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

D6417, D5133 (GI), D5800, D6335 (TEOST), D7097(MTEOS), D6082, D874 and D7528 (ROBO)

April 2022

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Executive Summary

- D5133 (Gelation Index)
  - There was a large decrease in the number of operationally invalid tests this period compared to the previous period. The number of operationally invalid tests decreased by ½ from 35 to 17.
- D6335 (TEOST)
  - TMC Memorandum 21-044, updating targets for reference oil 75-1 was issued 11/3/2021
  - Fail rate for TEOST has improved with respect to recent periods

B0.07 Bench Testing Executive Summary

- D6082 (High Temperature Foam) and D874 (Sulfated Ash)
- There were no tests which failed to meet acceptance criteria for both these test types.

- D7528 (ROBO)
- Long term severity trend (mild) as evidenced in the Cusum plots may indicate that targets may not be correct.
- Information letter 21-01, allowing an option to use dilute nitrogen dioxide in air was issued 11/3/21

- D5800 (NOACK)
- Long term severity trend (severe) as evidenced in the Cusum plots may indicate that targets may not be correct.

Calibrated Labs and Stands*

Test	Labs	Stands
D6417	7	9
D5800	9	21
D5133 (GI)	5	45
D6335 (TEOST)	8	12
D7097 (MTEOS)	8	37
D6082	4	5
D874	3	--
D7528 (ROBO)	6	27

*As of 3/31/2022

D02.B0.07
TMC Monitored Tests

October1, 2021 – March 31, 2022

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D6417: Estimation of Engine Oil Volatility by Capillary GC

Test Status	Validity Code	No. Tests
Acceptable Calibration Test	AC	18
Failed Calibration Test	OC	2
Total		**20**

Number of Labs Reporting Data: 7
Fail Rate of Operationally Valid Tests: 10%

D6417: Estimation of Engine Oil Volatility by Capillary GC

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

- There were no operationally invalid tests reported this period
- No D6417 TMC technical updates were issued this report period.

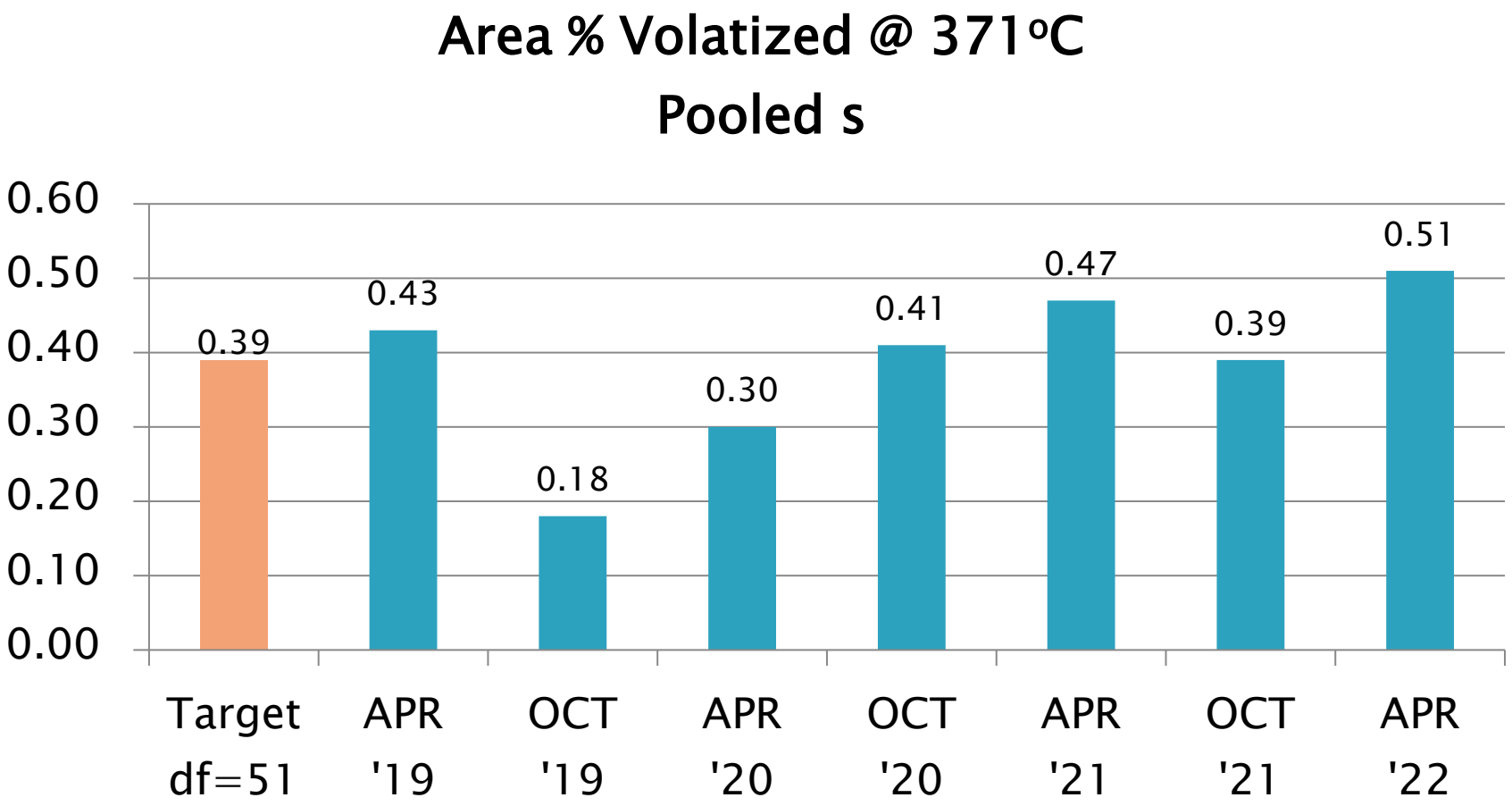
D6417: Estimation of Engine Oil Volatility by Capillary GC

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	-----
4/1/19 through 9/30/19	19	16	0.18	0.10
10/1/19 through 3/31/20	17	14	0.30	0.09
4/1/20 through 9/30/20*	16	13	0.41	-0.34
4/1/20 through 9/30/20*	14	11	0.31	0.01
10/1/20 through 3/31/21*	21	18	0.47	-0.81
10/1/20 through 3/31/21*	19	16	0.37	-0.43
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

*Period statistics with two mild results from rigs D5/D6 included and excluded (operational problem suspected but lab never confirmed)

D6417 Precision Estimates



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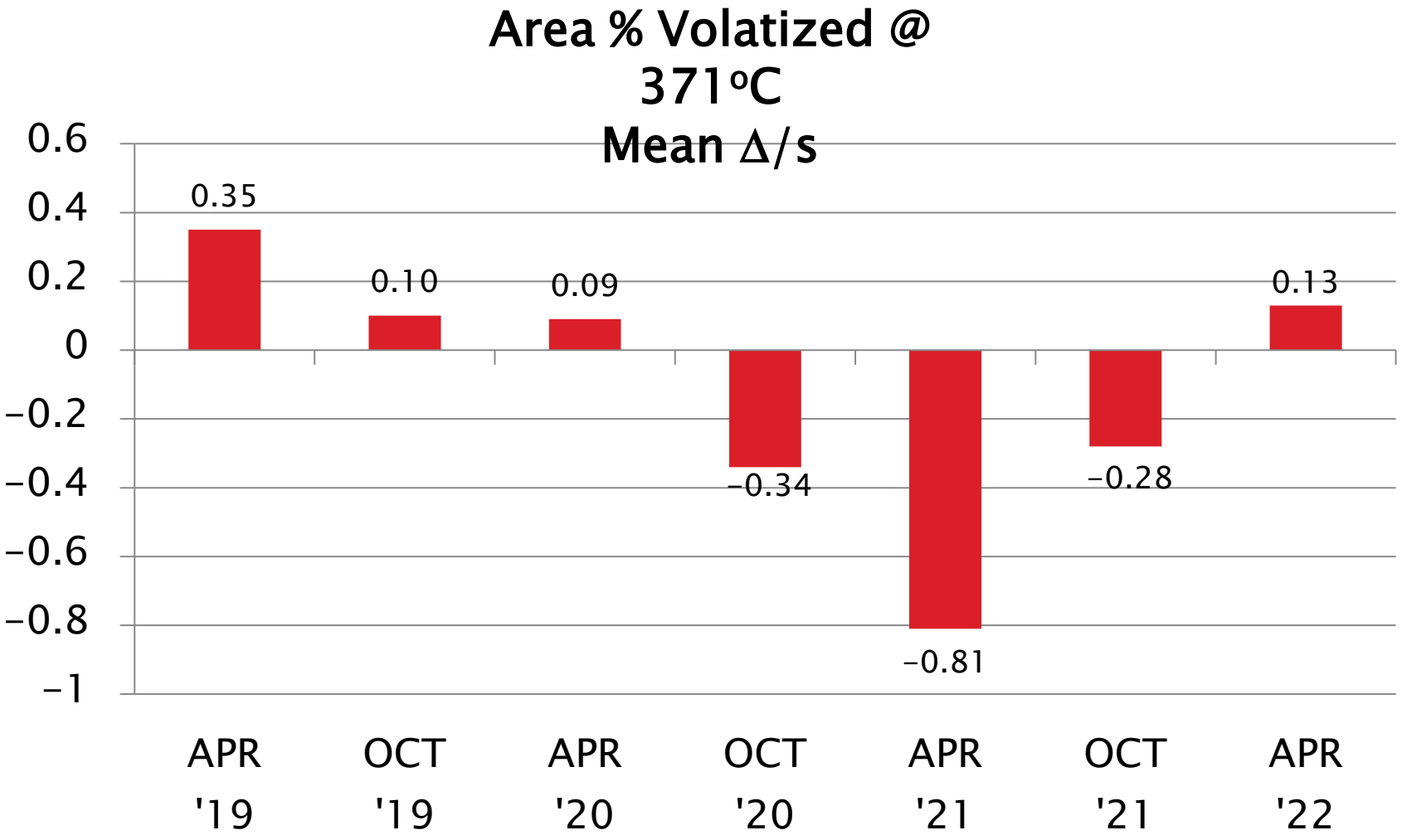
D6417 Severity Estimates



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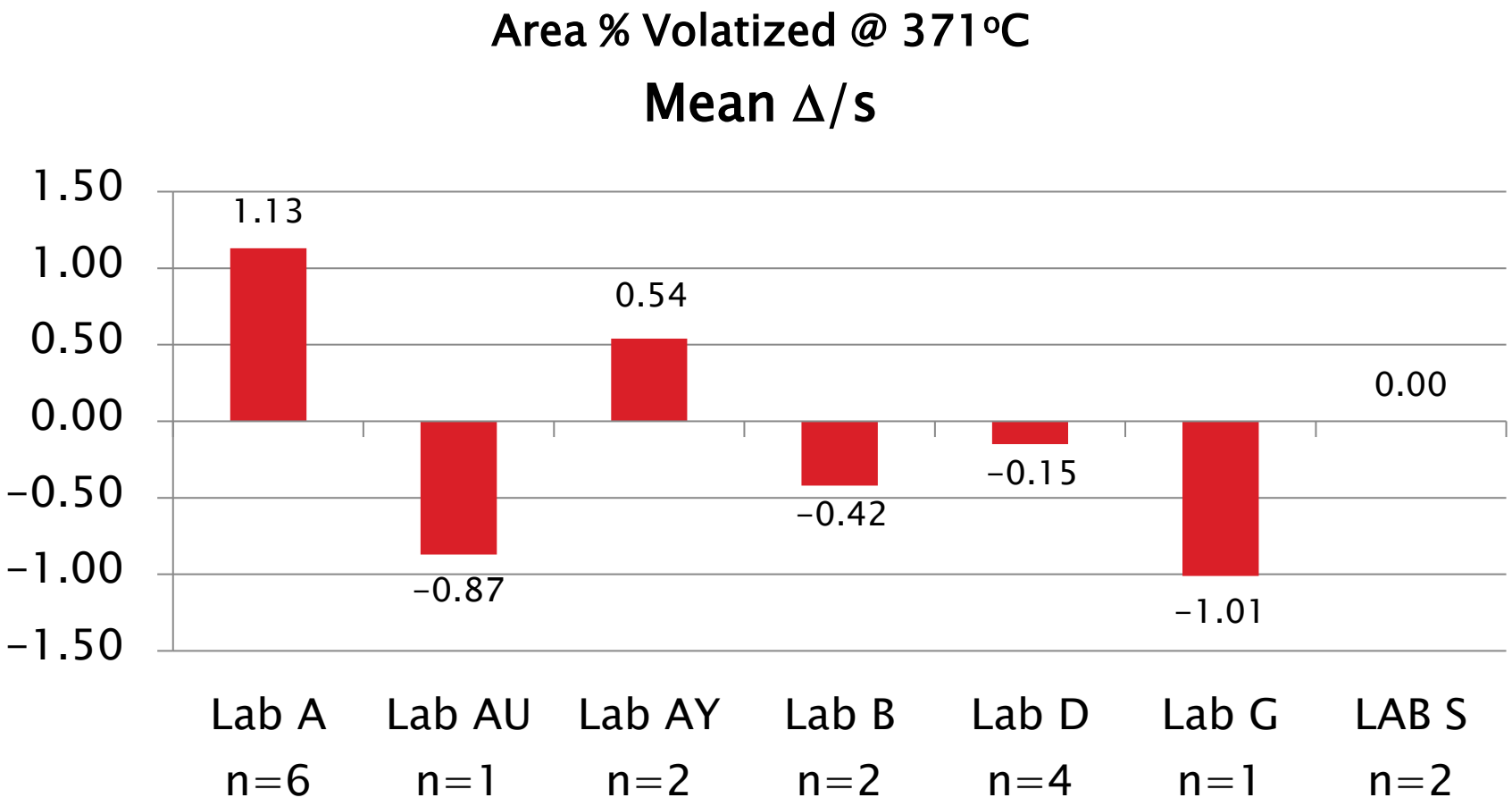
D6417 Lab Severity Estimates



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D6417: Estimation of Engine Oil Volatility by Capillary GC

- Precision (Pooled s) has degraded this period relative to previous period and historical rates.
- Performance (Mean Δ/s) is 0.13 s, close to target.
- CUSUM severity plot shows a mild trend over last three periods, with this period closer to target.

D6417 VOLATILITY BY GC INDUSTRY OPERATIONALLY VALID DATA

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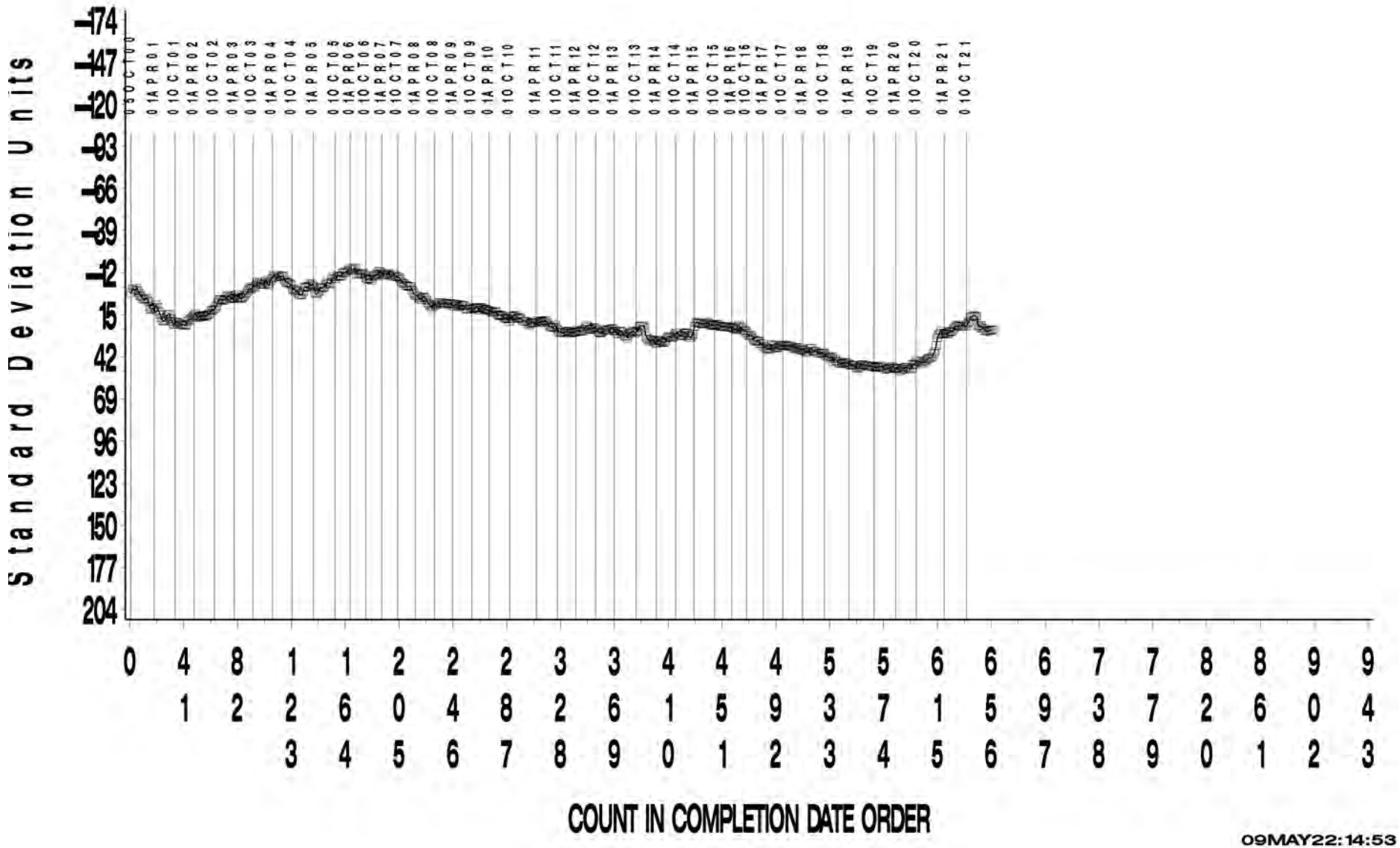
SAMPLE AREA % VOLATIZED

CUSUM Severity Analysis



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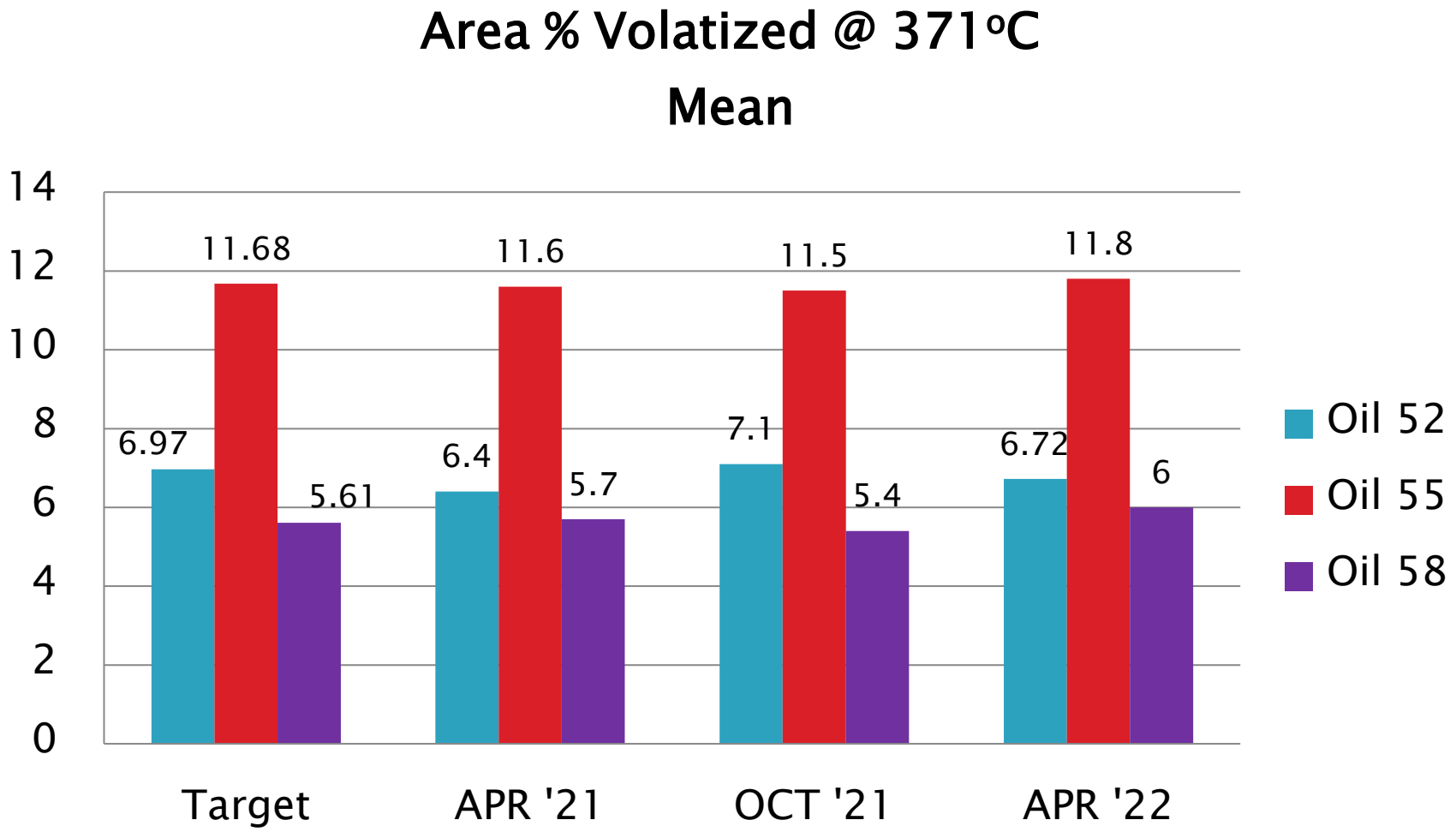
D6417 Performance by Oil



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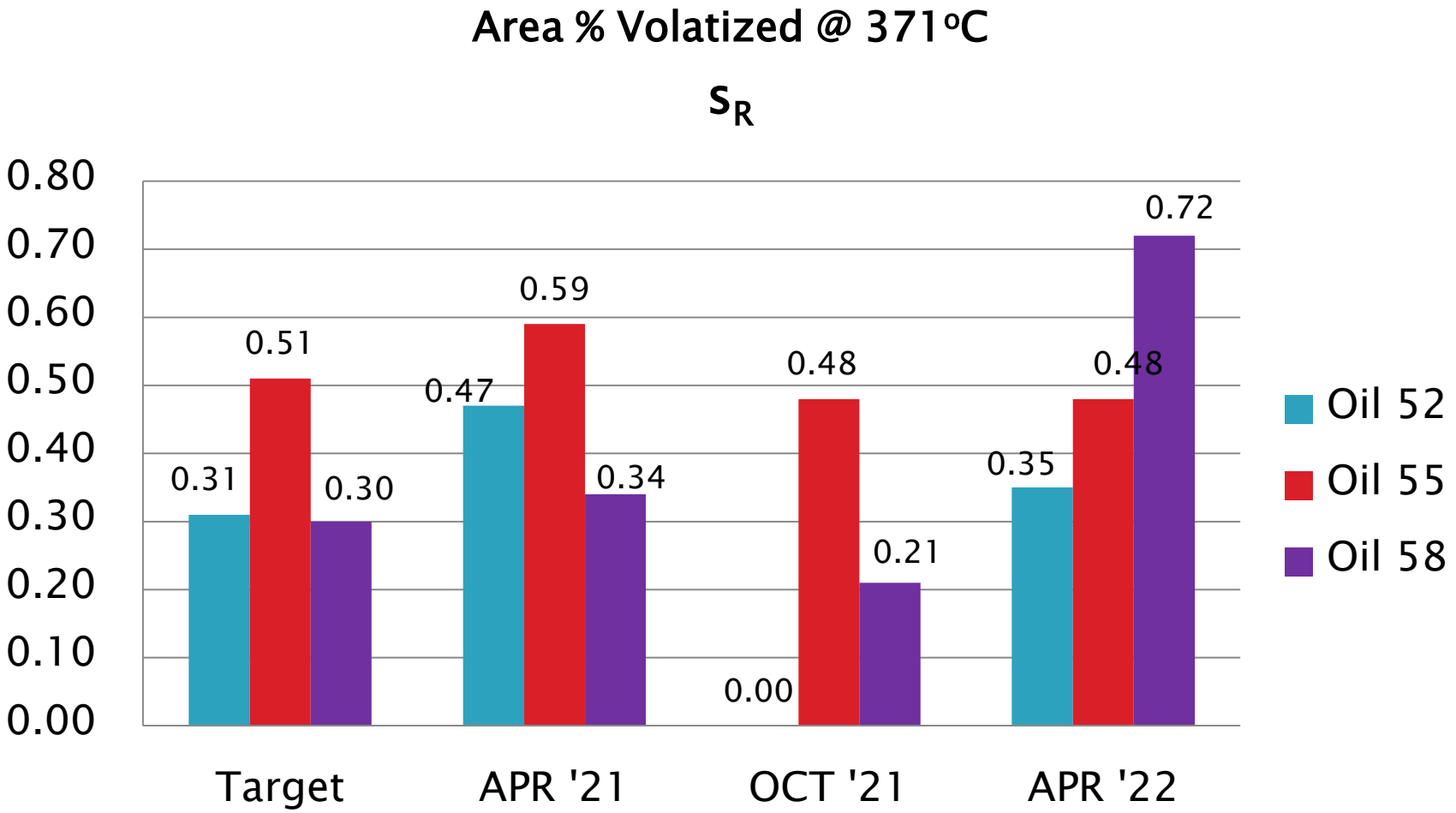
D6417 Performance by Oil



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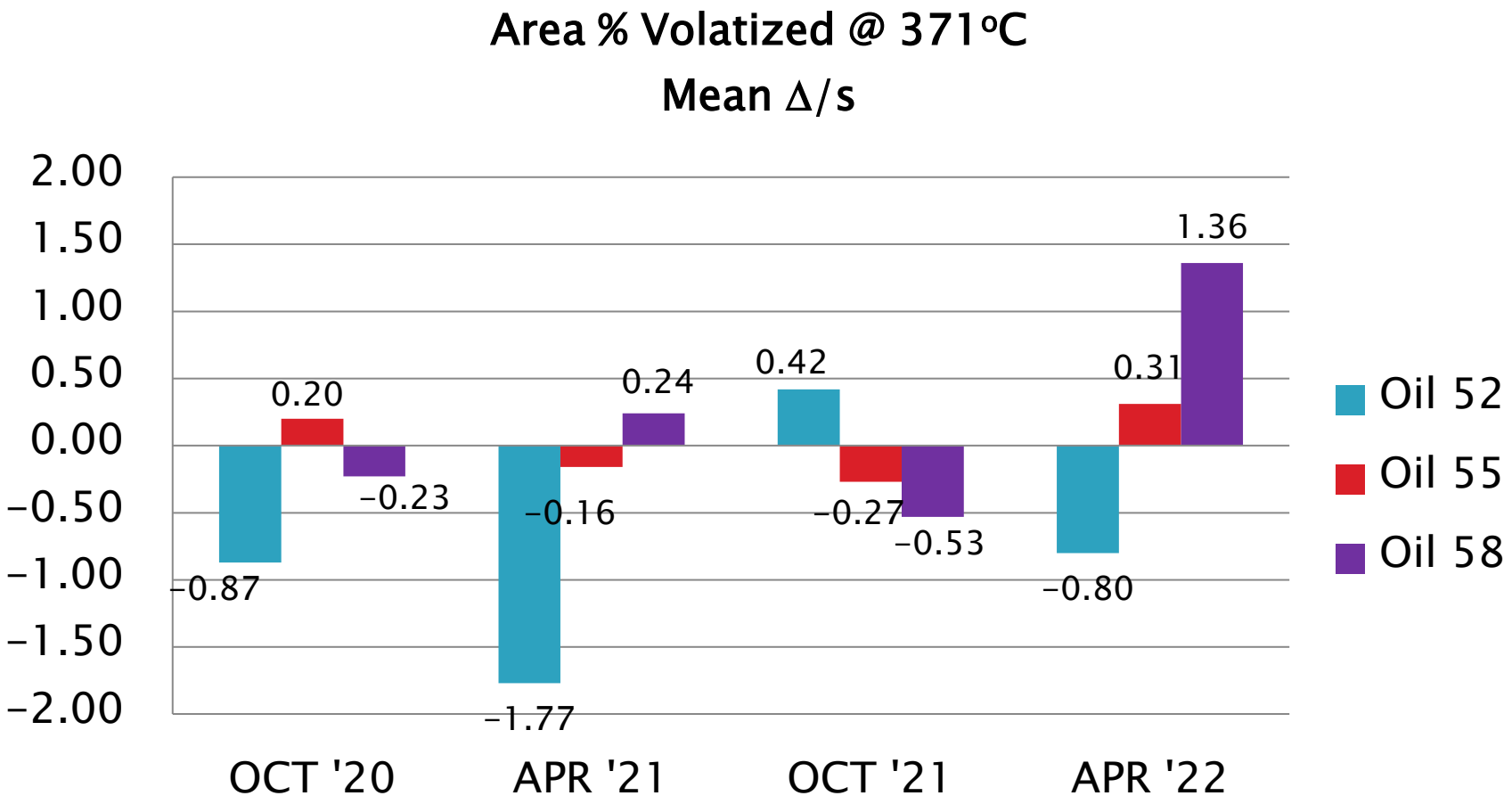
D6417 Performance by Oil



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D5800: Evaporation Loss of Lubricating Oil by Noack Method

Test Status	Validity Code	No. Tests
Acceptable Calibration Test	AC	134
Failed Calibration Test	OC	5
Operationally Invalidated by Lab	LC, XC	1
Operationally Invalidated After Initially Reported as Valid	RC	1
Rig Shakedown Runs	AN, ON	1
Total		**142**

Number of Labs Reporting Data: 9
Fail Rate of Operationally Valid Tests: 4%

D5800: Evaporation Loss of Lubricating Oil by Noack Method

Statistically Unacceptable Tests (OC)	No. Of Tests
Ei Level 3 Alarm Mild	1
Ei Level 3 Alarm Severe	2
Zi Level 2 Severity Alarm Severe (same lab/instrument)	2

- The 5 OC tests were on four different rigs at three labs.
  - Two on Zi L2 alarms (both severe) on rig A8
  - Two rigs (rig A17 and D6) triggered both Ei Level 3 alarm in the severe direction
  - Rig G5 sounded an Ei Level 3 alarm in the mild direction.

- No operationally valid tests exceed ±3 s this period.

