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Test Monitoring Center

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ASTM D02.B1 Semiannual Report Passenger Car Reference Oil Testing

April 2017

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Passenger Car Engine Oil Testing Executive Summary

▶ Seq. III

- IIIH Batch Code 4 pistons became available in March.

▶ Seq. VI

- One calibrated stand/engine combination remains for Sequence VID Testing
- Monitoring of the VIF Test began in March, no calibration attempts reported this period.

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Calibrated Labs and Stands*

Test	Labs	Stands
IIIF	3	4
IIIG/A/B	3	8
IIIH/A/B	5	8
IVA	3	4
VG	3	5
VID	1	1
VIE	5	14
VIII	2	4

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*As of 3/31/2017

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Sequence III F

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Sequence IIF Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	6
Failed Calibration Test	OC	1
Aborted	XC	1
Total		8

Sequence III F – Failed Tests

Test Status	Number of Tests
Stand Precision EWMA Alarm, Hours to 275% Viscosity Increase	1
Total	1

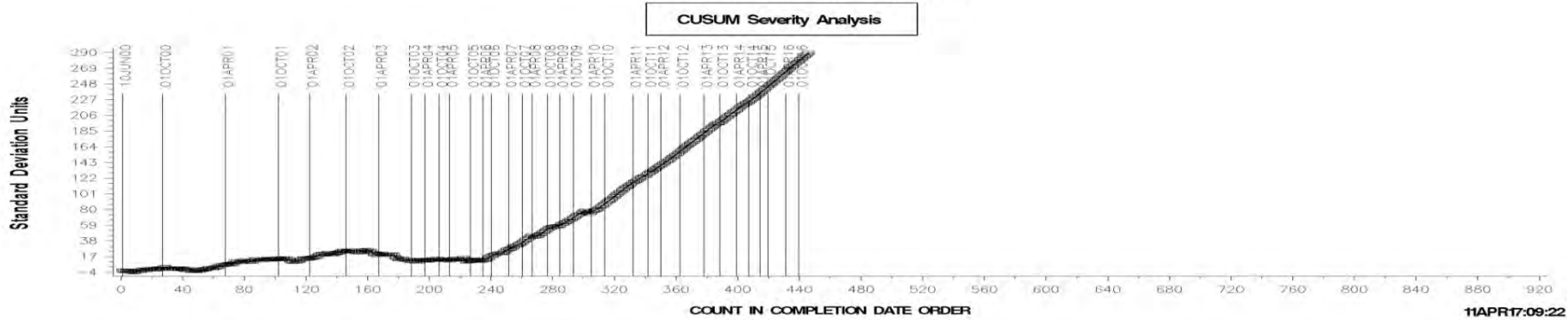
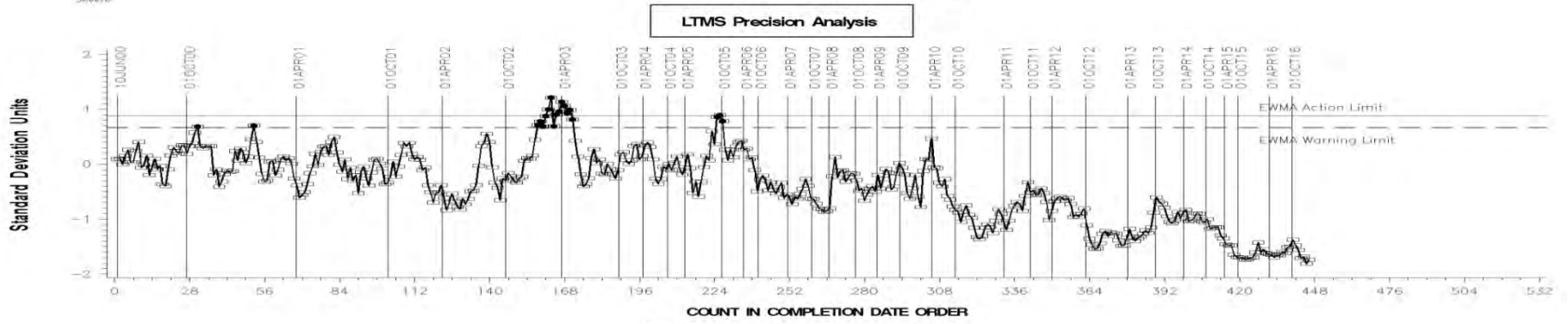
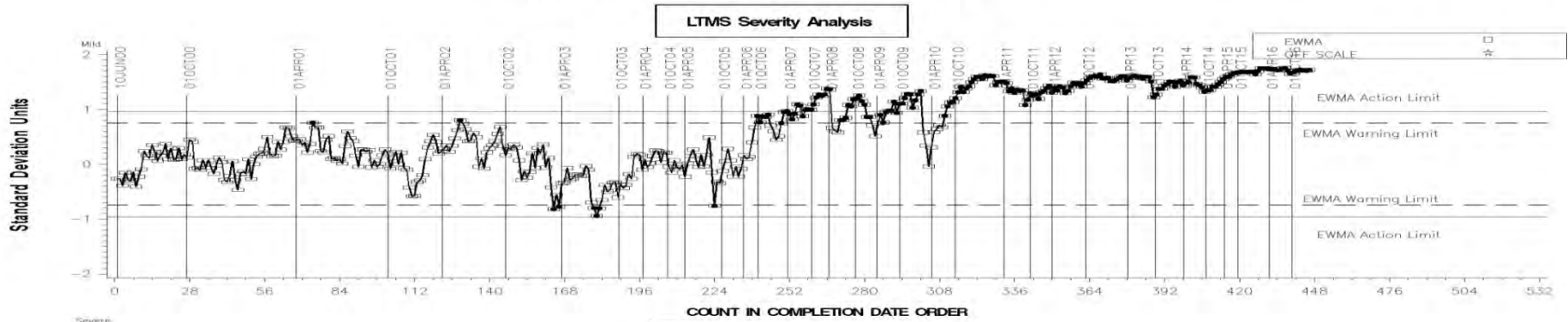
Sequence III F – Lost Tests

Test Status	Number of Tests
High Oil Consumption	1
Total	1

Sequence IIF Test Severity

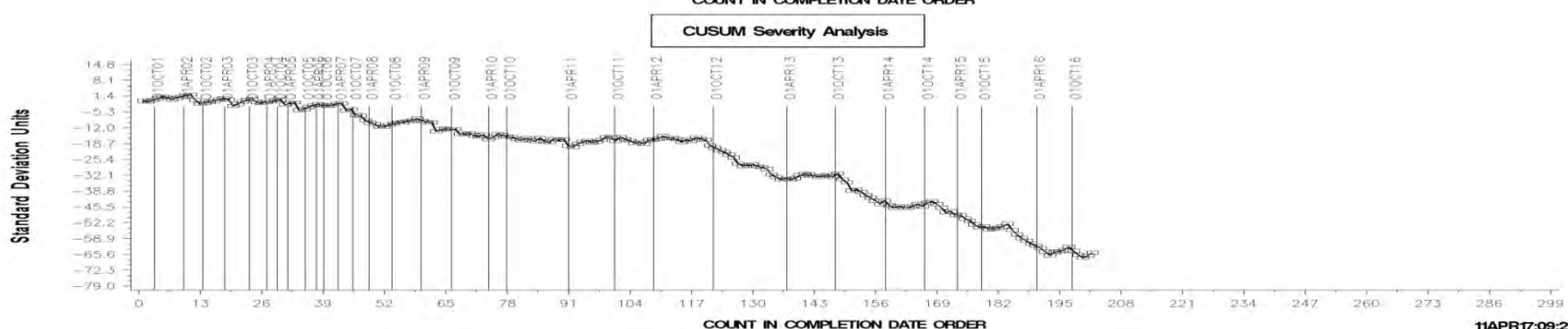
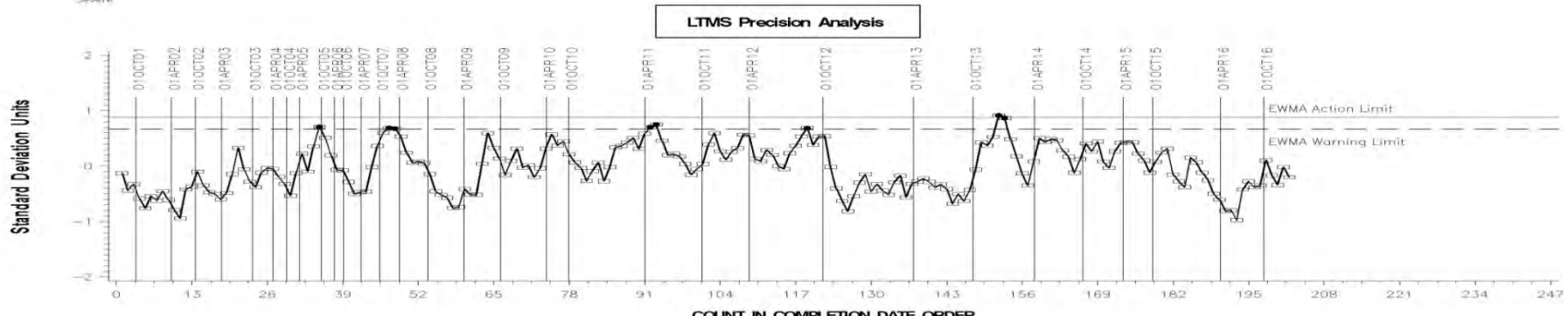
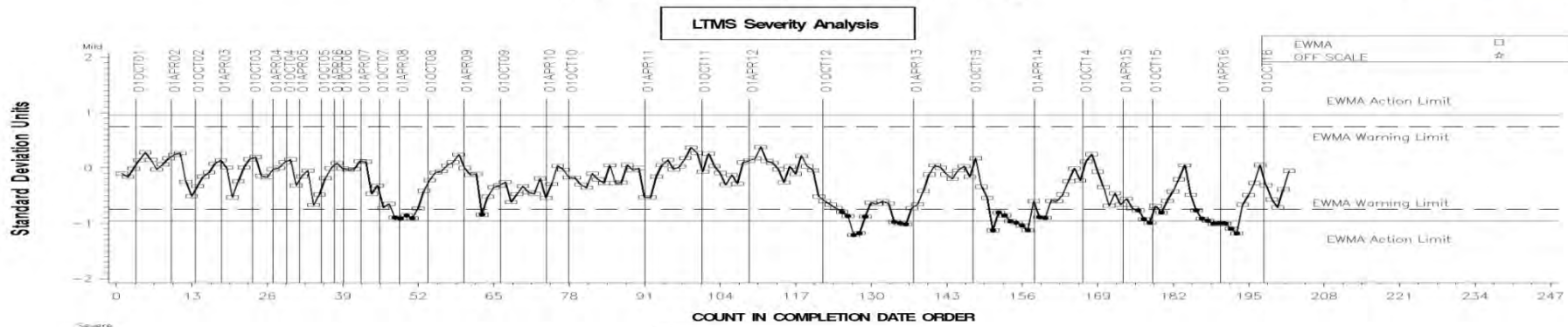
- APV
 - In severity action alarm, mild
 - Long-term mild trend continuing (Since October 2006)
- Hours to 275% Vis Increase
 - In control
- WPD
 - In control
- PV60
 - In severity action alarm (severe)

AVERAGE PISTON SKIRT VARNISH FINAL ORIG UNIT RES



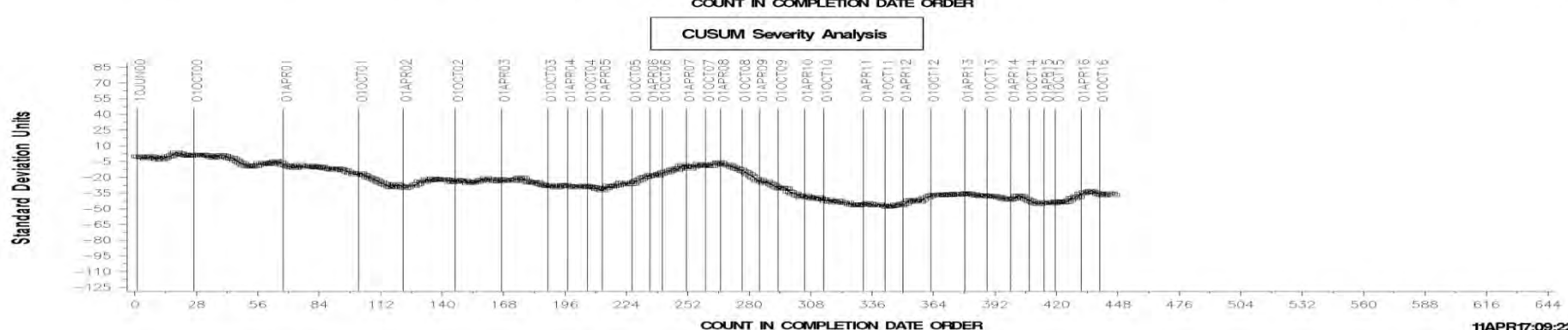
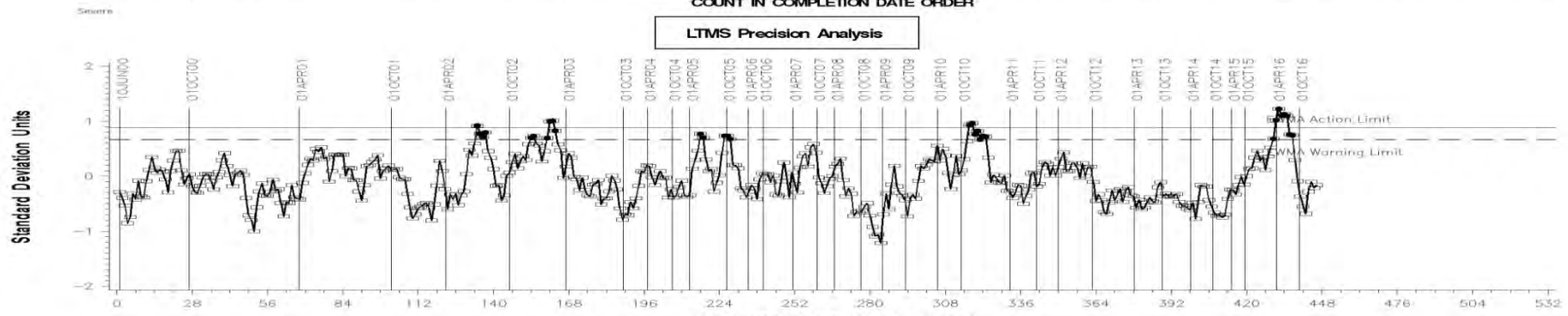
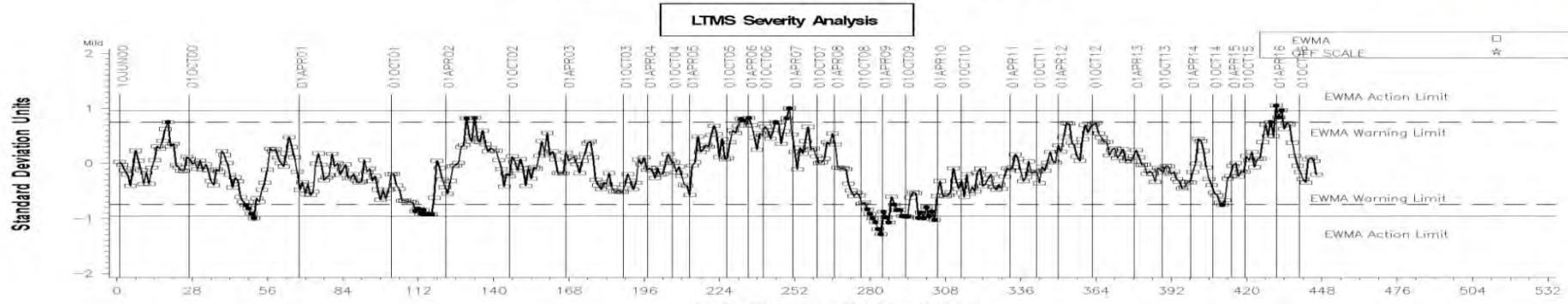
11APR17:09:22

HOURS FINAL ORIG RES (REFERENCE TESTS ONLY)



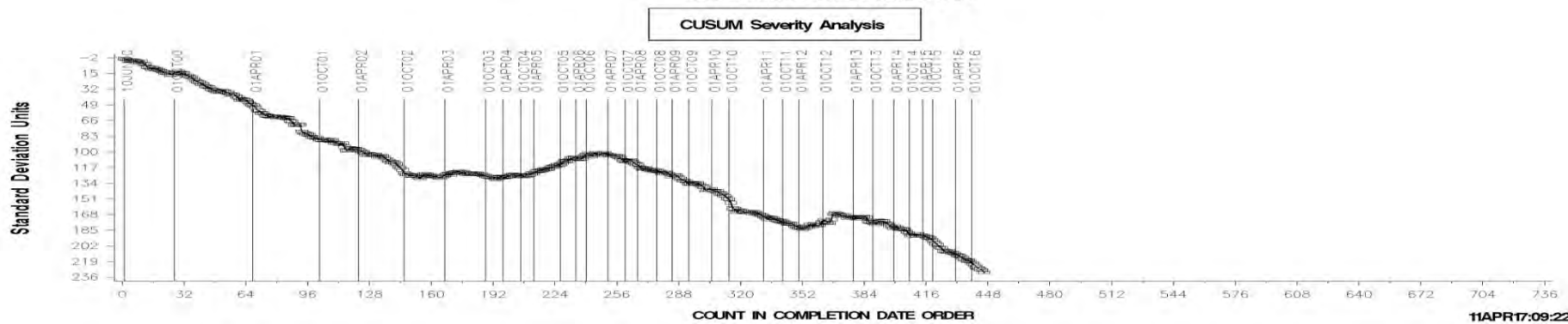
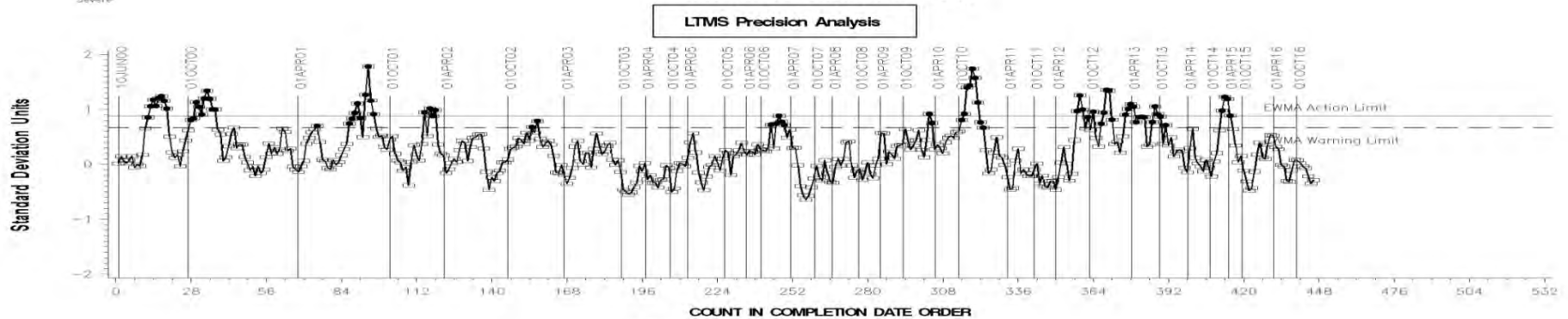
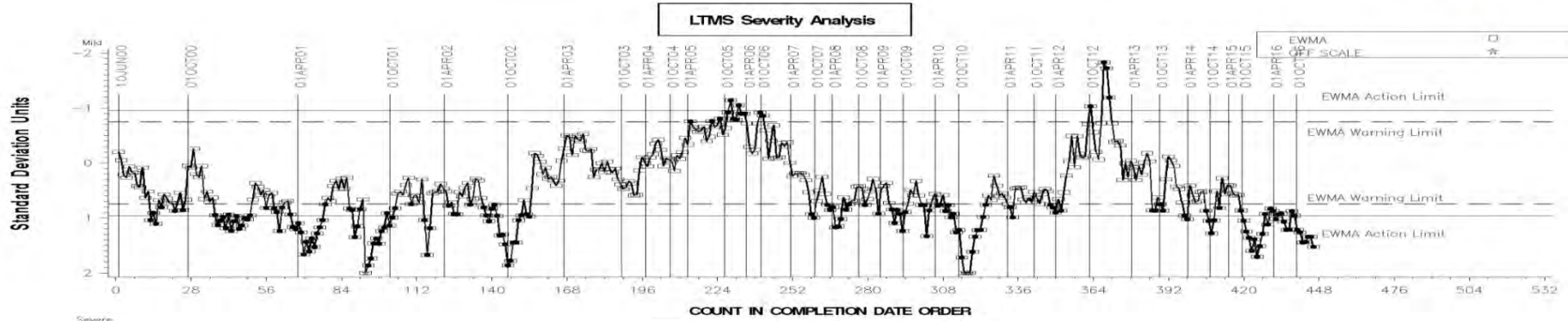
11APR17:09:22

