



A Program of ASTM International

# **Test Monitoring Center**

<https://www.astmtmc.org>

## **ASTM D02.B1 Semiannual Report Passenger Car Reference Oil Testing**

October 2021

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# Passenger Car Engine Oil Testing Executive Summary

## ▶ Test Monitoring Center

- The Test Monitoring Center is no longer part of Carnegie Mellon and is now affiliated with ASTM.

## ▶ Seq. VH

- The panel is in process of introducing reference oil 1011-1 and should be generating targets in the next quarter.

## ▶ Rating

- The Light Duty Rating Workshop scheduled for October 2021 was cancelled due to the Covid-19 pandemic. The TMC is attempting to arrange a workshop early 2022.

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# Calibrated Labs and Stands\*

Test	Labs	Stands
IIIH/A/B	4	12
IVA	2	2
IVB	4	6
VH	5	14
VIE	3	9
VIF	3	5
VIII	2	4
IX	3	5
X	4	5

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\*As of 9/30/2021

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# Sequence IIIH/A/B

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# Sequence IIIH Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	12
Operationally Invalid Calibration Test (Lab Determination)	LC	3
Aborted Calibration Test	XC	1
<b>Total</b>		<b>16</b>



# Sequence IIIH – Lost Tests\*

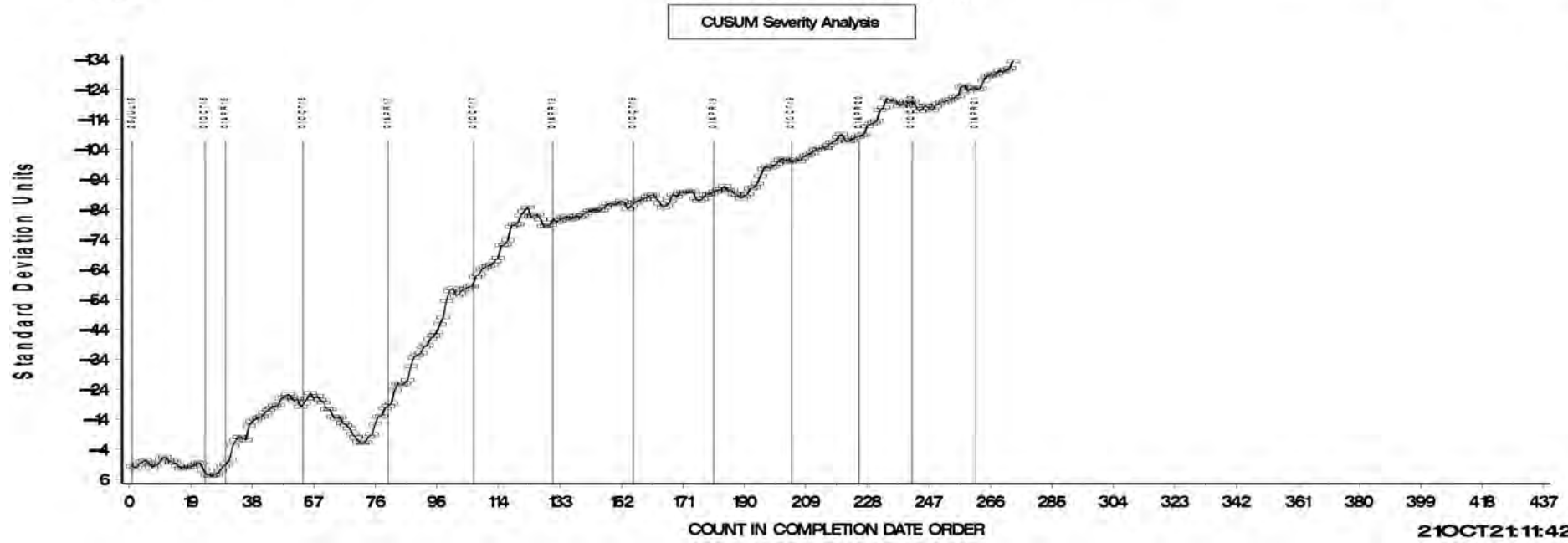
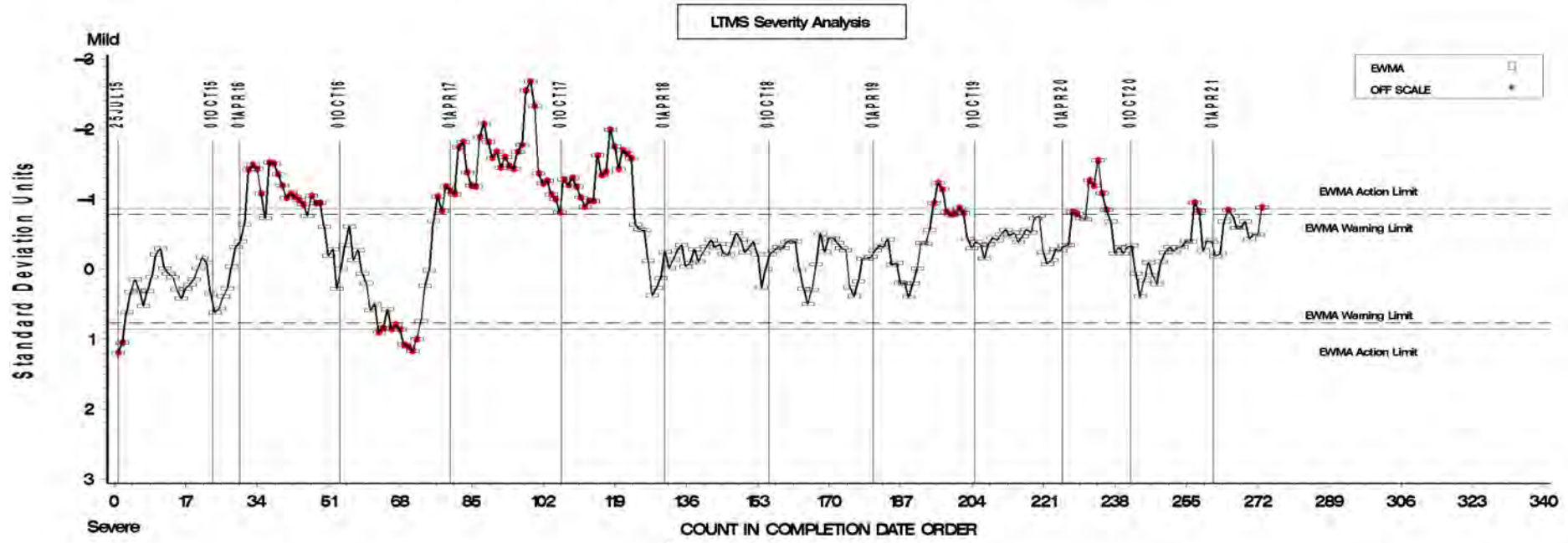
Test Status	Cause	#
Aborted	Hardware issue (retaining pin fell out of cam phaser)	1
Invalid	Load Calibration Error	1
Invalid	Oil Levelling Error	1
Invalid	Exhaust Backpressure Trap Gasket Failed	1
<b>Totals</b>		<b>4</b>

\*Invalid and aborted tests

# Sequence IIIH Test Severity

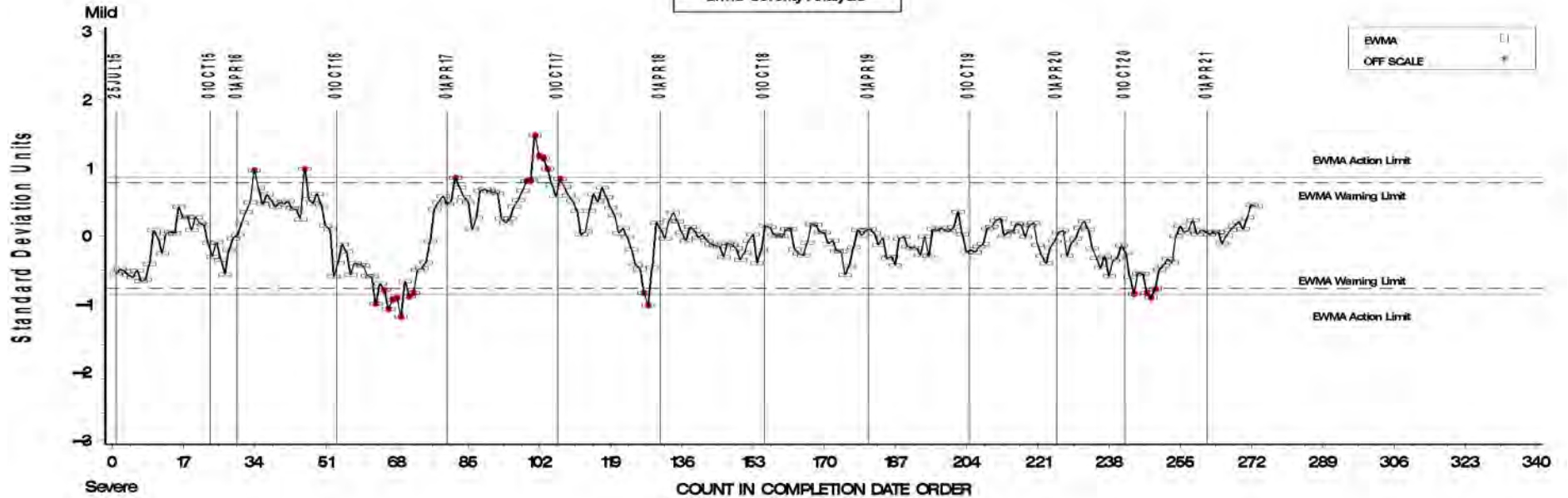
- APV and PVIS are in action alarm (mild direction)
- All other parameters are in control.

VISCOSITY INCREASE FINAL ORIG UNIT RES

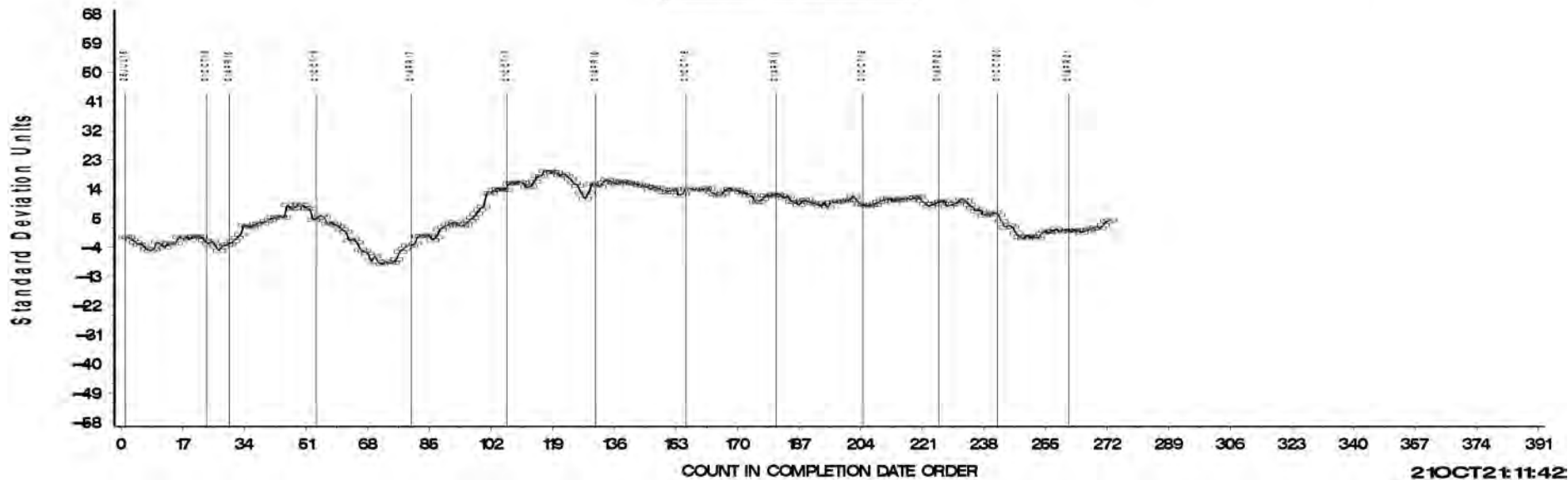


AVERAGE WEIGHTED PISTON DEPOSITS FNL ORIG U

LTMS Severity Analysis

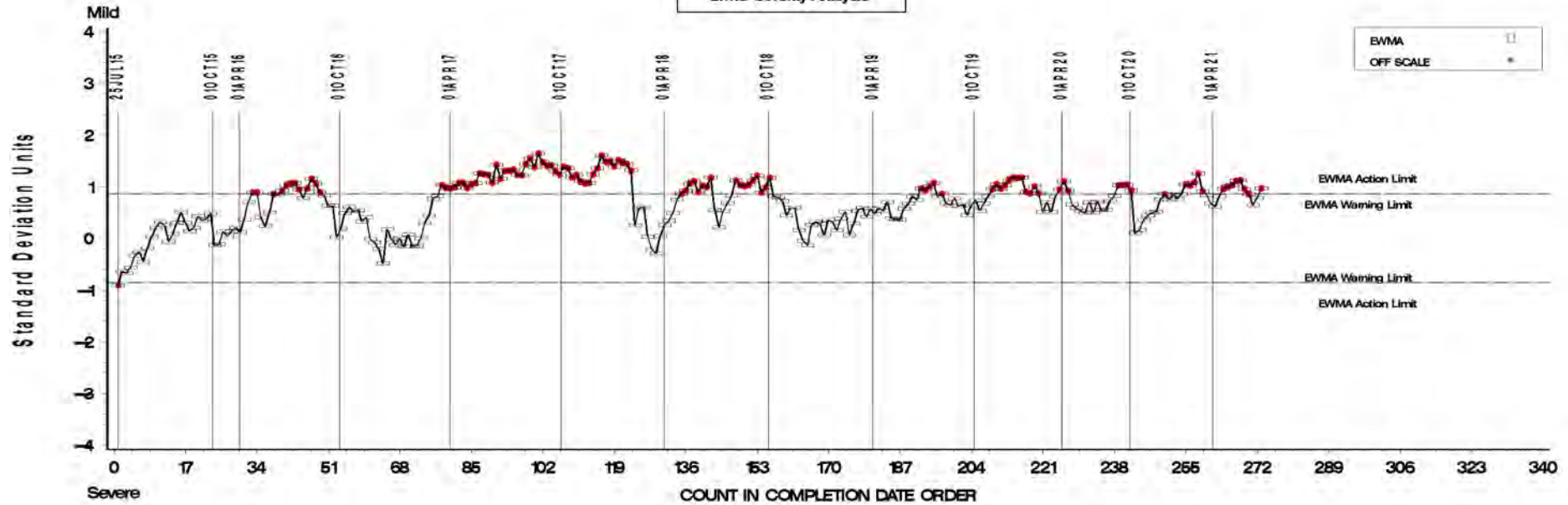


CUSUM Severity Analysis

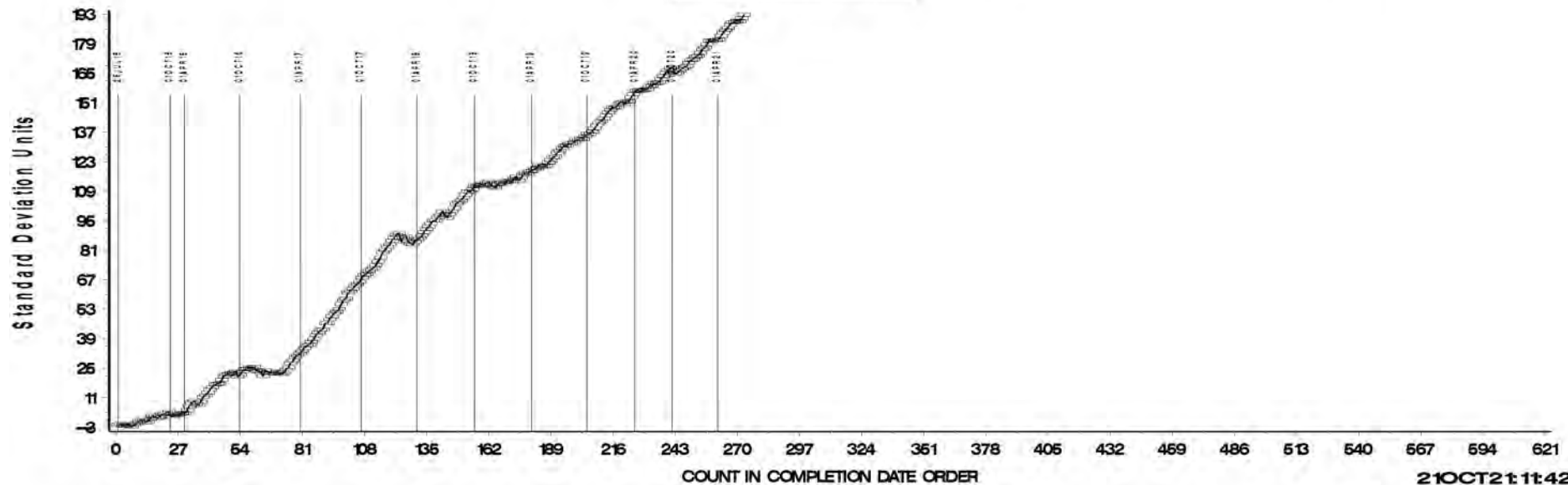


AVERAGE PISTON SKIRT VARNISH

LTMS Severity Analysis

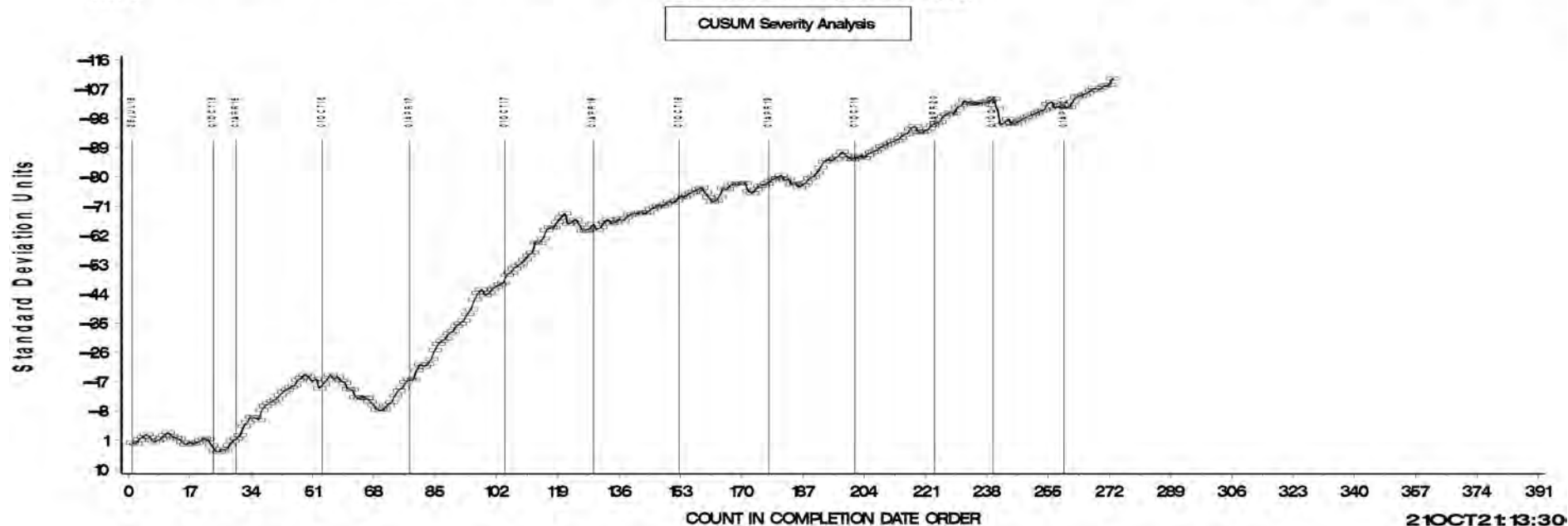
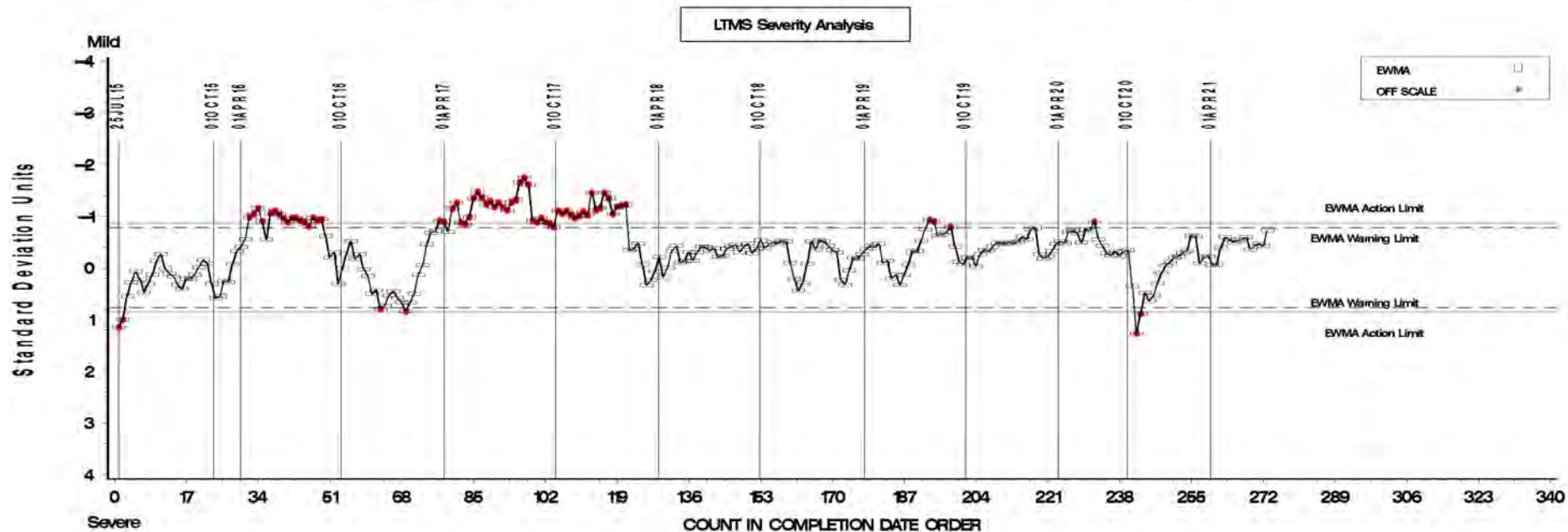


