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STAFF MANAGER:	Alyson Fick, ASTM International, (610) 832-9710, e-mail: afick@astm.org

Unapproved Meeting Minutes of the Technical Guidance Committee Virtual Meeting

Renaissance SeaWorld, Orlando, Florida

December 5, 2022

2:30 – 4:00 PM EST

Reply to: Patrick Lang

Southwest Research Institute, 6220 Culebra Road San Antonio, TX 78228

Phone: 210-522-2820, patrick.lang@swri.org

The meeting was called to order at 2:30 PM by Pat Lang.

Agenda:

The meeting agenda can be found as Attachment #1.

Membership Review:

The attendance list can be found as Attachment #2.

Review and Acceptance of Minutes:

Pat Lang requested approval of the June 27, 2022, meeting minutes (Seattle). A motion for approval was made by Bill Busher. No objections were voiced; the minutes we approved as written.

Motion was made by Andy Ritchie for approval of the October 18, 2022, meeting minutes (Pittsburg). No objections were voiced; the minutes we approved as written.

Action Item List:

The action item list was reviewed and can be found as Attachment #3. The status of each action item is listed.

Fuels Task Force Update:

Pat advised that all of the action items on the fuels task force list are complete. As a result, there was no formal report provided. If there are any new requests for the fuels task force to handle, the group will reconvene as needed.

Rating Task Force:

Bob Campbell provided a verbal update for the rating taskforce. A summary is as follows:

1) An open Heavy Duty (HD) workshop was held the week of September 18th in San Antonio.

2) Rating Manuals 20 and 21 have been available for purchase.

3) LED lights have been approved, working on specifying a light diffuser.

Jeff Clark commented that there have been some discussions on separating the rating workshop into two separate groups which would be field rating and lab ratings (standardized testing). This would allow for the light-duty and heavy-duty workshops to be held together and a separate date for the field rating workshop.

Old Business:

DACA II Review Task Force:

Pat Lang reported that the task force that is reviewing the DACA II document has continued to be active during this period with three virtual meetings held. A summary report can be found as Attachment #4. Pat further reported that the review has been completed as of the last conference call and a final version of the document will be distributed to all surveillance panels along with the extended TGC mailing list for additional review. Once completed, the document will be identified as DACA III. It should be noted that DACA III will apply to future tests; current tests will still be governed by DACA II.

Review of Pittsburgh TGC Meeting Presentation: (Travis Kostan)

At this point, Travis briefly went through some of the presentation that was shown at the TGC Meeting in Pittsburgh. The reason it was presented again in short is that there is a lot of LTMS information in the presentation and the goal of the TGC is to disseminate this information thoroughly. It highlights some of the potential misinterpretations of CUSUM plots, shows examples of how individual laboratory performances can impact target setting based on how the results are weighted relative to the number of tests run and further shows some scenarios of the impact of updating reference oil targets at the 10, 20 and 30 test intervals. The full presentation can be found as Attachment #5.

A question arose at the Pittsburgh meeting regarding the ownership of the LTMS document, specifically who has the authority to change it. Jeff Clark from the TMC thinks that there was a taskforce formed in the past and that Jim Rutherford was the leader.

Action Item:

Jeff Clark will back-track through some of the historical documents to see if he can determine exactly how the LTMS document was handled in the past regarding changes.

New Business:

Surveillance Panel Handbook:

One of the action items that came up in the meeting in Pittsburgh TGC meeting was to create a Surveillance Panel Chairman Handbook. The intent of this document would be to provide some guidelines for surveillance panel chairs relative to their responsibilities and also advise on the availability of existing documentation that can assist/guide them in their responsibilities.

YongLi McFarland and Andrew Stevens volunteered to take the lead on outing together the handbook. Andrew advised during the meeting that an initial draft/outline has already been created and sent around for comment, see Attachment #6. He encouraged all to provide any input they may have based on their experiences.

Next Meeting:

The next meeting is planned to be in the spring of 2023; location and date to be determined.

The meeting adjourned at 4:00 EST.

Attachment #1

Agenda

December 5, 2022

AGENDA

ASTM Technical Guidance Committee Meeting
Orlando, Florida

Patrick Lang – Chairman
Monday December 5, 2022–2:30 PM to 4:00 PM (Eastern)

1. Attendance
2. Chairman's Comments
3. Review & Acceptance of Minutes
    - 3.1. Acceptance of the June 27, 2022, meeting minutes (Seattle).
    - 3.2. Acceptance of the October 18, 2022, meeting minutes (Pittsburgh).
4. Review Action Item List (Pat Lang)
5. Fuel Task Force
    - 5.1. No activity this reporting period (all action items have been addressed)
6. Rating Task Force
    - 6.1. Update on status of rating task force activities (Bob Campbell)
7. Old Business
    - 7.1 DACA II Review Task Force Update (Pat Lang)
    - 7.2 Brief overview of key items discussed at Pittsburgh Mtg (Travis Kostan)
8. New Business
    - 8.1. Surveillance Panel Chair Handbook (YongLi McFarland/Andrew Stevens)
9. Next Meeting: To be announced
10. Adjournment

Attachment #2

Attendance List

December 5, 2022

Technical Guidance Committee----Voting Membership List Dec 5, 2022

NAME	COMPANY AND ADDRESS	PHONE NUMBER E-MAIL ADDRESS
Luke Moeling Test Developer	Caterpillar, Inc. Old Galeena Road Building H3000 Mossville, IL 61552-3000	Phone: (309) 494-1311 e-mail: Moehling_Luke@cat.com
Suzanne Neal Test Developer	Detroit Diesel/Daimler Truck NA 13400 Outer Drive West Detroit, MI 48239	Phone: (313)592-7130 e-mail: suzanne.neal@daimlertruck.com
Don Bell OSCT	Afton Chemical Corporation 500 Spring Street PO Box 2158 Richmond, VA 23218-2158	Phone: (804)-788-6332 e-mail: don.bell@aftonchemical.com
Mike Birke Elastomer Compatability (EOEC), LDEOC	Southwest Research Institute 6220 Culebra Road San Antonio, TX 78228-0510	Phone: (210) 522-5310 e-mail: mike.birke@swri.org
William Buscher, III Sequence IVA/IVB	Intertek Automotive Research 5404 Bandera Road San Antonio, TX 78238-1933	Phone: (210) 240-8990 e-mail: william.buscher@intertek.com
David Brass Mack/Volvo SP Chair	Infineum USA, L.P. 1900 East Linden Ave. Linden, NJ 07036-0735	Phone: (908) 474-3374 e-mail: david.brass@infineum.com
Tim Cushing Test Developer	GM Powertrain 823 Joslyn Road, Mail Code 483-730-312 Engine Engineering Building Pontiac, MI 48340-2920	Phone: (248) 881-3518 e-mail: timothy.cushing@gm.com
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Jeff Clark TMC Administrator	ASTM Test Monitoring Center 203 Armstrong Drive Freeport , PA 16229	Phone: (412) 365-1030 e-mail: jac@astmtmc.org
Justin Mills ROBO SP Chair	Evonik ,	Phone: (215) 706-5816 e-mail: justin.mills@evonik.com
Amy Ross Volatility, D5800/D6417	Valvoline ,	Phone: 859-357-3523 e-mail: amy_ross@valvoline.com

Technical Guidance Committee----Voting Membership List

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Juan Vega	Intertek Automotive Research ,	Phone: e-mail:
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Kwame Duho	Valvoline	Phone: 859-556-5031 e-mail: jkduho@valvoline.com
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Greer Gibbons	Lubrizol	Wickliffe, OH	greer.gibbons@lubrizol.com

Attachment #3

Action Items List

December 5, 2022

Technical Guidance Committee (TGC)

Action Items List Status as of 12-5-22:

1. Action Item – TGC to review the current "DACA II" document.

    - ***Near completion, update later in meeting***

2. Action Item – Create task force to review surveillance panel voting rules.

    - ***In Process: Chair chosen and meeting to be scheduled***

3. Action Item – TGC to review the current document for "out of control" tests.

    - ***Open***

4. Action Item – TGC to work on generating test procedure wording that would address the handling of testing anomalies.

    - ***Open***

5. Action Item (from Oct 2022 Mtg, Pittsburgh) – Create a Surveillance Panel Chairman Handbook to document the responsibilities associated with chairmanship positions.

    - ***In Process: Discussion today***

Attachment #4

DACA II Review Task Force Report

December 5, 2022

DACA II Review Task Force

SOUTHWEST RESEARCH INSTITUTE®

Prepared By: Patrick Lang

December 5, 2022

DACA III Review Task Force Activities

- Task force formed with Pat Lang as the chairman
- Group agreed that the final document will be called DACA III.
- Eight virtual meetings held to date with three taking place during this period.
- Topics covered thus far:
  - Filtering
  - System Time Response
  - Quality Index
- Final topic is measurement uncertainty.

Membership List

Attendance List for DACA II Review Task Force	
Name	**Company**
Amol Savant	Valvoline
Al Lopez Bill Buscher	Intertek
Andrew Stevens George Szappanos David Doerr Jim Matasic	Lubrizol
Randy Harmon John White Ron Barthold Khaled Rais Bob Warden Mike Lochte Ankit Chaudhry Tom Wirries Chris DesRuieeeau	Southwest Research
Bob Campbell	Afton
Tim Cushing	General Motors
Jim Gutzwiller Andy Ritchie	Infineum
Michael Tucker Rohit Rao Jason Griffin	Exxon Mobil
Mike Deegan	Ford
Robert Stockwell	Oronite
Jeff Clark Rich Grundza Sean Moyer	Test Monitoring Center

Questions?

Attachment #5

TGC Presentation from October 2022,

TGC Meeting

December 5, 2022

TGC Review of Lubricant Test Target Setting and Monitoring

PITTSBURGH, PA

OCTOBER 18, 2022

PREPARED BY TRAVIS KOSTAN, SWRI

Disclaimer

The presentation was put together by Travis Kostan from Southwest Research Institute. Due to the wide range of topics discussed, it was agreed in advance by the statistics group that a presentation of consensus opinions would not be feasible in a timely manner. The full statistics group met several times to discuss the material, and many contributions from others are included, but the final version is not expected to represent the full range of opinions.

Presentation Objective

The purpose of this presentation is to increase industry awareness about some current practices in place to develop and monitor lubricant tests that have become highlighted recently as needing further discussion amongst TGC members.

Specifically, we will discuss precision matrix target setting and control chart monitoring.

Agenda

1. Some Background on Control Charts
2. Precision Matrix Statistical Design, Execution, and Target Setting
3. Post-Matrix Process Options for Discussion
4. Surveillance Panel Chair Responsibility for Handling Alarms

Some Background on Control Charts

Control Charts

From LTMS Section 1 first paragraph:

"The purpose of the control charts is to monitor and track **both large abrupt changes and smaller consistent trends in both test severity and precision**. The Shewhart charts check for abrupt changes while the Exponentially Weighted Moving Average (EWMA) charts check for consistent changes and trends over time."

The document lists 5 control charts:

1. Shewhart Chart for Monitoring Severity (think Yi's)
2. Shewhart Chart for Monitoring Precision (think Ri's)
3. EWMA Chart for Monitoring Severity (think Zi's)
4. EWMA Chart for Monitoring Precision (think Qi's)
5. Shewhart Chart for Prediction Error (think ei's)

In addition to those list above, Cumulative Sum (CUSUM) charts are also given in many test types.

Steps for Control Chart Monitoring

1. Sufficient chart knowledge and understanding, so that proper charts are put in place for monitoring.
2. Understanding the factors and changes that may affect control chart behavior.
3. Proper problem identification.
4. Consequences and action steps to resolve problems when they arise.

Proper Charts In Place for Monitoring

When establishing an LTMS, the Surveillance Panel should put in place the proper charts to monitor the test as they see fit.

Many of the newer test types have elected to monitor long term severity (EWMA) with Zi values, and abrupt severity and precision is measured indirectly through ei values (Yi – Z(i-1)). When an industry Zi alarm is triggered, an email is automatically generated by TMC and sent to the Surveillance Panel chair and the test sponsor.

Most recently developed tests do not monitor long-term precision changes through control charts. Instead, TMC produces a review of standard deviations every six months and this is presented at the semi-annual D02 Subcommittee B meetings.

CUSUM charts are an additional way to monitor long-term severity. They are not used for pass/fail or for industry alarms. Unfortunately, these charts are the most commonly misinterpreted…

Cumulative Sum (CUSUM) Charts

The CUSUM chart is a time ordered summation of the Yi values.
Recall,

$$Y_i = \frac{Result\ - Target}{Standard\ Deviation}$$

$$CUSUM_i = CUSUM_{i-1} + Yi$$

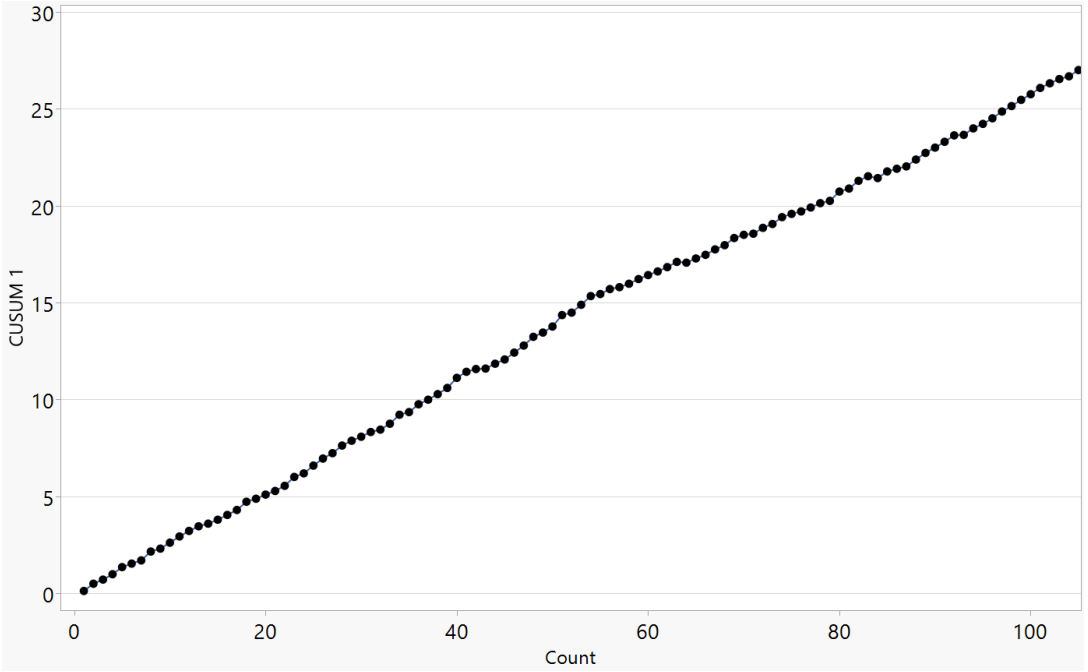
Result #	Result	RO Target	RO Standard Deviation	Yi Value	CUSUM
0	-	-	-	-	0
1	8	7	1	1	1
2	8	7	1	1	2
3	9	7	1	2	4
4	7	7	1	0	4
5	7	7	1	0	4

Cumulative Sum (CUSUM) Charts

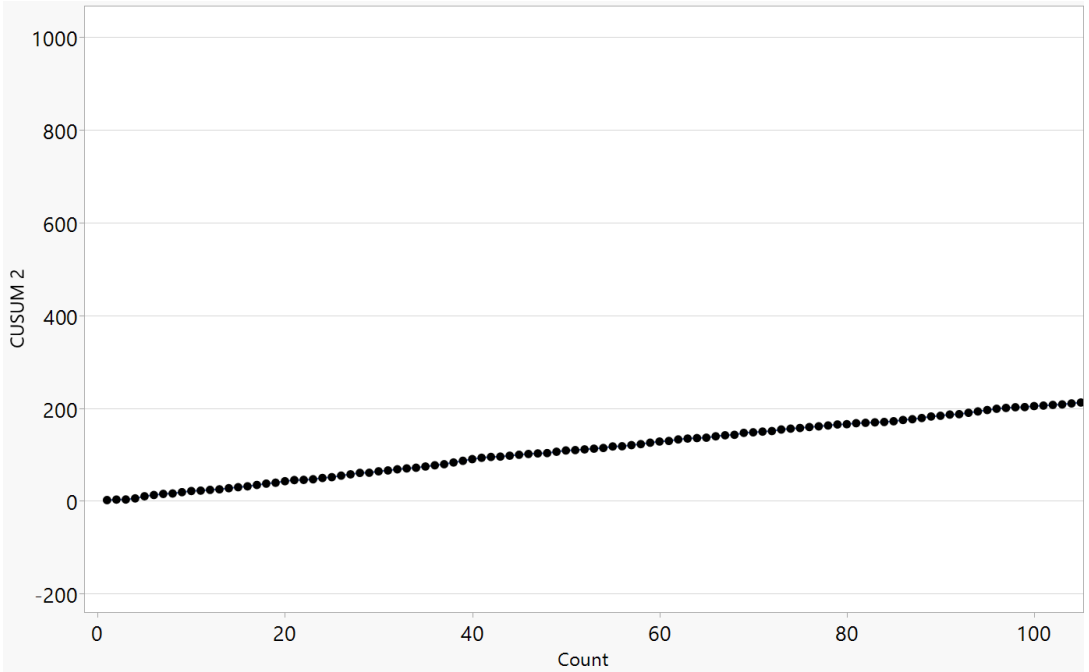
Two hypothetical CUSUM plots are shown below. From these graphs, can you identify:

1. Which CUSUMs are concerning and potentially indicating a test having severity problems?
2. Which test is in worse shape based on the plots?

CUSUM #1



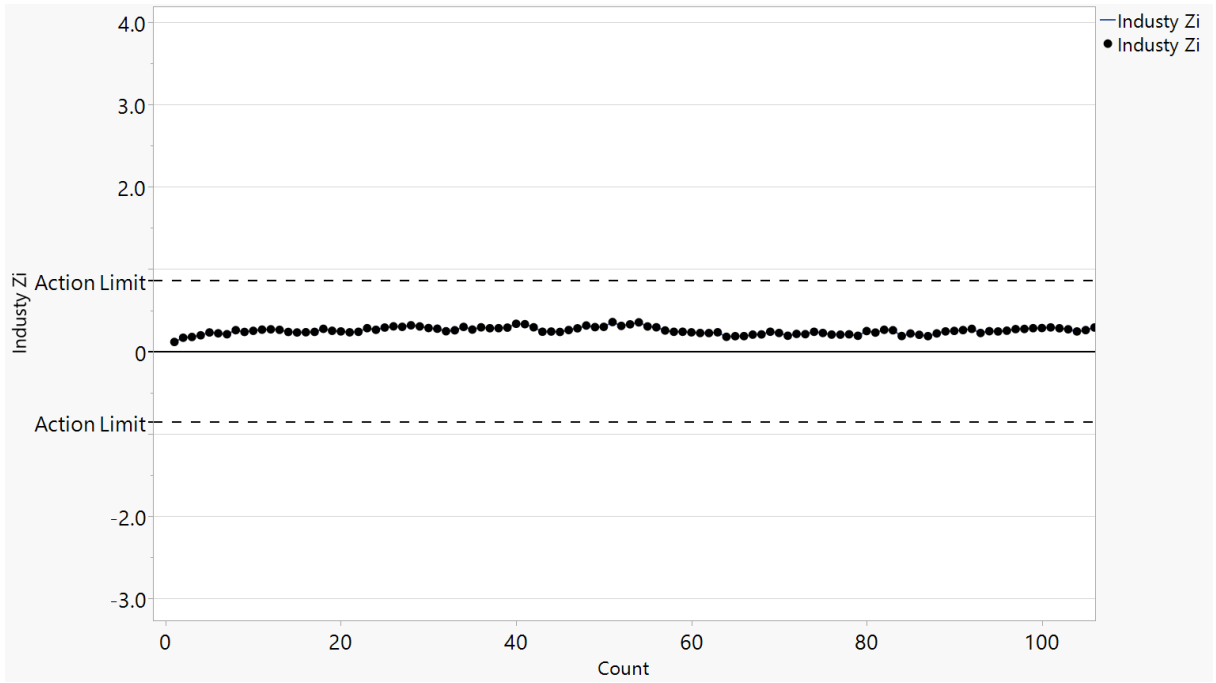
CUSUM #2



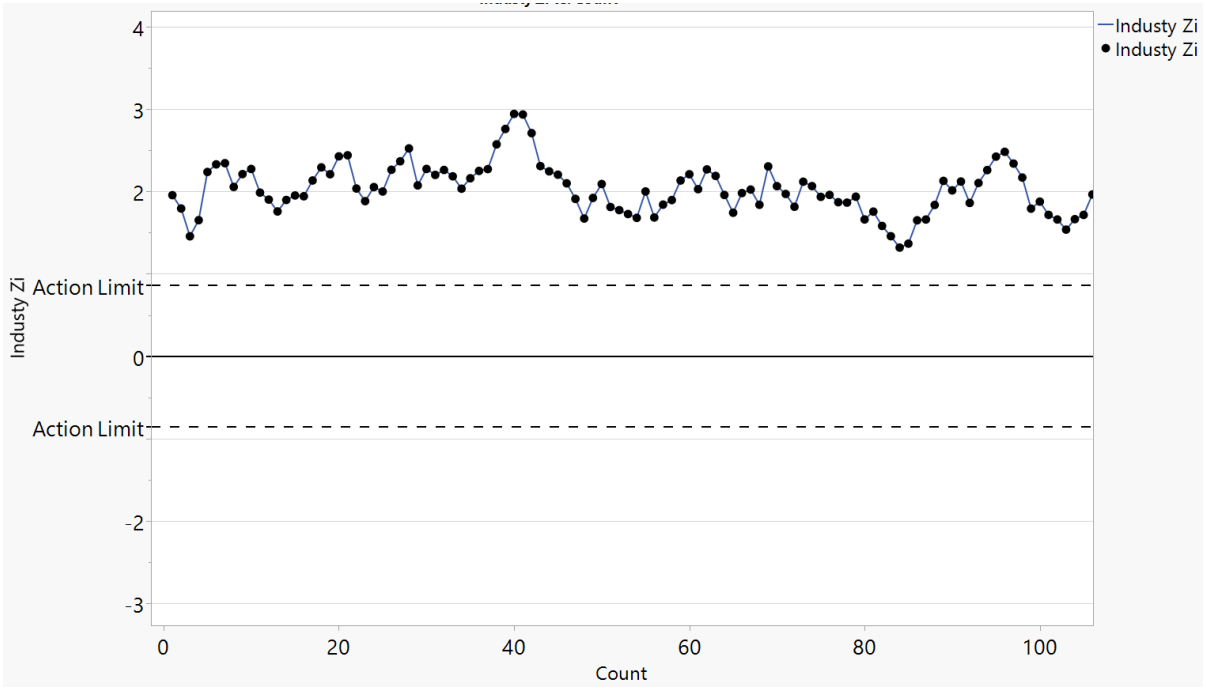
Cumulative Sum (CUSUM) Charts

Clearly only the test corresponding the CUSUM #2 is having a major severity issue. The scaling of the Y-axis on the CUSUM completely determines the angle of the CUSUM, which is often mistakenly used by many to say a test is having a severity problem. One must keep in mind that a sum of very small values can still look severe depending on the scaling.

CUSUM #1

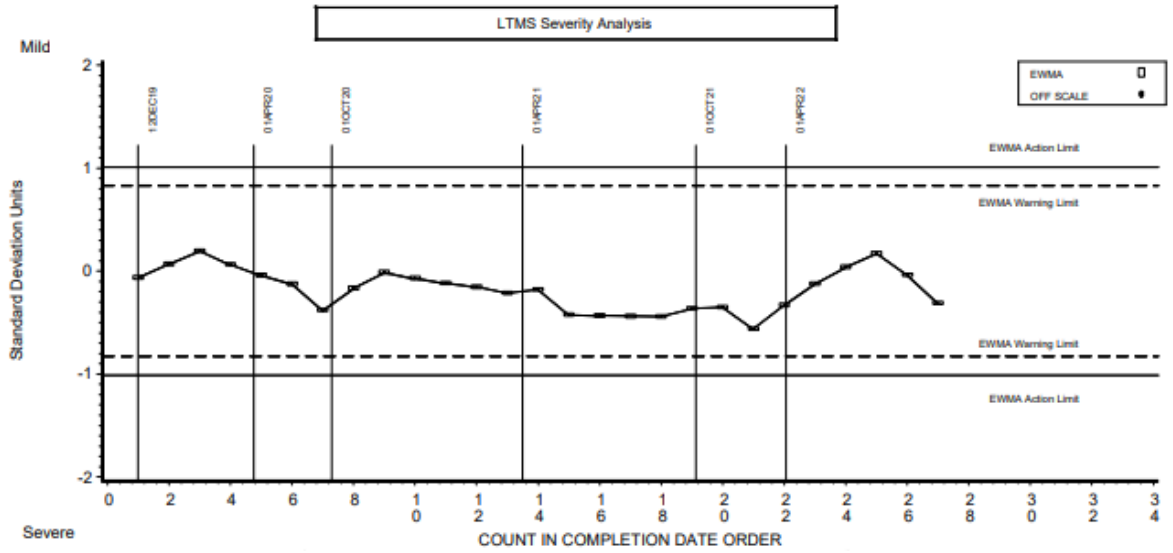


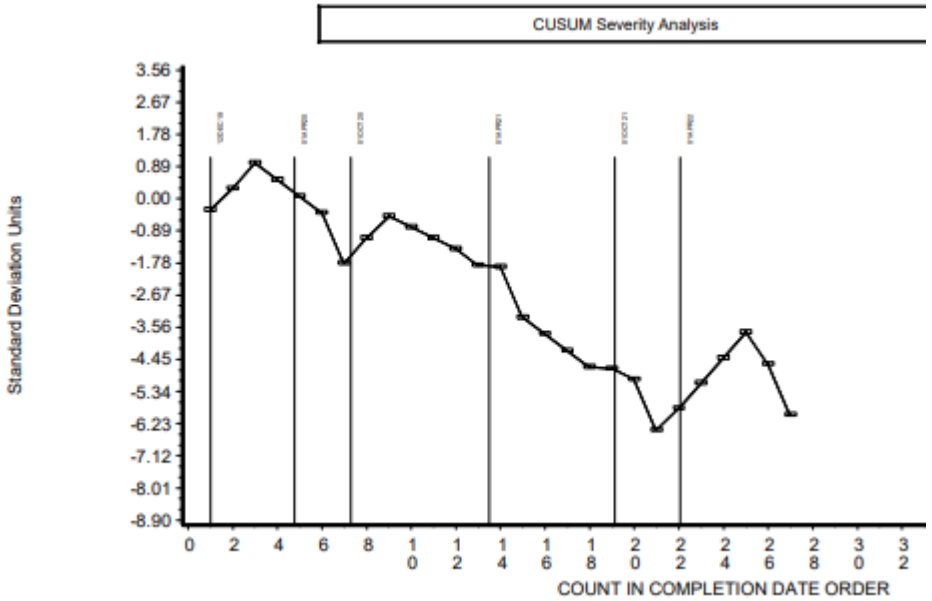
CUSUM #2



Cumulative Sum (CUSUM) Charts

Below is an example using the L-37-1 Pinion Gear Ridging parameter. The CUSUM is heading down at a 45 degree angle, but the test is not out of control.