AVERAGE WEIGHTED PISTON DEPOSITS FNL ORIG UNIT RES



11APR17:09:22

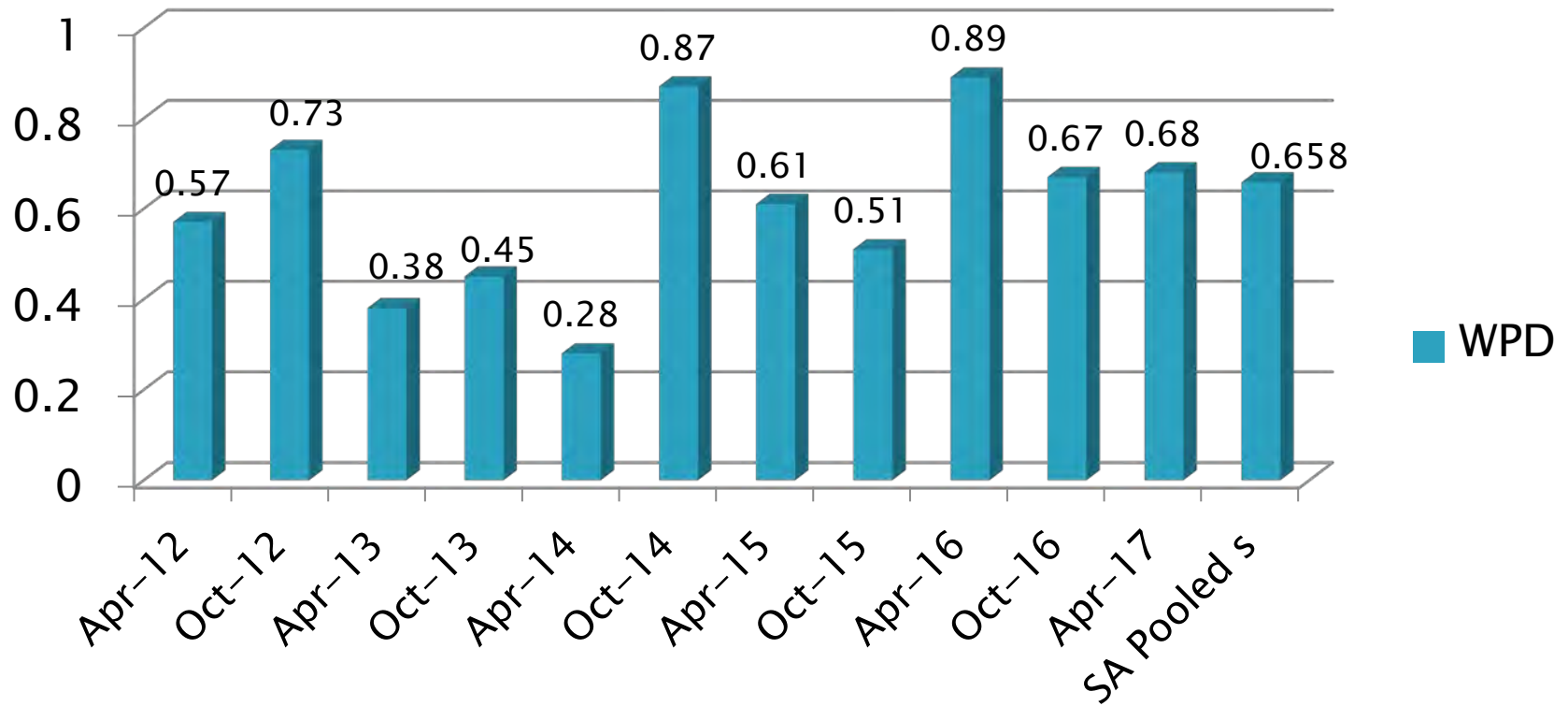
% VISCOSITY INCREASE @ 060 HOURS



11APR17:09:22

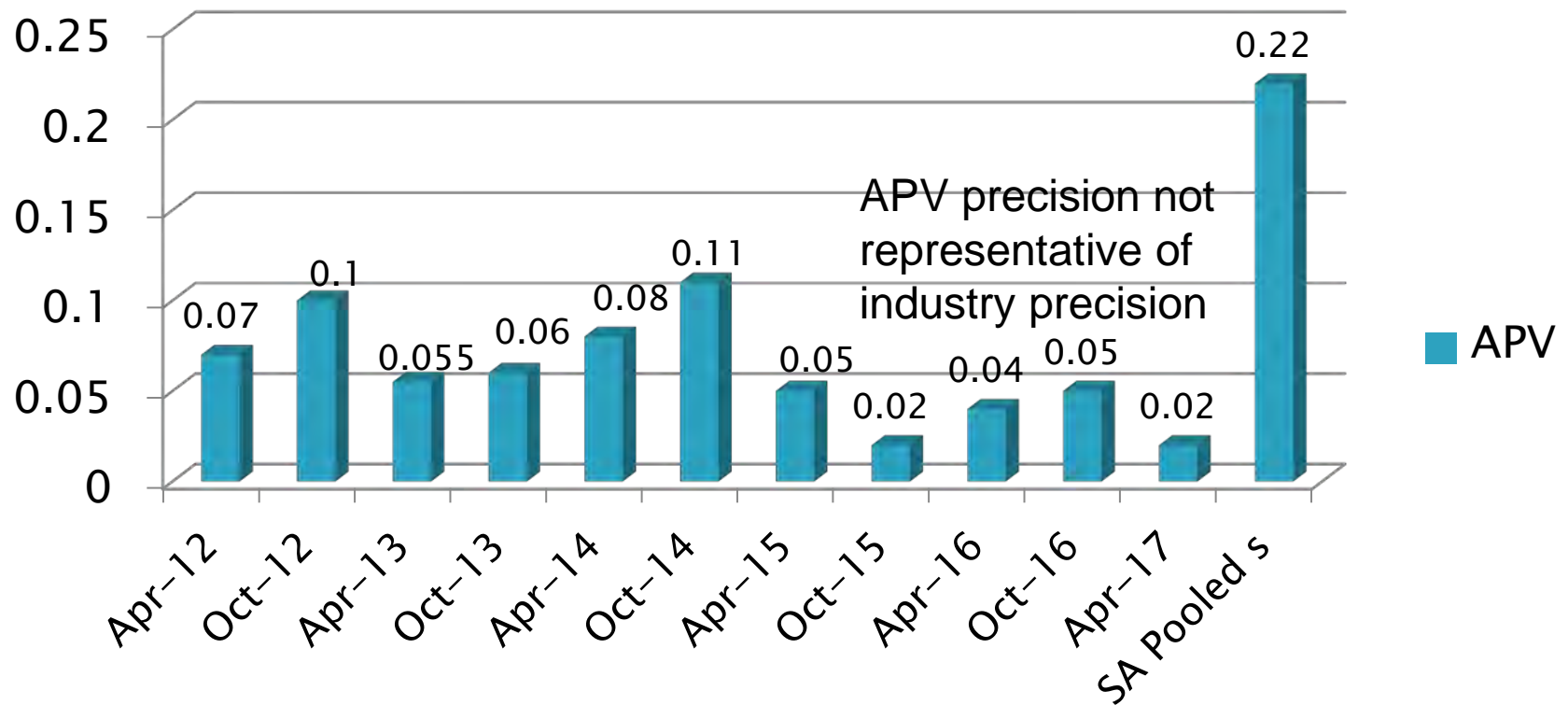
IIIF Precision Estimates

WPD



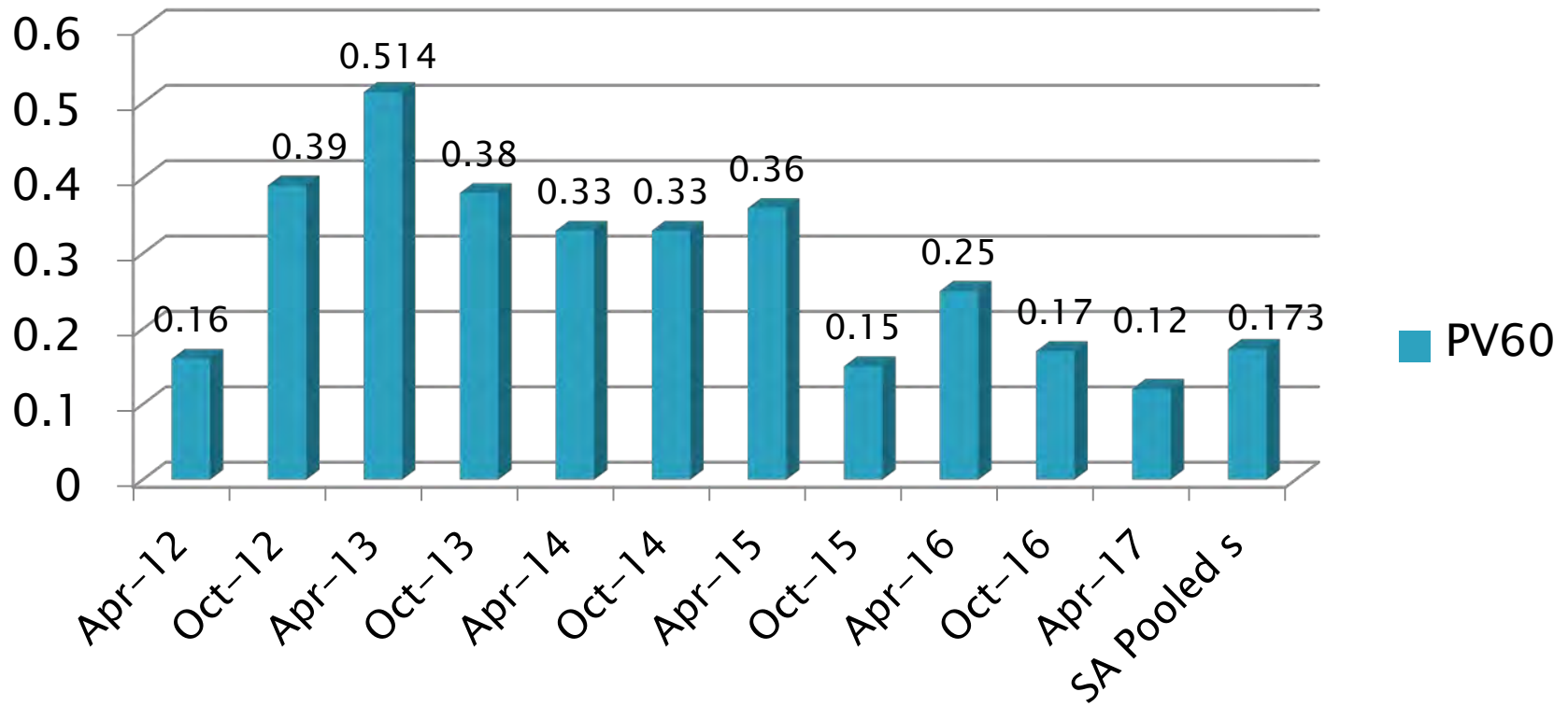
IIIF Precision Estimates

APV



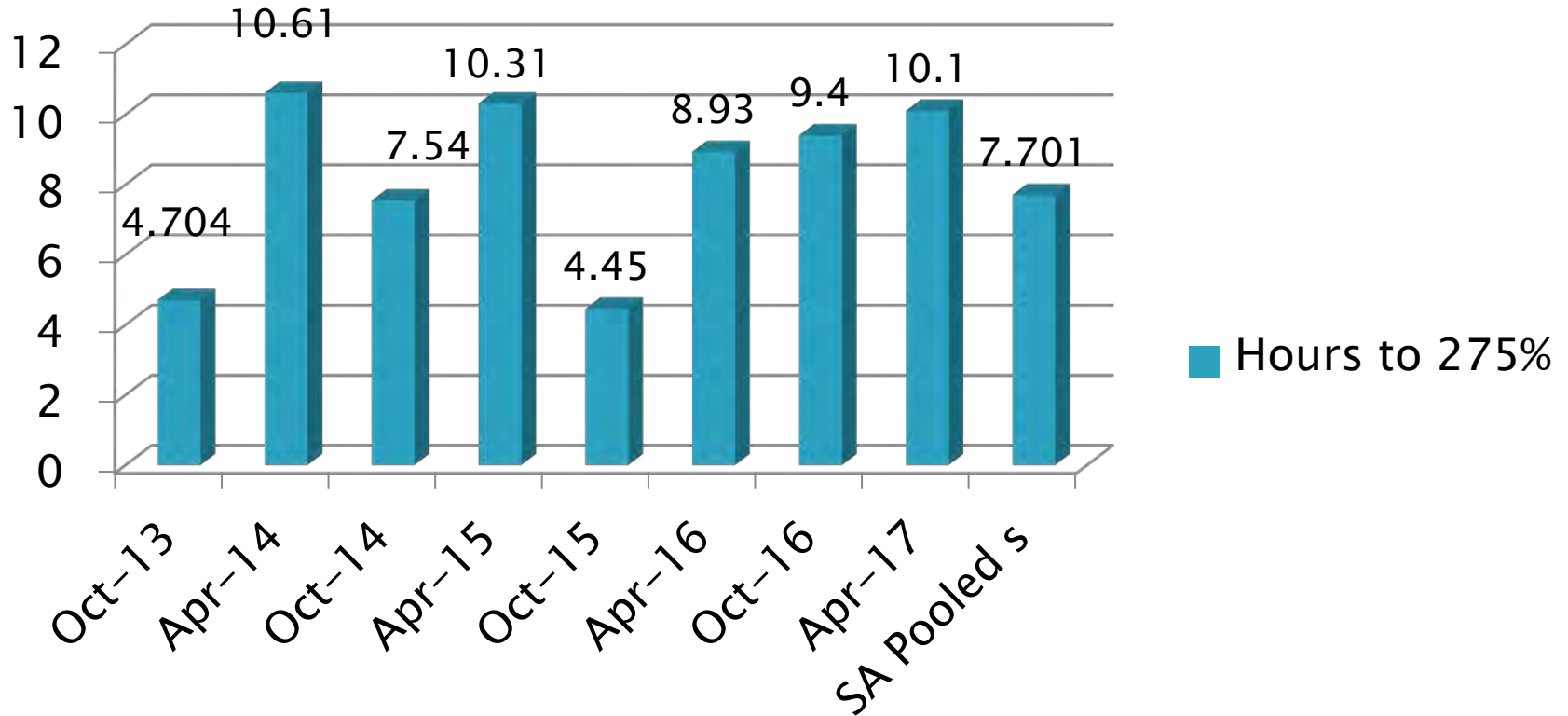
IIIF Precision Estimates

PV60



IIIF Precision Estimates

Hours to 275%



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Sequence IIIG/A/B

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Sequence IIIG Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	6
Statistically Unacceptable Calibration Test	OC	1
Aborted	XC	2
Total		9

Sequence IIIG – Lost Tests*

Test Status	Cause	#
Aborted	Unable to maintain oil temperature	1
Aborted	Coolant temperature control issues	1
Totals		2

*Invalid and aborted tests

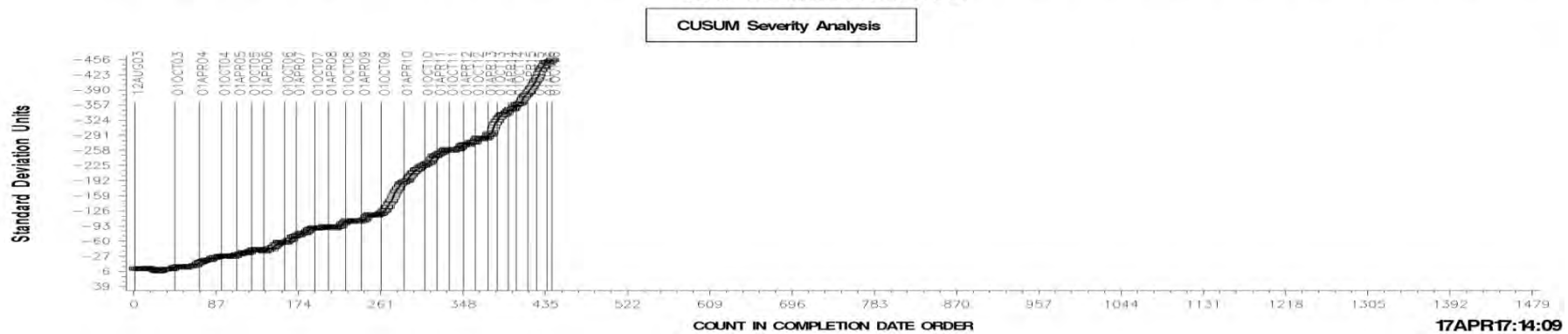
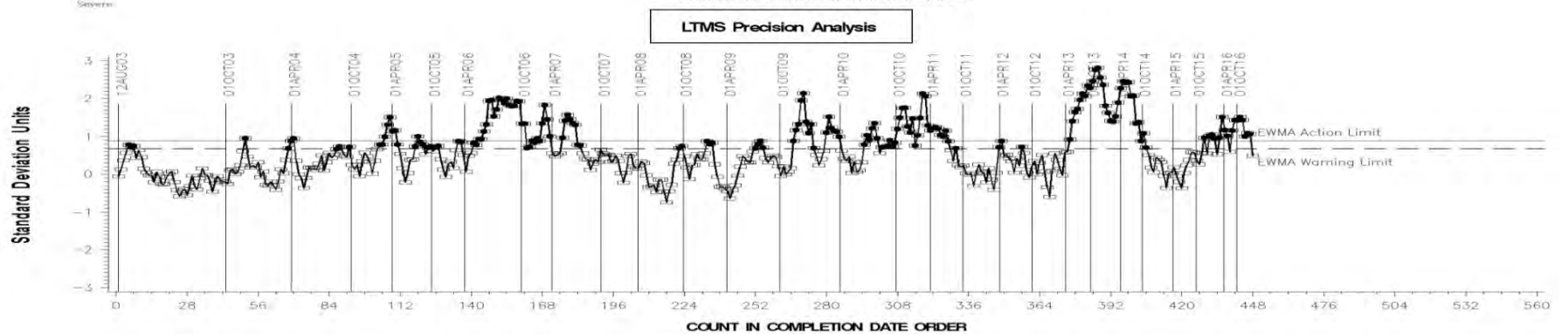
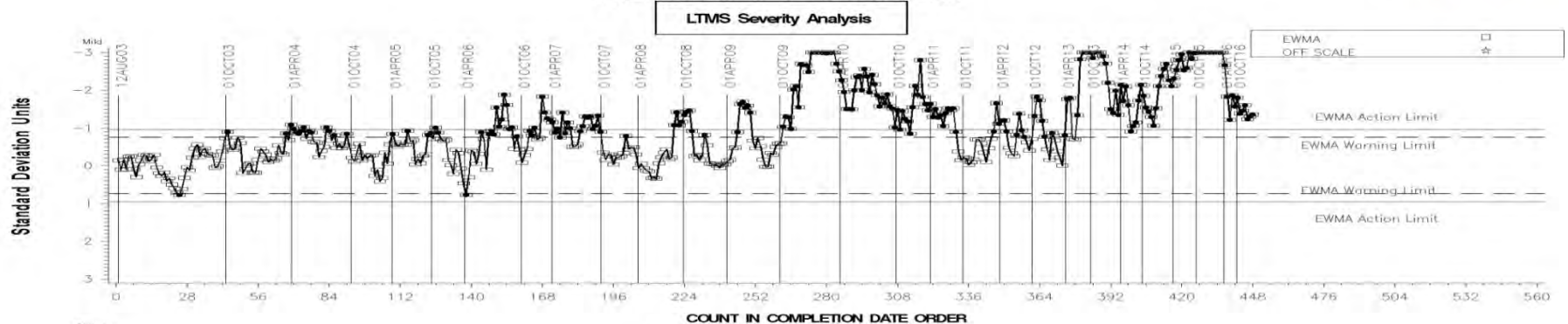
Sequence III G – Failed Tests

Test Status	#
Severe PVIS	1
Totals	1

Sequence IIIG Test Severity

- ACLW in severity action alarm
 - Long-term mild trend
- PVIS in precision action alarm
- WPD is in control
 - Long-term severe trend continuing
- MRV is in control
 - Long-term severe trend continuing
- PHOS is in control

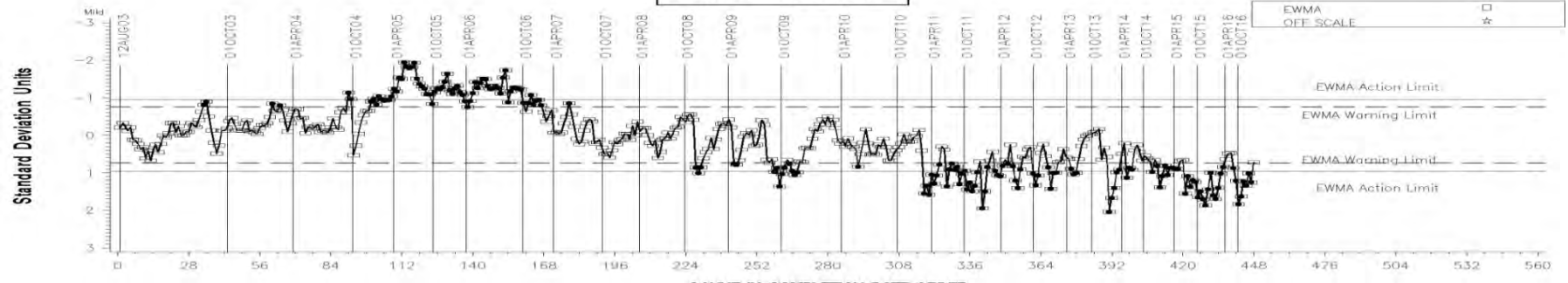
AVERAGE CAM + LIFTER WEAR



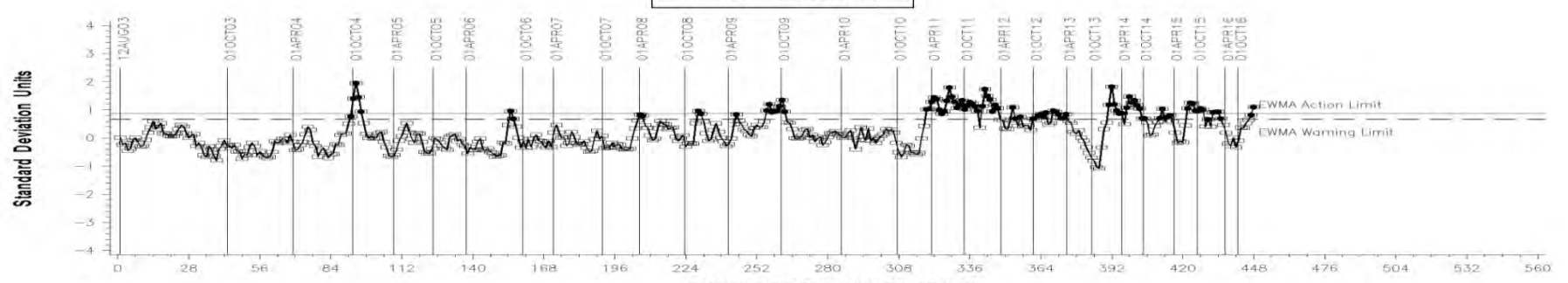
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VISCOSITY INCREASE

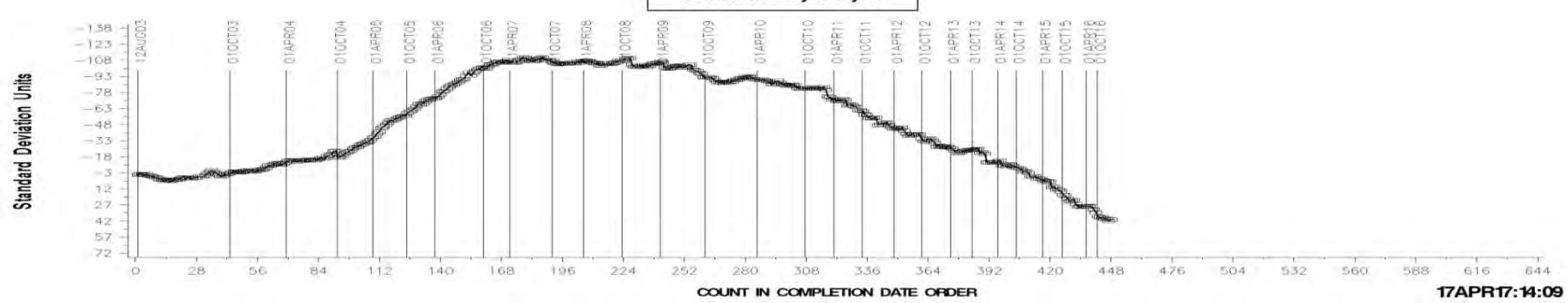
LTMS Severity Analysis



LTMS Precision Analysis

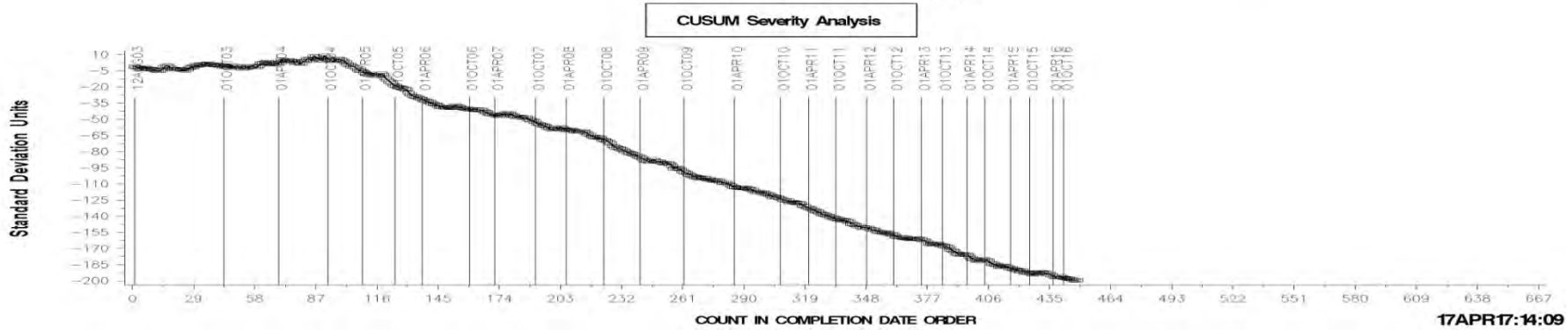
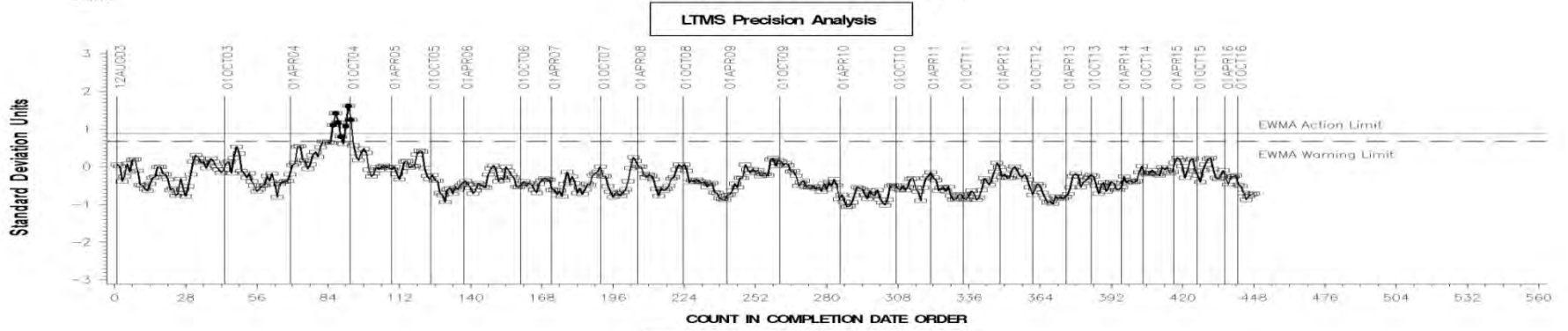
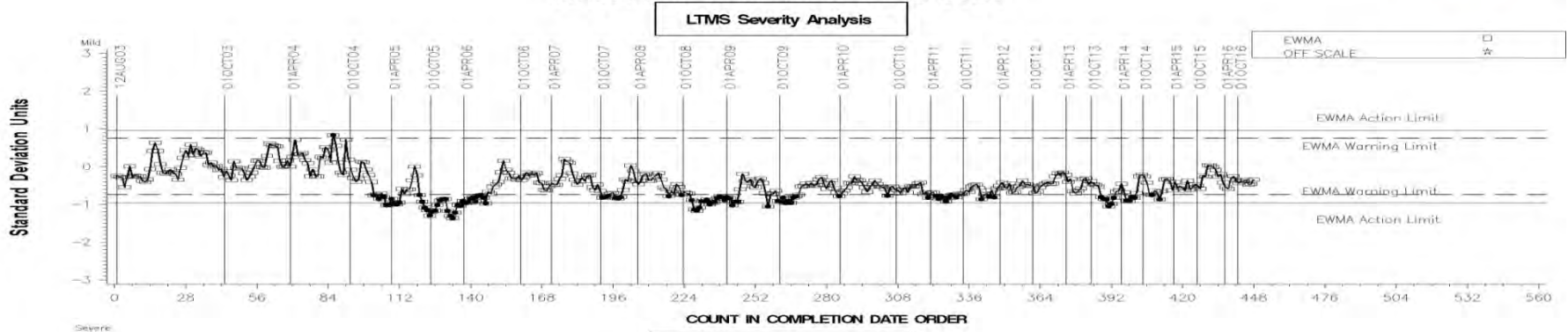


