# B07 Volatility Surveillance Panel Meeting

Amy Ross 20230607

# Minutes 20230607

- Antitrust Statement (Reviewed)
- Members List Review
  - updated 20230607 and is inserted at the end of the slides
- Minutes Approval from last meeting
  - Motion by Greg Miiller, Second by Robert Stockwell
- Reference Oil Checks
  - Reviewed by panel; no comments
- Stats Review
  - Presented by Ricard Affinito; virtually no change in standard deviation as confirmed by ANOVA from data up to 06/05/2023 (MSE = 0.0462); untransformed reference oil data shows unequal variances across range of mean values which reaffirms the natural log transformation of Noack data; overall fail rate remains low but observed slight deviation for the period upcoming which can be attributed to one rig (BD4 with an individual fail rate of 54%); no recommended changes at this time
  - Comment from Alfis Babajide (Shell) regarding the VOLD18 daily QC fluid as tested on NCK25G rigs
    - panel discussed troubleshooting options for a rig which is unable to pass daily reference checks, including pump calibrations, temperature probe calibration, firmware updates, proper filter maintenance, cup/lid pairing
    - AB asked for any panel members to comment if they had issues passing the VOLD18 fluid to which there was no response; it was noted that a rig cannot submit for calibration or perform testing with the intent of licensing without passing the daily QC check with VOLD18; other reference oils are suitable for use with Noack but the VOLD18 is a requirement for calibration and licensing data acquisition; Observing consistent lab/rig participation and relatively infrequent occurrence of recalled tests, it can be assumed that passing the VODL18 daily QC is not prohibitive of participation at this time
- B07 Semi-Annual report (slides included)

# Antitrust Statement

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Reminder: Electronic recording of ASTM meetings is prohibited.

# Members List – Updated 20230106

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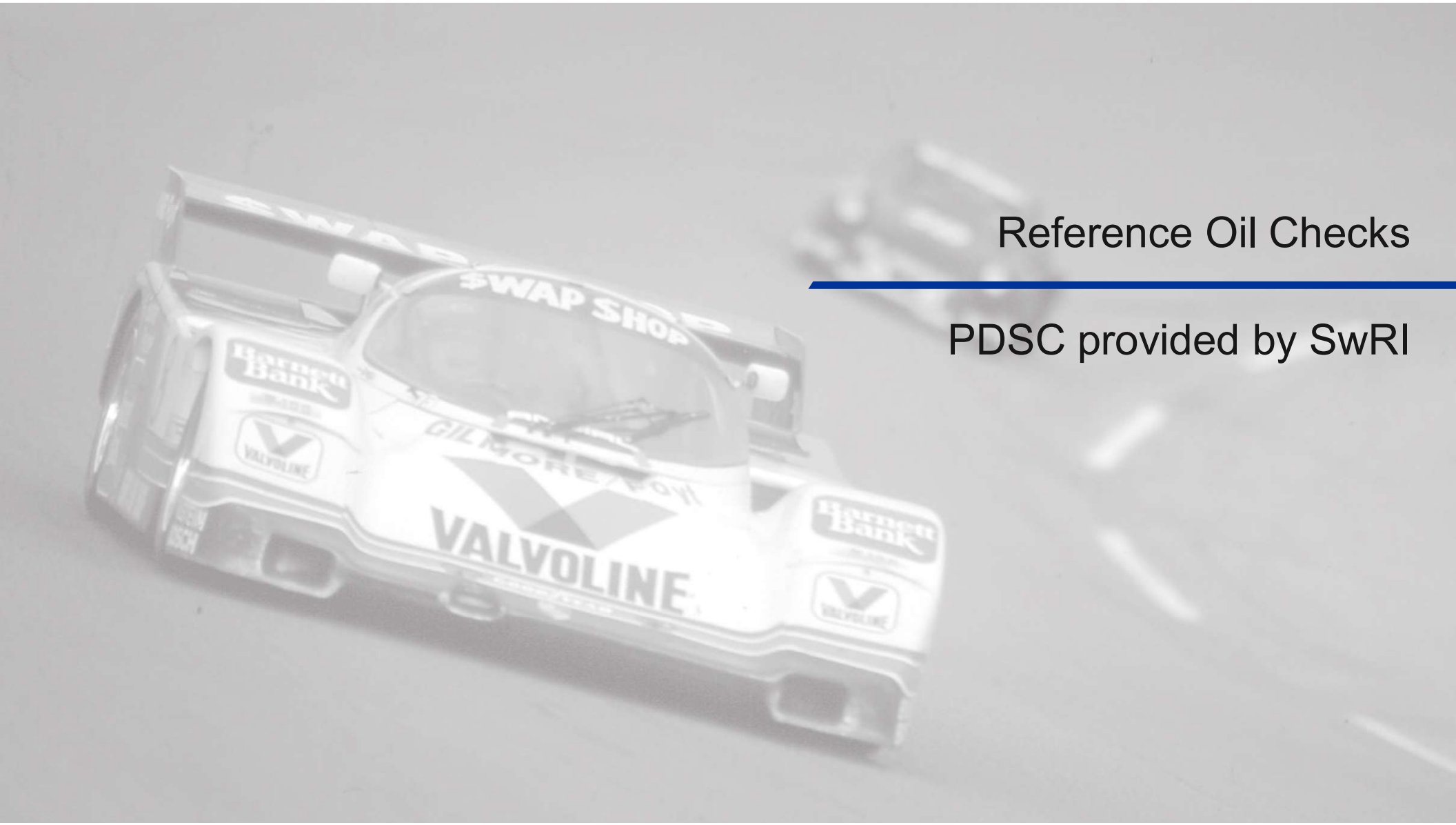
# Minutes 20221028

- Antitrust Statement
- Members List – Updated 20221028
- Approve minutes from last meeting – Motion Greg Miiller, Second Robert Stockwell
- June meeting review
- Noack rig population changes
- Targets discussion
  - Travis Kostan explained the impact of changing evaluation procedures on the pass/fail rate; target evaluations may not be the most reasonable way forward, but rather the correction factor and only if labs are unable to calibrate or some other extraneous circumstance arises; questions that should be addressed are if the SAs are working, if labs are able to indicate, do the EWMA plots corroborate the CUSUM conclusions (AR paraphrase); there are ten years worth of data contributing to the CUSUM plot and, although the mix has shifted, labs are still able to calibrate (AR note that fail rate is stable and possibly even declining)
  - Elisa Santos explained some history regarding the rationale behind selection of the data used and integrated for test monitoring; the acceptability of a mix of variables, such as oils, procedure, rig, etc., were evaluated and approved by the panel at the time of target establishment—changing this acceptability will require additional or alternative analyses
    - Richard Grundza additional commentary regarding the consistent movement of rigs in and out of the population and the notion that there will always be rigs with mild and severe performance (AR – regardless of rig type?); may require evaluation of targets but not necessarily a change
  - Statisticians clarified the need to evaluate more than just CUSUM plot to understand true performance of test as being “in control” or otherwise; EWMA chart of last period’s Noack data was displayed to clarify the difference in perception or conclusions
  - TMC shared CUSUM plots of individual reference fluids as well as highlighting the leveling off of test, overall, and specifically procedure B—perhaps we may need a deep dive in the rig populations over the years, beyond what was presented in this meeting
  - Greg Miiller and other panelists suggested that we review the firmware updates issued and recorded with candidate data to supplement our understanding of the rig population and performance
  - Panel consensus that we leave test in maintenance mode at this time with biannual evaluation concurrent with B07 period updates, or as needed
  - Amy Ross to convene with TMC (Richard/John) intermittently to review updated charts which are not typically included in the period summaries
  - *See slides at end for supplemental charts which were discussed or displayed*



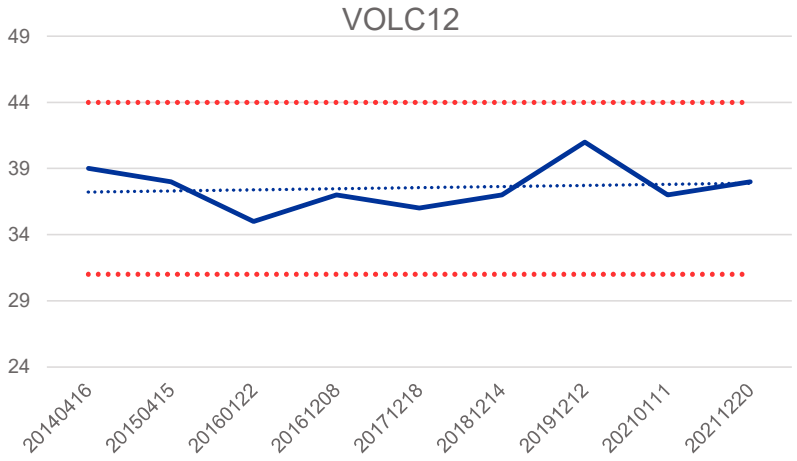

# Reference Oil Checks

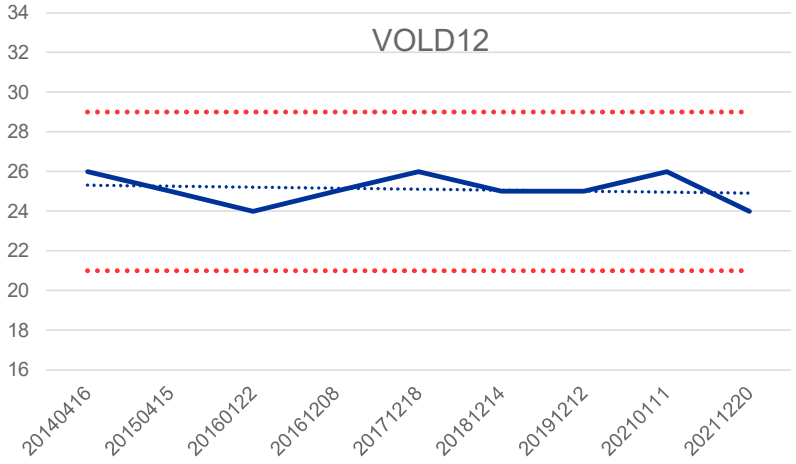
PDSC provided by SwRI

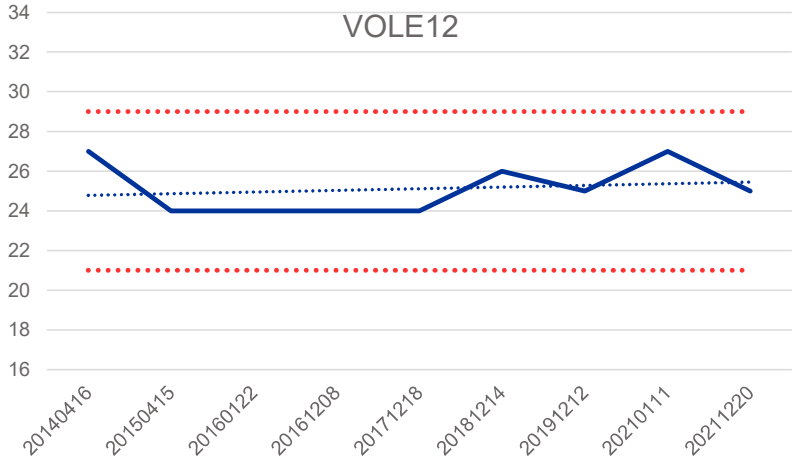
# PDSC D6186 Results

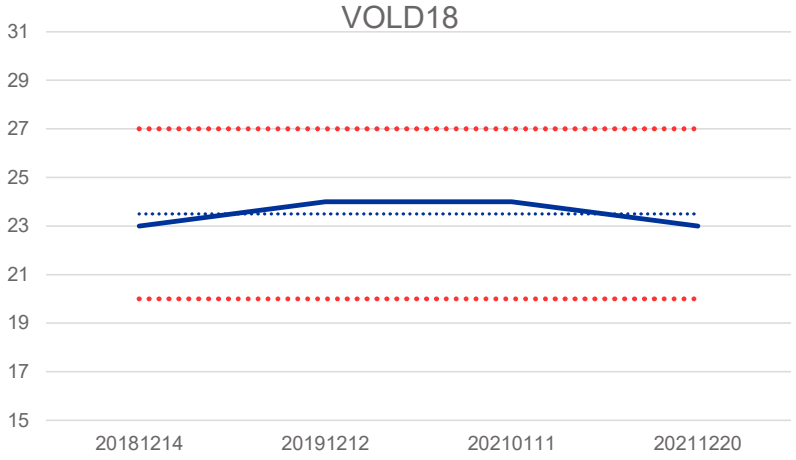
| | VOLC12 | | VOLD12 | | VOLE12 | | *VOLD14* | | VOLD18 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Report Date | minutes | Deg C | minutes | Deg C | minutes | Deg C | *minutes* | *Deg C* | minutes | Deg C |
| 20140416 | 39 | 210 | **26** | 210 | **27** | 210 | ---- | ---- | ---- | ---- |
| 20150415 | 38 | 210 | 25 | 210 | **24** | 210 | *21* | *210* | ---- | ---- |
| 20160122 | **35** | 210 | **24** | 210 | 24 | 210 | *23* | *210* | ---- | ---- |
| 20161208 | 37 | 210 | 25 | 210 | 24 | 210 | *24* | *210* | ---- | ---- |
| 20171218 | 36 | 210 | 26 | 210 | 24 | 210 | *24* | *210* | ---- | ---- |
| 20181214 | 37 | 210 | 25 | 210 | 26 | 210 | *26* | *210* | **23** | 210 |
| 20191212 | **41** | 210 | 25 | 210 | 25 | 210 | ---- | ---- | **24** | 210 |
| 20210111 | 37 | 210 | 26 | 210 | 27 | 210 | ---- | ---- | 24 | 210 |
| 20211220 | 38 | 210 | 24 | 210 | 25 | 210 | ---- | `---- | 23 | 210 |
| 20221230 | 38 | 210 | 25 | 210 | 27 | 210 | ---- | ---- | 23 | 210 |
| | | | | | | | | | | |
| Avg | 37.6 | | 25.1 | | 25.6 | | *24* | | 23.4 | |
| SD | 1.6 | | 0.7 | | 1.3 | | *2* | | 0.5 | |
| R | 13.2 | | 8.8 | | 8.9 | | *8* | | 8.2 | |
| r | 6.4 | | 4.3 | | 4.3 | | *4* | | 4.0 | |
| | | | | | | | | | | |
| Max Diff | 6 | | 2 | | 3 | | *5* | | 1 | |
| 2014 to 2022 | -1 | | -1 | | 0 | | *+5* | | 0 | |
| Avg Max | 39 | | 25 | | 26 | | *24* | | 24 | |
| R | 13 | | 9 | | 9 | | *8* | | 8 | |
| r | 7 | | 4 | | 4 | | *4* | | 4 | |
| Precision Statement: | | | | | | | | | | |
| RMIN | 24 | | 16 | | 16 | | 15 | | 15 | |
| RMAX | 51 | | 34 | | 34 | | 32 | | 32 | |
| rMIN | 31 | | 21 | | 21 | | 20 | | 19 | |
| rMAX | 44 | | 29 | | 30 | | 28 | | 27 | |

# PDSC D6186 Results



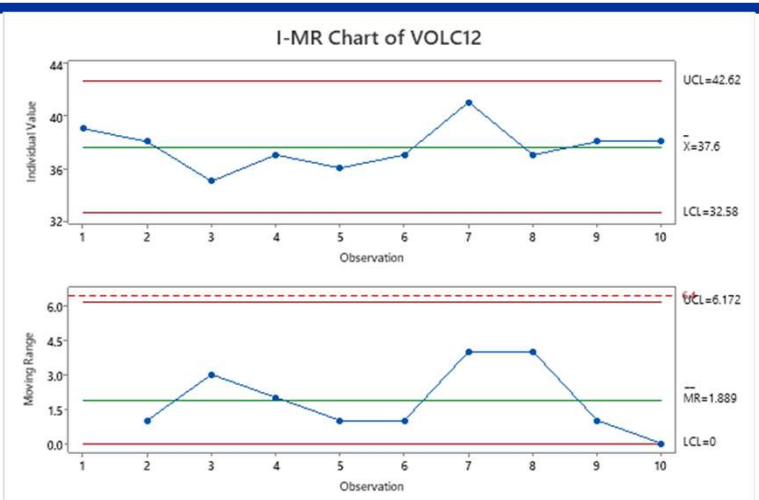



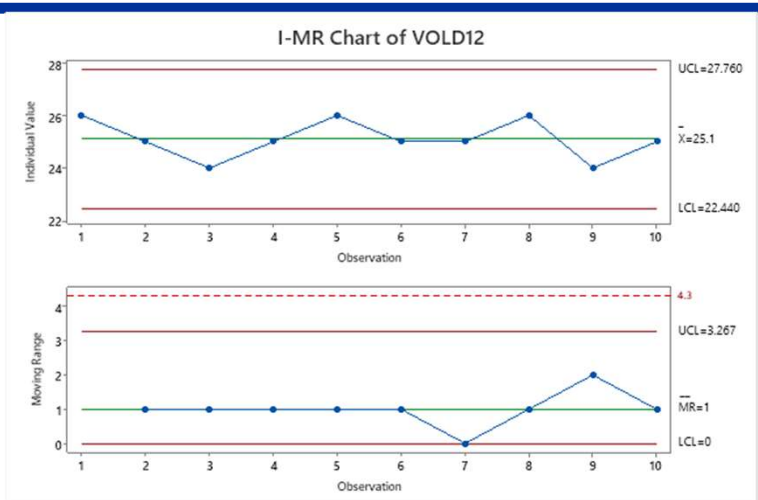



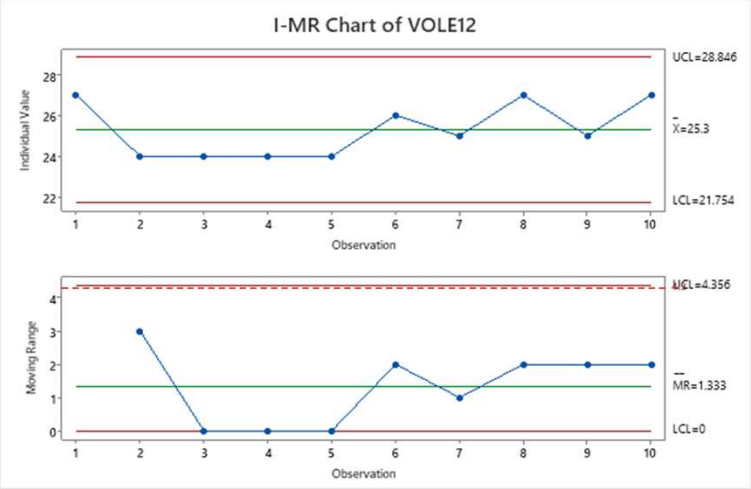

Reference lines are repeatability ranges per D6186

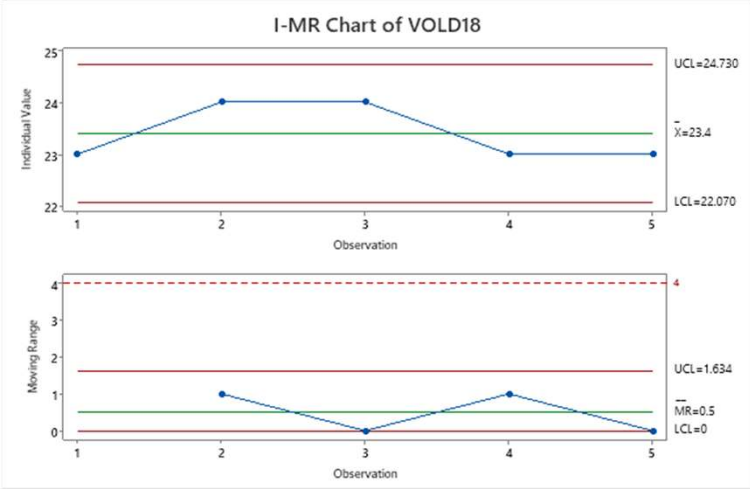
All oils showed no statistically significant changes in oxidative stability, wrt initial measurements or last measurement

# PDSC D6186 Results




Reference lines on MR section are repeatability values per D6186

# Stats Review

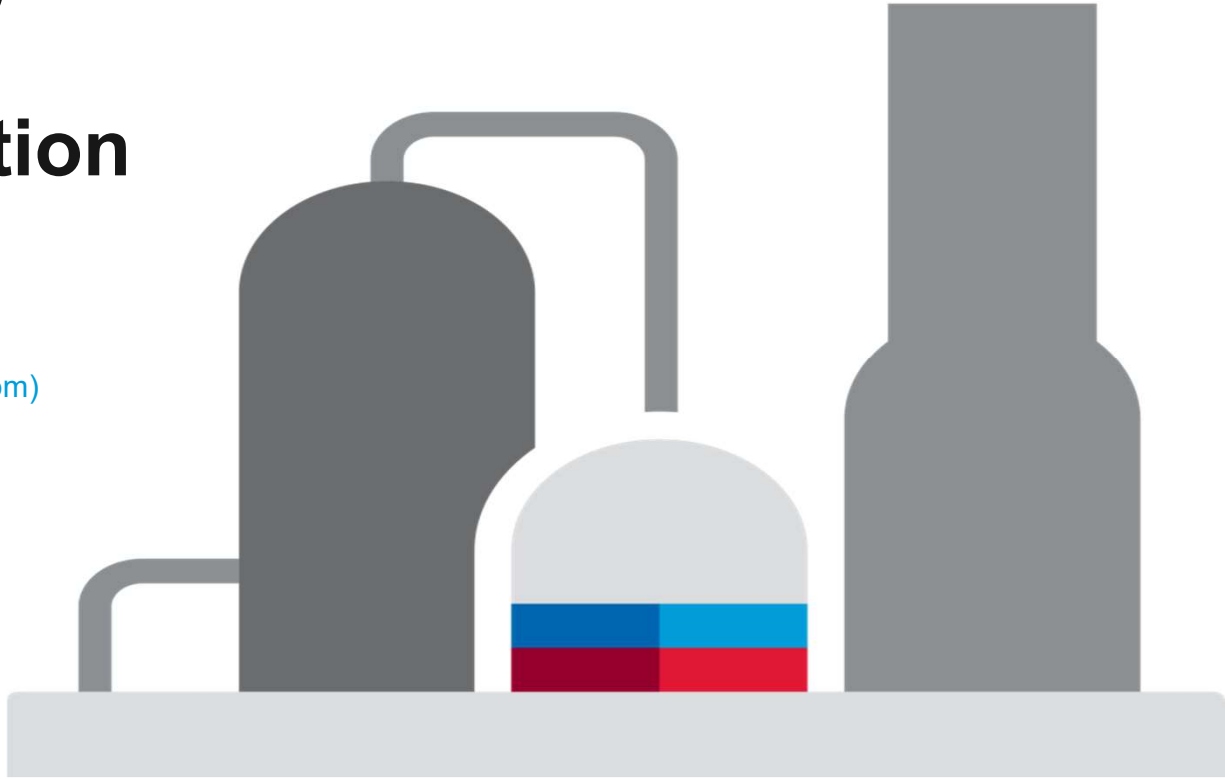
## Ricardo Affinito

# D5800 (NOACK)

# Standard Deviation Update

Ricardo Affinito (affinito@chevron.com)