D5800: Evaporation Loss of Lubricating Oil by Noack Method

- Two operationally invalid calibration runs were reported this period:
  - One test invalidated by TMC due to no QC result performed on the day of calibration (RC)
  - One test where the test sample was not removed from the oven within specified time (XC)

- 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	-----
10/1/18 through 3/31/19	151	148	0.81	0.51
4/1/19 through 9/30/19	164	161	0.81	0.65
10/1/19 through 3/31/20[1]	146	143	0.0503	0.54
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	139	136	0.0463	0.24

[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: Evaporation Loss of Lubricating Oil by Noack Method

Performance Comparison by Procedure & Model

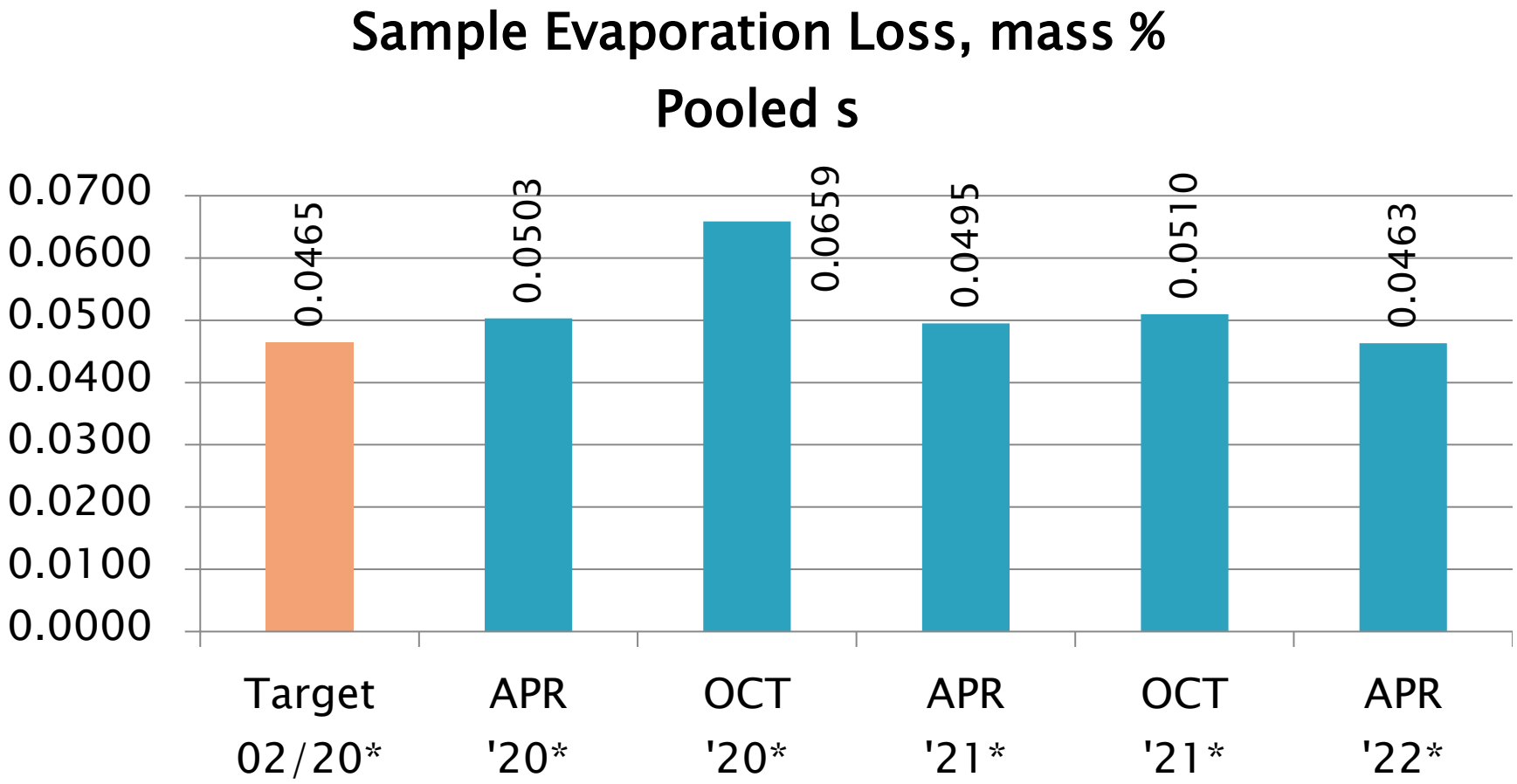
Sample Evaporation Loss, Mass %

Procedure	n	df	Pooled s	Mean Δ/s
Procedure B	85	82	0.0403	0.50
Procedure C	No Procedure C tests reported this period.			
Procedure D	54	51	0.0474	-0.15

Model	n	df	Pooled s	Mean Δ/s
NCK2	5	2	0.0115	-0.22
NCK25G	79	77	0.0404	0.54
NS2	54	51	0.0474	-0.15

1 Procedure B NCK2 Rig
17 Procedure B NCK25G Rigs
9 Procedure D NS2 Rigs

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.

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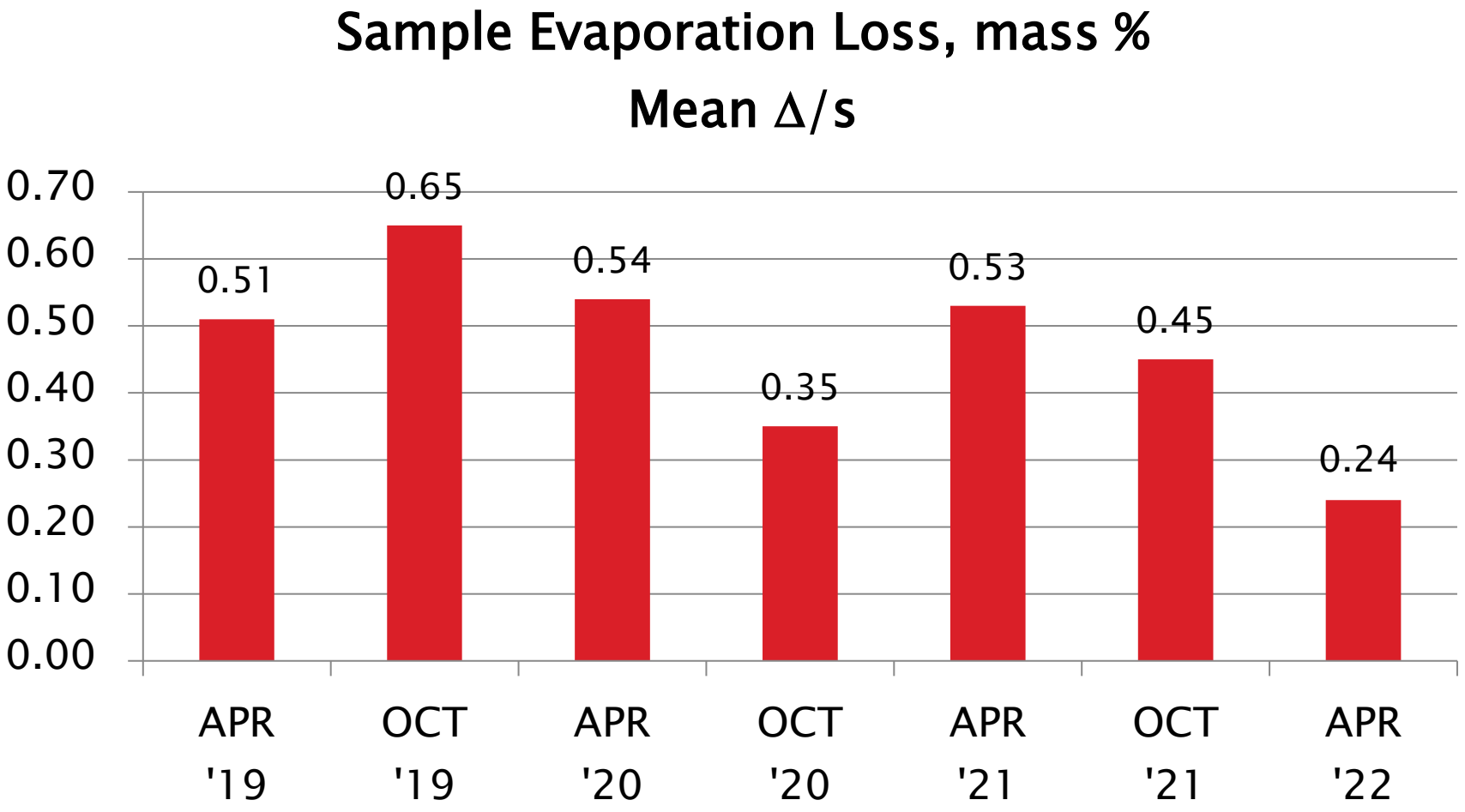
D5800 Severity Estimates



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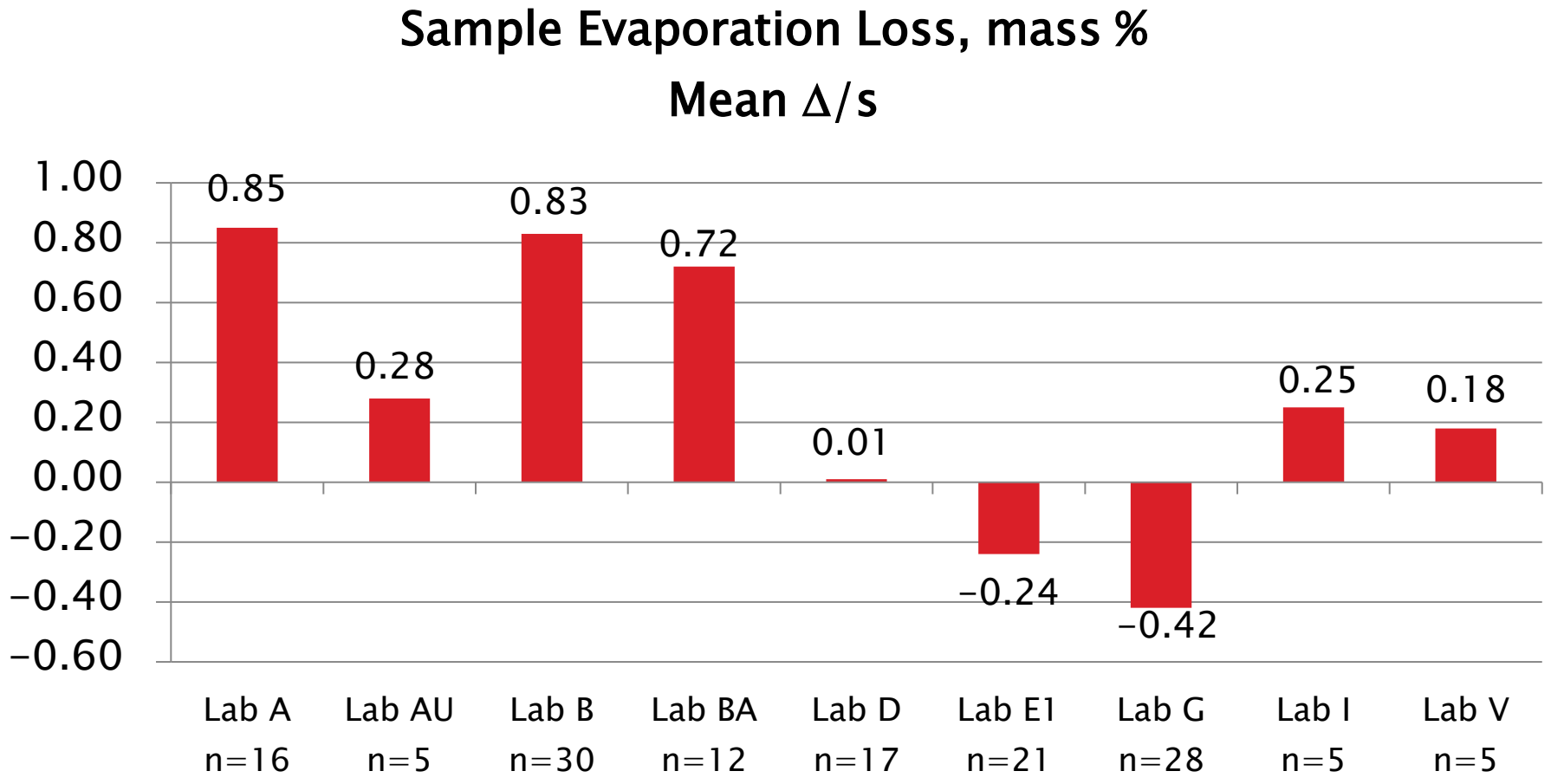
D5800 Lab Severity Estimates



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D5800: Evaporation Loss of Lubricating Oil by Noack Method

- Precision (Pooled s) is comparable to target precision (in natural log transformed units).
  - Directionally better than prior period
  - Little difference in precision between Procedure B rigs and Procedure D rigs.
- Performance (Mean Δ/s) is 0.24 s severe.
  - Procedure B rigs are trending 0.72 s severe while Procedure D rigs are trending −0.14 s mild.
- CUSUM severity plots shows a continuing overall severe trend with reference testing, completely attributable (this period) to procedure B tests. Procedure D tests have been trending mild for the past few periods. The industry EWMA Control chart is currently in control

D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA

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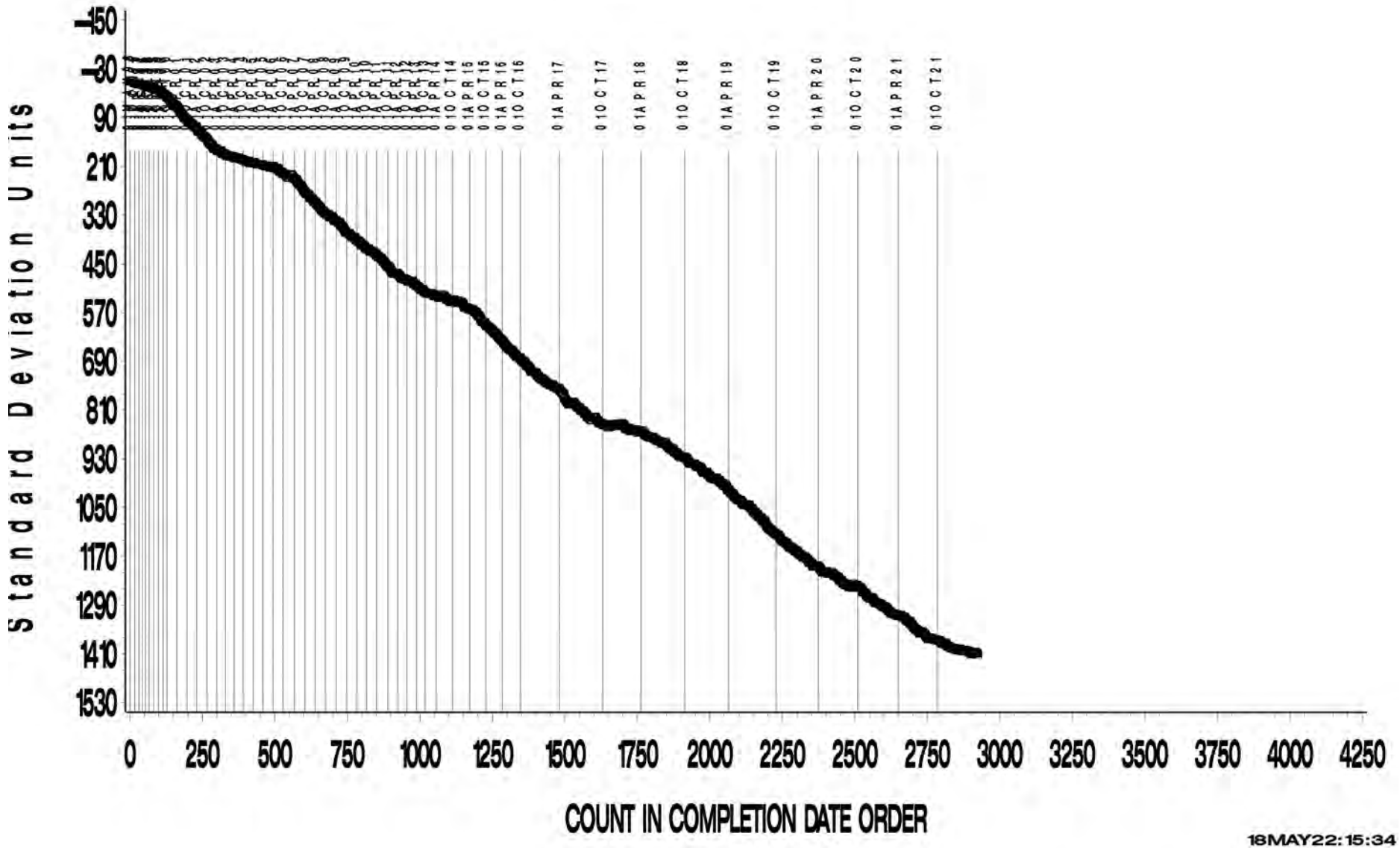
EVAPORATION LOSS, MASS%

CUSUM Severity Analysis



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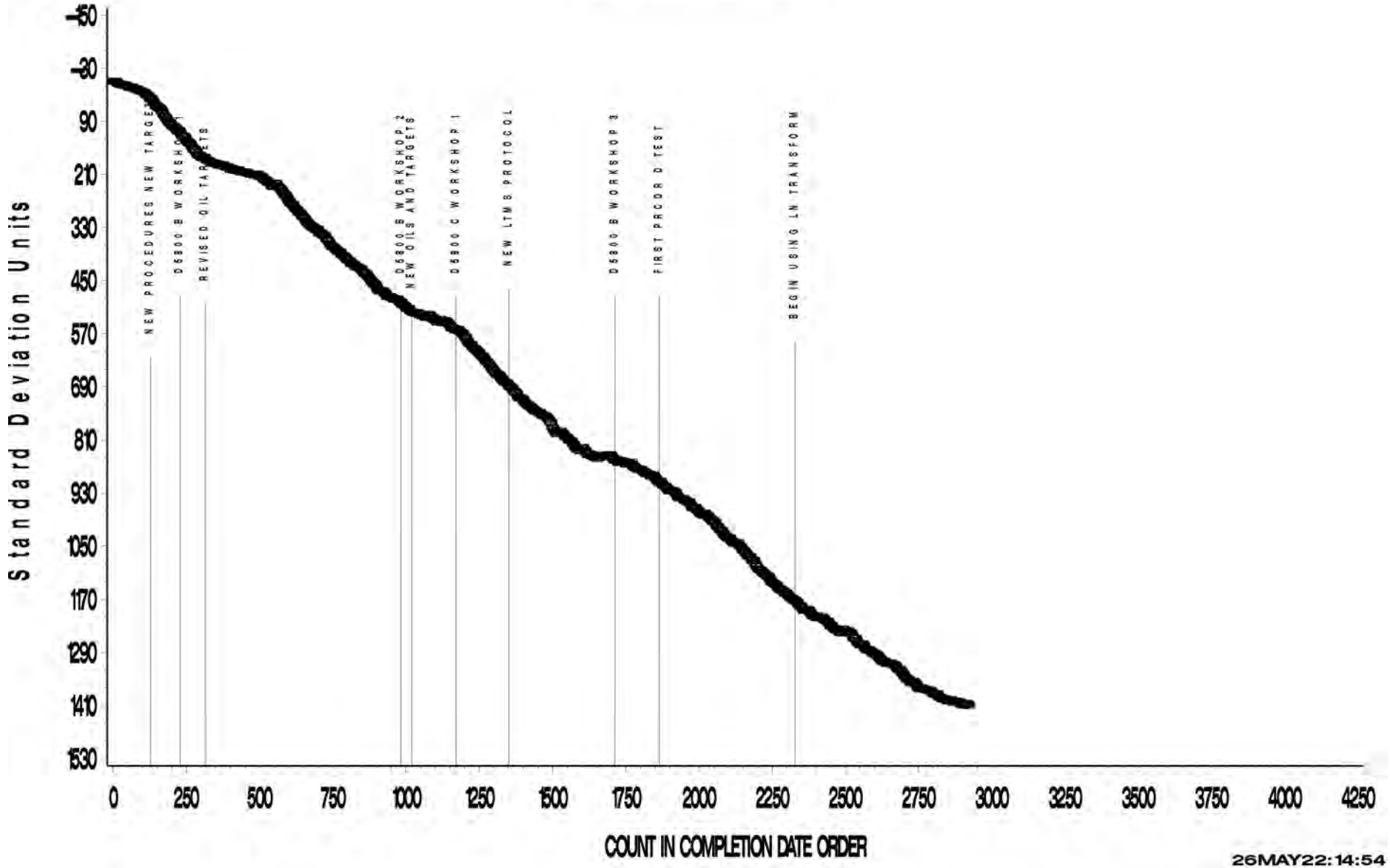
D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA

EVAPORATION LOSS, MASS%

CUSUM Severity Analysis



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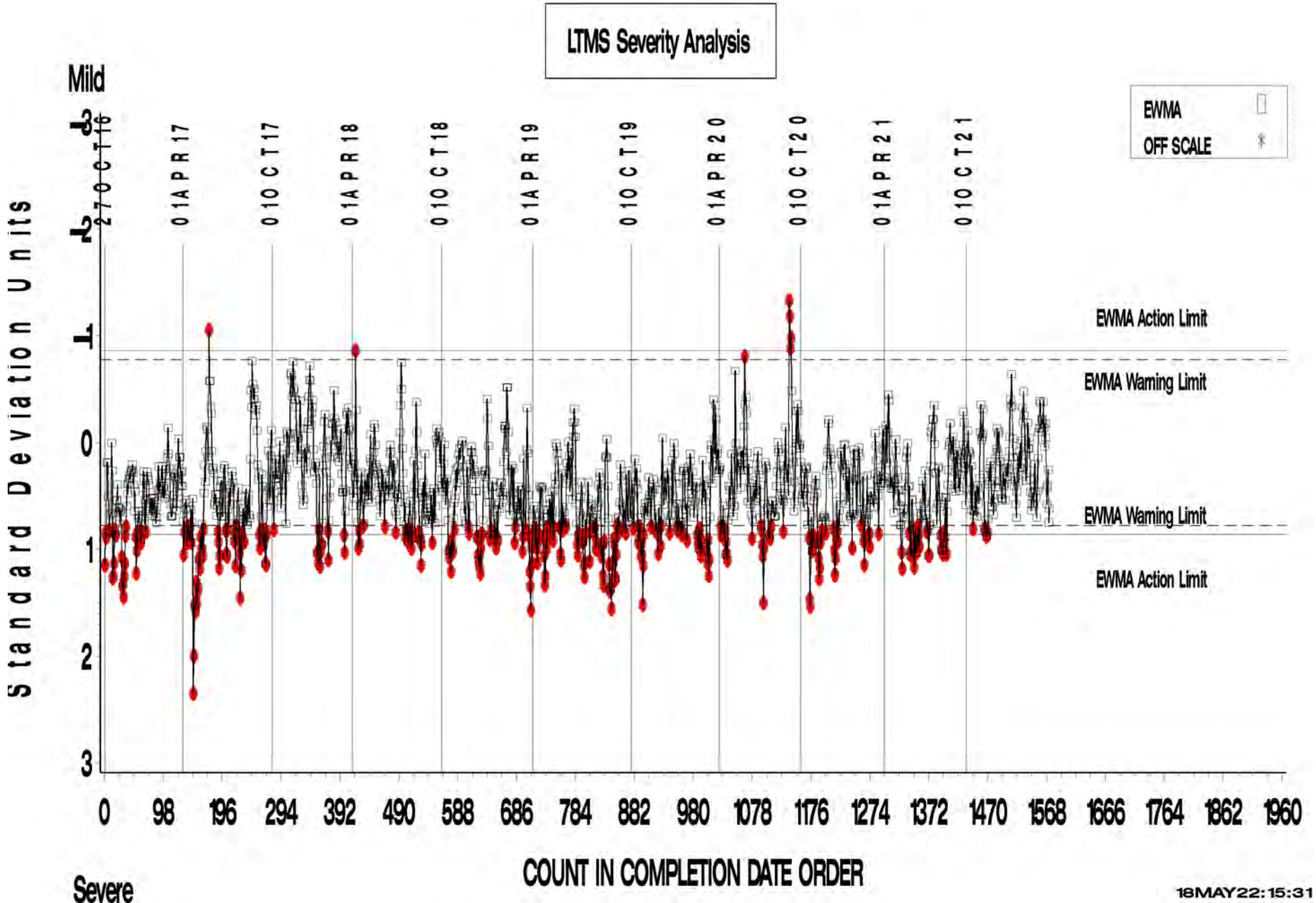
D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA
All tests Completed after 10/19/2016
EVAPORATION LOSS, MASS%



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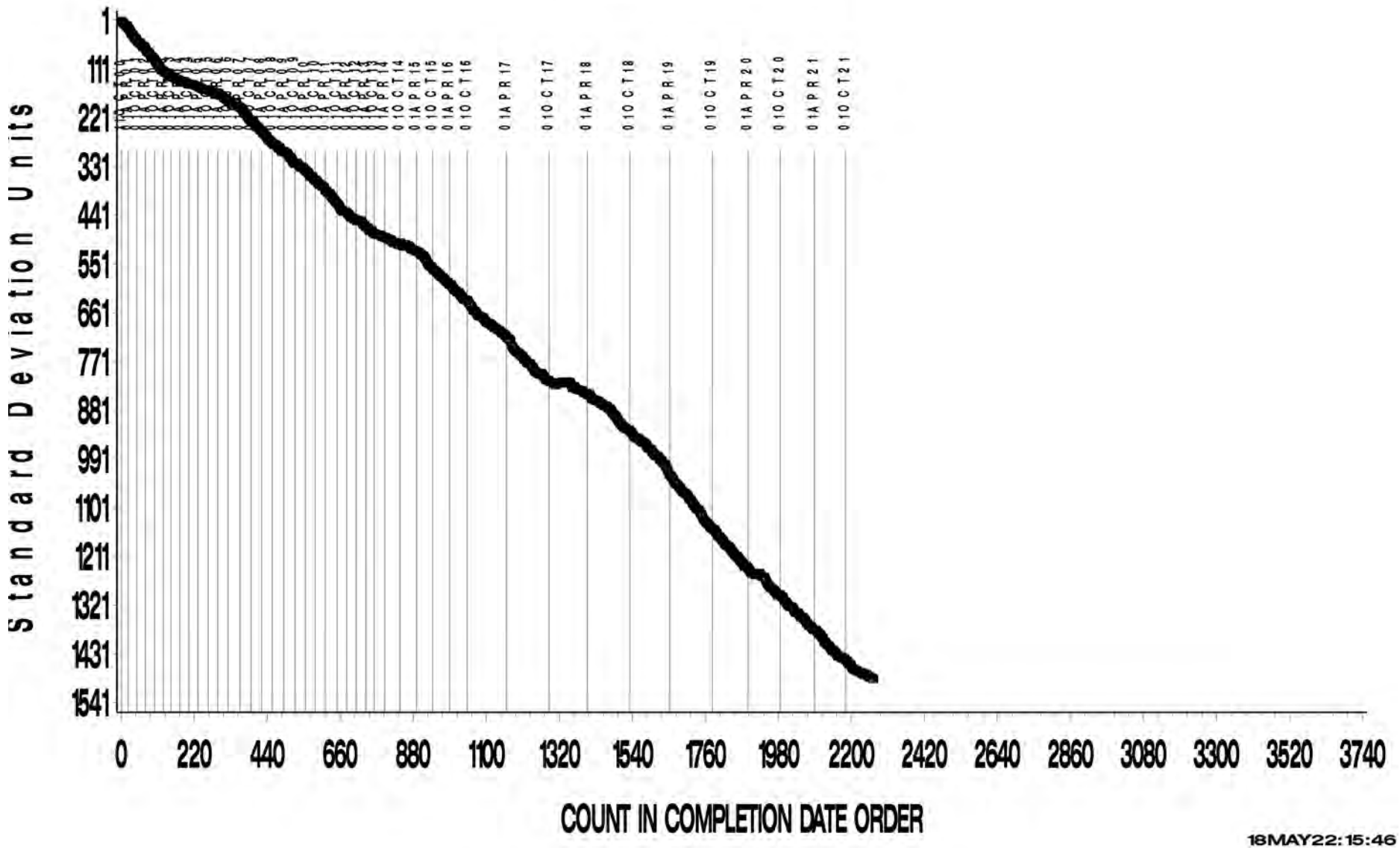
D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA
Procedure B
EVAPORATION LOSS, MASS%

CUSUM Severity Analysis



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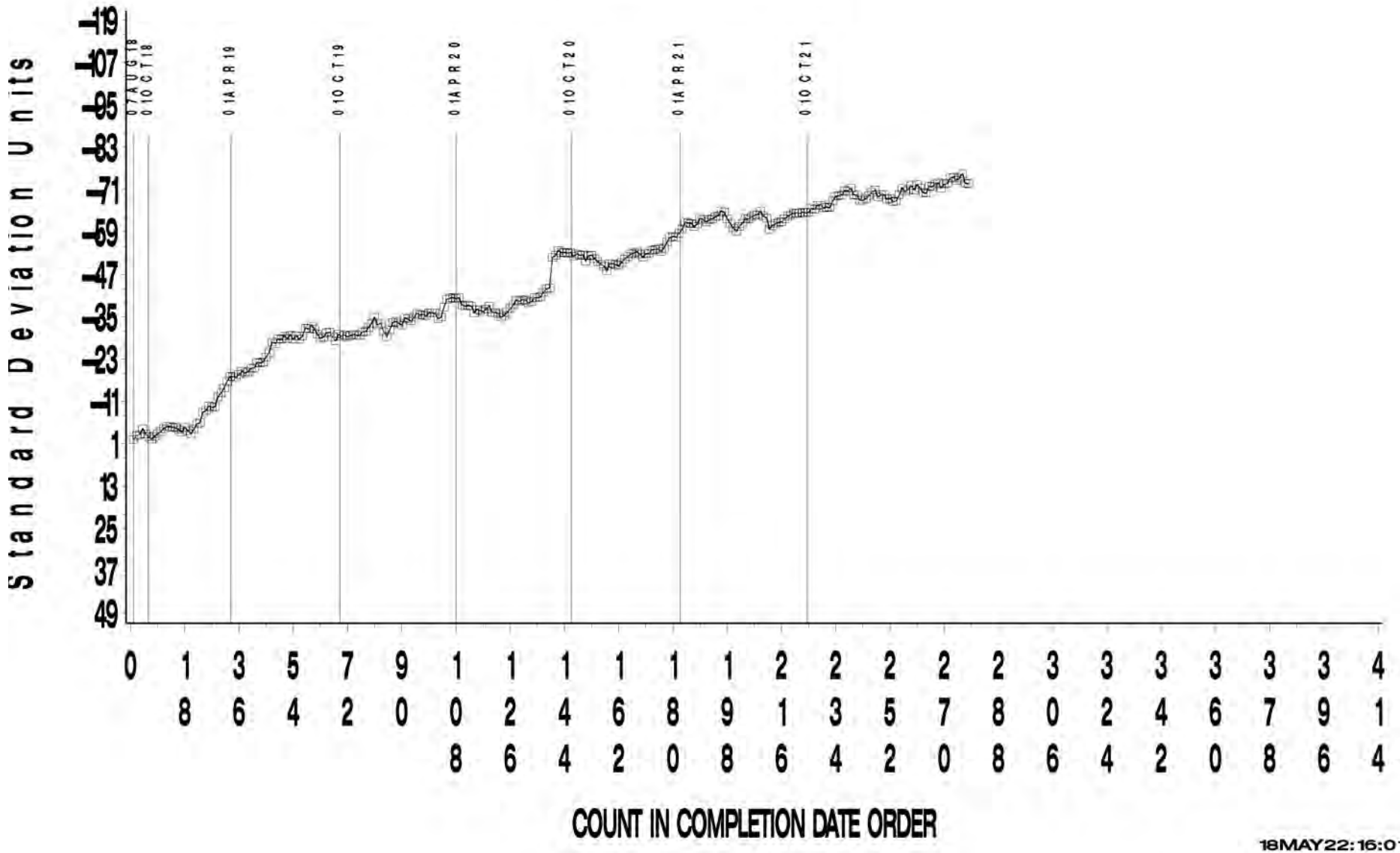
D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA

Procedure D

EVAPORATION LOSS, MASS%

CUSUM Severity Analysis



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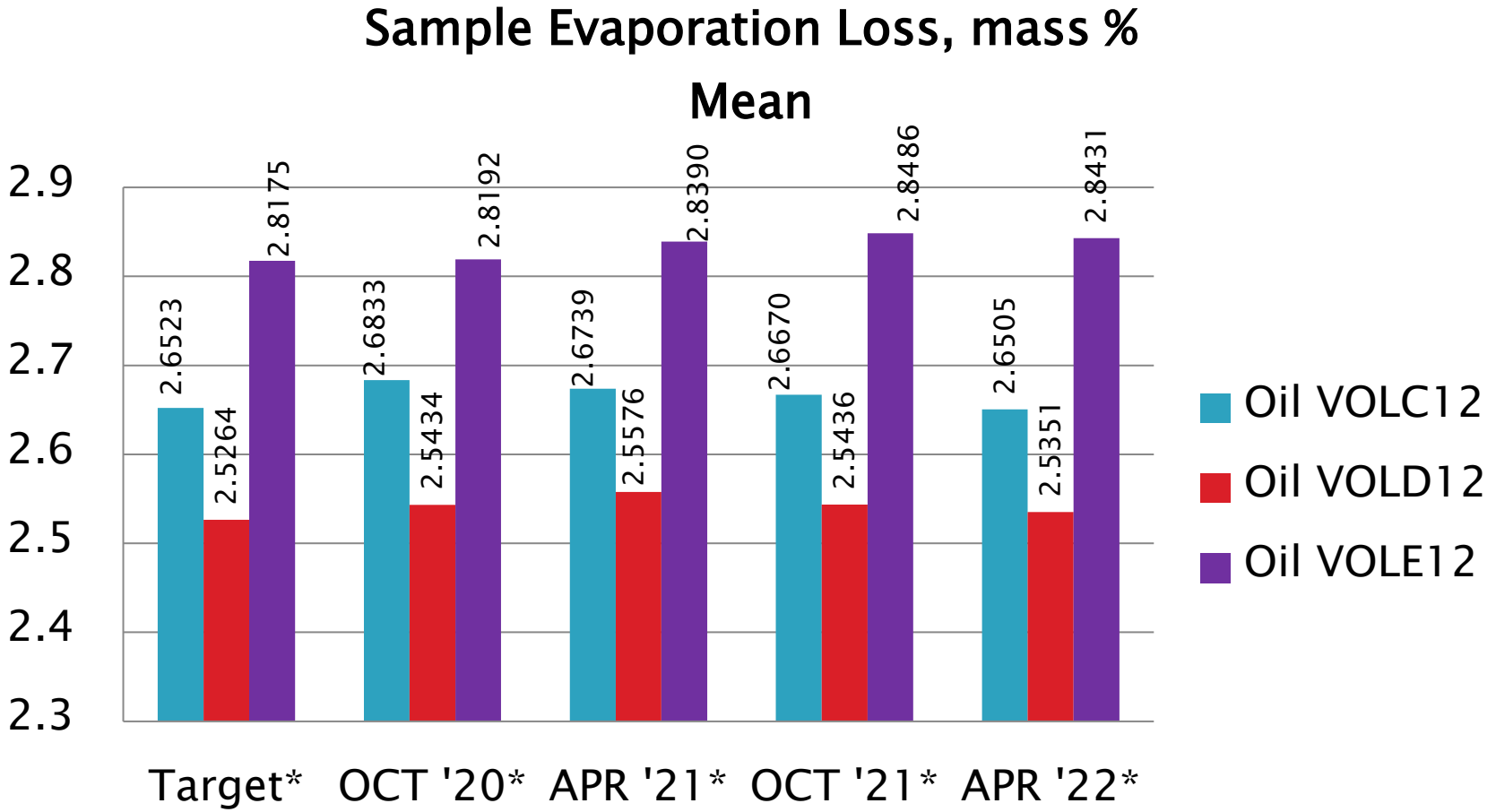
D5800 Performance by Oil



