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Test Monitoring Center

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ASTM D02.B1 Semiannual Report Passenger Car Reference Oil Testing

October 2018

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. IV B
	Seq. V G

Table of Contents

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

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. IVB
 - Monitoring of the Test began in May.
- ▶ Seq. VH
 - Testing completed on Fuel Batch GI0321NX10.
Surveillance panel approved for use on 10/9/18
- ▶ BOI-VGRA
 - Testing is complete for Sequence IIIH, VIE, VIF, IX, and X
 - Testing is underway for VH.

[Return to Table of Contents](#)

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Calibrated Labs and Stands*

Test	Labs	Stands
IIIF	2	2
IIIG/A/B	1	1
IIIH/A/B	5	17
IVA	2	2
IVB	4	8
VG	1	1

[Return to Table of Contents](#)

*As of 9/30/2018

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Calibrated Labs and Stands*

Test	Labs	Stands
VH	4	10
VIE	4	15
VIF	2	7
VIII	2	4
IX	3	5
X	3	6

[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	3
Statistically Unacceptable Calibration Test	OC	2
Total		5

Sequence III F – Failed Tests

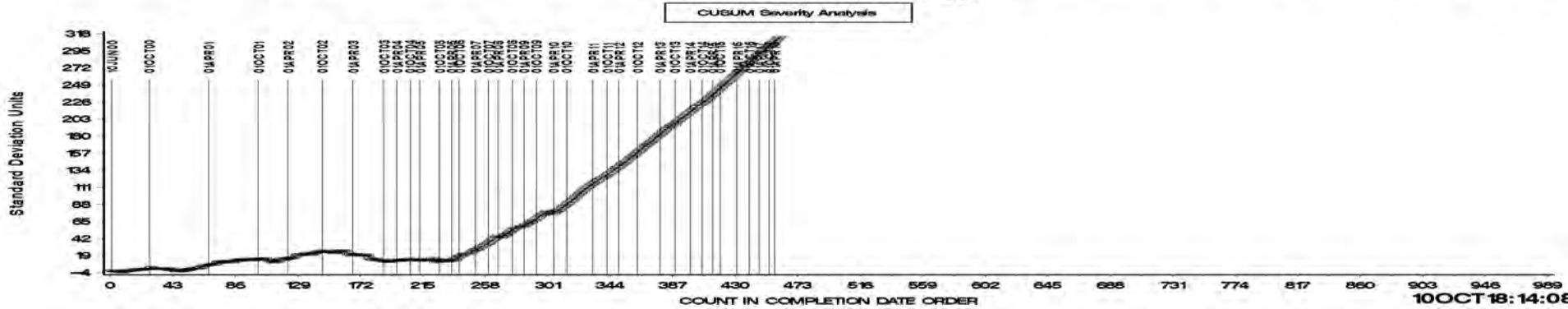
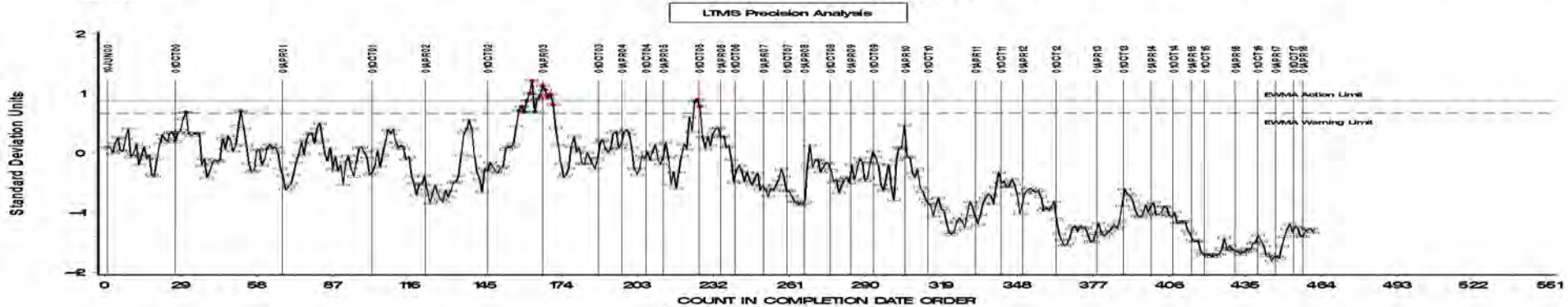
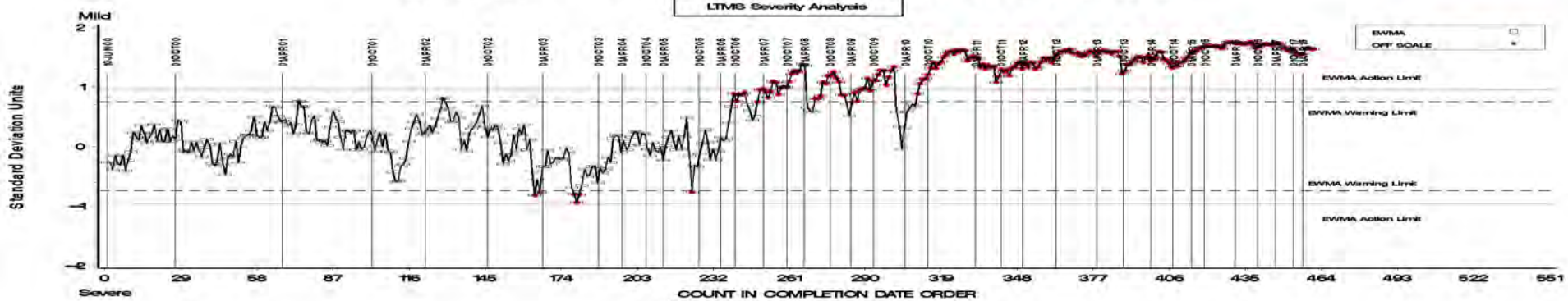
Test Status	#
Mild APV	1
Hours to 275% Vis Increase Precision Shewhart Alarm	1
Totals	2

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 severity warning alarm (severe)
- PV60
 - In severity action alarm (severe)

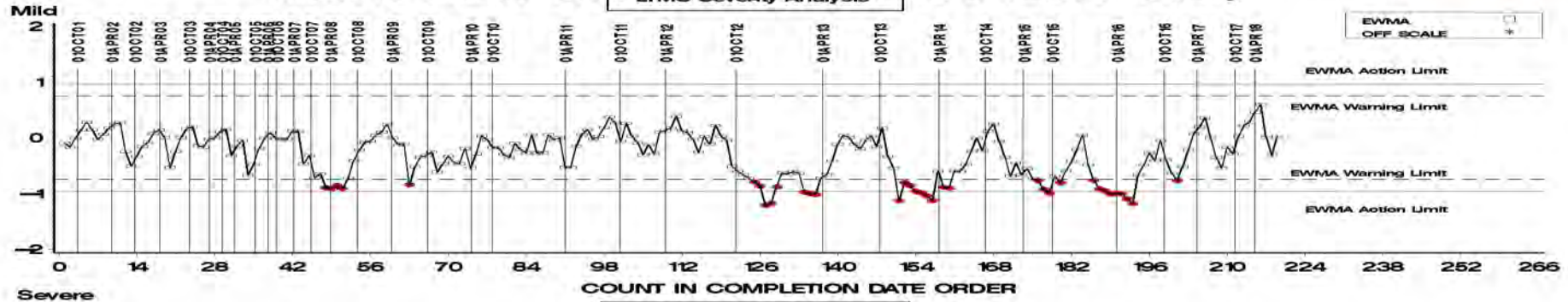
SEQUENCE IIIF INDUSTRY OPERATIONAL VALID DATA

AVERAGE PISTON SKIRT VARNISH FINAL ORIG UNIT RES

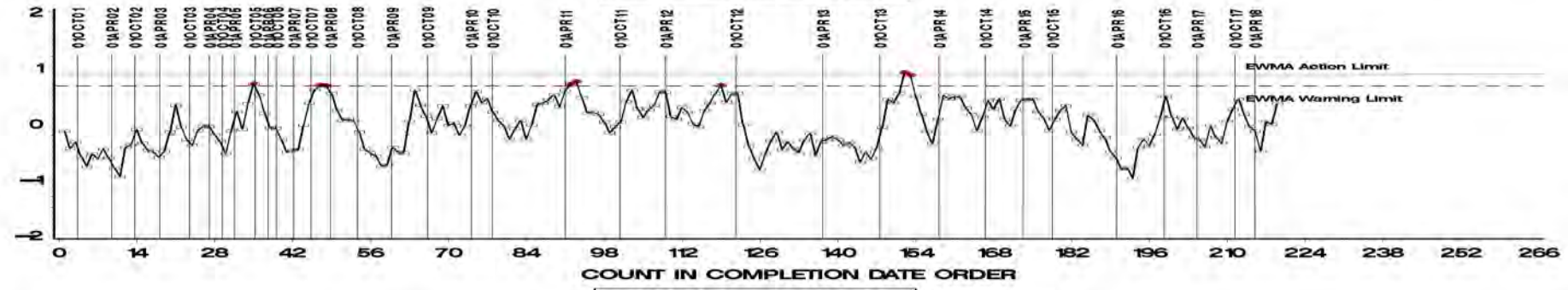


HOURS FINAL ORIG RES (REFERENCE TESTS ONLY)

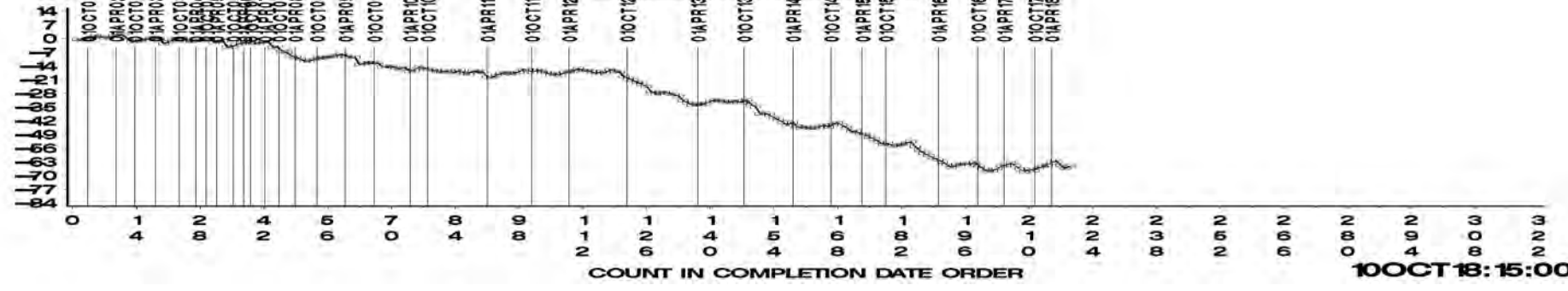
LTMS Severity Analysis



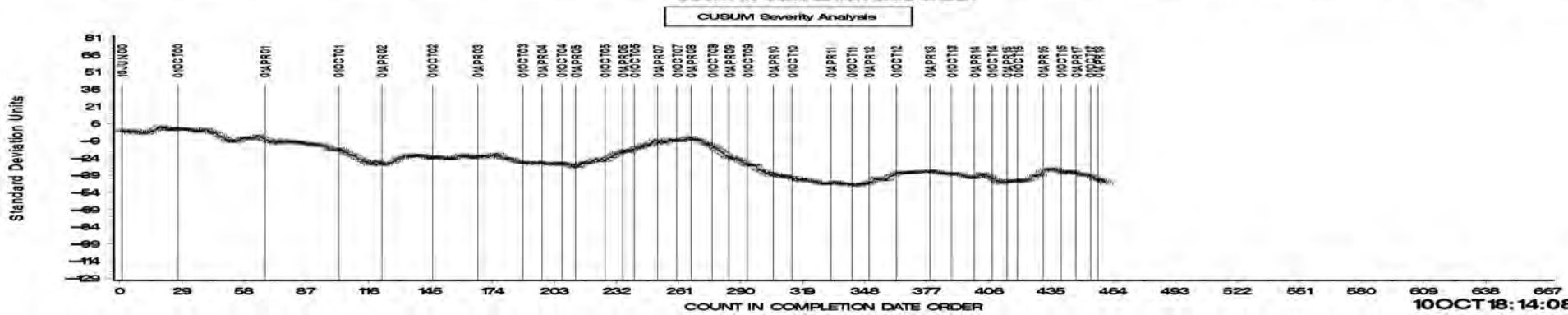
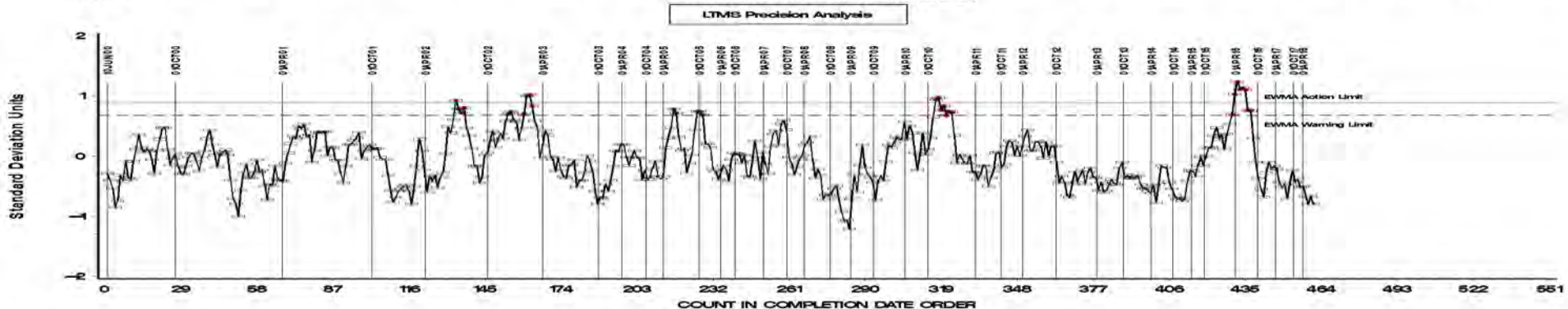
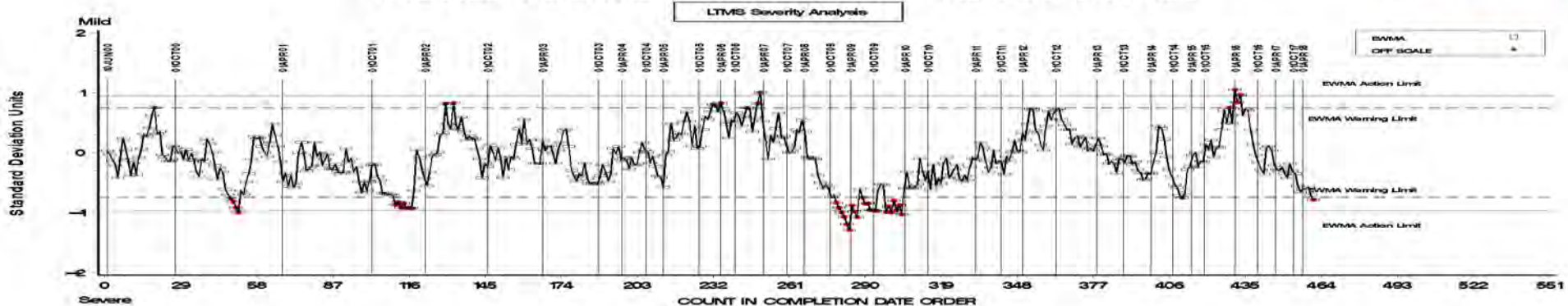
LTMS Precision Analysis



CUSUM Severity Analysis



AVERAGE WEIGHTED PISTON DEPOSITS FNL ORIG UNIT RES



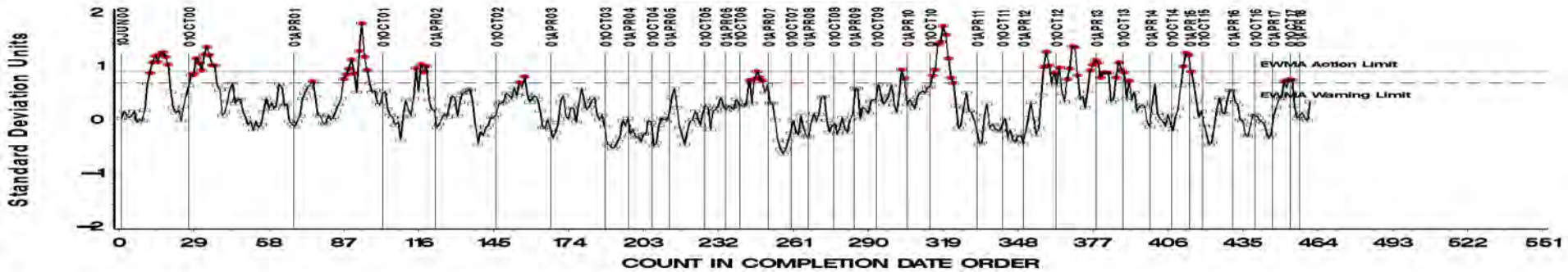
10OCT18: 14:08

% VISCOSITY INCREASE @ 060 HOURS

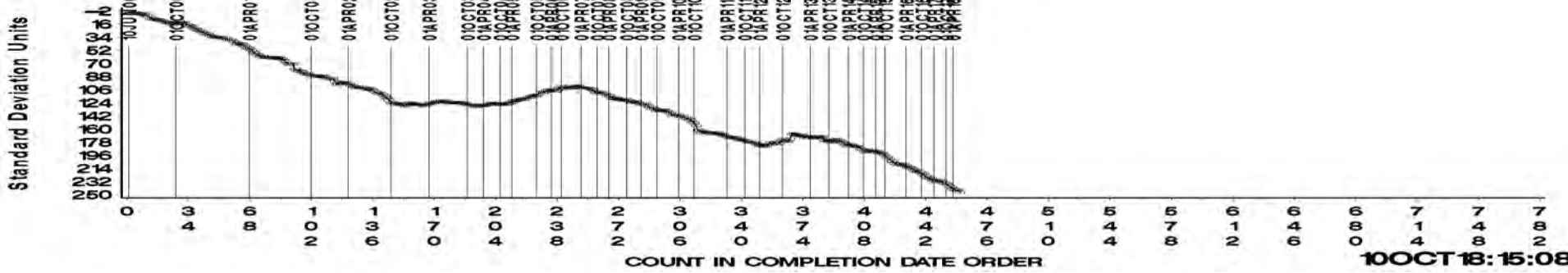
LIMS Severity Analysis



LIMS Precision Analysis



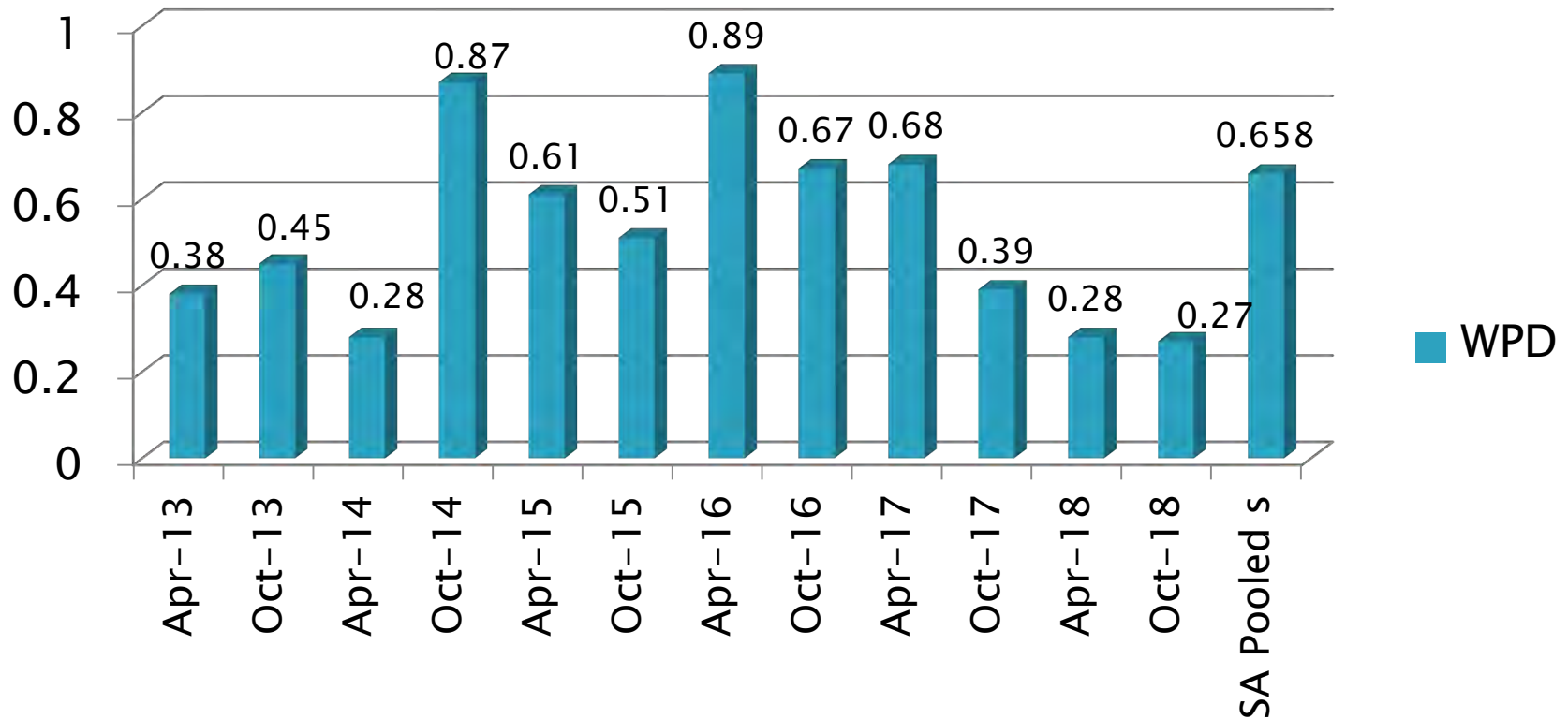
CUSUM Severity Analysis



10OCT18:15:08

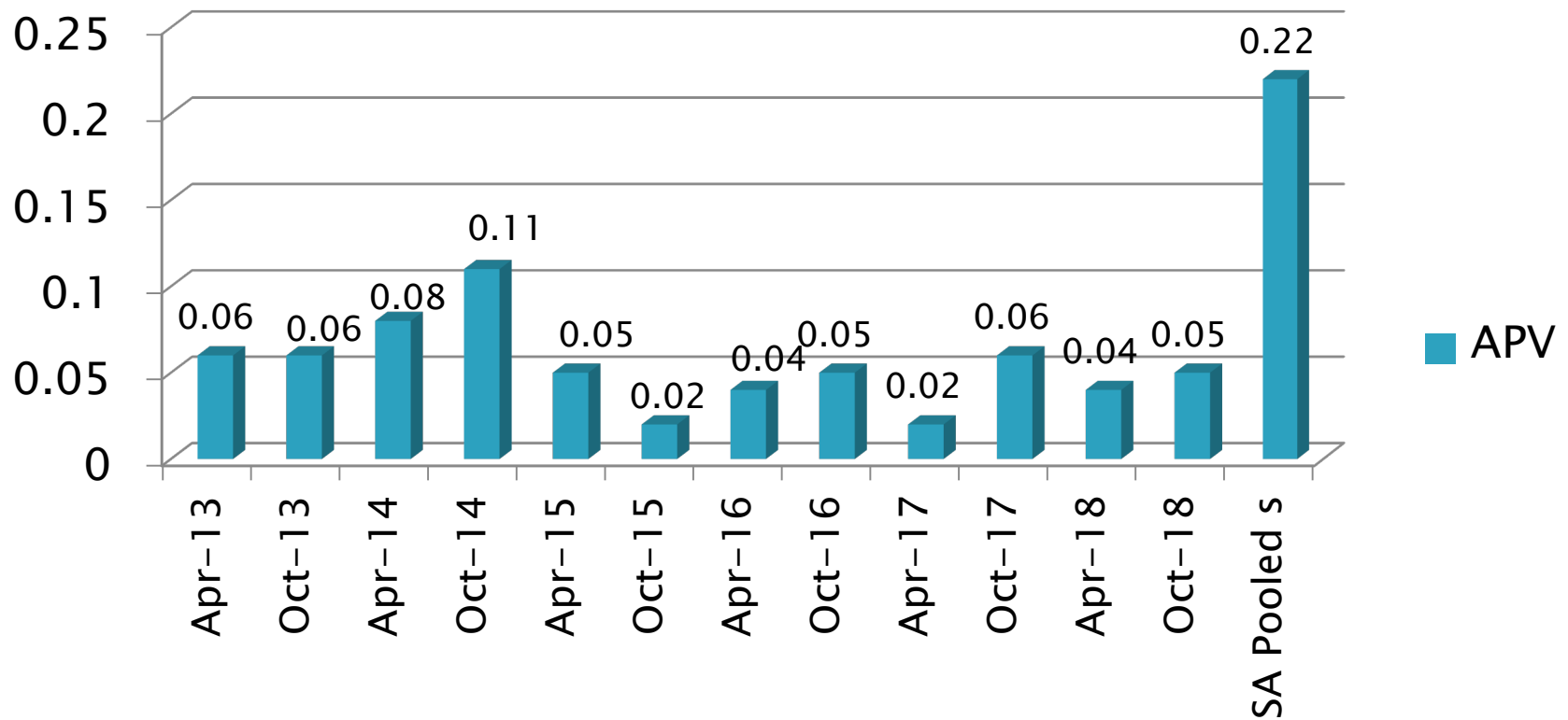
IIIF Precision Estimates

WPD



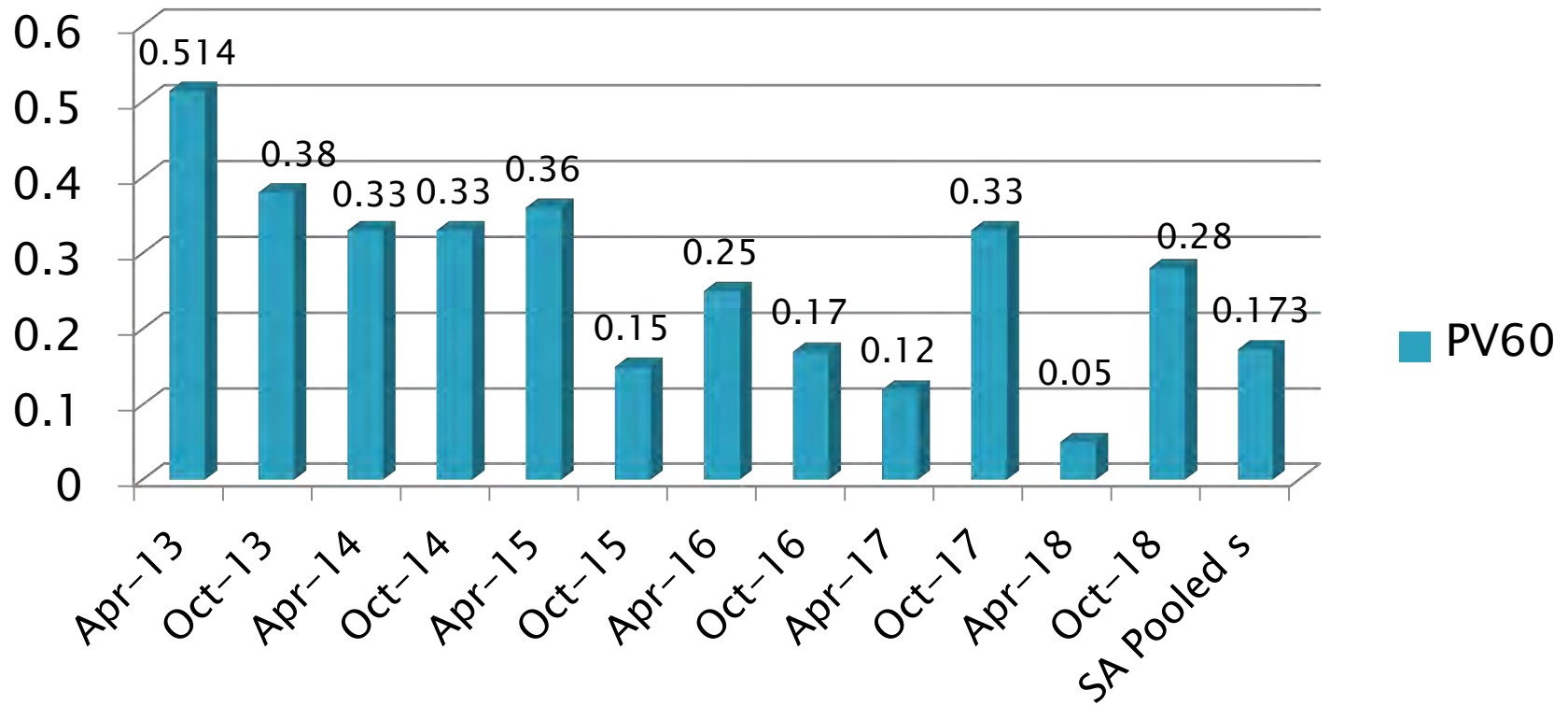
IIIF Precision Estimates

APV



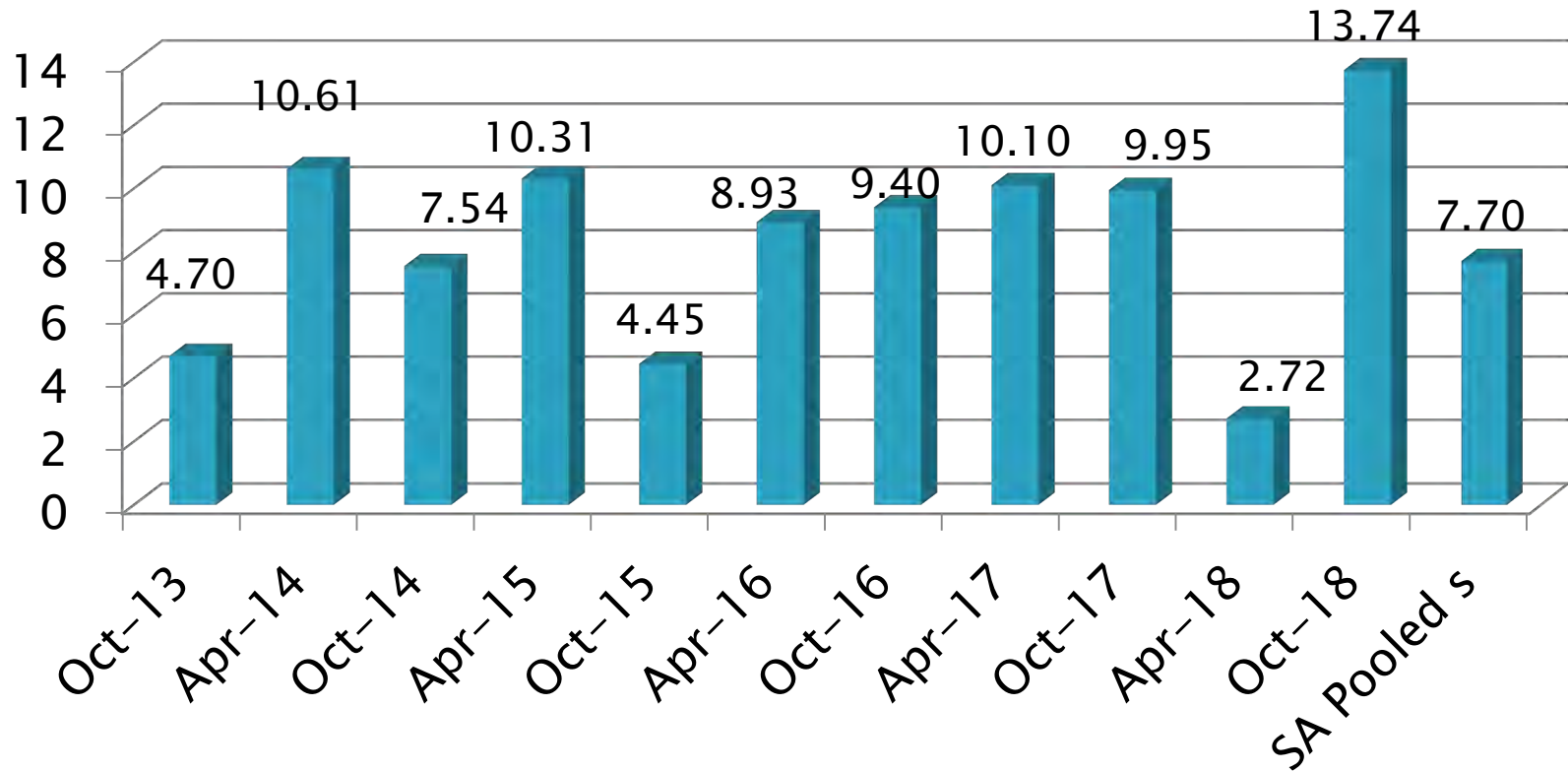
IIIF Precision Estimates

PV60



IIIF Precision Estimates

Hours to 275%



[Return to Table of Contents](#)