June 7th, 2023



# Summary

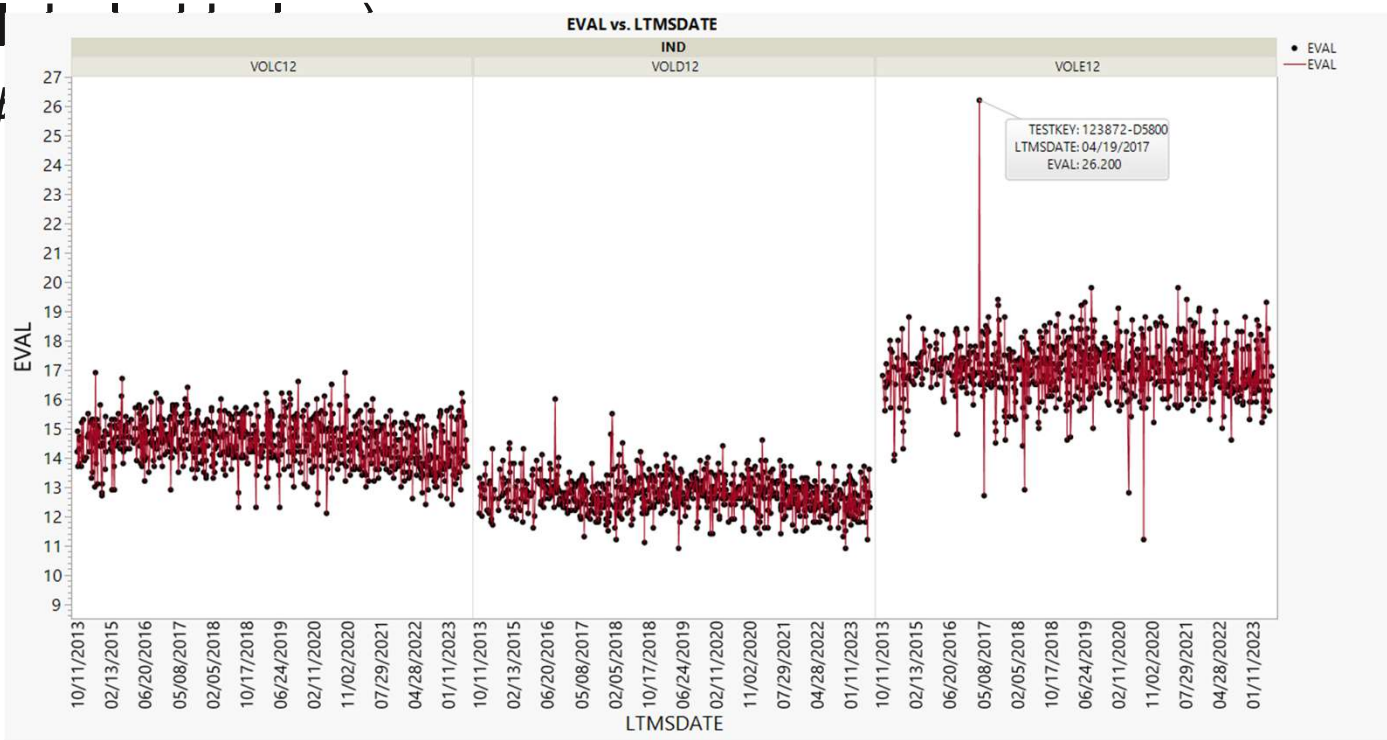
- Upon updating analyses with most recent data, there is practically no change in variability

  - After applying the Ln(.) transformation, the calculated standard deviation is equal to 0.0462, while the current (LTMS RO) standard deviation is 0.0465
  - No further action is recommended

- Rate of tests that did not meet statistical criteria has declined over time and now around 5%

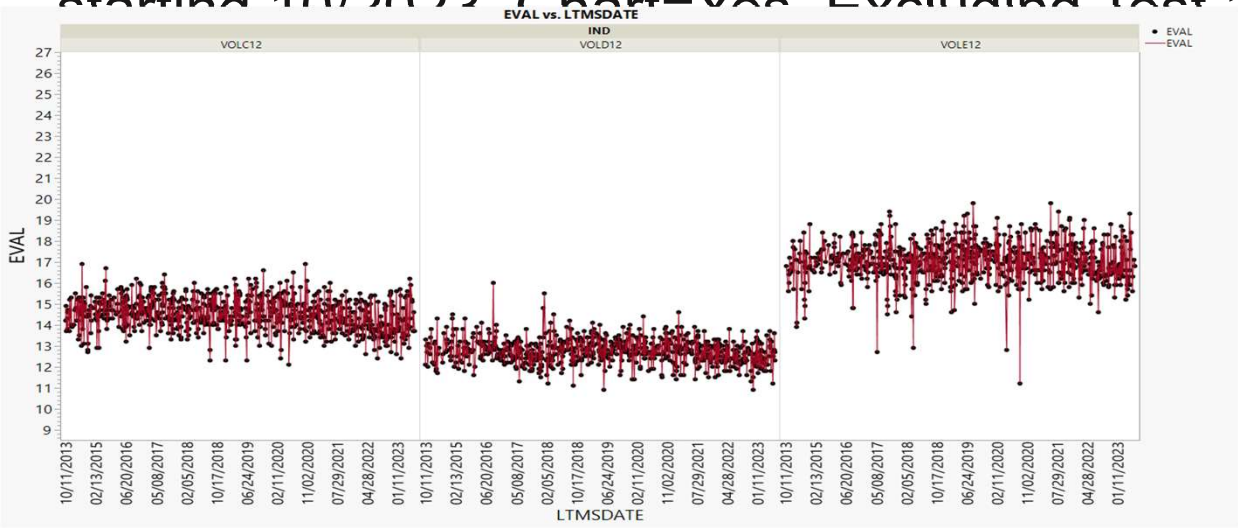
# Data Considered

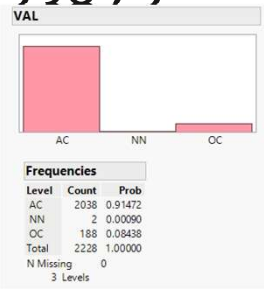
n = 2,228 tests (file download date 6/05/2023), starting 10/2023, Chart=Yes, Excluding Test 123872 (I
#

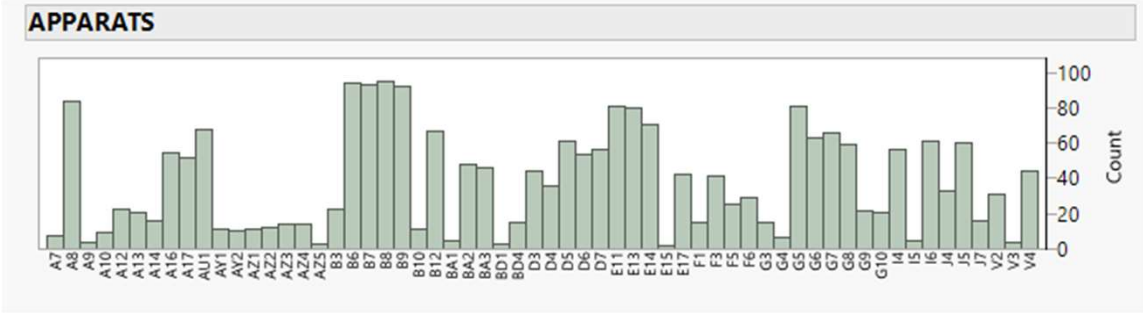


# Data Used

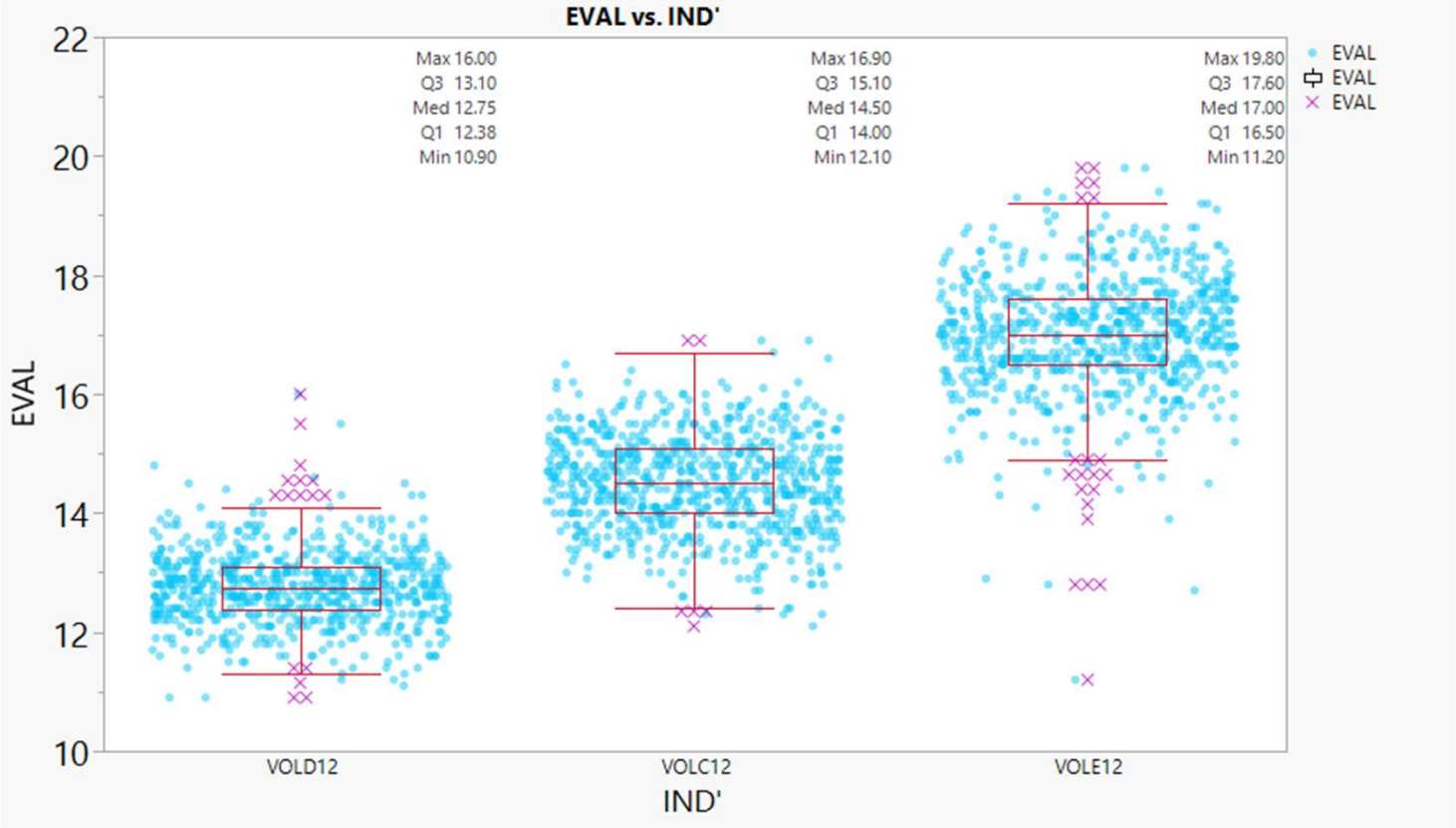
n = 2,228 tests (file download date 6/05/2023), starting 10/2023, Chart=Yes, Excluding Test 123872



# Evaporation Loss by Oil



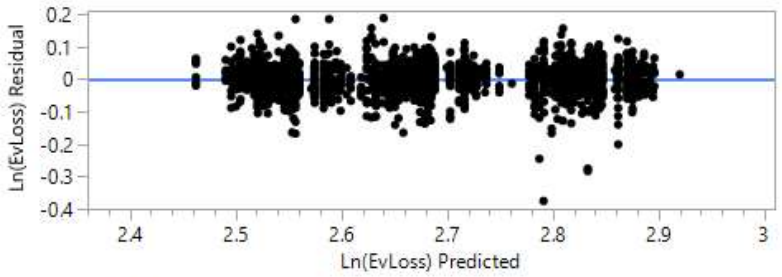
# SD Calculation (ANOVA: Oil and Apparatus)

**Response Ln(EvLoss)**

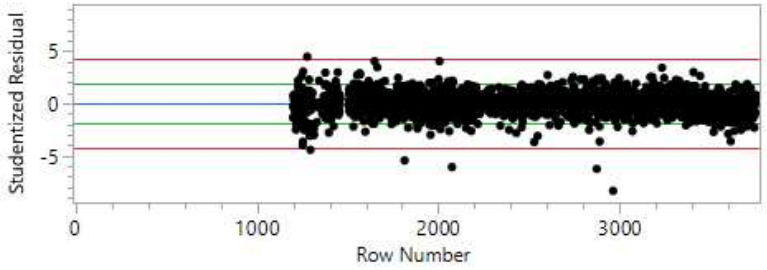
**Effect Summary**

| Source | Logworth | PValue |
|---|---|---|
| IND | 946.533 | 0.00000 |
| APPARATS | 117.943 | 0.00000 |

**Residual by Predicted Plot**




**Studentized Residuals**




Externally studentized residuals with 95% simultaneous limits (Bonferroni) in red, individual limits in green.

**Summary of Fit**

| | |
|---|---|
| RSquare | 0.874275 |
| RSquare Adj | 0.870734 |
| Root Mean Square Error | 0.046172 |
| Mean of Response | 2.685085 |
| Observations (or Sum Wgts) | 2228 |

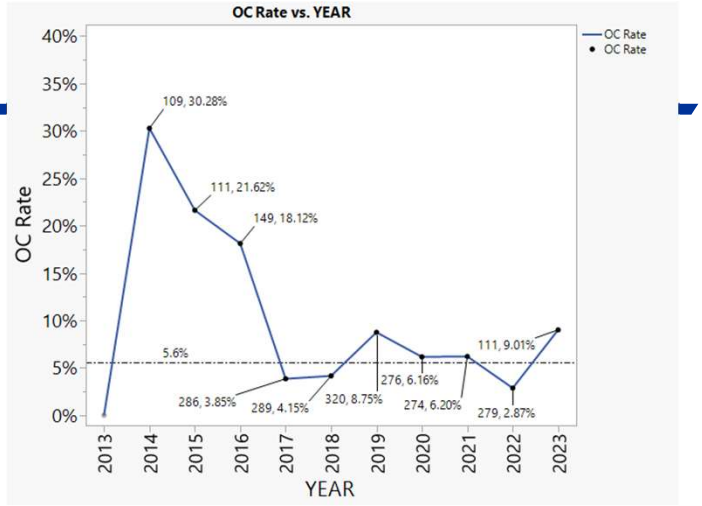
**Analysis of Variance**

| Source | DF | Sum of Squares | Mean Square | F Ratio |
|---|---|---|---|---|
| Model | 61 | 32.109636 | 0.526387 | 246.9186 |
| Error | 2166 | 4.617536 | 0.002132 | Prob > F |
| C. Total | 2227 | 36.727171 | | <.0001* |

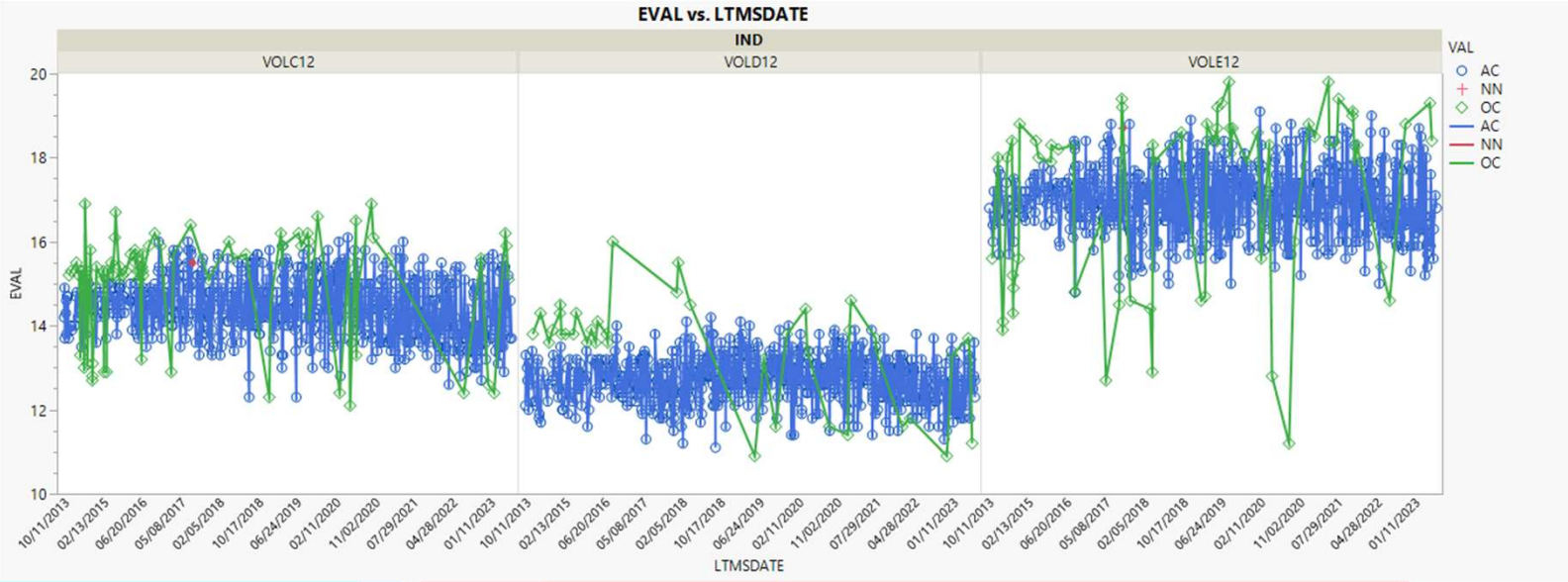
* With 123827, RMSE=0.04696

# Additional Plots

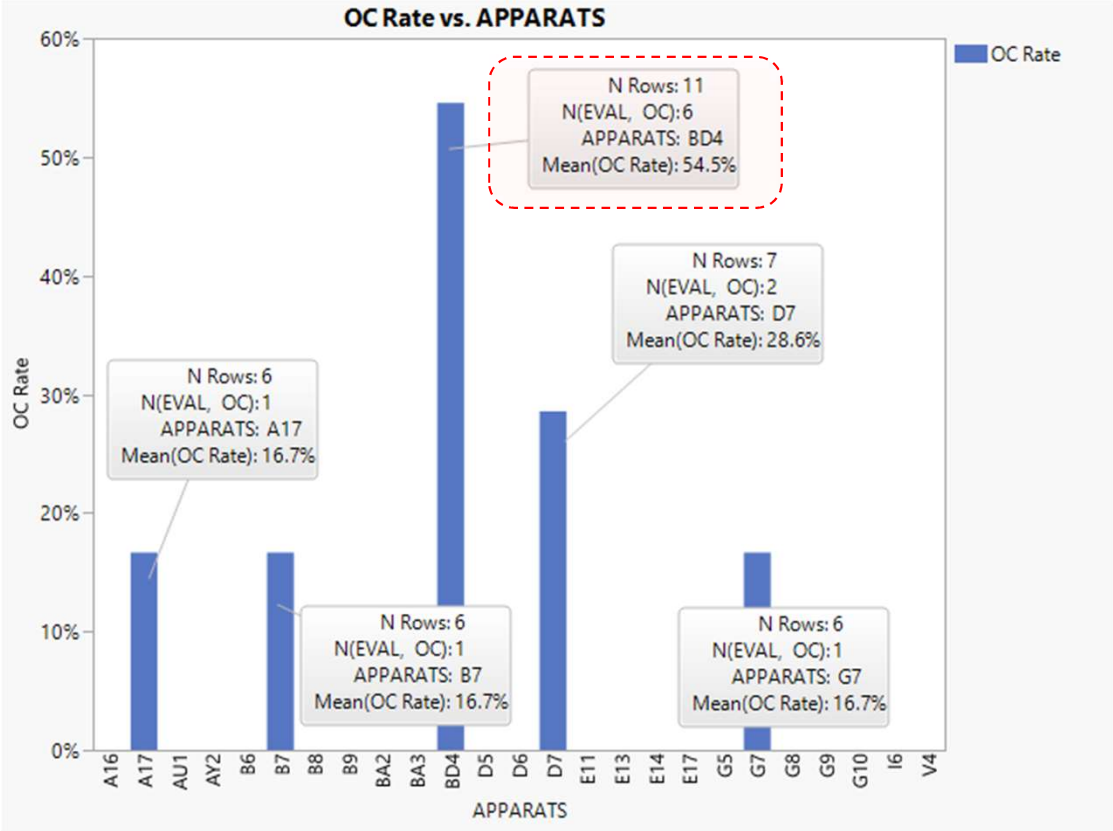
# OC Rate vs. Year



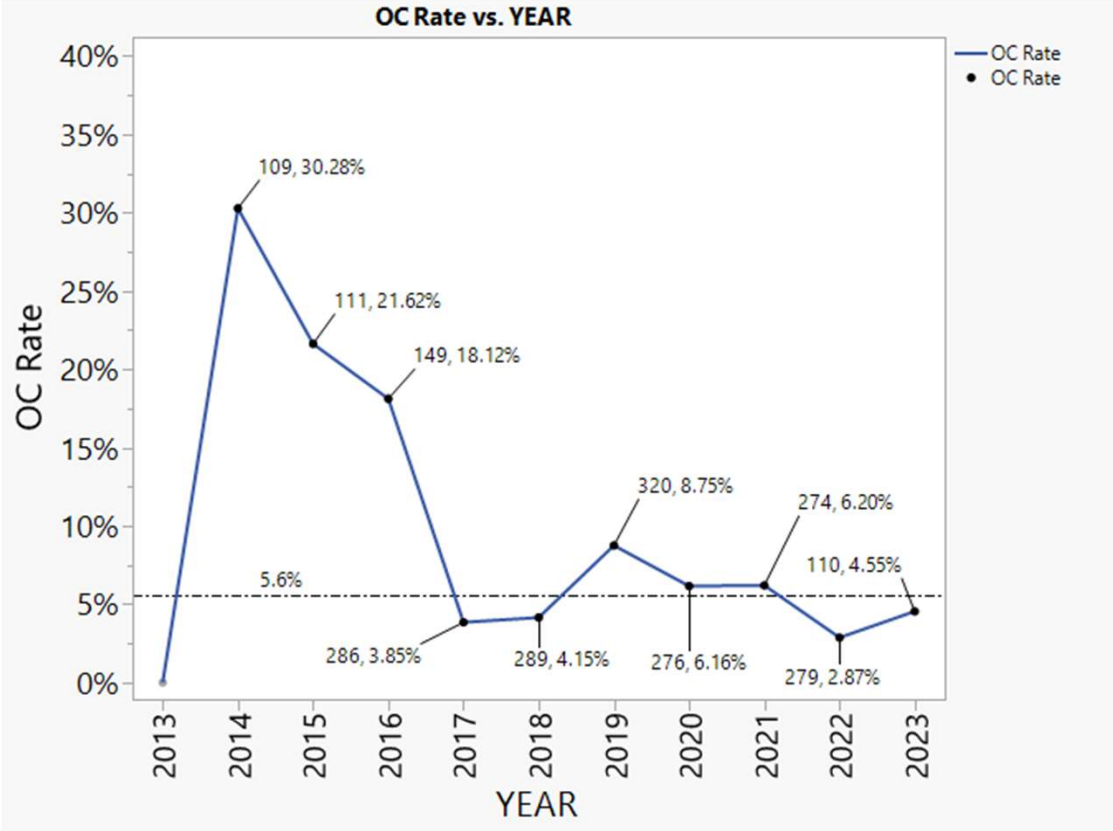

Rate of tests that do not meet statistical criteria (around 5.6%..)



