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ASTM D02.B1 Semiannual Report Passenger Car Reference Oil Testing

October 2020

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Passenger Car Engine Oil Testing Executive Summary

- ▶ Seq. IVB
 - The Sequence IVB Test Method has successfully completed committee (D02) ballot.
- ▶ Seq. VH
 - The panel agreed to introduce reference oil 931 and are generating targets for this oil.
- ▶ Seq. IX
 - Surveillance Panel approved use of Dealer pistons where labs ran out of Grade BB pistons. One laboratory has successfully calibrated with Grade AB1 pistons this report period.
- ▶ Rating
 - The Light Duty Rating Workshop scheduled for May 2020 was cancelled due to the Covid-19 pandemic.

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Calibrated Labs and Stands*

Test	Labs	Stands
IIIH/A/B	5	13
IVA	2	2
IVB	4	6
VH	4	8
VIE	4	10
VIF	4	5
VIII	2	2
IX	3	4
X	4	6

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*As of 9/30/2020

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Sequence IIIH/A/B

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Sequence IIIH Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	13
Statistically Unacceptable Calibration Test	OC	4
Operationally Invalid Calibration Test (Lab Judgement)	LC	1
Total		18

Sequence IIIH – Failed Tests

Test Status	#
Level 3 Ei alarm, PVIS	4
Totals	4

Sequence IIIH – Lost Tests

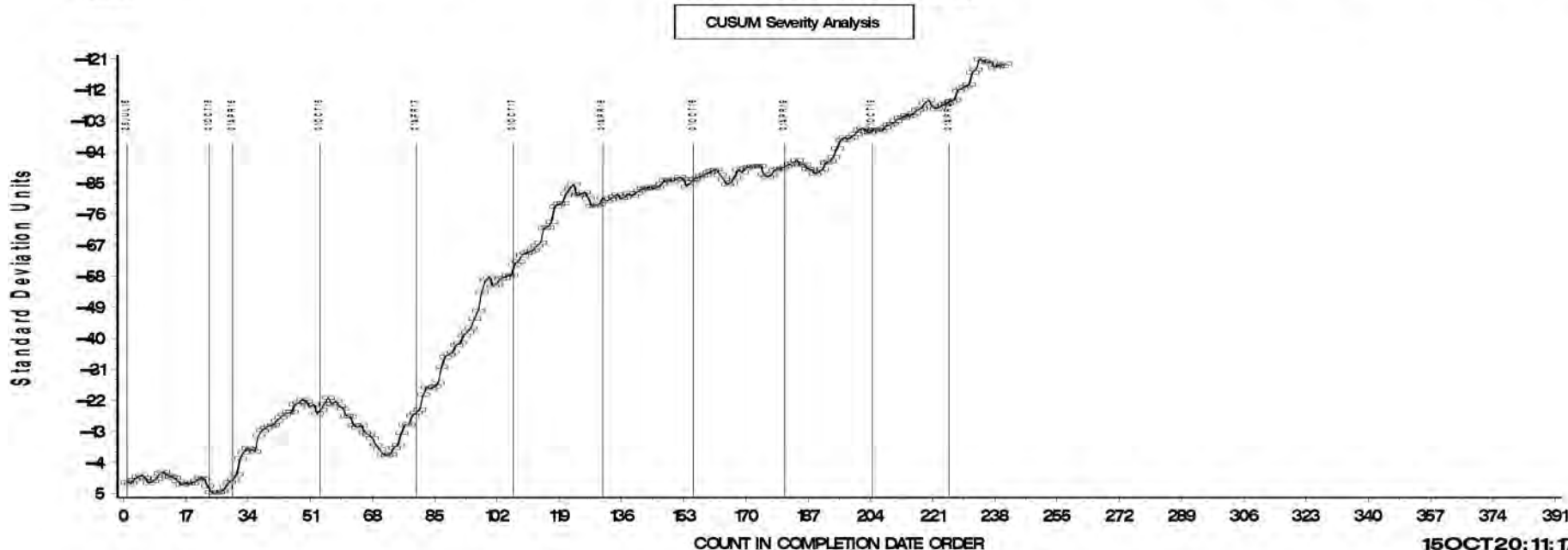
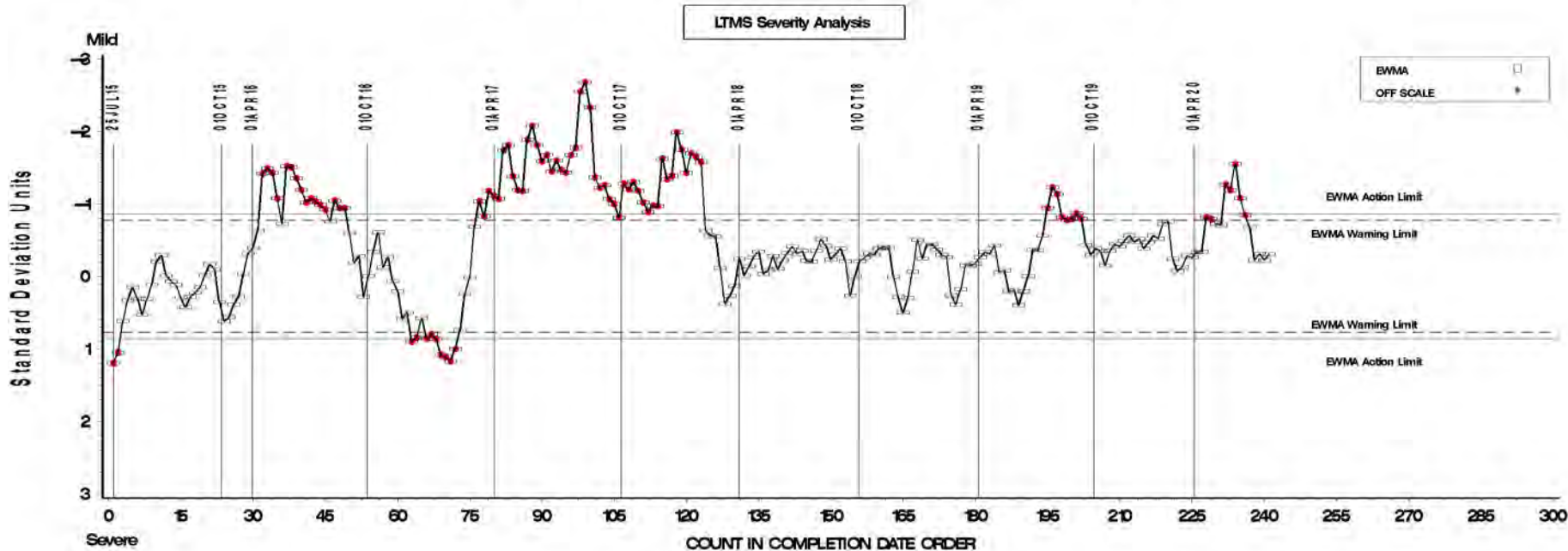
Test Status	Cause	#
Invalid	O ₂ Sensor Failure	1
Totals		1

*Invalid and aborted tests

Sequence IIIH Test Severity

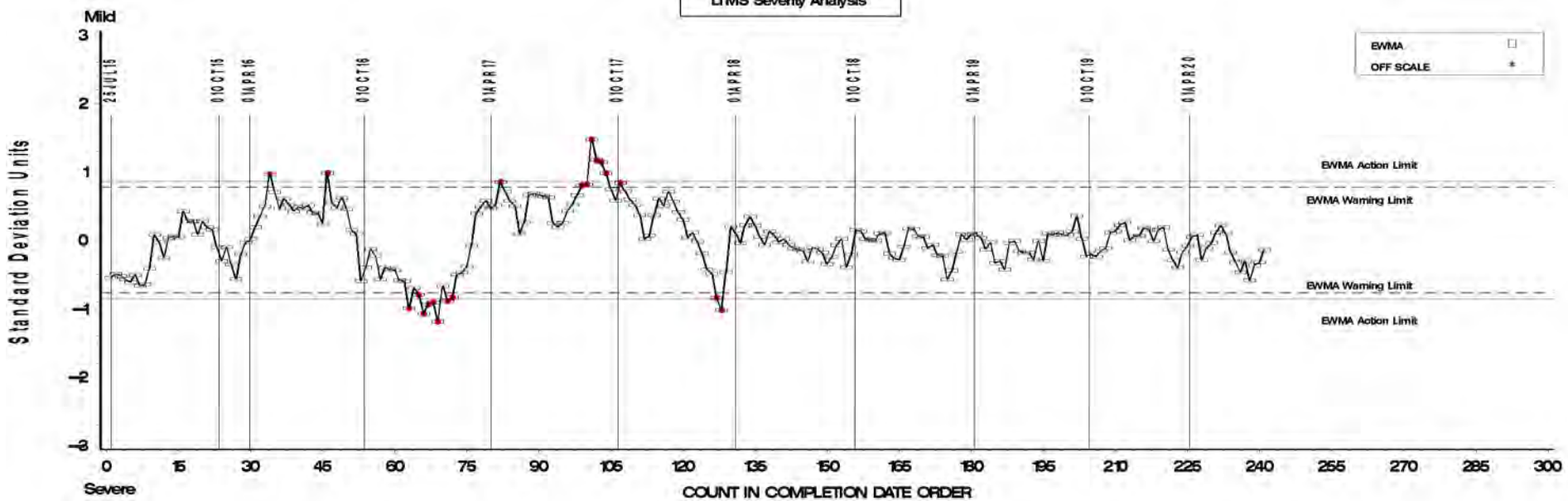
- All parameters are in control, except Average Piston Varnish, which is in action alarm (mild direction)

VISCOSITY INCREASE FINAL ORIG UNIT RES

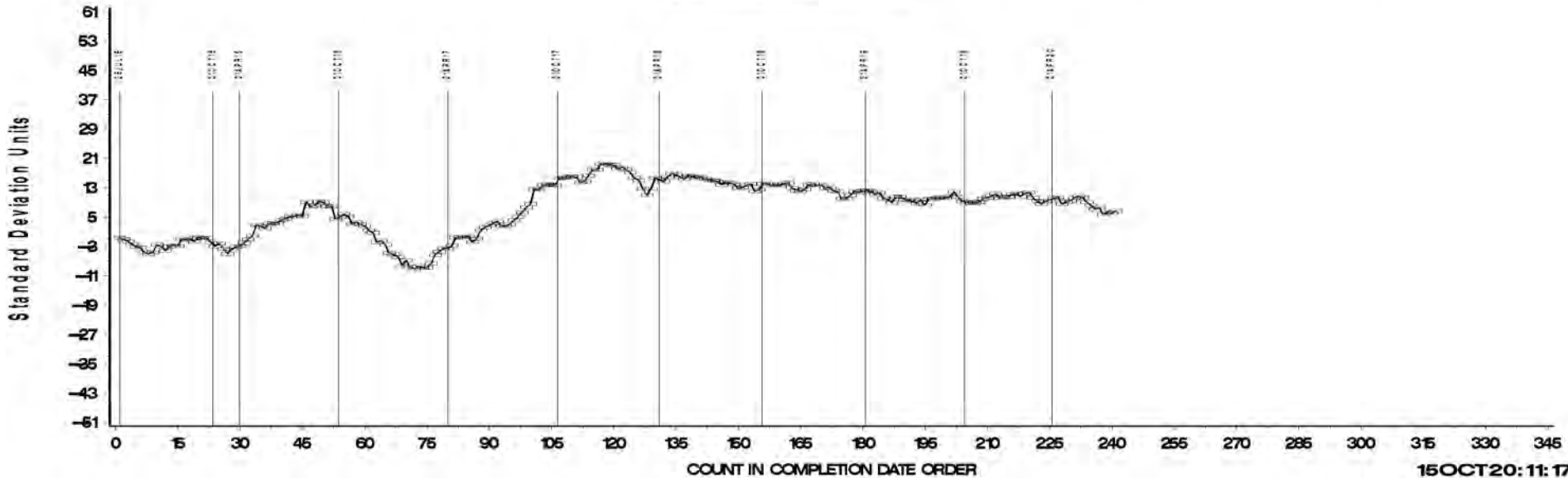


AVERAGE WEIGHTED PISTON DEPOSITS FNL ORIG U

LTMS Severity Analysis

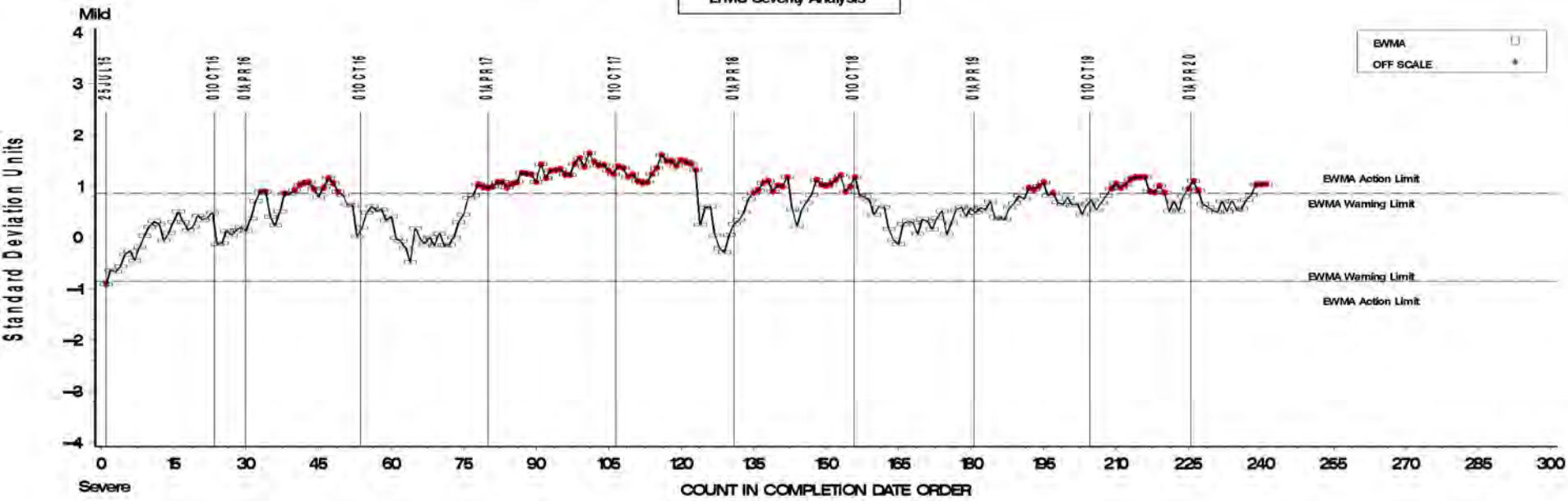


CUSUM Severity Analysis

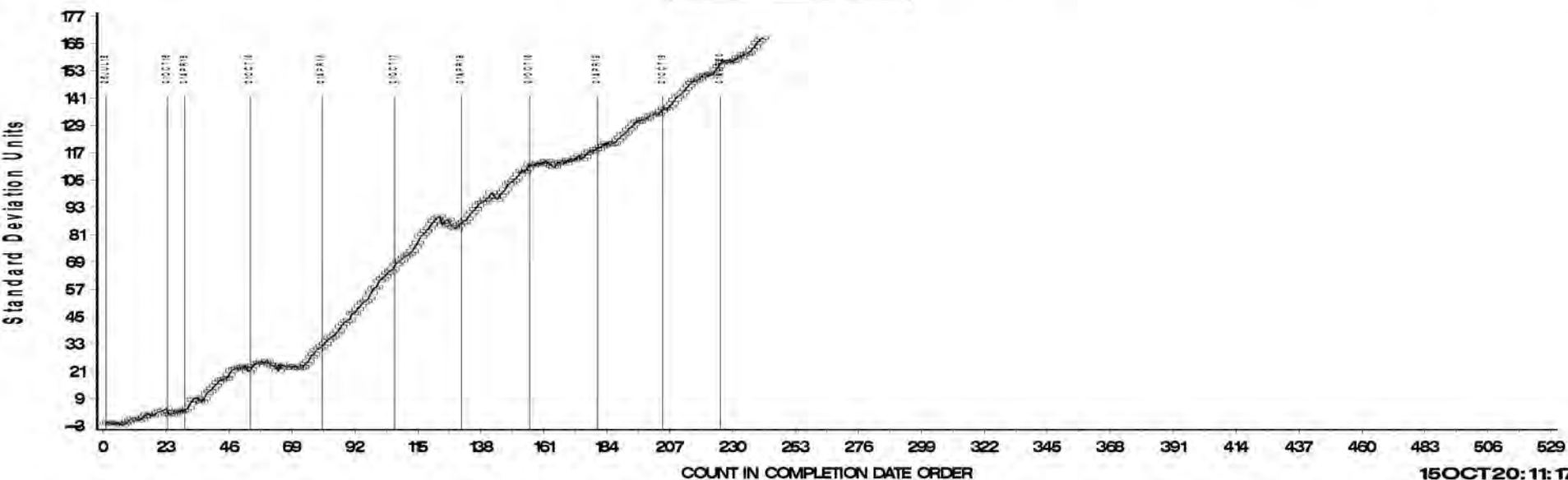


AVERAGE PISTON SKIRT VARNISH

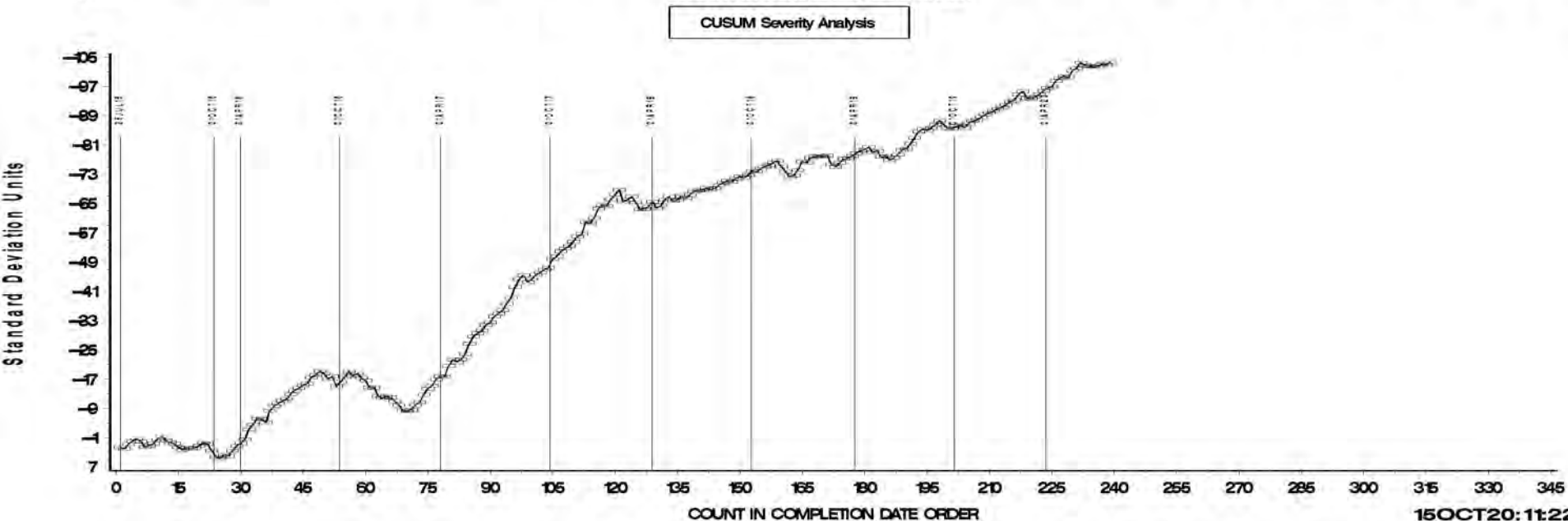
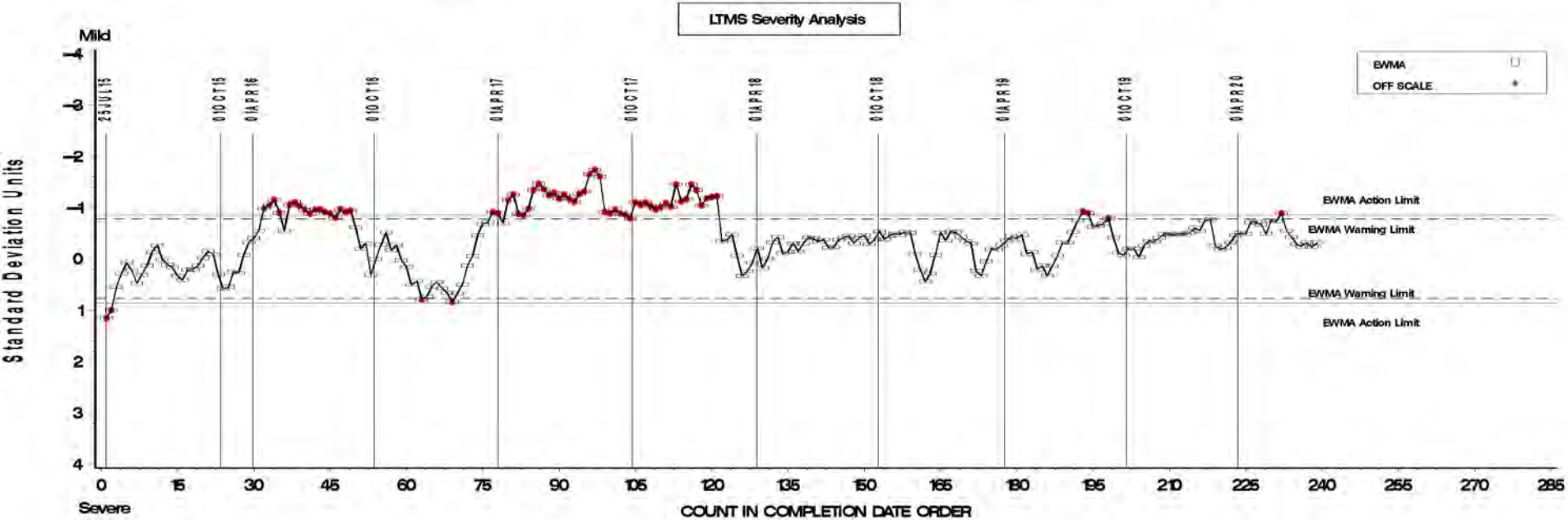
LTMS Severity Analysis



