NOACK discussion with Statisticians

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Performance you can rely on.

Background

- During the June 2019 meeting, I presented to a small group a graphical evaluation by apparatus of the agreement between the standardized Evaporation loss (Yi) from Calibration runs and Yi from VOLD14 Daily checks.

- In general, the plots by apparatus showed varying levels of agreement between the two series over time. Some instruments had better agreement than others.
  - Todd Dvorak volunteered to analyze the data further

- I also presented possible revisions of the standard deviation for untransformed and LN transformed evaporation loss. The group agreed that the LN transform should be recommended to the Surveillance Panel.
  - Details of the calculations are presented here

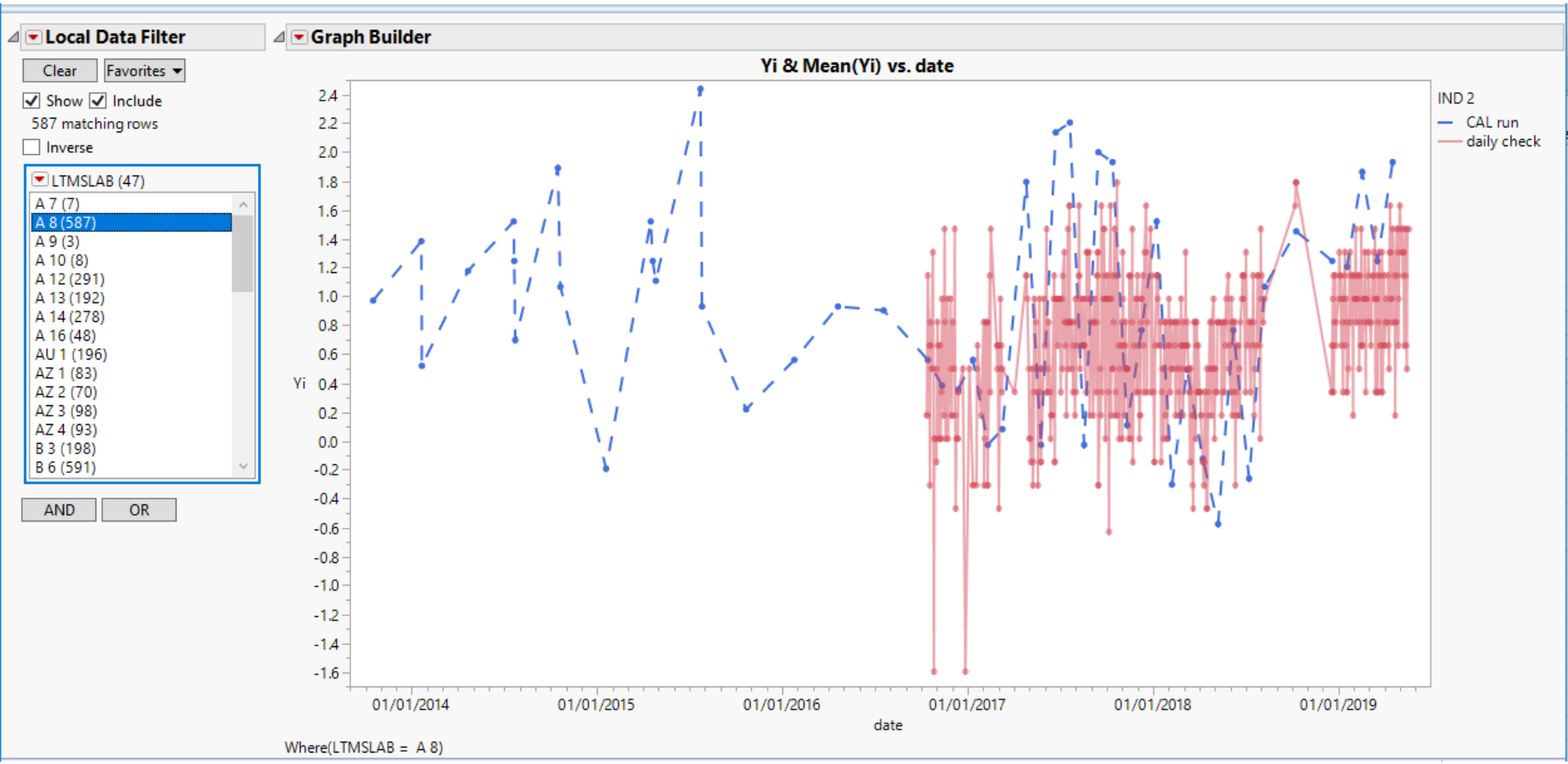
After the meeting

- I called Martin Chadwick to hear his thoughts about evaluating the appropriateness of the calibration interval. He thought that comparing SA's generated by Calibration runs and by VOLD14 Daily checks would be useful. We expect that the respective SAs be "close" to each other.
- I selected apparatus A8 to do an initial comparison
- I also included a comparison based only in VOLD14 varying the frequency of data collection
  - daily check
  - every two weeks
  - every month

