Sequence VH Test Severity Task Force

Call Minutes March 9, 2022

Attendees Present

Al Lopez – Intertek
Daniel Engstrom - Southwest Research
Ben Maddock – Afton
Andrew Stevens – Lubrizol
~~Amol Savant – Valvoline~~
Rich Grundza - ASTMTMC
Mike Deegan – Ford (Test Sponsor)
Rob Zdrodowski– Ford (Test Sponsor)
Doyle Boese – Infineum (Statistical Advisor)
Andrew Ritchie – Infineum
Charlie Leverett – Infineum (TF Chair)

Agenda

1. Approve the minutes from the 02/02/2022 and 02/16/22 calls. *Approved*

2. **Open Items to Discuss/Review**
   - RAC Data Presentation from Doyle – *Review attached*
     Discussion: *Doyle's presentation points out a possible flaw in the method to set reference oil targets. Rather than equal weighting by participants % of the contribution should be considered.*
   - Review current Industry Charts – Rich – *Charts attached*

The following items were tabled until the next meeting:

- Review lab results on external oil system volume measurements.
- Review TMC Lab Visit Spreadsheets by lab
  Labs were not prepared. We had a lengthy discussion on why this was important. Labs are expected to have this completed by 03/09
- Review Lab stand videos/pictures for other labs. *(IAR video is posted on TMC Website)*

- Review Labs Build data
- Review Lab Ramp transition plots from Valvoline.
- Review Dan's presentation on combined transition plots.

Review Action Items and Process

I want the group to work on completion dates for the following items

a.) Labs will complete TMC VH Lab Visit spreadsheet for each calibrated stand. *Comment: any stand not currently calibrated but which might be introduced in the next six months should be included.* – **Estimated completion 03/23/22**

b.) Labs will supply the build data for all runs on 1011-1. Please note if a lab has not run 1011-1, they are to provide the build data from their last two reference tests – **Charlie will issue a template to the labs to complete. Worksheet sent 02/11/22**

c.) Labs will supply transition plots for all 1011-1 tests. - **02/02/2022 reviewed all except Valvoline – Afton to submit theirs with windows of requirements.**

d.) Review specified Fuel analysis. Develop a method to handle out-of-spec results. – **No resolution, take it to the SP. 02/10/22 Resolved at SP level.**

e.) Doyle will continue to study RAC looking at all oils.

f.) Section 8.3.2.1 – Labs are requested to measure the internal volume of the external system. **Estimated completion 03/23/22.**

3. **Next Meeting** – ***March 23, at 9:00 CST***

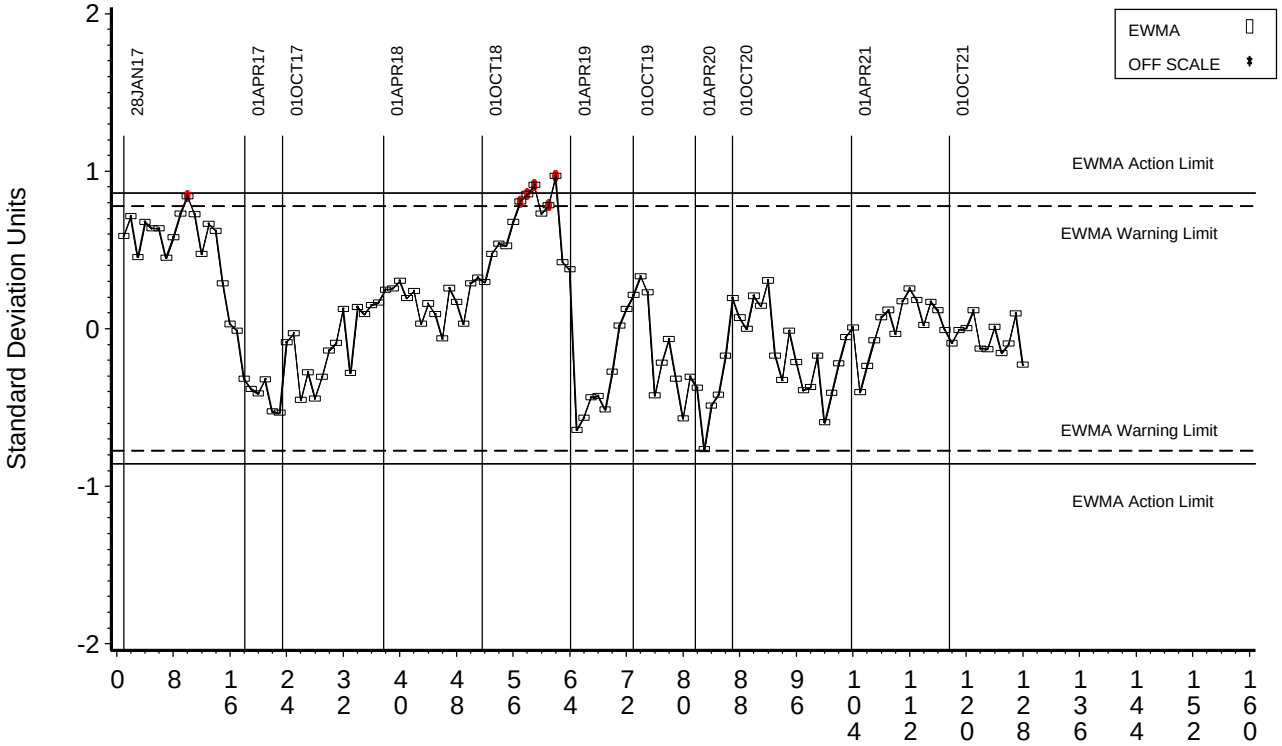
4. **Adjournment** - Meeting adjourned at 10:55 CST