CUSUM Severity Analysis



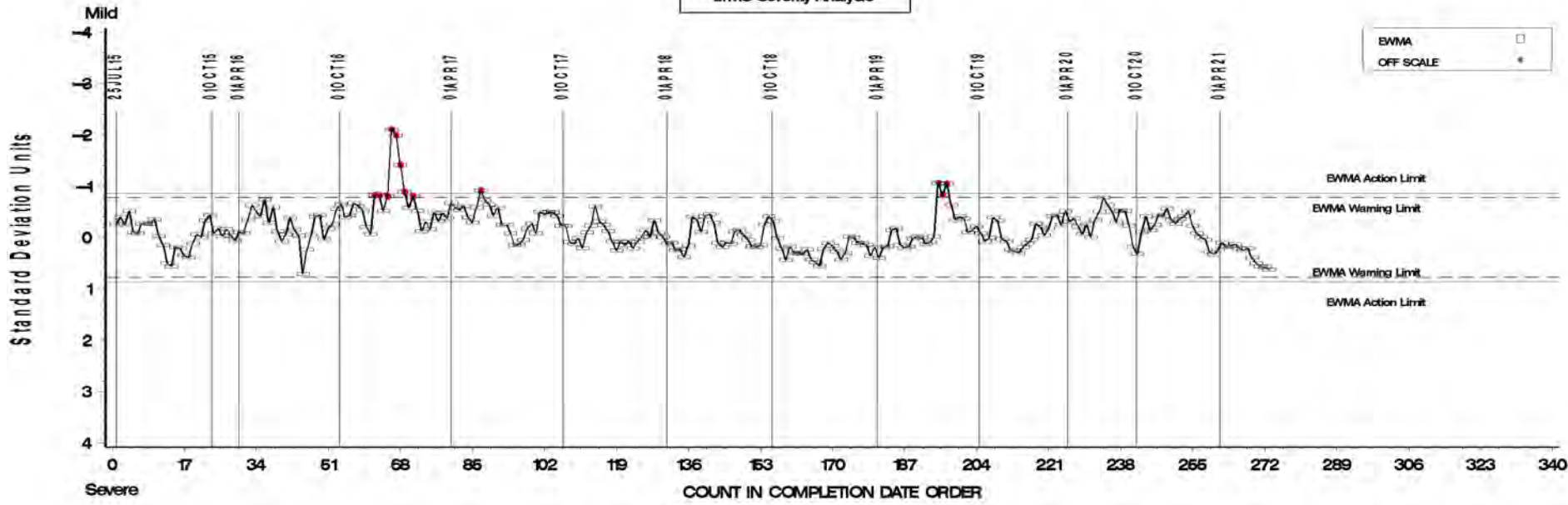


MRV FINAL ORIG UNIT RES [NM, FROZEN, SOLID]

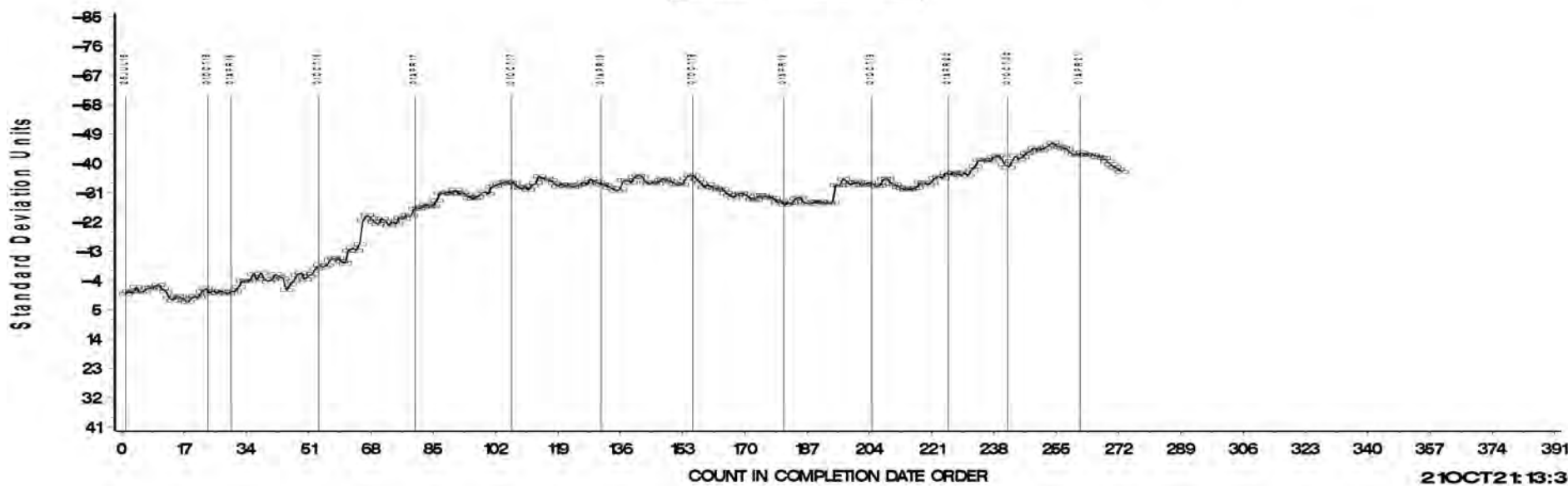


PHOSPHORUS RETENTION, FINAL RESULT

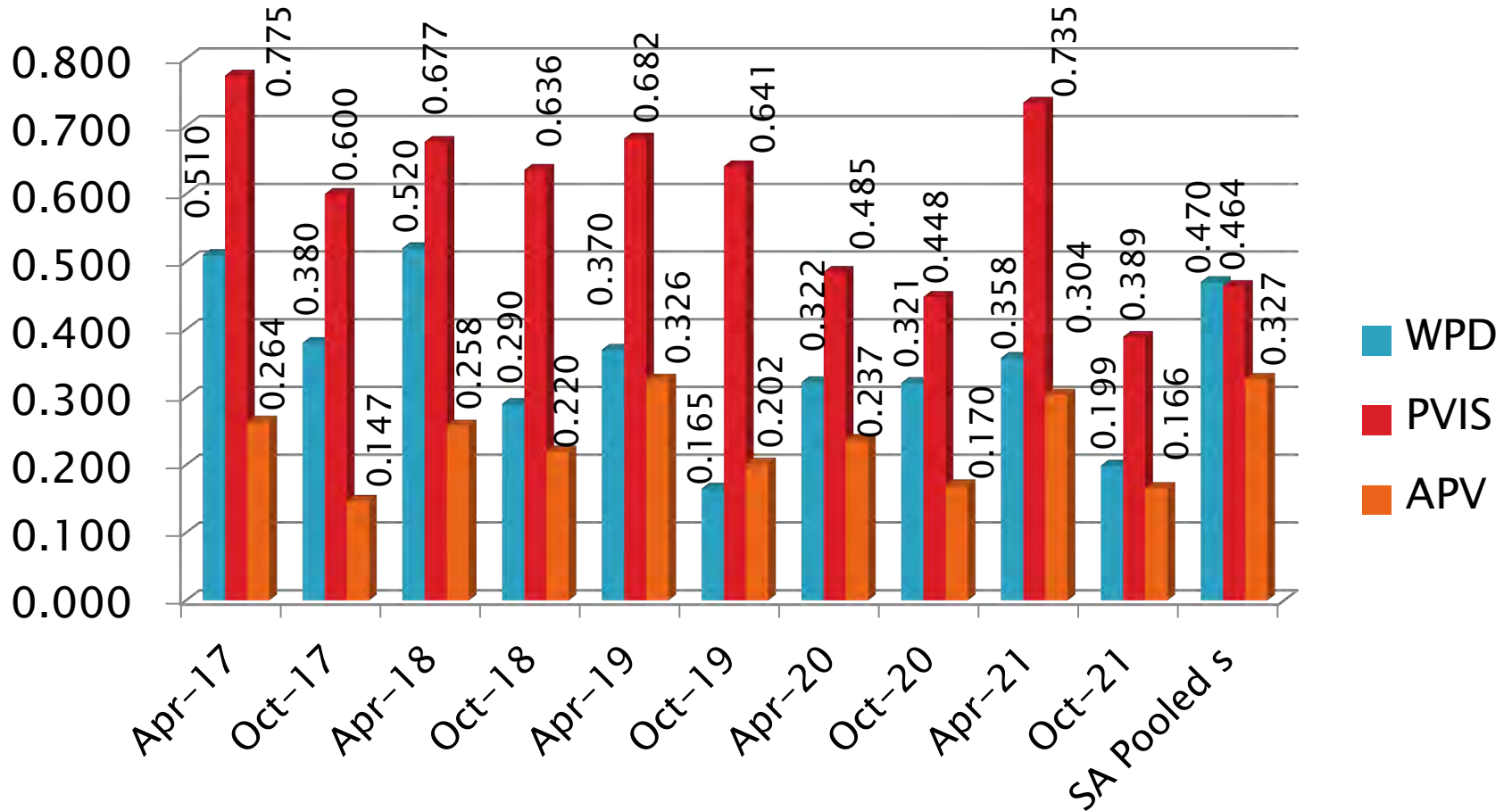
LTMS Severity Analysis



CUSUM Severity Analysis

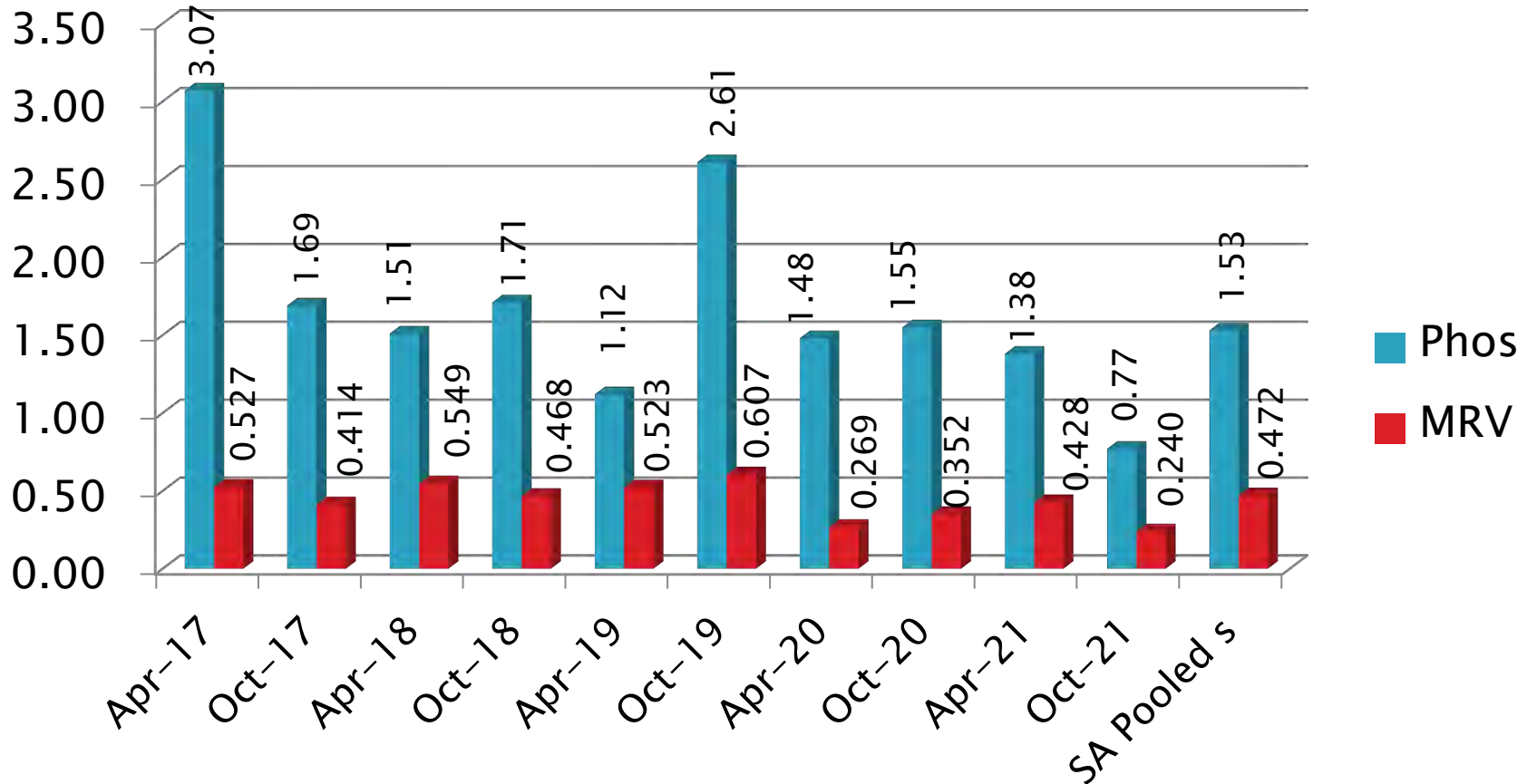


# IIH Precision Estimates





# IIIHA/B Precision Estimates



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# Sequence IVA

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# Sequence IVA Activity

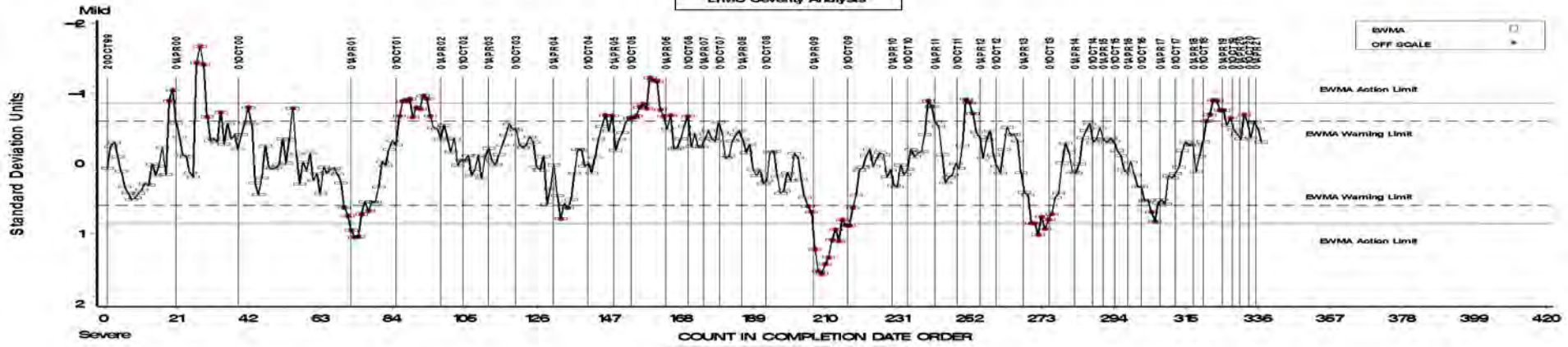
Test Status	Validity Code	#
Acceptable Calibration Test	AC	2
<b>Total</b>		<b>2</b>

# Sequence IVA Test Severity

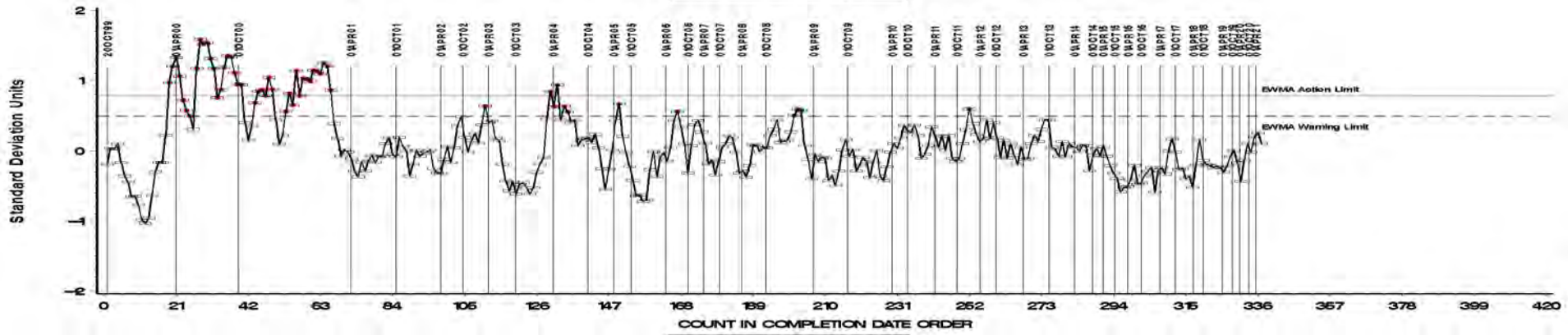
- ACW is within control limits.

AVERAGE CAM WEAR

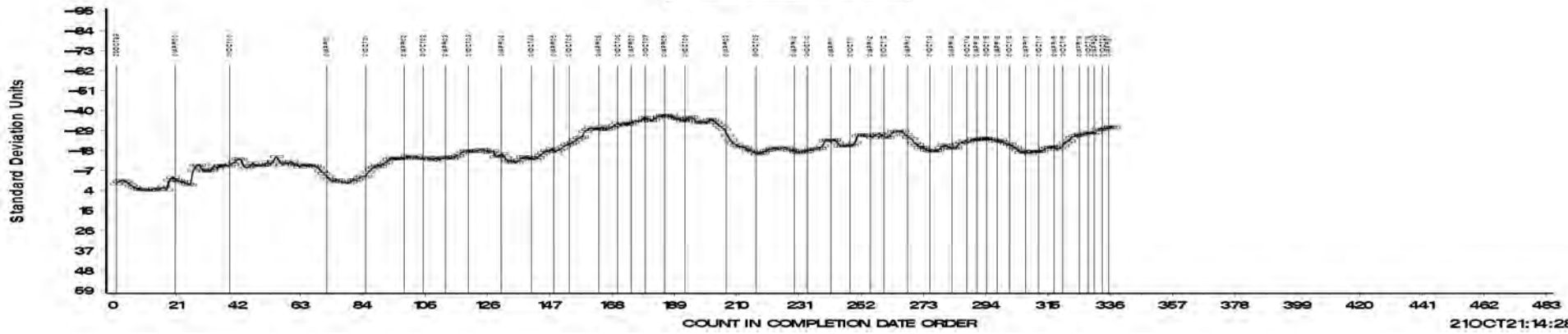
LTMS Severity Analysis



LTMS Precision Analysis



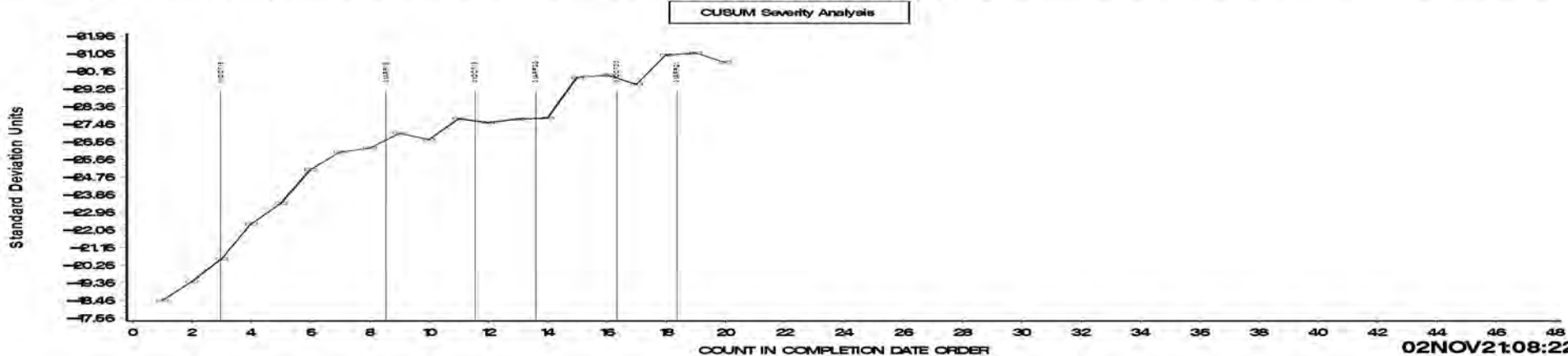
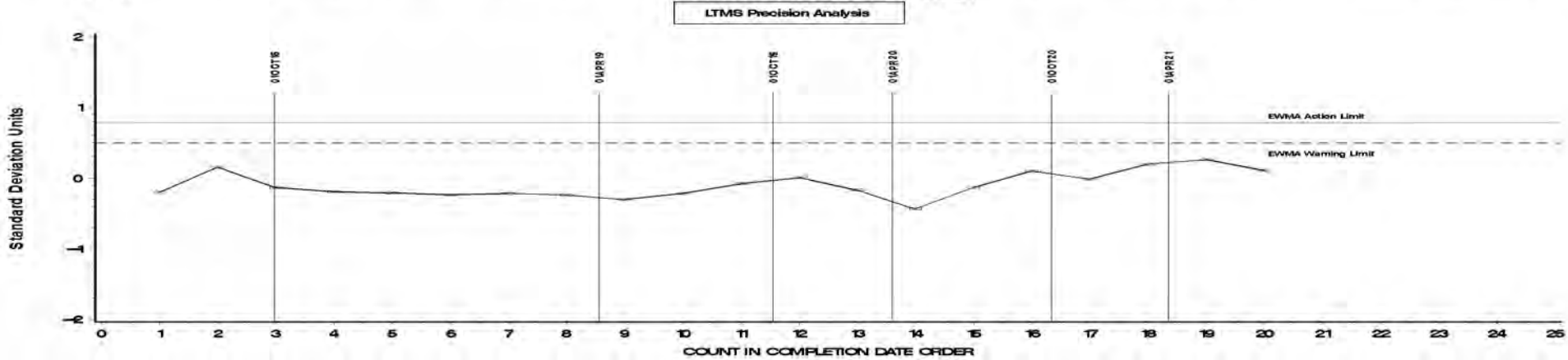
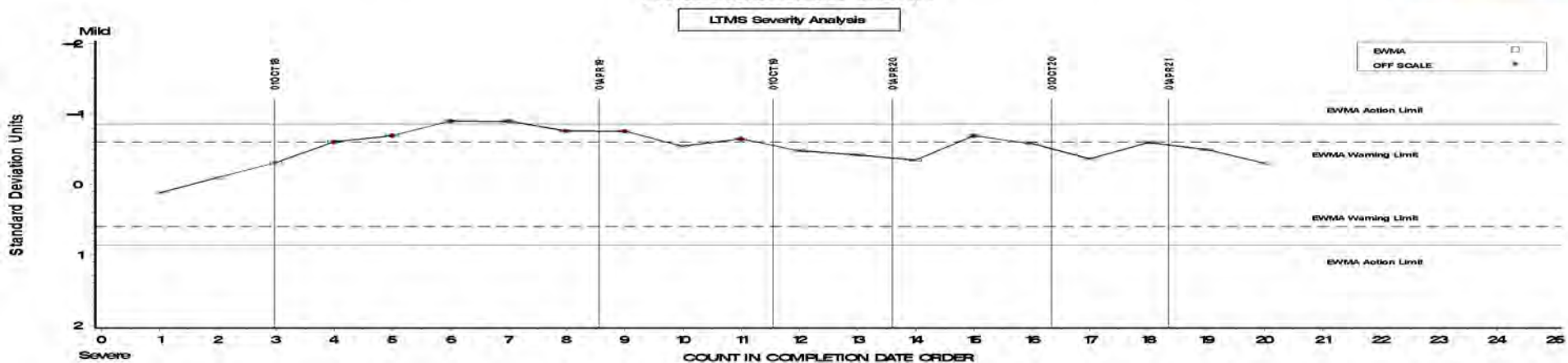
CUSUM Severity Analysis



