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ASTM D02.B0.07 Semi-Annual Report Bench Test Monitoring

D874 (SASH), D5133 (GI), D5800 (NOACK), D6082 (HT FOAM), D6335 (TEOST), D6417 (GC VOL), D6557 (BRT), D6594 (HTCBT), D6794 (EOWT), D6795 (EOFT), D7097(MTEOS), D7216 (EOEC/LDEOC) and D7528 (ROBO)

October 1, 2024 – March 31, 2025

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B0.07 Bench Testing Executive Summary

- D874 (Sulfated Ash)
- For the eighth consecutive 6-month period, there were no tests which failed to meet acceptance criteria for D874. Reference test results were close to target. Most assignments were with Reference Oil 92 to generate a batch of test results to establish final acceptance bands.
- D5133 (Gelation Index)
- Number of Labs running GI is the same as last period, but four units came back into calibration.
- D5800 (NOACK)
- Same number of labs and stands for past two semesters. Precision and Severity also consistent with the previous semester.

B0.07 Bench Testing Executive Summary

- D6082 (High Temperature Foam)
- No new labs added this semester. Test moved from On-Target to Severe.
- D6335 (TEOST)
- Two fewer labs and stands were calibrated this semester. Severity improved, but precision fell further away from target.
- D6417 (GC Volatility)
- No change in number of Labs/Stands. Precision remains on-target, but severity has moved slightly severe. One calibration fail this semester.
- D6557 (BRT)
- Round Robin using RO's 1006 and 820-1 was conducted on new ball bearing Batch E. Round Robin using RO's 86 and 87 with ball Bearing Batch E is underway. RO 1006 is being assigned for all calibration tests. A reblend of RO 82 has been received by TMC and is undergoing QC verification.

B0.07 Bench Testing Executive Summary

- D6594 (HTCBT)
- Three labs (two stands) fell off calibration status this semester. Most labs have now moved on to Batch P coupons although some labs still possess Batch O coupons. Copper and Lead results are on-target for Precision and both showing reduced Severity.
- D6794 (EOWT)
- No change in number of test labs. A reduction in severity has been observed for all Change in Flowrate Average (CIFA) water levels. TMC working with Reference Oil 79 supplier to determine if a reblend is possible.
- D6795 (EOFT)
- No change in number of test labs. Severity in Change in Flow Average (CIFA) has reduced for the second straight semester, however Precision had a significant shift away from target this semester. TMC working with Reference Oil 79 supplier to determine if a reblend is possible.

B0.07 Bench Testing Executive Summary

- D7097 (MTEOS)
- Same number of labs, but one stand added this semester. Precision regressed further back to 8.74 s, but Performance improved to 0.31 s this period. All operationally valid tests this period report using Rod Batch N. Most labs have now moved to Catalyst Batch 23AB, but one lab is still using Catalyst Batch 20AB. No labs used Catalyst Batch 19BA.
- D7216 (EOEC)/D7216 (LDEOC)
- All calibrations are using Ref Oil SL-107. A Round Robin to establish targets and acceptance bands for the new HNBR elastomer for EOEC was completed. The new elastomer test EOECH for PC-12 has been created and calibration test assignments are available for scheduling through TMC.
- D7528 (ROBO)
- Same number of labs, but one stand added this semester. Precision fell further to 0.20 (target 0.15). Performance moved back (-0.37) after being very Mild in the previous semester.

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TMC Monitored Tests

ASTM D 874

Sulfated Ash

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Calibrated Labs and Stands*

(change shown in parentheses)

Test	Labs	Stands
D874	5 (+0)	N/A
*As of 3/31/2025		

D874: Sulfated Ash

Test Status	Validity Code	No. Tests
Acceptable Calibration Test	AC	10
Total		**10**

Number of Labs Reporting Data: 5
Fail Rate of Operationally Valid Tests: 0%

D874: Sulfated Ash

Statistically Unacceptable Tests (OC)	No. Of Tests
No Failed tests	0

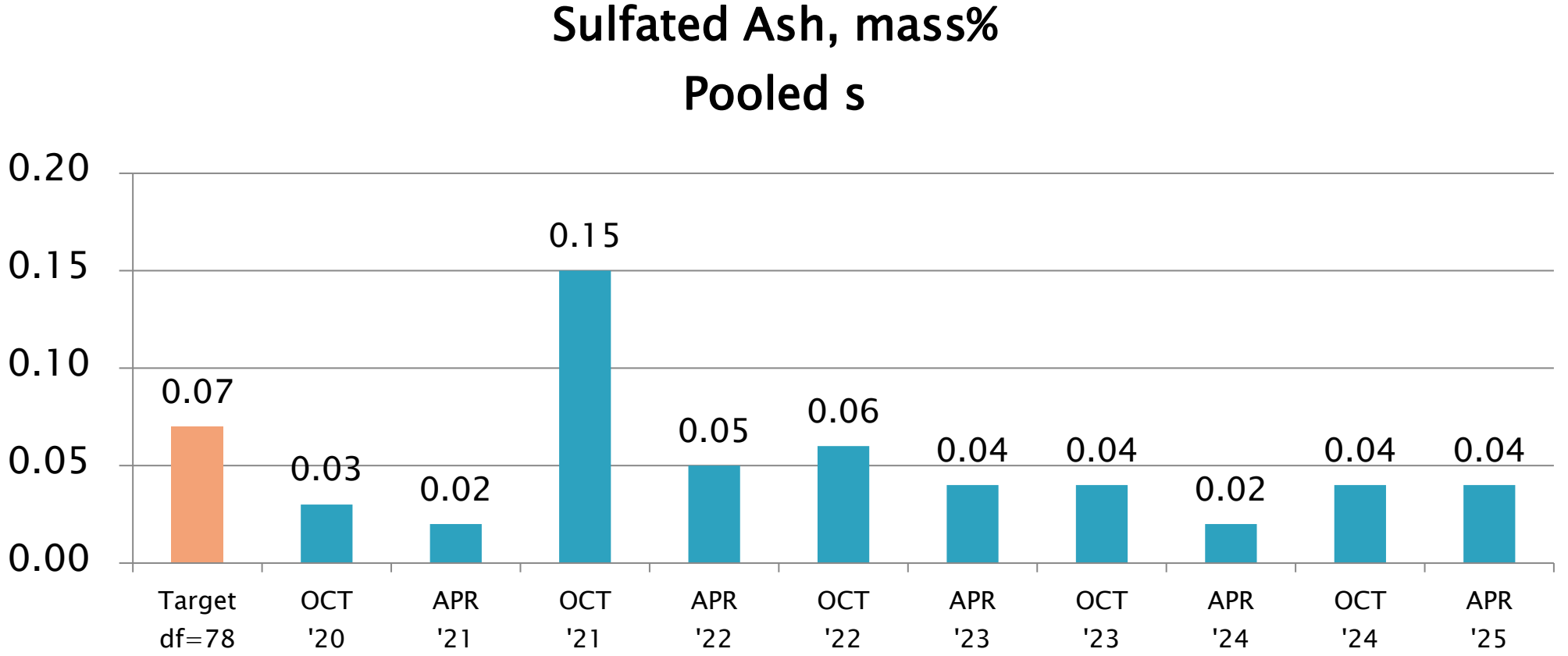
- No operationally invalid or statistically unacceptable tests this report period.

D874: Sulfated Ash

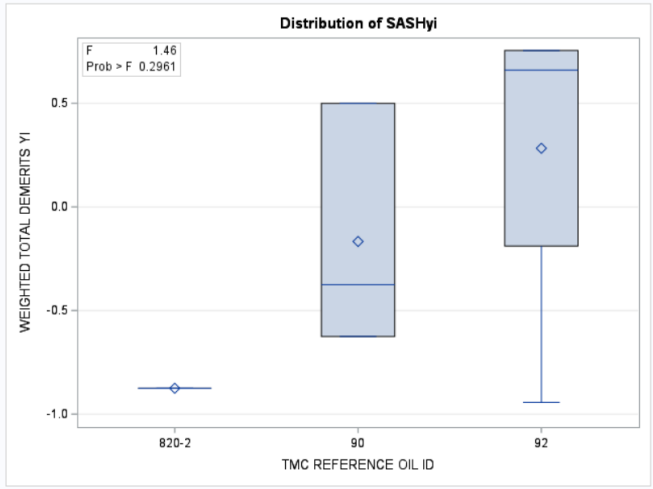
Period Precision and Severity Estimates

Total Deposits, mg	n	df	Pooled s	Mean Δ/s
Current Targets	81	78	0.07	-----
10/1/19 through 3/31/20	7	4	0.04	-0.71
4/1/20 through 9/30/20	8	5	0.03	-0.30
10/1/20 through 3/31/21	8	5	0.02	-0.35
4/1/21 through 9/30/21	10	7	0.15	0.37
10/1/21 through 3/31/22	9	6	0.05	-0.07
4/1/22 through 9/30/22	8	6	0.06	-0.38
10/1/22 through 3/31/23	11	8	0.04	-0.71
4/1/23 through 9/30/23	10	7	0.04	-0.46
10/1/23 through 3/31/24	11	8	0.02	-0.47
4/1/24 through 9/30/24	9	7	0.04	-0.45
10/1/24 through 3/31/25	10	7	0.04	0.03

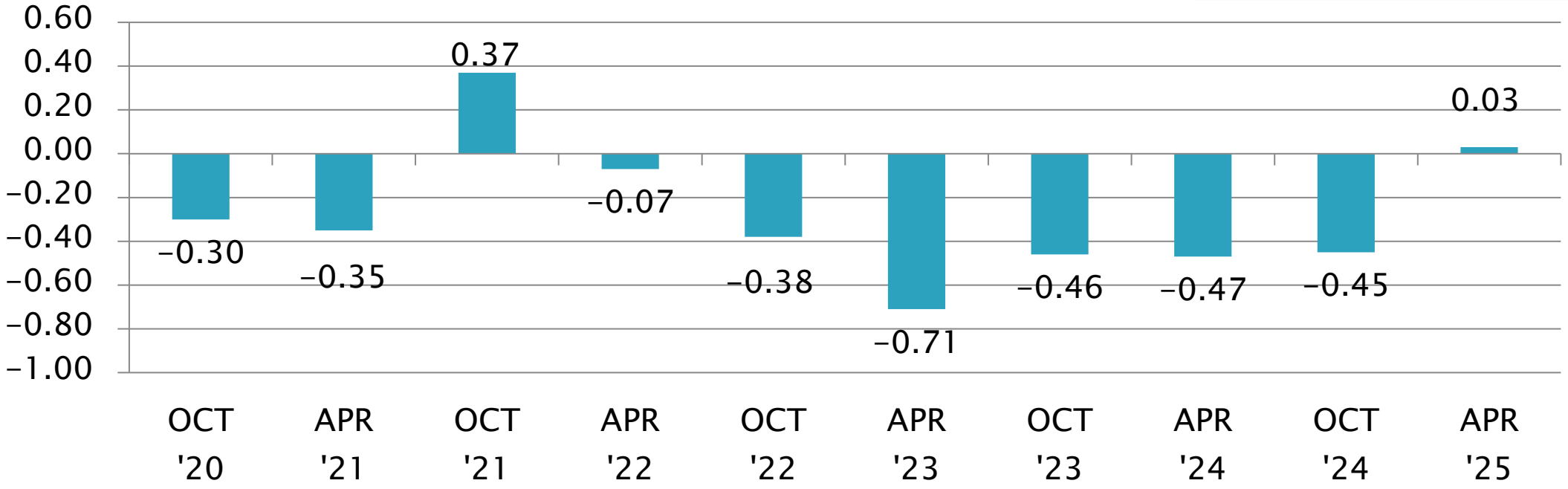
D874: Sulfated Ash



D874: Sulfated Ash



Sulfated Ash, mass%
Mean Δ/s



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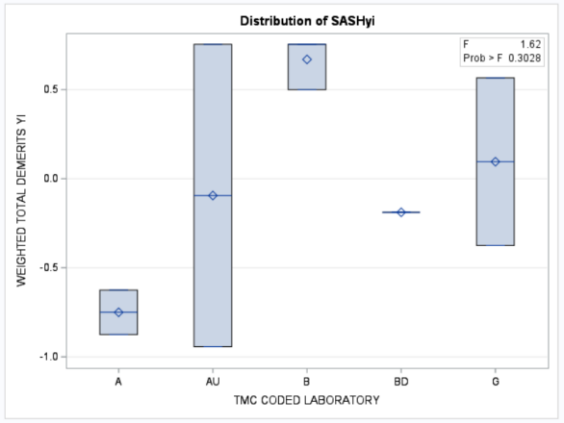
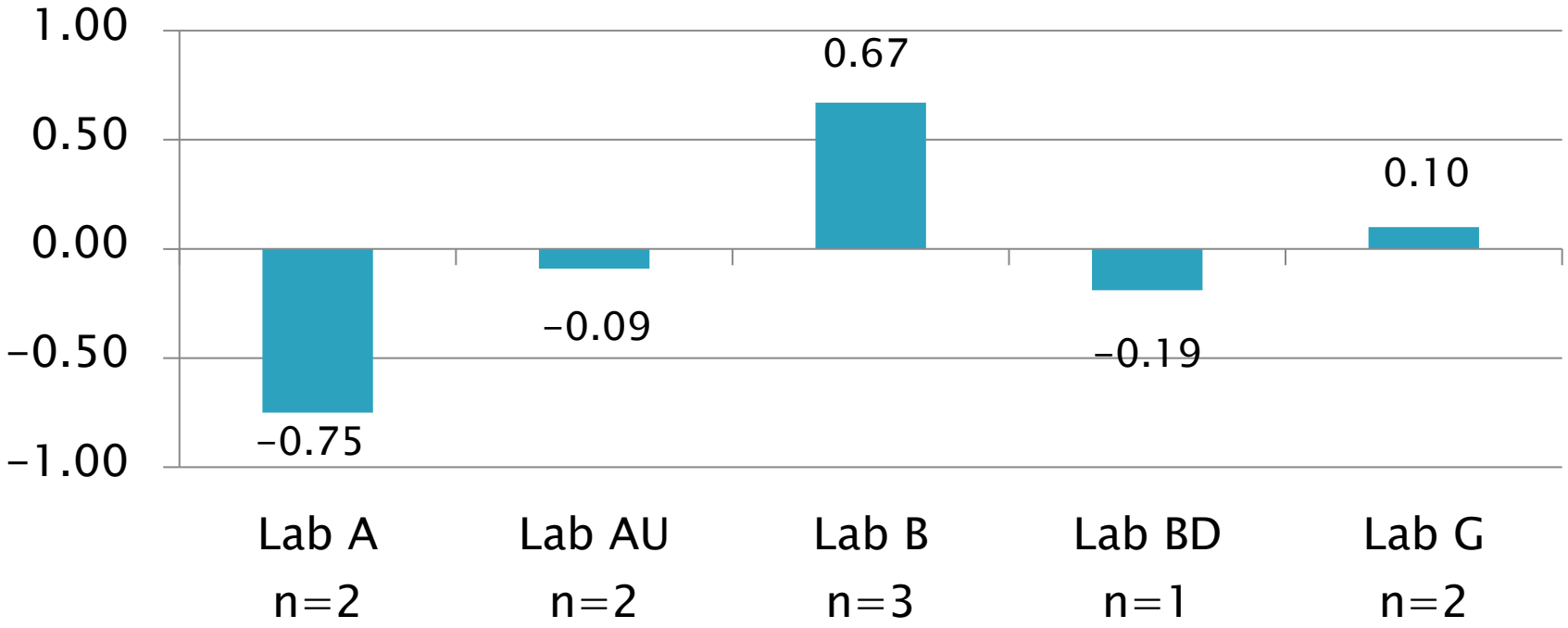
D874: Sulfated Ash



Sulfated Ash, mass%

Mean Δ/s

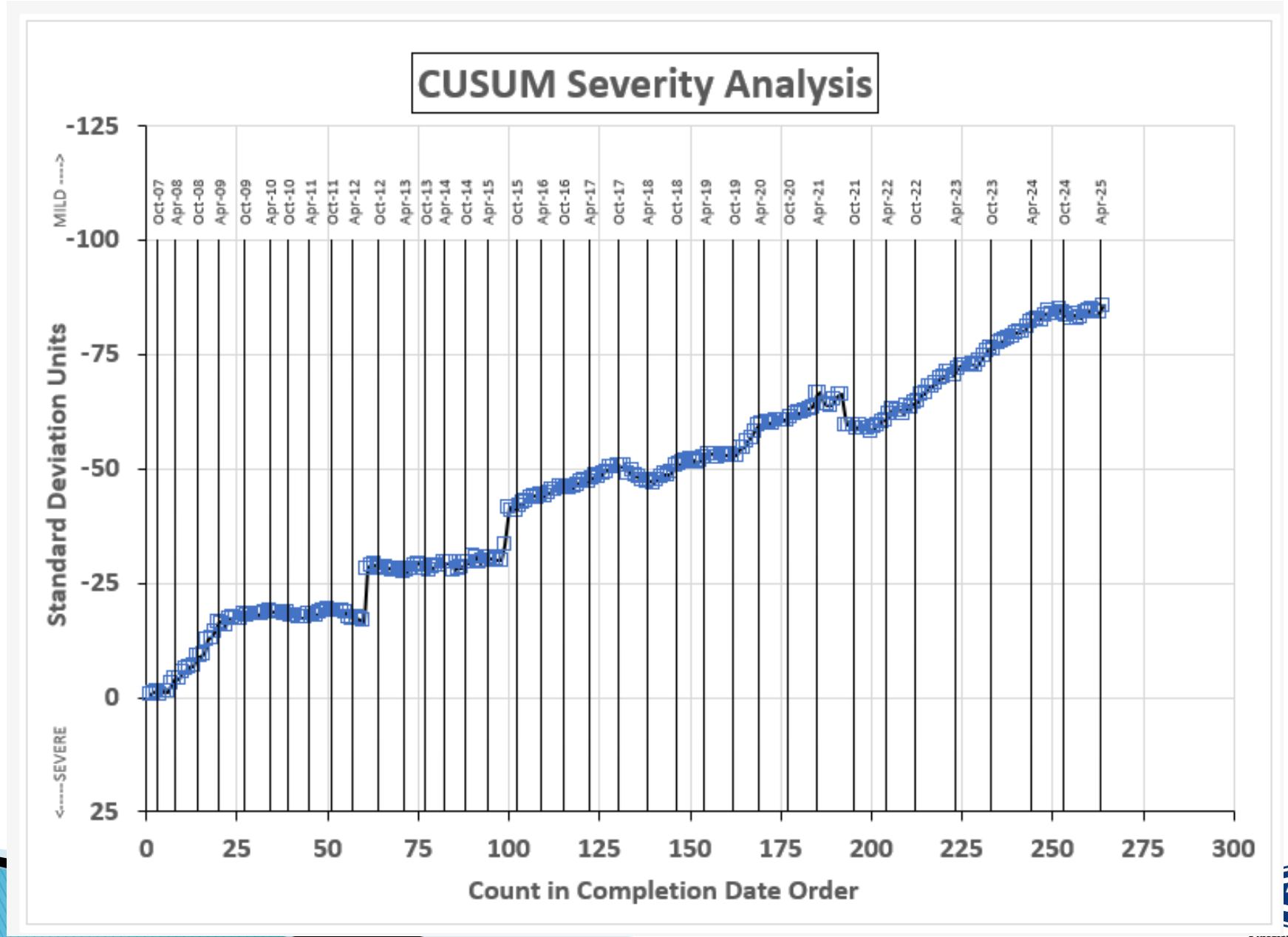


D874 (Sulfated Ash) Status

- Precision (Pooled s) remained at 0.04 again this semester.
- Performance (Mean Δ/s) moved closer to target at 0.03 s
- Labs with remaining Reference Oil 90 will be assigned until their supply is consumed (6 TESTKEYs total). TMC inventory of Reference Oil 90 is only used for fill requests for Daily QC.
- Thirteen (13) new Reference Oil 92 results completed in past year. Should be able to get four or five more runs and update the RO 92 targets around the end of the year.

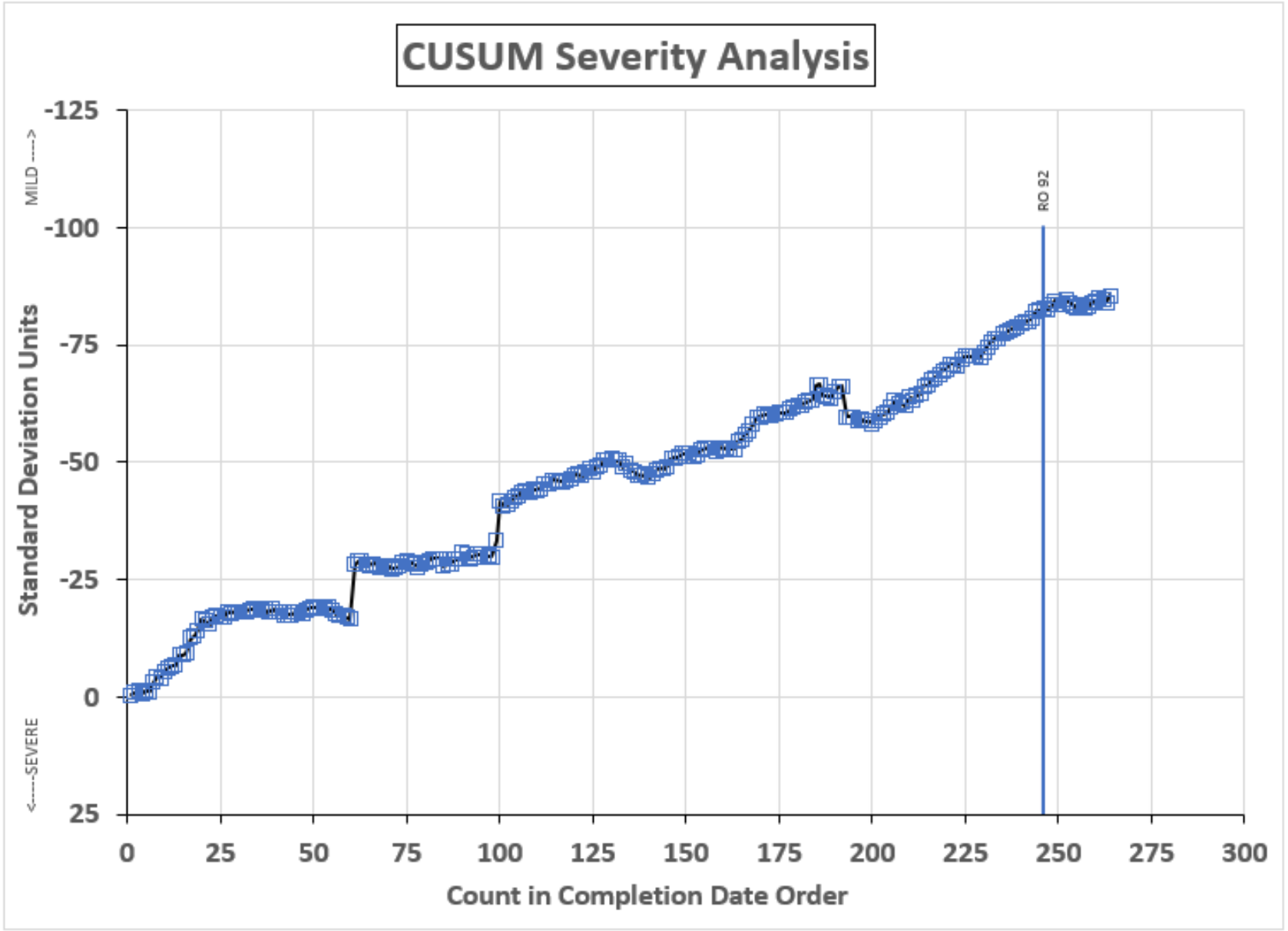
D874 INDUSTRY OPERATIONALLY VALID DATA

TEST SAMPLE PERCENT SULFATED ASH

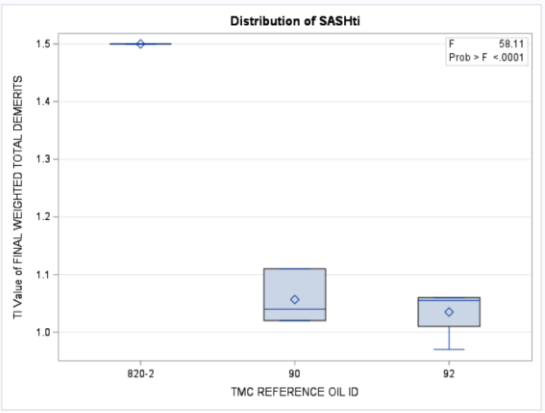


D874 INDUSTRY OPERATIONALLY VALID DATA

TEST SAMPLE PERCENT SULFATED ASH

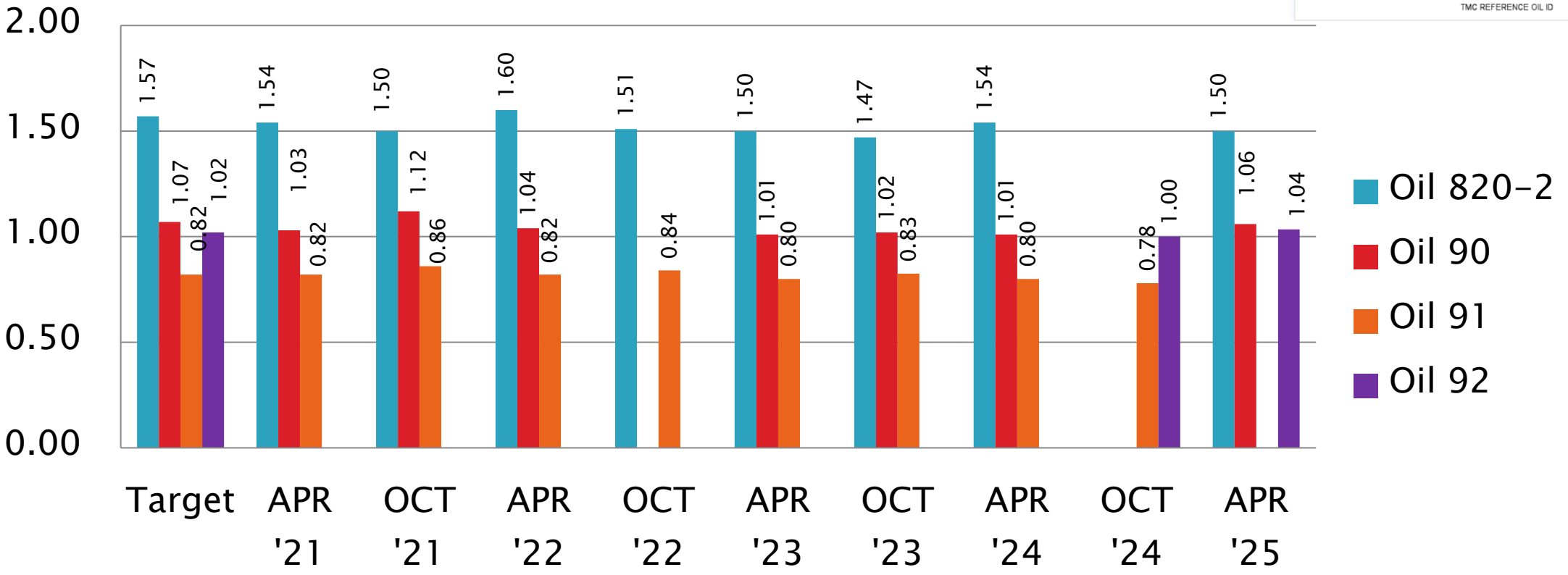


D874: Sulfated Ash



Sulfated Ash, mass%

Mean



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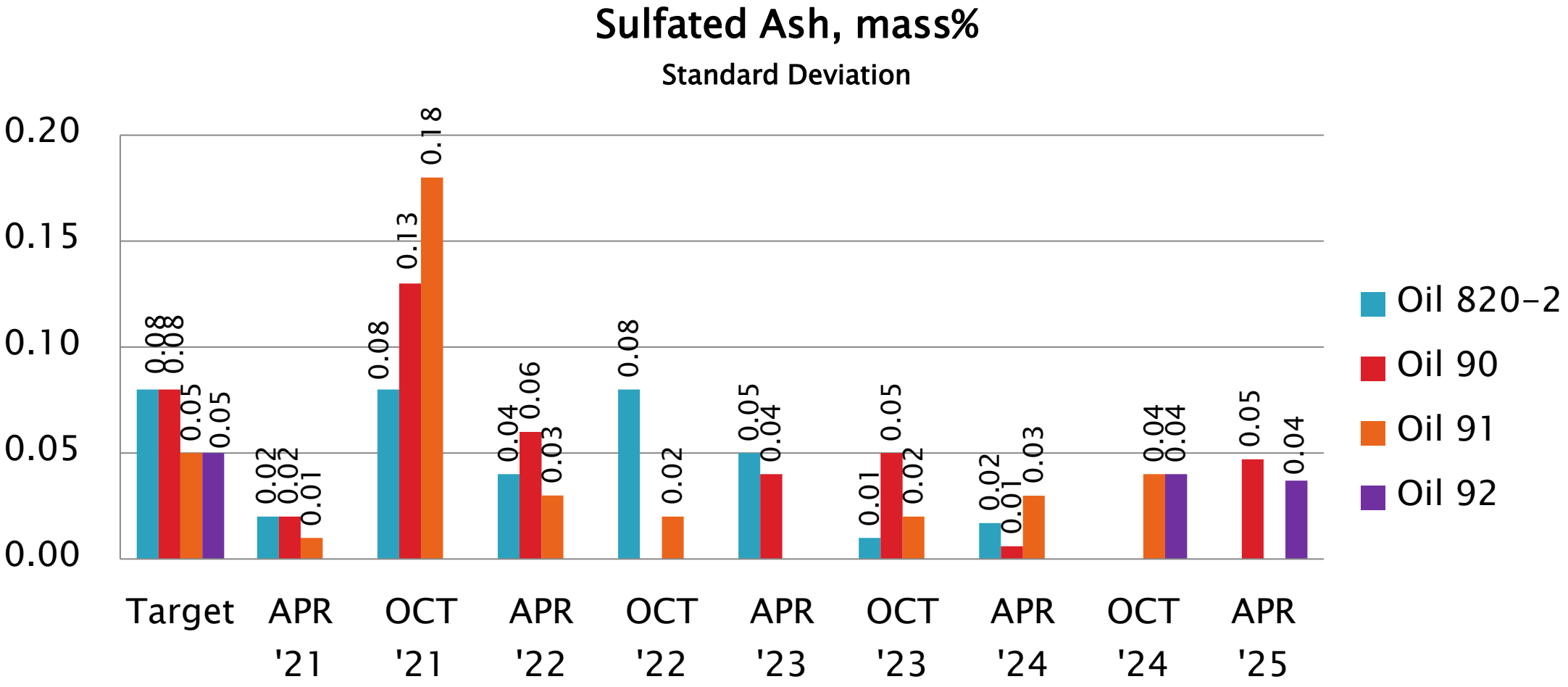
D874: Sulfated Ash



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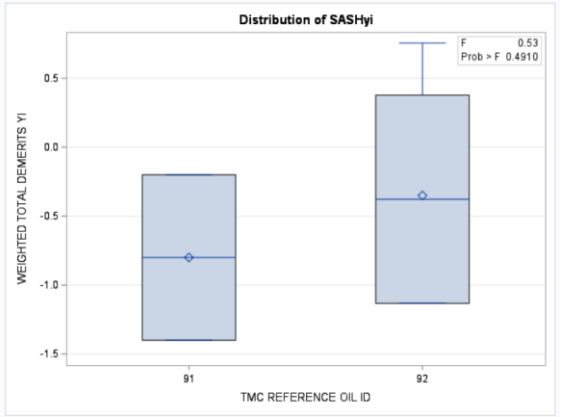
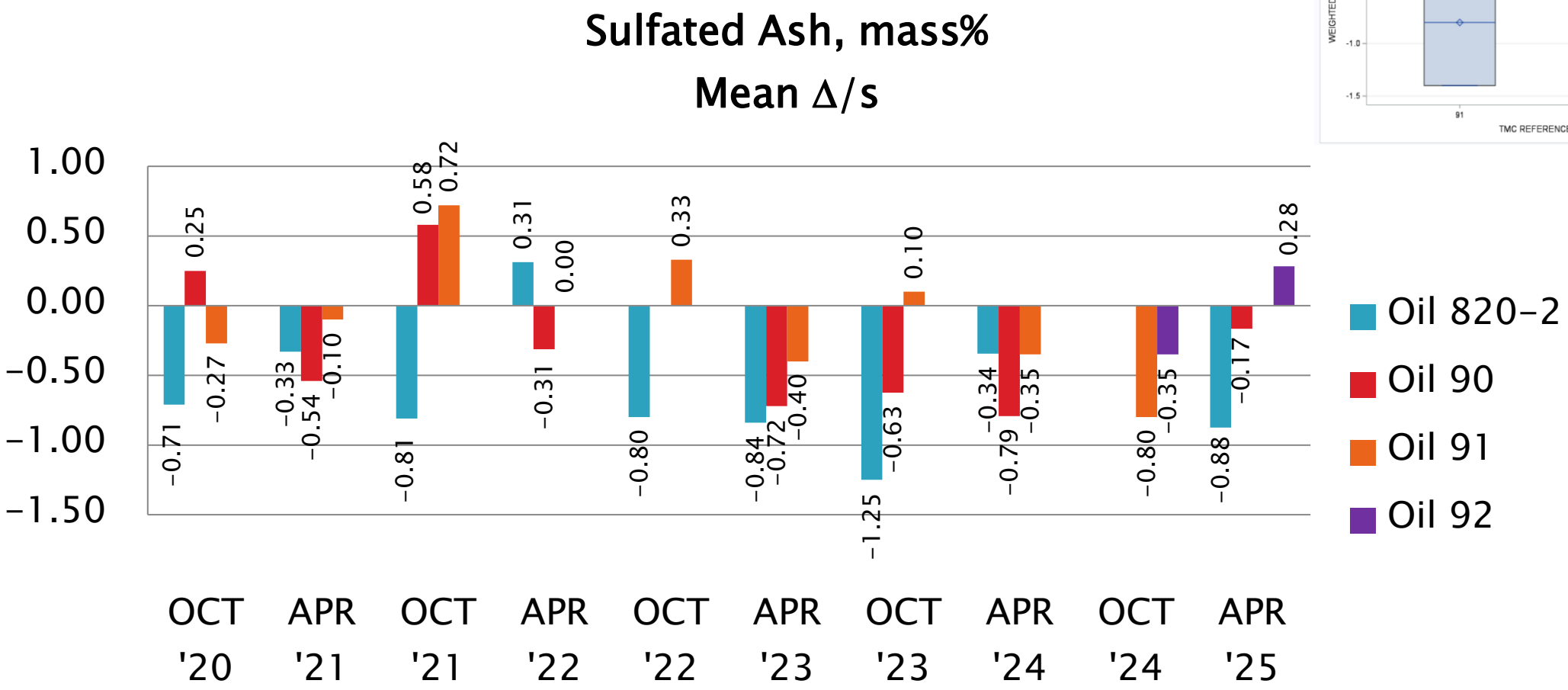
D874: Sulfated Ash





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Reference Oil Inventory

D874

Oil	Year Rec'd By TMC[A]	Tests	TMC Inventory, gallons	Gallons Shipped last 6 months	Estimated Life
820-2	2001	D874	5.91	0.08	5+ years
90[B]	2005	D874QC	2.23	0.26	1.5 years
91	2006	D874	2.90	0.08	5+ years
92	2020	D874	52.44	0.08	5+ years

[A] Integrity of TMC reference oils is confirmed annually by analytical QC testing of chemical and physical properties.
[B] TMC Inventory of Reference Oil 90 is now only used for D874QC Samples (1L sizes)

D02.B0.07
TMC Monitored Tests

ASTM D 5133

Gelation Index (GI)

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Calibrated Labs and Stands*

(change since last Semi-Annual Report)

Test	Labs	Stands
D5133	9 (+0)	46 (+4)
*As of 3/31/2025		

D5133: Gelation Index

Test Status	Validity Code	No. Tests
Acceptable Calibration Test	AC	62
Failed Calibration Test	OC	7
Operationally Invalidated by Lab	LC / LS / LN / XC / XS	3
Operationally Invalidated After Initially Reported as Valid	RC/RS	0
Acceptable Discrimination Tests	AS	34
Failed Discrimination Tests	OS	3
Informational Runs	NN / MN	0
Total		**109**

Number of Labs Reporting Data:	9	(previous 9)
Fail Rate of Operationally Valid Calibration Tests:	10.1 %	(previous 19.4%)
Fail Rate of Operationally Valid Discrimination Tests:	8.3 %	(previous 0%)

D5133: Gelation Index

Statistically Unacceptable Calibration Tests (OC)	No. Of Tests
Gelation Index Severe	4
Gelation Index Mild	3
Total	**7**

- Of the SEVEN "OC" tests
  - 1-GIC 18
  - 2-GIA 17
  - 4-1009
- Three between -1.96 and -3.0 sd from target
- Four greater than +4.0 sd from target

D5133: Gelation Index

Statistically Unacceptable Discrimination Tests (OS)	No. Of Tests
Gelation Index Severe (> 7.2)	3
Total	**3**

- There were Three Failing Discrimination Runs this Semester

D5133: Gelation Index

Tests Excluded From Statistics (Operationally or Otherwise)	Validity Code	No. Tests
Invalidated Runs	LC, LS, LN, RC, RS	0
Aborted Runs	XC, XS	3
Informational Runs (Acceptable Result)	NN	0
Informational Runs (Unacceptable Result)	MN	0
Total		**3**

- ONE Aborted Run due to Data Recorder Failure
- ONE Aborted Run due to Power Outage
- ONE Aborted Run due to High Torque

D5133: Gelation Index

Period Precision and Severity Estimates

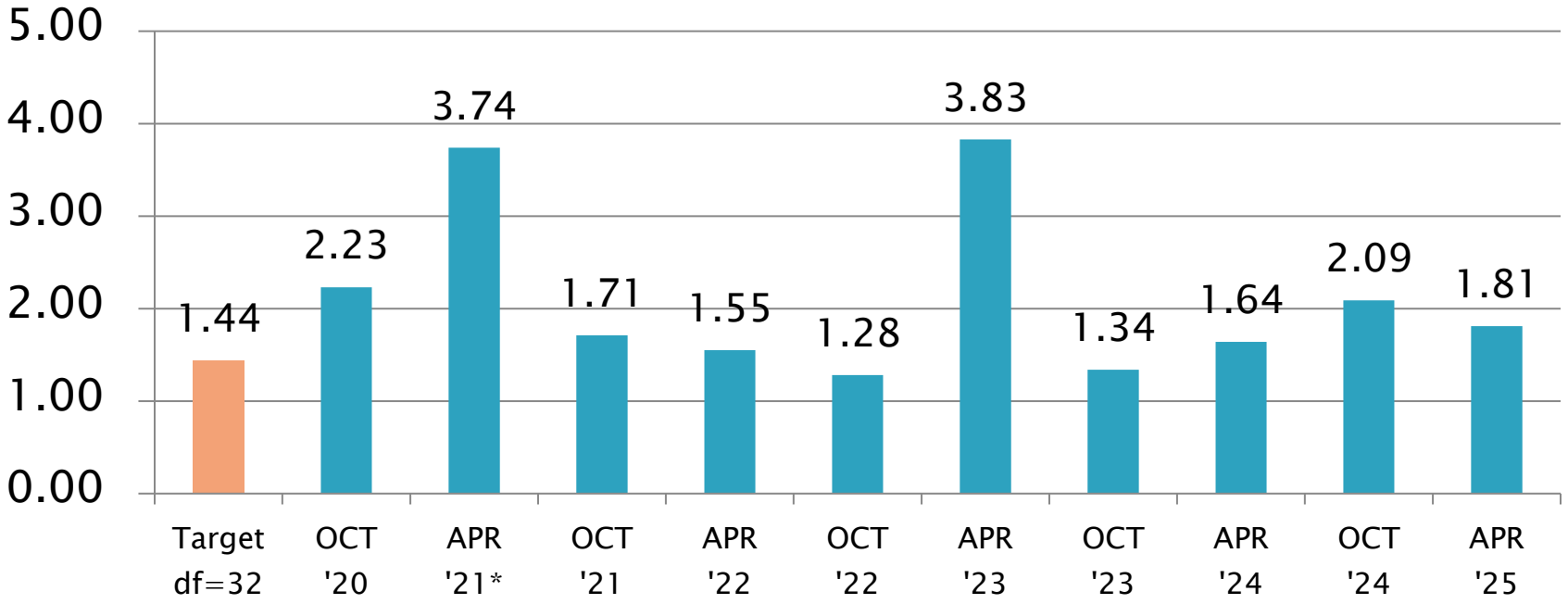
Gelation Index	n	df	Pooled s	Mean Δ/s
Targets Updated 20201001[1]	34	32	1.44	-----
4/1/20 through 9/30/20	52	48	2.23	-0.11
10/1/20 through 3/31/21[2]	116	113	3.74	-0.86
4/1/21 through 9/30/21	75	73	1.71	-0.20
10/1/21 through 3/31/22	61	59	1.55	-0.84
4/1/22 through 9/30/22	57	55	1.28	-0.41
10/1/22 through 3/31/23	84	80	3.83	-0.08
4/1/23 through 9/30/23	62	59	1.34	-0.21
10/1/23 through 3/31/24	57	54	1.64	-0.03
4/1/24 through 9/30/24	62	59	2.09	-0.92
10/1/24 through 3/31/25	69	66	1.81	-0.25

[1]Target precision based upon GIA17 and 1009 reference oils 10/1/2020
[2]Changed from bath to head-based monitoring scheme 10/1/2020

D5133 Precision Estimates

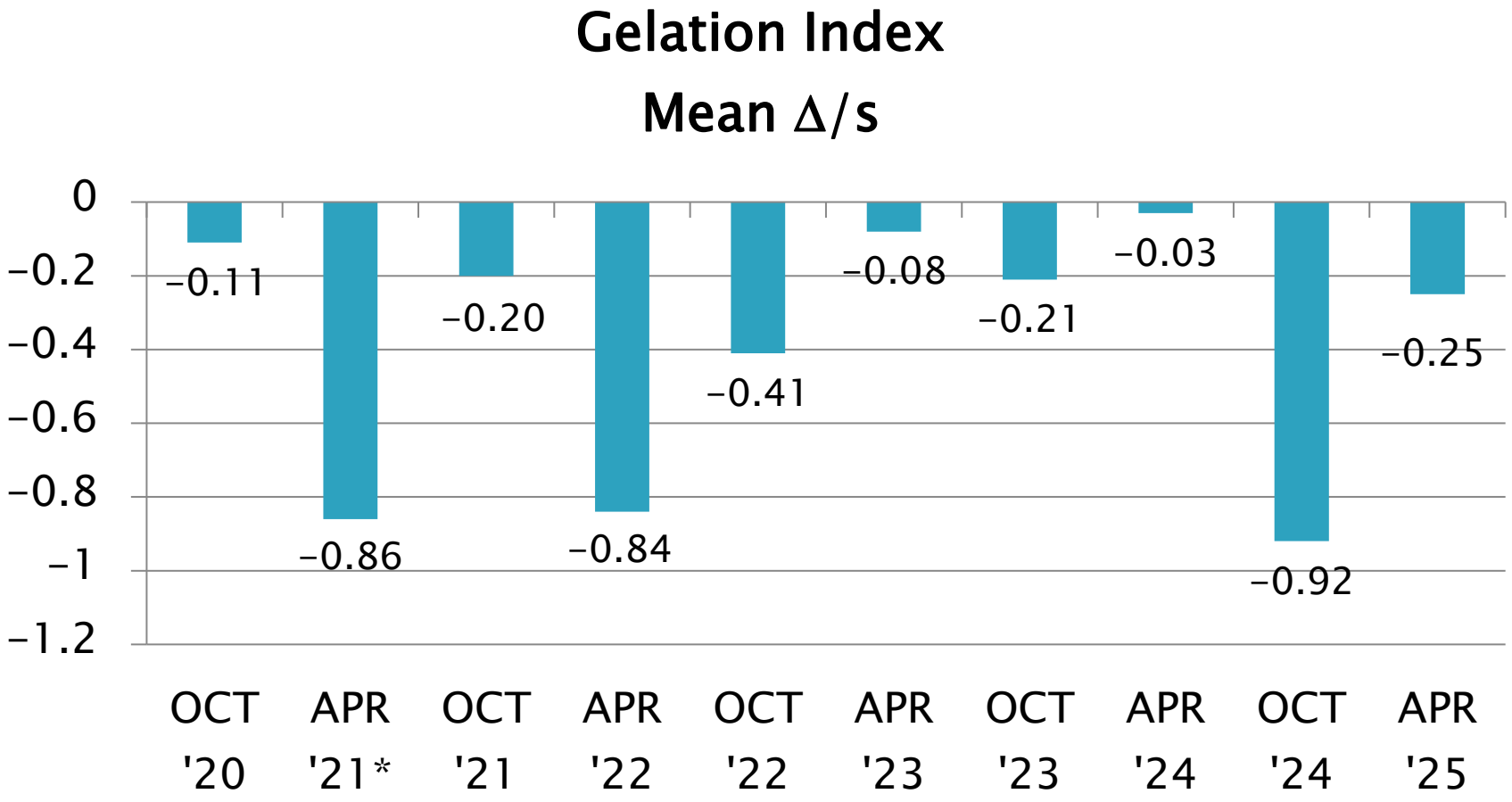
Gelation Index

Pooled s

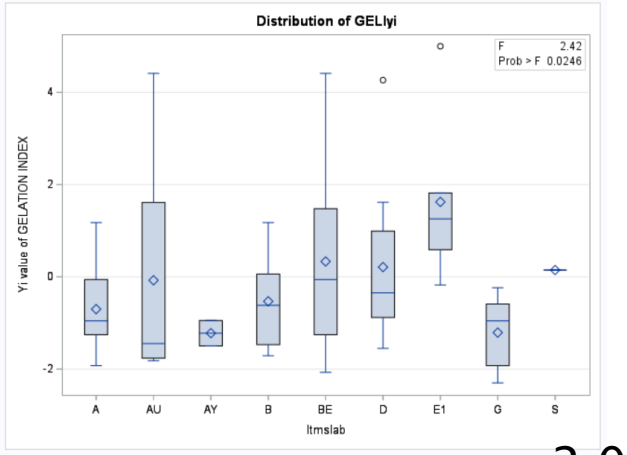


*Changed from bath to head-based monitoring scheme

D5133 Severity Estimates



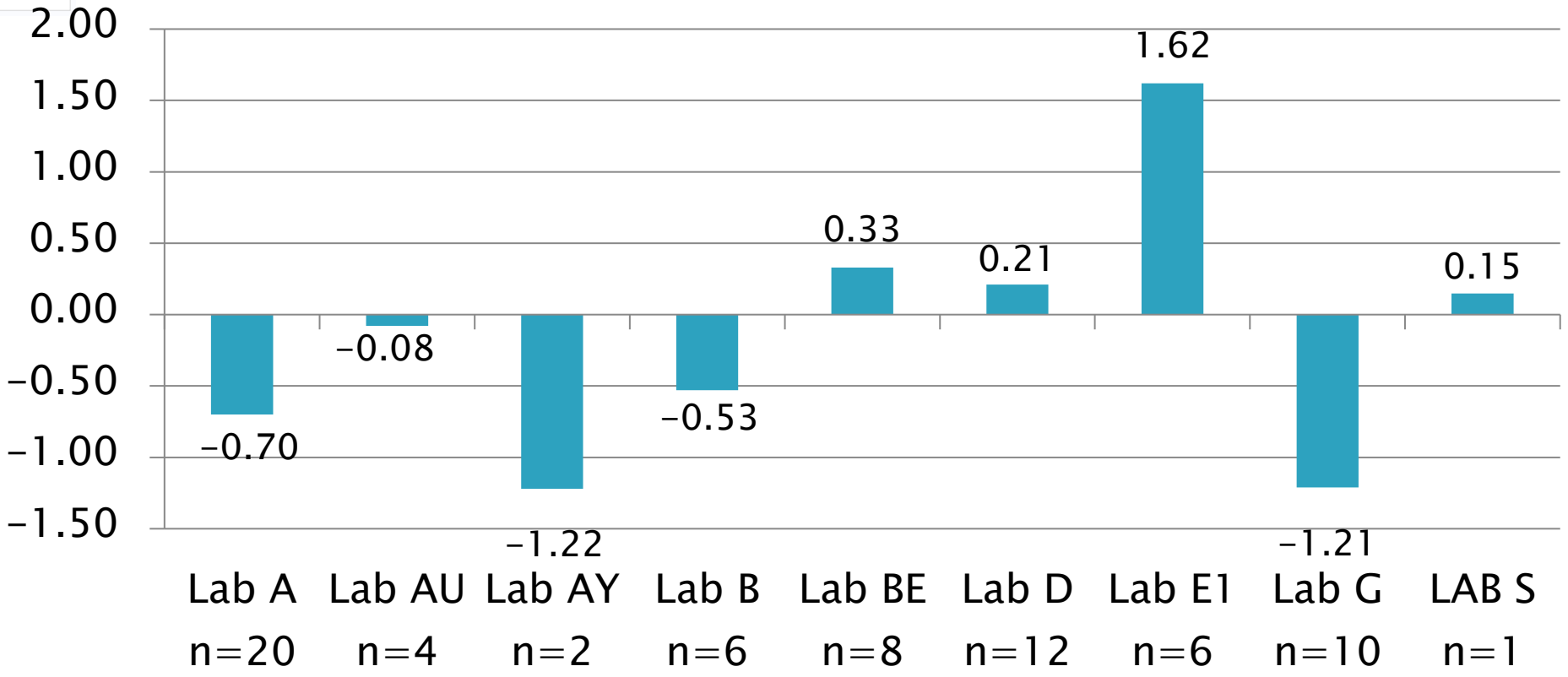
*Changed from bath to head-based monitoring scheme



D5133 Lab Severity Estimates

Gelation Index

Mean Δ/s



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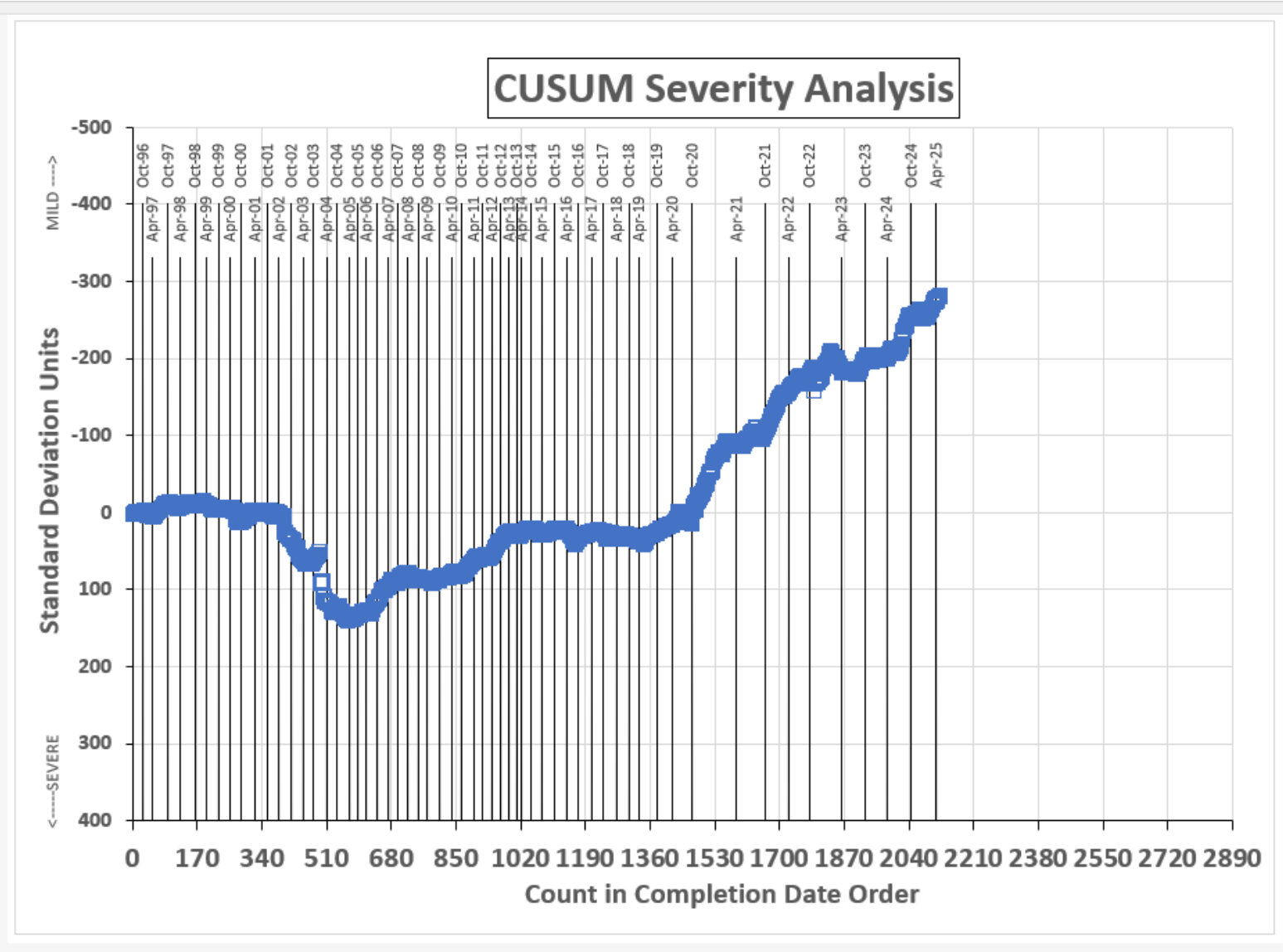
D5133: Gelation Index Test Status

- Fail rate of operationally valid tests dropped to 10.1%
  - Fail rate last period was 19.4%
- Three (3) operationally valid discrimination runs failed this period
  - ZERO (0) discrimination runs failed last period
- Precision (Pooled s) was 1.81, moving closer to target (1.44).
- Performance (Mean Δ/s) improved to -0.25 s showing that the testing is running slightly mild

GELATION INDEX



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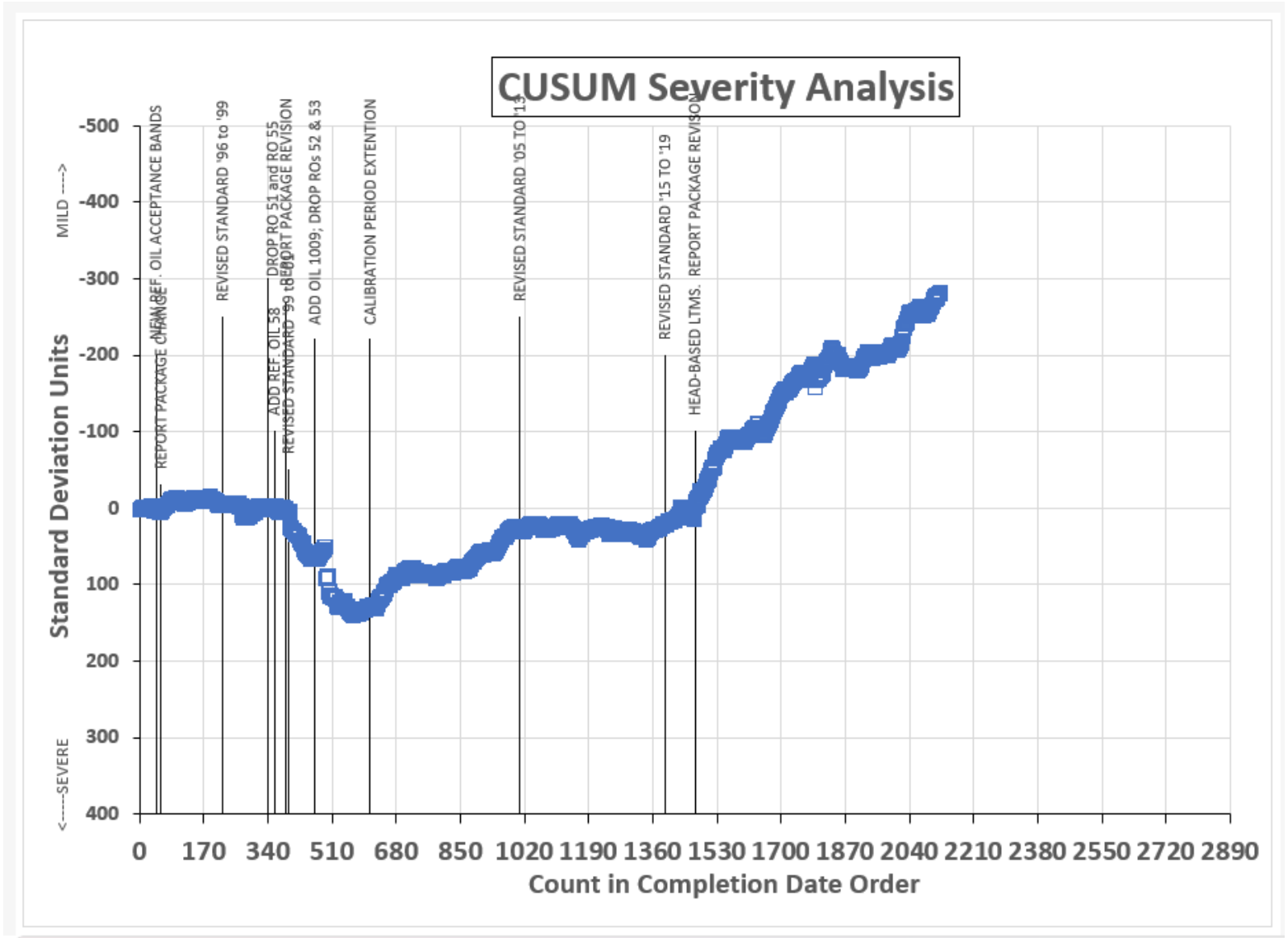
GELATION INDEX



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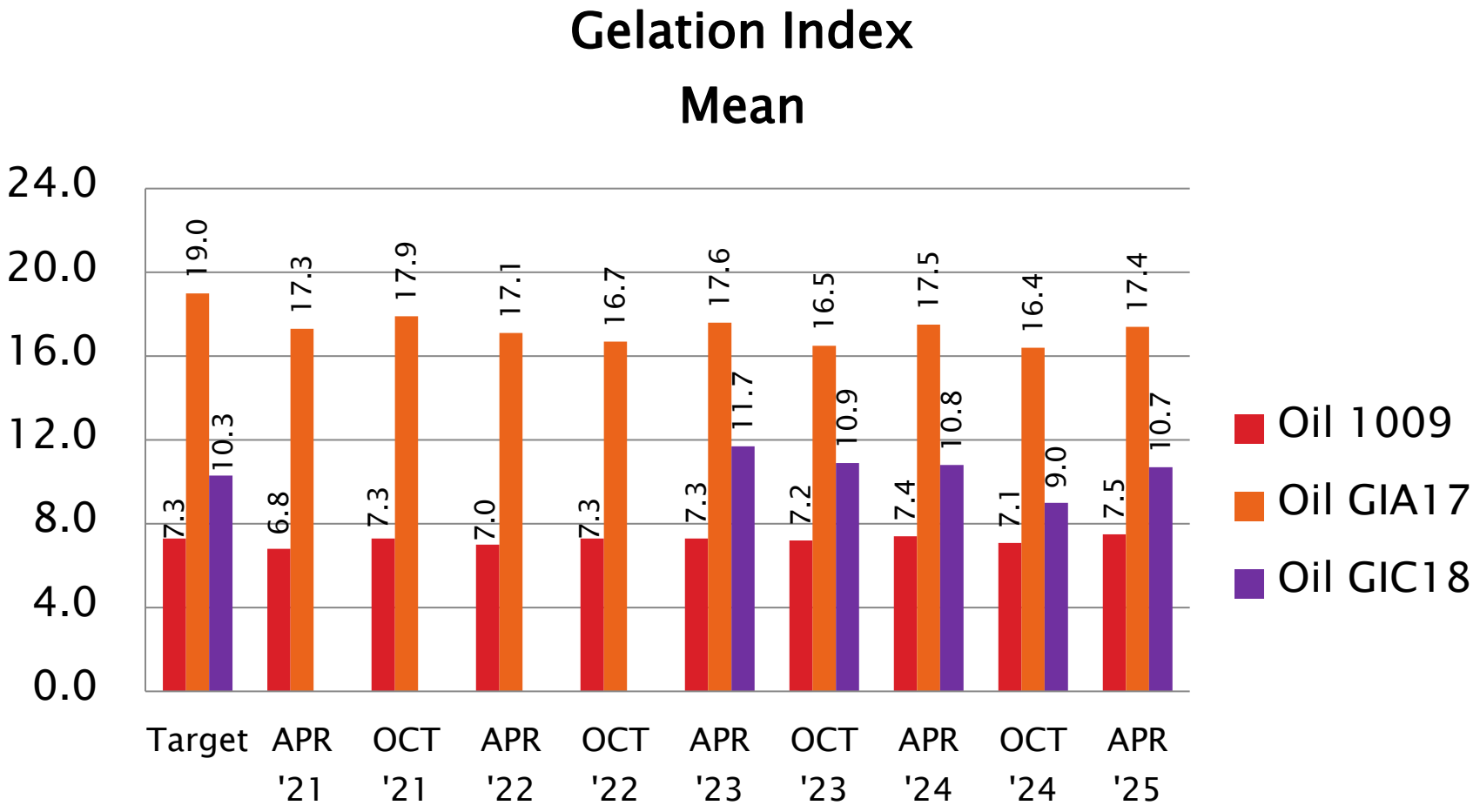
D5133 Performance by Oil



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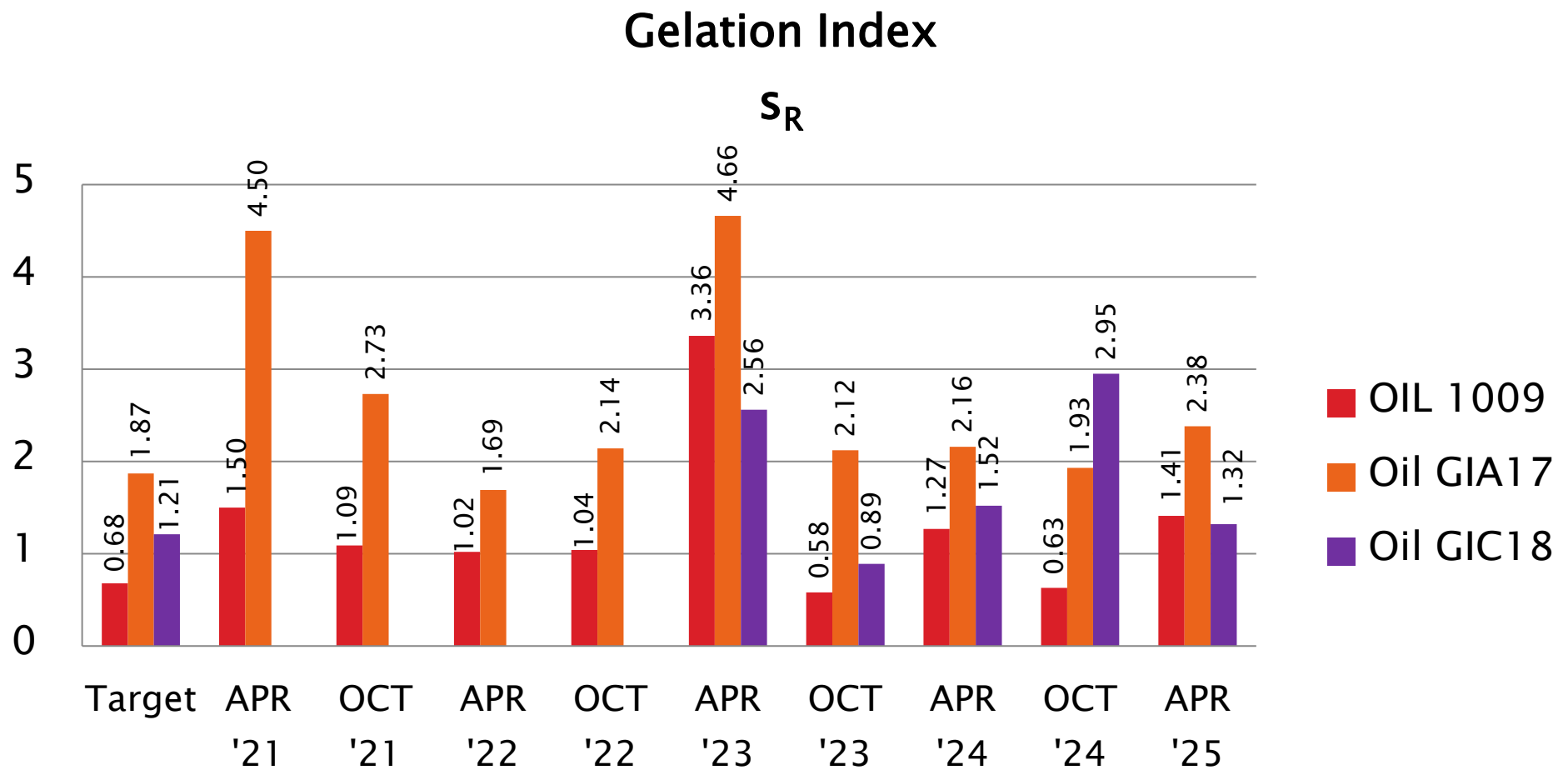
D5133 Performance by Oil



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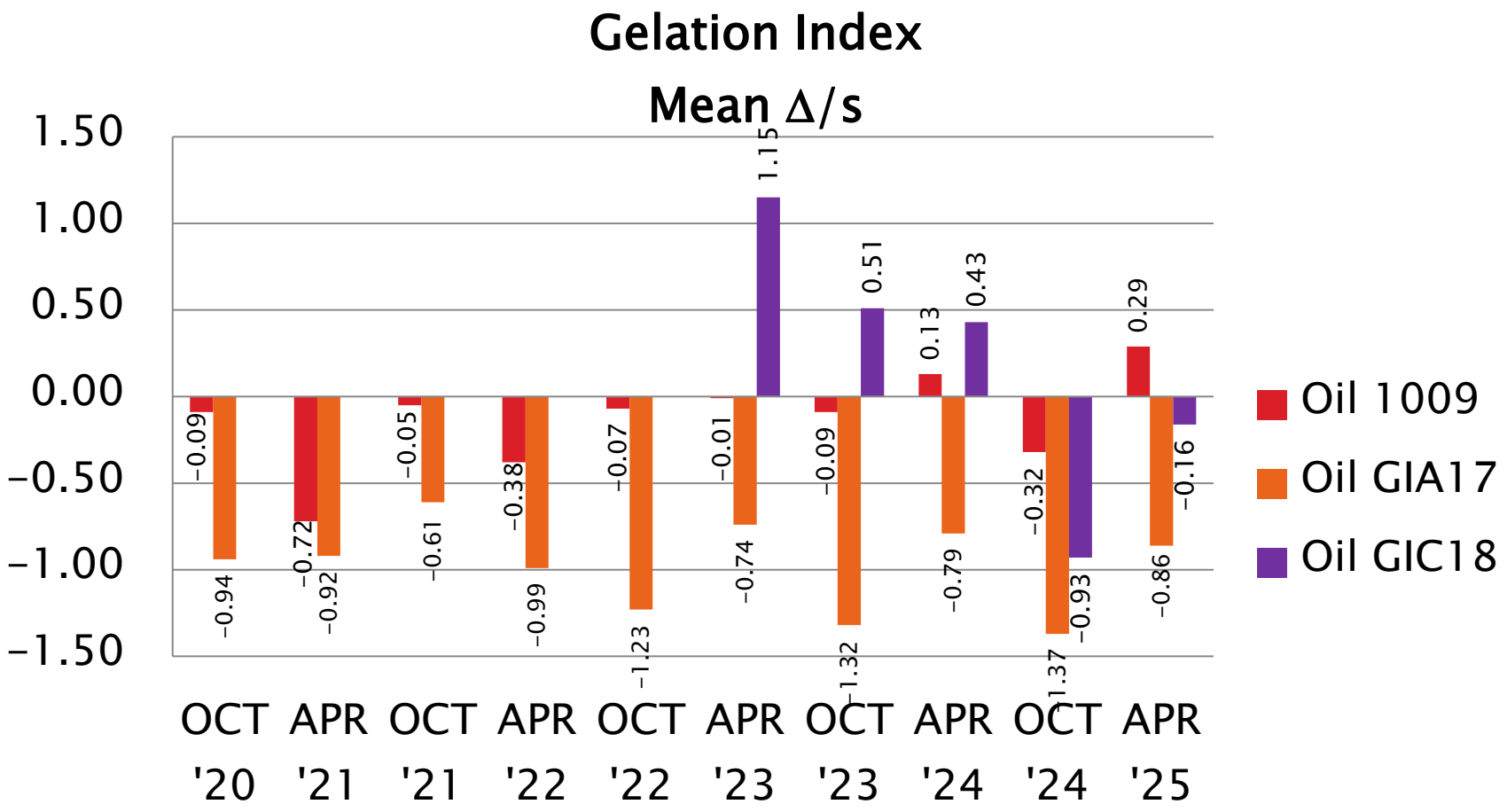
D5133 Performance by Oil



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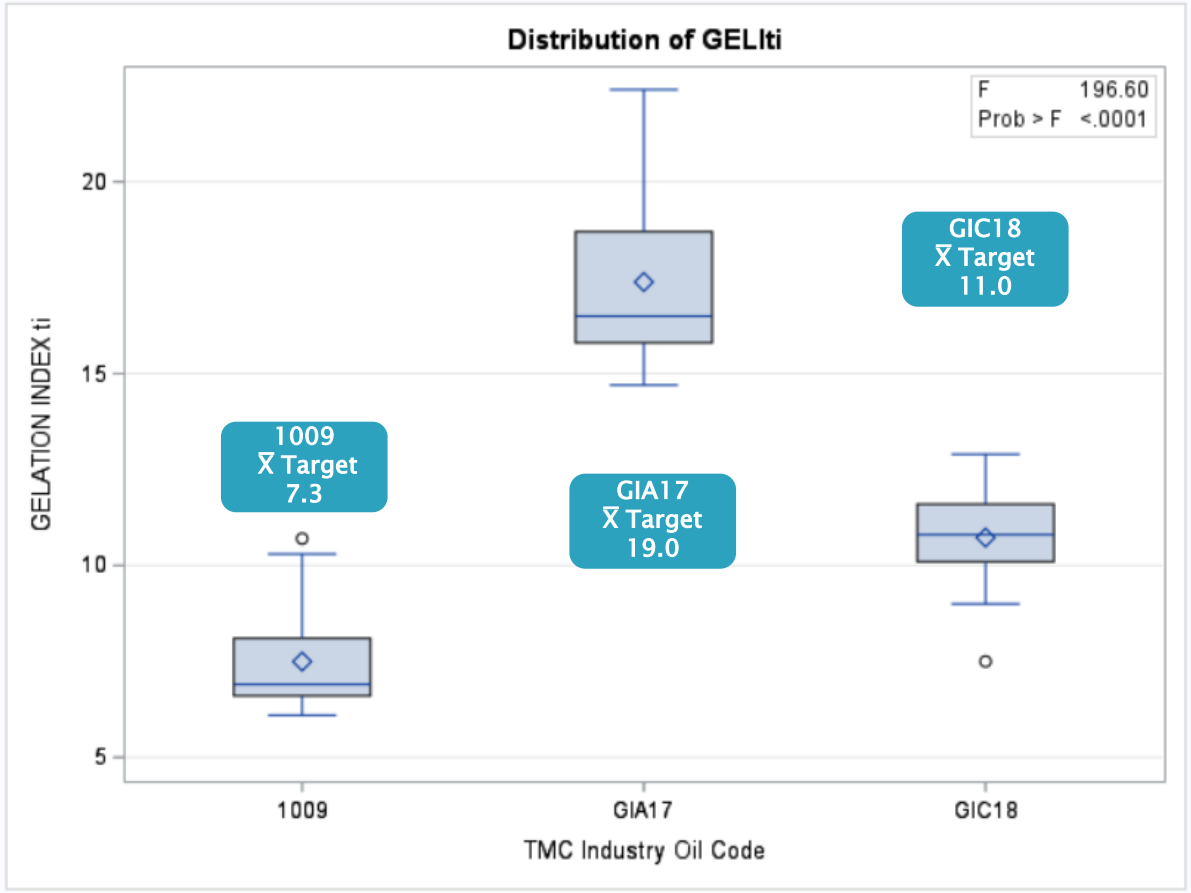
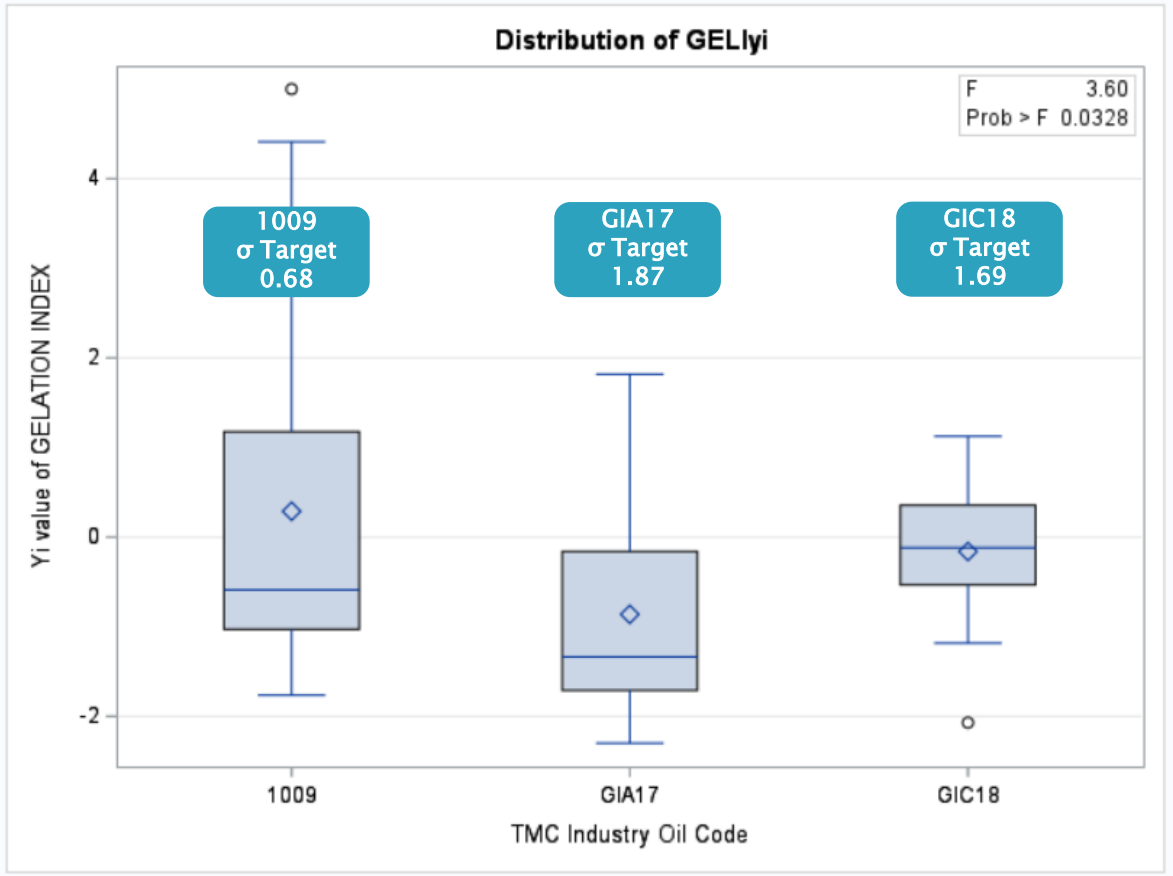
ASTM D5133 (GI): OCT23 – MAR24 Results





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Reference Oil Inventory

GI (D5133)

Oil	Year Rec'd By TMC[A]	Tests	TMC Inventory, gallons	Gallons Shipped last 6 months	Estimated Life
58[B]	1998	GI	111.5	0.19	5+ years
GIA17	2017	GI	5.15	0.16	5+ years
GIC18	2018	GI	7.82	0.14	5+ years
1009	2002	GI	33.30	0.11	5+ years

[A] Integrity of TMC reference oils is confirmed annually by analytical QC testing of chemical and physical properties.
[B] Reference Oil 58 is used in multiple Bench Test Areas and is the Discrimination Oil in D5133 (GI)

D02.B0.07
TMC Monitored Tests

ASTM D 5800

NOACK Volatility

October 1, 2024 – March 31, 2025

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Calibrated Labs and Stands*

(change since last Semi-Annual Report)

Test	Labs	Stands
D5800	14 (+0)	39 (+0)

*Between 10/1/2024 and 3/31/2025

D5800: Evaporation Loss of Lubricating Oil by Noack Method

Test Status	Validity Code	No. Tests
Acceptable Calibration Test	AC	177
Failed Calibration Test	OC	9
Operationally Invalidated by LAB	LC	3
Operationally Invalidated by TMC	RC	1
Aborted Test	XC	1
Acceptable Shakedown Run	NN	0
Unacceptable Shakedown Run	MN	0
Total		**191**

Number of Labs Reporting Data: 14

Fail Rate of Operationally Valid Tests: 4.86% (last Semester 2.12%)

D5800: Evaporation Loss of Lubricating Oil by Noack Method

Statistically Unacceptable Tests (OC)	No. Of Tests
Ei Level 3 Alarm Mild	3
Zi Level 2 Alarm Severe	1
Zi Level 2 Alarm Mild	2
Zi Level 2 and Ei Level 3 Alarms, Mild	2
Zi Level 2 and Ei level 3 Alarms, SEVERE	1

- NINE OC tests were on six different rigs at five different labs.
- FIVE (!) operationally valid tests exceeded ±3.0 s this period.

D5800: Evaporation Loss of Lubricating Oil by Noack Method

Failed (OC) Details	Procedure	Model	No. Tests
Ei Level 3 Alarm: Rig (E1-7) Mild, too imprecise to predict SA	D	NS2	1
Ei Level 3 Alarm: Rig (BA-2, BA-3) Mild, too imprecise to predict SA	B	NCK25G	2
Zi Level 2 Alarm: Rig (D3-1) Severe	B	NCK25G	1
Zi Level 2 Alarm: Rig (G-10, V-4) Mild	D	NS2	2
Zi Level 2 and Ei Level 3 Alarms, (G-10, V-4) Mild	D	NS2	2
Zi Level 2 and Ei Level 3 Alarms, (BA-3) Severe	B	NCK25G	1
Total			**9**
Fail Rate of Operationally Valid Tests: 2.12%			

D5800: Evaporation Loss of Lubricating Oil by Noack Method

Operationally Invalid Tests (LC, RC)

Four labs had invalidated calibration runs this period

- One test was invalidated by TMC due to DAILY QC Out of Range
- Two tests were invalidated by Lab due to use of wrong oil or wrong test unit
- One test was invalidated by Lab due to broken crucible

D5800 Technical Memos

No D5800 technical memos were issued by the TMC this period.

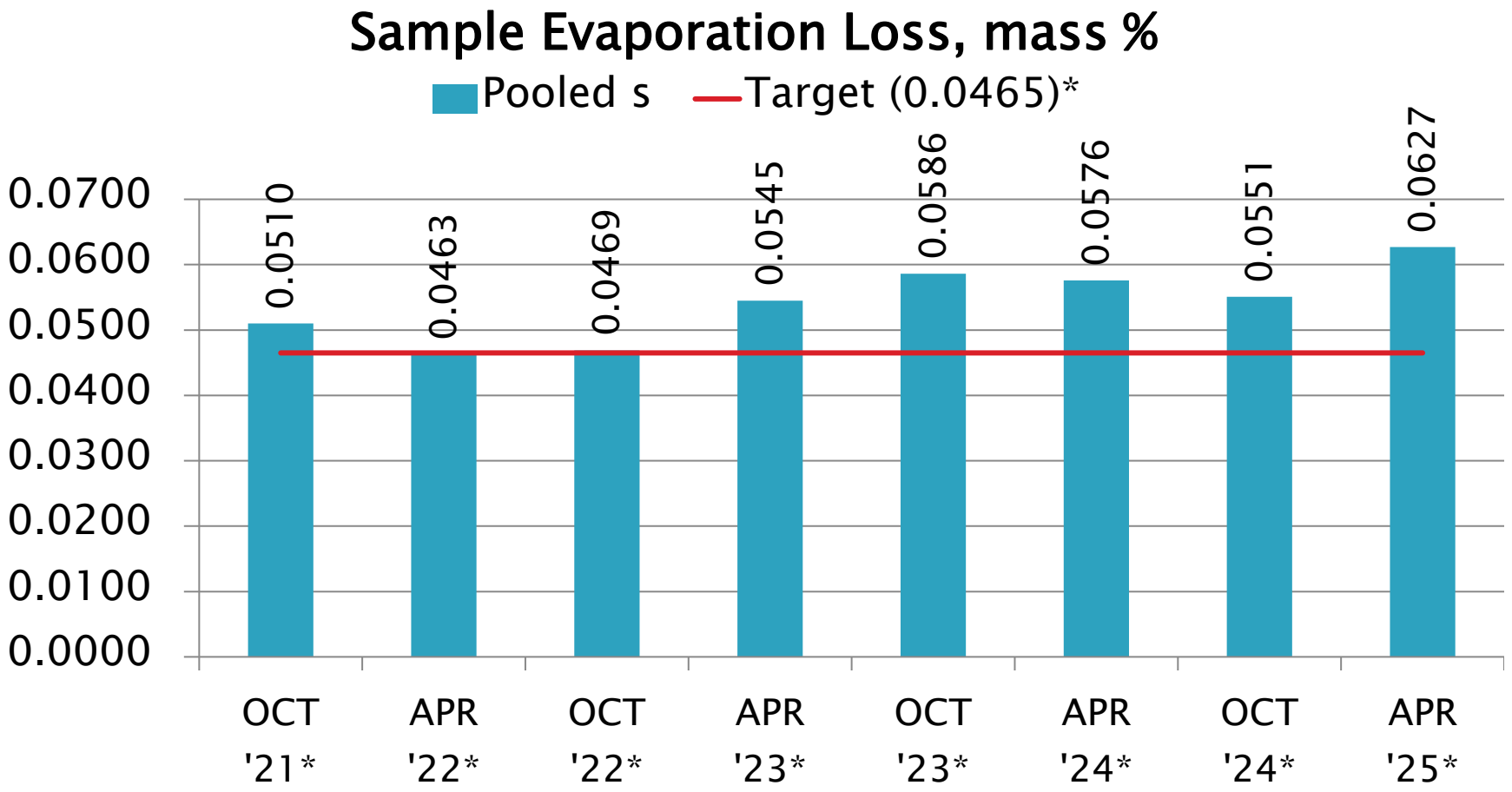
D5800: Evaporation Loss of Lubricating Oil by Noack Method

Period Precision and Severity Estimates

Sample Evaporation Loss, mass %	n	df	Pooled s	Mean Δ/s
Targets Effective 02/07/20[1]	78	75	0.0465	-----
4/1/20 through 9/30/20[1]	136	133	0.0659	0.35
10/1/20 through 3/31/21[1]	140	137	0.0495	0.53
4/1/21 through 9/30/21[1]	136	133	0.0510	0.45
10/1/21 through 3/31/22[1]	139	136	0.0463	0.24
4/1/22 through 9/30/22[1]	136	133	0.0469	-0.10
10/1/2022 through 3/31/23[1]	136	133	0.0545	-0.15
4/1/2023 through 9/30/23[1]	169	166	0.0586	0.33
10/1/2023 through 3/31/24[1]	174	171	0.0576	0.37
4/1/2024 through 9/30/24[1]	189	187	0.0551	0.23
10/1/2024 through 3/31/25[1]	186	183	0.0627	0.21

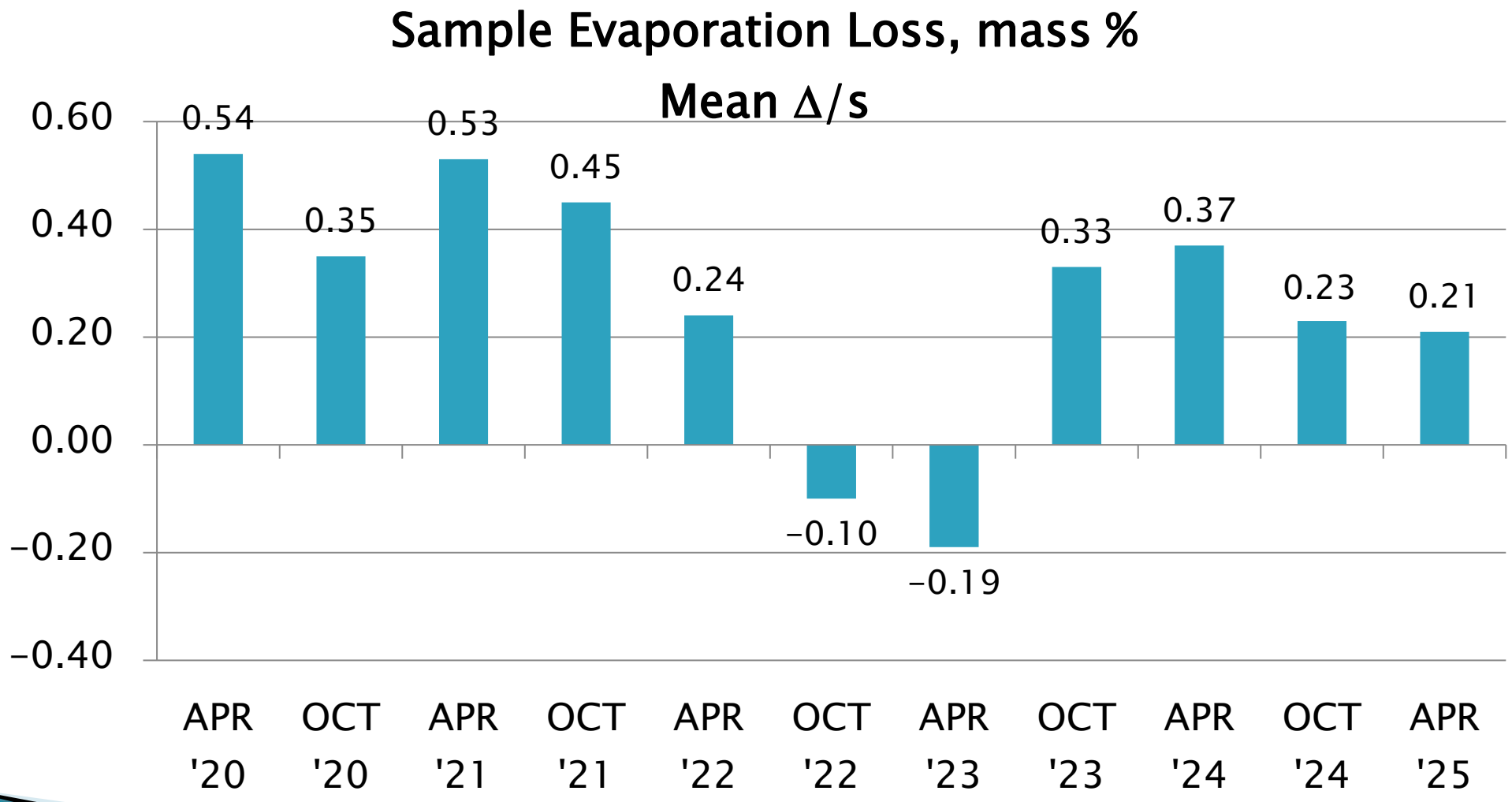
[1]Began monitoring natural log transformed test results on 20200207 making logarithmic scale changes for target and period precision estimates starting April 2020 report period

D5800 Precision Estimates



*Began monitoring natural log transformed test results on 20200207 making logarithmic scale changes for target and period precision estimates starting April 2020 report period.

D5800 Severity Estimates



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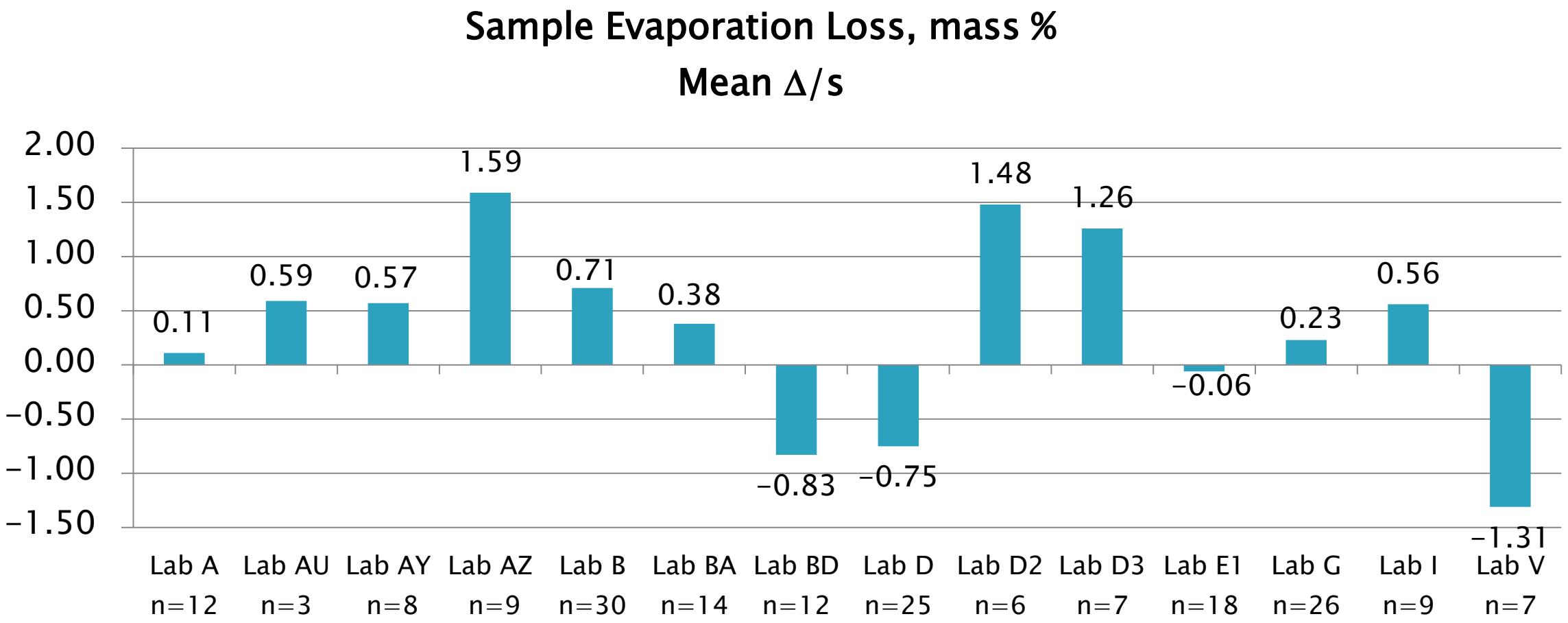
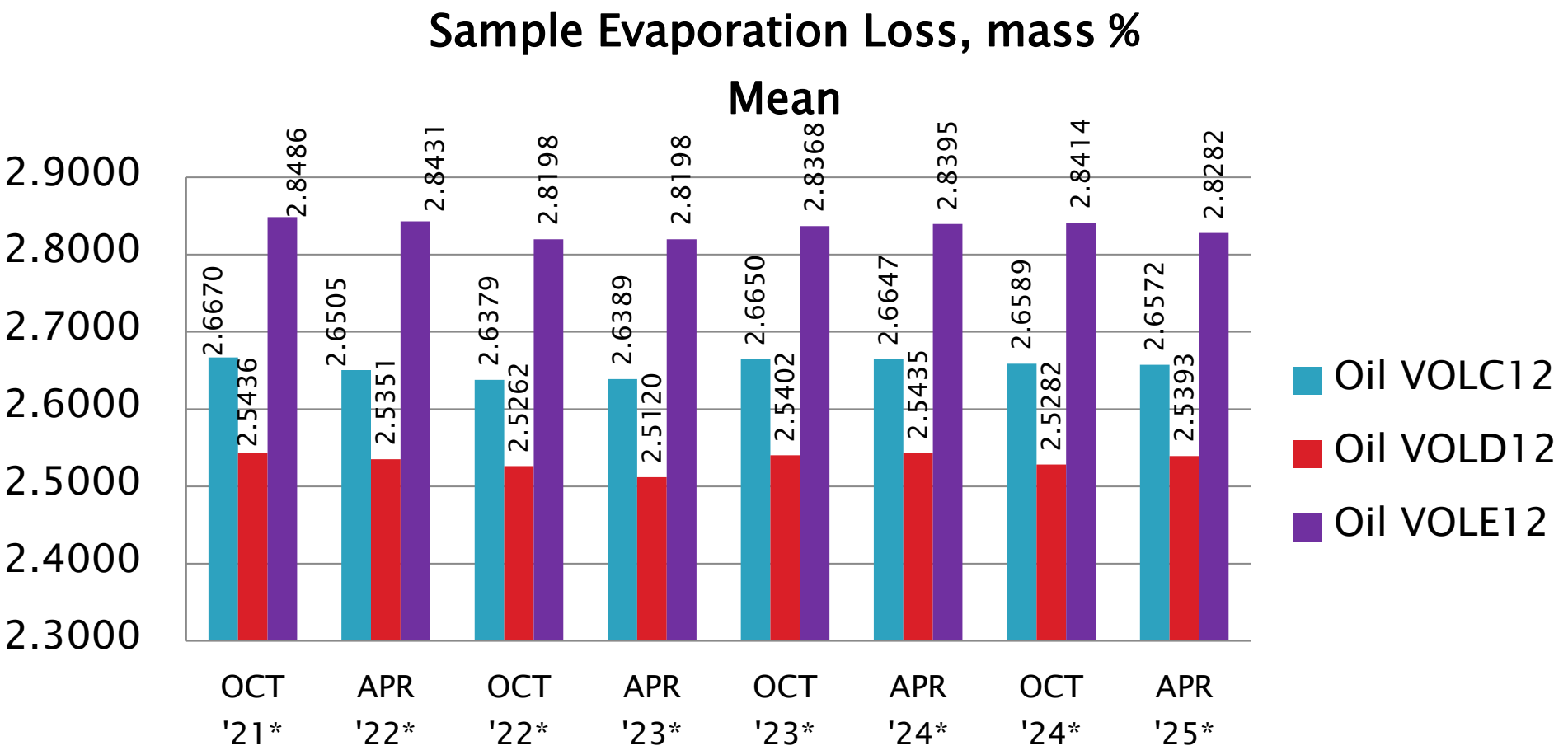
D5800 Lab Severity Estimates

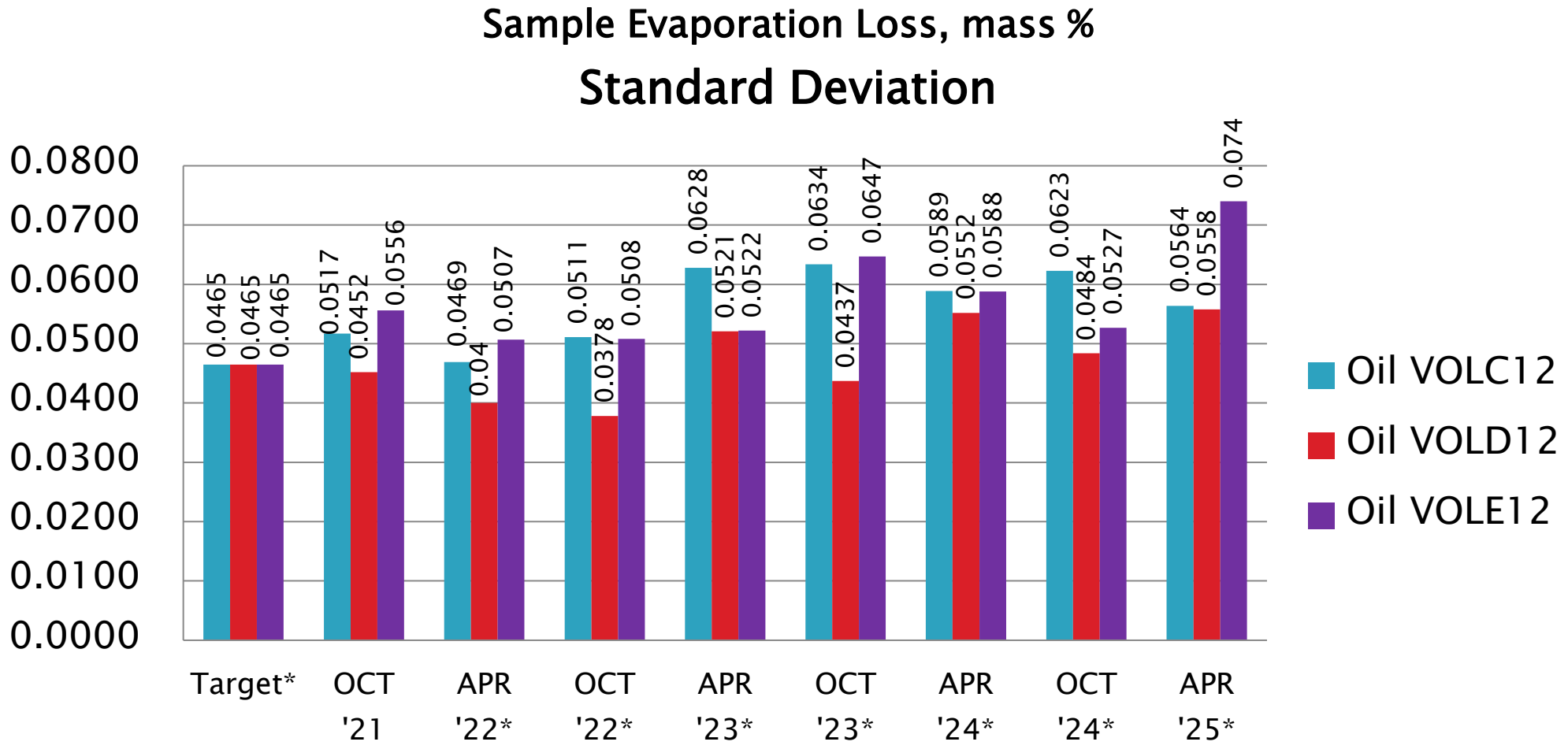


D5800 Performance by Oil



*Results transformed to natural log per updated LTMS 20200207

D5800 Performance by Oil



*Results transformed to natural log per updated LTMS 20200207

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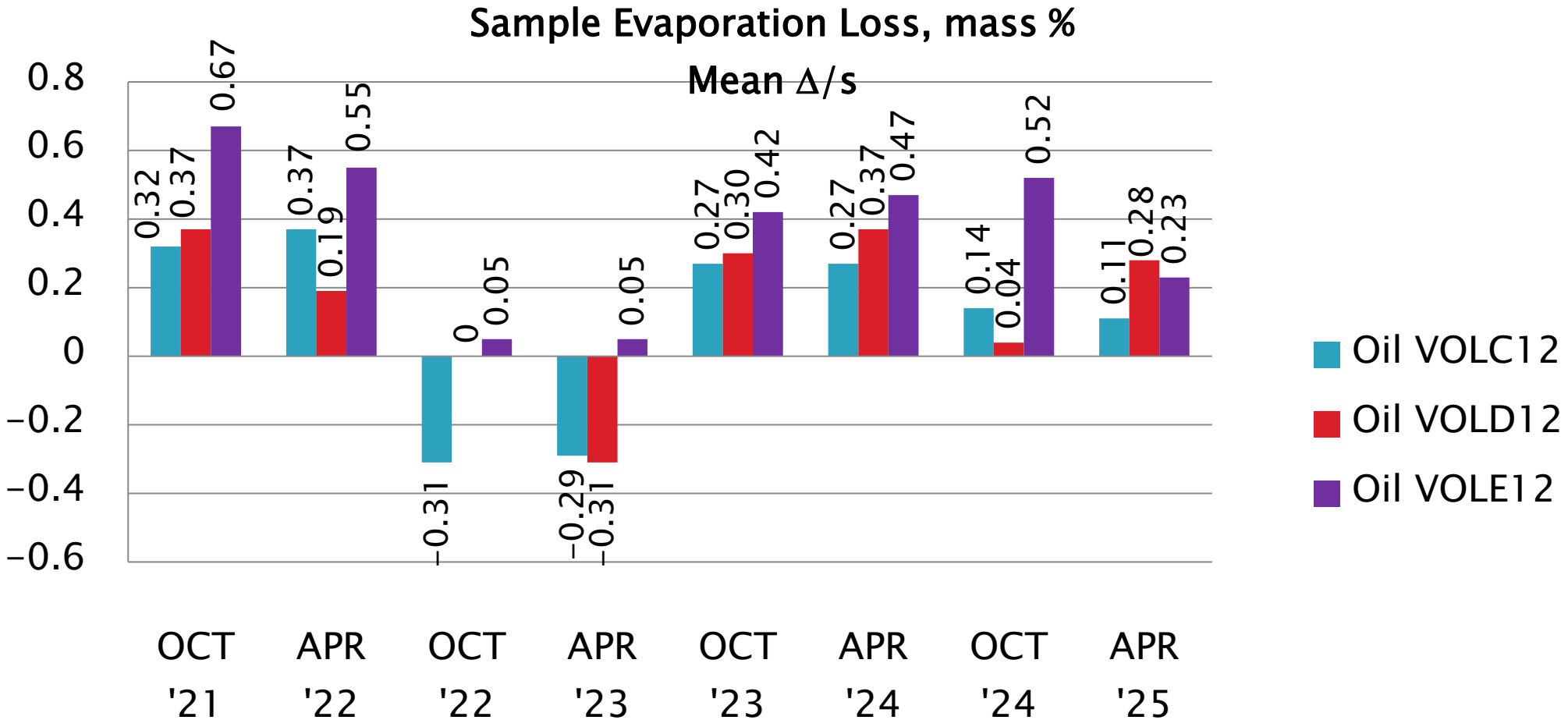
D5800 Performance by Oil



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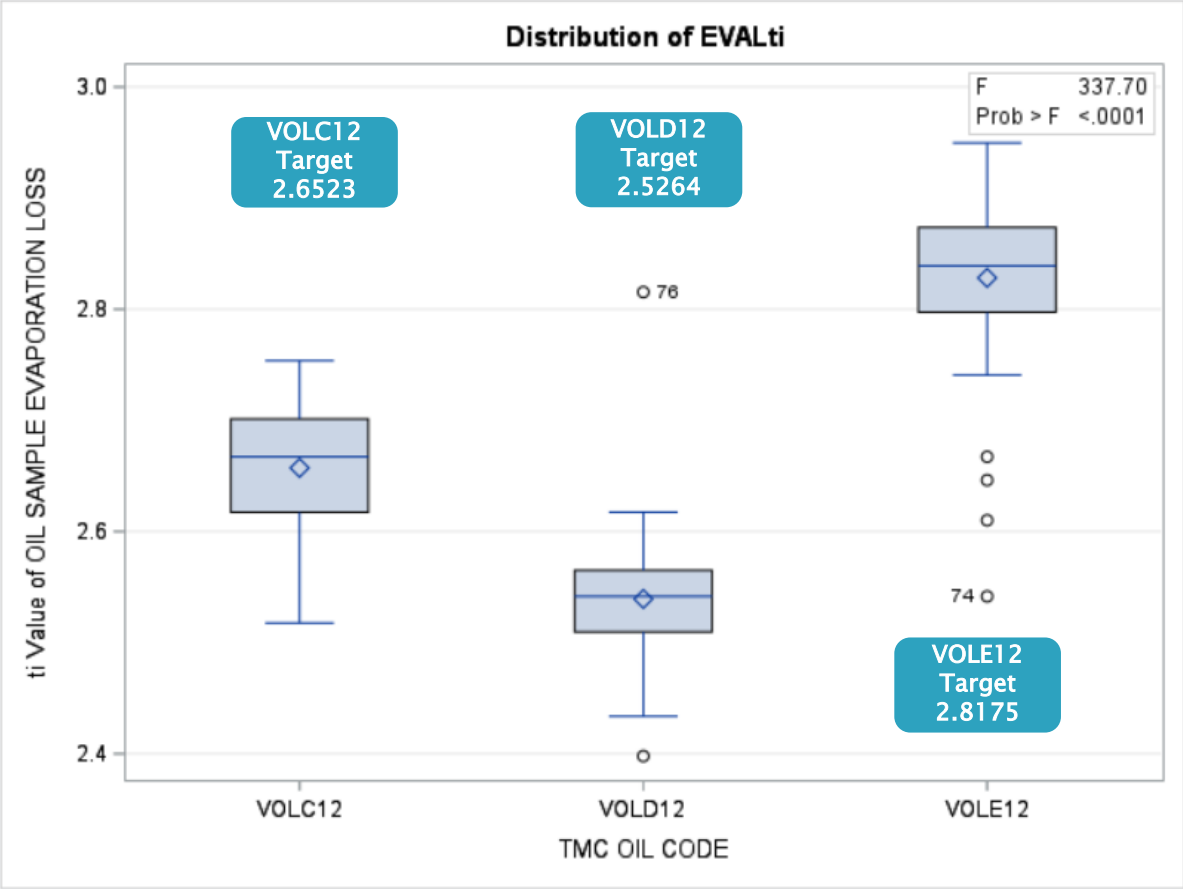
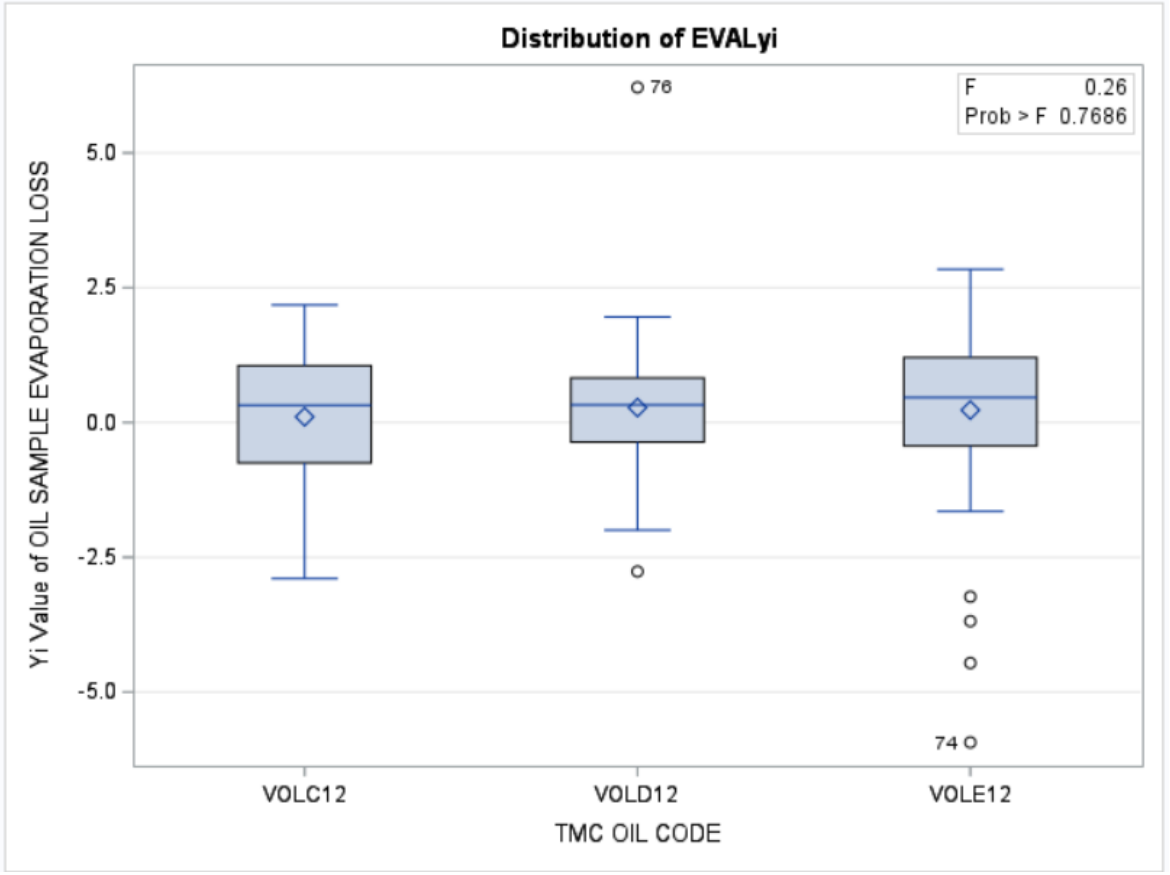
ALL

