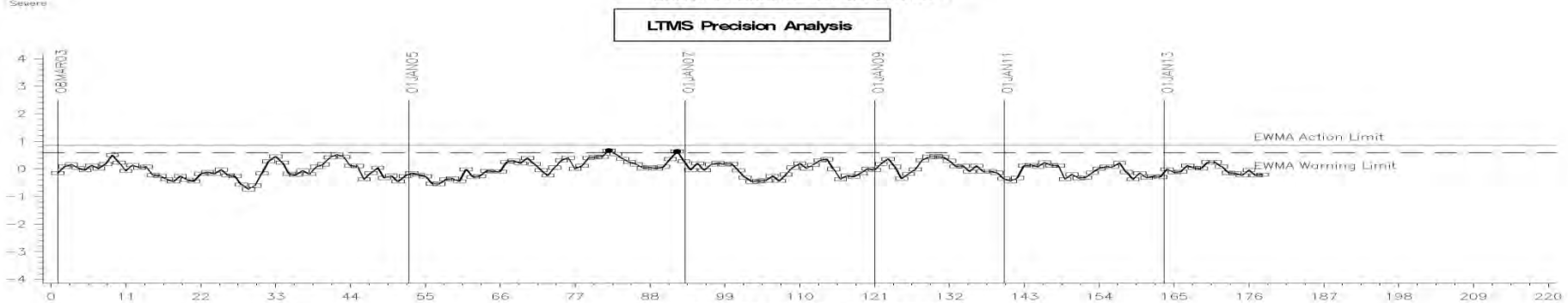
T-11 INDUSTRY OPERATIONAL VALID DATA

SOOT AT 12 cSt

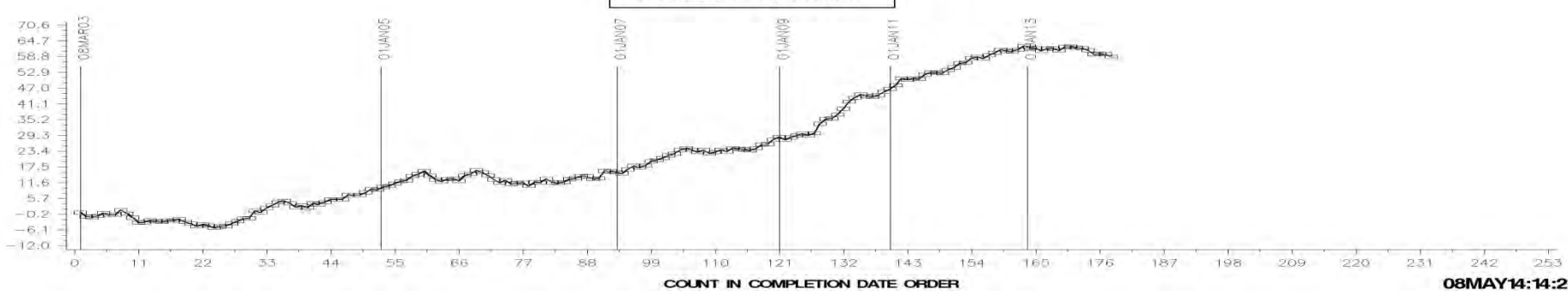
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



