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

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

October 2014

B0.07 Bench Testing Executive Summary

- D6417 (Volatility by GC)
  - Improved precision compared to last two periods
    - Comparable to target precision
  - Performance -0.35 s mild
  - No issues

B0.07 Bench Testing
Executive Summary

- D5800 (Volatility by Noack)
  - **New reference oils introduced prior period**
  - Precision significantly less precise
  - 36% fail rate on tests reported as operationally valid
  - Period severity on new oils is still severe (0.38 s), but less severe than prior periods using old (replaced) reference oils

B0.07 Bench Testing Executive Summary

- D5133 (Gelation Index)
  - Considerably degraded precision
    - More precise than target precision
  - Performance -0.17 s mild

B0.07 Bench Testing Executive Summary

- D6335 (TEOST-33C)
  - Precision (Pooled s) is more precise than prior period
    - Less precise than the updated target precision
  - Performance (Mean Δ/s) is 0.15 s severe
- D7097 (MHT-4 TEOST)
  - Precision (Pooled s) is more precise than prior periods
    - Significantly less precise than target precision four consecutive report periods
  - Performance (Mean Δ/s) is on target
    - Significant lab performance differences persist
    - Catalyst affects on oil severity are indicated
    - Overall severe performance of oil 432 (0.28 s, n=39) is nearly offset by overall mild performance of oil 434 (-0.35 s, n = 37)

B0.07 Bench Testing Executive Summary

- D6082 (High Temperature Foam)
  - Significantly degraded precision this period
    - Still more precise than target precision
  - Performance is on target
    - Lab severity differences noted
  - All operationally valid discrimination runs demonstrated acceptable discrimination

- D874 (Sulfated Ash)
  - Period precision equal to target precision
  - Performance nearly on target (0.09 s)
  - No issues

B0.07 Bench Testing Executive Summary

- D7528 (ROBO)
- 19% fail rate for operationally valid tests

- Precision (Pooled s) is more precise than prior period
  - Less precise than target precision

- Performance (Mean Δ/s) is -0.78 s mild
  - Seven of eight labs performing overall mild
  - Three labs more than 1 s mild, overall (Labs AO, B & D)
  - 15 of 16 OC tests failed mild of acceptance bands

- CUSUM Severity Plot shows an ongoing overall mild trend since the 01APR11 timeline

Calibrated Labs and Stands*

Test	Labs	Stands
D6417	5	7
D5800	7	17
D5133 (GI)	3	6
D6335 (TEOST)	5	7
D7097 (MTEOS)	7	37
D6082	4	5
D874	3	--
D7528 (ROBO)	3	13

*As of 9/30/2014

D02.B0.07
TMC Monitored Tests

- April 1, 2014 –
  September 30, 2014

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D6417: Estimation of Engine Oil Volatility by Capillary GC

Test Status	Validity Code	No. Tests
Acceptable Calibration Test	AC	14
Failed Calibration Test	OC	1
Operationally Invalidated by Lab	LC, XC	0
Operationally Invalidated After Initially Reported as Valid	RC	0
Total		**15**

Number of Labs Reporting Data: 5
Fail Rate of Operationally Valid Tests: 7%

D6417: Estimation of Engine Oil Volatility by Capillary GC

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

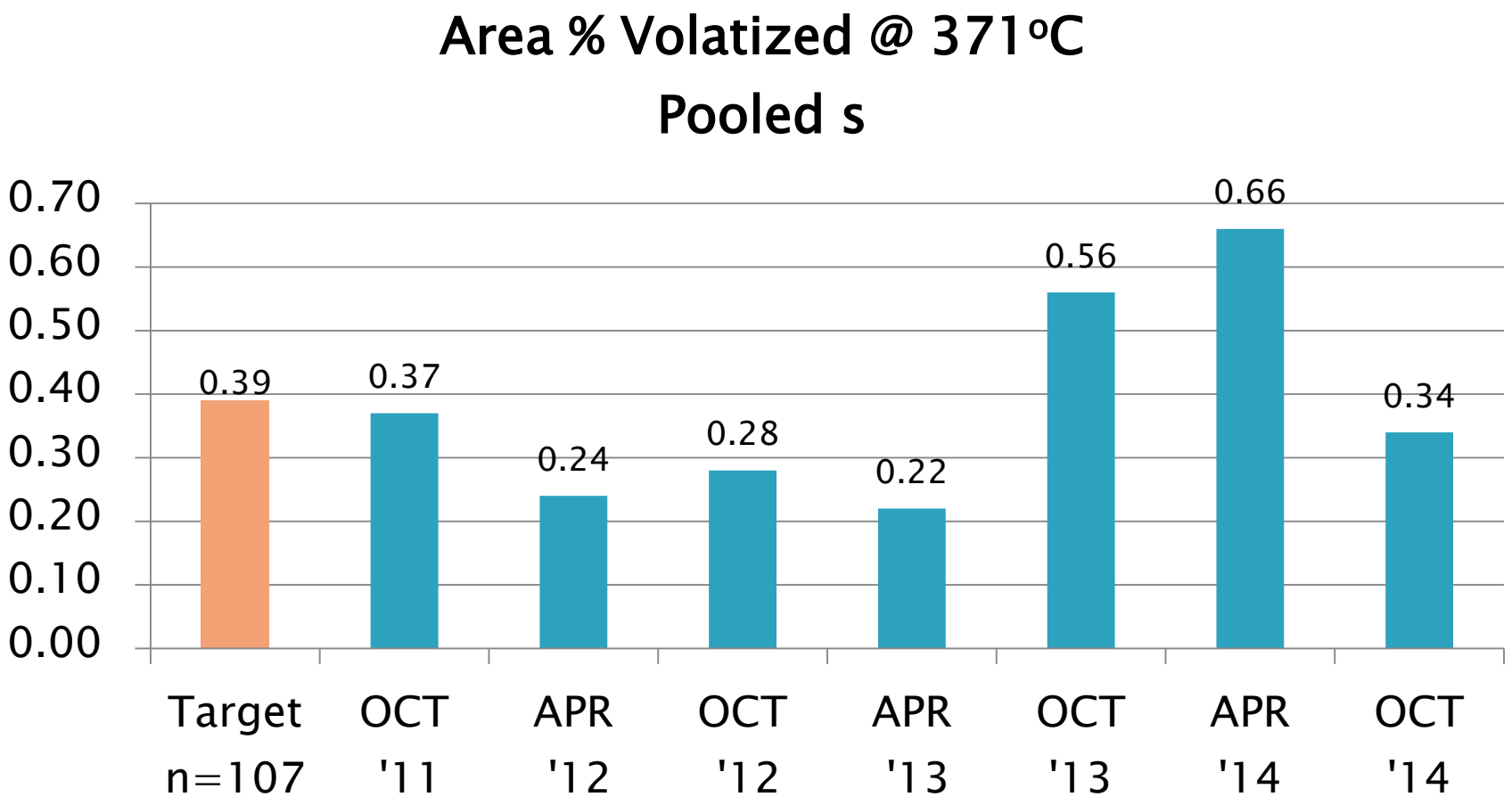
- No TMC technical updates issued this period

D6417: Estimation of Engine Oil Volatility by Capillary GC

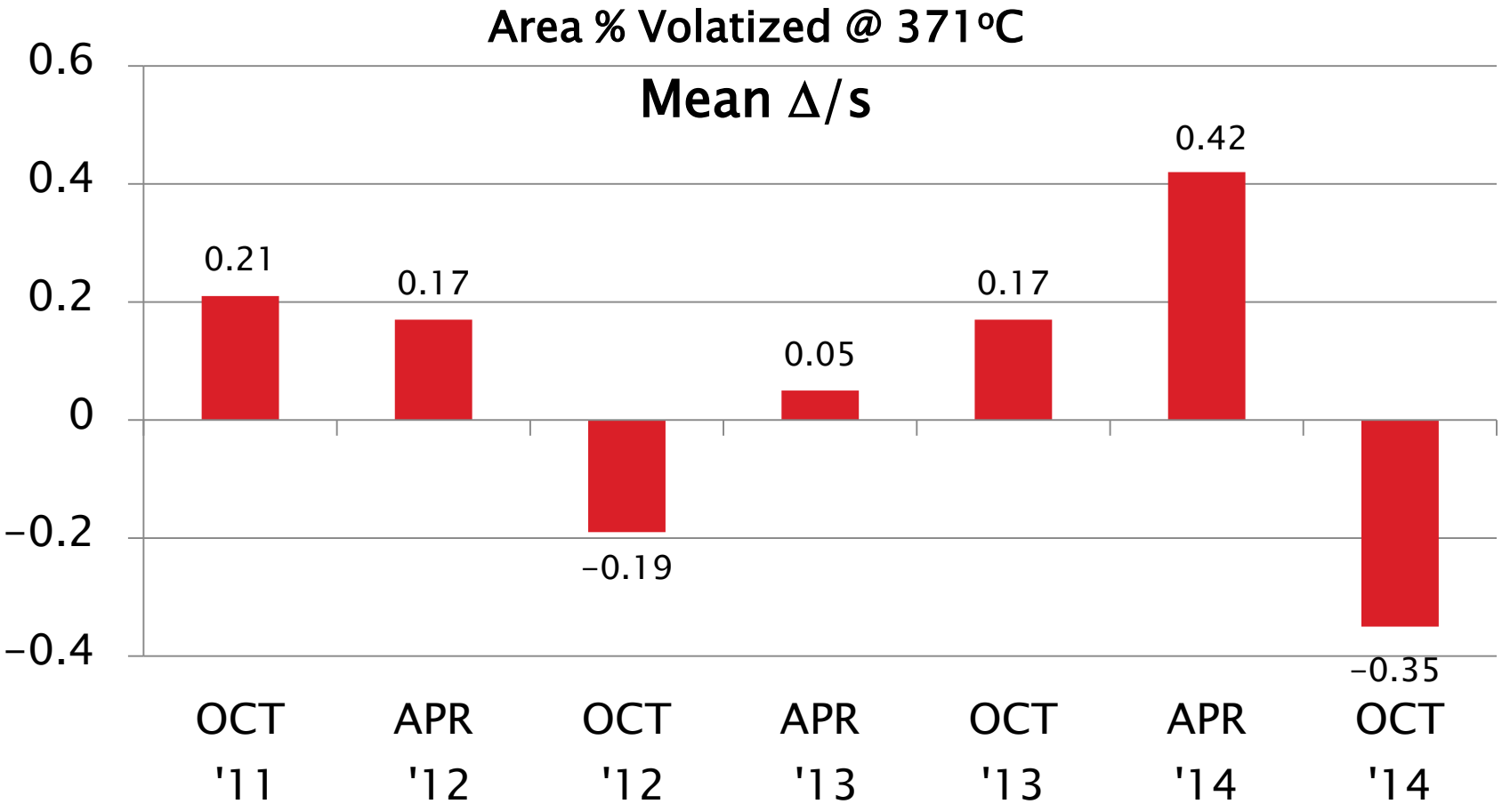
Period Precision and Severity Estimates

Area % Volatized @ 371°C	n	df	Pooled s	Mean Δ/s
Initial Selected Oils from RR	54	51	0.39	-----
4/1/11 through 9/30/11	16	13	0.37	0.21
10/1/11 through 3/31/12	14	11	0.24	0.17
4/1/12 through 9/30/12	15	12	0.28	-0.19
10/1/12 through 3/31/13	14	11	0.22	0.05
4/1/13 through 9/30/13	17	14	0.56	0.17
10/1/13 through 3/31/14	15	12	0.66	0.42
4/1/14 through 9/30/14	15	12	0.34	-0.35

D6417 Precision Estimates



D6417 Severity Estimates

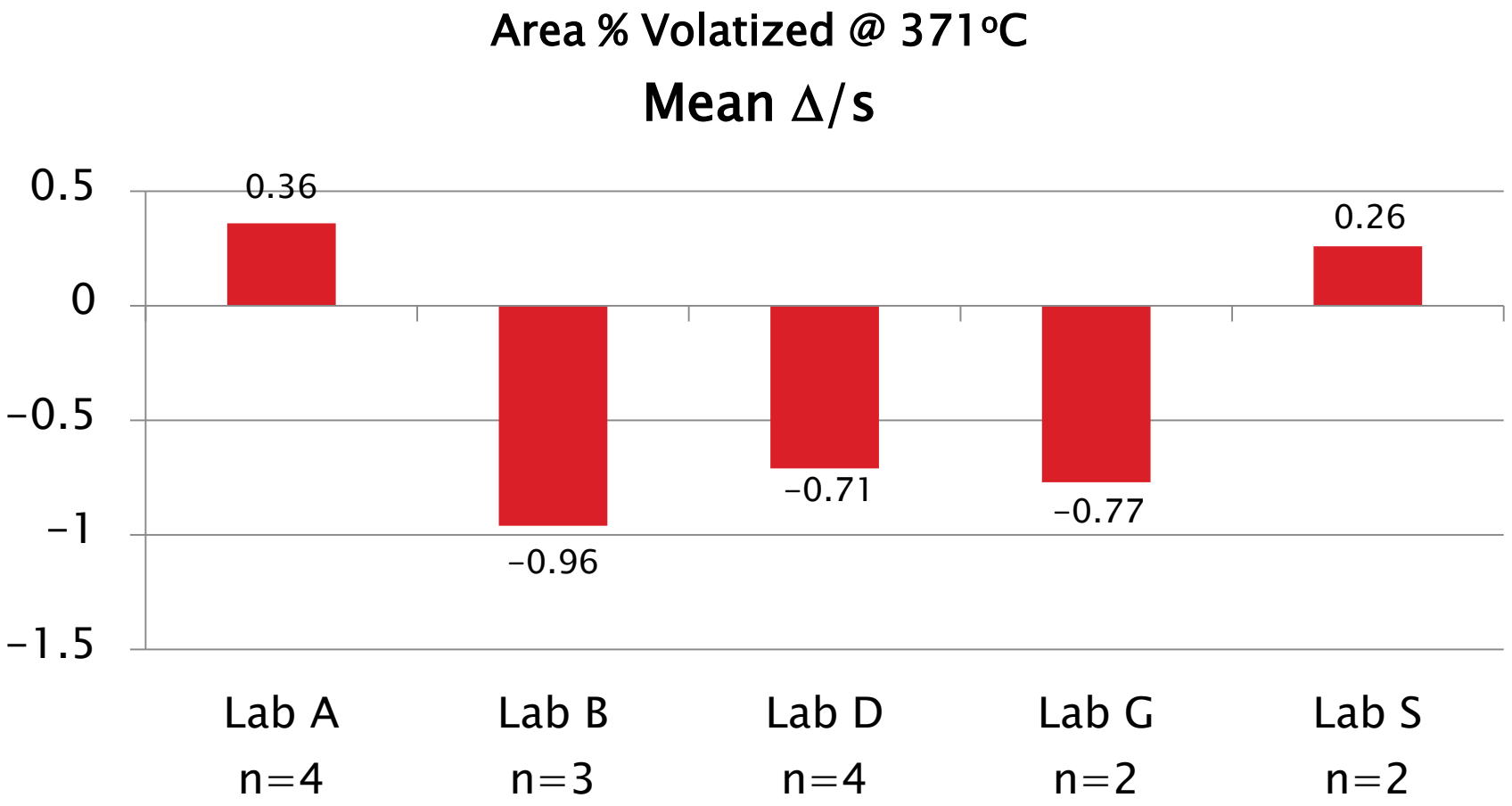


D6417: Estimation of Engine Oil Volatility by Capillary GC

Current Period Severity Estimates by Lab
Area % Volatized @ 371°C

	n	Mean Δ/s
Lab A	4	0.36
Lab B	3	-0.96
Lab D	4	-0.71
Lab G	2	-0.77
Lab S	2	0.26

D6417 Lab Severity Estimates



D6417: Estimation of Engine Oil Volatility by Capillary GC

- Precision (Pooled s) is improved
  - Comparable to the target precision
- Performance (Mean Δ/s) is mild (-0.35 s)
- Cusum plot shows variability with overall mild trend this period following a severe trend last period (mostly influenced by two very severe results from one lab).

D6417 VOLATILITY BY GC INDUSTRY OPERATIONALLY VALID DATA

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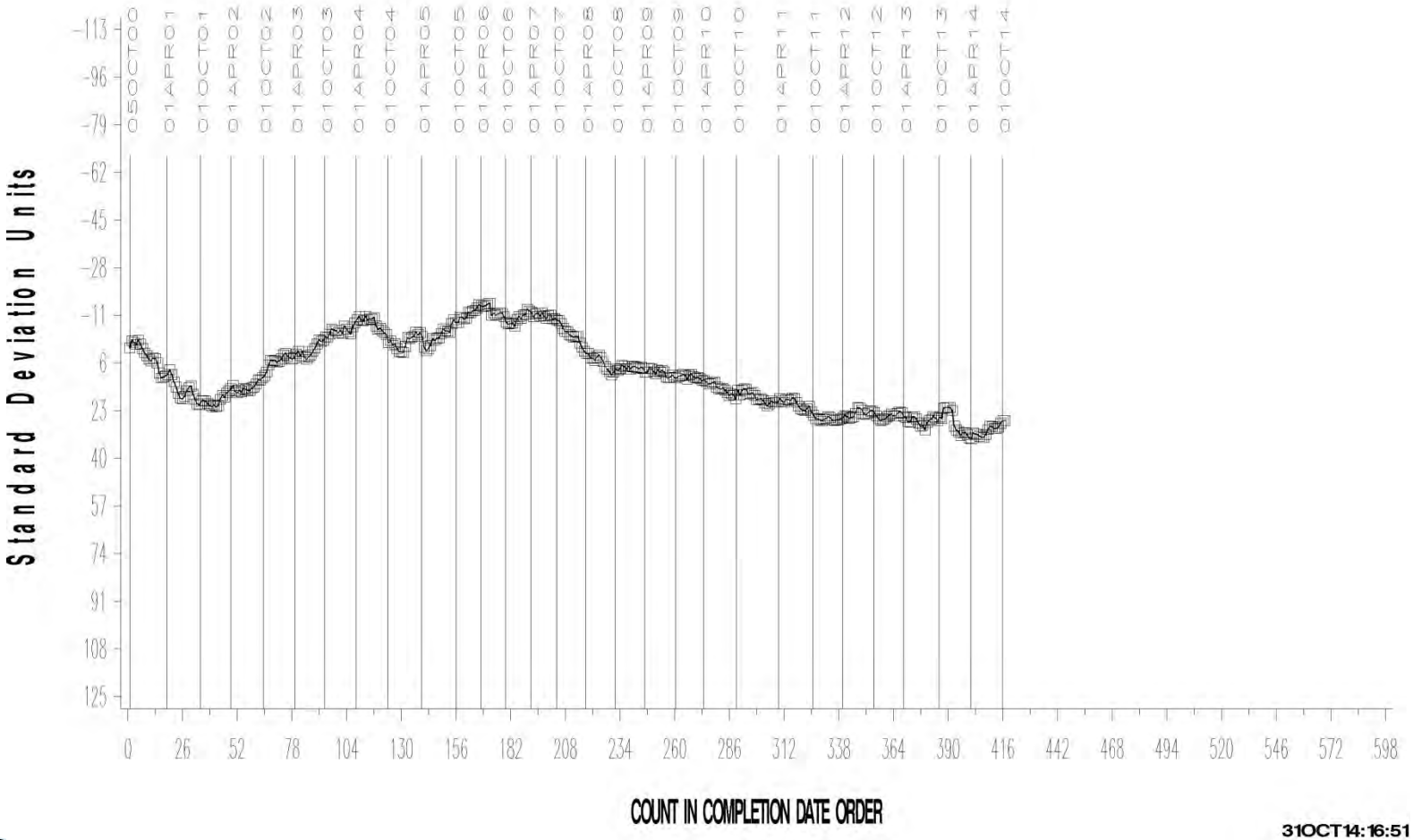
SAMPLE AREA % VOLATIZED

CUSUM Severity Analysis



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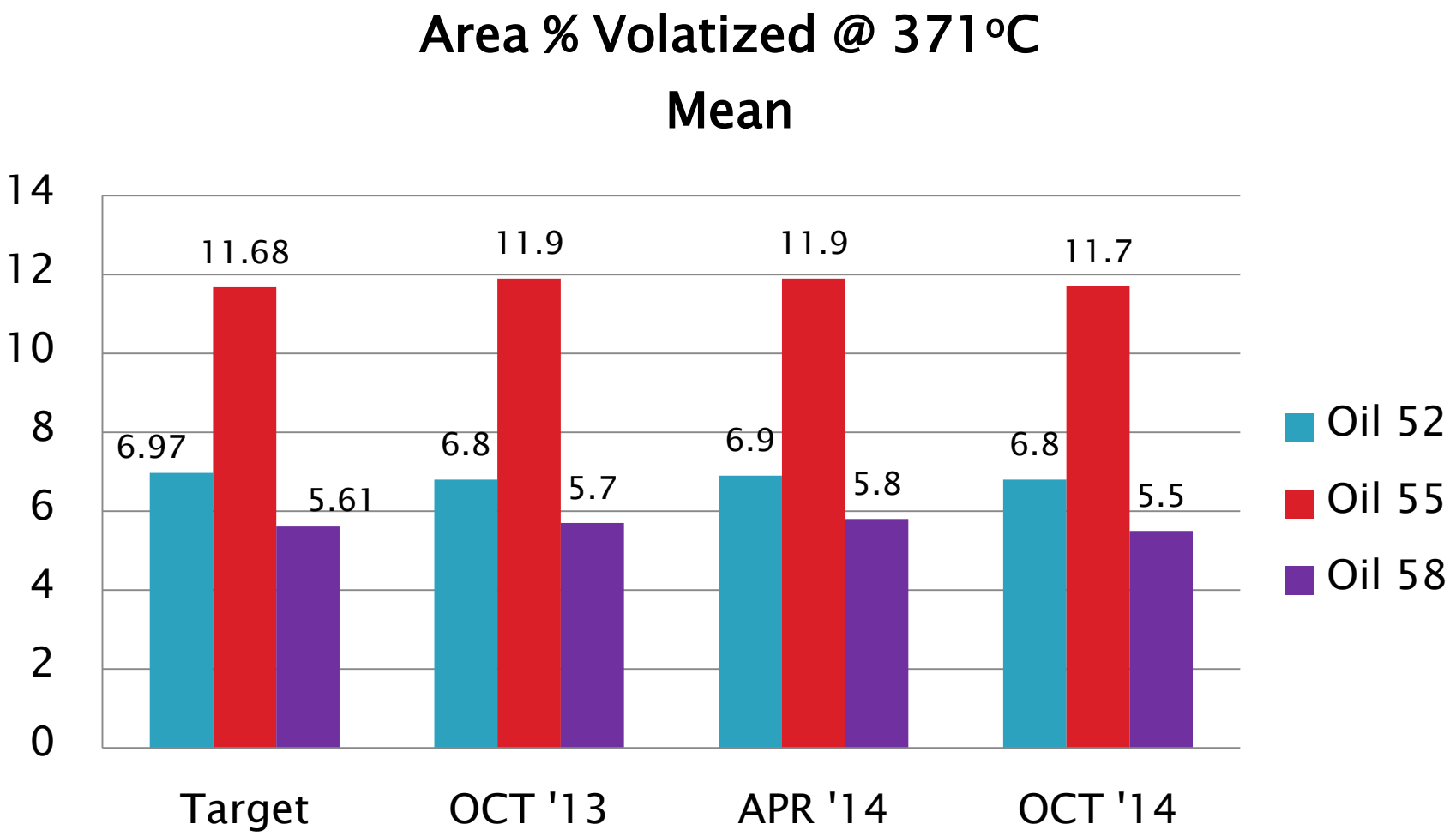
D6417: Estimation of Engine Oil Volatility by Capillary GC

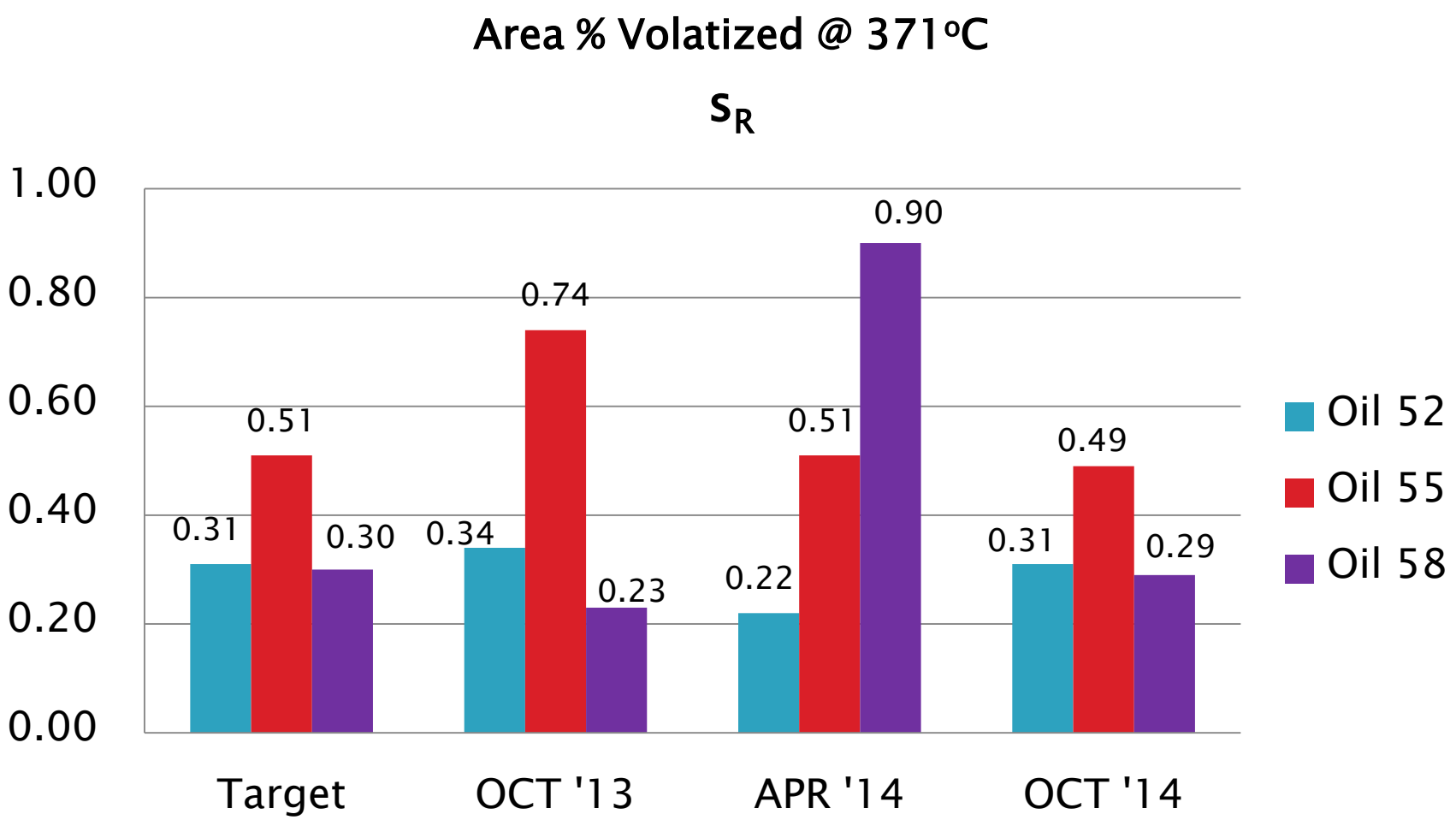
Area % Volatized @ 371°C
Performance by Oil

	Targets			4/1/13 - 9/30/13				10/1/13 - 3/31/14				4/1/14 - 9/30/14			
Oil Code	n	Mean	s_R	n	Mean	s_R	Mean Δ/s	n	Mean	s_R	Mean Δ/s	n	Mean	s_R	Mean Δ/s
52	18	6.97	0.31	4	6.8	0.34	-0.47	4	6.9	0.22	-0.23	8	6.8	0.31	-0.47
55	18	11.68	0.51	8	11.9	0.74	0.36	5	11.9	0.51	0.47	3	11.7	0.49	-0.03
58	18	5.61	0.30	5	5.7	0.23	0.37	6	5.8	0.90	0.80	4	5.5	0.29	-0.37

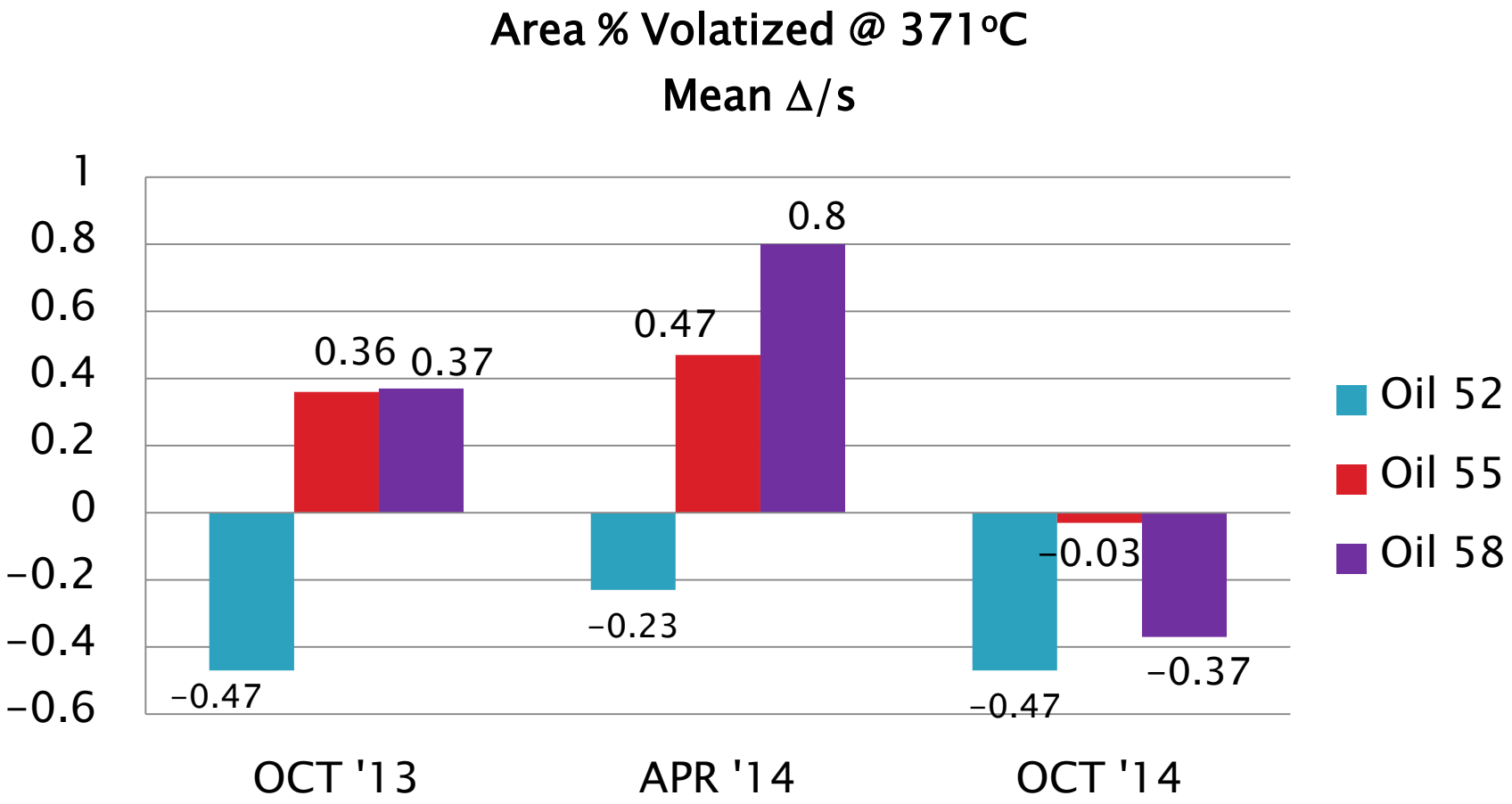
D6417 Performance by Oil



D6417 Performance by Oil



D6417 Performance by Oil



Return to Executive Summary

D5800: Evaporation Loss of Lubricating Oil by Noack Method

Test Status	Validity Code	No. Tests
Acceptable Calibration Test	AC	35
Failed Calibration Test	OC	20
Operationally Invalidated by Lab	LC, XC	1
Operationally Invalidated After Initially Reported as Valid	RC	1
Excluded For Other Reasons	NN	1
Total		**58**

Number of Labs Reporting Data: 9
Fail Rate of Operationally Valid Tests: 36%

D5800: Evaporation Loss of Lubricating Oil by Noack Method

Statistically Unacceptable Tests (OC)	No. Of Tests
Evaporation Loss Mild	7
Evaporation Loss Severe	13