CUSUM Severity Analysis



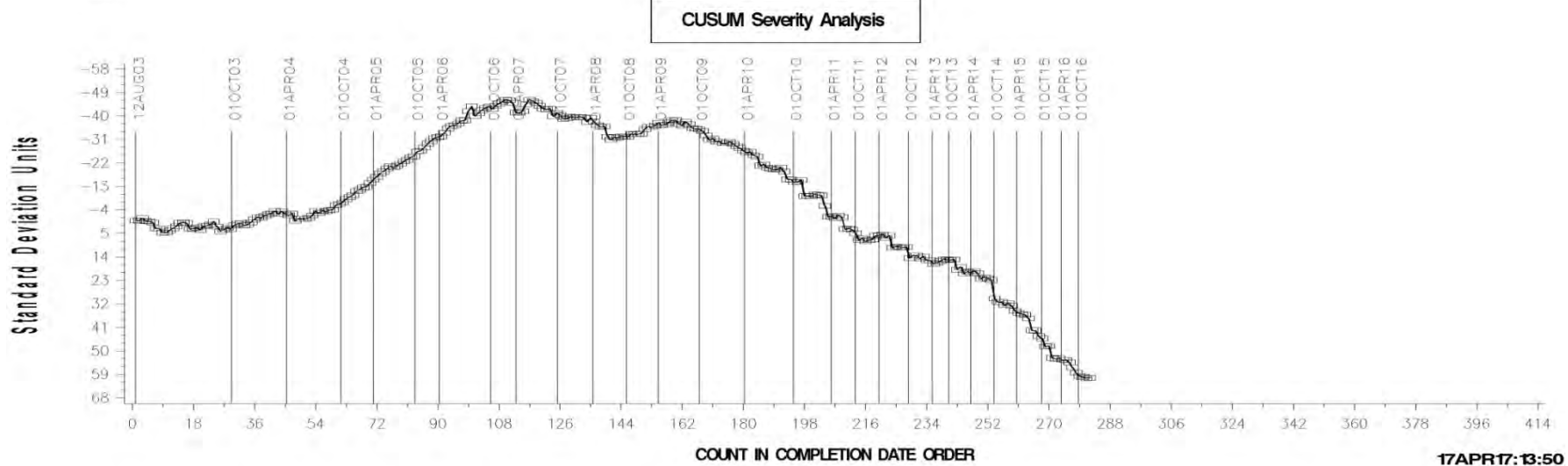
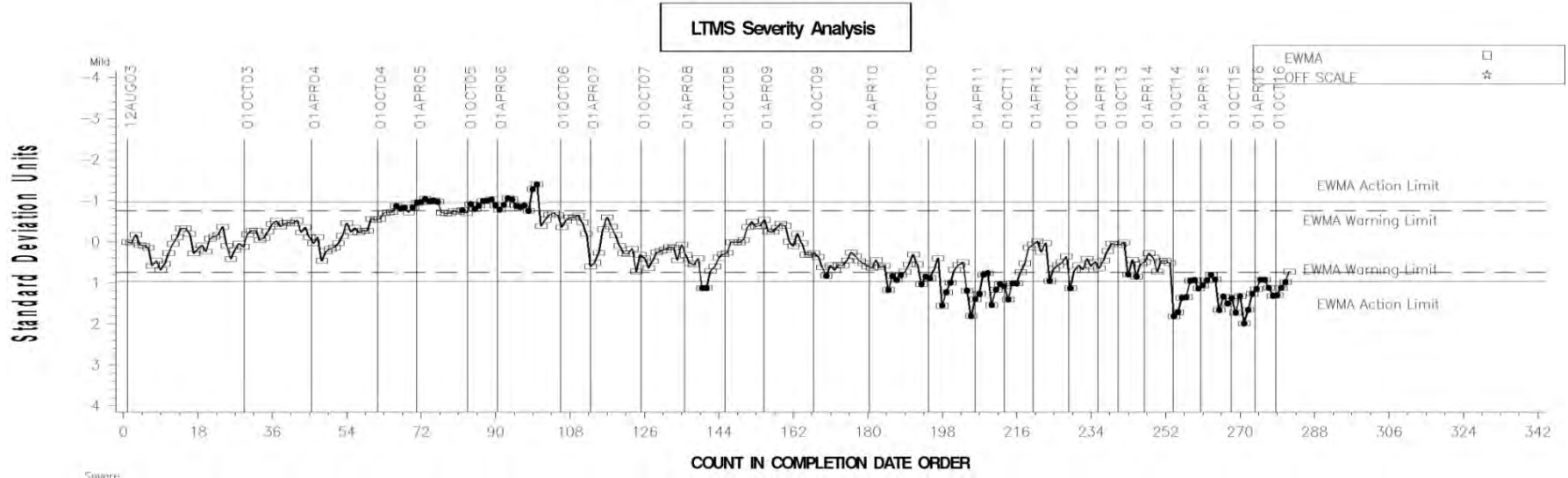
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AVERAGE WEIGHTED PISTON DEPOSITS



17/4PR17:14:09

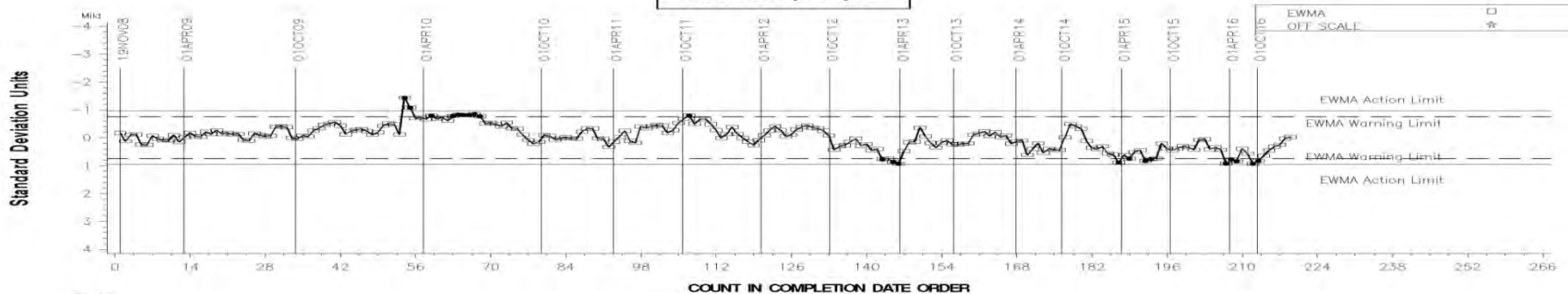
MRV VISCOSITY RESULT



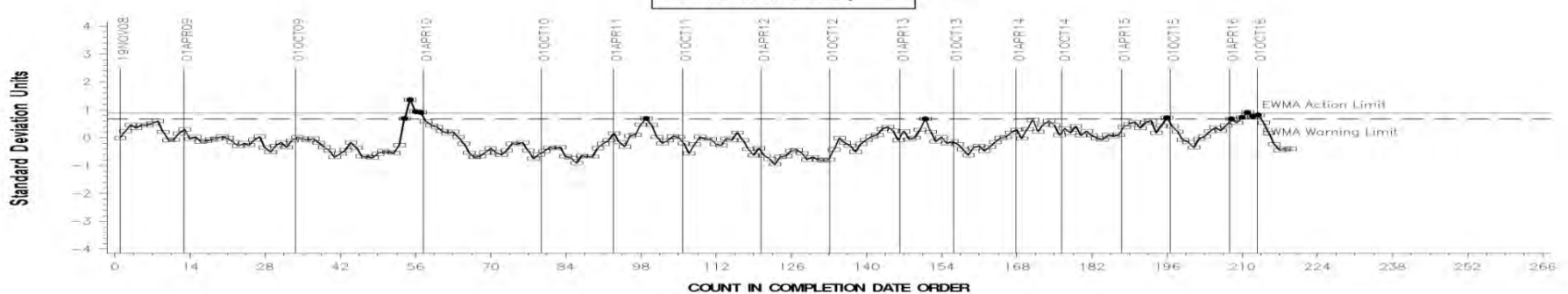
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PHOS RETENTION

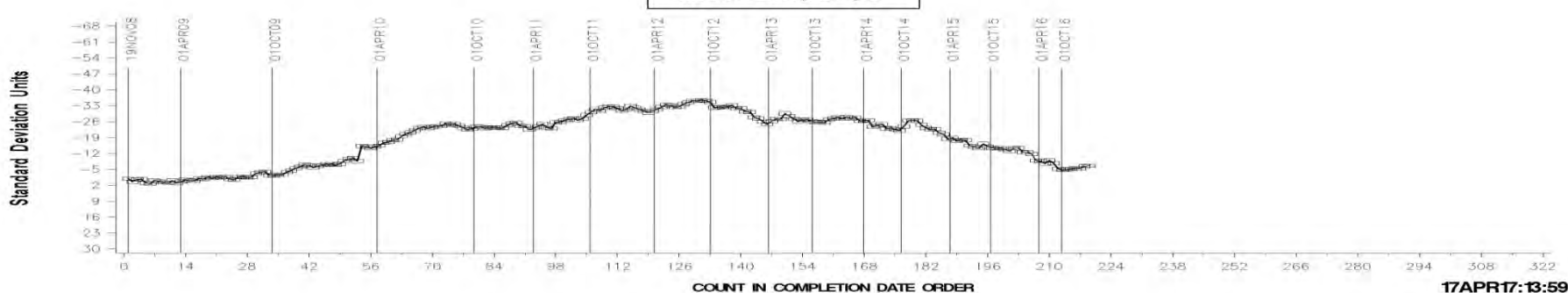
LTMS Severity Analysis



LTMS Precision Analysis

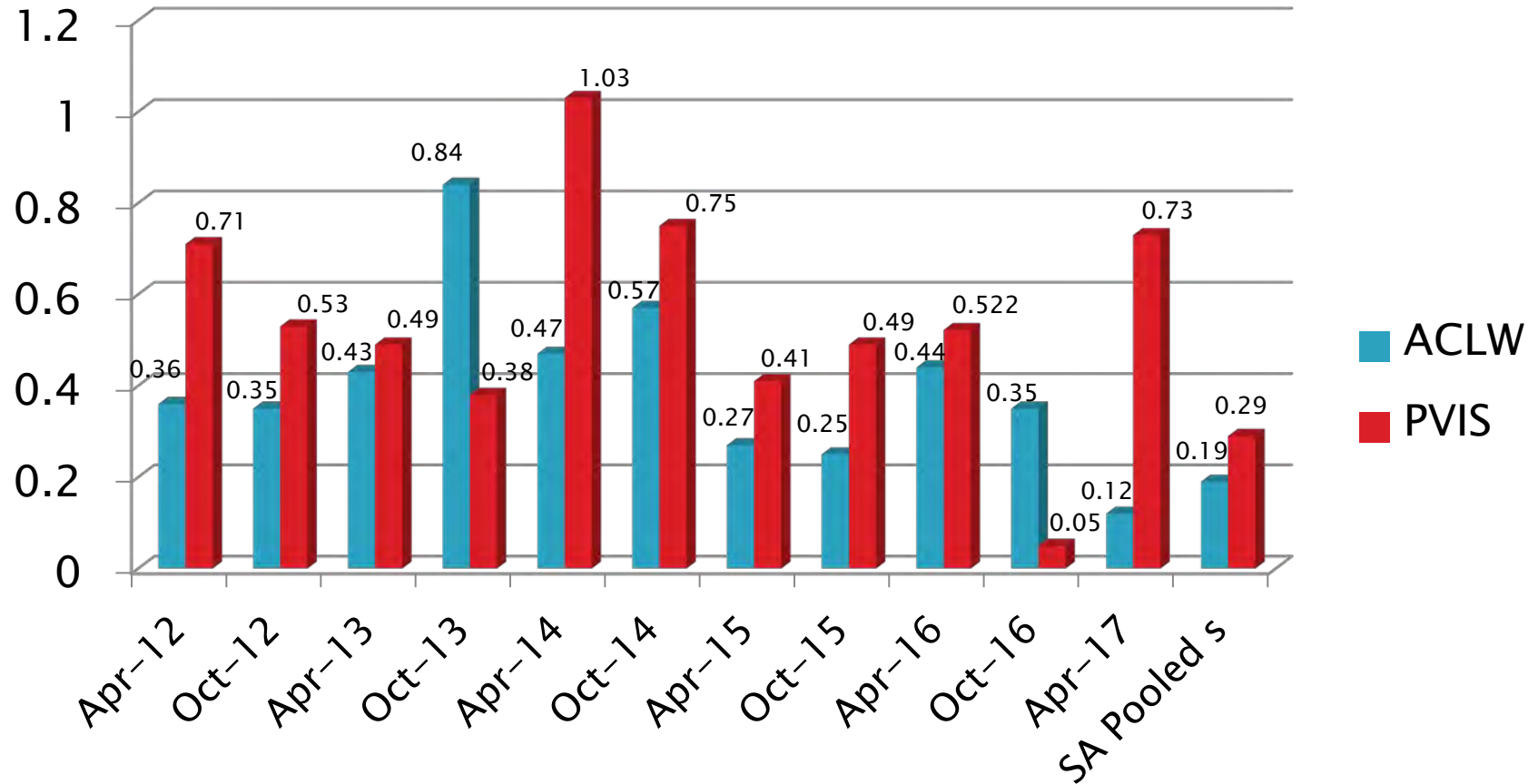


CUSUM Severity Analysis

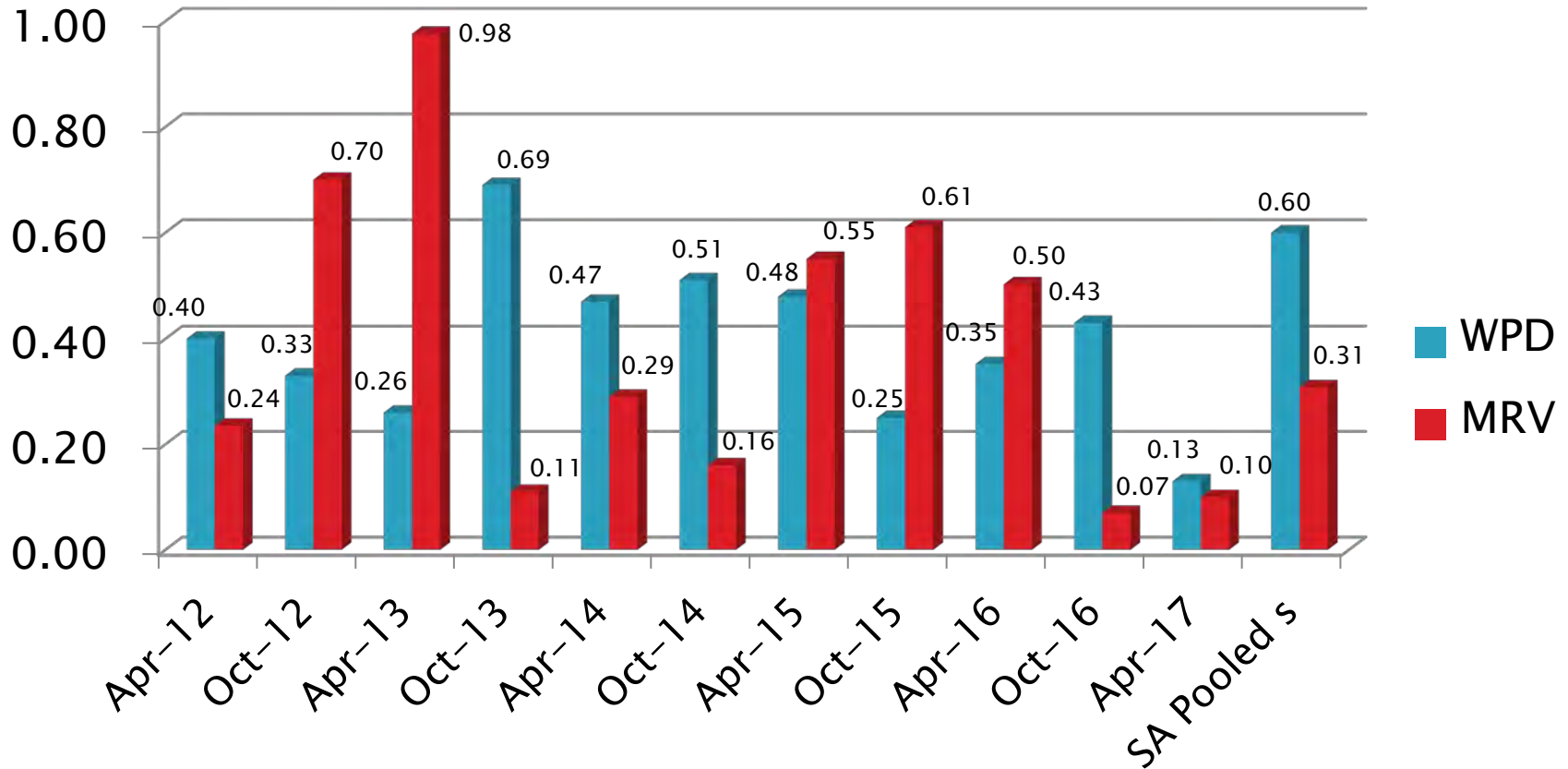


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IIIG Precision Estimates

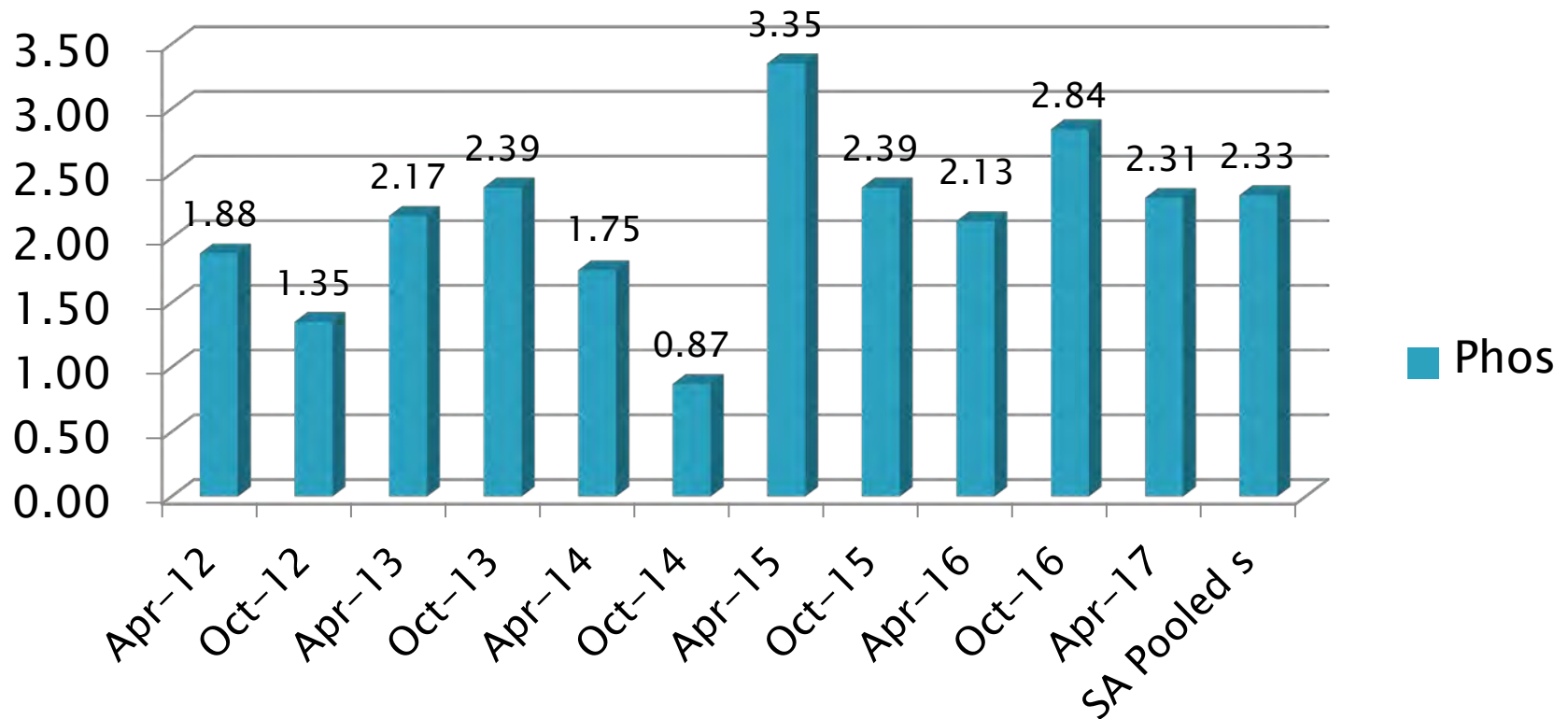


IIIG Precision Estimates



IIIG Precision Estimates

Phos



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Sequence IIIH Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	16
Statistically Unacceptable Calibration Test	OC	10
Operationally Invalid Calibration Test	LC	1
Acceptable Hardware Evaluation Test	AH	5
Aborted Calibration Test	XC	3
Not for Industry Statistics Test	NN	2
Total		37

Sequence IIIH – Failed Tests

Test Status	#
Level 3 Ei Alarm PVIS, WPD	4
Level 3 Ei Alarm PHOS	1
Level 3 Ei Alarm PVIS	3
Level 3 Ei Alarm WPD	2
Totals	10