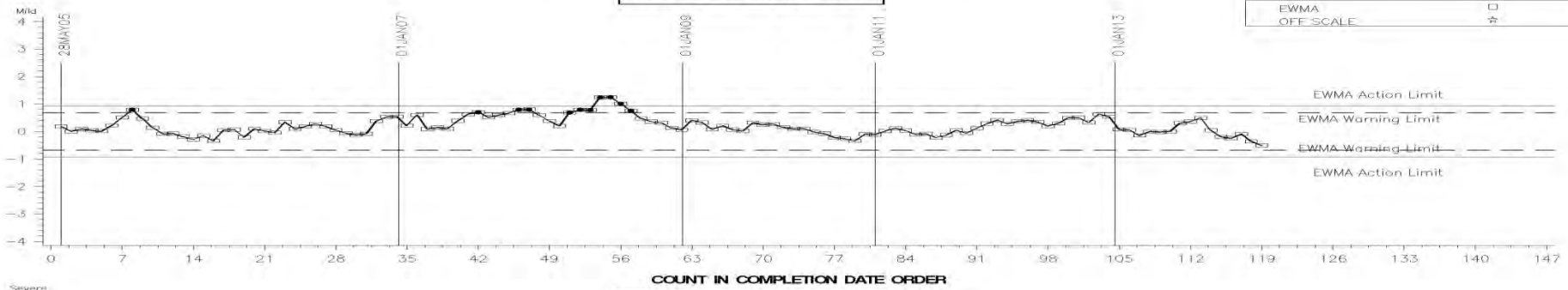
08MAY14:14:21

T-11 INDUSTRY OPERATIONALLY VALID DATA

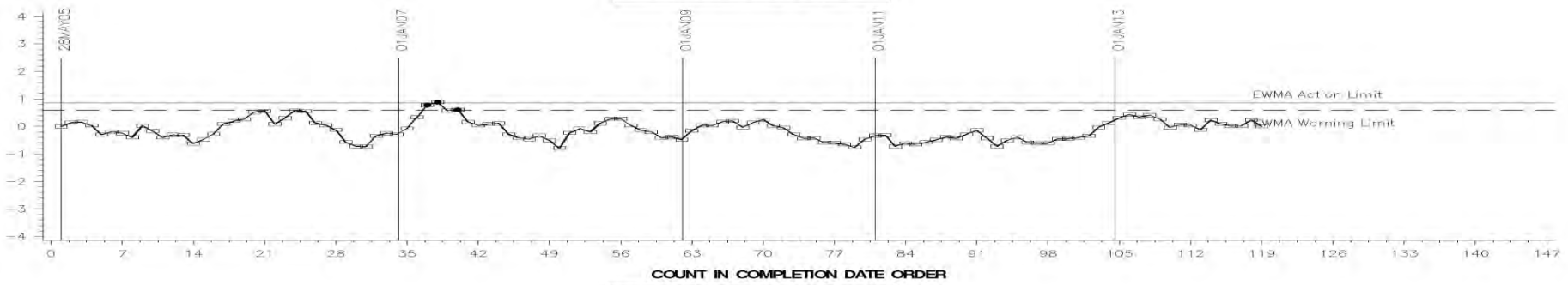


SOOT @ 4 cSt - FINAL RESULT

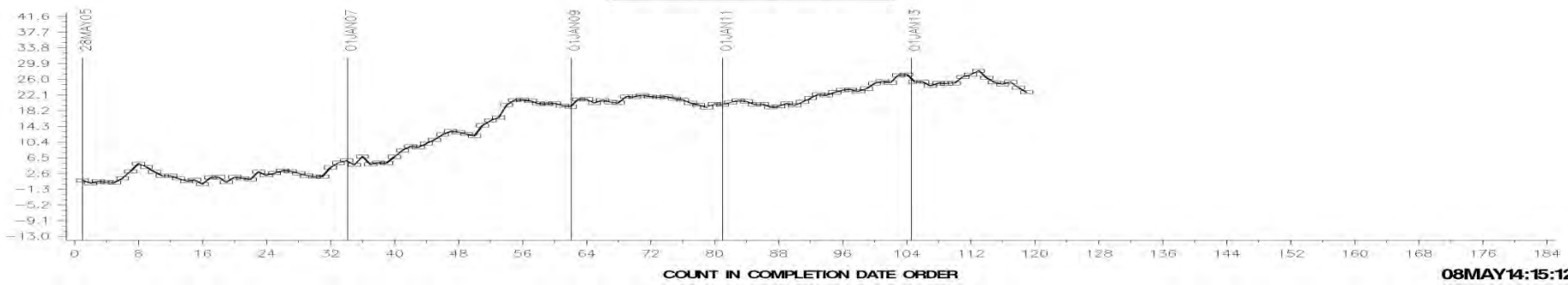
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