SEQUENCE VH INDUSTRY OPERATIONALLY VALID DATA

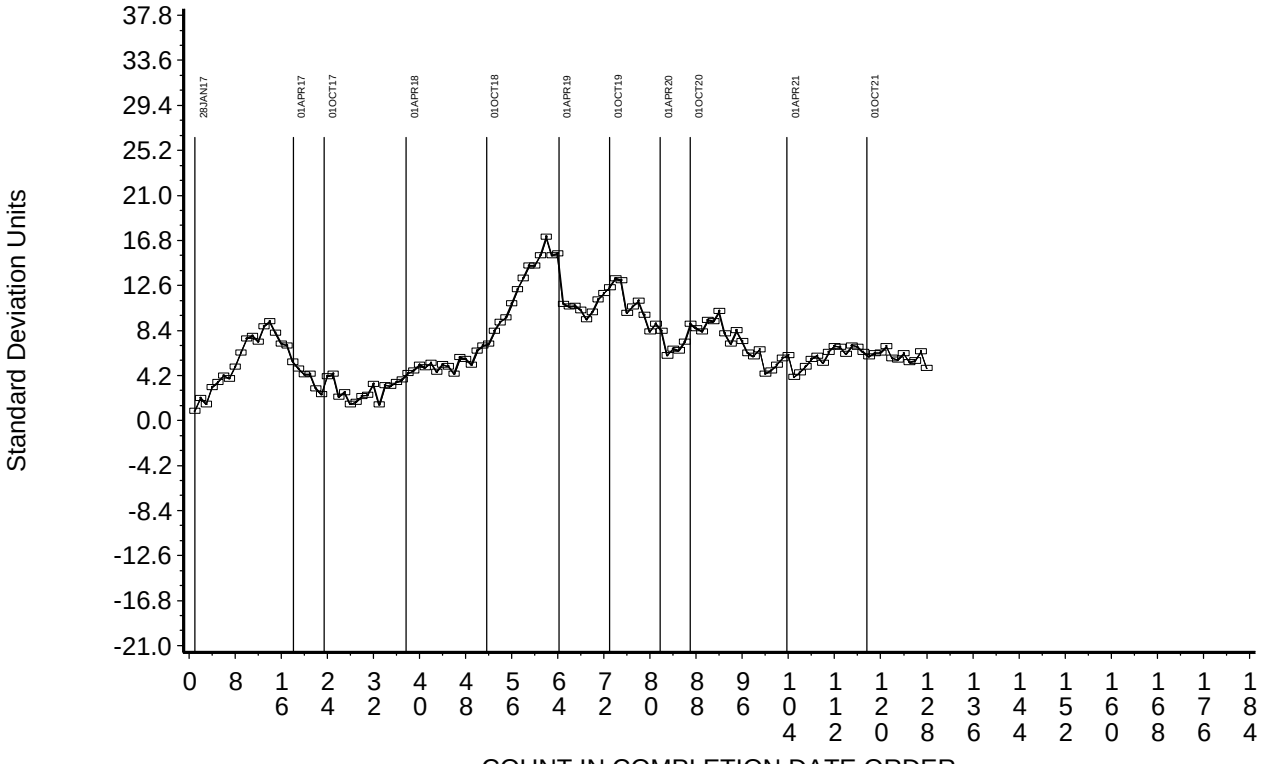
AVG. ENG. VARN. 50% RATING

A Program of ASTM International

LTMS Severity Analysis



CUSUM Severity Analysis



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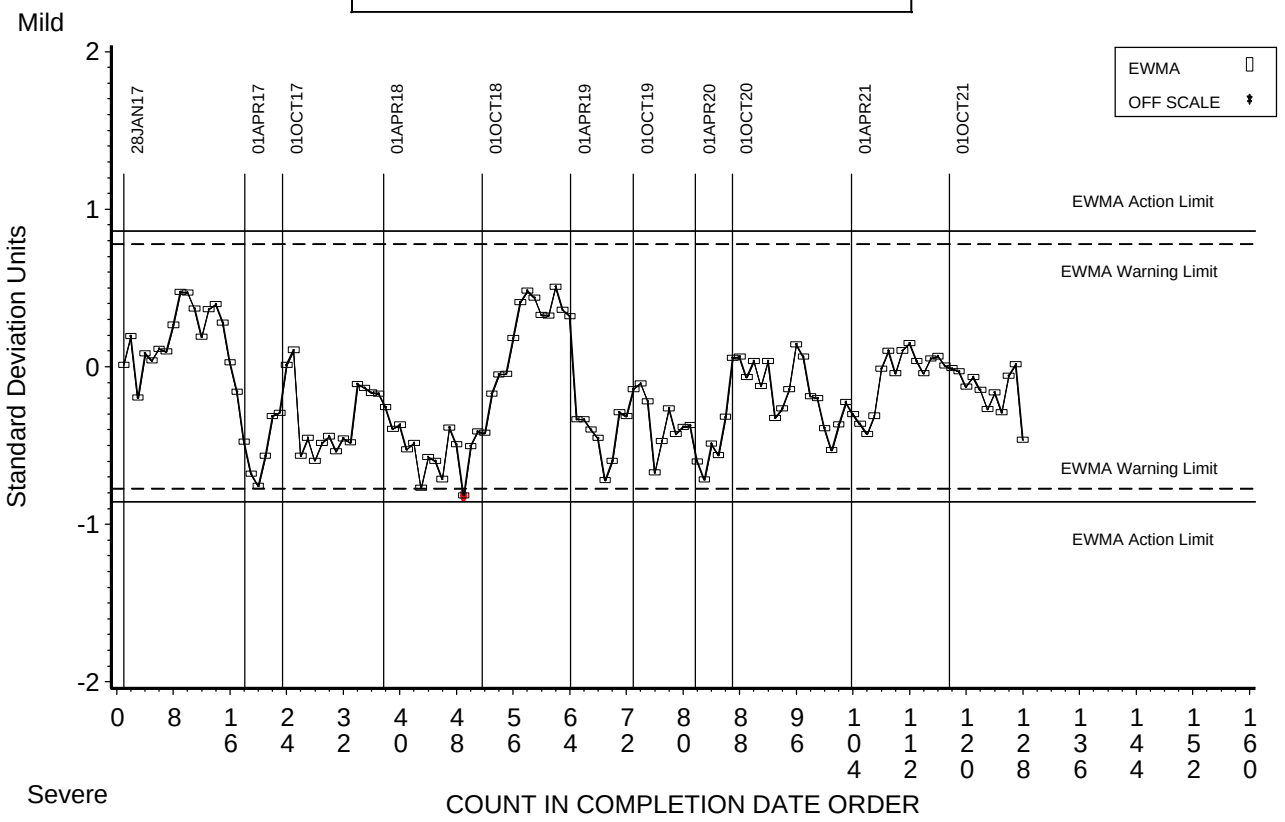
SEQUENCE VH INDUSTRY OPERATIONALLY VALID DATA

AVG PISTON SKIRT 50% RATING

LTMS Severity Analysis



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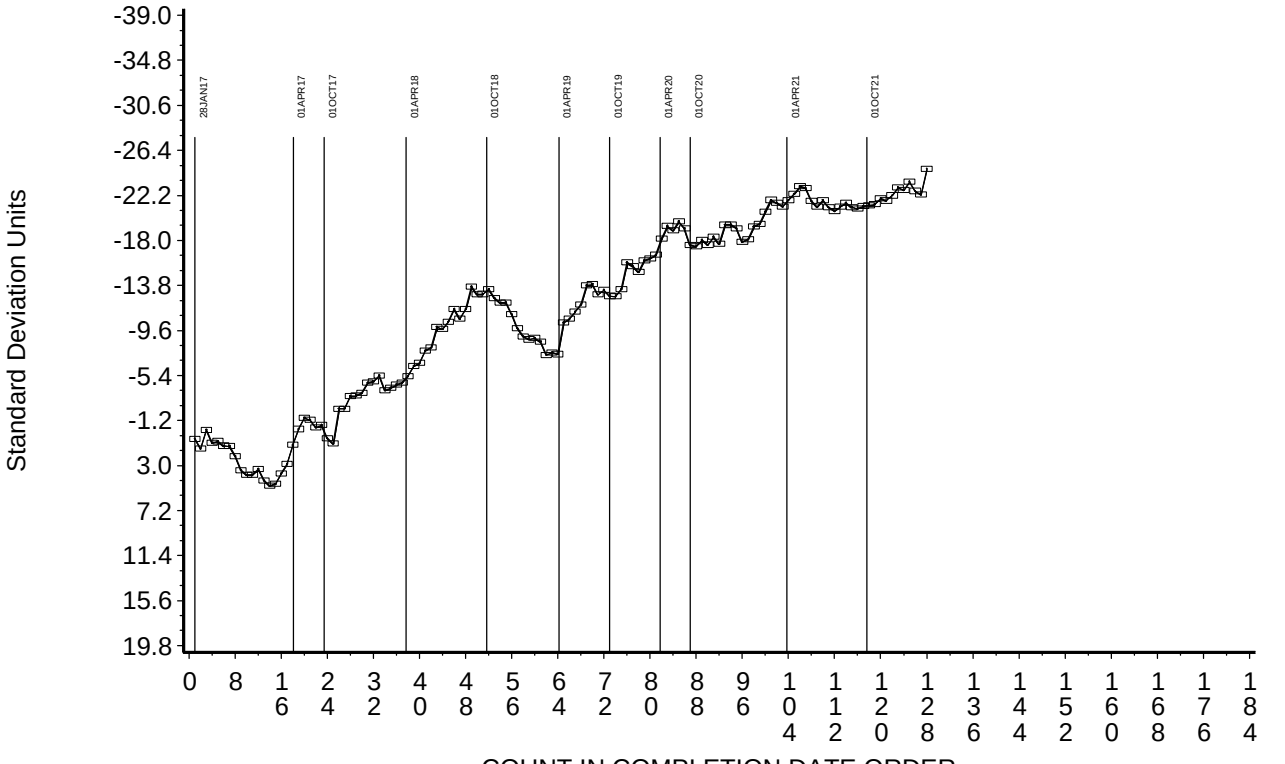