# 2023 OC Rate vs. APPARATS, BD4 Highest



# 2023 OC Rate without BD4 Data



# TMC Validity Codes

The following are the TMC validity/test designations:

| Validity Designation | Definition | Test Designation | Definition |
|---|---|---|---|
| A | acceptable for intended purpose | C | calibration test |
| O | operationally valid,<br>does not meet statistical criteria | D | double blind, for calibration |
| R | operationally invalid,<br>reported as valid by lab, not in stats | E | fuel run also for calibration |
| X | aborted, not in stats | F | fuel run for fuel approval only |
| L | operationally invalid<br>as determined by lab, not in stats | G | industry donated test, not for calibration |
| N | acceptable for intended purpose,<br>and not in stats | H | hardware run also for calibration |
| M | not acceptable for intended purpose, and not in stats | I | hardware run for hardware approval only |
| P | pending (not resolved), not in stats | N | non-blind, information |
| T | Temporary | O | calibration approval by sources other than TMC |
| | | S | discrimination test, not for calibration |


# B07 Semi-Annual Report, in full

TMC


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

## D5800 (NOACK)

April 2023

# B0.07 Bench Testing: D5800 NOACK
# Table of Contents

# B0.07 Bench Testing: D5800 NOACK Executive Summary

- CUSUM slope continued turning towards MILD after leveling off in the previous semester. Long-term severity trend (severe) in the CUSUM plots was a topic of discussion at the Surveillance Panel meeting in October. At this meeting, the panel concluded that a target change was not appropriate (at that time) but warranted a deeper investigation of test results by Procedure and/or by Model. Since the October Surveillance Panel meeting, it does appear that the severe trend abating is due to more D procedure rigs which are running on the MILD side of target while the B procedure rigs have moved back towards on-target (away from running on the SEVERE side of target).

# Calibrated Labs and Stands*

(change shown in parentheses)

| Test | Labs | Stands |
|---|---|---|
| D5800 | 11 (+1) | 25 (+0) |

*As of 3/31/2023

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# D02.B0.07
# TMC Monitored Tests

## ASTM D 5800

### Data Analysis

October 1, 2022 – March 31, 2023

Test Monitoring Center
https://www.astmtmc.org

A Program of ASTM International

# D5800: Evaporation Loss of Lubricating Oil by Noack Method

| Test Status | Validity Code | No. Tests |
|---|---|---|
| Acceptable Calibration Test | AC | 130 |
| Failed Calibration Test | OC | 6 |
| Operationally Invalidated by Lab | LC | 2 |
| **Total** | | **138** |

Number of Labs Reporting Data: 11
Fail Rate of Operationally Valid Tests: 4.3%
**up slightly from last period (3%, +2OC)*
*Same Total*

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

# D5800: Evaporation Loss of Lubricating Oil by Noack Method

| Statistically Unacceptable Tests (OC) | No. Of Tests |
|---|---|
| Ei Level 3 Alarm Mild | 2 |
| Ei Level 3 Alarm Severe | 2 |
| Zi Level 2 Severity Alarm Severe | 2 |

- The 6 OC tests were on four different rigs at 3 labs..
- No operationally valid tests have exceeded ±3 s for last two test periods.

*Similar to last period*

# D5800: Evaporation Loss of Lubricating Oil by Noack Method

| Failed (OC) Details | Procedure | Model | No. Tests |
|---|---|---|---|
| Zi Level 2 Alarm: Rig (BD1*) too Severe | B | NCK25G | 1 |
| Zi Level 2 Alarm: Rig (BD1*) too Severe | B | NCK25G | 1 |
| Ei Level 3 Alarm: Rig (B6) too imprecise to predict SA | B | NCK25G | 1 |
| Ei Level 3 Alarm: Rig (B7) too imprecise to predict SA | B | NCK25G | 1 |
| Ei Level 3 Alarm: Rig (D7) too imprecise to predict SA | D | NS2 | 1 |
| Ei Level 3 Alarm: Rig (D7) too imprecise to predict SA | D | NS2 | 1 |
| **Total** | | | 6 |
| **Fail Rate of Operationally Valid Tests: 4.3%** | | | |
| *BD1 is a new rig that has not yet achieved calibration status. | | | |

*Alarms all associated with different rigs than last period*

# D5800: Evaporation Loss of Lubricating Oil by Noack Method

## Operationally Invalid Tests (LC)

Two operationally invalid calibration runs were reported this period

- Both tests were lost due to faulty thermocouple. (LC)

## D5800 Technical Memos

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

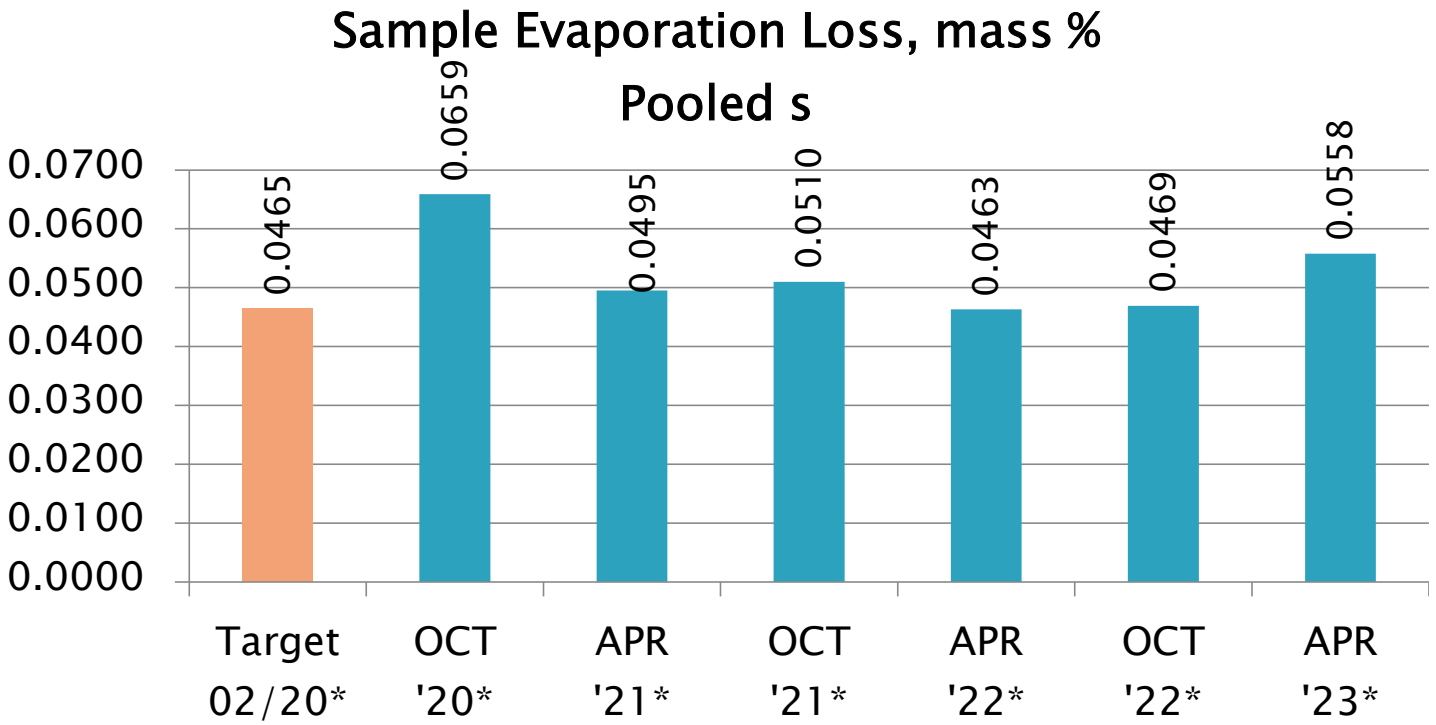
# D5800: Evaporation Loss of Lubricating Oil by Noack Method

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 | ----- |
| 4/1/19 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 |
| 4/1/22 through 9/30/22 | 136 | 133 | 0.0469 | -0.10 |
| 10/1/2022 through 3/31/23 | 136 | 133 | 0.0545 | -0.15 |

[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.

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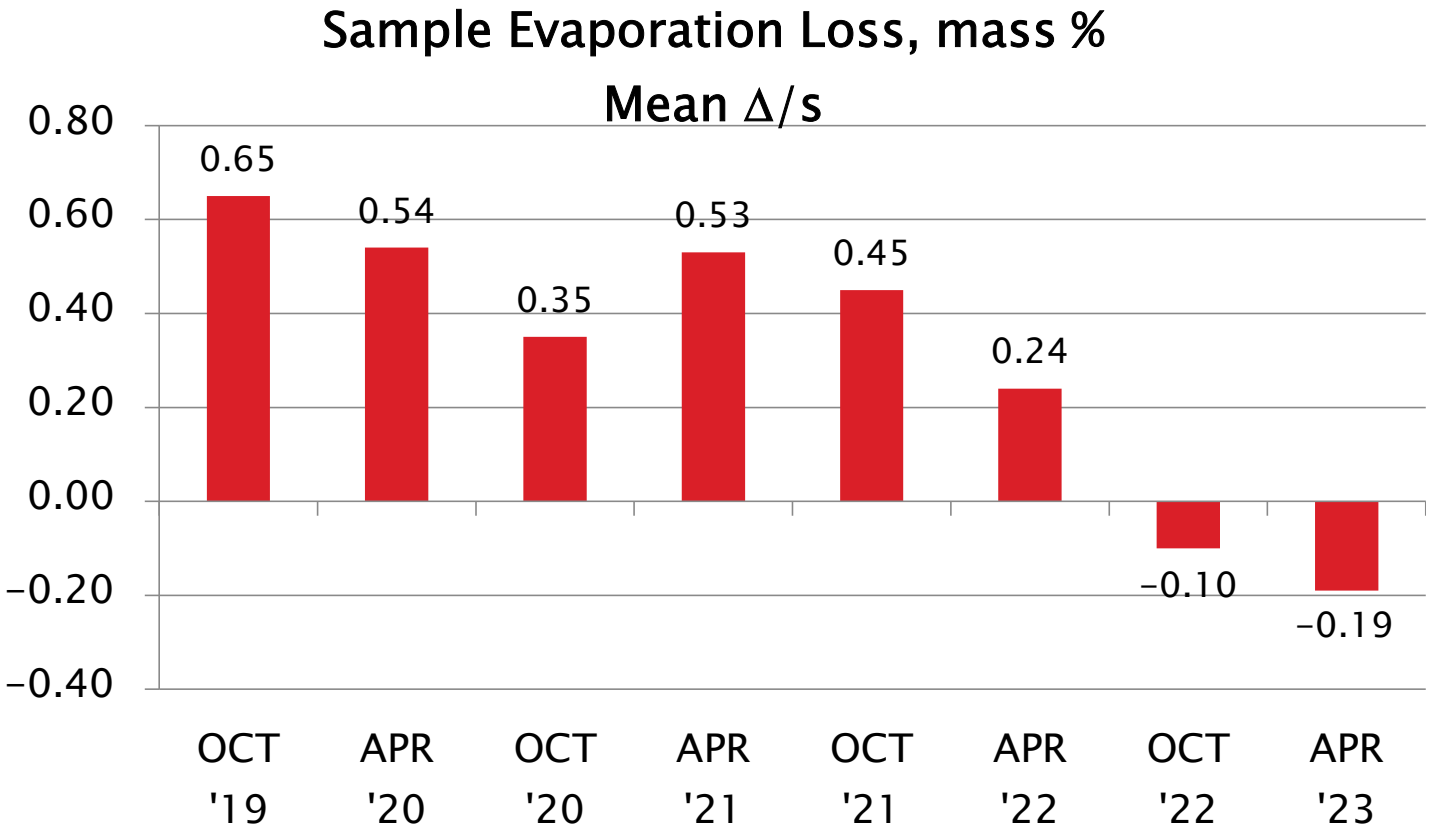
# D5800 Severity Estimates

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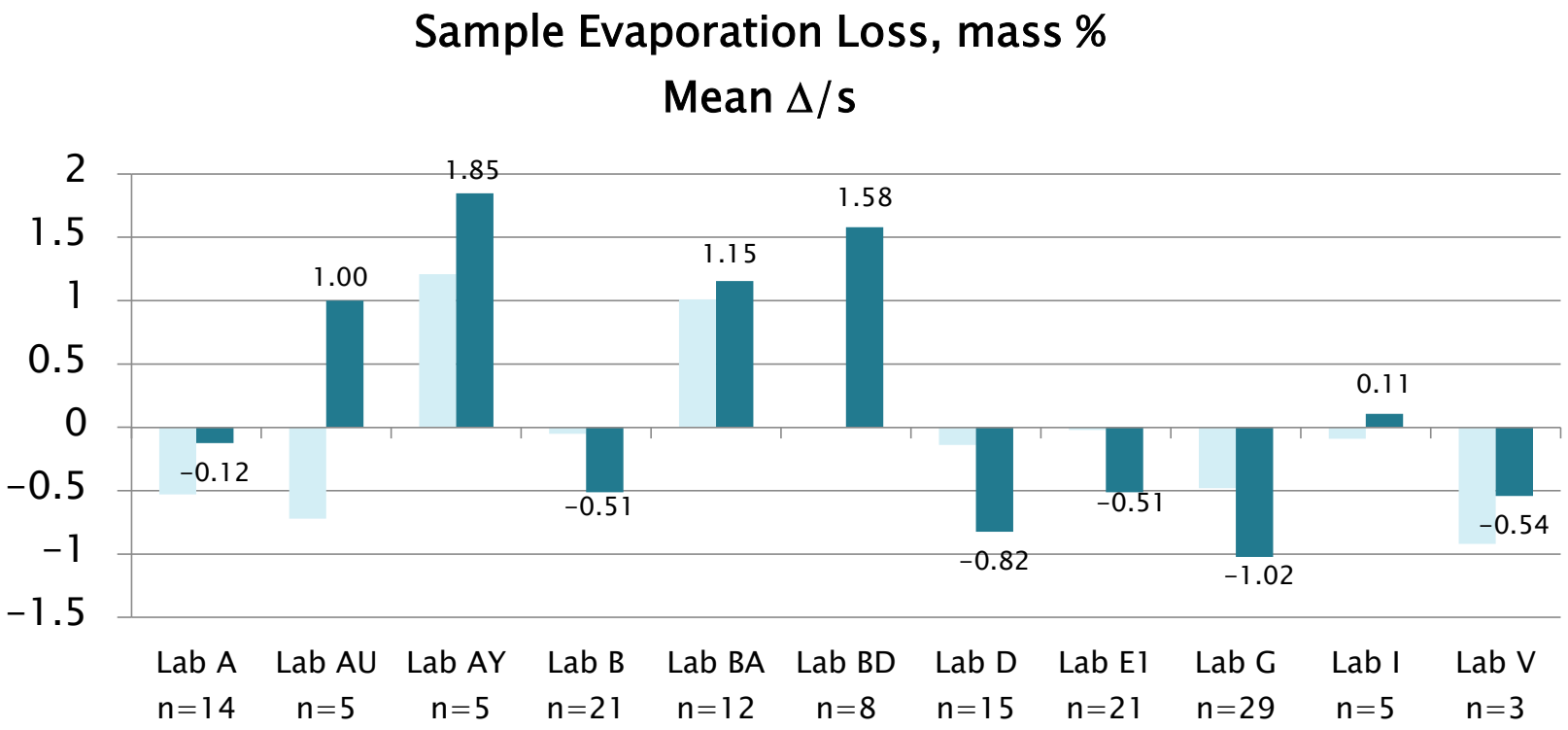
# D5800 Lab Severity Estimates

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# D02.B0.07
# TMC Monitored Tests

## ASTM D 5800

### Breakout by Procedure / Instrument

October 1, 2022 – March 31, 2023

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# 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 | 87 | 85 | 0.0564 *WORSE* | 0.15 *NC* |
| Procedure C | No Procedure C tests reported this period. | | | |
| Procedure D | 49 | 47 | 0.0405 *NC* | -0.78 *Sl.Deter.* |

| Model | n | df | Pooled s | Mean Δ/s |
|---|---|---|---|---|
| NCK2 | 6 | 3 | 0.0151 *Sl. Deter.* | -0.45 *(0.26)* |
| NCK25G | 82 *(+5)* | 79 | 0.0579 *Worse* | 0.19 *NC* |
| NS2 | 48 *(-6)* | 45 | 0.0350 *Improv.* | -0.70 *(-0.50)* |

1 Procedure B NCK2 Rig
15 Procedure B NCK25G Rigs
9 Procedure D NS2 Rigs
**No Change in population breakdown; Test counts mostly stable*

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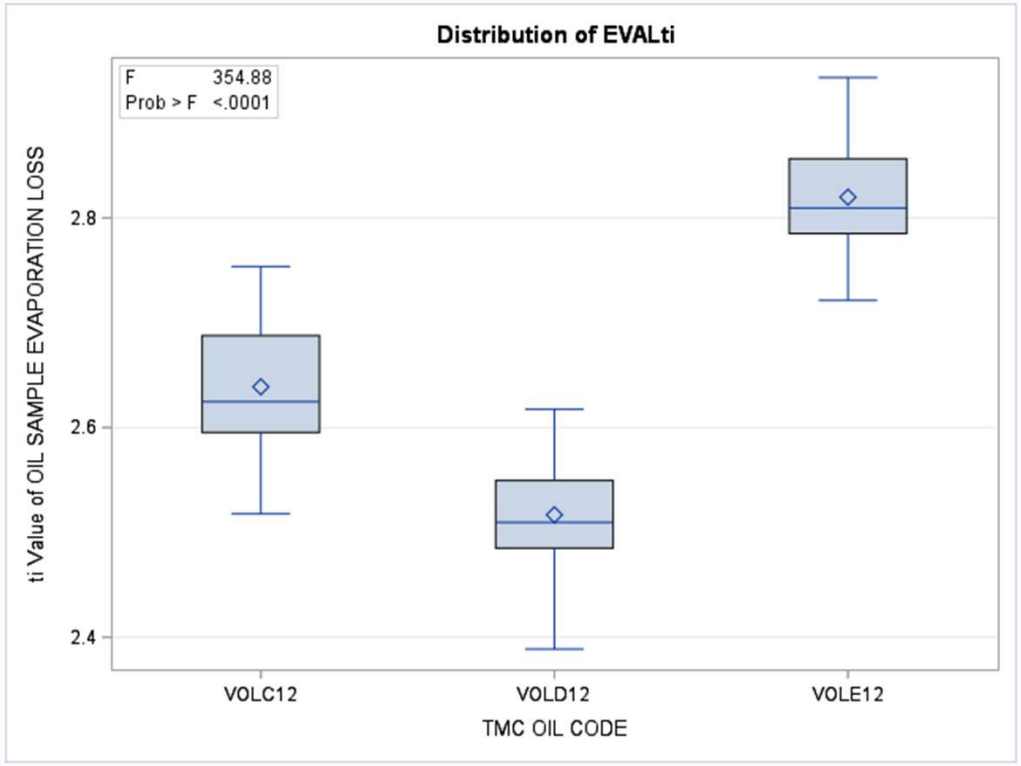
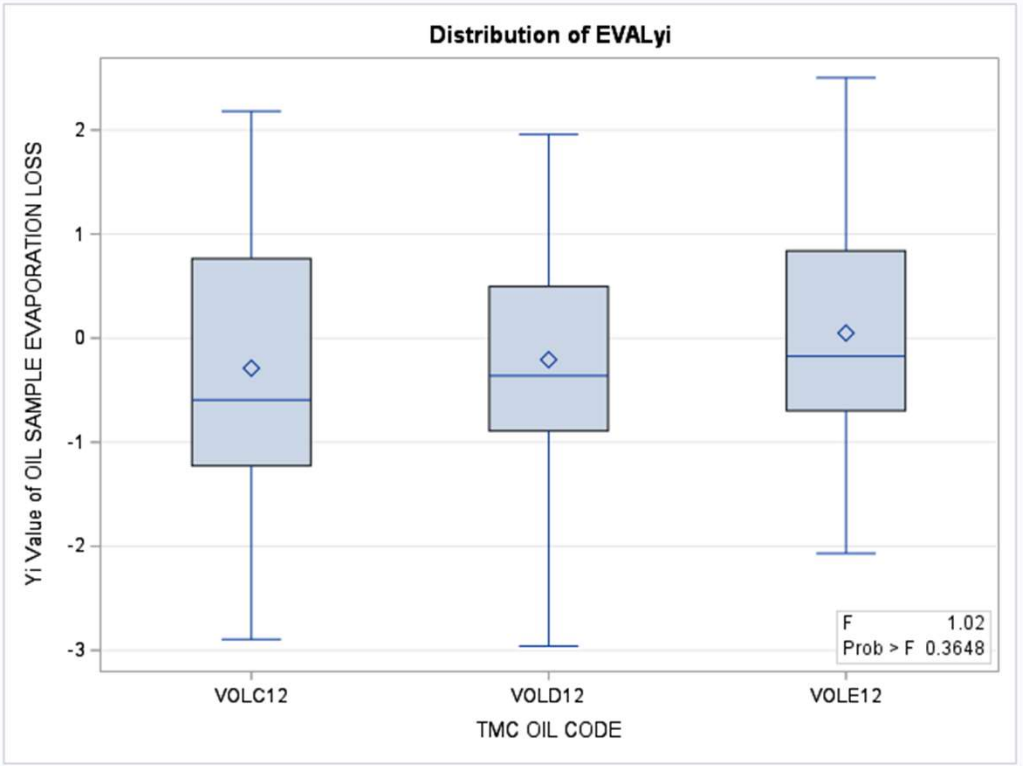
# All Procedures: Oct22 – Mar23 Results