*Results transformed to natural log per updated LTMS 20200207

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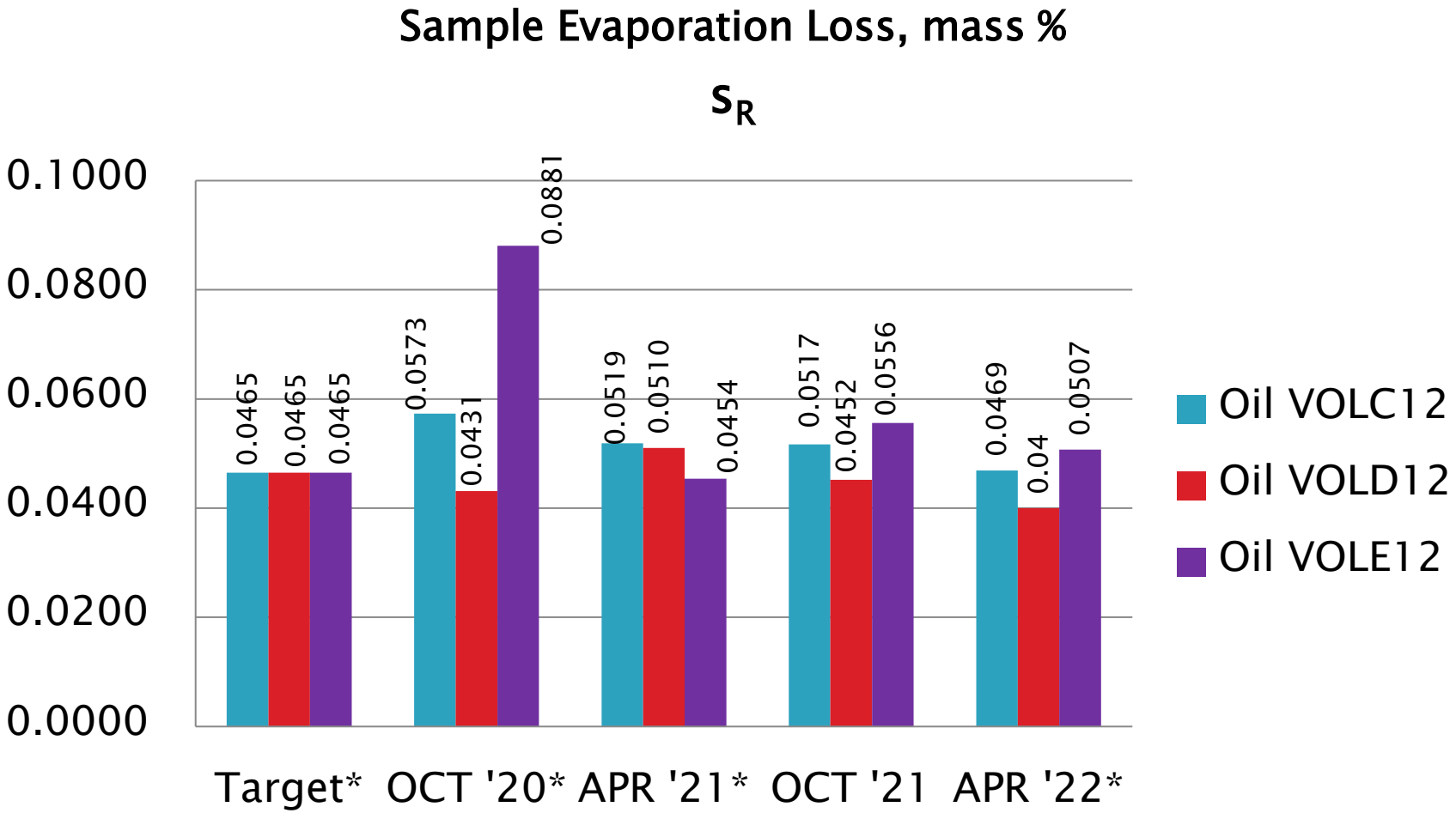
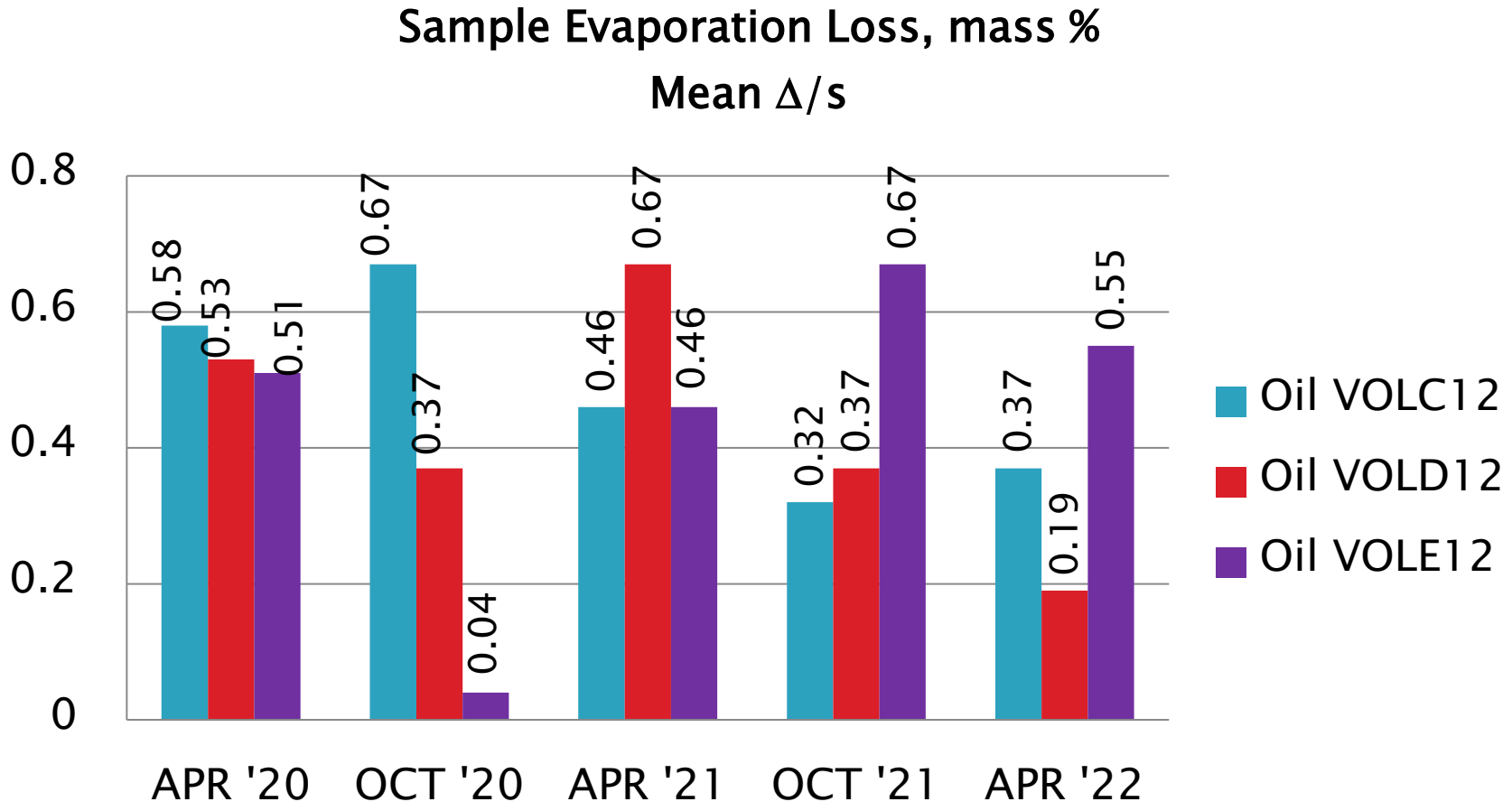
D5800 Performance by Oil



*Results transformed to natural log per updated LTMS 20200207

D5800 Performance by Oil



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D5133: Gelation Index

Test Status	Validity Code	No. Tests
Acceptable Calibration Test	AC	54
Failed Calibration Test	OC	7
Operationally Invalidated by Lab	LC, LS, XC, XS	7
Operationally Invalidated After Initially Reported as Valid	RC/RS	10
Acceptable Discrimination Tests	AS	48
Failed Discrimination Tests	OS	1
Total		**127**

Number of Labs Reporting Data: 9
(only 8 labs with chartable results this period)
Fail Rate of Operationally Valid Calibration Tests: 12.3%
Fail Rate of Operationally Valid Discrimination Tests: 2.1%

D5133: Gelation Index

Statistically Unacceptable Calibration Tests (OC)	No. Of Tests
Gelation Index Mild	6
Gelation Index Severe	1

- There was also a severe failing discrimination run this period, out of 48 reported as operationally valid.

- Of the 7 OC tests:
  - Two were < 2 s from targets (-1.9786)
  - Four were between ±2-3 s from targets
  - One between ±4-5 s from targets

D5133: Gelation Index

Tests Excluded From Statistics (Operationally or Otherwise)	Validity Code	No. Tests
Failed to Run a discrimination test for over a year	LC/RC	8
Power issue with head/unit (Same lab)	RC	3
Power Failure	XC/XS	3
Software issue, didn't acquire test data	LC	1
Lab did not conduct internal calibration	RC	2
Total		**17***

*Compared to 35 invalidated tests last period, when monitoring of individual heads started.

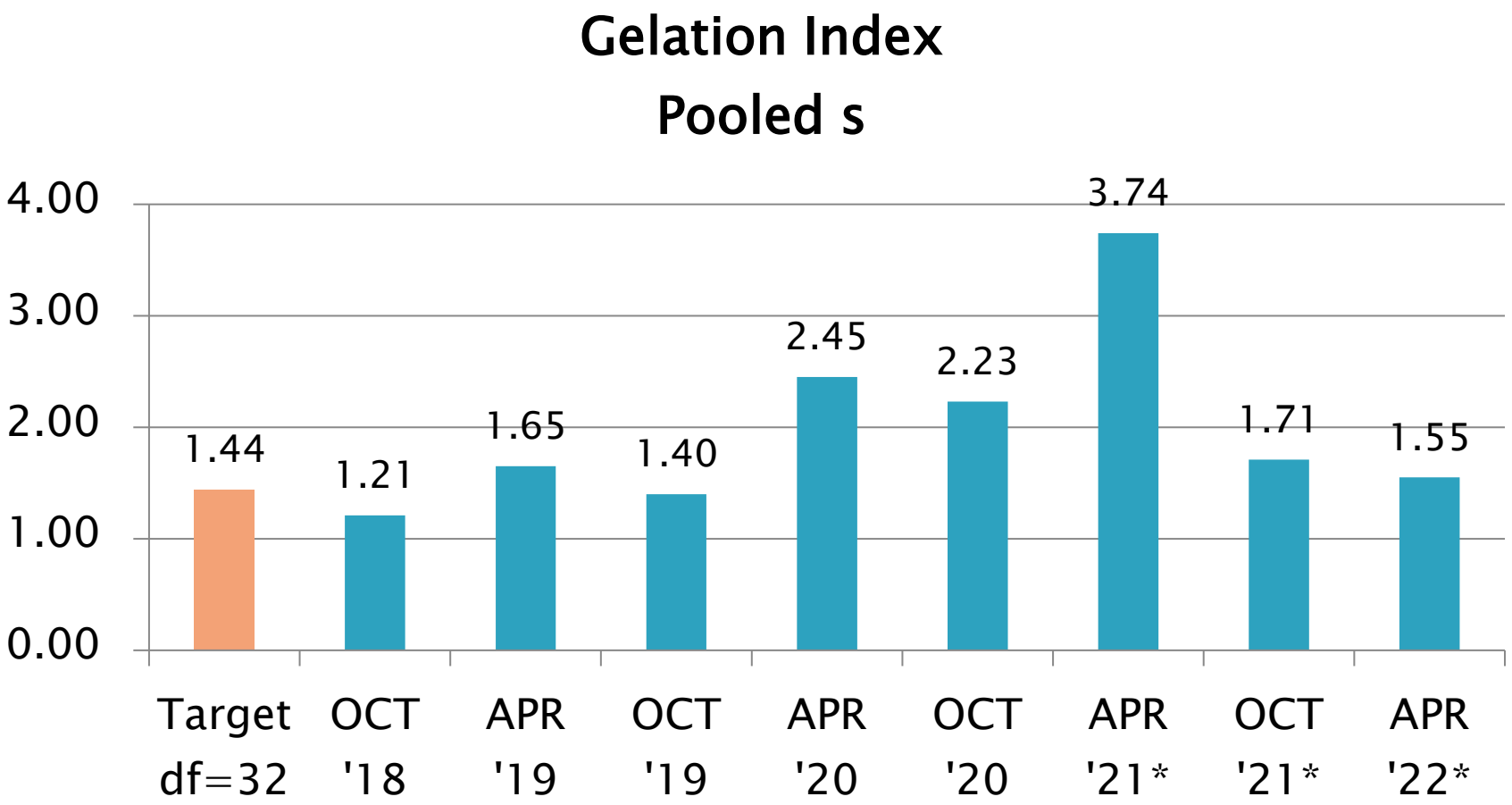
D5133: Gelation Index

Period Precision and Severity Estimates

Gelation Index	n	df	Pooled s	Mean Δ/s
Targets Updated 20201001[1]	34	32	1.44	-----
10/1/18 through 3/31/19	27	24	1.65	0.13
4/1/19 through 9/30/19	47	44	1.40	-0.25
10/1/19 through 3/31/20	41	37	2.45	-0.24
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[2]	75	73	1.71	-0.20
10/1/21 through 3/31/22[2]	61	59	1.55	-0.84

[1]Target precision updated to current reference oils GIA17 and 1009 only
[2]Changed from bath to head based monitoring scheme 10/1/20

D5133 Precision Estimates



*Changed from bath to head based monitoring scheme

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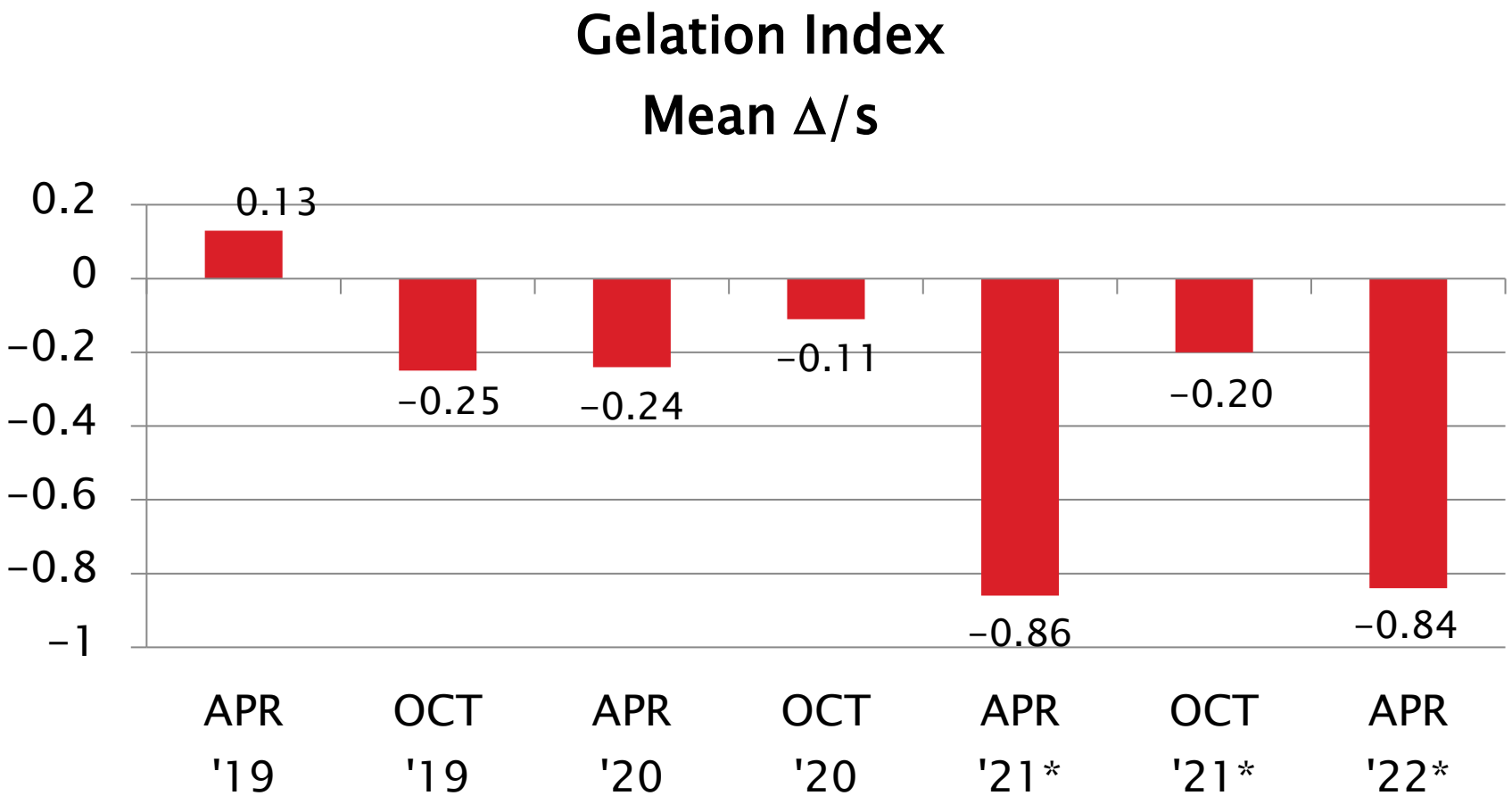
D5133 Severity Estimates



*Changed from bath to head based monitoring scheme

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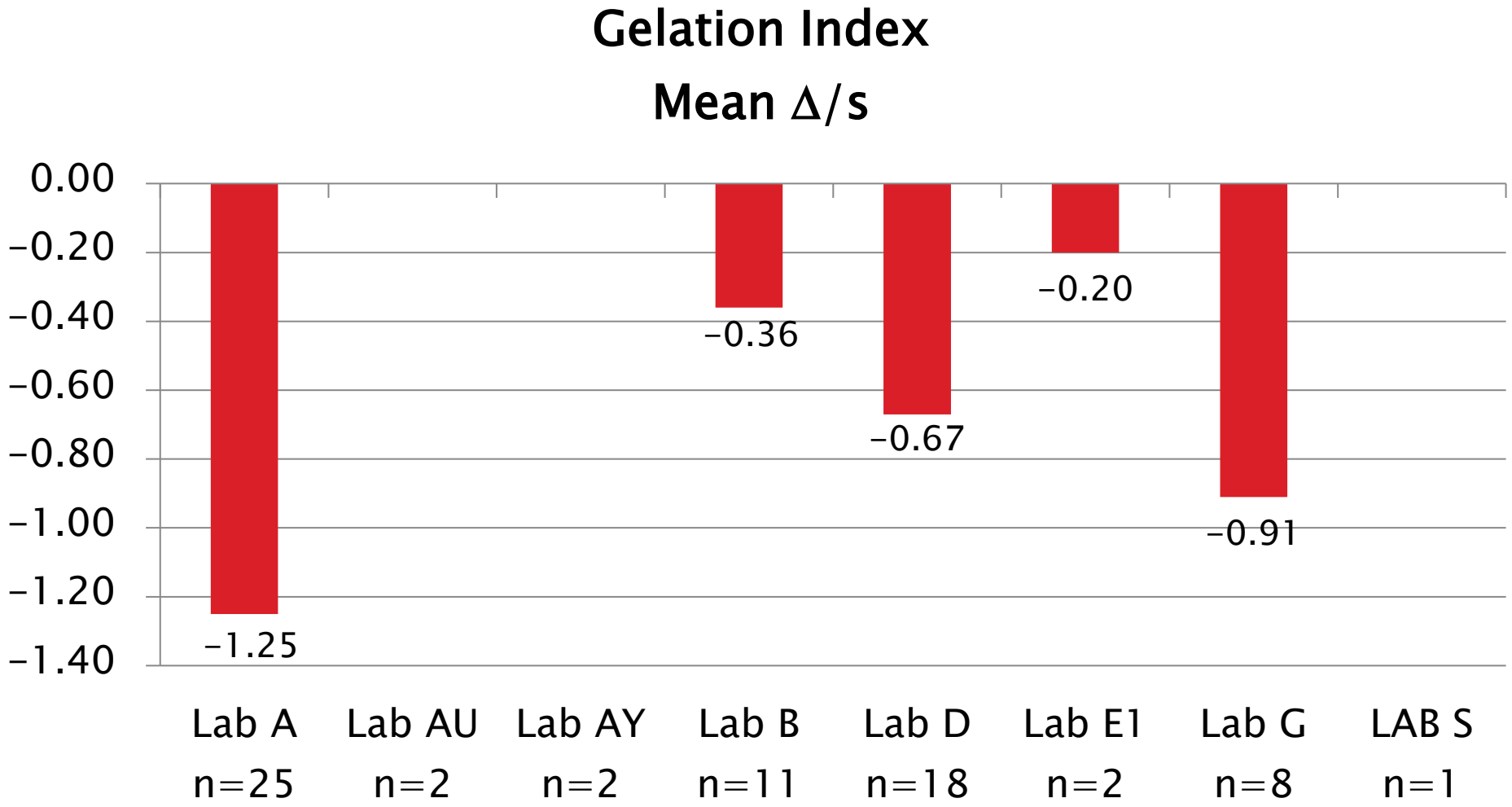
D5133 Lab Severity Estimates



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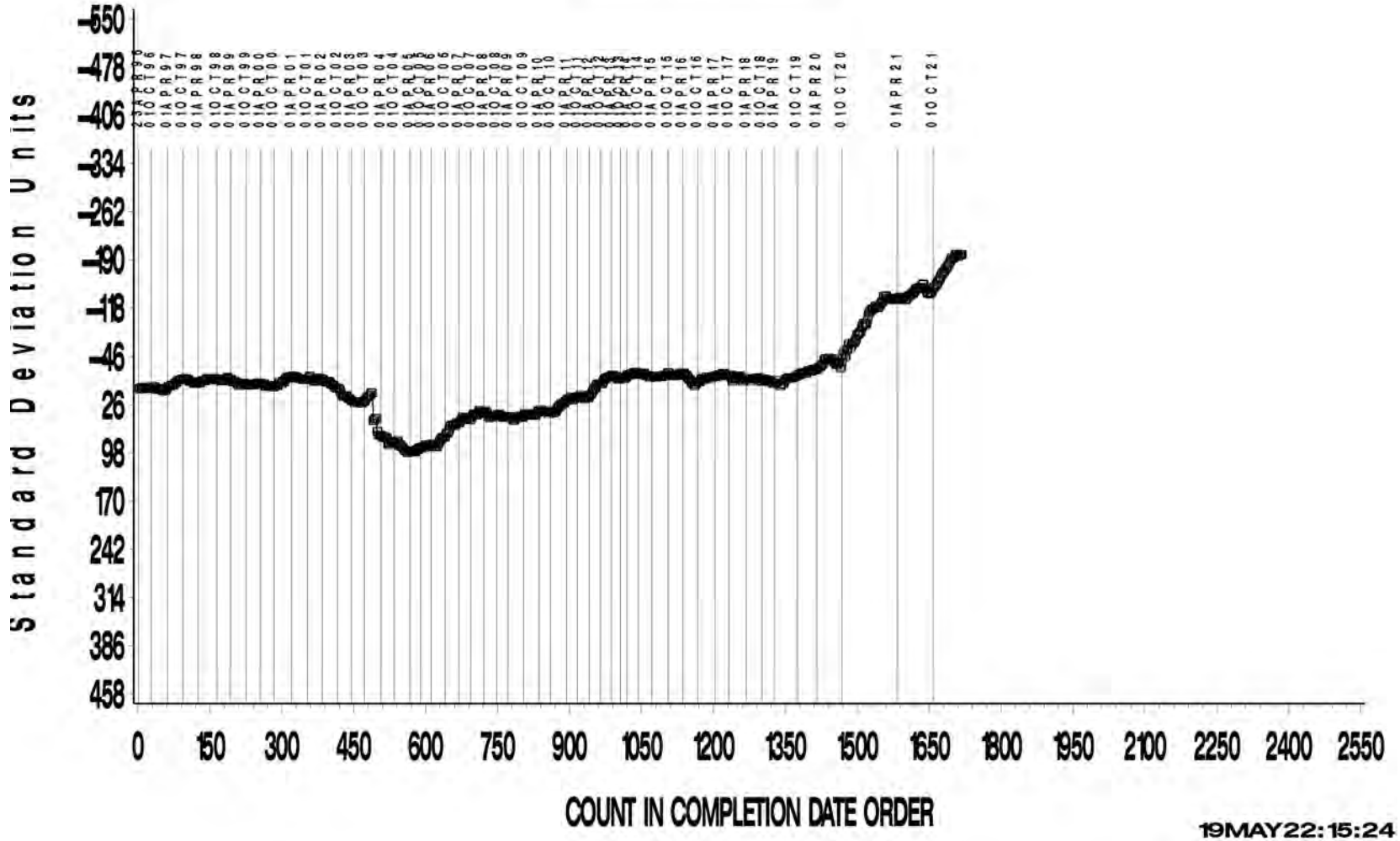
D5133: Gelation Index

- Fail rate of operationally valid tests is 12.3% this period
  - Compared to 12% fail rate last period
  - Fail rate of (new) discrimination runs reported as operationally valid was also 2%
  - Historic period fail rates have ranged between 6% and 26%
- Precision (Pooled s) is slightly more precise than last period
  - Comparable to updated target precision
- Performance (Mean Δ/s) is -0.84 s mild
  - ALL Five labs reporting data were mild of target
- A round robin is underway to evaluate a calibration oil that performs closer to the GF-5/6 pass/fail limit of 12 GI
  - To replace oil 58 that was reclassified as a discrimination oil

D5133 GELATION INDEX INDUSTRY OPERATIONALLY VALID

GELATION INDEX

CUSUM Severity Analysis



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D5133 GELATION INDEX INDUSTRY OPERATIONALLY VALID DATA

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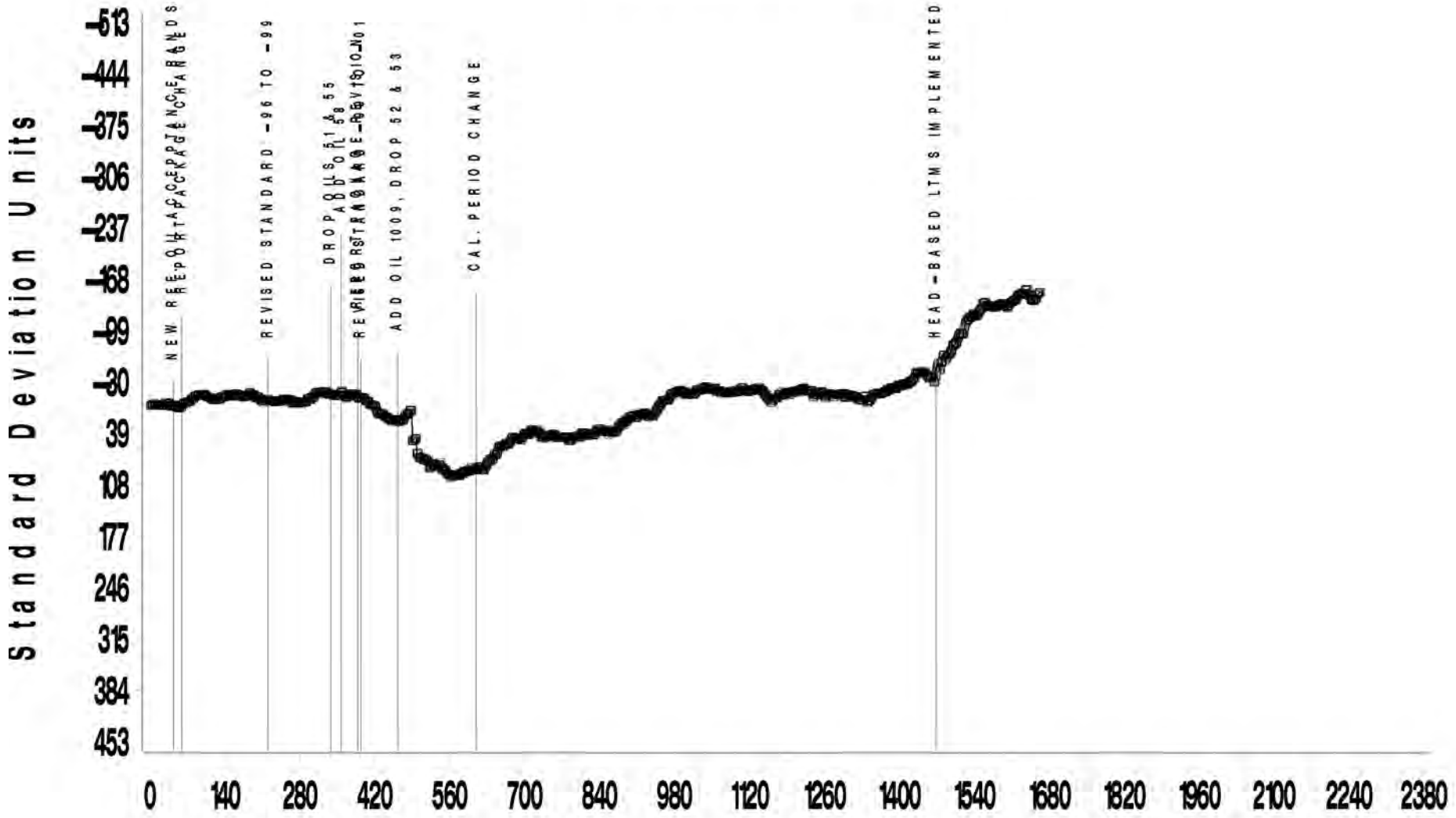
GELATION INDEX

CUSUM Severity Analysis



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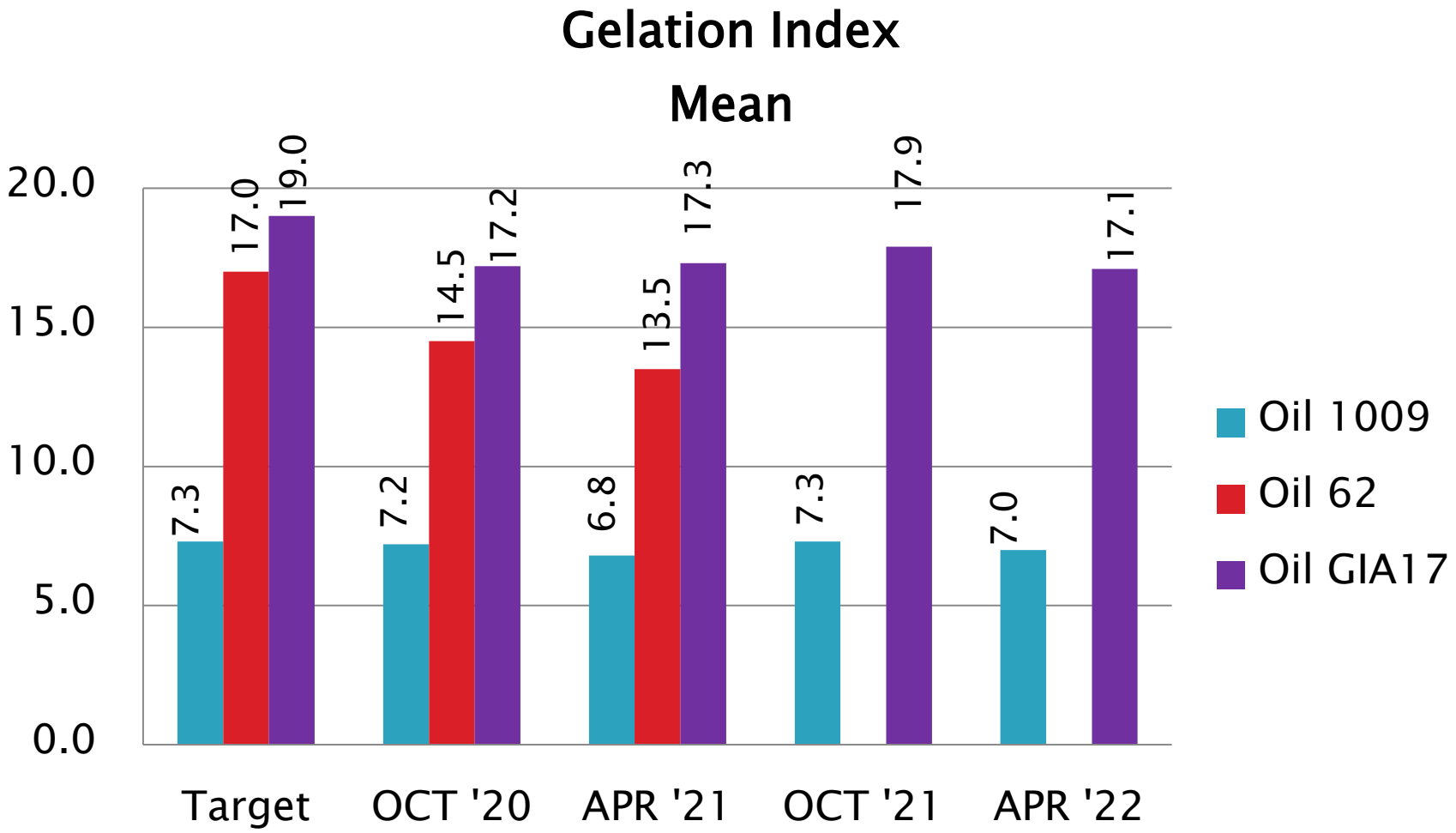
D5133 Performance by Oil



