



A Program of ASTM International

Test Monitoring Center

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

April 2015

Table of Contents

| Section | Topic |
|-------------------|--|
| Executive Summary | |
| | Summary Items |
| | Calibrated Labs and Stands |
| CAT Tests | |
| | 1K |
| | 1N |
| | 1M-PC |
| | 1P |
| | 1R |
| | C13 |

Table of Contents

| Section | Topic |
|-------------------------|---------------------------------|
| Cummins Tests | |
| | <u>ISB</u> |
| | <u>ISM</u> |
| Light Duty Diesel Tests | |
| | <u>EOAT</u> |
| | <u>RFWT</u> |
| Mack Tests | |
| | <u>T-8/T-8E</u> |
| | <u>T-11</u> |
| | <u>T-12</u> |
| | <u>T-12A</u> |

Table of Contents

| Section | Topic |
|------------------------|---|
| Additional Information | |
| | <u>Information Letters</u> |
| | <u>Reference Oil Inventory</u> |
| | <u>LTMS Deviations</u> |
| | <u>Quality Index Deviations</u> |
| | <u>TMC Laboratory Visits</u> |
| | <u>Test Area Time Lines</u> |
| | <u>Rating Workshop Data</u> |
| | <u>Misc. Information</u> |

Heavy Duty Testing

Executive Summary

- ▶ Reference Oils
 - 831-2
 - Reblend, 831-3, has been received and shipped to labs for C13 and ISB testing.
- ▶ 1 P Liners availability
 - New supplier has been found and new liner batch is being evaluated. New liners could be available as soon as late May.

[Return to Table of Contents](#)

Calibrated Labs and Stands*

| Test | Labs | Stands |
|------------|------|--------|
| 1K | 3 | 3 |
| 1N | 4 | 8 |
| 1M-PC | 1 | 1 |
| 1P | 2 | 2 |
| 1R | 1 | 1 |
| C13 | 2 | 5 |
| ISB | 3 | 9 |
| ISM | 4 | 7 |
| EOAT | 1 | 1 |
| RFWT | 2 | 2 |
| T-8/E | 2 | 4 |
| T-11 | 4 | 7 |
| T-12/T-12A | 4/4 | 11/11 |
| T-13 | 5 | 13 |
| COAT | 3 | 3 |

*As of 03/31/2015

[Return to Table of Contents](#)

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SCOTE 1K

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1 K Test Activity

| Test Status | Validity Code | # |
|-----------------------------|---------------|----------|
| Acceptable Calibration Test | AC | 1 |
| Failed Calibration Test | OC | 0 |
| Operationally Invalid | LC | 0 |
| Aborted | XC | 0 |
| Total | | 1 |

1 K Failed Tests

| Failed Parameter | Number of Tests |
|------------------|-----------------|
| No failed tests | |
| Total | 0 |

1 K Lost Tests*

| Status | Cause | # |
|--------------|------------------|----------|
| Invalid | No invalid tests | |
| Aborted | No aborted tests | |
| Total | | 0 |

*Invalid and aborted tests

1 K Test Severity

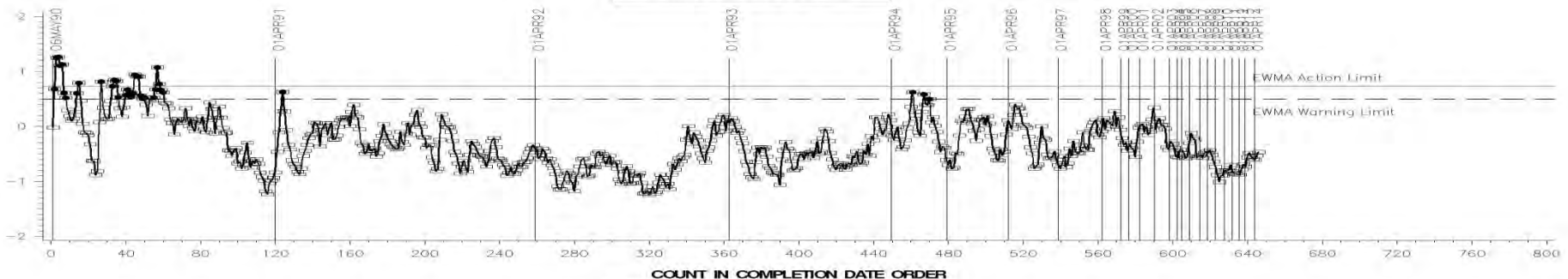
- ▶ WDK, TLHC, ETOC are in control. WDK near warning limit.
- ▶ TGF and TLHC
 - Within Chart Limits but near warning limit.
 - Long-term mild trend continuing
- ▶ BSOC in Warning Limit in the mild direction
 - Long-term mild trend continuing

FINAL TGF

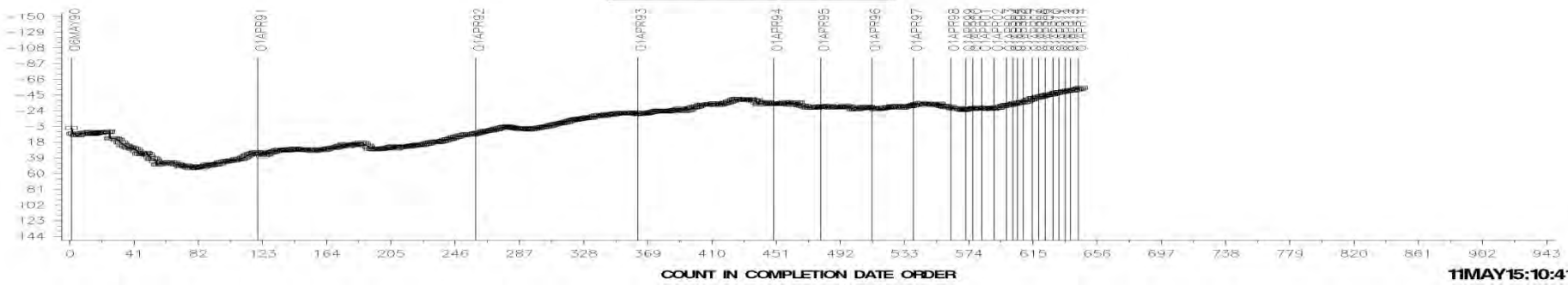
LTMS Severity Analysis



LTMS Precision Analysis



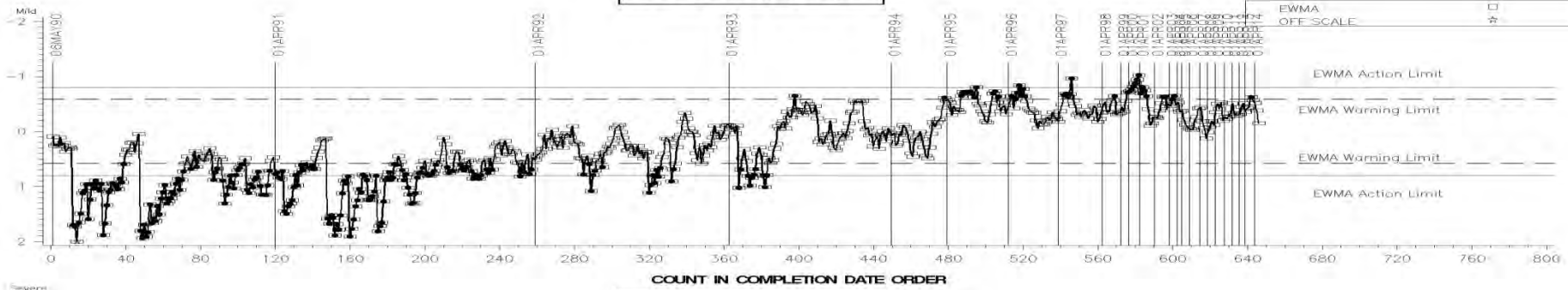
CUSUM Severity Analysis



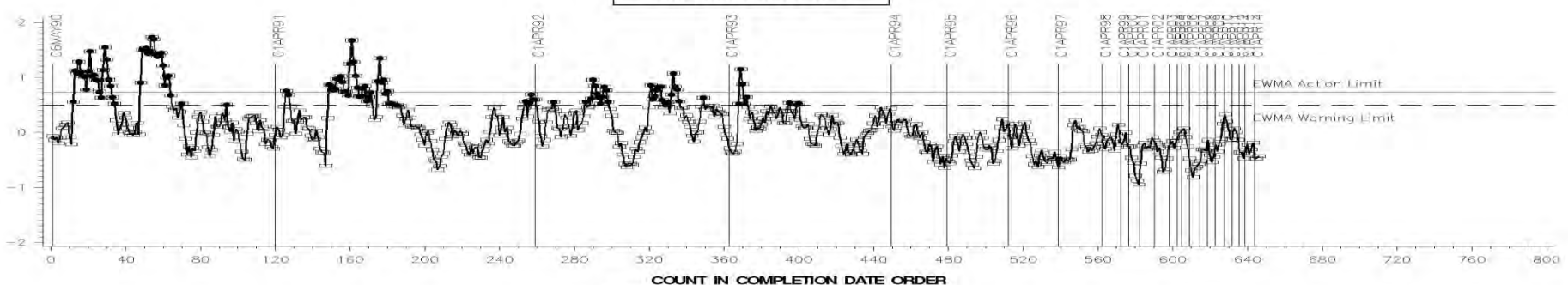
11MAY15:10:41

FINAL Weighted Total Demerits

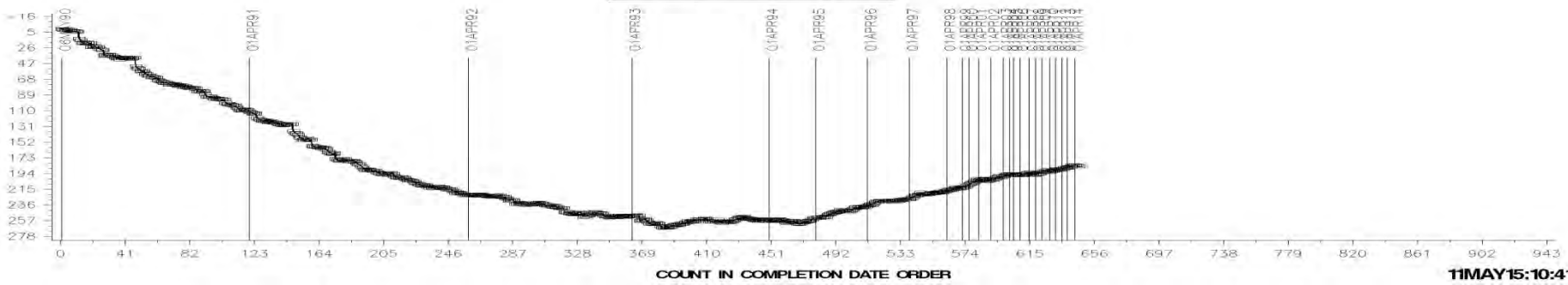
LTMS Severity Analysis



LTMS Precision Analysis



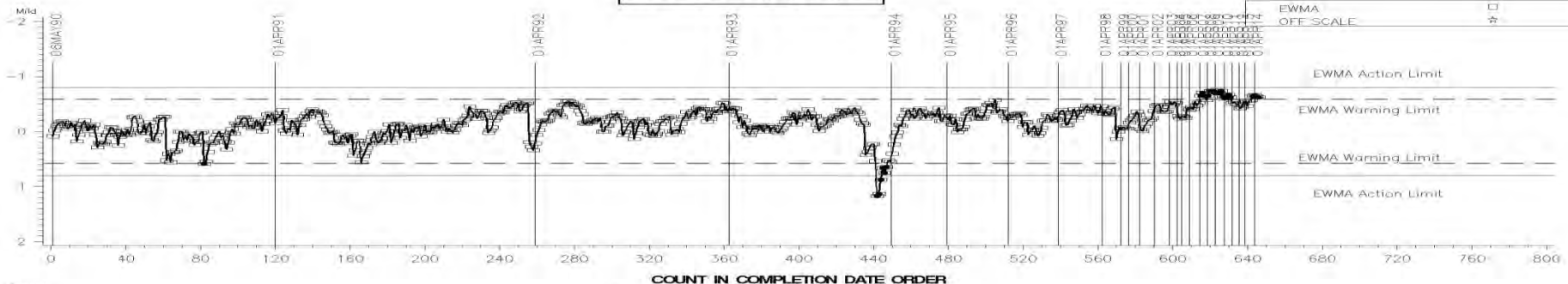
CUSUM Severity Analysis



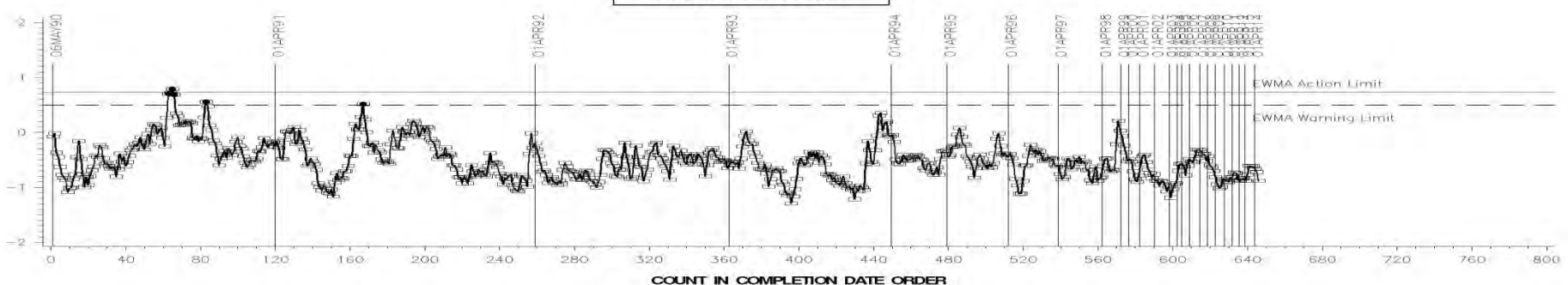
11MAY15:10:41

FINAL BSOC

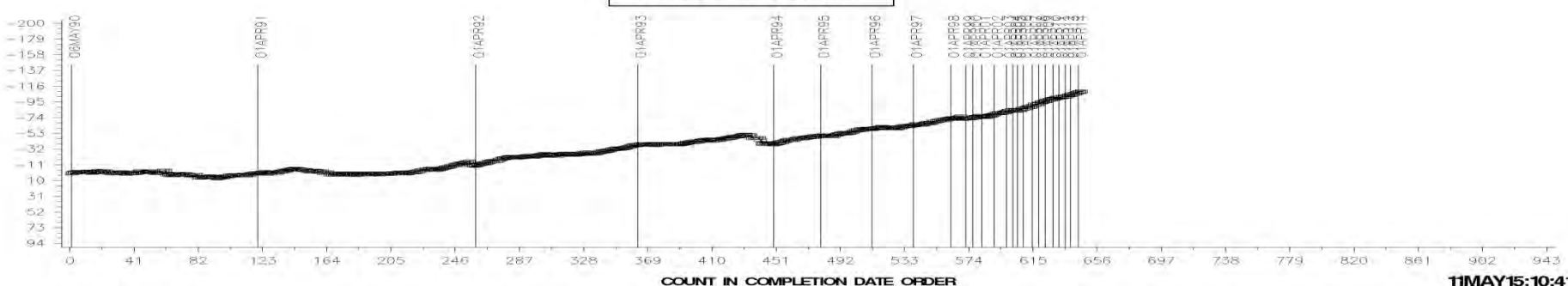
LTMS Severity Analysis



LTMS Precision Analysis



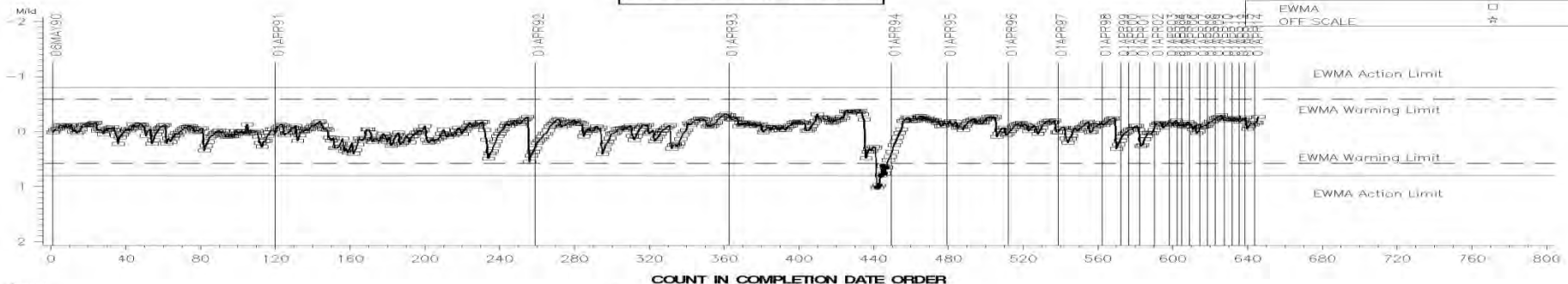
CUSUM Severity Analysis



11MAY15:10:41

FINAL EOTC

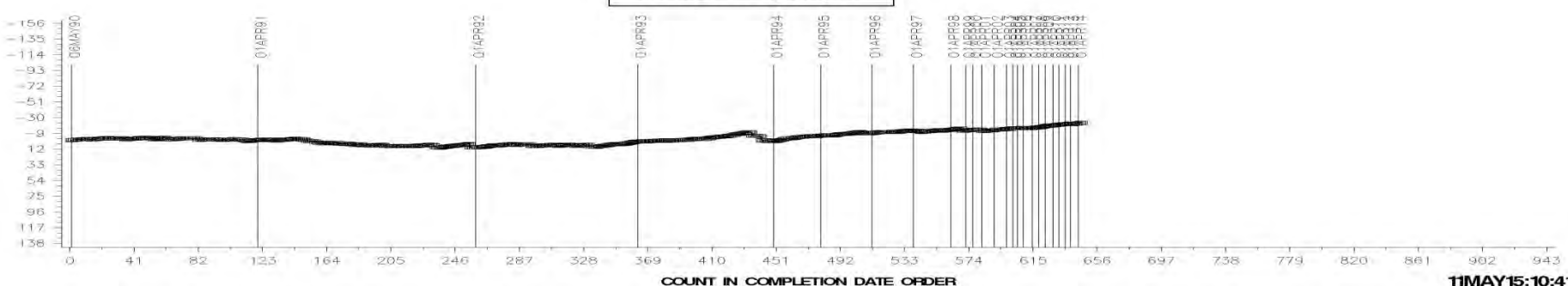
LTMS Severity Analysis



LTMS Precision Analysis

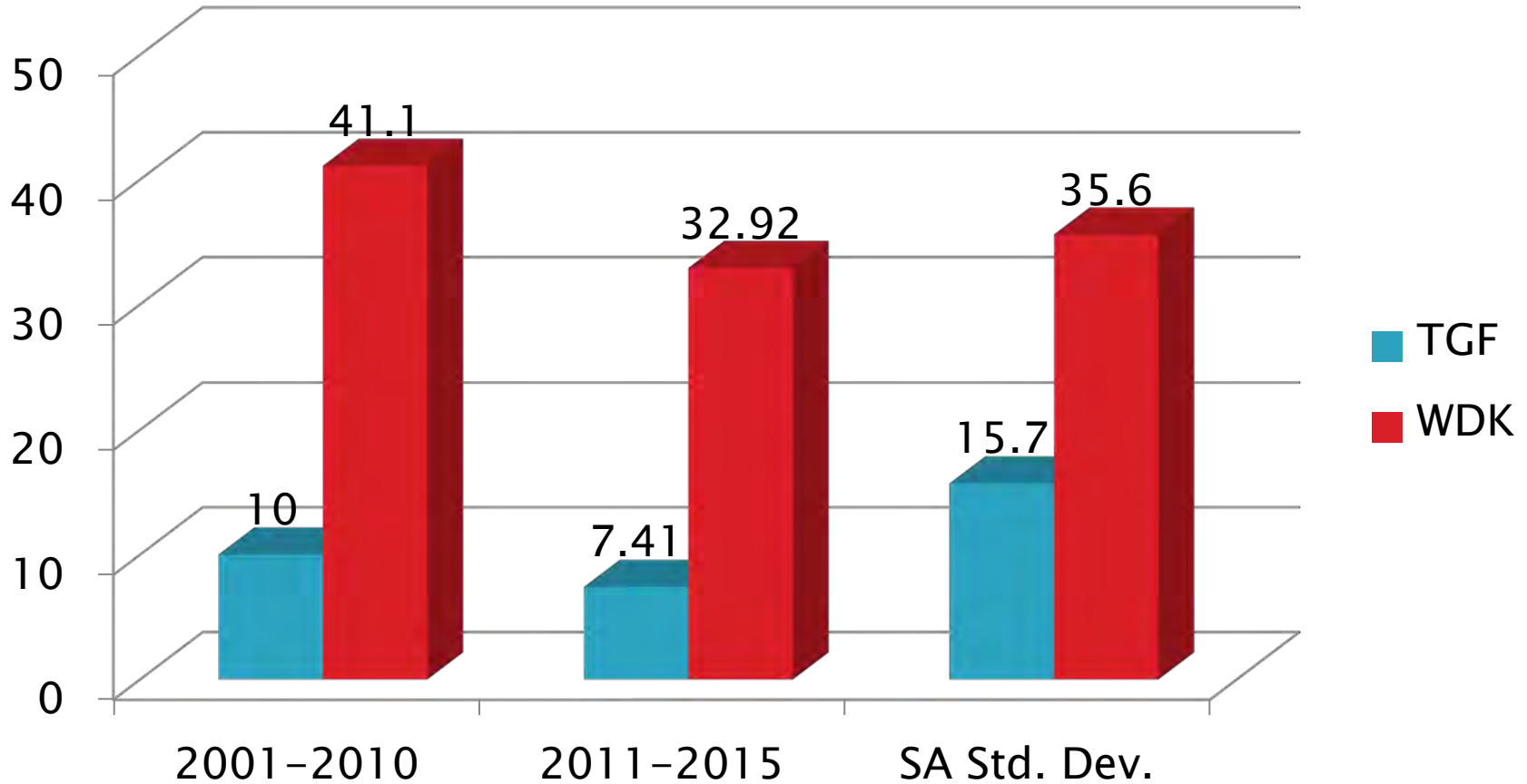


CUSUM Severity Analysis

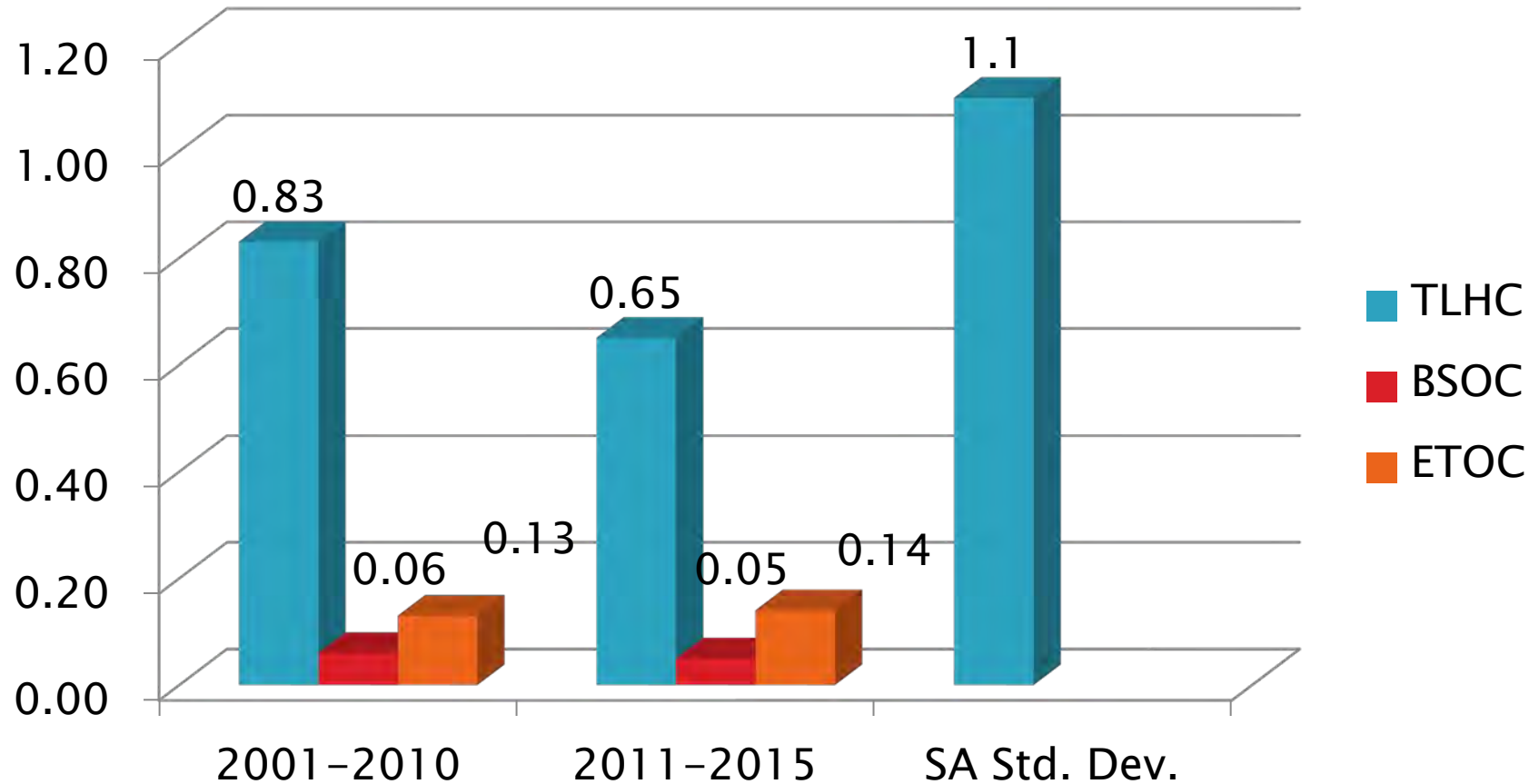


11MAY15:10:41

1 K Precision Estimates



1 K Precision Estimates



[Return to Table of Contents](#)

SCOTE 1N

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1 N Test Activity

| Test Status | Validity Code | # |
|-----------------------------|---------------|----------|
| Acceptable Calibration Test | AC | 6 |
| Failed Calibration Test | OC | 0 |
| Operationally Invalid | LC | 0 |
| Aborted | XC | 0 |
| Total | | 6 |

1 N Failed Tests

| Failed Parameter | Number of Tests |
|------------------|-----------------|
| No failed tests | |
| Total | 0 |

1 N Lost Tests*

| Status | Cause | # |
|--------------|------------------|----------|
| Invalid | No invalid tests | |
| Aborted | No aborted tests | |
| Total | | 0 |

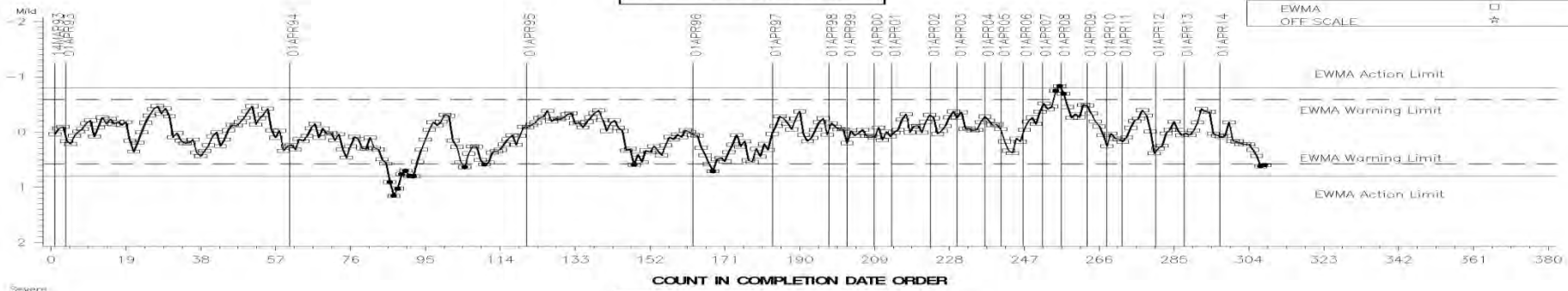
*Invalid and aborted tests

1 N Test Severity

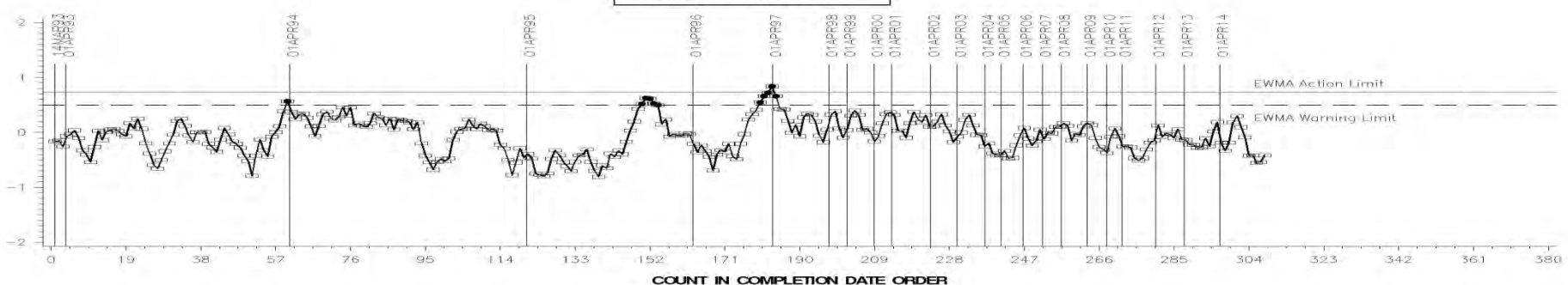
- ▶ BSOC and TLHC in action alarm
- ▶ WDN in control
- ▶ TGF in warning alarm mild direction
- ▶ TGF, WDN, TLHC, and BSOC trending mild
- ▶ Severity trends are being evaluated by surveillance panel
- ▶ New TGF transform instituted along with CF
- ▶ TLHC CF removed

FINAL CORRECTED TGF

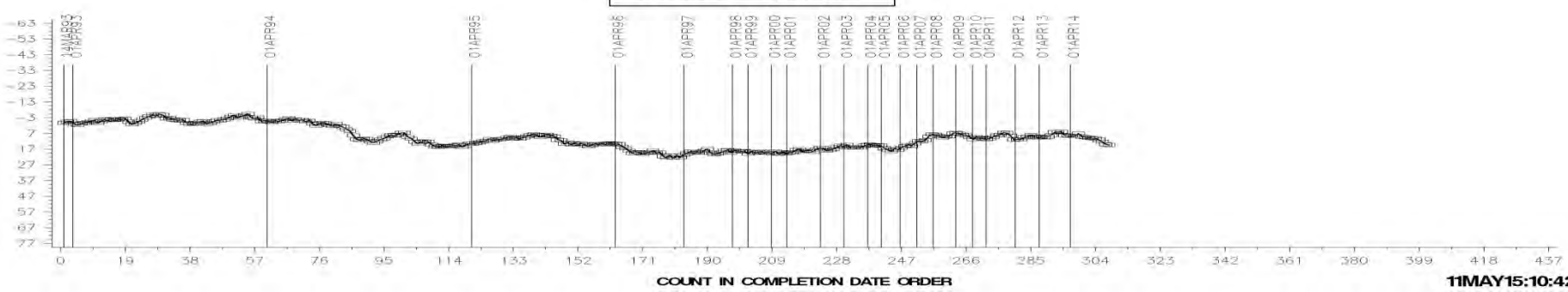
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



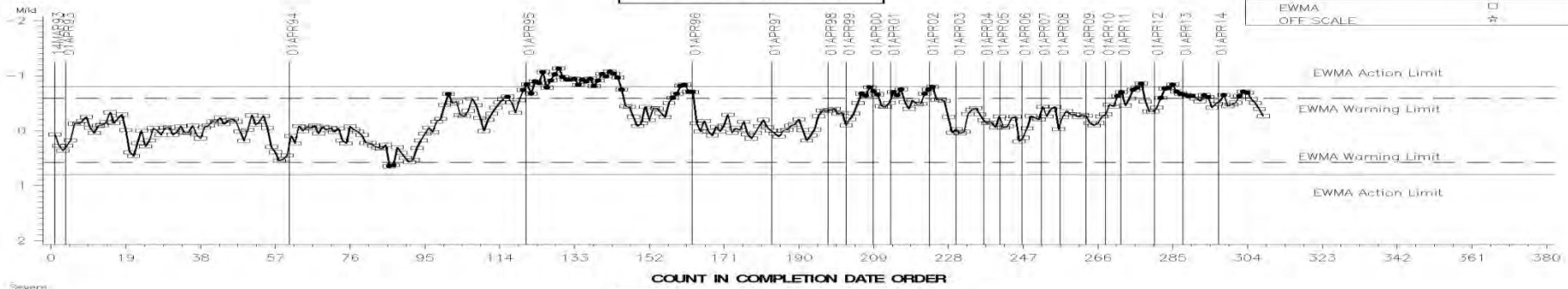
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CATERPILLAR 1N INDUSTRY OPERATIONALLY VALID DATA

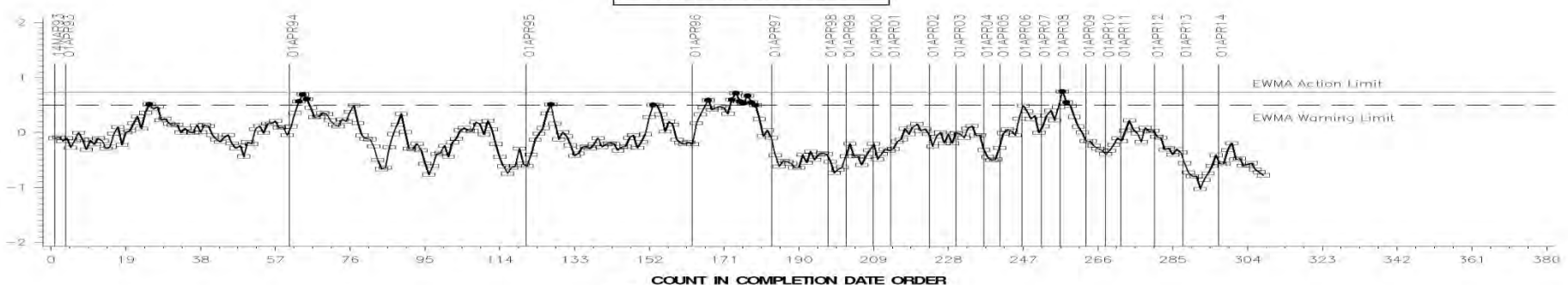


Weighted Total Demerits

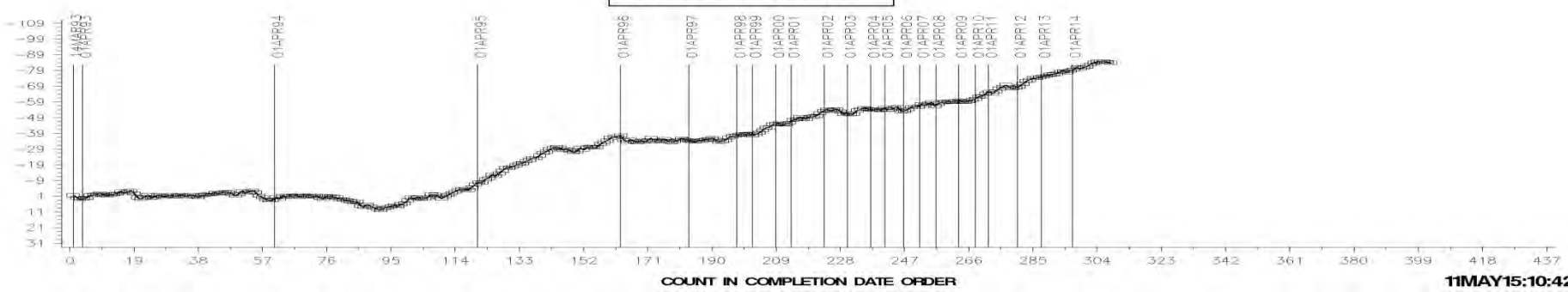
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis

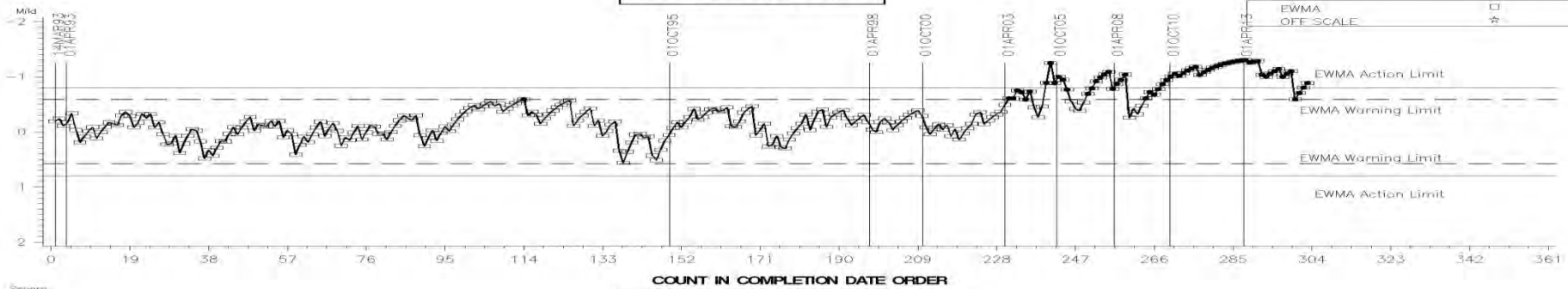


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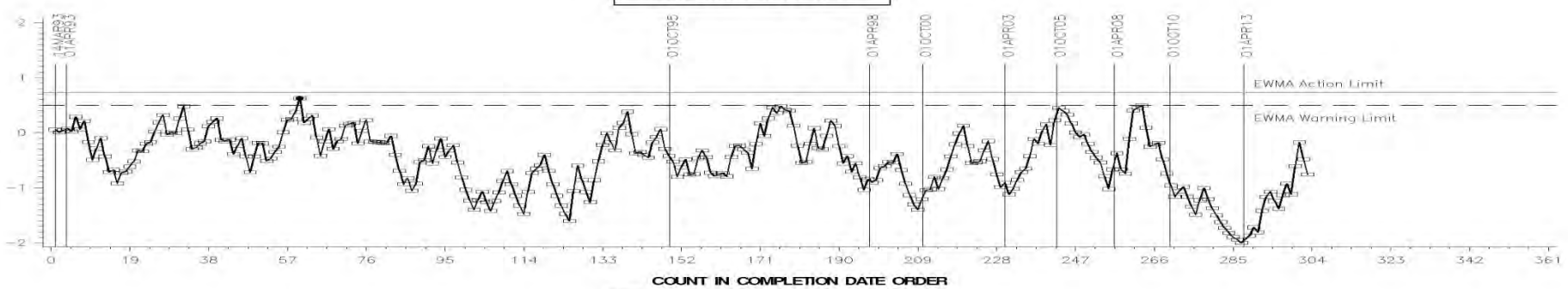


