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# **Test Monitoring Center**

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## **ASTM D02.B1 Semi-Annual Report Passenger Car Reference Oil Testing**

**April 2013**

# Passenger Car Engine Oil Testing Executive Summary

## ▶ IIIF

- Re-blend obtained for oil 433-1, panel needs to address introduction of reference oil [433-2](#).

## ▶ VG

- Initial targets generated for oil 940, replacement oil for 925-3.

## ▶ VID

- 23 tests reported this period for VIE development.
- Panel needs to address introduction [of 542-1](#)

# Passenger Car Engine Oil Testing Executive Summary

## ▶ IVA

- Lab disclosed tests had been run on modified hardware
- [Information letter](#) issued to not allow modifications to hardware
- After evaluation by panel, [information letter](#) issued to allow regrinding of cams, provided cams meet manufacturer's specification
- Results with reground cams which could not be verified as meeting manufacturer's specification removed from charts

# Calibrated Labs and Stands\*

Test	Labs	Stands
IIIF	3	5
IIIG/A/B	6	15
IVA	3	3
VG	2	5
VID	4	8
VIII	2	3

\*As of 3/31/2013

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# Test Activity Levels

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# Sequence Tests

Test Status	Validity Code	IIIF	IIIG	IVA
Acceptable Calibration Test	AC	9	11	8
Failed Calibration Test	OC	7	2	1
Operationally Invalid by Lab	LC	0	2	3
Aborted	XC	0	5	1
Abandon Stand/Engine	MC	2	0	0
Operationally Invalid, Lab & TMC	RC	0	0	0
Result Removed from Control Chart	NC	0	1	1
Decoded/Donated	NN/AG	5	0	0
<b>Total</b>		<b>23</b>	<b>21</b>	<b>14</b>

# Sequence Tests

Test Status	Validity Code	VG	VID	VIII
Acceptable Calibration Test	AC	5	37	3
Failed Calibration Test	OC	0	8	0
Operationally Invalid	LC	2	7	1
Aborted	XC	1	2	0
Abandon Stand/Engine	MC	0	1	0
Fuel Approval	PF	3	0	0
Decoded/Donated	NN/AG	2	23	0
<b>Total</b>		<b>13</b>	<b>78</b>	<b>4</b>

# Failed Tests

Test Status	Test	Number of Tests
Screened ACLW >20µm	IIIF	4
PVIS EWMA Precision Alarm, Screened ACLW >20µm	IIIF	1
Severe Viscosity Increase	IIIF	1
Mild Viscosity Increase	IIIF	1
Severe Viscosity Increase	IIIG	2
Severe ACW	IVA	1
FEI1 Mild	VID	3
FEI2 Mild	VID	2
FEI1 and FEI2 Mild	VID	1
FEI1 Severe	VID	1
FEI2 Severe	VID	1
<b>Total</b>		<b>18</b>



# Lost Tests\*

Slide 1 of 3

Test Status	Cause	IIIF	IIIG	IVA	VG	VID	VIII
Aborted	High Oil Consumption	0	1	0	0	0	0
Invalid	Oil Filter Block Temp. Calibration Error	0	1	0	0	0	0
Invalid	AFR Calibration Issue	0	1	0	0	0	0
Aborted	Oil Leak	0	1	0	0	0	0
Aborted	Load Control Issues	0	1	0	0	0	0
Aborted	Low Oil Pressure	0	1	0	0	0	0
Aborted	Number 4 Rod Bearing Spun	0	1	0	0	0	0
Invalid	Universal Joints Failed	0	0	1	0	0	0

(continued on next slide)

\*Invalid and aborted tests

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# Lost Tests\*

Slide 2 of 3

Test Status	Cause	IIIF	IIIG	IVA	VG	VID	VIII
Invalid	Fuel Injector Failure	0	0	1	0	0	0
Invalid	Ignition Intermittent During Transition	0	0	1	0	0	0
Aborted	Oil Cooler Failure	0	0	1	0	0	0
Aborted	Coolant in Engine	0	0	0	1	0	0
Invalid	RAC Coolant Flow Calibration Error	0	0	0	1	0	0
Invalid	Oil Leak, Rear Seal	0	0	0	1	0	0
Invalid	Exceeded Downtime Limit	0	0	0	0	2	0
Invalid	Stage 4 Exhaust Pressure out of Spec	0	0	0	0	1	0

(continued on next slide)

\*Invalid and aborted tests

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# Lost Tests\*

Slide 3 of 3

Test Status	Cause	IIIF	IIIG	IVA	VG	VID	VIII
Aborted	Damaged Crank Sensor Wiring	0	0	0	0	1	0
Aborted	Oil Leak	0	0	0	0	1	0
Invalid	Oil Circulation Pump Failure	0	0	0	0	1	0
Invalid	High Oil Consumption and Engine Misfire	0	0	0	0	1	0
Invalid	Bank 1 AFR Sensor Failure	0	0	0	0	1	0
Invalid	Oil Temp Calibration Error	0	0	0	0	1	0
Invalid	Improper Bearing Clearances	0	0	0	0	0	1
<b>Total</b>		<b>0</b>	<b>7</b>	<b>4</b>	<b>3</b>	<b>9</b>	<b>1</b>

\*Invalid and aborted tests

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# Test Severity

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# Test Severity

## ▶ IIIF

- WPD in control.
- APV
  - In severity action alarm, mild
  - Long-term mild trend continuing (Since April 2006)
- PVIS
  - In control for severity and precision, trending slightly severe.
- PV60
  - Precision action alarm

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

# Test Severity

## ▶ IIIG

- MRV is in control.
- PHOS in mild warning alarm.
- WPD is in control
  - Long-term severe trend continuing (Since late 2004)
- PVIS
  - Precision warning alarm, trending severe
- ACLW in mild warning alarm .
  - Long-term mild trend

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

# Test Severity

## ▶ IVA

- ACW in control.

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

## ▶ VG

- All parameters are in control for severity and precision.

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

# Test Severity

## ▶ VID

- FEI1 and FEI2 are in control.
- FEI1 trending mild this period.

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

## ▶ VIII

- BWL and Stripped Viscosity are in control.

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



# Test Precision

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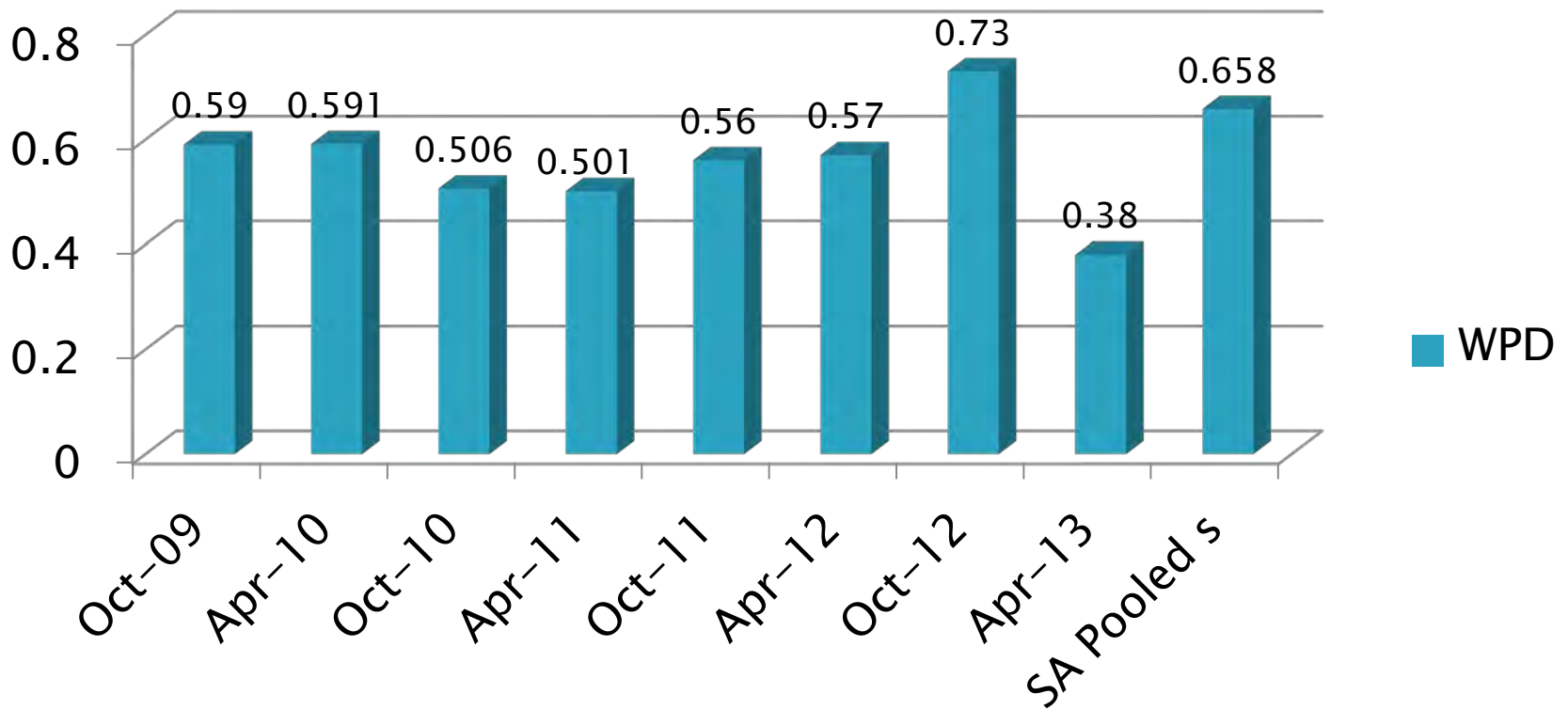
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# Test Precision Estimates

- ▶ Presented on a six month basis.
- ▶ Data presented for past four years.