# SEQUENCE IVA INDUSTRY OPERATIONALLY VALID DATA

Last 20 Tests

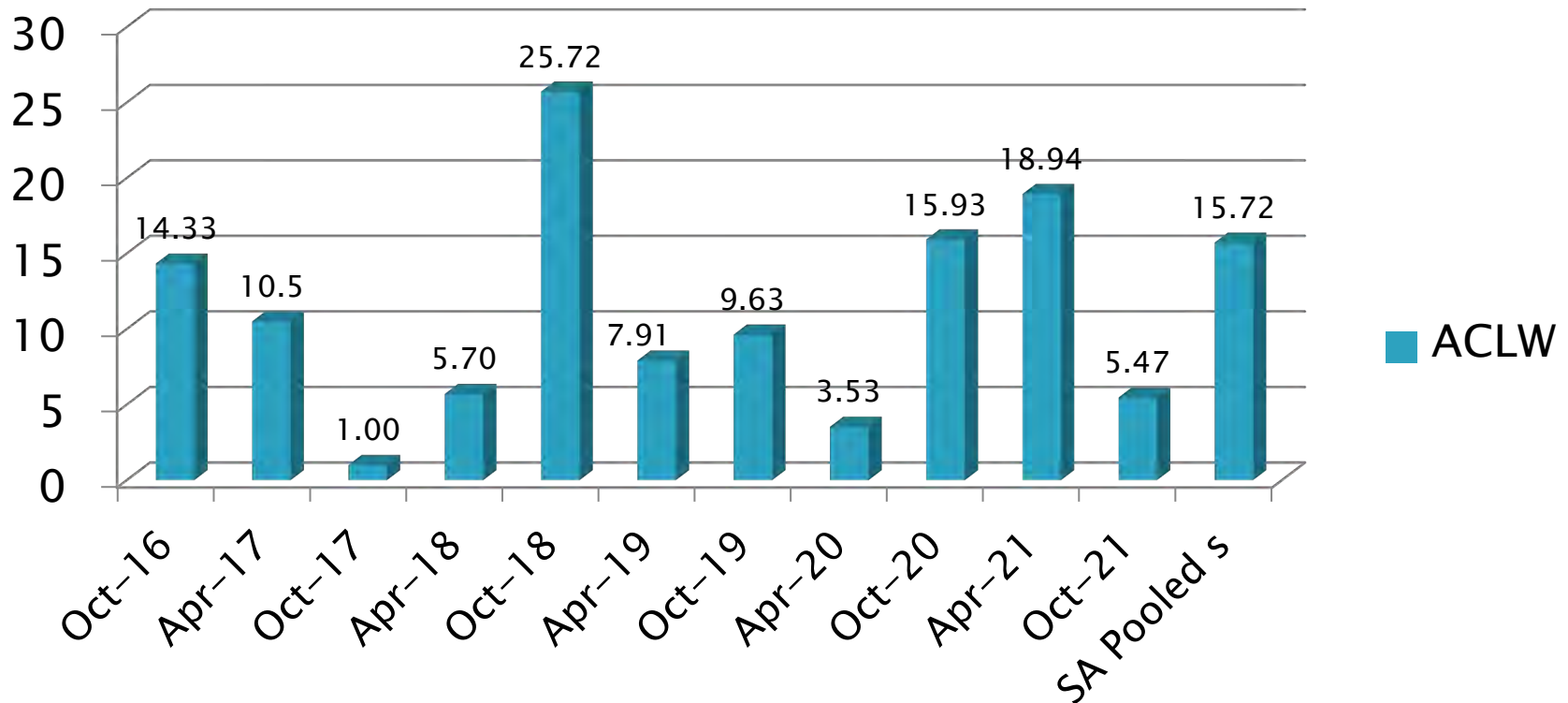
## AVERAGE CAM WEAR





# Sequence IVA Precision Estimates

## ACW



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# Sequence IVB

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# Sequence IVB Activity

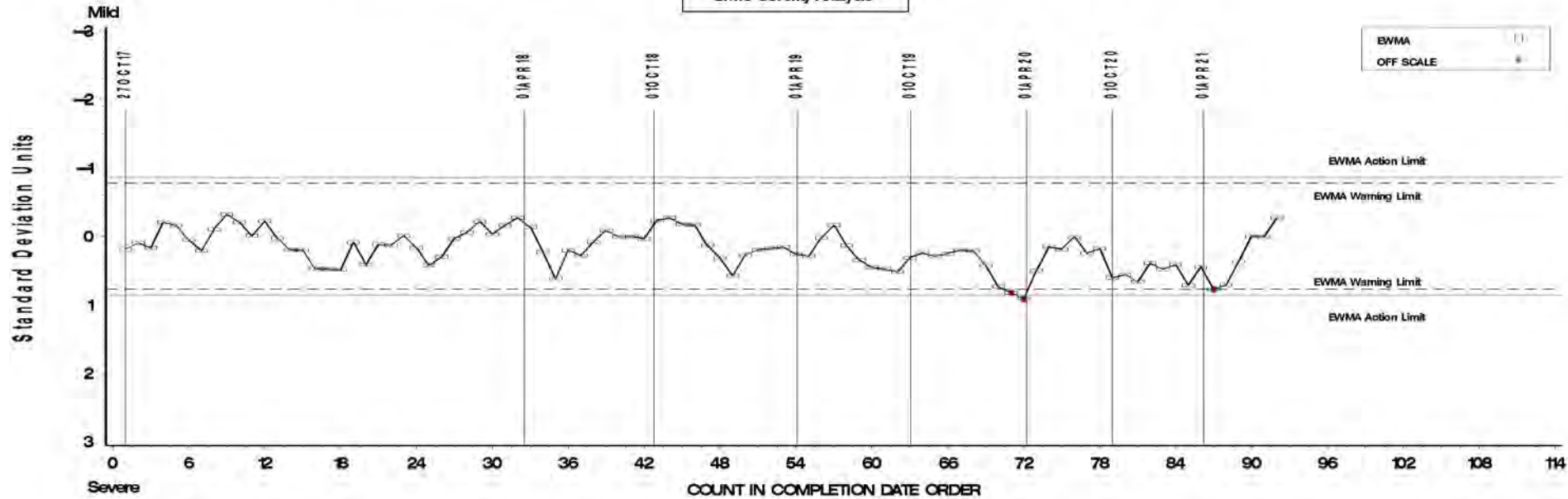
Test Status	Validity Code	#
Acceptable Calibration Test	AC	6
<b>Total</b>		<b>6</b>

# Sequence IVB Test Severity

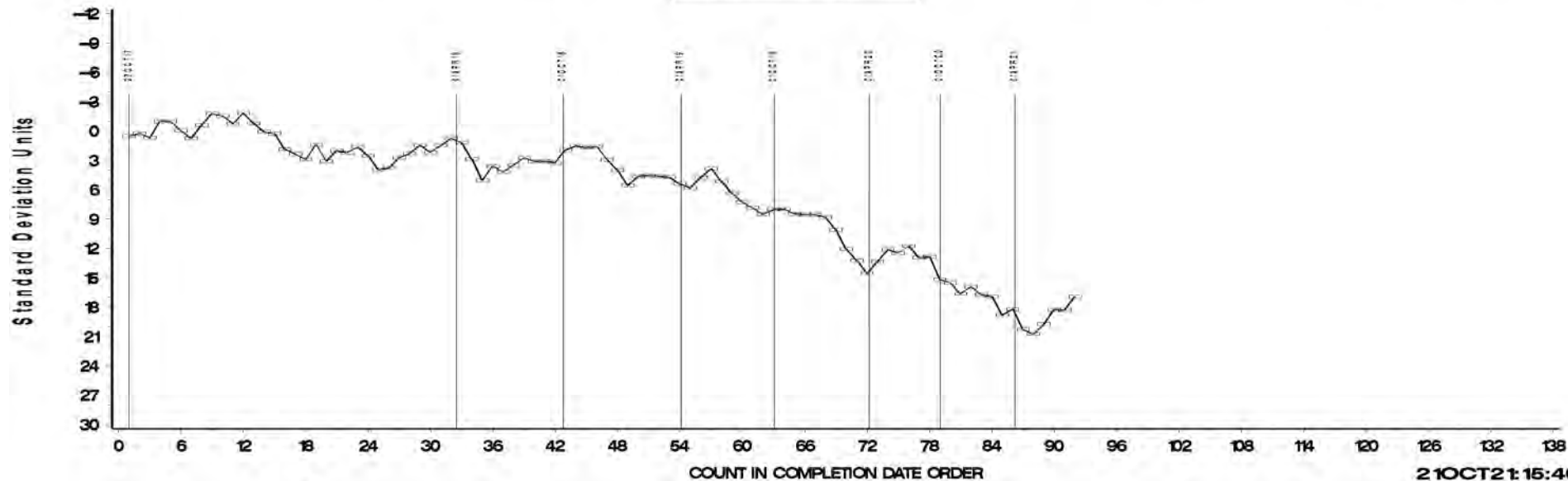
- AVLI and Fe in control.

AVERAGE VOLUME LOSS BY KEYENCE INTAKE Final

LTMS Severity Analysis

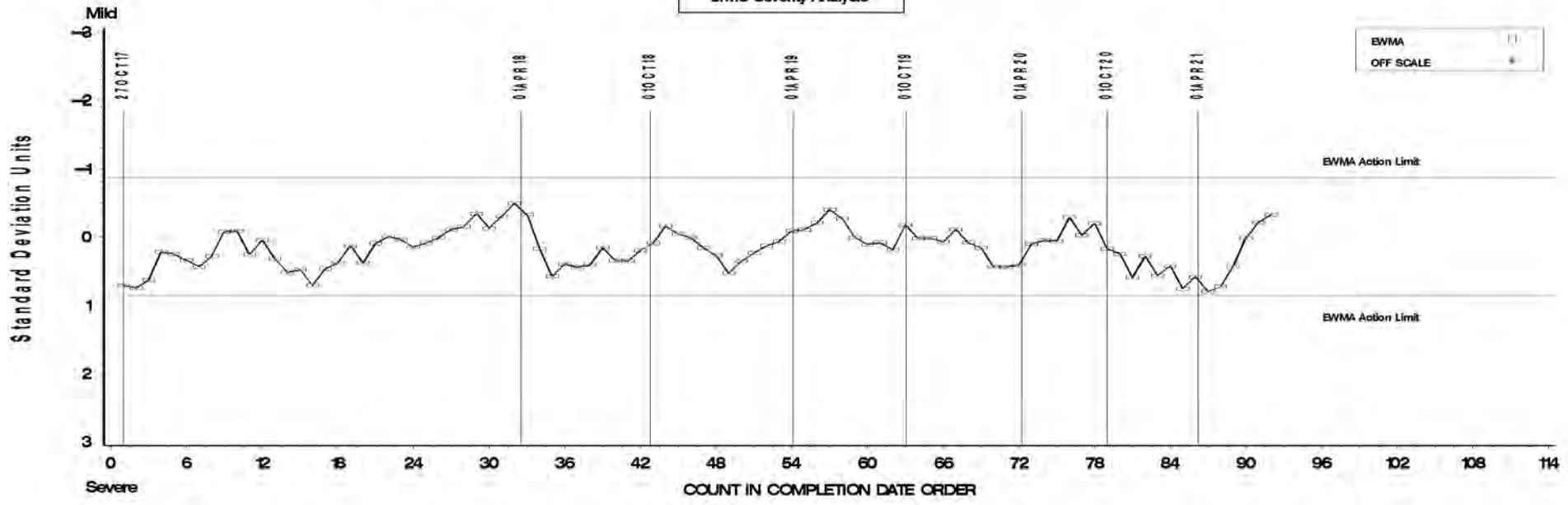


CUSUM Severity Analysis

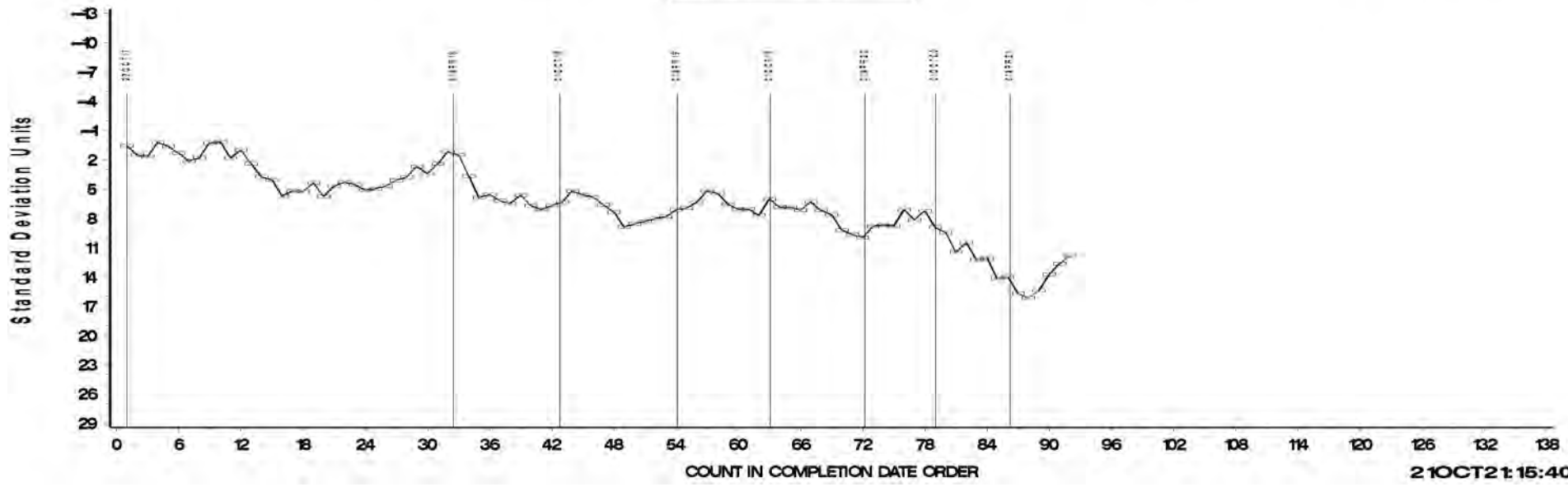


END OF TEST FE FINAL Severity Adjusted RESULT

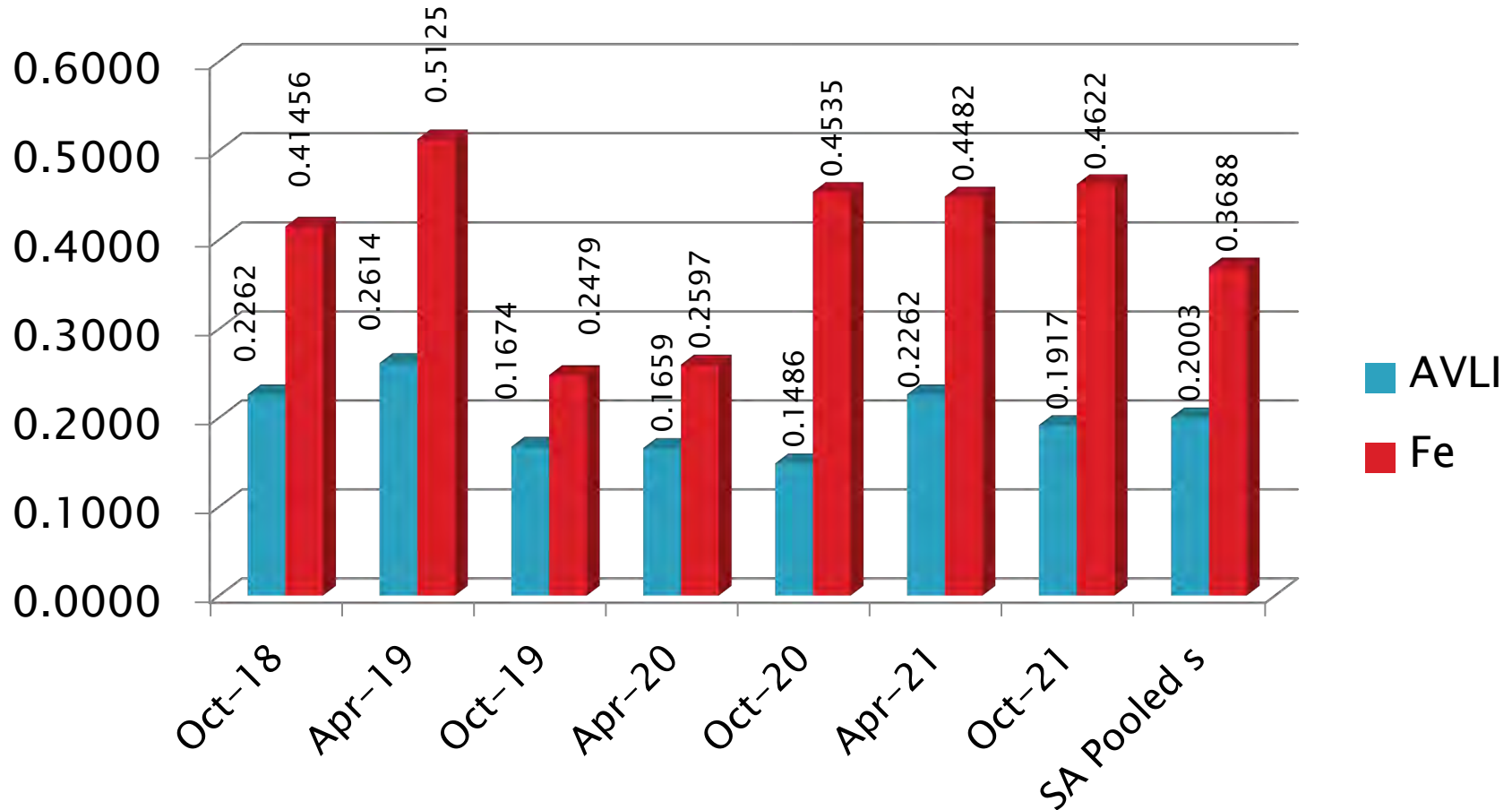
LTMS Severity Analysis



CUSUM Severity Analysis



# Sequence IVB Precision Estimates



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# Sequence VH

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# Sequence VH Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	11
Statistically Unacceptable Calibration Test	OC	3
Operationally Invalid Calibration Test (Lab Judgement)	LC	1
Pending Calibration Test (1011-1 Targets)	PC	3
Not for Industry Statistics (Alternate Fuel Test)	NN	1
<b>Total</b>		<b>19</b>