Apparatus A8

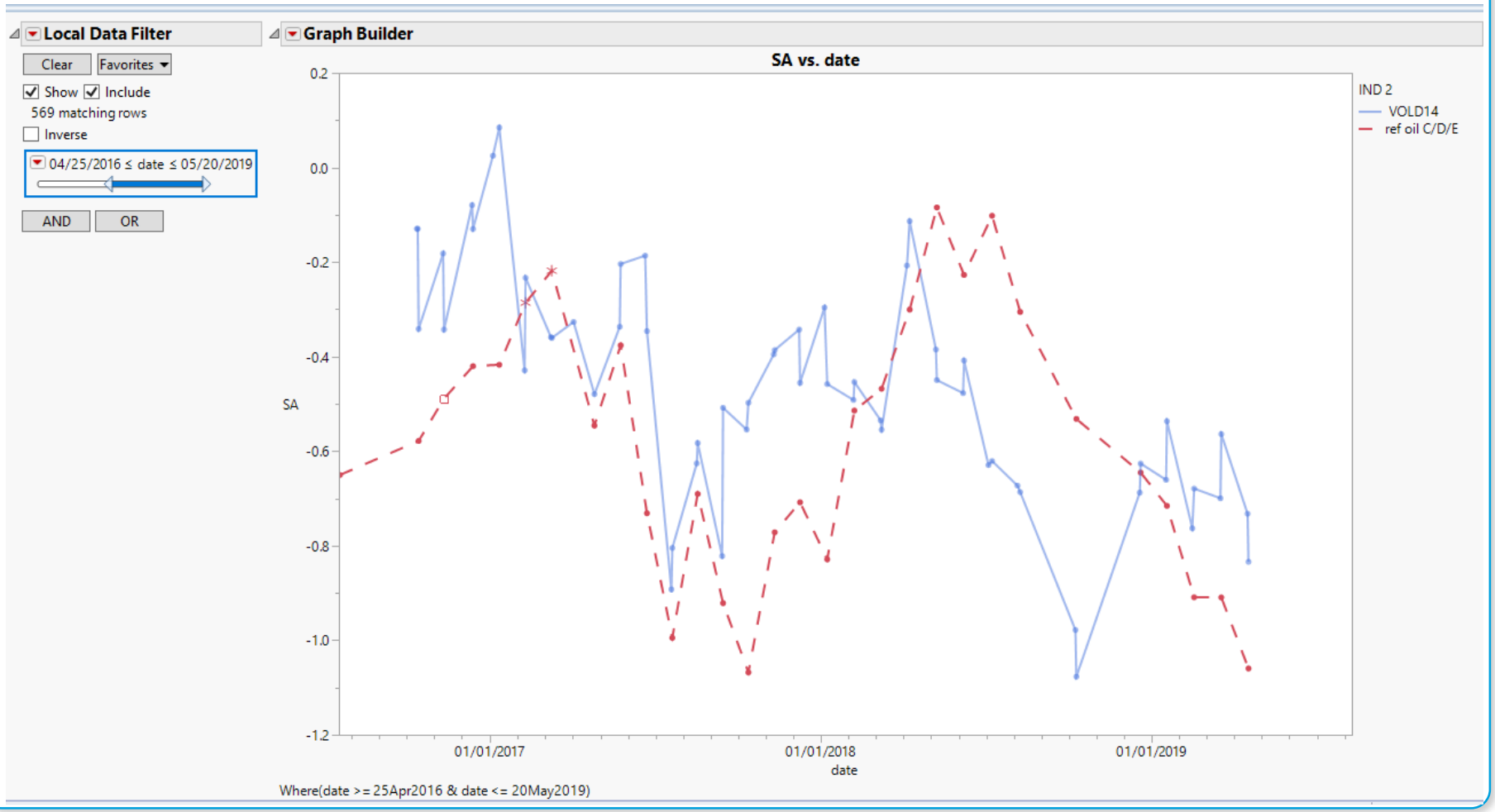
Standardized Evaporation loss (Yi) versus date by Calibration Run and Daily Check testing

- The plot below shows a certain degree of agreement between the Calibration Run and Daily Check testing. The more recent data seem to show an upward trend.

