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GM Reference Test Activity

Reference tests completed 4/1/2022 – 9/30/2022

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Summary of Tests

- GMAER - Aeration continues to trend mild at about the same level since 2019
- GMOD – All parameters in control and reblends being pursued for GMOD01 and GMOD02
- GMOEE - Severity trending at or near historic levels
- GMSPI3 – Test activity lower this period with severity near historic levels
- GMTTC – Continued to trend mild this period (with limited test results)

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Calibrated Labs and Stands*

Test	Labs	Stands
GMOD	4	6
GMAER	2	3
GMOEE	2	9
GMSP13	1	2
GMTC	1	2

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*As of 9/30/2022

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GMAER

October 2022

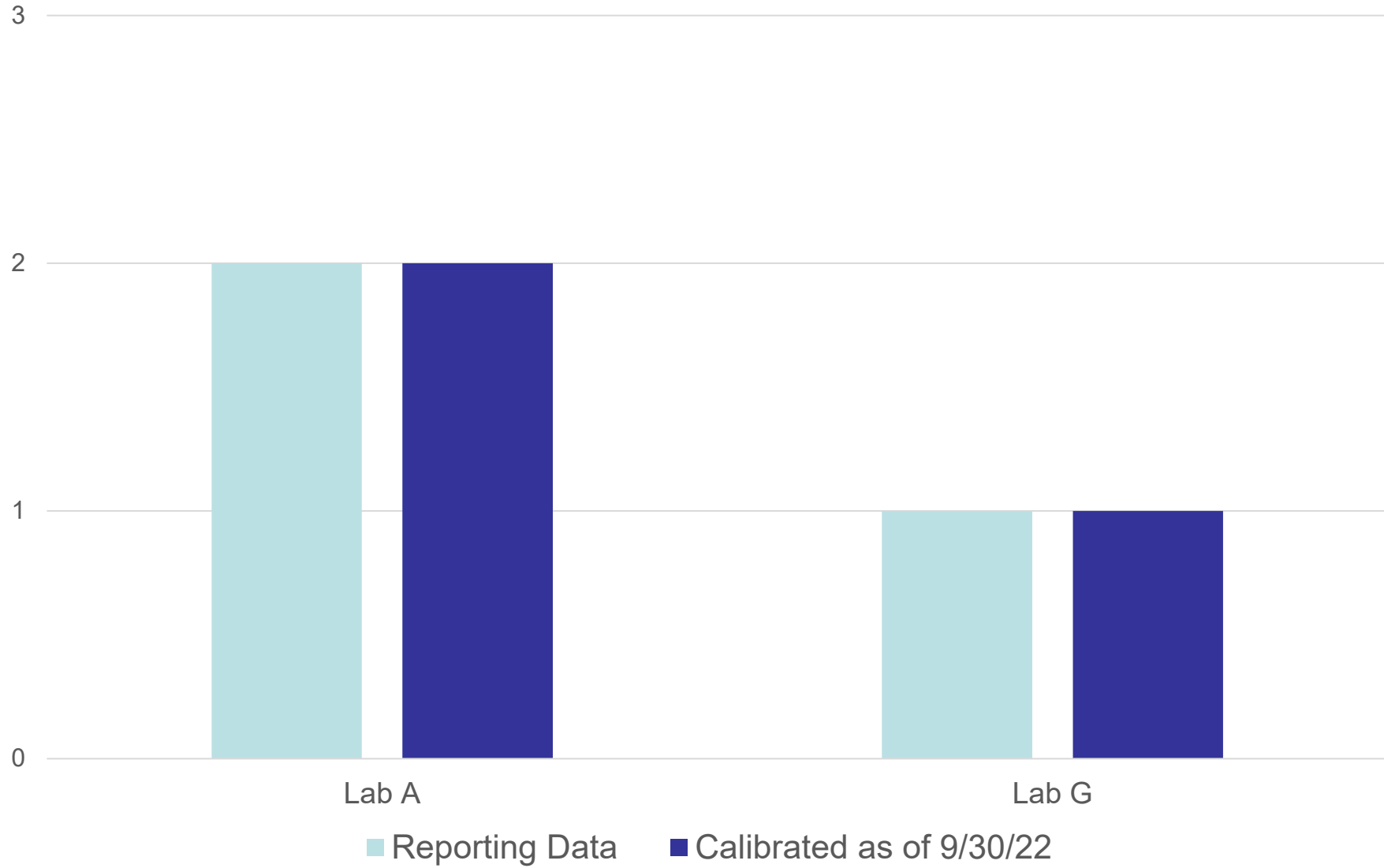
Summary of Activity

- Three calibrated stands in two laboratories
- Aeration continues to trend mild at about the same level since 2019

GMAER Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	5
Total		5

Calibrated Labs and Stands



GMAER - Failed Tests

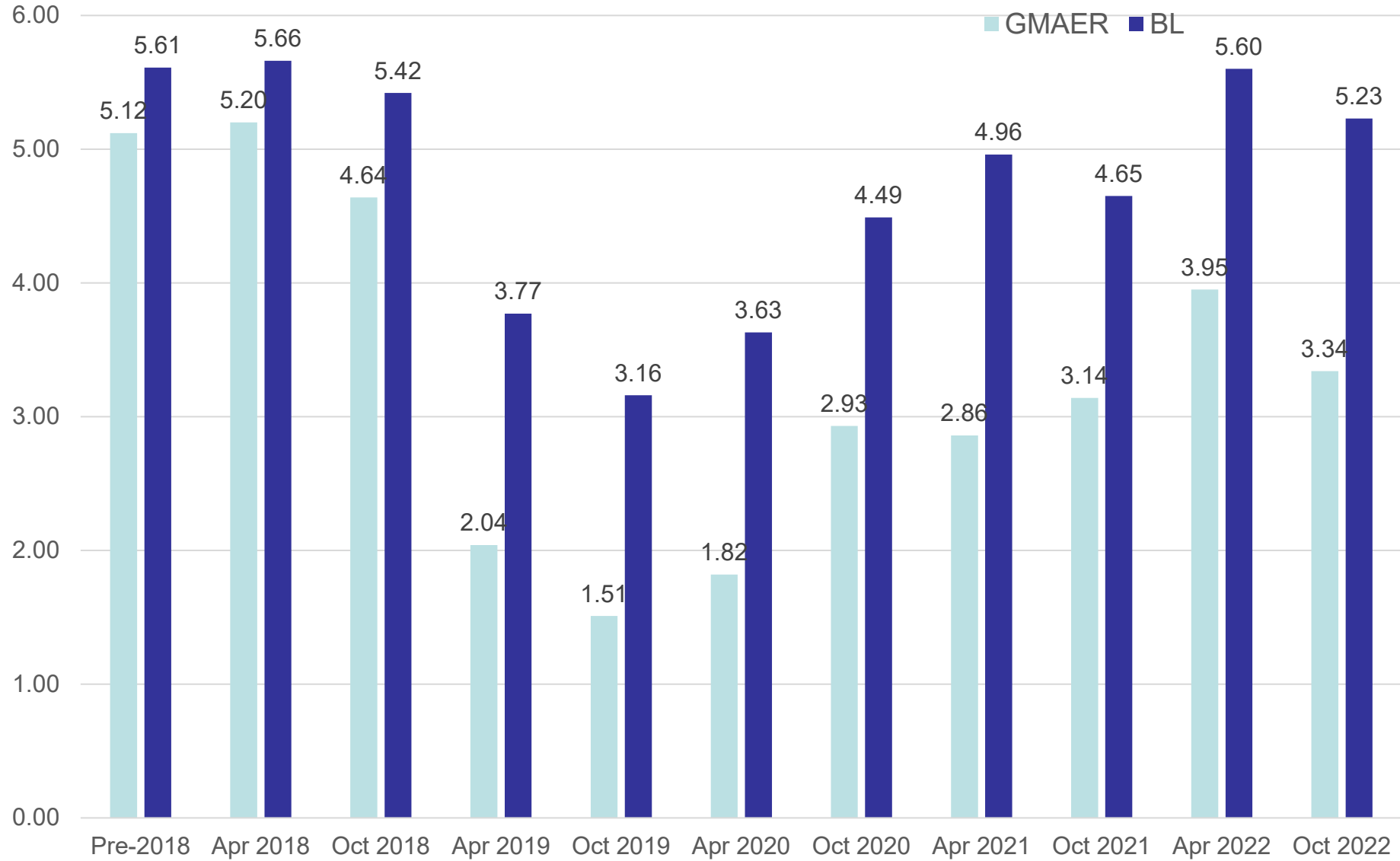
Test Status	#
No failed tests	-
Totals	0