All Procedures: OCT2024 – MAR2025 Results

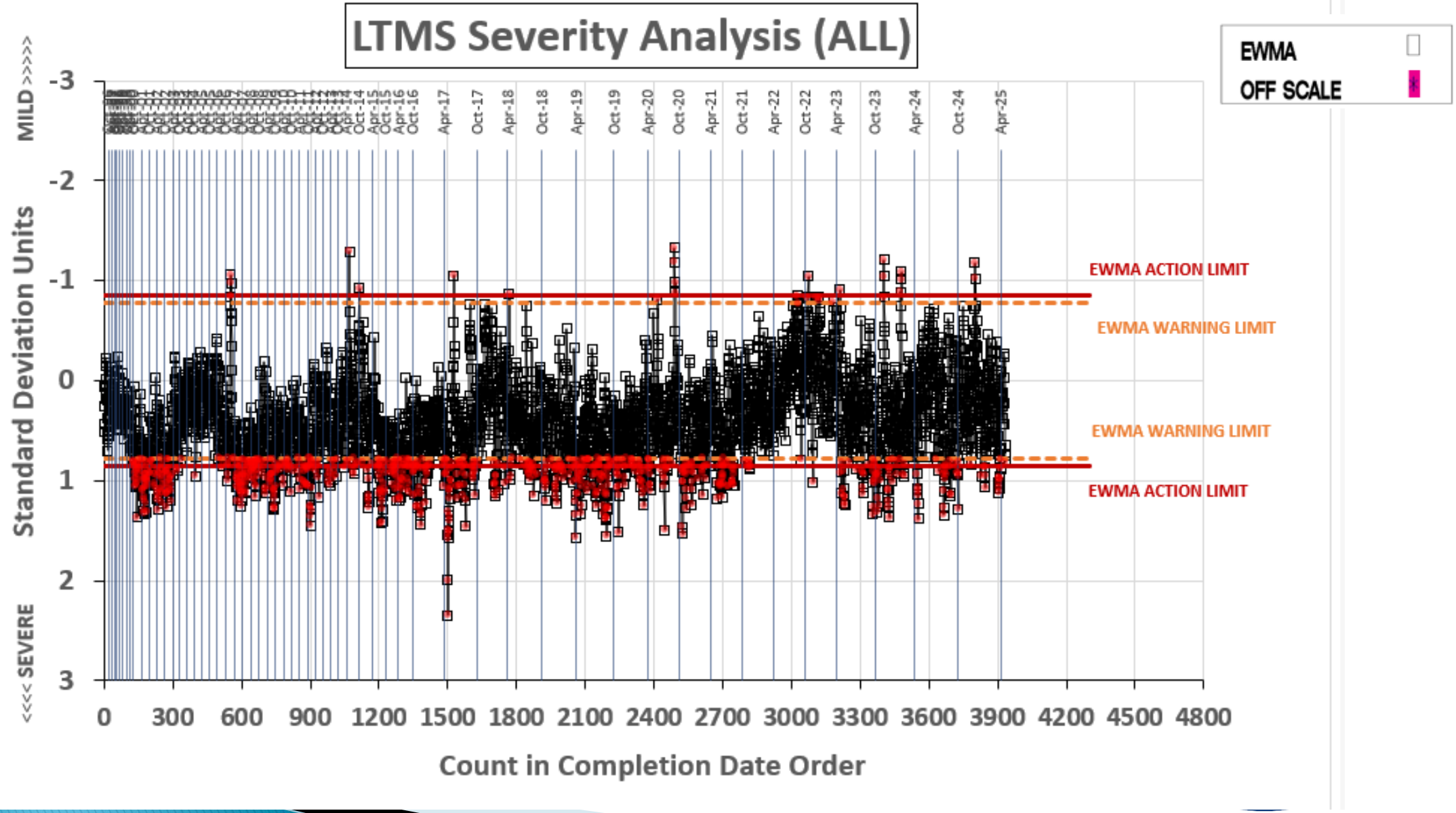




ALL

D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA

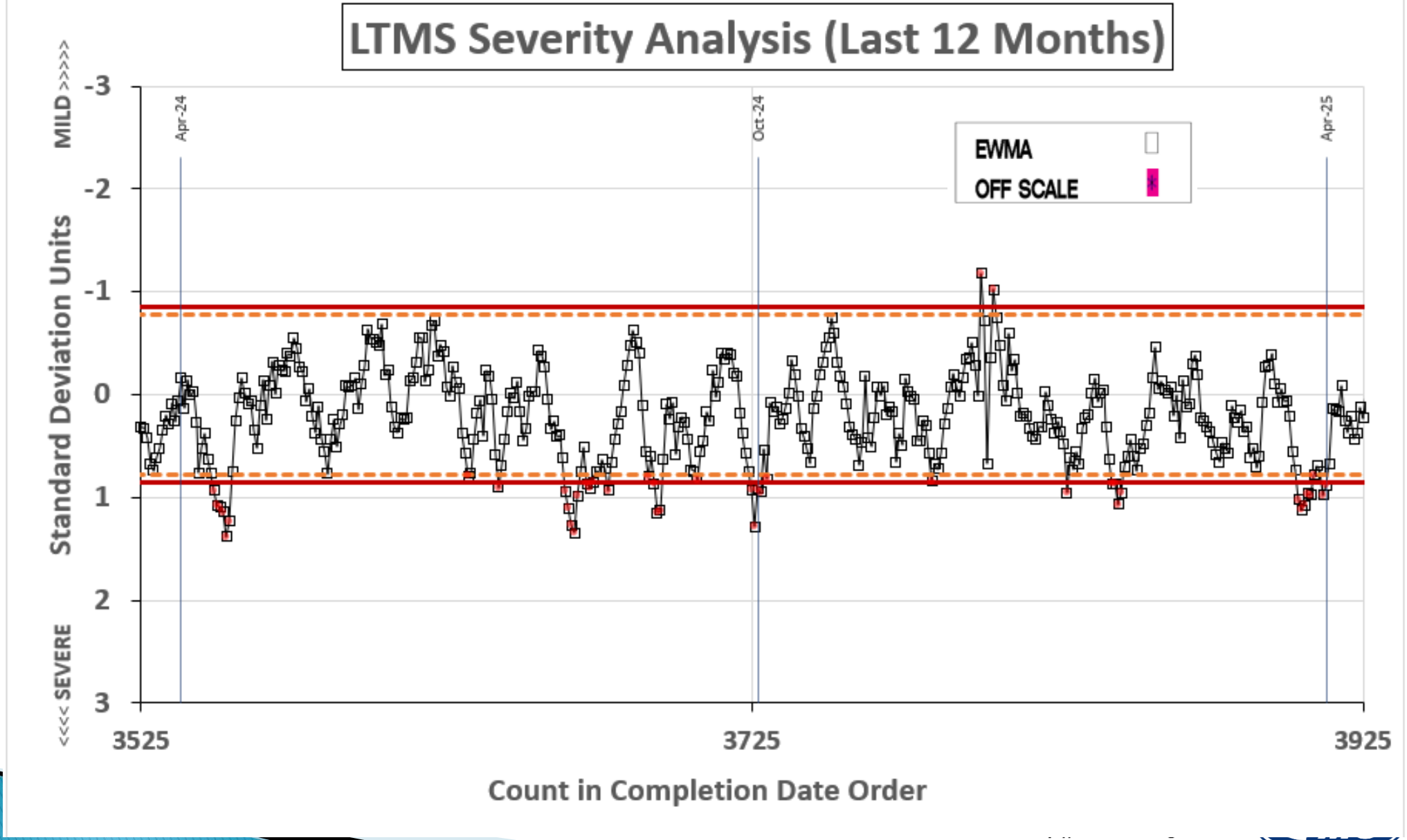
EVAPORATION LOSS, MASS%



ALL

D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA

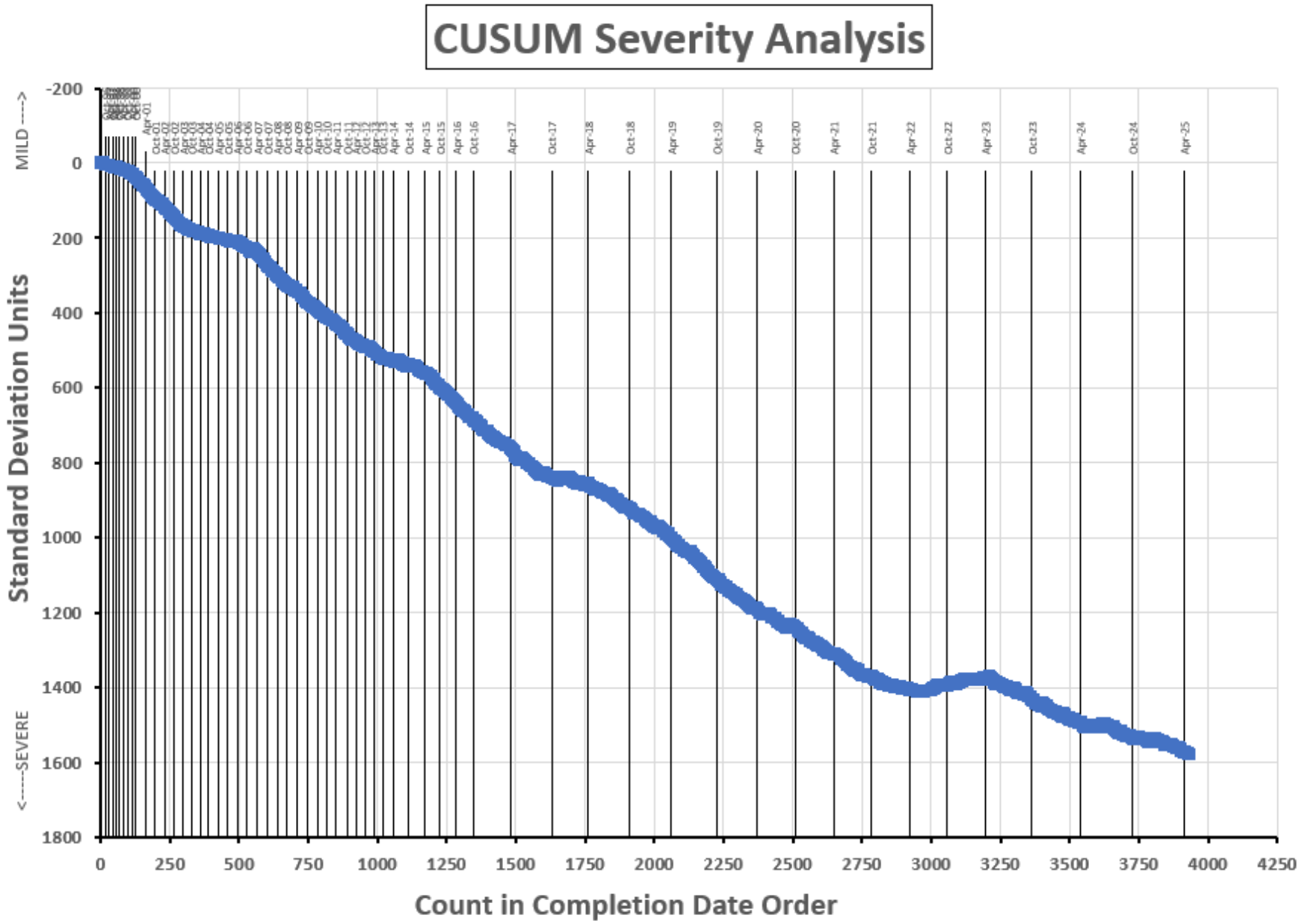
EVAPORATION LOSS, MASS%



D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA

ALL

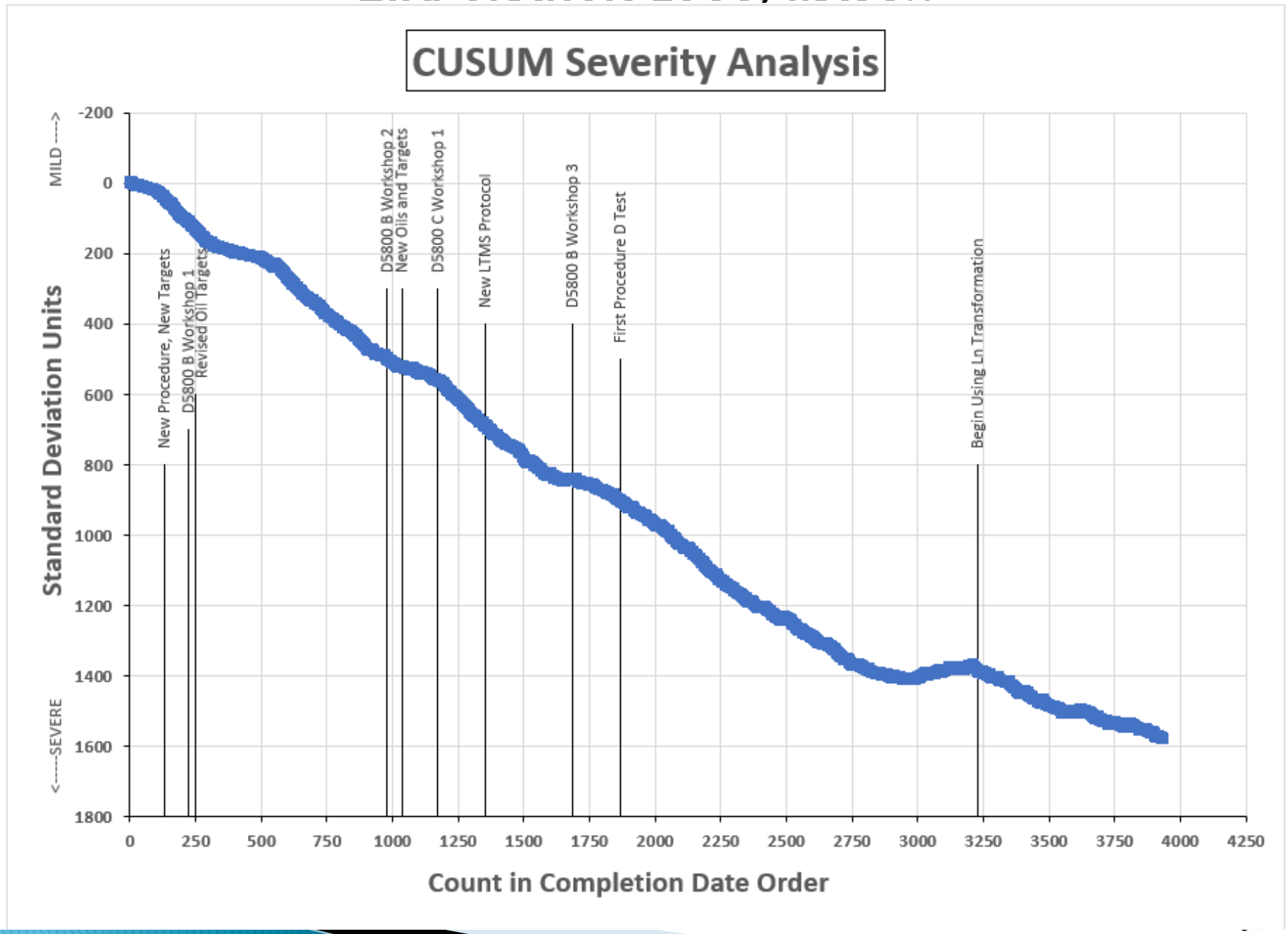
EVAPORATION LOSS, MASS%



D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA

ALL

EVAPORATION LOSS, MASS%



D5800: Evaporation Loss of Lubricating Oil by Noack Method and Rig Model

Performance Comparison
Sample Evaporation Loss, Mass %

Procedure	n	df	Pooled s	Mean Δ/s
Procedure B (NCK2, NCK25G)	108	105	0.0556	0.81
Procedure D (NS2)	78	75	0.0496	-0.63

Model	n	df	Pooled s	Mean Δ/s
NCK2 (B)	1	0	n/a	0.34
NCK25G (B)	107	104	0.0558	0.81
NS2 (D)	78	75	0.0496	-0.63

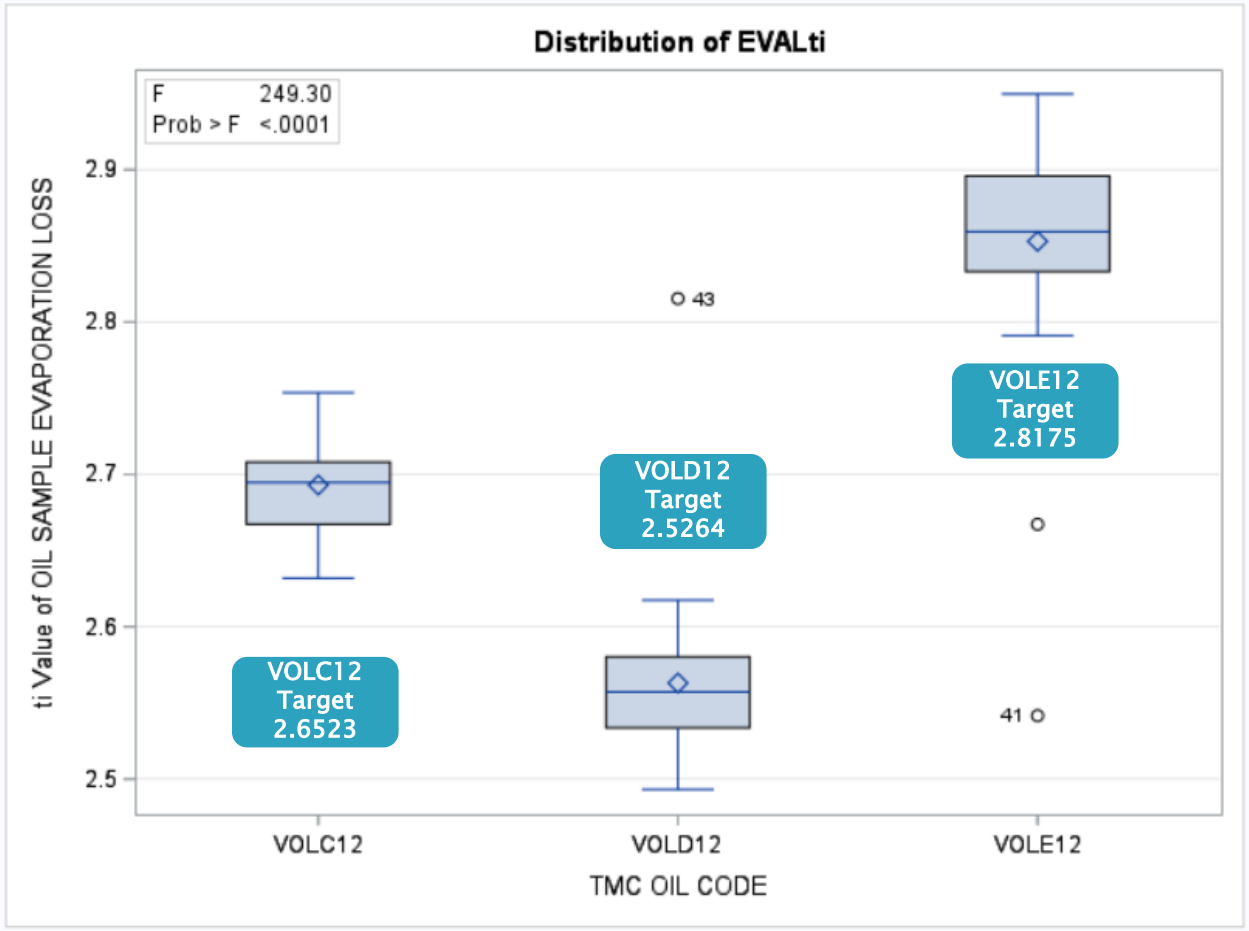
1 (+0) Procedure B NCK2 Rig
23 (+0) Procedure B NCK25G Rigs
15 (+0) Procedure D NS2 Rigs

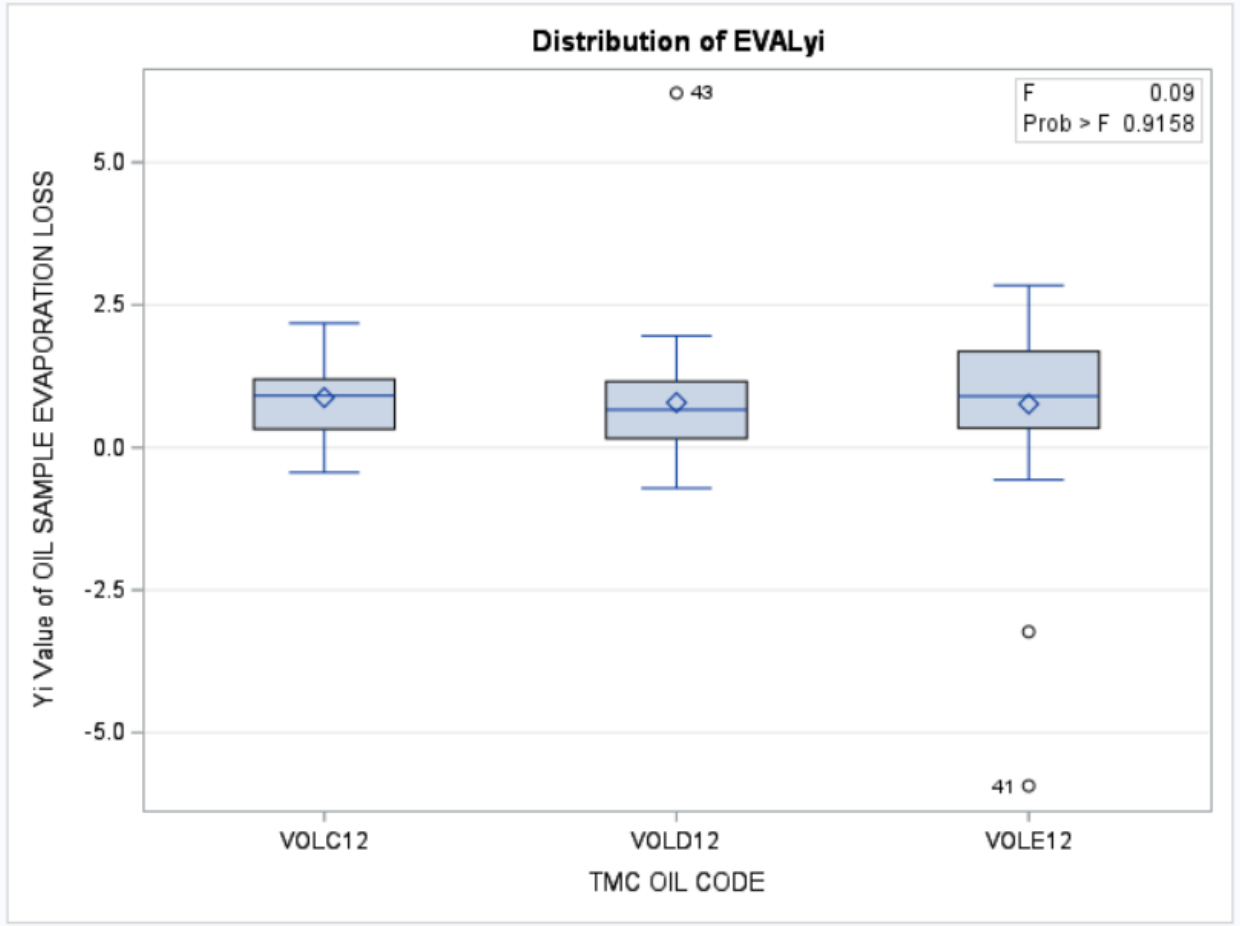
D5800: Evaporation Loss of Lubricating Oil by Noack Method: Industry Procedure B

Test Status	Validity Code	No. Tests
Acceptable Calibration Test	AC	104
Failed Calibration Test	OC	4
Total		**108**

Number of Labs Reporting Data: 2
Fail Rate of Operationally Valid Tests: 1.94%

Procedure B: OCT2024 – MAR2025 Results





B only

D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA
PROCEDURE B ONLY
EVAPORATION LOSS, MASS%

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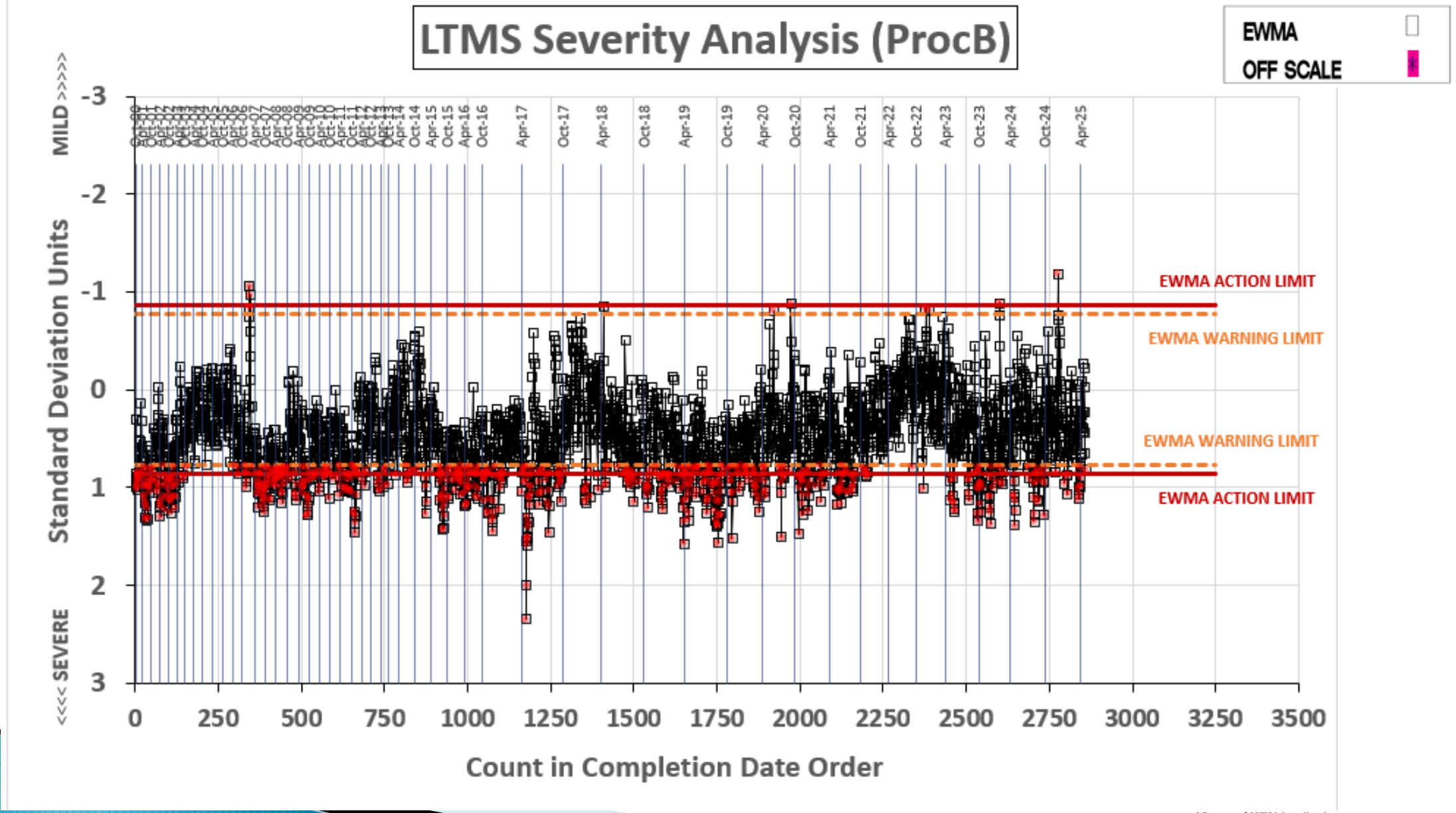

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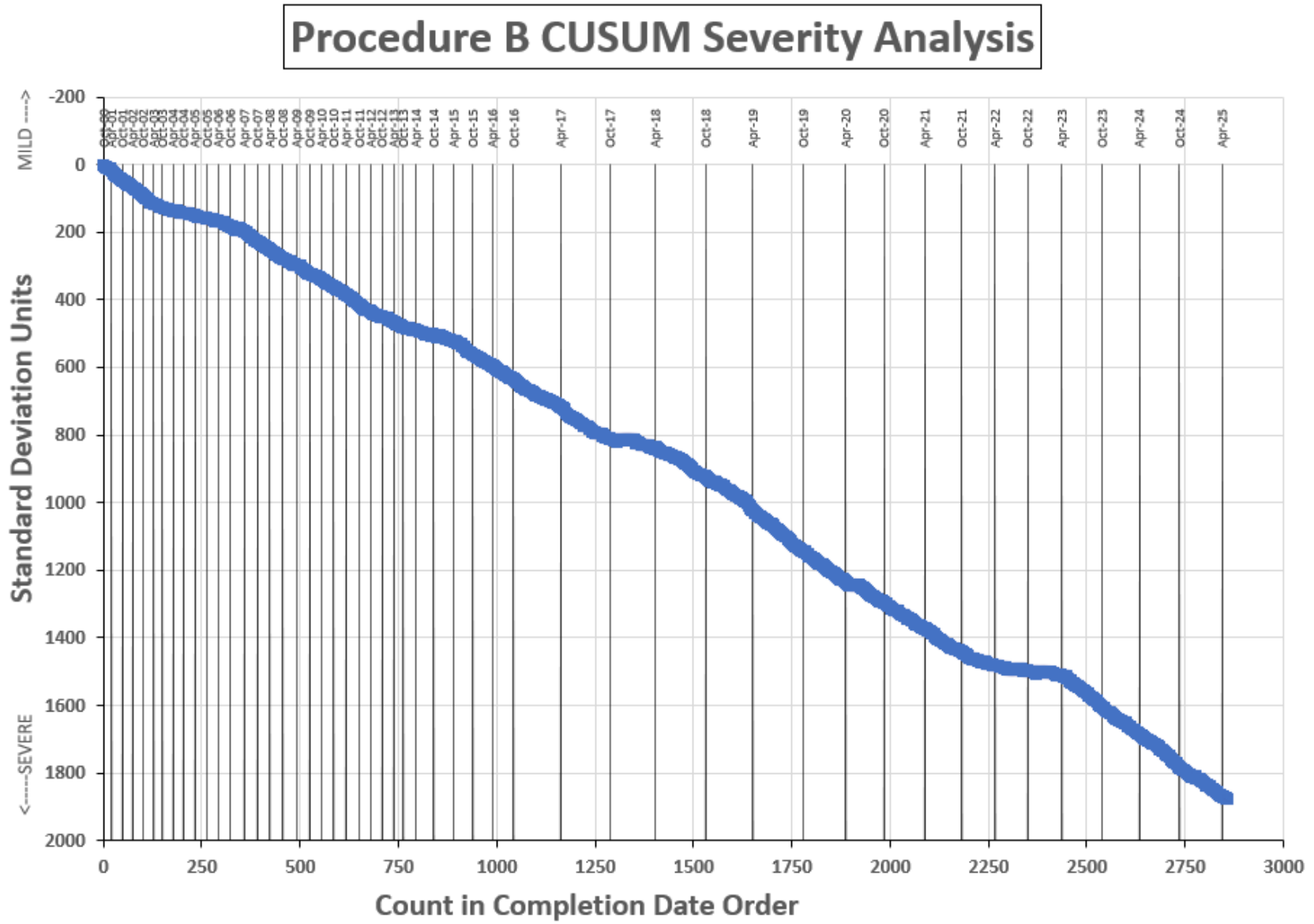
B only

D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA
PROCEDURE B ONLY
EVAPORATION LOSS, MASS%



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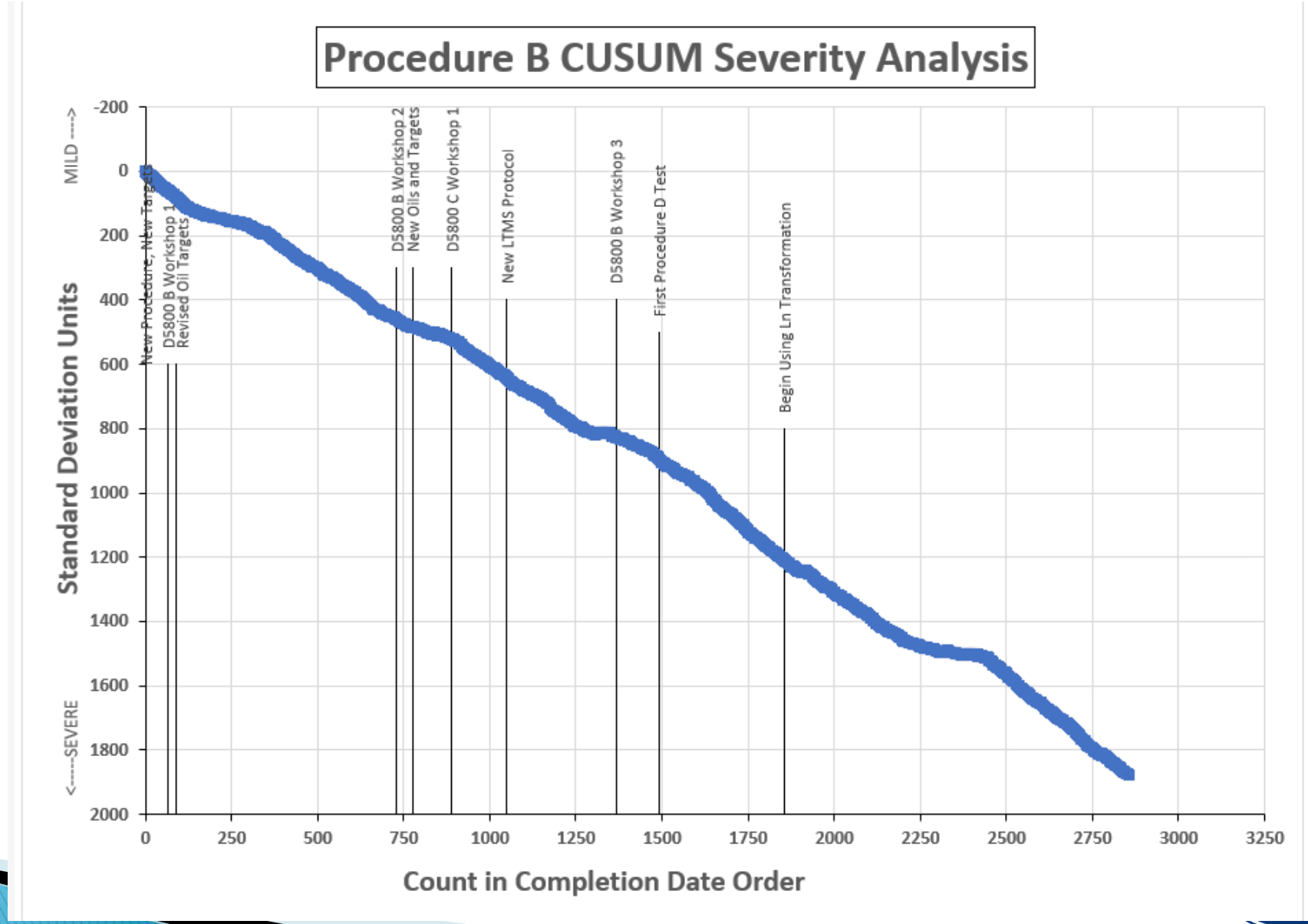
B only

D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA
PROCEDURE B ONLY
EVAPORATION LOSS, MASS%

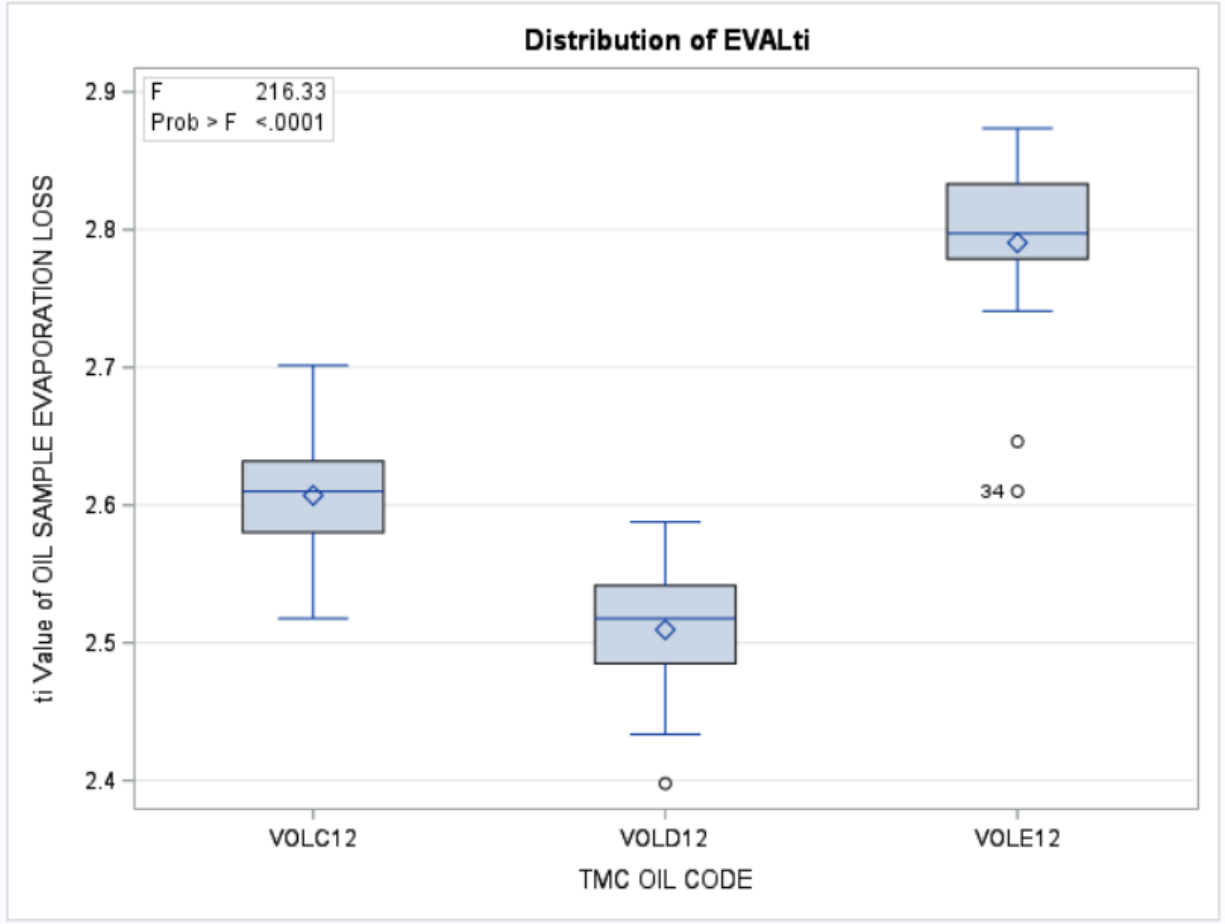


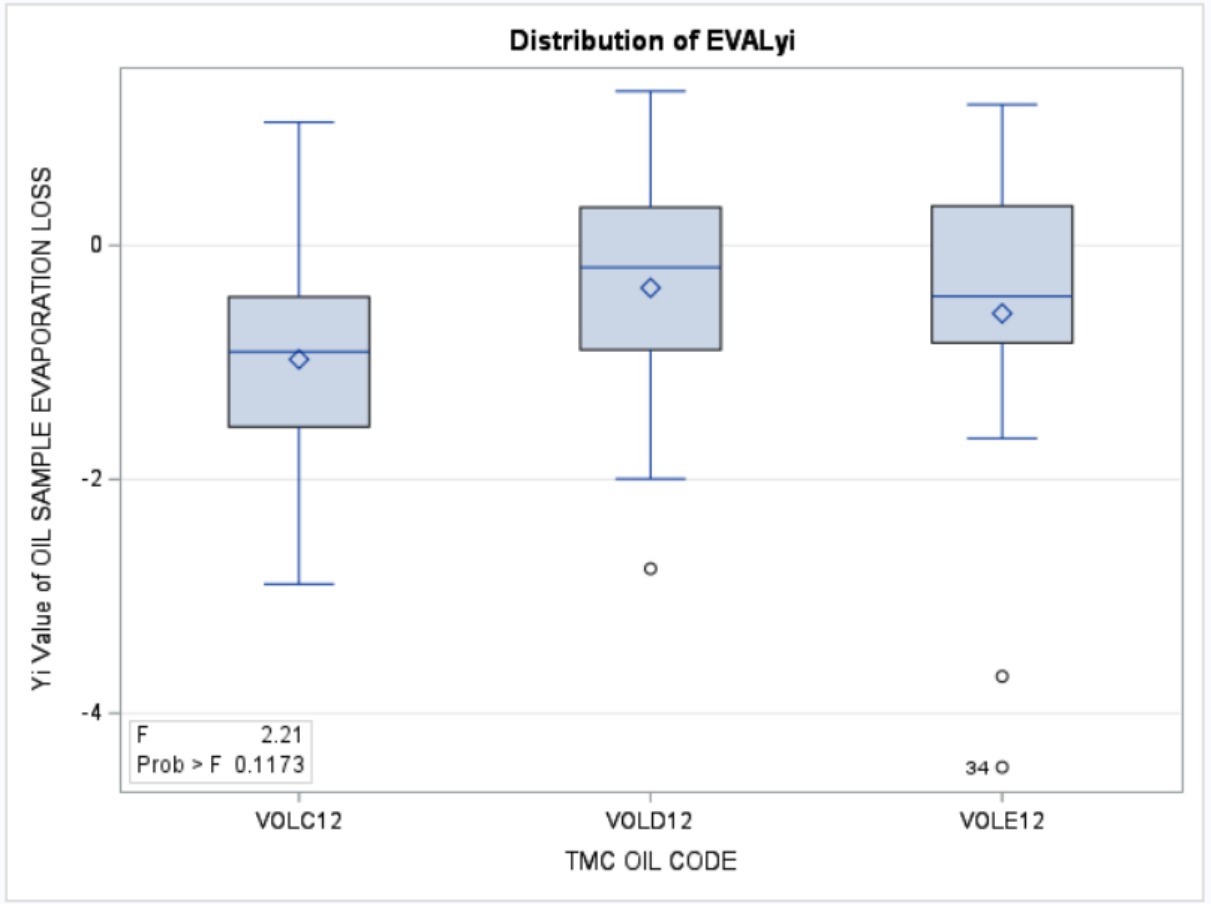
D5800: Evaporation Loss of Lubricating Oil by Noack Method: Industry Procedure D (NS2)

Test Status	Validity Code	No. Tests
Acceptable Calibration Test	AC	73
Failed Calibration Test	OC	5
Total		**78**

Number of Labs Reporting Data: 6
Fail Rate of Operationally Valid Tests: 2.32%

Procedure D (NS2): OCT2024 – MAR2025 Results





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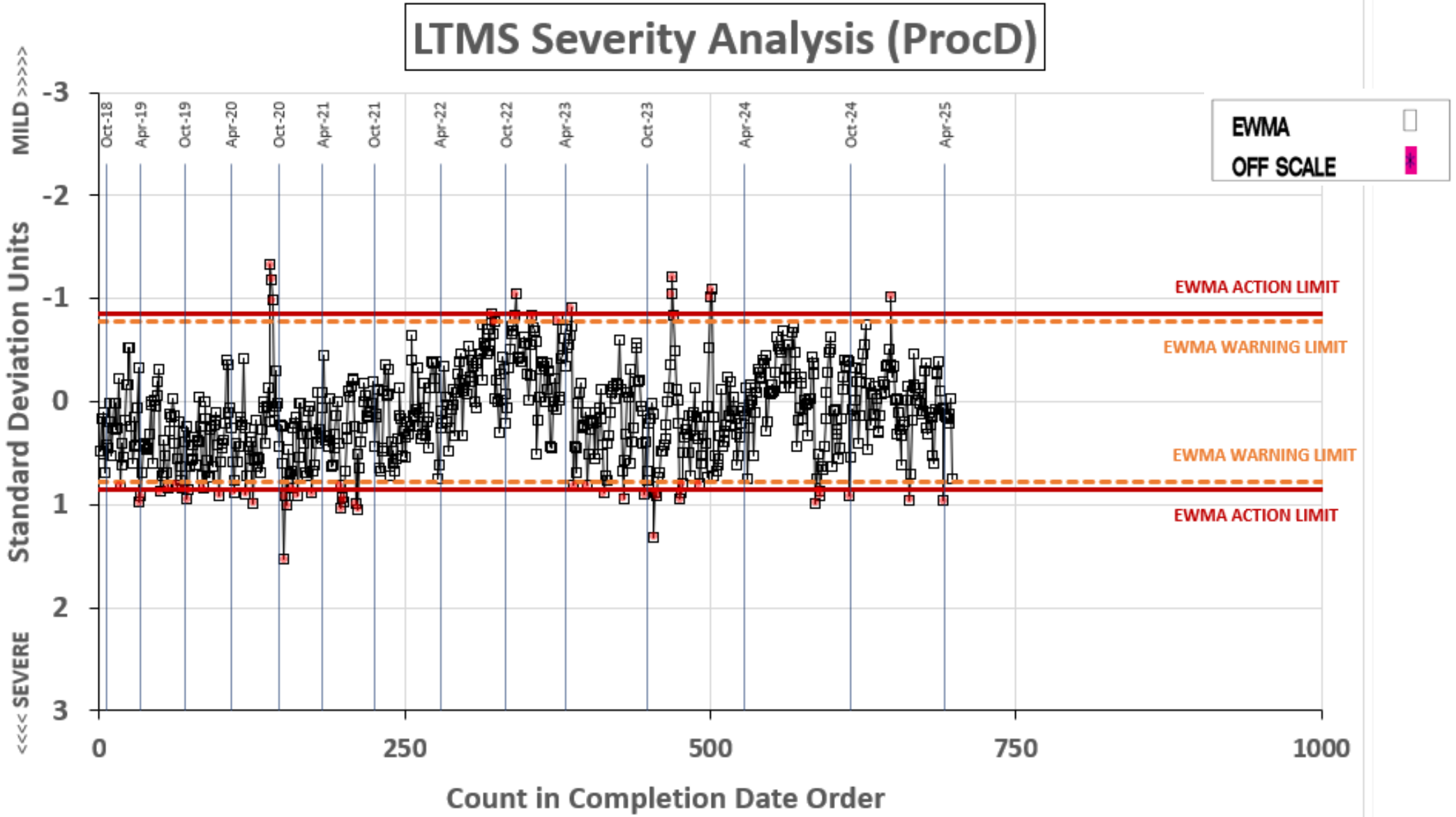
D only (NS2)

D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA

Procedure D Only

EVAPORATION LOSS, MASS%



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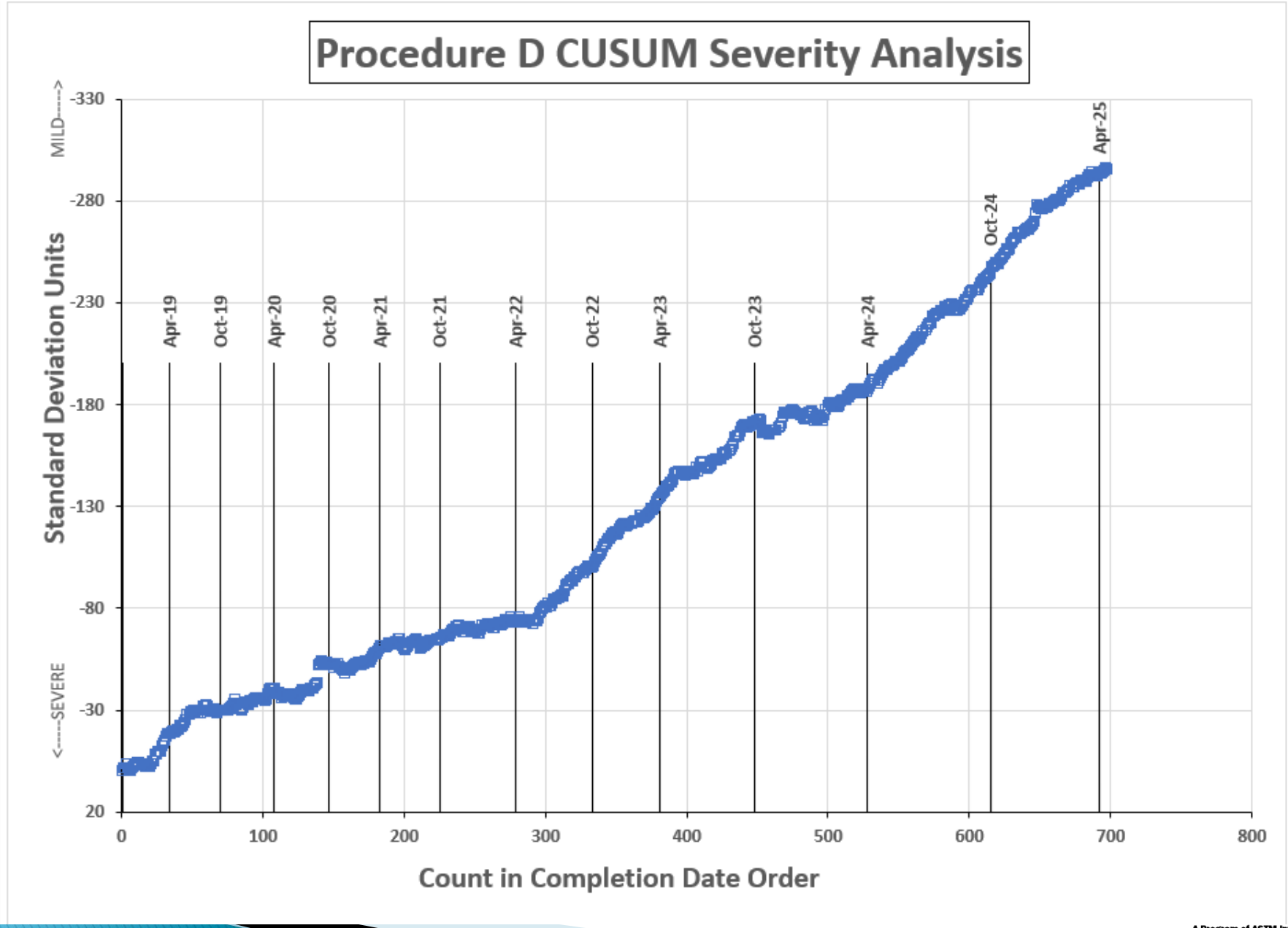
D only (NS2)

D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA

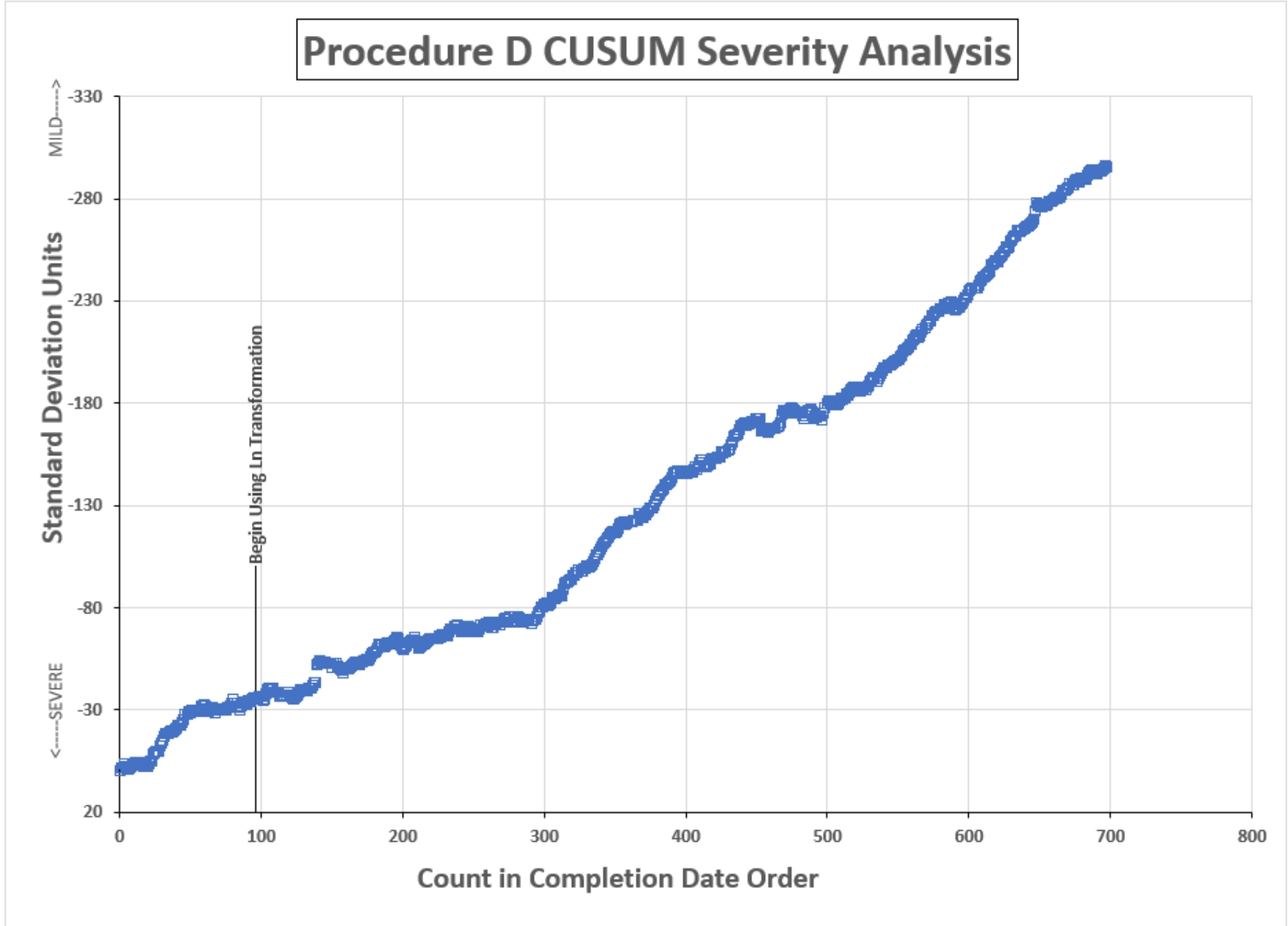
Procedure D Only

EVAPORATION LOSS, MASS%



D only (NS2)

D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA
Procedure D Only
EVAPORATION LOSS, MASS%

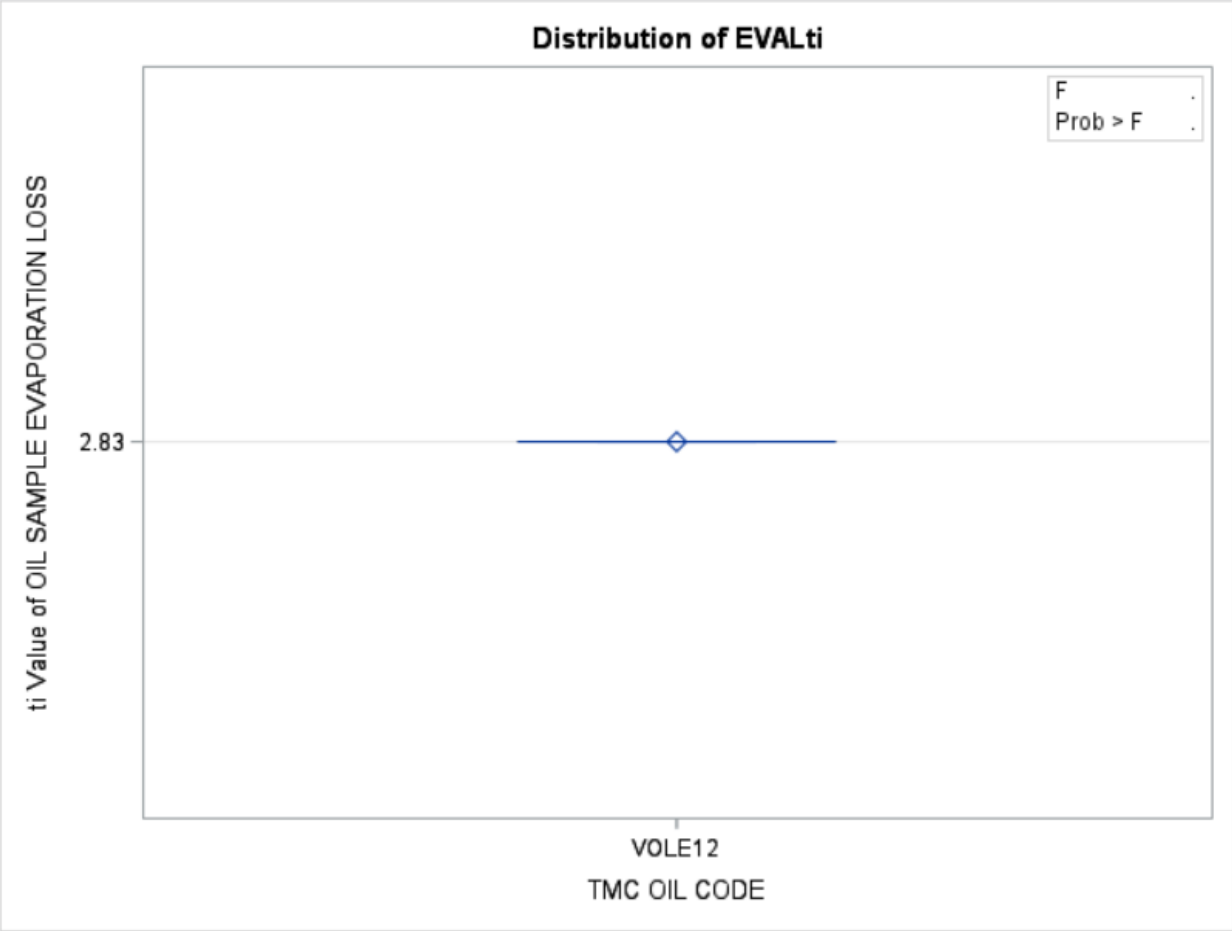


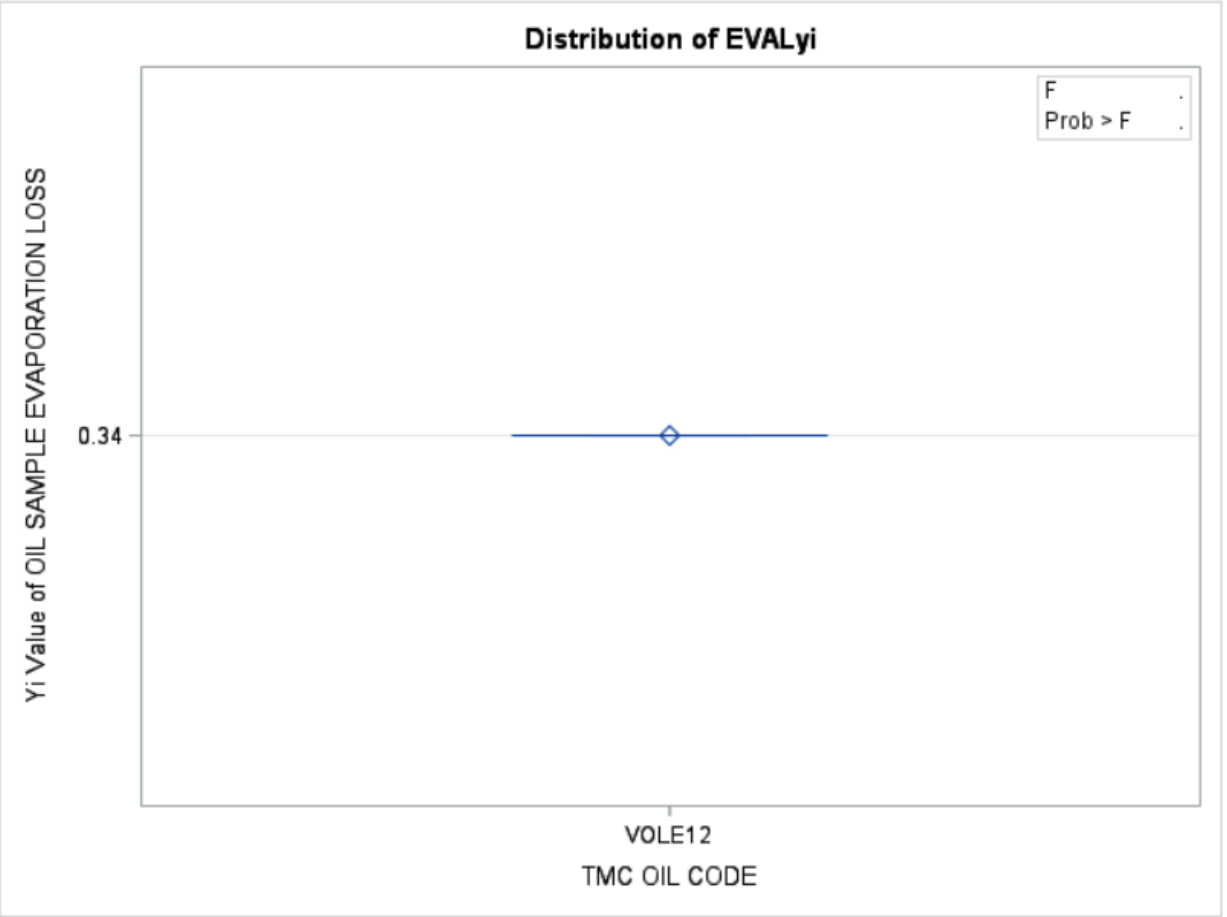
D5800: Evaporation Loss of Lubricating Oil by Noack Method: Industry Model NCK2

Test Status	Validity Code	No. Tests
Acceptable Calibration Test	AC	1
Failed Calibration Test	OC	0
Total		**1**

Number of Labs Reporting Data: 1
Fail Rate of Operationally Valid Tests: 0.0 %

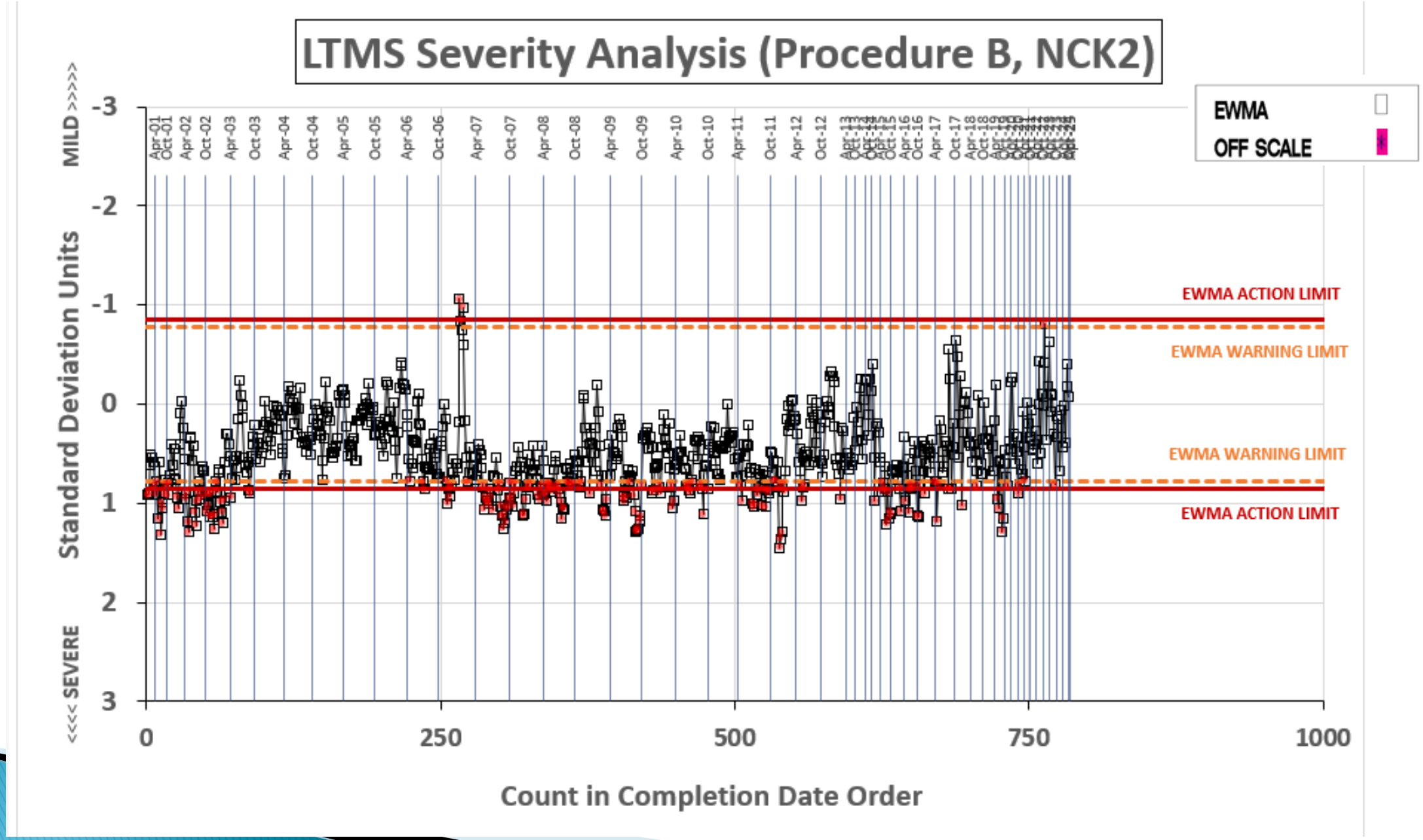
MODEL NCK2: OCT2024 – MAR2025 Results





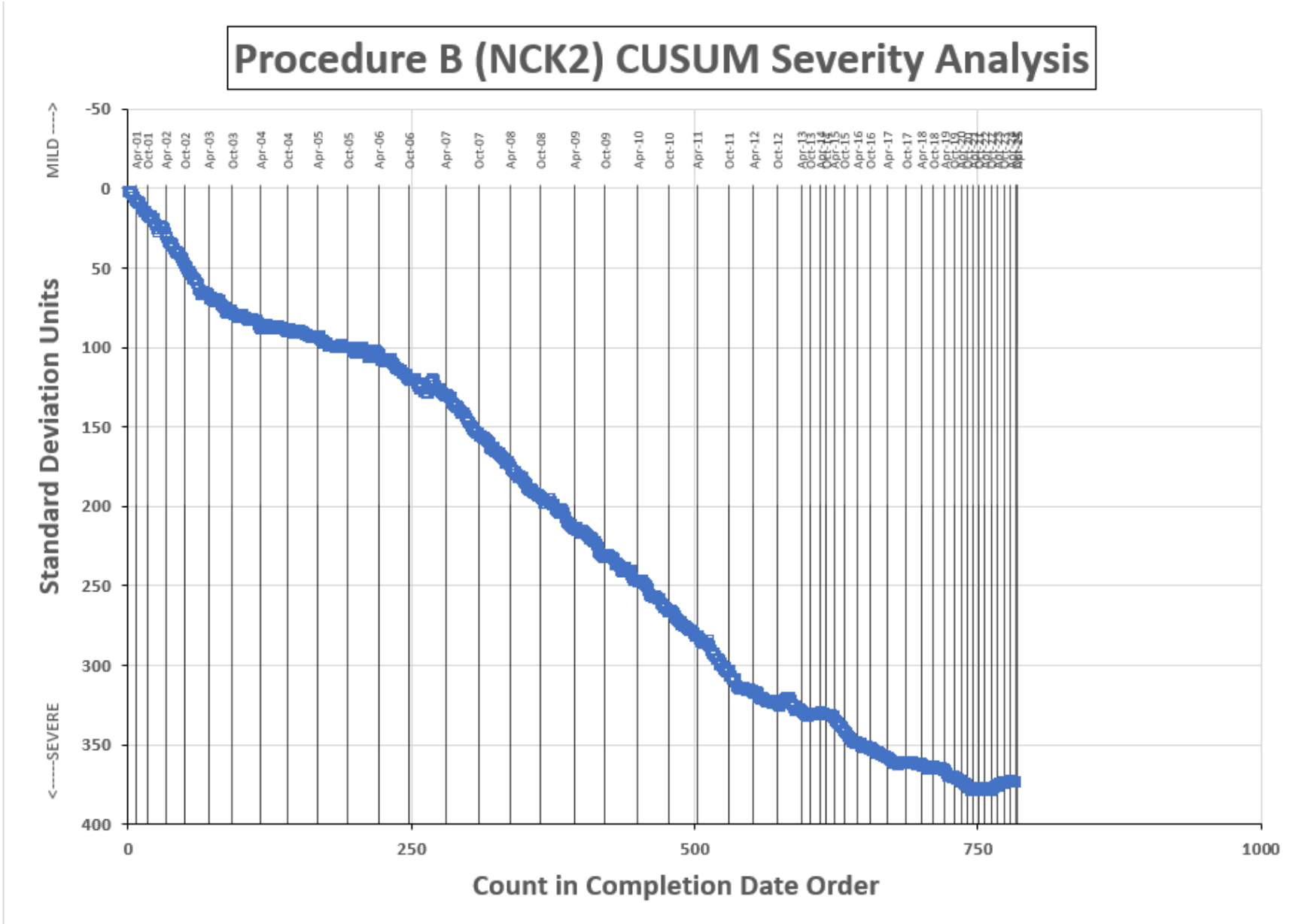
NCK2 only

D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA
MODEL NCK2 ONLY
EVAPORATION LOSS, MASS%



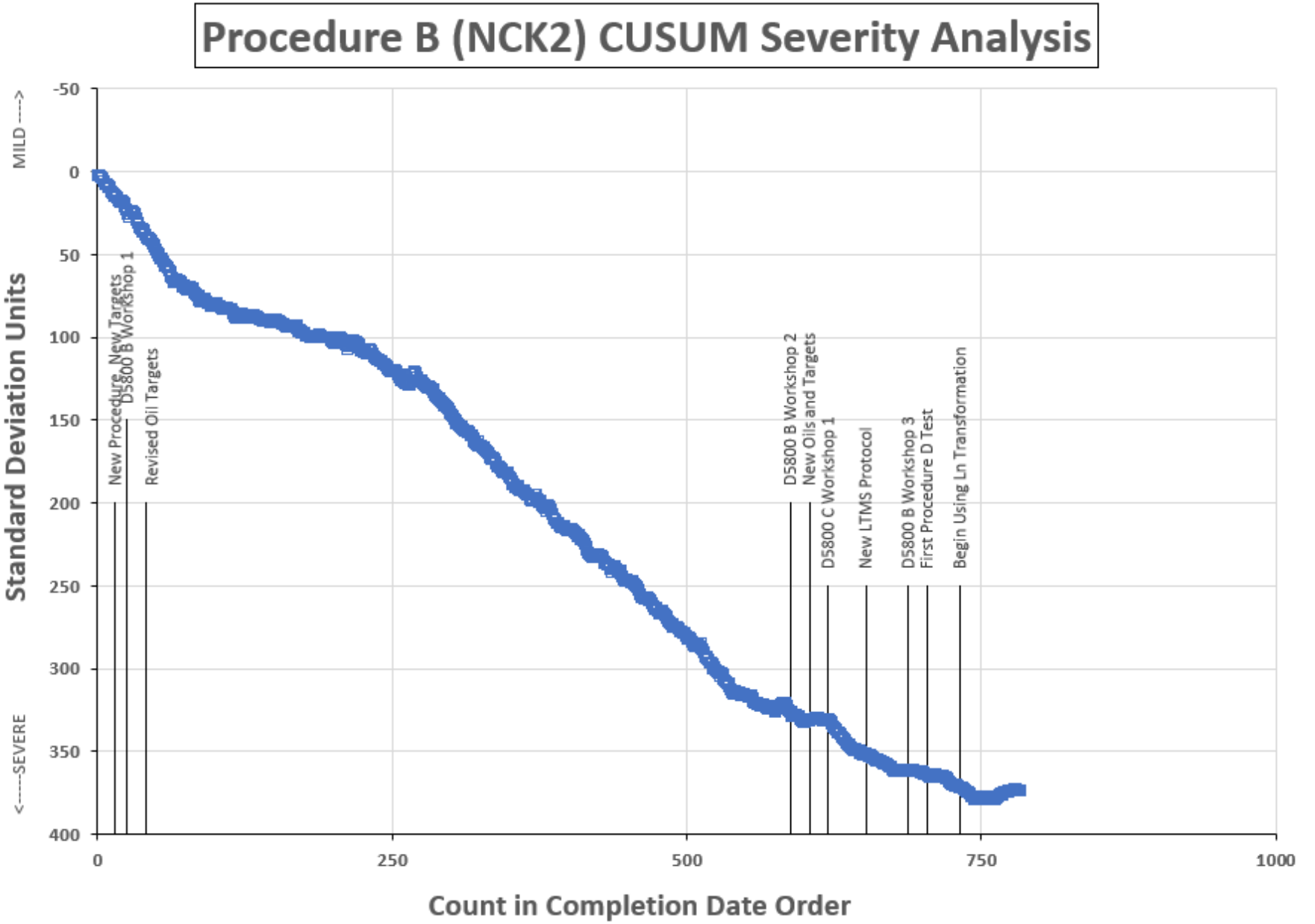
NCK2 only

D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA
MODEL NCK2 ONLY
EVAPORATION LOSS, MASS%



NCK2 only

D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA
MODEL NCK2 ONLY
EVAPORATION LOSS, MASS%

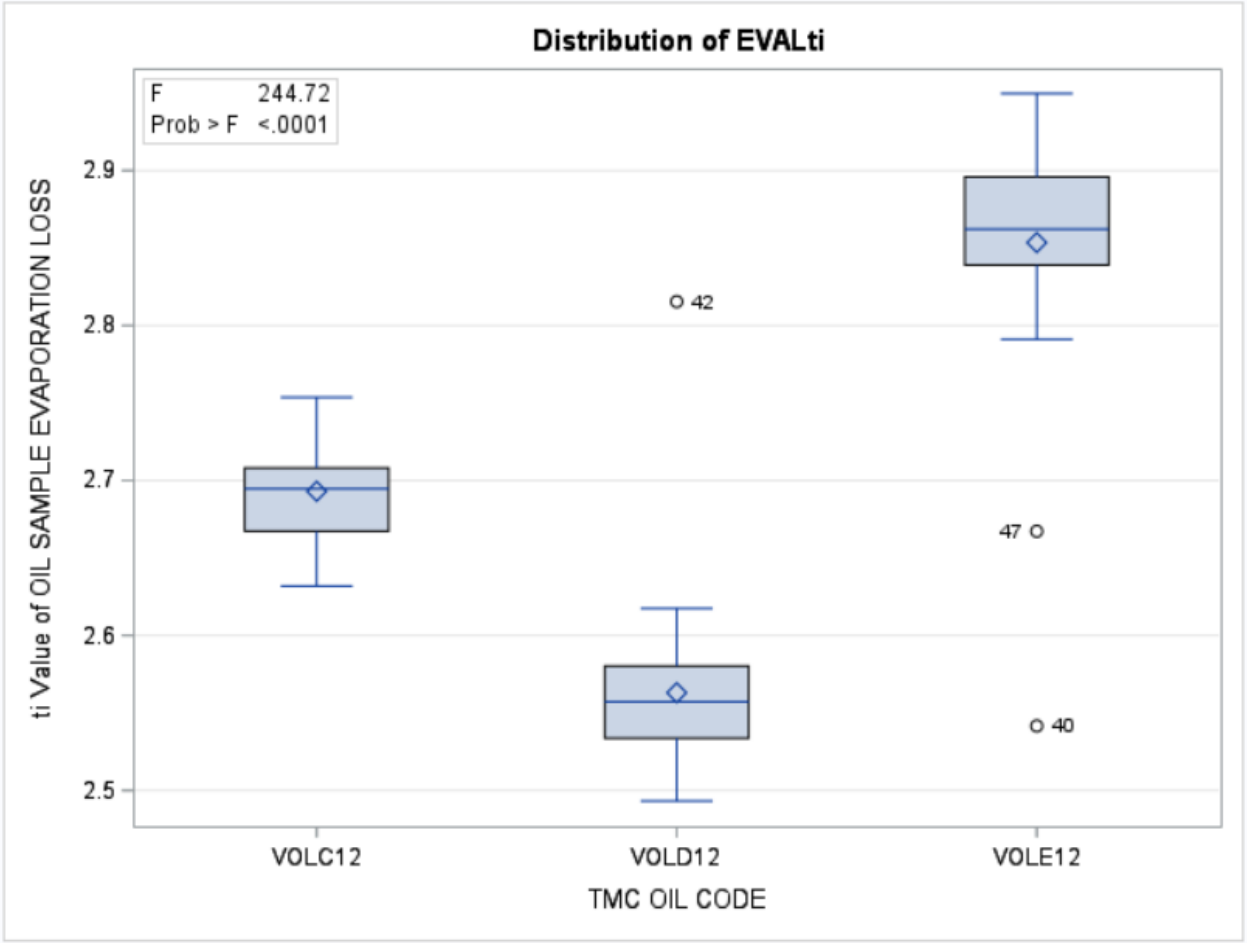


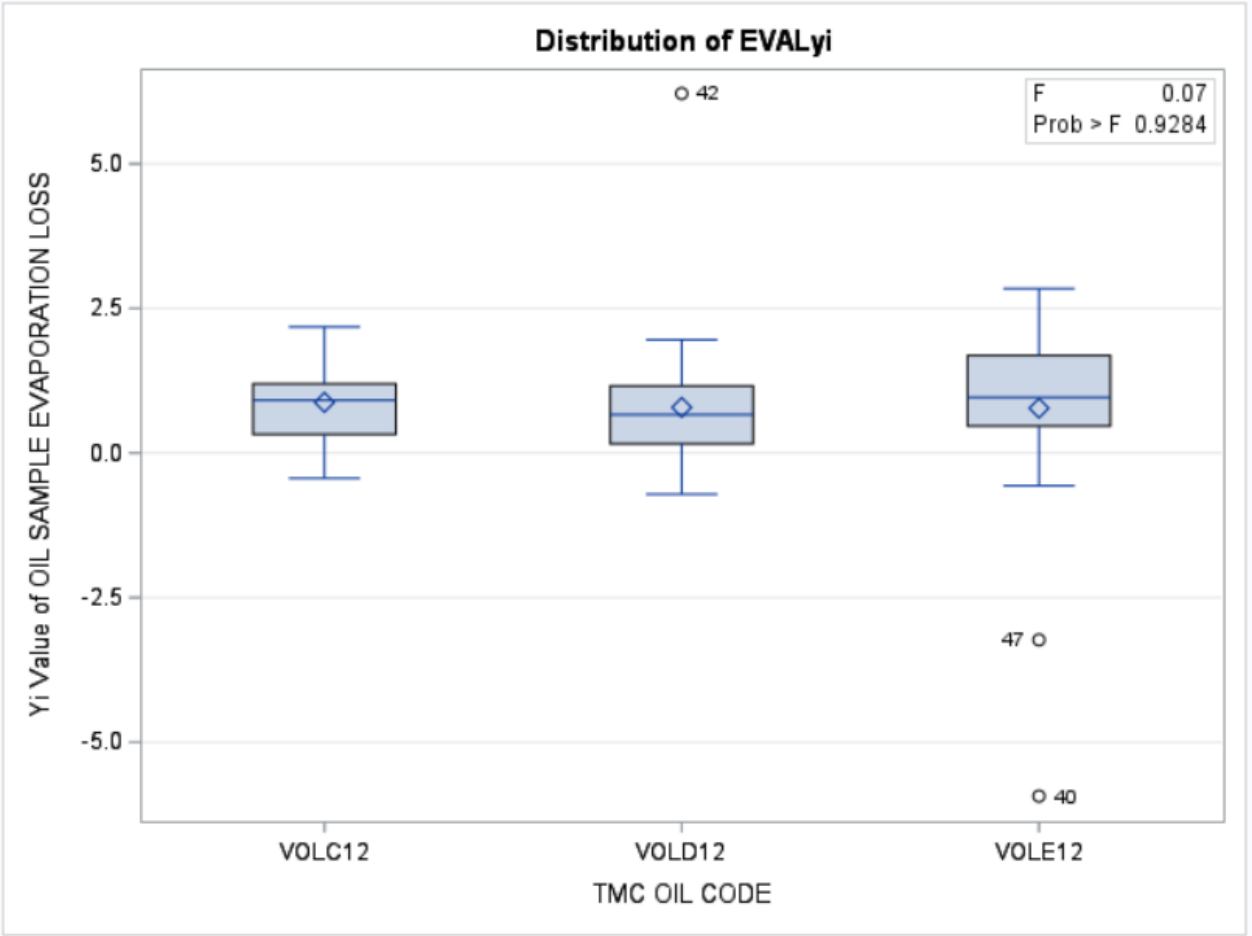
D5800: Evaporation Loss of Lubricating Oil by Noack Method: Industry Model NCK25G

Test Status	Validity Code	No. Tests
Acceptable Calibration Test	AC	103
Failed Calibration Test	OC	4
Total		**107**

Number of Labs Reporting Data: 10
Fail Rate of Operationally Valid Tests: 2.06%

MODEL NCK25G: OCT2024 – MAR25 Results





NCK25G only

D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA
MODEL NCK25G ONLY
EVAPORATION LOSS, MASS%

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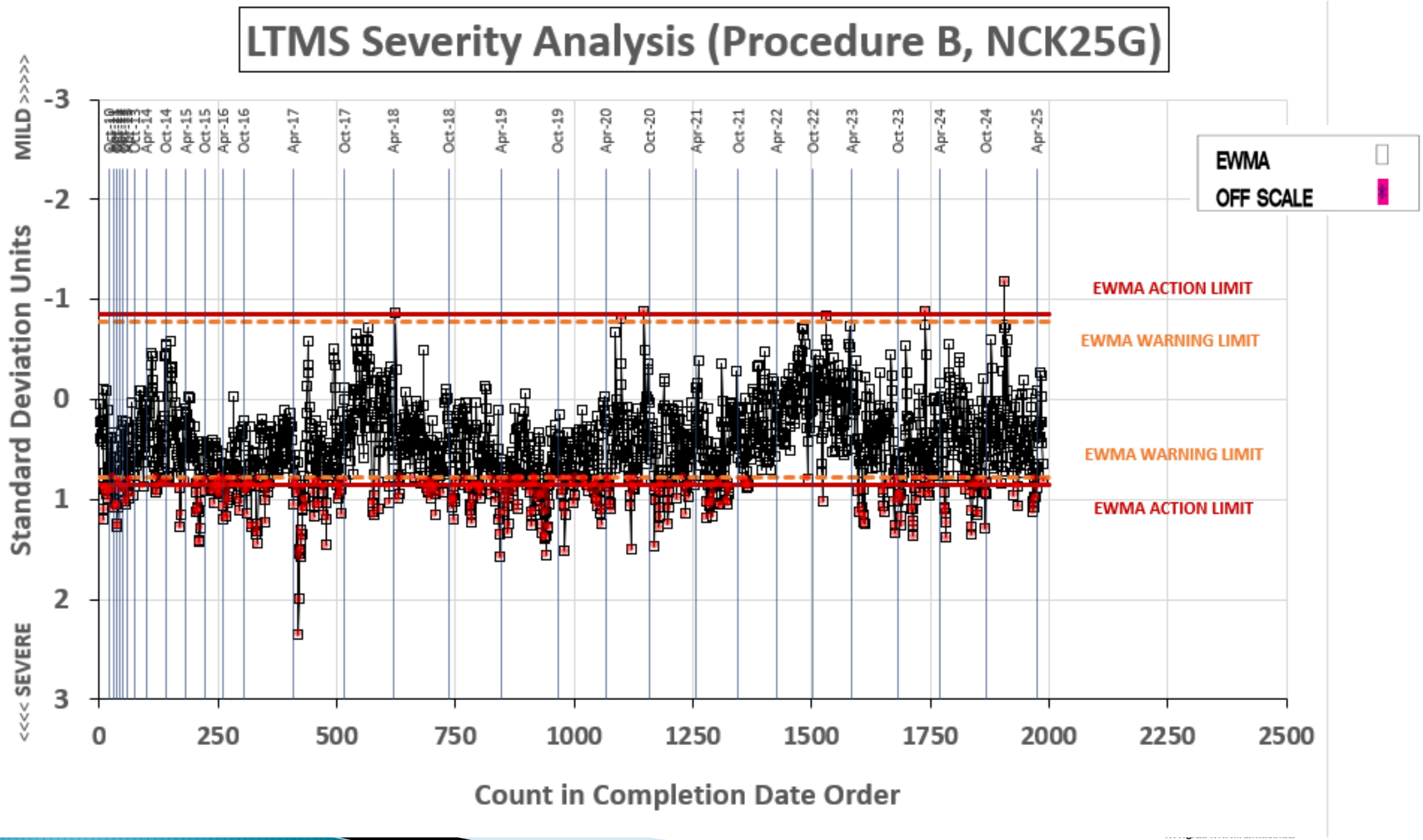
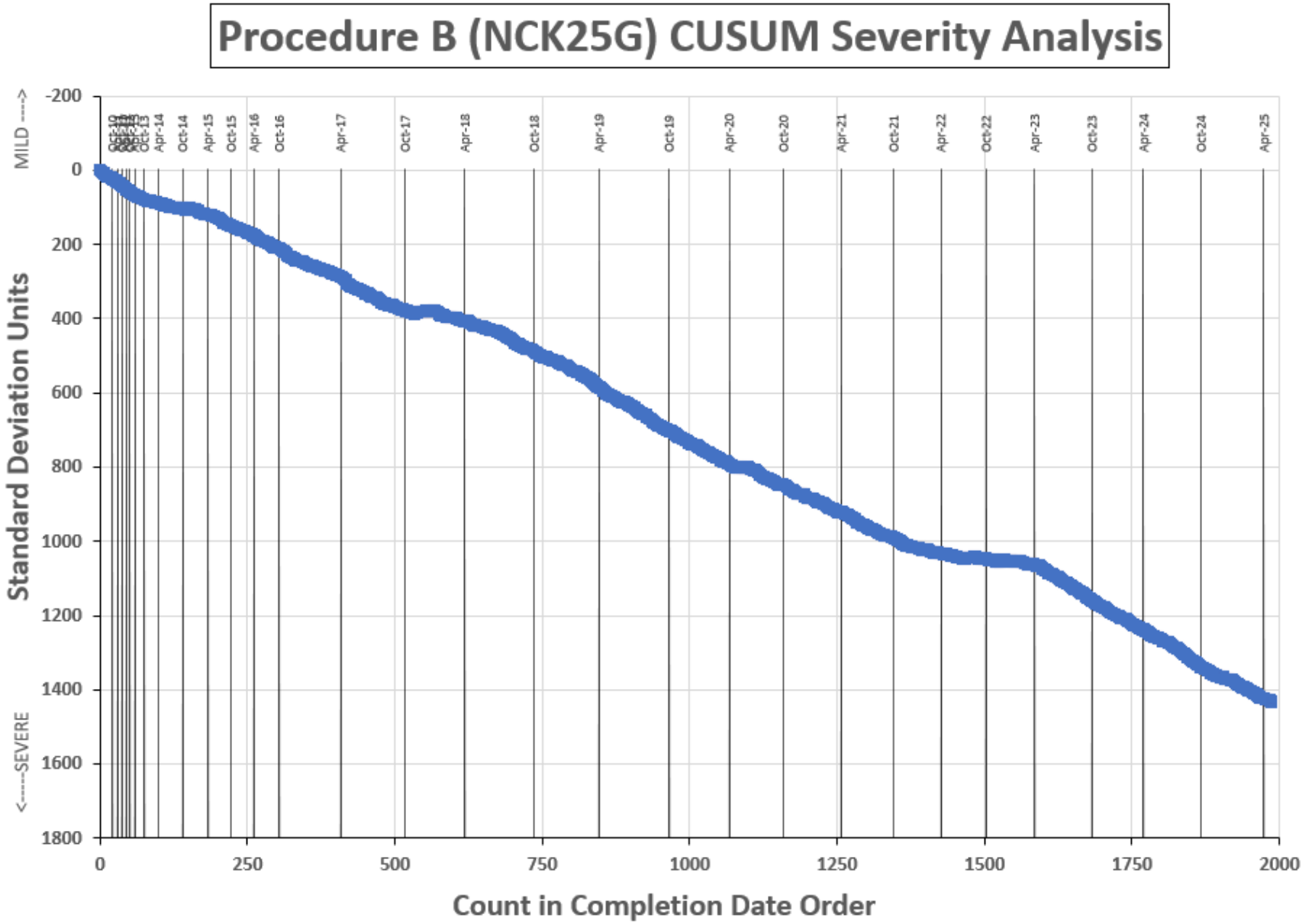


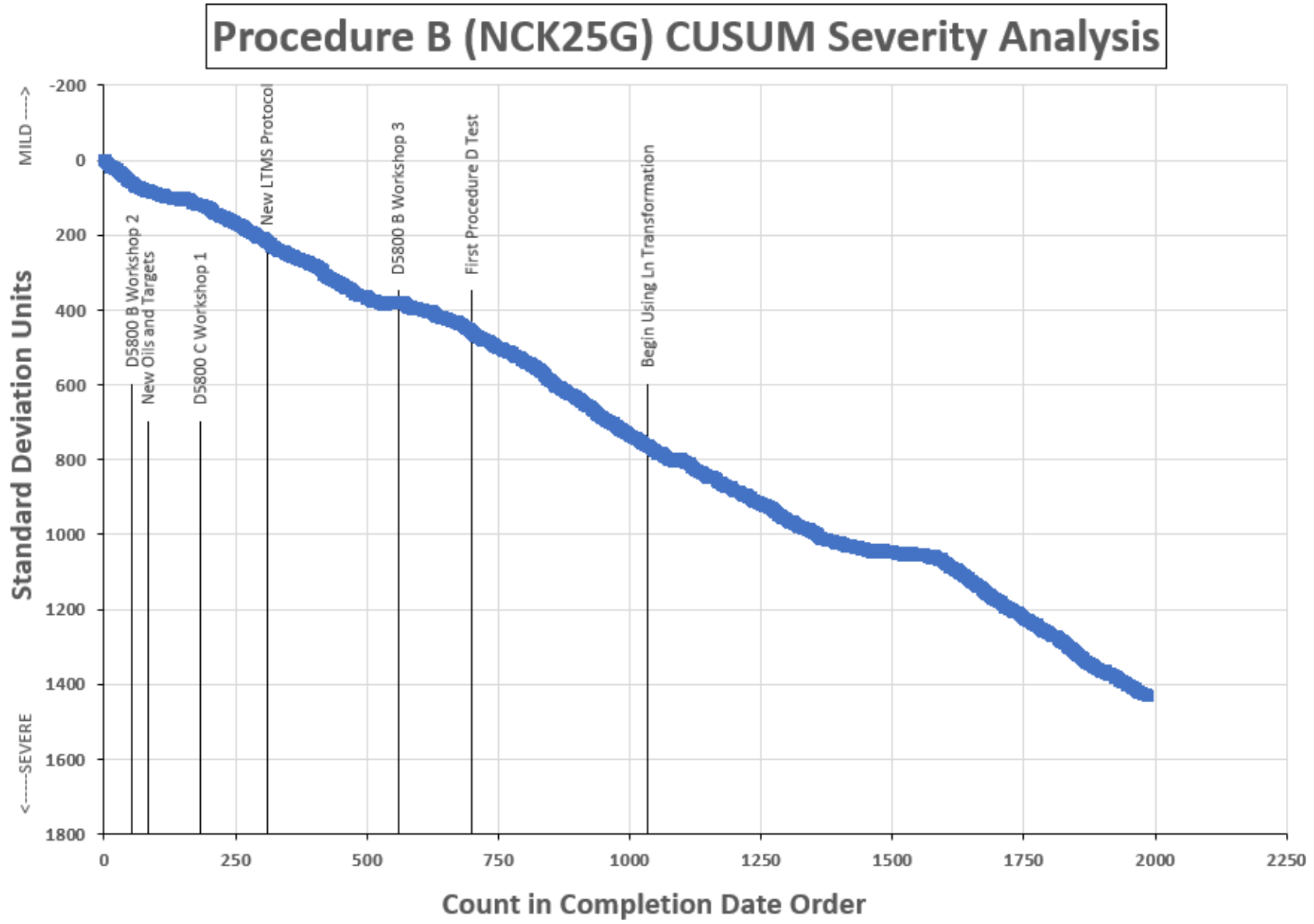
NCK25G only

D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA
MODEL NCK25G ONLY
EVAPORATION LOSS, MASS%



NCK25G only

D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA
MODEL NCK25G ONLY
EVAPORATION LOSS, MASS%



Reference Oil Inventory

D5800

Oil	Year Rec'd By TMC[A]	Tests	TMC Inventory, gallons	Gallons Shipped last 6 months	Estimated Life
VOLC12	2013	D5800	16.6	2.1	4 years
VOLD12	2013	D5800	14.8	2.0	4 years
VOLE12	2013	D5800	12.6	1.9	4 years
VOLD18	2018	D5800QC	516	46	5+ years

[A] Integrity of TMC reference oils is confirmed annually by analytical QC testing of chemical and physical properties.

D5800: Evaporation Loss of Lubricating Oil by Noack Method: Semester Summary

Precision (Pooled s) regressed this semester to 0.0627, moving away from 0.0465 target.

Performance (Mean Δ/s) continues to be severe at +0.21 s.

- Procedure B rigs continue to trend severe (+0.81 s) while Procedure D rigs continue to trend mild (-0.63 s).

Only one NCK2 (Procedure B) rig ran a single calibration test this semester. All other Procedure B rigs were NCK25G units

TABLE of CONTENTS

D02.B0.07
TMC Monitored Tests

ASTM D 6082

High Temperature Foam

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Calibrated Labs and Stands*

(change since last Semi-Annual report)

Test	Labs	Stands
D6082	7 (+0)	9 (+0)

*Between 10/1/2024 and 3/31/2025

D6082: High Temperature Foam

Test Status	Validity Code	No. Tests
Acceptable Calibration Test	AC	16
Failed Calibration Test	OC	1
Acceptable Discrimination Test	AS	8
Operationally Invalid, Reported as Valid	RC, RS	0
Operationally Invalid, Reported by Lab	LC, LS	0
Informational Run (Valid)	NN	0
Aborted Tests	XC, XS	0
Total		**25**

Number of Labs Reporting Data: 7
Fail Rate of Operationally Valid Calibration Tests: 5.9%

D6082: High Temperature Foam

Statistically Unacceptable Tests (OC, OS)	No. Of Tests
Foam Tendency Mild	0
Foam Tendency Severe	1
Total	**1**

- There was ONE statistically unacceptable calibration test this period.

D6082: High Temperature Foam

Operationally Unacceptable Tests (RC, LC, LS, XC, XS)	No. Of Tests
LC (Lab Invalid Calibration Run)	0
XC (Lab Aborted Calibration Run)	0
RC (TMC Invalidated Calibration Run)	0
XS (Lab Aborted Discrimination Run)	0
LS (Lab Invalid Discrimination Run)	0
Total	**0**

- There were ZERO operationally invalid results this report period.

D6082: High Temperature Foam

Informational Runs (MN, NN)	No. Of Tests
Non-blind Informational run on-target and valid (NN)	0
Non-blind Informational run invalid (MN)	0
Total	**0**

- There were no informational runs this report period.

D6082: High Temperature Foam (Tendency)

Period Precision and Severity Estimates

Foam Tendency, ml	n	df	Pooled s	Mean Δ/s
Targets updated 20201001[1]	18	17	9	-----
10/1/20 through 3/31/21	12	10	7	-0.48
4/1/21 through 9/30/21	14	13	7	-0.48
10/1/21 through 3/31/22	13	12	7	-0.57
4/1/22 through 9/30/22	15	14	4	-0.52
10/1/22 through 3/31/23	16	15	10	-0.69
4/1/23 through 9/30/23	14	13	4	-0.68
10/1/23 through 3/31/24	19	18	10	-0.62
4/1/24 through 9/30/24	18	17	13	-0.01
10/1/24 through 3/31/25	17	16	18	0.88

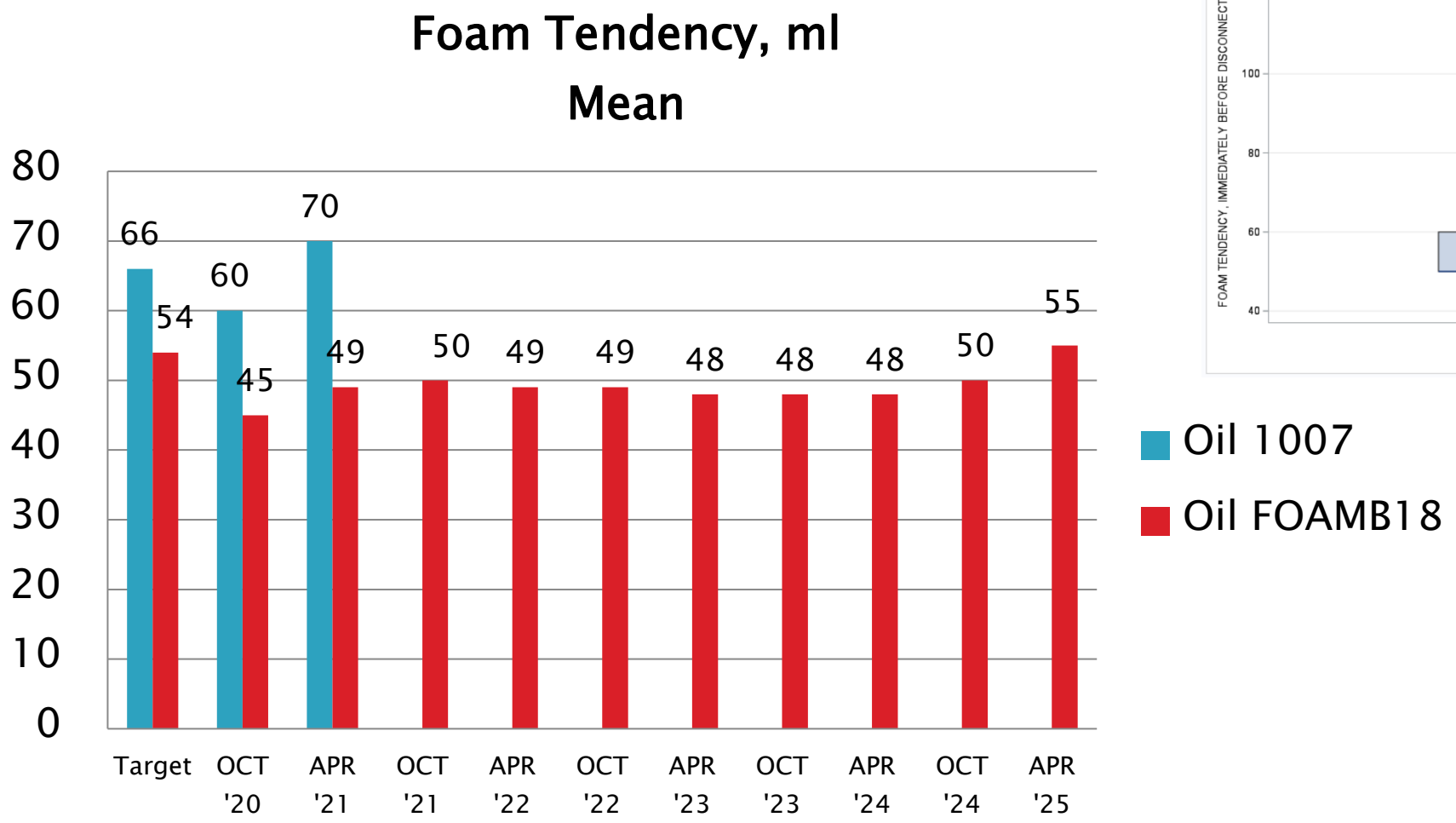
[1]Target precision updated to current reference oil FOAMB18

D6082: High Temperature Foam (Stability)

Period Precision and Severity Estimates

Foam Stability @ 1 min, ml	n	Mean	s
Current Targets	18	0.00	0.00
10/1/20 through 3/31/21	12	No non-zero occurrences	
4/1/21 through 9/30/21	14	No non-zero occurrences	
10/1/21 through 3/31/22	13	No non-zero occurrences	
4/1/22 through 9/30/22	15	No non-zero occurrences	
10/1/22 through 3/31/23	16	No non-zero occurrences	
4/1/23 through 9/30/23	14	No non-zero occurrences	
10/1/23 through 3/31/24	19	No non-zero occurrences	
4/1/24 through 9/30/24	18	No non-zero occurrences	
10/1/24 through 3/31/25	18	No non-zero occurrences	

D6082 Performance by Oil



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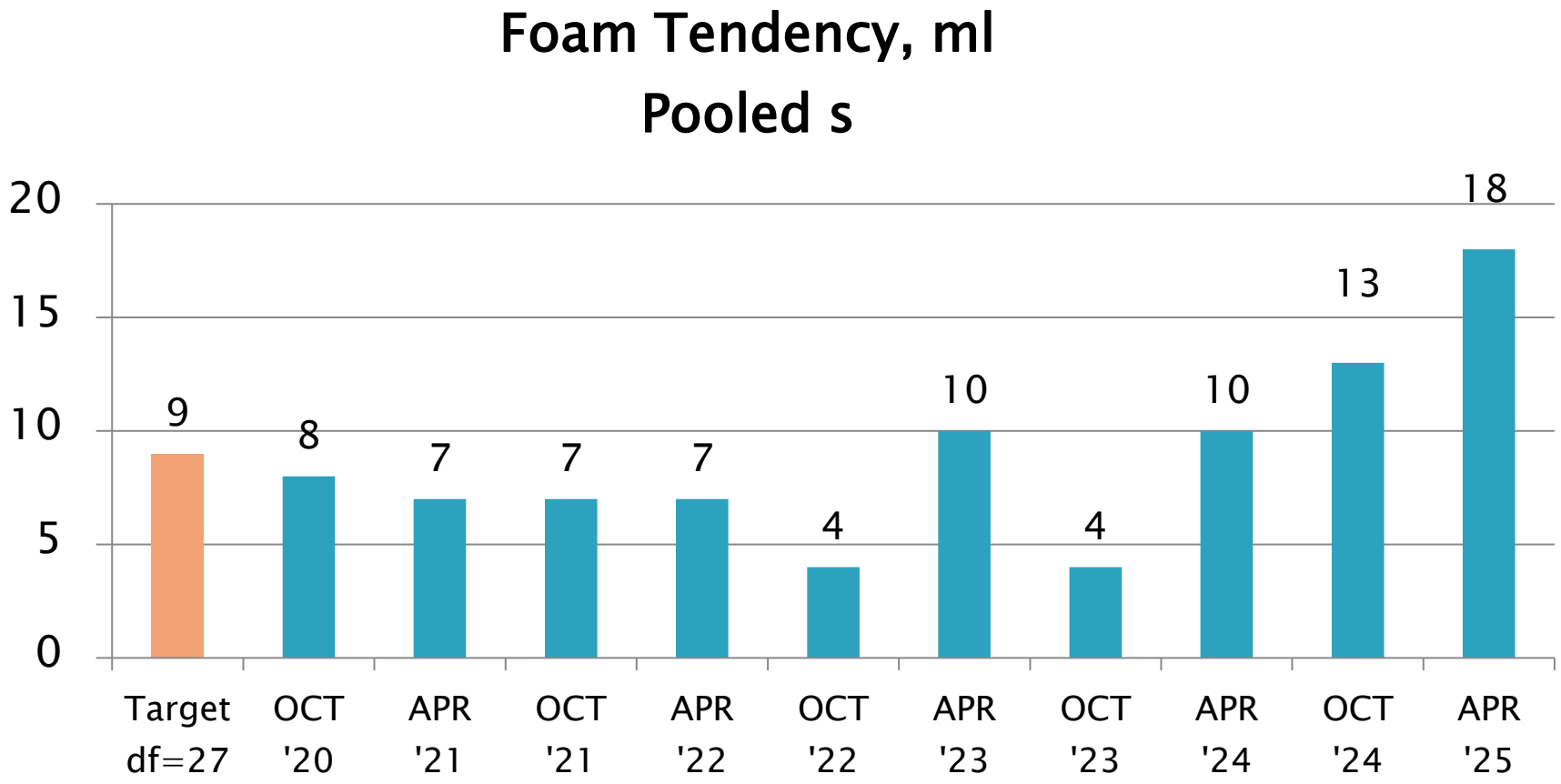
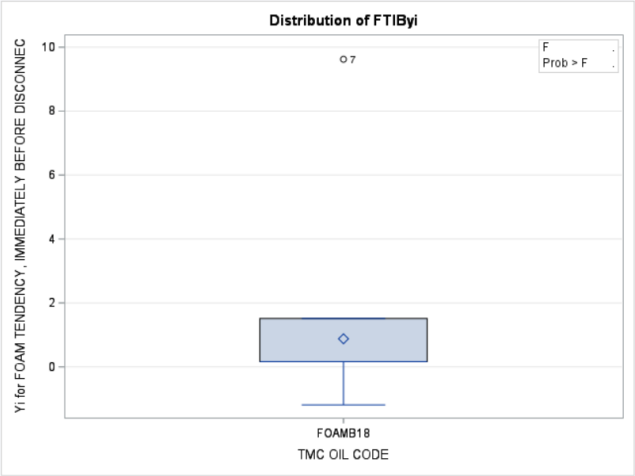
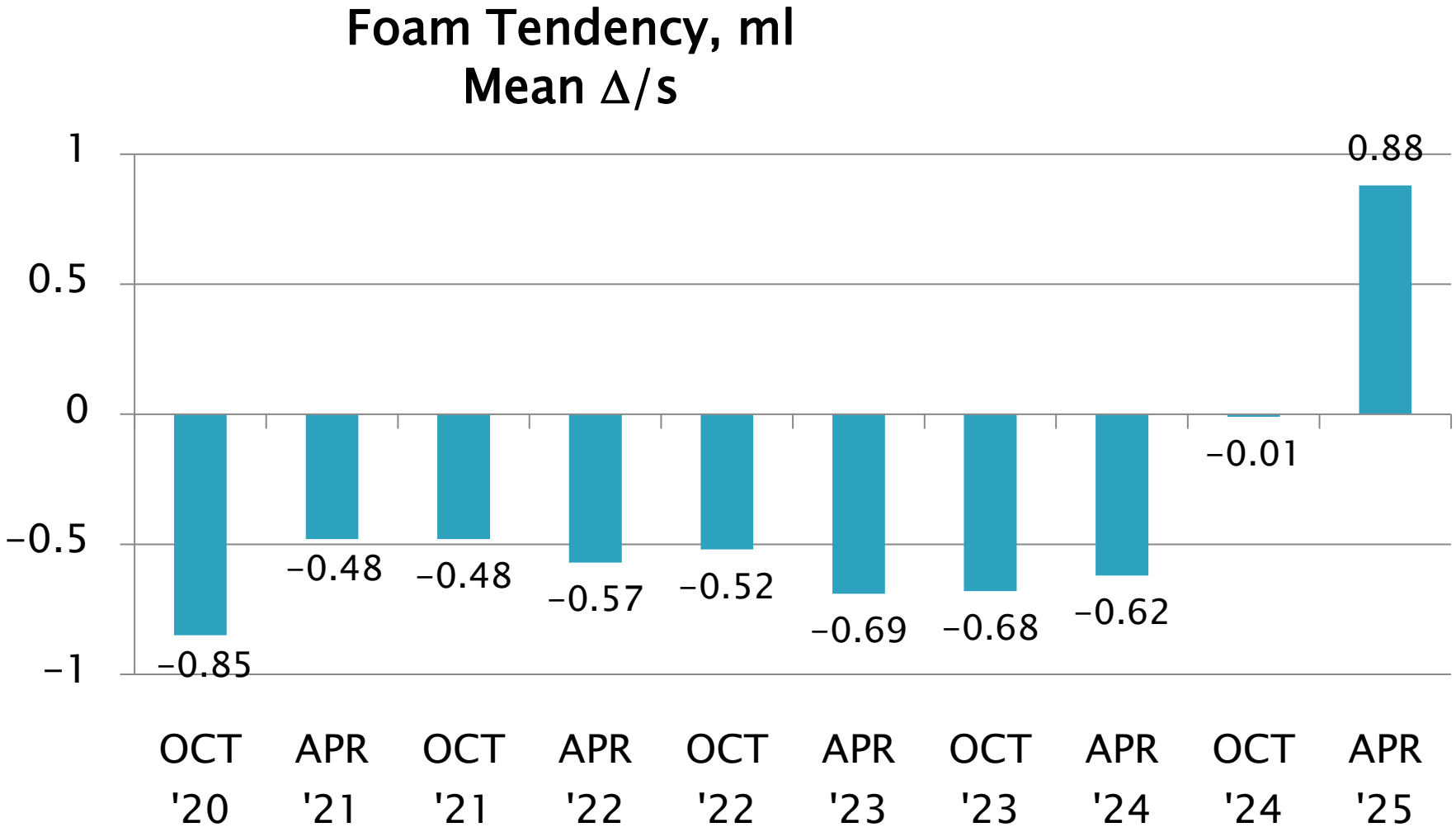
D6082: High Temperature Foam



D6082: High Temperature Foam





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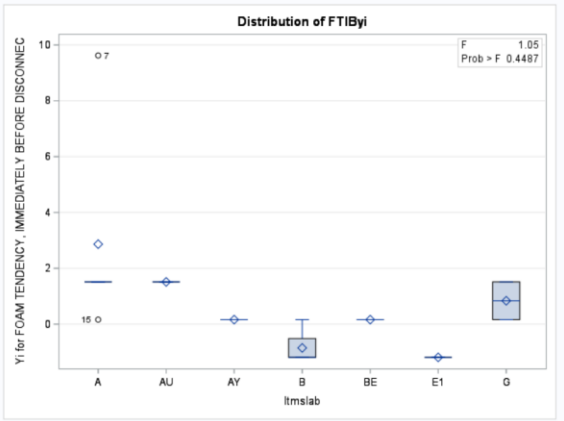
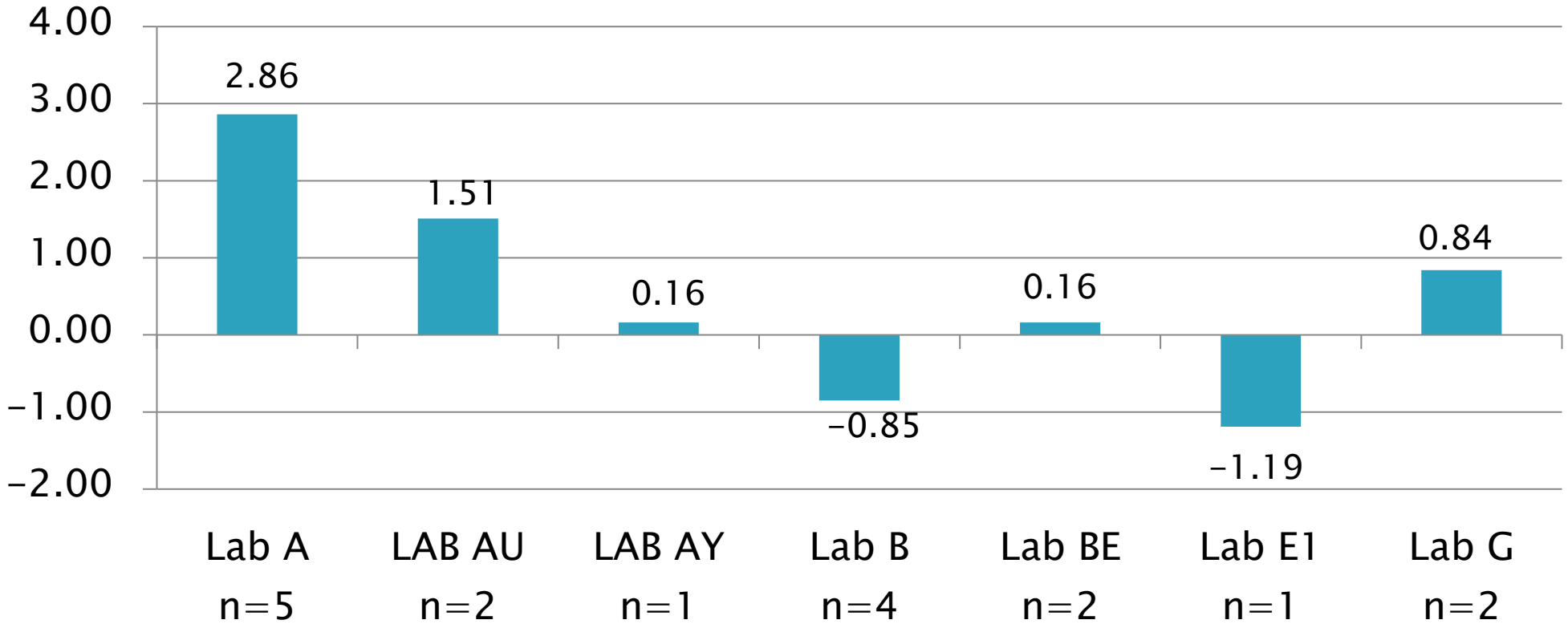


D6082: High Temperature Foam

Current Period Severity Estimates by Lab
Foam Tendency, ml



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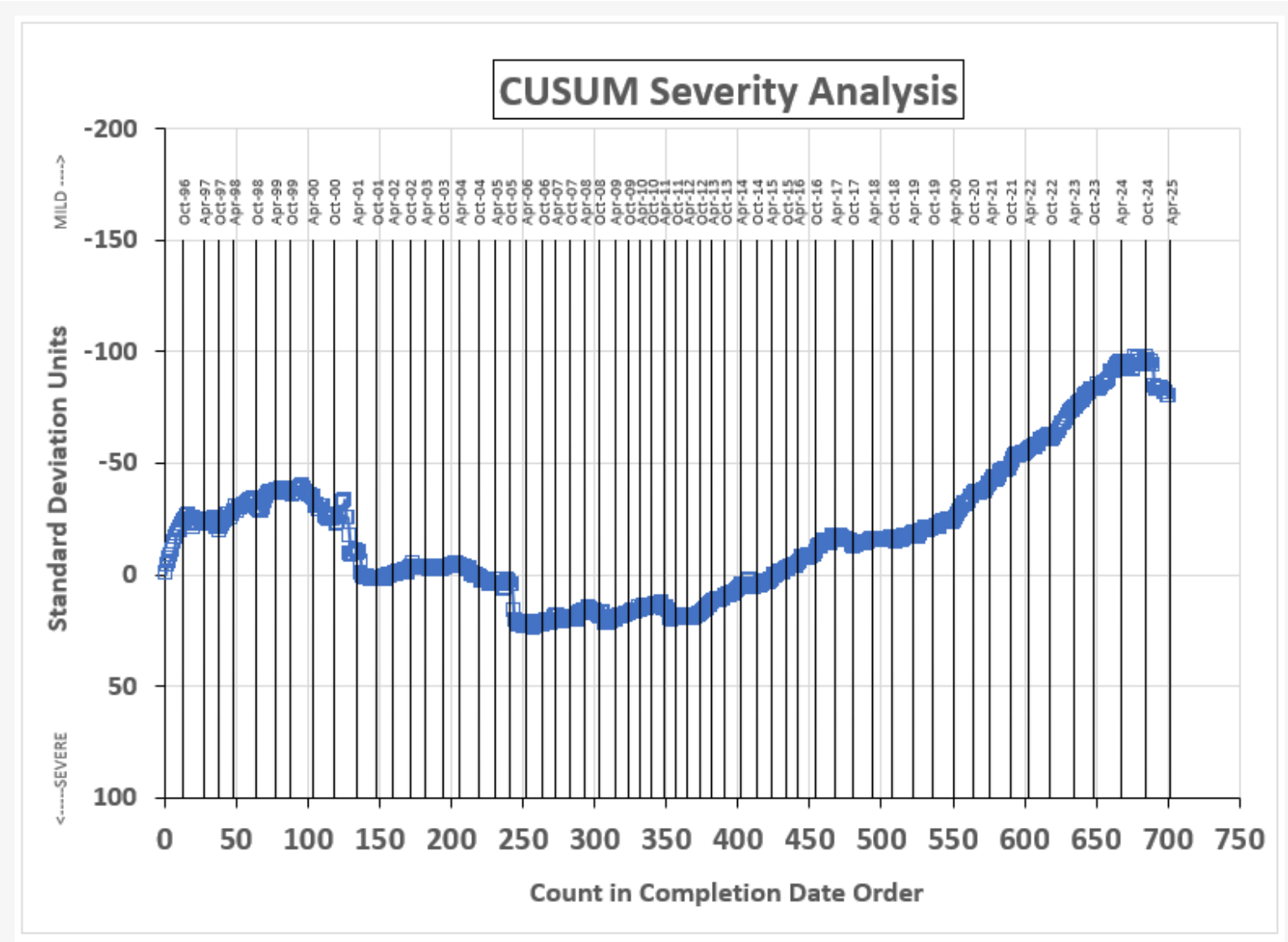
D6082: High Temperature Foam Status

- Foam Tendency Precision (Pooled s) has fallen further back (to 18) this semester. Previous semester Precision was 13.
- Performance (Mean Δ/s) has moved to severe at +0.88s.
- NEW FOAMB18 final targets, based upon 131 data points, were approved by the Surveillance Panel in June.
- No non-zero occurrences of Foam Stability
- No discrimination runs (on TMC oil 66) failed this semester.