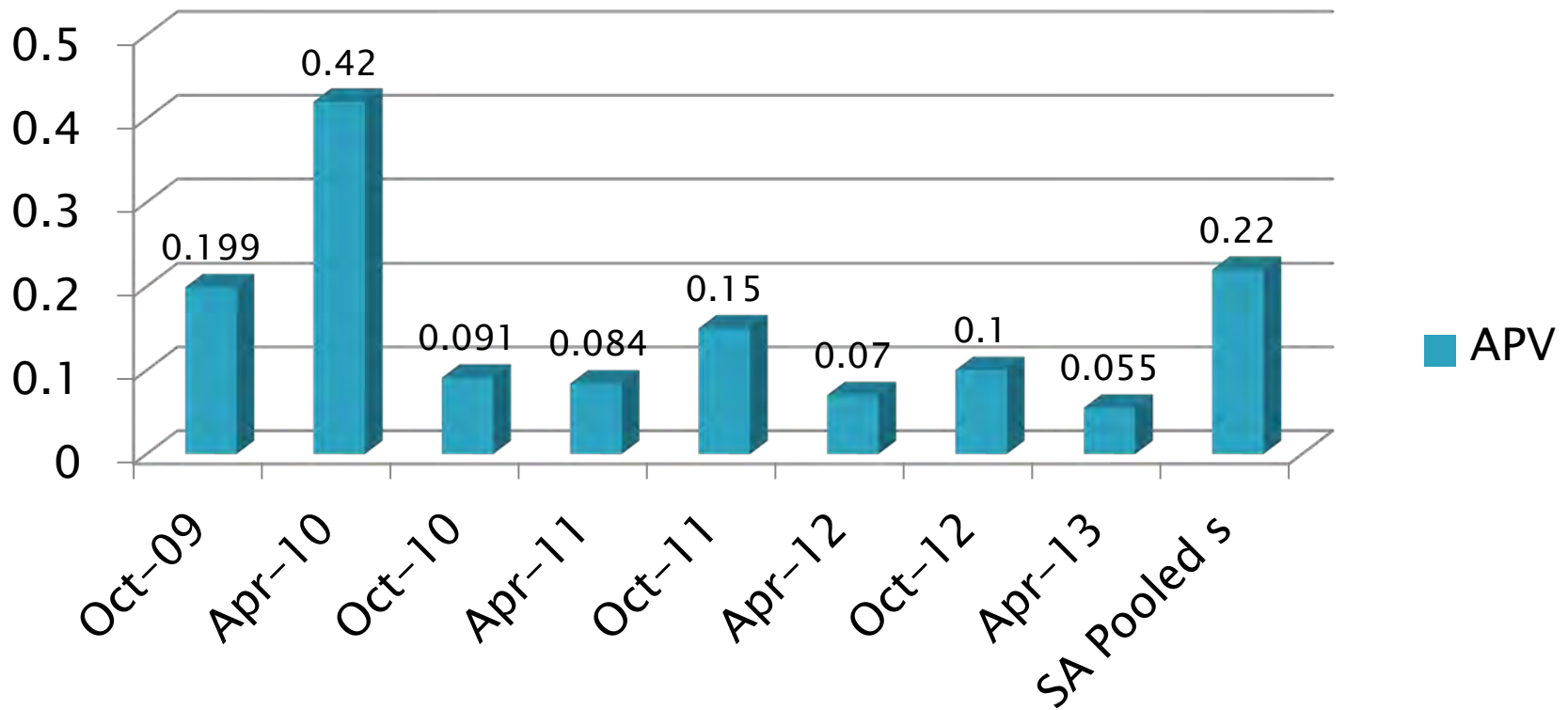
# IIIF Precision Estimates

## WPD



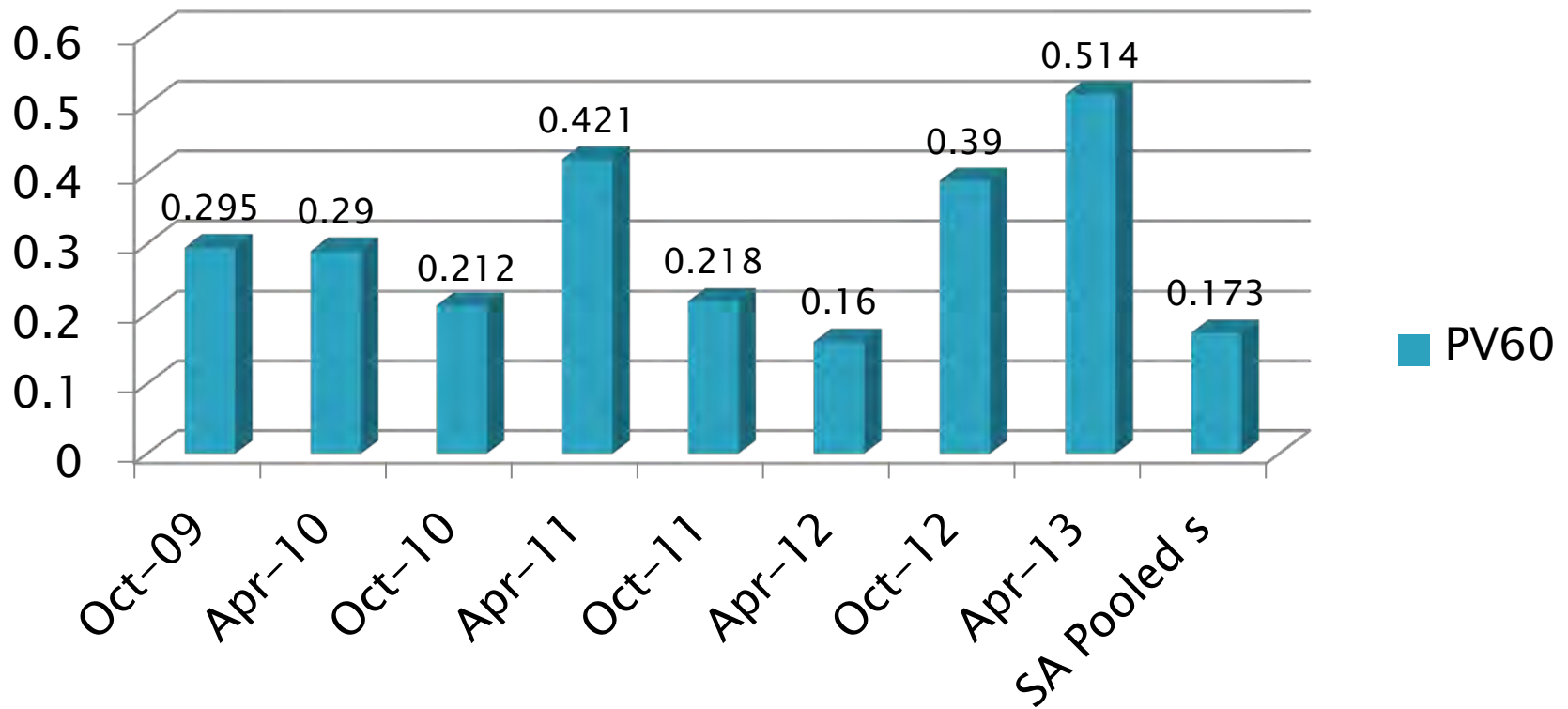
# IIIF Precision Estimates

APV



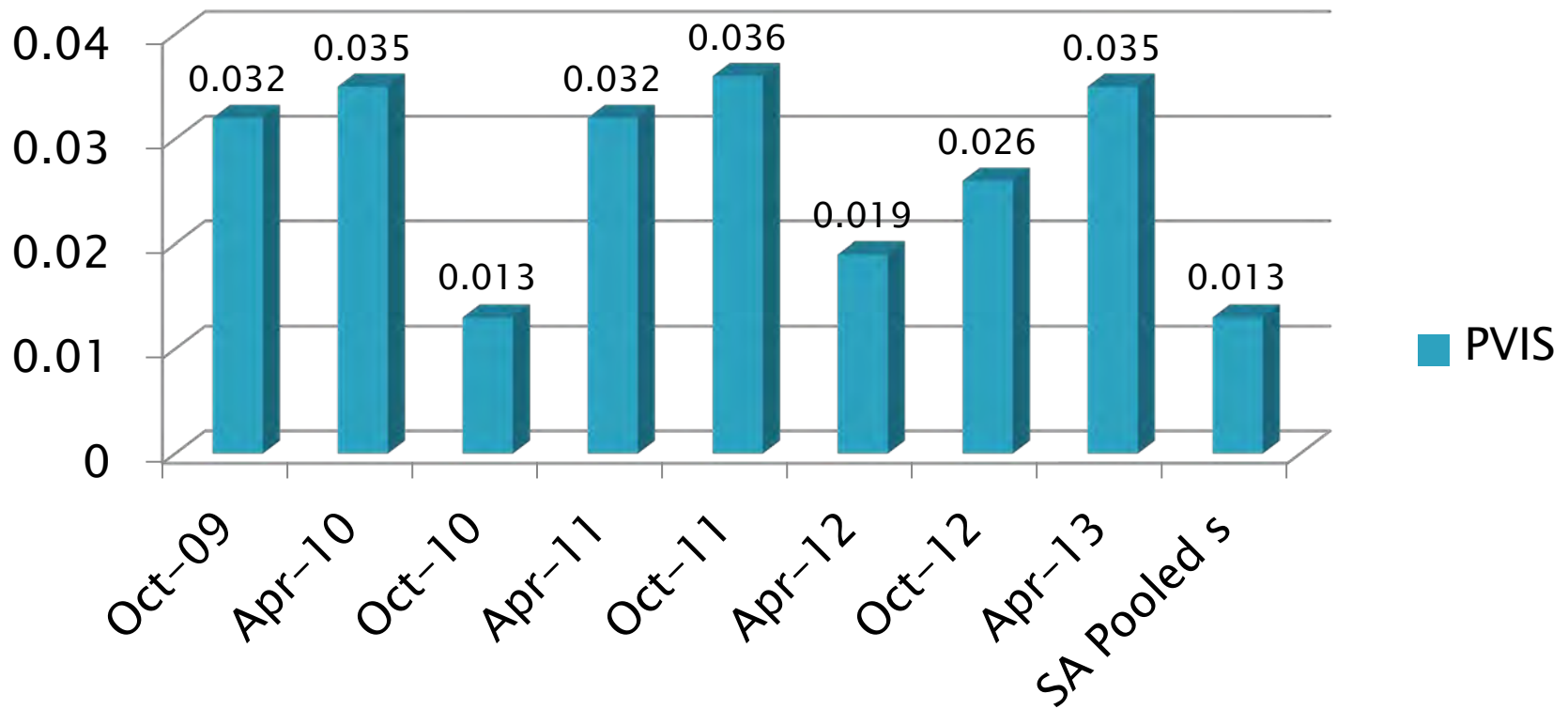
# IIIF Precision Estimates

## PV60

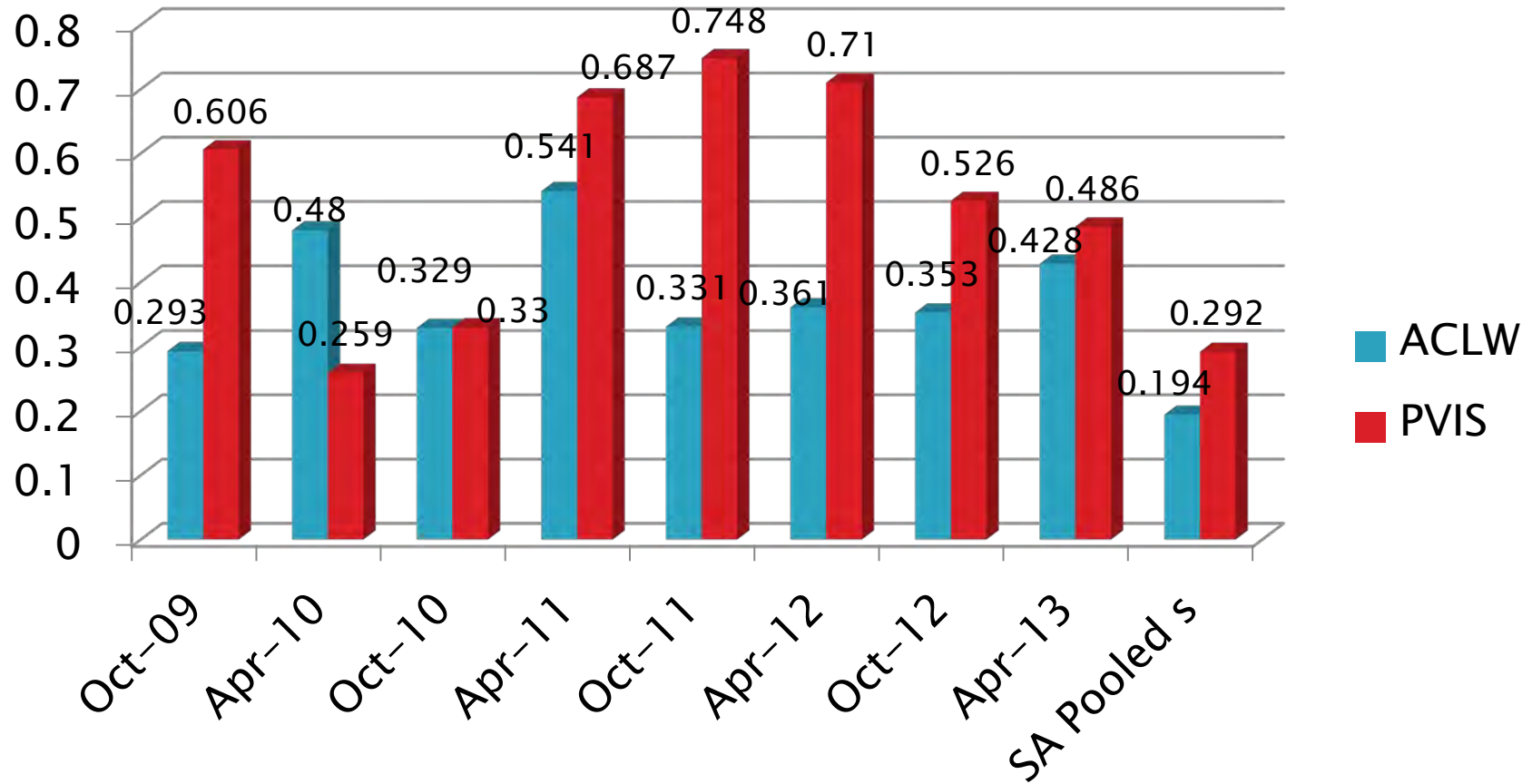


# IIIF Precision Estimates

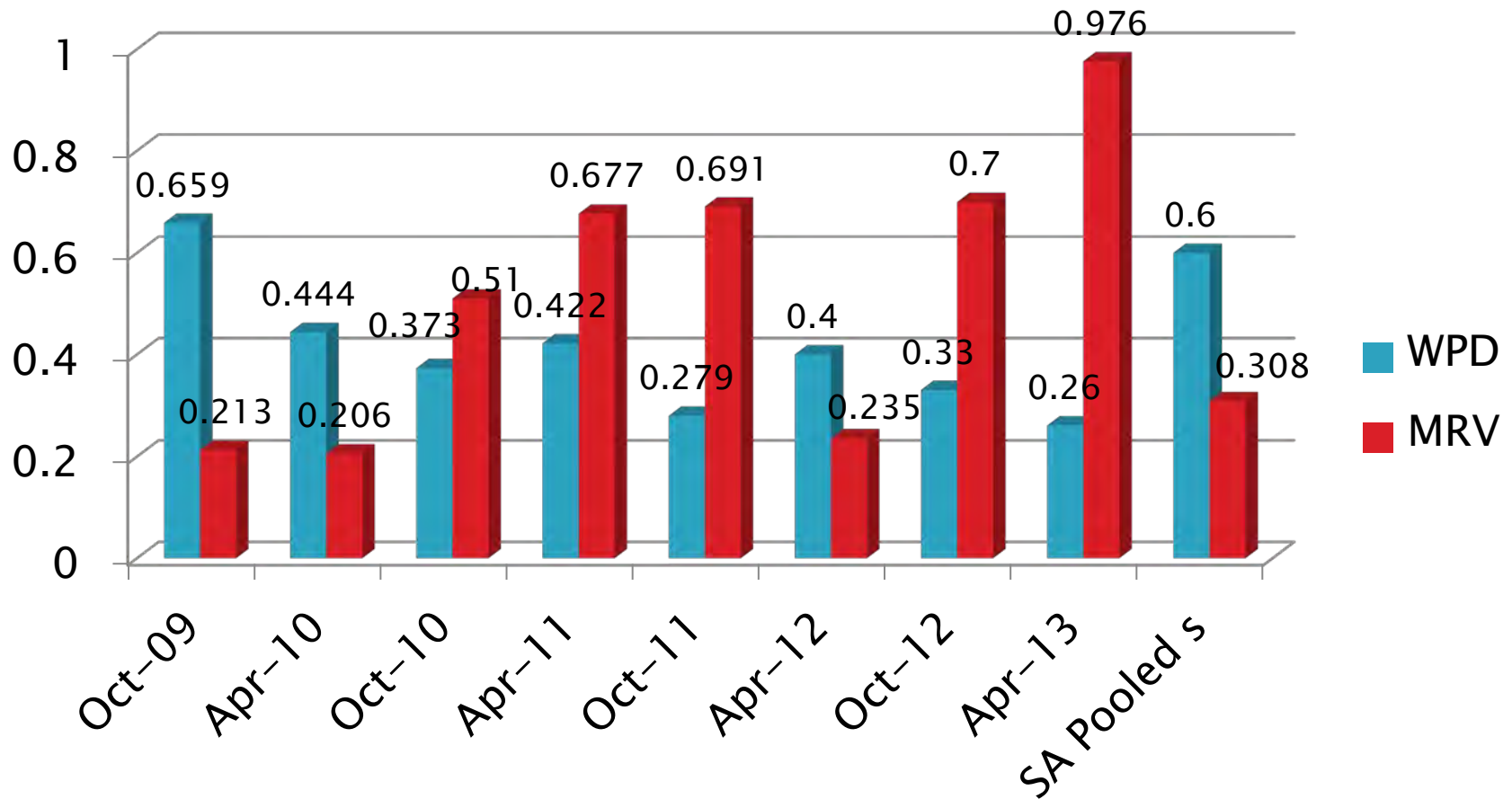
## PVIS



# IIIG Precision Estimates



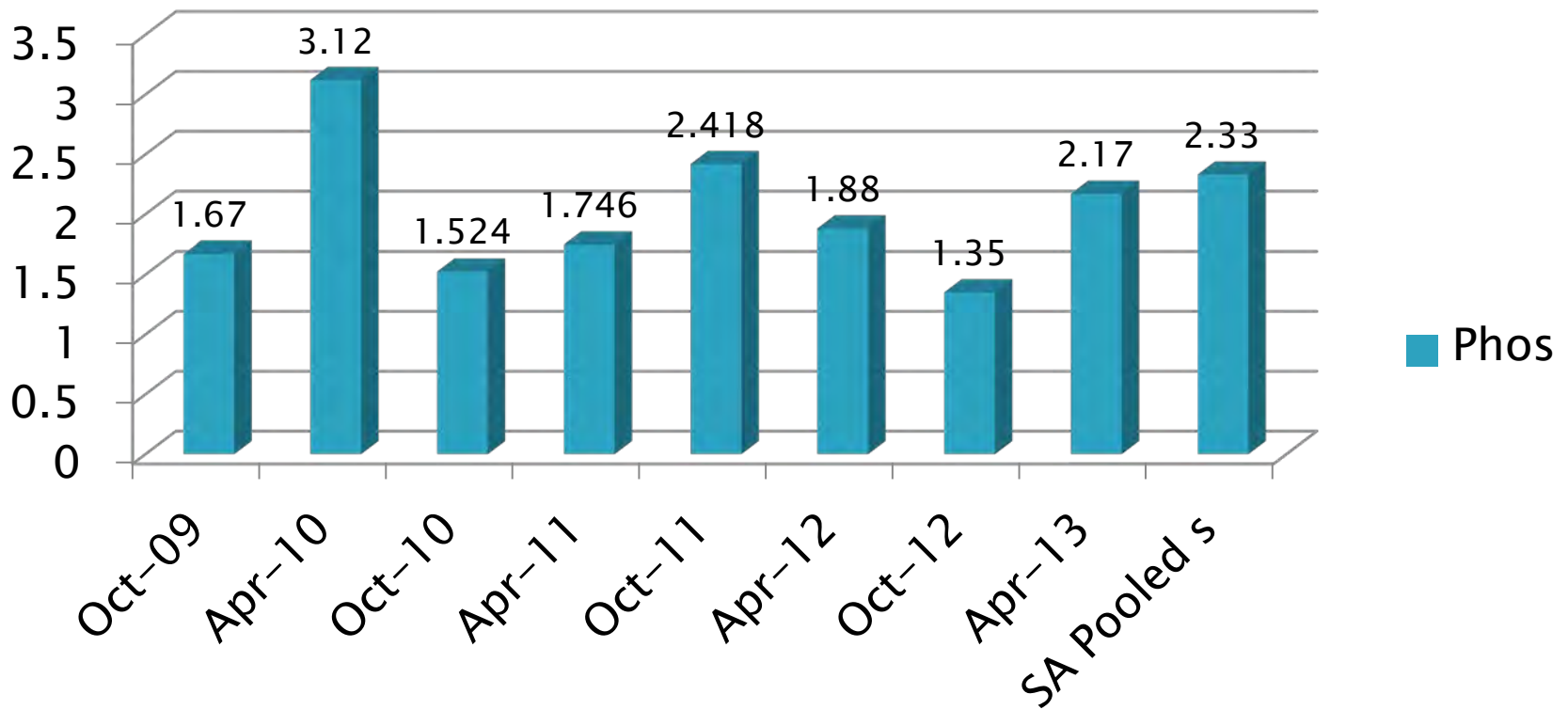
# IIIG Precision Estimates



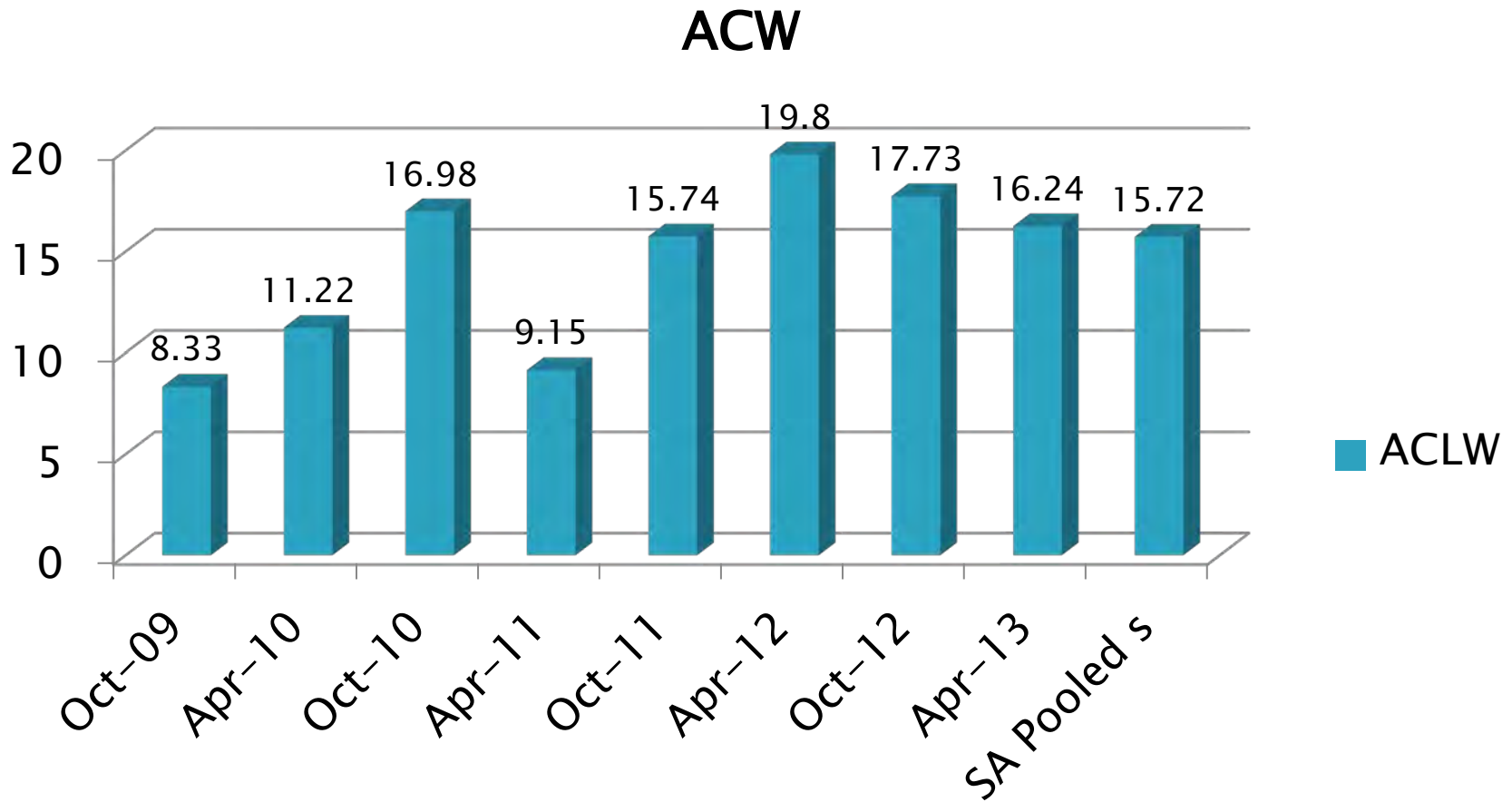


# IIIG Precision Estimates

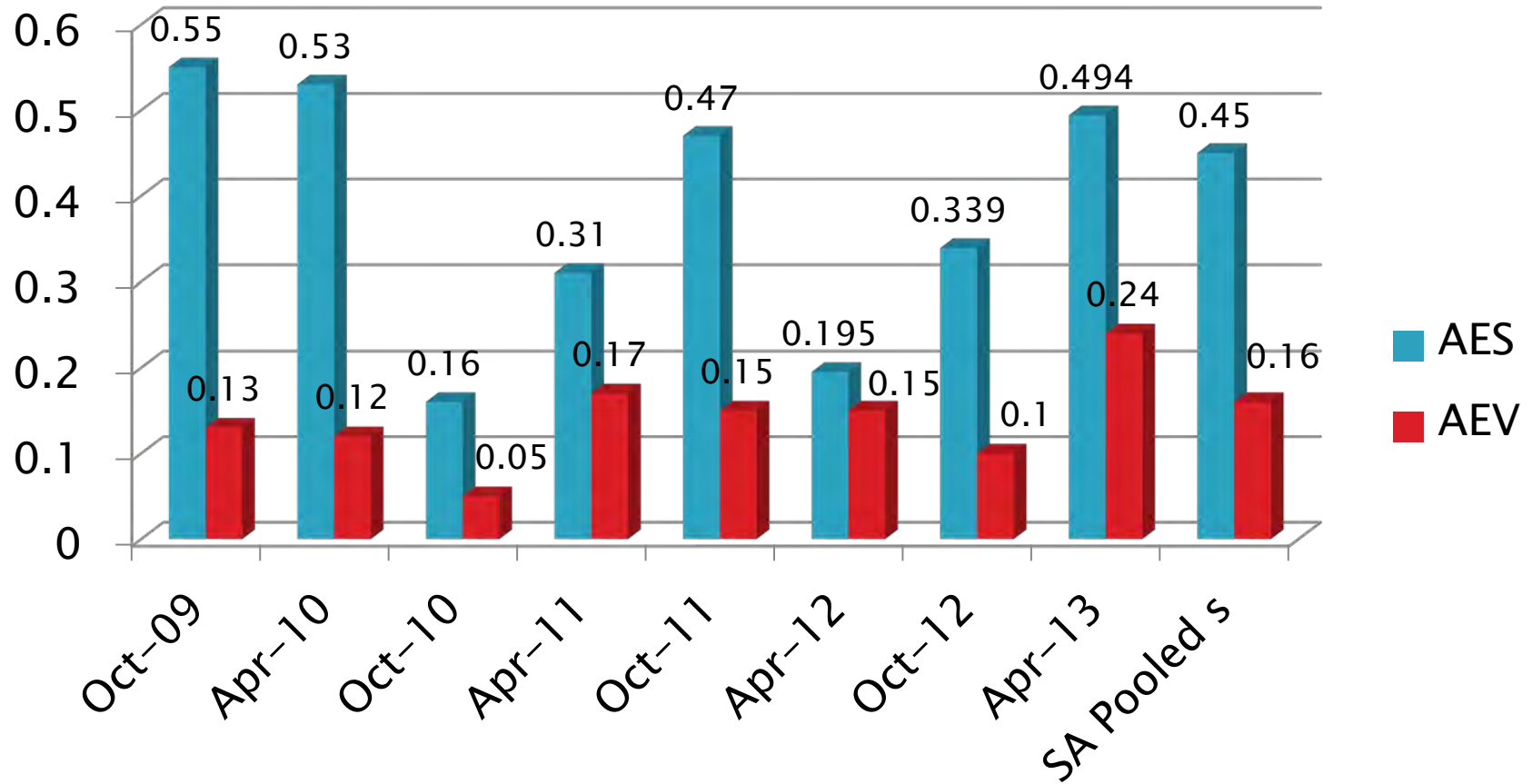
## Phos



# Sequence IVA Precision Estimates

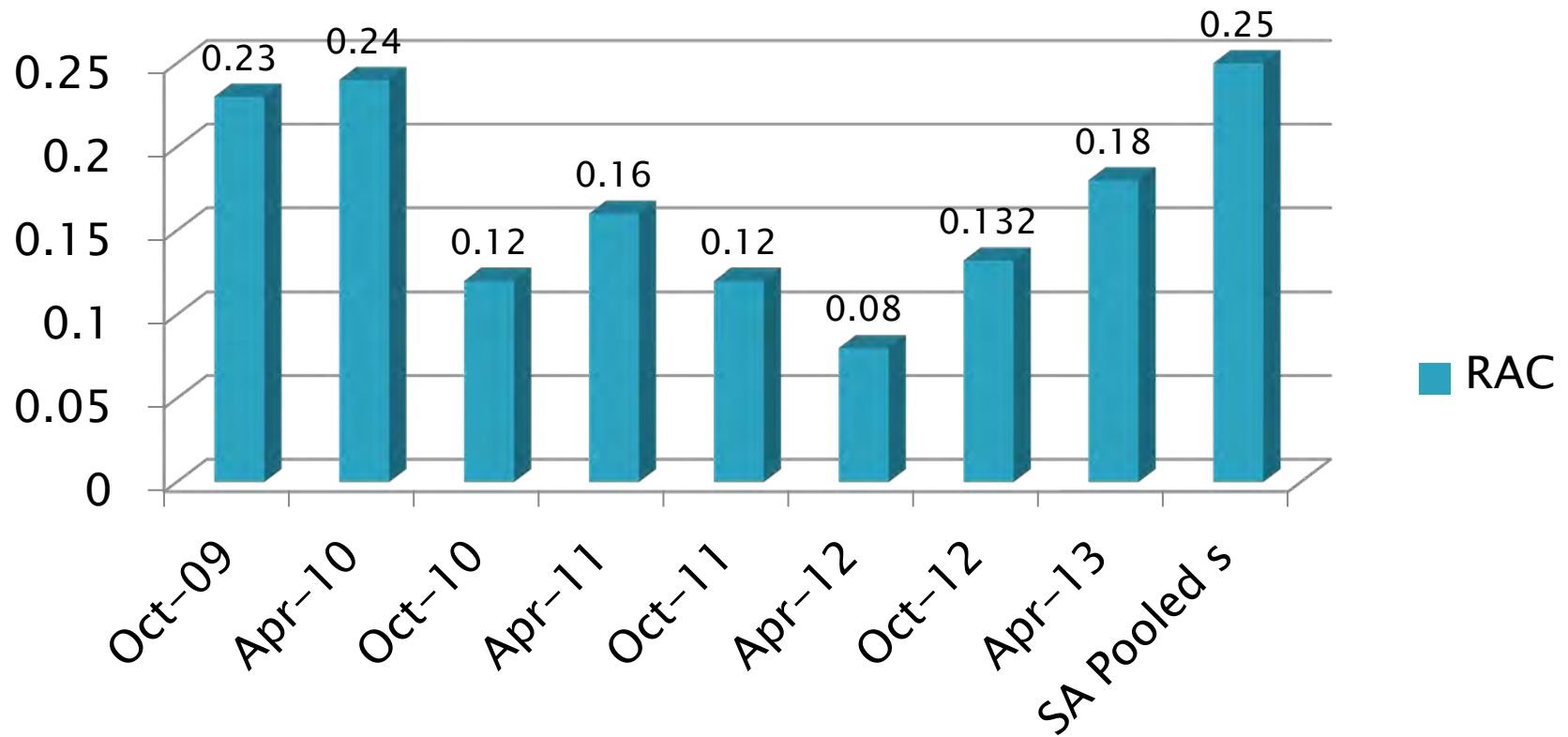


# Sequence VG Precision Estimates

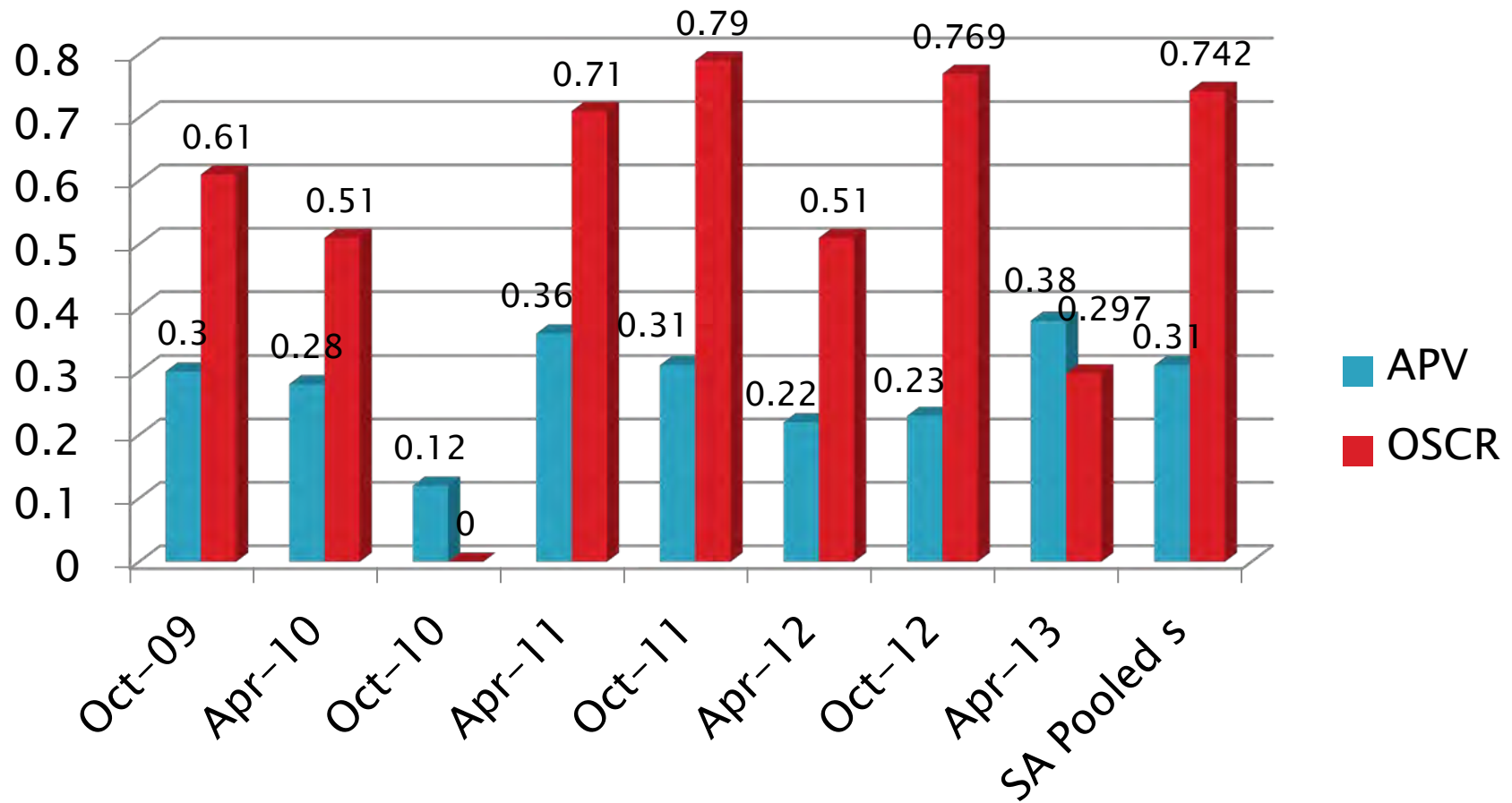


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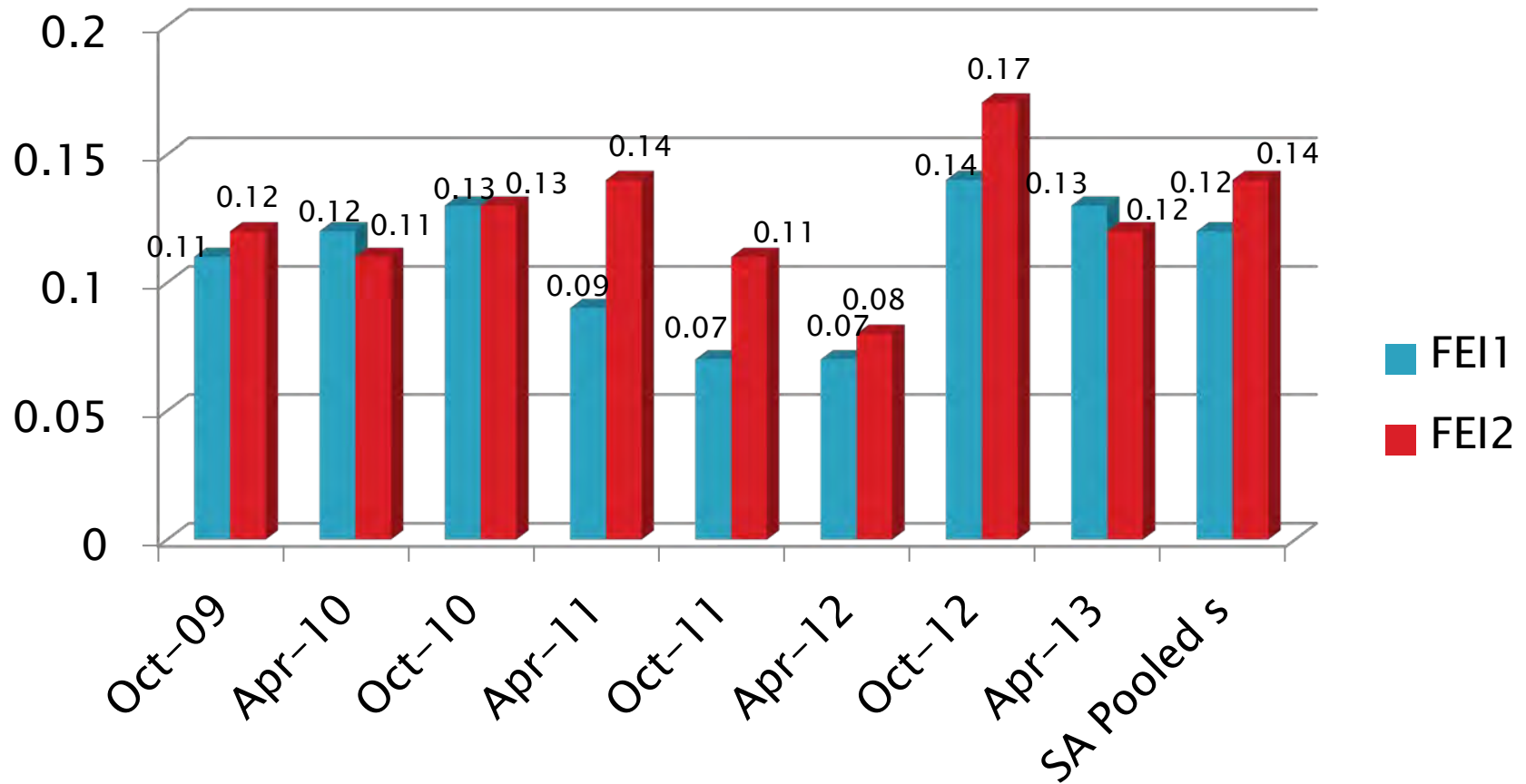
## RAC



# Sequence VG Precision Estimates

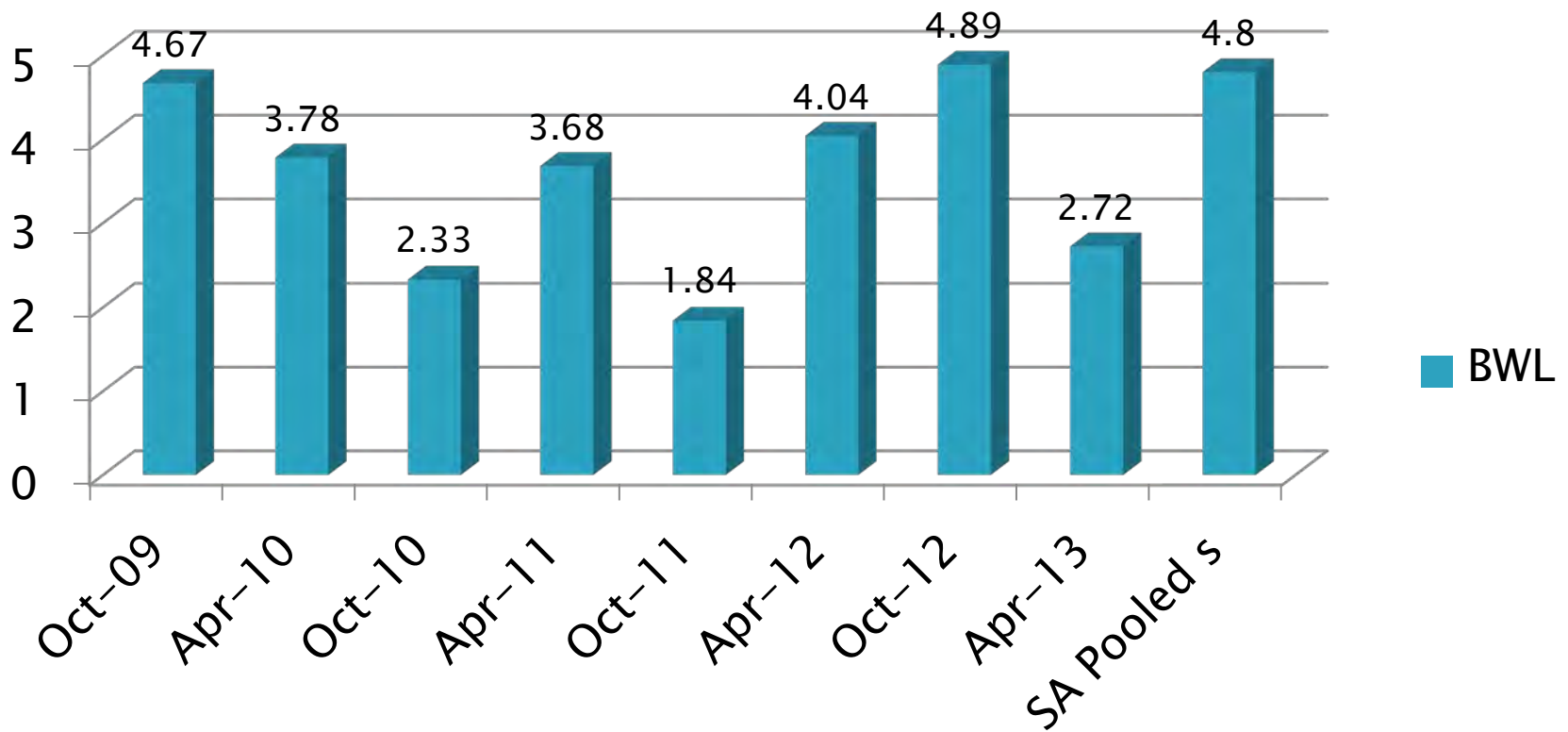


# Sequence VID Precision Estimates



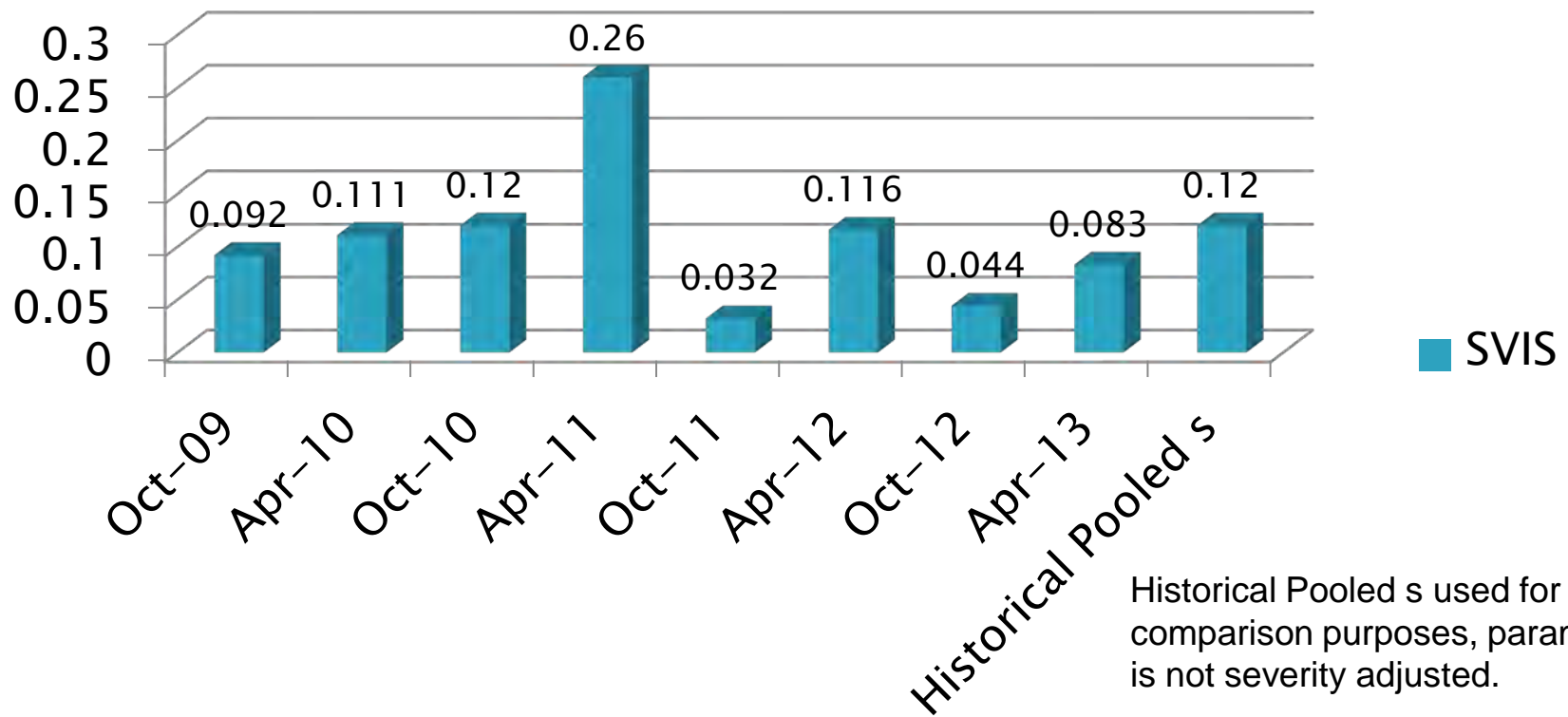
# Sequence VIII Precision Estimates

## BWL



# Sequence VIII Precision Estimates

## SVIS





# Information Letters

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# Information Letters\*

Test	Date	IL	Topic
IIIF	20130206	13-1	Corrected references to Rating Workshop and Manuals and corrected test hours for NOx Measurements.
IIIG	20130206	13-1	Corrected references to Rating Workshop and Manuals.
IVA	20130128	13-1	Addressed modifications to hardware.
IVA	20130208	13-2	Allow use of alternate oil cooler and increased number of runs to heads and block.
IVA	20130312	13-3	Allow use of reground cams and addressed issues regarding fuel analysis and reinstated Rocker Cover Gas Temperature measurement.
VG	20130218	13-1	Addressed modifications to test hardware and corrected references to rating manuals and workshop.

\*Available from TMC Website

[Return to Exec. Summary](#)

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# Reference Oil Inventory

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

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# Reference Oil Re-blends

- Oils with ~ 2 years or less supply
  - Oils Affected
    - 433-1
    - 542
    - Reblends obtained, panels need to address oil introduction.