Sequence IIIH – Lost Tests*

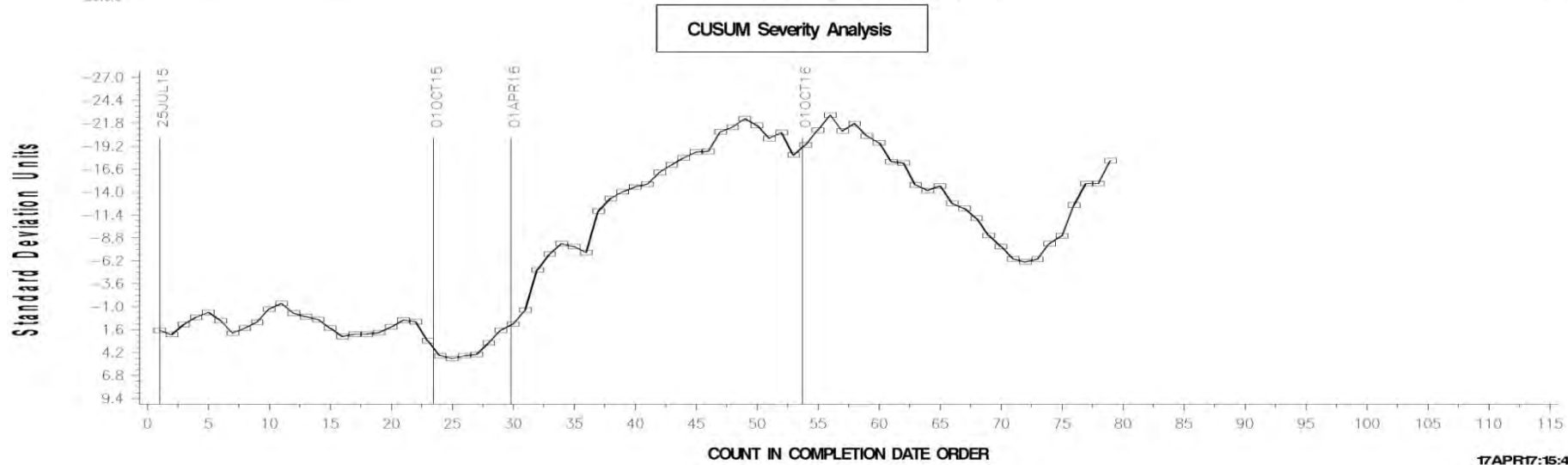
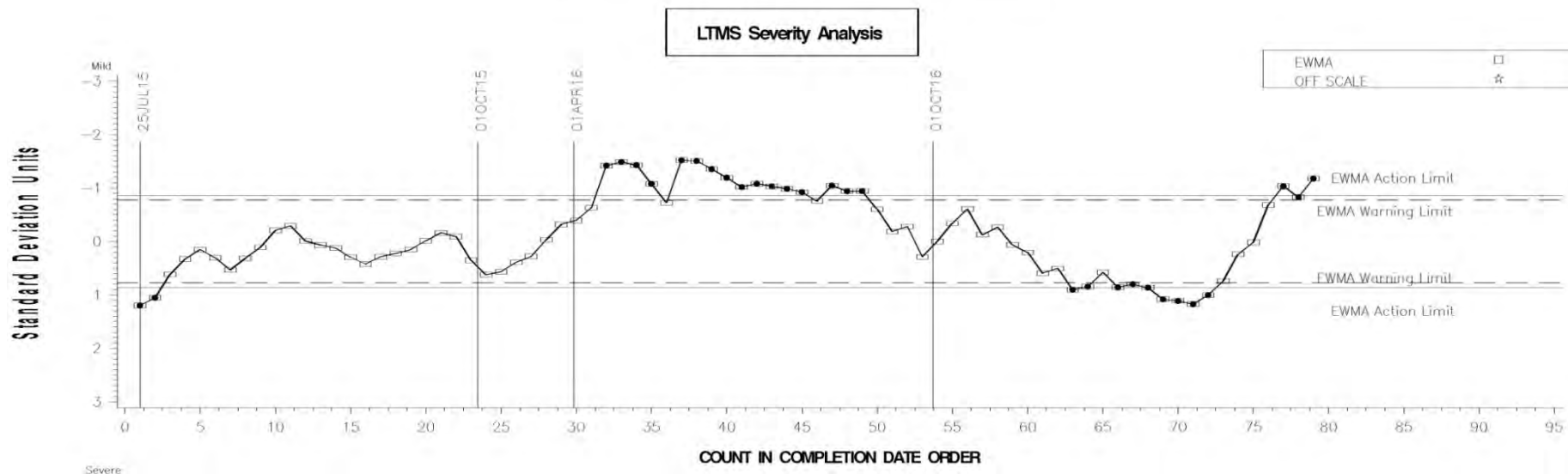
Test Status	Cause	#
Aborted	High Oil Consumption	3
Invalid	Exhaust Backpressure control, $Q_i < 0.000$	1
Totals		4

*Invalid and aborted tests

Sequence IIIH Test Severity

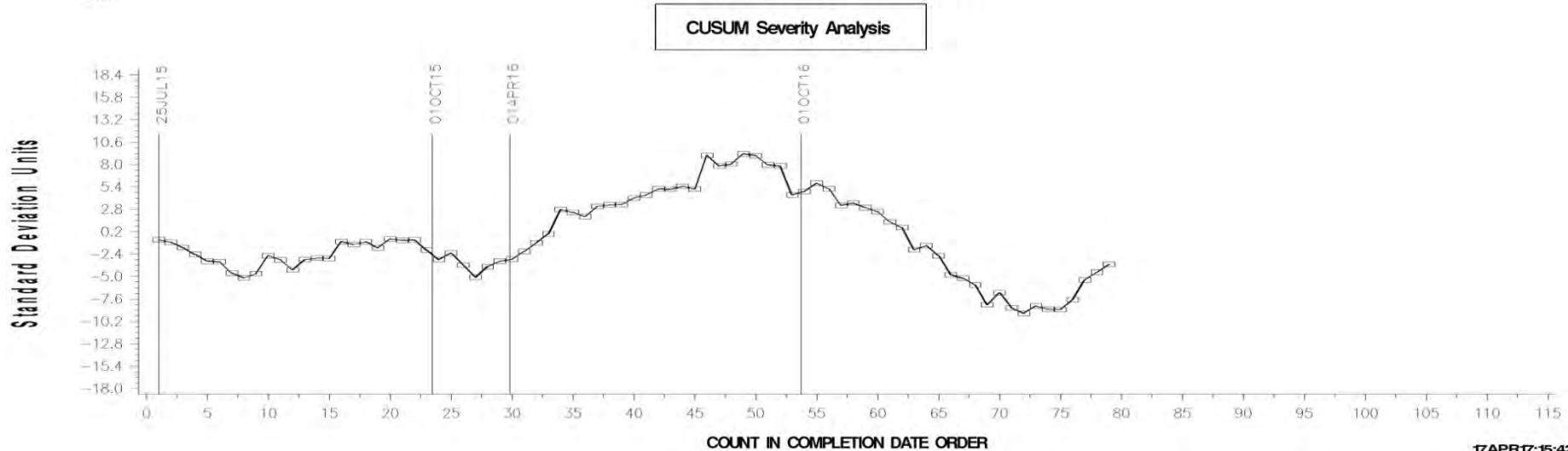
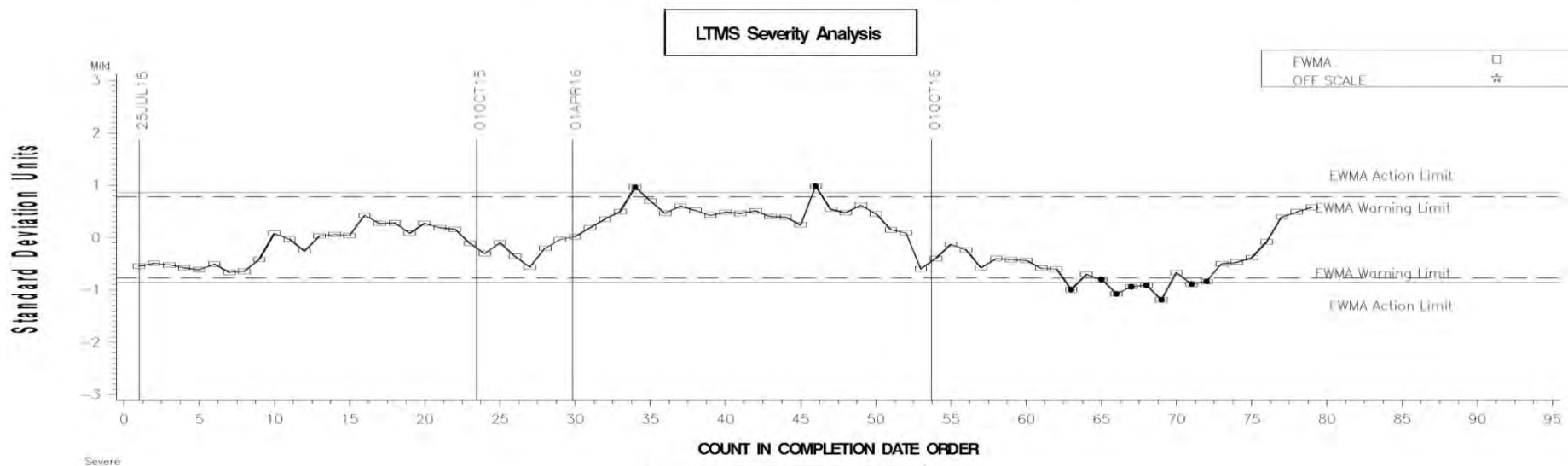
- PVIS is in severity action alarm (mild)
- WPD is in control
- MRV is in severity action alarm (mild)
- PHOS is in control

VISCOSITY INCREASE FINAL ORIG UNIT RES



17APR17:15:41

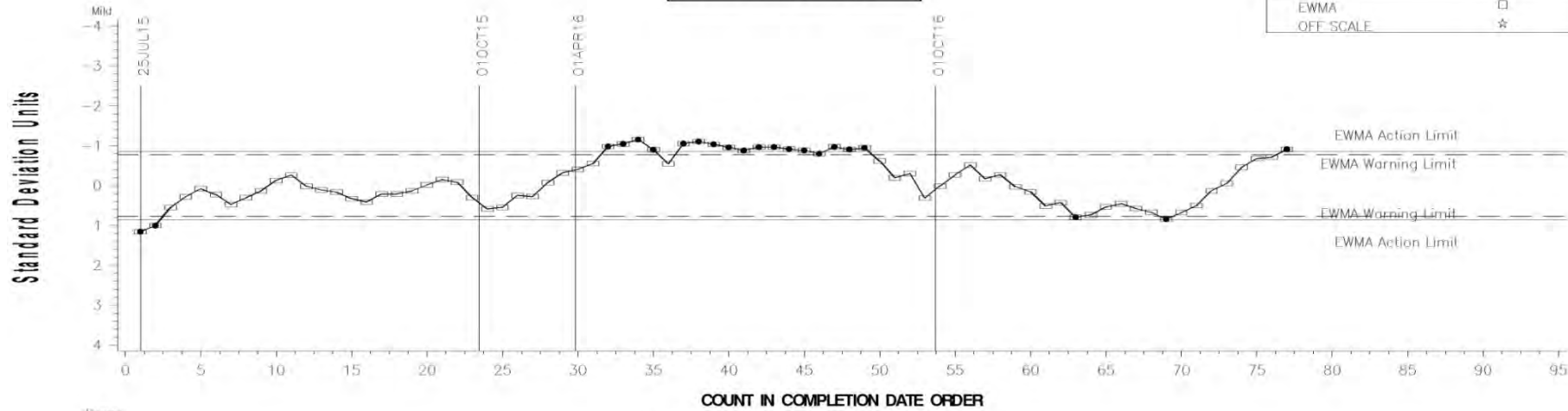
AVERAGE WEIGHTED PISTON DEPOSITS FNL ORIG U



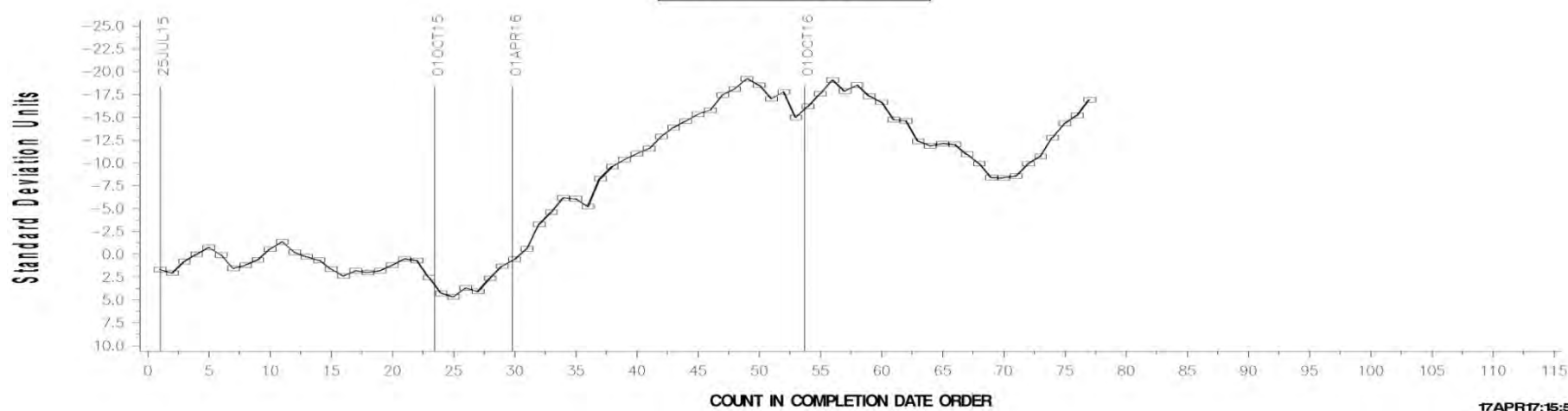
17 APR 17:15:42

MRV FINAL ORIG UNIT RES [NM, FROZEN, SOLID]

LTMS Severity Analysis

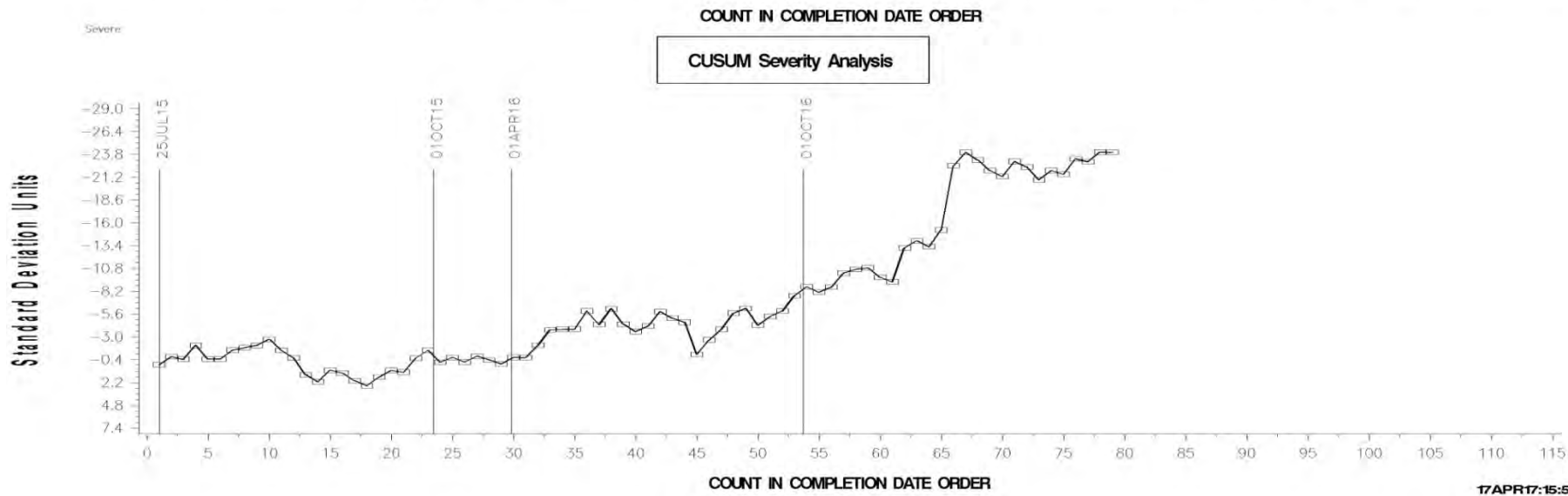
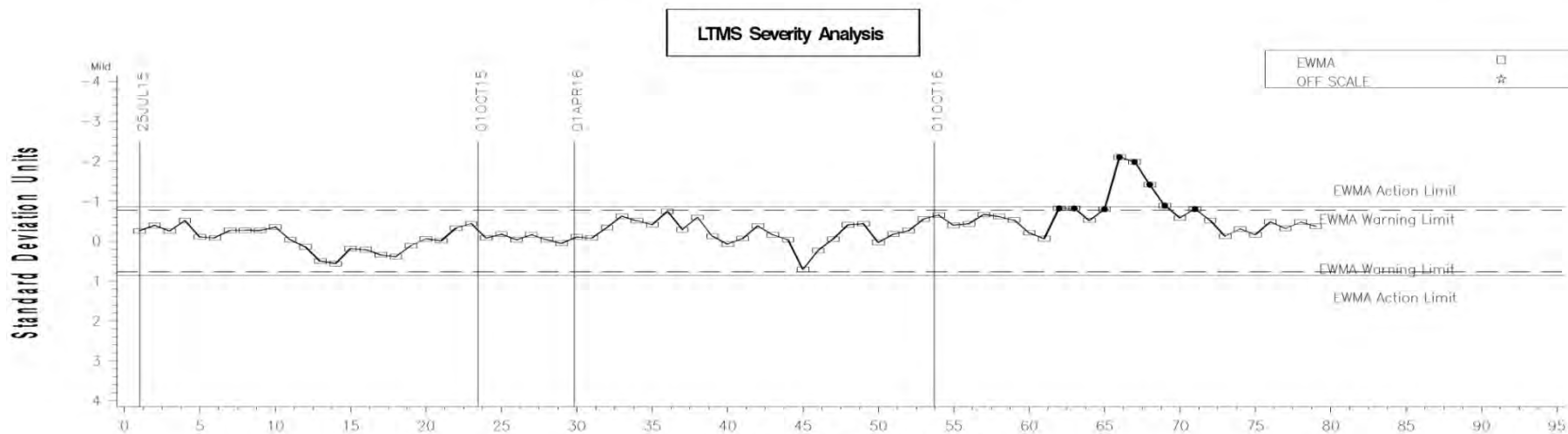


CUSUM Severity Analysis



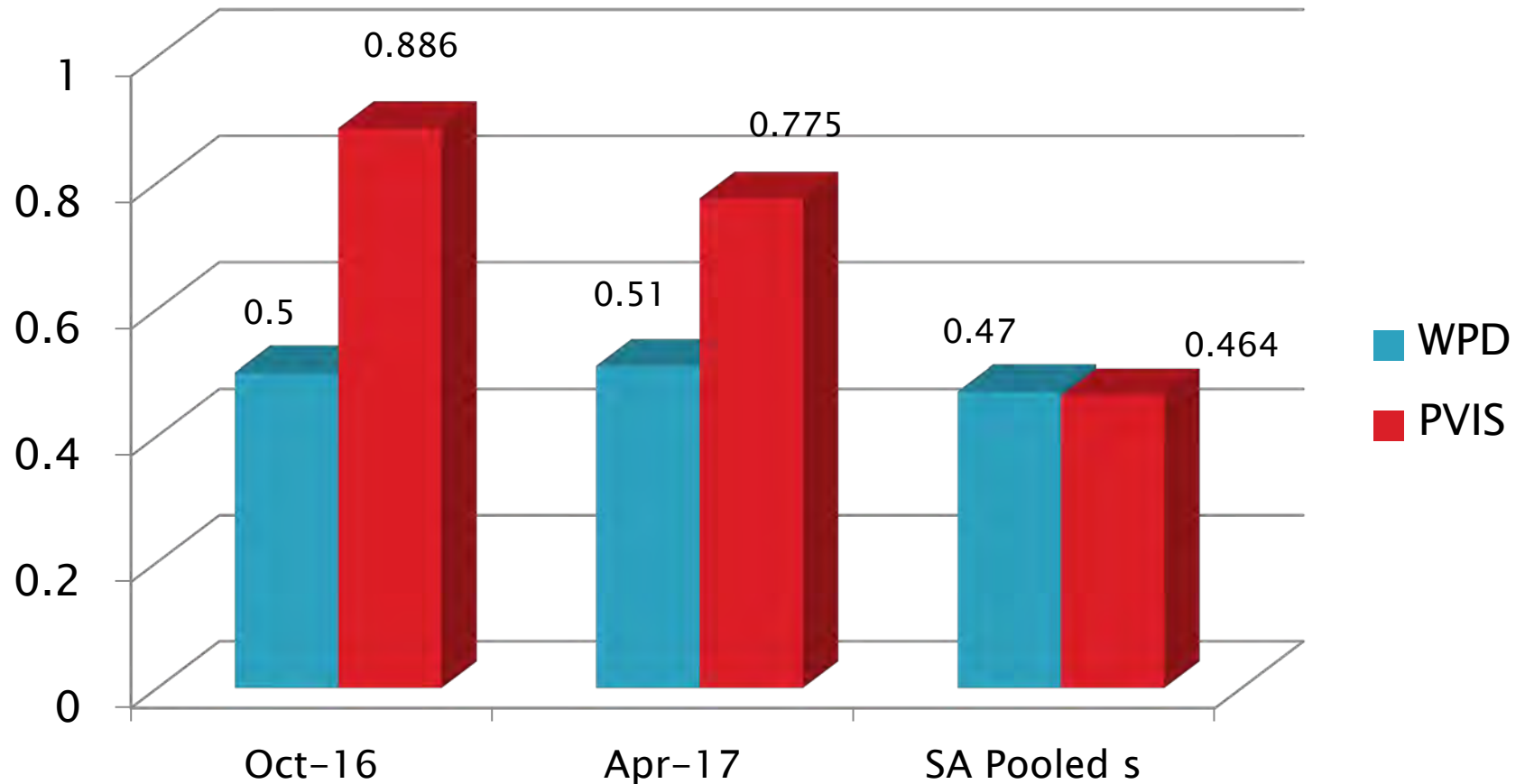
17 APR 17:15:52

PHOSPHORUS RETENTION, FINAL RESULT

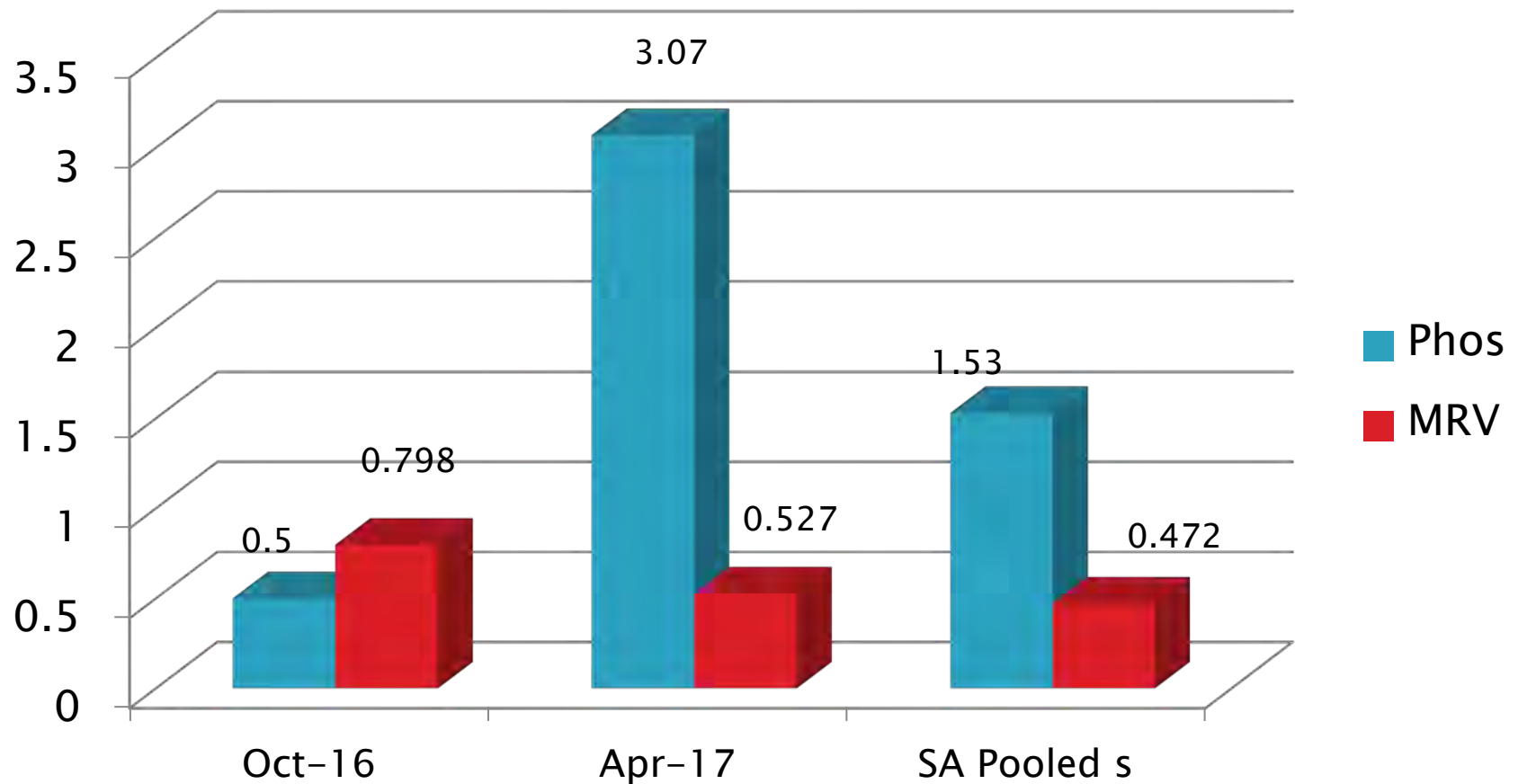


17APR17:15:54

IIH Precision Estimates



IIIHA/B Precision Estimates



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Sequence IVA

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Sequence IVA Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	6
Operationally Invalid Calibration Test	LC	1
Abandoned Engine	MC	1
Total		8