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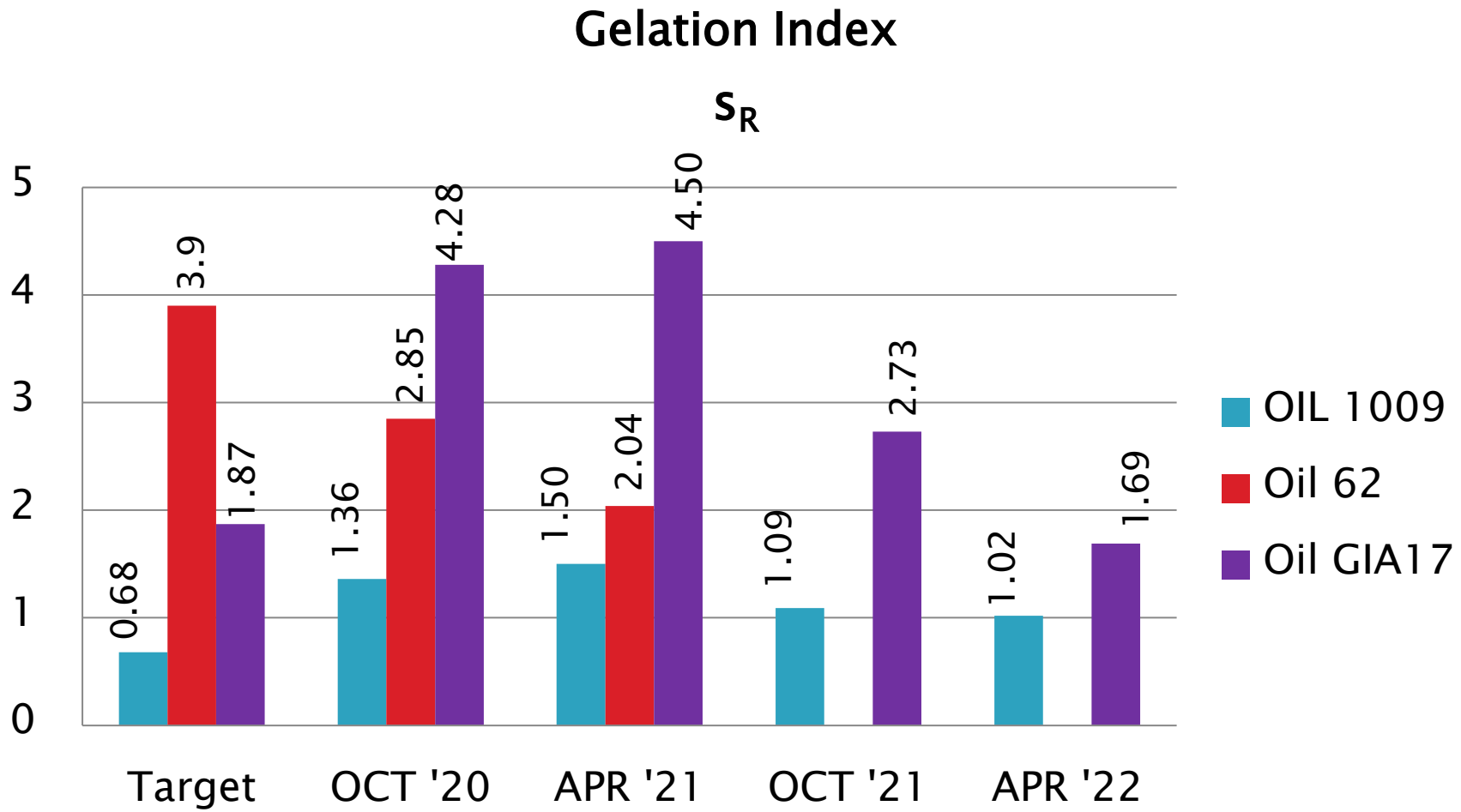
D5133 Performance by Oil



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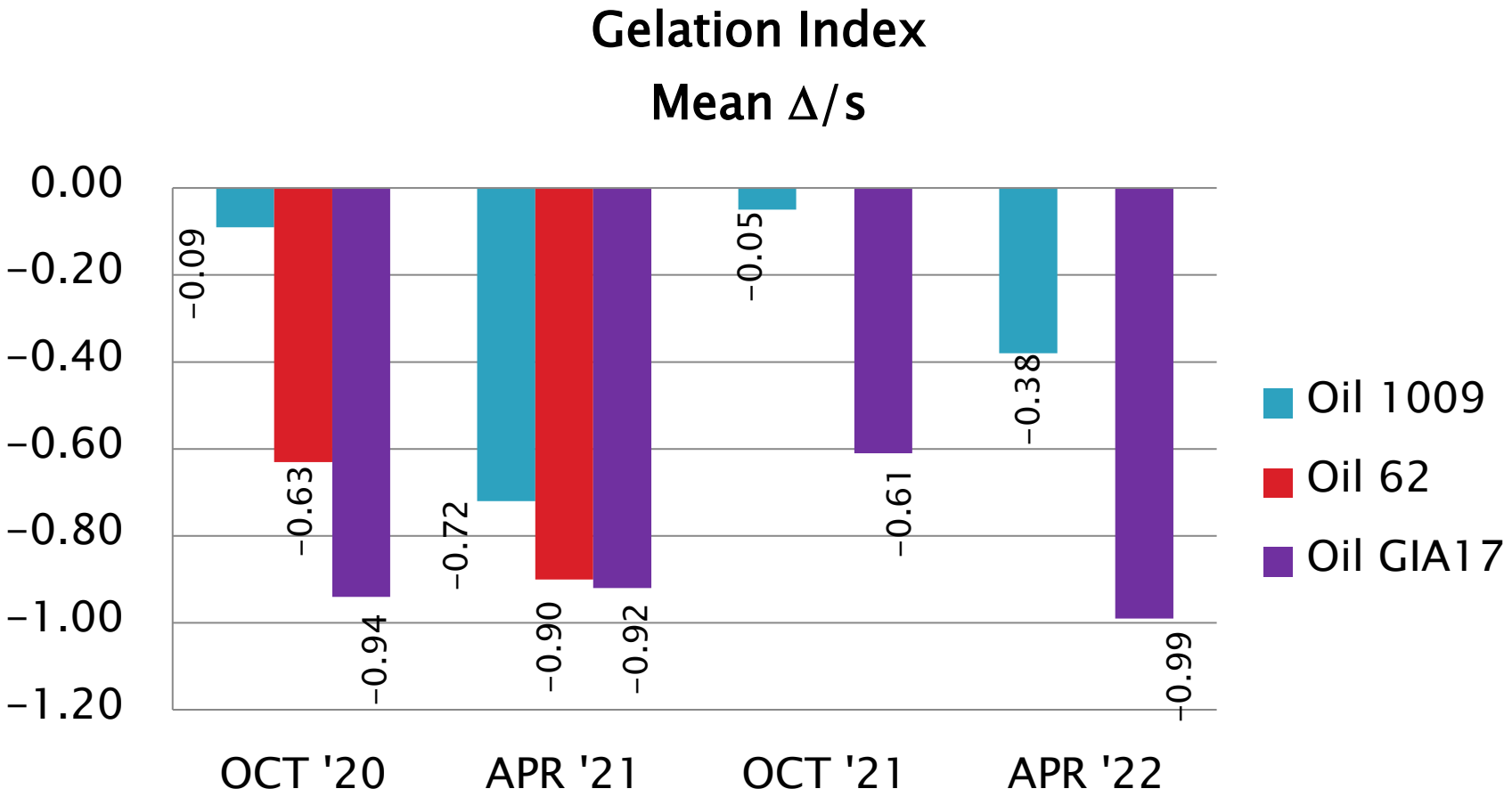
D5133 Performance by Oil



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D6335: Deposits by TEOST-33C

Test Status	Validity Code	No. Tests
Acceptable Calibration Test	AC	25
Failed Calibration Test	OC	2
Operationally Invalidated by Lab	LC, XC	2
Total		**29**

Number of Labs Reporting Data: 8
Fail Rate of Operationally Valid Tests: 7%

D6335: Deposits by TEOST-33C

Statistically Unacceptable Tests (OC)	No. Of Tests
Total Deposits Severe	2

- The two statistically unacceptable results this period were multiple fails on one stand (stand G4, both severe).
- There were two operationally invalid tests reported this period:
  - Incorrect Thermocouple insertion depth in reaction chamber (one test, LC)
  - Test sample ran on incorrect instrument (one test, LC)
- TMC Memo 21-044 issued November 3, 2021, updating targets for reference oil 75-1.

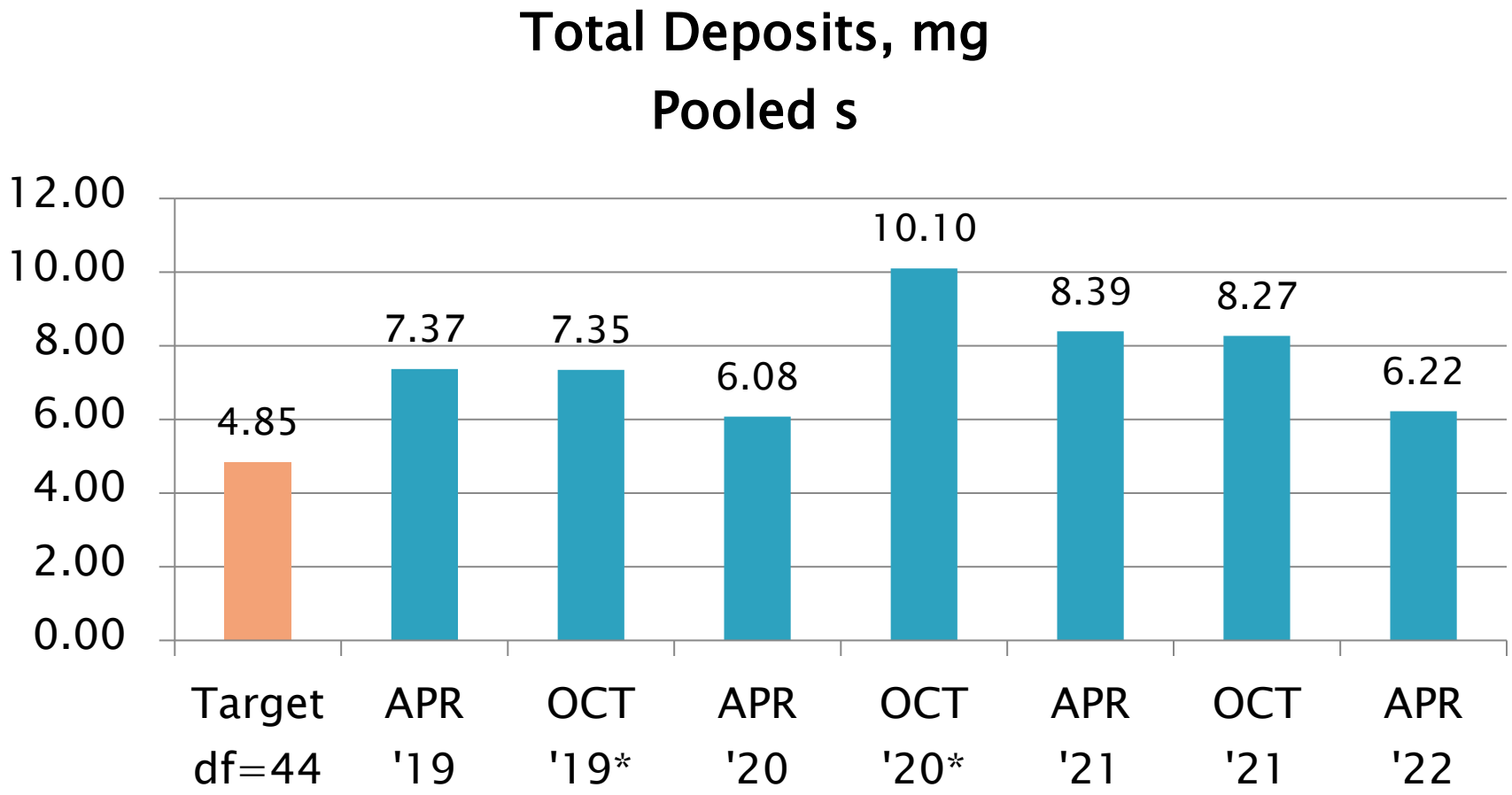
D6335: Deposits by TEOST-33C

Period Precision and Severity Estimates

Total Deposits, mg	n	df	Pooled s	Mean Δ/s
Updated Targets 20201001[1]	46	44	4.85	-----
4/1/17 through 9/30/19[2]	30	28	12.66	0.47
4/1/17 through 9/30/19[2]	26	24	7.35	-0.23
10/1/19 through 3/31/20	32	30	6.08	0.28
4/1/20 through 9/30/20[3]	33	30	11.44	0.02
4/1/20 through 9/30/20[3]	26	23	10.10	-0.02
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

[1]Target precision updated to include only current oils 75-1 and 435-2
[2]Four consecutive OC results on same rig included and excluded.
[3]Rig with six OC results included and excluded.

D6335 Precision Estimates



*Multiple OC results from single excessively failing rig excluded.

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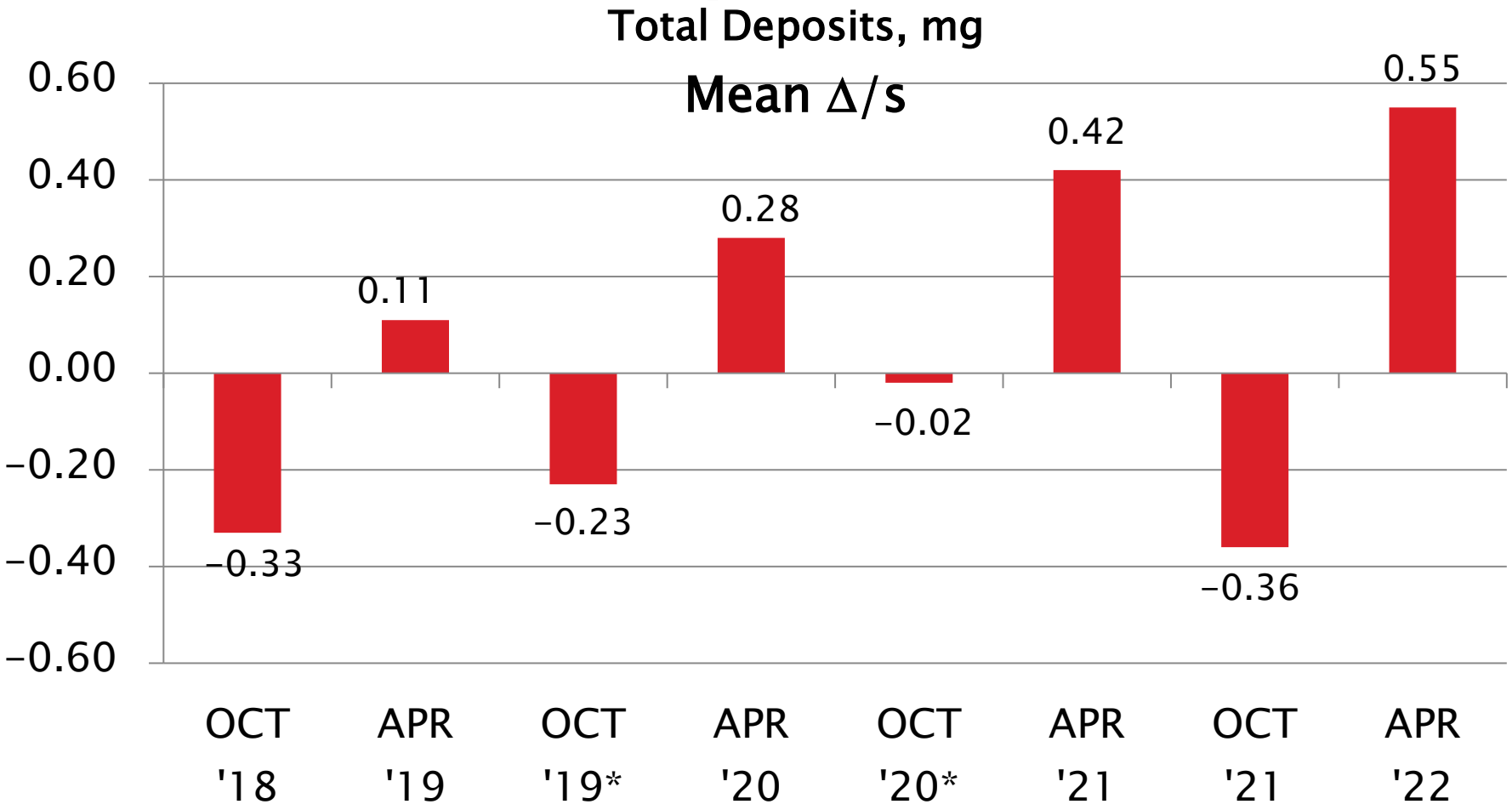
D6335 Severity Estimates



*Multiple OC results from single excessively failing rig excluded.

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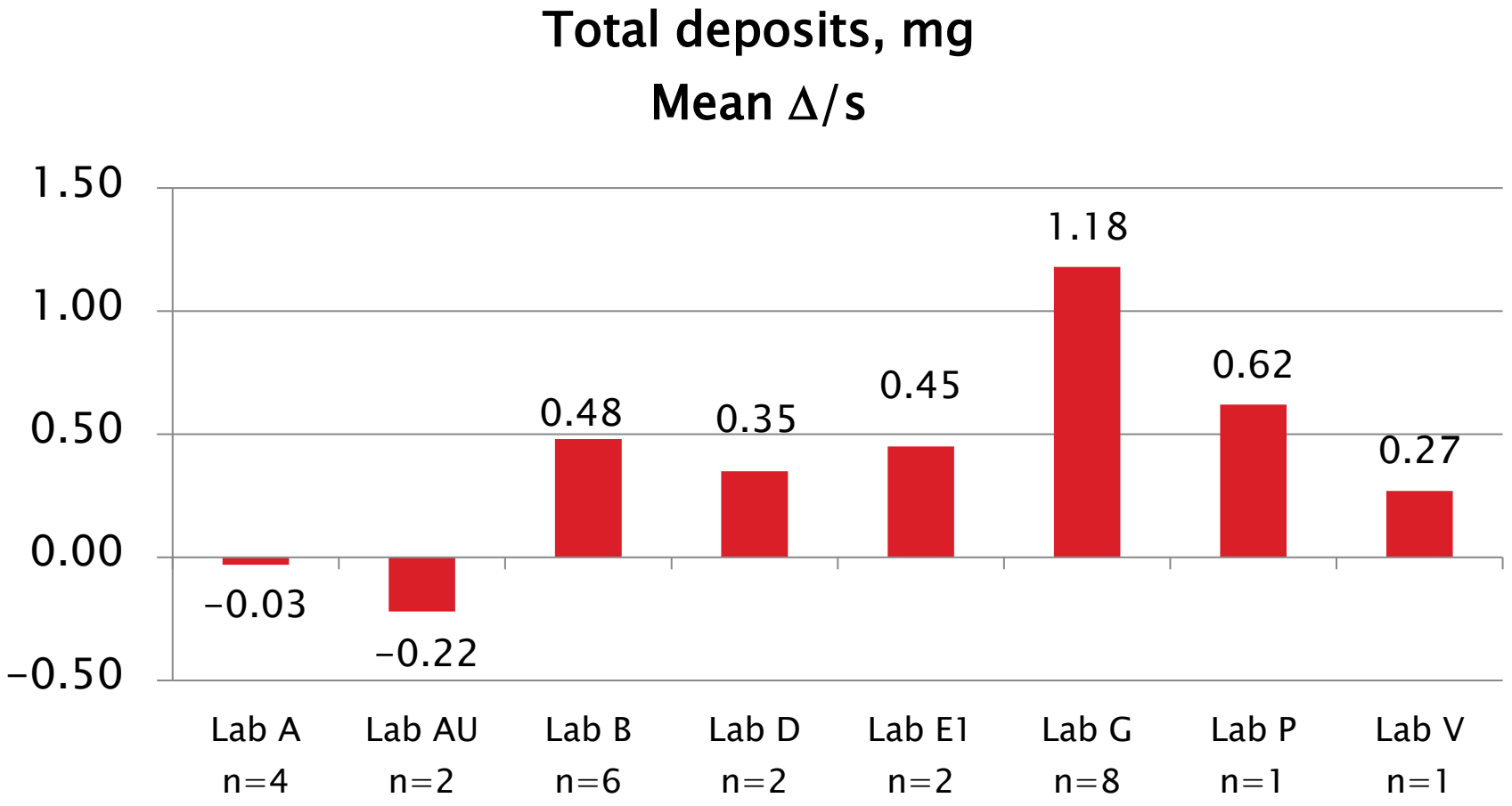
D6335 Lab Severity Estimates



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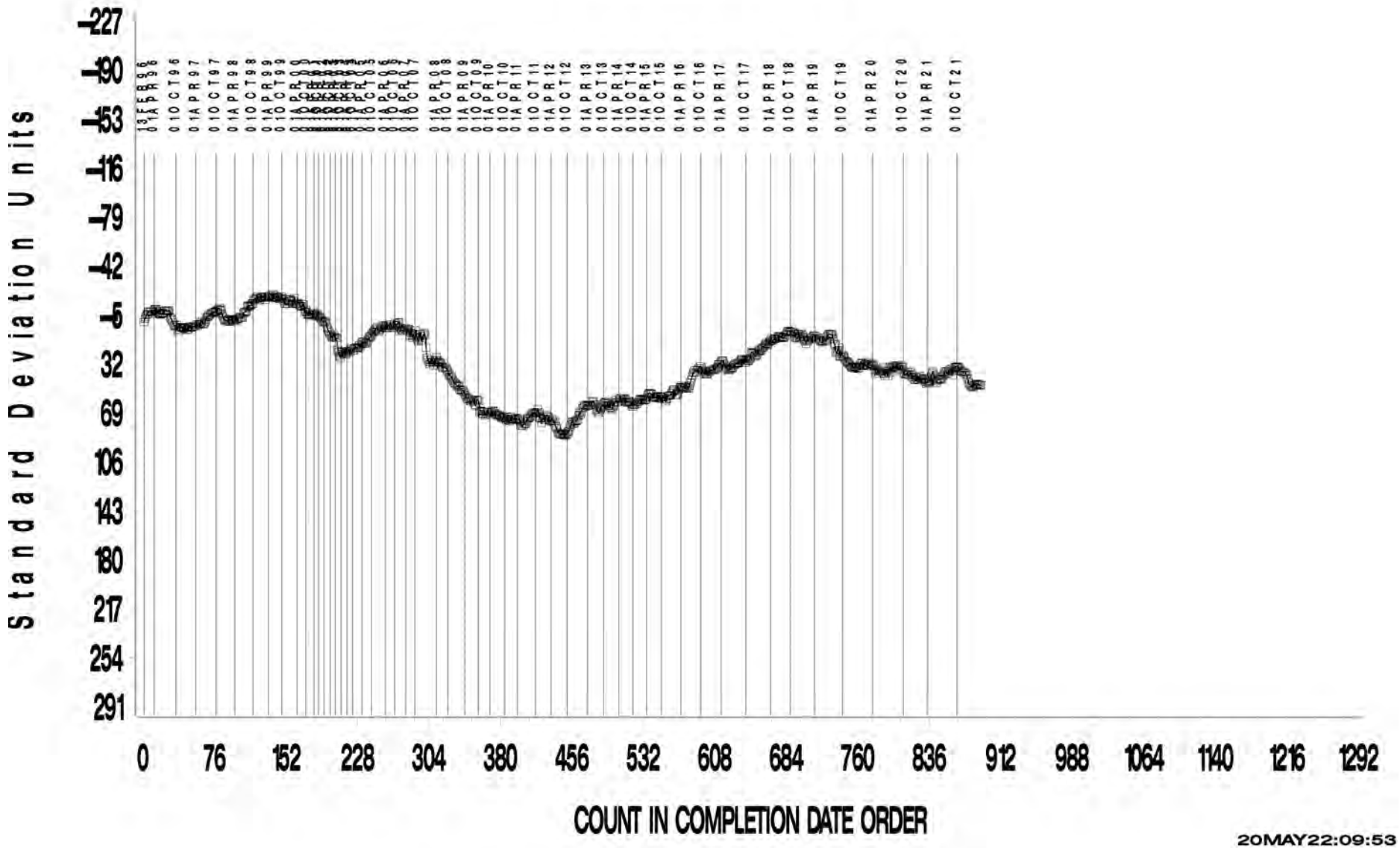
D6335: Deposits by TEOST-33C

- Precision (Pooled s) is directionally better when compared to the previous period but appears to be more imprecise compared to historical rates
  - Less precise than target precision
    - ere were no tests reported using oil 75; oil is nearly used up, one test remains in a low activity laboratory
- Performance (Mean Δ/s) is 0.55 s severe this period (compared to -0.36 s mild last period)
- Period fail rate of 7% on tests reported as operationally valid
  - Fail rate is much lower when compared to recent report periods.
- All tests this period report using Rod Batch M or N.

TEOST –33C INDUSTRY OPERATIONALLY VALID DATA

TOTAL DEPOSITS MG

CUSUM Severity Analysis

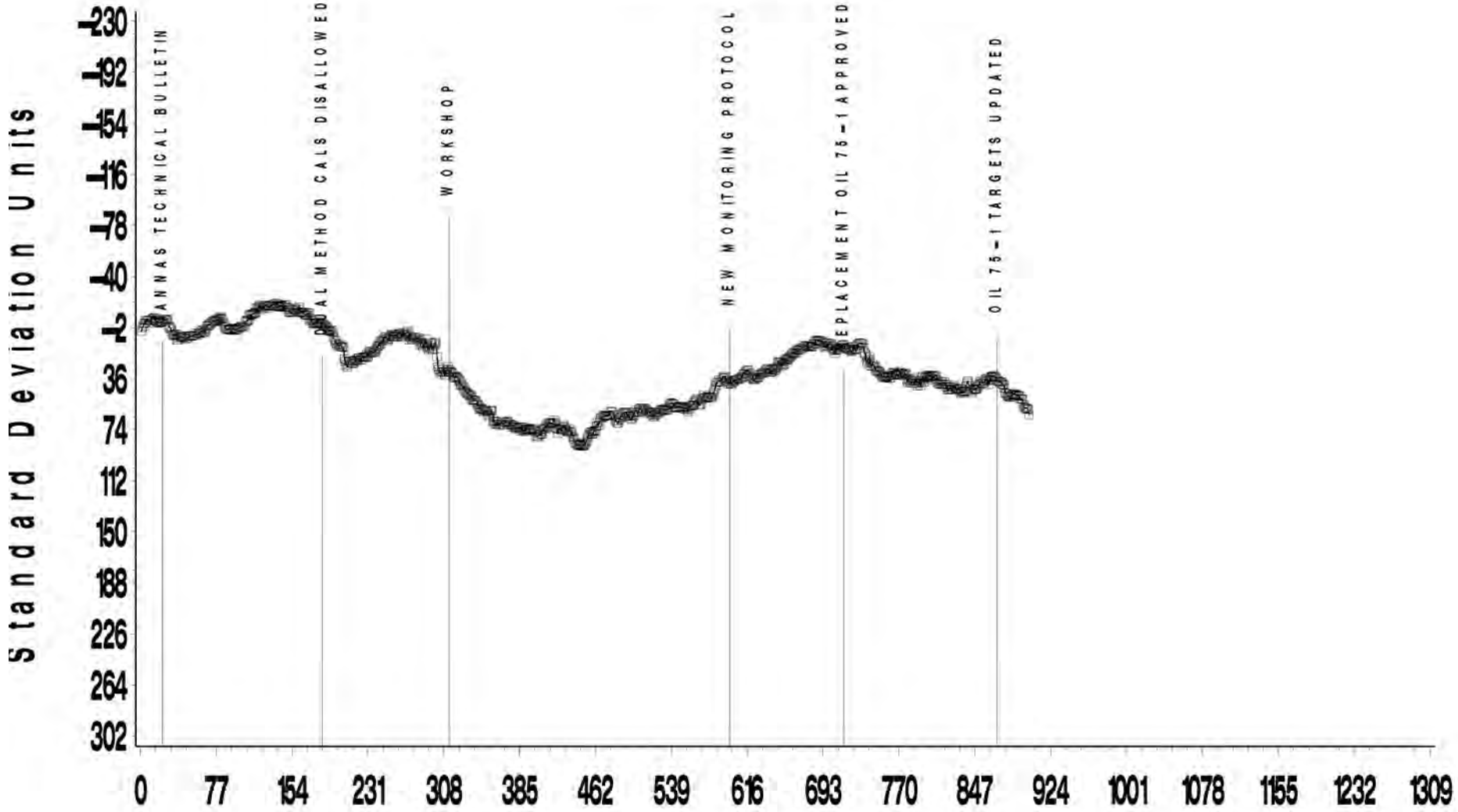


20MAY22:09:53

TEOST –33C INDUSTRY OPERATIONALLY VALID DATA

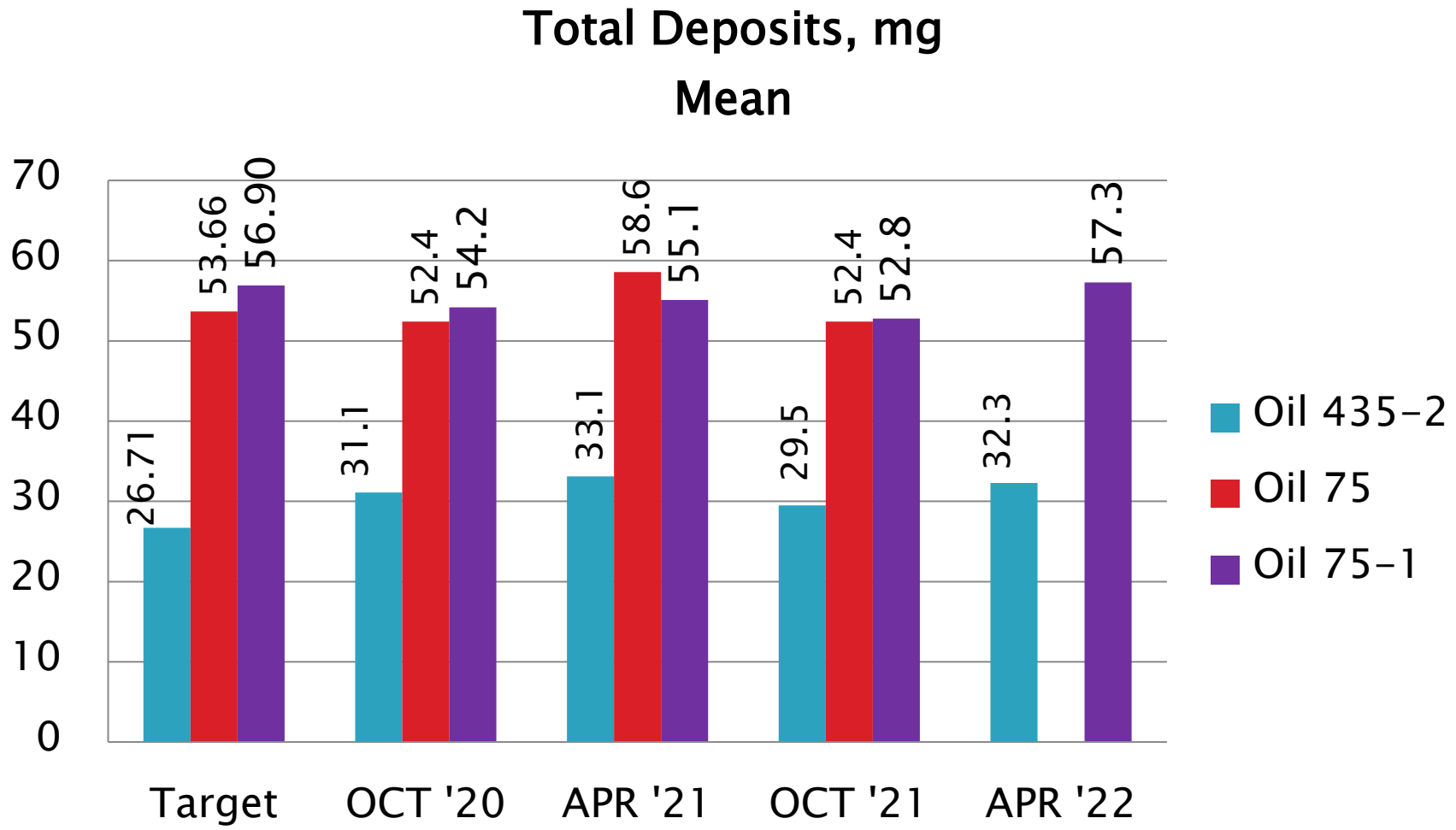
TOTAL DEPOSITS MG

CUSUM Severity Analysis



30MAY22:19:47

D6335 Performance by Oil



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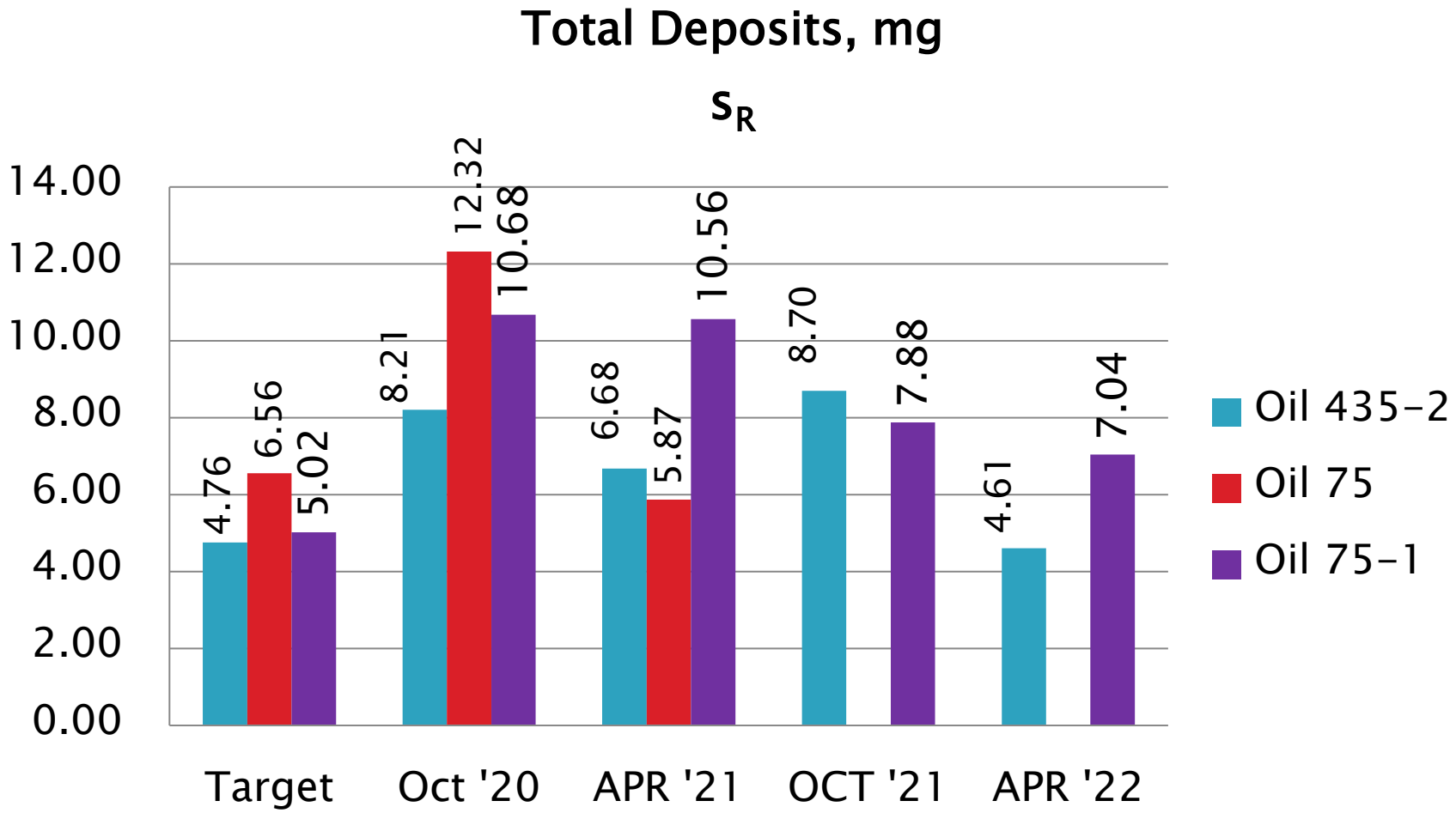
D6335 Performance by Oil



