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Test Monitoring Center

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ASTM D02.B1 Semiannual Report Passenger Car Reference Oil Testing

October 2017

Table of Contents

Section	Topic
Executive Summary	
	Summary Items
	Calibrated Labs and Stands
Test Area Status Summaries	
	Seq. III F
	Seq. III G
	Seq. III H
	Seq. IV A
	Seq. V G
	Seq. V H

Table of Contents

Section	Topic
Test Area Status Summaries	(cont.)
	Seq. VIE
	Seq. VIF
	Seq. VIII
	Seq. IX

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>

Passenger Car Engine Oil Testing Executive Summary

▶ Seq. VH

- Monitoring of the VH Test began in July, one new lab calibrated this period. Three other labs calibrated as a result of precision matrix.

▶ Seq. VID

- Test no longer available

[Return to Table of Contents](#)

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Passenger Car Engine Oil Testing Executive Summary

- ▶ Seq. VIF
 - VIF LTMS was approved in March, calibration testing began this period.
- ▶ Seq. IX (formerly LSPI)
 - Monitoring of the Test began in September with approval of 2016 BB grade pistons.

[Return to Table of Contents](#)

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Calibrated Labs and Stands*

Test	Labs	Stands
IIIF	2	3
IIIG/A/B	3	6
IIIH/A/B	5	14
IVA	3	4
VG	3	3

[Return to Table of Contents](#)

*As of 9/30/2017

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Calibrated Labs and Stands*

Test	Labs	Stands
VH	4	6
VIE	5	17
VIF	2	3
VIII	3	4
IX	2	4

[Return to Table of Contents](#)

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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
Total		7

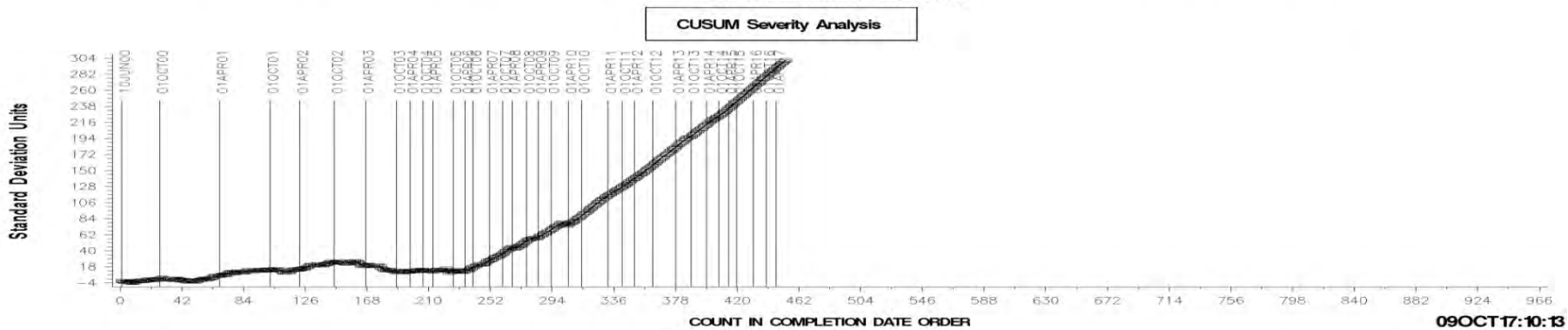
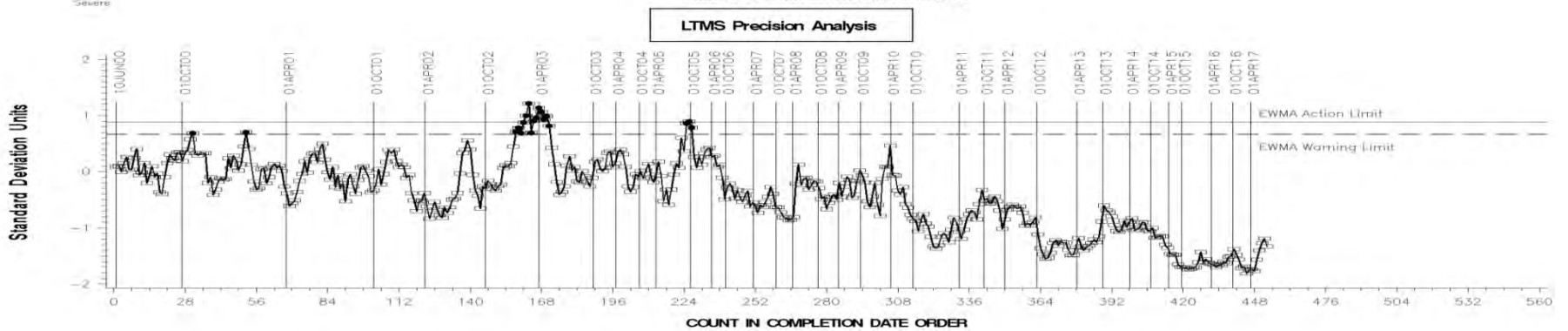
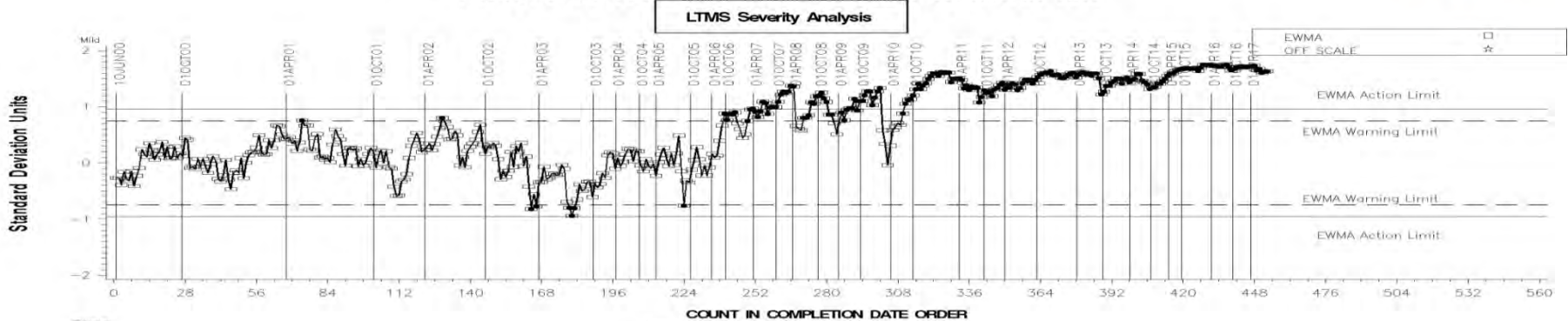
Sequence III F – Failed Tests

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

Sequence IIF Test Severity

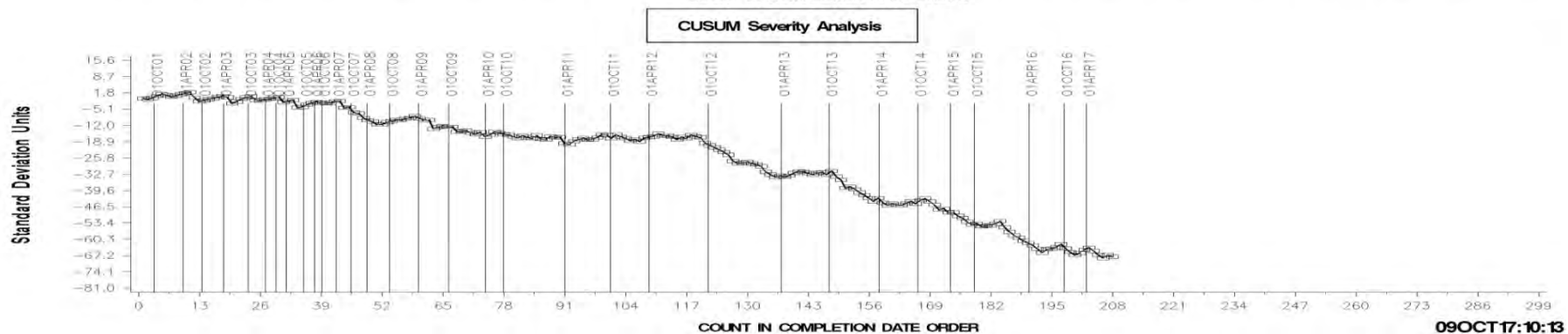
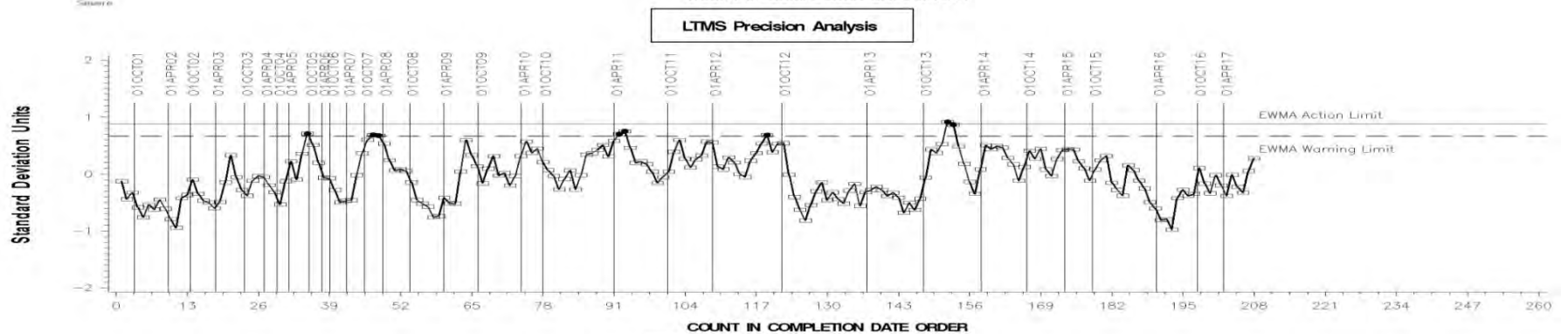
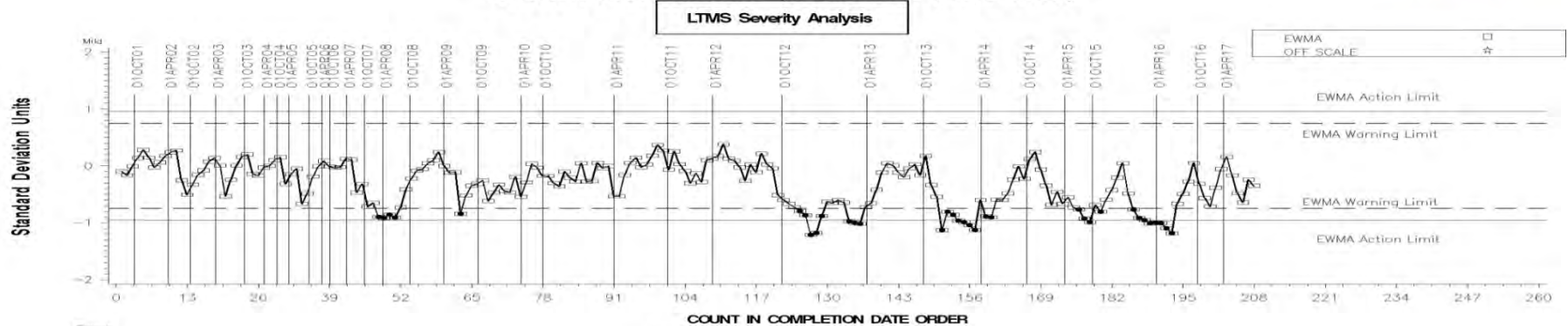
- APV
 - In severity action alarm, mild
 - Long-term mild trend continuing (Since October 2006)
- Hours to 275% Vis Increase
 - In control
- WPD
 - In control
- PV60
 - In severity action alarm (severe) and precision warning alarm

AVERAGE PISTON SKIRT VARNISH FINAL ORIG UNIT RES



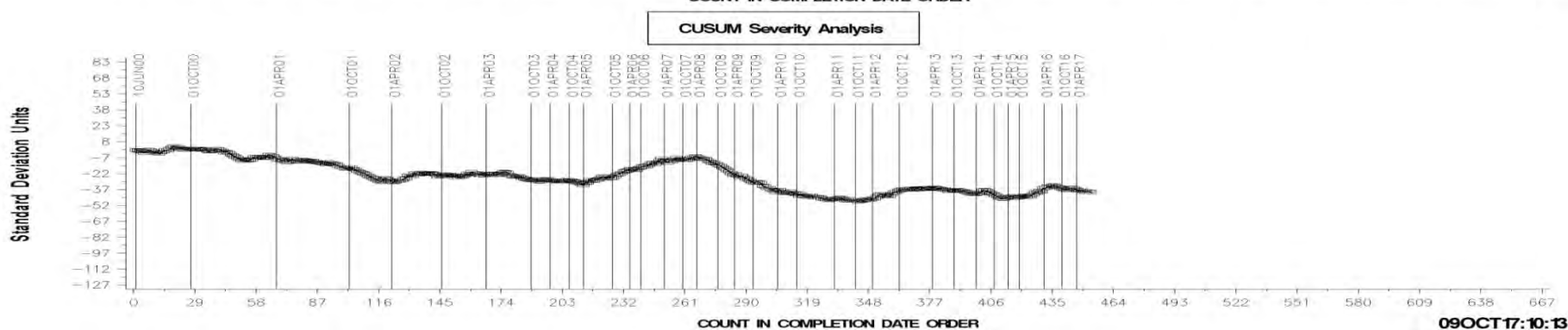
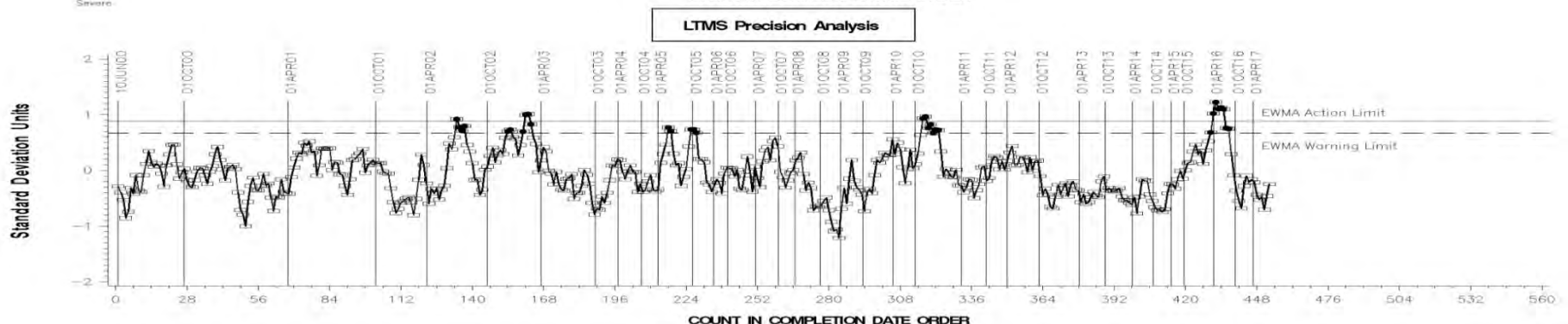
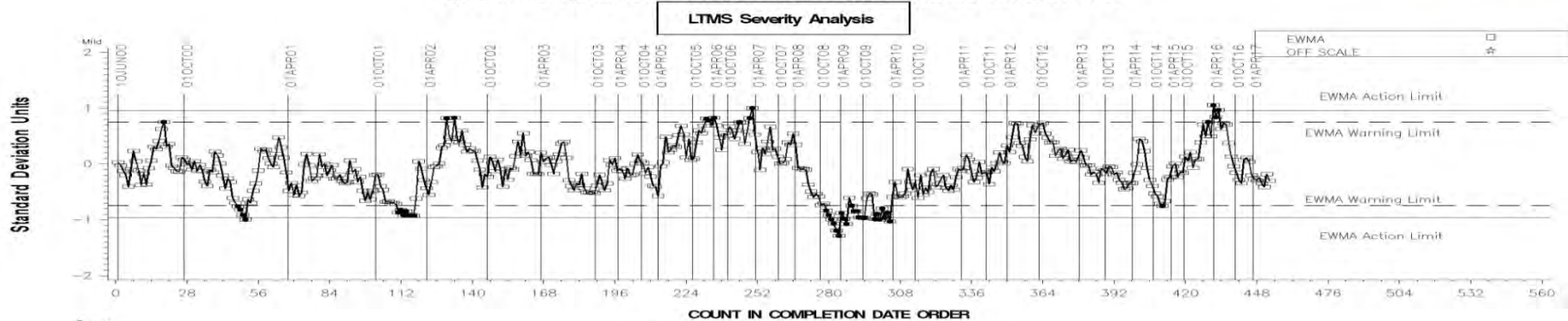
09OCT17:10:13

HOURS FINAL ORIG RES (REFERENCE TESTS ONLY)



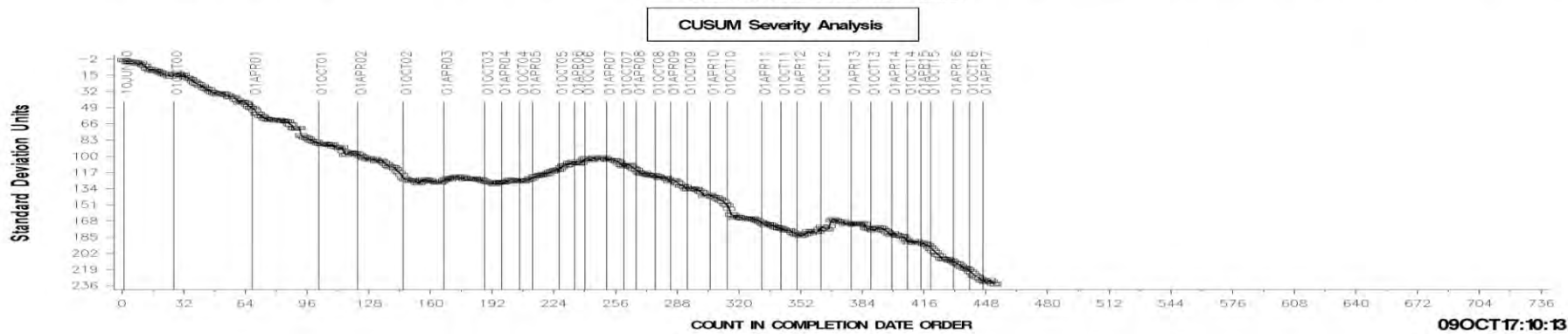
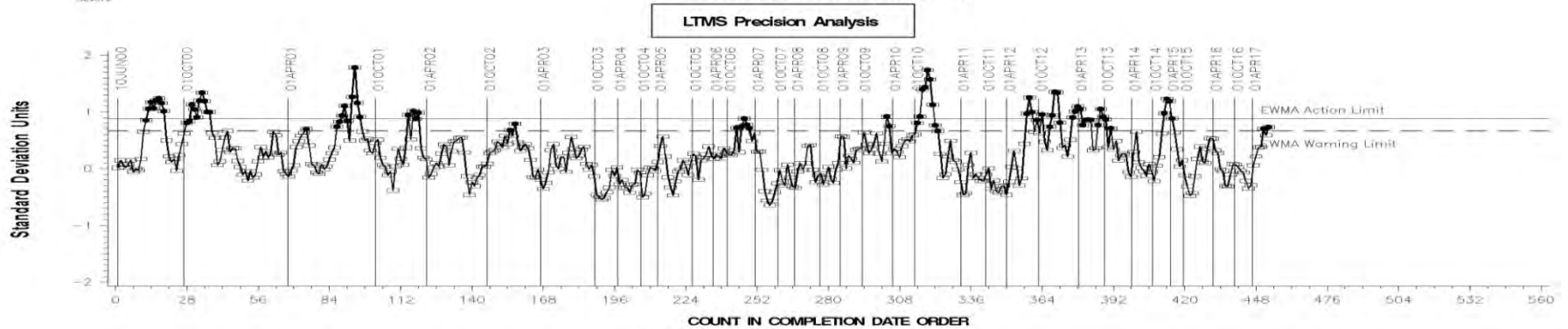
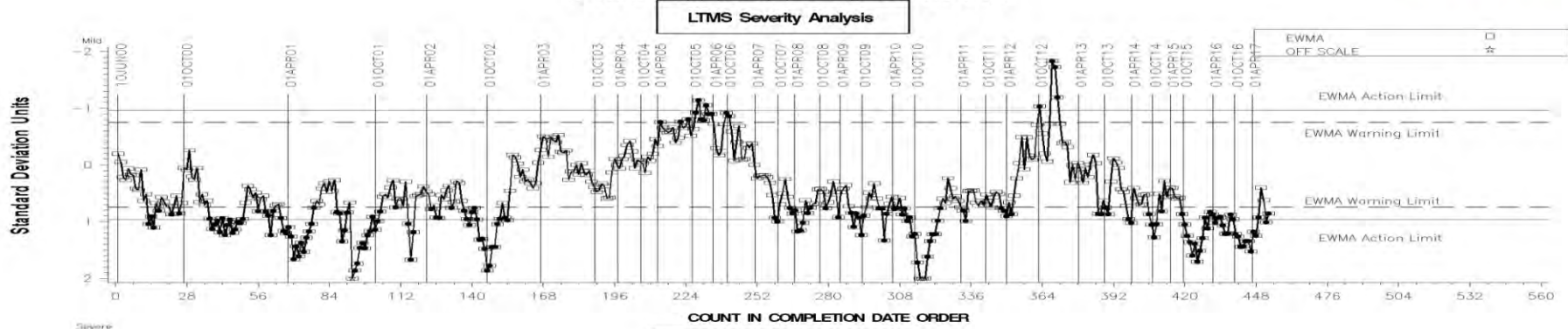
09OCT17:10:13