VOLC12 = 2.6523
VOLD12 = 2.5264
VOLD12 = 2.8175

Target SD = 0.0465

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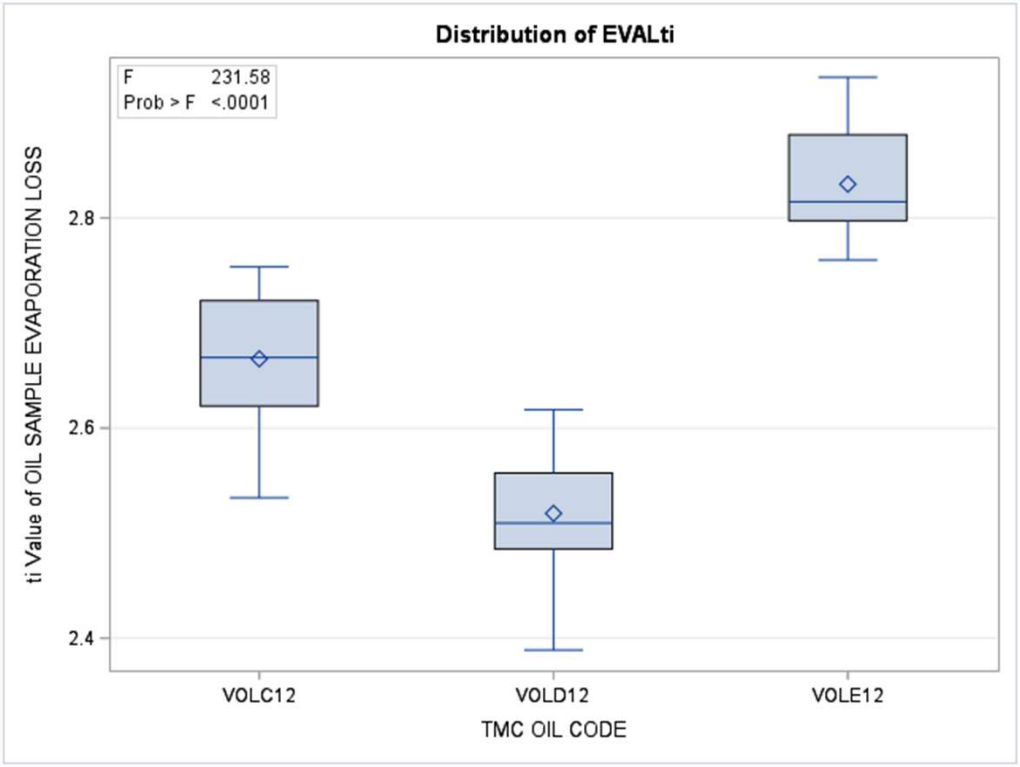
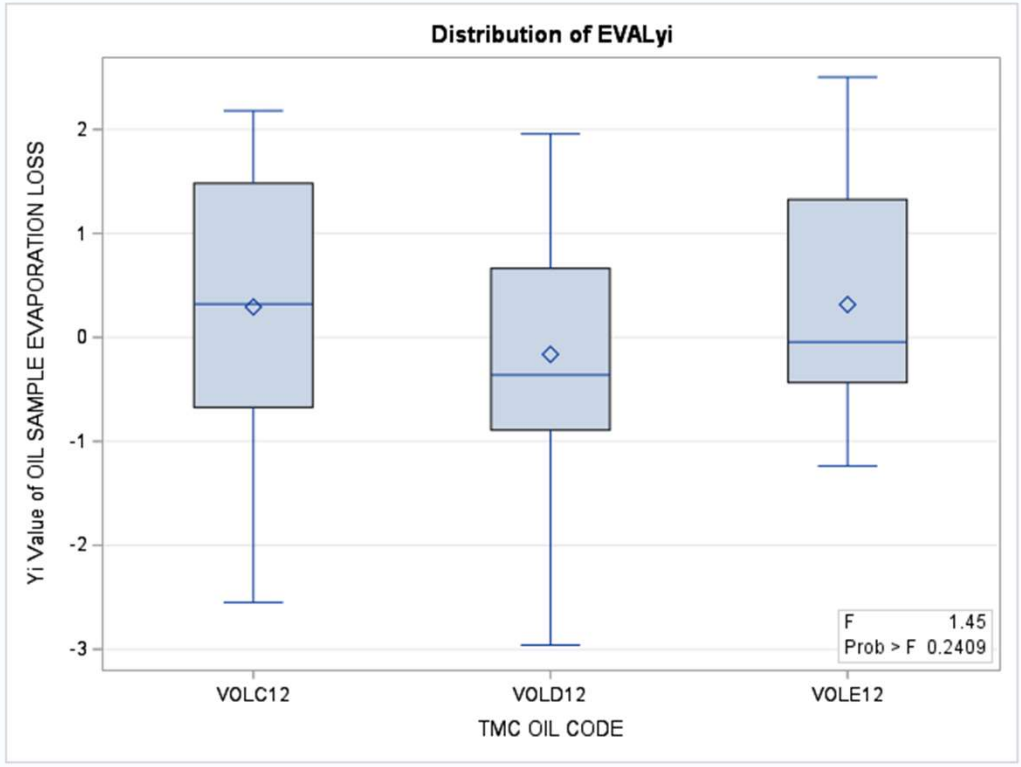
# Procedure B: Oct22 – Mar23 Results




VOLC12 = 2.6523
VOLD12 = 2.5264
VOLD12 = 2.8175

Target SD = 0.0465

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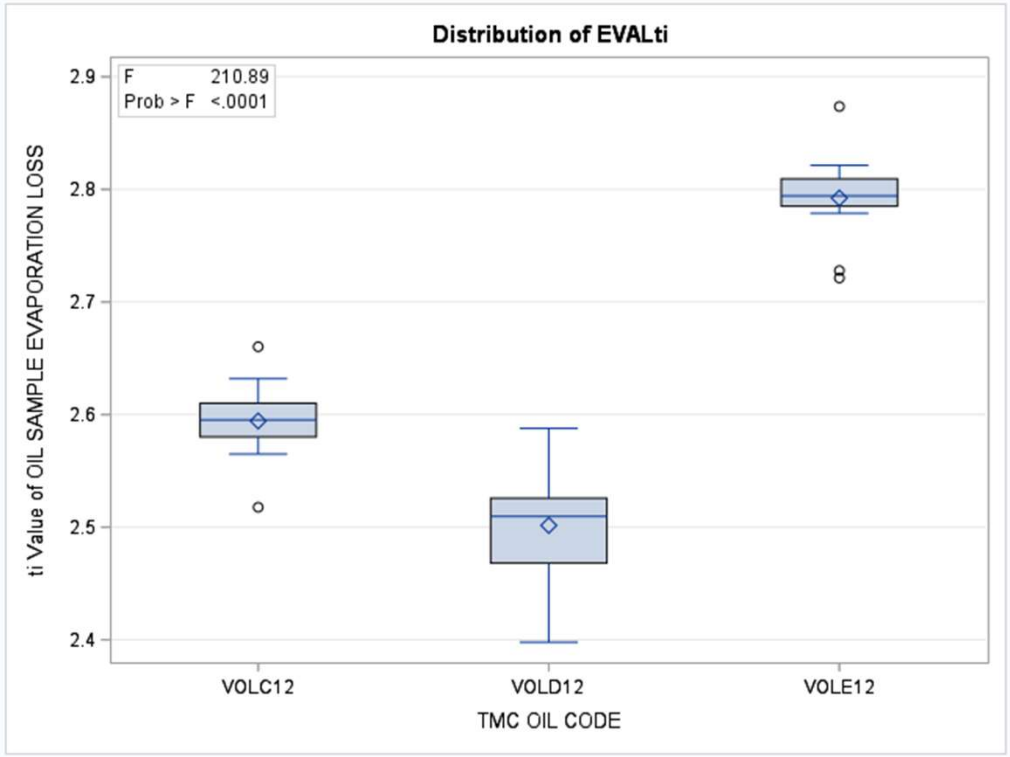
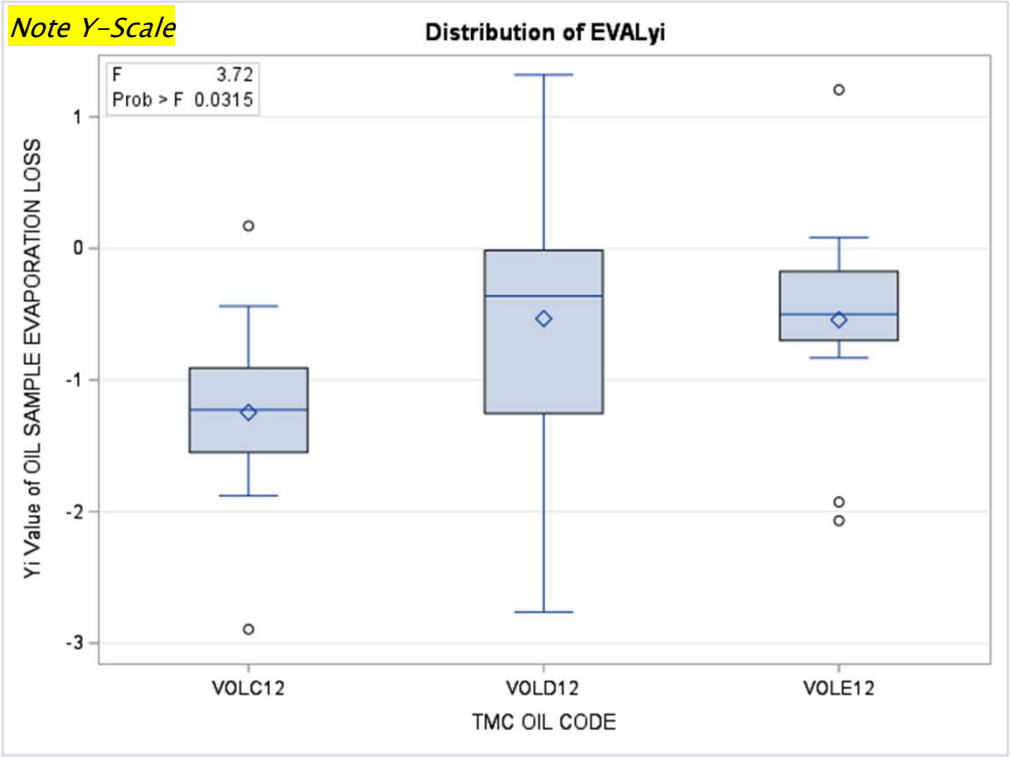
# Procedure D: Oct22 – Mar23 Results




*Note Y-Scale*




VOLC12 = 2.6523 Target SD = 0.0465
VOLD12 = 2.5264
VOLD12 = 2.8175

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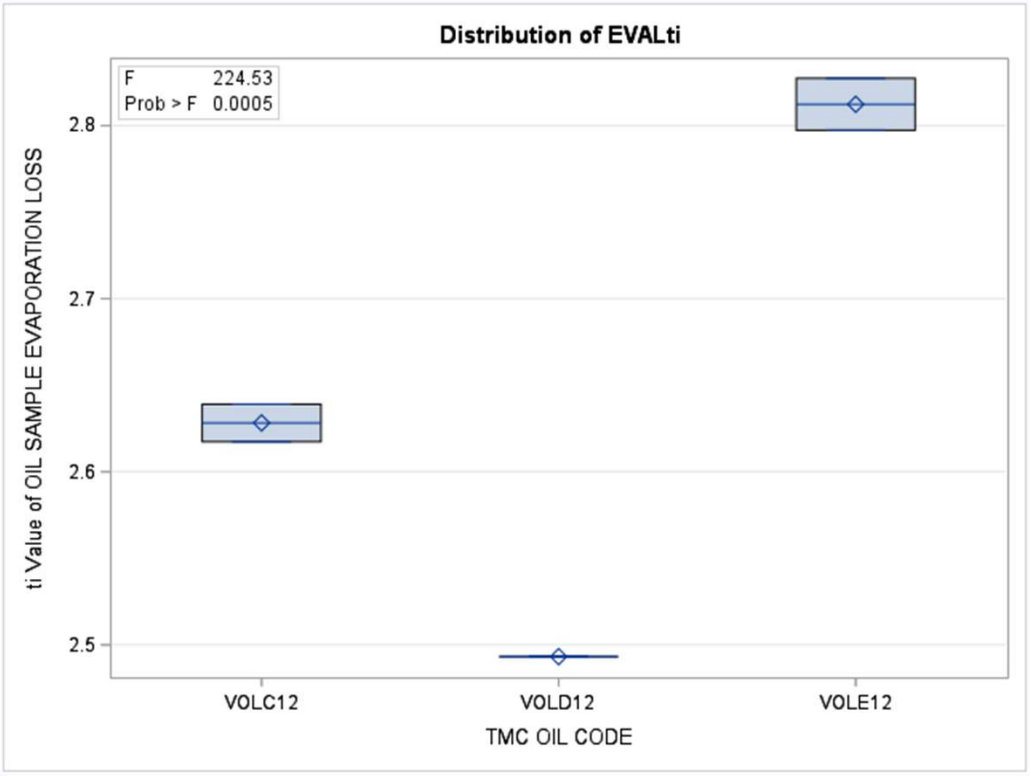
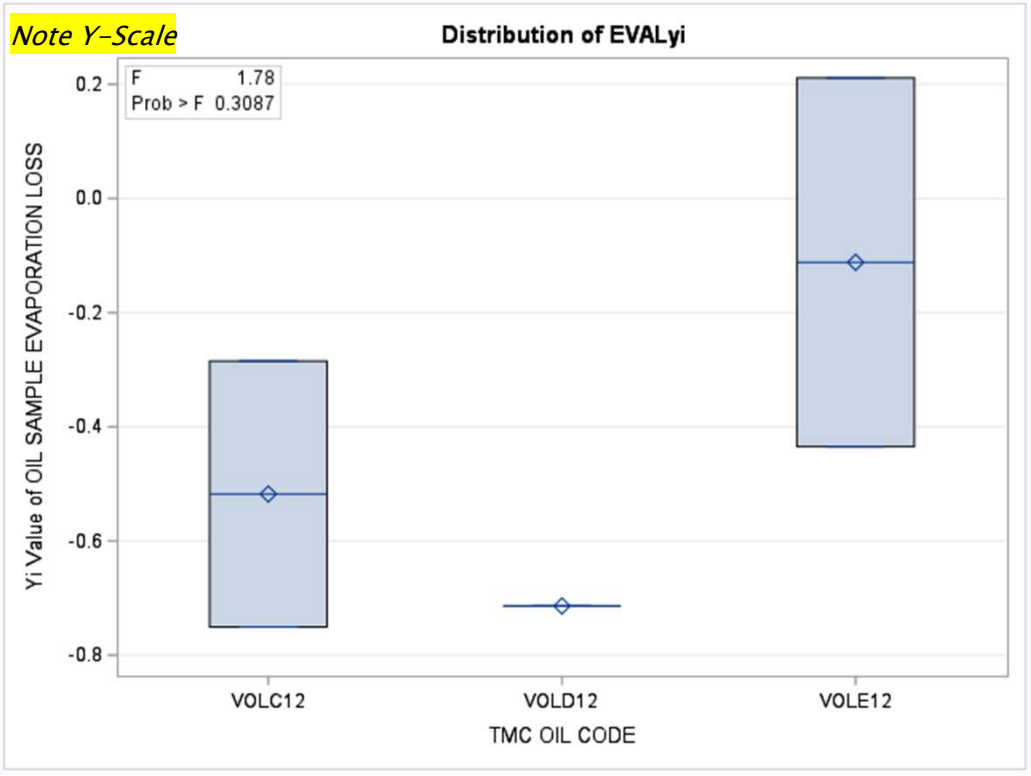
# MODEL NCK2: Oct22 – Mar23 Results




VOLC12 = 2.6523
VOLD12 = 2.5264
VOLD12 = 2.8175

Target SD = 0.0465

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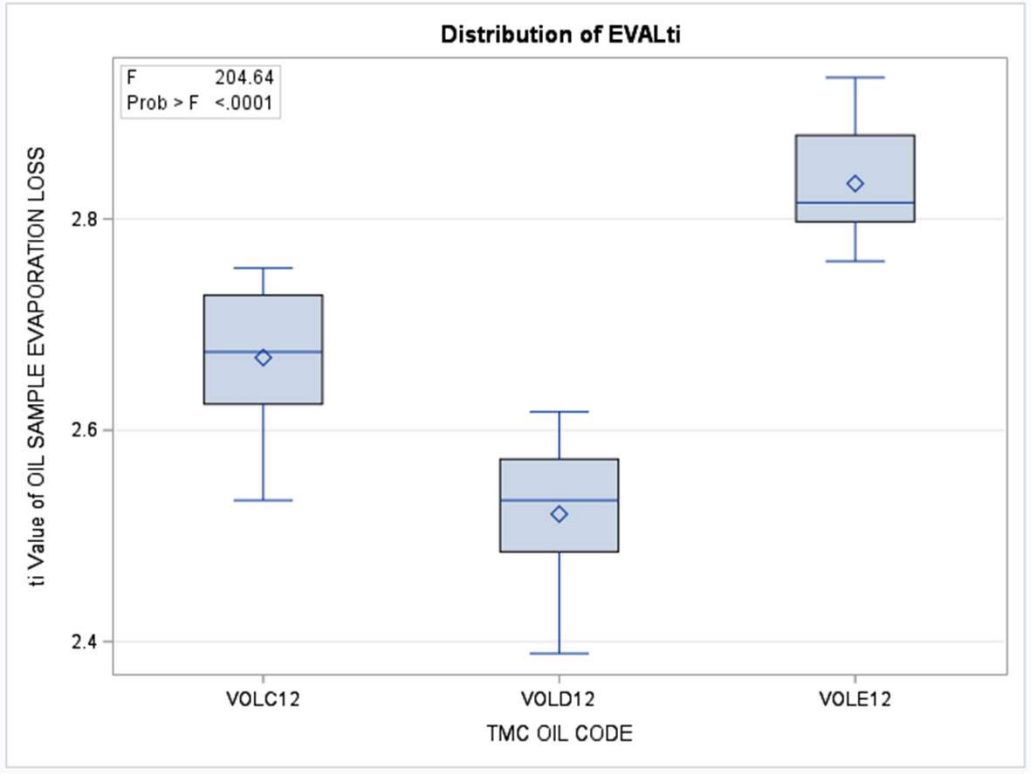
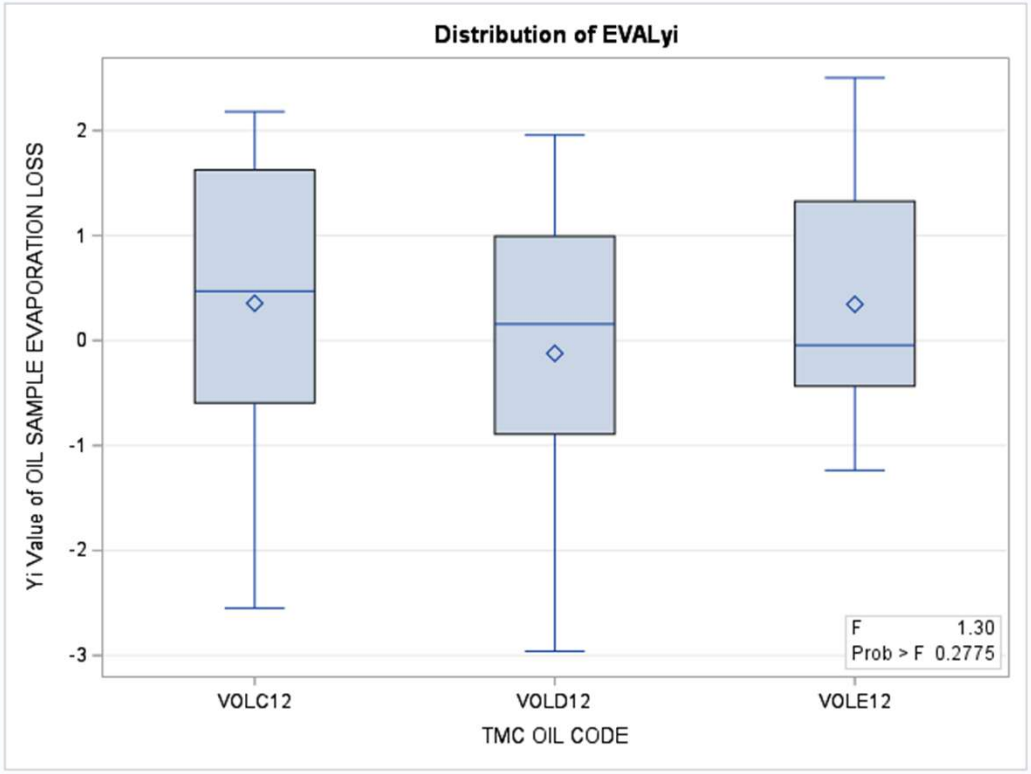
# MODEL NCK25G: Oct22 – Mar23 Results