08MAY14:15:12

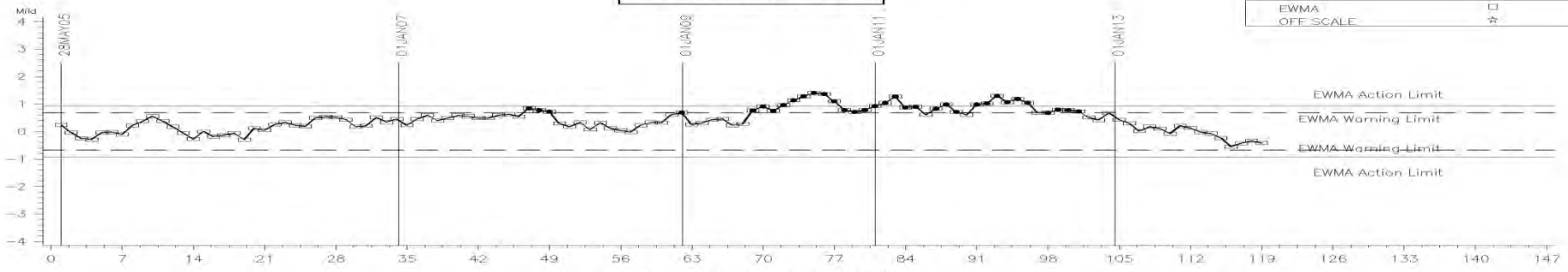


T-11 INDUSTRY OPERATIONALLY VALID DATA

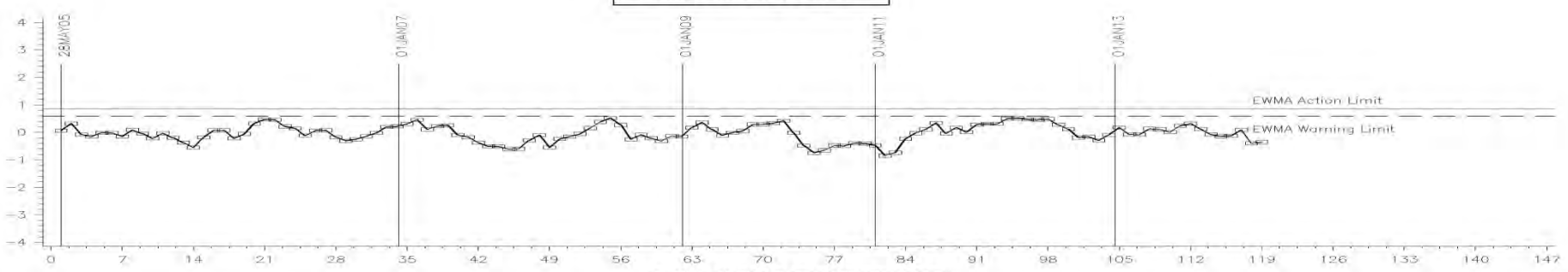


SOOT @ 15 cSt - FINAL RESULT

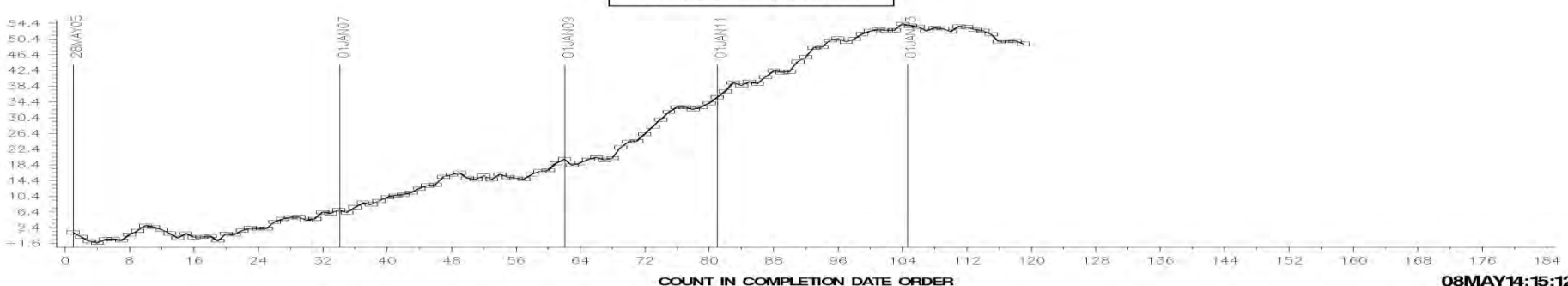
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



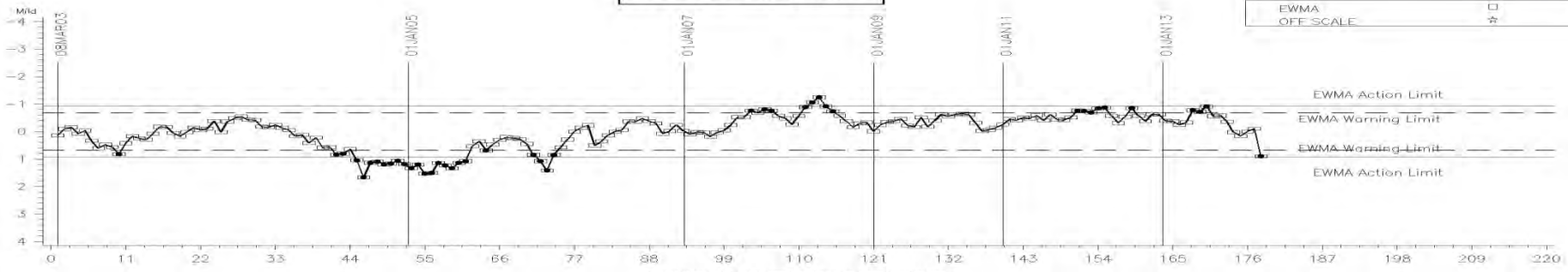
08MAY14:15:12



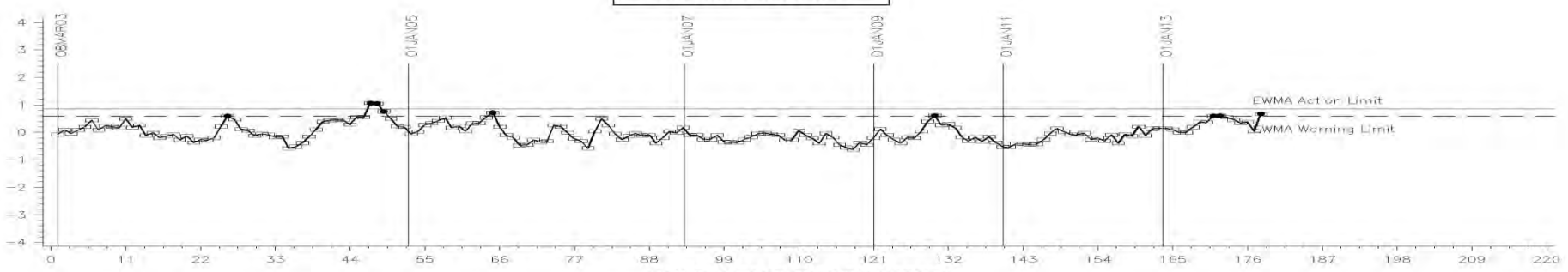
T-11 INDUSTRY OPERATIONALLY VALID DATA



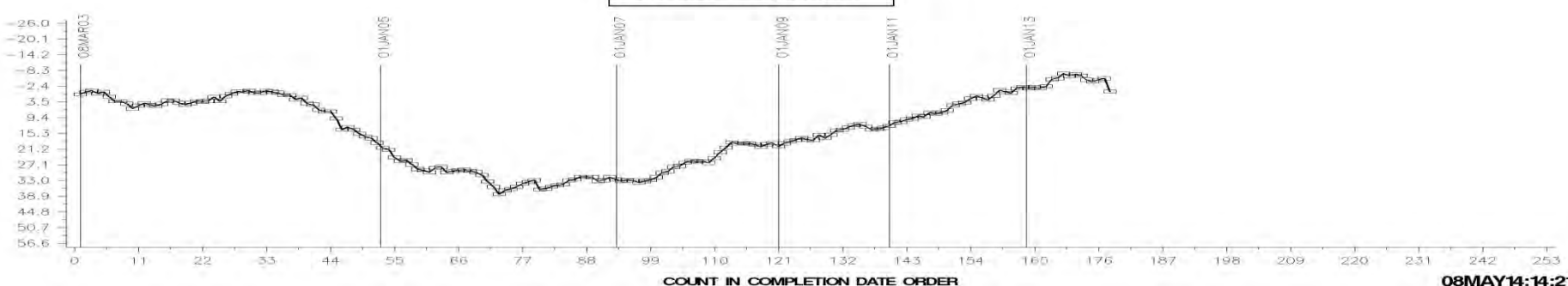
MRV VISCOSITY LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



08MAY14:14:21

[Return](#)