Sequence IVA – Lost Tests*

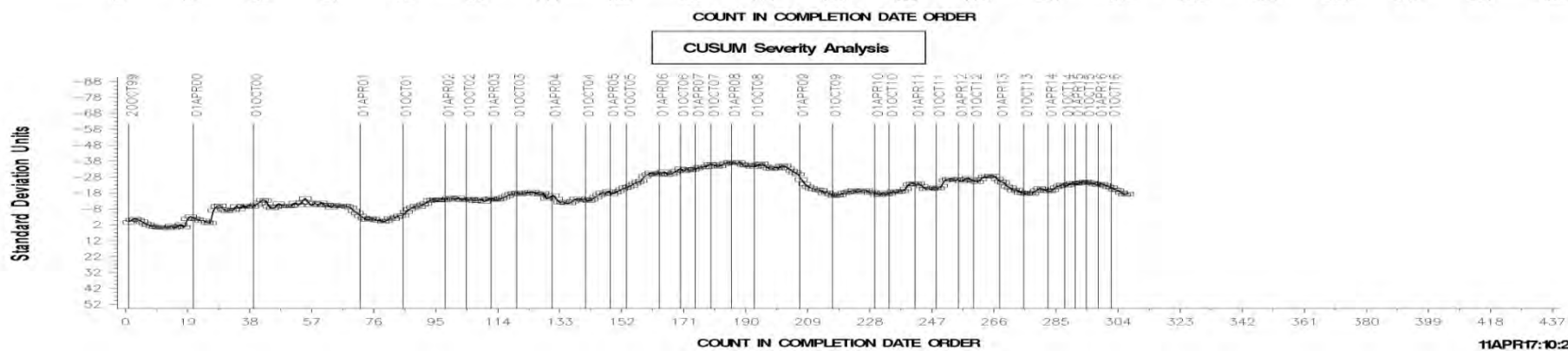
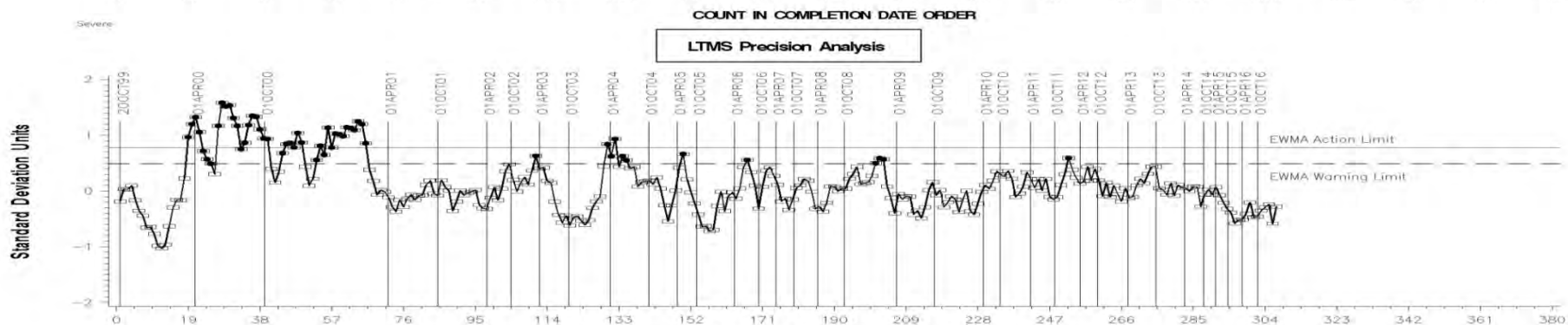
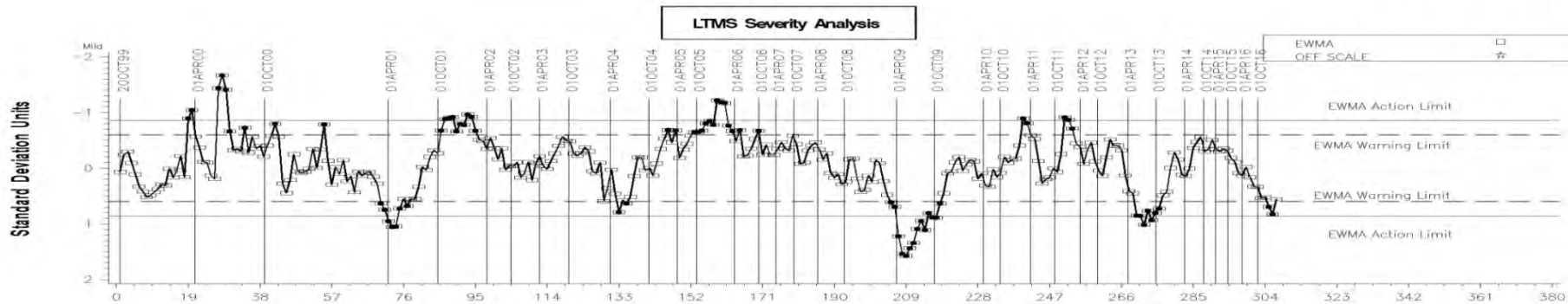
Test Status	Cause	#
Invalid		1
Totals		1

*Invalid and aborted tests

Sequence IVA Test Severity

- ACW in control.

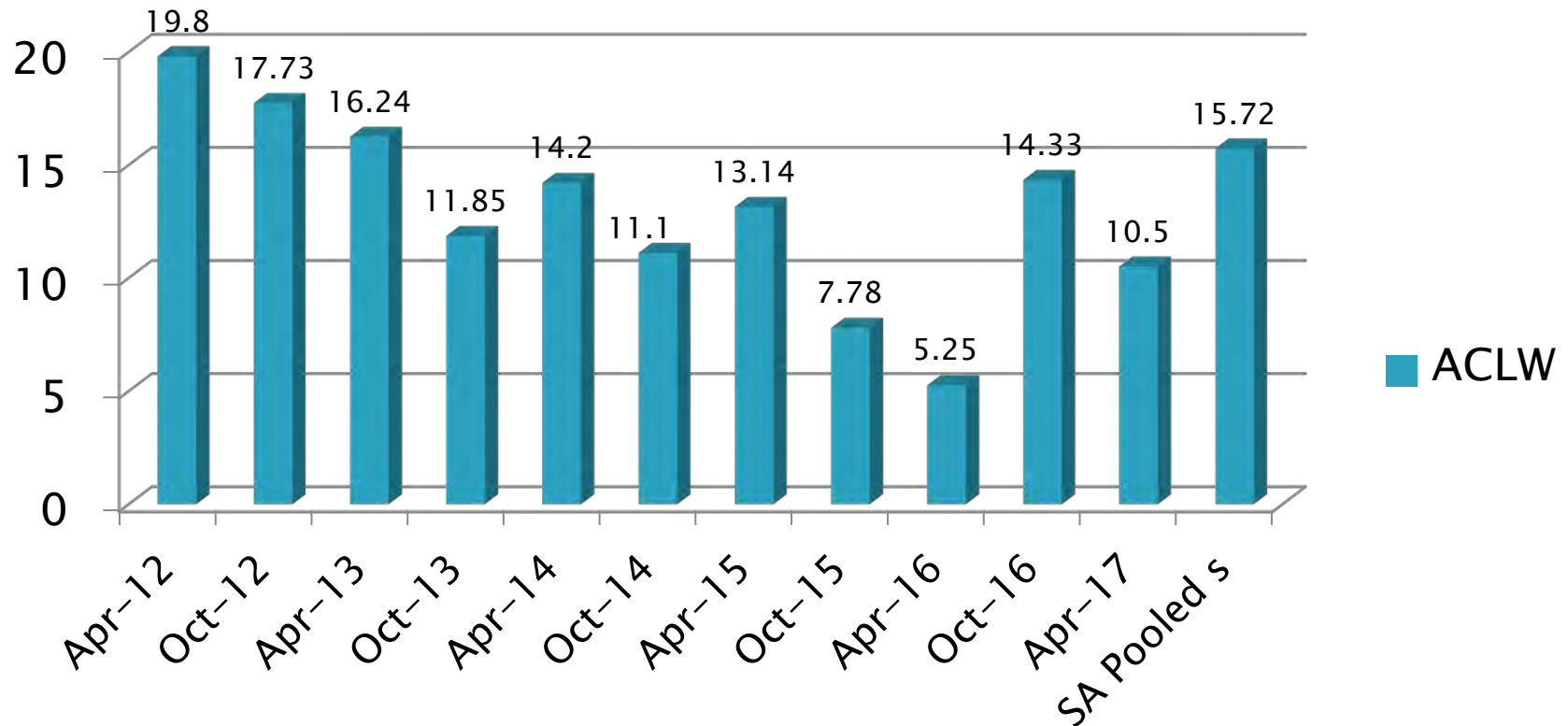
AVERAGE CAM WEAR



11APR17:10:24

Sequence IVA Precision Estimates

ACW



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Sequence VG

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Sequence VG Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	5
Aborted	XC	1
Total		6

Sequence VG – Lost Tests*

Test Status	Cause	#
Aborted	Computer Program Error	1
Totals		1

*Invalid and aborted tests

Sequence VG Test Severity

- All parameters in control

AVERAGE ENGINE SLUDGE

LTMS Severity Analysis



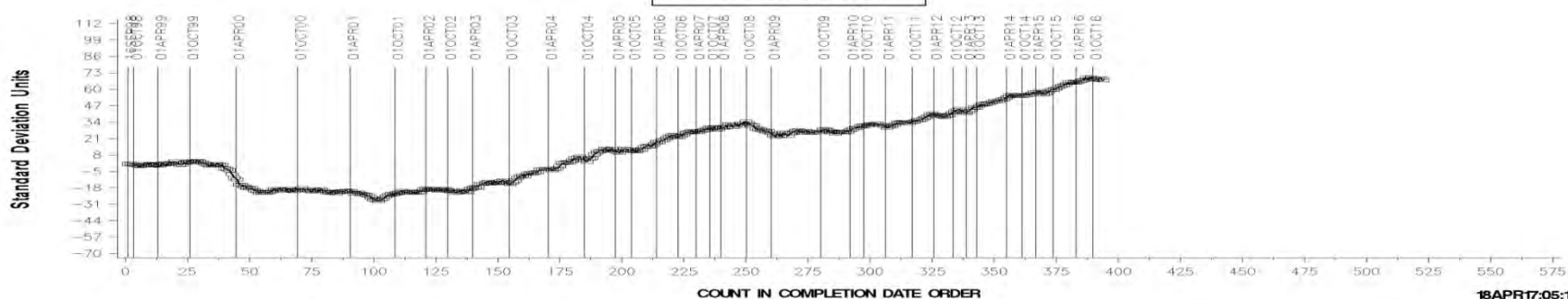
COUNT IN COMPLETION DATE ORDER

LTMS Precision Analysis



COUNT IN COMPLETION DATE ORDER

CUSUM Severity Analysis

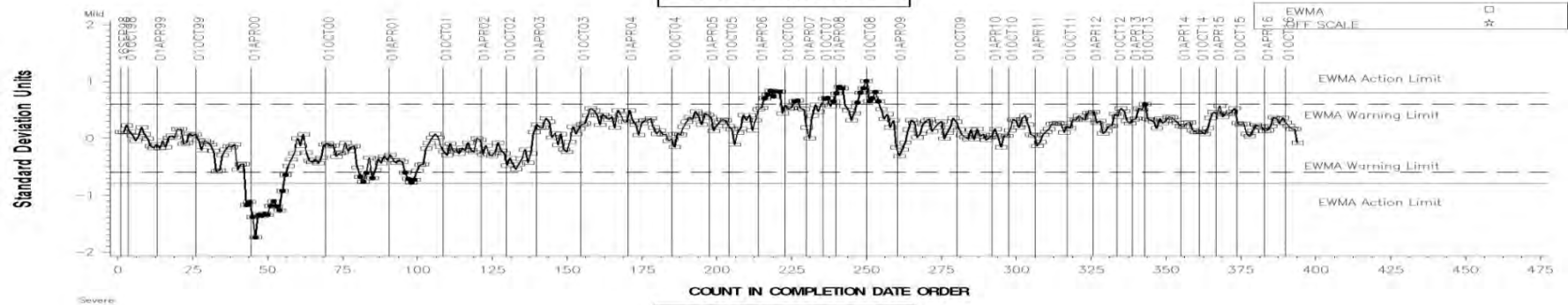


COUNT IN COMPLETION DATE ORDER

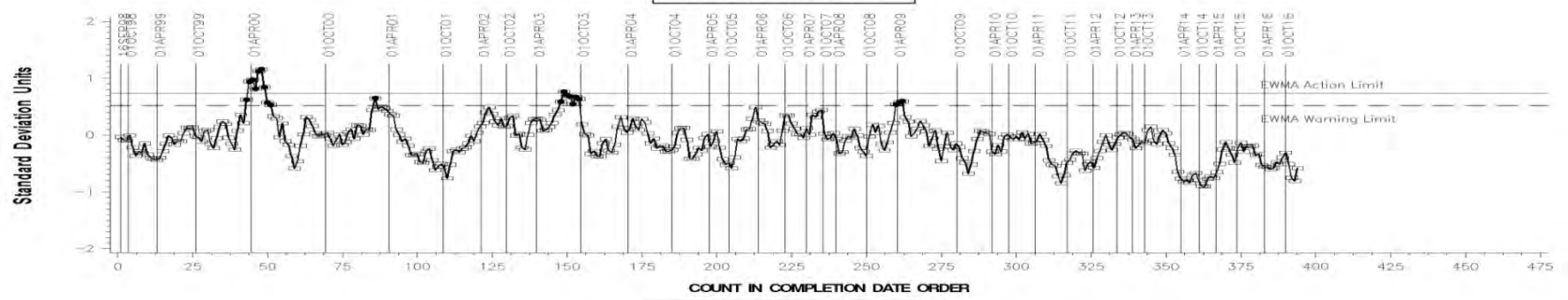
18APR17:05:13

AVERAGE ROCKER COVER SLUDGE

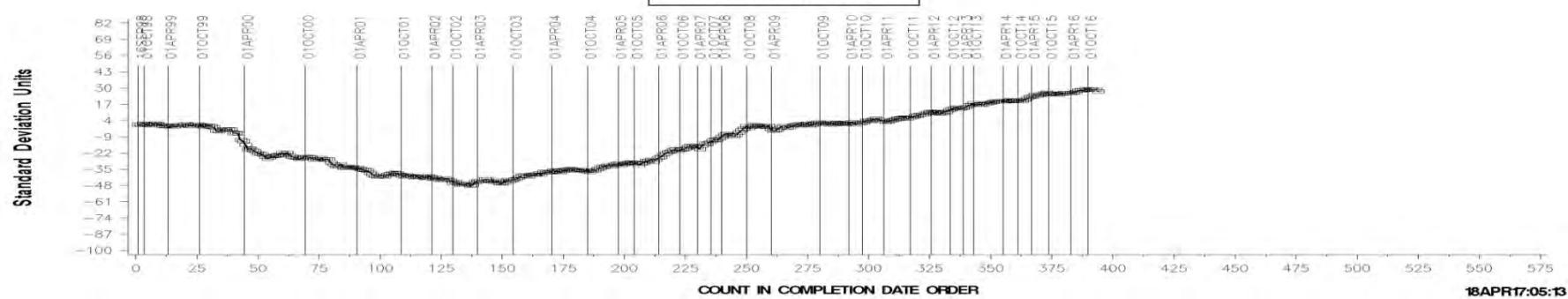
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis

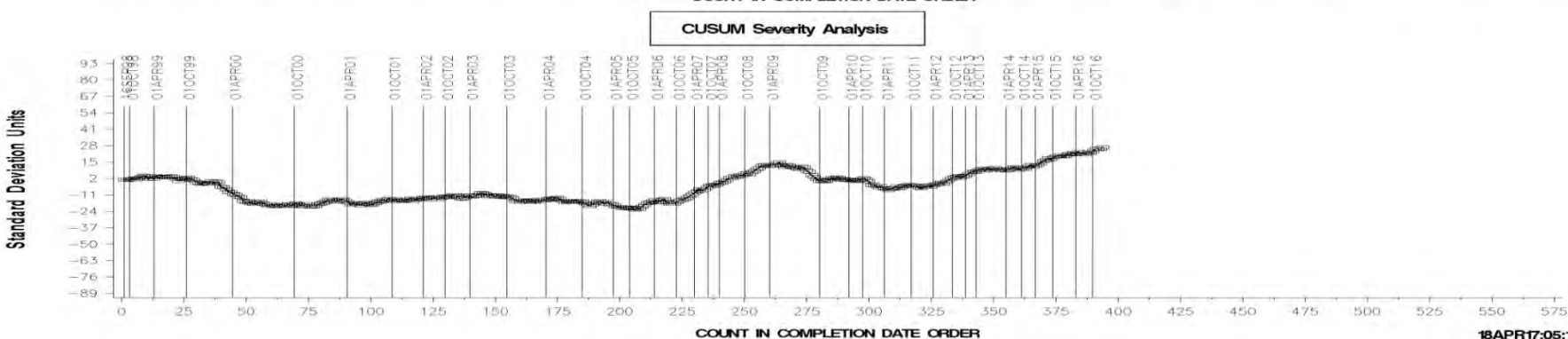
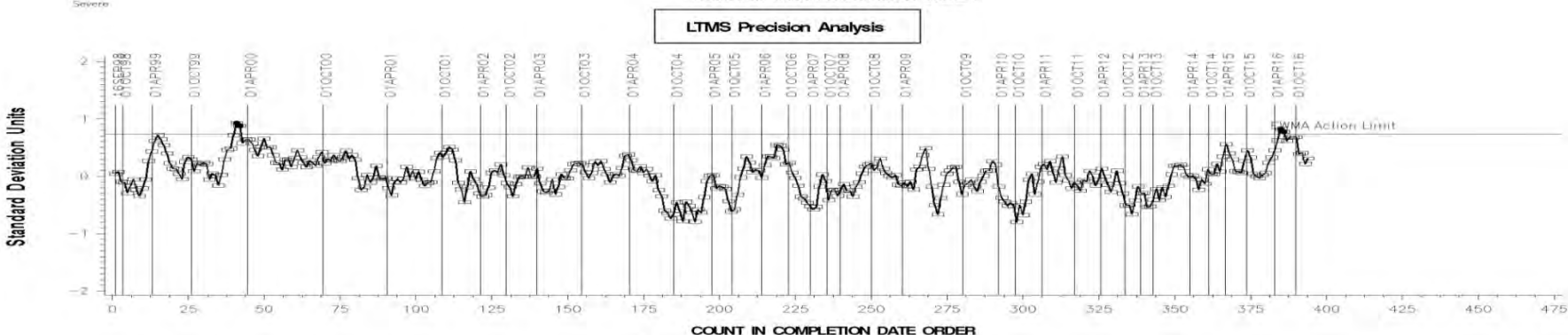
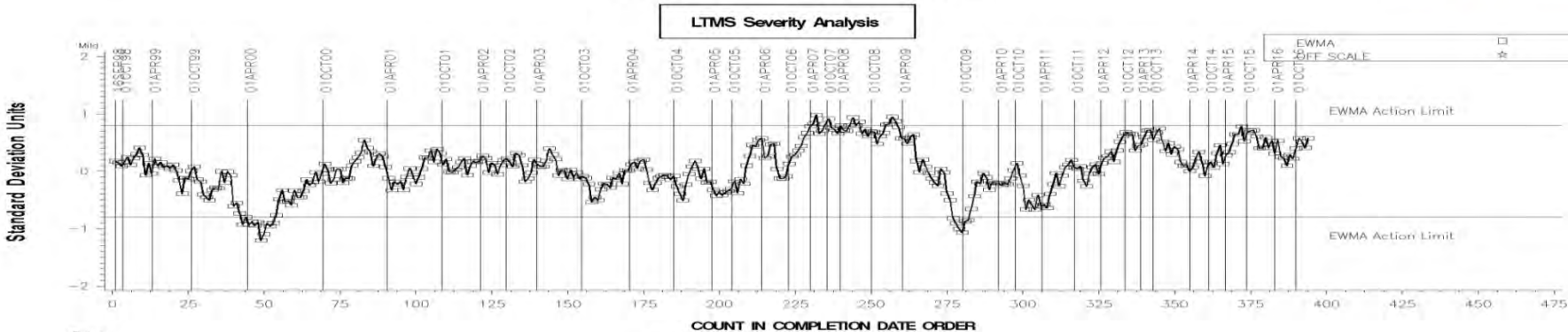