CUSUM Severity Analysis

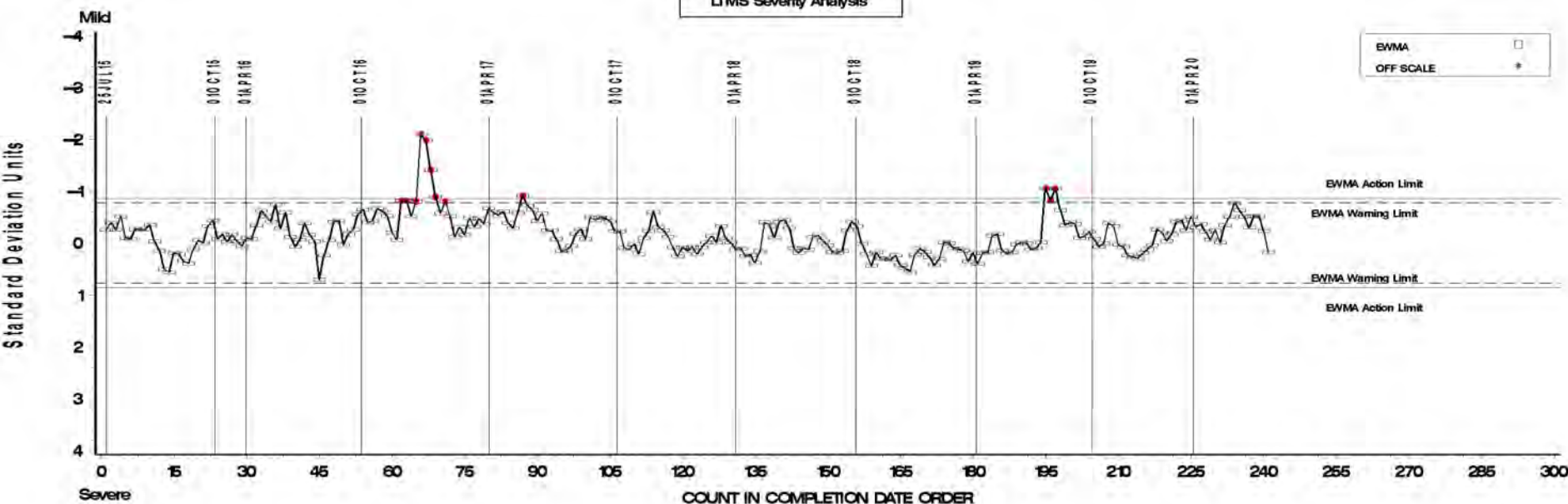


MRV FINAL ORIG UNIT RES [NM, FROZEN, SOLID]

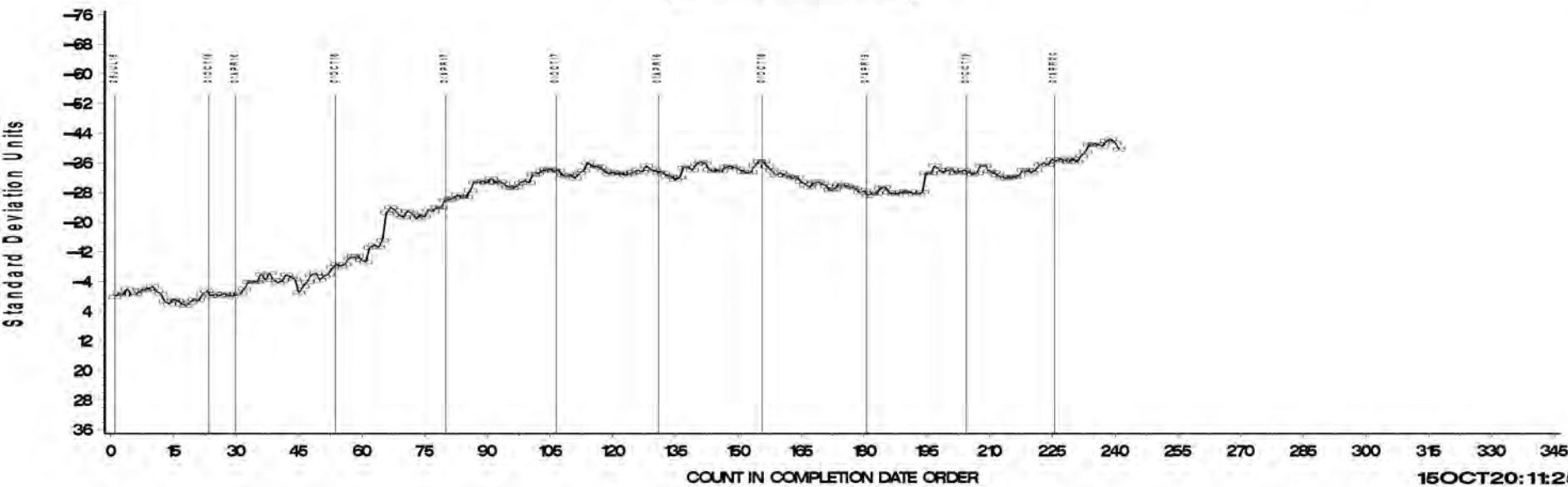


PHOSPHORUS RETENTION, FINAL RESULT

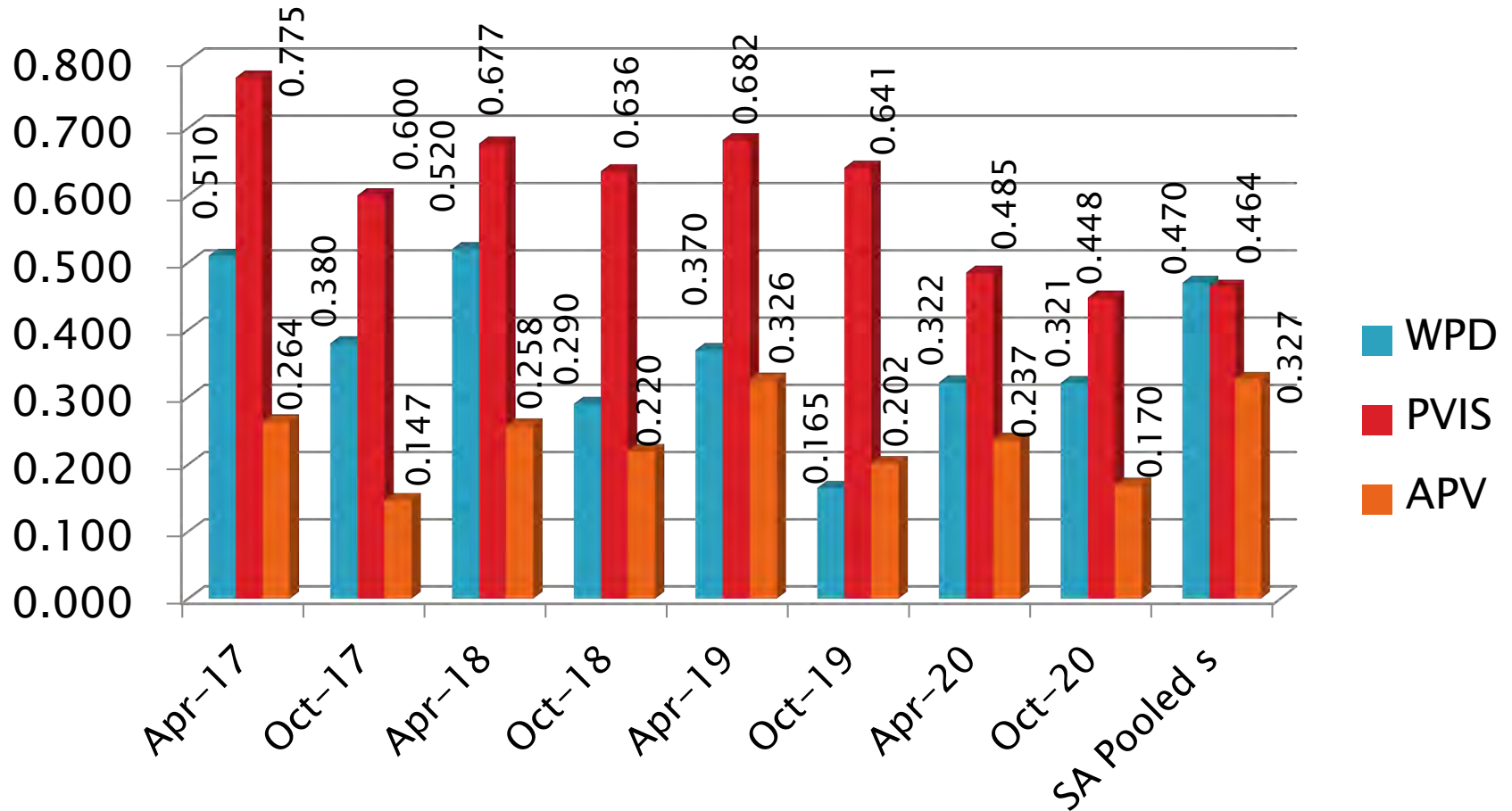
LTMS Severity Analysis



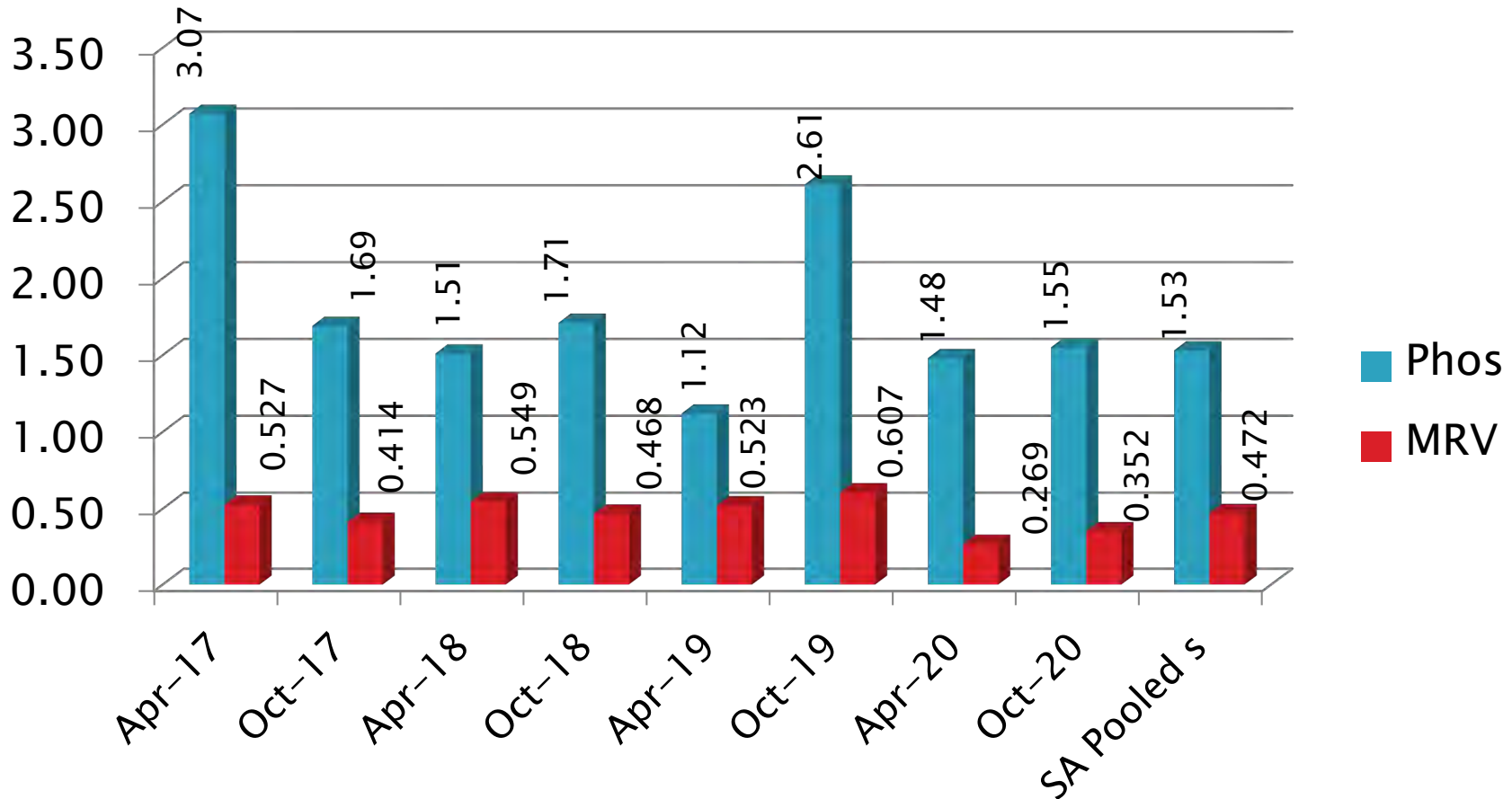
CUSUM Severity Analysis



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
Statistically Unacceptable Calibration Test	OC	1
Operationally Invalid Calibration Test (Lab determination)	LC	1
Total		4

Sequence IVA – Lost Tests

Test Status	#
Fresh Air Flow Meter Failure	1
Total	1

Sequence IVA – Failing Tests

Test Status	#
Average Cam Wear (ACW) Mild	1
Total	1

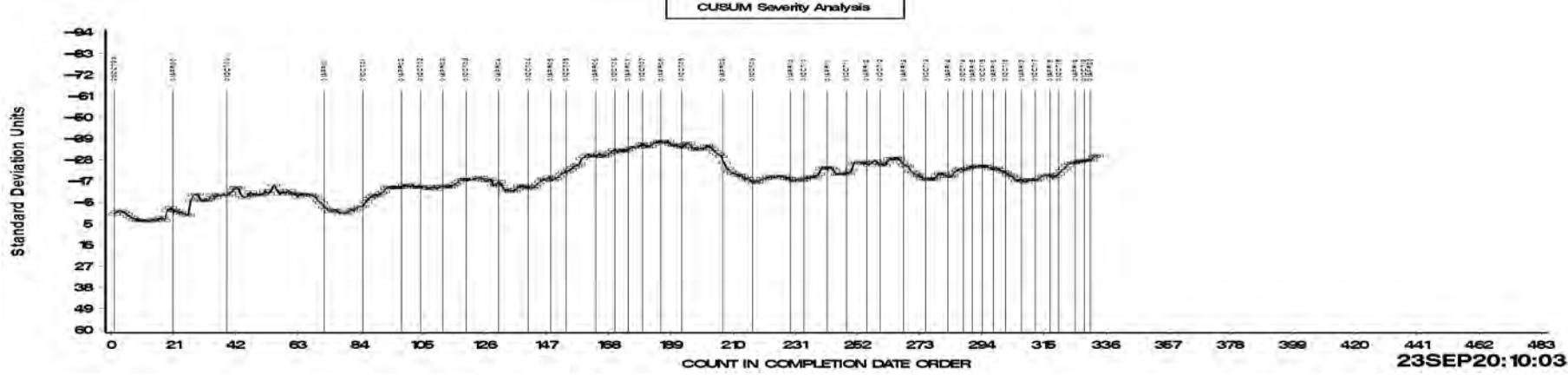
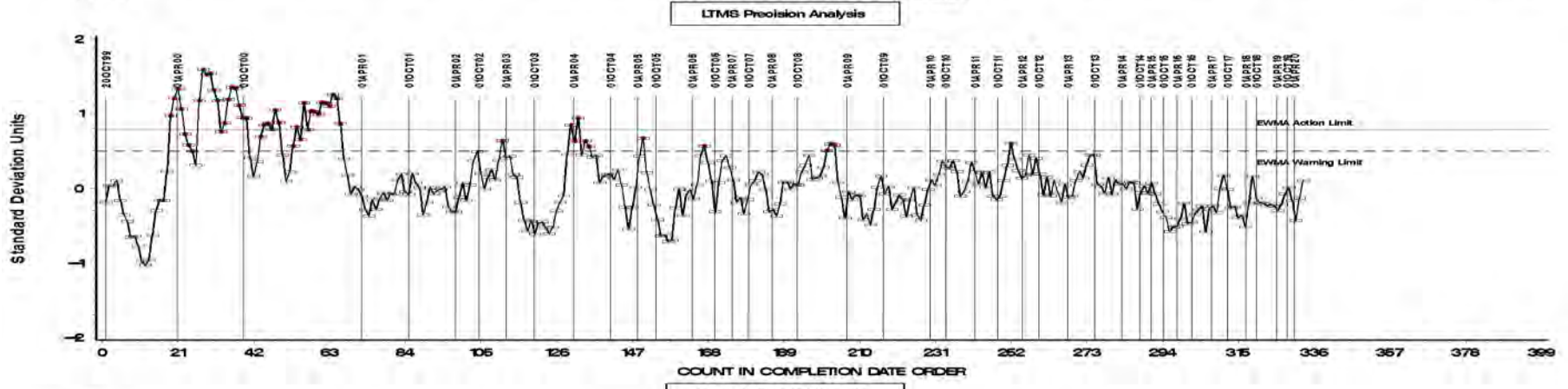
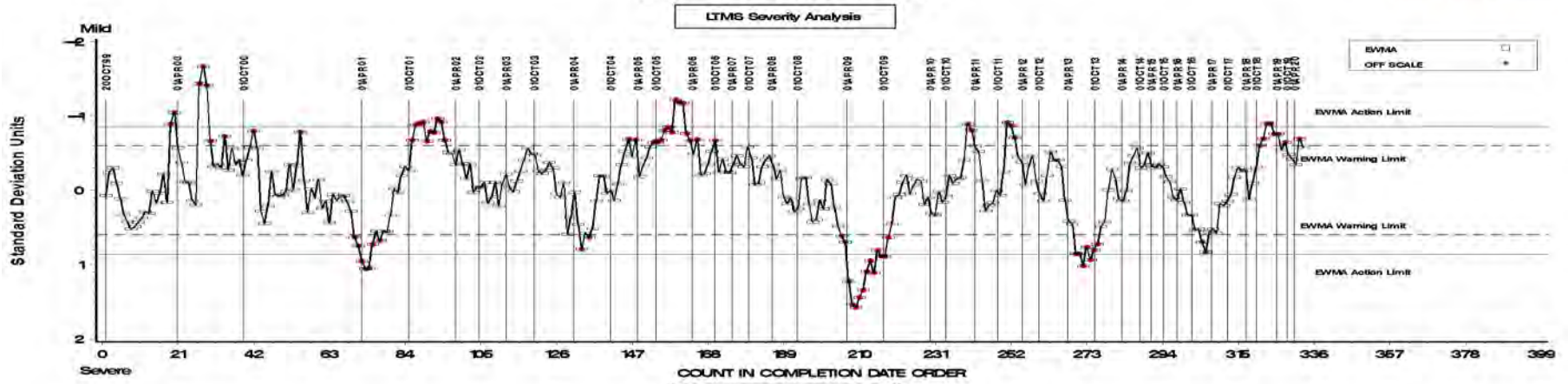
Sequence IVA Test Severity