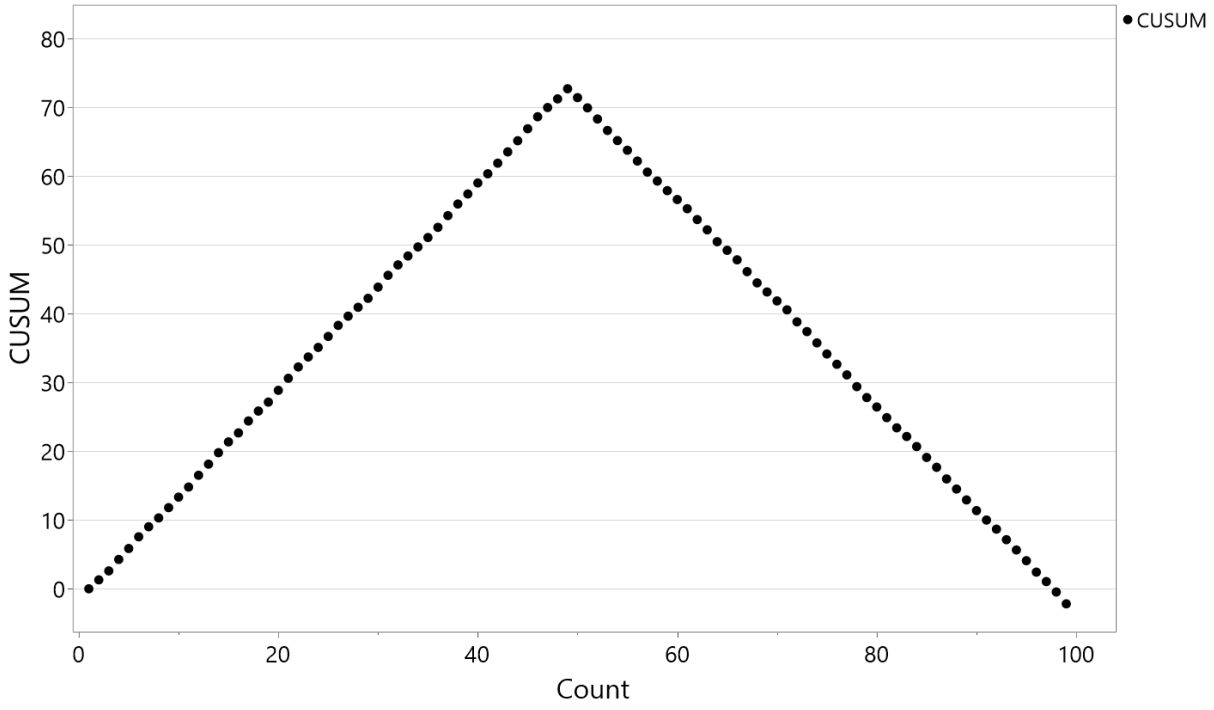




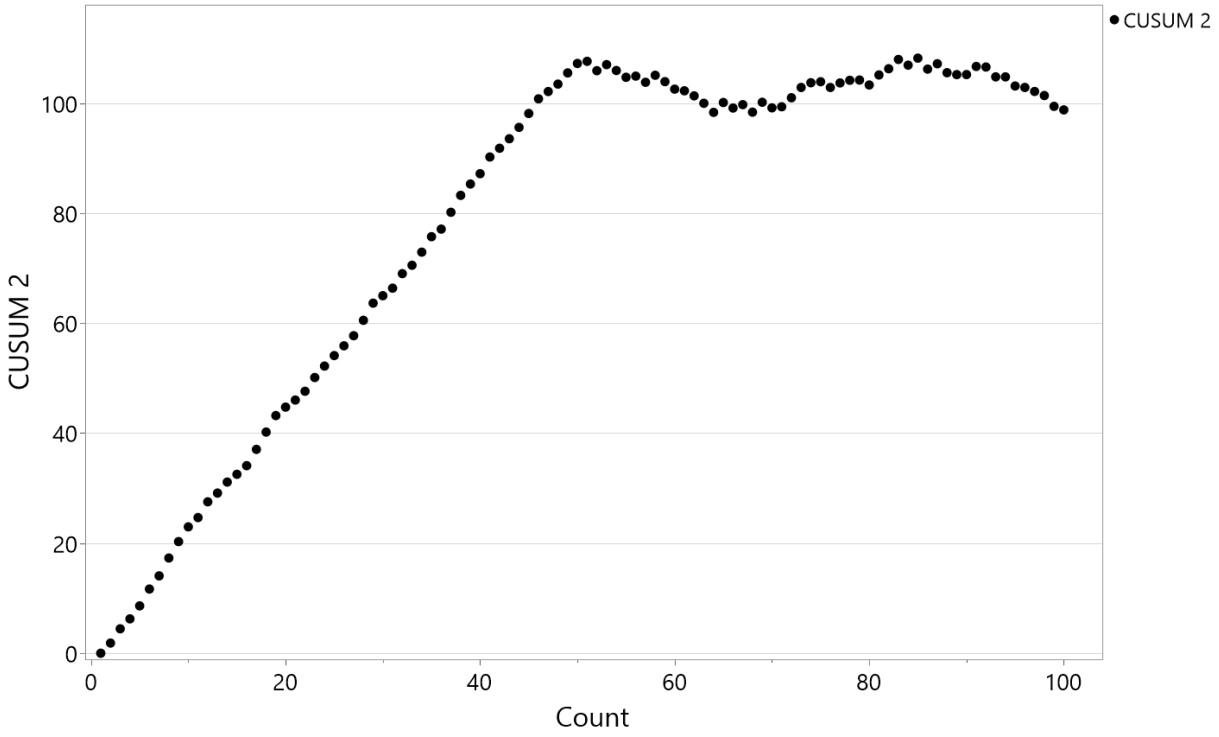
Cumulative Sum (CUSUM) Charts

In the two hypothetical CUSUM charts below, which test is in better shape after test 100?

CUSUM #1



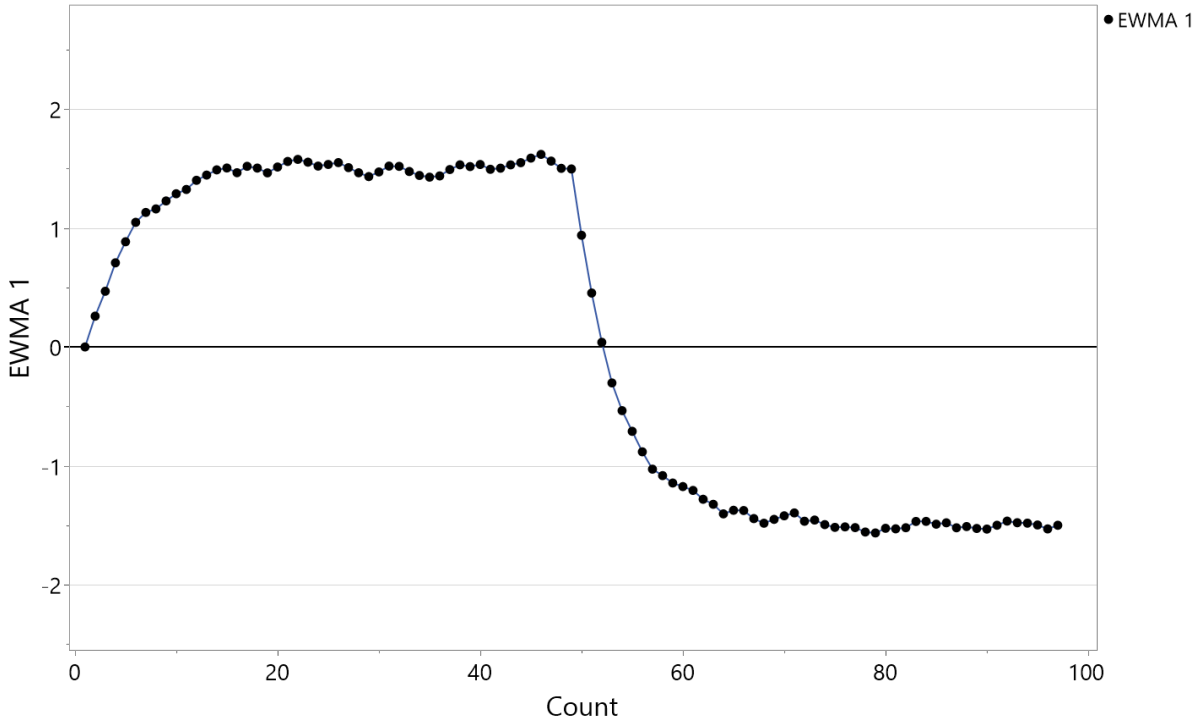
CUSUM #2



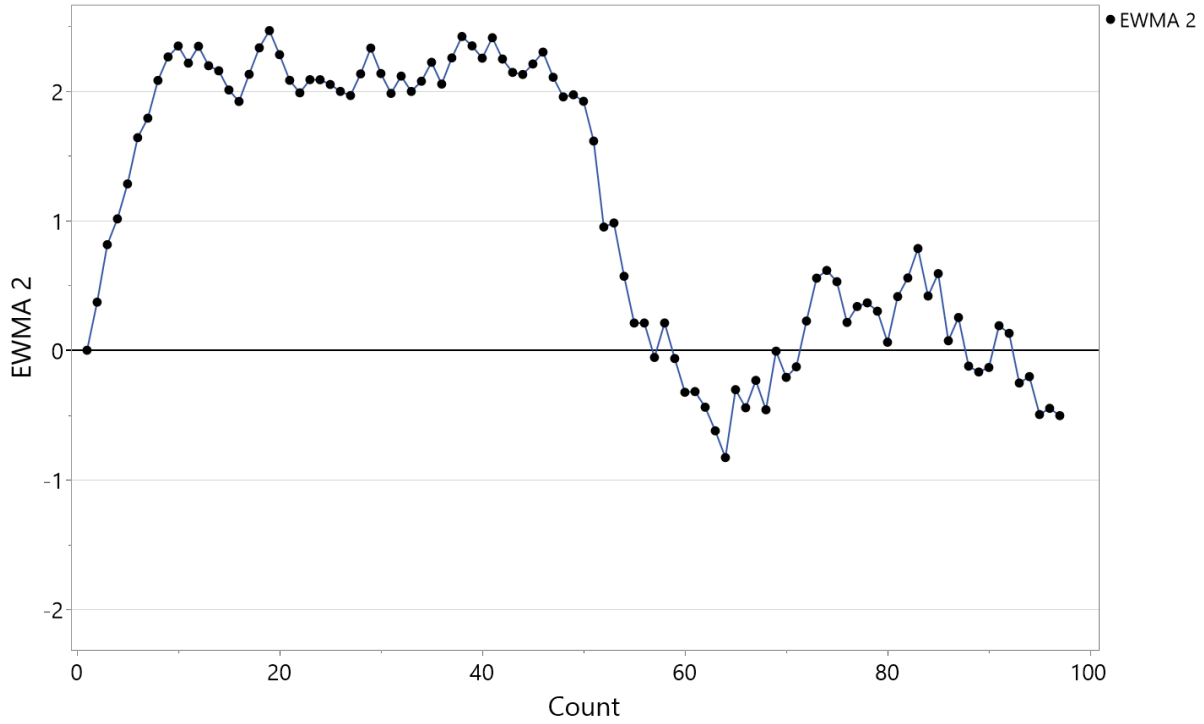
Cumulative Sum (CUSUM) Charts

The flat slope seen in the second CUSUM represents on target performance.

CUSUM #1

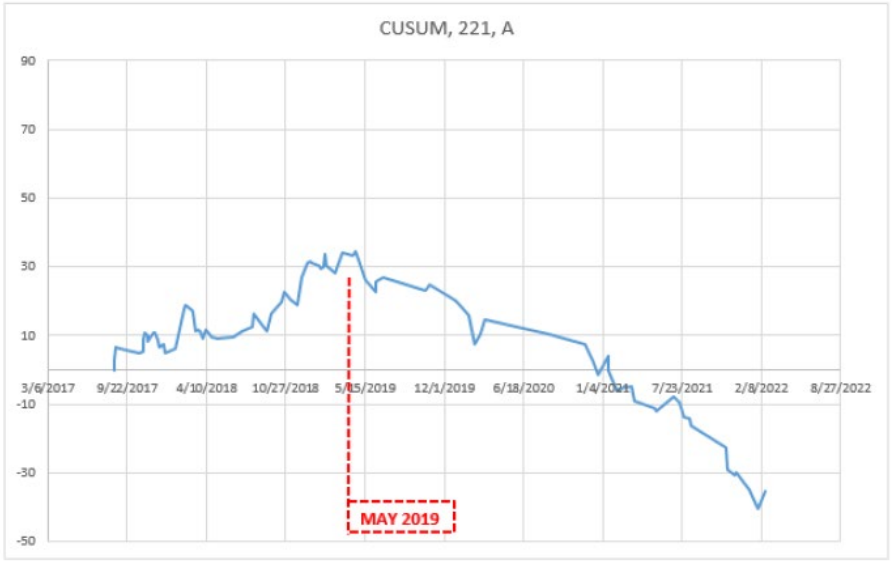


CUSUM #2



The Point

- Y-axis scaling can greatly influence the slope of a CUSUM chart.
- CUSUM plots are useful to see whether a test has been “on average” severe or mild by the recent direction of the line but should not be used to assess the degree of severity of a test. For that, the EWMA plot is the appropriate plot.
- CUSUM plots are also good for identifying inflection points when a test may have “changed” severity, such as in the plot below.



EWMA Severity Charts

The most commonly used chart to determine whether or not a test is “in-control.”

- Z_i is our best guess as to the current severity level of the industry.
- $Z_i =$ EWMA of the standardized test result at test order i
- $Z_i = \lambda * Y_i + (1 - \lambda) * Z_{i-1}$
  , where $0 < \lambda < 1$ is the weight factor, which determines by how much we “update” the Z_i value based on the current result (Y_i).

Example

- Current Industry severity level is half a standard deviation severe ($Z_i = 0.5$).
- New reference test is run and is 2 standard deviations severe ($Y_{i+1} = 2.0$)
- A Surveillance Panel chooses 20% lambda to “update” severity, so the new industry severity level is

$$Z_{i+1} = 20\% * 2.0 + 80\% * 0.5 = 0.8$$

EWMA Severity Charts

- EWMA charts typically have a “warning” limit and an “action” limit.
- When an industry warning or action limit is exceeded, the surveillance panel chair and test sponsor are notified by email.

Sequence IIIH Example

LUBRICANT TEST MONITORING SYSTEM CONSTANTS

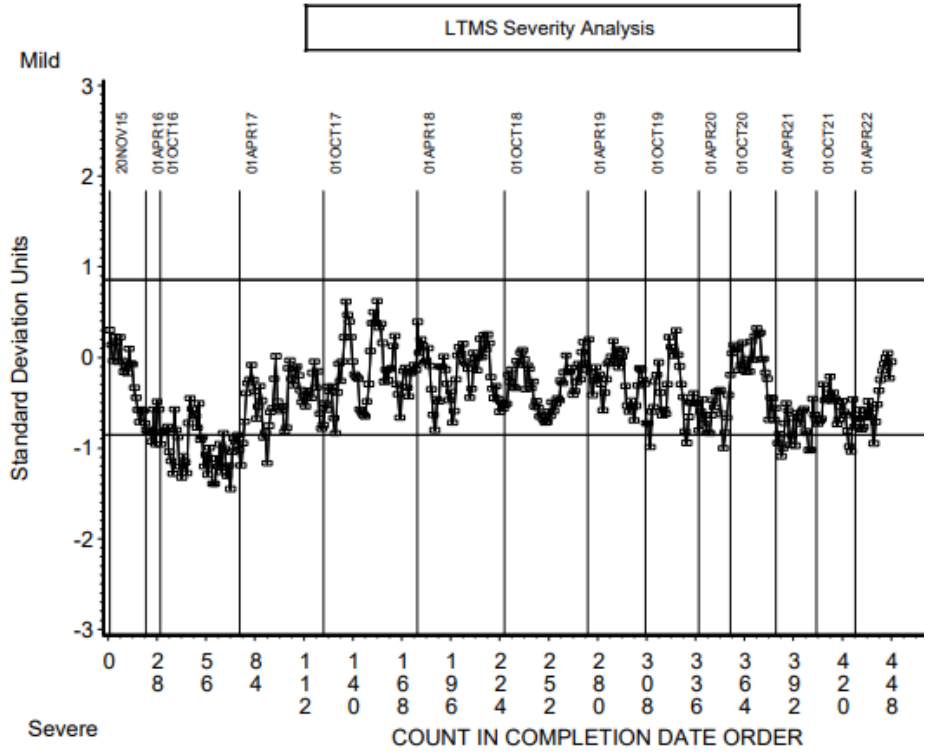
		EWMA Chart		Stand Prediction Error	
		Severity		Severity	
Chart Level	Limit Type	Lambda	Alarm	Limit Type	Limit
Stand	Level 1	0.3	0.000	Level 1	N/A
	Level 2		±1.800	Level 2	±1.734
				Level 3	±2.066
Industry	Level 1	0.2	±0.775	--	--
	Level 2		±0.859	--	--

How Often are Industry Severity Limits Exceeded?

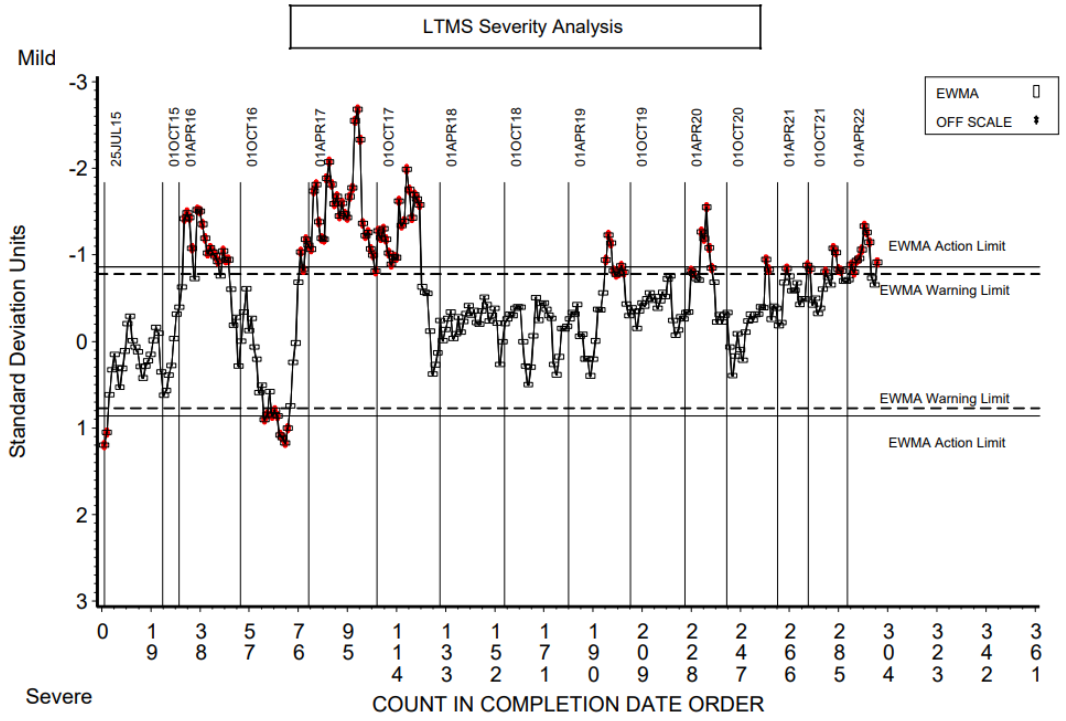
As the following slides will demonstrate, a test going into an out of control state has become a frequent and almost expected behavior…

How Often are Industry Severity Limits Exceeded?

VIE Fuel Economy Improvement Phase II

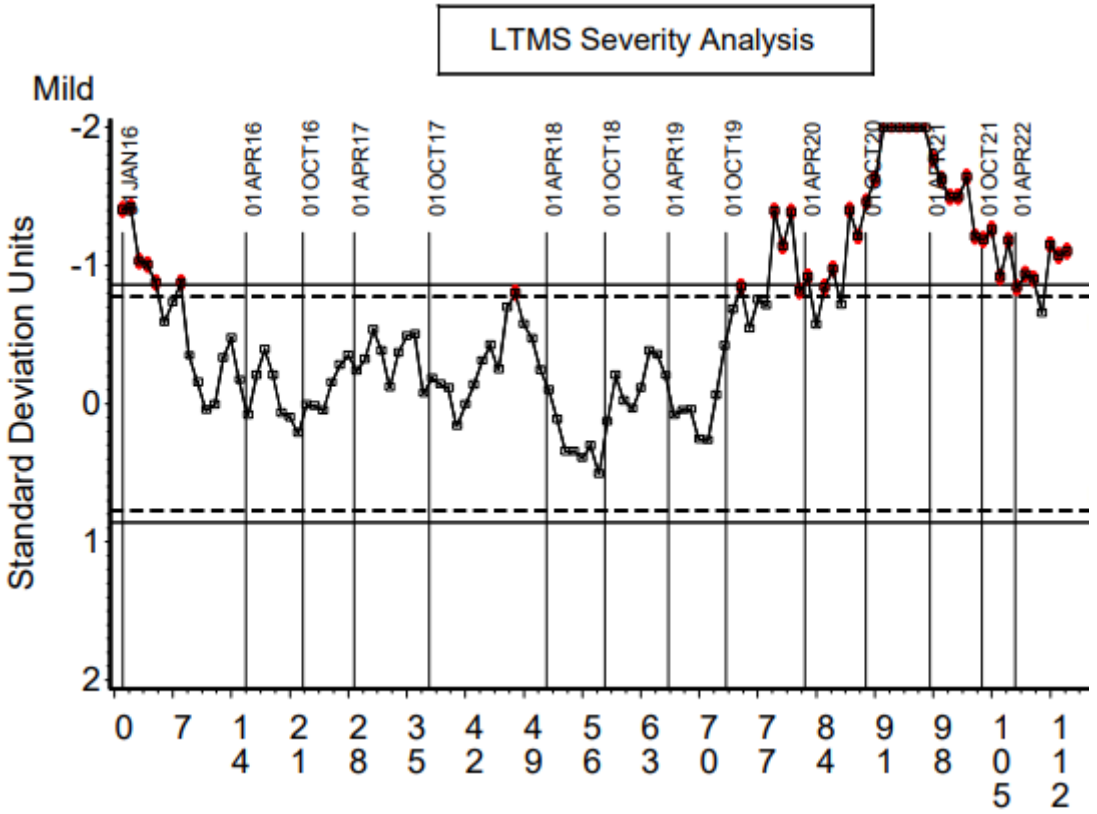


IIIH % Visc. Increase (PVIS)

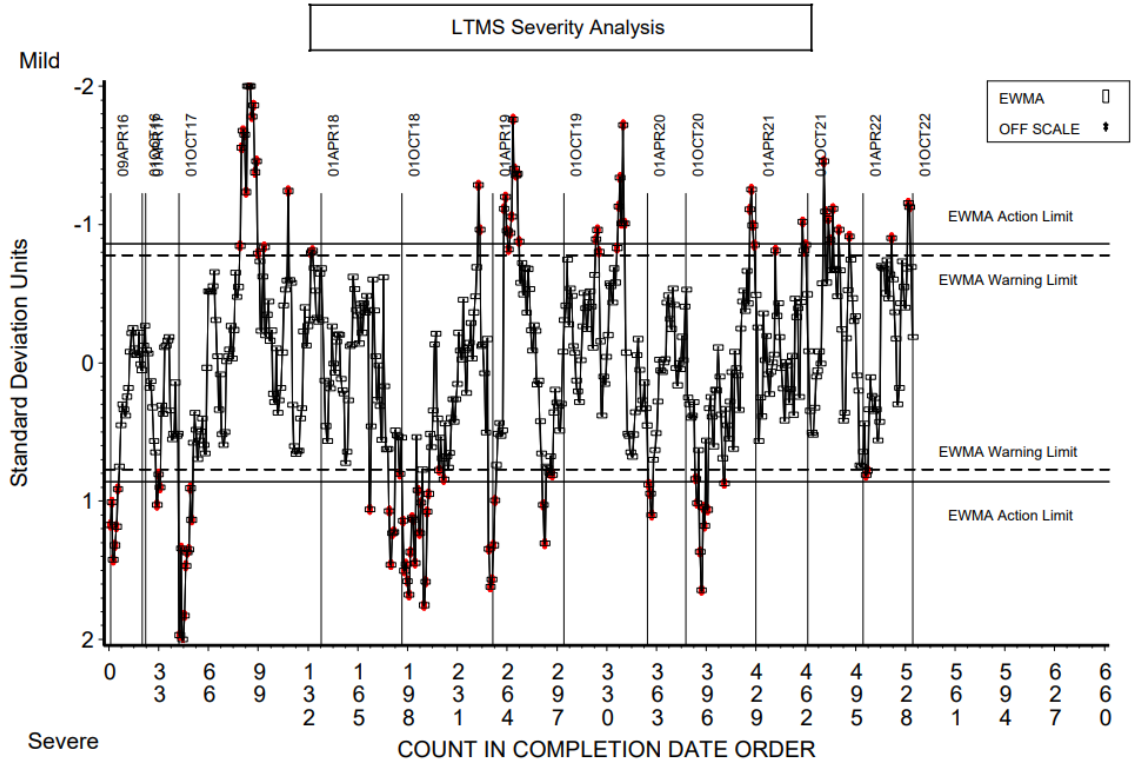


How Often are Industry Severity Limits Exceeded?