FOAM TENDENCY



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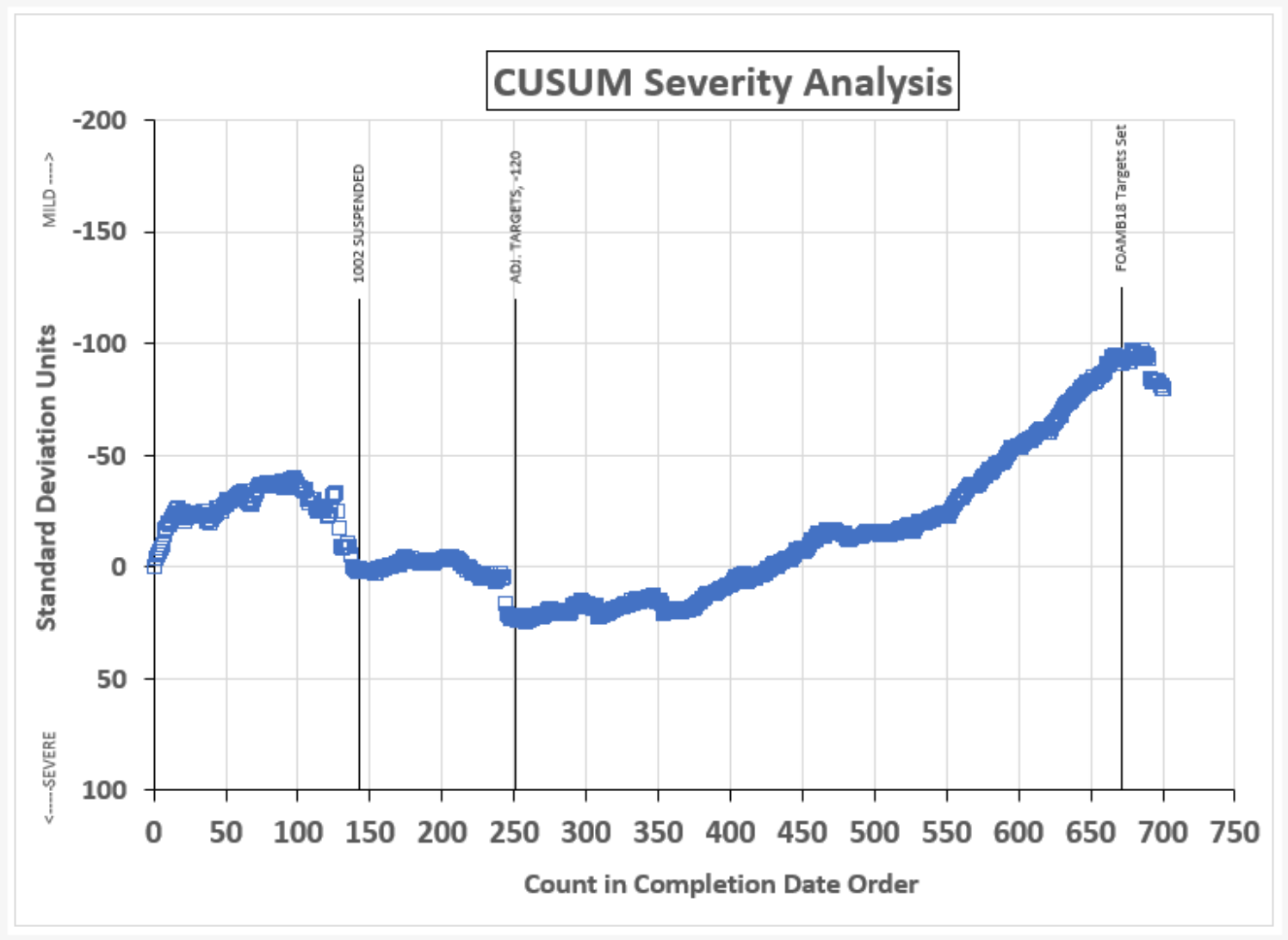
FOAM TENDENCY



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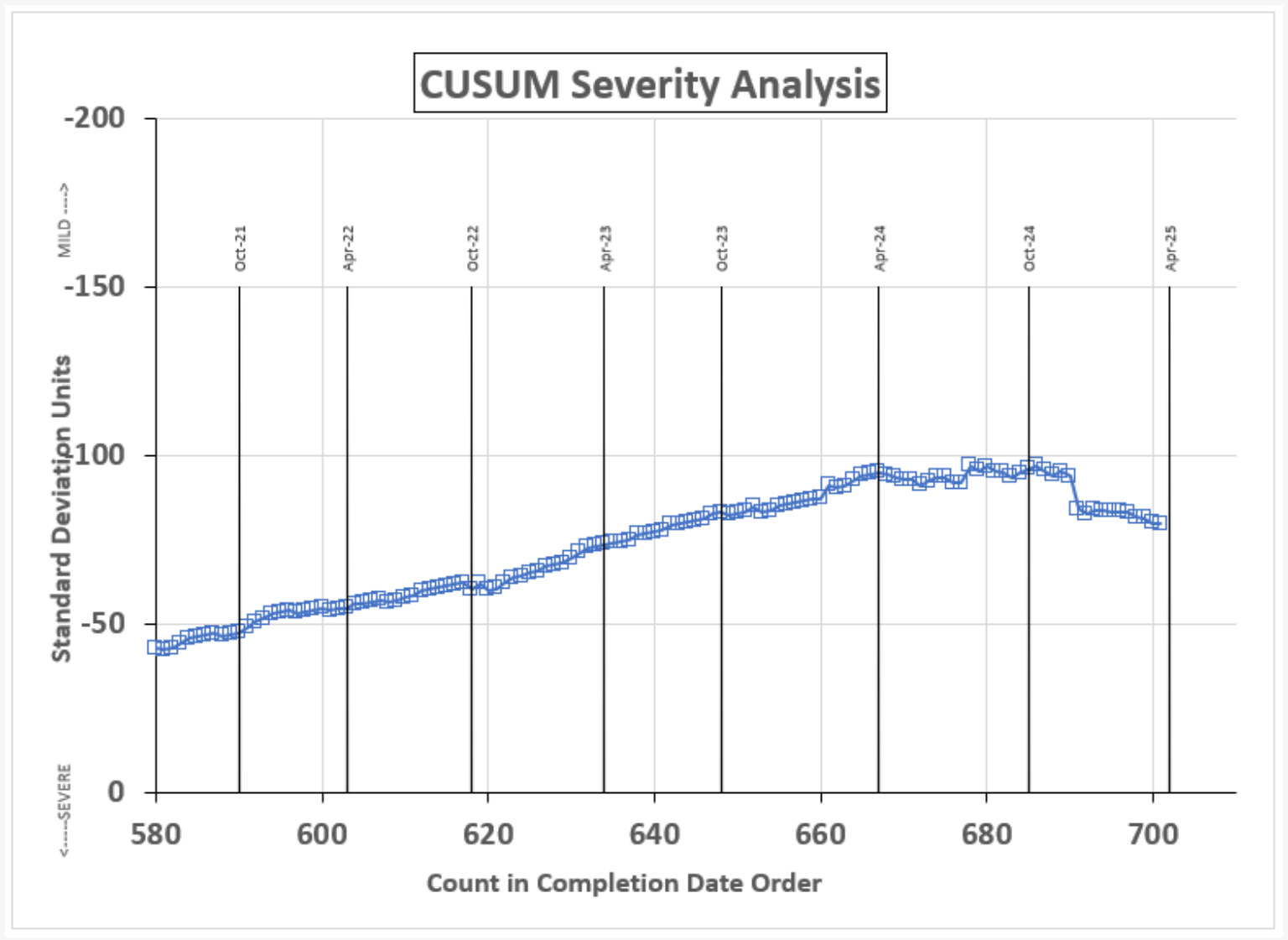
D6082 HIGH TEMPERATURE FOAM INDUSTRY OPERATIONALLY VALID DA
Last 120 Data Points
FOAM TENDENCY



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Reference Oil Inventory

D6082

Oil	Year Rec'd By TMC[A]	Tests	TMC Inventory, gallons	Gallons Shipped last 6 months	Estimated Life
FOAMB18	2018	D6082	67.18	1.11	5+ years
66	2002	D6082	66.3	1.40	5+ years

[A] Integrity of TMC reference oils is confirmed annually by analytical QC testing of chemical and physical properties.
[B] D874QC Samples (1L sizes) could quickly deplete Reference Oil 90 availability.

D02.B0.07
TMC Monitored Tests

ASTM D 6335

TEOST

October 1, 2024 – March 31, 2025

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Calibrated Labs and Stands*

(change since last Semi-Annual report)

Test	Labs	Stands
D6335	7 (-2)	12 (-2)
*As of 3/31/2025		

D6335: Deposits by TEOST-33C

Test Status	Validity Code	No. Tests
Acceptable Calibration Tests	AC	21
Failed Calibration Tests	OC	8
Operationally Invalid or Aborted by Lab	LC, XC	4
Informational Run (Test Result In Range)	NN	1
Informational Run (Test Result Out of Range)	MN	5
Donated Industry Runs (Ref Oil 75-2 Round Robin)	NG	14
Total		**53**

Number of Labs Reporting Data: 8 (9 Labs Last Period)
Fail Rate of Operationally Valid Tests: 27.6% (22.0% Last Period)

D6335: Deposits by TEOST-33C

Statistically Unacceptable Tests (OC)	No. Of Tests
Total Deposits Severe	5
Total Deposits Mild	3
Total	**8**
Operationally Invalid Tests (LC, XC)	**No. Of Tests**
XC: Instrument Failure (aborted run)	1
LC: Lab Invalidated Run (thermocouple failure)	2
LC: Lab Invalidated Run (rod pre-weight not recorded)	1
Total	**4**

- RO reblend 75-2 approved for use with current RO 75-1 acceptance range.

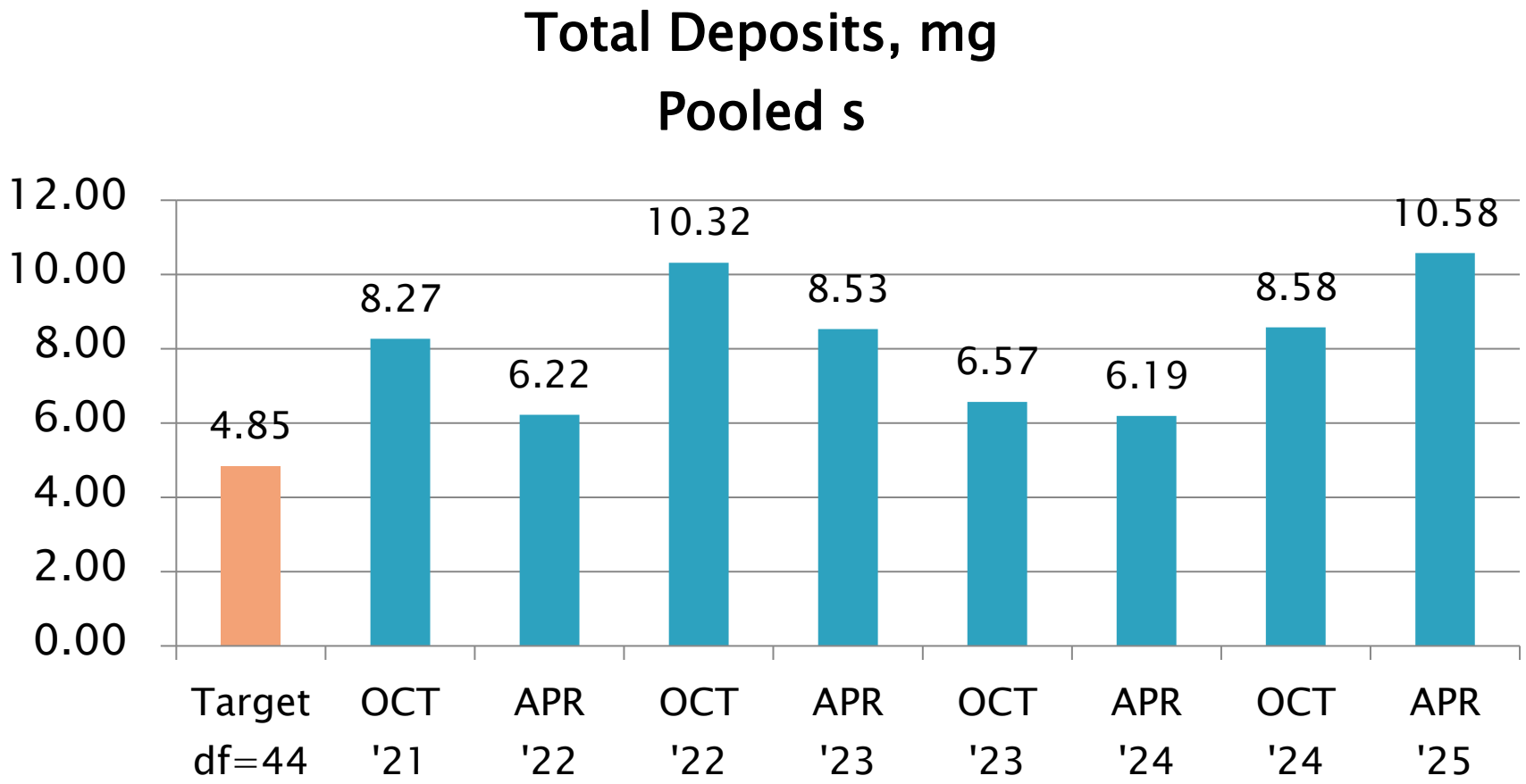
D6335: Deposits by TEOST-33C

Period Precision and Severity Estimates

Total Deposits, mg	n	df	Pooled s	Mean Δ/s
Updated Targets 20201001[1]	46	44	4.85	-----
10/1/20 through 3/31/21	26	23	8.39	0.42
4/1/21 through 9/30/21	31	28	8.27	-0.36
10/1/21 through 3/31/22	27	25	6.22	0.55
4/1/22 through 9/30/22	29	27	10.32	0.80
10/1/22 through 3/31/23	35	33	8.53	0.84
4/1/23 through 9/30/23	30	28	6.57	0.03
10/1/23 through 3/31/24	34	32	6.19	0.63
4/1/24 through 9/30/24	41	39	8.58	0.84
10/1/24 through 3/31/25	29	27	10.56	0.43

[1]Target precision updated to include only current oils 75-1 and 435-2

D6335 Precision Estimates



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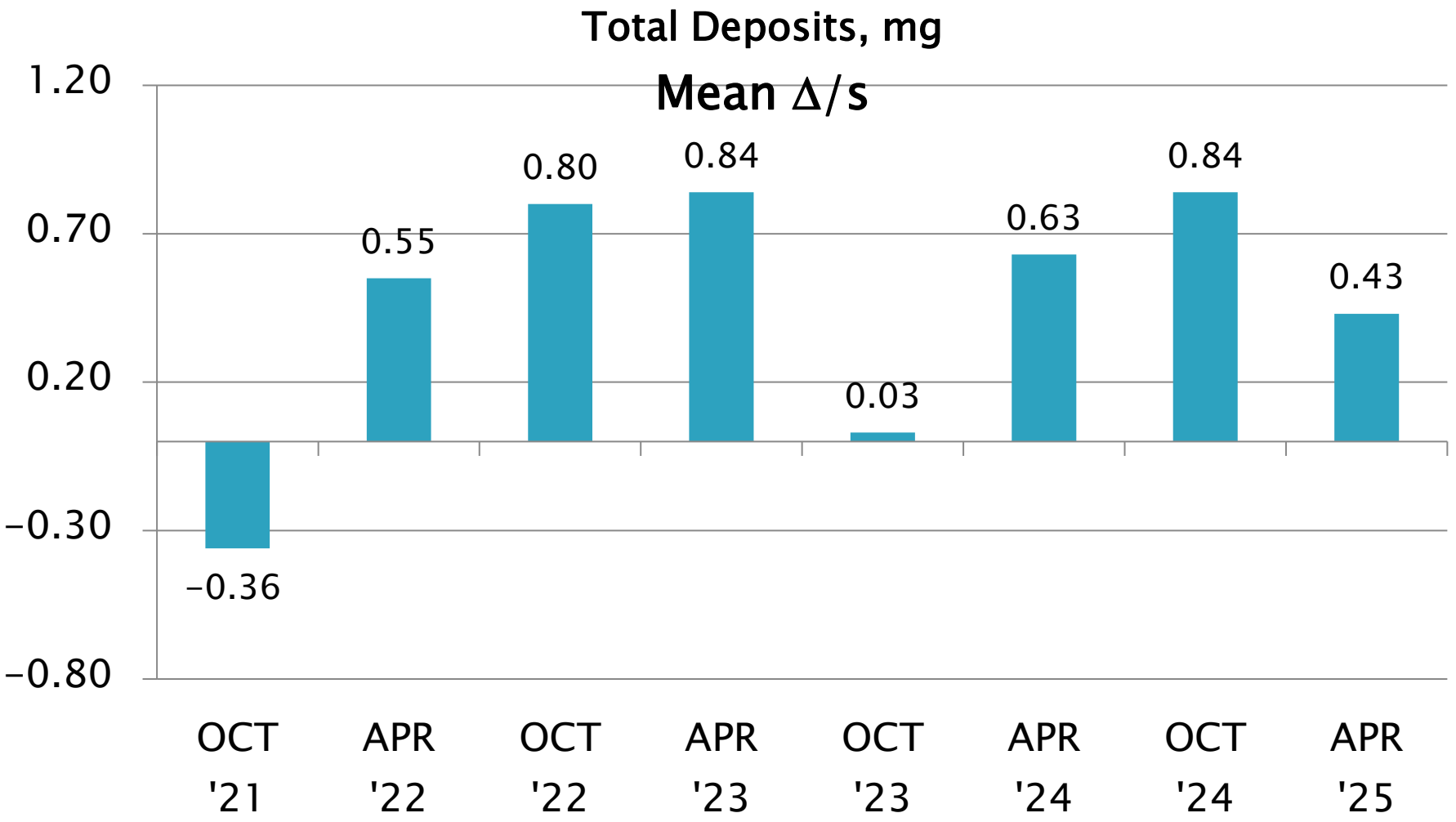
D6335 Severity Estimates



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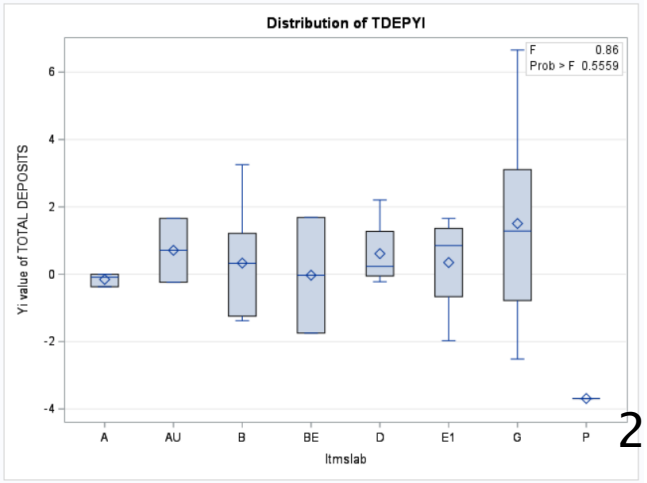
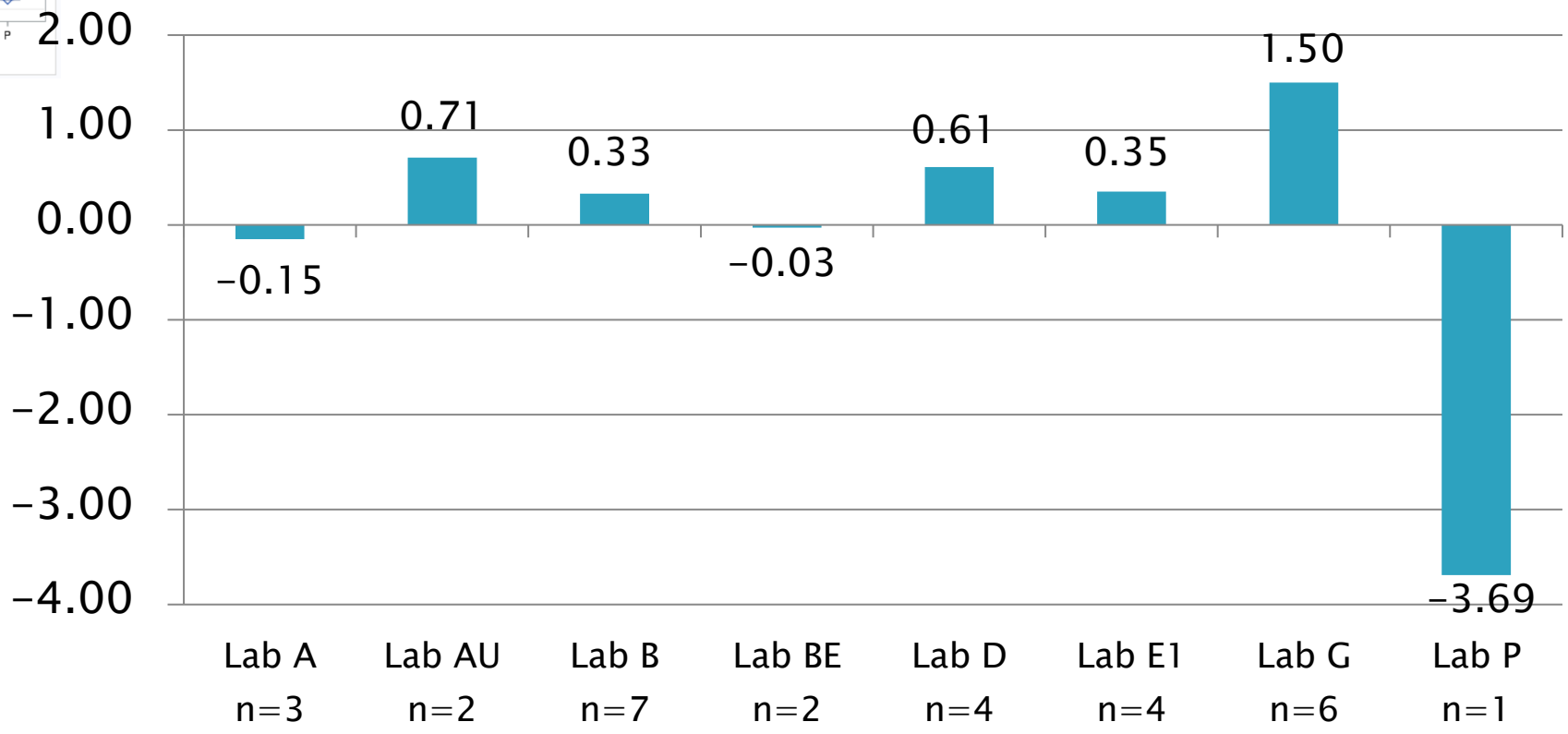


D6335 Lab Severity Estimates

Total deposits, mg

Mean Δ/s



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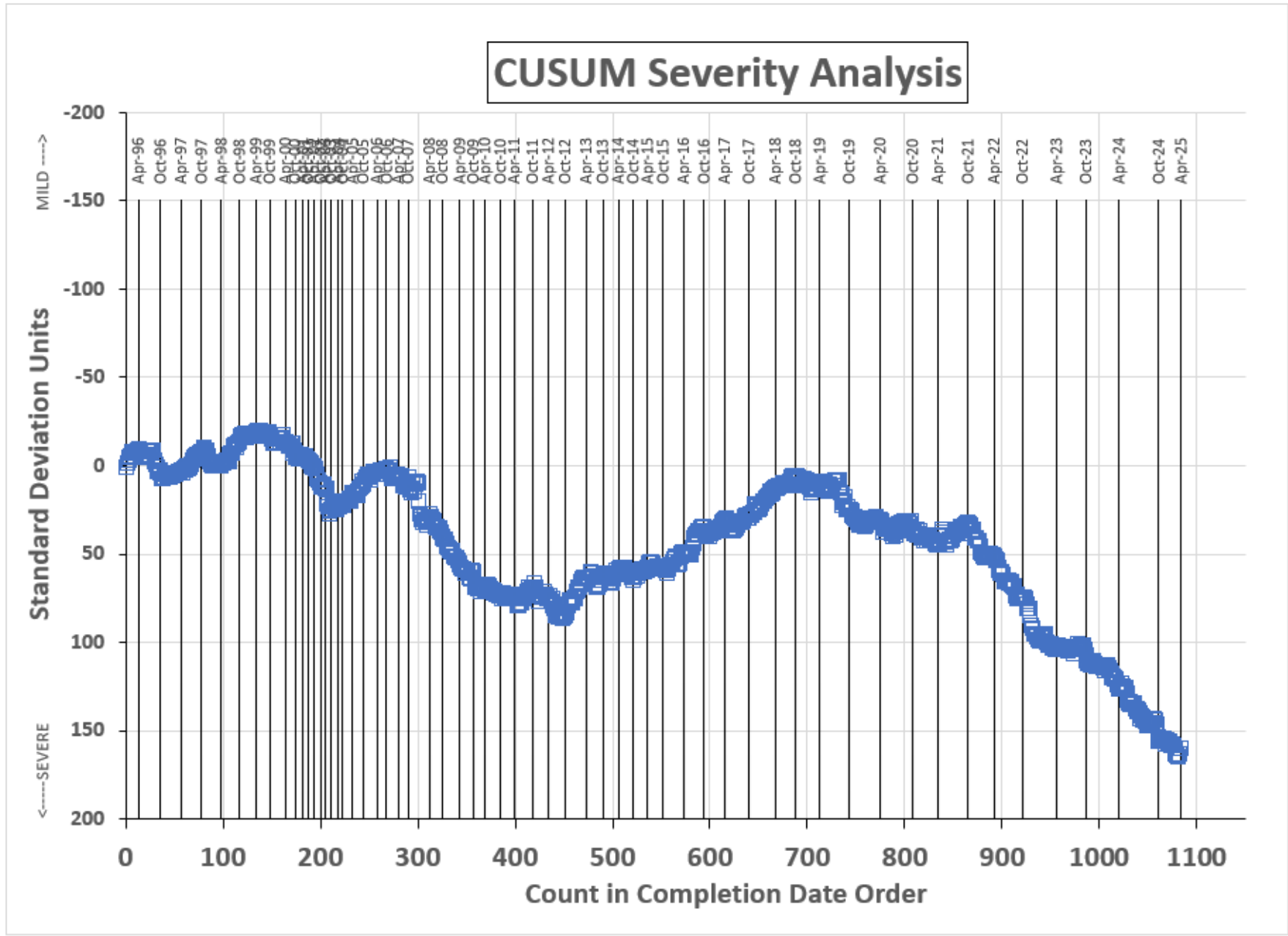
D6335: Deposits by TEOST-33C Status

- Precision (Pooled s) regressed further away from target this semester (10.56 s vs 8.58 s)
- Performance (Mean Δ/s) improved this this period moving to 0.43s (0.84 s last semester)
- Fail rate increased this semester to 27.6% this semester, last semester fail rate was 22.0%.
- All tests this period report used Rod Batch N.
- Reblend RO 75-2 has replaced batch 75-1. Surveillance Panel voted to carry-forward the existing acceptance range for 75-2, although round robin data is available to adjust the RO 75-2 targets if needed. RO 75-1 TESTKEYs will be assigned to consume inventories remaining at the labs.

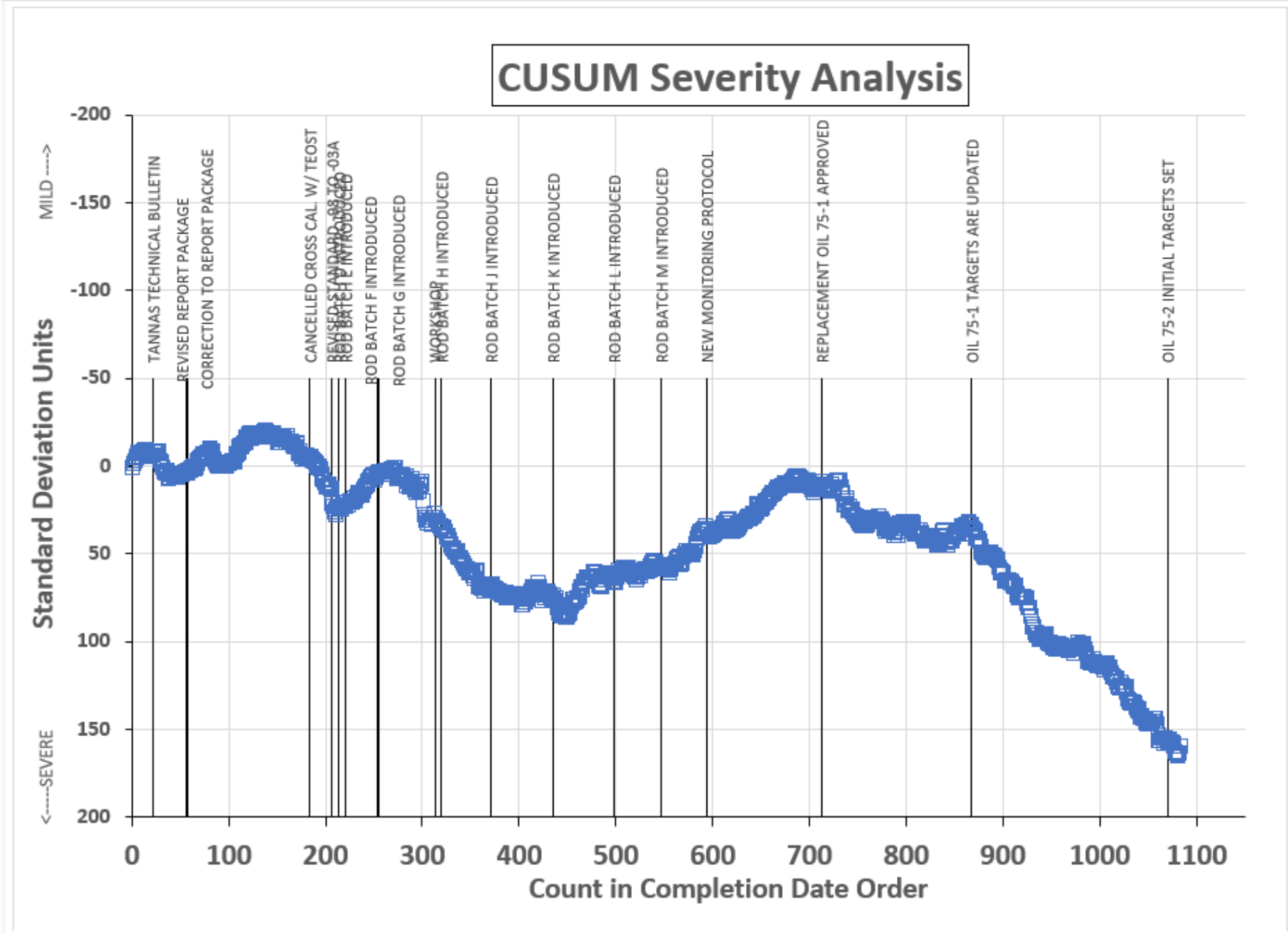
TEOST –33C INDUSTRY OPERATIONALLY VALID DATA

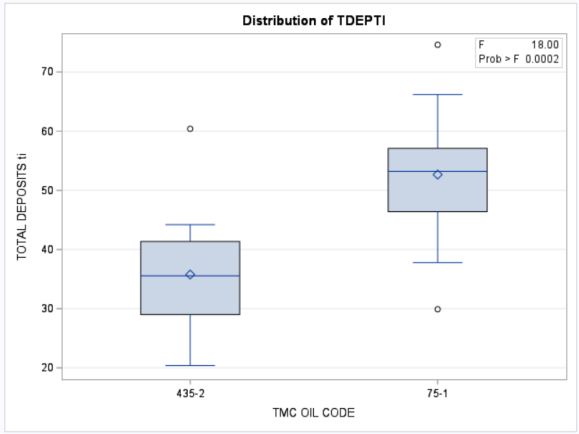
TOTAL DEPOSITS MG



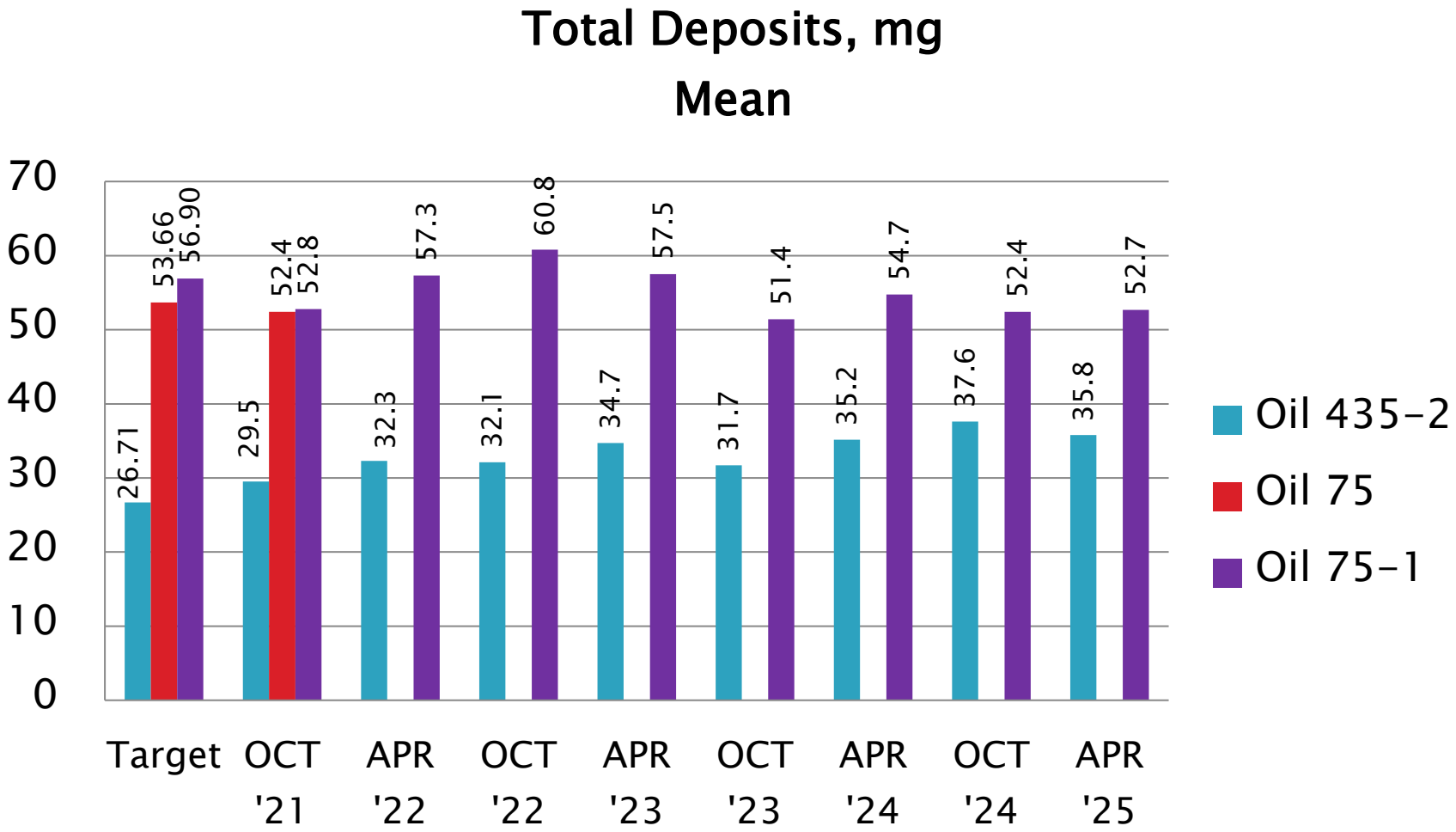
TEOST –33C INDUSTRY OPERATIONALLY VALID DATA

TOTAL DEPOSITS MG





D6335 Performance by Oil



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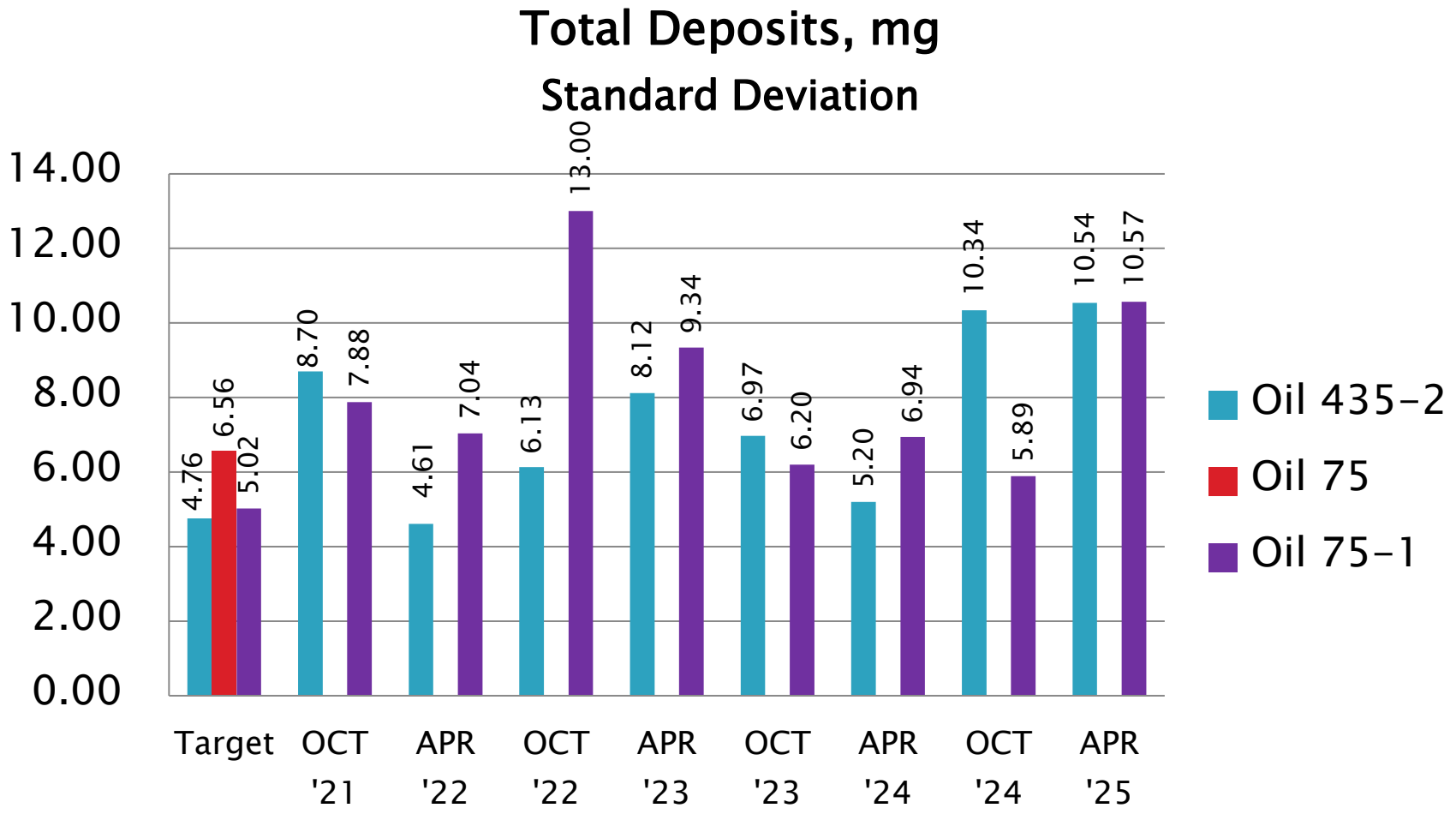
D6335 Performance by Oil



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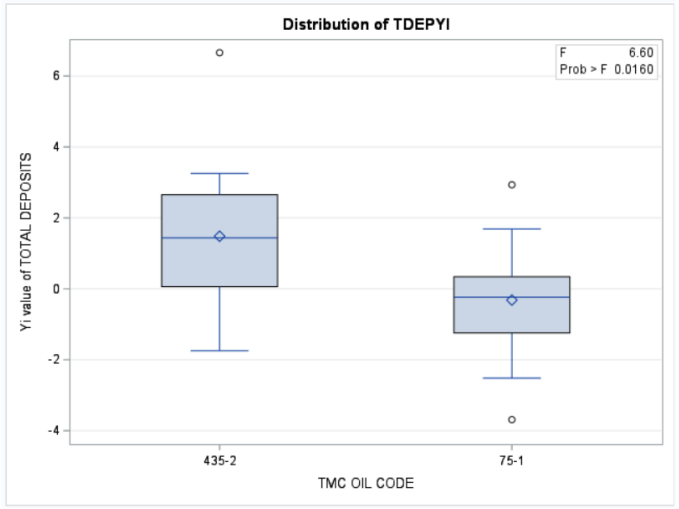
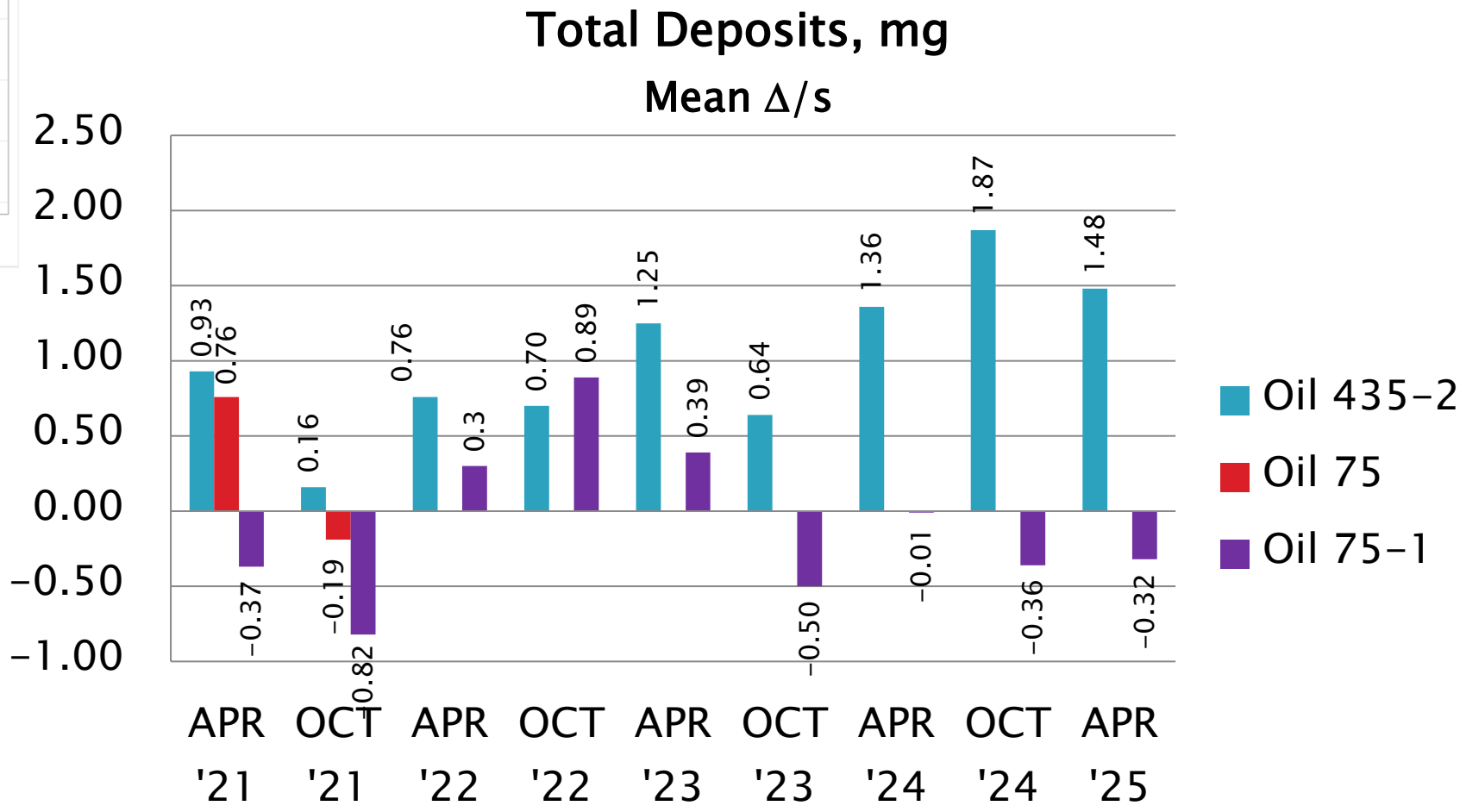


D6335 Performance by Oil



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Reference Oil Inventory

TEOST

Oil	Year Rec'd By TMC[A]	Tests	TMC Inventory, gallons	Gallons Shipped last 6 months	Estimated Life
75-1	2016	TEOST	0.00	0.00	None
75-2	2024	TEOST	6.86	0.41	5+ years
435-2[B]	2010	TEOST	31.73	0.66	5+ years

[A] Integrity of TMC reference oils is confirmed annually by analytical QC testing of chemical and physical properties.
[B] Multi-test oil; estimated aliquot reserved for bench testing.

D02.B0.07
TMC Monitored Tests

» ASTM D 6417

October 1, 2024 – March 31, 2025

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D6417 Calibrated Labs and Stands*

(change since last Semi-Annual report)

Test	Labs	Stands
D6417	7 (+0)	10 (+0)

*Between 10/1/2024 and 3/31/2025

D6417: Estimation of Engine Oil Volatility by Capillary GC

Test Status	Validity Code	No. Tests
Acceptable Calibration Test	AC	19
Failed Calibration Test	OC	1
Total		**20**

Number of Labs Reporting Data: 7
Fail Rate of Operationally Valid Tests: 5.0%

D6417: Estimation of Engine Oil Volatility by Capillary GC

Statistically Unacceptable Tests (OC)	No. Of Tests
Volatility Loss Mild	1
Volatility Loss Severe	0

Operationally Invalid Tests (LC)	No. Of Tests
Daily QC was out of range (Severe)	0

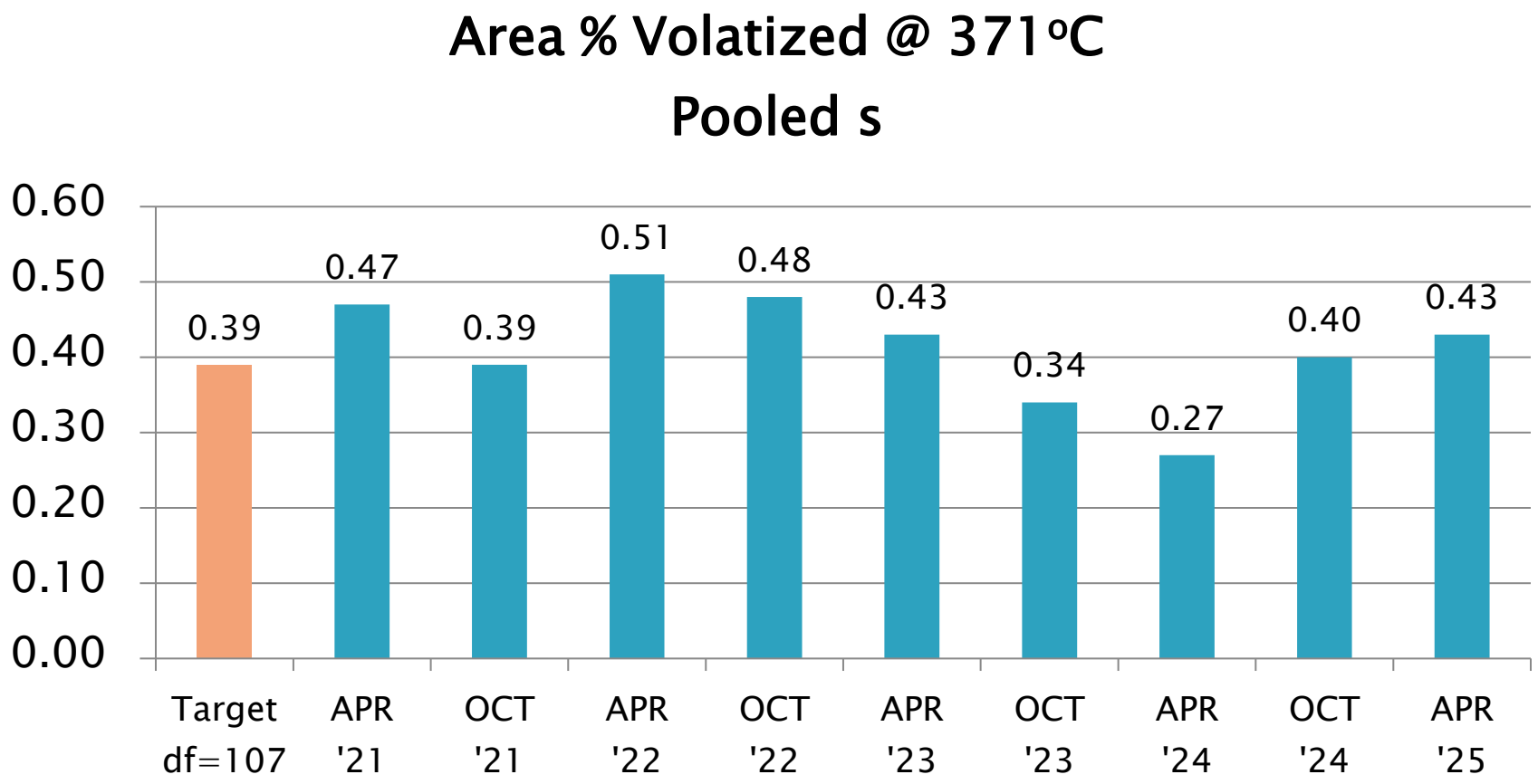
- No D6417 TMC technical updates were issued this report period.

D6417: Estimation of Engine Oil Volatility by Capillary GC

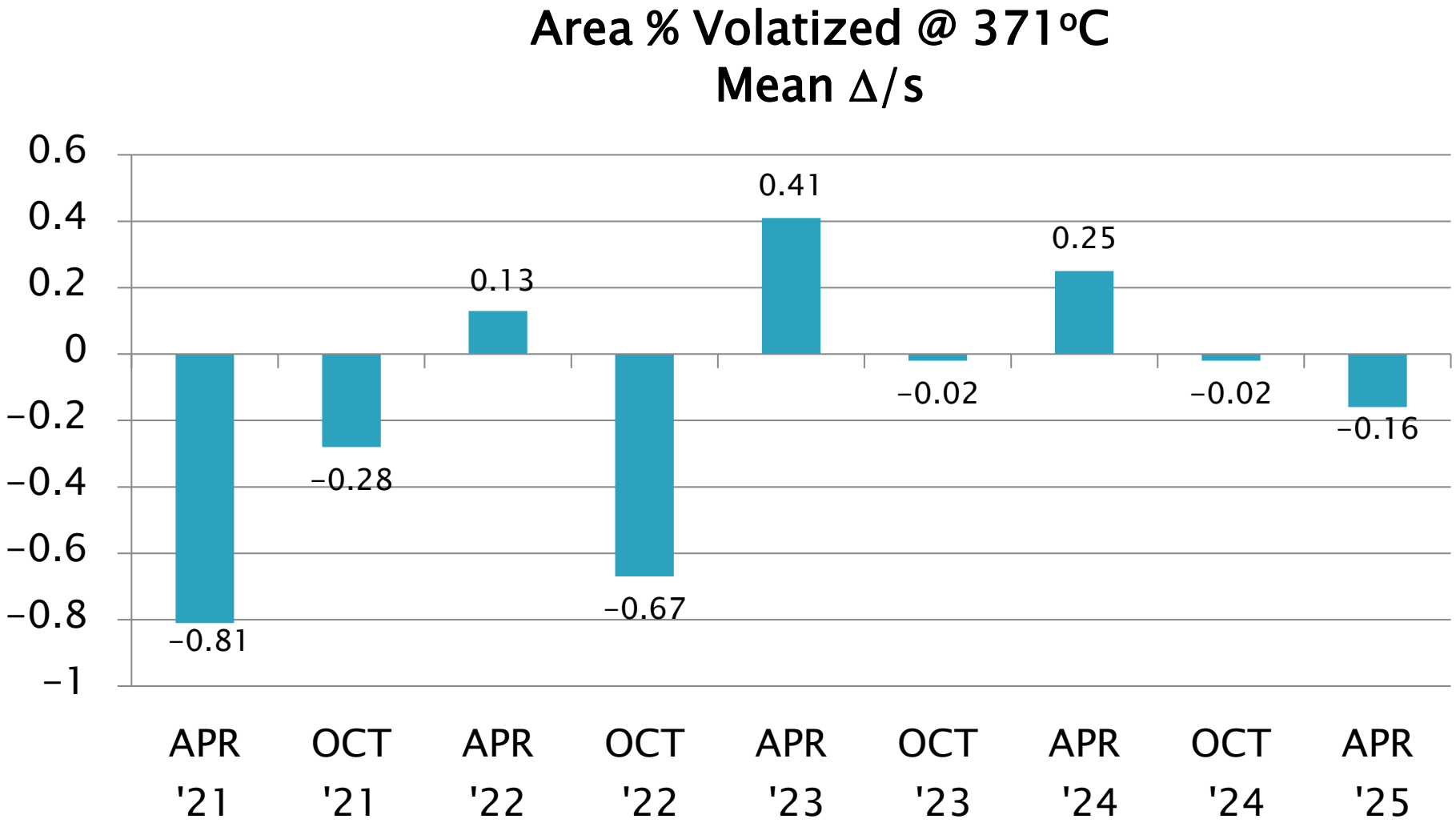
Period Precision and Severity Estimates

Area % Volatized @ 371°C	n	df	Pooled s	Mean Δ/s
Initial Selected Oils from RR	54	51	0.39	-----
4/1/21 through 9/30/21	17	14	0.39	-0.28
10/1/21 through 3/31/22	20	17	0.51	0.13
4/1/22 through 9/30/22	19	16	0.48	-0.67
10/1/22 through 3/31/23	18	15	0.43	0.41
4/1/23 through 9/30/23	16	13	0.34	-0.02
10/1/23 through 3/31/24	18	15	0.27	0.25
4/1/24 through 9/30/24	20	17	0.40	-0.02
10/1/24 through 3/31/25	20	17	0.43	-0.16

D6417 Precision Estimates



D6417 Severity Estimates



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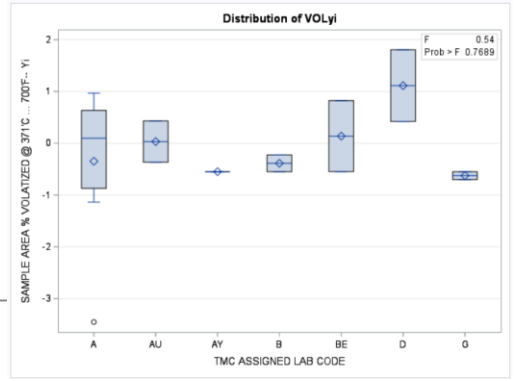
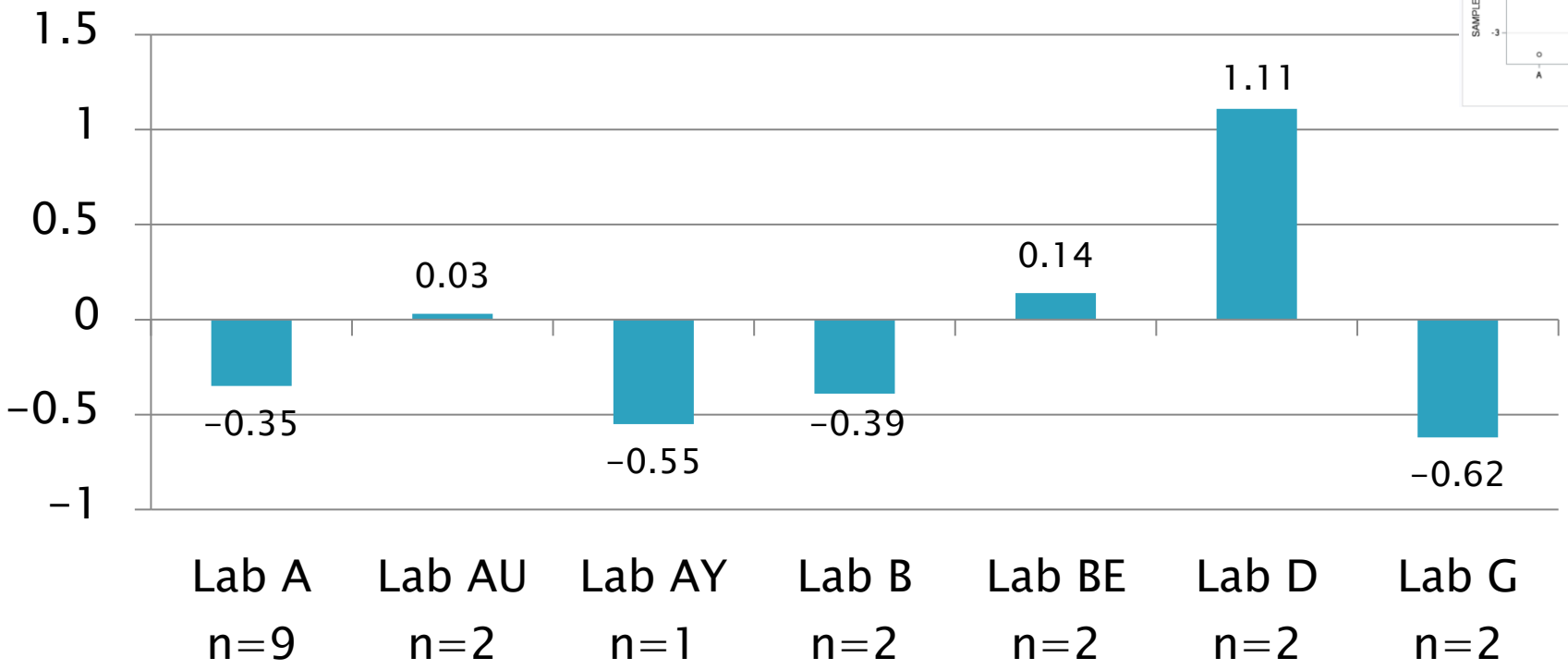
D6417 Lab Severity Estimates



Area % Volatized @ 371°C

Mean Δ/s



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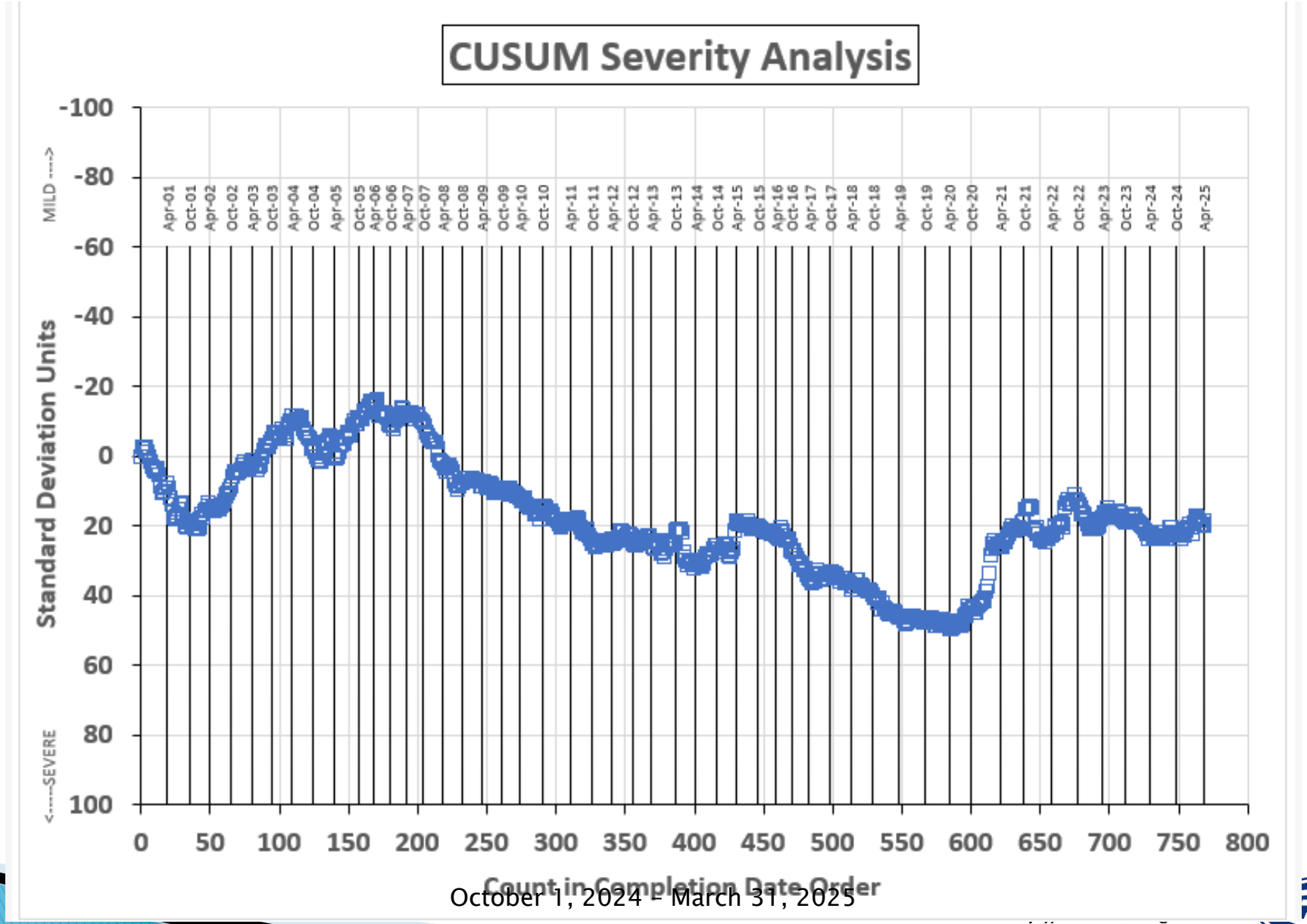
D6417 VOLATILITY BY GC INDUSTRY OPERATIONALLY VALID DATA

SAMPLE AREA % VOLATIZED



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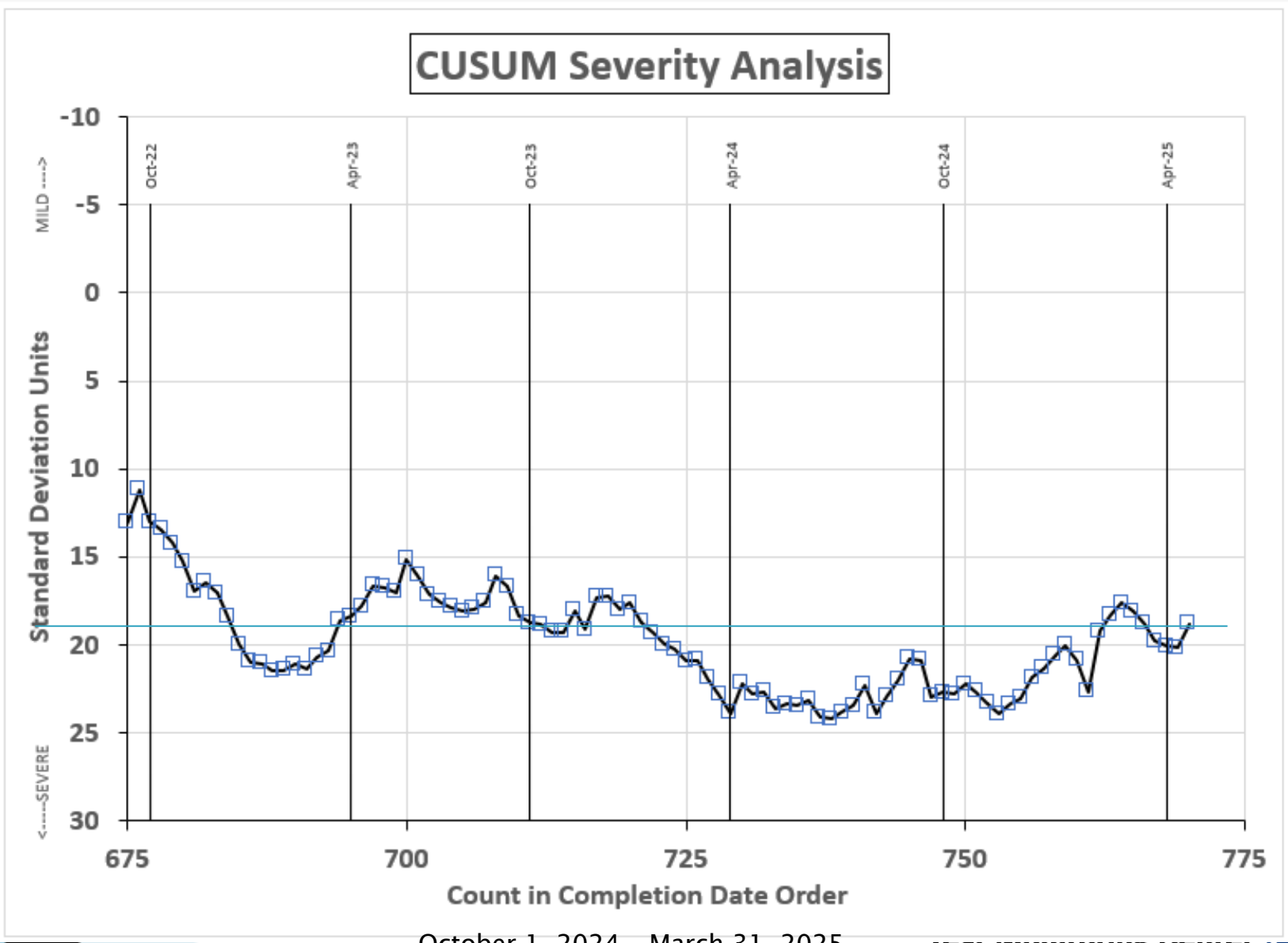
D6417 VOLATILITY BY GC INDUSTRY OPERATIONALLY VALID DATA
LAST 90 Points
SAMPLE AREA % VOLATIZED



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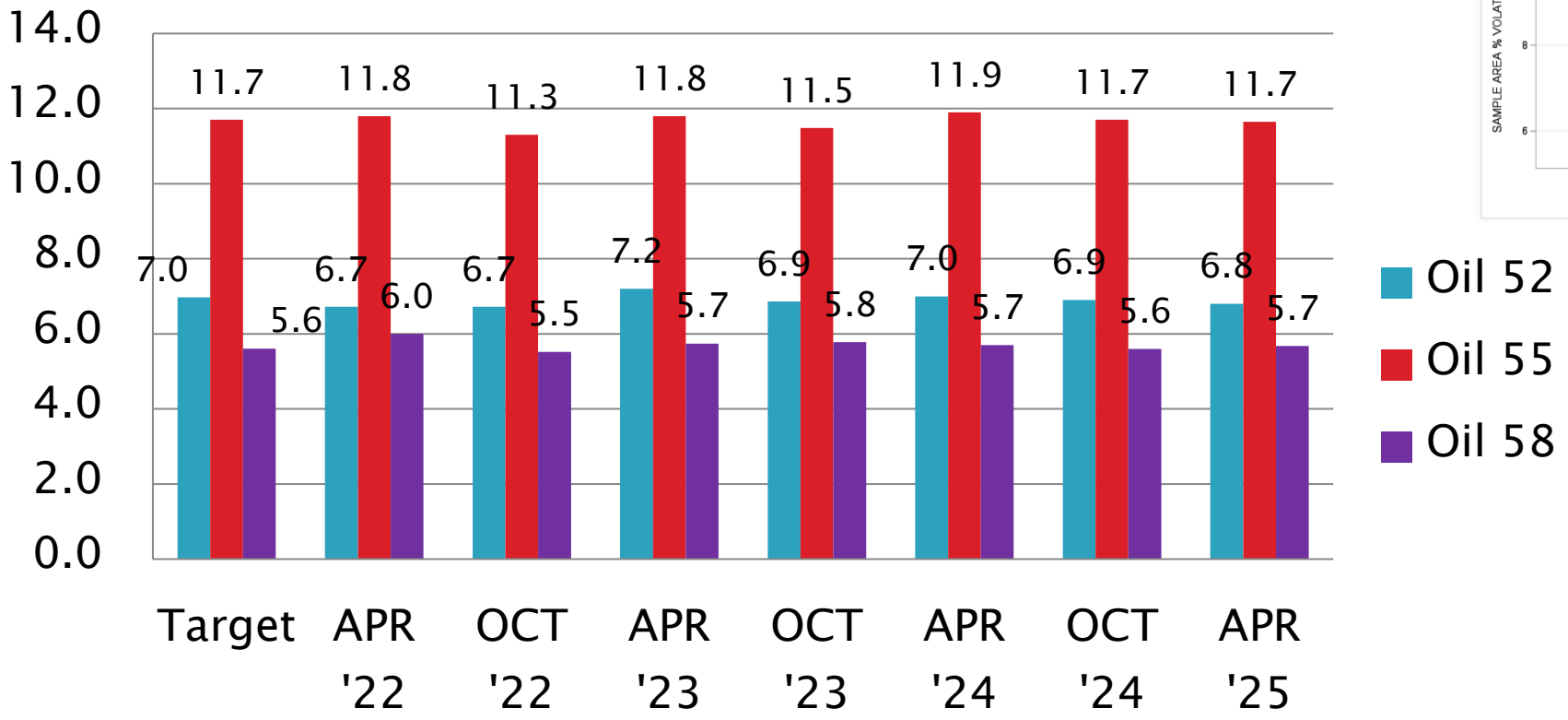
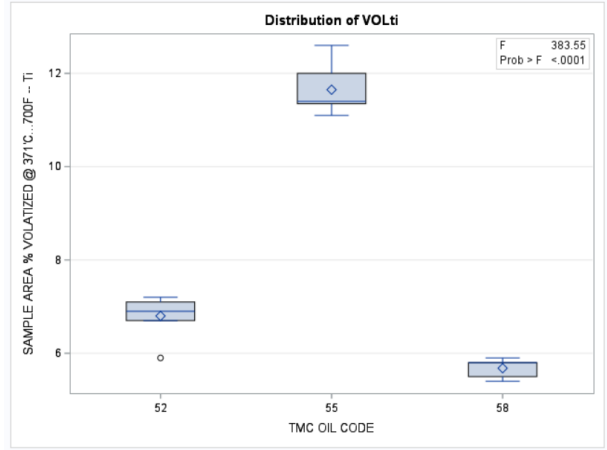
D6417 Performance by Oil





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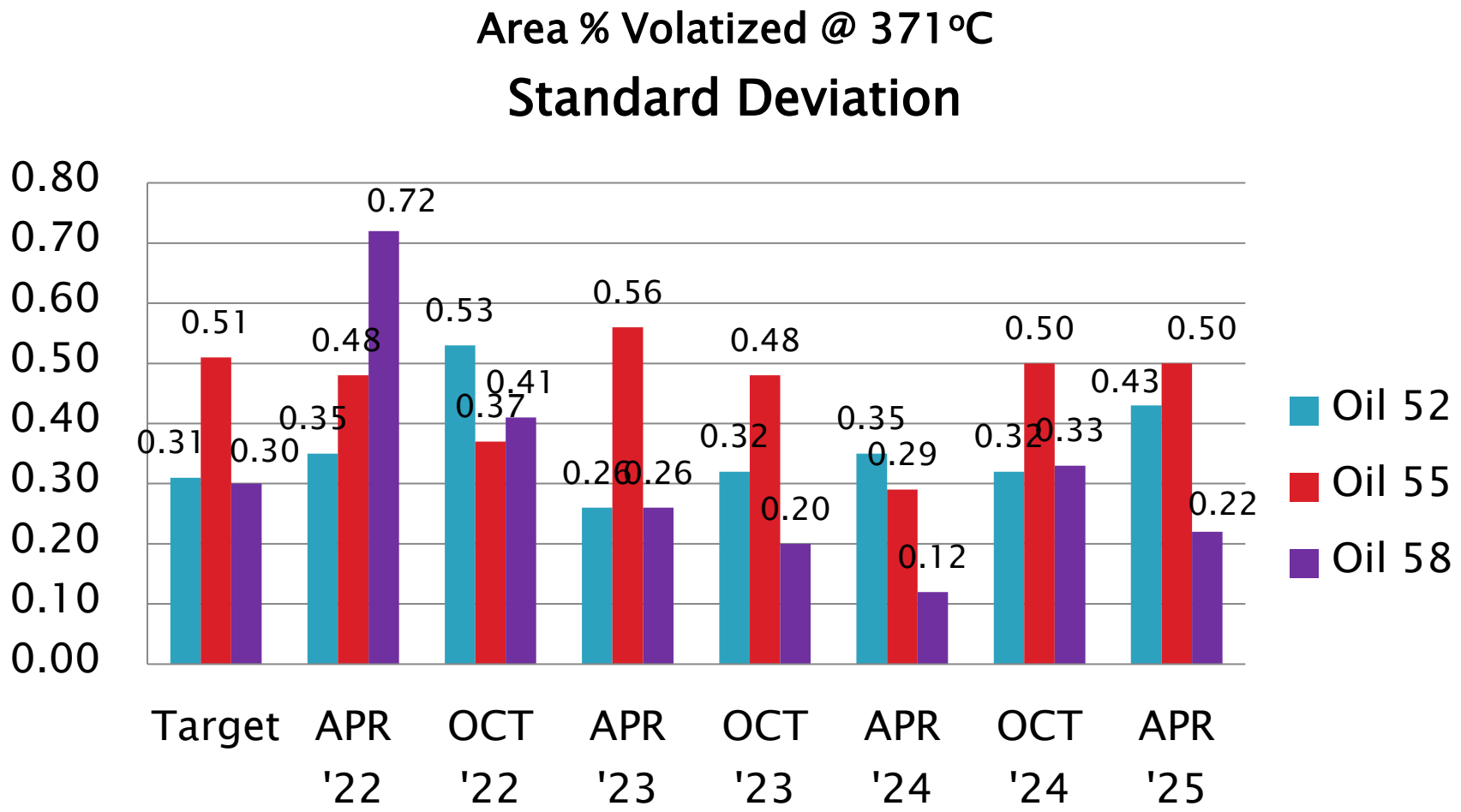
D6417 Performance by Oil



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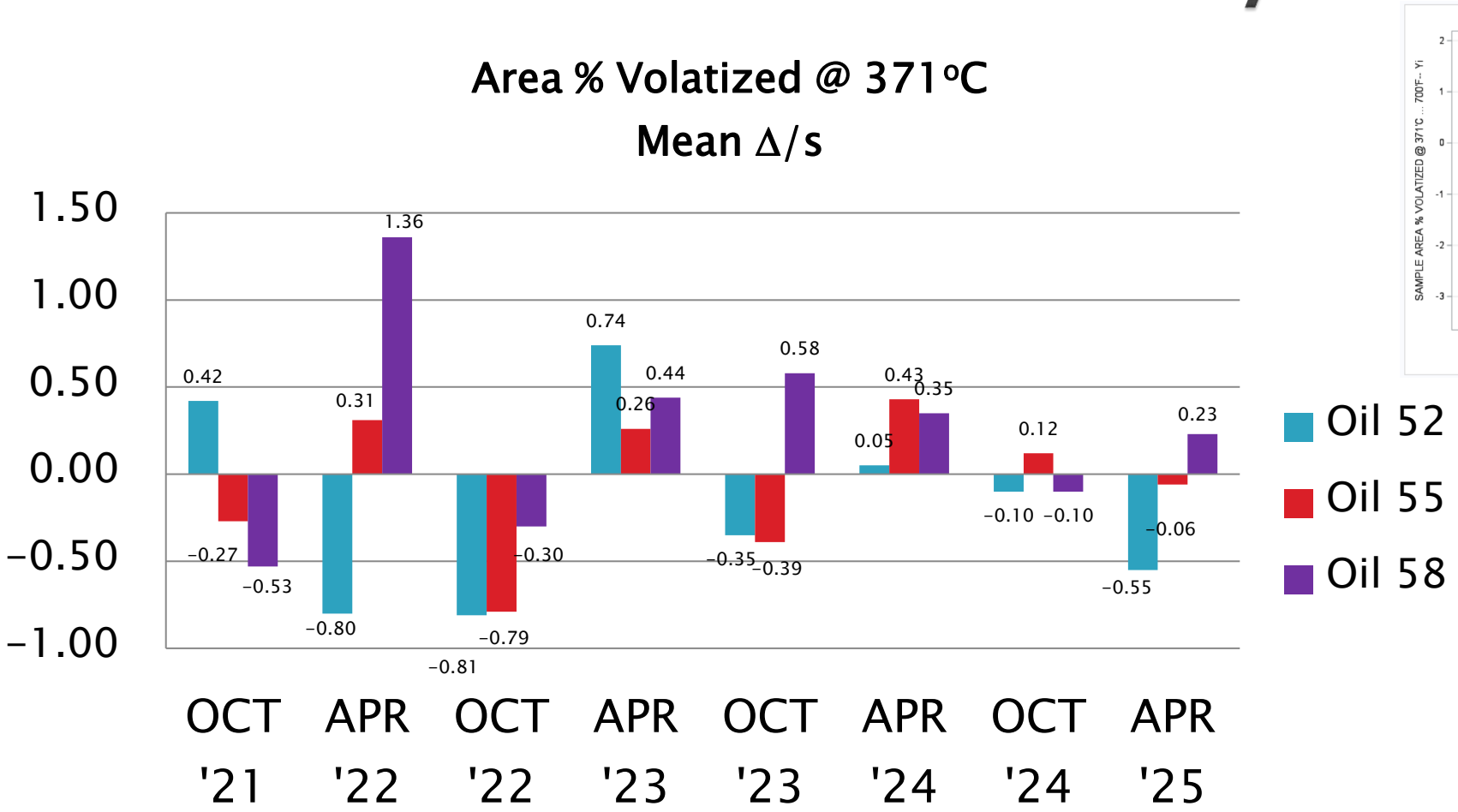
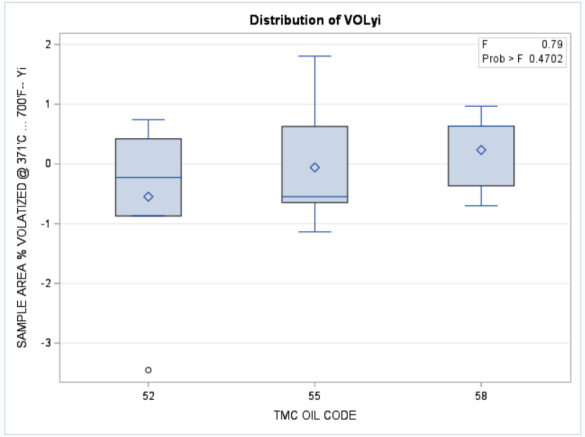
D6417 Performance by Oil





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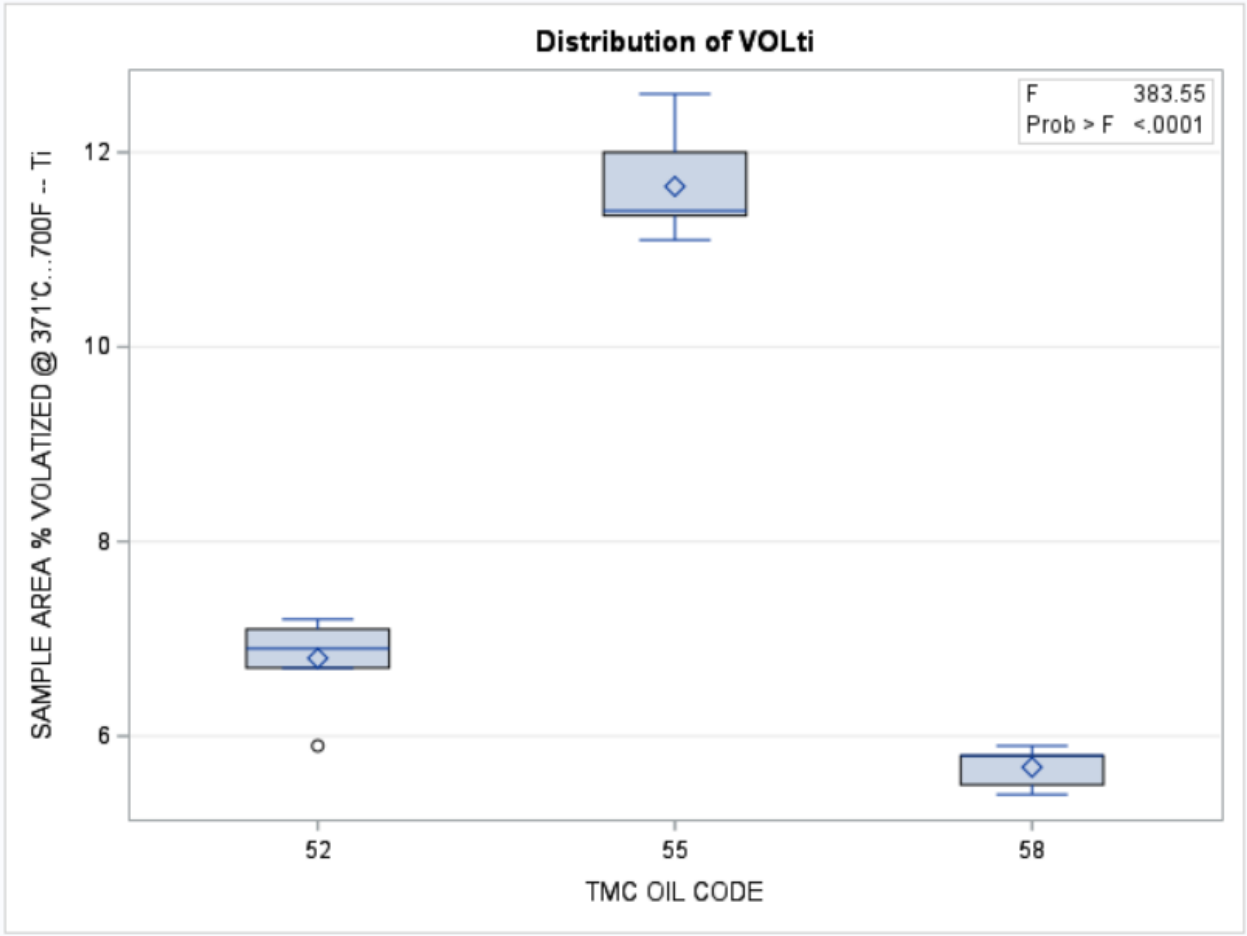
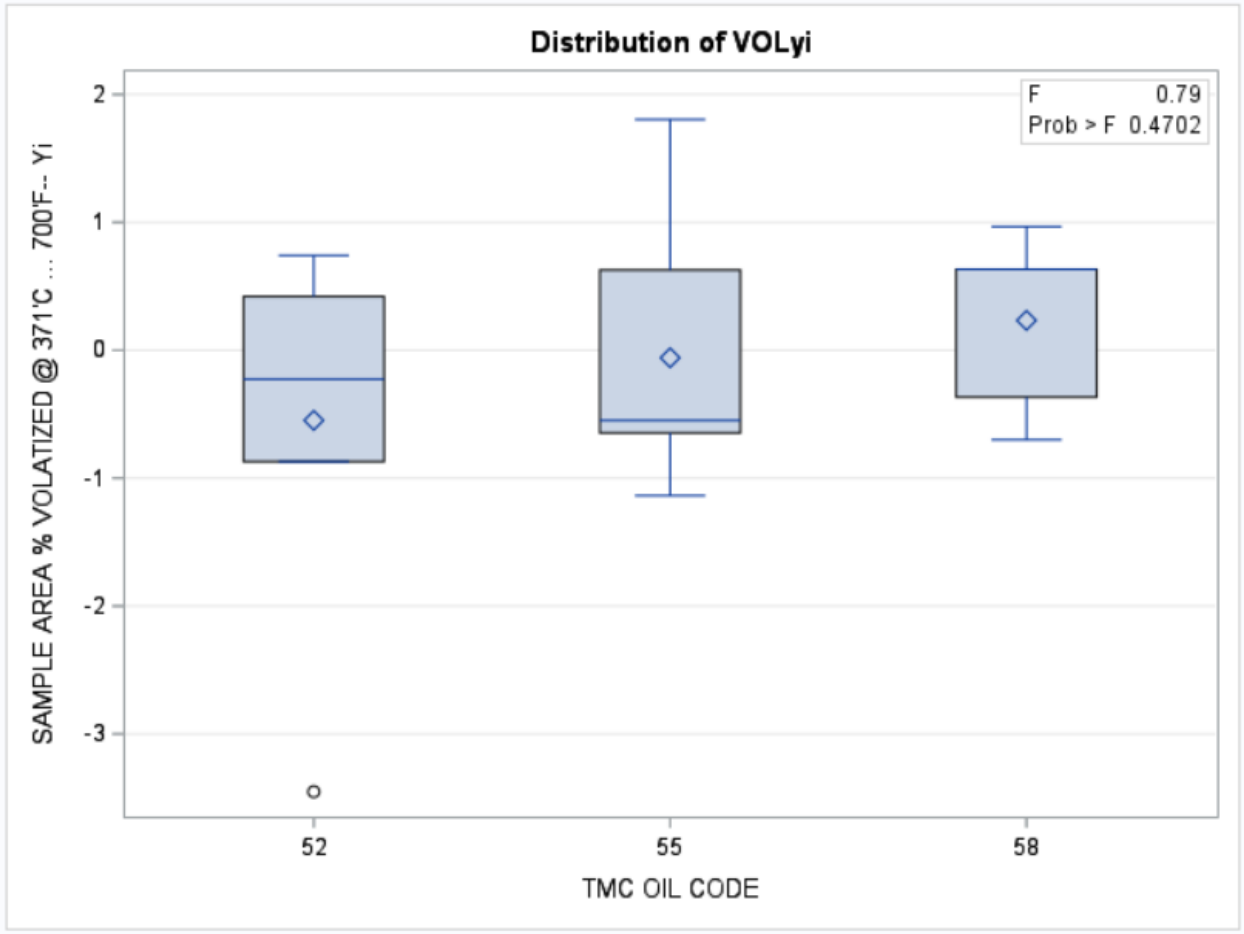
D6417 Performance by Oil





D6417: Estimation of Engine Oil Volatility by Capillary GC Status

- Precision (Pooled s) continues to be remarkably consistent and on target (again) this past semester.
- Performance (Mean Δ/s) moved slightly mild this semester but is still near target.
- CUSUM severity continuing to be relatively flat this semester

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Reference Oil Inventory

D6417

Oil	Year Rec'd By TMC[A]	Tests	TMC Inventory, gallons	Gallons Shipped last 6 months	Estimated Life
52[B]	1995	D6417	59.38	<0.01	5+ years
55	1995	D6417	65.89	<0.01	5+ years
58	1998	D6417, D6417QC	111.5	<0.01	5+ years

[A] Integrity of TMC reference oils is confirmed annually by analytical QC testing of chemical and physical properties.
[B] Reference Oil 58 is used in multiple Bench Test Areas.

D02.B0.07
TMC Monitored Tests

ASTM D 6557

Ball Rust Test (BRT)

October 1, 2024 – March 31, 2025

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Calibrated Labs and Stands*

(change since last Semi-Annual report)

Test	Labs	Stands
D6557	5 (+0)	5 (+0)
*As of 3/31/2025		

BRT Test Activity*

Test Status	Validity Code	Number of Tests
Acceptable Calibration Test	AC	155
Failed Calibration Test	OC	2
Operationally Invalid	LC, RC, LS, RS	4
Aborted Run	XC, XS	2
Shakedown Run (Result Within Acceptance Band)	NN	7
Shakedown Run (Result Outside Acceptance Band)	MN	0
Total		**170**

- 5 labs reported data

BRT Failed Tests

Failed Parameter (OC)	Number of Tests
Severe (low) Average Gray Value	1
Mild (high) Average Gray Value	1
Total	**2**

RO 82-1	One Mild Tests
RO 86	
RO 87	
RO 1006	One Severe Tests

BRT Failed Tests (OC) by Lab

Failed Parameter	LTMS Lab					#
	A	B	D	G	L	
Severe Average Gray Value	1	0	0	0	0	1
Mild Average Gray Value	0	0	0	1	0	1
Total	1	0	0	1	0	2

BRT Lost Tests*

Failed Parameter (LC, RC, XC)	Number of Tests
Acid Solution Issue (LC)	2
Power Outage (LC)	1
AGV Analysis Issue (LC)	1
Aborted due to Acid Pump Failure (XC)	1
Aborted due to Incorrect Acid Delivery Time (XC)	1
Total	**6**

*Invalid (LC, RC) and Aborted (XC) calibration tests

BRT Lost Tests by Lab

Cause	LTMS Lab					#
	A	B	D	G	L	
Acid Solution Problem	0	0	0	2	0	2
Power Outage	0	0	0	1	0	1
AGV Analysis Error	0	0	0	1	0	1
Acid Pump Failure	0	0	1	0	0	1
Incorrect Acid Delivery Time	0	0	0	1	0	1
Total	**0**	**0**	**1**	**5**	**0**	**6**

BRT (D6557) Rust Protection Test

Period Precision and Severity Estimates

Average Gray Value	n	df	Pooled s	Mean Δ/s
4/1/21 through 9/30/21	191	188	11.27	-0.20
10/1/21 through 3/31/22	141	138	16.28	0.12
4/1/22 through 9/30/22	154	151	21.10	-0.29
10/1/22 through 3/31/23	165	162	15.56	-0.17
4/1/23 through 9/30/23	171	168	17.56	0.34
10/1/23 through 3/31/24	183	179	13.75	0.32
4/1/24 through 9/30/24	166	162	14.41	-0.07
10/1/24 through 3/31/25	170	168	7.90	-0.61

*Period statistics for all Valid Reference Oil Results (pooled)

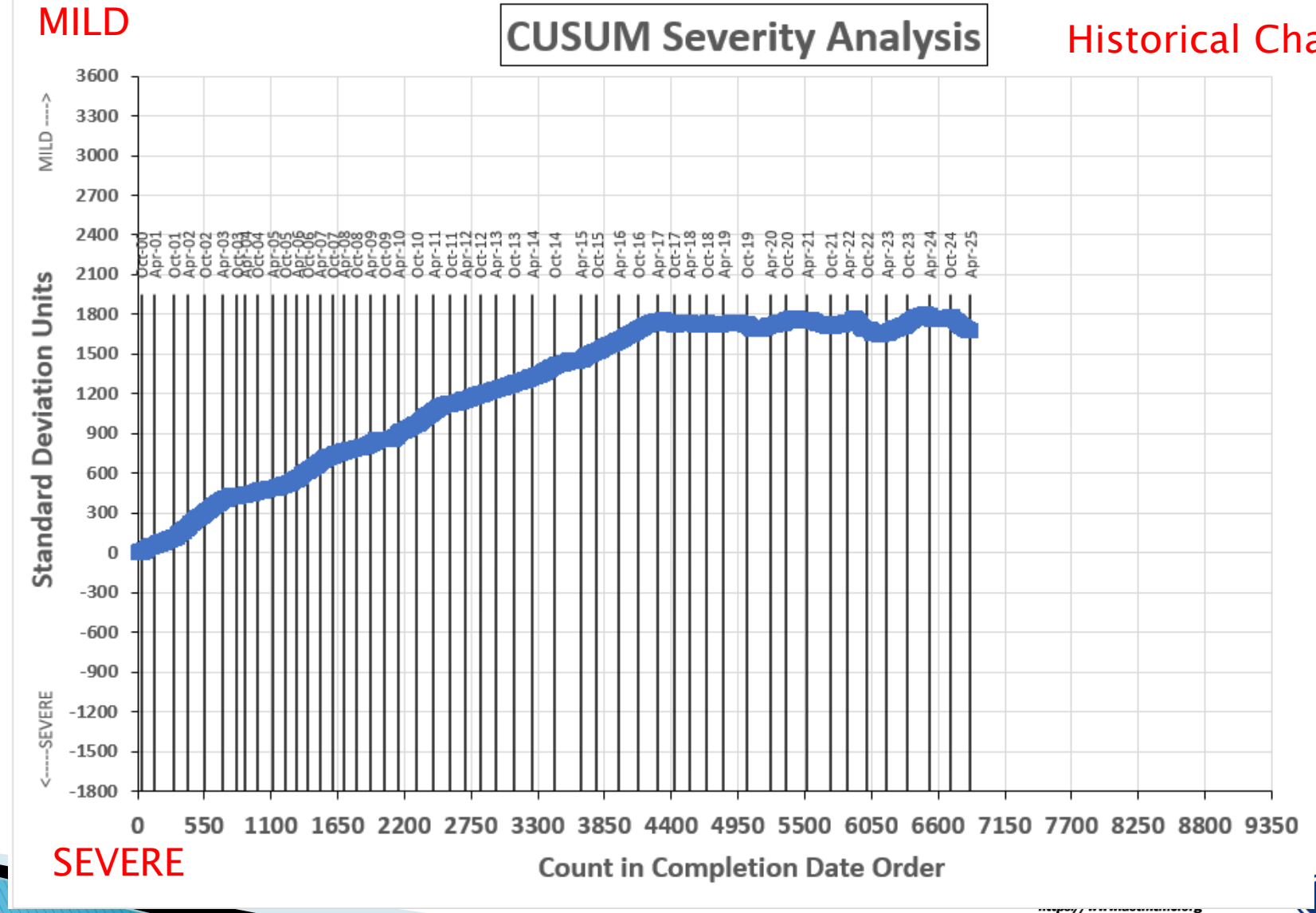
D6557: Ball Rust Test Status

- With the suspension of Reference Oils 86 and 87 due to severe test results, most data was generated on Reference Oil 1006 (High Reference Oil) and Reference Oil 82-1 (Low Reference Oil). However, Reference Oil 82-1 also started to show a severe trend at the end of previous semester (as well as being almost depleted from TMC Inventory), and therefore it too was removed from assignment rotation leaving only Reference Oil 1006 available for assignments for most of the October 2024 to March 2025 semester.
- Ball Bearing Batch E was round-robin tested in RO's 1006 and 82-1 to determine if it could be a replacement for current Ball Bearing Batch D. Data supported the replacement and Batch E Ball Bearings are now available for use in the BRT with no change from the current Acceptance Bands for Reference Oils 1006 and 82-1. A follow-up Round Robin with RO's 86 and 87 with Ball Bearing Batch E is currently underway.