- Failing results are across multiple labs, instruments and oils.
- Reason for operationally invalid results (two tests):
  - Daily calibration result not in specified limits
- One test (NN) on a new instrument (D4) reported as operationally valid but failed statistically, held out of statistics because instrument had not demonstrated a passing calibration. Subsequent run passed calibration.
- No technical memos issued this period

D5800: Evaporation Loss of Lubricating Oil by Noack Method

- Four instruments had two consecutive failing calibration attempts (OC) with a passing result on the third attempt.
  - All on either oil VOLC12 or VOLE12, none on mild performing oil VOLD12
  - Instruments A8, A10, B6, J5, where J5 repeated this pattern twice (fail, fail, pass)
    - All are NCK25G Models
- Two instruments had three consecutive failing runs, all reported as operationally valid (OC), and the instruments still haven't successfully calibrated as of 20141103.
  - Instruments A7 (Model NCK25G) & G4 (Model SVT1)
- Number of operationally valid results by oil:
  - VOLC12: 15 AC, 11 OC (3 mild, 8 severe)
  - VOLD12: 11 AC, 2 OC (2 mild)
  - VOLE12: 9 AC, 7 OC (3 mild, 4 severe)

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 10/1/2013	78	75	0.50	-----
10/1/11 through 3/31/12	32	29	0.78	0.54
4/1/12 through 9/30/12	33	30	0.67	0.56
10/1/12 through 3/31/13	33	30	0.79	0.43
4/1/13 through 9/30/13*	30	27	0.72	0.58
4/1/13 through 9/30/13*	27	24	0.46	0.31
10/1/13 through 3/31/14	38	34	0.59	0.37
4/1/14 through 9/30/14	55	52	1.04	0.38

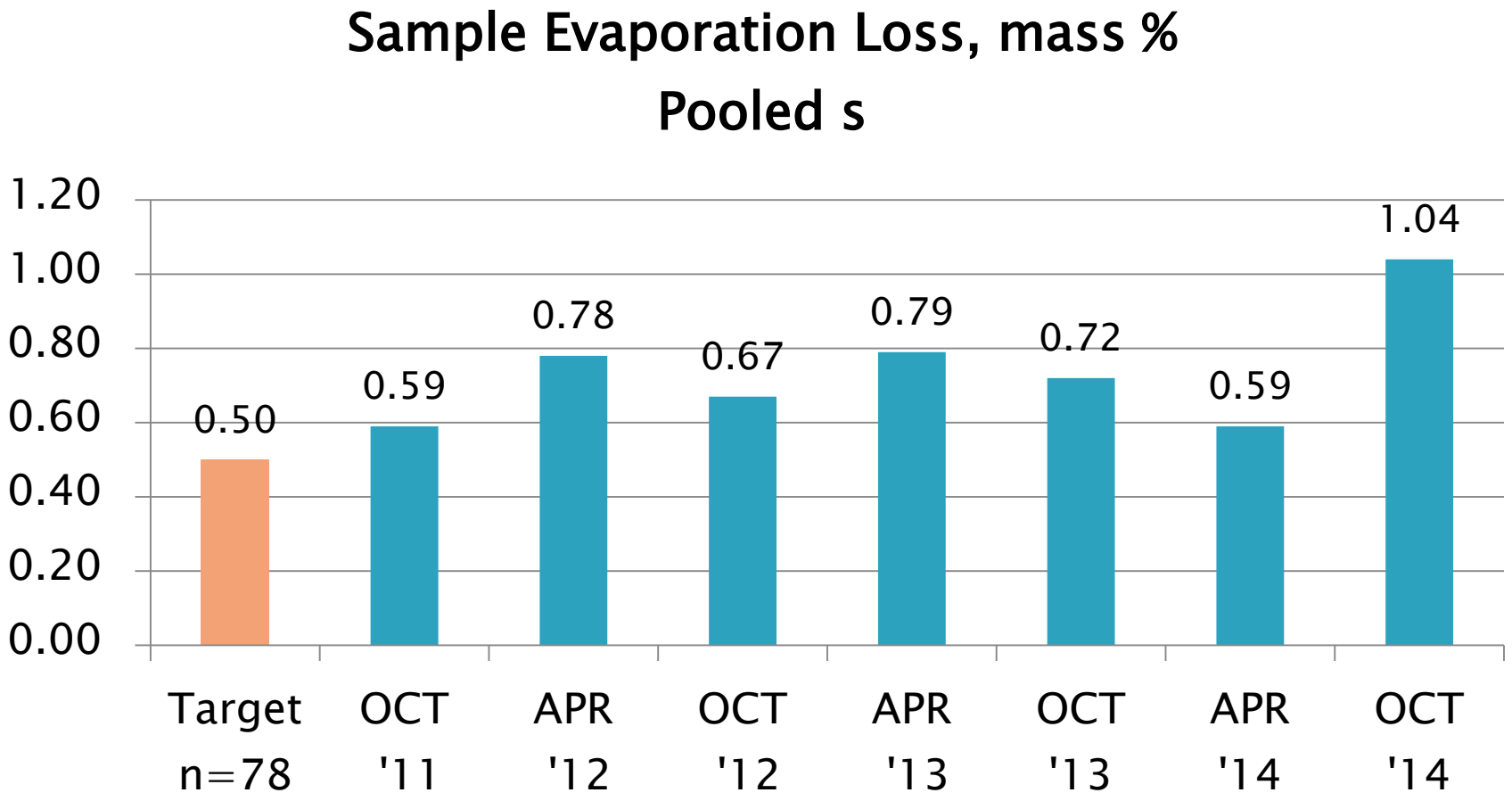
*Period statistics with 3 severe results on same instrument included and excluded

D5800: Evaporation Loss of Lubricating Oil by Noack Method

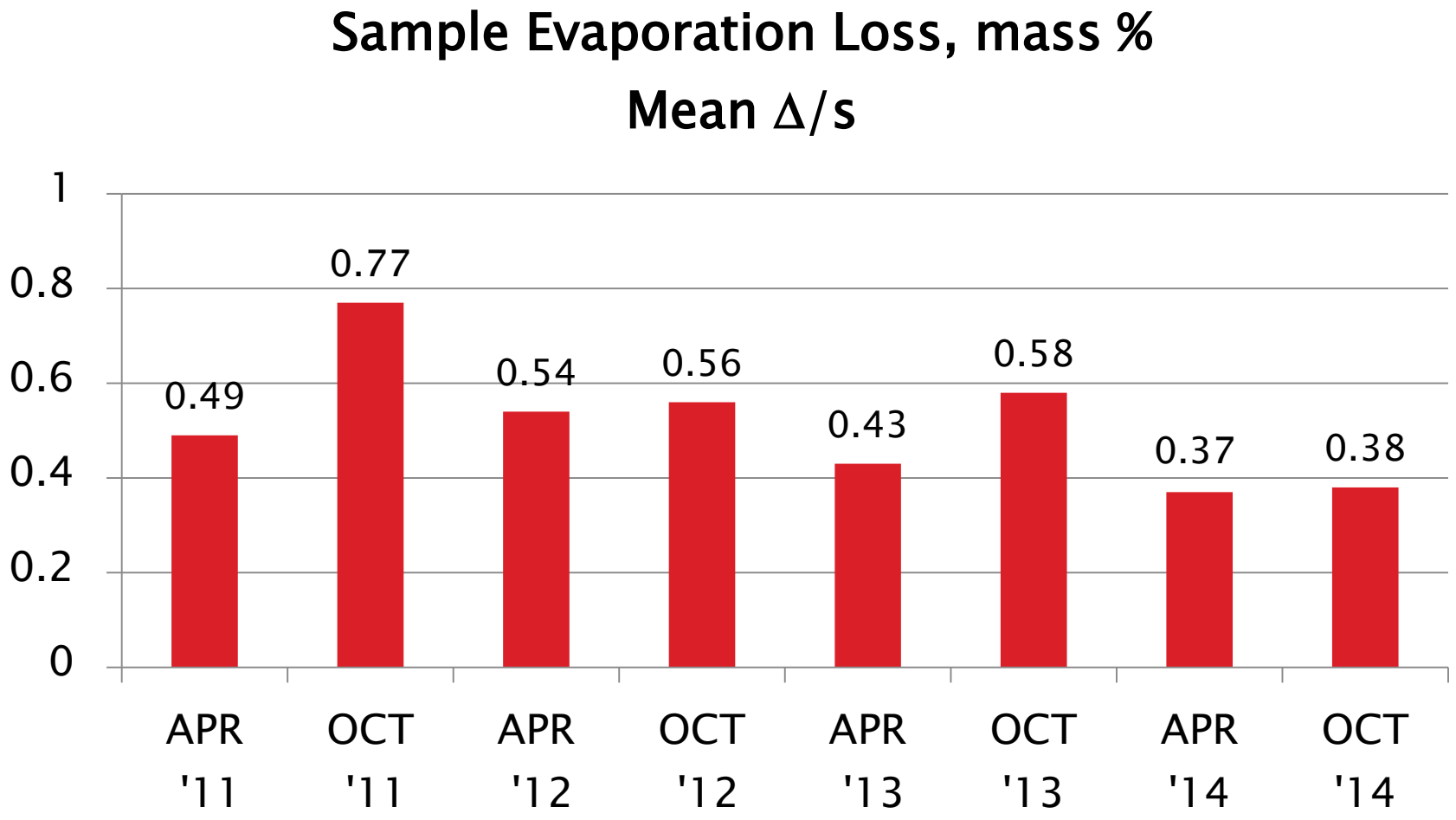
Performance Comparison by Procedure
Sample Evaporation Loss, Mass %

	n	df	Pooled s	Mean Δ/s
Procedure B	46	43	0.90	0.42
Procedure C	9	6	1.45	0.12

D5800 Precision Estimates



D5800 Severity Estimates



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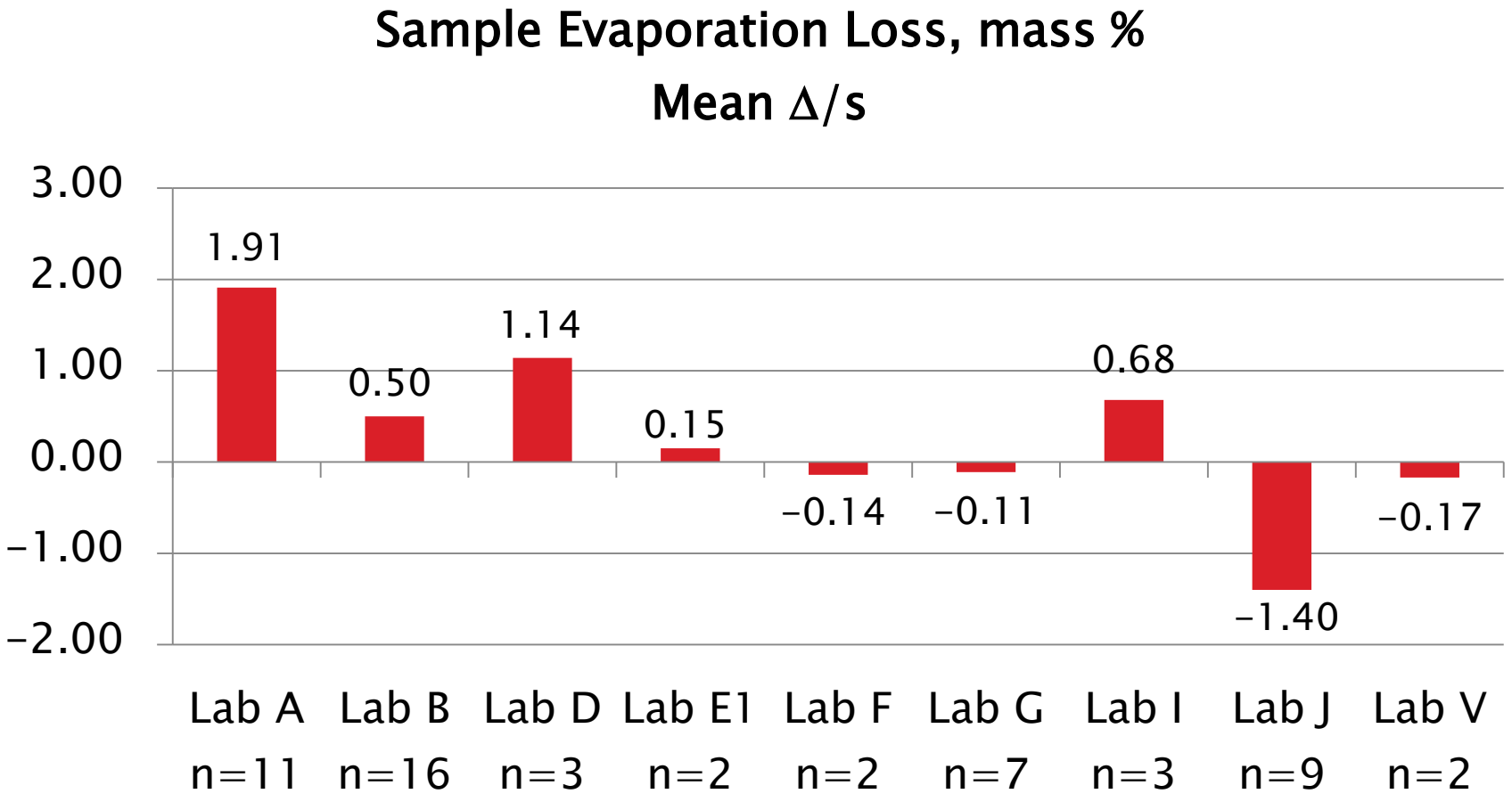
D5800: Evaporation Loss of Lubricating Oil by Noack Method

Current Period Severity Estimates by Lab
Sample Evaporation Loss, mass %

	n	Mean Δ/s
Lab A	11	1.91
Lab B	16	0.50
Lab D	3	1.14
Lab E1	2	0.15
Lab F	2	-0.14
Lab G	7	-0.11
Lab I	3	0.68
Lab J	9	-1.40
Lab V	2	-0.17

D5800 Lab Severity Estimates



D5800: Evaporation Loss of Lubricating Oil by Noack Method

- Precision (Pooled s), at 1.04 mass %, is significantly less precise than prior periods and compared to the new target precision (0.50 mass %).
- Performance (Mean Δ/s) is 0.38 s severe using new oil targets.
  - Comparable to last period, but with significantly worse precision and very high fail rate (36% of tests reported as operationally valid).
  - Period severity on VOLC12 is 1.05 s severe compared to 0.42 s last period
  - Period severity on VOLE12 is -0.58 s mild compared to 0.00 last period.
- Severity plot shows unexplained long-term severe trend since 01JUL06 timeline with recent decrease in severity following the introduction of the new reference oils, though still with overall severe performance and much worse precision.

D5800: Evaporation Loss of Lubricating Oil by Noack Method

Performance Comparison by Model
Sample Evaporation Loss, Mass %

	n	df	Pooled s	Mean Δ/s
NCK2	5	2	0.21	0.02
NCK25G	41	38	0.95	0.48
SNV1	1	0	---	-1.38
SVT1	8	5	1.59	0.31

D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA

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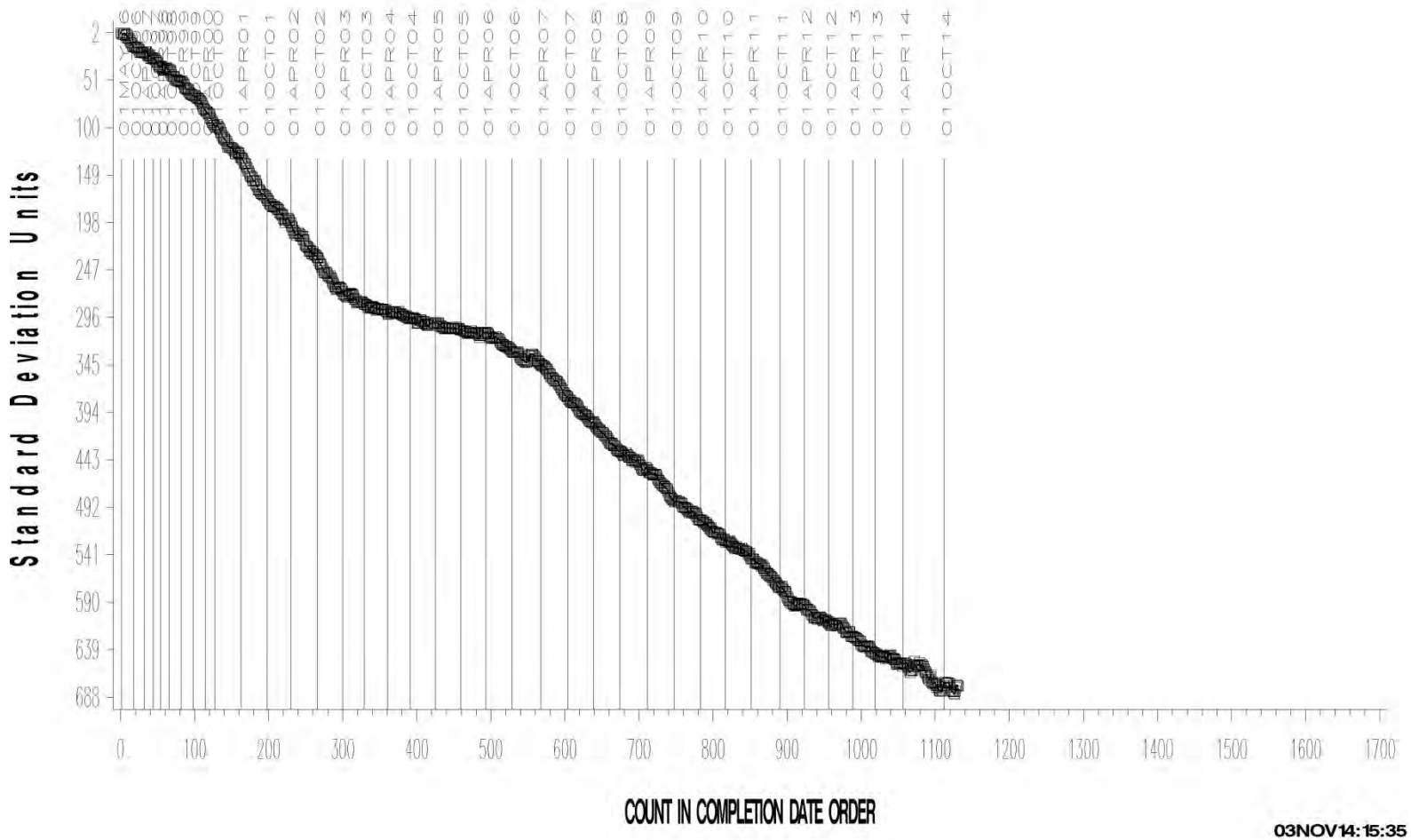
EVAPORATION LOSS, MASS%

CUSUM Severity Analysis



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D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA

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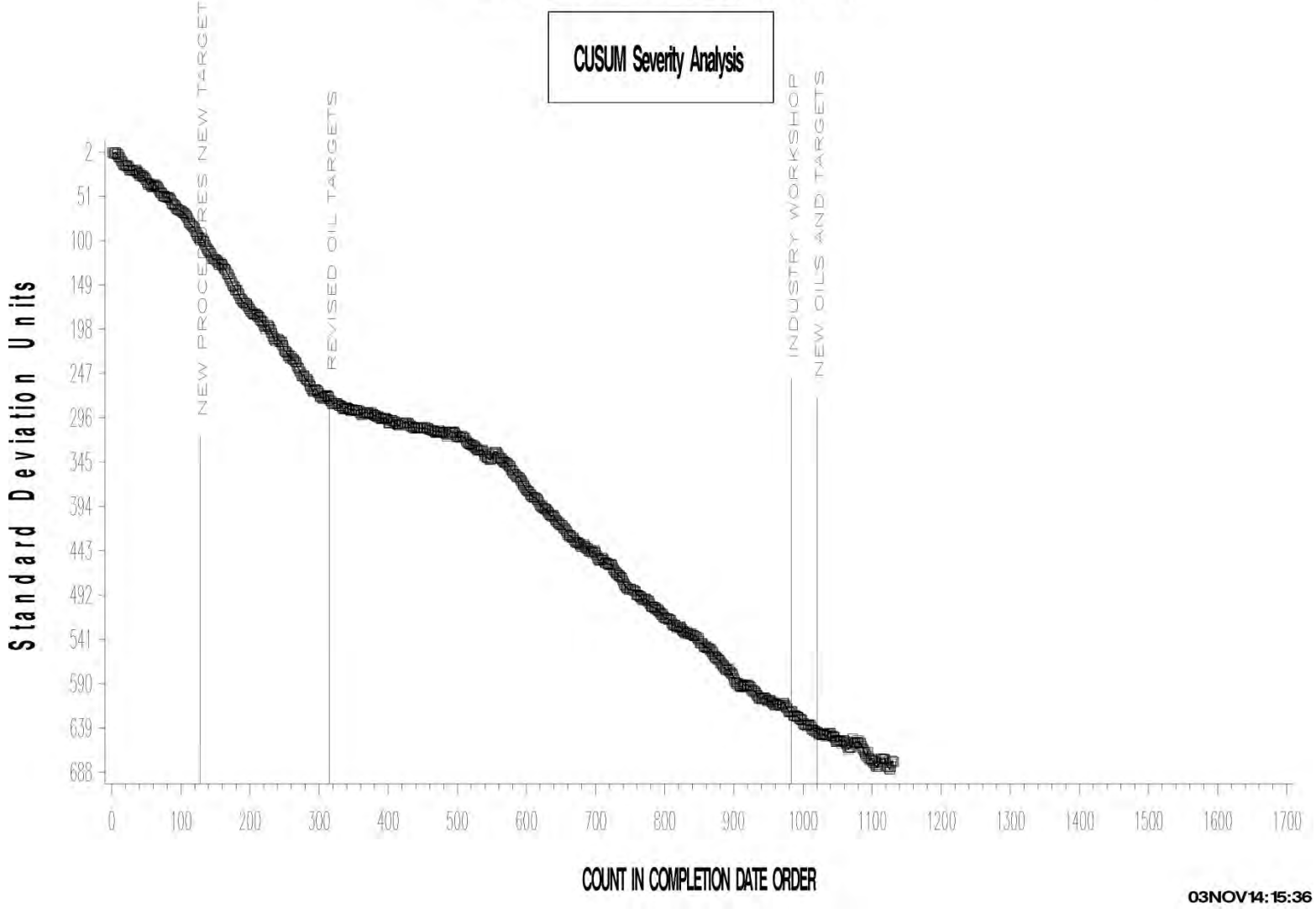
EVAPORATION LOSS, MASS%



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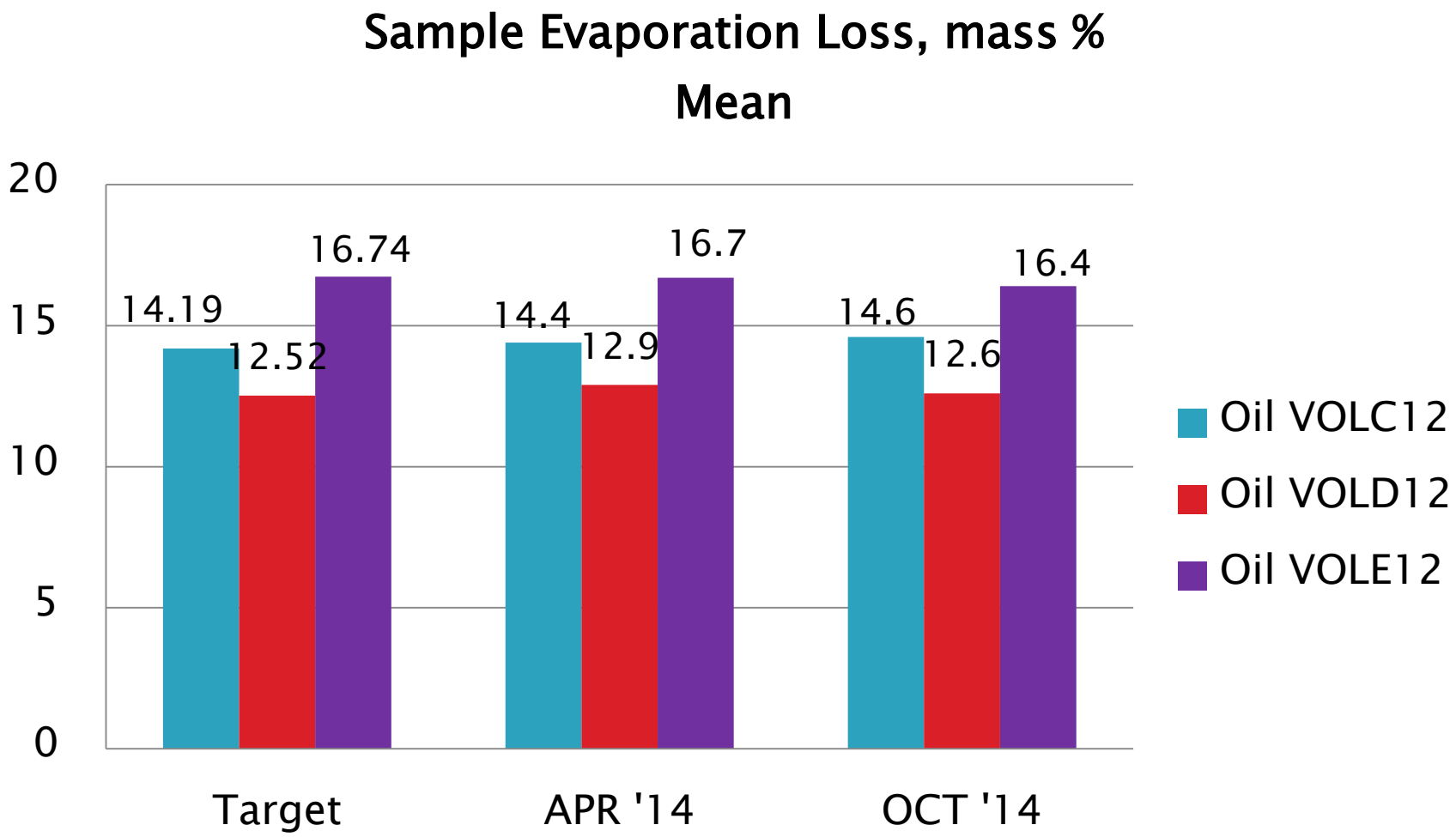
D5800: Evaporation Loss of Lubricating Oil by Noack Method

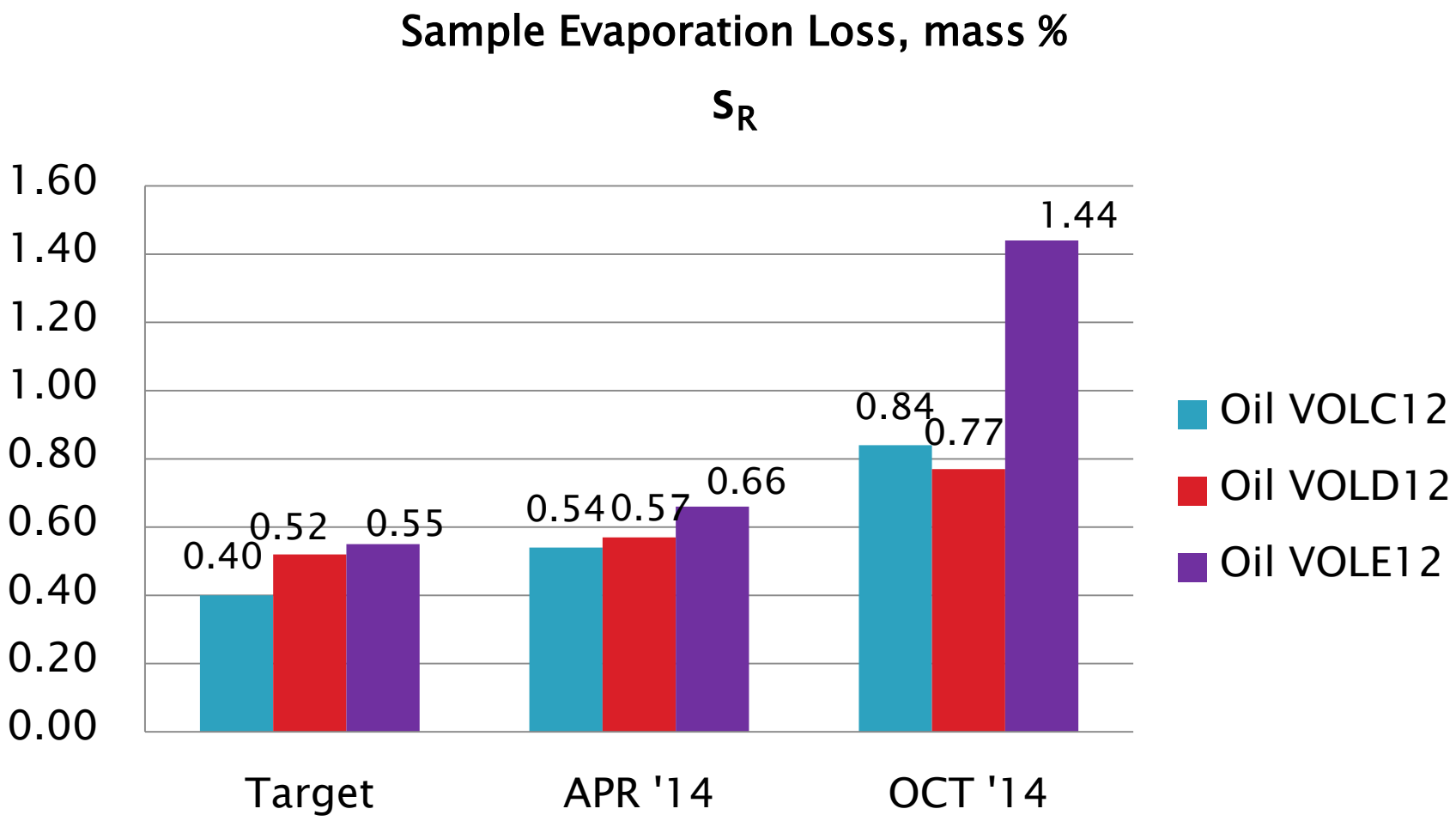
Sample Evaporation Loss, mass %
Performance by Oil

	Targets			4/1/13 – 9/30/13				10/1/13 – 3/31/14				4/1/134– 9/30/14			
Oil Code	n	Mean	s_R	n	Mean	s_R	Mean Δ/s	n	Mean	s_R	Mean Δ/s	n	Mean	s_R	Mean Δ/s
52	33	13.75	0.61	9	14.3	0.70	0.96	--	-----	-----	-----	--	-----	-----	-----
55	32	17.09	0.76	7	17.6	0.83	0.61	--	-----	-----	-----	--	-----	-----	-----
58	37	15.20	0.72	14	15.4	0.67	0.32	--	-----	-----	-----	--	-----	-----	-----
VOLC12	24	14.19	0.40	--	-----	-----	-----	14	14.4	0.54	0.42	26	14.6	0.84	1.05
VOLD12	27	12.52	0.52	--	-----	-----	-----	11	12.9	0.57	0.59	13	12.6	0.77	0.21
VOLE12	27	16.74	0.55	--	-----	-----	-----	12	16.7	0.66	0.00	16	16.4	1.44	-0.58

