

Cummins Surveillance Panel Teleconference
March 8, 2022 10:00 – 11:30 EST

Attendance:

Sean Moyer - TMC
Nick Ariemma - Lubrizol
Christian Porter, Todd Dvorak - Afton
Bob Warden, Jose Starling- SwRI
Andrew Smith, Martin Chadwick - Intertek
Dan Lanctot - TEI
Phil Shelton, Ryan Denton - Cummins
Elisa Santos, David Brass - Infineum
Prasad Tumati - Haltermann Solutions
Steve Jetter – ExxonMobil
David Lee, Jo Martinez, Marnix Torreman – Oronite
Amanda Stone -

Agenda:

- ISM IAS and Sludge action alarms corrective actions

Elisa Santos made a presentation of analysis done by the statisticians group looking into additional tests on the newest batch of ISM hardware (presentation attached to these minutes).

The statistician group recommended that the IAS CF be update but that the reference oil target standard deviation remain unchanged. There was some discussion around looking at the soot correction and how it affected the high IAS result for stand C1. No action was deemed necessary.

MOTION:

David brass motioned to change the IAS CF from 0.41 to 0.25 effective for candidate tests that end on or after 3/22/2022. Jose Starling seconded.

The motion carried unanimously.

There was discussion about the sludge dataset including the raters for each test, the change in filter plugging around the same time as well as investigating operational parameters that drive sludge. The statisticians recommended that further investigation be done to determine the causes for the sludge shift.

Action Items:

- Elisa and the stats group to look at individual sludge location breakdowns and filter plugging correlation data.
- Sean add sludge breakdowns and requested operational parameters to Itms file.

Next meeting tentatively scheduled for the week of March 21st.

Meeting adjourned at 11:28 EST.

Re-evaluation of ISM Coordinated Reference Tests w/ G Xheads: *Focus on Injector Adjusting Screw Wear at 3.9% soot and Sludge*

Statistics Group

02/11/2022

Performance you can rely on.



Statistics Group



- Elisa Santos, Infineum
- Jo Martinez, Chevron Oronite
- Martin Chadwick, Intertek
- Phil Scinto, Lubrizol
- Sean Moyer, TMC
- Todd Dvorak, Afton
- Travis Kostan, SwRI
- Taylor Lagler, Lubrizol

Summary (1 of 2)

- The ISM test has triggered
 - an Industry Action Alarm on Injector Adjusting Screw Wear (IAS) Zi and Qi
 - a warning alarm for Sludge (ASR) Qi.
- **IAS CF Proposal:** There are two options for CF (Chart = Yes); others can be generated if needed

G Xhead batch	IAS	issue	89.7 mg from C/1
current CF	0.41	overcorrecting	
option 1 *	0.25		exclude
option 2 *	0.19		include

* model LN transform; Lab/Stand, Parts, Oil reblend

Statistics Group Recommendation: Option 1

- The reason for this high result was shared with SP, but I could not find the record.
- **IAS standard deviation update** : current standard deviation is equal to 5.7 mg
 - No change. Calculations are based on excluding E crosshead batch of high variability

- **Sludge Proposal:**

- B/1 was the only stand producing Sludge at, approximately, 8 merits for batches E and F, before the G Xhead was used.
- B/1 generated 7.2, 7.4, 8 and 8.1 merits for G Xhead batch
- 2 out of 4 tests are very low when compared to the other labs
- **An investigation of stand B/1 is needed, before targets and standard deviation are updated.**

- The table below presents the impact on the target and std. dev. for four subsets of data