FINAL TRANS. TOP LAND HEAVY CARBON

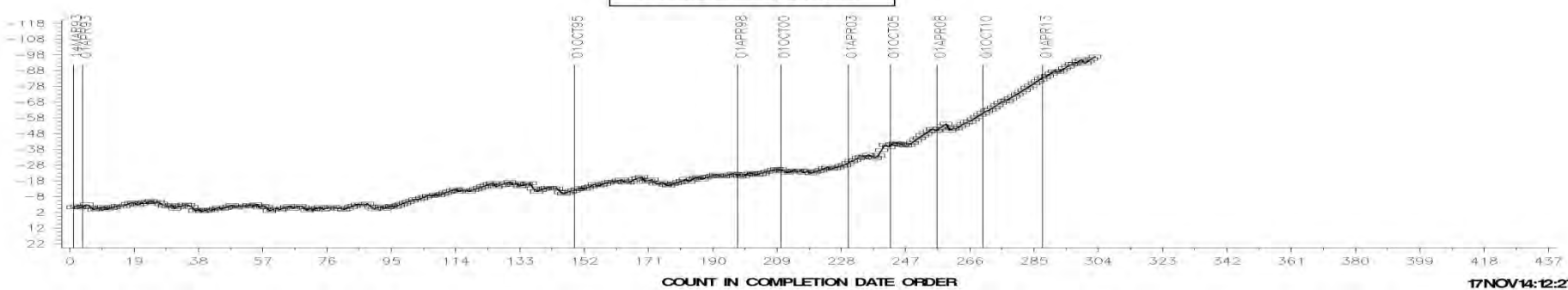
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



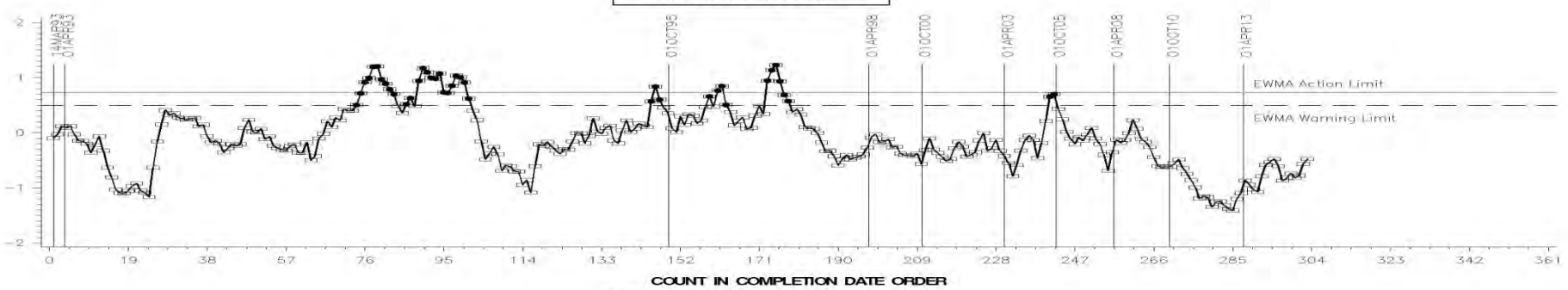
17/NOV/14:12:27

BSOC

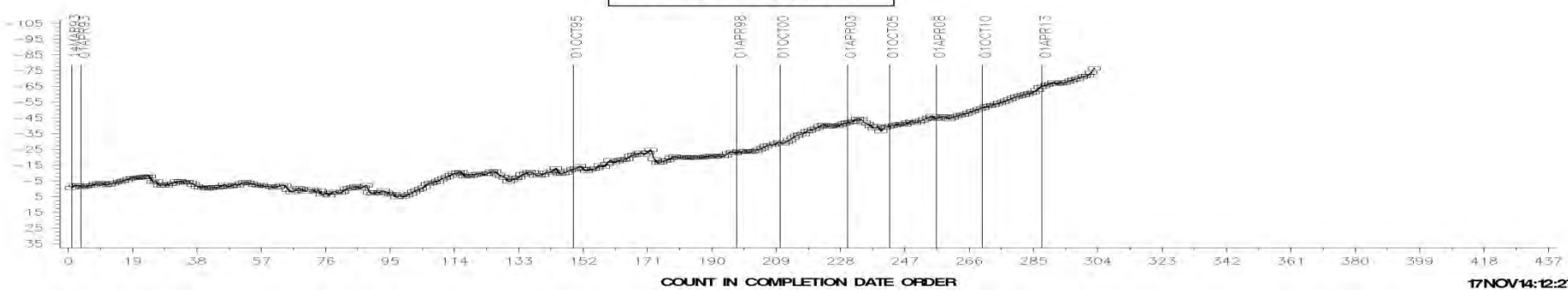
LTMS Severity Analysis



LTMS Precision Analysis



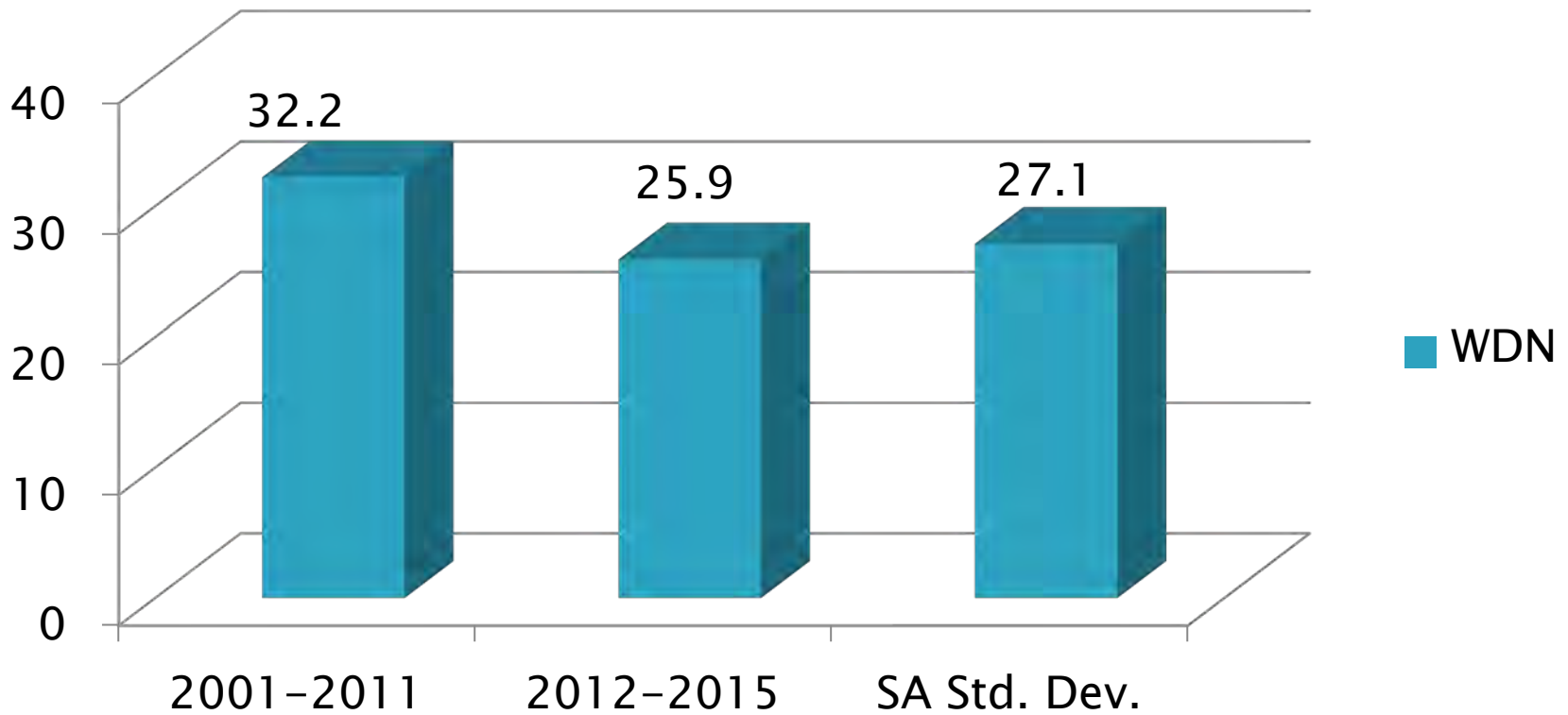
CUSUM Severity Analysis



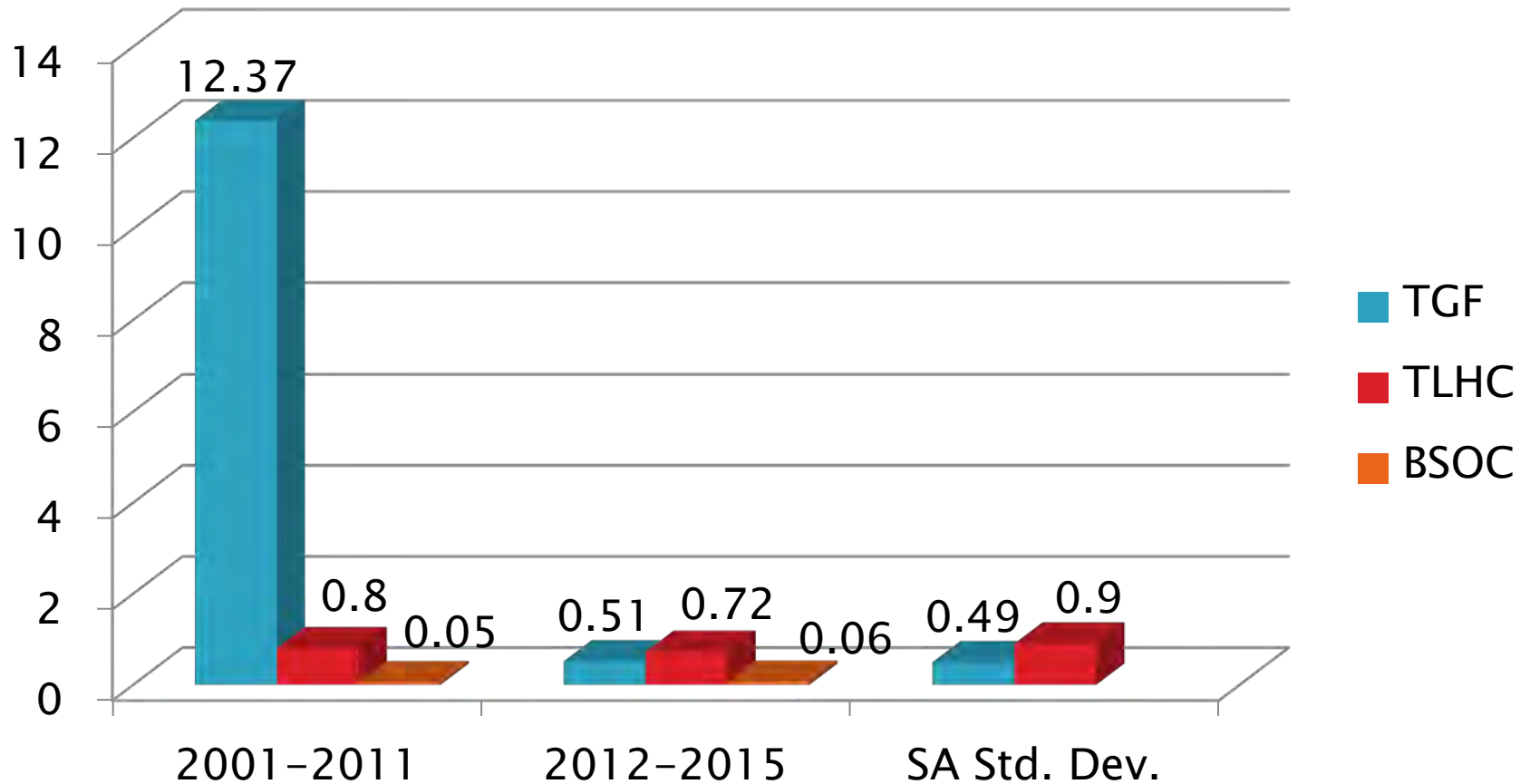
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1 N Precision Estimates

WDN



1N Precision Estimates



[Return to Table of Contents](#)

SCOTE 1M-PC

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1 M-PC Test Activity

| Test Status | Validity Code | # |
|-----------------------------|---------------|----------|
| Acceptable Calibration Test | AC | 1 |
| Failed Calibration Test | OC | 0 |
| Operationally Invalid | LC | 0 |
| Aborted | XC | 1 |
| Total | | 2 |

1 M-PC Failed Tests

| Failed Parameter | Number of Tests |
|------------------|-----------------|
| No failed tests | |
| Total | 0 |

1 M-PC Lost Tests*

| Status | Cause | # |
|--------------|------------------|----------|
| Aborted | Camshaft Failure | 1 |
| Total | | 1 |

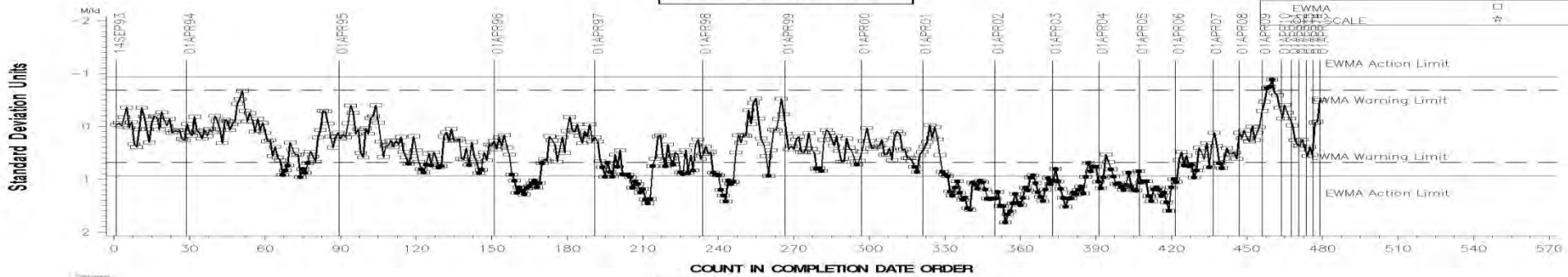
*Invalid and aborted tests

1 M-PC Test Severity

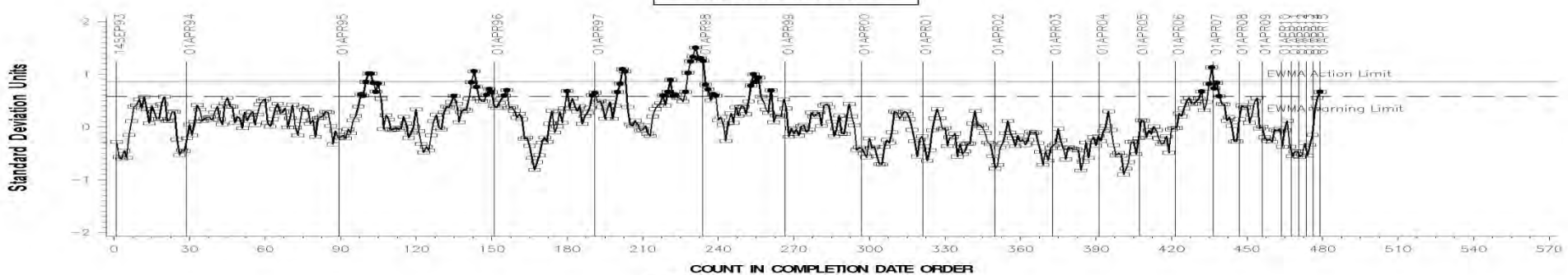
- ▶ TGF in precision warning alarm.
- ▶ WTD in severity action alarm mild direction.

FINAL TOP GROOVE FILLING

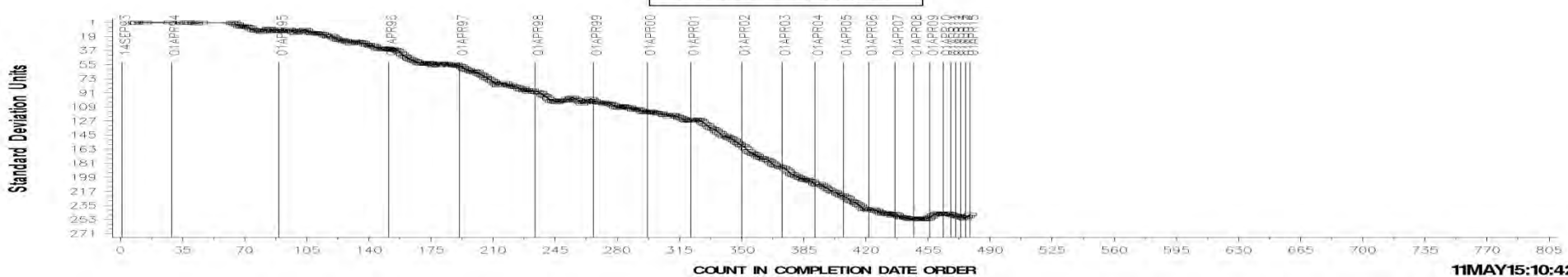
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



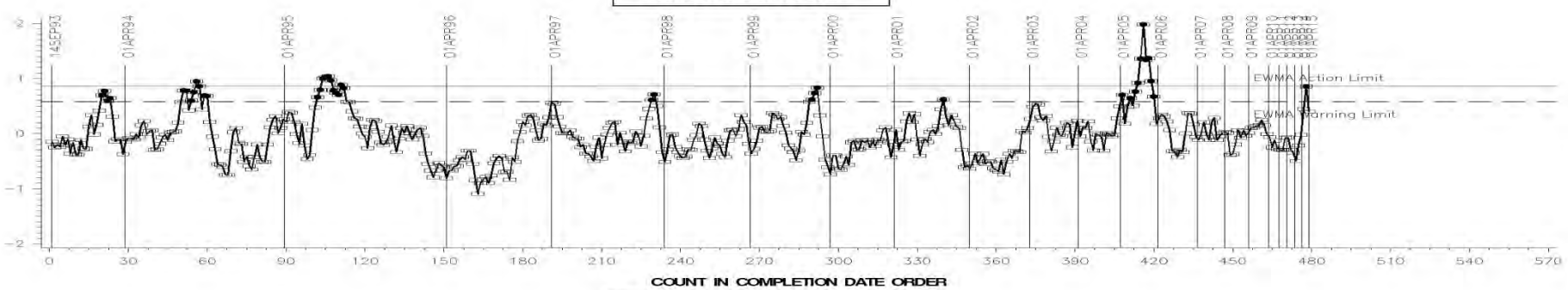
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Weighted Total Demerits

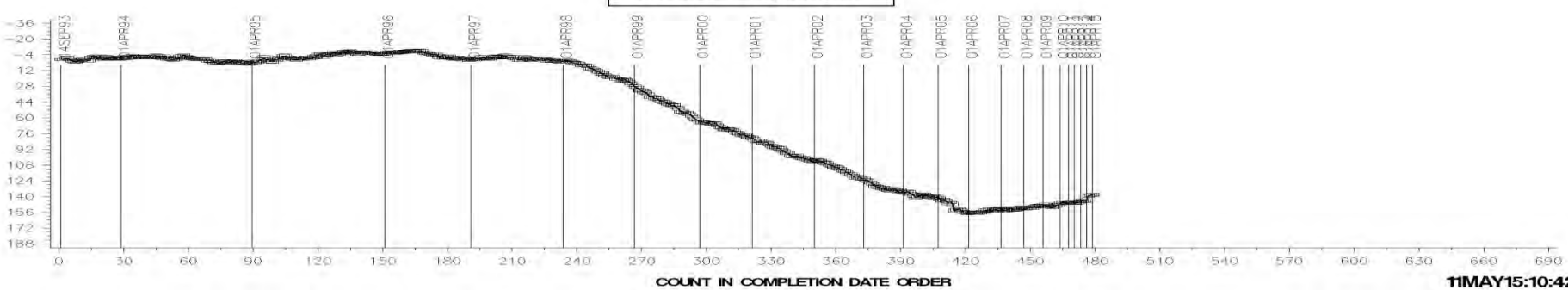
LTMS Severity Analysis



LTMS Precision Analysis

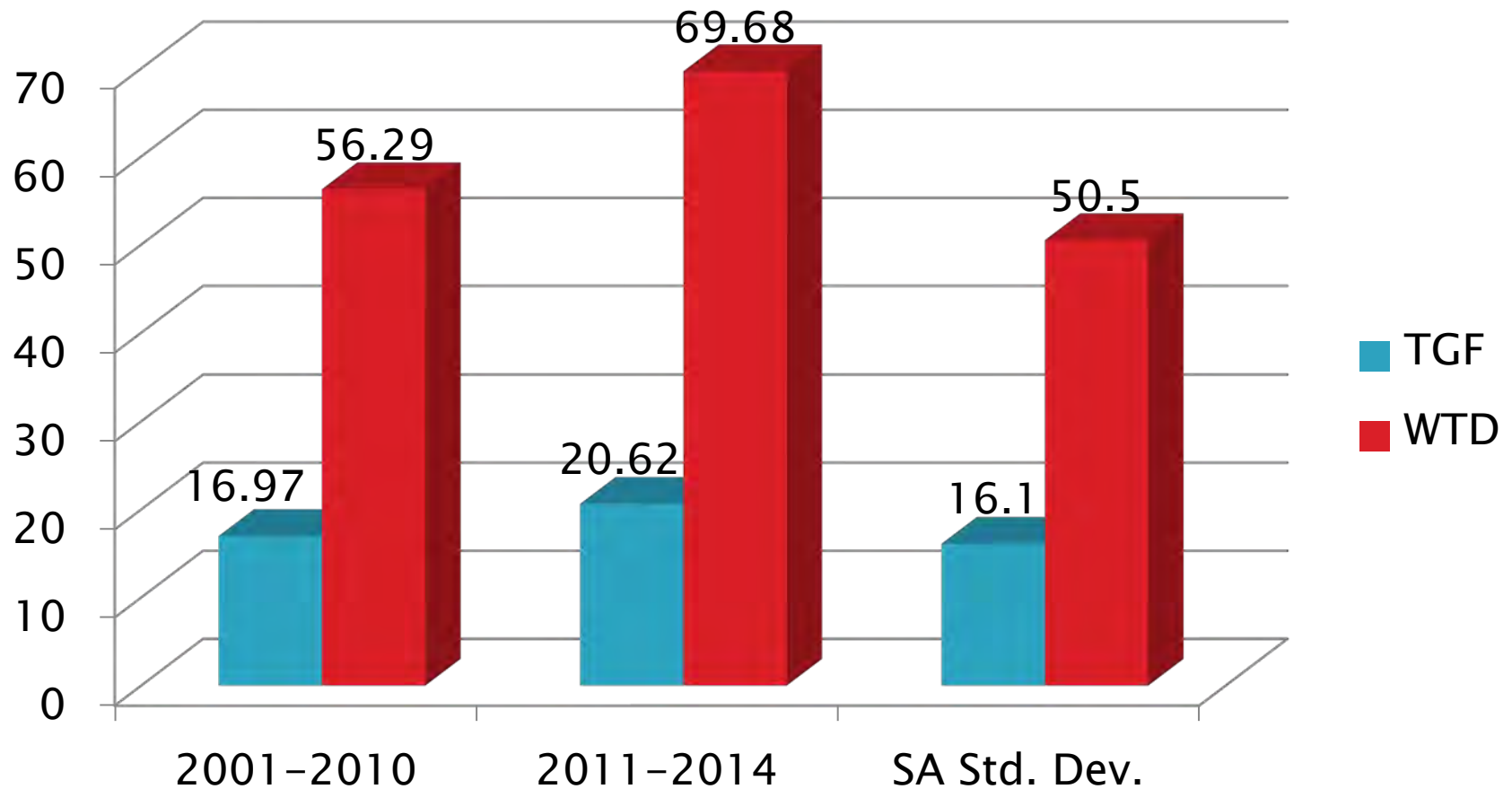


CUSUM Severity Analysis



11MAY15:10:42

1 MPC Precision Estimates



[Return to Table of Contents](#)

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1P Test Activity

| Test Status | Validity Code | # |
|-----------------------------|---------------|----------|
| Acceptable Calibration Test | AC | 0 |
| Failed Calibration Test | OC | 0 |
| Operationally Invalid | LC | 0 |
| Aborted | XC | 0 |
| Total | | 0 |

1 P Failed Tests

| Failed Parameter | Number of Tests |
|------------------|-----------------|
| No failed tests | |
| Total | 0 |

1P Lost Tests*

| Status | Cause | # |
|--------------|------------------|----------|
| Invalid | No invalid tests | |
| Aborted | No aborted tests | |
| Total | | 0 |

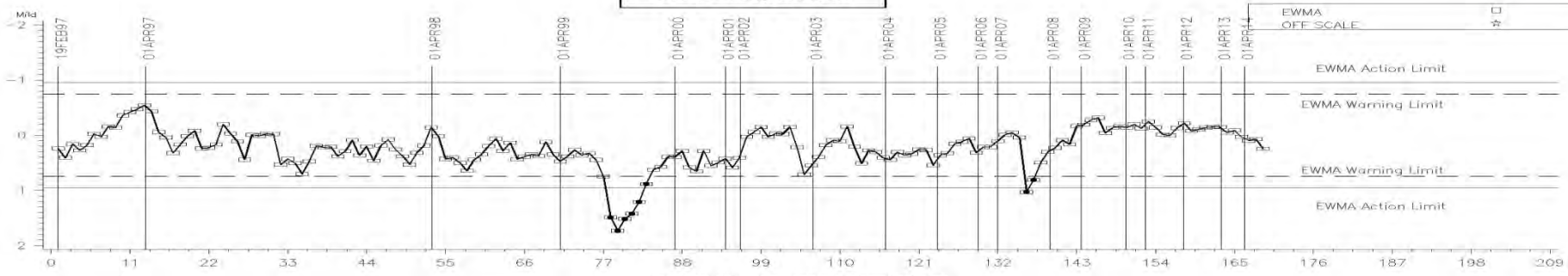
*Invalid and aborted tests

1 P Test Severity

- ▶ EOTOC is in action alarm (severe direction)
- ▶ OC, TGC, TLC and WD are in control.

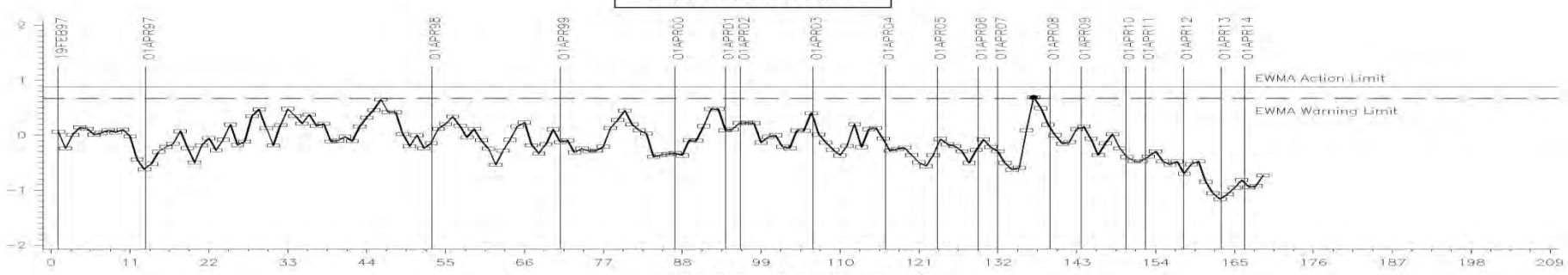
TOP GROOVE CARBON

LTMS Severity Analysis



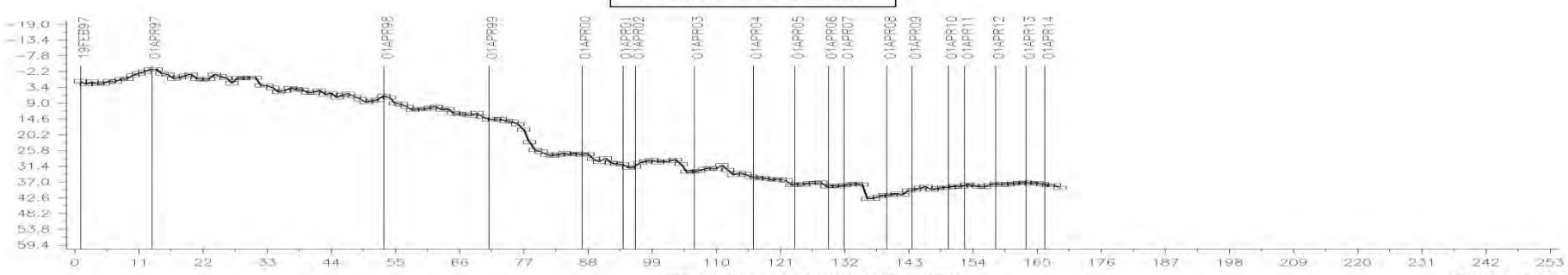
COUNT IN COMPLETION DATE ORDER

LTMS Precision Analysis



COUNT IN COMPLETION DATE ORDER

CUSUM Severity Analysis

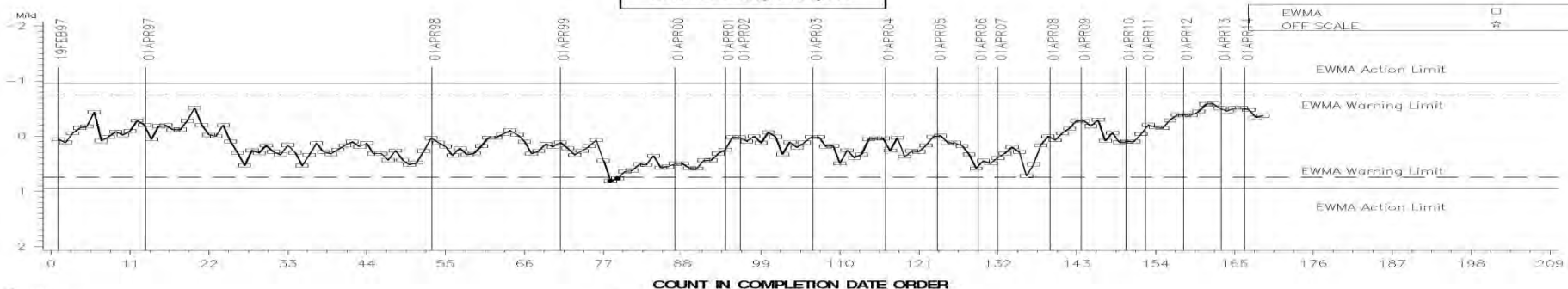


COUNT IN COMPLETION DATE ORDER

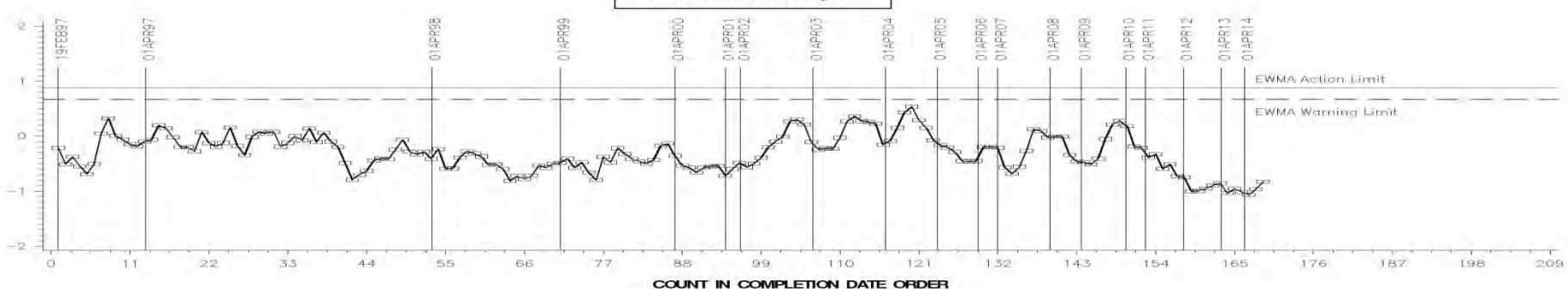
11MAY15:10:42

TOP LAND CARBON

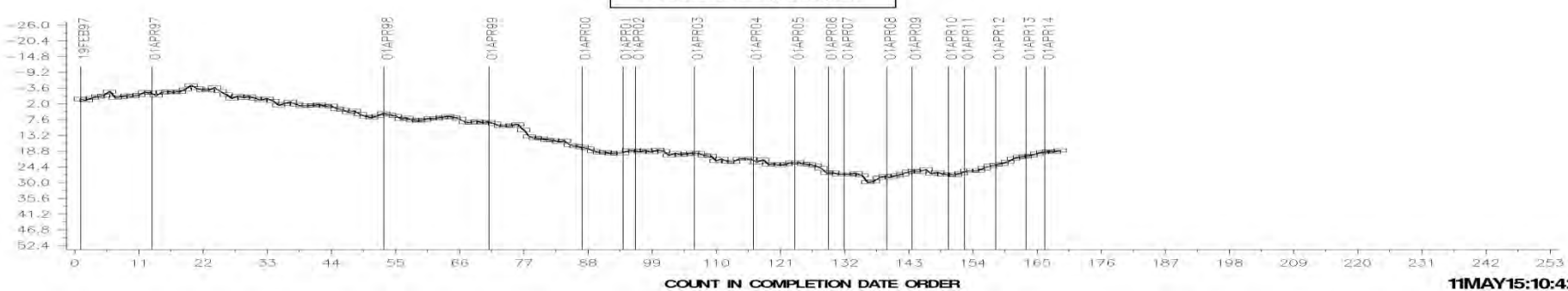
LTMS Severity Analysis



LTMS Precision Analysis



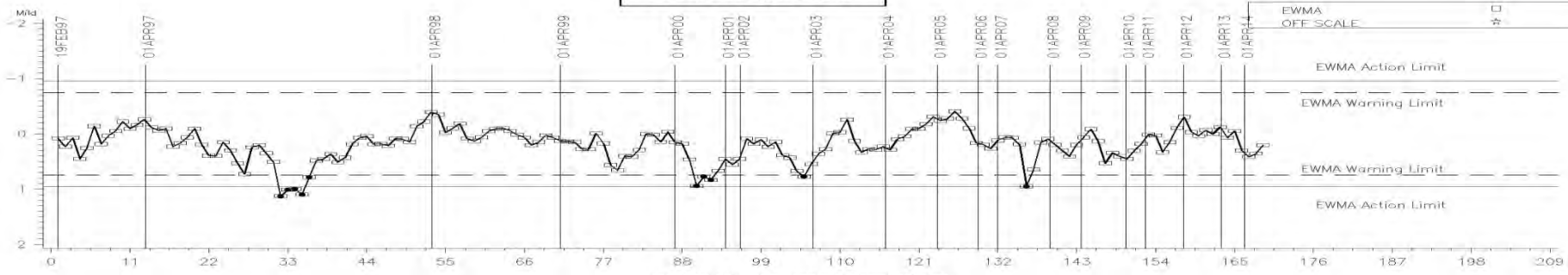
CUSUM Severity Analysis



11MAY15:10:42

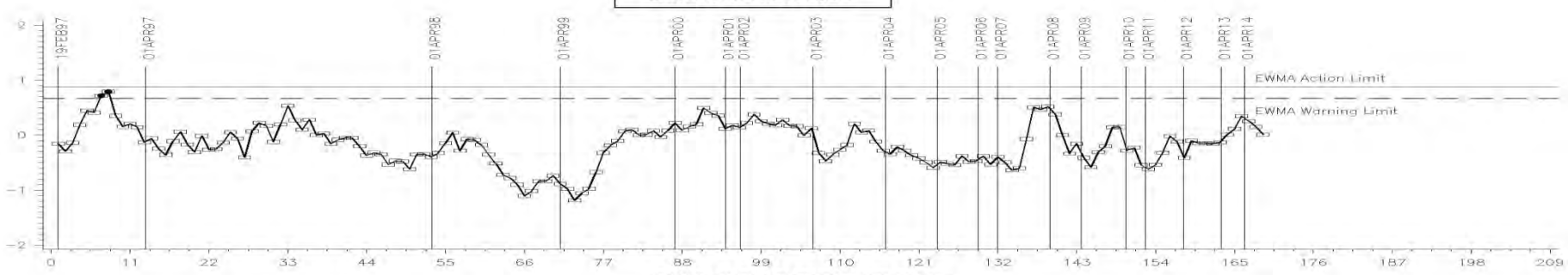
WEIGHTED TOTAL DEMERITS

LTMS Severity Analysis



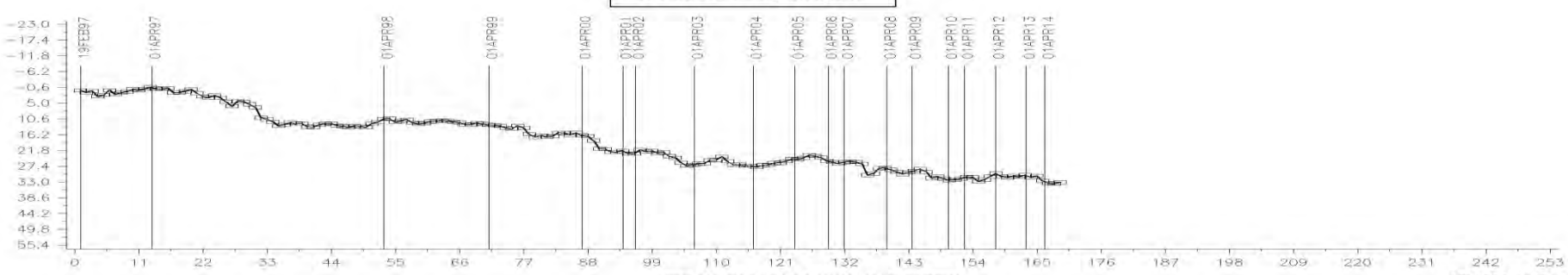
COUNT IN COMPLETION DATE ORDER

LTMS Precision Analysis



COUNT IN COMPLETION DATE ORDER

CUSUM Severity Analysis

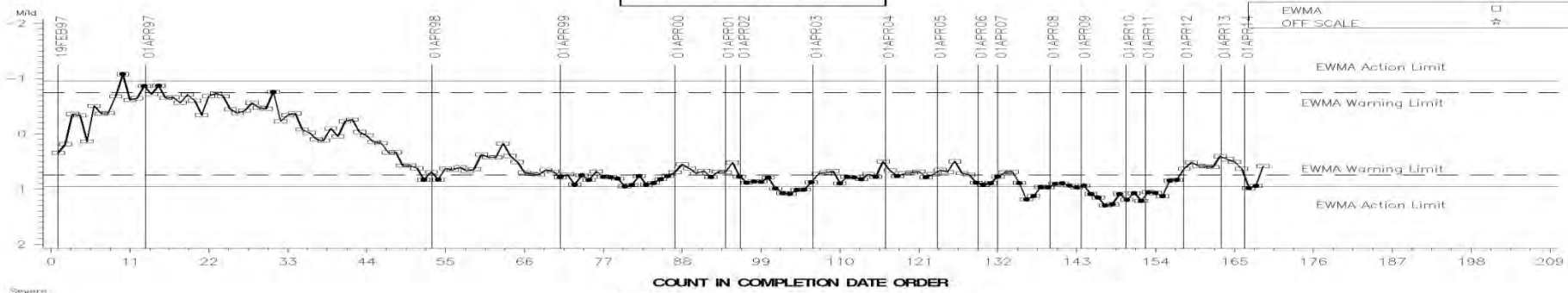


COUNT IN COMPLETION DATE ORDER

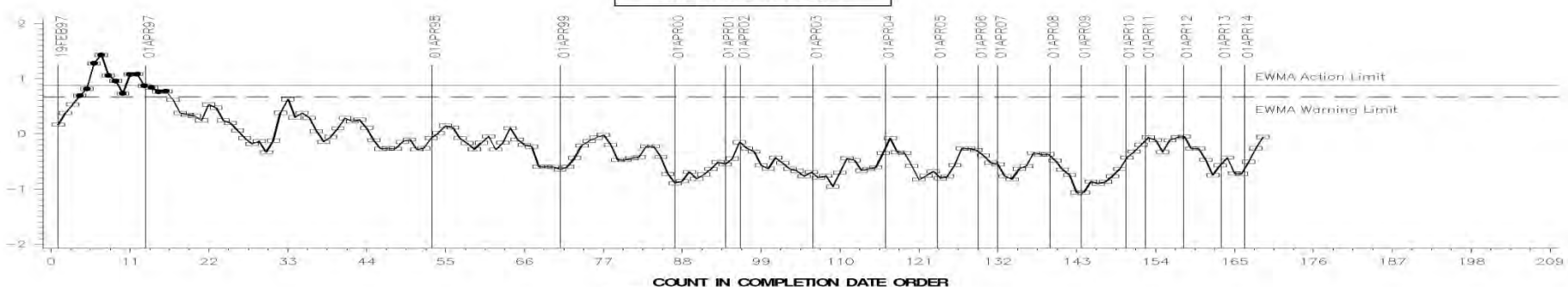
11MAY15:10:42

OIL CONSUMPTION

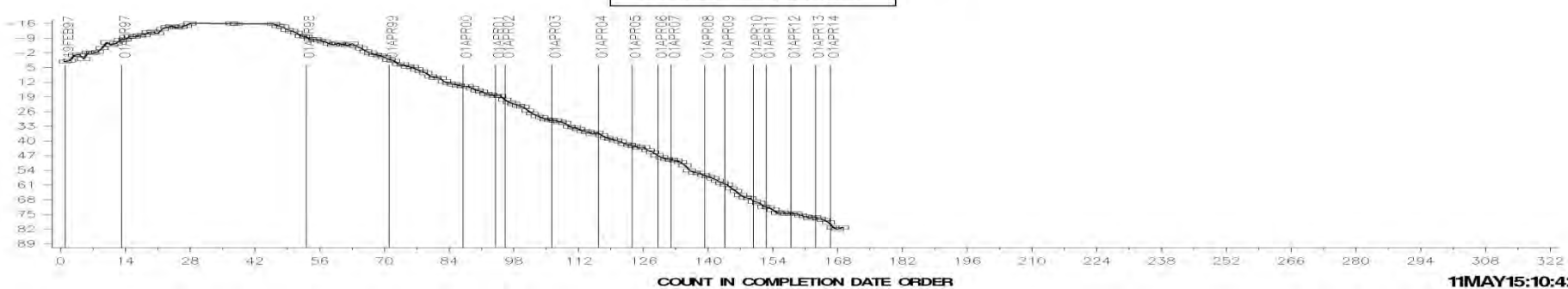
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