- ACW is in control

SEQUENCE IVA INDUSTRY OPERATIONALLY VALID DATA

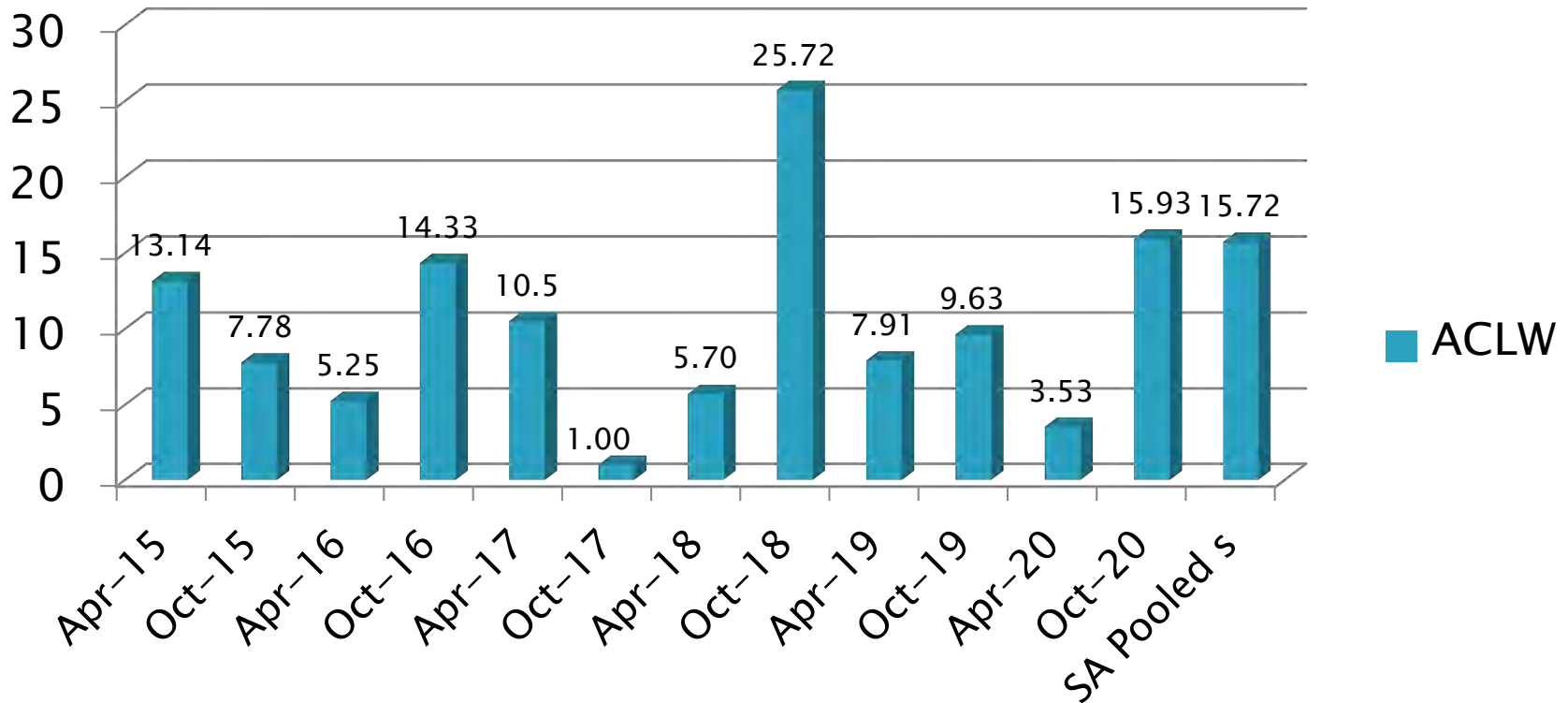


AVERAGE CAM WEAR



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
Operationally Invalid, lab determination	LC	1
Total		7

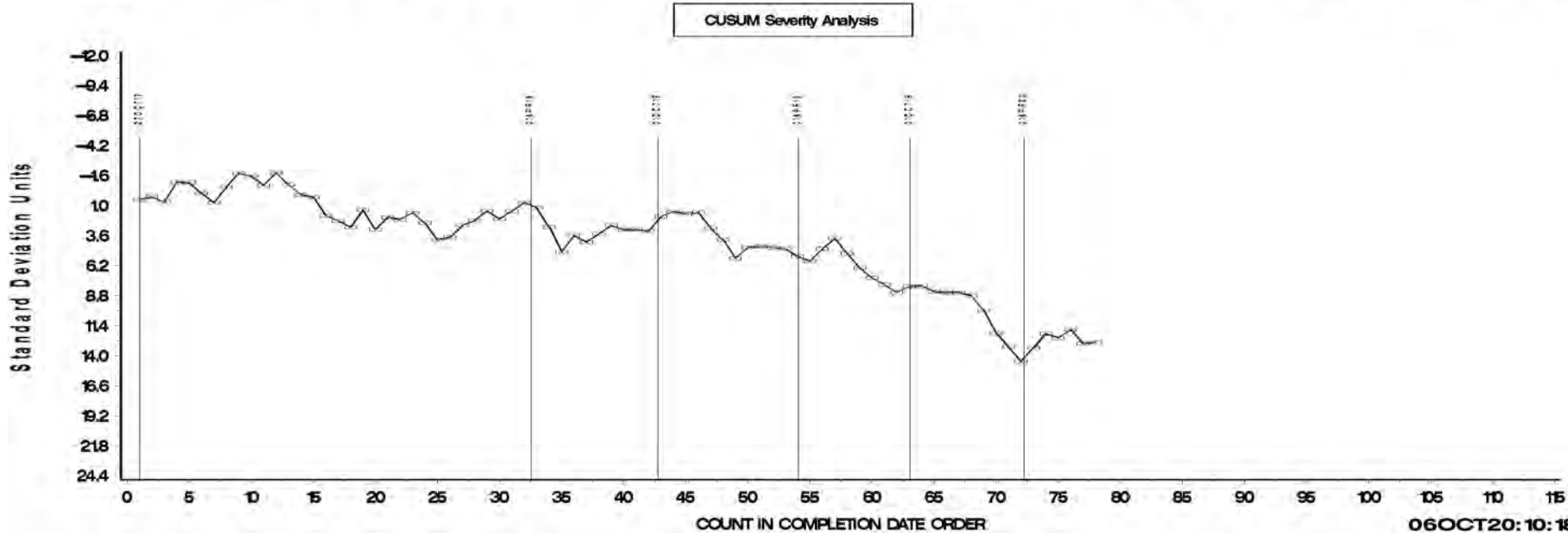
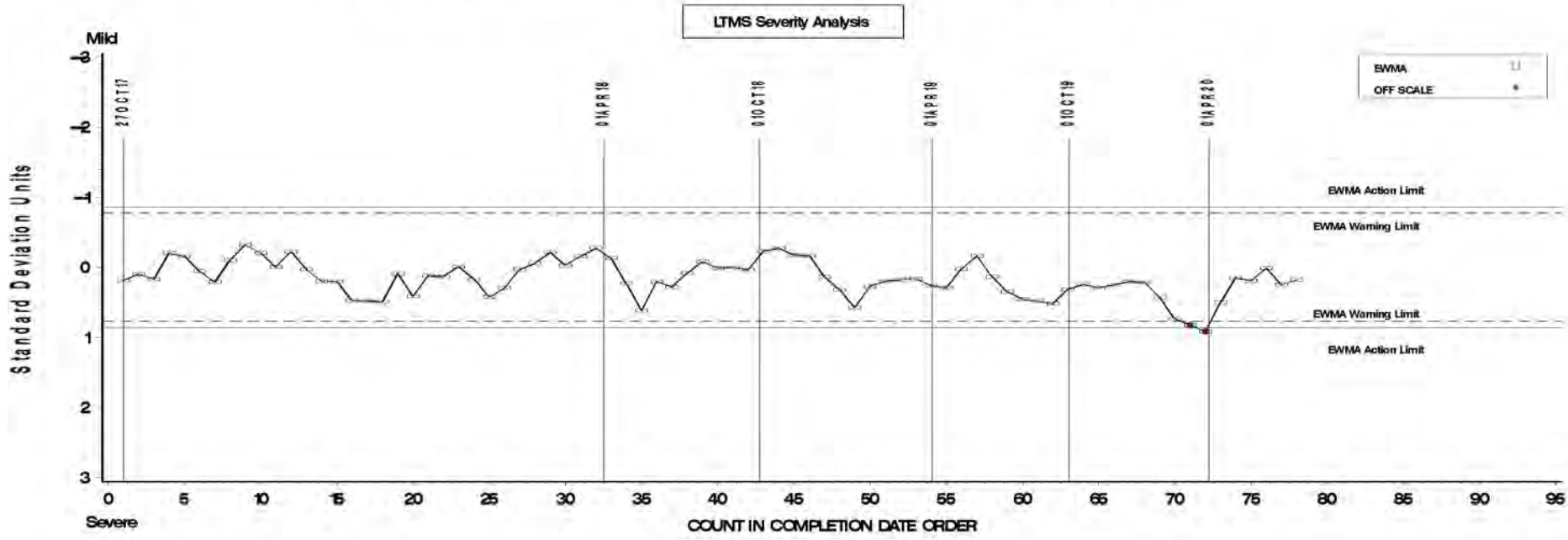
Sequence IVB – Lost Tests

Test Status	#
Engine Failure, stuck ring	1
Total	1

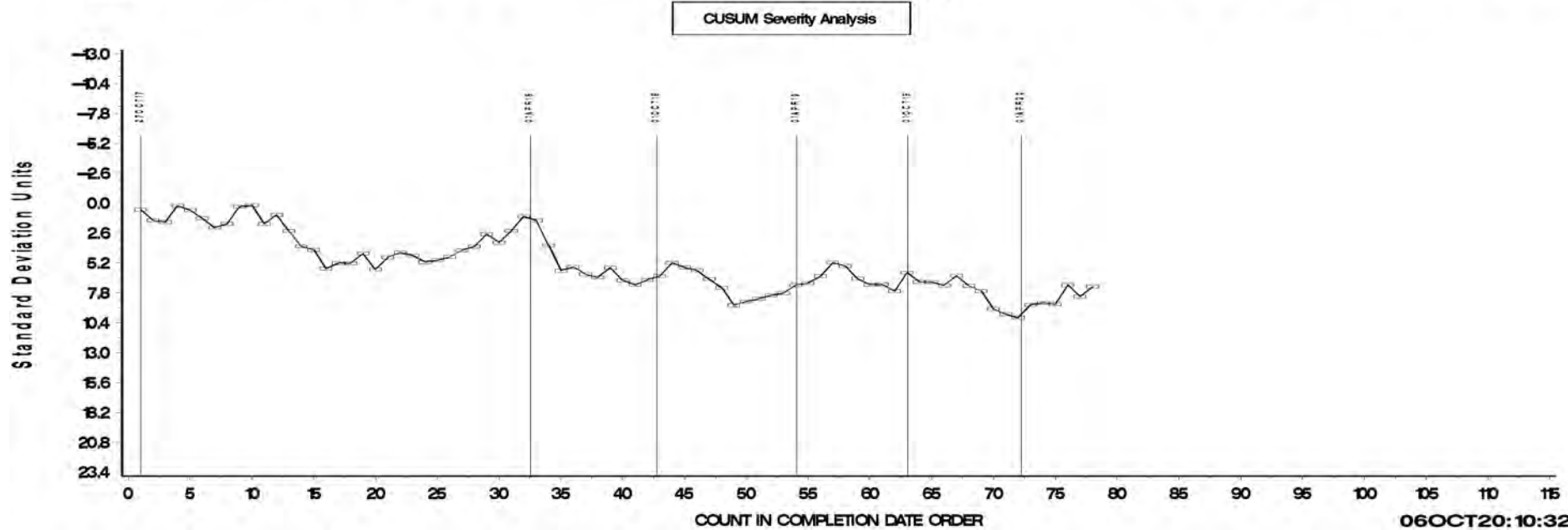
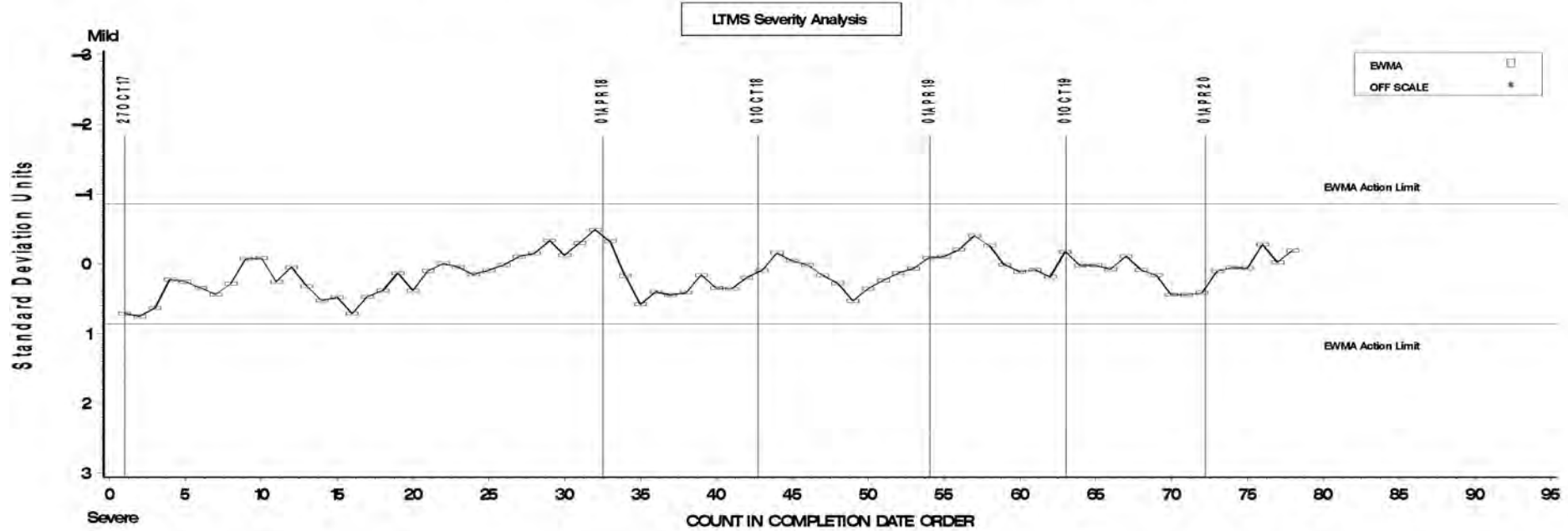
Sequence IVB Test Severity

- AVLI and Fe in control.

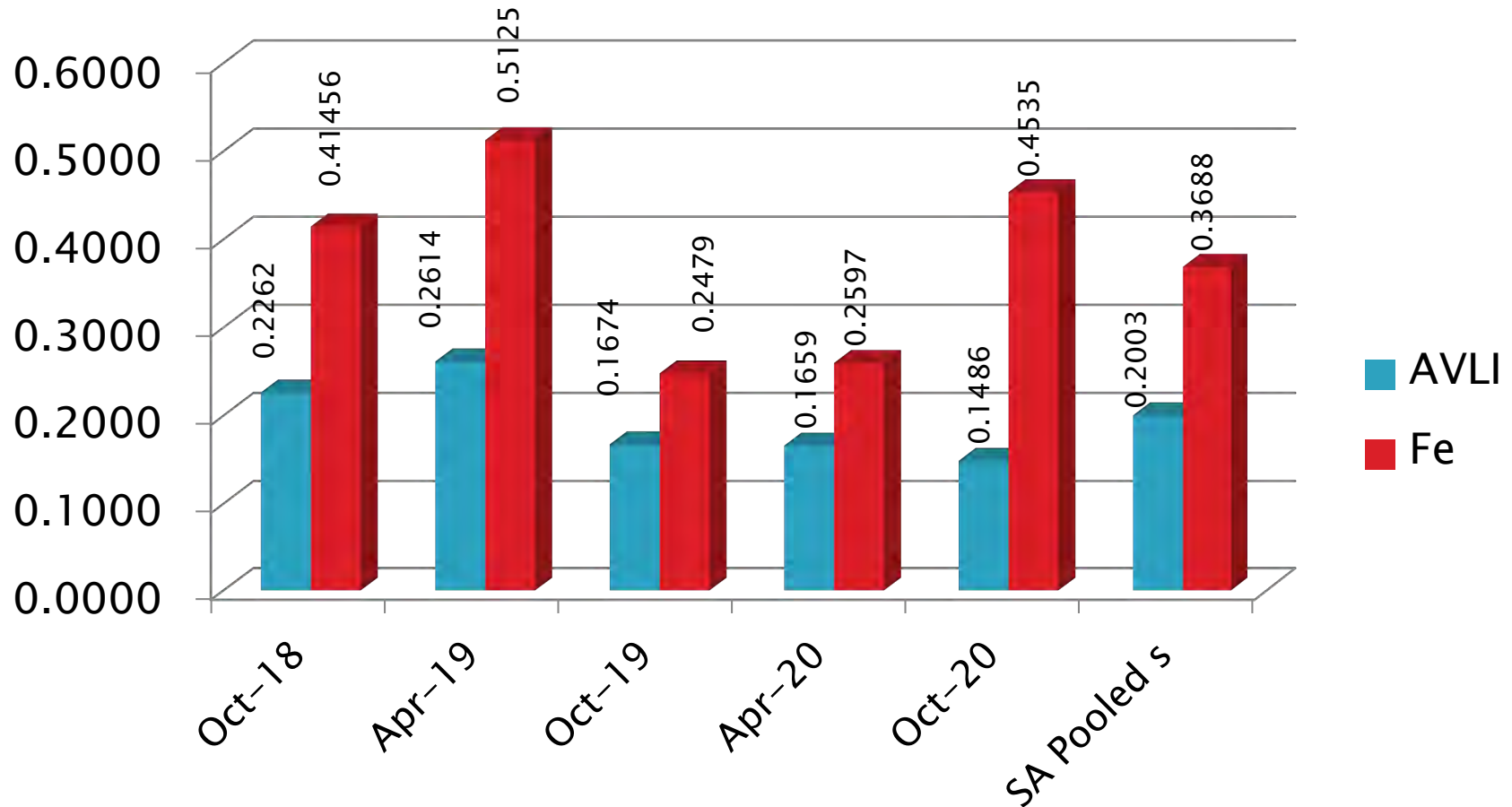
AVERAGE VOLUME LOSS BY KEYENCE INTAKE Final



END OF TEST FE FINAL Severity Adjusted RESULT



Sequence IVB Precision Estimates



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Sequence VH

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Sequence VH Activity

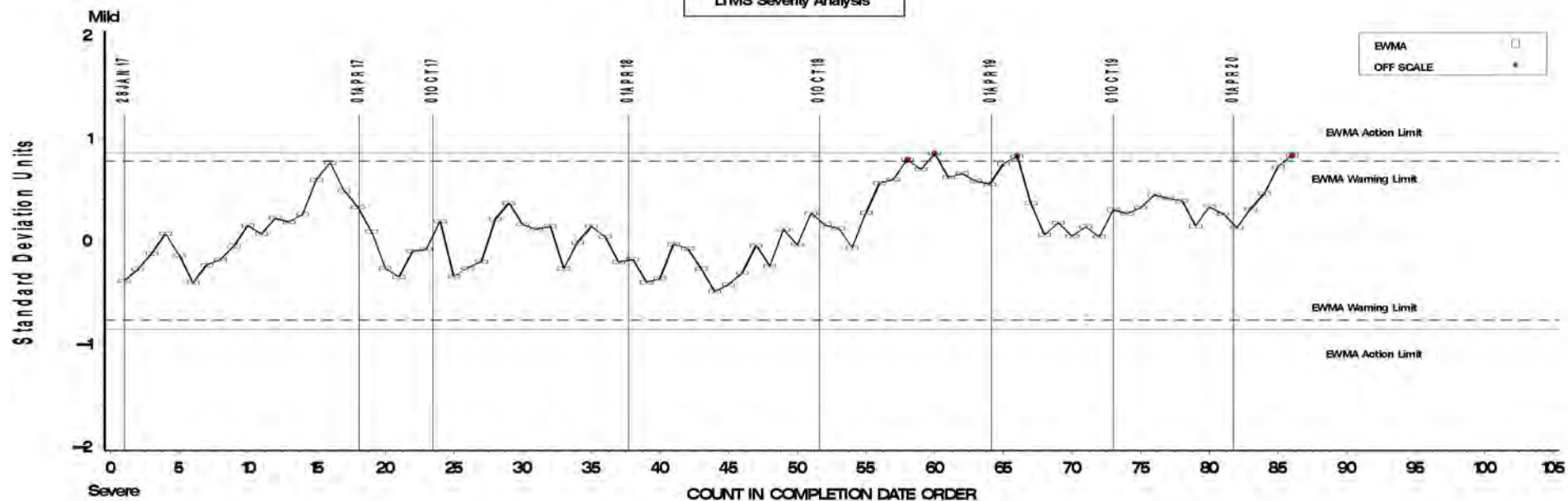
Test Status	Validity Code	#
Acceptable Calibration Test	AC	5
Pending Calibration, Reference oil 931	PC	3
Total		8