# Sequence VH – Lost Tests\*

Test Status	Cause	#
Invalid	High Oil Consumption	1
<b>Totals</b>		<b>1</b>

\*Invalid and aborted tests



# Sequence VH – Failing Tests

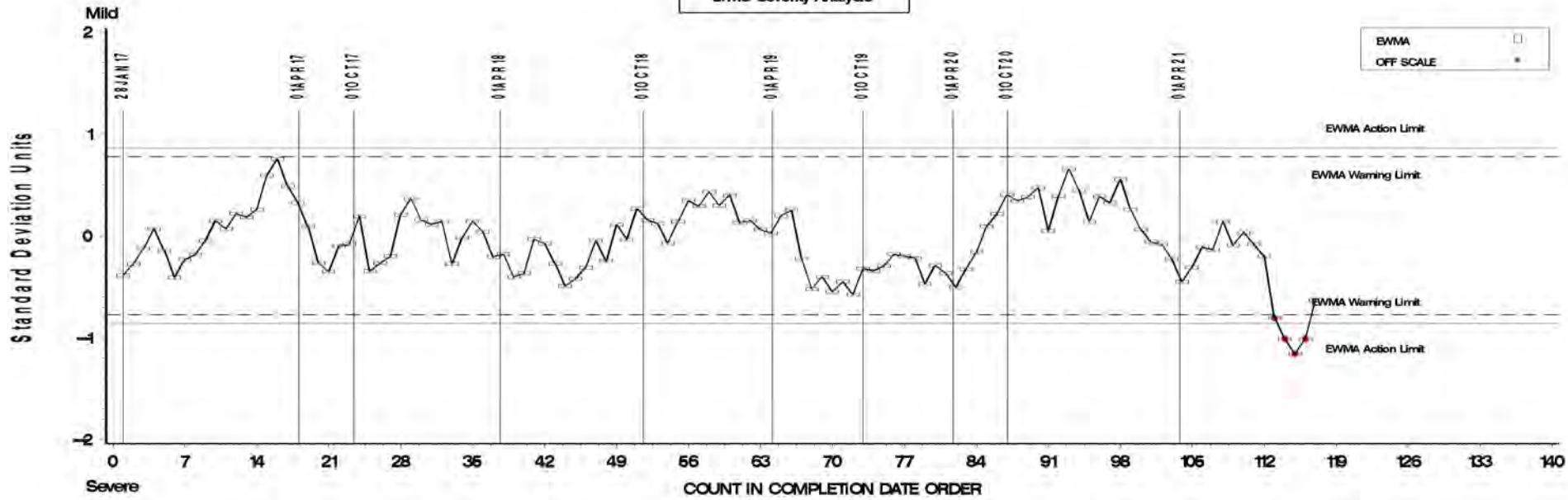
Test Status	#
RAC Ei Level 3 alarm (Mild Direction)	1
AES Ei Level 3 alarm (Severe Direction)	1
AES and RAC Ei Level 3 alarms (Severe Direction)	1
<b>Total</b>	<b>3</b>

# Sequence VH Test Severity

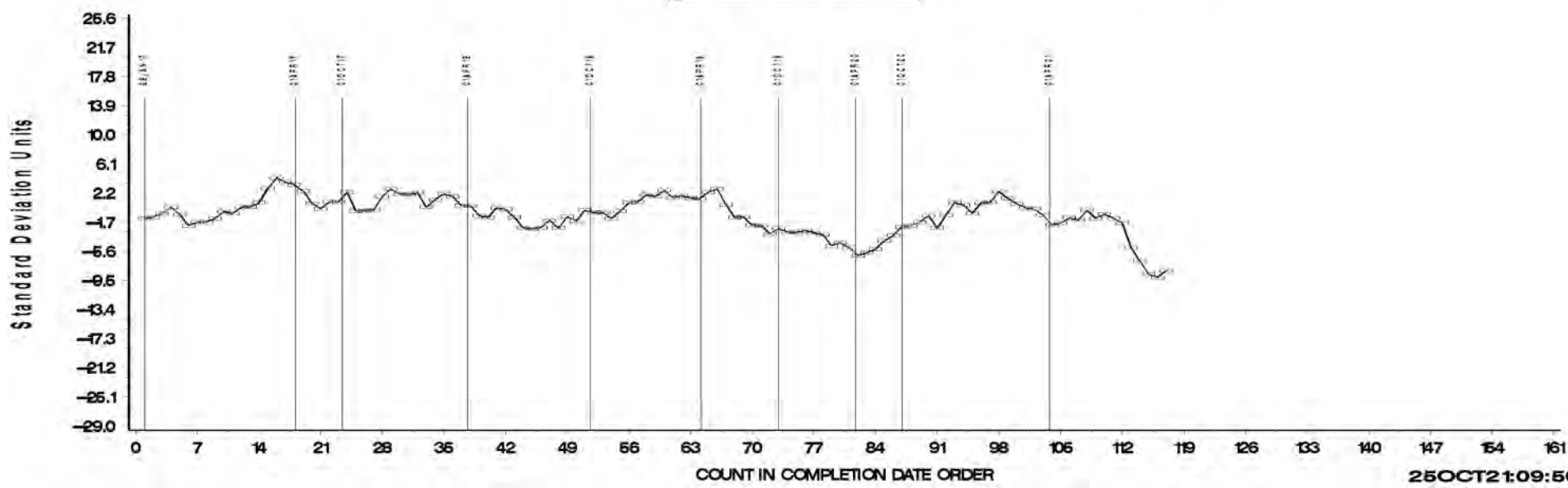
- All parameters within control limits.