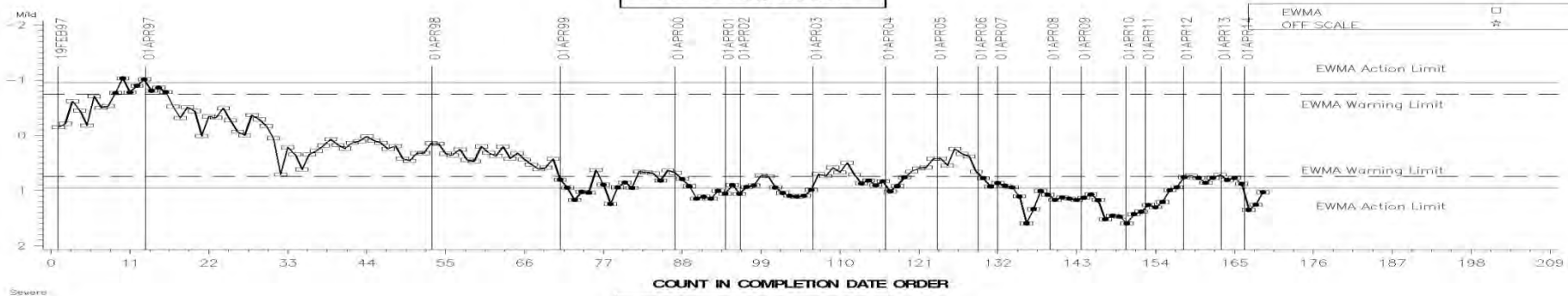
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CATERPILLAR 1P INDUSTRY OPERATIONALLY VALID DATA

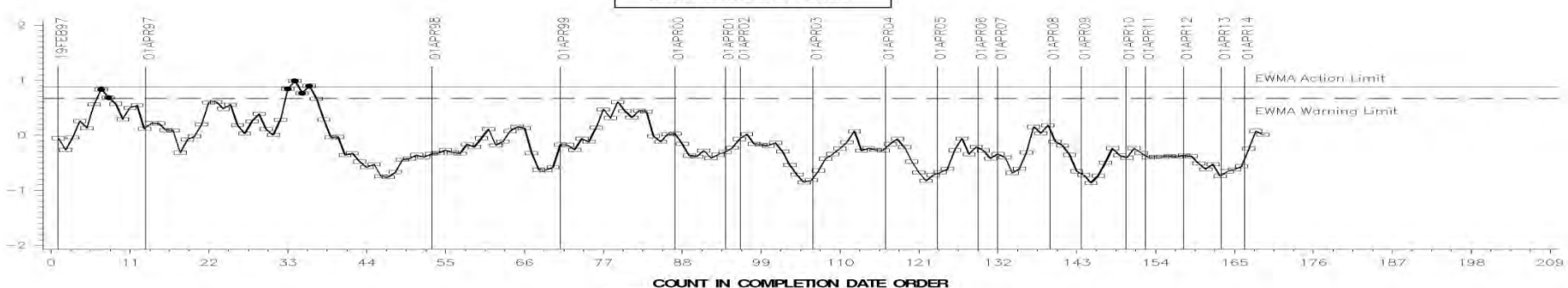


EOTC

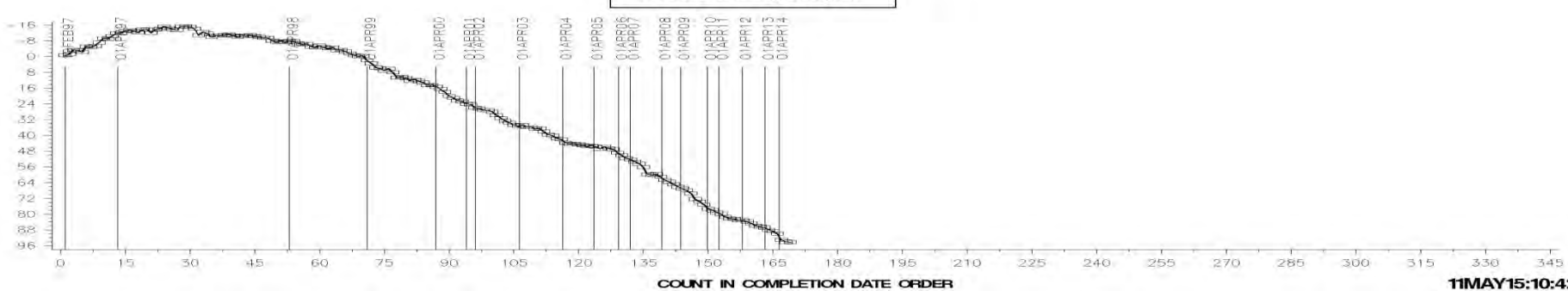
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



11MAY15:10:42

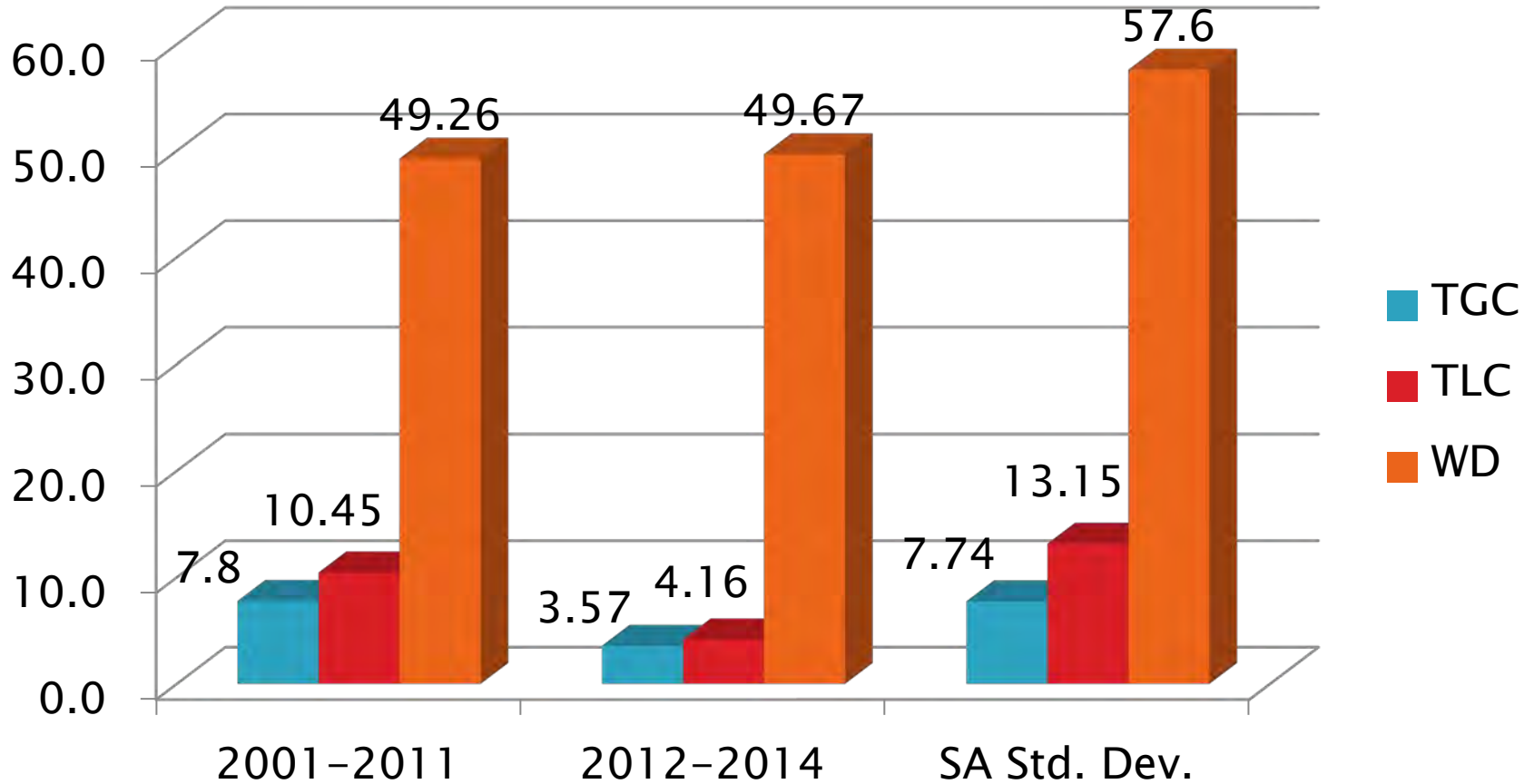
Test Monitoring Center

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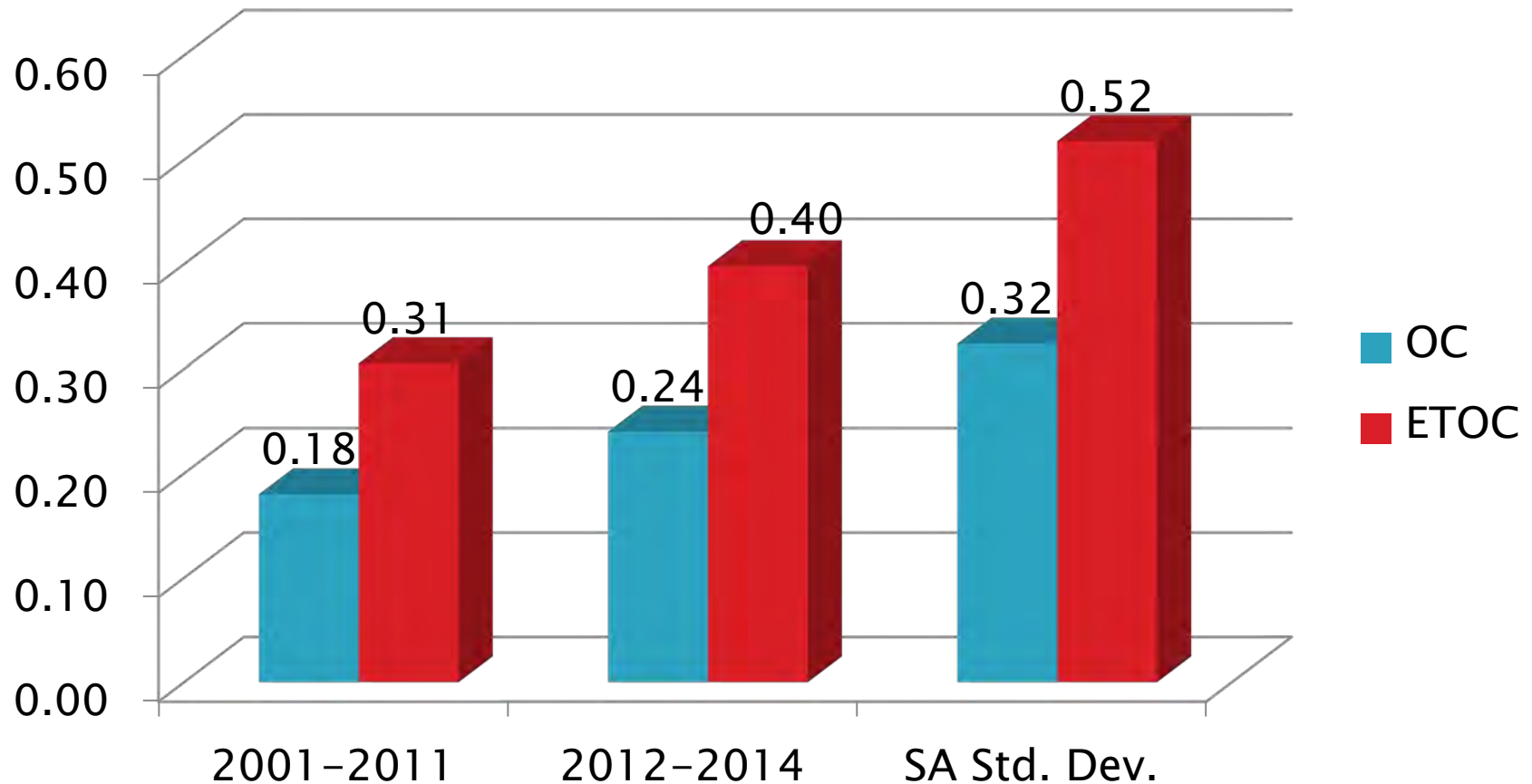


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1P Precision Estimates



1P Precision Estimates



[Return to Table of Contents](#)

SCOTE 1 R

»» April 2015

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1 R Test Activity

| Test Status | Validity Code | # |
|-----------------------------|---------------|----------|
| Acceptable Calibration Test | AC | 1 |
| Failed Calibration Test | OC | 1 |
| Operationally Invalid | LC | 0 |
| Aborted | XC | 0 |
| Total | | 2 |

1 R Failed Tests

| Failed Parameter | Number of Tests |
|------------------------------|-----------------|
| Severe WD, TGC, TLC and ETOC | 1 |
| Total | 1 |

1 R Lost Tests*

| Status | Cause | # |
|--------------|------------------|----------|
| Invalid | No invalid tests | |
| Aborted | No aborted tests | |
| Total | | 0 |

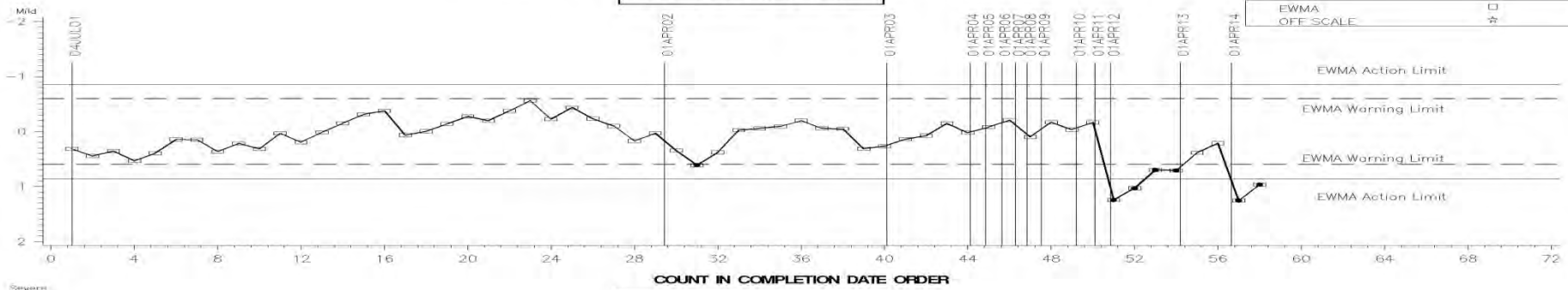
*Invalid and aborted tests

1 R Test Severity

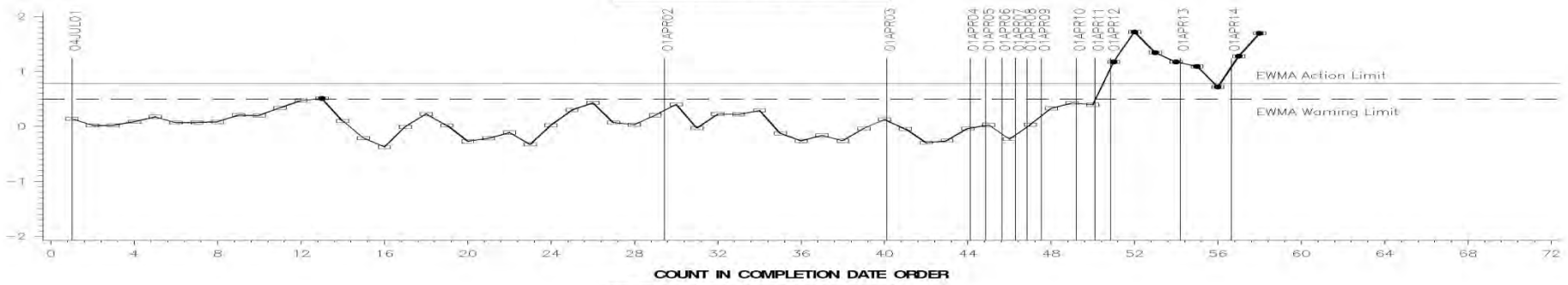
- ▶ ETOC and WD in severity action alarm severe direction
- ▶ BTOC is in control.
- ▶ WD, TGC, TLC and ETOC in precision alarm

FINAL WEIGHTED TOTAL DEMERITS (DEMERITS)

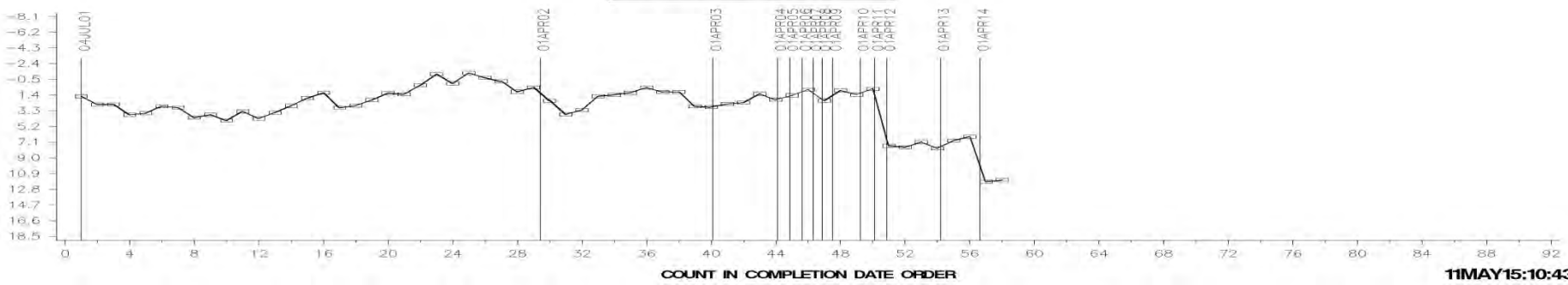
LTMS Severity Analysis



LTMS Precision Analysis



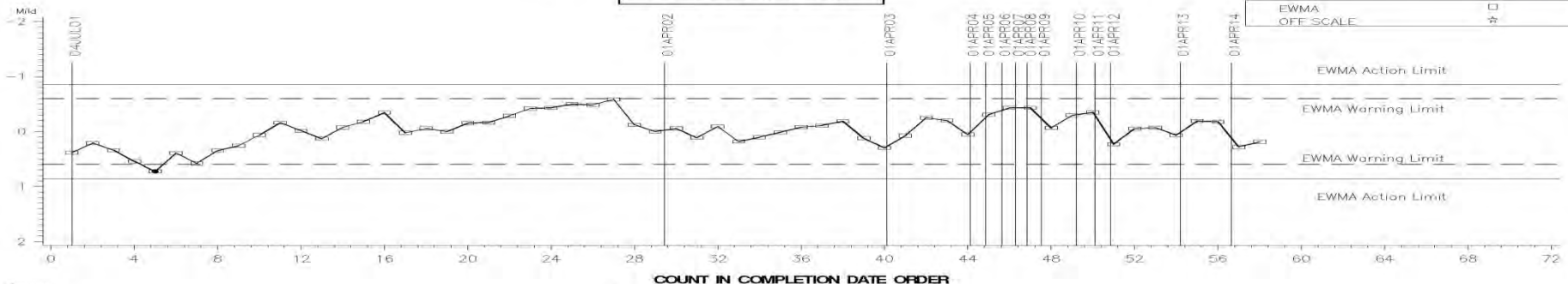
CUSUM Severity Analysis



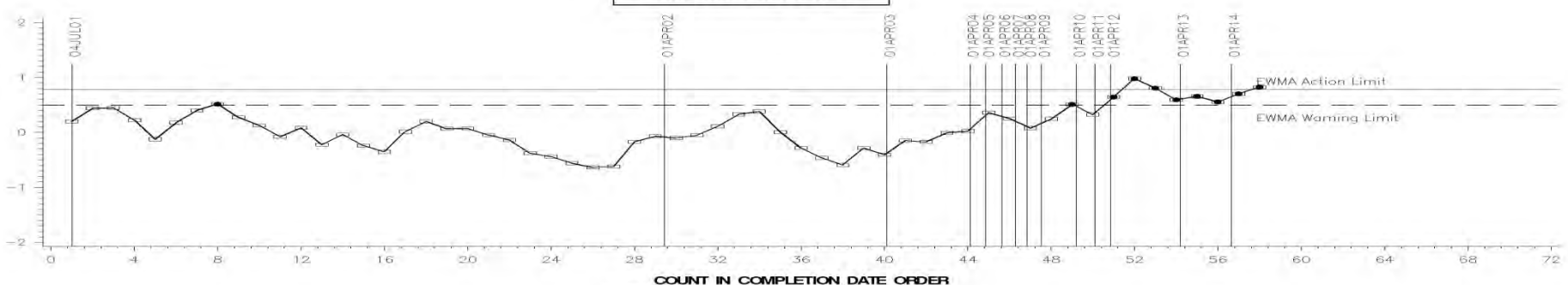
11MAY15:10:43

FINAL TOP GROOVE CARBON (DEMERITS)

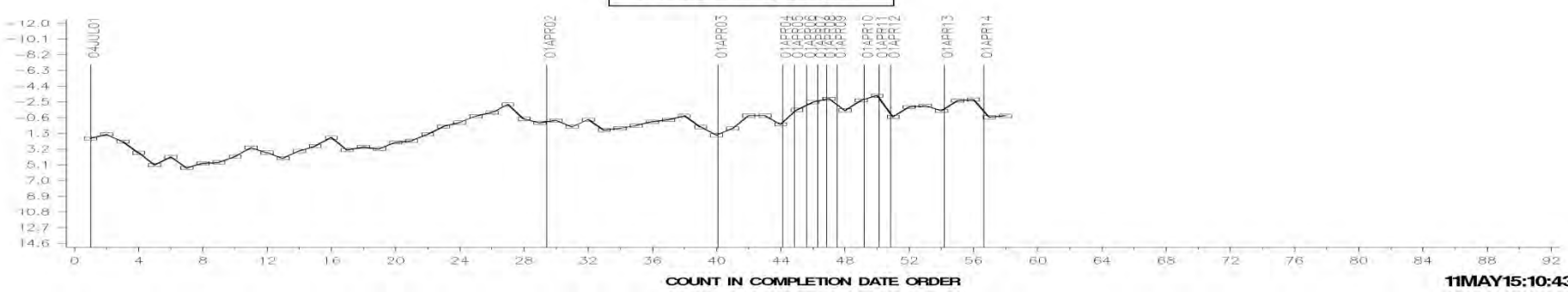
LTMS Severity Analysis



LTMS Precision Analysis



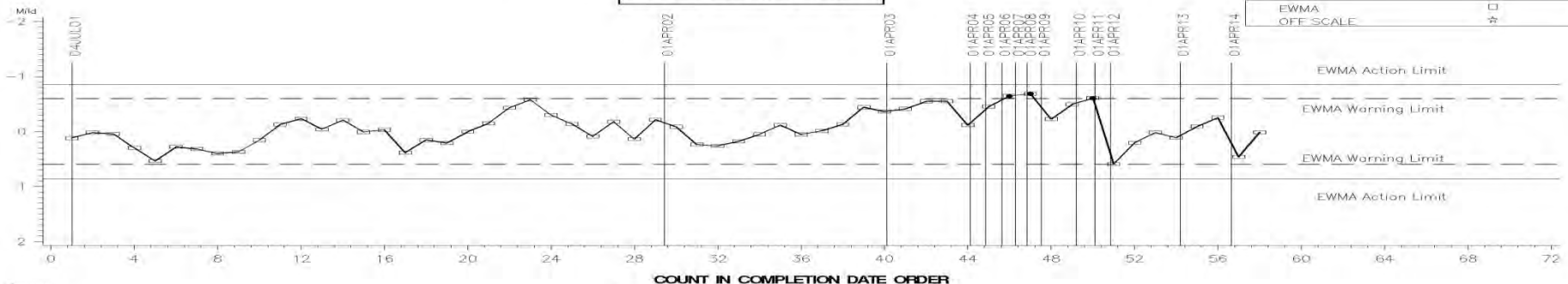
CUSUM Severity Analysis



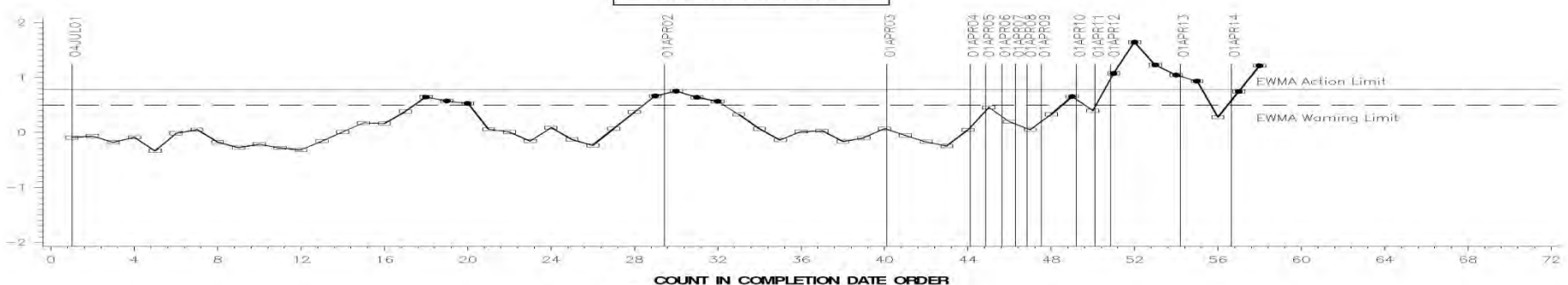
11MAY15:10:43

FINAL TOP LAND CARBON (DEMERITS)

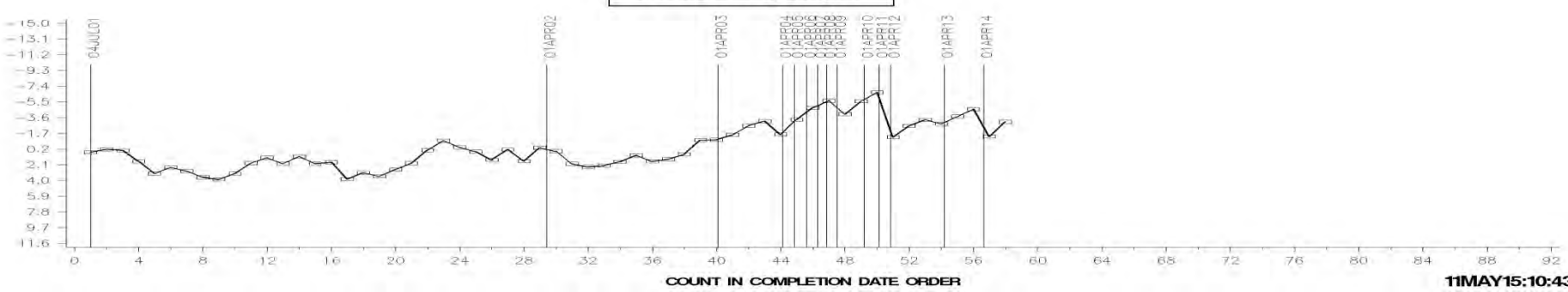
LTMS Severity Analysis



LTMS Precision Analysis



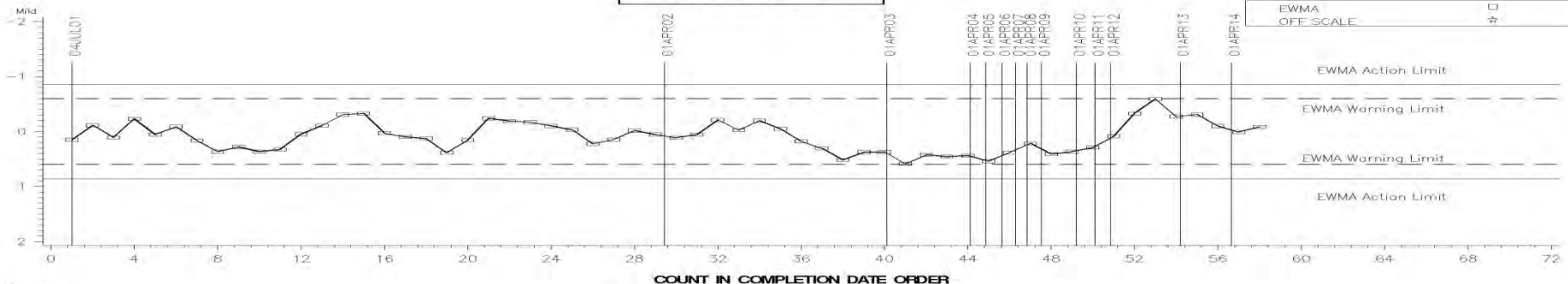
CUSUM Severity Analysis



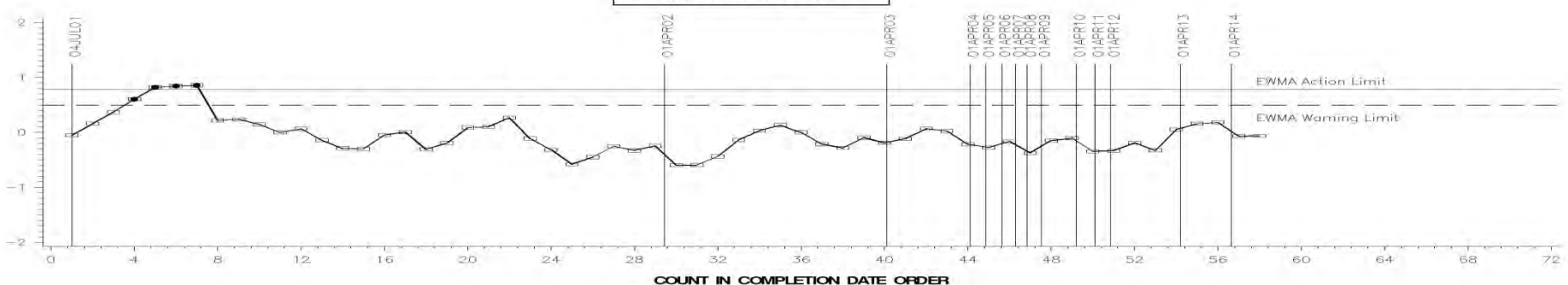
11MAY15:10:43

FINAL BOTOC

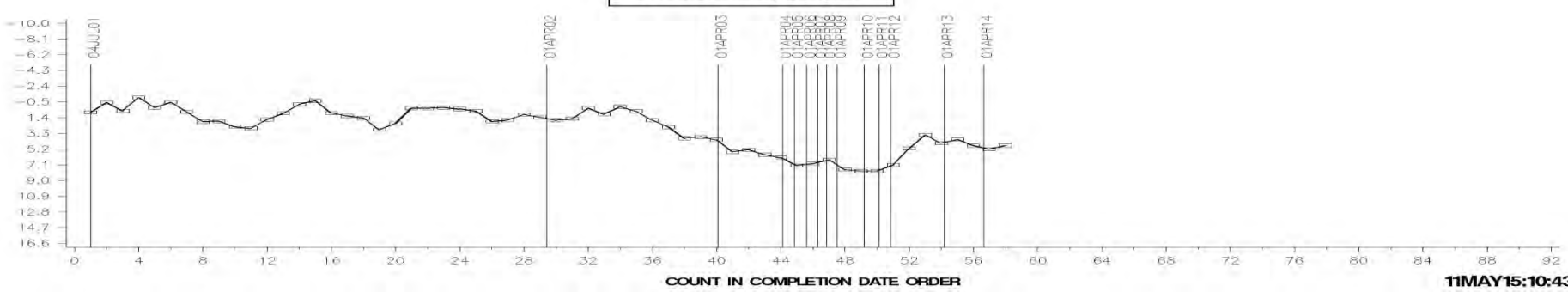
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



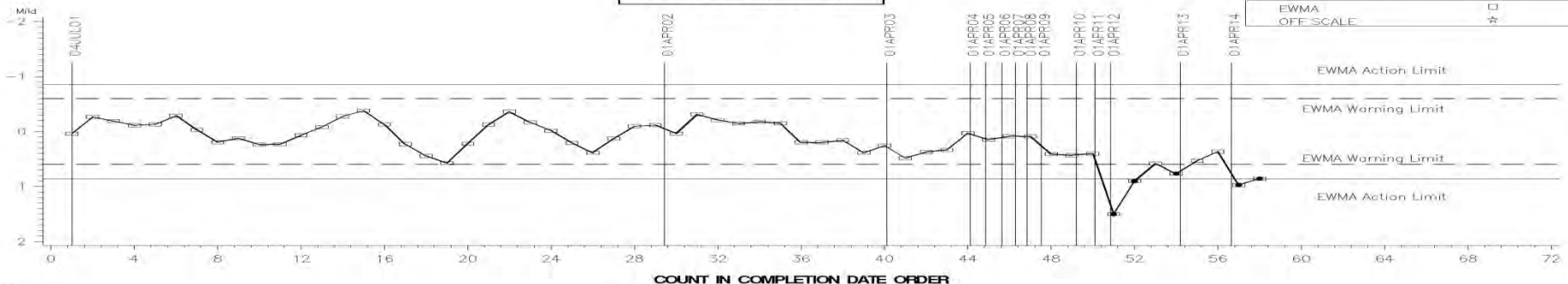
11MAY15:10:43

CATERPILLAR 1R INDUSTRY OPERATIONALY VALID DATA

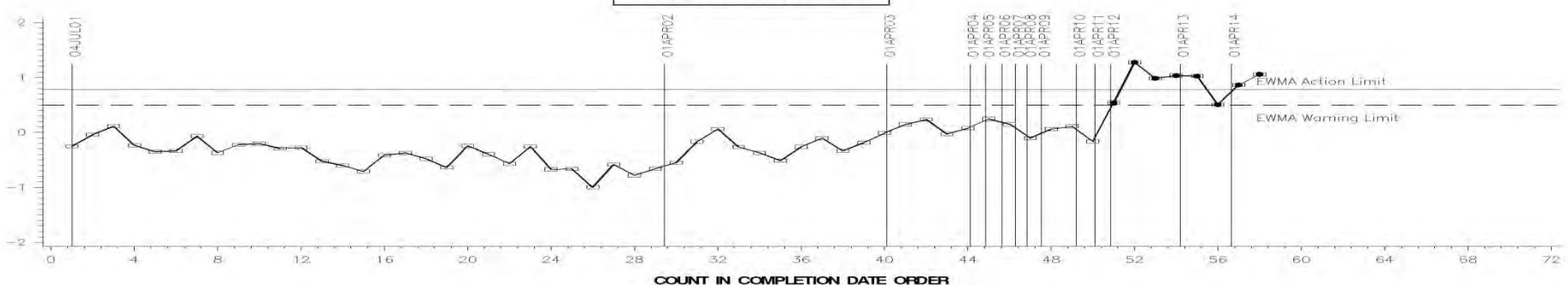


FINAL EOTOC (g/h)