AVERAGE WEIGHTED PISTON DEPOSITS FNL ORIG UNIT RES



09OCT17:10:13

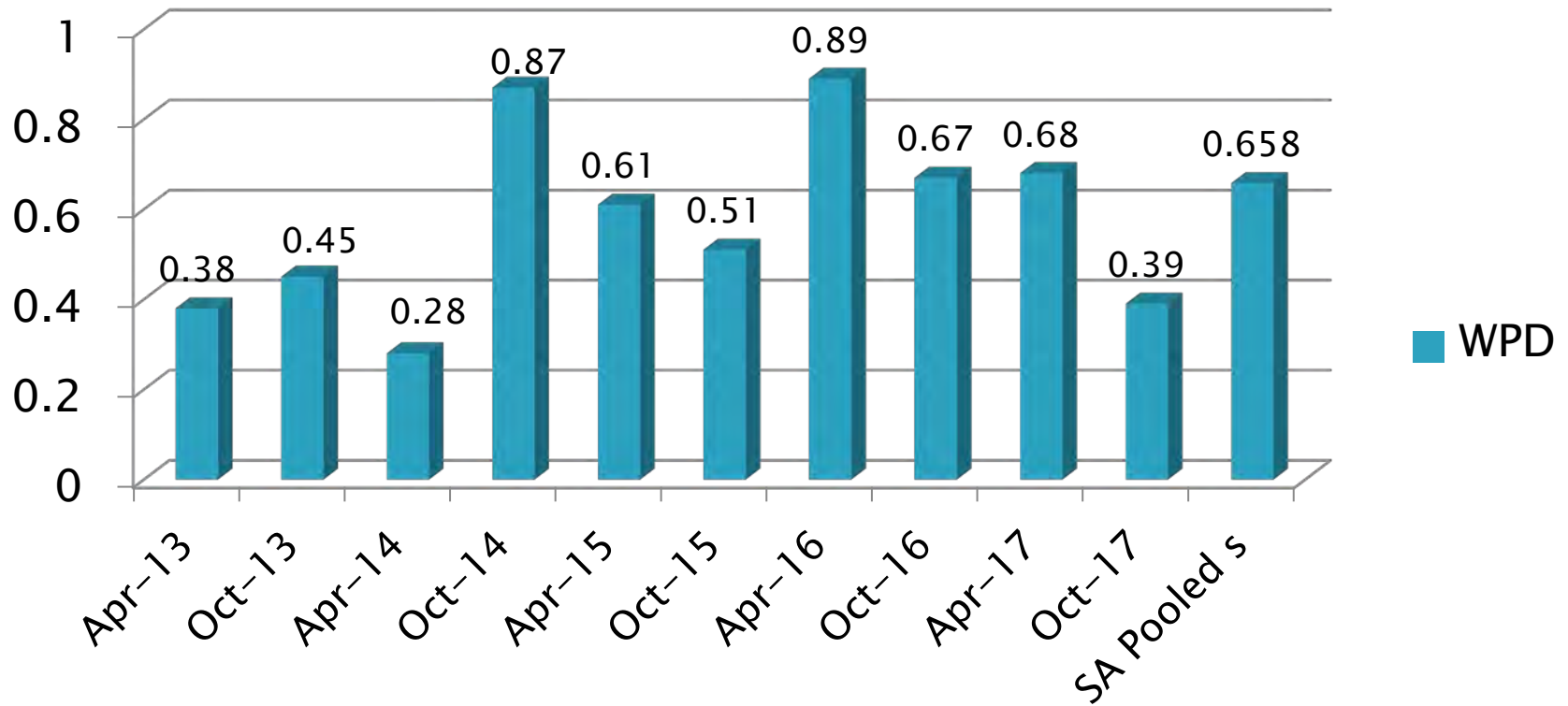
% VISCOSITY INCREASE @ 060 HOURS



09OCT17:10:13

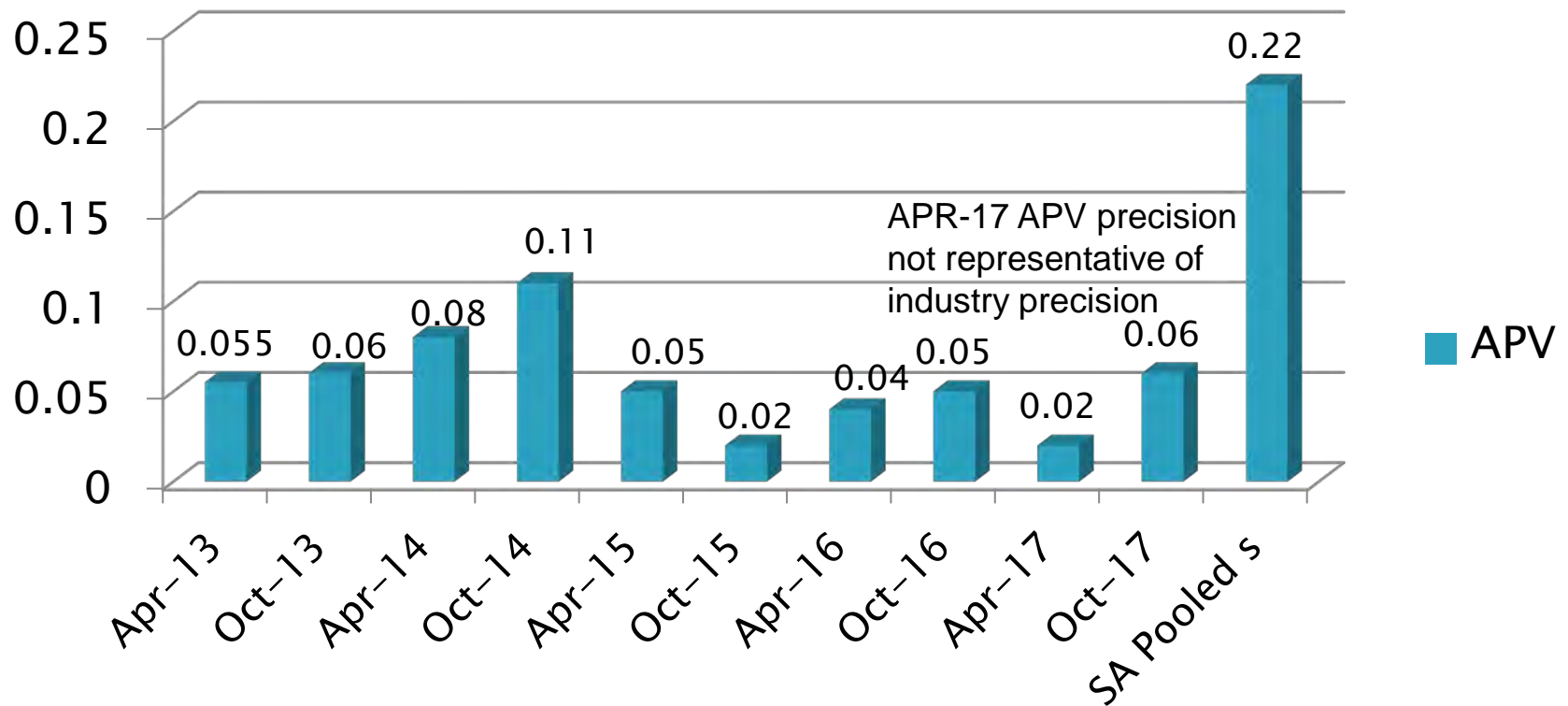
IIIF Precision Estimates

WPD



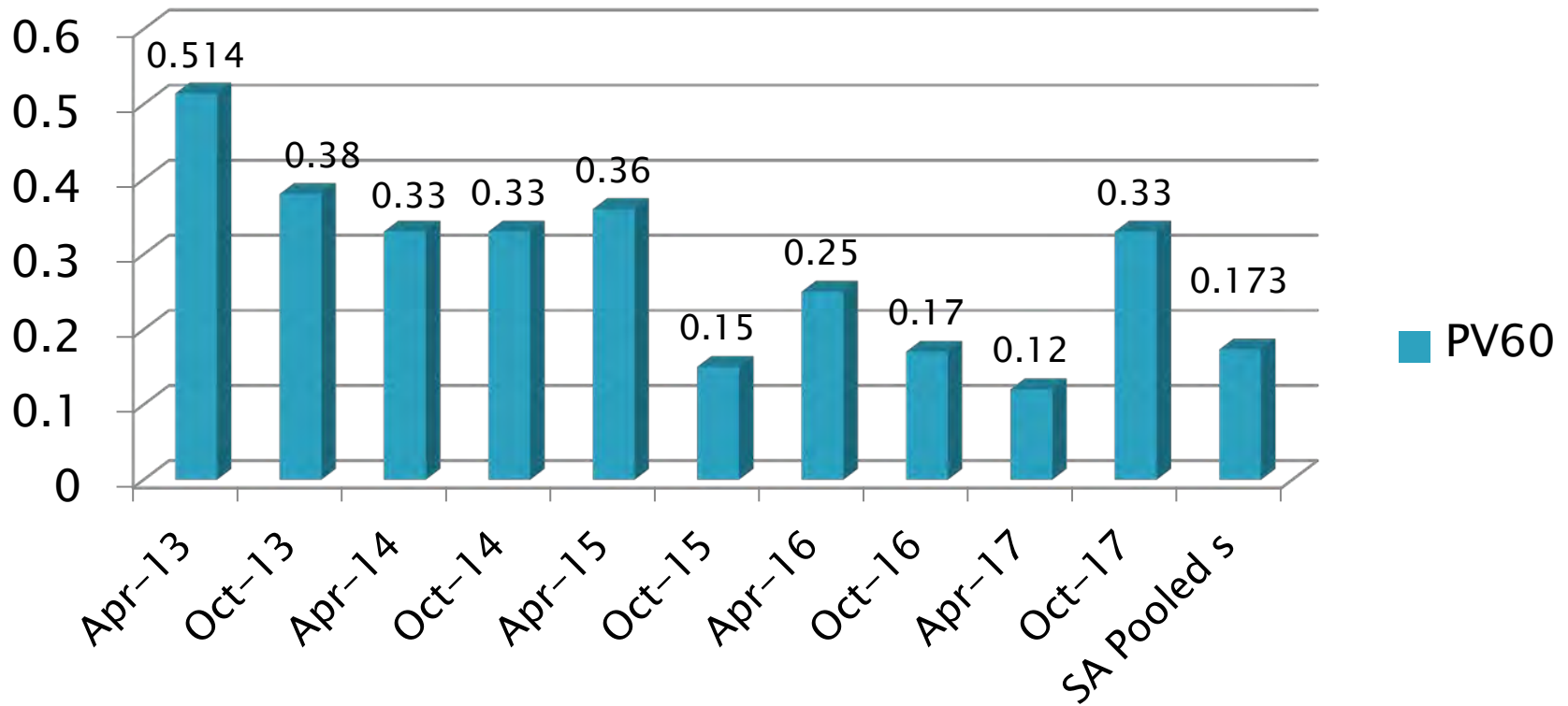
IIIF Precision Estimates

APV



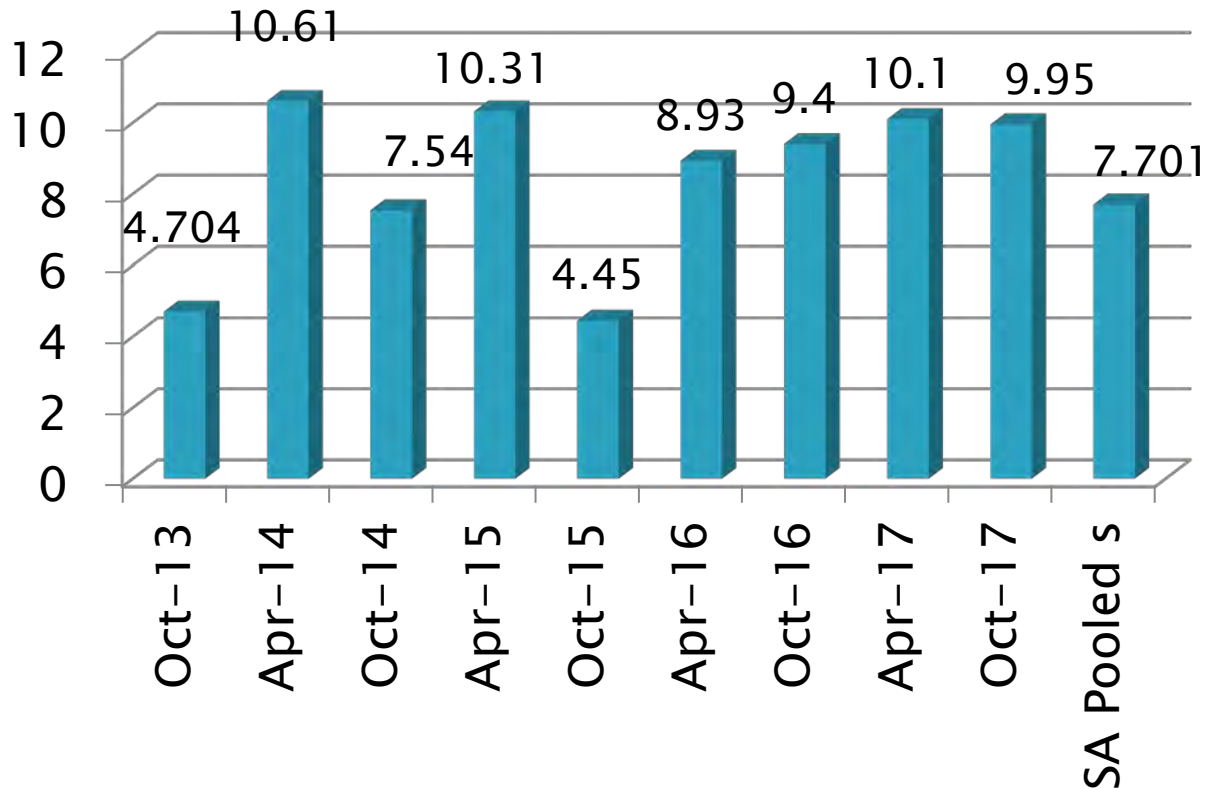
IIIF Precision Estimates

PV60



IIIF Precision Estimates

Hours to 275%



■ Hours to 275%

[Return to Table of Contents](#)

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Sequence IIIG/A/B

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Sequence IIIG Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	3
Statistically Unacceptable Calibration Test	OC	1
Total		4

Sequence III G – Failed Tests

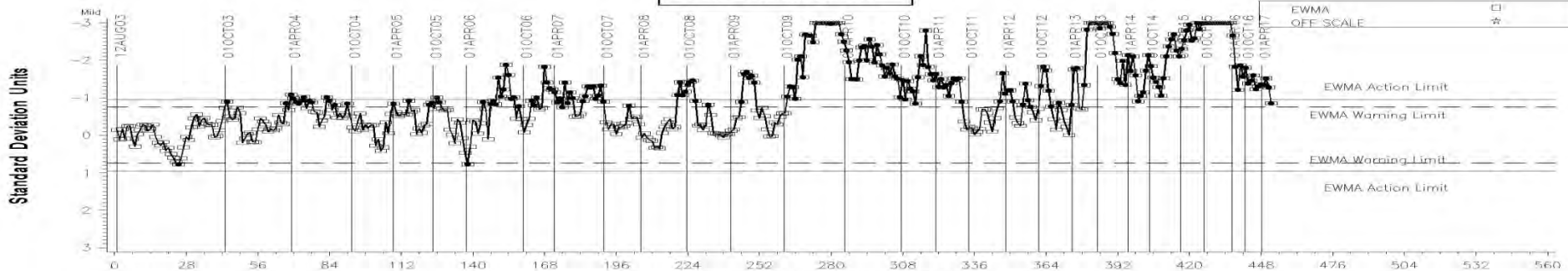
Test Status	#
Severe PVIS	1
Totals	1

Sequence IIIG Test Severity

- **ACLW** in severity warning alarm
 - Long-term mild trend
- **PVIS**
 - Precision action alarm
 - Severity action alarm (severe)
- **WPD** is in control
 - Long-term severe trend continuing
- **MRV** is in severity action alarm (severe)
 - Long-term severe trend continuing
- **PHOS** is in control

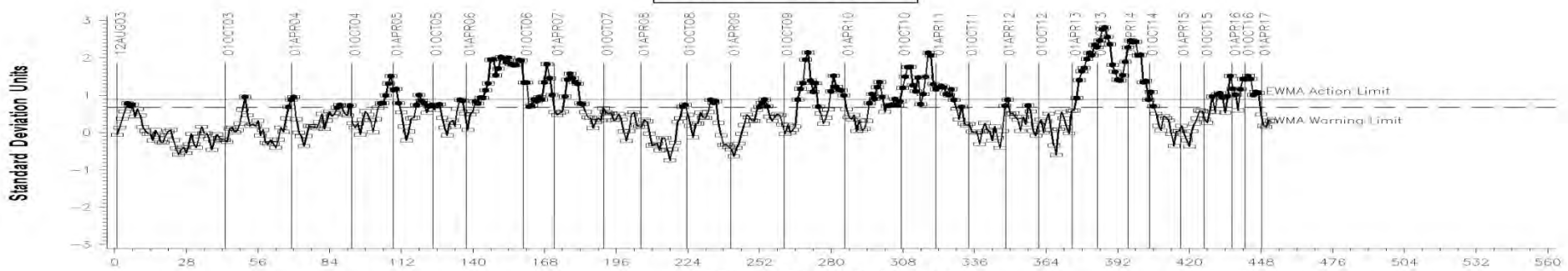
AVERAGE CAM + LIFTER WEAR

LTMS Severity Analysis



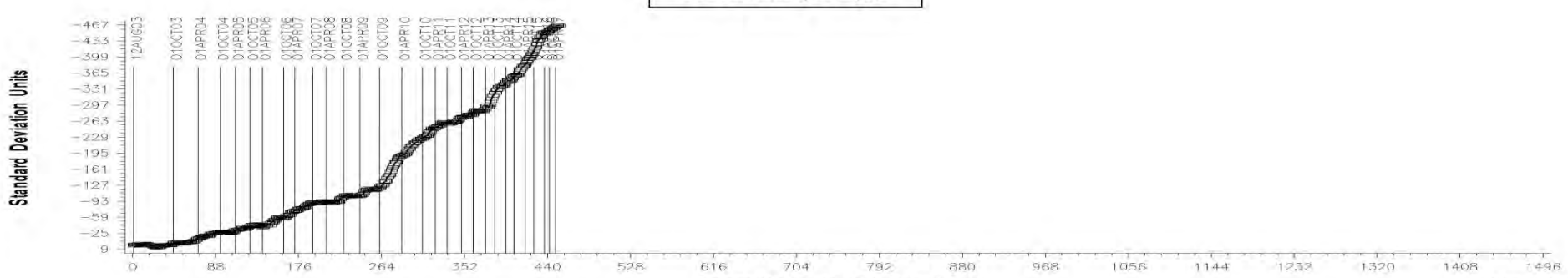
COUNT IN COMPLETION DATE ORDER

LTMS Precision Analysis



COUNT IN COMPLETION DATE ORDER

CUSUM Severity Analysis

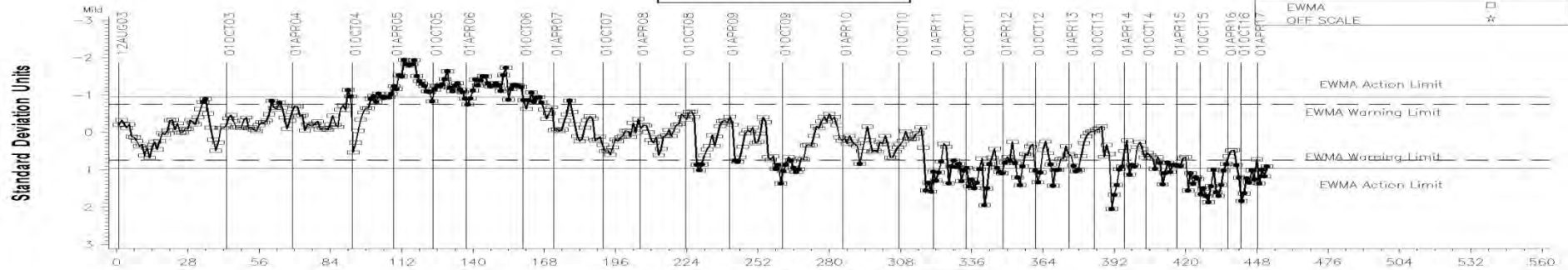


COUNT IN COMPLETION DATE ORDER

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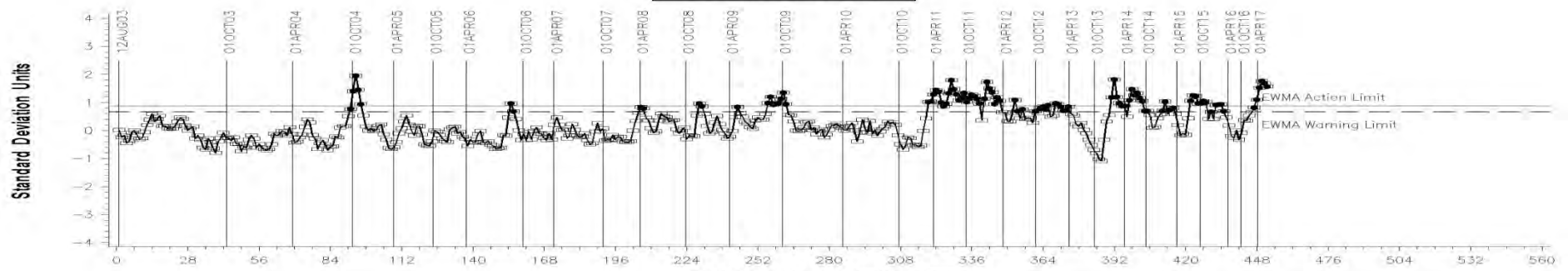
VISCOSITY INCREASE

LTMS Severity Analysis



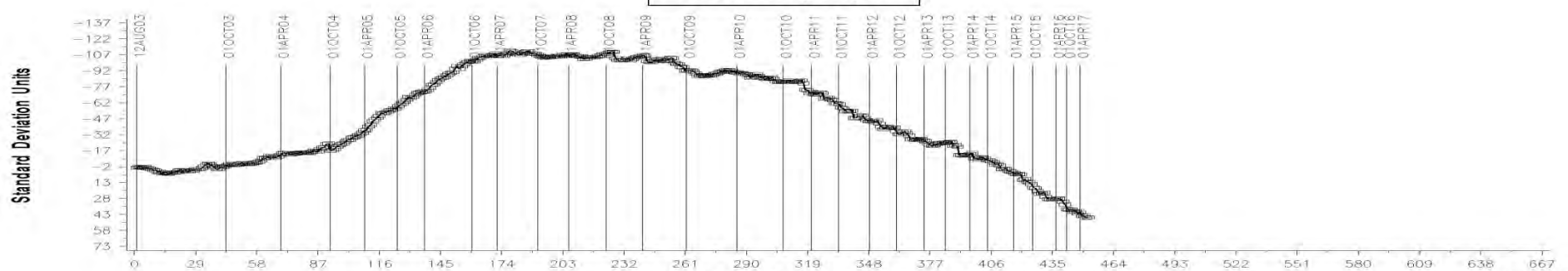
COUNT IN COMPLETION DATE ORDER

LTMS Precision Analysis



COUNT IN COMPLETION DATE ORDER

CUSUM Severity Analysis

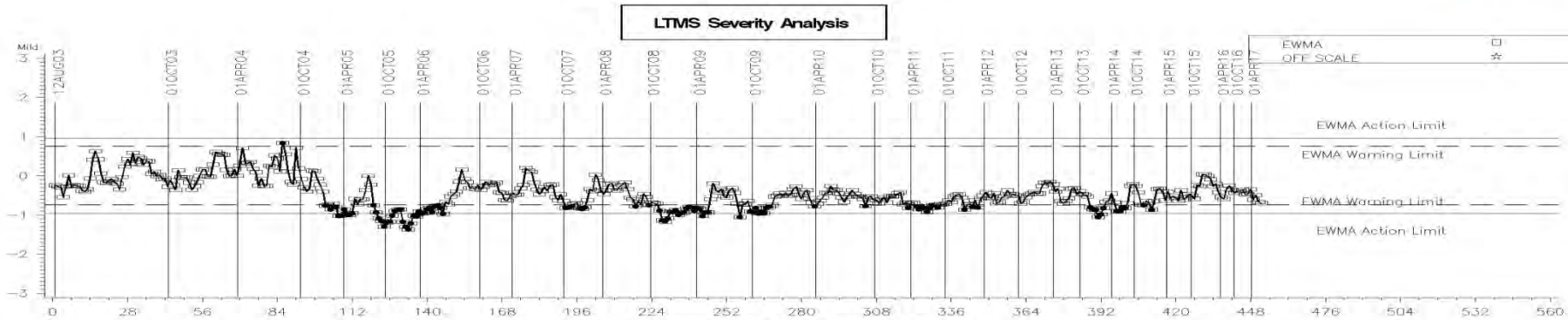


COUNT IN COMPLETION DATE ORDER

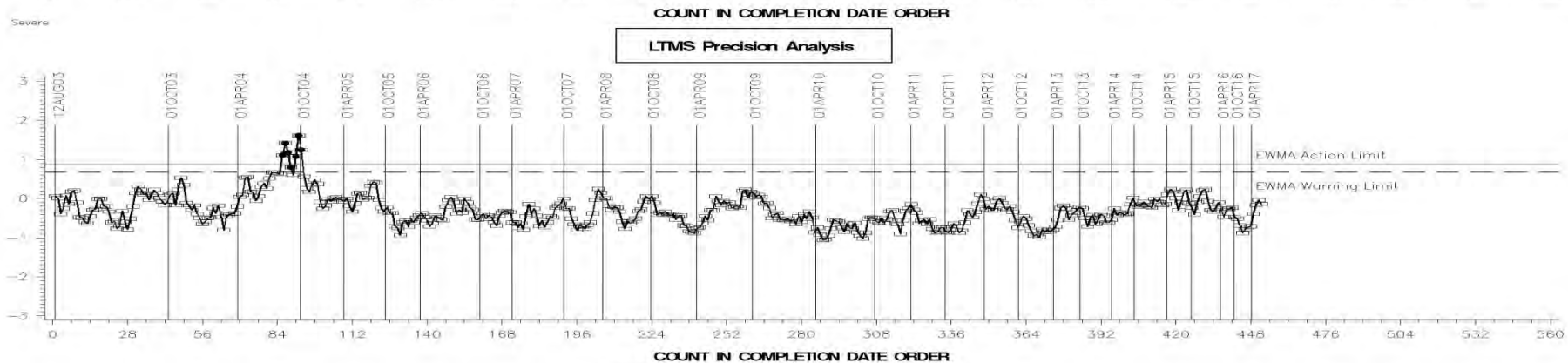
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AVERAGE WEIGHTED PISTON DEPOSITS

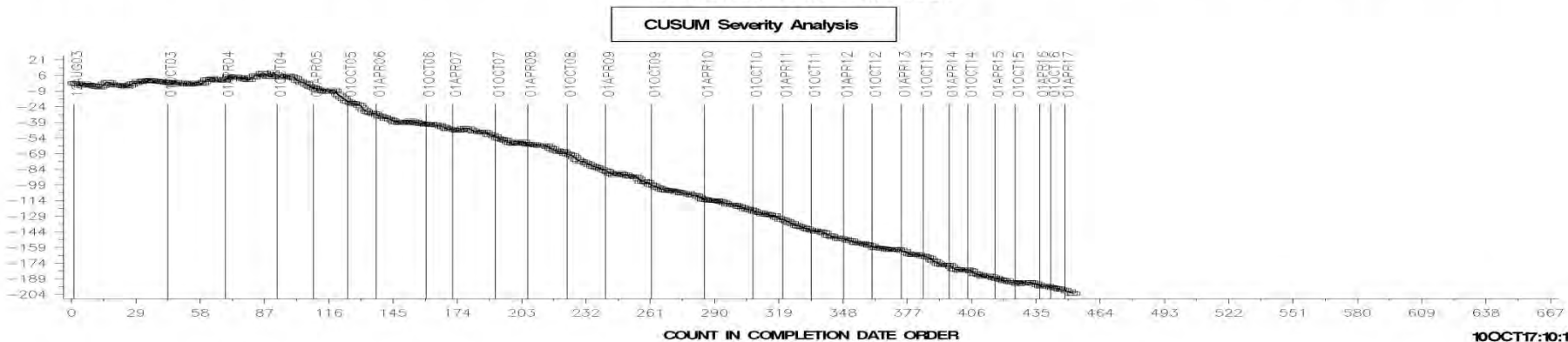
Standard Deviation Units



Standard Deviation Units



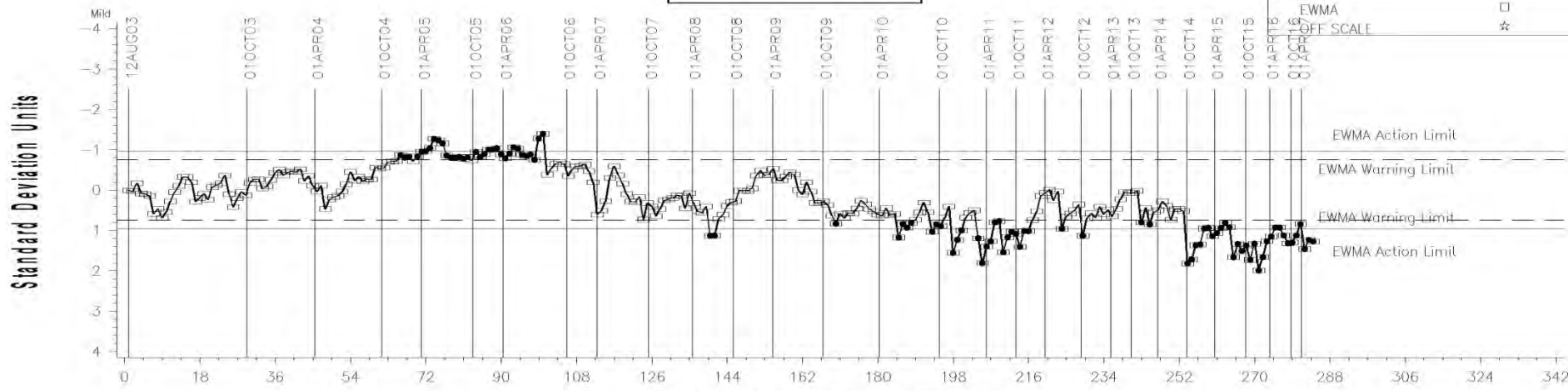
Standard Deviation Units



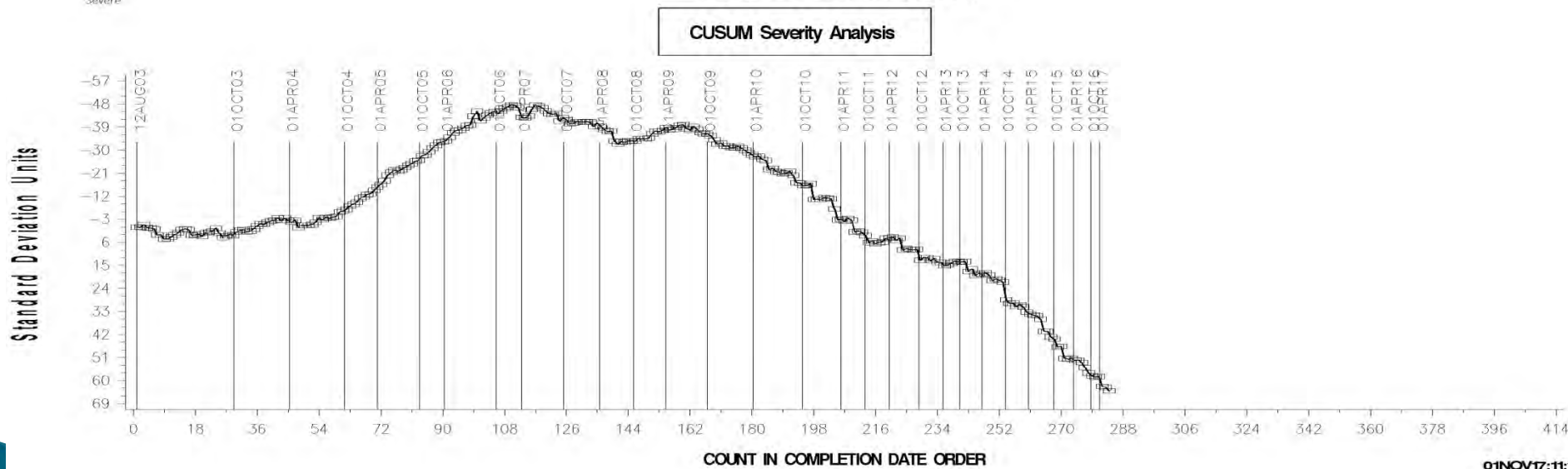
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MRV VISCOSITY RESULT