Sequence X Chain Stretch

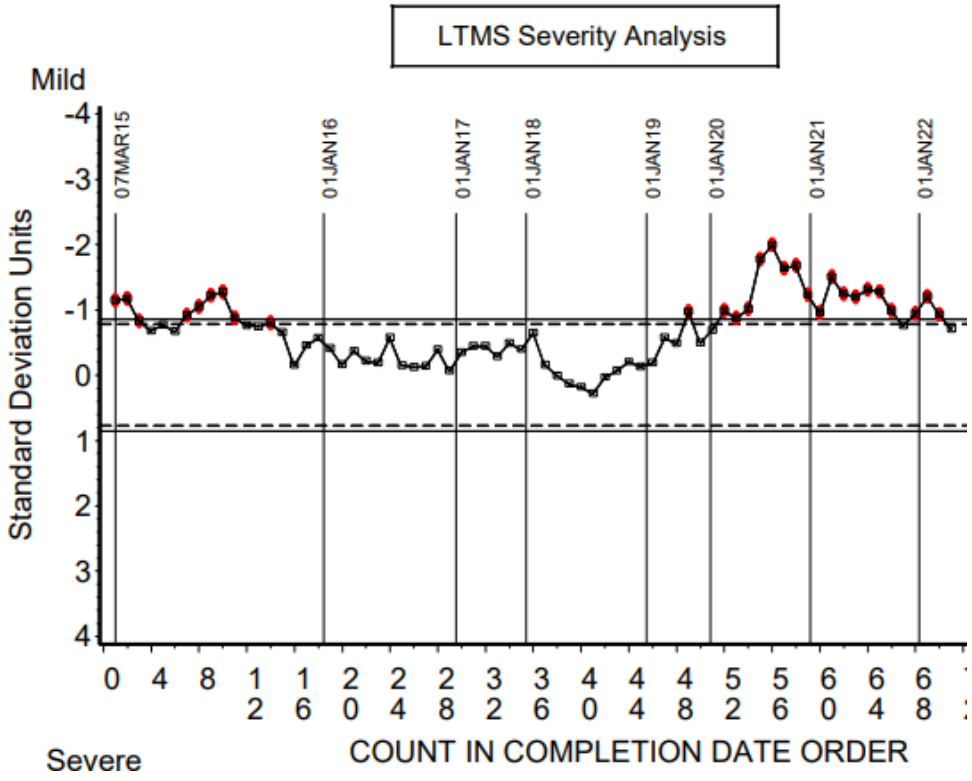


Sequence IX Avg. Pre-ignition Events

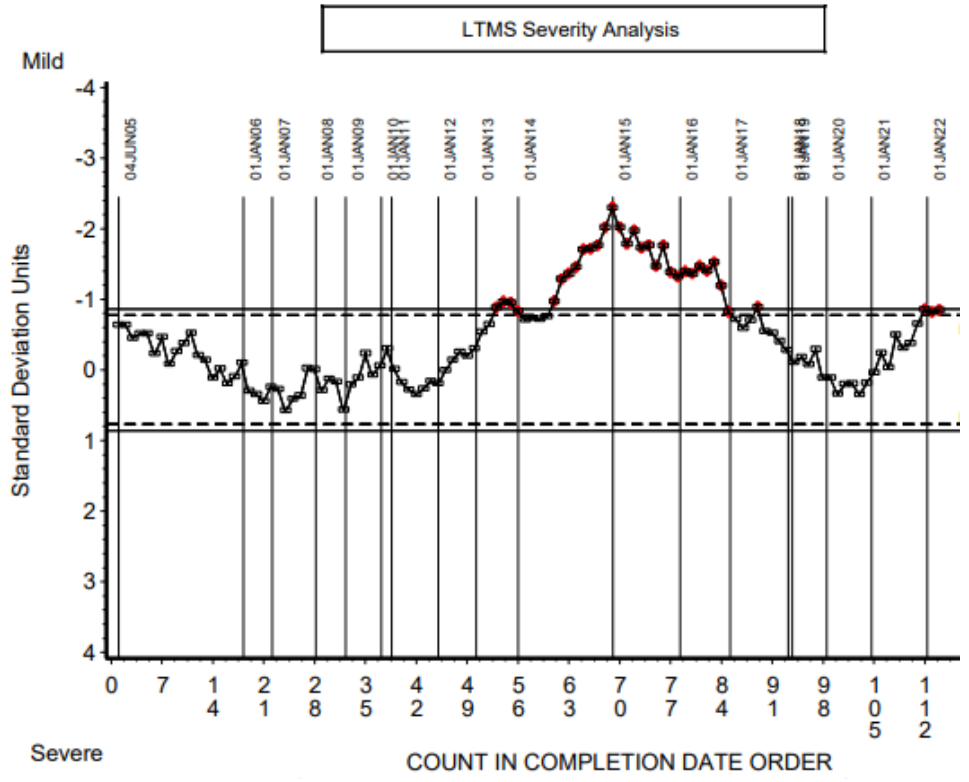


How Often are Industry Severity Limits Exceeded?

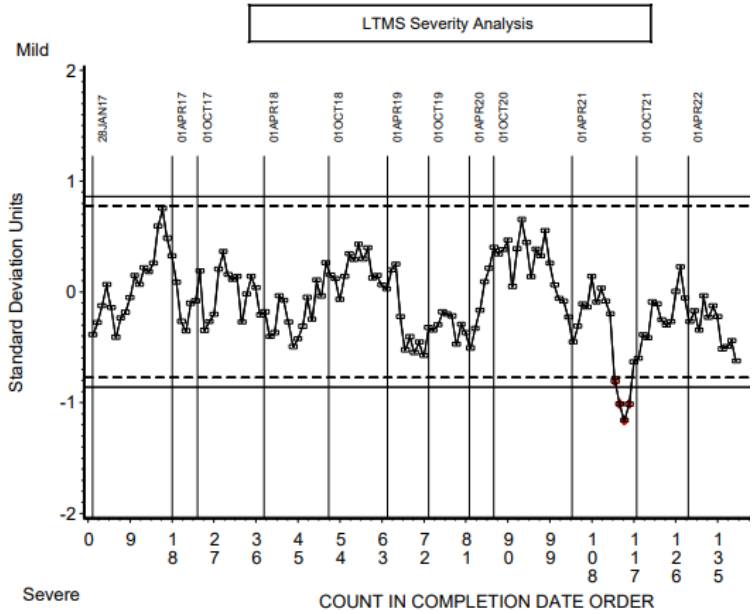
T13 Peak Height IR



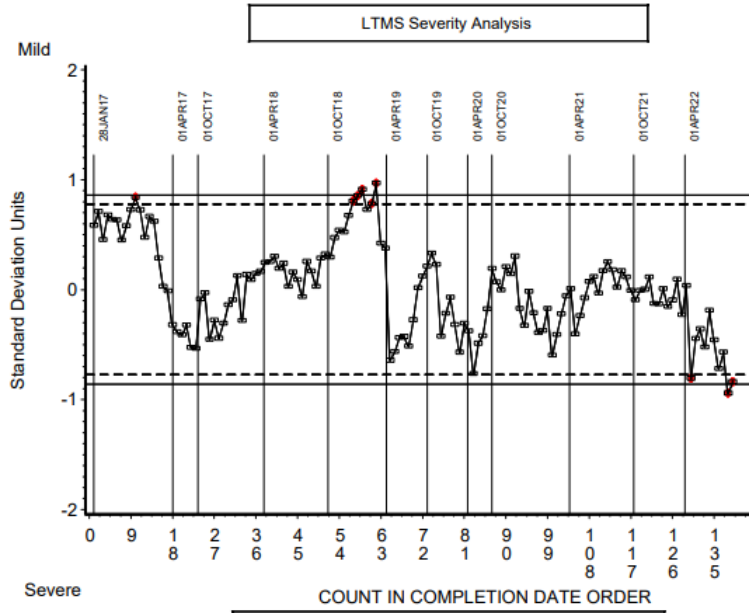
ISB Average Tappet Weight Loss



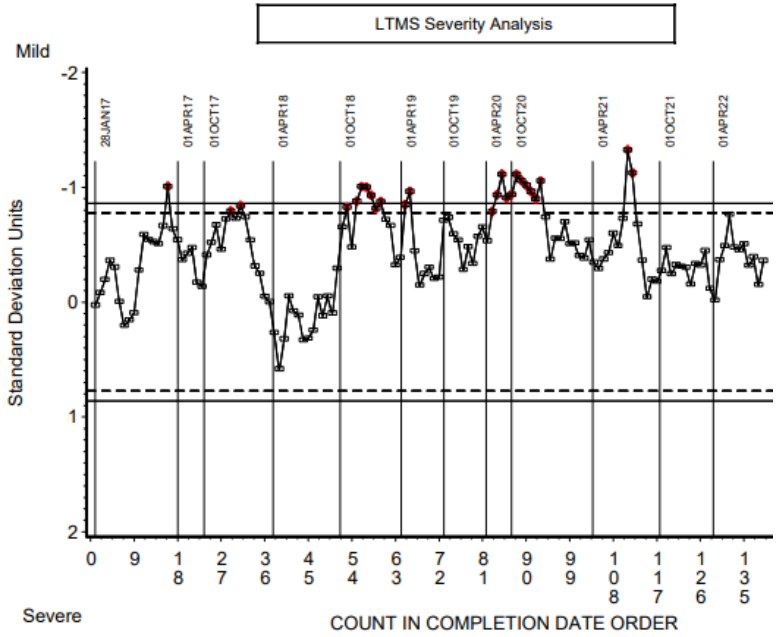
VH Avg. Engine Sludge



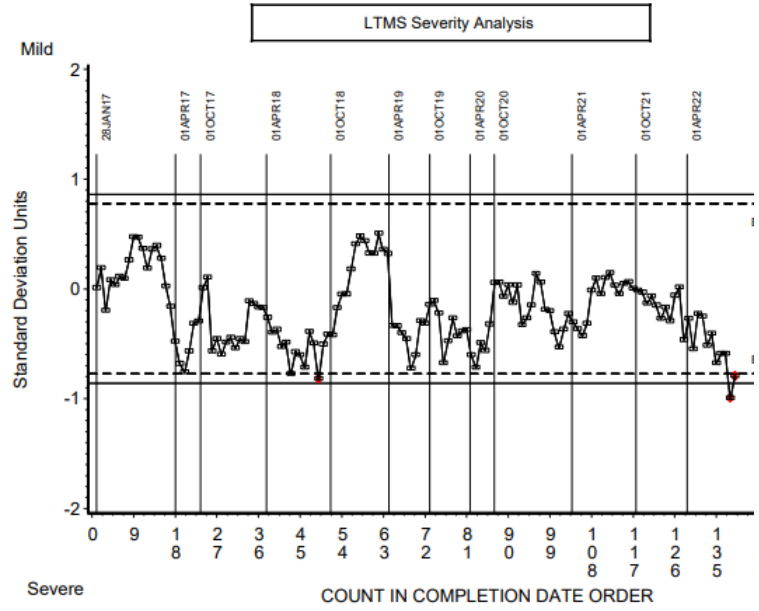
VH Avg. Engine Varnish



VH RAC Sludge

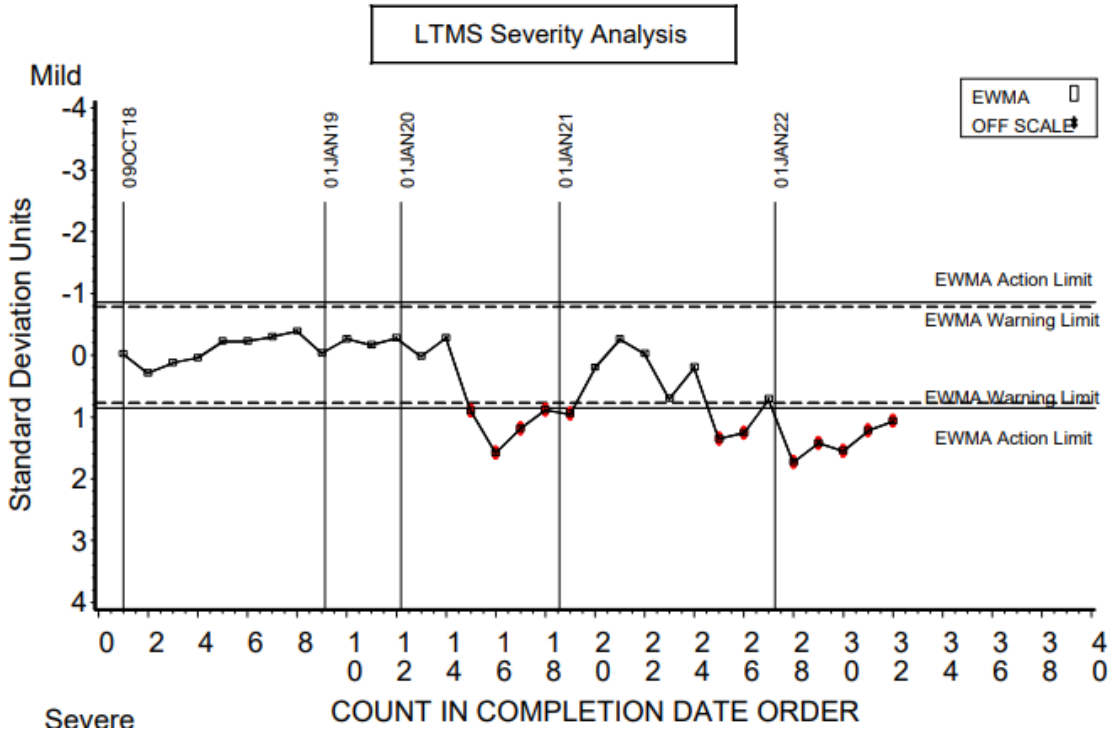


VH Avg. Piston Skirt Varnish

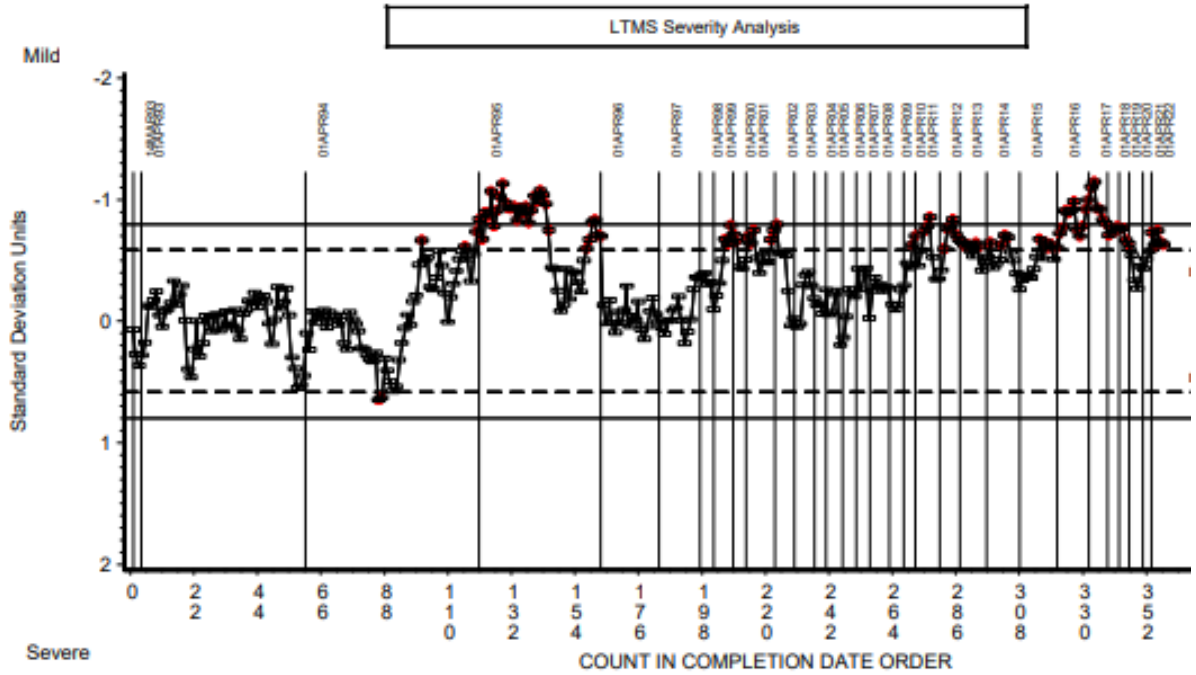


How Often are Industry Severity Limits Exceeded?

COAT 40-50 Hr. Avg. Aeration



1N Weighted Demerits



Just a Few Reasons Why

- Precision matrix data testing is often less than recommended and some amount of target inaccuracy is to be expected.
- Precision matrix test logistics often do not represent test conditions over the life of the test. Standard deviations increase with introduction of new labs, stands, parts, reference oil age, raters, time, etc.
- Monitoring methodology may not match target setting methodology.
- Significant lab differences may exist in the precision matrix which can contribute to the appearance of off-target performance post-precision matrix.

Some Additional Details are Necessary

Discussion is needed on why so many alarms occur, how to reduce them, and actions for SP chairs to take when tests are outside the control limits. However, it is important than each person have a good understanding of some of they key factors at play prior to having this discussion.

The following sections are intended to provide the necessary details to help facilitate this discussion later today.

Precision Matrix Design and Target Setting

What is a Precision Matrix?

The primary purpose of the precision matrix is to establish baseline reference oil performance that can be used to monitor the state of the test over time.

Some key items should be considered carefully to best achieve this stated goal, such as:

1. What is to be monitored (discrimination, precision, target performance at P/F limit, etc.)?
2. What reference oils are required to accomplish #1?
3. How many labs and stands? How many tests per lab-stand?

We will save the discussion of #1 and #2 for another day, and focus on #3, as it relates to the current topics of discussion most directly.

How many tests?

- ASTM D6300
  - 30 error degrees of freedom for repeatability
  - 30 error degrees of freedom for reproducibility
- In particular for engine testing, a large precision matrix coming anywhere near ASTM D6300 requirements is too costly and time consuming, so a common approach has been “as much testing as we can fund,” which is typically insufficient and can result in costly problems later down the road.

To best answer the question of how many labs, stands, and test per combination, we need to have more in-depth discussion around the how various precision matrix designs change our ability to estimate repeatability vs. reproducibility and the potential impacts on test monitoring. This is discussed next…

What are repeatability degrees of freedom?

Roughly speaking, a degree of freedom can be thought of as an extra data point above and beyond what is required to estimate the model variables. A higher number of repeatability degrees of freedom leads to better estimates of test precision, including pooled and individual oil standard deviations.

What are repeatability degrees of freedom?

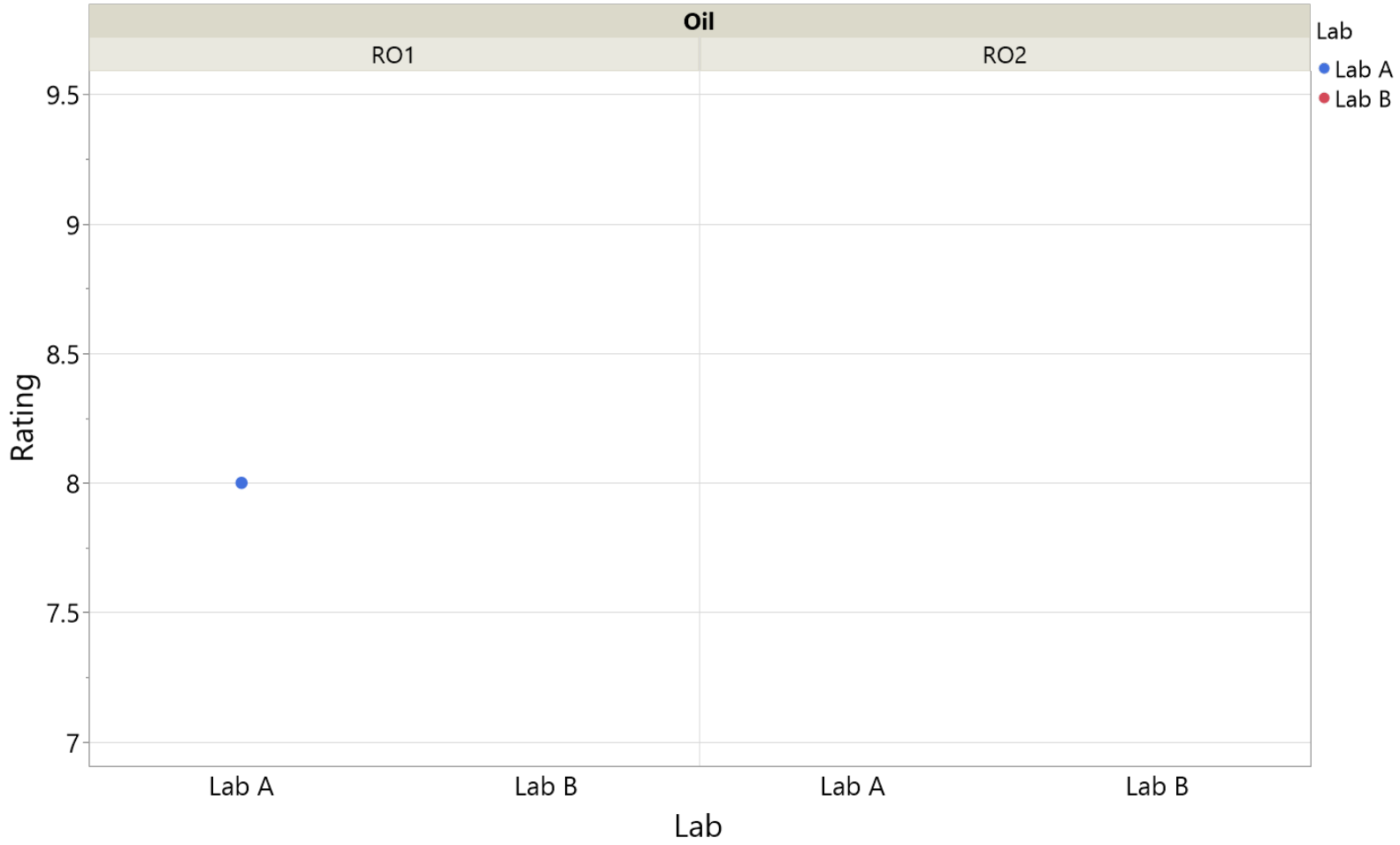
The Model is:

$$Rating = Intercept$$

All of the data is required for the estimation of the oil mean, and we have nothing left to estimate variability.

<u>Result:</u>

0 total degrees of freedom



What are repeatability degrees of freedom?

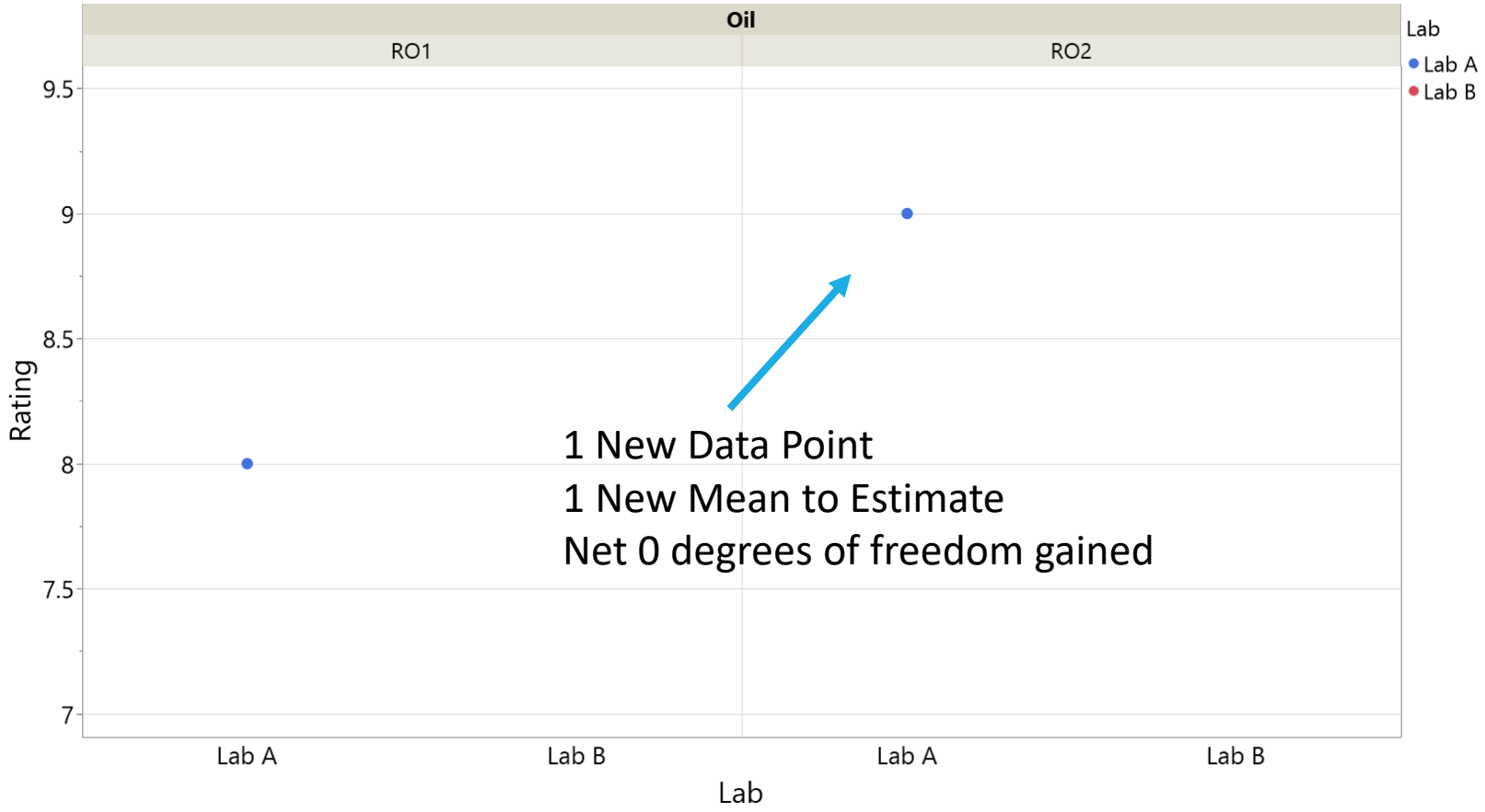
The Model is:

$$Rating = Intercept + (\beta_1 * RO2)$$

All of the data is required for the estimation of the oil means, and we have nothing left to estimate variability.