LTMS Severity Analysis



LTMS Precision Analysis



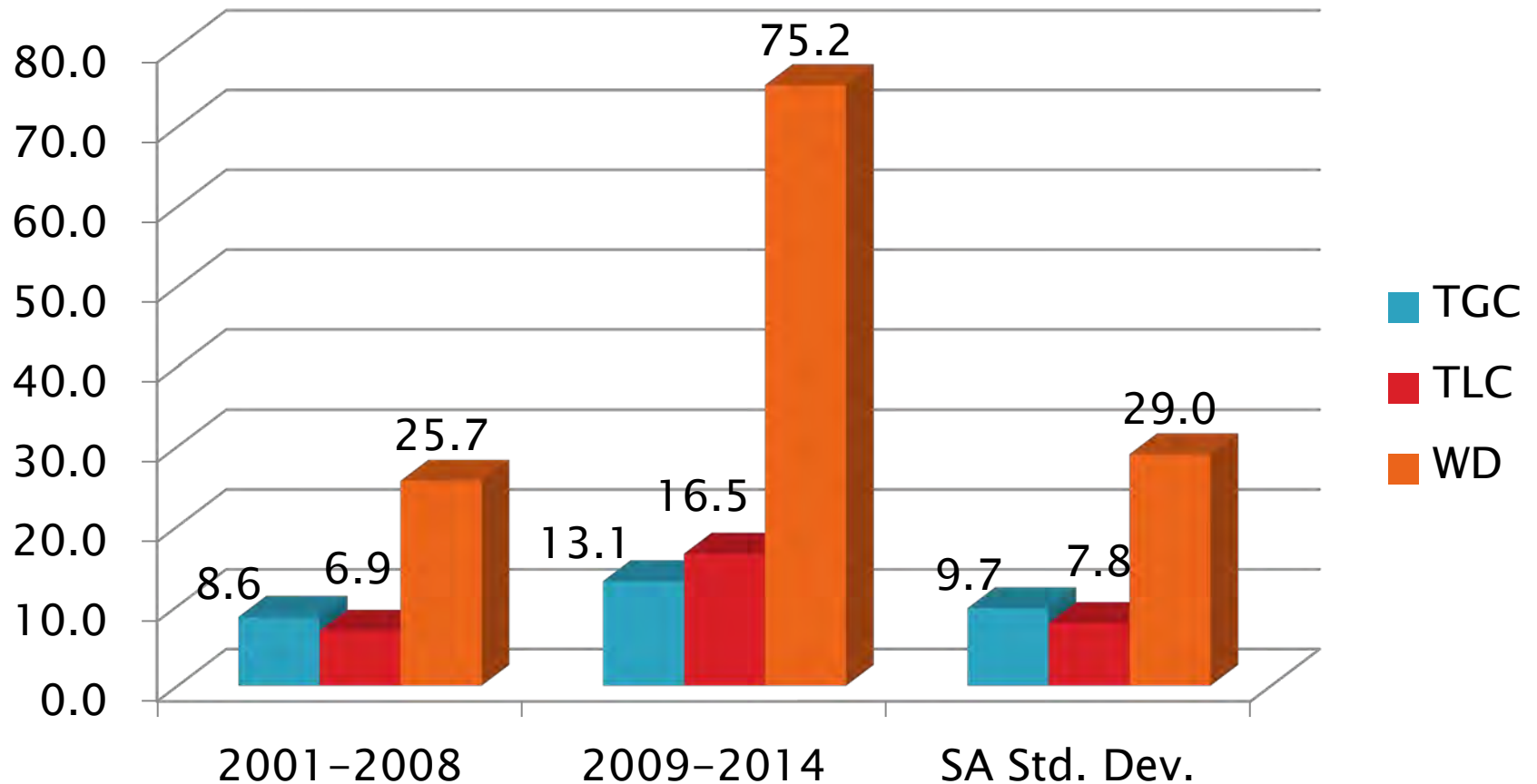
CUSUM Severity Analysis



11MAY15:10:43

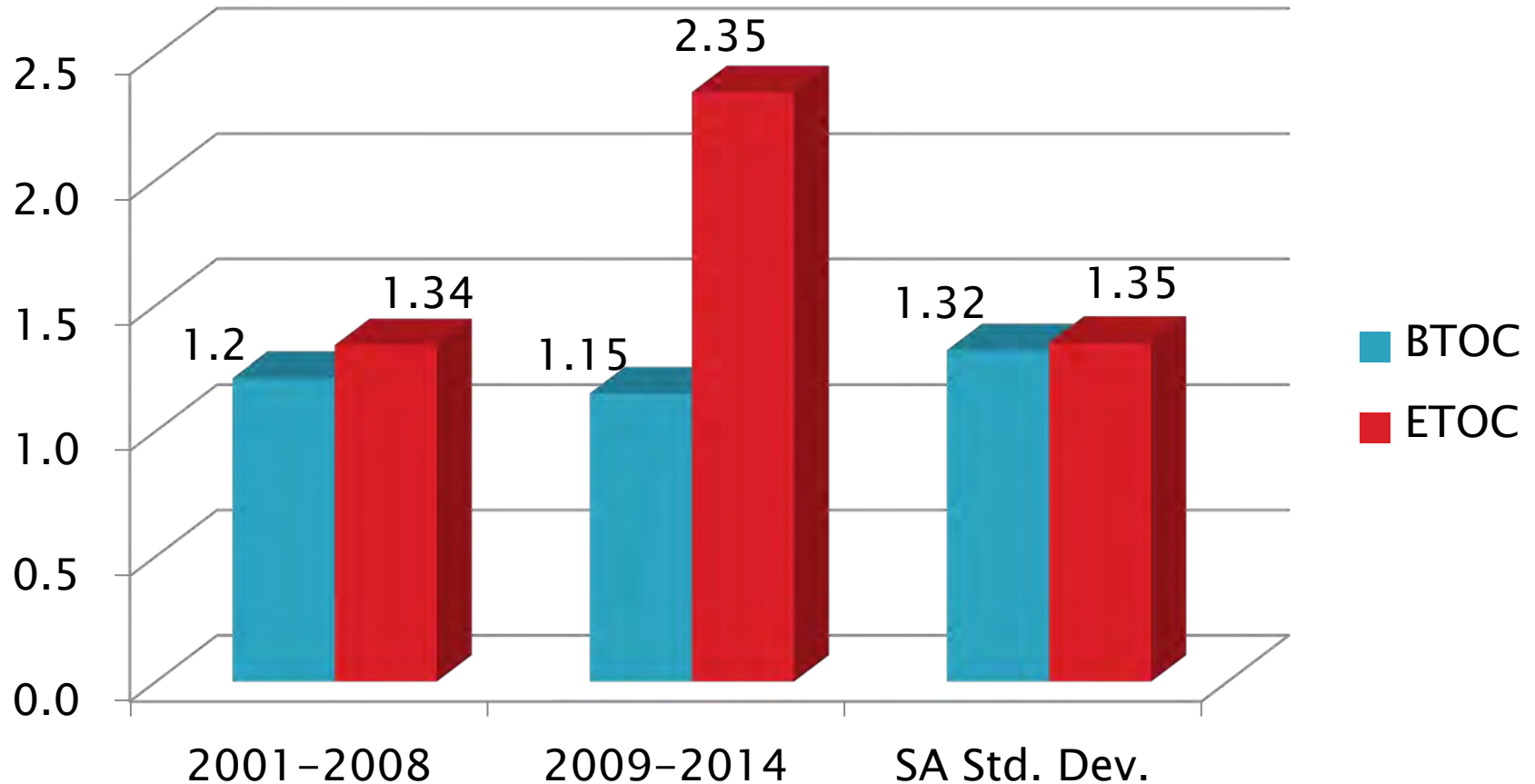


1R Precision Estimates



[Return to Table of Contents](#)

1 R Precision Estimates



[Return to Table of Contents](#)

CAT C13

»» April 2015

Test Monitoring Center

<http://astmtmc.cmu.edu>



A Program of ASTM International

C13 Test Activity

| Test Status | Validity Code | C13 |
|-----------------------------|---------------|----------|
| Acceptable Calibration Test | AC | 5 |
| Failed Calibration Test | OC | 0 |
| Operationally Invalid | LC | 0 |
| Aborted | XC | 0 |
| Total | | 5 |

C13 Failed Tests

| Failed Parameter | Number of Tests |
|------------------|-----------------|
| No failed tests | |
| Total | 0 |

C13 Lost Tests*

| Status | Cause | # |
|--------------|------------------|----------|
| Invalid | No invalid tests | |
| Aborted | No aborted tests | |
| Total | | 0 |

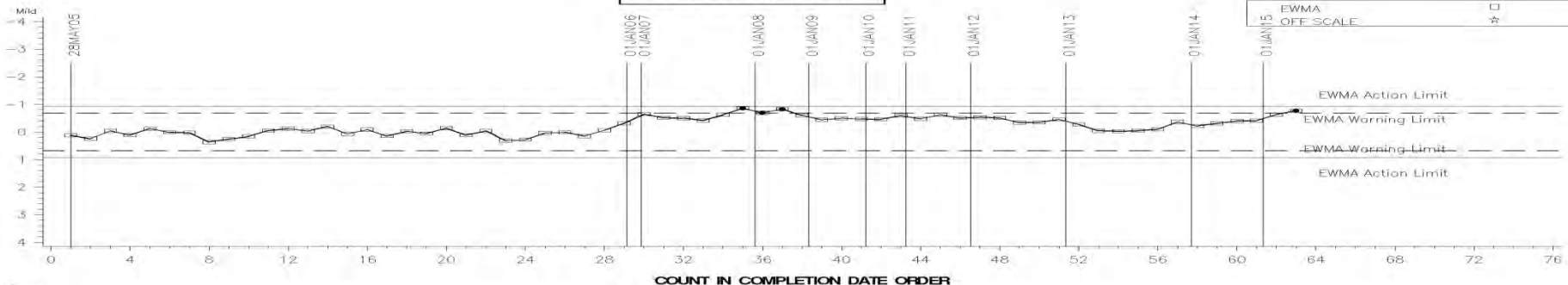
*Invalid and aborted tests

C13 Test Severity

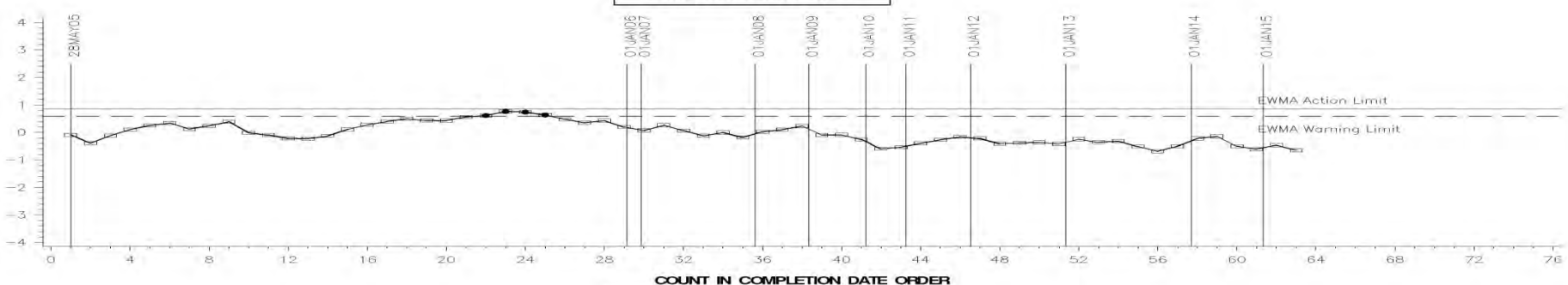
- ▶ TGC and OC are in control.
- ▶ R2TC in severity action alarm, extreme mild direction. Also in precision warning alarm.
- ▶ TLC in severity warning alarm mild direction.

TOP LAND CARBON AVG. — FINAL RESULT

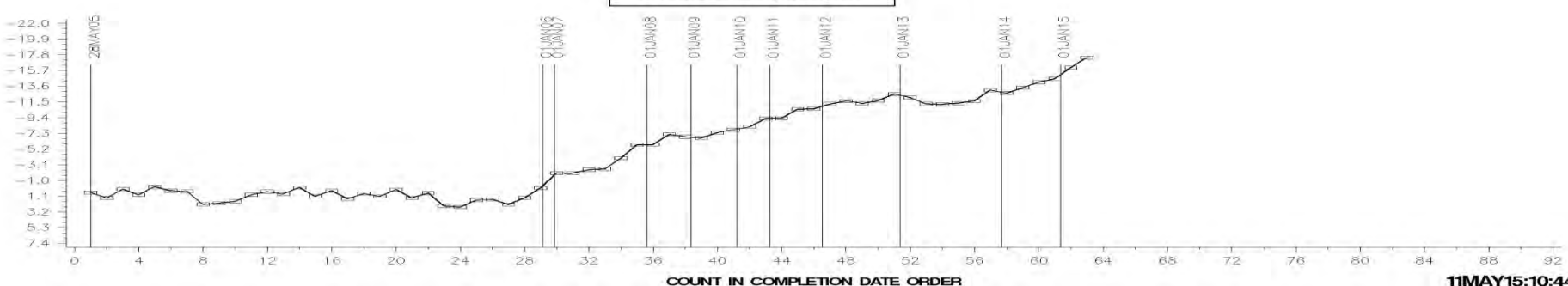
LTMS Severity Analysis



LTMS Precision Analysis



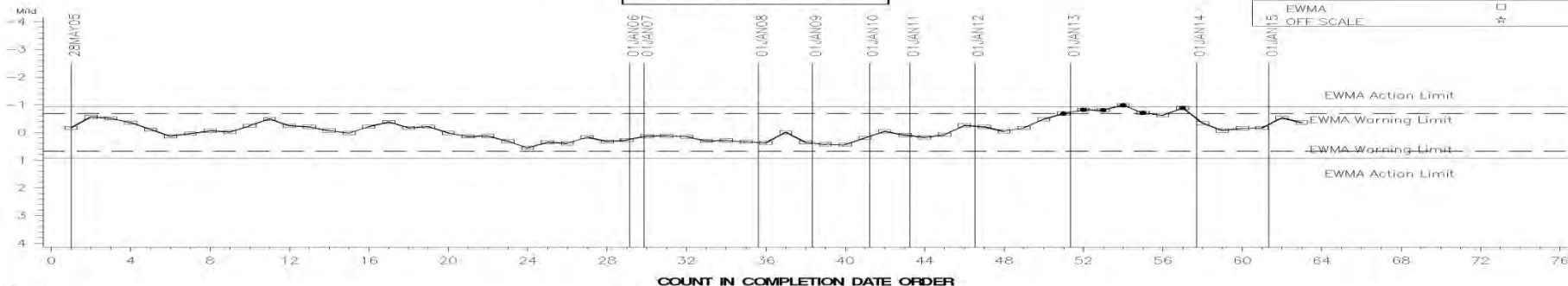
CUSUM Severity Analysis



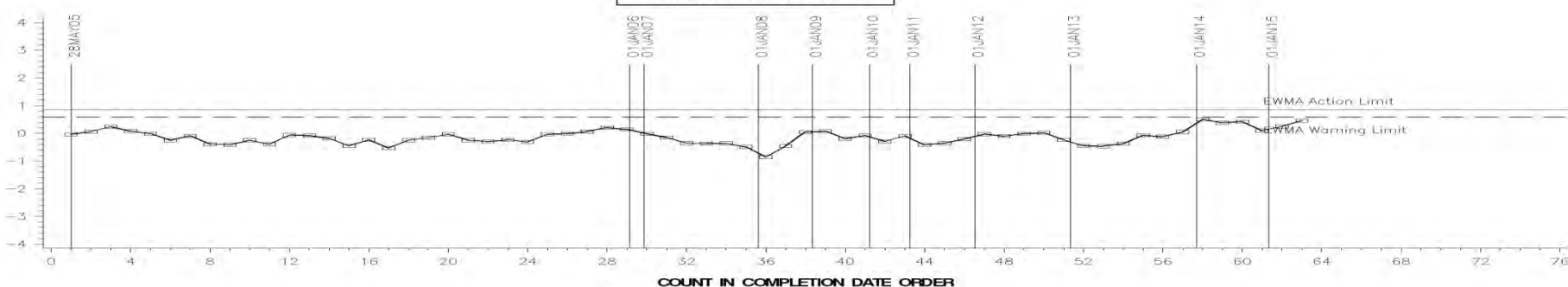
11MAY15:10:44

TOP GROOVE CARBON AVG — FINAL RESULT

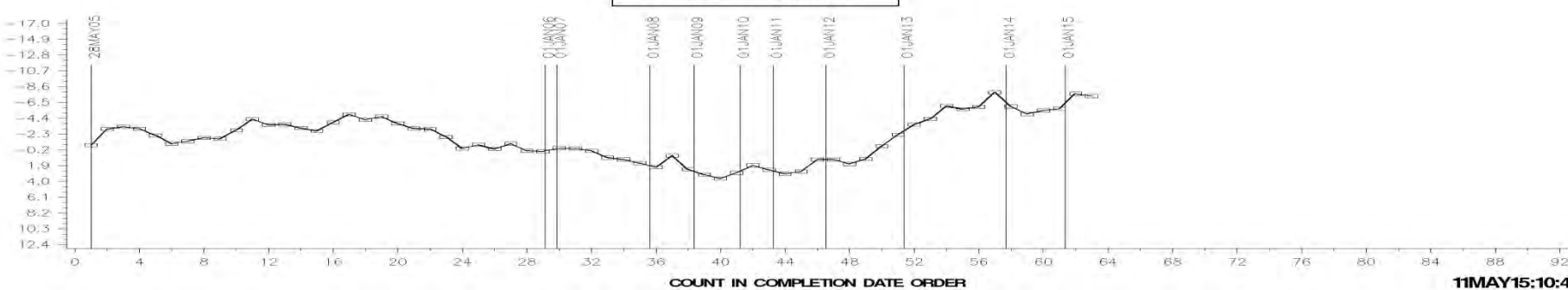
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis

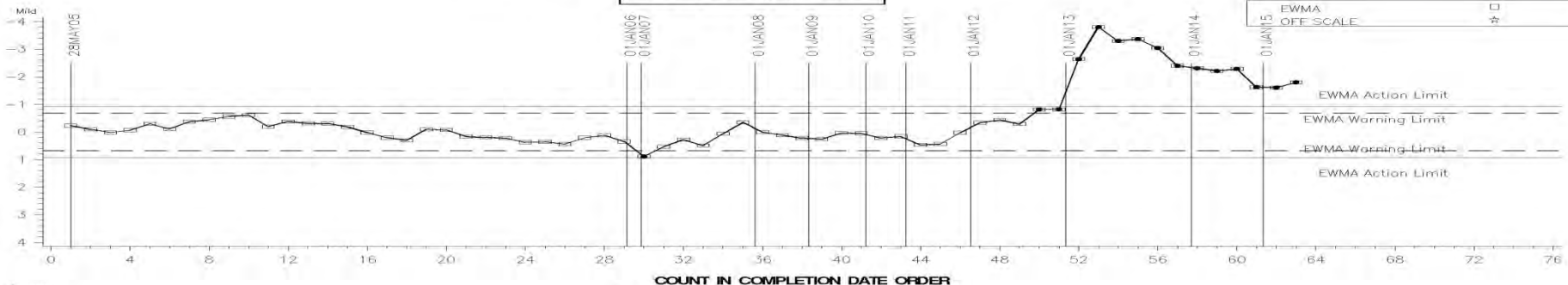


11MAY15:10:44

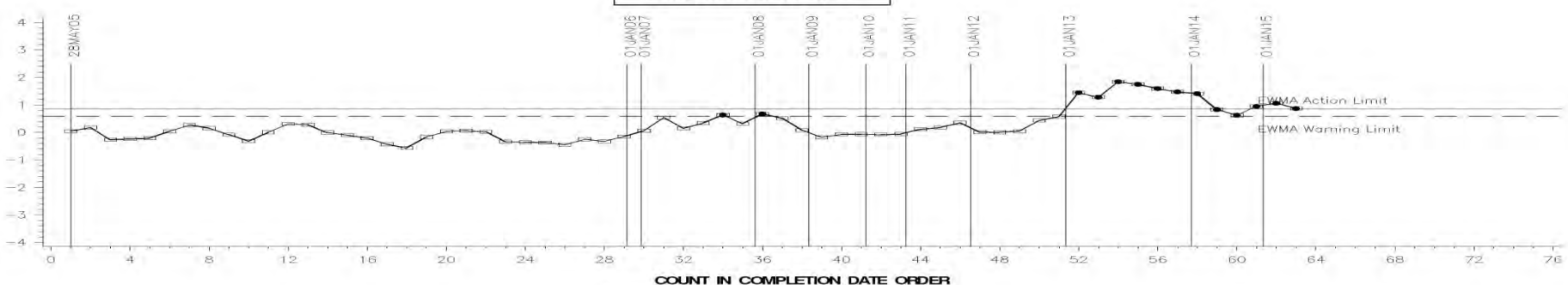
C13 INDUSTRY OPERATIONALLY VALID DATA

2ND RING TOP CARBON AVG. — FINAL RESULT

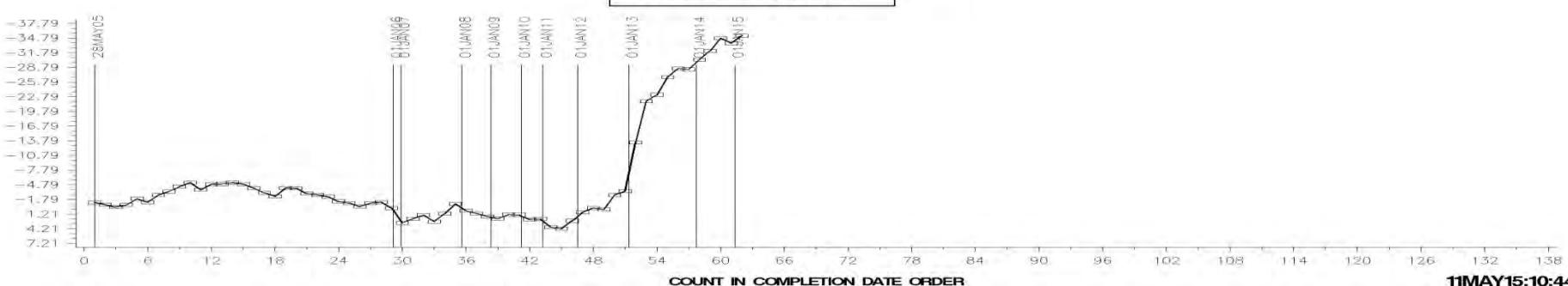
LTMS Severity Analysis



LTMS Precision Analysis



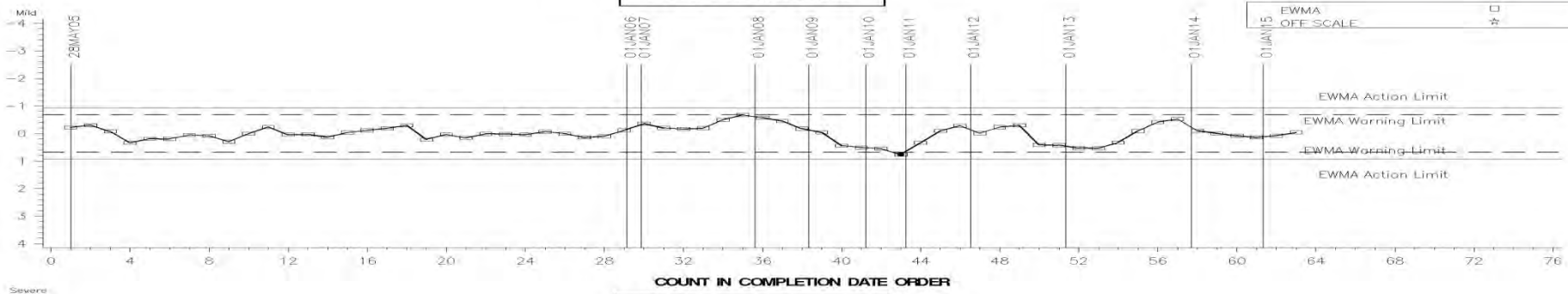
CUSUM Severity Analysis



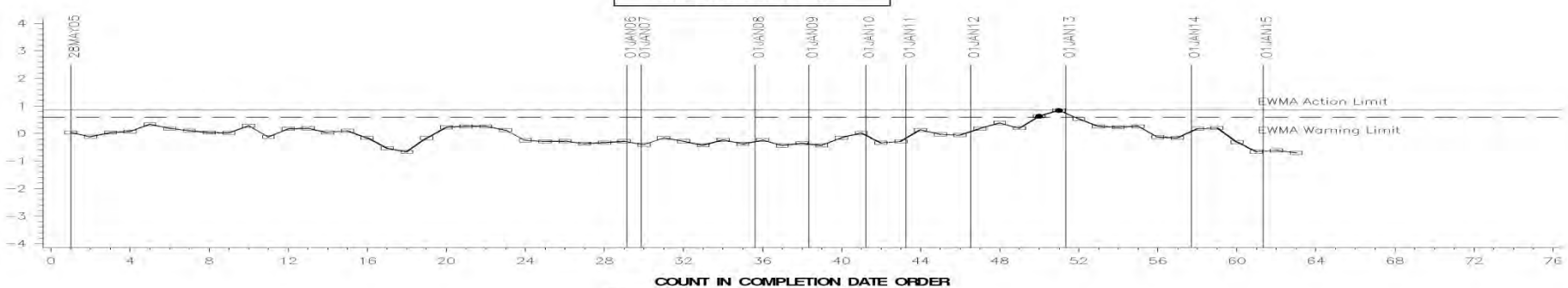
11MAY15:10:44

OIL CONS. DELTA — FINAL RESULT

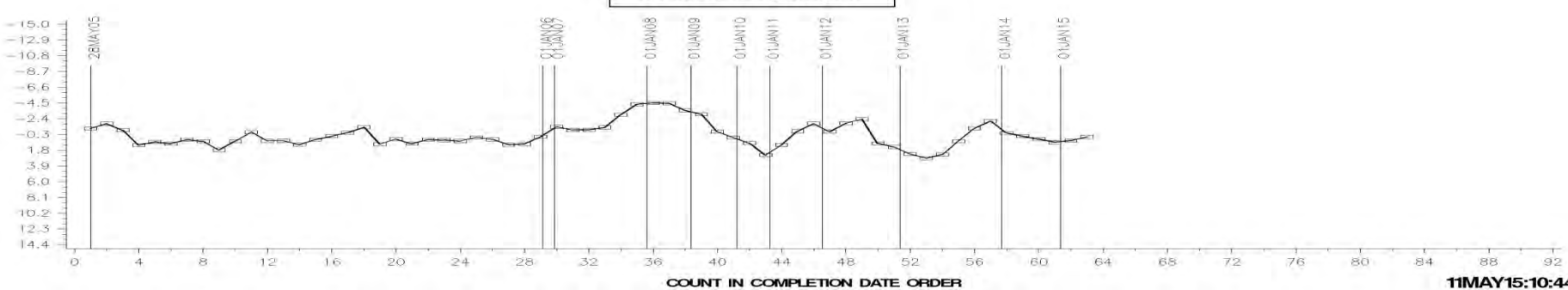
LTMS Severity Analysis



LTMS Precision Analysis

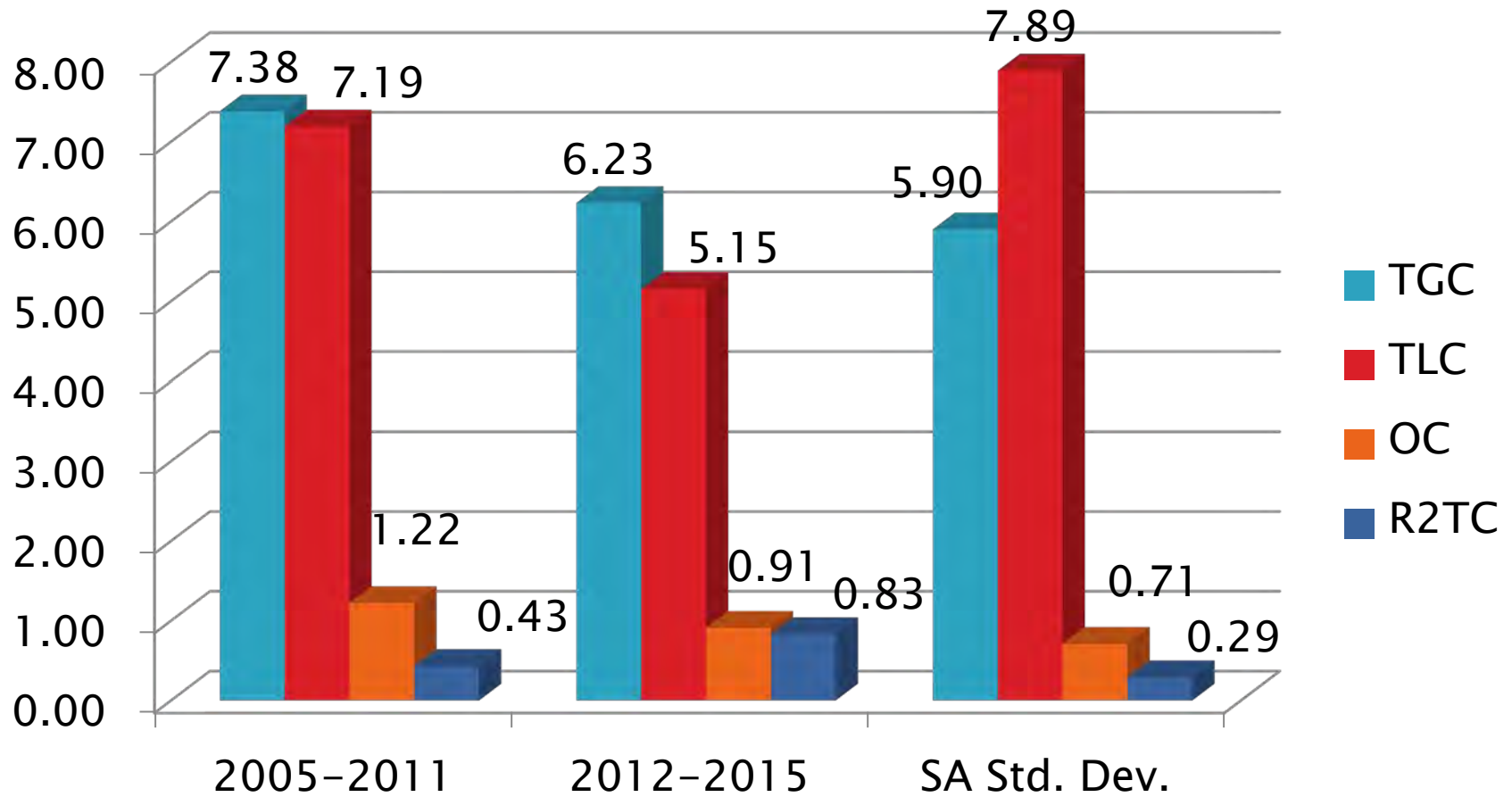


CUSUM Severity Analysis



11MAY15:10:44

C13 Precision Estimates



[Return to Table of Contents](#)

Cummins ISB

»» April 2015

Test Monitoring Center

<http://astmtmc.cmu.edu>



A Program of ASTM International

ISB Test Activity

| Test Status | Validity Code | # |
|-----------------------------|---------------|-----------|
| Acceptable Calibration Test | AC | 8 |
| Failed Calibration Test | OC | 5 |
| Operationally Invalid | LC | 1 |
| Aborted | XC,XH | 3 |
| Donated | AG | 2 |
| Information | LN | 1 |
| Total | | 20 |

ISB Failed Tests

| Failed Parameter | Number of Tests |
|------------------------|-----------------|
| Mild ATWL | 2 |
| Severe ATWL | 1 |
| Severe ACSW. Mild ATWL | 2 |
| Total | 5 |

ISB Lost Tests*

| Status | Cause | # |
|--------------|------------------------------|----------|
| XC | Missed soot window | 1 |
| XC | Aborted EGR Failure | 1 |
| XH | Engine Failure - Loss of oil | 1 |
| Total | | 3 |

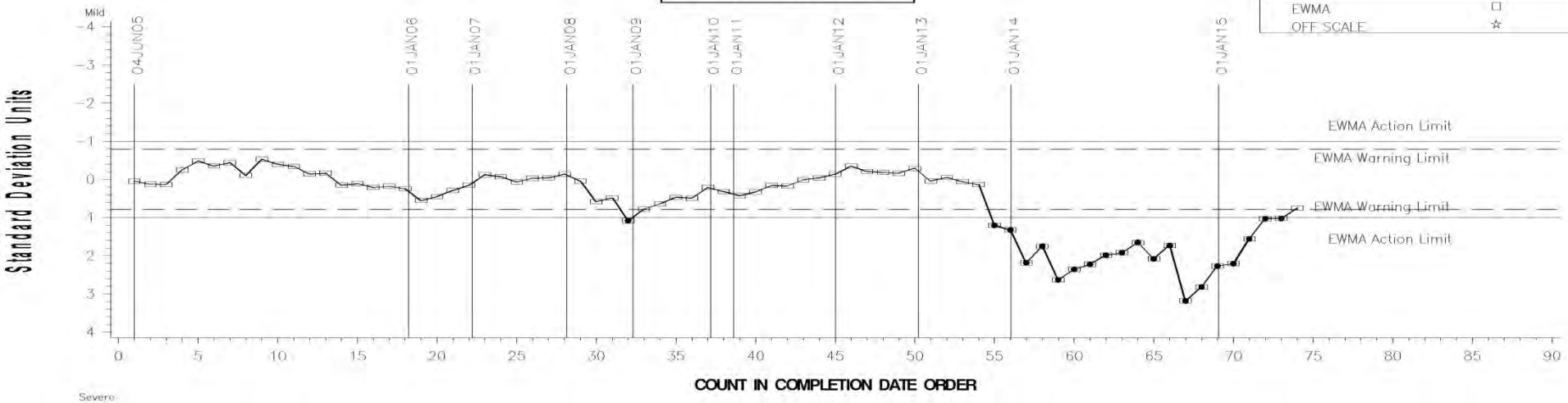
*Invalid and aborted tests

ISB Test Severity

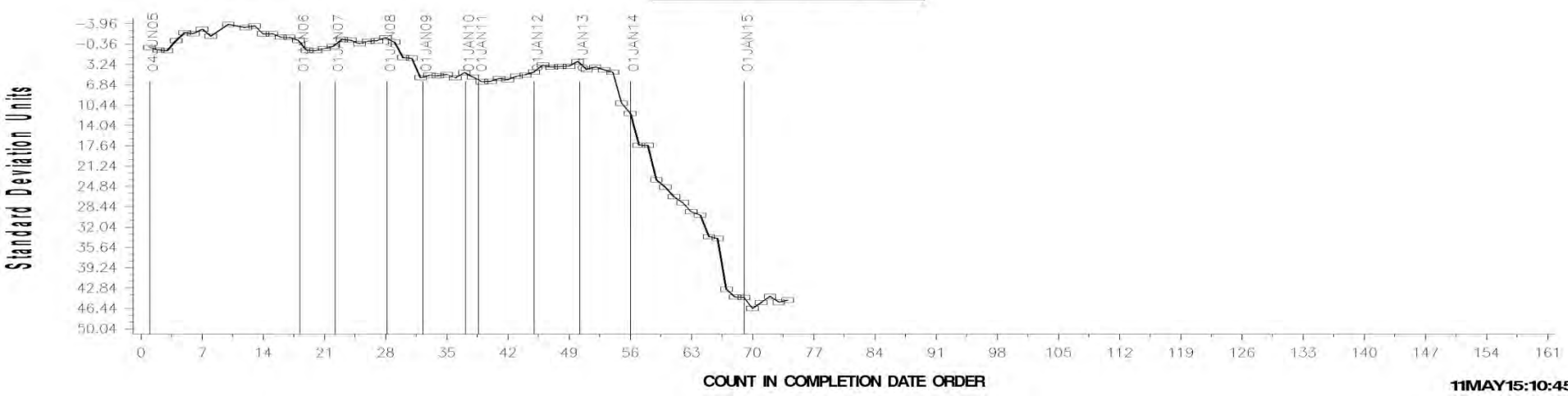
- ▶ ACSW is in warning alarm severe direction
- ▶ ATWL in action alarm in the mild direction