BALL RUST TEST INDUSTRY OPERATIONALLY VALID DATA

REFERENCE AVERAGE GRAY VALUE

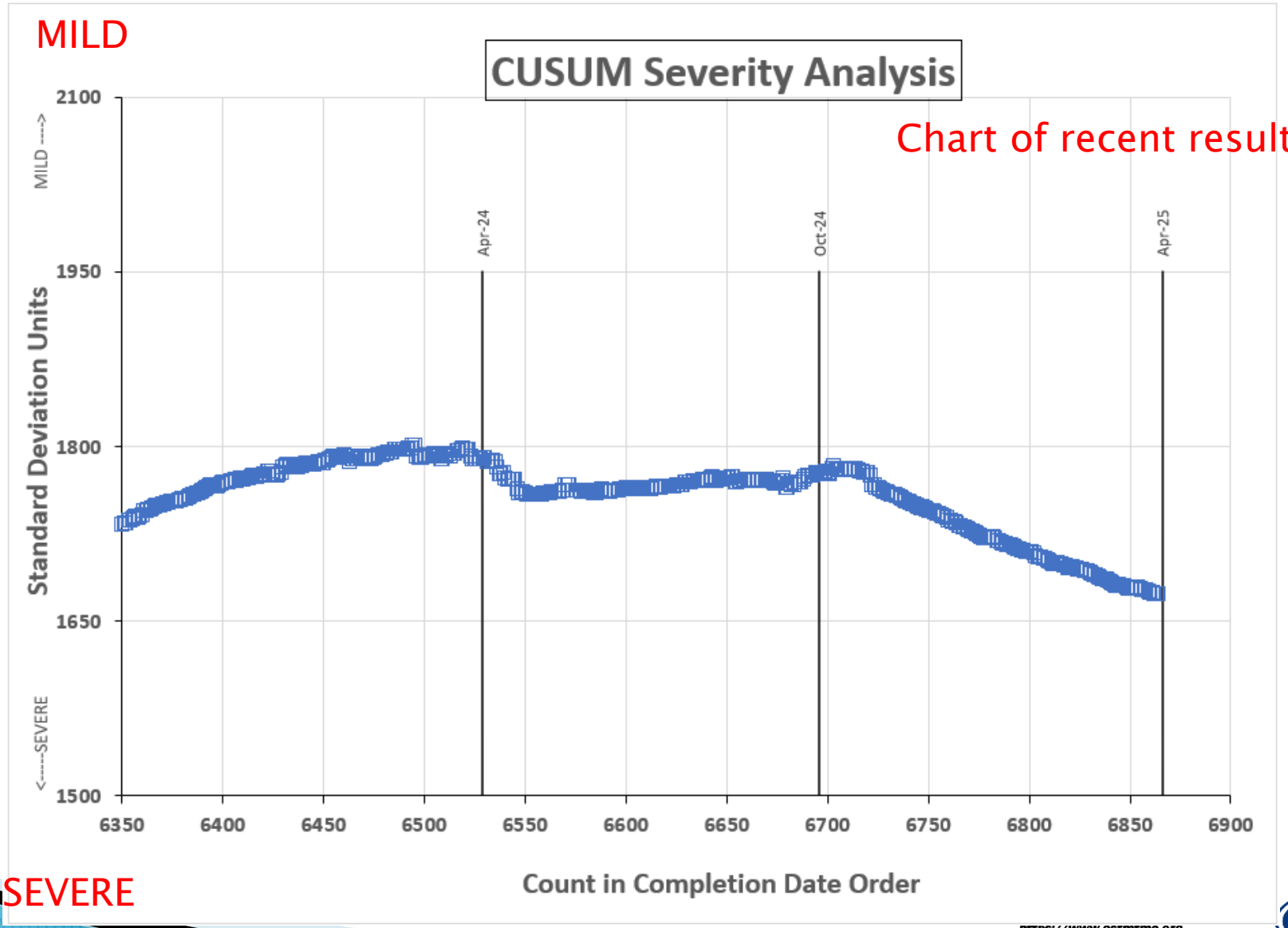
MILD



SEVERE

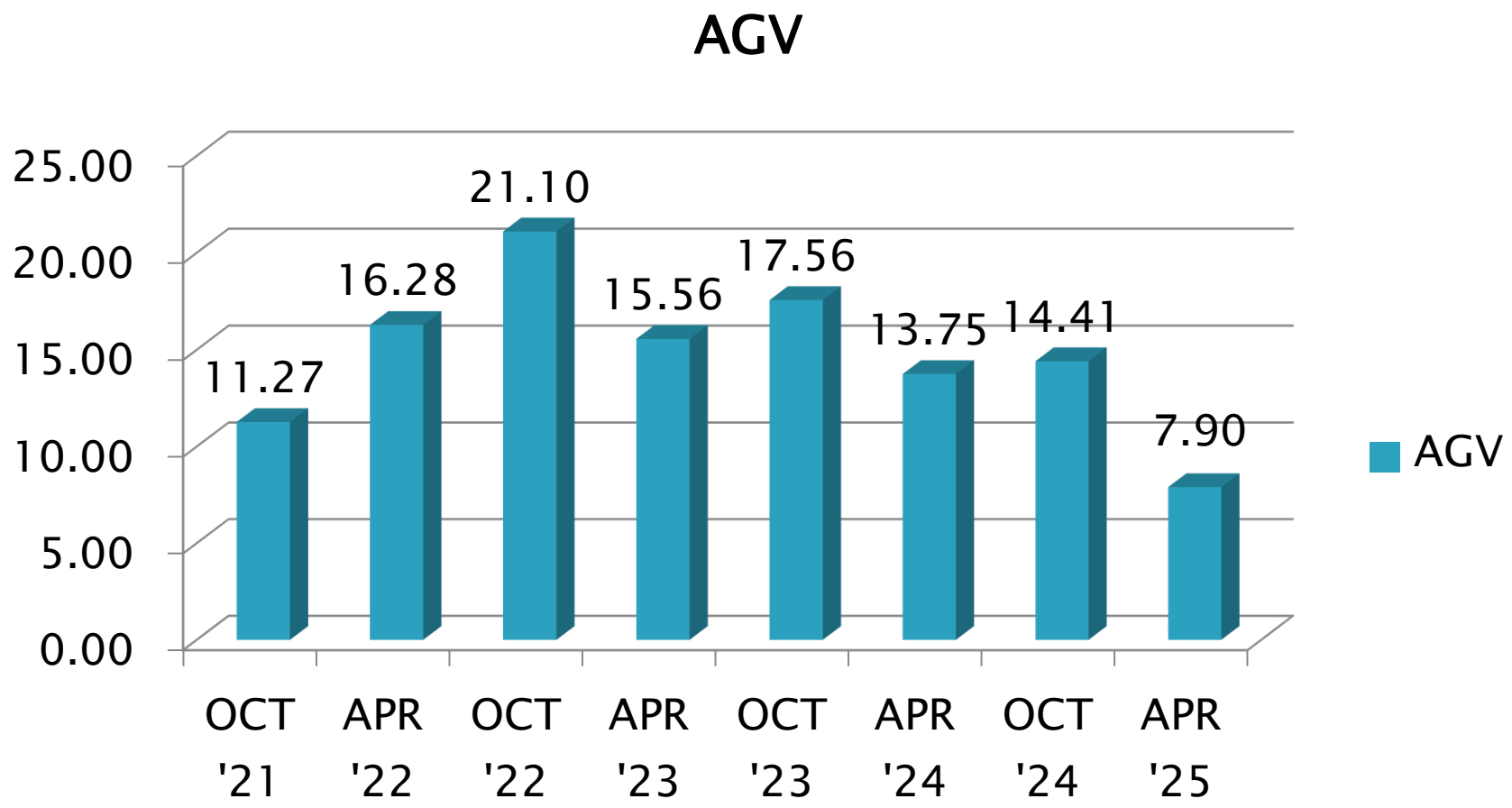
BALL RUST TEST INDUSTRY OPERATIONALLY VALID DATA
Last 500 Points
REFERENCE AVERAGE GRAY VALUE

MILD



SEVERE

BRT Precision (Pooled s) Estimates



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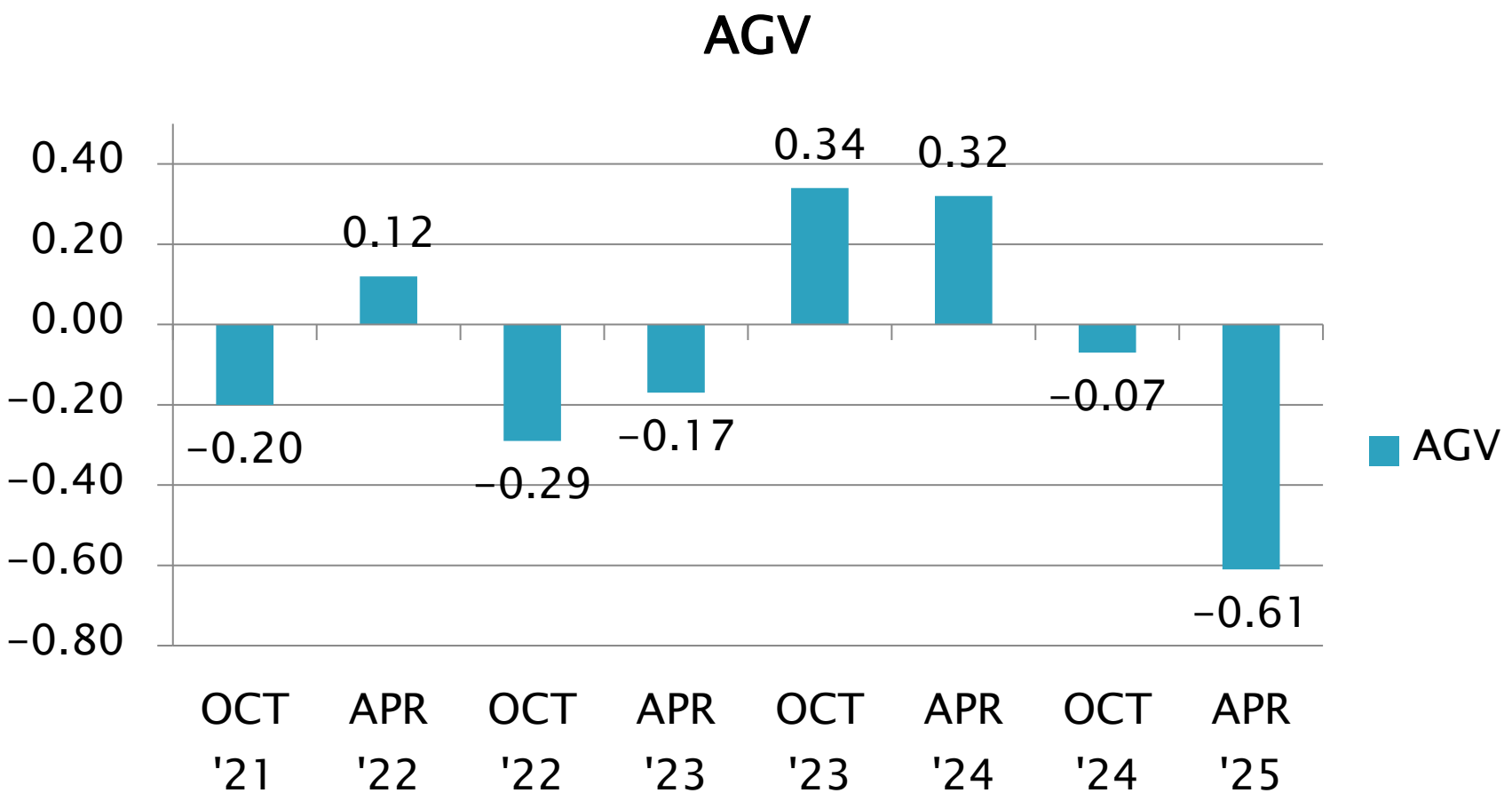
BRT Performance (Mean Δ/s) Estimates



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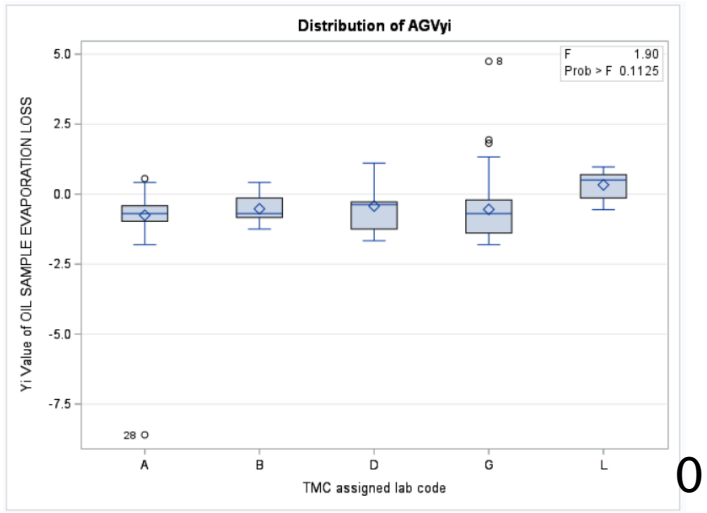
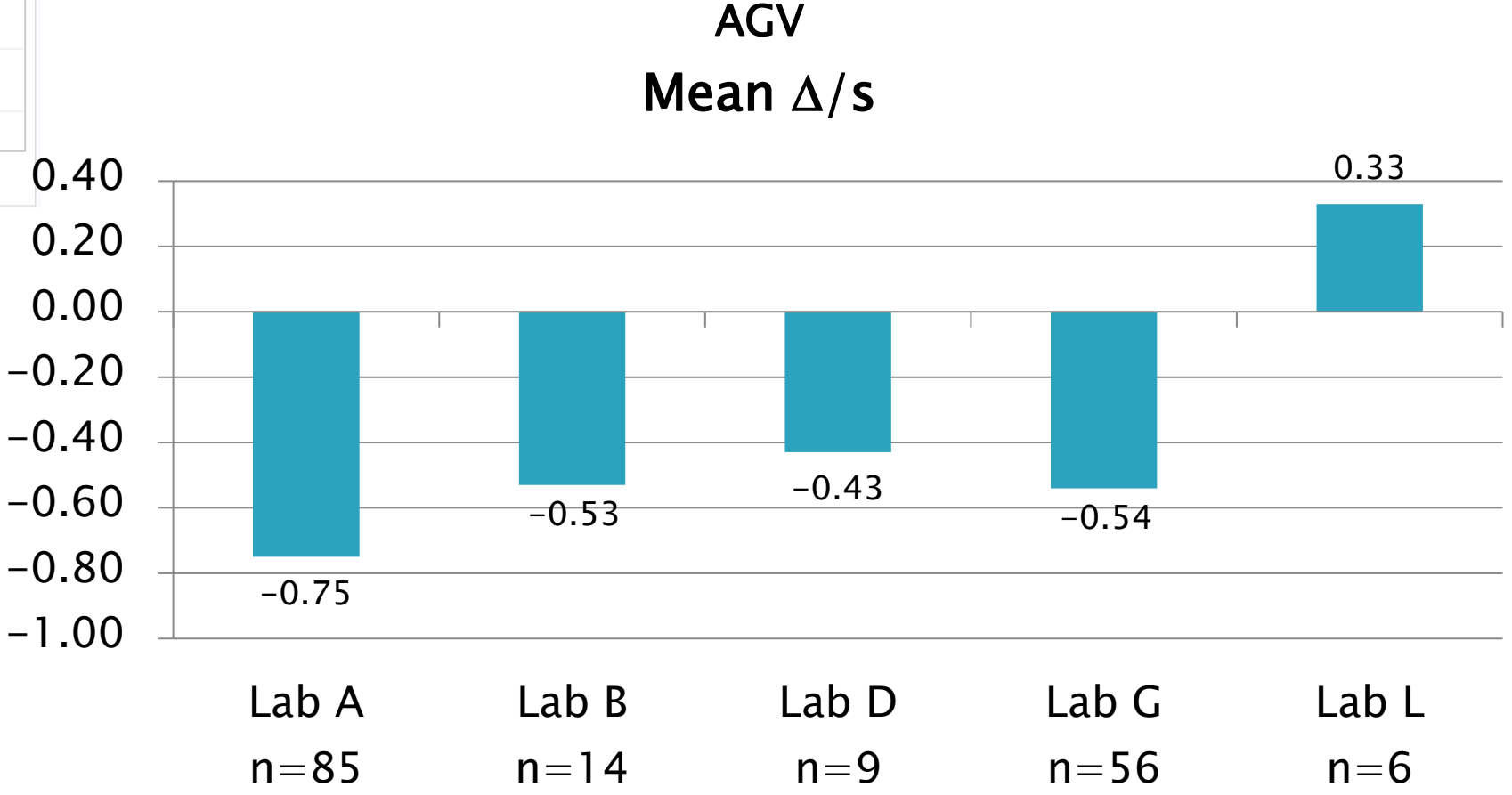
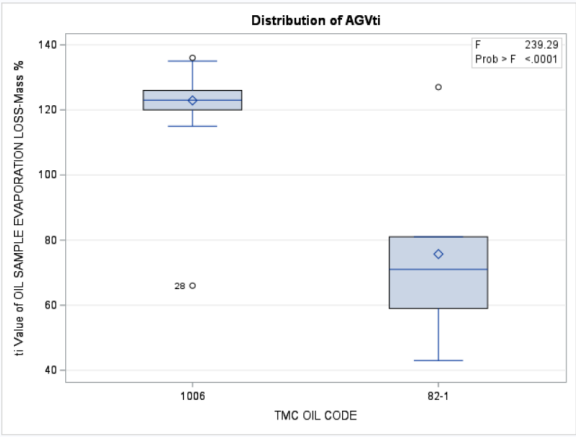


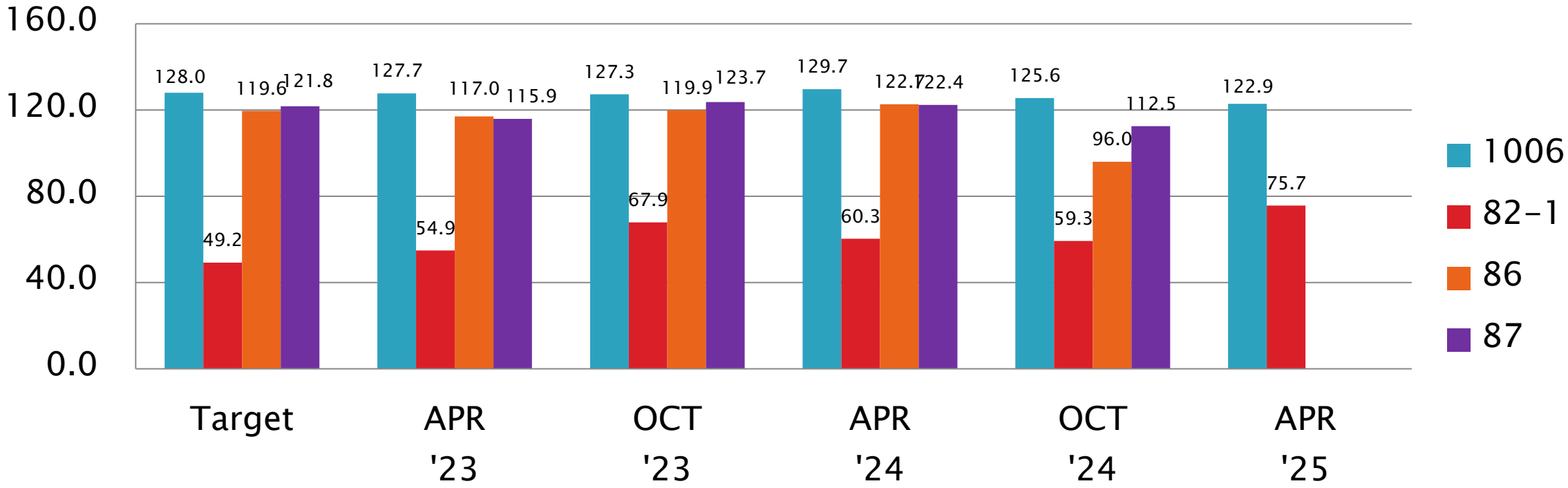
BRT Lab Severity Estimates



BRT Performance by OIL



Average Gray Value
Mean



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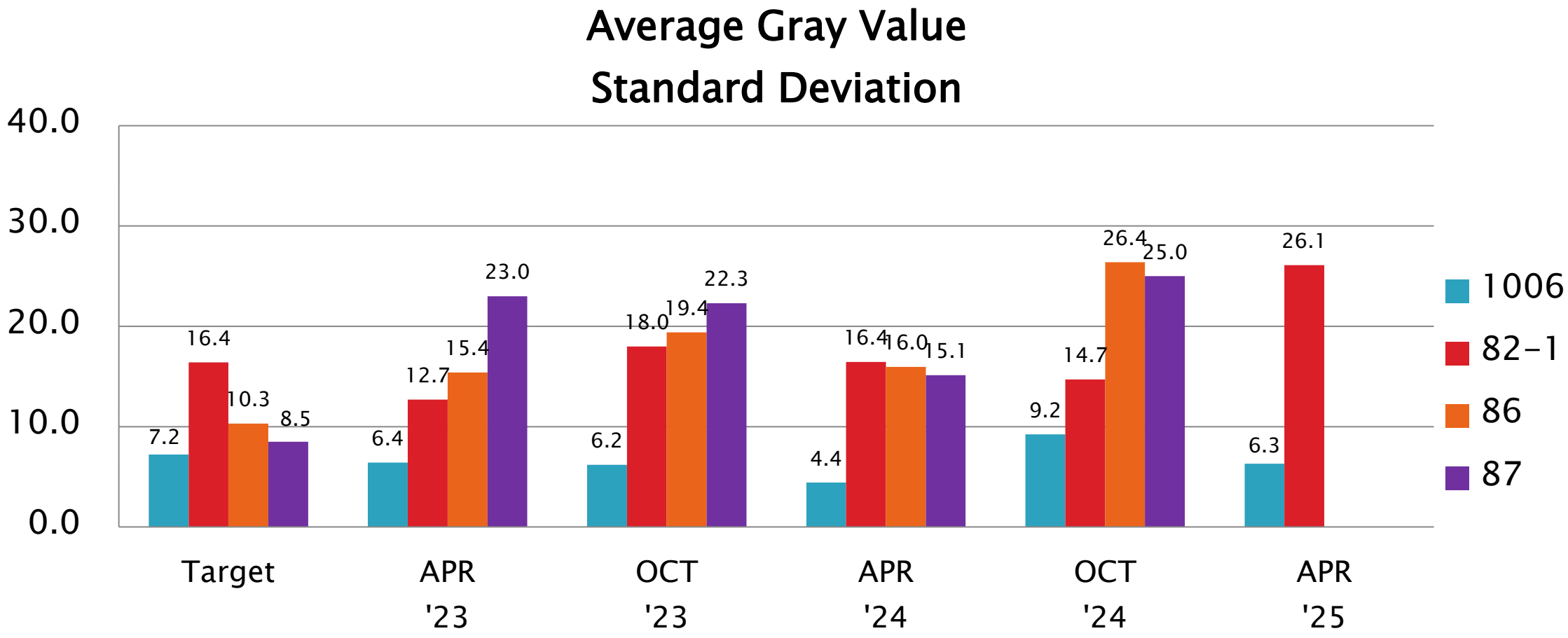
BRT Performance by OIL



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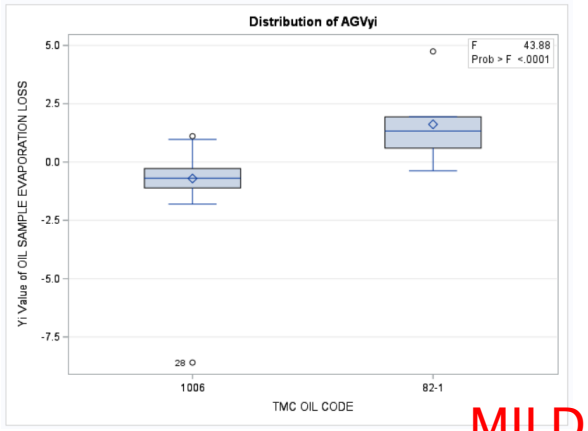
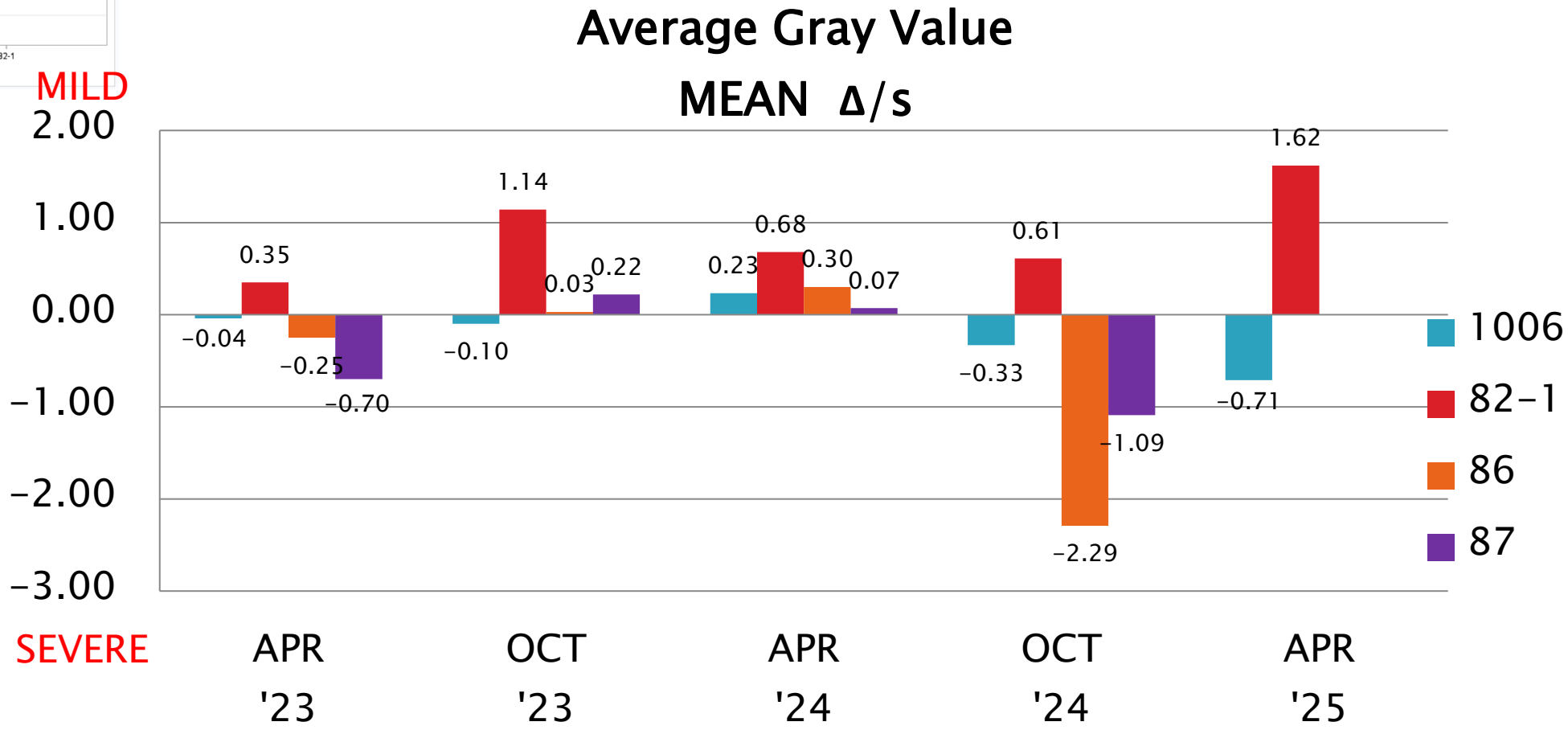


BRT Performance by OIL



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Information Letters & Memos*

Test	Date	IL / Memo	Topic
BRT	20240503	Mem24-016	Suspension of assignments of Reference Oils 86 and 87
BRT	20240914	Mem24-025	TMC Investigation of Reference Oil 86 and 87 Performance

*Available from TMC Website

Reference Oil Inventory Estimated Life

Oil	TMC Inventory (gallons)	Quantity Shipped in last 6 months (gallons)	Total Assignments[1] made over Semester	Estimated Life
1006	26.35	1.31	179	5+ years
82-1	0.5	0.0	5	< 1 year
86	49.0	0.0	6	5+ years
87	92.9	0.0	6	5+ years

[1]- Includes Informational (i.e. "Shakedown") run assignments

D02.B0.07
TMC Monitored Tests

ASTM D 6594

High Temperature Corrosion Bench Test (HTCBT)

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Calibrated Labs and Stands*

(change since last Semi-Annual report in parentheses)

Test	Labs	Stands
D6594	7 (-3)	24 (-2)
*As of 3/31/2025		

HTCBT Test Activity*

Test Status	Validity Code	Number of Tests
Acceptable Calibration Test	AC	231
Failed Calibration Test	OC	19[1]
Operationally Invalid, by lab	LC	3
Informational Test Aborted	XN	2
Information Run in Range	NN	5
Information Run out of Range	MN	4
Total		**264**

7 labs reported data (3 LESS from previous semester)

[1] A DECREASE of 2 from previous semester

HTCBT Failed Tests

Failed Parameter (OC)	Number of Tests
Lead Concentration Severe	6
Lead Concentration Mild	5
Copper Concentration Severe	1
Copper Concentration Mild	4
Lead and Copper Concentrations (both) Severe	3
Total	**19**

NOTE: Of the 19 failing tests
8 (42.1%) were on runs with 1005-5 Reference Oil
11 (57.9%) were on runs with 44-5 Reference Oil

HTCBT Failed Tests by Lab

Failed Parameter (OC)	LTMS Lab										#
	A	L	G	I	V	BB	BC	B	P	BE	
Lead Concentration Severe	2	0	2	0	1			0	1		
Lead Concentration Mild	0	0	1	0	0			0	4		
Copper Concentration Severe	0	1	0	0	0			0	0		
Copper Concentration Mild	0	0	4	0	0			0	0		
Lead and Copper Concentrations (both) Severe	0	1	2	0	0			0	0		
Totals	**2**	**2**	**9**	**0**	**1**			**0**	**5**		**19**

HTCBT Lost Tests*

Status (LC, XC, LN, XN)	Cause	#
Aborted (XN)	Informational run aborted due to Air Flow Problems	2
Total		**2**

*Invalid or Aborted calibration tests

HTCBT Lost Tests by Lab

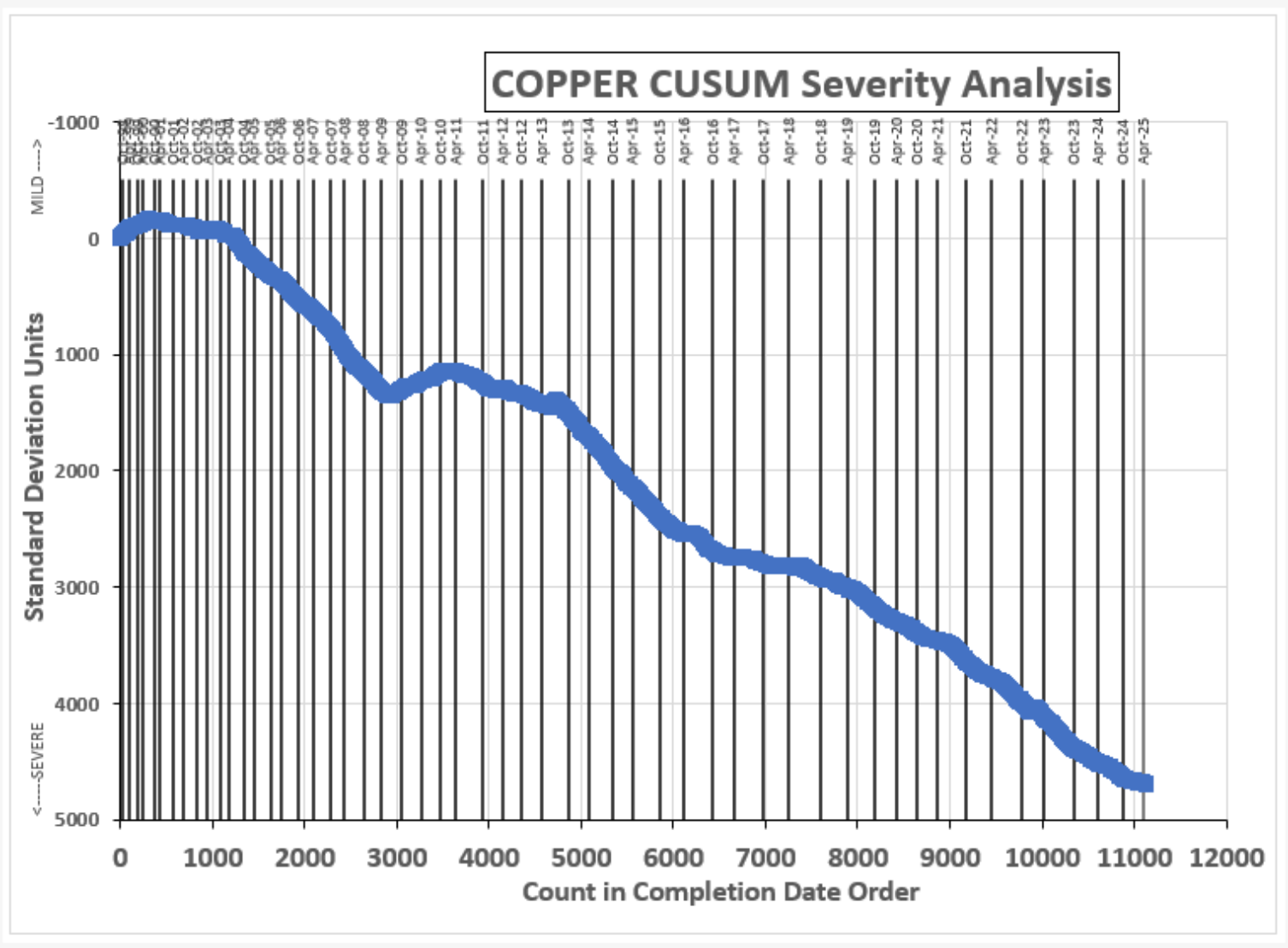
Failed Parameter (LC, XC)	LTMS Lab										#
	A	L	G	I	V	BB	BC	B	P	BE	
Informational Run Air Flow Issue	2	0	0	0	1	0	0	0	0	0	2
Total	2	0	0	0	0	0	0	0	0	0	2

HTCBT Test Status

- Most labs now using Batch P coupons although a few labs continue to test with Batch O coupons.
- Few TESTKEYs of Reference Oil 44-4 remaining at labs. Most labs now using Reference Oil 44-5.
- Three labs did not calibrate this semester, but one lab added a new stand this semester

HIGH TEMP CBT INDUSTRY OPERATIONALLY VALID DATA

COPPER CHANGE (ppm)



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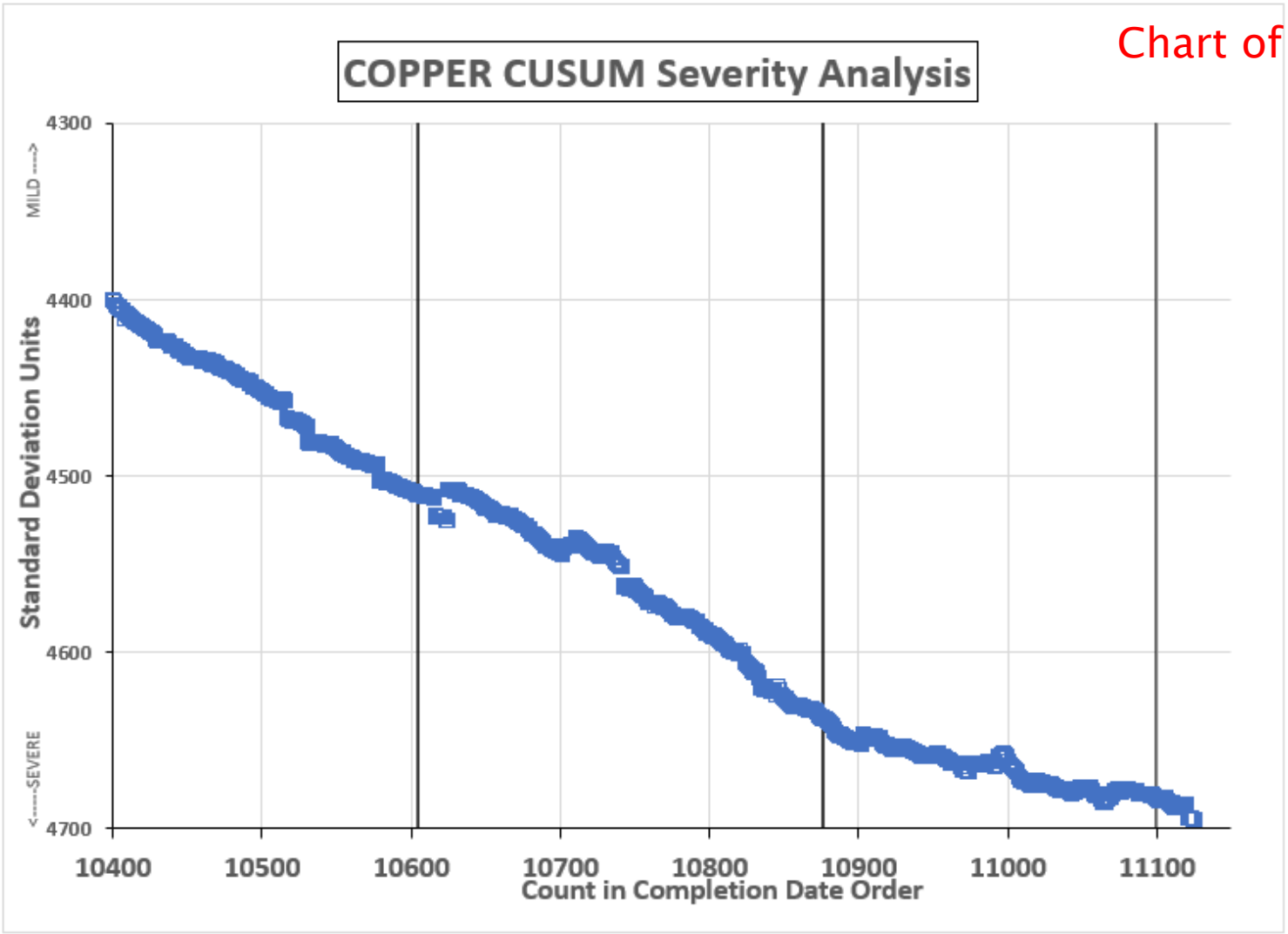
HIGH TEMP CBT INDUSTRY OPERATIONALLY VALID DATA
LAST 600 DATA POINTS
COPPER CHANGE (ppm)

Chart of recent results



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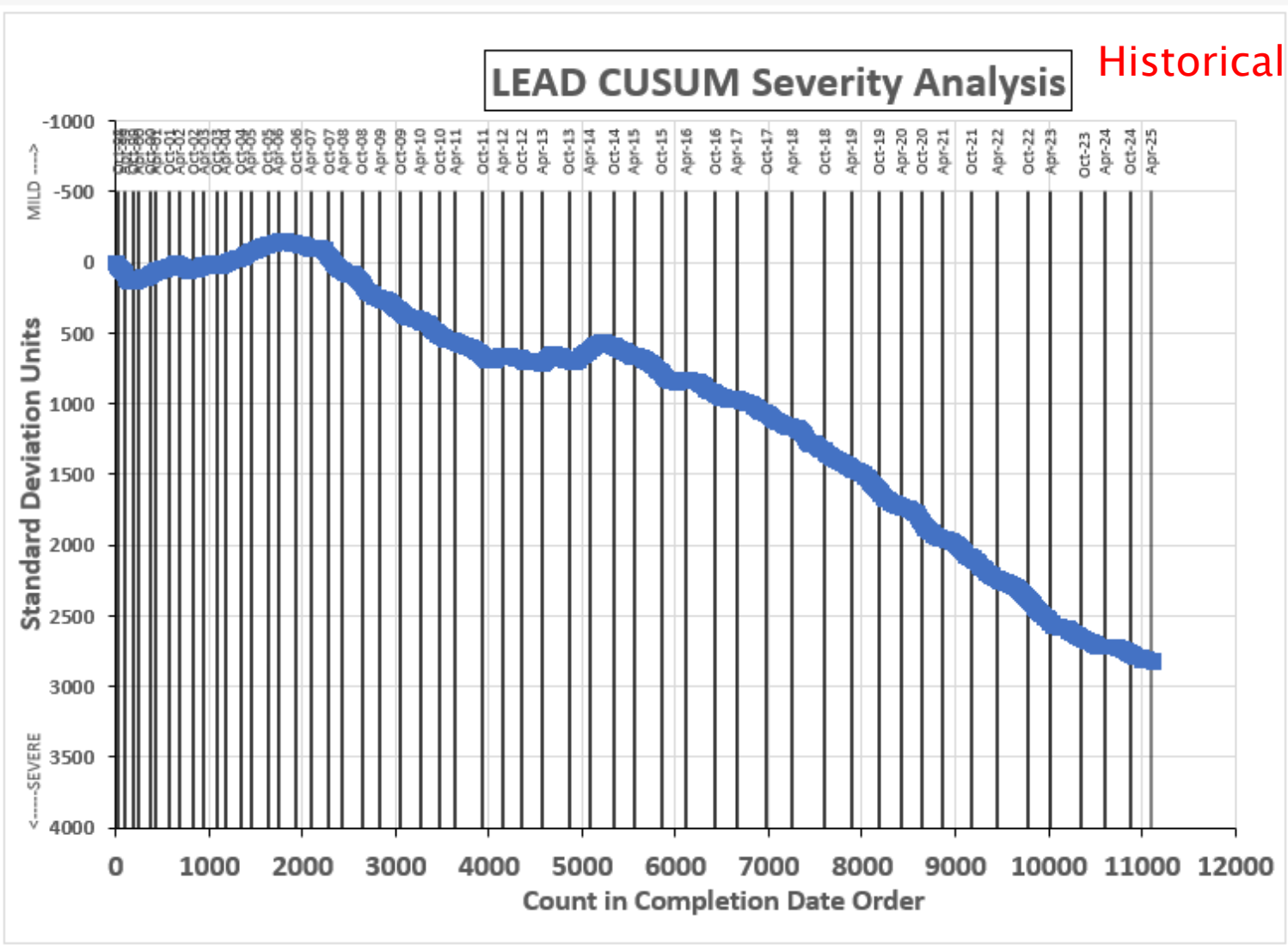
HIGH TEMP CBT INDUSTRY OPERATIONALLY VALID DATA

LEAD CHANGE (ppm)



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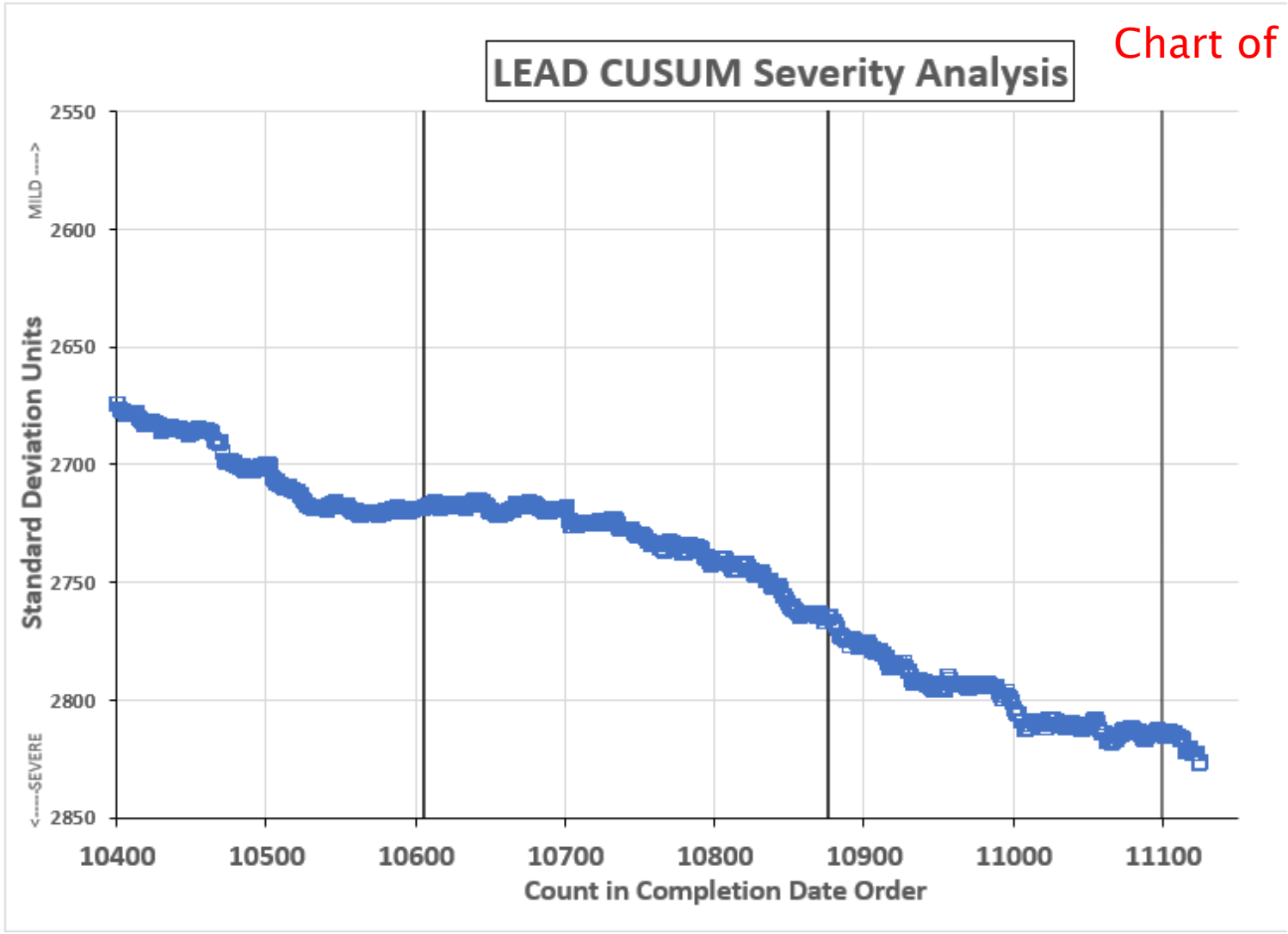
HIGH TEMP CBT INDUSTRY OPERATIONALLY VALID DATA
LAST 600 DATA POINTS
LEAD CHANGE (ppm)

Chart of recent results



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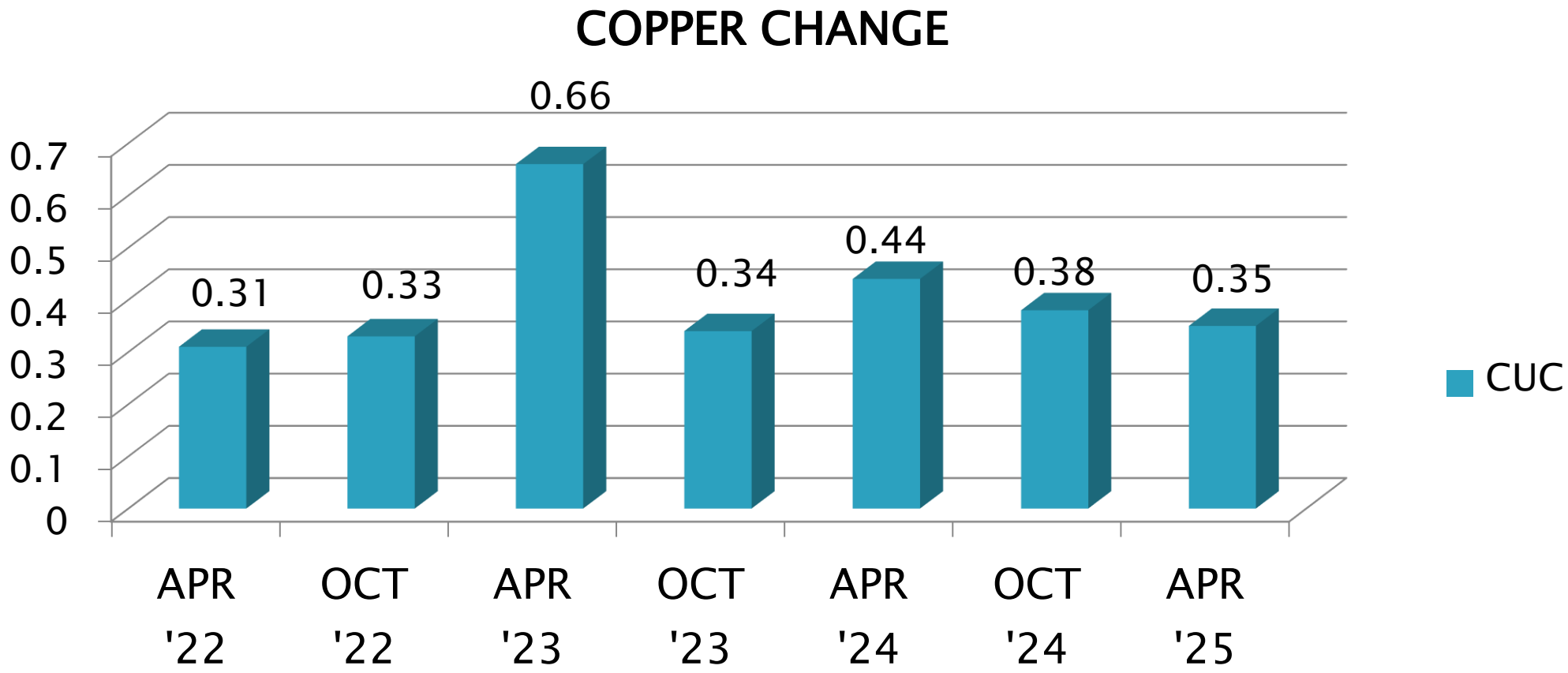
HTCBT (D6594): High Temperature Corrosion Bench Test

Period Precision and Severity Estimates: Copper Change

Date Range	n	df	Pooled s	Mean Δ/s
10/1/21 through 3/31/22	305	302	0.31	0.53
4/1/22 through 9/30/22	306	303	0.33	0.63
10/1/22 through 3/31/23	263	260	0.66	0.57
4/1/23 through 9/30/23	296	293	0.34	0.87
10/1/23 through 3/31/24	287	284	0.44	0.39
4/1/24 through 9/30/24	244	241	0.38	0.53
10/1/24 through 3/31/25	250	248	0.35	0.23

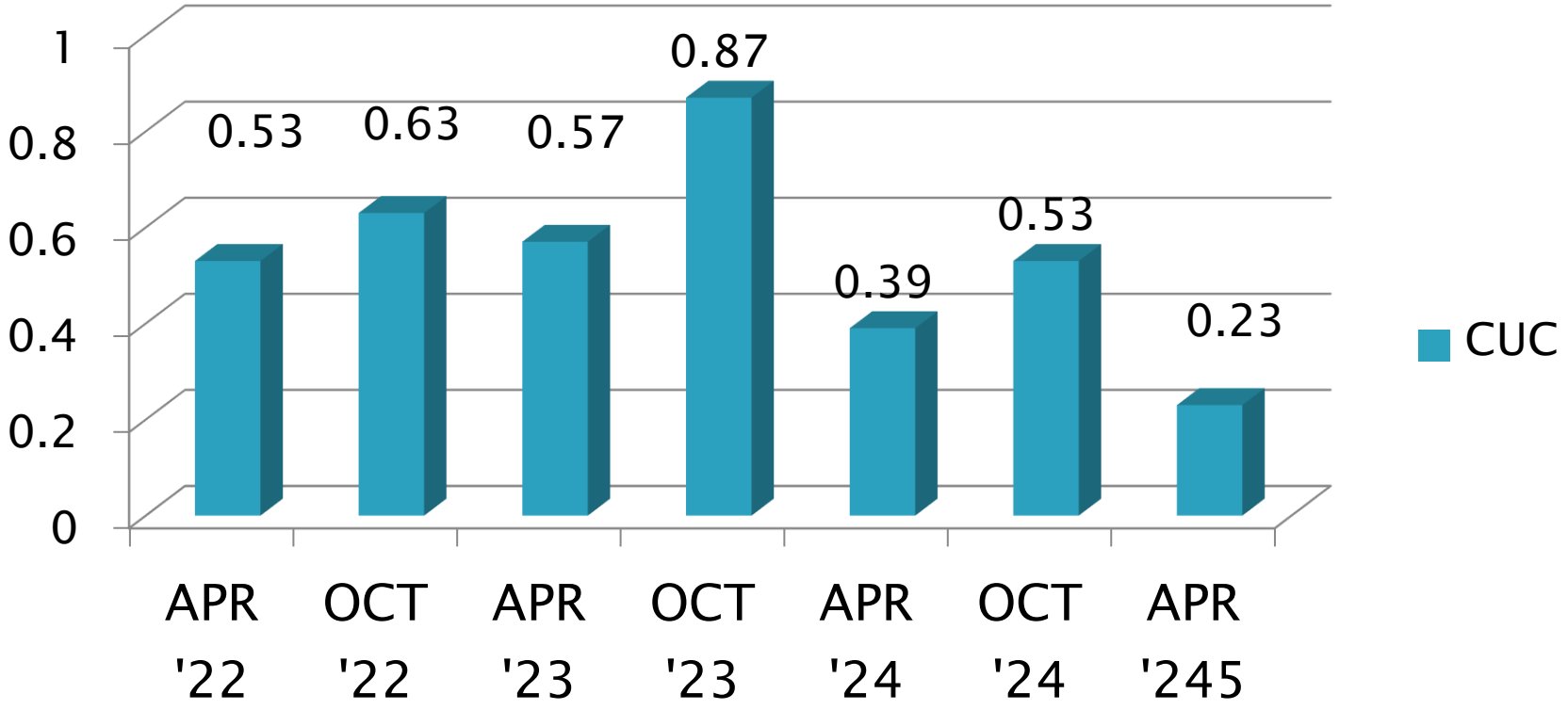
*Period statistics for all Valid Reference Oil Results (pooled)

HTCBT Precision (Pooled s) Estimates



HTCBT Performance (mean Δ/s) Estimates

COPPER CHANGE



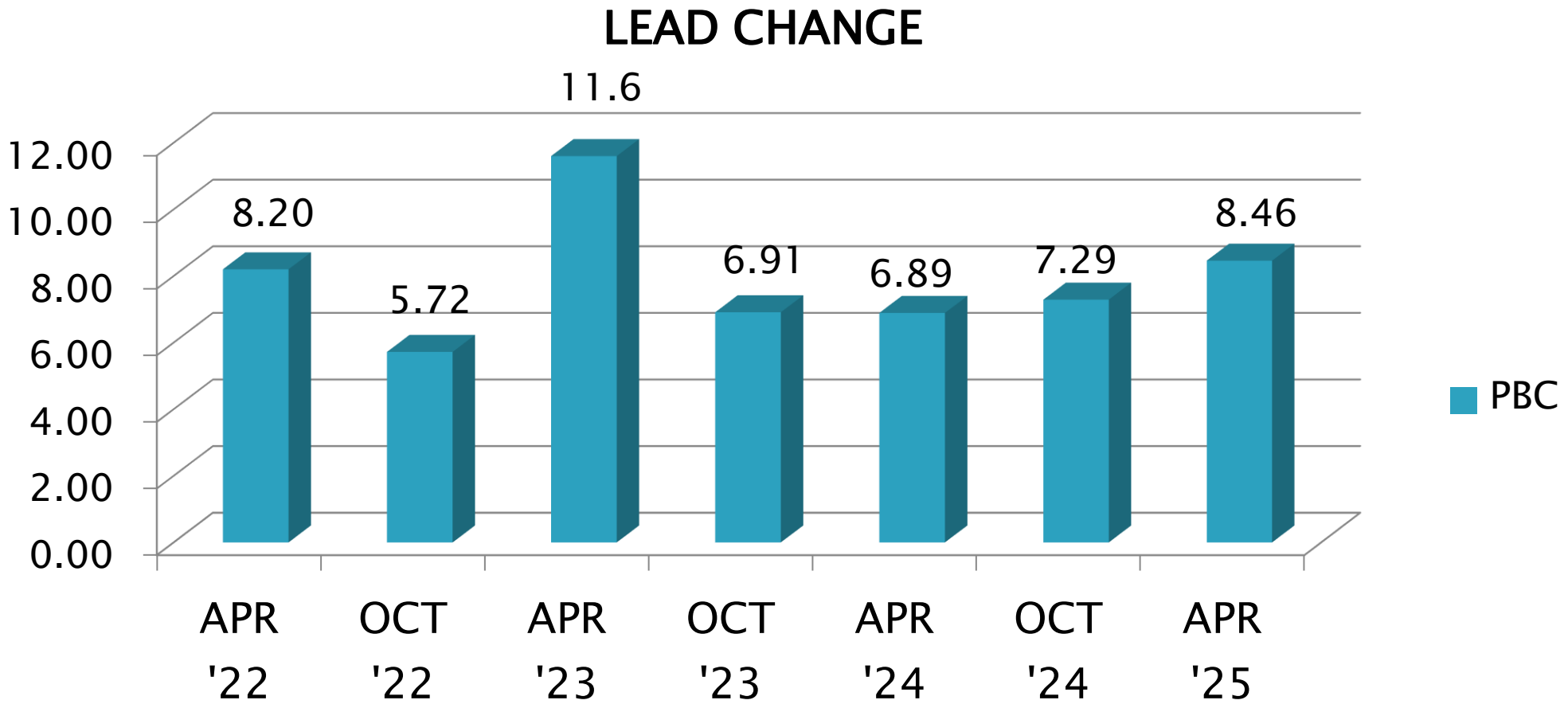
HTCBT (D6594): High Temperature Corrosion Bench Test

Period Precision and Severity Estimates: Lead Change

Average Gray Value	n	df	Pooled s	Mean Δ/s
10/1/21 through 3/31/22	305	302	8.20	0.55
4/1/22 through 9/30/22	306	303	5.72	0.43
10/1/22 through 3/31/23	263	260	11.6	0.69
4/1/23 through 9/30/23	296	293	6.91	0.31
10/1/23 through 3/31/24	287	284	6.89	0.20
4/1/24 through 9/30/24	244	241	7.29	0.20
10/1/24 through 3/31/25	250	248	8.46	0.24

*Period statistics for all Valid Reference Oil Results (pooled)

HTCBT Precision (Pooled s) Estimates



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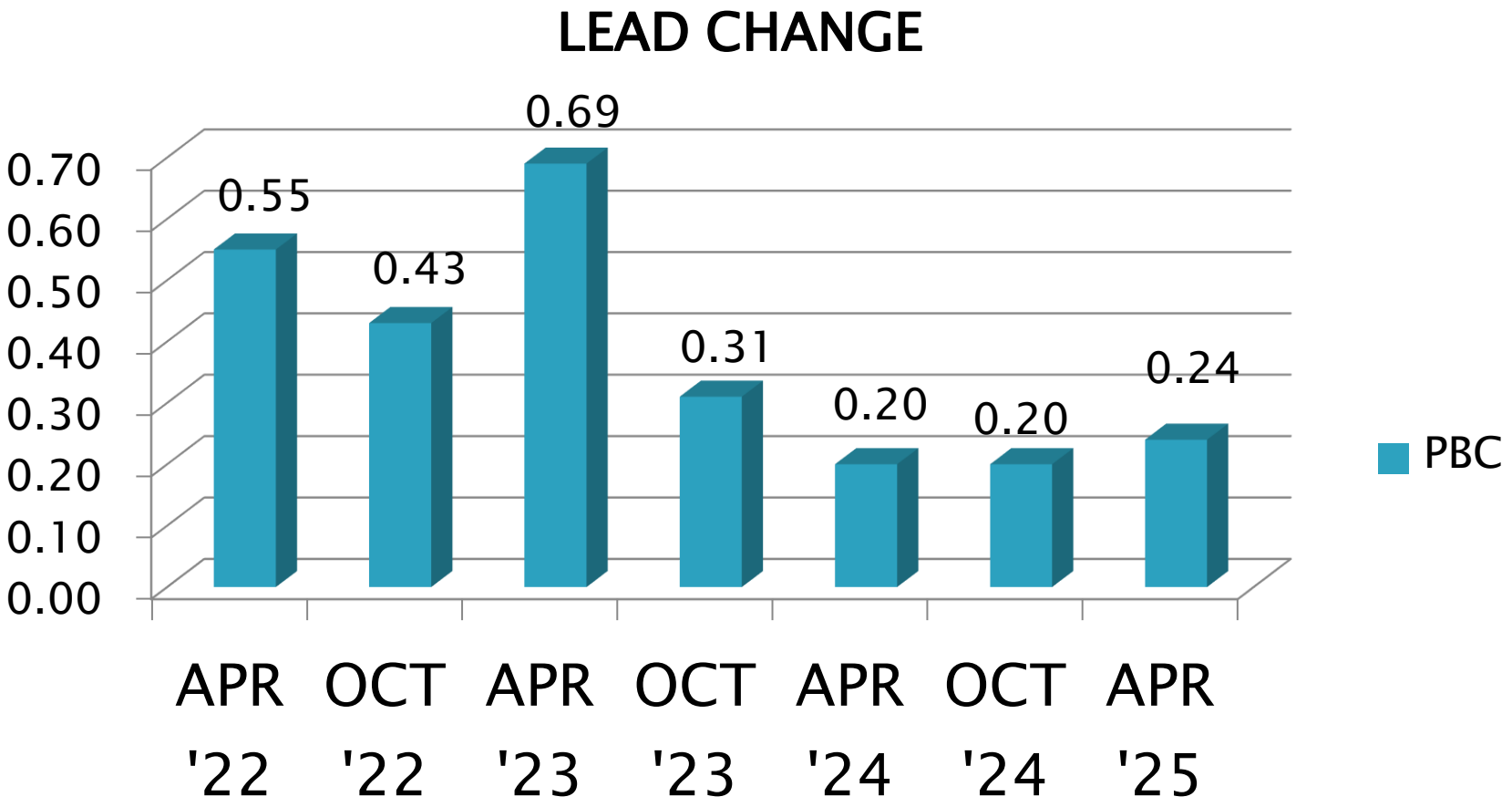
HTCBT Performance (mean Δ/s) Estimates



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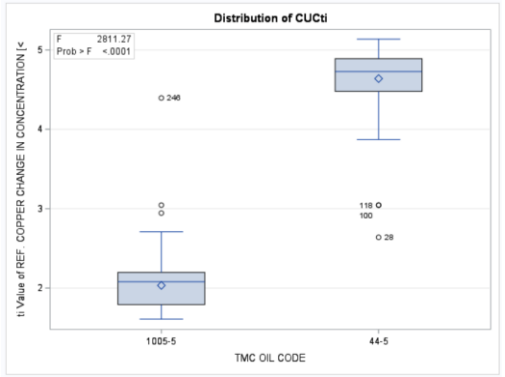
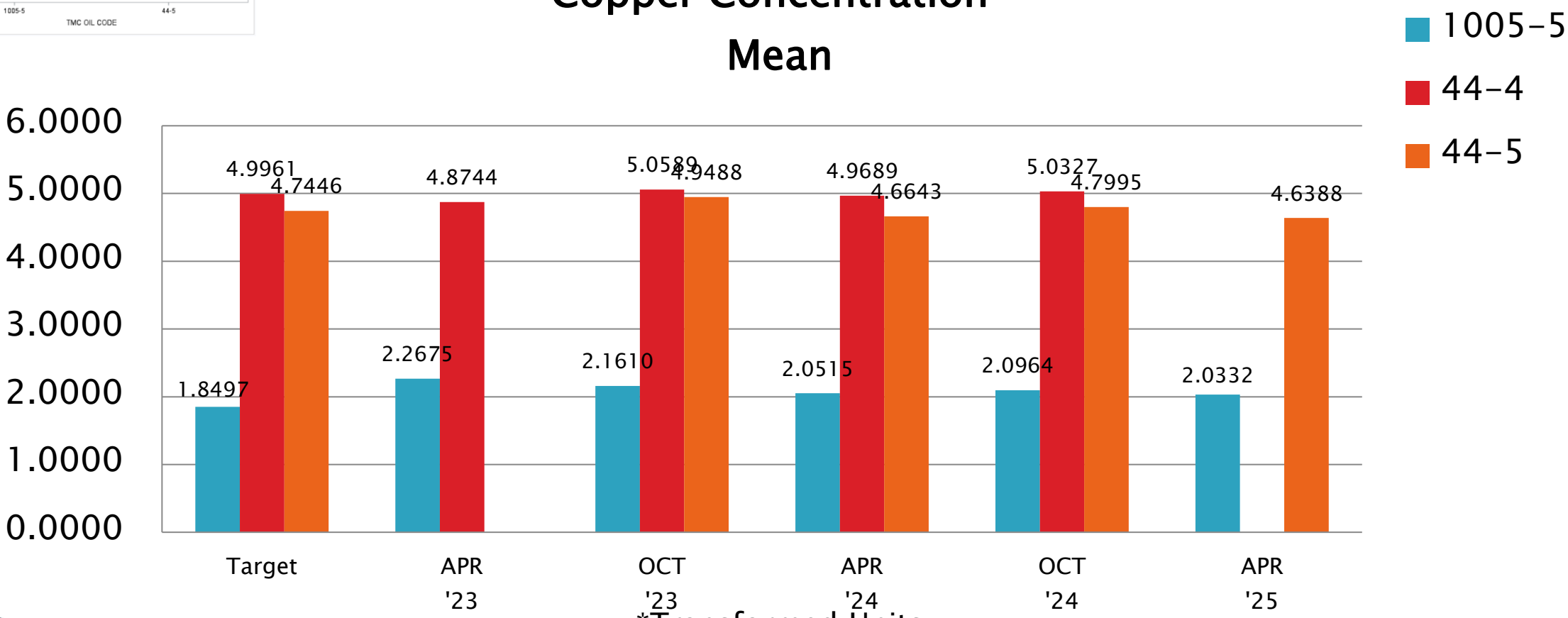


HTCBT Performance by OIL

Copper Concentration*
Mean



*Transformed Units

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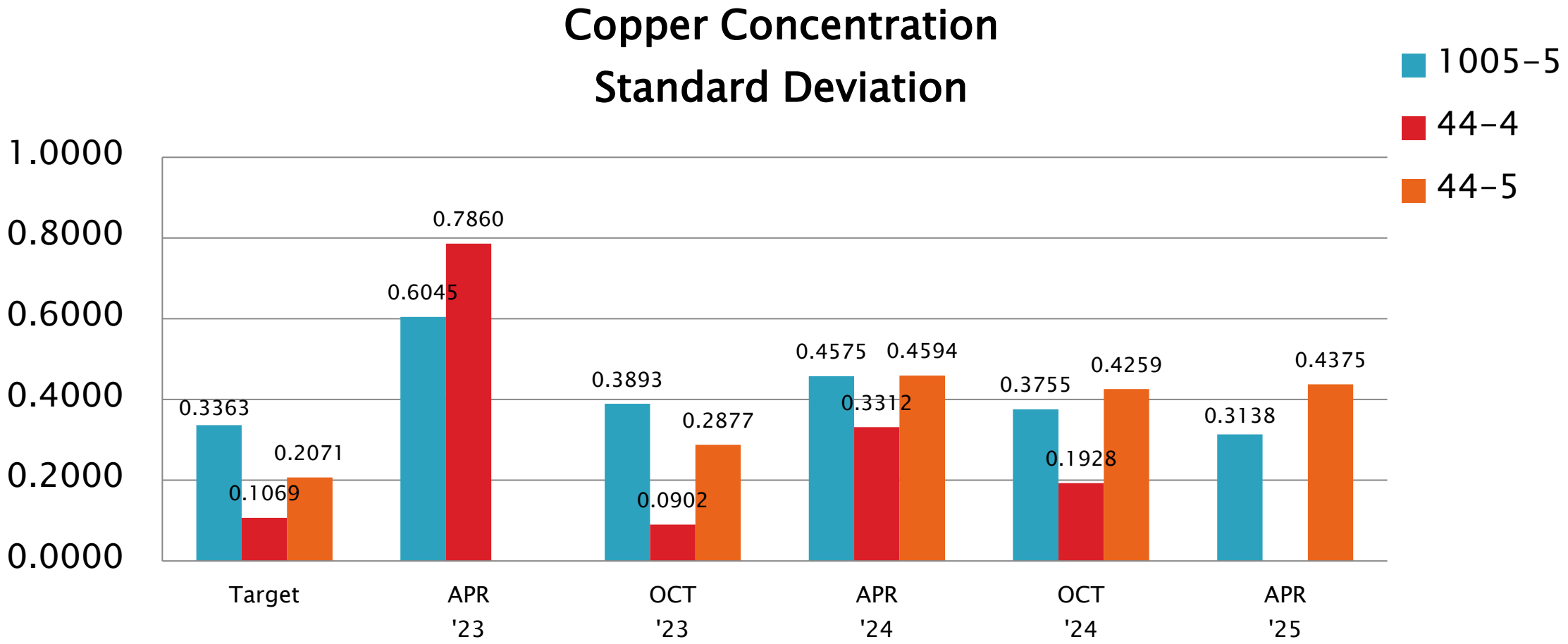
HTCBT Performance by OIL



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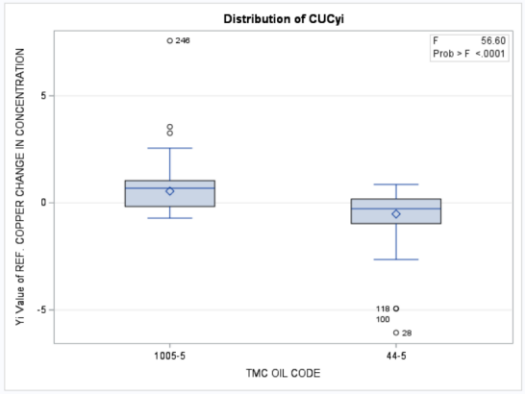
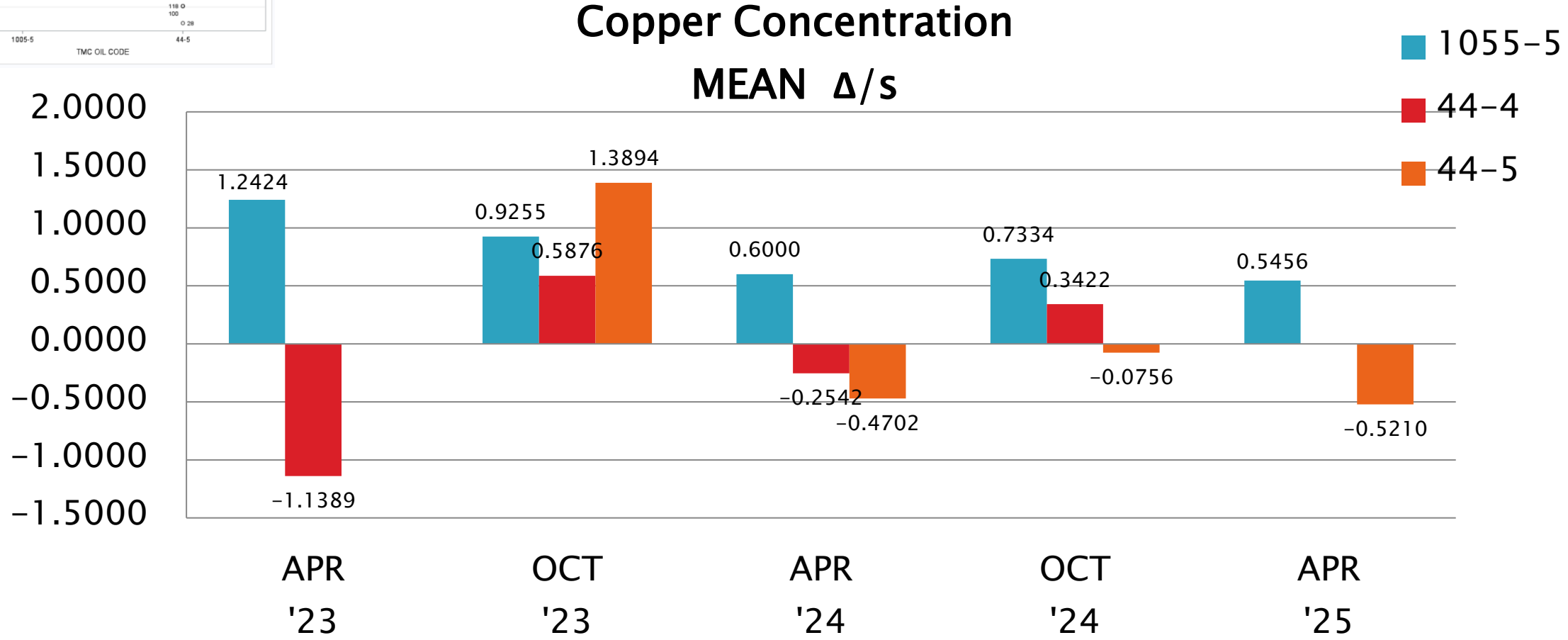


HTCBT Performance by OIL



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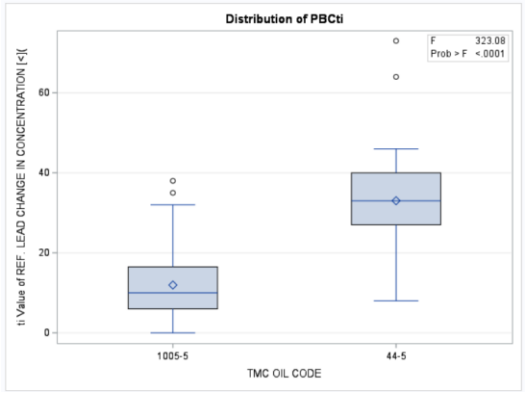
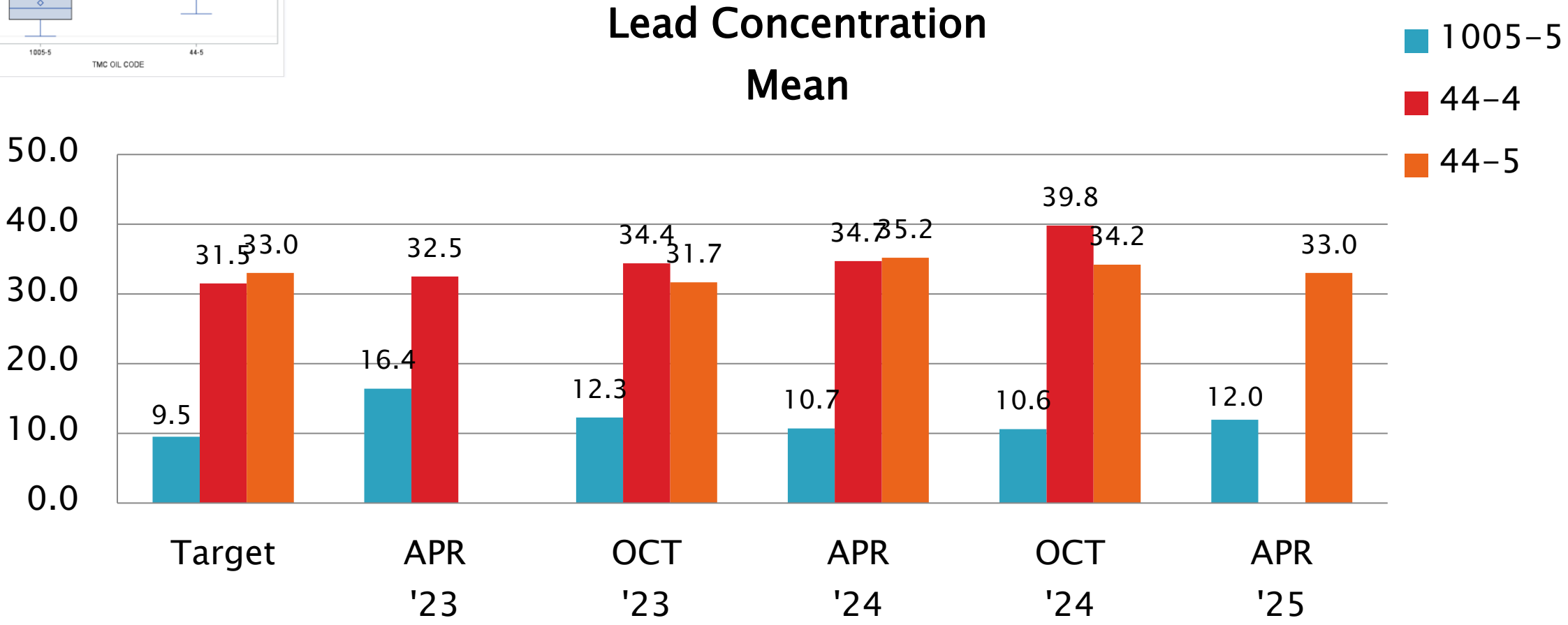


HTCBT Performance by OIL



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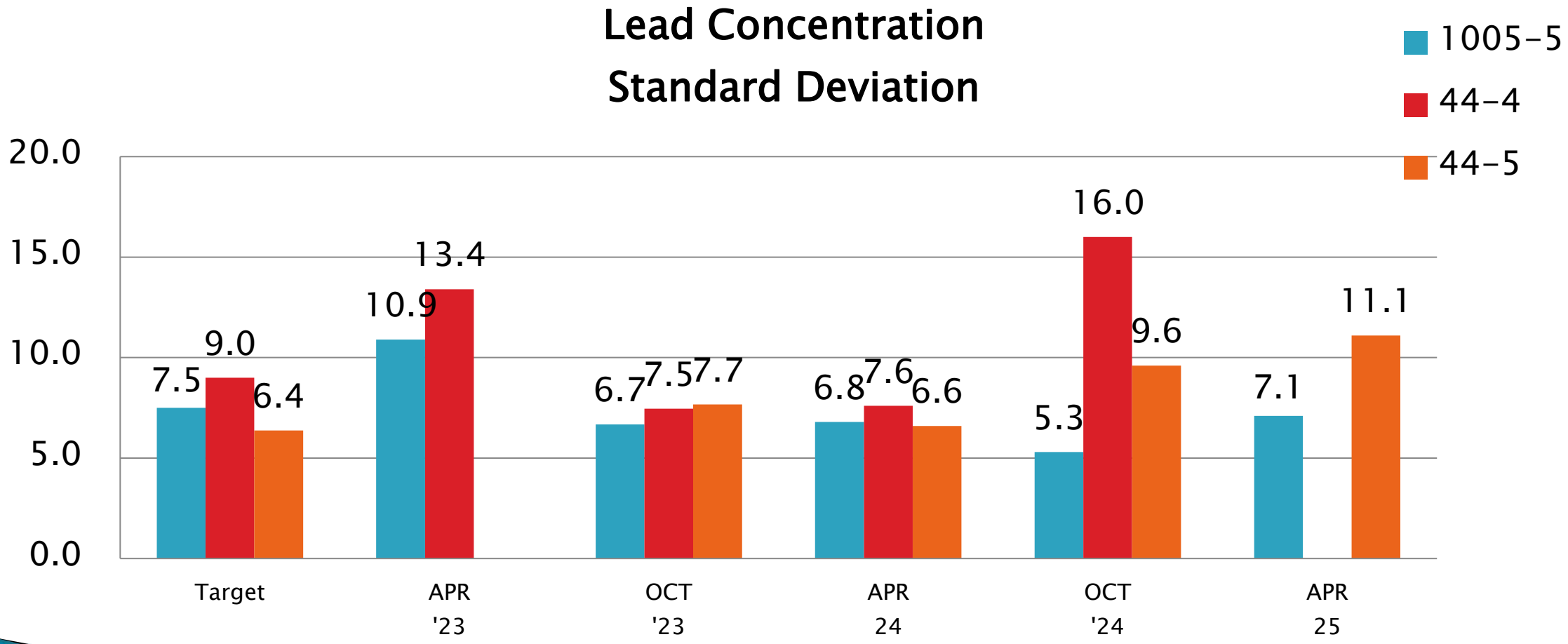
HTCBT Performance by OIL



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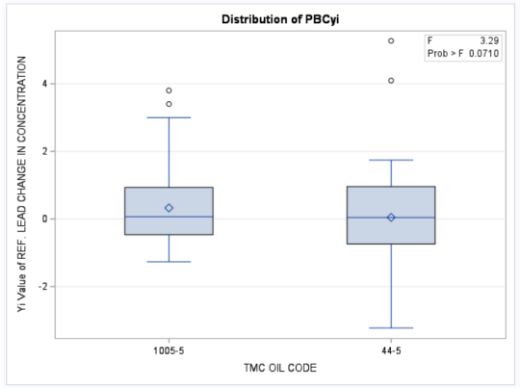
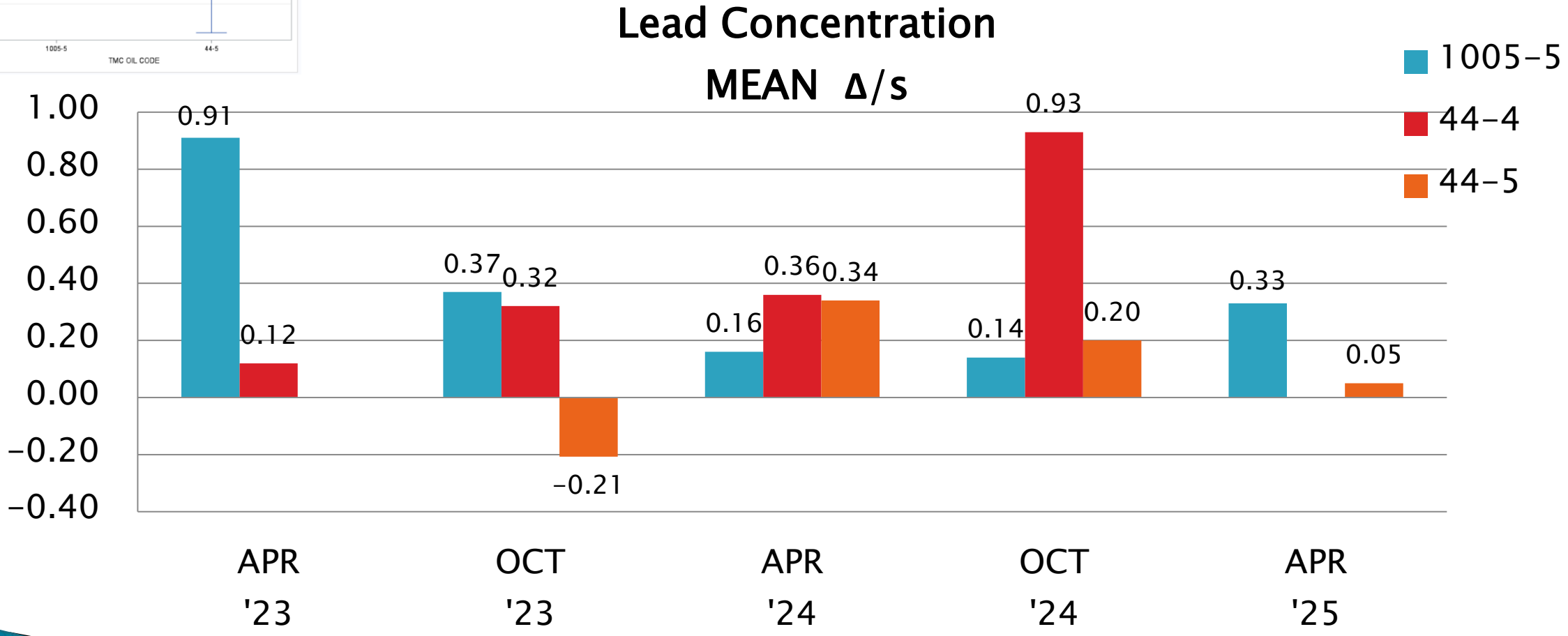


HTCBT Performance by OIL



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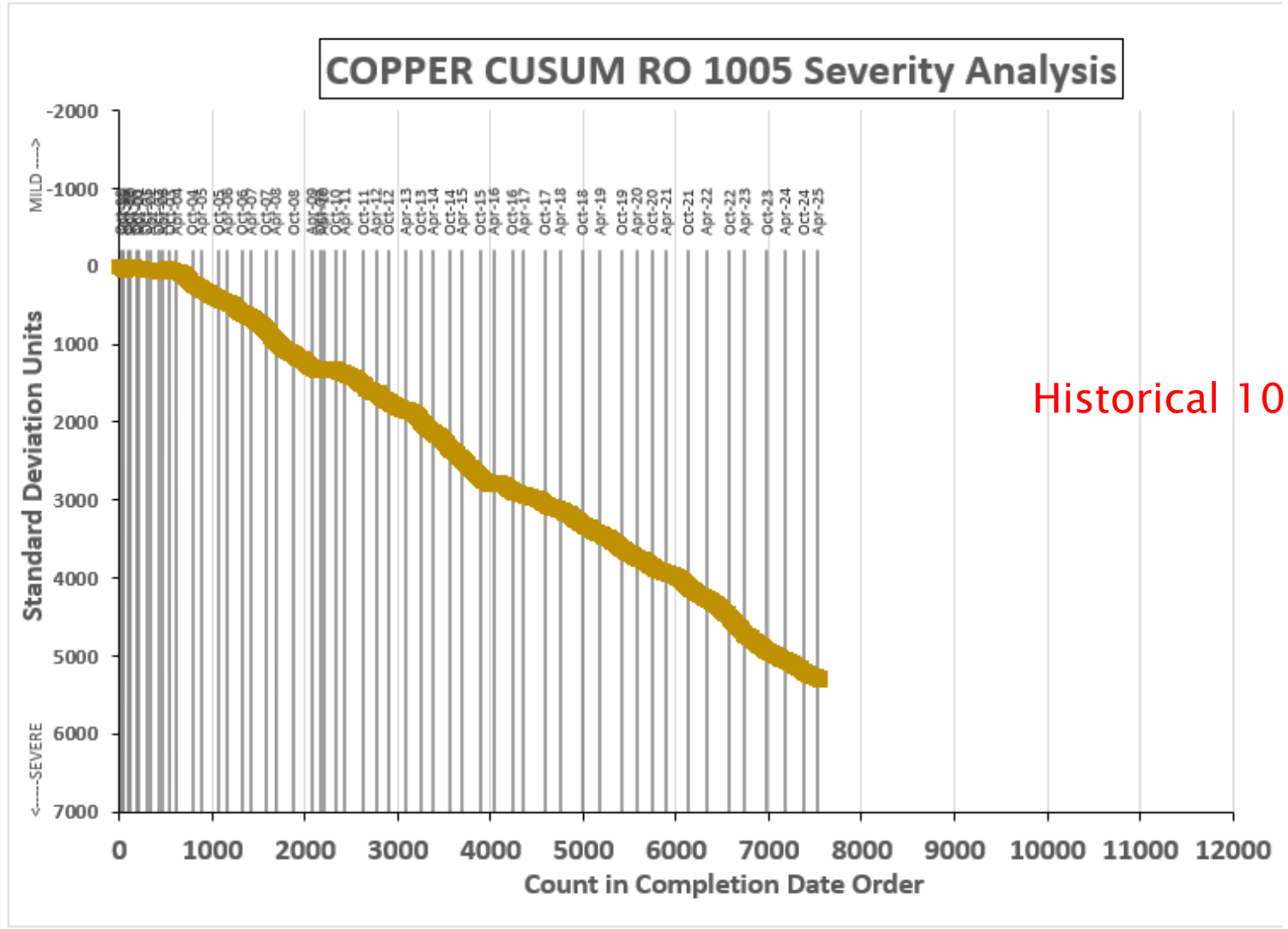
HIGH TEMP CBT INDUSTRY OPERATIONALLY VALID DATA
Oil 1005 –x Only
COPPER CHANGE (ppm)



Historical 1005-x Chart

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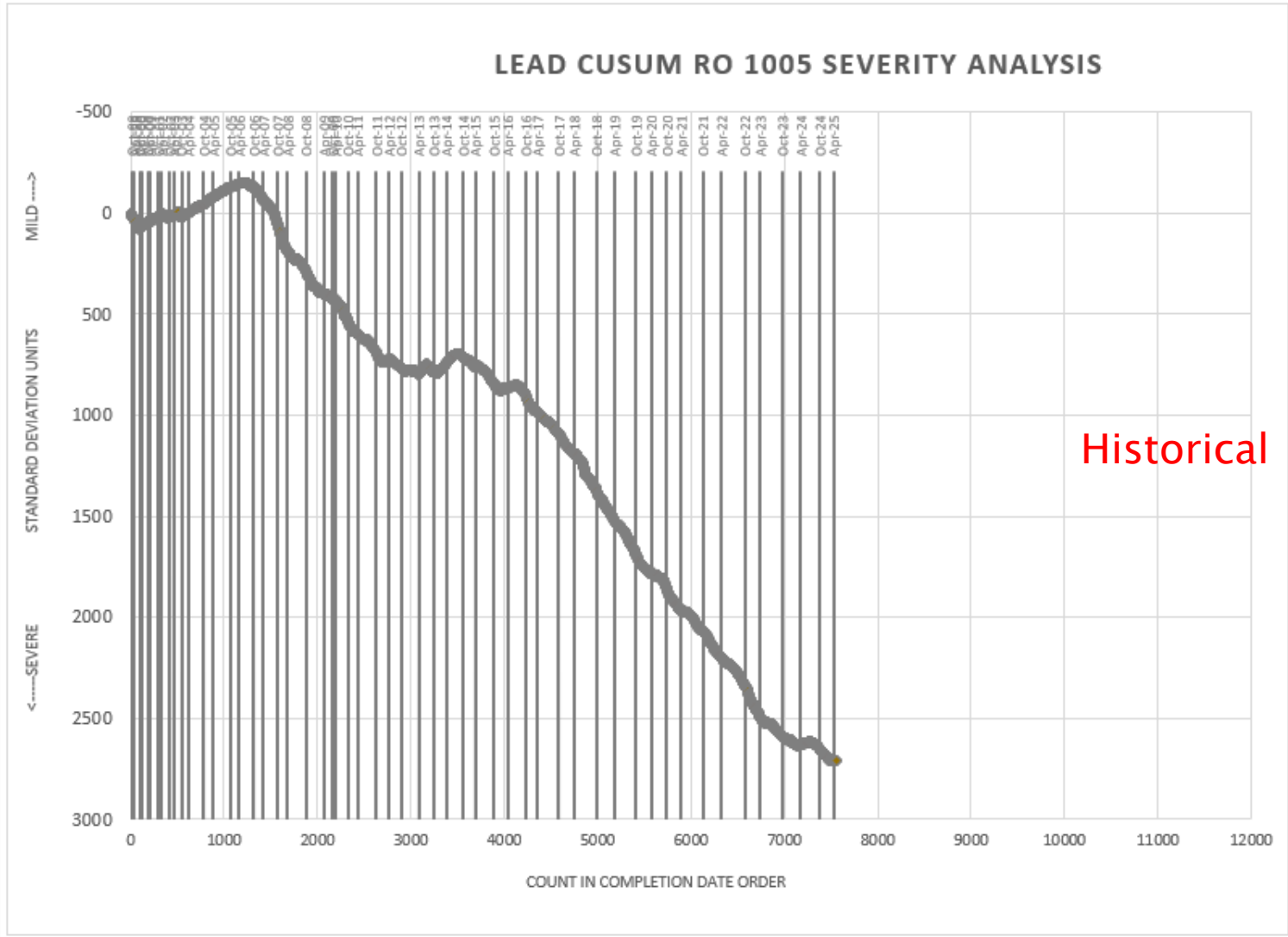
HIGH TEMP CBT INDUSTRY OPERATIONALLY VALID DATA
Oil 1005 –x Only
LEAD CHANGE (ppm)



Historical 1005-x Chart

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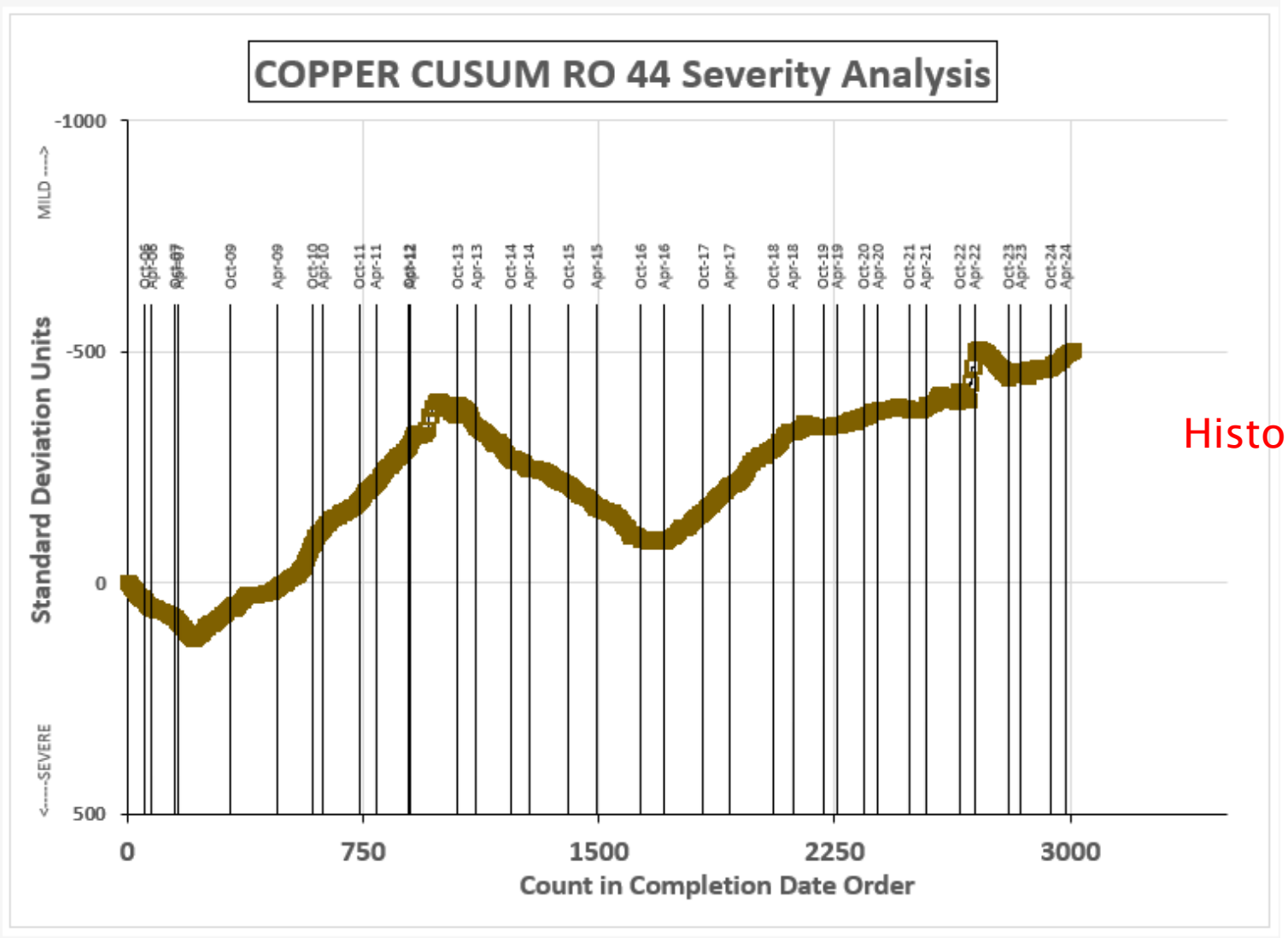
HIGH TEMP CBT INDUSTRY OPERATIONALLY VALID DATA
Oil 44–x Only
COPPER CHANGE (ppm)



Historical 44–x Chart

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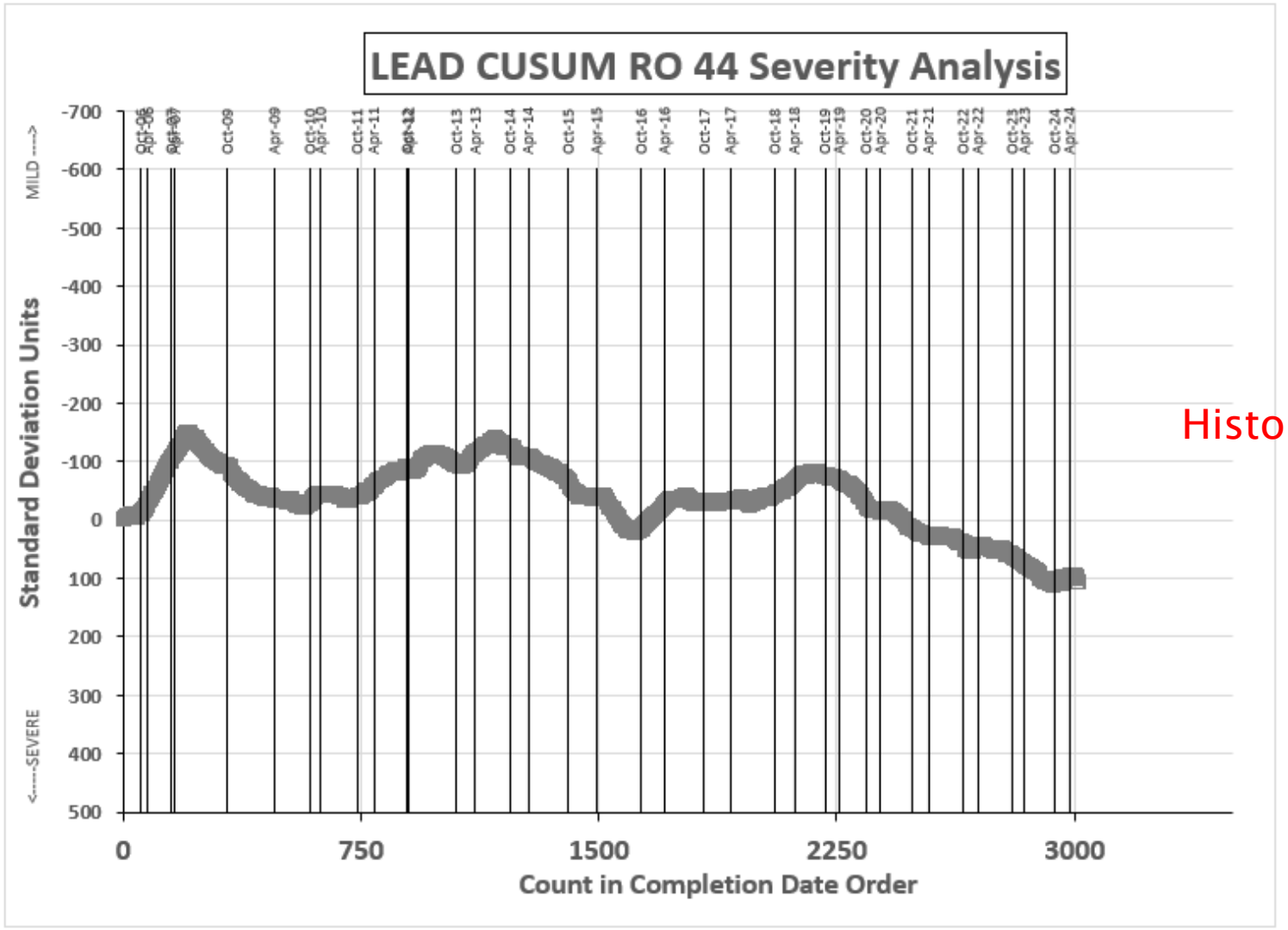
HIGH TEMP CBT INDUSTRY OPERATIONALLY VALID DATA
Oil 44 –x Only
LEAD CHANGE (ppm)



Historical 44-x Chart

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Information Letters and Memos*

Test	Date	IL/Memo	Topic
HTCBT			

No new Information Letters or Memos issued this semester.

*Available from TMC Website

Reference Oil Inventory Estimated Life

D6594

Oil	TMC Inventory (gallons)	Quantity Shipped in last 6 months (gallons)	Lab Assignments Made	Estimated Life
44-5	45.3	2.0	76	5+ year
1005-5	23.4 (Reserved drum – Additional oil available at the TMC)	5.6	182	5+ year

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TMC Monitored Tests

ASTM D 6794

Engine Oil Water Tolerance (EOWT)

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Calibrated Labs and Stands*

(change since last Semi-Annual report)

Test	Labs	Stands
D6794	5 (+0)	N/A
*As of 3/31/2025		

EOWT Test Activity by Treat Rate

Test Status	Validity Code	Number of Tests by Water Treat Rate				Total
		0.6%	1.0%	2.0%	3.0%	
Acceptable Calibration Test	AC	187	190	187	189	753
Failed Calibration Test	OC	0	1	2	3	6
Acceptable Information Run	NN	0	0	0	0	0
Unacceptable Information Run	MN	0	0	0	0	0
Invalid Calibration Test	LC, RC	0	0	0	0	0
Aborted Calibration Test	XC	1	1	1	1	4
Total		**188**	**192**	**190**	**193**	**763**

- 5 labs reported data

EOWT Test Activity by Reference Oil*

Test Status	Validity Code	Number of Tests by Reference Oil		Total
		77-3	79	
Acceptable Calibration Test	AC	373	380	**753**
Failed Calibration Test	OC	6	0	**6**
Acceptable Informational Test	NN	0	0	**0**
Unacceptable Informational Test	MN	0	0	**0**
Invalid Calibration Test	LC, RC	0	0	**0**
Aborted Calibration Test	XC	2	2	**4**
Total		**381**	**382**	**763**

- No Informational runs requested this semester

EOWT Failed Tests

Failed Parameter (OC)	Number of Tests				Total
	0.6%	1.0%	2.0%	3.0%	
Severe Change in Flowrate	0	1	0	2	3
Mild Change in Flowrate	0	0	2	1	3
Total	**0**	**1**	**2**	**3**	**6**

EOWT Failed Tests by Lab

Failed Parameter (OC)	LTMS Lab						#
	A	B	BE	G	I	L	
Severe Change in Flowrate	3	N/A	0	0	0	0	3
Mild Change in Flowrate	3	N/A	0	0	0	0	3
Total	**6**	**N/A**	**0**	**0**	**0**	**0**	**6**

EOWT Lost Calibration Tests*

Cause	Number of Tests				#
	0.6%	1.0%	2.0%	3.0%	
Samples stored in oven too long	1	1	1	1	4
Total	**1**	**1**	**1**	**1**	**4**

*Invalid (LC,RC) and Aborted (XC) calibration tests

D6794: EOWT

Period Precision and Severity Estimates

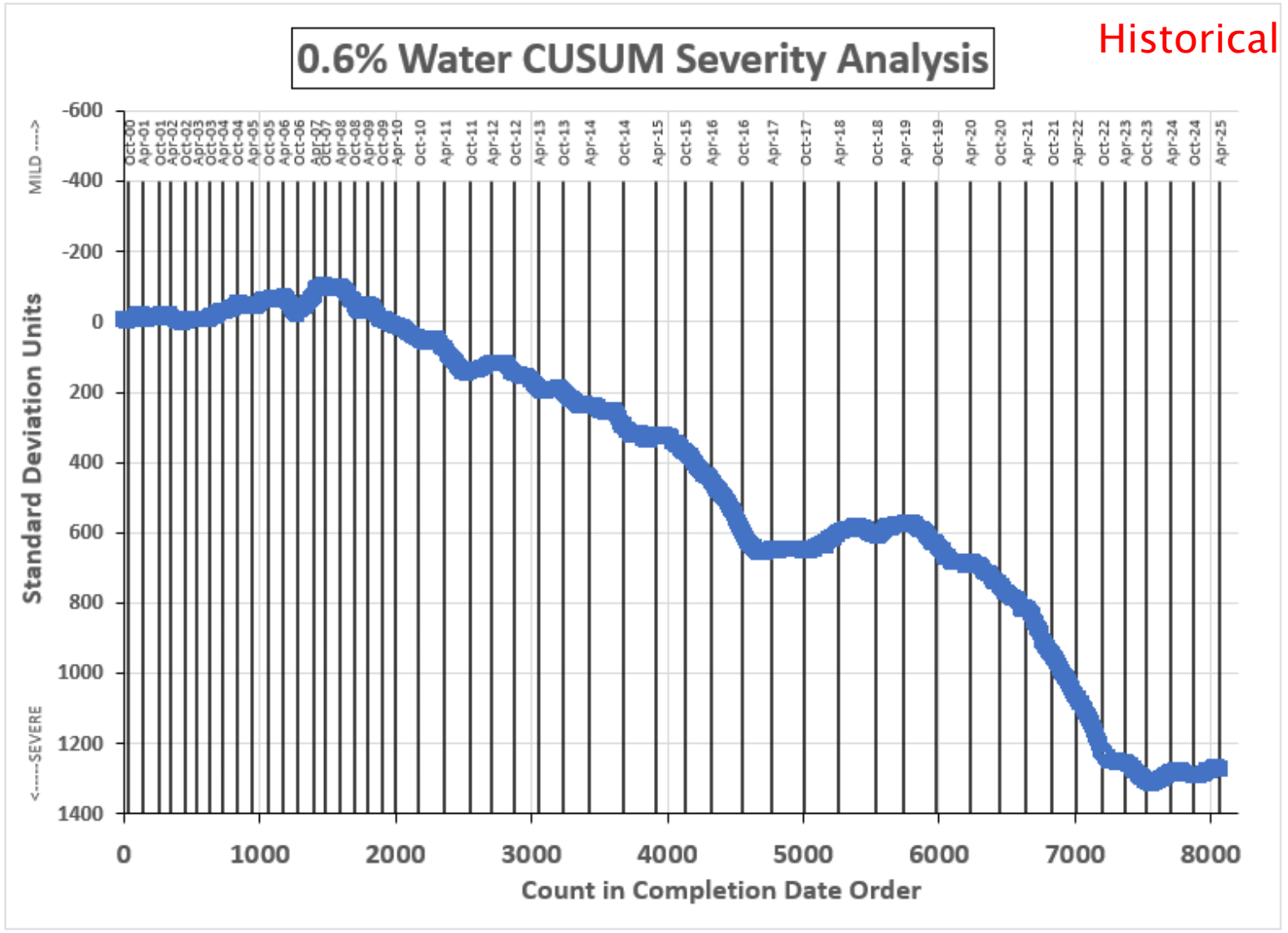
Change in Filtration Rate	H_2O %	n	df	Pooled s	Mean Δ/s
10/1/24 through 3/31/25	ALL	759	757	3.74	0.08
10/1/24 through 3/31/25	0.6	187	185	3.44	-0.10
10/1/24 through 3/31/25	1.0	191	189	3.08	0.04
10/1/24 through 3/31/25	2.0	189	187	3.44	0.17
10/1/24 through 3/31/25	3.0	192	190	3.30	0.22

EOWT Test Status

- Change in Flowrate Average (CIFA) is moving milder as reduced severity estimates (Mean Δ/s) results were found for all four water treat levels as compared to previous semester.
- TMC is working with Reference Oil 79 supplier to determine if a reblend is possible.
  - Reference Oil 79 is also used in the EOFT and is the single Reference Oil for that Bench Test.

EOWT INDUSTRY OPERATIONALLY VALID DATA
CFA 0.6% Water Treat Rate
20 —25 ML CHANGE IN FLOWRATE AVG.

Historical Chart



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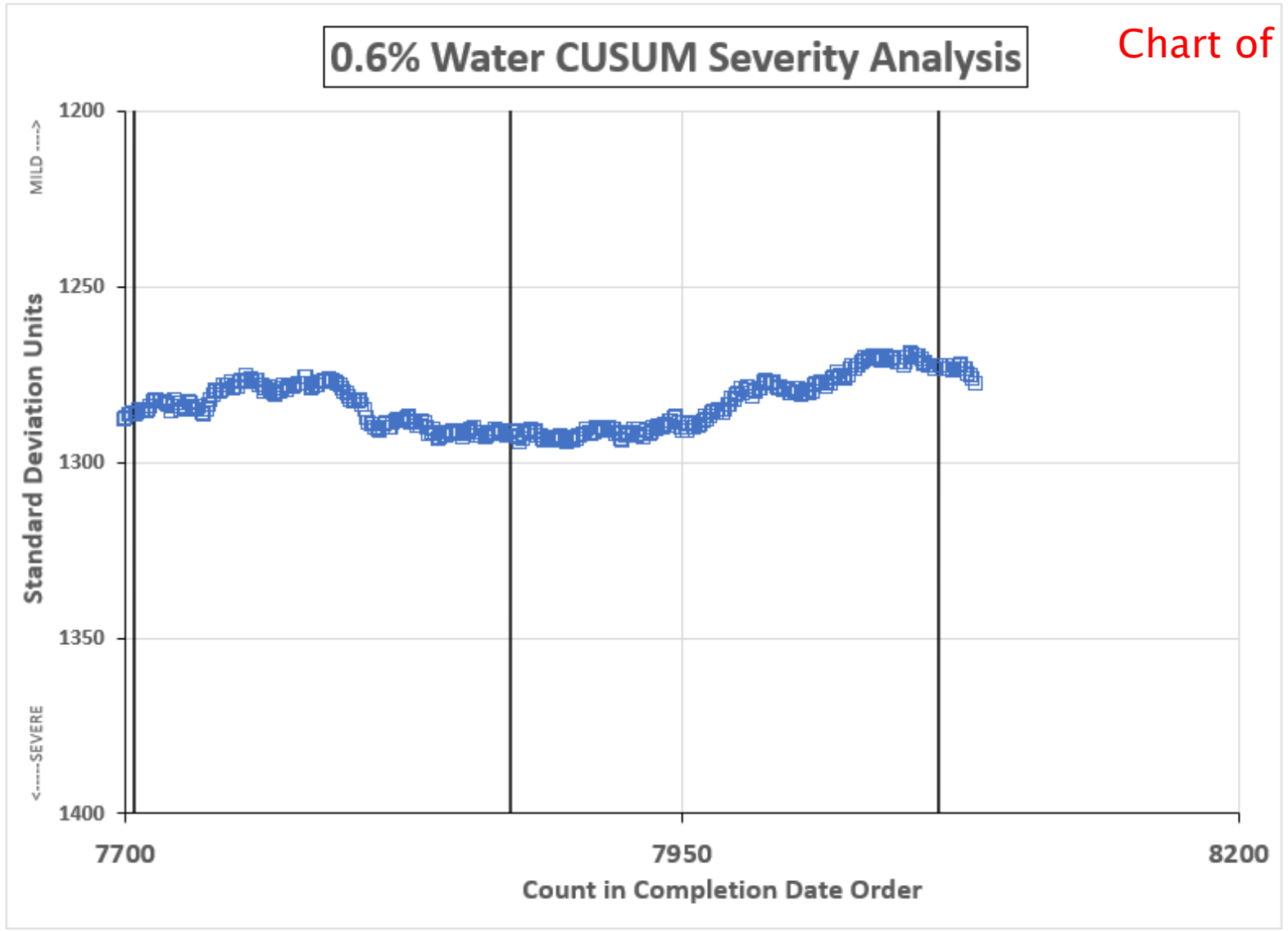
EOWT INDUSTRY OPERATIONALLY VALID DATA
CFA 0.6% Water Treat Rate (Last 400 Data Points)
20 —25 ML CHANGE IN FLOWRATE AVG.

Chart of recent results



October 1, 2024 – March 31, 2025

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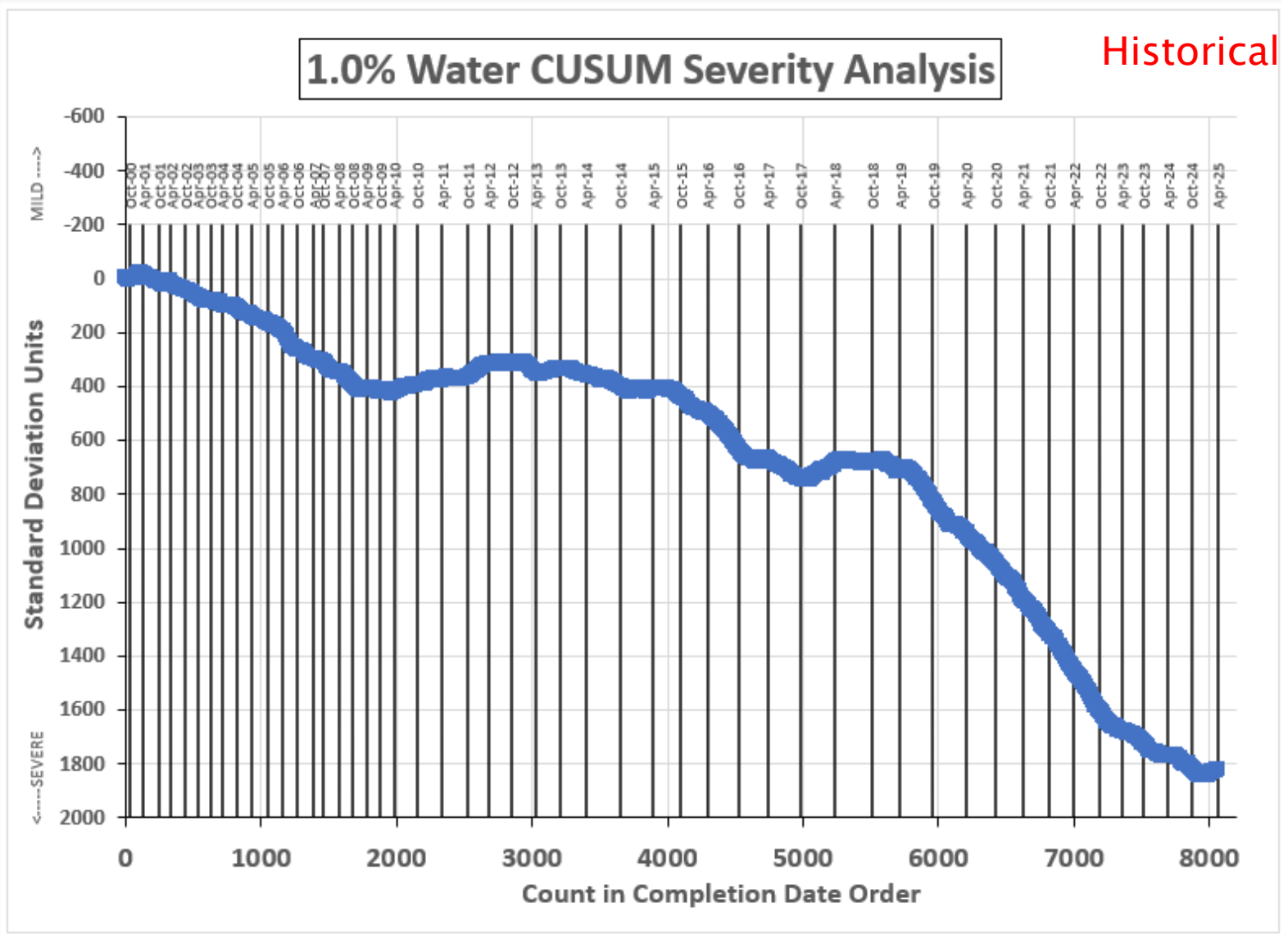
EOWT INDUSTRY OPERATIONALLY VALID DATA
CFA 1.0% Water Treat Rate
20 —25 ML CHANGE IN FLOWRATE AVG.

Historical Chart



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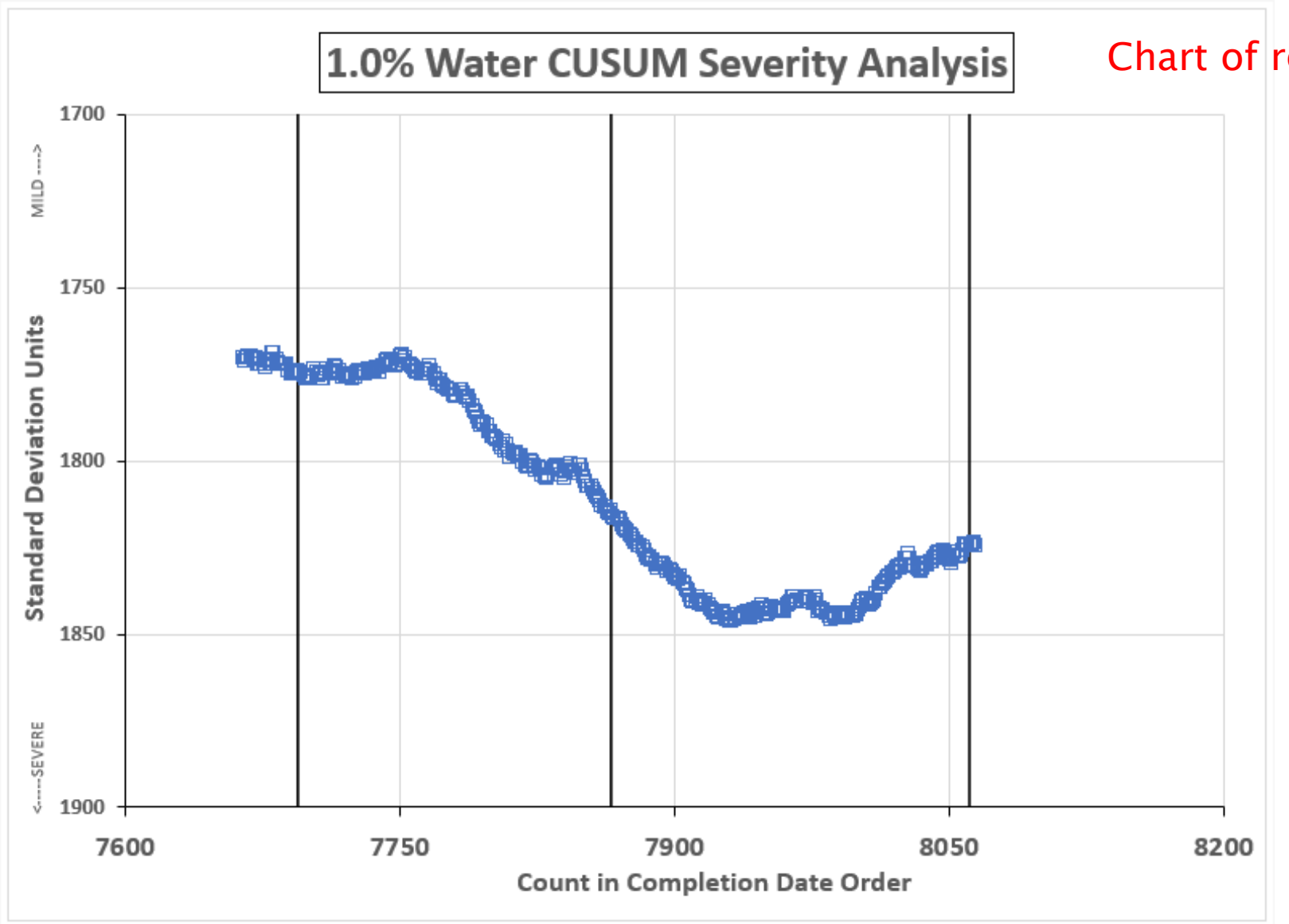

Chart of recent results

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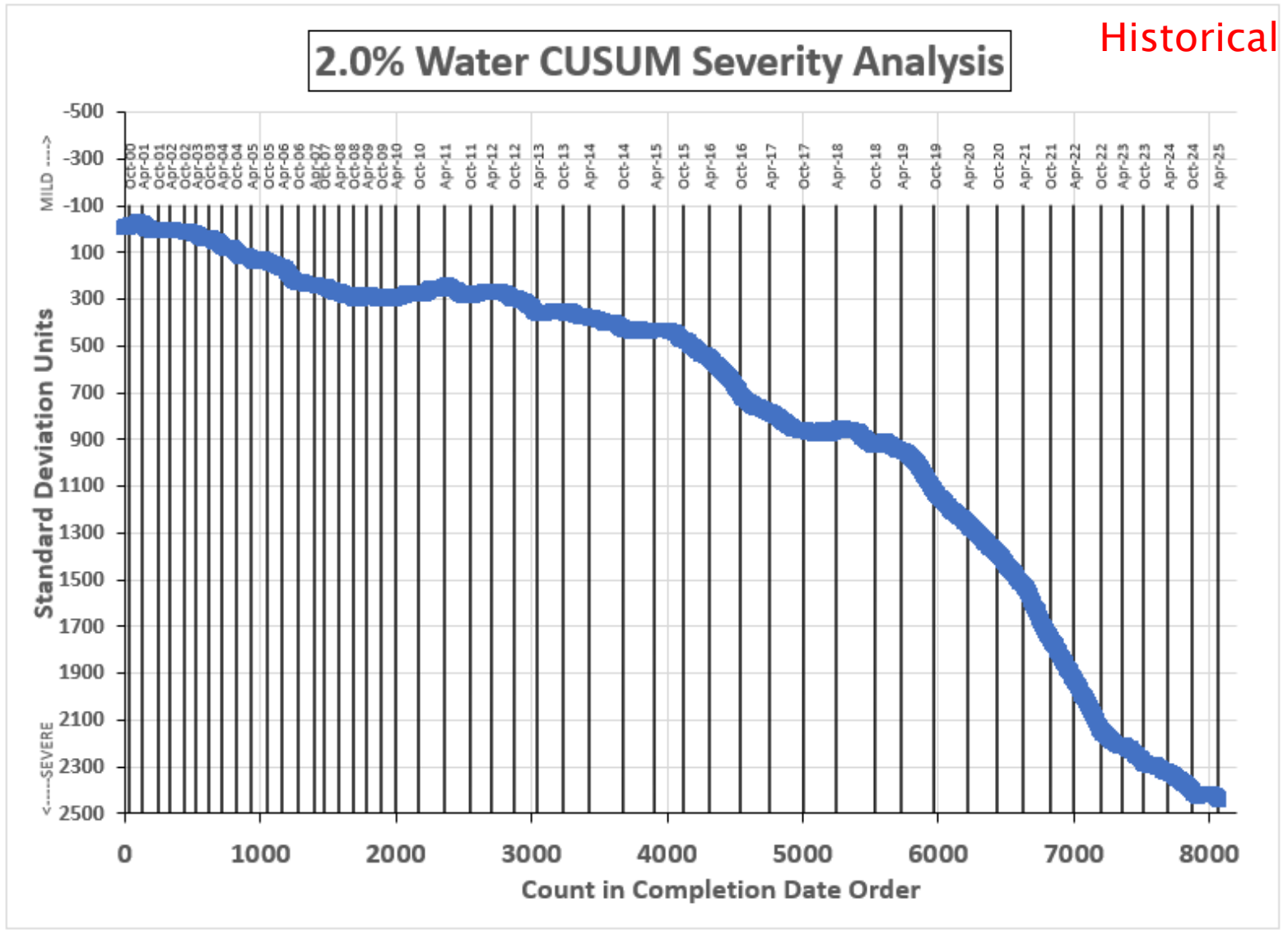
EOWT INDUSTRY OPERATIONALLY VALID DATA
CFA 2.0% Water Treat Rate
20 —25 ML CHANGE IN FLOWRATE AVG.

Historical Chart



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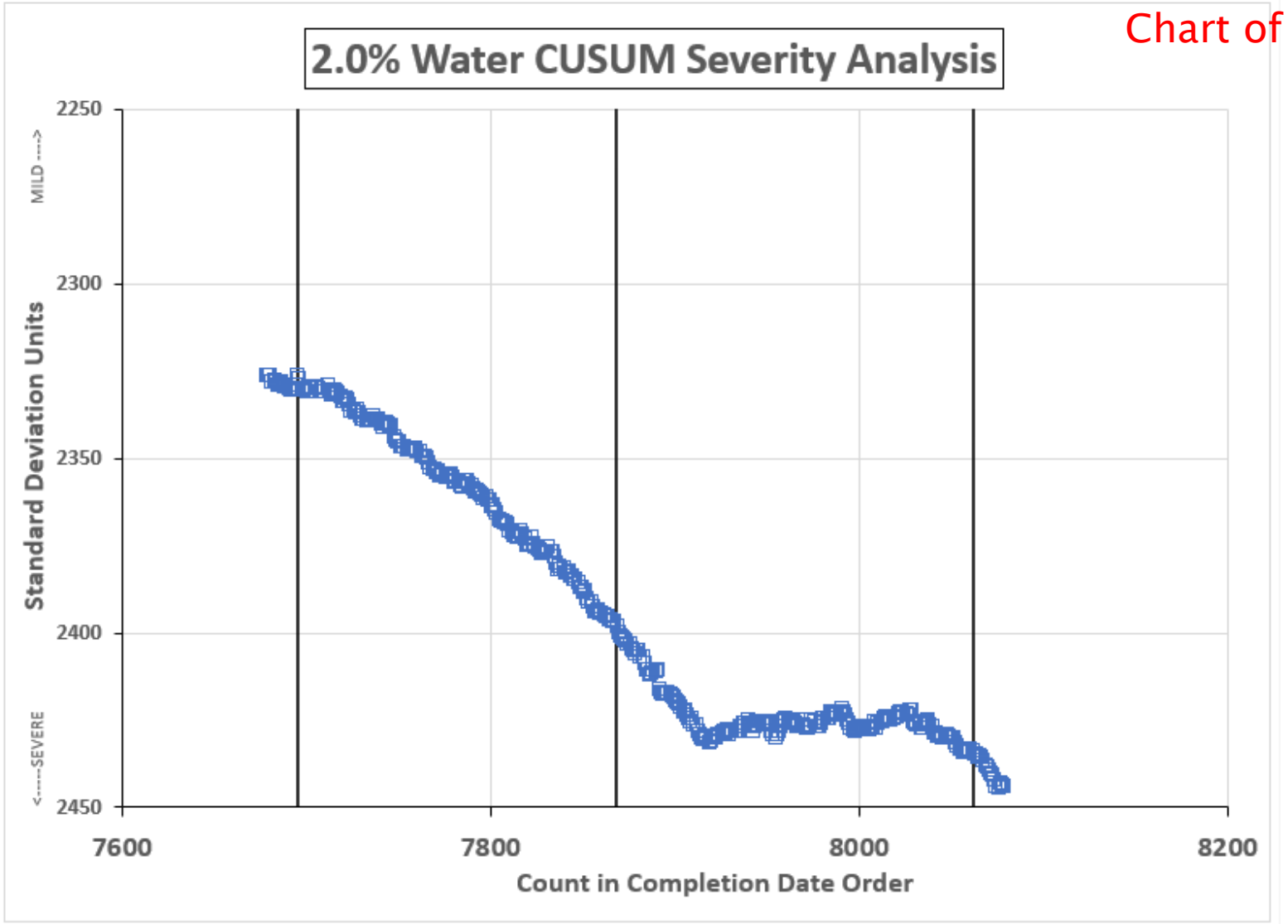

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EOWT INDUSTRY OPERATIONALLY VALID DATA
CFA 3.0% Water Treat Rate
20 —25 ML CHANGE IN FLOWRATE AVG.