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Sequence IIIG/A/B

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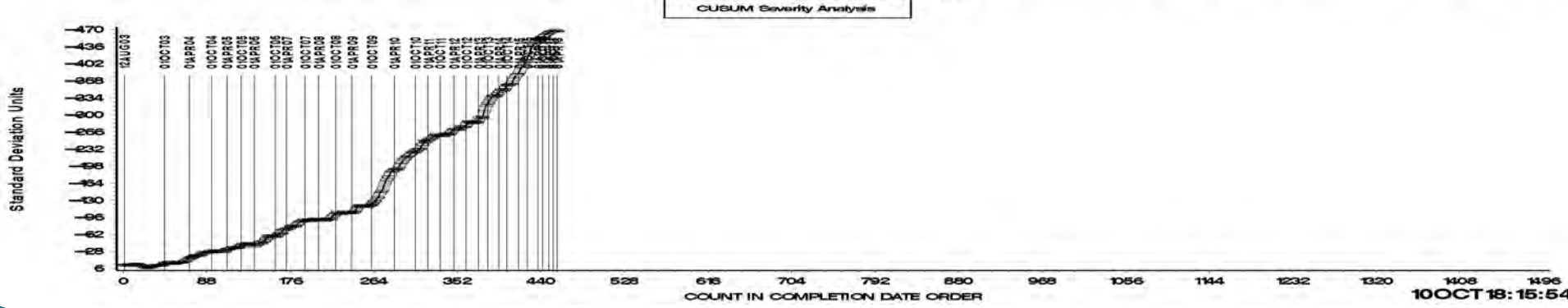
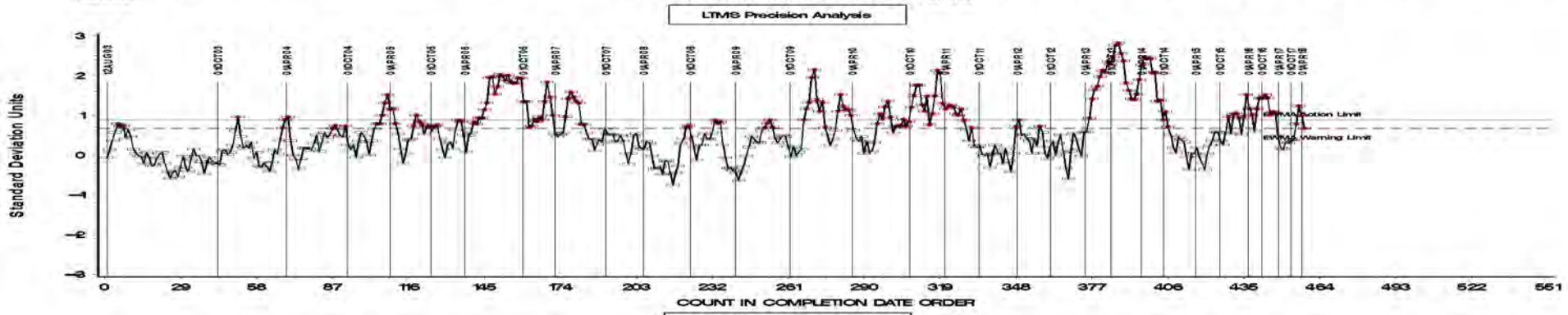
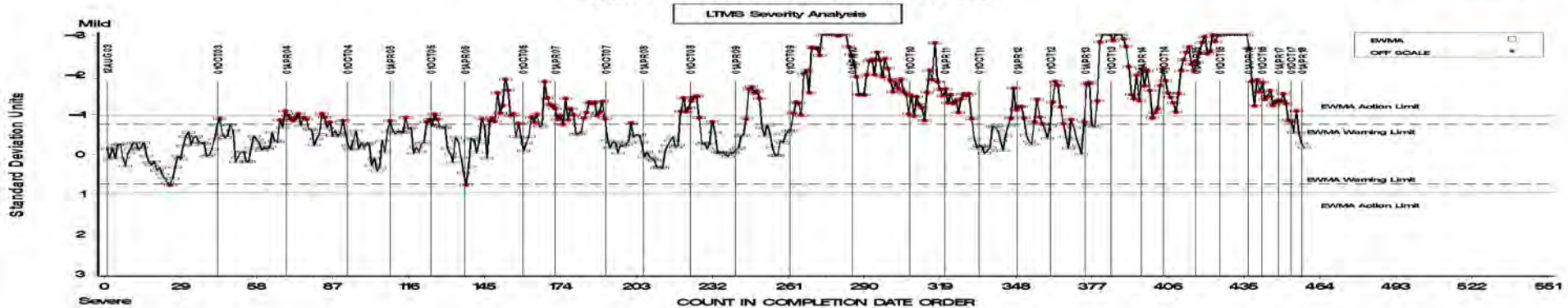
Sequence IIIG Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	1
Total		1

Sequence IIIG Test Severity

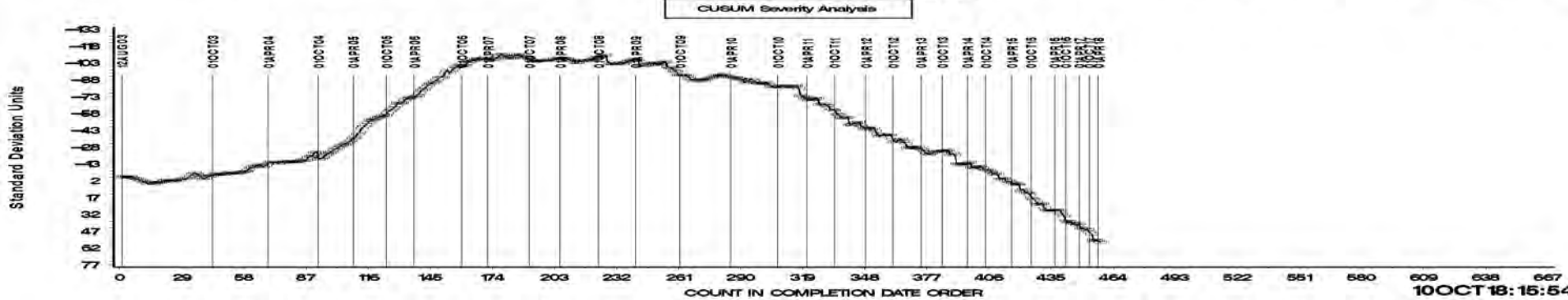
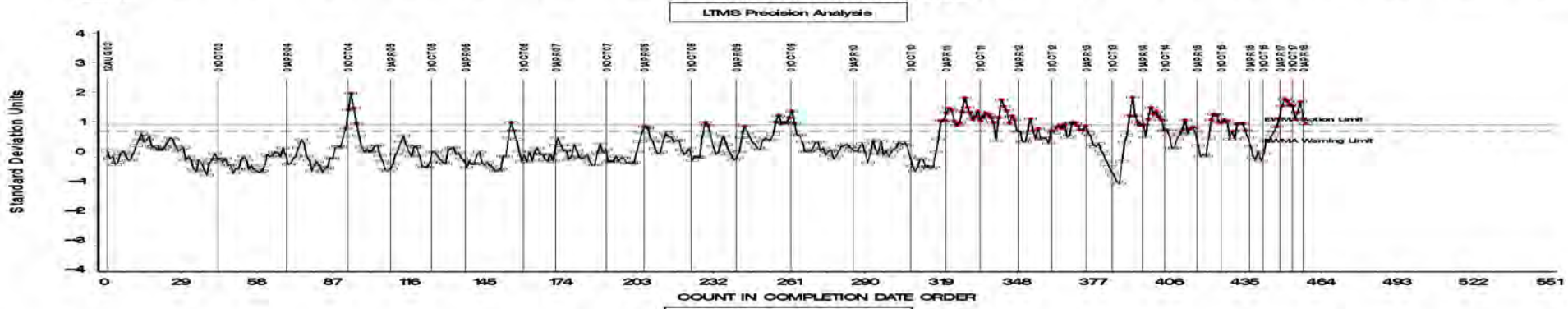
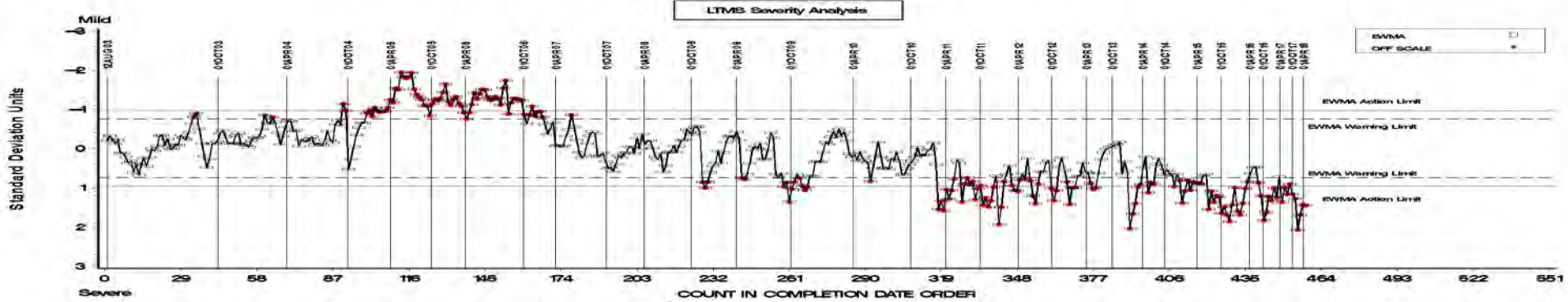
- **ACLW in precision warning alarm**
 - Long-term mild trend
- **PVIS**
 - Precision action alarm
 - Severity action alarm (severe)
- **WPD in severity warning alarm**
 - Long-term severe trend continuing
- **MRV is in severity action alarm (severe)**
 - Long-term severe trend continuing
- **PHOS in control**
- **Precision plots not updated, only 1 test reported**

AVERAGE CAM + LIFTER WEAR



10OCT18:15:54

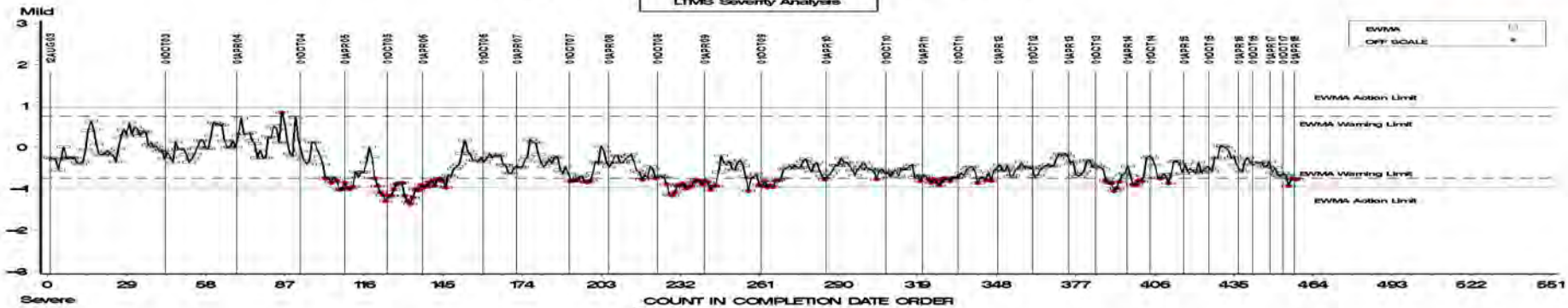
VISCOSITY INCREASE



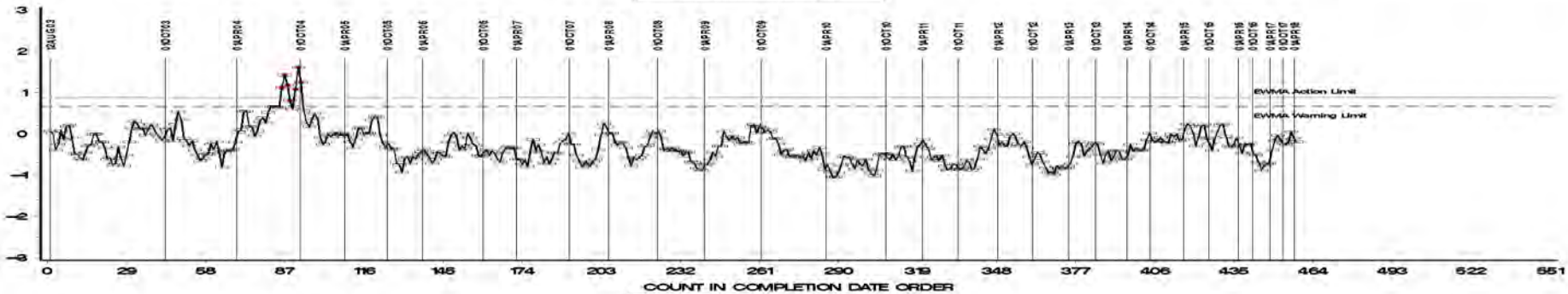
SEQUENCE III G INDUSTRY OPERATIONALLY VALID DATA

AVERAGE WEIGHTED PISTON DEPOSITS

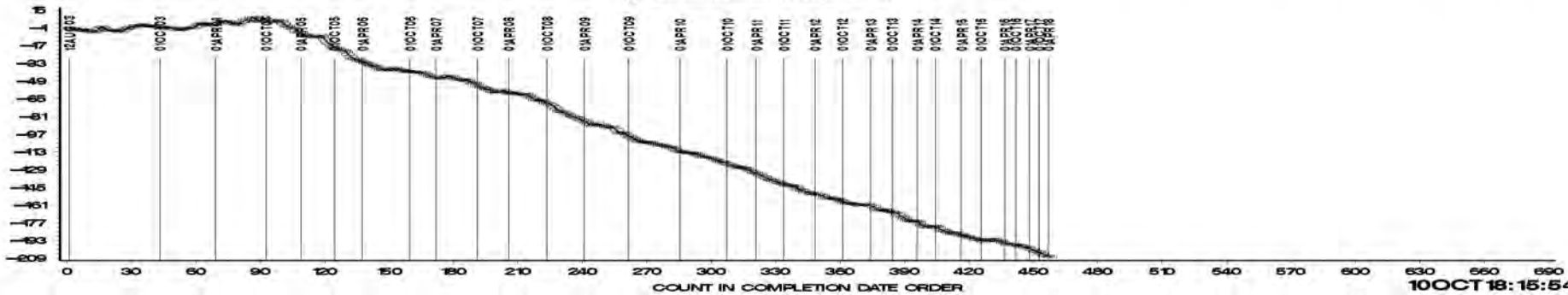
LTMS Severity Analysis



LTMS Precision Analysis



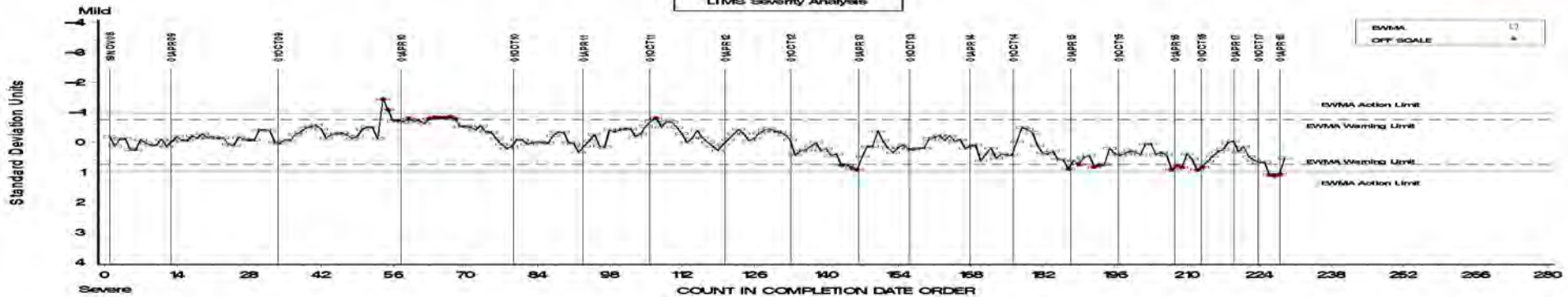
CUSUM Severity Analysis



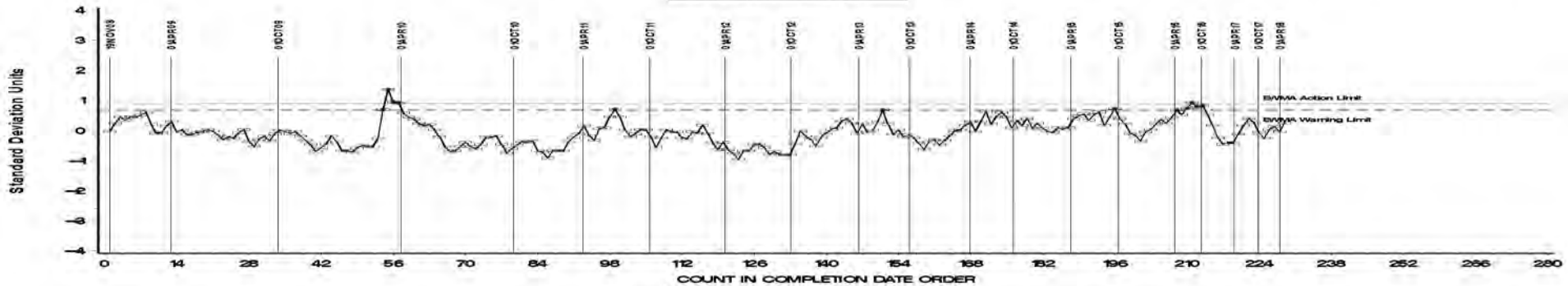
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PHOS RETENTION

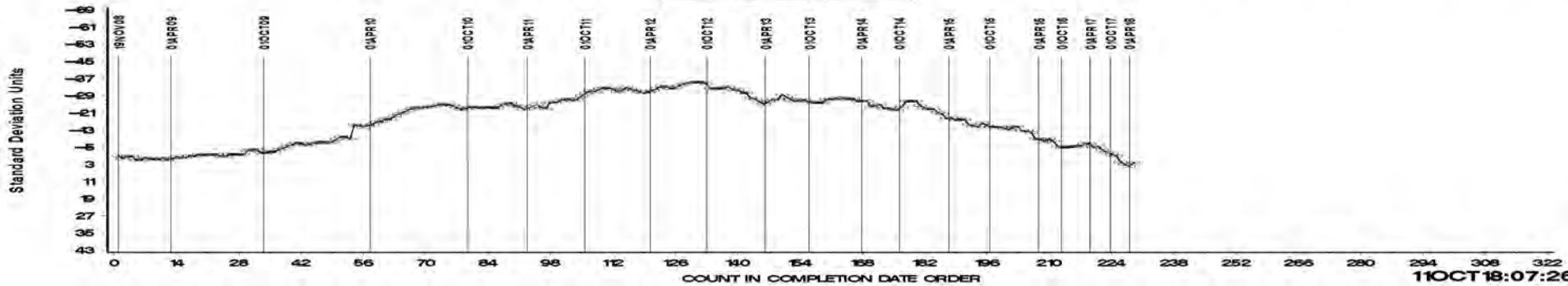
LTMS Severity Analysis



LTMS Precision Analysis

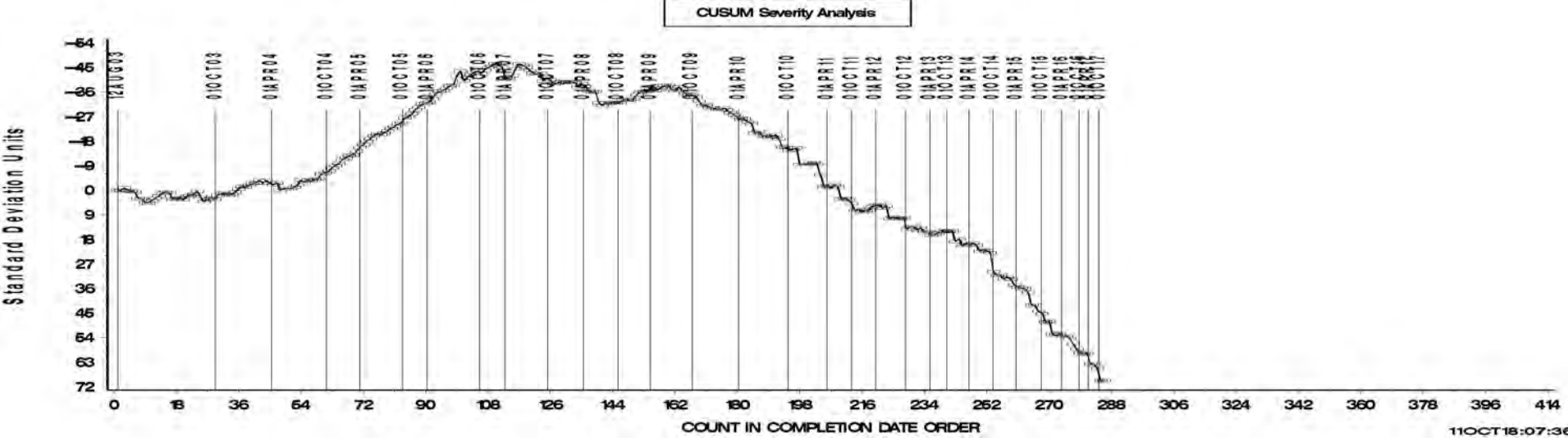
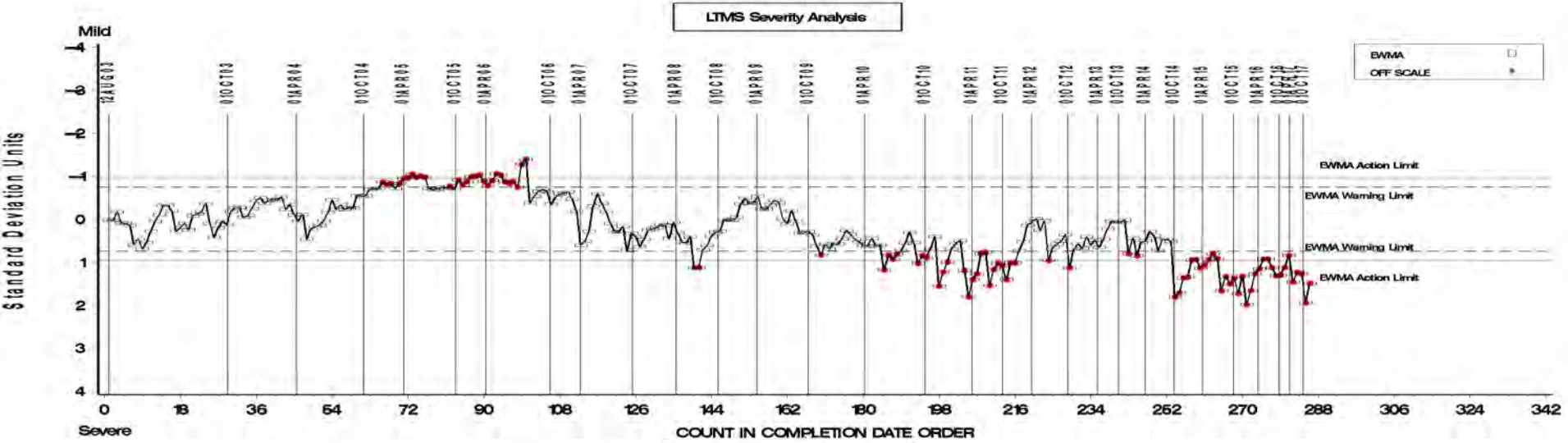


CUSUM Severity Analysis



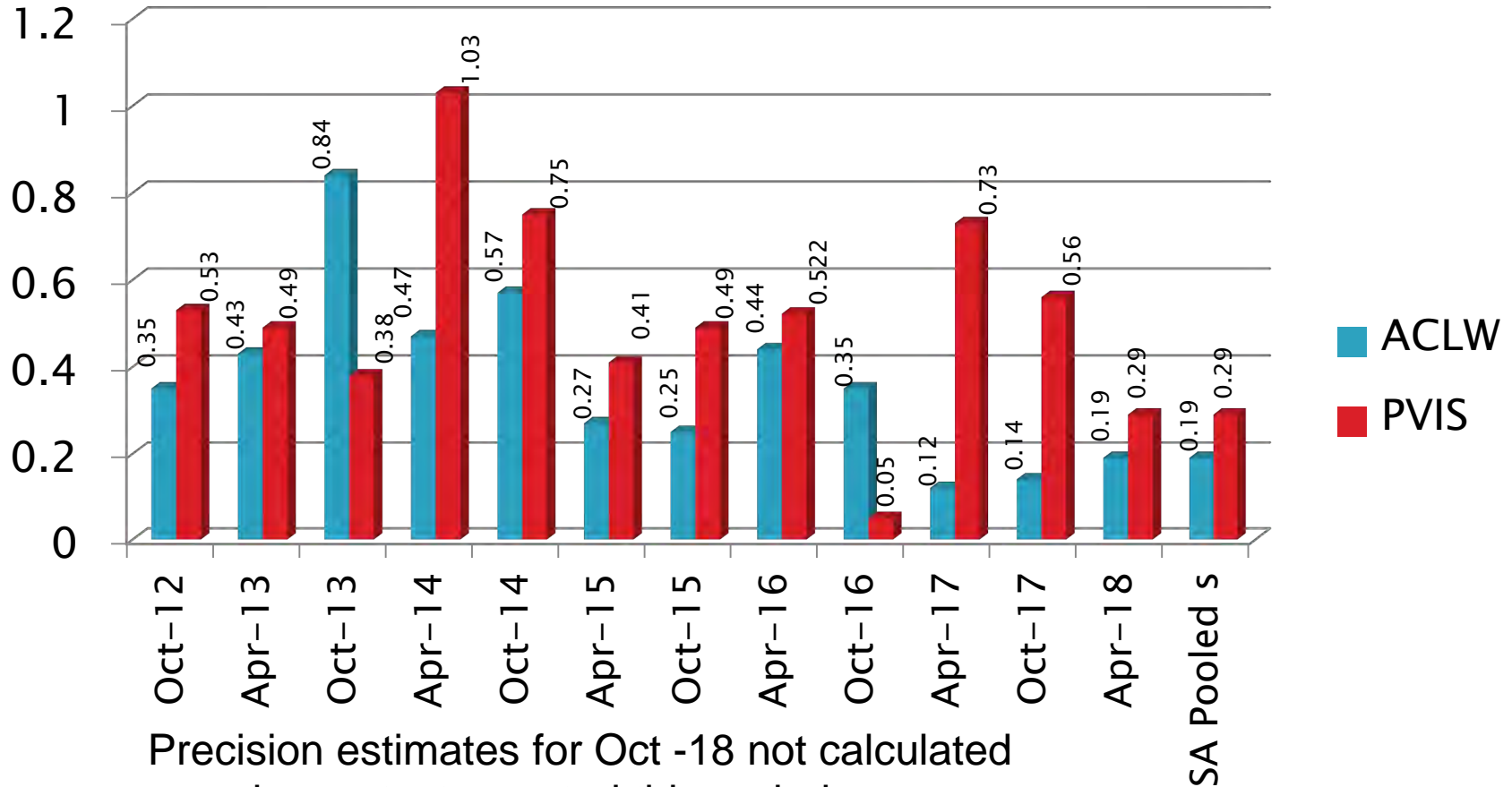
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MRV VISCOSITY RESULT