AVERAGE CAMSHAFT WEAR

LTMS Severity Analysis



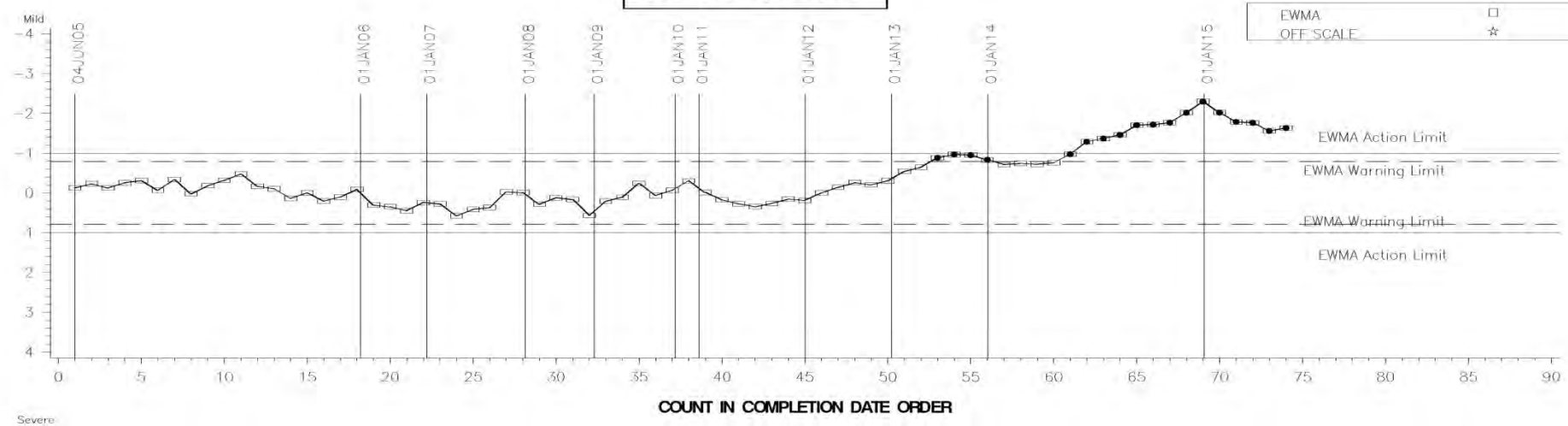
CUSUM Severity Analysis



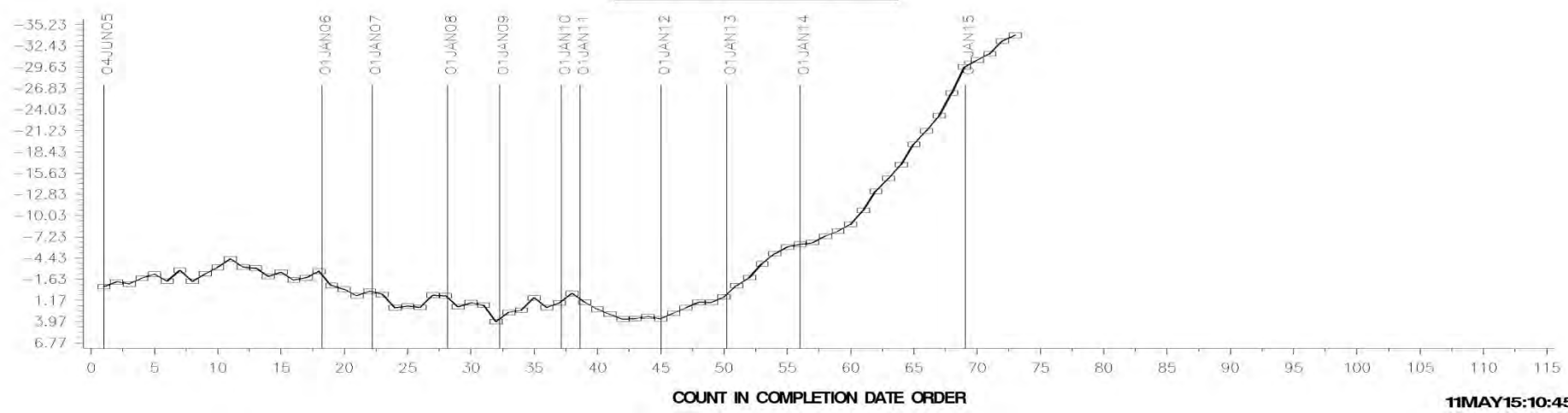
11MAY15:10:45

AVERAGE TAPPET WEIGHT LOSS

LTMS Severity Analysis

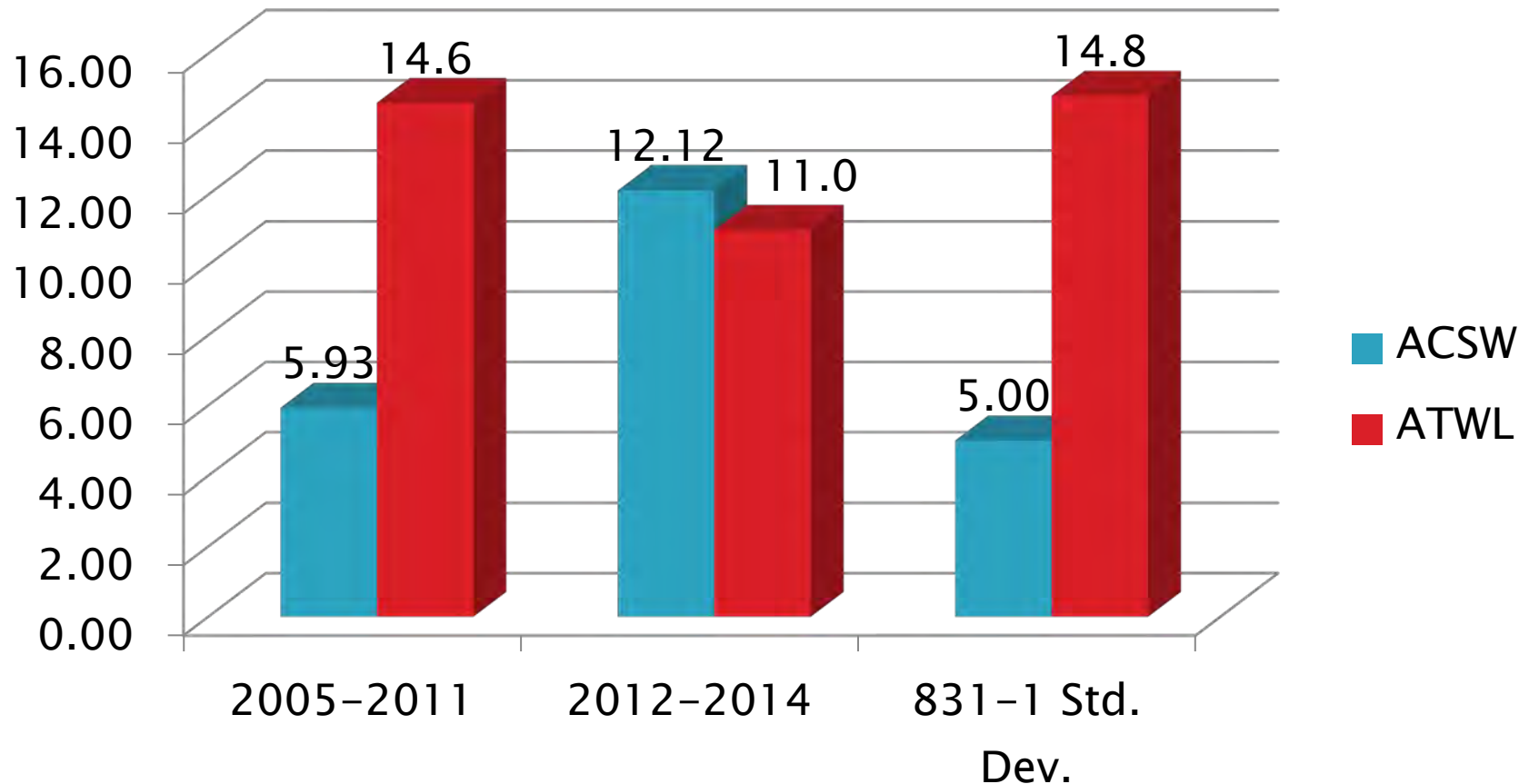


CUSUM Severity Analysis



11MAY15:10:45

ISB Precision Estimates



[Return to Table of Contents](#)

Cummins ISM

»» April 2015

Test Monitoring Center

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A Program of ASTM International

ISM Test Activity

| Test Status | Validity Code | # |
|-----------------------------|---------------|----------|
| Acceptable Calibration Test | AC | 4 |
| Failed Calibration Test | OC | 1 |
| Operationally Invalid | LC | 1 |
| Aborted | XC | 0 |
| Total | | 6 |

ISM Failed Tests

| Failed Parameter | Number of Tests |
|--|-----------------|
| Severe filter plugging delta pressure, Mild sludge | 1 |
| Total | 1 |

ISM Lost Tests*

| Status | Cause | # |
|--------------|------------------|----------|
| Invalid | 150 Hr soot < 6% | 1 |
| Total | | 1 |

*Invalid and aborted tests

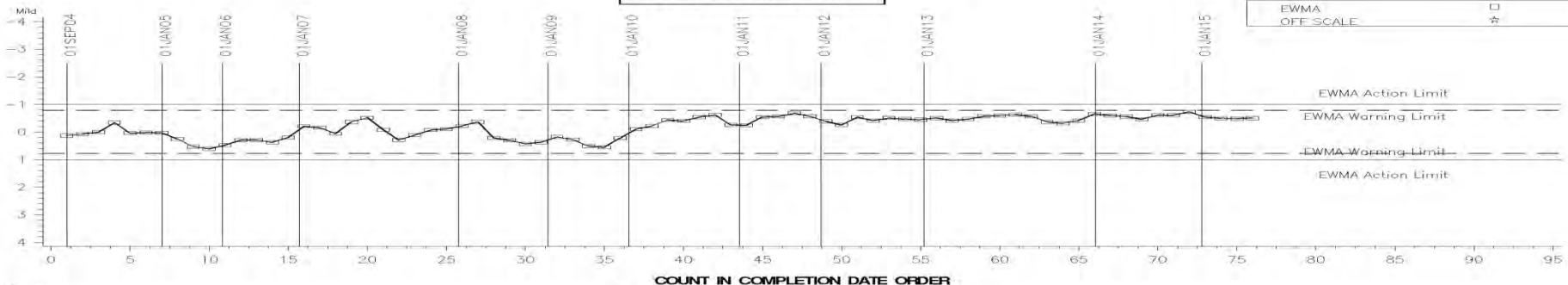
ISM Test Severity

- ▶ ASR in severity action alarm mild direction
- ▶ IAS in precision action alarm
- ▶ CWL, FPD, and in control.
 - CWL trending mild.
 - FPD mild trend may be ending.

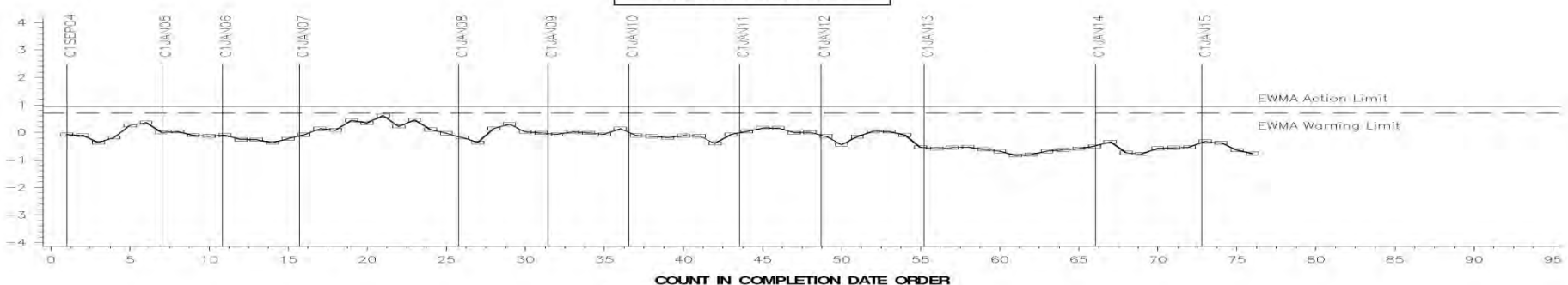
ISM INDUSTRY OPERATIONALLY VALID DATA

CROSSHEAD WEIGHT LOSS ADJUSTED TO 3.9 % SOOT

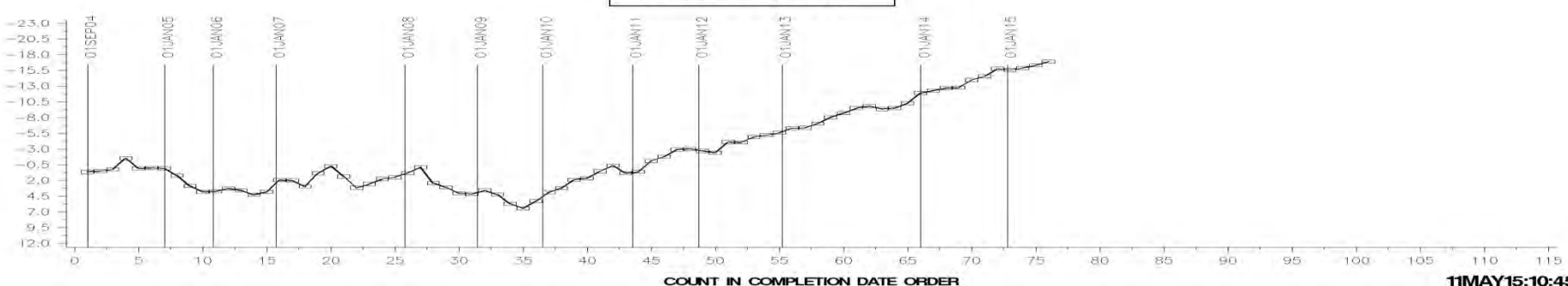
LTMS Severity Analysis



LTMS Precision Analysis



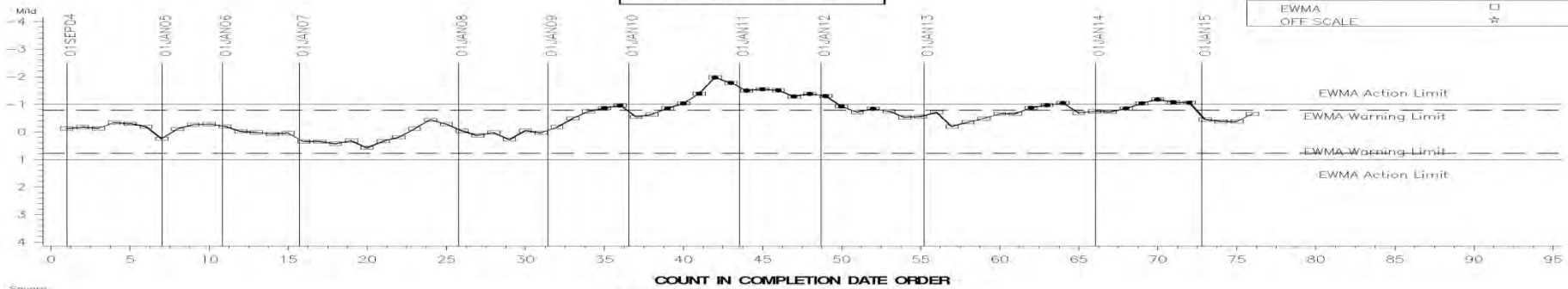
CUSUM Severity Analysis



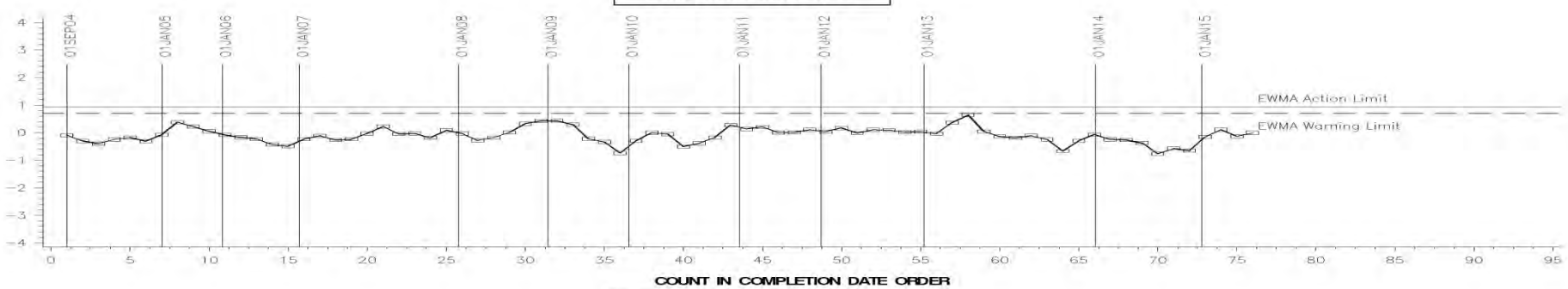
11MAY15:10:45

FILTER PLUGGING DELTA P

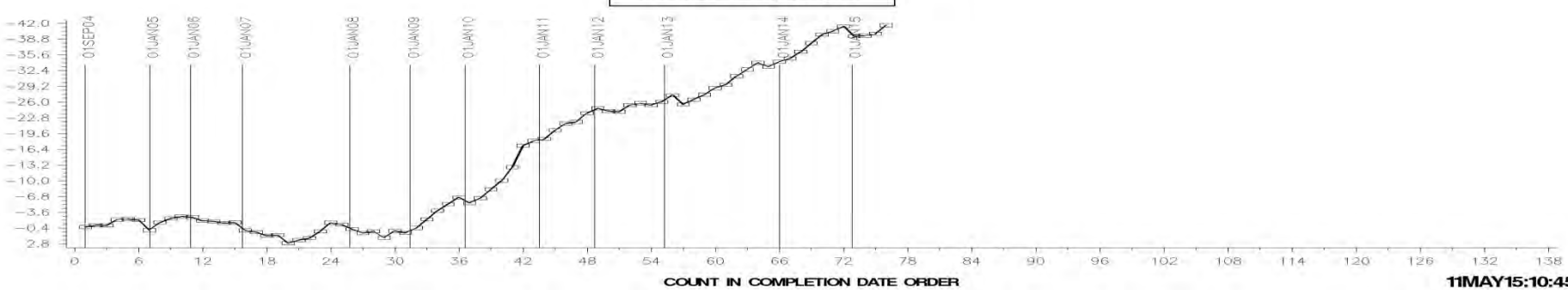
LTMS Severity Analysis



LTMS Precision Analysis



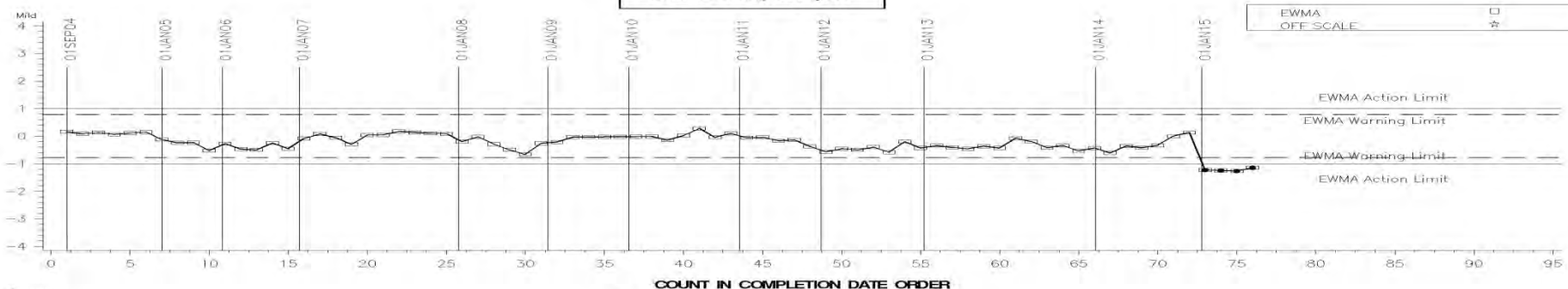
CUSUM Severity Analysis



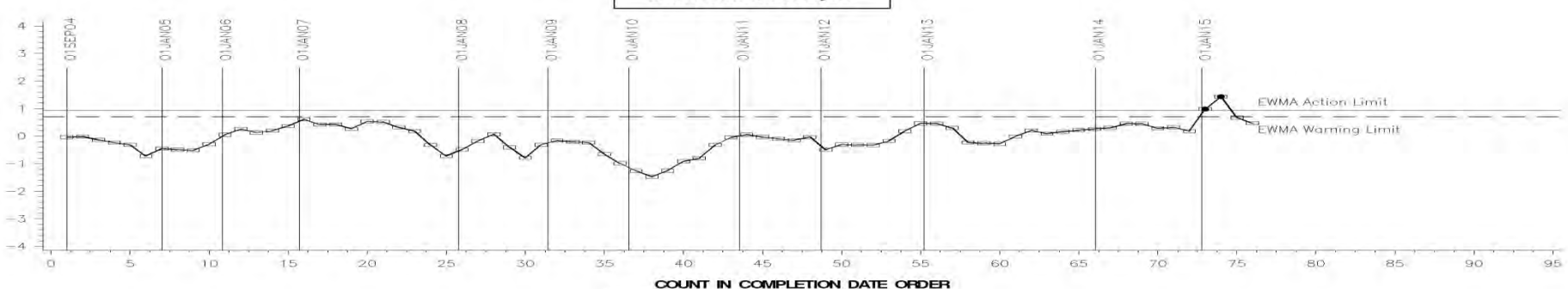
11MAY15:10:45

AVERAGE SLUDGE RATING

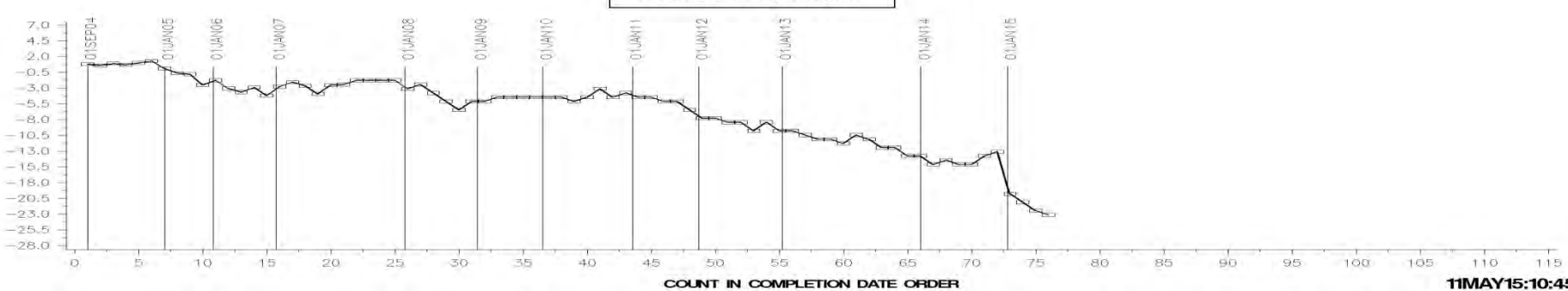
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis

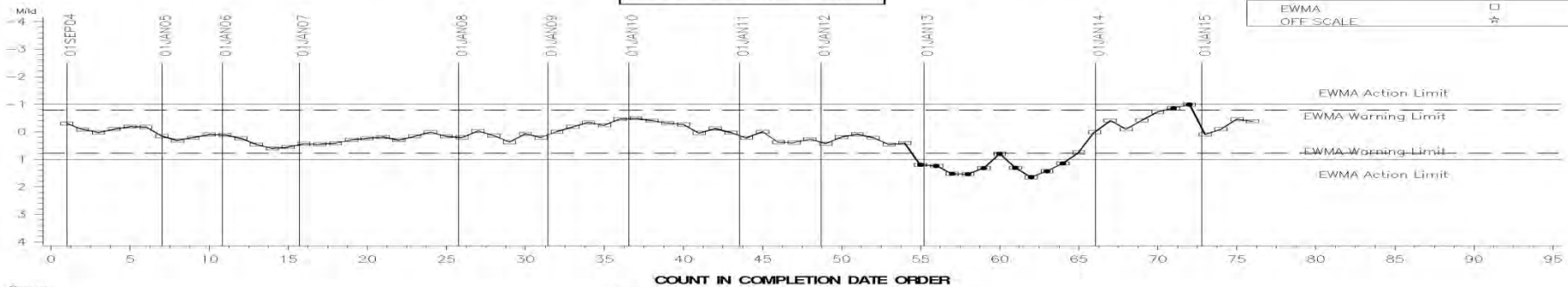


11MAY15:10:45

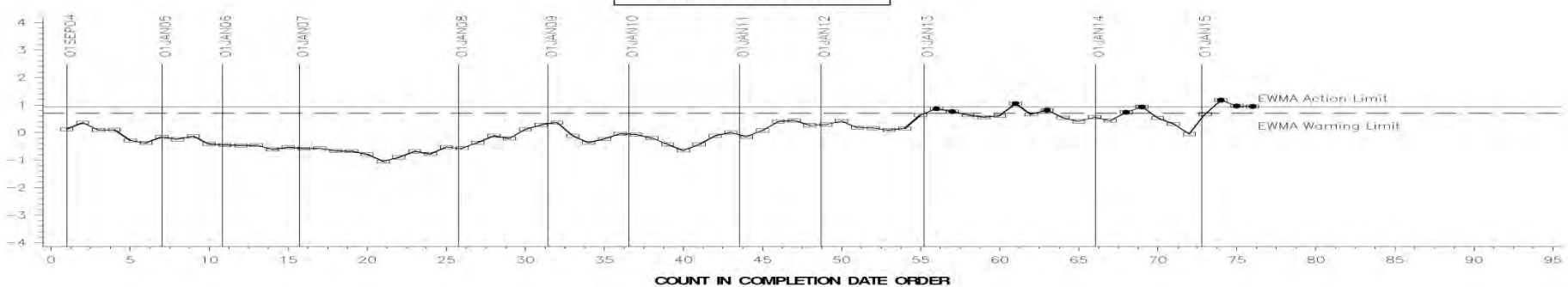
ISM INDUSTRY OPERATIONALLY VALID DATA

INJECTOR SCREW WEIGHT LOSS ADJUSTED TO 3.9% SOOT

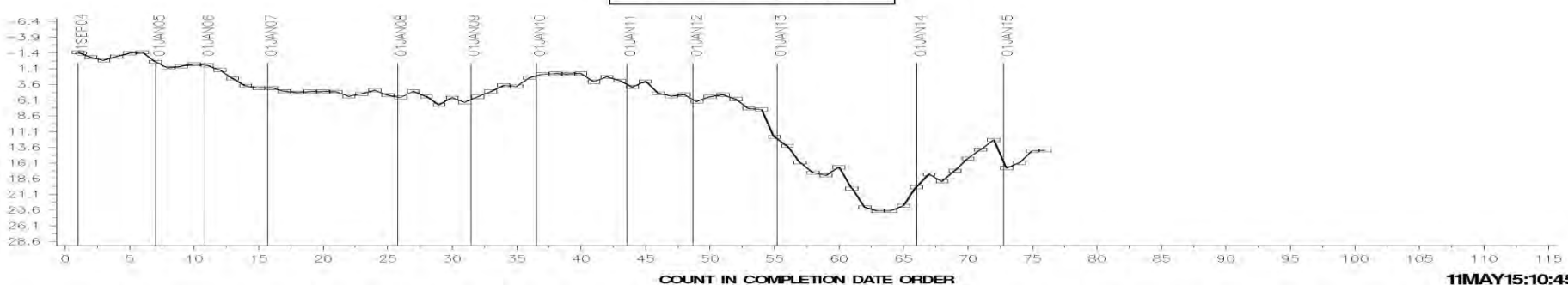
LTMS Severity Analysis



LTMS Precision Analysis

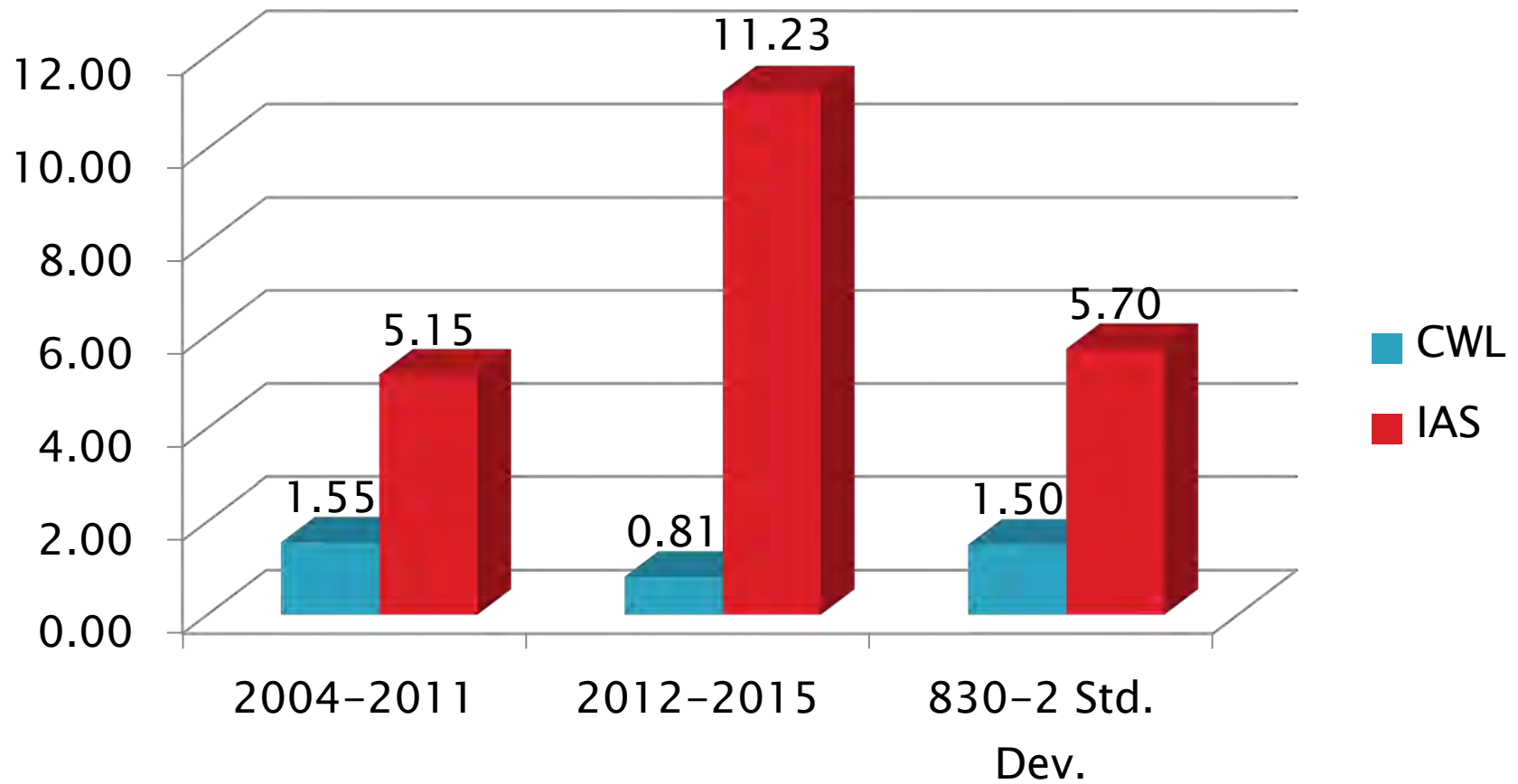


CUSUM Severity Analysis

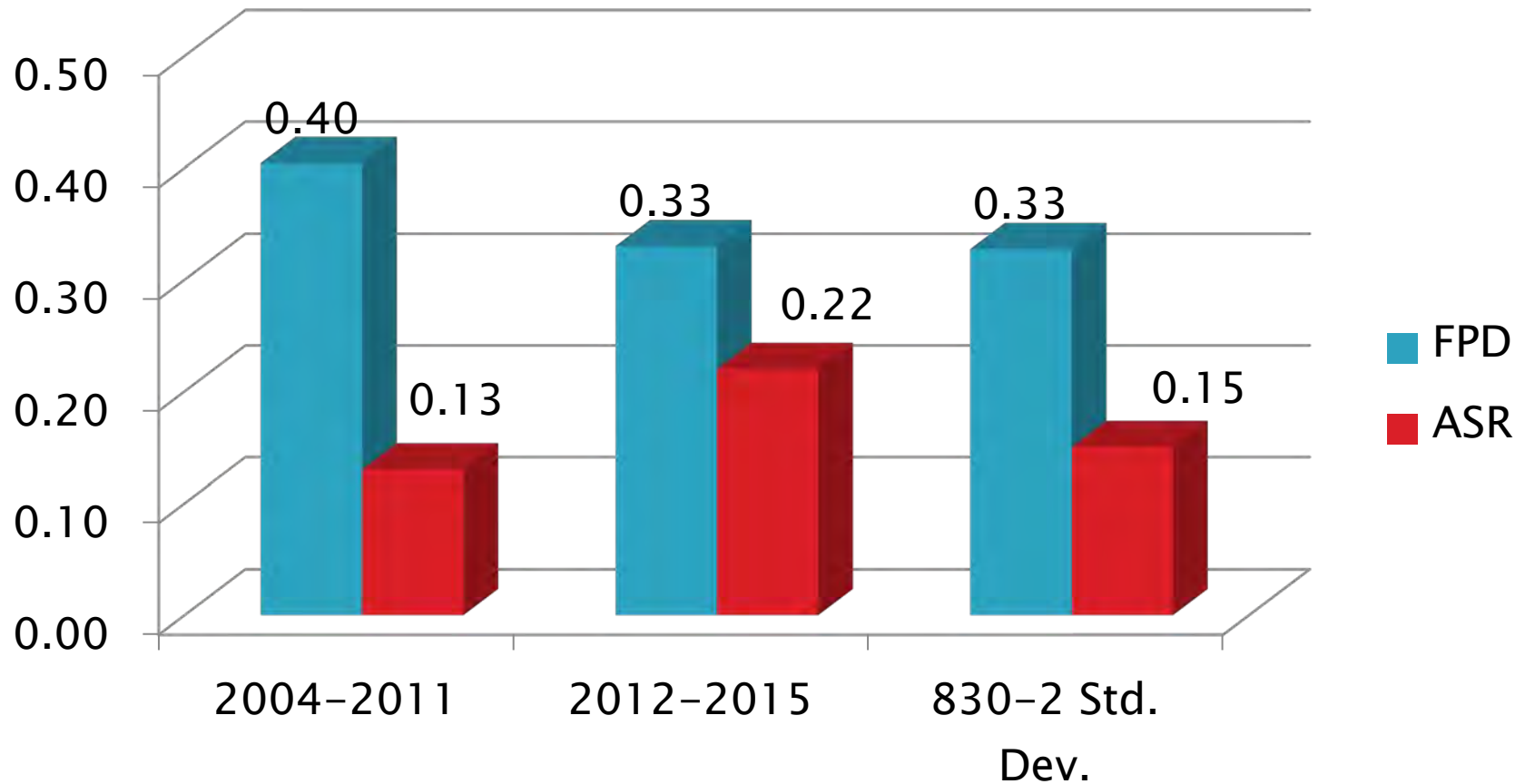


11MAY15:10:45

ISM Precision Estimates



ISM Precision Estimates



[Return to Table of Contents](#)

Test Monitoring Center

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A Program of ASTM International

EOAT

»» April 2015

EOAT Test Activity

| Test Status | Validity Code | # |
|-----------------------------|---------------|----------|
| Acceptable Calibration Test | AC | 0 |
| Failed Calibration Test | OC | 0 |
| Operationally Invalid | LC | 0 |
| Aborted | XC | 0 |
| Total | | 0 |

EOAT Failed Tests

| Failed Parameter | Number of Tests |
|------------------|-----------------|
| No failed tests | |
| Total | 0 |

EOAT Lost Tests*

| Status | Cause | # |
|--------------|------------------|----------|
| Invalid | No invalid tests | |
| Aborted | No aborted tests | |
| Total | | 0 |

*Invalid and aborted tests

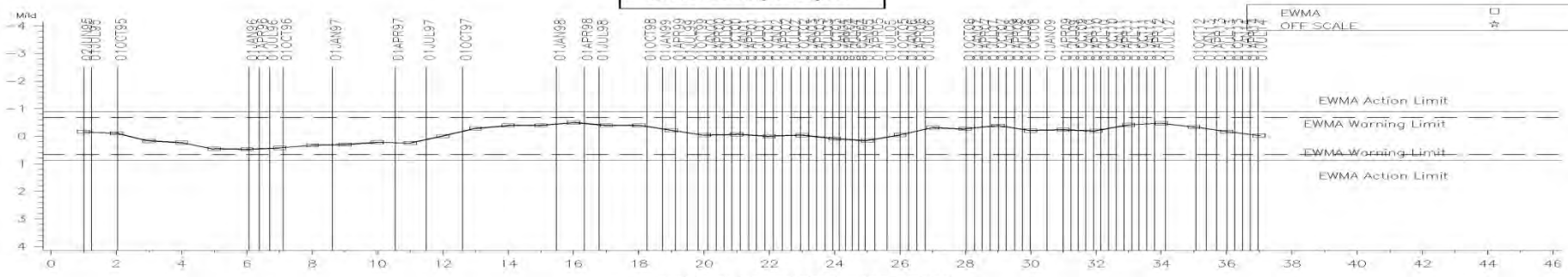
EOAT Test Severity

- ▶ AEOA in control.