Sequence VH Test Severity

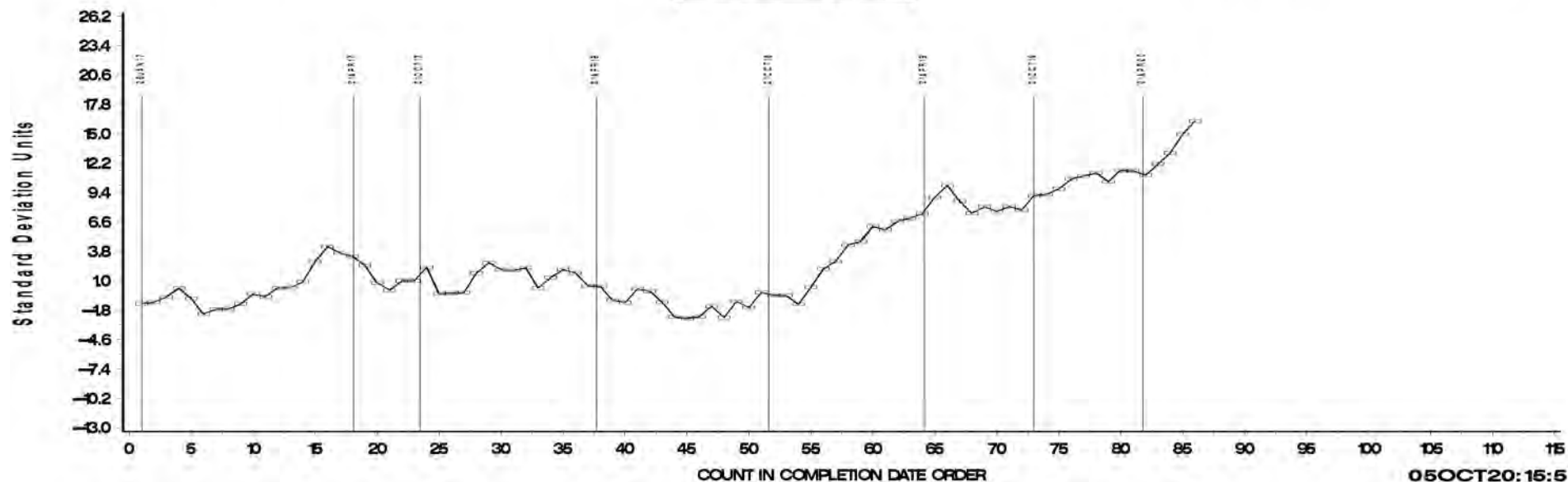
- AES is in severity warning alarm (mild)
- RAC is in severity action alarm (mild)
- AE50 and AP50 are in control