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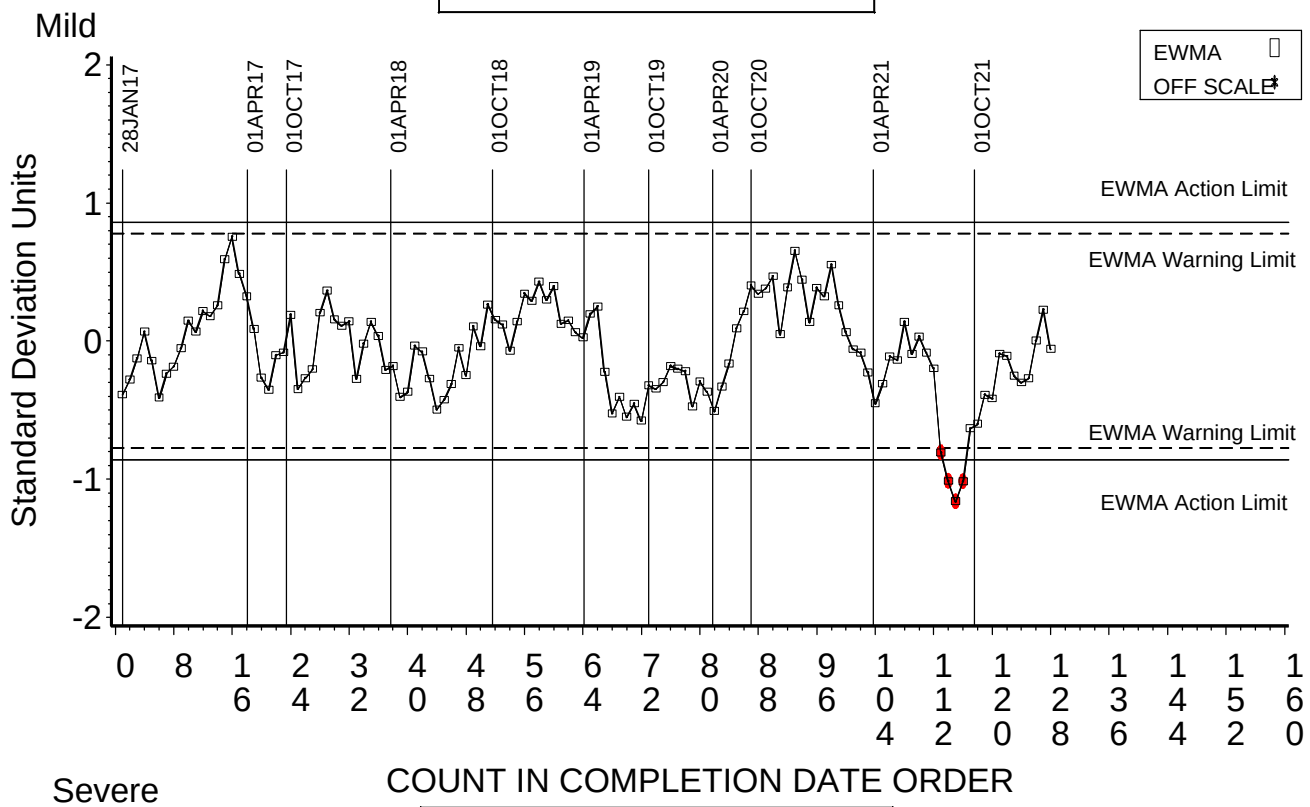
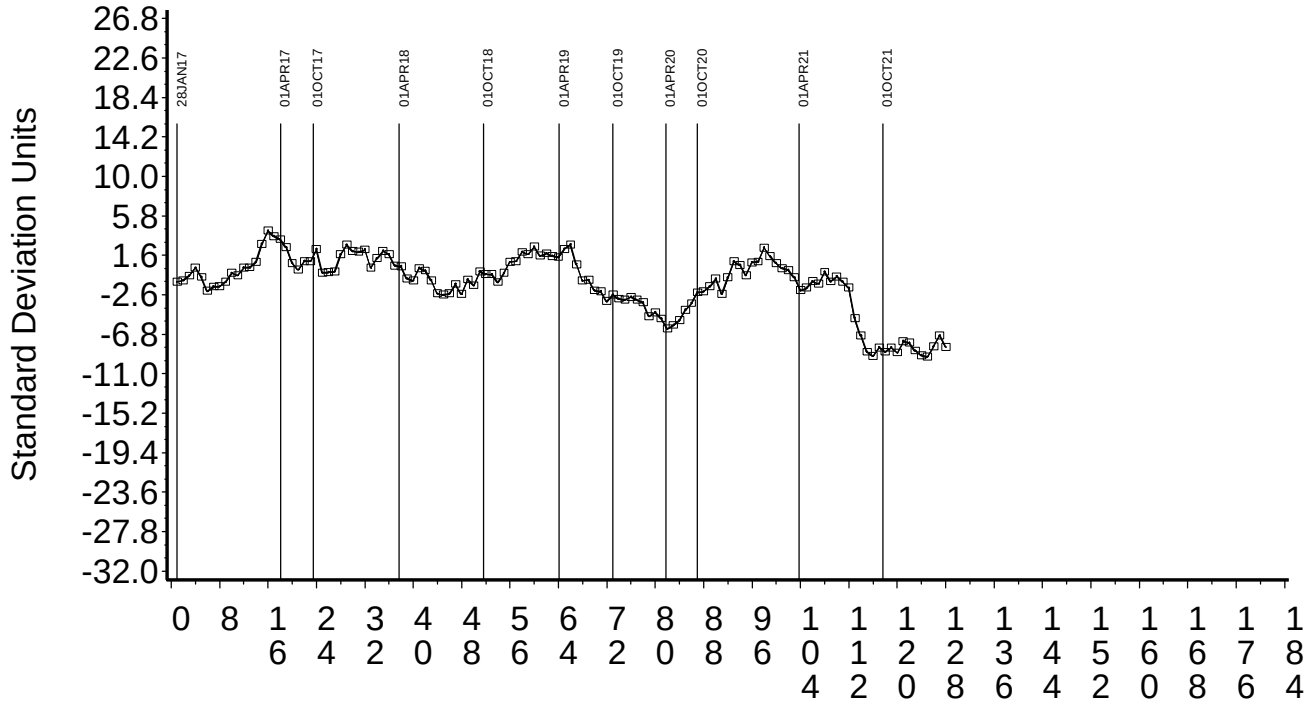
SEQUENCE VH INDUSTRY OPERATIONALLY VALID DATA

AVERAGE ENGINE SLUDGE

LTMS Severity Analysis



CUSUM Severity Analysis



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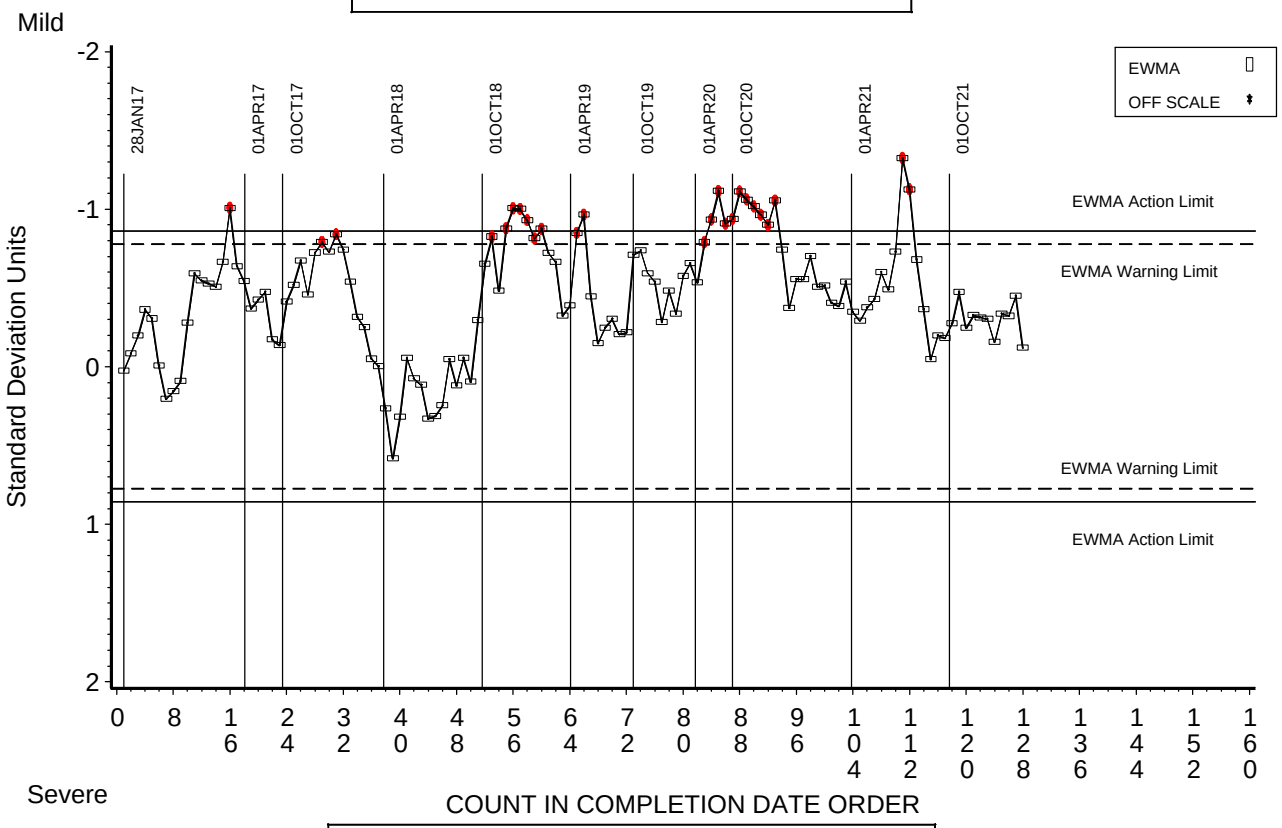
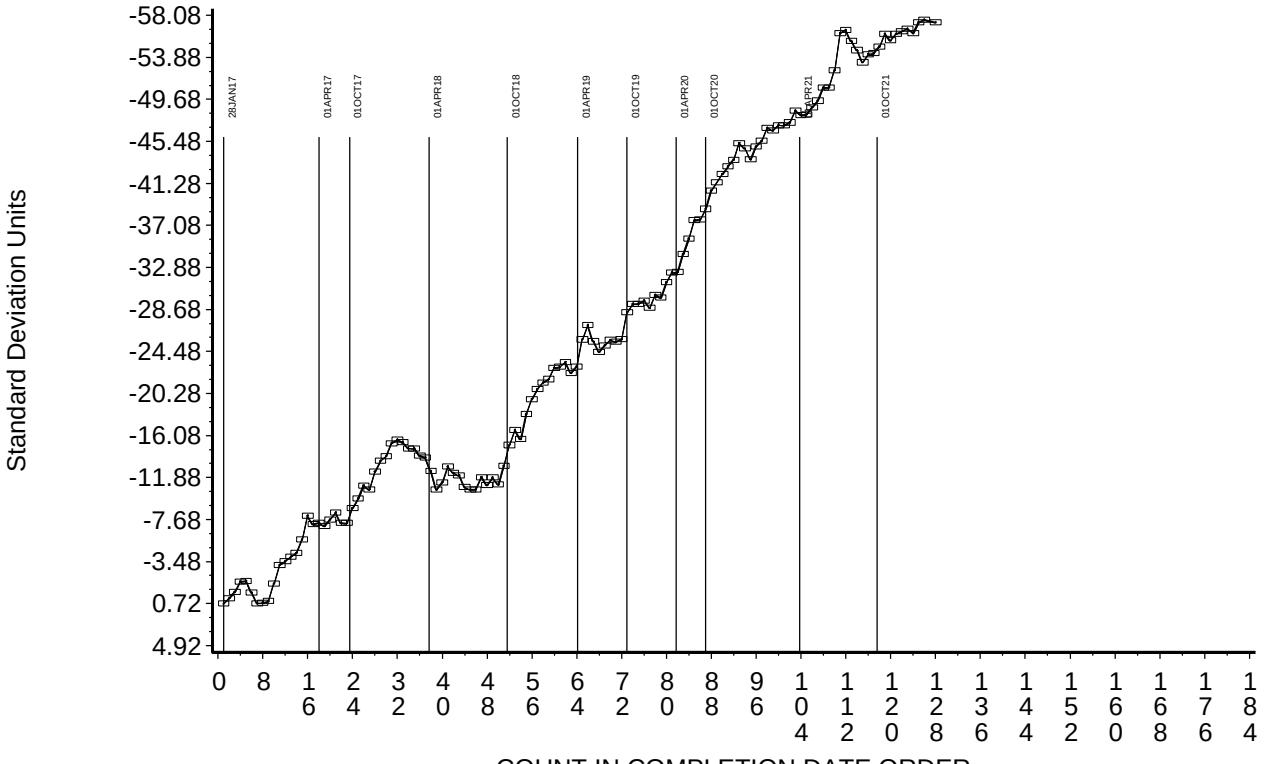
SEQUENCE VH INDUSTRY OPERATIONALLY VALID DATA