18APR17:05:13

SEQUENCE VG INDUSTRY OPERATIONALLY VALID DATA



AVG. ENG. VARN. 3—PART APV + BAFFLES



18APR17:05:13

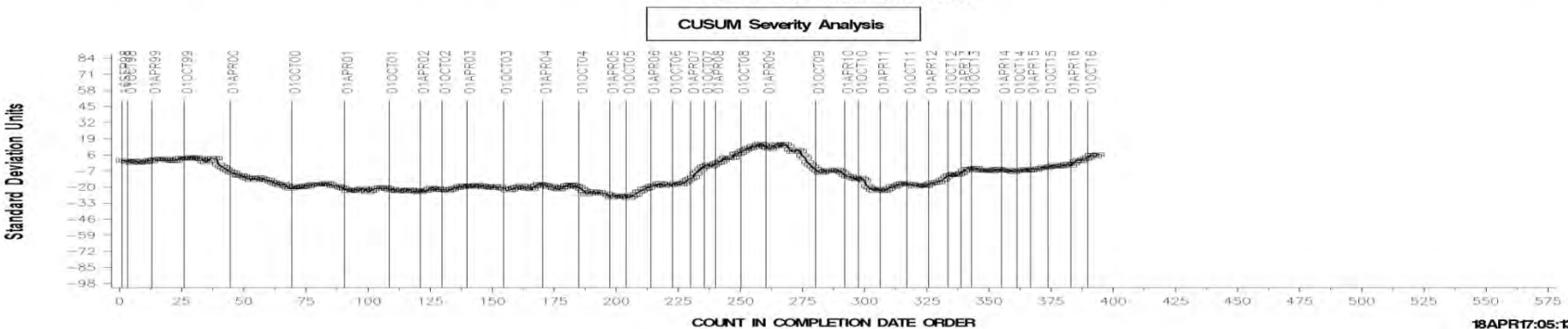
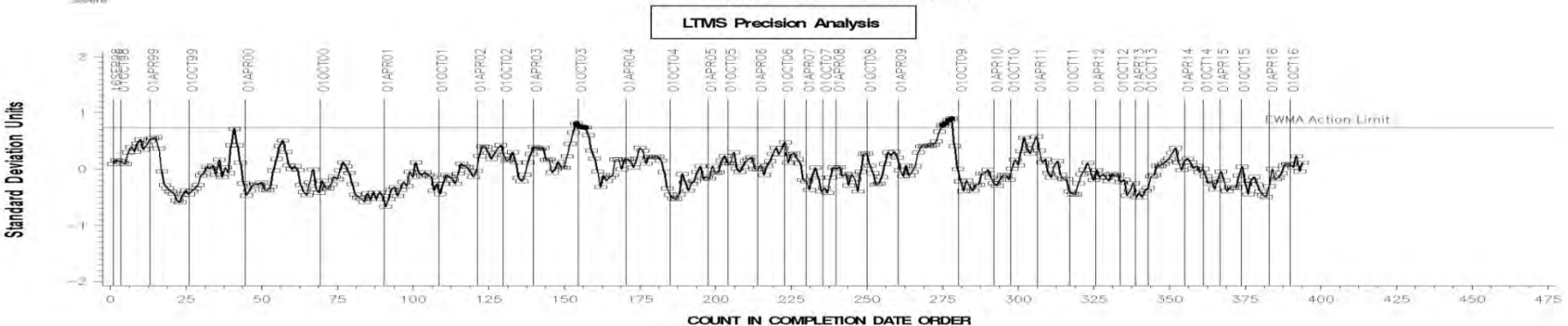
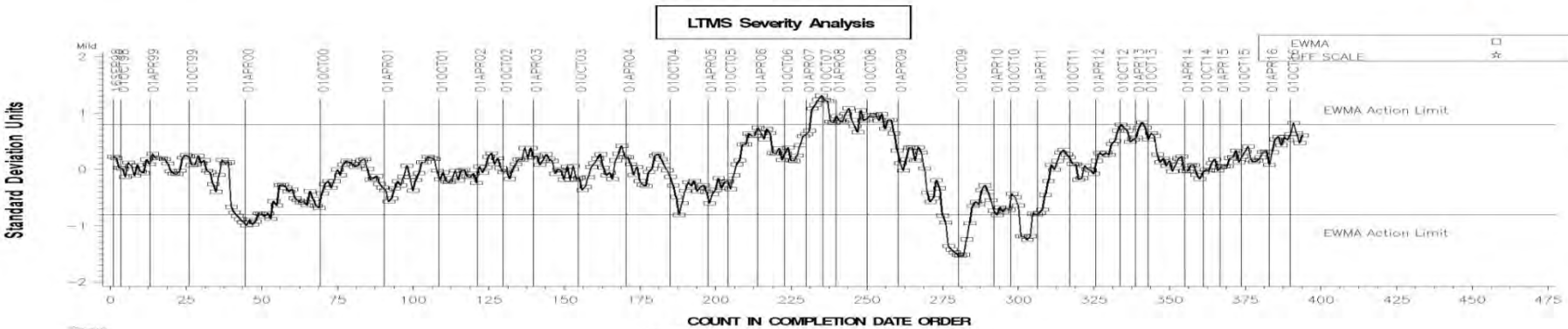
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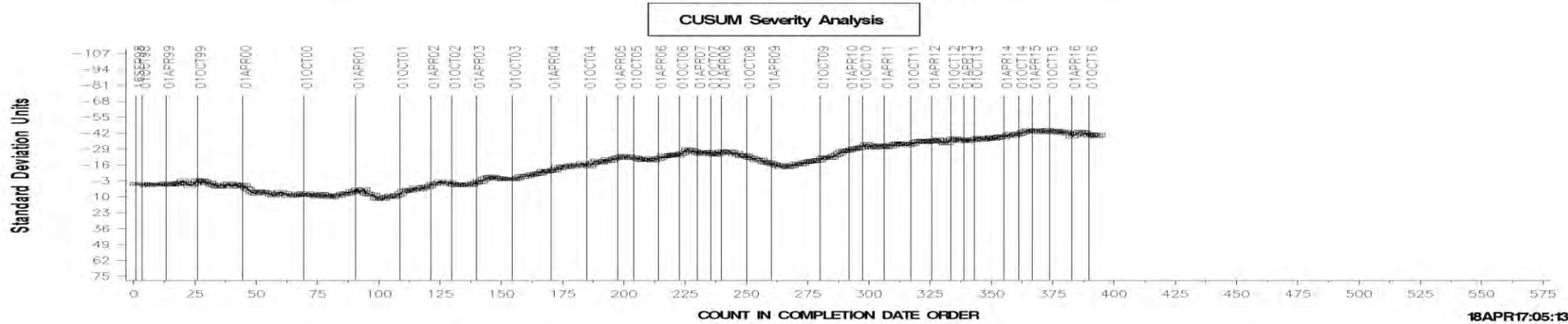
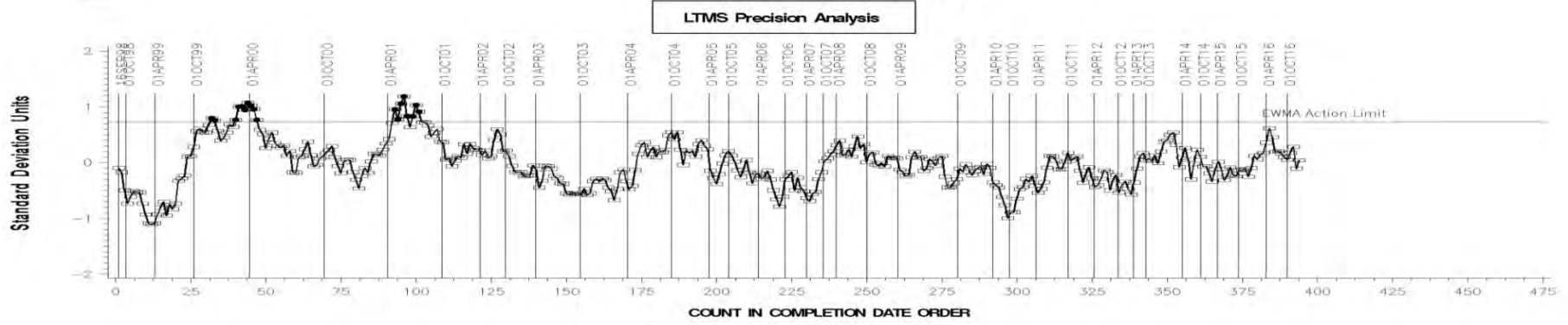
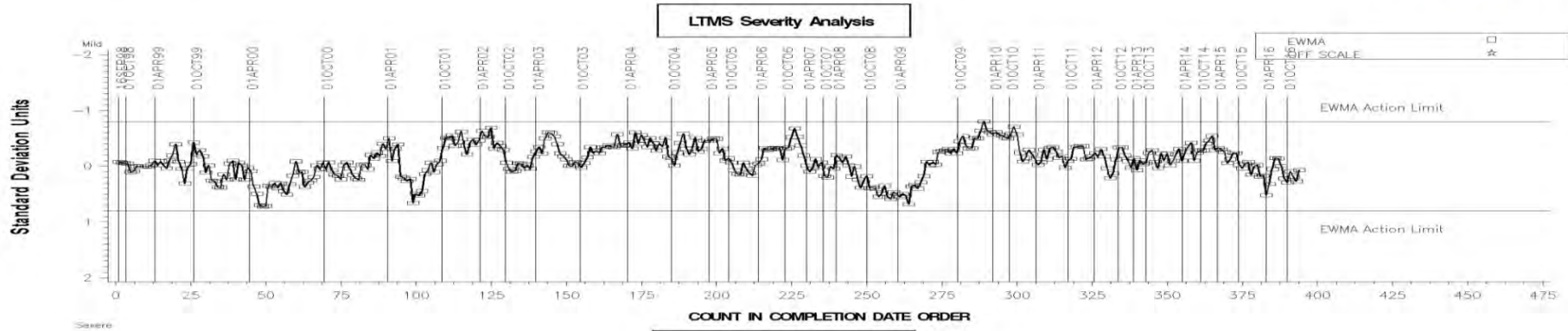
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AVG PISTON SKIRT RATING



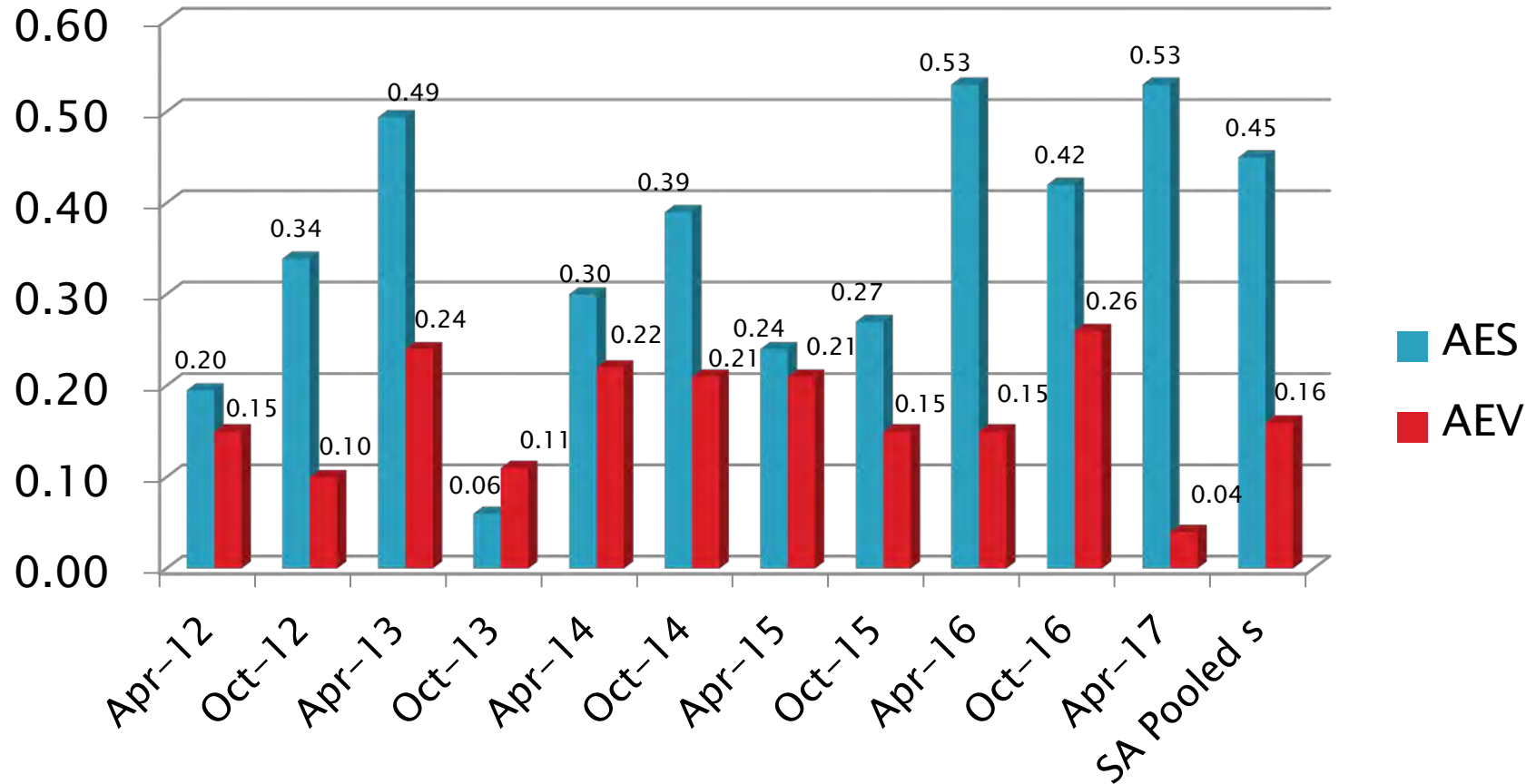
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OIL SCREEN SLUDGE



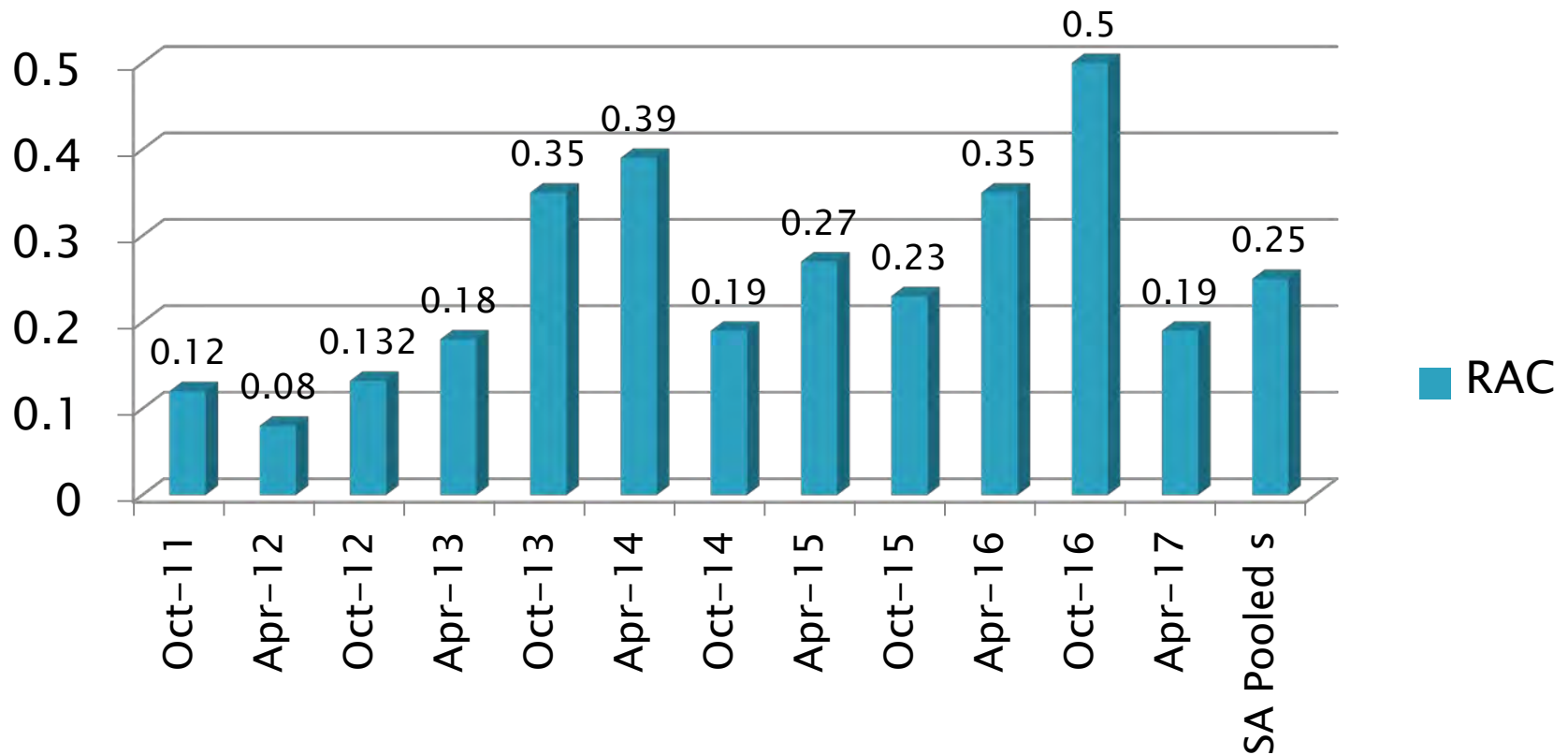
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Sequence VG Precision Estimates

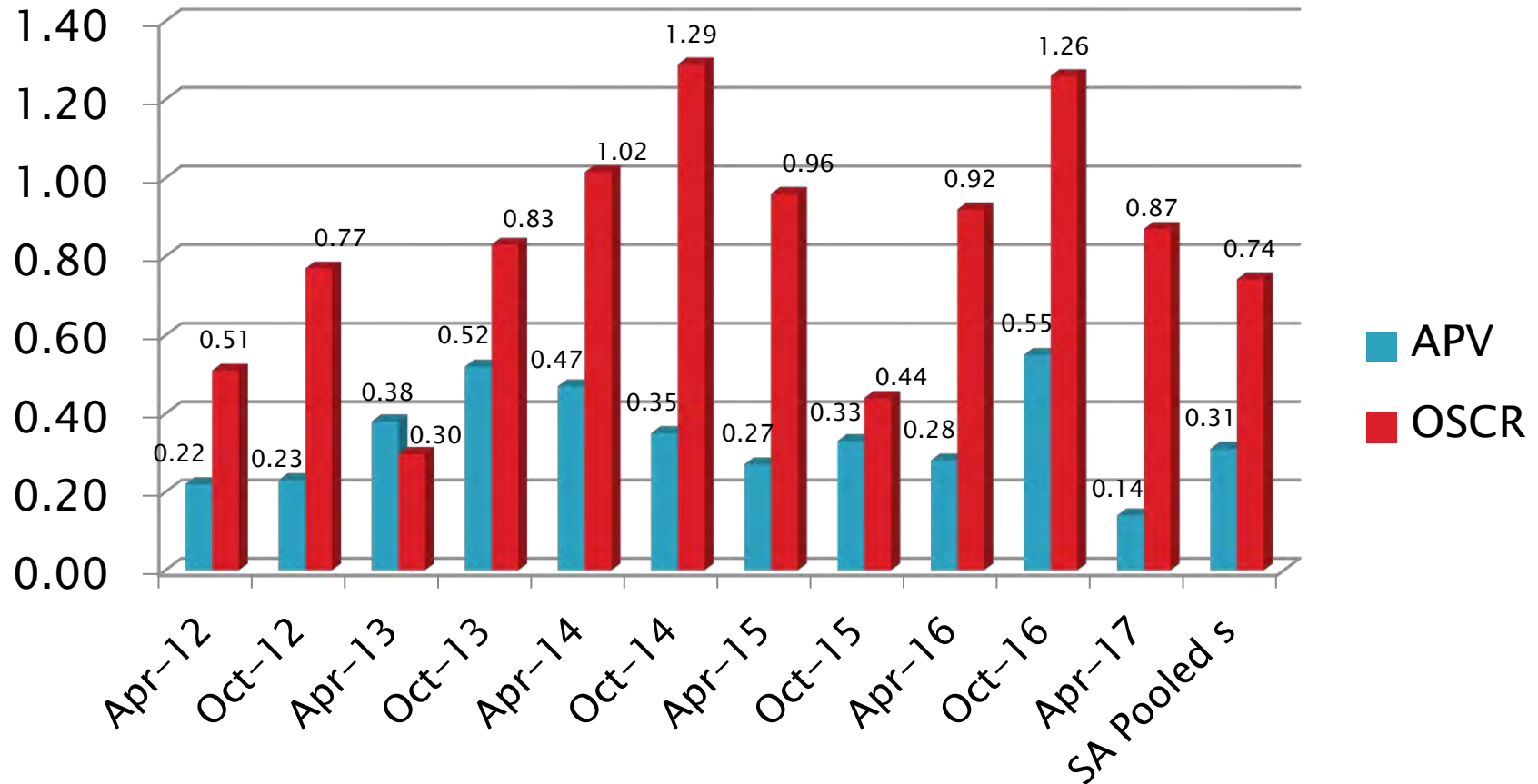


Sequence VG Precision Estimates

RAC



Sequence VG Precision Estimates



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Sequence VID

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Sequence VID Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	7
Failed Statistically	OC	3
Engine Abandoned, did not calibrate	MC	1
Operationally Invalid, Lab and TMC judgement	RC	1
Total		12

Sequence VID – Failed Tests

Test Status	Number of Tests
Severe FEI2	1
Mild FEI1	1
Mild FEI1 and FEI2	1
Total	3

Sequence VID – Lost Tests*

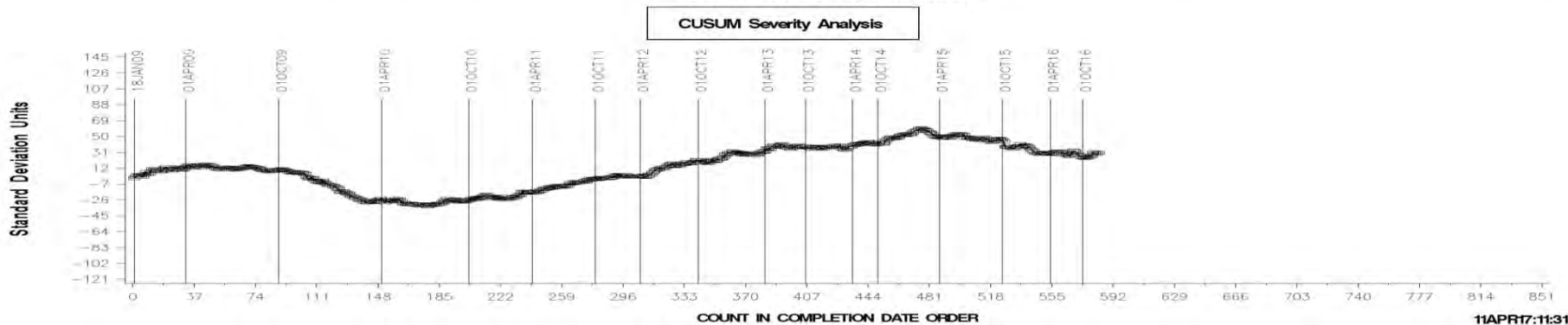
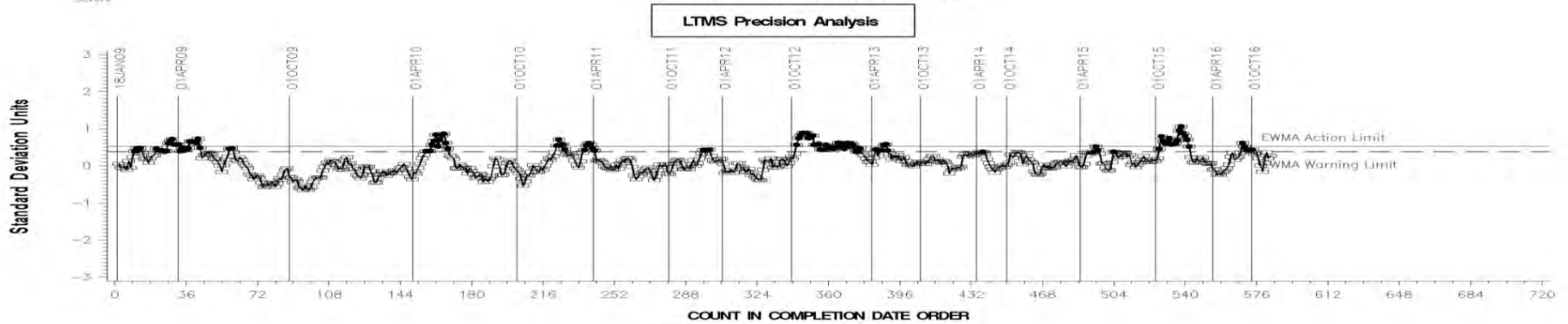
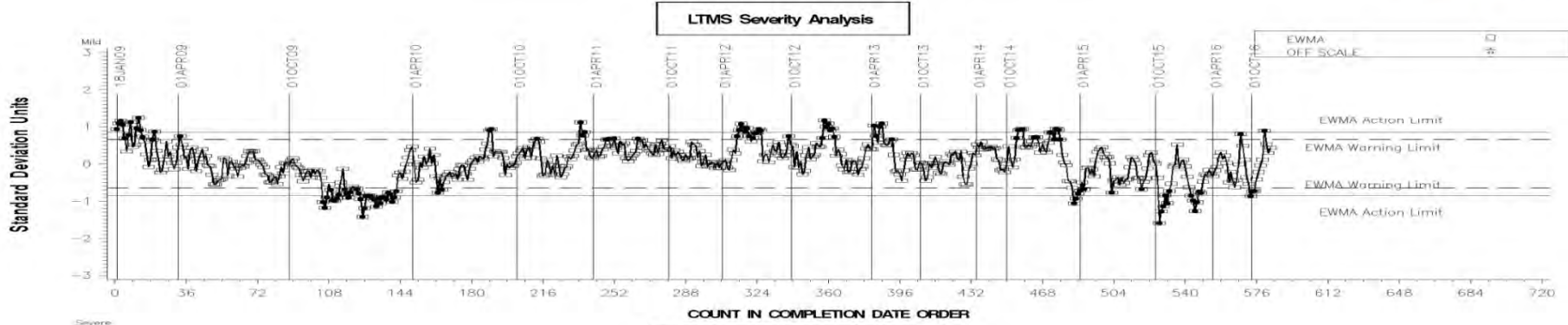
Test Status	Cause	#
Invalid	Load control	1
Totals		1