AVERAGE ENGINE SLUDGE

LTMS Severity Analysis

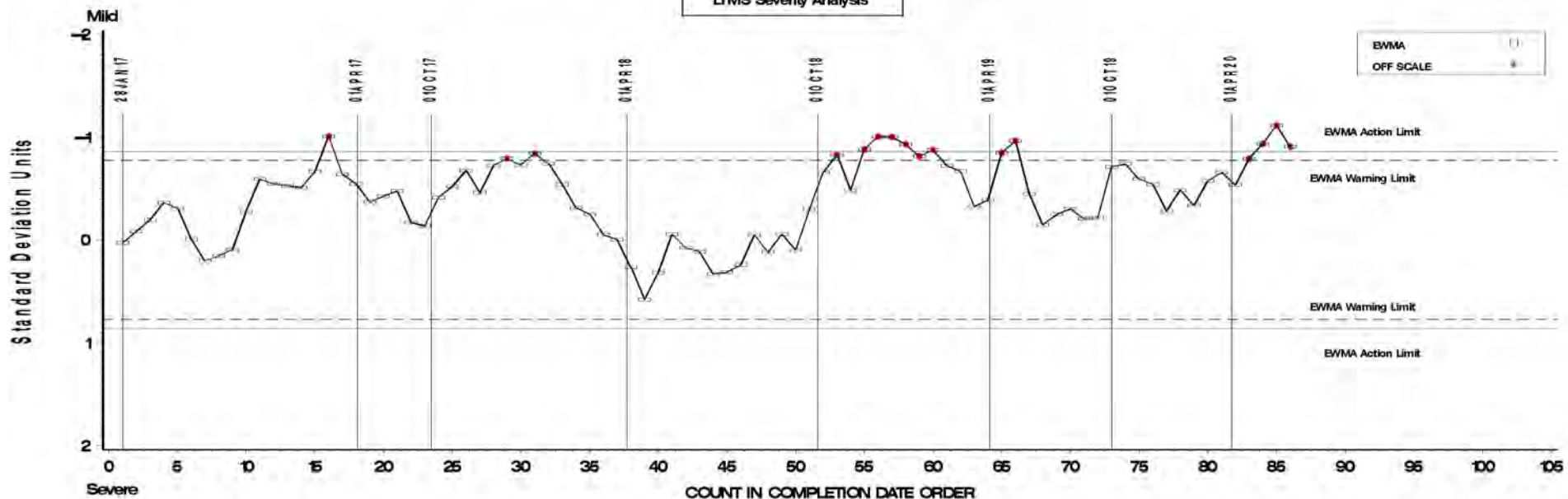


CUSUM Severity Analysis

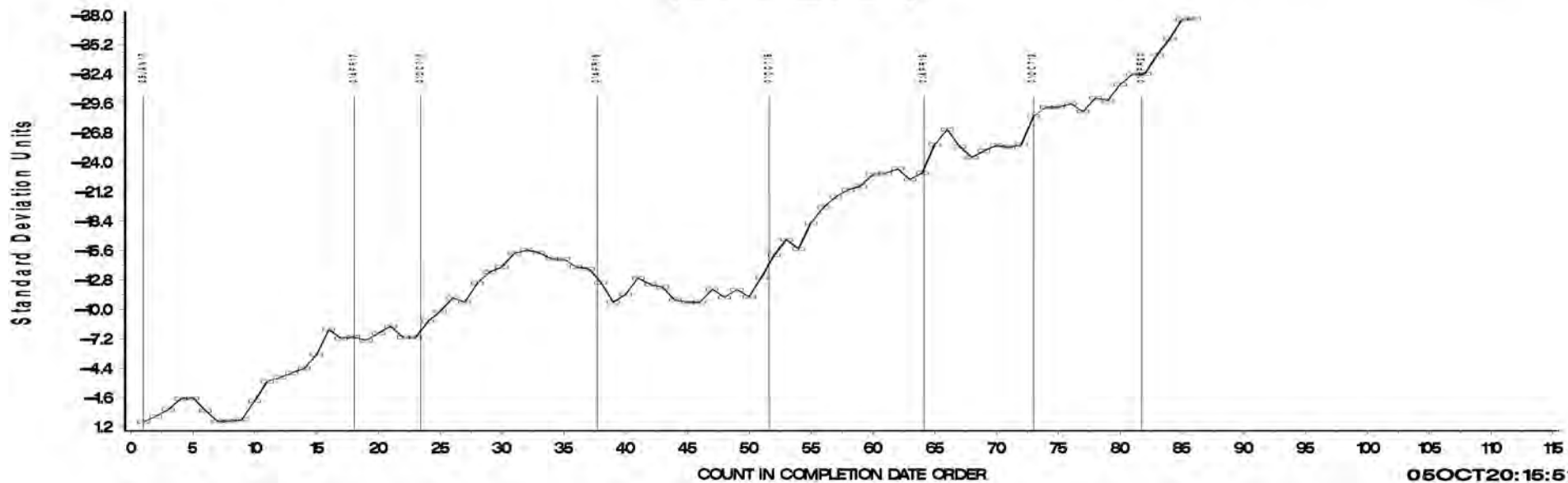


AVERAGE ROCKER COVER SLUDGE

LTMS Severity Analysis

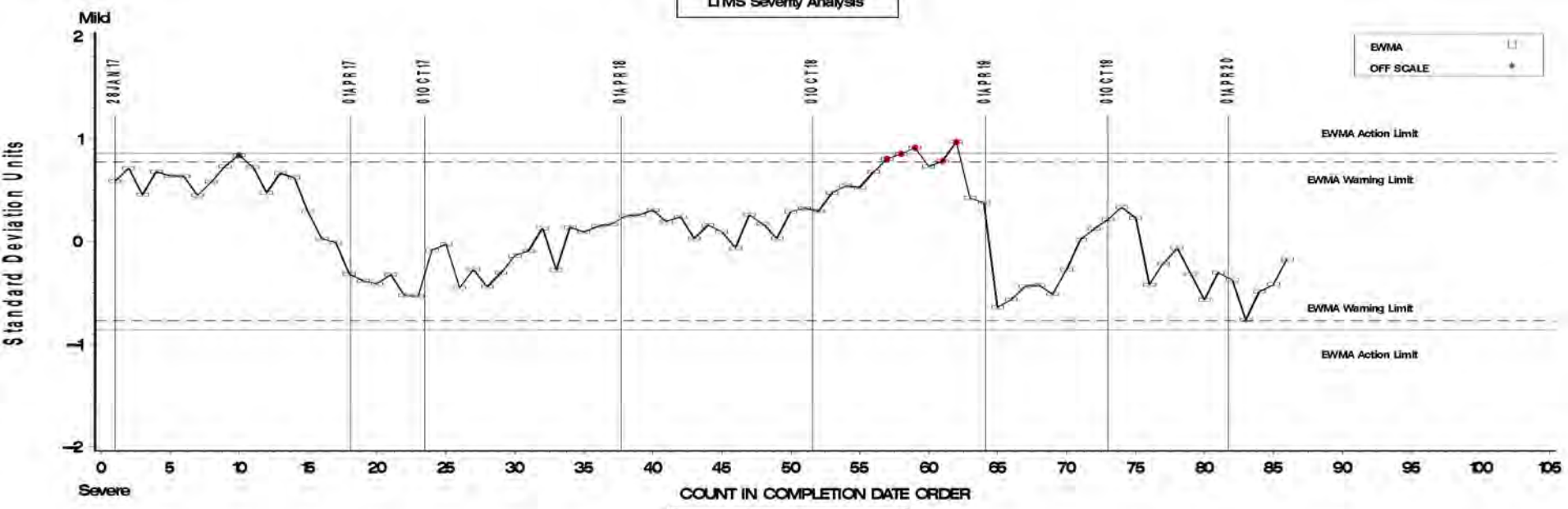


CUSUM Severity Analysis

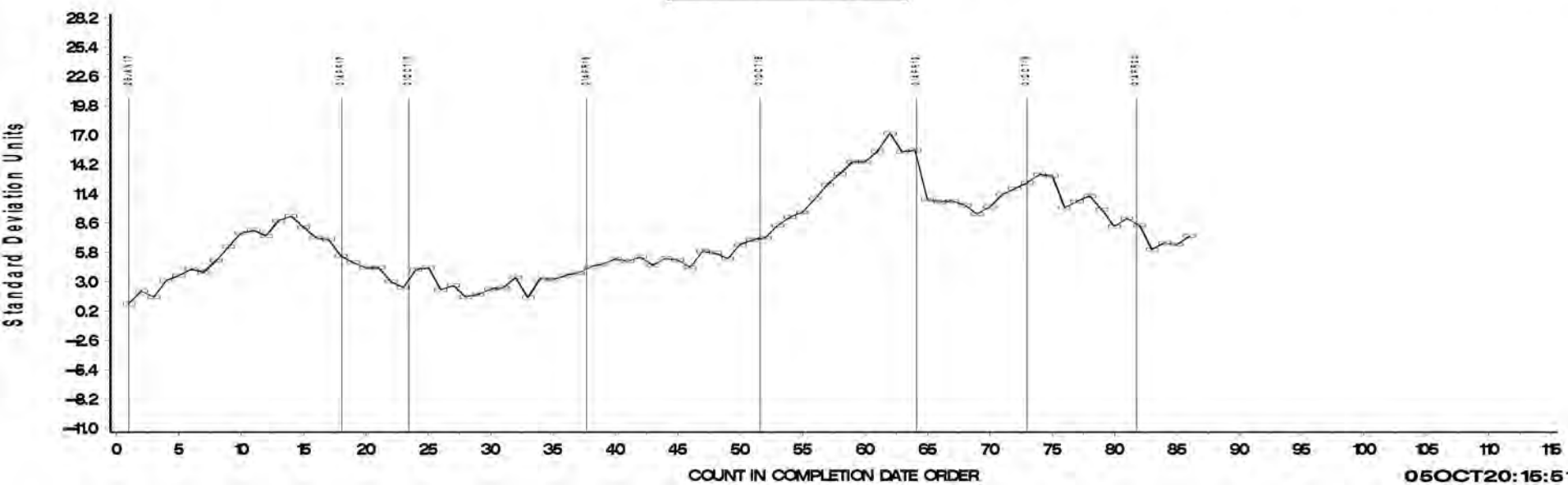


AVG. ENG. VARN. 50% RATING

LTMS Severity Analysis

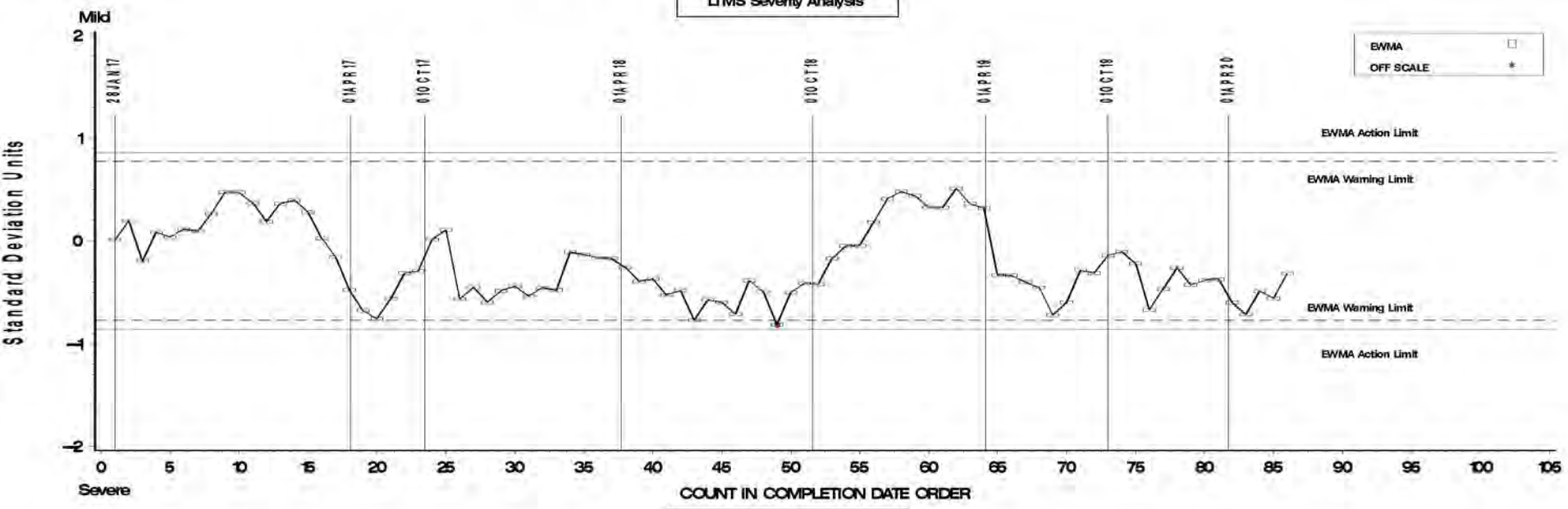


CUSUM Severity Analysis

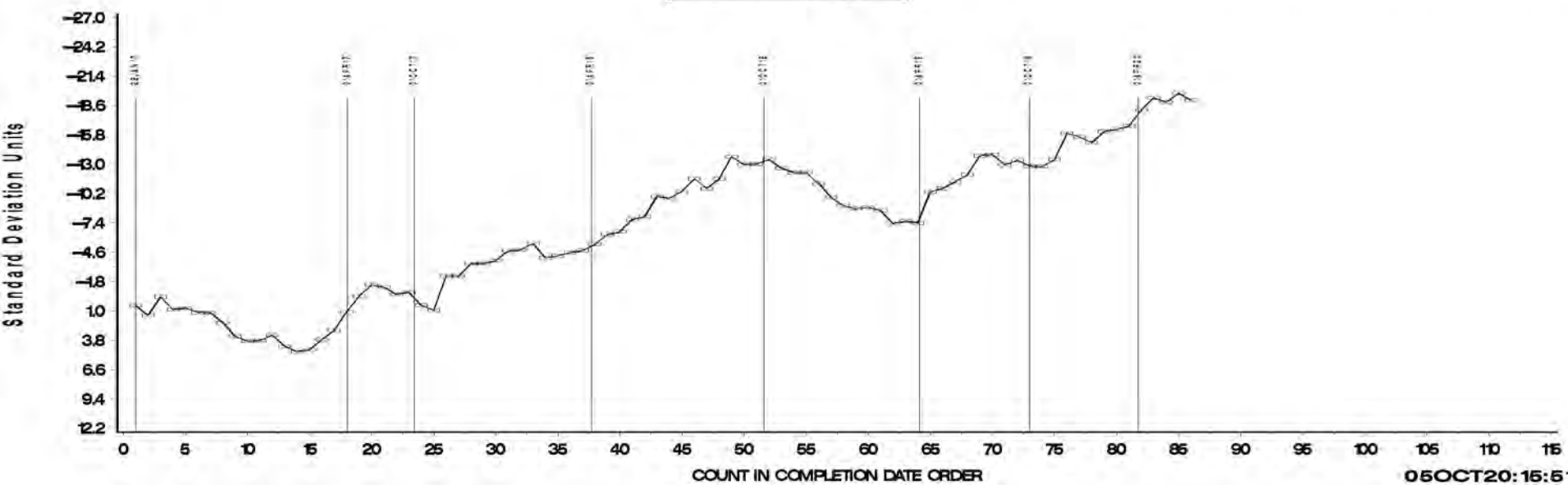


AVG PISTON SKIRT 50% RATING

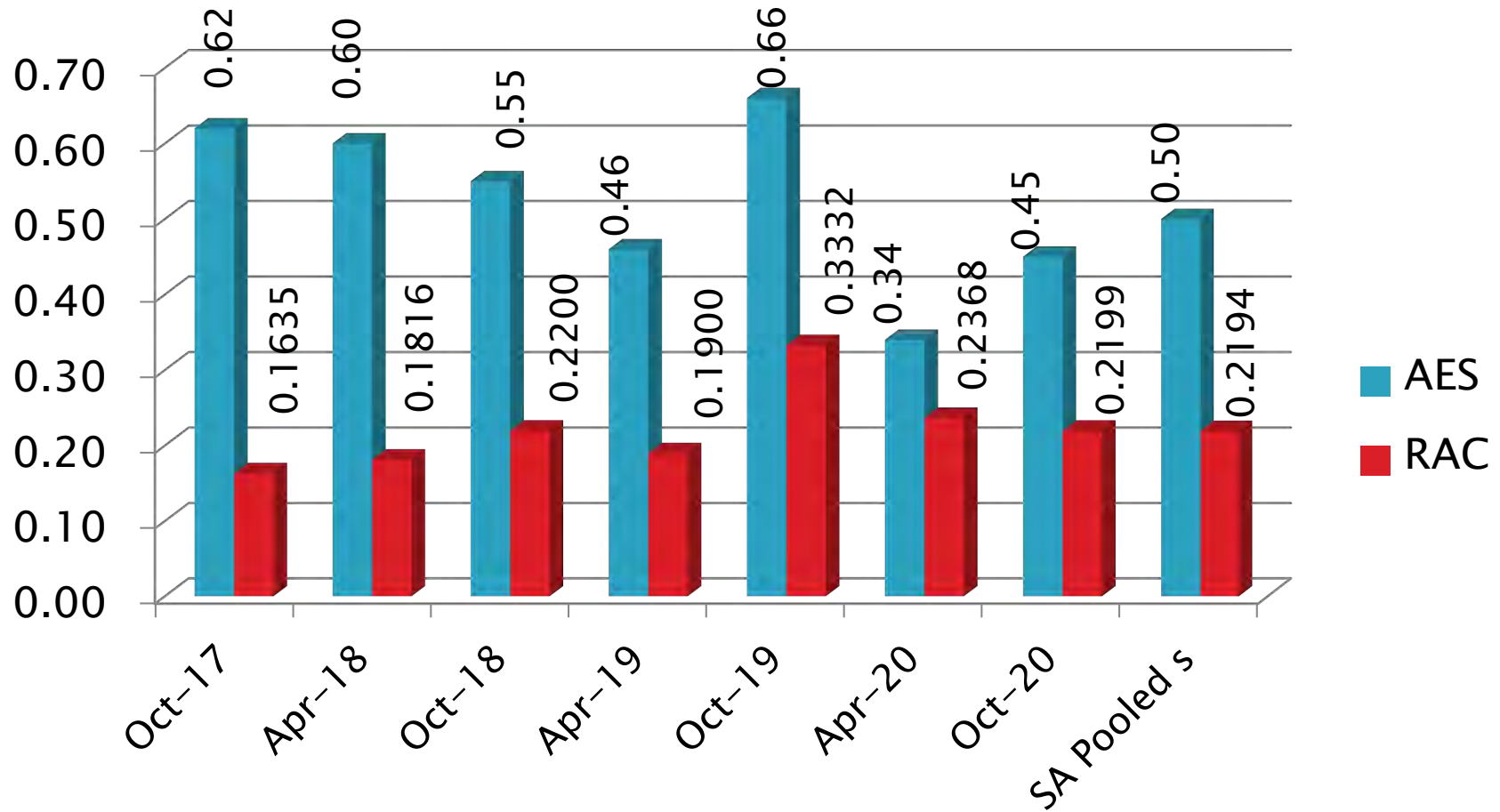
LTMS Severity Analysis



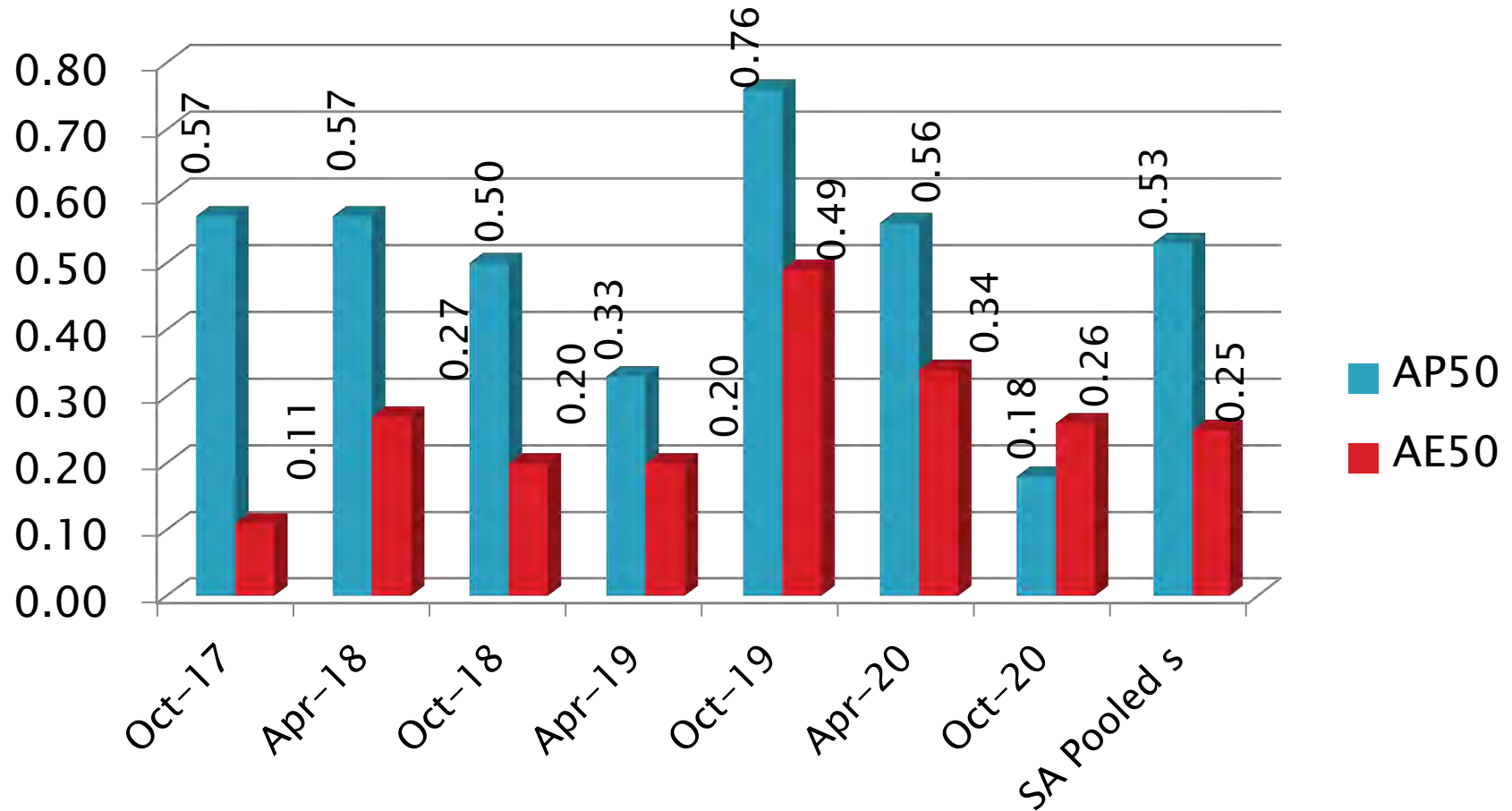
CUSUM Severity Analysis



Sequence VH Precision Estimates



Sequence VH Precision Estimates



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Sequence VIE

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Sequence VIE Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	17
Statistically Unacceptable Calibration Test	OC	1
Aborted Calibration Test	XC	1
Operationally Invalid Calibration Test (lab determination)	LC	1
Total		20

Sequence VIE- Failed Tests

Test Status	#
FEI1 Severe	1
Total	1

Sequence VIE – Lost Tests*

Test Status	Cause	#
Aborted	Exceeded Maximum Allowable Downtime	1
Invalid	Oil Circulation Pump Failure	1
Totals		2

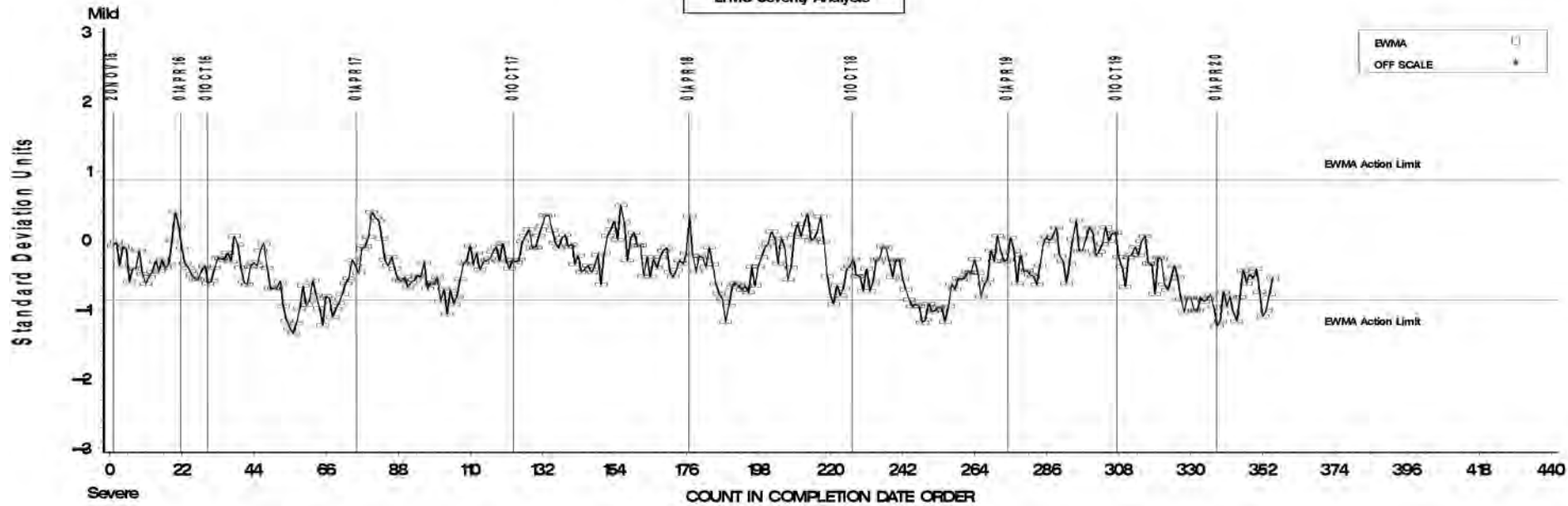
*Invalid and aborted tests

Sequence VIE Test Severity

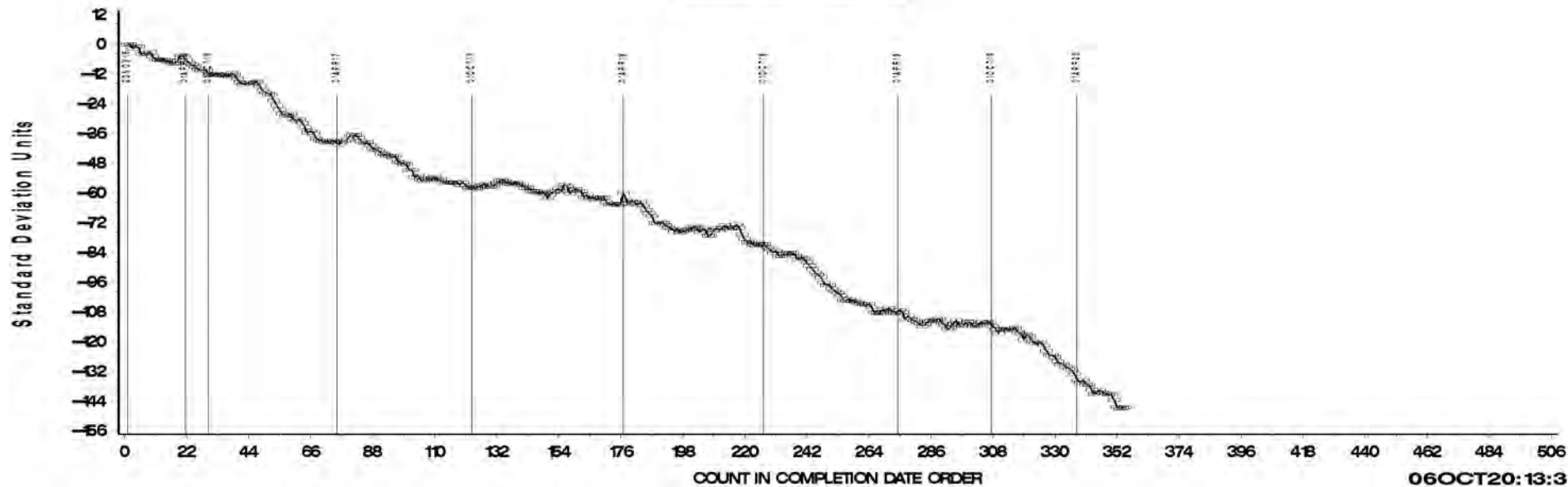
- FEI1 and FEI2 are in control

FEI FINAL RESULT PHASE I

LTMS Severity Analysis

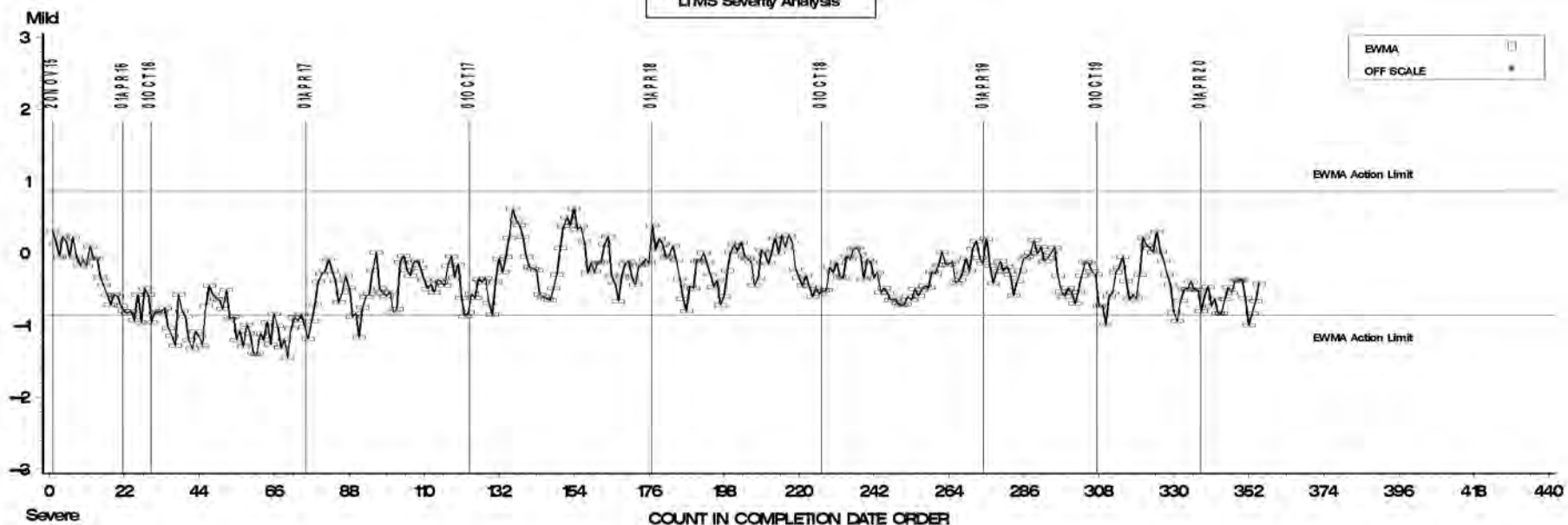


CUSUM Severity Analysis

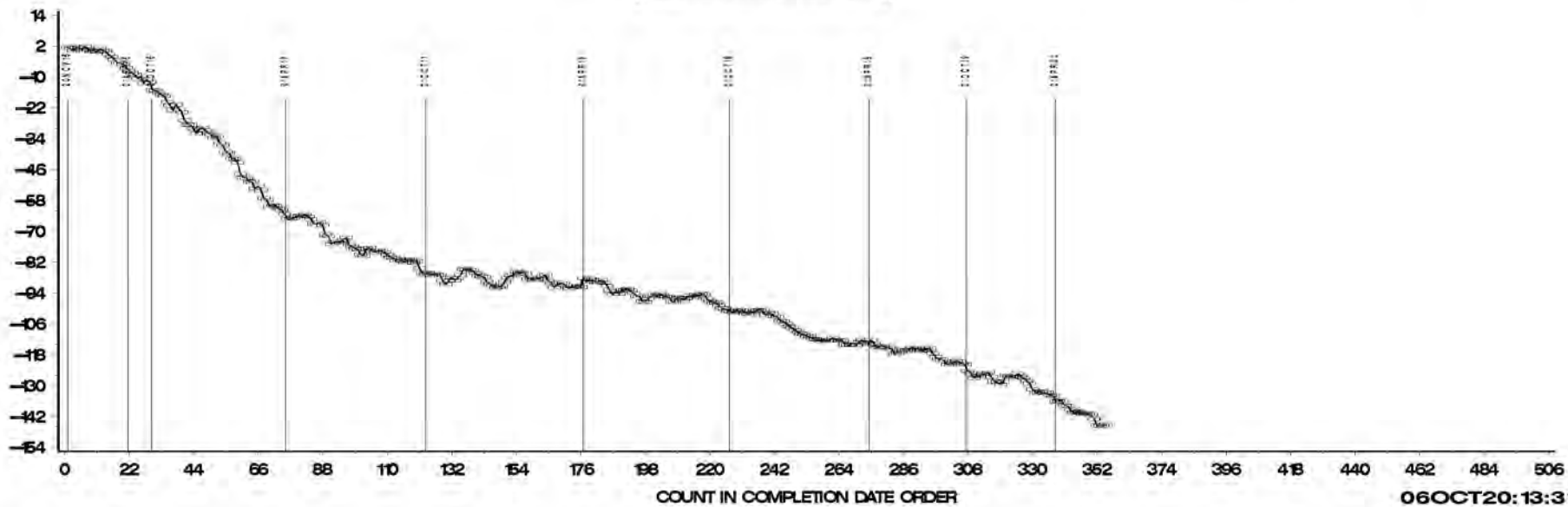


FEI FINAL RESULT PHASE II

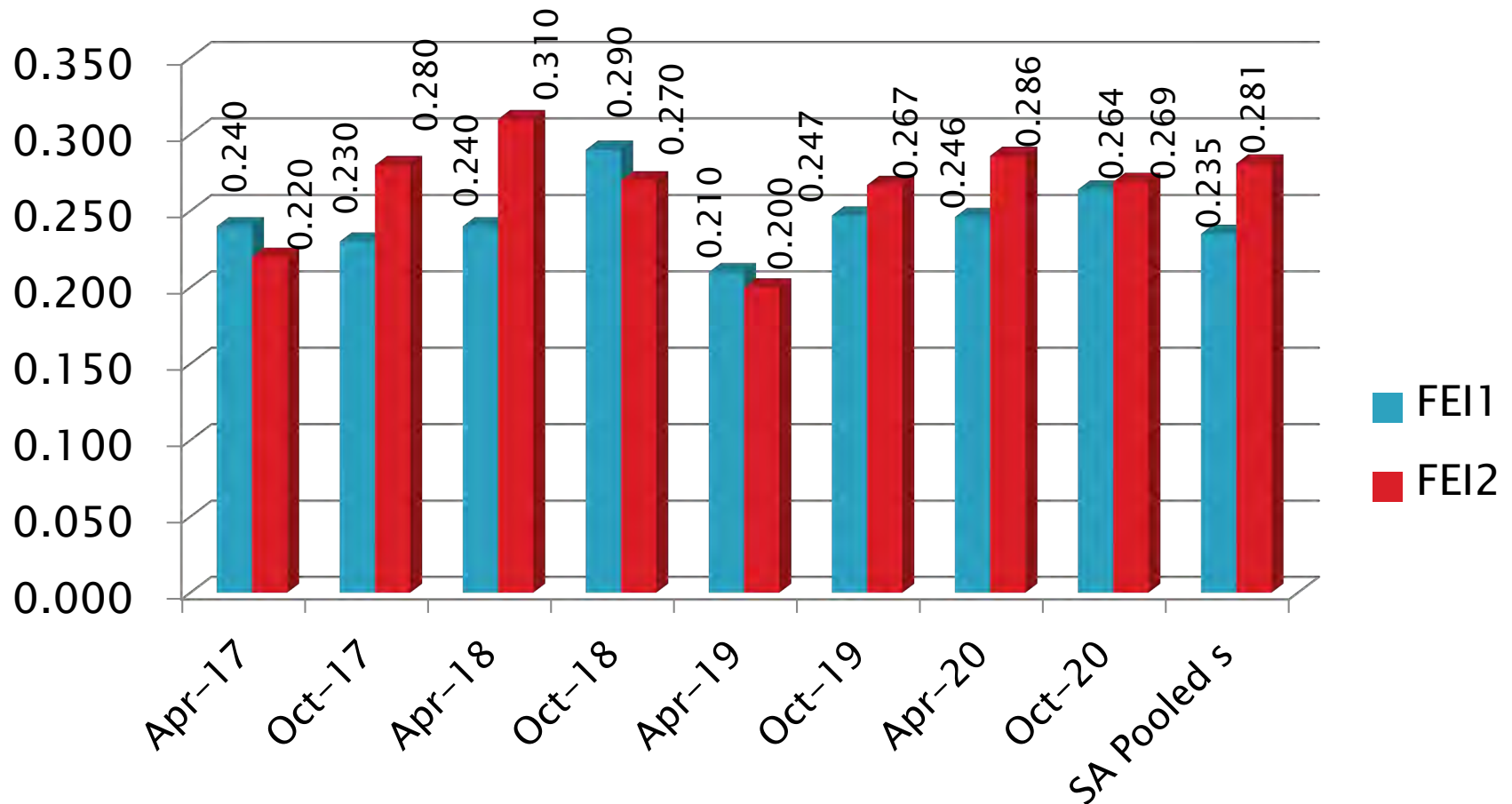
LTMS Severity Analysis



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	12
Failed Statistically	OC	2
Invalid by Lab	LC	2
Aborted	XC	1
Total		17