GMAER - Lost Tests*

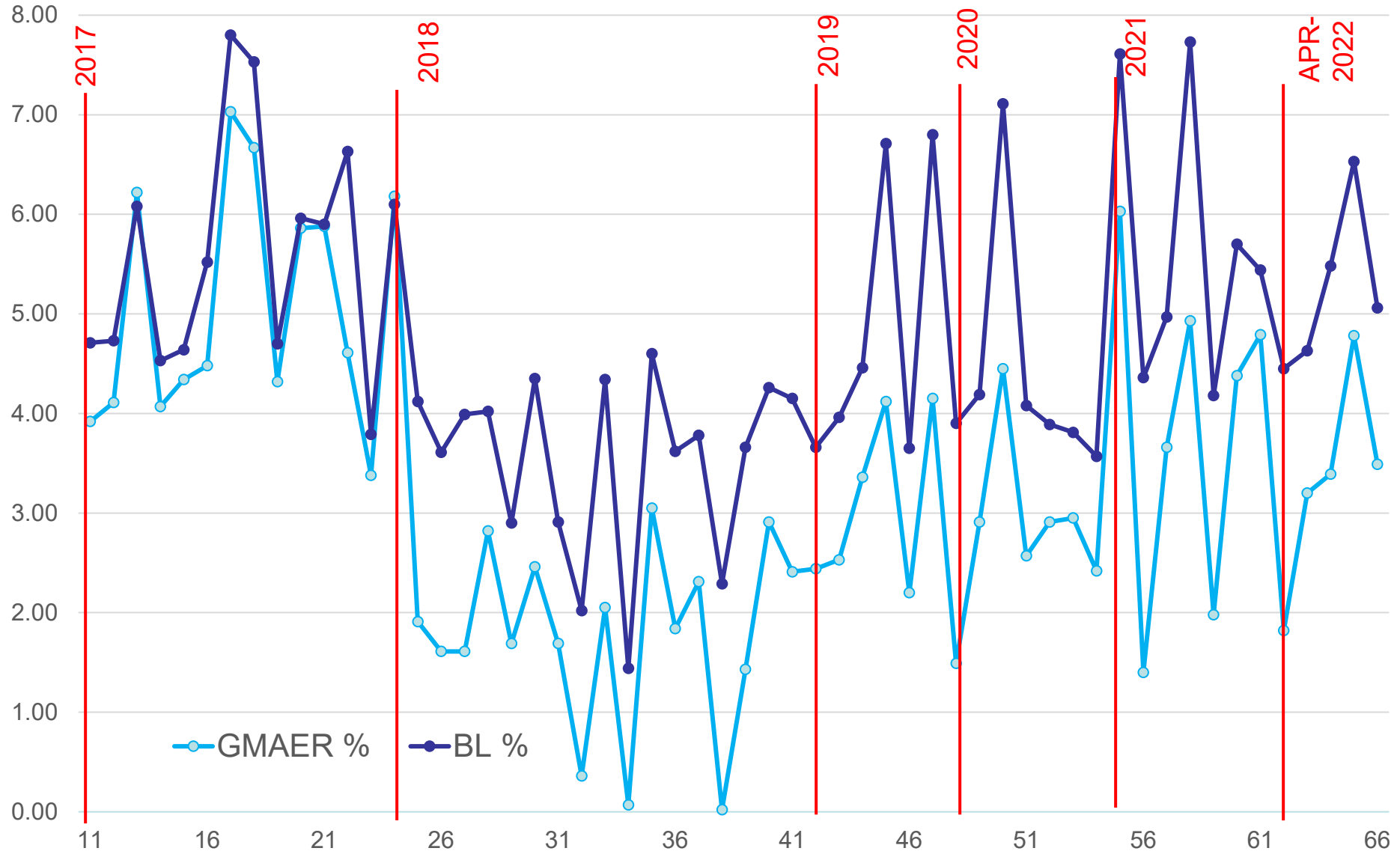
Test Status	#
No lost tests	-
Totals	0

*Invalid and aborted tests

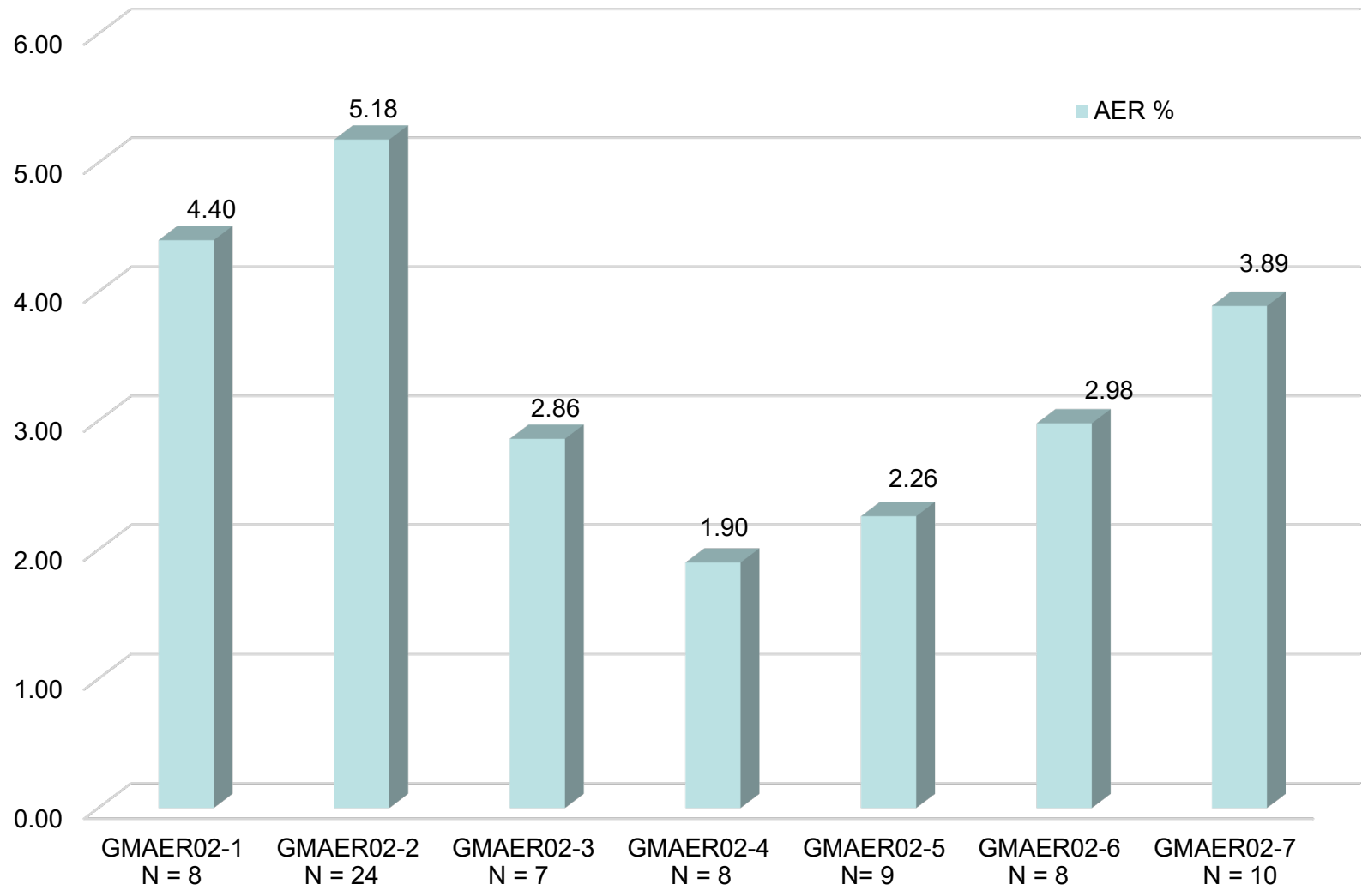
Average Aeration by Report Period



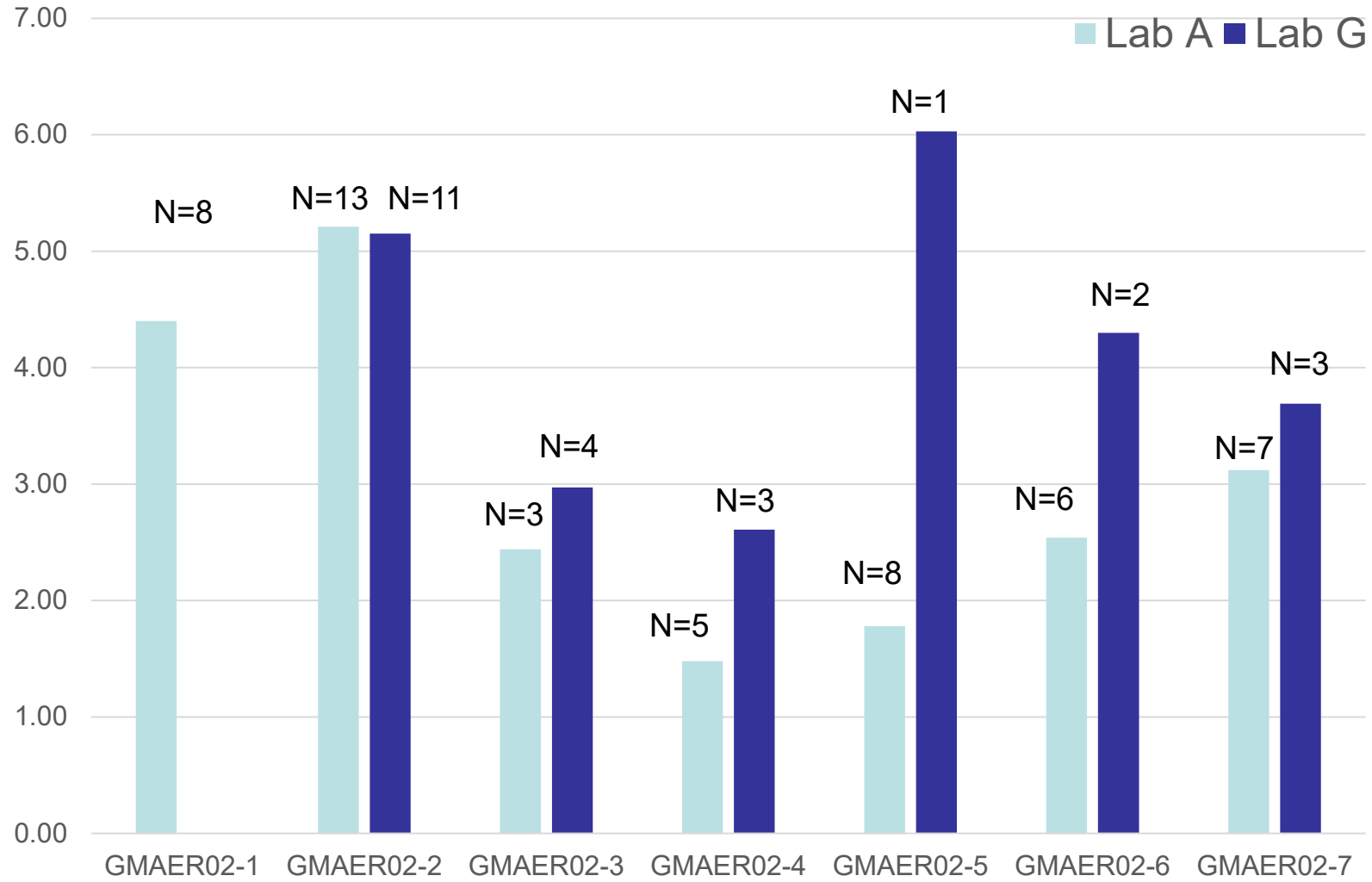
GMAER02 and GMAERBL Reference Test Results



Average AER by Reference Oil Batch



Average Aeration by Lab and Reference Oil Blend



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GMOD

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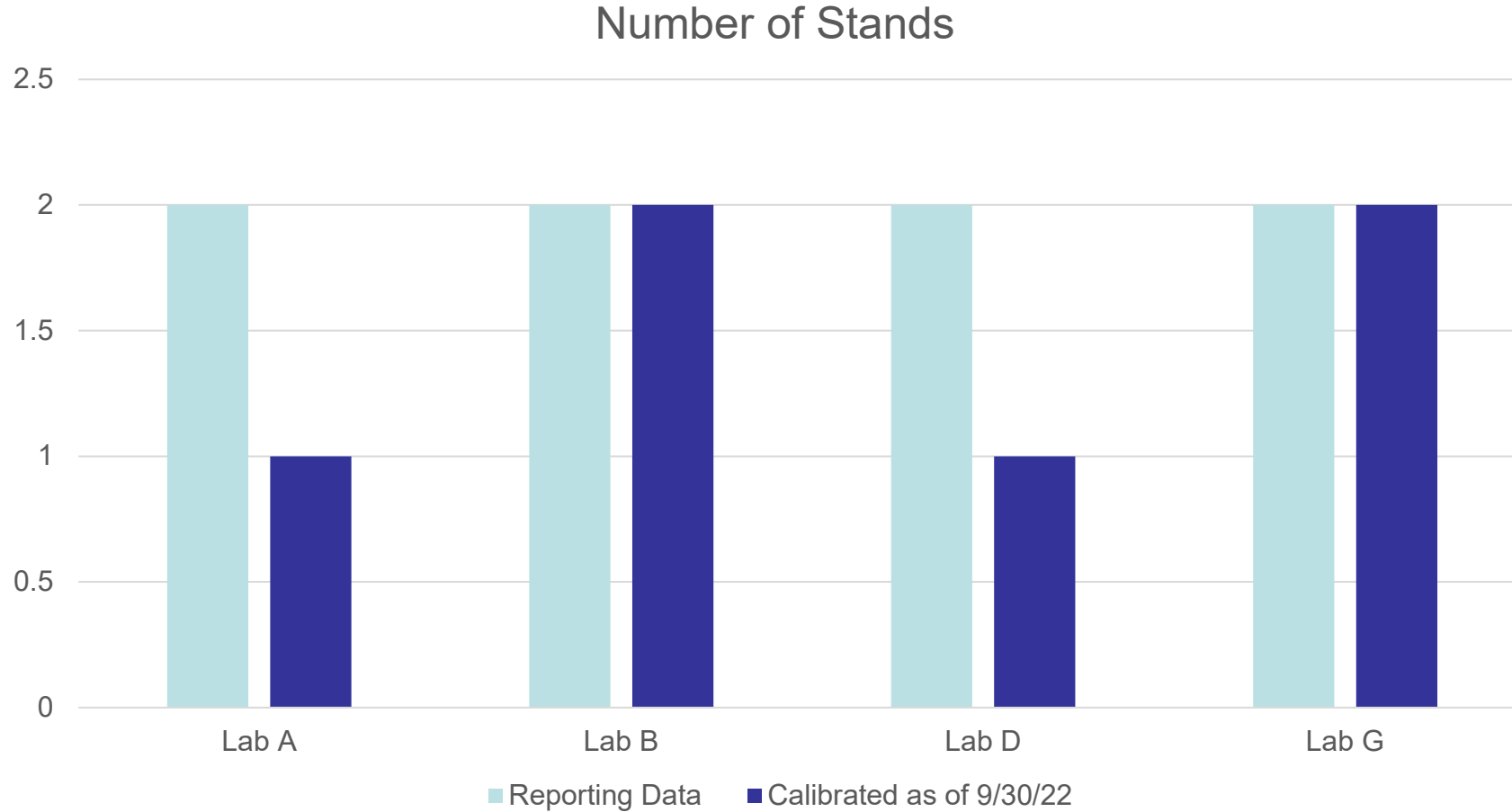
Summary of Activity

- Six calibrated stands in four laboratories
- Reference oil
 - Approximately 1 year supply of GMOD01-1 and 1.5-to-2-year supply of GMOD02-1 at TMC with reblends being pursued for both
 - RO 434-3 being introduced.
 - GMOD Test Team agreed to new targets for Reference Oil 434-3. Awaiting LTMS document update to allow use with new targets.
- All parameters in control for severity and precision

GMOD Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	10
Terminated Calibration Tests	XC	1
Operationally Invalid Calibration Test (lab determination)	LC	2
Total		13