*Invalid and aborted tests

Sequence VID Test Severity

- FEI1 is in control
- FEI2 is in Precision and Severity (severe) Action Alarm

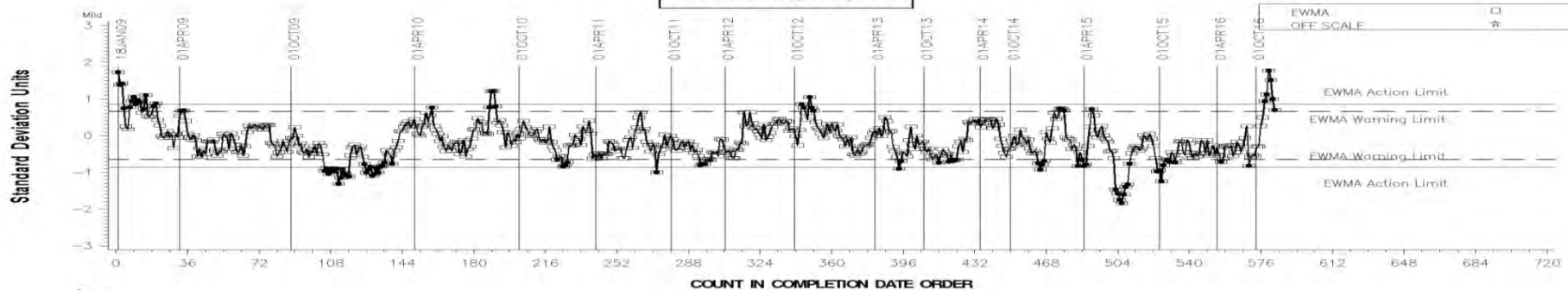
FEI FINAL RESULT PHASE I



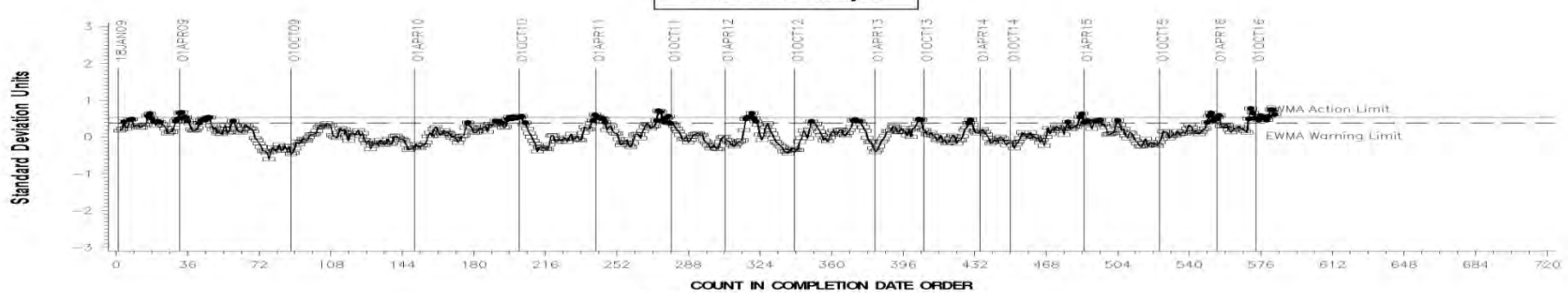
11APR17:11:31

FEI FINAL RESULT PHASE II

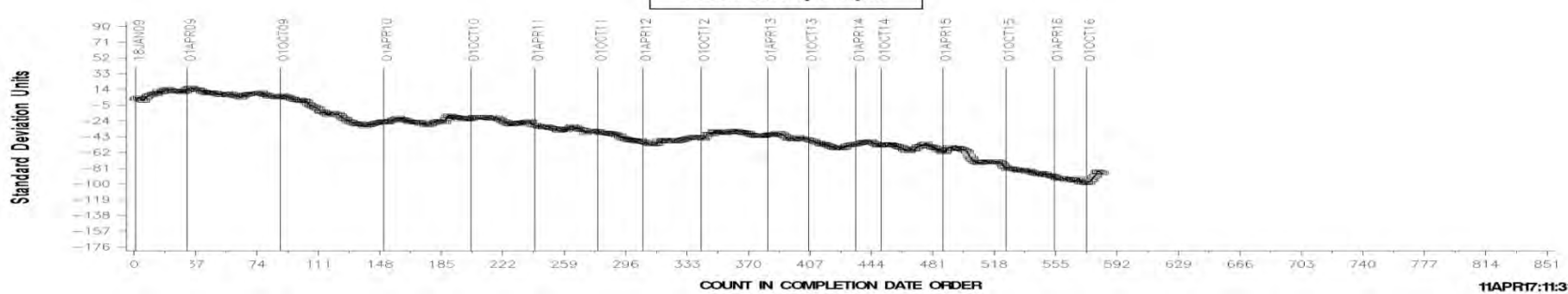
LTMS Severity Analysis



LTMS Precision Analysis

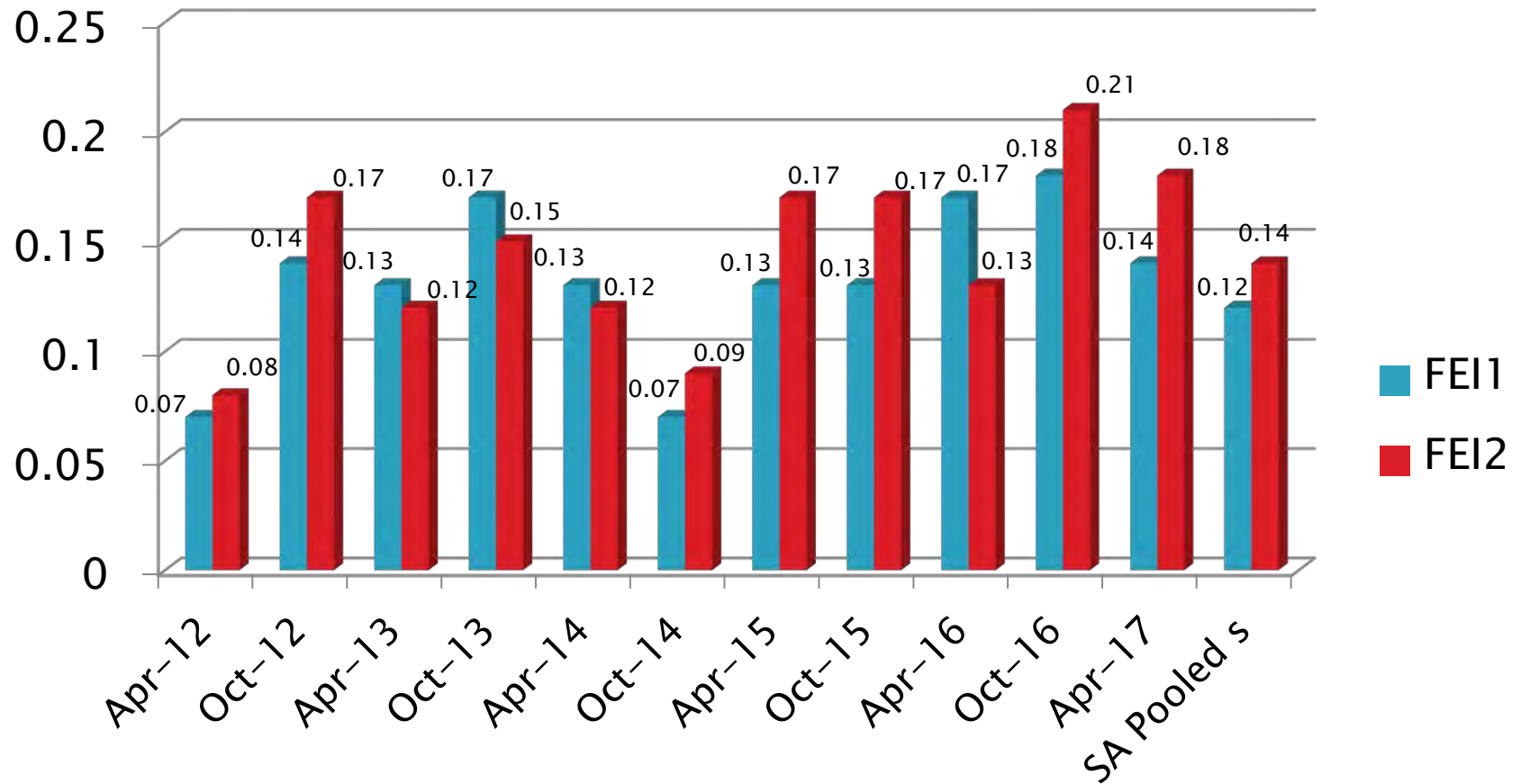


CUSUM Severity Analysis



11APR17:11:31

Sequence VID Precision Estimates



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Sequence VIE

»» April 2017

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Sequence VIE Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	35
Acceptable Donated Test (5 th Run)	AG	6
Failed Statistically	OC	11
Operationally Invalid Donated Test	LG	1
Operationally Invalid Calibration Test	LC	2
Aborted Calibration Tests	XC	3
Not for Industry Statistics Test (shakedown test with GM kit Engine)	NN	2
Abandoned Engine	MC	5
Total		65

Sequence VIE – Failed Tests

Test Status	Number of Tests
Severe FEI2	7
Severe FEI1	1
Severe FEI1 and FEI2	3
Total	11

Sequence VIE – Lost Tests*

Test Status	Cause	#
Invalid	Exhaust Backpressure out of spec (operator error)	1
Invalid	Erratic computer control	1
Invalid	Unable to maintain fuel temperature control	1
Aborted	Fuel to Flowmeter temperature out of spec	1
Aborted	Dyno overheated	1
Aborted	Computer control issues	1
Totals		6

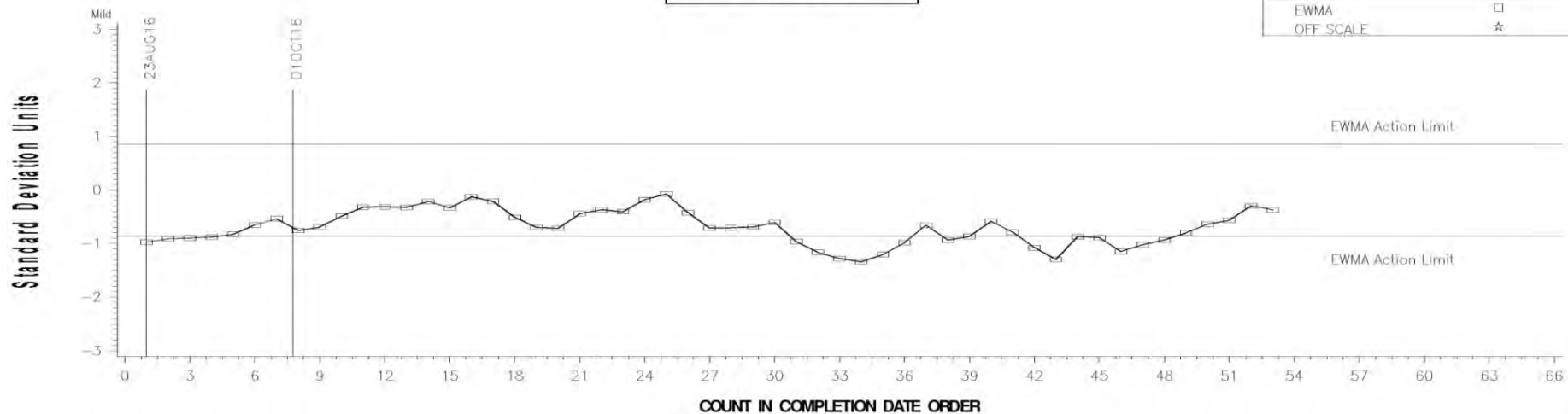
*Invalid and aborted tests

Sequence VIE Test Severity

- FEI1 is within control limits
 - had been severe until recently
- FEI2 is in action alarm and trending severe

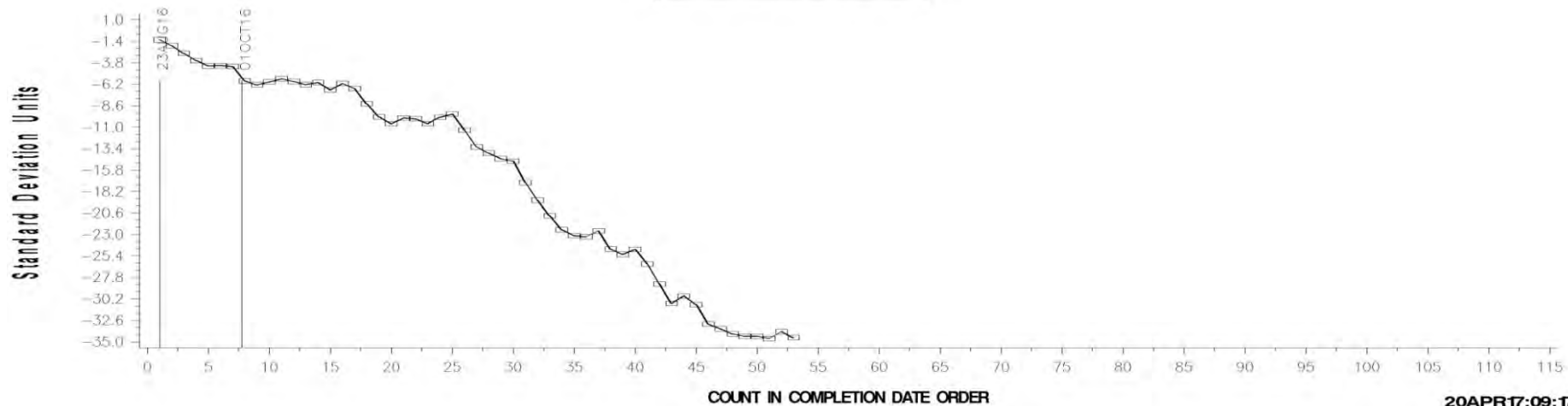
FEI FINAL RESULT PHASE I

LTMS Severity Analysis



COUNT IN COMPLETION DATE ORDER

CUSUM Severity Analysis

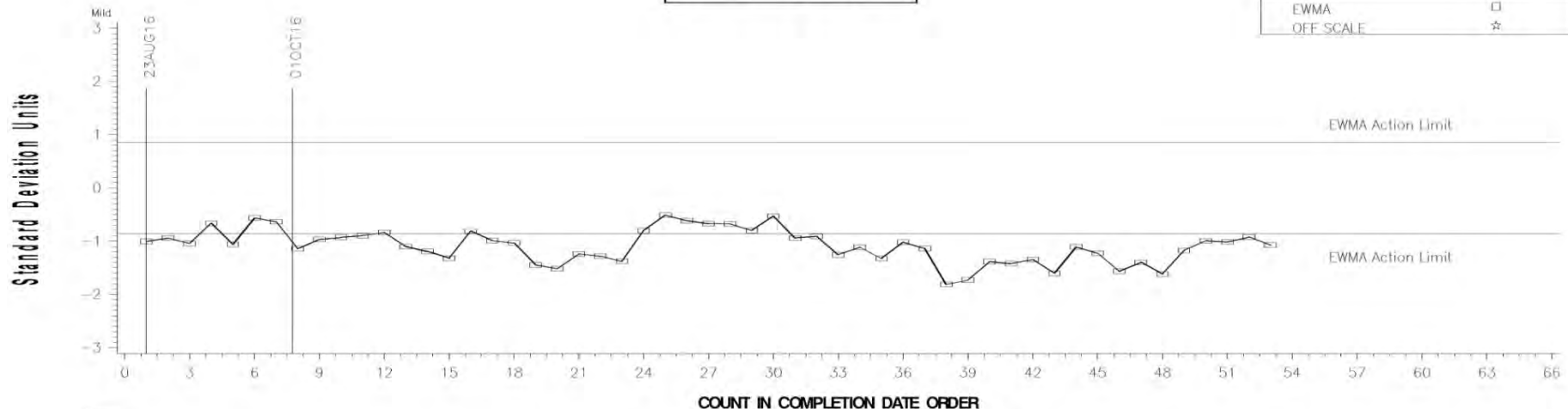


COUNT IN COMPLETION DATE ORDER

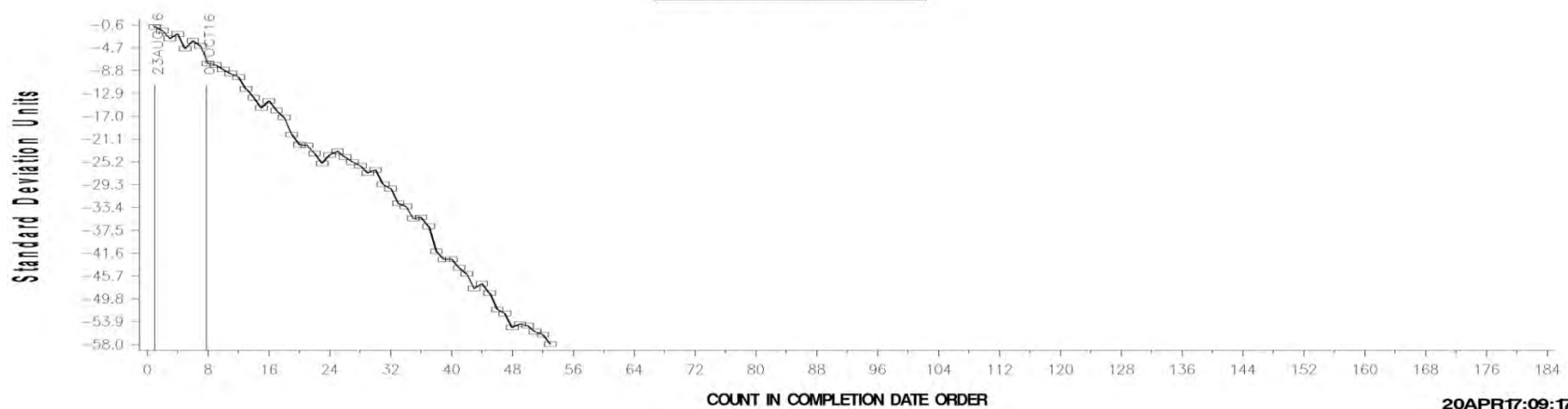
20 APR 17 09:17

FEI FINAL RESULT PHASE II

LTMS Severity Analysis

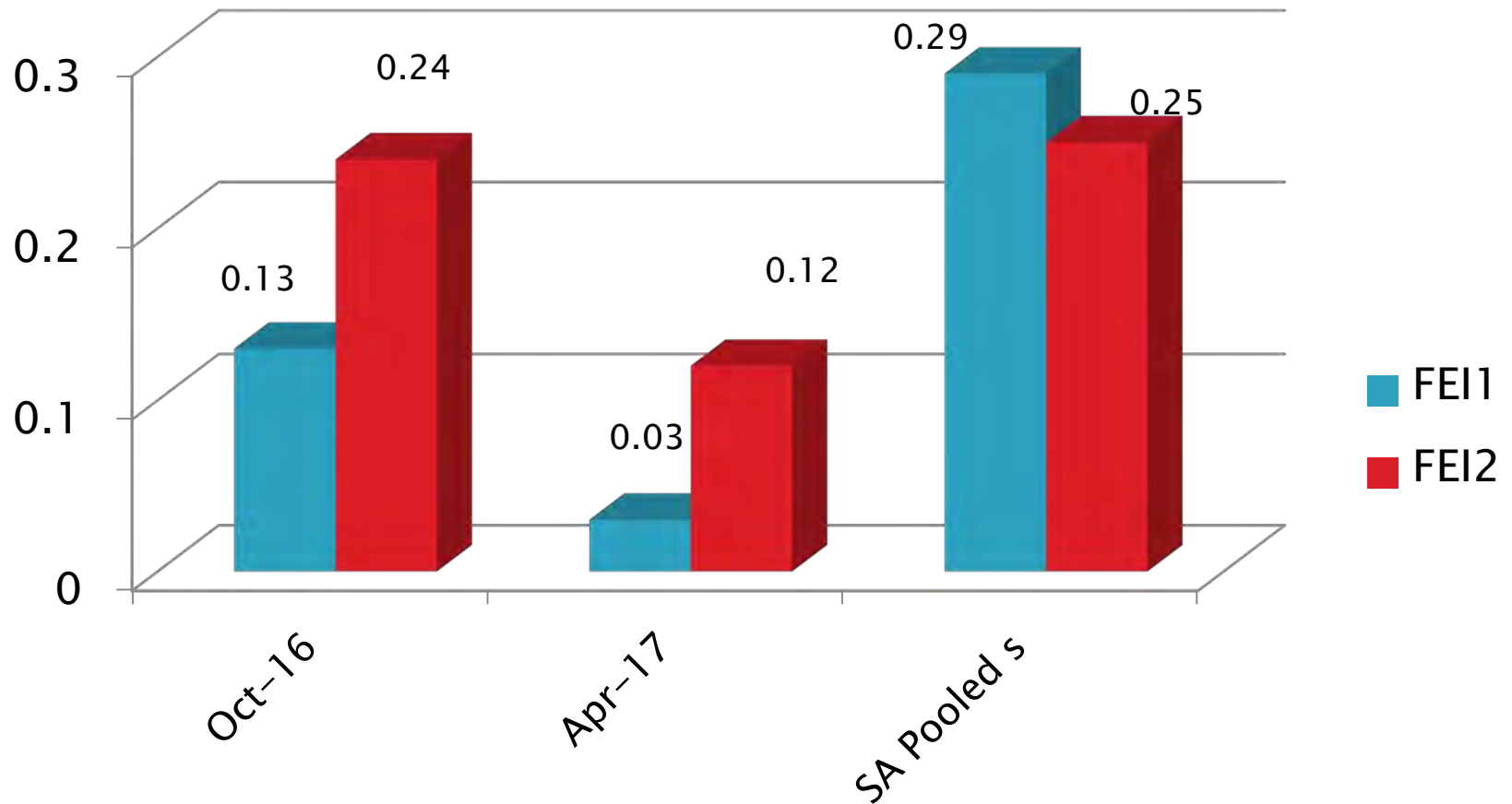


CUSUM Severity Analysis



20APR17:09:17

Sequence VIE Precision Estimates



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Sequence VIII

»» April 2017

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Sequence VIII Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	7
Operationally Invalid Calibration Test	LC	2
Total		9

Sequence VIII – Lost Tests*

Test Status	Cause	#
Invalid	Excessive Mechanical Wear	2
Totals		2

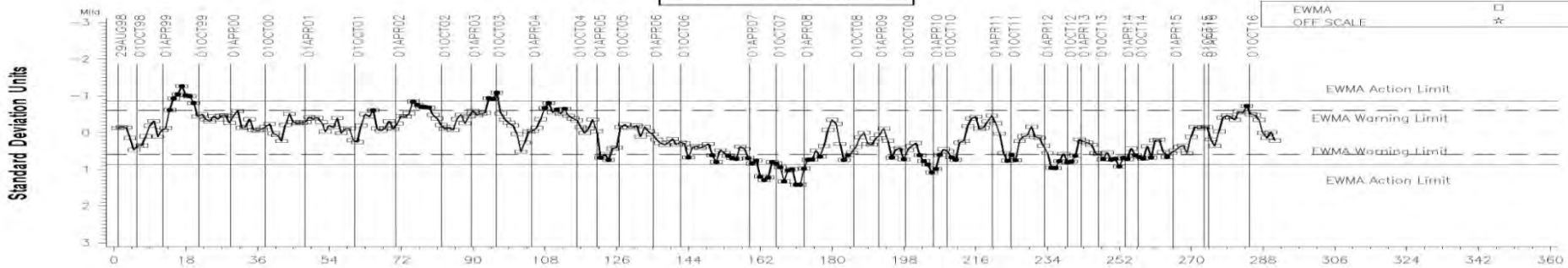
*Invalid and aborted tests

Sequence VIII Test Severity

- Bearing Weight Loss and Stripped Viscosity are in control for both severity and precision