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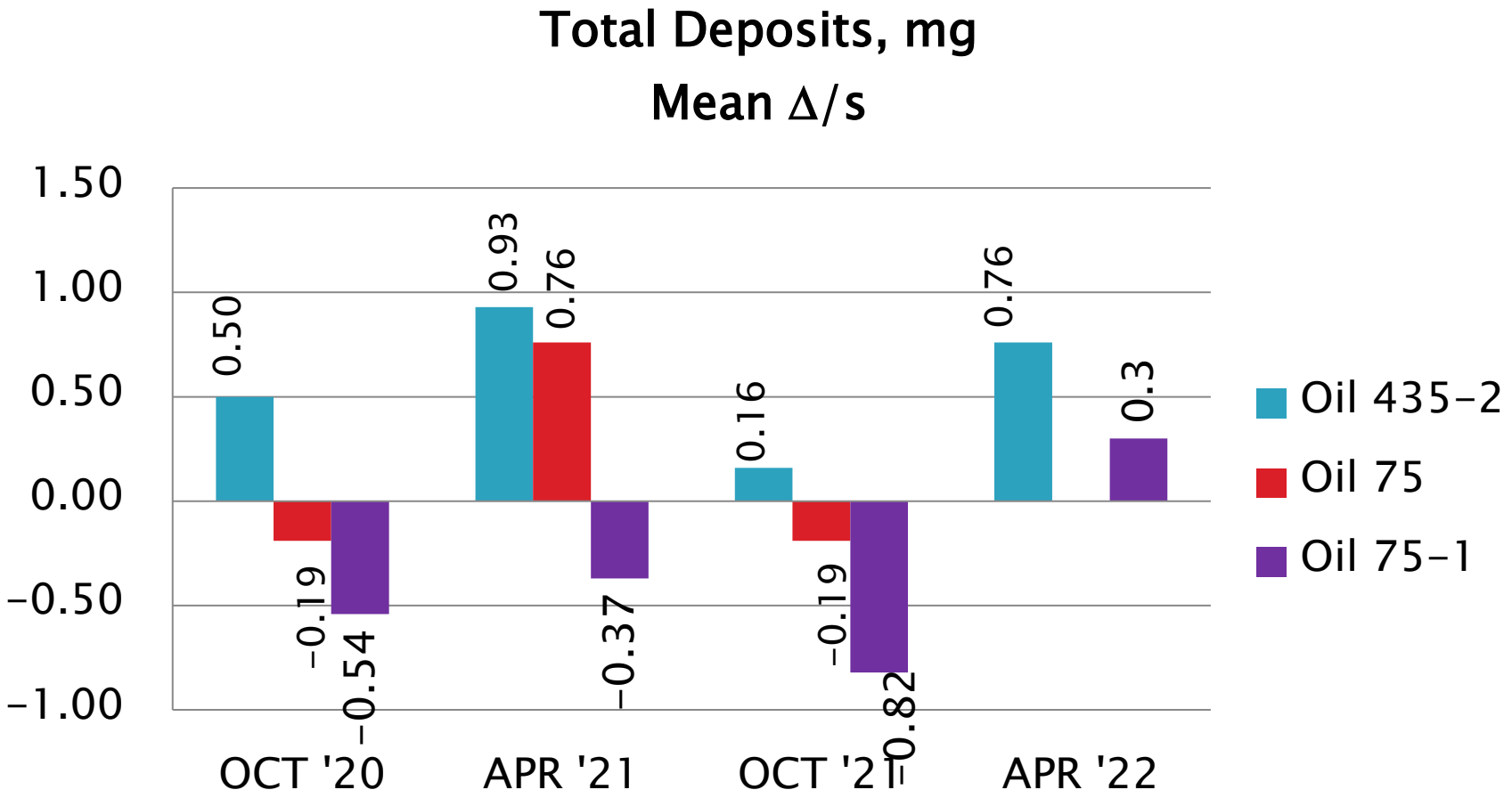
D6335 Performance by Oil



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D7097: Deposits by MHT TEOST

Test Status	Validity Code	No. Tests
Acceptable Calibration Test	AC	66
Failed Calibration Test	OC	9
Operationally Invalidated by Lab	LC	11
Operationally Invalidated After Initially Reported as Valid	RC	2
Instrument Shakedown Run	NI	2
Total		**90**

Number of Labs Reporting Data: 8
Fail Rate of Operationally Valid Tests: 14%

D7097: Deposits by MHT TEOST

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

D7097: Deposits by MHT TEOST Summary of Invalid Tests

Operationally Invalid Tests	Validity Code	No. Of Tests
Air Off During Test	LC	4
Measurement Error, Total Rod Weight Switched	LC	1
Improper Set Up	LC	1
Air Flow Failed	LC	2
Feed Tube Failure	LC	1
Catalyst Weight ratio incorrect	LC	2
Sample Weight and Catalyst weight incorrect	RC	2

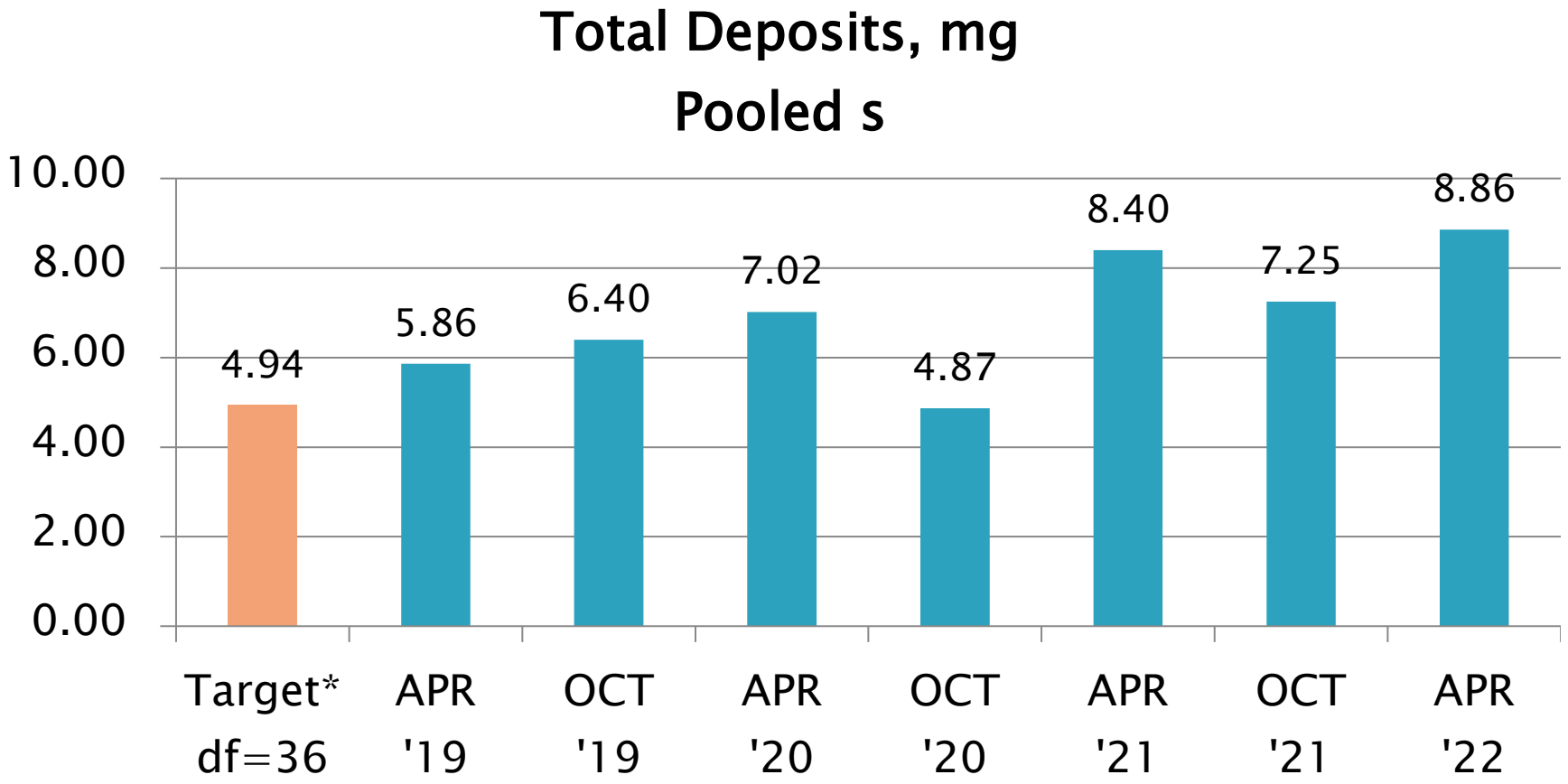
D7097: Deposits by MHT TEOST

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	-----
10/1/18 through 3/31/19	97	95	5.86	-0.14
4/1/19 through 9/30/19	109	107	6.40	-0.30
10/1/19 through 3/31/20	103	101	7.02	-0.02
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

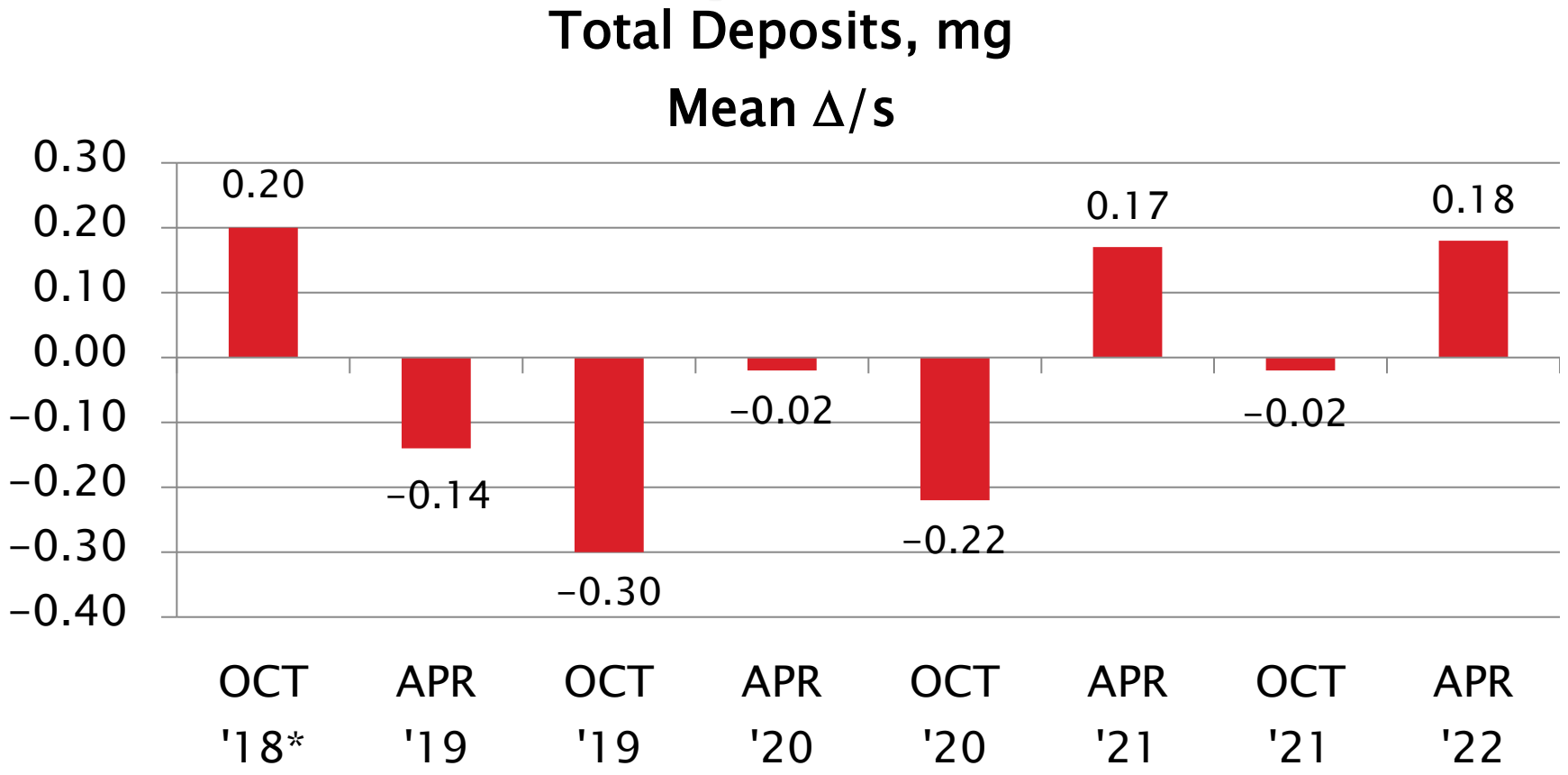
[1]Target precision updated to reference oils 432 and 434-3 preliminary

D7097 Precision Estimates



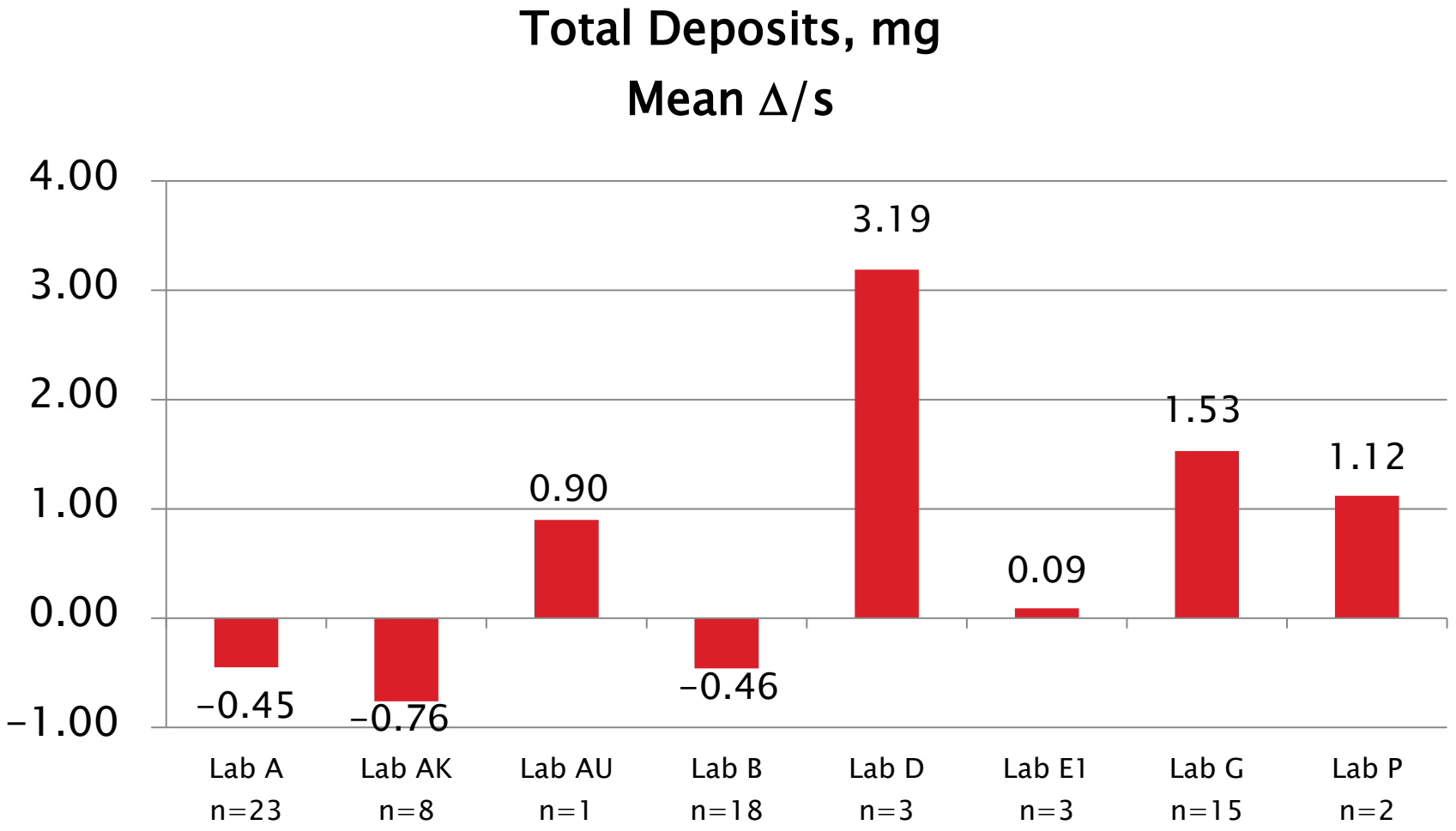
*Target precision updated to reference oils 432 and 434-3 preliminary
**One severe OC test from instrument G5 excluded (8.9 s)

D7097 Severity Estimates



*One severe OC test from instrument G5 excluded (8.9 s)

D7097 Lab Severity Estimates



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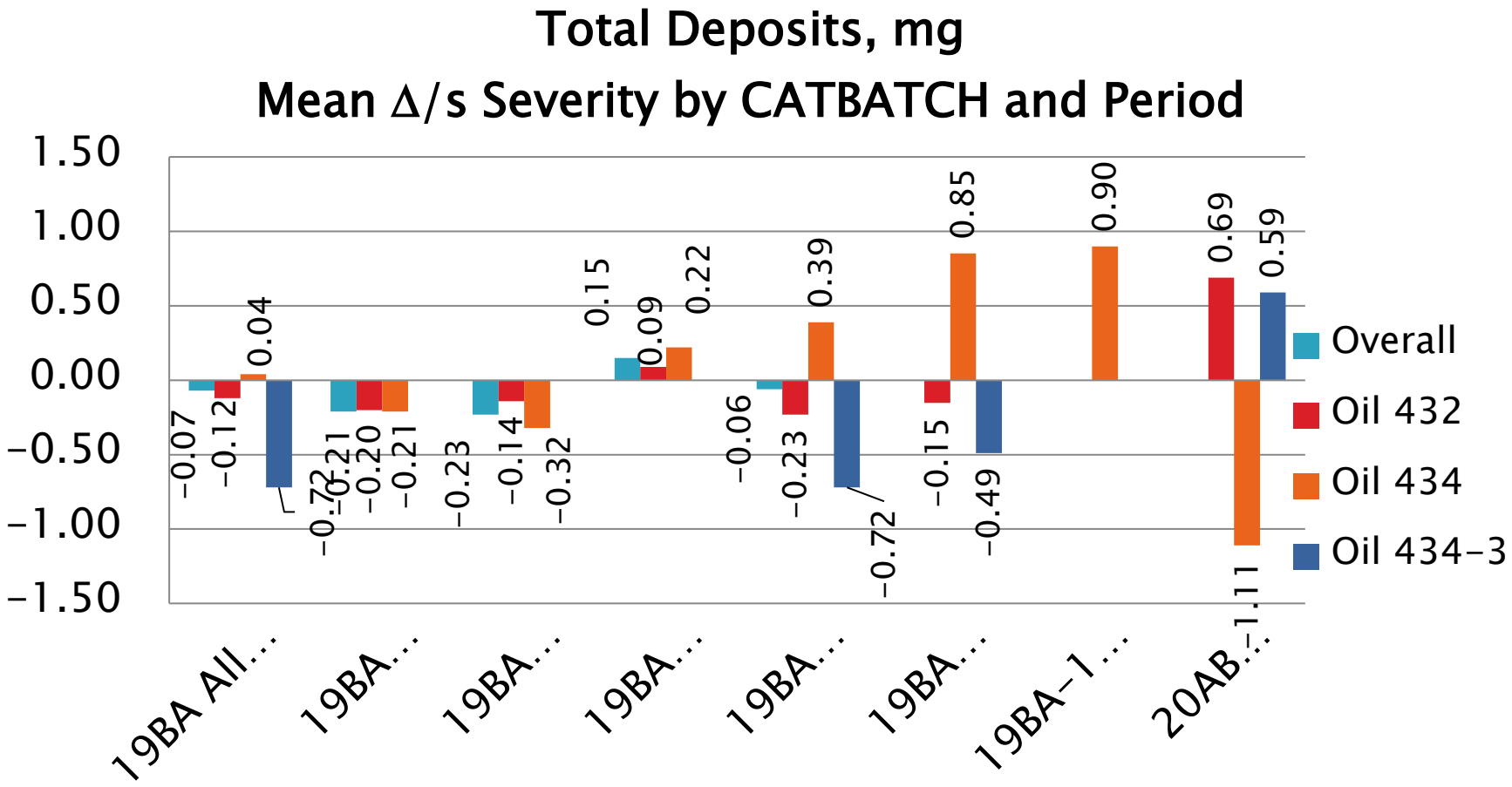
D7097: Deposits by MHT TEOST



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D7097: Deposits by MHT TEOST

- Precision (Pooled s) has continued to degrade precise for the past three report periods
  - Significantly less precise than prior or updated target precision
- Performance (Mean Δ/s) is slightly severe (-0.18 s)
- All operationally valid tests this period report using Rod Batches M or N (new).
- All operationally valid calibration tests this period report using Catalyst Batch 1 19BA (n=46) 19BA-1 (n=1) or 20AB (n=28)
- Overall severity on catalyst batch 19BA (n=217) appears to be on-target, and on target for oils 432 and 434.
  - Replacement oil 434-3 introduced this period, running -0.72 s mild (n=10).

MHT—4 TEOST INDUSTRY OPERATIONALLY VALID DATA

TOTAL DEPOSITS MG

CUSUM Severity Analysis

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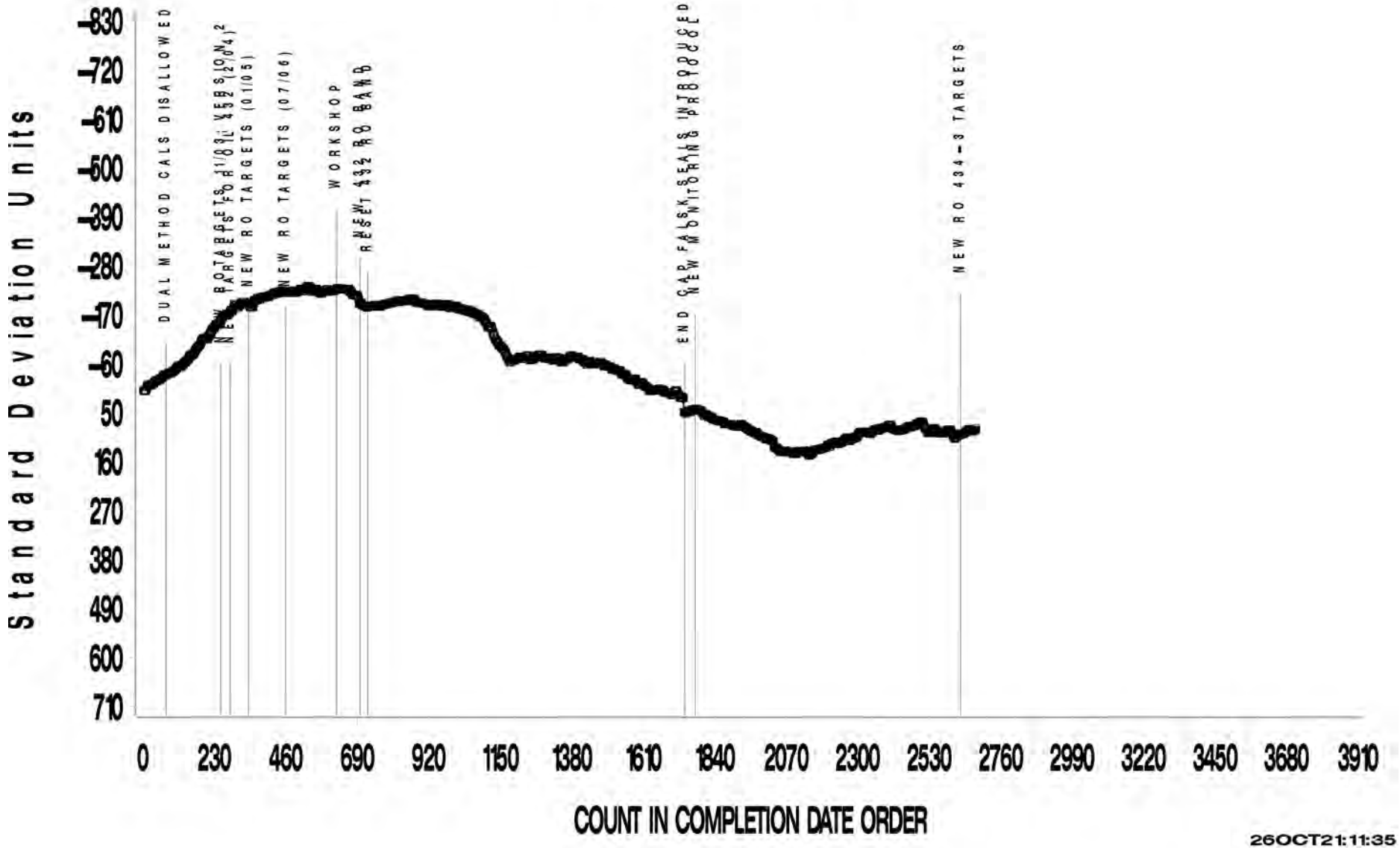
MHT –4 TEOST INDUSTRY OPERATIONALLY VALID DATA