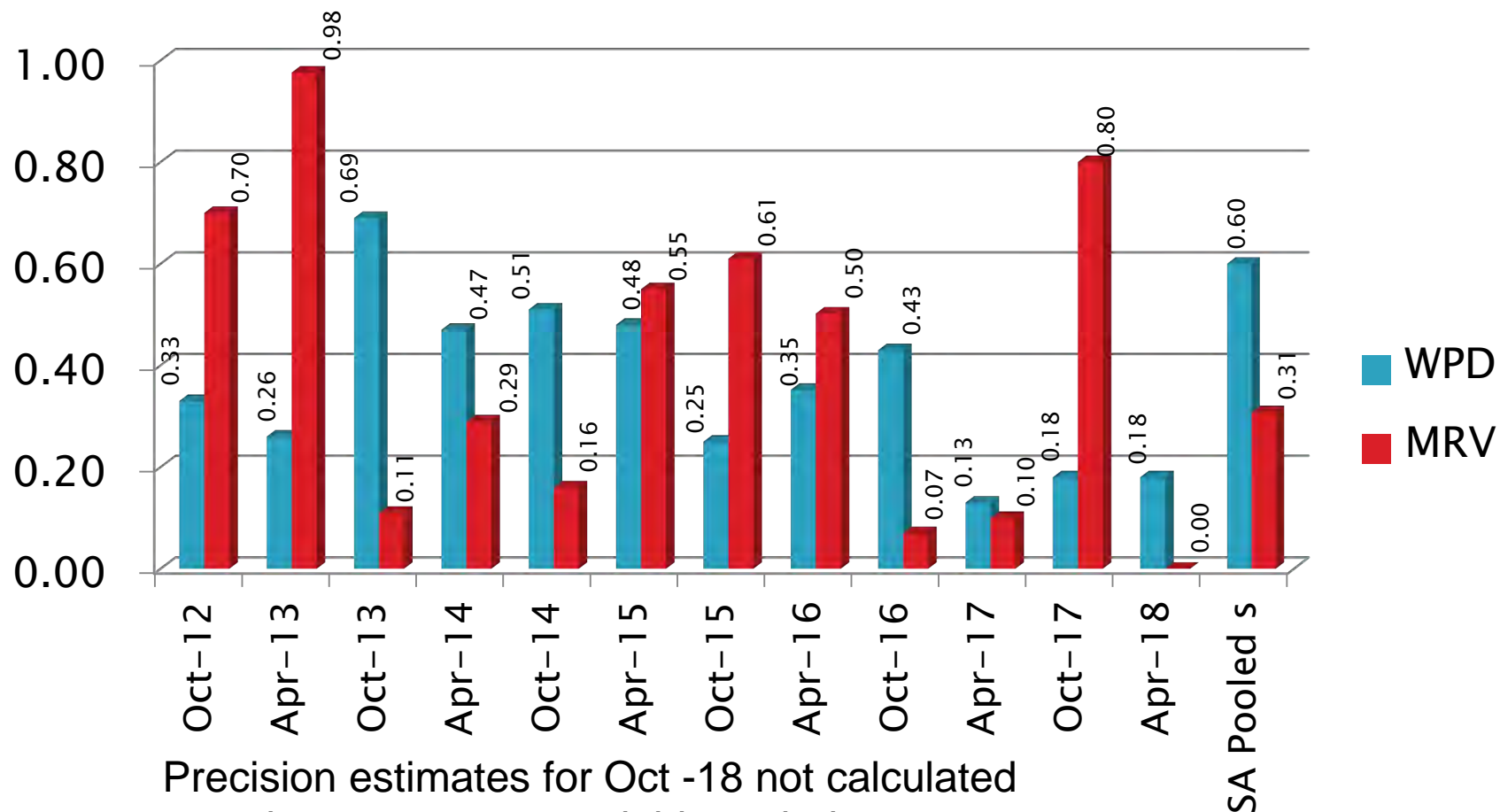
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IIIG Precision Estimates



Precision estimates for Oct -18 not calculated as only one test reported this period

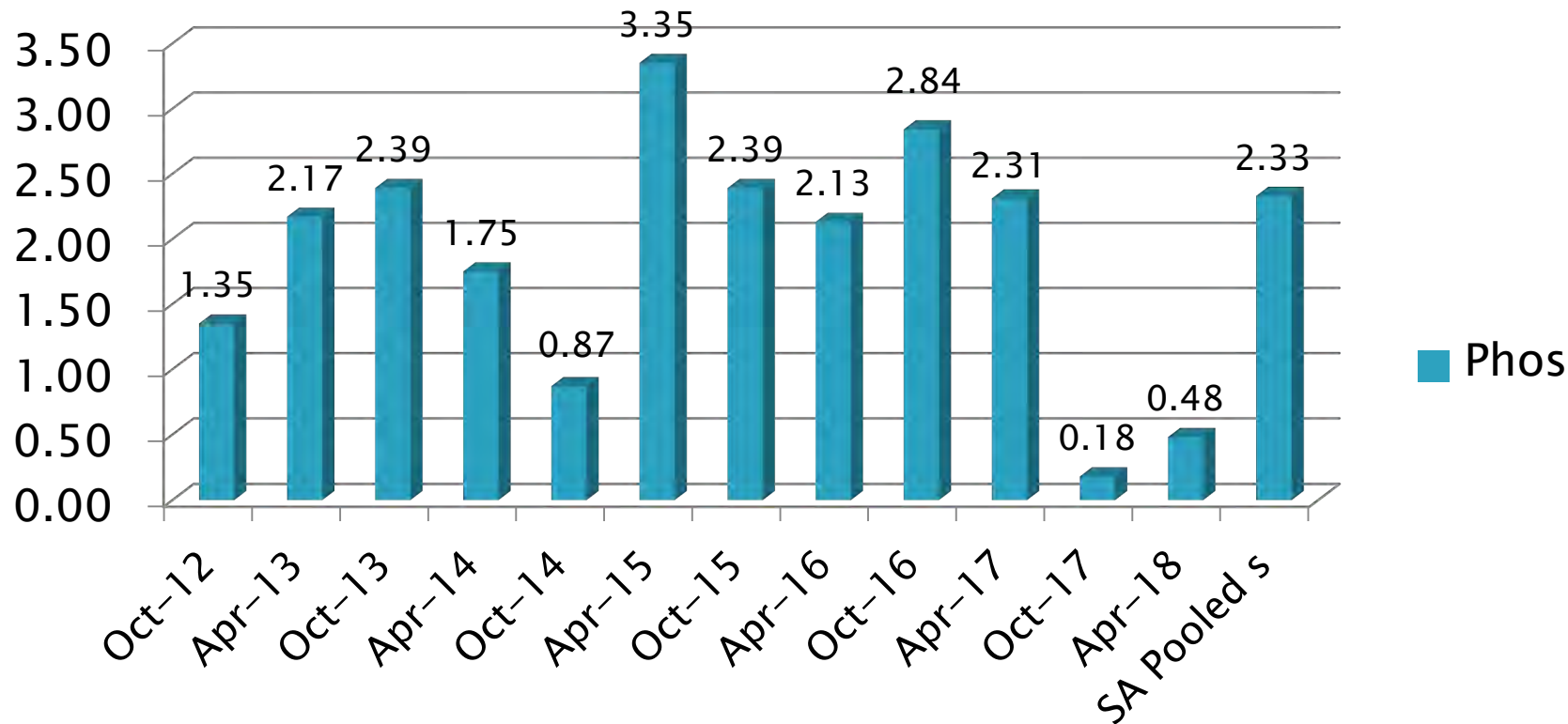
IIIG Precision Estimates



Precision estimates for Oct -18 not calculated as only one test reported this period

IIIG Precision Estimates

Phos



Precision estimates for Oct -18 not calculated as only one test reported this period

[Return to Table of Contents](#)

Sequence IIIH/A/B

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Sequence IIIH Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	21
Statistically Unacceptable Calibration Test	OC	3
Pending Calibration Test, Reference Oil 434-3 Targets	PC	1
Aborted Industry Support Test (BOI-VGRA, 70 Hour IIIH)	XI	2
BOI-VGRA Matrix Tests, 70 hour IIIH Tests	NI	14
Total		41

Sequence IIIH – Failed Tests

Test Status	#
Level 3 Ei Alarm PVIS, MRV, WPD	1
Level 3 Ei Alarm PVIS, MRV	1
Level 3 Ei Alarm PVIS	1
Totals	3

Sequence IIIH – Lost Tests*

Test Status	Cause	#
Aborted	Unable to maintain oil pressure	1
Aborted	High oil consumption	1
Totals		2

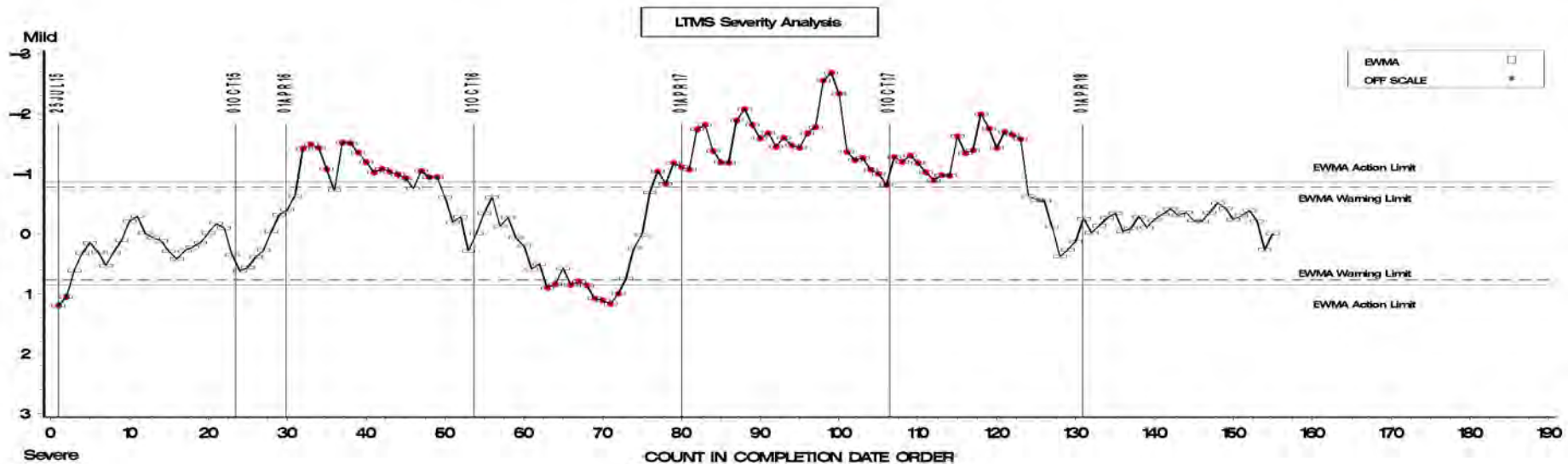
*Invalid and aborted tests

Sequence IIIH Test Severity

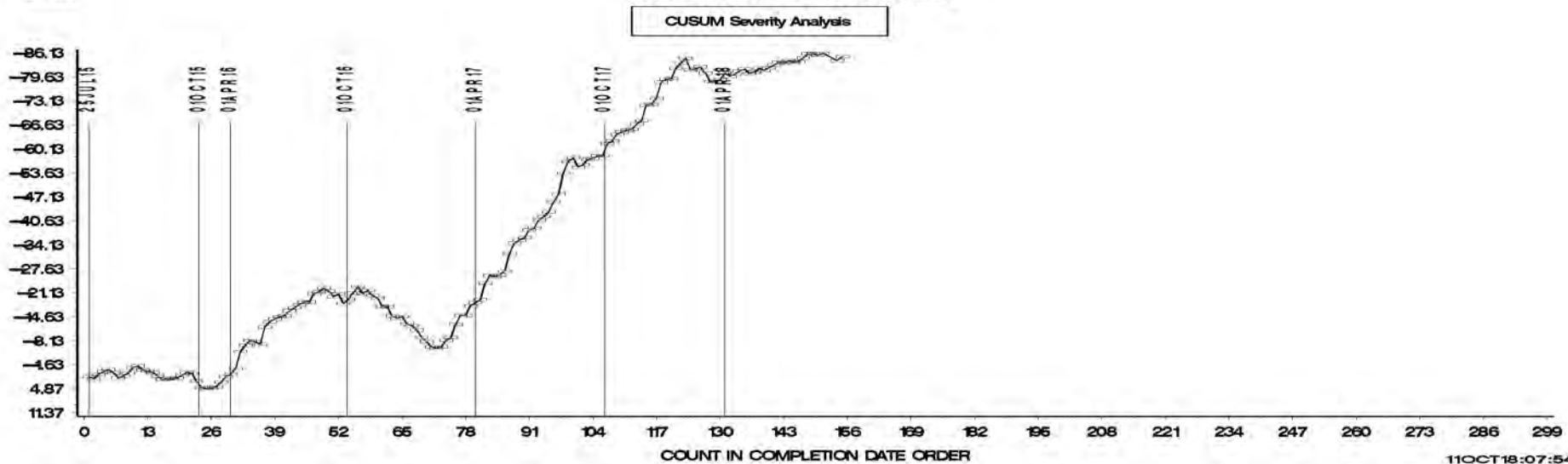
- All parameters are in control

VISCOSITY INCREASE FINAL ORIG UNIT RES

Standard Deviation Units



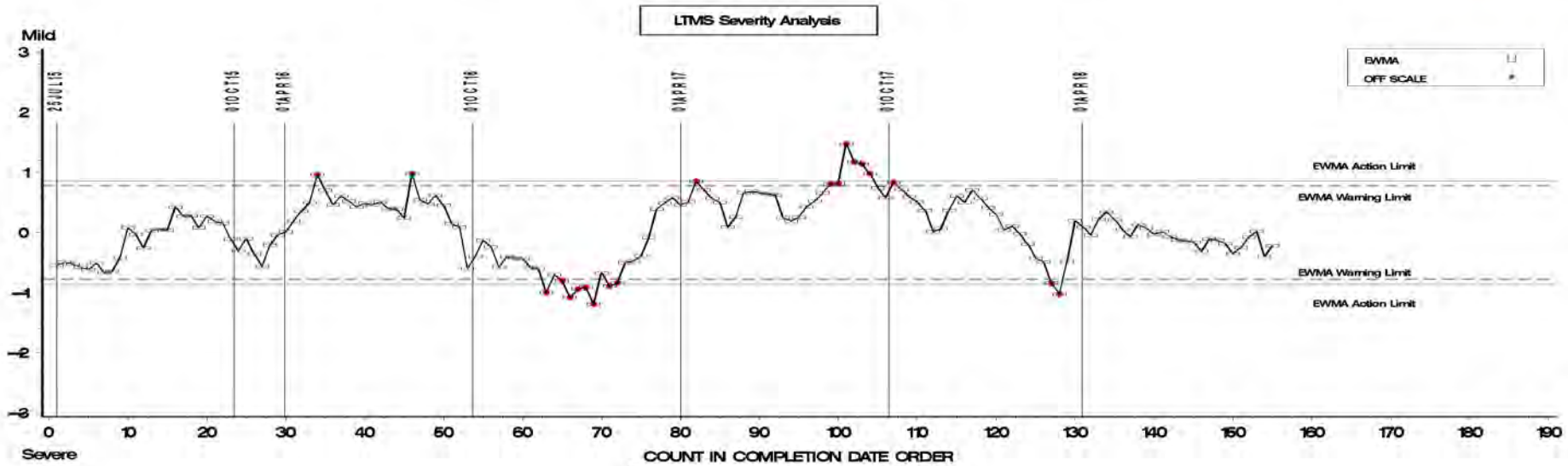
Standard Deviation Units



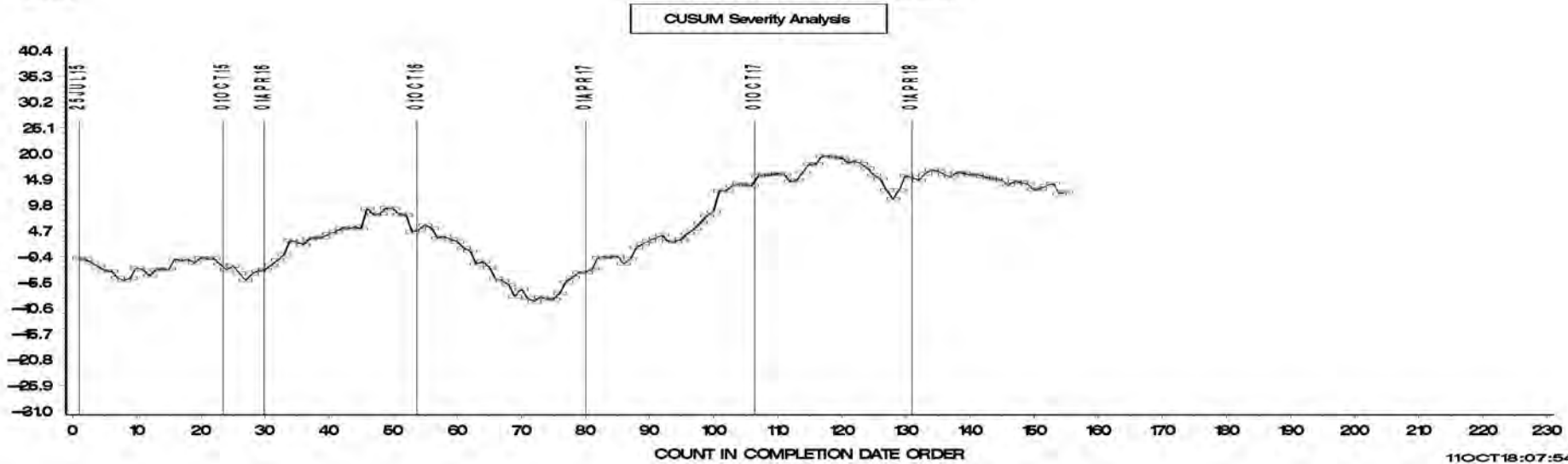
11OCT18:07:54

SEQUENCE IIIH INDUSTRY OPERATIONALLY VALID DATA
 AVERAGE WEIGHTED PISTON DEPOSITS FNL ORIG U

Standard Deviation Units

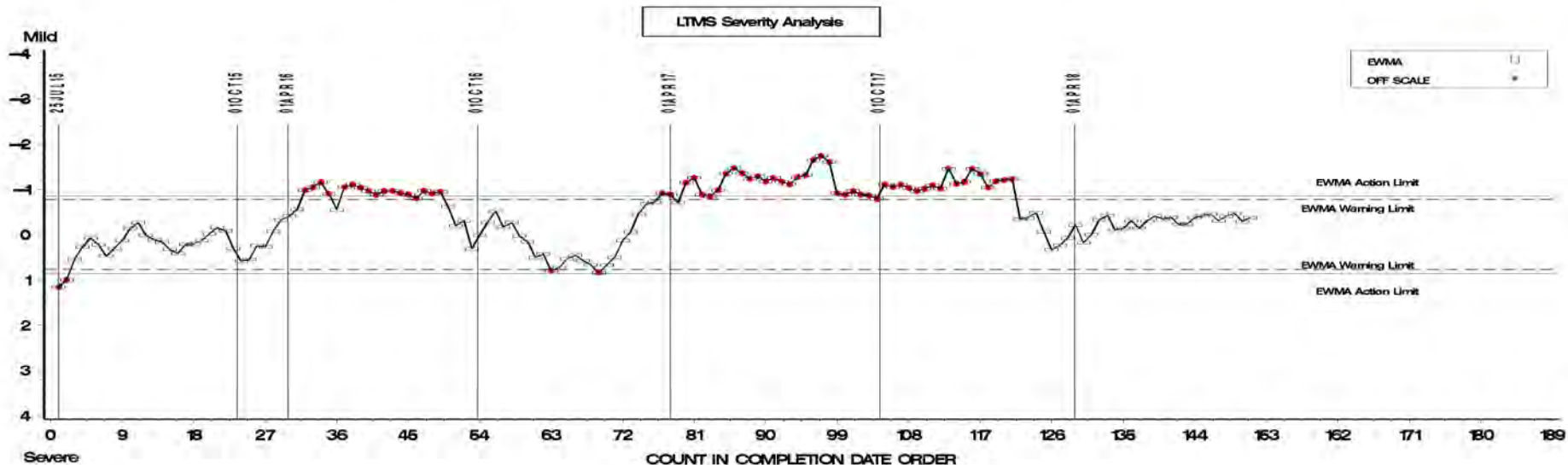


Standard Deviation Units

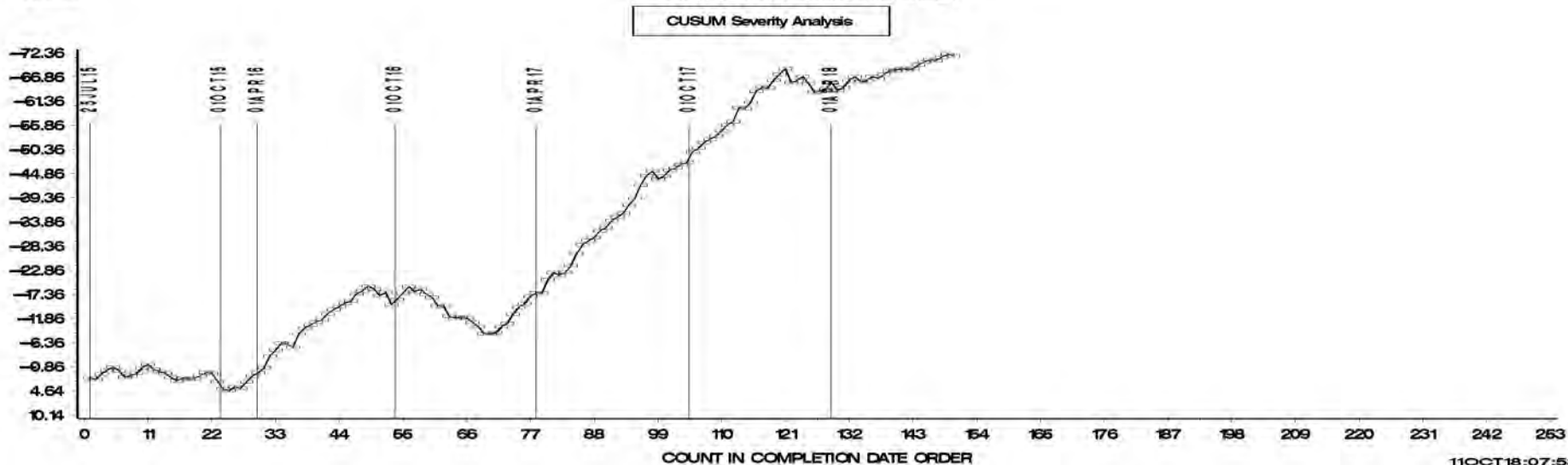


11OCT18:07:54

Standard Deviation Units



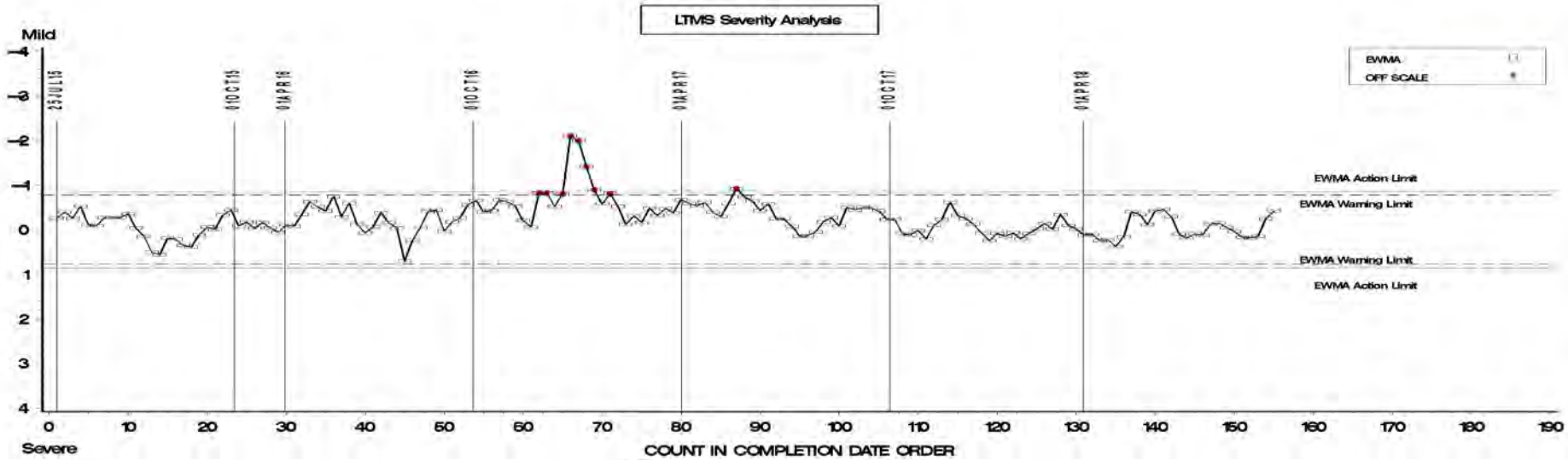
Standard Deviation Units



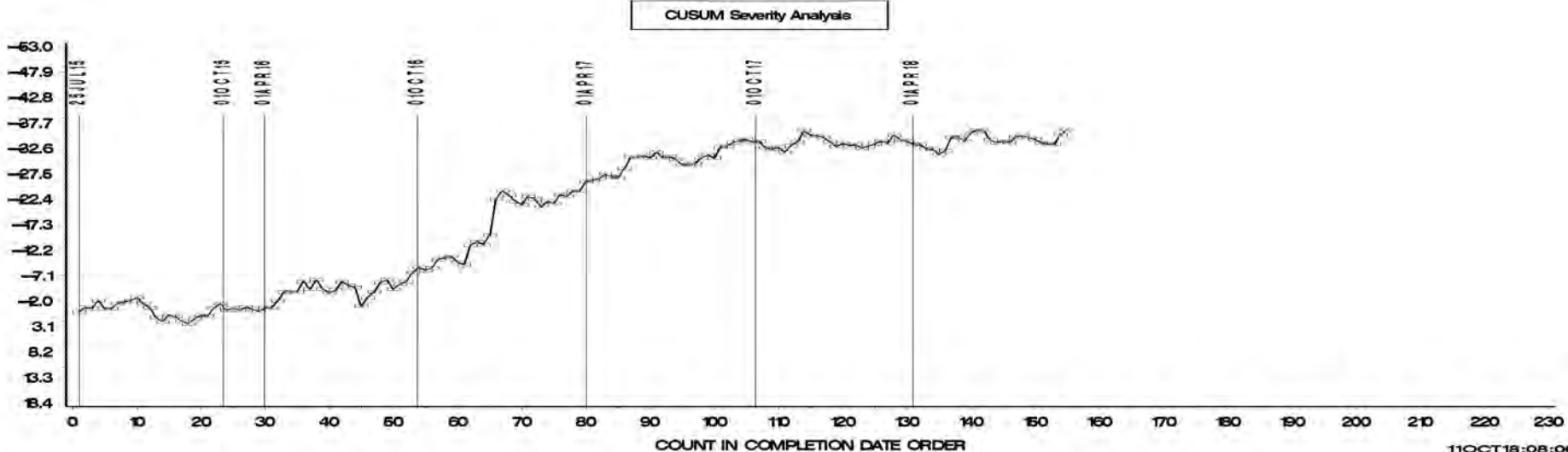
11OCT18:07:58

PHOSPHORUS RETENTION, FINAL RESULT

Standard Deviation Units

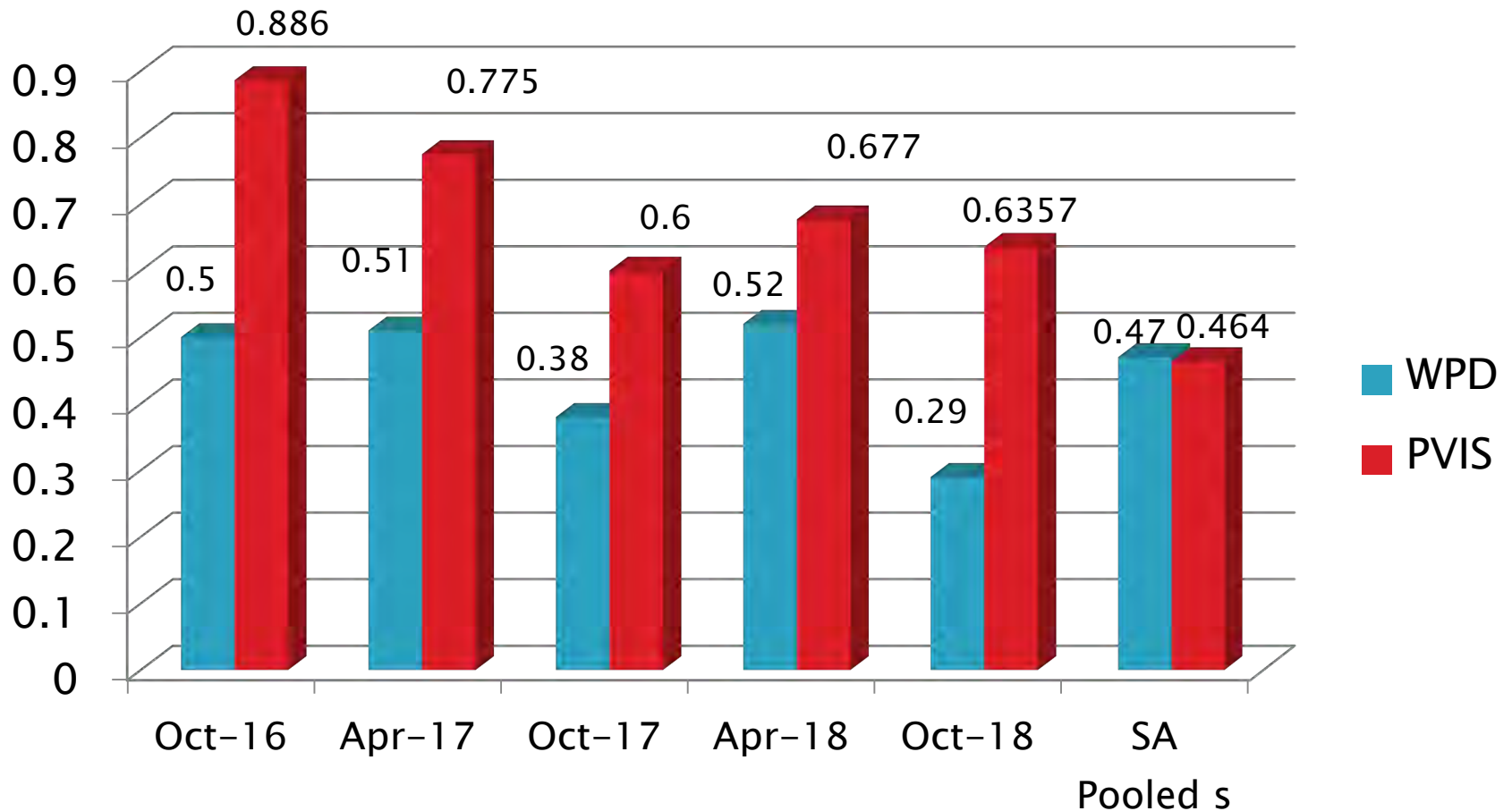


Standard Deviation Units

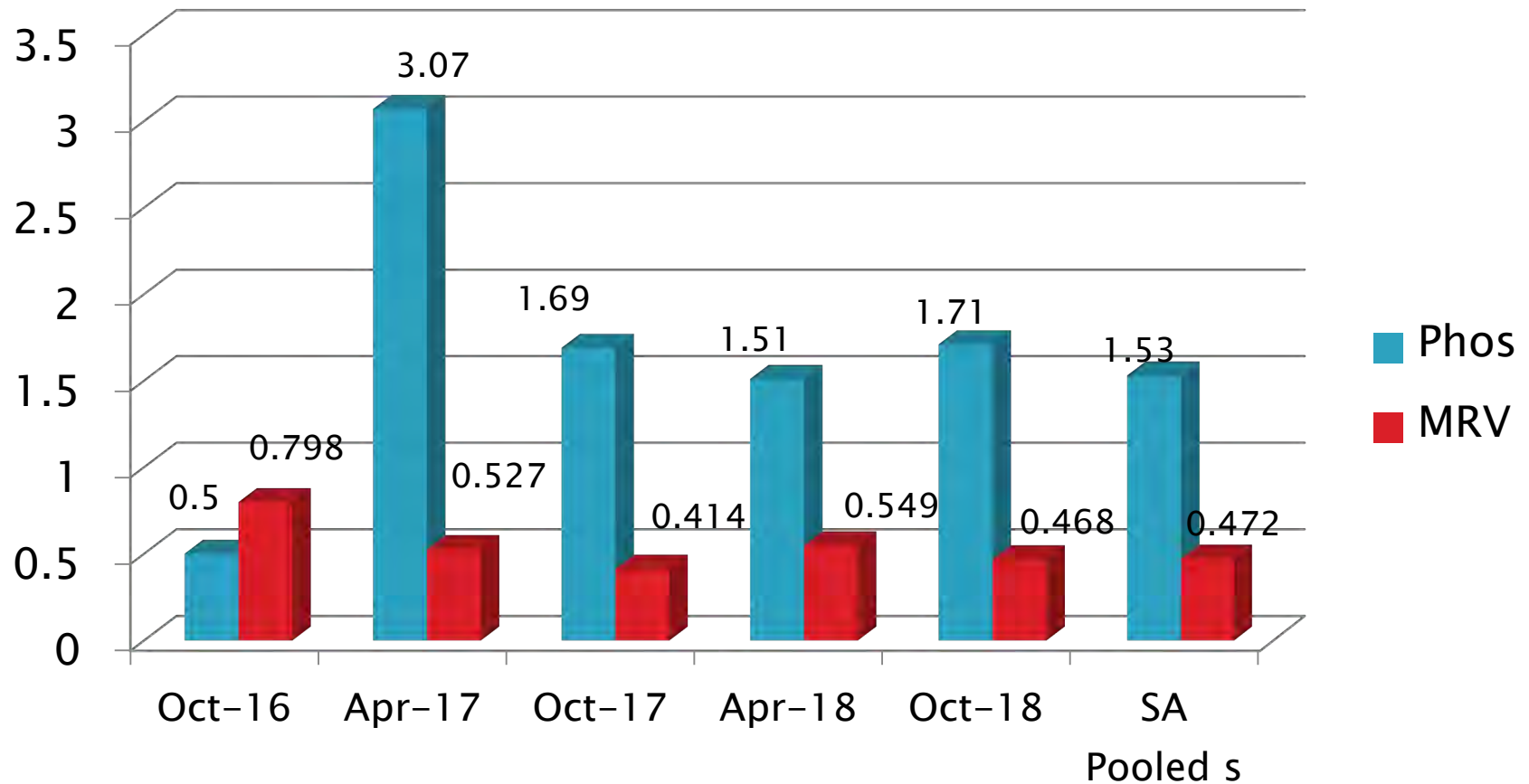


11OCT18:08:00

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	2
Operationally Invalid, Lab determination	LC	1
Total		3