VOLC12 = 2.6523
VOLD12 = 2.5264
VOLD12 = 2.8175

Target SD = 0.0465

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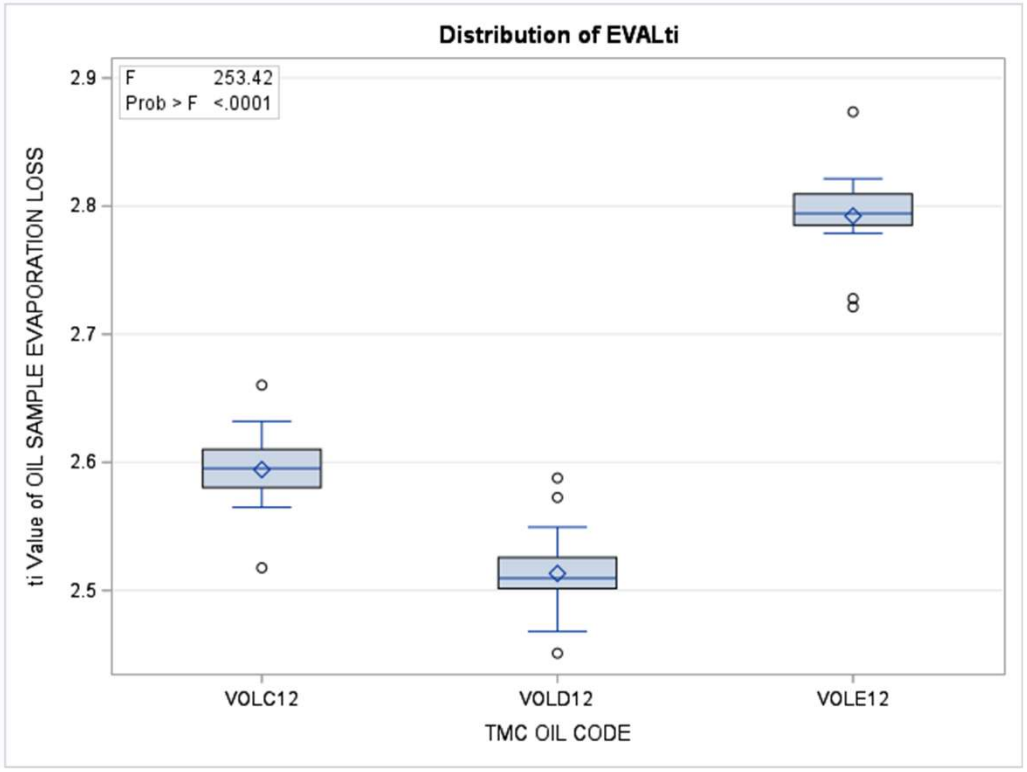
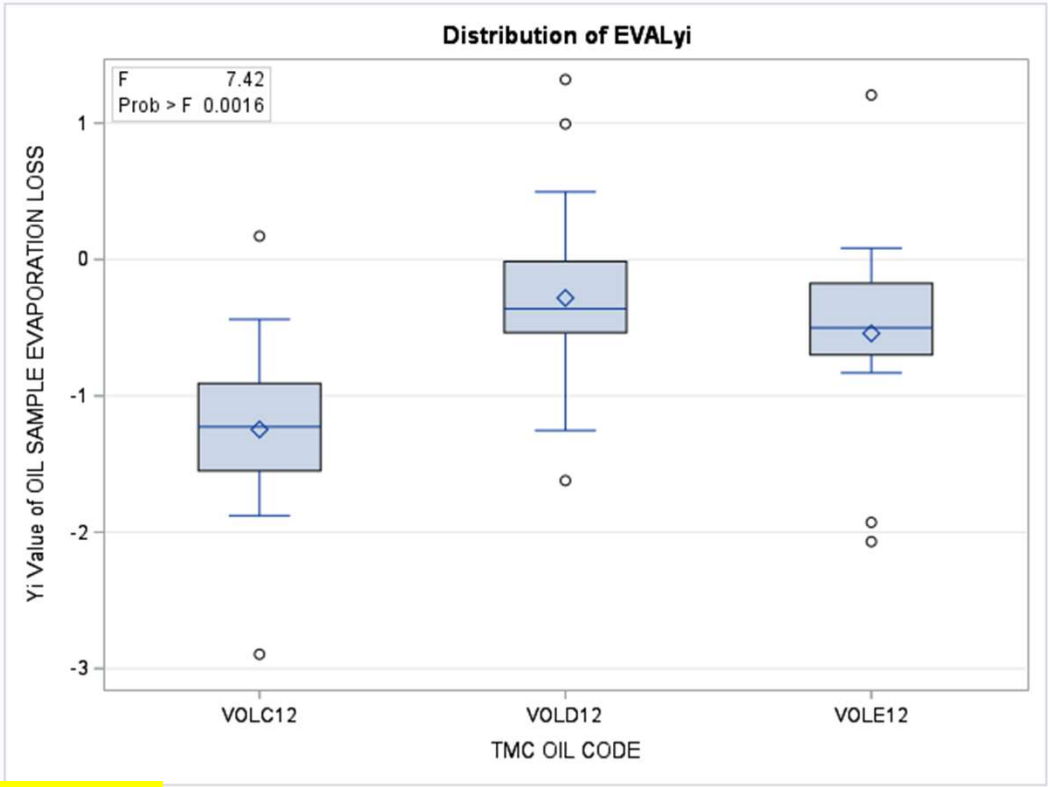
# MODEL NS2: Oct22 – Mar23 Results




VOLC12 = 2.6523
VOLD12 = 2.5264
VOLD12 = 2.8175

Target SD = 0.0465

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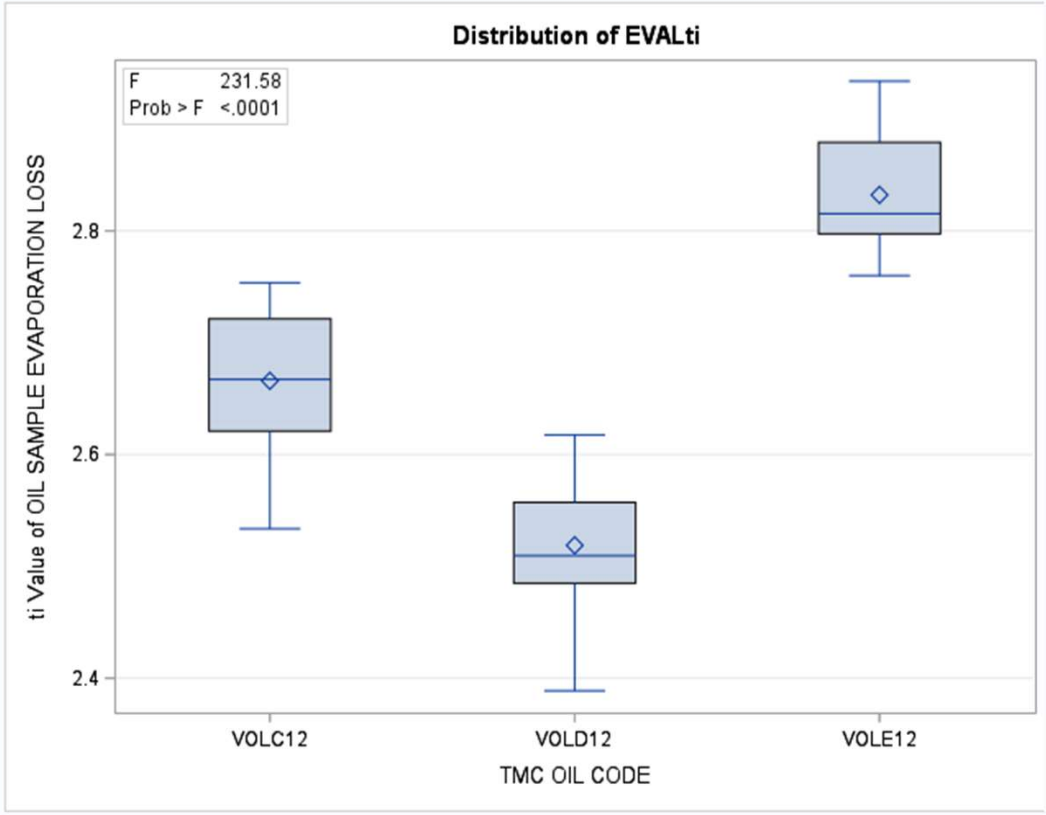
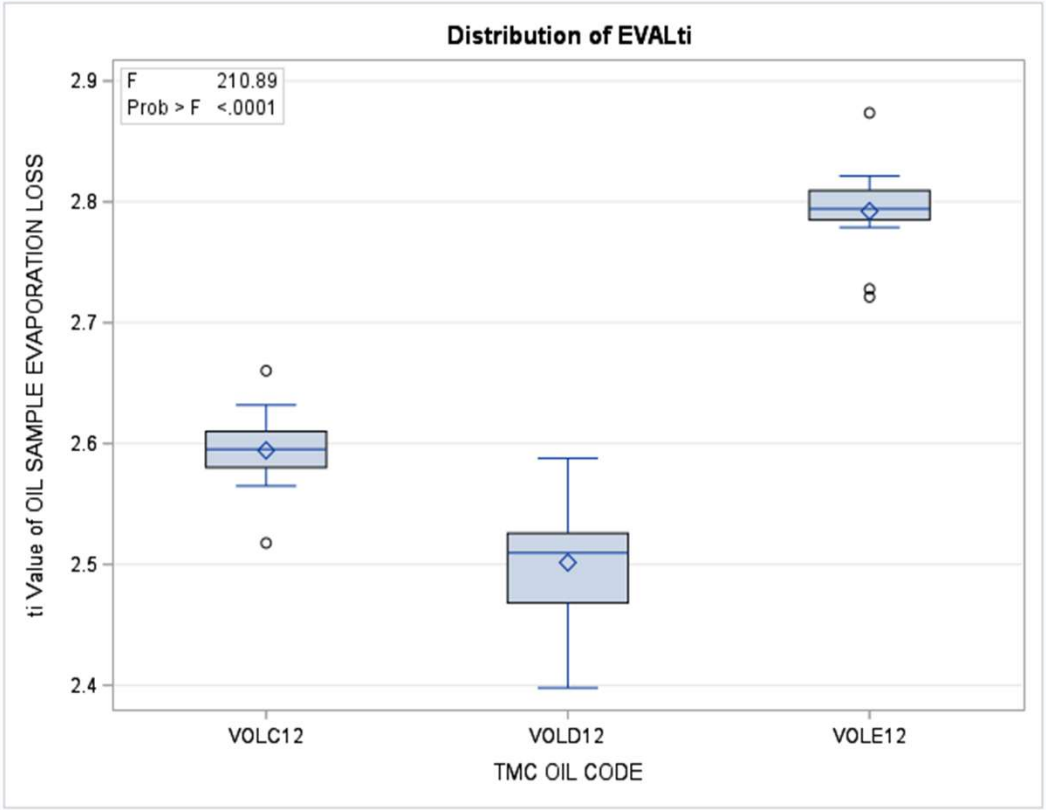
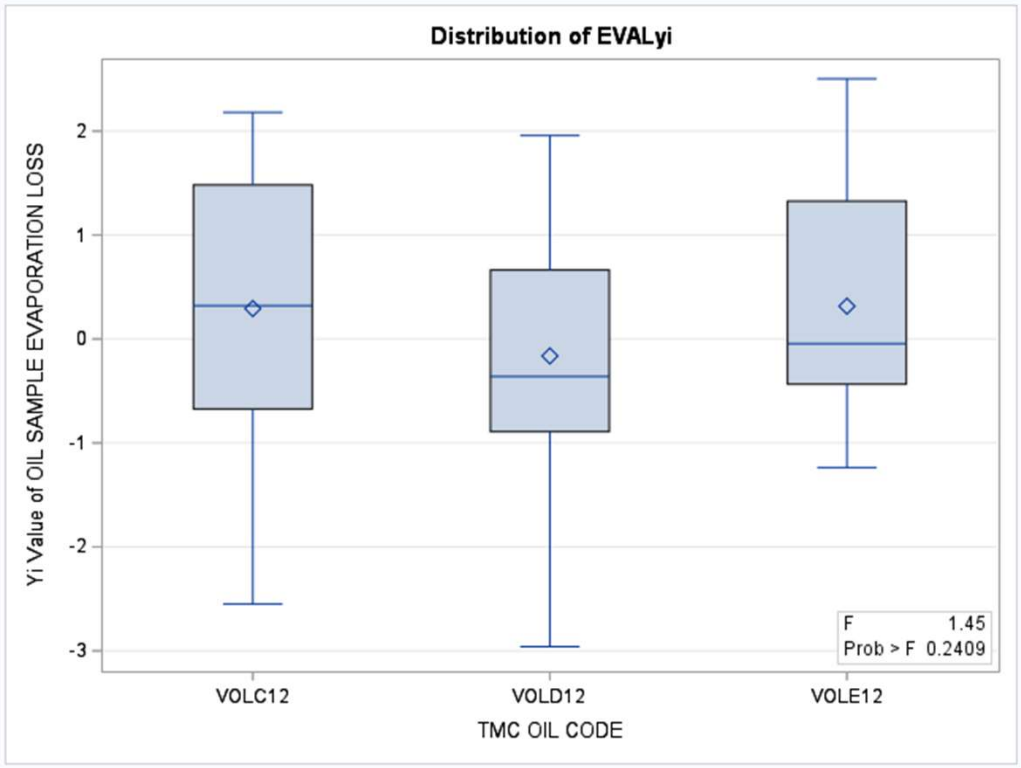
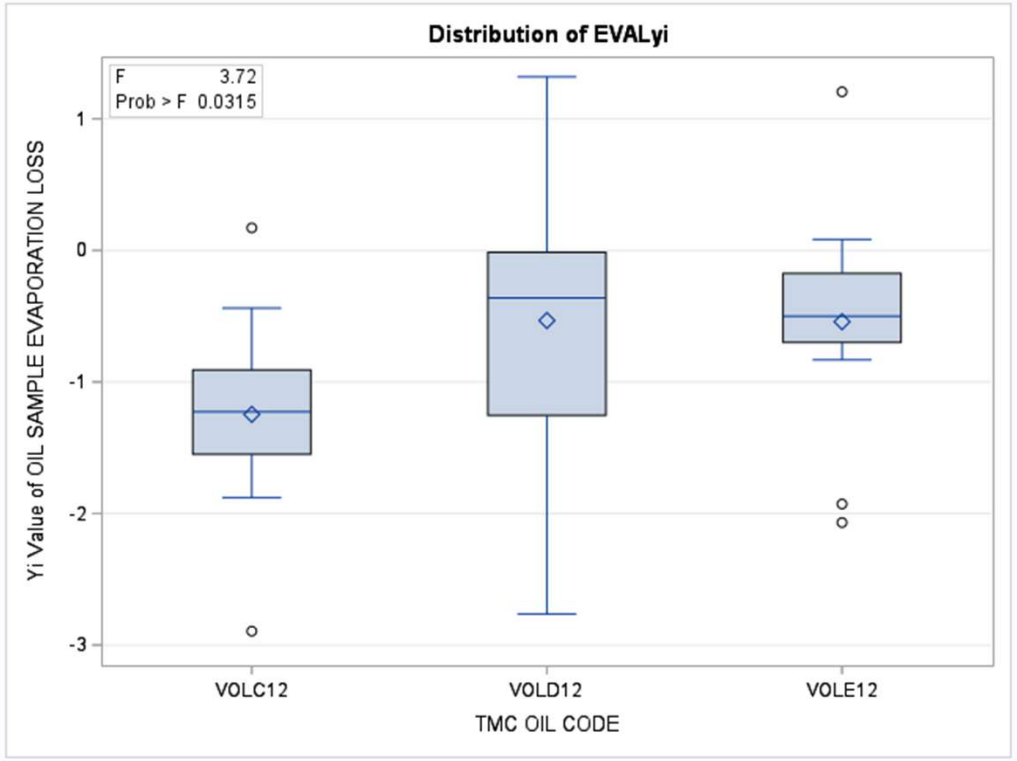
# By Procedure Comparisons (B vs. D, respectively)



# By Procedure Comparisons (B vs. D, respectively)




$$Y_i = \frac{T_i - \text{MEAN}}{\text{STANDARD DEVIATION}}$$

# D02.B0.07
# TMC Monitored Tests

## ASTM D 5800

### CUSUM and EWMA Plots

October 1, 2022 – March 31, 2023

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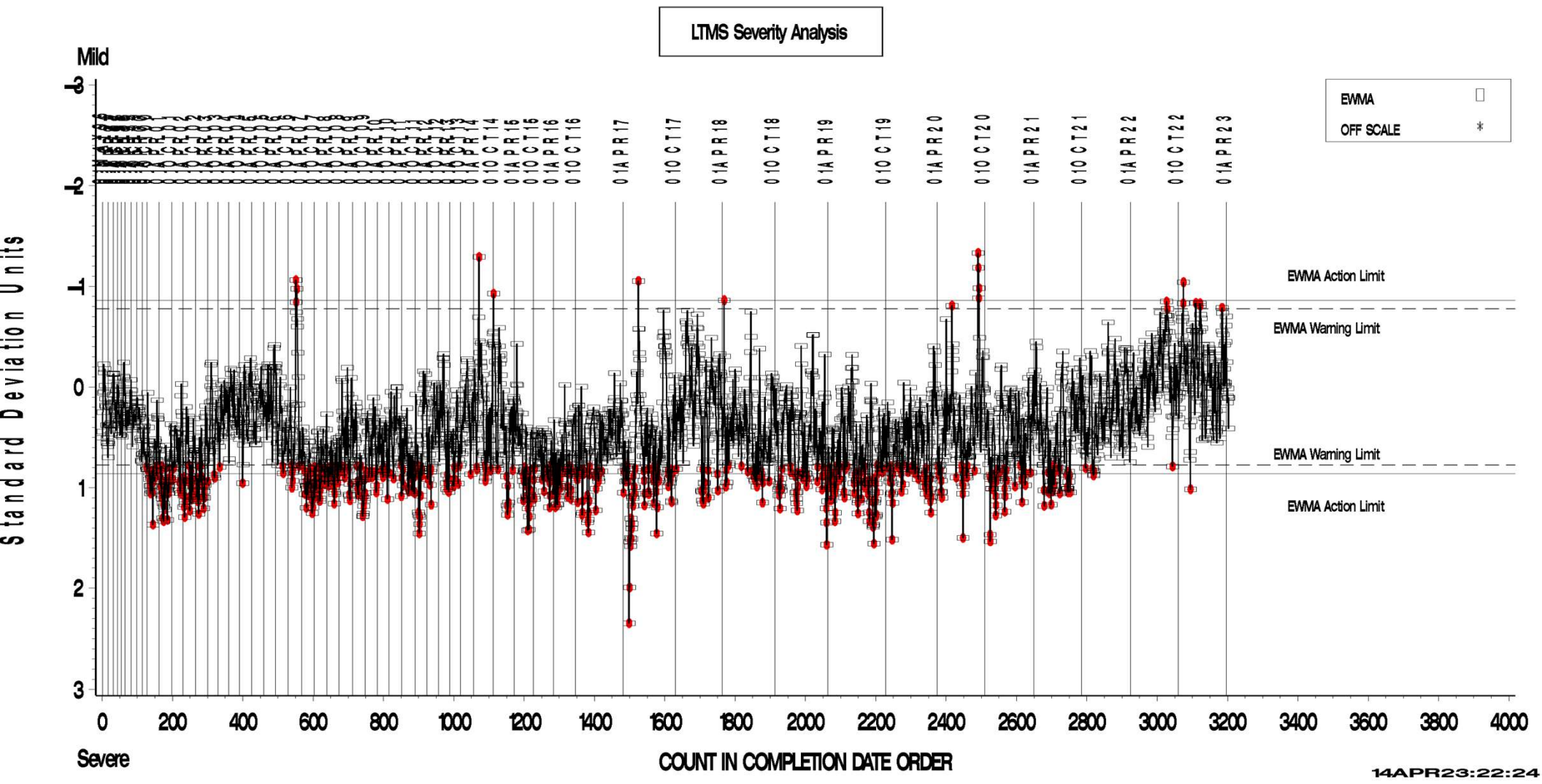
ALL