<u>Result:</u>

0 total degrees of freedom



What are repeatability degrees of freedom?

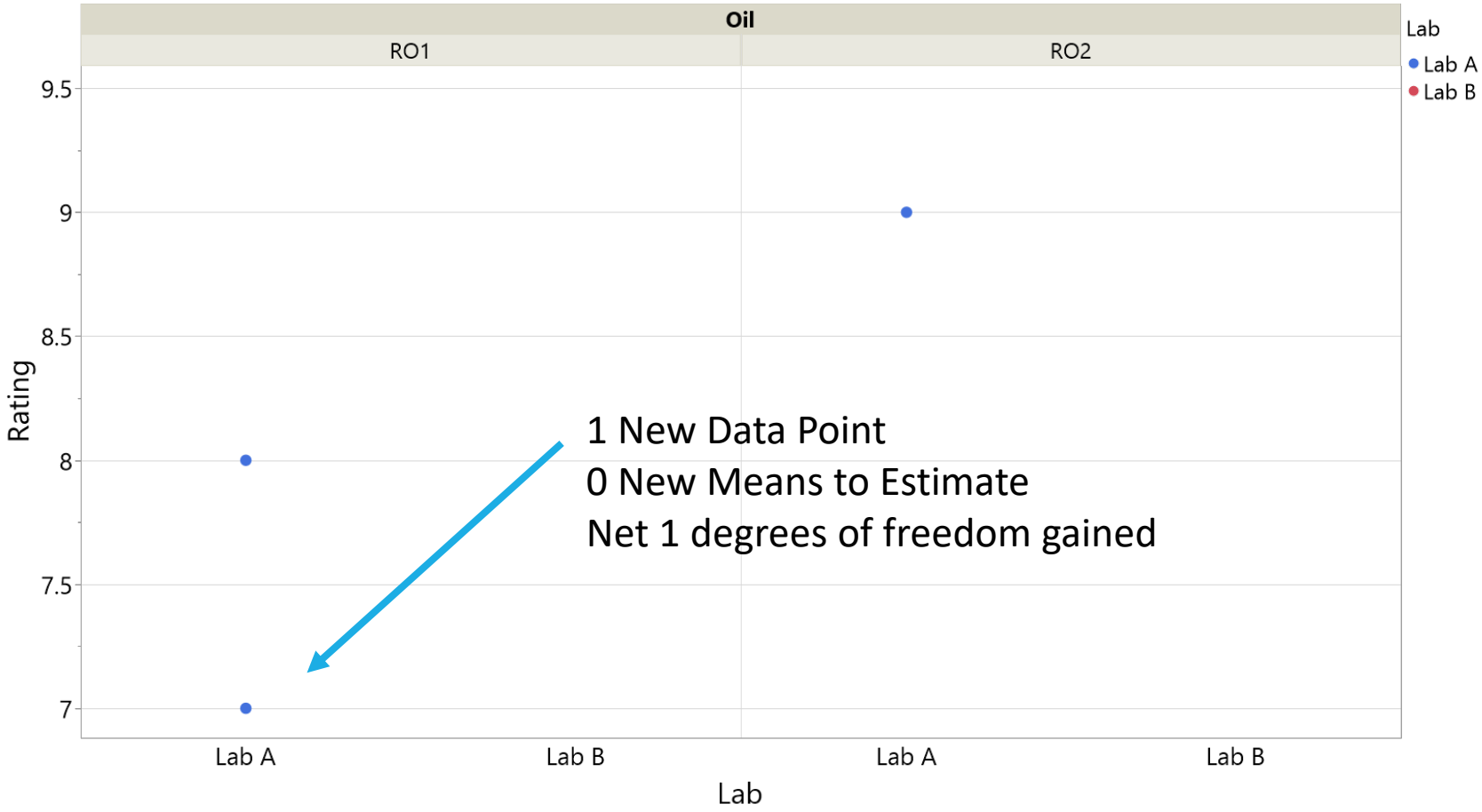
The Model is:

$$Rating = Intercept + (\beta_1 * RO2)$$

One extra data point obtained, with no new variables. We can now get our first estimate of a standard deviation.

Result:

1 total degree of freedom



What are repeatability degrees of freedom?

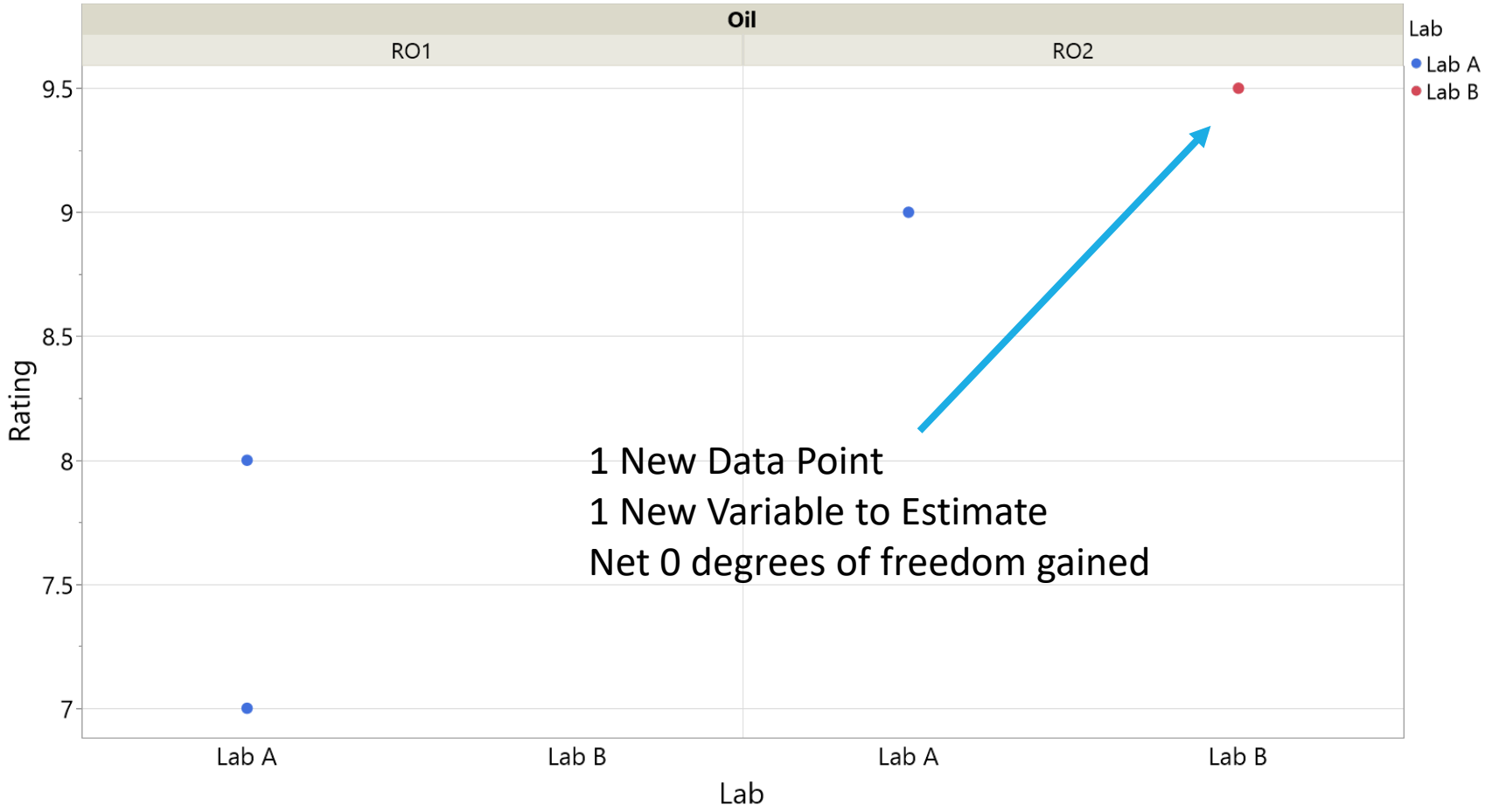
The Model is:

$$Rating = Intercept + (\beta_1 * RO2) + (\beta_2 * LabB)$$

The new data point is required to estimate the differences between labs, so we don't gain any degrees of freedom for estimating variability.

Result:

1 total degree of freedom



What are repeatability degrees of freedom?

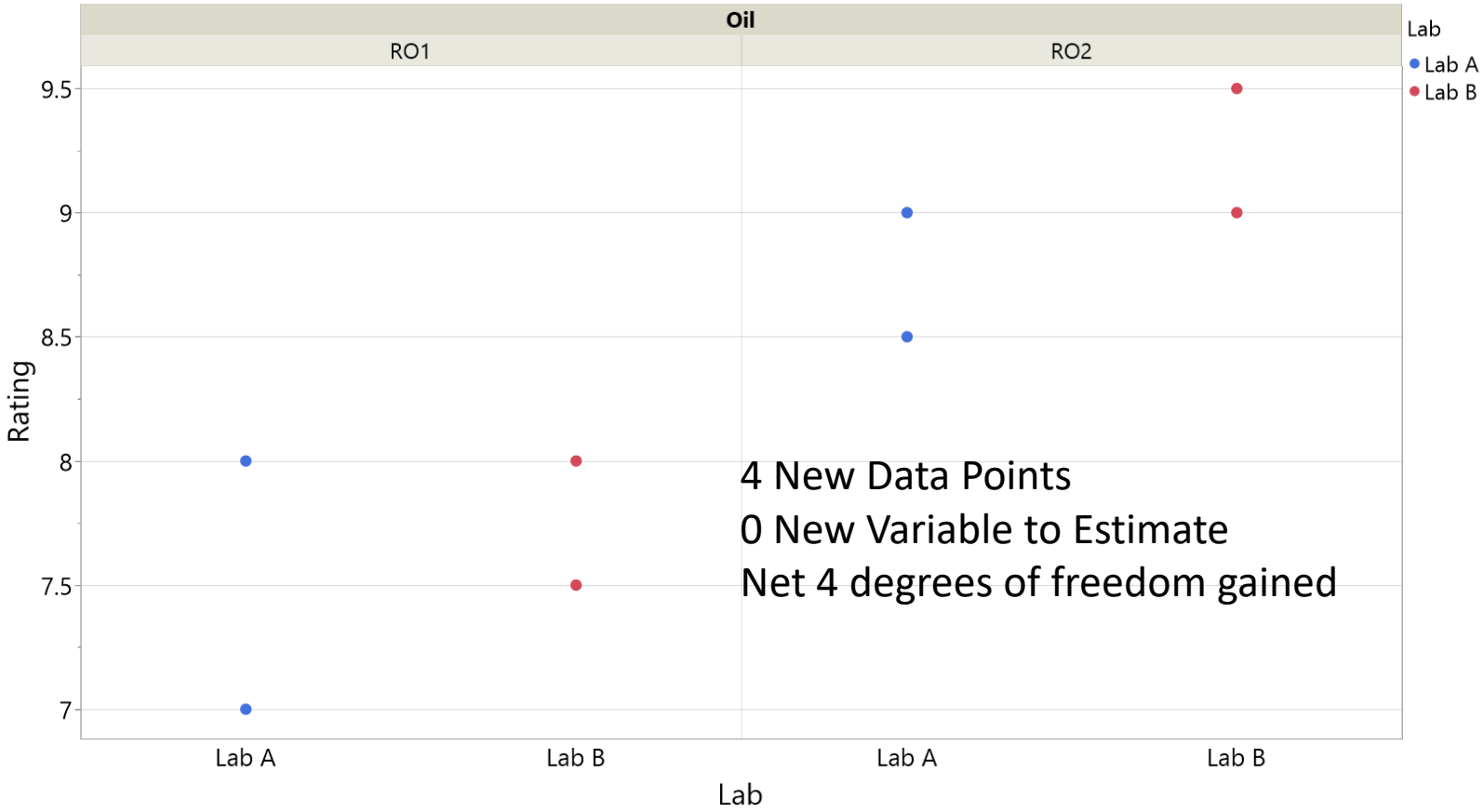
The Model is:

$$Rating = Intercept + (\beta_1 * RO2) + (\beta_2 * LabB)$$

There are four new data points and no new model variables, so all four points count as degrees of freedom.

Result:

5 total degrees of freedom



Main Idea: Our ability to estimate the repeatability of the test increases as the difference between total data points and # of variables increases.

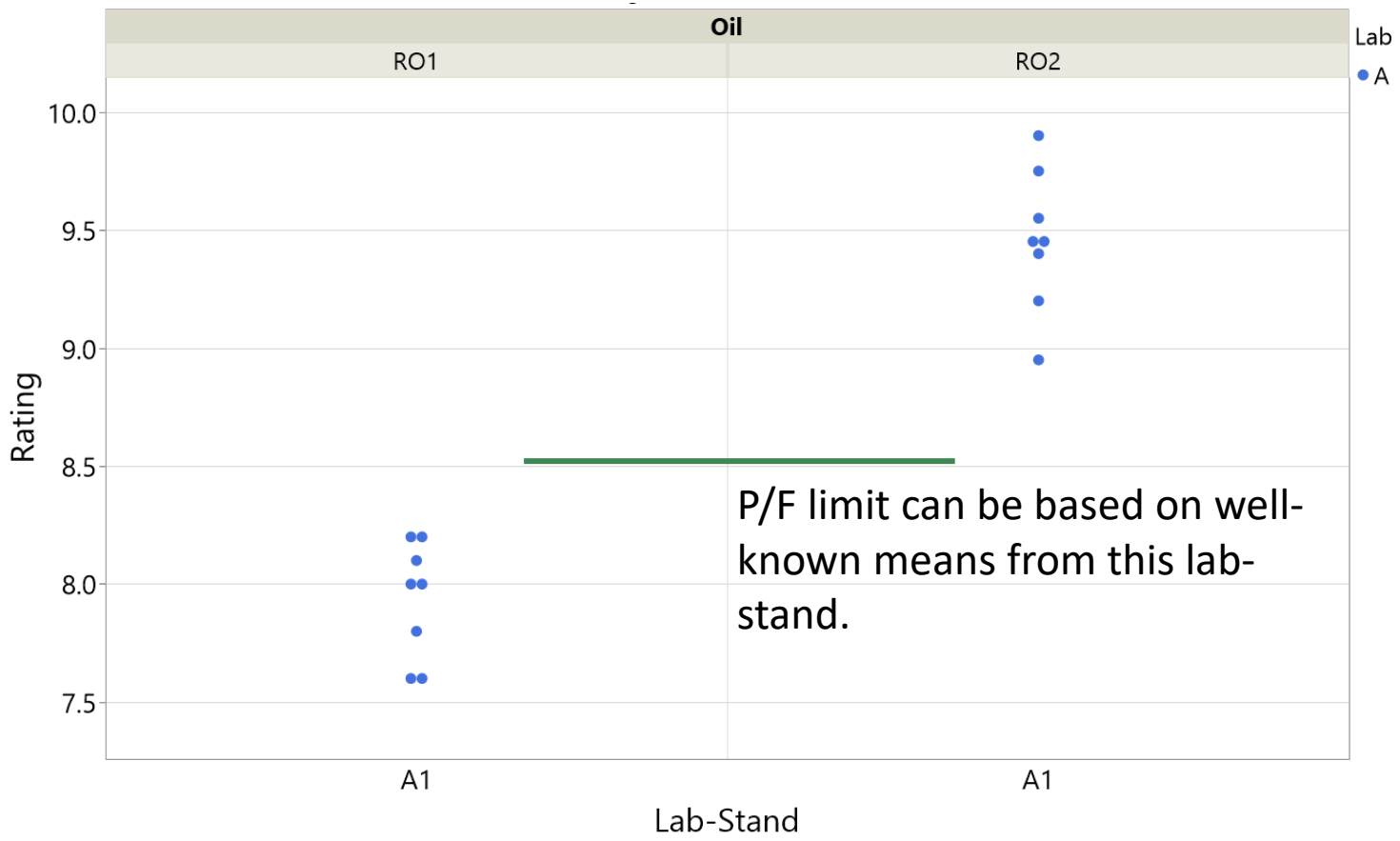
Question

Question:
If time wasn't a factor, would it then be better to run the whole precision matrix on a single lab-stand combination to minimize variables and maximize repeatability degrees of freedom?

Answer:
No, because we need additional lab and stands to estimate reproducibility.

Example

Let’s pretend only one lab is available for precision matrix testing, and the data shown in the plots was used to generate means, standard deviations and test pass/fail limits.



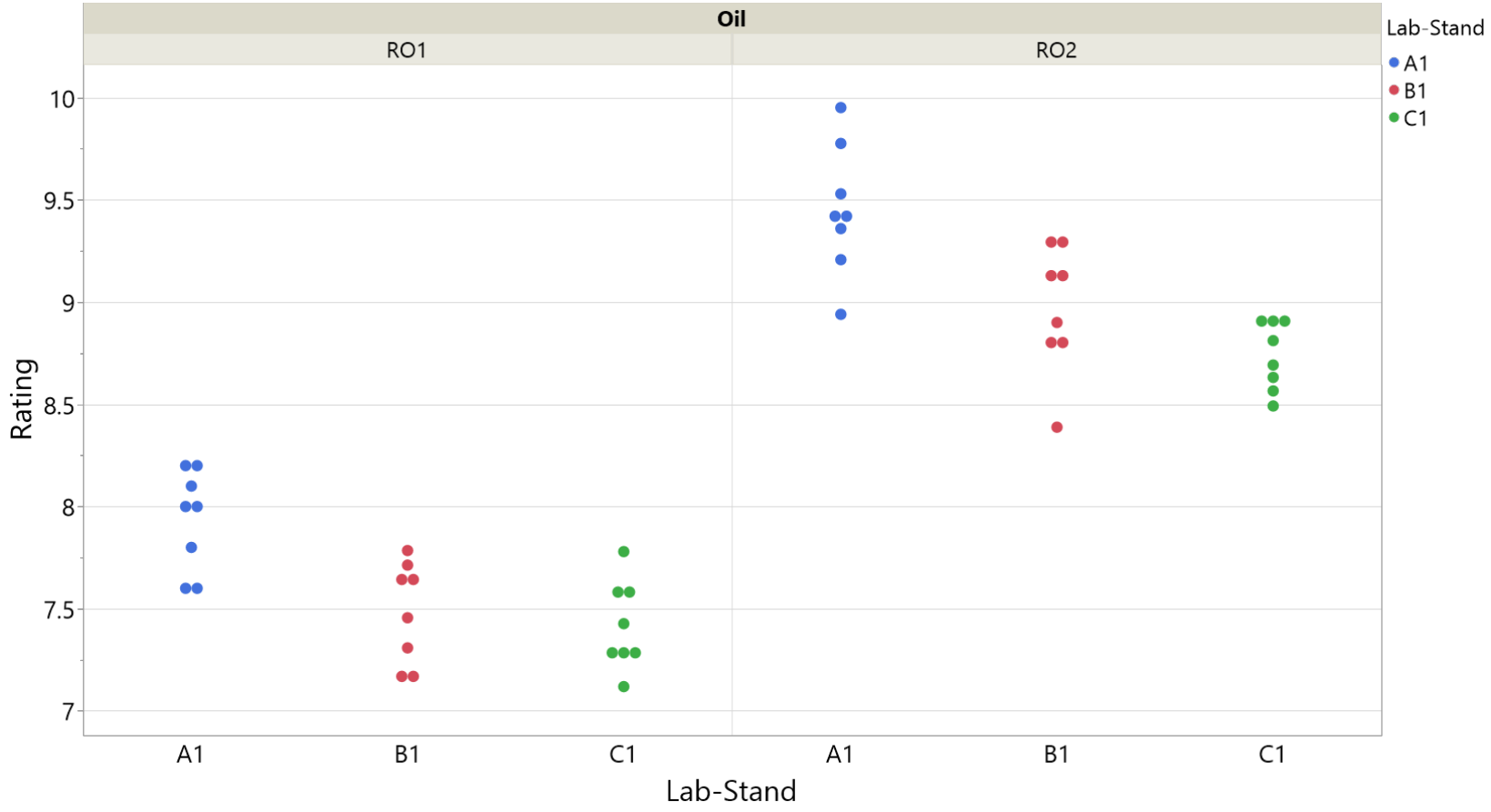
Example

Lab-stands entering the system post-precision matrix may not match the severity level of the precision matrix lab or labs.

Typical Responses:

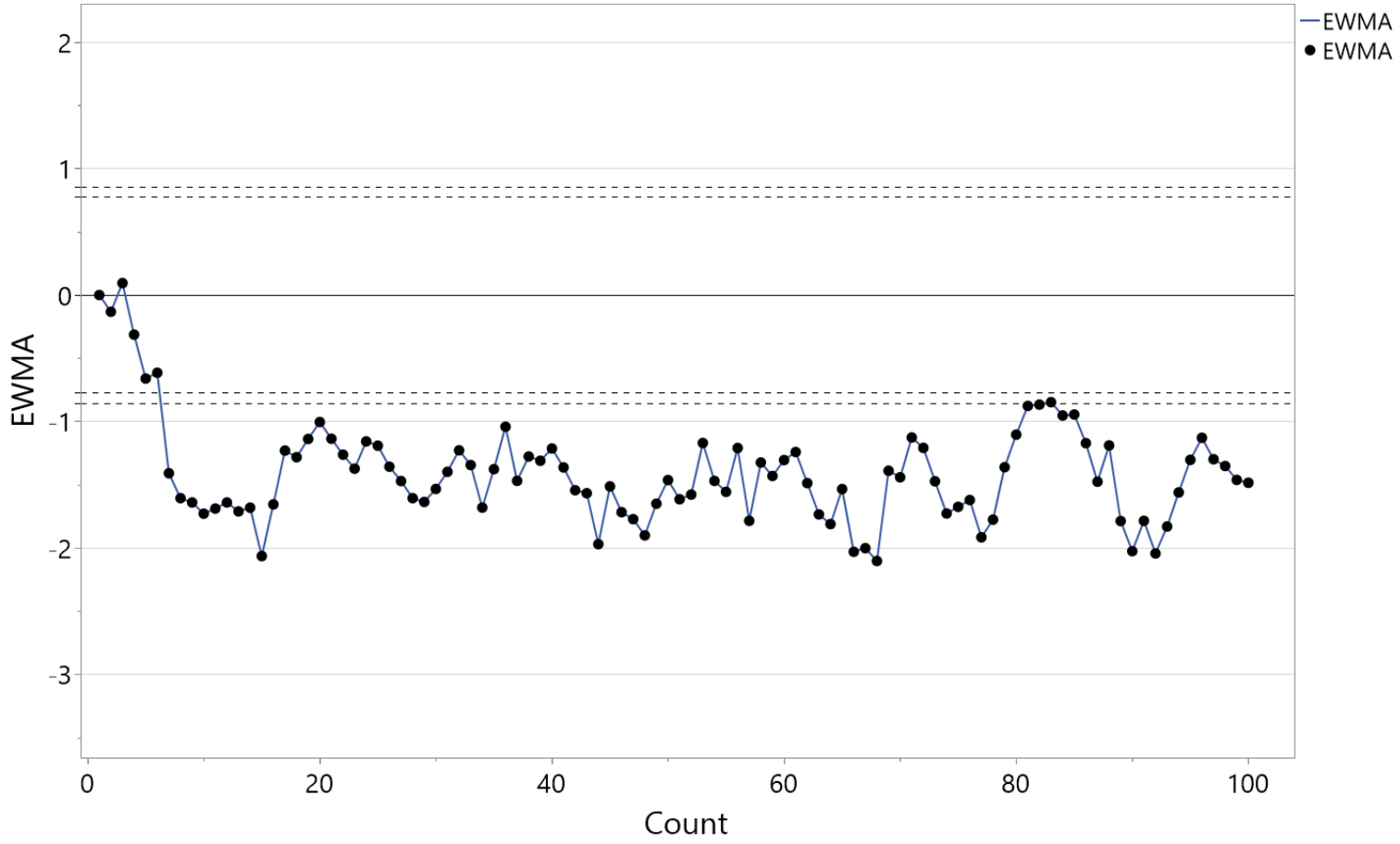
1) Labs will have to troubleshoot until the can move their severity to appropriate levels.
2) The labs should have participated in the precision matrix to have their data counted in target setting.