LTMS Severity Analysis



CUSUM Severity Analysis

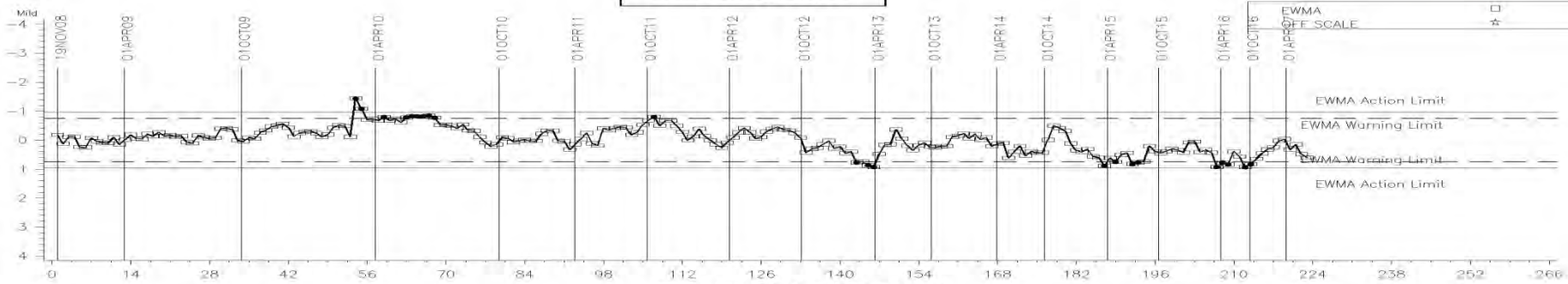


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PHOS RETENTION

LTMS Severity Analysis

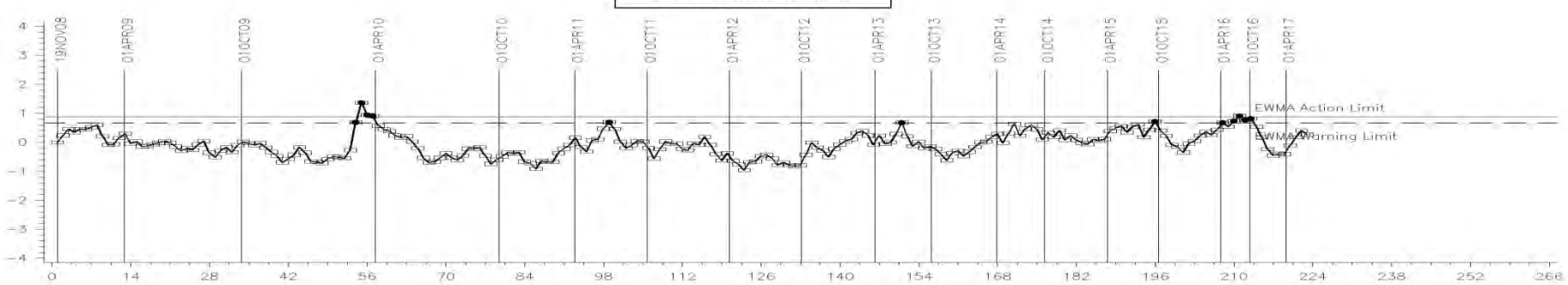
Standard Deviation Units



COUNT IN COMPLETION DATE ORDER

LTMS Precision Analysis

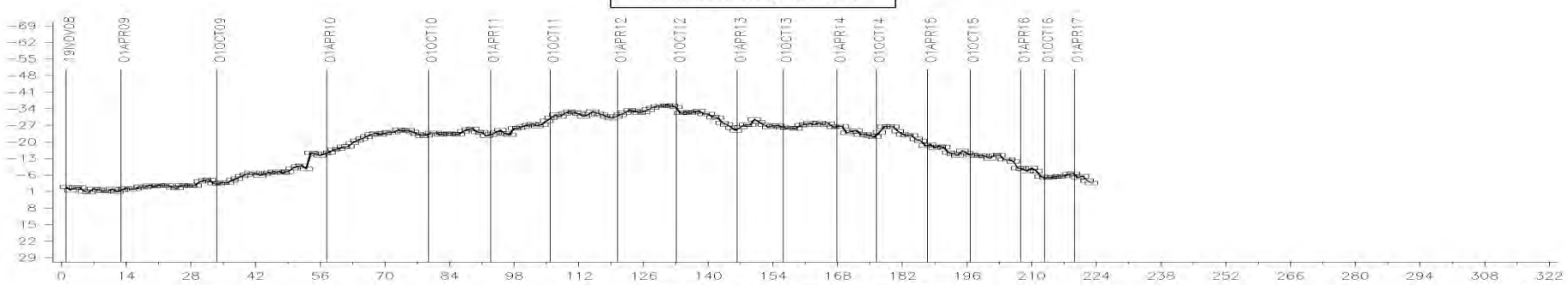
Standard Deviation Units



COUNT IN COMPLETION DATE ORDER

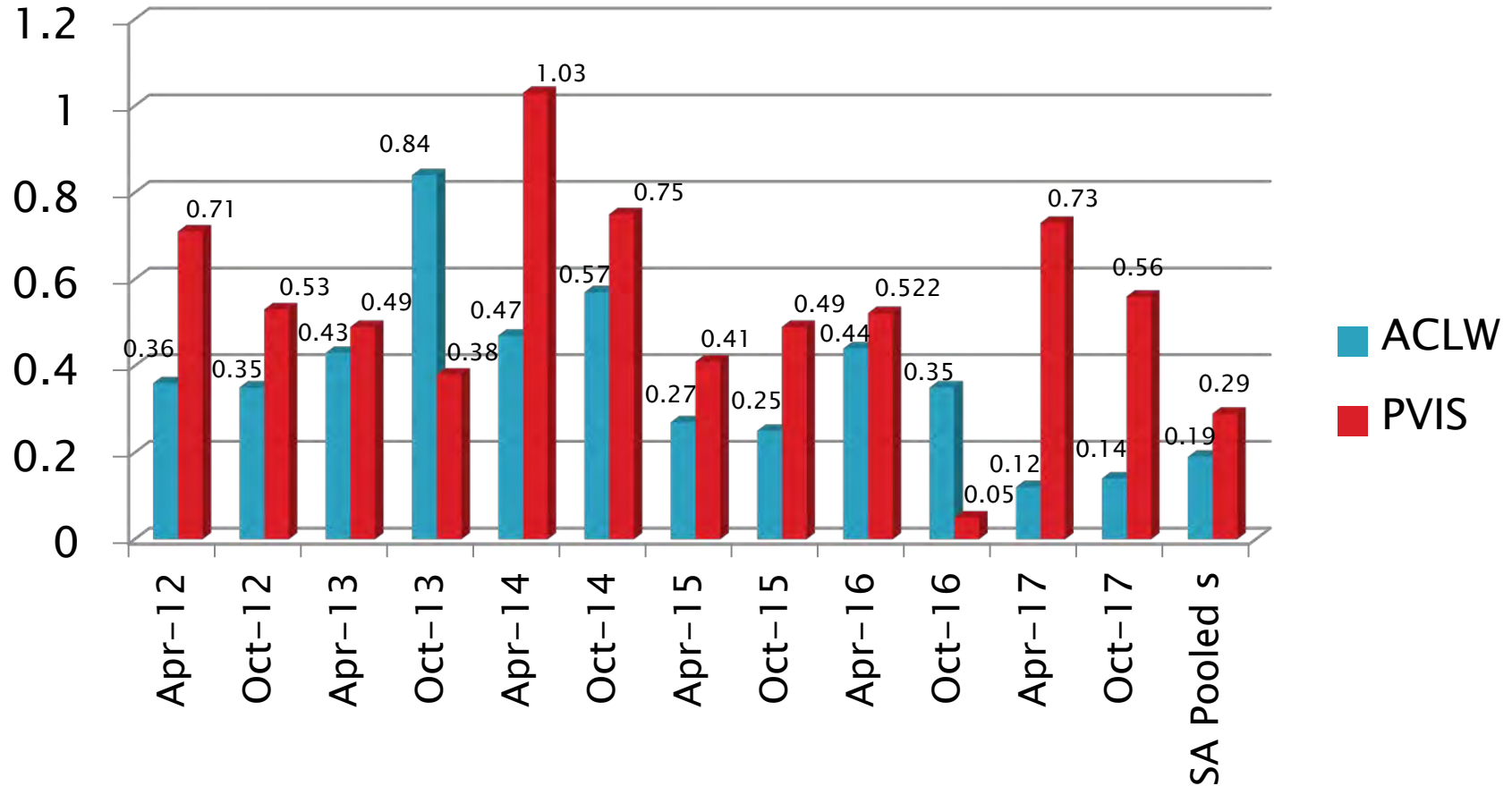
CUSUM Severity Analysis

Standard Deviation Units

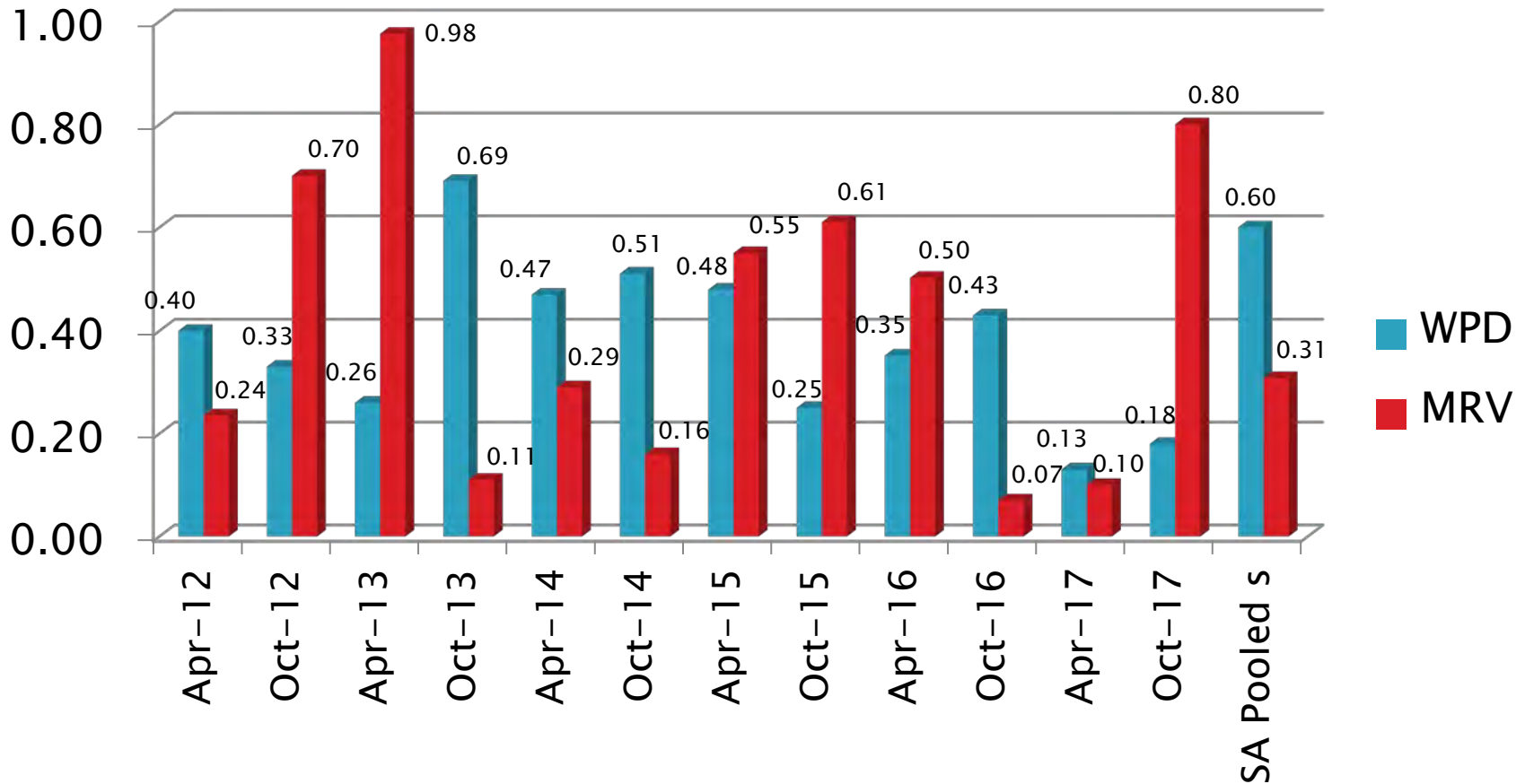


COUNT IN COMPLETION DATE ORDER

IIIG Precision Estimates



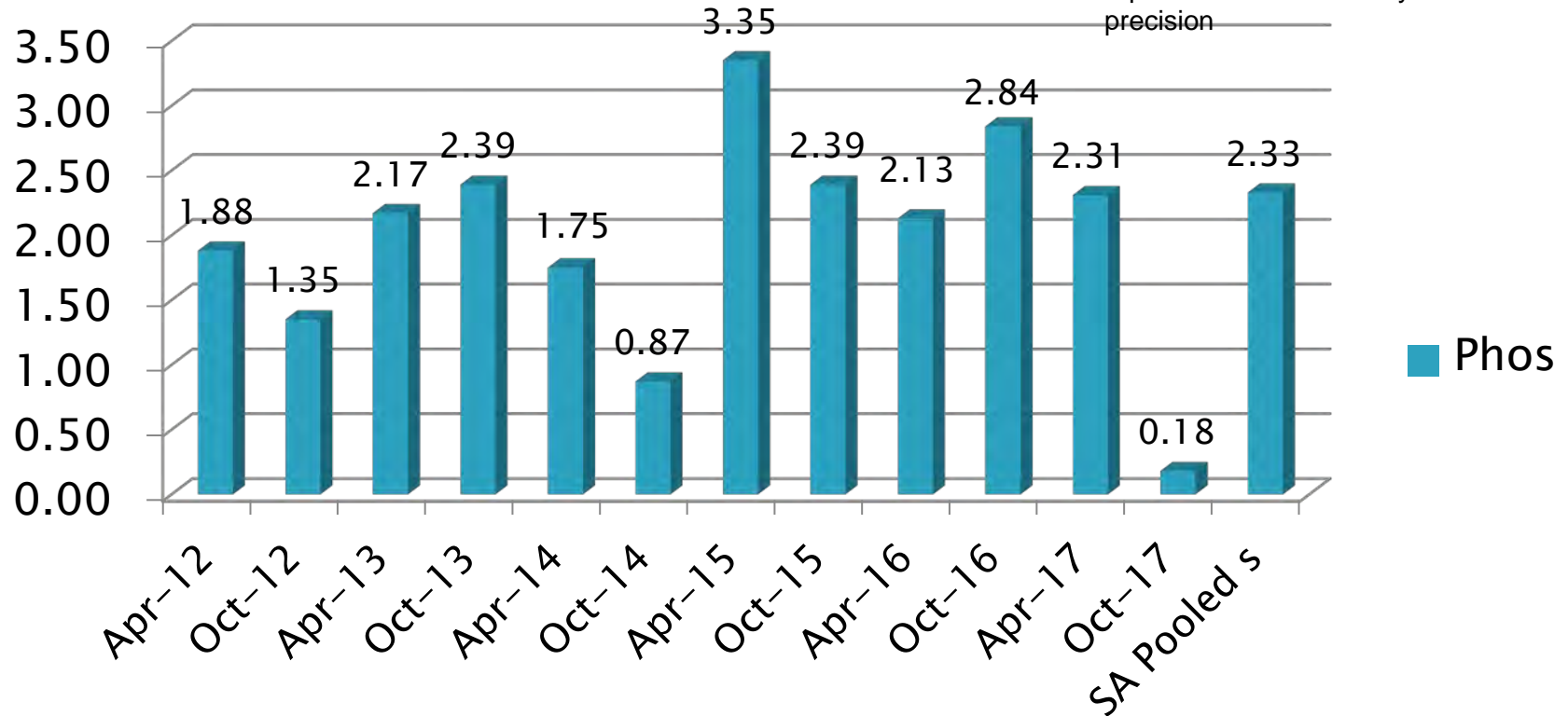
IIIG Precision Estimates



IIIG Precision Estimates

Phos

PHOS precision not representative of industry precision



[Return to Table of Contents](#)

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Sequence IIIH/A/B

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Sequence IIIH Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	19
Statistically Unacceptable Calibration Test	OC	9
Operationally Invalid Calibration Test	LC	3
Acceptable Industry Support Test	AI	4
Total		35

Sequence IIIH – Failed Tests

Test Status	#
Level 3 Ei Alarm PVIS, MRV, PHOS	1
Level 3 Ei Alarm PVIS, MRV	8
Totals	9

Sequence IIIH – Lost Tests*

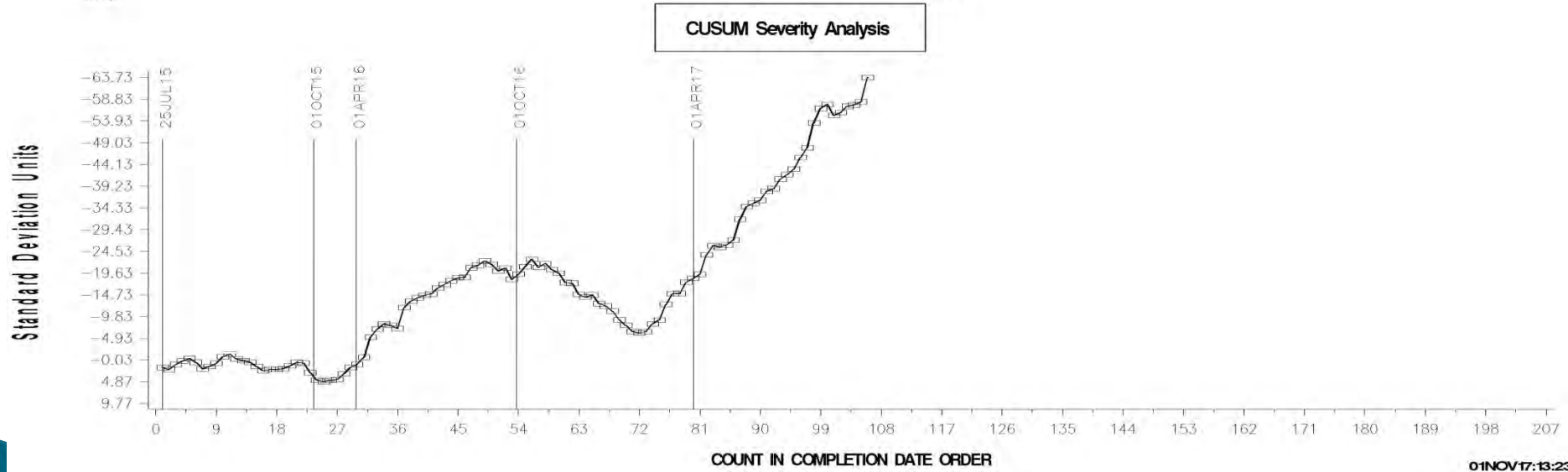
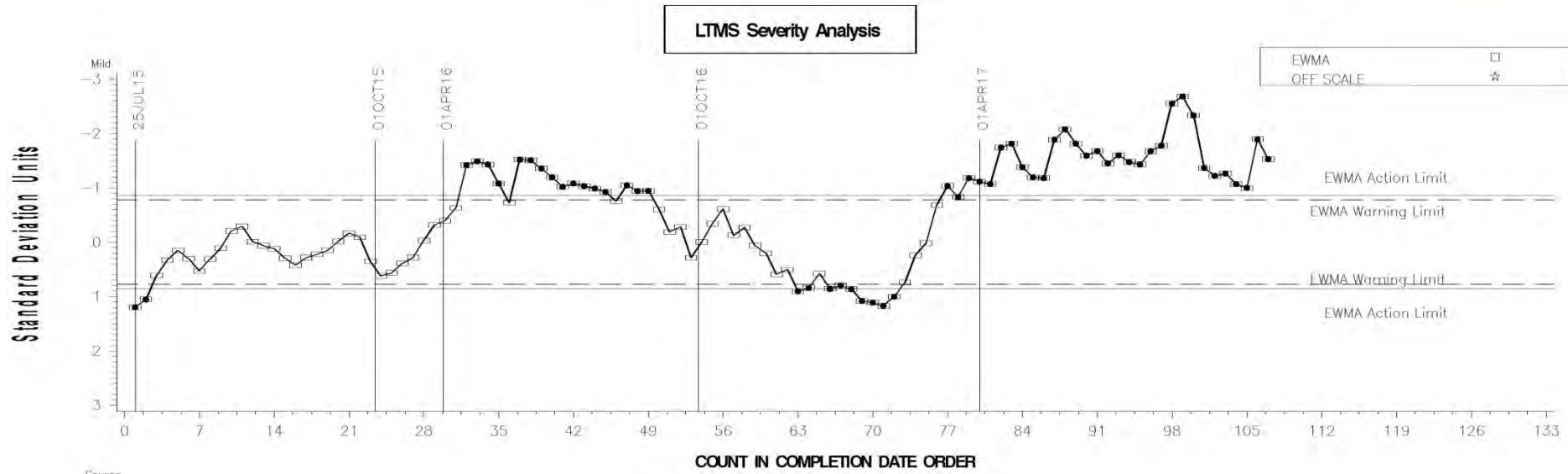
Test Status	Cause	#
Invalid	Exhaust Backpressure probe mis-oriented	1
Invalid	Coolant out thermocouple improper insertion depth	2
Totals		3

*Invalid and aborted tests

Sequence IIIH Test Severity

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

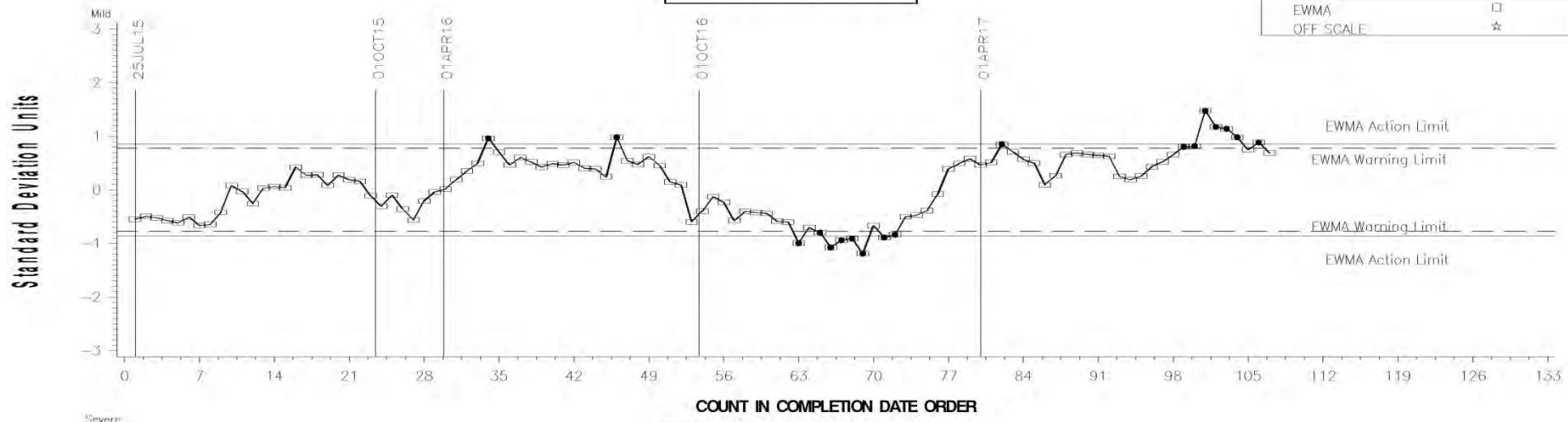
VISCOSITY INCREASE FINAL ORIG UNIT RES



01NOV17:13:23

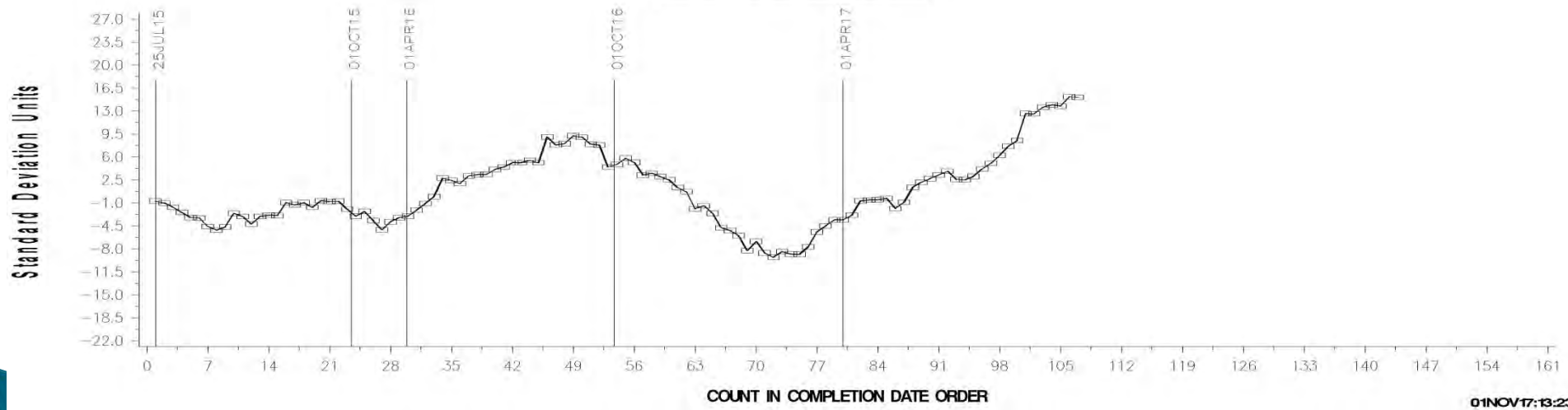
AVERAGE WEIGHTED PISTON DEPOSITS FNL ORIG U

LTMS Severity Analysis



COUNT IN COMPLETION DATE ORDER

CUSUM Severity Analysis

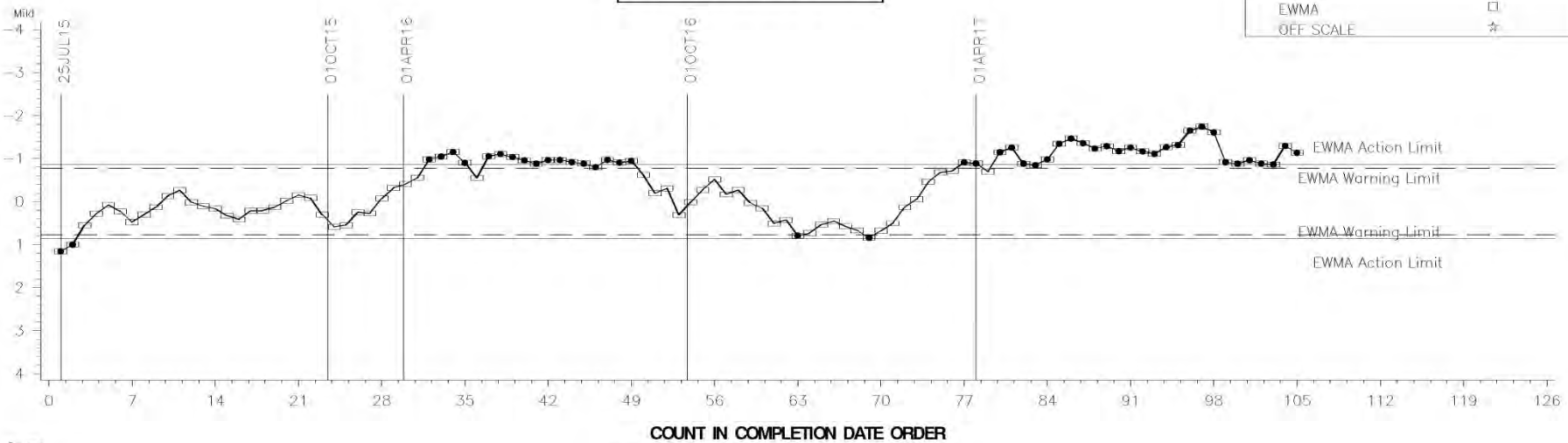


COUNT IN COMPLETION DATE ORDER

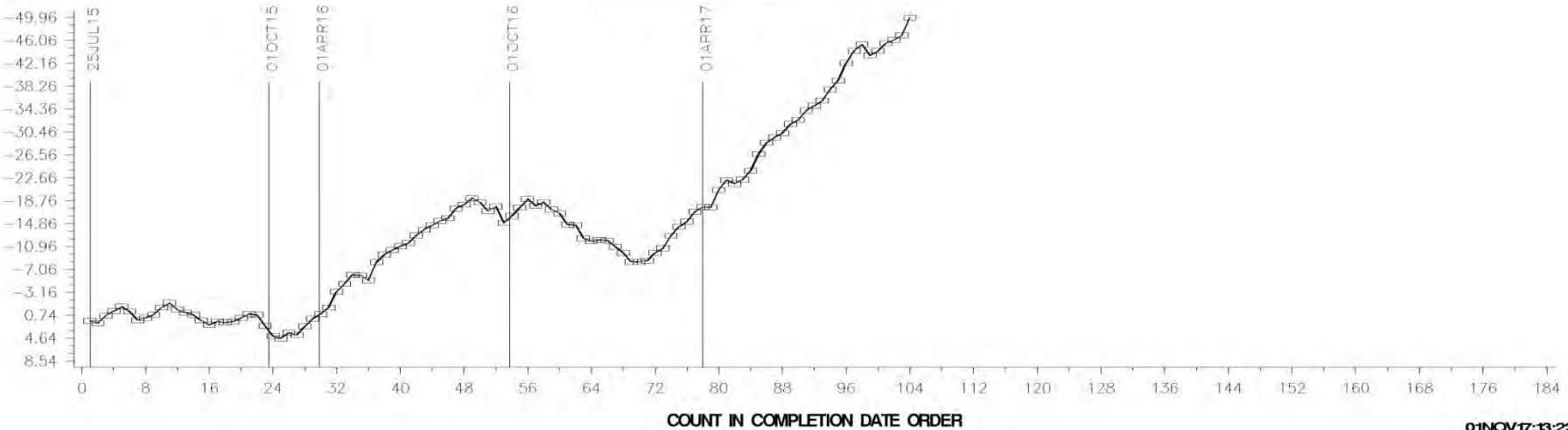
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MRV FINAL ORIG UNIT RES [NM, FROZEN, SOLID]