# D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA

## EVAPORATION LOSS, MASS%

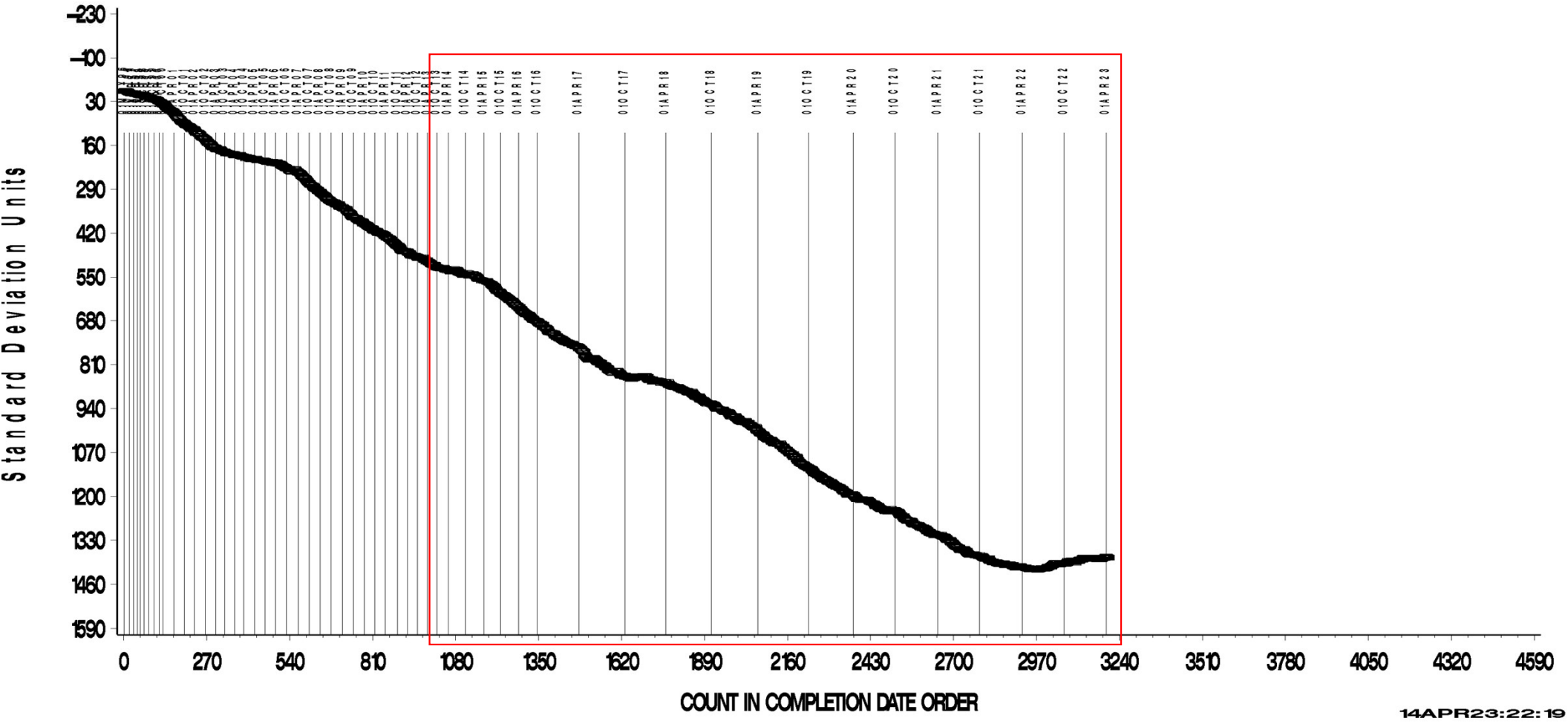


ALL

# D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA

## EVAPORATION LOSS, MASS%

CUSUM Severity Analysis

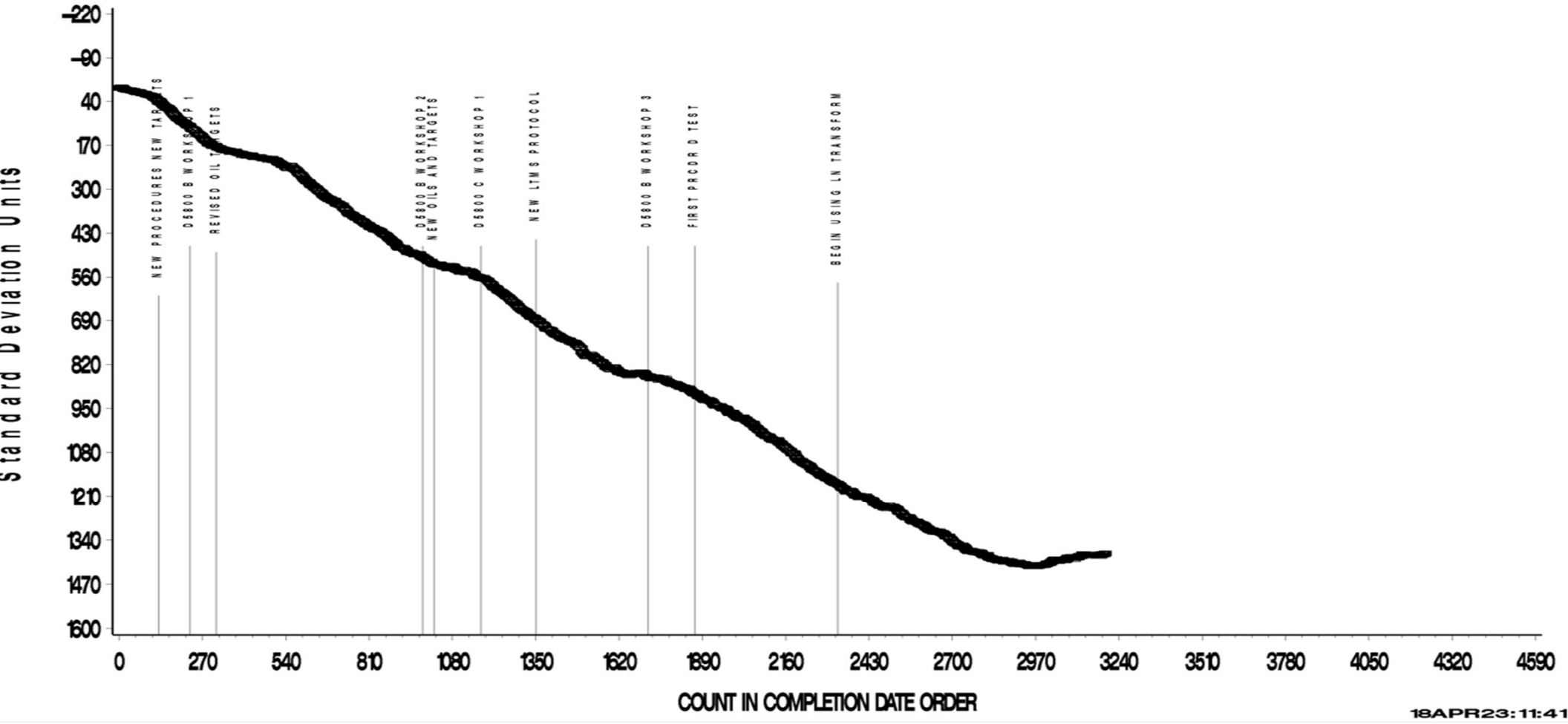


ALL

# D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA

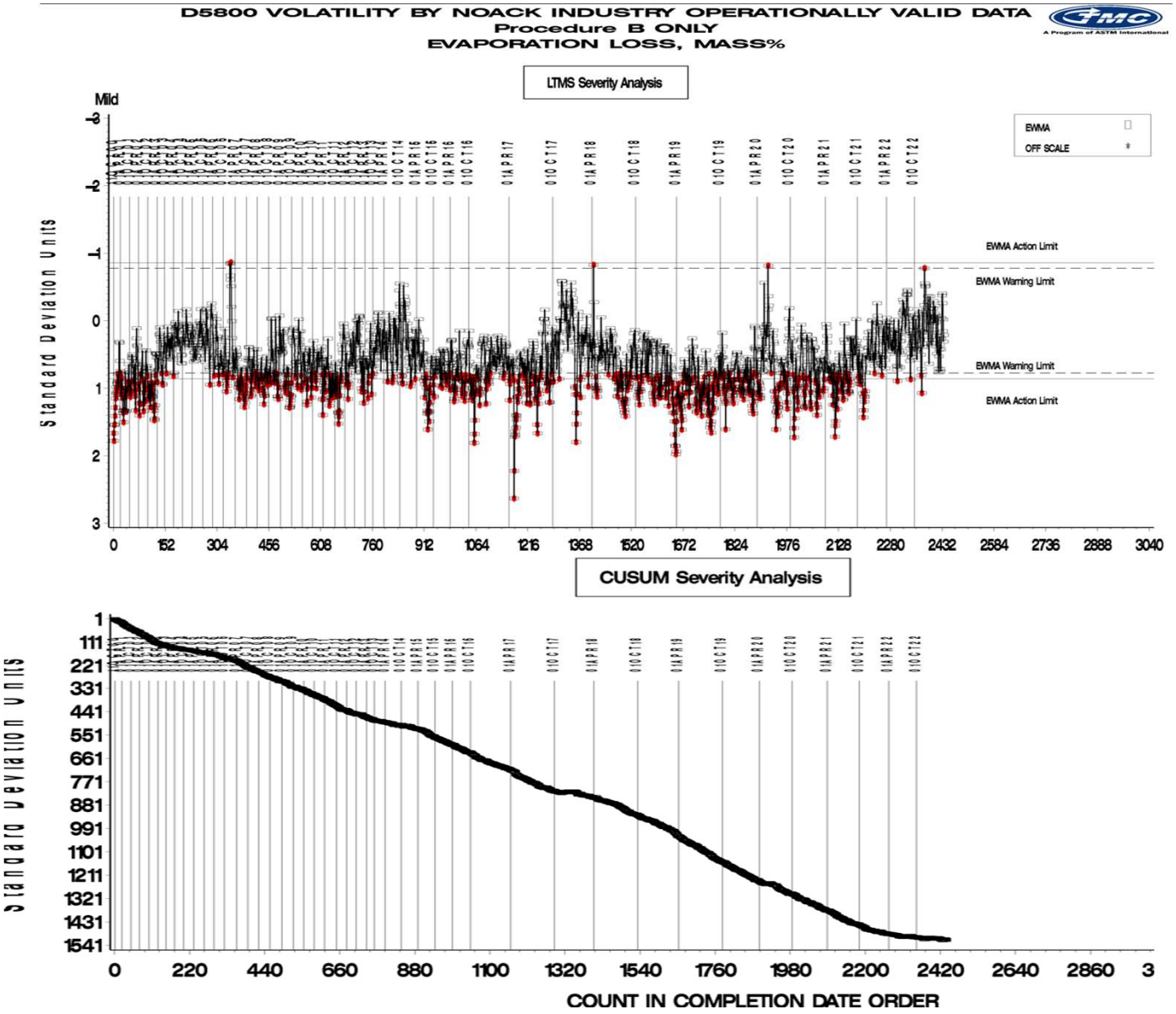
## EVAPORATION LOSS, MASS%

CUSUM Severity Analysis

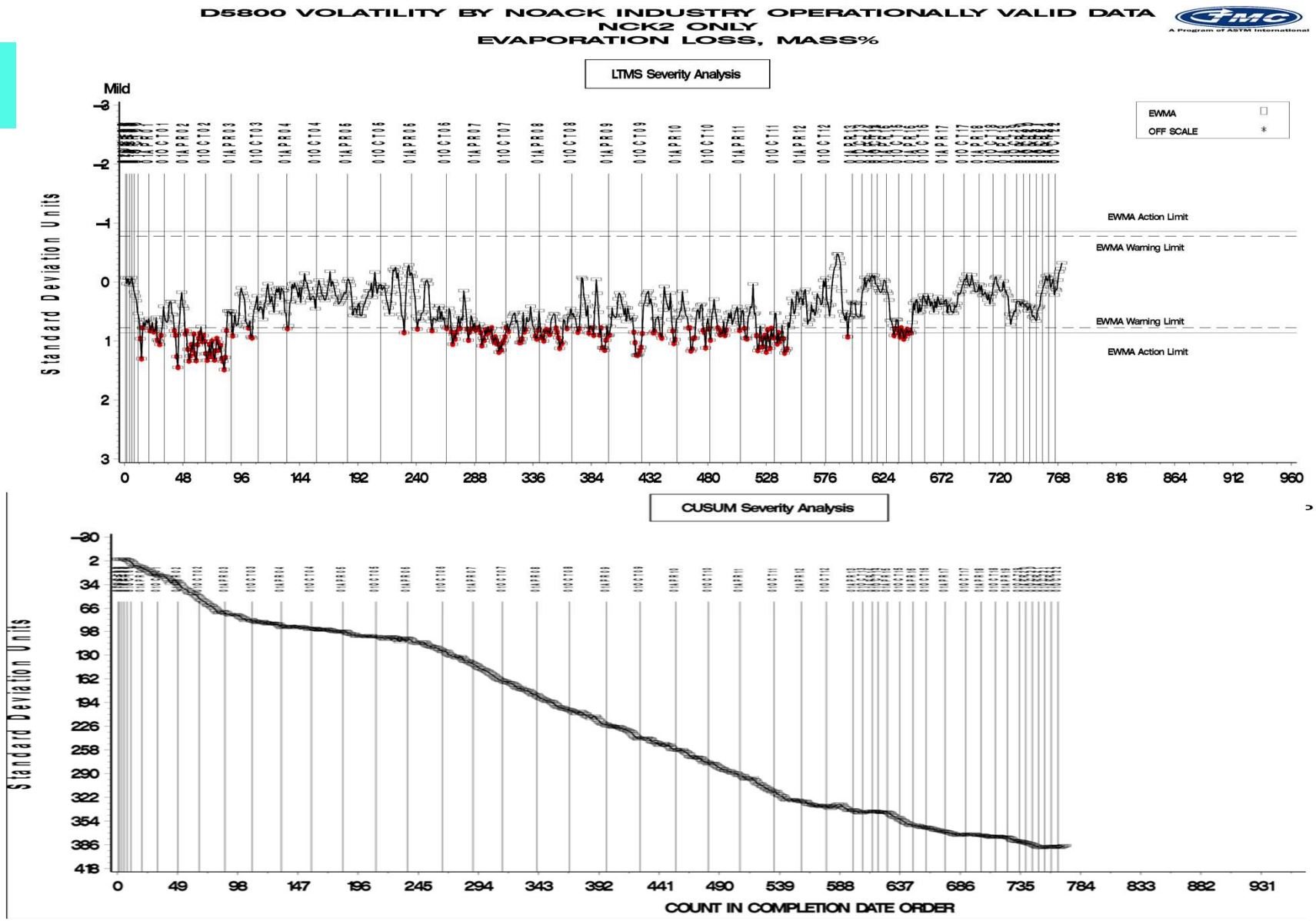



18APR23:11:41

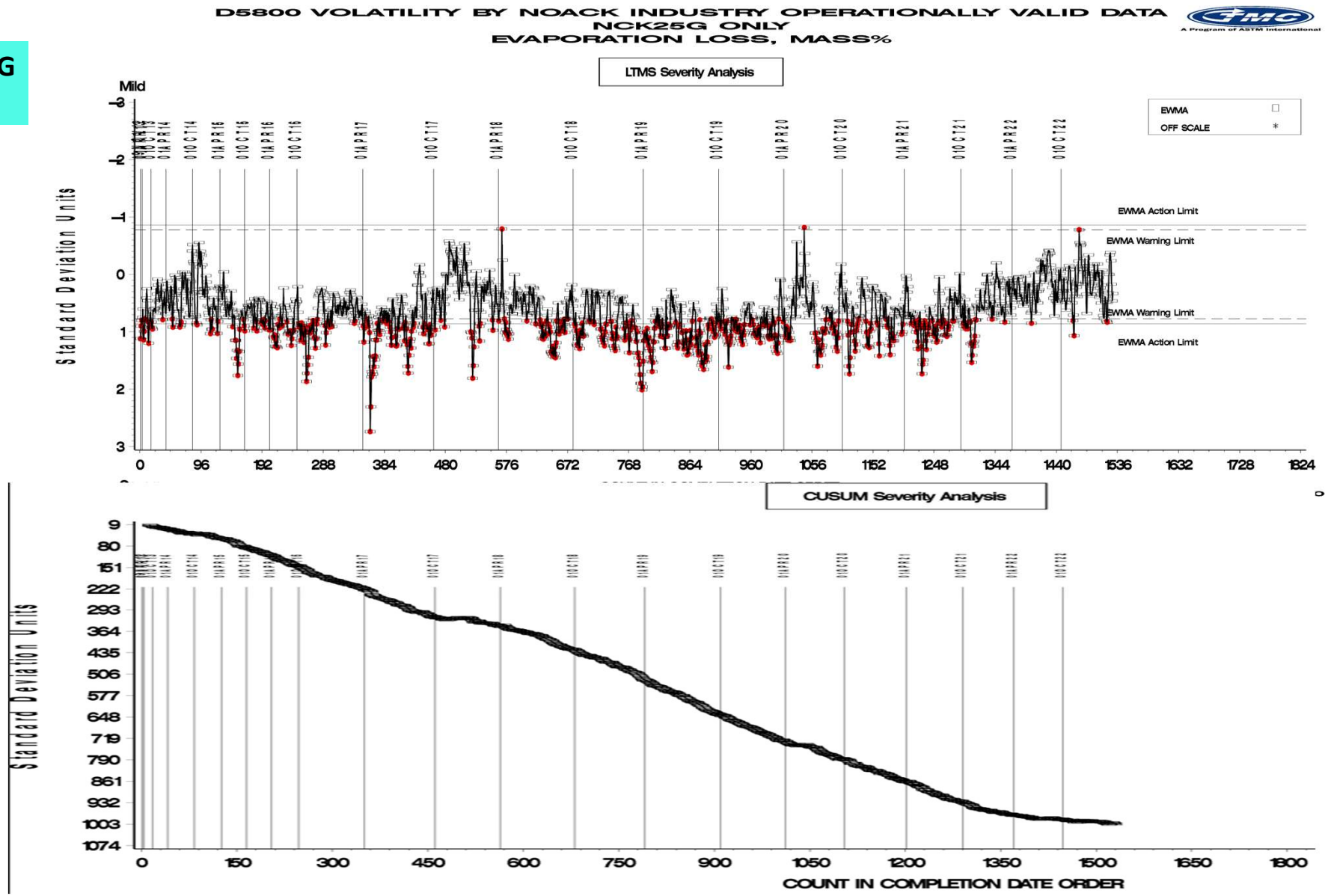
**B only**


D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA
Procedure B ONLY
EVAPORATION LOSS, MASS%
LTMS Severity Analysis
Mild
EWMA
OFF SCALE
EWMA Action Limit
EWMA Warning Limit
EWMA Warning Limit
EWMA Action Limit
Standard Deviation Units
CUSUM Severity Analysis
COUNT IN COMPLETION DATE ORDER

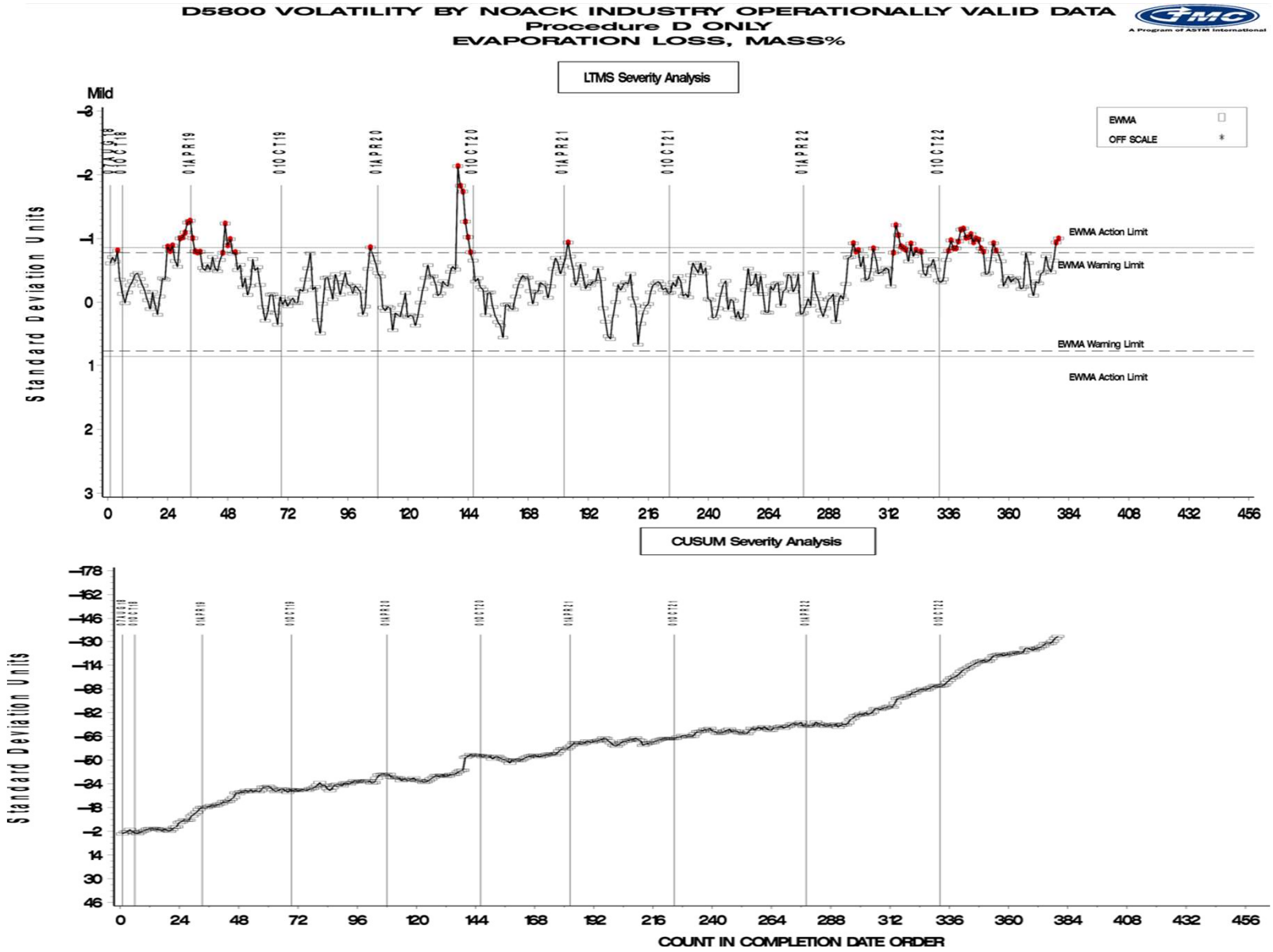
**NCK2 only**


D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA
NCK2 ONLY
EVAPORATION LOSS, MASS%
LTMS Severity Analysis
Mild
Standard Deviation Units
EWMA
OFF SCALE
EWMA Action Limit
EWMA Warning Limit
EWMA Warning Limit
EWMA Action Limit
CUSUM Severity Analysis
Standard Deviation Units
COUNT IN COMPLETION DATE ORDER

**NCK25G only**


D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA
NCK25G ONLY
EVAPORATION LOSS, MASS%
LTMS Severity Analysis
Mild
Standard Deviation Units
EWMA
OFF SCALE
EWMA Action Limit
EWMA Warning Limit
EWMA Warning Limit
EWMA Action Limit
CUSUM Severity Analysis
Standard Deviation Units
COUNT IN COMPLETION DATE ORDER

**D only (NS2)**


D5800 VOLATILITY BY NOACK INDUSTRY OPERATIONALLY VALID DATA
Procedure D ONLY
EVAPORATION LOSS, MASS%
LTMS Severity Analysis
Mild
EWMA
OFF SCALE
EWMA Action Limit
EWMA Warning Limit
EWMA Warning Limit
EWMA Action Limit
Standard Deviation Units
CUSUM Severity Analysis
Standard Deviation Units
COUNT IN COMPLETION DATE ORDER

# D02.B0.07
# TMC Monitored Tests

## ASTM D 5800

### Breakout by Reference Oil

October 1, 2022 – March 31, 2023

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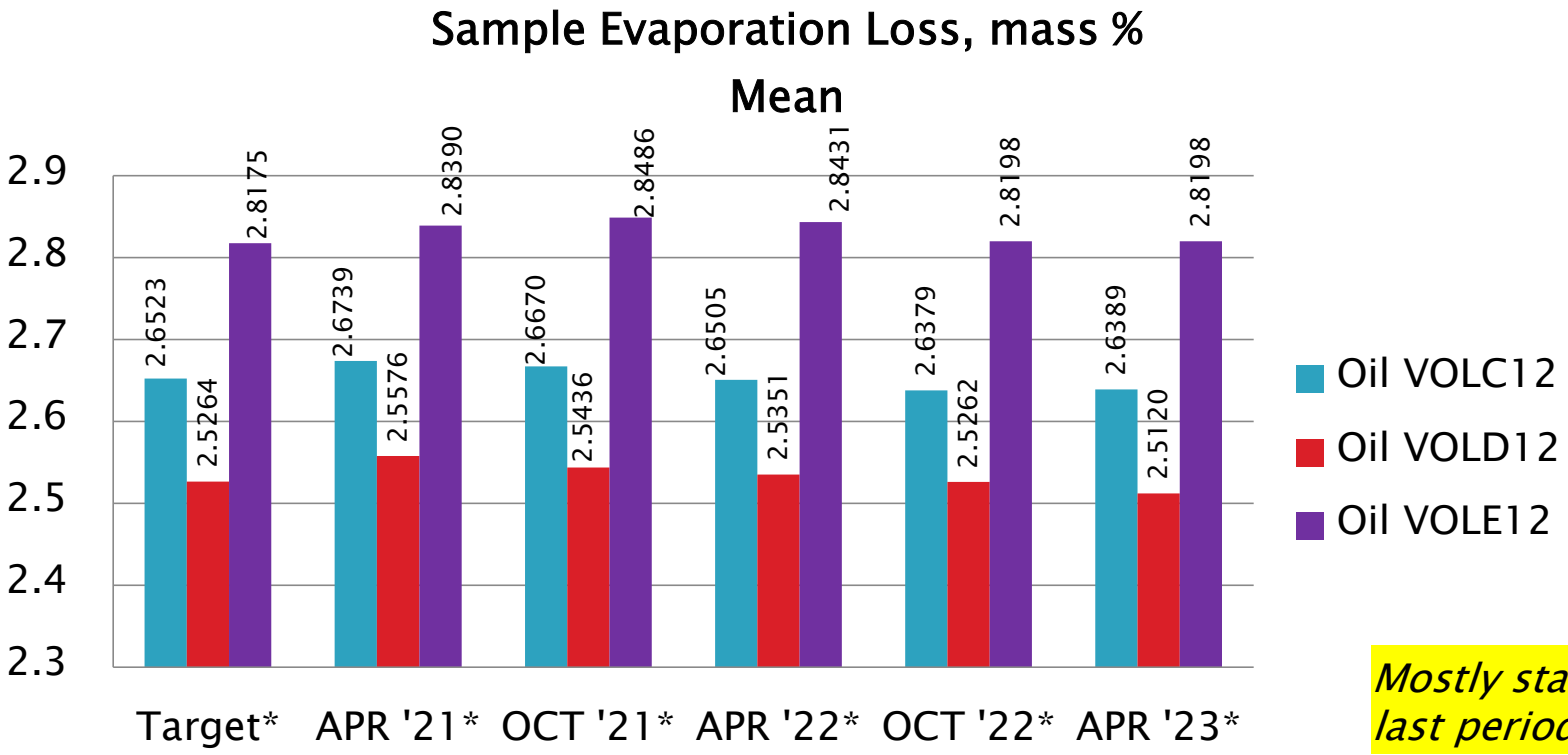
# D5800 Performance by Oil