### AVERAGE ENGINE SLUDGE

LTMS Severity Analysis

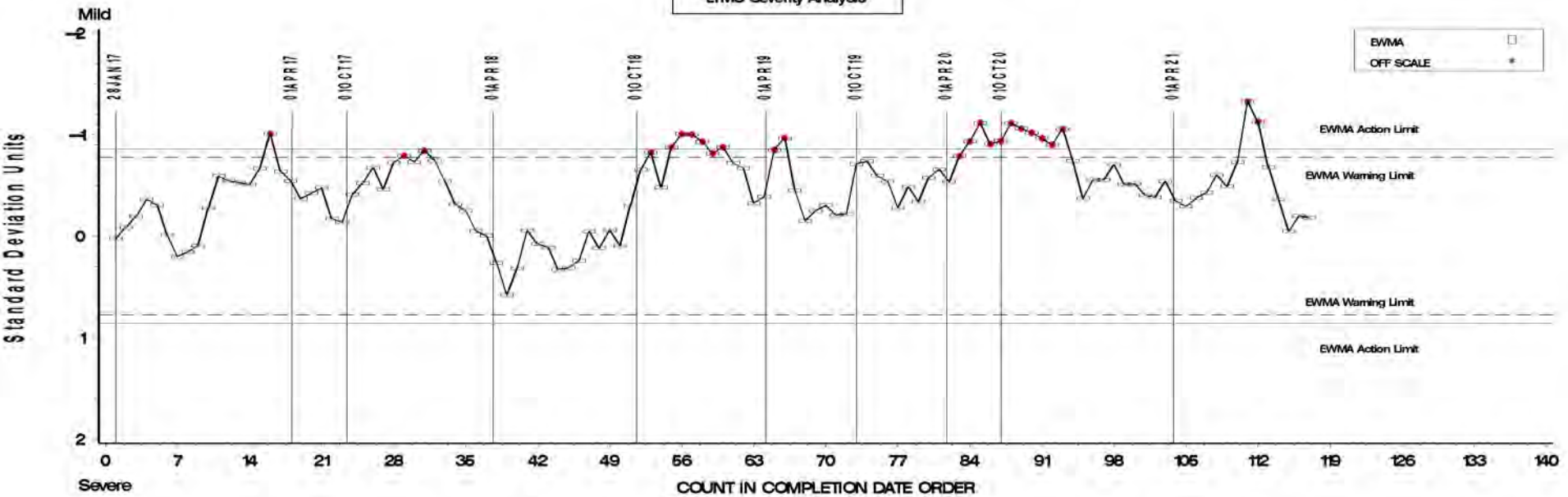


CUSUM Severity Analysis

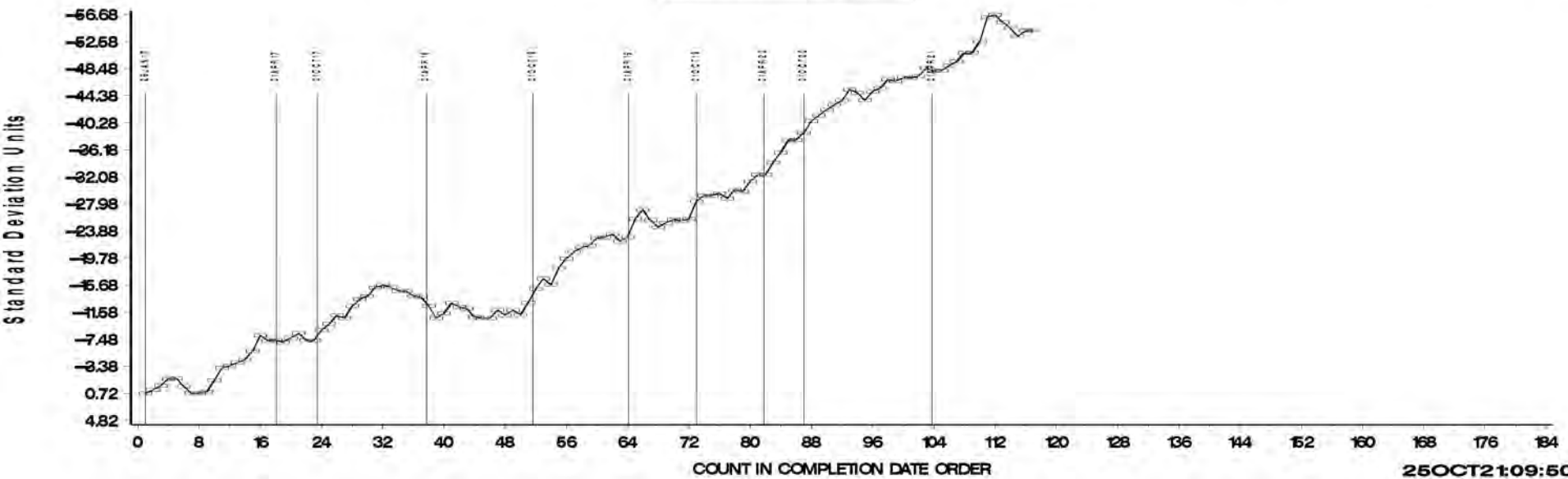


AVERAGE ROCKER COVER SLUDGE

LTMS Severity Analysis

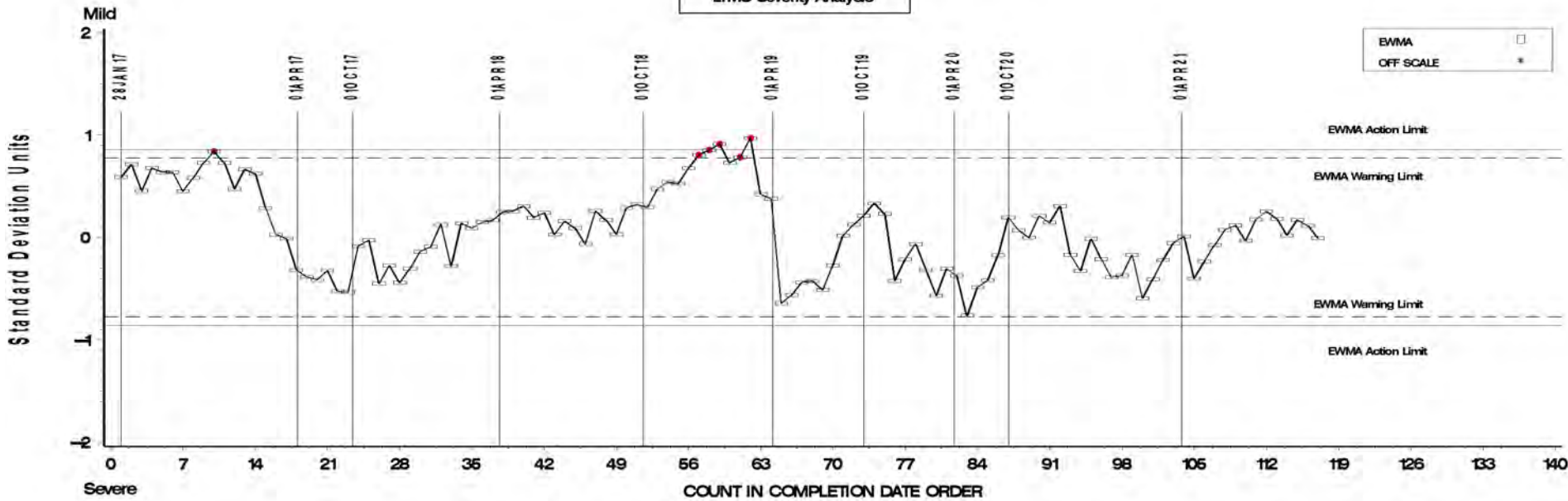


CUSUM Severity Analysis

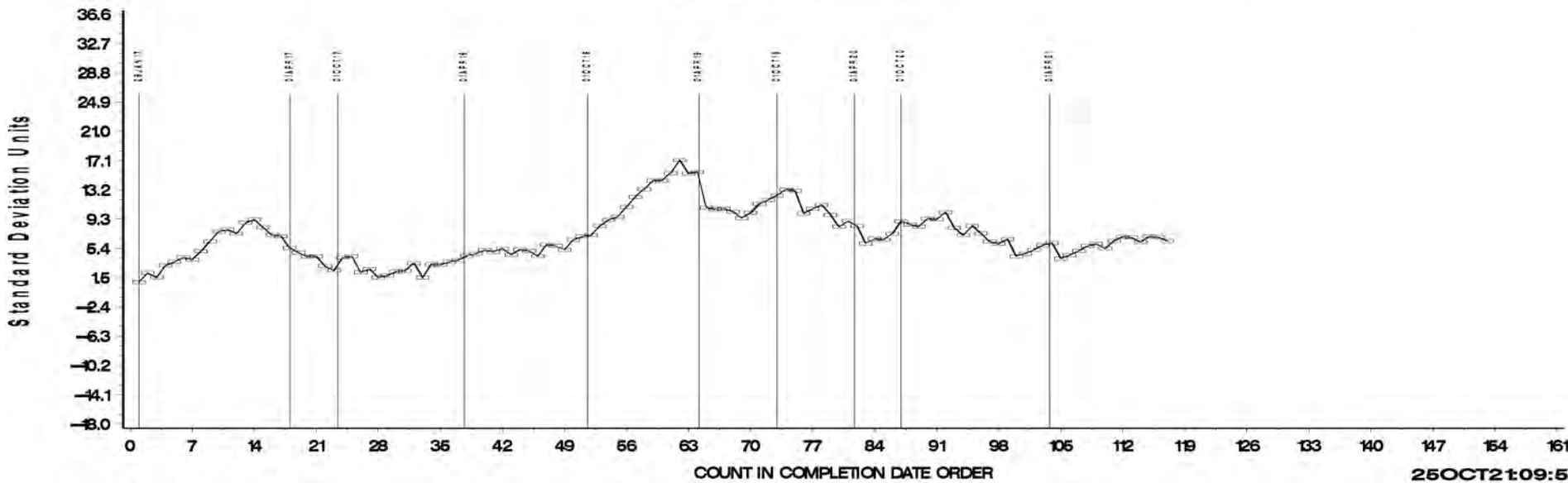


AVG. ENG. VARN. 50% RATING

LTMS Severity Analysis



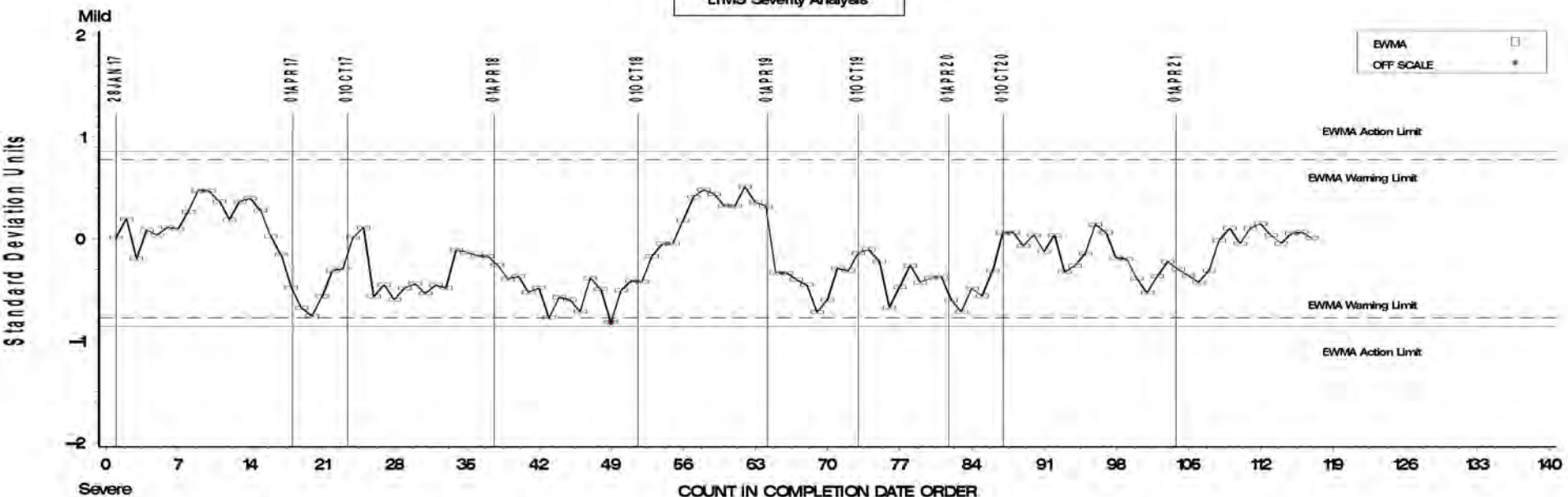
CUSUM Severity Analysis



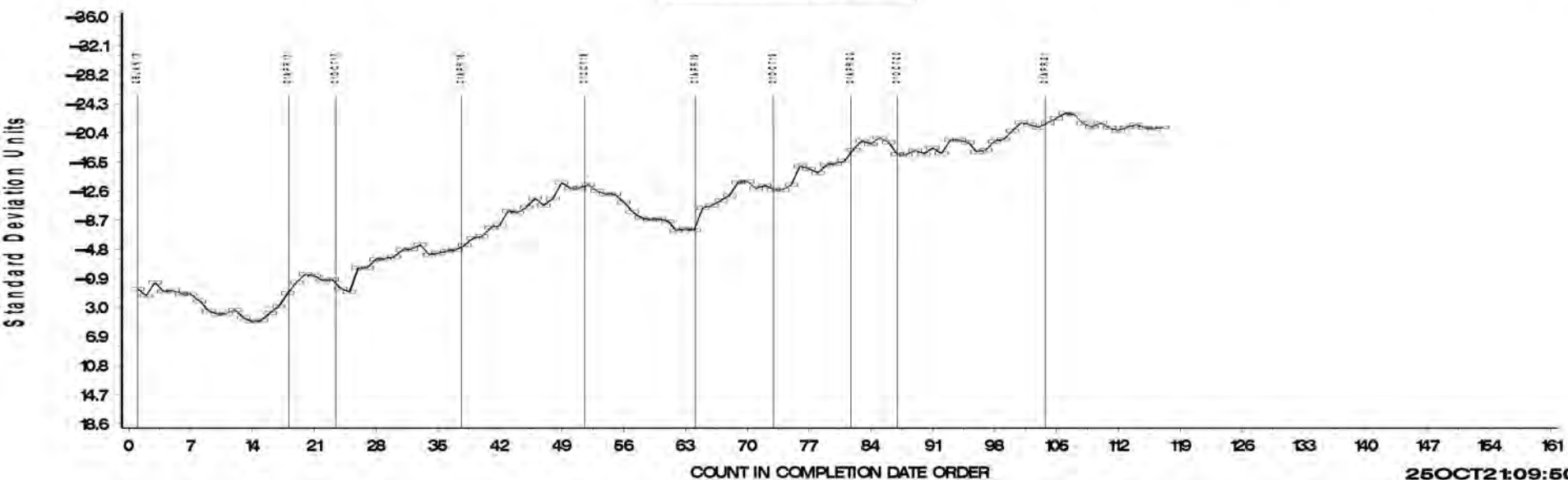


AVG PISTON SKIRT 50% RATING

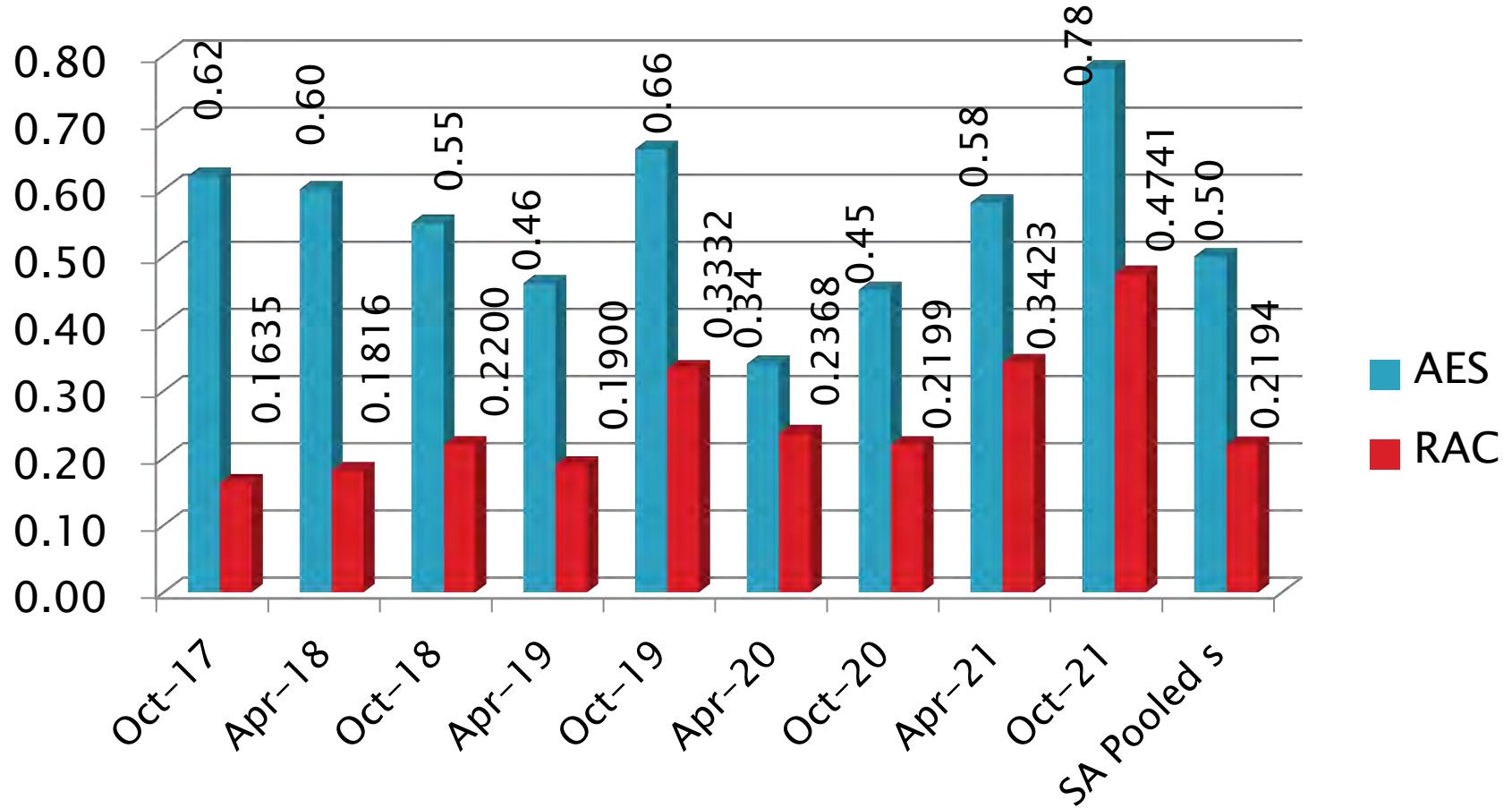
LTMS Severity Analysis



CUSUM Severity Analysis

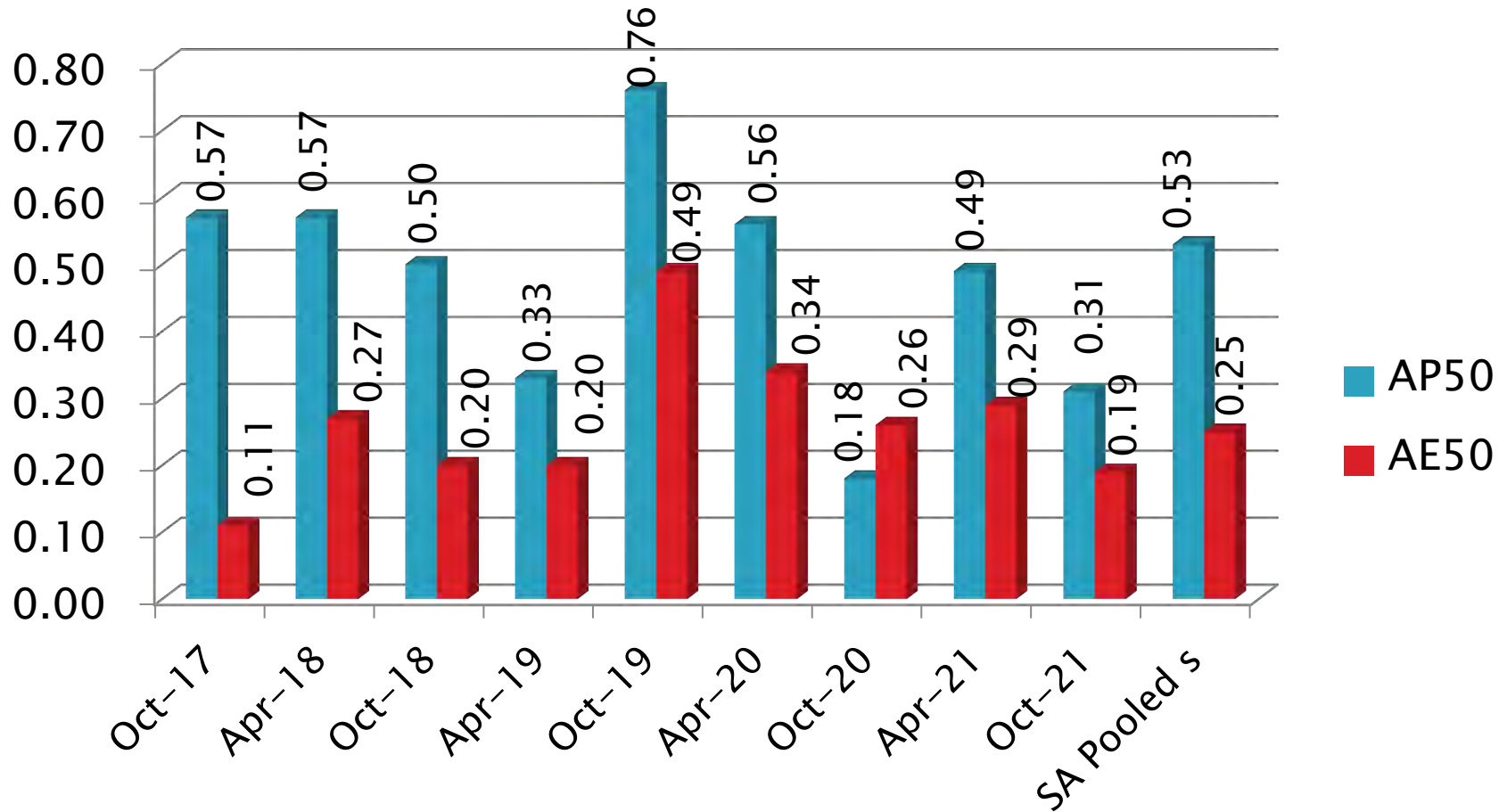


# Sequence VH Precision Estimates





# Sequence VH Precision Estimates



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# Sequence VIE

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# Sequence VIE Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	24
Statistically Unacceptable Calibration Test	OC	3
Aborted Calibration Test	XC	1
<b>Total</b>		<b>28</b>

# Sequence VIE- Failed Tests

Test Status	#
FEI1 Severe	1
FEI2 Severe	1
FEI1 and FEI2 Severe	1
<b>Total</b>	<b>3</b>

# Sequence VIE – Lost Tests\*

Test Status	Cause	#
Aborted	Dyno Bearing Failure	1
<b>Totals</b>		<b>1</b>

\*Invalid and aborted tests

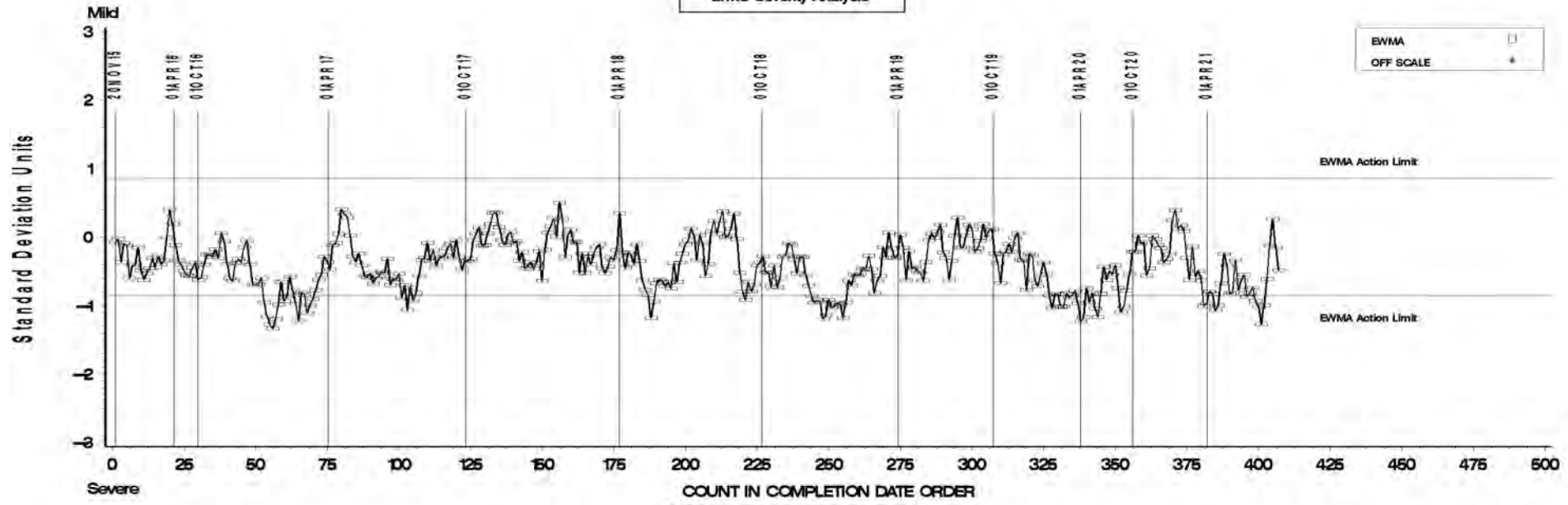
# Sequence VIE Test Severity

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

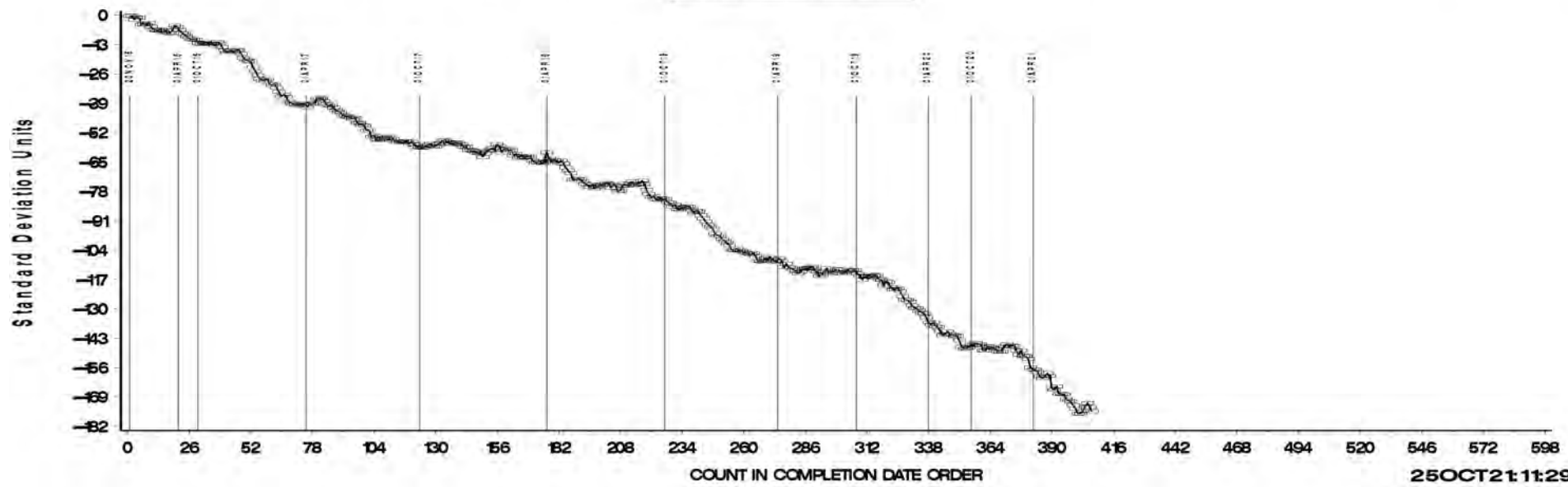


FEI FINAL RESULT PHASE I

LTMS Severity Analysis

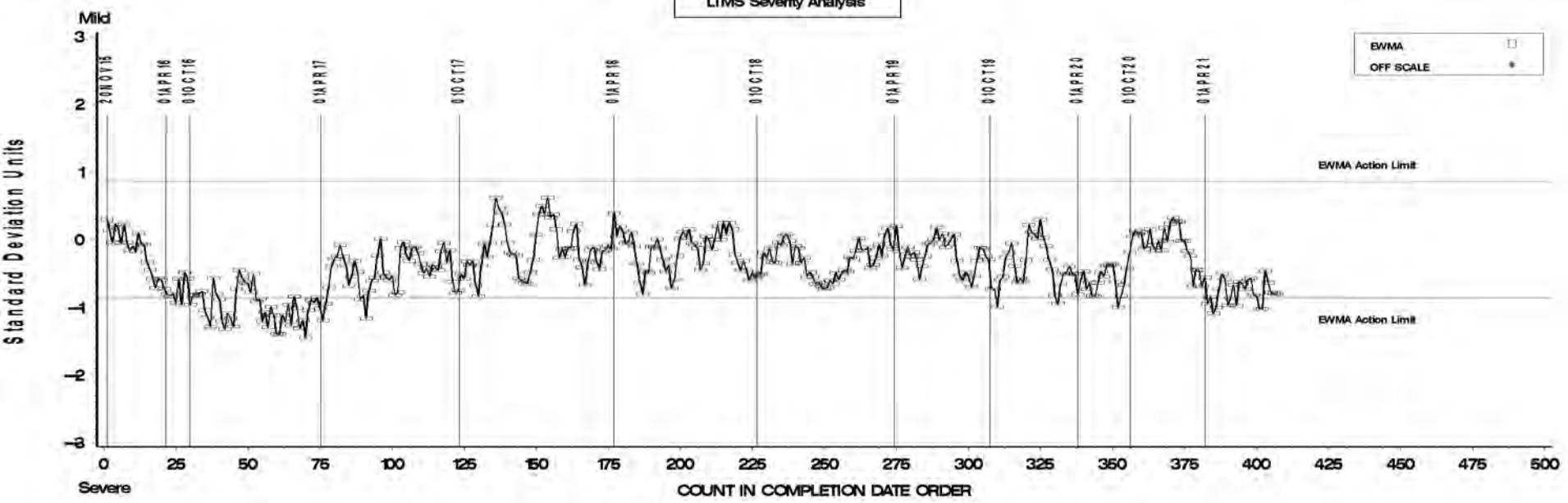


CUSUM Severity Analysis

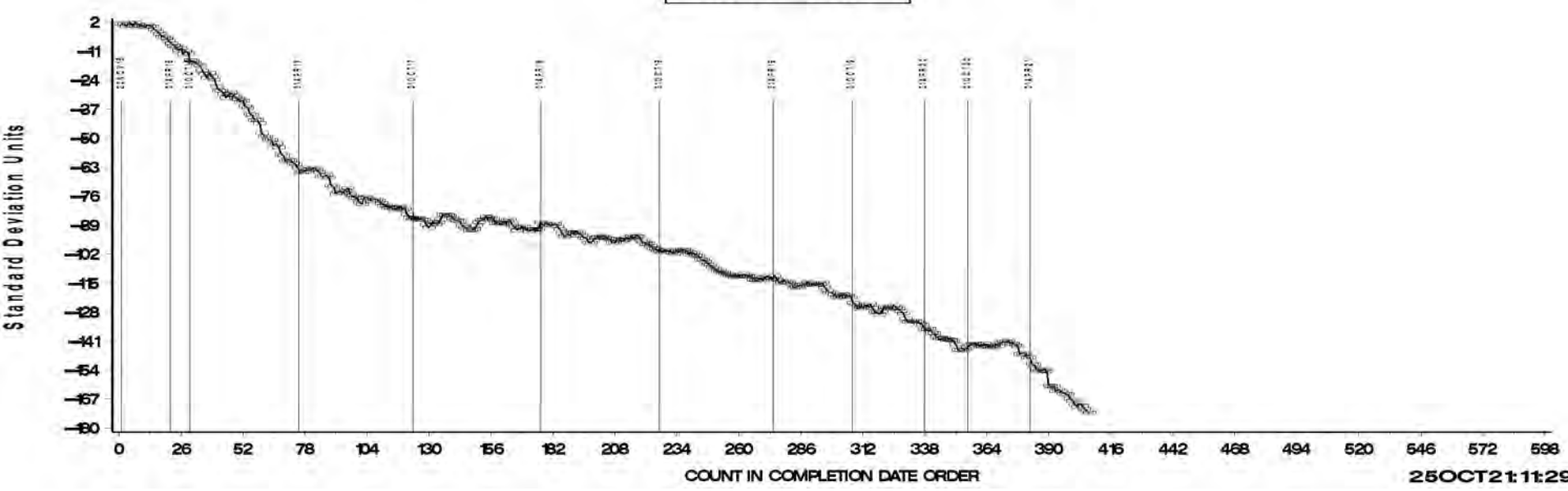


FEI FINAL RESULT PHASE II

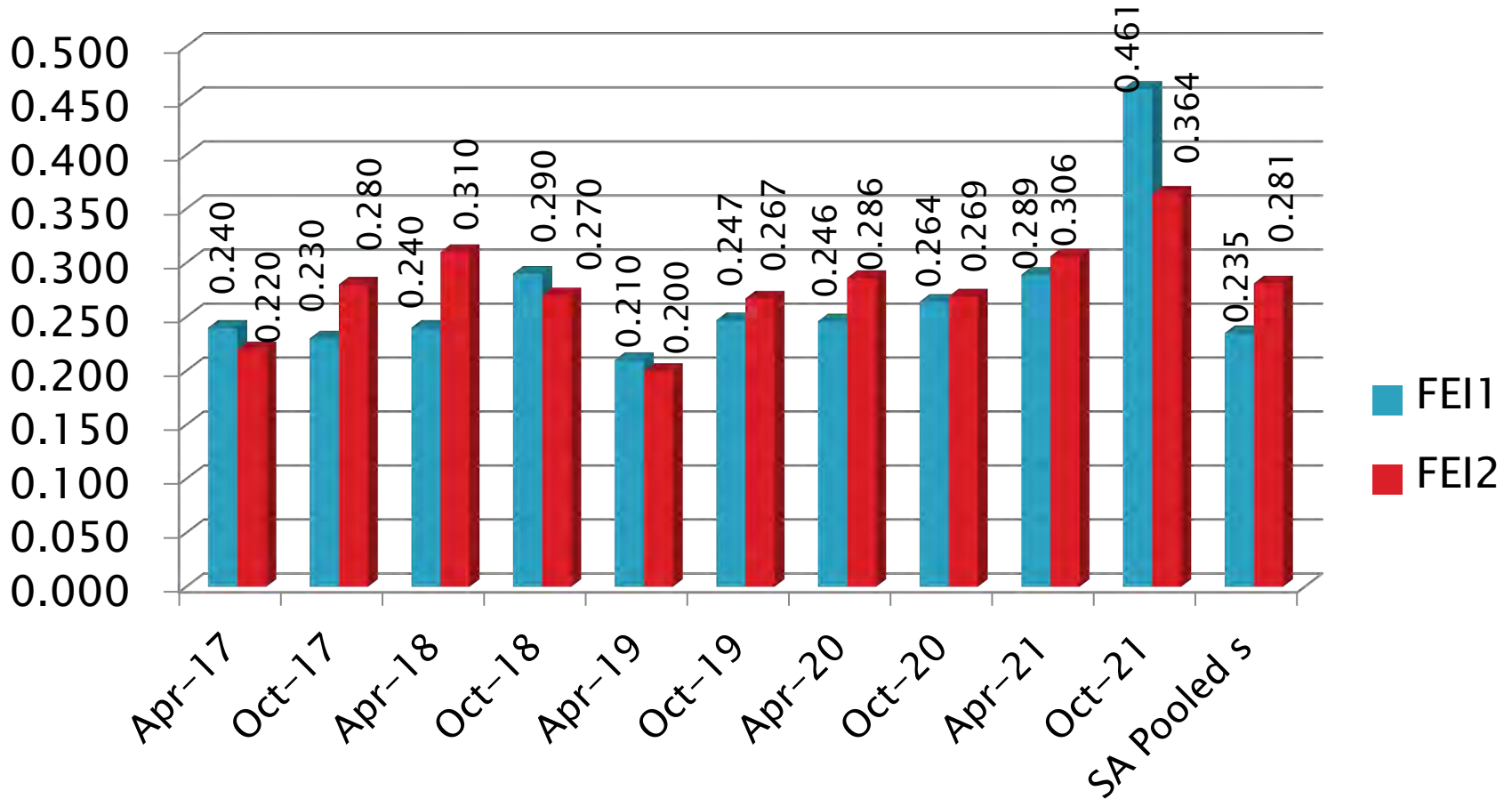
LTMS Severity Analysis



CUSUM Severity Analysis



# Sequence VIE Precision Estimates



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# Sequence VIF

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# Sequence VIF Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	18
Failed Statistically	OC	2
Engine Abandoned	MC	3
Aborted	XC	1
<b>Total</b>		<b>24</b>

# Sequence VIF – Failed Tests

Test Status	Number of Tests
Severe FEI1	1
Wi and VI Alarm FEI2	1
<b>Total</b>	<b>2</b>

# Sequence VIF – Lost Tests\*

Test Status	Cause	#
Aborted	Downtime Exceeded Procedural Limit	1
<b>Total</b>		<b>1</b>