Result:
Confidence interval on LTMS RO means are smaller with less labs, but only apply to the lab(s) in the matrix. Non-participating labs may have trouble calibrating. Standard deviation of RO results will increase.



EWMA from Example

Assuming equal run frequency, the previous example would immediately be out of control and look something like the graph below.

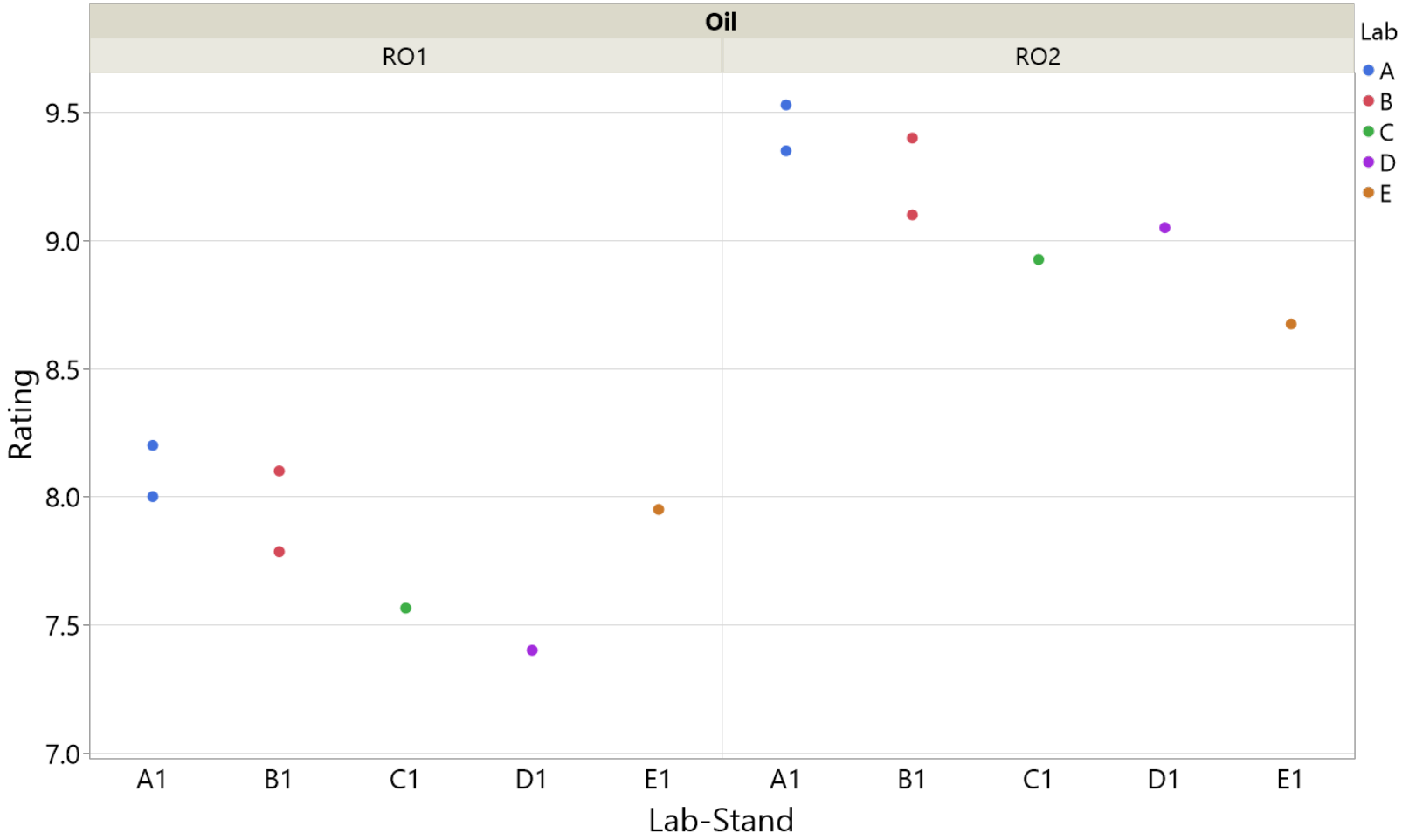


Another Example

Result:
RO Mean considers more labs, but the uncertainty of the means will be huge. The repeatability estimate will also be poor with a lack of repeatability degrees of freedom.

The example considers more labs but doesn't get many repeats at any of the combinations, so our test repeatability estimate could be very inaccurate.

Do we have concerning lab differences, or is it just variability of the test?

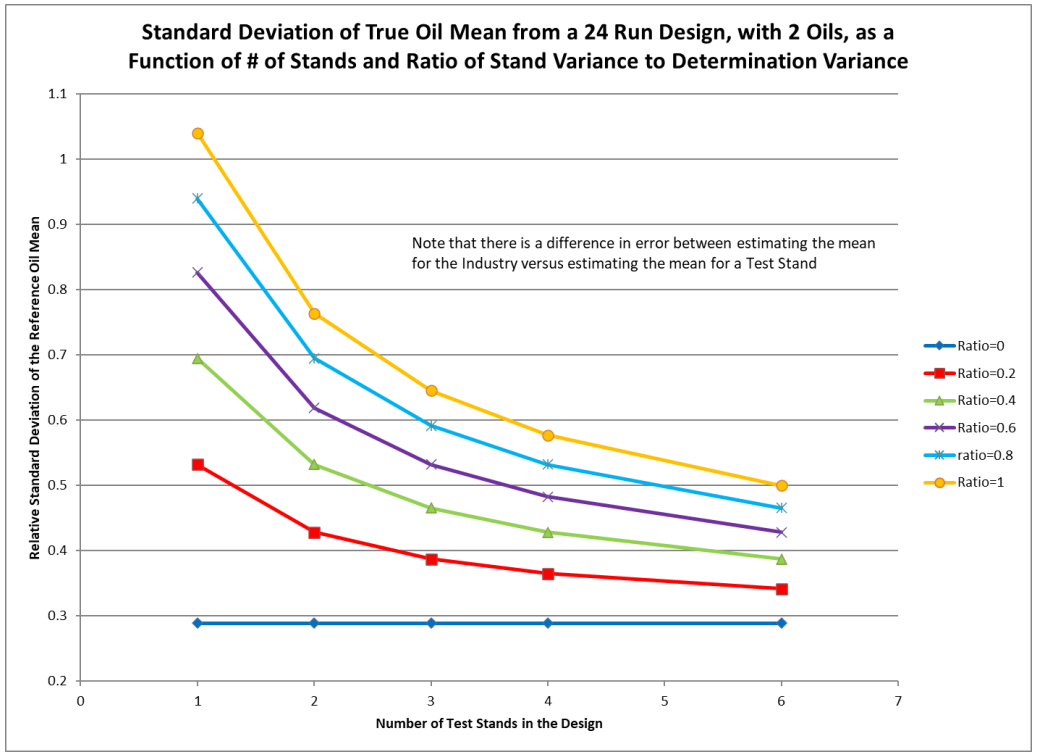


The Point

Choosing the right combination of labs, stands, and number of tests is a balancing act:

- Need as many labs and stands as possible to understand industry wide reproducibility and to ensure oil targets are representative of industry performance.
- Need as large of a difference as possible between data points and variables to increase repeatability degrees of freedom.
- Methods exists to find optimal combinations for precision matrix designs but may be limited by participants and resources. We should make better use of these methods and power calculations in the future, but again we will save that discussion for another day.

Balancing repeatability and reproducibility in PM Design based on stand-to-stand variability.



Setting Targets, Critical Question

When lab differences exists in the precision matrix, what do we do?

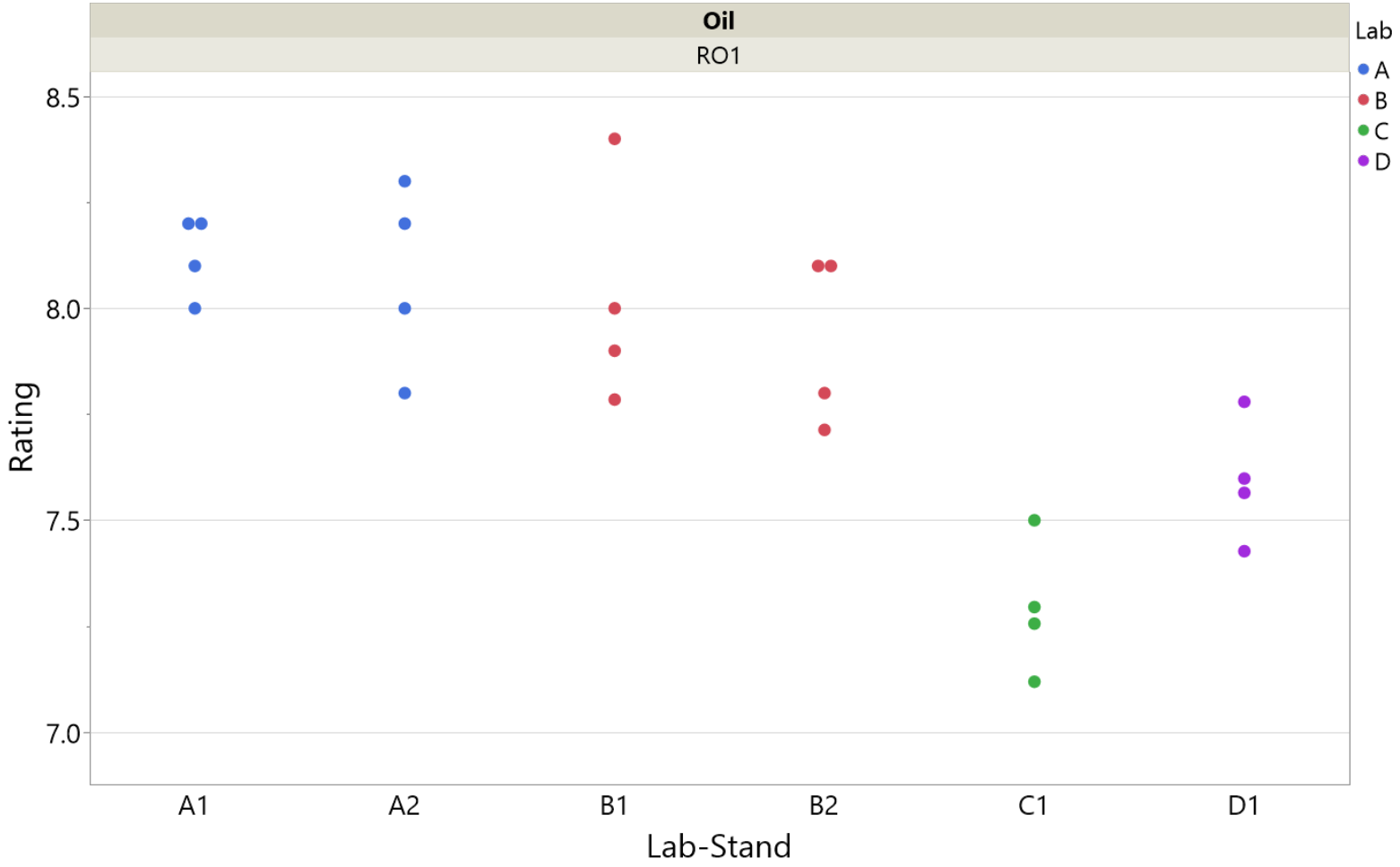
1. Accept differences as acceptable?
2. Reject data and use targets based on other labs data?
3. Down-weight data in target setting?

The way lab differences are treated in the precision matrix will inform expectations for control chart monitoring.

Discussion Point

- Hypothetical Data shown in the plot to the right.
- Lab A and Lab B ran twice as many data points on this oil.
- Labs C and D about 0.50-0.75 merits more severe.

Critical Question:
Where is the right place to set the mean for this reference oil?

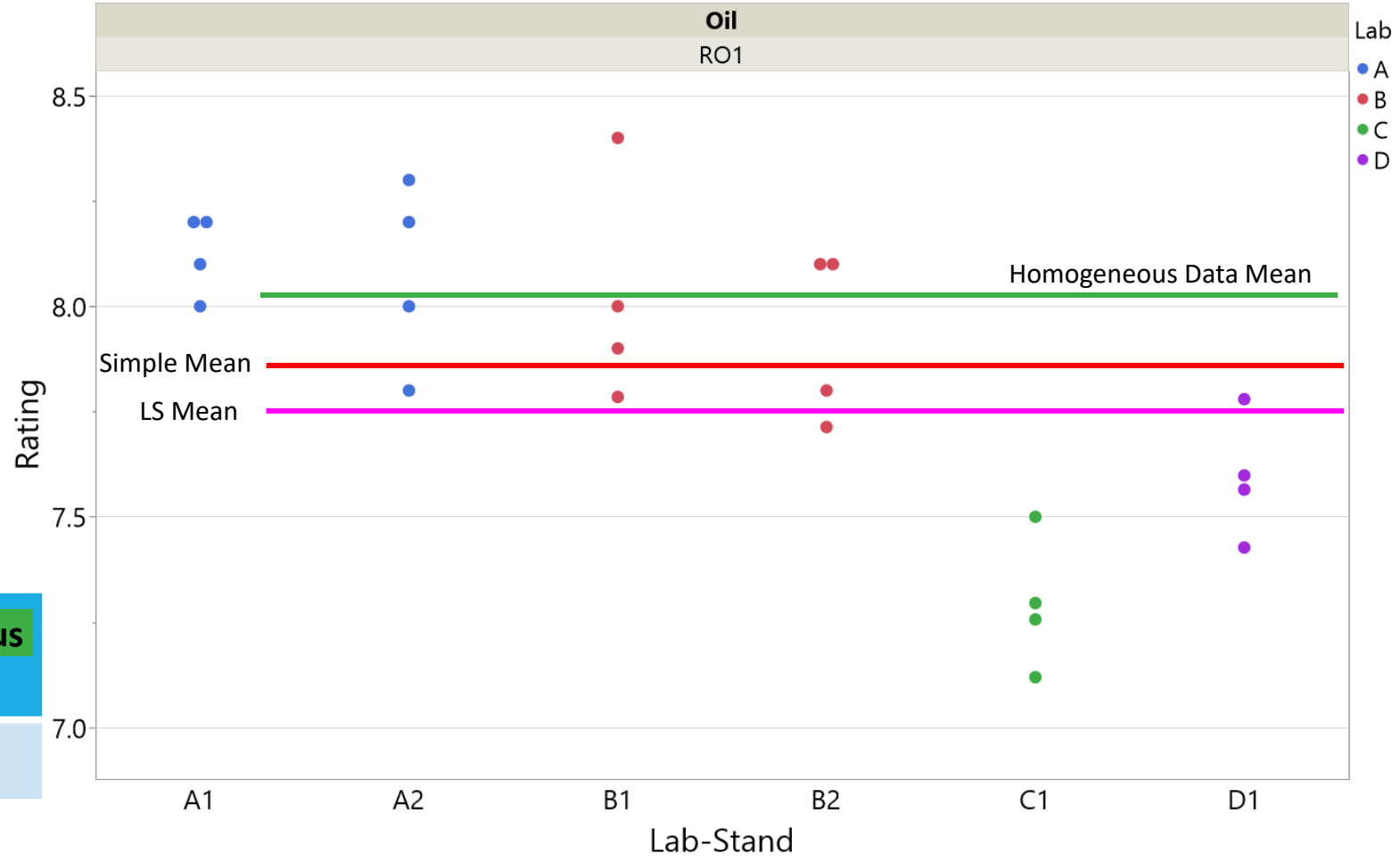


Options for Reference Oil Target Mean

The most traditional method used in the development of PC-11 and GF-6 engine oils testing was through model least squares (LS) means. The approach gives a mean as the average of lab averages (so here, 25% weight each lab). A simple mean would give Lab A (1/3) weight, Lab B (1/3), Labs C (1/6), and Lab D (1/6).

Oil	LS Mean	Simple Mean	Homogeneous Data Mean
RO1	7.74	7.84	8.04

*not an exhaustive list of options



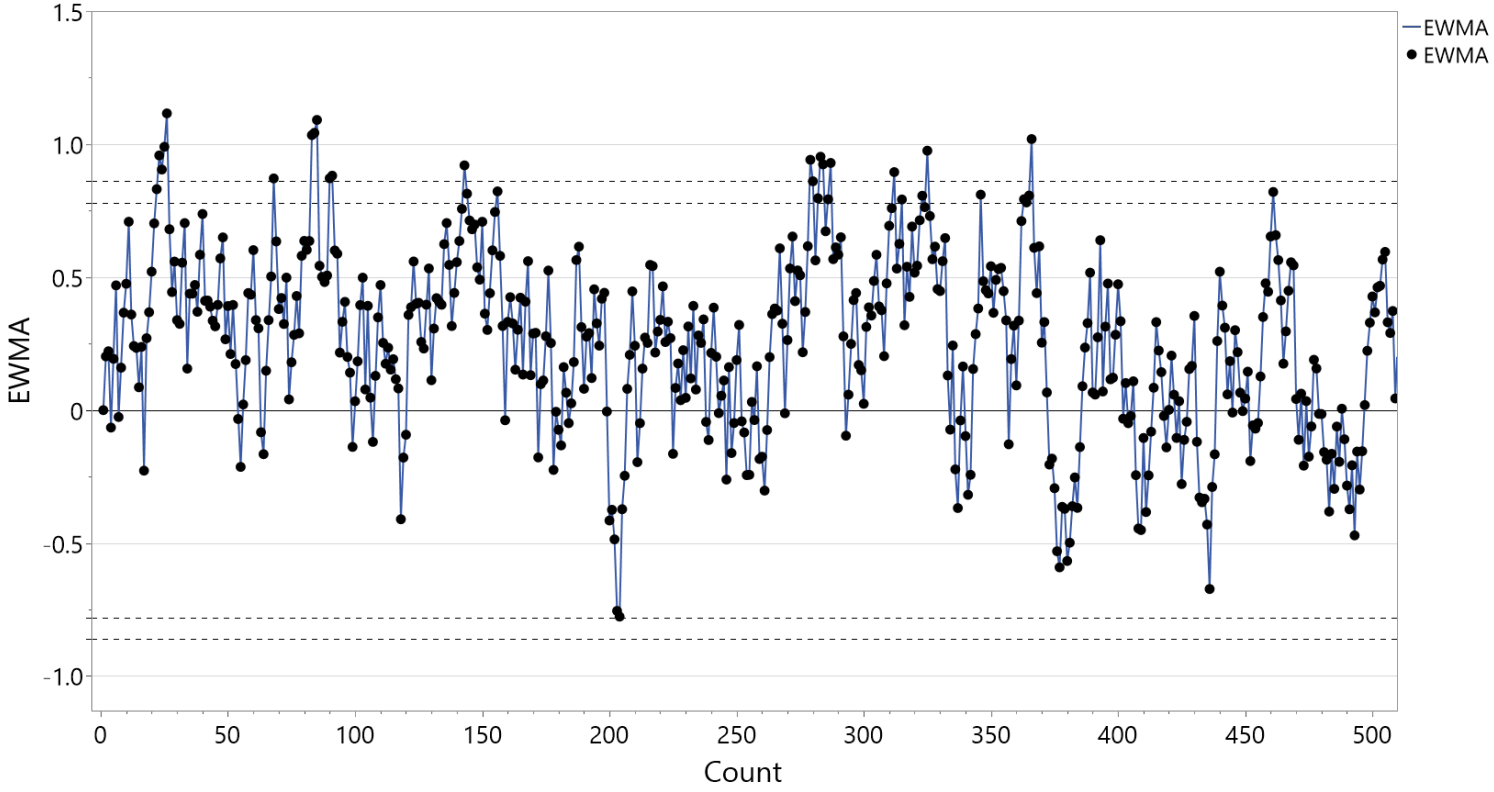
One Potential Problem with LS Means

The LS mean requires the assumption of equal run frequency among labs in order to remain "on-target."

If Labs A and B generate twice as much data as labs C and D, the test will be expected to be on average mild of target based on this PM data.

Lab	Prob. of Selection	Distribution
A	1/3	$Normal(8.10,0.16)$
B	1/3	$Normal(7.97,0.22)$
C	1/6	$Normal(7.29,0.16)$
D	1/6	$Normal(7.59,0.15)$

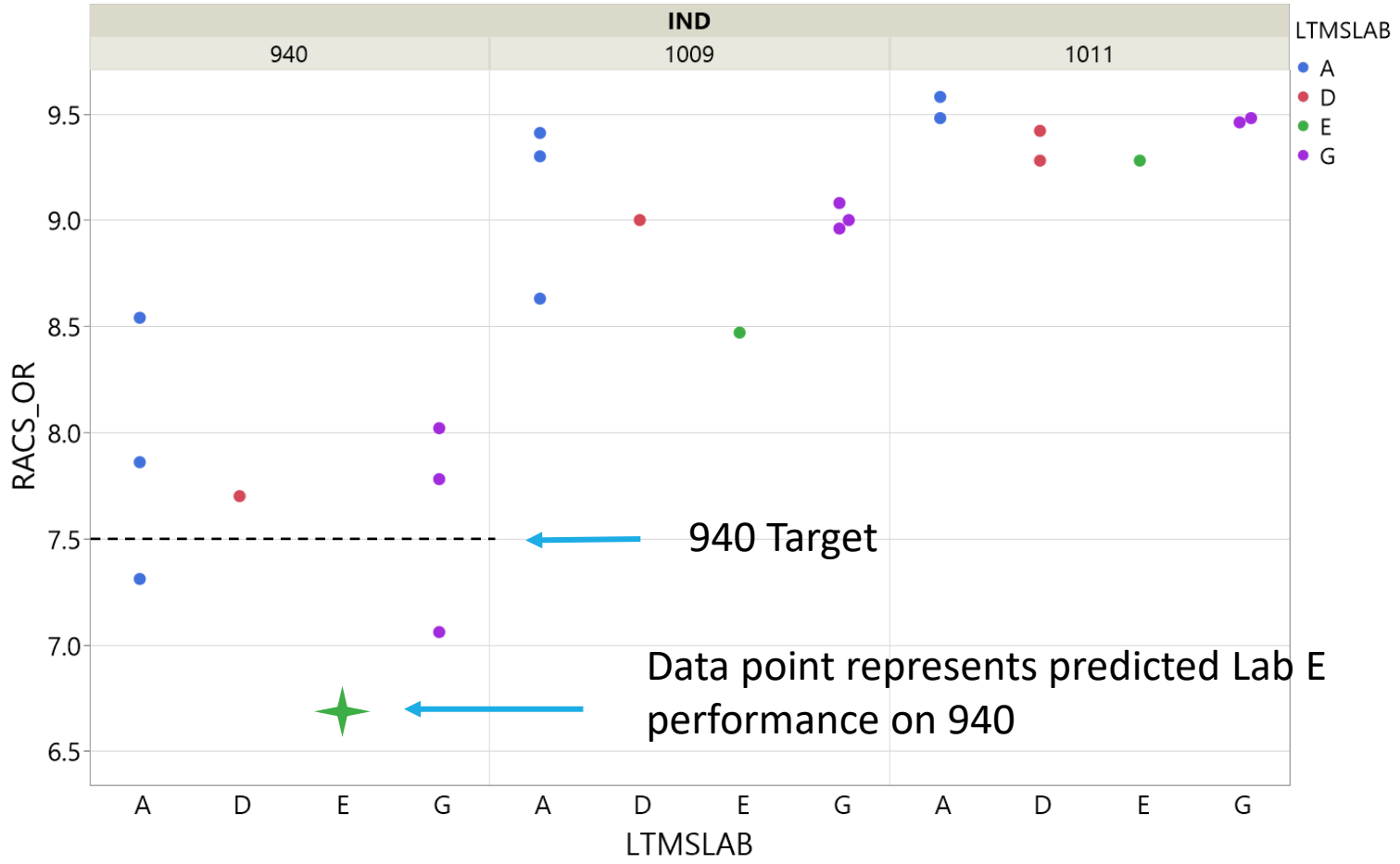
Data Simulation Based on LS Mean Target of 7.74 and simple std. dev of 0.34



The point:
Traditional control chart monitoring will center the charts using weights based on run frequency. More on this and other options later…

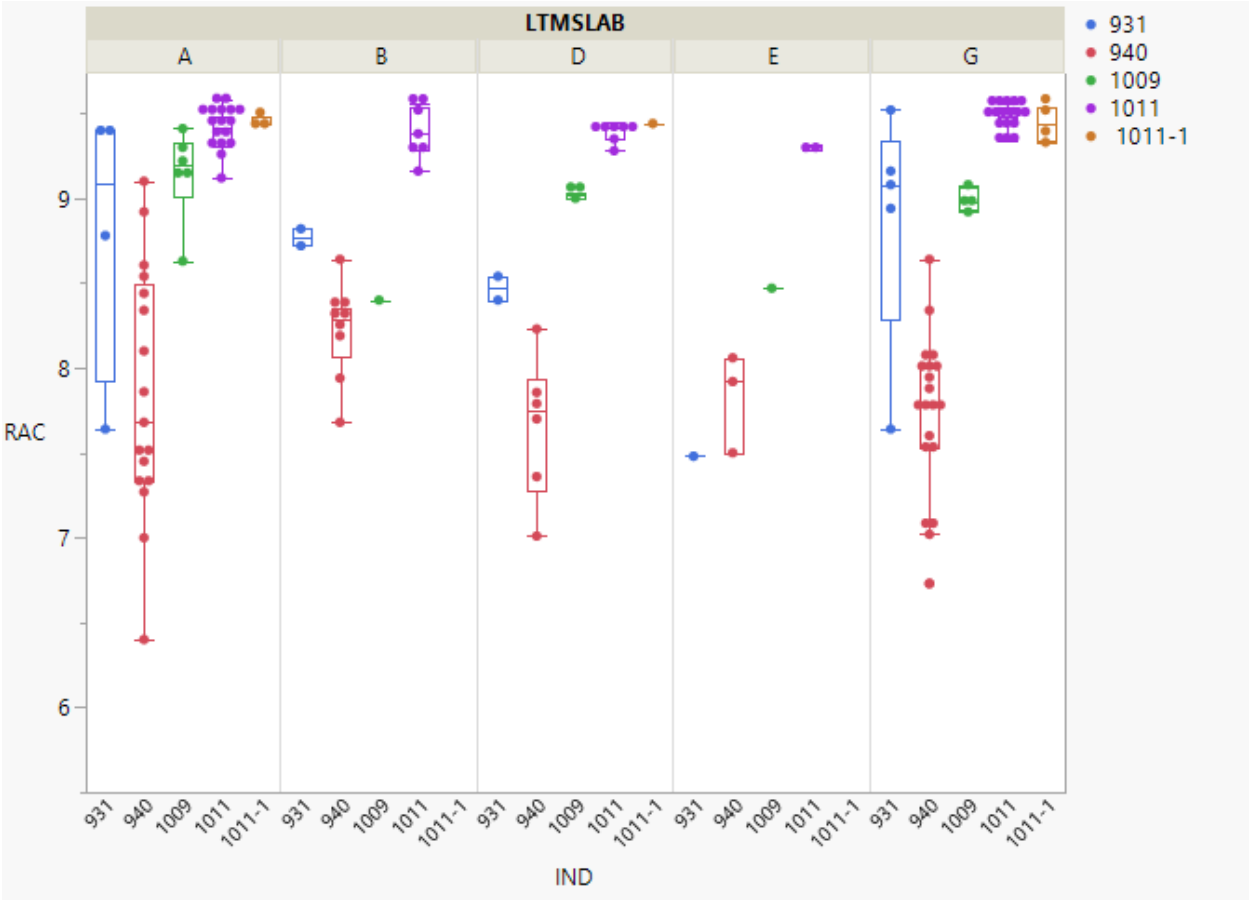
VH Rocker Cover Sludge

In the VH test, only two data points were considered valid from Lab E. Based on relative severity to other labs, an expected 940 performance could be predicted, and Lab E data still contributed 25% of the weight in reference oil target setting.