Sequence IVA – Lost Tests*

Test Status	Cause	#
Invalid	MAP Leak	1
Totals		1

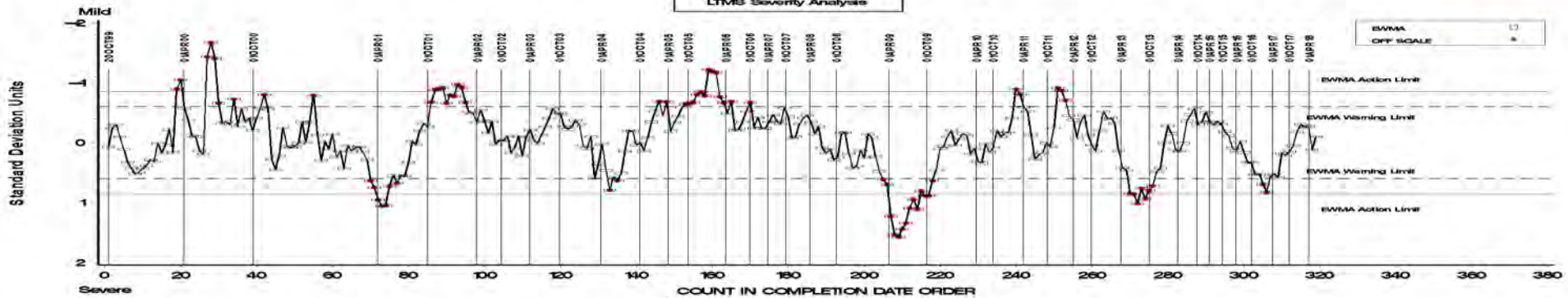
*Invalid and aborted tests

Sequence IVA Test Severity

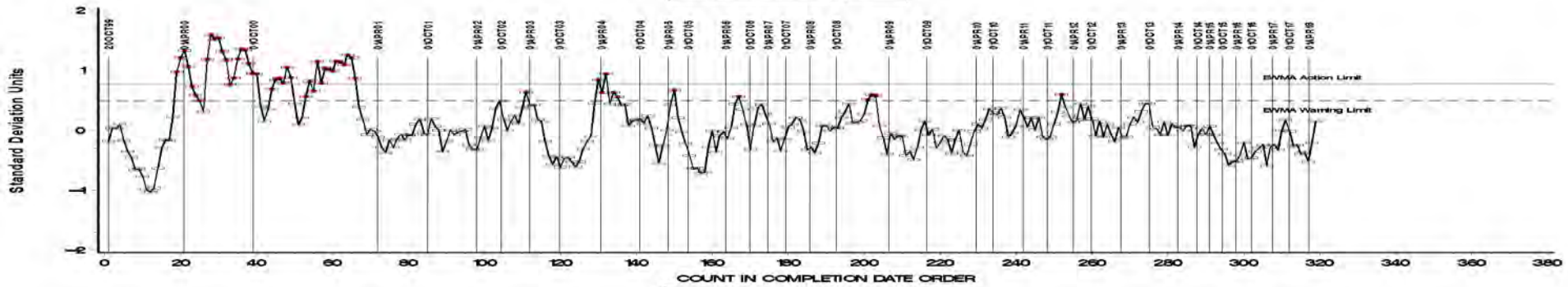
- ACW in control.

AVERAGE CAM WEAR

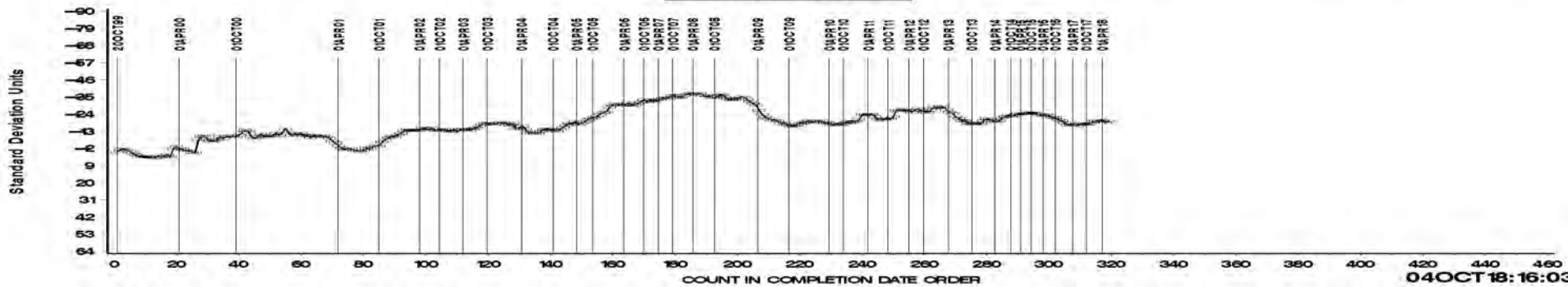
LTMS Severity Analysis



LTMS Precision Analysis



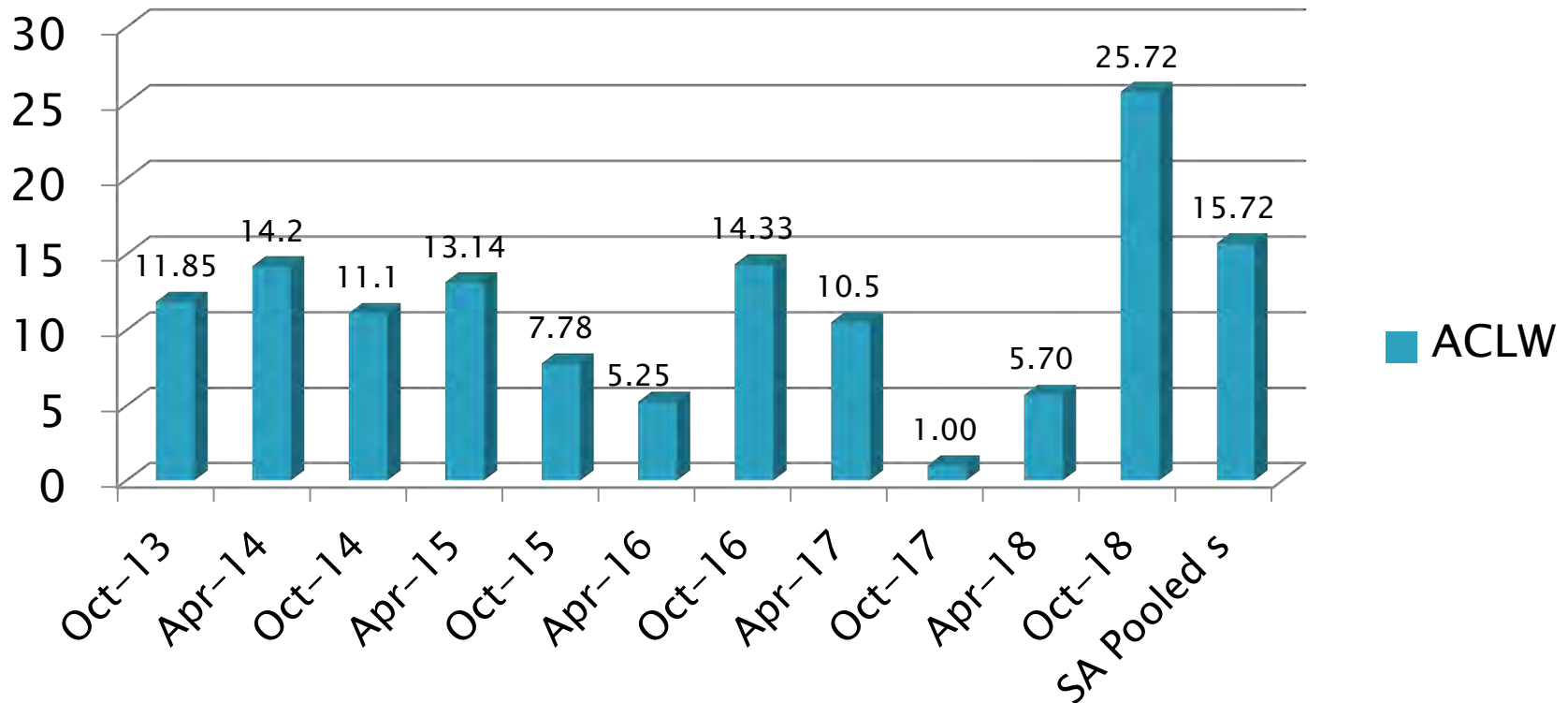
CUSUM Severity Analysis



04OCT'18: 16:03

Sequence IVA Precision Estimates

ACW



Precision estimates for Oct -18 based on two test results

[Return to Table of Contents](#)

Sequence IVB

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Sequence IVB Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	10
Operationally Invalid, Lab determination	LC	2
Acceptable Donated Test (Keyence Round Robin Lifters)	AG	1
Industry Support Test (Engine Life)	NI	1
Total		14

Sequence IVB – Lost Tests*

Test Status	Cause	#
Invalid	Lobe Failure	1
Invalid	Temperature Calibration Error, Oil Gallery Temperature	1
Totals		2

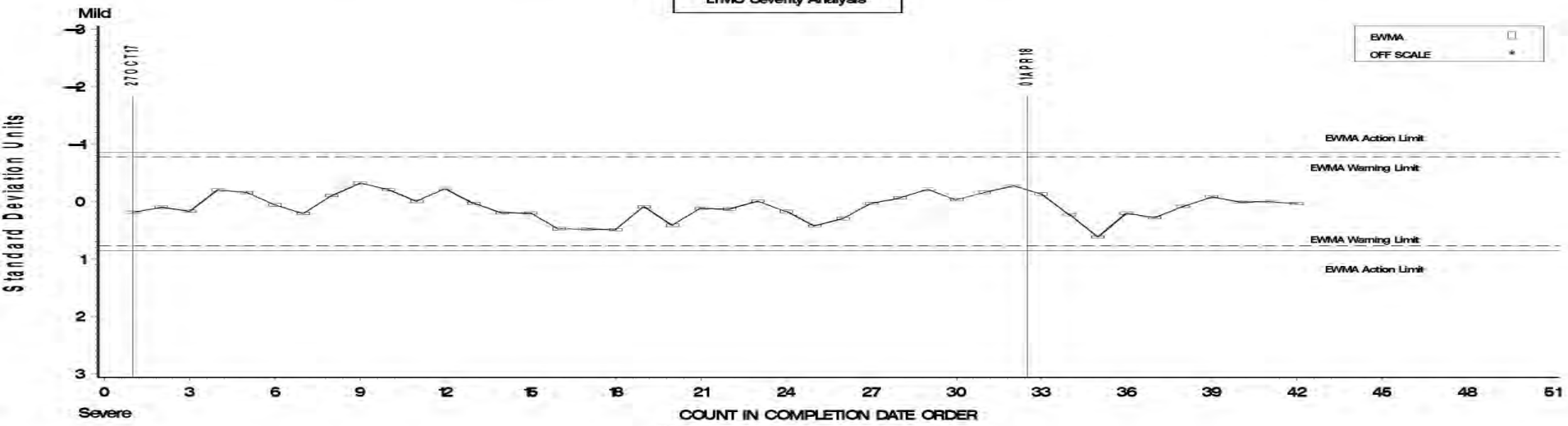
*Invalid and aborted tests

Sequence IVB Test Severity

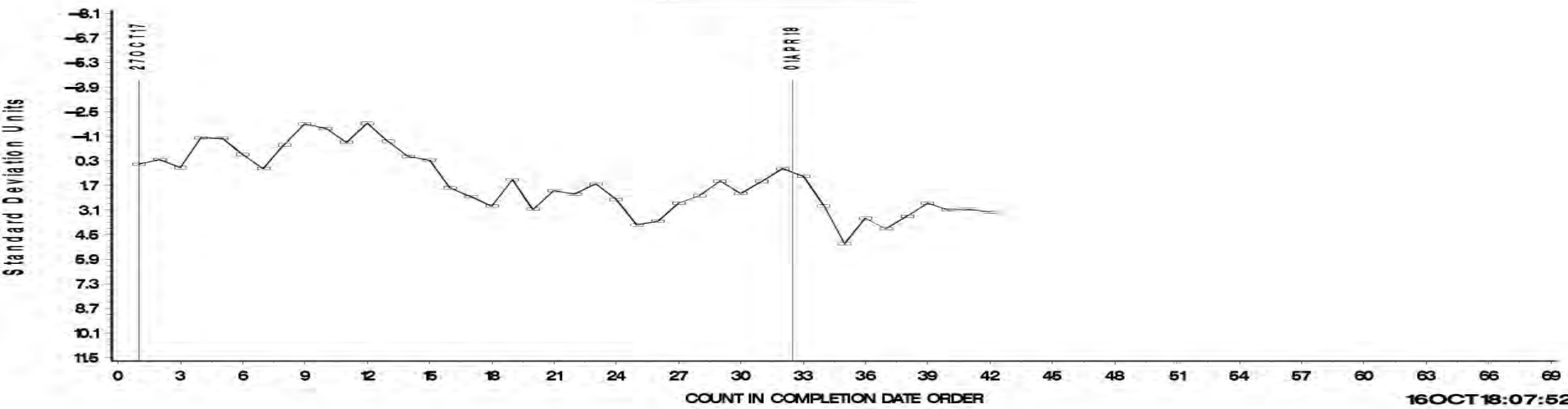
- AVLI in control.

AVERAGE VOLUME LOSS BY KEYENCE BUCKET LIFTER, INTAKE

LTMS Severity Analysis



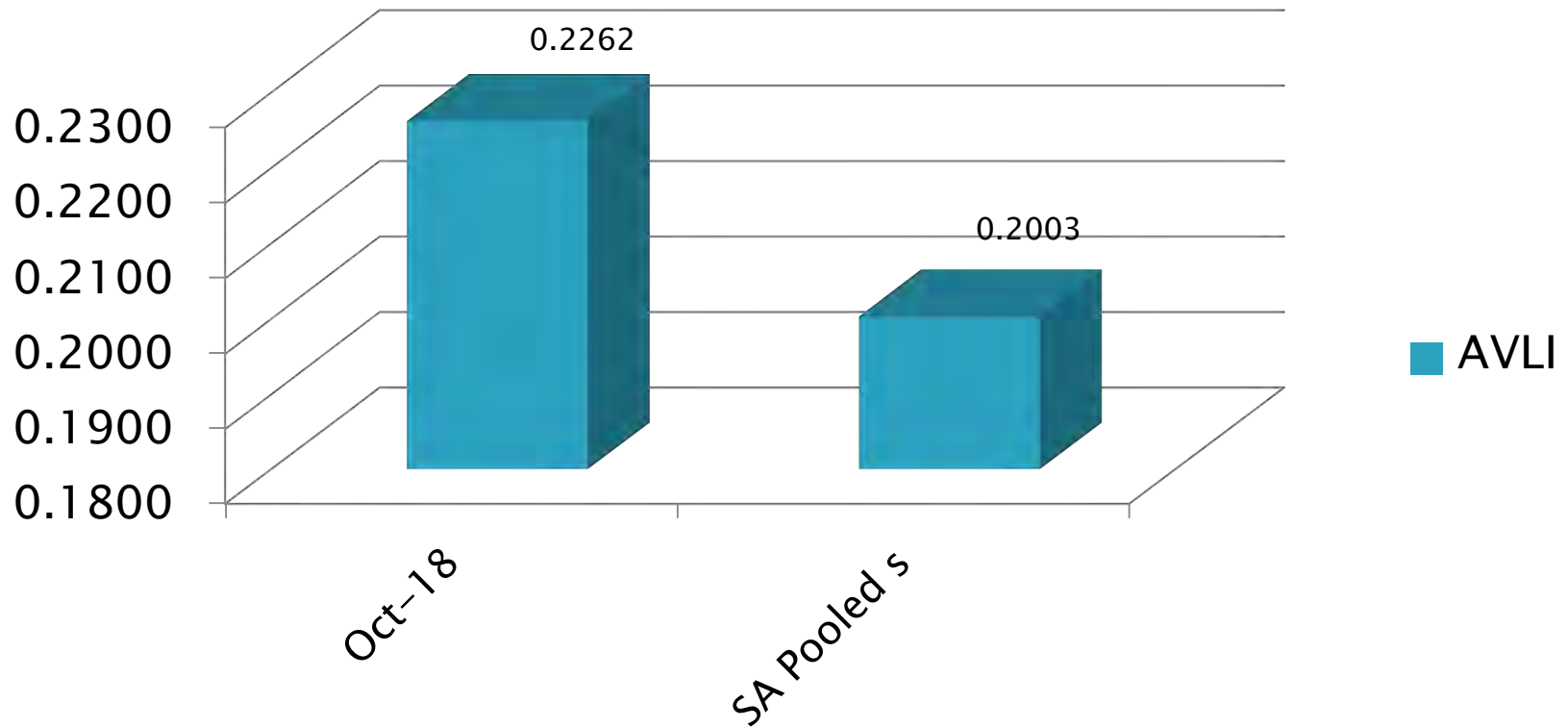
CUSUM Severity Analysis



16OCT18:07:52

Sequence IVB Precision Estimates

AVLI



[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	1
Total		1

Sequence VG Test Severity

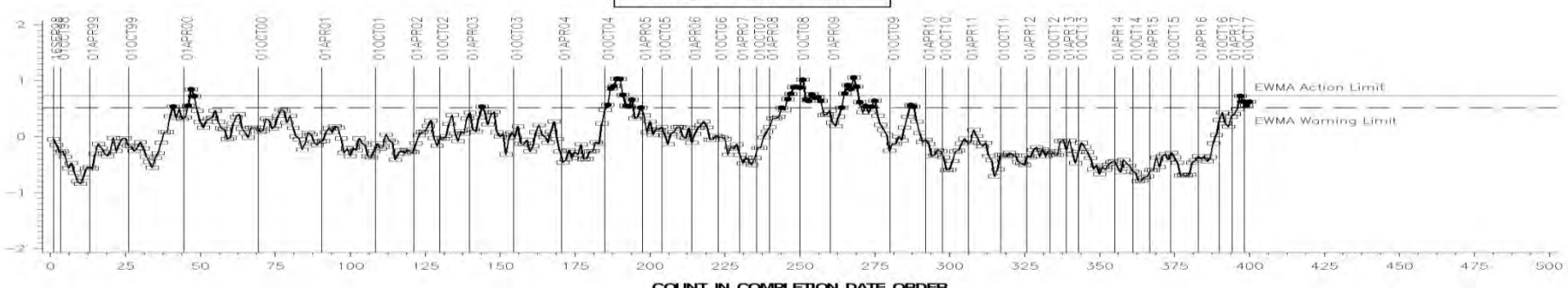
- AES in precision warning alarm
- All other parameters in control
- Precision estimates not calculated as only 1 test was reported

AVERAGE ENGINE SLUDGE

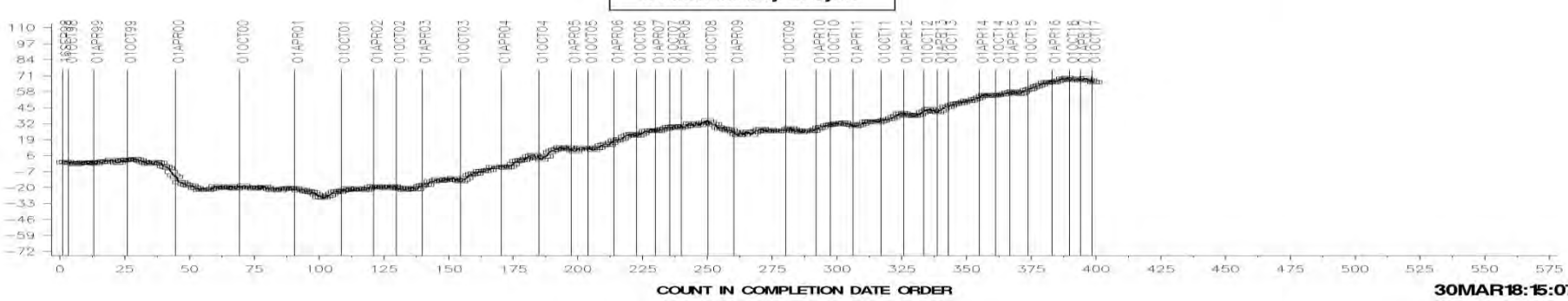
LTMS Severity Analysis



LTMS Precision Analysis



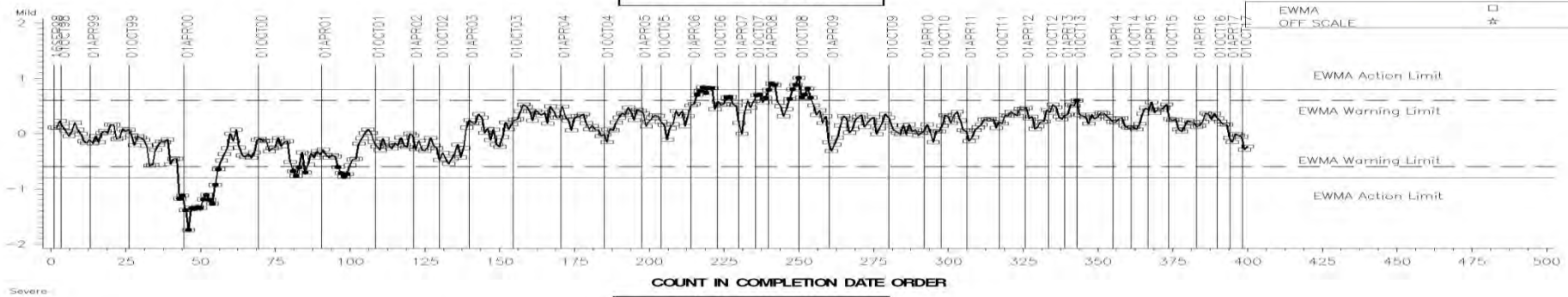
CUSUM Severity Analysis



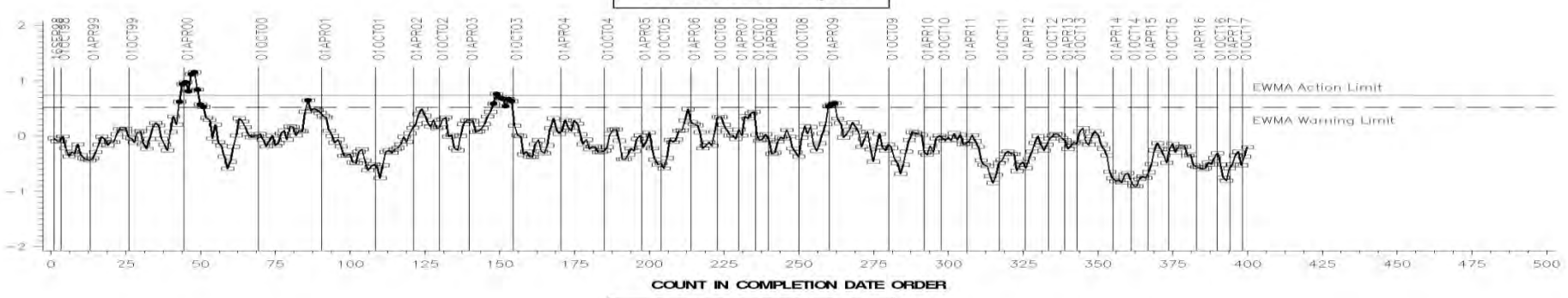
30MAR18:15:07

AVERAGE ROCKER COVER SLUDGE

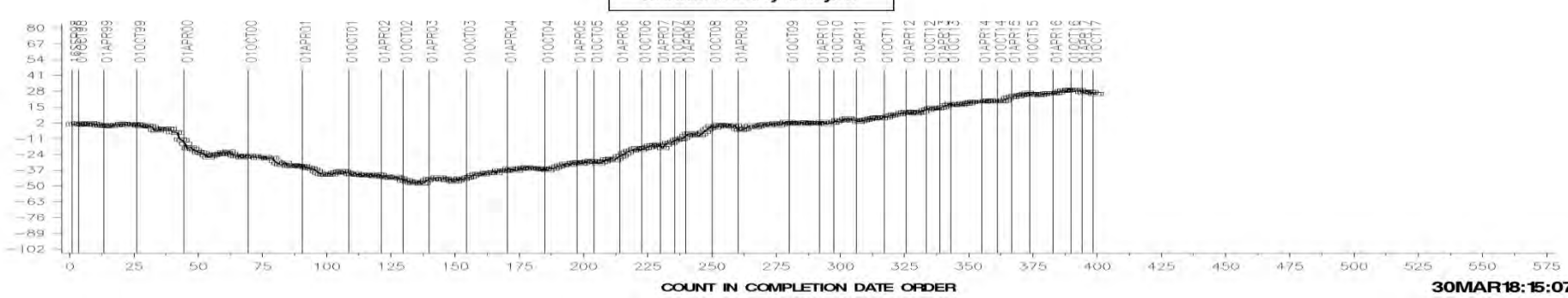
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis



30MAR18:15:07

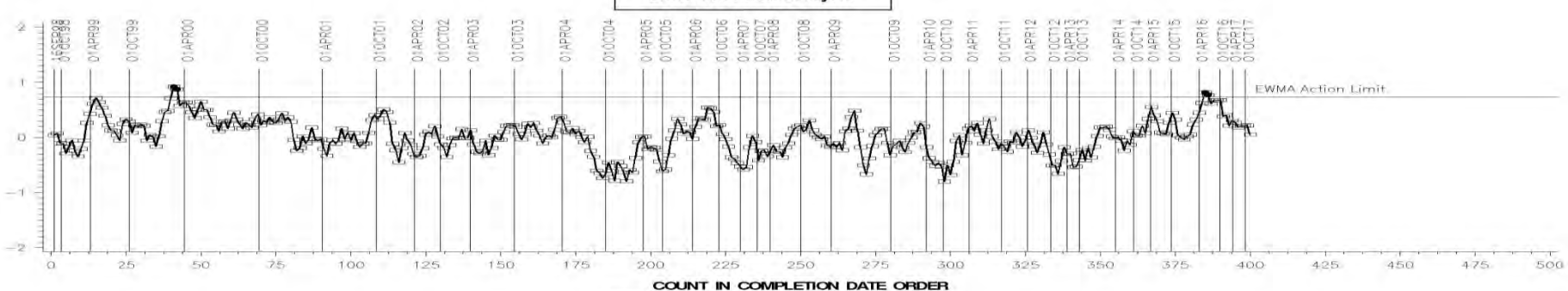
SEQUENCE VG INDUSTRY OPERATIONAL VALID DATA