Sequence VIF – Failed Tests

Test Status	Number of Tests
Severe FEI1	1
Mild FEI1	1
Total	2

Sequence VIF – Lost Tests*

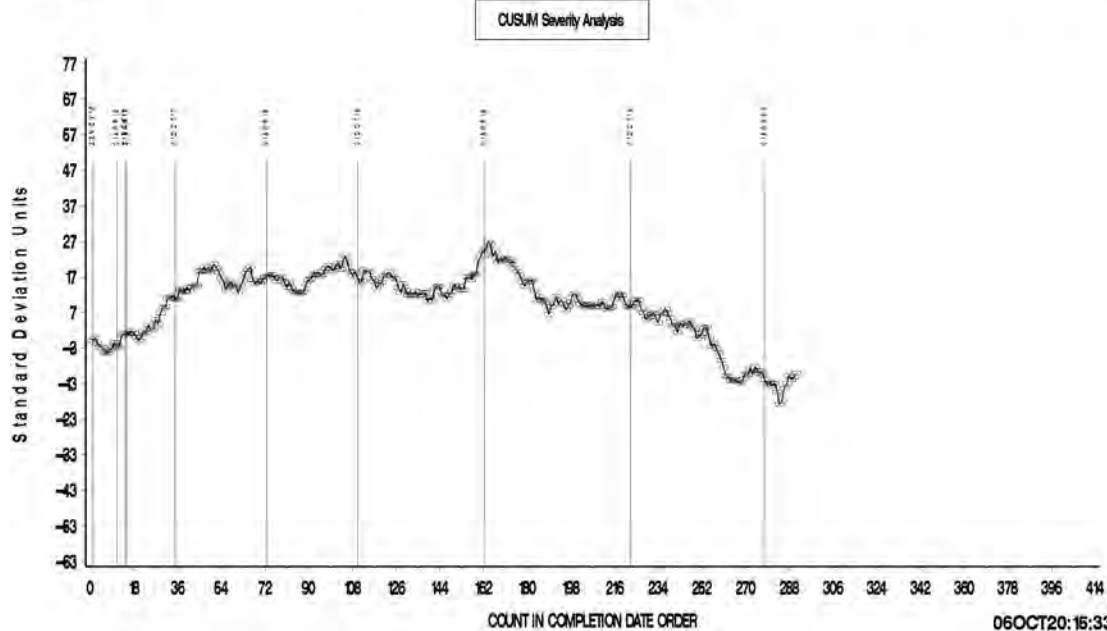
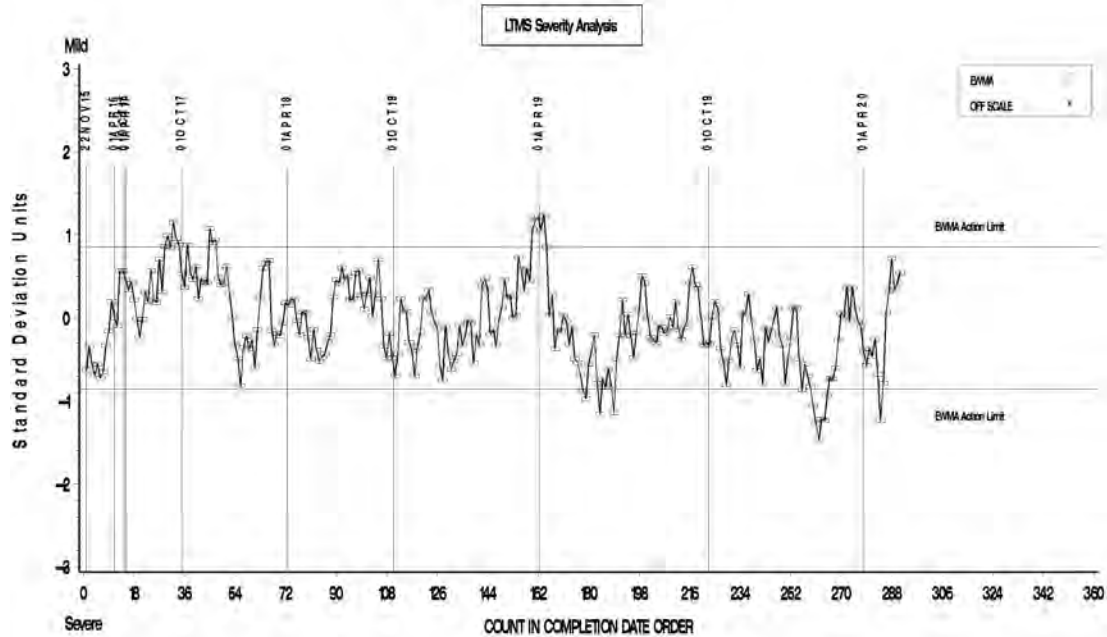
Test Status	Cause	#
Aborted	Downtime Exceeded Procedural Limit	1
Invalid	Data Acquisition System Issues	1
Invalid	BLB2 Torque Out of Specification	1
Total		3

*Invalid and aborted tests

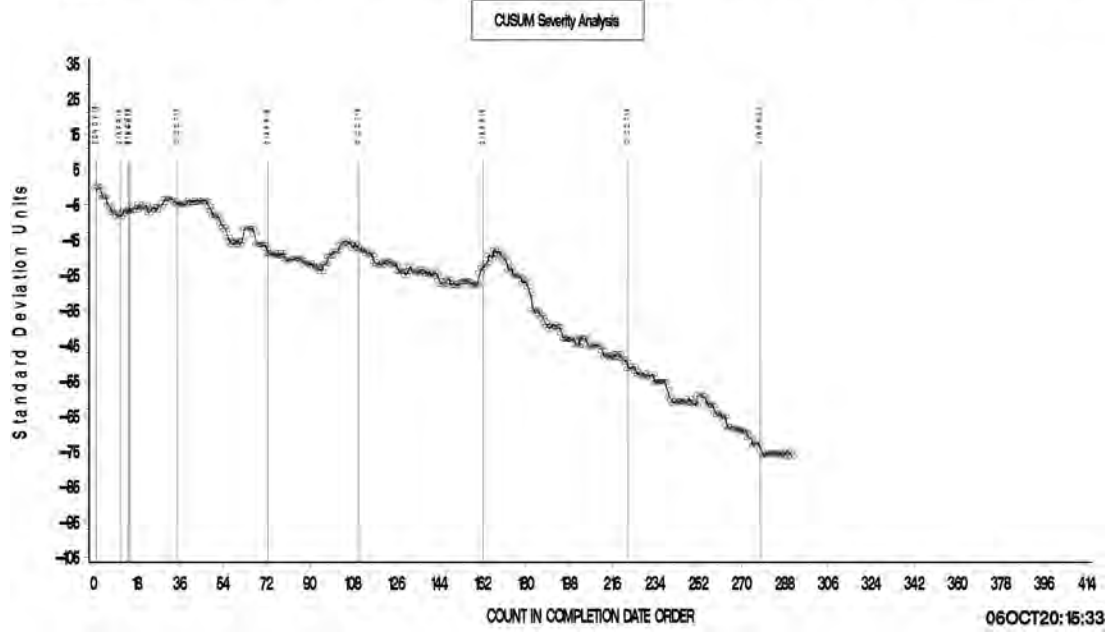
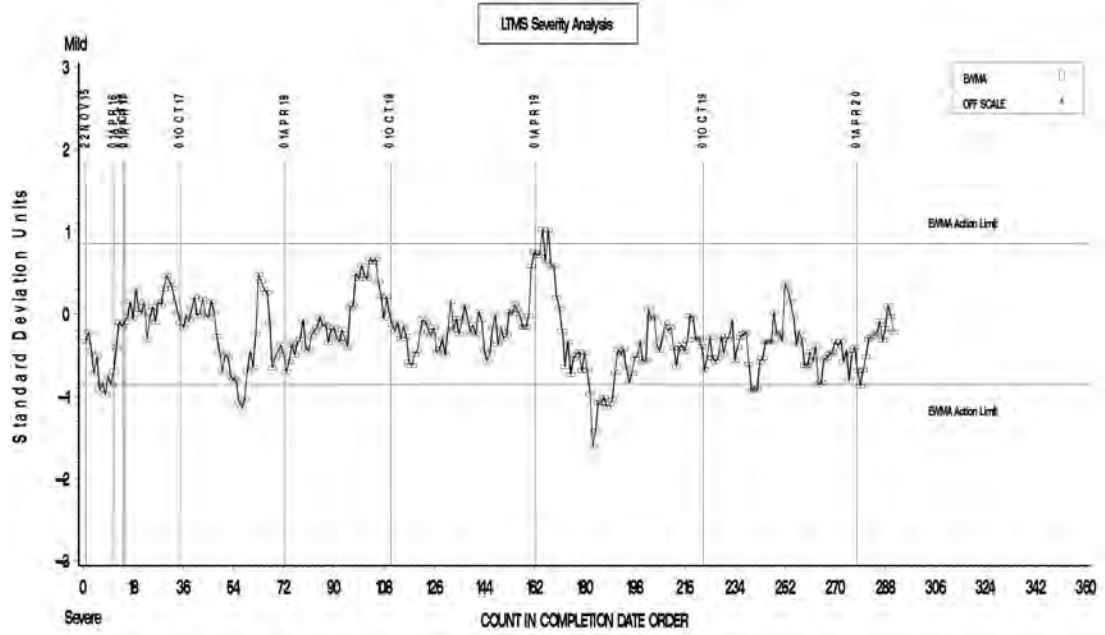
Sequence VIF Test Severity

- FEI1 is in control
- FEI2 is in control

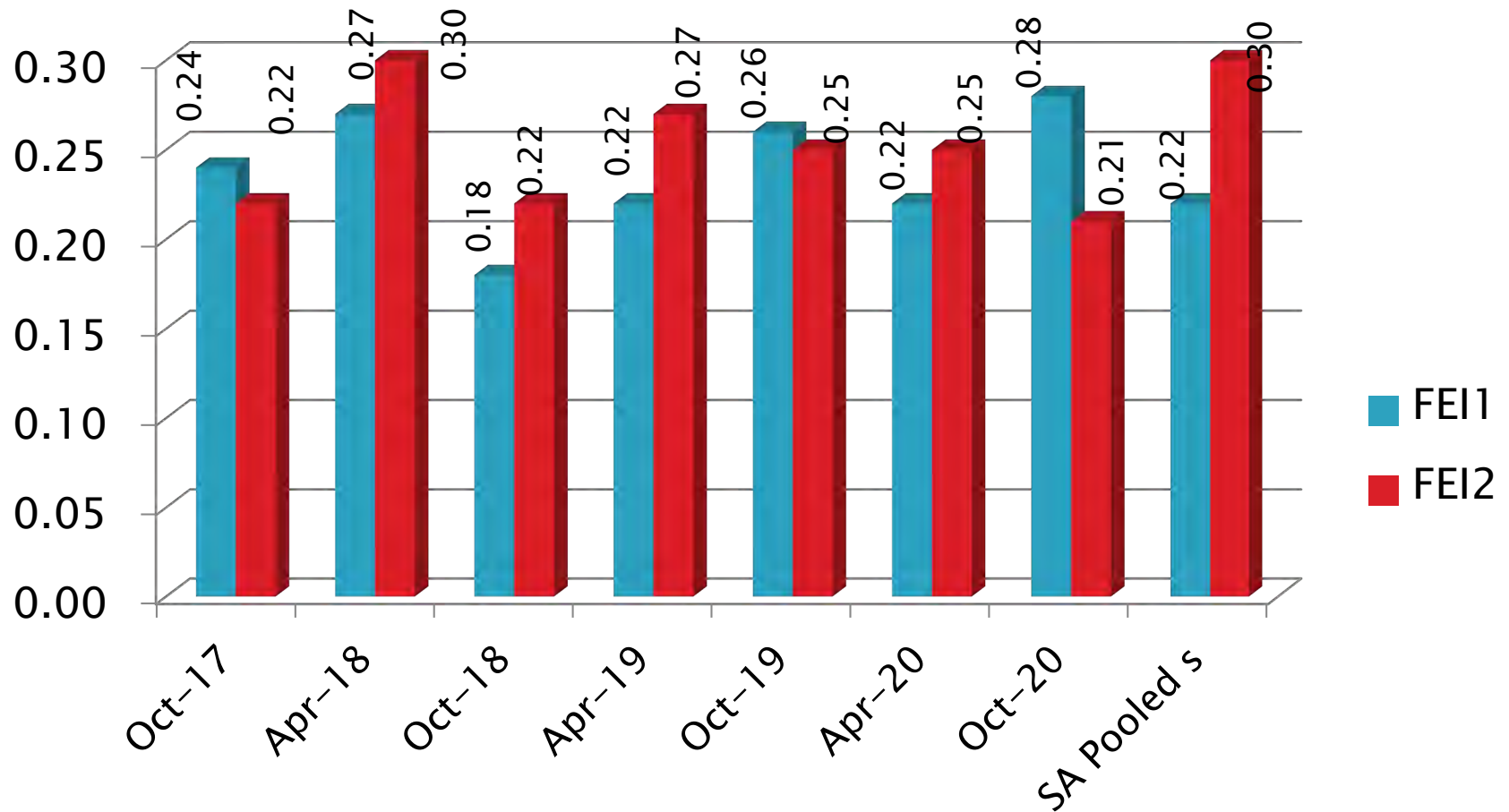
FEI FINAL RESULT PHASE I



FEI FINAL RESULT PHASE II



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	2
Statistically Unacceptable Calibration Test	XC	1
Operationally Invalid Calibration Test, Lab Judgement	LC	1
Total		4

Sequence VIII – Lost Tests

Test Status	Cause	#
Invalid	Lost Oil Pressure	1
Aborted	Coolant Leak into Engine	1
Totals		2

*Invalid and aborted tests

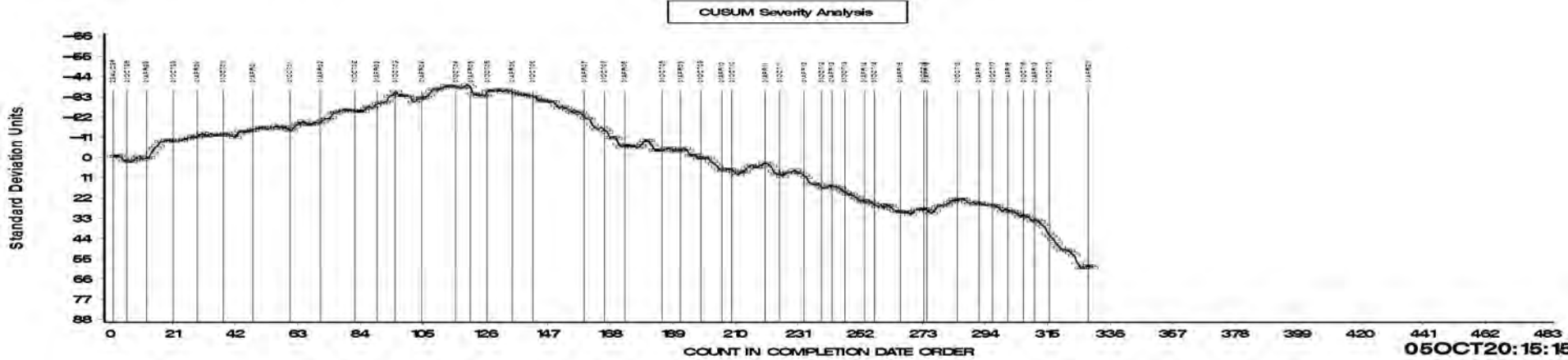
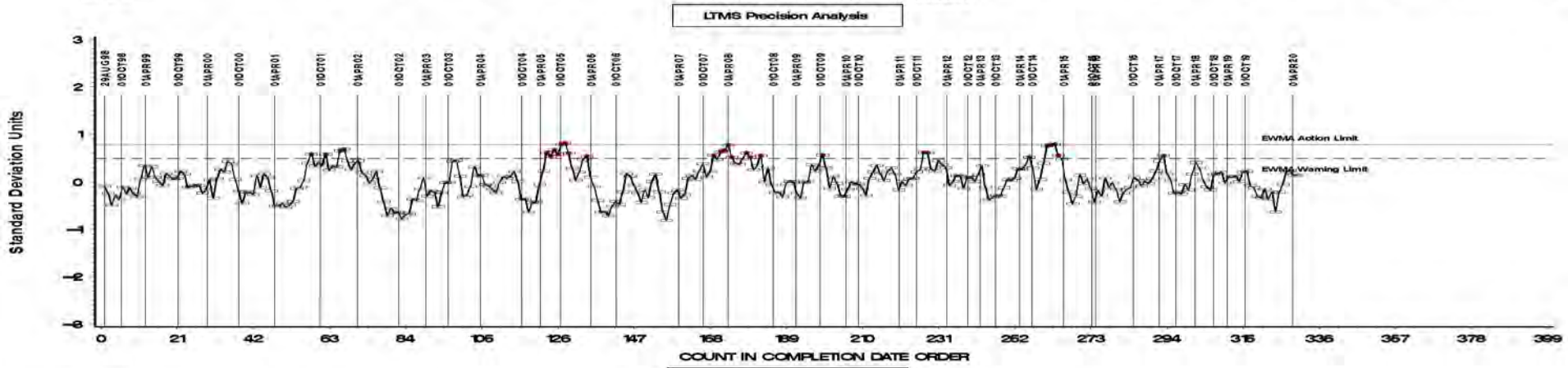
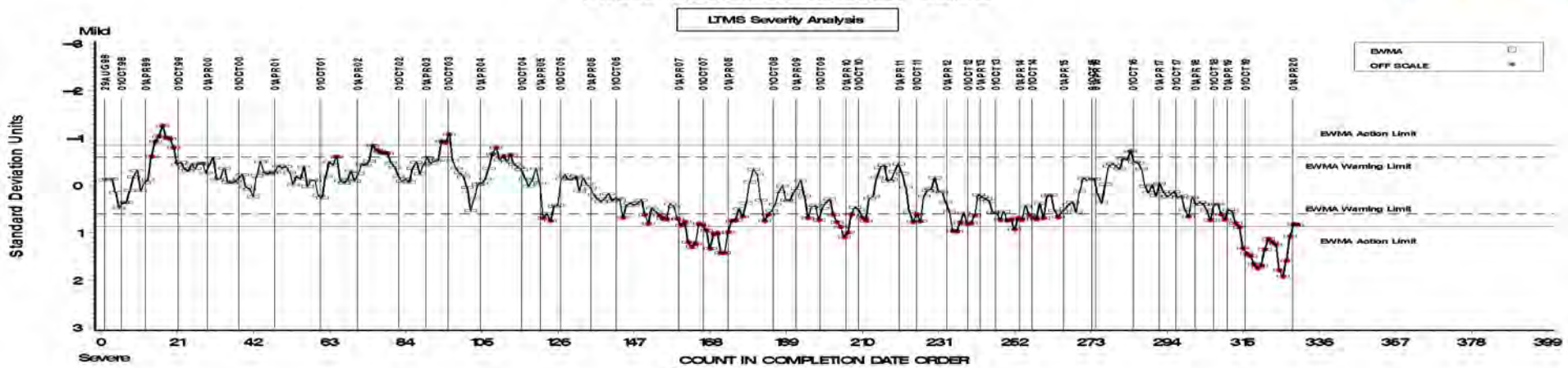
Sequence VIII Test Severity