\*Invalid and aborted tests

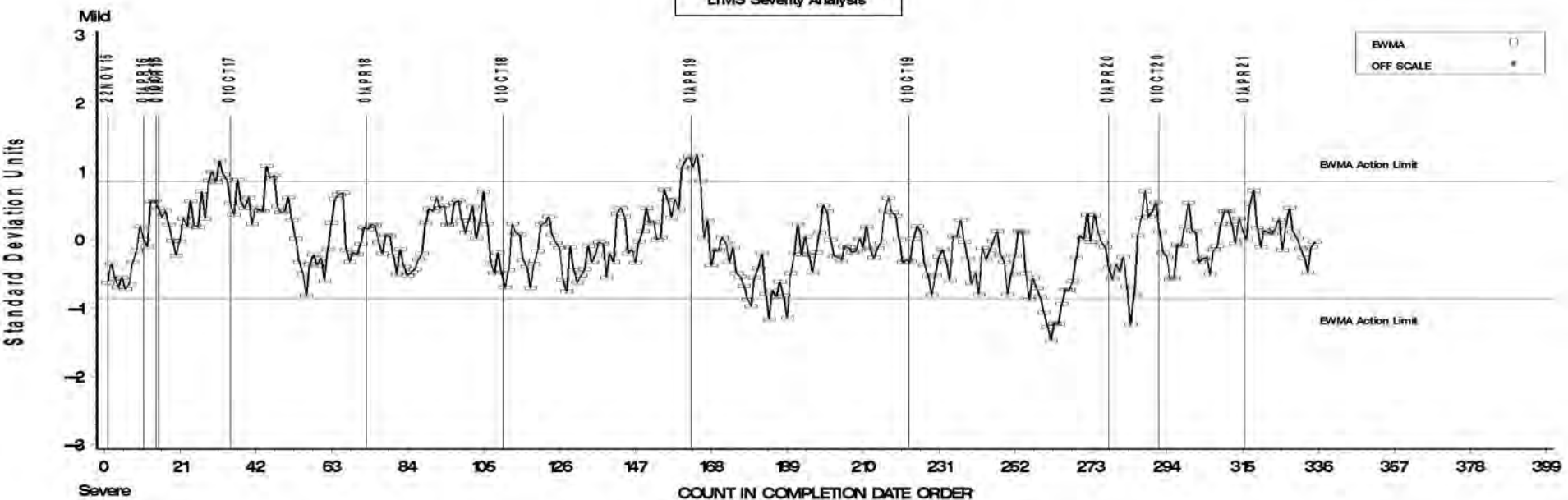


# Sequence VIF Test Severity

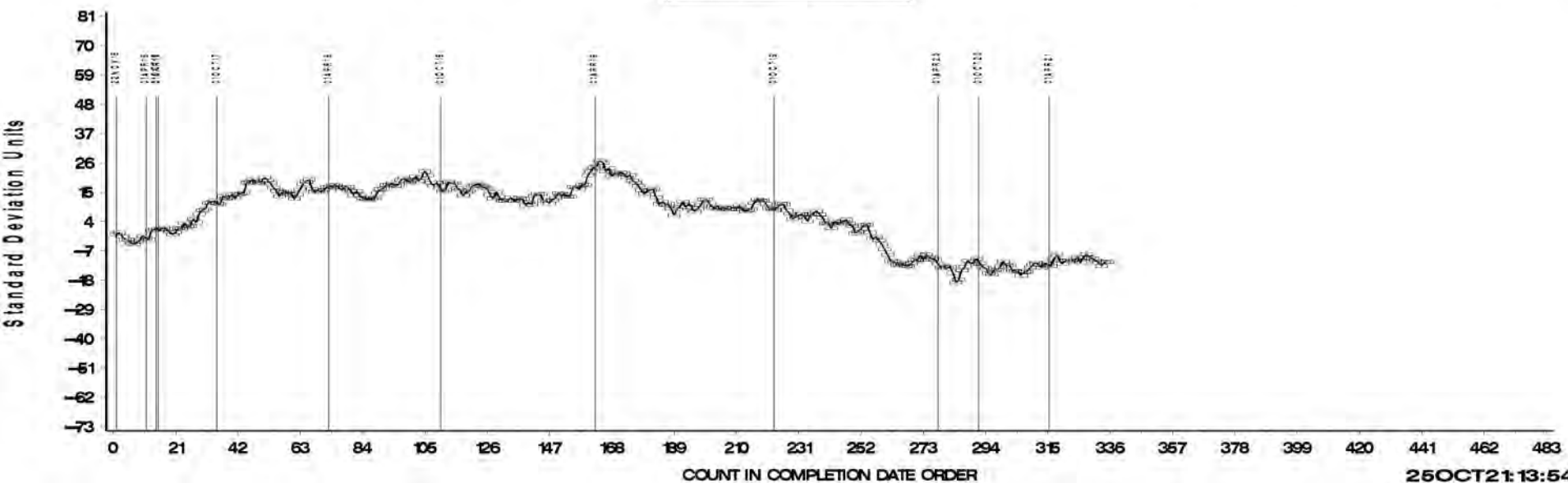
- FEI1 is in control
- FEI2 is in control

FEI FINAL RESULT PHASE I

LTMS Severity Analysis

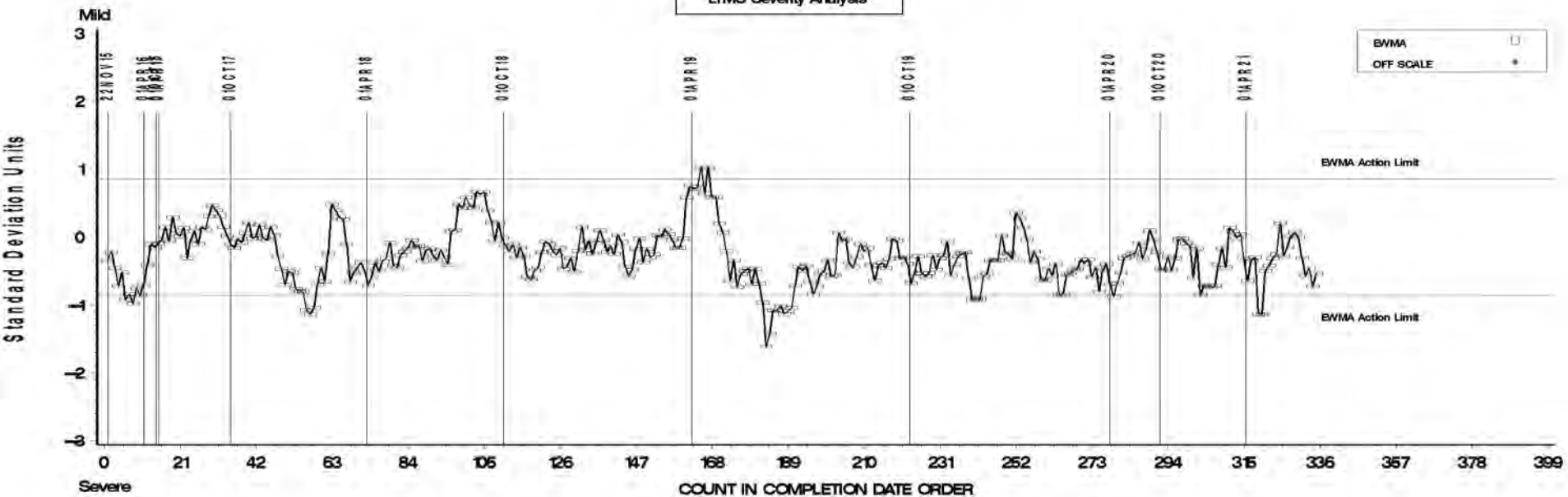


CUSUM Severity Analysis

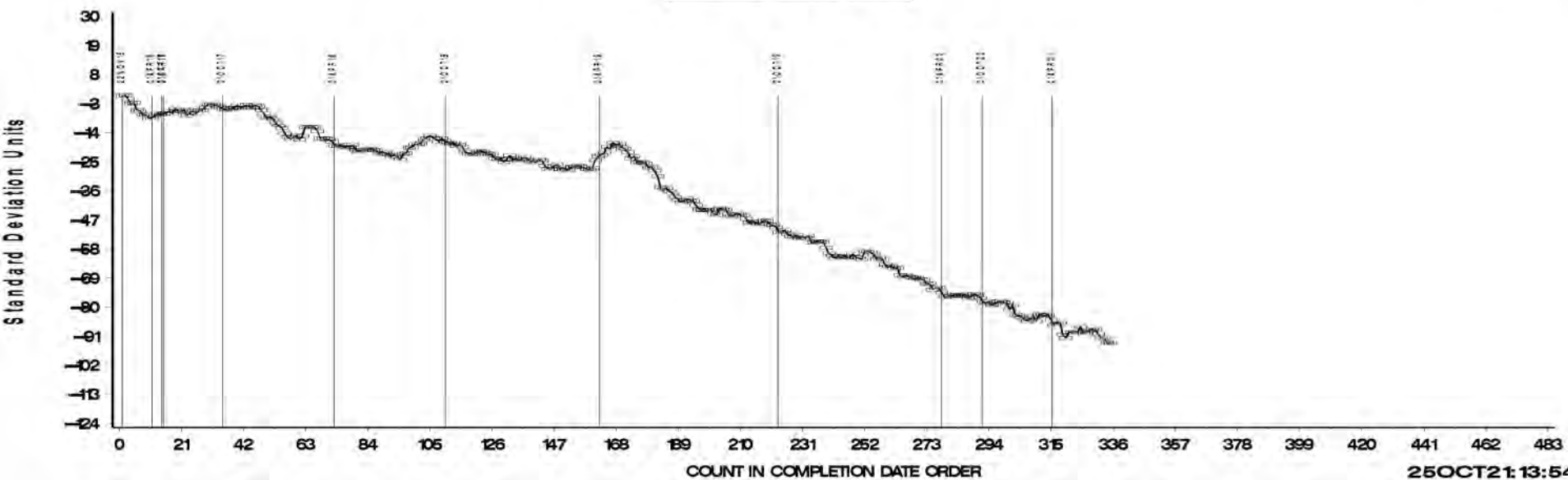


FEI FINAL RESULT PHASE II

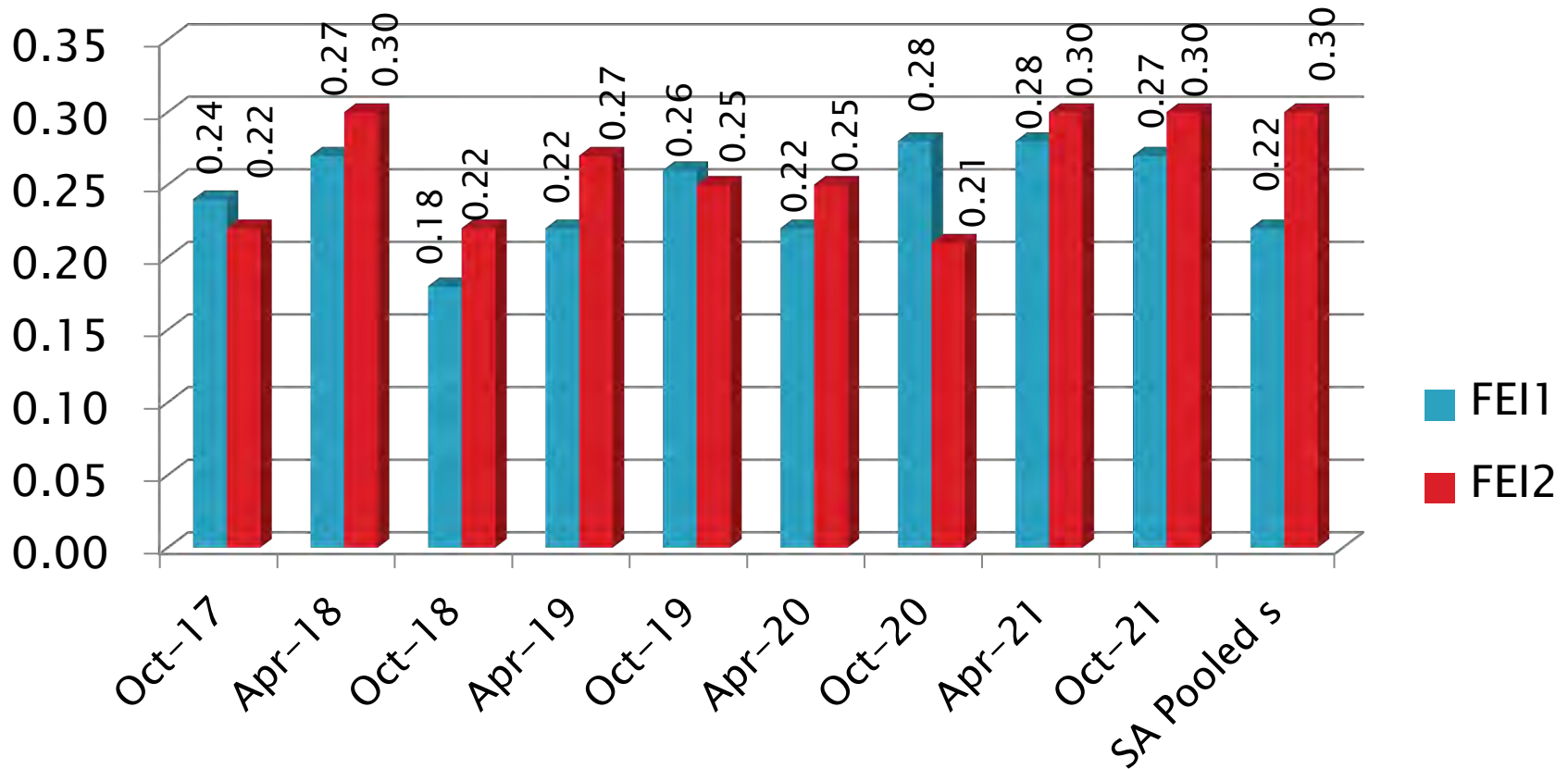
LTMS Severity Analysis



CUSUM Severity Analysis



# Sequence VIF Precision Estimates



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# Sequence VIII

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# Sequence VIII Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	6
Operationally Invalid Calibration Test, Lab and TMC Judgement	RC	3
Total		9

# Sequence VIII – Lost Tests

Test Status	Cause	#
Invalid	Lab adjusted build practices within procedural limits for subsequent reference and candidate tests	3
<b>Totals</b>		<b>3</b>

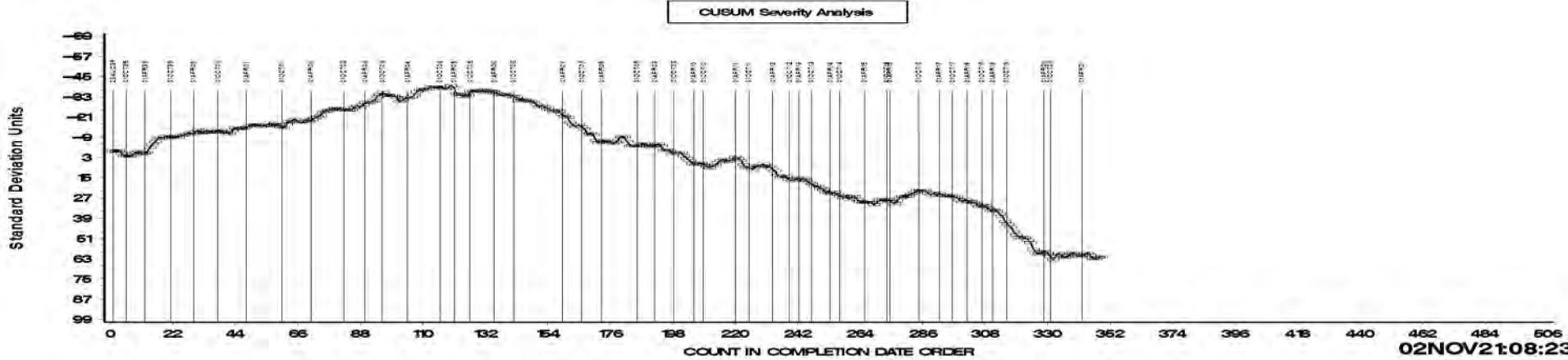
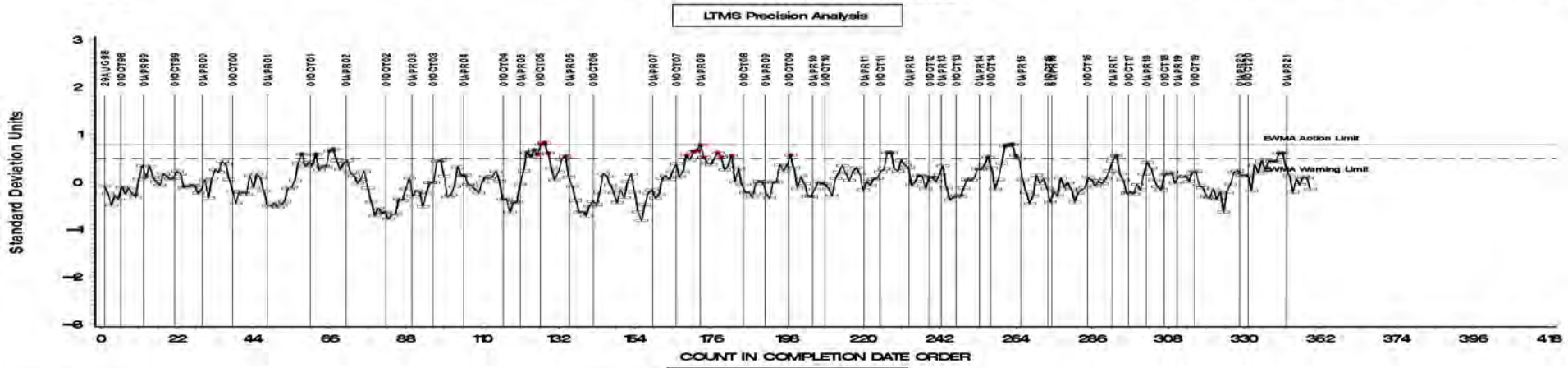
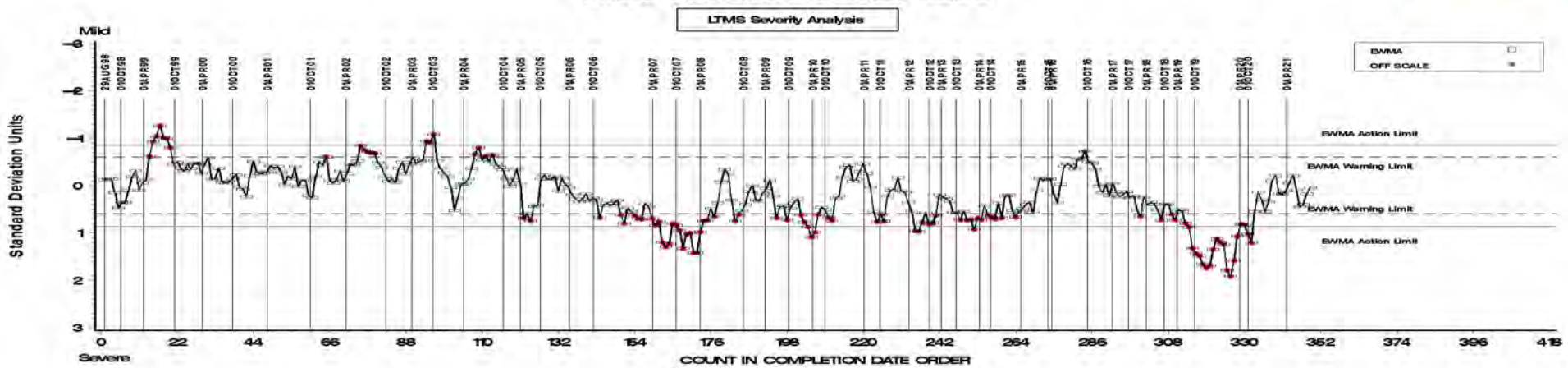
\*Invalid and aborted tests