AVG. ENG. VARN. 3—PART APV + BAFFLES

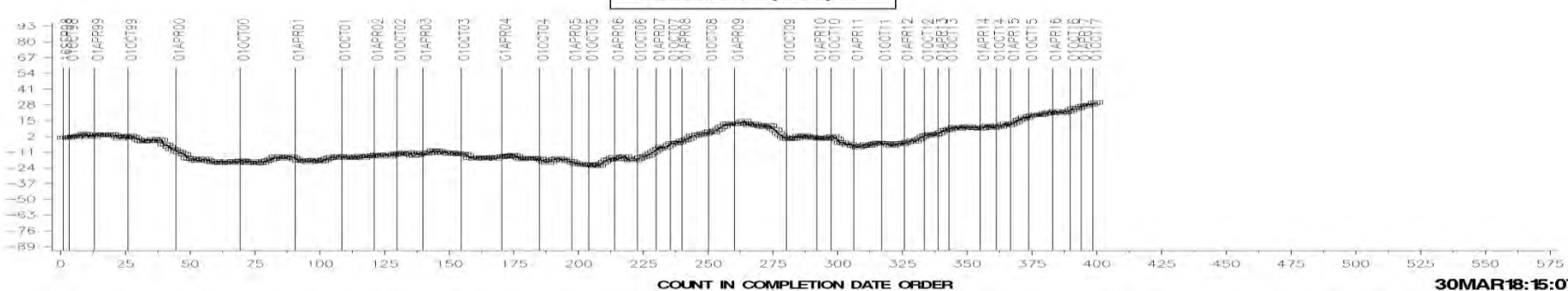
LTMS Severity Analysis



LTMS Precision Analysis



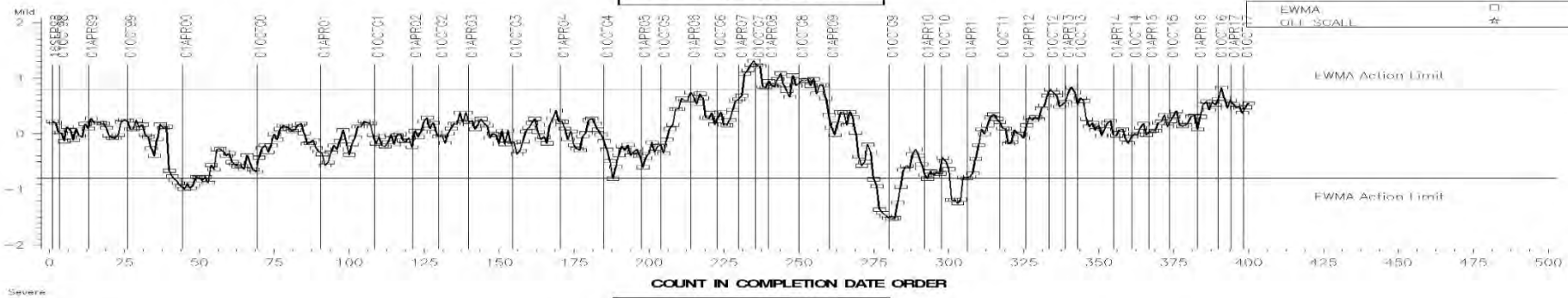
CUSUM Severity Analysis



30MAR18: 15:07

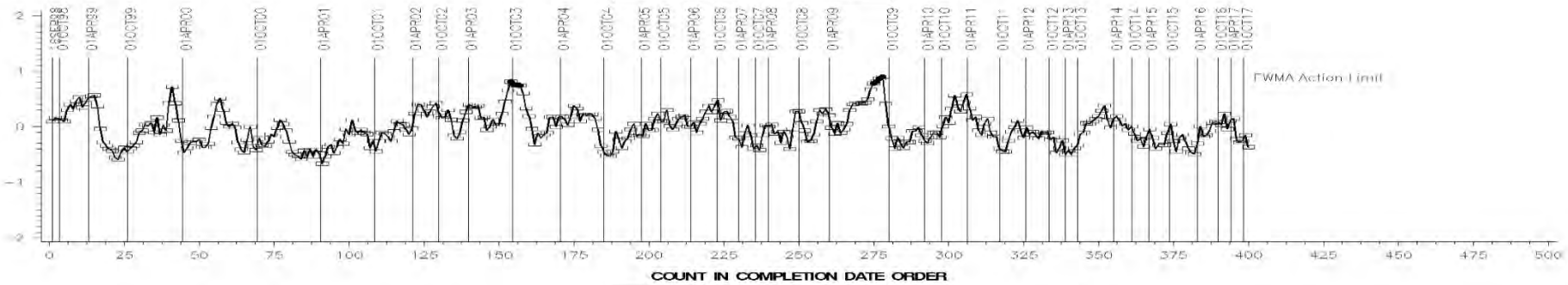
AVG PISTON SKIRT RATING

LTMS Severity Analysis



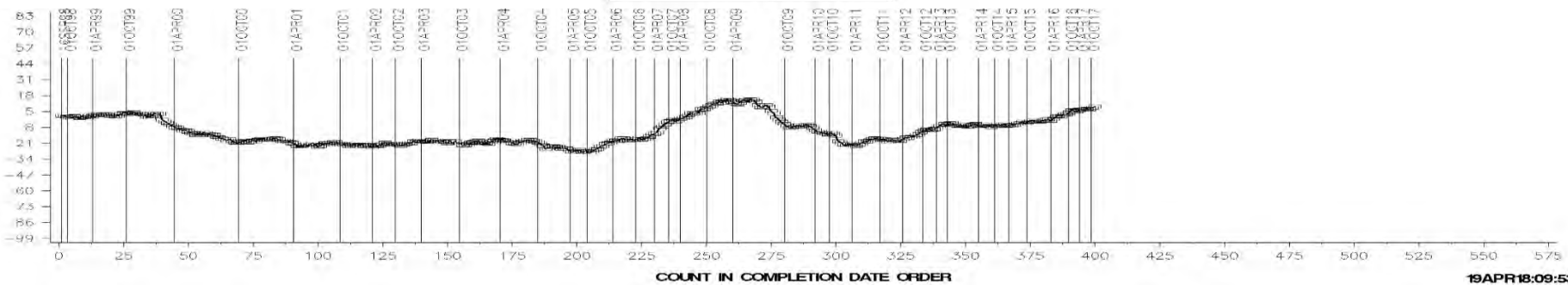
COUNT IN COMPLETION DATE ORDER

LTMS Precision Analysis



COUNT IN COMPLETION DATE ORDER

CUSUM Severity Analysis



19APR18:09:53

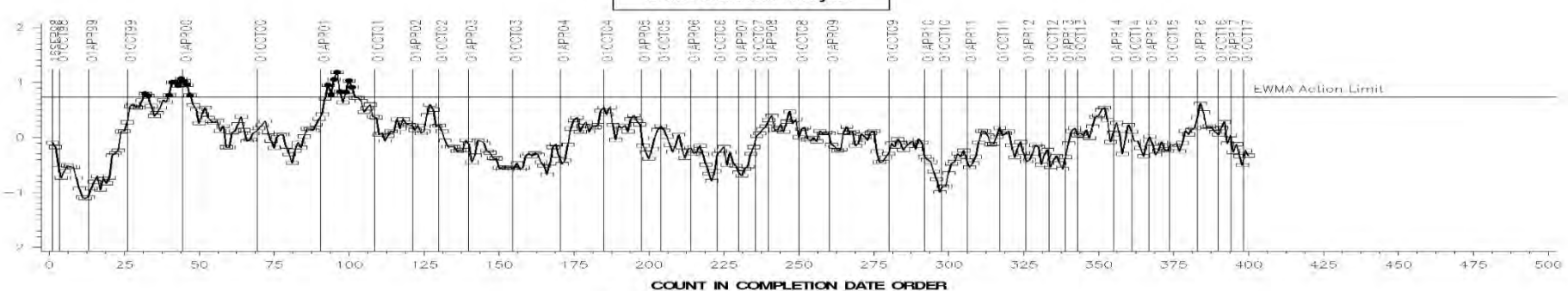
OIL SCREEN SLUDGE

LTMS Severity Analysis



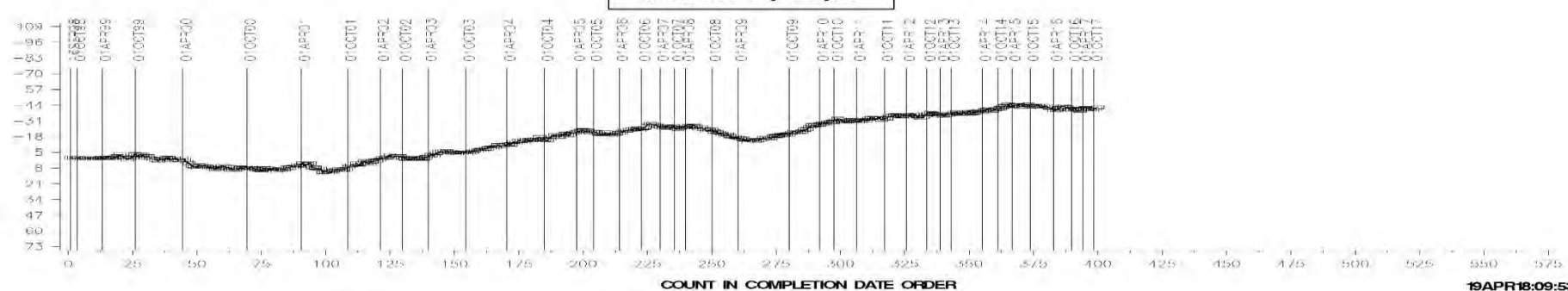
COUNT IN COMPLETION DATE ORDER

LTMS Precision Analysis



COUNT IN COMPLETION DATE ORDER

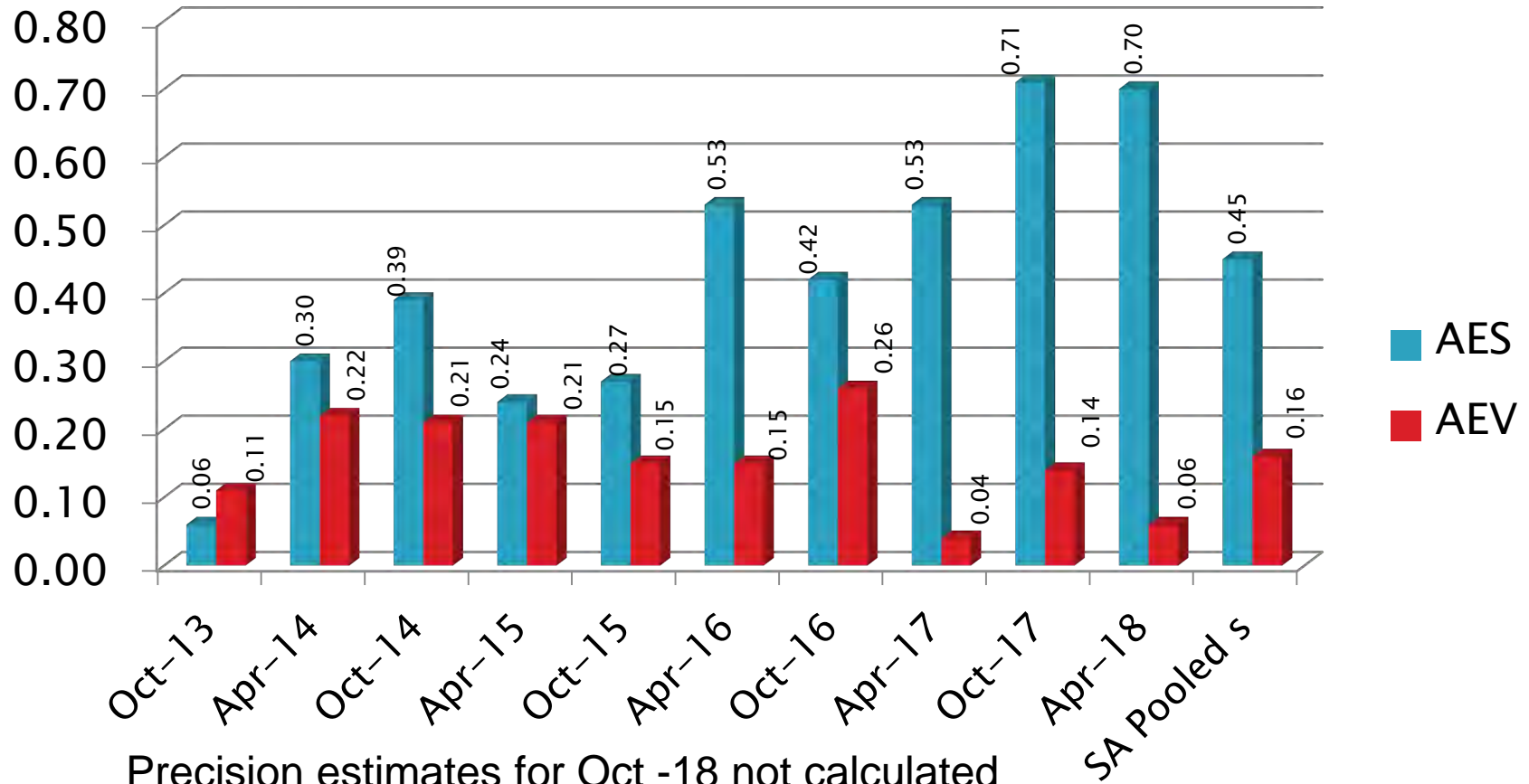
CUSUM Severity Analysis



COUNT IN COMPLETION DATE ORDER

19APR18:09:53

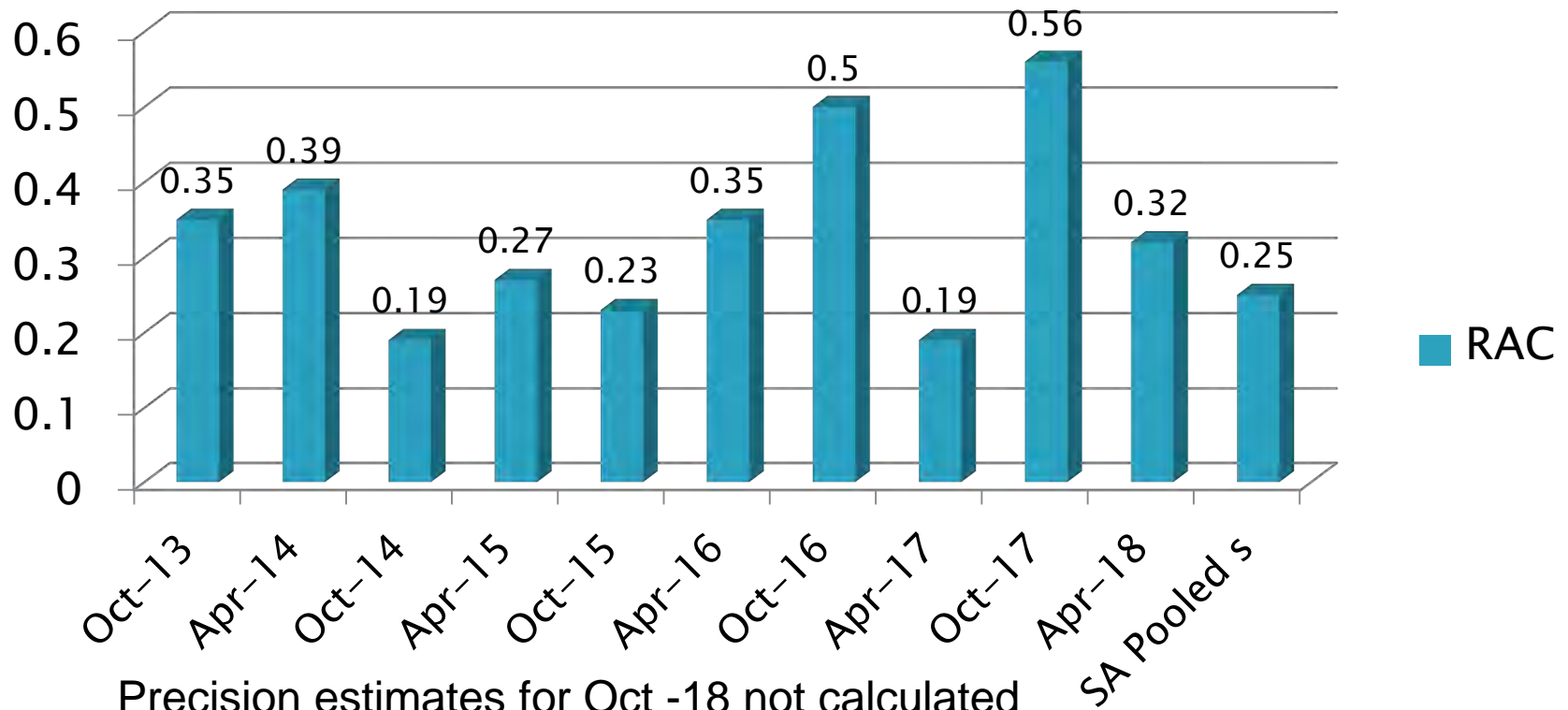
Sequence VG Precision Estimates



Precision estimates for Oct -18 not calculated as only one test reported this period

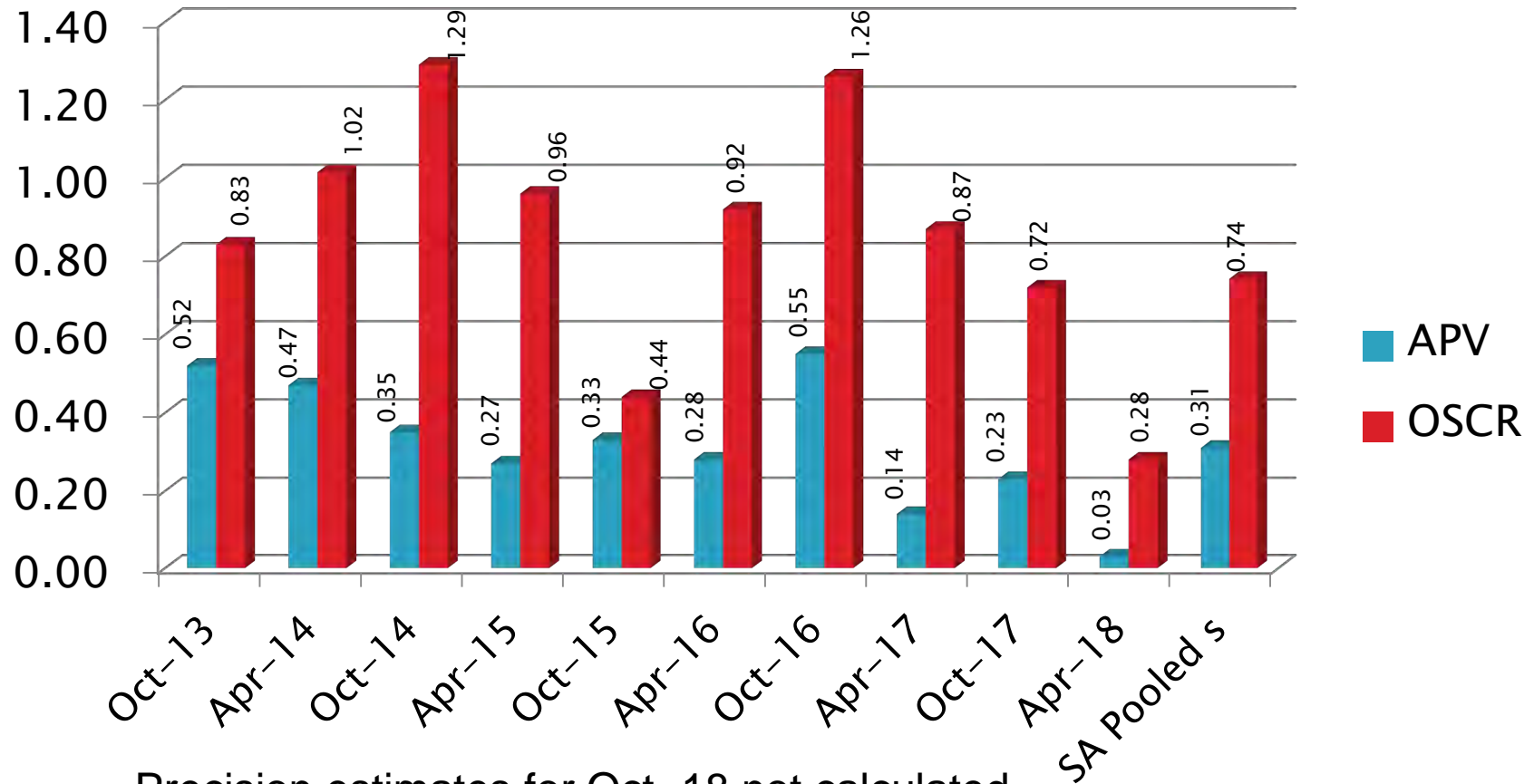
Sequence VG Precision Estimates

RAC



Precision estimates for Oct -18 not calculated as only one test reported this period

Sequence VG Precision Estimates



Precision estimates for Oct -18 not calculated as only one test reported this period

[Return to Table of Contents](#)

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Sequence VH

»» October 2018

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Sequence VH Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	13
Statistically Unacceptable Calibration	OC	2
BOI-VGRA Matrix Test	NI	2
Fuel Approval Test	AF	15
Total		32

Sequence VH – Failing Tests

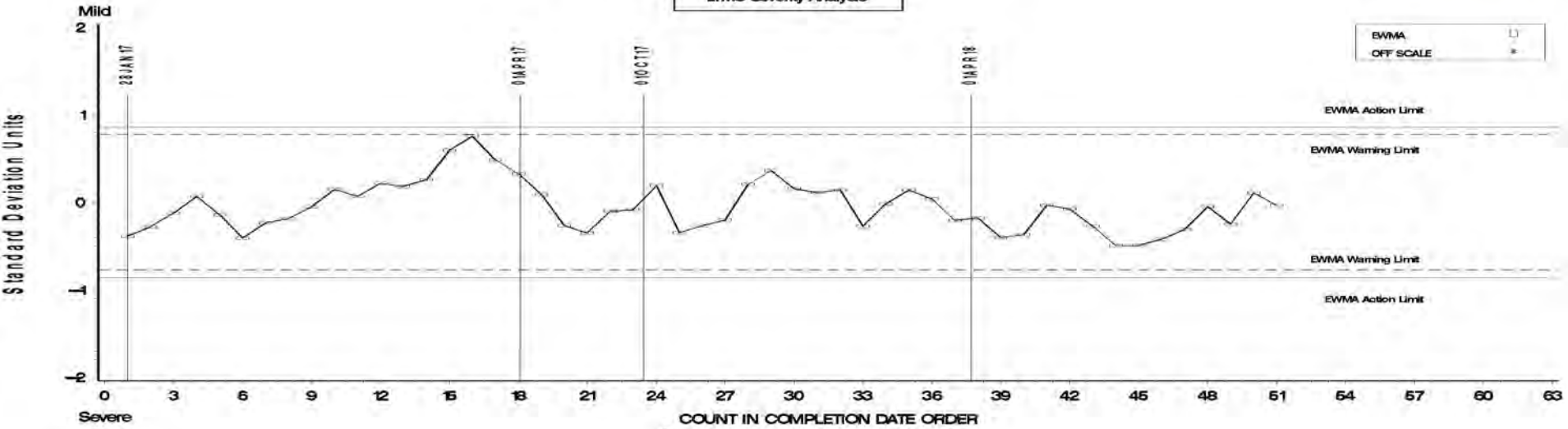
Test Status	#
Level 3 Ei Alarm RAC	2
Totals	2

Sequence VH Test Severity

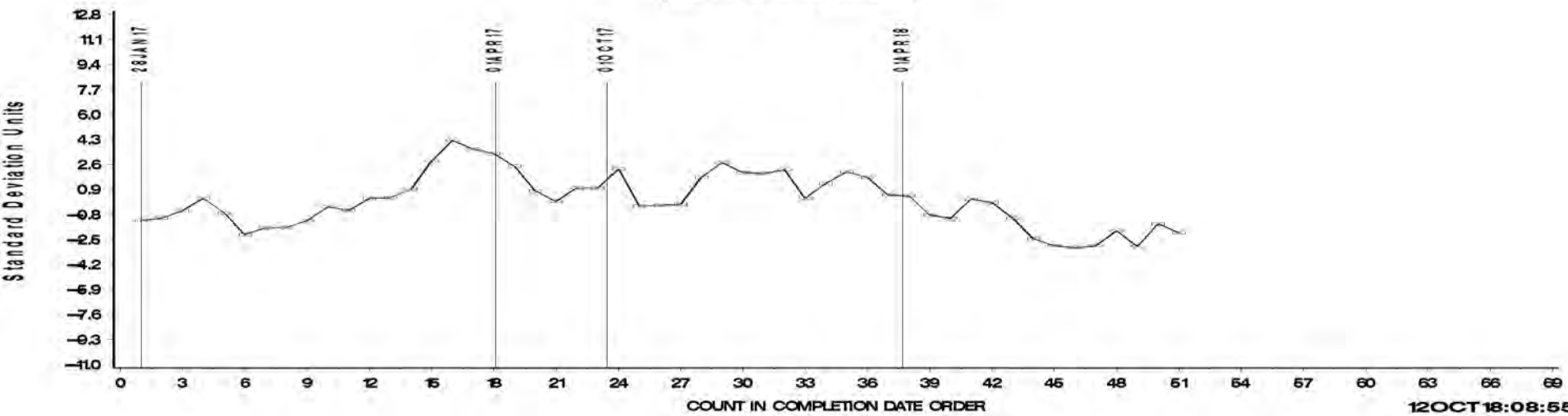
- All parameters in control

AVERAGE ENGINE SLUDGE

LTMS Severity Analysis



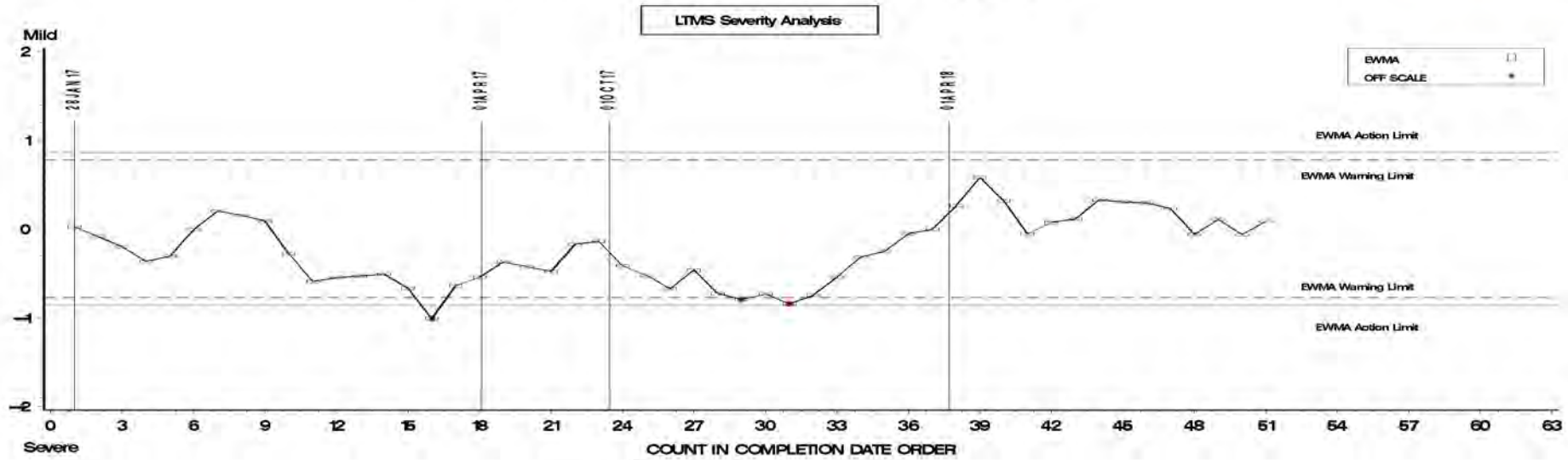
CUSUM Severity Analysis



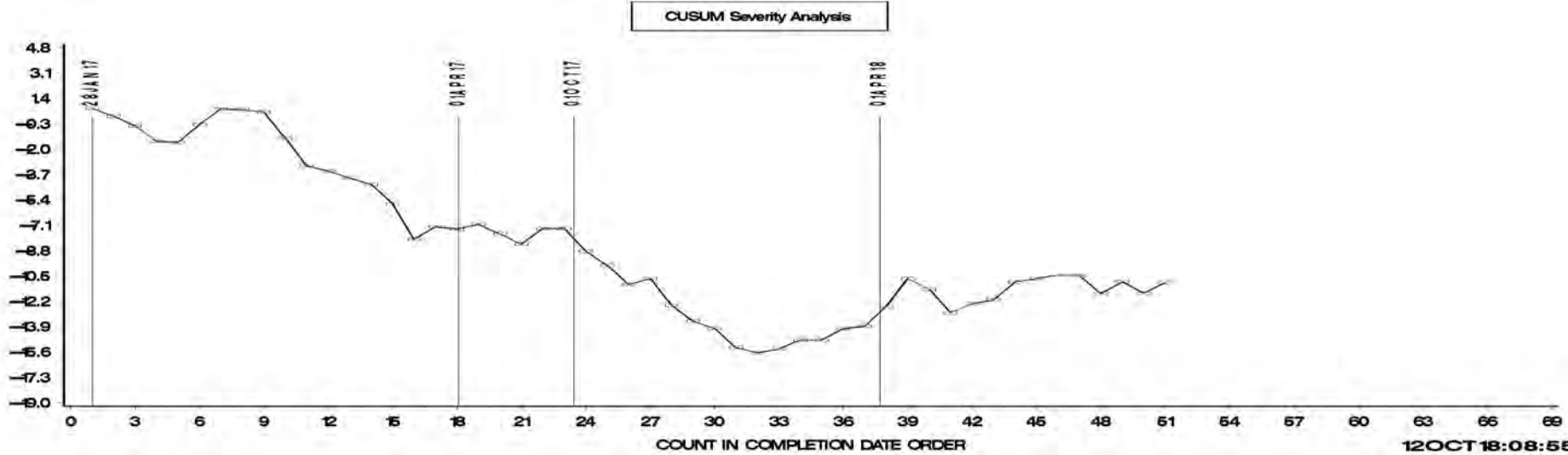
12OCT18:08:55

AVERAGE ROCKER COVER SLUDGE

Standard Deviation Units

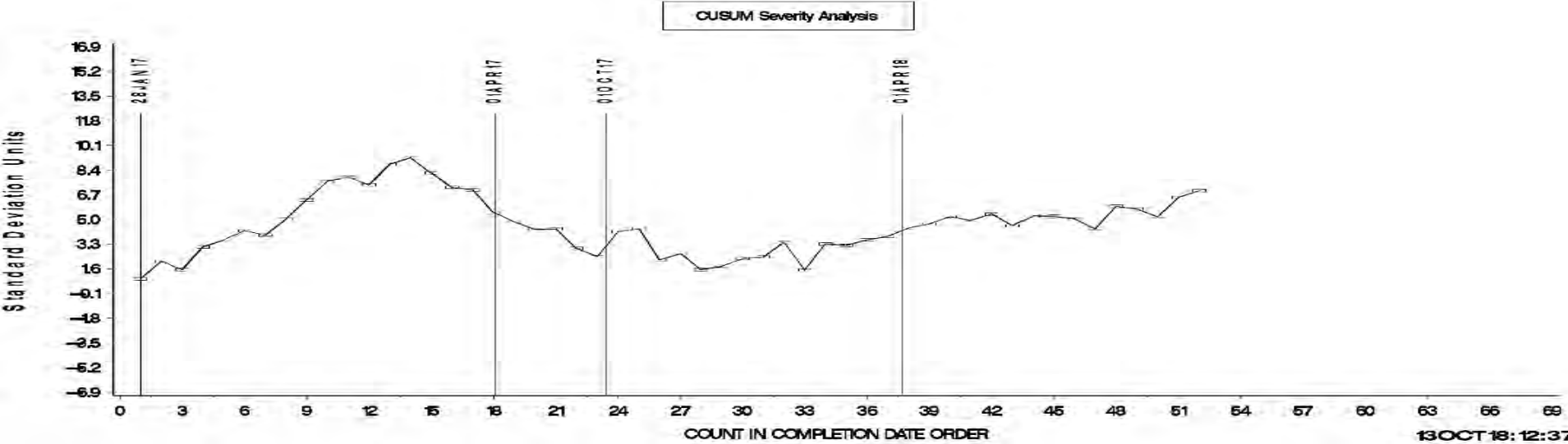
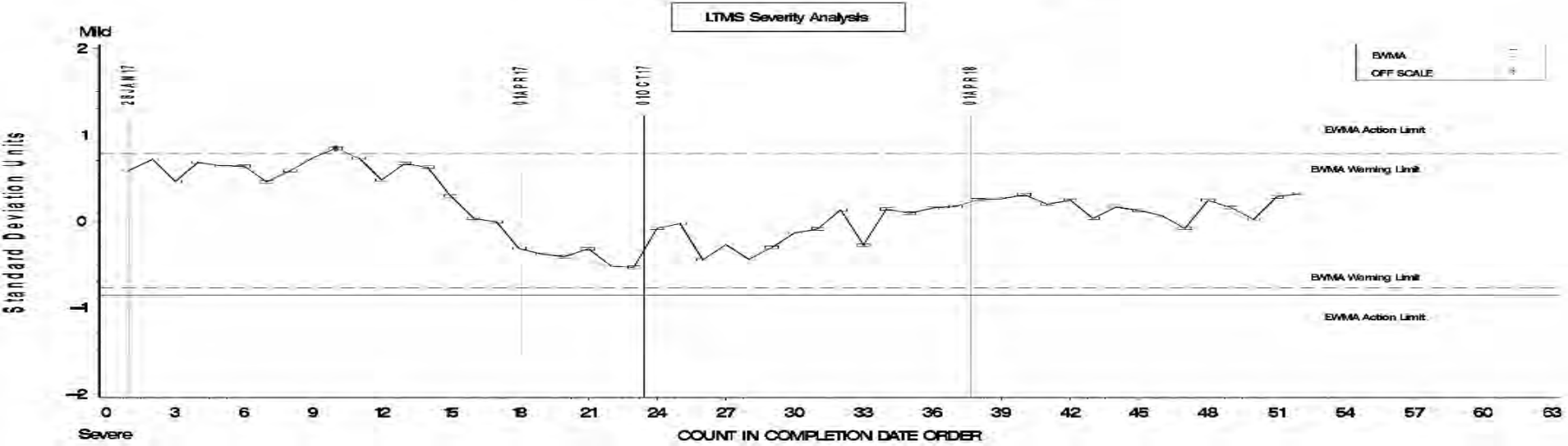