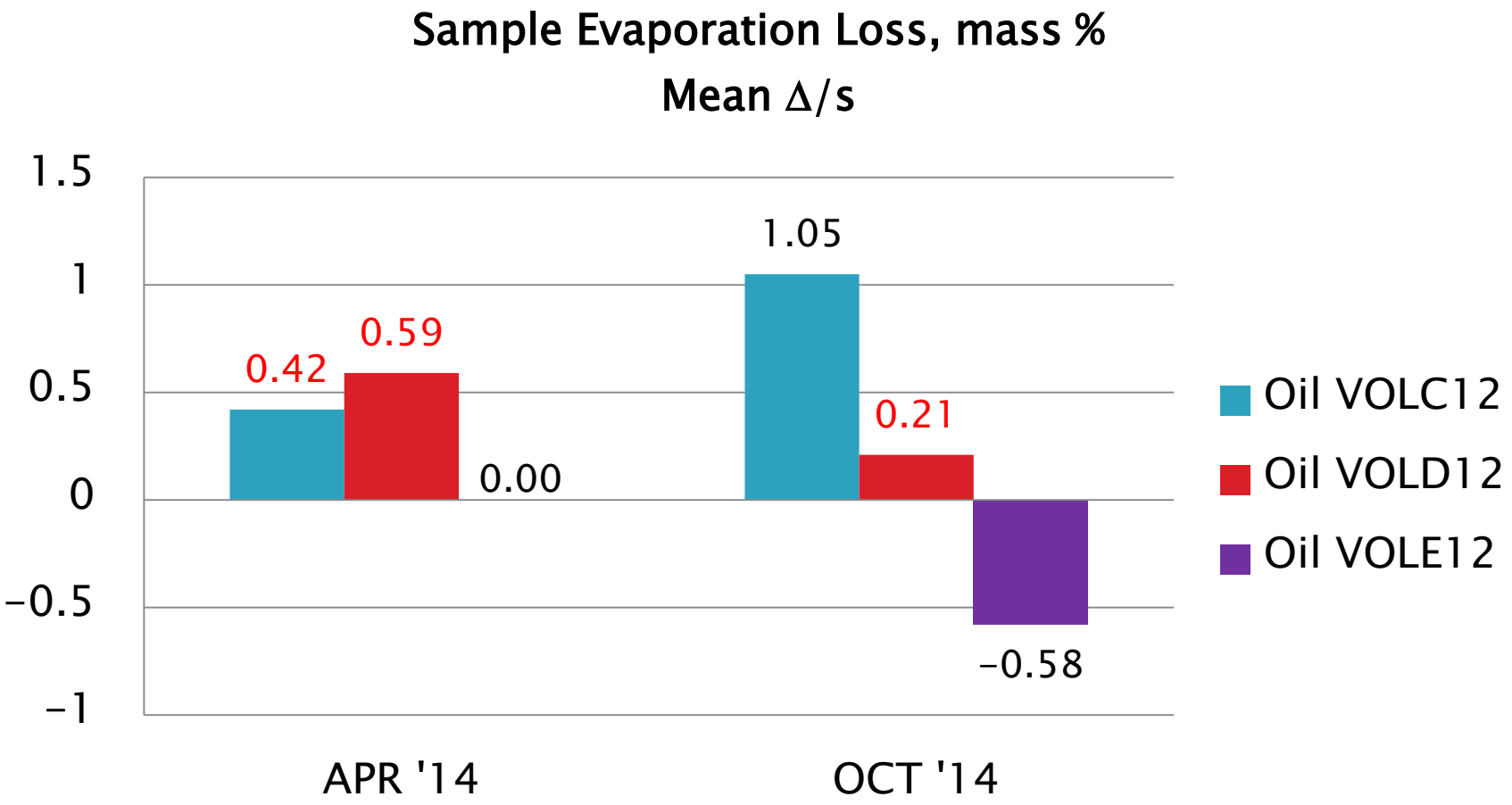
D5800 Performance by Oil



D5800 Performance by Oil



D5800 Performance by Oil



Return to Executive Summary

D5133: Gelation Index

Test Status	Validity Code	No. Tests
Acceptable Calibration Test	AC	21
Failed Calibration Test	OC	3
Operationally Invalidated by Lab	LC, XC	0
Operationally Invalidated After Initially Reported as Valid	RC	0
Total		**24**

Number of Labs Reporting Data: 4
Fail Rate of Operationally Valid Tests: 12%

D5133: Gelation Index

Statistically Unacceptable Tests (OC)	No. Of Tests
Gelation Index Mild	3
Gelation Index Severe	0

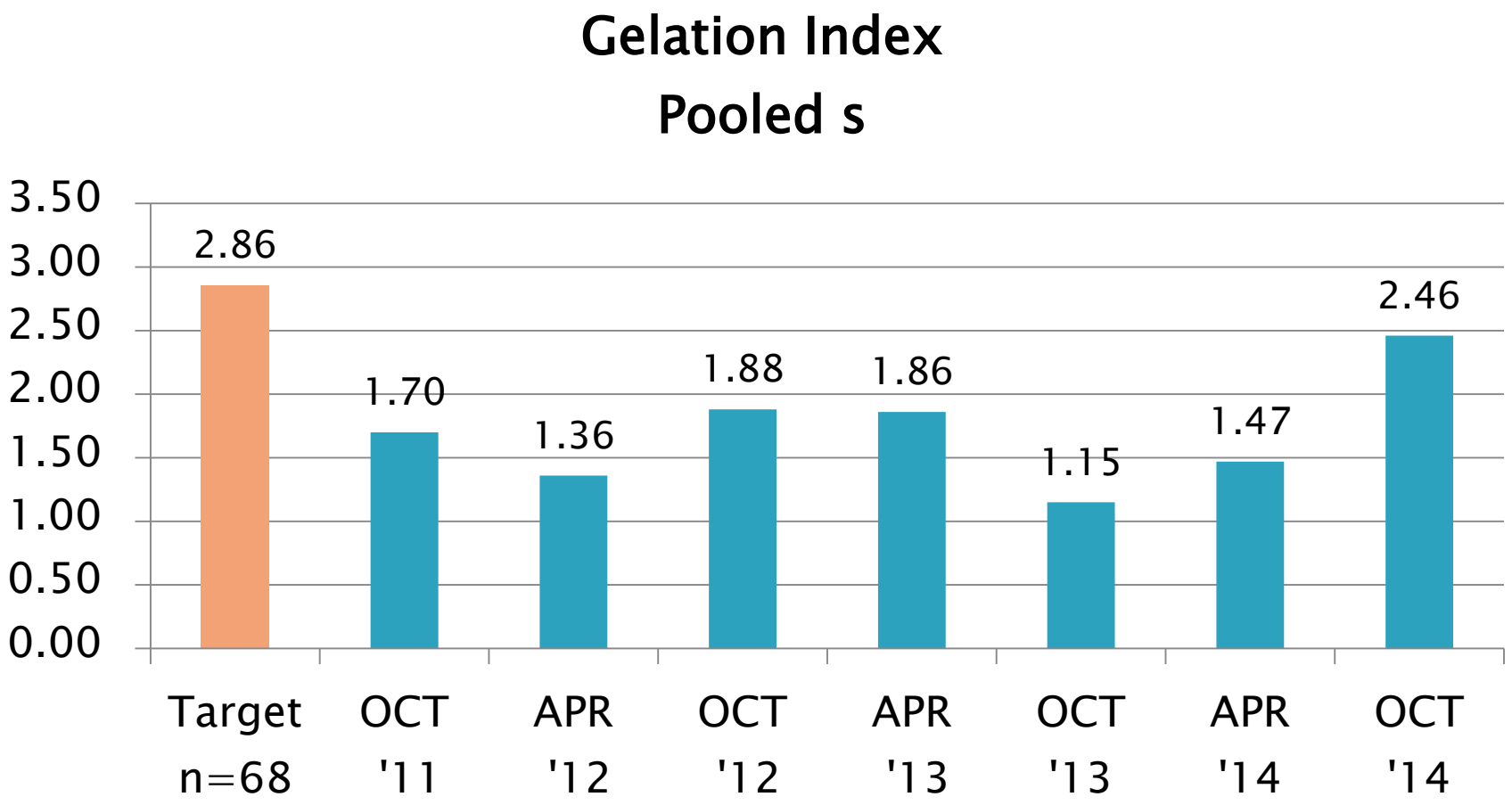
- No operationally invalid tests reported this period
- No TMC technical updates issued this period

D5133: Gelation Index

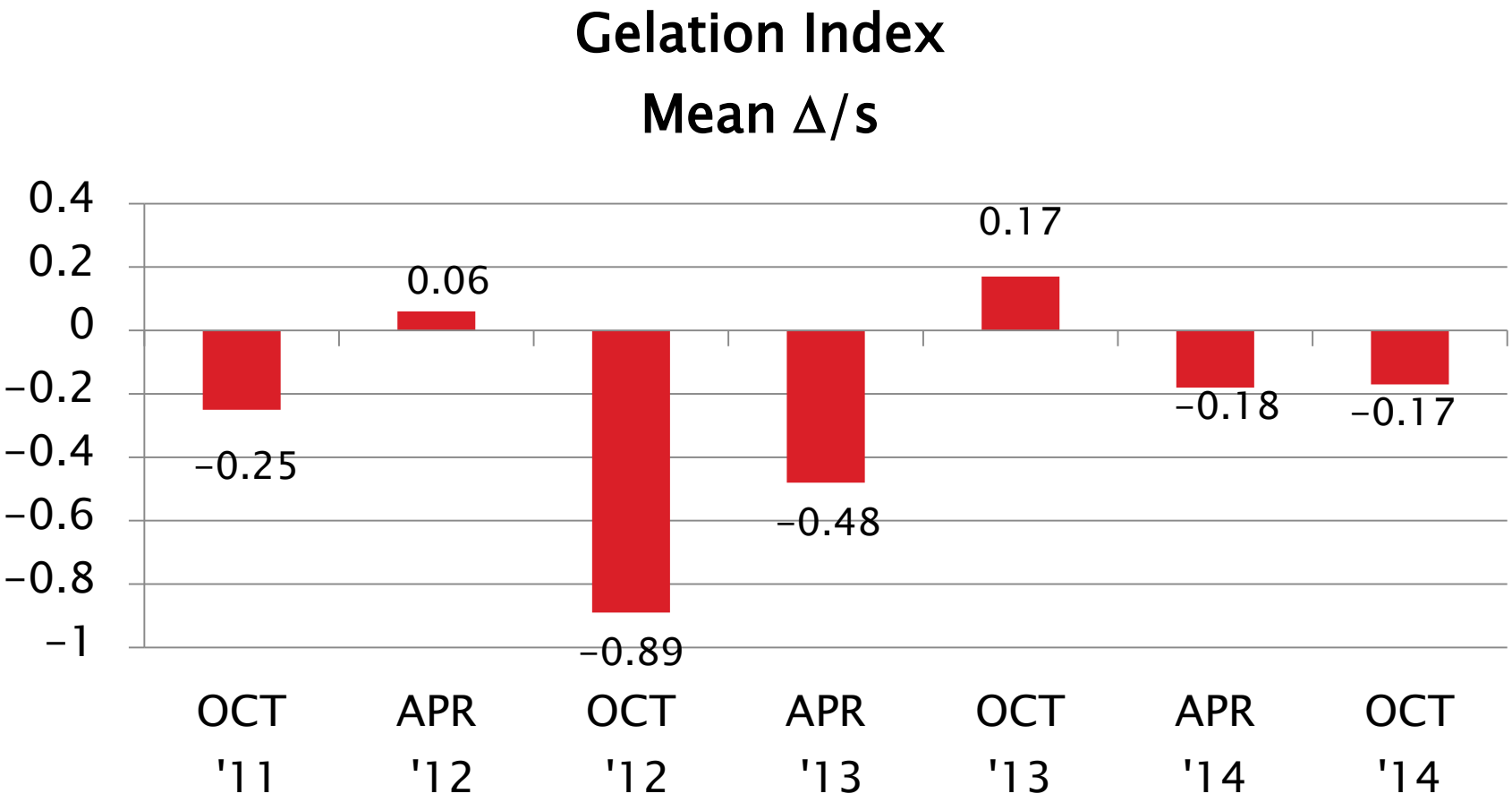
Period Precision and Severity Estimates

Gelation Index	n	df	Pooled s	Mean Δ/s
Current Targets 7/15/2003	68	65	2.86	-----
4/1/11 through 9/30/11	23	20	1.70	-0.25
10/1/11 through 3/31/12	24	21	1.36	0.06
4/1/12 through 9/30/12	24	21	1.88	-0.89
10/1/12 through 3/31/13	22	19	1.86	-0.48
4/1/13 through 9/30/13	19	16	1.15	0.17
10/1/13 through 3/31/14	14	11	1.47	-0.18
4/1/14 through 9/30/14	24	21	2.46	-0.17

D5133 Precision Estimates



D5133 Severity Estimates



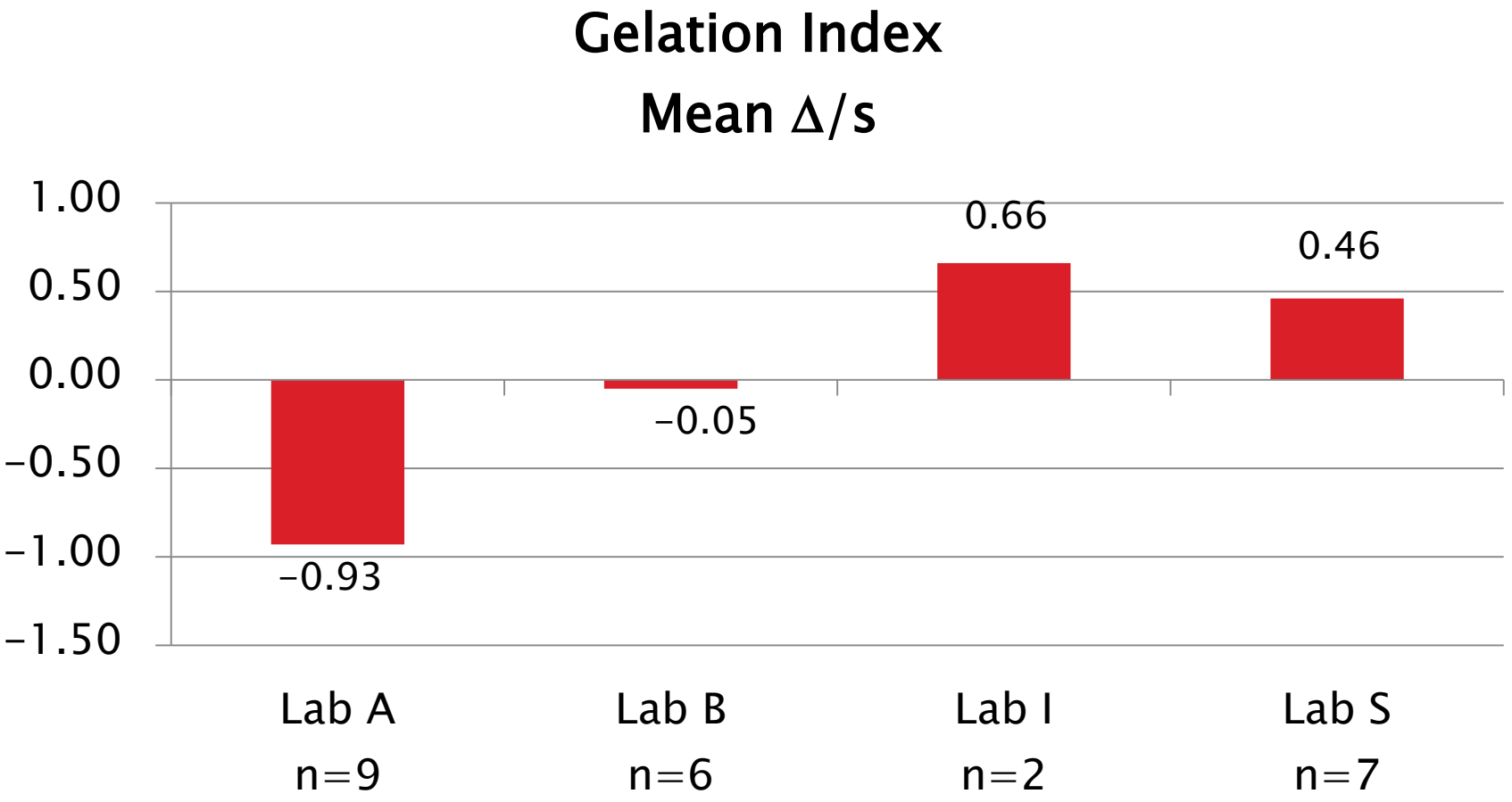
D5133: Gelation Index

Current Period Severity Estimates by Lab

Gelation Index

	n	Mean Δ/s
Lab A	9	-0.93
Lab B	6	-0.05
Lab I	2	0.66
Lab S	7	0.46

D5133 Lab Severity Estimates



D5133: Gelation Index

- Precision (Pooled s) is considerably less precise than prior period
  - More precise than target precision
- Performance (Mean Δ/s) is -0.17 s mild

D5133 GELATION INDEX INDUSTRY OPERATIONALLY VALID DATA

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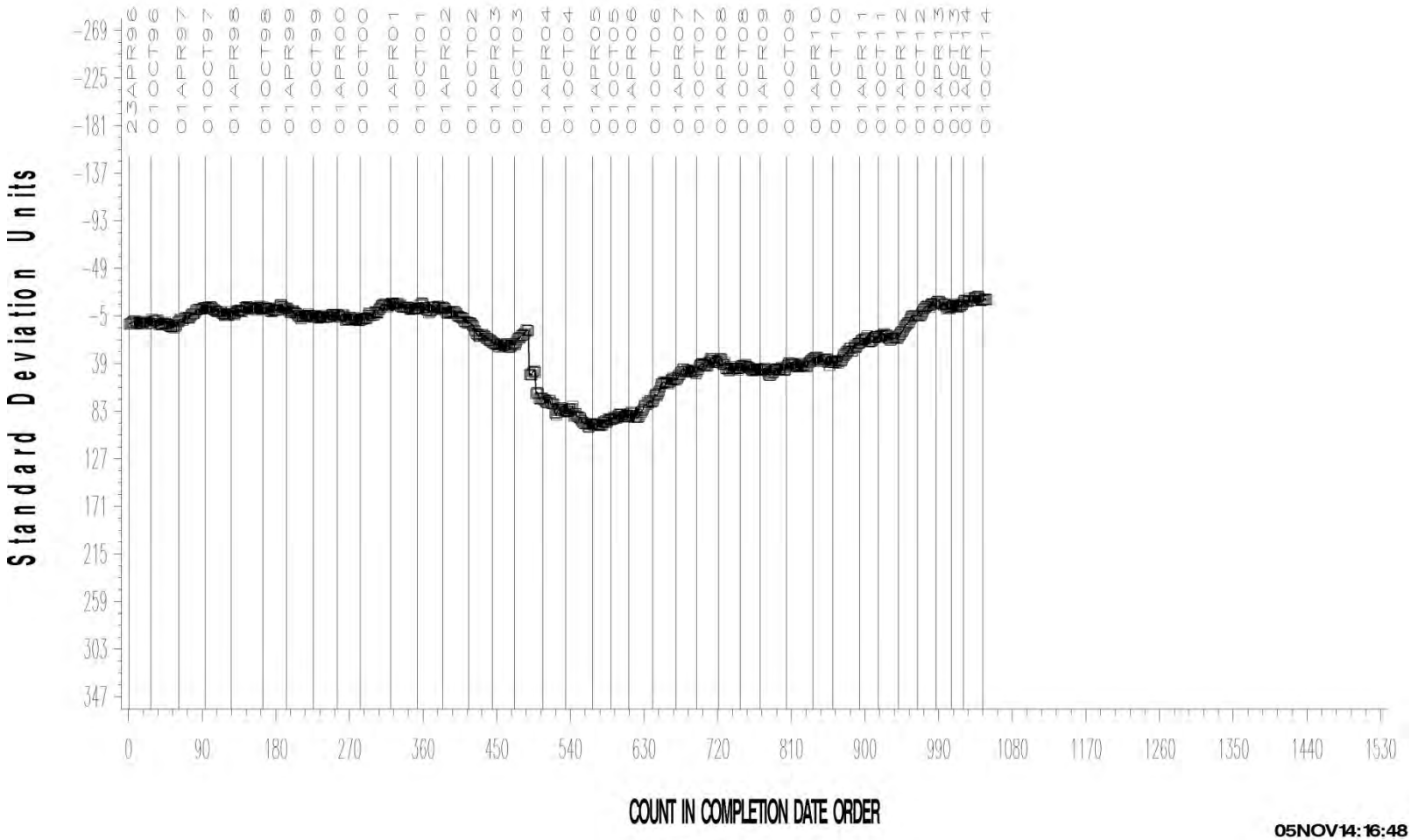
GELATION INDEX

CUSUM Severity Analysis



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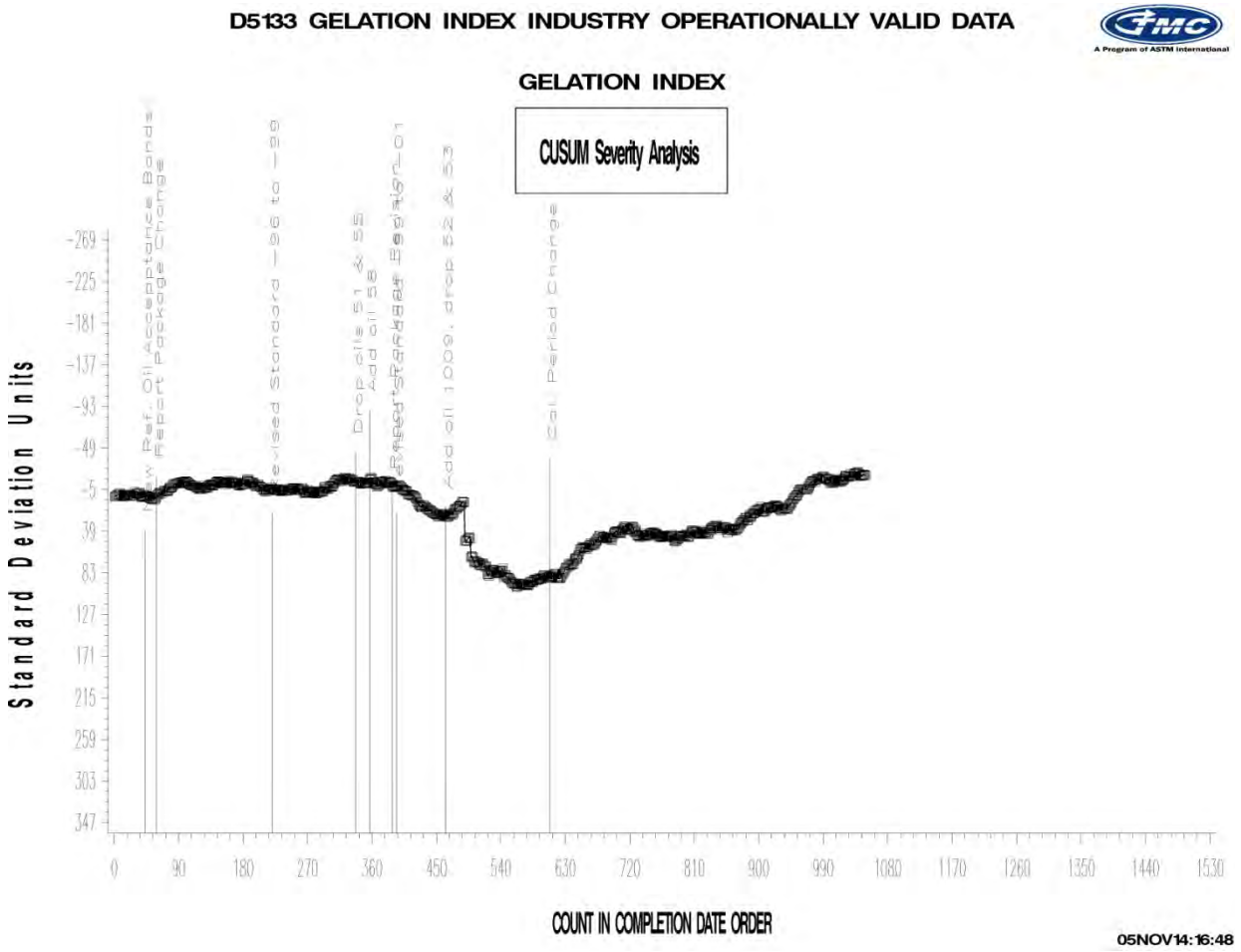
D5133: Gelation Index

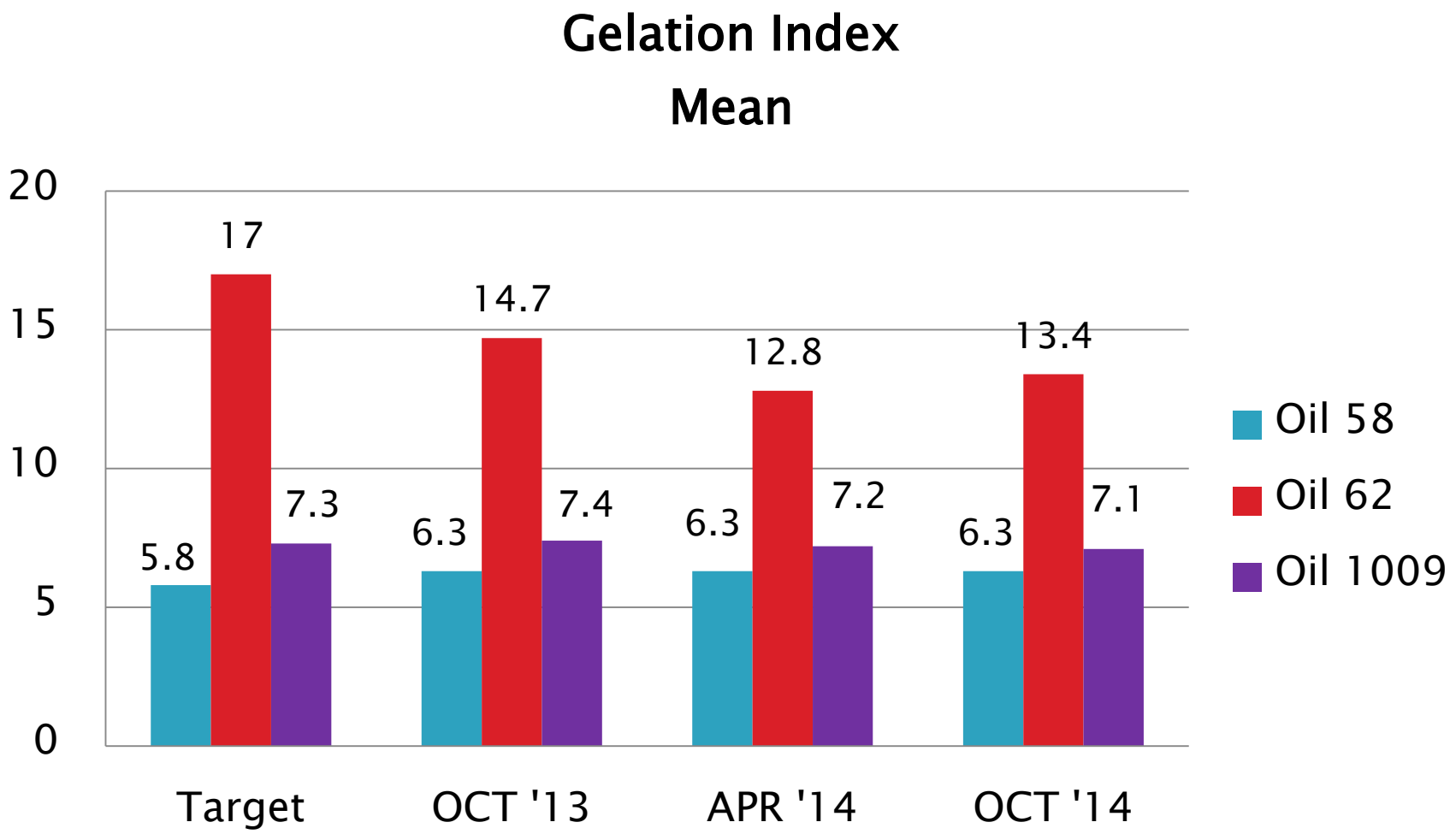


D5133 Performance by Oil

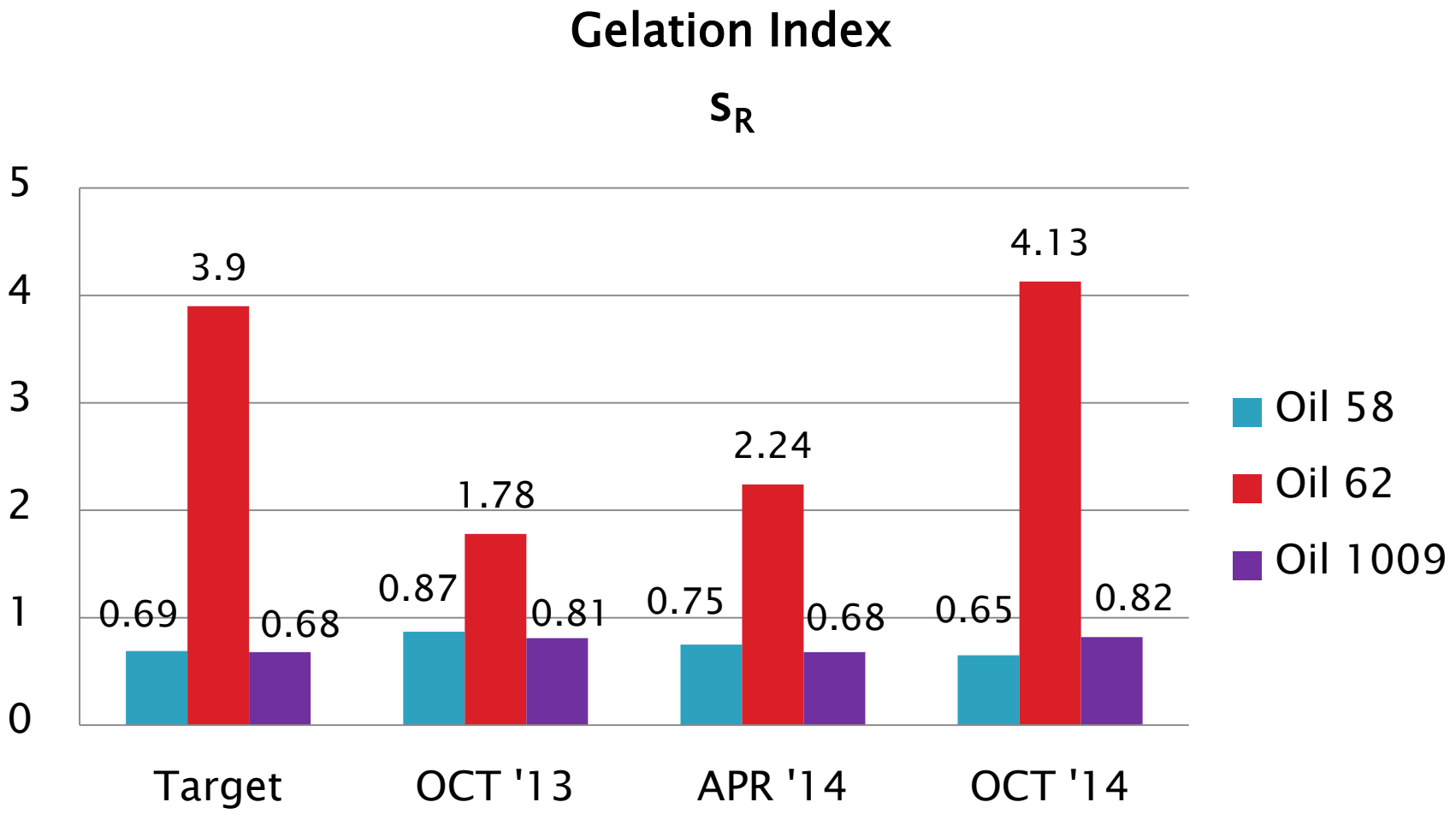
Gelation Index
Performance by Oil

	Targets			4/1/13 – 9/30/13				10/1/13 – 3/31/14				4/1/14 – 9/30/14			
Oil Code	n	Mean	s_R	n	Mean	s_R	Mean Δ/s	n	Mean	s_R	Mean Δ/s	n	Mean	s_R	Mean Δ/s
58	17	5.8	0.69	6	6.3	0.87	0.75	5	6.3	0.75	0.75	8	6.3	0.65	0.76
62	35	17.0	3.90	5	14.7	1.78	-0.59	5	12.8	2.24	-1.08	8	13.4	4.13	-0.92
1009	16	7.30	0.68	8	7.4	0.81	0.20	4	7.2	0.68	-0.22	8	7.1	0.82	-0.35