TOTAL DEPOSITS MG

CUSUM Severity Analysis

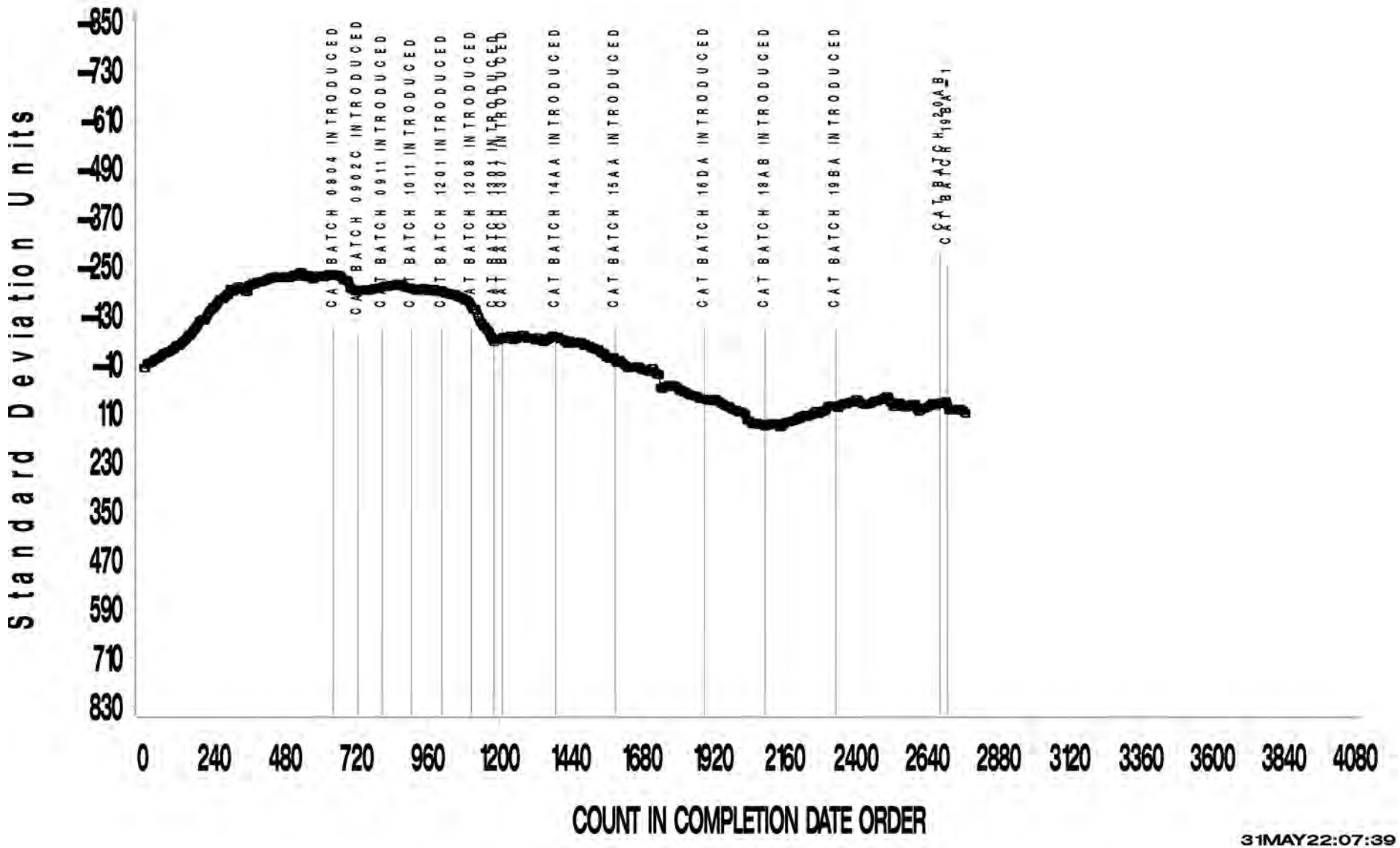


26OCT21:11:35

MHT –4 TEOST INDUSTRY OPERATIONALLY VALID DATA

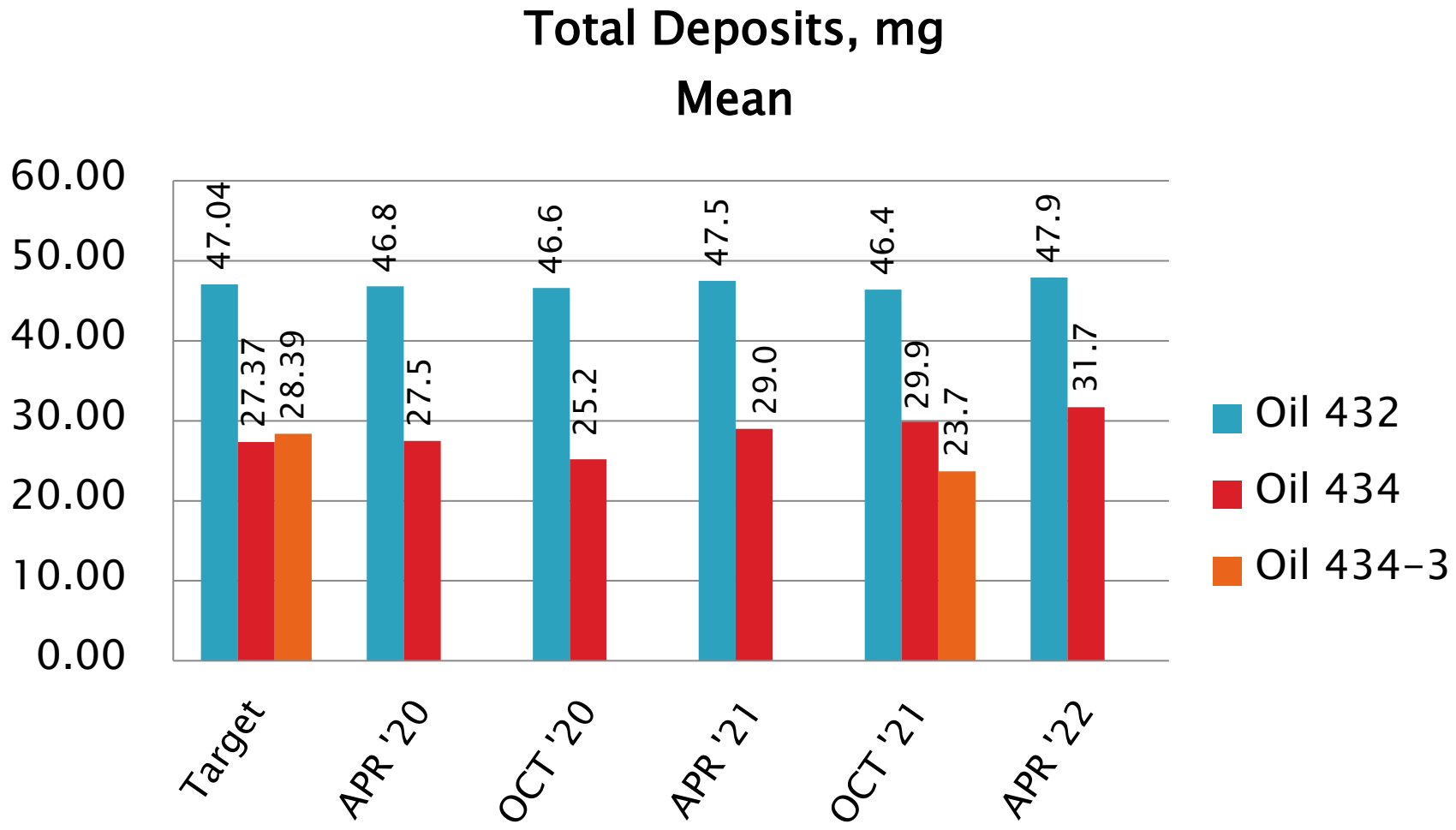
TOTAL DEPOSITS MG

CUSUM Severity Analysis

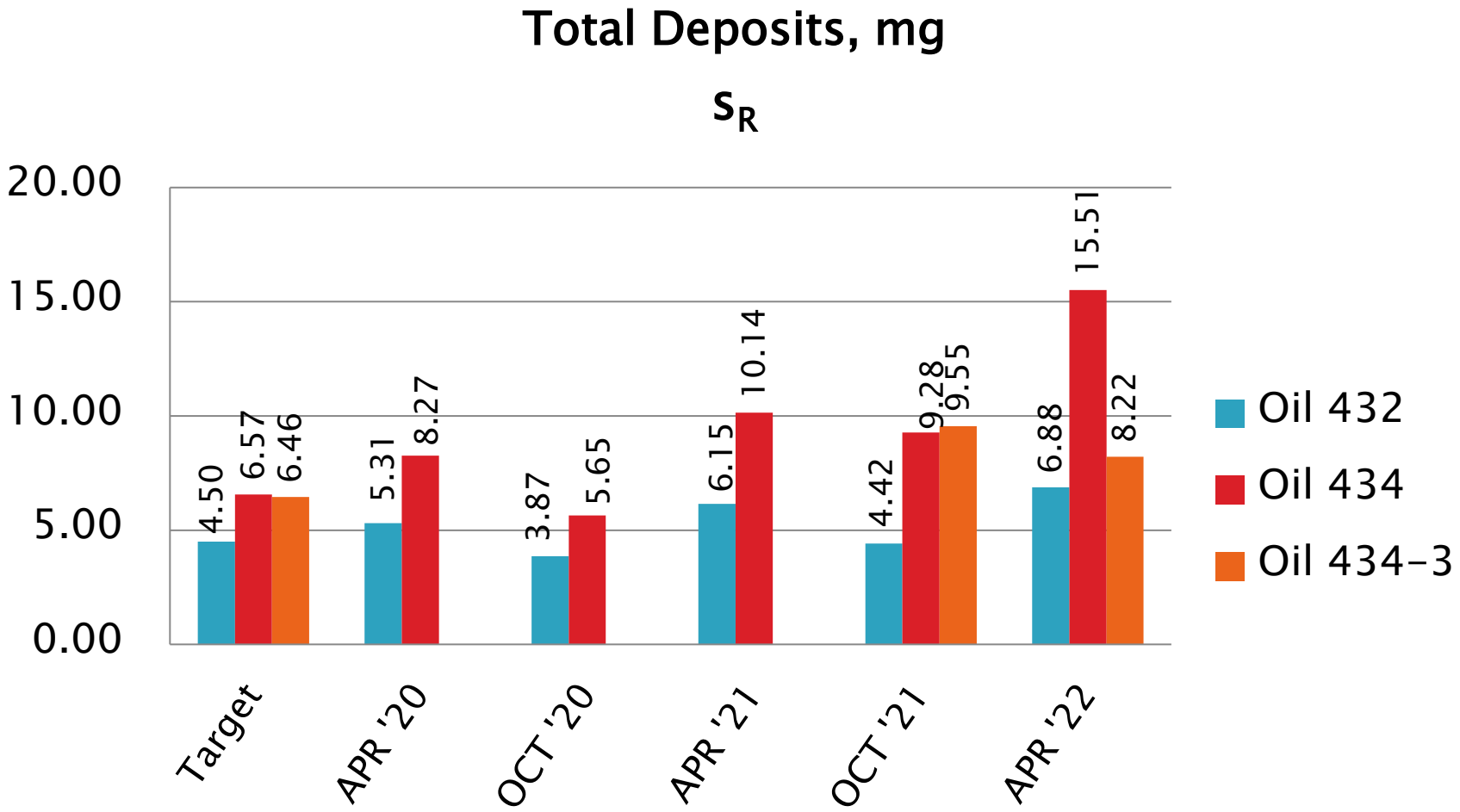


31MAY22:07:39

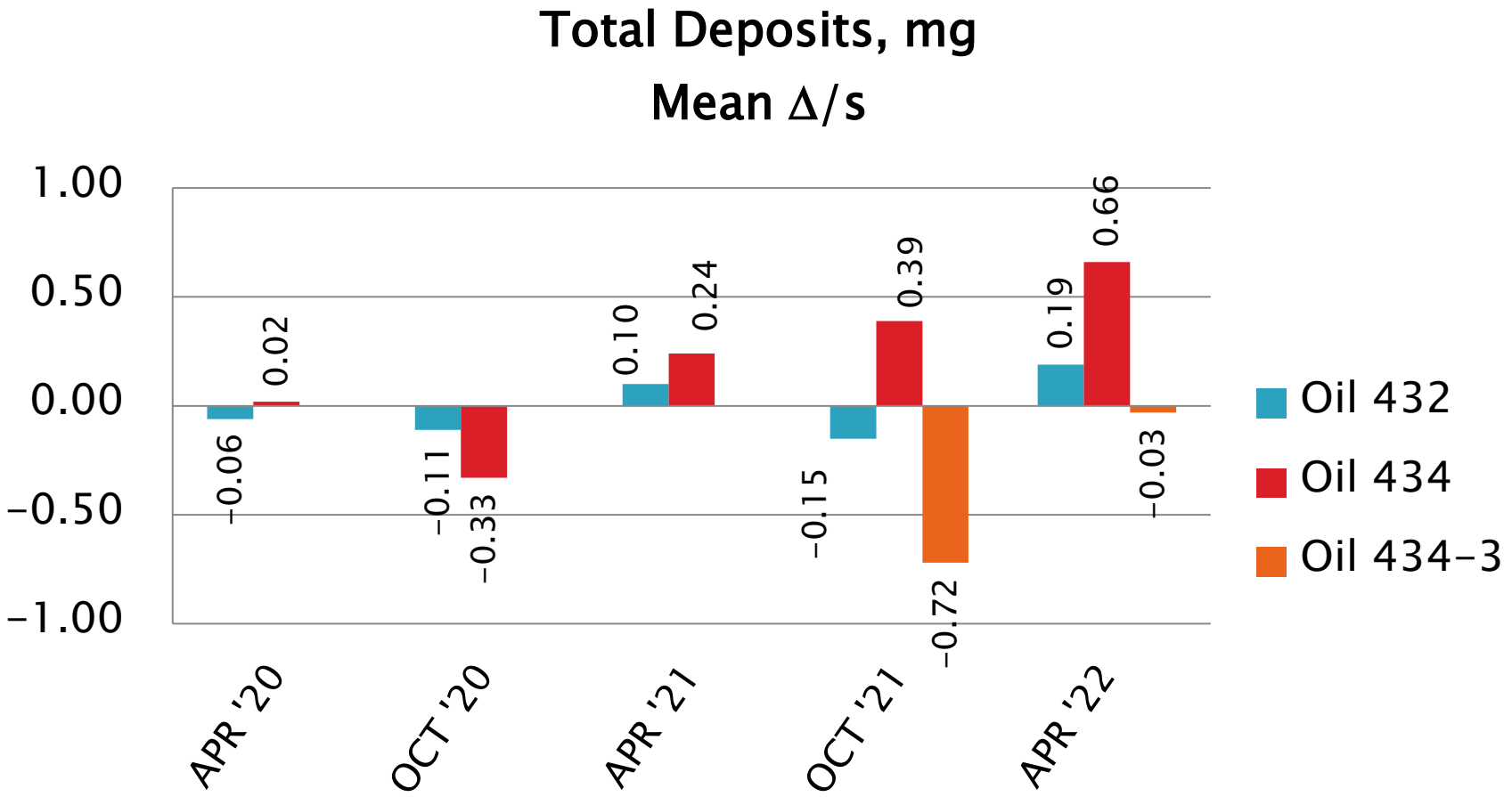
D7097 Performance by Oil



D7097: Deposits by MHT TEOST



D7097: Deposits by MHT TEOST



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D6082: High Temperature Foam

Test Status	Validity Code	No. Tests
Acceptable Calibration Test	AC	13
Acceptable Discrimination Test	AS	6
Total		**19**

Number of Labs Reporting Data: 6
Fail Rate of Operationally Valid Calibration Tests: 0%

D6082: High Temperature Foam

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

- All severe oil discrimination runs (on TMC oil 66) reported this period demonstrated acceptable discrimination.
  - Discrimination runs are not evaluated for overall period precision or severity due to poor test precision above 100 ml foam tendency.
- There were no operationally invalid or statistically unacceptable results this report period.

D6082: High Temperature Foam

Period Precision and Severity Estimates

Foam Tendency, ml	n	df	Pooled s	Mean Δ/s
Targets updated 20201001[1]	18	17	9	-----
4/1/18 through 9/30/18	14	13	9	-0.07
10/1/18 through 3/31/19	14	13	12	-0.07
4/1/19 through 9/30/19	14	12	12	-0.18
10/1/19 through 3/31/20	15	13	10	-0.23
4/1/20 through 9/30/20	13	11	8	-0.85
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

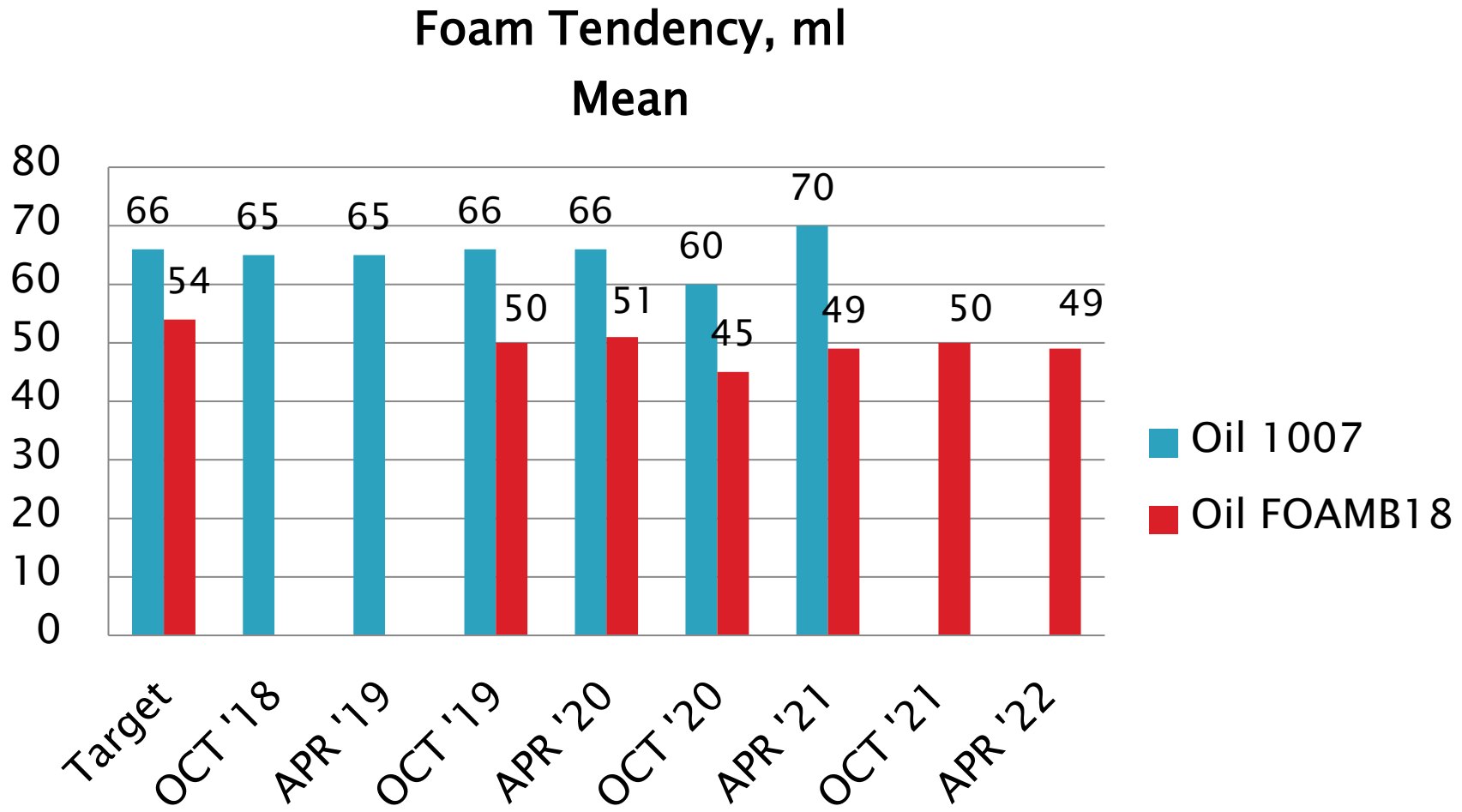
[1]Target precision updated to current reference oil FOAMB18

D6082: High Temperature Foam

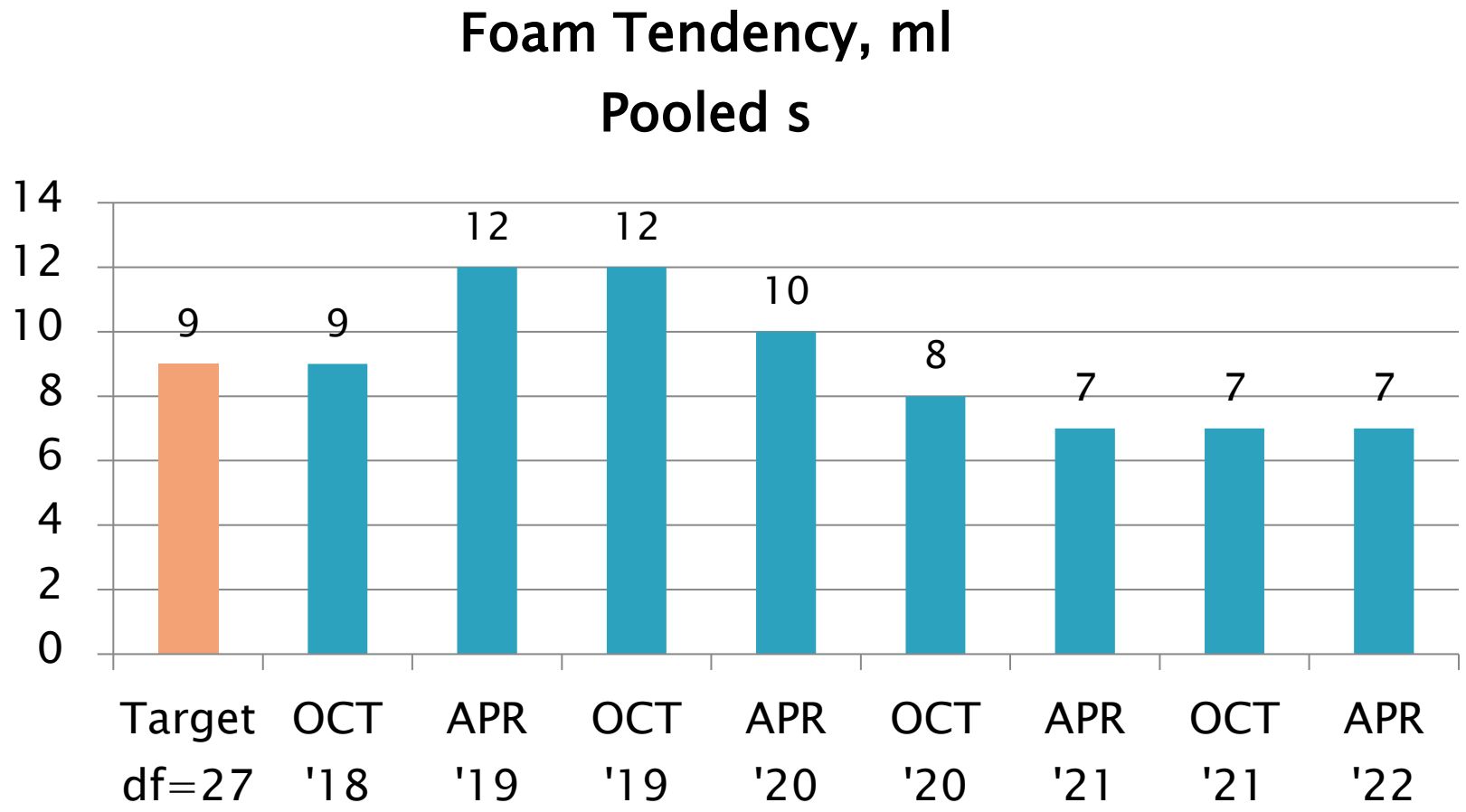
Period Precision and Severity Estimates

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

D6082 Performance by Oil



D6082: High Temperature Foam



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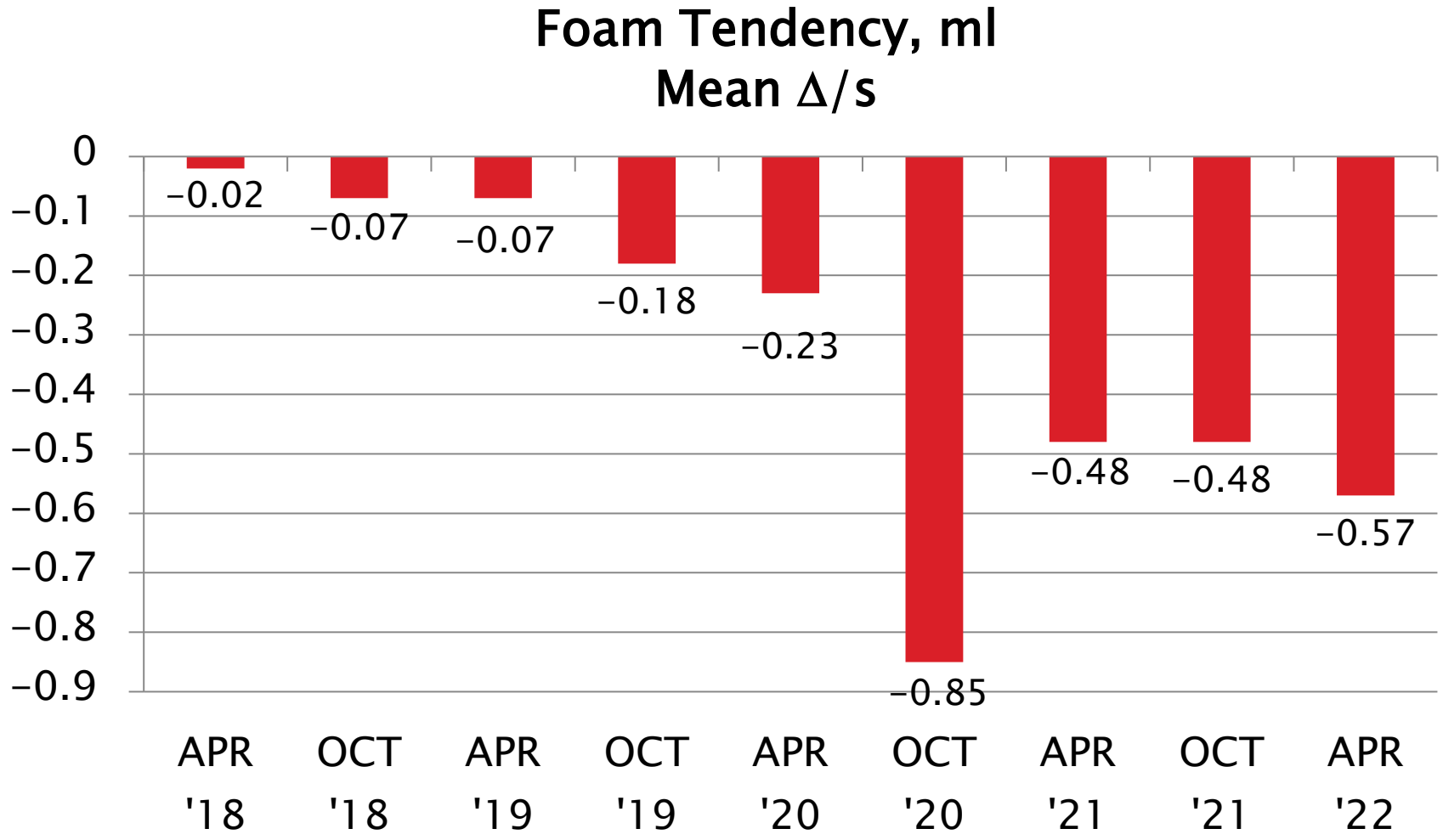
D6082: High Temperature Foam



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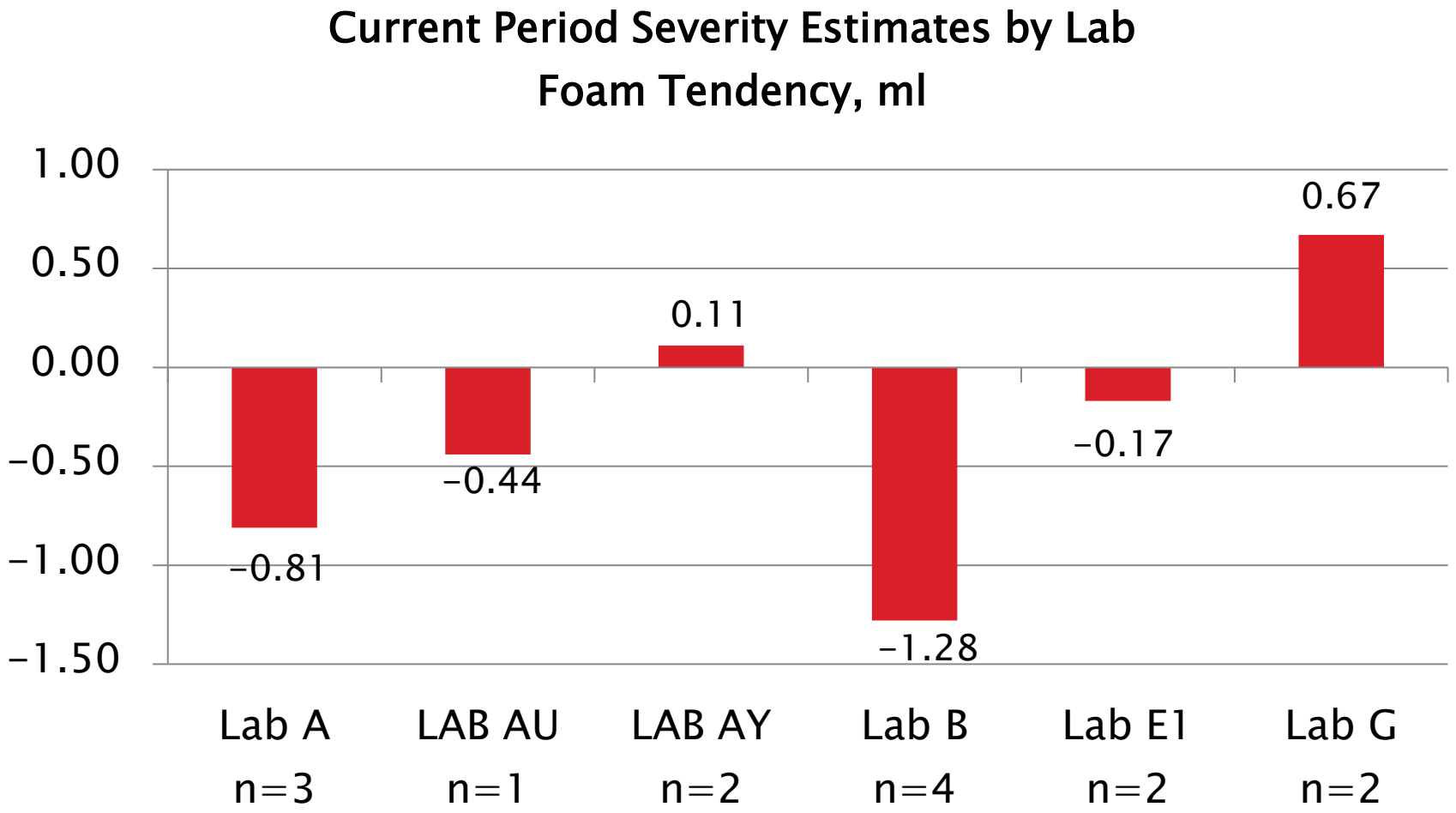
D6082: High Temperature Foam



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D6082: High Temperature Foam

- Foam Tendency Precision (Pooled s) is the same as last period
  - More precise than oil FOAMB18 target precision
    - Oil 1007 is entirely used up, 2nd report period of all reference tests on replacement oil FOAMB18 only.
- Performance (Mean Δ/s) is -0.57s mild
  - Fifth consecutive period of mild performance on FOAMB18.
    - Target performance, set on 18 runs in a RR, may need revisited.
- No non-zero occurrences of Foam Stability
- All six severe oil discrimination runs (on TMC oil 66) demonstrated acceptable discrimination on foam tendency (>100 ml).