LTMS Severity Analysis



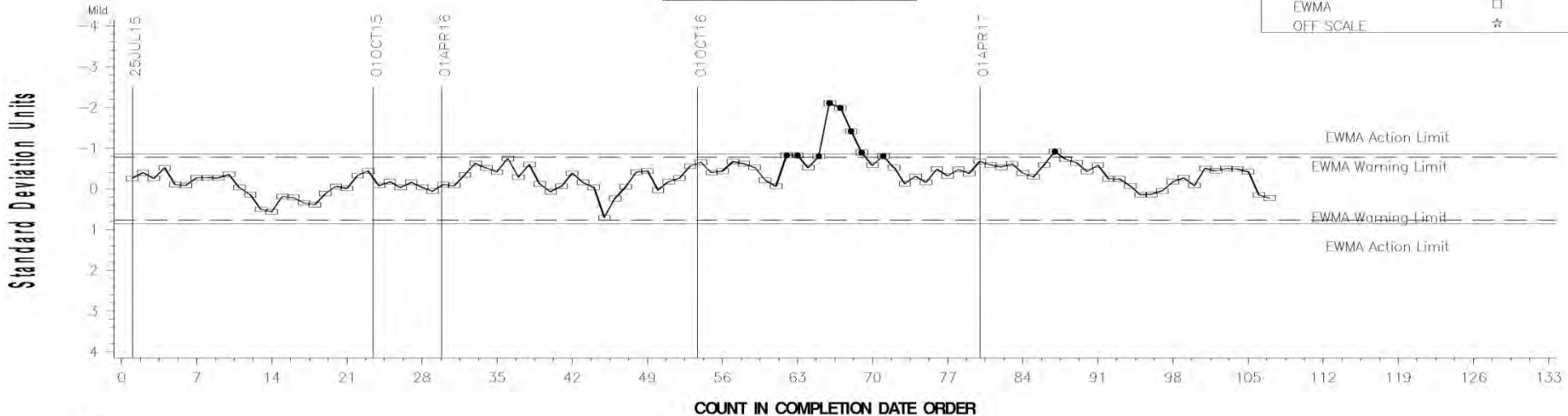
CUSUM Severity Analysis



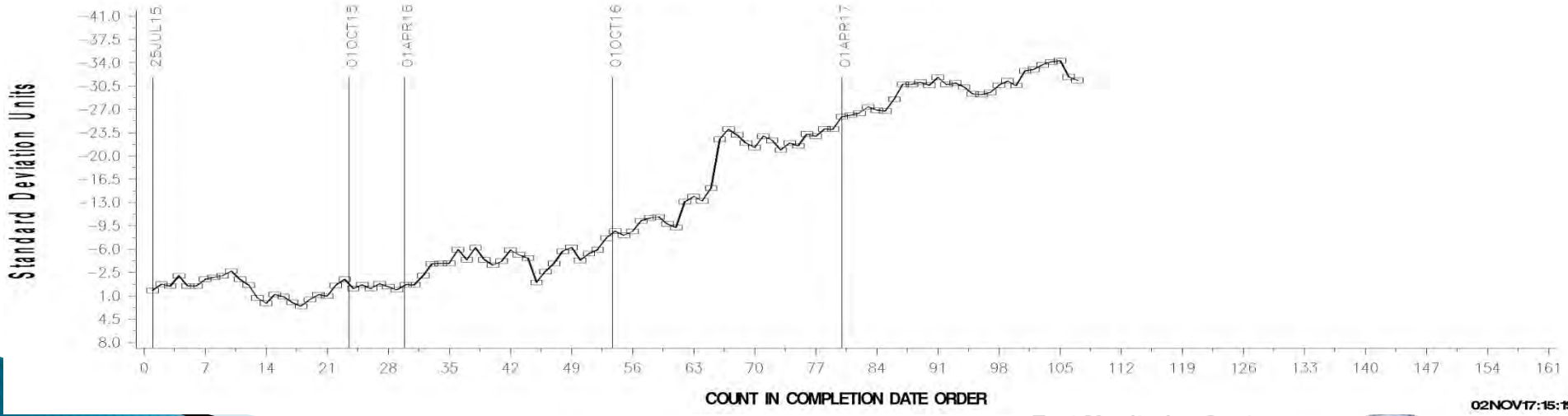
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PHOSPHORUS RETENTION, FINAL RESULT

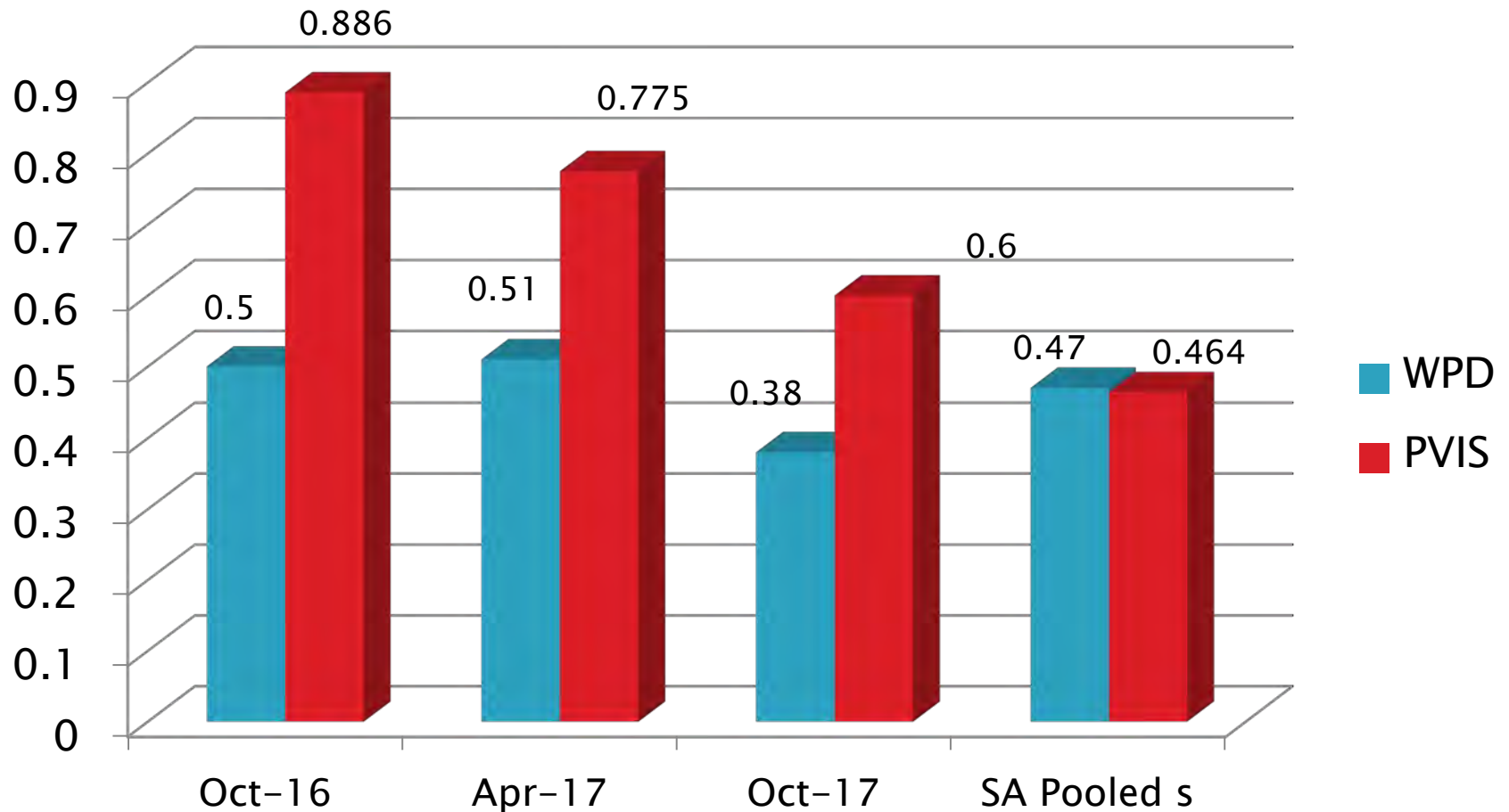
LTMS Severity Analysis



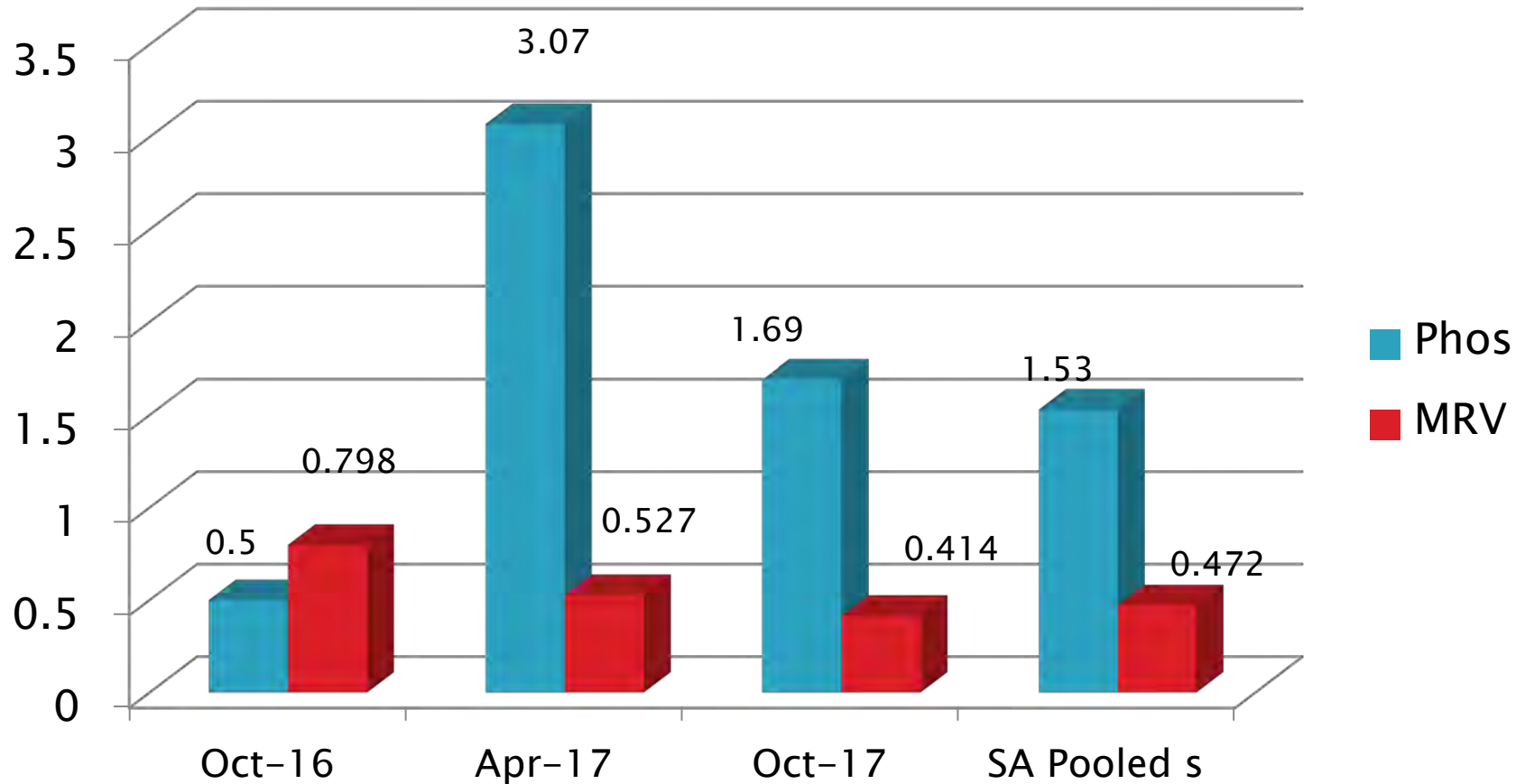
CUSUM Severity Analysis



IIH Precision Estimates



IIIHA/B Precision Estimates



[Return to Table of Contents](#)

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Sequence IVA

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Sequence IVA Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	4
Total		4

Sequence IVA Test Severity

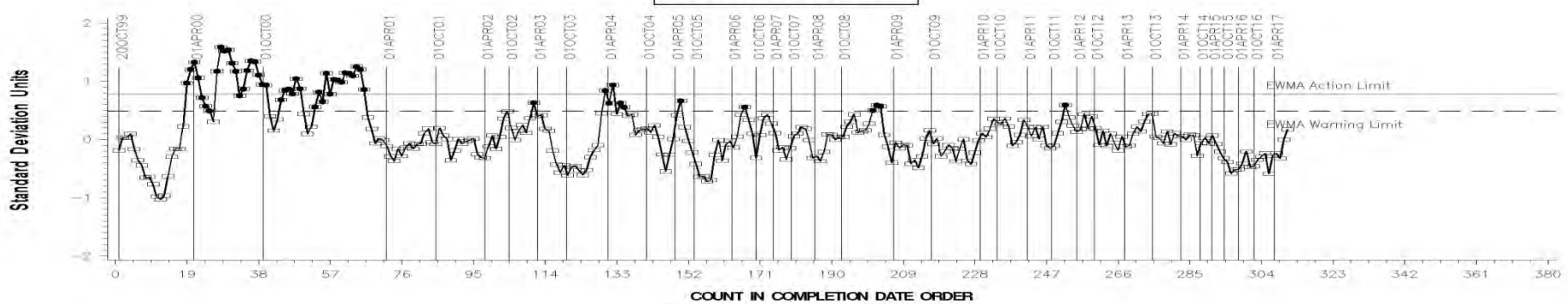
- ACW in control.

AVERAGE CAM WEAR

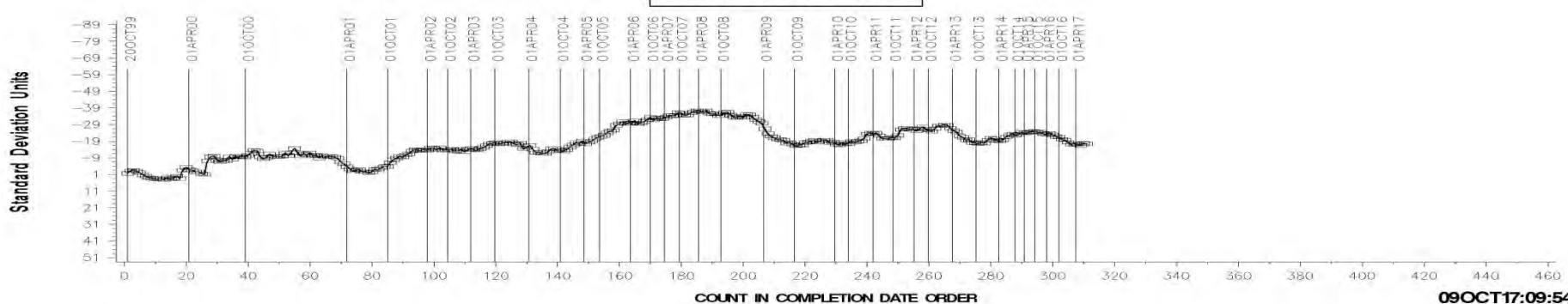
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



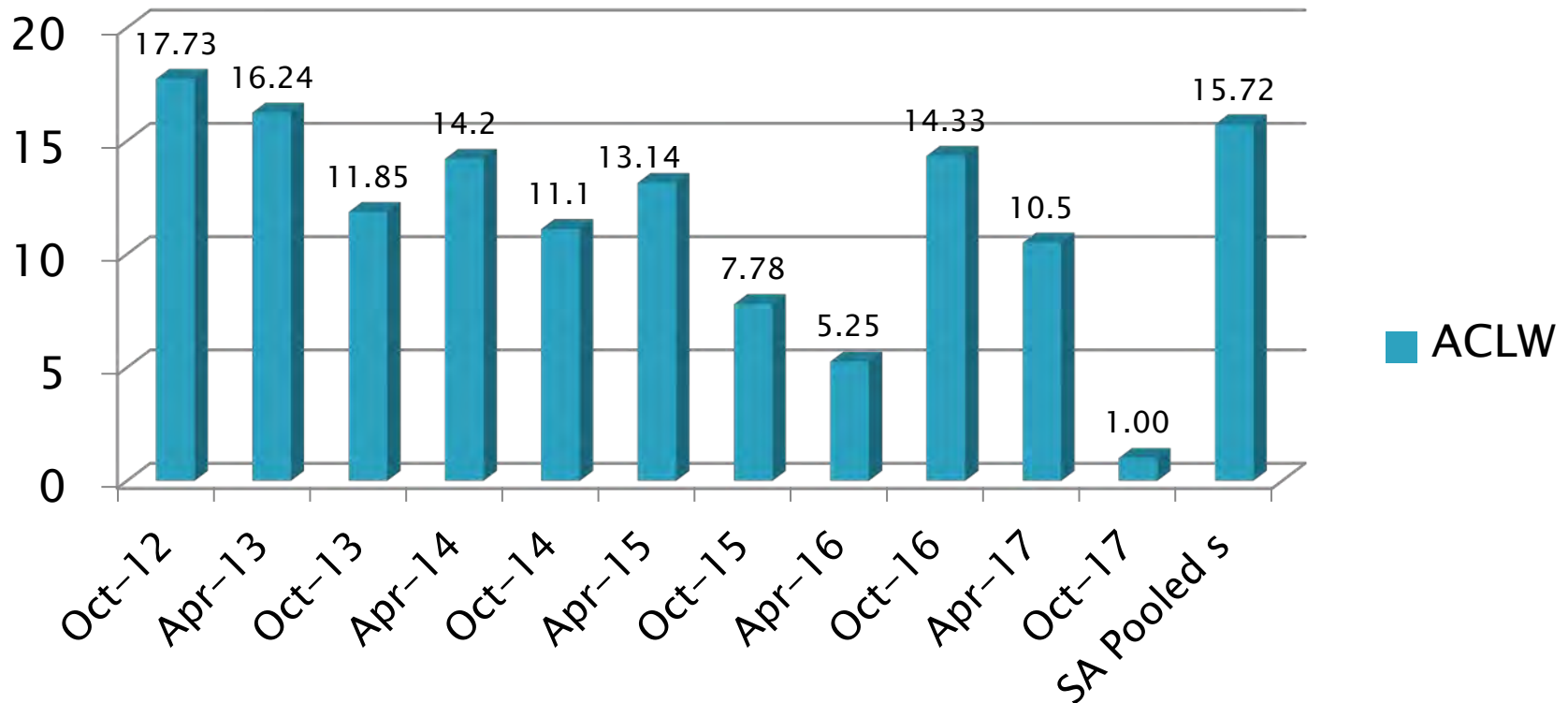
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Sequence IVA Precision Estimates

ACW



[Return to Table of Contents](#)

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Sequence VG

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Sequence VG Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	3
Statistically unacceptable Calibration Test	OC	1
Total		4

Sequence VG – Failed Tests

Test Status	#
Mild AES	1
Totals	1

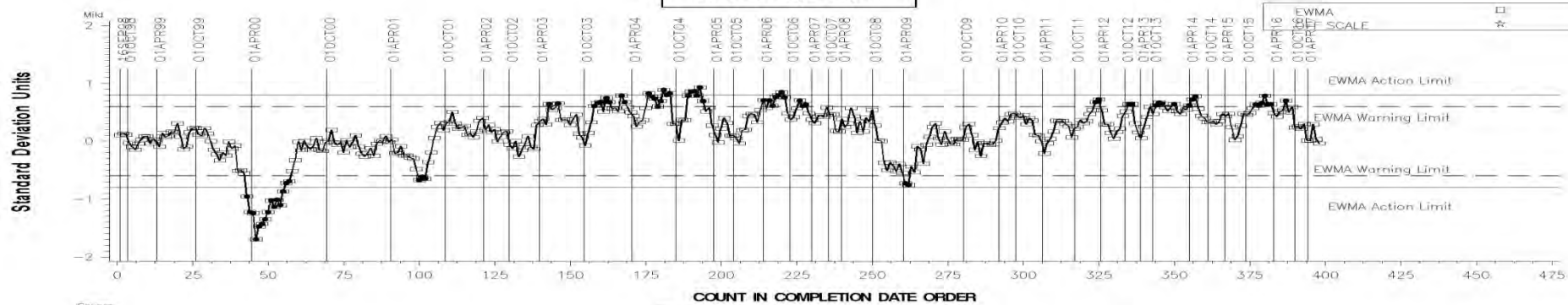
Sequence VG Test Severity

- AES in precision warning alarm
- All other parameters in control

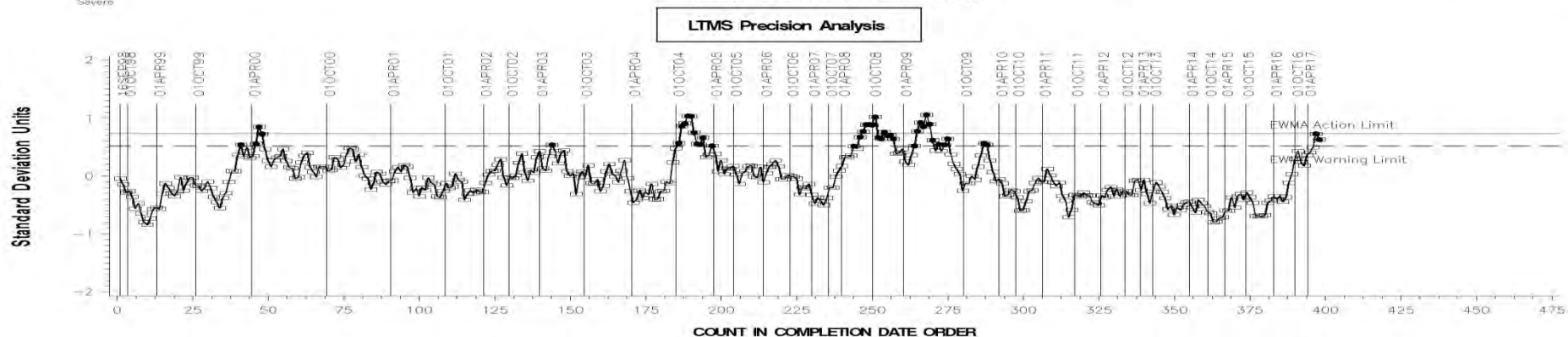
SEQUENCE VG INDUSTRY OPERATIONAL VALID DATA

AVERAGE ENGINE SLUDGE

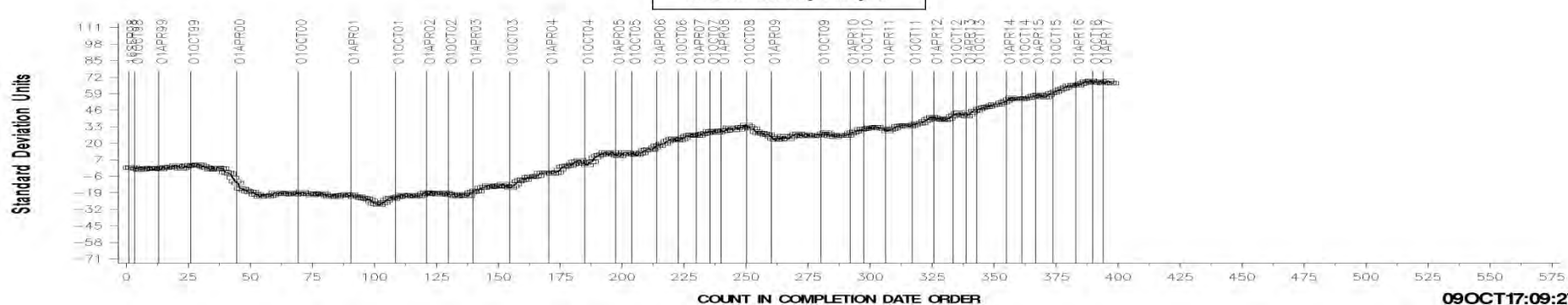
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



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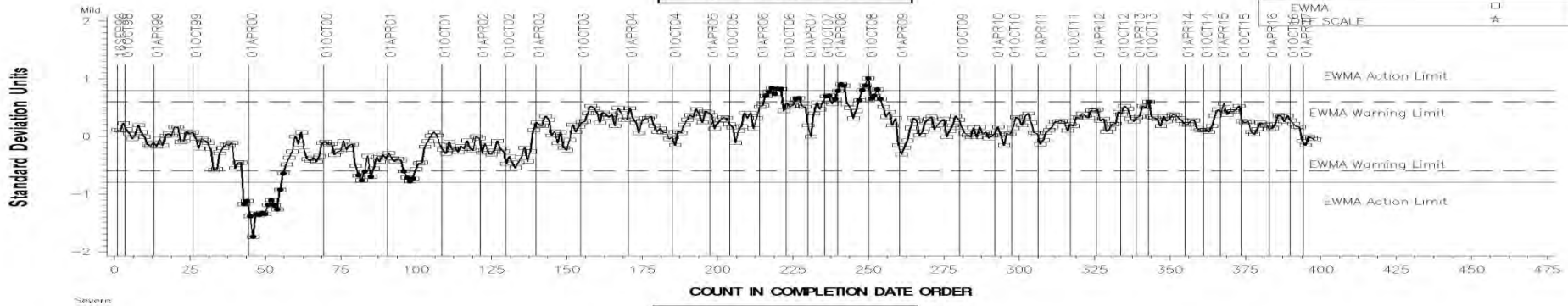


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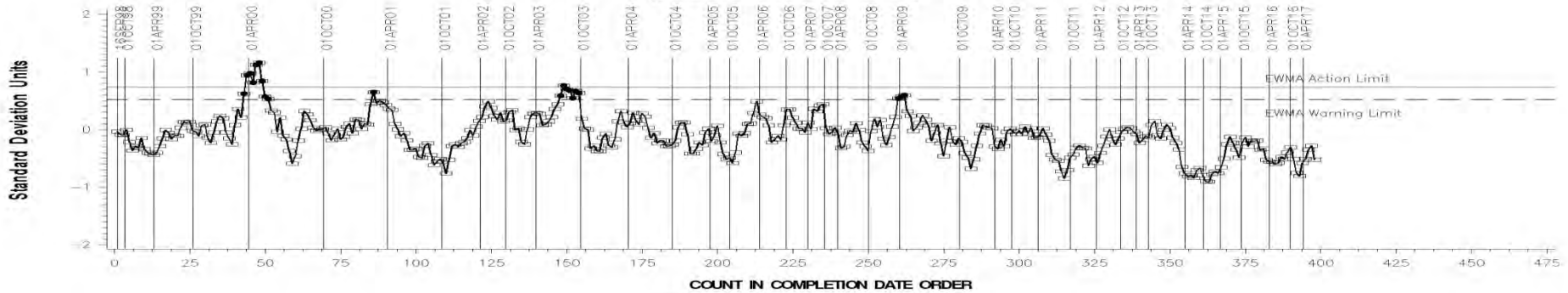
AVERAGE ROCKER COVER SLUDGE

LTMS Severity Analysis



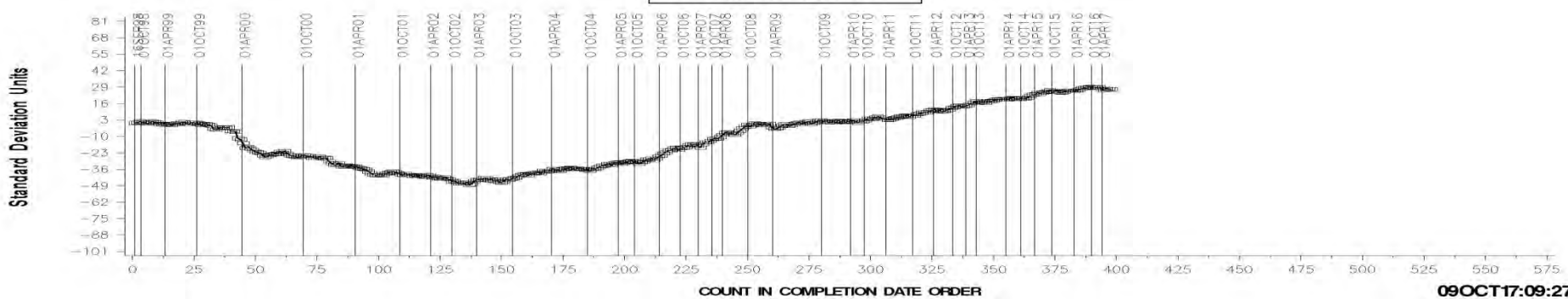
COUNT IN COMPLETION DATE ORDER

LTMS Precision Analysis



COUNT IN COMPLETION DATE ORDER

CUSUM Severity Analysis



COUNT IN COMPLETION DATE ORDER

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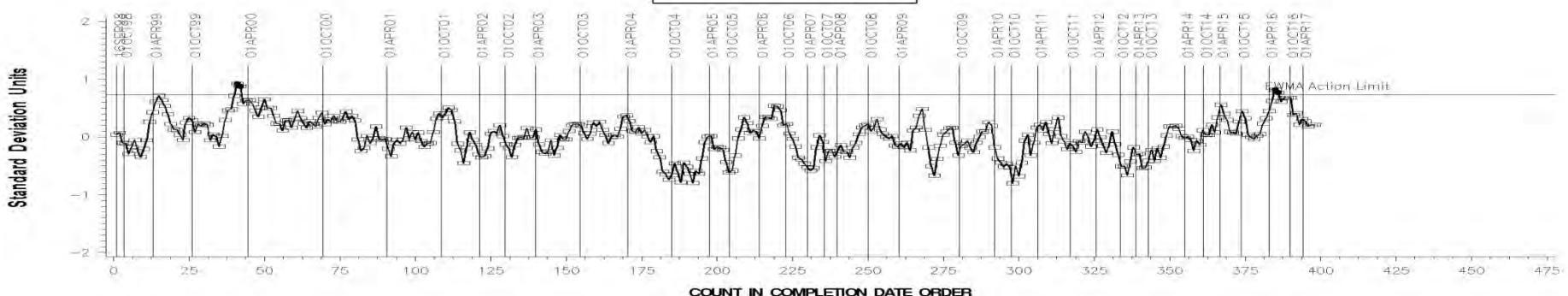
SEQUENCE VG INDUSTRY OPERATIONAL VALID DATA