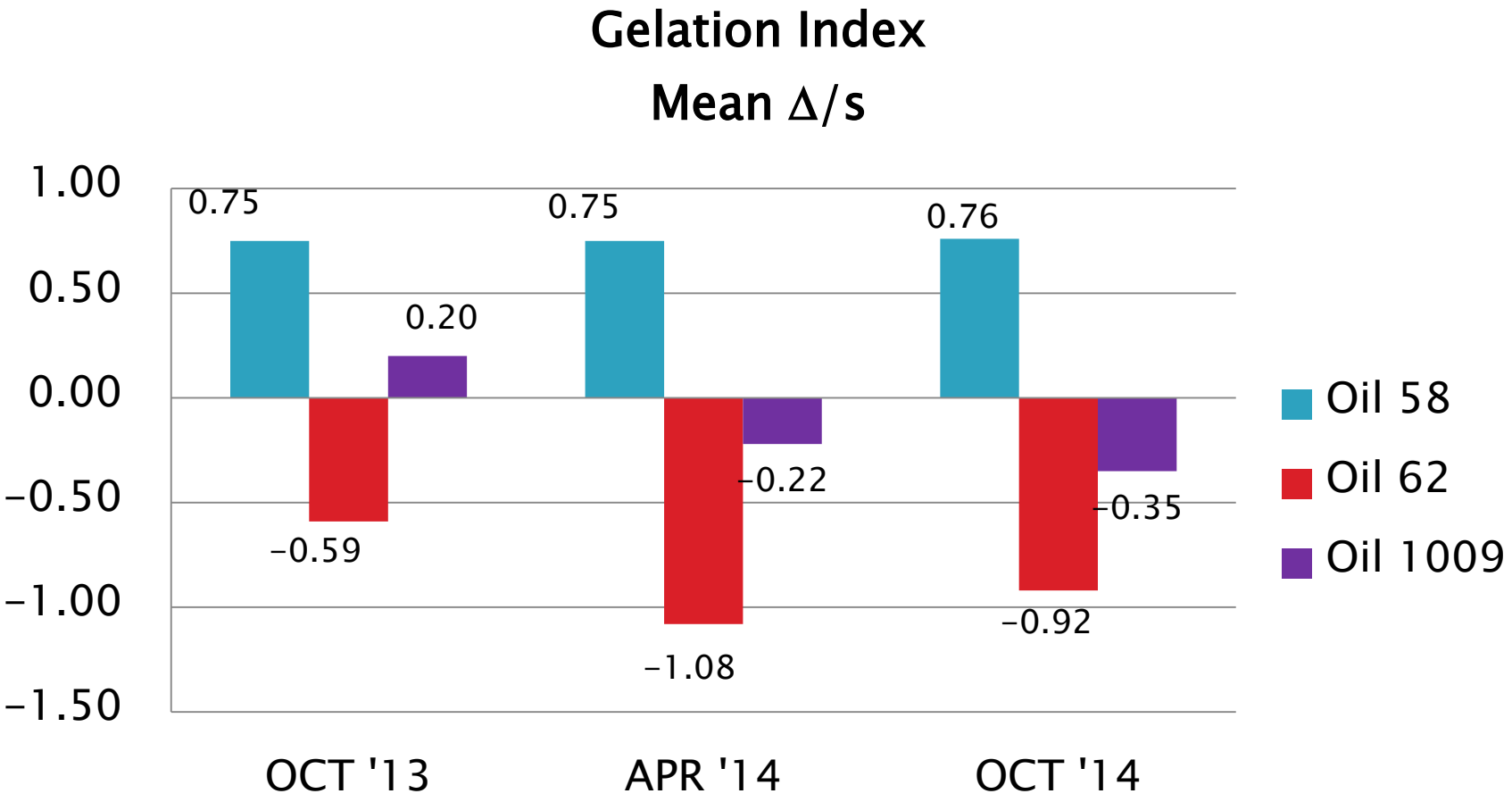
D5133 Performance by Oil



D5133 Performance by Oil



D5133 Performance by Oil



Return to Executive Summary

D6335: Deposits by TEOST-33C

Test Status	Validity Code	No. Tests
Acceptable Calibration Test	AC	14
Failed Calibration Test	OC	1
Operationally Invalidated by Lab	LC, XC	2
Operationally Invalidated After Initially Reported as Valid	RC	0
Total		**17**

Number of Labs Reporting Data: 5
Fail Rate of Operationally Valid Tests: 7%

D6335: Deposits by TEOST-33C

Statistically Unacceptable Tests (OC)	No. Of Tests
Total Deposits Mild	0
Total Deposits Severe	1

- Two operationally invalid tests reported this period:
  - One invalidated (LC) due to incorrect thermocouple depth immediately following a severe fail (OC)
  - One aborted by lab (XC) because of external debris contamination (broken glass) in the oxidized sample

D6335: Deposits by TEOST-33C

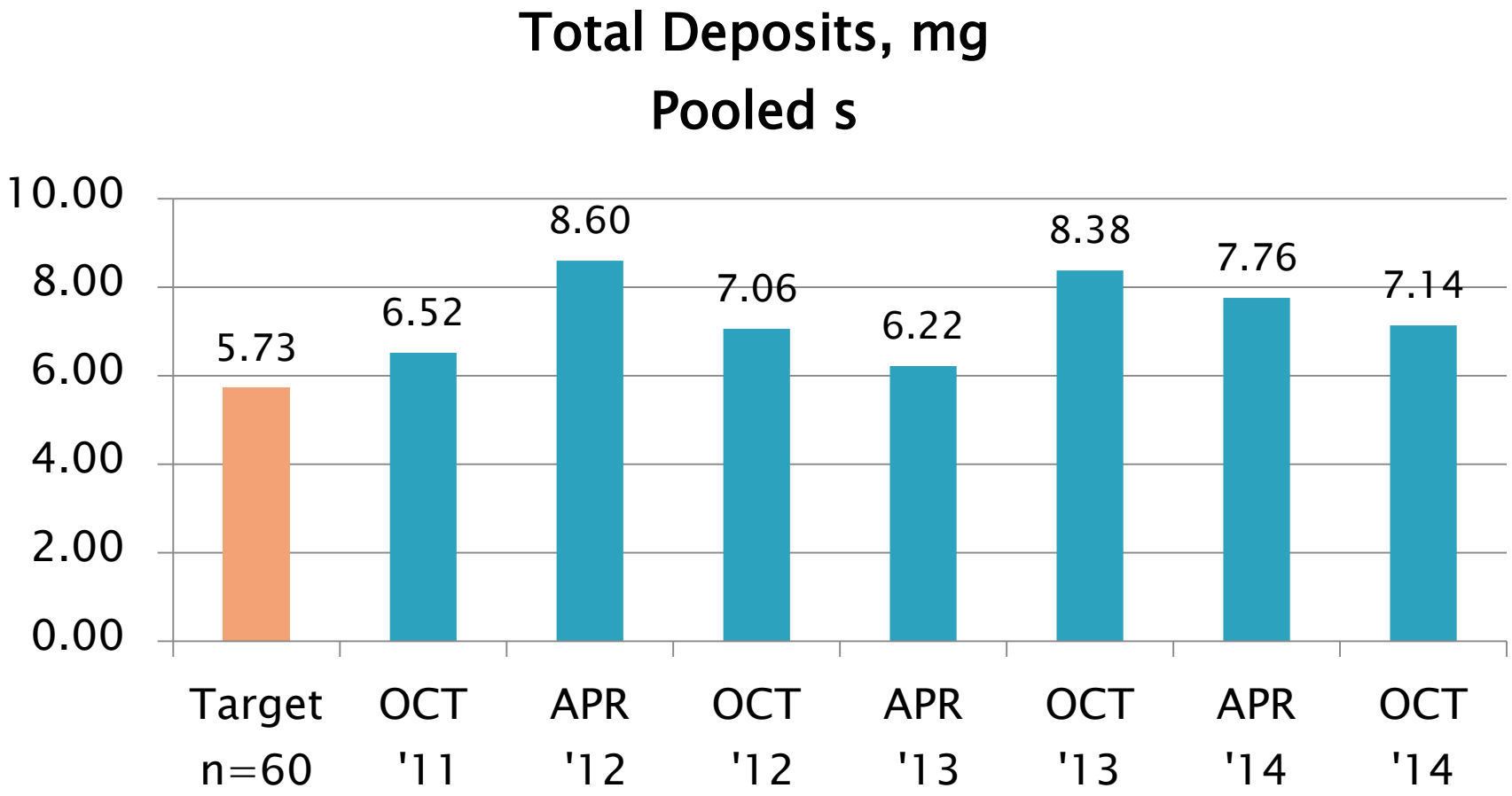
- No TMC technical updates issued this period

D6335: Deposits by TEOST-33C

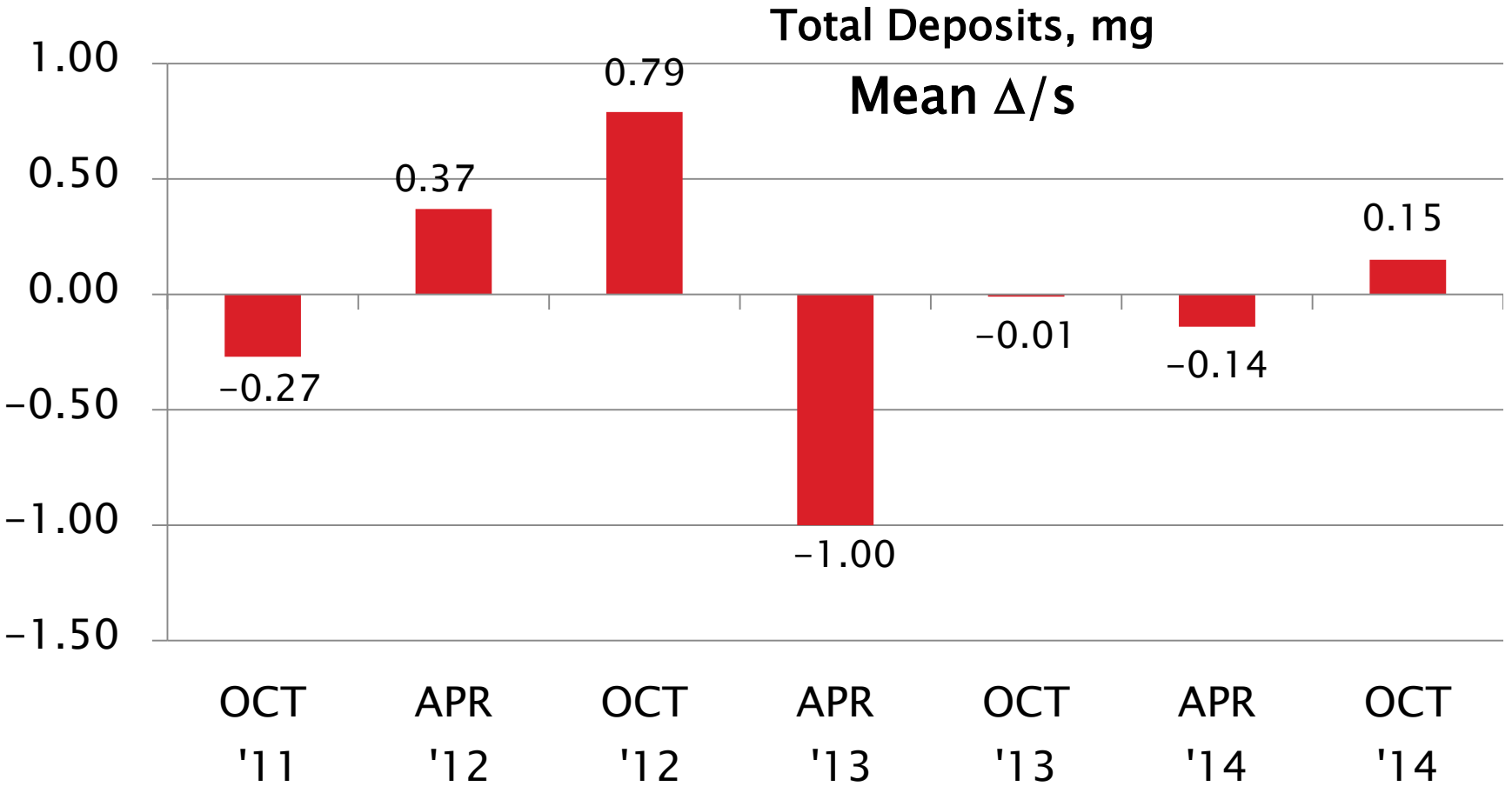
Period Precision and Severity Estimates

Total Deposits, mg	n	df	Pooled s	Mean Δ/s
Updated Targets 20130415	60	58	5.73	-----
4/1/11 through 9/30/11	19	15	6.52	-0.27
10/1/11 through 3/31/12	16	12	8.60	0.37
4/1/12 through 9/30/12	18	15	7.06	0.79
10/1/12 through 3/31/13	22	20	6.22	-1.00
4/1/13 through 9/30/13	17	15	8.38	-0.01
10/1/13 through 3/31/14	16	14	7.76	-0.14
4/1/14 through 9/30/14	15	13	7.14	0.15

D6335 Precision Estimates



D6335 Severity Estimates

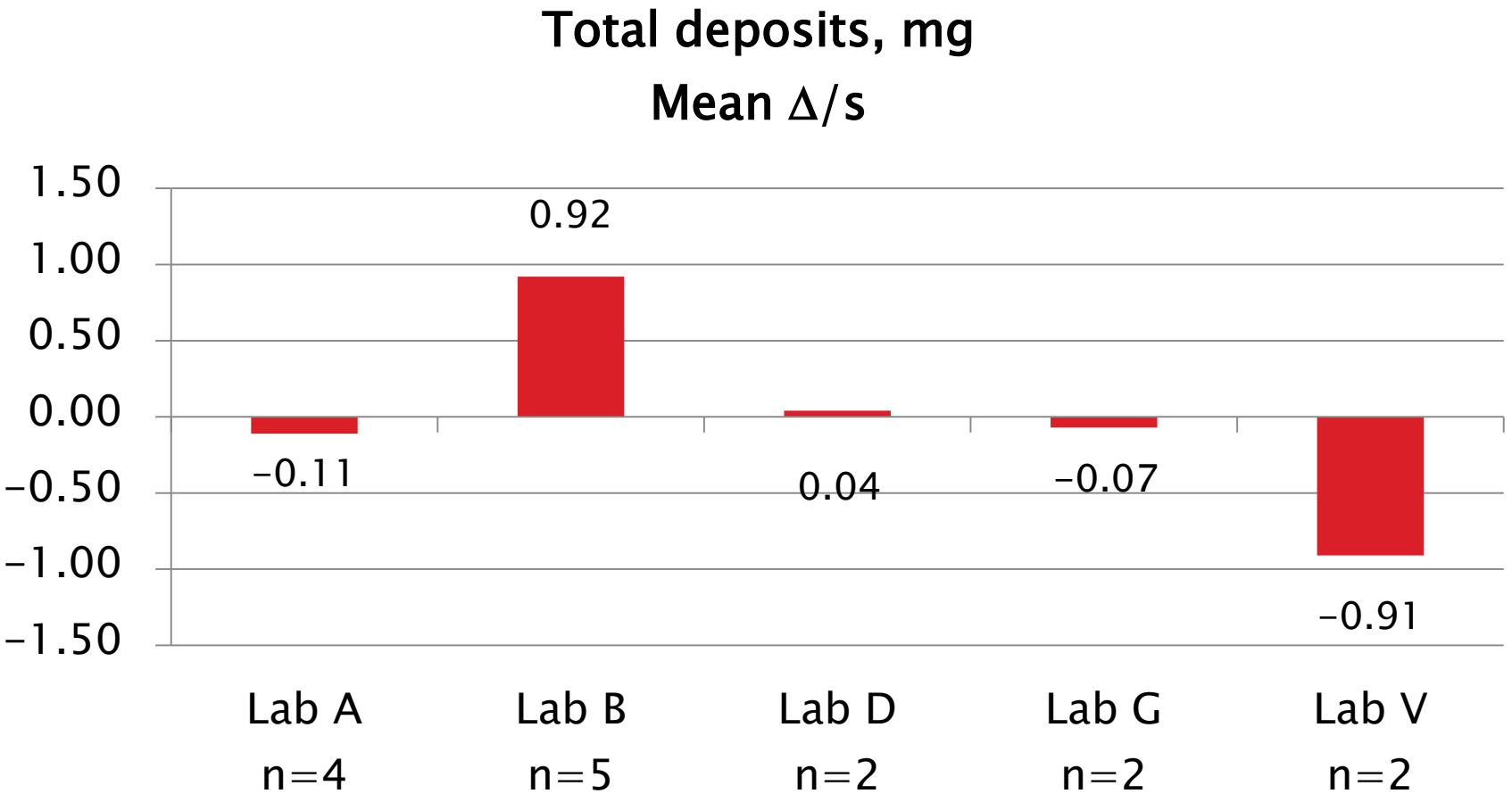


D6335: Deposits by TEOST-33C

Current Period Severity Estimates by Lab
Total Deposits, mg

	n	Mean Δ/s
Lab A	4	-0.11
Lab B	5	0.92
Lab D	2	0.04
Lab G	2	-0.07
Lab V	2	-0.91

D6335 Lab Severity Estimates



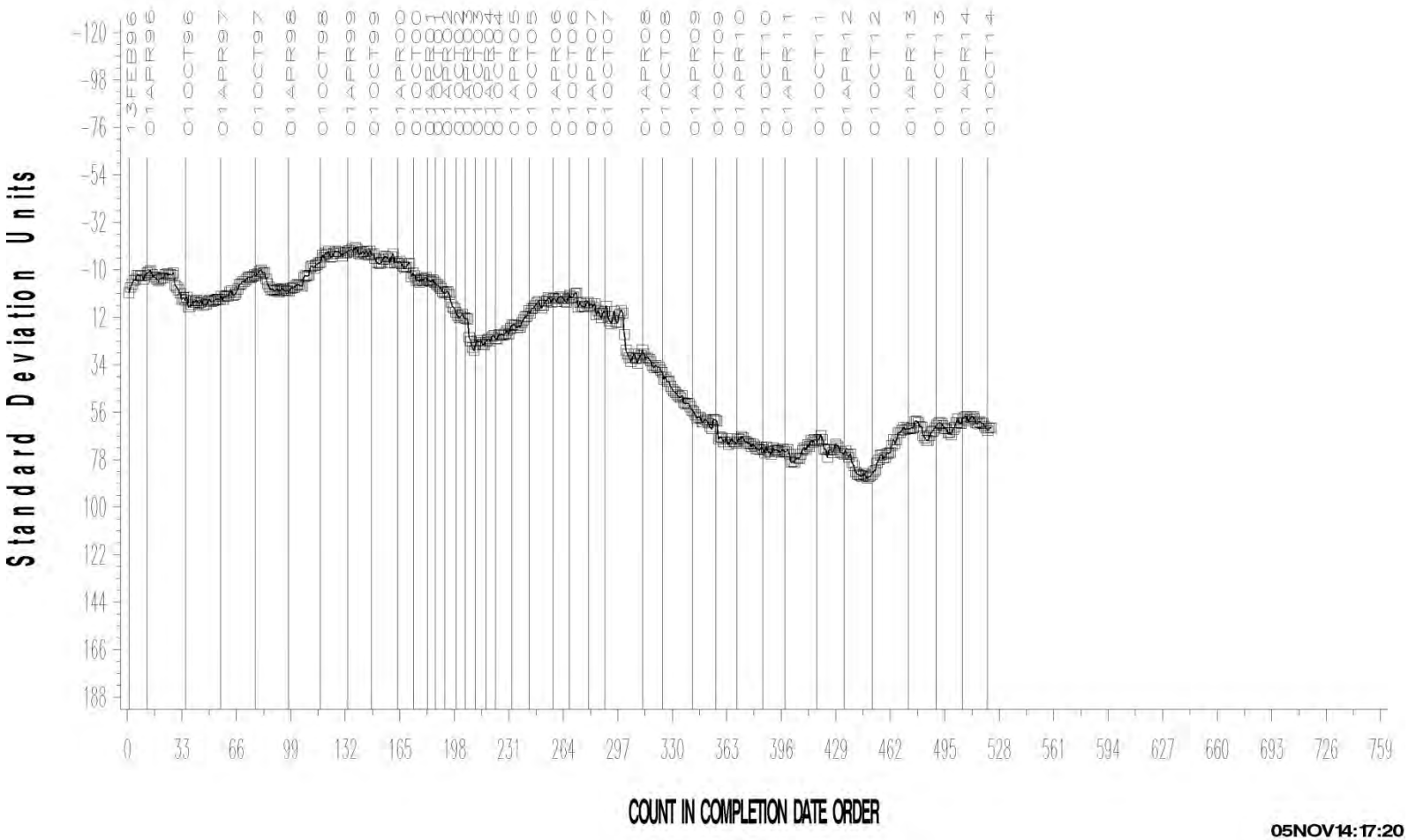
D6335: Deposits by TEOST-33C

- Precision (Pooled s) is more precise than prior period
  - Less precise than target precision
- Performance (Mean Δ/s) is 0.15 s severe
- All tests this period report using Rod Batches K or L

TEOST—33C INDUSTRY OPERATIONALLY VALID DATA

TOTAL DEPOSITS MG

CUSUM Severity Analysis



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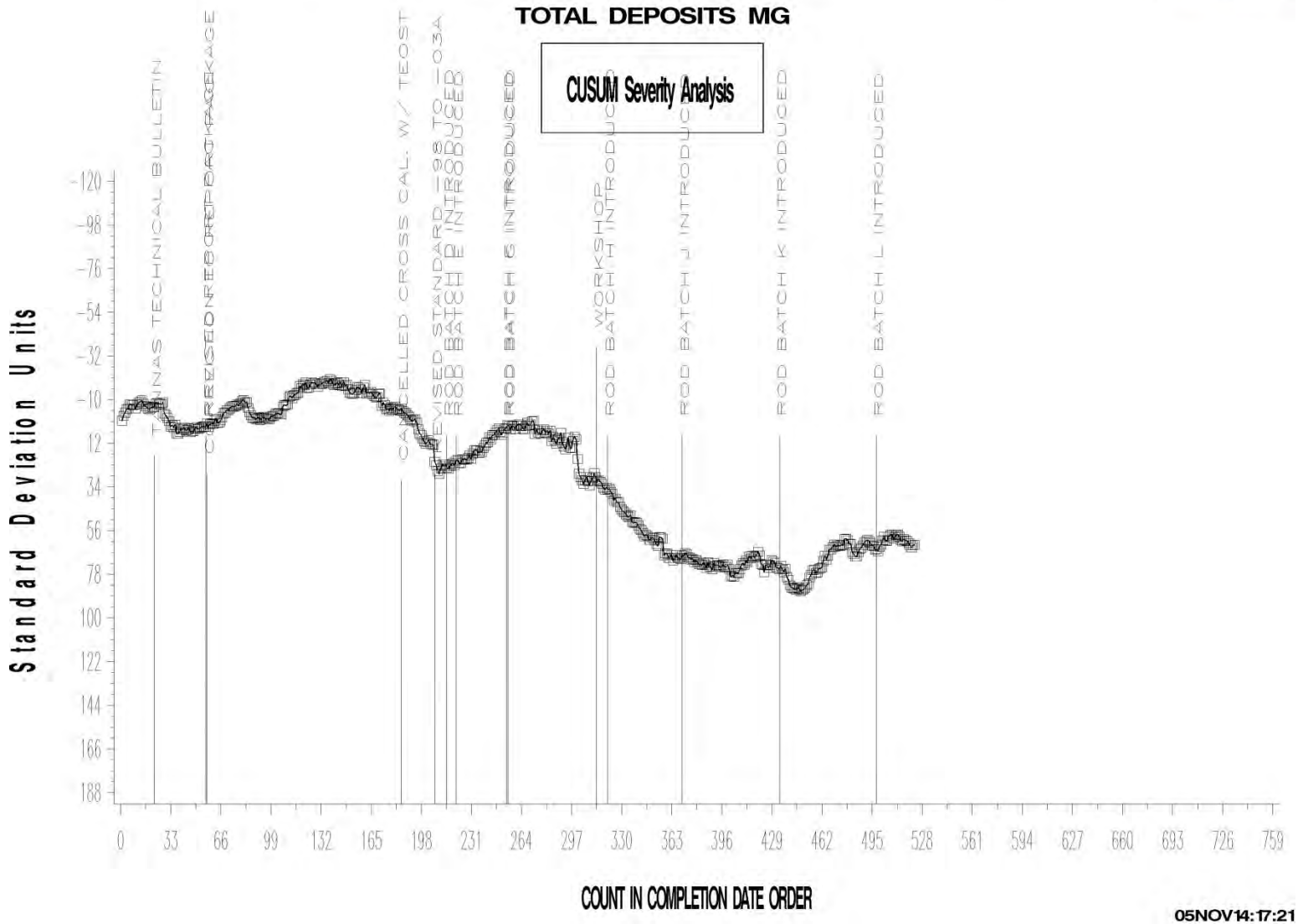
TEOST–33C INDUSTRY OPERATIONALLY VALID DATA



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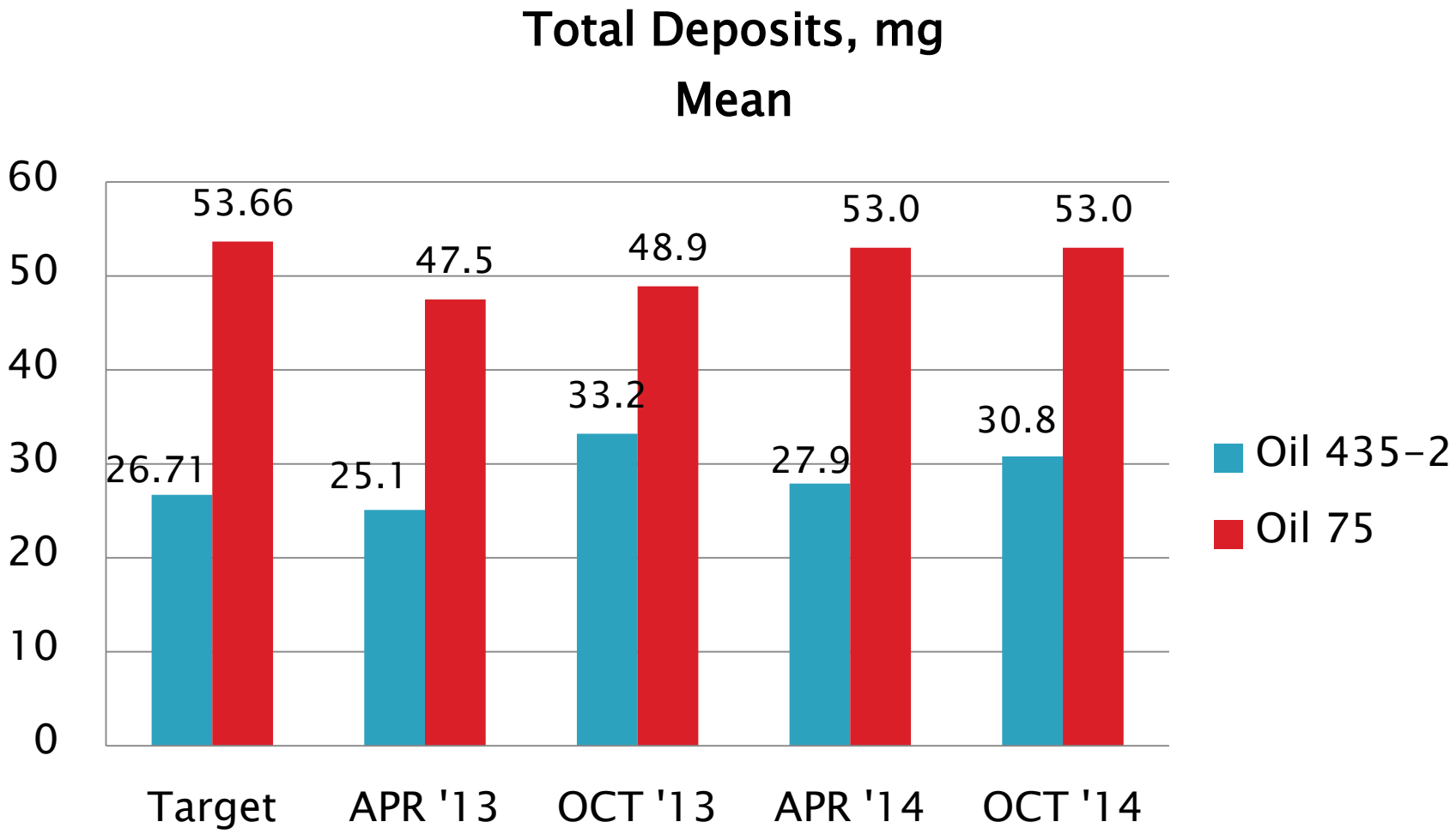
D6335 Performance by Oil

Total Deposits, mg
Performance by Oil

	Targets 20130415			4/1/13 – 9/30/13				10/1/13 – 3/31/14				4/1/14 – 9/30/14			
Oil Code	n	Mean	s_R	n	Mean	s_R	Mean Δ/s	n	Mean	s_R	Mean Δ/s	n	Mean	s_R	Mean Δ/s
435-2	30	26.71	4.76	7	33.2	7.16	1.00	9	27.9	6.70	-0.17	7	30.8	4.99	0.44
75	30	53.66	6.56	10	48.9	9.10	-0.72	7	53.0	9.00	-0.10	8	53.0	8.57	-0.10

D6335 Performance by Oil



Test Monitoring Center
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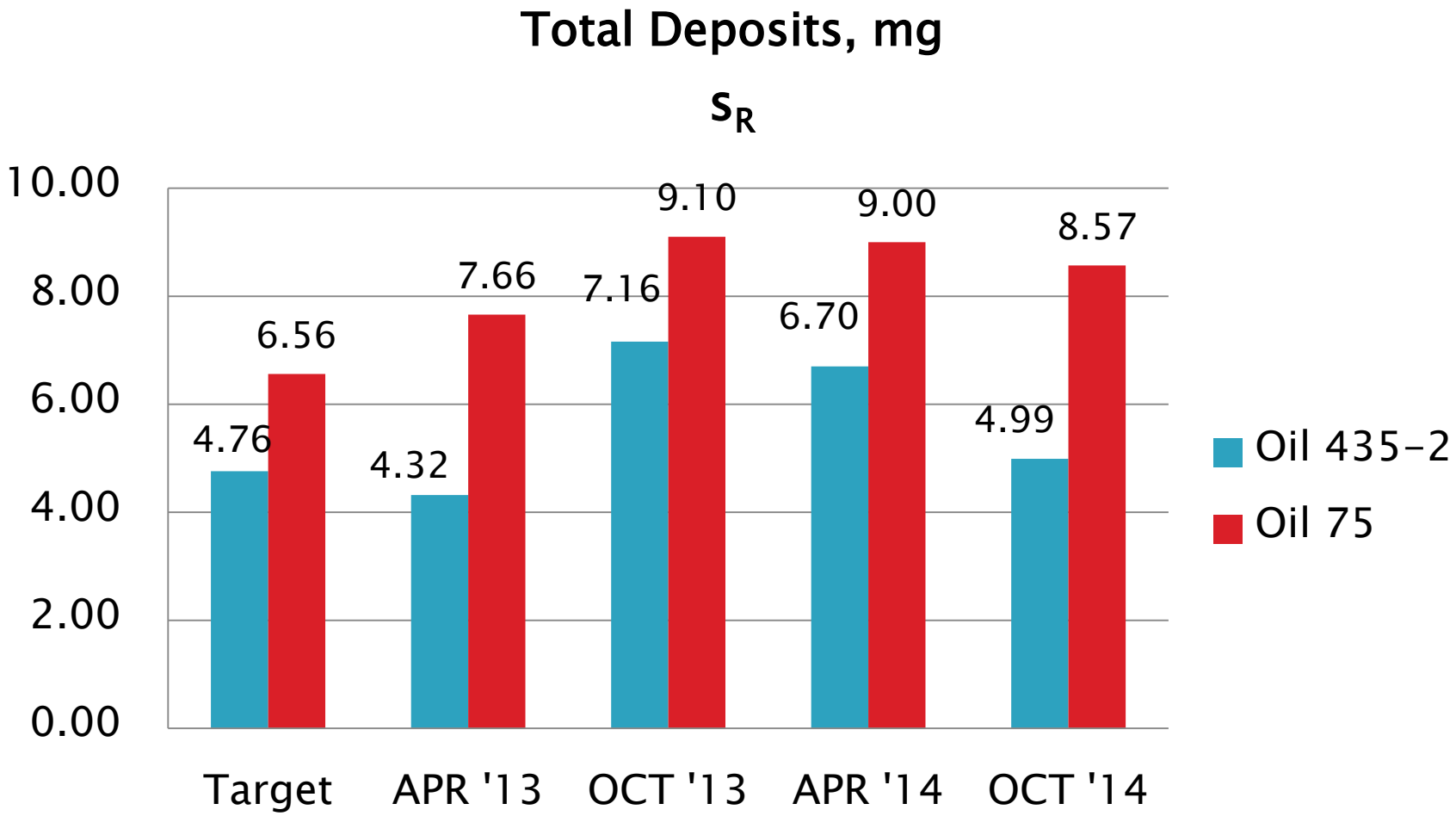
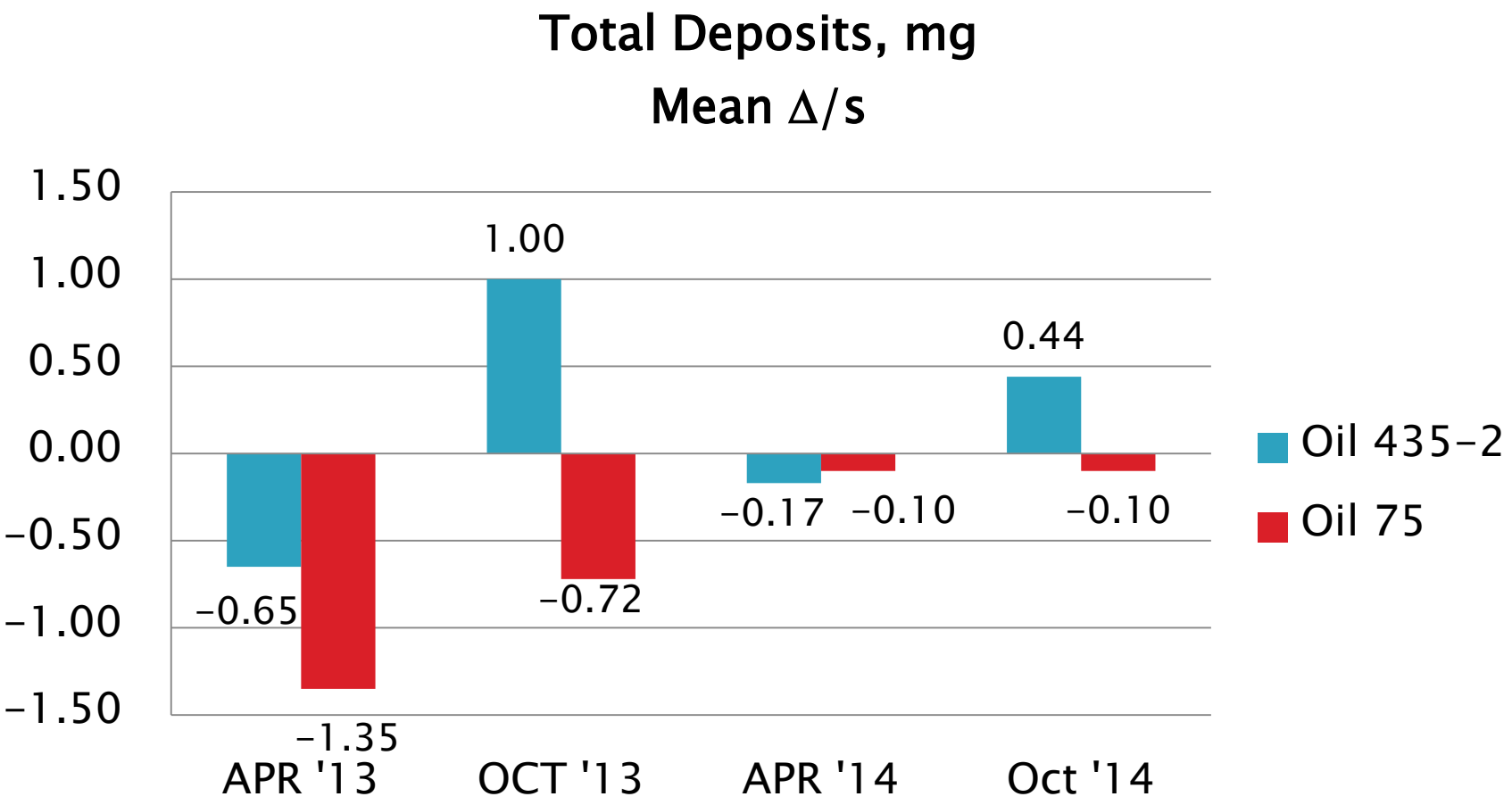
A Program of ASTM International