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

SEQUENCE VIII INDUSTRY OPERATIONALLY VALID DATA



FINAL BEARING WEIGHT LOSS

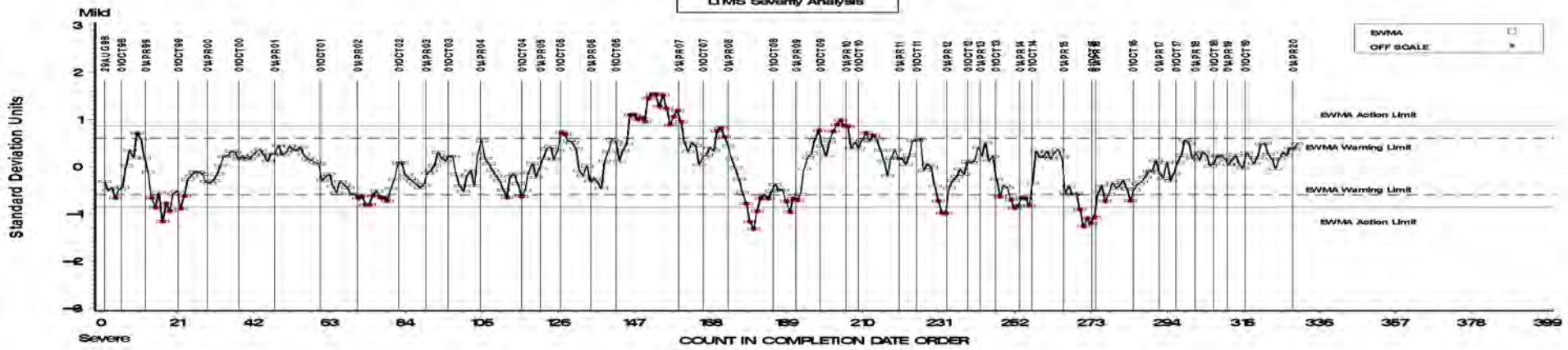


SEQUENCE VIII INDUSTRY OPERATIONALLY VALID DATA

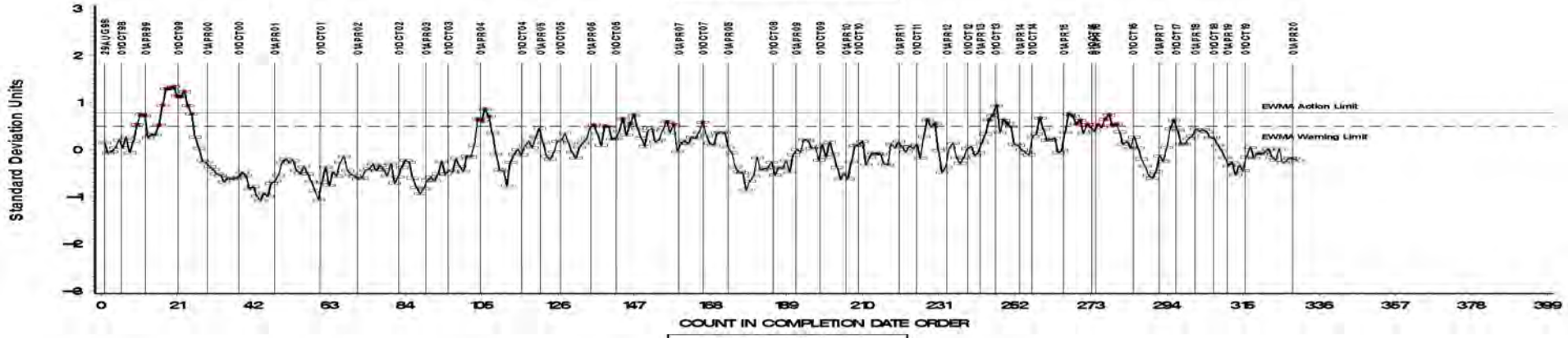


STRIPPED VIS. @ 100 DEG C

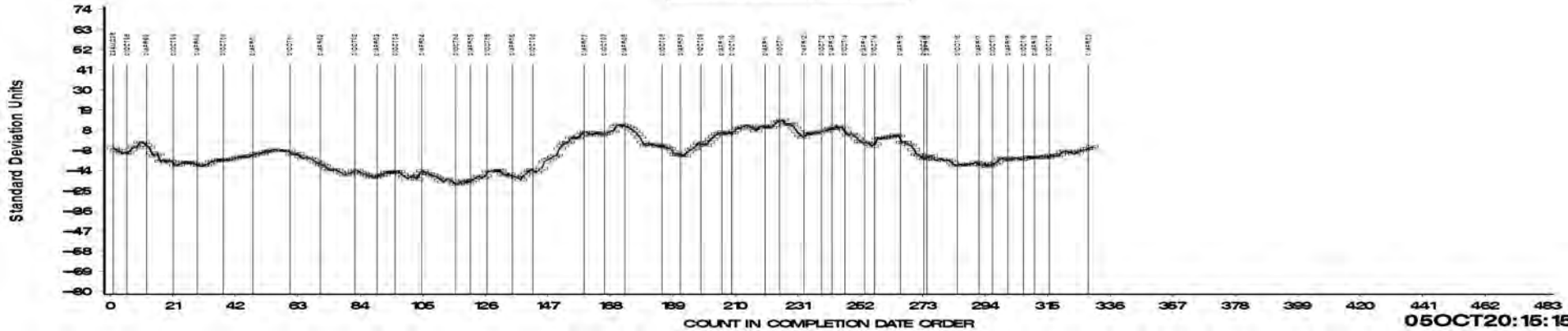
LTMS Severity Analysis



LTMS Precision Analysis

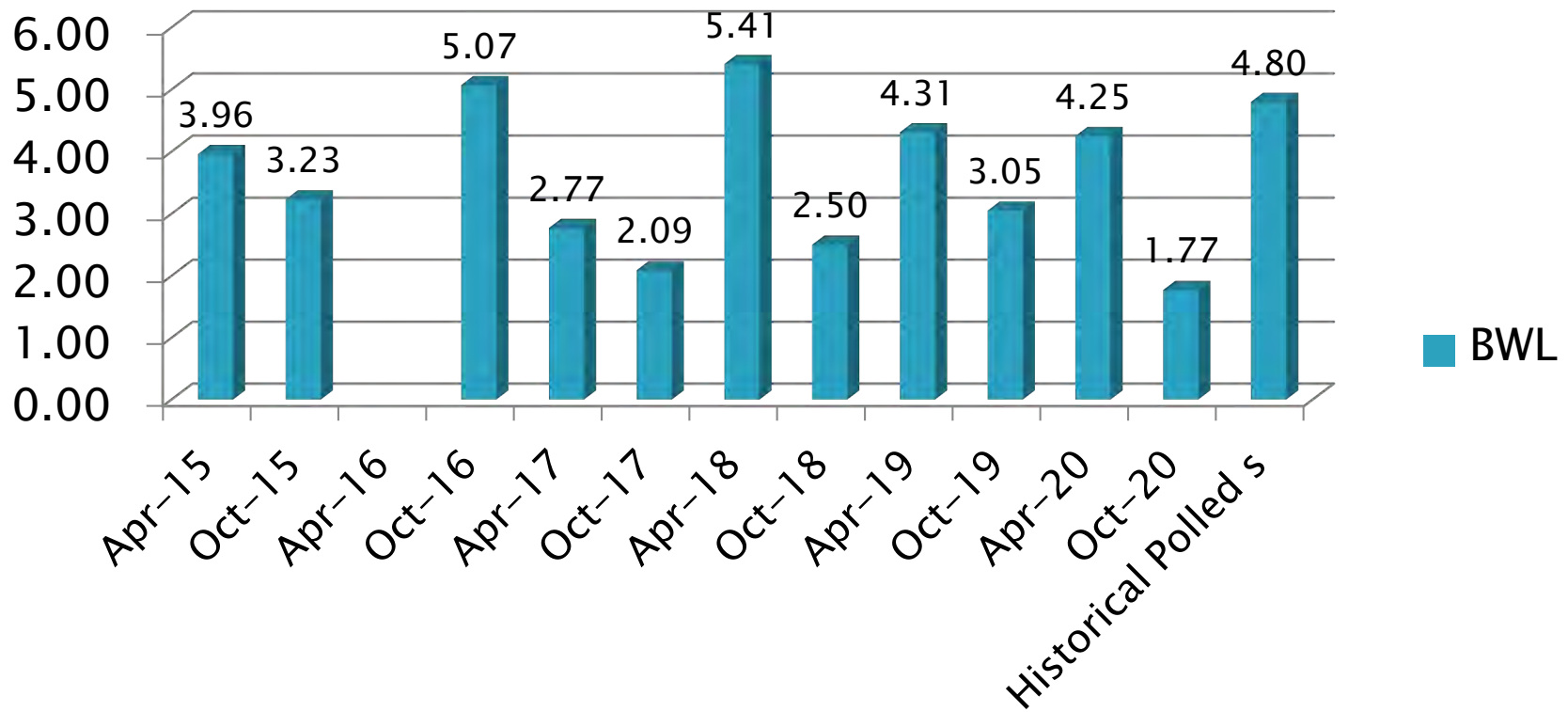


CUSUM Severity Analysis



Sequence VIII Precision Estimates

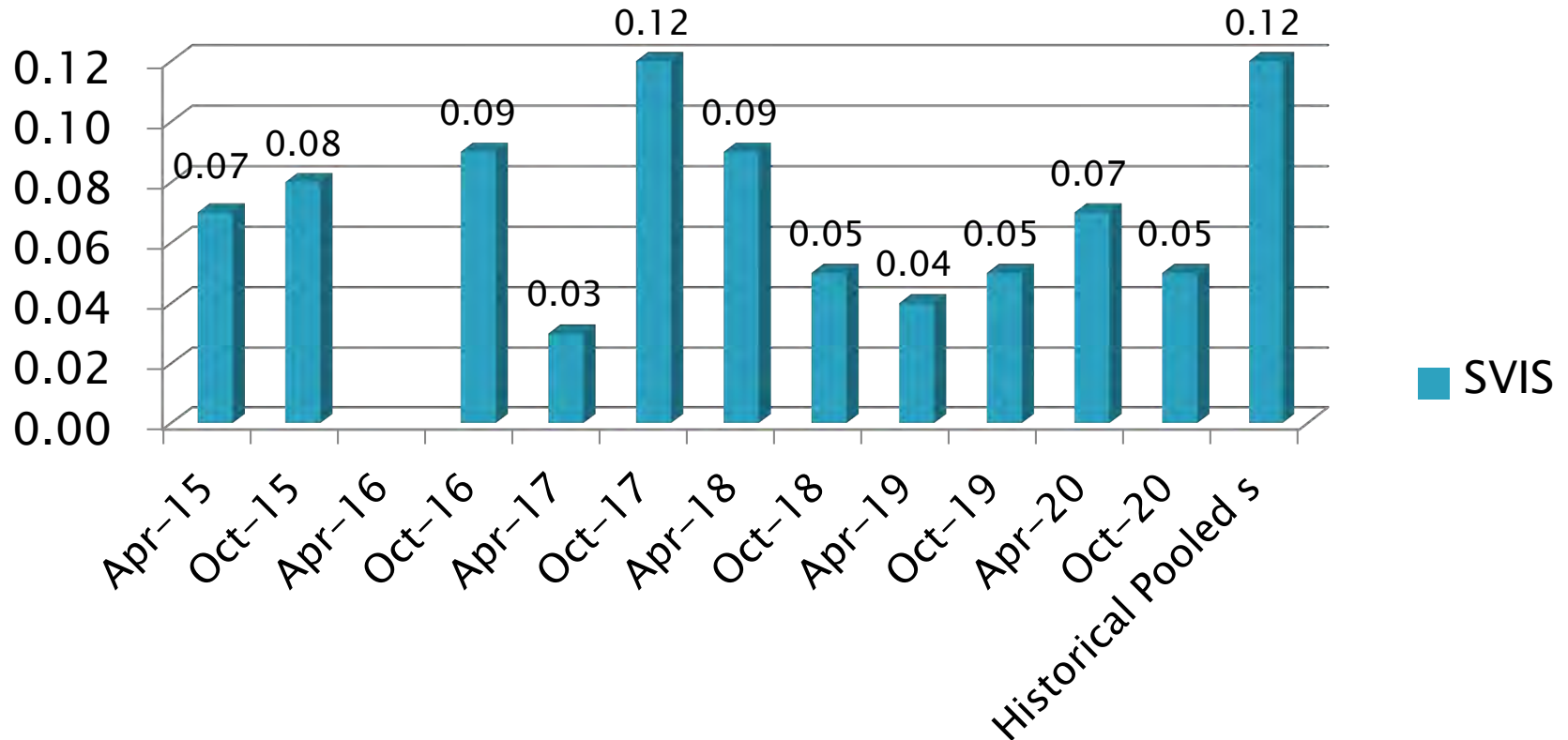
BWL



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	20
Statistically Unacceptable Calibration Test	OC	4
Operationally Invalid Calibration Test, lab determination	LC	3
Not for Industry Statistic Test, Used Oil LSPI Tests	NI	9
Abandoned Engine, Did Not Calibrate	MC	2
Not for Industry Statistics Test, 2019 BB Piston	NN	1
Total		39

Sequence IX – Failed Tests

Test Status	Number of Tests
Ei Level 3 alarm	4
Total	4

Sequence IX – Lost Tests*

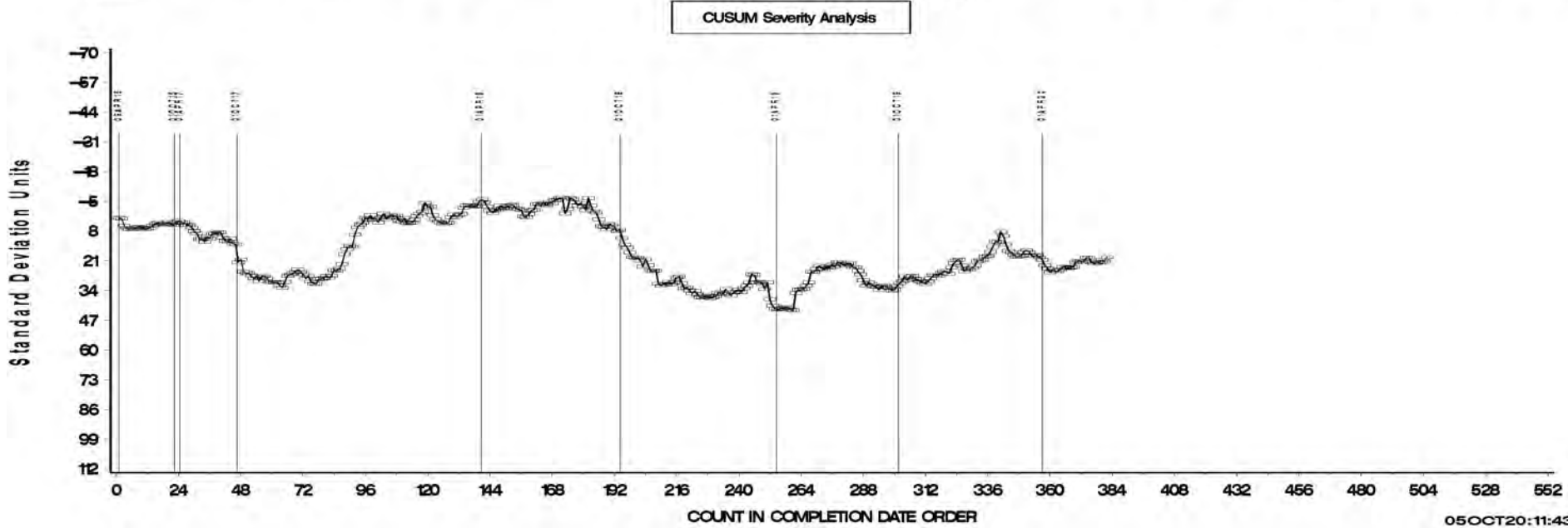
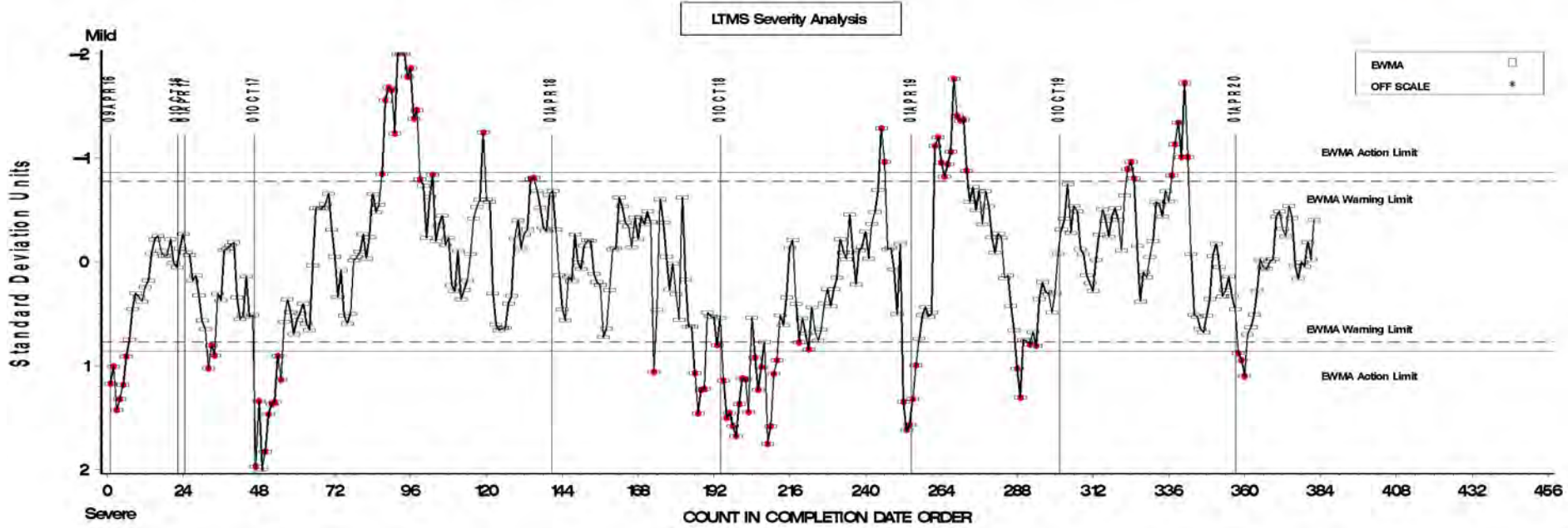
Test Status	Cause	#
Invalid	Lost Operational Data	1
Invalid	Did not obtain Four Iterations with Minimum # of Combustion Cycles	1
Invalid	AVL Encoder Alignment Issue	1
Totals		3

*Invalid and aborted tests

Sequence IX Test Severity

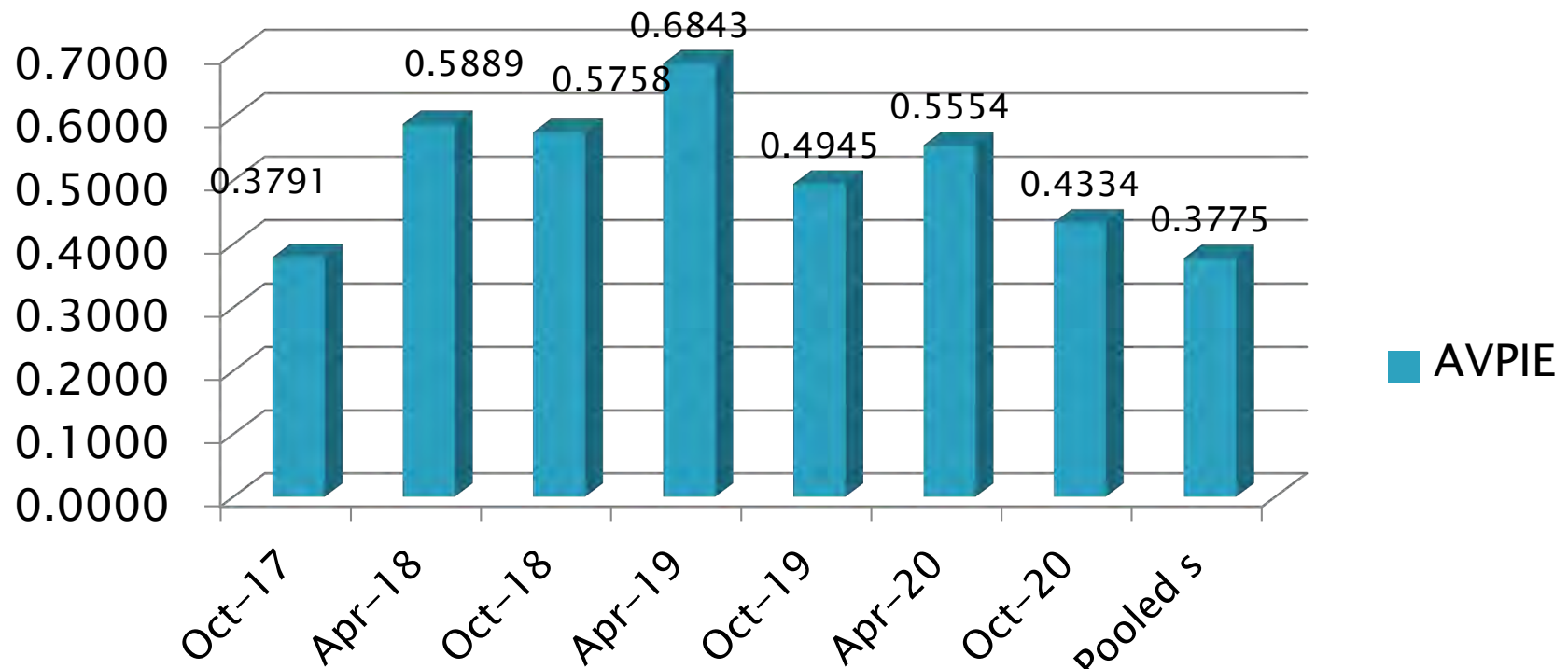
- Average number of Pre-ignitions in control.