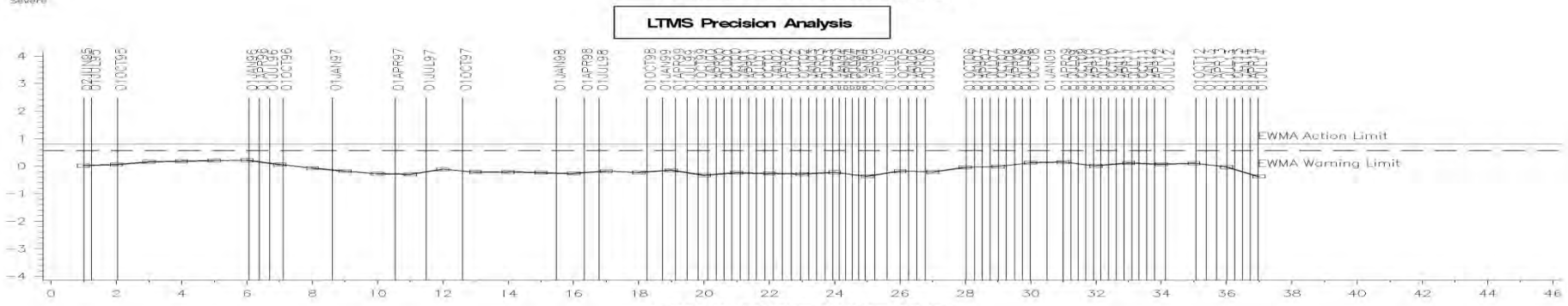
EOAT INDUSTRY OPERATIONAL VALID DATA

ENGINE OIL AERATION

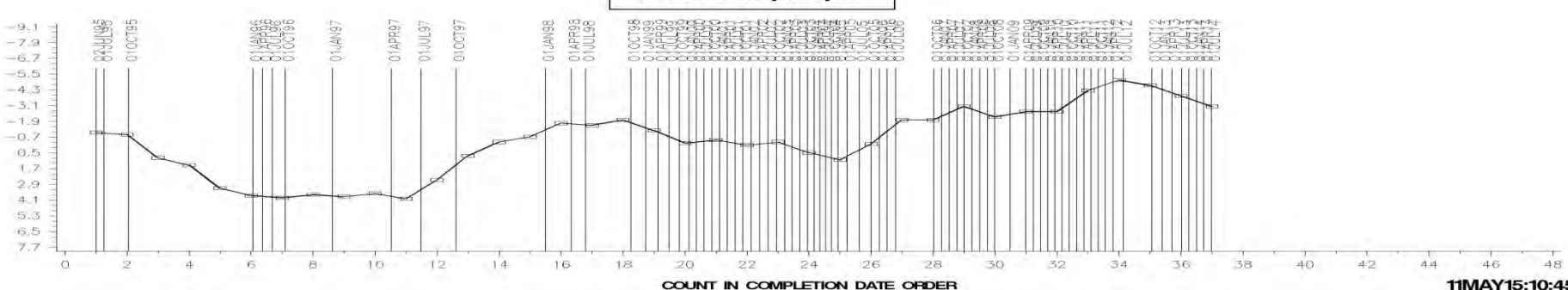
LTMS Severity Analysis



LTMS Precision Analysis



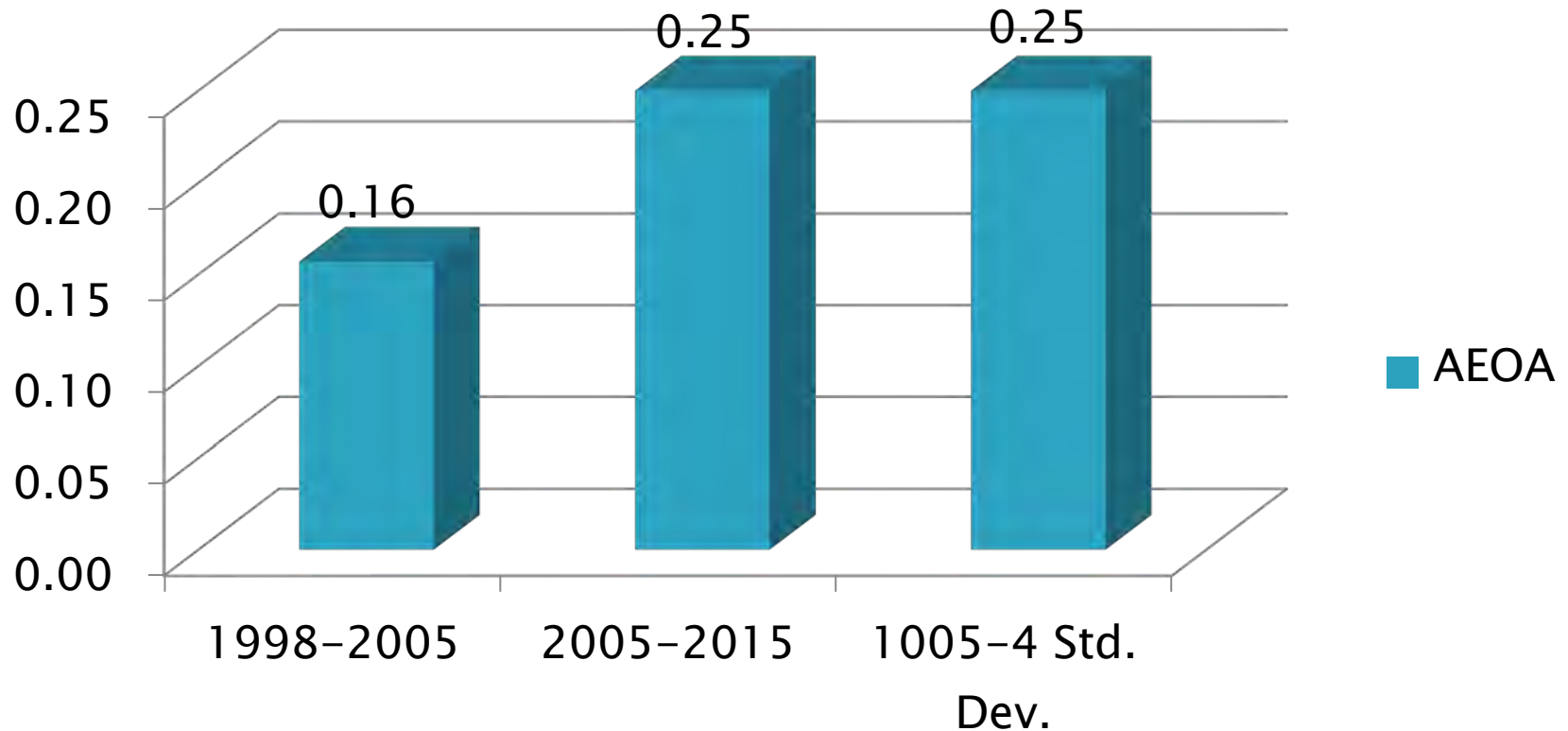
CUSUM Severity Analysis



11MAY15:10:45

EOAT Precision Estimates

AEOA



[Return to Table of Contents](#)

Test Monitoring Center

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A Program of ASTM International

RFWT

»» April 2015

Test Monitoring Center

<http://astmtmc.cmu.edu>



A Program of ASTM International

RFWT Test Activity

| Test Status | Validity Code | # |
|-----------------------------|---------------|----------|
| Acceptable Calibration Test | AC | 1 |
| Failed Calibration Test | OC | 0 |
| Operationally Invalid | LC | 0 |
| Aborted | XC | 0 |
| Total | | 1 |

RFWT Failed Tests

| Failed Parameter | Number of Tests |
|------------------|-----------------|
| No failed tests | |
| Total | 0 |

RFWT Lost Tests*

| Status | Cause | # |
|--------------|------------------|----------|
| Invalid | No invalid tests | |
| Aborted | No aborted tests | |
| Total | | 0 |

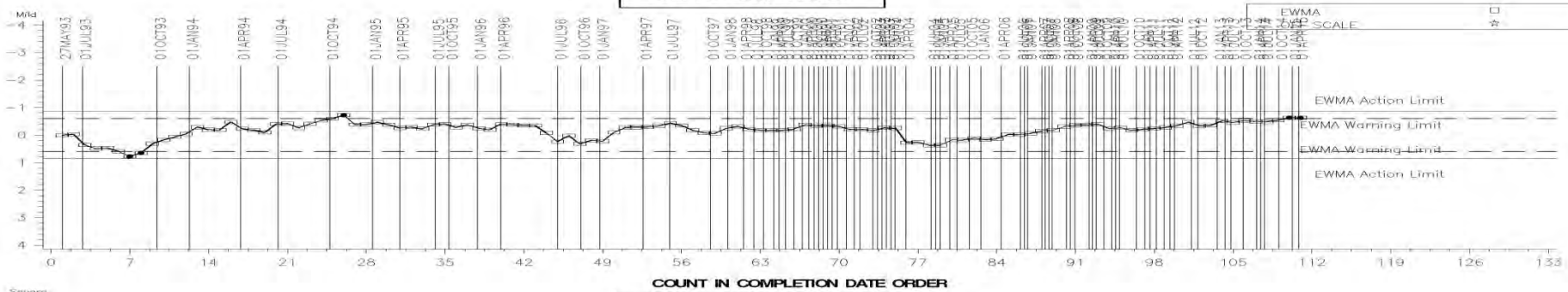
*Invalid and aborted tests

RFWT Test Severity

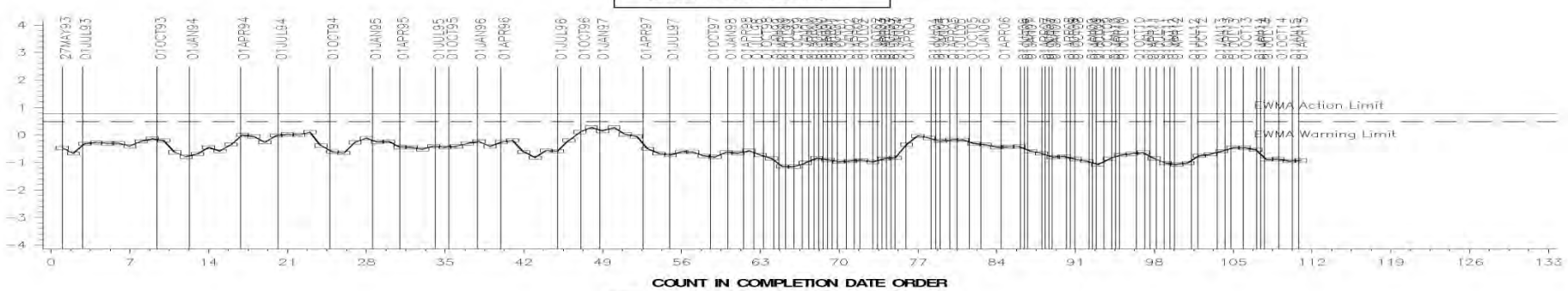
- ▶ AFW in warning alarm mild direction.

Average Follower Wear

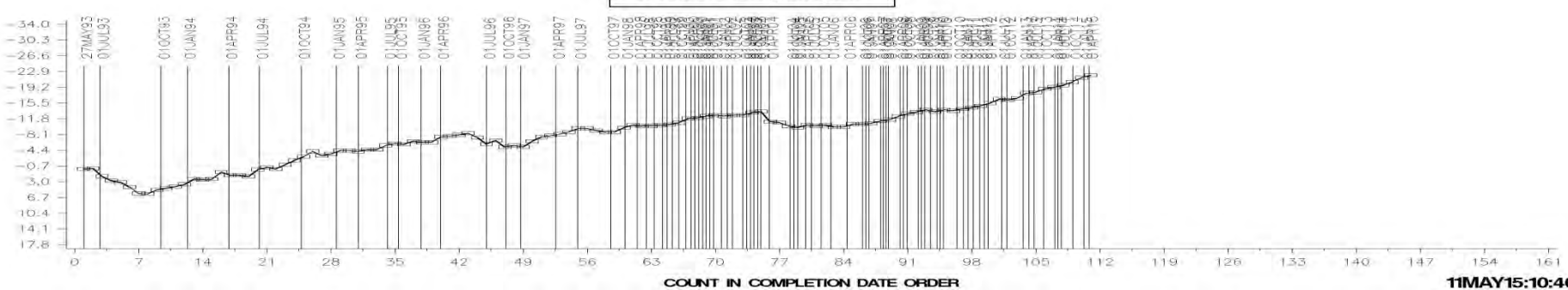
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



11MAY15:10:46

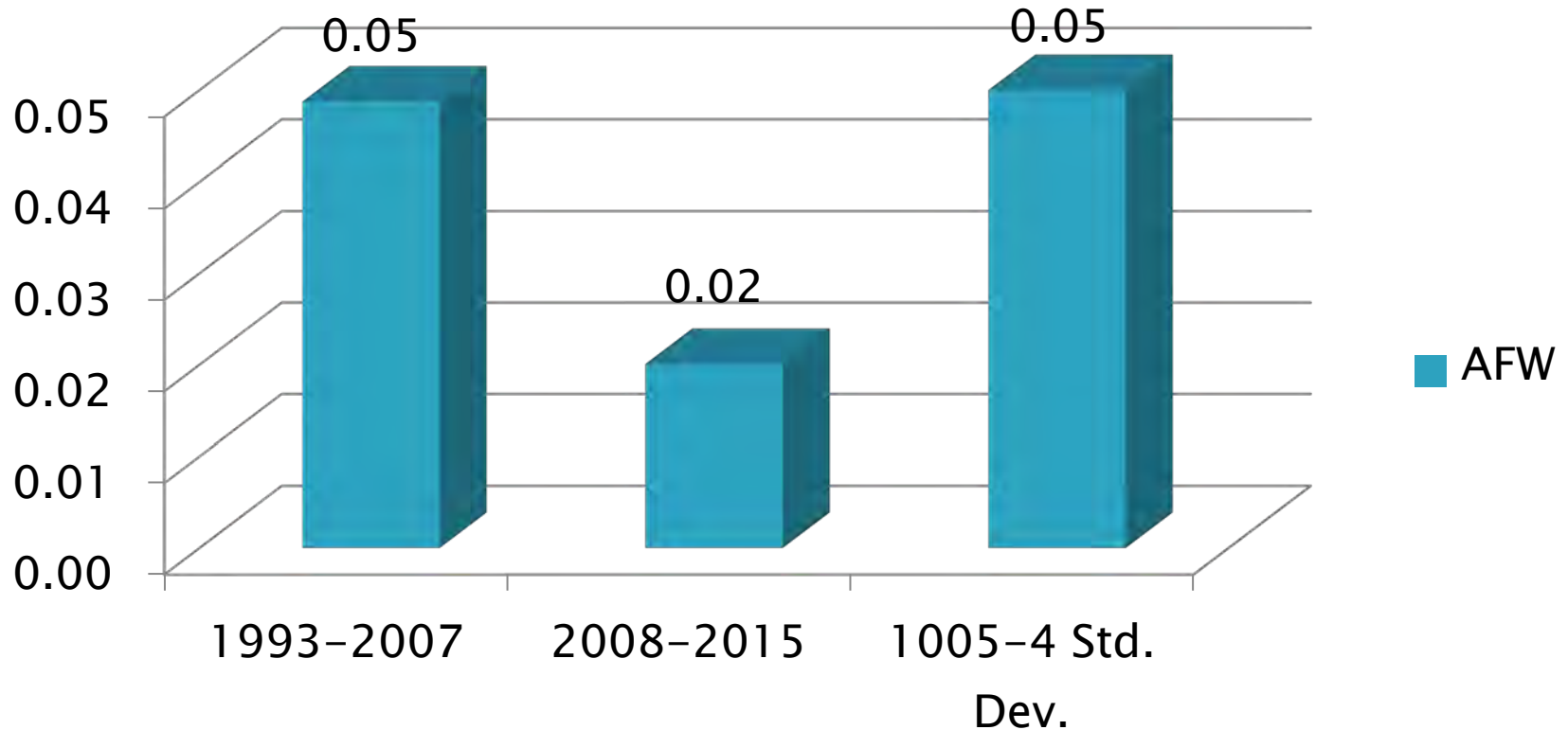
Standard Deviation Units

Standard Deviation Units

Standard Deviation Units

RFWT Precision Estimates

AFW



[Return to Table of Contents](#)

Test Monitoring Center

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A Program of ASTM International

Mack T-8/T-8E

»» April 2015

Test Monitoring Center

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A Program of ASTM International

T-8/T-8E Test Activity

| Test Status | Validity Code | # |
|-----------------------------|---------------|----------|
| Acceptable Calibration Test | AC | 4 |
| Failed Calibration Test | OC | 0 |
| Operationally Invalid | LC | 0 |
| Aborted | XC | 1 |
| Total | | 5 |

T-8/T8-E Failed Tests

| Failed Parameter | Number of Tests |
|------------------|-----------------|
| No failed tests | |
| Total | 0 |

T-8/T8-E Lost Tests*

| Status | Cause | # |
|--------------|-------------------------------------|----------|
| Aborted | High Oil Consumption - Safety Issue | 1 |
| Total | | 1 |

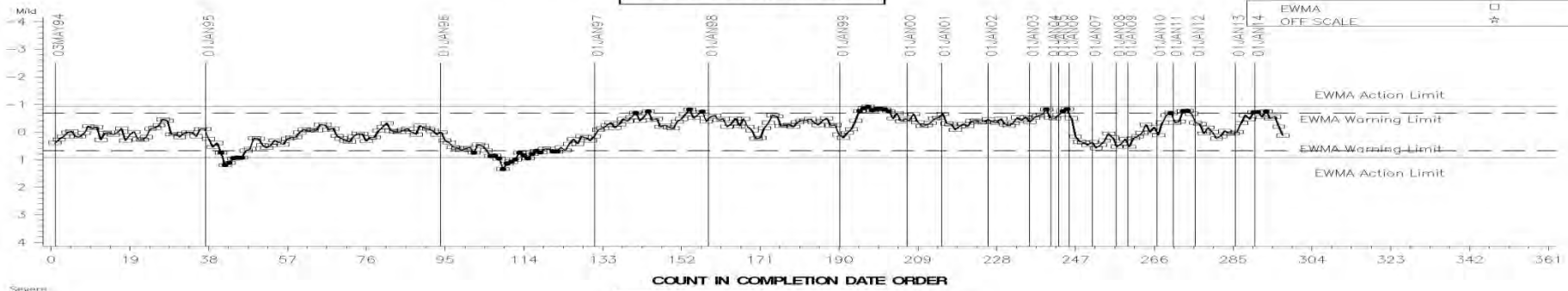
*Invalid and aborted tests

T-8/T-8E Test Severity

- ▶ VI38, RV48 and RV2 are in control.

FINAL REFERENCE VISCOSITY AT 3.8% TGA SOOT LEVEL

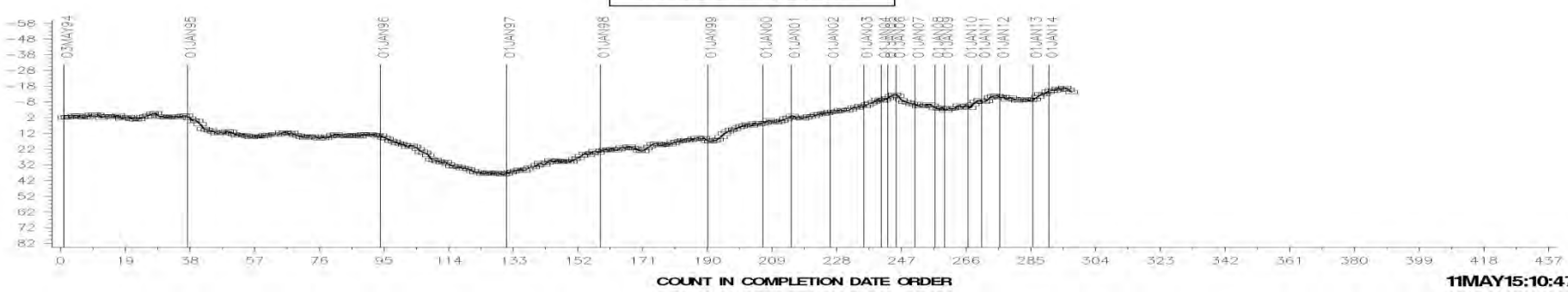
LTMS Severity Analysis



LTMS Precision Analysis



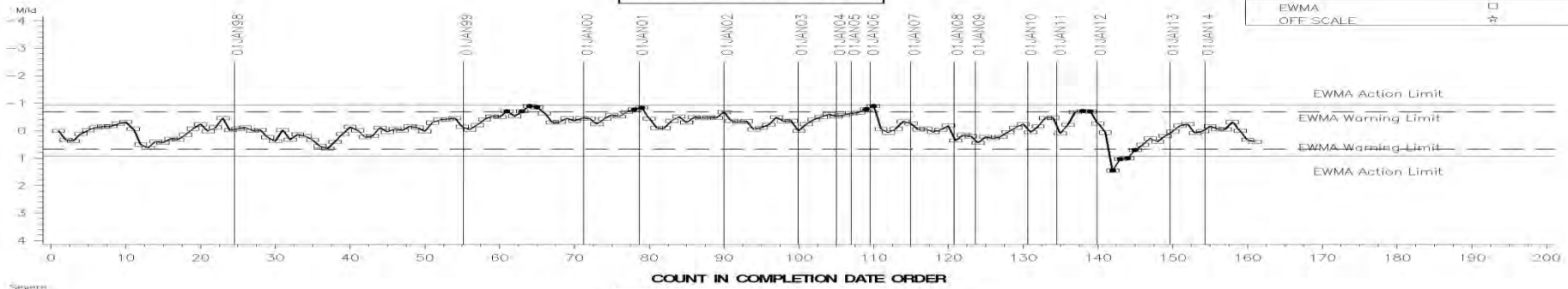
CUSUM Severity Analysis



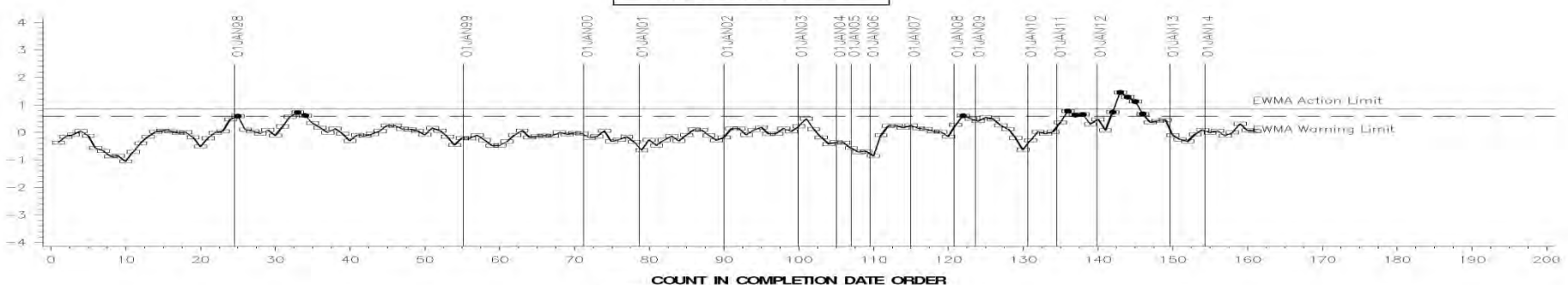
11MAY15:10:47

FINAL RELATIVE VISCOSITY (50% LOSS)

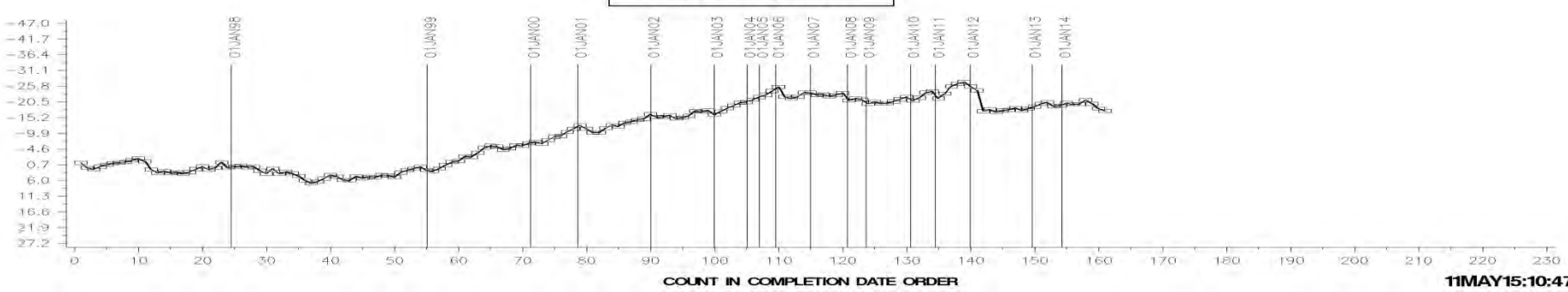
LTMS Severity Analysis



LTMS Precision Analysis



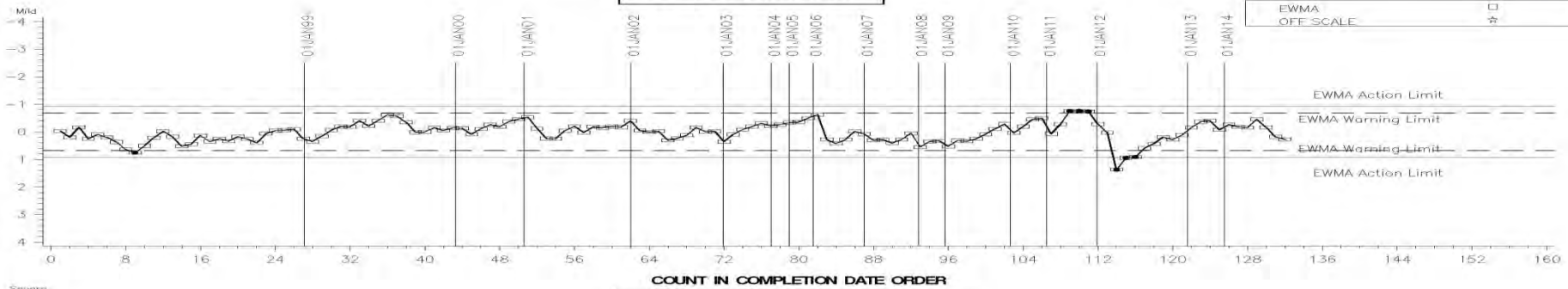
CUSUM Severity Analysis



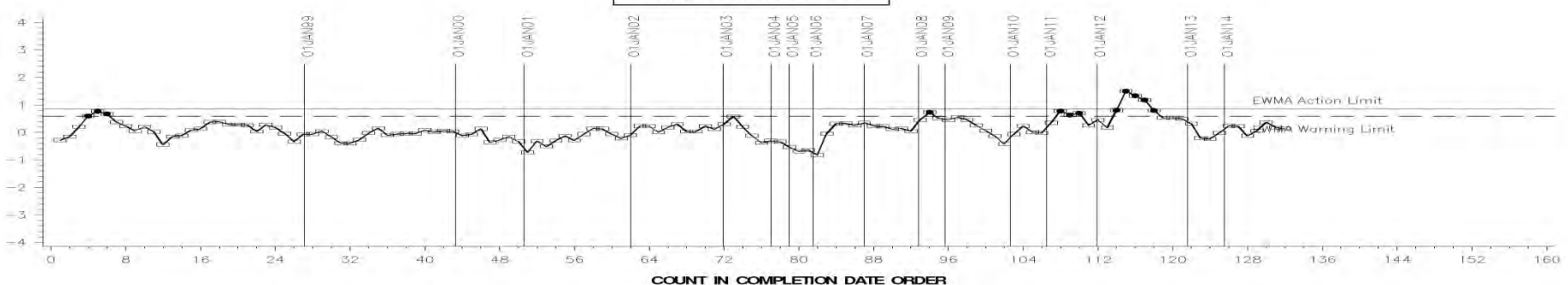
11MAY15:10:47

FINAL RELATIVE VISCOSITY (100% LOSS)

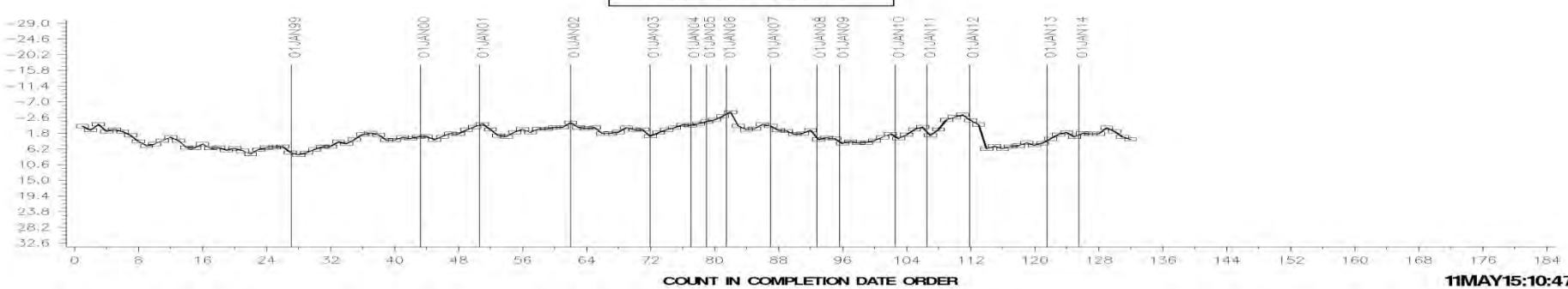
LTMS Severity Analysis



LTMS Precision Analysis

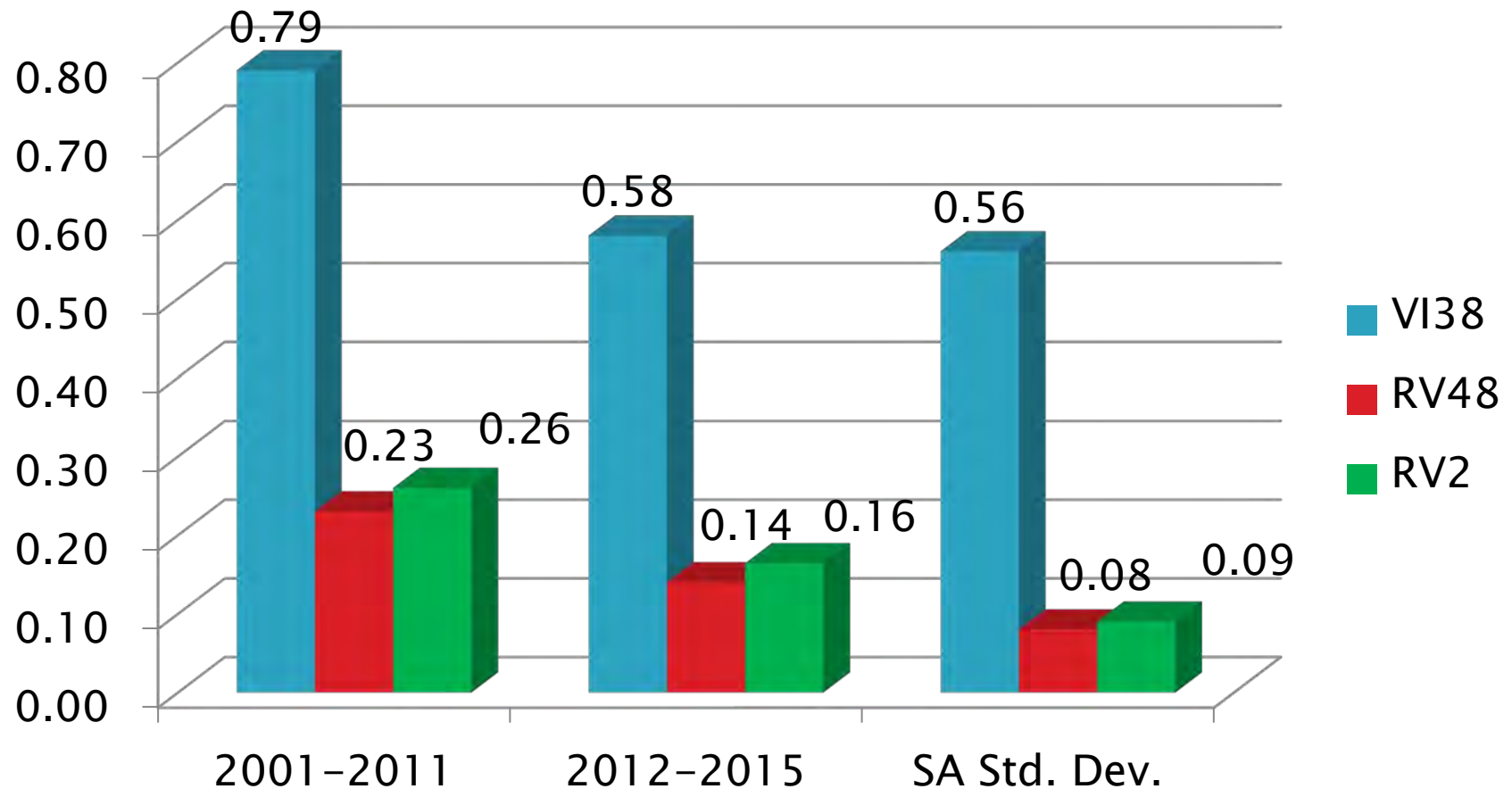


CUSUM Severity Analysis



11MAY15:10:47

T-8/E Precision Estimates



[Return to Table of Contents](#)

Test Monitoring Center

<http://astmtmc.cmu.edu>



A Program of ASTM International

Mack T-11

»» April 2015

Test Monitoring Center

<http://astmtmc.cmu.edu>



A Program of ASTM International

T-11 Test Activity

| Test Status | Validity Code | # |
|-----------------------------|---------------|----------|
| Acceptable Calibration Test | AC | 6 |
| Failed Calibration Test | OC | 0 |
| Operationally Invalid | LC | 0 |
| Aborted | XC | 1 |
| Total | | 7 |

T-11 Failed Tests

| Failed Parameter | Number of Tests |
|------------------|-----------------|
| No failed tests | |
| Total | 0 |

T-11 Lost Tests*

| Status | Cause | # |
|--------------|-------------------------------------|----------|
| Aborted | High Oil Consumption - Safety Issue | 1 |
| Total | | 1 |

*Invalid and aborted tests

Test Monitoring Center

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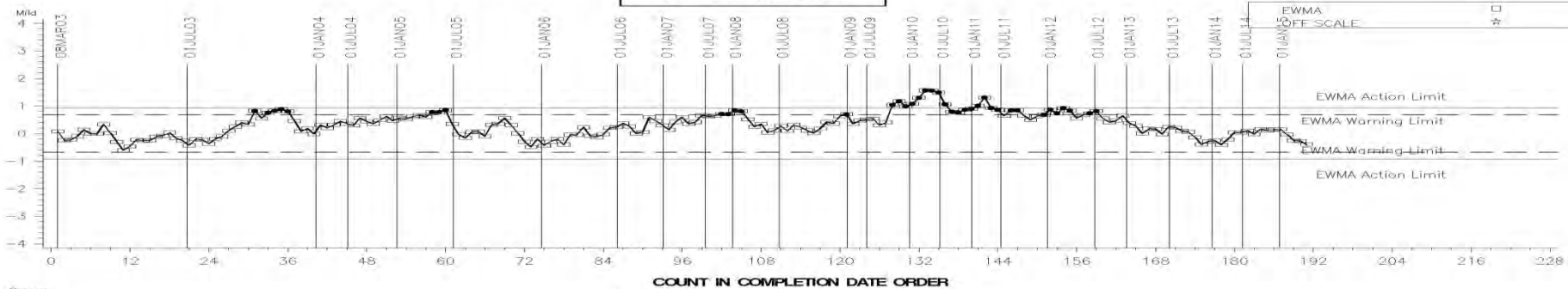
T-11 Test Severity

- ▶ SOOT and SOOT5 in control chart limits.
- ▶ SOOT4 in severity warning alarm mild direction.
- ▶ MRV in precision action alarm.