Historical Chart

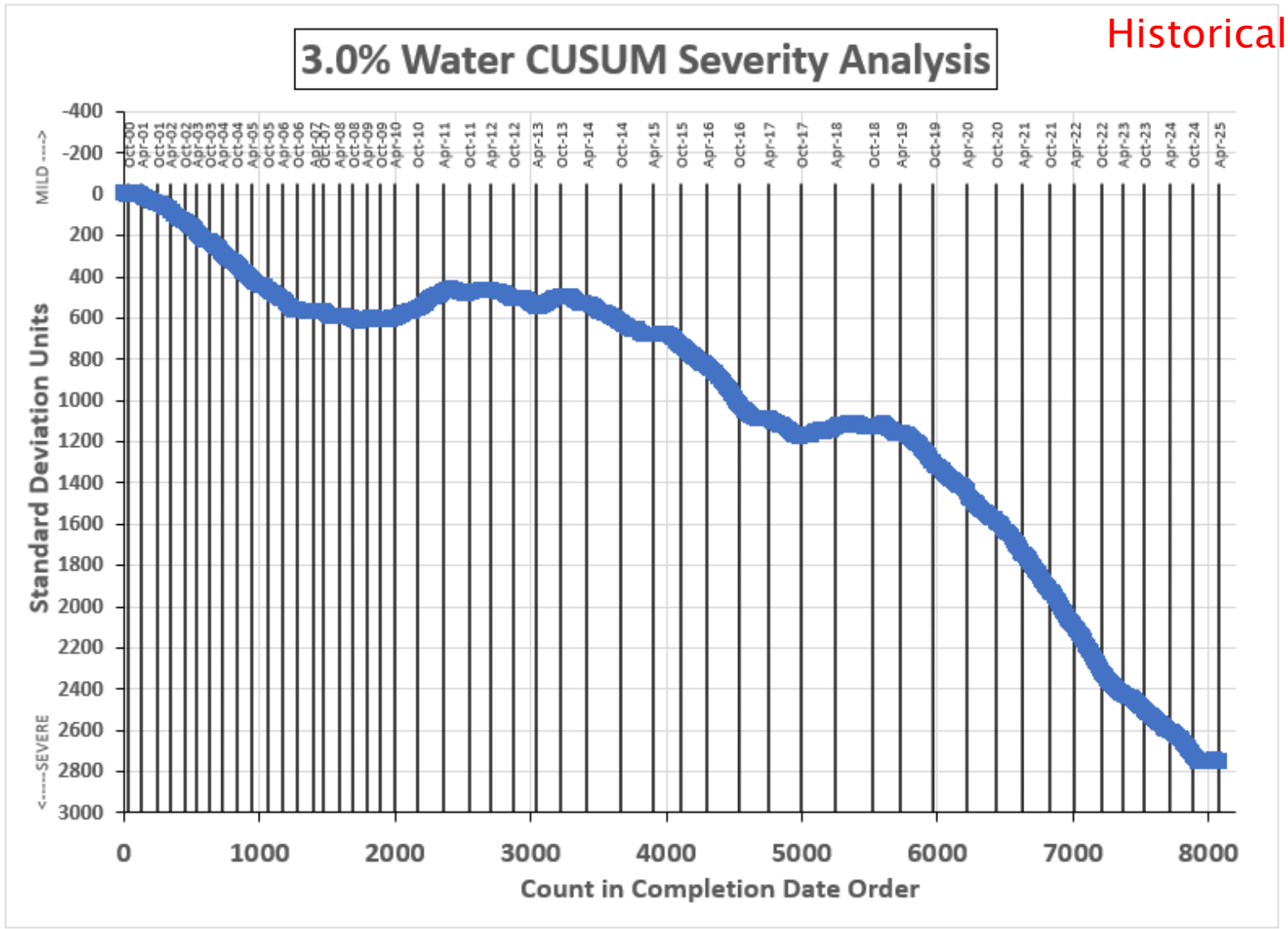

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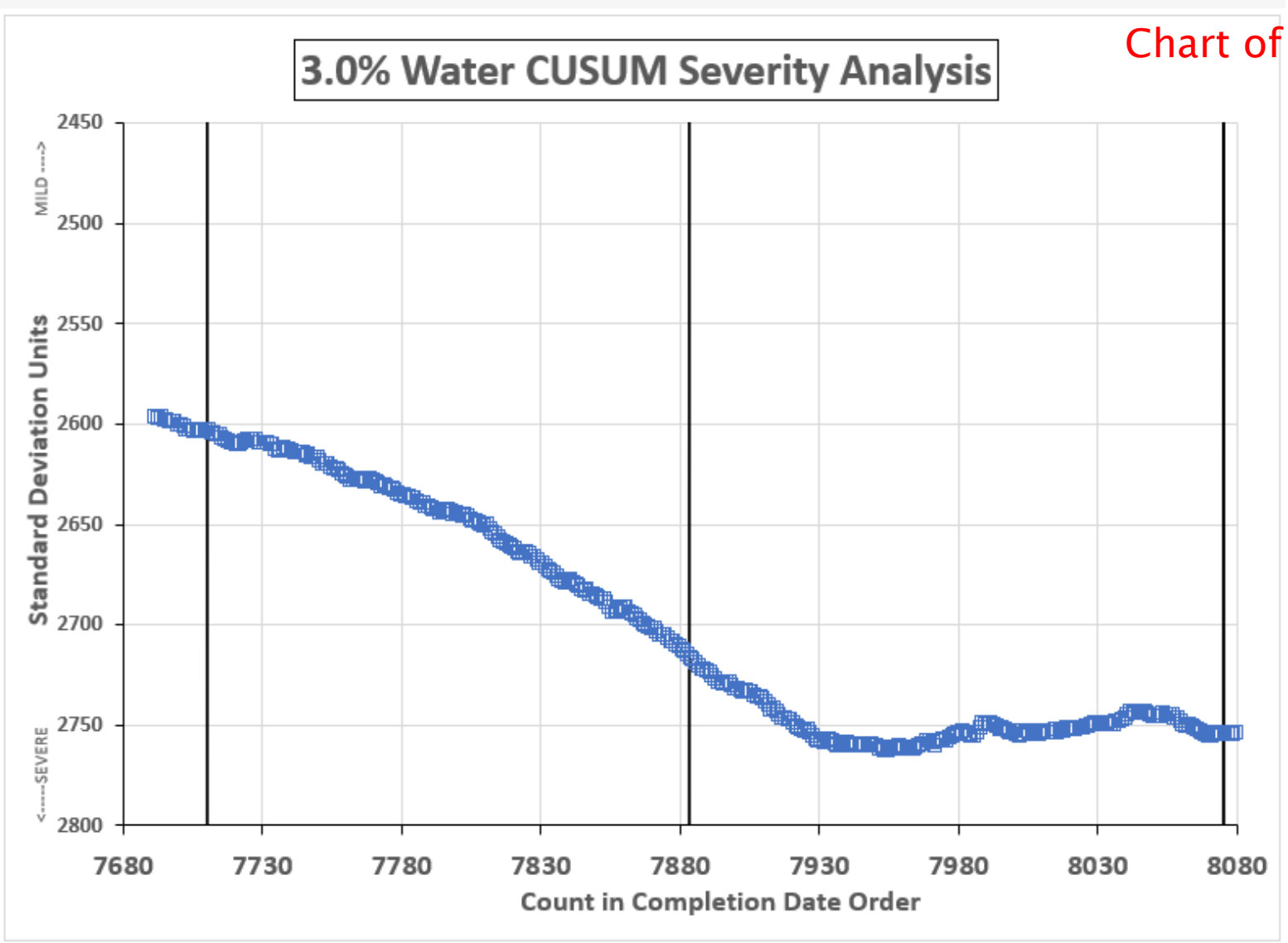
Chart of recent results



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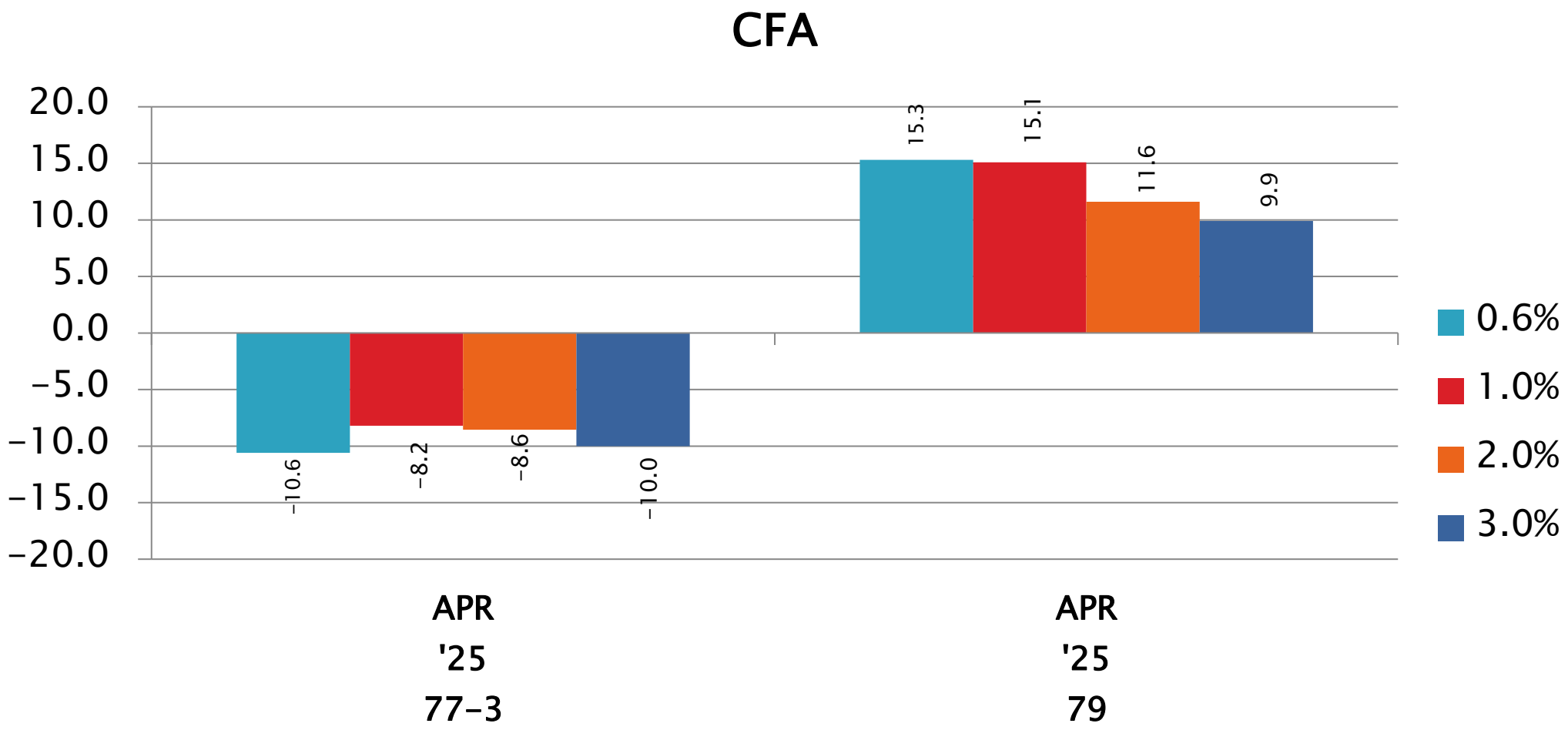
EOWT MEAN CFA's (%) by Reference Oil



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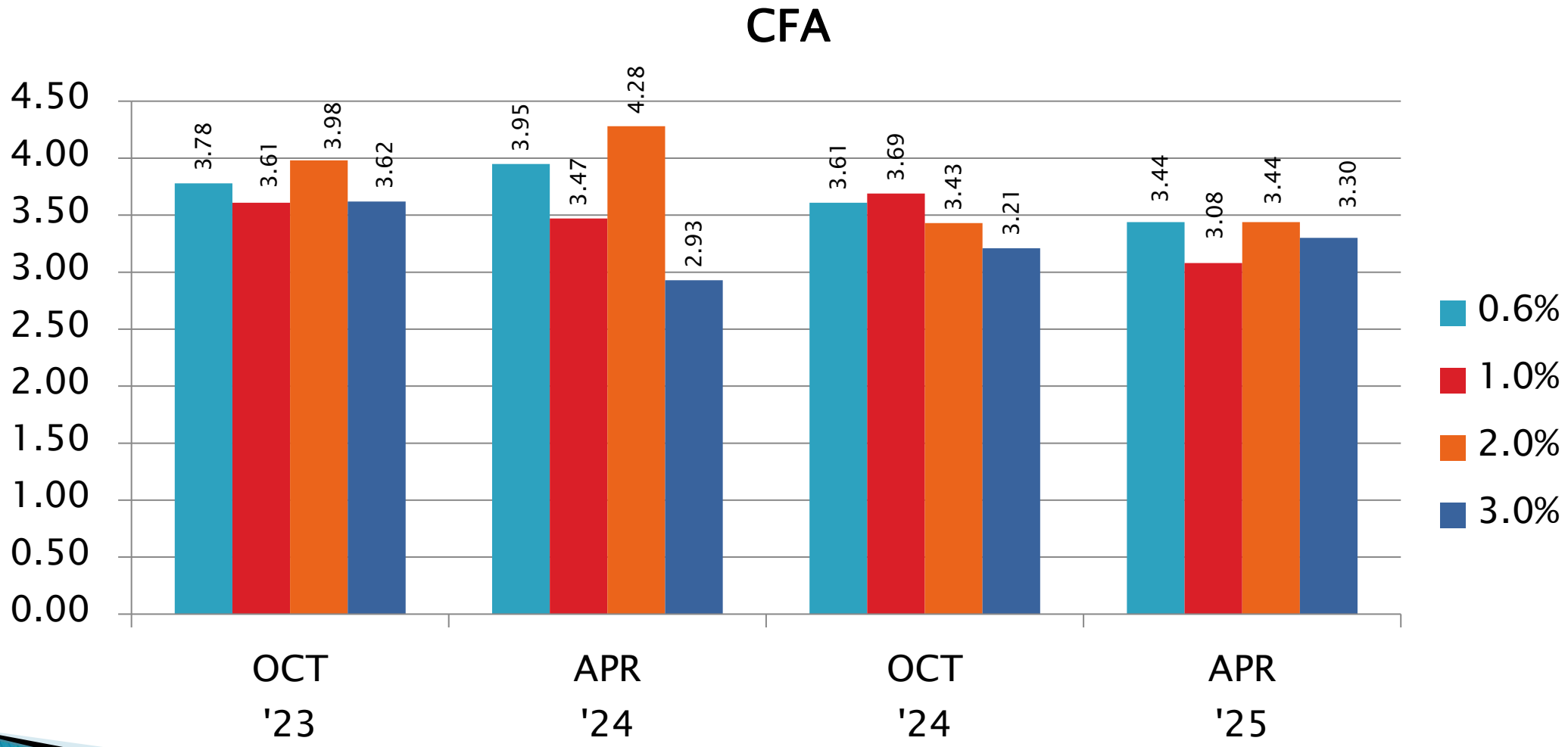
EOWT Precision (Pooled s) Estimates



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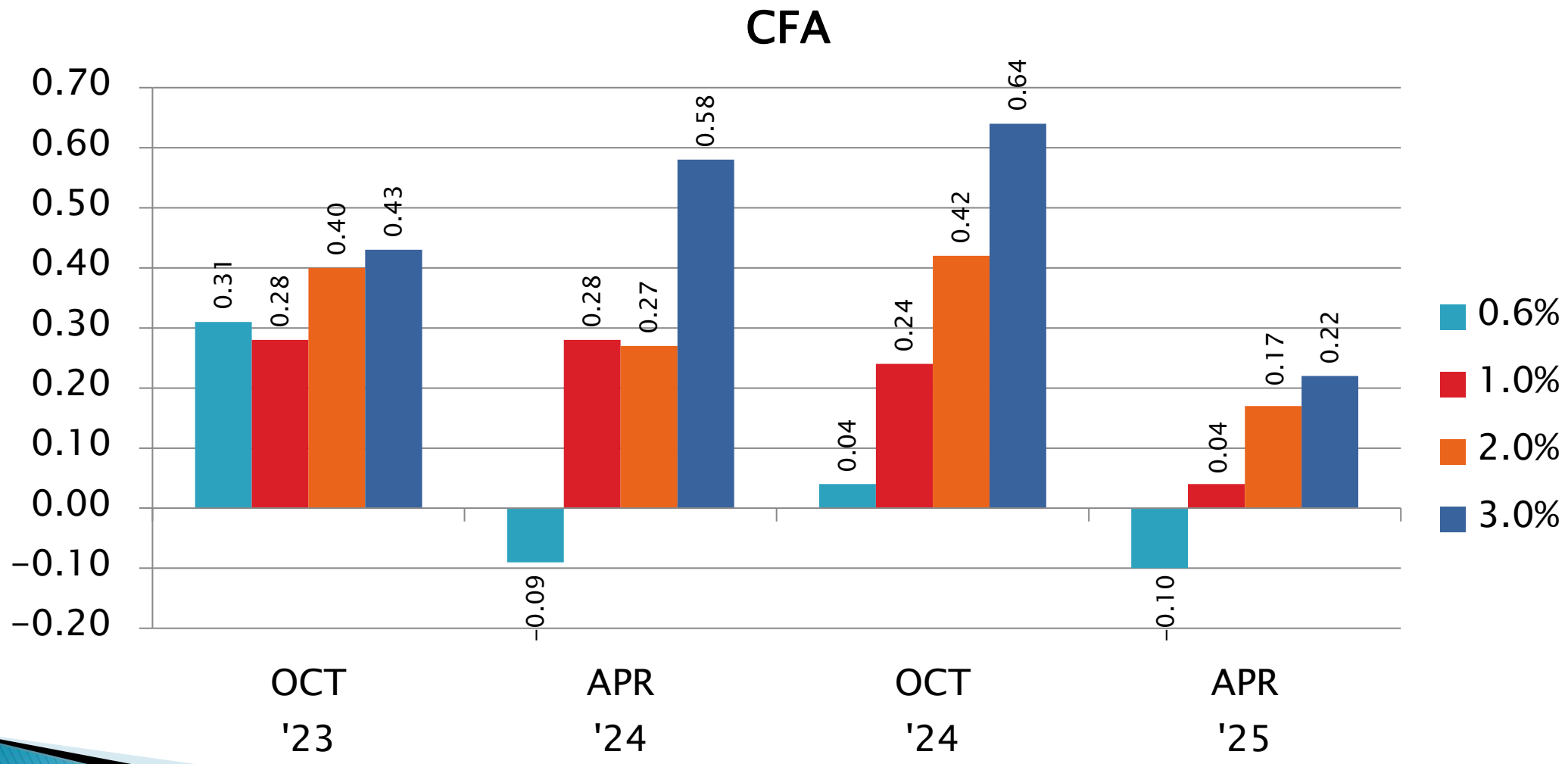
EOWT Performance (Mean Δ/s) Estimates



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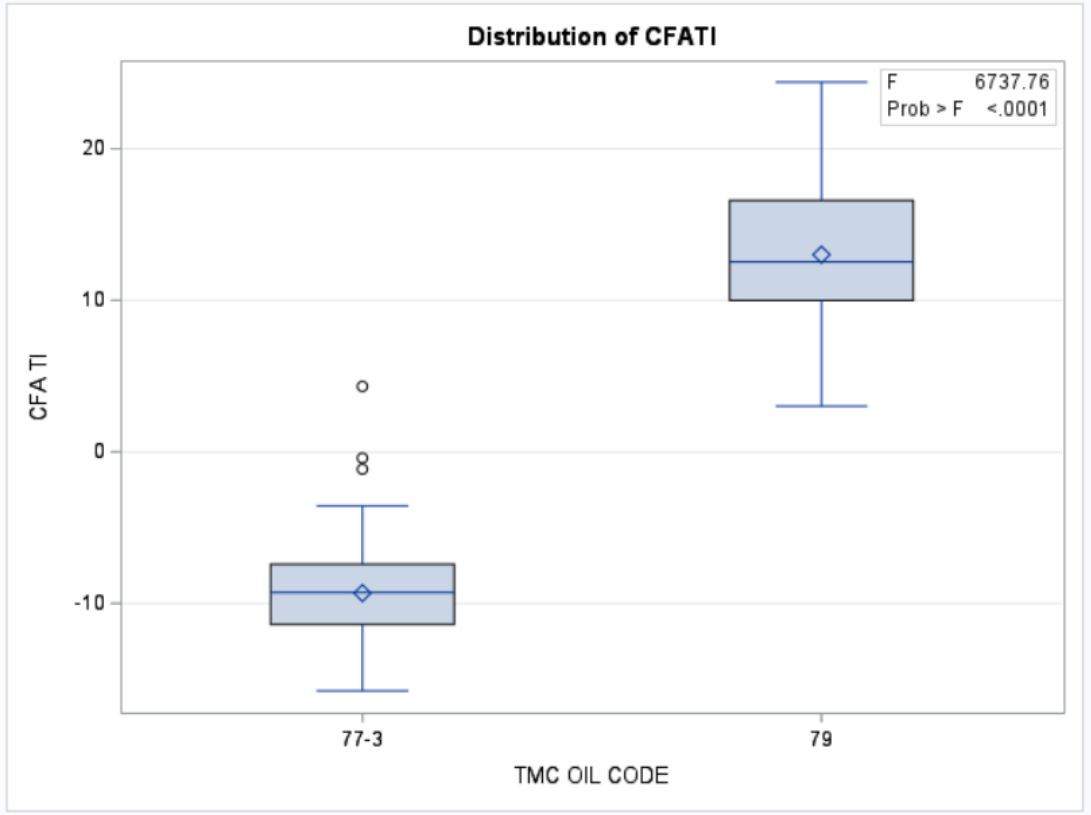
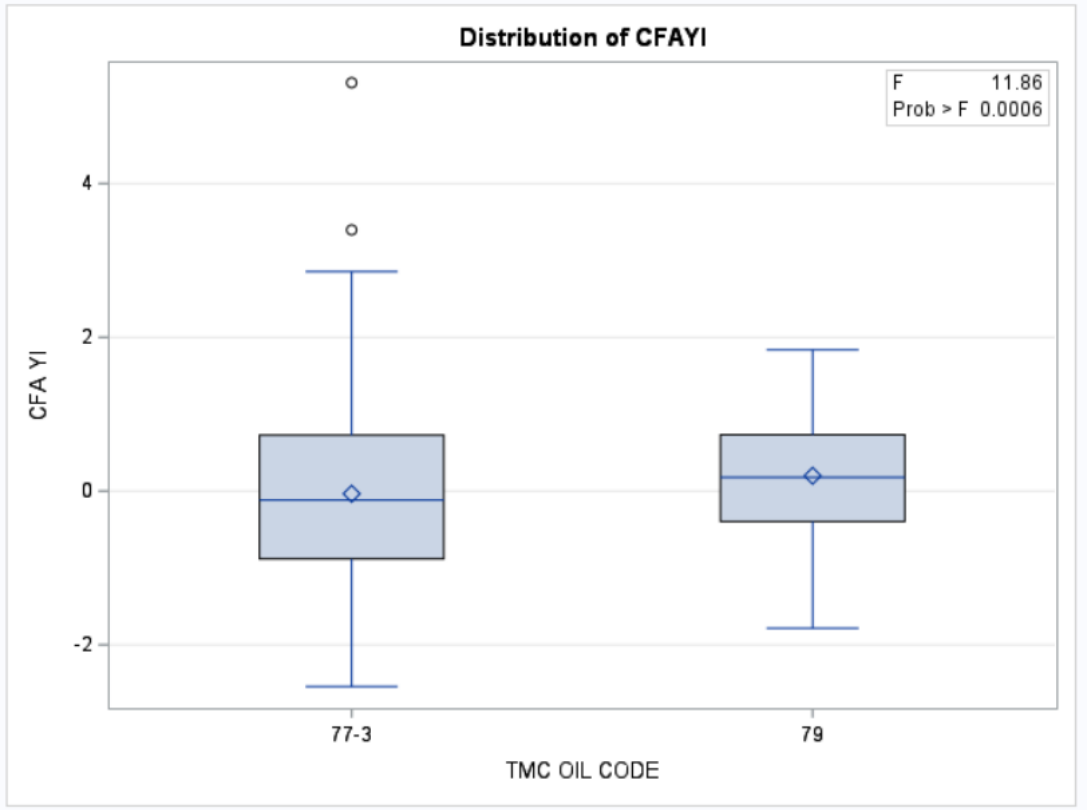
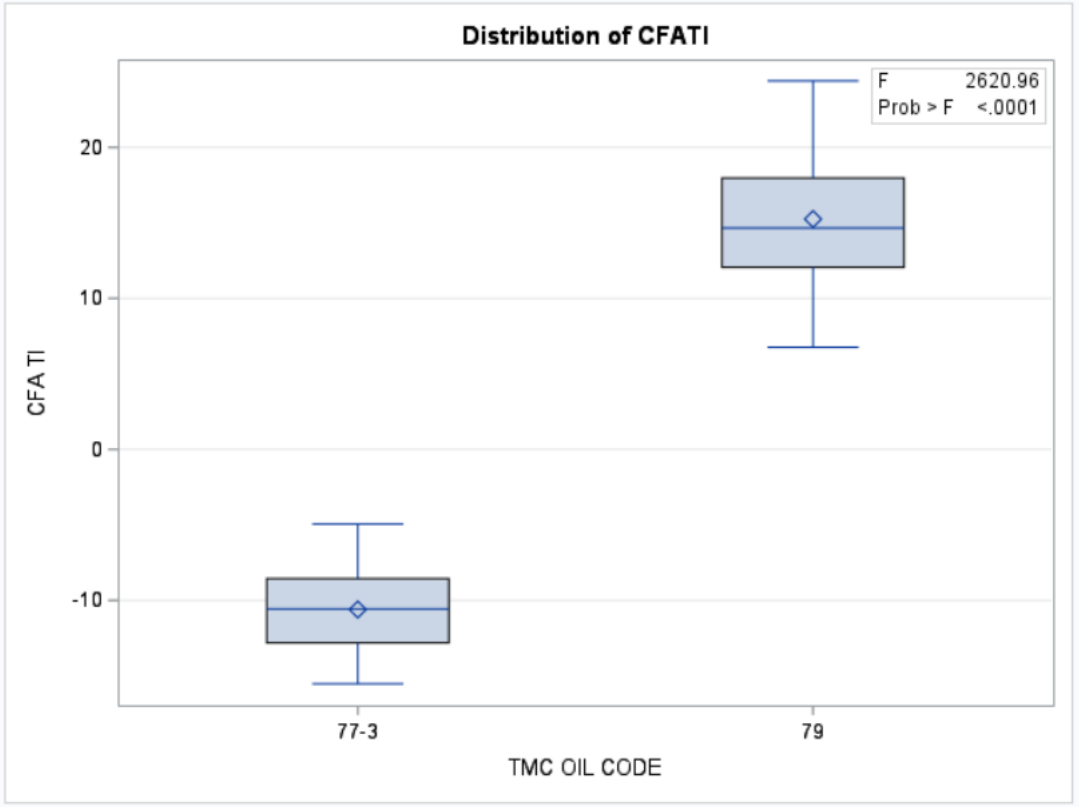
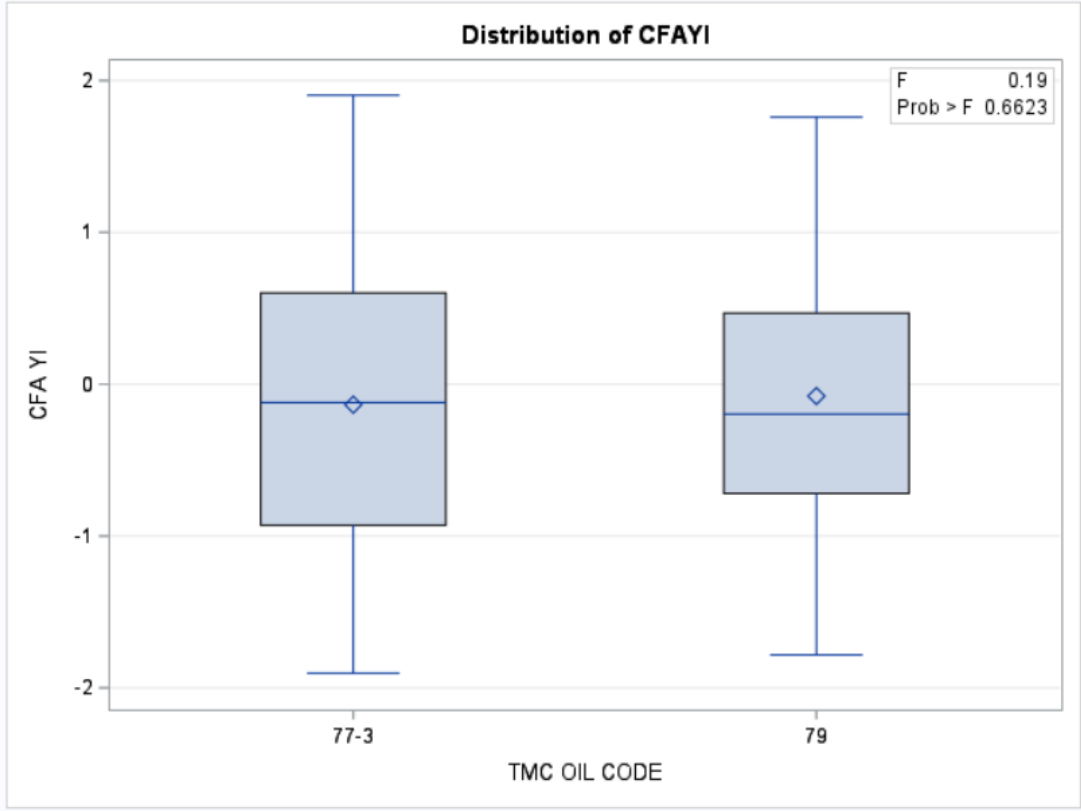
EOWT Results by Reference Oil: All Water Levels



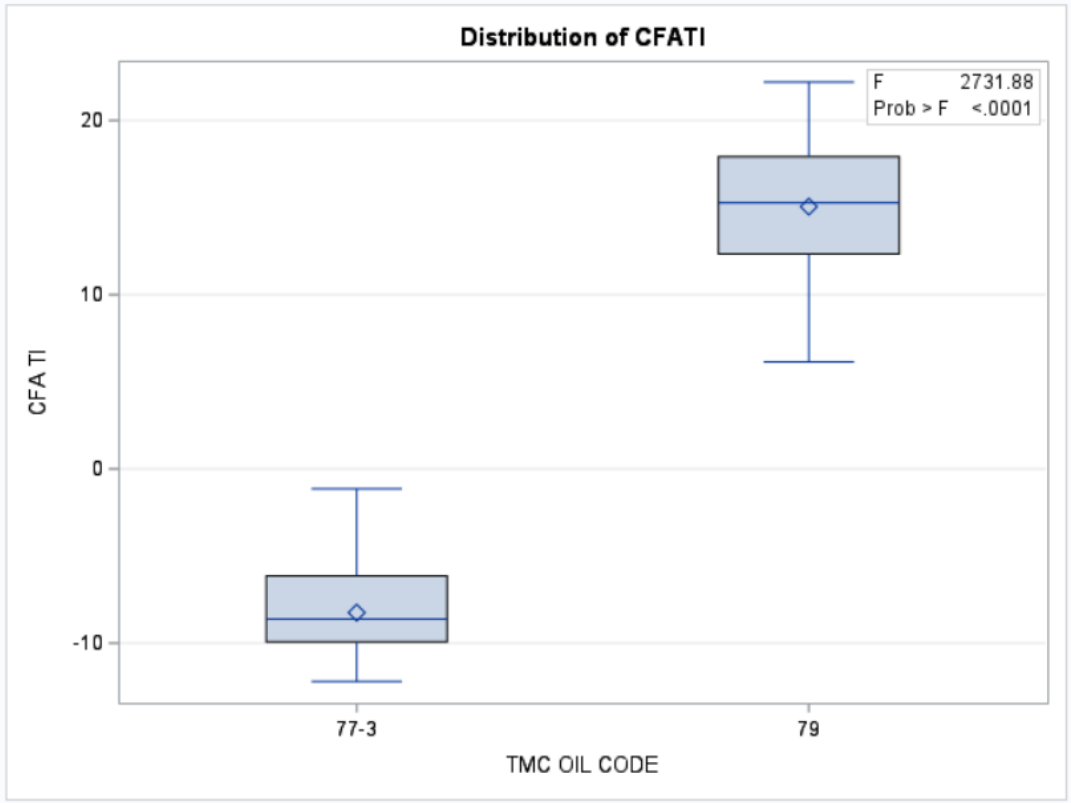


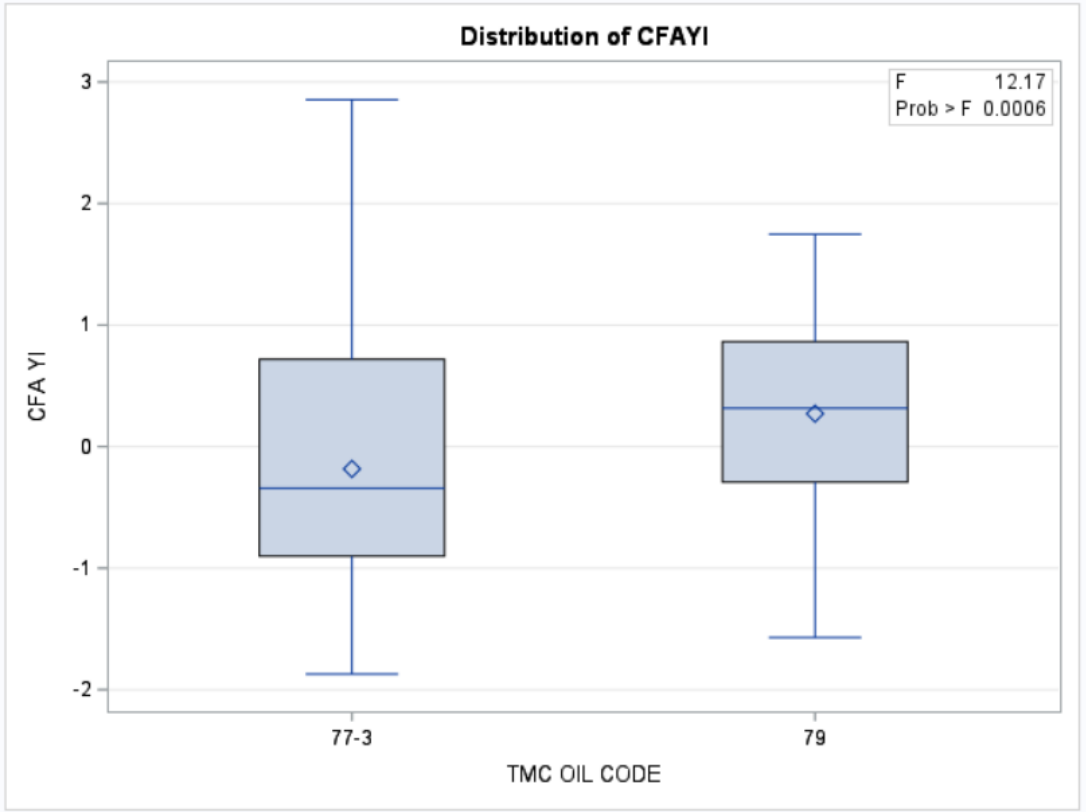
EOWT 0.6% Results by Reference Oil



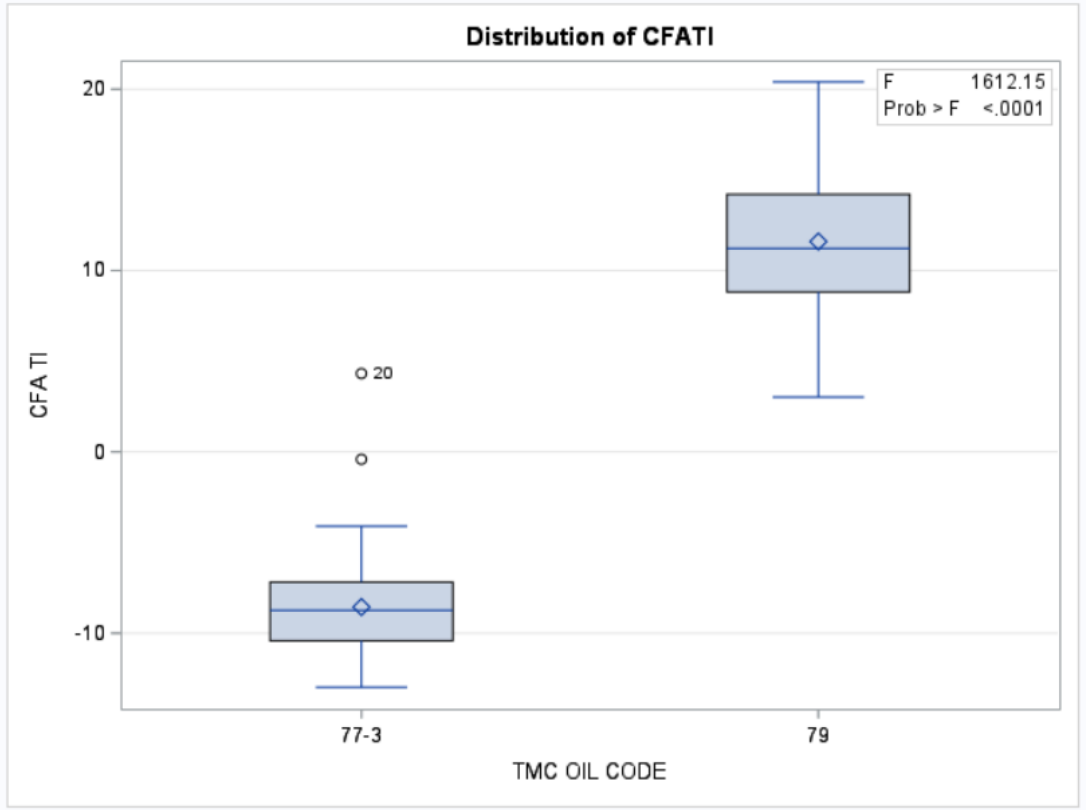


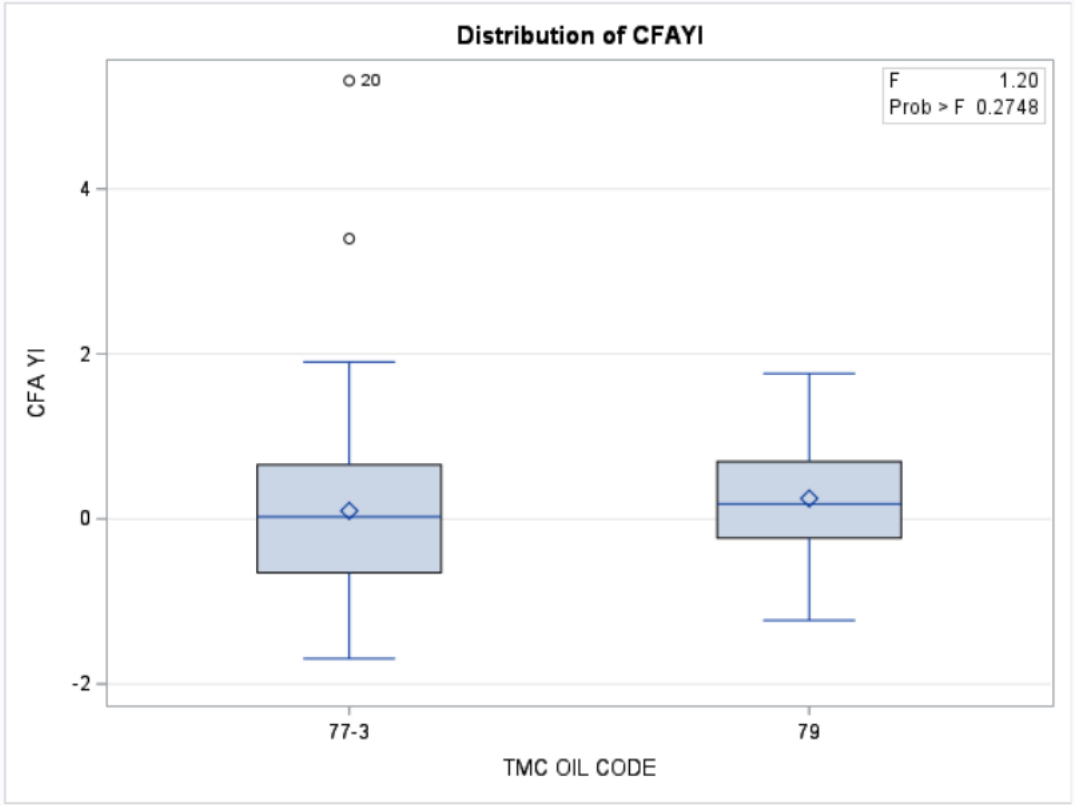
EOWT 1.0% Results by Reference Oil



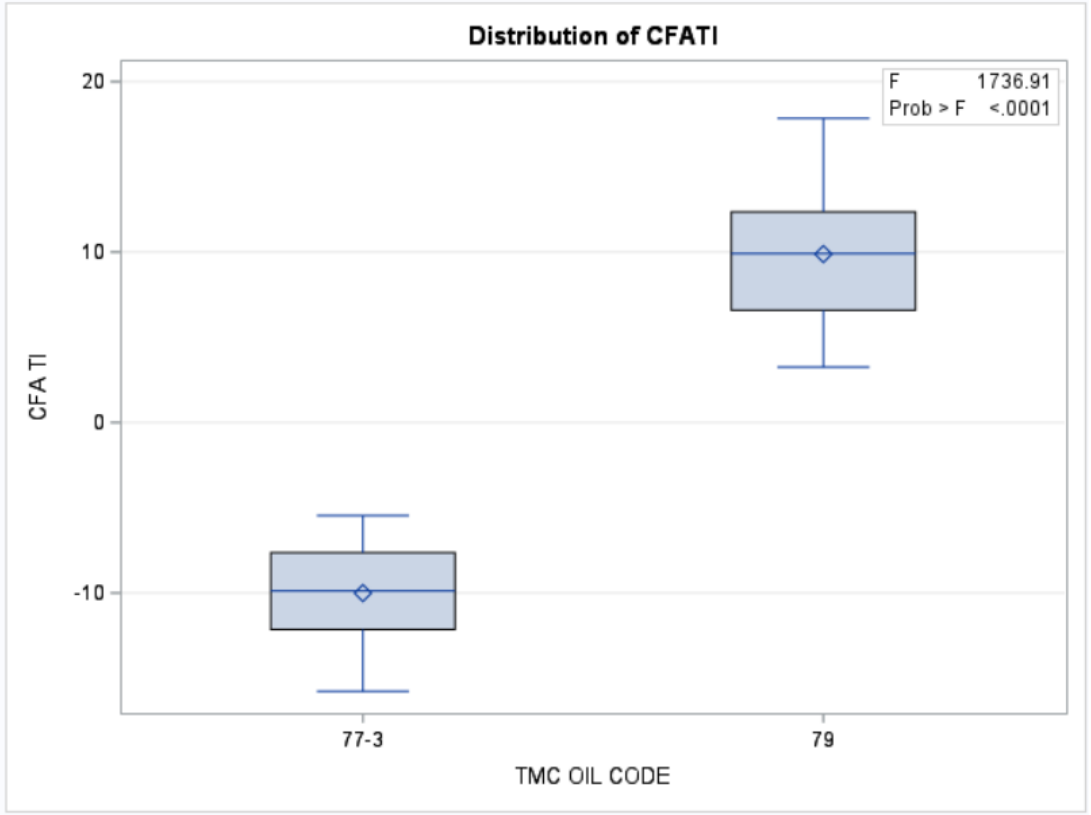


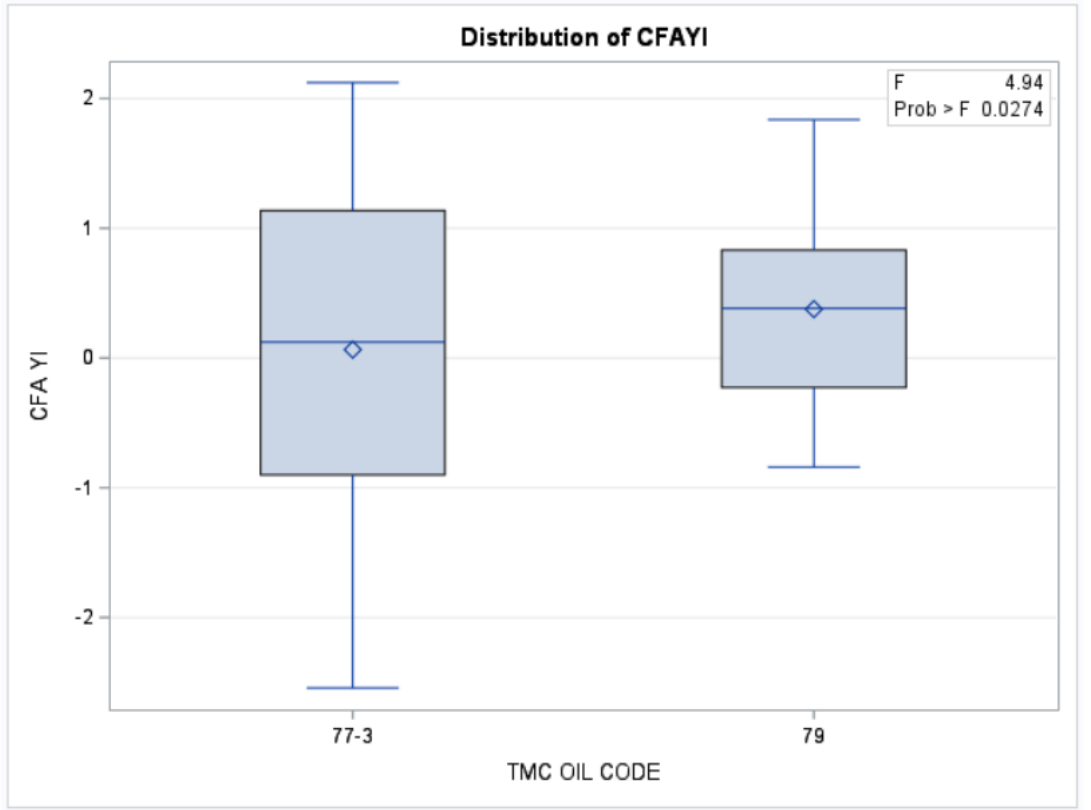
EOWT 2.0% Results by Reference Oil





EOWT 3.0% Results by Reference Oil





Information Letters*

Test	Date	IL	Topic
			No new information letters this period.

*Available from TMC Website

Reference Oil Inventory Estimated Life

EOWT & EOFT

Oil	TMC Inventory (gallons)	TEST	Total Assignments made over Semester	Volume of Samples Assigned (Gallons)	Estimated Life[1]
77-3	350.0	EOWT	390	24.3	5+ years
79	78.3	EOWT	391	26.2	~1 year
		EOFT	117	7.9	

1-Based upon Sample Assignment Rate from past 6 months.

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D02.B0.07
TMC Monitored Tests

ASTM D 6795

Engine Oil Filterability Test (EOFT)

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Calibrated Labs and Stands*

(change since last Semi-Annual report)

Test	Labs	Stands
D6795	5 (+0)	N/A
*As of 3/31/2025		

EOFT Test Activity*

Test Status	Validity Code	Number of Tests
Acceptable Calibration Test	AC	114
Failed Calibration Test	OC	2
Invalid Calibration Test	LC	1
Acceptable Informational Run	NN	0
Unacceptable Informational Run	MN / XN	0
Total		**117**

- 98.3% Acceptable Calibration (AC) Testing Rate
  - 5 labs reported data this semester

EOFT Failed Tests

Failed Parameter	Number of Tests
Change in Flow Average (CIFA) Severe	2
Change in Flow Average (CIFA) Mild	0
Total	**2**

EOFT Failed Tests by Lab

Failed Parameter	LTMS Lab						#
	A	B	G	I	L	BE	
Change in Flow Average (CIFA) Severe	0	N/A	1	0	1	0	2
Change in Flow Average (CIFA) Mild	0	N/A	0	0	0	0	0
Totals	**0**	**N/A**	**1**	**0**	**1**	**0**	**2**

EOFT Lost Tests*

Status	Cause	No. of Tests
Invalid (L,R)	Oven Temperature Issue	1
Aborted (X)		0
Total		**1**

*Invalid and aborted calibration tests

EOFT Information/Shakedown Tests

Informational / Shakedown Results	Number of Tests
None	0
Total	**0**

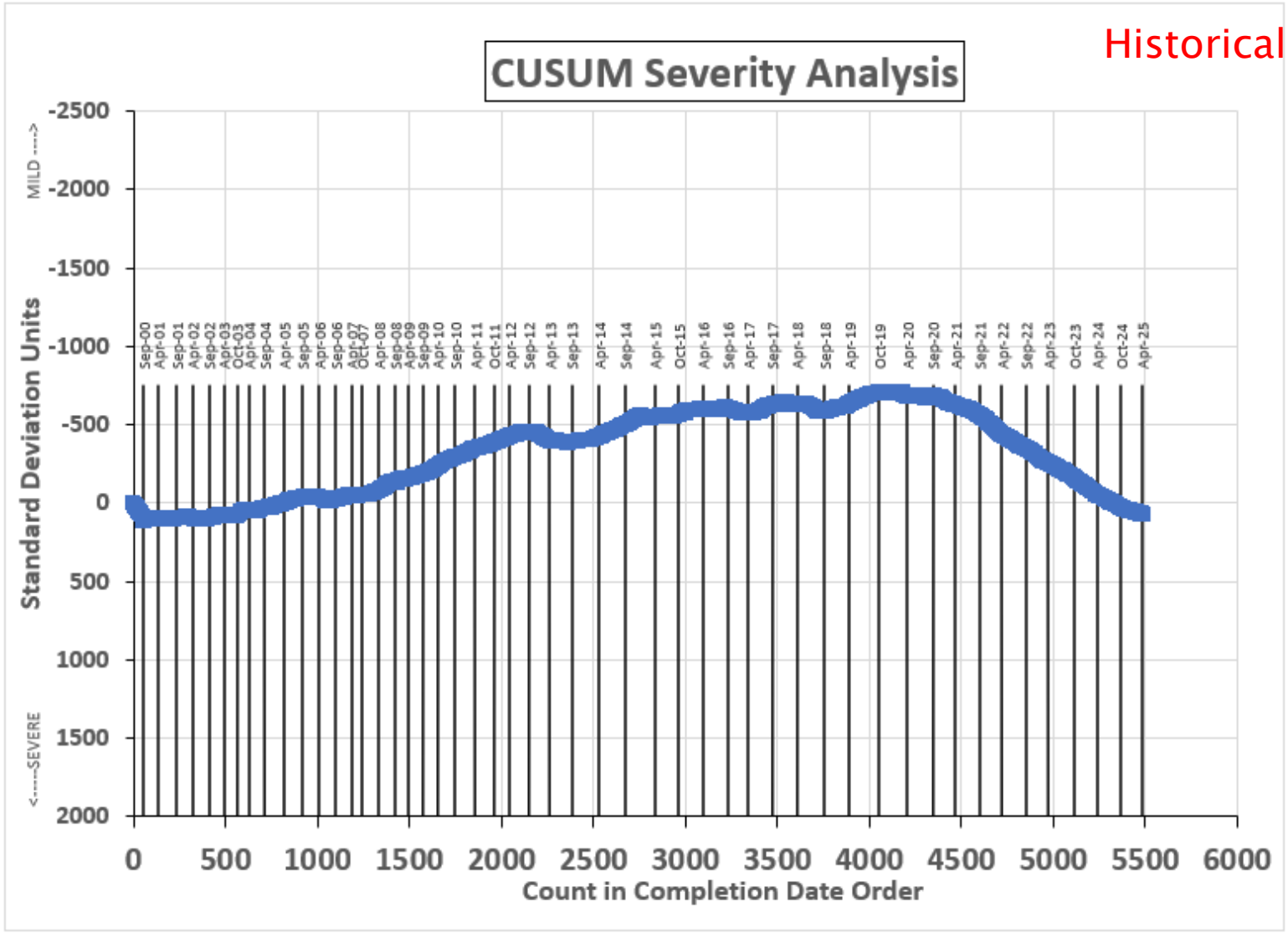
EOFT Test Status

- Change in Flow Average (CIFA) continues to trend severe although CUSUM slope appears to be leveling off this semester.
- Precision (Pooled s) rose to 5.76 s, highest it has been in several years.
- Performance (Mean Δ/s) was found to be 0.41, the lowest it has been since October 2021.

EOFT INDUSTRY OPERATIONALLY VALID DATA

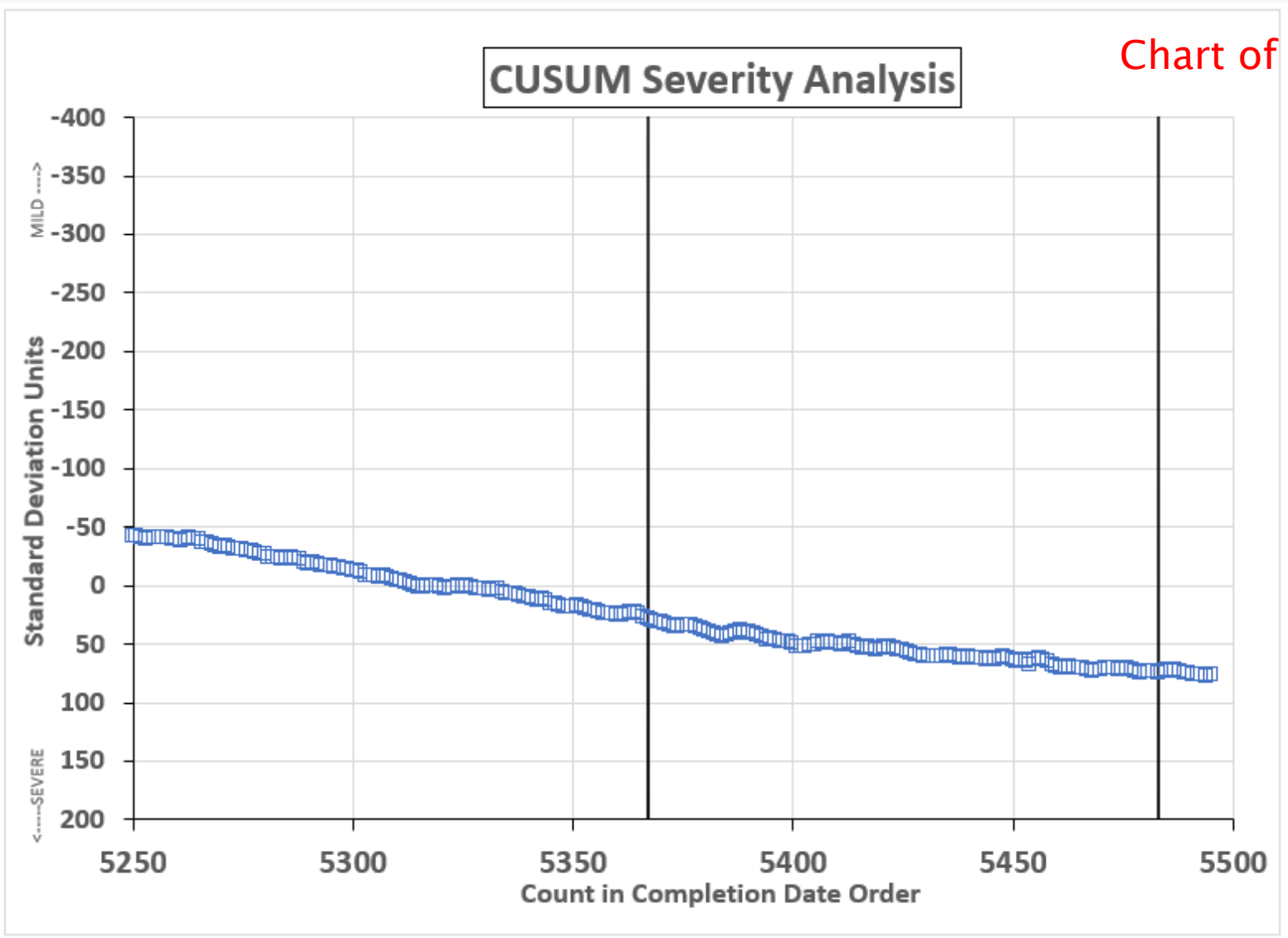
20 —25 ML CHANGE IN FLOWRATE AVERAGE (%)

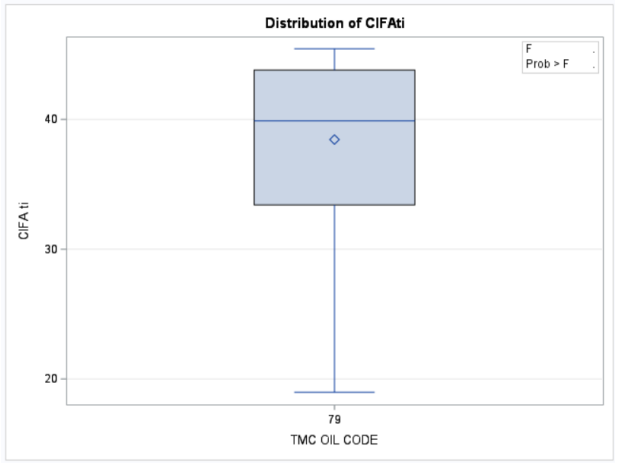
Historical Chart



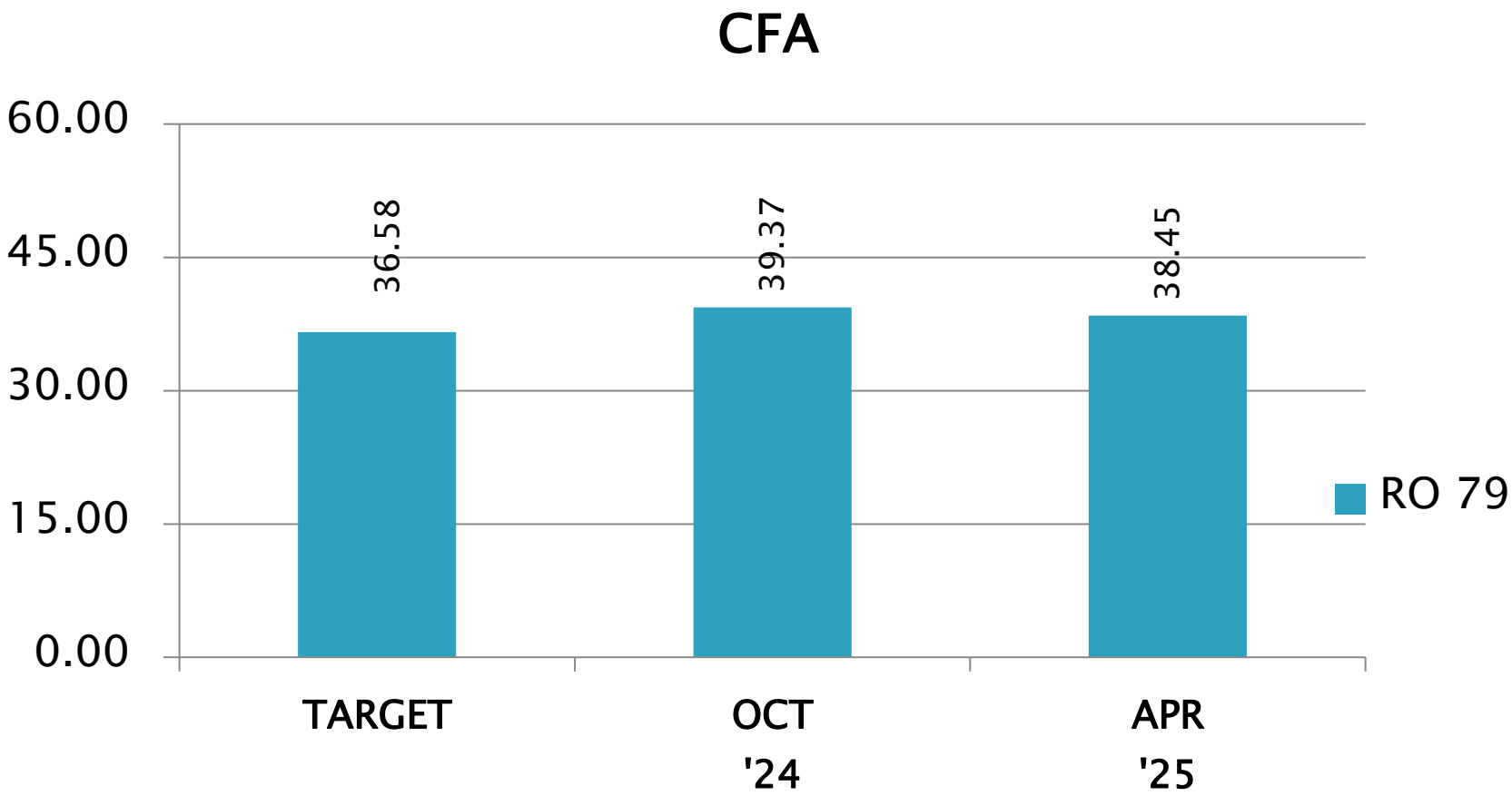
EOFT INDUSTRY OPERATIONALLY VALID DATA
Last 250 Data Points
20 —25 ML CHANGE IN FLOWRATE AVERAGE (%)

Chart of recent results





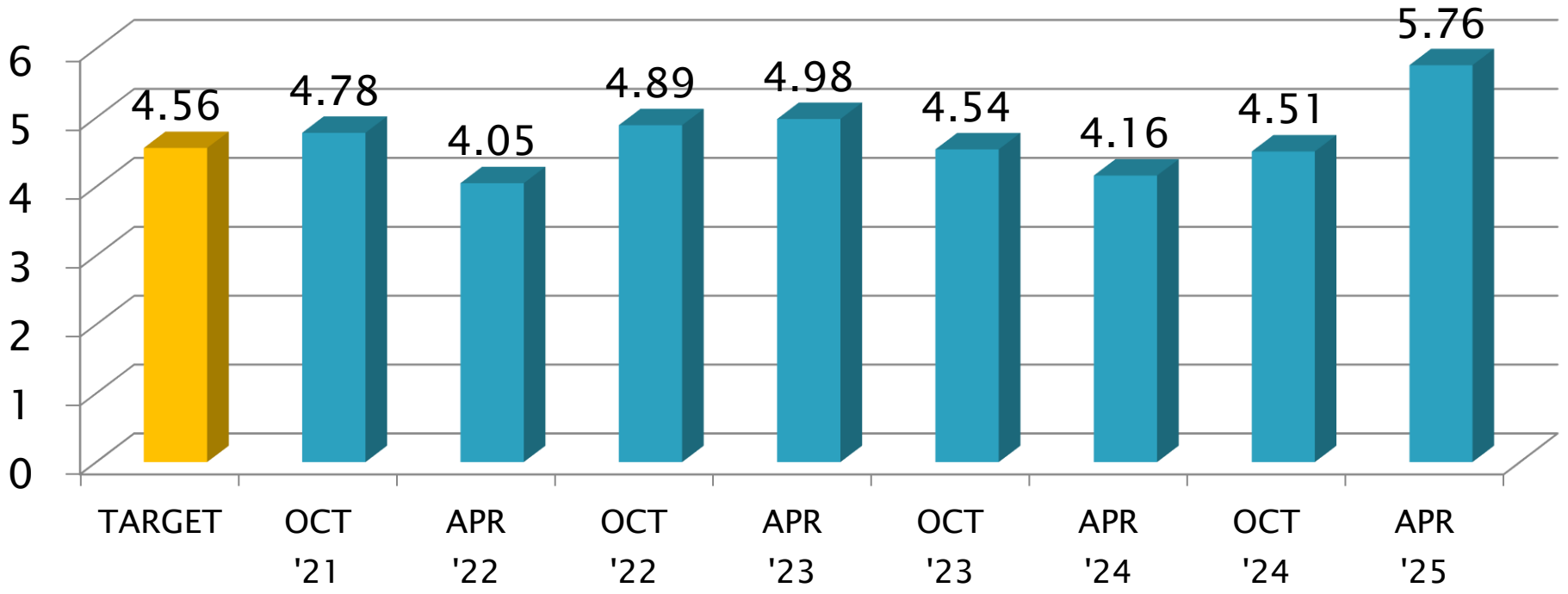
EOFT MEAN CFA's (%)

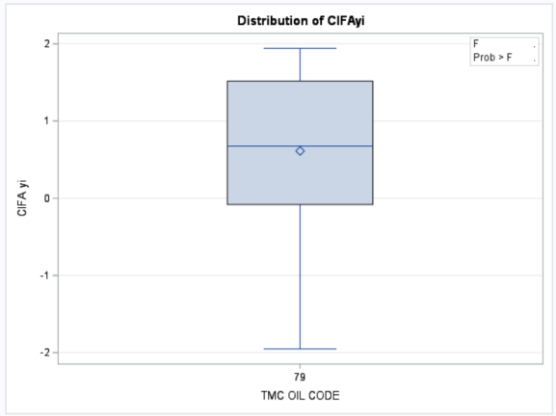


EOFT Precision Estimates

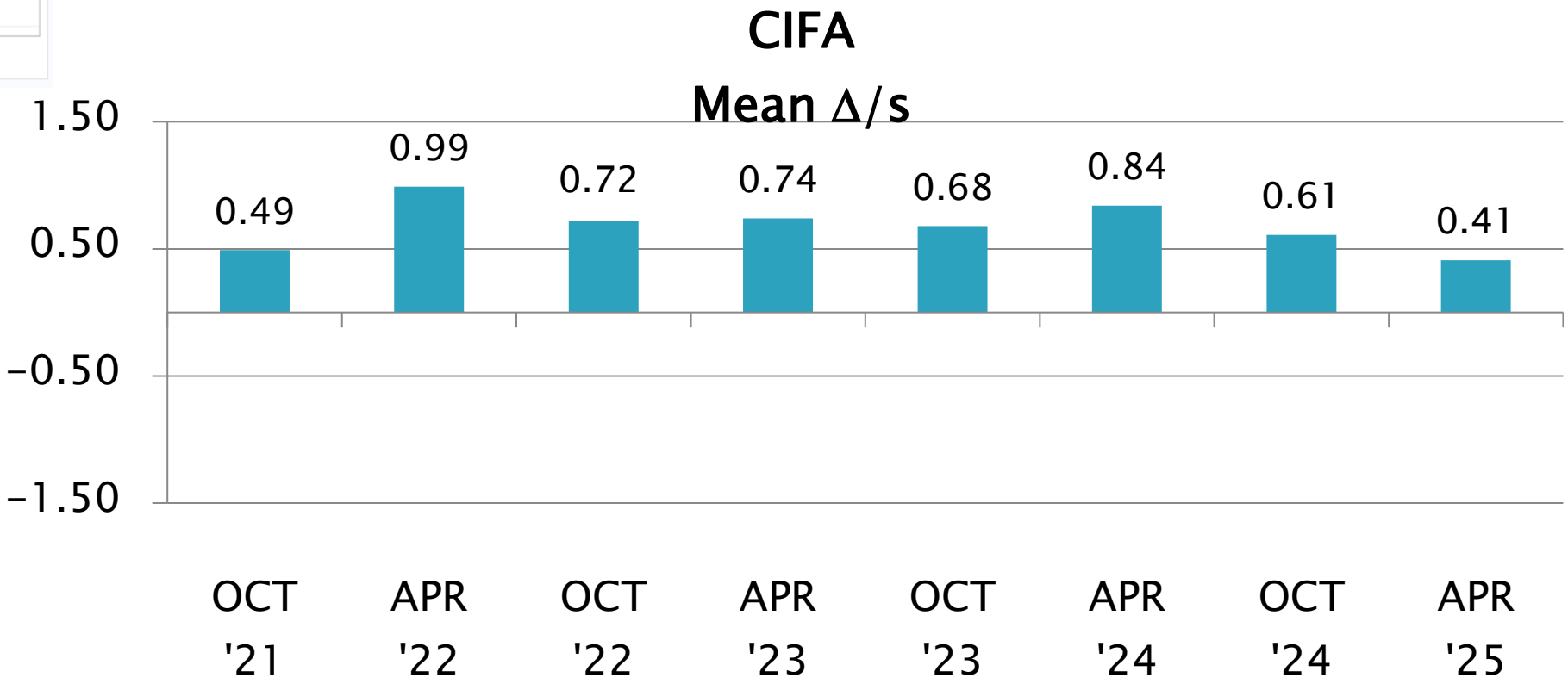
CIFA

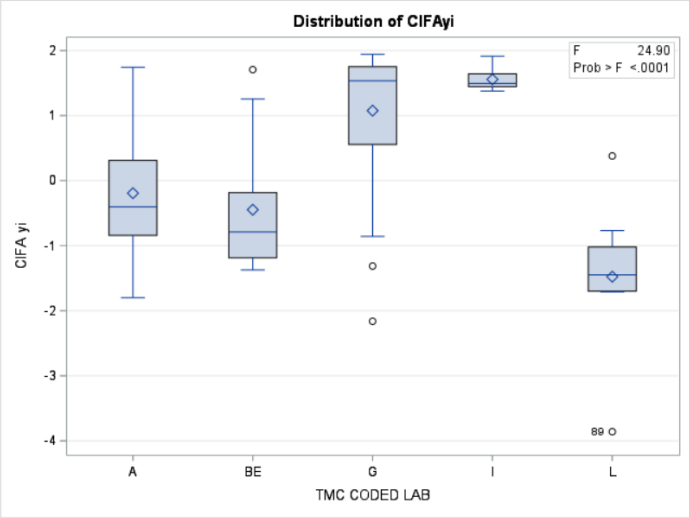
Pooled s



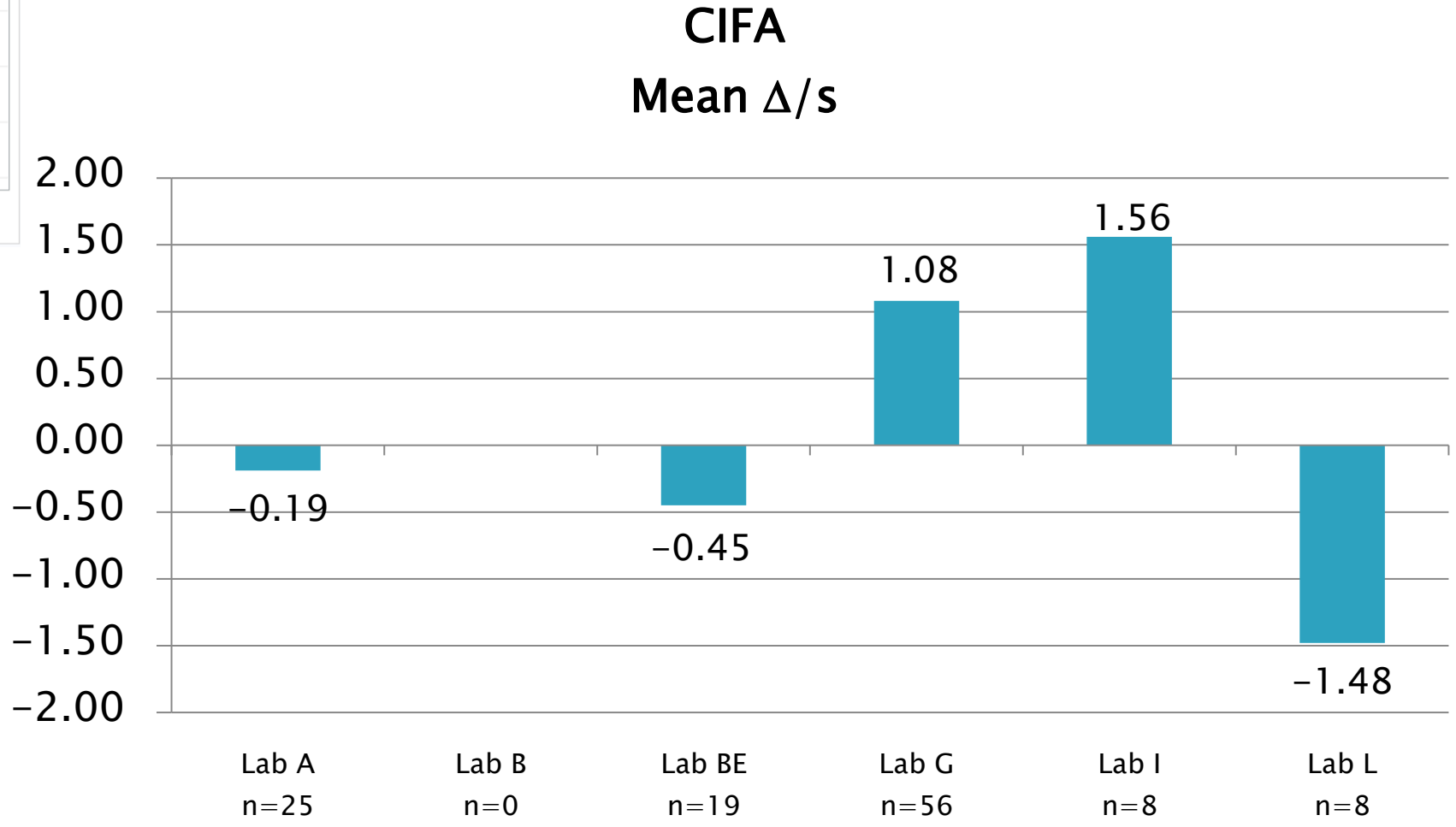


EOFT Severity Estimates





EOFT Lab Severity Estimates



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Information Letters*

Test	Date	IL	Topic
			No new information letters this period.

*Available from TMC Website

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EOWT & EOFT

Oil	TMC Inventory (gallons)	TEST	Total Assignments made over Semester	Volume of Samples Assigned (Gallons)	Estimated Life[1]
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		EOFT	117	7.9	

1-Based upon Sample Assignment Rate from past 6 months.

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D02.B0.07
TMC Monitored Tests

ASTM D 7097

Medium High Temperature TEOST (MTEOS)

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Calibrated Labs and Stands*

(change since last Semi-Annual report)

Test	Labs	Stands
D7097	11 (+0)	36 (+1)
*As of 3/31/2025		

D7097: Deposits by MTEOS

Test Status	Validity Code	No. Tests
Acceptable Calibration Test	AC	64
Failed Calibration Test	OC	8
Operationally Invalidated by Lab	LC	0
Operationally Invalidated by TMC	RC	1
Operationally Invalid (Aborted)	XC	0
Acceptable Informational Run	NN	1
Unacceptable Informational Run	MN	0
Total		**74**

Number of Labs Reporting Data: 11 (+0)
Fail Rate of Operationally Valid Tests: 11.1% (13.2% last period)

D7097: Deposits by MTEOS

Statistically Unacceptable Tests (OC)	No. Of Tests
Total Deposits Severe	7
Total Deposits Mild	1
Total	**8**

FOUR Labs had OC results.
All SEVEN Severe fails were on RO 434-3
One Mild fail on RO 432.

D7097: Deposits by MTEOS
Summary of Invalid Tests

Operationally Invalid Tests (LC, RC, XC)	Validity Code	No. Of Tests
Aborted by Lab	XC	0
Invalidated by TMC. Sample Weight out of Range	RC	1
Invalidated by Lab	LC	0
Total		**1**

D7097: Deposits by MTEOS
Summary of Informational Tests

Informational / Shakedown Tests (NN, MN)	Validity Code	No. Of Tests
Shakedown run, Deposits in Range	NN	1
Shakedown run, Deposits not in Range (Severe)	MN	0
Total		**1**

D7097: Deposits by MTEOS

Period Precision and Severity Estimates

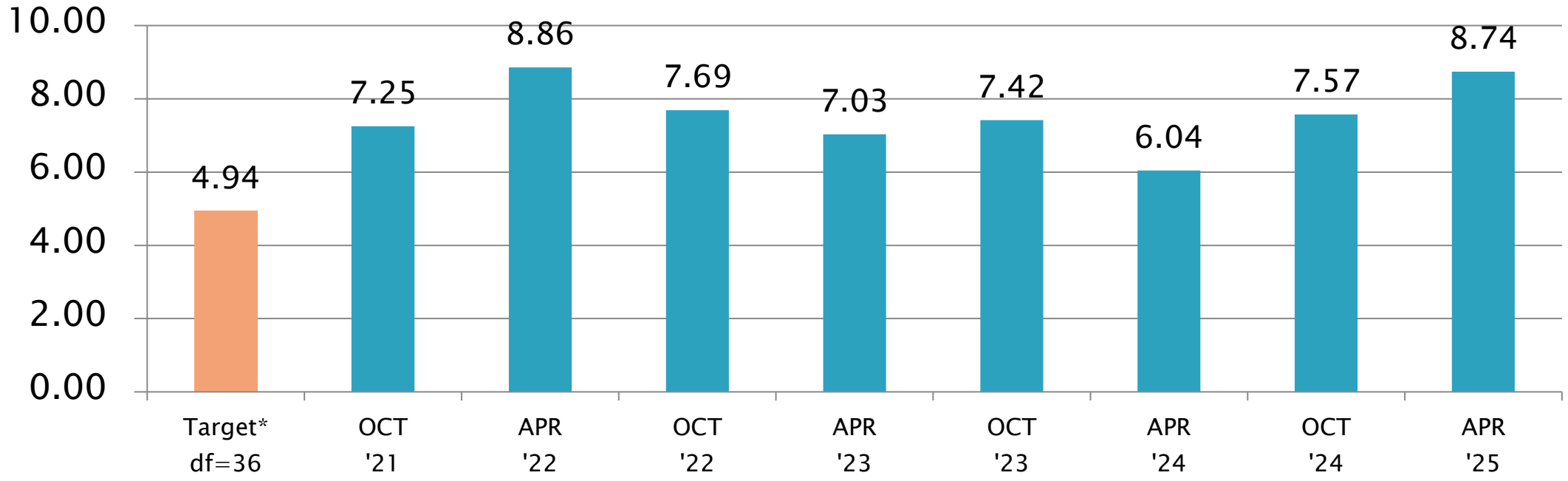
Total Deposits, mg	n	df	Pooled s	Mean Δ/s
Current Targets 9/30/2021[1]	38	36	4.94	-----
4/1/20 through 9/30/20	72	70	4.87	-0.22
10/1/20 through 3/31/21	101	99	8.40	0.17
4/1/21 through 9/30/21	81	78	7.25	-0.02
10/1/21 through 3/31/22	75	73	8.86	0.18
4/1/22 through 9/30/22	77	75	7.69	0.69
10/1/22 through 3/31/23	67	65	7.03	0.41
4/1/22 through 9/30/23	74	71	7.42	0.31
10/1/23 through 3/31/24	65	62	6.04	0.19
4/1/24 through 9/30/24	76	73	7.57	0.43
10/1/24 through 3/31/25	72	70	8.74	0.31

[1]Target precision updated to reference oils 432 and 434-3 preliminary

D7097 Precision Estimates

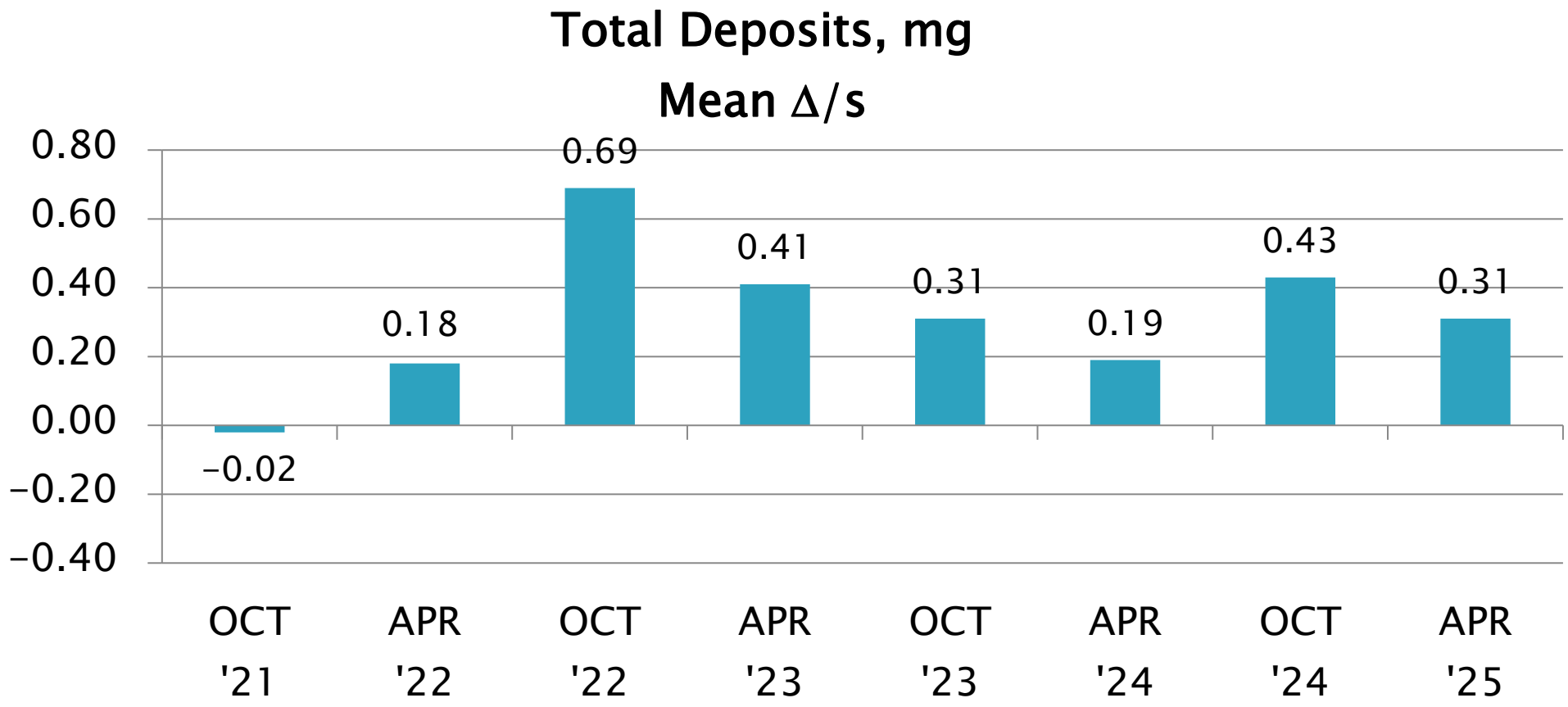
Total Deposits, mg

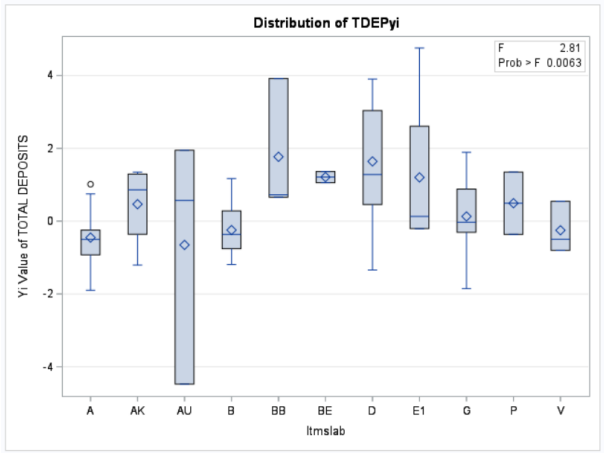
Pooled s



*Target precision updated to reference oils 432 and 434-3 preliminary

D7097 Severity Estimates

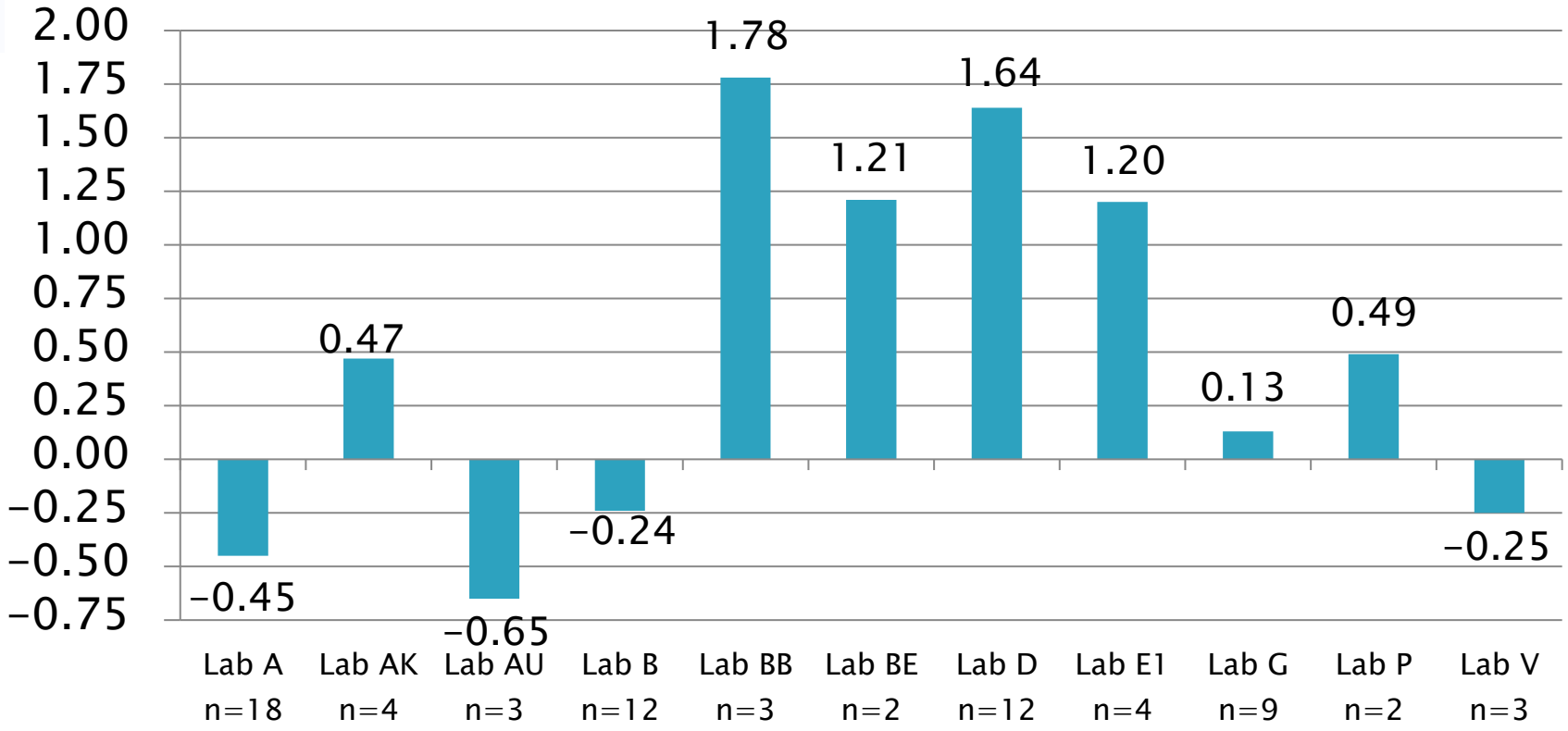




D7097 Lab Severity Estimates

Total Deposits, mg

Mean Δ/s



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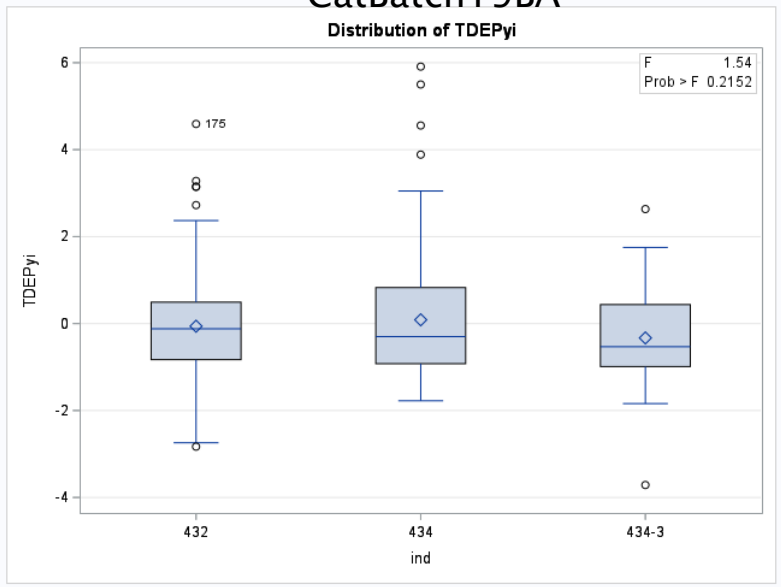
D7097: Deposits by MTEOS

- Precision (Pooled s) regressed further to 8.74 s this reporting period
- Performance (Mean Δ/s) has improved, moving from 0.43 s back up to 0.31 s this semester.
- All 72 operationally valid tests this period report using Rod Batch N.
- Most operationally valid calibration tests this period report using Catalyst Batch 23AB (n=69). Only three tests used Catalyst Batch 20AB (n=3).
  - No runs used Catalyst Batch 19BA this semester

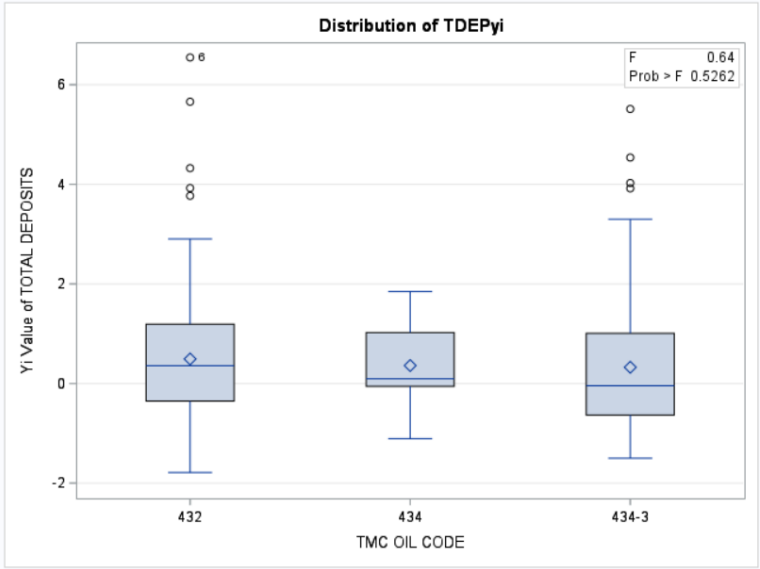
D7097: Deposits by MHT TEOST

- No new runs on catalyst batch 19BA this semester
  - Total Runs and Yi statistic for batch 19BA remain at n=349, Yi = -0.02.
- Only 3 new runs on catalyst batch 20AB (total n=322). Performance (Yi) unchanged at 0.41.
- Newest catalyst batch 23AB now has 138 runs. Performance (Yi) continues to improve.
  - YI = 0.44 APR '25; Yi = 0.53 OCT '24; Yi=1.39 APR '24

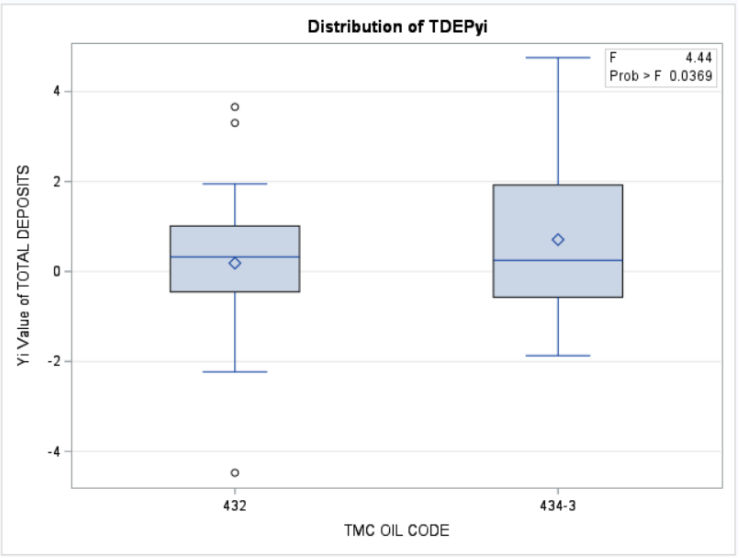
CatBatch19BA



CatBatch20AB



CatBatch23AB



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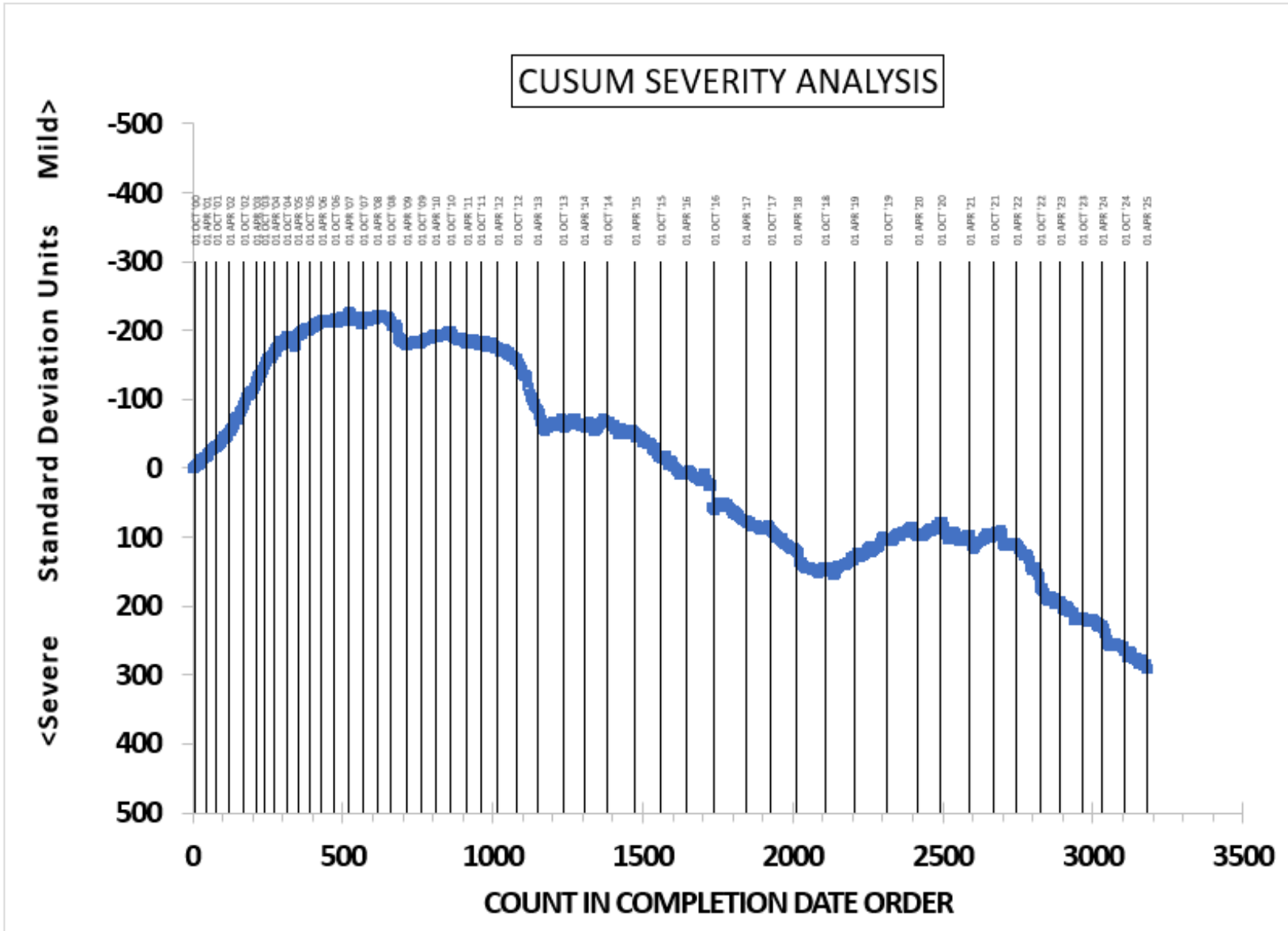
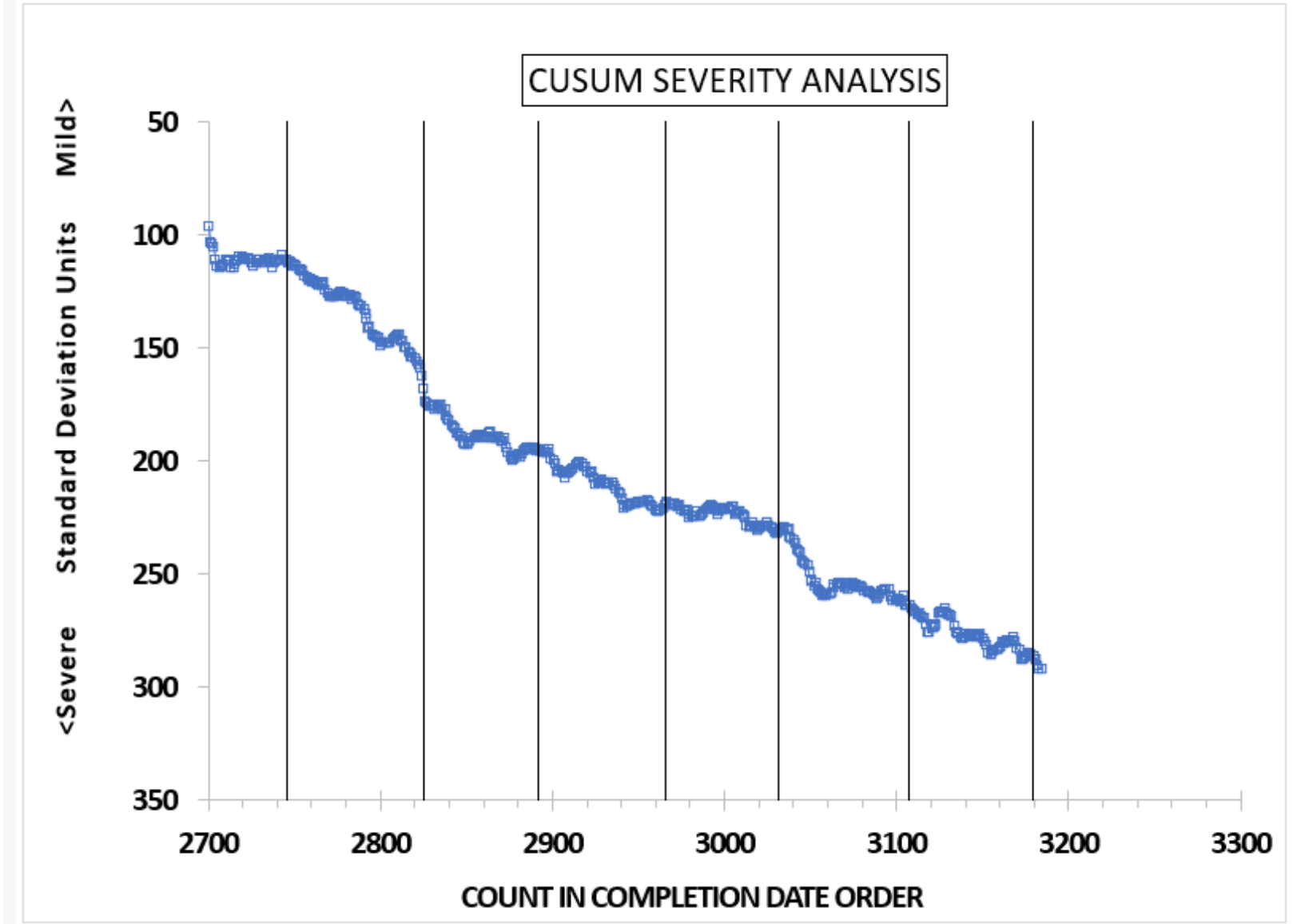
MHT—4 TEOST INDUSTRY OPERATIONALLY VALID DATA

TOTAL DEPOSITS MG



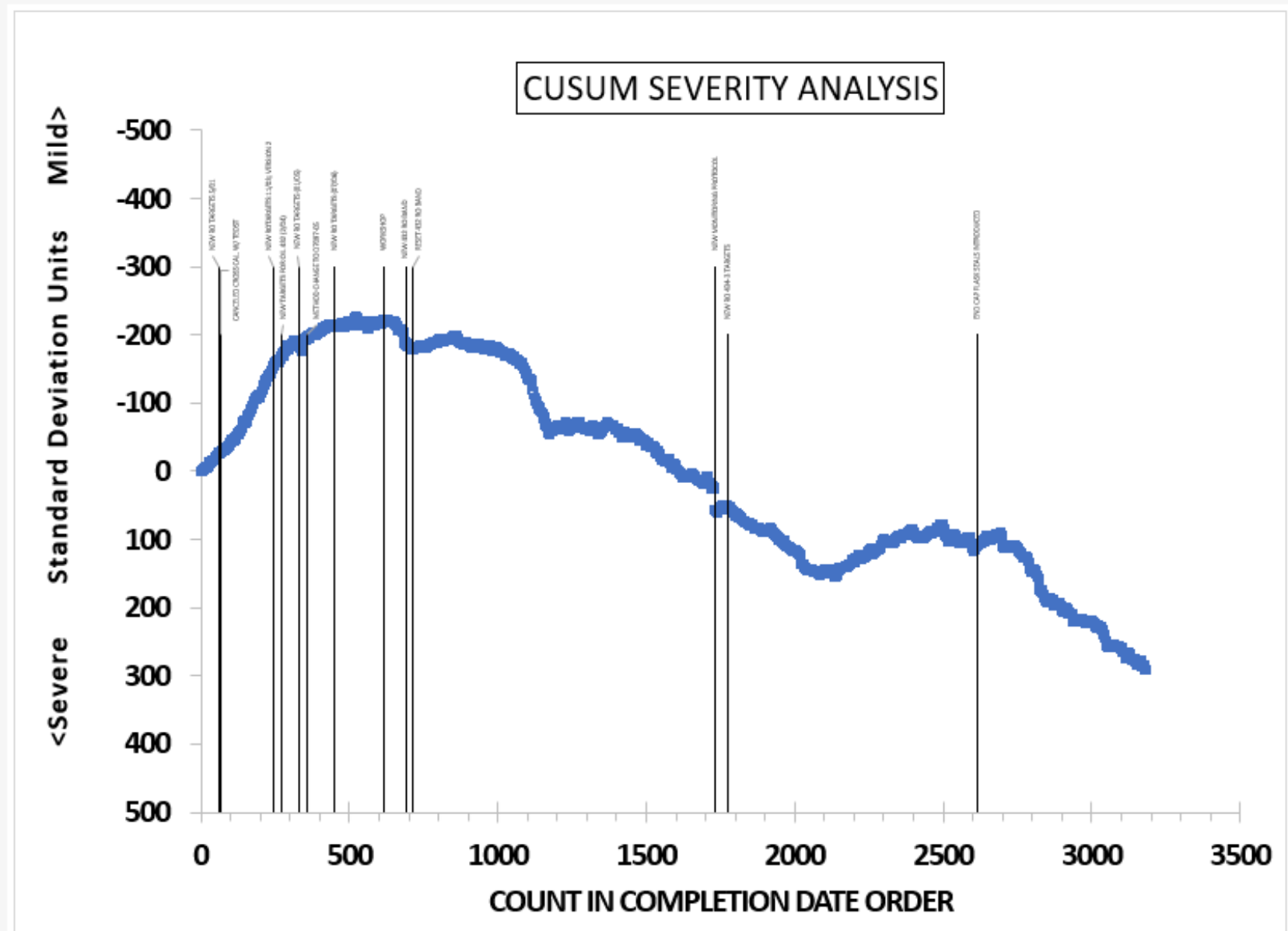
MHT—4 TEOST INDUSTRY OPERATIONALLY VALID DATA
Last 500 Points
TOTAL DEPOSITS MG



MHT—4 TEOST INDUSTRY OPERATIONALLY VALID DATA

SEVERITY DATES

TOTAL DEPOSITS MG



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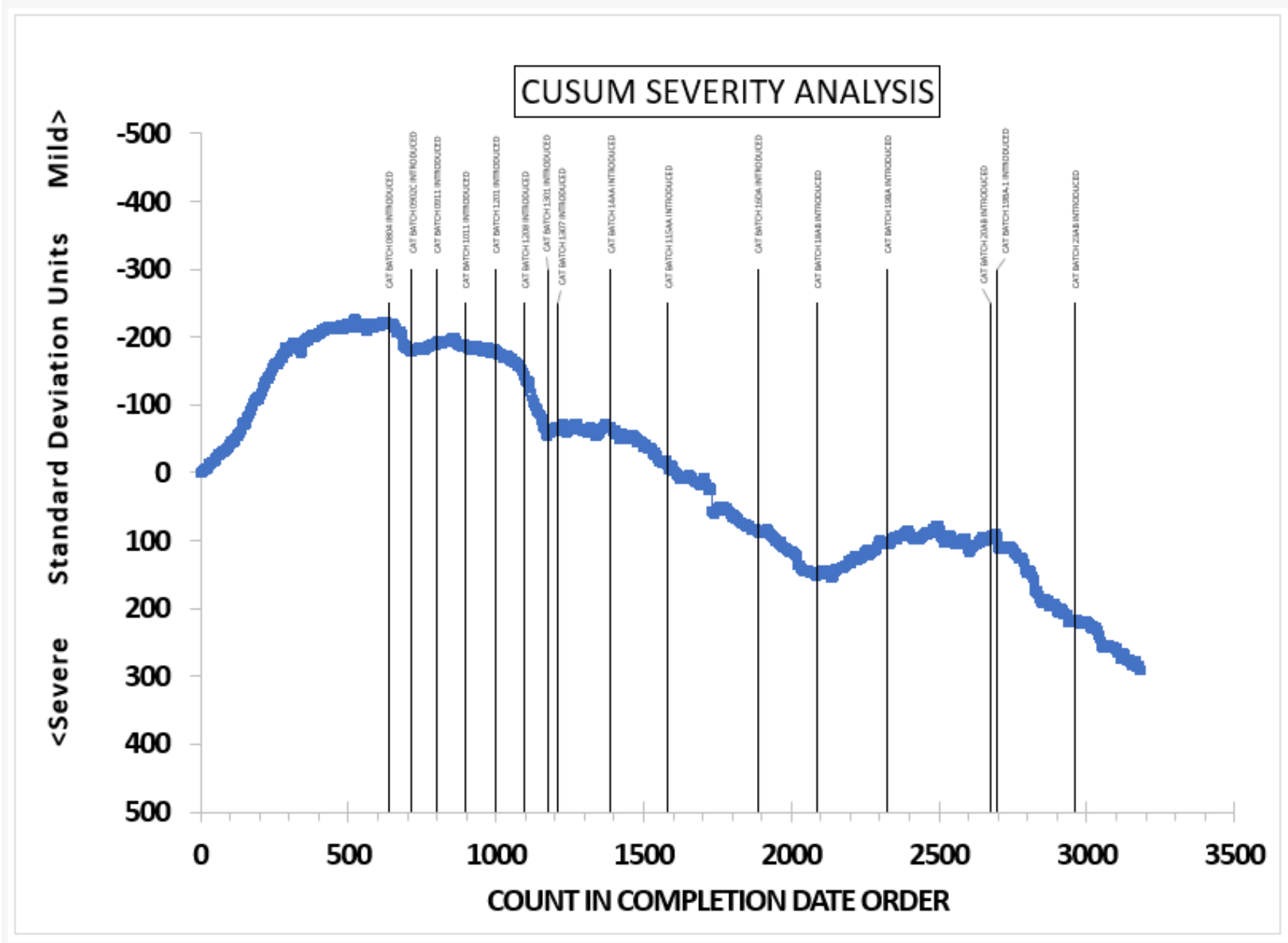
MHT—4 TEOST INDUSTRY OPERATIONALLY VALID DATA

CATALYST BATCH

TOTAL DEPOSITS MG



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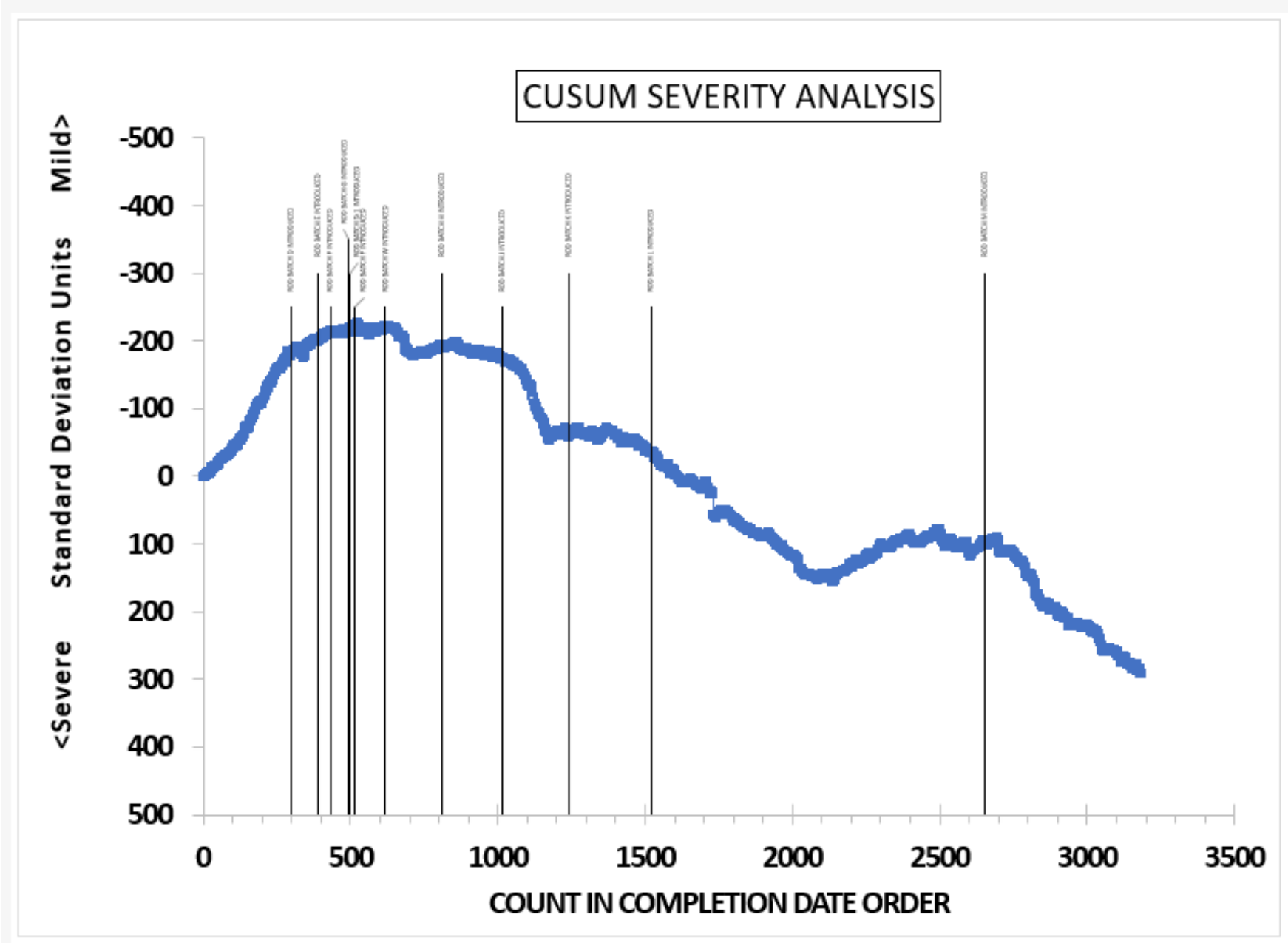
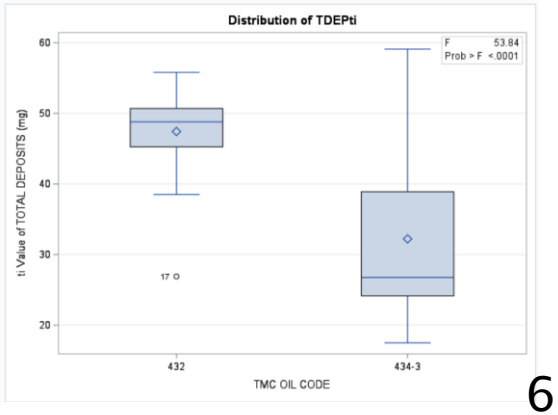
MHT –4 TEOST INDUSTRY OPERATIONALLY VALID DATA

ROD BATCH

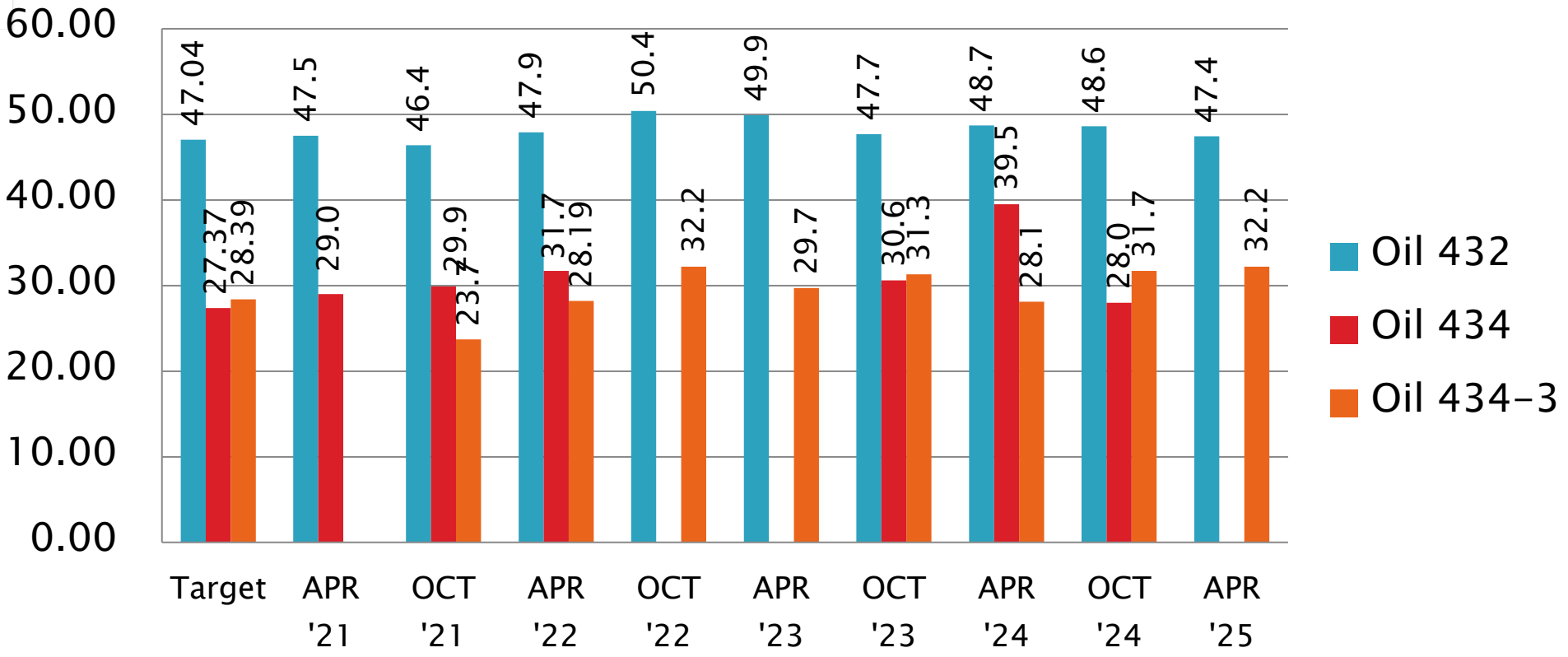
TOTAL DEPOSITS MG





D7097 Performance by Oil

Total Deposits, mg
Mean



*Only a single RO 434 run for APR'24 and OCT'24.