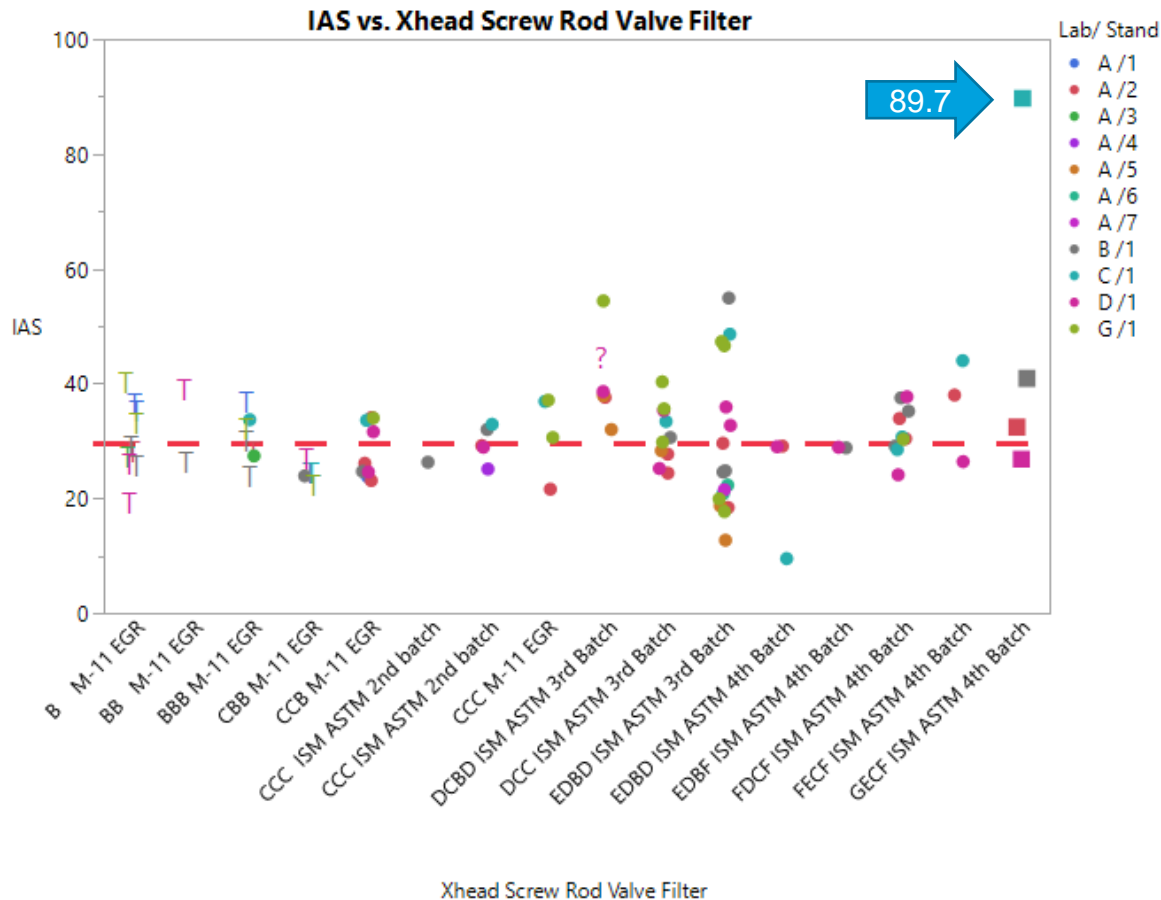
Before updating Sludge target and std dev. investigate B/1 test results				
Options	sample size	mean	standard deviation	data
current state	5	8.24	0.503	data from SP meeting 04/2020
1	8	8.34	0.3114	chart = Yes; exclude B/1 = 7.4 & 7.2
2	10	8.13	0.5187	chart = Yes
3	11	8.07	0.5274	all data available, including chart =N (A/2= 7.5)
4	9	8.24	0.4035	include chart =N (A/2 = 7.5); exclude B/1 = 7.4 & 7.2

Injector adjusting screw wear at 3.9% soot (milligrams)

Injector adjusting screw wear at 3.9% soot (milligrams)

- Last SP meeting 04/16/2020 reached consensus: **Do nothing**
- We also raised the potential increased variability