AVERAGE ROCKER COVER SLUDGE

LTMS Severity Analysis



CUSUM Severity Analysis



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VH RACS Severity

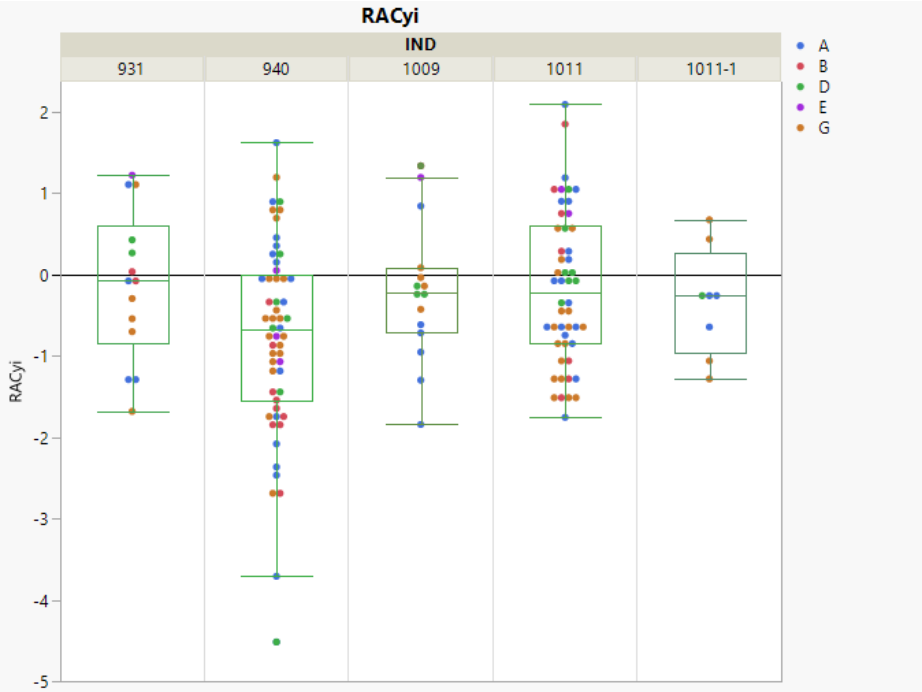
D. Boese

March 9, 2022

Performance you can rely on.

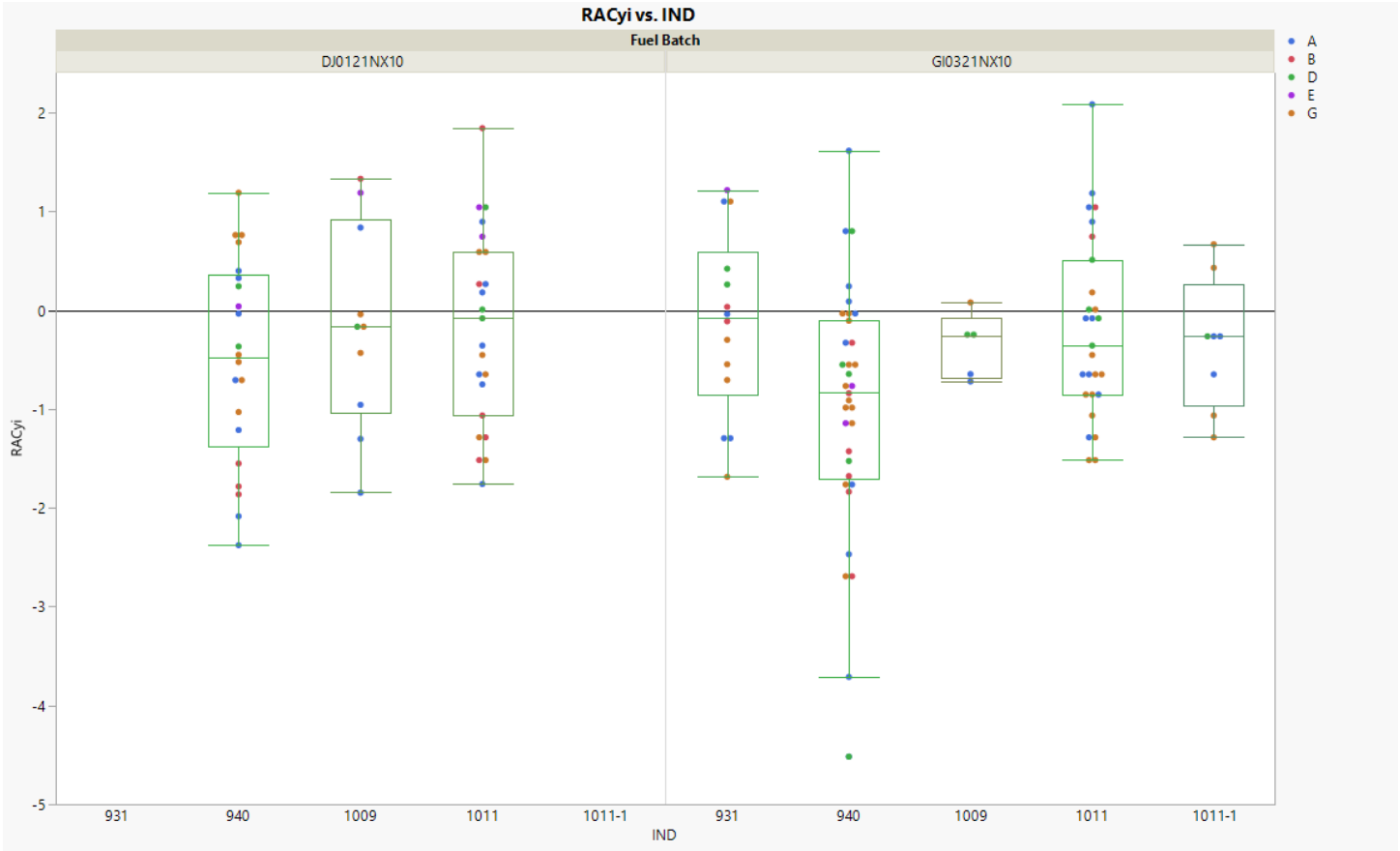
Infineum

Valid VH RAC



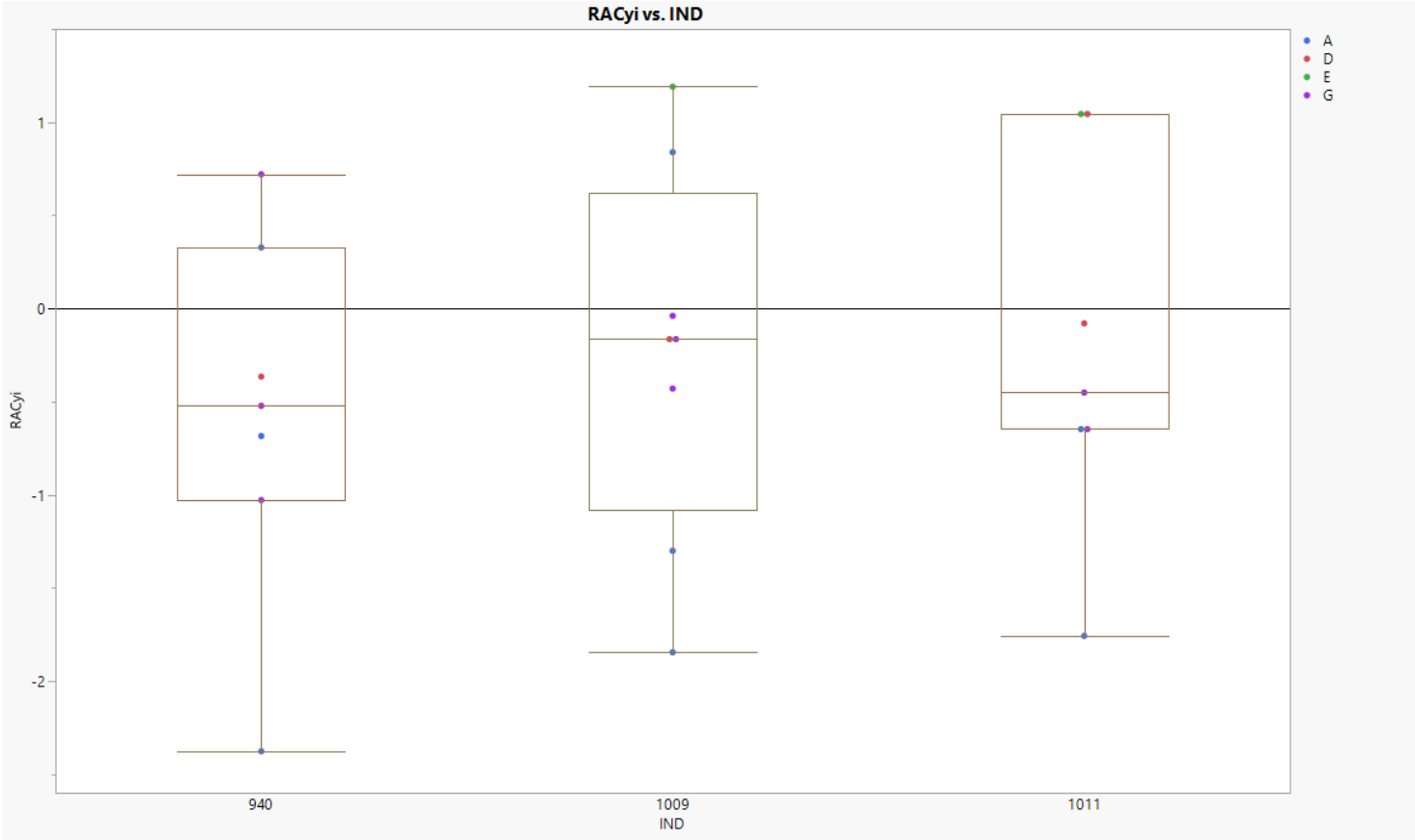
- The medians for 1009, 1011 and 1011-1 are approximately 0.2 to 0.3 standard deviations mild.
- The median for 940 is about 0.7 standard deviations mild.