# Sequence VIII Test Severity

- Both parameters are in control

## FINAL BEARING WEIGHT LOSS

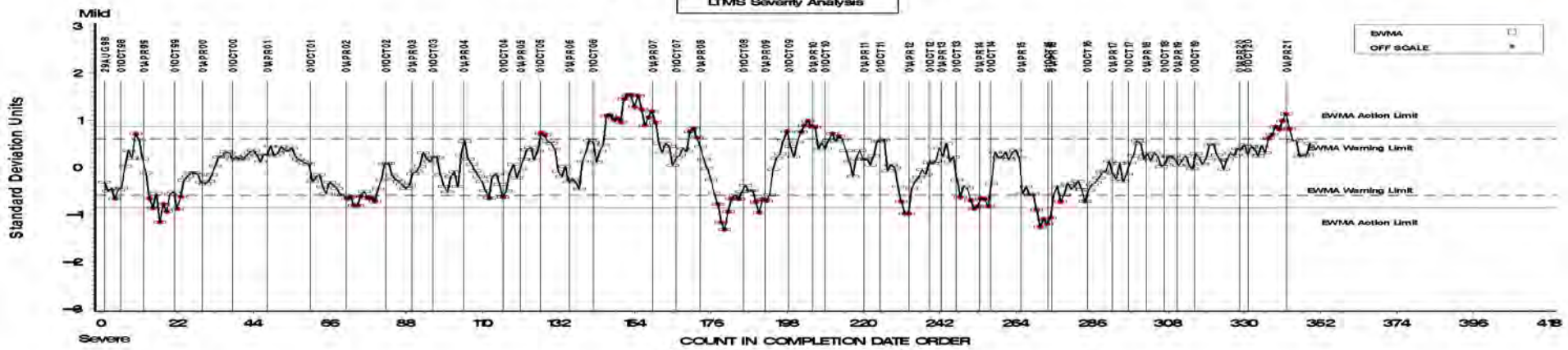


# SEQUENCE VIII INDUSTRY OPERATIONALLY VALID DATA

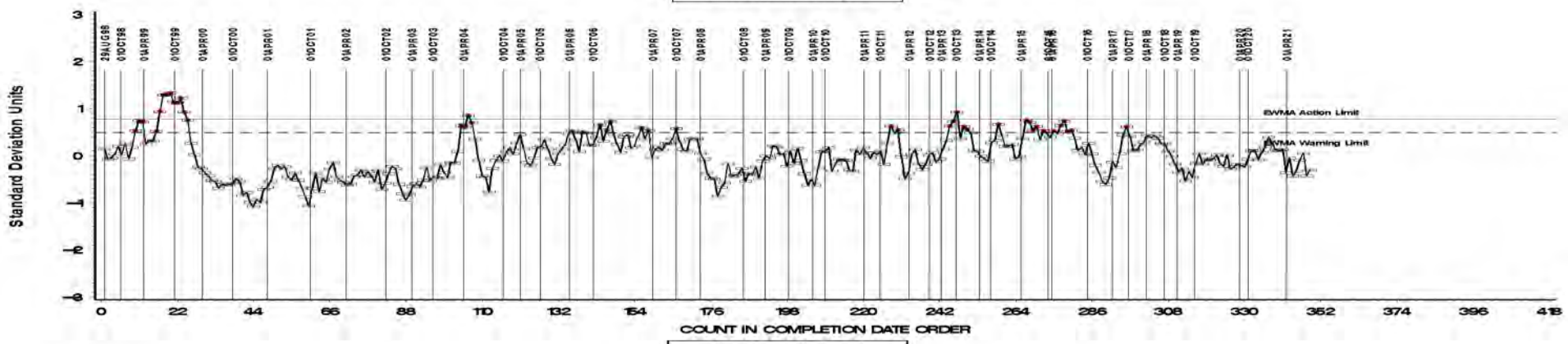


## STRIPPED VIS. @ 100 DEG C

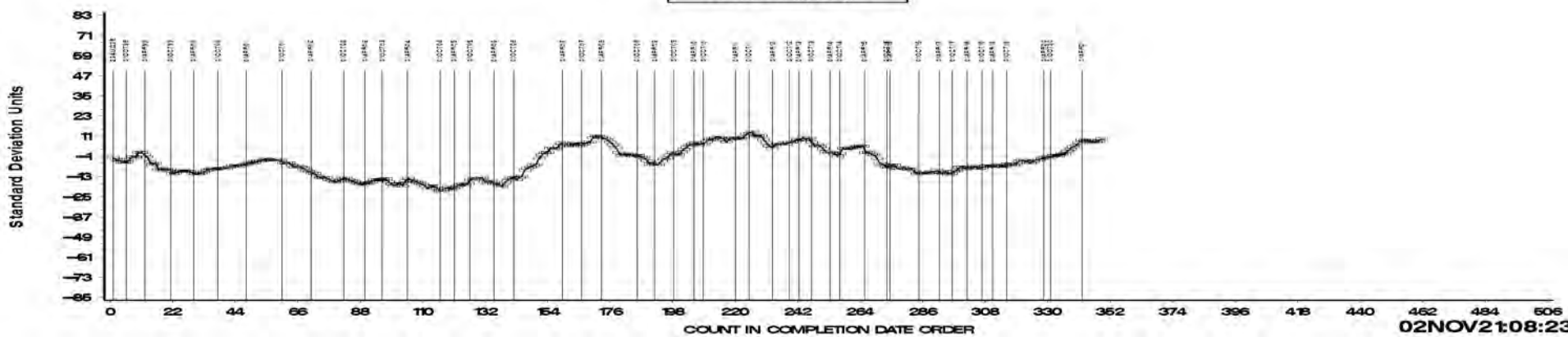
LTMS Severity Analysis



LTMS Precision Analysis

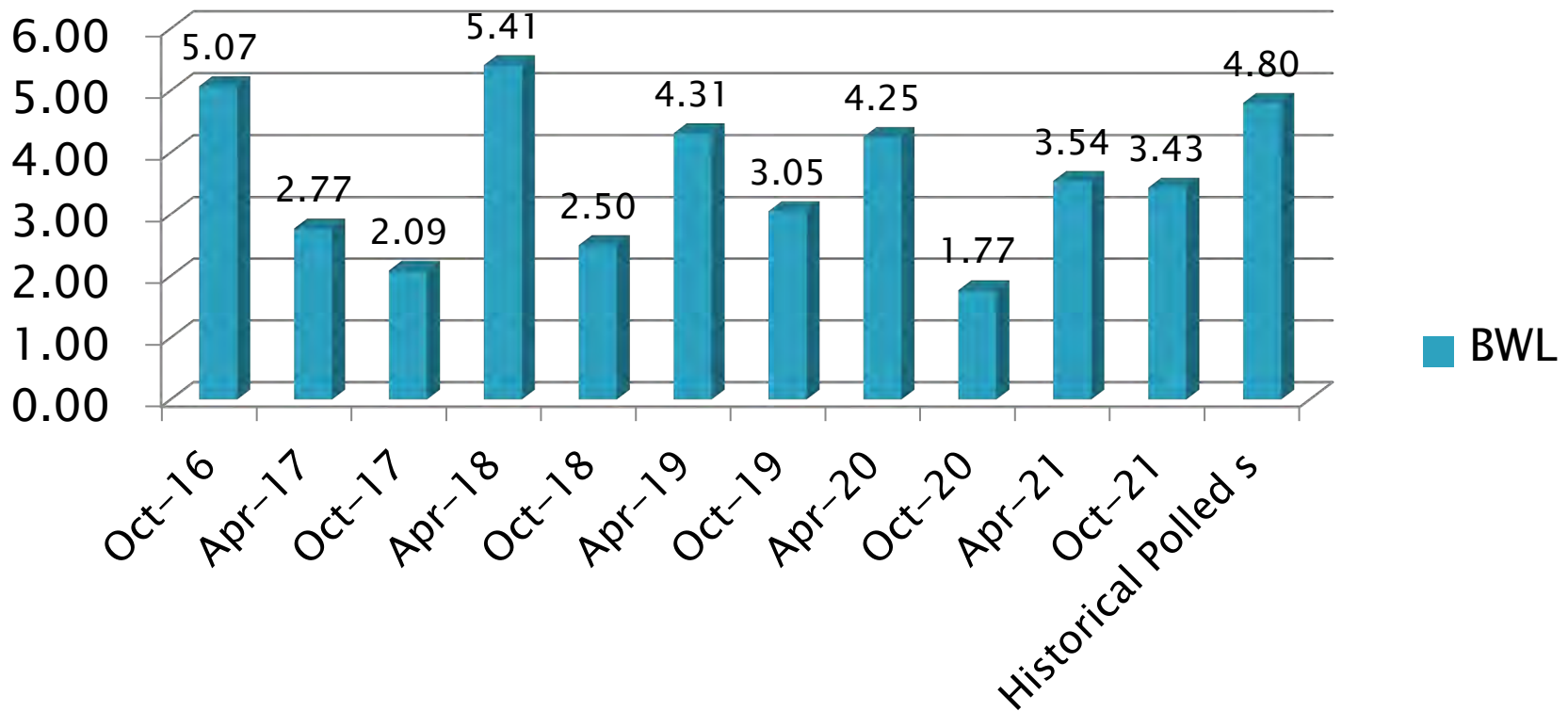


CUSUM Severity Analysis



# Sequence VIII Precision Estimates

## BWL

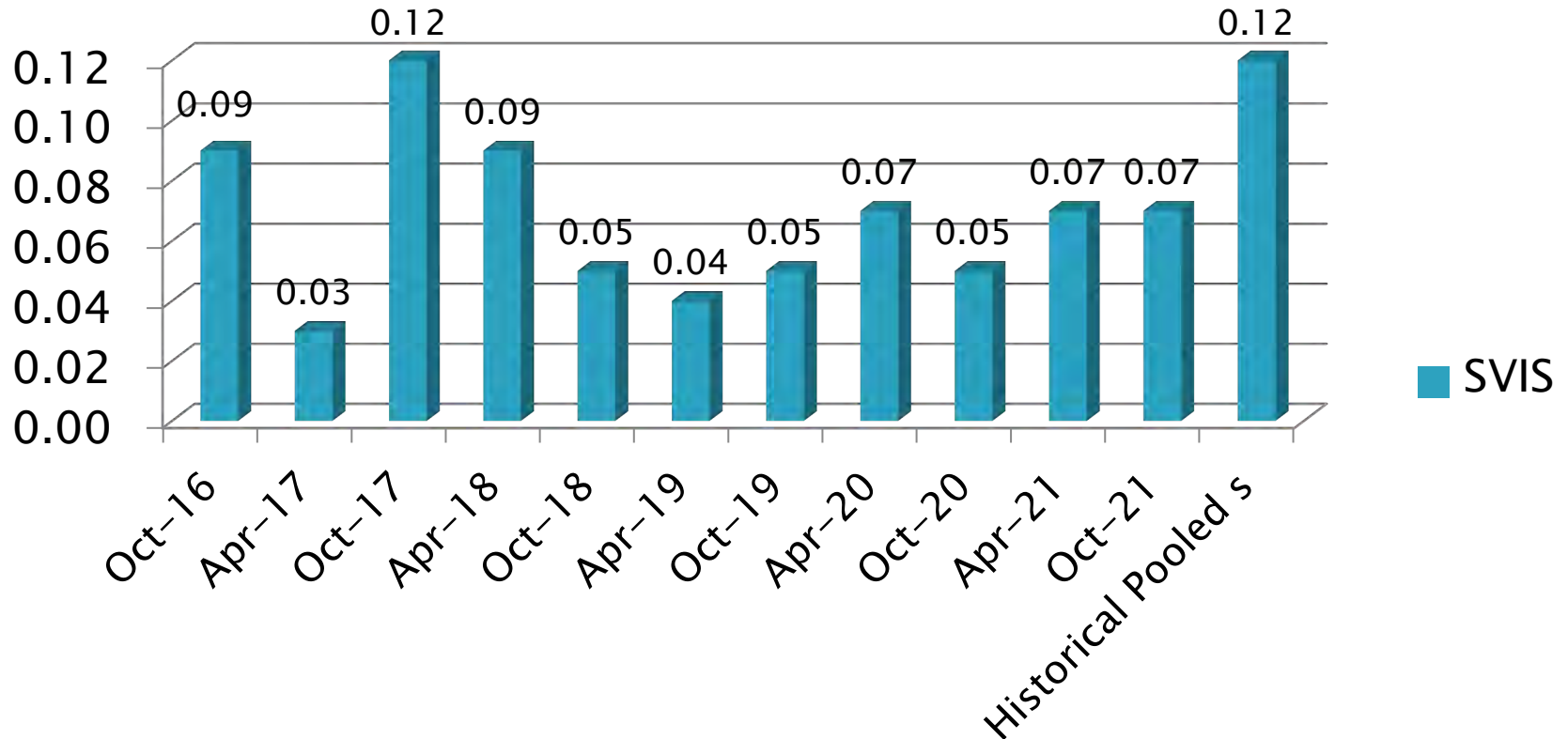




# Sequence VIII Precision Estimates

## SVIS

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



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# Sequence IX

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# Sequence IX Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	26
Statistically Unacceptable Calibration Test	OC	7
Operationally Invalid Calibration Test, lab determination	LC	2
Aborted Calibration Test	XC	2
Not for Industry Statistics Test, Alternate Fuel	NN	1
<b>Total</b>		<b>38</b>



# Sequence IX – Failed Tests

Test Status	Number of Tests
Ei Level 3 alarm (mild direction)	5
Ei Level 3 alarm (severe direction)	2
<b>Total</b>	<b>7</b>

# Sequence IX – Lost Tests\*

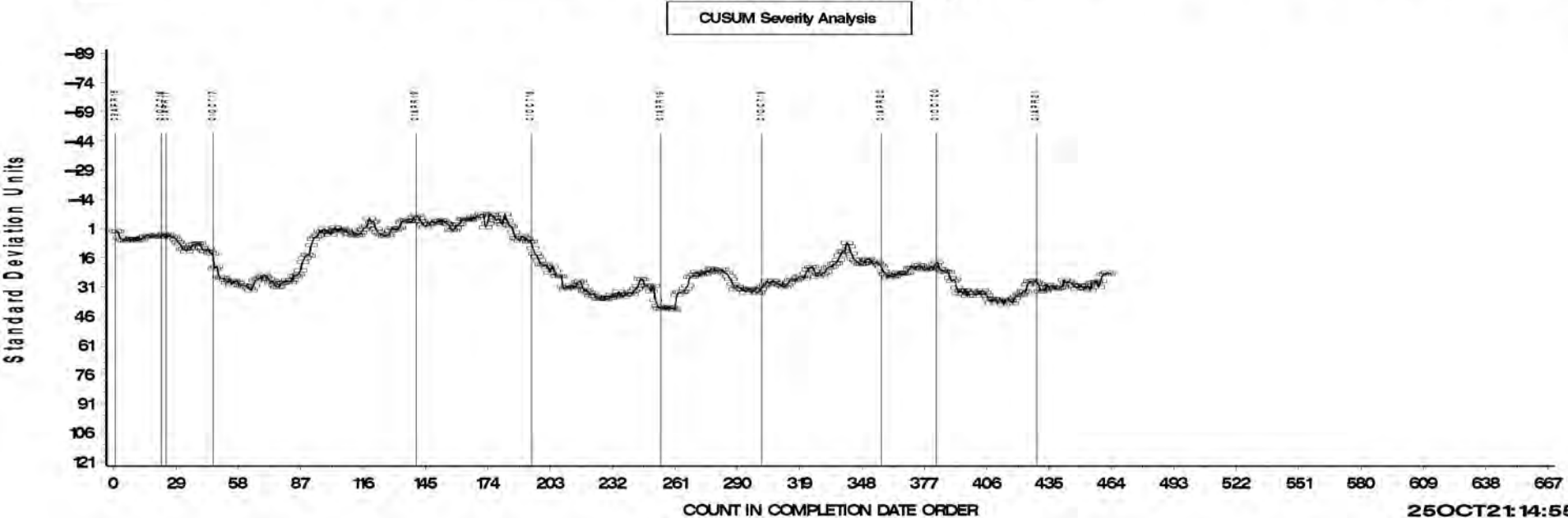
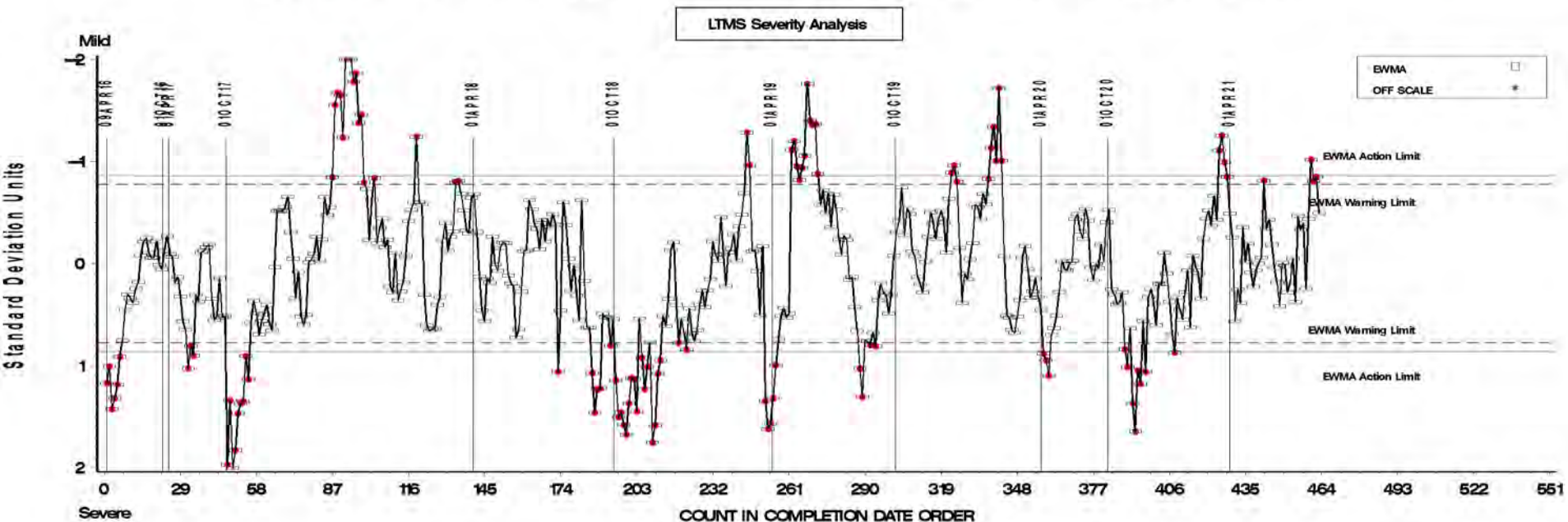
Test Status	Cause	#
Terminated	High number of Preignitions, engine removed from system	1
Invalid	Exceeded total test time	1
Invalid	Mass Air Flow and O <sub>2</sub> sensors failed	1
Terminated	Exceeded total test time	1
<b>Totals</b>		<b>4</b>

\*Invalid and aborted tests

# Sequence IX Test Severity

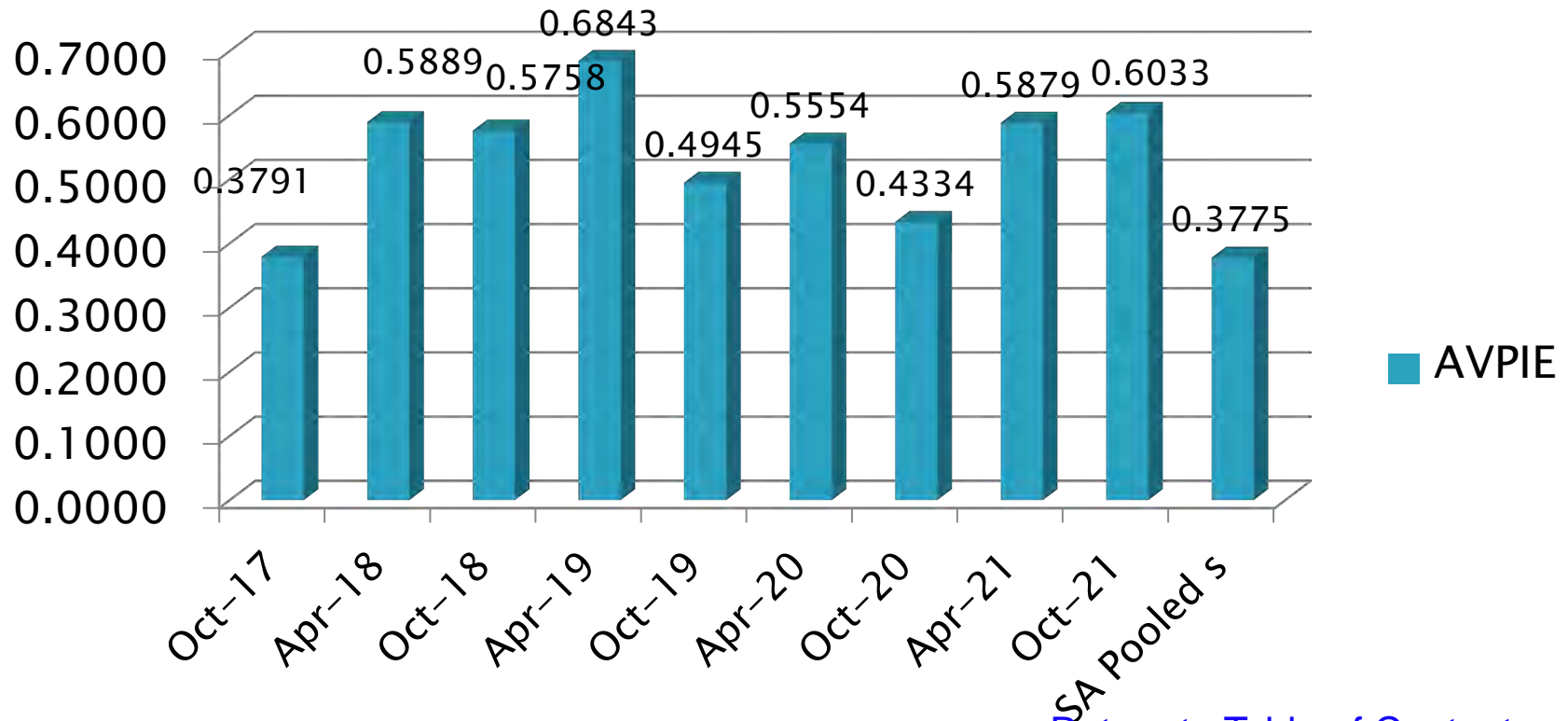
- Average number of Pre-ignitions in control.