D6082 HIGH TEMPERATURE FOAM INDUSTRY OPERATIONALLY VALID DAT

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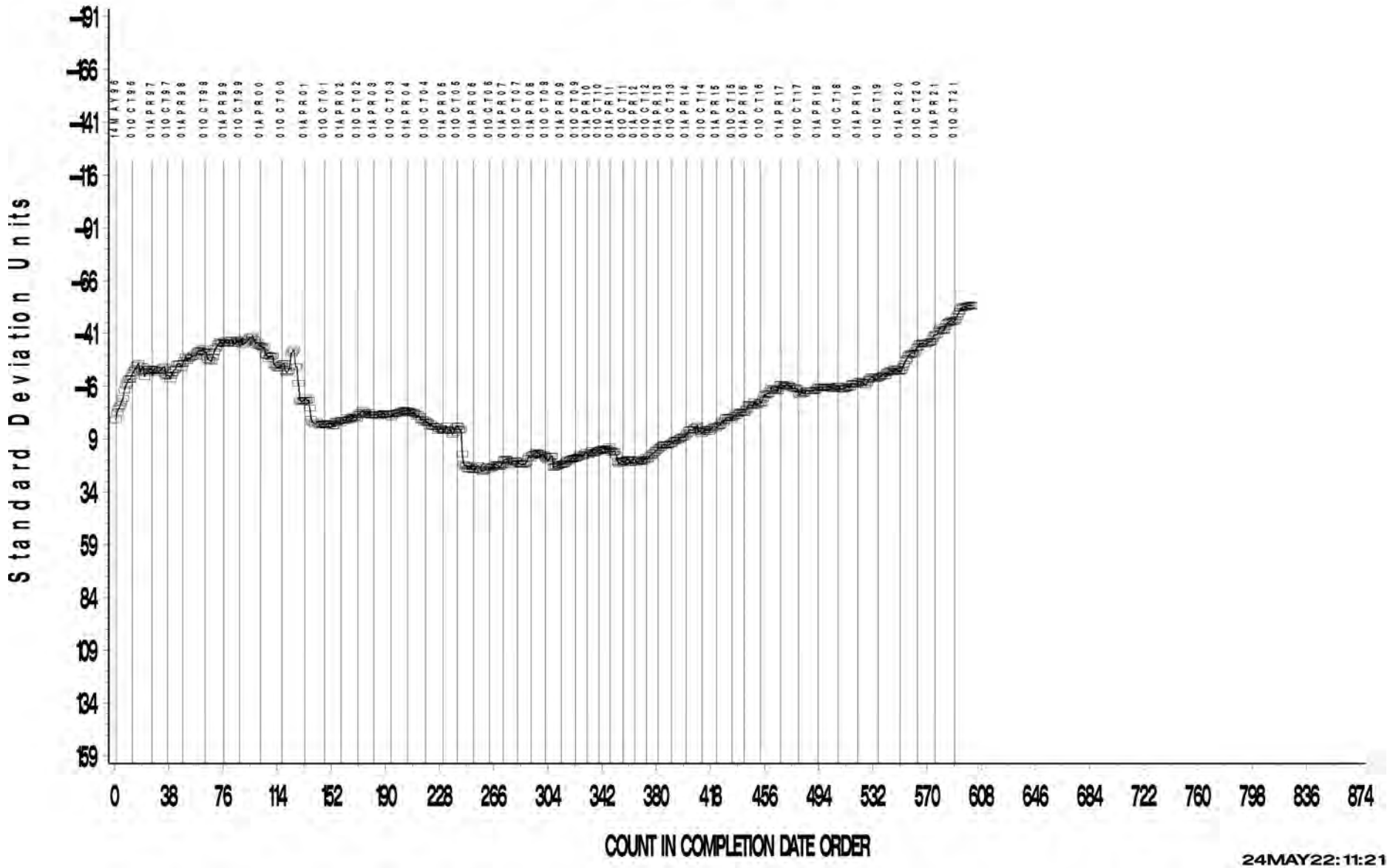
FOAM TENDENCY

CUSUM Severity Analysis



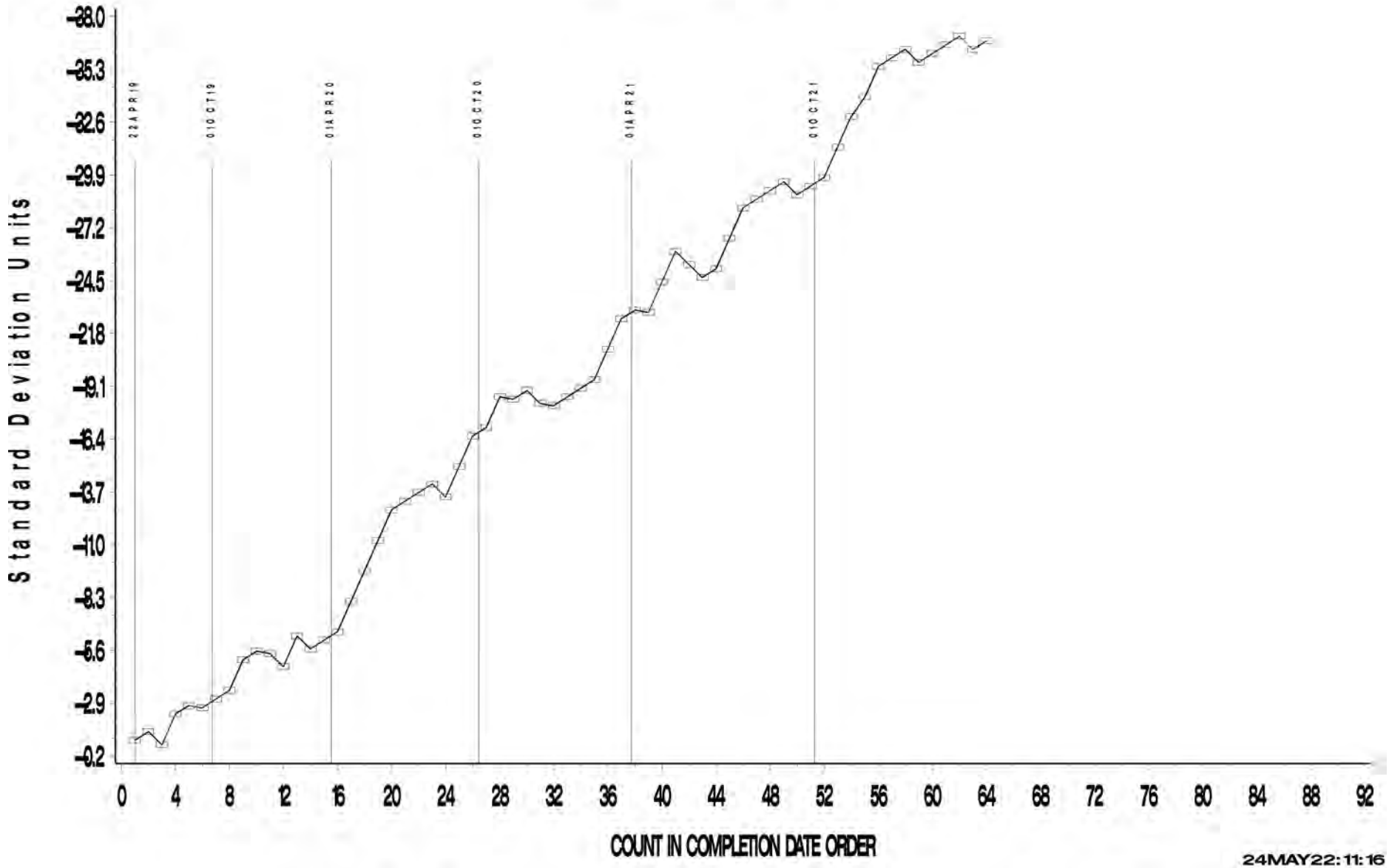
24MAY22:11:21

D6082 HIGH TEMPERATURE FOAM INDUSTRY OPERATIONALLY VALID DAT

Oil FOAMB18 ONLY

FOAM TENDENCY

CUSUM Severity Analysis



24MAY22:11:16

D874: Sulfated Ash

Test Status	Validity Code	No. Tests
Acceptable Calibration Test	AC	9
Total		**9**

Number of Labs Reporting Data: 4
Fail Rate of Operationally Valid Tests: 0%

D874: Sulfated Ash

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

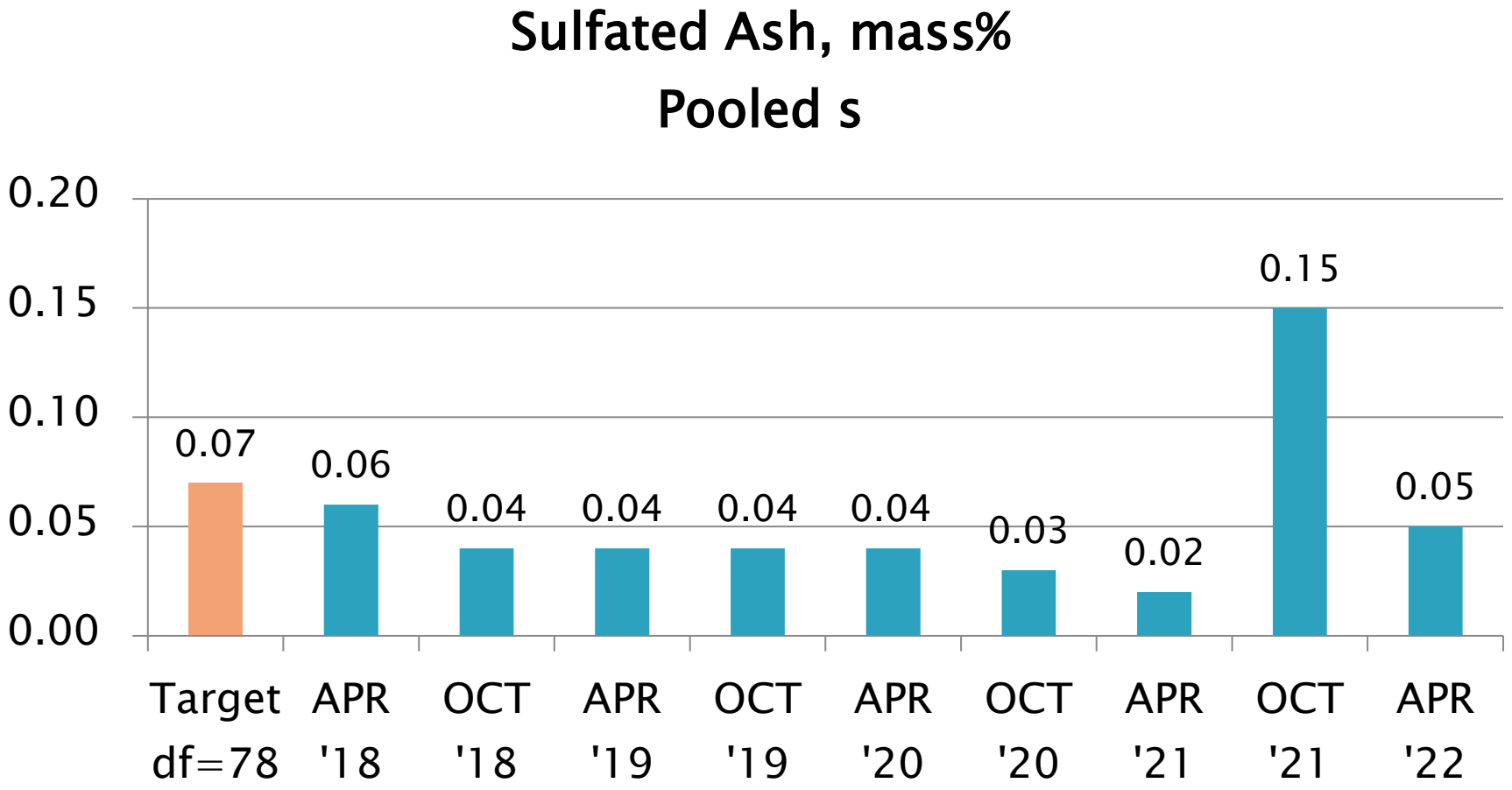
- No operationally invalid or statistically unacceptable tests this report period.

D874: Sulfated Ash

Period Precision and Severity Estimates

Total Deposits, mg	n	df	Pooled s	Mean Δ/s
Current Targets	81	78	0.07	-----
4/1/18 through 9/30/18	8	5	0.04	-0.22
10/1/18 through 3/31/19	8	5	0.04	-0.33
4/1/19 through 9/30/19	8	5	0.04	-0.18
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

D874: Sulfated Ash



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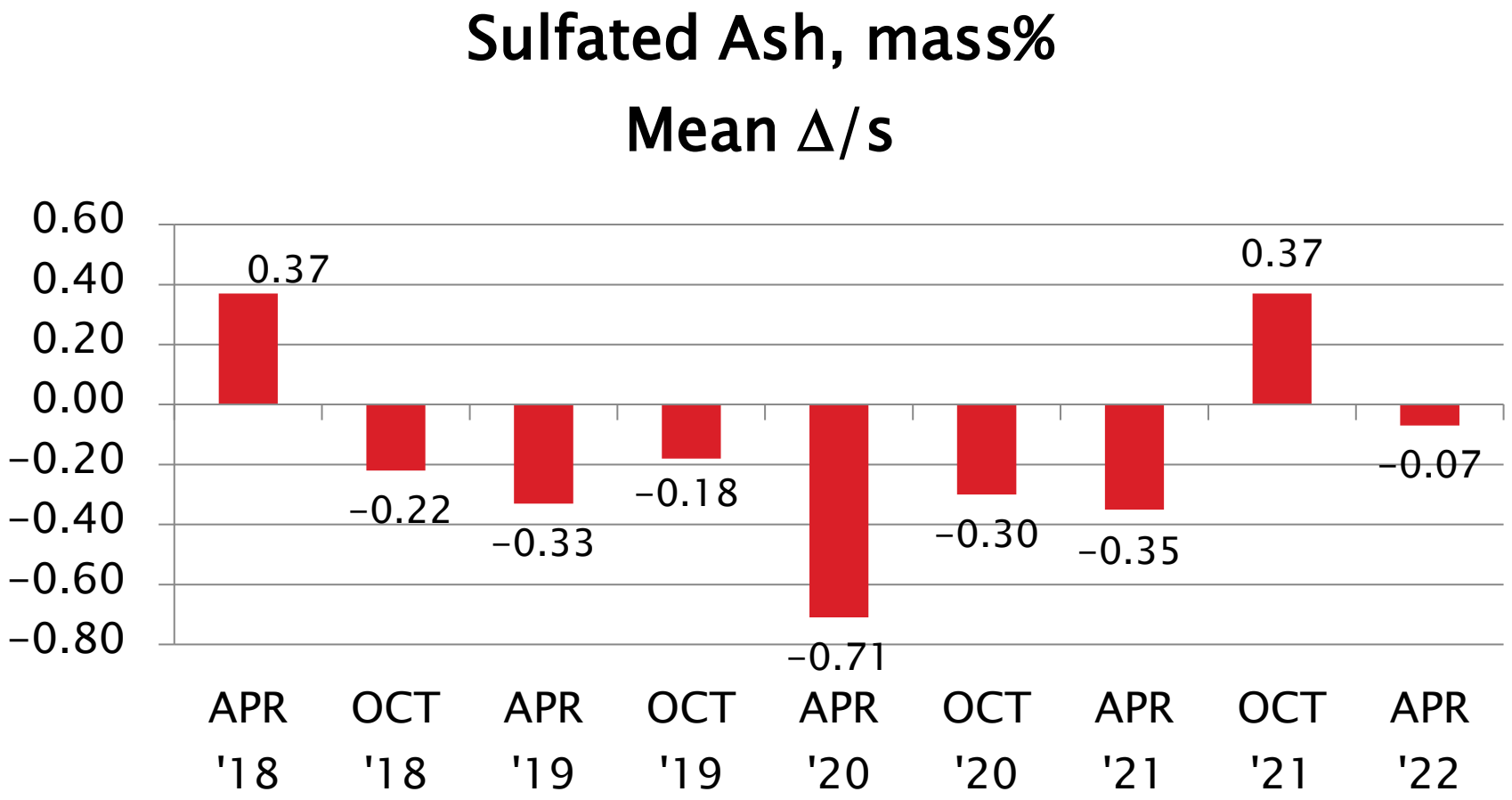
D874: Sulfated Ash



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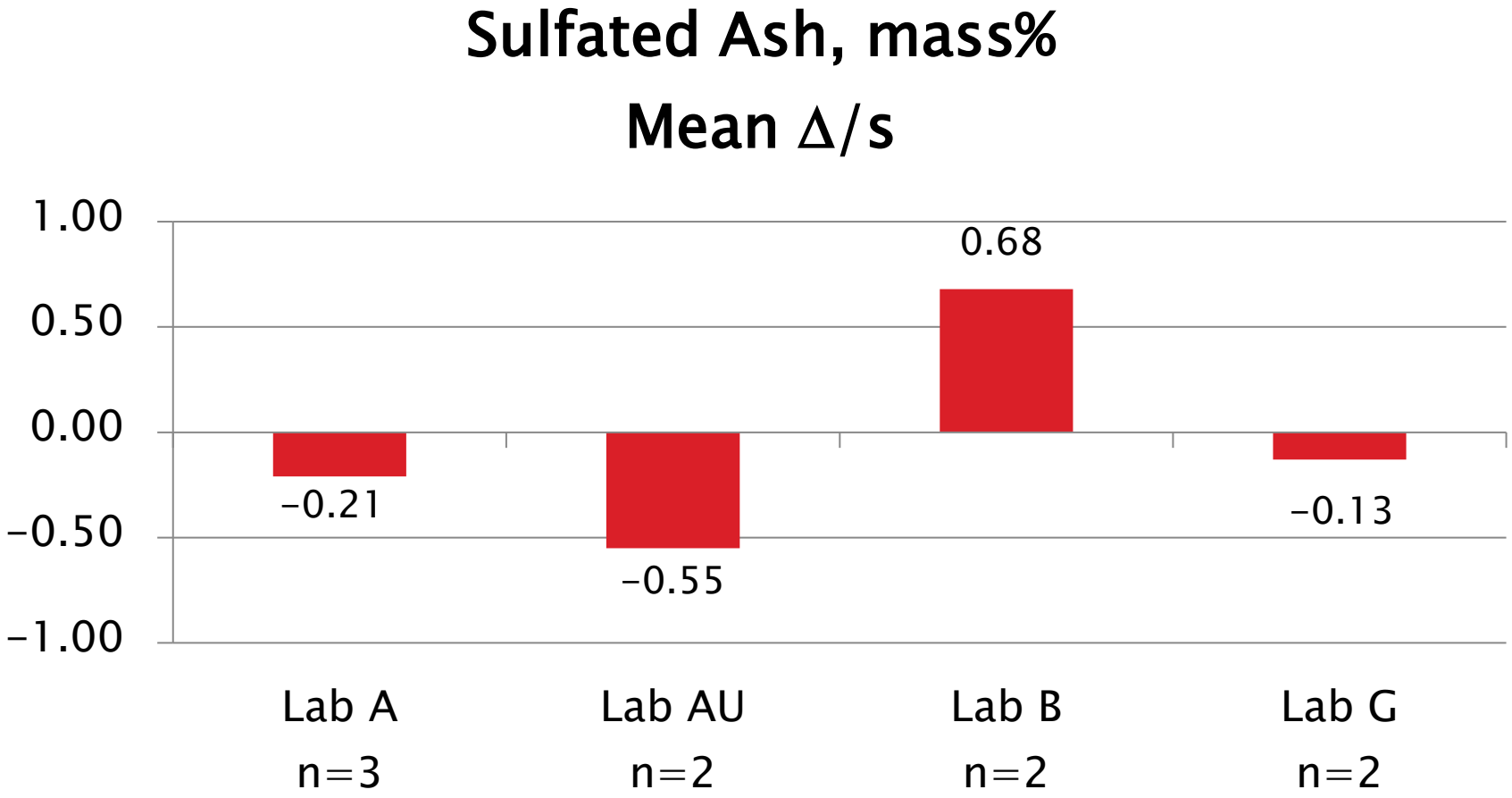
D874: Sulfated Ash



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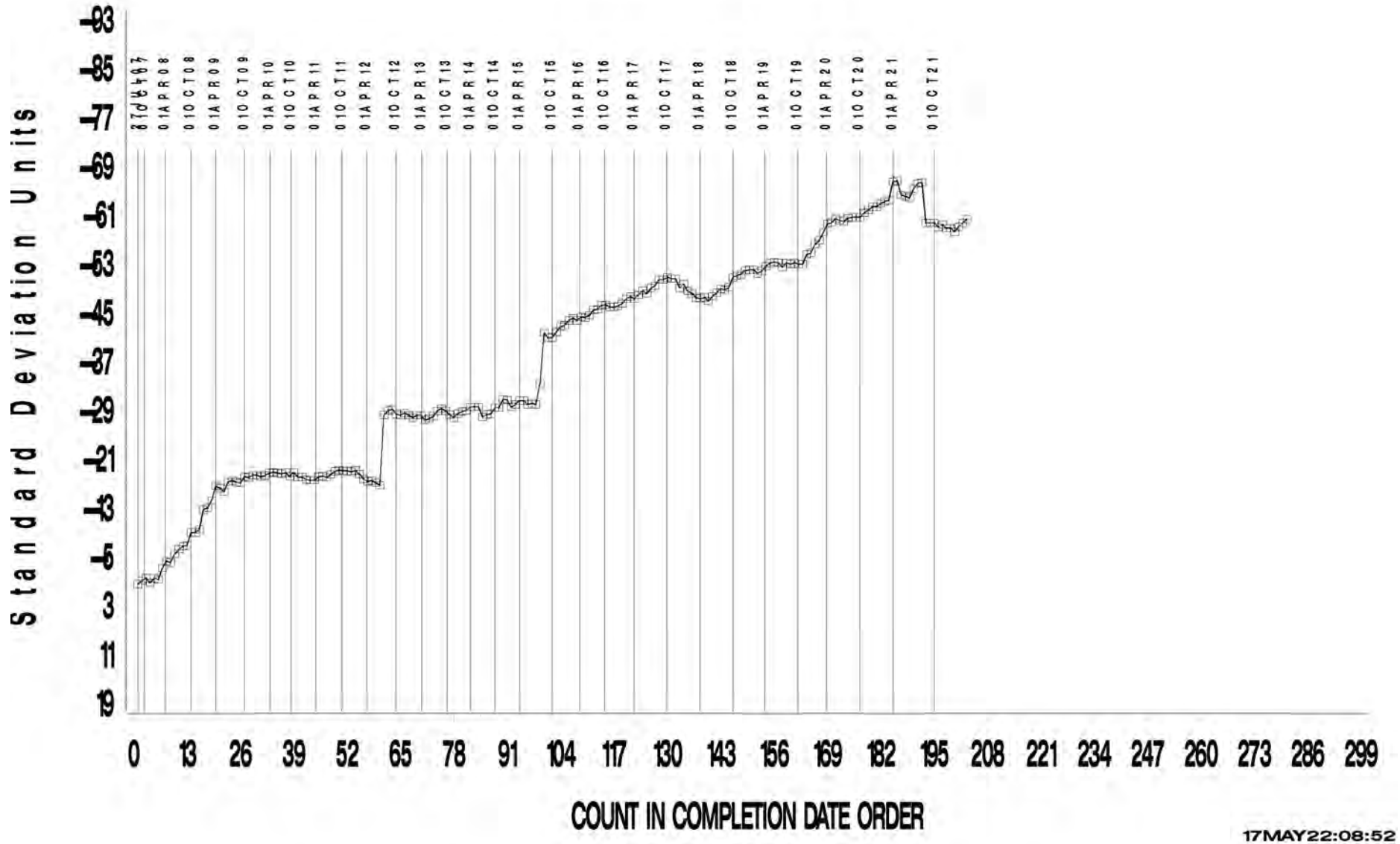
D874: Sulfated Ash

- Precision (Pooled s) has improved with respect to the previous period and is in line with historical estimates
- Performance (Mean Δ/s) is -0.07 s which is on or near target

D874 INDUSTRY OPERATIONALLY VALID DATA

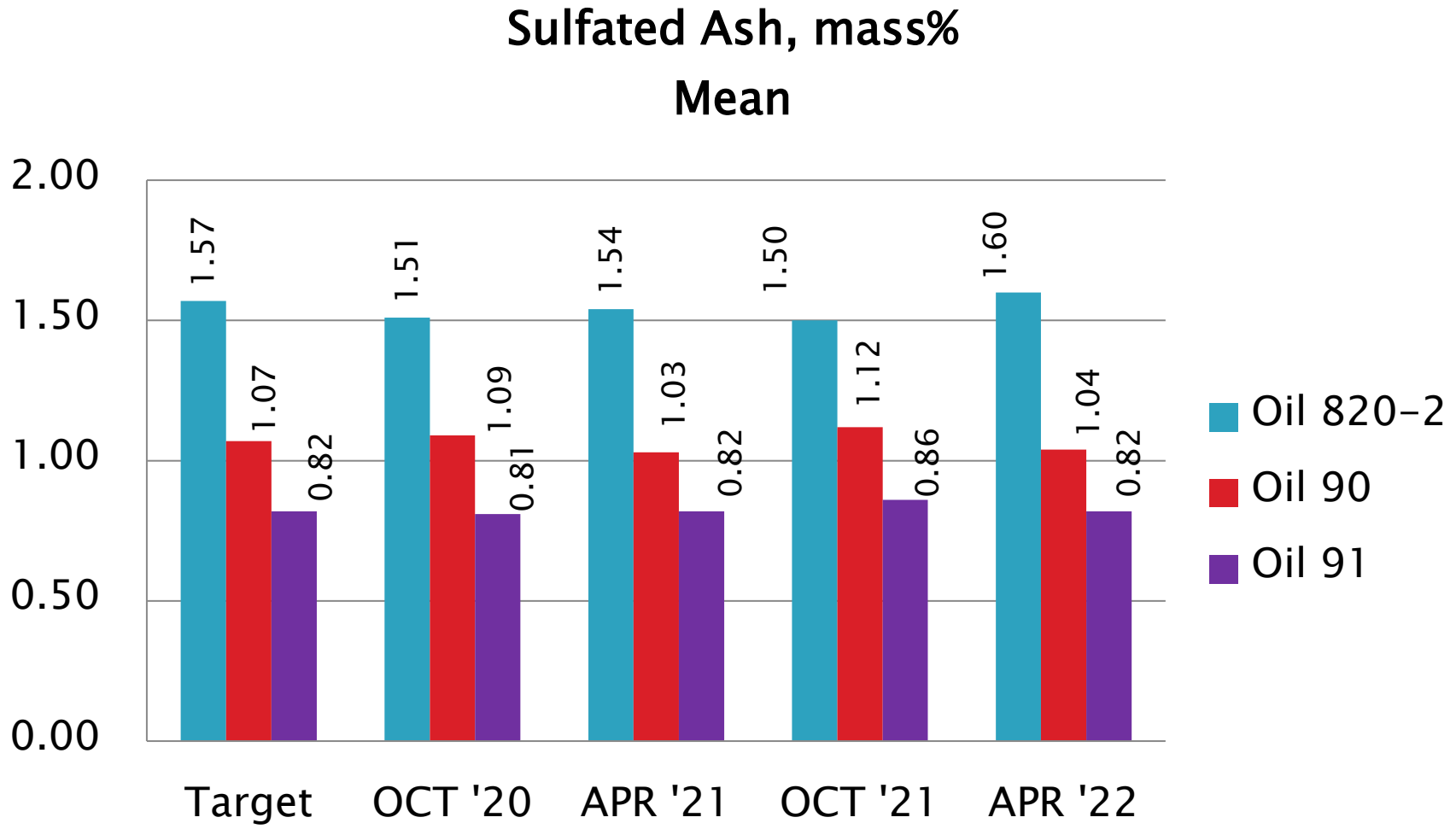
TEST SAMPLE PERCENT SULFATED ASH

CUSUM Severity Analysis



17MAY22:08:52

D874: Sulfated Ash



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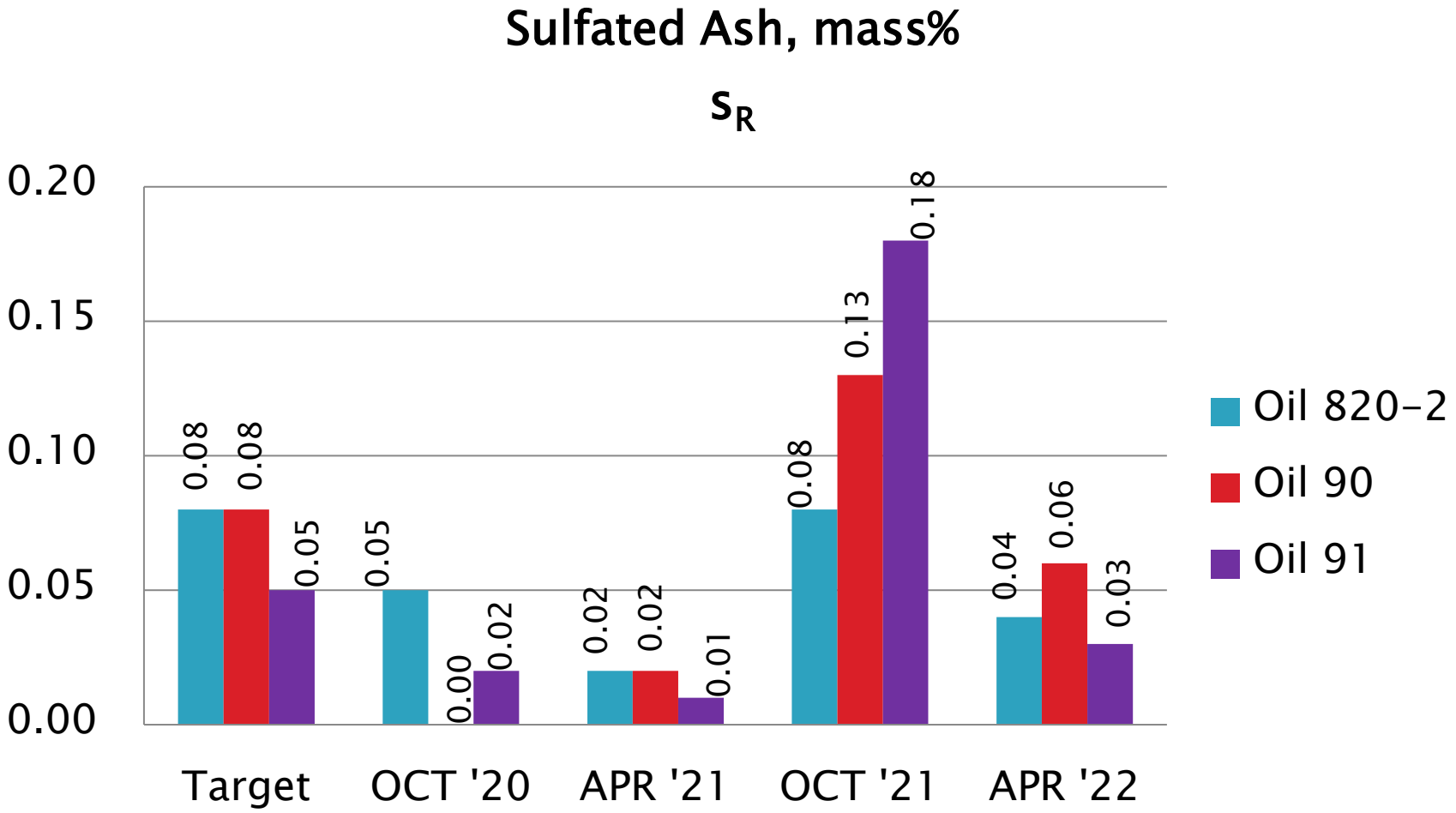
D874: Sulfated Ash



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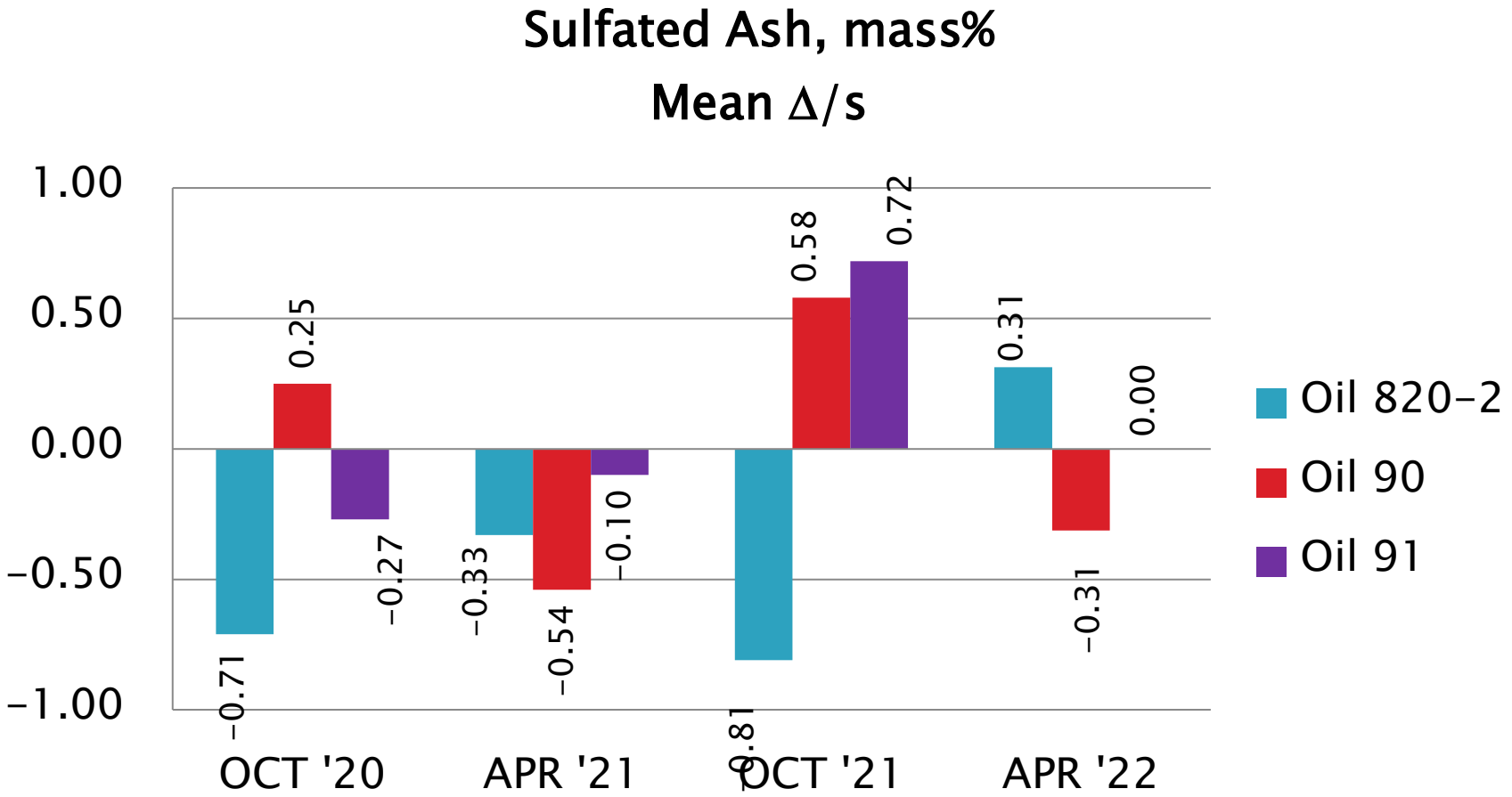
D874: Sulfated Ash



Return to Executive Summary

D7528: Oxidation by ROBO

Test Status	Validity Code	No. Tests
Acceptable Calibration Test	AC	96
Failed Calibration Test	OC	10
Operationally Invalidated by Lab	LC, XC	7
Operationally Invalidated After Initially Reported as Valid	RC	1
Total		**114**

Number of Labs Reporting Data: 10
Fail Rate of Operationally Valid Tests: 11%

D7528: Oxidation by ROBO

Statistically Unacceptable Tests (OC)	No. Of Tests
Natural Log (MRV Viscosity) Mild	10

- Information Letter 21-1 was issued 11/3/21 and added an option to use dilute nitrogen dioxide in air

D7528: Oxidation by ROBO

Operationally Invalid Calibration Tests

Test Status	Cause	#
Invalid	Yield stress >35kPa	2
Aborted	Heater Failed	1
Aborted	Reactor stopped heating (same lab)	2
Aborted	Flask overheated	1
Aborted	Stirrer failed	1
Aborted	Sample became Contaminated	1
Totals		**8**