Valid RAC by Fuel Batch



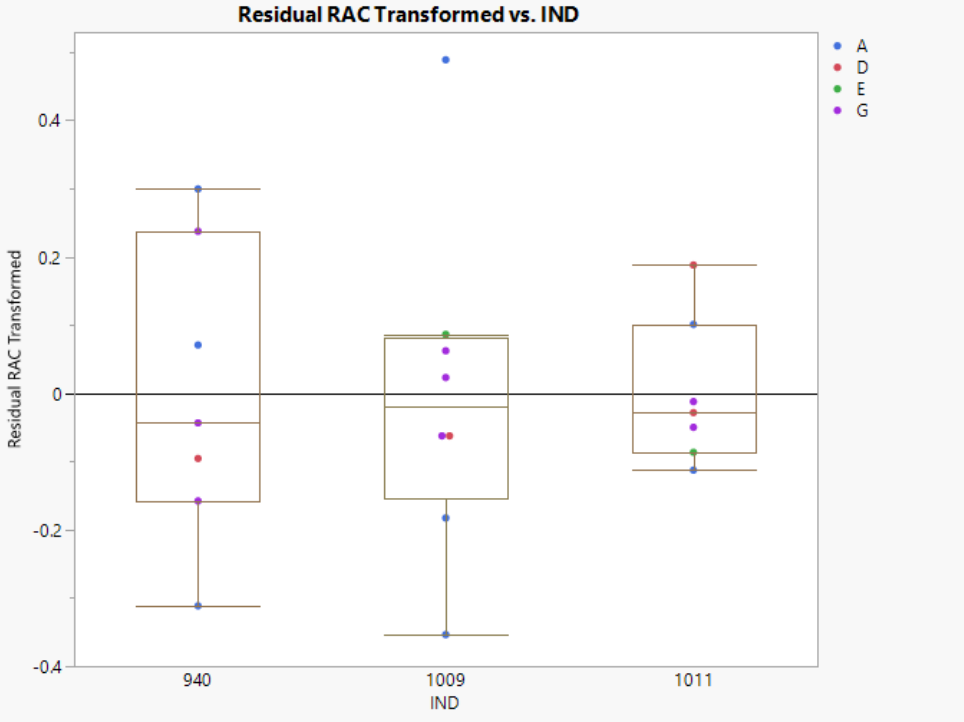
- The medians are mild for all ROs for each fuel batch.

Precision Matrix



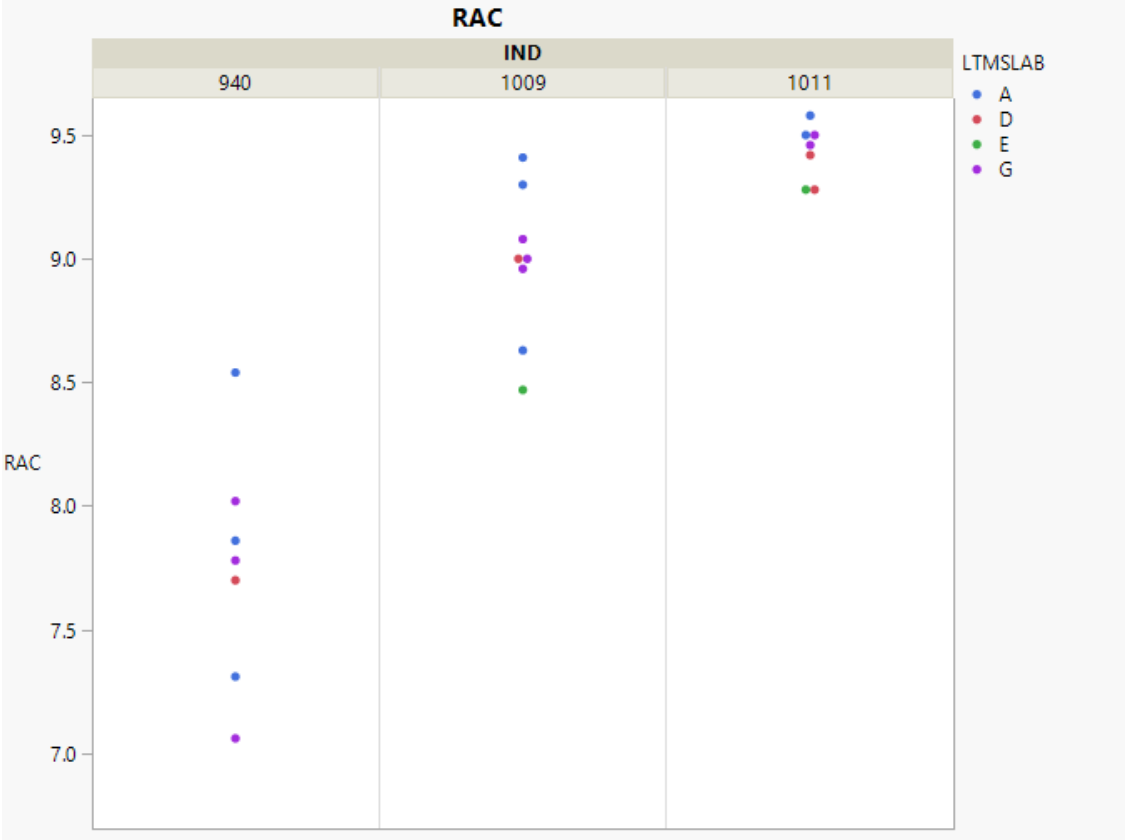
- The majority of the Precision Matrix RAC Yi's are mild.

Precision Matrix Residuals



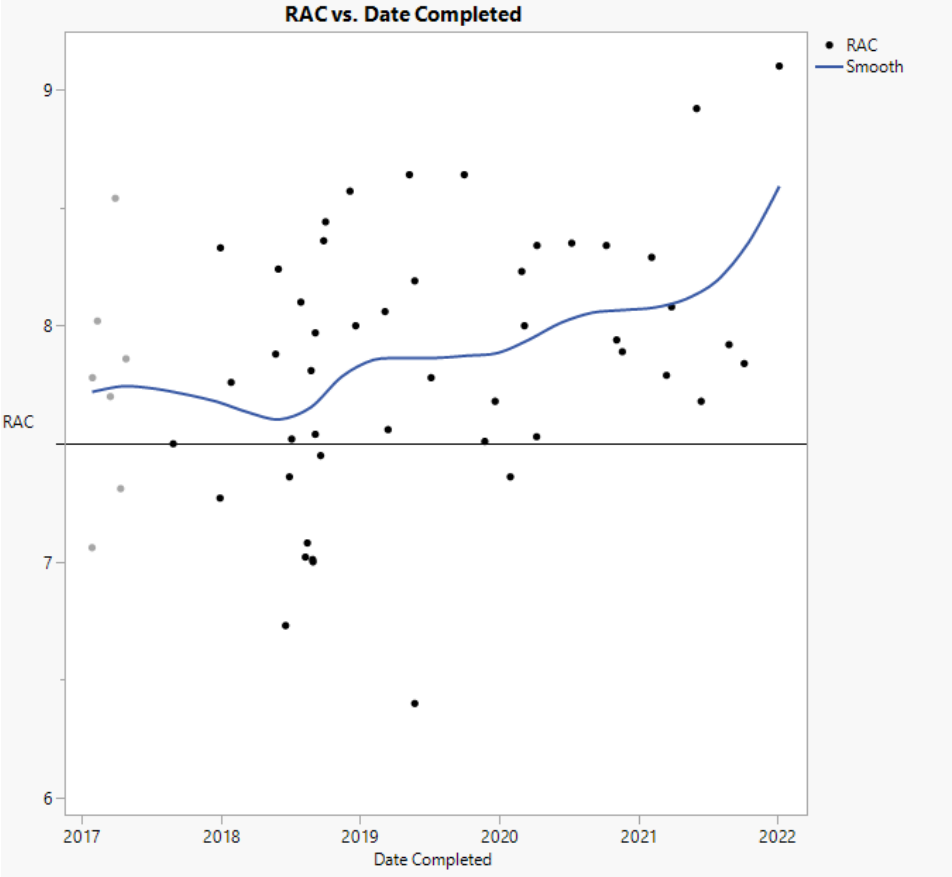
- The Precision Matrix transformed RAC (n = 22) was regressed on Lab and RO.
- Though the medians for each are slightly negative, the means are 0 by necessity of the model structure.
- The medians being negative while the means are 0 indicates that the tail on the positive side is a bit longer than the negative (positive skew).