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# Reference Oil Inventory Estimated Life

Oil	Tests	Original Blend Amount	Quantity Shipped in last 6 months	TMC Inventory	Lab Inventory	Estimated Life
433-1	IIIF	1045	76	36	48	<1 year
433-2	IIIF	500	0	500	0	3+ years
434	IIIG	550	0	5	12	<1 year
434-1	IIIG	660	24	168	28	3 years
435	IIIG	550	0	2	4	<1 year
435-2	IIIG	550	16	350	24	5+ years
438	IIIG	990	36	208	48	3+ years
540	VID	1100	30	383	25	4+ years
541	VID	550	35	5	10	<1 year
541-1	VID	550	120	290	60	5+ years

# Reference Oil Inventory Estimated Life

Oil	Tests	Original Blend Amount	Quantity Shipped in last 6 months	TMC Inventory	Lab Inventory	Estimated Life
542	VID	1100	165	109	70	1 year
542-1	VID	275	0	275	0	2+ years
704-1	VIII	897	0	192	16	5+ years
925-3	VG	975	0	10	6	<1 year
940	VG	560	15	496	36	5+ years
1006-2	IVA, VG, VIII	5500	116	3483	107	5+ years
1007	IVA, VG	1968	2	19	38	<1 year
1009	VG	1100	40	347	27	5+ years
1010	IIIG, VID	1100	60	475	111	5+ years

# LTMS Deviations

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# LTMS Deviations

- Two LTMS Deviations in Current Period
  - VID New Engine Reference Oil Order
    - requires oils 542, 541 and 1010 be run in new engine
    - lab invalidated 541 result after 1010 result had begun
    - lab ran 542, 1010 and 541, out of order specified in LTMS
  - IIG calibration period adjusted
    - due to potential sample mislabeling/contamination
    - initial viscosities did not match for reference oil
    - lab re-ran reference, but had been granted calibration status on previous test



# LTMS Deviations

## Historical Count of PCEO LTMS Deviations

Test	LTMS Deviations
IIIF	5
IIIG	6
IVA	7
VG	8
VID	2
VIII	3

# Quality Index Deviations

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# Quality Index Deviations

- No PCEO Quality Index Deviations this period

Historical Count of PCEO Quality Index Deviations

Test	Quality Index Deviations
IIIF	25
IIIG	11
IVA	28
VG	38

# TMC Laboratory Visits

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# TMC Lab Visits

Test	Number of Labs Visited
VID	1
VIII	1

# TMC Lab Visits

- VID and VIII visits did not identify any issues at any labs visited.

# Test Area Timelines

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# Test Area Timeline Additions\*

Test	Date	Topic	IL
IIIF	20130206	Corrected references to Rating Workshop and Manuals and corrected test hours for NOx Measurements.	13-1
IIIG	20130206	Corrected references to Rating Workshop and Manuals.	13-1
IVA	20130128	Addressed modifications to hardware.	13-1
IVA	20130208	Allow use of alternate oil cooler and increased number of runs to heads and block.	13-2
IVA	20130312	Allow use of reground cams and addressed issues regarding fuel analysis and reinstated Rocker Cover Gas Temperature measurement.	13-3
IVA	20120320	Update reference oil 1006-2, targets with N =29	
VG	20121114	Initial Targets for Reference Oil 940, N = 5	
VG	20130218	Addressed modifications to test hardware and corrected references to rating manuals and workshop.	13-1

\*As of 3/31/2013



# Additional Information

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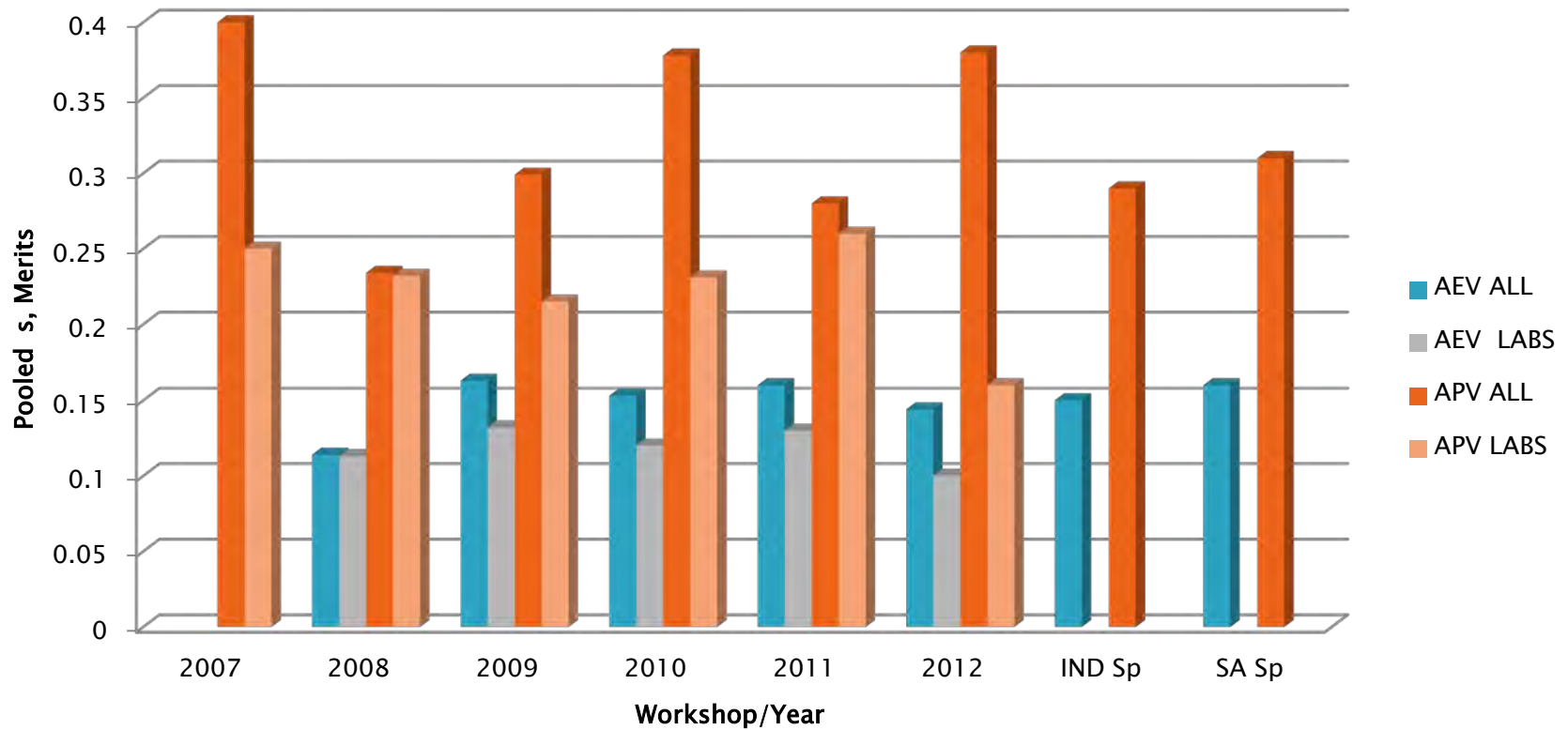
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# Additional Information

- ▶ Summary of Precision Data From Light Duty Rating workshops:
  - VG Average Piston and Average Engine Varnish.
  - IIIG WPD.

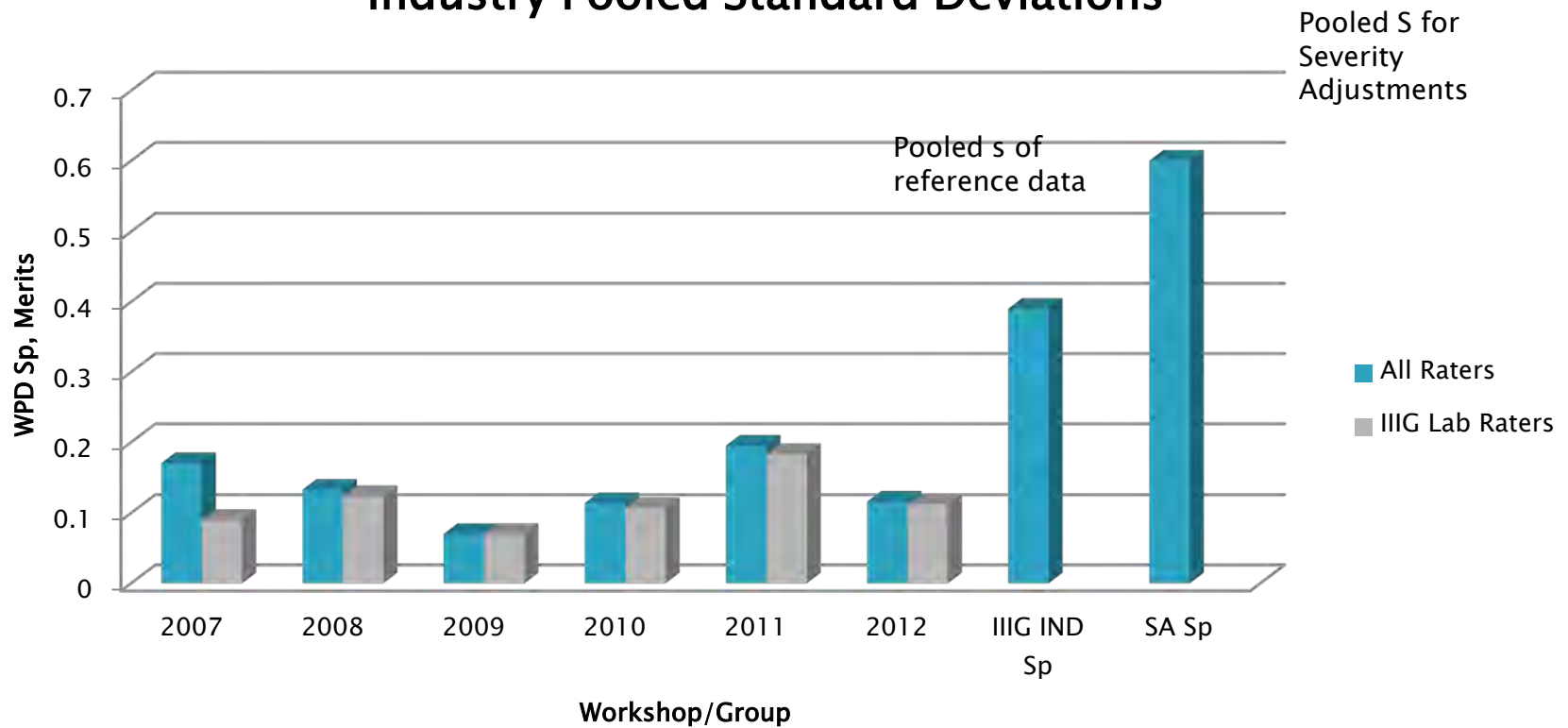
# Sequence VG Precision Estimates

## Workshop Data for VG Varnish



# Sequence IIIG Precision Estimates

## Comparison of Workshop Pooled Standard Deviations with Industry Pooled Standard Deviations



# Additional Information

- ▶ Available on TMC Website:
  - Live Reference Test Data Bases
  - Surveillance Panel Meeting Minutes
  - Test Area Alarm Logs
  - Complete Test Area Timelines
  - LTMS Manual
  
- ▶ [www.astmtmc.cmu.edu](http://www.astmtmc.cmu.edu)



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## Appendix 1 PCMO Reference Oil Testing Control Charts

April 2013



# Appendix 1.a

## IIIF Control Charts

» Severity, Precision, and CuSum

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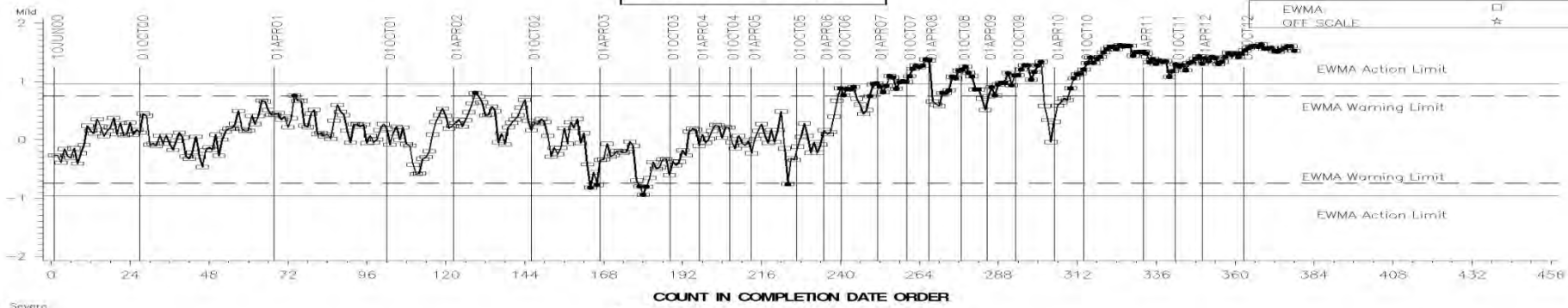


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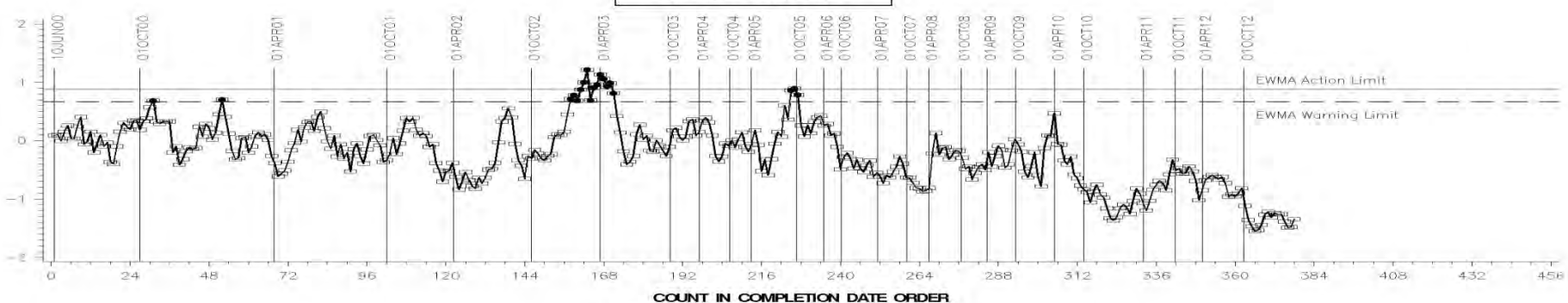
AVERAGE PISTON SKIRT VARNISH FINAL ORIG UNIT RES