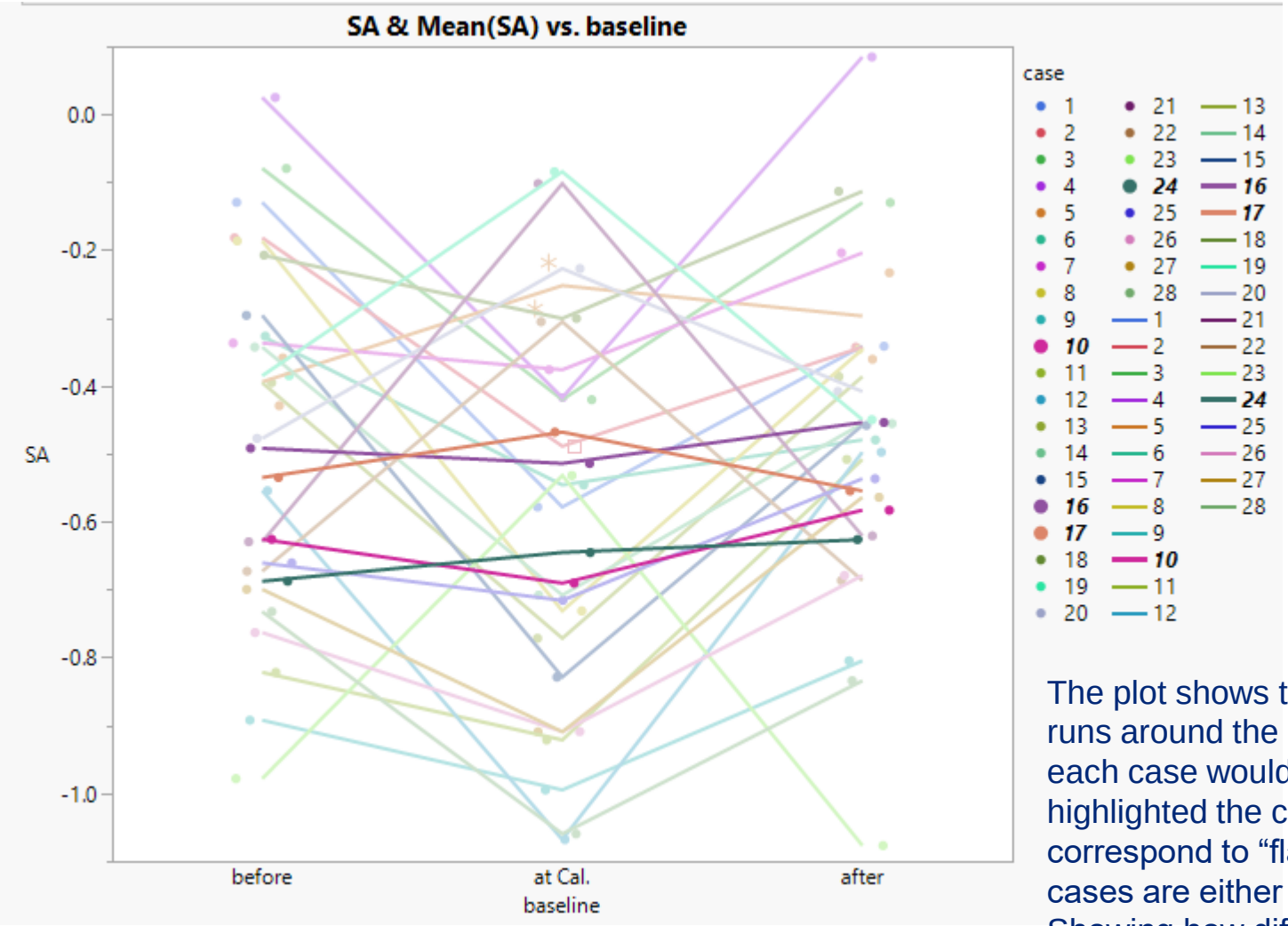


Severity adjustments based on daily VOLD14 versus Severity adjustments based on monthly Cal. run