Test Monitoring Center
<http://astmtmc.cmu.edu>



Appendix 1.m

T-12 Control Charts

» Severity, Precision, and CuSum

Test Monitoring Center

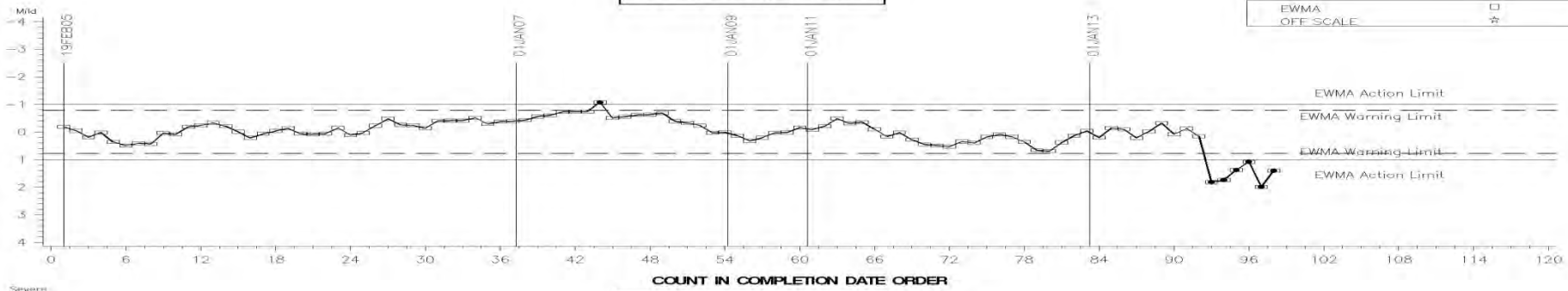
<http://astmtmc.cmu.edu>



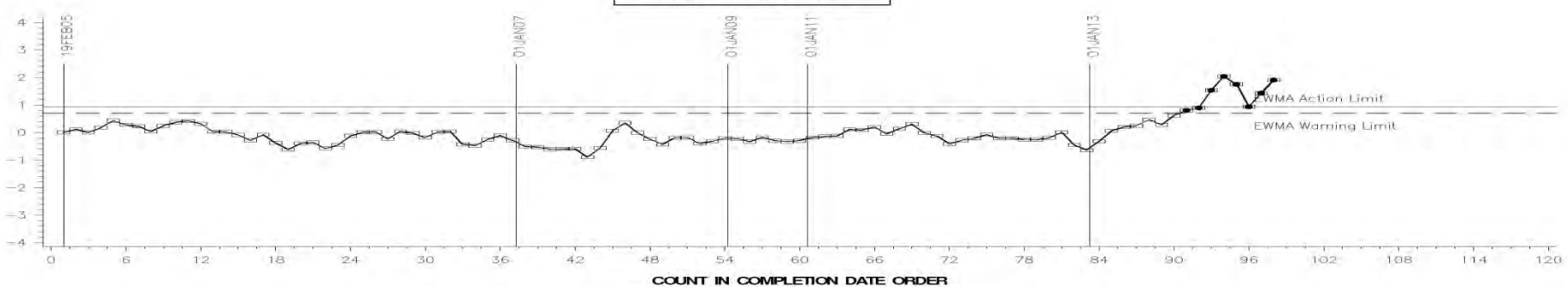
A Program of ASTM International

FINAL TRANS. RES. DELTA PB @ EOT

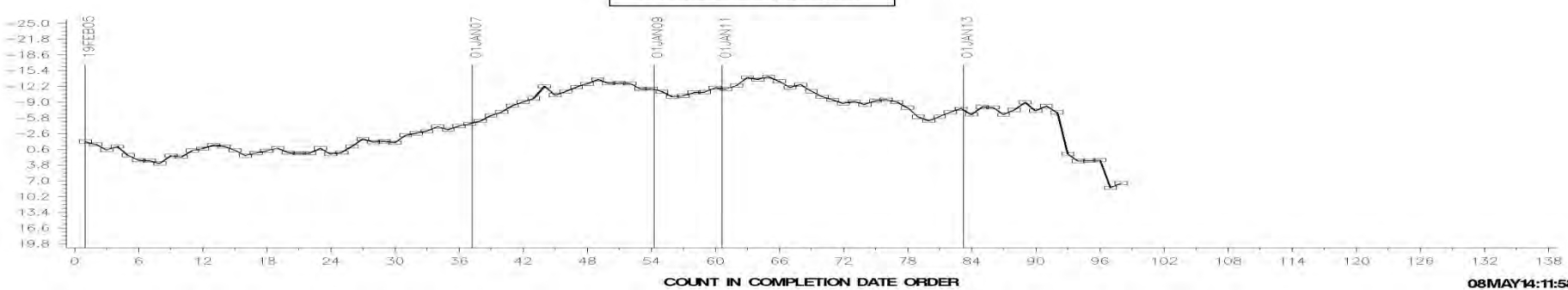
LTMS Severity Analysis



LTMS Precision Analysis



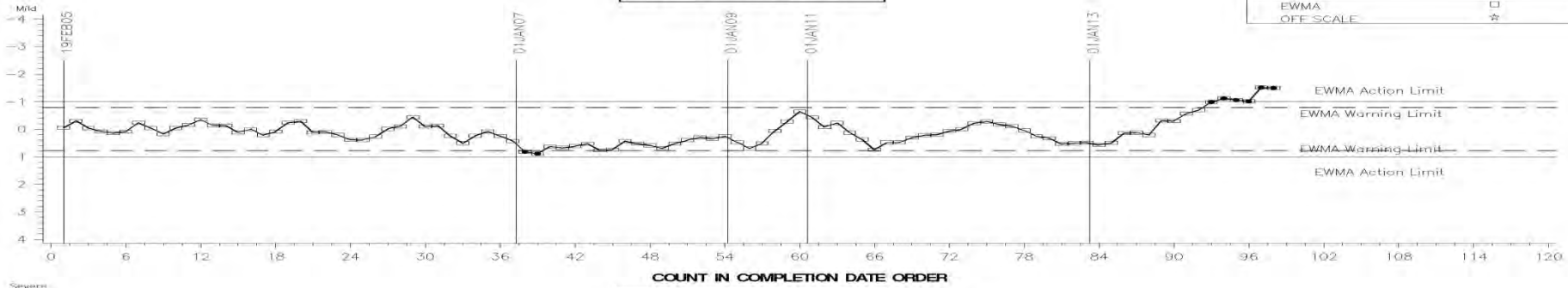
CUSUM Severity Analysis



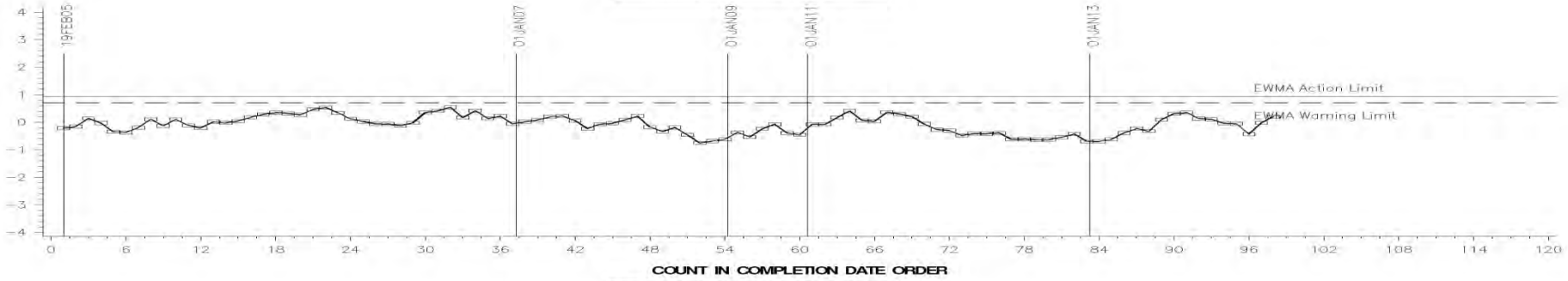
08MAY14:11:58

AVG. CYLINDER LINER WEAR (CLW)