GMOD Test Stands



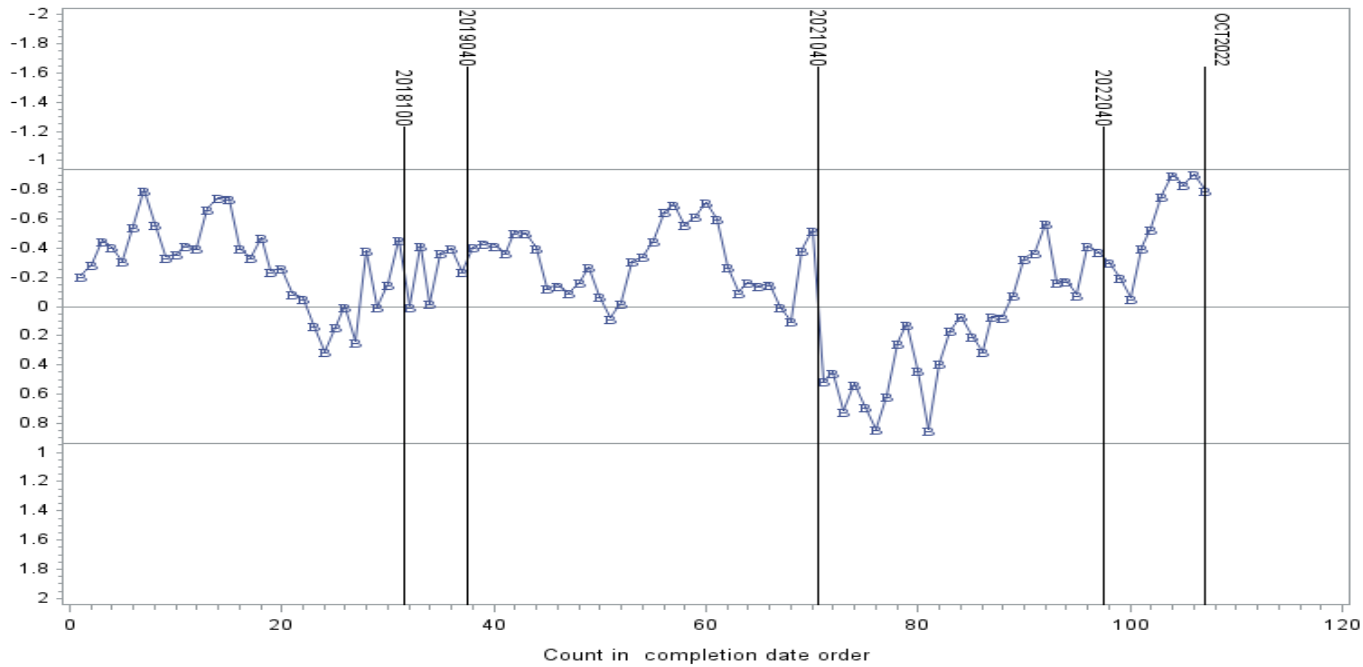
GMOD - Failed Tests

Test Status	#
No Failed tests	0
Total	0

GMOD – Lost Tests

Test Status	Validity Code	#
Terminated Calibration Test, high oil consumption	XC	1
Operationally Invalid Calibration Test, AFR and fuel consumption high, traced to grounding issue	LC	1
Operationally Invalid Calibration Test, coolant temperature control issues	LC	1
Total		3

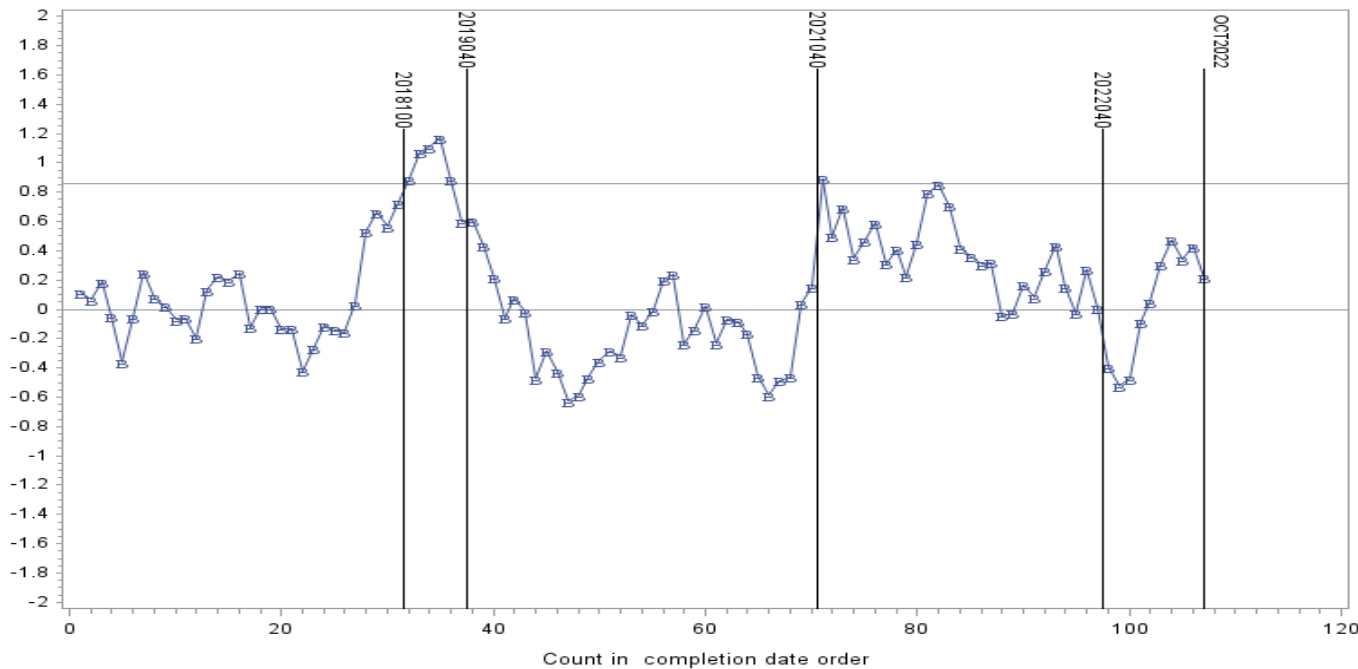
PVIS LTMS Severity Analysis



PVIS Severity / Precision

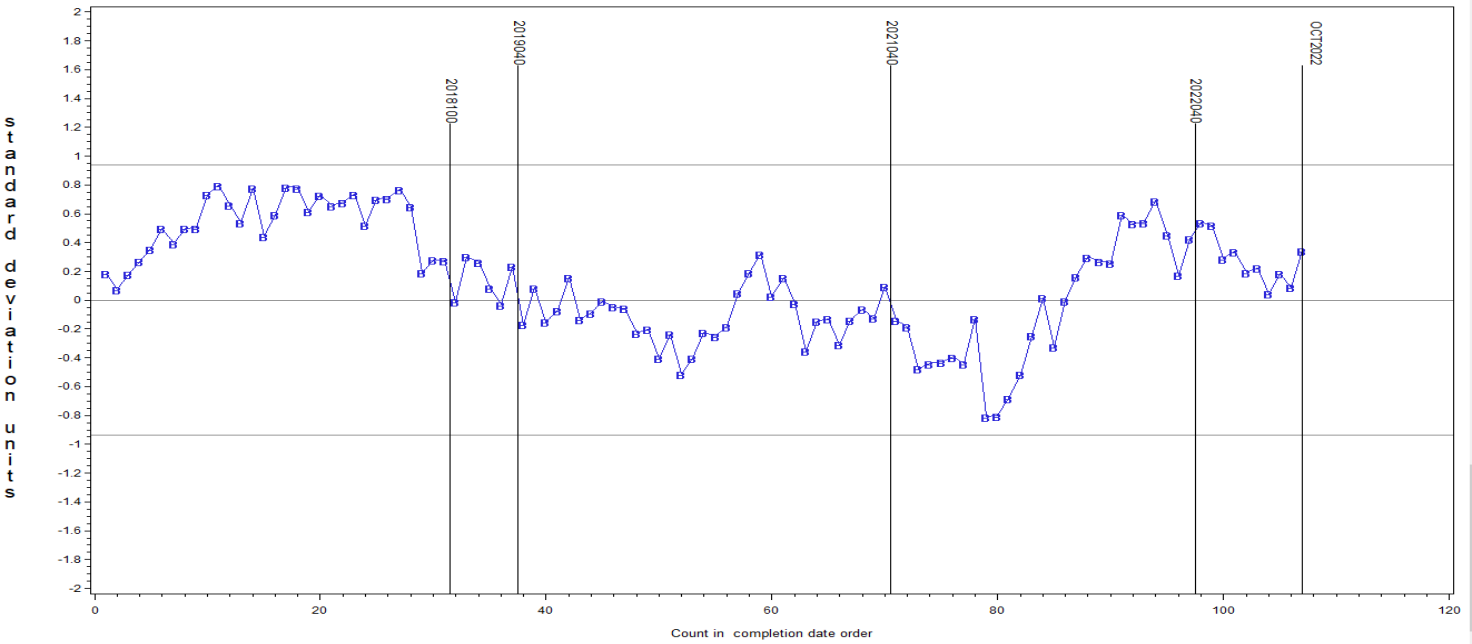
- PVIS is in control for severity and precision

PVIS LTMS Precision Analysis



- Trending mild relative to precision matrix targets

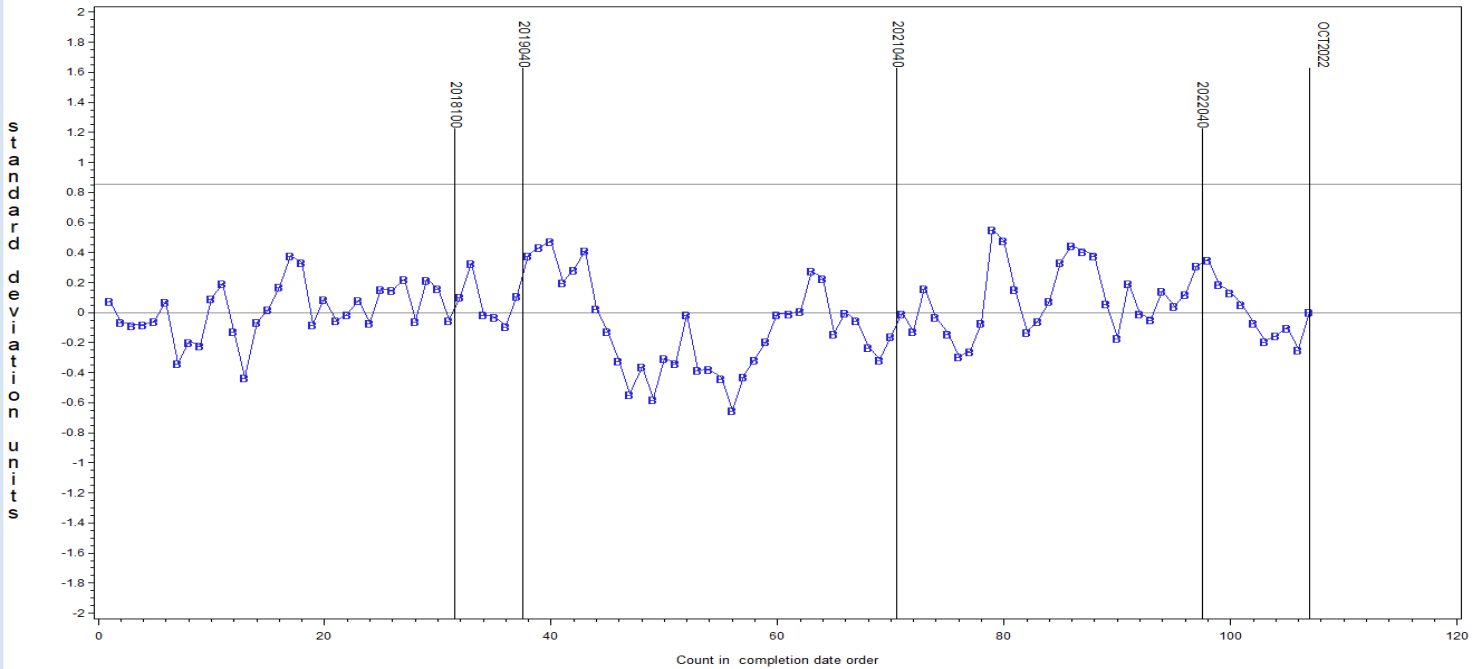
GM Oxidation and Deposit Test
WPD LTMS Severity Analysis



WPD Severity / Precision

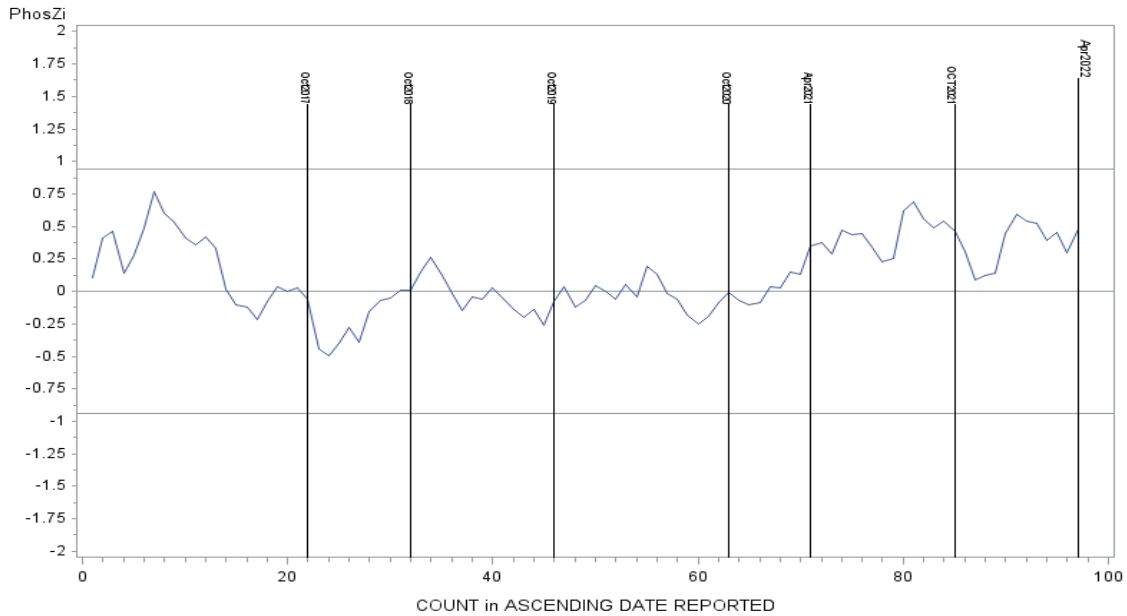
- WPD is in control for severity and precision