*Mostly stable from last period*

*Results transformed to natural log per updated LTMS 20200207

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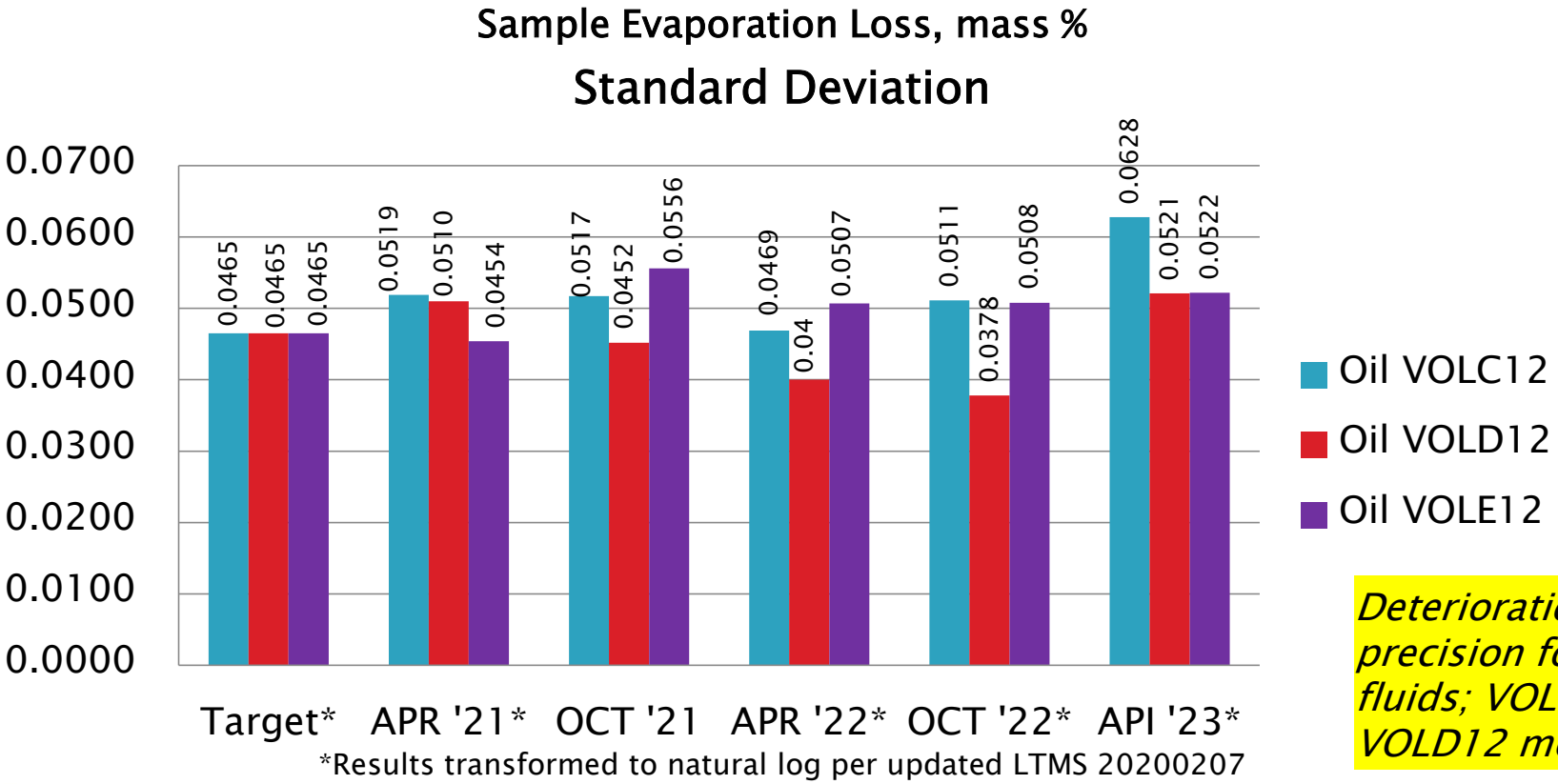
# D5800 Performance by Oil




*Results transformed to natural log per updated LTMS 20200207

*Deterioration of precision for all fluids; VOLC12 and VOLD12 most notable*

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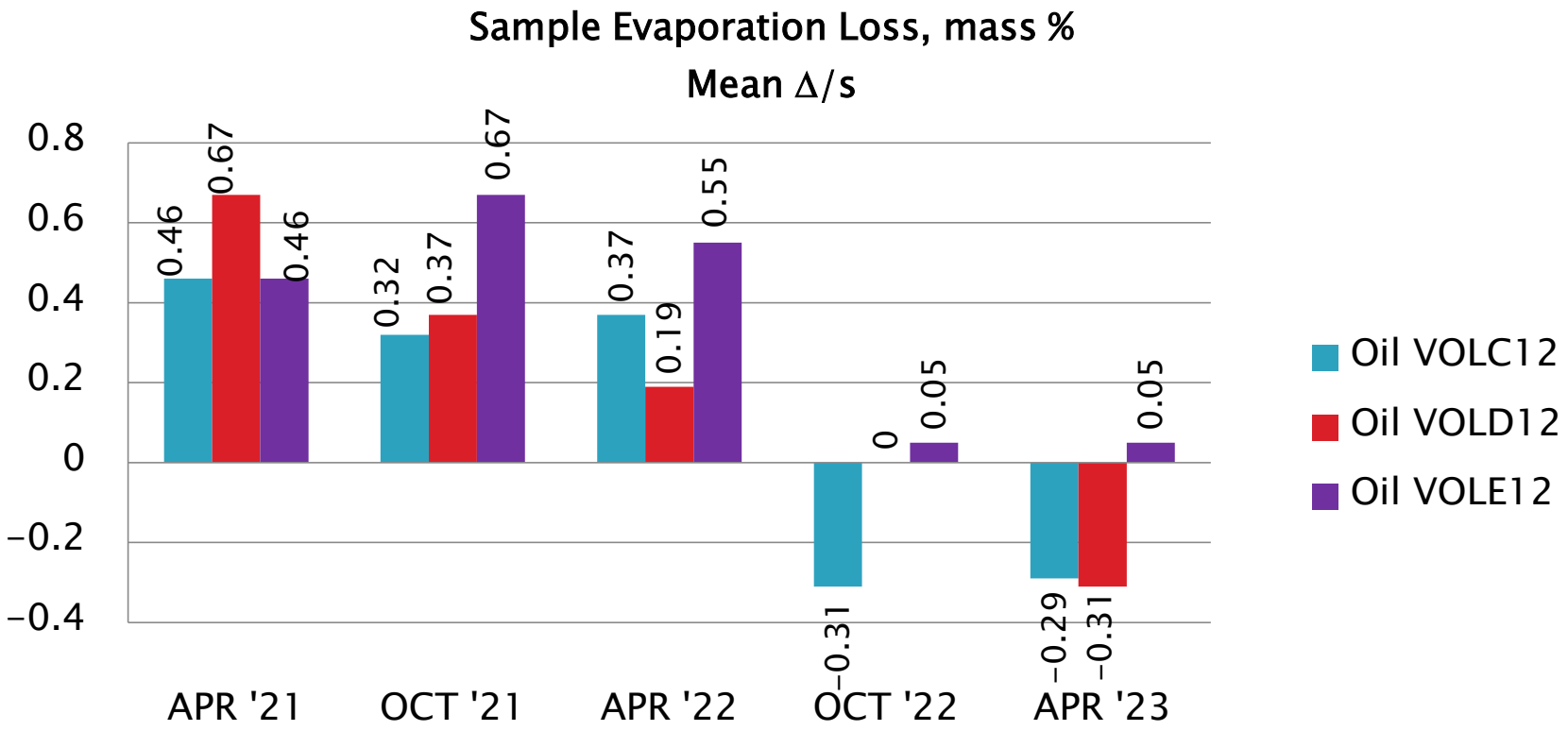
# D5800 Performance by Oil

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# D02.B0.07
# TMC Monitored Tests

## ASTM D 5800

### SEMESTER SUMMARY

October 1, 2022 – March 31, 2023

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

Precision (Pooled s) remains comparable to target precision (in natural log transformed units), but slightly higher than previous semester.

- Performance (Mean Δ/s) continues to move mild, falling from −0.10 s to −0.19 s in the past six months.
  - Procedure B rigs continue to trend slightly severe (0.17 s) while Procedure D rigs continue to trend mild (−0.78 s).
- CUSUM plot shows a reversing of the severe trend that the test has seen for many semesters and now shows a relatively flat line. This is due to mild test results from Procedure D units and Procedure B units coming out of a severe trend to be mostly on-target. The industry EWMA Control chart is currently in control.

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# D02.B0.07
# TMC Monitored Tests

## ASTM D 6417

October 1, 2022 – March 31, 2023

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# Calibrated Labs and Stands*

(change shown in parentheses)

| Test | Labs | Stands |
|---|---|---|
| D6417 | 7 (+0) | 9 (+0) |
| *As of 3/31/2023 | | |

# D6417: Estimation of Engine Oil Volatility by Capillary GC

| Test Status | Validity Code | No. Tests |
|---|---|---|
| Acceptable Calibration Test | AC | 18 |
| Failed Calibration Test | OC | 0 |
| **Total** | | **18** |

Number of Labs Reporting Data: 7
Fail Rate of Operationally Valid Tests: 0%
**Stable/improved from last period*

# D6417: Estimation of Engine Oil Volatility by Capillary GC

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

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

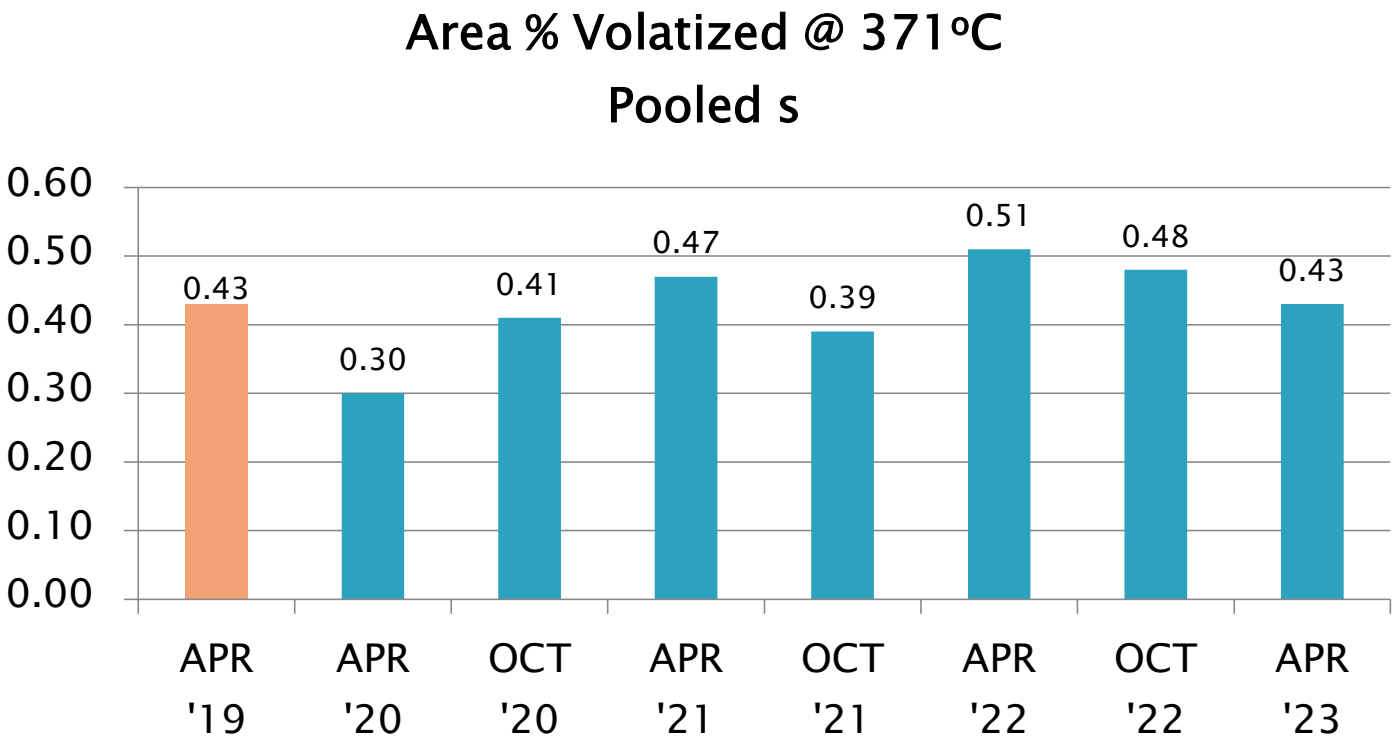
# D6417: Estimation of Engine Oil Volatility by Capillary GC

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 | ----- |
| 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 |
| 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 |

*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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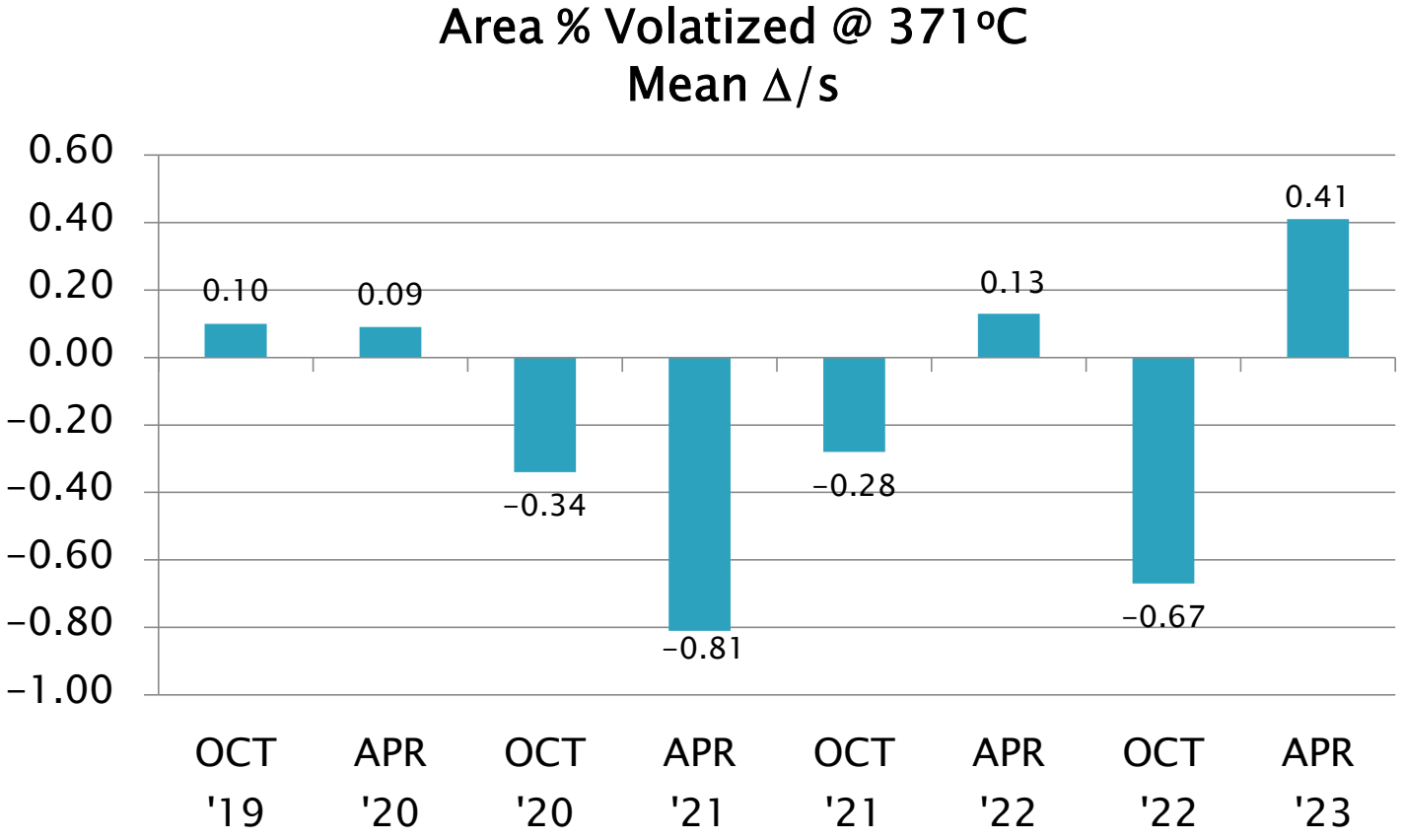
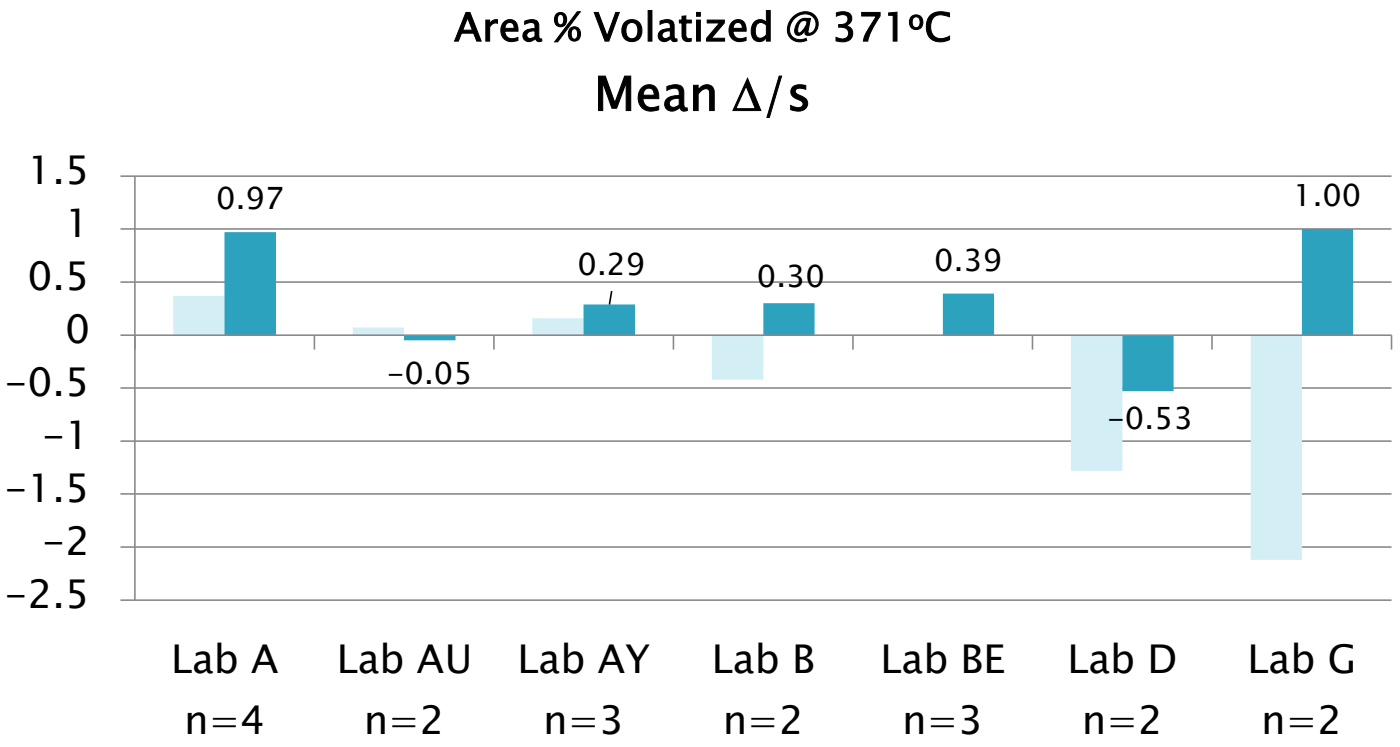
# D6417 Severity Estimates



# D6417 Lab Severity Estimates

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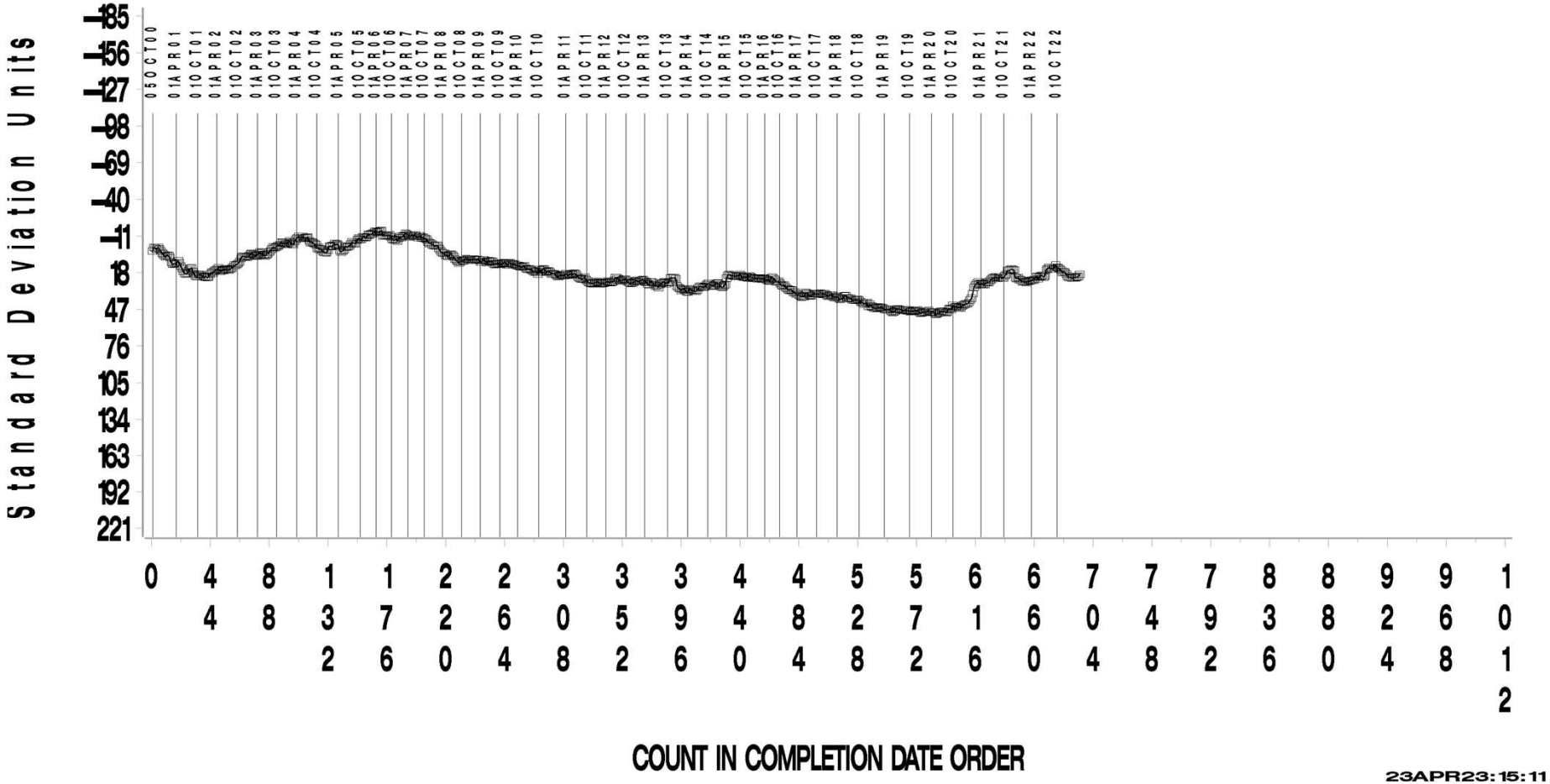
# D6417: Estimation of Engine Oil Volatility by Capillary GC

- Precision (Pooled s) has been very consistent over the past 6 semesters.
- Performance (Mean Δ/s) has flipped to +0.41 s severe but closer to target compared to prior reporting period (-0.67 s).
- CUSUM severity plot is currently in a MILD trend but has been relatively "flat" for the past three semesters, circling around CUSUM value of 19.7 during this time.