AVG. ENG. VARN. 3-PART APV + BAFFLES

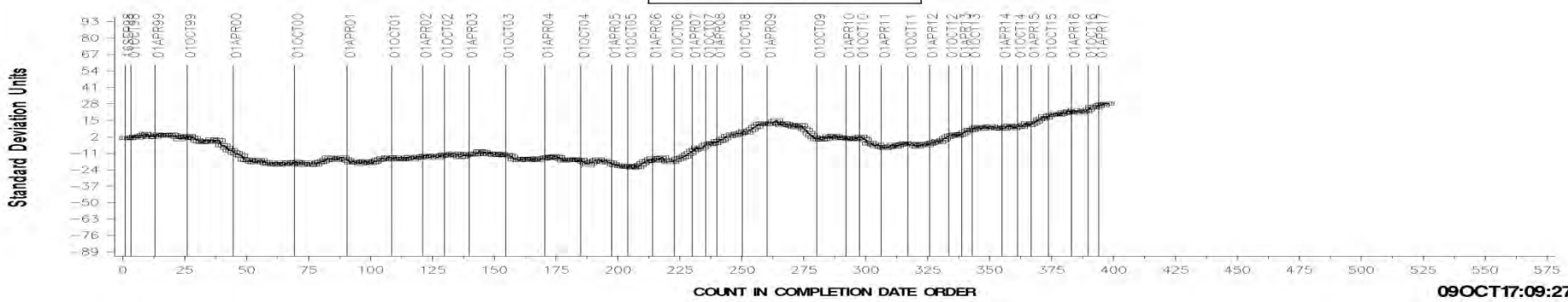
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



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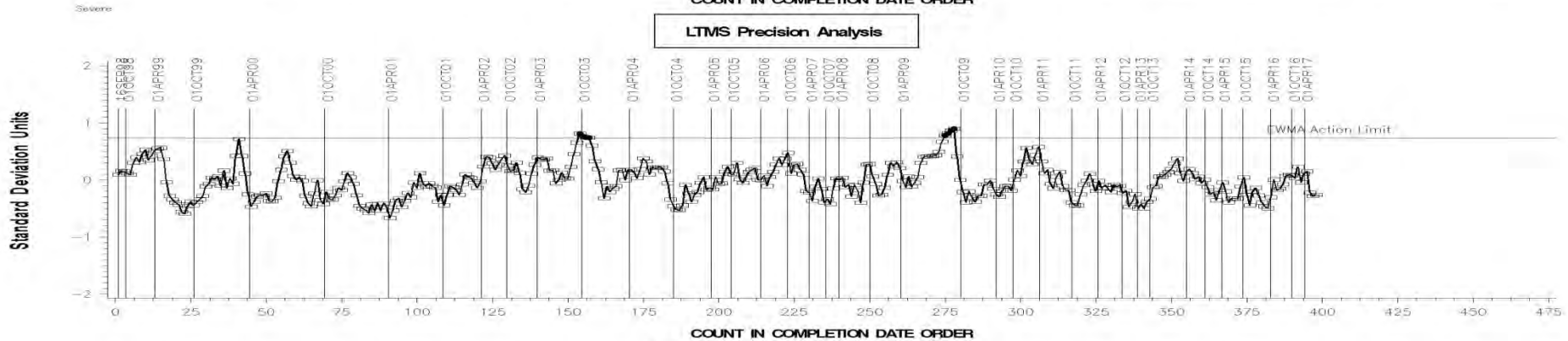


AVG PISTON SKIRT RATING

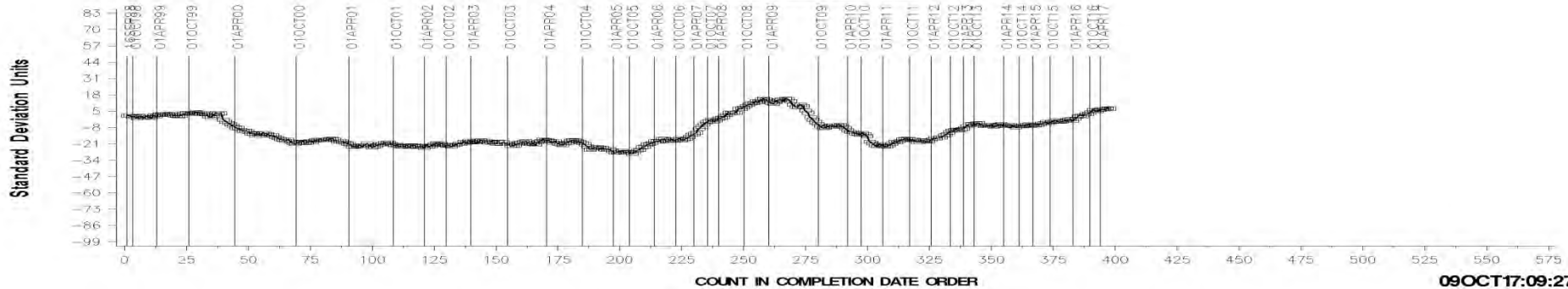
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



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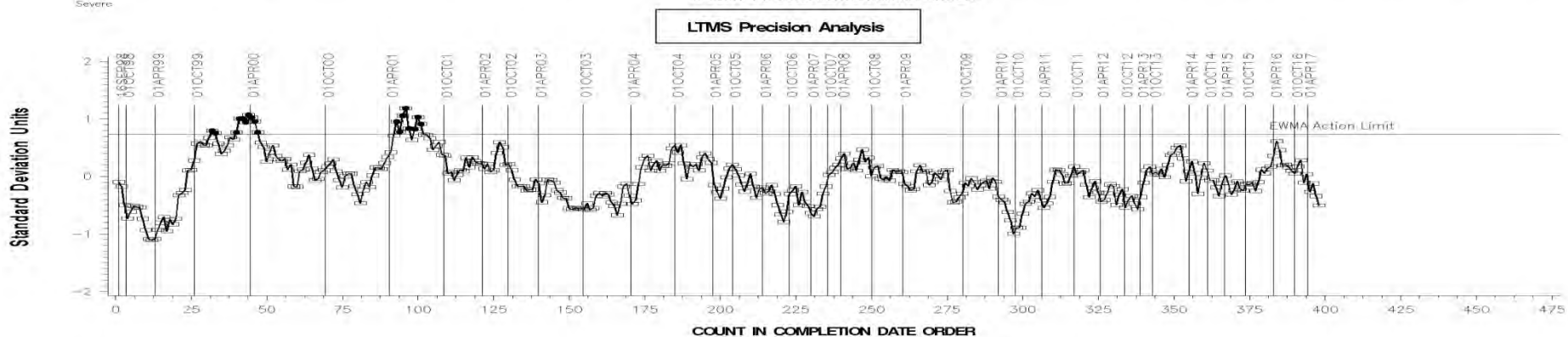
SEQUENCE VG INDUSTRY OPERATIONALLY VALID DATA

OIL SCREEN SLUDGE

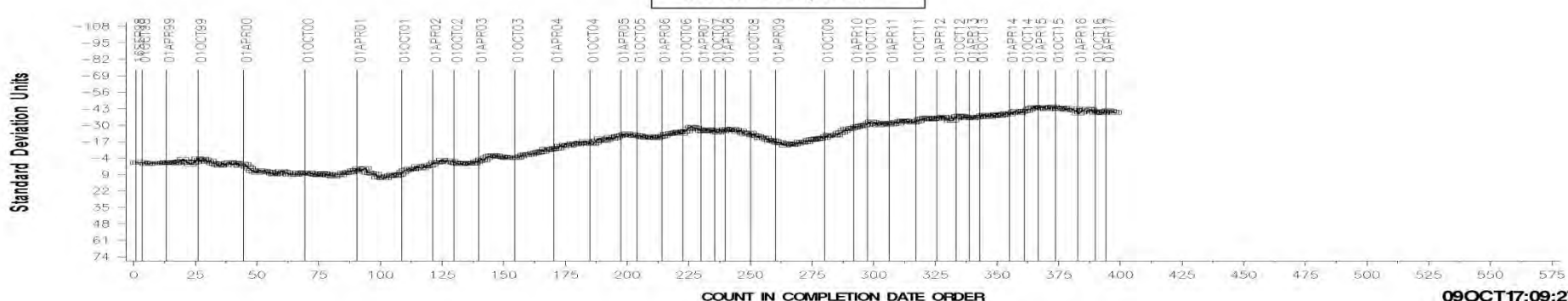
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



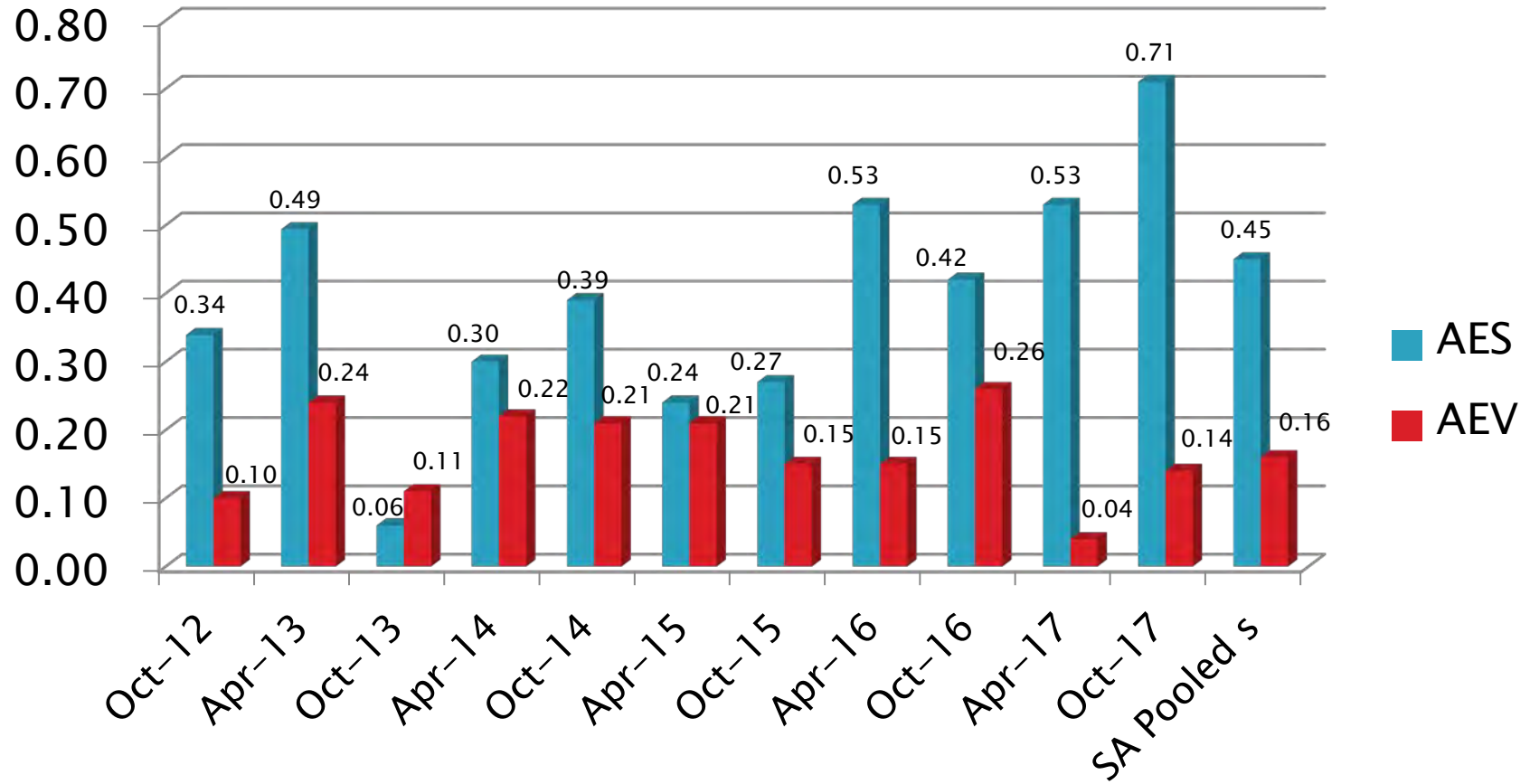
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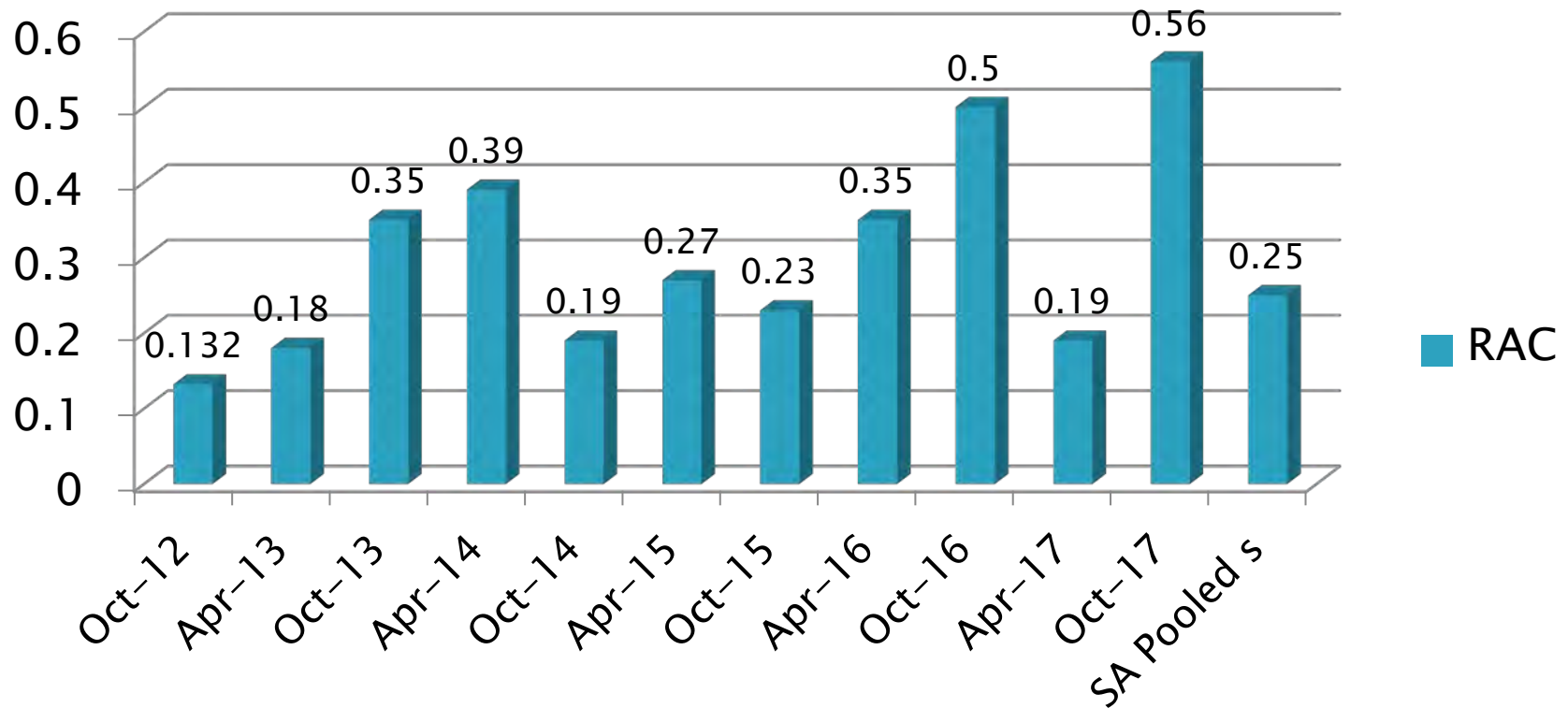


Sequence VG Precision Estimates

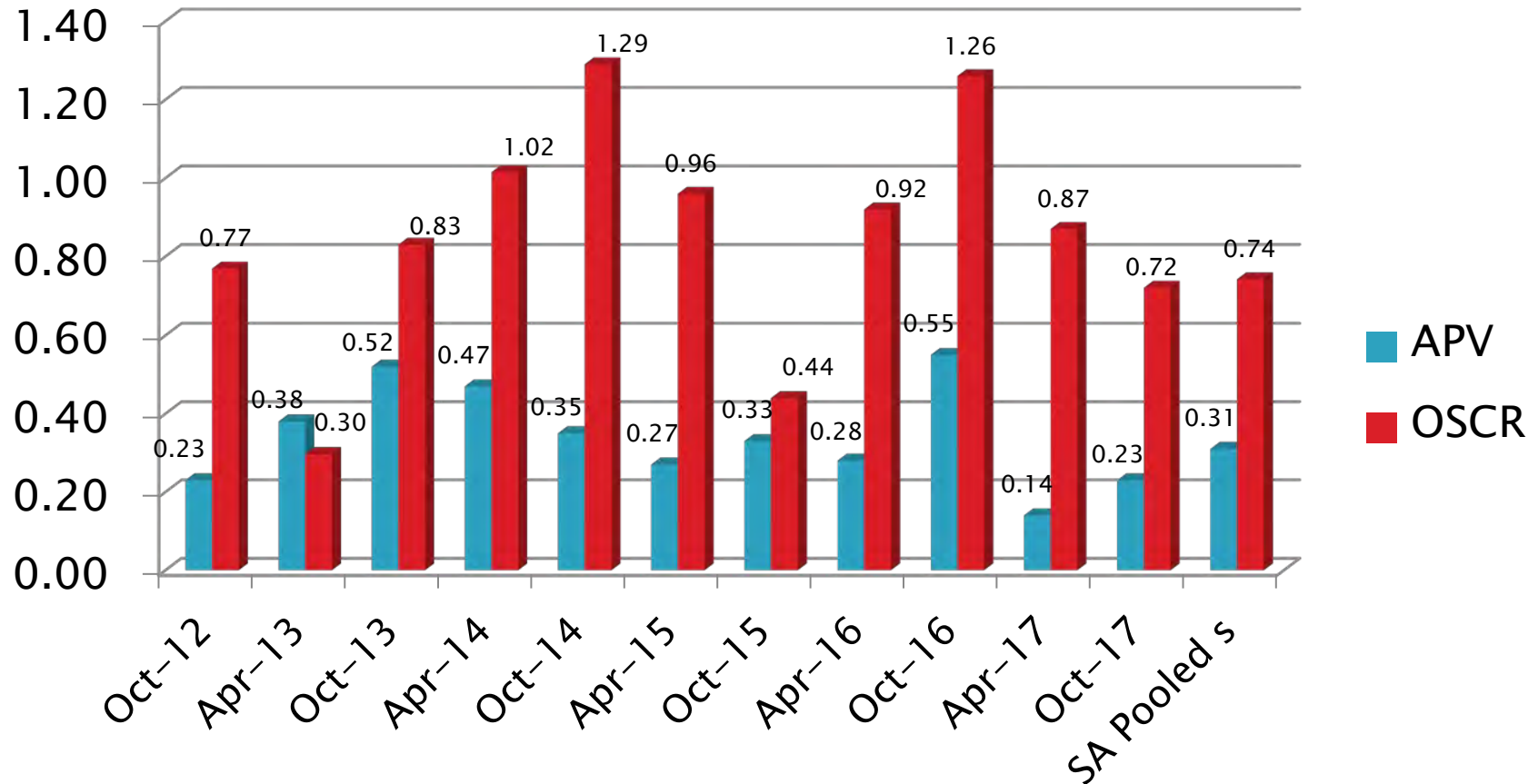


Sequence VG Precision Estimates

RAC



Sequence VG Precision Estimates



[Return to Table of Contents](#)

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Sequence VH

»» October 2017

Test Monitoring Center

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A Program of ASTM International

Sequence VH Activity

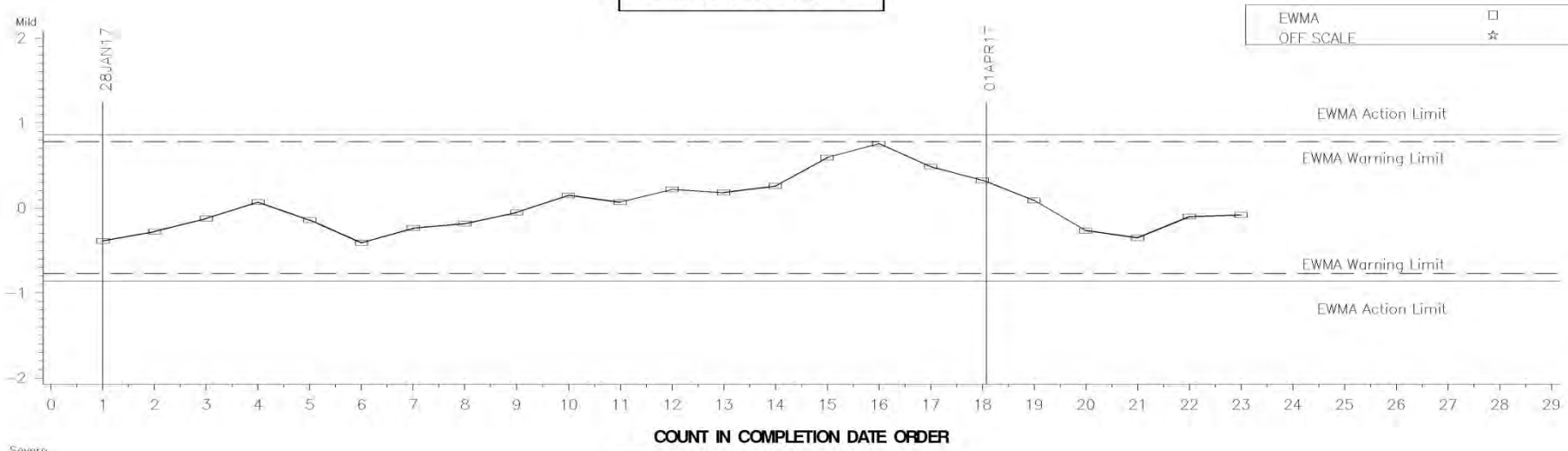
Test Status	Validity Code	#
Acceptable Calibration Test	AC	1
Acceptable Matrix Test Used for Calibration	AO	4
Total		5