Apparatus A8: They look surprisingly different

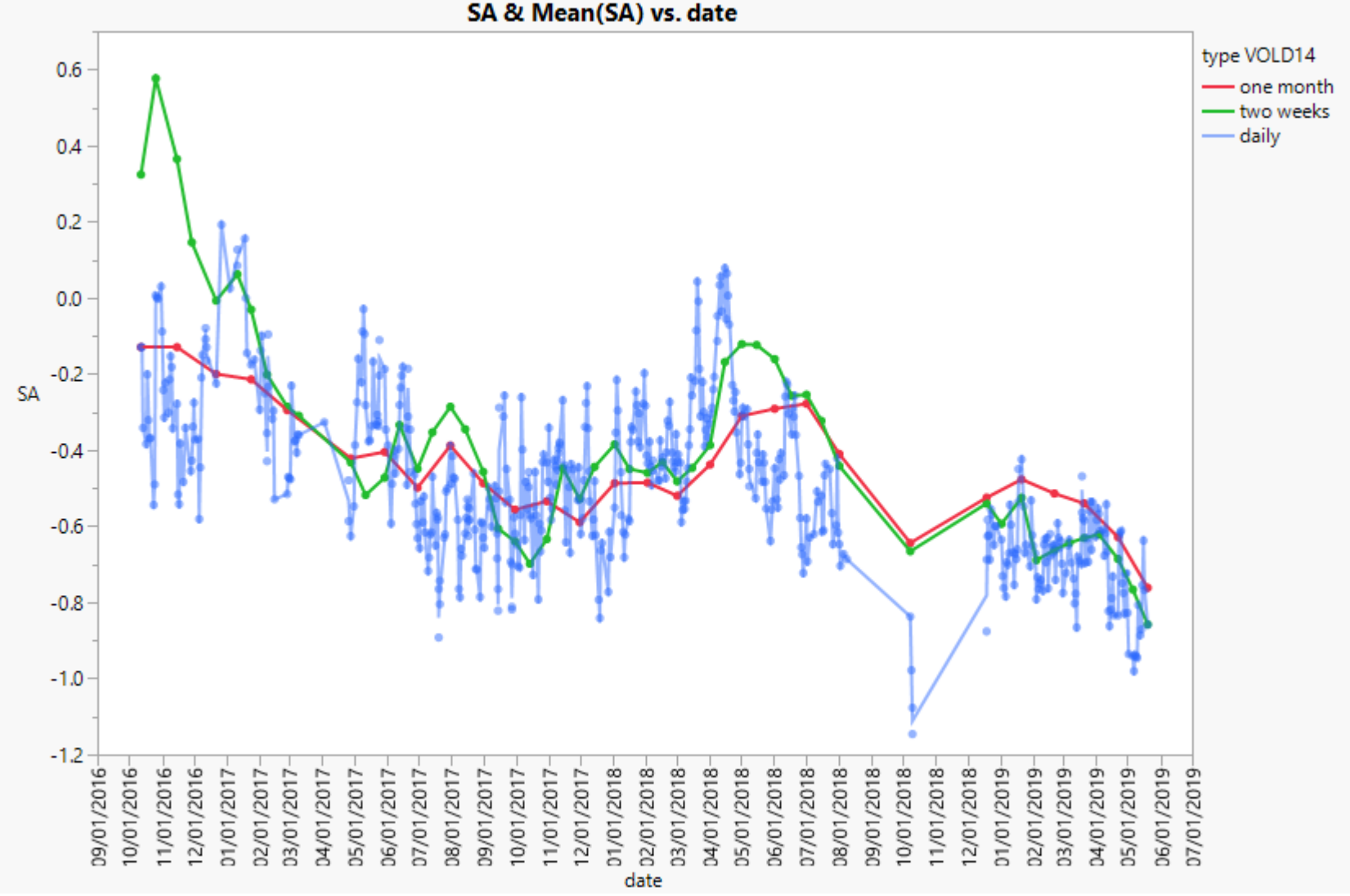


Apparatus A8
The plot below shows how close the VOLD14 SA is of the Cal run SA (at the Cal run time)



The plot shows the two VOLD 14 runs around the CAL run. Ideally, each case would be a flat line. I highlighted the cases that correspond to “flat” lines. The other cases are either “V” or “A” shaped. Showing how different the SAs are at the CAL run time.

ONLY VOLD14 comparisons: from daily checks, two weeks and monthly checks. This comparison eliminates the differences between VOLD14 and the reference oils, focusing the discussion on the frequency that the data are collected