Standard Deviation Units



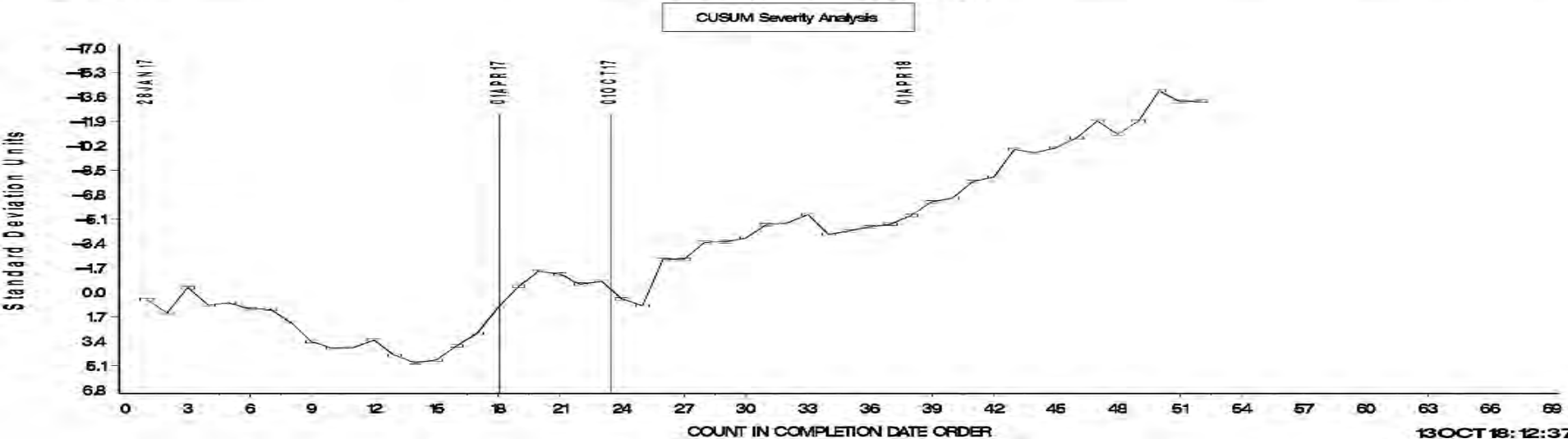
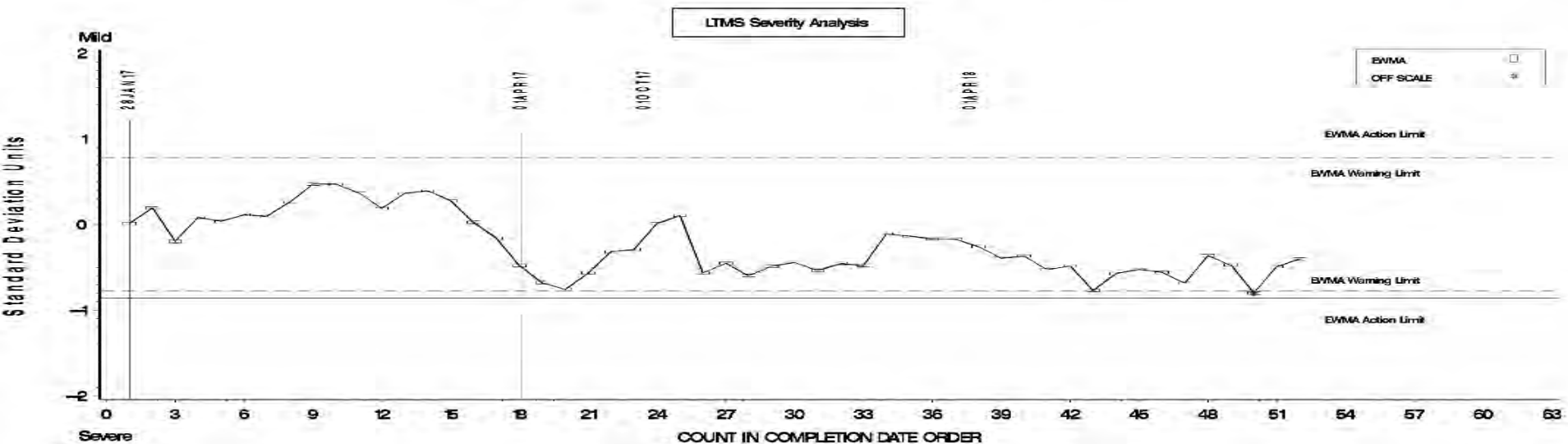
12OCT18:08:55

AVG. ENG. VARN. 50% RATING



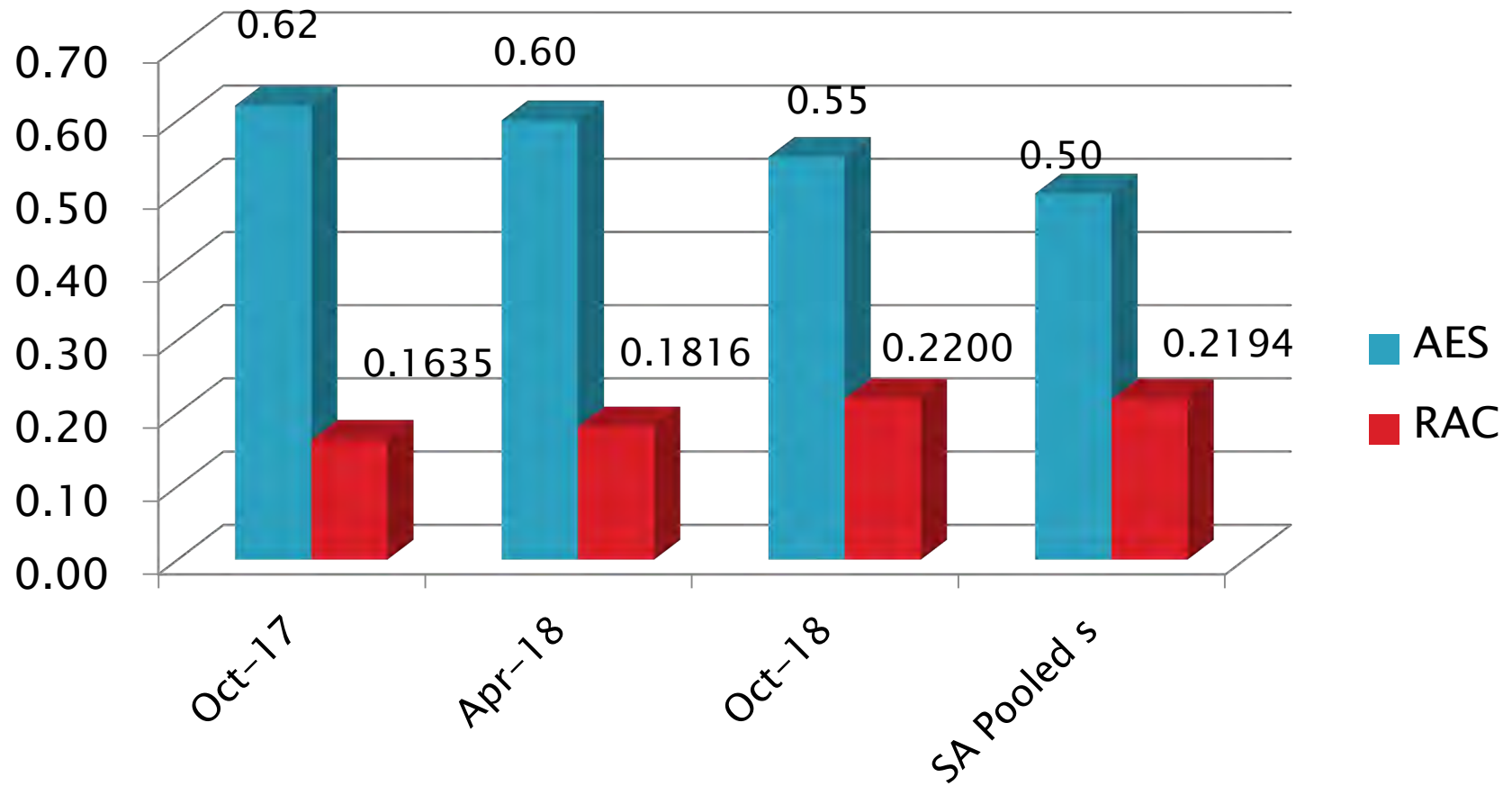
13OCT18: 12:37

AVG PISTON SKIRT 50% RATING

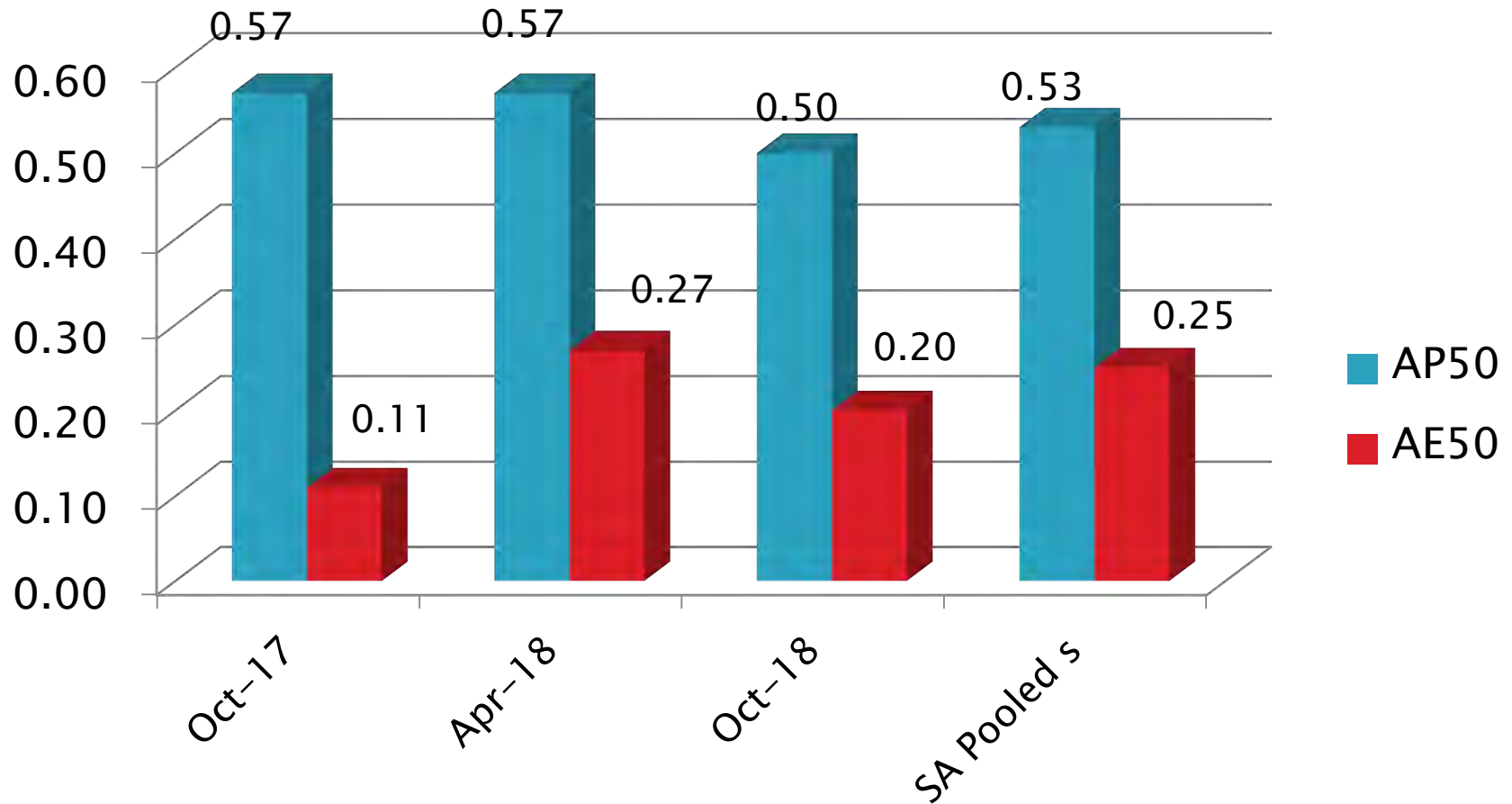


13 OCT 18: 12:37

Sequence VH Precision Estimates



Sequence VH Precision Estimates



[Return to Table of Contents](#)

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Sequence VIE

»» October 2018

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Sequence VIE Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	51
Acceptable Industry Information Run (BOI-VGRA)	NI	7
Failed Statistically	OC	4
Operationally Invalid Calibration Test, Lab Judgement	LC	2
Operationally Invalid Calibration Test, Lab and TMC Judgement	RC	2
Aborted Calibration Test	XC	1
Total		67

Sequence VIE – Failed Tests

Test Status	Number of Tests
Mild FEI1	1
FEI1 and FEI2 Mild	1
FEI1 Severe	1
FEI1 VI Alarm	1
Total	4

Sequence VIE – Lost Tests*

Test Status	Cause	#
Aborted	Fuel flow control	1
Invalid	Exhaust backpressure out of spec	1
Invalid	Damaged oil filter	1
Invalid	Coolant flow control stage 5	1
Invalid	Micro Motion transmitter intermittent failure	1
Totals		5

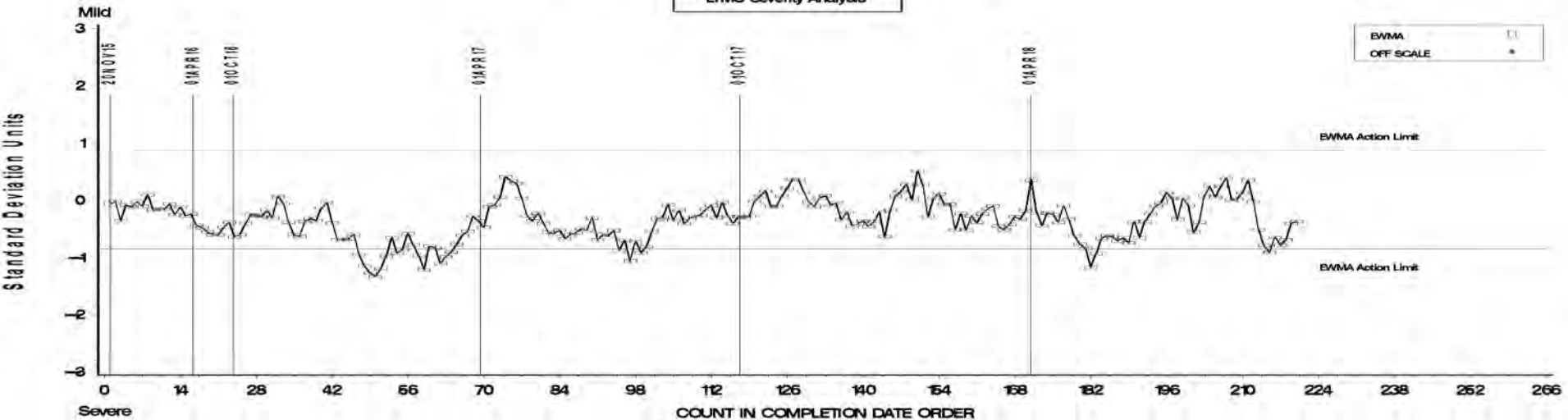
*Invalid and aborted tests

Sequence VIE Test Severity

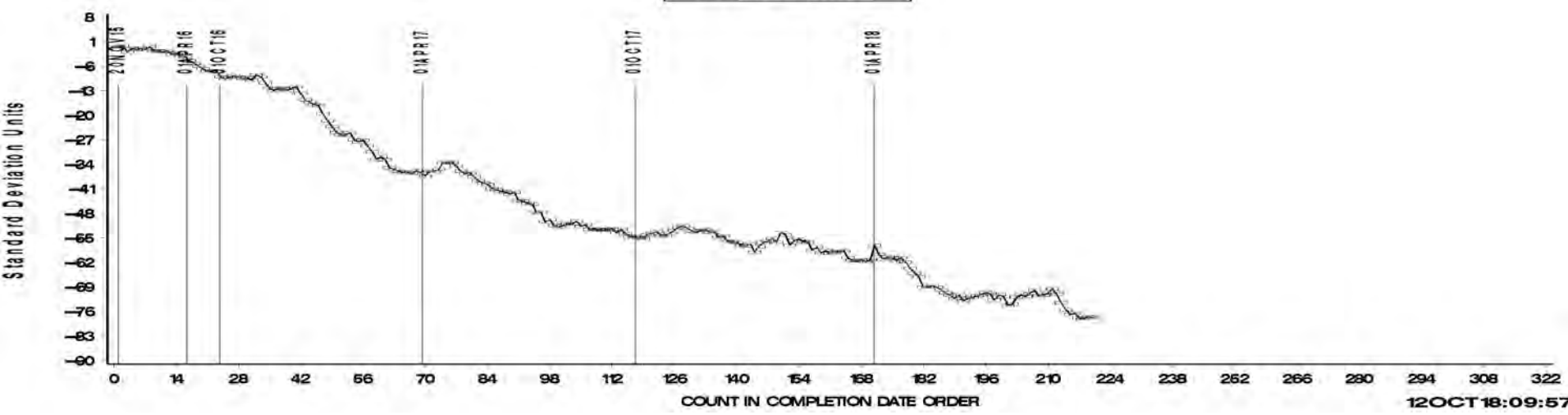
- FEI1 and FEI2 are in control

FEI FINAL RESULT PHASE I

LTMS Severity Analysis



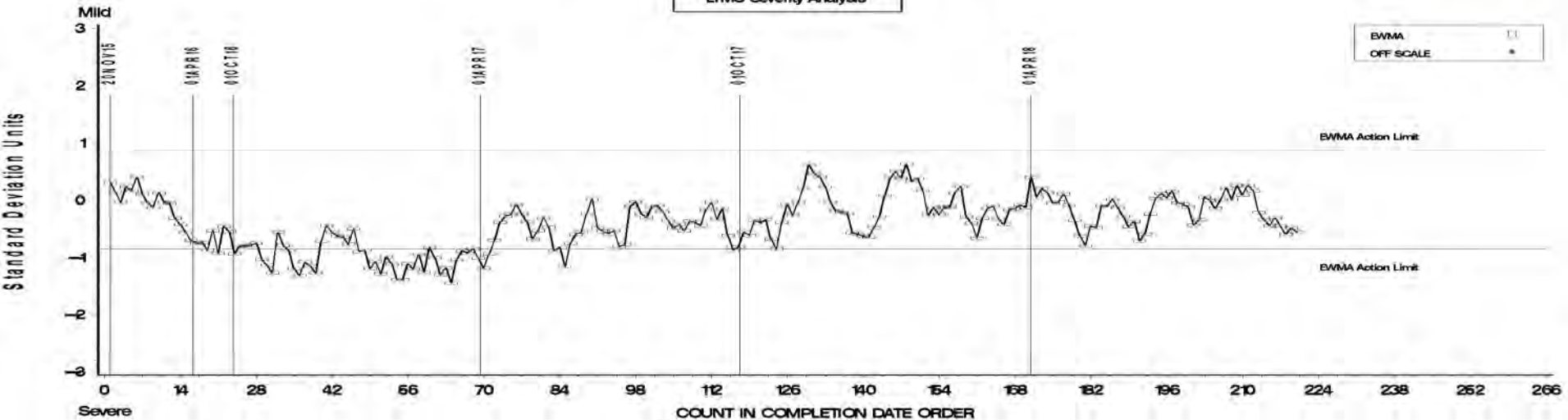
CUSUM Severity Analysis



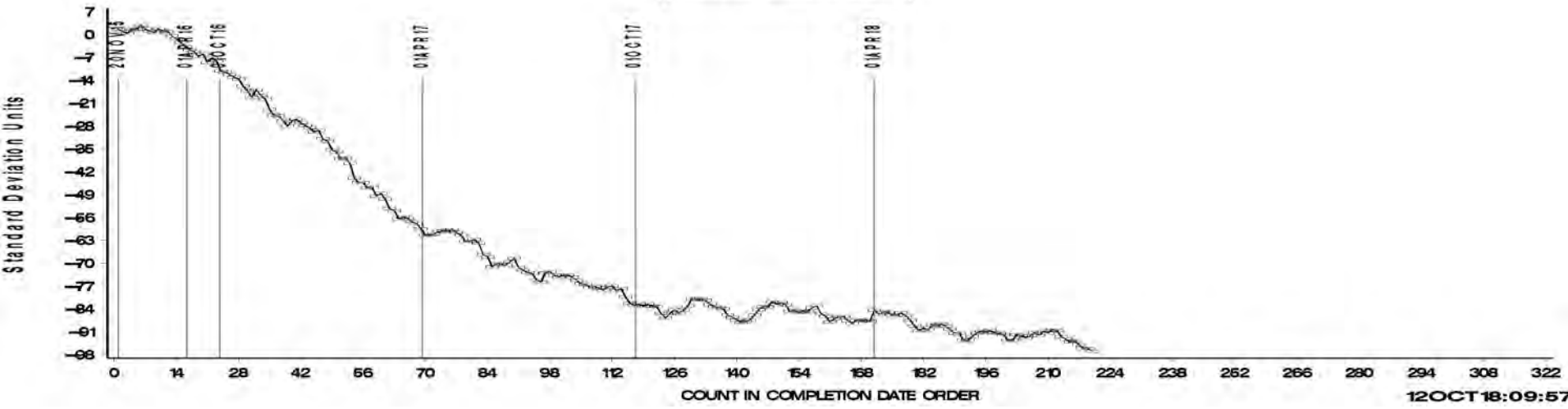
12OCT18:09:57

FEI FINAL RESULT PHASE II

LTMS Severity Analysis

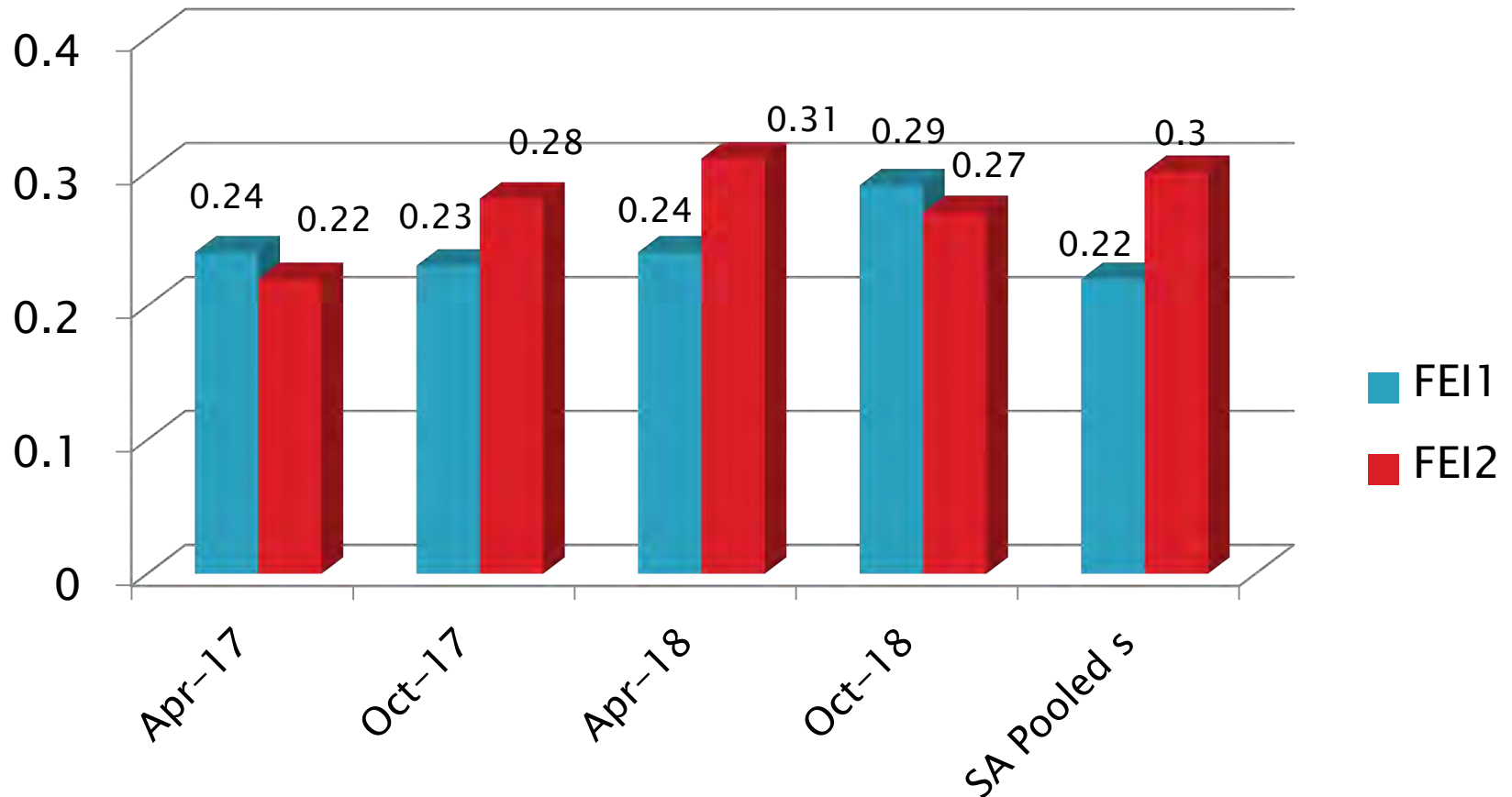


CUSUM Severity Analysis



12OCT18:09:57

Sequence VIE Precision Estimates



[Return to Table of Contents](#)

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Sequence VIF

»» October 2018

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Sequence VIF Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	36
Failed Statistically	OC	2
Acceptable Industry Information Test (BOI)	NI	1
Total		39

Sequence VIF – Failed Tests

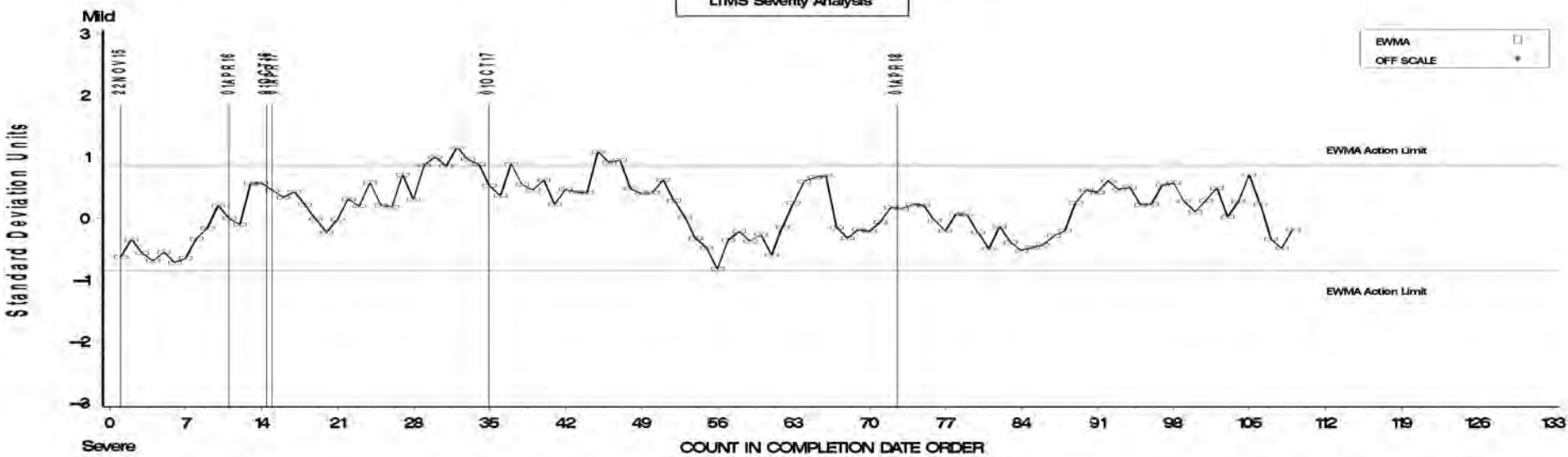
Test Status	Number of Tests
Severe FEI1	1
Vi Alarm FEI2	1
Total	2