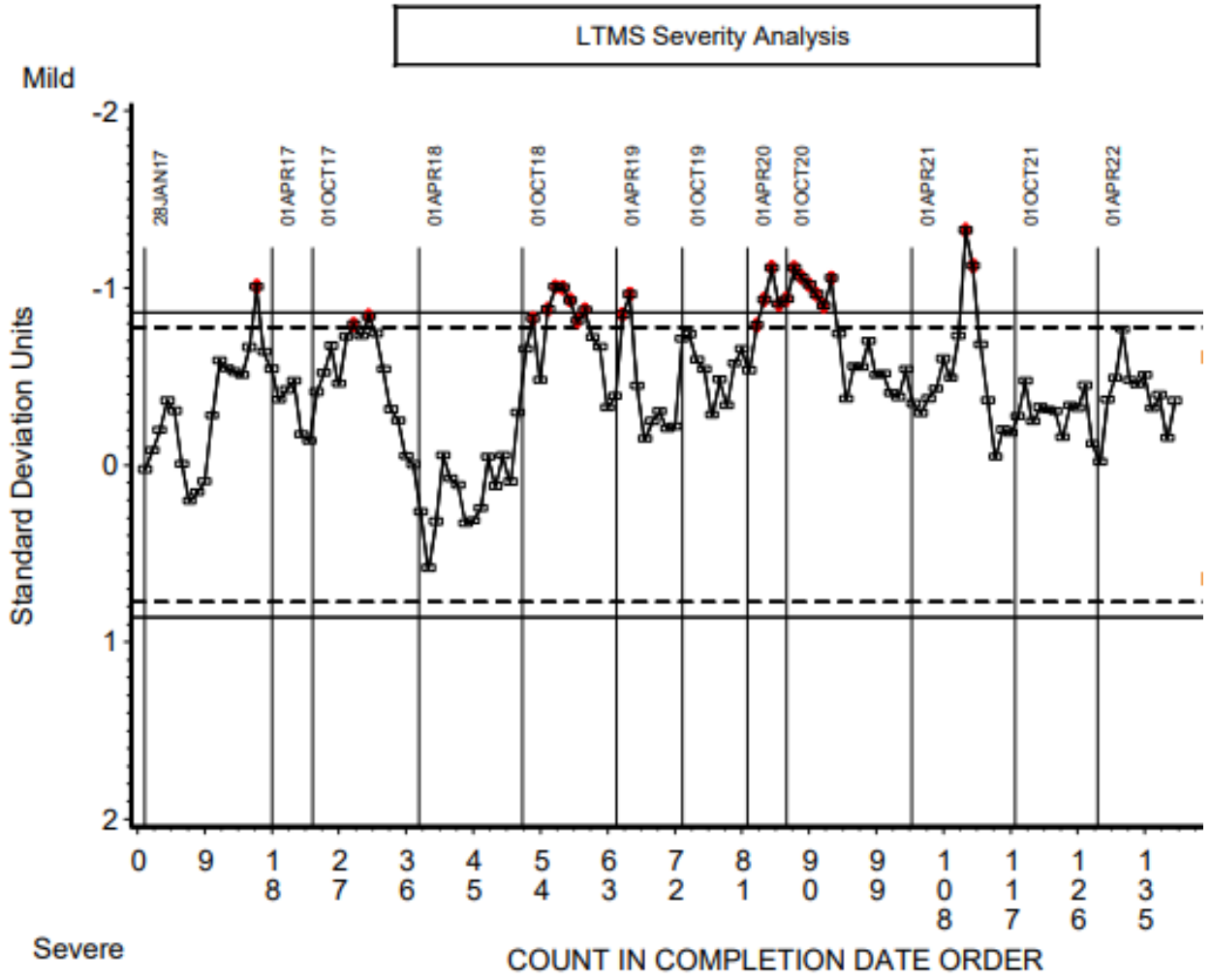
From VH Severity Task Force Slides

- Lab E's lowest 940 result is 7.50, substantially higher than the 6.67 projected via the Precision Matrix model.
- Lab E has the, or among the, lowest RAC for 931, 1009 and 1011 but is mid-range for 940. (Note, this does not appear to be a transformation issue because E's 931 is in the lower region of its 940 results.)
- The 2 lowest RACs are 6.40 (Lab A) and 6.73 (Lab G). The rest are 7.00 or higher.



VH RAC Severity EWMA

The mildness of the VH RAC is entirely expected based on the precision matrix target setting methodology and the lack of data following the matrix from Lab E.



So Where Do We Set Targets?

- There can be no “one-size” fits all approach to setting targets.
- The ideal situation is that all labs would have an equal amount of runs in the precision matrix, and no lab differences would exist.
- Labs often generate different amounts of data. Should labs with more data be given more weight? Does the answer depend on how much data each lab is expected to generate post-PM?
- When lab differences exist, the target setting methodology will play a key role in determining control chart expectations. How do we approach lab differences? What would we have done differently in the VH case when Lab E only had two acceptable runs?

Post-Precision Matrix Process Options for Discussion

Some Post PM Process Options for Discussion

- Update Reference Oil means and standard deviations after an additional “X” number of tests have been run post-precision matrix (i.e. 10, 20, 30).
- Adjust control chart methodology to match target setting methodology.
- Add additional granularity to monitoring, such as at the reference oil level and/or lab level to better understand severity details.

What about Updating Means and Standard Deviations?

Included in LTMS Appendix F (Gears) and Appendix G (LD and HD):

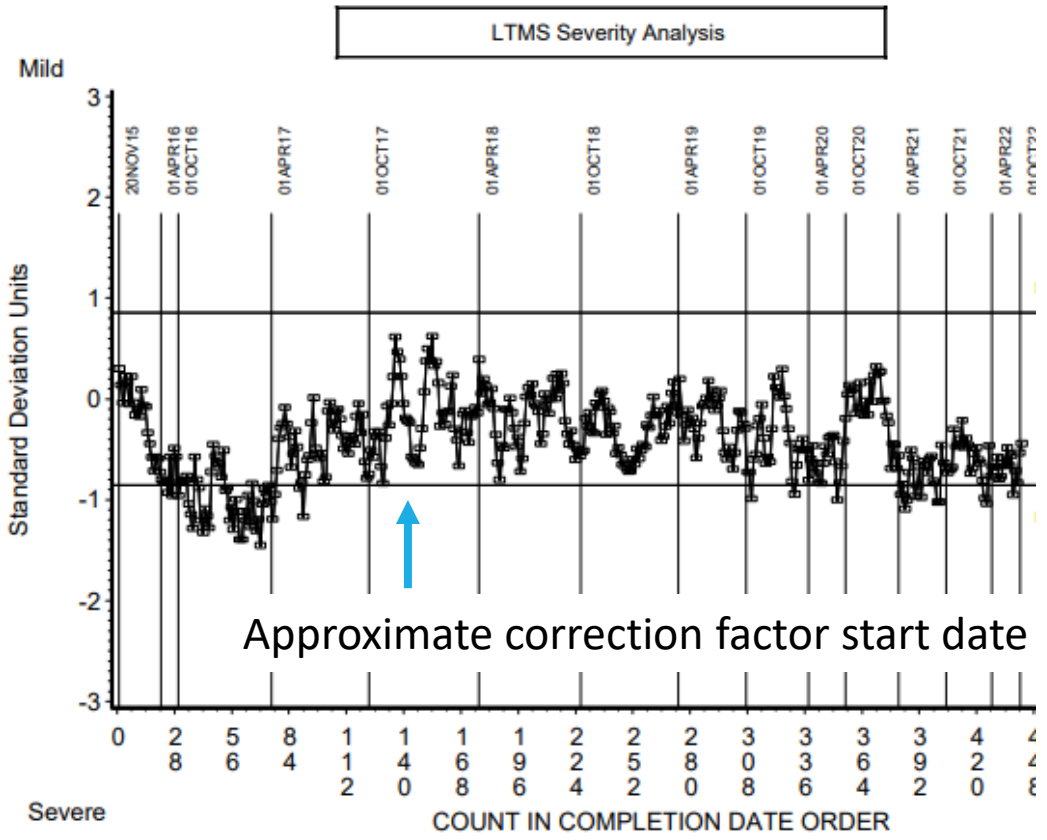
Reference Oil Target Updates

A surveillance panel has the discretion to update reference oil targets at any time. At a minimum, targets for each reference oil should be updated when 10, 20, and 30 tests have been completed. When laboratory bias exists, test results in the target data set should be severity adjusted prior to calculating targets.

An Example with the VIE FEI Data

- A total of 56 tests run for the VIE precision matrix, but only 29 were used in final target setting due to the decision to limit engine life to 4 runs.
- Precision matrix analysis completed summer of 2016.
- Test was severe right out of the gate.
- A task force was formed, but ultimately no root cause was discovered.
- In March 2018 a correction factor was put in place of +0.21 for FEI1 and +0.22 for FEI2.
- Correction was back-applied to previous 3 reference tests in order to catch up lagging Zi values.

FEI 2 shown here



An Example with the VIE FEI Data

- 10 additional tests obtained by 10/15/2016
- 20 additional tests obtained by 12/09/2016
- 30 additional tests obtained by 01/21/2017

Updated Targets Based on LS Means from the model FEI ~ Oil + Lab

FEI 1

Reference Oil	PM Target (n=29)	PM + 10 Target (n=39)	PM + 20 Target (n=49)	PM + 30 Target (n=59)	Target - Correction Factor
542-2	2.56 (9)	2.52 (12)	2.55 (16)	2.53 (19)	2.35
544	1.30 (9)	1.26 (12)	1.26 (14)	1.28 (19)	1.09
1010-1	1.90 (11)	1.86 (15)	1.84 (19)	1.84 (21)	1.69
Avg. Diff. from Target	n/a	-0.04	-0.04	-0.04	-0.21

FEI 2

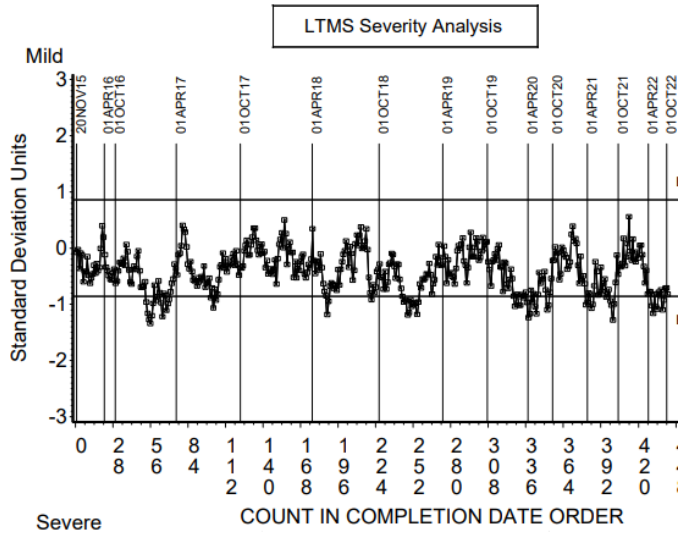
Reference Oil	PM Target (n=29)	PM + 10 Target (n=39)	PM + 20 Target (n=49)	PM + 30 Target (n=59)	Target - Correction Factor
542-2	1.73 (9)	1.61 (12)	1.67 (16)	1.68 (19)	1.52
544	1.41 (9)	1.45 (12)	1.41 (14)	1.43 (19)	1.20
1010-1	1.82 (11)	1.75 (15)	1.72 (19)	1.70 (21)	1.61
Avg. Diff. from Target	n/a	-0.05	-0.05	-0.05	-0.22

An Example with the VIE FEI Data

- 30 additional tests obtained by 01/21/2017
- Cleary this date range includes some of the severe data, especially for FEI2, so why has the target not changed?

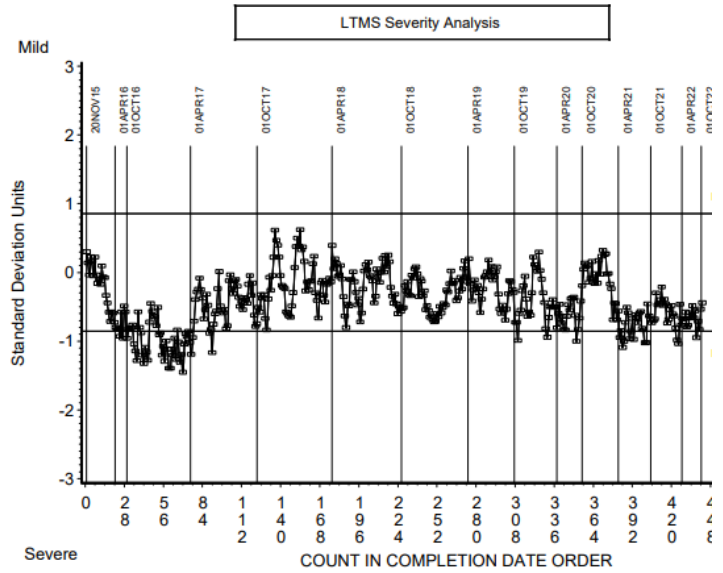
FEI 1

Reference Oil	PM Target (n=29)	PM + 30 Target (n=59)	Target - Correction Factor
542-2	2.56 (9)	2.53 (19)	2.35
544	1.30 (9)	1.28 (19)	1.09
1010-1	1.90 (11)	1.84 (21)	1.69
Avg. Diff. from Target	n/a	-0.04	-0.21



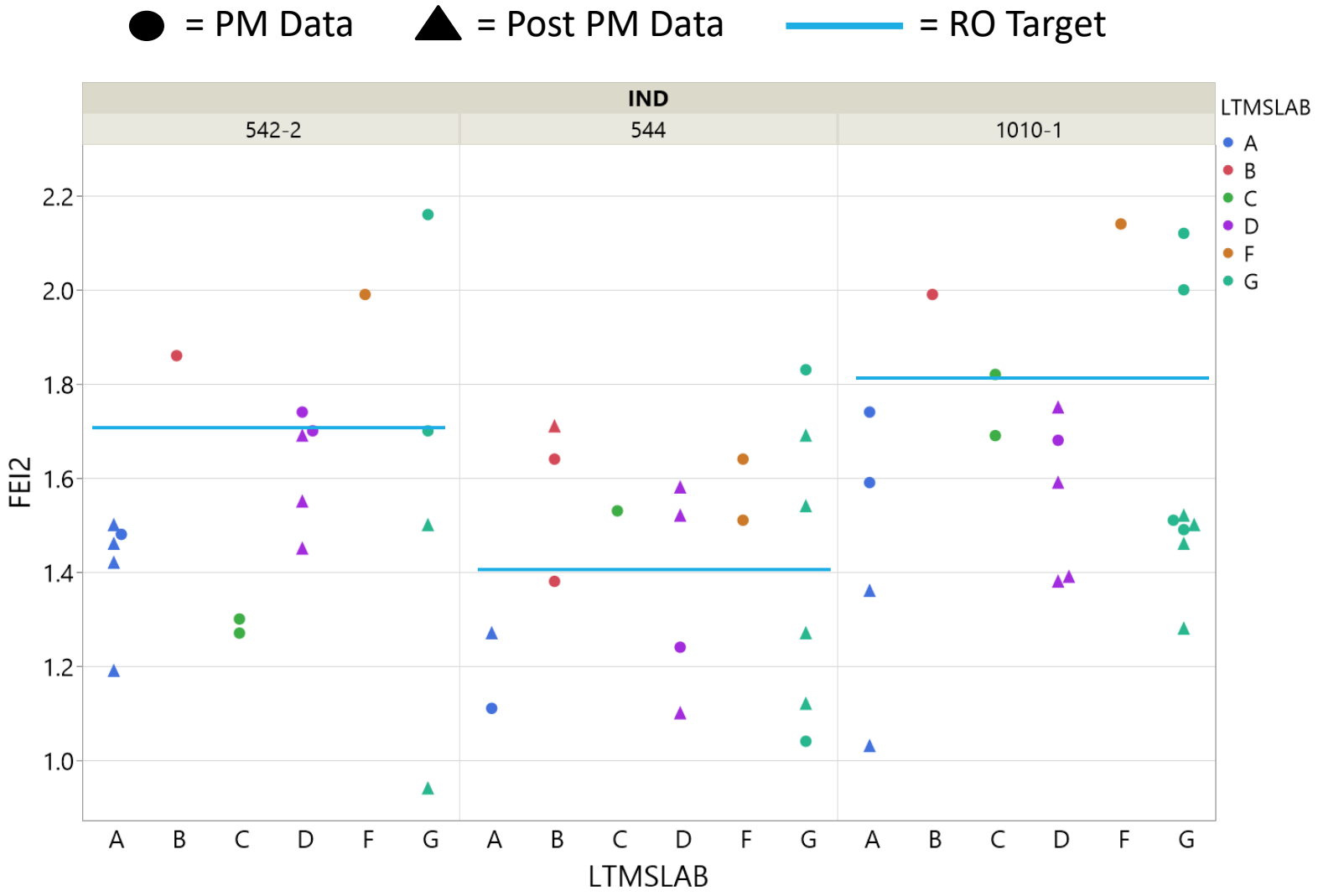
FEI 2

Reference Oil	PM Target (n=29)	PM + 30 Target (n=59)	Target - Correction Factor
542-2	1.73 (9)	1.68 (19)	1.52
544	1.41 (9)	1.43 (19)	1.20
1010-1	1.82 (11)	1.70 (21)	1.61
Avg. Diff. from Target	n/a	-0.05	-0.22



An Example with the VIE FEI Data

Labs B and F were two mild labs representing 33% of the target setting labs. These two labs only contributed a single data point post-precision matrix. Almost all post-PM data came from Lab G (close to target on average in PM), Lab D (slightly severe of target in PM), and Lab A (severe of target in PM).

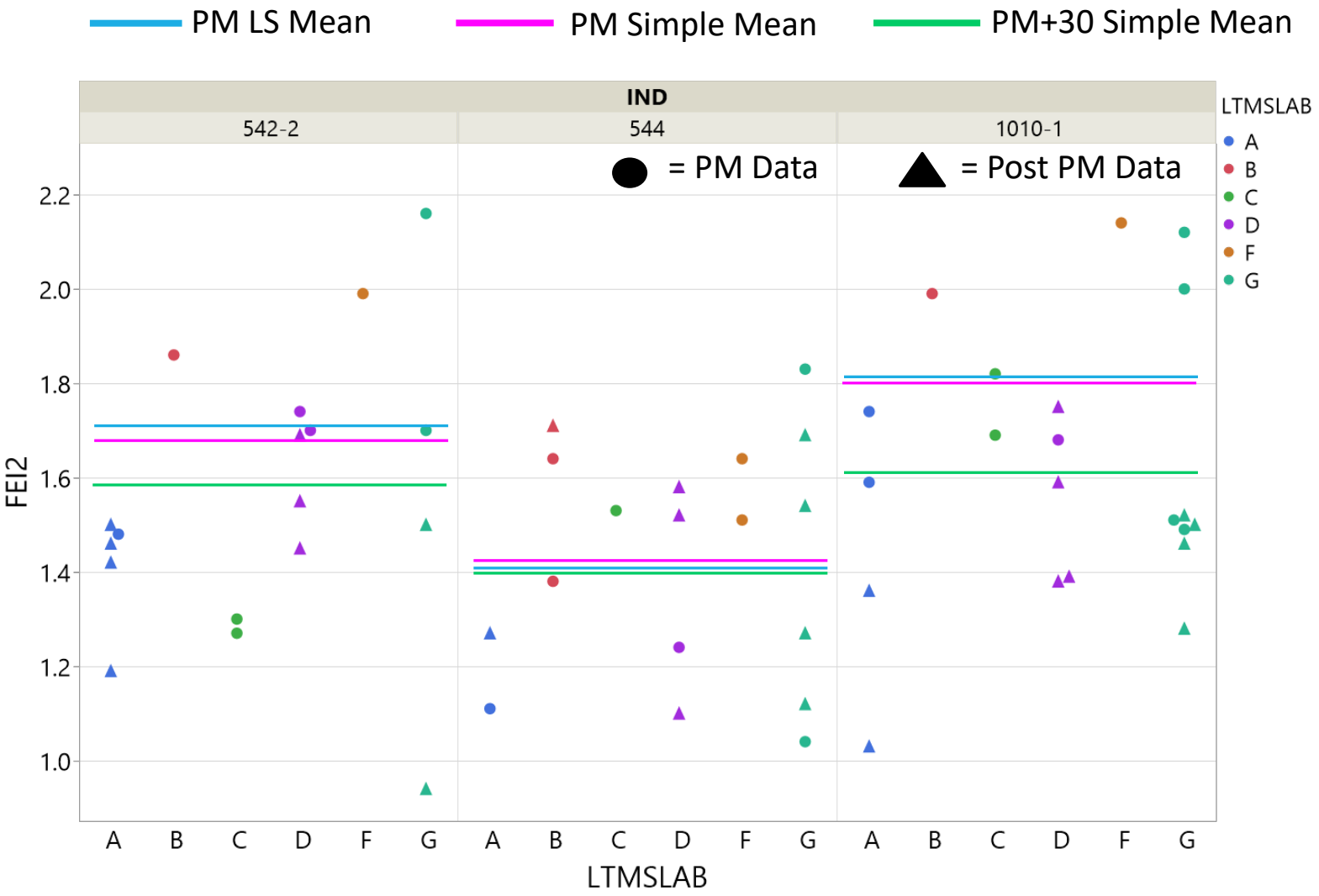


Using Simple Mean for Target Setting and Updating

Target Setting with Simple mean would have made little difference initially, would have observed about half the difference after 30 tests.