October 1, 2024 – March 31, 2025

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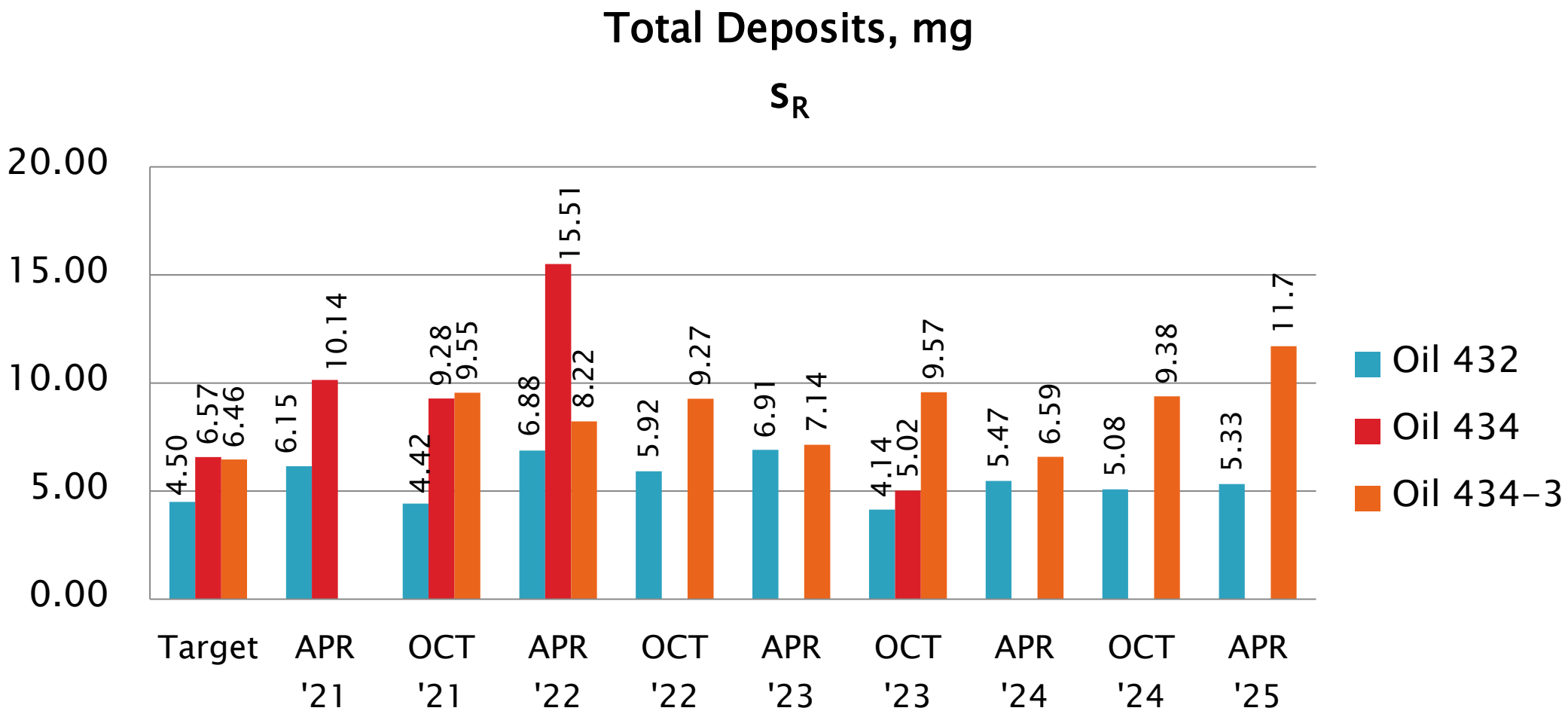
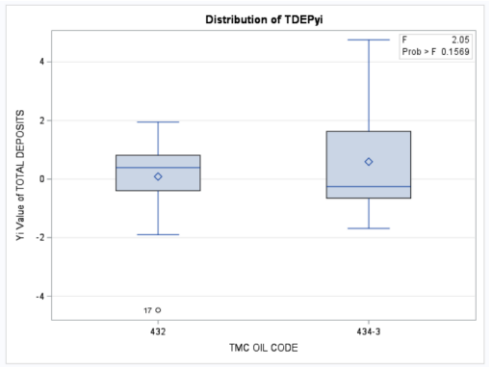
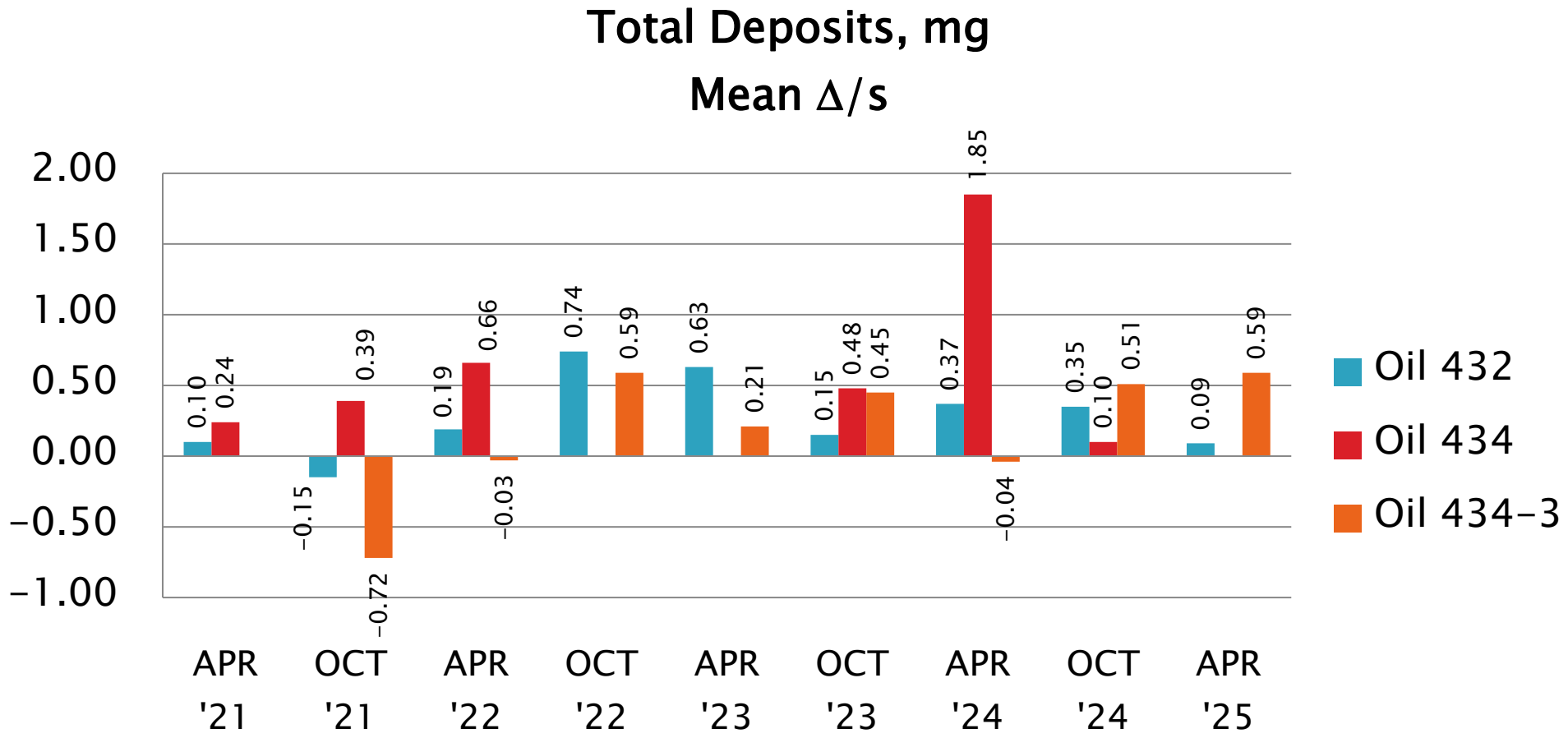
D7097: Deposits by MHT TEOST



*Only single RO 434 runs. No StDEV result available for APR'24 and OCT'24.



D7097: Deposits by MHT TEOST



*Only a single RO 434 run for APR'24 and OCT'24.

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Reference Oil Inventory

MTEOS

Oil	Year Rec'd By TMC[A]	Tests	TMC Inventory, gallons	Gallons Shipped last 6 months	Estimated Life
432	1998	MTEOS	100.98	0.31	5+ years
434-3[B]	2017	MTEOS	11.78	2.90	1.5 years

[A] Integrity of TMC reference oils is confirmed annually by analytical QC testing of chemical and physical properties.
[B] Multi-test oil; estimated supply of drum reserved for bench testing – other drums available.

D02.B0.07
TMC Monitored Tests

ASTM D 7216

Engine Oil Elastomer Compatibility (EOEC/LDEOC)

October 1, 2024 – March 31, 2025

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ASTM Reference Testing Semi-Annual Report D7216 EOEC

October 1, 2024 – March 31, 2025

ASTM D 7216

Engine Oil Elastomer Compatibility

EOEC (Heavy-Duty)	
OHT PART NUMBER	BATCH CODE*
OHTEOEC-NBR-A	33
OHTEOEC-ACM-B	33
OHTEOEC-FKM-A	32
OHTEOEC-MAC-A	25
OHTLDEOC-VMQ1-A	43
OHTLDEOC-HNBR-A	1

* As of 20250403

Calibrated Labs and Stands[1]

(change since last Semi-Annual report)

Test	Labs	Stands
D7216 EOEC	8[2] (+0)	N/A

[1] As of 3/31/2025

2 Not all elastomer types were run at each lab

EOEC Test Activity*

Test Status		Fluoroelast.	Nitrile	Polyacrylate	Silicone	Ethylene Acrylate	Total
LABS BATHS		6 29	7 25	7 25	8 23	7 23	
Acceptable Calibration Test	AC	59	80	54	54	52	**299**
Failed Calibration Test	OC	2	1	0	1	1	**5**
Operationally Invalid, by lab	LC	0	1	0	0	0	**1**
Operationally Invalid, by TMC	RC	0	0	1	0	1	**2**
Aborted	XC	1	1	2	2	1	**7**
Acceptable Informational Run	NN	26	0	0	0	0	**26**
Unacceptable Informational Run	MN	1	0	0	0	0	**1**
Total		**89**	**83**	**57**	**57**	**55**	**341**

EOEC Failed Calibration Tests*

Cause	Elastomer	No. of Tests
TENSILE STRENGTH & HARDNESS (SEVERE)	NBR	1
HARDNESS (MILD)	MAC	1
ELONGATION (SEVERE)	VMQ	1
VOLUME CHANGE (SEVERE)	FKM	2
Total		**5**

* FOUR failing calibration tests from TWO different labs

EOEC Lost Tests*

Validity	Cause	No. of Tests
XC	Aborted Test Due to Power Outage	7
LC	Test Ran on Wrong Elastomer Type	1
RC	Incorrect Bath Heating Time	2
Total		**10**

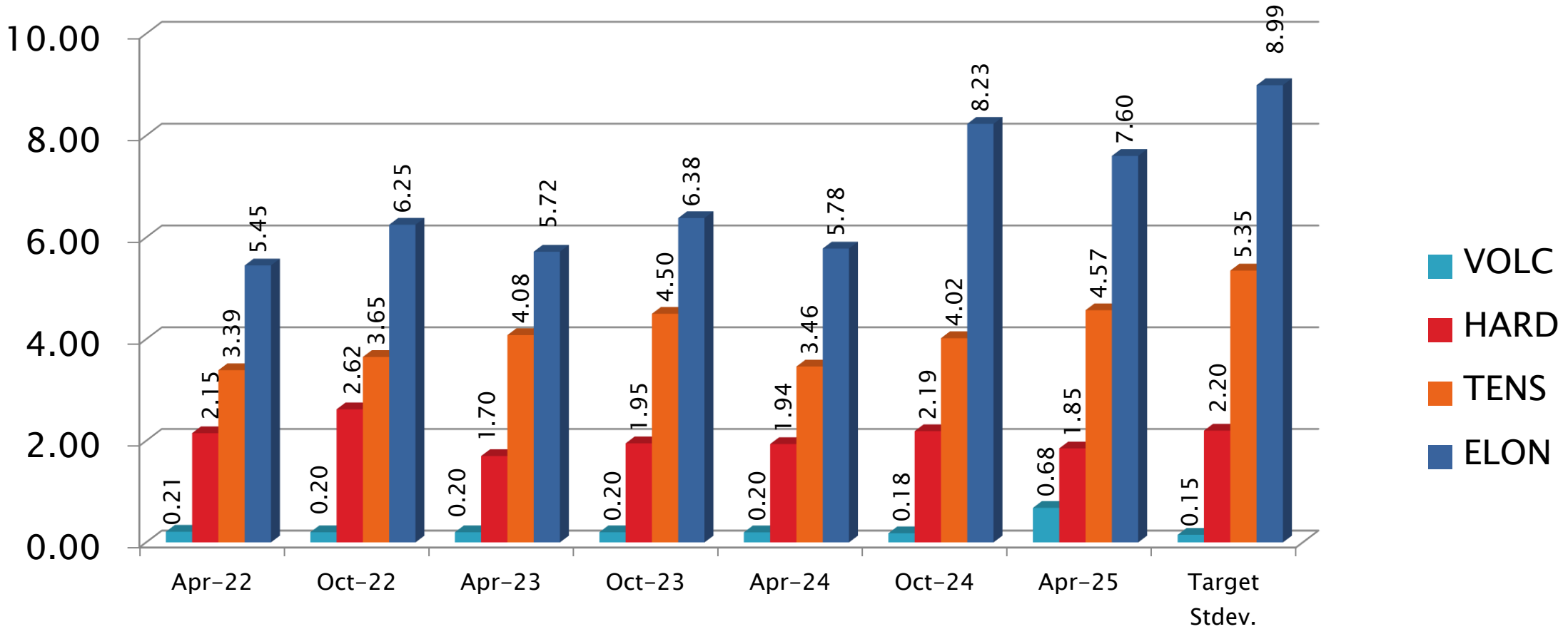
*Invalid and aborted calibration tests

EOEC Test Severity

Fluoroelastomer (FKM)

Parameter	Period Mean Δ/s	Status
Volume Change	1.2362	Very Severe
Points Hardness Change	0.2501	Slightly Severe
Tensile Strength Change	0.0901	On Target
Elongation Change	-0.4461	Mild

EOEC Precision (Pooled s) Estimates: Fluoroelastomer



EOEC Precision Estimates by Lab: FKM

Test Parameter	Statistic	LTMS Lab							
		A	B	BB	G	I	L	P	V
	n=	17	6	0	20	10	4	4	0
Volume	Mean	0.45	0.46		0.88	0.68	0.37	0.39	
	Pooled s	0.11	0.06		1.13	0.19	0.09	0.20	
	Mean /s	0.10	0.10		3.00	1.65	-0.49	-0.32	
Hardness	Mean	9.00	9.00		7.15	9.70	9.75	9.50	
	Pooled s	1.27	1.10		2.25	0.82	0.96	0.58	
	Mean /s	0.44	0.44		-0.40	0.75	0.78	0.66	
Tensile Strength	Mean	-72.8	-72.5		-71.1	-68.1	-69.5	-66.9	
	Pooled s	1.79	1.43		6.78	2.33	2.43	2.41	
	Mean /s	-0.28	-0.22		0.04	0.61	0.34	0.83	
Elongation	Mean	-70.3	-65.4		-56.5	-59.2	-65.4	-60.1	
	Pooled s	2.72	1.14		8.22	2.88	2.19	1.24	
	Mean /s	-1.31	-0.77		0.22	-0.9	-0.77	-0.18	

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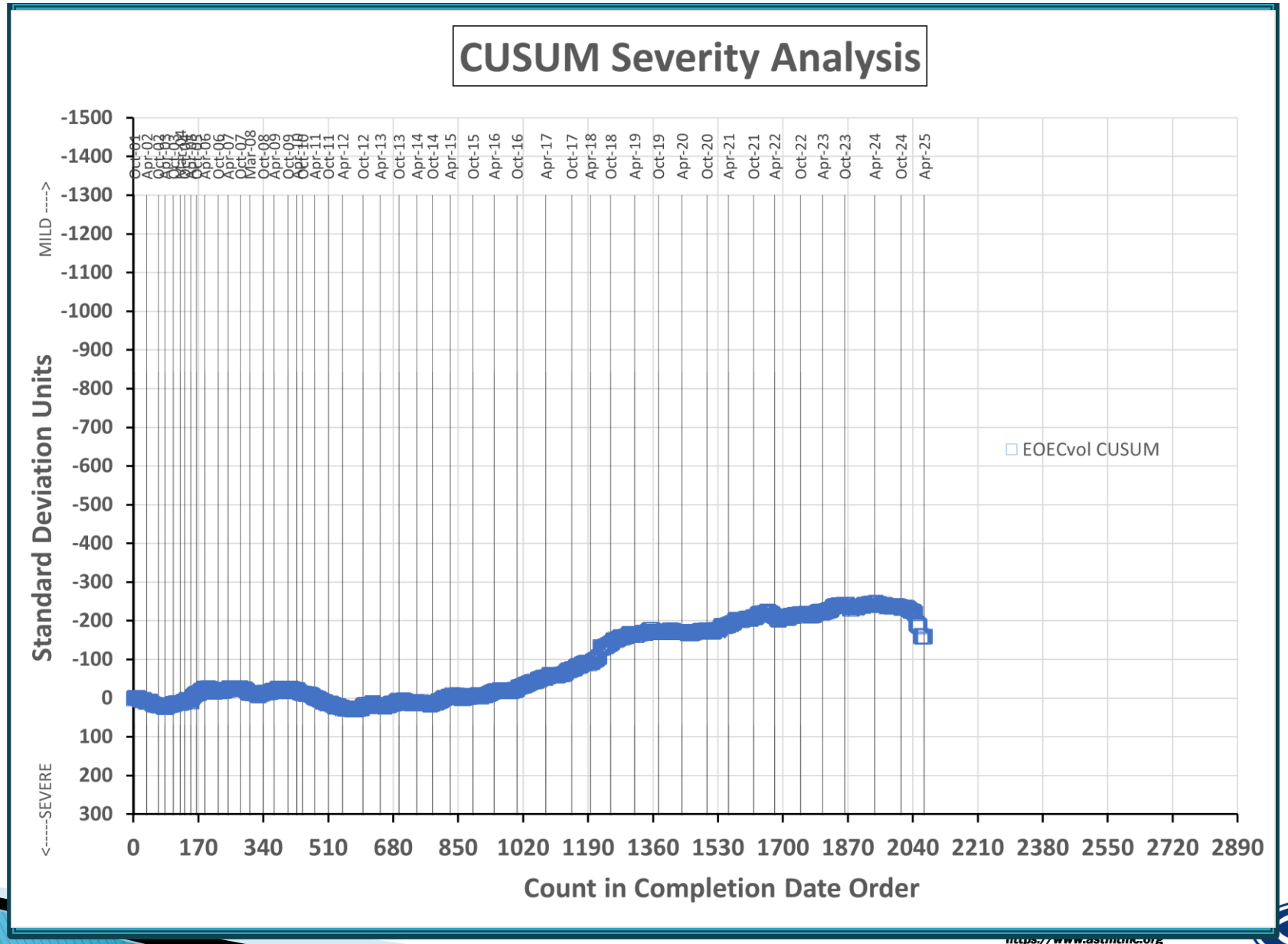
FLUOROELASTOMER VOLUME CHANGE CORRECTED AVERAGE



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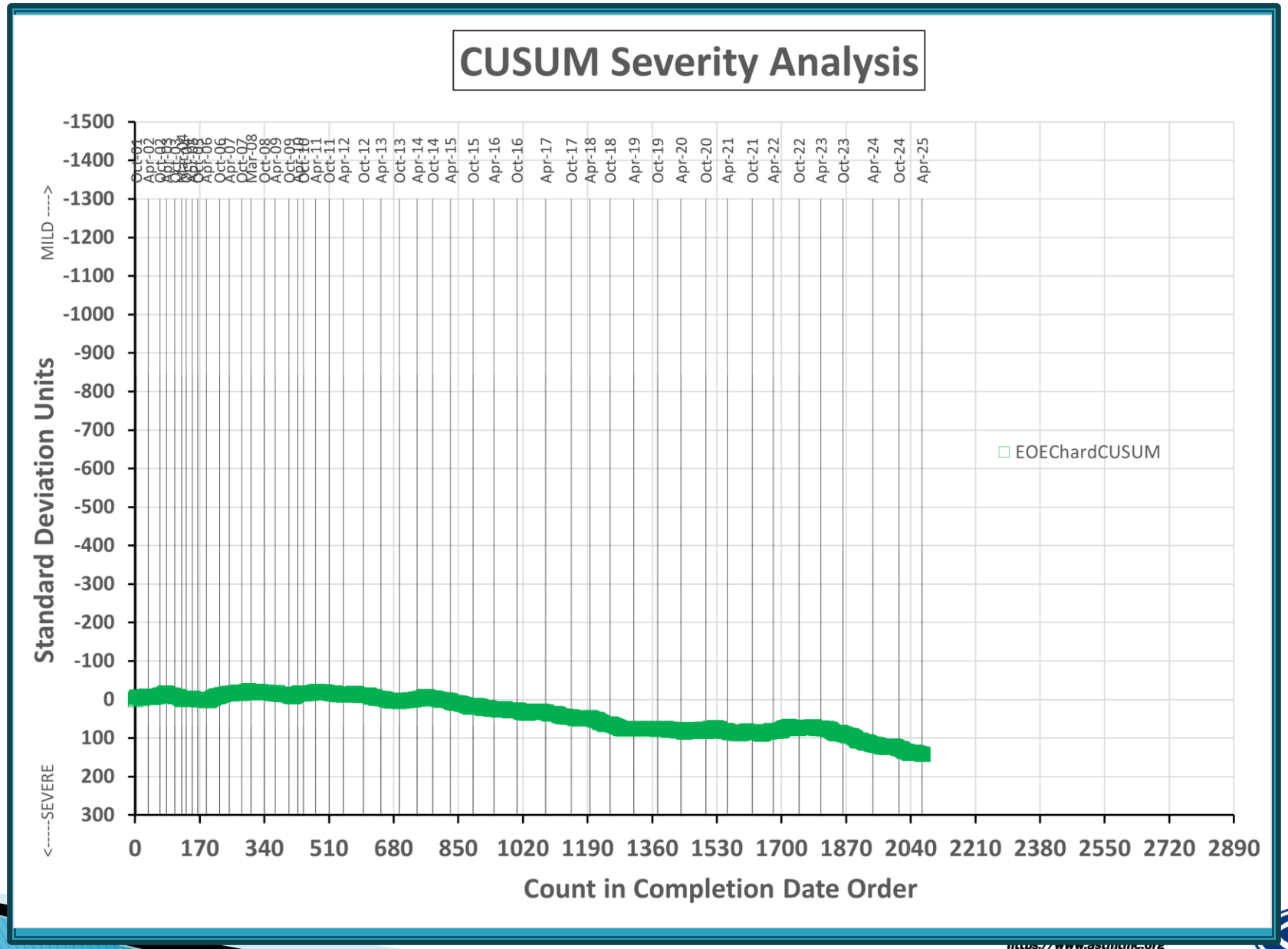
FLUOROELASTOMER PTS HARDNESS CHANGE CORRECTED AVG



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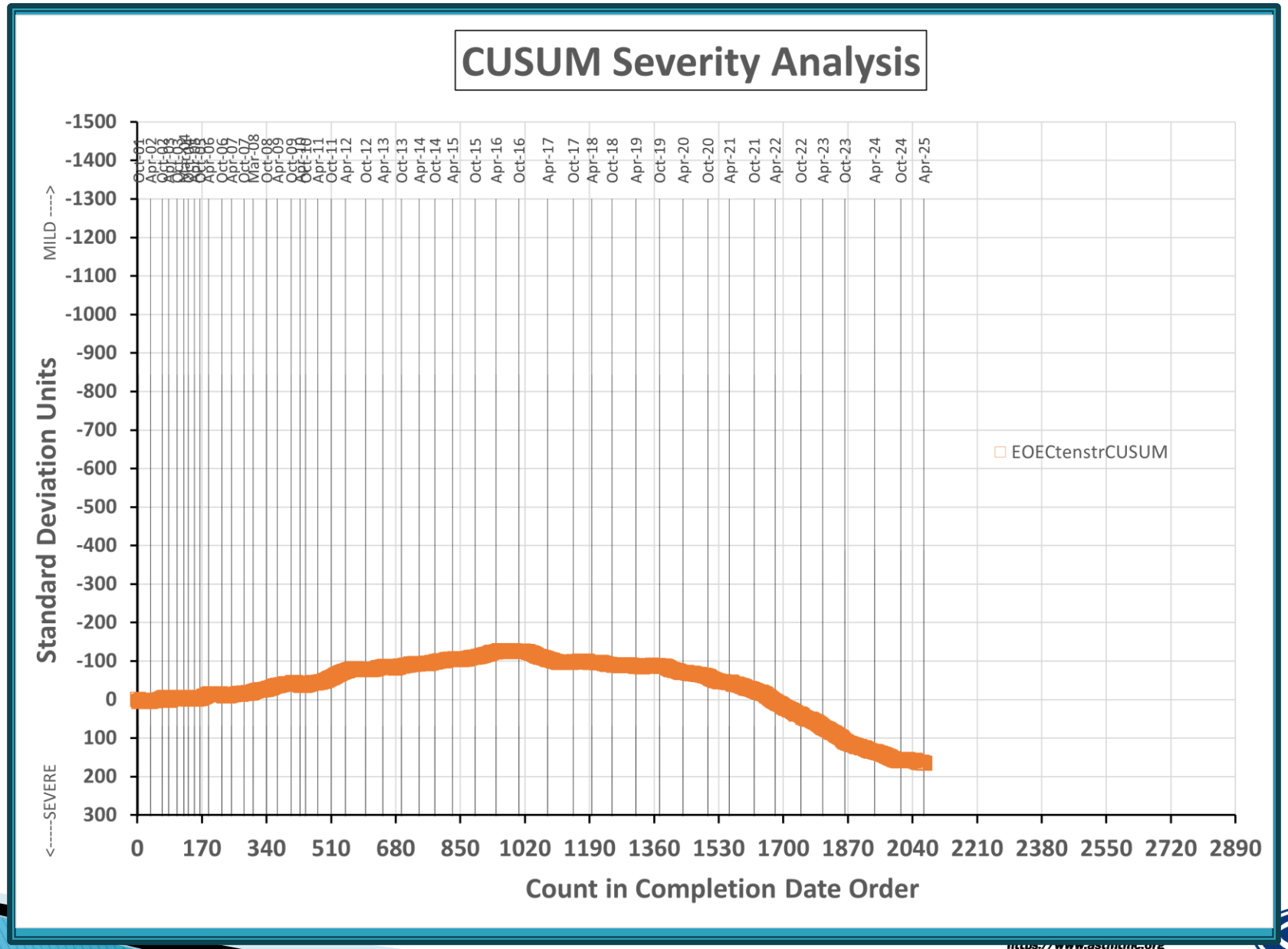
FLUOROELASTOMER TENS STRENGTH CHANGE CORRECTED AVG



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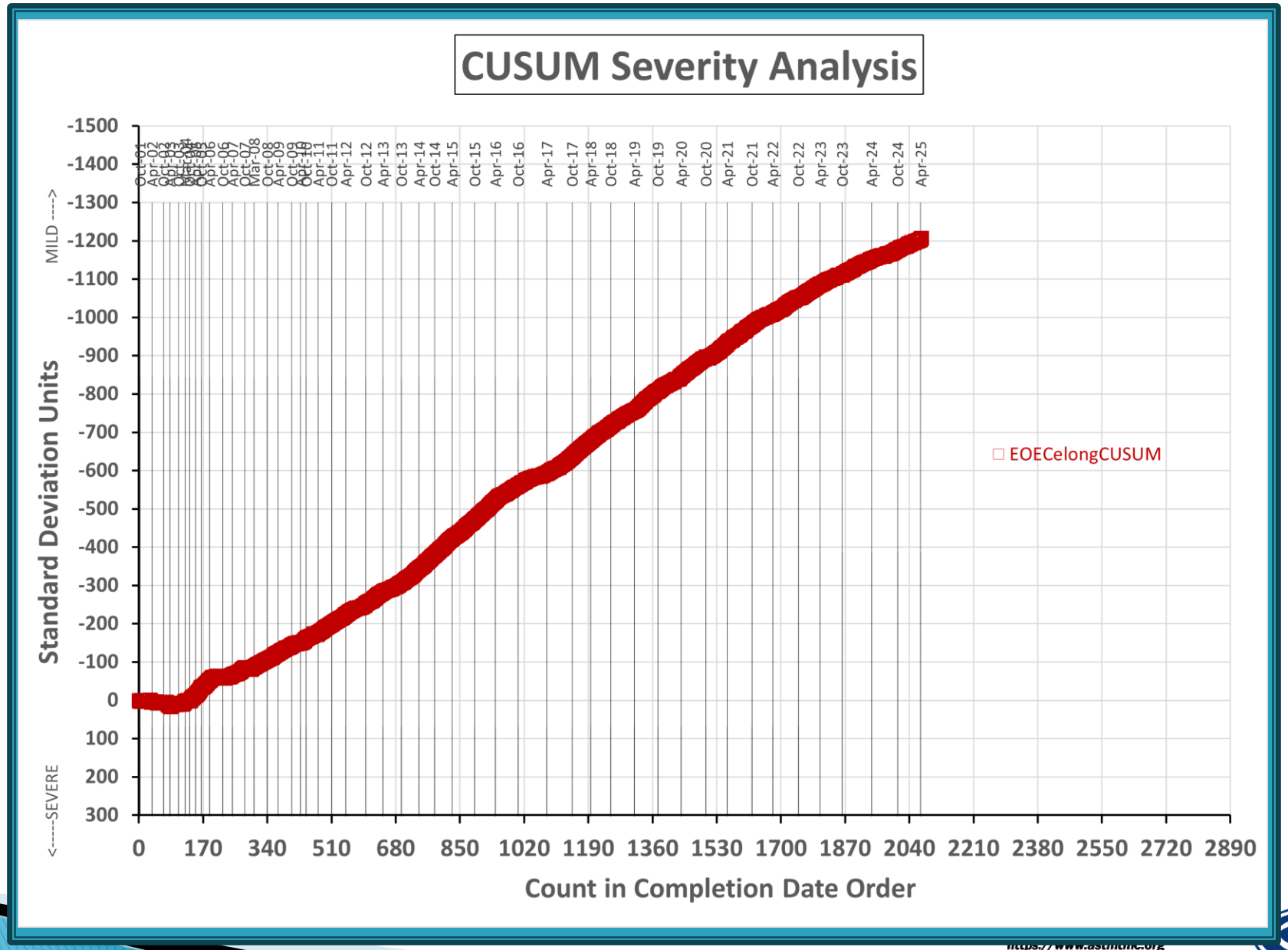
FLUOROELASTOMER ELONGATION CHANGE CORRECTED AVG

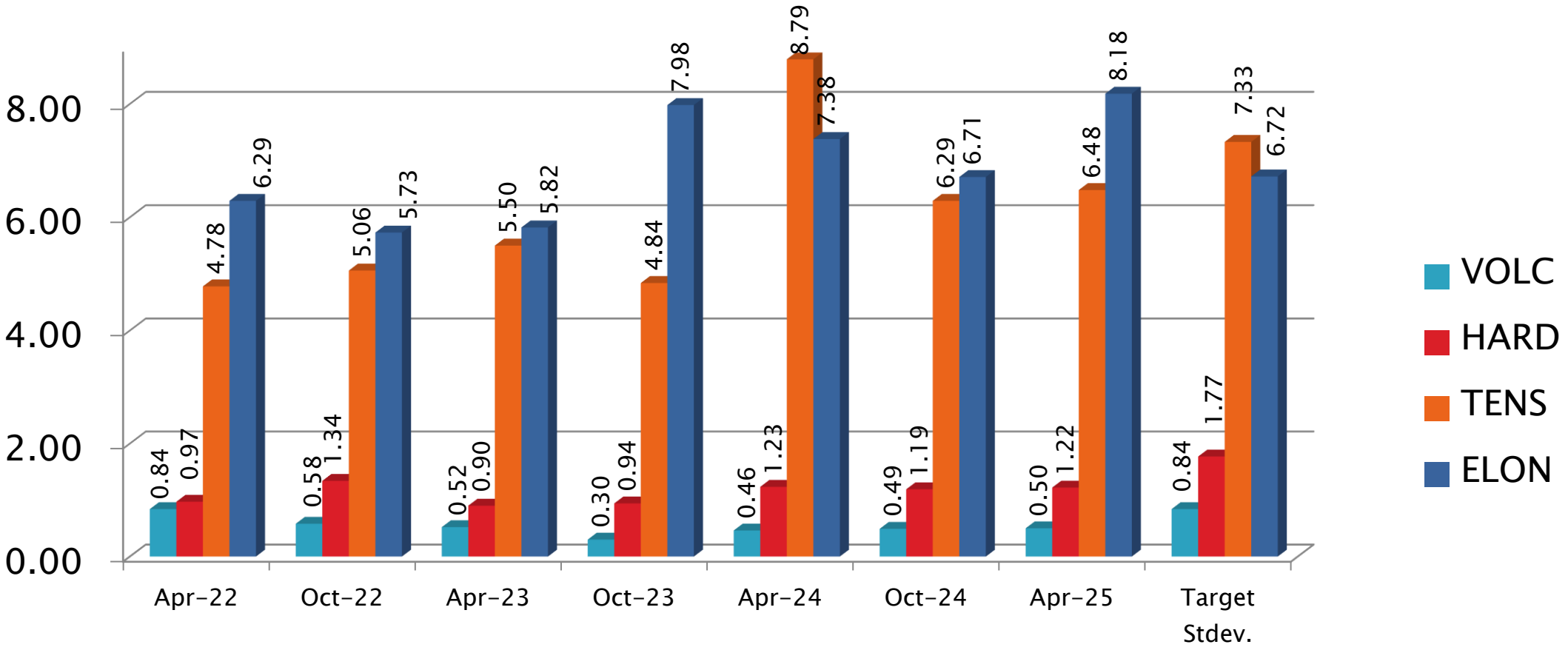


EOEC Test Severity

Nitrile (NBR)

Parameter	Period Mean Δ/s	Status
Volume Change	-0.4087	Mild
Points Hardness Change	1.2609	Very Severe
Tensile Strength Change	-0.9317	Mild
Elongation Change	-0.1628	Slightly Mild

EOEC Precision Estimates – Nitrile

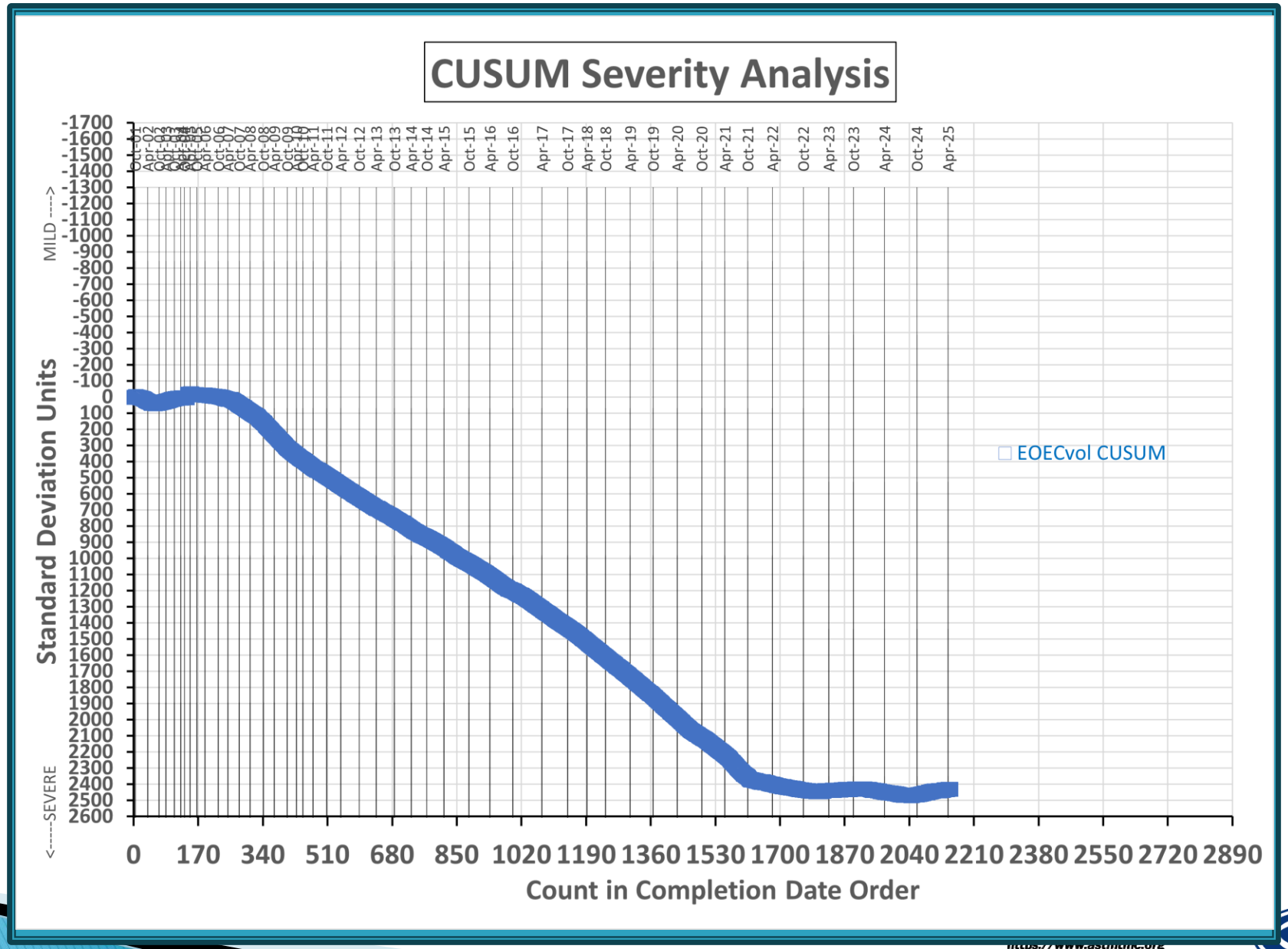


EOEC Precision Estimates by Lab: NBR

Test Parameter	Statistic	LTMS Lab							
		A	B	BB	G	I	L	P	V
	n=	19	4	0	21	18	3	7	9
Volume	Mean	1.32	1.58		1.19	1.54	1.98	1.42	1.45
	Pooled s	0.16	0.12		0.46	0.82	0.21	0.14	0.38
	Mean /s	-0.49	-0.18		-0.65	-0.24	0.28	-0.38	-0.34
Hardness	Mean	4.16	4.75		3.81	4.56	1.67	4.86	3.33
	Pooled s	0.50	0.50		1.21	0.62	0.58	1.07	2.12
	Mean /s	1.32	1.65		1.12	1.54	-0.09	1.71	0.85
Tensile Strength	Mean	-3.68	-8.18		-5.46	-0.92	0.00	-0.73	-9.72
	Pooled s	3.63	3.87		9.68	4.03	5.61	3.88	2.86
	Mean /s	-0.88	-1.50		-1.13	-0.51	-0.38	-0.48	-1.71
Elongation	Mean	-36.3	-39.2		-33.0	-33.8	-26.9	-33.8	-39.0
	Pooled s	3.01	2.63		14.4	4.39	4.06	2.67	2.29
	Mean /s	-0.39	-0.82		0.10	-0.02	1.01	-0.02	-0.79

EOEC — NITRILE INDUSTRY OPERATIONALLY VALID DATA

REFERENCE NITRILE VOLUME CHANGE CORRECTED AVERAGE



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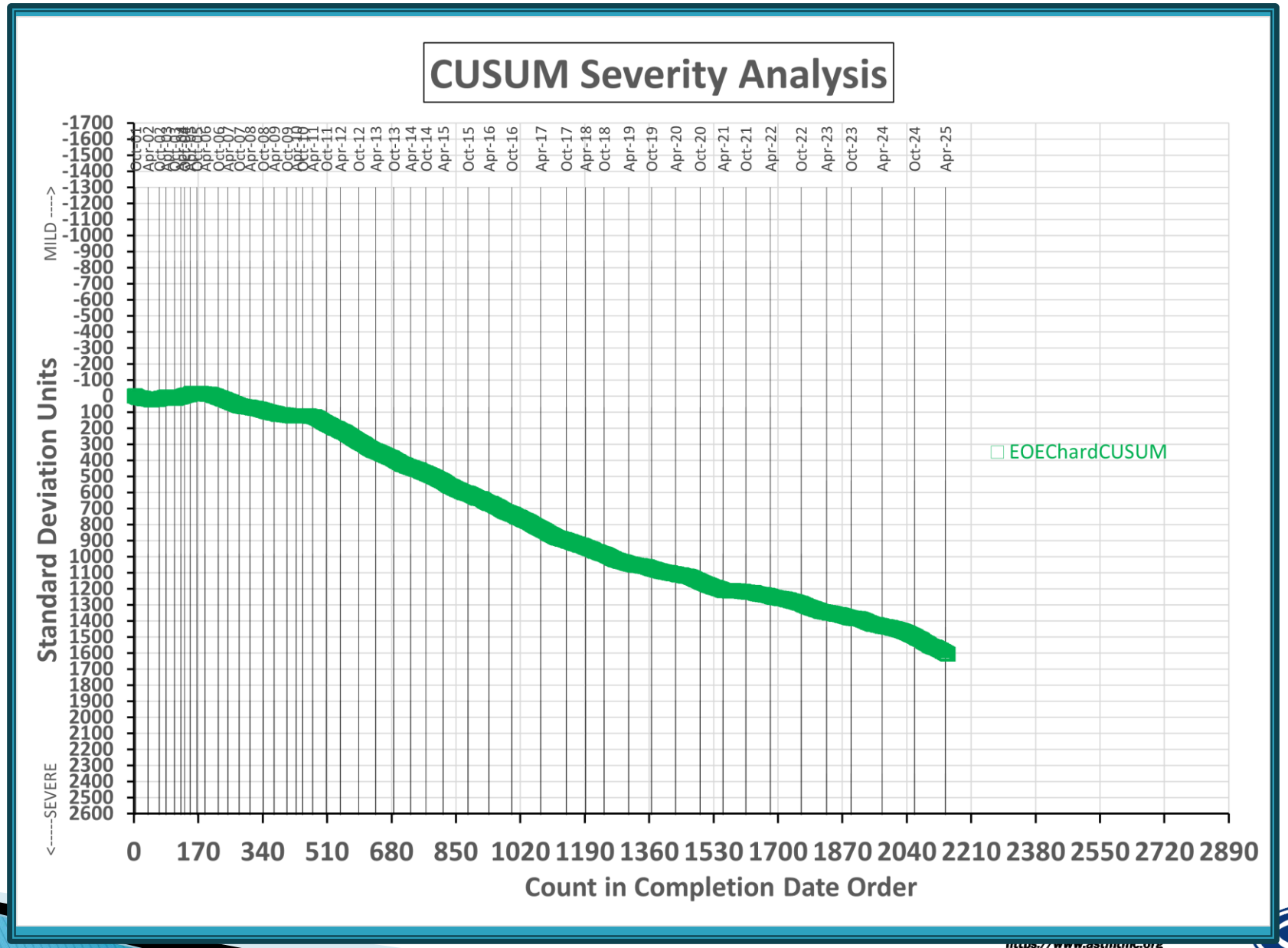
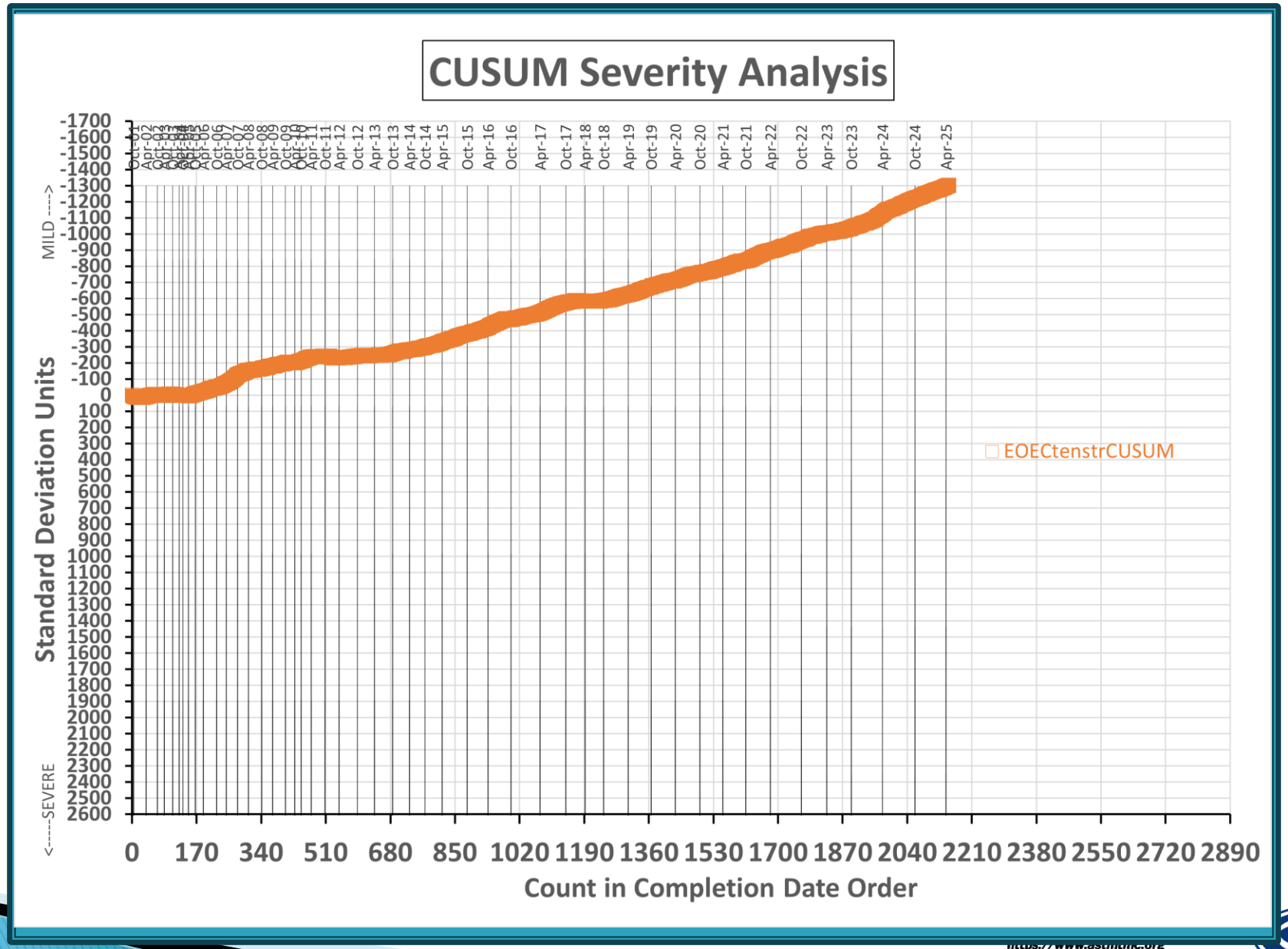


EOEC — NITRILE INDUSTRY OPERATIONALLY VALID DATA

REF NITRILE TENS STRENGTH CHANGE CORRECTED AVG



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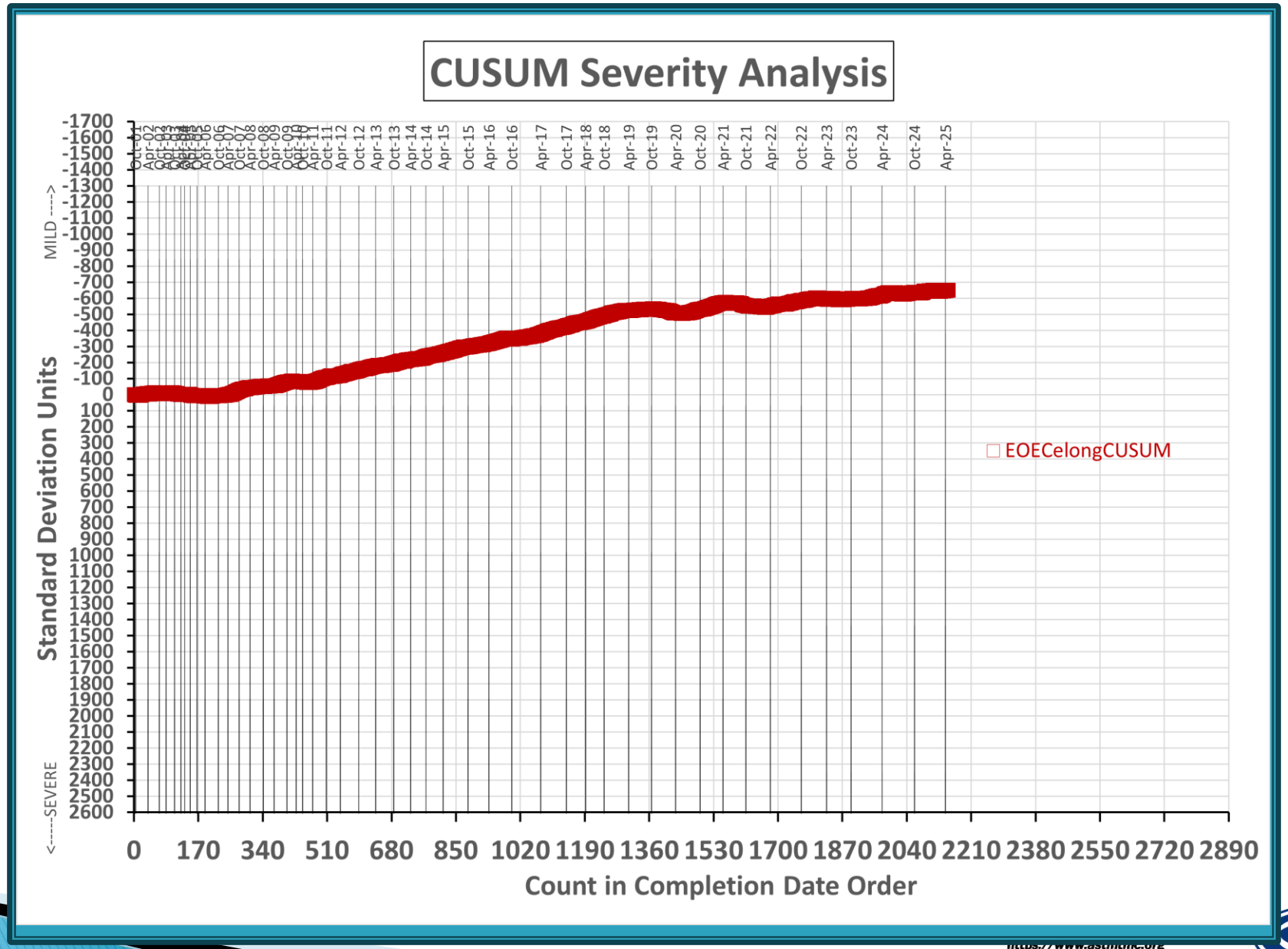
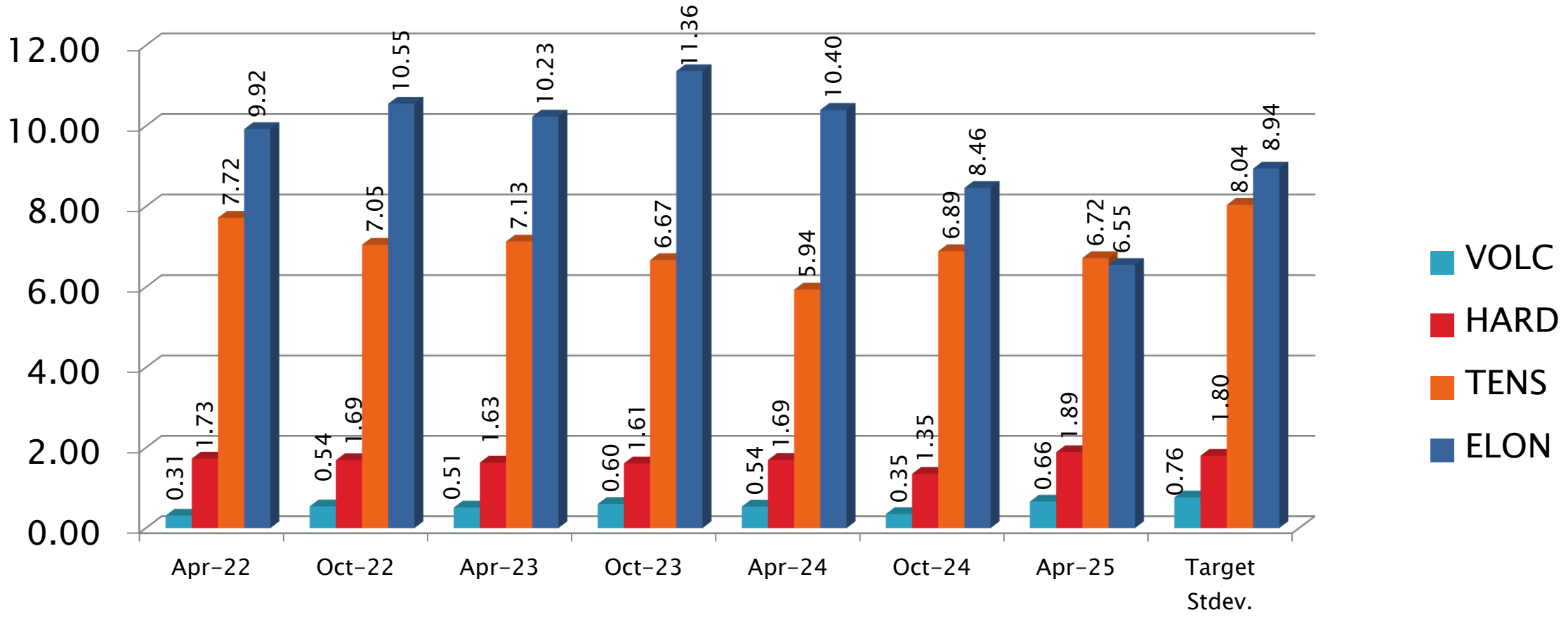


EOEC Test Severity

Polyacrylate (ACM)

Parameter	Period Mean Δ/s	Status
Volume Change	2.13	Very Severe
Points Hardness Change	-0.90	Mild
Tensile Strength Change	0.47	Severe
Elongation Change	0.97	Severe

EOEC Precision Estimates – Polyacrylate

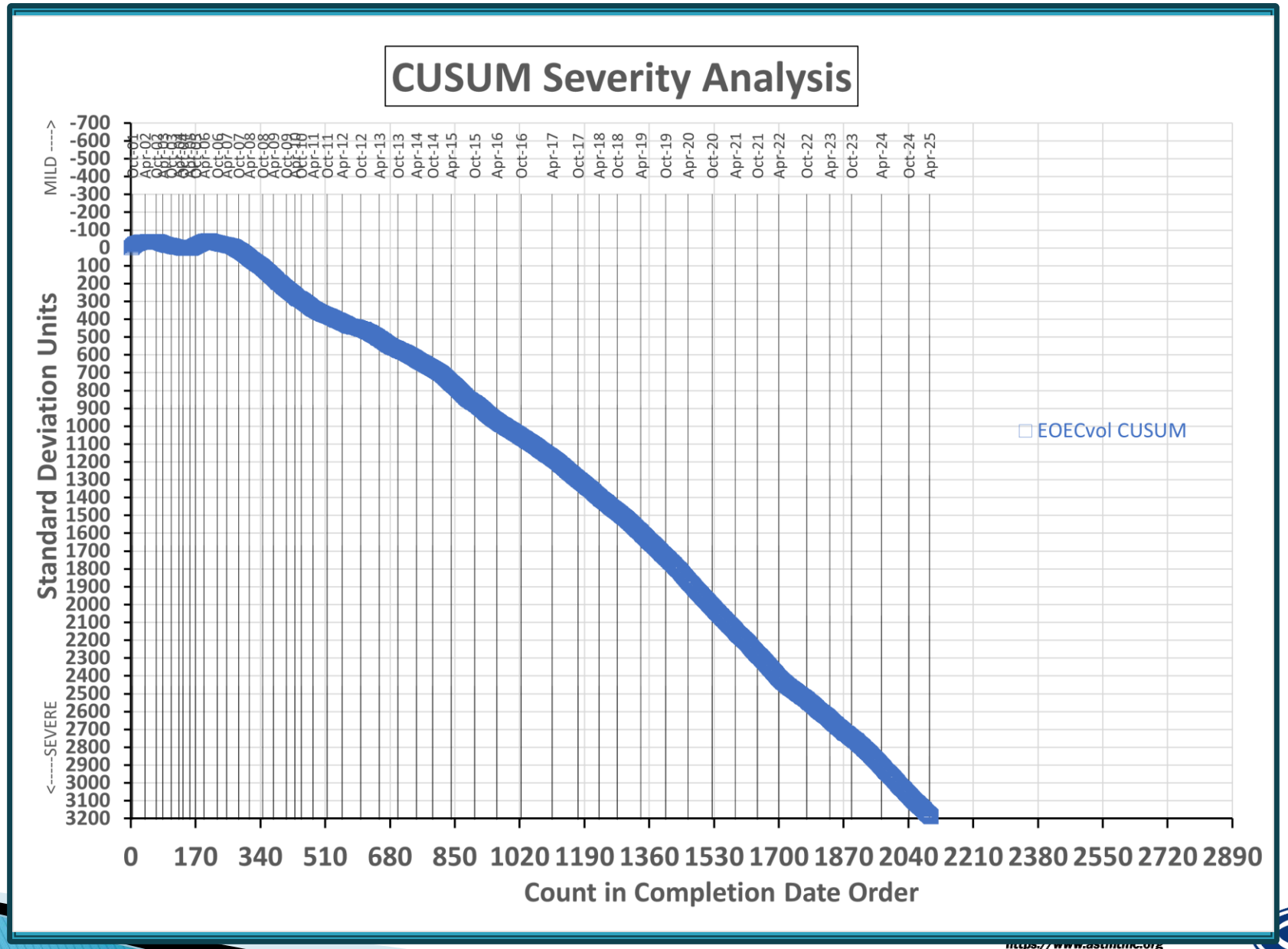


EOEC Precision Estimates by Lab: ACM

Test Parameter	Statistic	LTMS Lab							
		A	B	BB	G	I	L	P	V
	n=	15	4	0	18	9	3	4	1
Volume	Mean	2.06	2.11		1.41	2.21	1.40	1.87	1.86
	Pooled s	0.16	0.09		0.94	0.35	0.12	0.43	
	Mean /s	2.45	2.51		1.59	2.64	1.57	2.20	2.18
Hardness	Mean	-3.20	-2.25		-0.94	-1.00	-0.33	-0.25	-3.00
	Pooled s	0.86	1.50		2.34	0.87	1.15	0.50	
	Mean /s	-1.77	-1.24		-0.52	-0.55	-0.18	-0.13	-1.66
Tensile Strength	Mean	6.07	5.55		-1.22	9.41	4.37	6.35	7.60
	Pooled s	3.23	4.10		8.53	3.51	1.88	2.13	
	Mean /s	0.71	0.65		-0.18	1.13	0.50	0.75	0.90
Elongation	Mean	-13.0	-12.0		-13.3	-18.3	-7.53	-18.8	-8.40
	Pooled s	4.98	4.16		8.31	3.72	7.48	2.78	1.59
	Mean /s	1.07	1.18		1.05	0.48	1.68	0.42	

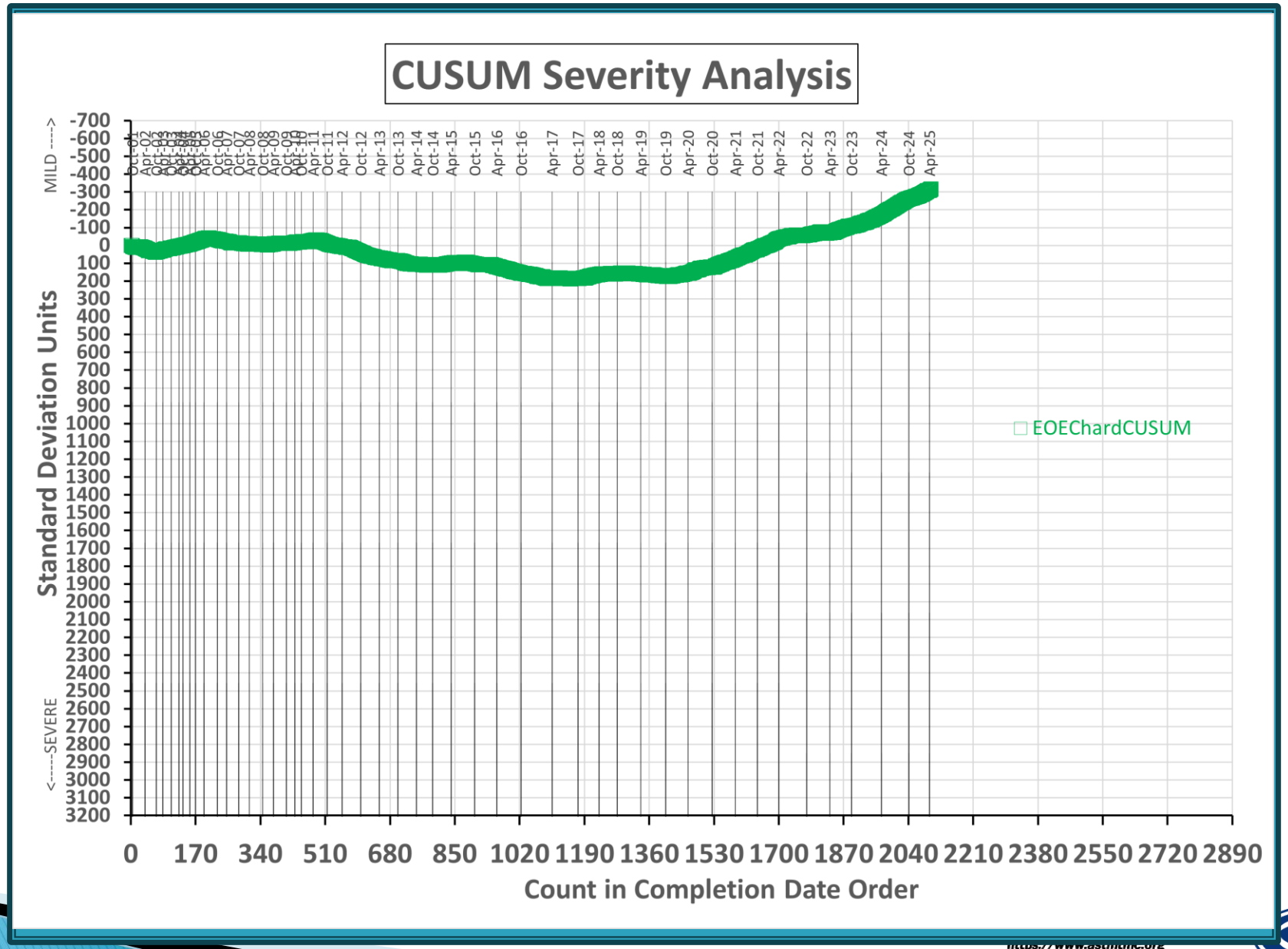
EOEC — POLYACRYLATE INDUSTRY OPERATIONALLY VALID DATA

REFERENCE POLYACRYLATE VOLUME CHANGE CORRECTED AVG



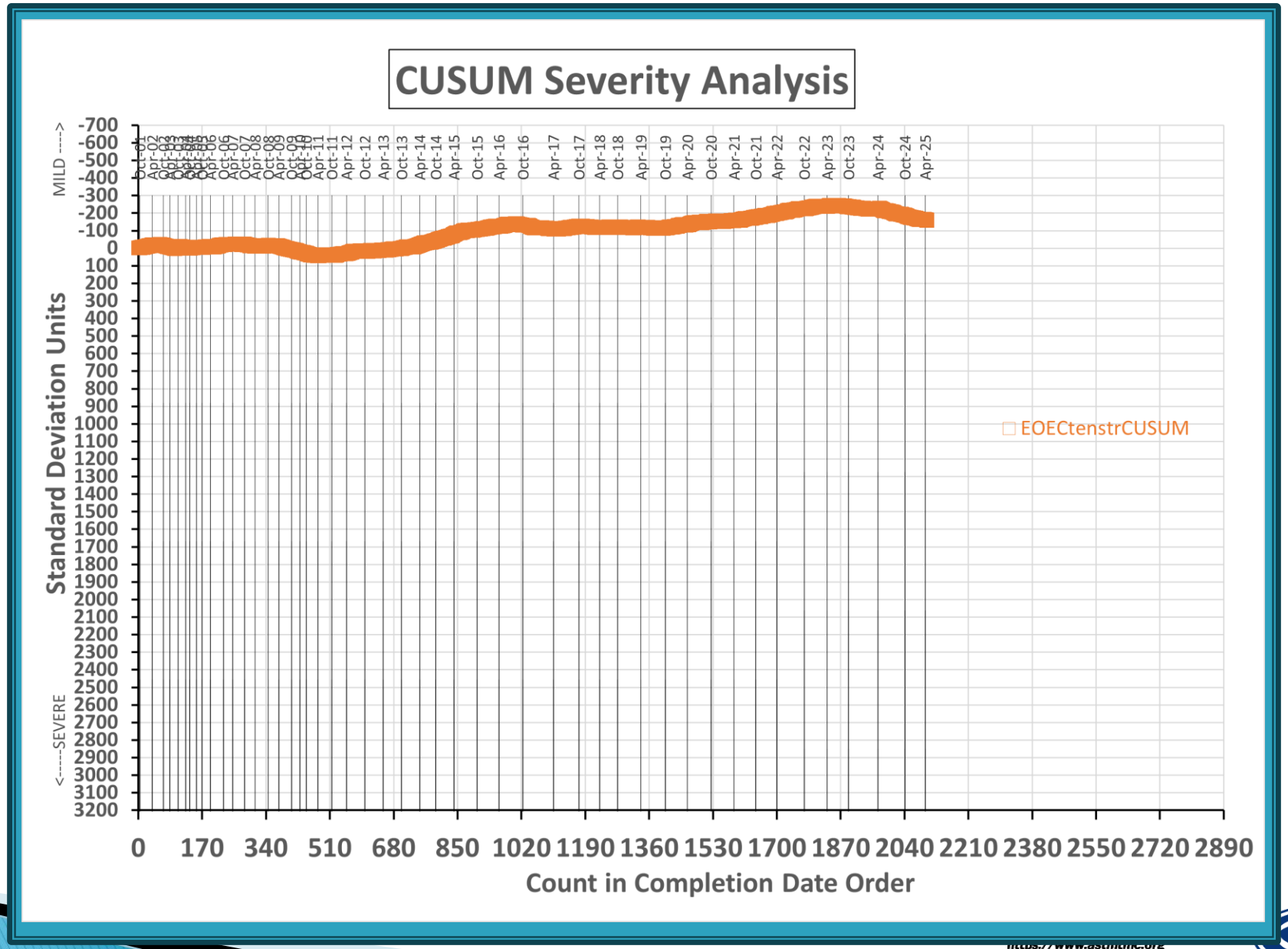
EOEC — POLYACRYLATE INDUSTRY OPERATIONALLY VALID DATA

REF POLYACRYLATE PTS HARD CHANGE CORRECTED AVG



EOEC —POLYACRYLATE INDUSTRY OPERATIONALLY VALID DATA

REF POLYACRYLATE TENS STRNGTH CHANGE CORRECTED AVG



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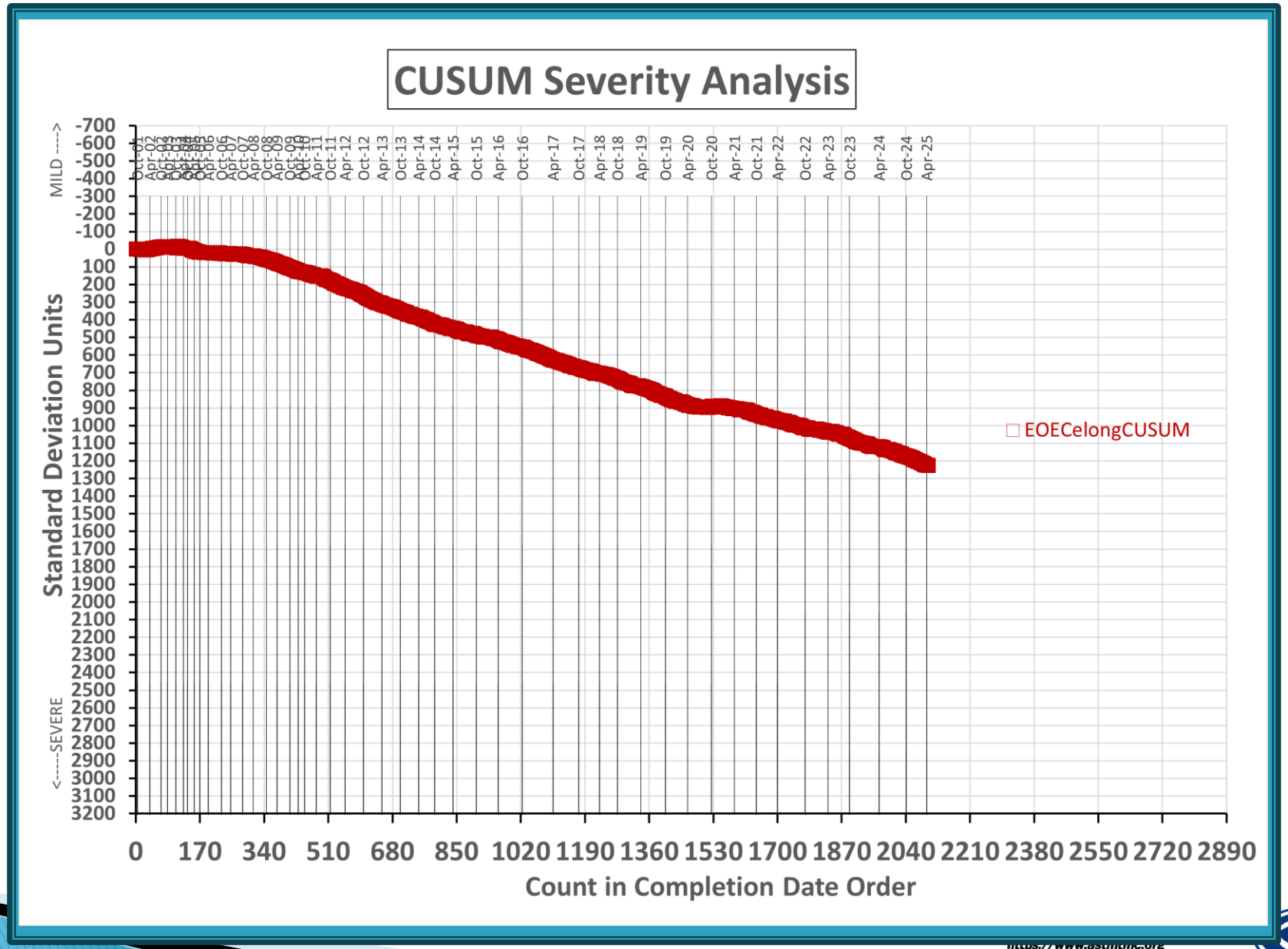
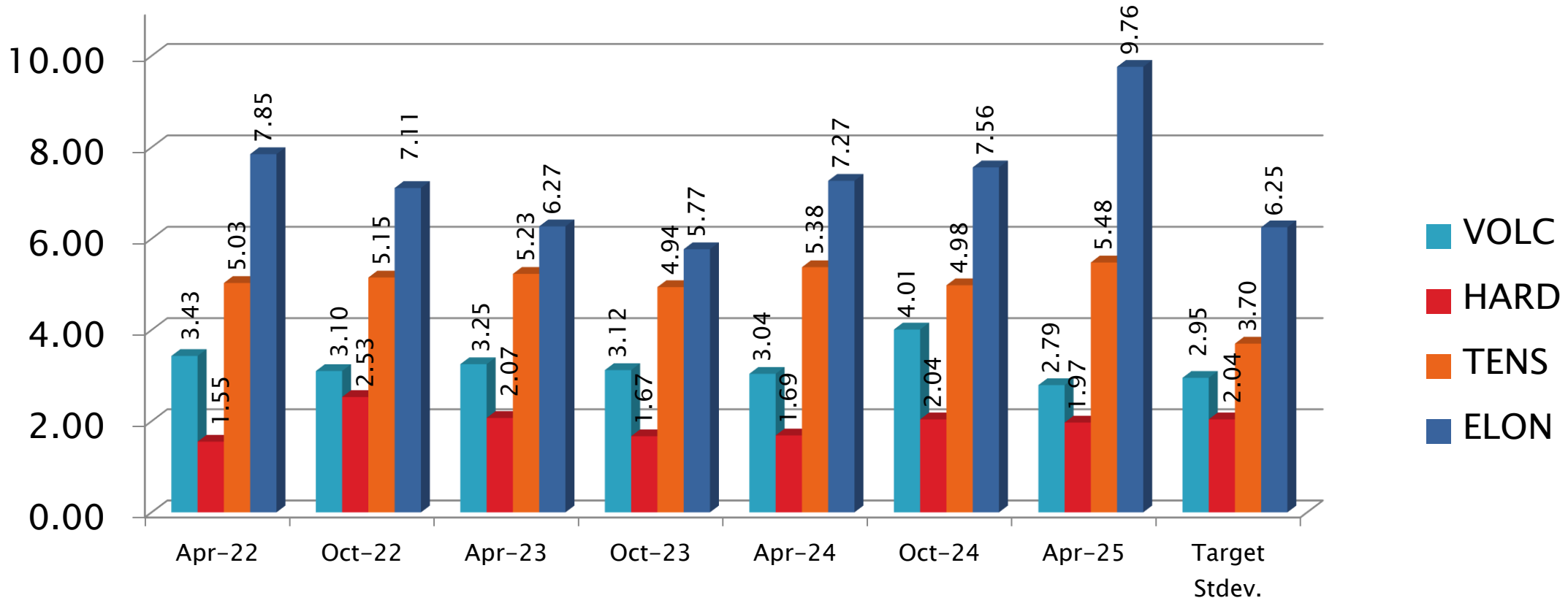


EOEC Test Severity

Silicone (VMQ)

Parameter	Period Mean Δ/s	Status
Volume Change	0.7431	Severe
Points Hardness Change	-0.6282	Mild
Tensile Strength Change	-0.2708	Slightly Mild
Elongation Change	0.0028	On-Target

EOEC Precision Estimates – Silicone

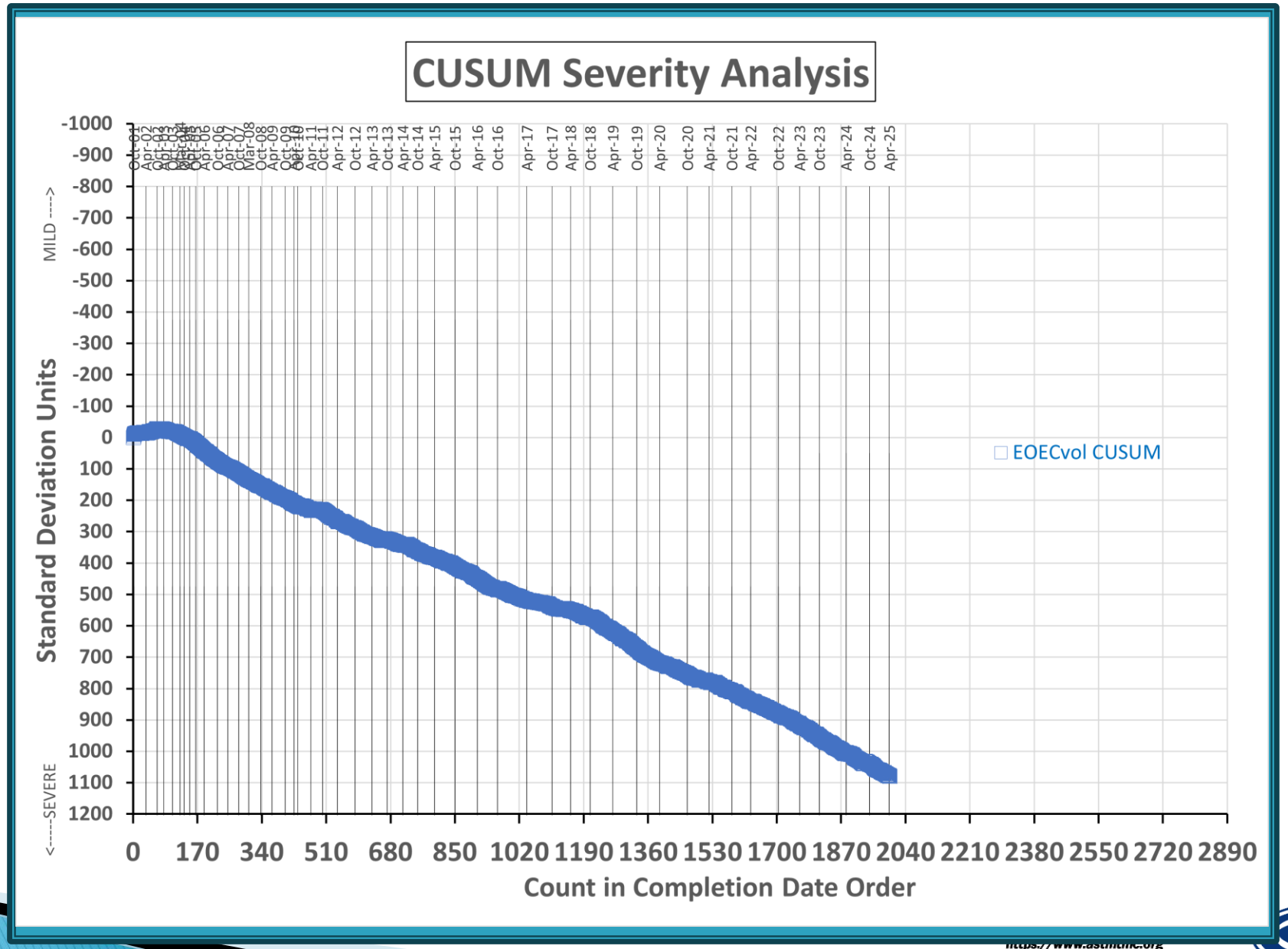


EOEC Precision Estimates by Lab: VMQ

Test Parameter	Statistic	LTMS Lab							
		A	B	BB	G	I	L	P	V
	n=	12	5	1	21	8	4	3	1
Volume	Mean	34.1	34.0	27.8	37.1	31.5	31.1	34.3	31.7
	Pooled s	0.53	0.56		2.12	1.32	1.49	0.74	
	Mean /s	0.67	0.63	-1.48	1.67	-0.23	-0.36	0.73	-0.16
Hardness	Mean	-24.5	-23.4	-17.0	-23.6	-21.9	-19.0	-23.3	-21.0
	Pooled s	0.90	1.14		1.25	0.99	0.82	0.58	
	Mean /s	-1.38	-0.84	2.29	-0.92	-0.10	1.31	-0.81	0.33
Tensile Strength	Mean	-33.5	-34.3	-33.2	-36.7	-36.3	-25.0	-37.4	-36.3
	Pooled s	3.03	2.34		6.83	3.22	1.54	3.41	
	Mean /s	0.06	-0.14	0.14	-0.80	-0.70	2.36	-0.98	-0.69
Elongation	Mean	-25.3	-26.4	-27.5	-24.4	-27.6	-14.8	-25.4	-31.8
	Pooled s	2.77	2.39		15.5	3.17	2.77	4.99	
	Mean /s	-0.07	-0.25	-0.43	0.07	-0.44	1.61	-0.10	-1.12

EOEC —SILICONE INDUSTRY OPERATIONALLY VALID DATA

REFERENCE SILICON VOLUME CHANGE CORRECTED AVG



EOEC —SILICONE INDUSTRY OPERATIONALLY VALID DATA

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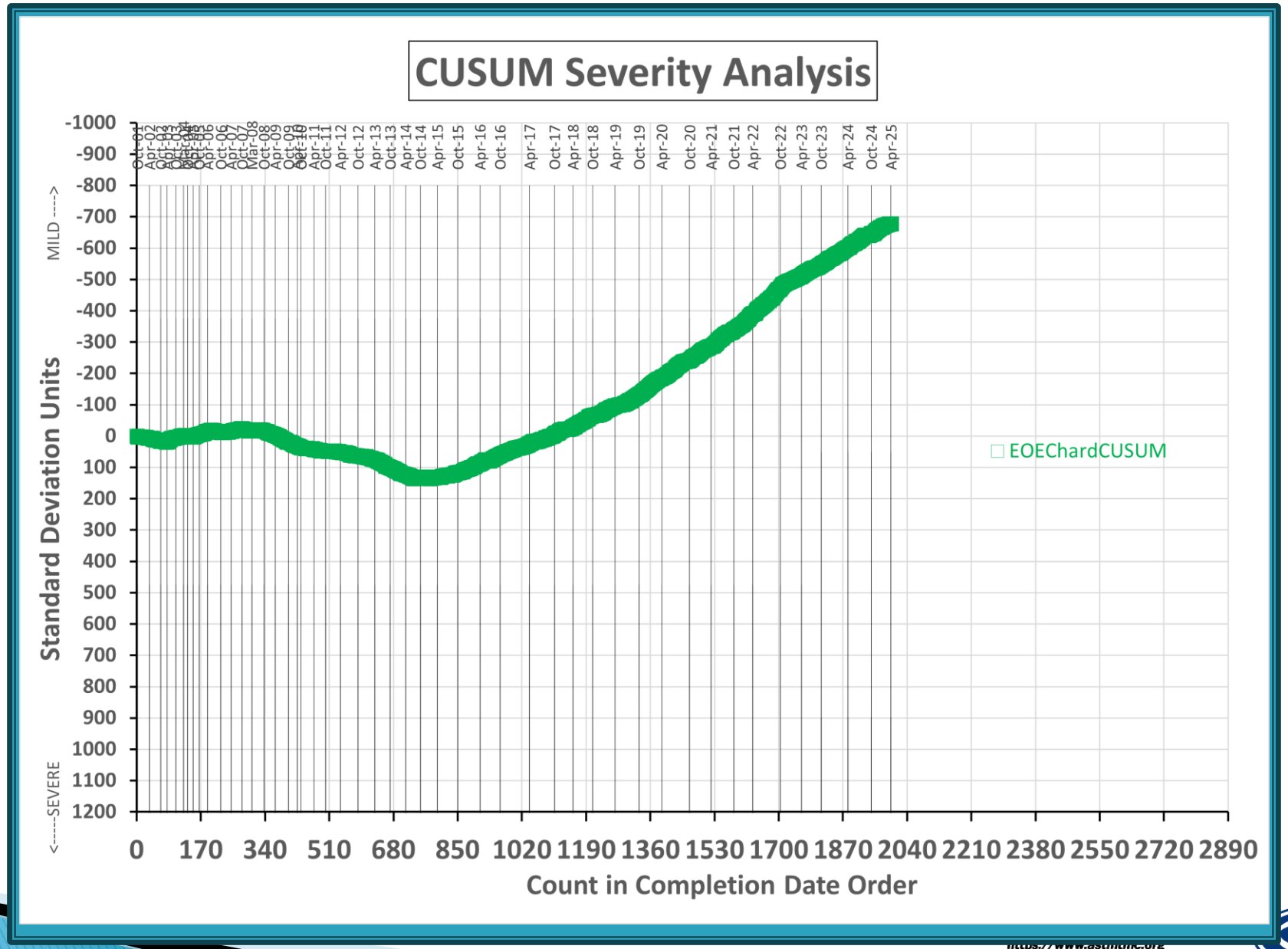

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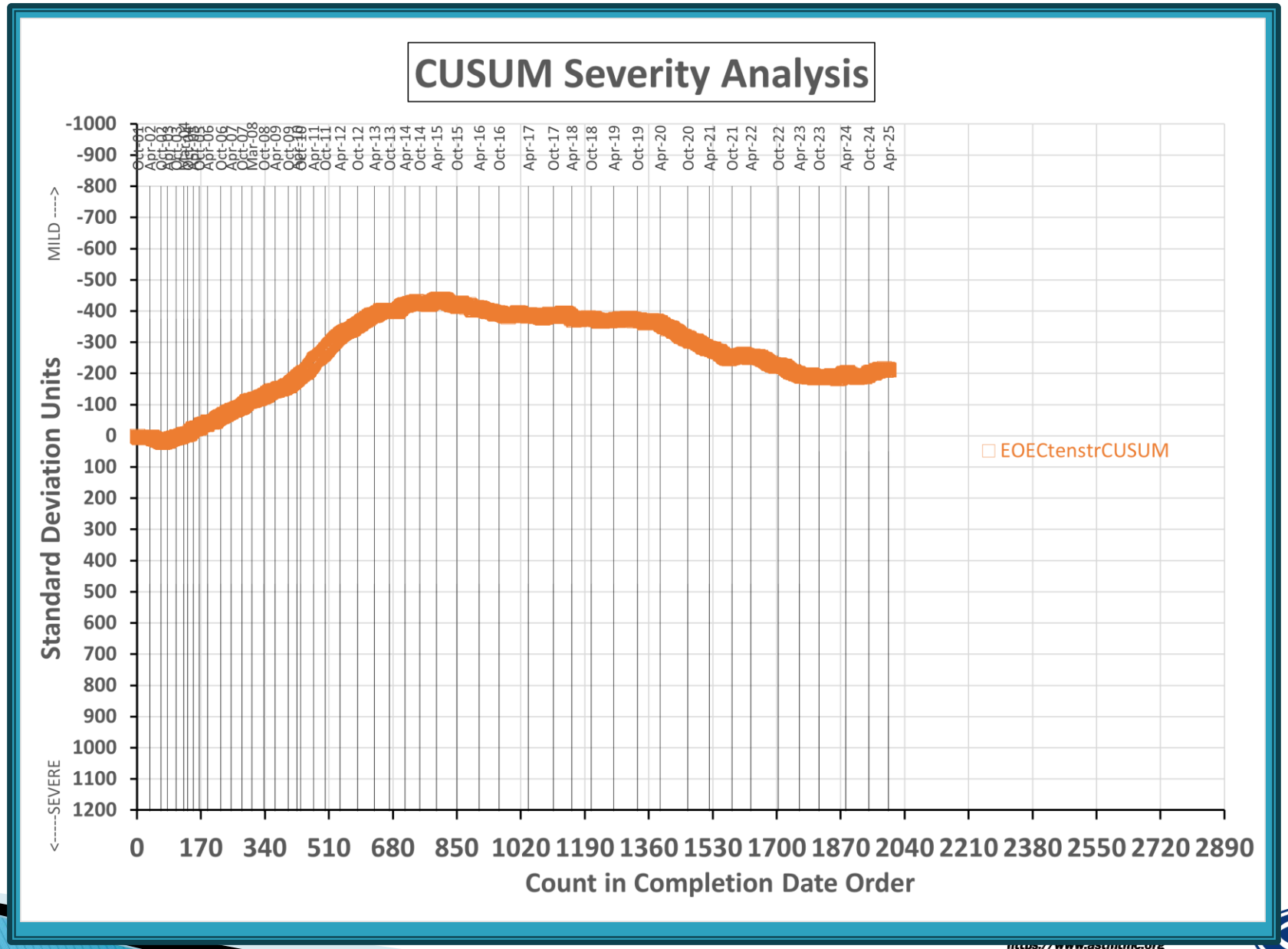

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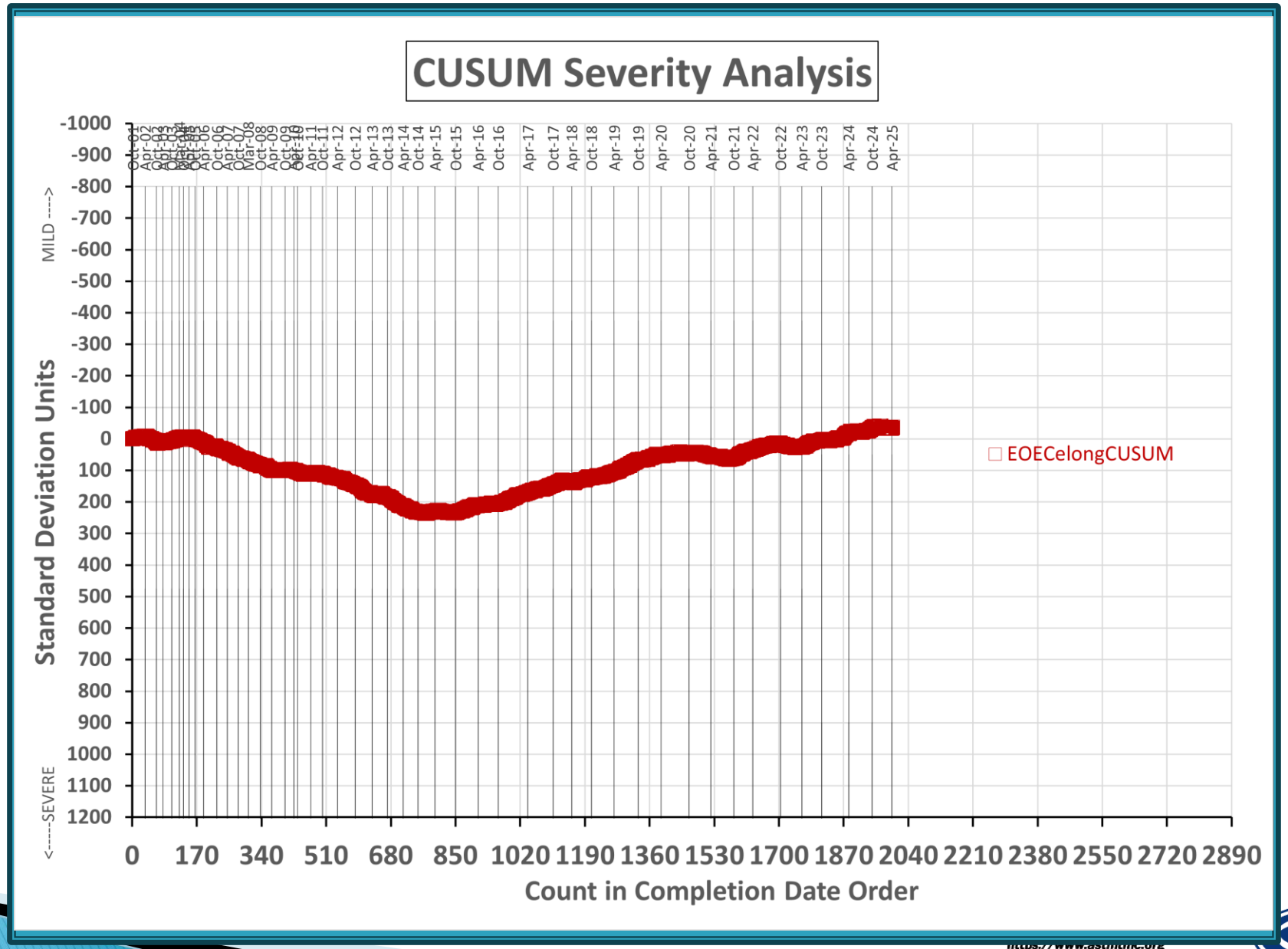
REF SILICON ELONGATION CHANGE CORRECTED AVG

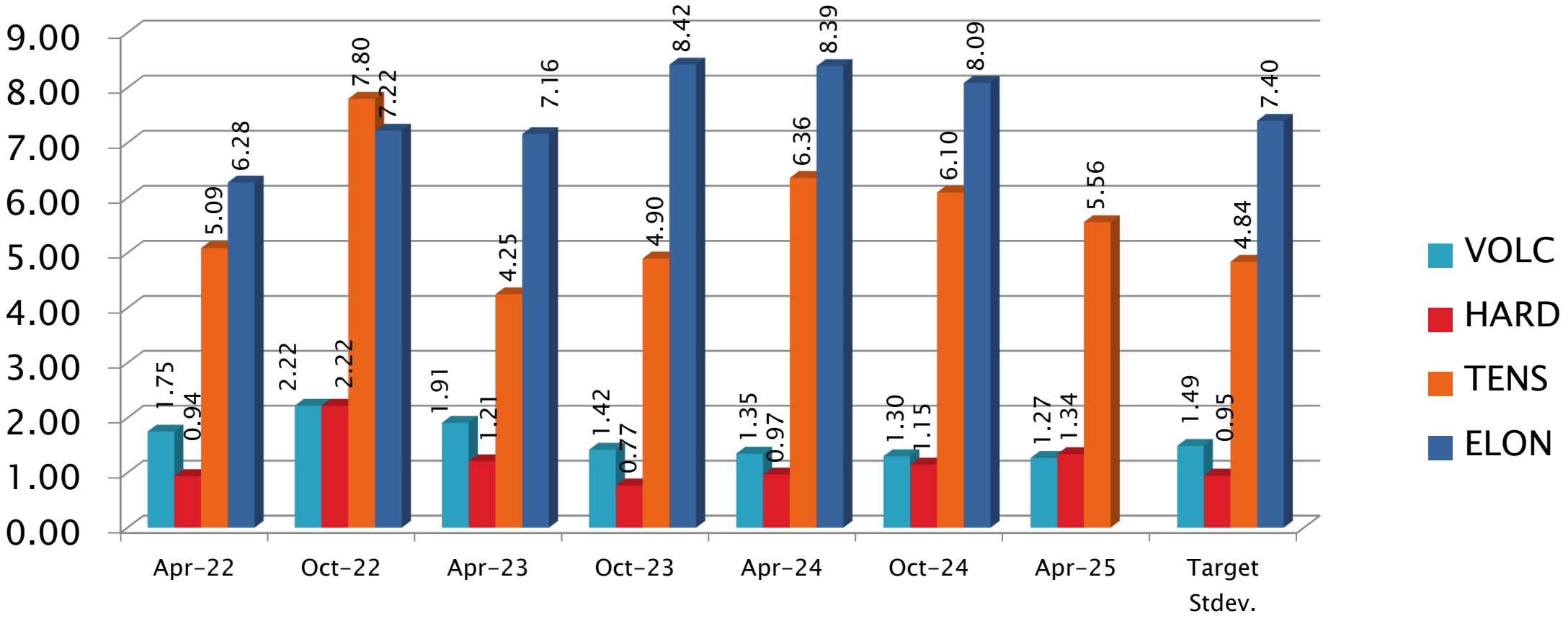


EOEC Test Severity

Ethylene Acrylate "VAMAC" (MAC)

Parameter	Period Mean Δ/s	Status
Volume Change	0.8157	Severe
Points Hardness Change	-0.8344	Mild
Tensile Strength Change	-0.8229	Mild
Elongation Change	-0.2796	Slightly Mild

EOEC Precision Estimates – VAMAC

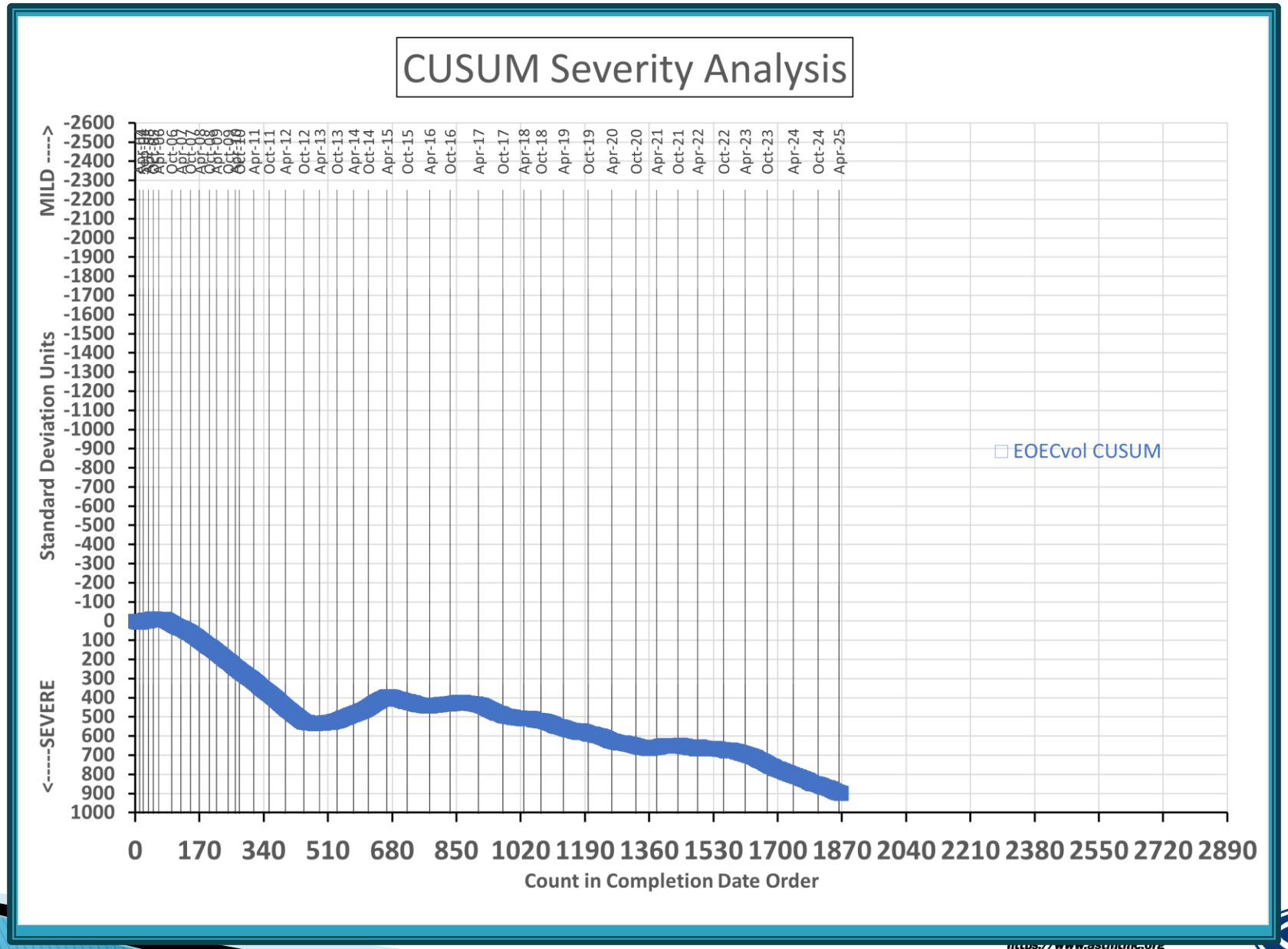


EOEC Precision Estimates by Lab: MAC

Test Parameter	Statistic	LTMS Lab							
		A	B	BB	G	I	L	P	V
	n=	14	5	0	20	9	1	1	3
Volume	Mean	19.4	19.7		20.0	20.6	18.4	19.7	18.3
	Pooled s	0.90	0.79		1.52	1.01		1.36	0.48
	Mean /s	0.56	0.75		0.95	1.38	-0.13	0.79	-0.15
Hardness	Mean	-9.07	-9.40		-7.75	-7.67	-7.00	-8.67	-8.00
	Pooled s	0.92	0.89		1.41	1.00		1.53	1.73
	Mean /s	-1.68	-2.02		-0.28	-0.20	0.51	-1.25	-0.55
Tensile Strength	Mean	-20.4	-18.0		-19.4	-20.9	-5.40	-13.2	-21.8
	Pooled s	4.46	2.74		5.56	5.74		5.37	7.21
	Mean /s	-1.04	-0.56		-0.85	-1.15	2.05	0.44	-1.32
Elongation	Mean	-36.9	-37.6		-33.2	-45.6	-29.4	-38.7	-37.4
	Pooled s	4.99	6.97		11.5	3.04		1.60	7.07
	Mean /s	-0.27	-0.36		0.24	-1.44	0.75	-0.50	-0.33

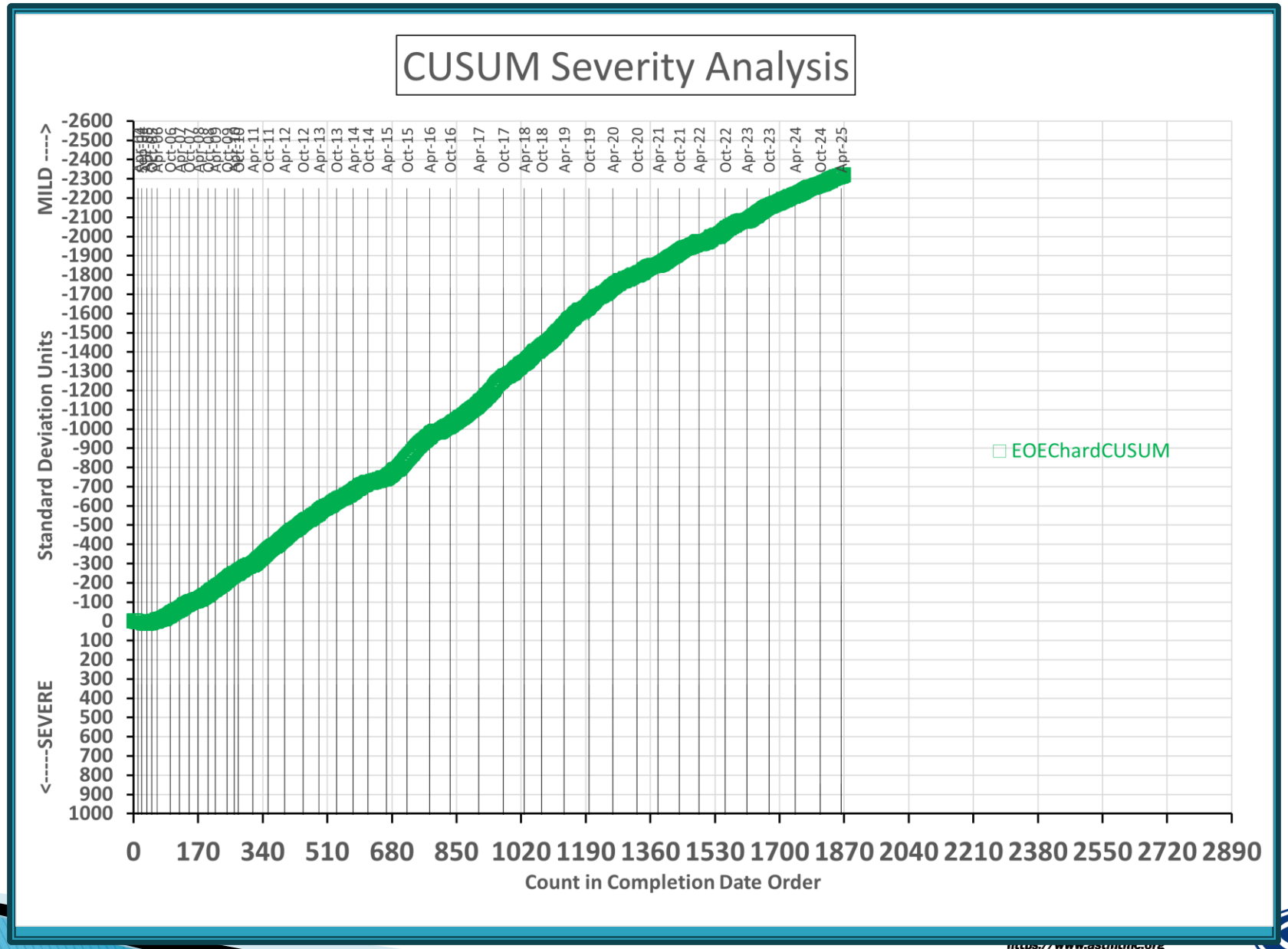
EOEC — ETHYLENEACRYLATE INDUSTRY OPERATIONALLY VALID DATA

REFERENCE VAMAC G VOLUME CHANGE CORRECTED AVERAGE



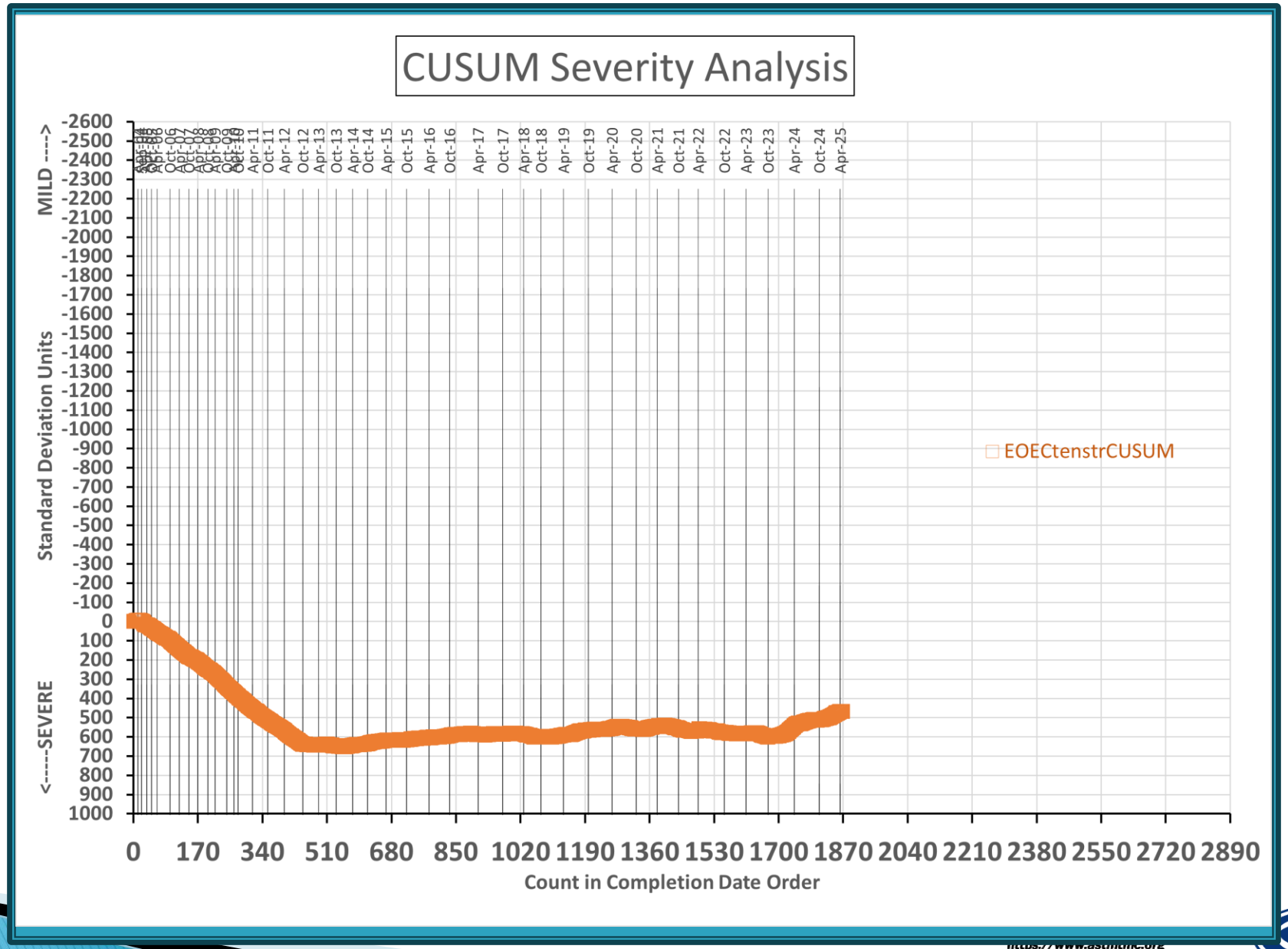
EOEC — ETHYLENEACRYLATE INDUSTRY OPERATIONALLY VALID DATA

REF VAMAC G POINTS HARDNESS CHANGE CORRECTED AVG



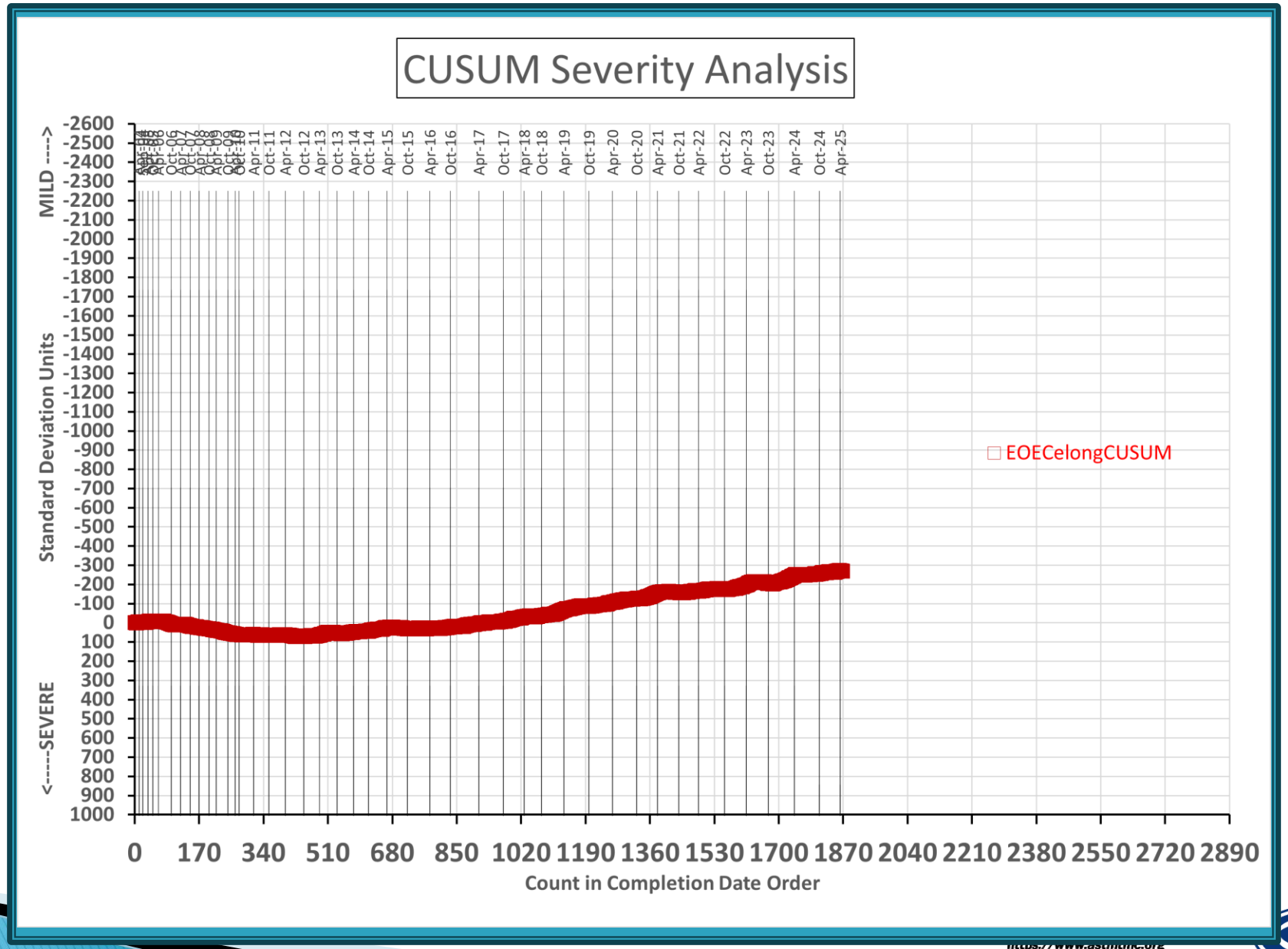
EOEC — ETHYLENEACRYLATE INDUSTRY OPERATIONALLY VALID DATA

REF VAMAC G TENSILE STRENGTH CHANGE CORRECTED AVG



EOEC — ETHYLENEACRYLATE INDUSTRY OPERATIONALLY VALID DATA

REF VAMAC G ELONGATION CHANGE CORRECTED AVG



Information Letters & Technical Updates*

EDIT Needed

Test	Date	IL or Memo Number	Topic
EOEC	20241031	IL24-01	Adjusted Specification Limits for EOEC D7216 Tests added to EOEC IL folder

*Available from TMC Website

Reference Oil Inventory Estimated Life

EOEC & LDEOC

Oil	TMC Inventory Gallons	Gallons Shipped Past 6 Months	Estimated Life [C]
SL107 [A, B]	1202	280	2 years

[A] TMC Inventory is used across several test methods

[B] SL107 has fully replaced oil 1006; Oil 1006 is no longer used as an EOEC Reference Fluid

[C] Use Rate of SL107 will accelerate due to addition of five new Elastomers to D7216:
FOUR: ILSAC GF-7
ONE: PC-12

TABLE of CONTENTS

EDIT Needed

ASTM Reference Testing Semi-Annual Report D7216 LDEOC

October 1, 2024 to March 31, 2025

ASTM D 7216

Engine Oil Elastomer Compatibility

LDEOC (Light-Duty)	
OHT PART NUMBER	BATCH CODE*
OHTLDEOC-HNBR1-A	33
OHTLDEOC-FKM1-A	30
OHTLDEOC-ACM1-B	26
OHTLDEOC-VMQ1-A	43
OHTLDEOC-AEM1-B	32
OHTLDEOC-ACM2-A	2
OHTLDEOC-AEM2-A	2
OHTLDEOC-FKM3-A	2
OHTLDEOC-AEM3-A	2

* As of 20250403

LDEOC Test Activity

Test Status		Ethylene Acrylate	Fluoroelast.	Nitrile	Polyacrylate	Silicone	Total
LABS BATHS		7 26	6 23	7 18	7 28	7 27	
Acceptable Calibration Test	AC	58	52	63	63	65	**301**
Failed Calibration Test	OC	2	3	0	3	1	**9**
Operationally Invalid, by lab	LC	0	0	0	0	0	**0**
Operationally Invalid, by TMC	RC	0	0	0	0	0	**0**
Aborted	XC	1	2	2	1	2	**8**
Acceptable Informational Run	NN	0	0	0	14	0	**14**
Unacceptable Informational Run	MN	0	0	0	0	0	**0**
Total		**61**	**57**	**65**	**81**	**68**	**332**

LDEOC Test Activity

Test Status		Ethylene Acrylate 2	Ethylene Acrylate 3	Fluoroelast.3	Polyacrylate2	Total
LABS BATHS		6 27	6 28	6 30	6 31	
Acceptable Calibration Test	AC	62	64	54	64	**244**
Failed Calibration Test	OC	1	1	1	2	**5**
Operationally Invalid, by lab	LC	0	0	1	1	**2**
Operationally Invalid, by TMC	RC	0	0	1	0	**1**
Aborted	XC	2	1	1	2	**6**
Acceptable Informational Run	NN	0	0	0	0	**0**
Unacceptable Informational Run	MN	0	0	0	0	**0**
Total		**65**	**66**	**58**	**69**	**258**

Calibrated Labs and Stands[1]

(change shown in parentheses)

Test	Labs	Stands
D7216 LDEOC	7[2] (+0)	N/A

[1] As of 3/31/2025

[2] Not all Elastomer Types were run at each lab

LDEOC Failing Calibration (OC) Tests

Cause	Elastomer	#
TENSILE STRENGTH (MILD)	1-ACM1, 1-ACM2	2
VOLUME (MILD)	2-AEM1	2
VOLUME (SEVERE)	1-FKM1	1
HARDNESS (MILD)	3-ACM1	3
TENSILE STRENGTH (SEVERE)	1-VMQ1	1
HARDNESS (SEVERE)	1-FKM3	1
VOLUME (MILD), HARDNESS (SEVERE)	1-AEM2	1
VOLUME (SEVERE), HARDNESS (MILD)	1-AEM3	1
VOL (SEVERE), HARD/TENS (MILD)	1-FKM1	1
VOL, HARD (MILD), TENS (SEVERE)	1-FKM1	1
Total		**14**

There were FOURTEEN failing LDEOC Calibration Tests reported this period from FIVE different labs.