Sequence VH Test Severity

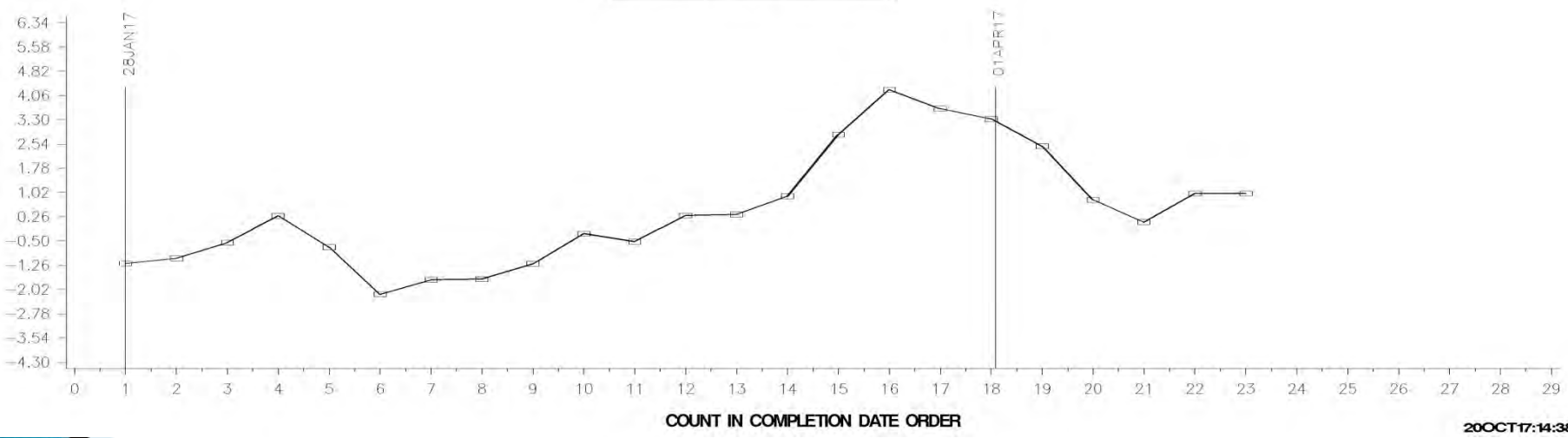
- All parameters in control

AVERAGE ENGINE SLUDGE

LTMS Severity Analysis

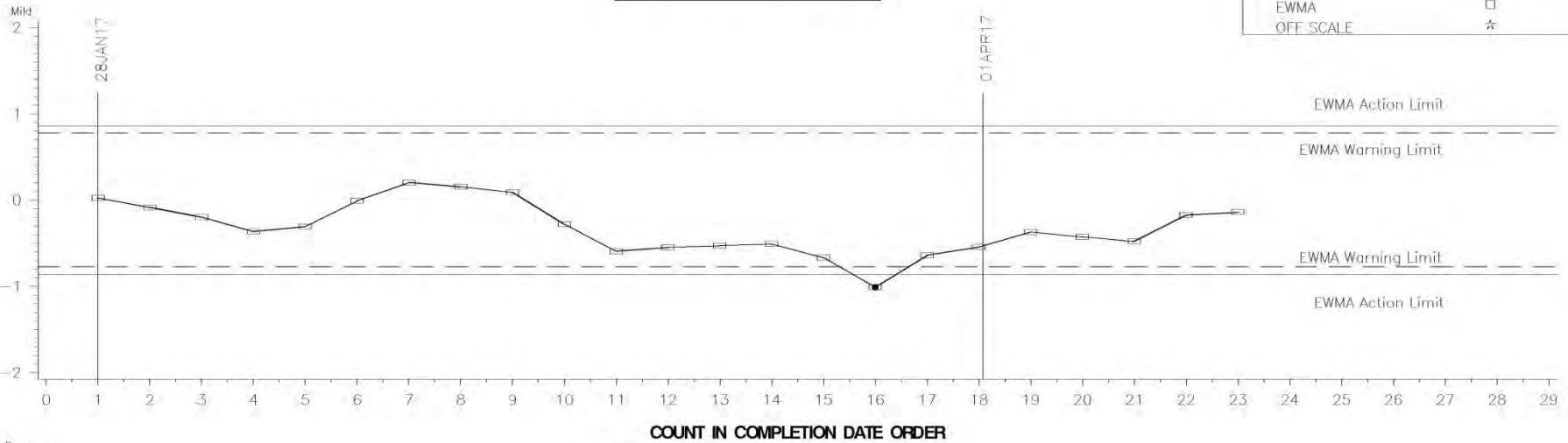


CUSUM Severity Analysis

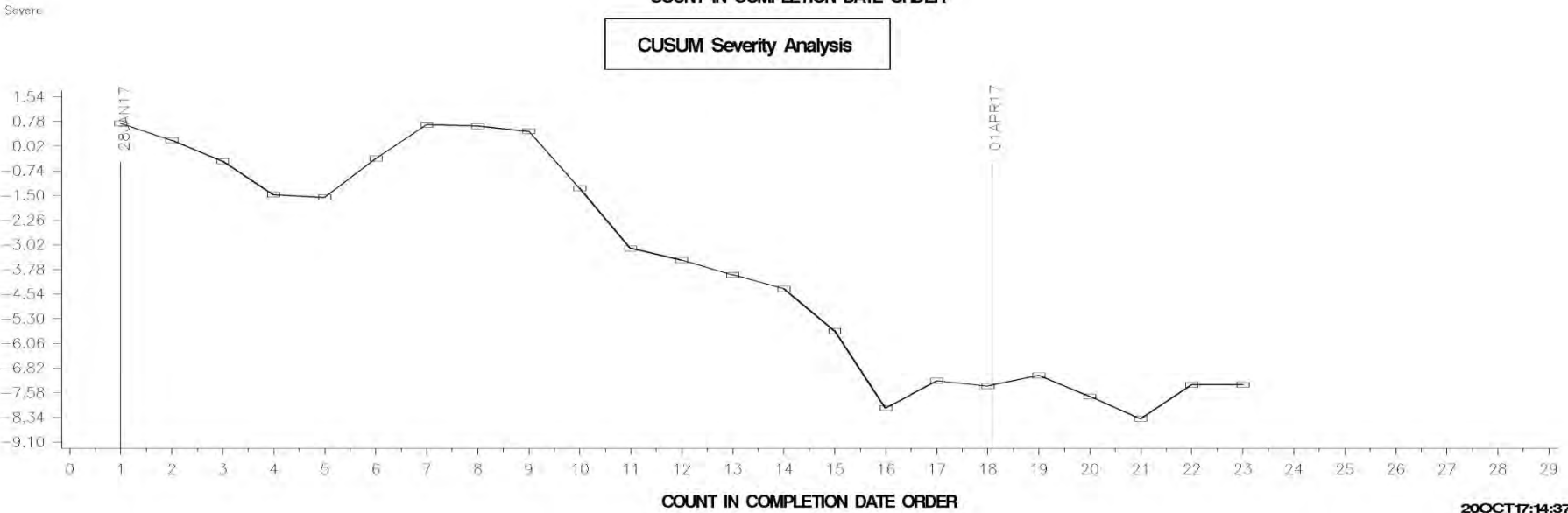


AVERAGE ROCKER COVER SLUDGE

LTMS Severity Analysis

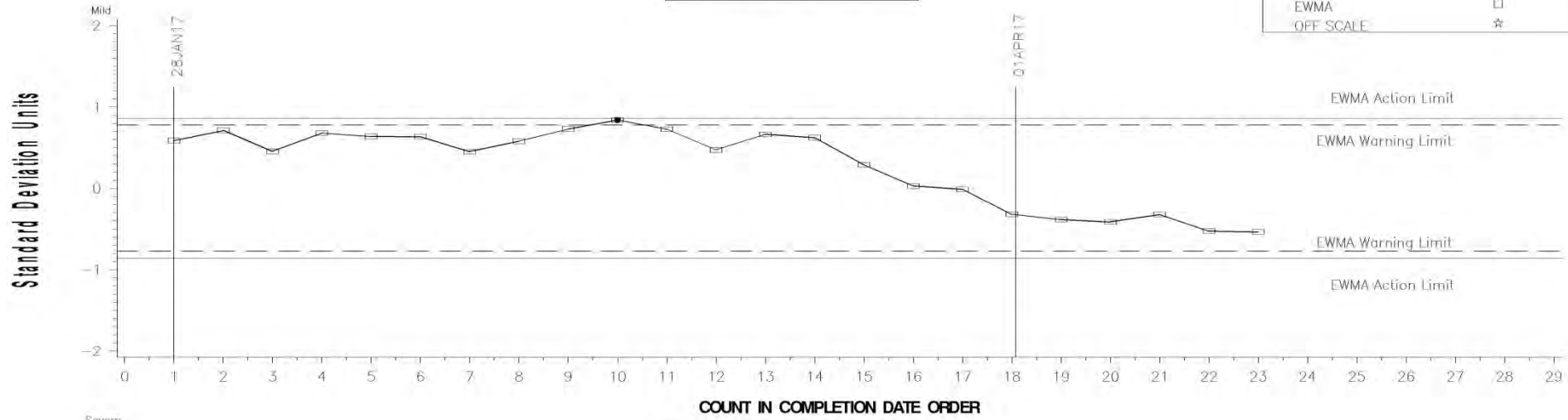


CUSUM Severity Analysis

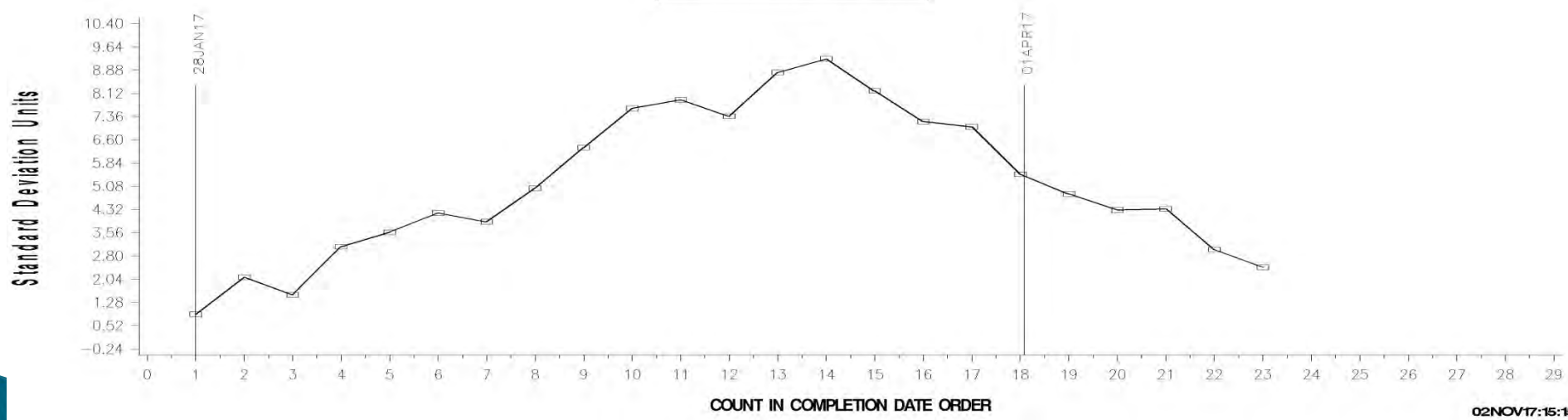


AVG. ENG. VARN. 50% RATING

LTMS Severity Analysis

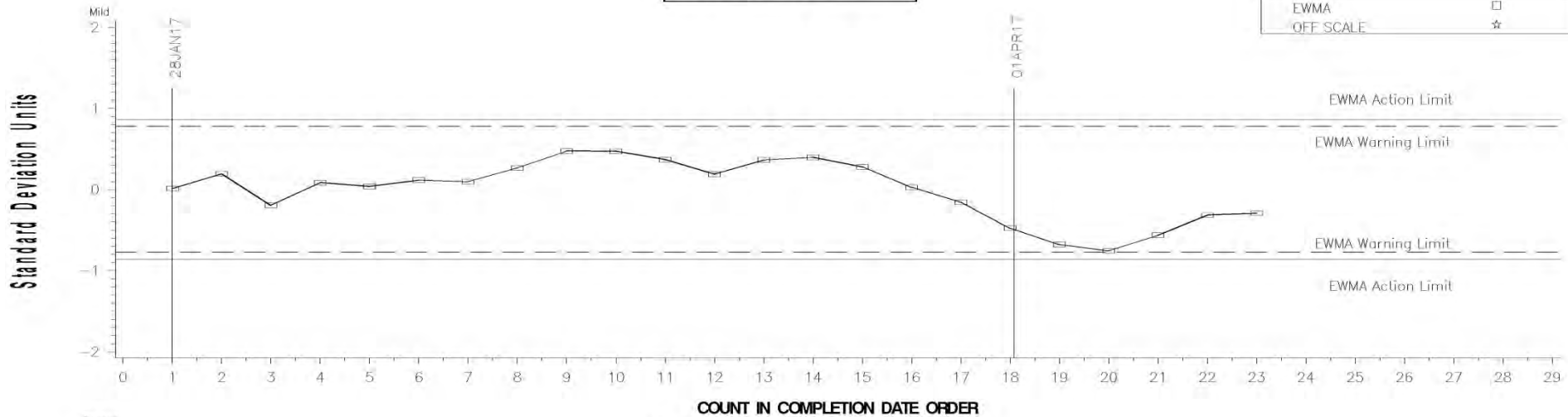


CUSUM Severity Analysis

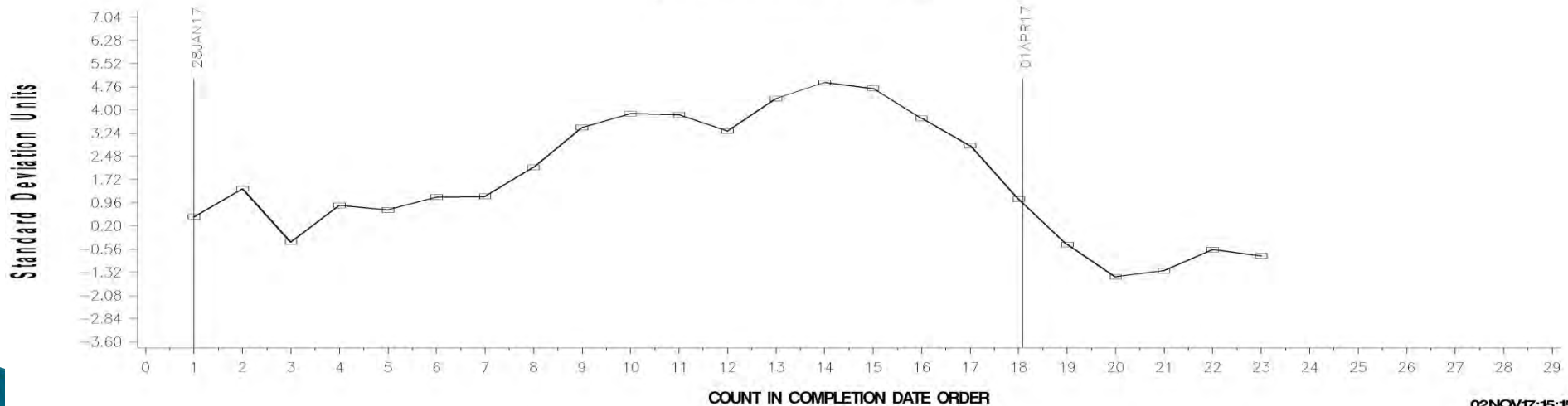


AVG PISTON SKIRT 50% RATING

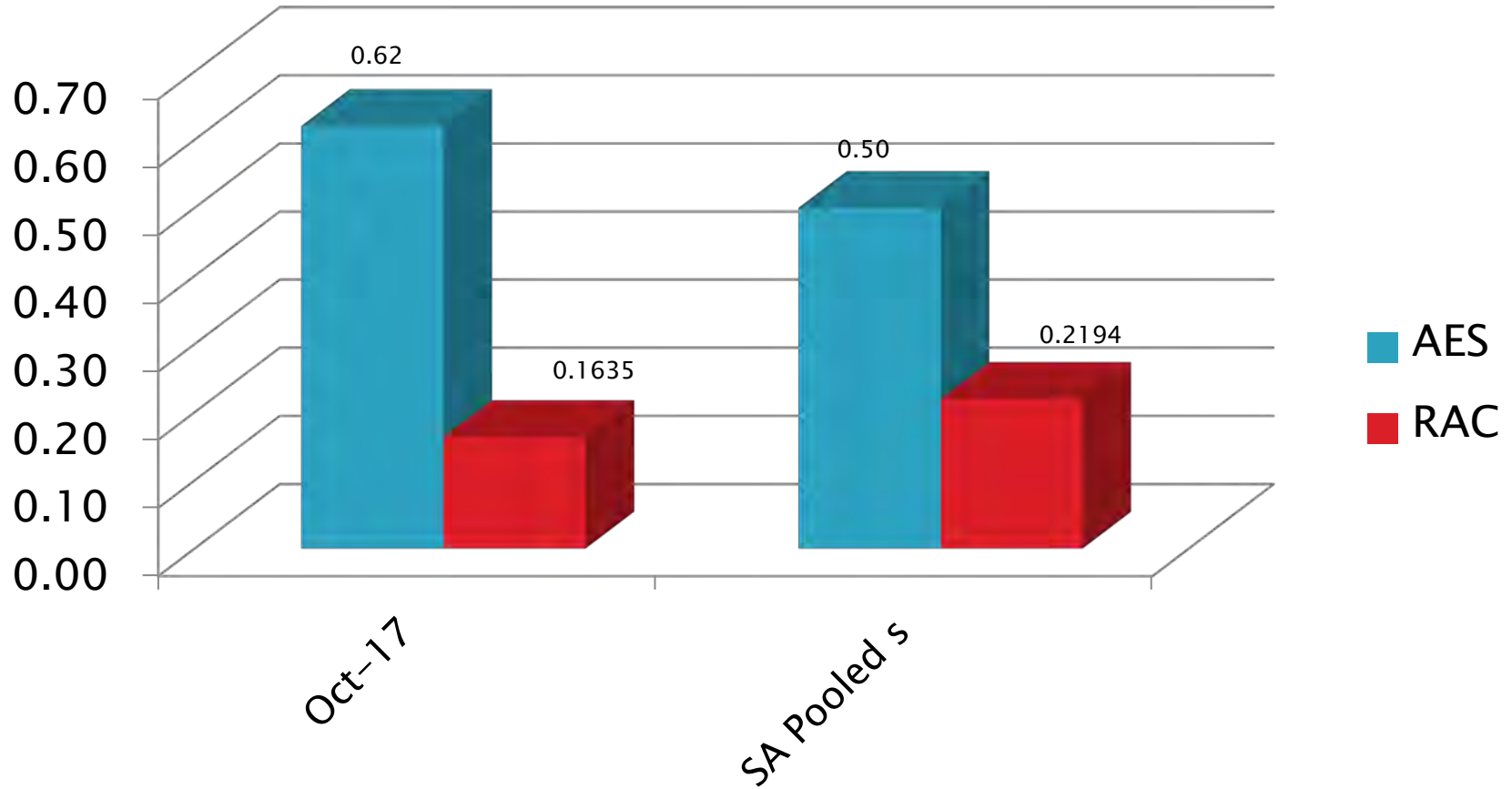
LTMS Severity Analysis



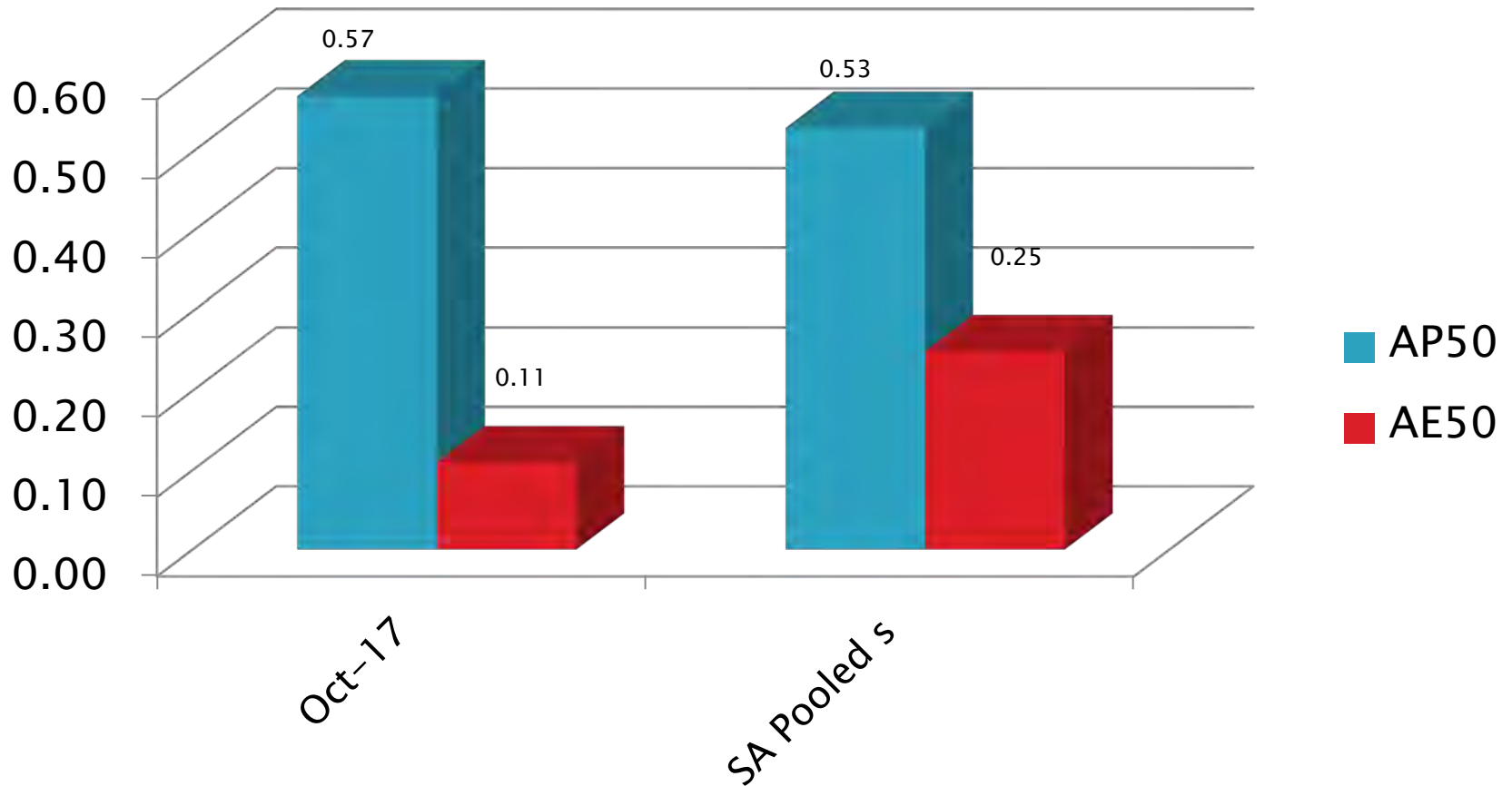
CUSUM Severity Analysis



Sequence VH Precision Estimates



Sequence VH Precision Estimates



[Return to Table of Contents](#)

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Sequence VIE

»» October 2017

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Sequence VIE Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	40
Acceptable Donated Test (5 th Run and Short Block)	AG	22
Acceptable Industry Information Run	AI	26
Failed Statistically	OC	8
Operationally Invalid Calibration Test	LC	2
Aborted Calibration Tests	XC	1
Aborted Industry Information Run	XI	1
Abandoned Engine	MC	1
Total		101

Sequence VIE – Failed Tests

Test Status	Number of Tests
Severe FEI2	6
FEI1 and FEI2 Severe	1
FEI1 Severe and FEI2 Mild	1
Total	8

Sequence VIE – Lost Tests*

Test Status	Cause	#
Aborted	Crank Sensor Failed	1
Aborted	Load Cell Linkage Failed	1
Invalid	Average Coolant In Temperature Out of Spec	1
Totals		3

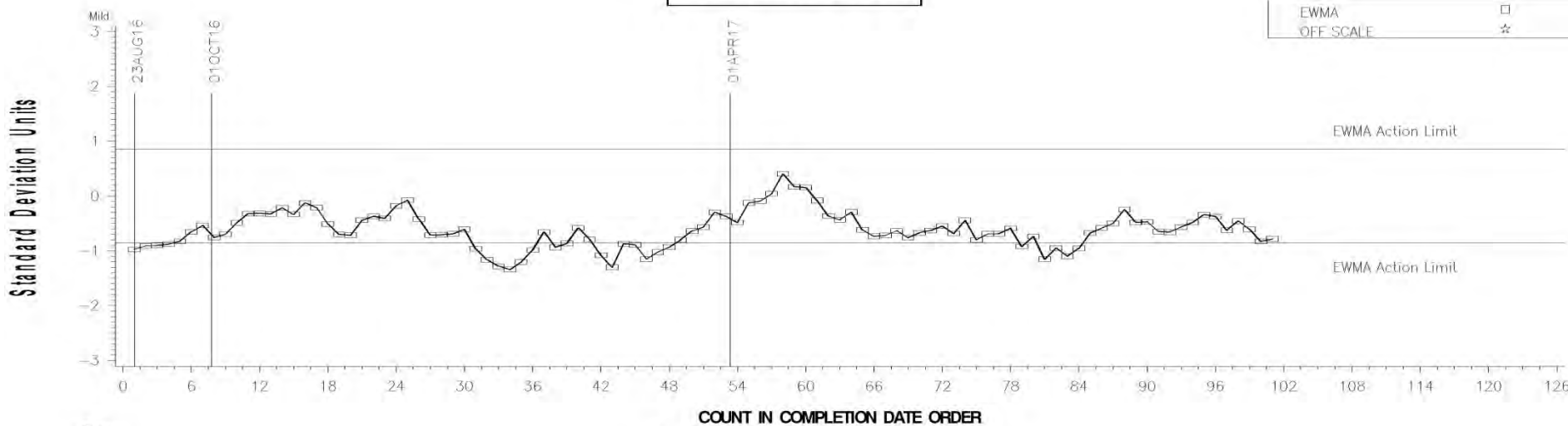
*Invalid and aborted tests

Sequence VIE Test Severity

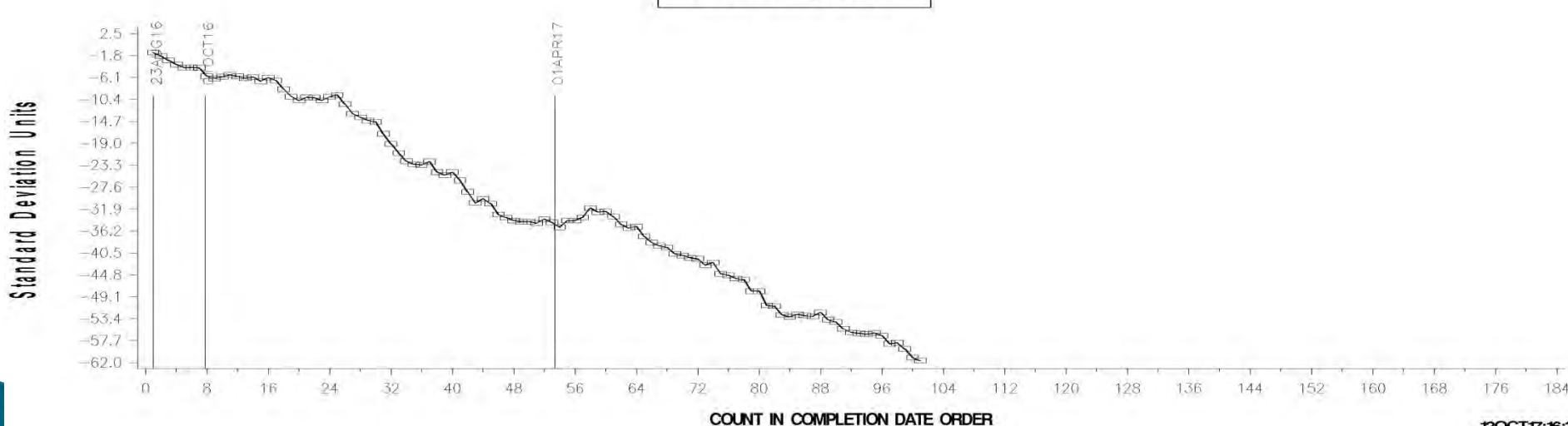
- FEI1 is in control
- FEI2 is in severity alarm (severe)

FEI FINAL RESULT PHASE I

LTMS Severity Analysis

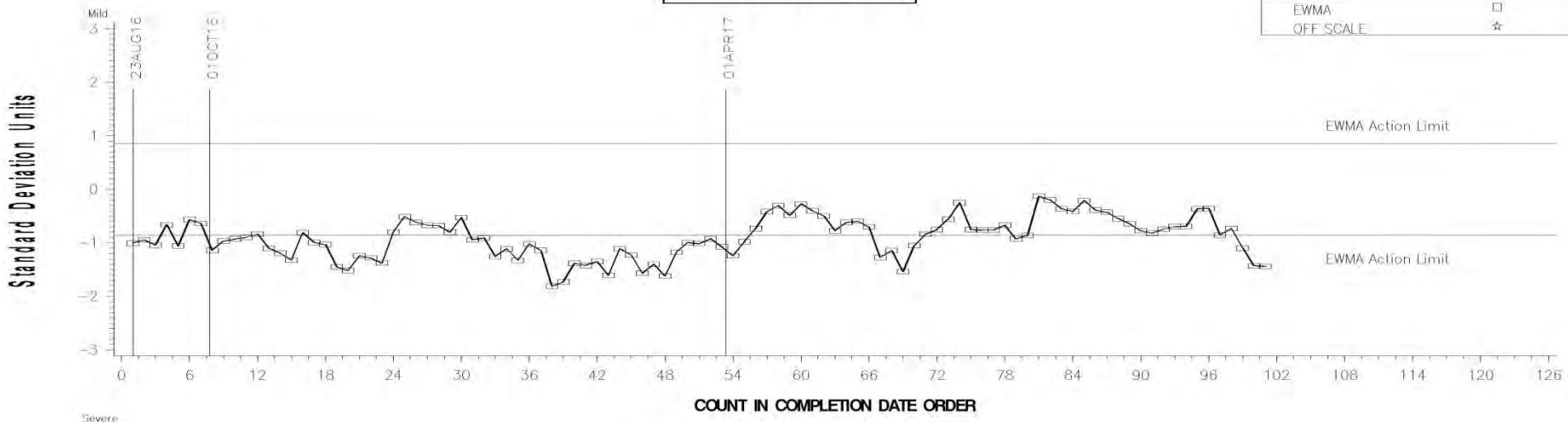


CUSUM Severity Analysis

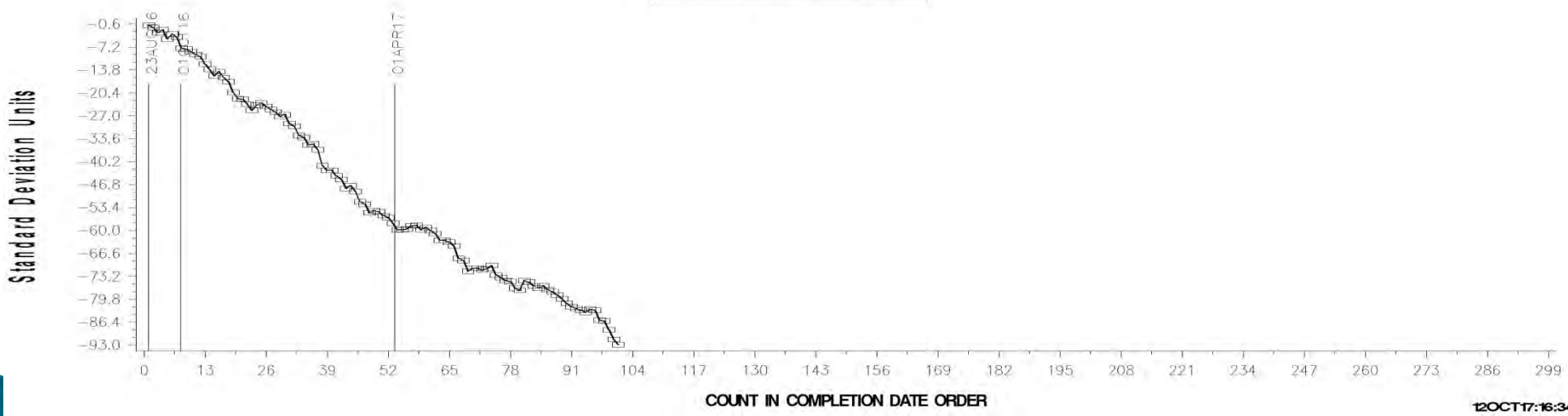


FEI FINAL RESULT PHASE II

LTMS Severity Analysis

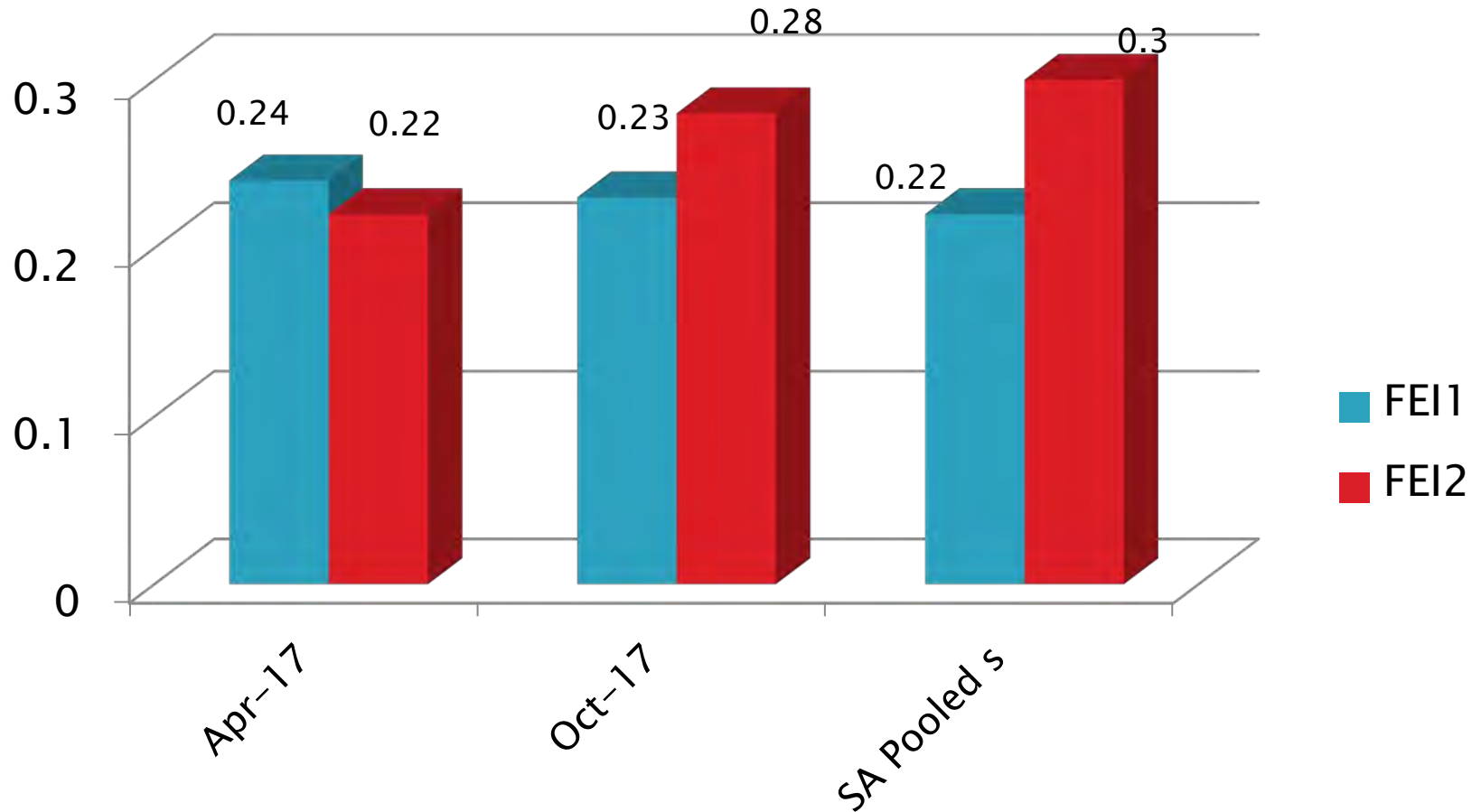


CUSUM Severity Analysis



12OCT17:16:34

Sequence VIE Precision Estimates



[Return to Table of Contents](#)