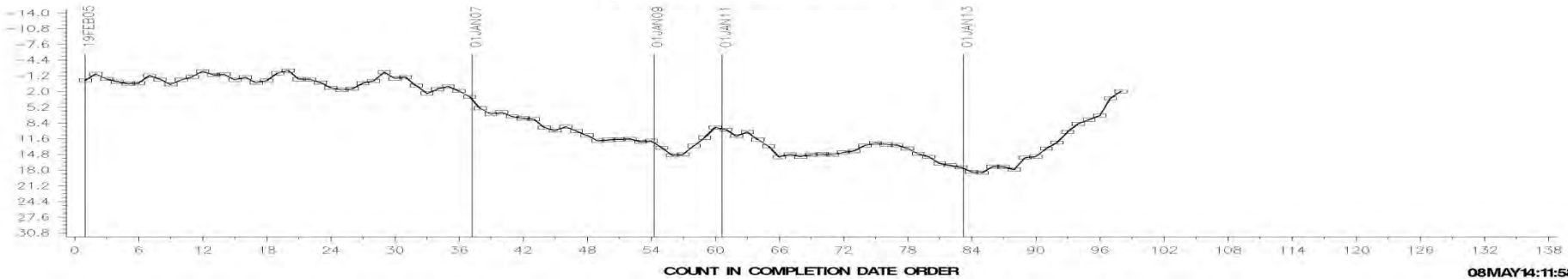
LTMS Severity Analysis



LTMS Precision Analysis



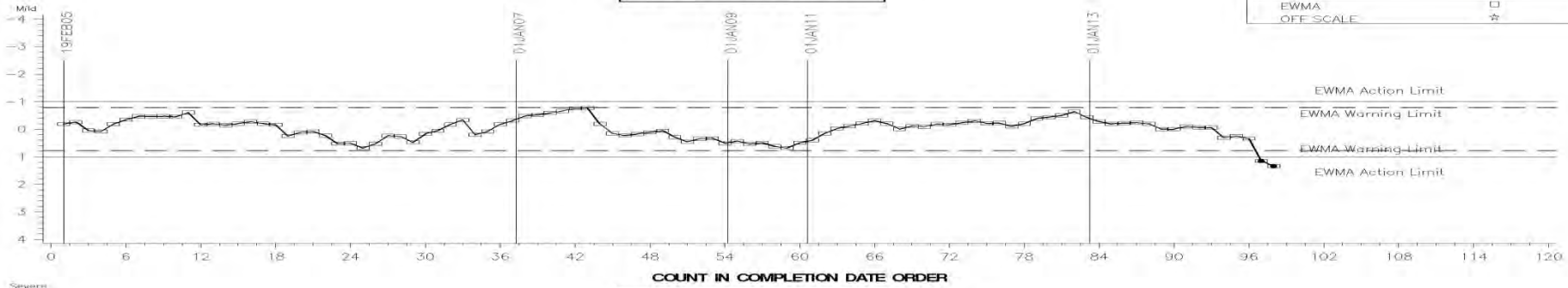
CUSUM Severity Analysis



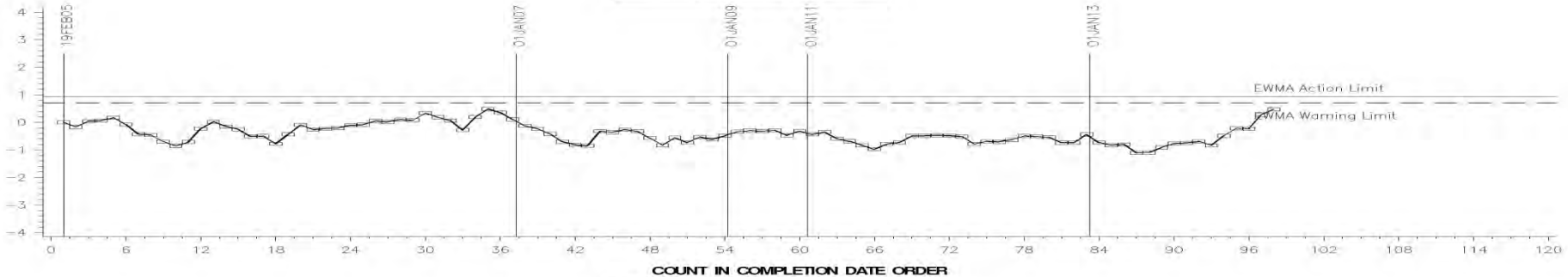
08MAY14:11:58

AVG. TOP RING WEIGHT LOSS (TRWL)