FEI 2

Reference Oil	LS Mean PM Target	Simple Mean PM Target (n=29)	PM + 30 Target (n=59)	Target - Correction Factor
542-2	1.73 (9)	1.69 (9)	1.59 (19)	1.52
544	1.41 (9)	1.44 (9)	1.40 (19)	1.20
1010-1	1.82 (11)	1.80 (11)	1.62 (21)	1.61
Avg. Diff. from Target	n/a	-0.01	-0.12	-0.22

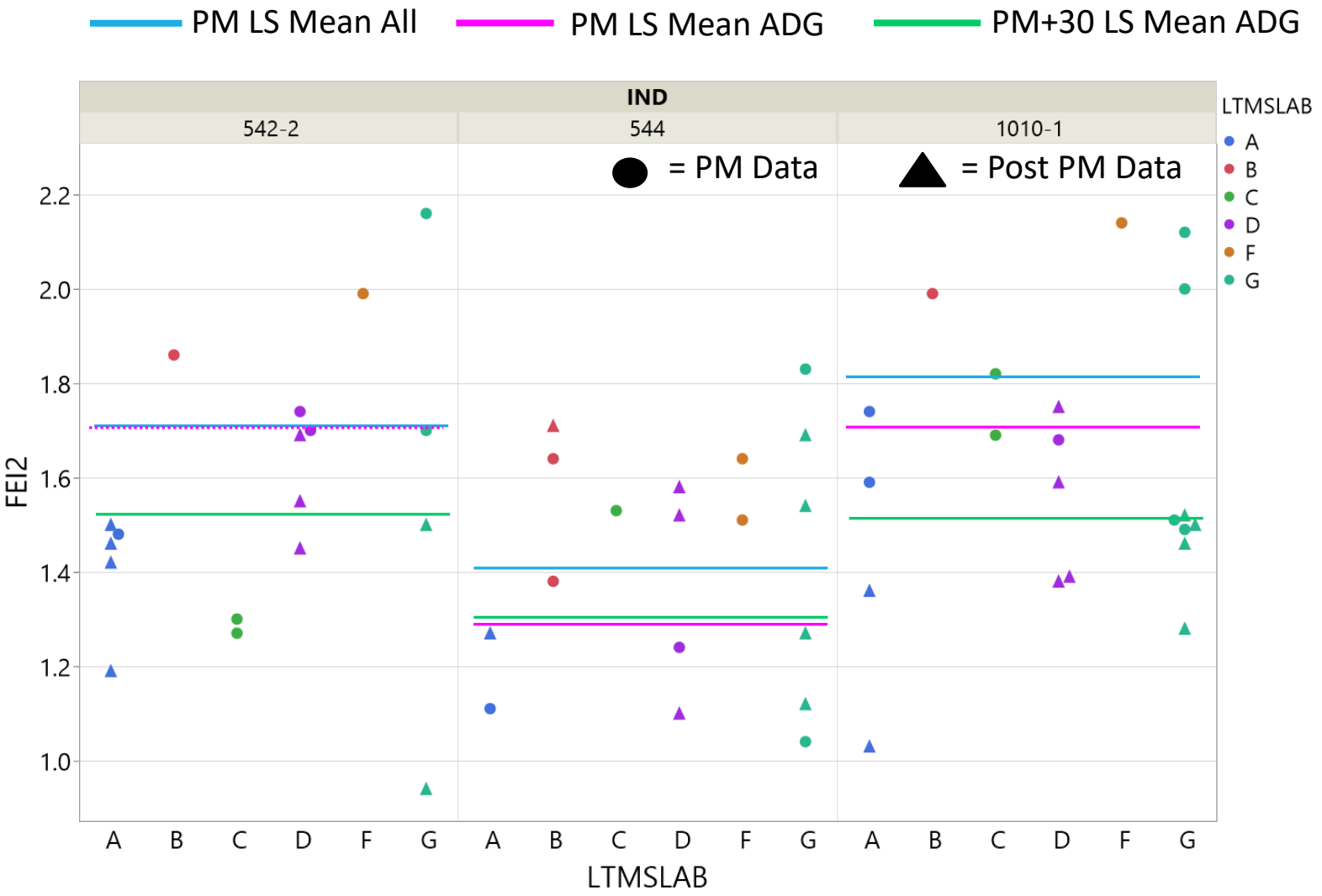


Using Labs A,D,G LS Mean for Target Setting and Updating

Target Setting based on averages of labs generating most of the data post PM would have been closer to center initially and similar to correction factor levels after the 30 tests.

FEI 2

Reference Oil	All Lab LS Mean PM Target	Lab ADG LS Mean PM Target (n=29)	Lab ADG LS Mean PM + 30 Target (n=59)	Target - Correction Factor
542-2	1.73 (9)	1.73 (9)	1.54 (19)	1.52
544	1.41 (9)	1.27 (9)	1.29 (19)	1.20
1010-1	1.82 (11)	1.69 (11)	1.53 (21)	1.61
Avg. Diff. from Target	n/a	-0.09	-0.20	-0.22

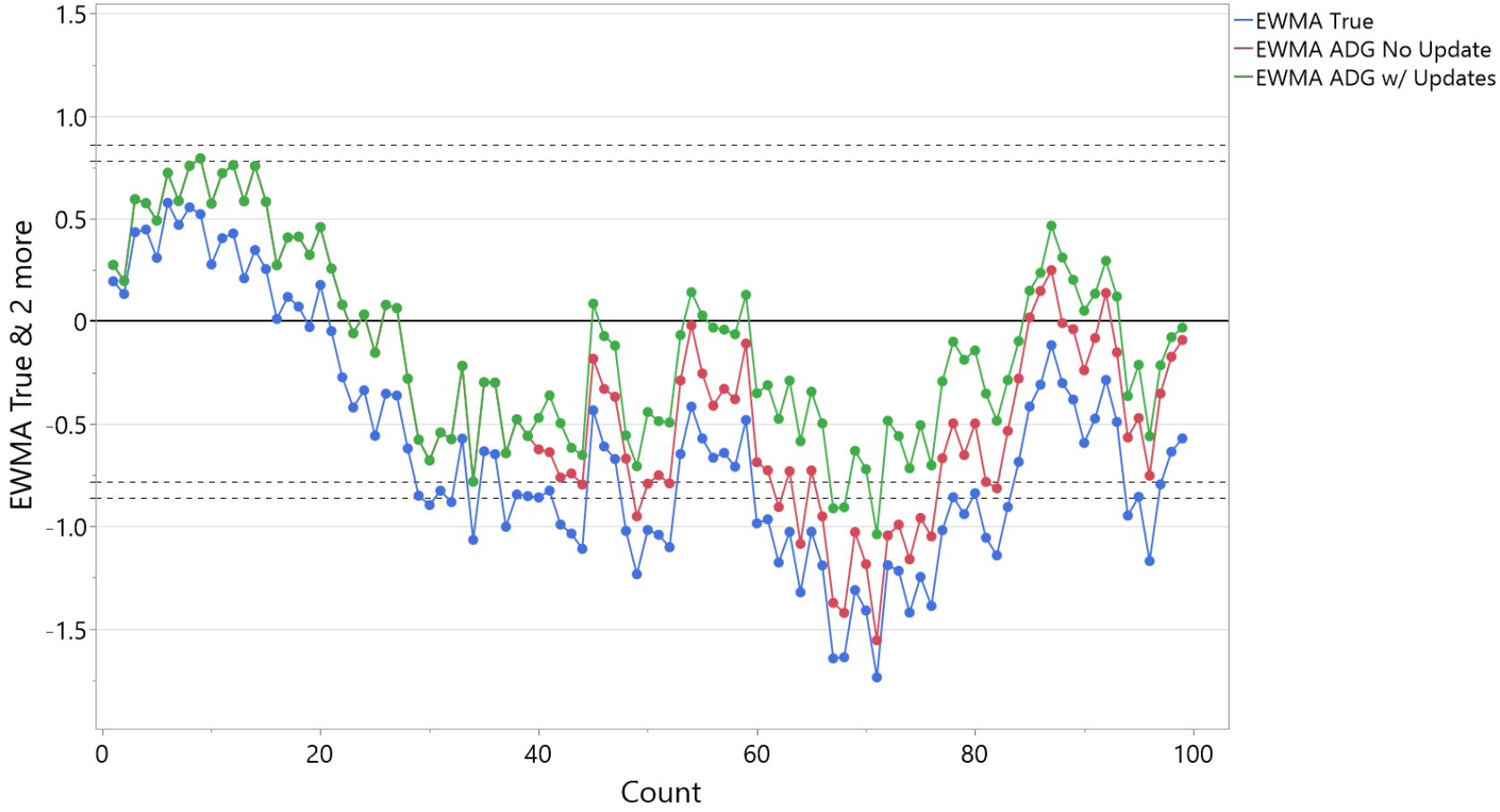


Using Labs A,D,G LS Mean for Target Setting and Updating

The control charts move closer to target with the use of target setting for labs who will subsequently run contribute data post precision matrix.

Test results were more severe after the precision matrix, so this approach would not have resolved the entire severity issue.

All labs included in these charts



Updating Targets Can Affect Candidate Pass/Fail Probability

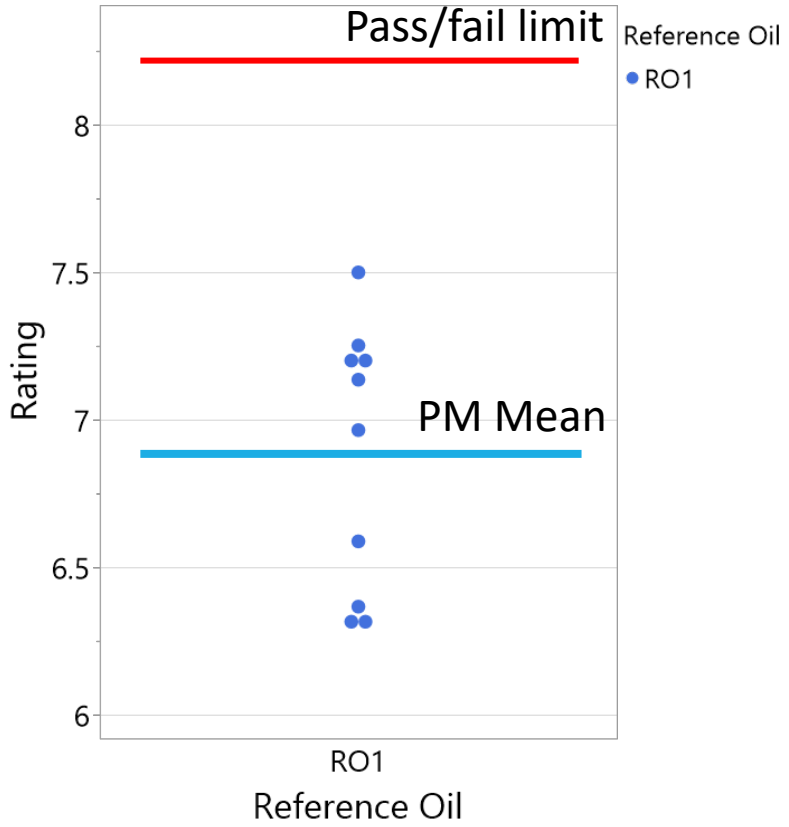
If a test is stable post-precision matrix, updating targets will result in better estimates. However, if a true change has taken place, updating targets with the change included can change candidate test pass/fail probability.

Consider the following hypothetical precision matrix data, which a pass/fail limit was determined from. Consider a candidate test right at the pass/fail limit (probability of pass = 50%).

RO Mean	RO Std. Dev.
6.88	0.45

Tolerance Intervals

Proportion	Lower TI	Upper TI	1-Alpha
0.950	5.37	8.40	0.950



Updating Target Can Affect Candidate Pass/Fail Probability

Severity Adjustments

For a hypothetical lab running 1 standard deviation severe, we would expect our candidate at 8.40 to get a 7.95 in the lab.

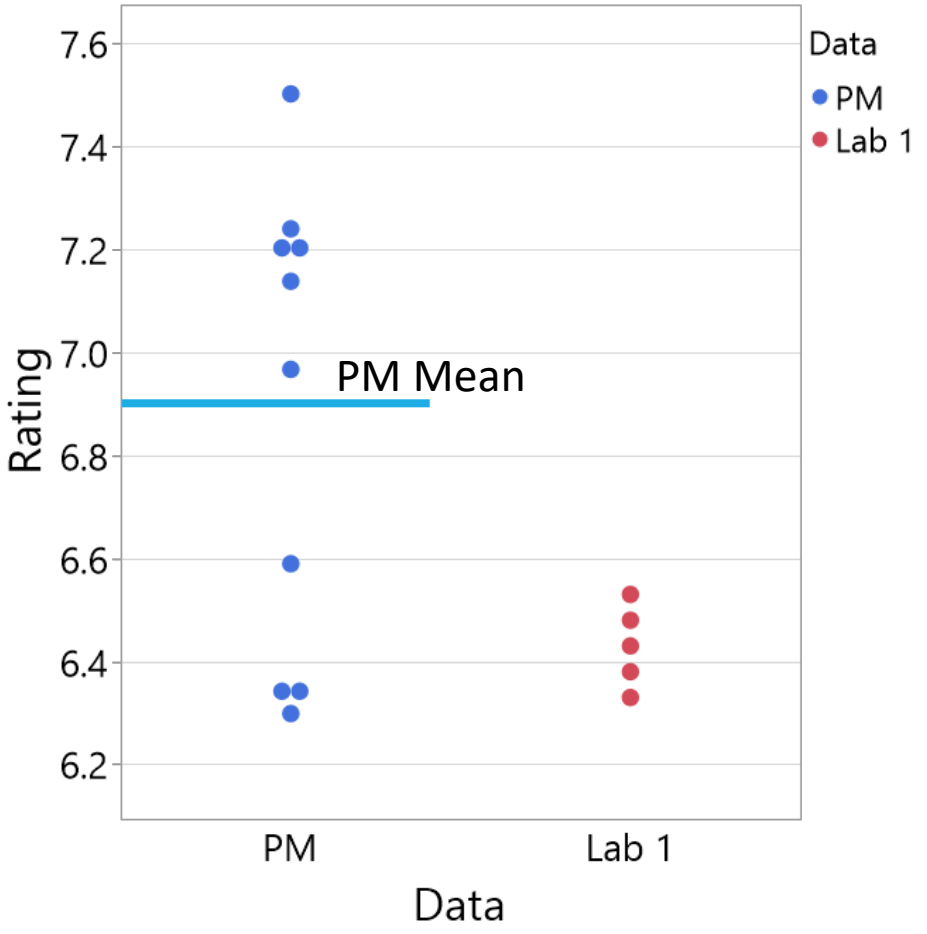
Severity adjustments would bring this result back up to an 8.40.

$$\begin{aligned} &Final\ Candidate\ Result \\ =&Result + Severity\ Adjustment \\ &= Result + (-Z_i * Std.Dev.) \\ &= 7.95 + 1.01 * .45 \\ &= 8.40 \end{aligned}$$

RO Mean	RO Std. Dev.
6.88	0.45

Result	Yi	Zi*
1	-1.00	-1.00
2	-0.78	-0.96
3	-1.22	-1.01
4	-0.89	-0.98
5	-1.11	-1.01

*fast start Zi for first 3



For a stable test, severity adjustments maintain the candidate probability of pass.

Updating Target Can Affect Candidate Pass/Fail Probability

Updating Targets

If true change in test has occurred, candidates should have moved by a similar amount. Updated targets would result in severity adjustments not capturing the full extent of the change, changing the probability of pass for the candidate.

PM Mean
6.88

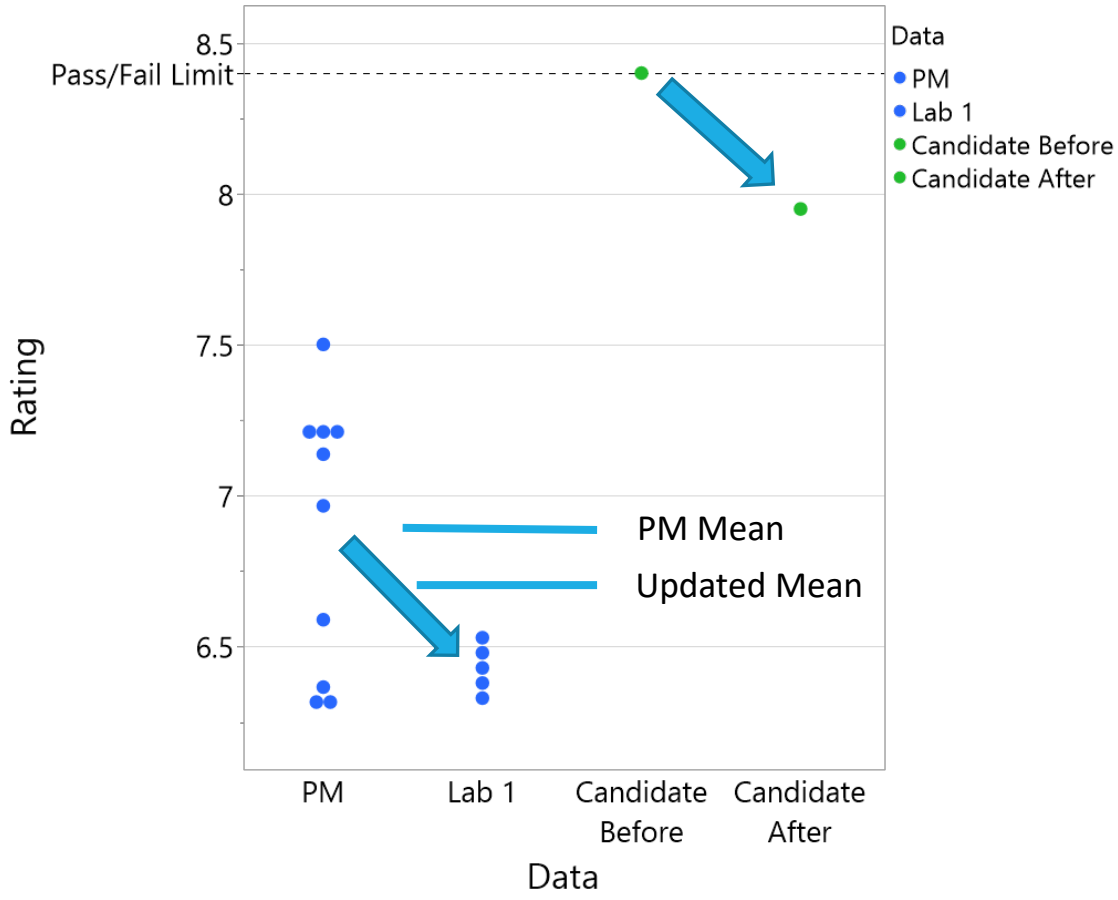
Result	Yi	Zi*
1	-1.00	-1.00
2	-0.78	-0.96
3	-1.22	-1.01
4	-0.89	-0.98
5	-1.11	-1.01

$$Final\ Candidate\ Result = Result + (-Z_i * Std.Dev.) = 7.95 + 1.01 * .45 = 8.40$$

Updated Mean
6.73

Result	Yi	Zi*
1	-0.71	-0.71
2	-0.48	-0.67
3	-0.95	-0.72
4	-0.60	-0.70
5	-0.83	-0.73

$$Final\ Candidate\ Result = Result + (-Z_i * Std.Dev.) = 7.95 + 0.73 * .45 = 8.28$$



*For simplicity, std. dev. of 0.45 used for both cases, as well as fast start Zi.

Updating Target Can Affect Candidate Pass/Fail Probability

Correction Factors

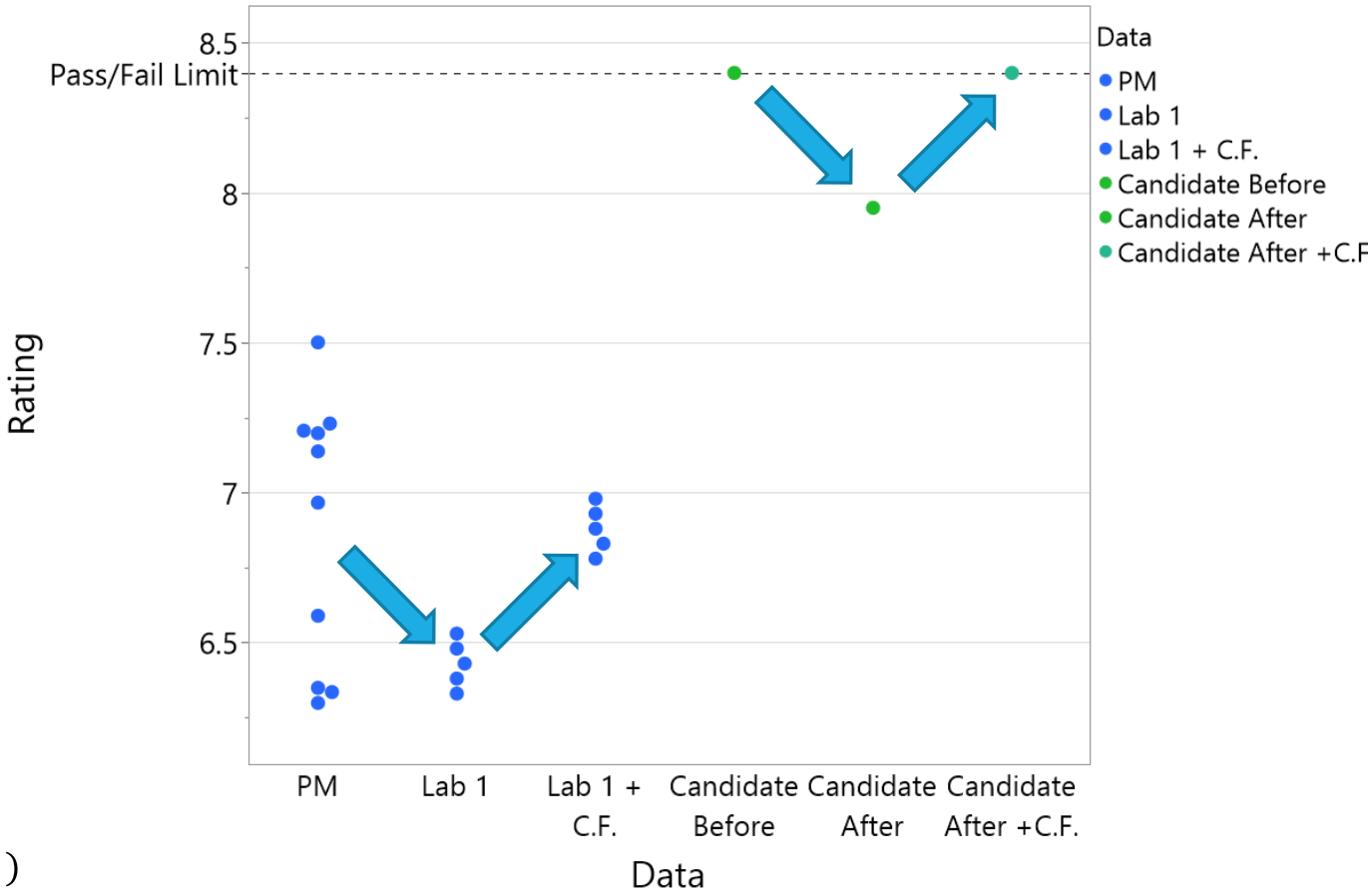
- Correction factors can bring a test back on target, and are not expected to change the probability of pass if the candidate result has moved similarly to the reference oil(s).

Result	Yi	Zi*
1	-1.00	-1.00
2	-0.78	-0.96
3	-1.22	-1.01
4	-0.89	-0.98
5	-1.11	-1.01

$$Final\ Candidate\ Result = Result + (-Z_i * Std.\ Dev.) = 7.95 + 1.01 * .45 = 8.40$$

Result	Yi (after C.F)	Zi*
1	0.00	0.00
2	0.22	0.04
3	-0.22	-0.01
4	0.11	0.02
5	-0.11	-0.01

$$Final\ Candidate\ Result = Result + C.F. + (-Z_i * Std.\ Dev.) = 7.95 + 0.45 + 0.01 * .45 = 8.40$$



Updating RO Means Short Summary

- Updating targets is generally avoided but can be acceptable if badly needed due to an insufficient data set in the precision matrix.
  - Update data should be collected in a short period of time.
  - It must be agreed that the test was stable for the entire time range of data used.

- Severity adjustments and corrections factors are generally preferable to updating RO means, and should not change candidate probability of pass (**assuming representative reference oil behavior**).

Lab/Stand Bias Target Update Headaches

- Updating targets and new Reference Oil (RO) introduction presents challenges
  - Test severity shifts that differ by RO and/or lab/stand, parts batch, fuel, etc.
  - Different mix of labs/stands than original Matrix
  - SAs lag and re-analysis of entire dataset may be required

- Tradeoffs in updating targets post-matrix
  - Pros
    - If the test has not changed over time, more data means a “better” estimate of the targets
    - Reduces bias introduced by small sample size from the matrix
    - Labs may have time to learn from each other and become more consistent
  - Cons
    - Over a “long enough” time period, the test will change
      - New labs/stands/engines, parts and fuel are introduced, as well as age effects on parts and fuel
      - Lab practices and raters will learn and improve, and may, become different
      - Seasonal effects
    - Updated targets that have been biased by real changes may effectively change the P/F limit

Lab/Stand Bias Target Update Ideas

- Establish Reference Oil (RO) targets using as many tests as possible from Matrix
  - Use Regression analysis to predict RO performance using Technology, Base Oil, Grade, Lab, Stand, etc.
    - Target a prediction variance of 0.3 or less for the RO MEAN
  - Run Matrix in the shortest time frame possible
    - Use same parts and fuel unless changes designed into the matrix to test robustness
  - At least 4 tests per Matrix Factor Level
  - Re-run Outliers identified from the Matrix
  - Select ROs that fit the chemical box in the limiting Viscosity Grade at the P/F limit
  - Resolve RO by Lab interactions before moving on from the Matrix
  - Identify the homogeneous dataset
- Take advantage of entire LTMS dataset when updating targets
  - Better to re-analyze since SAs lag and use of SAs in setting targets may be biased
  - Utilize reference and Matrix data from every lab/stand with at least 4 test results (that are not outliers) to estimate targets
    - Requires adding Technology and Base Oil codes for reference and Matrix oils in LTMS dataset
  - Use regression analysis considering all possible covariates (lab, stand, engine, test parts and fuel, run order, time, etc.).
  - Identify the homogeneous dataset

Updating targets for a RO re-blend

- Reference oils should be blended to last the life of the test for the category
- But if needed, to introduce a re-blend, enough data should be examined and analyzed to determine if the mean performance of the oil has changed. (A change in the mean performance of the oil is DIFFERENT from a change in the engine test reflected in the oil performance.) Determination of a change in performance is made through statistical analyses considering all possible covariates.
- If the oil performance has changed, then the oil re-blend may be attempted a second time, or the oil may be assigned a different designation with new targets

Example: IIIH

Updated 434-3 PVIS targets in 2018

Sequence IIIH Reference Oil Targets									
		Effective Dates		Average Piston Varnish		Percent Viscosity Increase		Weighted Piston Deposits	
Oil	n	From[1]	To[2]	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s
434-2[3]	10	07-01-15	10-10-18	9.16	0.34	4.7191	0.4310	4.16	0.70
434-2[4]	46	10-11-18	***	9.16	0.381	4.7191	0.4310	4.16	0.70
434-3[4]	46	07-01-15	11-12-18	9.16	0.381	4.7191	0.4310	4.16	0.70
434-3[5]	11	11-13-18	***	9.16	0.381	5.7602	0.6598	4.16	0.70
436[3]	9	07-01-15	10-10-18	9.71	0.10	3.3289	0.3138	4.63	0.28
436[4]	61	10-11-18	***	9.71	0.124	3.3289	0.3138	4.63	0.28
438-1[3]	9	07-01-15	10-10-18	9.39	0.31	3.9754	0.9558	3.66	0.43
438-1[4]	61	10-11-18	***	9.39	0.276	3.9754	0.9558	3.66	0.43

1 Effective for all tests completed on or after this date
2 *** = Currently in effect
3 Targets based on precision matrix analysis
4 Targets based on all data reported for APV standard deviation only
5 Targets updated for Percent Viscosity Increase only

RO Re-blend Ideas

- If a new re-blend is truly different, failure to update with a new target will affect pass/fail probability, because the reference material has changed, not the test, and therefore, not the candidates.