GM Oxidation and Deposit Test
WPD LTMS Precision Analysis



- Severity is on or near target relative to precision matrix targets

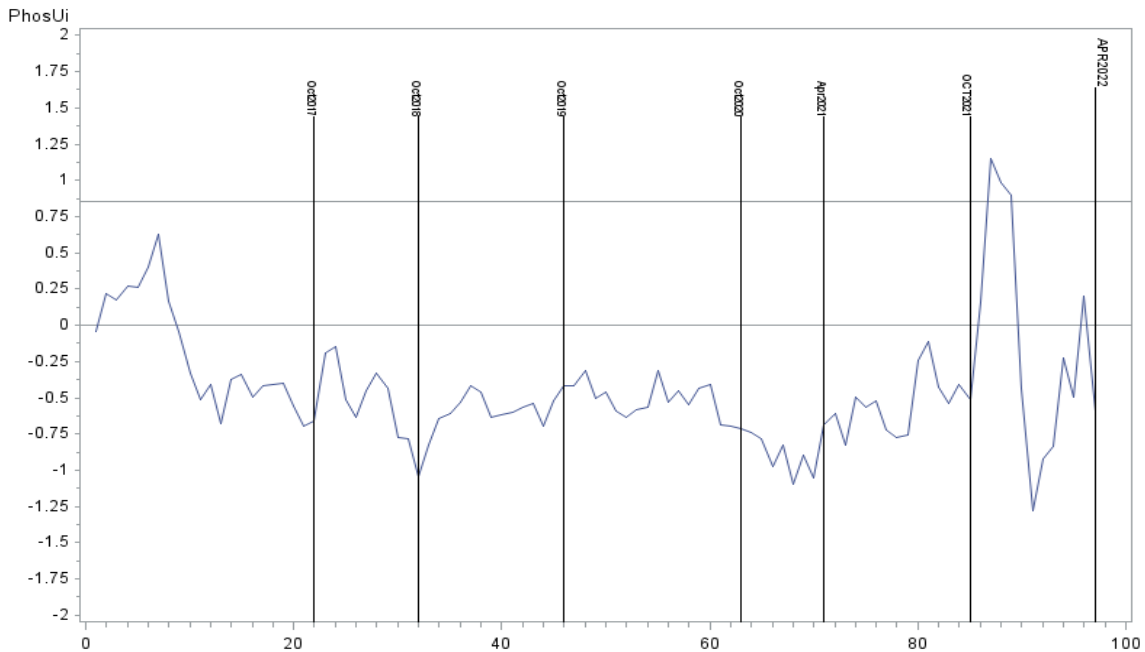
GM Oxidation and Deposit Test
Phos LTMS Severity Analysis



PHOS Severity / Precision

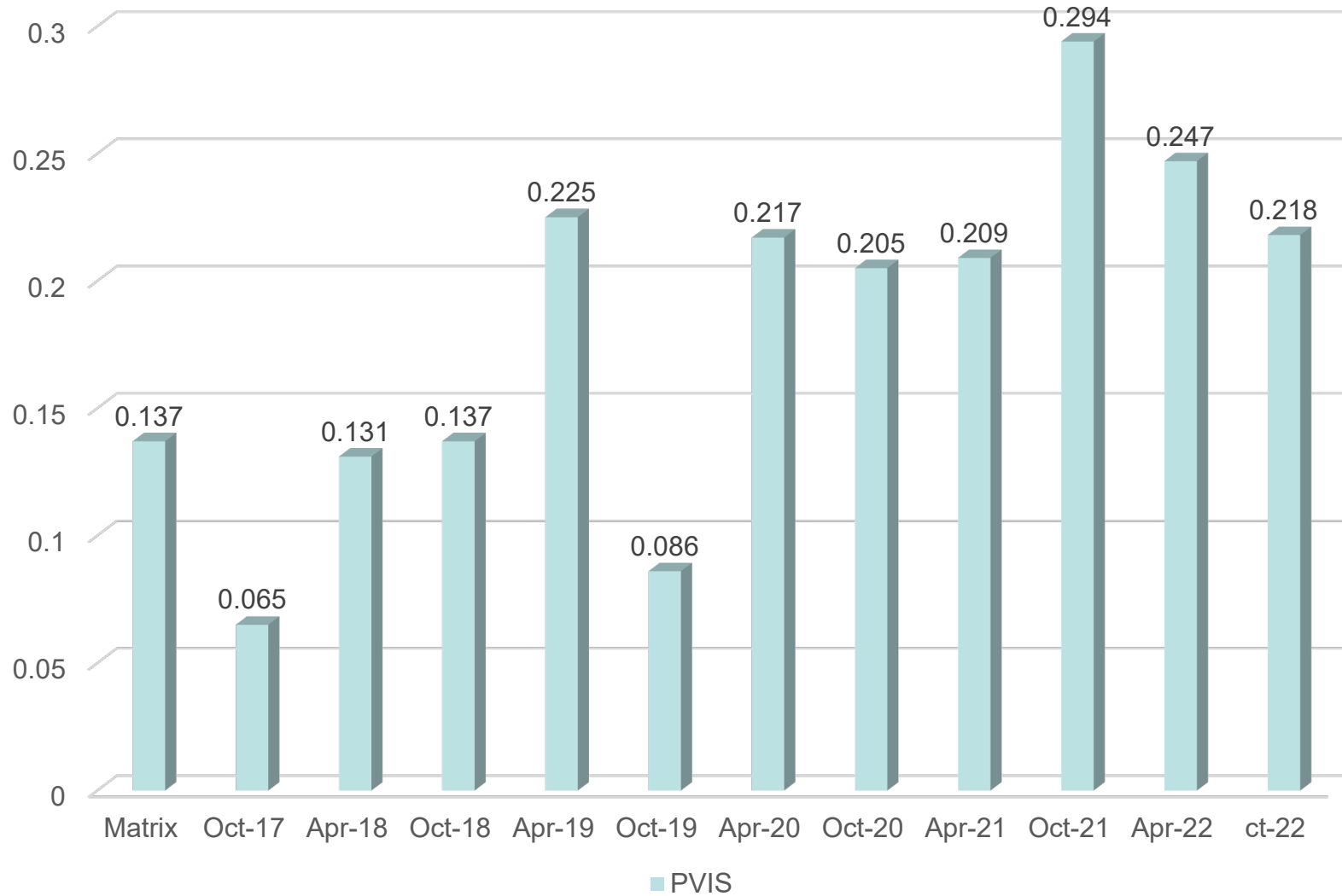
- PHOS is in control for severity and precision

GM Oxidation and Deposit Test
Phos LTMS Precision Analysis



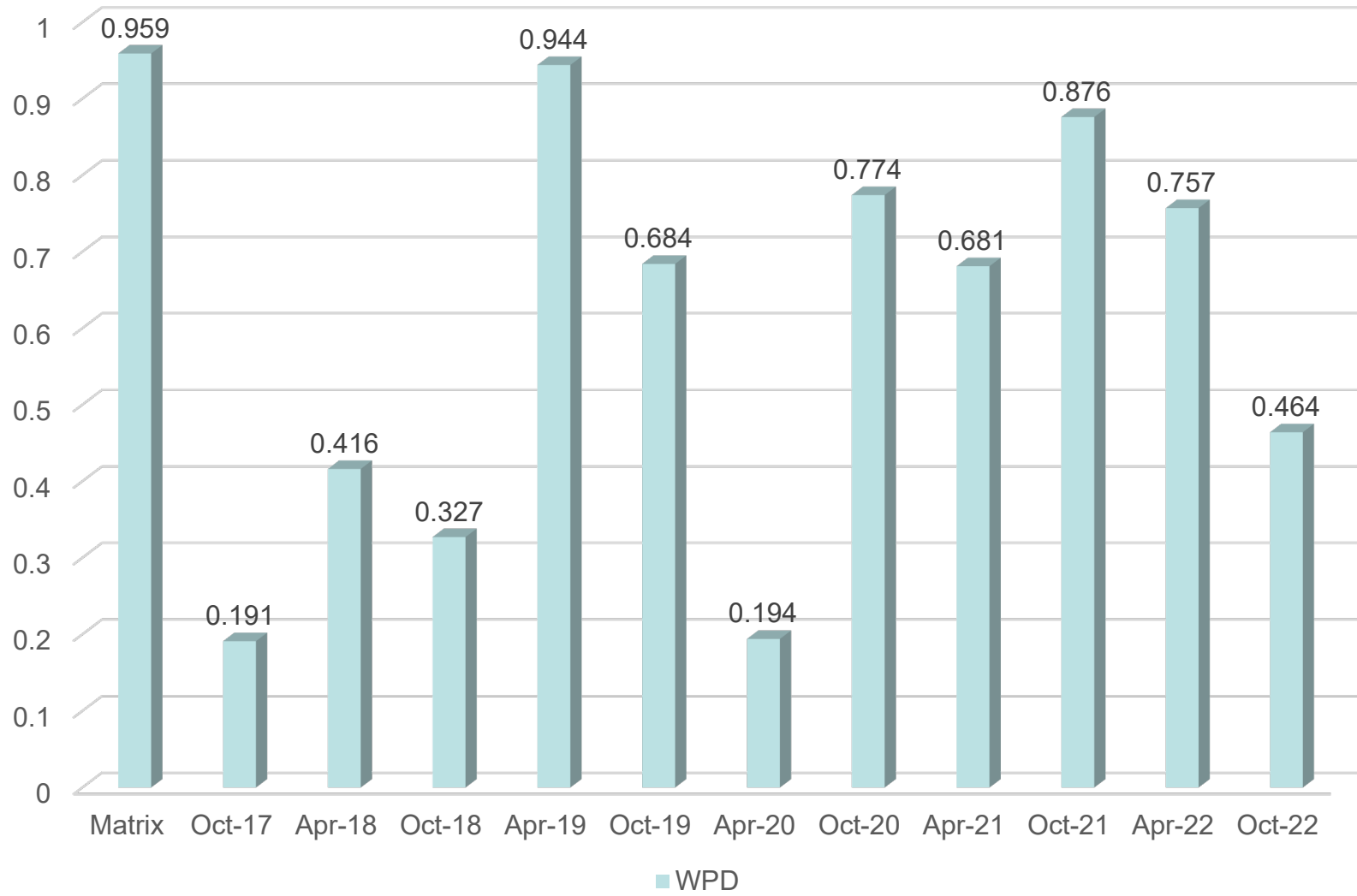
- Appears to be trending mild relative to precision matrix targets (not a calibration criteria)