Sequence VIF

»» October 2017

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Sequence VIF Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	17
Acceptable Donated Test (5 th Run)	AG	6
Failed Statistically	OC	3
Operationally Invalid Calibration Test	LC	1
Acceptable Industry Information Test	AI	4
Total		31

Sequence VIF – Failed Tests

Test Status	Number of Tests
Severe FEI2	1
Vi Alarm FEI1	1
Vi Alarm FEI2	1
Total	3

Sequence VIF – Lost Tests*

Test Status	Cause	#
Invalid	Inadequate speed control	1
Totals		1

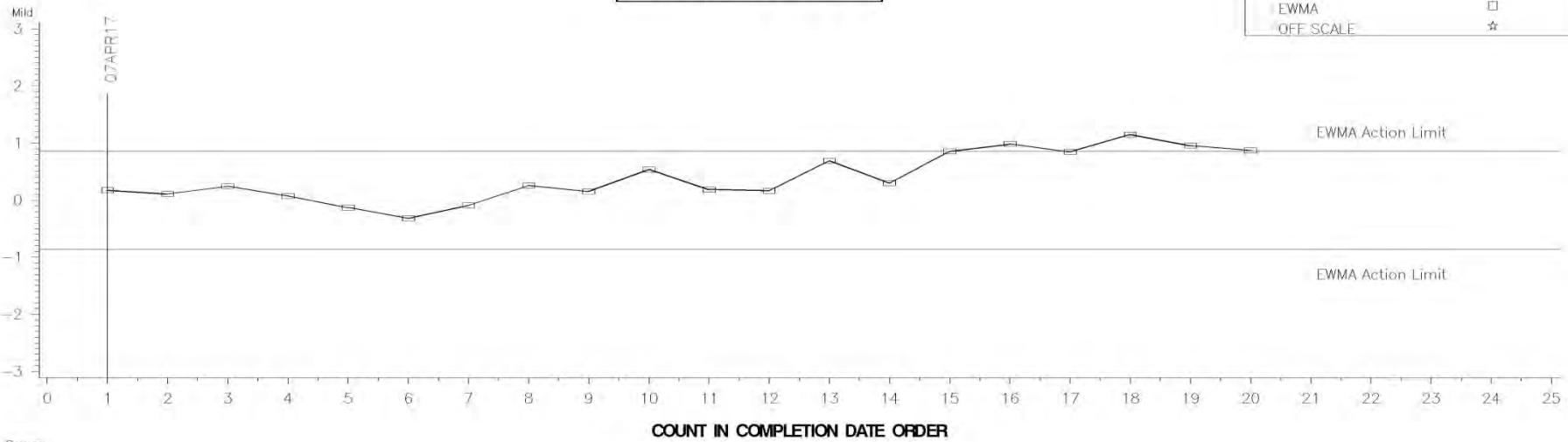
*Invalid and aborted tests

Sequence VIF Test Severity

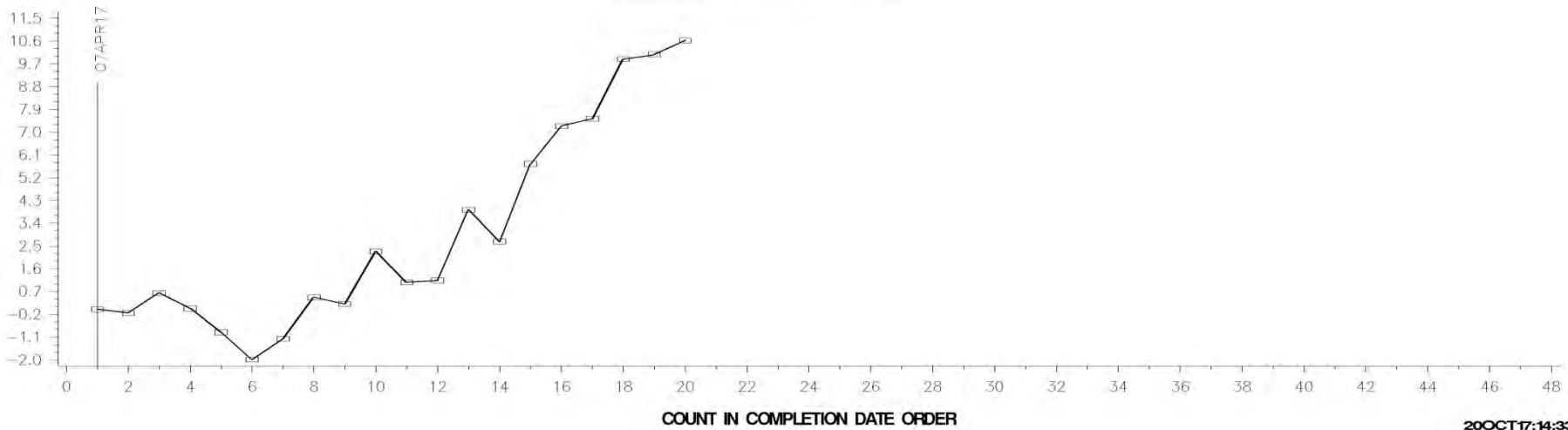
- FEI1 is in action alarm (mild direction)
- FEI2 is in control

FEI FINAL RESULT PHASE I

LTMS Severity Analysis



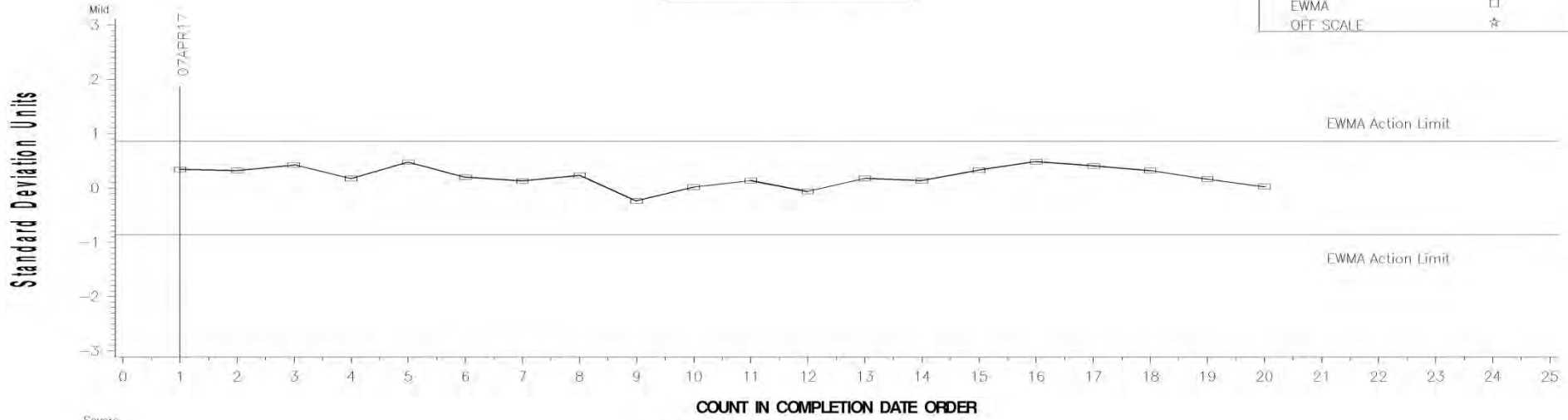
CUSUM Severity Analysis



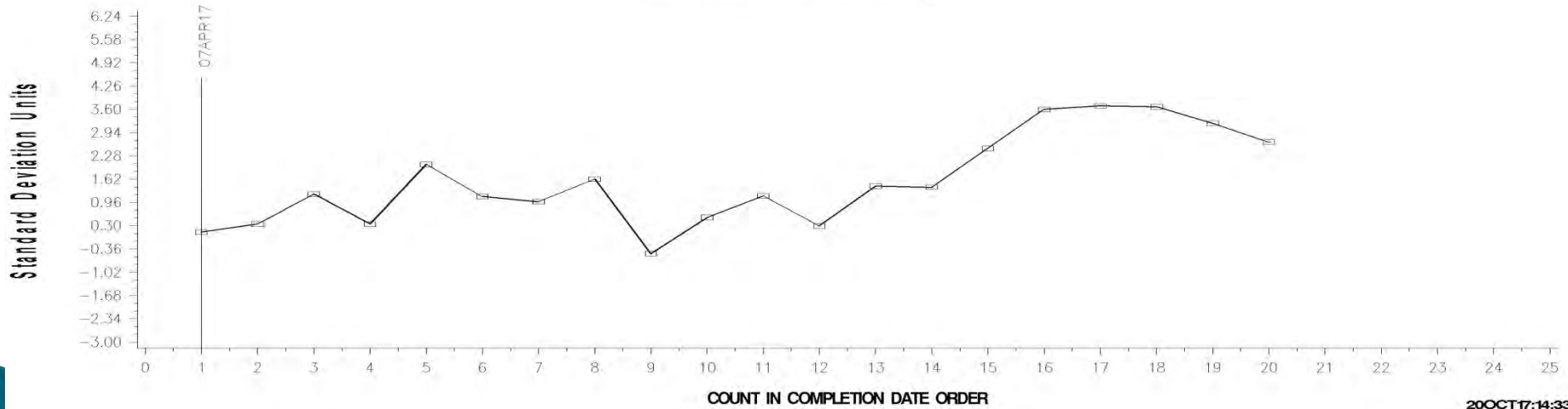
20OCT17:14:33

FEI FINAL RESULT PHASE II

LTMS Severity Analysis

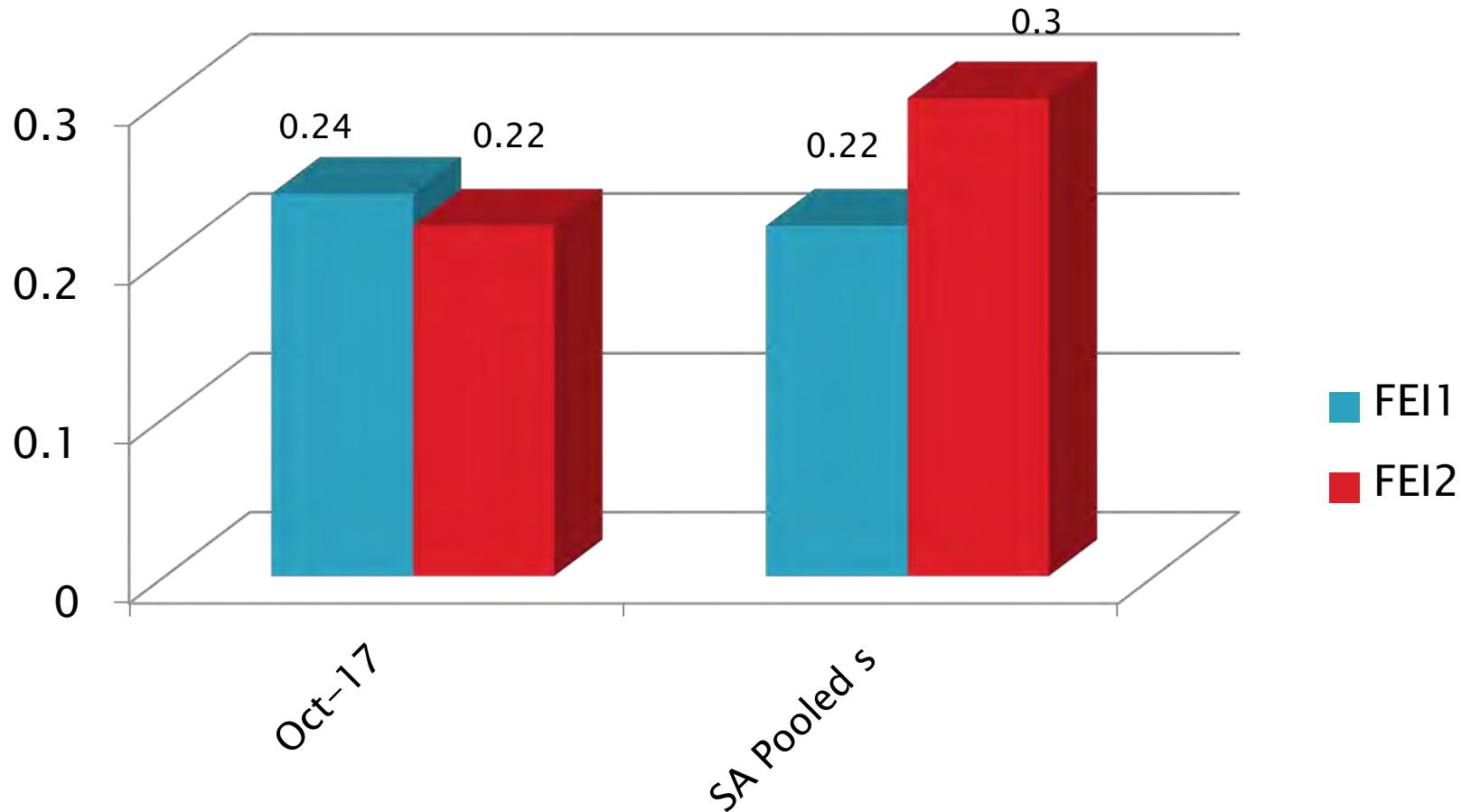


CUSUM Severity Analysis



20OCT17:14:33

Sequence VIF Precision Estimates



[Return to Table of Contents](#)

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Sequence VIII

»» October 2017

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Sequence VIII Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	5
Operationally Invalid Calibration Test	LC	1
Total		6

Sequence VIII – Lost Tests*

Test Status	Cause	#
Invalid	Coolant temperature control	1
Totals		1

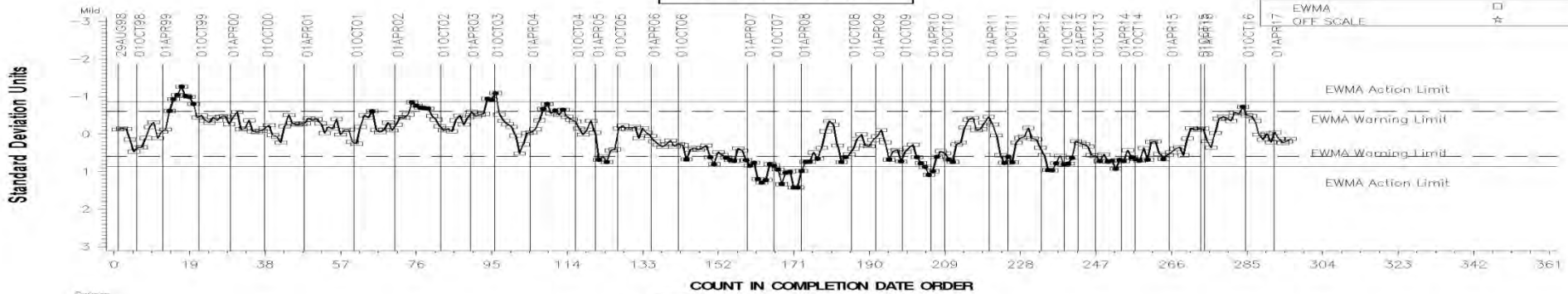
*Invalid and aborted tests

Sequence VIII Test Severity

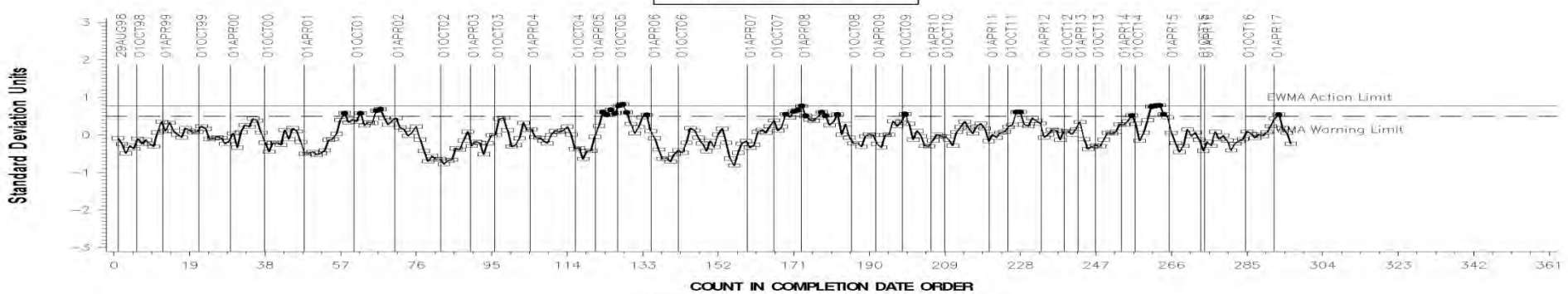
- Bearing Weight Loss is in control
- Stripped Viscosity is in precision warning alarm.

FINAL BEARING WEIGHT LOSS

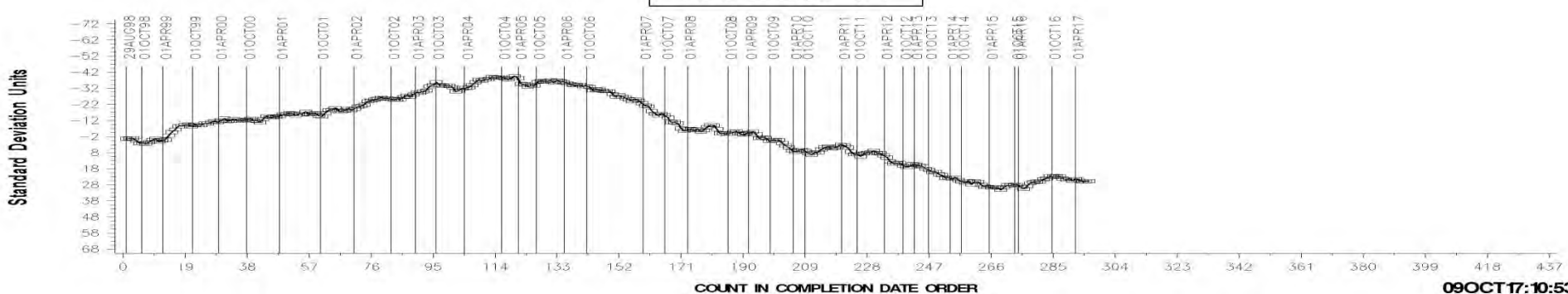
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



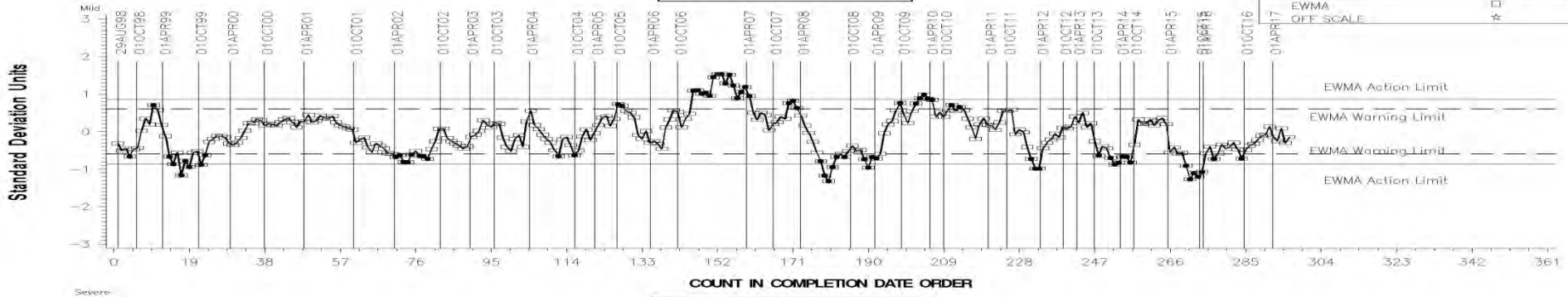
09OCT17:10:53

SEQUENCE VIII INDUSTRY OPERATIONALLY VALID DATA

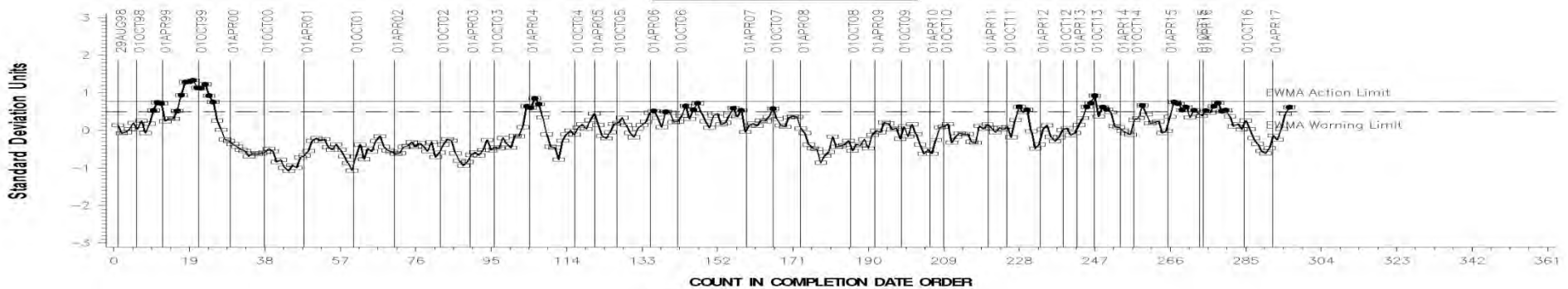


STRIPPED VIS. @ 100 DEG C

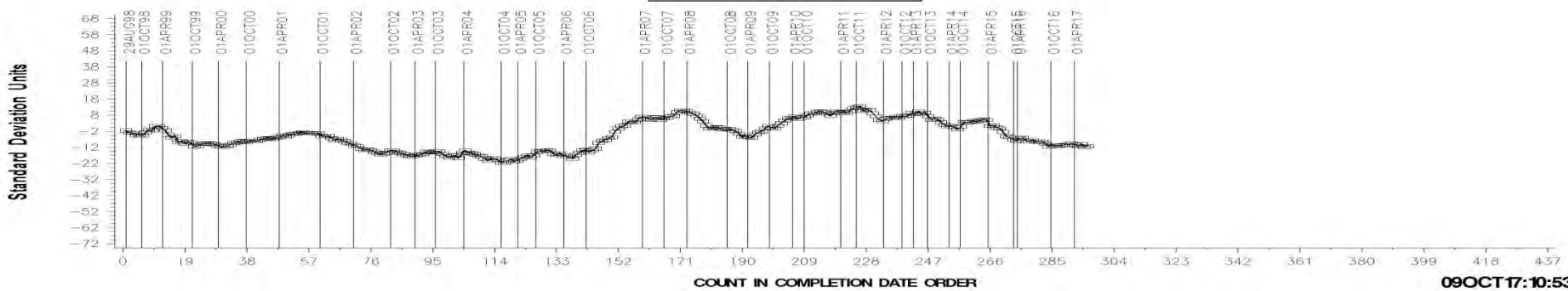
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis

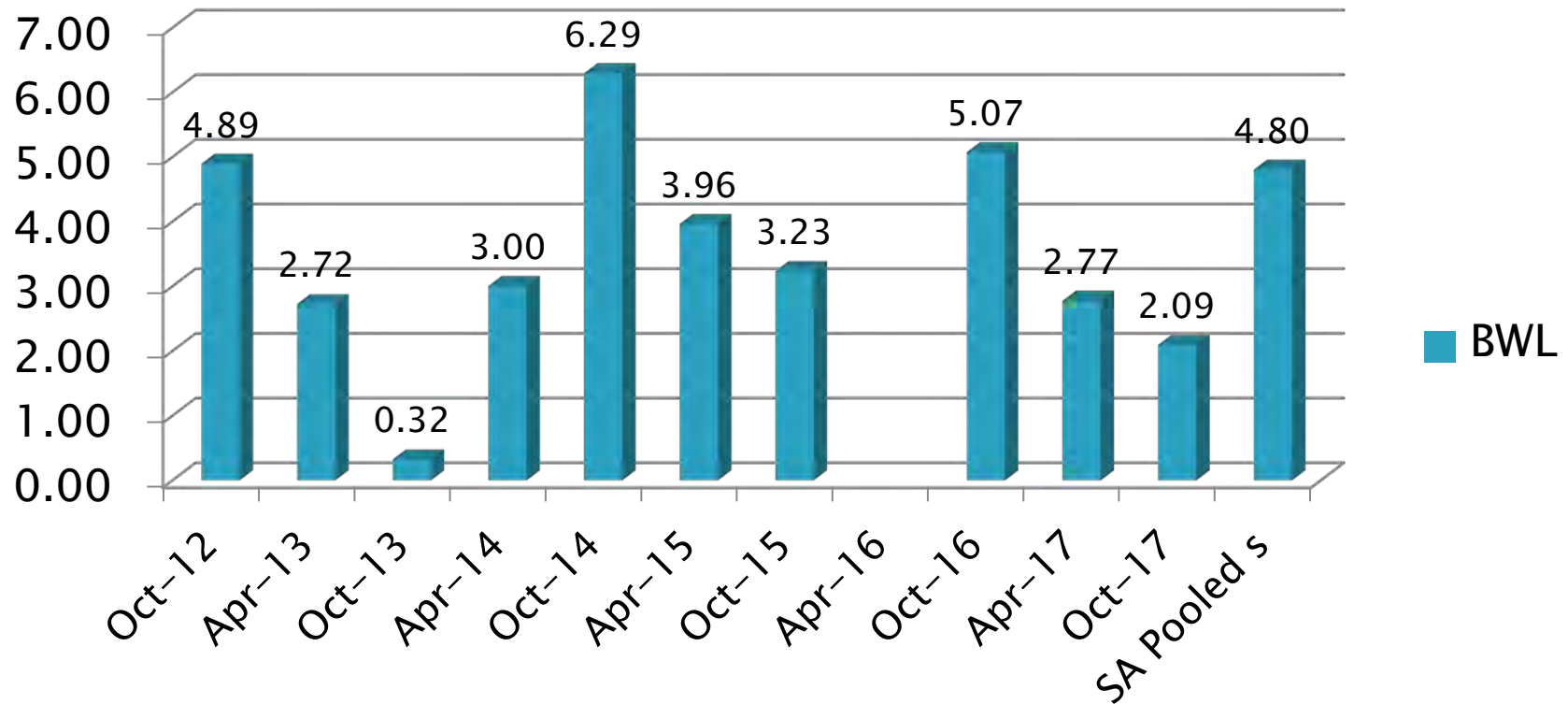


09OCT17:10:53



Sequence VIII Precision Estimates

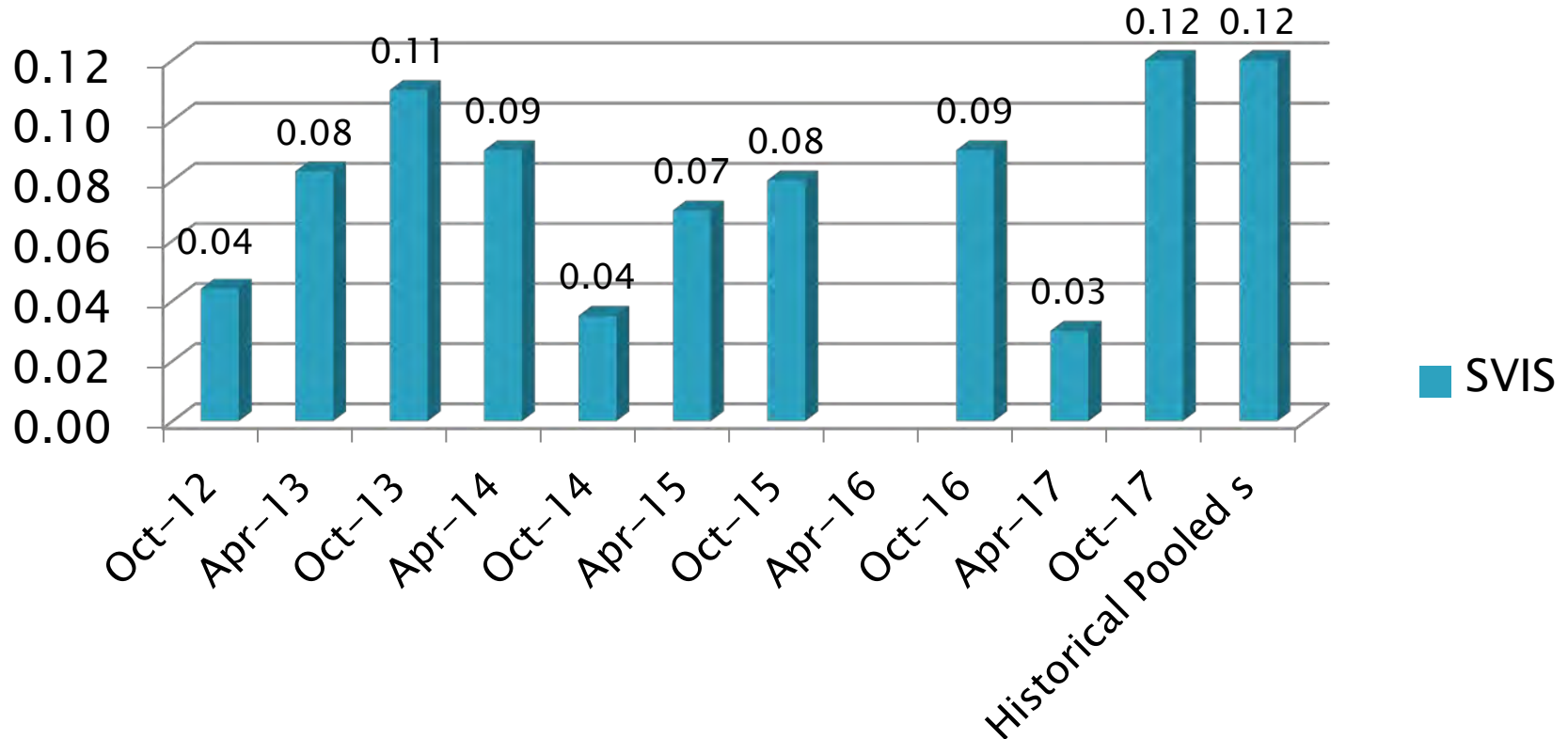
BWL



Sequence VIII Precision Estimates

SVIS

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



[Return to Table of Contents](#)