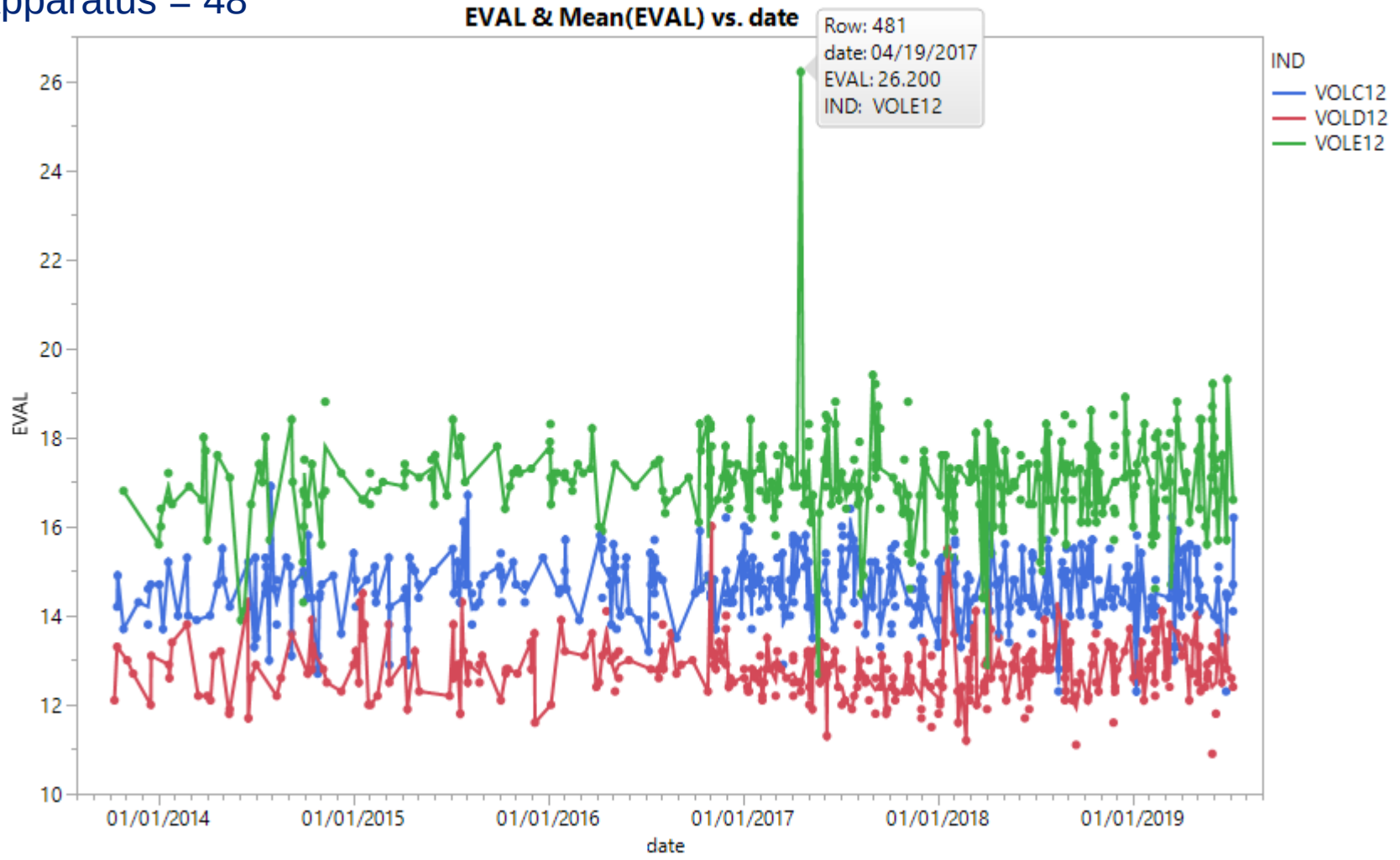
Updated standard deviation

Summary

- After reviewing the most recent data, the statisticians would like to recommend that the LN transformation be applied to Evaporation Loss.
- After applying the LN transformation, the new standard deviation should be equal to 0.0465

Updated Standard deviation

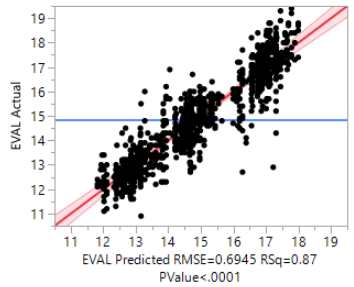
Data: 1,124 tests (file 07/09/2019); 10 2013 forward; chart =Yes
Apparatus = 48



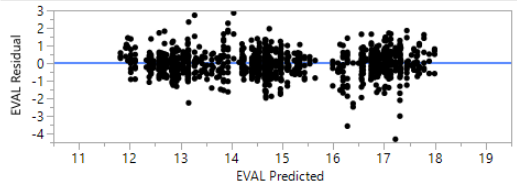
Model 1: Apparatus and Oil without transformation, excluded testkey 123872 (EVAL=26.2)

Response EVAL

Actual by Predicted Plot



Residual by Predicted Plot



Summary of Fit

RSquare	0.866031
RSquare Adj	0.859913
Root Mean Square Error	0.694468
Mean of Response	14.82342
Observations (or Sum Wgts)	1123

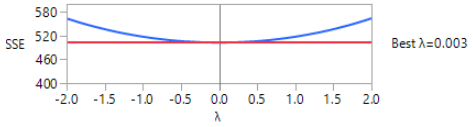
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	49	3345.2814	68.2710	141.5573
Error	1073	517.4926	0.4823	Prob > F
C. Total	1122	3862.7741		<.0001*

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
APPARATS	47	47	186.8231	8.2419	<.0001*
IND	2	2	3142.1169	3257.526	<.0001*