PVIS – Pooled s Values by Report Period

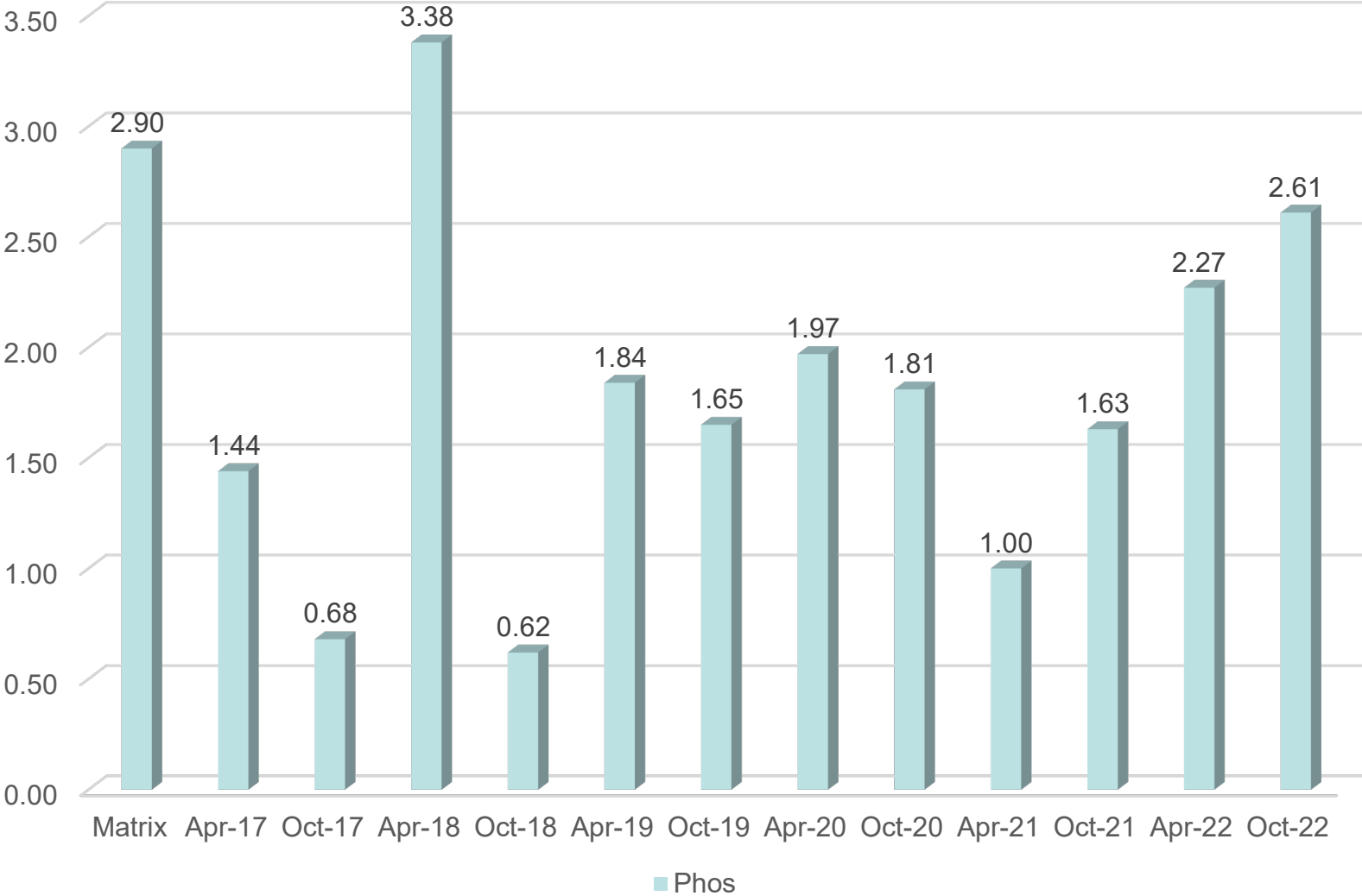


PVIS estimates calculated in transformed units

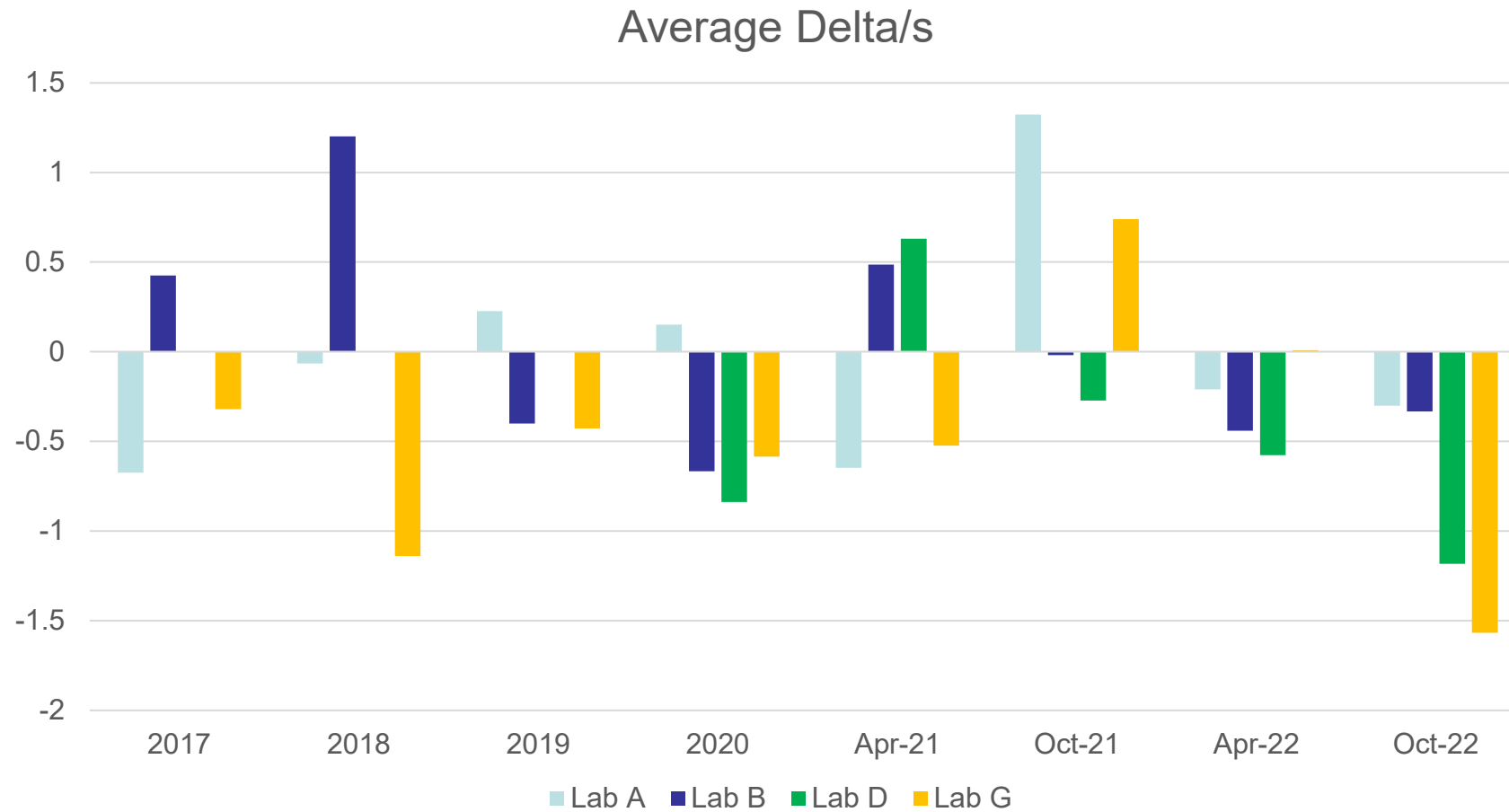
WPD – Pooled s Values by Report Period



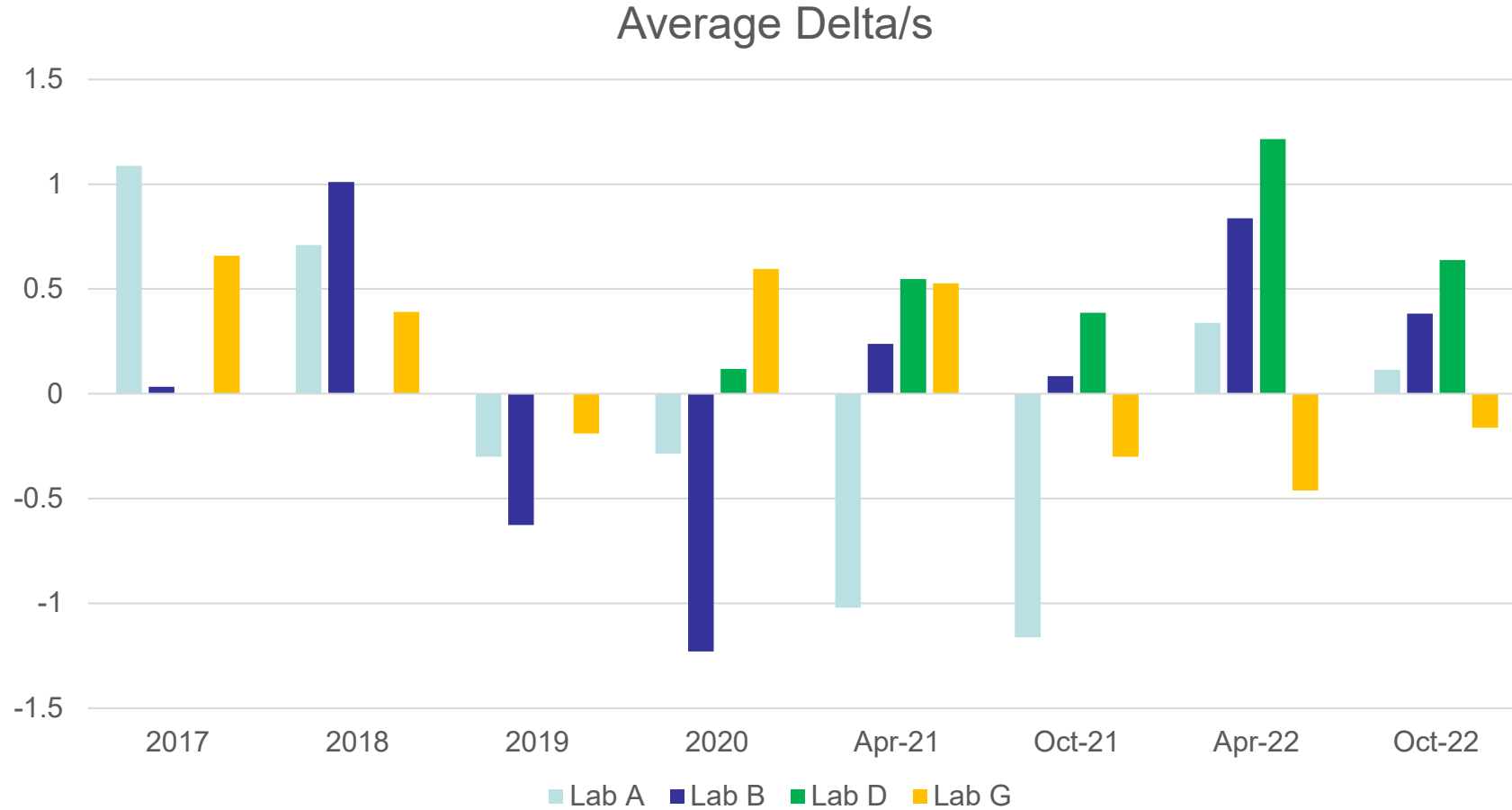
PHOS – Pooled s Values by Report Period



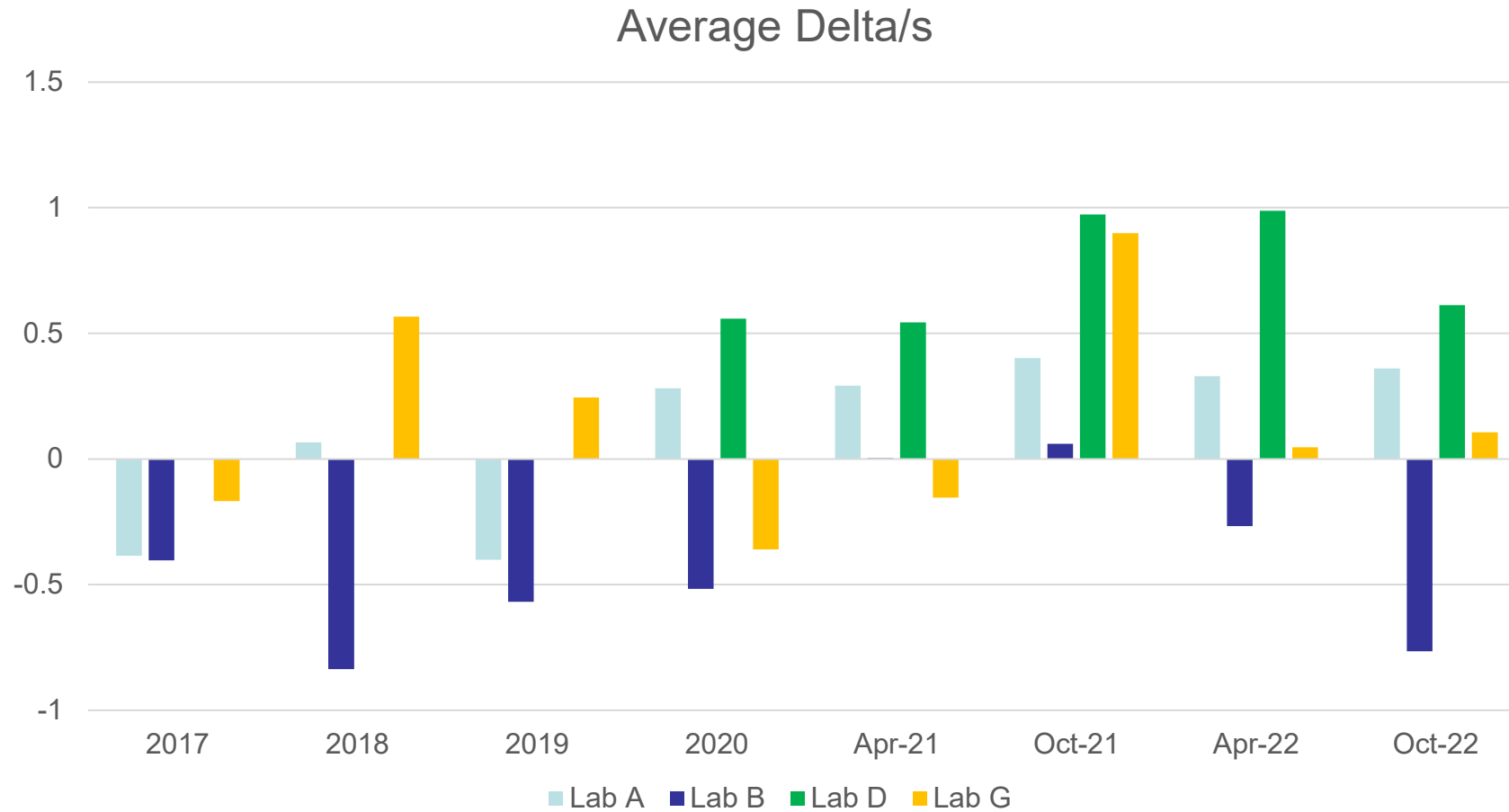
Average delta/s by Lab % Viscosity Increase