LDEOC Lost Tests

Validity	Cause	No. of Tests
LC	WRONG ELASTOMER USED (FKM1)	1
RC	SAMPLES REMOVED FROM BATH TOO SOON	1
LC	SAMPLES DISPOSED BEFORE DATA TAKEN	1
XC	POWER OUTAGE	14
Total		**17**

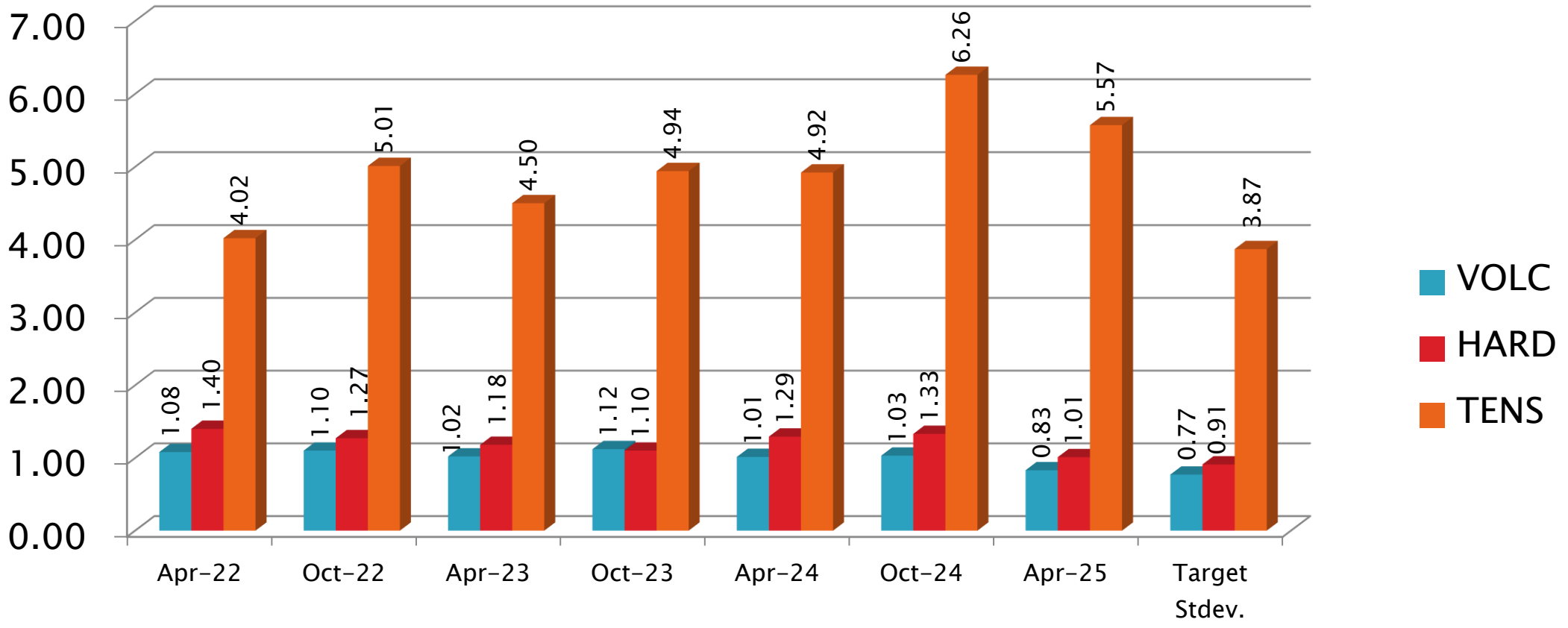
*Invalid (LC,RC) and Aborted (XC) calibration tests

LDEOC Test Severity

Ethylene Acrylate (AEM1)

Parameter	Period Mean Δ/s	Status
Volume Change	-0.9112	Mild
Points Hardness Change	0.8388	Severe
Tensile Strength Change	-0.3342	Slightly Mild

LDEOC Precision Estimates – Ethylene Acrylate



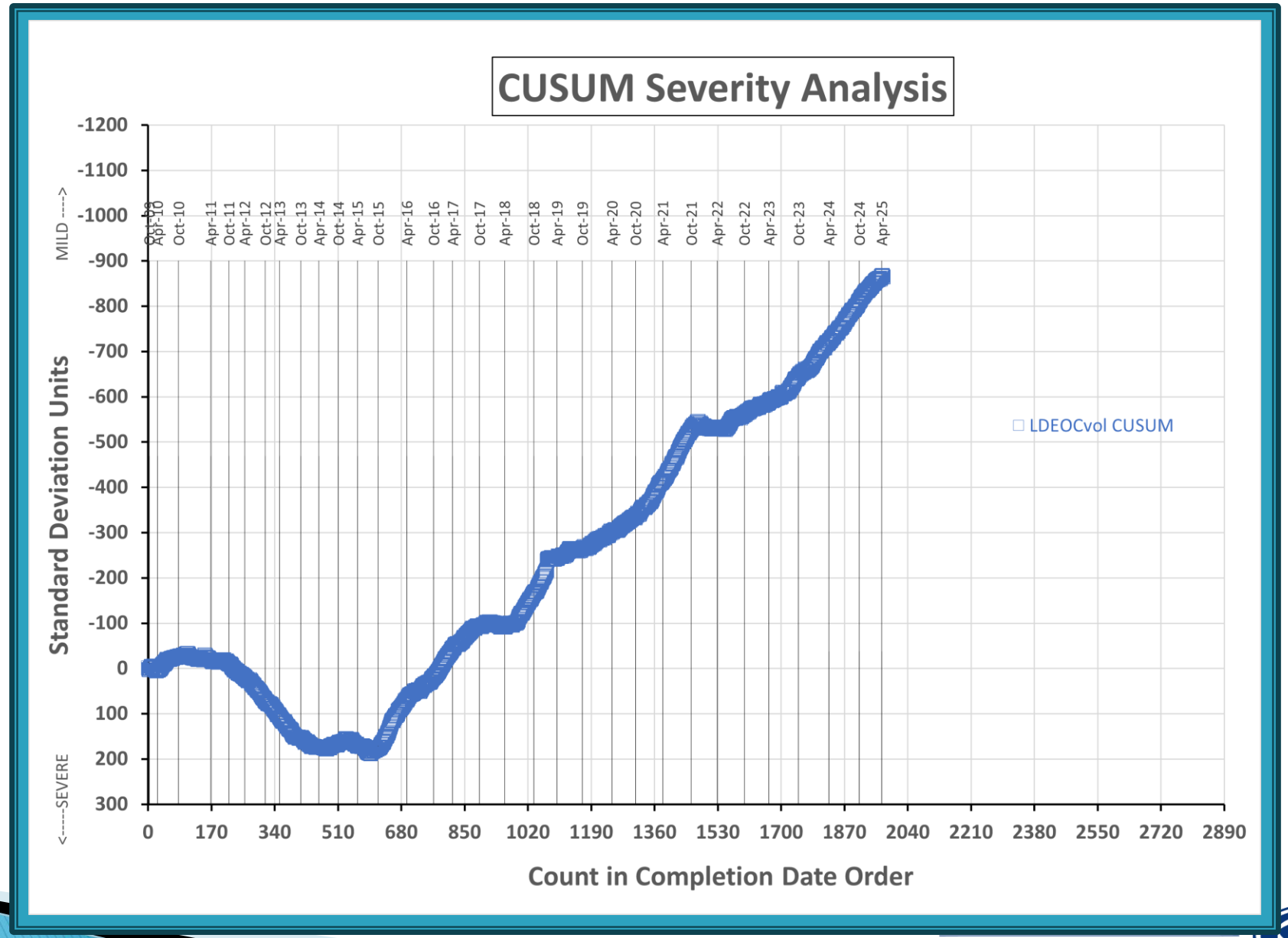
October 1, 2024 – March 31, 2025

Test Monitoring Center
https://www.astmtmc.org
A Program of ASTM International

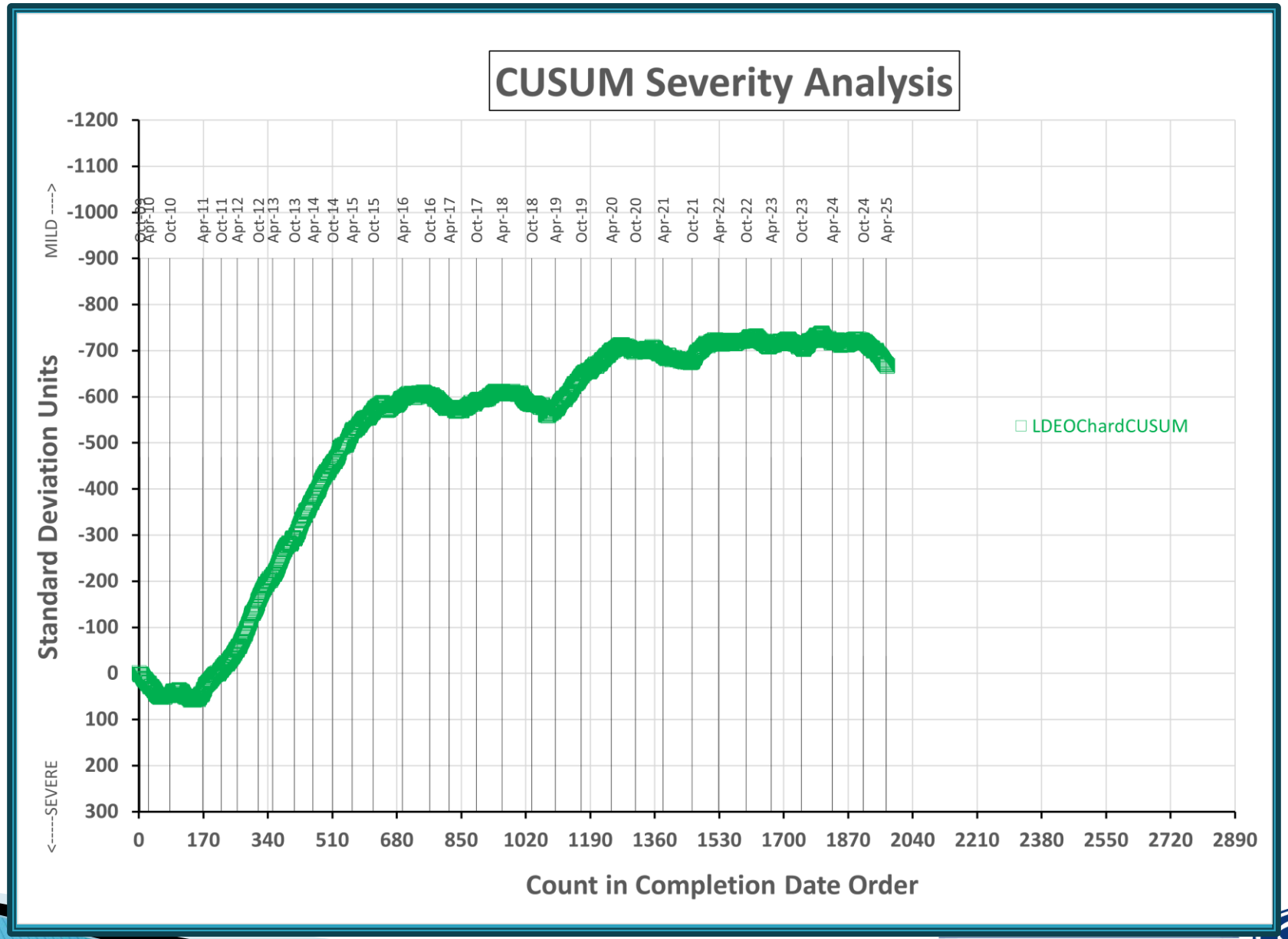
LDEOC Precision Estimates by Lab: AEM1

Test Parameter	Statistic	LTMS Lab							
		A	B	E	G	I	L	P	V
	n=	19	8	0	18	10	1	1	3
Volume	Mean	23.2	23.4		24.0	23.9	23.8	22.3	21.7
	Pooled s	0.42	0.30		0.95	0.53			0.25
	Mean /s	-1.33	-0.99		-0.31	-0.33	-0.48	-2.45	-3.25
Hardness	Mean	-12.4	-12.4		-11.3	-11.6	-13.0	-13.0	-12.7
	Pooled s	0.83	1.51		0.77	0.70			0.58
	Mean /s	0.40	0.39		1.53	1.24	-0.30	-0.30	0.07
Tensile Strength	Mean	-17.3	-23.1		-21.0	-12.3	-10.2	-13.2	-16.4
	Pooled s	4.04	2.35		6.00	2.53			3.65
	Mean /s	-0.12	-1.61		-1.09	1.18	1.72	0.94	0.11

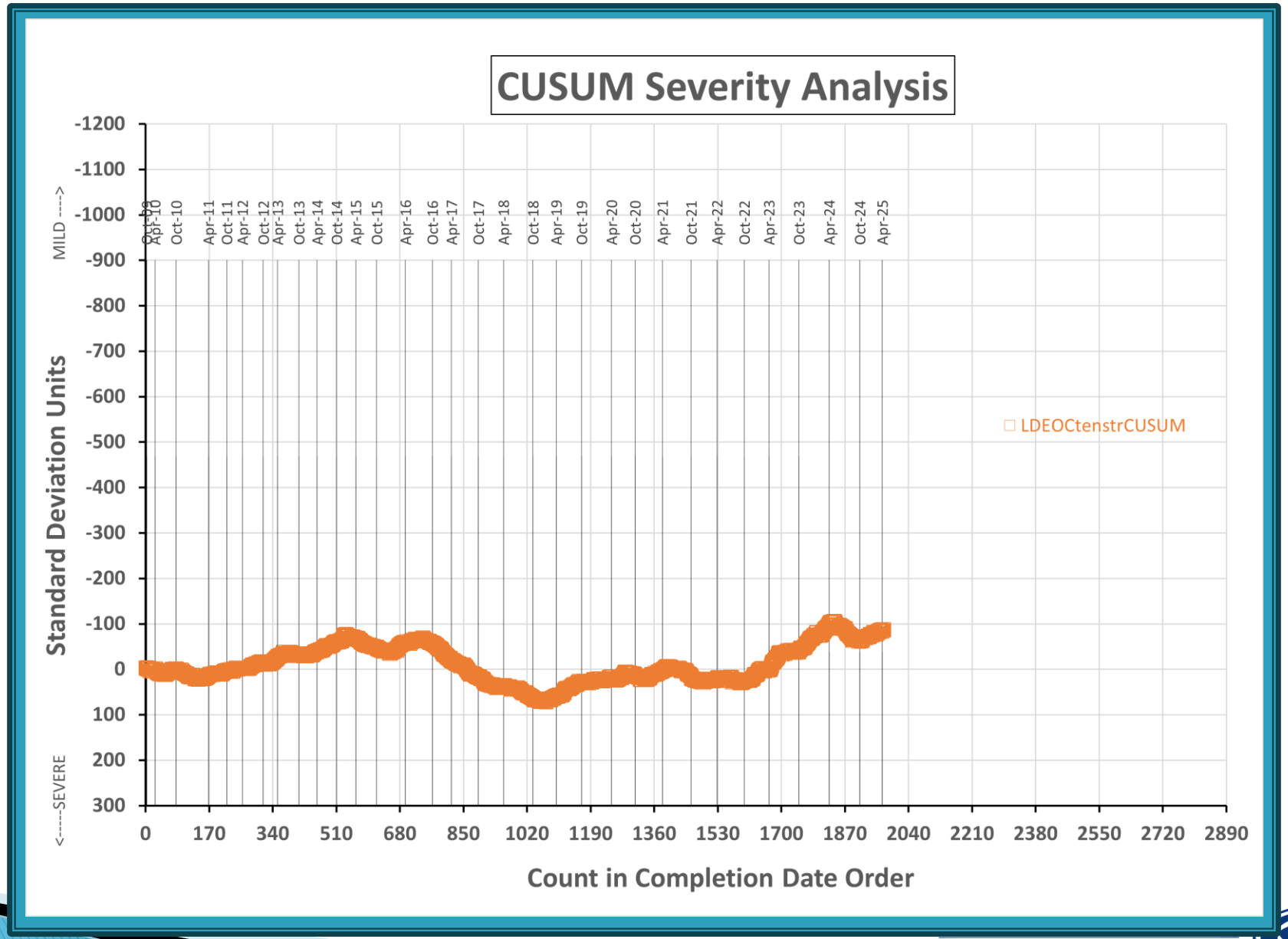
LDEOC – ETHYLENE ACRYLATE INDUSTRY OPERATIONALLY VALID DATA
ETHYLENE ACRYLATE VOLUME CHANGE FINAL



LDEOC – ETHYLENE ACRYLATE INDUSTRY OPERATIONALLY VALID DATA
ETHYLENE ACRYLATE HARDNESS CHANGE FINAL



LDEOC – ETHYLENE ACRYLATE INDUSTRY OPERATIONALLY VALID DATA
ETHYLENE ACRYLATE TENSILE STRENGTH CHANGE FINAL

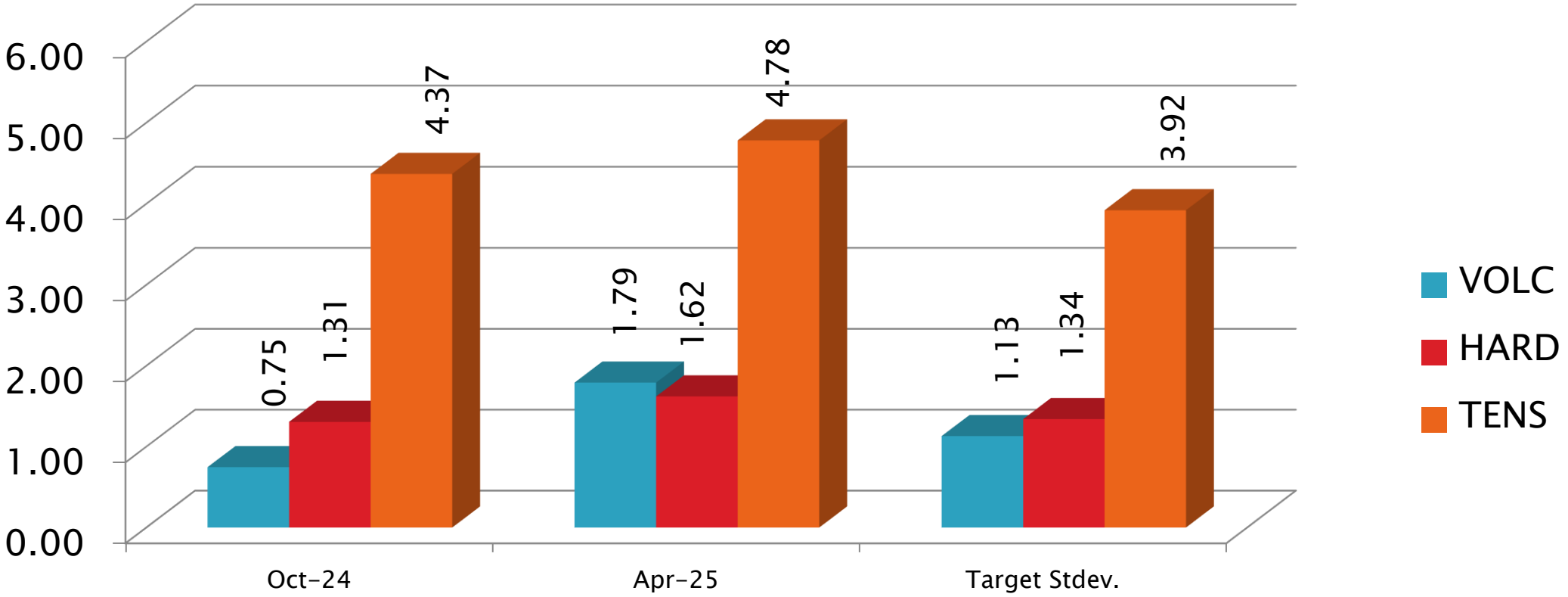


LDEOC Test Severity

Ethylene Acrylate (AEM2)

Parameter	Period Mean Δ/s	Status
Volume Change	0.0409	On-Targe
Points Hardness Change	-0.4634	Mild
Tensile Strength Change	-0.8049	Mild

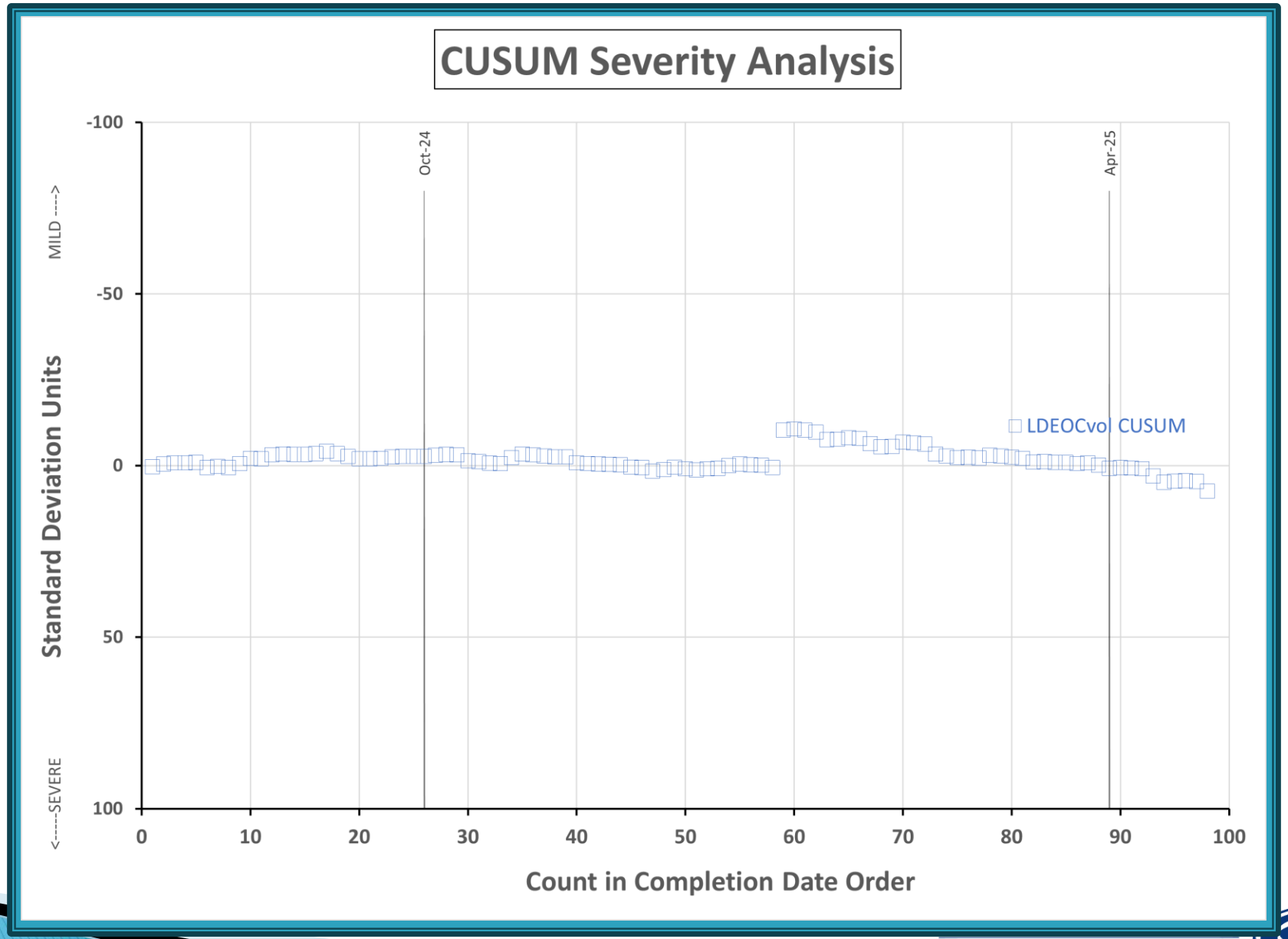
LDEOC Precision Estimates – Ethylene Acrylate 2



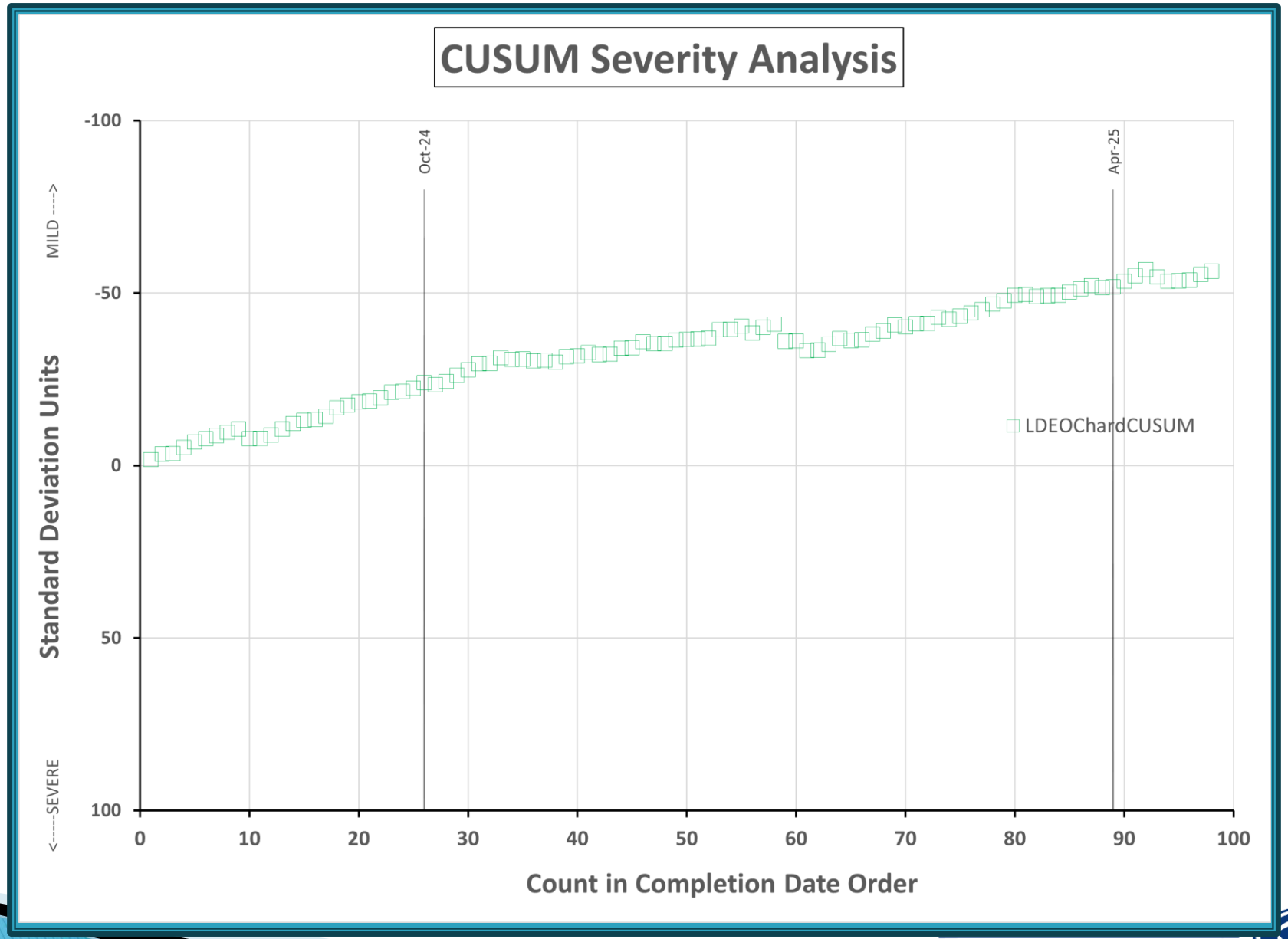
LDEOC Precision Estimates by Lab: AEM2

Test Parameter	Statistic	LTMS Lab							
		A	B	E	G	I	L	P	V
	n=	34	8	0	14	1	0	1	5
Volume	Mean	20.6	21.4		21.8	22.1		21.7	20.6
	Pooled s	2.16	0.21		1.41				0.51
	Mean /s	-0.31	0.33		0.75	0.97		0.62	-0.32
Hardness	Mean	-8.68	-7.50		-8.14	-9.00		-7.00	-8.60
	Pooled s	1.66	1.07		1.29				2.70
	Mean /s	-0.68	0.19		-0.29	-0.93		0.57	-0.63
Tensile Strength	Mean	-43.5	-47.7		-48.1	-45.7		-43.3	-44.6
	Pooled s	3.57	2.74		5.85				6.84
	Mean /s	-0.37	-1.45		-1.56	-0.94		-0.33	-0.66

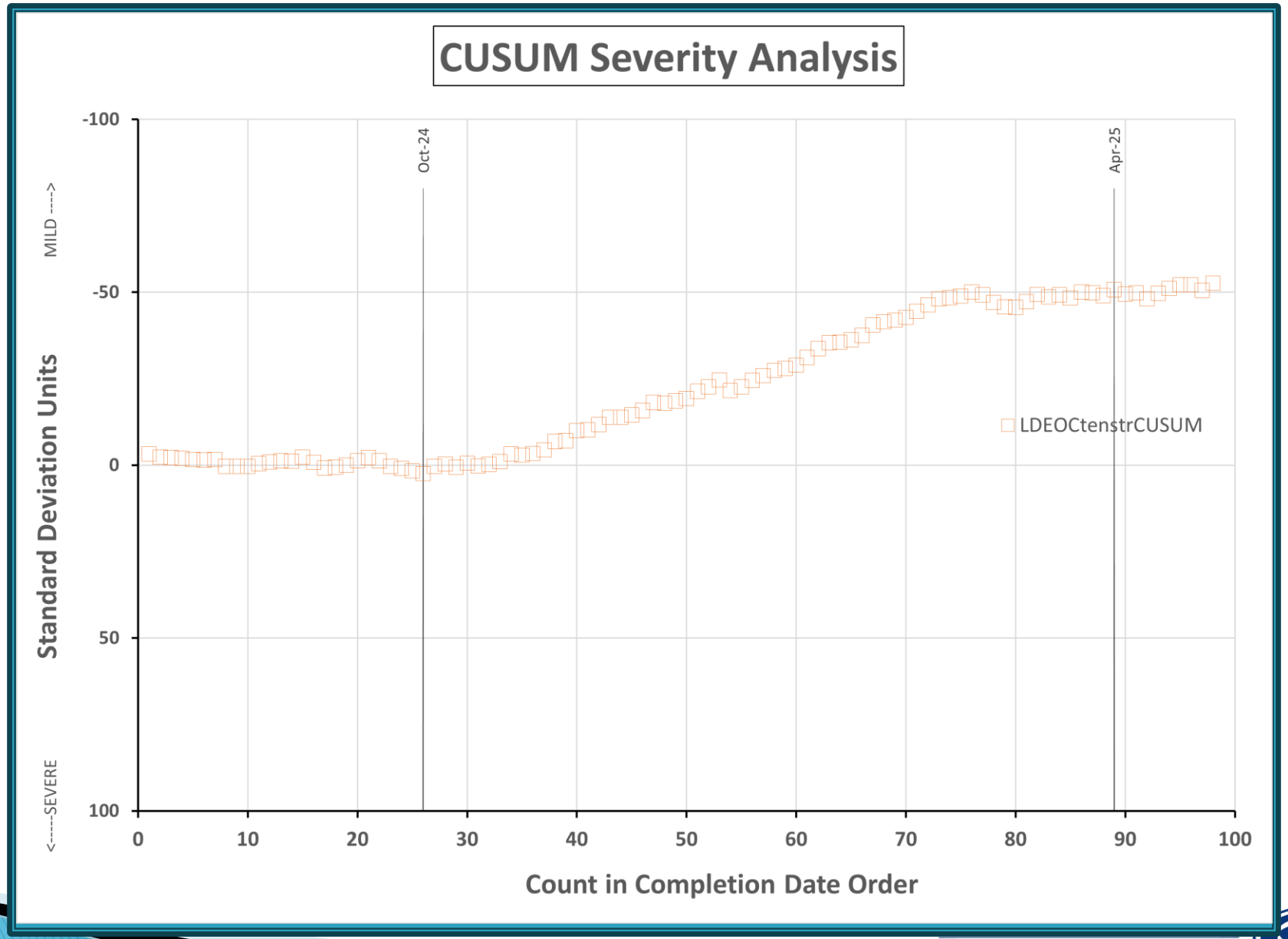
LDEOC – ETHYLENE ACRYLATE INDUSTRY OPERATIONALLY VALID DATA
ETHYLENE ACRYLATE-2 VOLUME CHANGE FINAL



LDEOC – ETHYLENE ACRYLATE INDUSTRY OPERATIONALLY VALID DATA
ETHYLENE ACRYLATE-2 HARDNESS CHANGE FINAL



LDEOC – ETHYLENE ACRYLATE INDUSTRY OPERATIONALLY VALID DATA
ETHYLENE ACRYLATE-2 TENSILE STRENGTH CHANGE FINAL

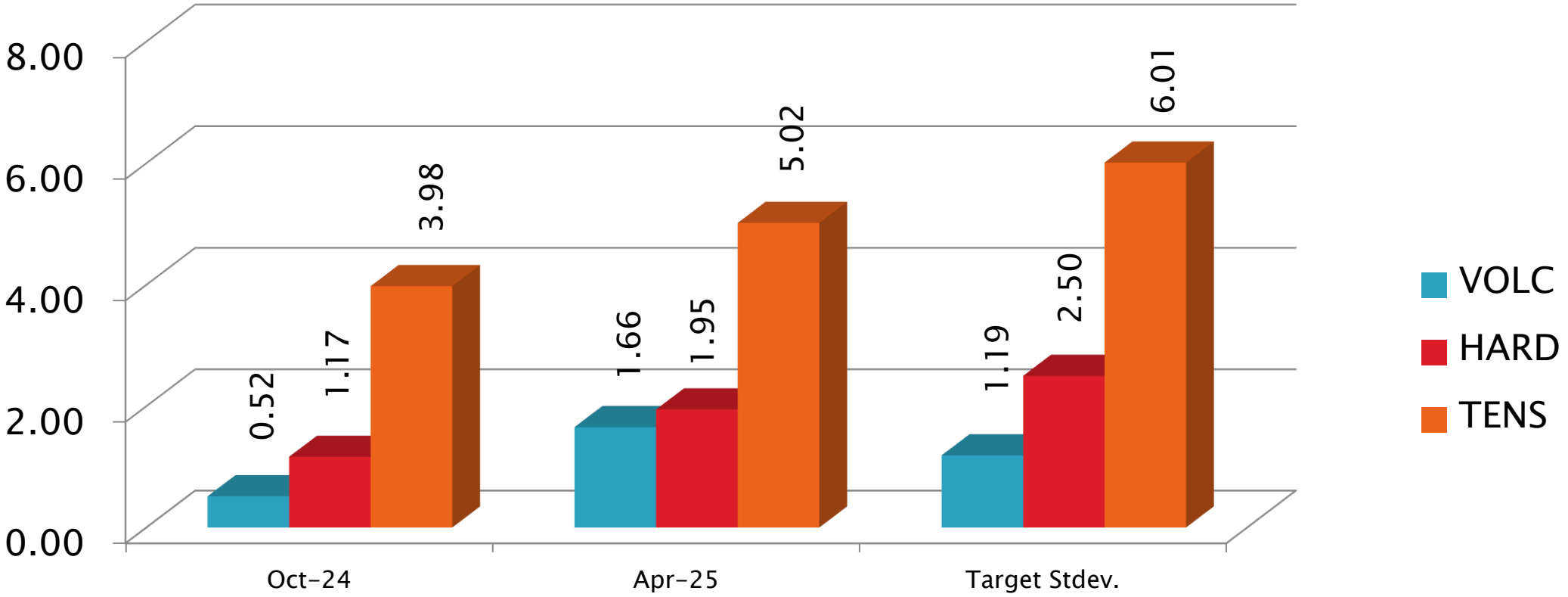


LDEOC Test Severity

Ethylene Acrylate (AEM3)

Parameter	Period Mean Δ/s	Status
Volume Change	0.4962	Severe
Points Hardness Change	0.3114	Severe
Tensile Strength Change	-1.1774	Very Mild

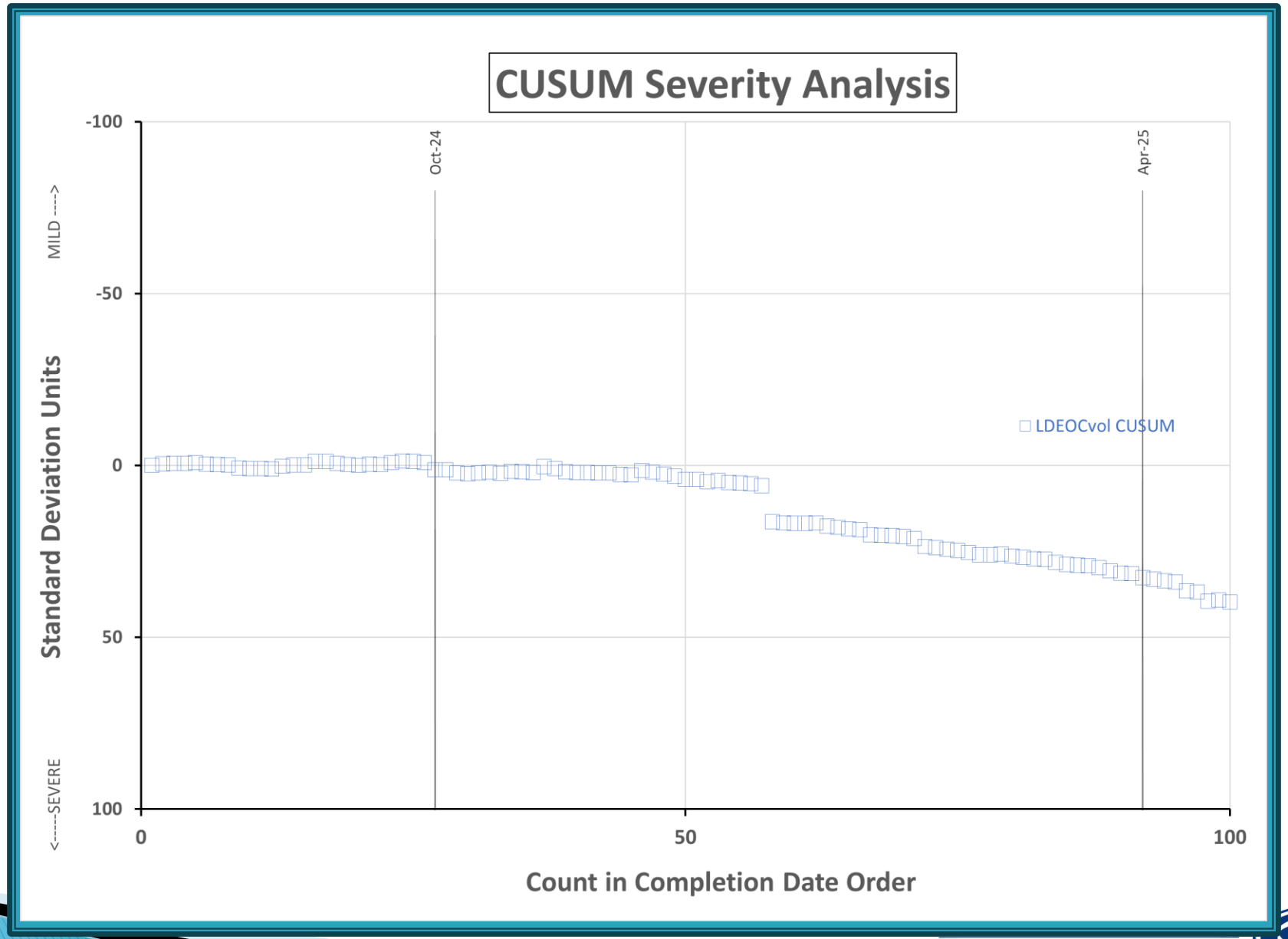
LDEOC Precision Estimates – Ethylene Acrylate 3



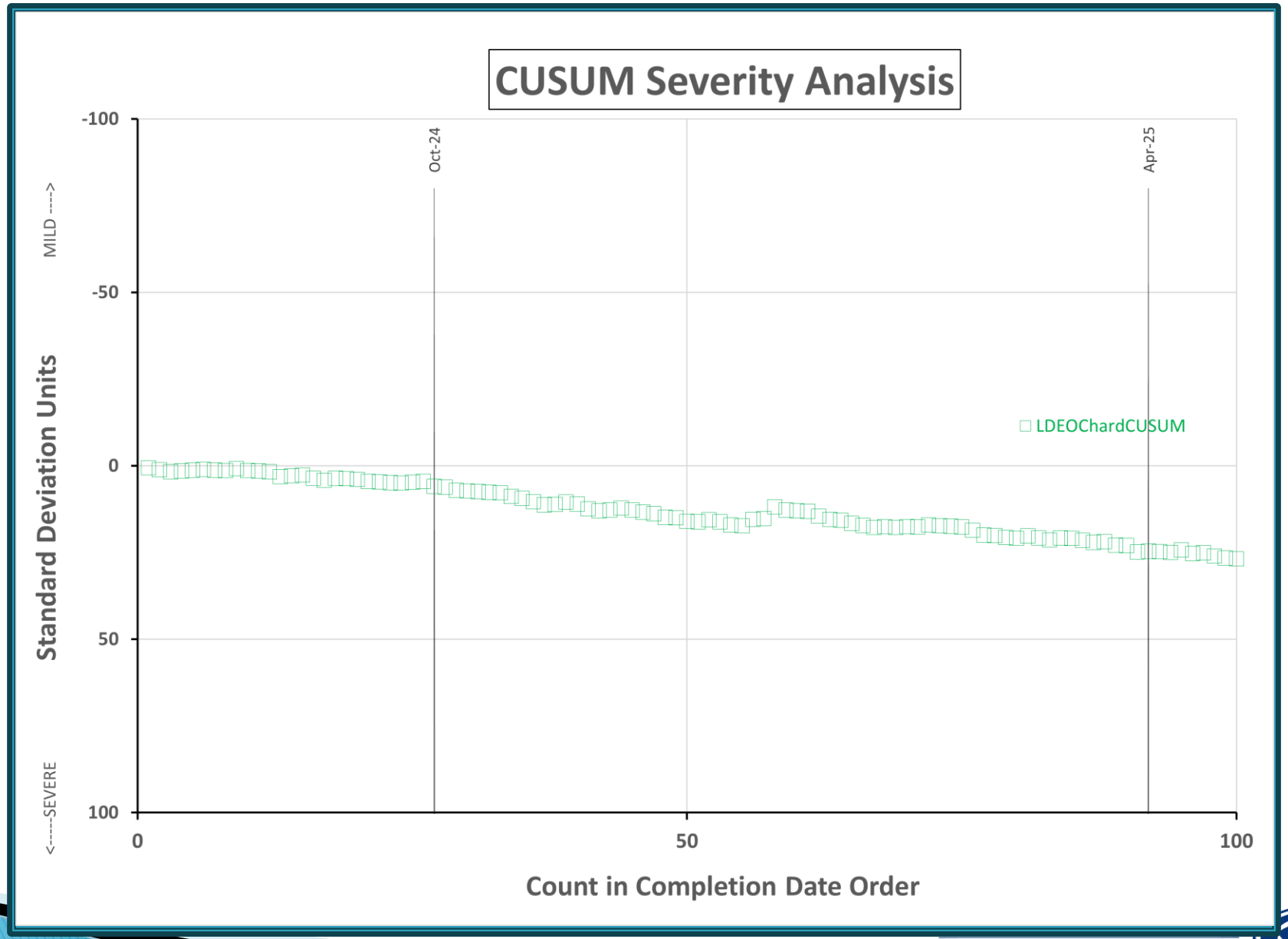
LDEOC Precision Estimates by Lab: AEM3

Test Parameter	Statistic	LTMS Lab							
		A	B	E	G	I	L	P	V
	n=	34	8	0	15	1	0	1	6
Volume	Mean	8.92	8.70		9.08	10.16		8.69	8.13
	Pooled s	2.12	0.31		1.15				0.72
	Mean /s	0.53	0.35		0.68	1.58		0.34	-0.13
Hardness	Mean	-0.09	1.62		0.73	1.00		2.00	-0.33
	Pooled s	1.75	1.19		2.05				3.01
	Mean /s	0.14	0.83		0.47	0.58		0.98	0.04
Tensile Strength	Mean	-44.0	-46.3		-46.7	-42.1		-45.8	-47.6
	Pooled s	-5.06	1.80		4.92				7.28
	Mean /s	-0.97	-1.35		-1.43	-0.65		-1.27	-1.57

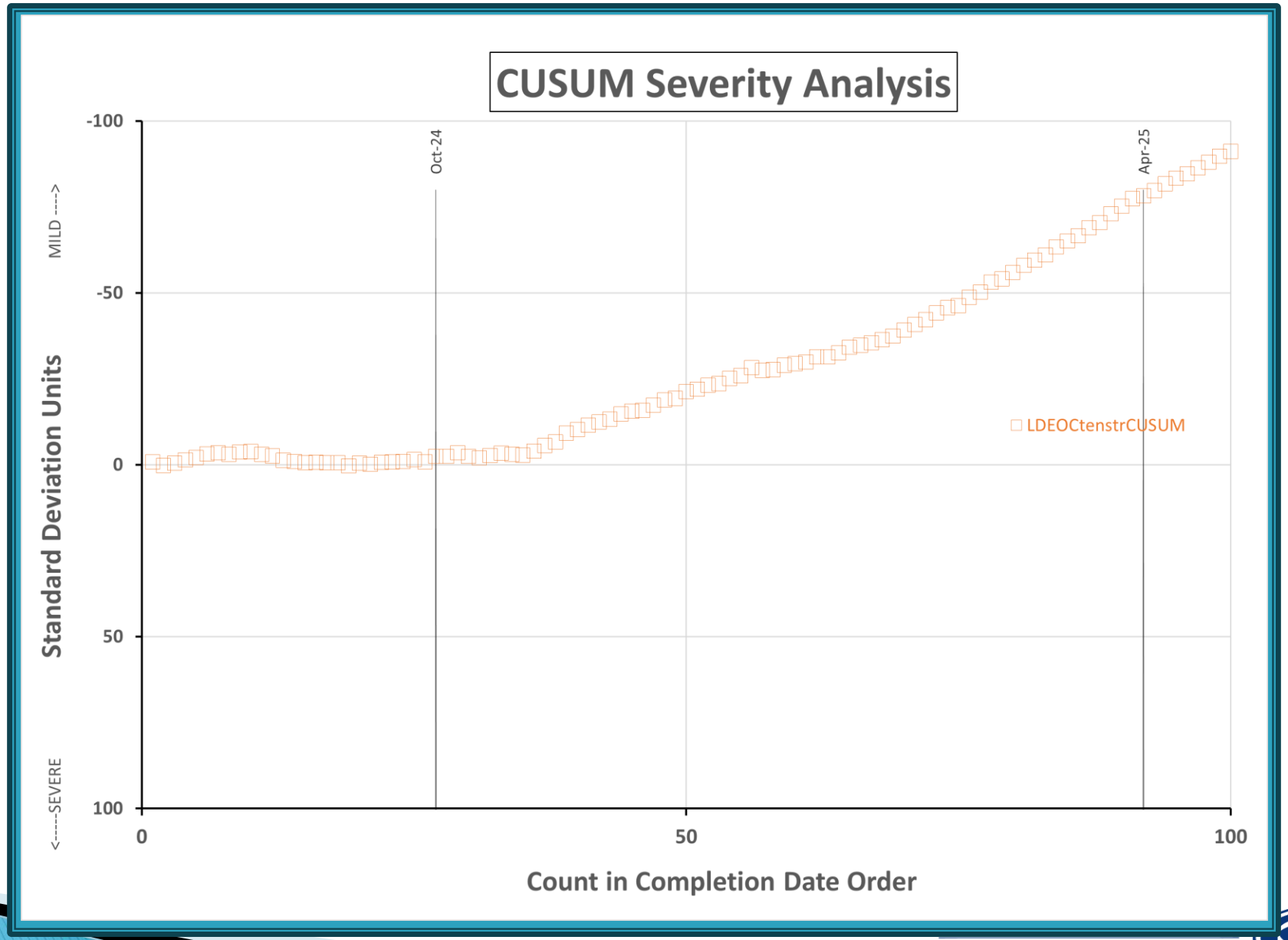
LDEOC – ETHYLENE ACRYLATE INDUSTRY OPERATIONALLY VALID DATA
ETHYLENE ACRYLATE-3 VOLUME CHANGE FINAL



LDEOC – ETHYLENE ACRYLATE INDUSTRY OPERATIONALLY VALID DATA
ETHYLENE ACRYLATE-3 HARDNESS CHANGE FINAL



LDEOC – ETHYLENE ACRYLATE INDUSTRY OPERATIONALLY VALID DATA
ETHYLENE ACRYLATE-3 TENSILE STRENGTH CHANGE FINAL

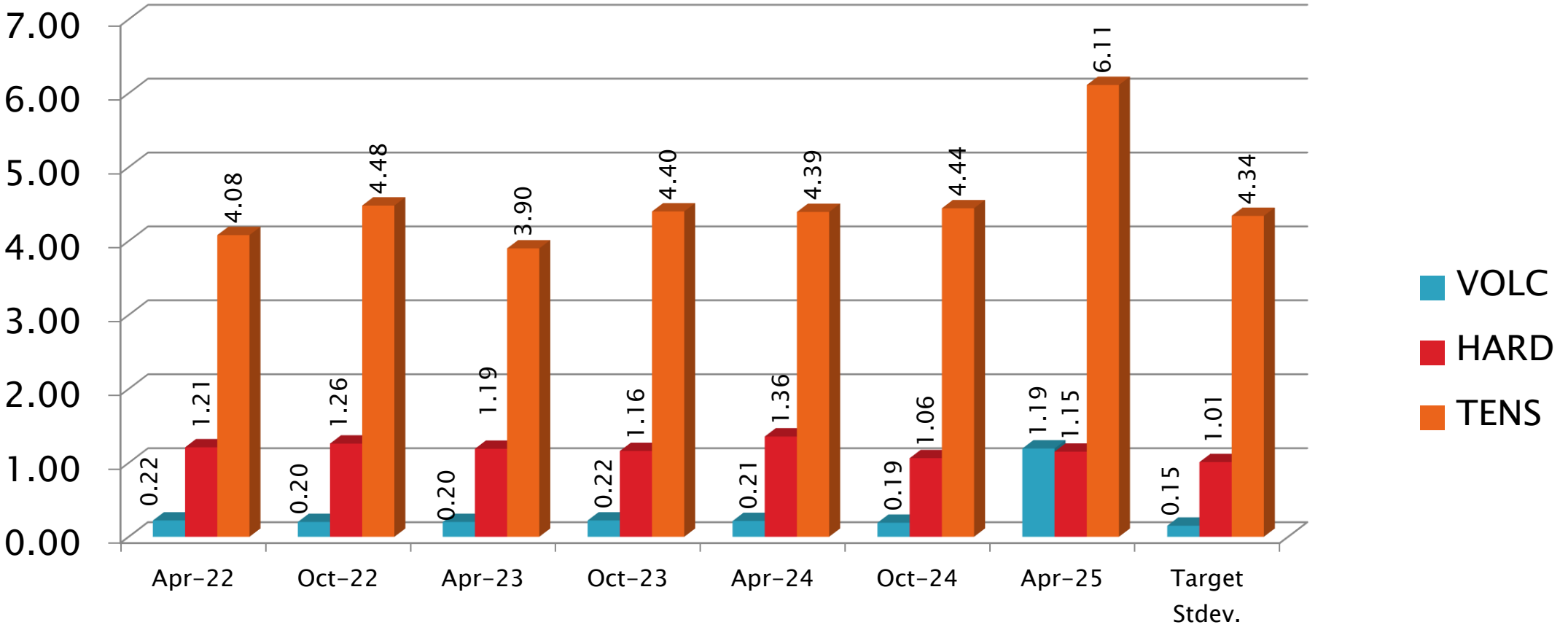


LDEOC Test Severity

Fluoroelastomer (FKM1)

Parameter	Period Mean Δ/s	Status
Volume Change	-1.7891	Very Mild
Points Hardness Change	-0.2610	Slightly Mild
Tensile Strength Change	0.1797	Slightly Severe

LDEOC Precision Estimates – Fluoroelastomer

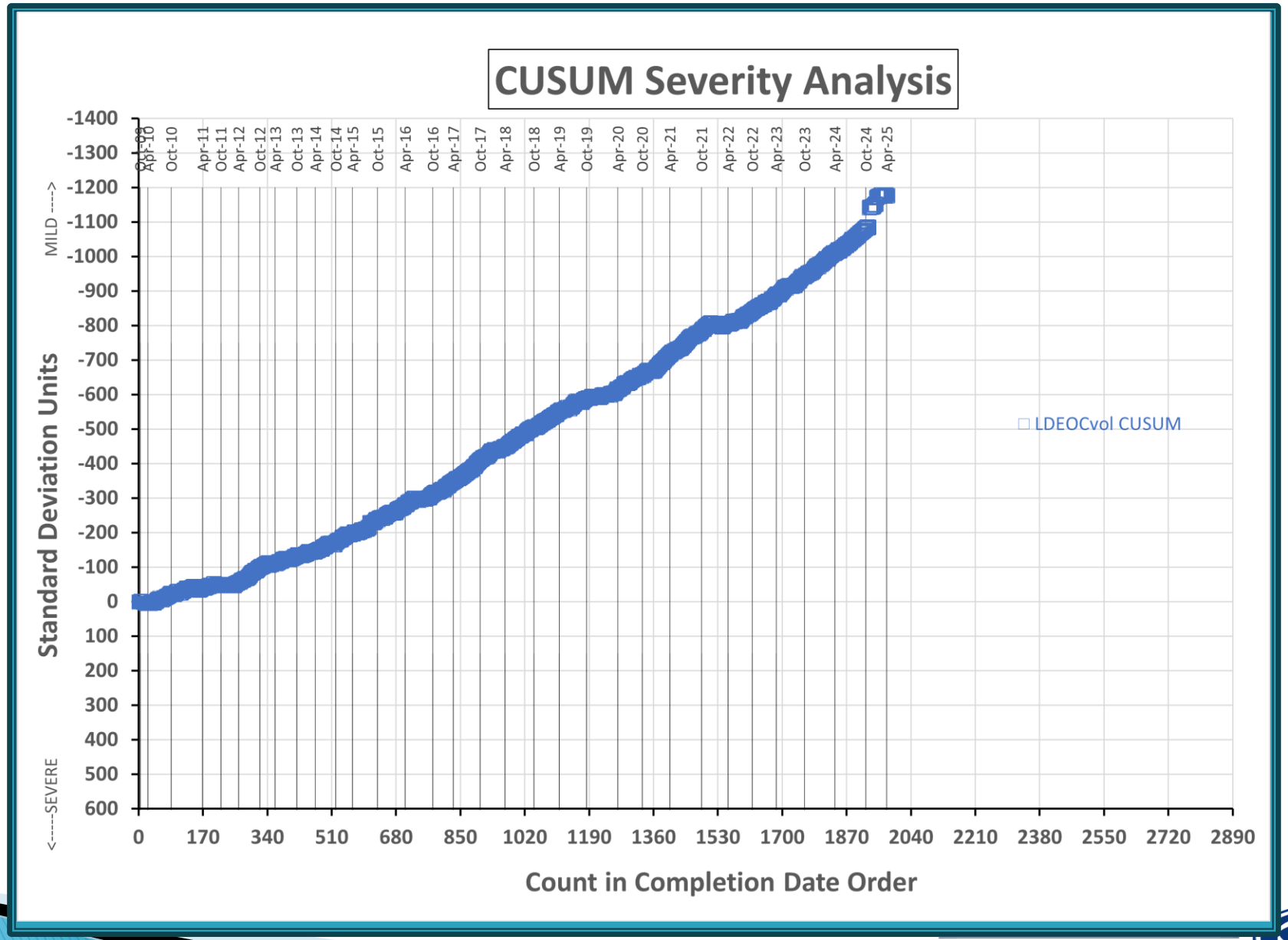


October 1, 2024 – March 31, 2025

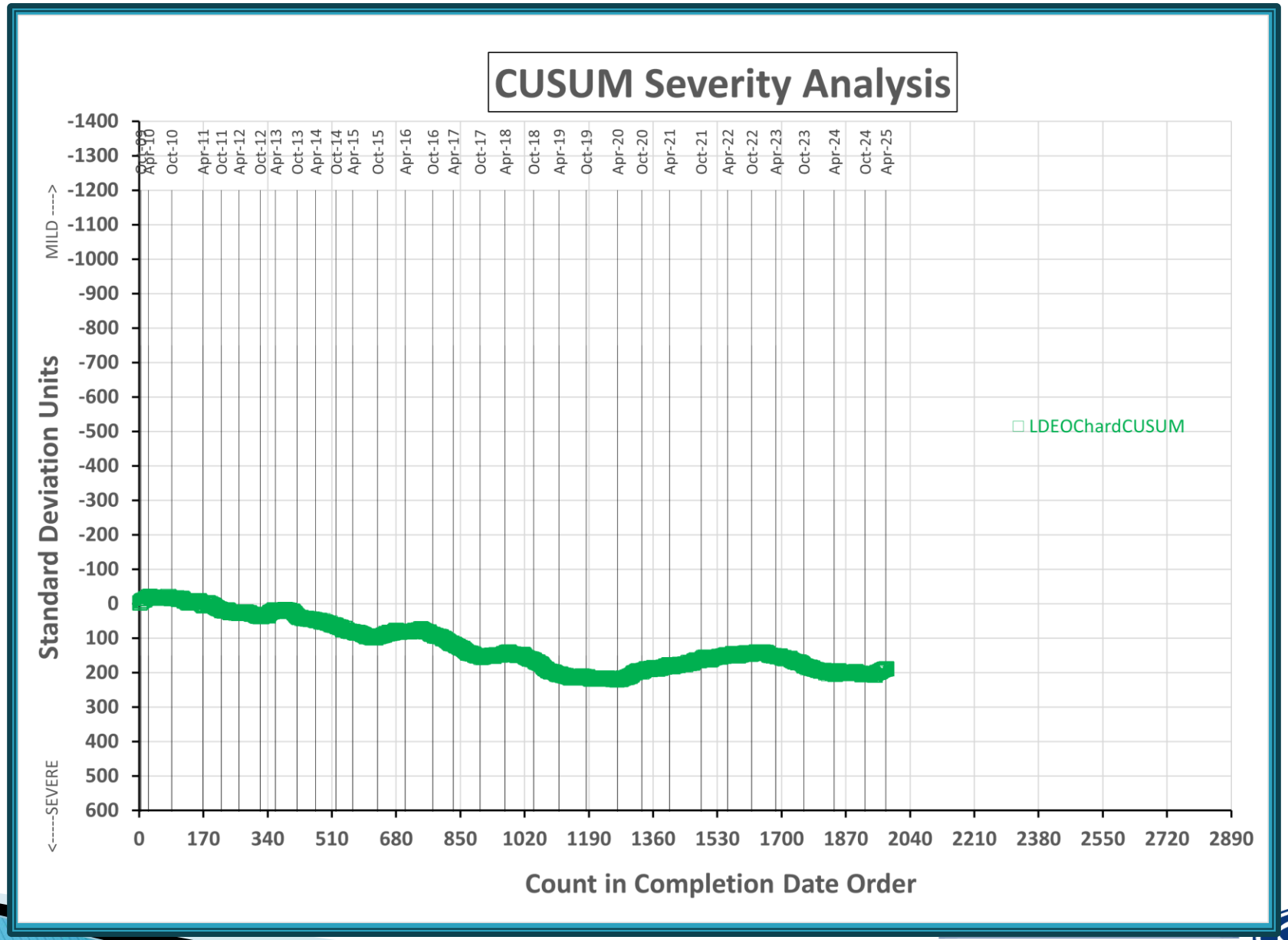
LDEOC Precision Estimates by Lab: FKM1

Test Parameter	Statistic	LTMS Lab*							
		A	B	E	G	I	L	P	V
	n=	18	9	0	15	10	1	0	2
Volume	Mean	0.58	0.52		-0.06	0.73	0.40		0.36
	Pooled s	0.15	0.10		2.25	0.31			0.06
	Mean /s	-0.64	-1.07		-4.96	0.33	-1.87		-2.17
Hardness	Mean	4.06	3.78		3.4	3.80	5.00		5.00
	Pooled s	1.16	0.83		1.45	0.63			1.41
	Mean /s	-0.04	-0.32		-0.69	-0.30	0.89		0.89
Tensile Strength	Mean	-58.4	-57.7		-57.5	-49.4	-59.7		-64.2
	Pooled s	2.50	1.33		9.00	1.96			1.70
	Mean /s	-0.22	-0.07		-0.02	1.85	-0.53		-1.57

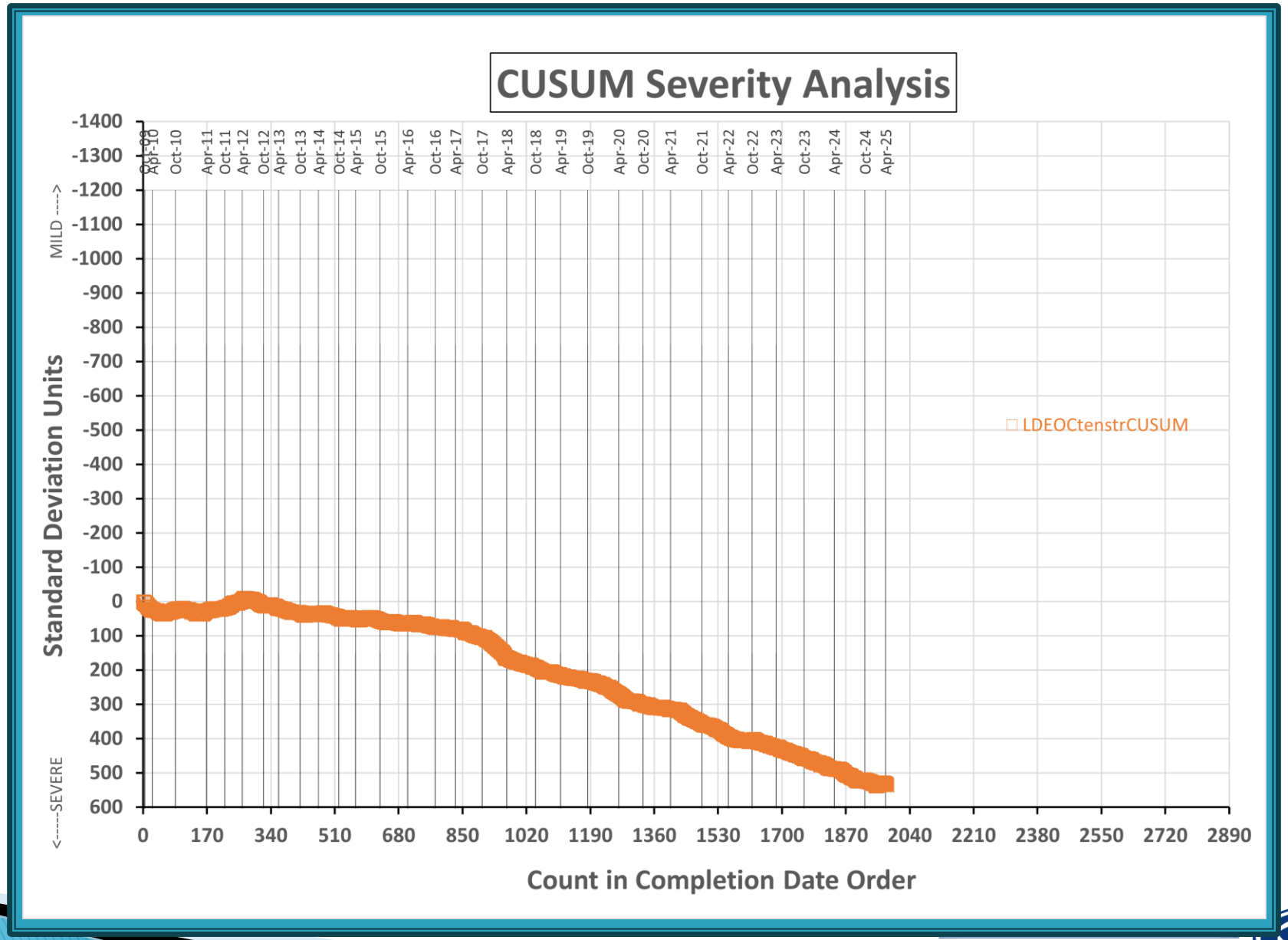
LDEOC – ETHYLENE ACRYLATE INDUSTRY OPERATIONALLY VALID DATA
FLUOROELASTOMER VOLUME CHANGE FINAL



LDEOC – ETHYLENE ACRYLATE INDUSTRY OPERATIONALLY VALID DATA
FLUOROELASTOMER HARDNESS CHANGE FINAL



LDEOC – ETHYLENE ACRYLATE INDUSTRY OPERATIONALLY VALID DATA
FLUOROELASTOMER TENSILE STRENGTH CHANGE FINAL

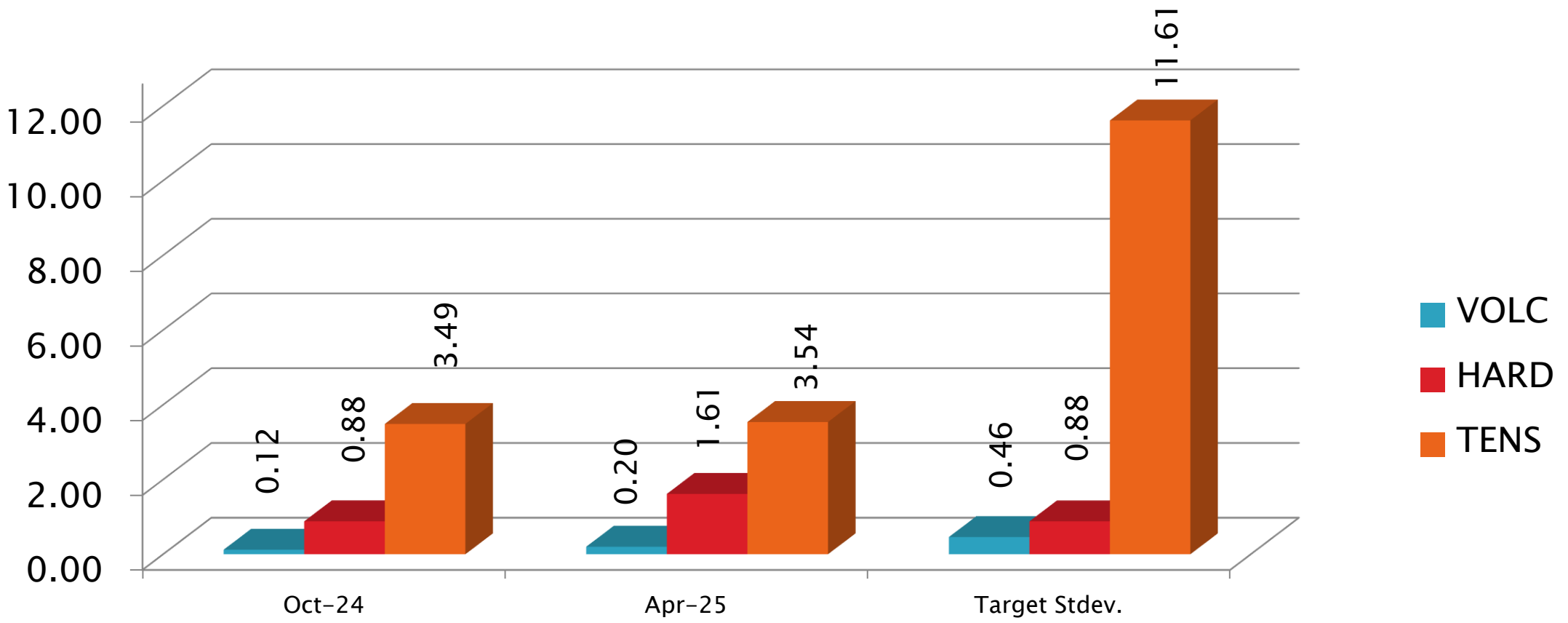


LDEOC Test Severity

Fluoroelastomer (FKM3)

Parameter	Period Mean Δ/s	Status
Volume Change	0.1640	Slightly Severe
Points Hardness Change	0.2273	Slightly Severe
Tensile Strength Change	-0.6201	Mild

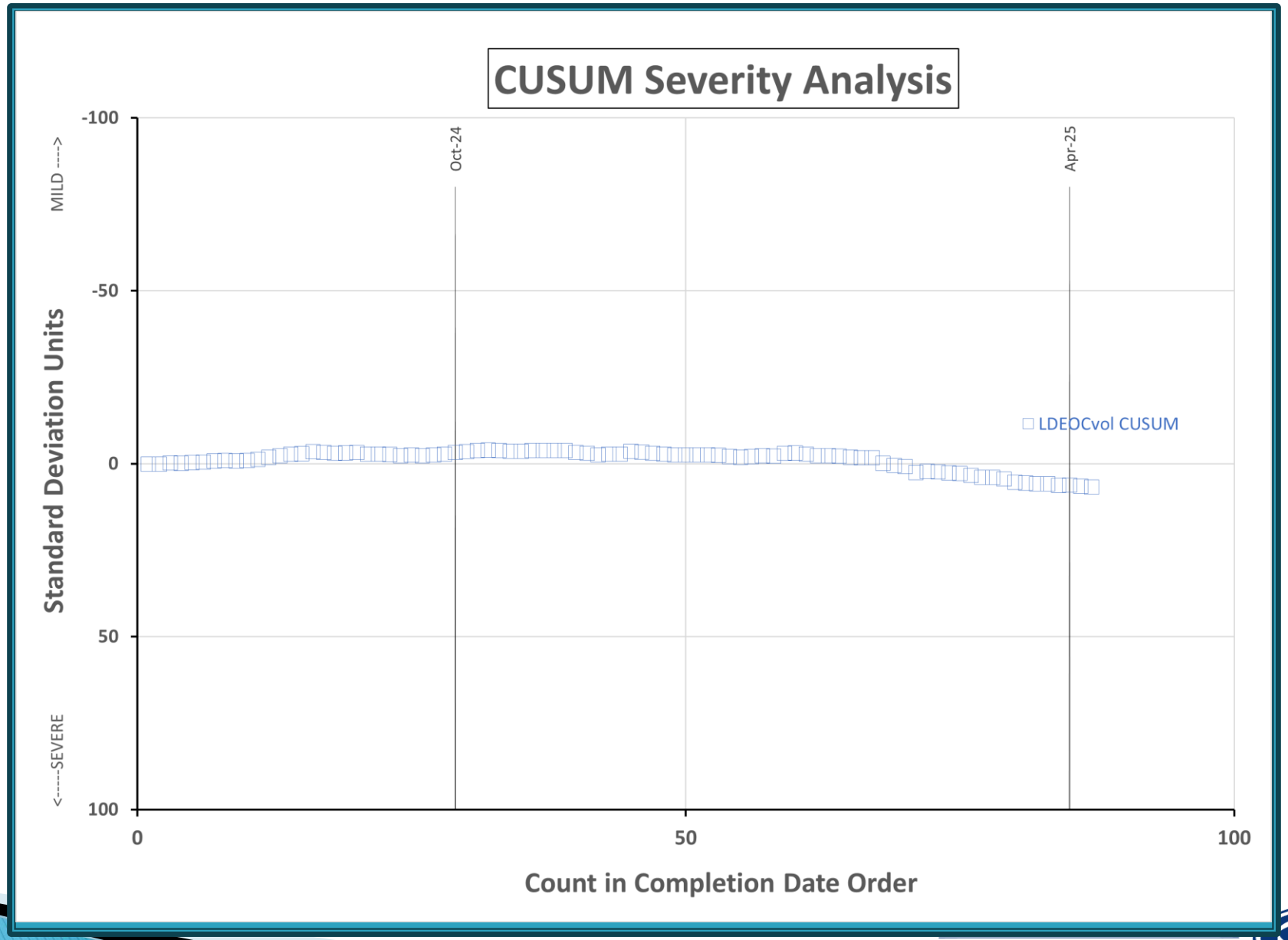
LDEOC Precision Estimates – Fluoroelastomer3



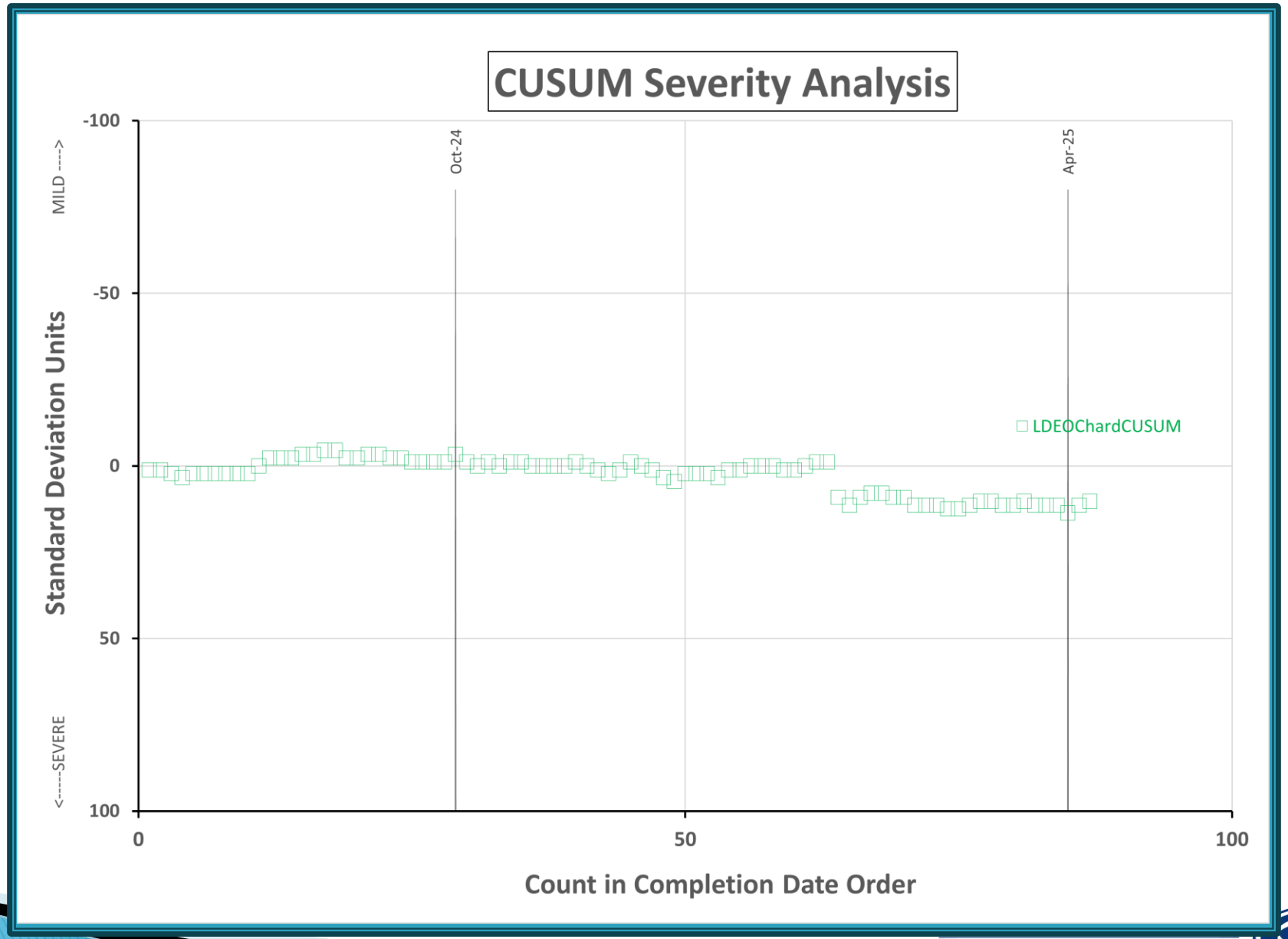
LDEOC Precision Estimates by Lab: FKM3

Test Parameter	Statistic	LTMS Lab*							
		A	B	E	G	I	L	P	V
	n=	26	8	0	14	1	0	1	5
Volume	Mean	0.84	0.74		0.86	1.48		0.37	0.76
	Pooled s	0.10	0.09		0.29				0.09
	Mean /s	0.20	-0.02		0.23	1.59		-0.83	0.02
Hardness	Mean	4.15	4.00		3.71	4.00		5.00	6.00
	Pooled s	0.92	0.76		1.49				4.06
	Mean /s	0.17	0.00		-0.32	0		1.13	2.27
Tensile Strength	Mean	-58.0	-57.6		-55.9	-51.4		-51.5	-62.5
	Pooled s	2.12	1.23		4.78				2.10
	Mean /s	-0.66	-0.62		-0.47	-0.09		-.10	-1.04

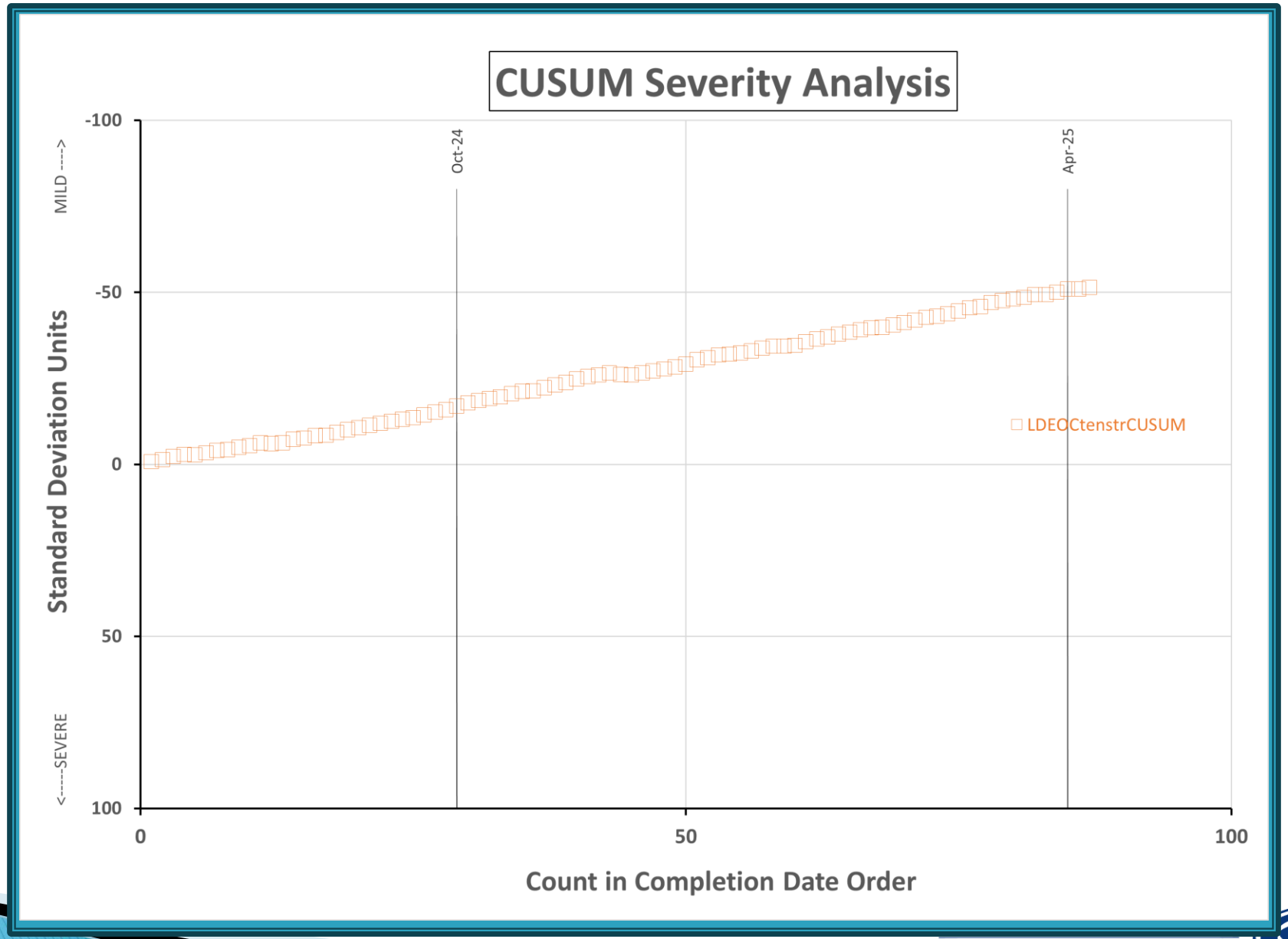
LDEOC – ETHYLENE ACRYLATE INDUSTRY OPERATIONALLY VALID DATA
FLUOROELASTOMER-3 VOLUME CHANGE FINAL



LDEOC – ETHYLENE ACRYLATE INDUSTRY OPERATIONALLY VALID DATA
FLUOROELASTOMER-3 HARDNESS CHANGE FINAL



LDEOC – ETHYLENE ACRYLATE INDUSTRY OPERATIONALLY VALID DATA
FLUOROELASTOMER-3 TENSILE STRENGTH CHANGE FINAL

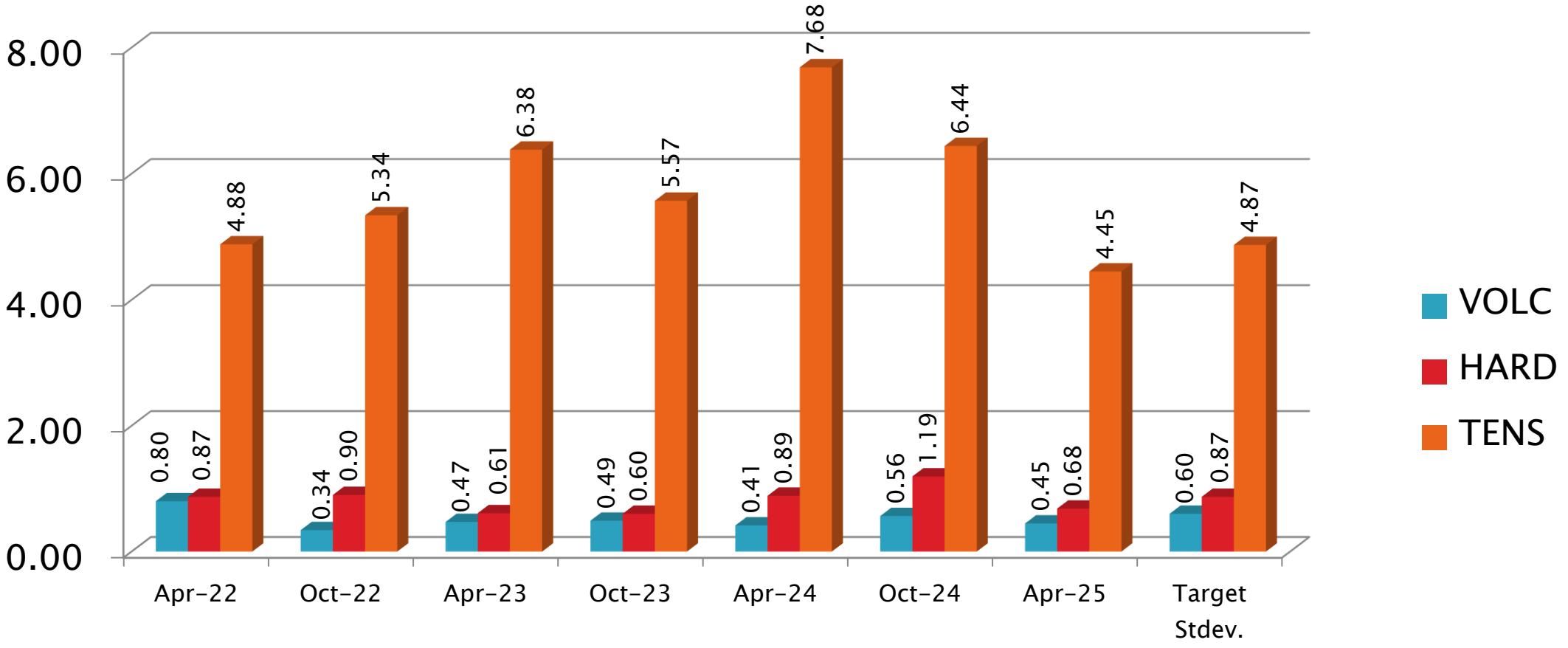


LDEOC Test Severity

Nitrile (NBR1)

Parameter	Period Mean Δ/s	Status
Volume Change	1.1119	Severe
Points Hardness Change	-0.6871	Mild
Tensile Strength Change	-0.9573	Mild

LDEOC Precision Estimates – Nitrile



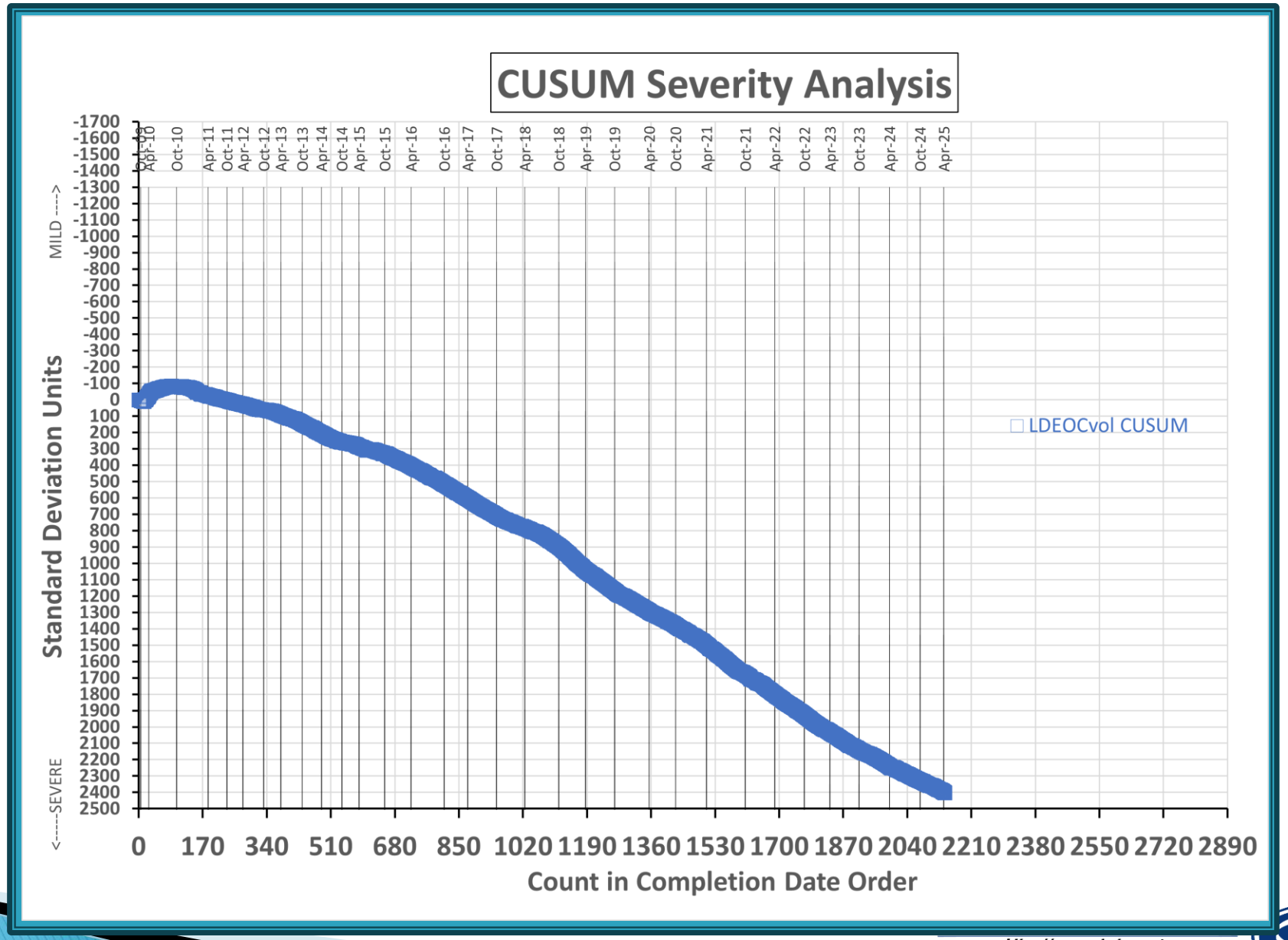
October 1, 2024 – March 31, 2025

LDEOC Precision Estimates by Lab: NBR1

Test Parameter	Statistic	LTMS Lab							
		A	B	E	G	I	L	P	V
	n=	20	9	0	17	11	1	1	4
Volume	Mean	1.08	1.19		0.77	1.05	1.31	0.60	0.86
	Pooled s	0.22	0.20		0.60	0.61			0.06
	Mean /s	1.26	1.45		0.75	1.22	1.65	0.47	0.89
Hardness	Mean	−1.80	−1.22		−1.88	−2.00	0	−2.00	−2.25
	Pooled s	0.70	0.83		0.33	0.45			0.96
	Mean /s	−0.71	−0.05		−0.81	−0.94	1.35	−0.94	−1.23
Tensile Strength	Mean	2.60	2.41		−1.00	2.45	−6.10	1.00	0.95
	Pooled s	3.34	4.65		5.72	3.36			0.06
	Mean /s	−0.69	−0.73		−1.43	−0.72	−2.48	−1.02	−1.03

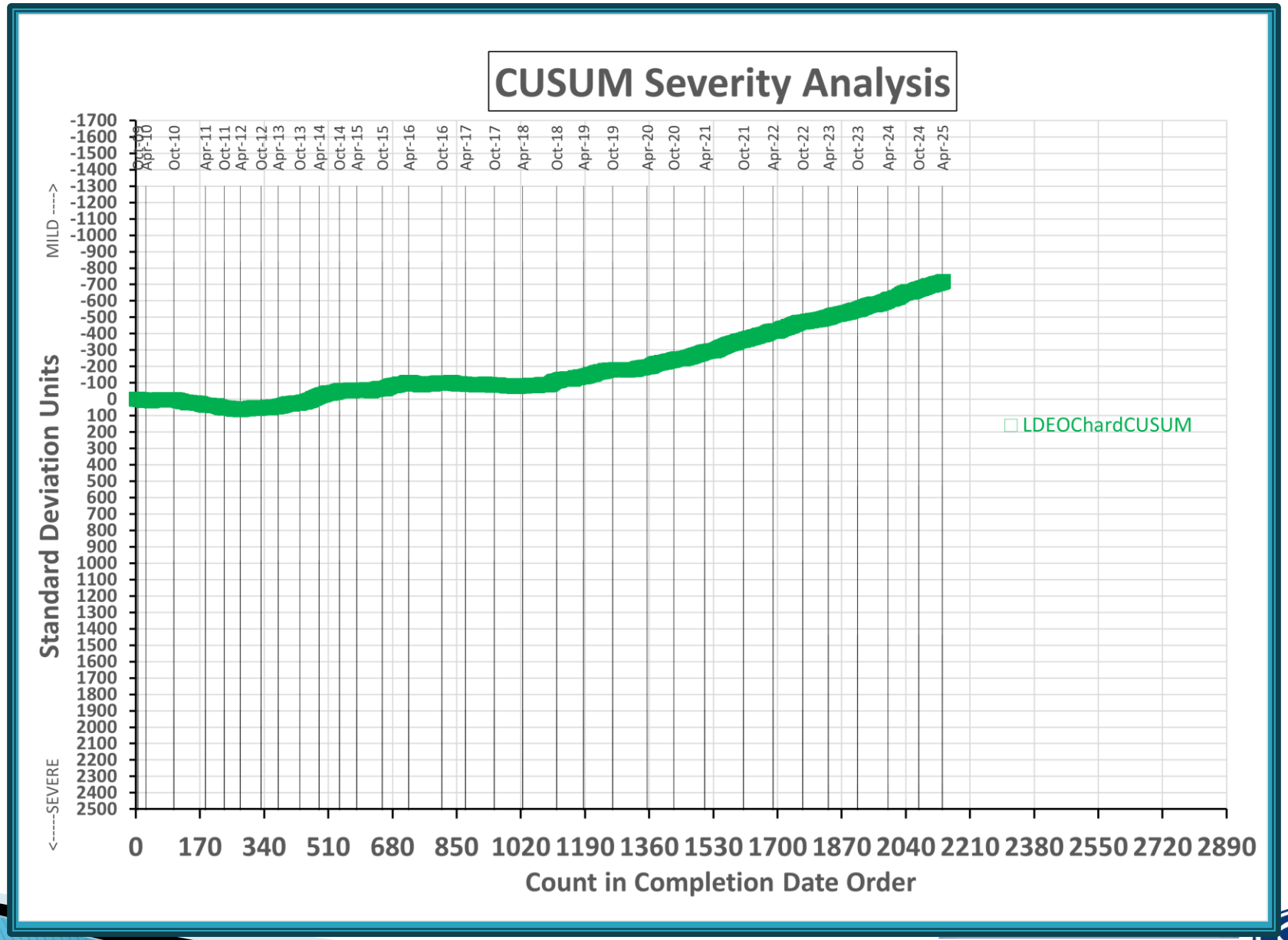
LDEOC —NITRILE INDUSTRY OPERATIONALLY VALID DATA

REFERENCE NITRILE VOLUME CHANGE FINAL



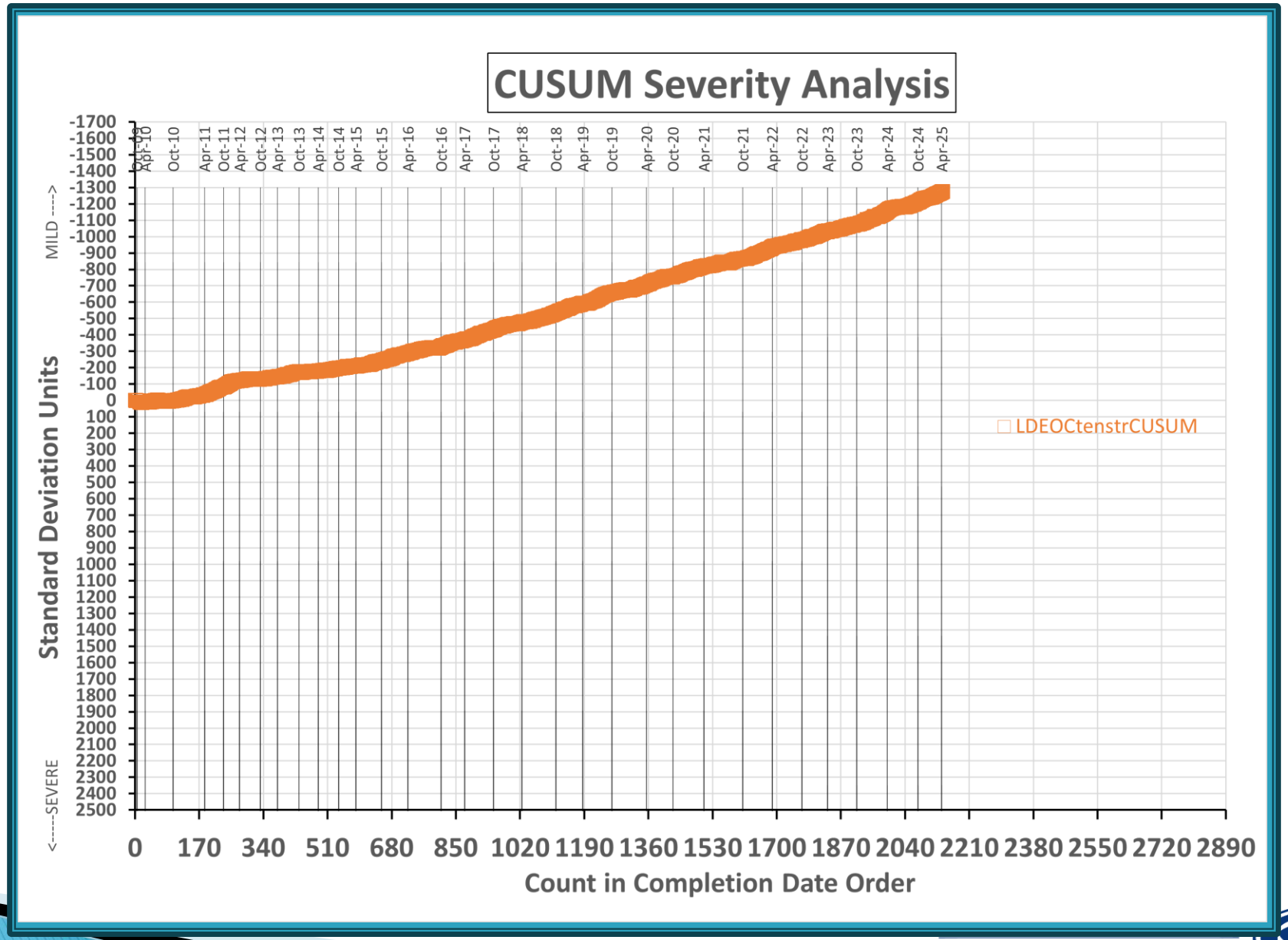
LDEOC —NITRILE INDUSTRY OPERATIONALLY VALID DATA

REF NITRILE POINTS HARDNESS CHANGE AVERAGE



LDEOC —NITRILE INDUSTRY OPERATIONALLY VALID DATA

REF NITRILE TENSILE STRENGTH CHANGE FINAL

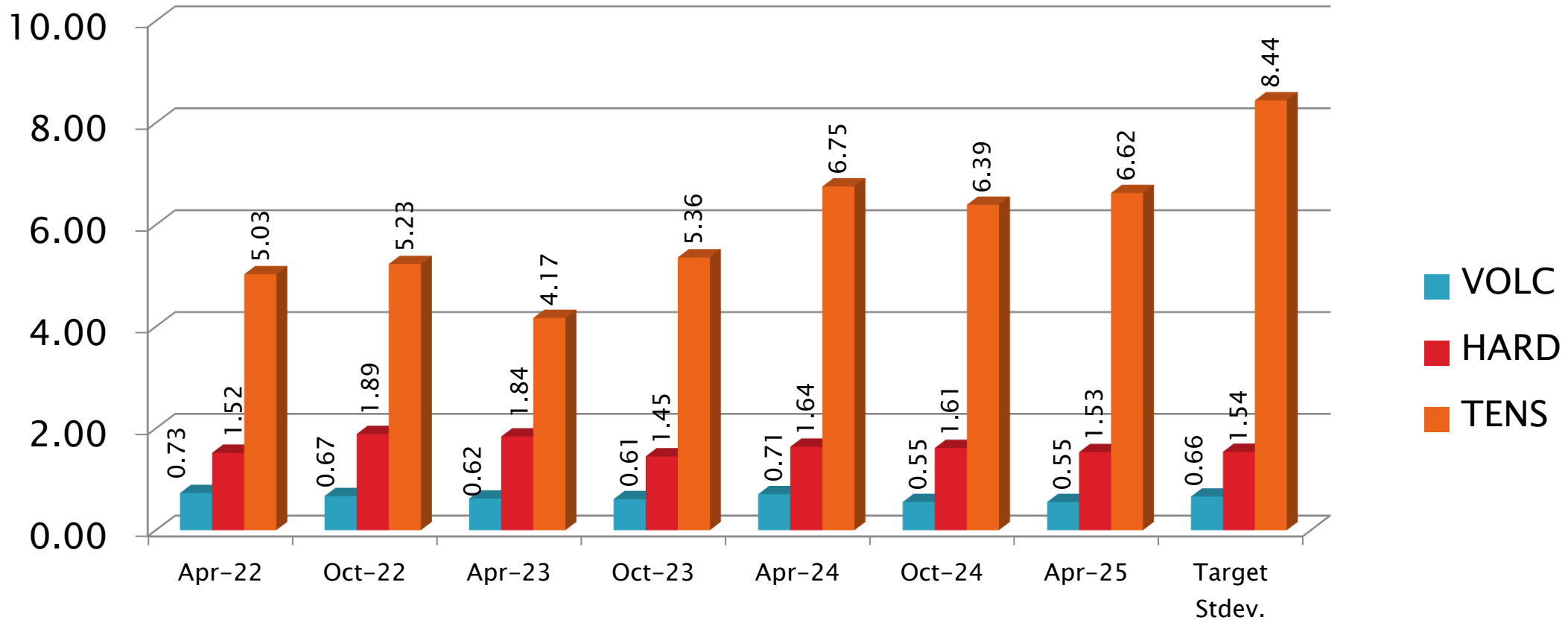


LDEOC Test Severity

Polyacrylate (ACM1)

Parameter	Period Mean Δ/s	Status
Volume Change	-0.3955	Mild
Points Hardness Change	-1.3788	Very Mild
Tensile Strength Change	-0.4376	Mild