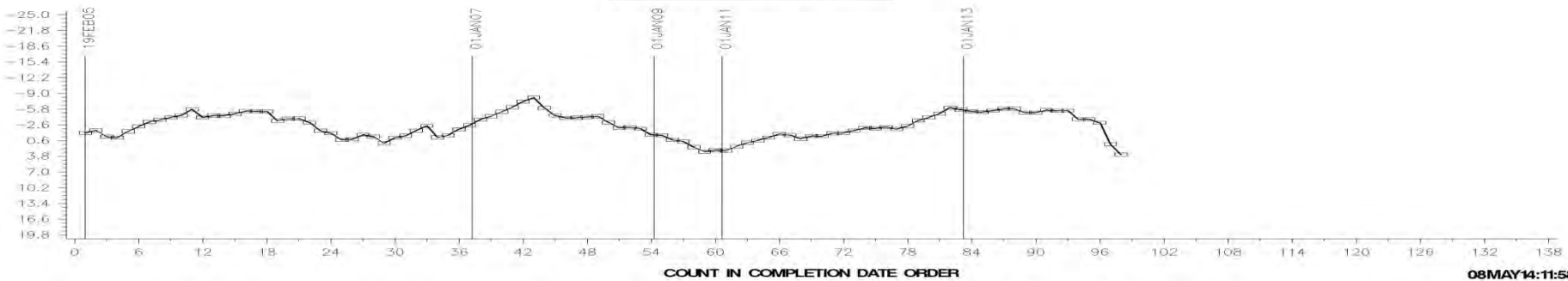
LTMS Severity Analysis



LTMS Precision Analysis



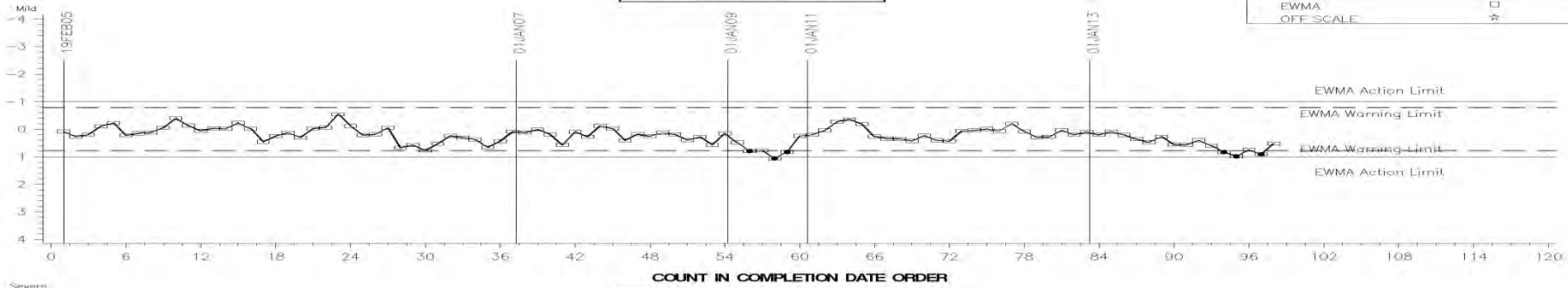
CUSUM Severity Analysis



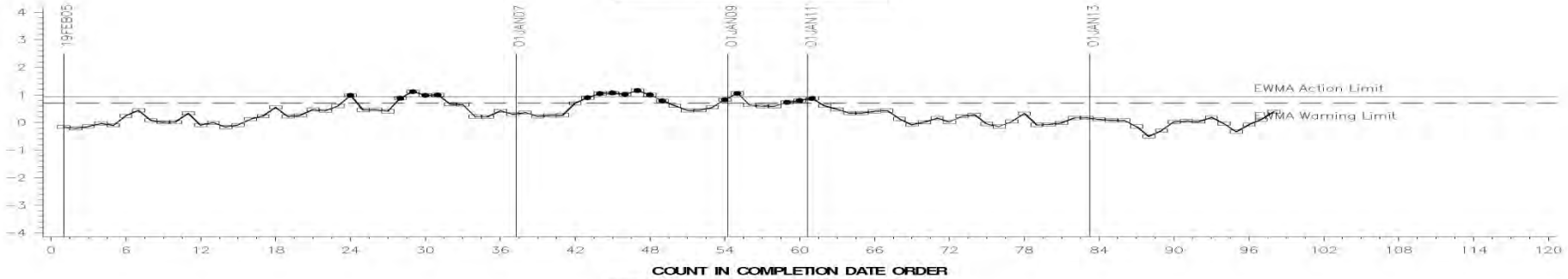
08MAY14:11:58

FINAL TRANS. RES. OIL CONSUMPTION

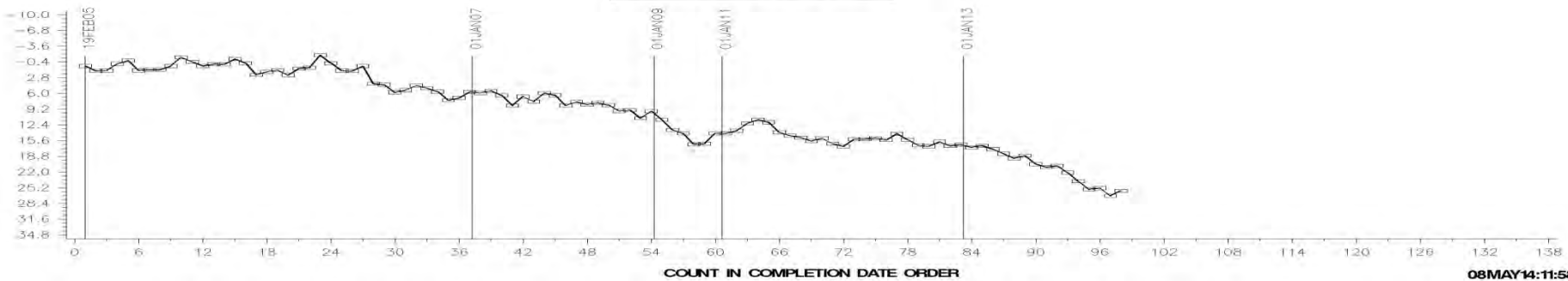