Average delta/s by Lab Weighted Piston Deposits



Average delta/s by Lab % Phosphorus Retention



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GMOEE

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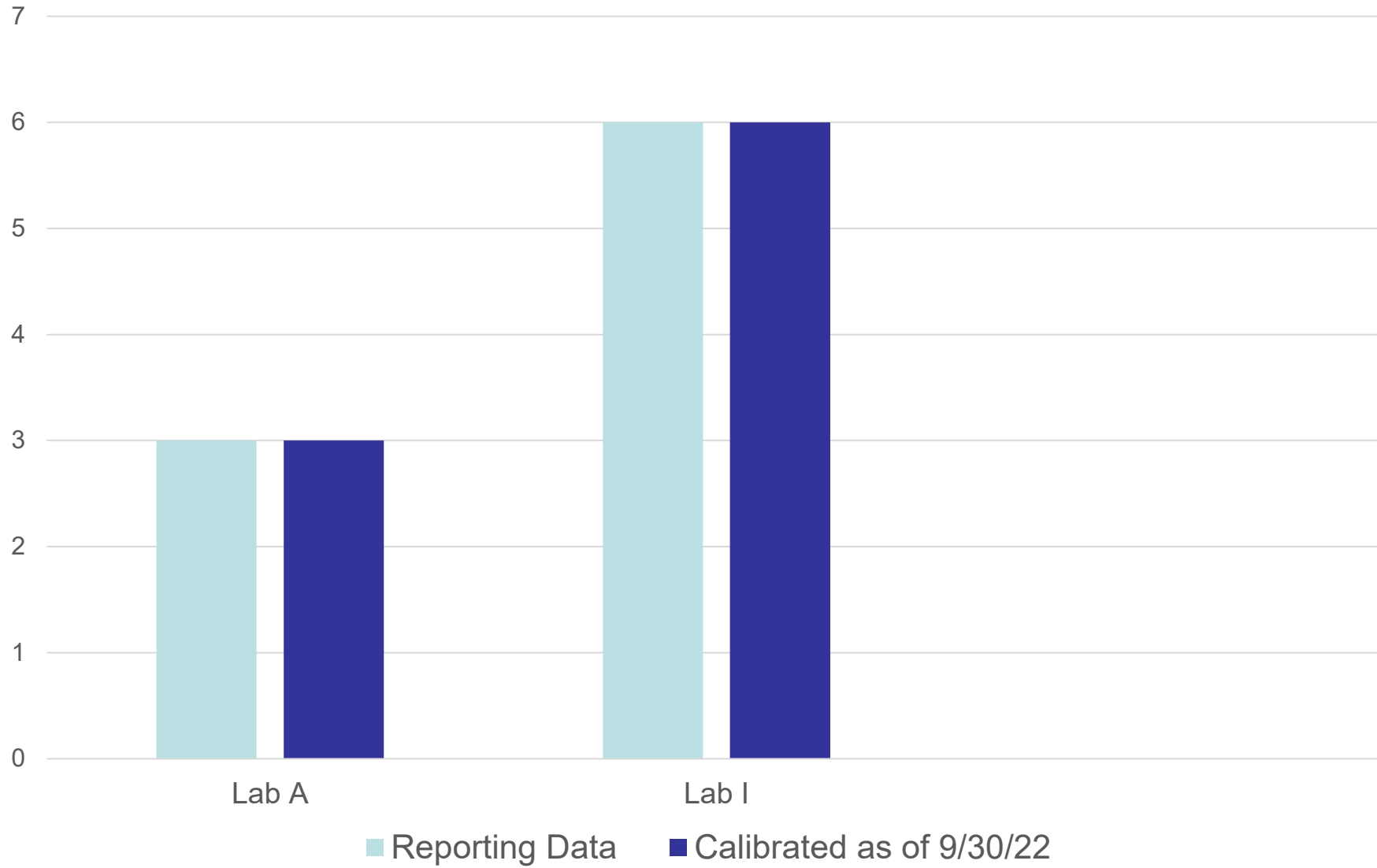
Summary of Activity

- 8 calibrated stands in 2 laboratories
- Severity remains stable at about the same level as the previous two periods.

GMOEE Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	9
Statistically Unacceptable Calibration Test	OC	1
Total		10

Calibrated Labs and Stands



GMOEE - Failed Tests

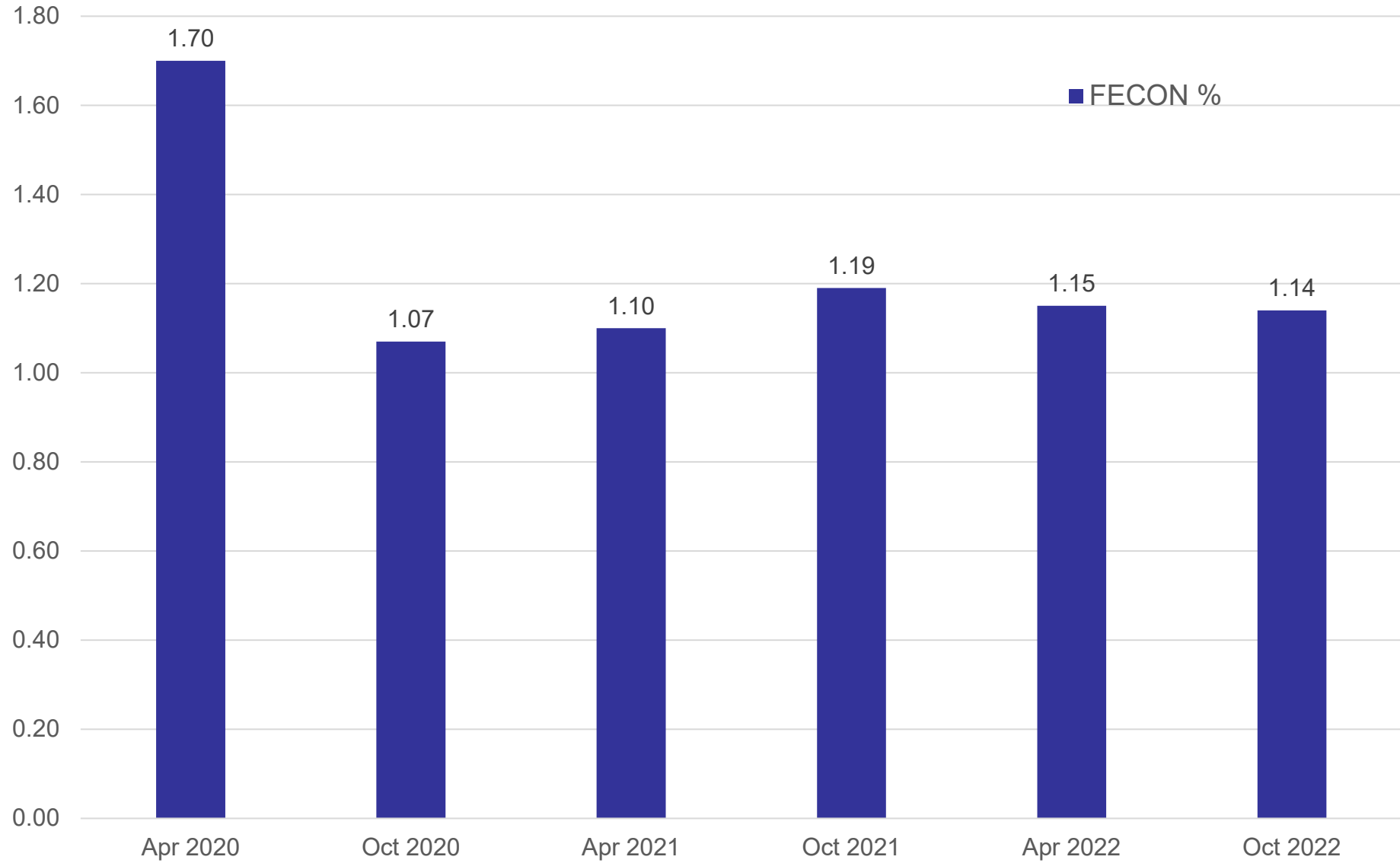
Test Status	#
Severe VFE	1
Totals	1

GMOEE - Lost Tests*

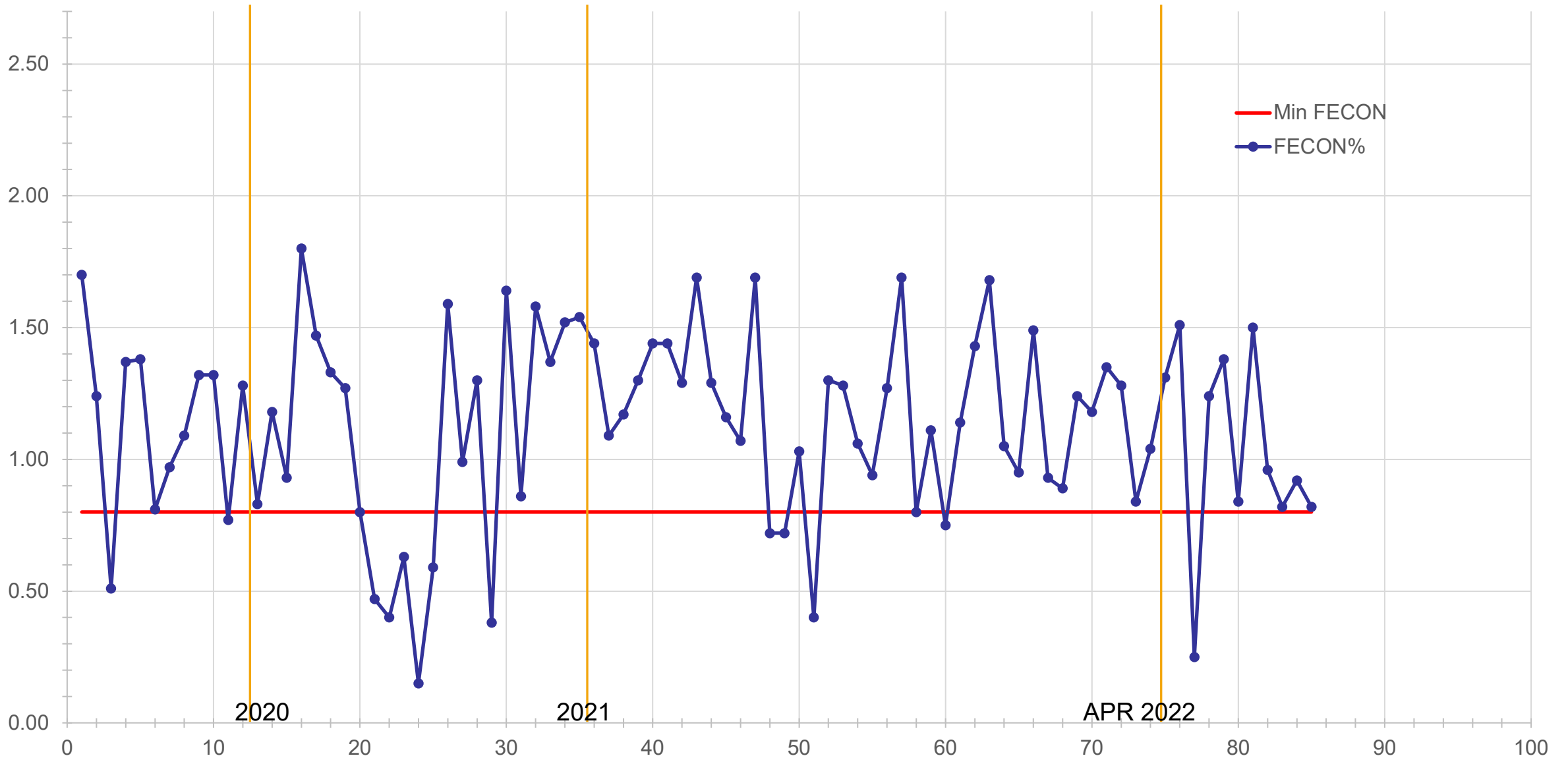
Test Status	#
No lost tests	-
Totals	0

*Invalid and aborted calibration tests

Average FECON by Report Period



GMOEE Reference Test Results



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GMSP13

October 2022

Summary of Activity

- Reference test activity was somewhat lower for this period when compared to the previous year
- Severity and precision levels have been steady for 2022