Sequence VIF Test Severity

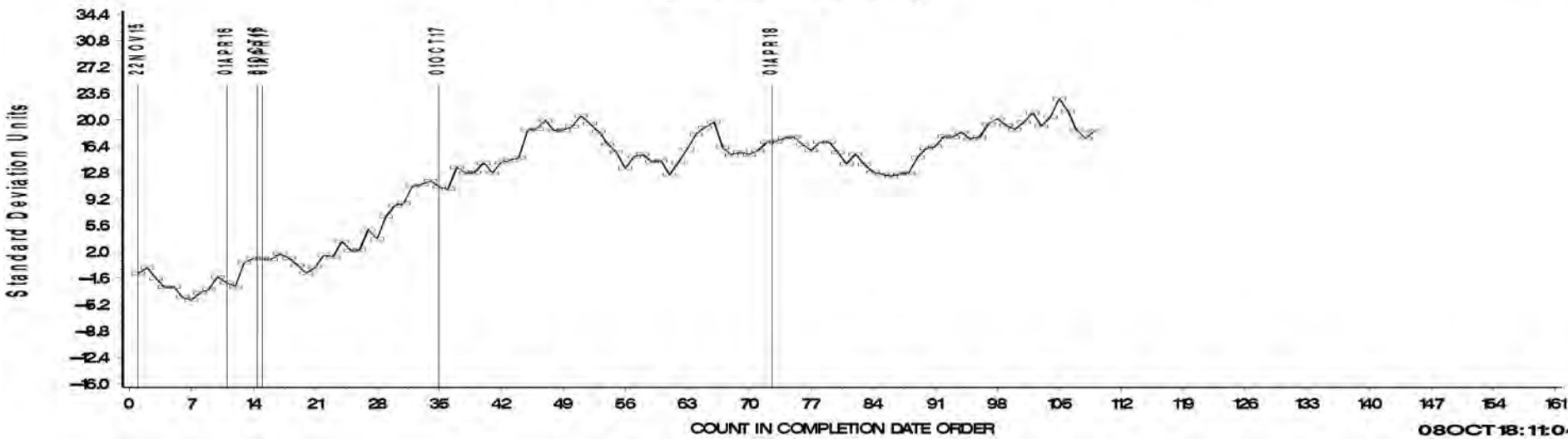
- FEI1 and FEI2 are in control

FEI FINAL RESULT PHASE I

LTMS Severity Analysis



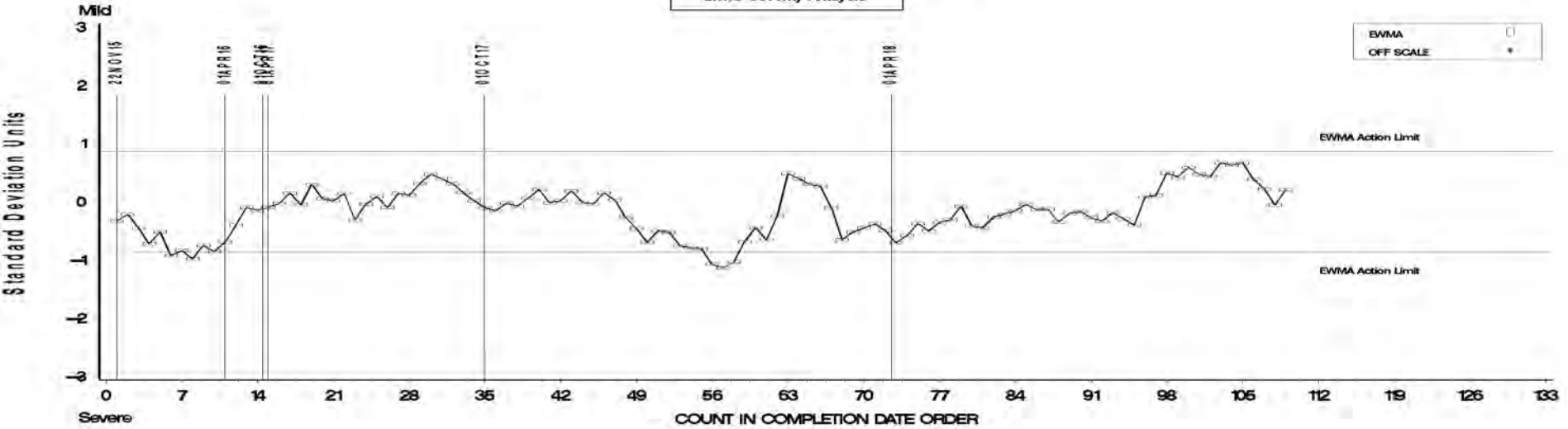
CUSUM Severity Analysis



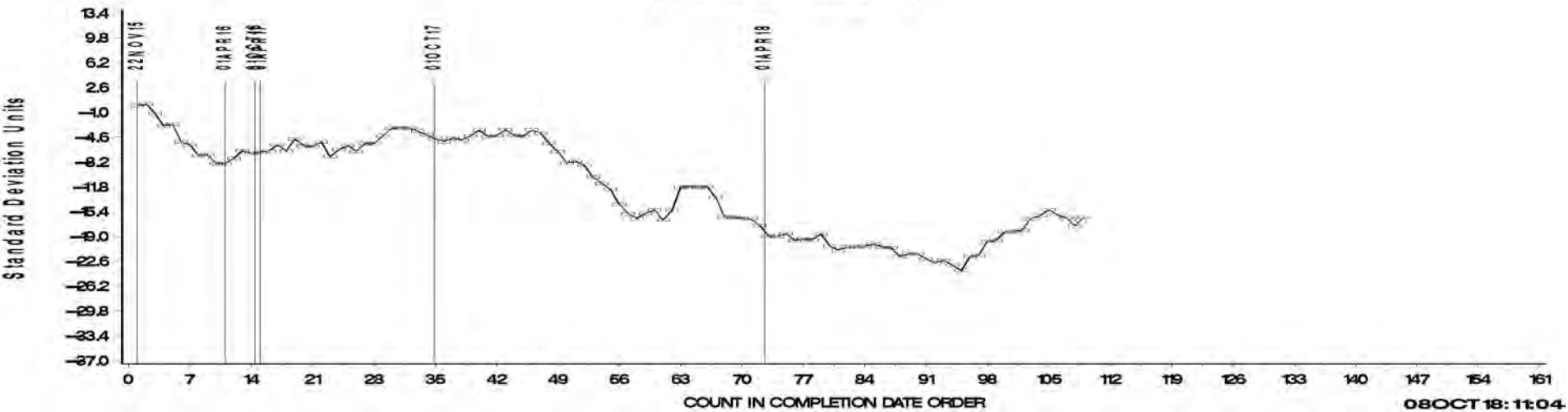
08OCT18: 11:04

FEI FINAL RESULT PHASE II

LTMS Severity Analysis

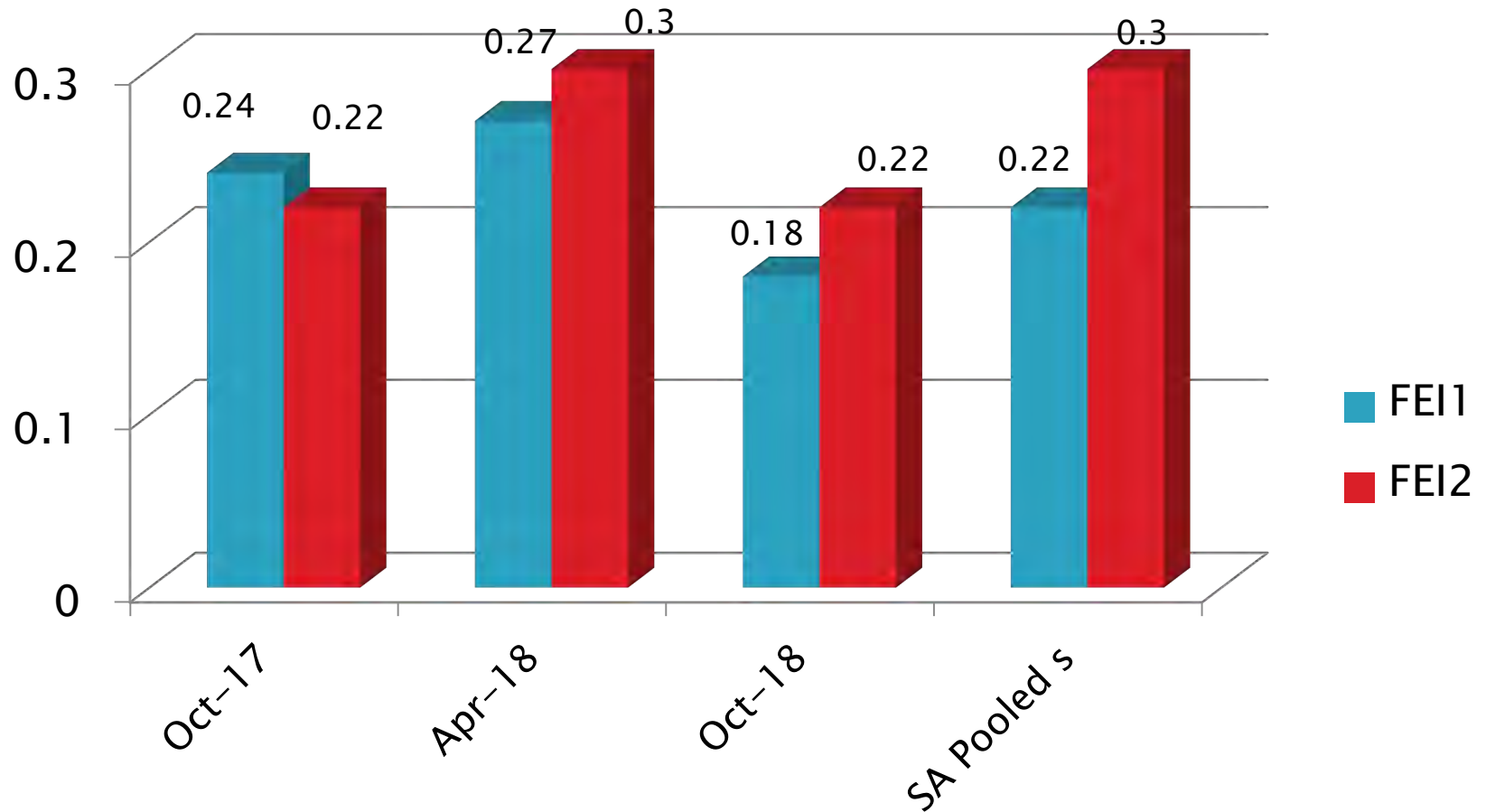


CUSUM Severity Analysis



08OCT18: 11:04

Sequence VIF Precision Estimates



[Return to Table of Contents](#)

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Sequence VIII

»» October 2018

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A Program of ASTM International

Sequence VIII Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	6
Operationally Invalid Calibration Test	LC	5
Total		11

Sequence VIII – Lost Tests*

Test Status	Cause	#
Invalid	Downtime exceeded procedural limit	1
Invalid	High mechanical wear	4
Totals		5

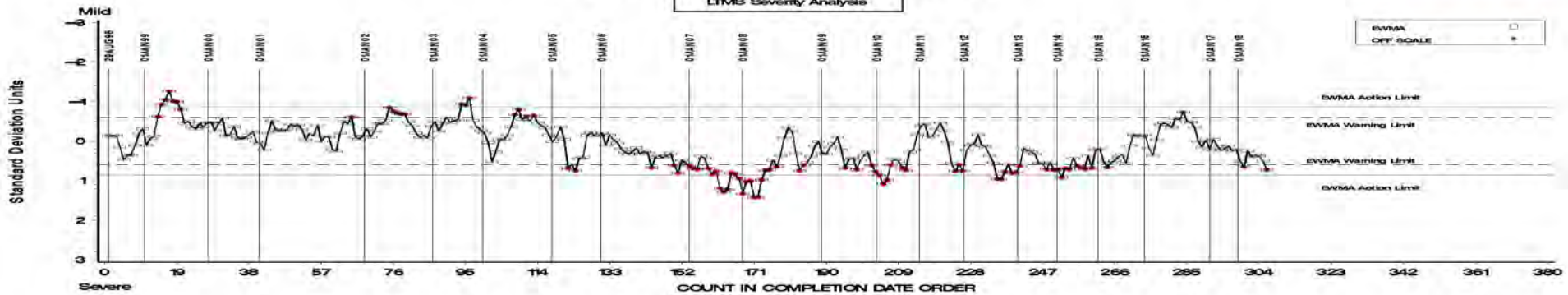
*Invalid and aborted tests

Sequence VIII Test Severity

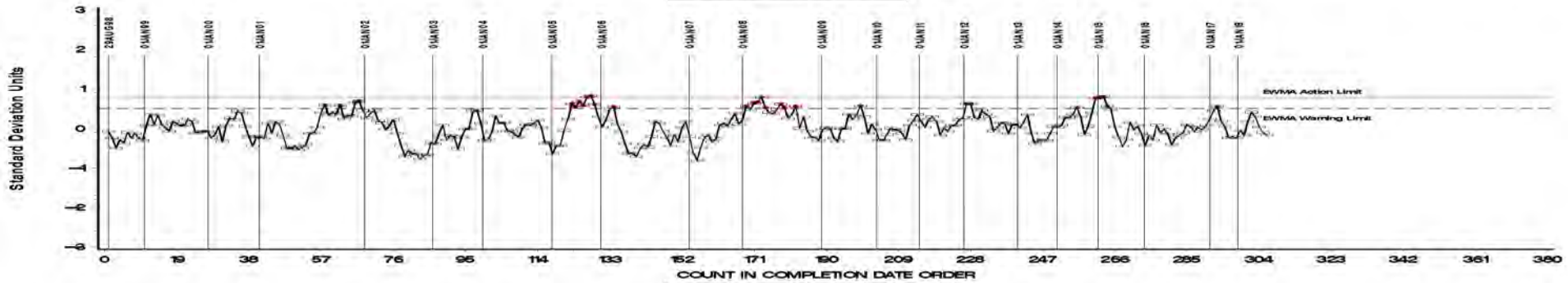
- Bearing Weight Loss is in severity warning alarm (severe direction)
- Stripped Viscosity is in control

FINAL BEARING WEIGHT LOSS

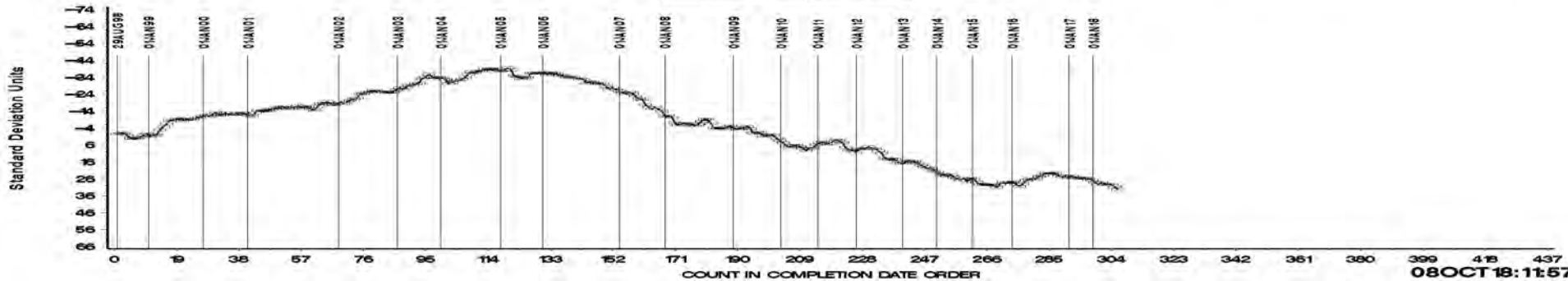
LTMS Severity Analysis



LTMS Precision Analysis



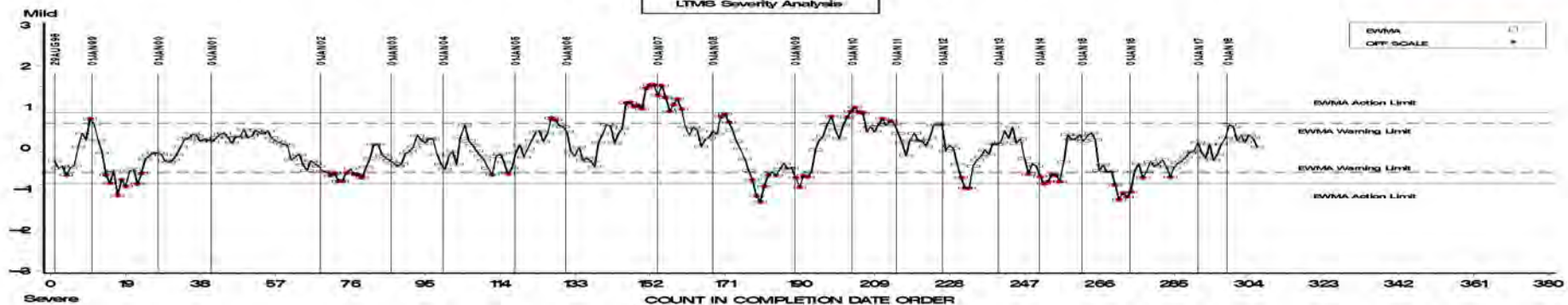
CUSUM Severity Analysis



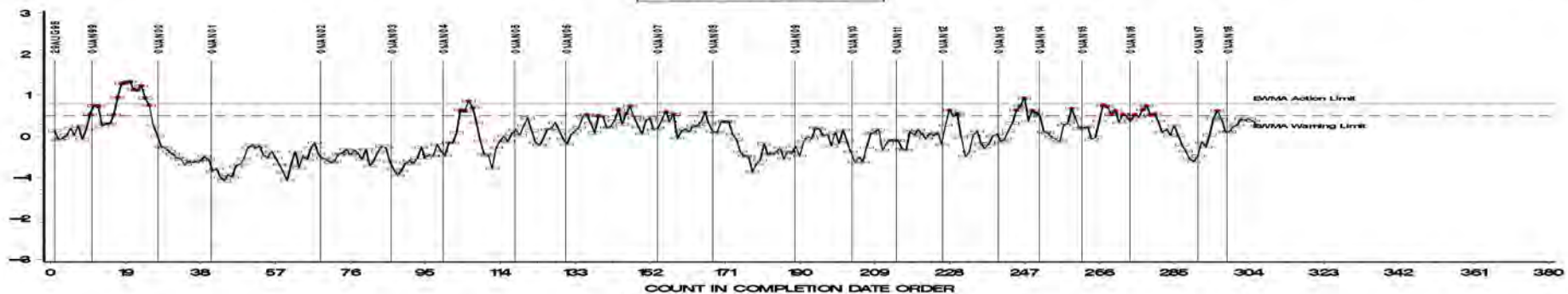
08OCT18:11:57

STRIPPED VIS. @ 100 DEG C

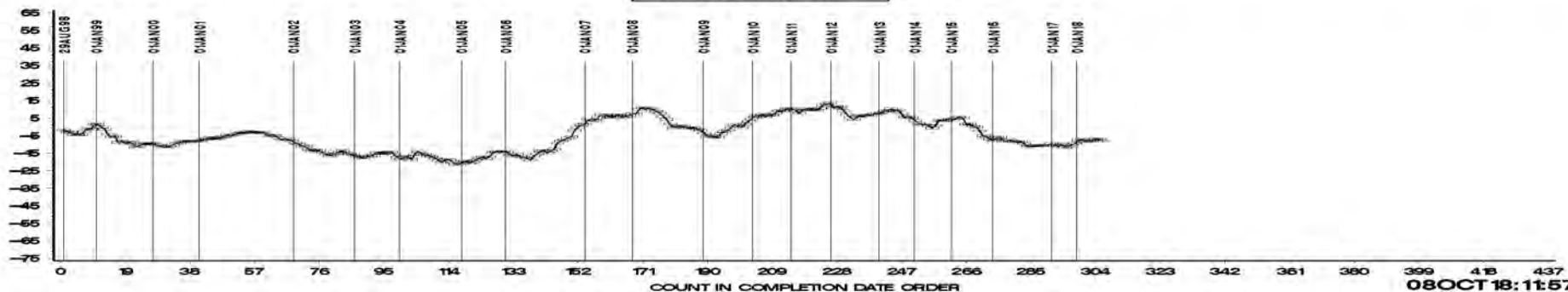
LTMS Severity Analysis



LTMS Precision Analysis



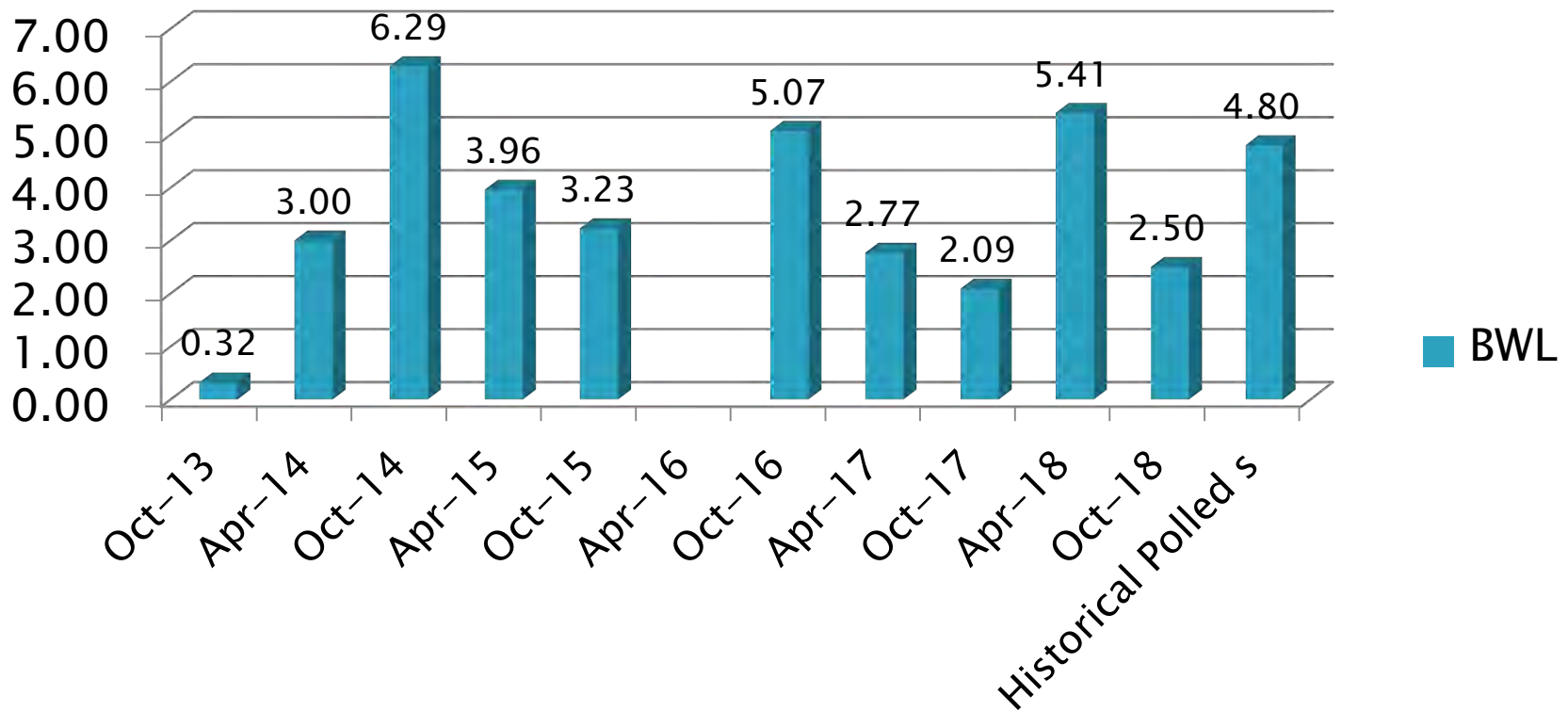
CUSUM Severity Analysis



08OCT18:11:57

Sequence VIII Precision Estimates

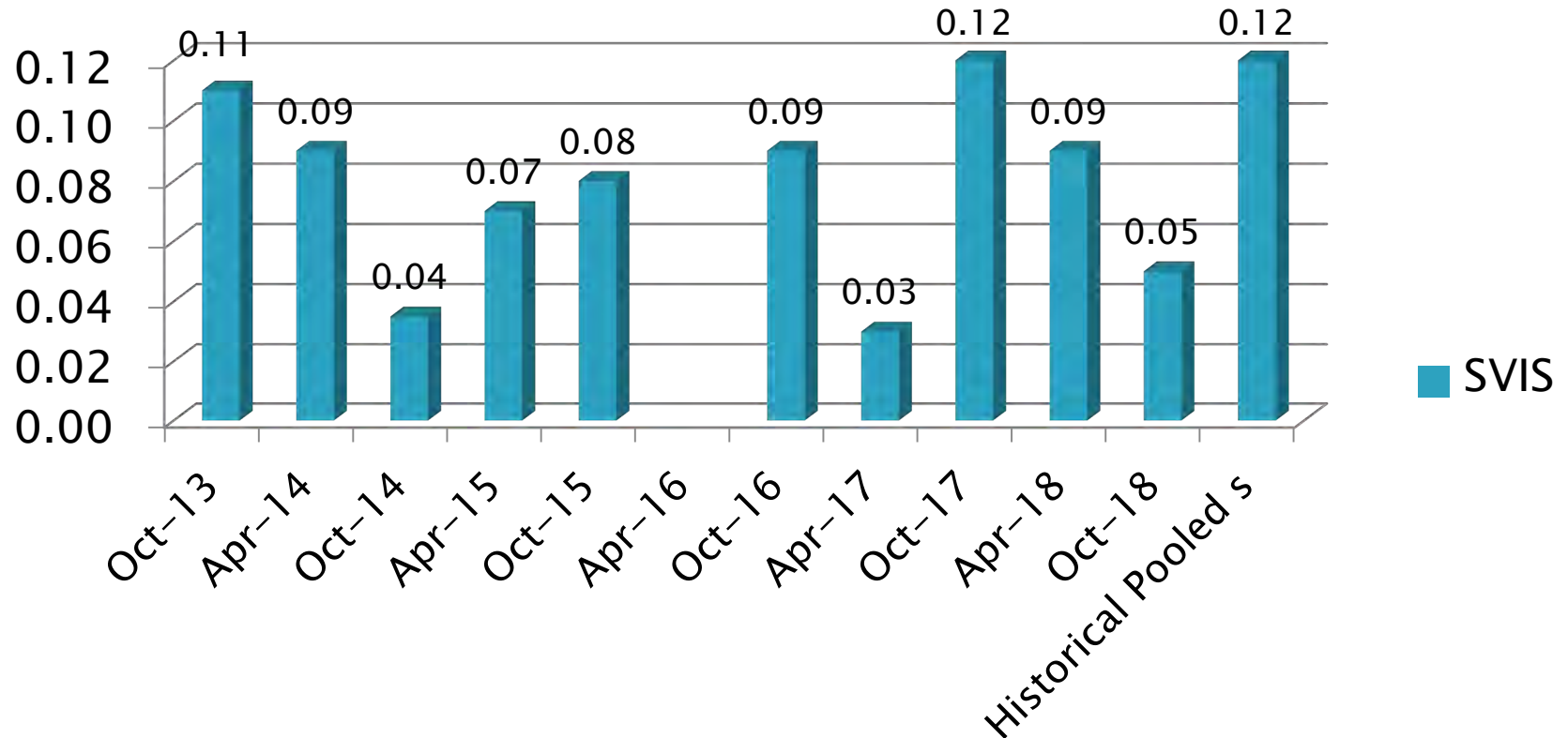
BWL



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 2018

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Sequence IX Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	42
Alternate Fuel Test	NF	1
Industry Information Test, BC Grade Pistons	NI	16
Invalid Donated test, Reference oil 224	LG	1
Operationally Invalid, Laboratory Judgement	LC	5
Statistically Unacceptable Calibration Test	OC	12
Total		77

Sequence IX – Failed Tests

Test Status	Number of Tests
Mild Average Pre-ignitions	6
Severe Average Pre-ignitions	6
Total	12

Sequence IX – Lost Tests*

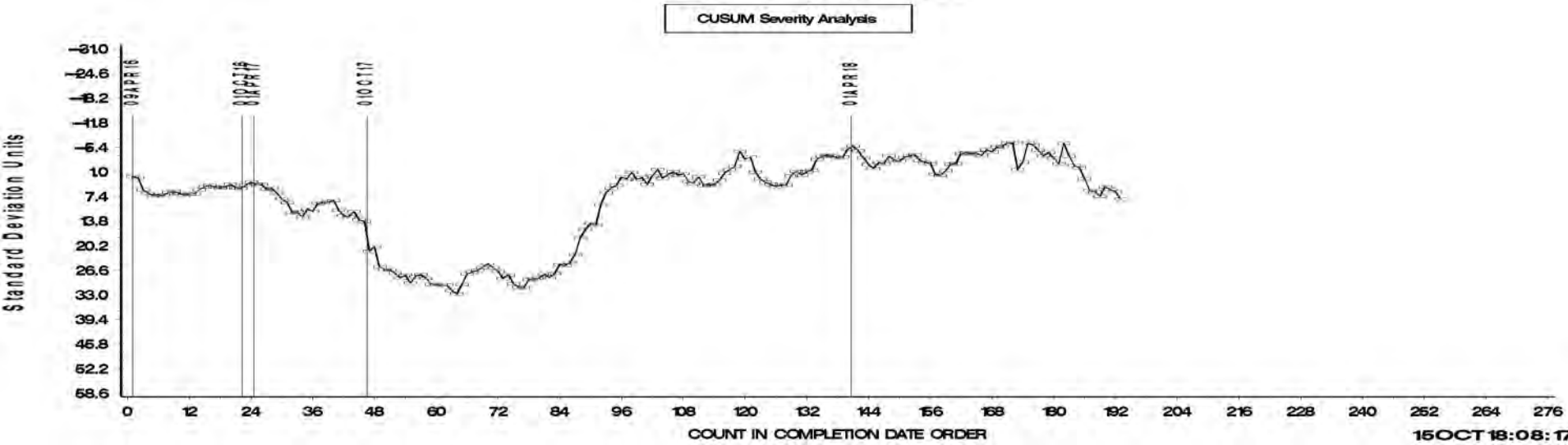
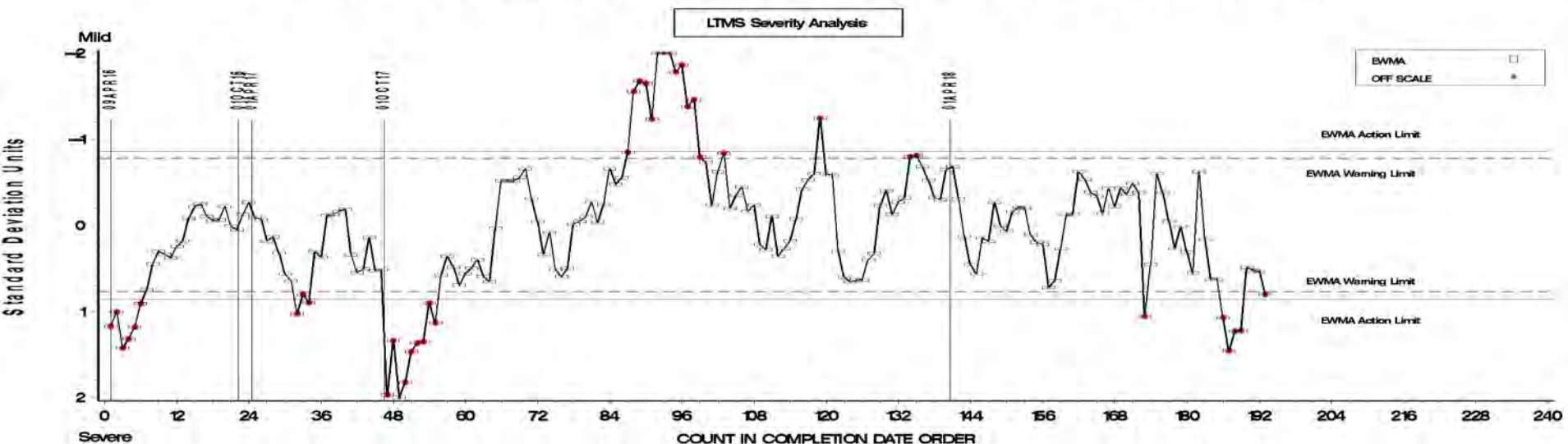
Test Status	Cause	#
Invalid	Cylinder 4 high activity	1
Invalid	Unable to obtain 4 valid iterations	5
Totals		6