- If a Re-blend is determined to different, enough data should be collected to determine the new mean.

- Often times re-blends are brought in on level 2 ei limits. Smaller differences may still go unnoticed in these cases. Monitoring of test severity by reference oil may help to identify a problem sooner (more on this later).

Updating Standard Deviations

It is generally agreed that updating standard deviations should be done. Variability is highly likely to change over the course of a test, and proper estimates are key to ensure proper severity adjustment standard deviations and proper calibration limits for labs.

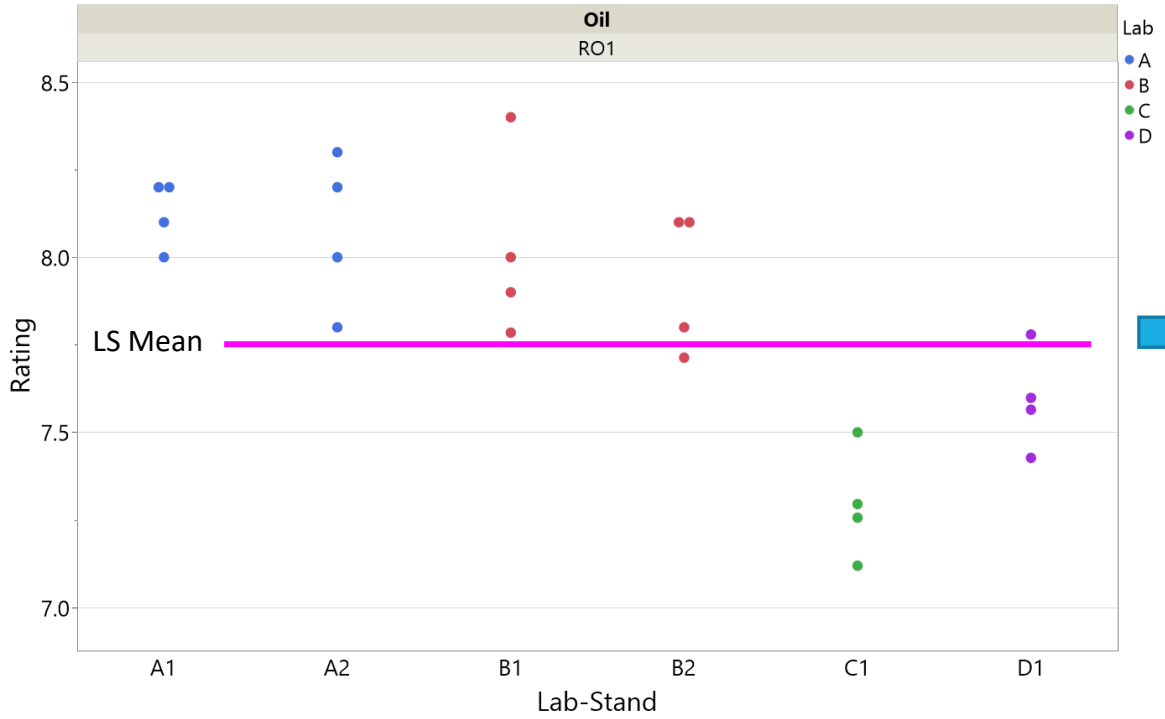
However, though standard deviations are presented semi-annually at ASTM D02 Sub B meetings, there is no mechanism in place to prompt analysis to determine if updating is necessary.

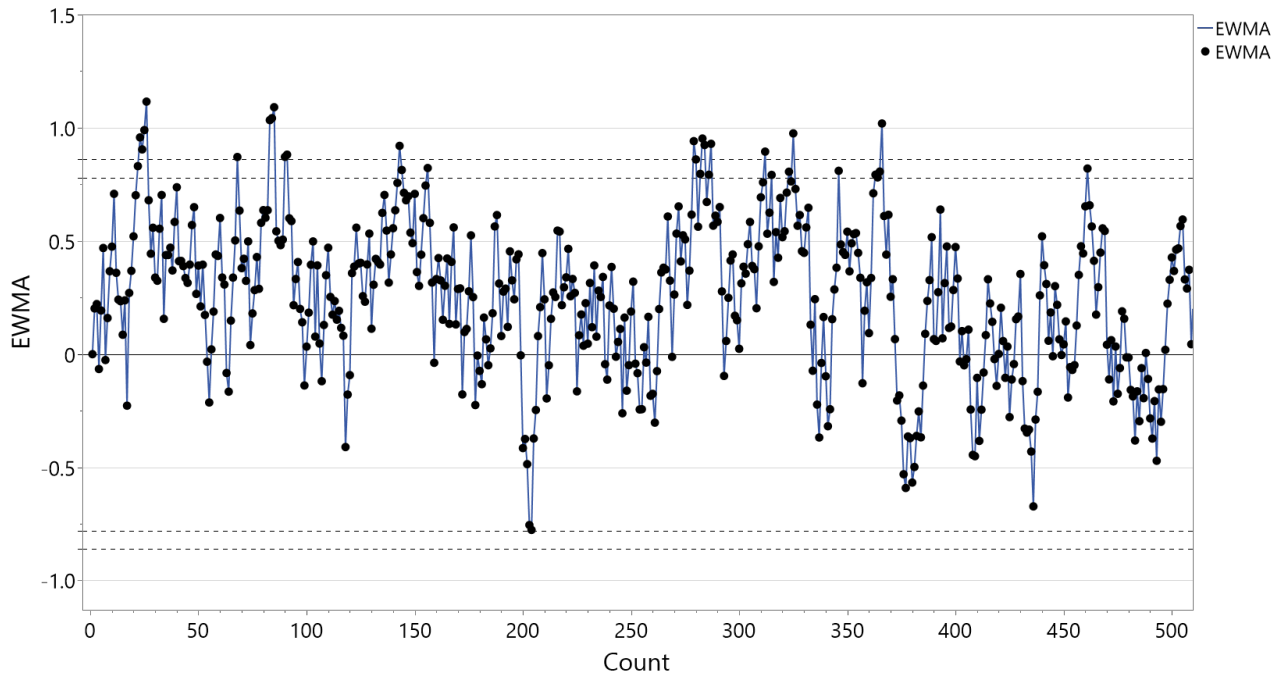
Should there be something?

Control Chart Methodology Ideas

Control Chart Methodology Ideas

With enough care and thought, control charts can be deployed using methodologies which more closely matches the target setting methodology. For example, let's revisit out hypothetical example below where Labs A and B generate 2X data post-PM compared with Labs C and D.



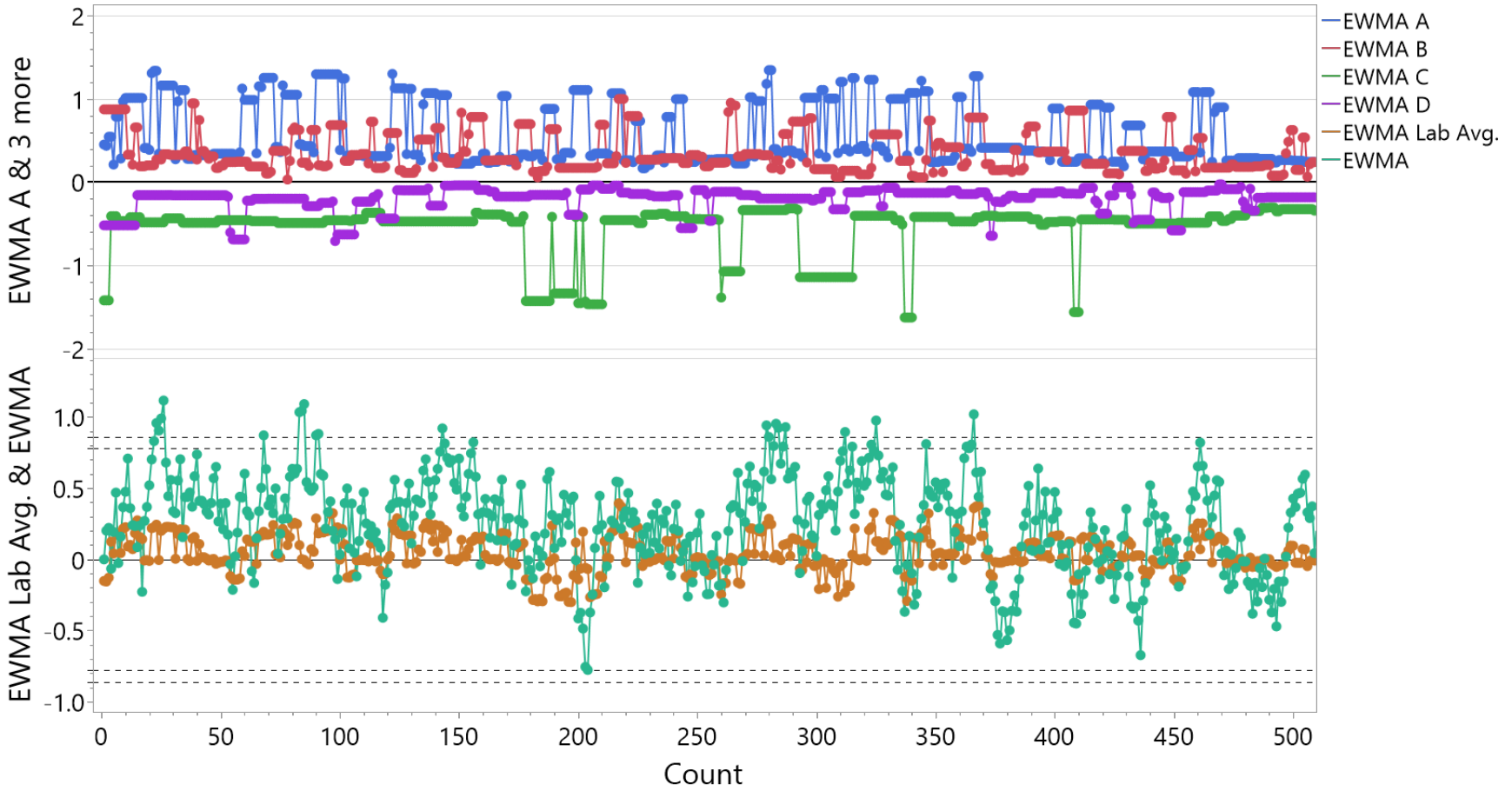


Control Chart Methodology Ideas

In the case of LS Means, one idea for a control chart would be to monitor the average of the lab severity, thus matching the methodology of the target setting.

<u>Obvious Challenges</u>

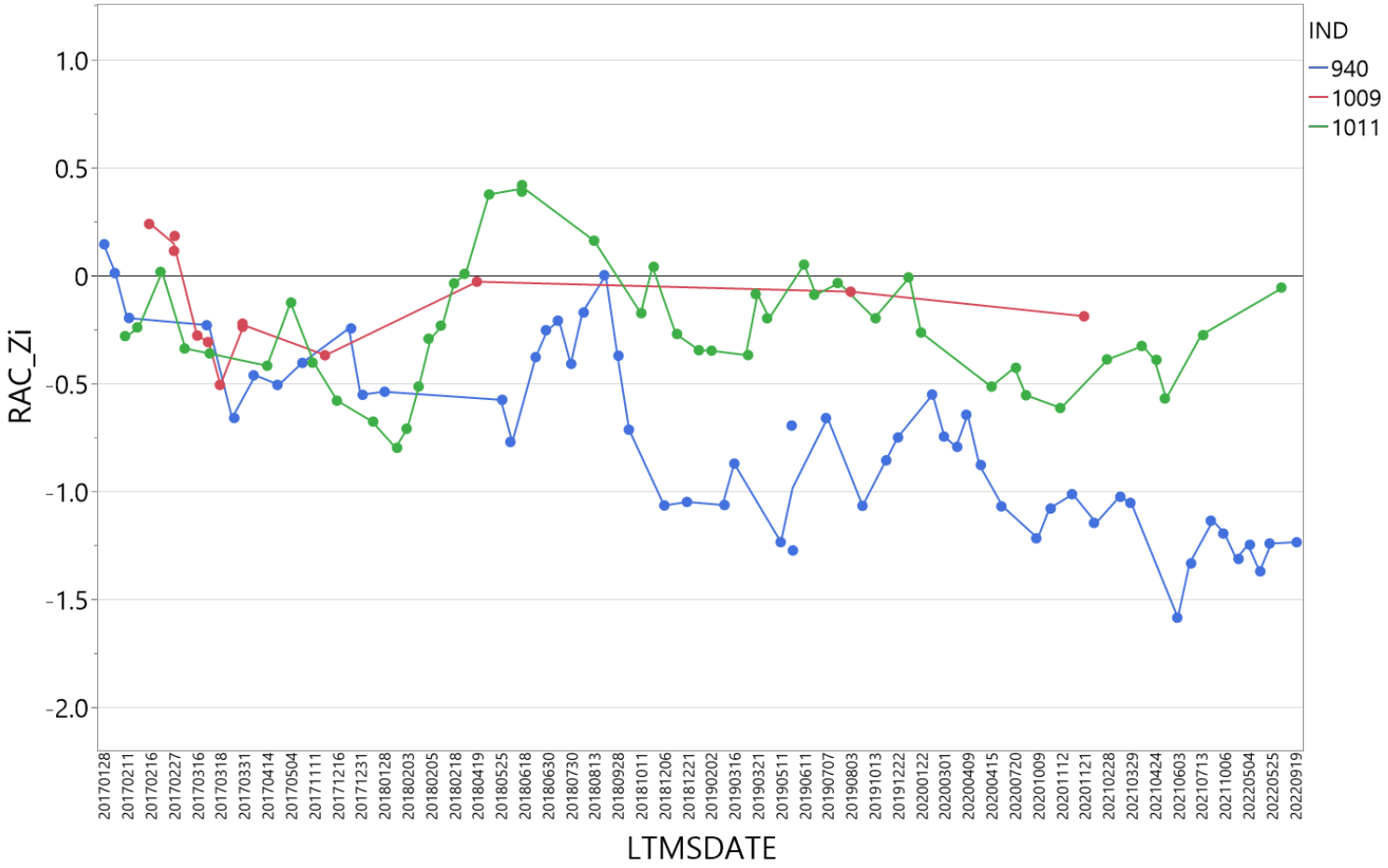
- How to handle new labs/stands?
- How to handle labs who stop running the test?
- Many others that would need to be worked out, but it could be done with enough careful planning.



Additional Monitoring by Reference Oil?

Even if not used for alarms, monitoring severity by reference oil may be helpful, and could have flagged a problem with 940 sooner.

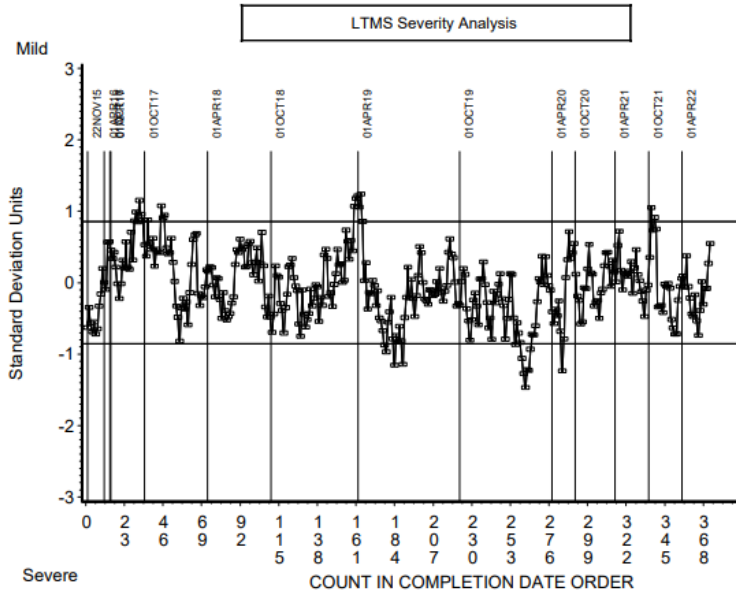
Could also help with RO re-blends introduced with only level 2 ei limits.

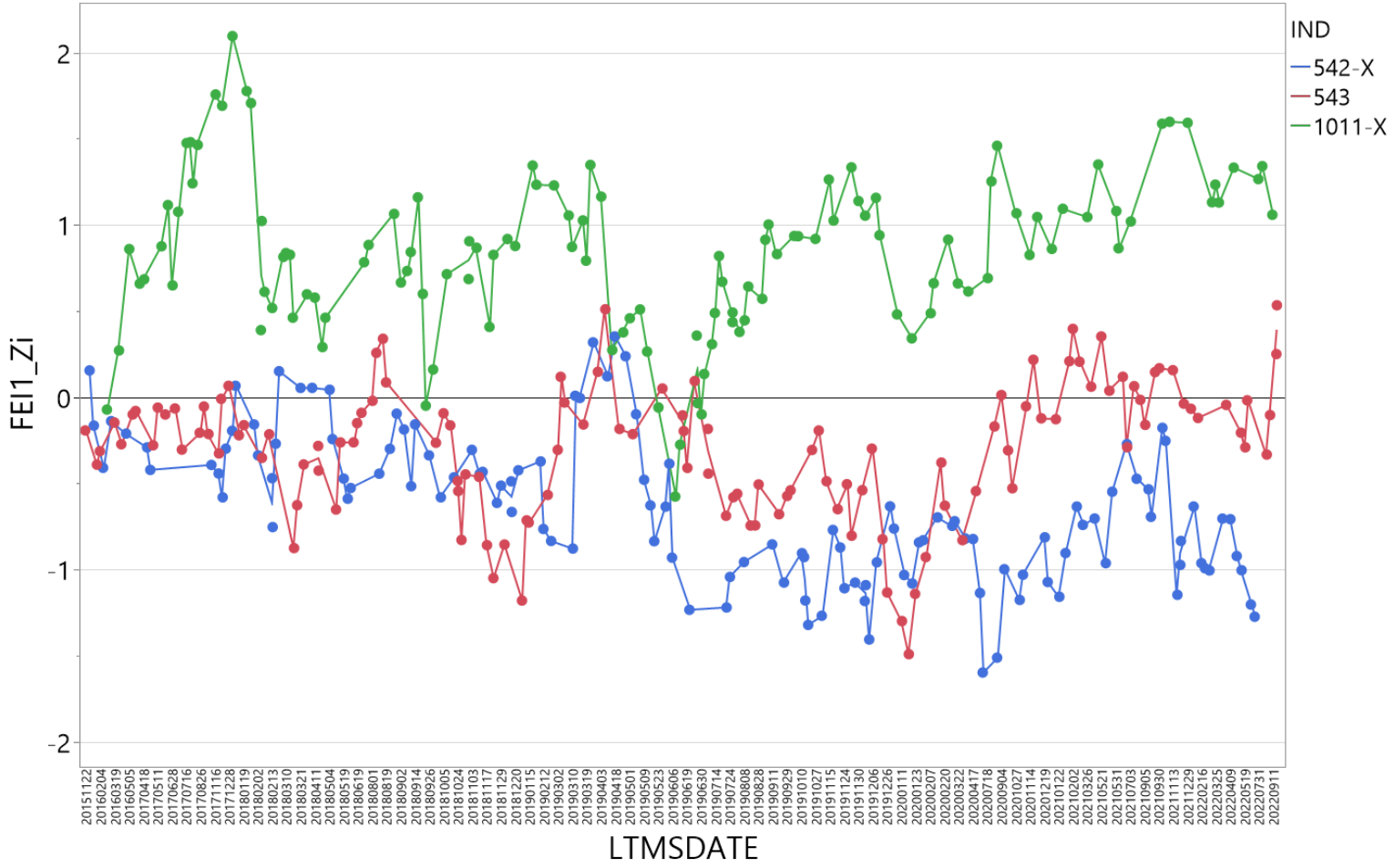


Additional Monitoring by Reference Oil?

-Sequence VIF Fuel Economy Improvement Phase I

With two oils off target by one sigma in opposite directions, the EWMA will not flag a problem.





Control Chart Methodology Summary

- Many control charts are doomed to fail from the beginning due to the disconnect between monitoring methodology and target setting methodology.

- Careful consideration should be given during the target setting phase and the control chart deployment phase for how the phases can be best aligned to minimize false alarms with monitoring. Creative solutions can be explored in future tests.

- Additional granularity in monitoring (lab and/or stand, reference oil) could be beneficial to quickly identify and troubleshoot problems. Some problems may go unnoticed with the current system.

Presentation Topics Summary

- Control charts must be well understood by users, or they can do more harm than good. They may lead to wasted time and energy troubleshooting problems that may not exist.

- Precision matrix target setting methodology has likely not been a well understood topic in recent history, in particular with GF-6 tests that were developed so rapidly and tended to default to LS means without much, if any, discussion. More careful consideration should be given to future test developments.

- Target setting methodology and control charting methodology have in many cases not been aligned. It is important to understand the connection between these two:
  - During precision matrix design
  - During target setting
  - During control chart deployment

- Additional granularity in control charting may be an important addition to future test types.

Responsibilities of the Surveillance Panel Chairs when monitoring control charts.

What actions should a surveillance panel chair take when a control chart shows a test to be deviating.

- Advise the full panel of the trend/alarm and call a meeting
  - Should there be a time limit on how quickly this should happen?
  - Do we need guidelines on when to take action if we are not in alarm, i.e. a trend is happening, but we haven't hit an alarm yet?

- Many times a SP chair takes action but can't bring the test back to center.
  - what action should be taken at this point?
  - what is our tolerance level in terms of allowing this to persist if a solution can't be found

Attachment #6

Surveillance Panel Handbook Outline

December 5, 2022

ASTM D.02.B Surviellance Panel Chair's Handbook: Brainstorming	
Responsibilities/Expectations	**Tools/Resources**
Background Industry Knowledge	Org Chart of D02.B
	Purpose of different Subcommitte groups (emphasis on who is a member - aka SP Chairs not knowing they're part of TGC, etc.)
Prepare & Circulate Semi-Annual Reports for ASTM Meetings	Guidelines for Semi-Annual Reports
Maintain a Current Active Membership List	
Continual communications with industry stakeholders on test changes, problems, needs. This can include hardware, reference oil, and other topics.	
Liasison with other SP Chairs through TGC	
Respond to Test Procedure Questions	
Liaison with the TMC to monitor the performance of calibration oil and fuel inventories	TMC Contacts Link
	Fuel Supplier Contacts Link
Stewarding with the TMC the introduction of calibration oil reblends and new calibration oils	Guidance for Intro Process
Liaison with OEM/CPD to monitor parts supply	
Review and Update Scope & Objectives	Guide for S&O Development
Running Meetings as Issues Arise	Guidelines for Running SP Meetings (Minutes captured and posted in timely manner, Robert's Rules of Order etc)?
	ASTM Voting Guidelines (general)
	ASTM Voting Guidelines for Negative Ballots (How to coordinate SP response, etc.)
	Guidelines for Drafting Ballots and Information Letters
Reviewing Information Letter Ballots	Guide for Utilizing ASTM to Review Ballots
Constant Monitoring of Industry Control Charts	Doc to explain creation and interpretation of control charts (Deeper explanations of CUSUM, etc.)
	Link to LTMS doc. Explanation of use?
	List of industry statisticians that support each method? (maybe out of scope of method but should exist somewhere???)
	Links to D6300 / D6299?
	Guidelines for taking actions resulting from control chart activity
	Close monitoring coming out of Precision Matrix
	Guidelines for updating r/R or targets (i.e. old 10/20/30 reference tests rule or whatever that will look like in the future)
	Guidelines for developing correction factors
Lead Development/Incorporation of New Test Into New Spec	Guidelines for developing control charts
	Guidelines for developing severity adjustments
	Guidelines for Developing Precision Matrix
	Flow chart of development/incorporation process
	Checklist of development tasks
	Guidelines for Creating an ASTM standard
	Explanation / Guidelines for BOI/VGRA Matrix
	Incorporate language to consider "proper" subtests for bench/engine tests (i.e. an actual ASTM method with r/R)
	Mention contacting D02.96 for support when incorporating subtests

Links Primary	Links Secondary
https://www.astmtmc.org/ftp/docs/astmOrganizationChart.pdf	https://astmtmc.org/SurveillancePanelList.aspx
??	
??	SemiReports (astmtmc.org)
Group (astmtmc.org)	
??	Introduction.pdf (astmtmc.org)
??	
www.astmtmc.org - /ftp/docs/technicalguidancecommittee/minutes/BestPractices/	
Microsoft Word - Regs April 2015.docx (astmtmc.org)	
Microsoft Word - Regs April 2015.docx (astmtmc.org)	D020000Bylaws.PDF
Microsoft Word - Regs April 2015.docx (astmtmc.org)	
Microsoft Word - Regs April 2015.docx (astmtmc.org)	
Microsoft Word - Regs April 2015.docx (astmtmc.org)	
Itms.pdf (astmtmc.org)	
Itms.pdf (astmtmc.org)	
DataAnalystList.pdf (astmtmc.org)	
D02 Committee Documents: D6300 D2PP link	
OutofControl.pdf (astmtmc.org)	
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Itms.pdf (astmtmc.org)	
Itms.pdf (astmtmc.org)	
Itms.pdf (astmtmc.org)	
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GuideForTestDevelopment.pdf (astmtmc.org)	Microsoft PowerPoint - PC-10 Lessons Learned Question 8.ppt (astmtmc.org)
Microsoft Word - Regs April 2015.docx (astmtmc.org)	ASTM D02 Facts For members Section 5 : Development of a Standard
??	