GMSPi3 Activity

Test Status	Validity Code	#
Acceptable Calibration Test*	AC	60
Statistically Unacceptable Calibration Test	OC	17
Invalid Calibration Test	LC	9
Total		86

GMSPi3 - Failed Tests

Test Status	#
Pre-Ignition Events - Mild	17
Totals	17

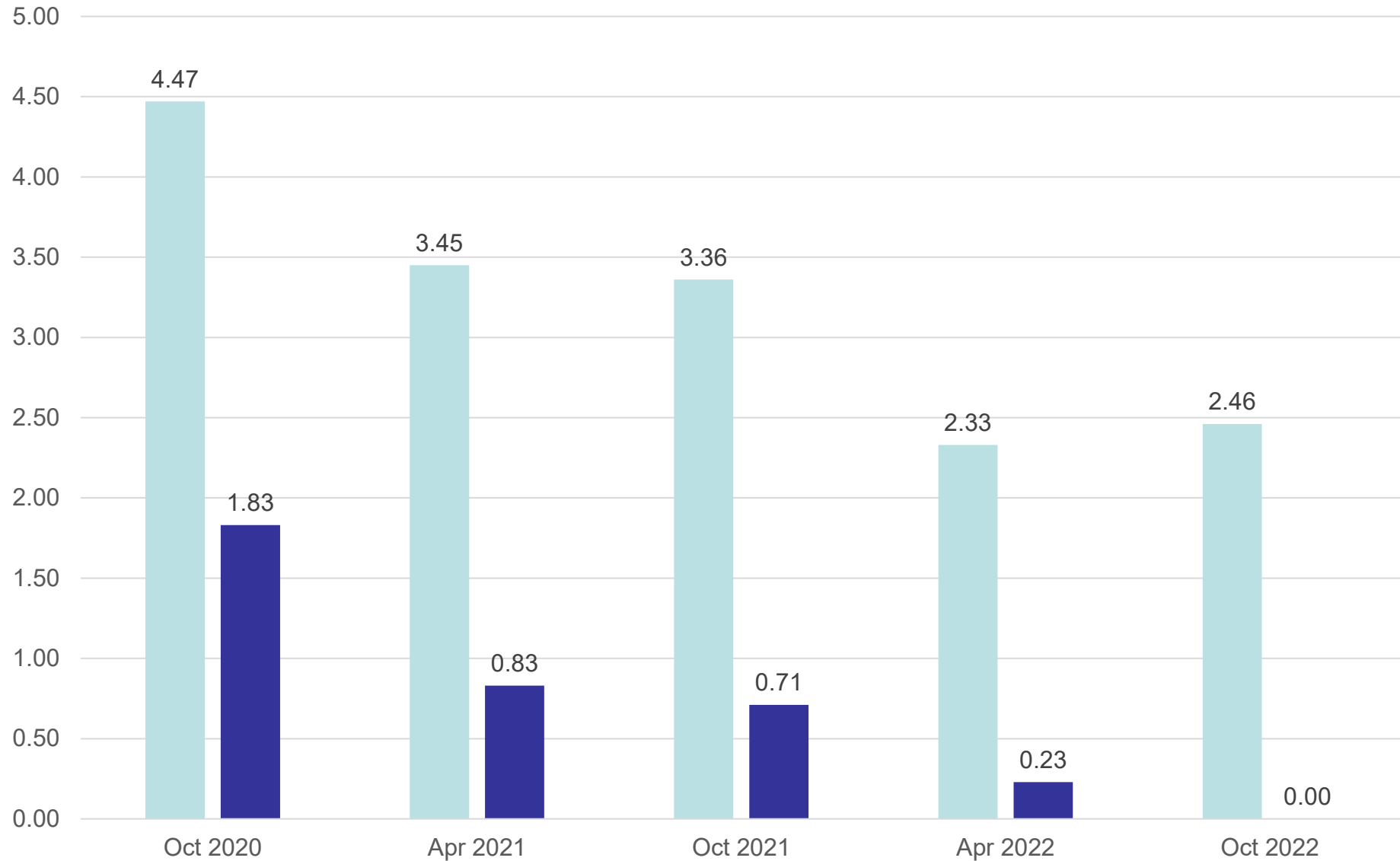
GMSPi3 - Lost Tests*

Test Status	#
Less than the minimum number of combustion cycles	4
Torque Qi less than 0.000	1
Failed Engine Health Check	1
Exceeded down time limit	3
Totals	9

*Invalid and aborted tests

Average TPICBEVT by Report Period

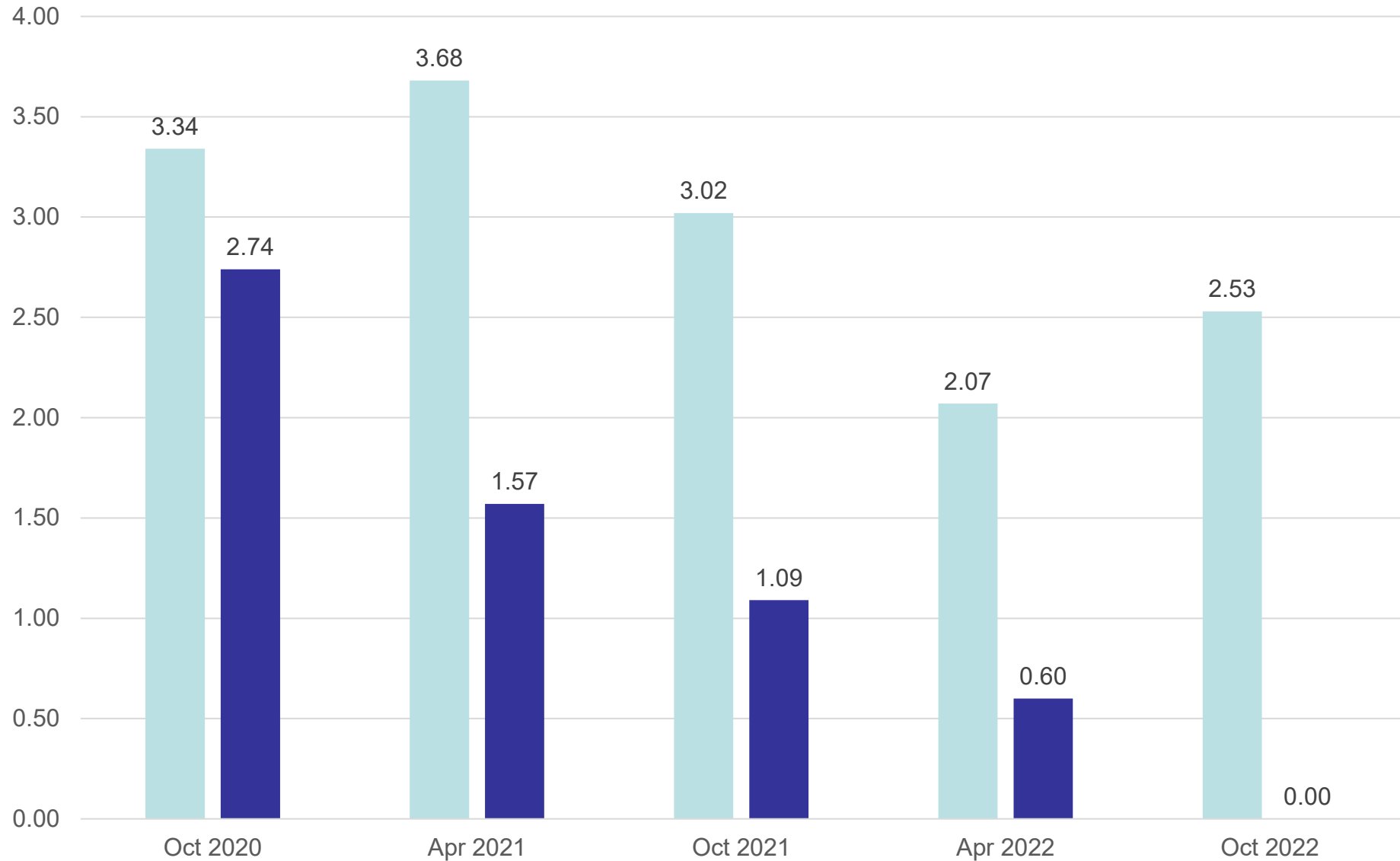
GMPI01 GMPI02



Oct 2020 averages include non-blind development tests

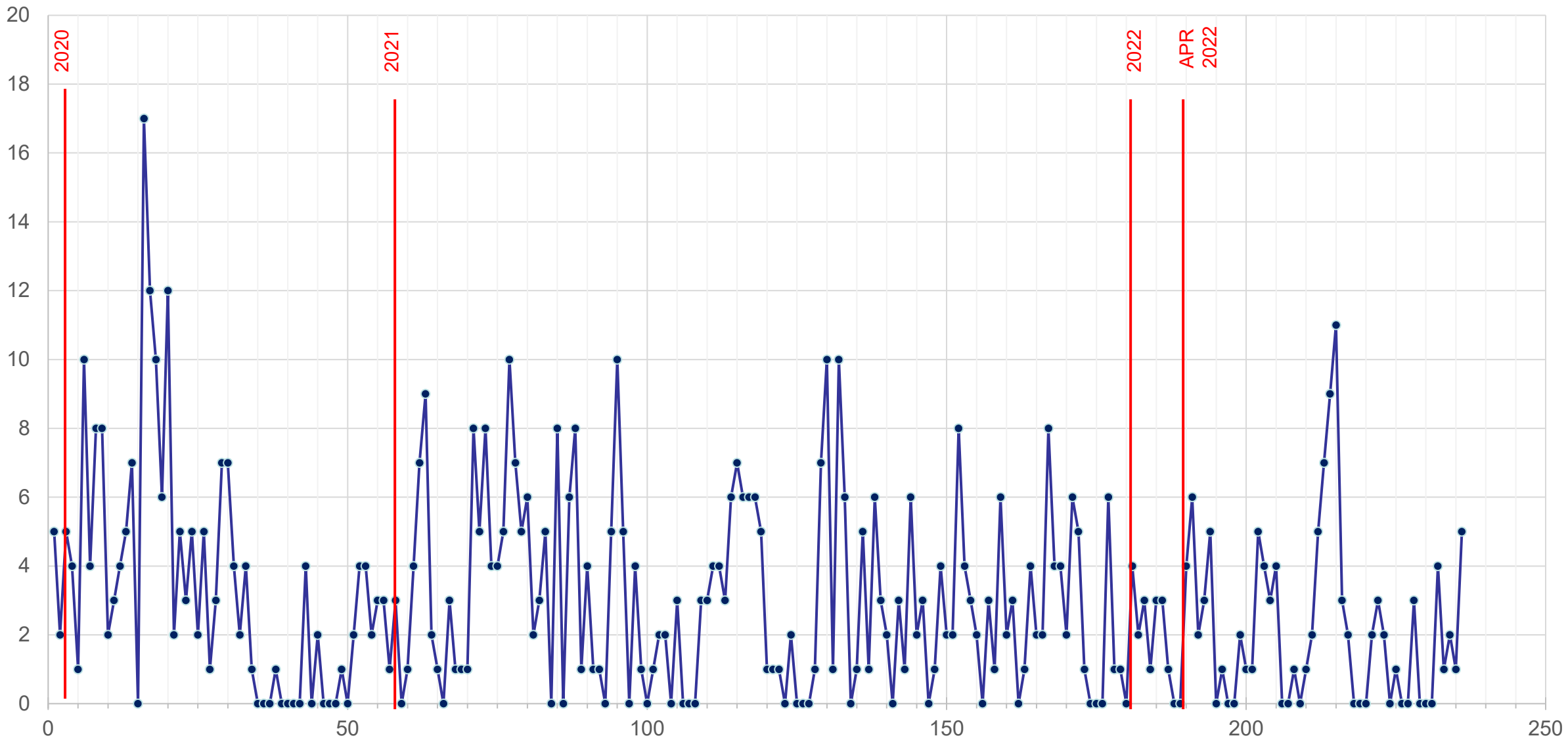
Standard Deviation of TPICBEVT by Report Period