*Invalid and aborted tests

Sequence IX Test Severity

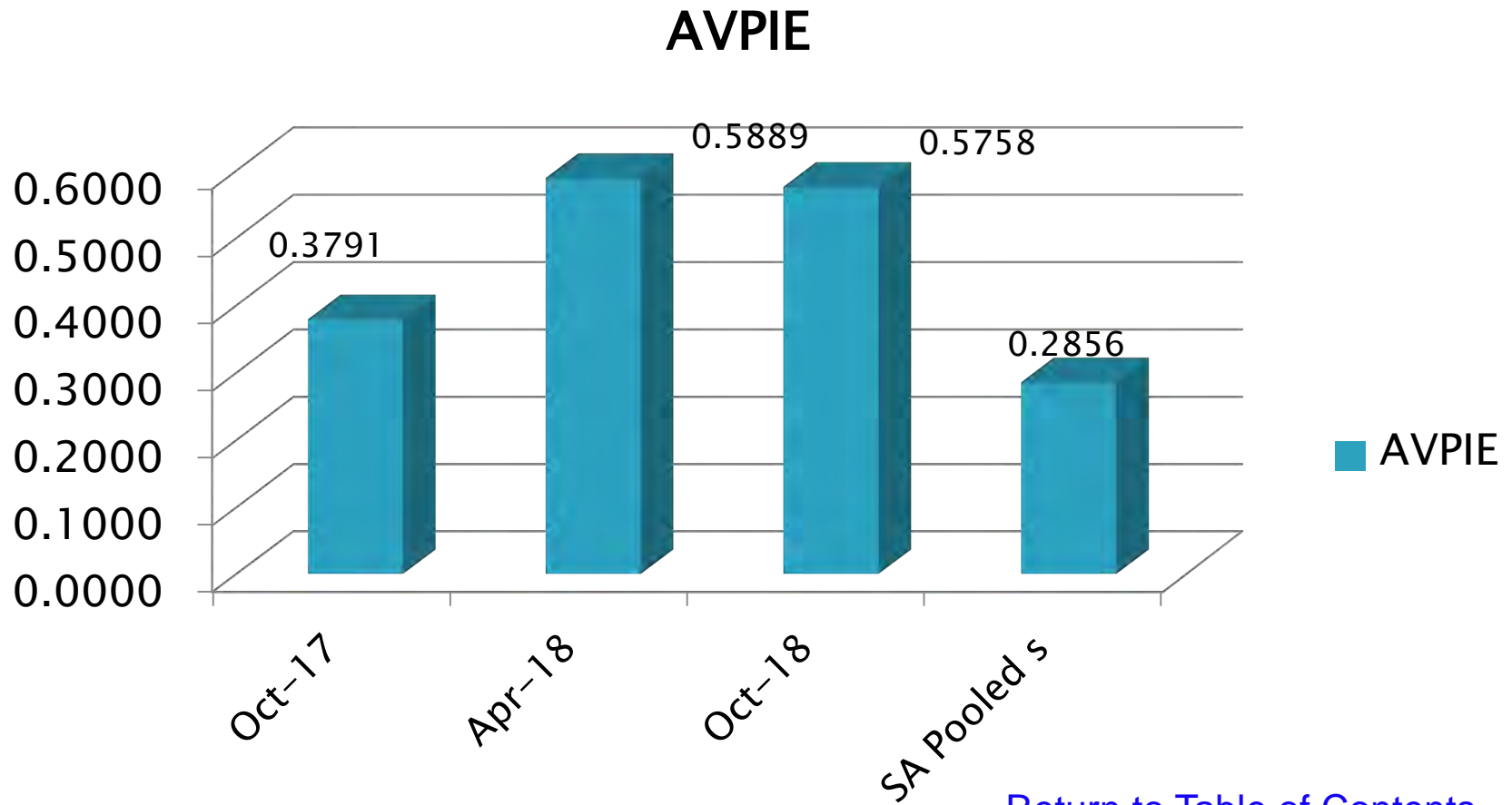
- Average number of Pre-ignitions in severity warning alarm.

AVERAGE NUMBER OF PREIGNITIONS FROM VALID ITERATIONS



15OCT18:08:17

Sequence IX Precision Estimates



[Return to Table of Contents](#)

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Sequence X

»» October 2018

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Sequence X Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	6
Operationally Valid BOI-VGRA Test	NI	8
Aborted Calibration Test	XC	2
Statistically Unacceptable Calibration Test	OC	1
Total Number of Tests		17

Sequence X – Lost Tests*

Test Status	Cause	#
Aborted	Turbocharger failure	1
Aborted	Oil loss during break-in	1
Totals		2

*Invalid and aborted tests

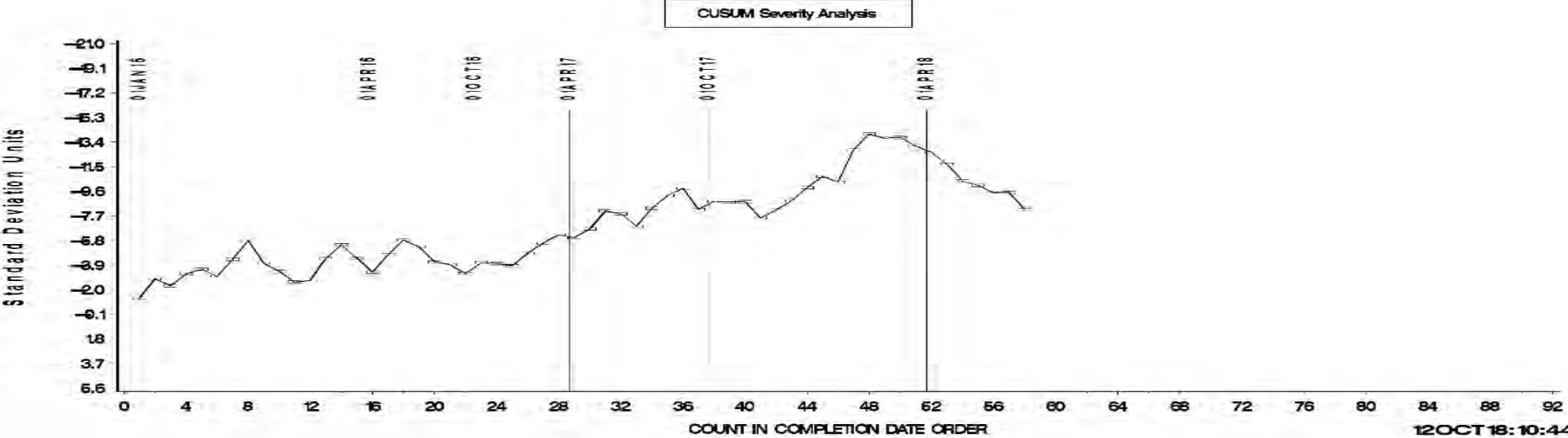
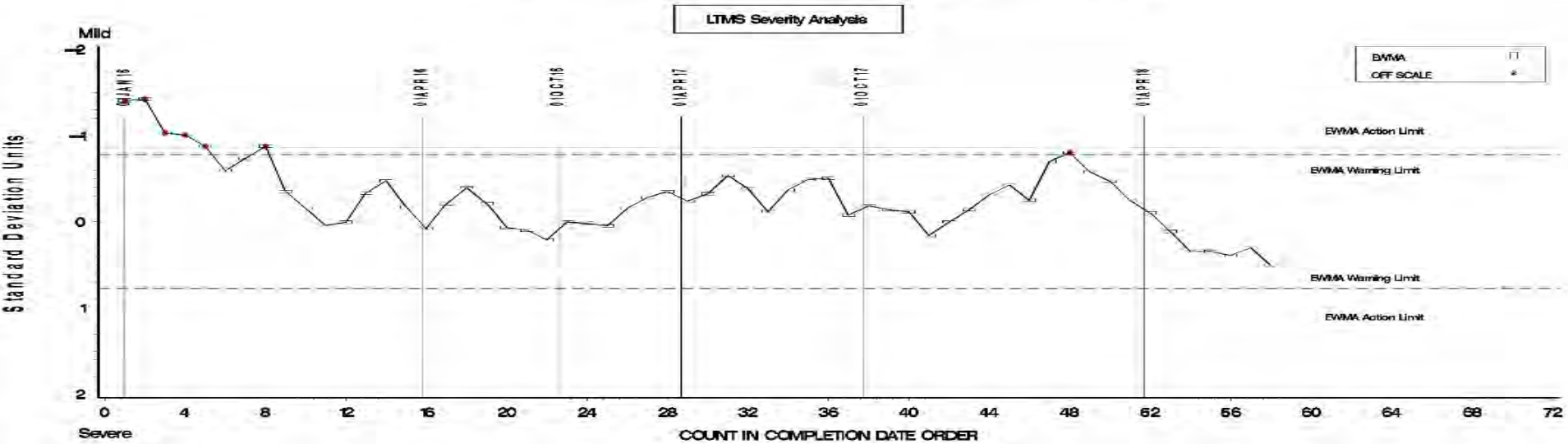
Sequence X – Failed Tests

Test Status	Number of Tests
Level 3 Ei Alarm	1
Total	1

Sequence X Test Severity

- Average Chain Stretch % in control.

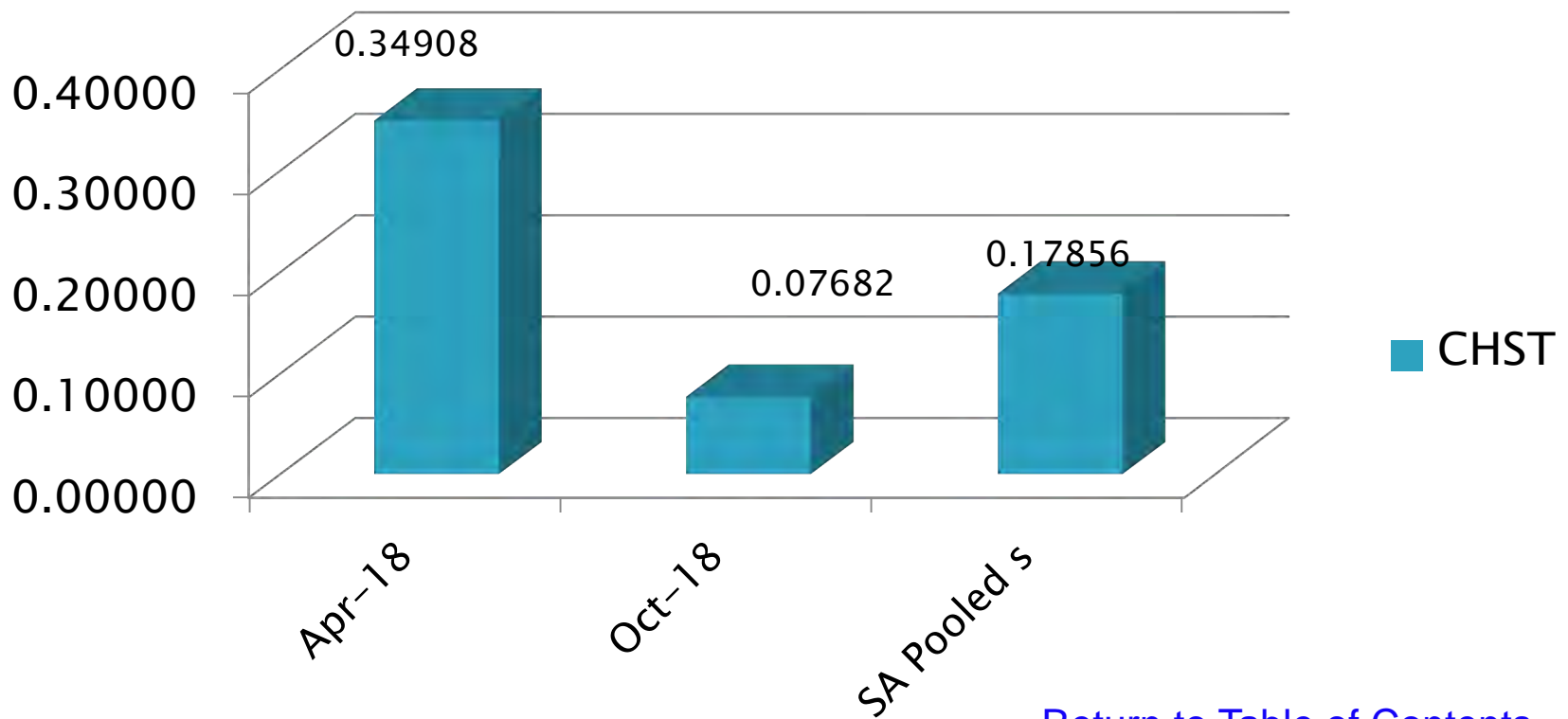
END OF TEST CHAIN WEAR FINAL RESULT



12OCT18: 10:44

Sequence X Precision Estimates

CHST



[Return to Table of Contents](#)

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Information Letters

»» October 2018

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Information Letters*

Test	Date	IL	Topic
IIIH	20180406	18-2	Revised updated Phosphorus measurement procedure
IIIH	20180731	18-3	Added provisions for alternate cooling system, updated Tables 1 and 3 and Added dynamometer supplier information
VIE	20180410	18-1	Added industry correction factors of +0.21 for FEI1 and +0.22 for FEI2
VIE	20180723	18-2	Added piston valve actuator to recommended hardware and corrected/updated supplier information footnotes
VIE	20180823	18-3	Corrected formulas in Annexes A15 and A16

*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 222 and 224

- < 1 year supply, supplier contacted, re-blend not available. 224 is available for introduction

➤ TMC 300-1

- This re-blend is available, not introduced yet.

➤ TMC 434-3

- This re-blend is available, tests being run to generate targets.

Reference Oil Re-blends (cont)

➤ TMC 438-2

- This re-blend is available, not yet introduced

➤ TMC 1009-1

- This re-blend is available, not introduced yet.

➤ TMC 542-3

- Little over a year supply remaining, supplier contacted for 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
220	IX	1100	145	440	50	3 years
221	IX	2120	150	1364	60	2.5+ years
222	IX	1040	145	61	60	<1 year
270	X	1100	15	863	30	5 years
271	X	980	20	804	45	5 years
300	IVB	330	0	7	16	<1 year
300-1	IVB	378	32	346	24	5 years
433-1	IIIF	1045	0	0	8	<1 year
433-2	IIIF	500	32	146	32	2+ years
434	IIIG	550	0	<1	12	<1 year

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
434-1	IIIG	660	0	4	20	1.5 years
434-2	IIIG, IIIH	495	18	7	28	<1 year
434-3	IIIG, IIIH	980	50	885	44	5+ years
435	IIIG	550	0	2	4	<1 year
435-2	IIIG	550	18	139	32	3+ years
436	IIIH	1100	25	772	36	5+ years
438	IIIG	990	0	16	28	1.5 years
438-1	IIIH	605	16	26	36	<1 year
438-2	IIIH	540	0	540	0	5 years
542-2	VIE	1000	0	0	6	<1 year
542-3	VIE	997	190	370	136	1+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
543	VIF	1100	105	657	48	3+ Years
544	VIE	897	44	277	78	2+ years
704-1	VIII	897	14	89	10	5+ years
940	VG, VH	560	42	157	24	2+ years
1006-2	IVA, VG, VIII	5500	320	1024	32	2 years
1009	VG, VH, VIII	1100	0	34	6	<1 year
1009-1	VG, VH, VIII	1100	9	1094	15	5 years
1010-1	VIE	1760	218	583	108	2 years
1011	IVB/VH/VIF/X	1100	183	495	148	2 years
1012	IVB	2200	64	2001	16	5+ years

[Return to Table of Contents](#)

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LTMS Deviations

»» April 1, 2018 –
September 30, 2018

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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
VIF	0
VIII	3
IX	0
X	0

[Return to Table of Contents](#)

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Quality Index Deviations

»» April 1, 2018 –
September 30, 2018

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Quality Index Deviations

- Two Quality Index Deviations this Report Period.
 - VH – Exhaust backpressure (Lab G)
 - VH – Engine oil inlet and coolant outlet temperatures (Lab A)

Quality Index Deviations

Historical Count of PCEO Quality Index Deviations

Test	Quality Index Deviations
IIIF	28
IIIG	16
IIIH	5
IVA	30
VG	46
VH	2
IX	1
X	2

[Return to Table of Contents](#)

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TMC Laboratory Visits

»» April 1, 2018 –

September 30, 2018

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TMC Lab Visits

Test	Number of Labs Visited
IIIH	3
VH	2
VIE	3
VIII	1
X	1

Lab Visit Issues

- VIII
 - Crankcase pressure not located properly.
- IIIH
 - A minimum of 10 lengths of straight pipe not maintained downstream of J-Tec meter.

Labs have notified the TMC that these items were corrected or were corrected during the visit

[Return to Table of Contents](#)

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Test Area Timelines

»» April 1, 2018 –
September 30, 2018

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Test Area Timeline Additions*

Test	Date	Topic	IL
IIIH	20180406	Revised updated Phosphorus measurement procedure	18-2
IIIH	20180731	Added provisions for alternate cooling system, updated Tables 1 and 3 and Added dynamometer supplier information	18-3
IVB	20180510	LTMS Implemented for AVLI Parameter	N/A
VIE	20180410	Added industry correction factors of +0.21 for FEI1 and +0.22 for FEI2	18-1
VIE	20180723	Added piston valve actuator to recommended hardware and corrected/updated supplier information footnotes	18-2
VIE	20180823	Corrected formulas in Annexes A15 and A16	18-3

*As of 09/30/2018

[Return to Table of Contents](#)

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Rating Workshop Data

»» 2018 Light Duty Workshop

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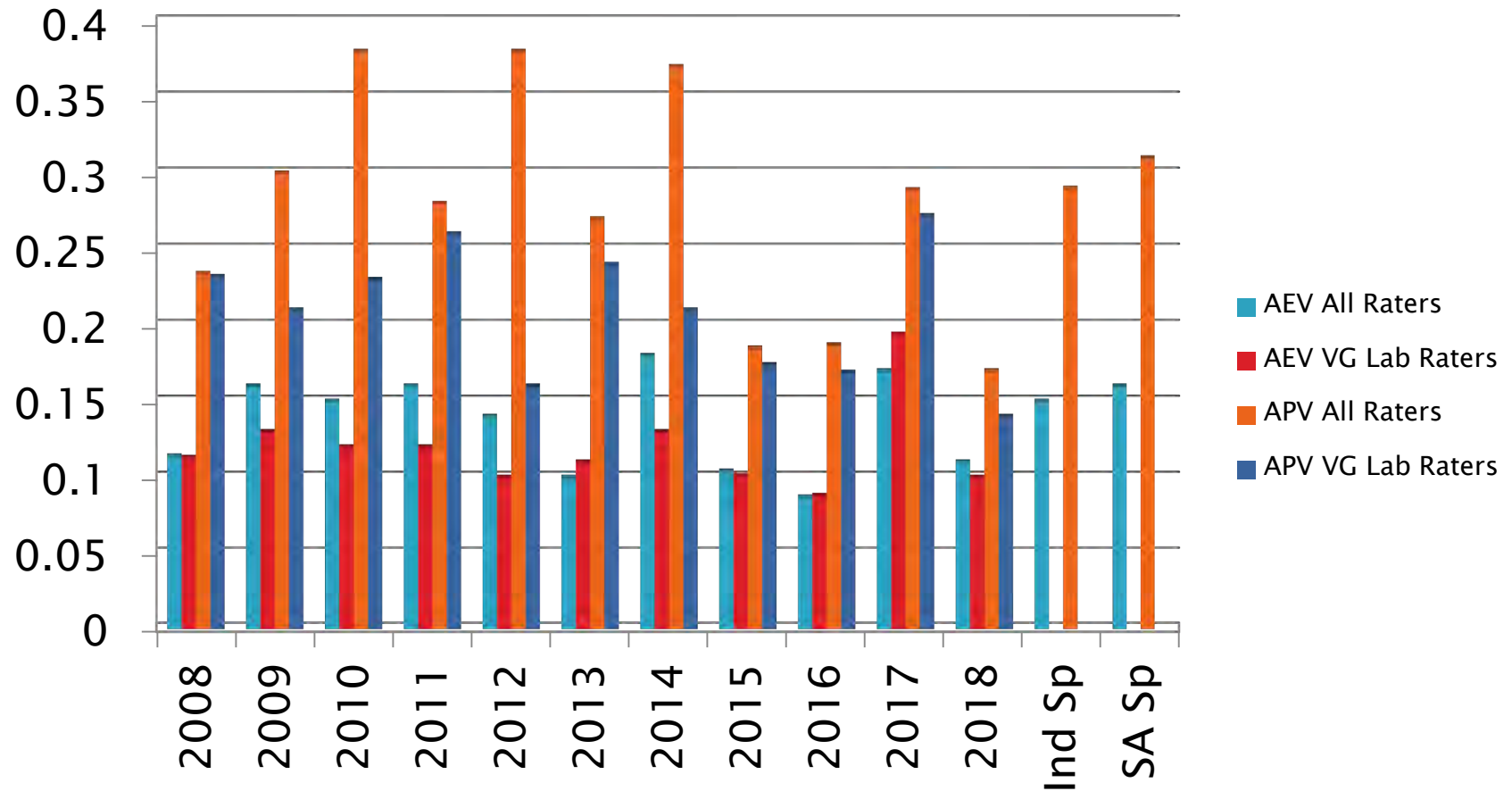
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Rating Workshop Data

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

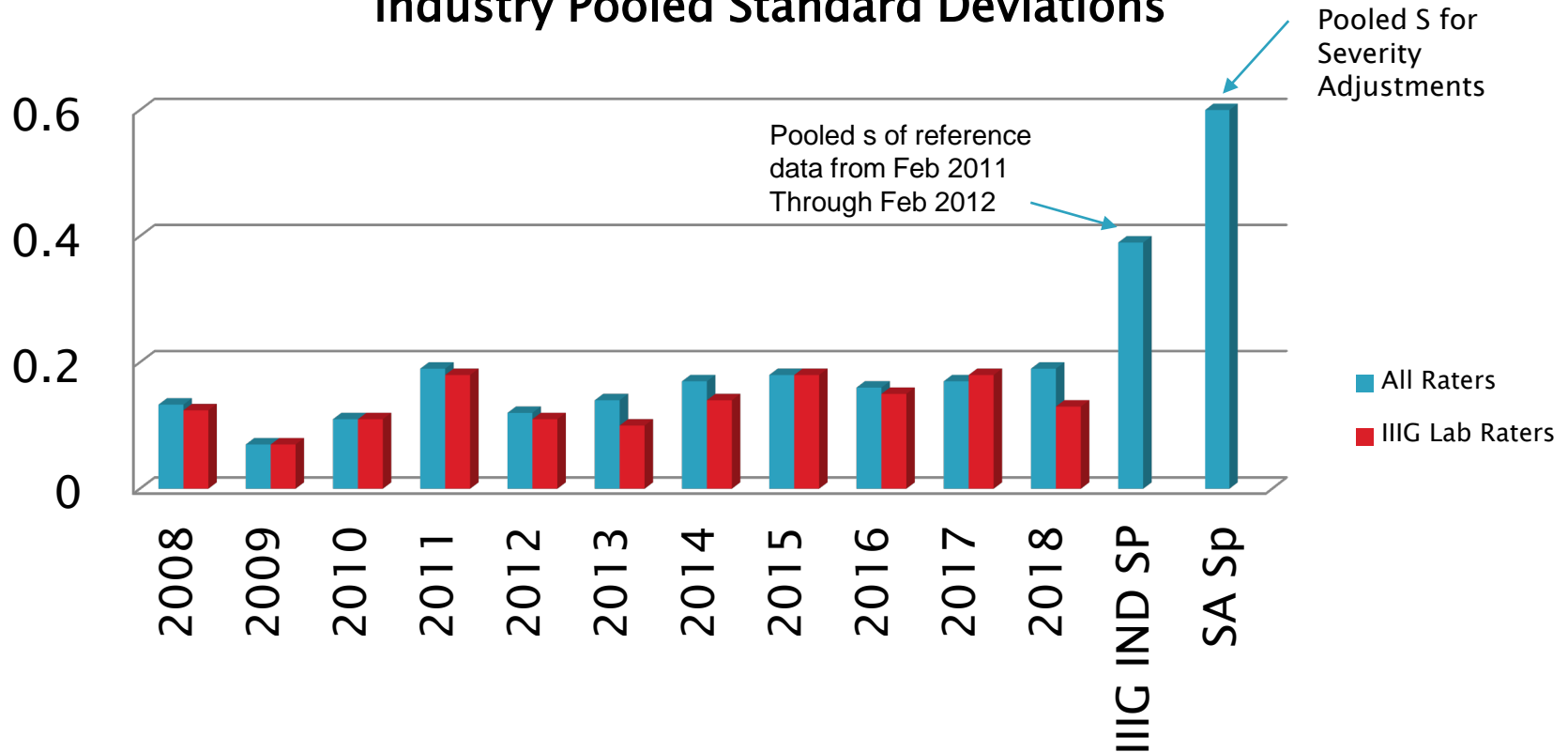
Sequence VG Precision–Rating Workshop Data

Workshop Data for VG/VH 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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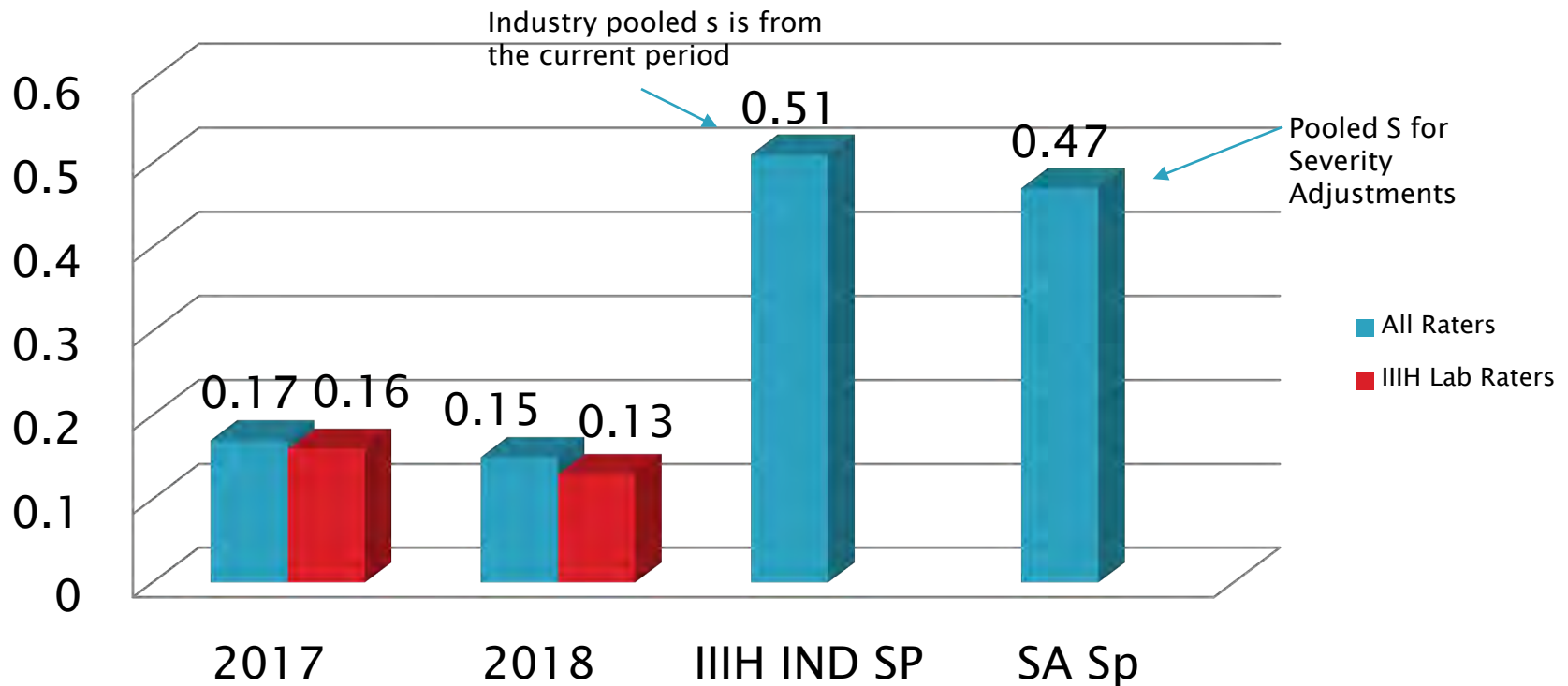
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Sequence IIH Precision – Rating Workshop Data

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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