Precision Matrix RAC Distribution by RO.



- Lab E had 2 valid results, one on 1009 and an another on 1011.
- Those results were the lowest (tied for lowest for 1011) for each RO.
- The model predicted Lab E would yield a mean RAC of 6.67 for RO 940.

RO 940



- Bolded are post PM.
- 7.50 is back transformed target.

Precision Matrix Regression Analysis

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
LTMSLAB	3	3	0.4478957	3.1012	0.0563
IND	2	2	6.8854557	71.5110	<.0001*

Expanded Estimates

Nominal factors expanded to all levels

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	0.1458611	0.055529	2.63	0.0183*
LTMSLAB[A]	-0.225539	0.079052	-2.85	0.0115*
LTMSLAB[D]	0.0128785	0.096099	0.13	0.8951
LTMSLAB[E]	0.2873388	0.125363	2.29	0.0358*
LTMSLAB[G]	-0.074679	0.079052	-0.94	0.3589
IND[940]	0.769636	0.069088	11.14	<.0001*
IND[1009]	-0.094356	0.065417	-1.44	0.1685
IND[1011]	-0.675281	0.069088	-9.77	<.0001*

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
940	0.9154971	0.09513092	0.78867
1009	0.0515056	0.08263125	-0.02355
1011	-0.5294195	0.08484251	-0.57047

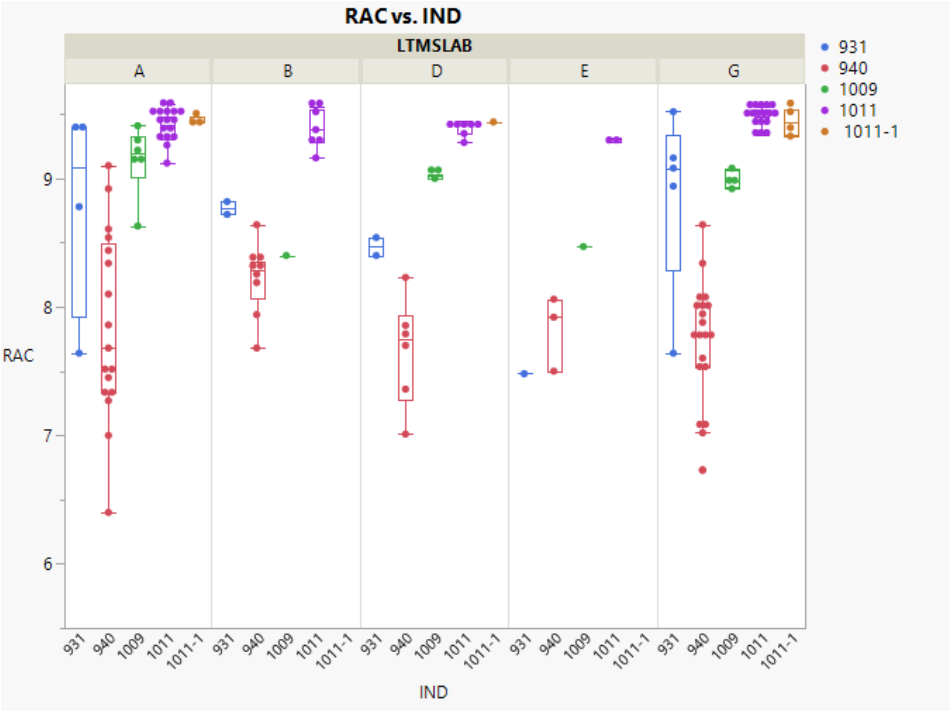
- Note that Lab E is nearly 0.3 severe.
- The 2 labs that run the majority of the tests are both mild of the average.

Precision Model Implications

	LS Mean Transformed RAC			Back Transformed RAC		
	940	1009	1011	940	1009	1011
A	0.6900	-0.1740	-0.7550	8.01	9.16	9.53
D	0.9284	0.0644	-0.5165	7.47	8.93	9.40
E	1.2028	0.3388	-0.2421	6.67	8.60	9.22
G	0.8408	-0.0232	-0.6041	7.68	9.02	9.45
Average	0.9155	0.0515	-0.5294	7.50	8.95	9.41
Avg. w/o E	0.8197	-0.0443	-0.6252	7.73	9.04	9.46
Avg. (n = 142)	0.7359	-0.0177	-0.5681	7.91	9.02	9.43

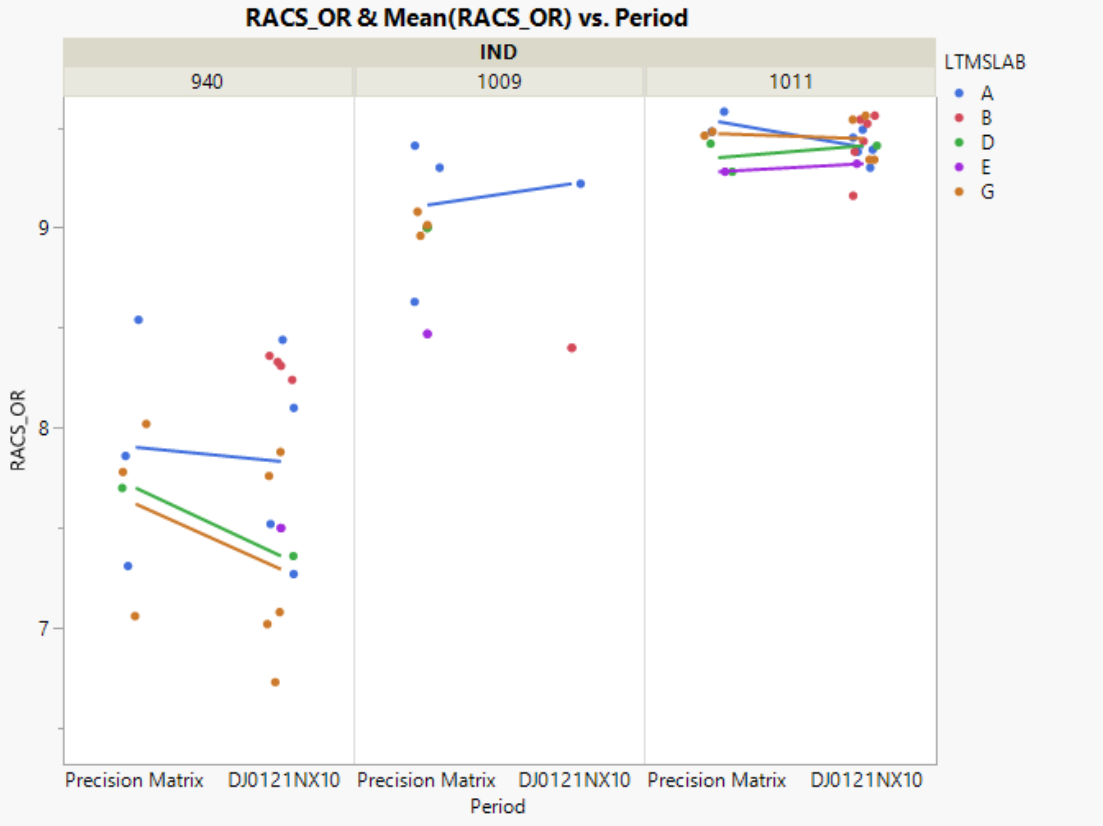
- The model predicted Lab E would yield a mean RAC of 6.67 for RO 940.

Valid RAC Results



- 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.

PM and Post PM DJ Fuel Batch Tests



- For each of the 3 oils, the ranges for both periods are similar.
- For 940, Lab A's averages for both periods are similar but for Lab D and G, the PM averages are mild of the Post PM period.

Industry Alarms

Parameter	Test Number	Lab	Stand	Oil	Yi	Zi
AES	113	A	5	931	-3.2333	-0.8068
	114	A	5	1011	-1.8421	-1.0139
	115	E	1	931	-1.7500	-1.1611
	116	E	1	940	-0.4286	-1.0146
AEV	10	A	2	1011	1.2857	0.8412
	57	G	4	940	1.3214	0.8066
	58	G	2	1011	1.0476	0.8548
	59	D	1	1011	1.1429	0.9124
	61	G	1	940	1.0000	0.7840
	62	G	5	1011	1.7143	0.9700
APV	49	A	4	1011	-2.1042	-0.8153

- The majority of the industry alarms has been for RAC.