LTMS Severity Analysis



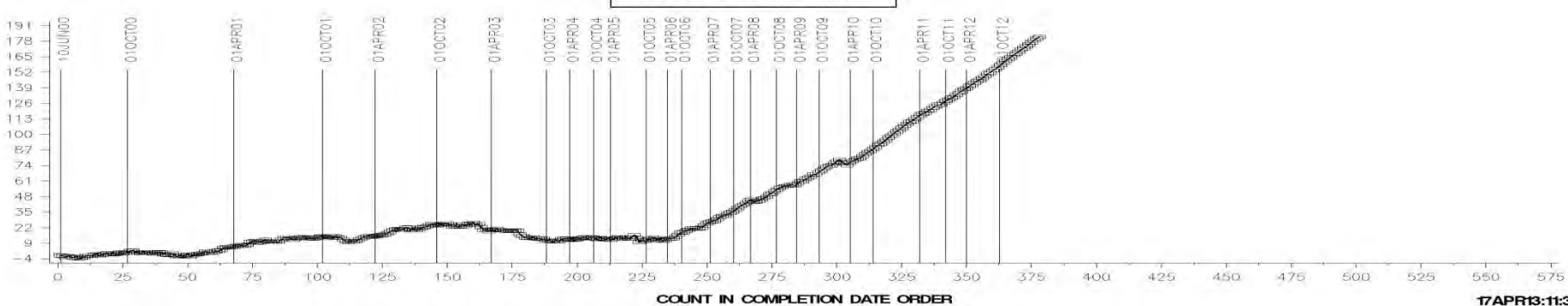
COUNT IN COMPLETION DATE ORDER

LTMS Precision Analysis



COUNT IN COMPLETION DATE ORDER

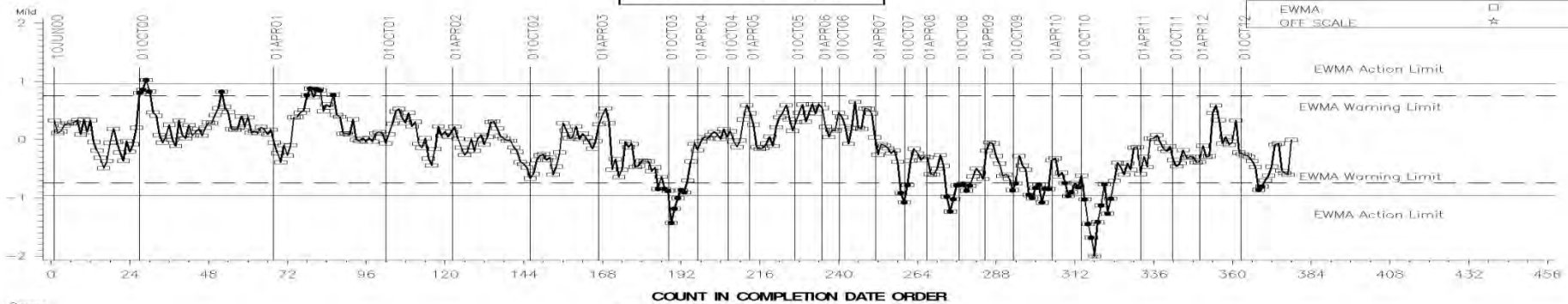
CUSUM Severity Analysis



COUNT IN COMPLETION DATE ORDER

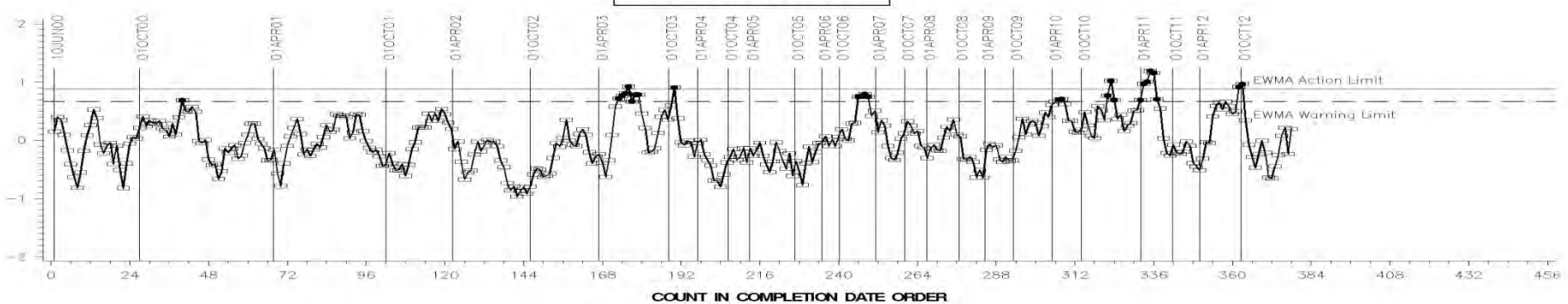
% VISCOSITY INCREASE

LTMS Severity Analysis



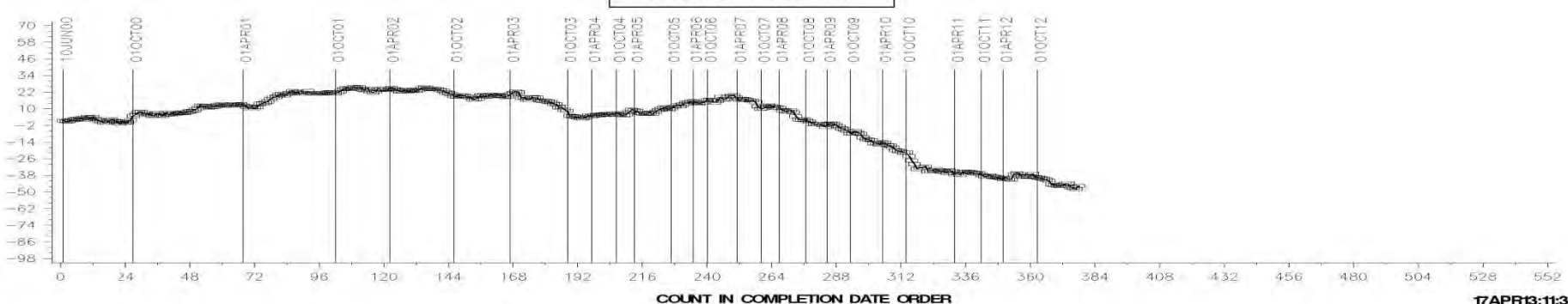
COUNT IN COMPLETION DATE ORDER

LTMS Precision Analysis



COUNT IN COMPLETION DATE ORDER

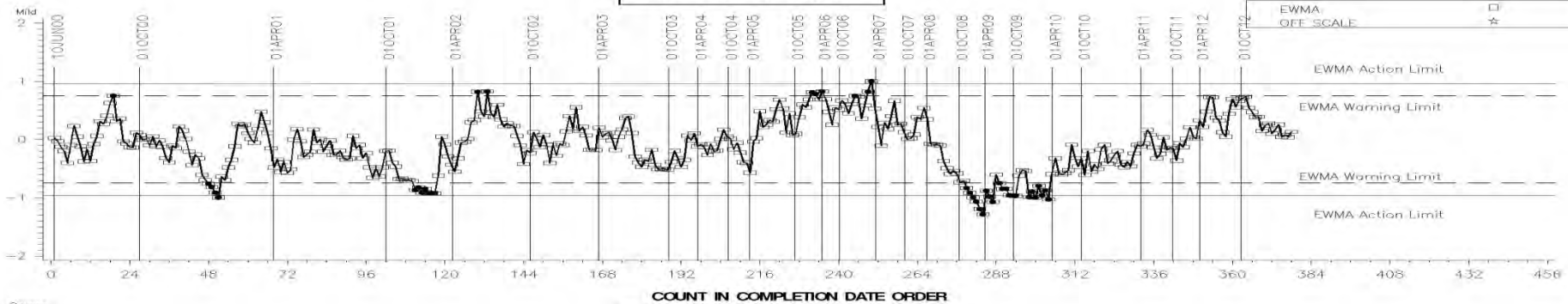
CUSUM Severity Analysis



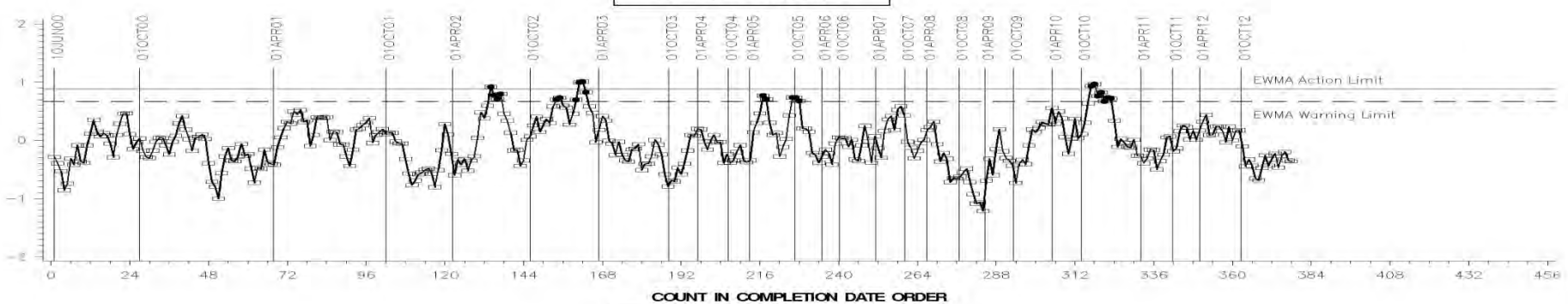
COUNT IN COMPLETION DATE ORDER

AVERAGE WEIGHTED PISTON DEPOSITS FNL ORIG UNIT RES

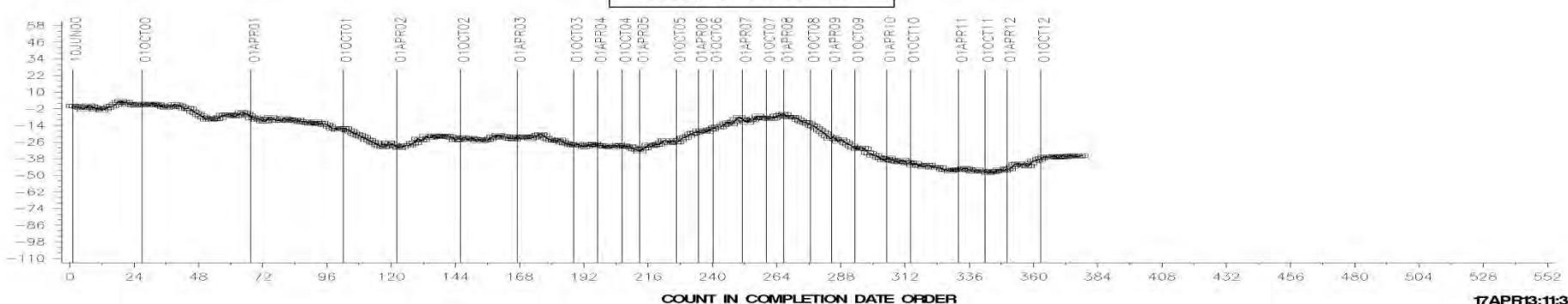
LTMS Severity Analysis



LTMS Precision Analysis



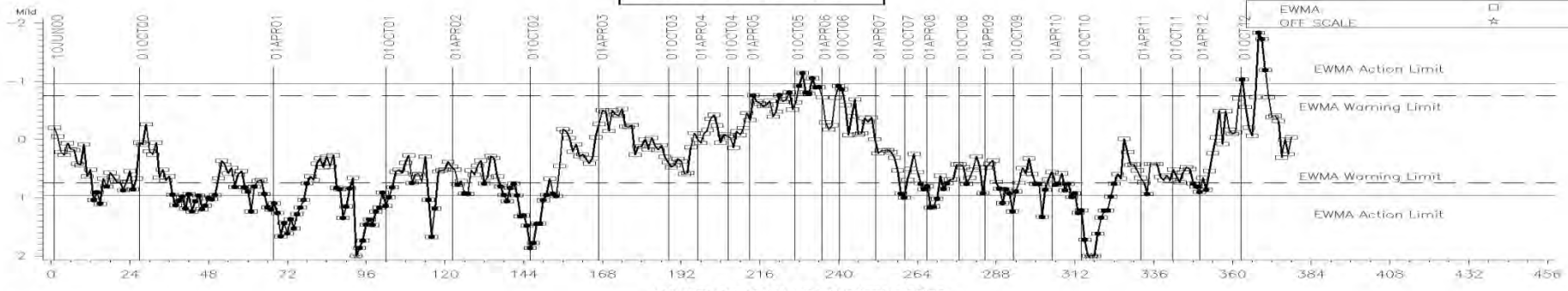
CUSUM Severity Analysis



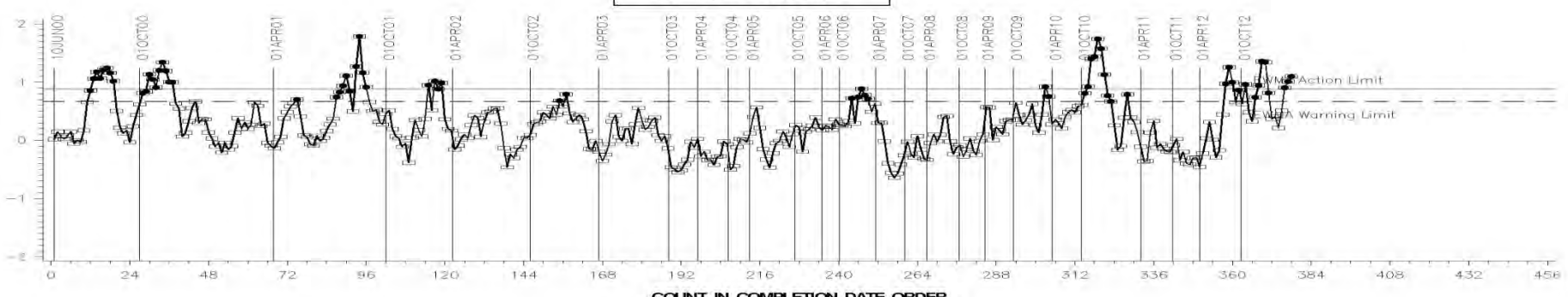


% VISCOSITY INCREASE @ 060 HOURS

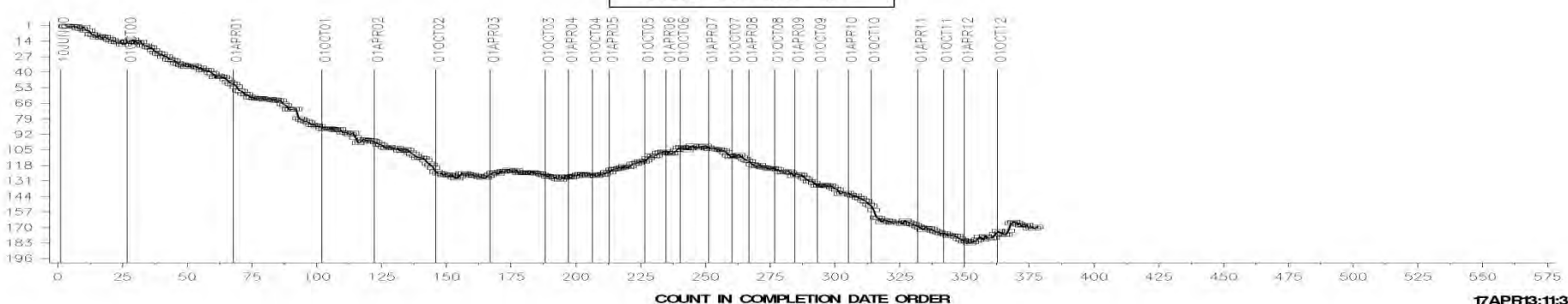
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



17APR13:11:31

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# Appendix 1.b

## IIIG/A/B Control Charts

» Severity, Precision, and CuSum

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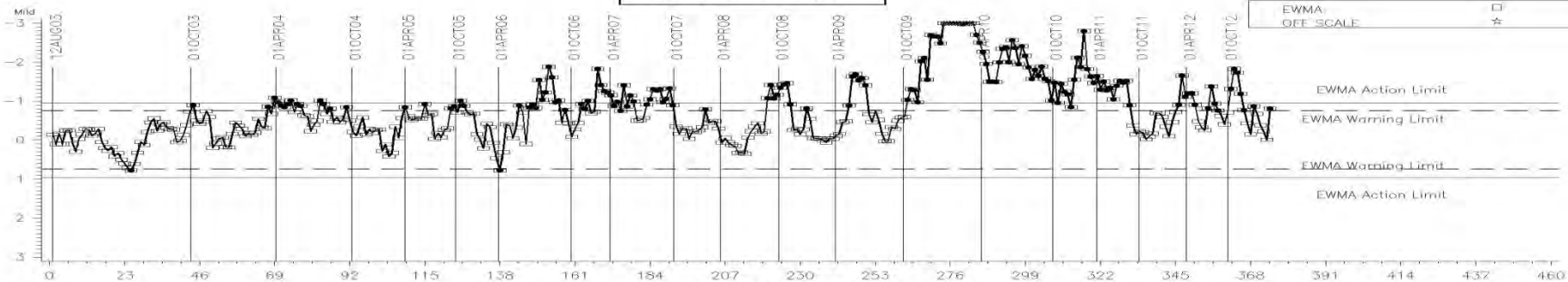
<http://astmtmc.cmu.edu>



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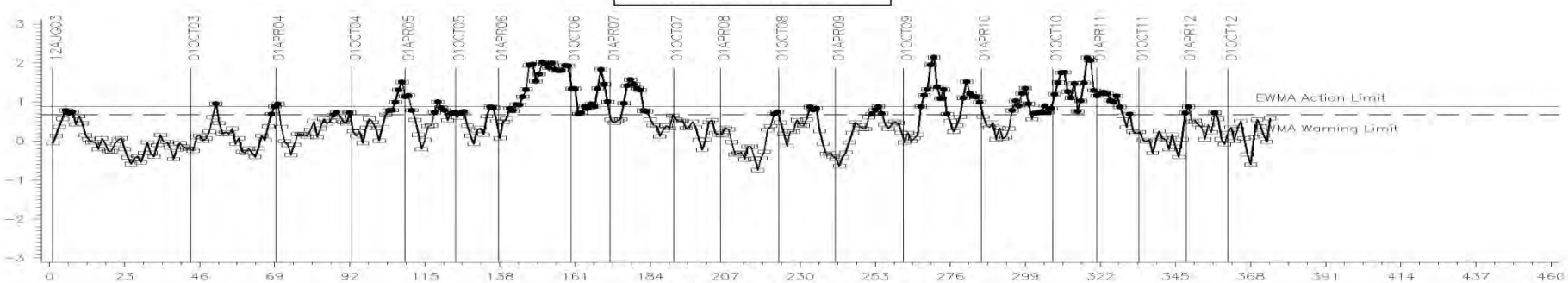
AVERAGE CAM + LIFTER WEAR