# D6417 VOLATILITY BY GC INDUSTRY OPERATIONALLY VALID DATA

## SAMPLE AREA % VOLATIZED

**CUSUM Severity Analysis**




23APR23:15:11

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

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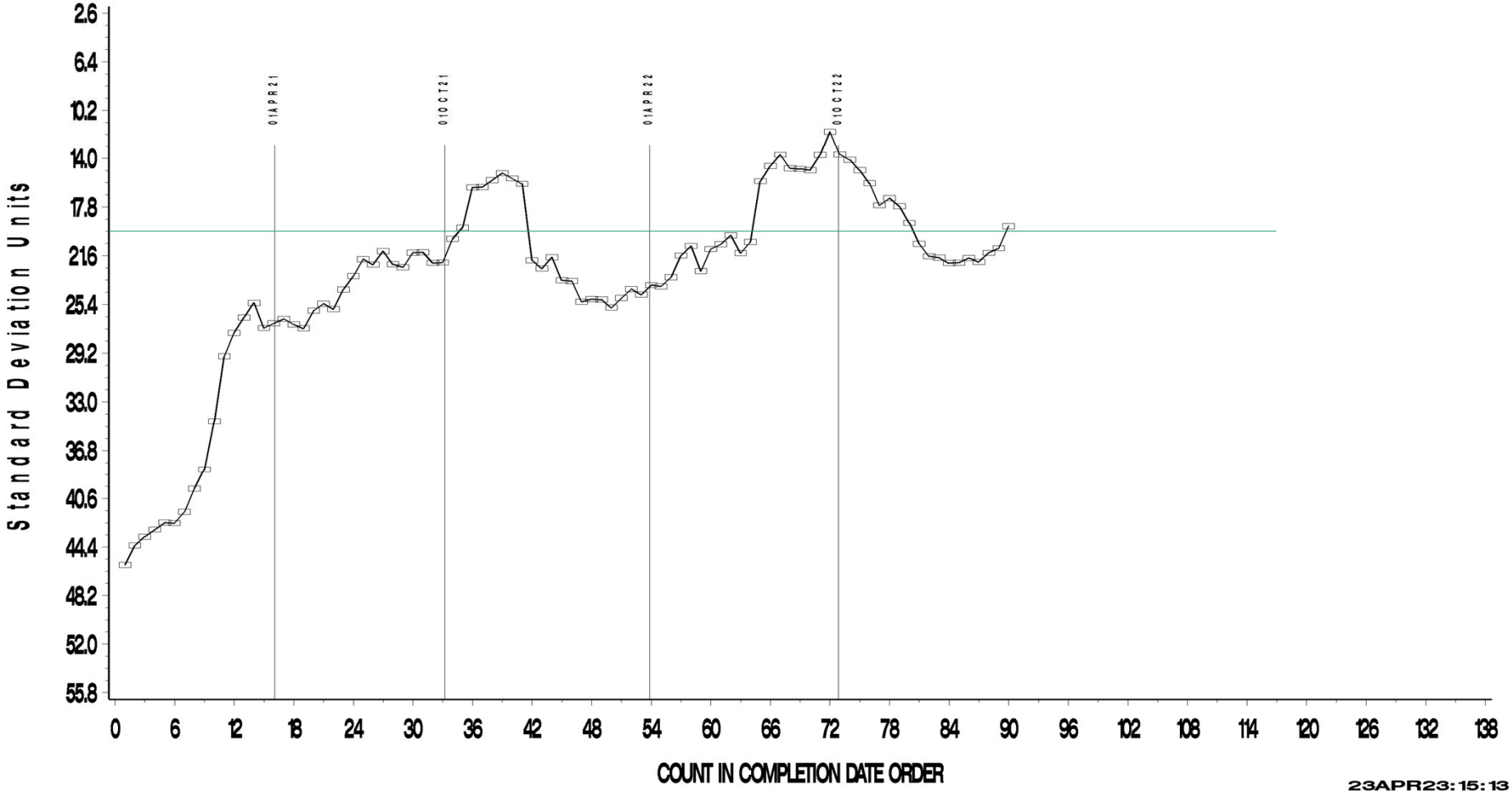
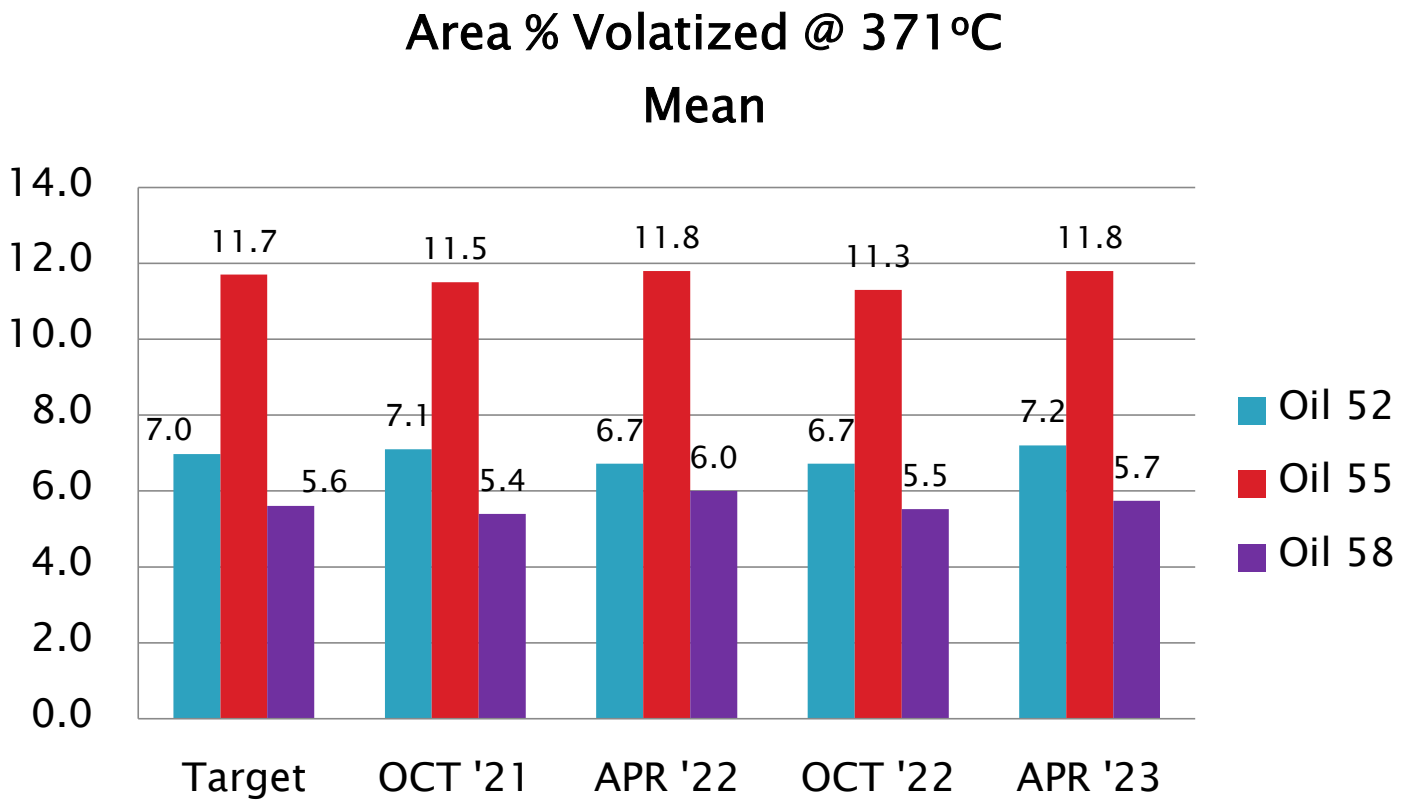
CUSUM Severity Analysis




23APR23:15:13

# D6417 Performance by Oil

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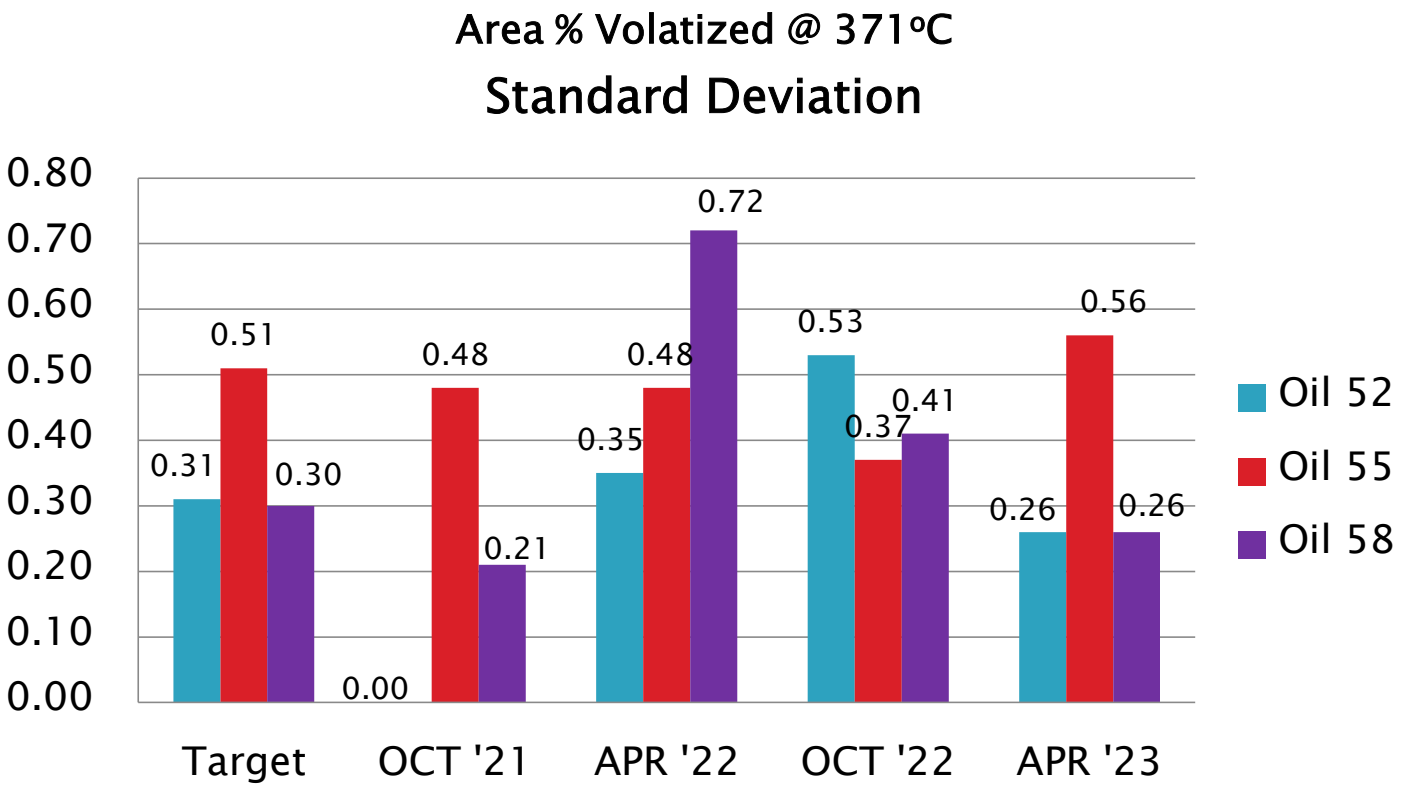
# D6417 Performance by Oil

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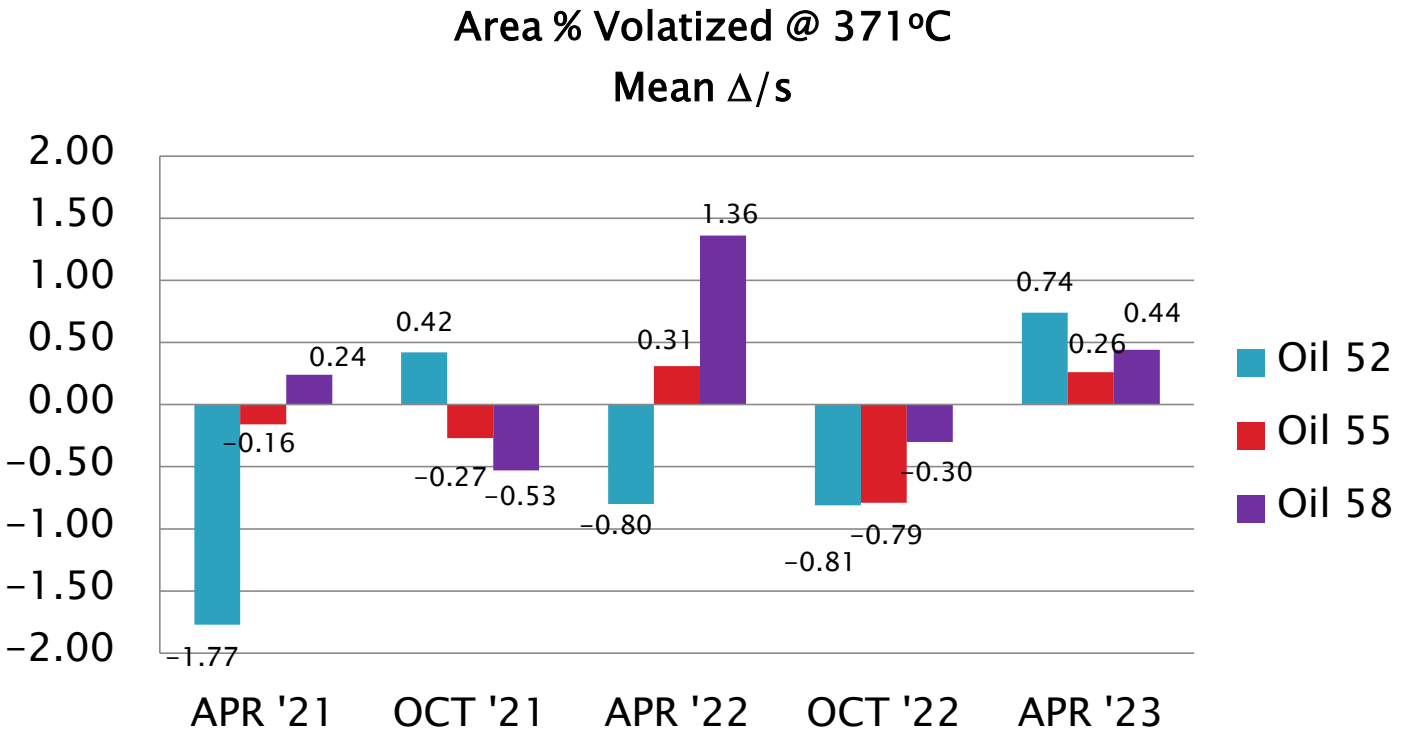
# D6417 Performance by Oil

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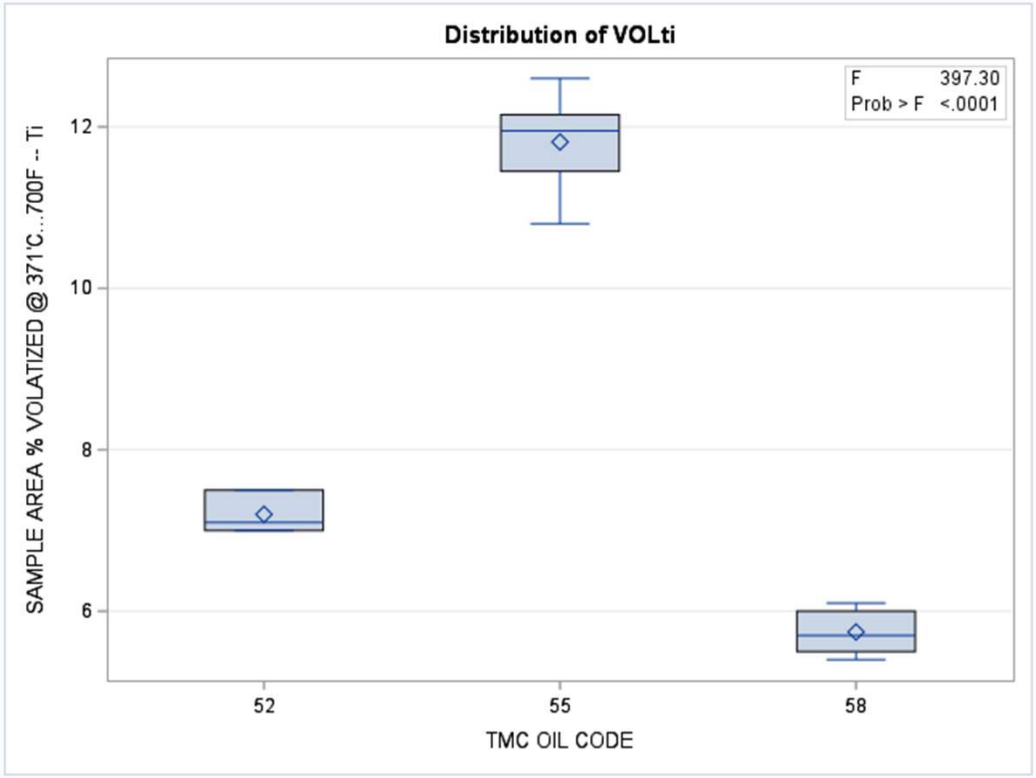
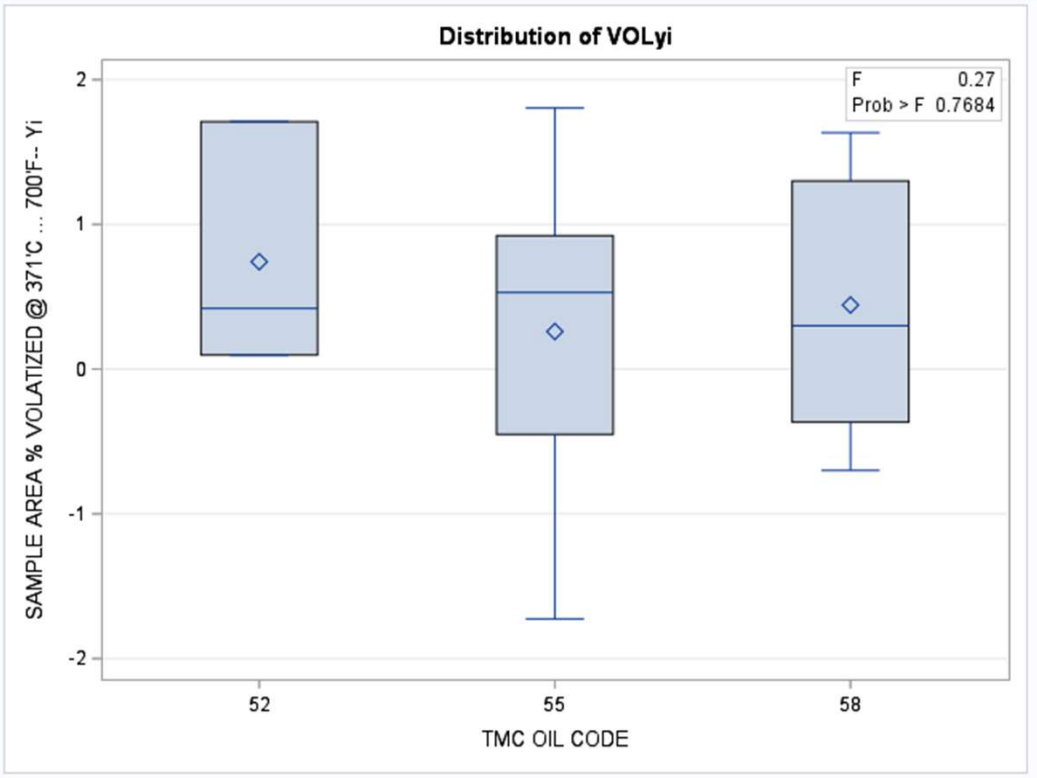
# Distribution of D6417 by Oil




Oil 52 = 6.97
Oil 55 = 11.68
Oil 58 = 5.61

Oil 52 SD Target = 0.31
Oil 55 SD Target = 0.51
Oil 58 SD Target = 0.30

# Reference Oil Inventory

- As of 3/31/2023

Test Monitoring Center
https://www.astmtmc.org
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# Reference Oil Inventory

D5800

| Oil | Year Received By TMC[A] | Tests | TMC Inventory, gallons | Gallons Shipped (last 6 mos) | Depletion Rate [B] |
|---|---|---|---|---|---|
| VOLC12 | 2013 | D5800 | 23.2 | 1.4 | 8 years |
| VOLD12 | 2013 | D5800 | 21.3 | 3.9 | 3 years |
| VOLE12 | 2013 | D5800 | 19.2 | 3.6 | 3 years |
| VOLD18 | 2018 | D5800QC | 706 | 126 | 3 years |

[A] The integrity of TMC reference oils is confirmed annually by analytical QC testing of chemical and physical properties.
[B] Based upon Shipping rate from last 6 months.

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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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Further Discussion?

Valvoline

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