AVERAGE NUMBER OF PREIGNITIONS FROM VALID ITERATIONS



# Sequence IX Precision Estimates

## AVPIE



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# Sequence X

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# Sequence X Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	6
Operationally Invalid Calibration Test, Lab Judgement	LC	1
Terminated Calibration Test	XC	1
Not for Industry Statistics Test (shakedown tests to evaluate installation of blowby orifice)	NN	4
<b>Total Number of Tests</b>		<b>12</b>



# Sequence X – Lost Tests\*

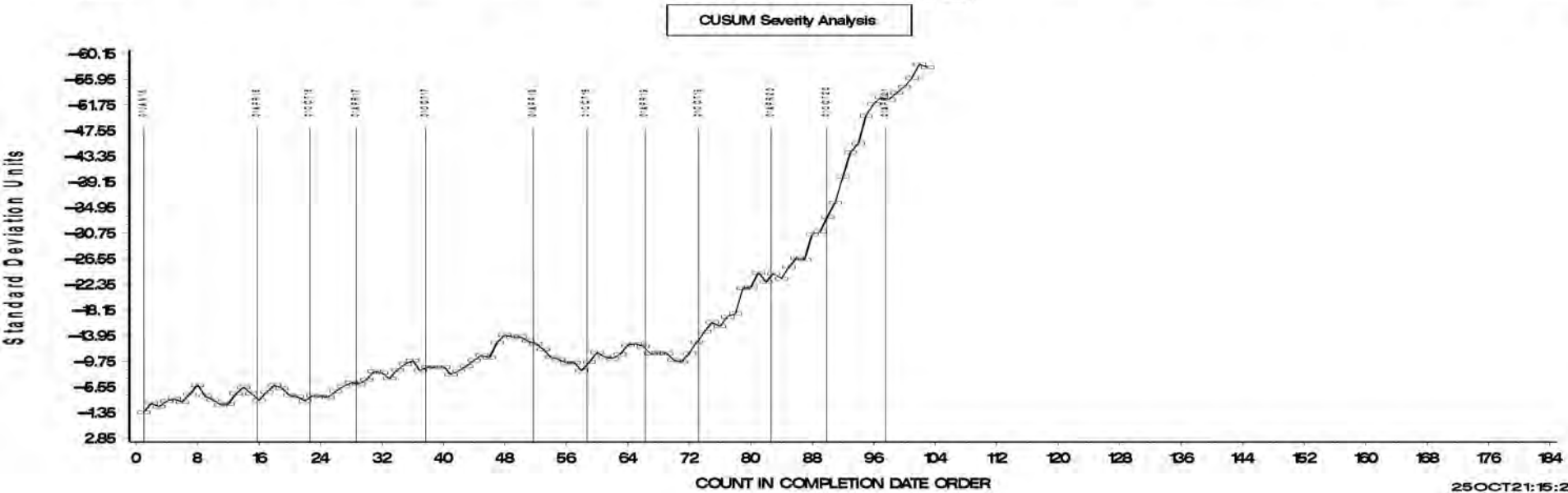
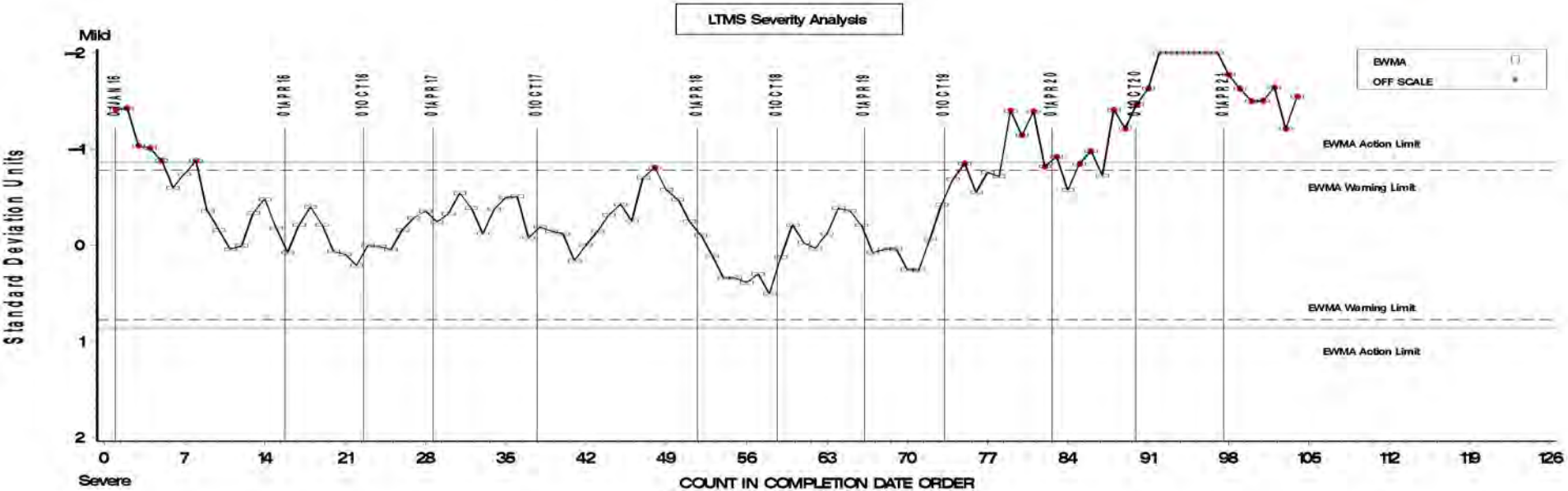
Test Status	Cause	#
Terminated	Missed Blowby reading	1
Invalid	Test ran 48 hours with blowby orifice installed	1
<b>Totals</b>		<b>2</b>

\*Invalid and aborted tests

# Sequence X Test Severity

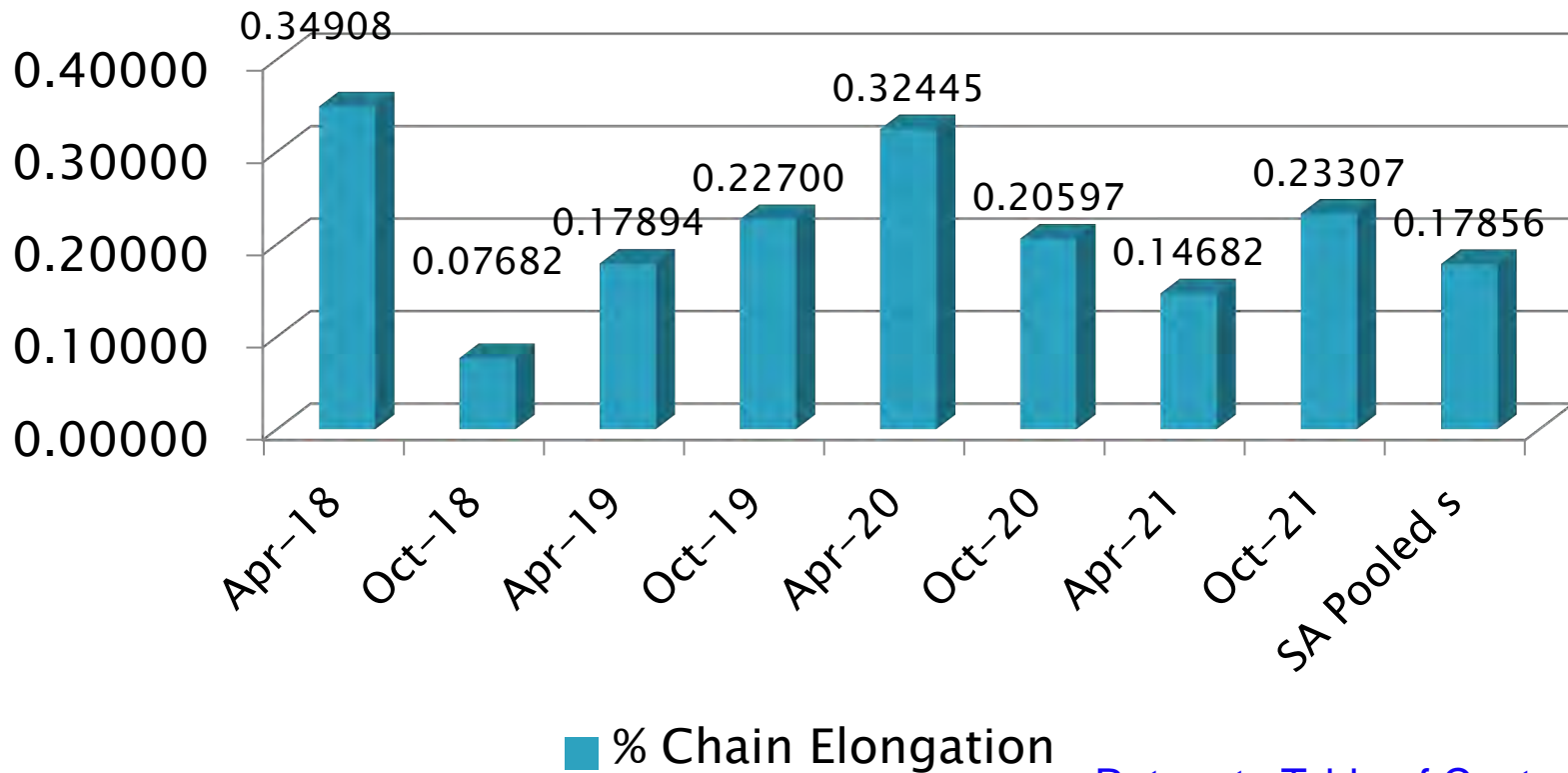
- Average Chain Stretch % in Severity Action Alarm (mild)

END OF TEST CHAIN WEAR FINAL RESULT



# Sequence X Precision Estimates

## % Chain Elongation



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# Information Letters

»» October 2021

# Information Letters\*

Test	Date	IL	Topic
IVB	20210803	21-2	Removed Annex A10, Replaced 1006-2 with SL107 as break-in oil and revised instrumentation calibration frequency to prior to conducting a reference sequence.
IX	20210823	21-2	Modified Tables 8, 11, A5.2 and A5.7 and added clarification to where downtime begins in Section 13.4.
VH	20210909	21-2	Corrected parameter for acceptance of alternate fuel from Yi to Zi in annex A16.
VIII	20210519	21-1	Removed fuel specification from test method.
X	20210917	21-1	Allowed several components to be used for more than 6 tests, updated surface finish requirements, clarified connecting rod orientation and better defined the orientation of the blowby gas thermocouple.

\*Available from TMC Website

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# Reference Oil Inventory

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



# Reference Oil Re-blends

## ➤ TMC 220, 224 and 1010-1

- A reblend is being requested for RO 220 and a reblend is in process for reference oils 224 and 1010-1.

## ➤ TMC 704-1

- The supplier has been contacted and this oil can not be reblended. The panel may need to search for a replacement.

# Reference Oil Re-blends

## ➤ TMC 543-1 and 542-5

- A reblend of Reference oil 543 has been obtained and is available for introduction. A reblend of Reference oil 542 was recently received by the TMC.

## ➤ TMC 1010-1

- A reblend (1010-2) has been requested.

## ➤ TMC 1011-1

- This oil is reblend of 1011. It is currently being introduced for the VIF and Sequence VH methods. The Sequence IVB panel agreed to introduce this reblend as well.

# 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	54	76	85	~1 year
221	IX	2120	102	459	55	2.5 years
222*	IX	1040	60	0	35	<1 year
224	IX	1026	112	155	55	~1 year
270	X	1100	56	680	45	5 years
271	X	980	20	689	35	5 years
300-1	IVB	378	22	237	20	3 years
434-2	IIIH	495	0	0	12	<1 year

\* Reference oil 222 can not be re-blended

# 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
434-3	IIIH	980	44	632	30	5+ years
436	IIIH	1100	20	578	20	5+ years
438-1	IIIH	605	0	0	2.5	<1 year
438-2	IIIH	540	22.5	388	22.5	5 years
542-3	VIE/VIF	997	0	5	18	<1 Year
542-4	VIE/VIF	1100	160	132	150	<1 Year
543	VIF	1100	63	119	72	~1 Year
544	VIE	897	30	201	48	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
704-1	VIII	897	5	17.5	12.5	1.5 years
931	VH	908	43	826	33	5+ years
940	VH	560	28	53	27	1.5 years
1006-2	IVA, VIII	5500	25	206	25	4 years
1009-1	VH, VIII	1100	21	922	3	5 years
1010-1	VIE	1760	91	66	114	~1 year
1011	IVB/VH/VIF/X	1100	0	0	42	Depleted
1011-1	IVB/VH/VIF/X	1395	100	1192	66	5+ years
1012	IVB	2200	84	1362	65	5+ years

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# LTMS Deviations

»» April 1, 2021 –  
September 30, 2021

# LTMS Deviations

- No LTMS Deviations this period



# LTMS Deviations

## Historical Count of PCEO LTMS Deviations

Test	LTMS Deviations
IIIH	0
IVA	7
IVB	0
VH	0
VIE	0
VIF	0
VIII	3
IX	0
X	0

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# Quality Index Deviations

»» April 1, 2021 –

September 30, 2021

# Quality Index Deviations

- Three Quality Index Deviations were requested this report period.
  - VH Deviation for RAC inlet temperature control due to partially clogged heat exchanger.
  - IVB Deviation for Torque control due to a failed relay in the dynamometer cooling circuit.
  - IVA Deviation for Intake air pressure control caused by an operator not reconnecting the supply air hose.

# Quality Index Deviations

## Historical Count of PCEO Quality Index Deviations

Test	Quality Index Deviations
IIIH	8
IVA	32
IVB	2
VH	8
IX	1
X	2

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# TMC Laboratory Visits

»» April 1, 2021 –

September 30, 2021

# TMC Lab Visits

Test	Number of Labs Visited
IIIH	3
IVB	1
IX	1
VH	1
VIE/VIF	2
VIII	0
X	2

# Lab Visit Issues

Sequence IX–Intake air thermocouple not at proper insertion depth.

Sequence X – Flowmeter (J–Tec) did not have 10 pipe diameters of pipe/tubing downstream of meter outlet.

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# Test Area Timelines

»» April 1, 2021 –  
September 30, 2021

# Test Area Timeline Additions\*

Test	Date	Topic	IL
IVB	20210803	Removed Annex A10, Replaced 1006-2 with SL107 as break-in oil and revised instrumentation calibration frequency to prior to conducting a reference sequence.	21-2
IX	20210823	Modified Tables 8, 11, A5.2 and A5.7 and added clarification to where downtime begins in Section 13.4.	21-2
VH	20210909	Corrected parameter for acceptance of alternate fuel from Yi to Zi in annex A16.	21-2
VIII	20210519	Removed fuel specification from test method.	21-1
X	20210917	Allowed several components to be used for more than 6 tests, updated surface finish requirements, clarified connecting rod orientation and better defined the orientation of the blowby gas thermocouple.	21-1

\*As of 09/30/2021

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# Rating Workshop Data

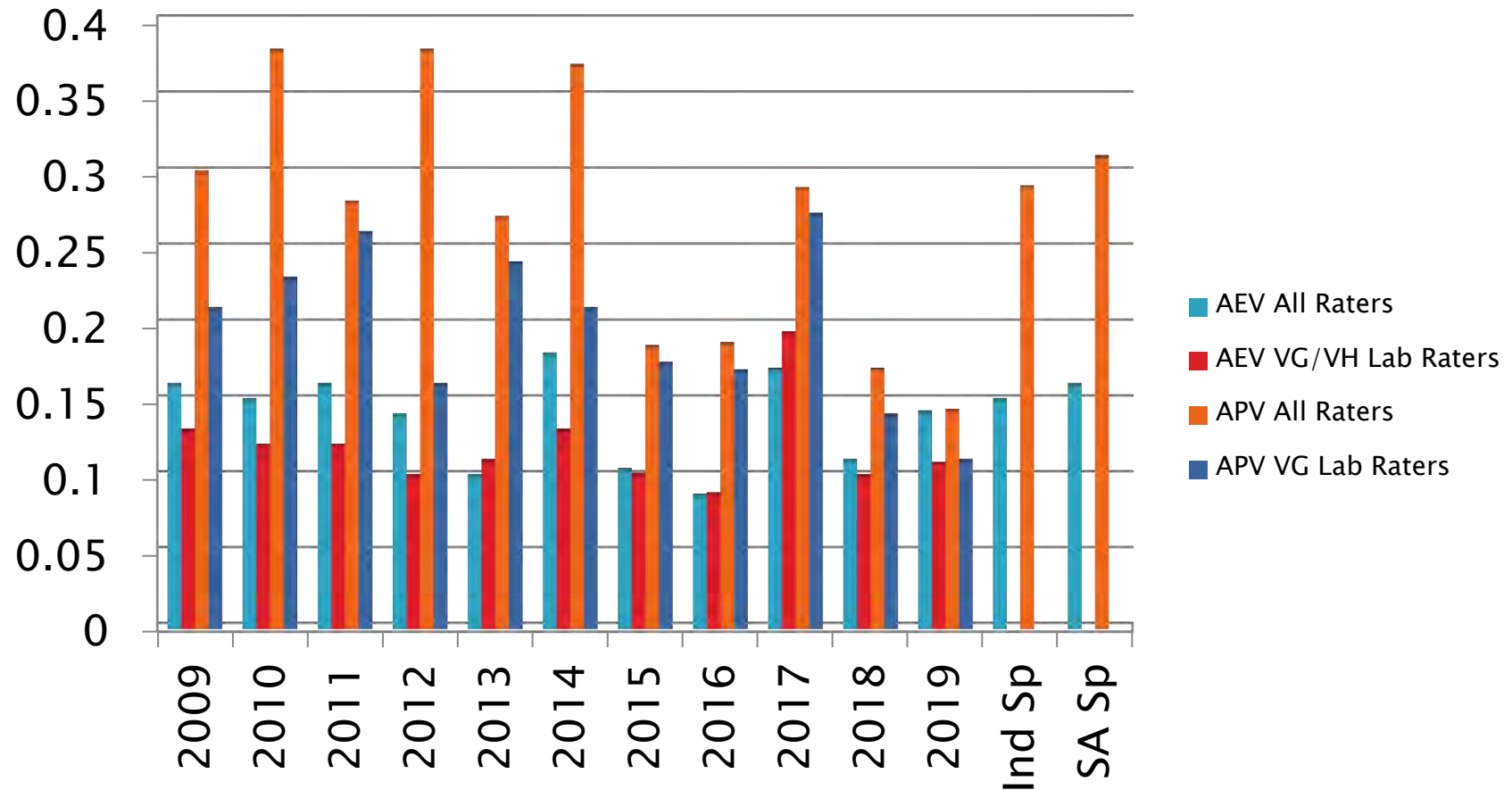
»» 2019 Light Duty Workshop

# Rating Workshop Data

- ▶ Summary of Precision Data From Light Duty Rating workshops:
  - VH Average Piston and Average Engine Varnish.
  - IIIH WPD
  - Data is from 2019 workshop; 2020 and 2021 workshops were cancelled due to pandemic. The TMC is looking into setting up a workshop for early 2022.

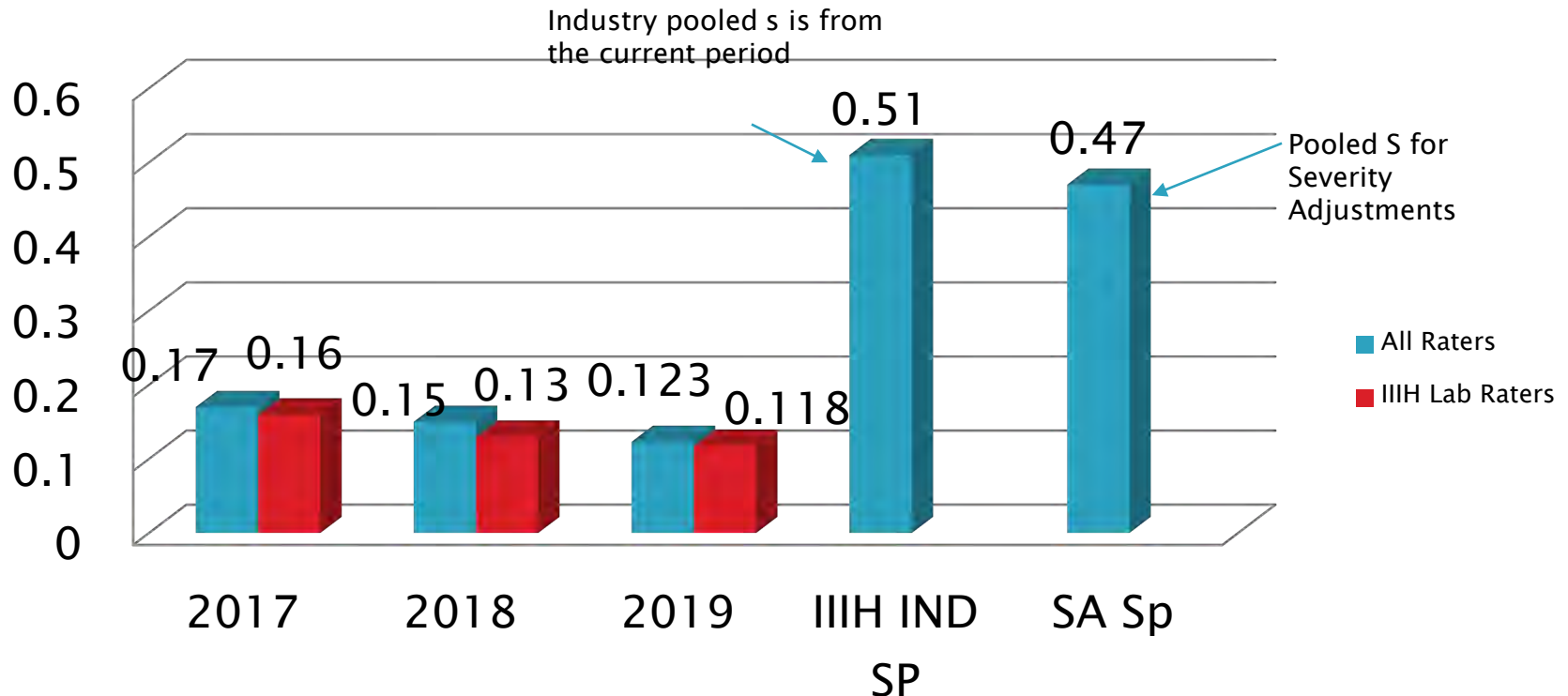
# Sequence VG/VH Precision-Rating Workshop Data

## Workshop Data for VG/VH Varnish



# Sequence IIH 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
- ▶ <https://www.astmtmc.org>

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