LTMS Severity Analysis



LTMS Precision Analysis

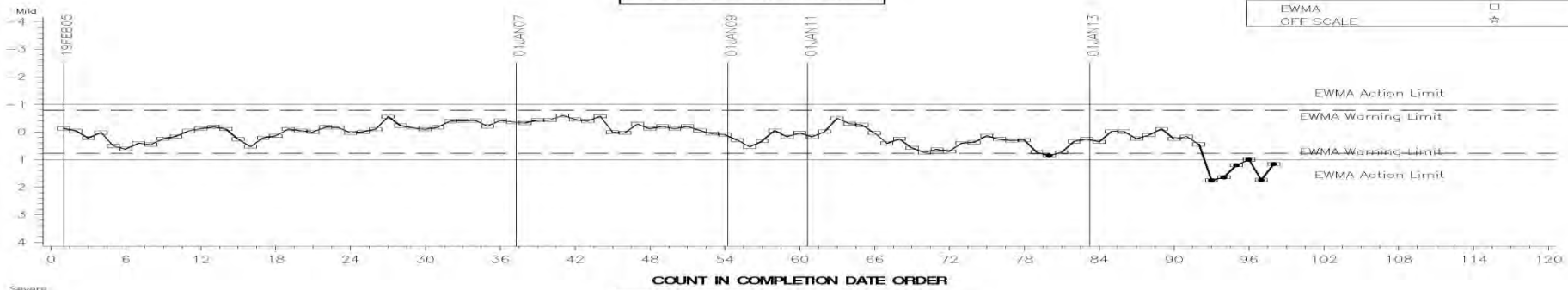


CUSUM Severity Analysis

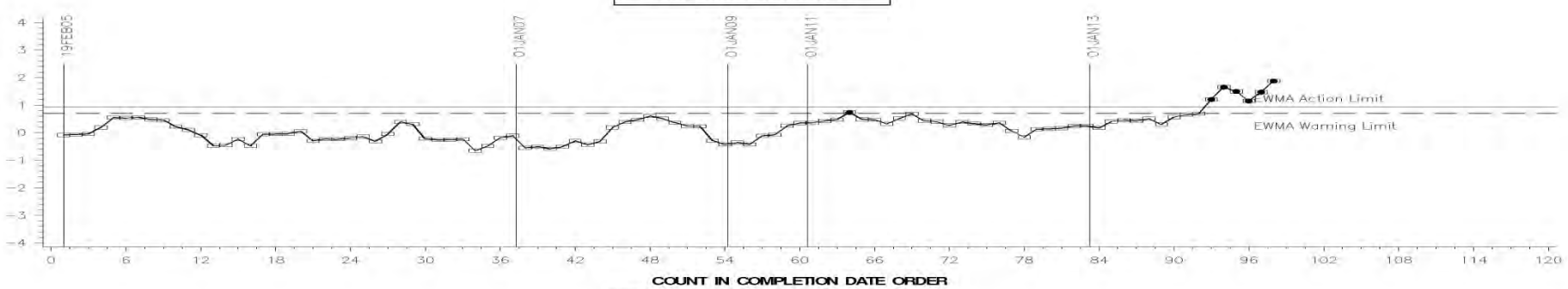


08MAY14:11:58

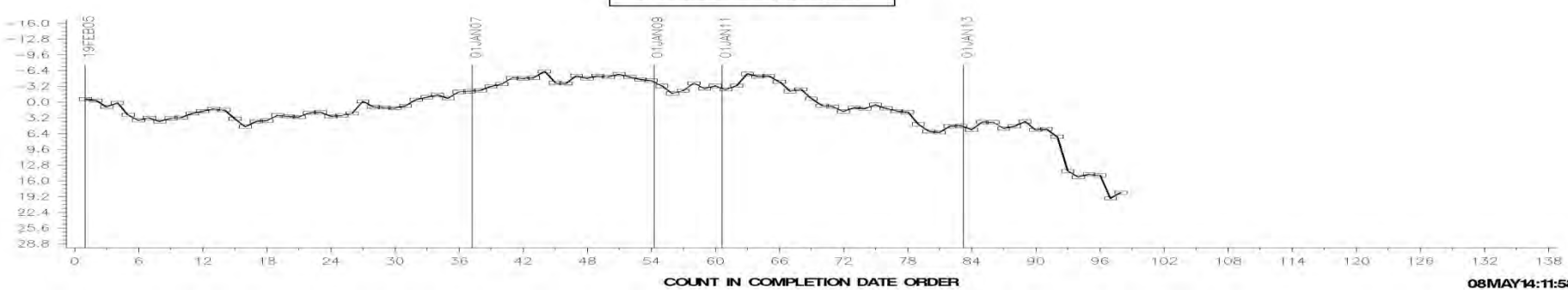
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