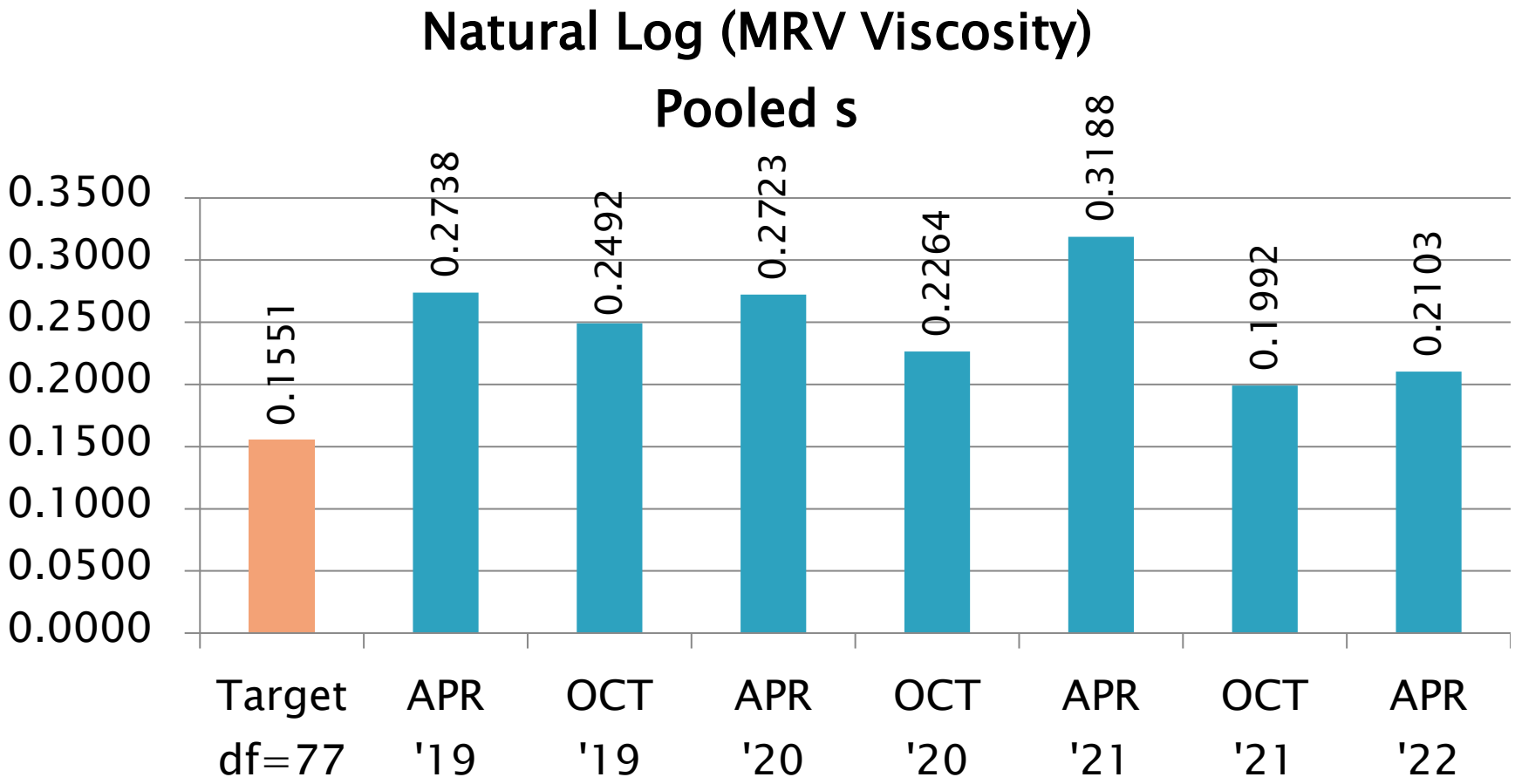
D7528: Oxidation by ROBO

Period Precision and Severity Estimates

Natural Log (MRV Viscosity)	n	df	Pooled s	Mean Δ/s
Targets Updated 20211021[1]	80	77	0.1551	-----
10/1/18 through 3/31/19	100	96	0.2738	0.04
4/1/19 through 9/30/19	95	91	0.2492	-0.32
10/1/19 through 3/31/20	158	153	0.2723	-0.10
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

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

D7528: Oxidation by ROBO



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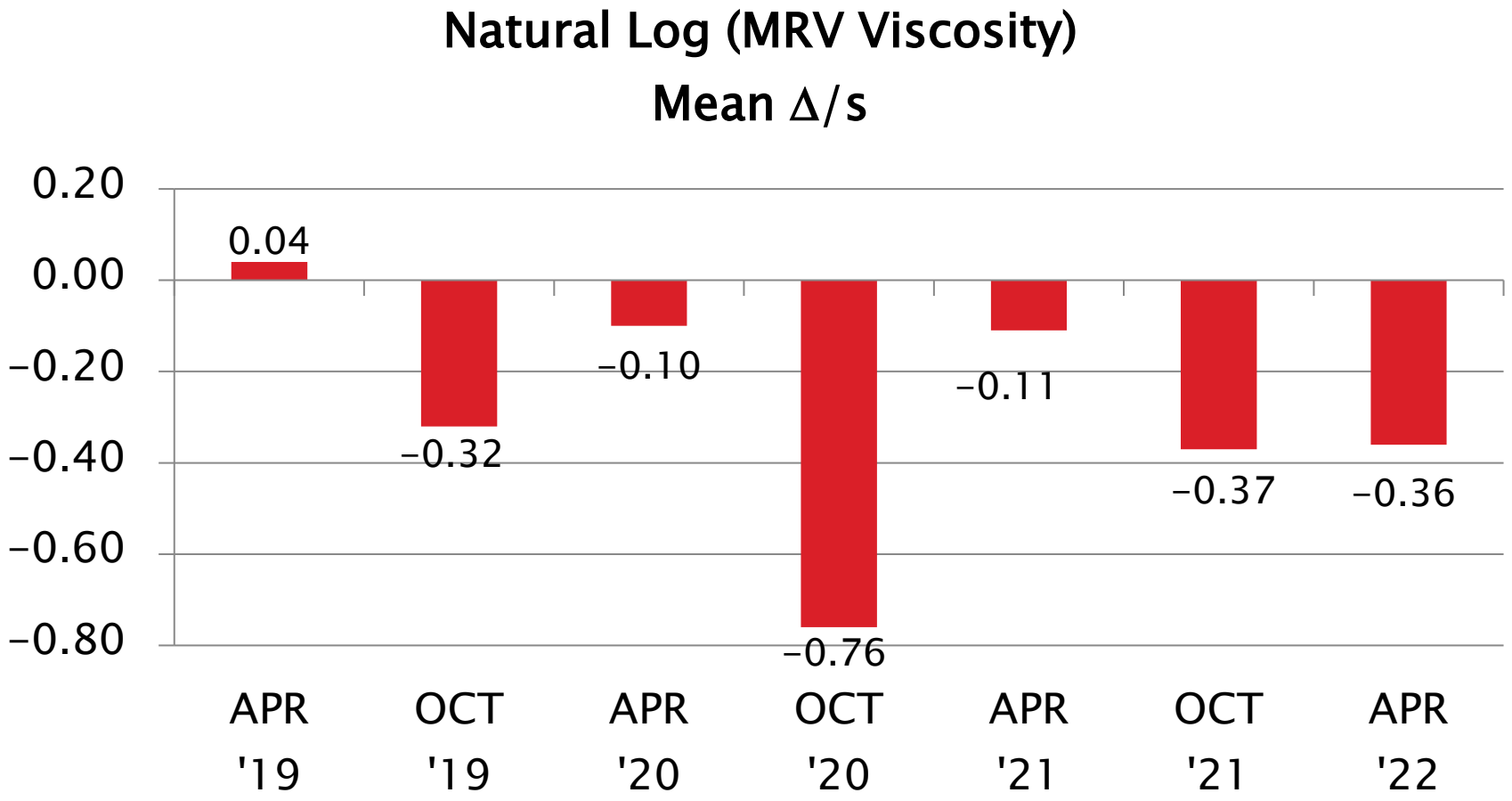
D7528: Oxidation by ROBO



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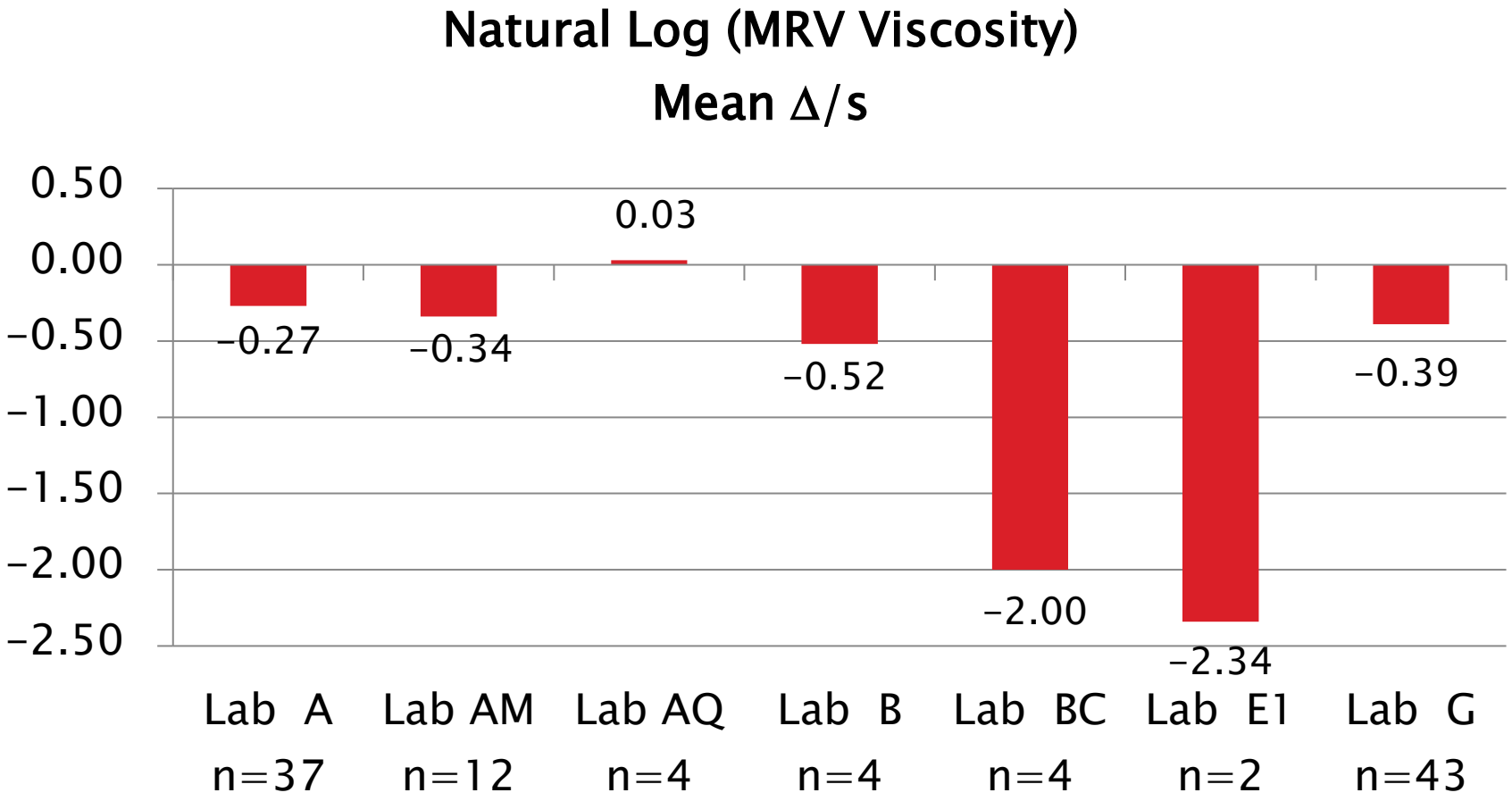
D7528: Oxidation by ROBO



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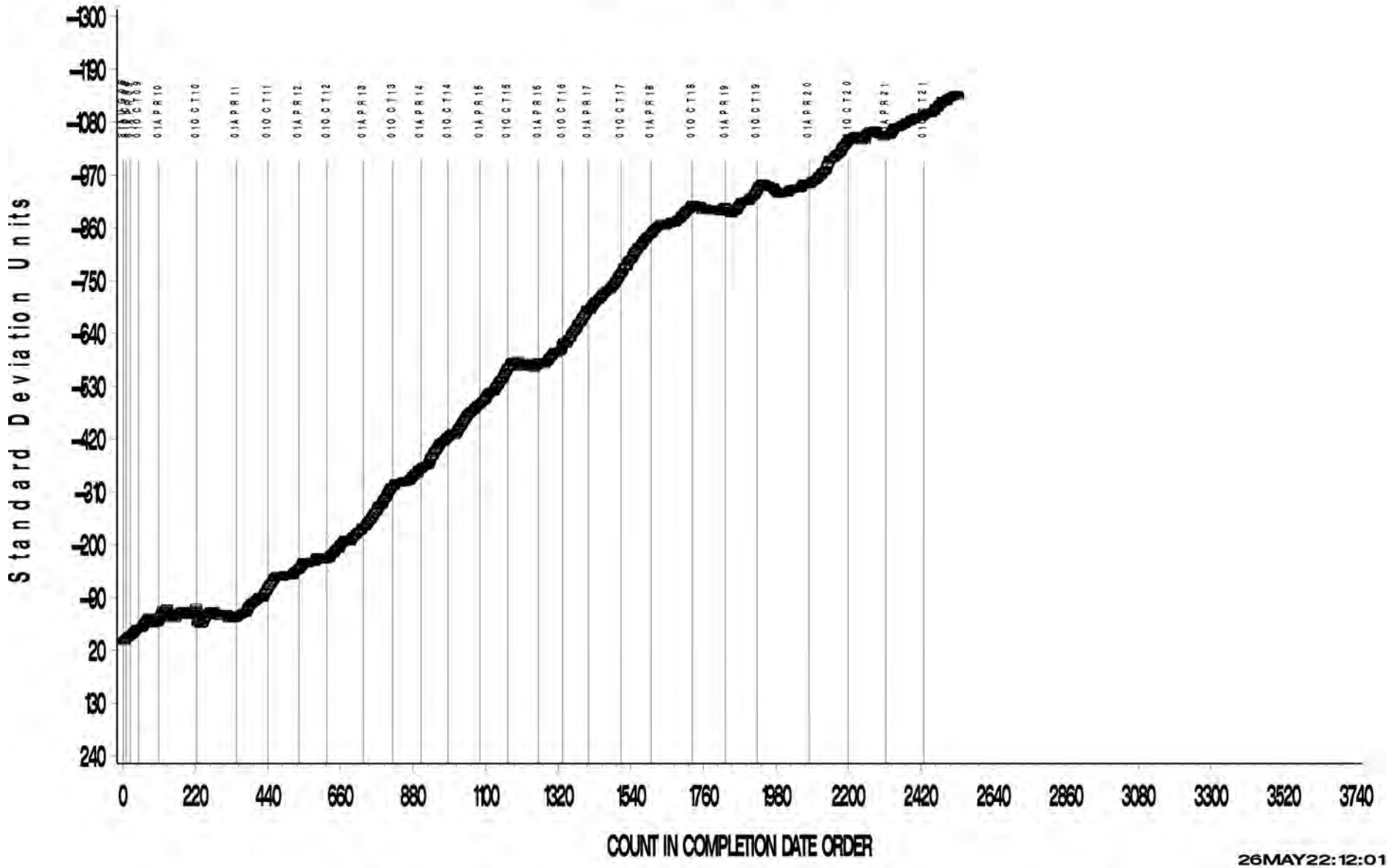
D7528: Oxidation by ROBO

- Precision (Pooled s) is comparable to recent report periods but directionally worse when compared to target precision
- Severity (Mean Δ/s) is -0.36 s mild for this report period
- CUSUM severity plot shows long term mild trend of varying levels

ROBO TEST INDUSTRY OPERATIONALLY VALID DATA

AGED OIL MRV APPARENT VISCOSITY

CUSUM Severity Analysis



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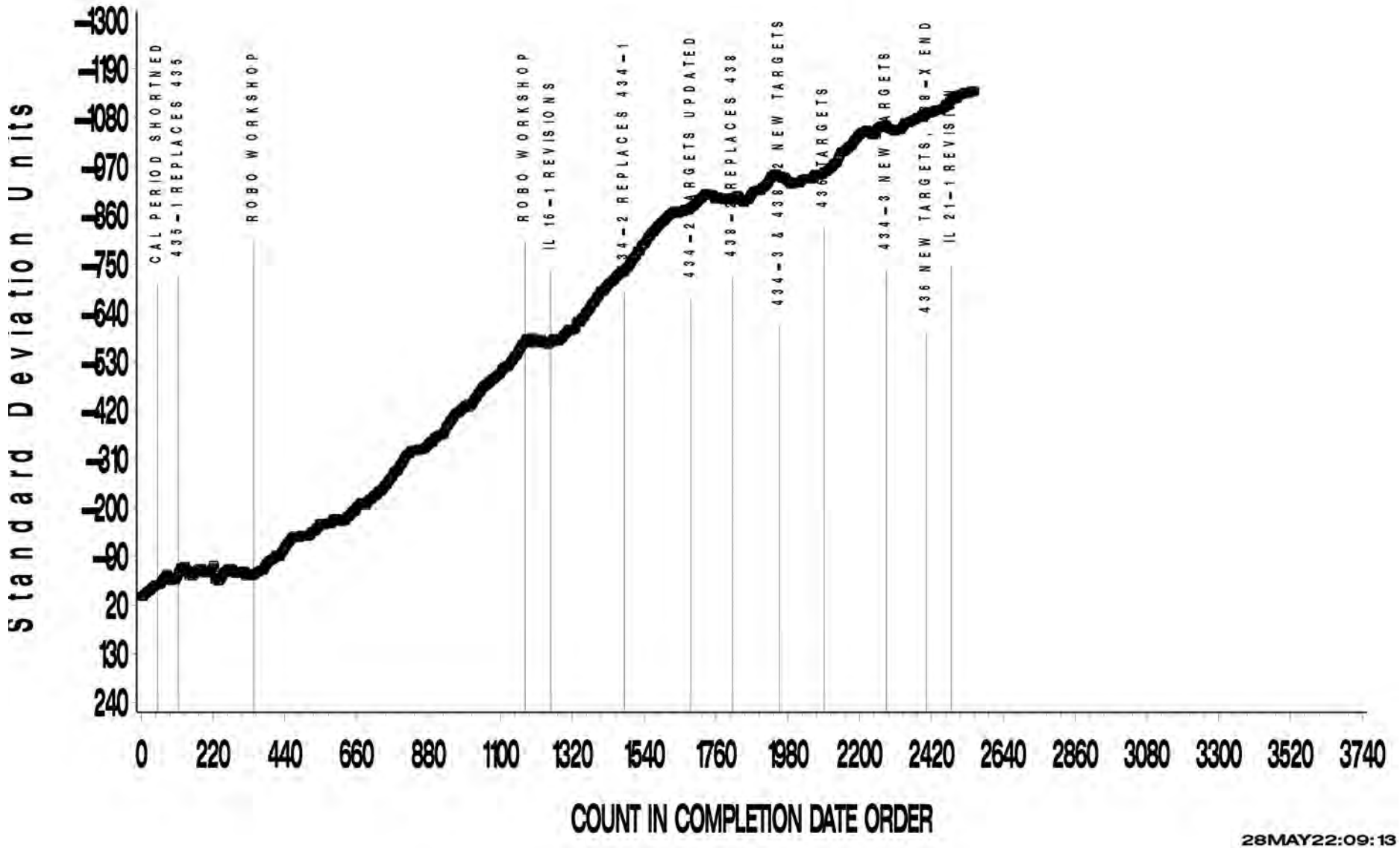
ROBO TEST INDUSTRY OPERATIONALLY VALID DATA

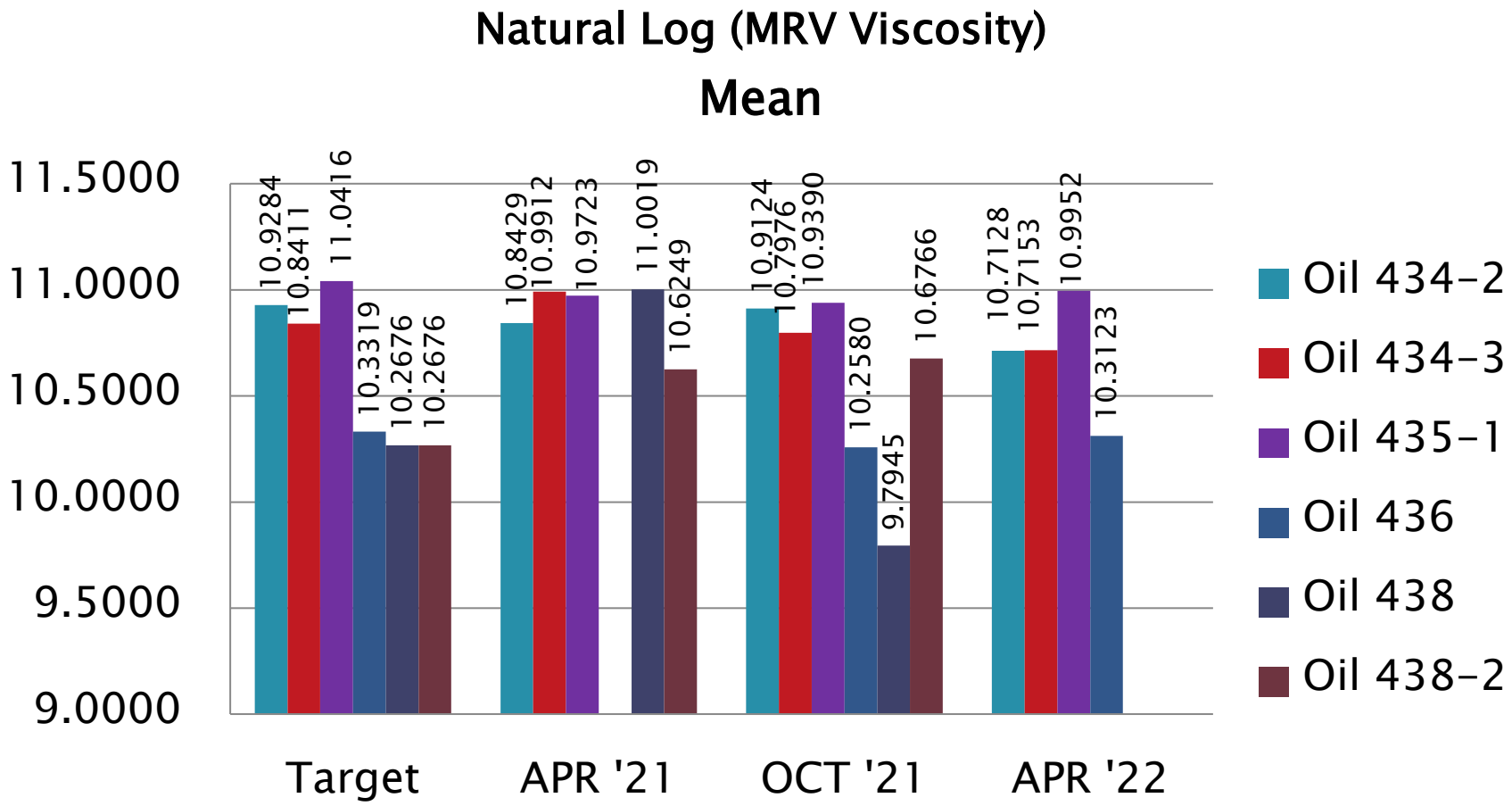
AGED OIL MRV APPARENT VISCOSITY

CUSUM Severity Analysis



28MAY22:09:13

D7528: Oxidation by ROBO



Test Monitoring Center
https://www.astmtmc.org
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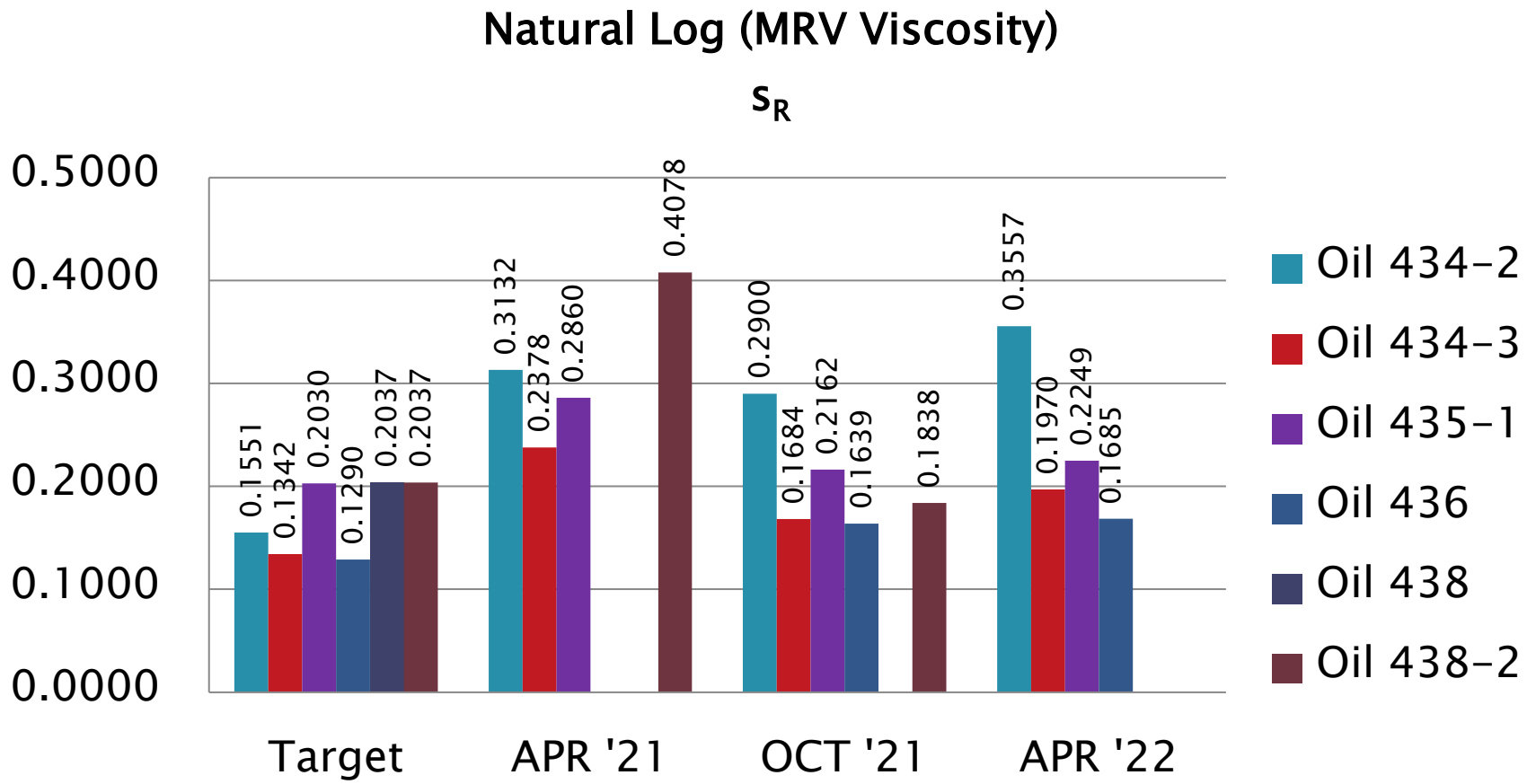
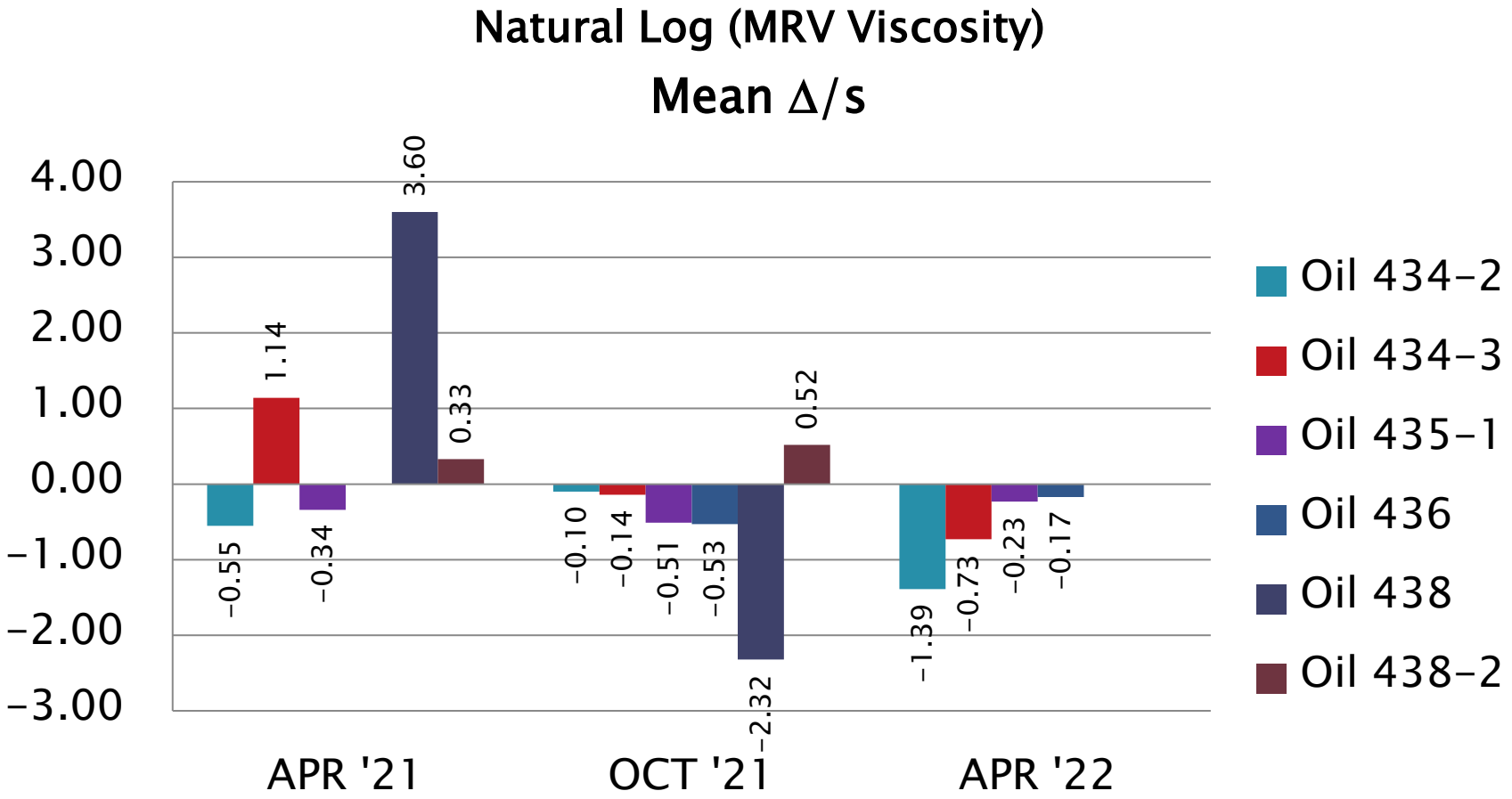
D7528: Oxidation by ROBO



D7528: Oxidation by ROBO



Return to Executive Summary

Reference Oil Inventory

As of 3/31/2022

Test Monitoring Center
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Reference Oil Inventory

D5800

Oil	Year Rec'd By TMC[A]	Tests	TMC Inventory, gallons	Gallons Shipped last 12 months
VOLC12	2013	D5800	26.8	2.5
VOLD12	2013	D5800	25.2	2.6
VOLE12	2013	D5800	22.8	2.6
VOLD18	2018	D5800QC	832	82

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

Reference Oil Inventory

D6417, GI

Oil	Year Rec'd By TMC[A]	Tests	TMC Inventory, gallons	Gallons Shipped last 12 months
52	1995	D6417	59.4	0.01
55	1995	D6417	65.9	0.10
58	1998	D6417, D6417QC, GI	111.5	0.84
GIA17	2017	GI	8.3	2.5
GIC18	2018	GI	9.8	0.6
1009	2002	GI	35.9	0.7

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

Reference Oil Inventory

TEOST, MTEOS & ROBO

Oil	Year Rec'd By TMC[A]	Tests	TMC Inventory, gallons	Gallons Shipped last 12 months
432	1998	MTEOS	102.4	0.4
75-1	2016	TEOST	4.3	0.5
435-2[B]	2010	TEOST	36.4	3.0
434-3[B]	2017	ROBO/MTEOS	31.5	3.3
435-1	2008	ROBO	348.1	0.9
436[B]	2014	ROBO	39.9	4.3

[A]The 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.

Reference Oil Inventory

D6082 & D874

Oil	Year Rec'd By TMC[A]	Tests	TMC Inventory, gallons	Gallons Shipped last 12 months
FOAMB18	2018	D6082	82.3	3
66	2002	D6082	72.9	2.2
820-2	2001	D874	3.4	0
90	2005	D874/D874QC	11.7	0
91	2006	D874	3.1	0.3

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

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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