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Sequence IX

»» October 2017

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Sequence IX Activity

Test Status – Page 1 of 2	Validity Code	#
Acceptable Calibration Test	AC	19
Acceptable Donated Test	AG	3
Acceptable Discrimination Test	AS	2
Statistically Unacceptable Calibration Test	OC	3
Not for Industry Statistics Tests (unapproved Hardware, stand shakedown)	NN	24

Sequence IX Activity

Test Status – Page 2 of 2	Validity Code	#
Aborted Calibration Test	XC	2
Abandon engine	MN	1
Operationally Invalid Calibration Test (Lab Judgement)	LC	1
Operationally Invalid Not for Industry statistics Test (Lab Judgement)	LN	7
Total		62

Sequence IX – Lost Tests*

Test Status	Cause	#
Invalid	Invalid combustion data	2
Aborted	Operator error	1
Aborted	Exceeded number of invalid iterations allowed	1
Invalid	Unable to control load	1
Invalid	Failed O2 sensor	2
Invalid	Data acquisition system failure	1
Invalid	Air Charge Temperature Qi issues	2
Totals		10

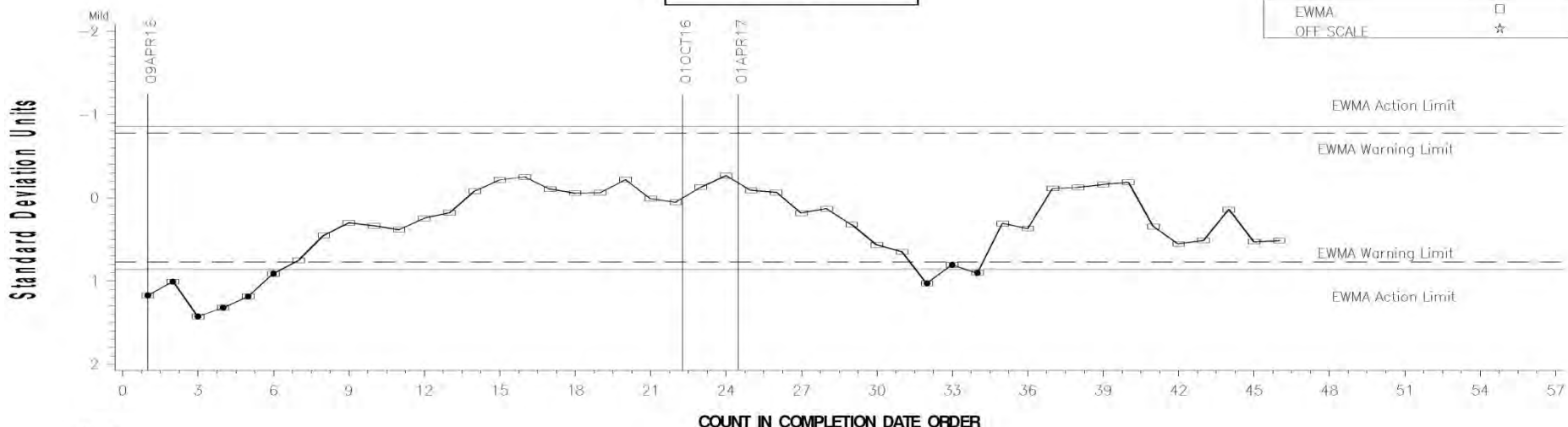
*Invalid and aborted tests

Sequence IX Test Severity

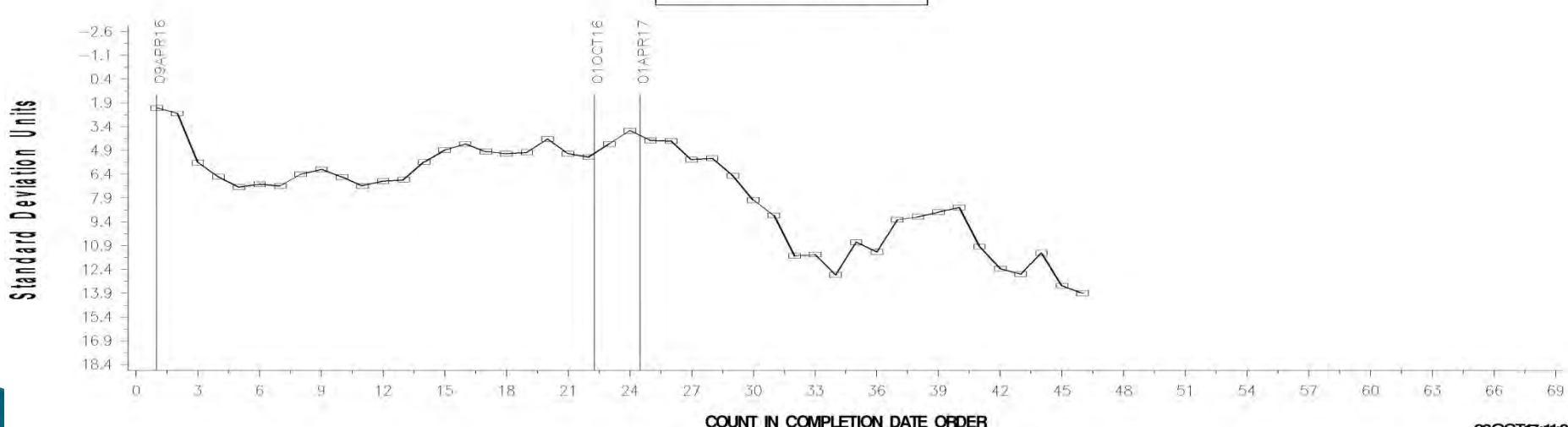
- Average number of Pre-ignitions in control.

AVERAGE NUMBER OF PREIGNITIONS FROM VALID ITERATIONS

LTMS Severity Analysis

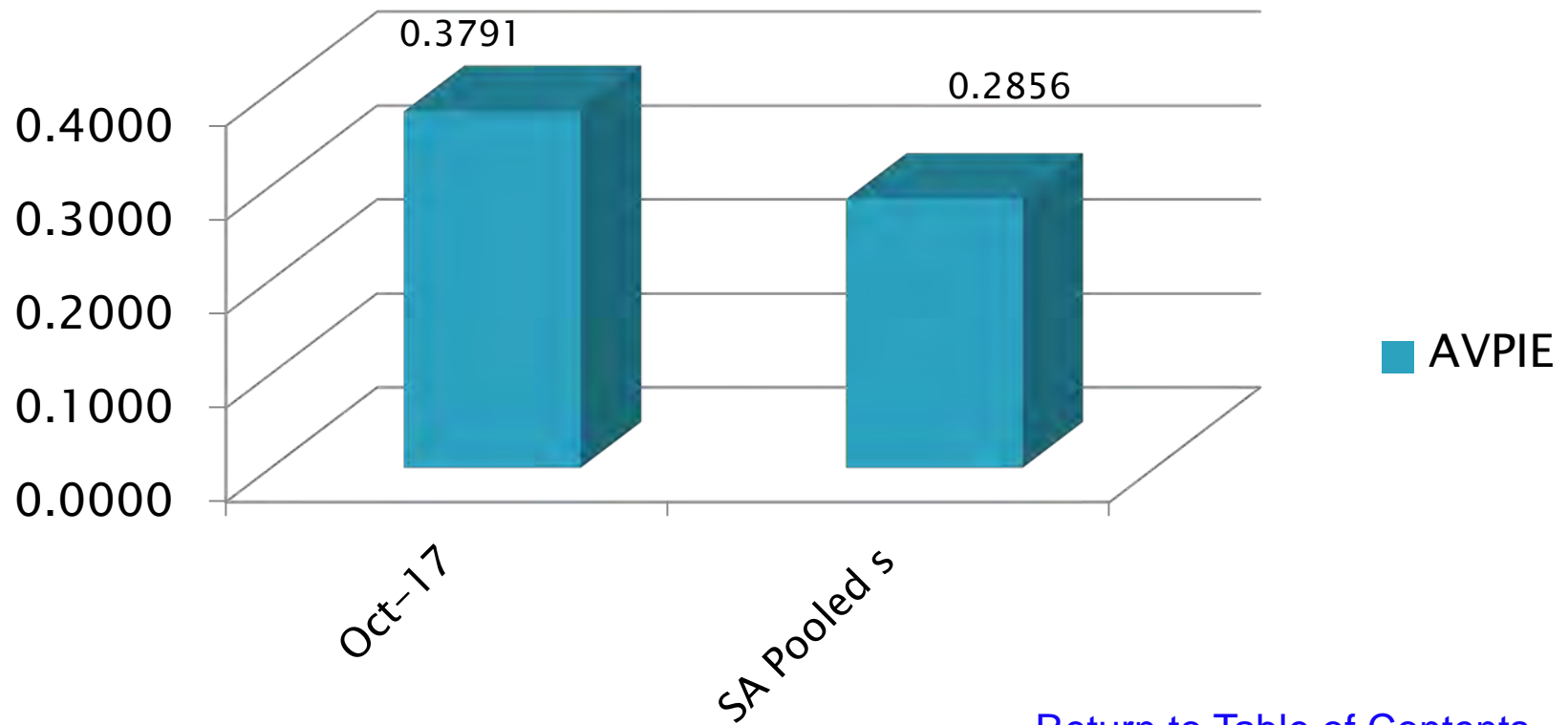


CUSUM Severity Analysis



Sequence IX Precision Estimates

AVPIE



[Return to Table of Contents](#)

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Information Letters

»» April 1, 2017 –

September 30, 2017

Test Monitoring Center

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Information Letters*

Test	Date	IL	Topic
IIIF	20170419	17-1	Allowed re-use of rocker arm OHT3F-058-1
IIIF	20170425	17-2	Changed honing machine calibration from annually to bi-annually
IIIF	20170703	17-3	Allowed re-use of connecting rods
IIIG	20170419	17-1	Allowed re-use of rocker arm OHT3F-058-1
IIIG	20170508	17-2	Revised honing machine calibration from annually to bi-annually
IIIG	20170531	17-3	Allowed re-use of connecting rods

*Available from TMC Website

[Return to Table of Contents](#)

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Information Letters*

Test	Date	IL	Topic
IIIH	20170425	17-2	Corrected test numbering to address runs on stand
IIIH	20170703	17-3	Incorporated IL 17-1 and 17-2 into Test Method D8111 and addressed errors in Tables A10 and A11
IIIH	20170810	17-4	Corrected typographical error in Table 7
IIIH	20170822	17-5	Corrected errors in section 11.8.2 pertaining to J-Tec blow-by meter configuration
VIE	20170925	17-3	Incorporated IL 17-1 and 17-2 into Test Method D8114 and added oil pump G4124A, addressed BLB3 in FEI calculations and corrected errors in Annex A15

*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 Re-blends

➤ TMC 300

- Supplier has been contacted for Re-blend.

➤ TMC 434-3

- Re-blend is available, not introduced yet.

➤ TMC 542-3

- Reblend introduced this report period.

➤ TMC 438-2

- Re-blend is available, not introduced yet.

➤ TMC 1009

- Re-blend is available, not introduced yet.

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
220	IX	1100	125	608	45	3 years
221	IX	2120	155	1818	50	5+ years
222	IX	1040	230	431	60	1.5 years
300	IVA	330	80	43	32	<1 year
433-1	IIIF	1045	0	0	8	<1 year
433-2	IIIF	500	26	196	32	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	35	25	28	<1 year
434-3	IIIG, IIIH	980	0	980	0	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
435	IIIG	550	0	2	4	<1 year
435-2	IIIG	550	12	157	32	3+ years
436	IIIH	1100	18	902	36	5+ years
438	IIIG	990	12	38	20	1.5 years
438-1	IIIH	605	20	116	40	2 years
542-2	VIE	1000	25	0	24	<1 years
542-3	VIE	997	139	858	60	3+ Years
543	VIF	1100	123	817	48	3+ Years
544	VIE	897	134	428	78	2+ years
704-1	VIII	897	2	103	10	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
925-3	VG	975	0	10	6	<1 year
940	VG, VH	560	18	226	18	3+ years
1006-2	IVA, VG, VIII	5500	224	1629	25	2+ years
1007	IVA, VG	1968	0	0	30	<1 year
1009	VG, VH, VIII	1100	5	39	21	<1 year
1009-1	VG, VH, VIII	1100	6	1094	6	5 years
1010-1	VIE	1760	224	1044	138	5 years
1011	VIF	1100	72	863	42	4 years
1012	IVB	2200	47	2101	32	5+ years

[Return to Table of Contents](#)

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LTMS Deviations

»» April 1, 2017 –
September 30, 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

[Return to Table of Contents](#)

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Quality Index Deviations

»» April 1, 2017 –

September 30, 2017

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Quality Index Deviations

- Two Quality Index Deviations this Report Period.
 - IVA – Engine coolant flow
 - IIIH – Intake air temperature and coolant out temperature

Quality Index Deviations

Historical Count of PCEO Quality Index Deviations

Test	Quality Index Deviations
IIIF	28
IIIG	16
IIIH	5
IVA	29
VG	45

[Return to Table of Contents](#)

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TMC Laboratory Visits

»» April 1, 2017 –

September 30, 2017

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TMC Lab Visits

Test	Number of Labs Visited
VIE	1
IVB	2

Lab Visit Issues

- IVB
 - Process water connections to blowby heat exchanger reversed.

[Return to Table of Contents](#)

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Test Area Timelines

»» April 1, 2017 –
September 30, 2017

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Test Area Timeline Additions*

Test	Date	Topic	IL
IIIF	20170419	Allowed re-use of rocker arm OHT3F-058-1	17-1
IIIF	20170425	Changed honing machine calibration from annually to bi-annually	17-2
IIIF	20170703	Allowed re-use of connecting rods	17-3
IIIG	20170419	Allowed re-use of rocker arm OHT3F-058-1	17-1
IIIG	20170425	Changed honing machine calibration from annually to bi-annually	17-2
IIIG	20170703	Allowed re-use of connecting rods	17-3
IIIH	20170425	Corrected test numbering to address runs on stand	17-2

*As of 09/30/2017

[Return to Table of Contents](#)

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Test Area Timeline Additions*

Test	Date	Topic	IL
IIIH	20170703	Incorporated IL 17-1 and 17-2 into Test Method D8111 and addressed errors in Tables A10 and A11	17-3
IIIH	20170810	Corrected typographical error in Table 7 of test method	17-4
IIIH	20170822	Corrected errors in section 11.8.2 pertaining to J-Tec blowby meter configurations	17-5
VIE	20170925	Incorporated IL17-1 and 17-2 into Test Method D8114, added oil pump G4124A, addressed BLB3 in FEI calculations and corrected errors in Annex A15.	17-3
VIF	20170407	Begin calibrated testing	
IX	20170815	Begin calibrated testing with 2016 Grade BB Pistons	

*As of 09/30/2017

[Return to Table of Contents](#)

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Rating Workshop Data

»» 2017 Light Duty Workshop

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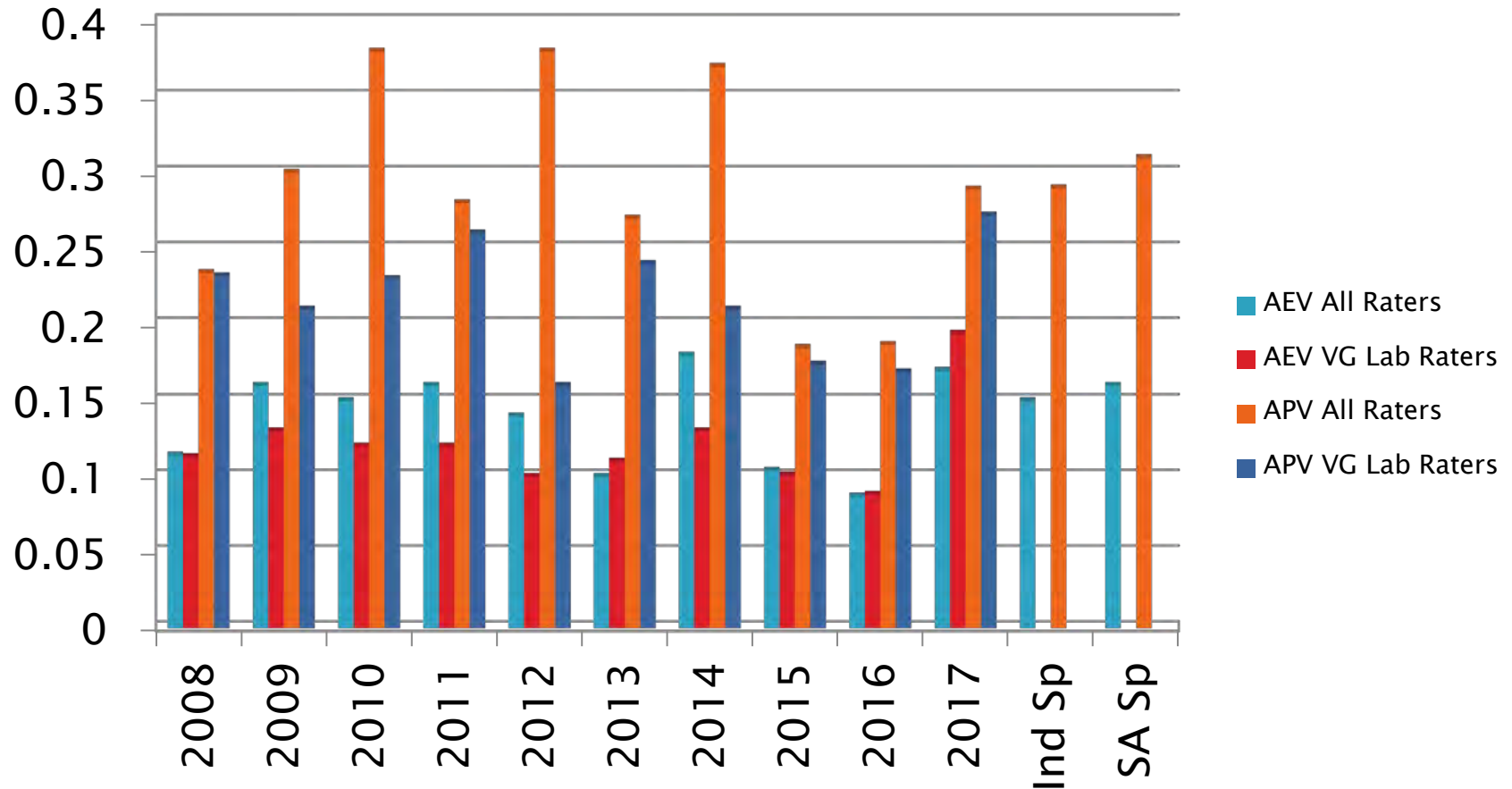
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Rating Workshop Data

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

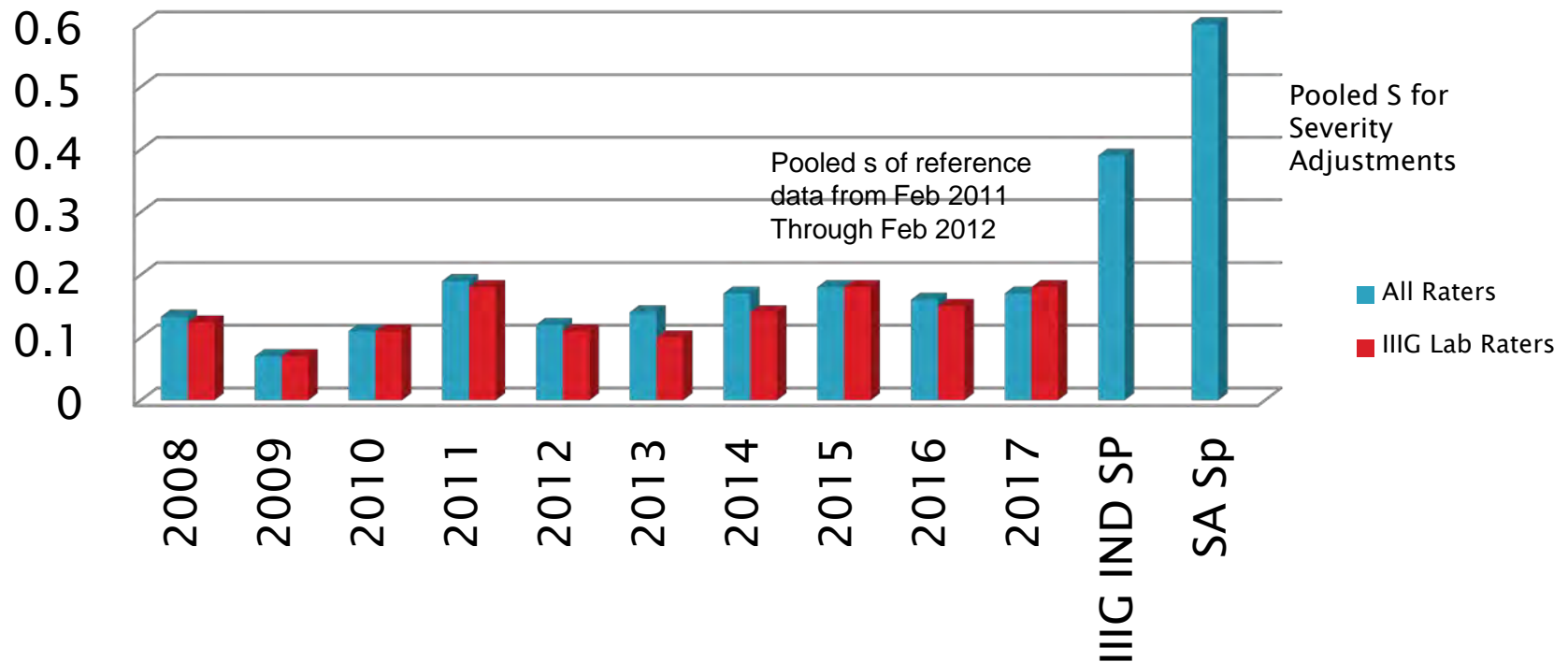
Sequence VG Precision-Rating Workshop Data

Workshop Data for VG Varnish



Sequence IIIG Precision – Rating Workshop Data

Comparison of Workshop Pooled Standard Deviations with Industry Pooled Standard Deviations



[Return to Table of Contents](#)

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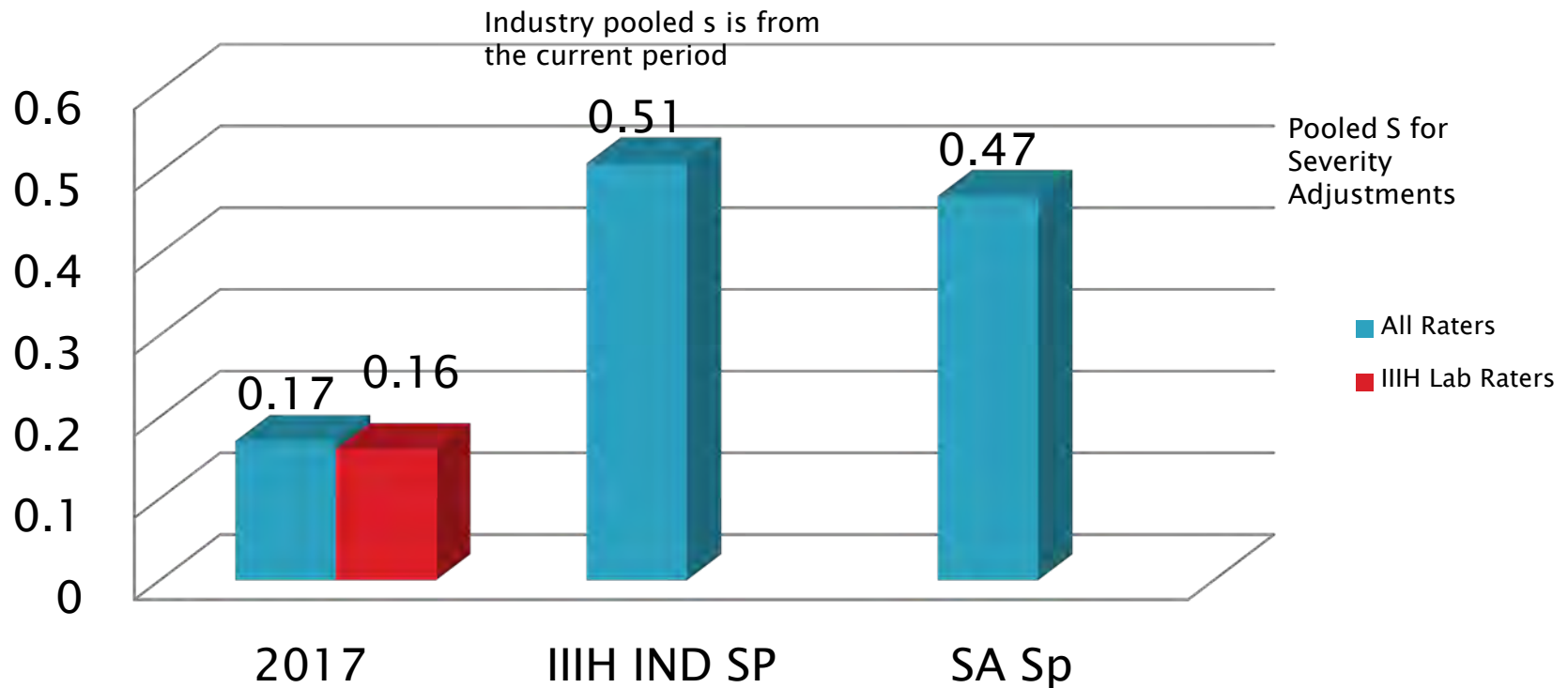
<http://astmtmc.cmu.edu>



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Sequence IIH Precision – Rating Workshop Data

Comparison of Workshop Pooled Standard Deviations with Industry Pooled Standard Deviations



[Return to Table of Contents](#)

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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

[Return to Table of Contents](#)

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