D6335 Performance by Oil



D6335 Performance by Oil



Return to Executive Summary

D7097: Deposits by MHT TEOST

Test Status	Validity Code	No. Tests
Acceptable Calibration Test	AC	67
Failed Calibration Test	OC	9
Operationally Invalidated by Lab	LC, XC	3
Operationally Invalidated After Initially Reported as Valid	RC	0
Donated Catalyst Screener Runs	AG, OG	12
Non-blind Shakedown Run	NN	2
Total		**93**

Number of Labs Reporting Data: 7

Fail Rate of Operationally Valid Tests: 12%

D7097: Deposits by MHT TEOST

Statistically Unacceptable Tests (OC)	No. Of Tests
Total Deposits Mild	3
Total Deposits Severe	6

- Three operationally invalid calibration tests this period:
  - Temperature off spec., one test (XC)
  - Power failure, two tests (XC)

- Two decoded runs (NN) to troubleshoot two different instruments at different labs; one following a severe fail (OC), one to confirm a new rig performance before calibrating; both subsequently calibrated successfully

- 12 donated runs to screen new catalyst batch 14AA (AG, OG)

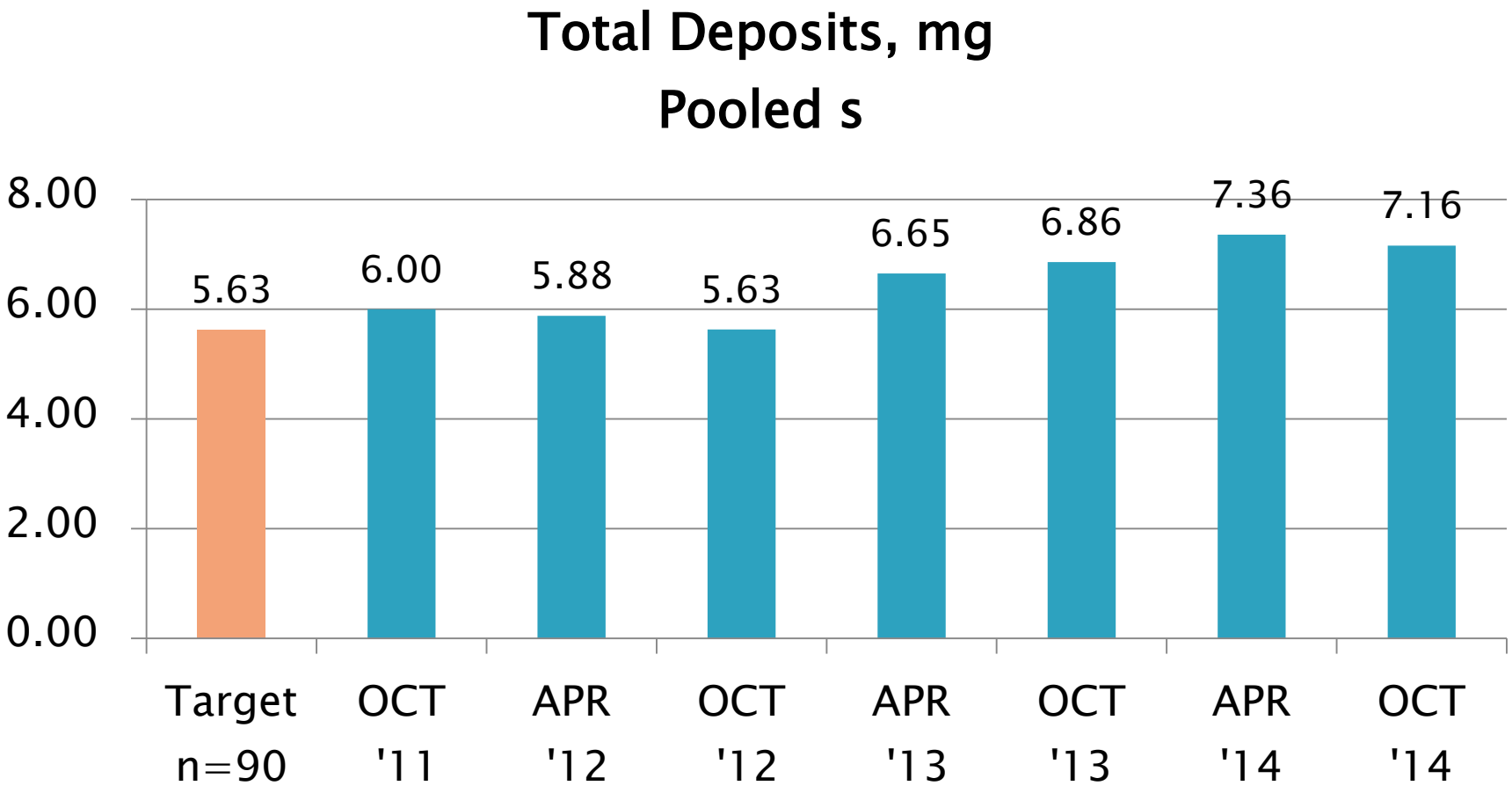
- No TMC technical updates issued this period

D7097: Deposits by MHT TEOST

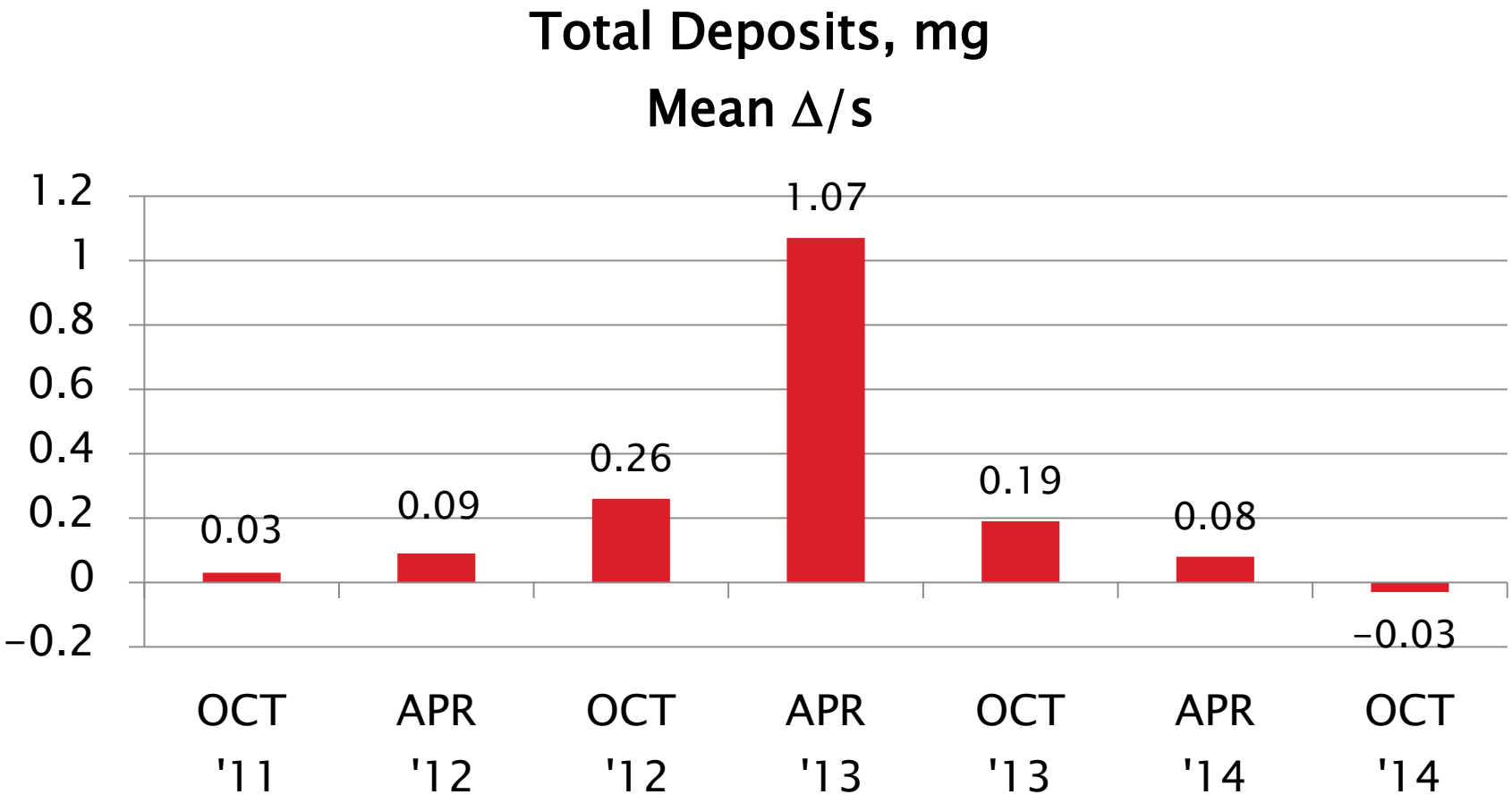
Period Precision and Severity Estimates

Total Deposits, mg	n	df	Pooled s	Mean Δ/s
Current Targets 7/31/2006	90	87	5.63	-----
4/1/11 through 9/30/11	46	43	6.00	0.03
10/1/11 through 3/31/12	56	54	5.88	0.09
4/1/12 through 9/30/12	65	62	5.63	0.26
10/1/12 through 3/31/13	68	66	6.65	1.07
4/1/13 through 9/30/13	85	83	6.86	0.19
10/1/13 through 3/31/14	71	69	7.36	0.08
4/1/14 through 9/30/14	76	74	7.16	-0.03

D7097 Precision Estimates



D7097 Severity Estimates

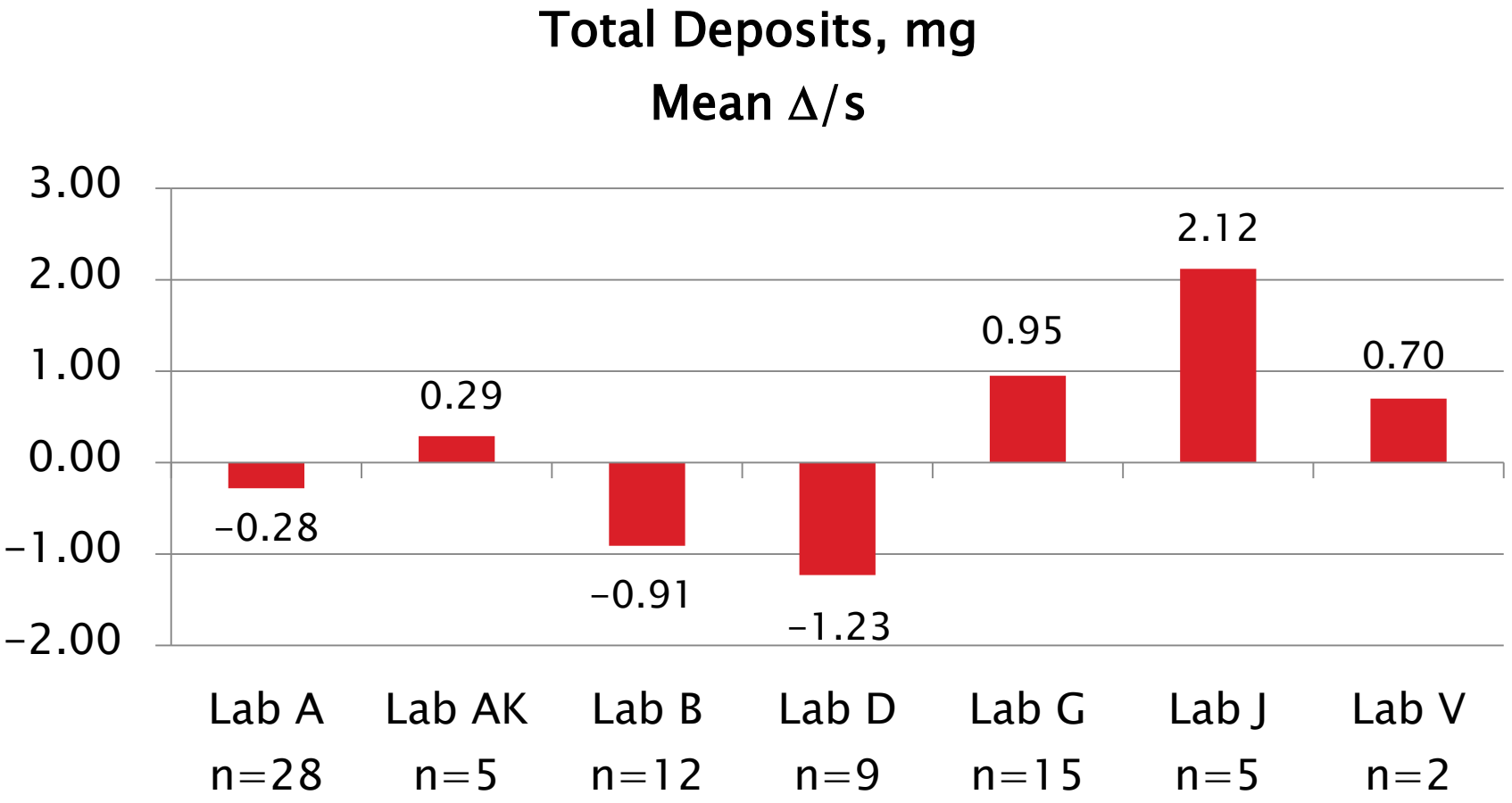


D7097: Deposits by MHT TEOST

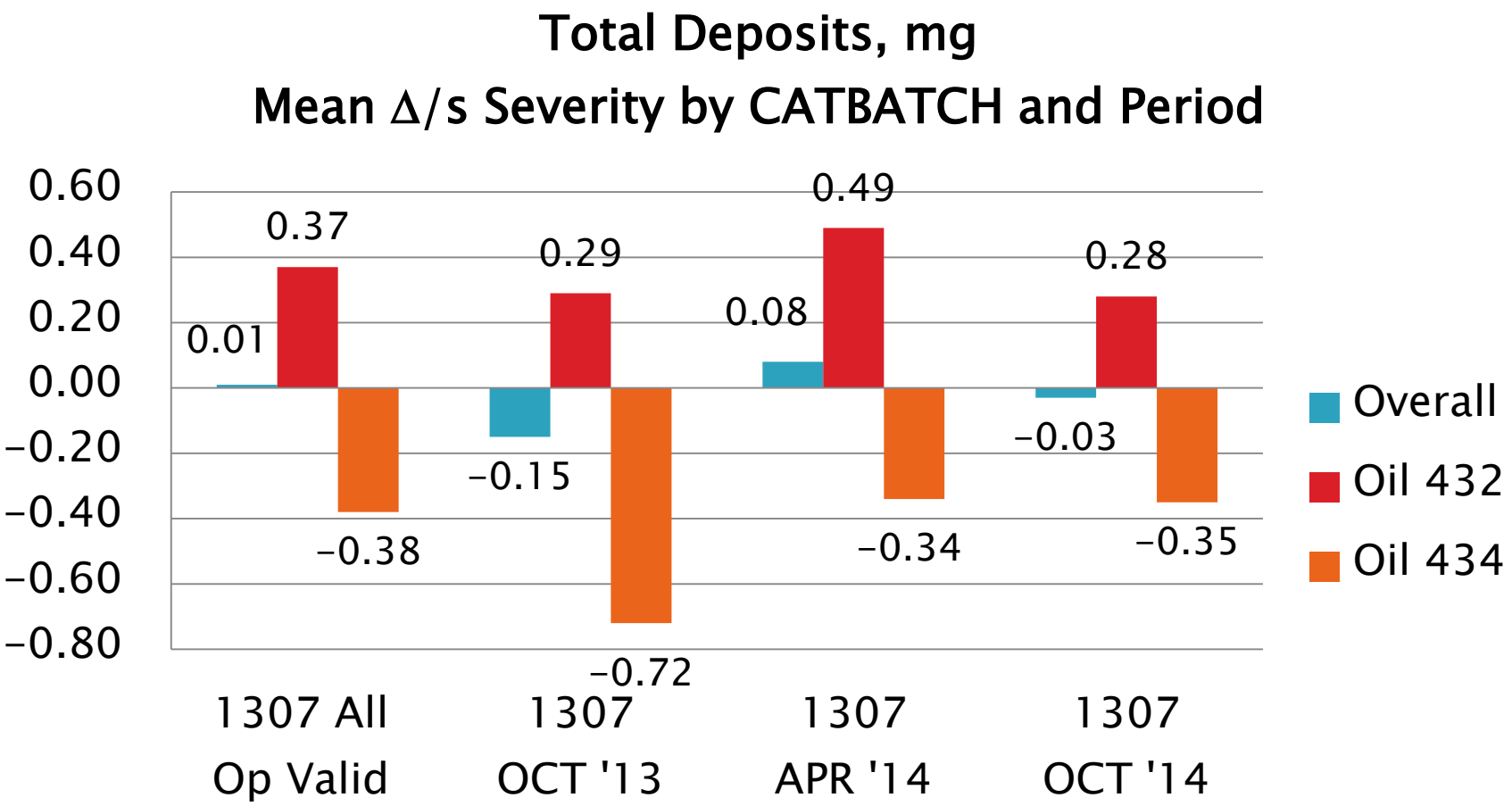
Current Period Severity Estimates by Lab
Total Deposits, mg

	n	Mean Δ/s
Lab A	28	-0.28
Lab AK	5	0.29
Lab B	12	-0.91
Lab D	9	-1.23
Lab G	15	0.95
Lab J	5	2.12
Lab V	2	0.70

D7097 Lab Severity Estimates



D7097: Deposits by MHT TEOST



D7097: Deposits by MHT TEOST

- Precision (Pooled s) is more precise than prior period
  - Significantly less precise than target precision
- Performance (Mean Δ/s) is nearly on-target at -0.03 s mild
  - Lab J overall 2.1 s severe on five tests
- All completed tests this period report using Rod Batch L
- All completed calibration tests this period report using Catalyst Batch 1307

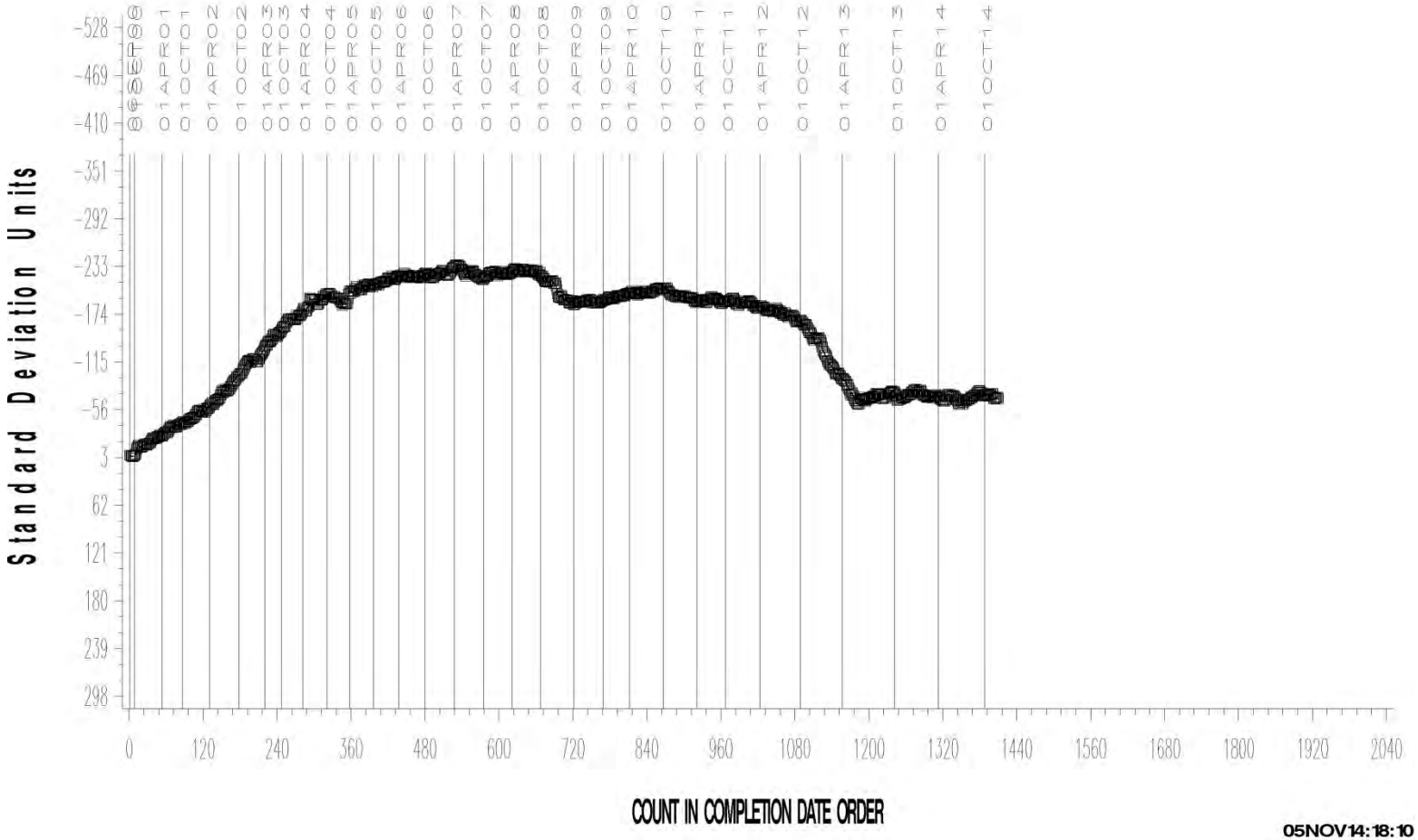
D7097: Deposits by MHT TEOST

- CUSUM severity plot shows OVERALL severity issues associated with prior catalyst batches seem to be resolved with significant leveling to nearly on target performance since the introduction of catalyst batch 1307
  - However, significant lab performance differences persist; overall precision is still quite poor compared to current target precision, and compared to earlier report periods
  - Once again, the overall severe performance of oil 432 (0.28 s, n=39) is nearly offset by overall mild performance of oil 434 (-0.35 s, n = 37)
  - Catalyst batches have proven to bias performance differently for different oils, and may partially explain observed severity differences by catalyst batch and oil, but not the ongoing lab severity differences or the poor overall period precision over the last four report periods

MHT—4 TEOST INDUSTRY OPERATIONALLY VALID DATA

TOTAL DEPOSITS MG

CUSUM Severity Analysis



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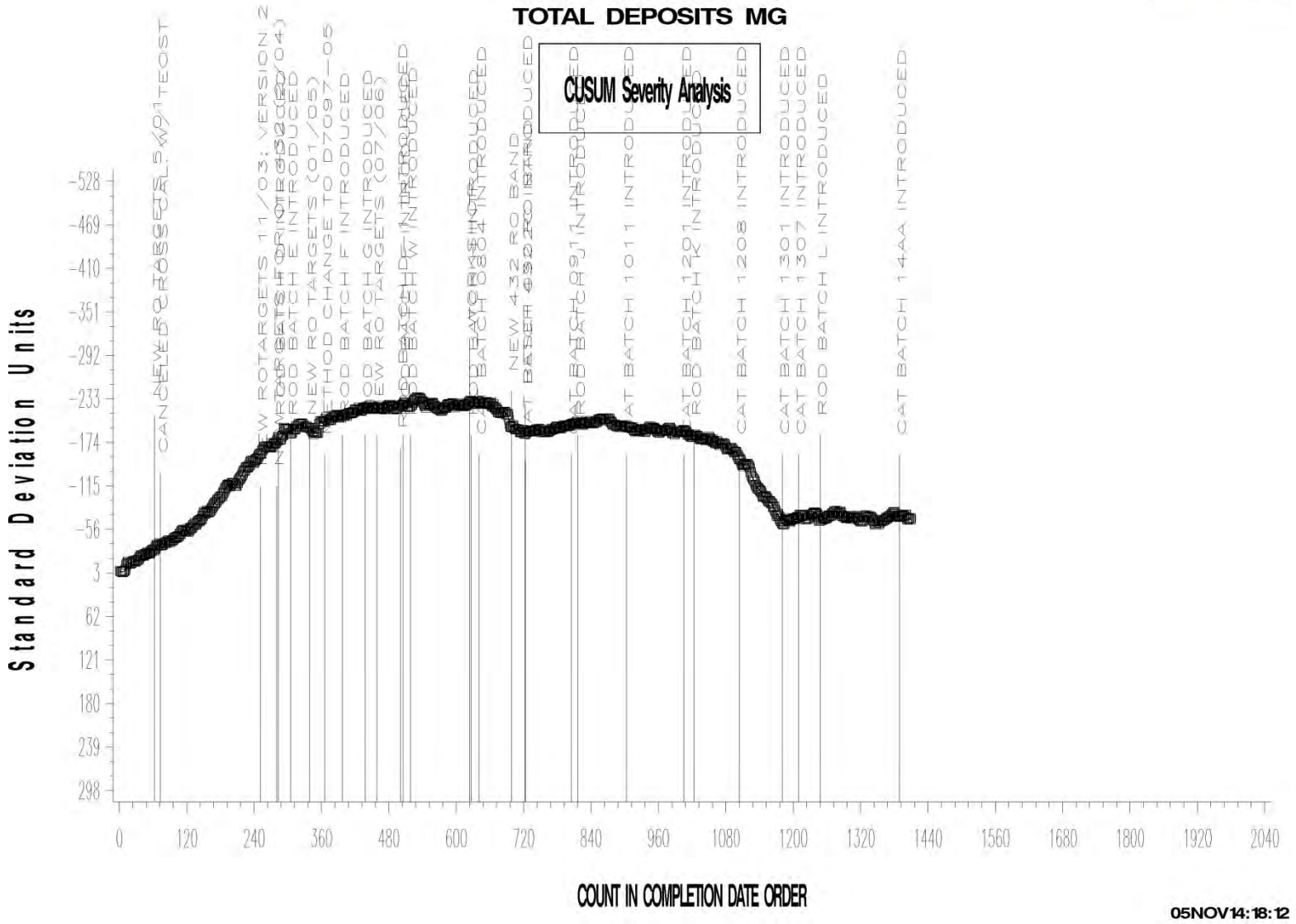
MHT—4 TEOST INDUSTRY OPERATIONALLY VALID DATA



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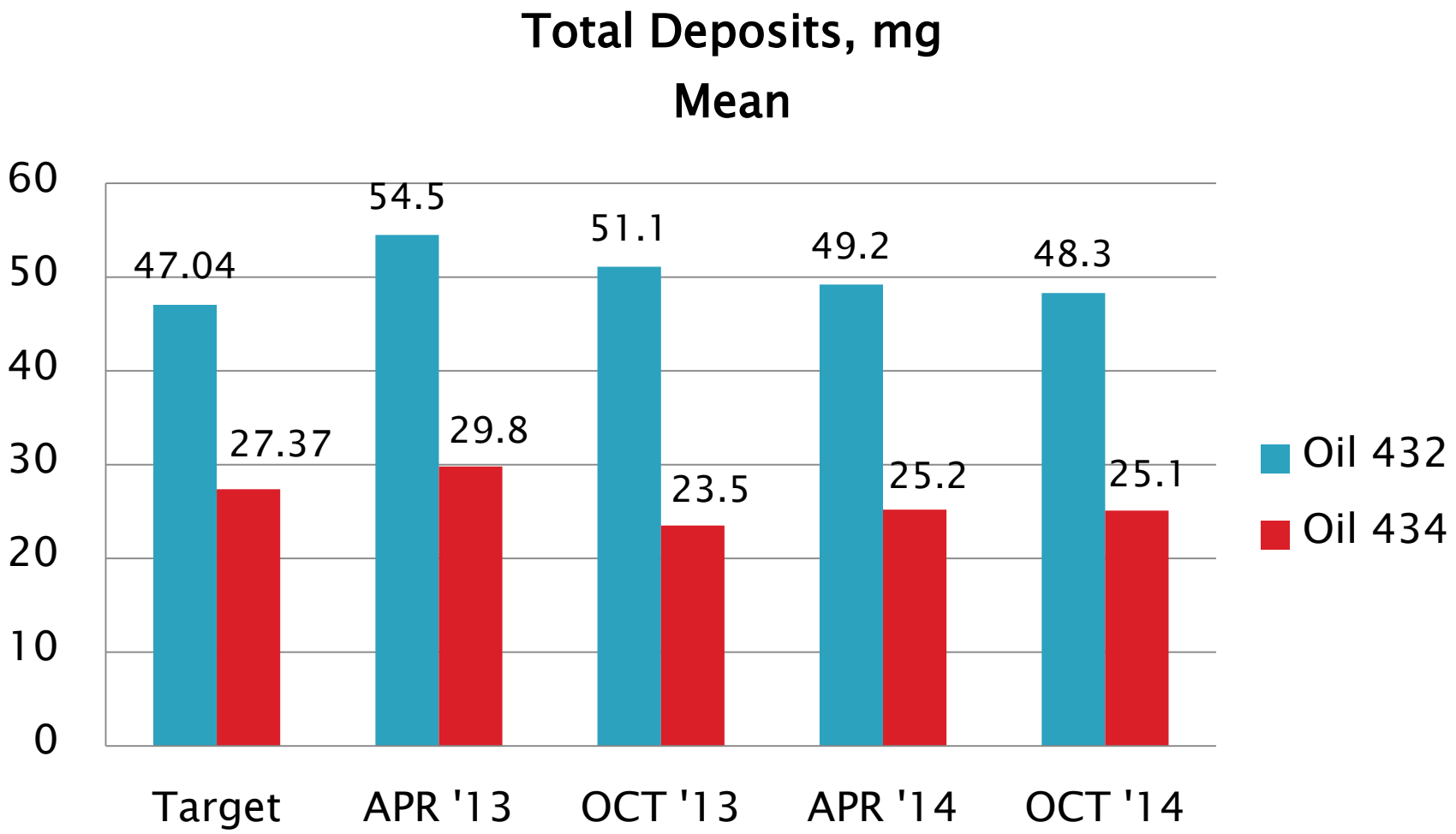
Test Monitoring Center
http://astmtmc.cmu.edu