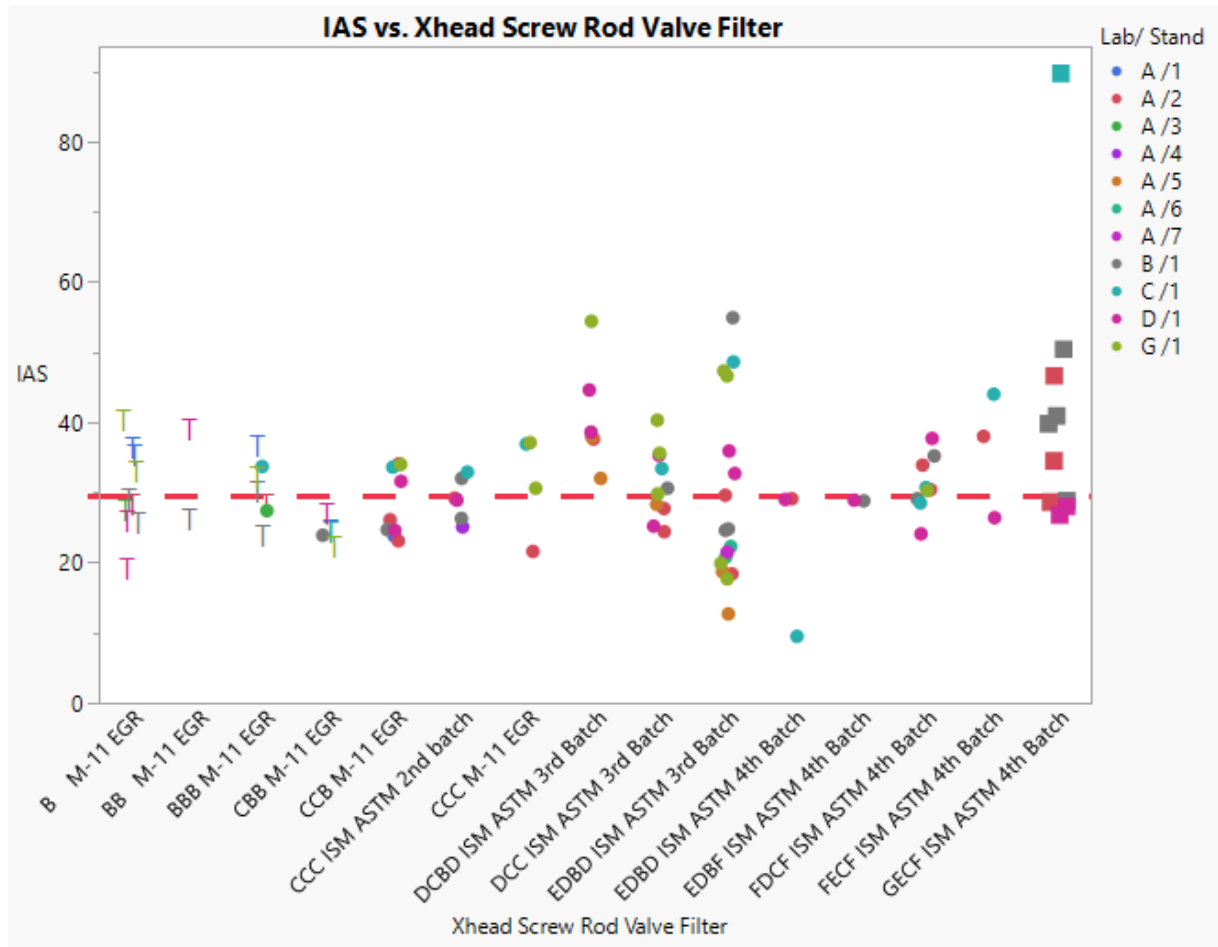
Data then...
04/16/2020



Current data: 830-2/ 830-3, chart =yes IAS versus parts changes over time



It seems that current CF=0.41 is overcorrecting

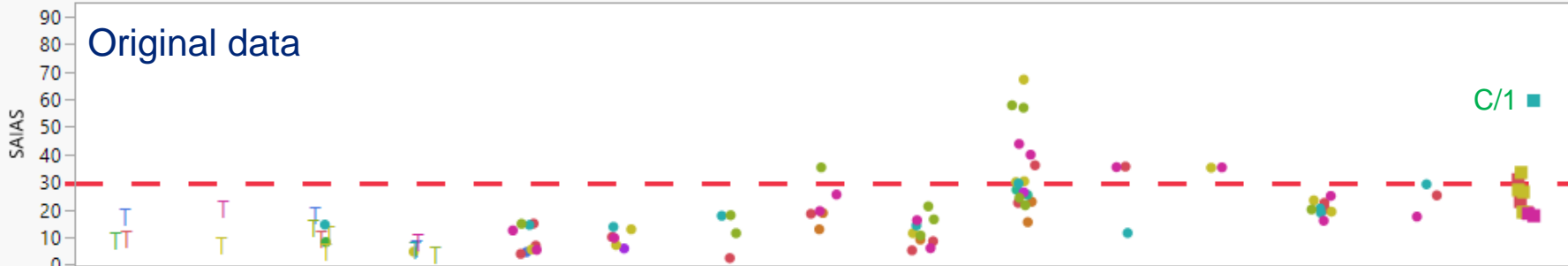


SAIAS Orig, IAS after current CF 0.41, IAS after proposed CF with and without 89.7 from Lab C vs. Xhead Screw Rod Valve Filter