08MAY14:11:58

[Return](#)

Test Monitoring Center

<http://astmtmc.cmu.edu>



A Program of ASTM International

Appendix 1.n

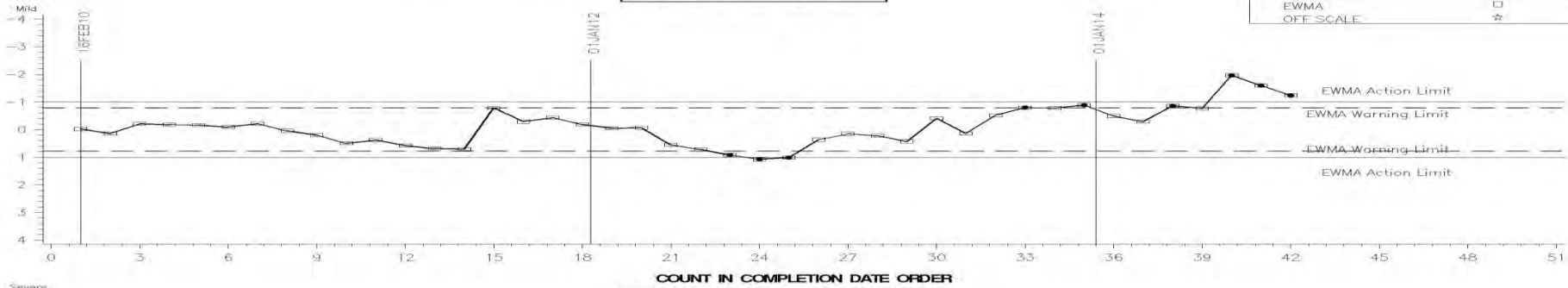
T-12A Control Charts

» Severity, Precision, and CuSum

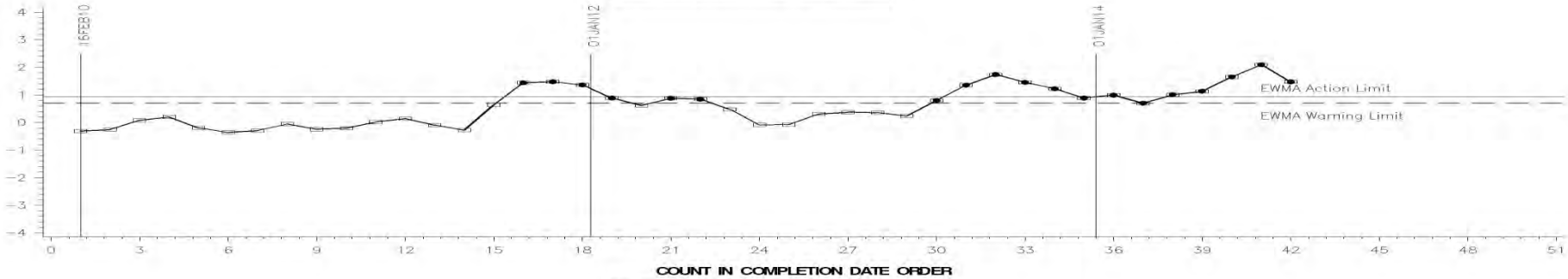
MACK T-12A INDUSTRY OPERATIONALLY VALID DATA

FINAL ORIGINAL UNIT MRV VISCOSITY [NM, SOLID, FROZEN, <, >]

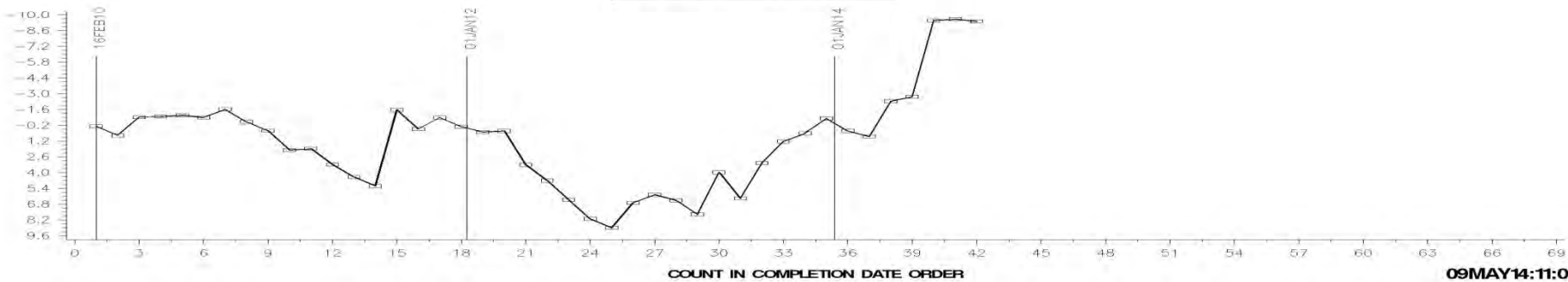
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



09MAY14:11:08

[Return](#)

Test Monitoring Center

<http://astmtmc.cmu.edu>



A Program of ASTM International