T-11 INDUSTRY OPERATIONAL VALID DATA

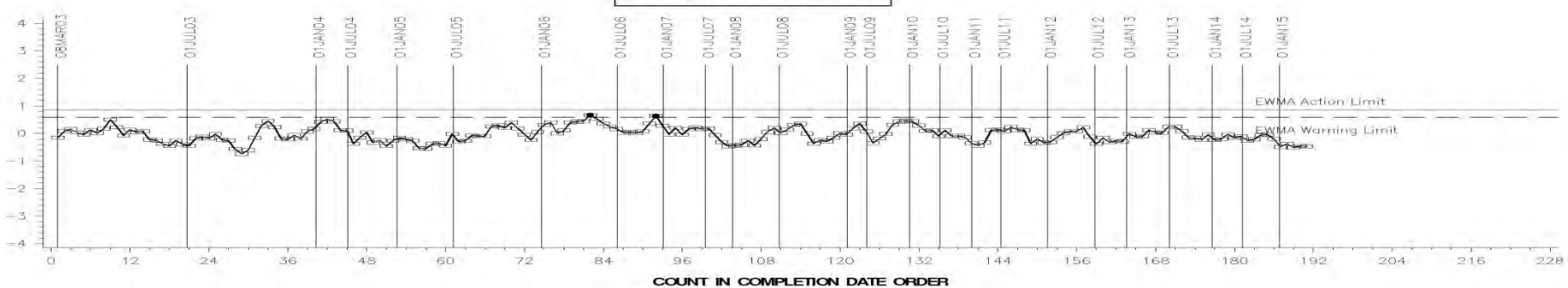
SOOT AT 12 cSt

LTMS Severity Analysis



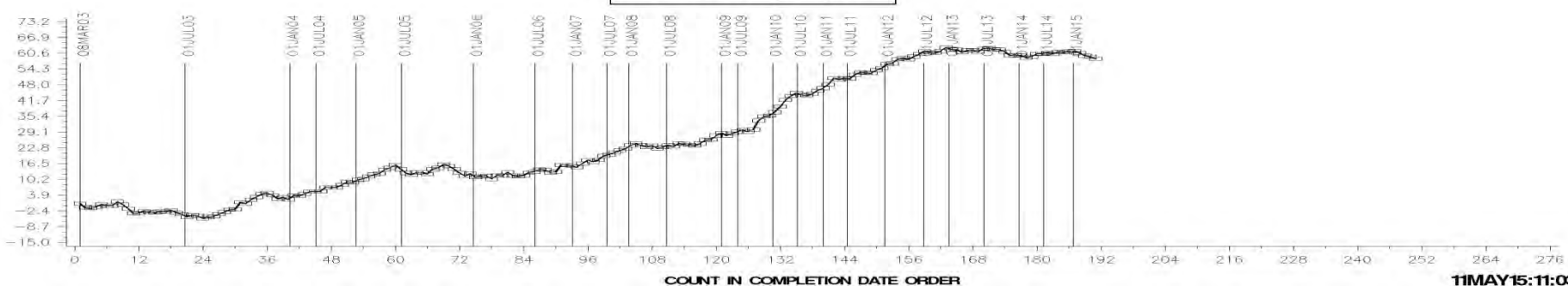
COUNT IN COMPLETION DATE ORDER

LTMS Precision Analysis



COUNT IN COMPLETION DATE ORDER

CUSUM Severity Analysis

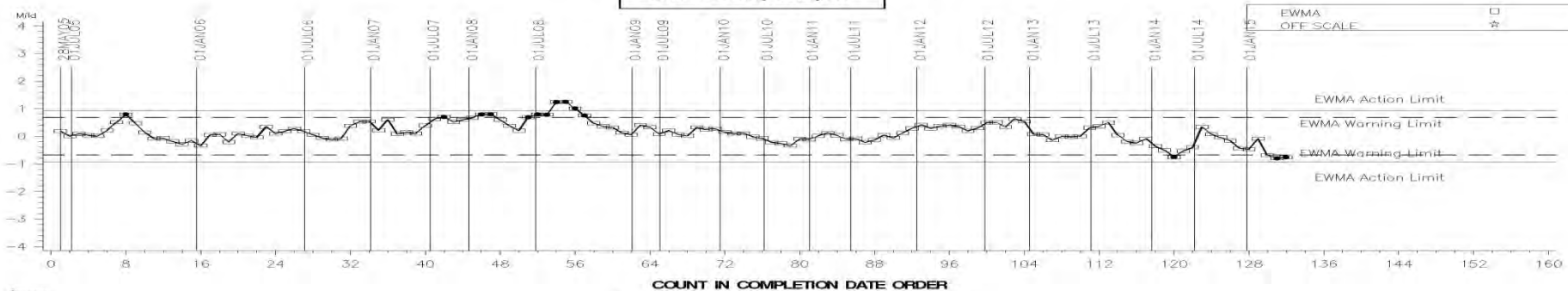


COUNT IN COMPLETION DATE ORDER

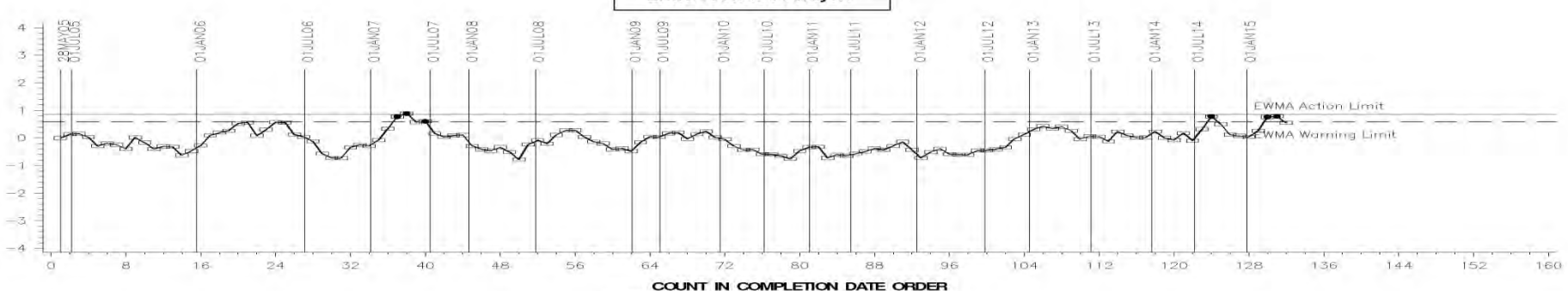
11MAY15:11:03

SOOT @ 4 cSt - FINAL RESULT

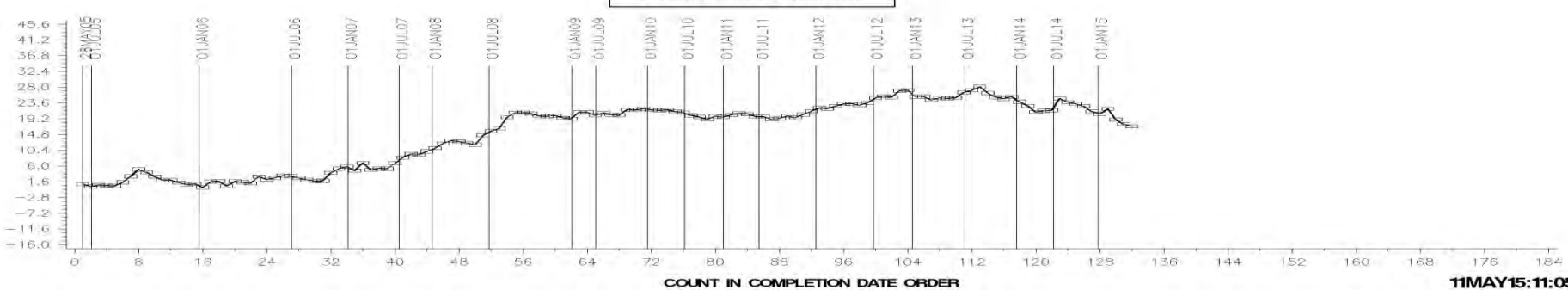
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis

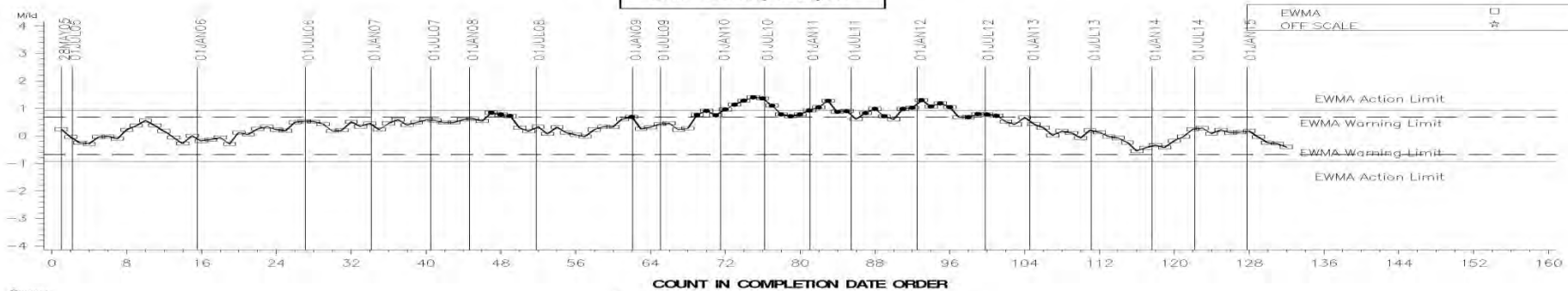


11MAY15:11:05

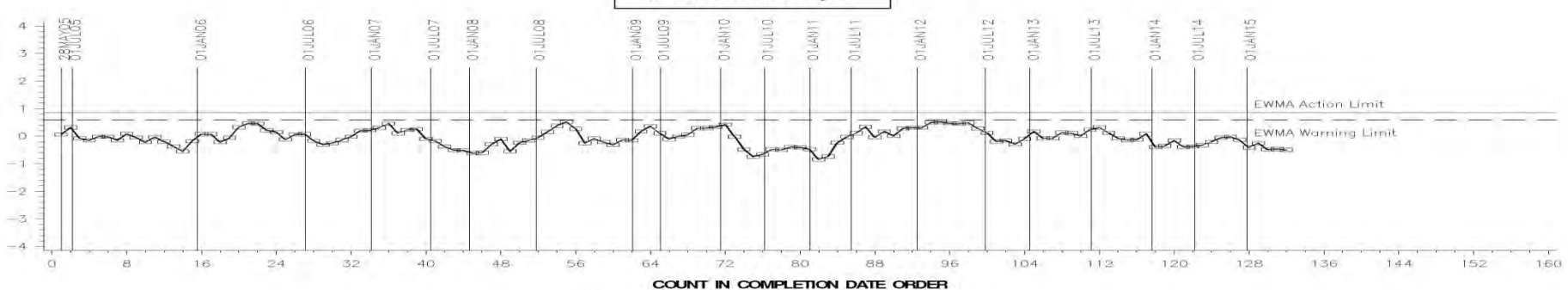
T-11 INDUSTRY OPERATIONALLY VALID DATA

SOOT @ 15 cSt - FINAL RESULT

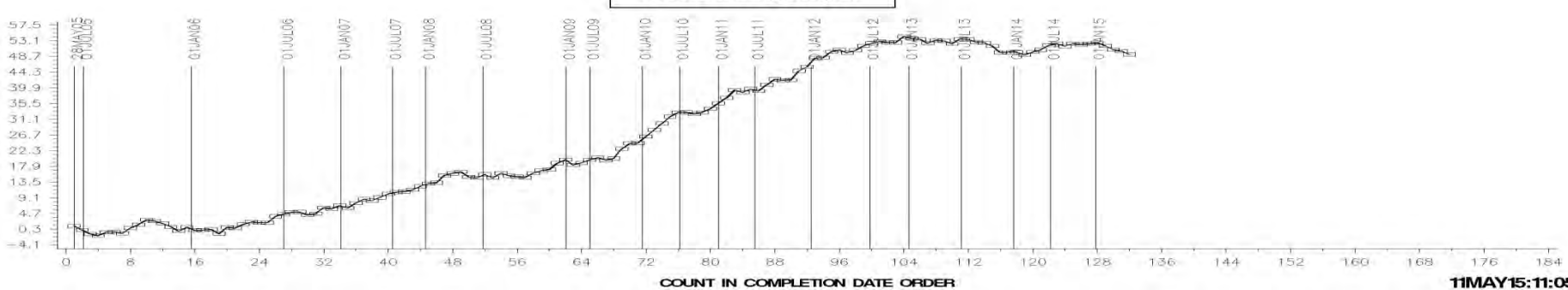
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis

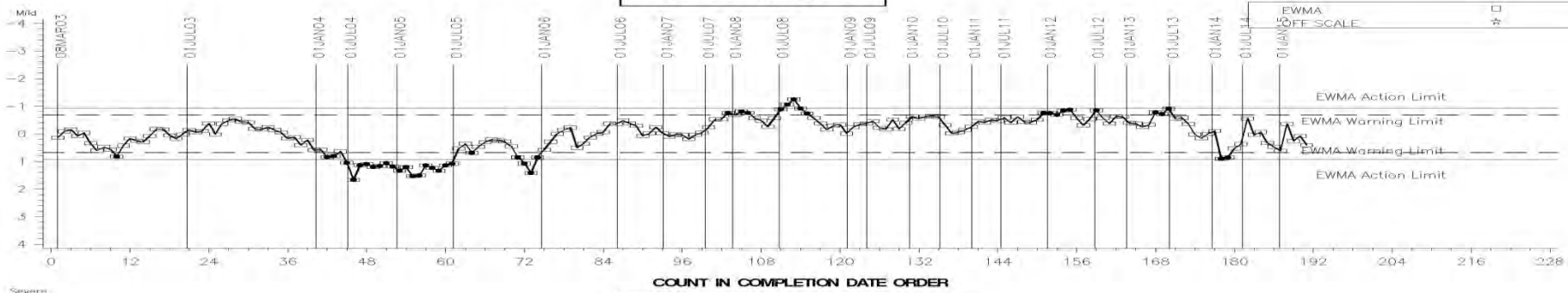


11MAY15:11:05

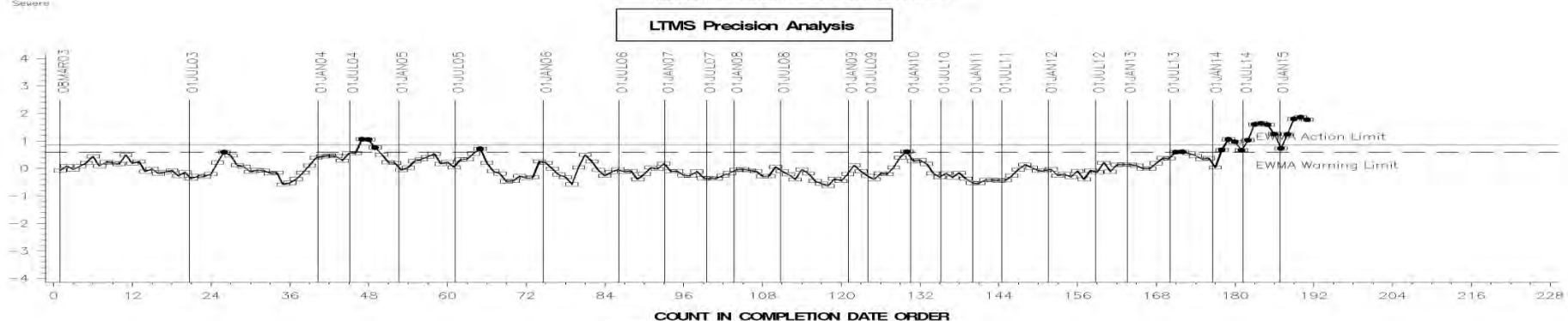
T-11 INDUSTRY OPERATIONALLY VALID DATA

MRV VISCOSITY

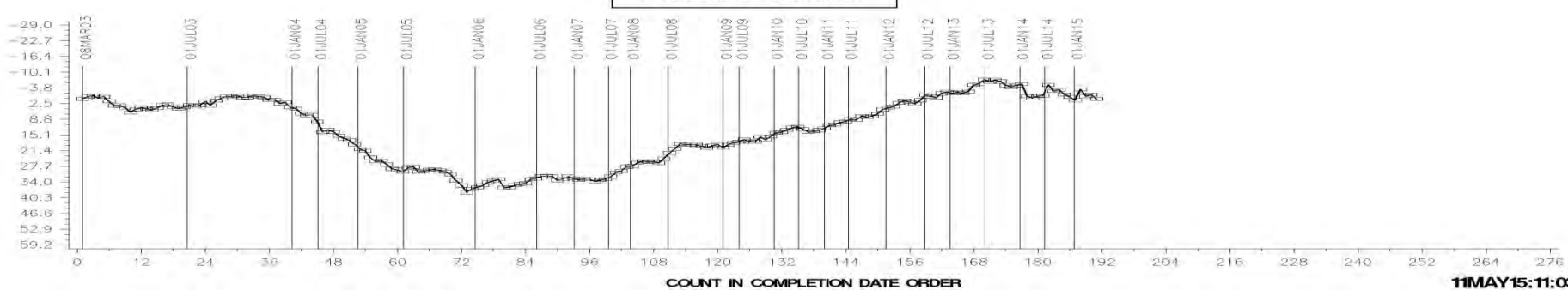
LTMS Severity Analysis



LTMS Precision Analysis

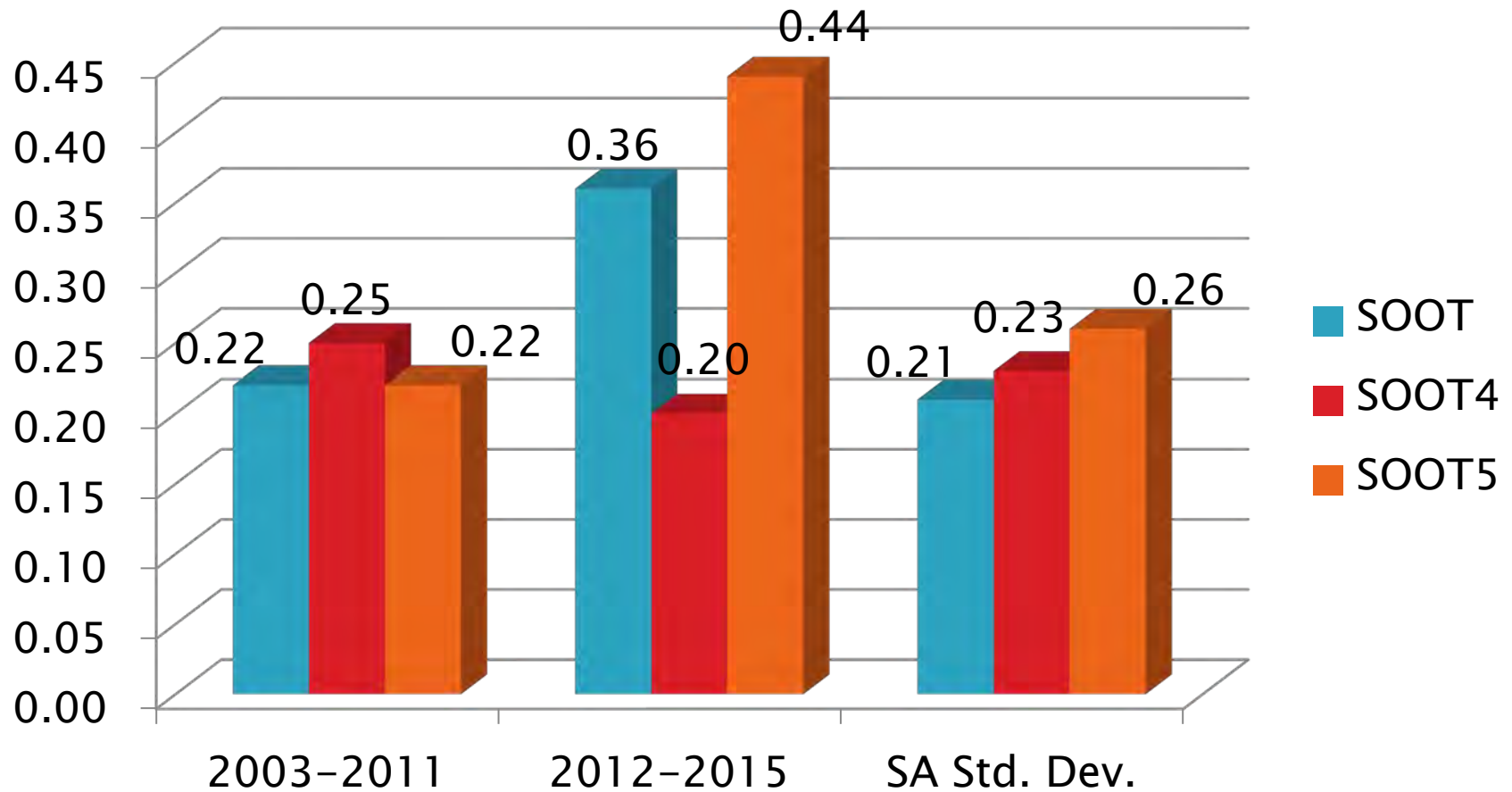


CUSUM Severity Analysis



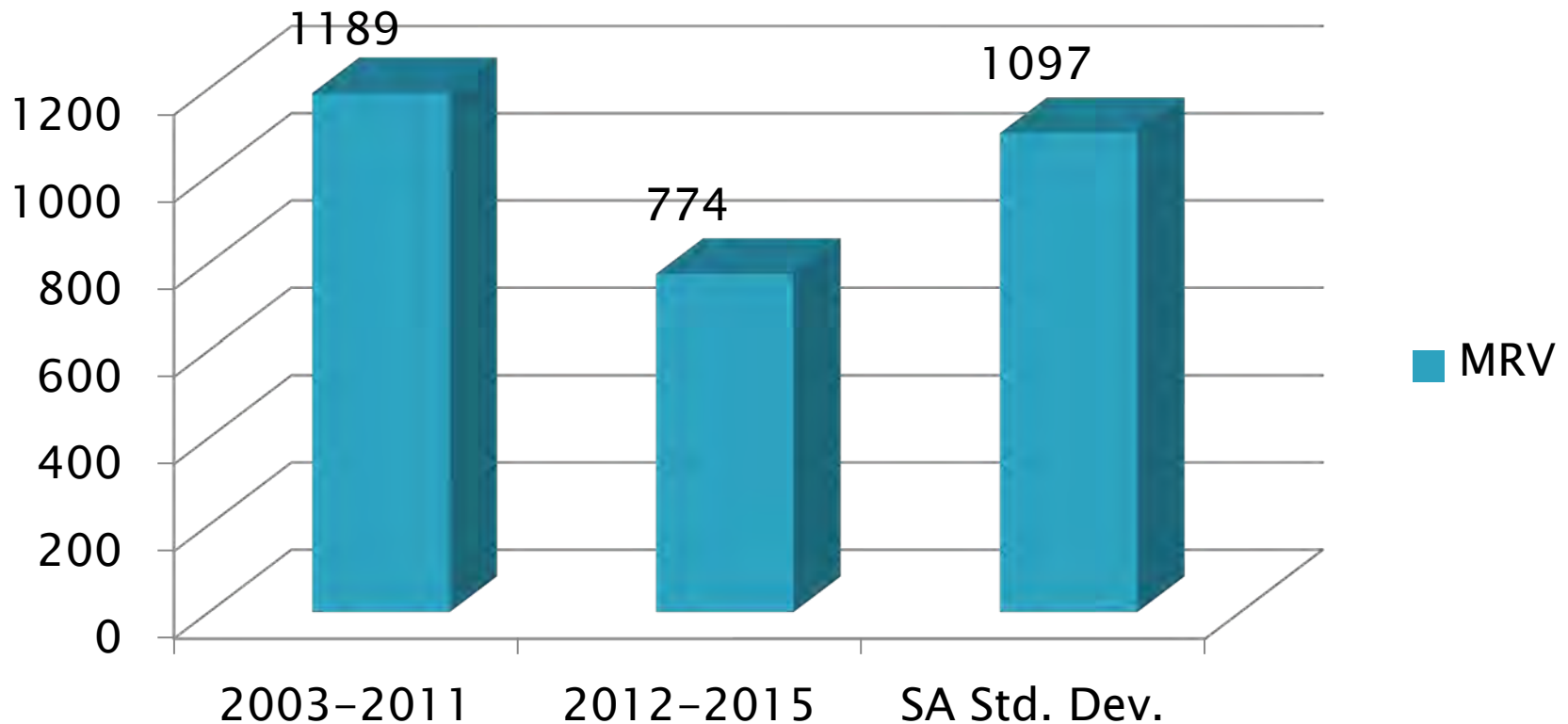
11MAY15:11:03

T-11 Precision Estimates



T-11 Precision Estimates

MRV



[Return to Table of Contents](#)

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Mack T-12

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T-12 Test Activity

| Test Status | Validity Code | # |
|-----------------------------|---------------|-----------|
| Acceptable Calibration Test | AC | 7 |
| Failed Calibration Test | OC | 1 |
| Operationally Invalid | LC | 3 |
| Aborted | XC | 2 |
| Total | | 13 |

T-12 Failed Tests

| Failed Parameter | Number of Tests |
|------------------|-----------------|
| Mild Pb | 1 |
| Total | 1 |

T-12 Lost Tests*

| Status | Cause | # |
|--------------|------------------------------------|----------|
| XC | High oil consumption -Safety issue | 1 |
| XC | Missed oil add @ 120 Hrs | 1 |
| LC | Incorrect oil sample | 1 |
| LC | Missed soot window | 2 |
| Total | | 5 |

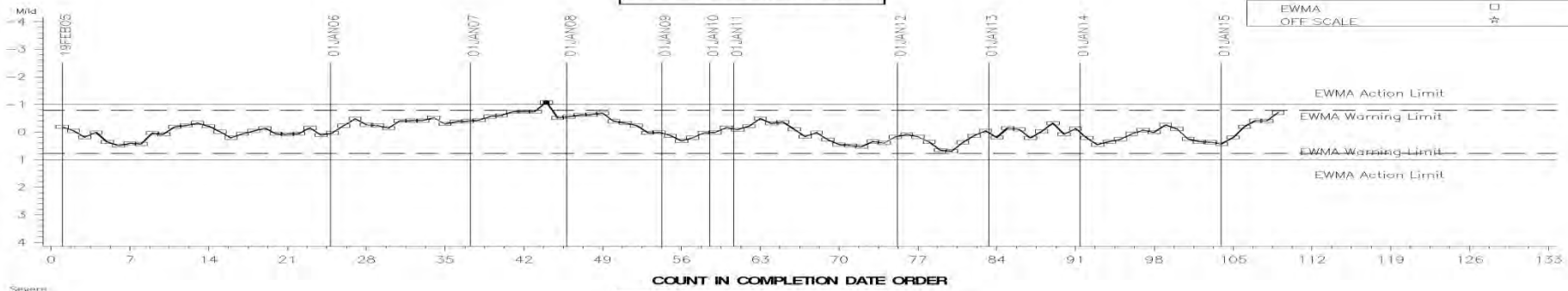
*Invalid and aborted tests

T-12 Test Severity

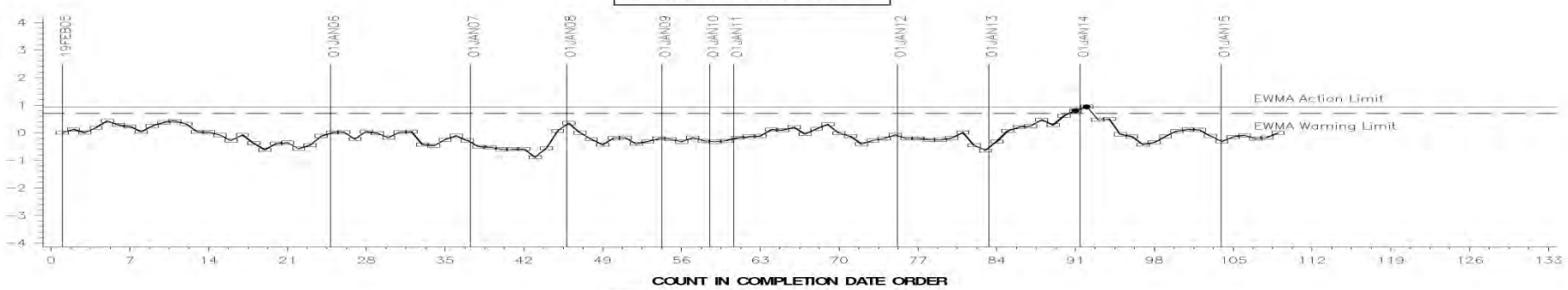
- ▶ All parameters are in control.

FINAL TRANS. RES. DELTA PB @ EOT

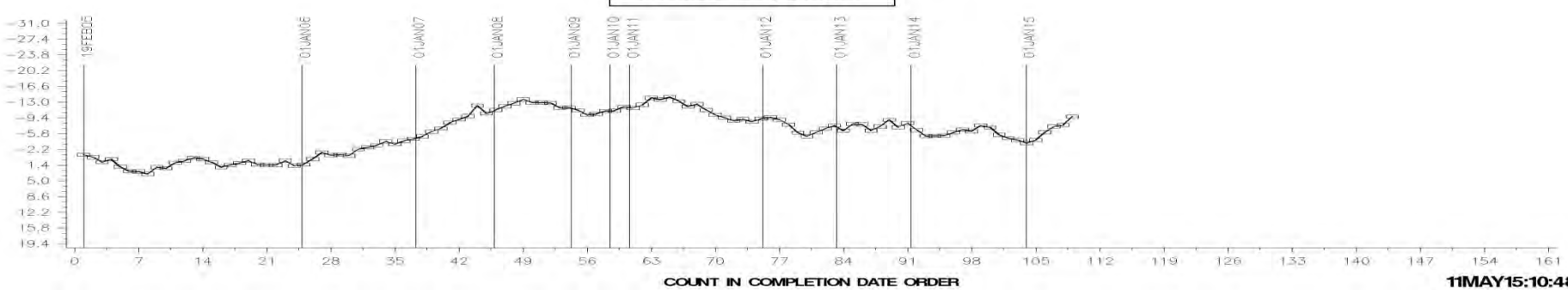
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis

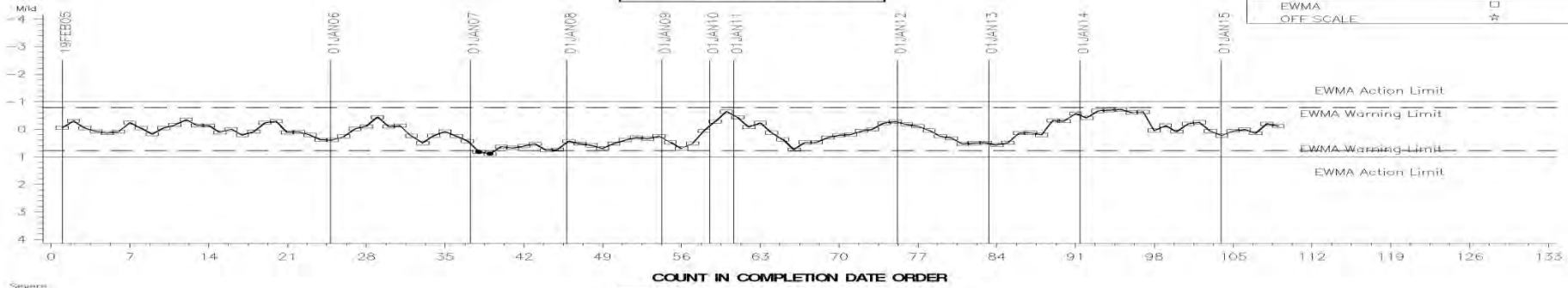


11MAY15:10:48

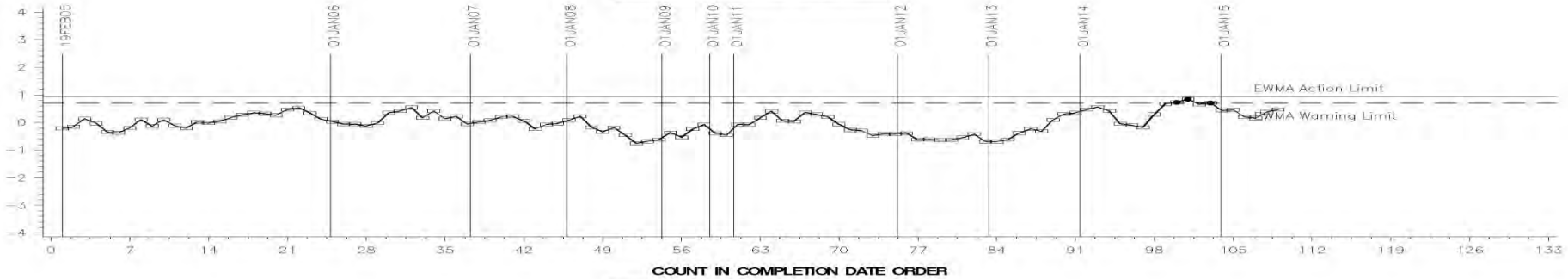
MACK T-12 INDUSTRY OPERATIONALLY VALID DATA

AVG. CYLINDER LINER WEAR (CLW)

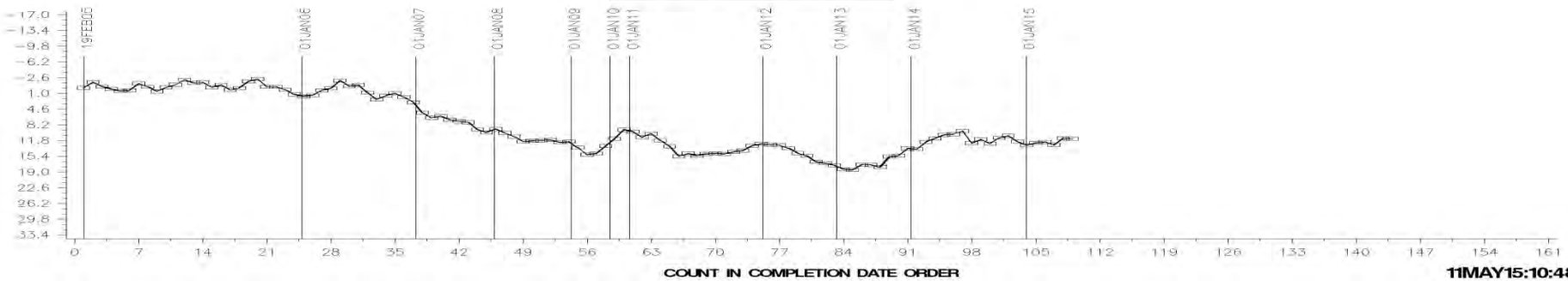
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis

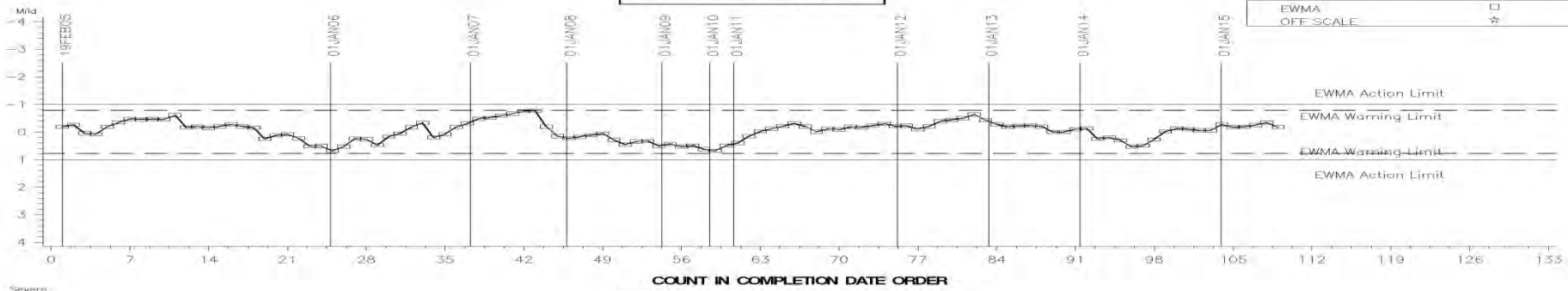


11MAY15:10:48

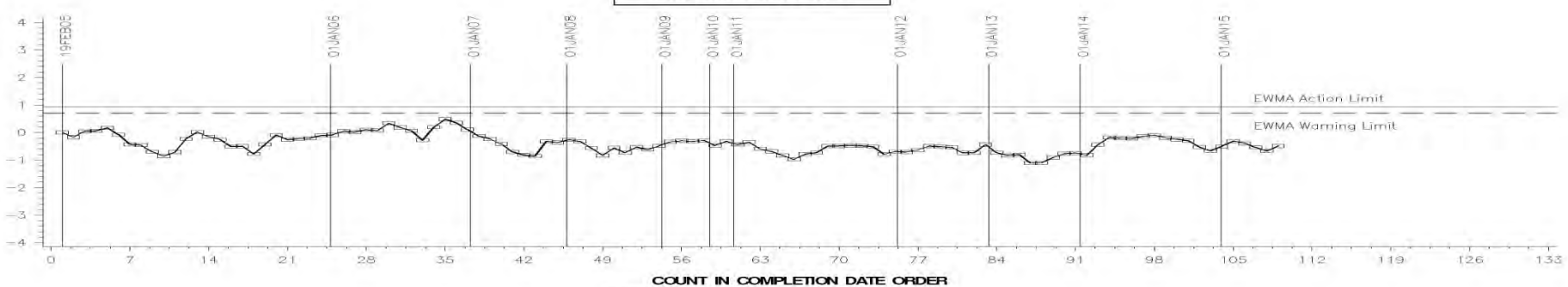
MACK T-12 INDUSTRY OPERATIONALLY VALID DATA

AVG. TOP RING WEIGHT LOSS (TRWL)