Box-Cox Transformations



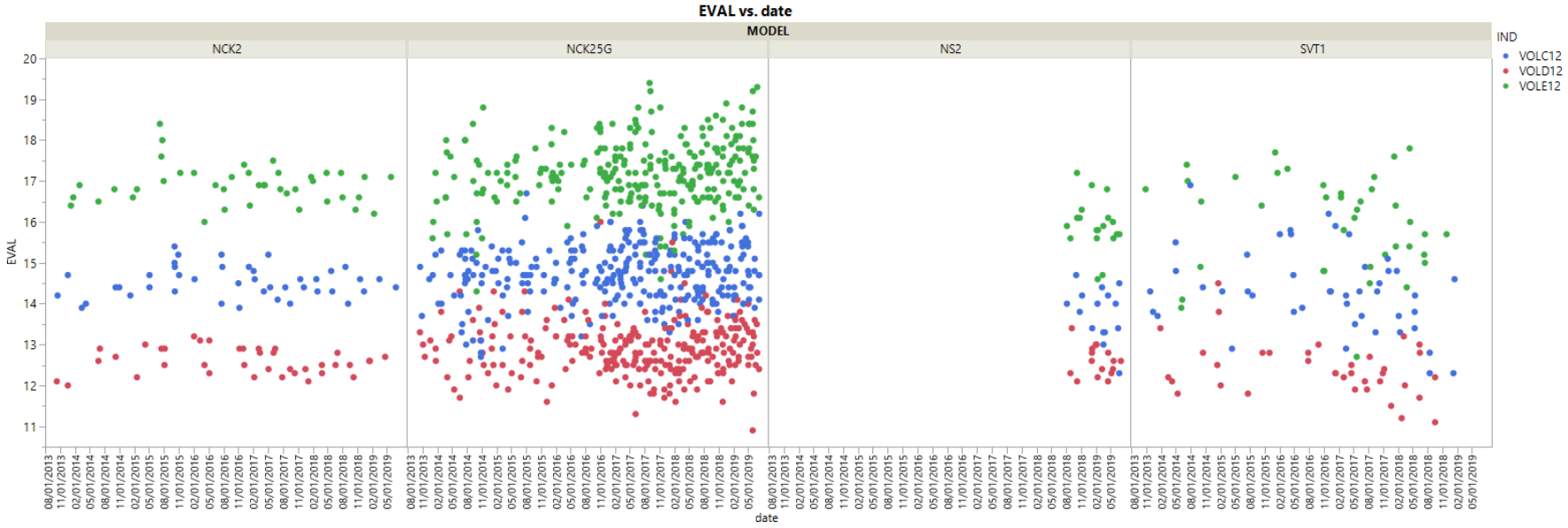
RMSE = 0.6945 compared to 0.73 (the current standard deviation)

LN transformation seems proper according to the Box-Cox method

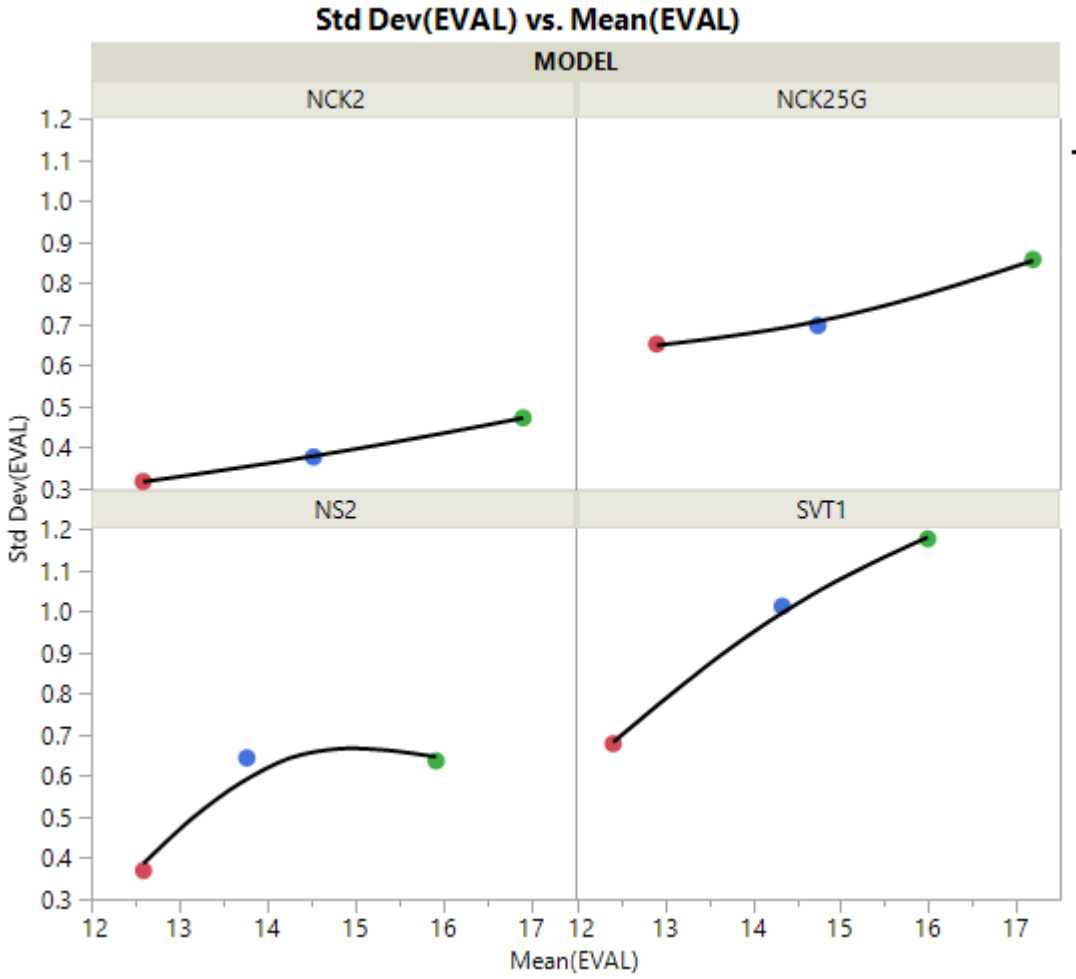
	MODEL	N Rows
1	NCK2	121
2	NCK25G	831
3	NS2	50
4	SVT1	121

Exploring the variability of the test by oil and model

Evaporation Loss by date, model and oil



Variability seems to increase with the mean of Evaporation loss, indicating the need of a transformation for Evaporation loss.