LTMS Severity Analysis



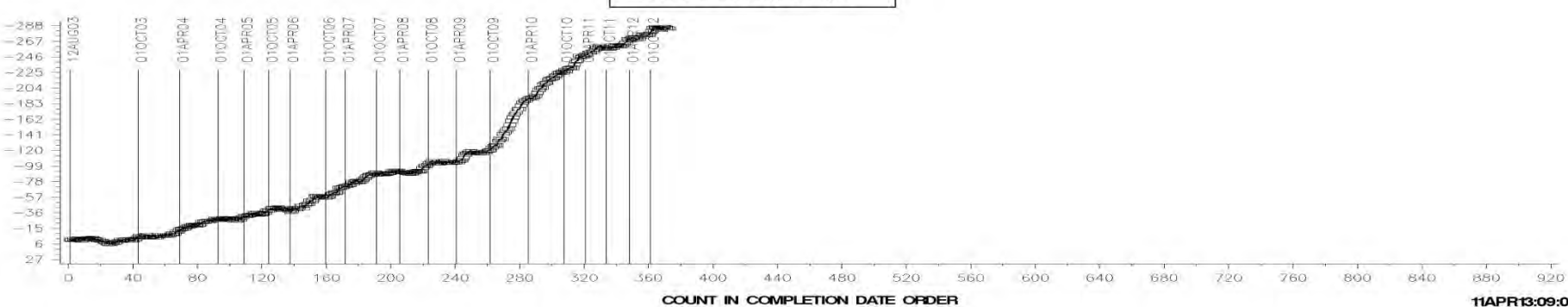
COUNT IN COMPLETION DATE ORDER

LTMS Precision Analysis



COUNT IN COMPLETION DATE ORDER

CUSUM Severity Analysis

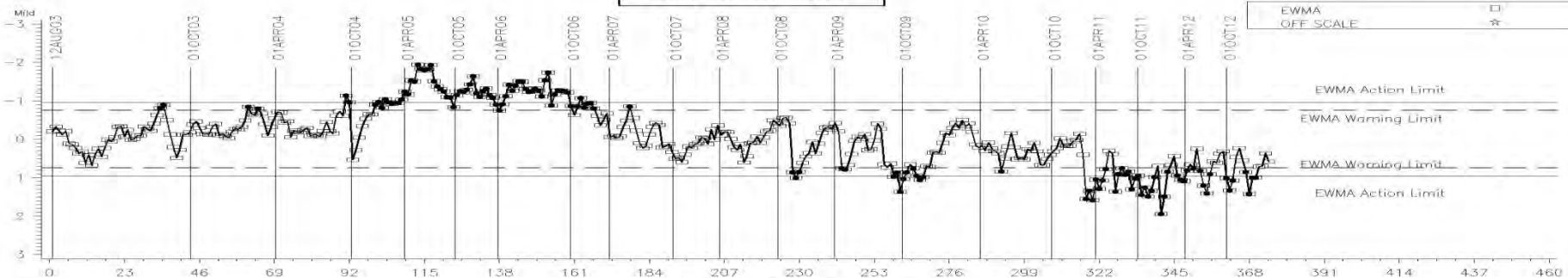


COUNT IN COMPLETION DATE ORDER



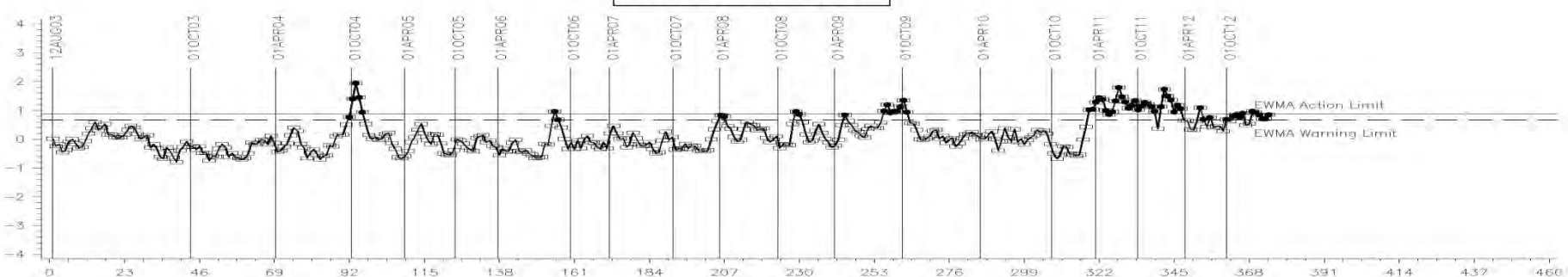
VISCOSITY INCREASE

LTMS Severity Analysis



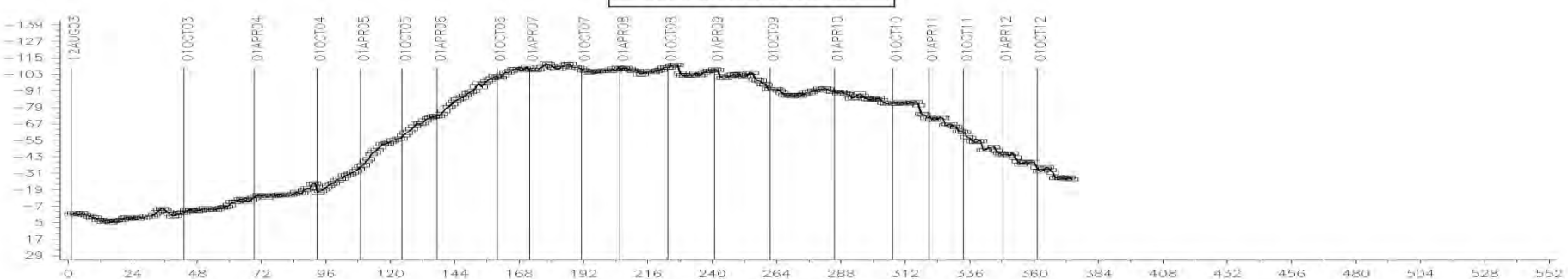
COUNT IN COMPLETION DATE ORDER

LTMS Precision Analysis



COUNT IN COMPLETION DATE ORDER

CUSUM Severity Analysis

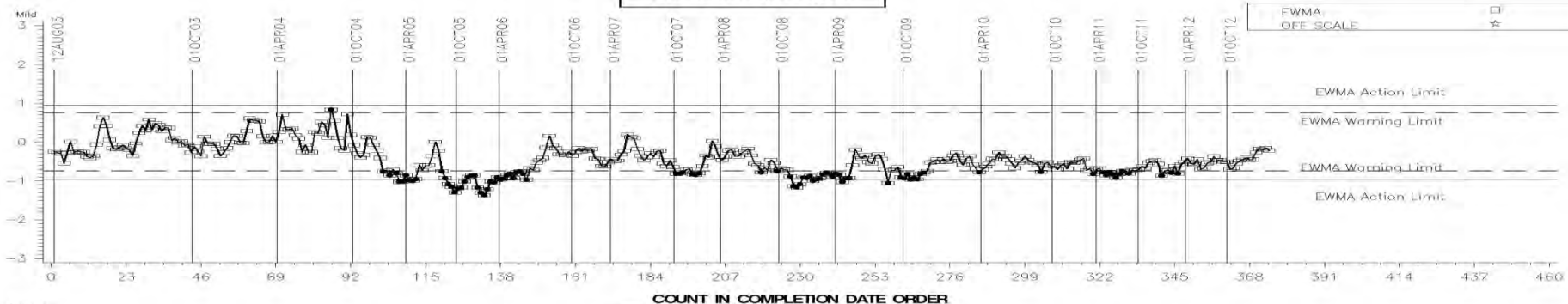


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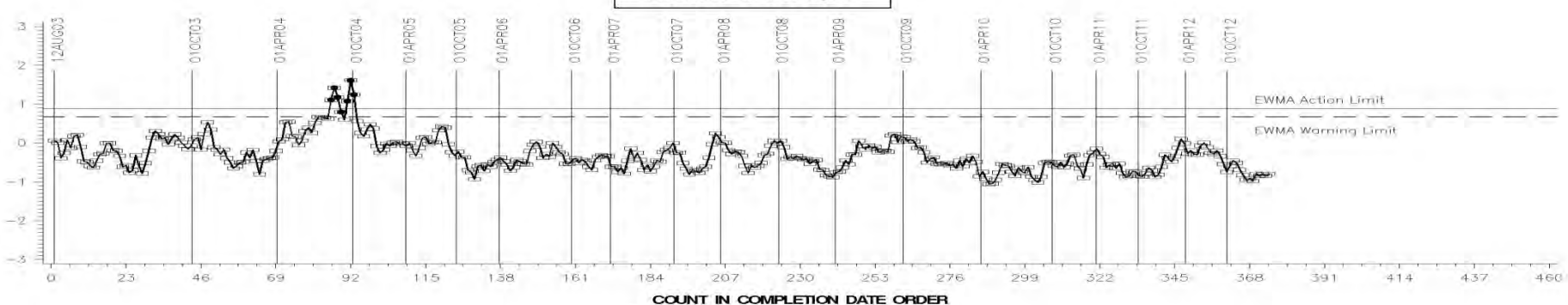
29APR13:13:38

AVERAGE WEIGHTED PISTON DEPOSITS

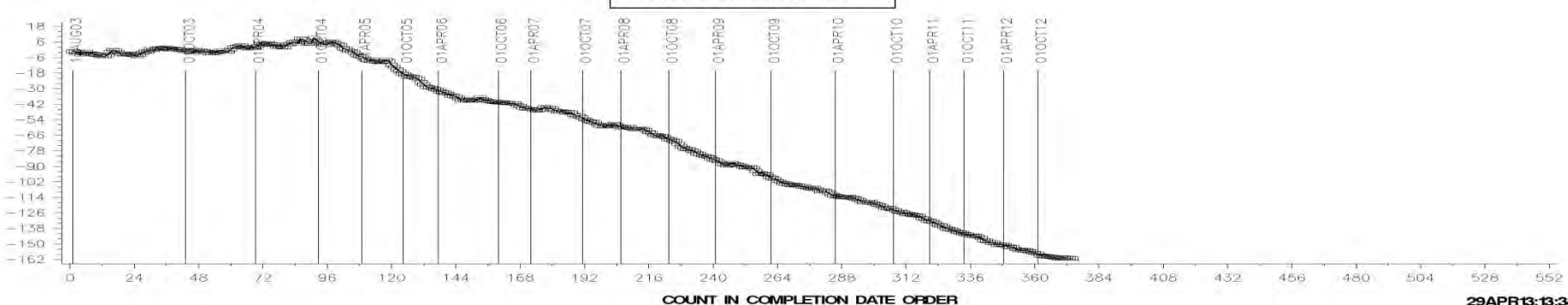
LTMS Severity Analysis



LTMS Precision Analysis



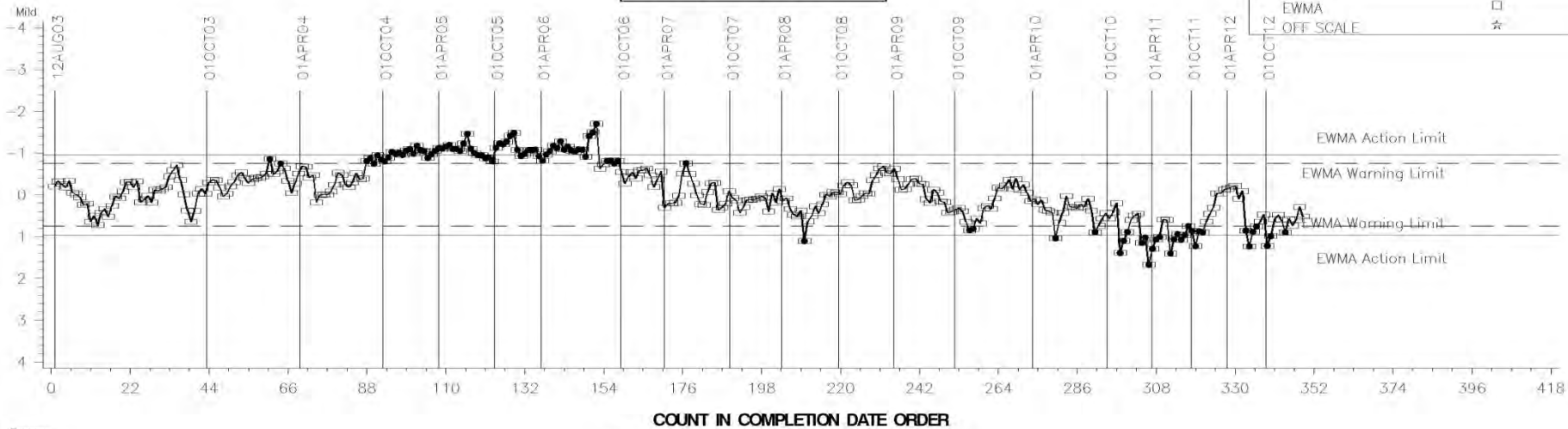
CUSUM Severity Analysis



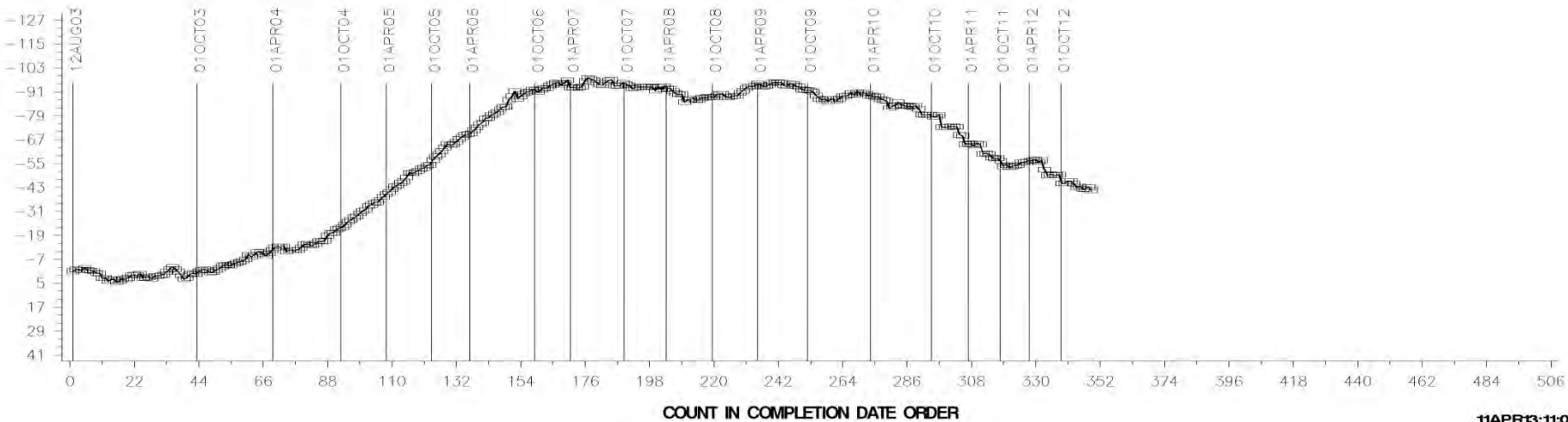


**SEQUENCE IIIA INDUSTRY OPERATIONAL VALID DATA**  
**Excludes 435 due to Shear**  
**MRV VISCOSITY RESULT**

**LTMS Severity Analysis**



**CUSUM Severity Analysis**

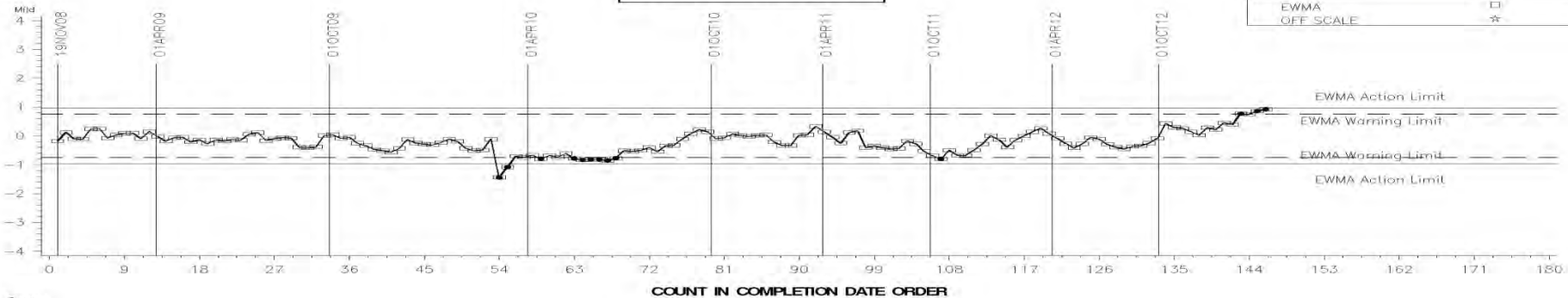


11APR13:11:04

PHOS RETENTION

LTMS Severity Analysis

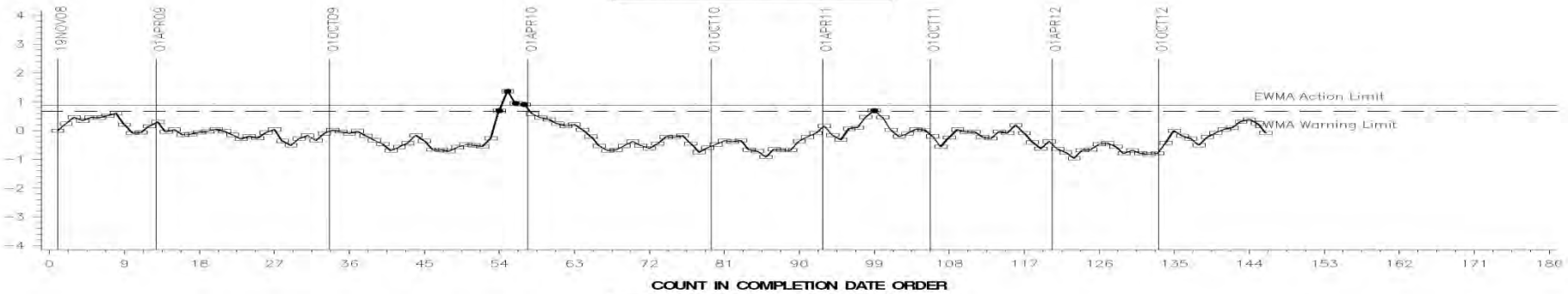
Standard Deviation Units



COUNT IN COMPLETION DATE ORDER

LTMS Precision Analysis

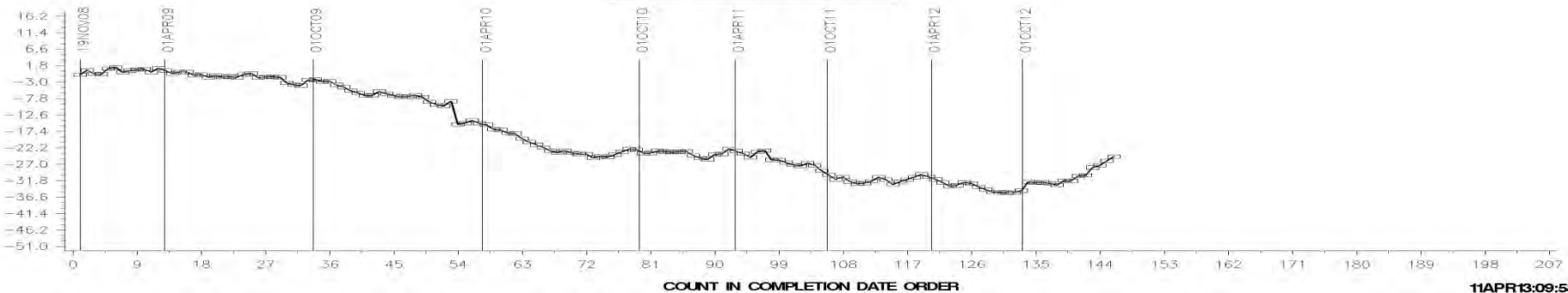
Standard Deviation Units



COUNT IN COMPLETION DATE ORDER

CUSUM Severity Analysis

Standard Deviation Units



COUNT IN COMPLETION DATE ORDER

11APR13:09:58

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# Appendix 1.c

## Sequence IVA Control Charts

» Severity, Precision, and CuSum

Test Monitoring Center

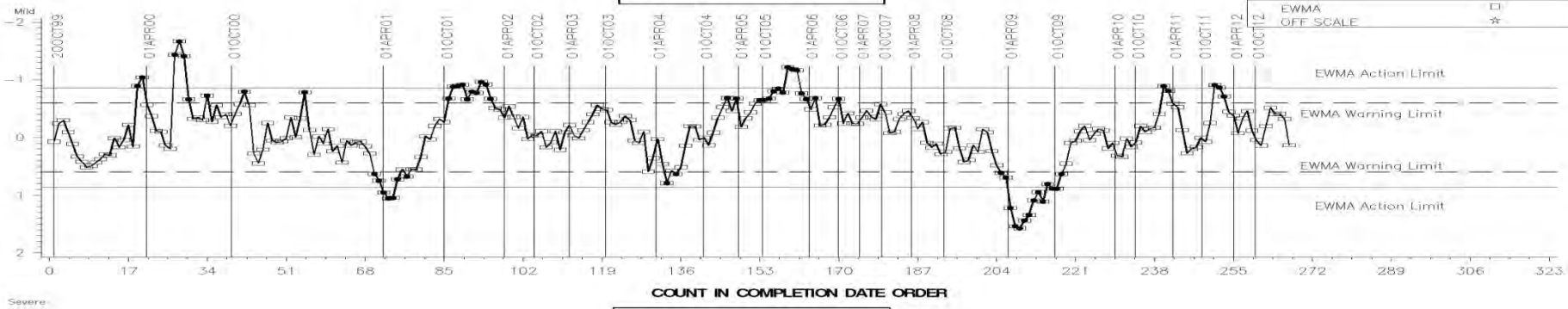
<http://astmtmc.cmu.edu>



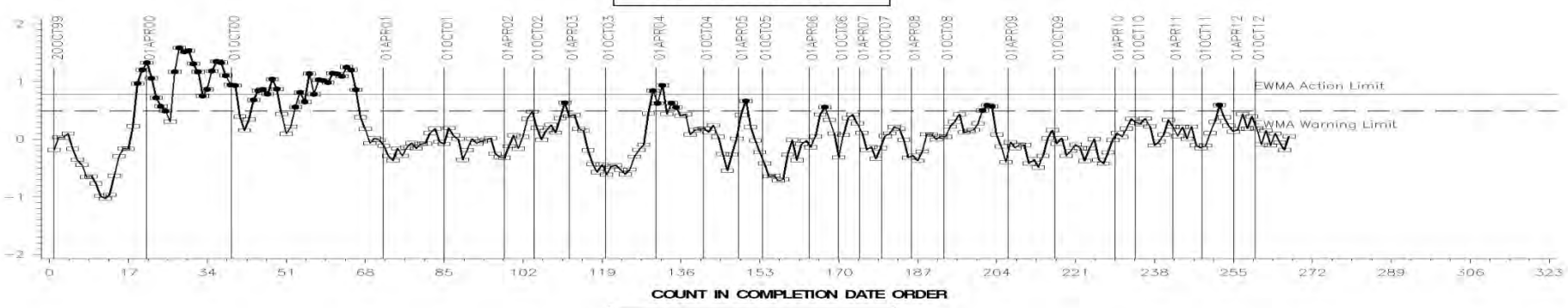
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AVERAGE CAM WEAR

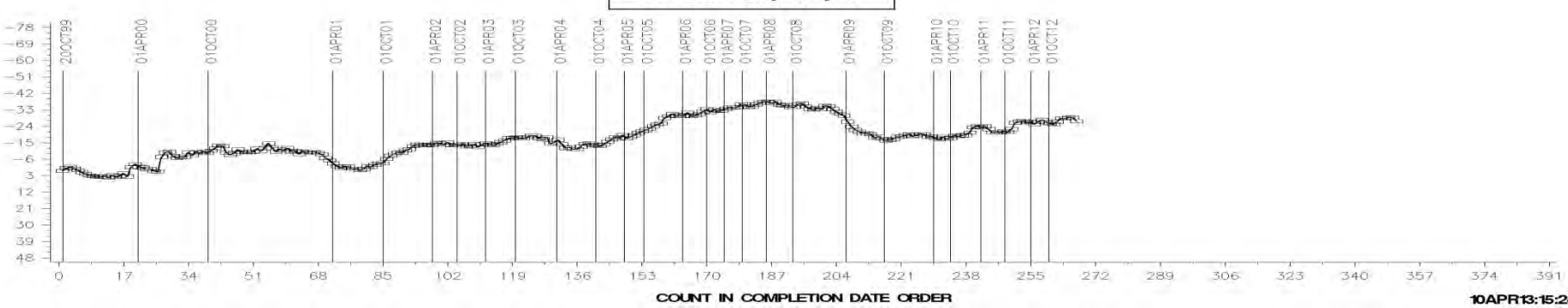
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