D7097 Performance by Oil

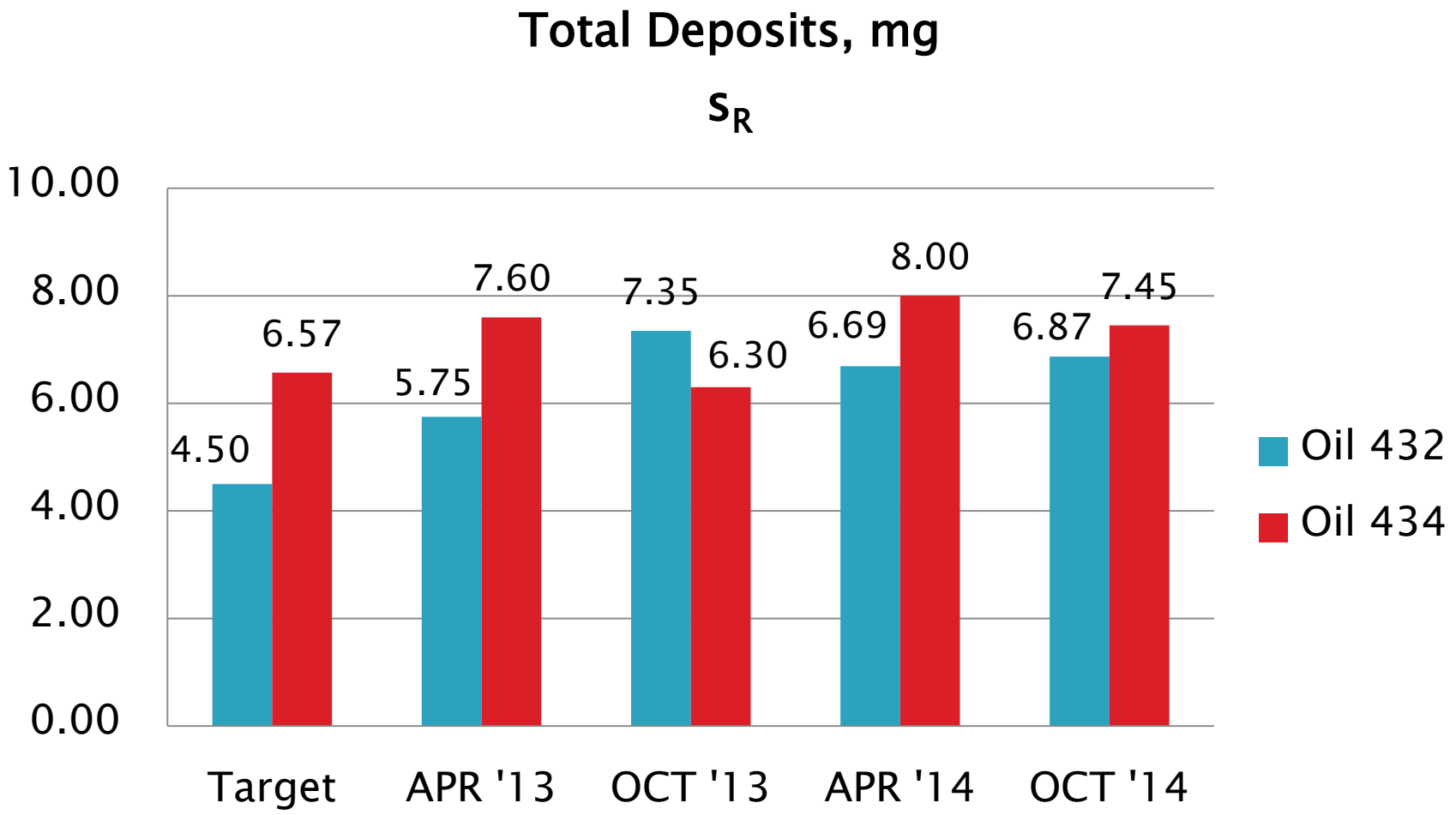
Total Deposits, mg
Performance by Oil

	Targets			4/1/13 – 9/30/13				10/1/13 – 3/31/14				4/1/14 – 9/30/14			
Oil Code	n	Mean	s_R	n	Mean	s_R	Mean Δ/s	n	Mean	s_R	Mean Δ/s	n	Mean	s_R	Mean Δ/s
432	30	47.04	4.50	44	51.1	7.35	0.91	36	49.2	6.69	0.49	39	48.3	6.87	0.28
434	30	27.37	6.57	41	23.5	6.30	-0.58	35	25.2	8.00	-0.34	37	25.1	7.45	-0.35

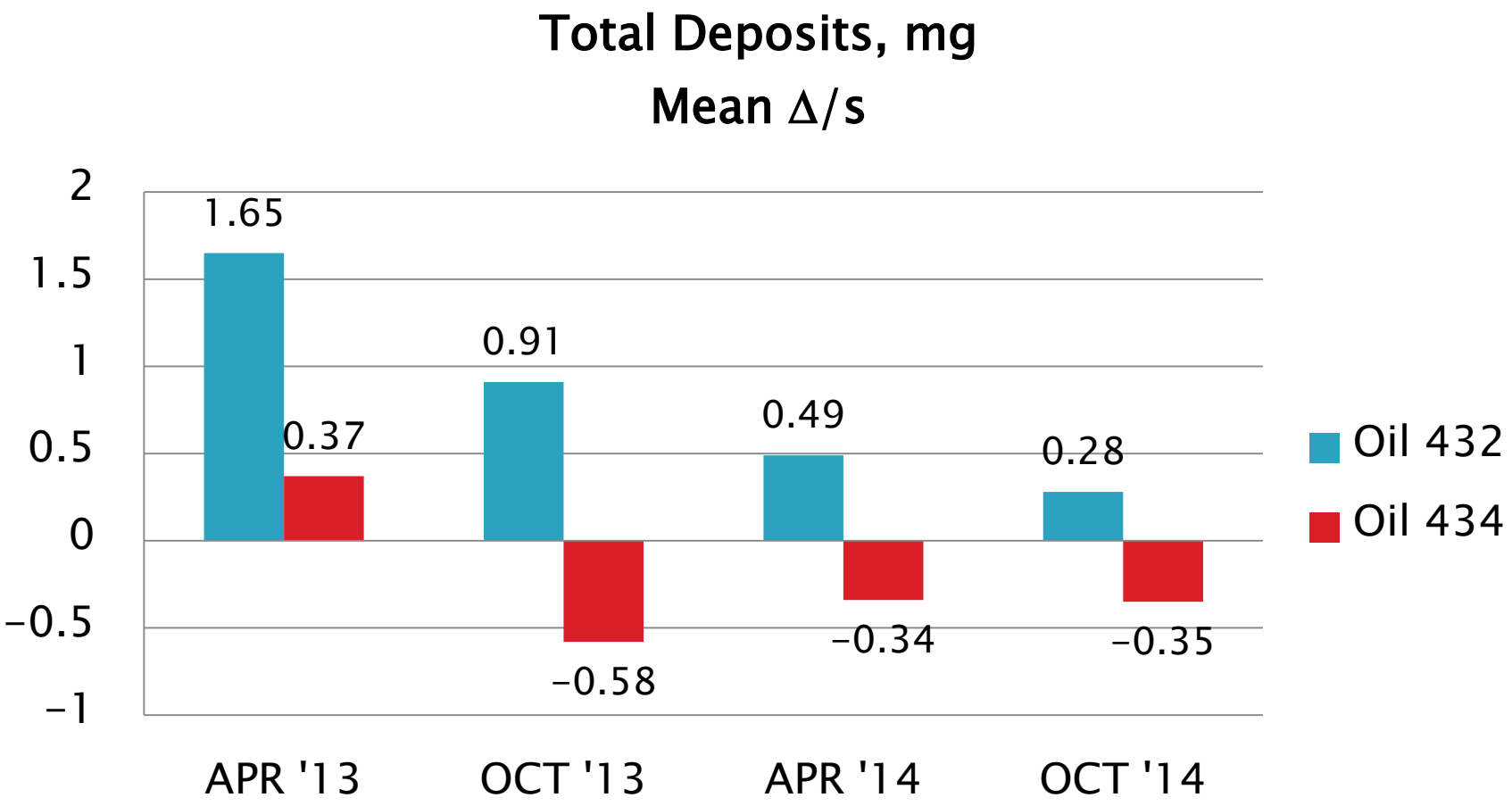
D7097 Performance by Oil



D7097: Deposits by MHT TEOST



D7097: Deposits by MHT TEOST



Return to Executive Summary

D6082: High Temperature Foam

Test Status	Validity Code	No. Tests
Acceptable Calibration Test	AC	10
Acceptable Discrimination Test	AS	5
Failed Calibration Test	OC	1
Operationally Invalidated by Lab	LC, XC, XS	2
Operationally Invalidated After Initially Reported as Valid	RC	0
Total		**18**

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

D6082: High Temperature Foam

Statistically Unacceptable Tests (OC)	No. Of Tests
Foam Tendency Mild	0
Foam Tendency Severe	1

- Two Operationally invalid test reported this period:
  - Calibration/discrimination pair aborted because blend option A was not performed (XC & XS)

- All operationally valid discrimination runs reported this period could discriminate oil 66 as a GF-5/SN failing oil for Foam Tendency

- No TMC technical updates issued this period

D6082: High Temperature Foam

Period Precision and Severity Estimates Oil 1007

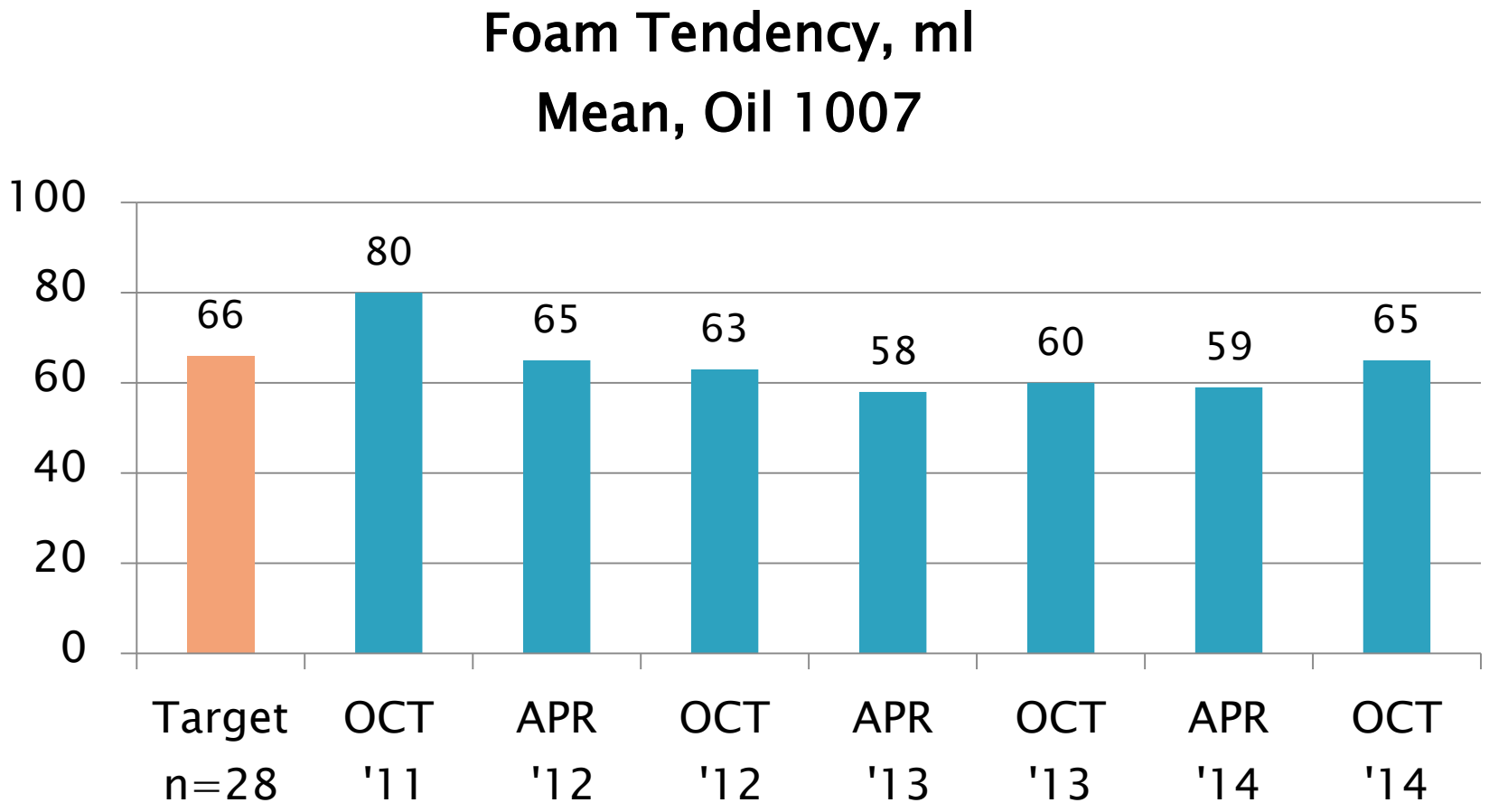
Foam Tendency, ml	n	Mean	Pooled s	Mean Δ/s
Current Targets	28	65.71	19.28	-----
4/1/11 through 9/30/11	9	80	26	0.74
10/1/11 through 3/31/12	8	65	13	-0.05
4/1/12 through 9/30/12	9	63	13	-0.14
10/1/12 through 3/31/13	8	58	10	-0.45
4/1/13 through 9/30/13	9	60	7	-0.32
10/1/13 through 3/31/14	11	59	8	-0.39
4/1/14 through 9/30/14	11	65	22	-0.05

D6082: High Temperature Foam

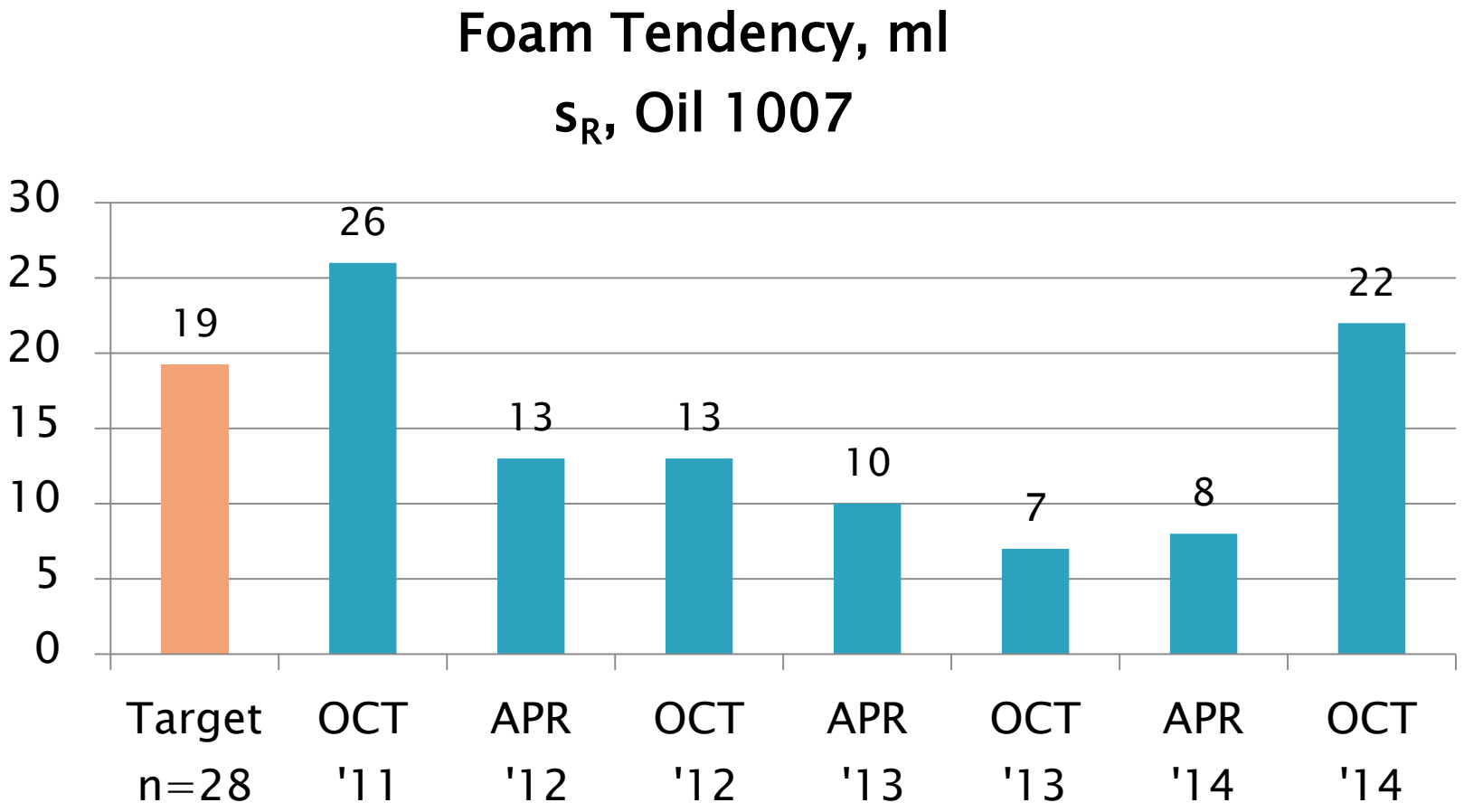
Period Precision and Severity Estimates Oil 1007

Foam Stability @ 1 min, ml	n	Mean	s
Current Targets	28	0.00	0.00
4/1/11 through 9/30/11	9	No non-zero occurrences	
10/1/11 through 3/31/12	8	No non-zero occurrences	
4/1/12 through 9/30/12	9	No non-zero occurrences	
10/1/12 through 3/31/13	8	No non-zero occurrences	
4/1/13 through 9/30/13	9	No non-zero occurrences	
10/1/13 through 3/31/14	11	No non-zero occurrences	
4/1/14 through 9/30/14	11	No non-zero occurrences	

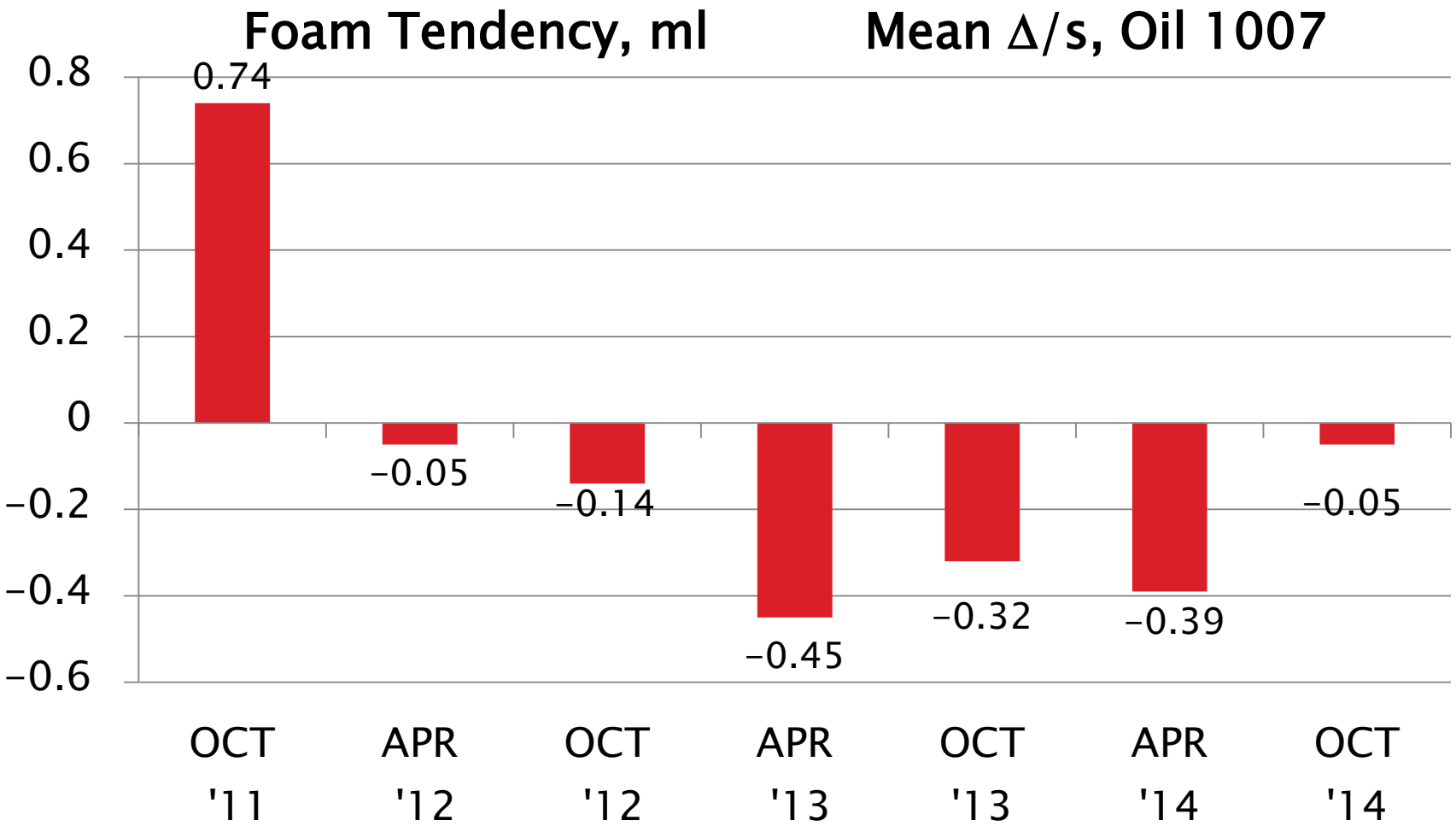
D6082: High Temperature Foam



D6082: High Temperature Foam



D6082: High Temperature Foam

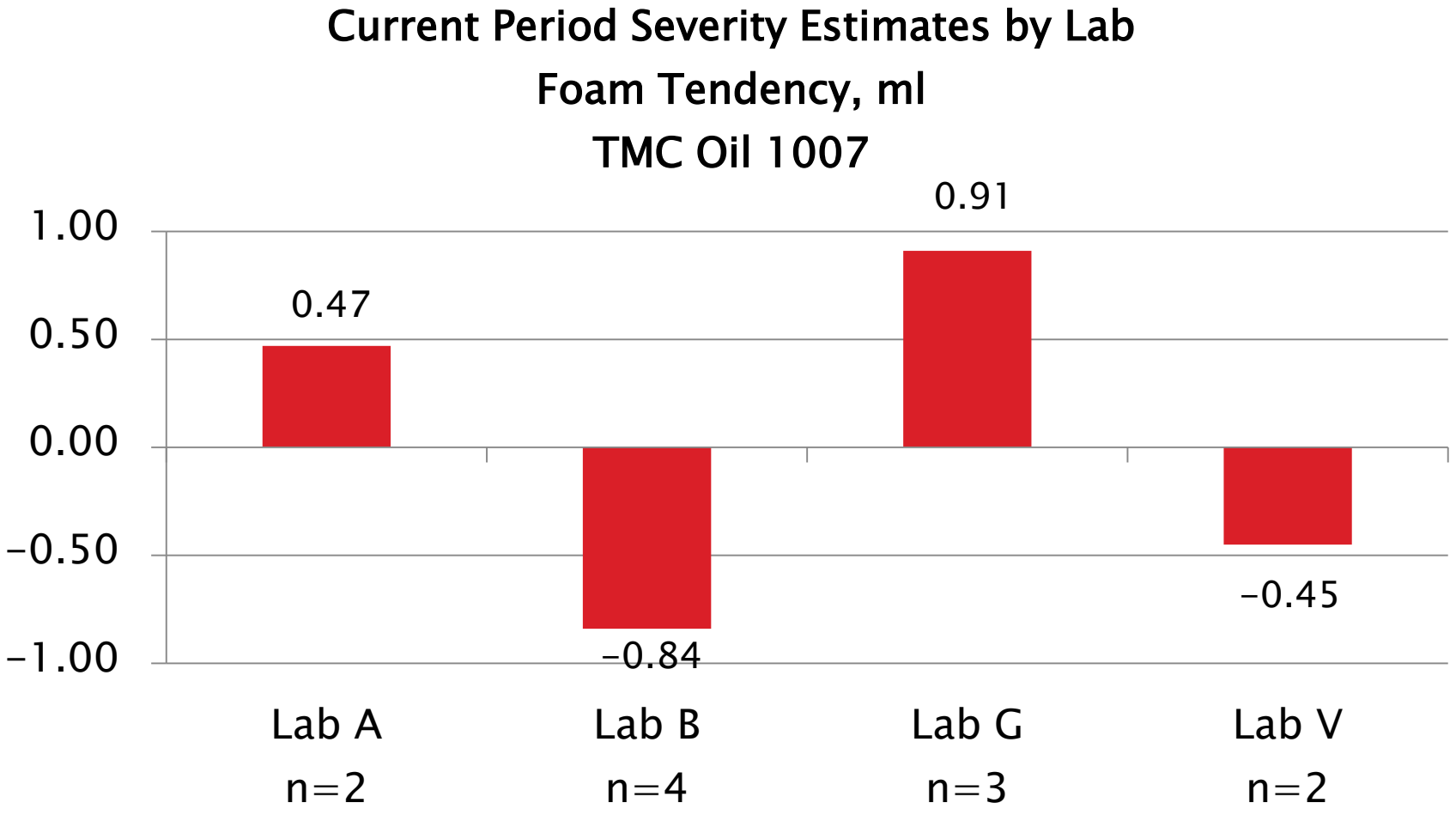


D6082: High Temperature Foam

Current Period Severity Estimates by Lab
Foam Tendency, ml
TMC Oil 1007

	n	Mean Δ/s
Lab A	2	0.47
Lab B	4	-0.84
Lab G	3	0.91
Lab V	2	-0.45

D6082: High Temperature Foam



D6082: High Temperature Foam

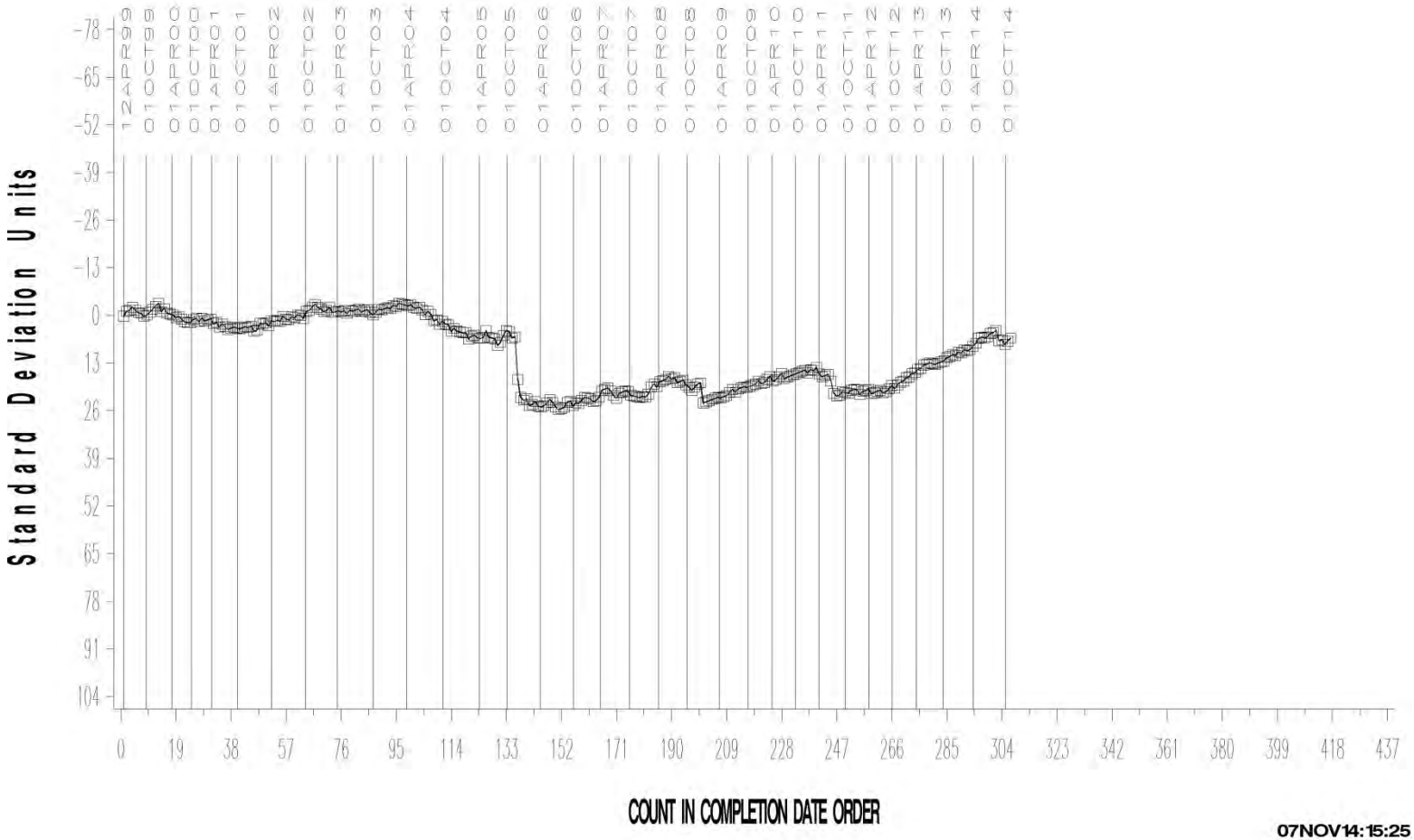
- Foam Tendency Precision (Pooled s) is significantly less precise than prior period
  - More precise than target precision
  - Unusual variability this period, even considering a failing result
- Performance (Mean Δ/s) is on target
  - Would have been mild, and comparable to prior periods, if not for a single, severe fail (2.8 s, Lab G)
  - Notable lab severity difference this period
- No non-zero occurrences of Foam Stability
- All operationally valid discrimination runs demonstrated acceptable discrimination

D6082 HIGH TEMPERATURE FOAM INDUSTRY OPERATIONALLY VALID DATA

IND='1007'

FOAM TENDENCY

CUSUM Severity Analysis



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Return to Executive Summary

D874: Sulfated Ash

Test Status	Validity Code	No. Tests
Acceptable Calibration Test	AC	6
Failed Calibration Test	OC	0
Operationally Invalidated by Lab	LC, XC	0
Operationally Invalidated After Initially Reported as Valid	RC	0
Total		**6**

Number of Labs Reporting Data: 3
Fail Rate of Operationally Valid Tests: 0%

D874: Sulfated Ash

Statistically Unacceptable Tests (OC)	No. Of Tests
Sulfated Ash Mild	0
Sulfated Ash Severe	0

- No operationally or statistically invalid tests reported this period
- No TMC technical updates issued this period