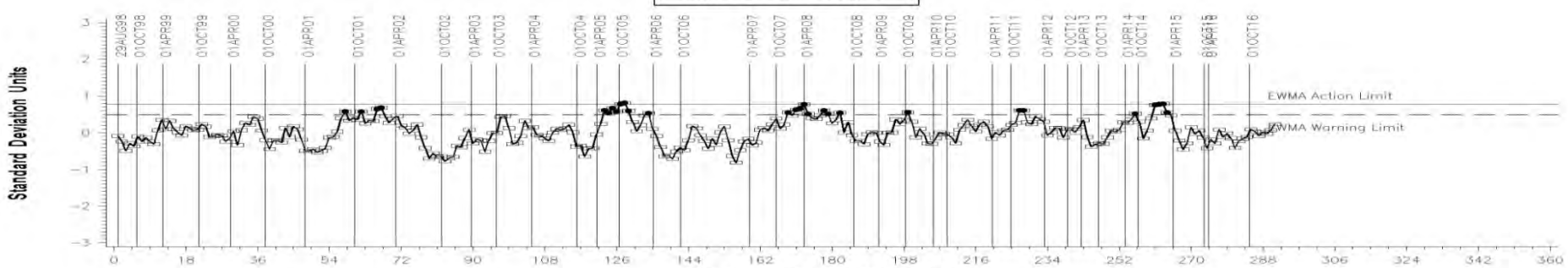
FINAL BEARING WEIGHT LOSS

LTMS Severity Analysis



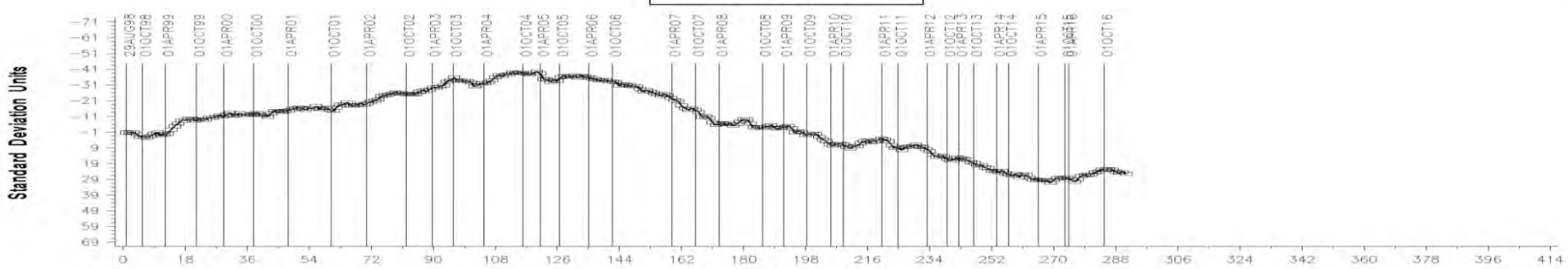
COUNT IN COMPLETION DATE ORDER

LTMS Precision Analysis



COUNT IN COMPLETION DATE ORDER

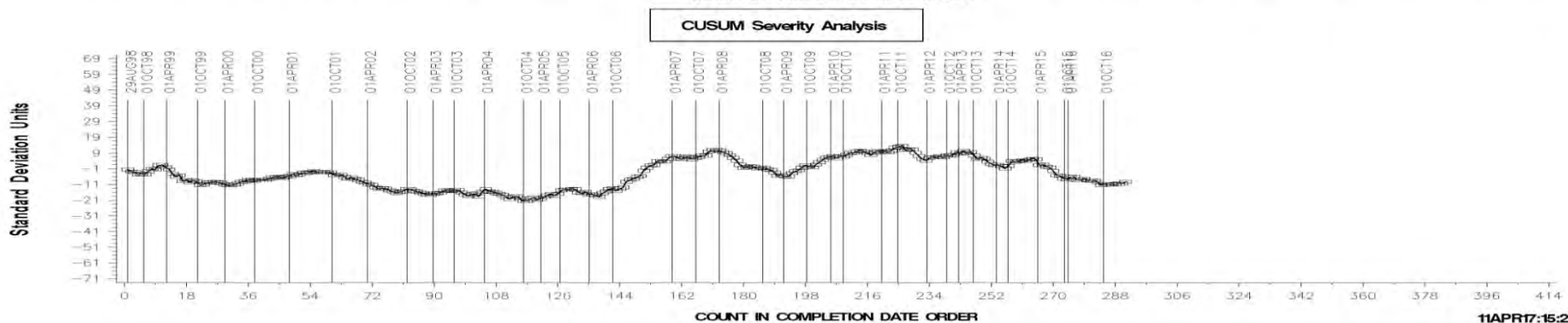
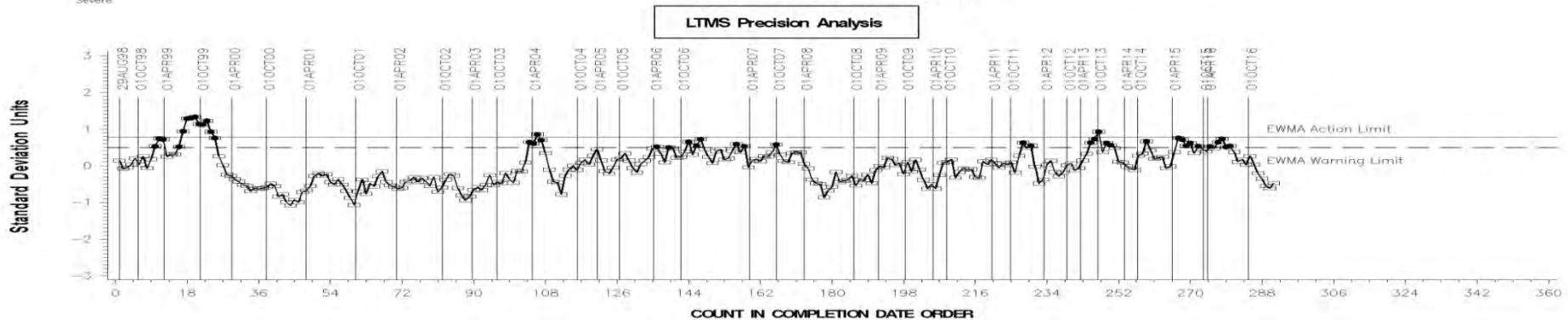
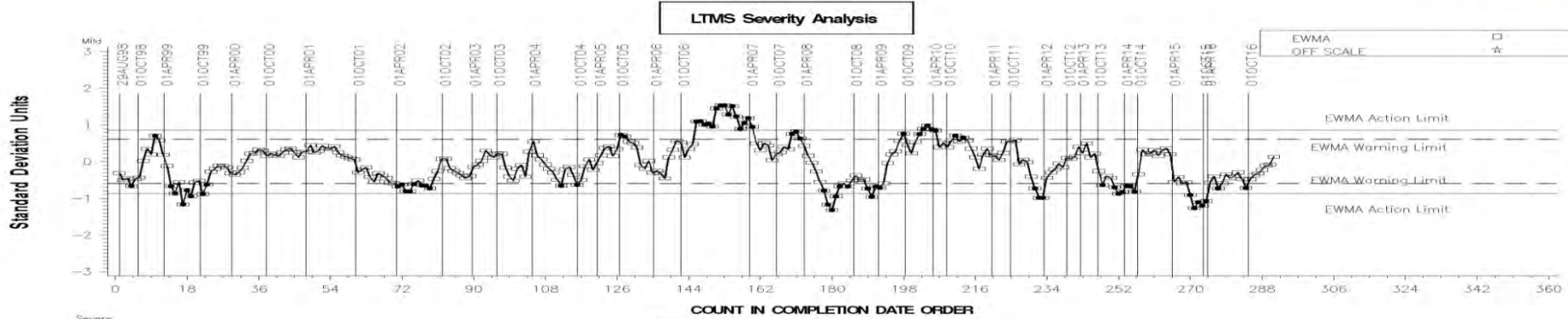
CUSUM Severity Analysis



COUNT IN COMPLETION DATE ORDER

11APR17:15:21

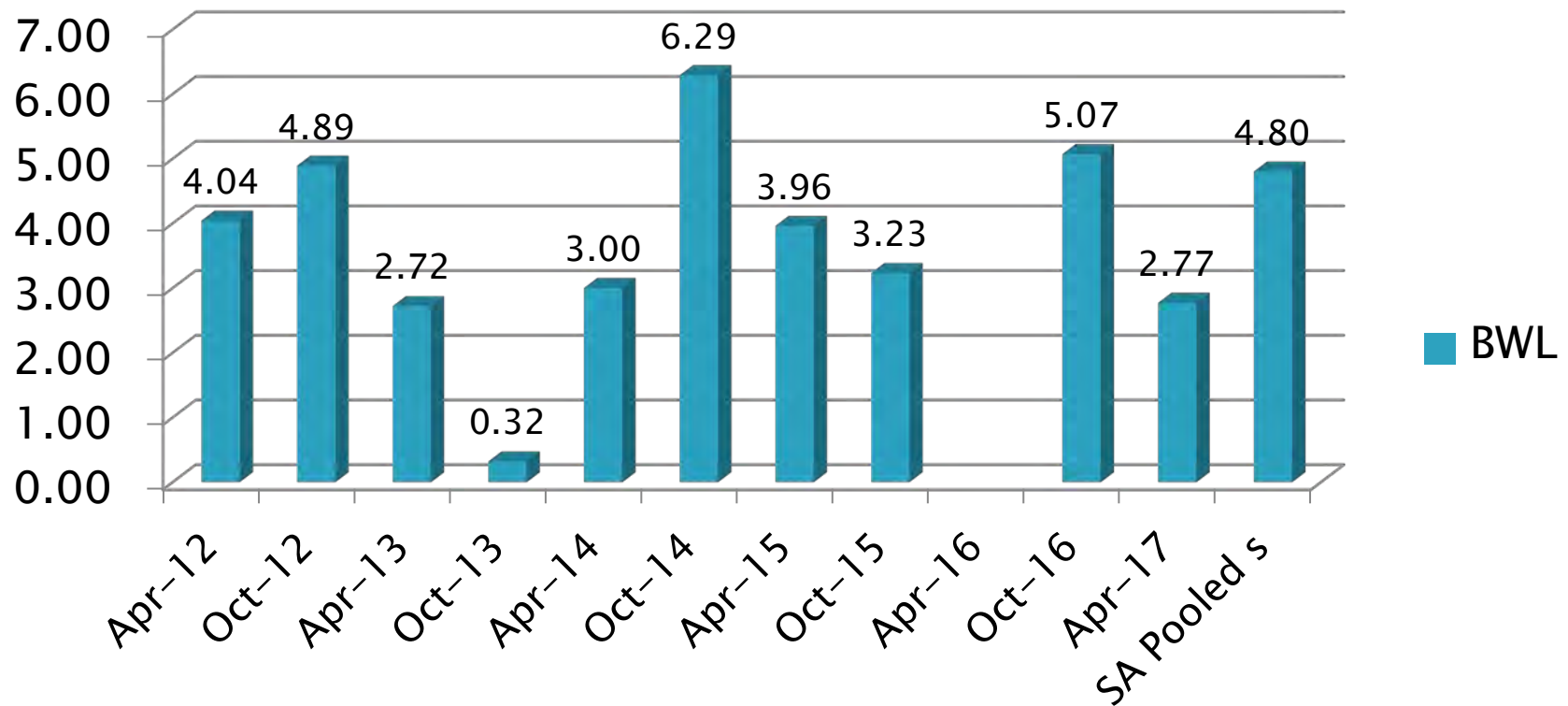
STRIPPED VIS. @ 100 DEG C



11APR17:15:21

Sequence VIII Precision Estimates

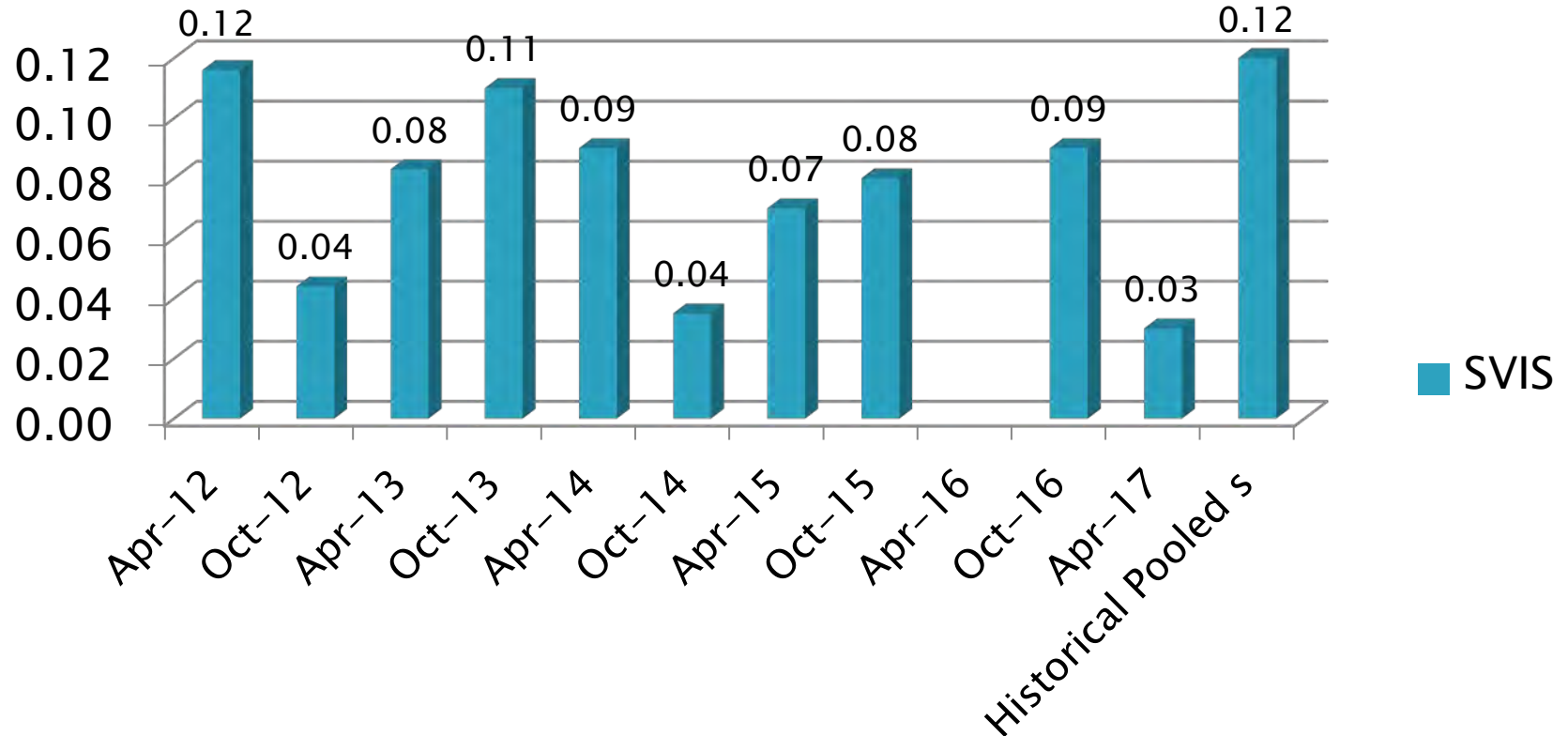
BWL



Sequence VIII Precision Estimates

SVIS

Historical Pooled s used for comparison purposes, parameter is not severity adjusted.



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Information Letters

»» October 1, 2016 –
March 31, 2017

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Information Letters*

Test	Date	IL	Topic
IIIH	20170321	17-1	Mandated the use of fans to cool sensor near exhaust system and addressed mounting of blowby canister and insulating of blowby hoses
IVA	20170216	17-1	Allowed use of alternate fuel pump
VIE	20170131	17-1	Allowed use of break in stand and changed calibration intervals when new engines are installed
VIE	20170301	17-2	Addressed discrepancy in calibration period

*Available from TMC Website

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Reference Oil Inventory

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

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Reference Oil Re-blends

➤ TMC 434-2

- Supplier has been contacted for re-blend

➤ TMC 542-3

- Re-blend of 542 is available, will need to introduce re-blend during next report period.

➤ TMC 1007

- Cannot be re-blended

➤ TMC 1009

- Supplier has been contacted and is working on a re-blend

Reference Oil Inventory Estimated Life

Oil	Tests	Original Blend Amount (gallons)	Quantity Shipped in last 6 months	TMC Inventory (gallons)	Lab Inventory (gallons)	Estimated Life
300	IVA	330	15	155	32	2+ years
433-1	IIIF	1045	0	0	8	<1 year
433-2	IIIF	500	40	222	28	2+ years
434	IIIG	550	0	<1	12	<1 year
434-1	IIIG	660	0	4	24	1.5 years
434-2	IIIG, IIIH	495	60	60	28	1 year
435	IIIG	550	0	2	4	<1 year
435-2	IIIG	550	0	170	28	3+ years
436	IIIH	1100	18	902	36	5+ years

Reference Oil Inventory Estimated Life

Oil	Tests	Original Blend Amount (gallons)	Quantity Shipped in last 6 months	TMC Inventory (gallons)	Lab Inventory (gallons)	Estimated Life
438	IIIG	990	12	38	20	1.5 years
438-1	IIIH	605	72	136	40	1.5 years
540	VID	1100	30	190	30	4+ years
542	VID	1100	0	0	5	<1 year
542-2	VID/E	1000	166	25	95	<1 years
542-3	VIE	997	0	997	0	4+ Years
543	VIF	1100	80	940	60	3+ Years
544	VIE	897	120	562	132	3+ years
704-1	VIII	897	4	105	10	3+ years

Reference Oil Inventory Estimated Life

Oil	Tests	Original Blend Amount (gallons)	Quantity Shipped in last 6 months	TMC Inventory (gallons)	Lab Inventory (gallons)	Estimated Life
925-3	VG	975	0	10	6	<1 year
940	VG, VH	560	18	244	18	3+ years
1006-2	IVA, VG, VIII	5500	140	1943	62	2+ years
1007	IVA, VG	1968	0	0	30	<1 year
1009	VG, VIII	1100	15	39	18	<1 year
1010	IIIG, VID	1100	0	3	5	<1 year
1010-1	VID/E	1760	224	1044	138	5 years
1011	VIF	1100	126	935	135	4 years
1012	IVB	2200	52	2148	32	5+ years

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LTMS Deviations

»» October 1, 2016 –
March 31, 2017

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LTMS Deviations

- No LTMS Deviations this period

LTMS Deviations

Historical Count of PCEO LTMS Deviations

Test	LTMS Deviations
IIIF	6
IIIG	6
IIIH	0
IVA	7
VG	8
VID	3
VIE	0
VIII	3

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Quality Index Deviations

»» October 1, 2016 –
March 31, 2017

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Quality Index Deviations

- Two Quality Index Deviations this Report Period.
 - IIIH – Intake Air Pressure
 - IIIH – Intake Air Temperature

Quality Index Deviations

Historical Count of PCEO Quality Index Deviations

Test	Quality Index Deviations
IIIF	28
IIIG	16
IIIH	4
IVA	28
VG	45

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TMC Laboratory Visits

»» October 1, 2016 –

April 31, 2017

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TMC Lab Visits

Test	Number of Labs Visited
VIE	3

Lab Visit Issues

- VIE
 - More than 2” of exposed T/C sheathing, fuel rail temperature
 - Improper location of intake air thermocouple

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Test Area Timelines

»» October 1, 2016 –
March 31, 2017

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Test Area Timeline Additions*

Test	Date	Topic	IL
IIIH	20170321	Mandated the use of fans to cool sensor near exhaust system and addressed mounting of blowby canister and insulating of blowby hoses	17-1
IVA	20170216	Allowed use of alternate fuel pump	17-1
VIE	20170131	Allowed use of break in stand and changed calibration intervals when new engines are installed	17-1
VIE	20170131	Addressed discrepancy in calibration period	17-1
VIF	20170323	Calibrated testing available	

*As of 03/31/2017

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Rating Workshop Data

»» 2016 Light Duty Workshop

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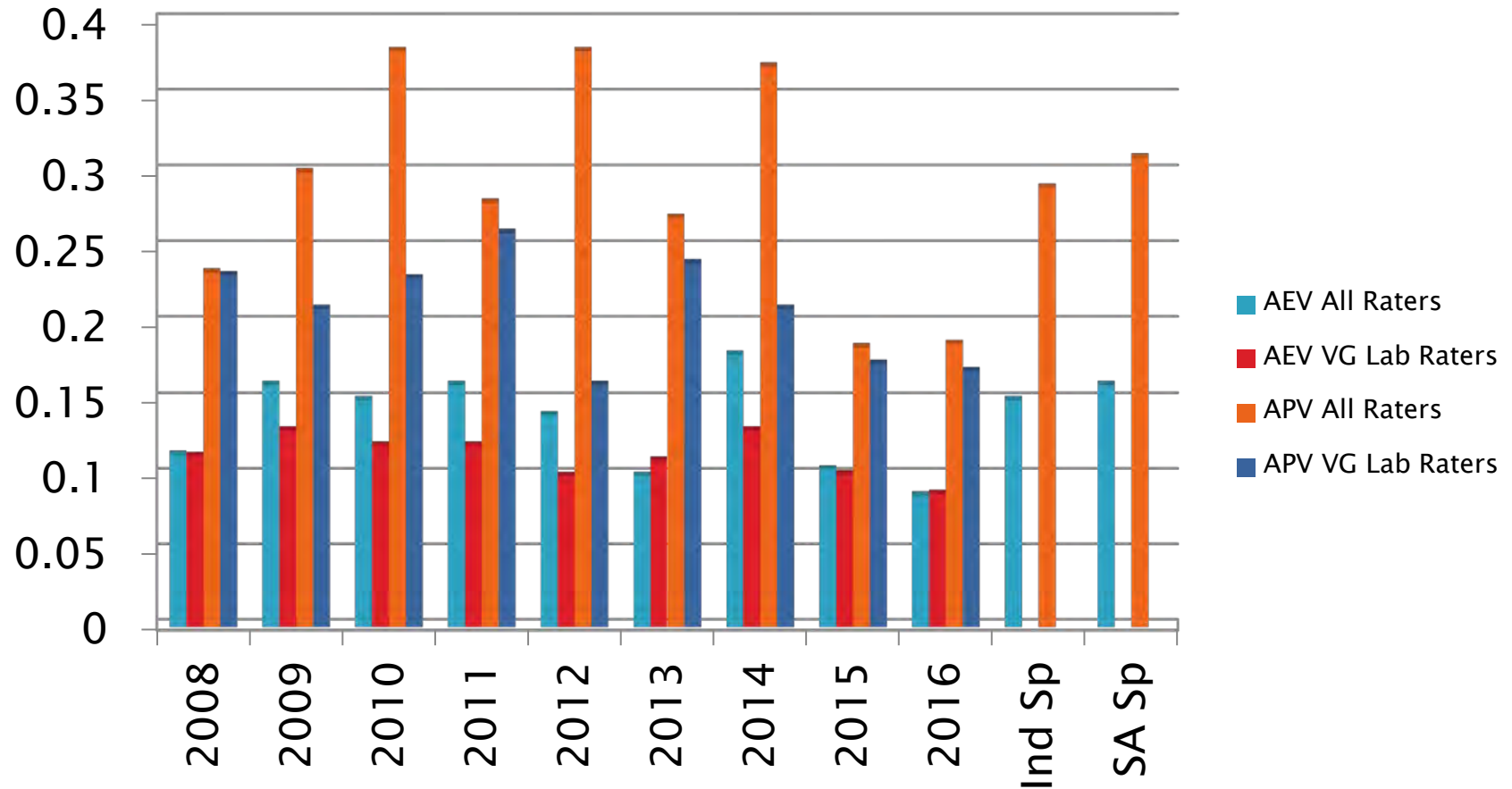
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Rating Workshop Data

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

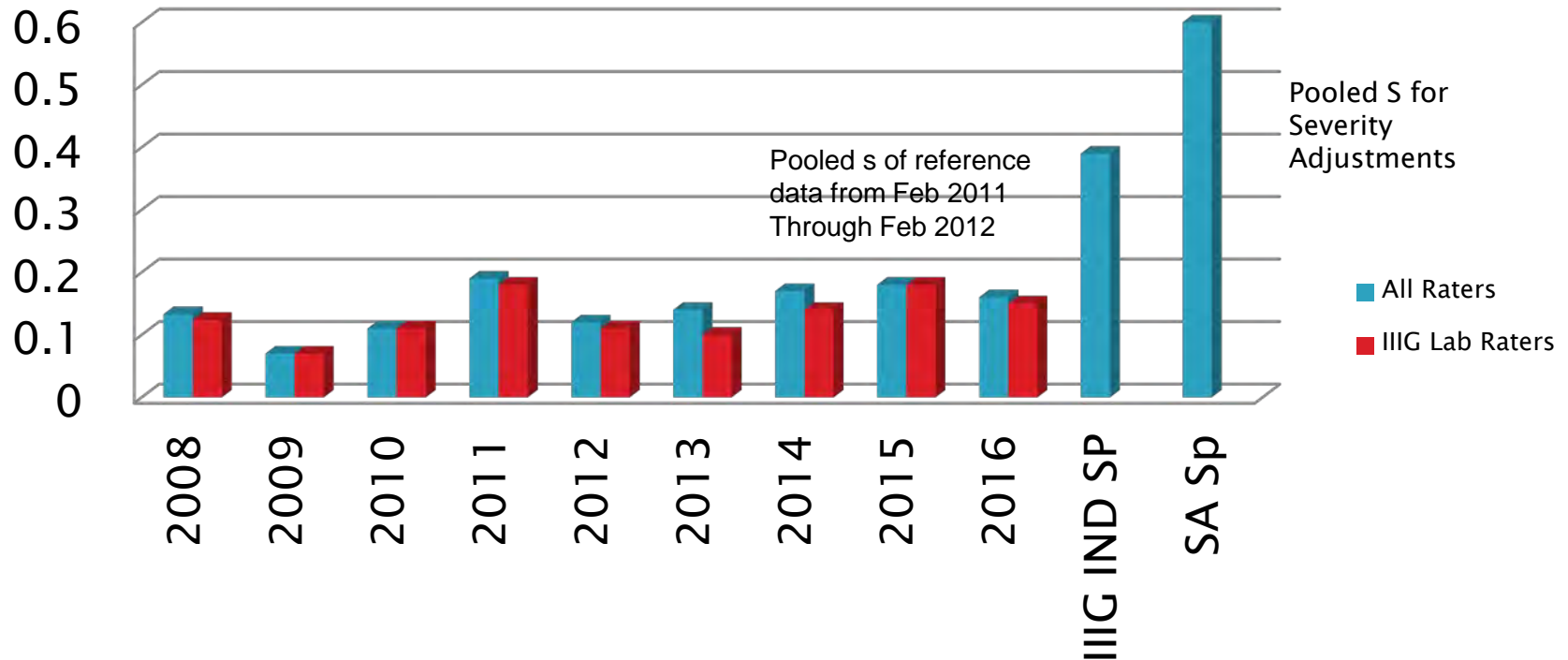
Sequence VG Precision–Rating Workshop Data

Workshop Data for VG Varnish



Sequence IIIG Precision – Rating Workshop Data

Comparison of Workshop Pooled Standard Deviations with Industry Pooled Standard Deviations



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Miscellaneous 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

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