GMPI01 GMPI02

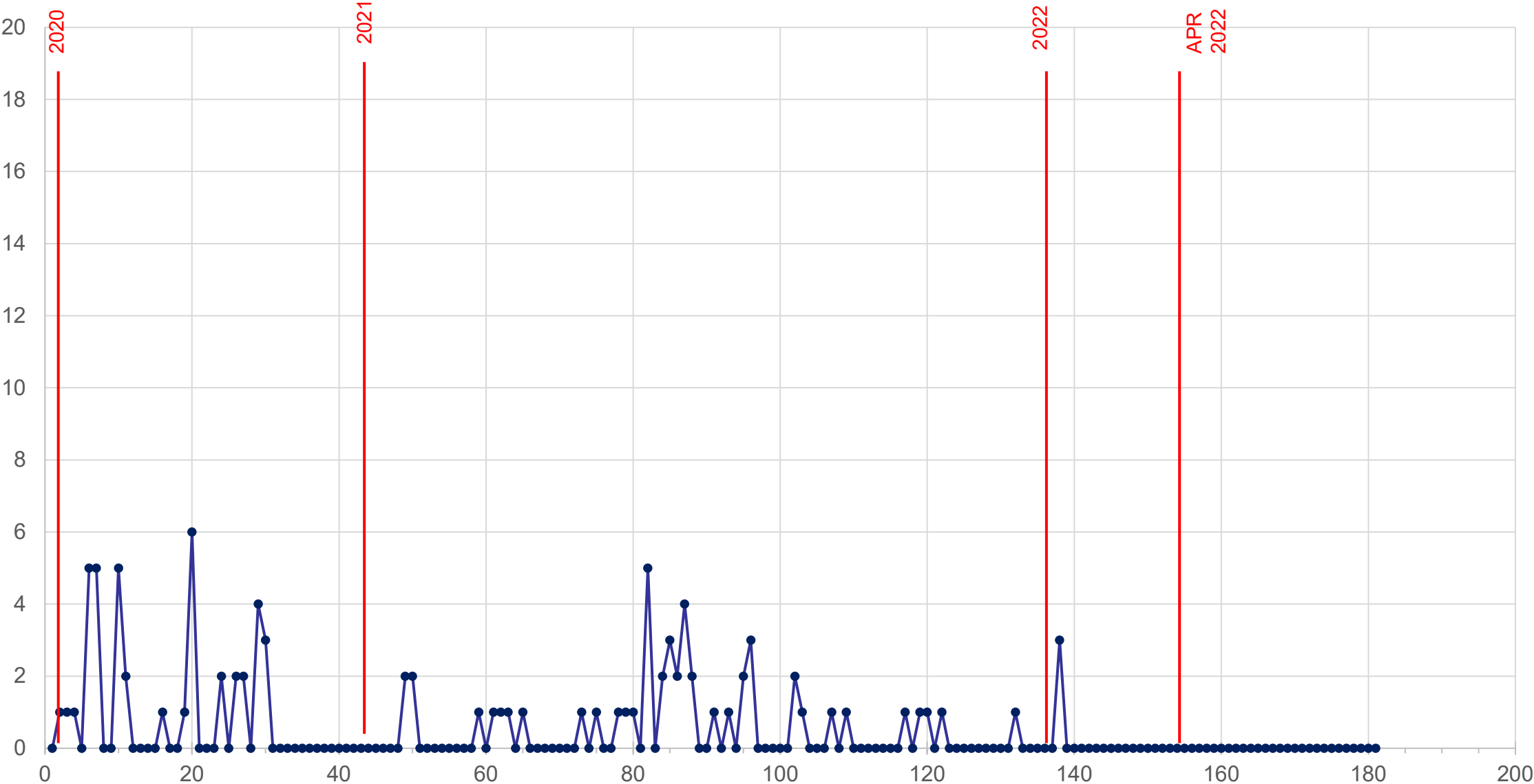


Oct 2020 standard deviations include non-blind development tests

GMPI01 Reference Test Results



GMPI02 Reference Test Results



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GMTC

October 2022

Summary of Activity

- Two reference tests reported this period
 - Both successfully calibrated the test stand
 - TCOC1800 Continues to trend mild

GMTC Activity

Test Status	Validity Code	#
Acceptable Calibration Test	AC	2
Statistically Unacceptable Calibration Test	OC	0
Aborted Calibration Test	XC	0
Invalid Calibration Test	LC	0
Total		2

GMTC - Failed Tests

Test Status	#
No failed tests	-
Totals	0

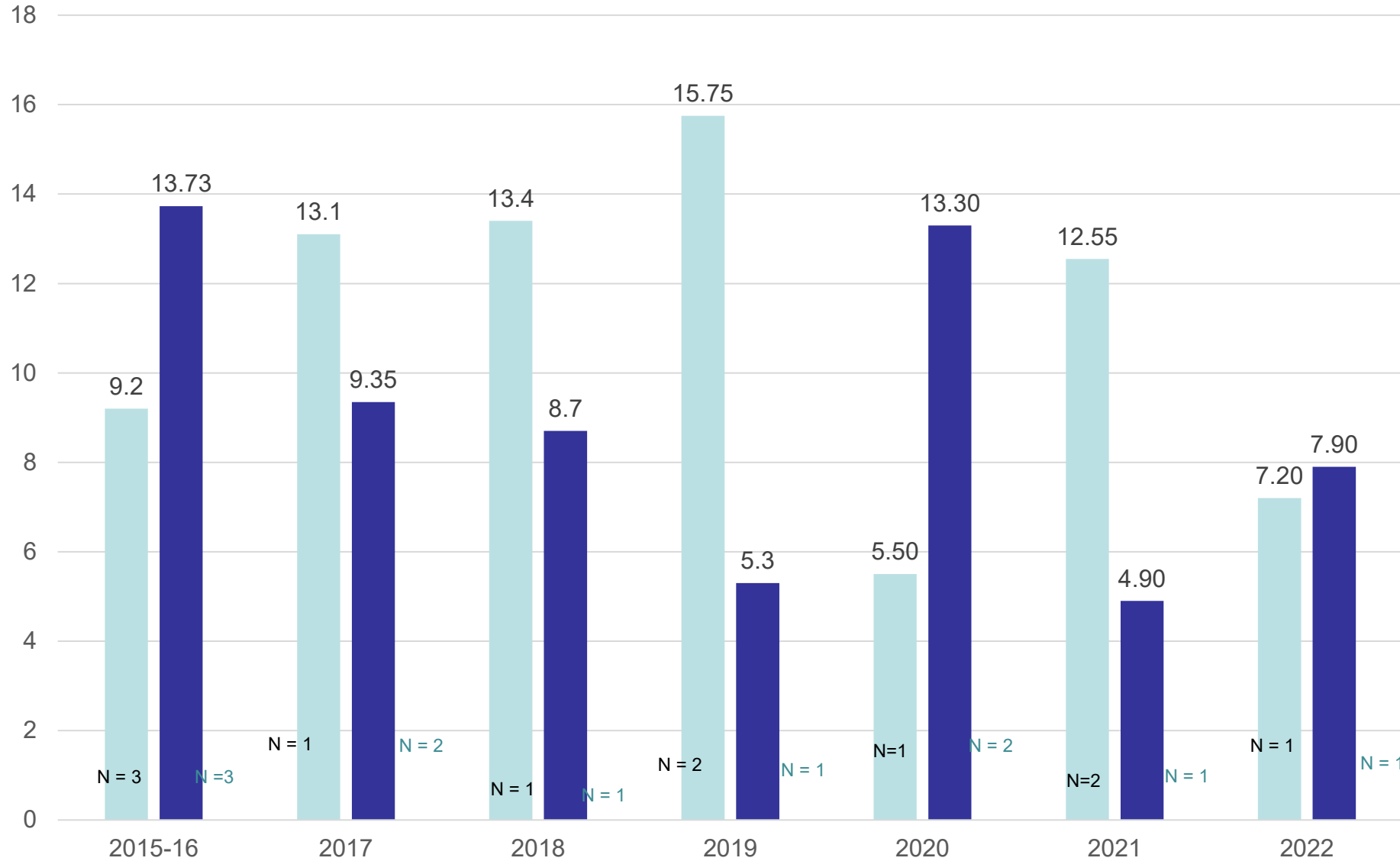
GMTC - Lost Tests*

Test Status	#
No lost tests	-
Totals	0

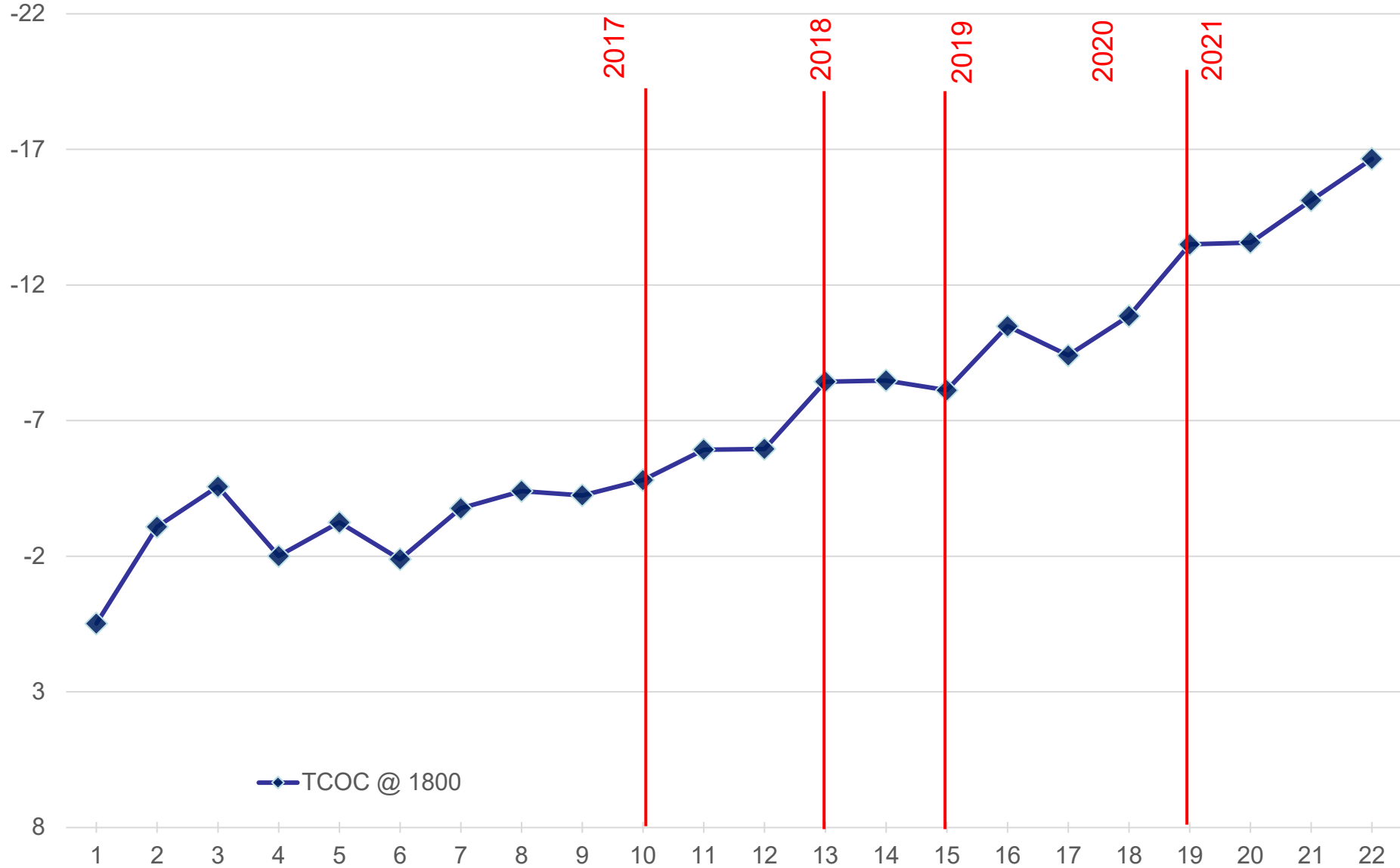
*Invalid and aborted tests

Average TCOC1800 by Report Period

GMTC01 GMTC02



TCOC1800 Reference Test Results – CuSum Chart



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Lab Visits

October 2022

TMC/GM Lab Visits

Test	Number of Labs Visited
GMAER	0
GMOD	3
GMOEE	3
GMSP13	0
GMTC	0

Lab Visit Issues

GMOD - Tee in Blowby system not at 6 ± 3 ".

GMOD – Incorrect spark plug wires installed.

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Oil Inventory

October 2022

Reference Oil Inventory Estimated Life

Oil	Tests	Original Blend Amount (gallons)	TMC Inventory (gallons)	Lab Inventory (samples)	Estimated Life
GMOD01-1	GMOD	320	15	8	~1 year
GMOD02-1	GMOD	320	48	8	1.5 years
434-2	IIIH/GMOD	550	0	2	depleted
434-3*	IIIH/GMOD	980	725	8	5+ years
GMAER02-7	GMAER	103	27	5	~1 year
GMPI02-3	GMSPi3	526	101	3	~1 year
GMPI01-4	GMSPi3	529	394	5	~6 years

* The inventory of 434-3 should last considerably longer as IIH has decreased quantity shipped from 4 gallons to 2.5 gallons.

Reference Oil Inventory Estimated Life

Oil	Tests	Original Blend Amount (gallons)	TMC Inventory (gallons)	Lab Inventory (samples)	Estimated Life
GMTC01-1	GMTC	110	30	2	~ 5 Years
GMTC02-1	GMTC	144	72	2	~ 5 Years
GMVFEBL02-2	GMOEE	3402	2160	-	2 years
GMVFEHR01-1	GMOEE	1080	3.4	15	~ 6 months
GMVFEHR01-2	GMOEE	2120	1994	8	5 Years

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