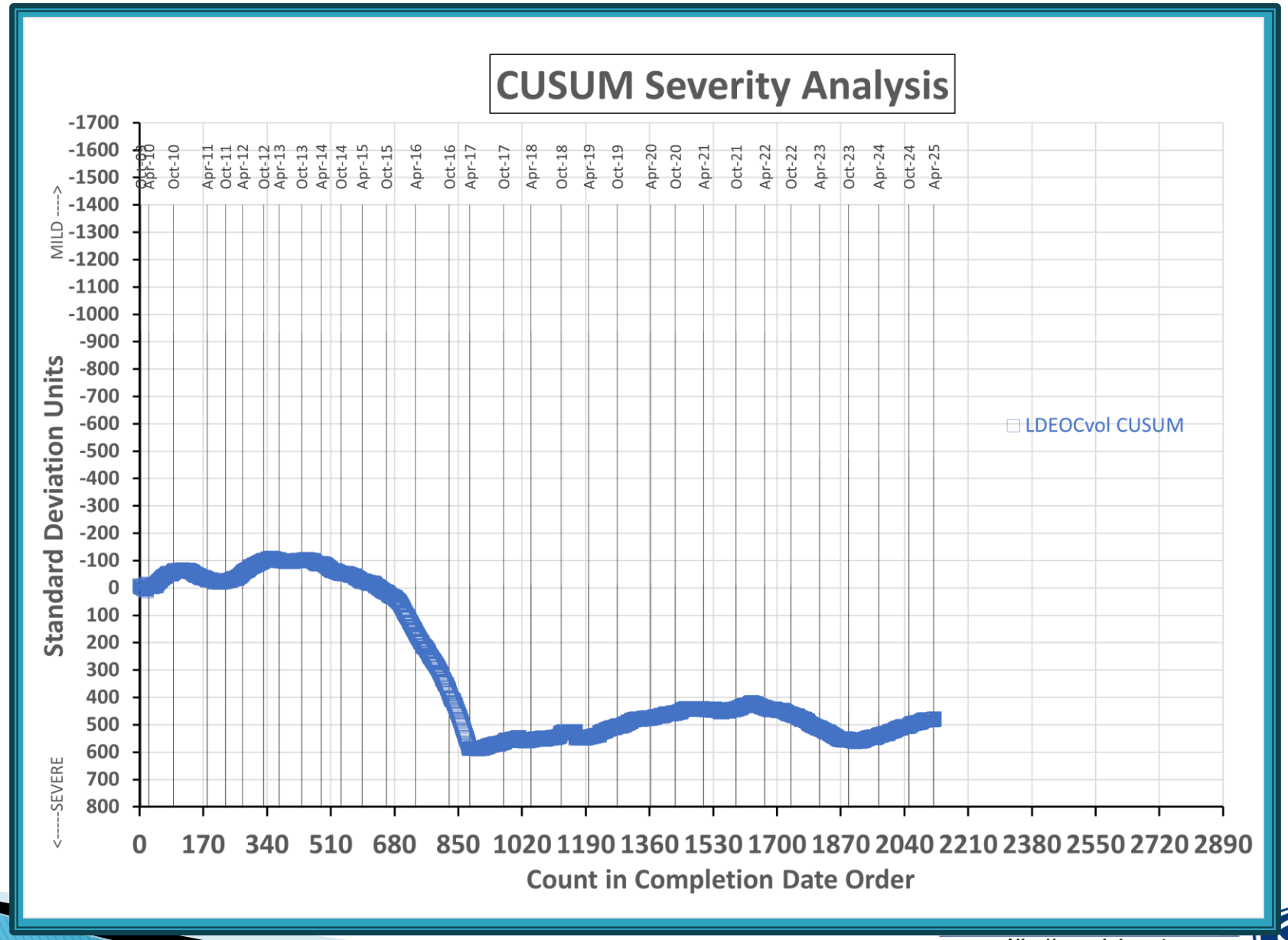
LDEOC Precision Estimates – Polyacrylate



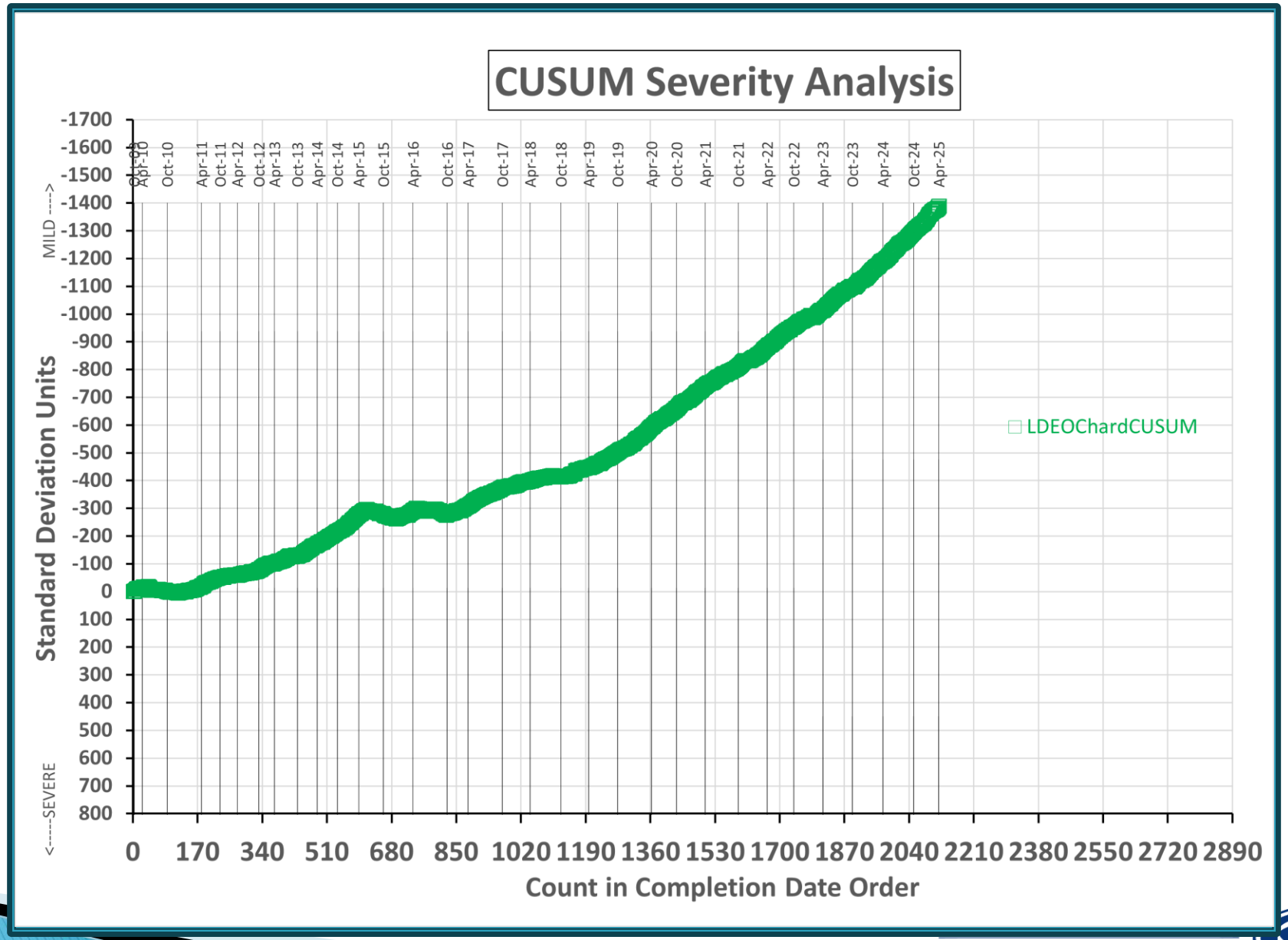
LDEOC Precision Estimates by Lab: ACM1

Test Parameter	Statistic	LTMS Lab							
		A	B	E	G	I	L	P	V
	n=	19	10	2	20	9	1	0	5
Volume	Mean	1.63	1.87	1.52	1.85	2.17	2.32		1.32
	Pooled s	0.33	0.32	0.04	0.80	0.39			0.17
	Mean /s	-0.64	-0.27	-0.80	-0.31	0.18	0.41		-1.11
Hardness	Mean	-3.05	-1.90	-4.00	-1.85	-0.67	-1.00		-5.00
	Pooled s	0.78	0.57	0.00	1.39	1.00			1.58
	Mean /s	-1.85	-1.10	-2.46	-1.06	-0.30	-0.51		-3.11
Tensile Strength	Mean	-1.43	-0.40	-1.25	-1.54	-0.16	-2.1		-1.14
	Pooled s	6.88	4.37	1.06	8.67	4.18			7.72
	Mean /s	-0.47	-0.35	-0.45	-0.49	-0.32	-0.55		-0.44

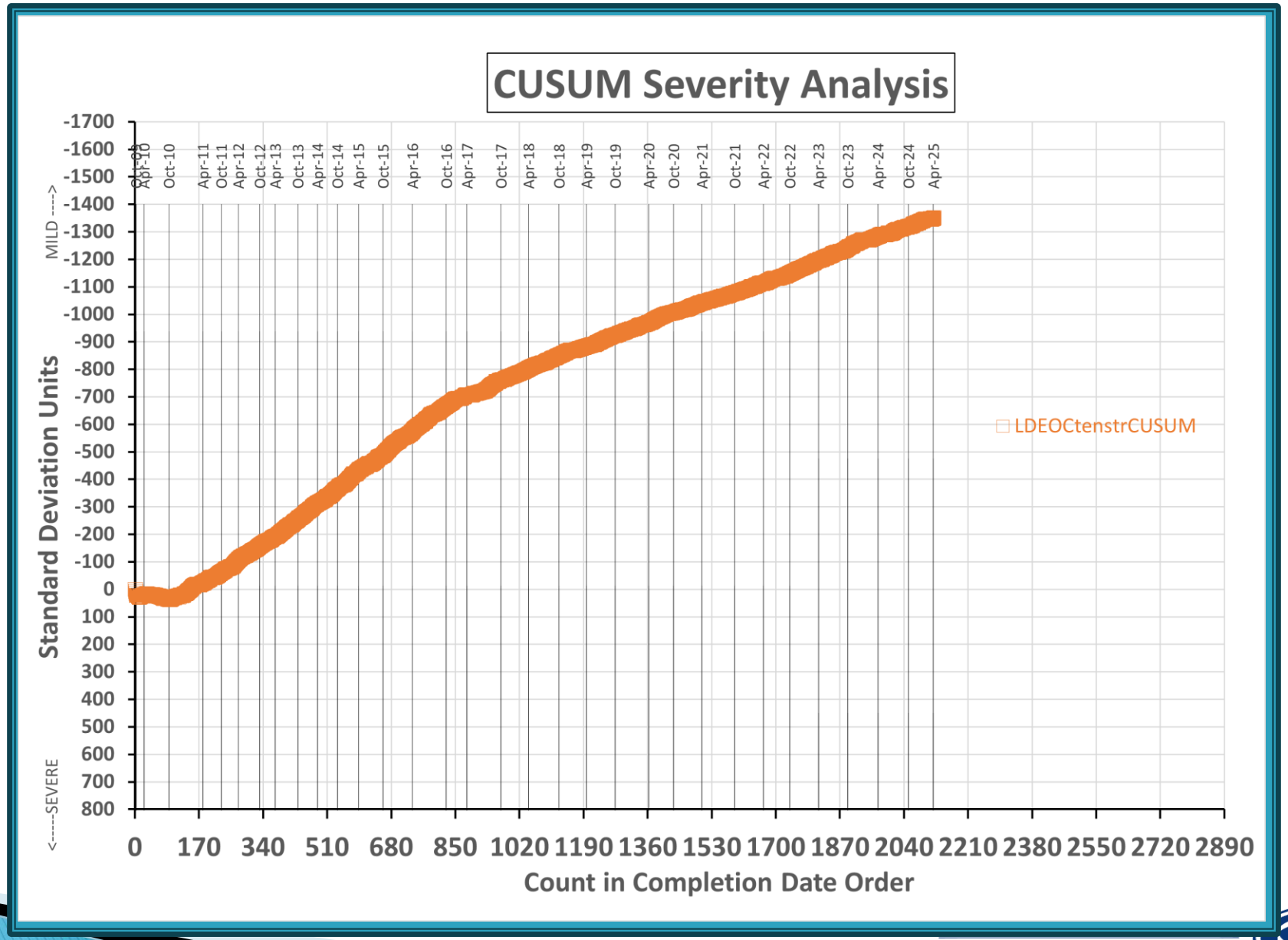
LDEOC – ETHYLENE ACRYLATE INDUSTRY OPERATIONALLY VALID DATA
POLYACRYLATE VOLUME CHANGE FINAL



LDEOC – ETHYLENE ACRYLATE INDUSTRY OPERATIONALLY VALID DATA
POLYACRYLATE HARDNESS CHANGE FINAL



LDEOC – ETHYLENE ACRYLATE INDUSTRY OPERATIONALLY VALID DATA
POLYACRYLATE TENSILE STRENGTH CHANGE FINAL

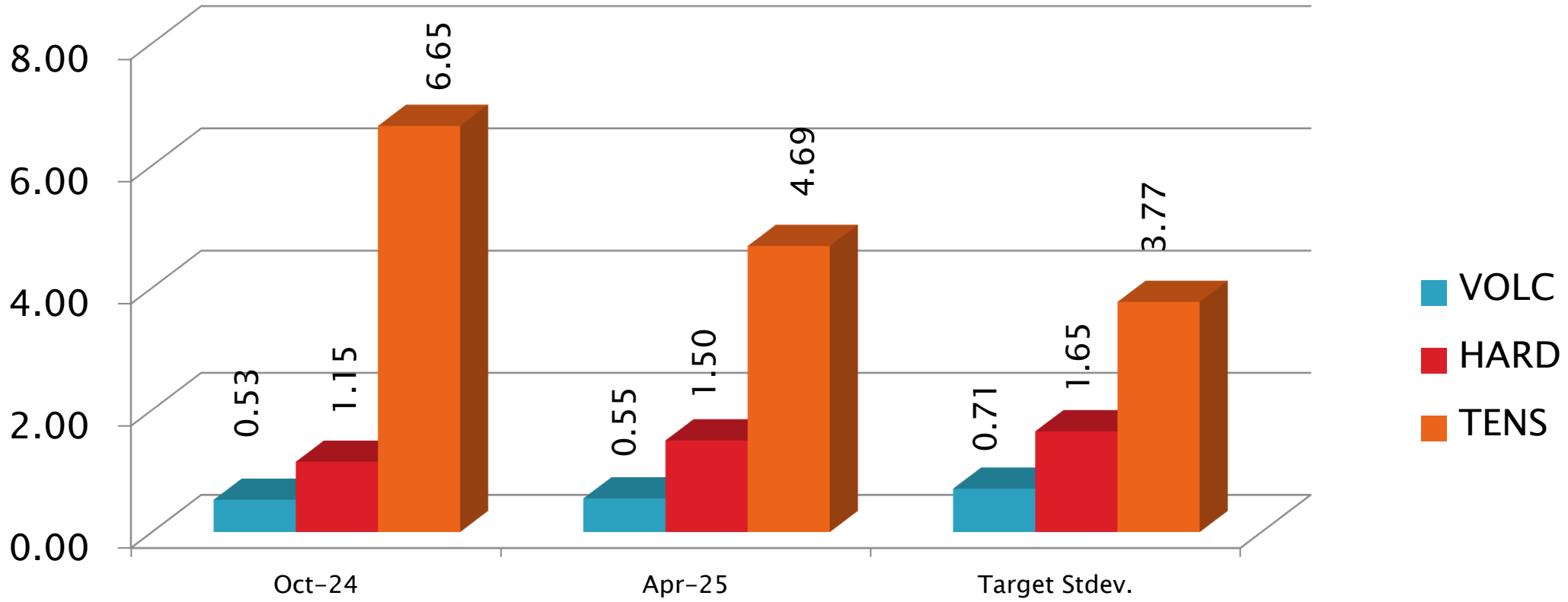


LDEOC Test Severity

Polyacrylate (ACM2)

Parameter	Period Mean Δ/s	Status
Volume Change	0.9701	Severe
Points Hardness Change	-1.2494	Very Mild
Tensile Strength Change	-0.9593	Mild

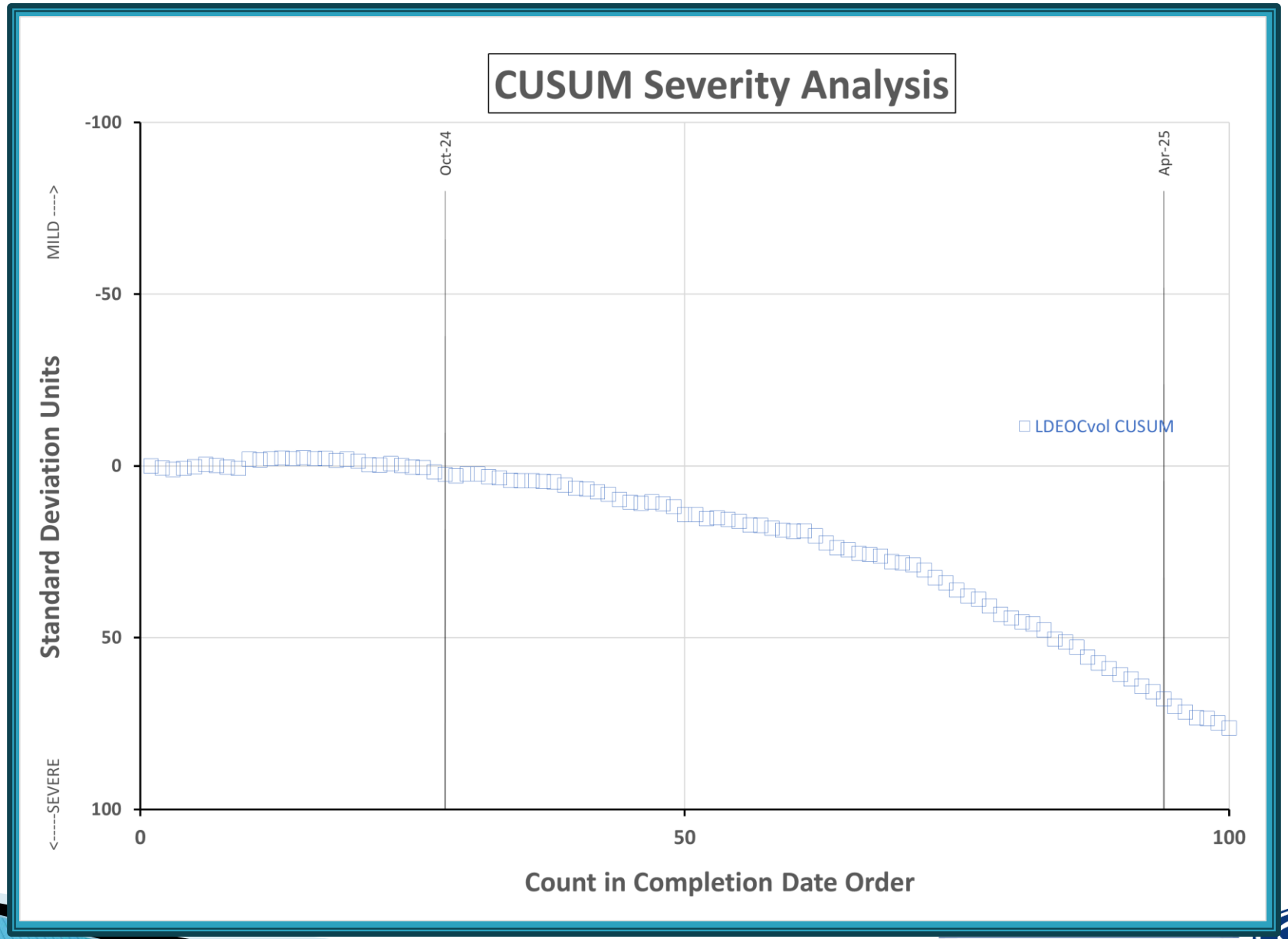
LDEOC Precision Estimates – Polyacrylate2



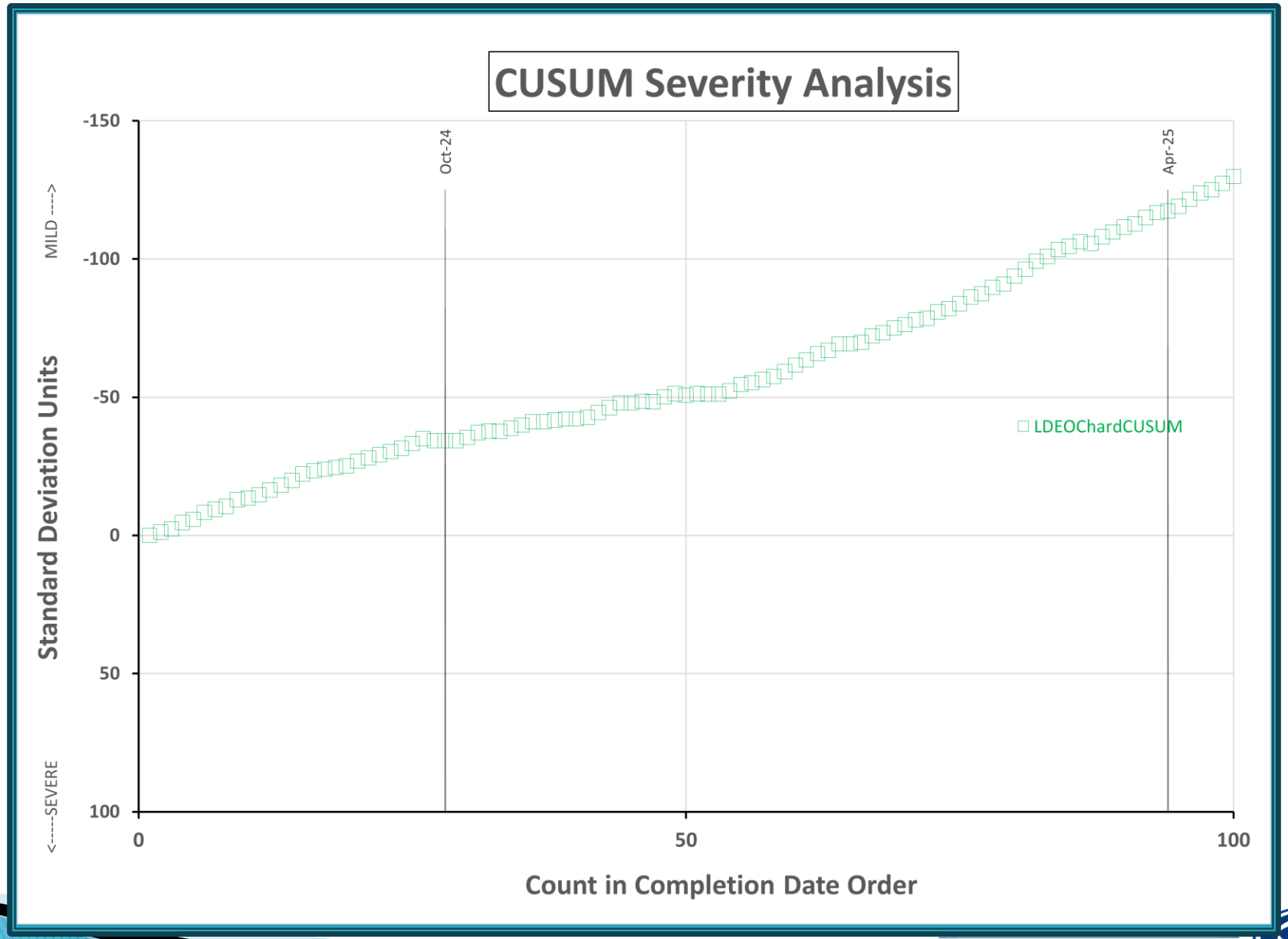
LDEOC Precision Estimates by Lab: ACM2

Test Parameter	Statistic	LTMS Lab							
		A	B	E	G	I	L	P	V
	n=	34	9	0	16	1	0	1	5
Volume	Mean	11.6	11.7		11.7	12.9		12.44	11.2
	Pooled s	0.52	0.18		0.64				0.48
	Mean /s	0.95	1.00		1.02	2.80		2.10	0.29
Hardness	Mean	-4.50	-3.22		-3.69	-1.00		-4.00	-5.60
	Pooled s	1.31	0.83		1.66				1.34
	Mean /s	-1.46	-0.69		-0.97	0.66		-1.16	-2.13
Tensile Strength	Mean	-16.8	-22.3		-16.6	-16.8		-17.1	-19.2
	Pooled s	3.53	3.58		6.20				4.63
	Mean /s	-0.73	-2.18		-0.66	-0.72		-0.80	-1.36

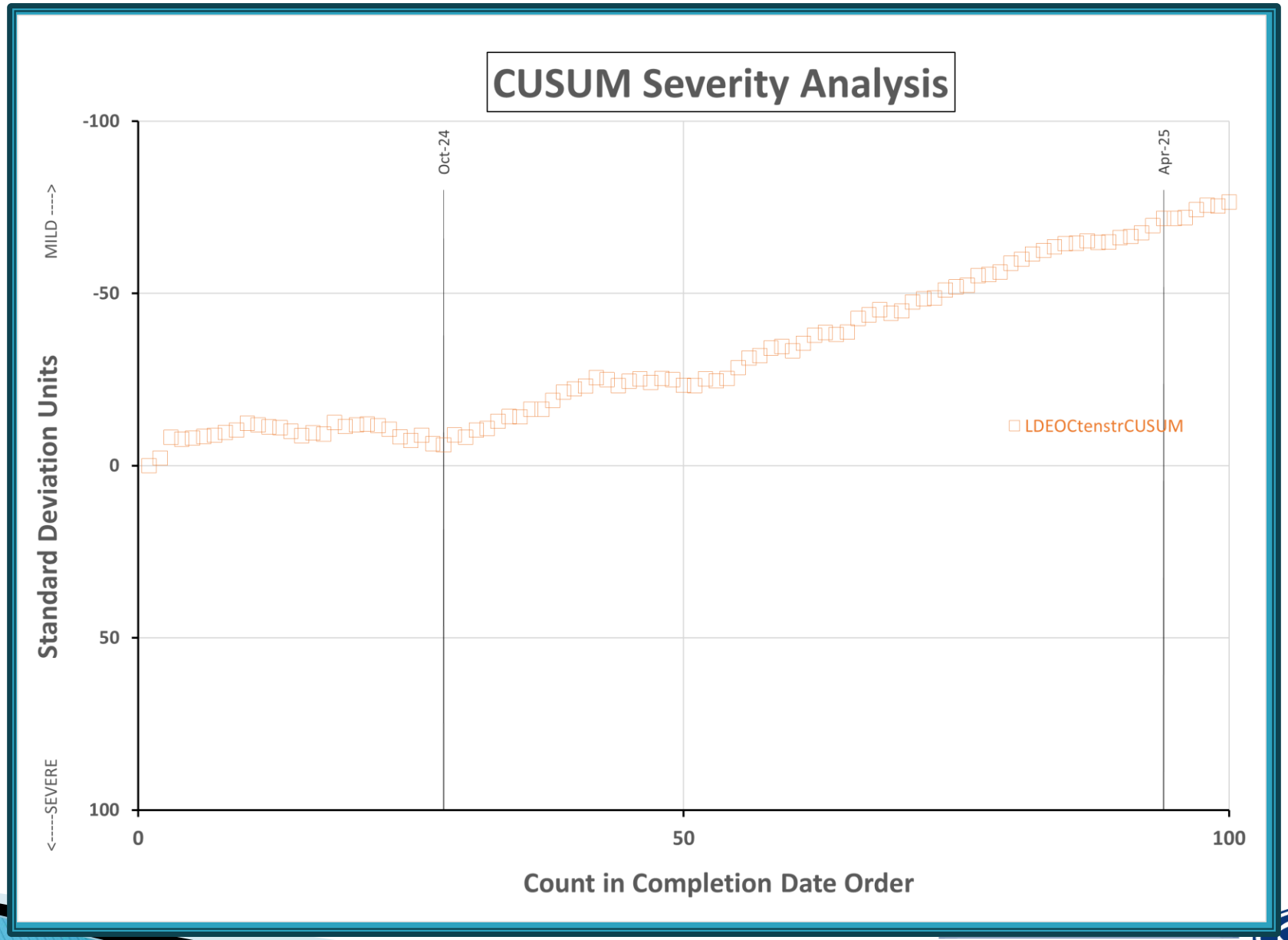
LDEOC – ETHYLENE ACRYLATE INDUSTRY OPERATIONALLY VALID DATA
POLYACRULATE-2 VOLUME CHANGE FINAL



LDEOC – ETHYLENE ACRYLATE INDUSTRY OPERATIONALLY VALID DATA
POLYACRYLATE-2 HARDNESS CHANGE FINAL



LDEOC – ETHYLENE ACRYLATE INDUSTRY OPERATIONALLY VALID DATA
POLYACRYLATE-2 TENSILE STRENGTH CHANGE FINAL

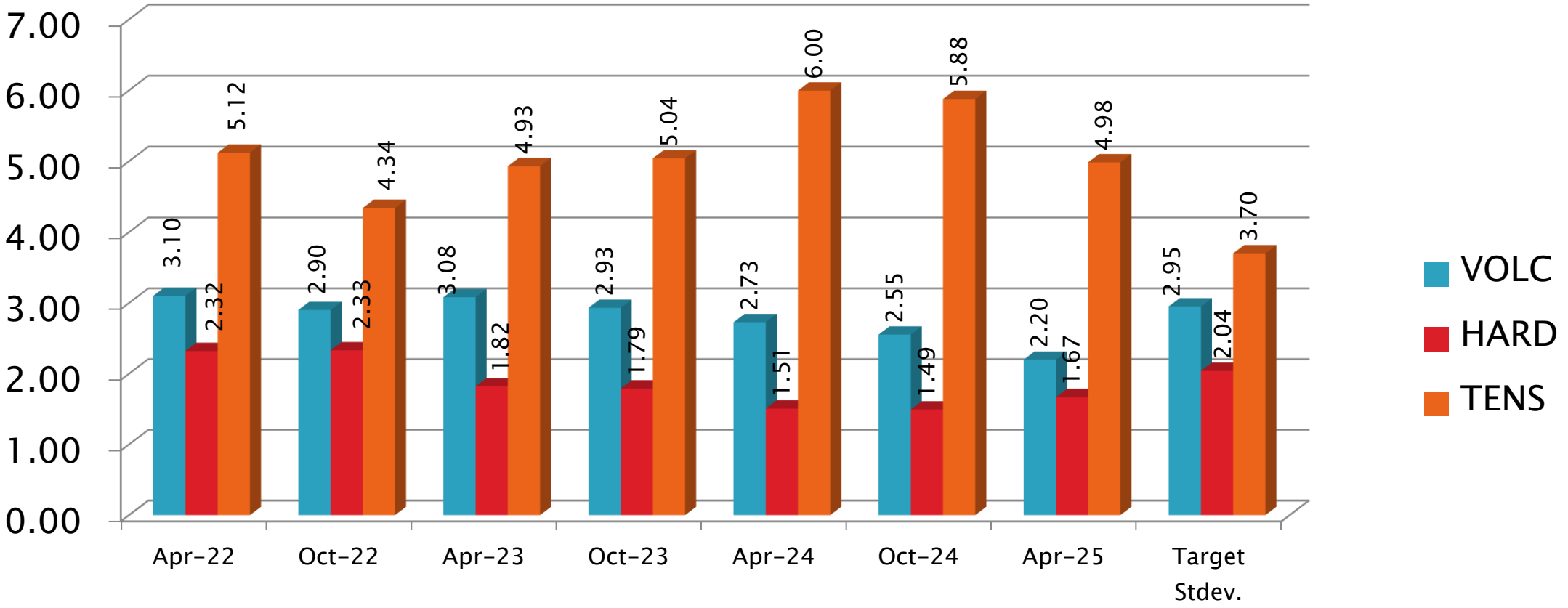


LDEOC Test Severity

Silicone (VMQ1)

Parameter	Period Mean Δ/s	Status
Volume Change	0.6193	Severe
Points Hardness Change	-0.5728	Mild
Tensile Strength Change	-0.4218	Mild

LDEOC Precision Estimates – Silicone



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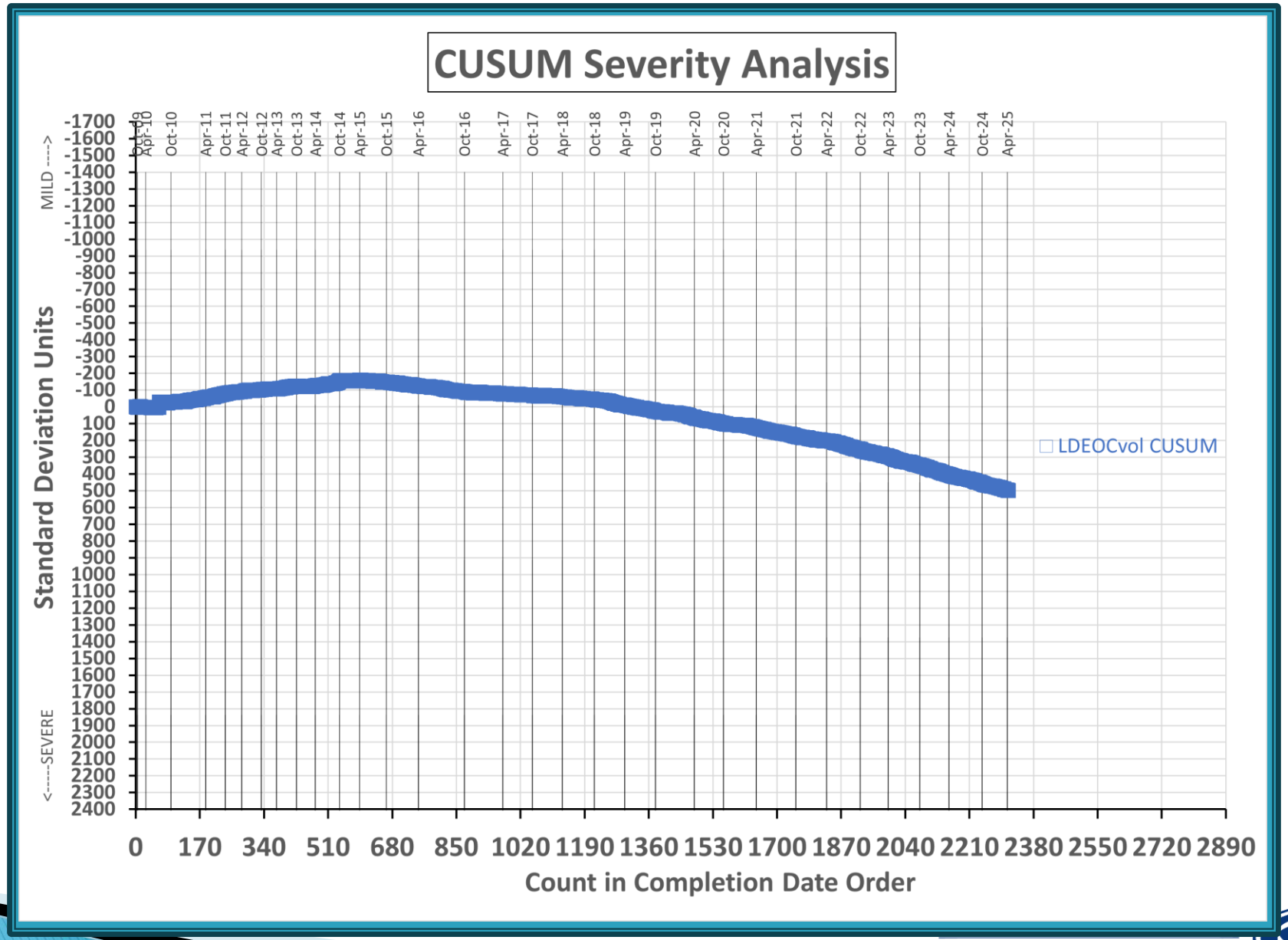
LDEOC Precision Estimates by Lab: VQM1

Test Parameter	Statistic	LTMS Lab							
		A	B	E	G	I	L	P	V
	n=	20	10	0	16	10	4	1	5
Volume	Mean	34.1	34.0		36.5	30.8	31.6	33.5	34.1
	Pooled s	0.58	0.60		2.01	1.34	0.86		0.96
	Mean /s	0.65	0.61		1.46	-0.45	-0.20	0.44	0.65
Hardness	Mean	-24.0	-22.9		-23.3	-21.9	-18.5	-23.0	-21.8
	Pooled s	1.00	0.88		1.14	0.57	1.00		1.30
	Mean /s	-1.16	-0.60		-0.80	-0.11	1.56	-0.65	-0.06
Tensile Strength	Mean	-34.1	-37.1		-38.5	-36.0	-26.8	-34.1	-32.1
	Pooled s	4.20	2.28		5.35	4.60	1.51		2.94
	Mean /s	-0.09	-0.92		-1.28	-0.60	1.87	-0.09	0.46

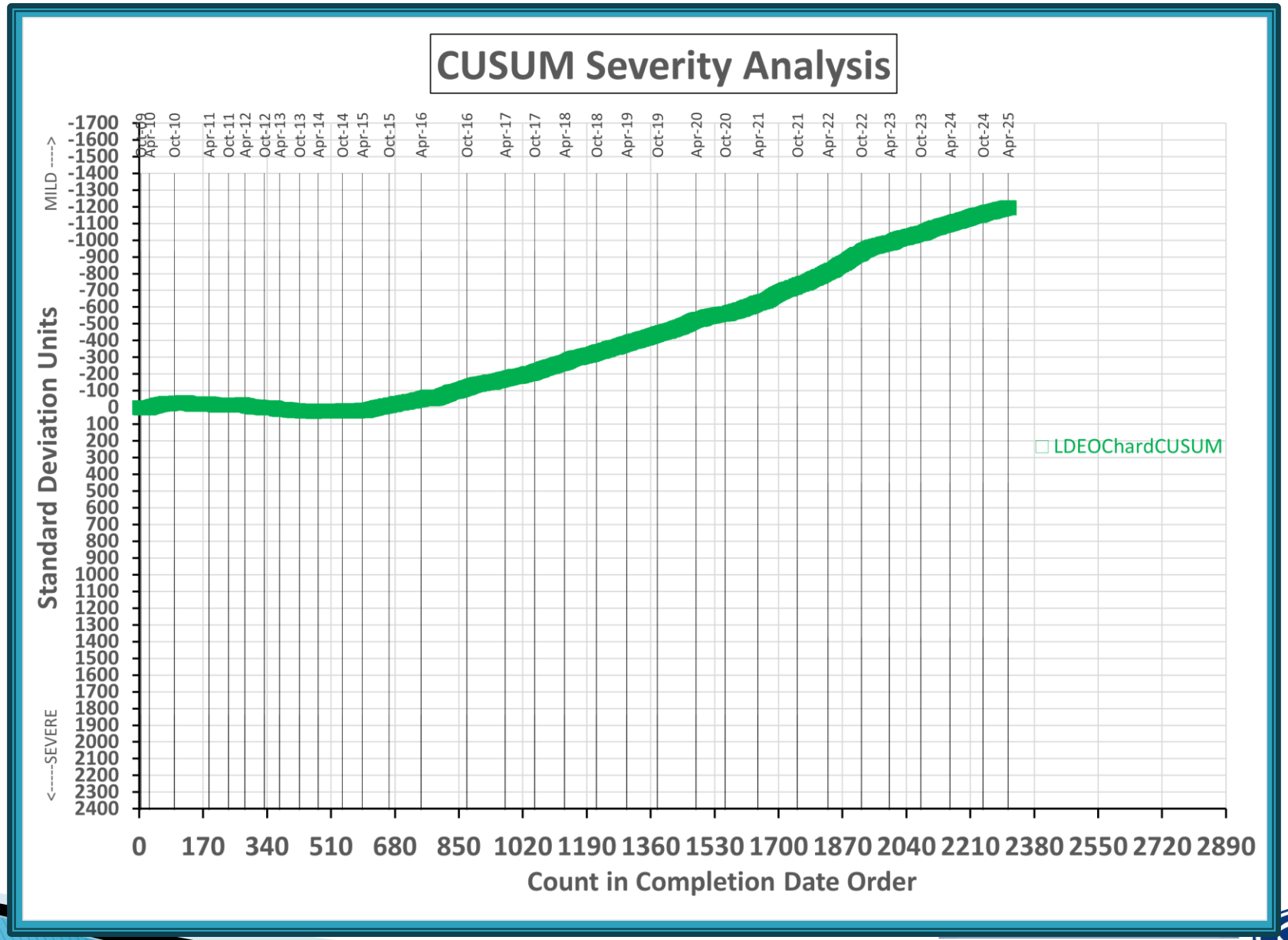
LDEOC —SILICONE INDUSTRY OPERATIONALLY VALID DATA

REFERENCE SILICON VOLUME CHANGE FINAL



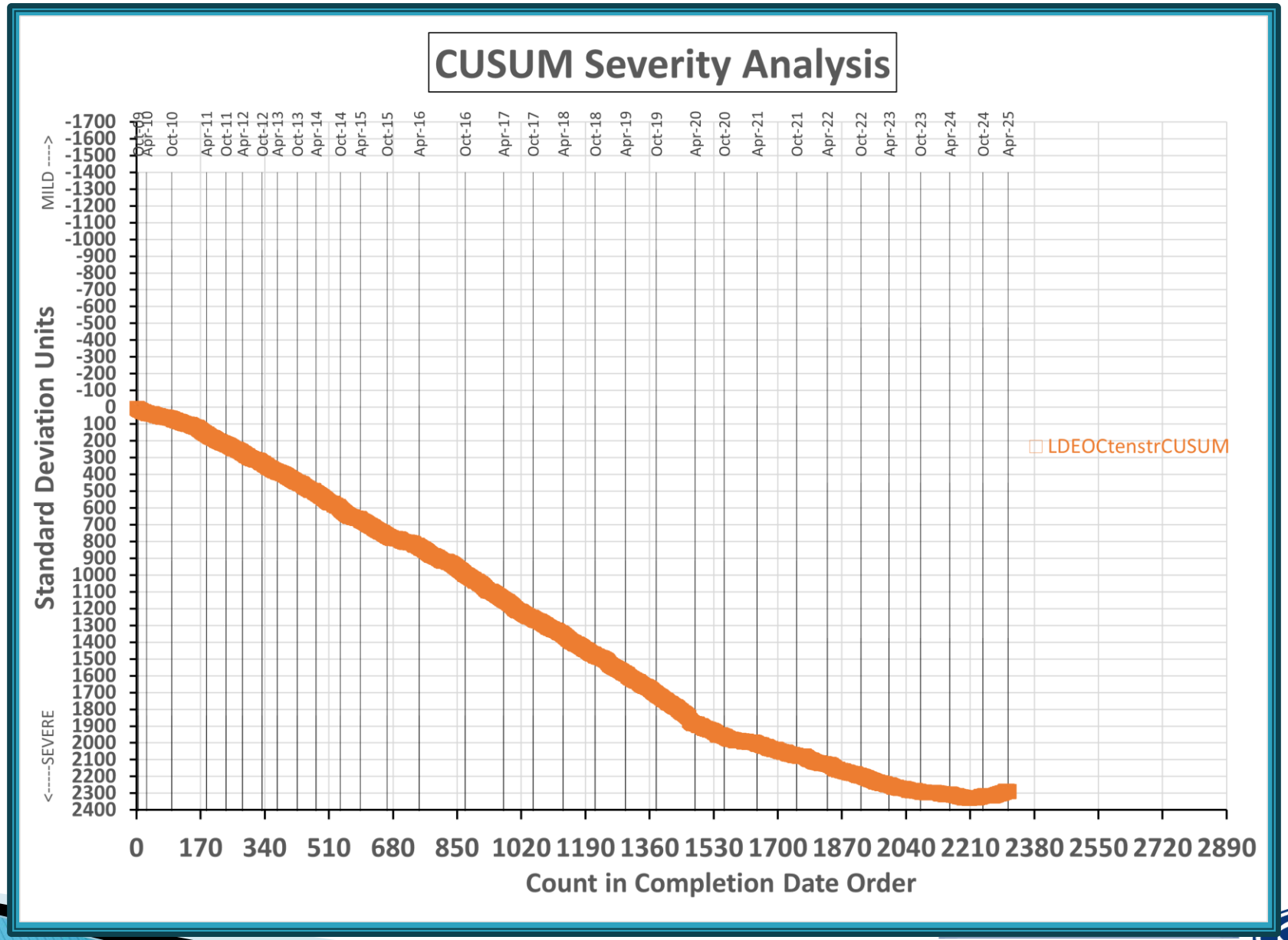
LDEOC —SILICONE INDUSTRY OPERATIONALLY VALID DATA

REFERENCE SILICON POINTS HARDNESS FINAL



LDEOC —SILICONE INDUSTRY OPERATIONALLY VALID DATA

REF SILICON TENSILE STRENGTH CHANGE FINAL



Information Letters & Technical Updates*

EDIT Needed

Test	Date	IL or Memo Number	Topic
LDEOC	20240424	LDEOC-20231005	Report Package Revision Notice – addition of 4 new elastomers.

*Available from TMC Website

Reference Oil Inventory Estimated Life

EOEC & LDEOC

Oil	TMC Inventory Gallons	Gallons Shipped Past 6 Months	Estimated Life [C]
SL107 [A, B]	1202	280	2 years

[A] TMC Inventory is used across several test methods

[B] SL107 has fully replaced oil 1006; Oil 1006 is no longer used as an EOEC Reference Fluid

[C] Use Rate of SL107 will accelerate due to addition of five new Elastomers to D7216:
FOUR: ILSAC GF-7
ONE: PC-12

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D02.B0.07
TMC Monitored Tests

ASTM D 7528

ROBO

October 1, 2024 – March 31, 2025

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Calibrated Labs and Stands*

(change since last Semi-Annual report)

Test	Labs	Stands
D7528	6 (+0)	29 (+1)
*As of 3/31/2025		

D7528: Oxidation by ROBO

Test Status	Validity Code	No. Tests
Acceptable Calibration Test	AC	89
Failed Calibration Test	OC	8
Operationally Invalidated or Aborted by Lab	LC, XC	9
Operationally Invalidated After Initially Reported as Valid	RC	1
Total		**107**

Number of Labs Reporting Data: 6
Fail Rate of Operationally Valid Tests: 8.2% (12.0% last period)

D7528: Oxidation by ROBO

Statistically Unacceptable Tests (OC)	No. Of Tests
Natural Log (MRV Viscosity) Severe	3
Natural Log (MRV Viscosity) Mild	5
Total	**8**

D7528: ROBO Failed Tests by Lab

Failed Parameter	LTMS Lab				Number of Tests
	A	AM	AQ	G	
Natural Log (MRV Viscosity) Severe	1	1	1	O	3
Natural Log (MRV Viscosity) Mild	2	0	0	3	5
Total	**3**	**1**	**1**	**3**	**8**

- EIGHT different units from FOUR different labs reported failing calibration tests

D7528: Oxidation by ROBO

Operationally Invalid (LC, RC) or Aborted (XC) Calibration Tests

Test Status	Cause	No. of Tests
Invalidated by Lab (LC)	Wrong Test Temperature	2
Invalidated by Lab (LC)	High Volatiles	1
Invalidated by TMC (RC)	Yield Stress NOT <35 Pa (and not RO 434-3)	1
Aborted Test (XC)	Test Temperature off Spec	2
Aborted Test (XC)	Excess NO2 delivered	3
Aborted Test (XC)	Reference Oil contaminated	1
Totals		**10**

D7528: Oxidation by ROBO

Period Precision and Severity Estimates

Natural Log (MRV Viscosity)	n	df	Pooled s	Mean Δ/s
Targets Updated 20211021[1]	80	77	0.1551	-----
4/1/20 through 9/30/20	119	113	0.2264	-0.76
10/1/20 through 3/31/21	113	108	0.3188	-0.11
4/1/21 through 9/30/21	116	110	0.1992	-0.37
10/1/21 through 3/31/22	106	102	0.2103	-0.36
4/1/22 through 9/30/22	105	101	0.1868	-0.06
10/1/22 through 3/31/23	94	91	0.2000	0.11
4/1/23 through 9/30/23	103	100	0.1990	-0.11
10/1/23 through 3/31/24	91	88	0.1741	-0.12
4/1/24 through 9/30/24	92	88	0.1893	-0.72
10/1/24 through 3/31/25	97	94	0.1957	-0.37

[1]Updated targets to include latest primary reference oils 434-3, 435-1 and 436

D7528: Oxidation by ROBO

NO_2 Delivery Mechanism	Number of Total Tests	Number Of AC Tests	Pass Rate (%)	Number of Labs	Number of Rigs	LAB ID's
Dilute	41	37	90.2	2	14	G, AM
Liquid	56	52	92.9	5	16	A, AQ, B, BC, G
BOTH (Totals)	**97**	**89**	**91.8**	**6***	**30**	**A, AM, AQ, B, BC, G**

*One lab is conducting tests with both NO_2 delivery methods.

D7528: Oxidation by ROBO

Precision, Performance (Mean Δ/s) by Lab and NO_2 Delivery Mechanism

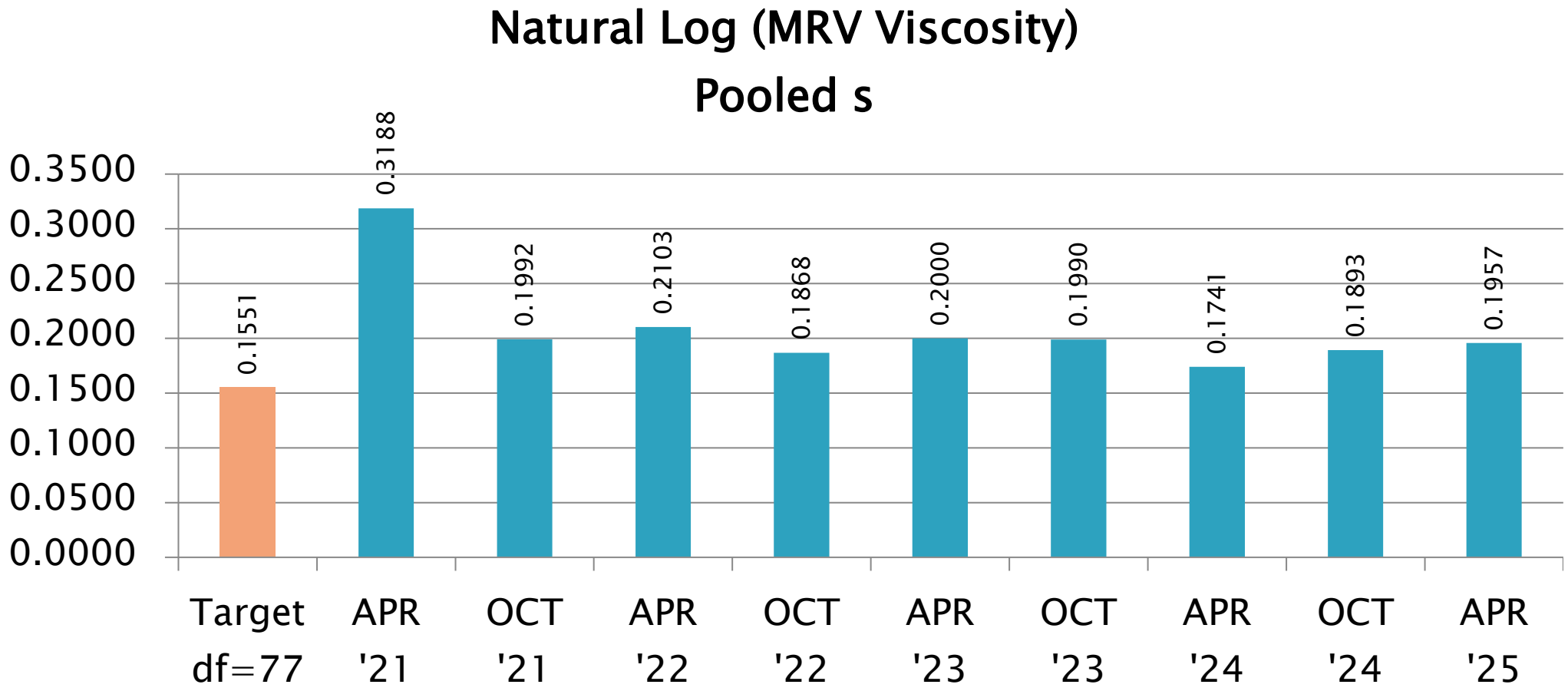
NO_2 Delivery		Ref Oil 434-2	Ref Oil 434-3	Ref Oil 435-1	Ref Oil 436	TOTAL
Dilute	No. of Runs	0	9	22	10	41
	Mean		10.6112	10.9841	10.3357	10.7441
	Pooled s		0.1491	0.1807	0.1735	0.1728
	Mean Δ/s		-1.48	-0.28	0.03	-0.47
Liquid	No. of Runs	0	10	29	17	56
	Mean		10.7202	10.9664	10.3434	10.7333
	Pooled s		0.1775	0.2463	0.1629	0.2131
	Mean Δ/s		-0.70	-0.37	0.09	-0.29
BOTH	No. of Runs	0	19	51	27	97
	Mean		10.6685	10.9740	10.3406	10.7378
	Pooled s		0.1696	0.2186	0.1636	0.1957
	Mean Δ/s		-1.07	-0.33	0.07	-0.37

D7528: Oxidation by ROBO

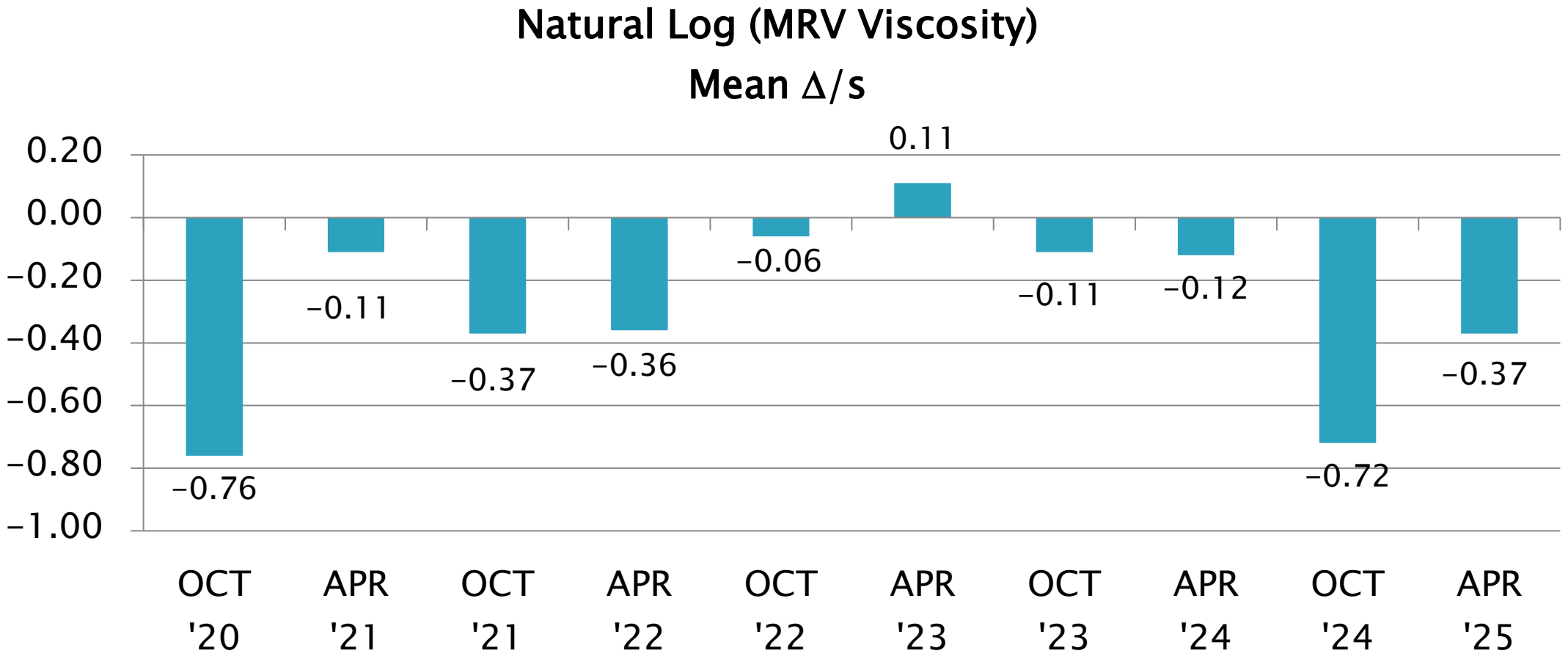
Period Performance (Mean Δ/s) by Lab and NO_2 Delivery Mechanism

NO_2 Delivery Mechanism	LAB A (all L)	LAB AM (all D)	LAB AQ (all L)	LAB B (all L)	LAB BC (all L)	LAB G (mix)
Dilute	n = 0	n = 7	n = 0	n = 0	n = 0	n = 34
	N/A	0.54	N/A	N/A	N/A	-0.68
Liquid	n = 37	n = 0	n = 2	n = 9	n = 2	n = 6
	-0.57	N/A	2.13	1.02	-1.23	-1.02
BOTH	**n = 37**	**n = 7**	**n =2**	**n = 9**	**n = 2**	**n = 40**
	-0.57	**0.54**	**2.13**	**1.02**	**-1.23**	**-0.73**

D7528: Oxidation by ROBO



D7528: Oxidation by ROBO



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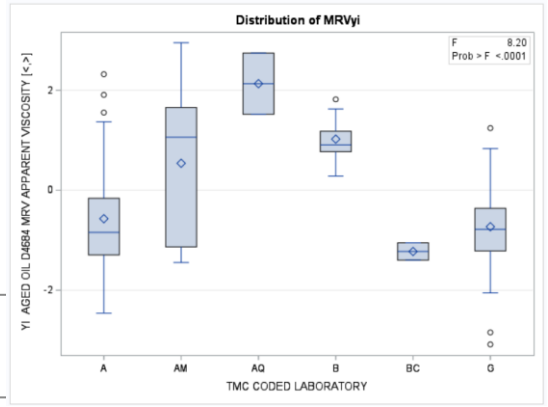
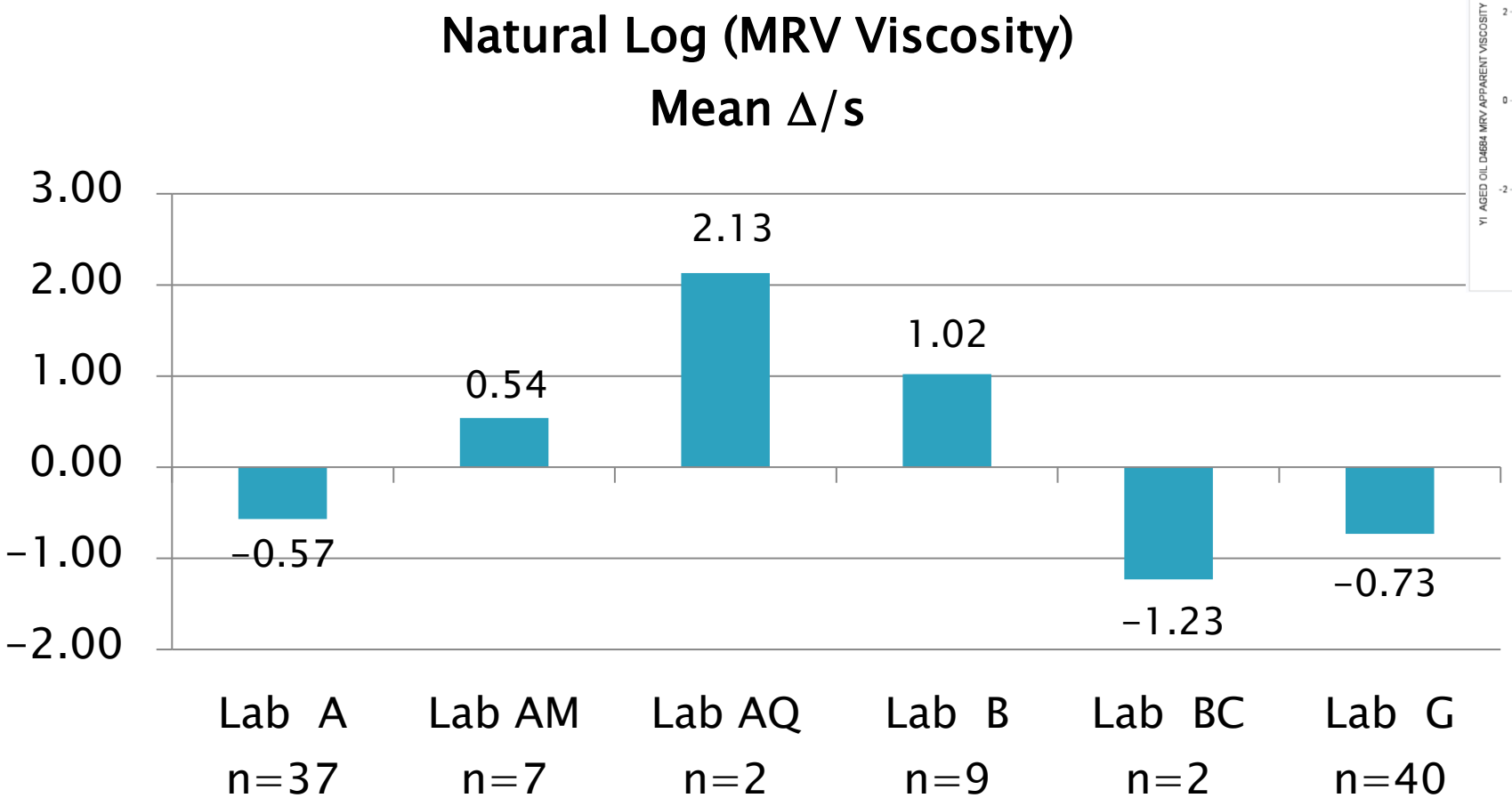
D7528: Oxidation by ROBO





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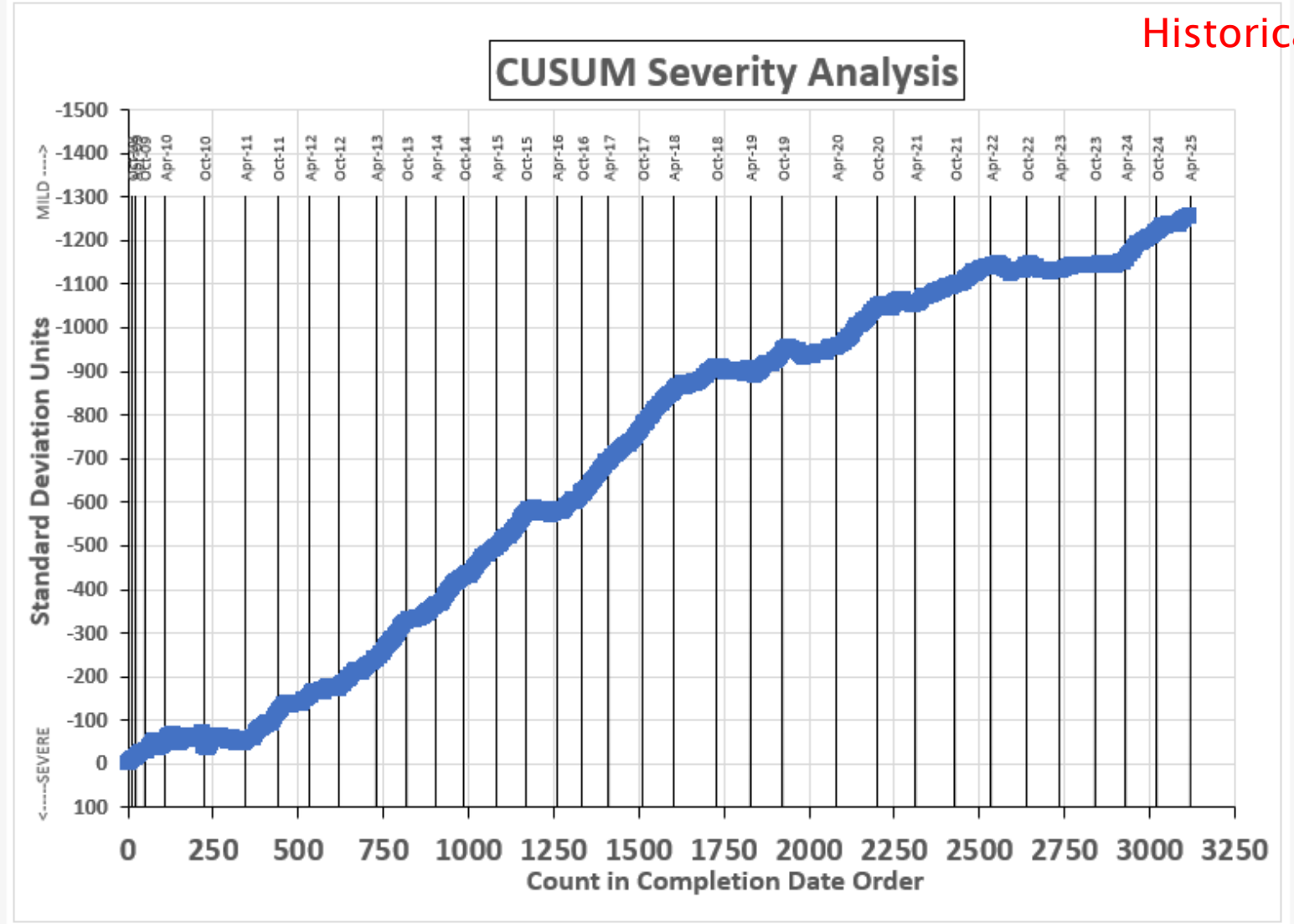
D7528: Oxidation by ROBO

- Precision (Pooled s) remained at 0.19 for the second consecutive semester.
- Severity (Mean Δ/s) has moved up to -0.37 reversing from the very mild trend from last semester.
- CUSUM plot for NO2 delivery method (D = dilute) shows a leveling off from the mild test results.
- CUSUM plot for NO2 delivery method (L = liquid) showed an overall mild trend for the Oct24-Mar25 semester, but early results in the current semester have shown an abrupt change to a severe trend.

ROBO TEST INDUSTRY OPERATIONALLY VALID DATA

AGED OIL MRV APPARENT VISCOSITY

Historical Chart



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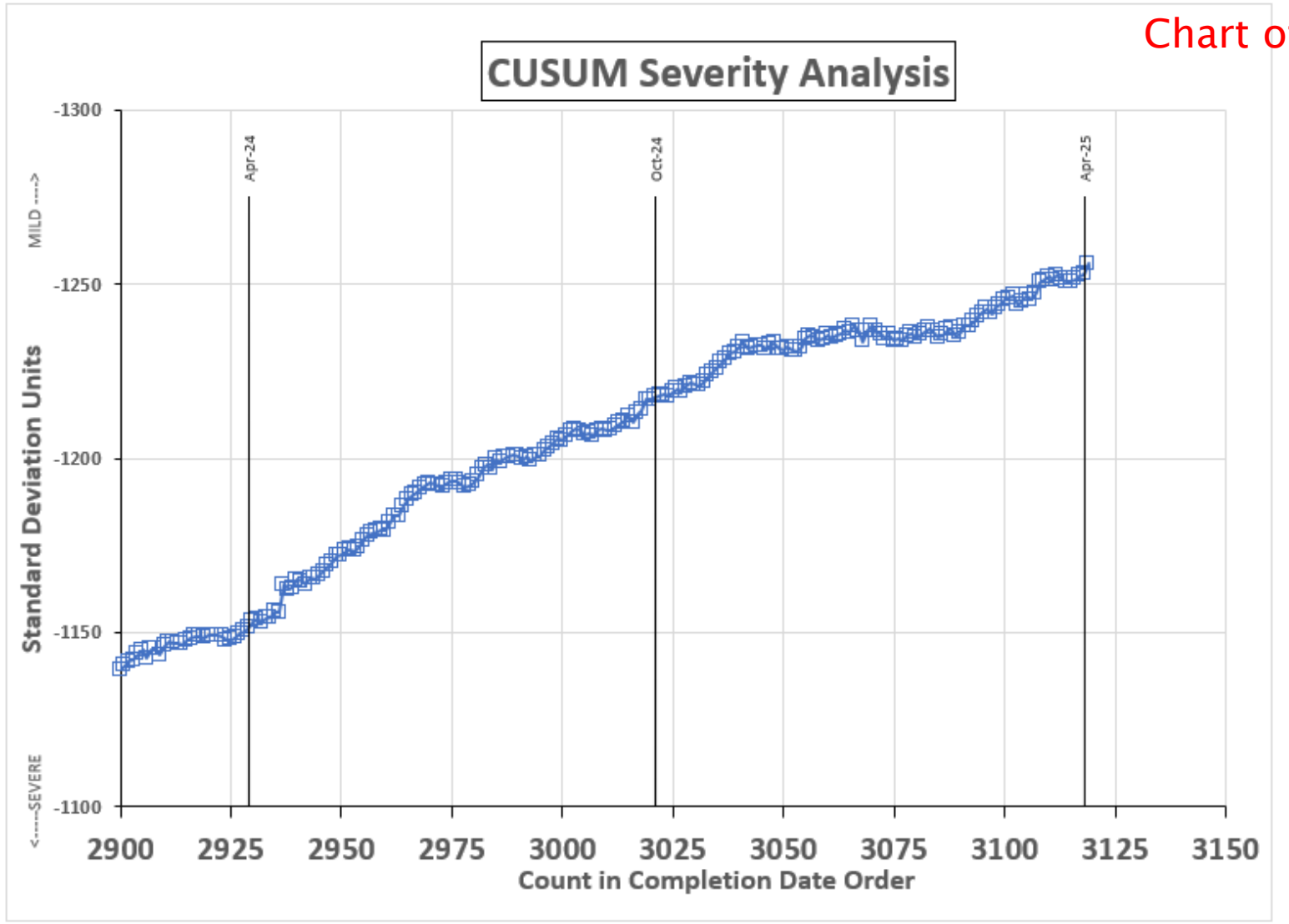
ROBO TEST INDUSTRY OPERATIONALLY VALID DATA
Last 200 Data Points
AGED OIL MRV APPARENT VISCOSITY

Chart of recent results



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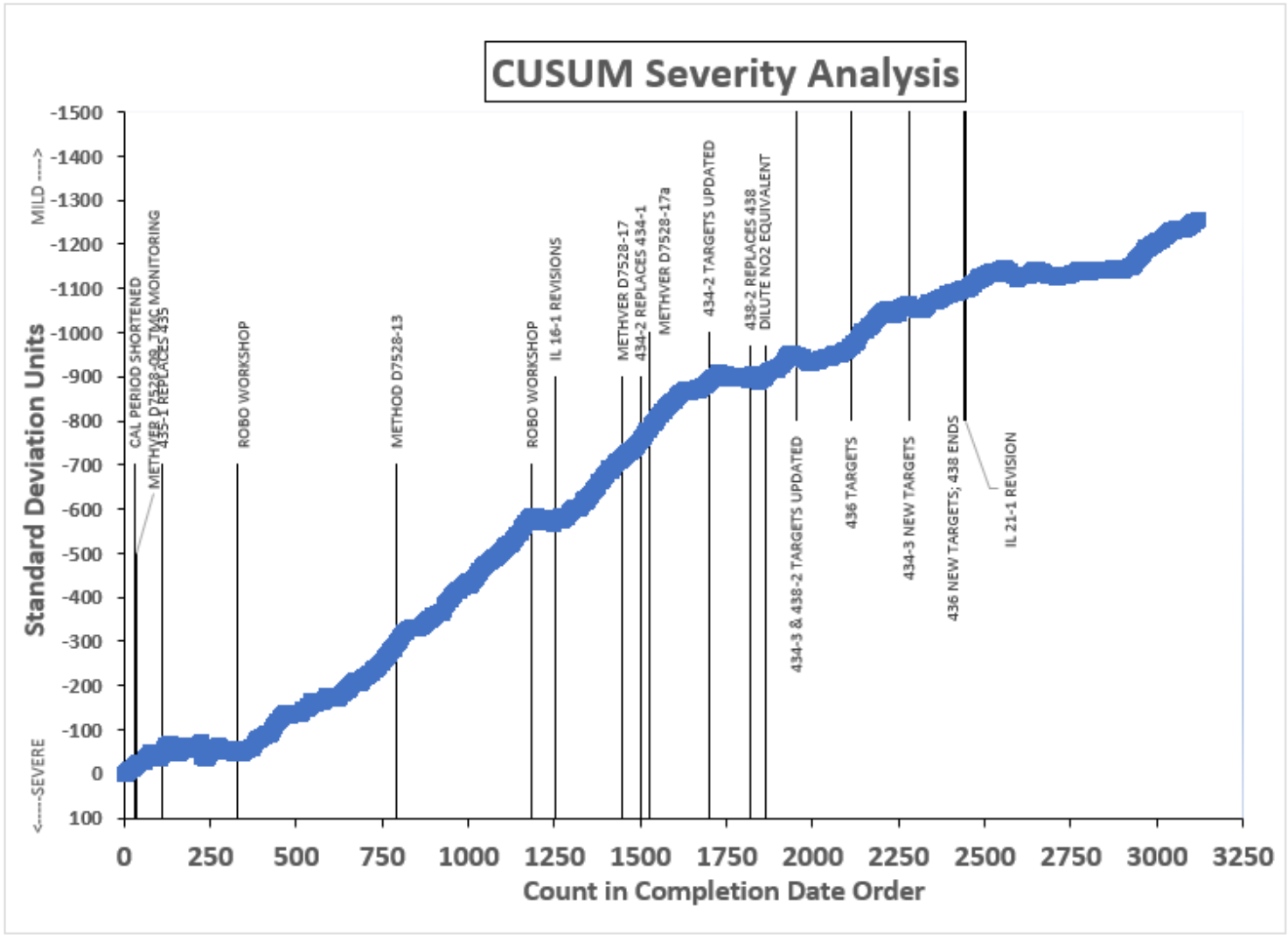
ROBO TEST INDUSTRY OPERATIONALLY VALID DATA

AGED OIL MRV APPARENT VISCOSITY



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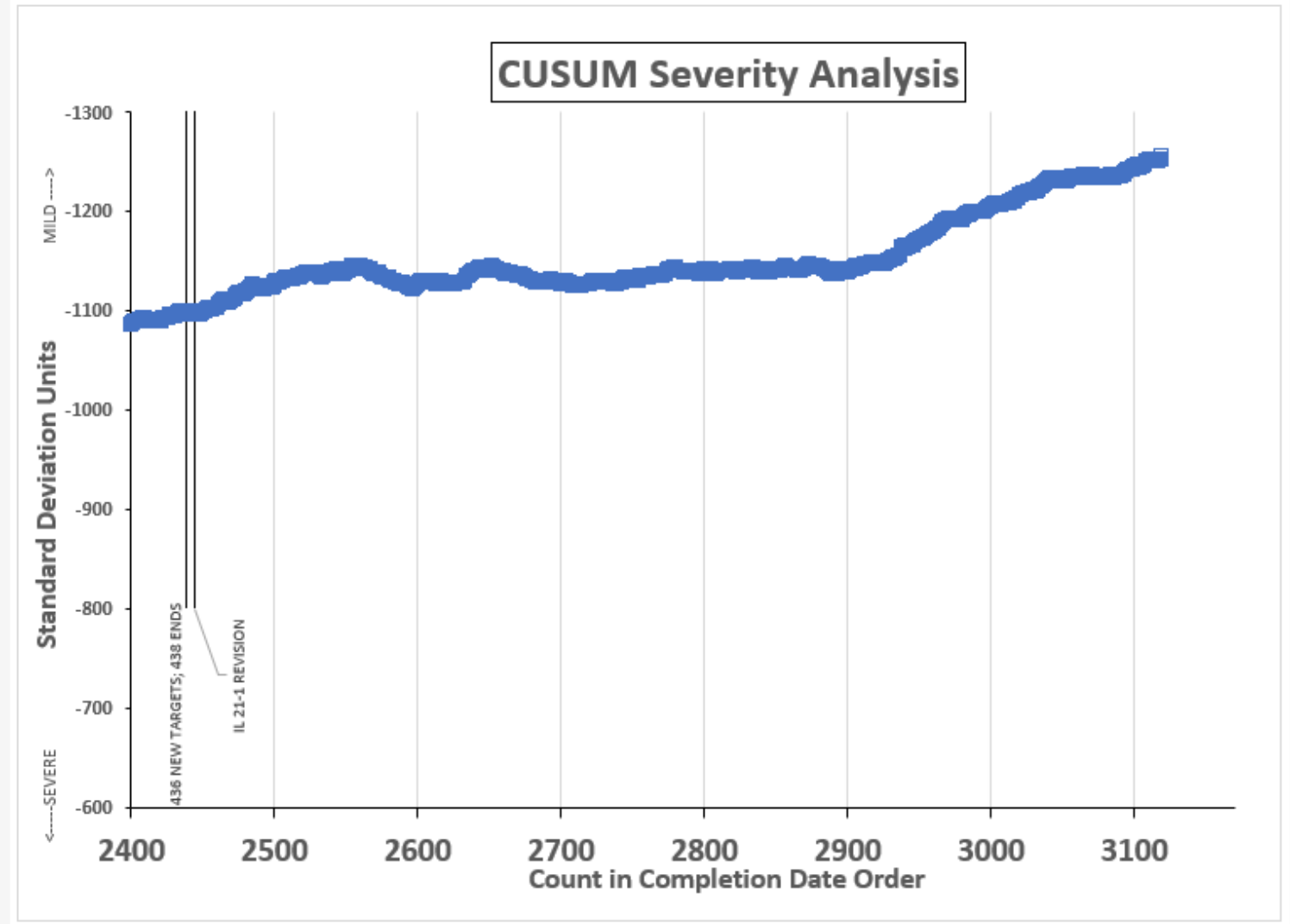
ROBO TEST INDUSTRY OPERATIONALLY VALID DATA
Last 750 Data Points
AGED OIL MRV APPARENT VISCOSITY



ROBO TEST INDUSTRY OPERATIONALLY VALID DATA
NO2 Option L ONLY
AGED OIL MRV APPARENT VISCOSITY

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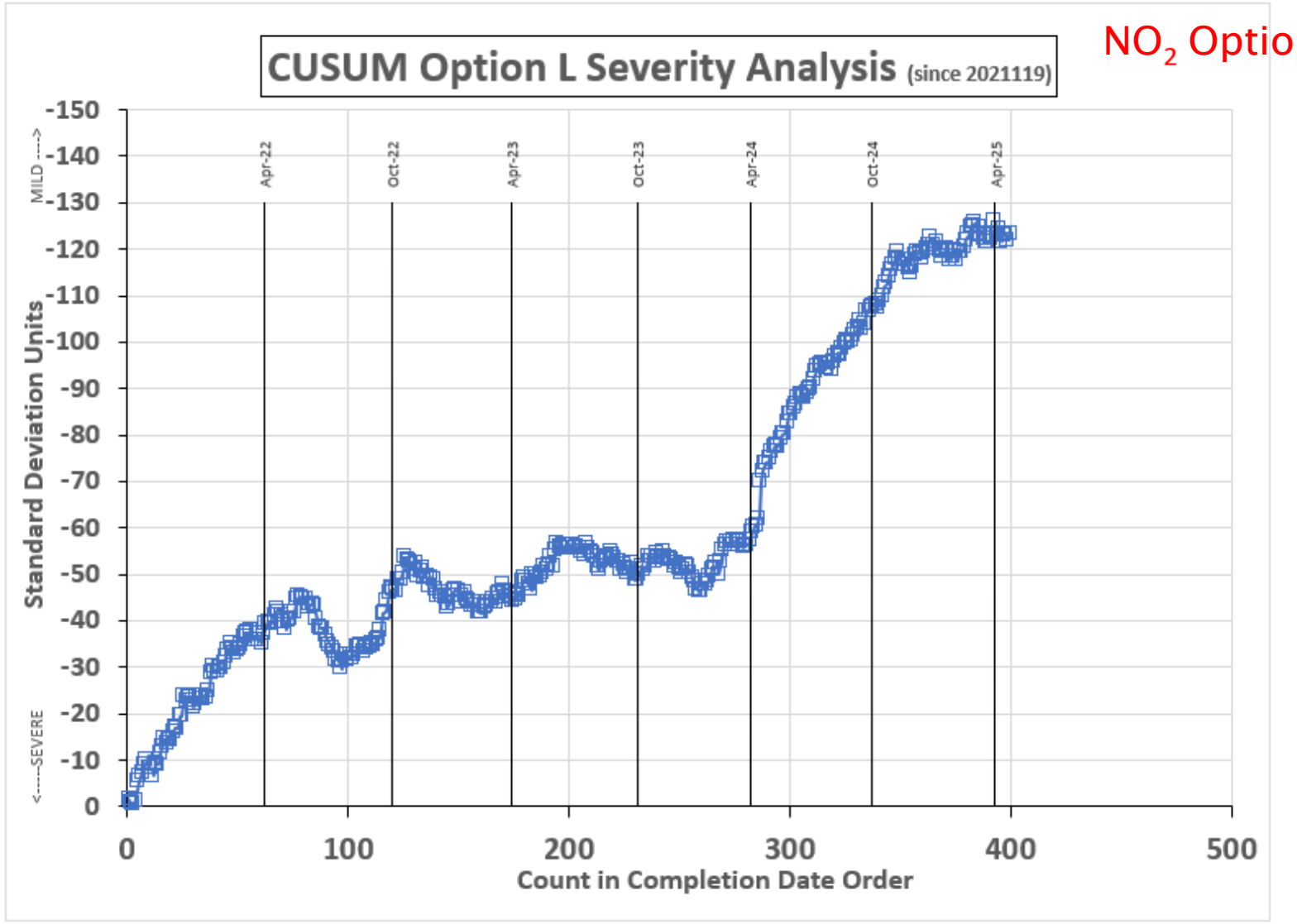
NO_2 Option L Chart



October 1, 2024 – March 31, 2025

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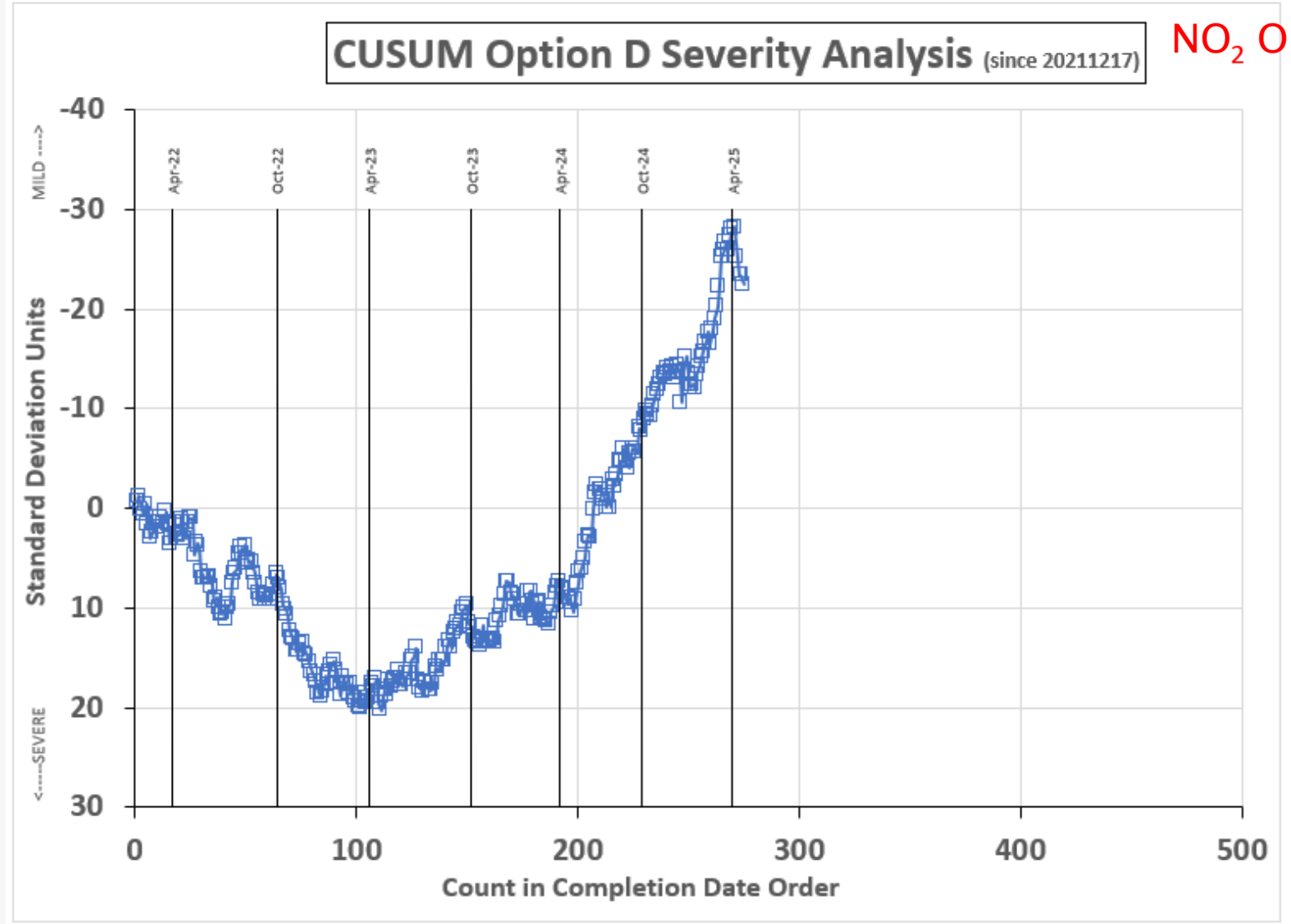
ROBO TEST INDUSTRY OPERATIONALLY VALID DATA
NO2 Option D ONLY
AGED OIL MRV APPARENT VISCOSITY



NO_2 Option D Chart

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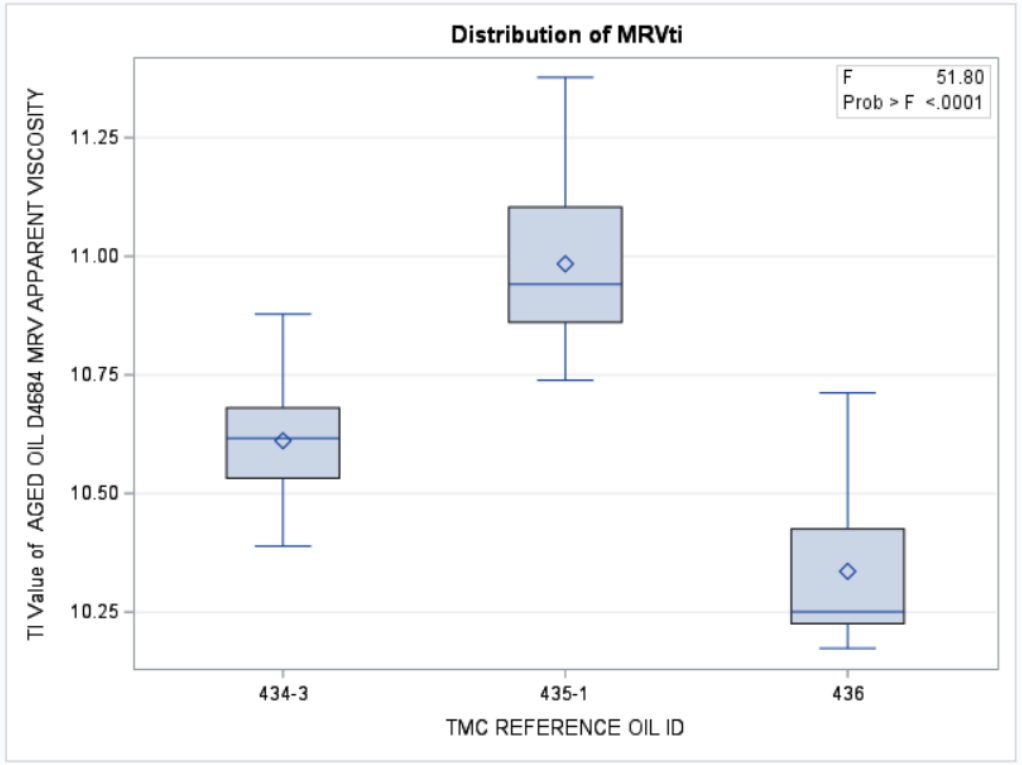
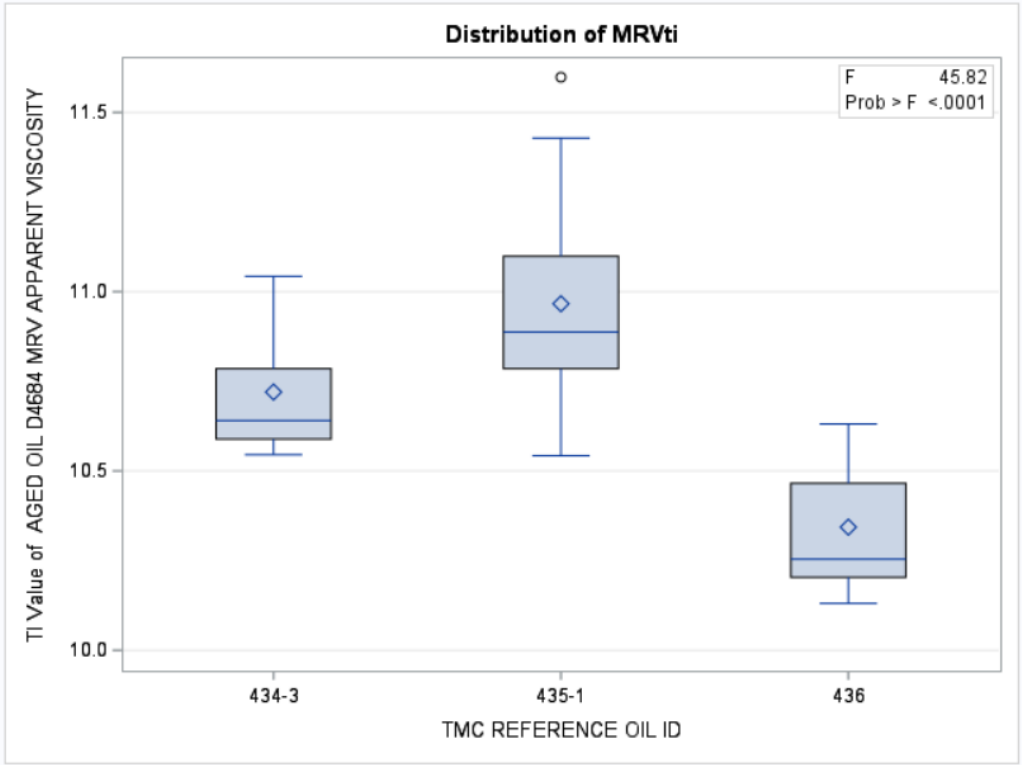
Means by Reference Oil, NO2 Delivery

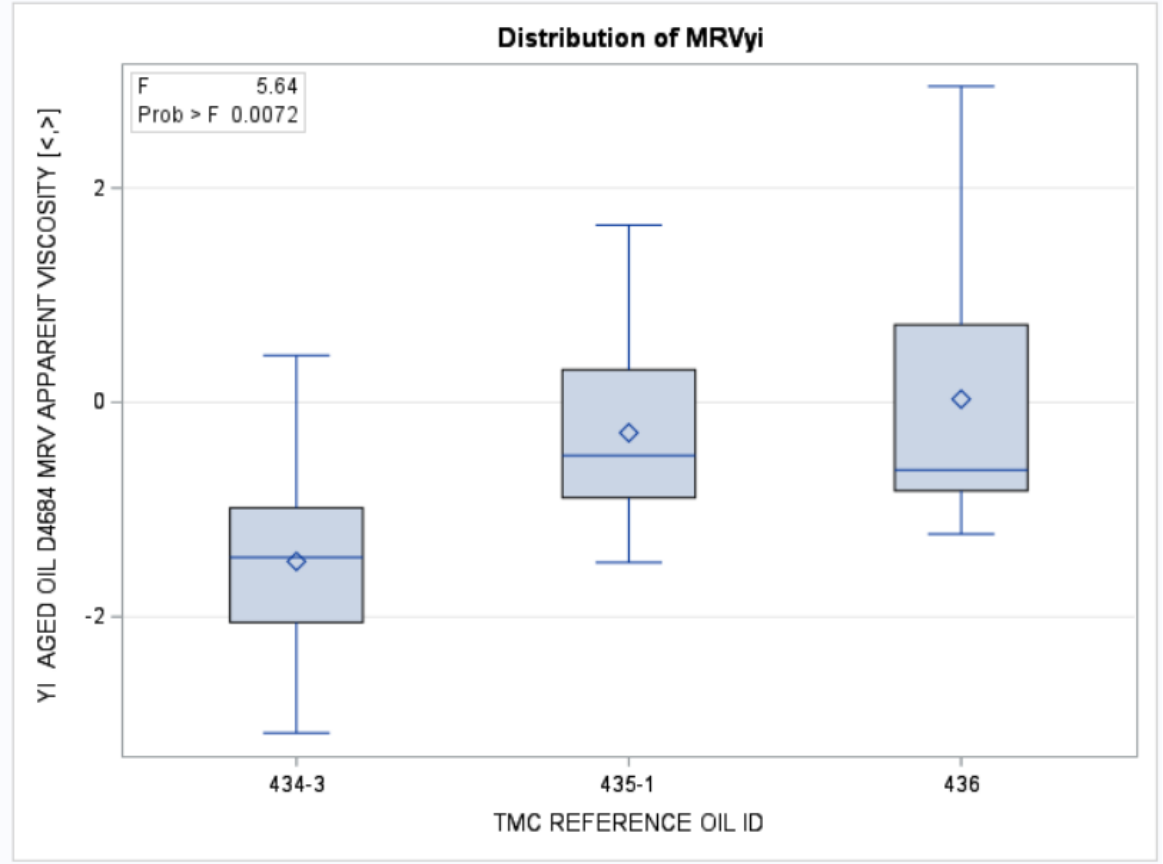
D (left) and L (right)

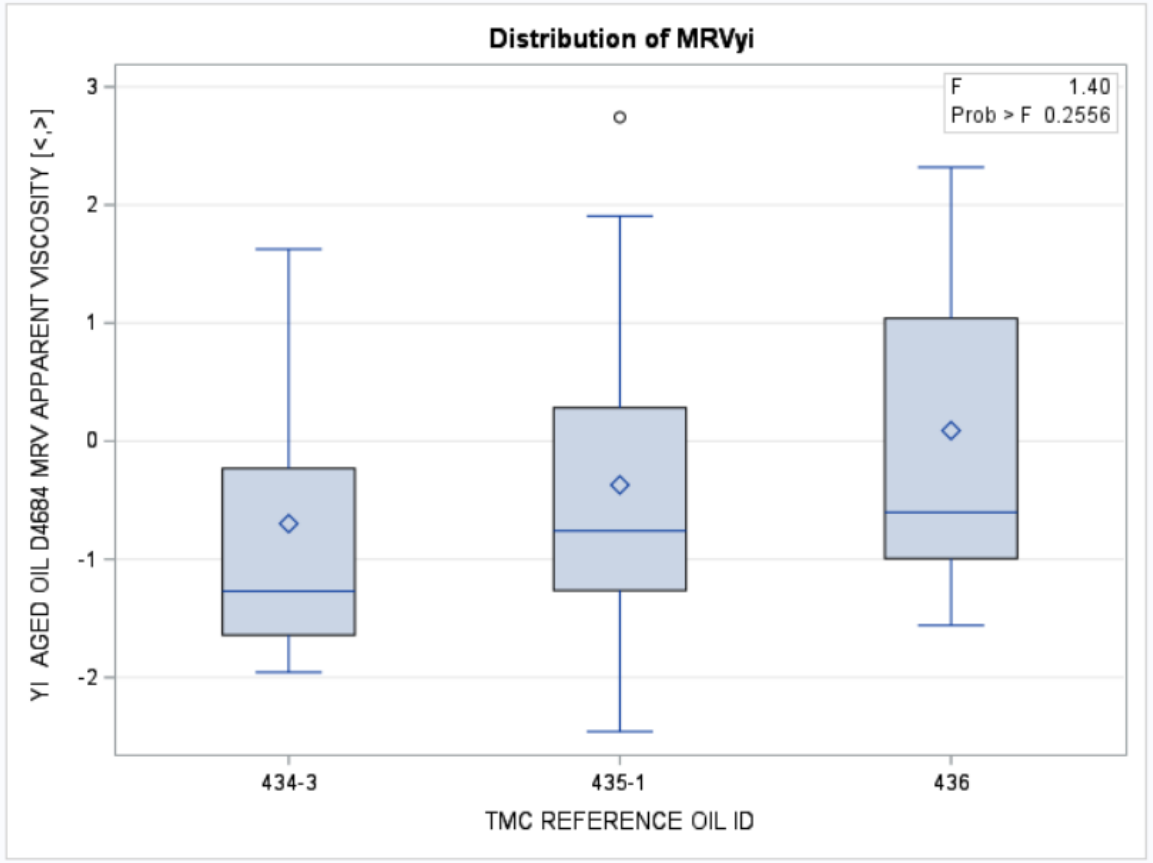




Performance by Ref Oil, NO2 Delivery

D (left) and L (right)





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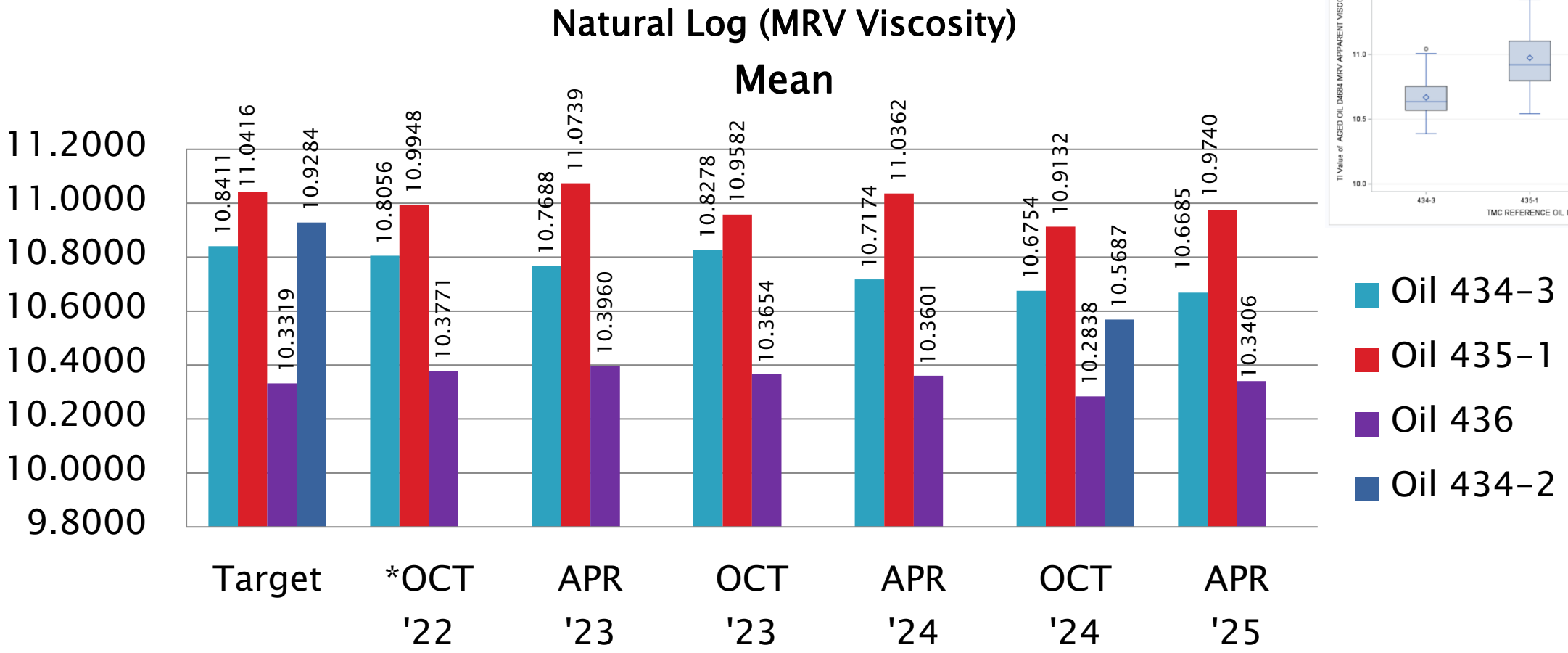
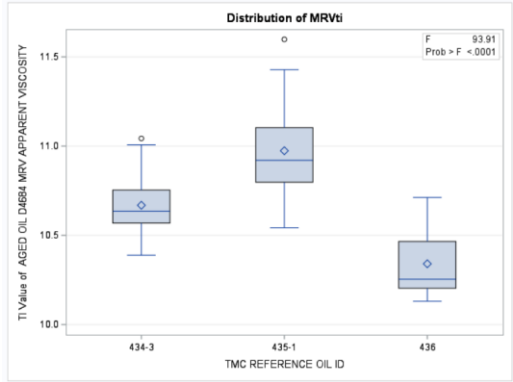
D7528: Oxidation by ROBO





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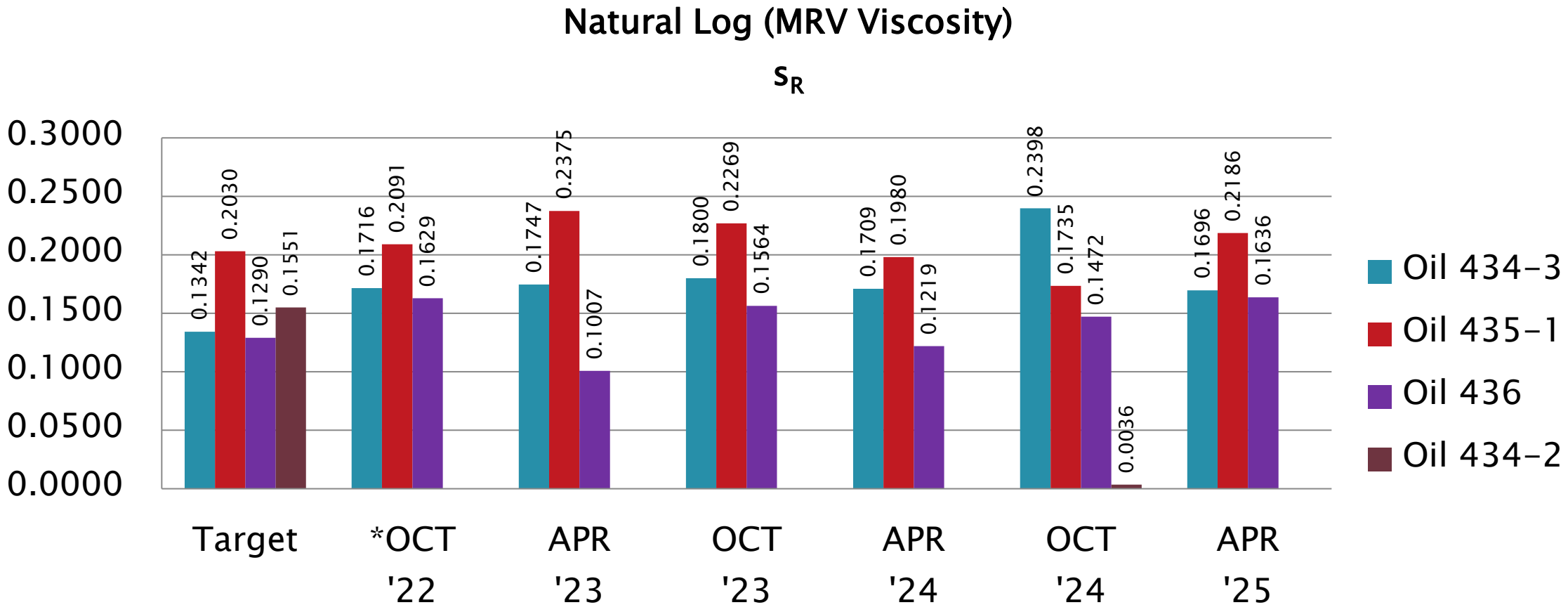
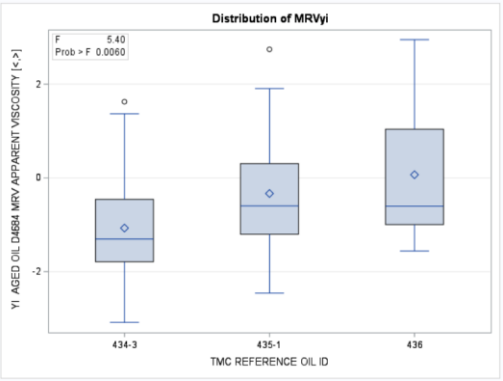
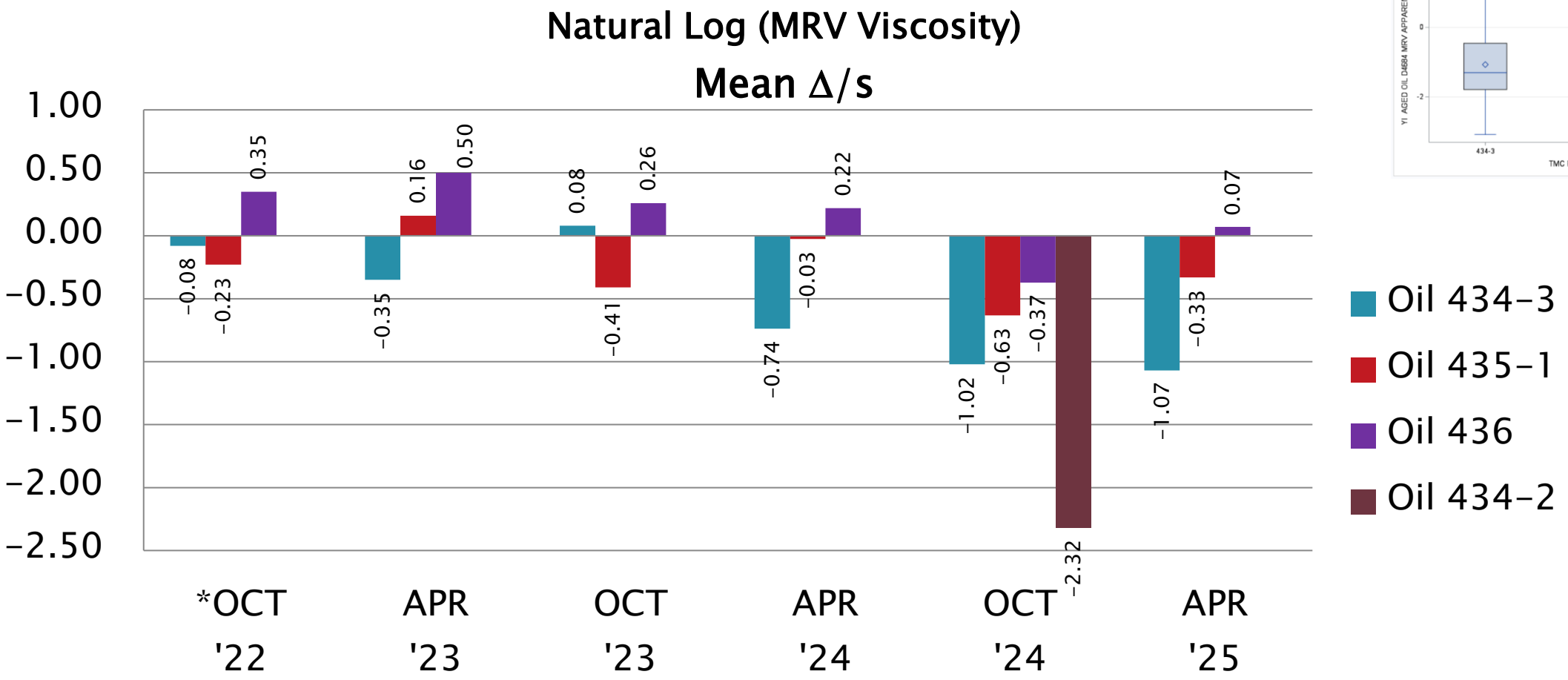
D7528: Oxidation by ROBO



D7528: Oxidation by ROBO





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Reference Oil Inventory

ROBO

Oil	Year Rec'd By TMC[A]	Tests	TMC Inventory, gallons	Gallons Shipped last 6 months	Estimated Life
434-3[B]	2017	ROBO	11.78	2.90	2 years
435-1	2008	ROBO	33.23	7.40	2 years
436[B]	2014	ROBO	29.21	3.06	5+ years

[A] Integrity of TMC reference oils is confirmed annually by analytical QC testing of chemical and physical properties.
[B] Multi-test oil; estimated aliquot reserved for bench testing.

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Reference Oil Inventory

As of 3/31/2025

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Reference Oil Inventory: May 2025

Original Blend	Section	Oil	Tests	Year	Blend Quantity	TMC Inventory	Estimated Life
44	BENCH	44-5	D6594	2022	54	45.3	> 5
52	BENCH	52	D6417	1995	100	59.38	> 5
55	BENCH	55	D6417	1995	100	65.89	> 5
58	BENCH	58	D6417, D6417QC, GI	1998	159	111.5	> 5
66	BENCH	66	D6082	2002	108	66.3	> 5
75	BENCH	75-2	TEOST	2024	8	6.86	>5
77	BENCH	77-3	EOWT	2015	900	350	> 5
79	BENCH	79	EOFT, EOWT	2014	1026	78.3	1.0
82	BENCH	82-1	BRT	2008	10	0.5	<1
86	BENCH	86	BRT	2017	54	49	>5
87	BENCH	87	BRT	2017	98	92.9	>5
90	BENCH	90	D874QC	2005	49.5	2.23	1.5
91	BENCH	91	D874	2006	5	2.90	> 5
92	BENCH	92	D874	2020	52	52.44	> 5
432	BENCH	432	MTEOS	1998	207	100.98	> 5
434	BENCH	434-3	MTEOS, ROBO	2017	55	11.78	1.5
435	BENCH	435-1	ROBO	2008	55	33.23	2.0
435	BENCH	435-2	TEOST	2010	550	31.73	> 5
436	BENCH	436	ROBO	2014	55	29.21	> 5
820	BENCH	820-2	D874	2001	55	5.91	> 5
1005	BENCH	1005-5	D6594	2015	55	23.4	> 5
1006	BENCH	1006	BRT	1996	55	26.35	> 5
1009	BENCH	1009	GI	2002	55	33.30	> 5
FOAMB18	BENCH	FOAM18B	D6082	2018	102	67.18	> 5
GIA17	BENCH	GIA17	GI	2017	10	5.15	> 5
GIC18	BENCH	GIC18	GI	2018	10	7.82	> 5
SL107	BENCH	SL107	EOEC, LDEOC	2019	3868	1202	2.0
VOLC12	BENCH	VOLC12	D5800	2013	55	16.6	4
VOLD12	BENCH	VOLD12	D5800	2013	55	14.8	4
VOLD18	BENCH	VOLD18	D5800QC	2018	1092	516	> 5
VOLE12	BENCH	VOLE12	D5800	2012	55	12.6	4

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Additional Information

Additional Information

- Available on the TMC's Website:
  - Lubricant Test Monitoring System (LTMS) Document
  - CUSUM Severity Plots
  - Reference Data, Period Statistics and Timelines
  - Information Letters and Technical Memos
  - Report Forms & Data Dictionaries
  - Online Store, and more…

- www.astmtmc.org

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