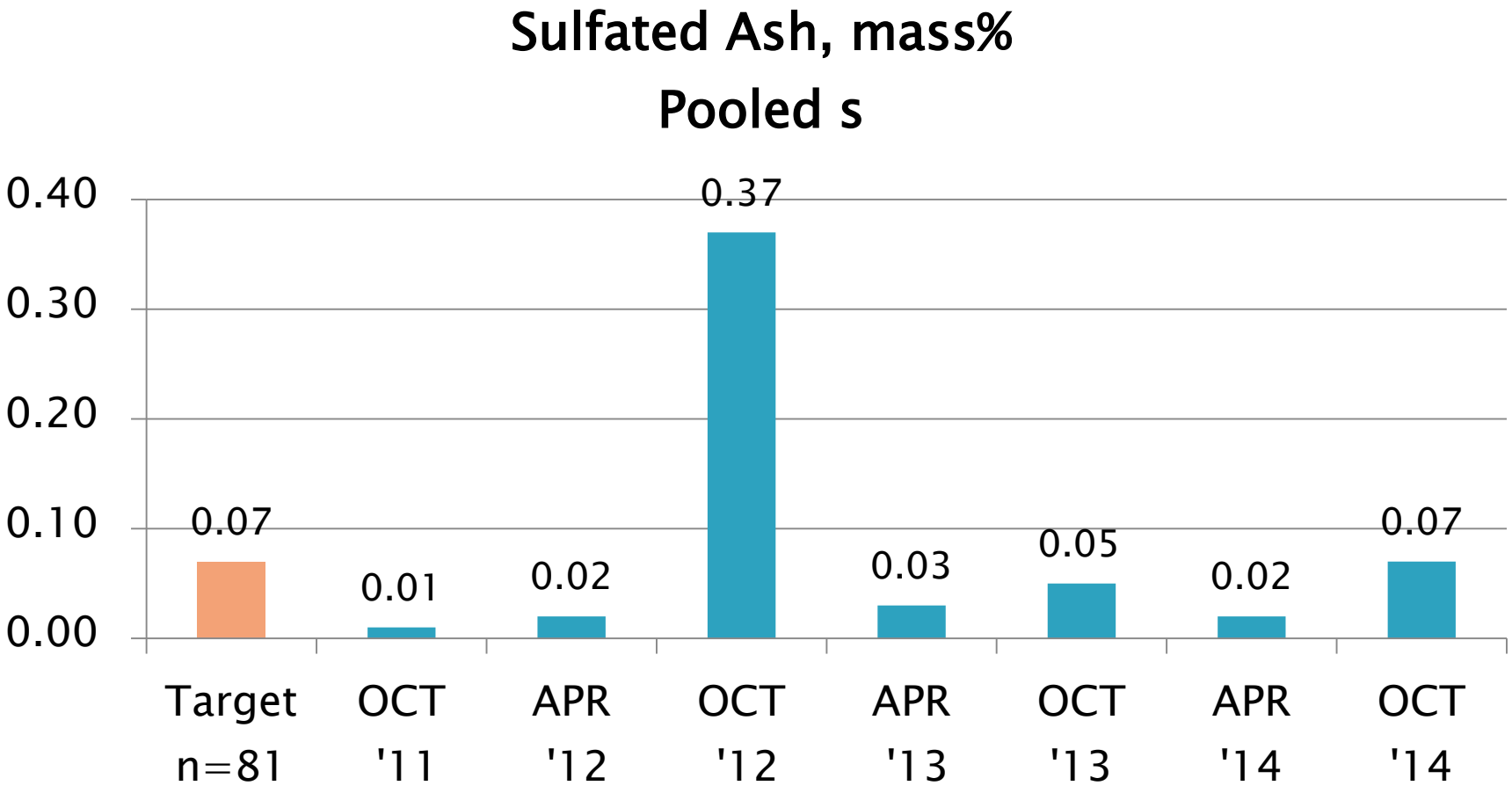
D874: Sulfated Ash

Period Precision and Severity Estimates

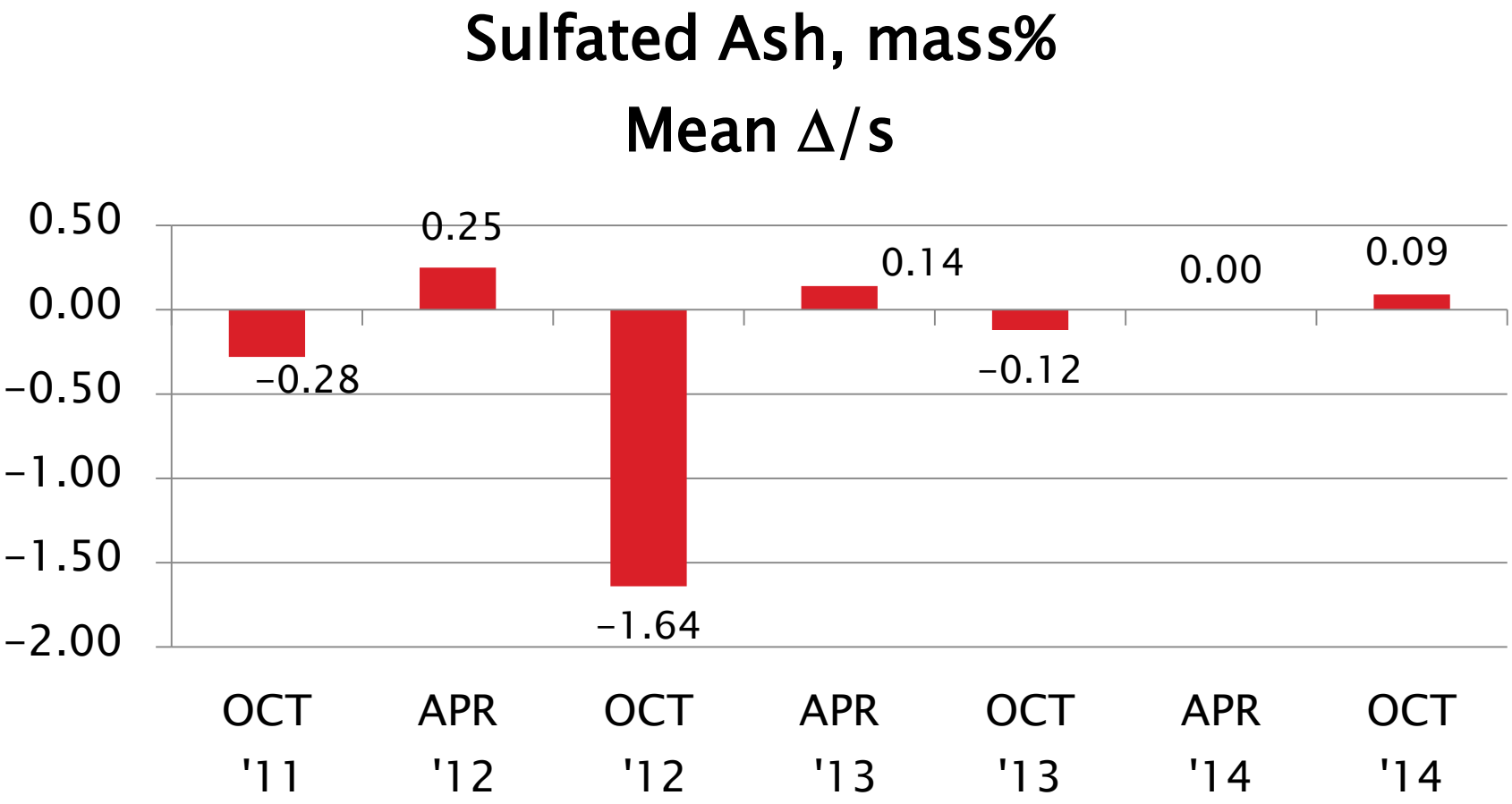
Total Deposits, mg	n	df	Pooled s	Mean Δ/s
Current Targets	81	78	0.07	-----
4/1/11 through 9/30/11	6	3	0.01	-0.28
10/1/11 through 3/31/12	6	4	0.02	0.25
4/1/12 through 9/30/12*	7	4	0.37	-1.64
4/1/12 through 9/30/12*	6	3	0.04	0.01
10/1/12 through 3/31/13	7	4	0.03	0.14
4/1/13 through 9/30/13	6	3	0.05	-0.12
10/1/13 through 3/31/14	5	2	0.02	0.00
4/1/14 through 9/30/14	6	3	0.07	0.09

*Period statistics with and without extreme result included

D874: Sulfated Ash



D874: Sulfated Ash

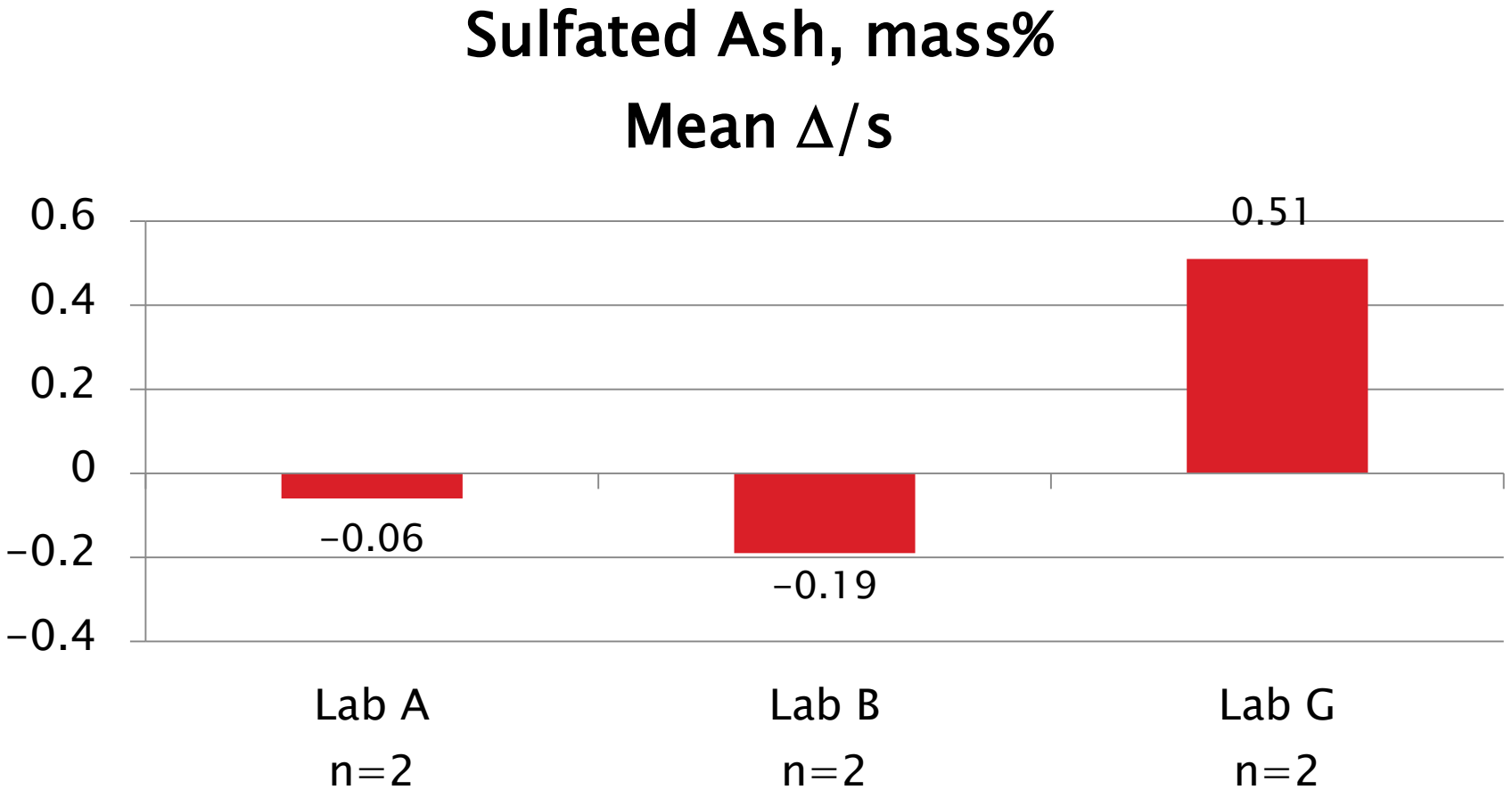


D874: Sulfated Ash

Current Period Severity Estimates by Lab
Sulfated Ash, mass%

	n	Mean Δ/s
Lab A	2	-0.06
Lab B	2	-0.19
Lab G	2	0.51

D874: Sulfated Ash



D874: Sulfated Ash

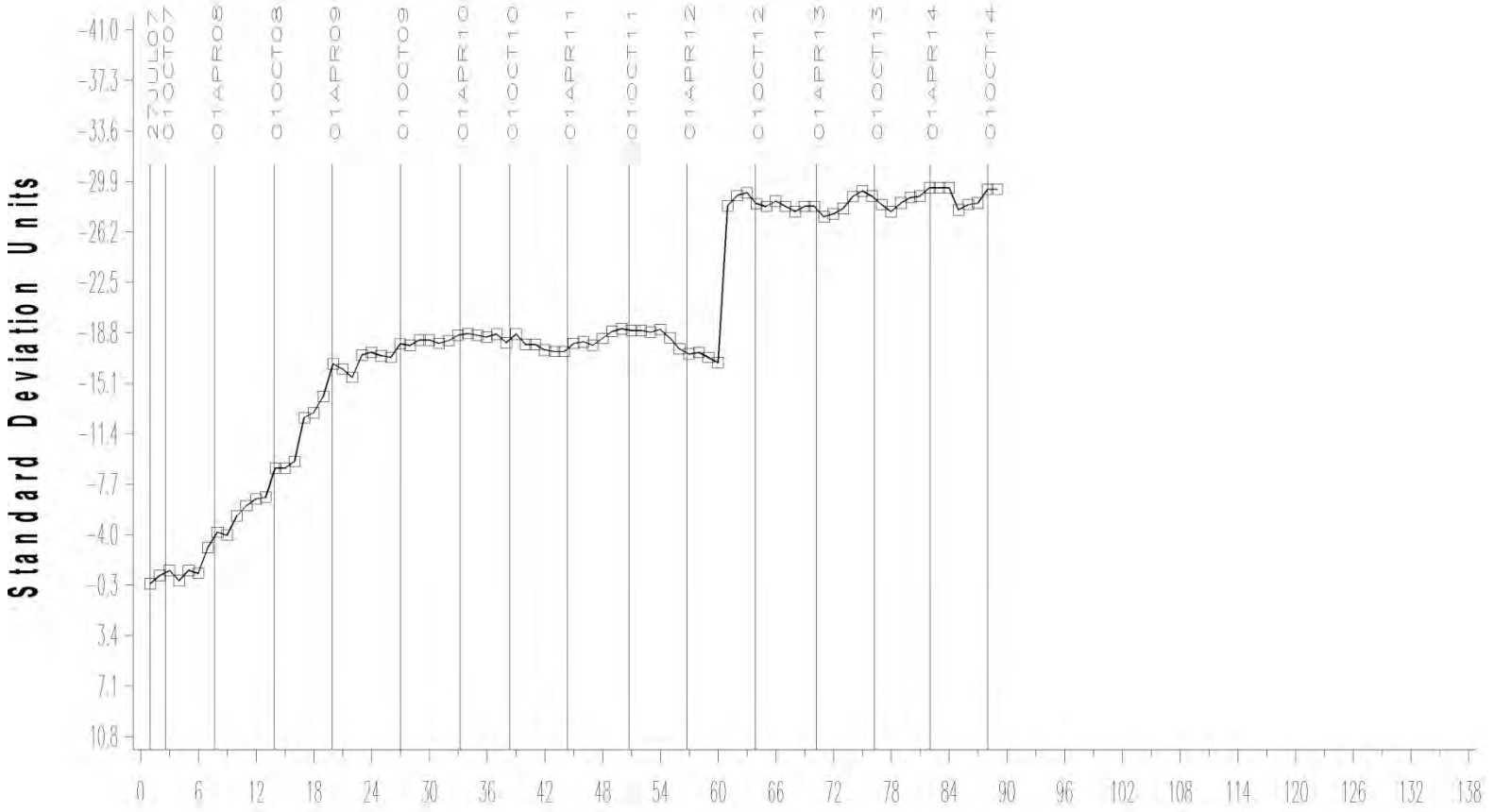
- Precision (Pooled s) is slightly less precise compared to prior periods
  - Equal to target precision

- Performance (Mean Δ/s) is nearly on target (0.09 s)

D874 INDUSTRY OPERATIONALLY VALID DATA

TEST SAMPLE PERCENT SULFATED ASH

CUSUM Severity Analysis



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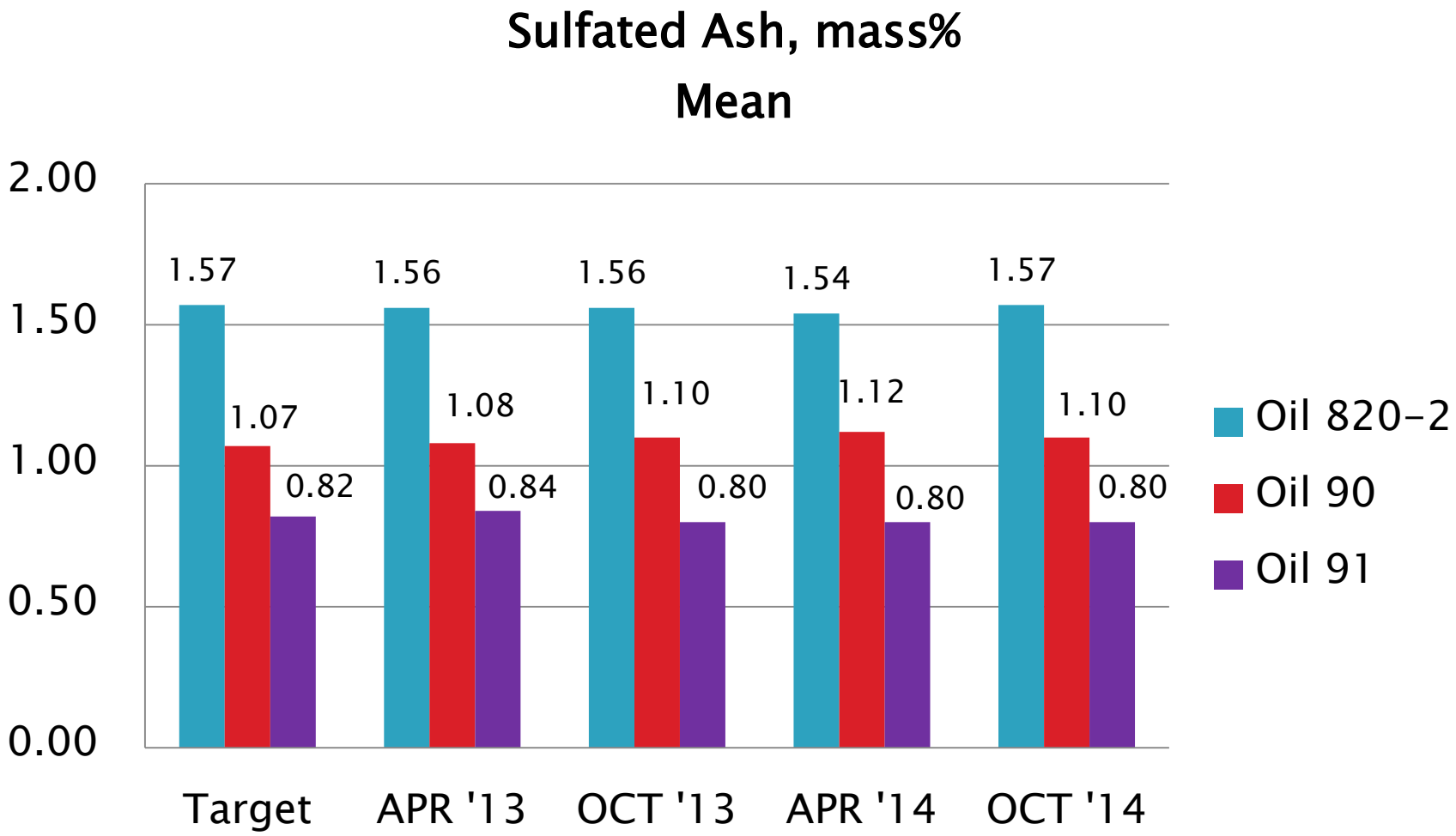
D874: Sulfated Ash

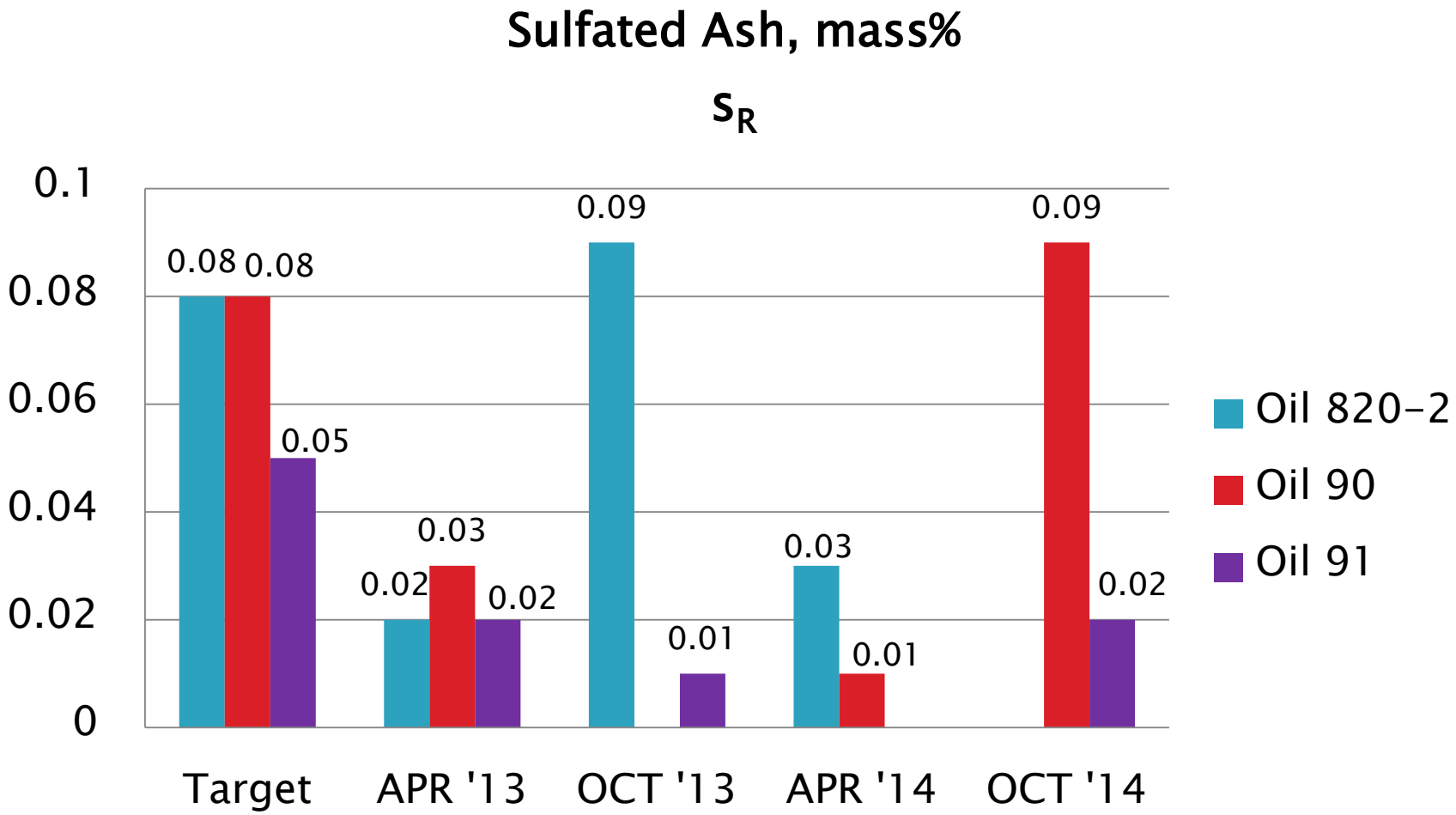
Performance by Oil
Sulfated Ash, mass%

	Targets			4/1/13 – 9/30/13				10/1/13 – 3/31/14				4/1/14 – 9/30/14			
Oil Code	n	Mean	s_R	n	Mean	s_R	Mean Δ/s	n	Mean	s_R	Mean Δ/s	n	Mean	s_R	Mean Δ/s
820-2	27	1.57	0.08	2	1.56	0.09	-0.06	2	1.54	0.03	-0.38	1	1.57	---	0.00
90	27	1.07	0.08	1	1.10	---	0.38	2	1.12	0.01	0.56	3	1.10	0.09	0.38
91	27	0.82	0.05	3	0.80	0.01	-0.33	1	0.80	----	-0.40	2	0.80	0.02	-0.30

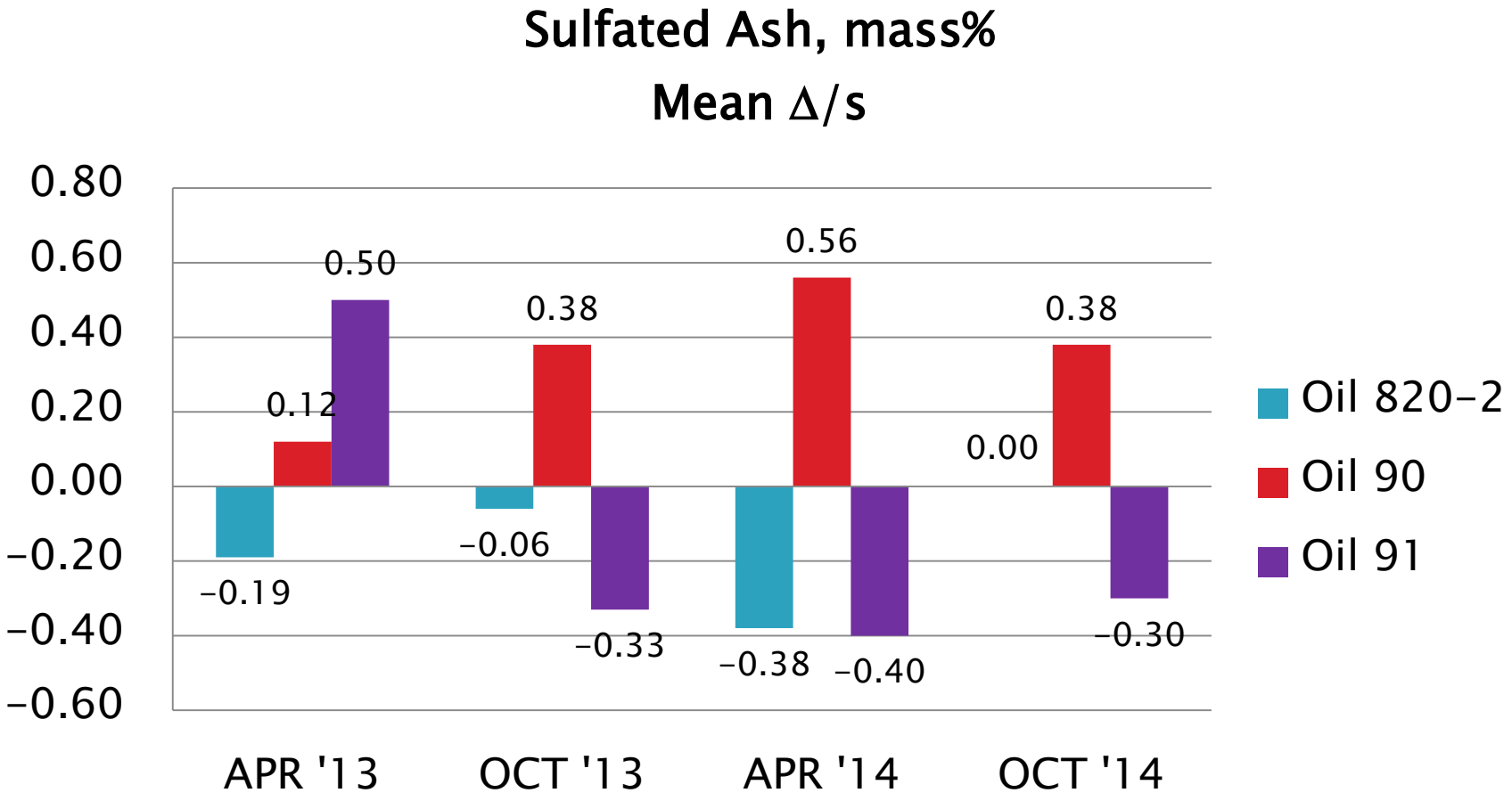
D874: Sulfated Ash



D874: Sulfated Ash



D874: Sulfated Ash



Return to Executive Summary

D7528: Oxidation by ROBO

Test Status	Validity Code	No. Tests
Acceptable Calibration Test	AC	67
Failed Calibration Test	OC	16
Operationally Invalidated by Lab	LC, XC	6
Operationally Invalidated After Initially Reported as Valid	RC	3
Non-reference shakedown, excluded from statistics	NN, XN	3
Total		**95**

Number of Labs Reporting Data: 9
Fail Rate of Operationally Valid Tests: 19%

D7528: Oxidation by ROBO

Operationally Invalid Tests

- 4 tests vacuum system failure (LC, XC)
- 1 tests heater or heater control failure (XC)
- 1 test power failure (XC)
- 1 test MRV run at wrong temperature (RC)
- 2 tests unexplained high EOT volatiles (RC)

- Also had 2 successful pre-calibration shakedown runs (NN) reported for new rig (AQ2), and one run aborted due to power failure (XN); aborted run successfully made up after the end of report period for total of three successful pre-calibration runs, as required for new rigs.

D7528: Oxidation by ROBO

Statistically Unacceptable Tests (OC)	No. Of Tests
Natural Log (MRV Viscosity) Mild	15
Natural Log (MRV Viscosity) Severe	1

- No TMC technical updates issued this period.