Parameter	Test Number	Lab	Stand	Oil	Yi	Zi
RAC	16	A	2	940	-2.3764	-1.0084
	29	B	1	1011	-1.0632	-0.7926
	31	G	1	1011	-1.2845	-0.8414
	53	B	3	1011	-1.5155	-0.8267
	55	A	2	940	-2.4683	-0.8791
	56	G	4	1011	-1.5155	-1.0064
	57	G	4	940	-0.9839	-1.0019
	58	G	2	1011	-0.6472	-0.9309
	59	D	1	1011	-0.3557	-0.8159
	60	E	1	940	-1.1186	-0.8764
	65	B	3	940	-2.6903	-0.8499
	66	B	3	940	-1.4255	-0.9650
	83	A	3	940	-1.8083	-0.7902
	84	G	5	1011	-1.5155	-0.9352
	85	B	2	940	-1.8351	-1.1152
	86	A	2	1011	-0.0797	-0.9081
	87	G	1	1011	-1.0632	-0.9391
	88	G	3	940	-1.8083	-1.1130
	89	B	3	940	-0.8531	-1.0610
	90	A	5	1011	-0.8511	-1.0190
	91	G	4	940	-0.7470	-0.9646
	92	A	4	1009	-0.6445	-0.9006
	93	B	2	940	-1.6770	-1.0559
	95	A	3	931	-1.2933	-0.8524
	111	A	5	940	-3.7103	-1.3225
	112	A	1	940	-0.3271	-1.1235
	127	A	2	940	-4.5171	-1.1616

Lab Calibration Fails

Test Number	Lab	Preceding Stand	Alarm Stand	Preceding Oil	Oil	Parameter	Zi-1	Yi	Zi	ei
109	A	3	1	1011	931	AES	1.11012	-1.0167	0.472074	-2.12682
113	A	1	5	940	931	AES	-0.08032	-3.2333	-1.02622	-3.15298
119	A	5	2	1011	1011-1	AES	-1.27098	1.2105	-0.52654	2.481482
33	A	2	1	1011	1011	AEV	0.321483	-1.9048	-0.3464	-2.22628
63	B	2	3	1011	940	AEV	-0.34448	-4.7143	-1.65543	-4.36982
76	B	3	3	940	940	AEV	-0.75	-3.0357	-1.43571	-2.2857
99	D	1	2	931	940	AEV	-0.16371	-2.2857	-0.80031	-2.12199
16	A	1	2	1009	940	RAC	-1.5964	-2.3764	-1.8304	-0.78
17	A	2	1	940	1009	RAC	-1.8304	0.8388	-1.0296	2.6692
67	A	1	3	1011	940	RAC	-0.9174	1.617	-0.1571	2.5344
111	A	1	5	931	940	RAC	-0.7427	-3.7103	-1.633	-2.9676
113	A	1	5	940	931	RAC	-1.0519	1.103	-0.4054	2.1549
38	B	1	2	1011	1009	RAC	-1.3541	1.3332	-0.5479	2.6873
39	B	2	2	1009	1011	RAC	-0.5479	1.8454	0.1701	2.3933
65	B	2	3	1011	940	RAC	-0.3508	-2.6903	-1.0527	-2.3395
73	G	4	5	1011	940	RAC	-0.2416	-2.6903	-0.9762	-2.4487
96	G	4	2	940	931	RAC	-1.092	1.103	-0.4335	2.195
26	B		1		1011	APV	-1.48787	-3.25	-2.01651	-1.76213
65	B	2	3	1011	940	APV	-0.35257	-2.9531	-1.13273	-2.60053
3	G	2	2	940	1011	APV	0.32798	-1.75	-0.29541	-2.07798

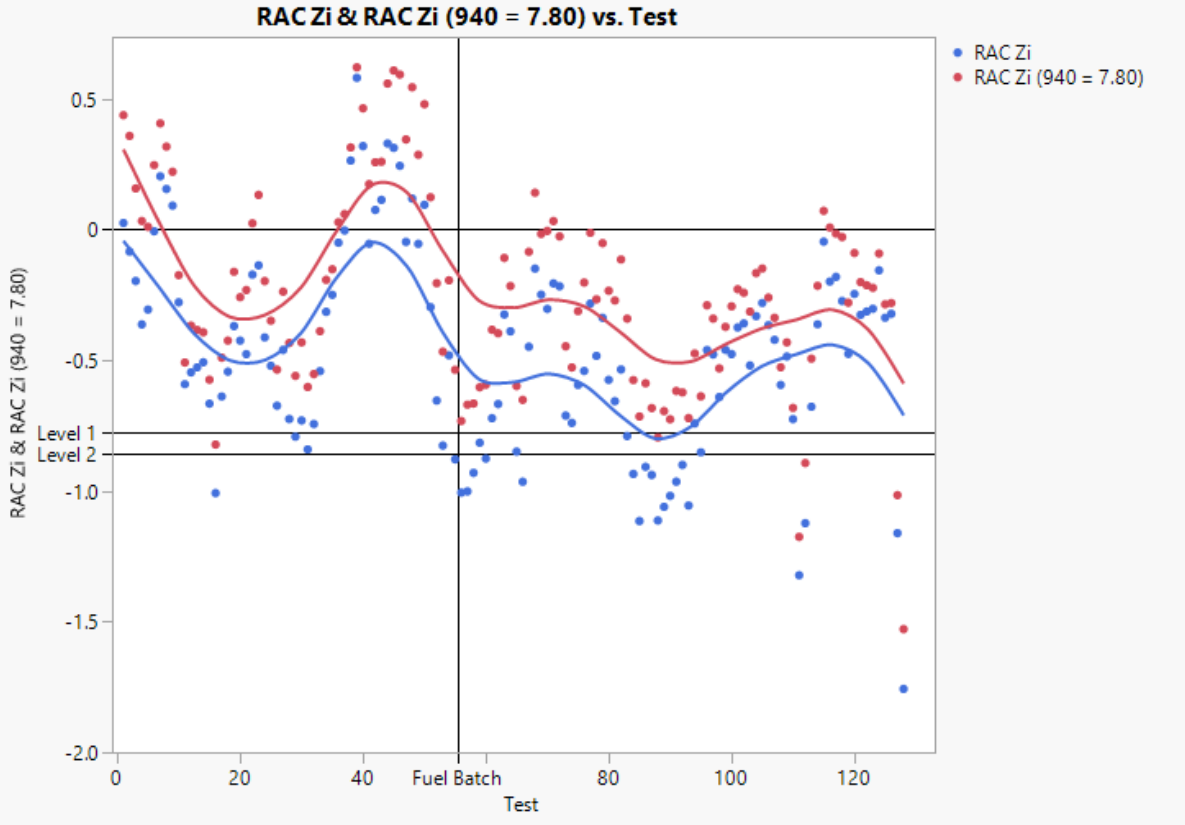
RAC LS Means from Various Subsets

Untransformed RAC LS Means

Source		All Labs			Exclude Lab E			Exclude Lab E - RAC Not Trans		
Subset	Target	All	Excl 3 A Hi 940	DI Fuel	All	Excl 3 A Hi 940	DI Fuel	All	Excl 3 A Hi 940	DI Fuel
n		143	140	54	136	133	50	136	133	50
931	8.74	8.78	8.79		8.89	8.89		8.78	8.78	
940	7.50	7.83	7.75	7.76	7.91	7.83	7.76	7.86	7.79	7.73
1009	8.95	8.98	8.99	9.03	9.04	9.05	9.03	9.03	9.04	9.00
1011	9.41	9.40	9.40	9.43	9.43	9.43	9.43	9.43	9.44	9.42
1011-1	9.41	9.41	9.42		9.44	9.44		9.47	9.48	