MODEL	IND	N Rows	Mean(EVAL)	Std Dev(EVAL)
NCK2	VOLC12	42	14.5238	0.37729
NCK2	VOLD12	38	12.5895	0.31775
NCK2	VOLE12	41	16.9024	0.47249
NCK25G	VOLC12	296	14.7389	0.69673
NCK25G	VOLD12	265	12.9019	0.65183
NCK25G	VOLE12	270	17.1922	0.8571
NS2	VOLC12	15	13.7667	0.64328
NS2	VOLD12	16	12.5938	0.36963
NS2	VOLE12	19	15.9158	0.63619
SVT1	VOLC12	45	14.3333	1.01175
SVT1	VOLD12	36	12.4056	0.67779
SVT1	VOLE12	40	15.9925	1.17569

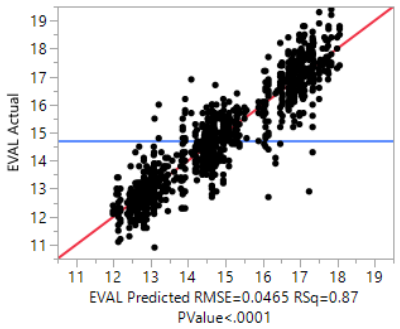
Model 2: Apparatus and Oil with LN transformation excluded testkey 123872 (EVAL=26.2)

RMSE = 0.0465 is the recommended standard deviation

LN transformation seems proper according to the Box-Cox method (more details in the next slide)

Response Log(EVAL)

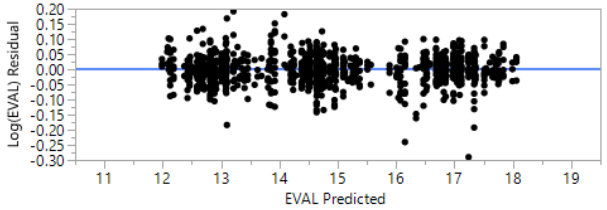
Actual by Predicted Plot



Lack Of Fit

Source	DF	Sum of Squares	Mean Square	F Ratio
Lack Of Fit	91	0.2699745	0.002967	1.4187
Pure Error	982	2.0535860	0.002091	Prob > F
Total Error	1073	2.3235605		0.0080*
				Max RSq
				0.8825

Residual by Predicted Plot



Summary of Fit

RSquare	0.867059
RSquare Adj	0.860988
Root Mean Square Error	0.046535
Mean of Response	2.688417
Observations (or Sum Wgts)	1123

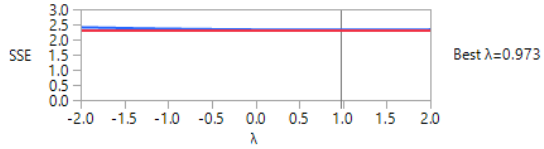
Analysis of Variance

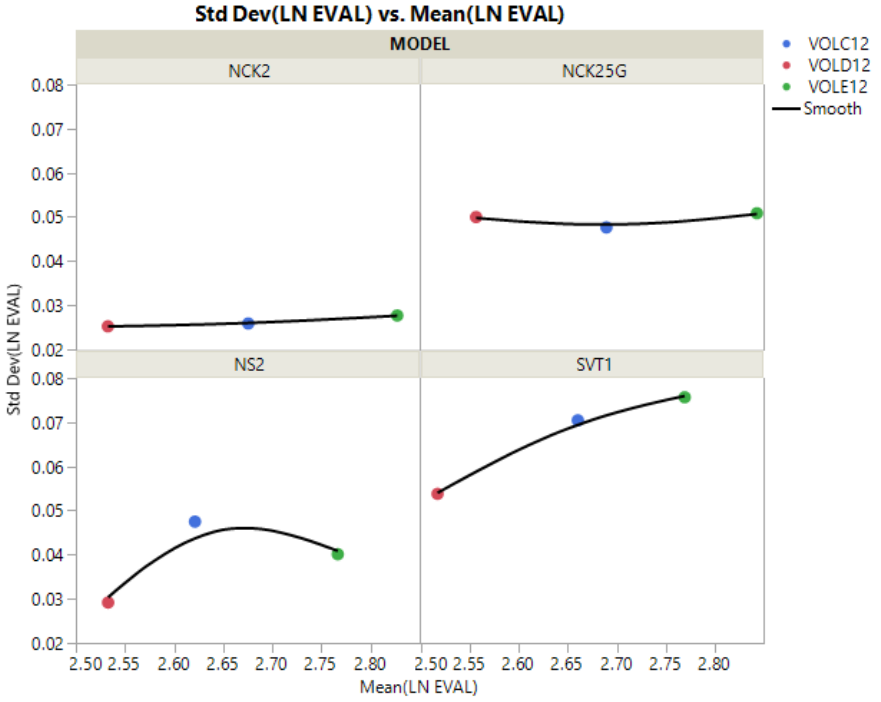
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	49	15.154542	0.309276	142.8211
Error	1073	2.323560	0.002165	Prob > F
C. Total	1122	17.478102		<.0001*