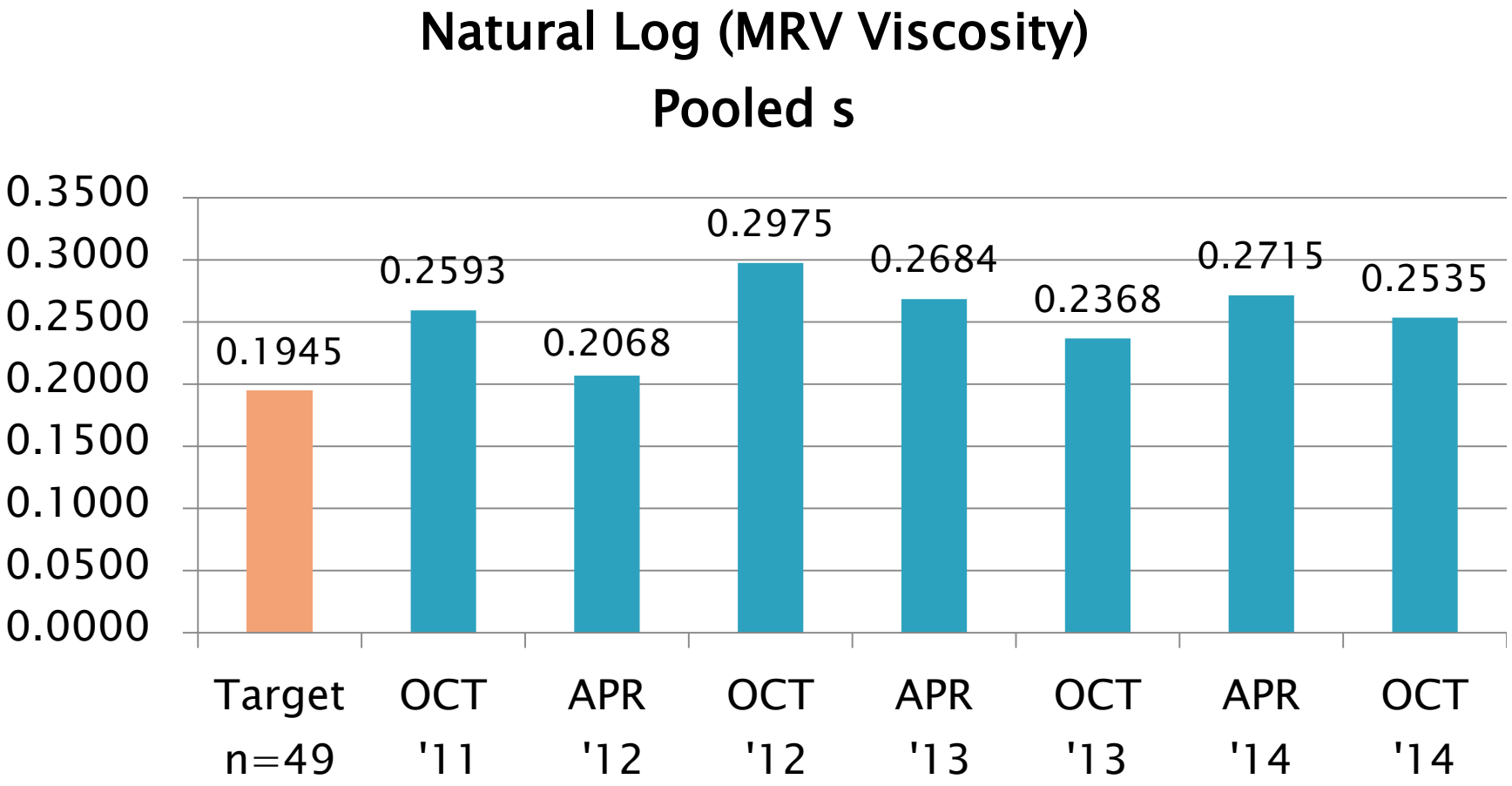
D7528: Oxidation by ROBO

Period Precision and Severity Estimates

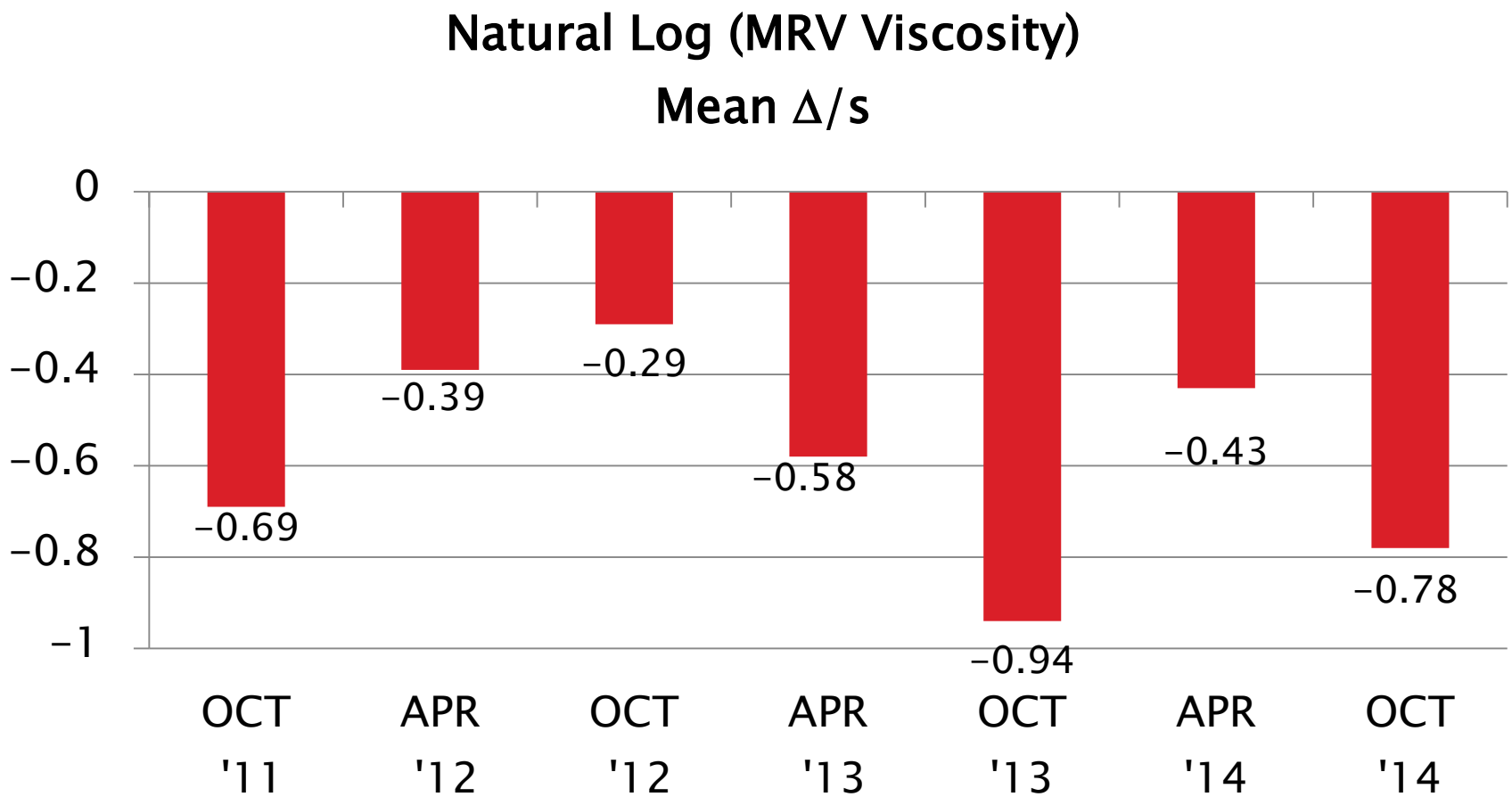
Natural Log (MRV Viscosity)	n	df	Pooled s	Mean Δ/s
Current Targets	49	46	0.1945	-----
4/1/11 through 9/30/11	96	92	0.2593	-0.69
10/1/11 through 3/31/12	93	90	0.2068	-0.39
4/1/12 through 9/30/12	86	83	0.2975	-0.29
10/1/12 through 3/31/13	109	106	0.2684	-0.58
4/1/13 through 9/30/13	90	87	0.2368	-0.94
10/1/13 through 3/31/14	85	82	0.2715	-0.43
4/1/14 through 9/30/14	83	80	0.2535	-0.78

*Period statistics with and without extreme result included

D7528: Oxidation by ROBO



D7528: Oxidation by ROBO



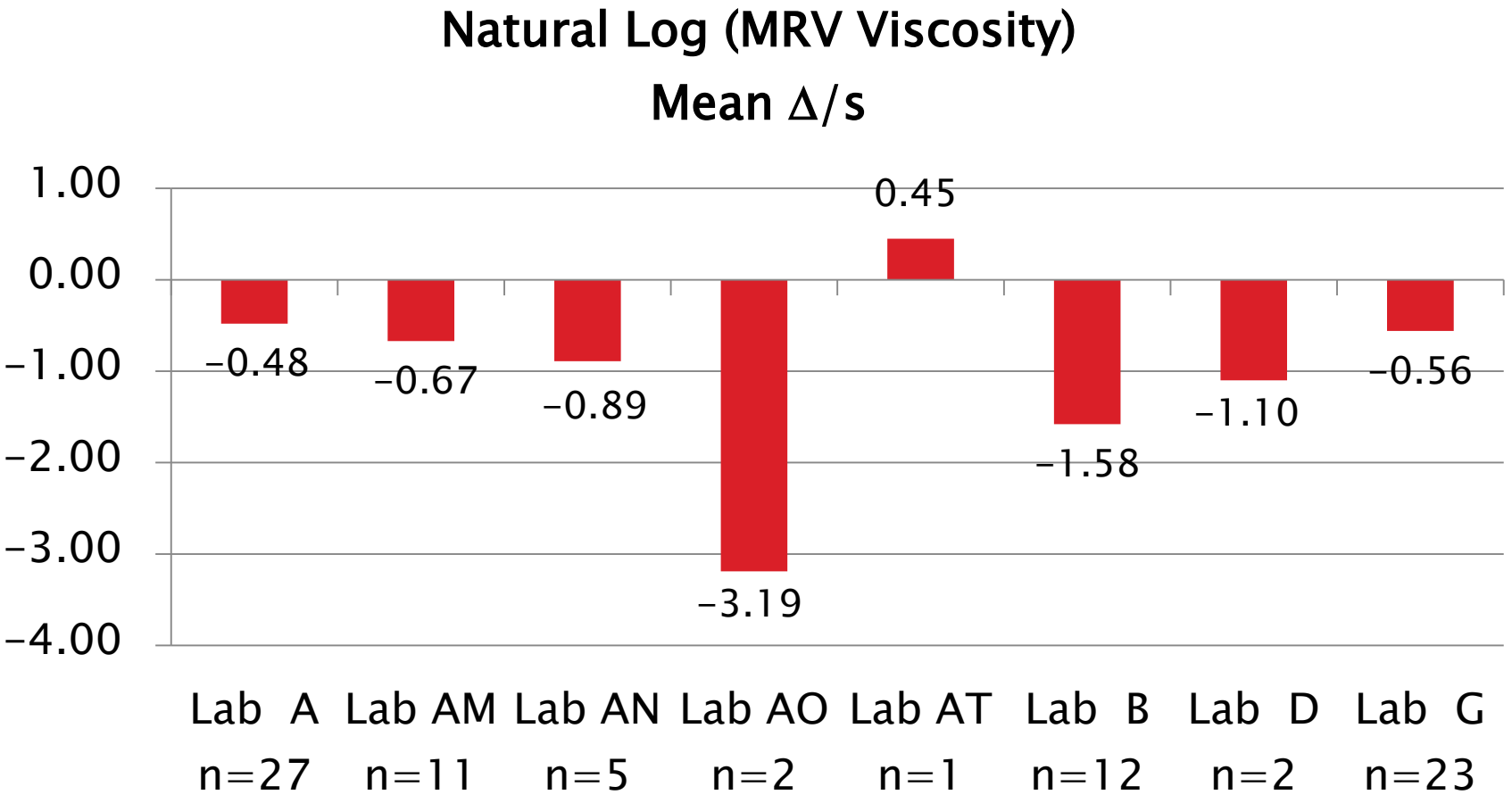
D7528: Oxidation by ROBO

Current Period Severity Estimates by Lab
Natural Log (MRV Viscosity)

	n	Mean Δ/s
Lab A	27	-0.48
Lab AM	11	-0.67
Lab AN	5	-0.89
Lab AO	2	-3.19
Lab AT	1	0.45
Lab B	12	-1.58
Lab D	2	-1.10
Lab G	23	-0.56

Lab AQ reported only shakedown runs this period, no calibrations.

D7528: Oxidation by ROBO



D7528: Oxidation by ROBO

- Precision (Pooled s) is more precise than prior period
  - Still less precise than target precision

- Performance (Mean Δ/s) is −0.78 s mild
  - All but one lab mild to some extent
  - Three labs more than 1 s mild, overall (Labs AO, B & D)
  - Four tests reported as operationally valid are more than 3 s from target (all fail to calibrate but included in statistics):
    - Rig AM4 −3.1 s mild, Oil 435-1
    - Rig G5 −5.0 s mild, Oil 435-1
    - Rig G6 −3.1 s mild, Oil 434-1
    - Rig AO1 −4.0 s mild, Oil 435-1

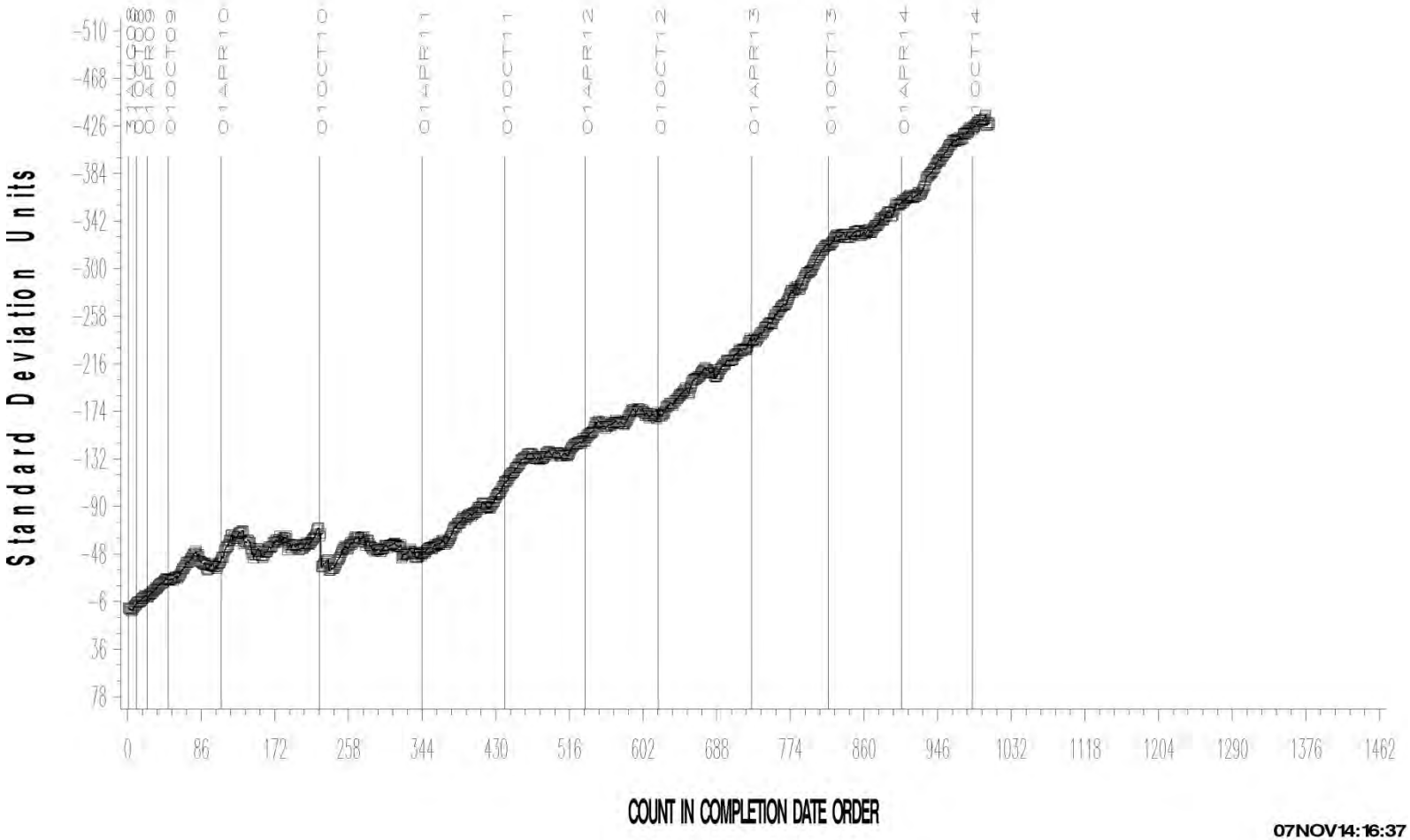
D7528: Oxidation by ROBO

- CUSUM Severity Plot shows an ongoing overall mild trend since the 01APR11 timeline (following the ROBO workshop) with only brief periods of leveling (on-target) performance.

ROBO TEST INDUSTRY OPERATIONALLY VALID DATA

AGED OIL MRV APPARENT VISCOSITY

CUSUM Severity Analysis



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ROBO TEST INDUSTRY OPERATIONALLY VALID DATA

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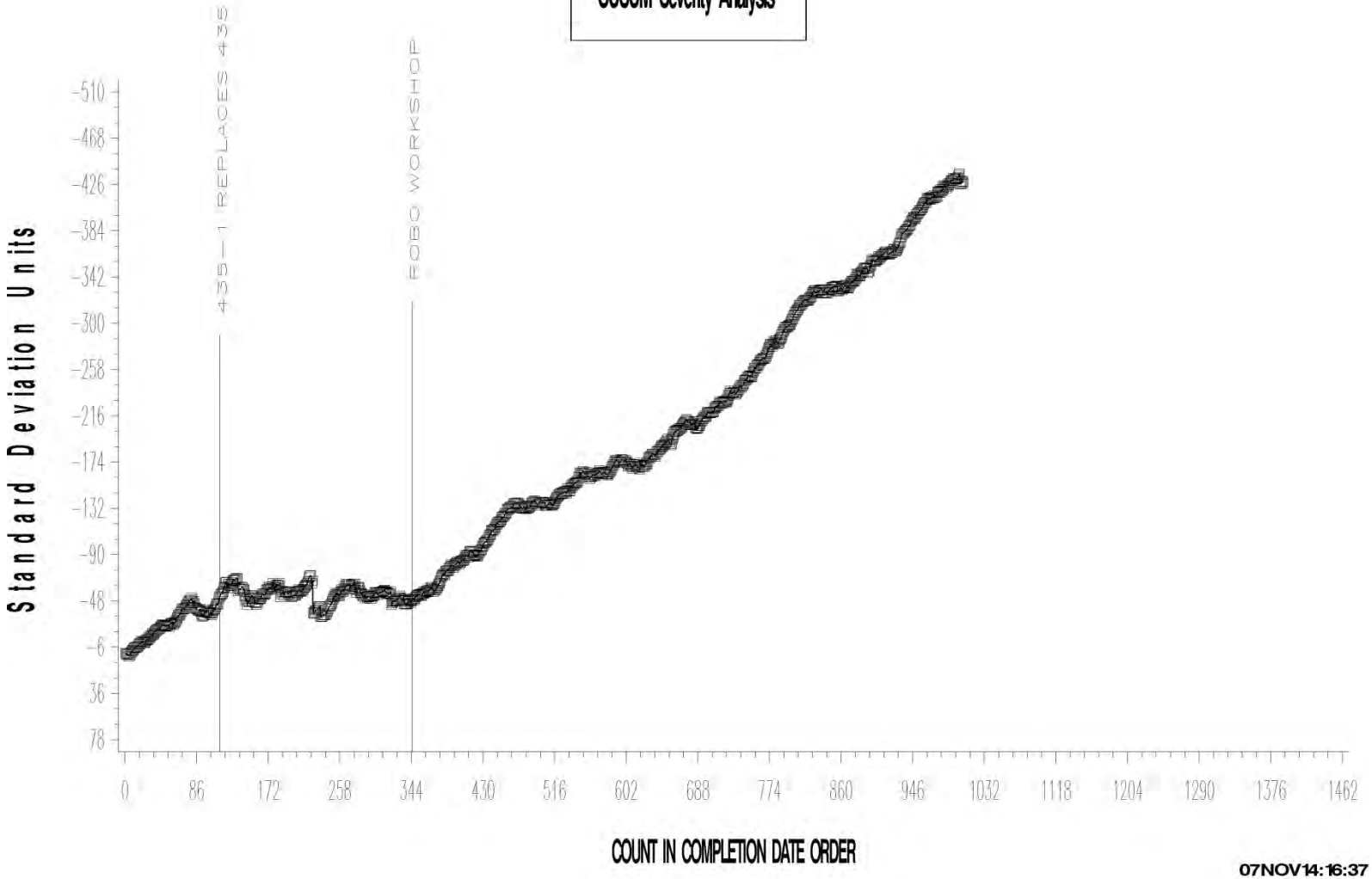
AGED OIL MRV APPARENT VISCOSITY

CUSUM Severity Analysis



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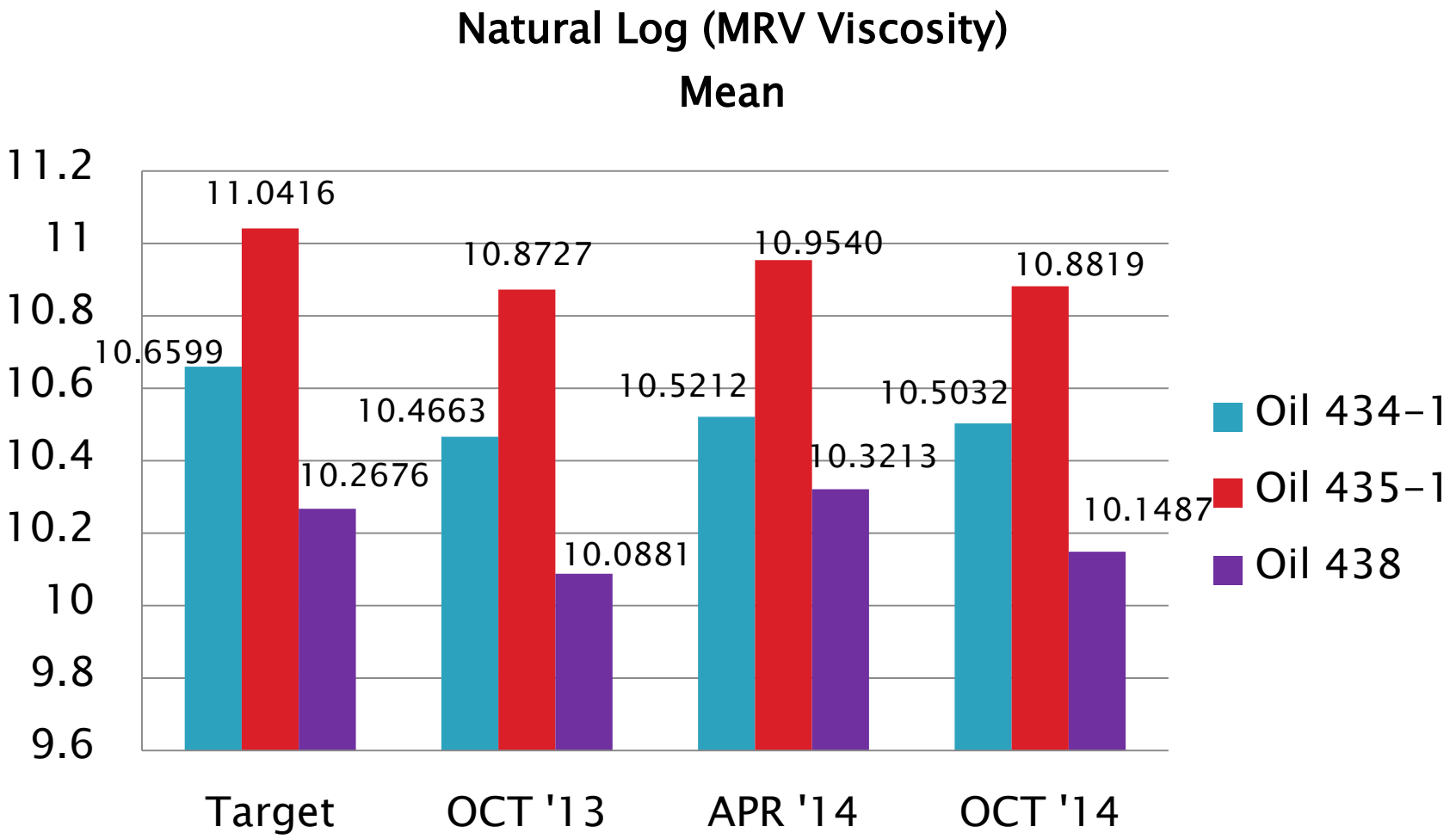
D7528: Oxidation by ROBO

Performance by Oil
Natural Log (MRV Viscosity)

	Targets			4/1/13 - 9/30/13				10/1/13 - 3/31/14				4/1/14 - 9/30/14			
Oil Code	n	Mean	s_R	n	Mean	s_R	Mean Δ/s	n	Mean	s_R	Mean Δ/s	n	Mean	s_R	Mean Δ/s
434-1	13	10.6599	0.1672	27	10.4663	0.2154	-1.16	33	10.5212	0.2227	-0.83	22	10.5032	0.2142	-0.94
435-1	22	11.0416	0.2030	40	10.8727	0.2749	-0.83	33	10.9540	0.2530	-0.43	41	10.8819	0.2845	-0.79
438	14	10.2676	0.2037	23	10.0881	0.1818	-0.88	19	10.3213	0.3658	0.26	20	10.1487	0.2223	-0.58

D7528: Oxidation by ROBO



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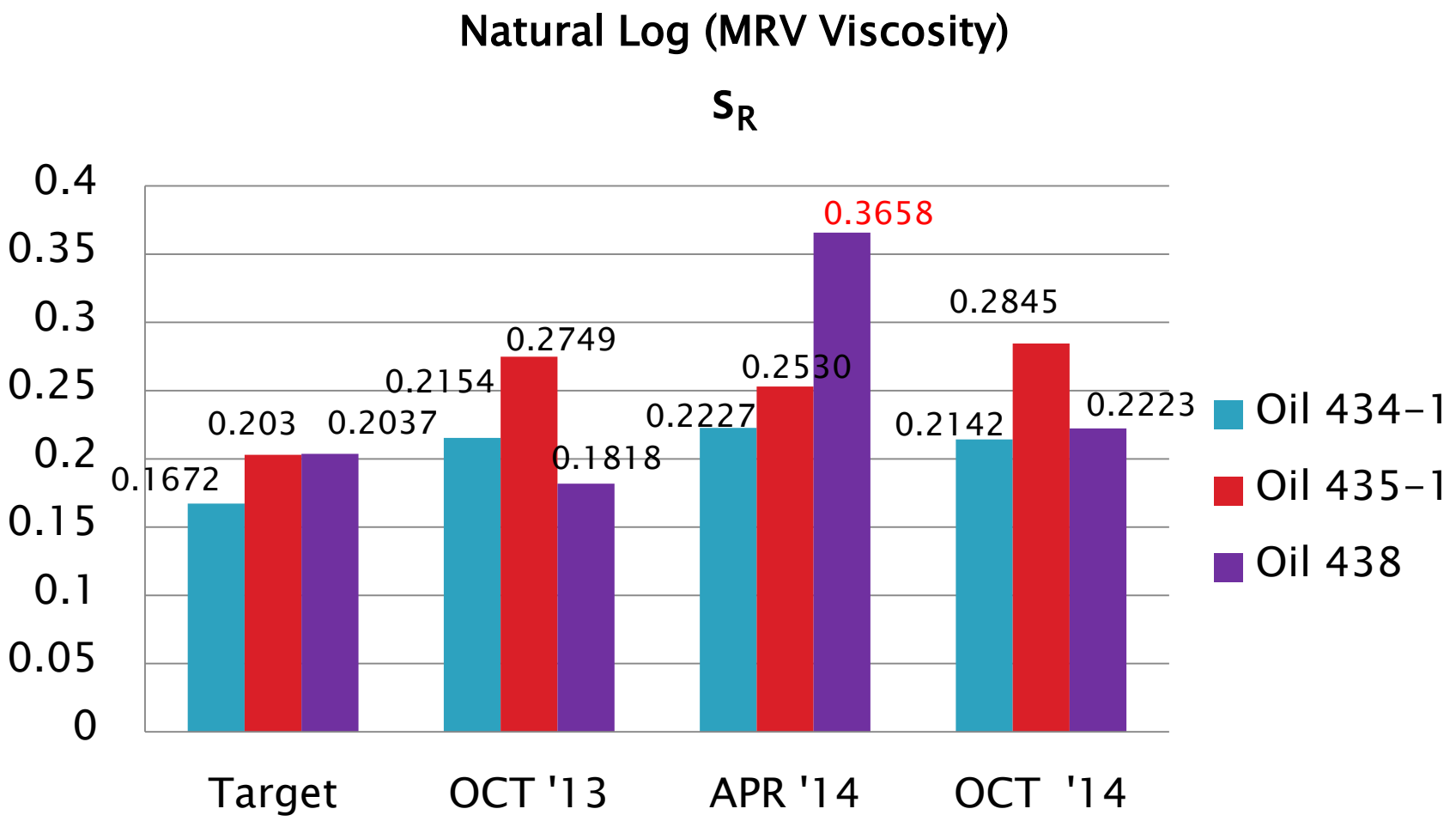
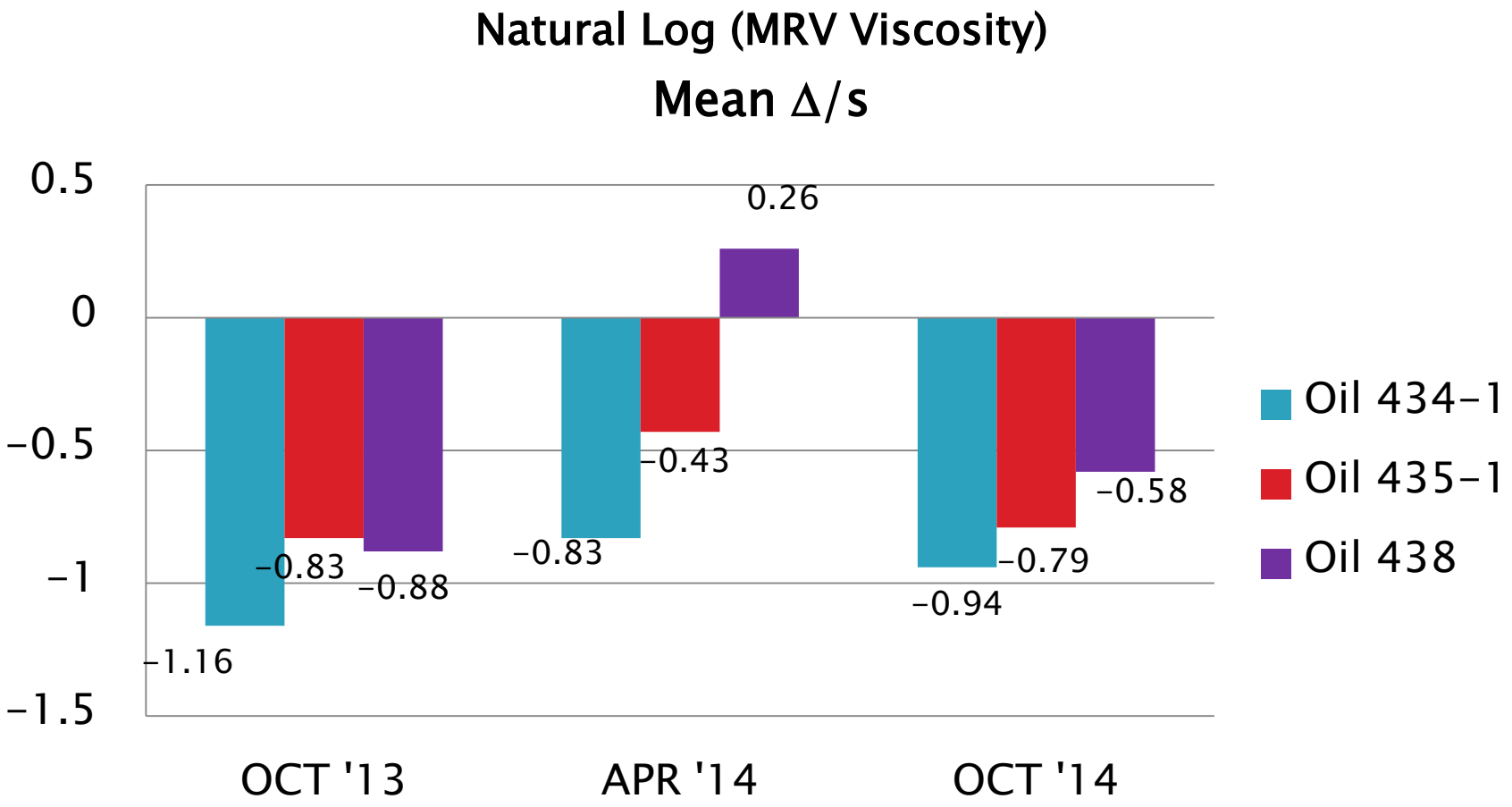


D7528: Oxidation by ROBO



Return to Executive Summary

Non-monitored Bench Tests

- **D6922 Homogeneity and Miscibility**
  - The TMC distributes six D6922 reference oils.
  - The TMC does not collect reference data or monitor test results for this test at this time.
  - **Oils rec'd by TMC 2002 – 2003**
    - **Formulations are at least 12 years old now**
    - **Should section or panel consider updating?**

- **D7563 Emulsification**
  - The TMC distributes two D7563 reference oils.
  - The TMC does not collect reference data or monitor test results for this test at this time.

Reference Oil Inventory

- As of 9/30/2014

Reference Oil Inventory

D5800, D6417, GI

Oil	Year Rec'd By TMC	Tests	TMC Inventory, gallons	Gallons Shipped last 12 months
VOLC12	2013	D5800	51.5	1.8
VOLD12	2013	D5800	52.0	1.3
VOLE12	2013	D5800	51.8	1.5
VOLD14	2014	D5800QC	438.7	1.3
52	1995	D6417	59.1	0.0
55	1995	D6417	66.2	0.0
58	1998	D6417, GI	110.3	0.1
62	1996	GI	1.4	0.1
1009*	2002	GI	46.9	----

*Multi-test oil; estimated aliquot reserved for bench testing.

Reference Oil Inventory

TEOST, MTEOS & ROBO

Oil	Year Rec'd By TMC	Tests	TMC Inventory, gallons	Gallons Shipped last 12 months
432	1998	MTEOS	112.5	0.6
434	2003	MTEOS	4.2	0.5
75	2010	TEOST	5.2	0.5
435-2*	2010	TEOST	45.7	----
434-1*	2008	ROBO	6.8	----
435-1*	2008	ROBO	30.7	----
438*	2003	ROBO	19.3	----

*Multi-test oil; estimated aliquot reserved for bench testing.

Reference Oil Inventory

D6082 & D874

Oil	Year Rec'd By TMC	Tests	TMC Inventory, gallons	Gallons Shipped last 12 months
1007	1998	D6082	17.2	2.6
66	2002	D6082	89.6	1.2
820-2	2001	D874	10.2	0.0
90	2005	D874	30.8	0.8
91	2006	D874	4.0	0.0

Reference Oil Inventory

D6922 Homogeneity & Miscibility Oils

Oil	Year Rec'd By TMC	Tests	TMC Inventory, gallons	Gallons Shipped last 12 months
HMA	2002	H&M	143.6	9.8
HMB	2002	H&M	147.4	10.0
HMC	2003	H&M	133.6	9.8
HMD	2002	H&M	141.4	9.8
HME	2002	H&M	127.4	9.8
HMF	2002	H&M	149.9	9.8

Reference Oil Inventory

D7563 Emulsion Retention Oils

Oil	Year Rec'd By TMC	Tests	TMC Inventory, gallons	Gallons Shipped last 12 months
EM2	2011	Emulsion	7.9	0.8
EM2-1	2011	Emulsion	25.0	0.0
EM5	2011	Emulsion	7.9	0.8
EM5-1	2011	Emulsion	25.0	0.0

Reference Oil Shipping Aliquots

Test	Quantity
D6417	1 ml
D6417QC	118 ml
D5800	100 ml
GI	25 ml
MTEOS	17 ml
TEOST	125 ml
D6082	525 ml
D874	32 ml
D874QC	1000 ml
ROBO	300 ml
ROBOQC	1000 ml
H&M	1000 ml
D7563	1000 ml

Additional Information

Additional Information

- Available on the TMC's Website:
  - CUSUM Severity Plots
  - Reference Data, Period Statistics and Timelines
  - Information Letters and Technical Memos
  - Report Forms & Data Dictionaries
  - Online Store, and more…

- www.astmtmc.cmu.edu

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