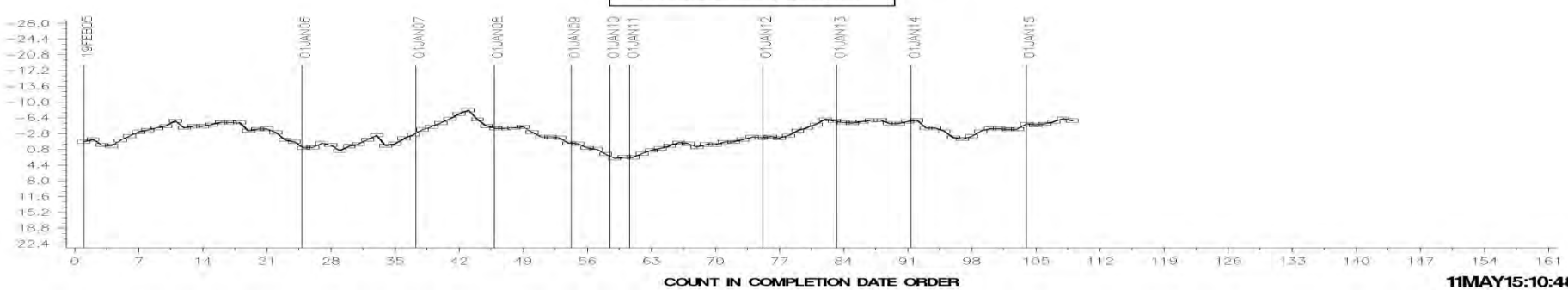
LTMS Severity Analysis



LTMS Precision Analysis



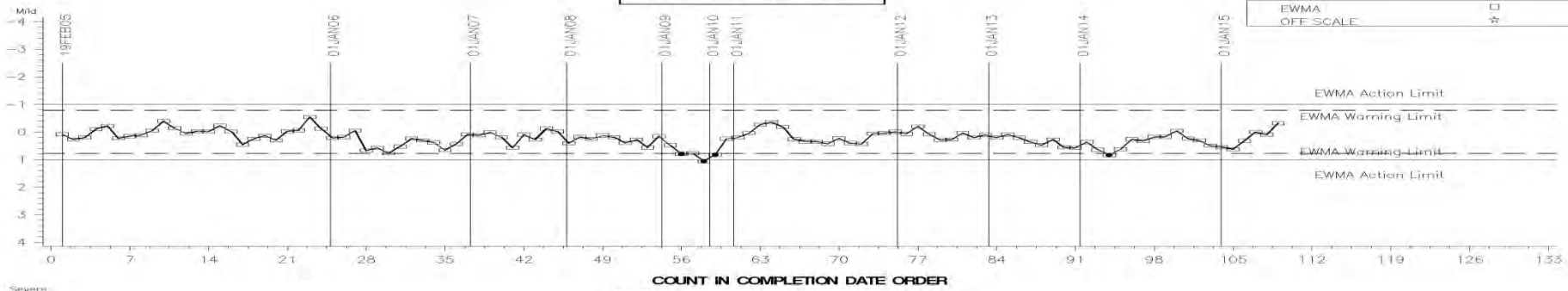
CUSUM Severity Analysis



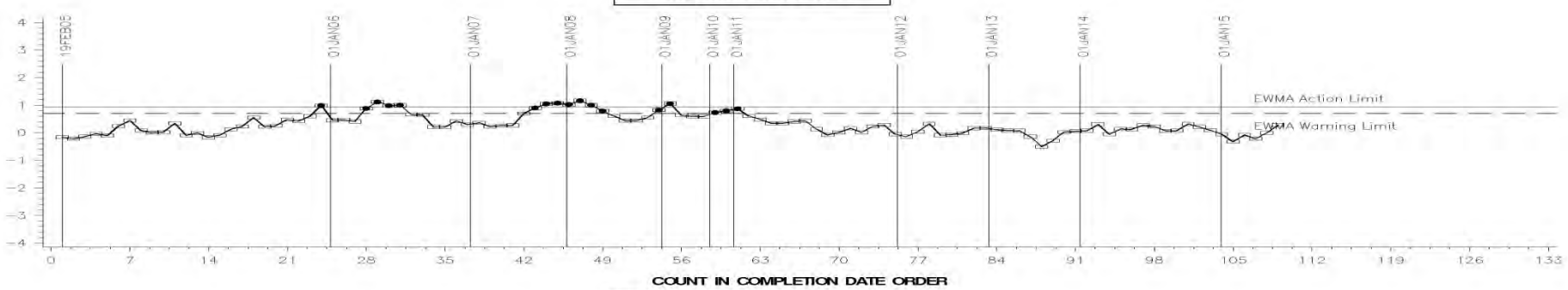
11MAY15:10:48

FINAL TRANS. RES. OIL CONSUMPTION

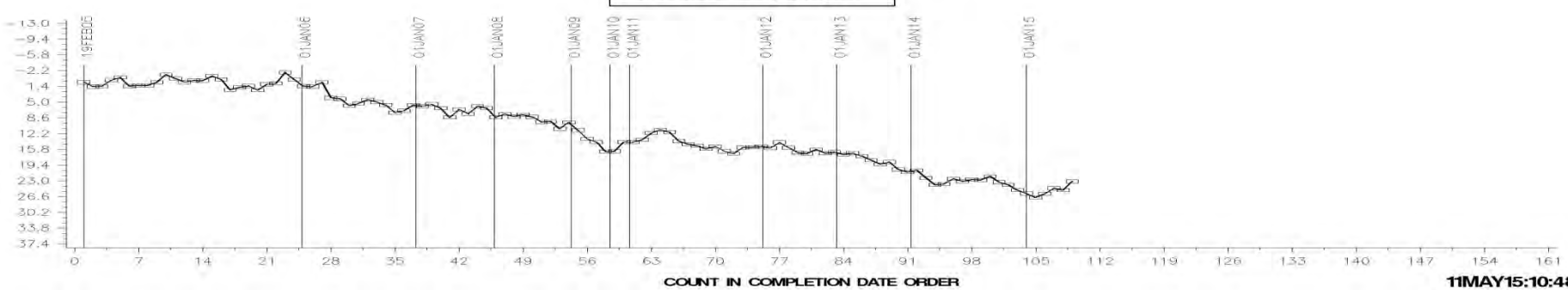
LTMS Severity Analysis



LTMS Precision Analysis



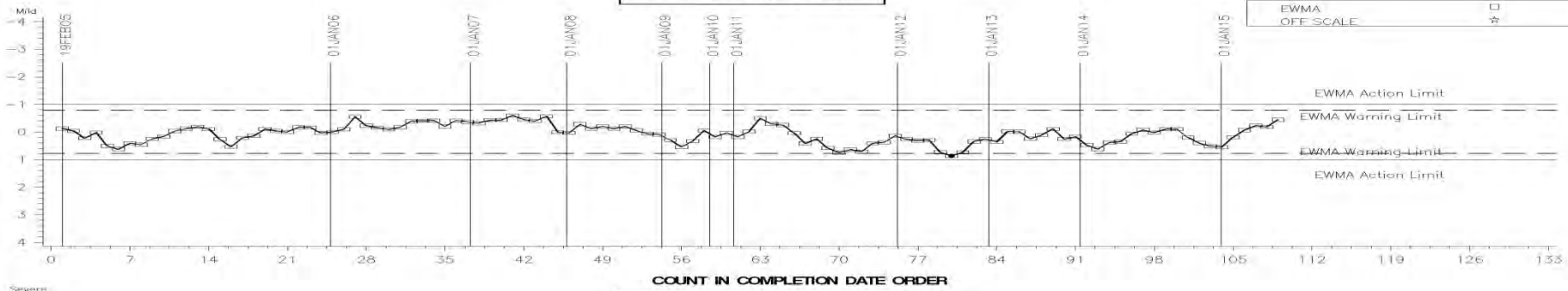
CUSUM Severity Analysis



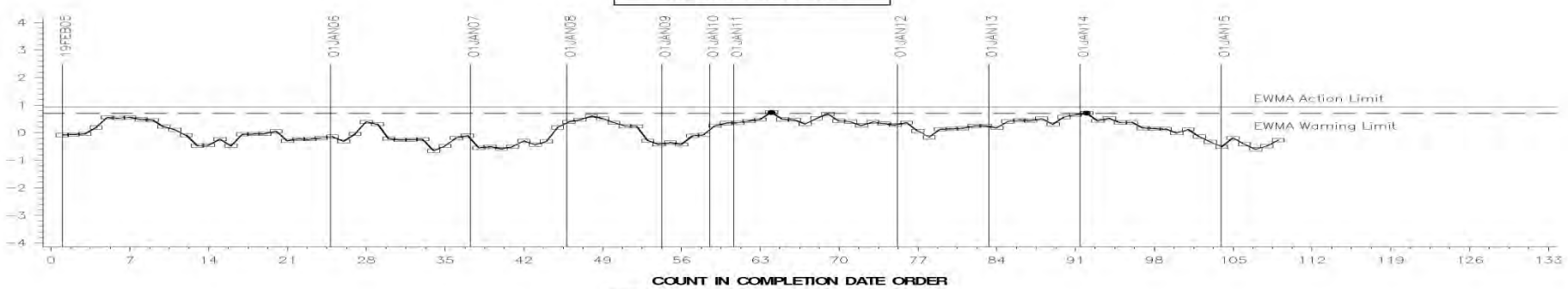
11MAY15:10:48

FINAL TRANS. RES. DELTA PB 250-300H

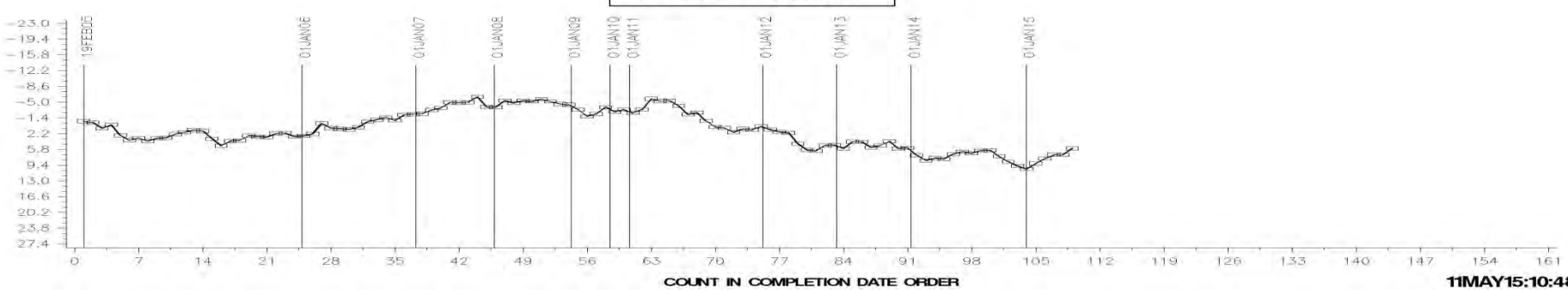
LTMS Severity Analysis



LTMS Precision Analysis

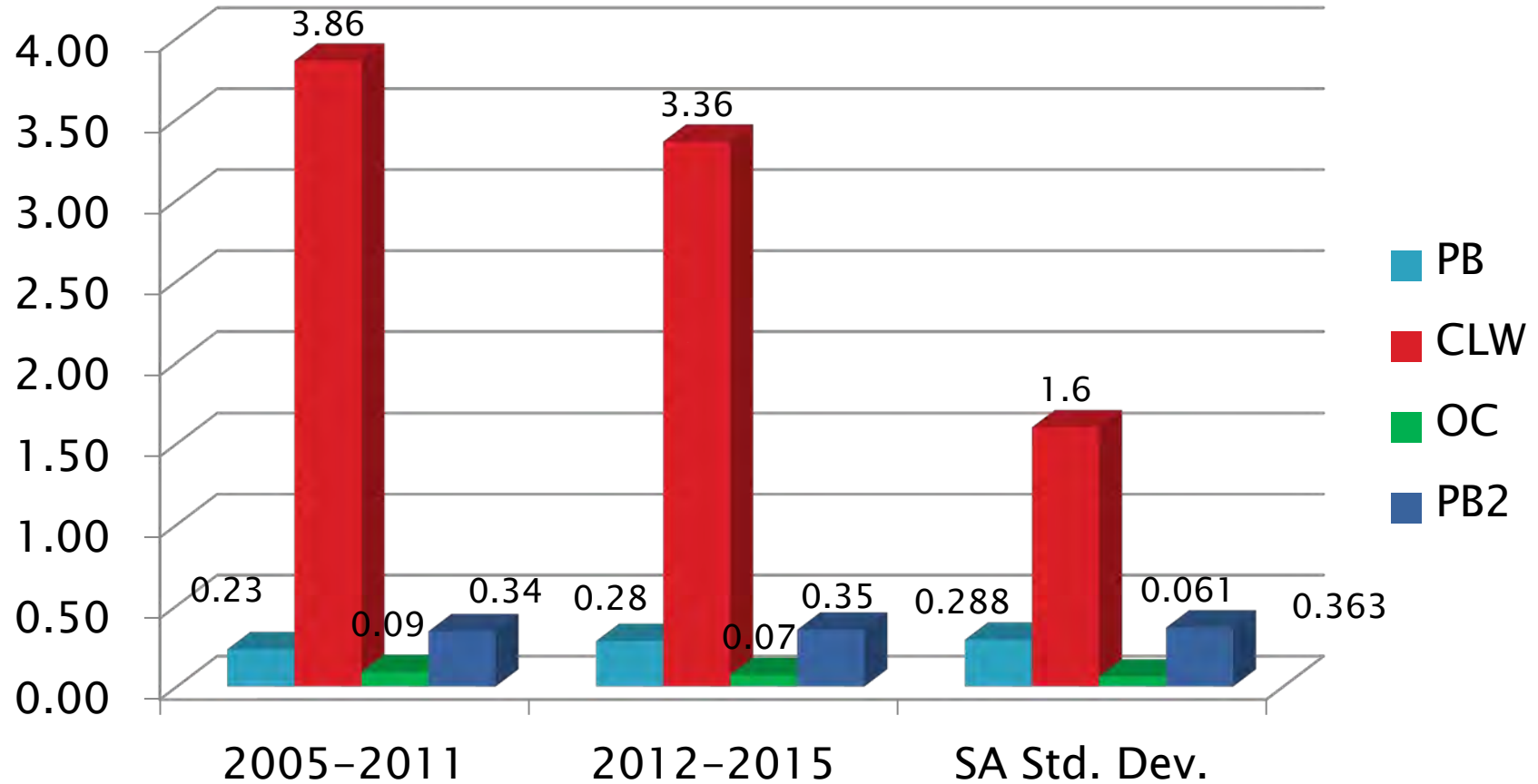


CUSUM Severity Analysis



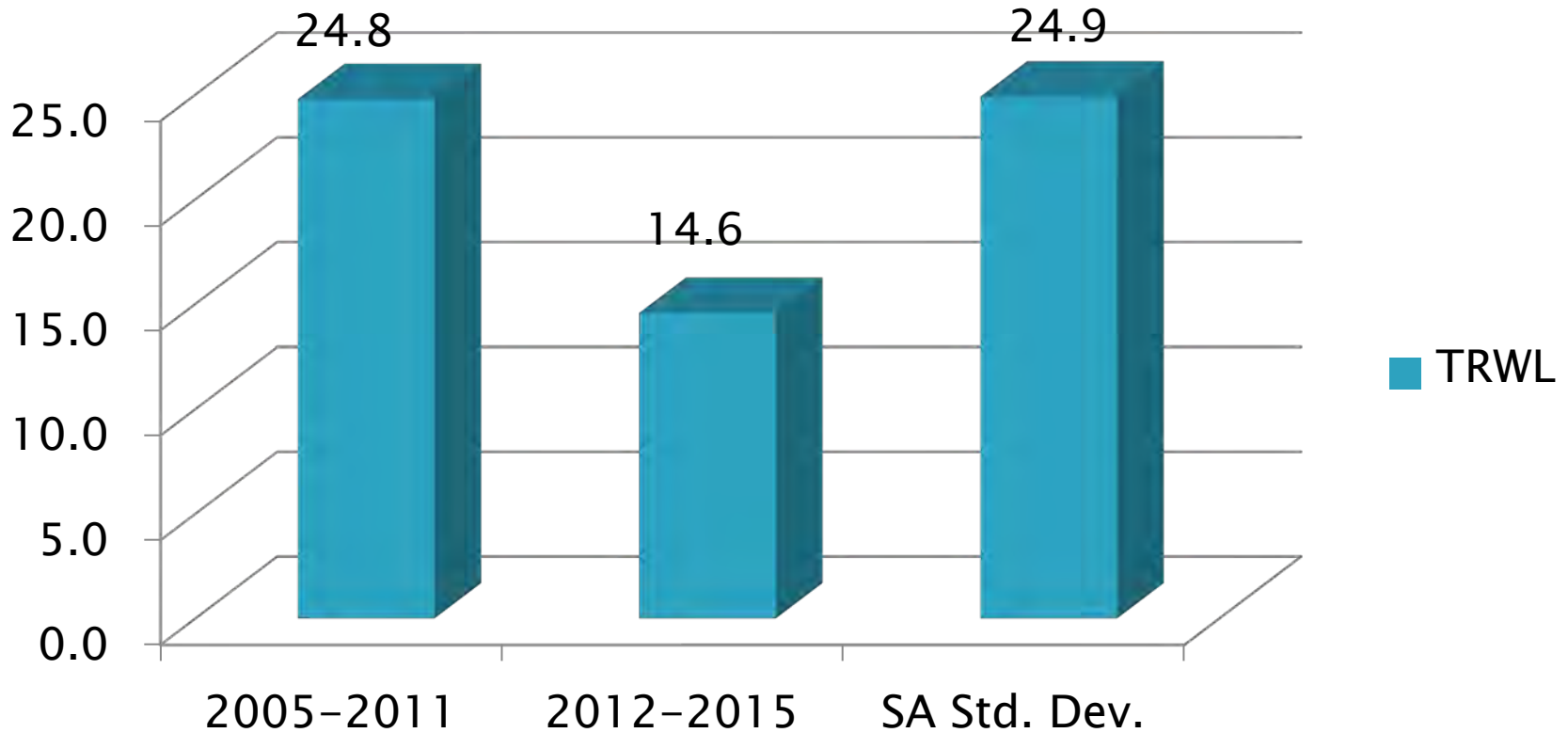
11MAY15:10:48

T-12 Precision Estimates



T-12 Precision Estimates

TRWL



[Return to Table of Contents](#)

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Mack T-12A

»» April 2015

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T-12A Test Activity

| Test Status | Validity Code | # |
|-----------------------------|---------------|-----------|
| Acceptable Calibration Test | AC | 8 |
| Failed Calibration Test | OC | 0 |
| Operationally Invalid | LC | 3 |
| Aborted | XC | 2 |
| Total | | 13 |

T-12A Failed Tests

| Failed Parameter | Number of Tests |
|------------------|-----------------|
| No failed tests | |
| Total | 0 |

T-12A Lost Tests*

| Status | Cause | # |
|--------------|------------------------------------|----------|
| XC | High oil consumption -Safety issue | 1 |
| XC | Missed oil add @ 120 Hrs | 1 |
| LC | Incorrect oil sample | 1 |
| LC | Missed soot window | 2 |
| Total | | 5 |

*Invalid and aborted tests

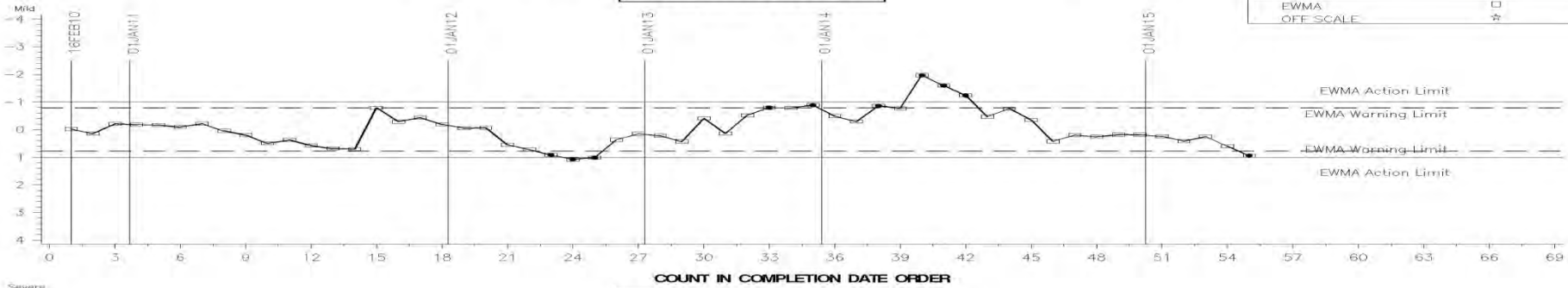
T-12A Test Severity

- ▶ MRV is in a severity warning alarm.

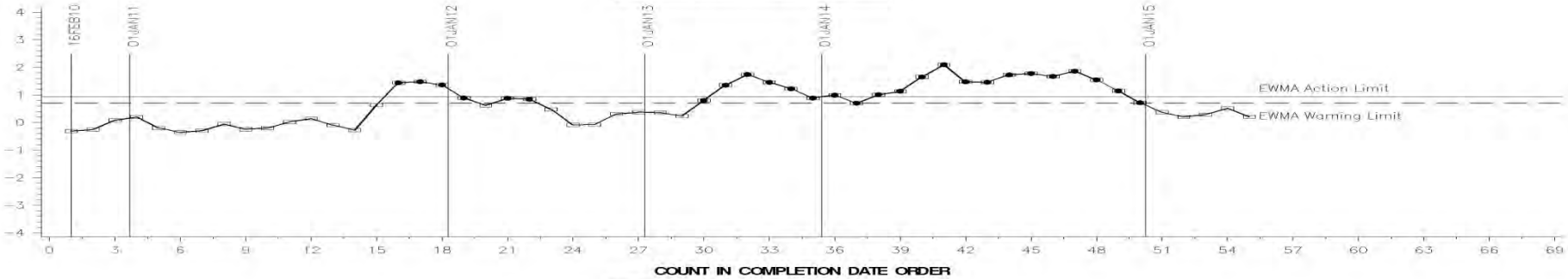
MACK T-12A INDUSTRY OPERATIONAL VALID DATA

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

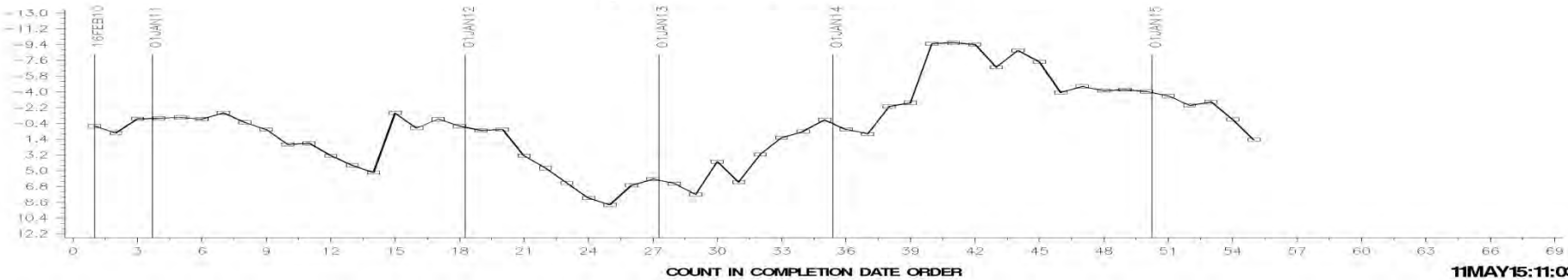
LTMS Severity Analysis



LTMS Precision Analysis



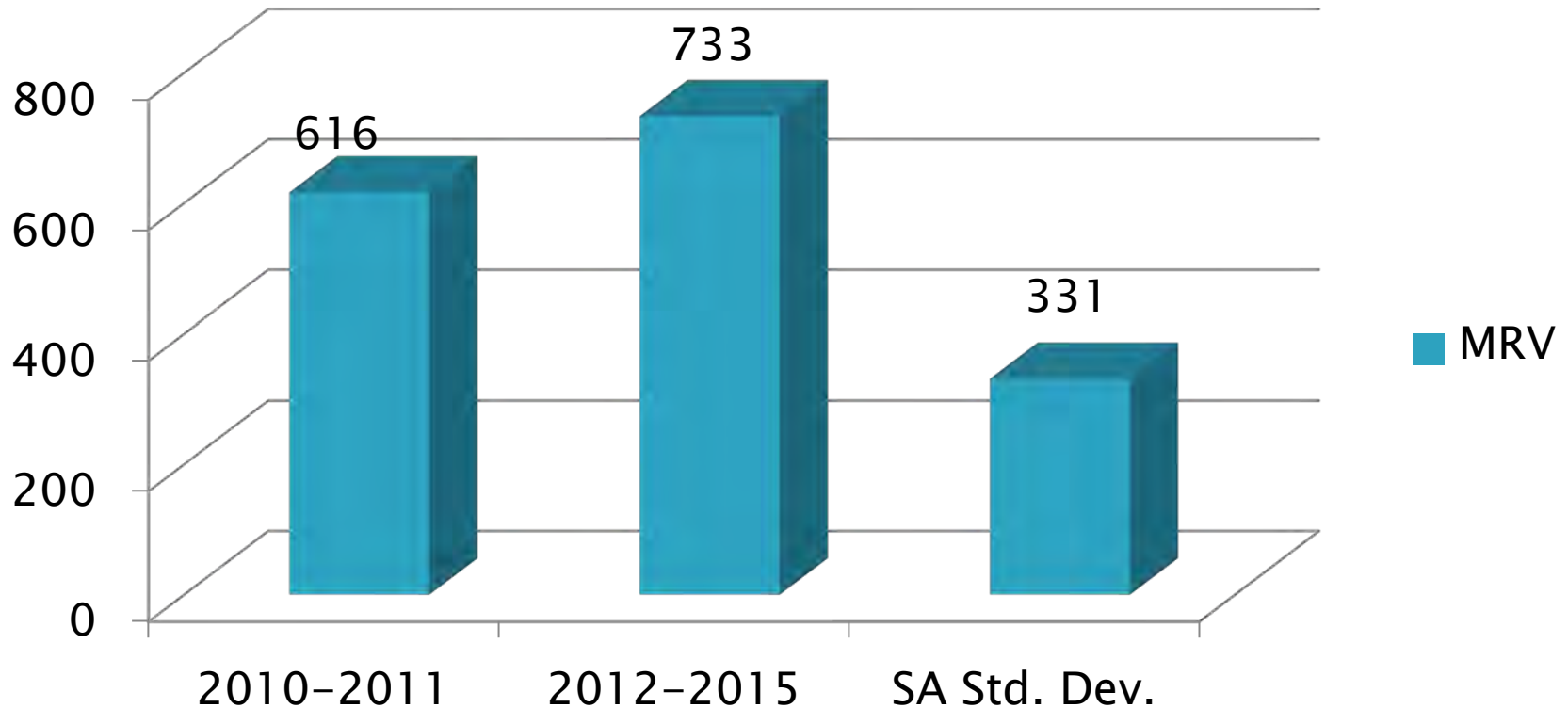
CUSUM Severity Analysis



11MAY15:11:03

T-12A Precision Estimates

MRV



[Return to Table of Contents](#)

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Information Letters

»» October 1, 2014 –
March 31, 2015

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Information Letters*

| Test | Date | IL | Topic |
|----------|------------|------|---|
| ISM | 10/3/2014 | 14-1 | New OFDP Correction Factor and Reporting Method |
| 1P | 10/28/2014 | 14-2 | Revision to 1P Procedure to Allow Engineering Review of Negative Quality Index Values |
| ISB | 11/10/2014 | 14-1 | Corrected Annotation of FIG. A4.7 – Thermocouple Insertion Depth |
| T8 | 1/23/2015 | 15-1 | T-8 Timing Changes – Clarification and Intercooler Information Update |
| T11, T12 | 1/27/2015 | 15-1 | Intercooler Requirement Change |
| C13 | 2/4/2015 | 15-1 | ECM Software P/N Update |
| 1K/1N | 2/20/2015 | 15-1 | Changes to 1N Top Groove Fill and Top Land Heavy Carbon Reporting |

*Available from TMC Website

[Return to Table of Contents](#)

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Reference Oil Inventory

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

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Reference Oil Reblends

- ▶ C13 and ISB
 - Re-blend completed as 831-3. Available for testing.

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 |

[Return to Table of Contents](#)

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LTMS Deviations

»» October 1, 2014 –
March 31, 2015

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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 |

[Return to Table of Contents](#)

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Quality Index Deviations

»» October 1, 2014 –
March 31, 2015

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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 |

[Return to Table of Contents](#)

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TMC Laboratory Visits

»» October 1, 2014 –
March 31, 2015

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TMC Lab Visits

- ▶ No HD lab visits during the reporting period.

[Return to Table of Contents](#)

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Test Area Timelines

»» October 1, 2014 –
March 31, 2015

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Test Area Timeline Additions*

| Test | Date | Topic | IL/Memo |
|---------|----------|---|---------|
| ISM | 20141003 | New OFDP Correction Factor | 14-1 |
| 1P | 20141028 | Revision to 1P Procedure to Allow Engineering Review of Negative Quality Index Values | 14-1 |
| ISB | 20141110 | Corrected Annotation of FIG. A4.7 – Thermocouple Insertion Depth | 14-1 |
| T8 | 20150123 | T-8 Timing Changes – Clarification and Intercooler Information Update | 15-1 |
| T11,T12 | 20150127 | Intercooler Requirement Change | 15-1 |
| C13 | 20150204 | ECM Software P/N Update | 15-1 |
| 1K/1N | 20150220 | Changes to 1N Top Groove Fill and Top Land Heavy Carbon Reporting | 15-1 |

[Return to Table of Contents](#)

*As of 3/31/2015

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Rating Workshop Data

»» 2014 Heavy Duty Workshop

Test Monitoring Center

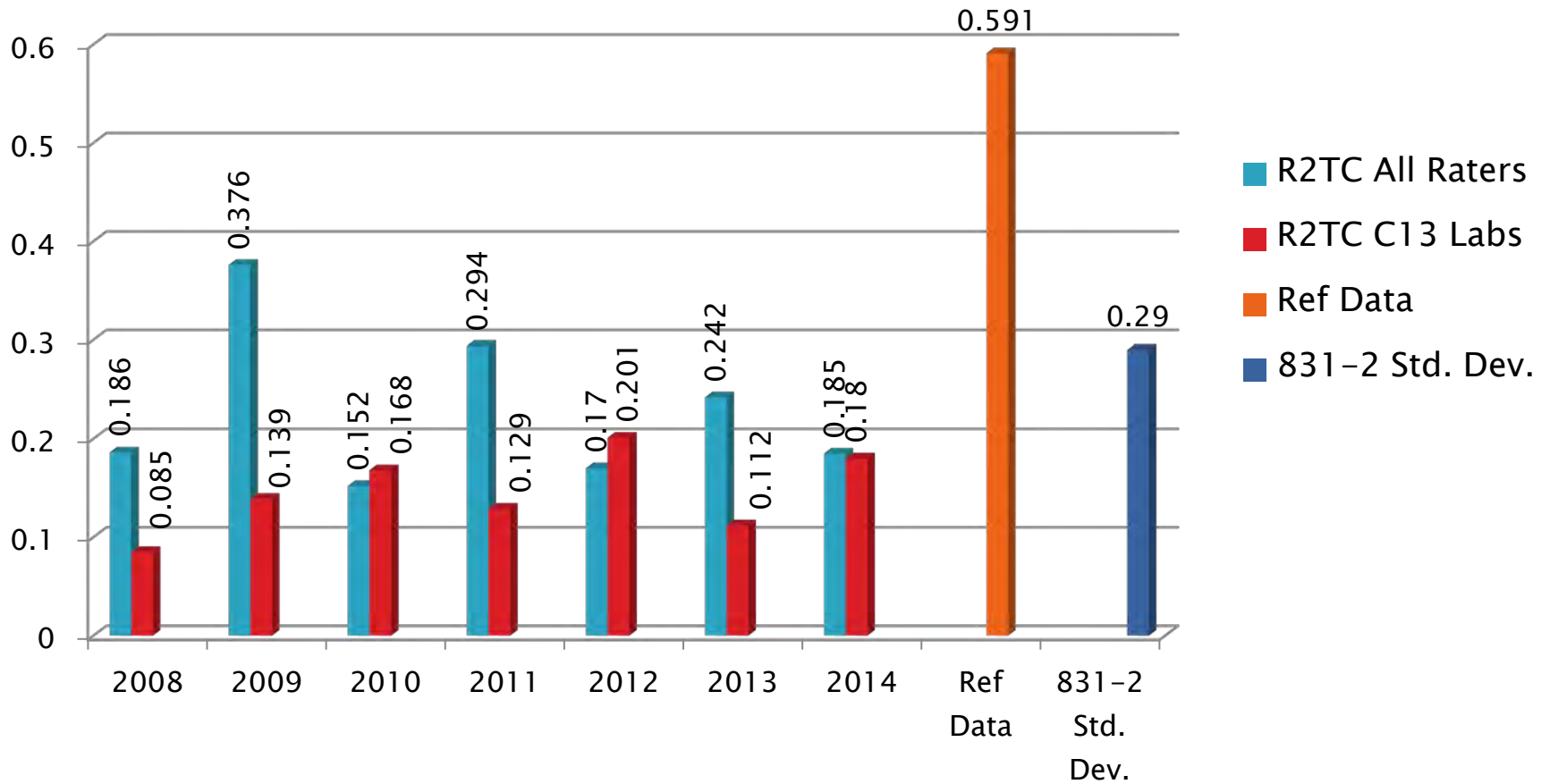
<http://astmtmc.cmu.edu>



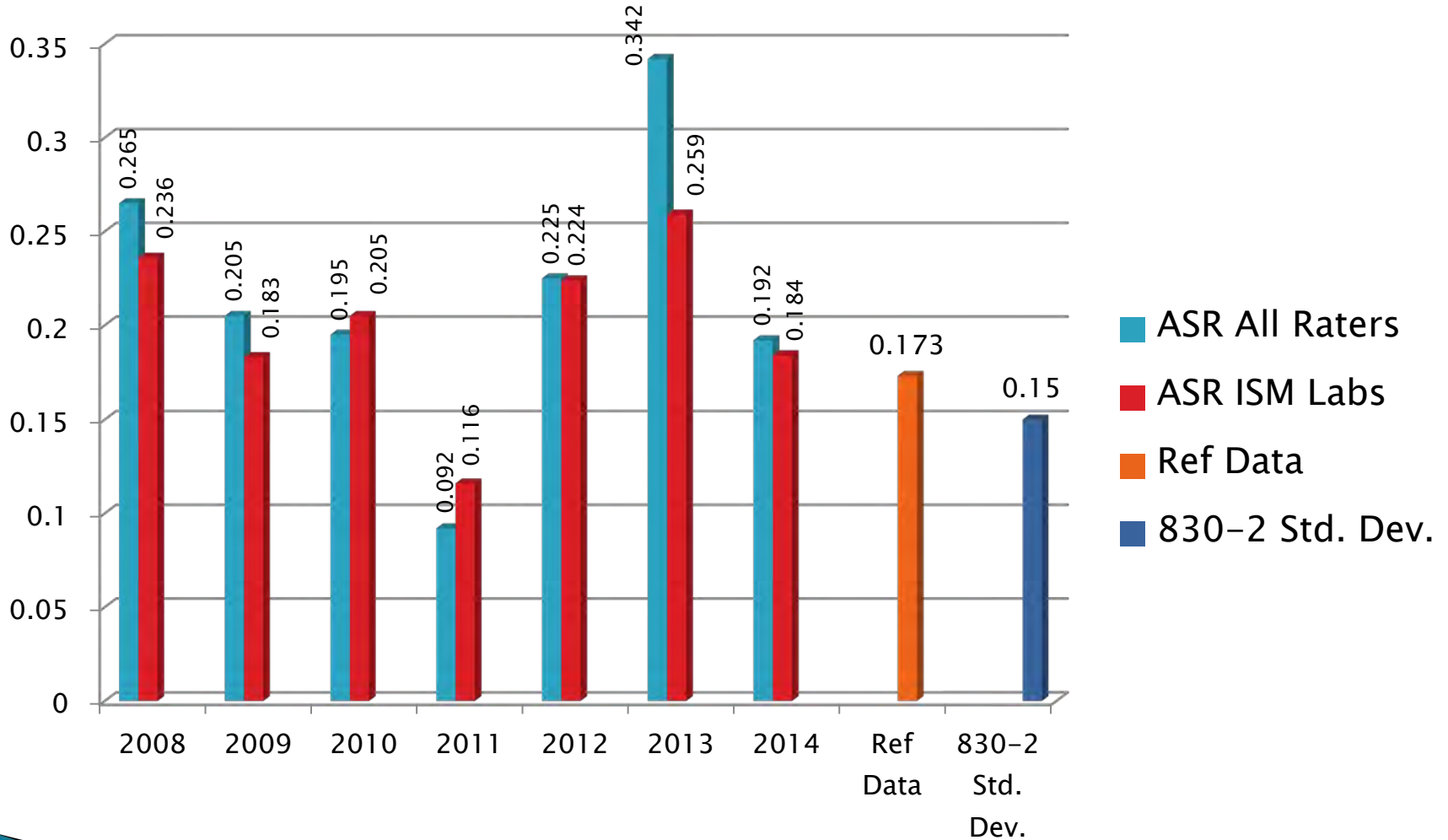
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C13 2nd Ring Carbon Precision – Rating Workshop Data

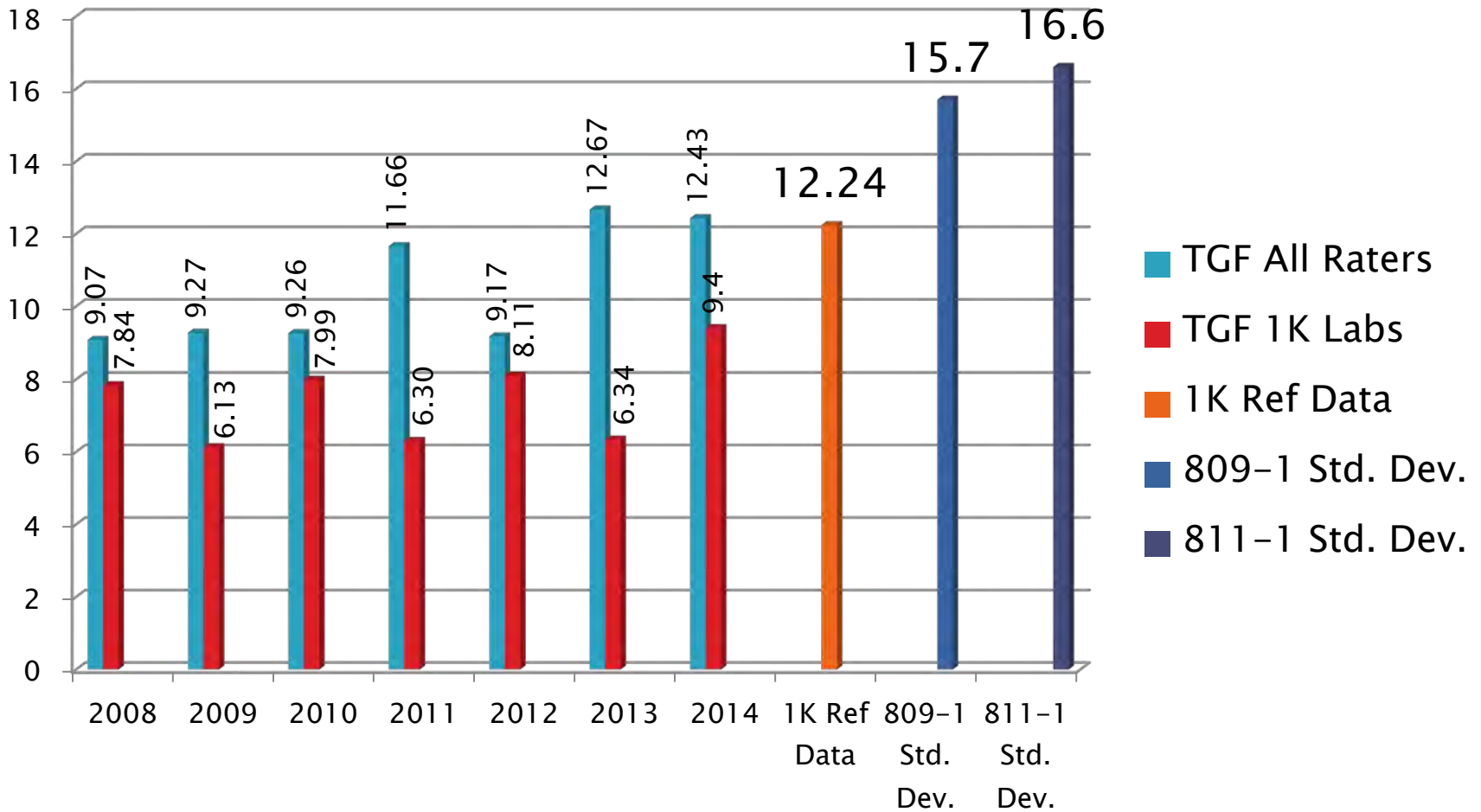
R2TC



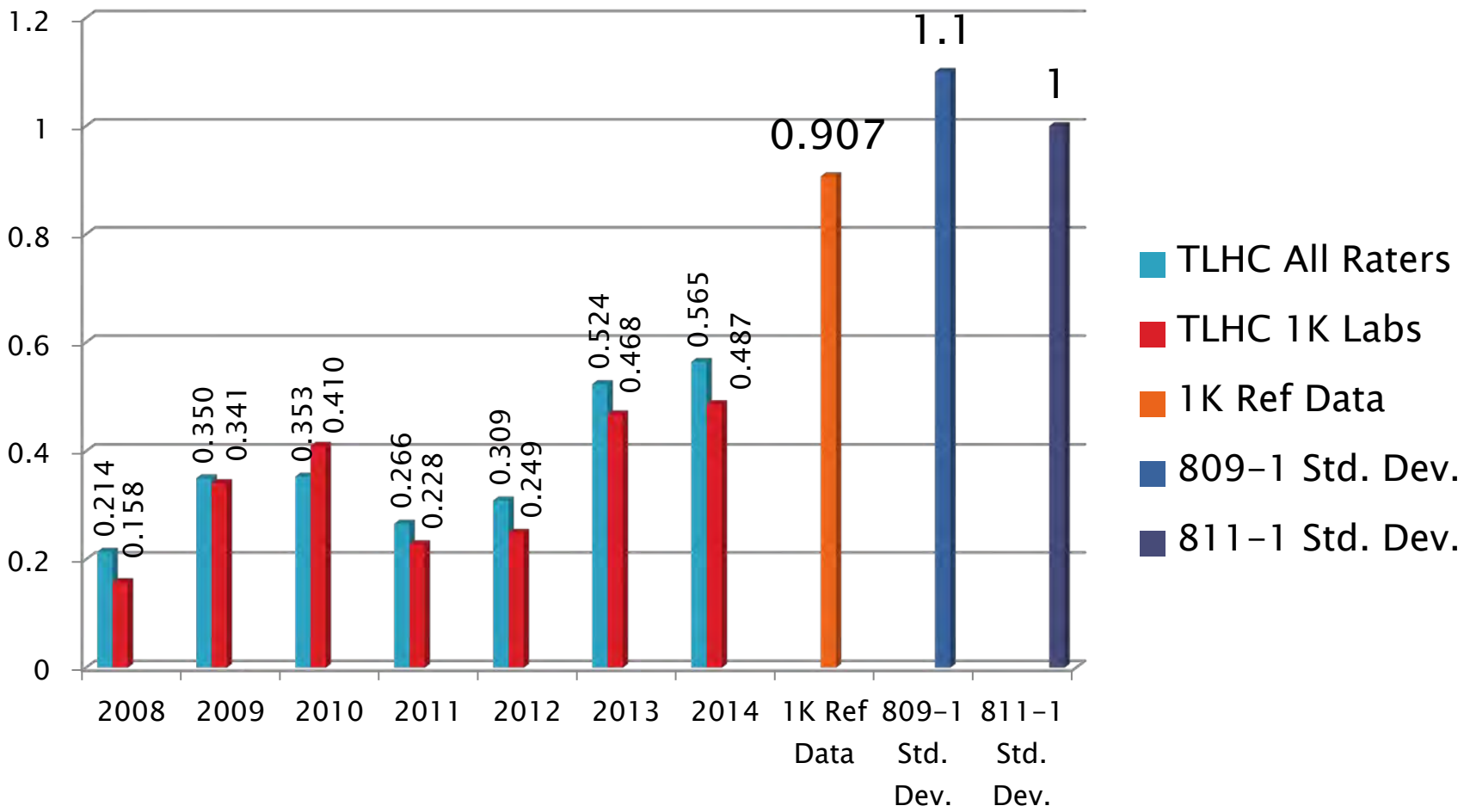
ISM Sludge Rating Precision – Rating Workshop Data



Deposit Rating Precision - Rating Workshop Data



Deposit Rating Precision - Rating Workshop Data



[Return to Table of Contents](#)

Miscellaneous 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

[Return to Table of Contents](#)

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