Effect Tests

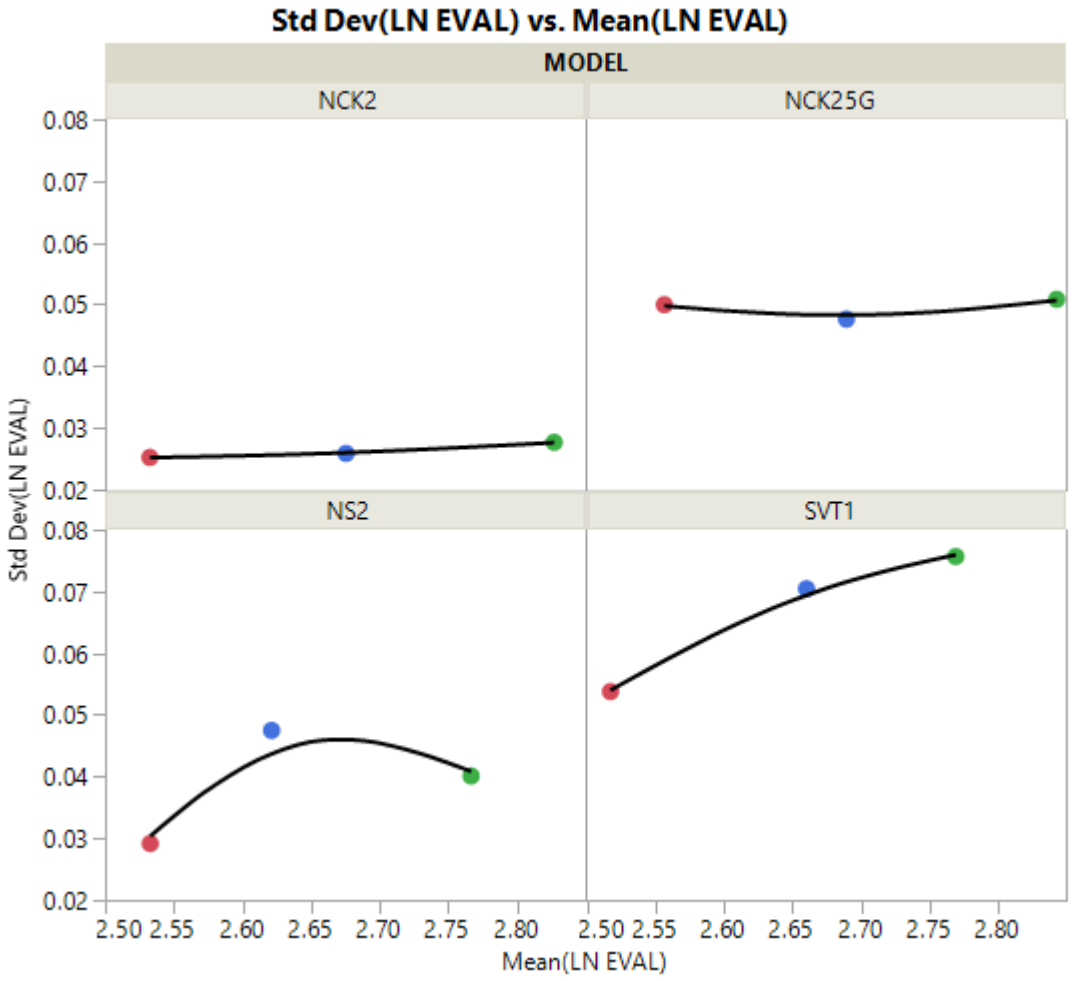
Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
APPARATS	47	47	0.830275	8.1577	<.0001*
IND	2	2	14.246743	3289.511	<.0001*

Box-Cox Transformations





After the transformation, as desired, the variability is constant for NCK2 and NCK25G models – most of the test data. NS2 does not change. The variability for SVT1 does not increase as fast.



MODEL	IND	N Rows	Mean(LN EVAL)	Std Dev(LN EVAL)
NCK2	VOLC12	42	2.6755	0.0259
NCK2	VOLD12	38	2.5326	0.0252
NCK2	VOLE12	41	2.8271	0.0277
NCK25G	VOLC12	296	2.6894	0.0476
NCK25G	VOLD12	265	2.5561	0.05
NCK25G	VOLE12	270	2.8432	0.0509
NS2	VOLC12	15	2.6212	0.0475
NS2	VOLD12	16	2.5328	0.0292
NS2	VOLE12	19	2.7666	0.0401
SVT1	VOLC12	45	2.6602	0.0704
SVT1	VOLD12	36	2.5167	0.0538
SVT1	VOLE12	40	2.7694	0.0757