10APR13:15:24

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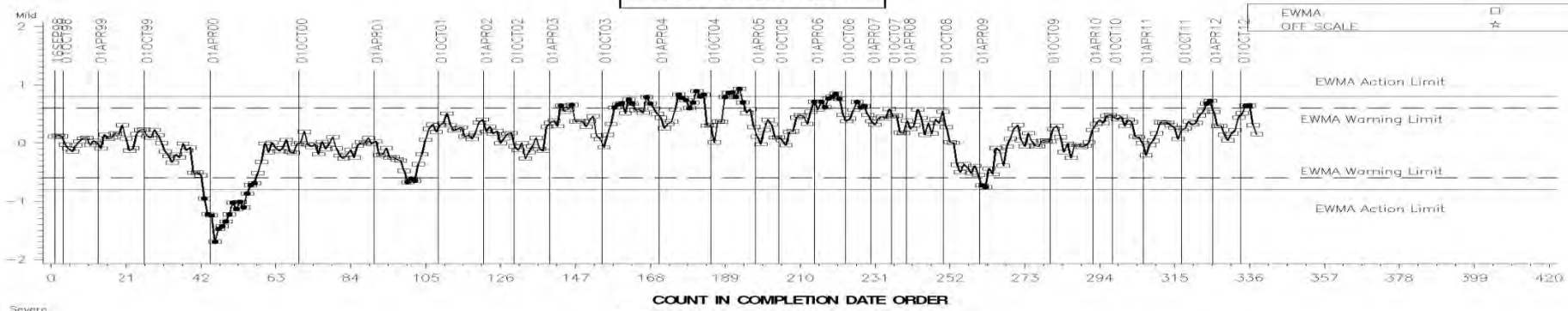
# Appendix 1.d

## Sequence VG Control Charts

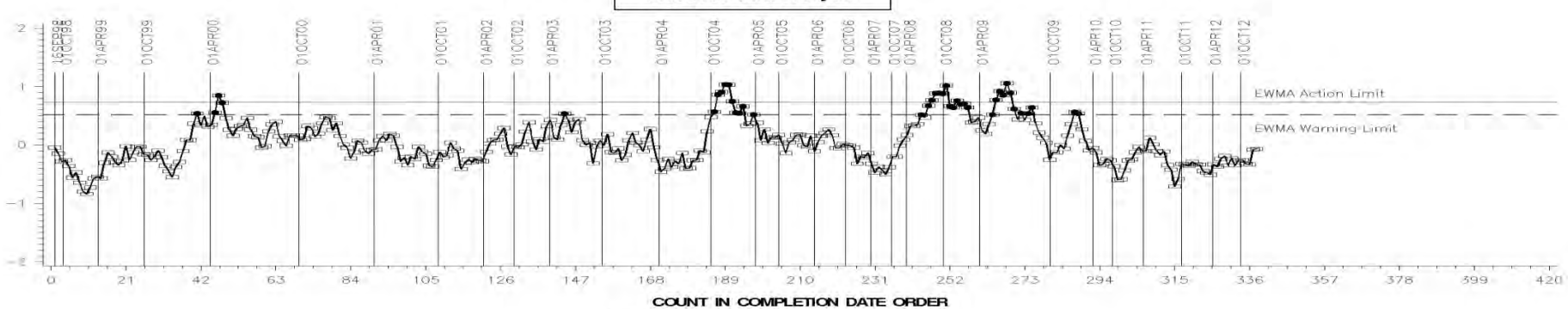
» Severity, Precision, and CuSum

AVERAGE ENGINE SLUDGE

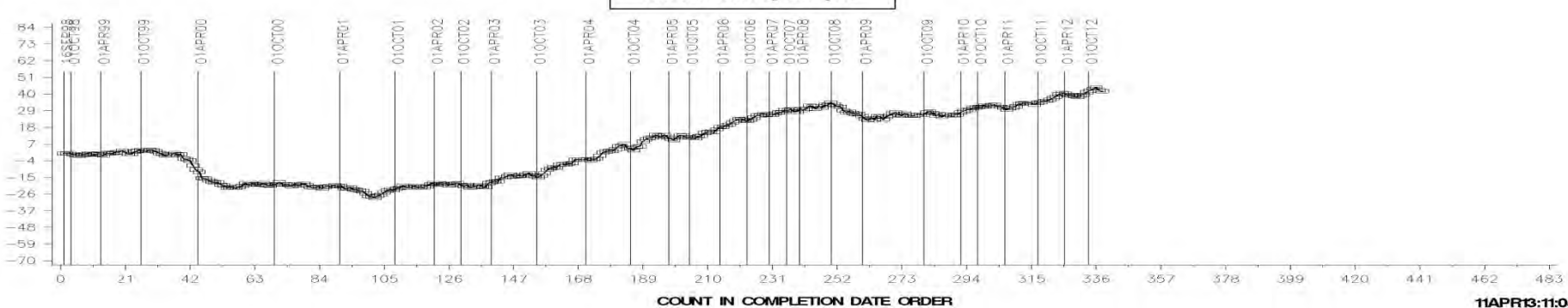
LTMS Severity Analysis



LTMS Precision Analysis

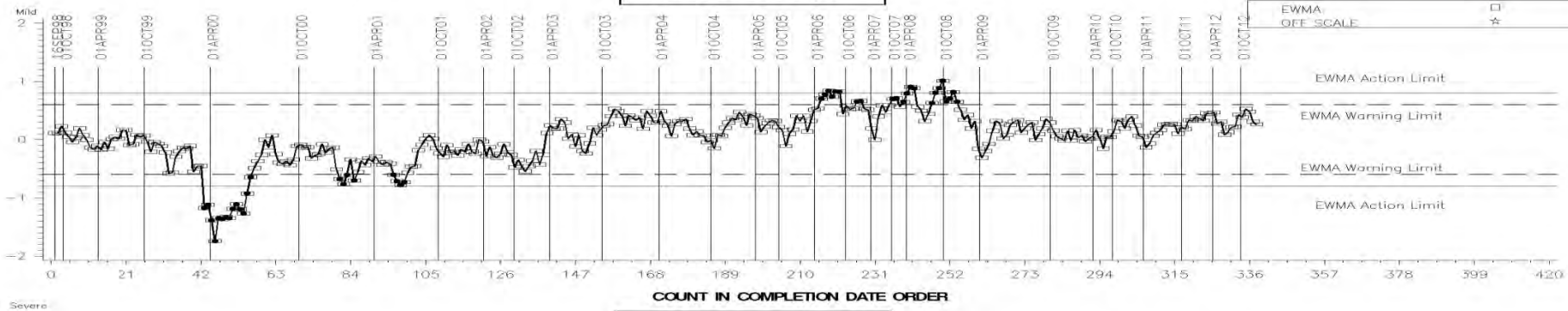


CUSUM Severity Analysis

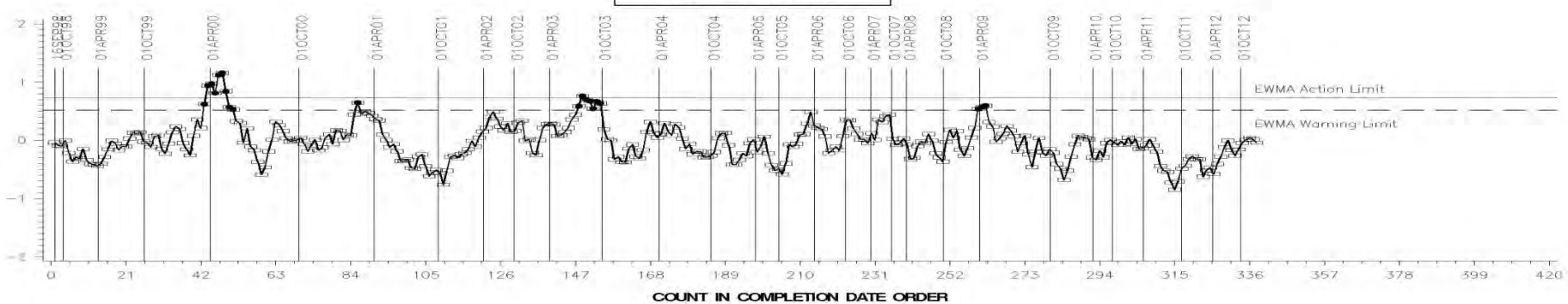


AVERAGE ROCKER COVER SLUDGE

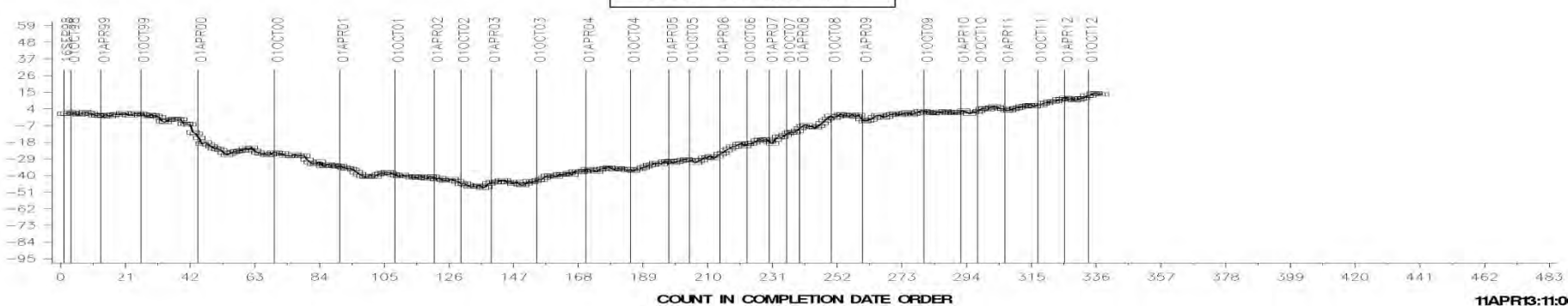
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis

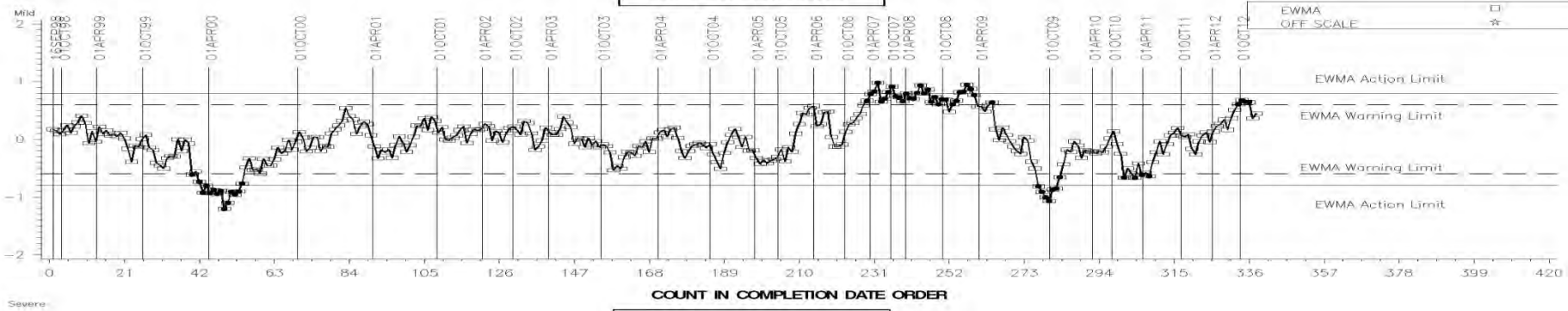




SEQUENCE VG INDUSTRY OPERATIONALLY VALID DATA

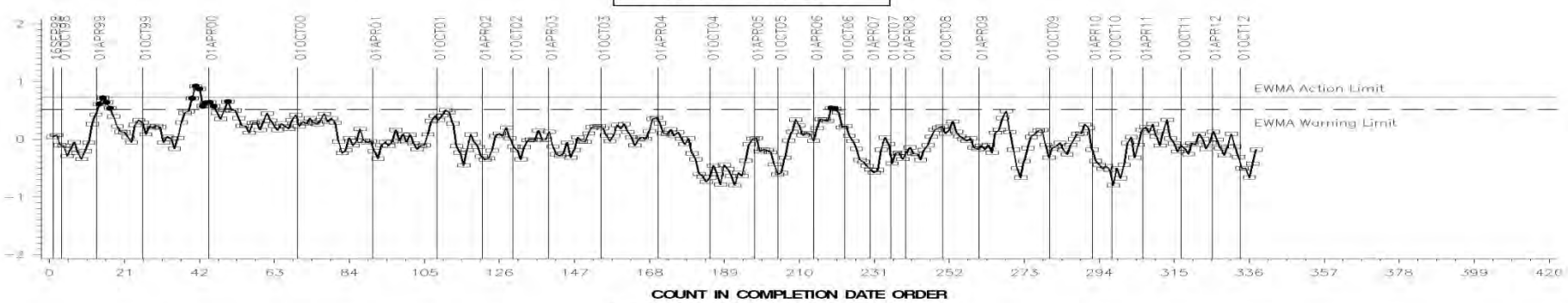
AVG. ENG. VARN. 3—PART APV + BAFFLES

LTMS Severity Analysis



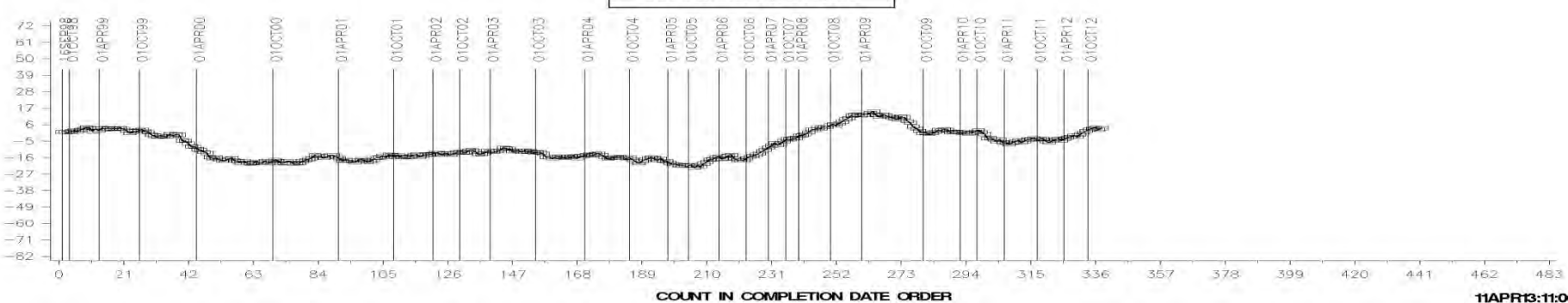
COUNT IN COMPLETION DATE ORDER

LTMS Precision Analysis



COUNT IN COMPLETION DATE ORDER

CUSUM Severity Analysis



COUNT IN COMPLETION DATE ORDER

11APR13:11:06



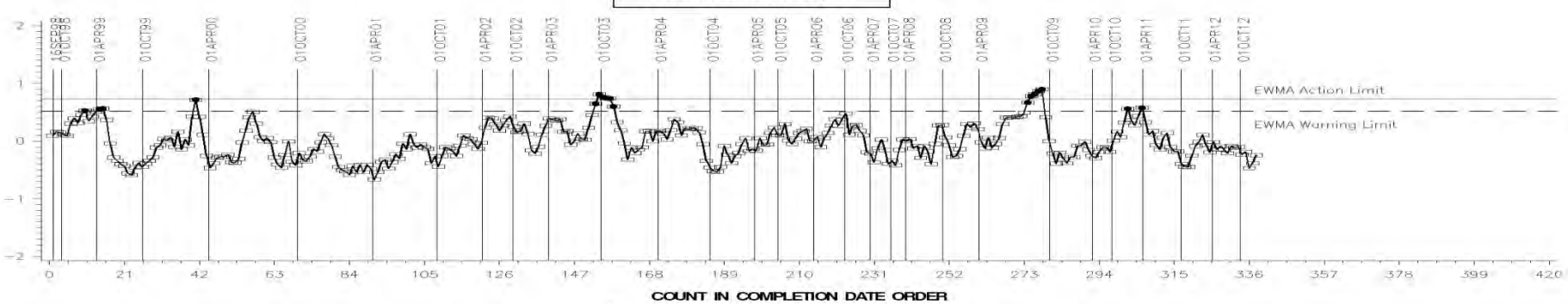
AVG PISTON SKIRT RATING

LTMS Severity Analysis



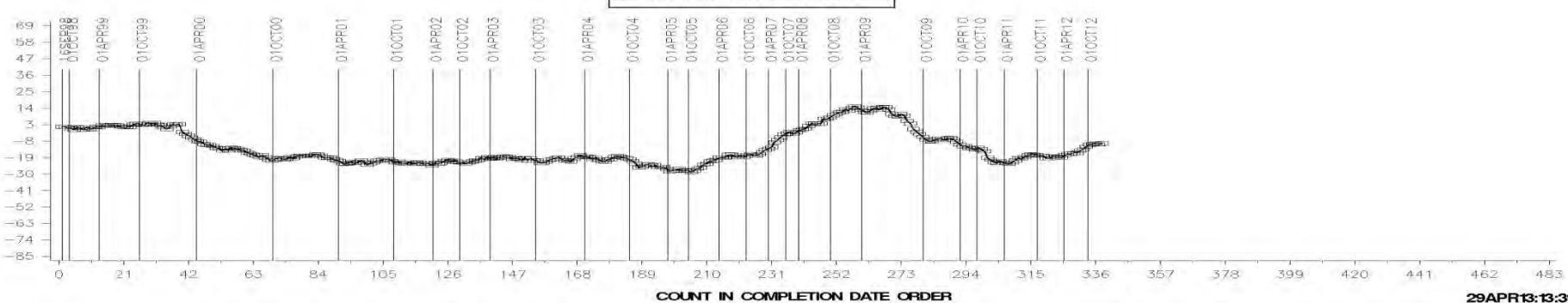
COUNT IN COMPLETION DATE ORDER

LTMS Precision Analysis



COUNT IN COMPLETION DATE ORDER

CUSUM Severity Analysis

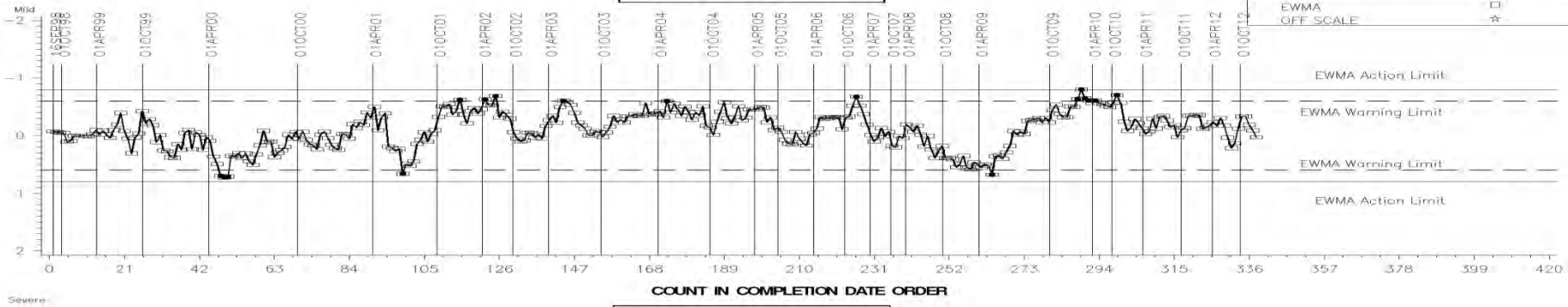


COUNT IN COMPLETION DATE ORDER

29APR13:13:39

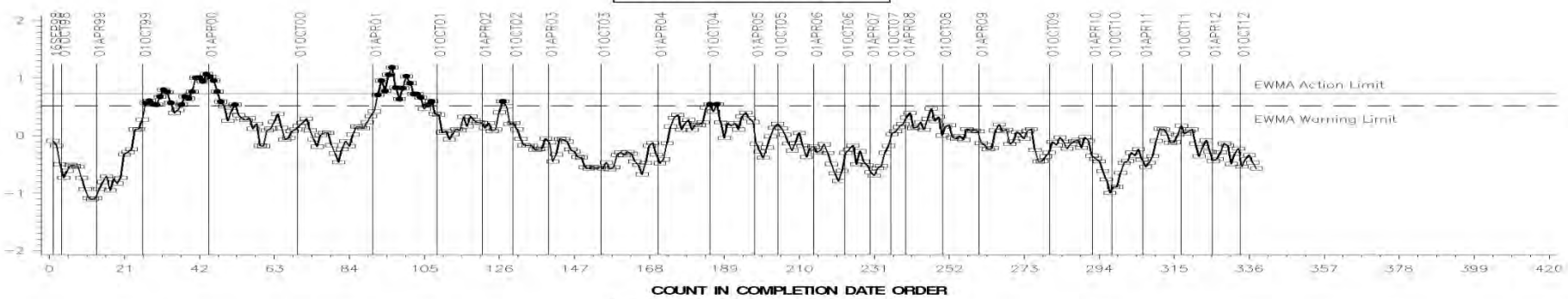
OIL SCREEN SLUDGE

LTMS Severity Analysis



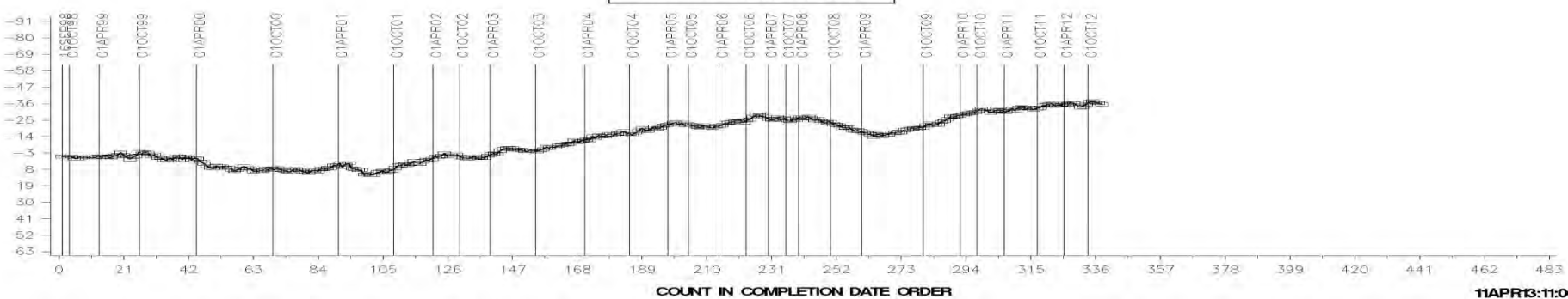
COUNT IN COMPLETION DATE ORDER

LTMS Precision Analysis



COUNT IN COMPLETION DATE ORDER

CUSUM Severity Analysis



COUNT IN COMPLETION DATE ORDER

11APR13:11:06

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# Appendix 1.e

## Sequence VID Control Charts

» Severity, Precision, and CuSum

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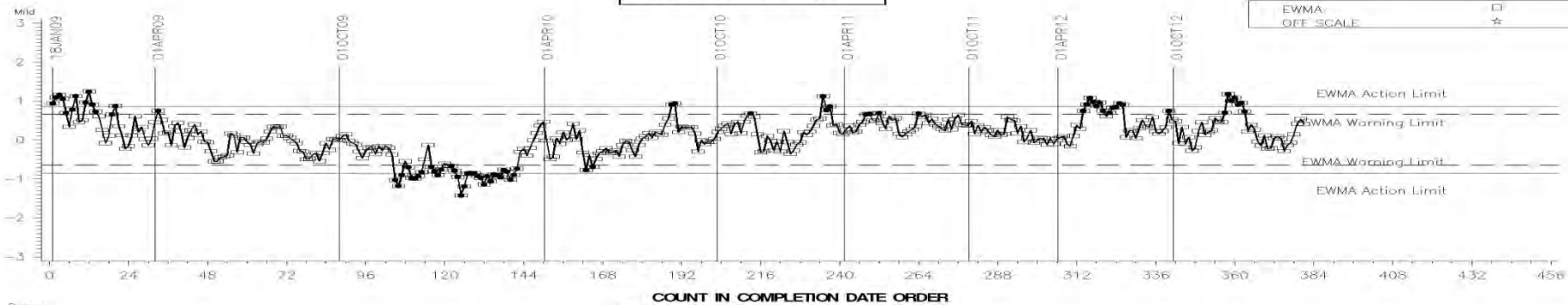


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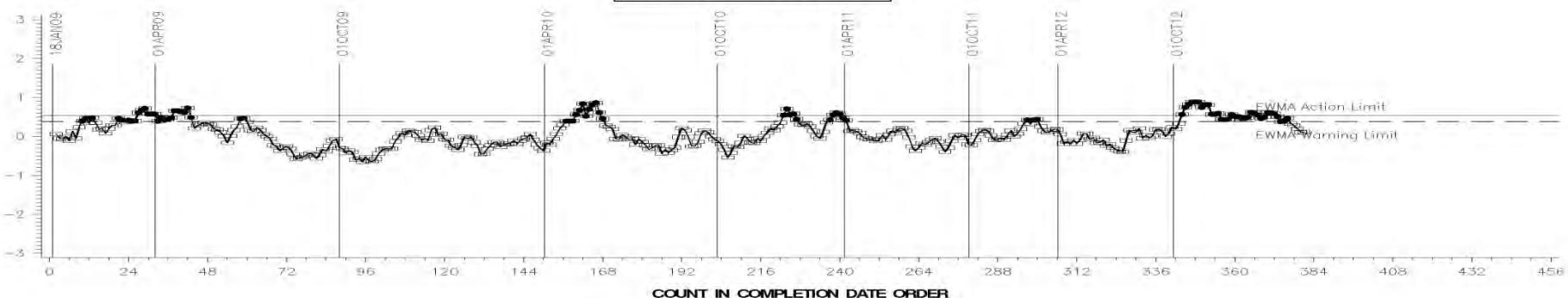
FEI FINAL RESULT PHASE I

LTMS Severity Analysis



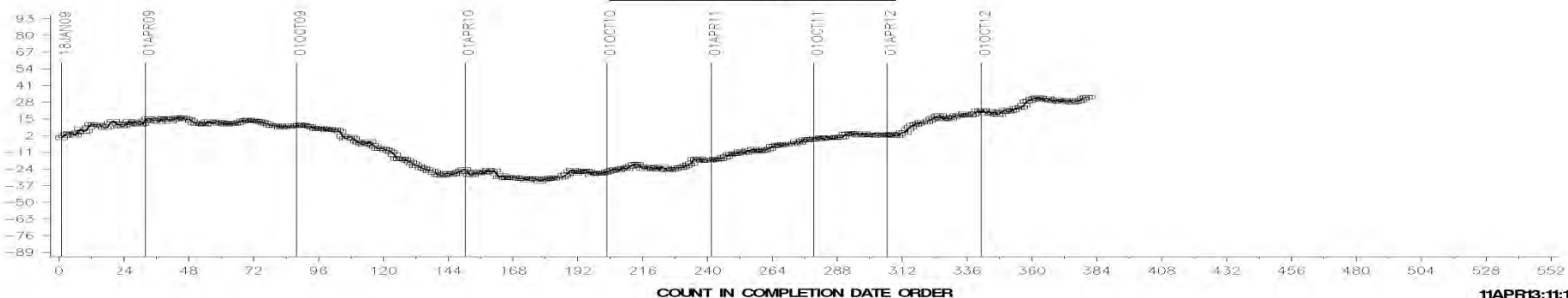
COUNT IN COMPLETION DATE ORDER

LTMS Precision Analysis



COUNT IN COMPLETION DATE ORDER

CUSUM Severity Analysis

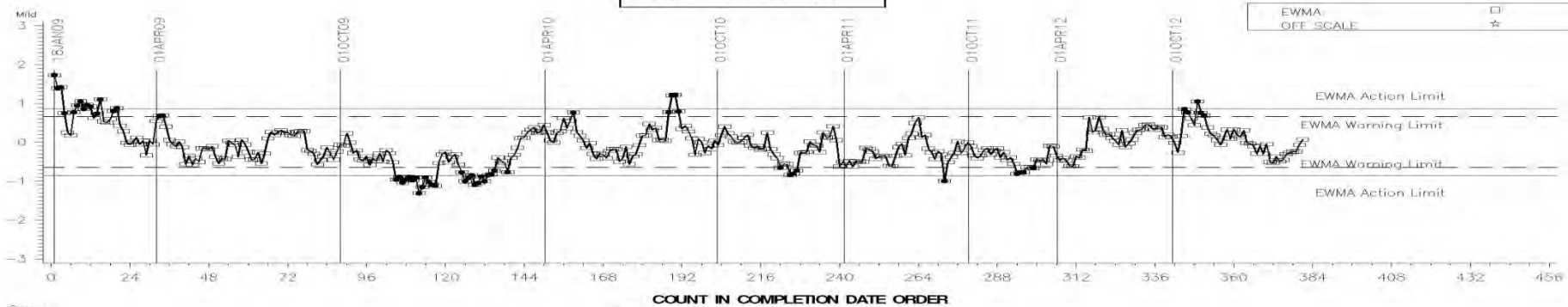


COUNT IN COMPLETION DATE ORDER

11APR13:11:14

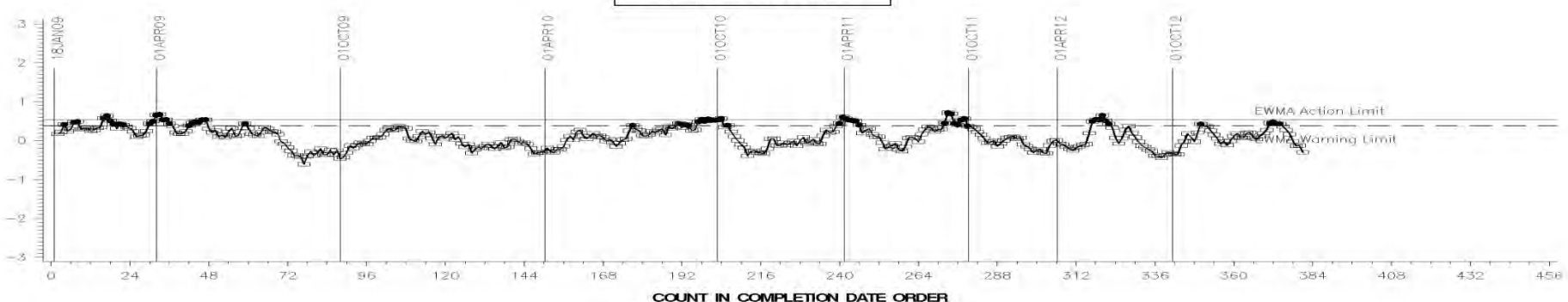
FEI FINAL RESULT PHASE II

LTMS Severity Analysis



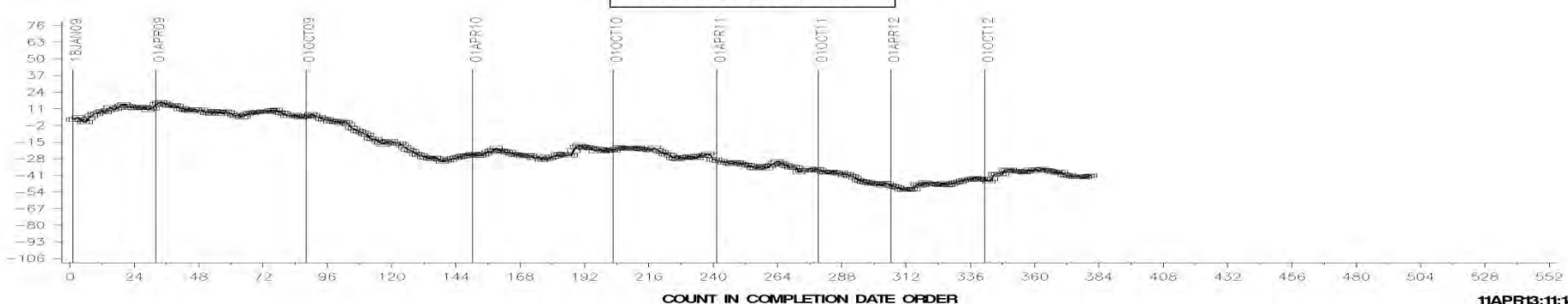
COUNT IN COMPLETION DATE ORDER

LTMS Precision Analysis



COUNT IN COMPLETION DATE ORDER

CUSUM Severity Analysis



COUNT IN COMPLETION DATE ORDER

11APR13:11:14

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# Appendix 1.f

## Sequence VIII Control Charts

» Severity, Precision, and CuSum

Test Monitoring Center

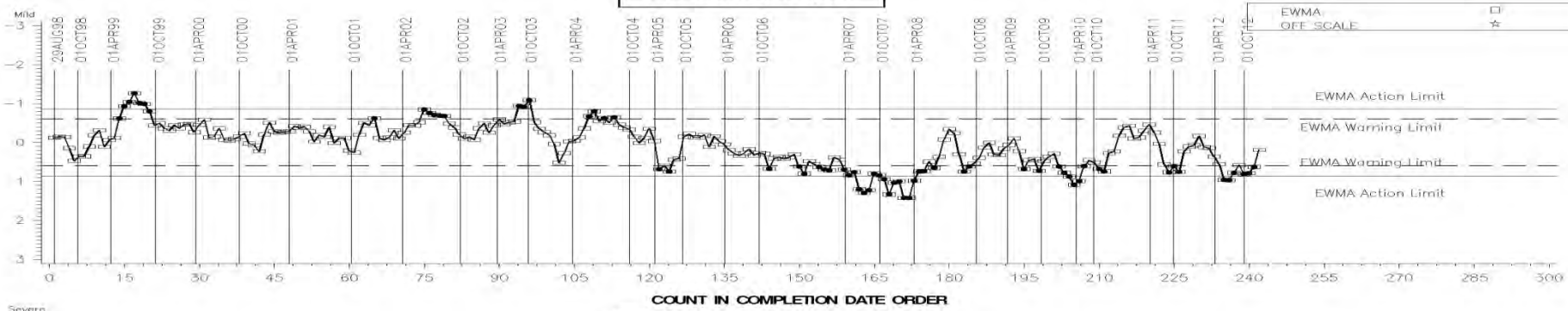
<http://astmtmc.cmu.edu>



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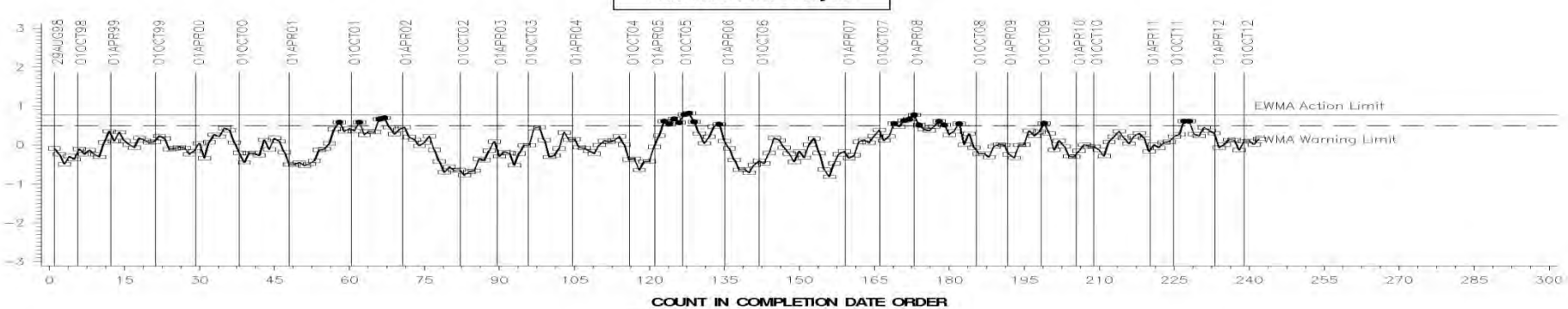
FINAL BEARING WEIGHT LOSS

LTMS Severity Analysis



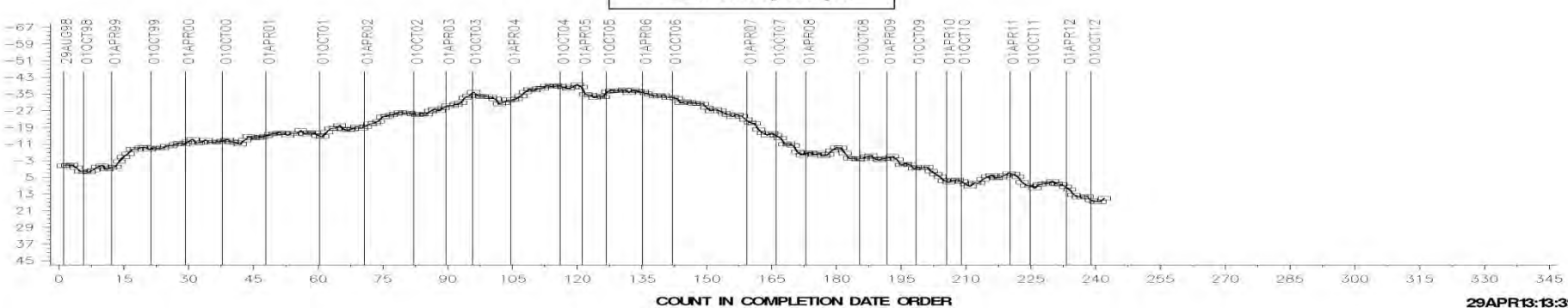
COUNT IN COMPLETION DATE ORDER

LTMS Precision Analysis



COUNT IN COMPLETION DATE ORDER

CUSUM Severity Analysis



COUNT IN COMPLETION DATE ORDER

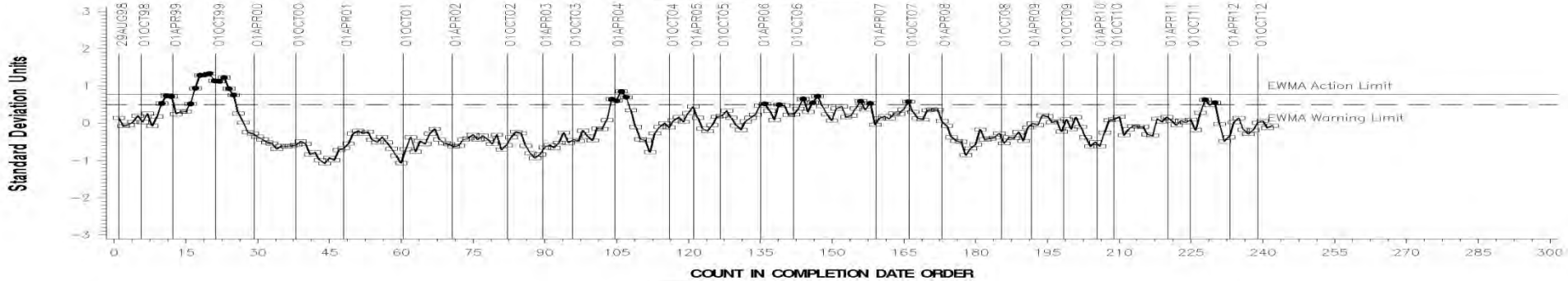


STRIPPED VIS. @ 100 DEG C

LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis