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
Statistically Unacceptable Calibration Test	OC	1
Operationally Invalid Calibration Test (Lab determination)	LC	1
Aborted Calibration Test	XC	1
Total Number of Tests		9

Sequence X – Failed Tests

Test Status	Number of Tests
CHST Ei Level 3 alarm	1
Total	1

Sequence X – Lost Tests*

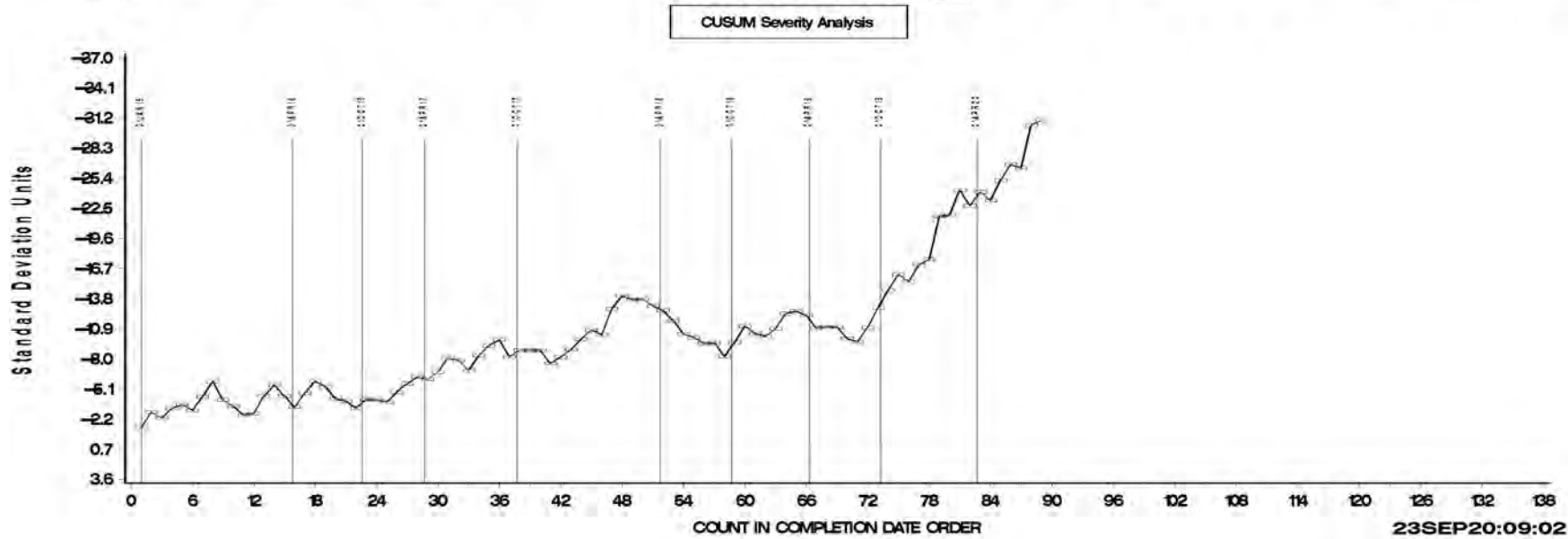
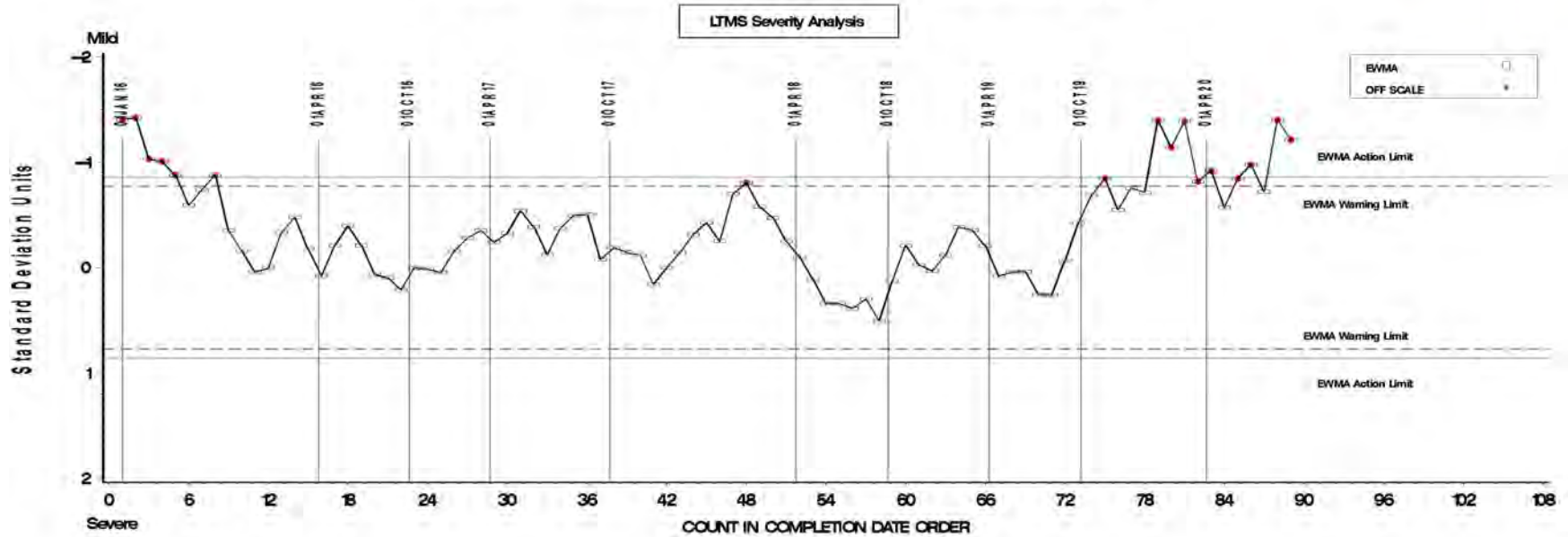
Test Status	Cause	#
Invalid	Computer Issues	1
Aborted	Engine mount failure	1
Totals		2

*Invalid and aborted tests

Sequence X Test Severity

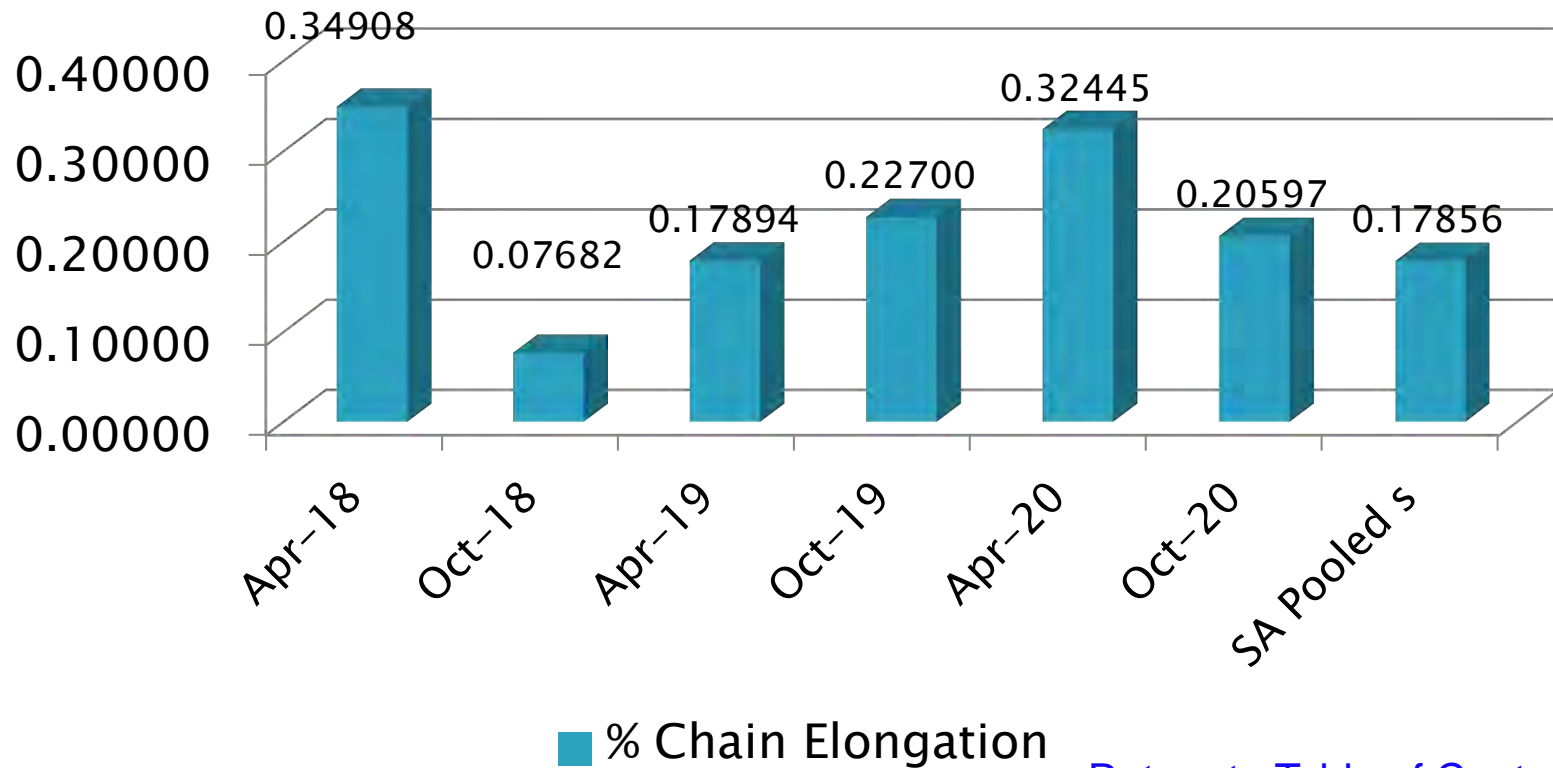
- Average Chain Stretch % in Severity Action Alarm (mild)

END OF TEST CHAIN WEAR FINAL RESULT



Sequence X Precision Estimates

% Chain Elongation



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Information Letters

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Information Letters*

Test	Date	IL	Topic
IIIH	20200501	20-2	Removed redundant section 6.2.3.
IIIH	20200519	20-3	Corrected note 7 which erroneously showed a transformation being applied to WPD.
IIIH	20200707	20-4	Clarified reporting requirements for IIIH 60 hour and IIIH 70 hour test procedures and test results.
VIE	20200813	20-2	Corrected footnote 22 regarding research report.
VIE	20200831	20-3	Revised section 6.2.6 to show the correct figure identifying the pressure probe drawing.

*Available from TMC Website

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Information Letters* (cont.)

Test	Date	IL	Topic
VIE	20200914	20-4	Corrected engine hour correction multiplier in equation A15.7.
VIF	20200813	20-2	Corrected footnote 22 regarding research report.
VIF	2020080	20-3	Revised section 6.2.6 to show the correct figure identifying the pressure probe drawing.
X	20200414	20-2	Updated procedure to show provisions allowing a stand to be calibrated for more than one test type.
X	20200911	20-3	Corrected table 12 to identify the a natural log transformation is applied to Chain elongation parameter.

*Available from TMC Website

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Reference Oil Inventory

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

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Reference Oil Re-blends

➤ TMC 543

- A re-blend has been requested for this oil.

➤ TMC 1009-1

- This oil is being held for IVA and VIII. This oil was also being used as a break in oil for IVB. Recently, IV panel agreed to use SL107 for IVB break-in since 1006-2 can not be re-blended.

Reference Oil Re-blends (cont)

➤ TMC 1009-1

- The Sequence V panel agreed to removed this oil due to performance issues. A replacement oil, 931 has been obtained and is being introduced, with three tests completed this report period.

➤ TMC 1011-1

- Reblend, 1011-1, is now available and needs to be introduced (IVB/VH/VIF/X) in the near future as quantities of 1011 are nearly exhausted.

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	53	197	85	2 years
221	IX	2120	128	636	90	2.5 years
222*	IX	1040	60	0	35	<1 year
224	IX	1026	112	384	110	1.5 years
270	X	1100	42	766	35	5 years
271	X	980	30	699	55	5 years
300-1	IVB	378	0	259	40	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	25	752	27.5	5+ years
436	IIIH	1100	15	700	20	5+ years
438-1	IIIH	605	0	0	10	<1 year
438-2	IIIH	540	7.5	427	7.5	5 years
542-3	VIE/VIF	997	82	5	18	<1 Year
542-4	VIE/VIF	1100	74	426	114	1.5 Years
543	VIF	1100	27	227	54	1.5 Years
544	VIE	897	12	233	72	4+ 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	8	41.5	12	2 years
931	VH	908	30	878	15	5+ years
940	VH	560	0	96	15	2+ years
1006-2	IVA, VIII	5500	30	250	48	1.5 years
1009-1	VH, VIII	1100	21	922	3	5 years
1010-1	VIE	1760	66	227	78	~2 years
1011	IVB/VH/VIF/X	1100	0	13	103	<1 year
1011-1	IVB/VH/VIF/X	1395	0	1395	0	5+ years
1012	IVB	2200	50	1560	65	5+ years

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LTMS Deviations

»» April 1, 2020 –
September 30, 2020

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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, 2020 –
September 30, 2020

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Quality Index Deviations

- Three IIIH Quality Index Deviations were requested this Report Period.
 - Deviation for Intake Air Temperature due to Air Handler inoperative during first 30 minutes of test.
 - Two deviations for coolant out temperature control (same lab and stand) due to heat exchanger plumbed incorrectly.

Quality Index Deviations

Historical Count of PCEO Quality Index Deviations

Test	Quality Index Deviations
IIIH	8
IVA	30
IVB	1
VH	5
IX	1
X	2

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TMC Laboratory Visits

»» April 1, 2020 –
September 30, 2020

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TMC Lab Visits

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

Lab Visit Issues

No Lab Visits were conducted this report period.

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Test Area Timelines

»» April 1, 2020 –
September 30, 2020

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Test Area Timeline Additions*

Test	Date	Topic	IL
IVB	20200901	Sequence IVB Test Method passed D02 Ballot	
IIIH	20200501	Removed redundant section 6.2.3.	20-2
IIIH	20200519	Corrected note 7 which erroneously showed a transformation being applied to WPD.	20-3
IIIH	20200707	Clarified reporting requirements for IIIH 60 hour and IIIH 70 hour test procedures and test results.	20-4
VIE	20200813	Corrected footnote 22 regarding research report.	20-2
VIE	20200831	Revised section 6.2.6 to show the correct figure identifying the pressure probe drawing.	20-3

*As of 09/30/2020

Test Area Timeline Additions*

Test	Date	Topic	IL
VIE	20200904	Corrected engine hour correction multiplier in equation A15.7.	20-4
VIF	20200813	Corrected footnote 22 regarding research report.	20-2
VIF	20200831	Revised section 6.2.6 to show the correct figure identifying the pressure probe drawing.	20-3
X	20200414	Updated procedure to show provisions allowing a stand to be calibrated for more than one test type.	20-2
X	20200911	Corrected table 12 to identify the a natural log transformation is applied to Chain elongation parameter.	20-3

*As of 09/30/2020

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Rating Workshop Data

»» 2019 Light Duty Workshop

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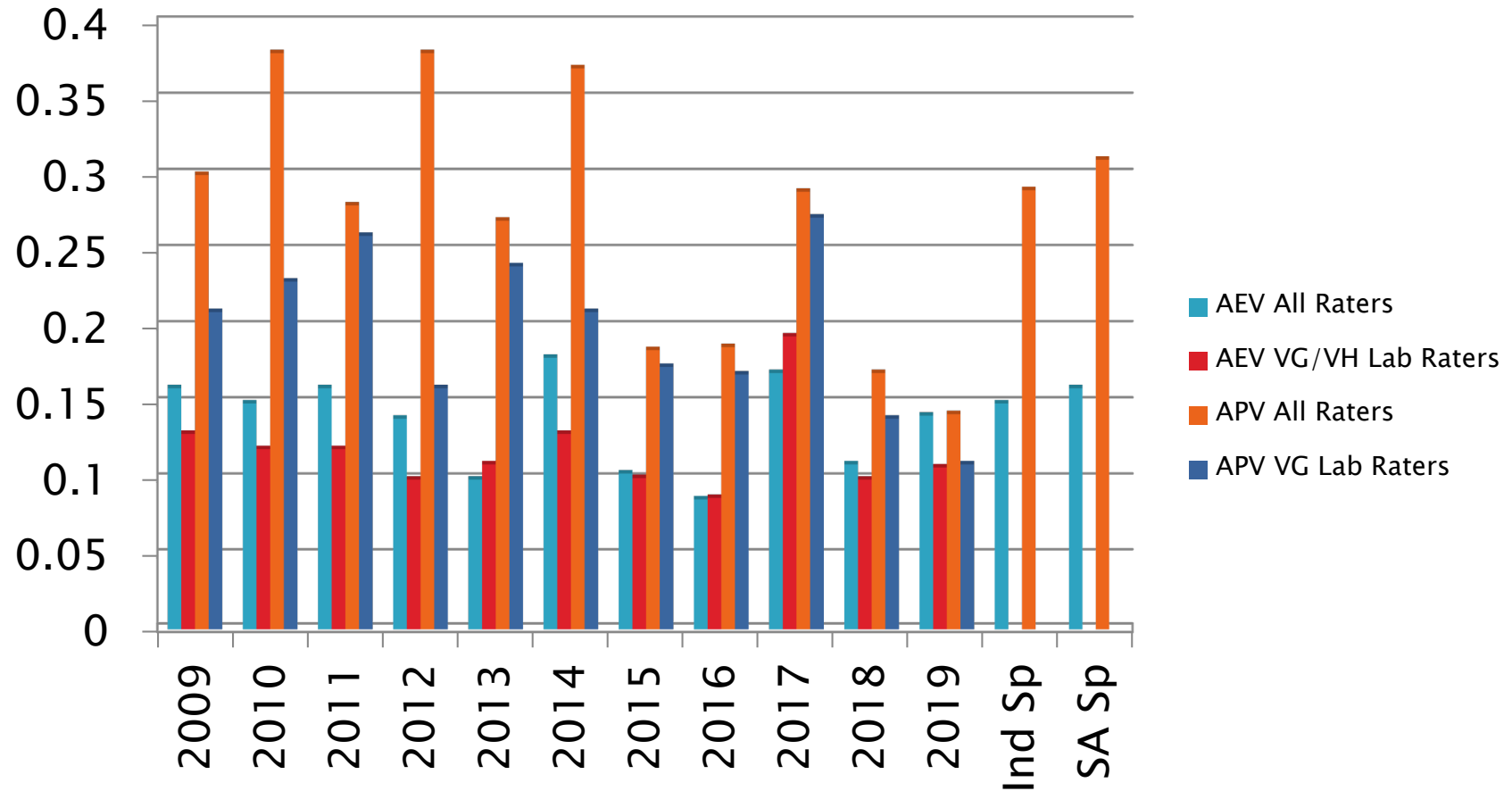
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Rating Workshop Data

- ▶ Summary of Precision Data From Light Duty Rating workshops:
 - VH Average Piston and Average Engine Varnish.
 - IIIH WPD
 - Data is from 2019 workshop; 2020 workshop was cancelled due to pandemic.

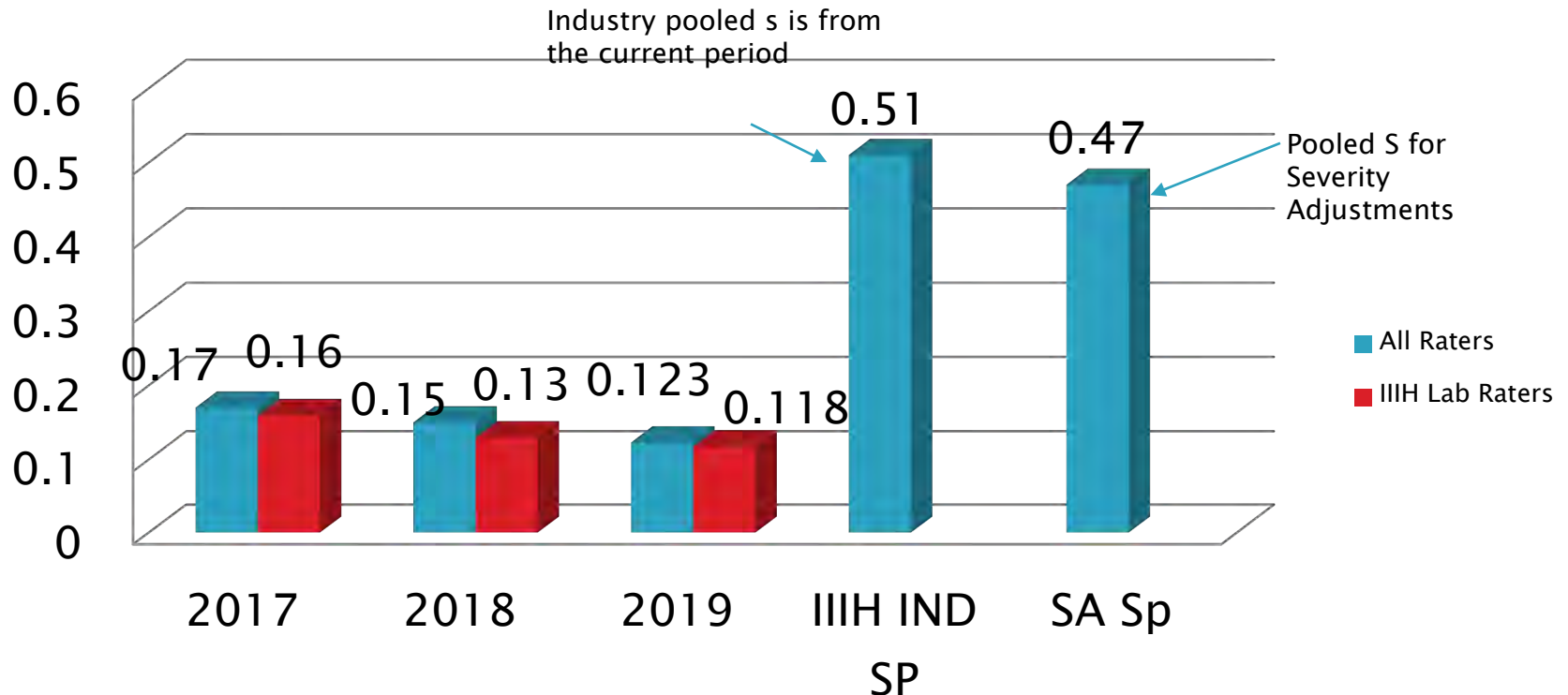
Sequence VG/VH Precision-Rating Workshop Data

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

- ▶ www.astmtmc.cmu.edu

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