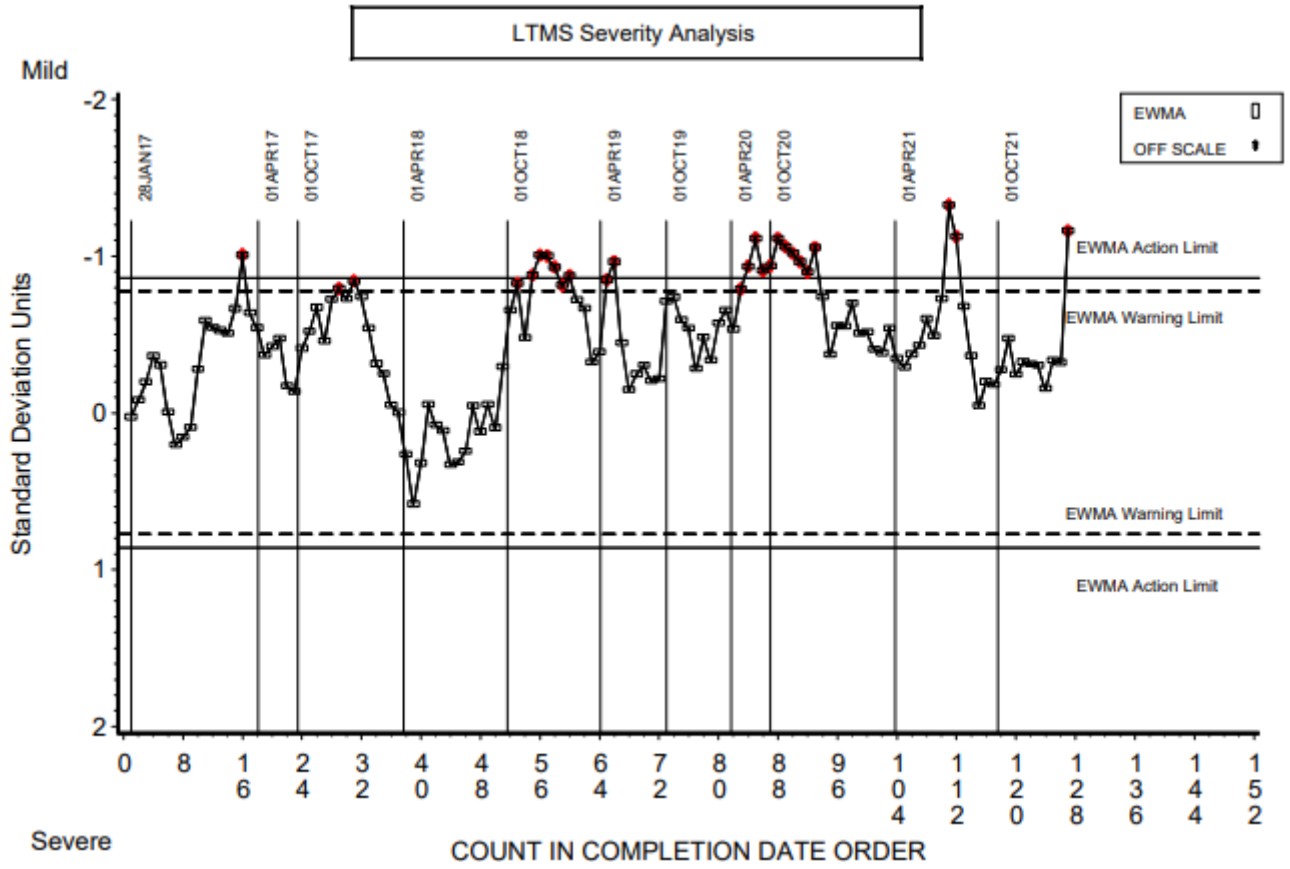
- If we are to recalculate the RAC targets what subset would we use and which ROs should be revised?
- For the ROs other than 940, the LS Means for the various subsets are all very similar (generally, within 0.10).
  - Recommend against changing these targets.
- The alternative LS Means for 940 range from 7.75 to 7.85, which is 0.5 to 0.7 standard deviations mild of the current target.

RAC Zi with RO 940 Target Change



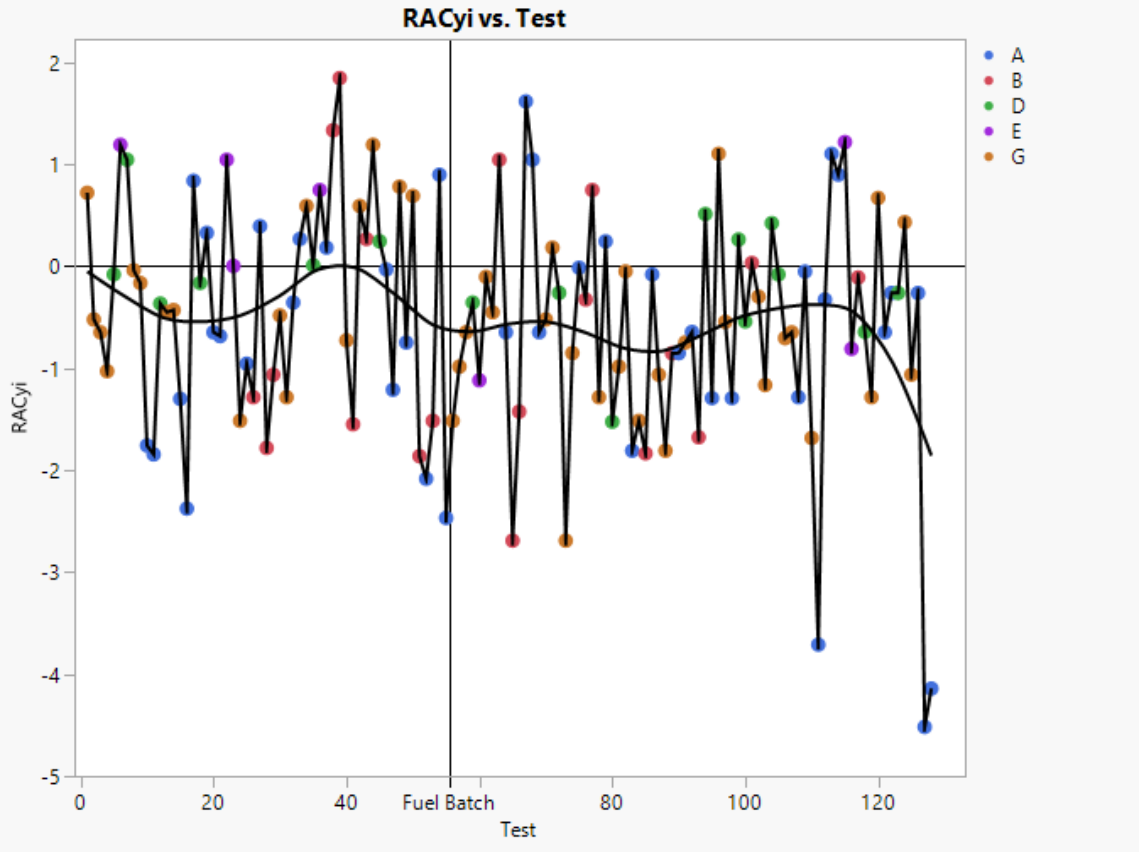
- Increasing RO 940 target from 7.50 to 7.80 reduces number of historic alarms from 28 to 6.
- The severity appears to have shifted mild just before the fuel batch change.

RAC EWMA



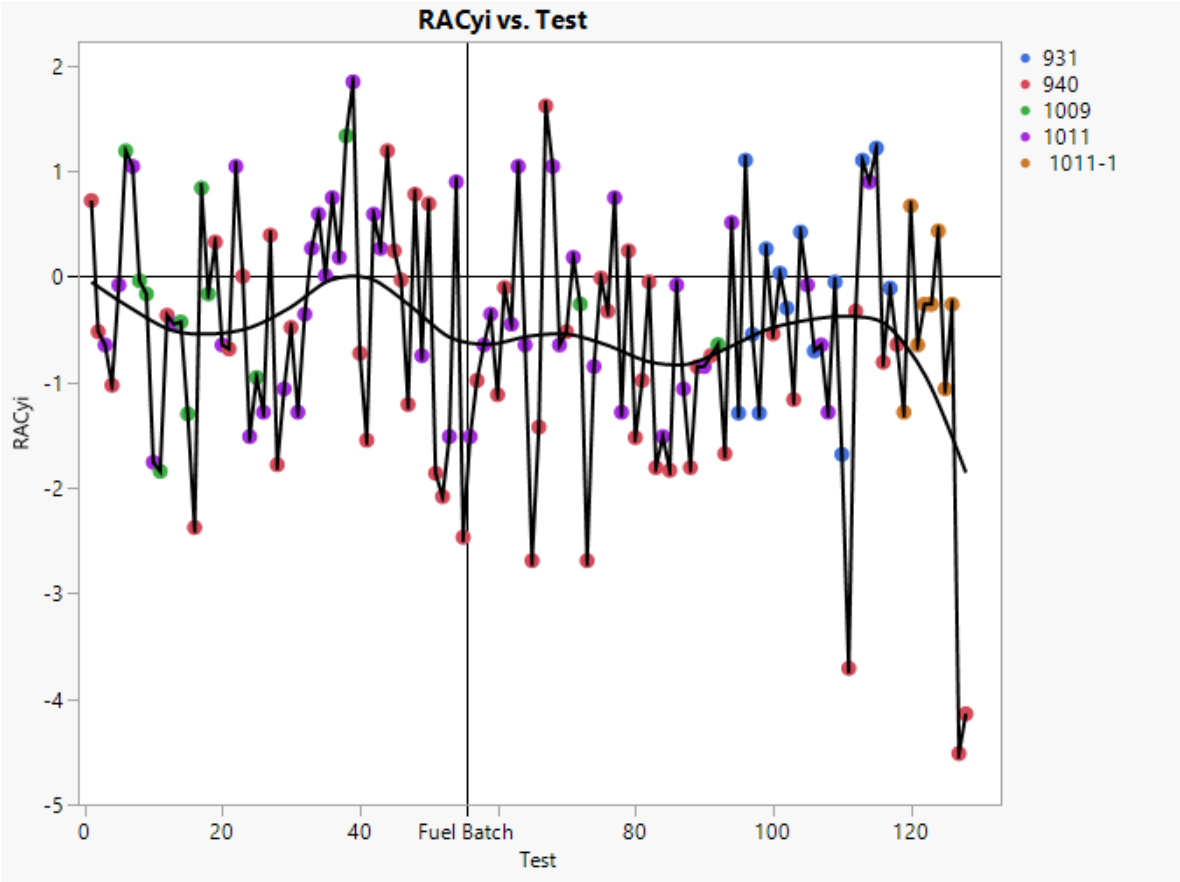
- RAC has been mild (EWMA < 0) for most of the test's life.

RAC Yi with Lab



- 4 of the 5 tests prior to the fuel batch change were mild.
- 3 of those tests were from SwRI and the other 2 from LZ.
- There are 8 tests with Yi < -2 – 6 of those are from SwRI.

RAC Yi with RO



- The lowest 9 Yi are RO 940.
- However, the mildness issue goes beyond RO 940 and appears to have surfaced prior to the fuel batch change.

Permissions