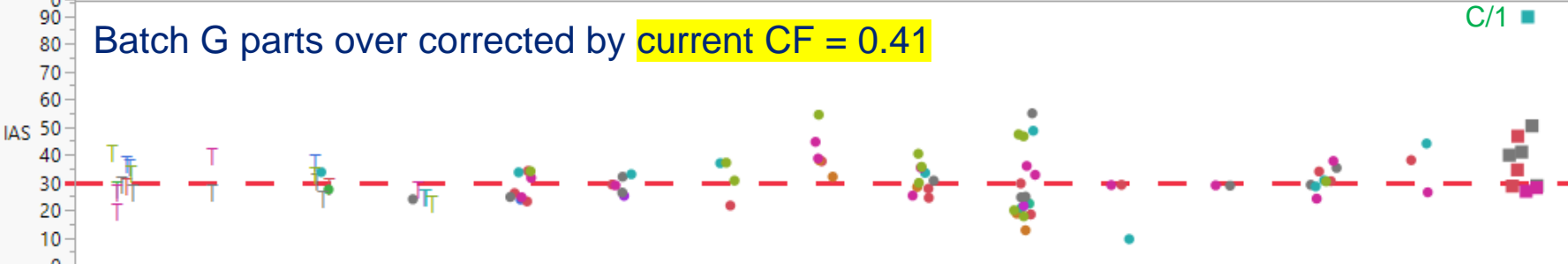
Lab/ Stand

- A /1
- A /2
- A /3
- A /4
- A /5
- A /6
- A /7
- B /1
- C /1
- D /1
- G /1
- B /1

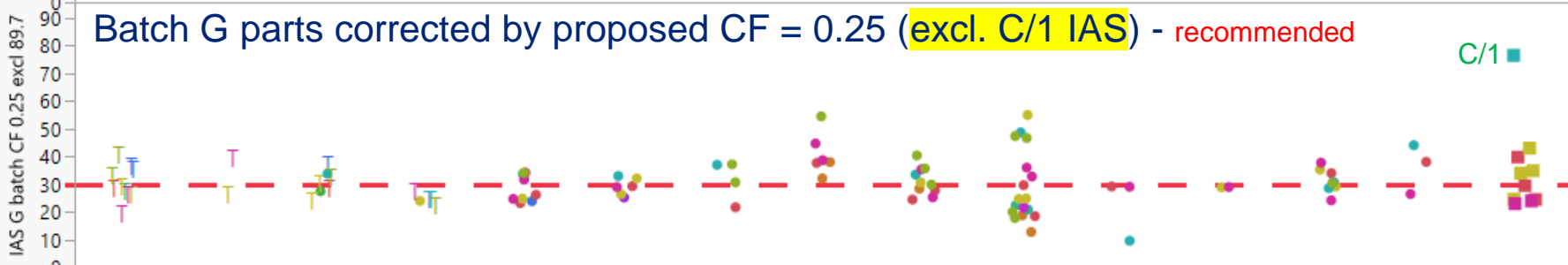
Original data



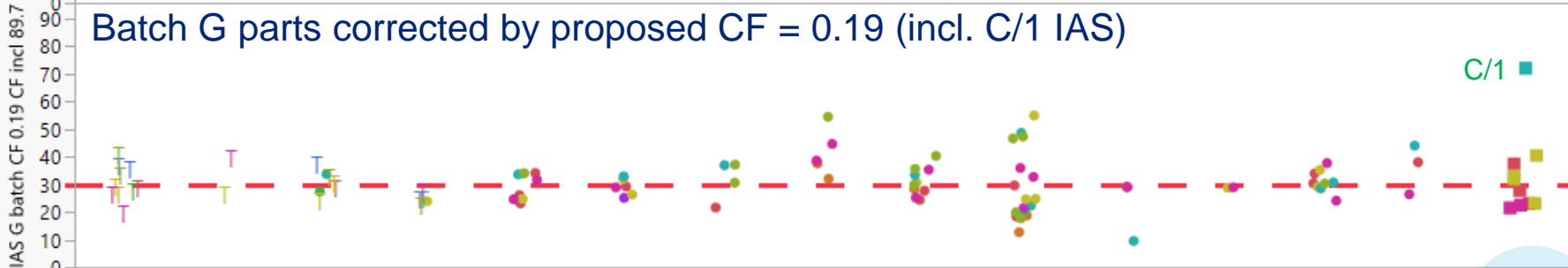
Batch G parts over corrected by **current CF = 0.41**



Batch G parts corrected by proposed CF = 0.25 (excl. C/1 IAS) - recommended



Batch G parts corrected by proposed CF = 0.19 (incl. C/1 IAS)



B M-11 EGR BB M-11 EGR BBB M-11 EGR CBB M-11 EGR CCB M-11 EGR CCC ASTM 2nd batch CCC M-11 EGR DCBD ASTM 3rd Batch DCC ASTM 3rd Batch EDBD ASTM 3rd Batch EDBD ASTM 4th Batch EDBF ASTM 4th Batch FDCF ASTM 4th Batch FEFC ASTM 4th Batch GEFC ASTM 4th Batch

Xhead Screw Rod Valve Filter

G Xhead batch

IAS standard deviation update : current standard deviation is equal to 5.7 mg



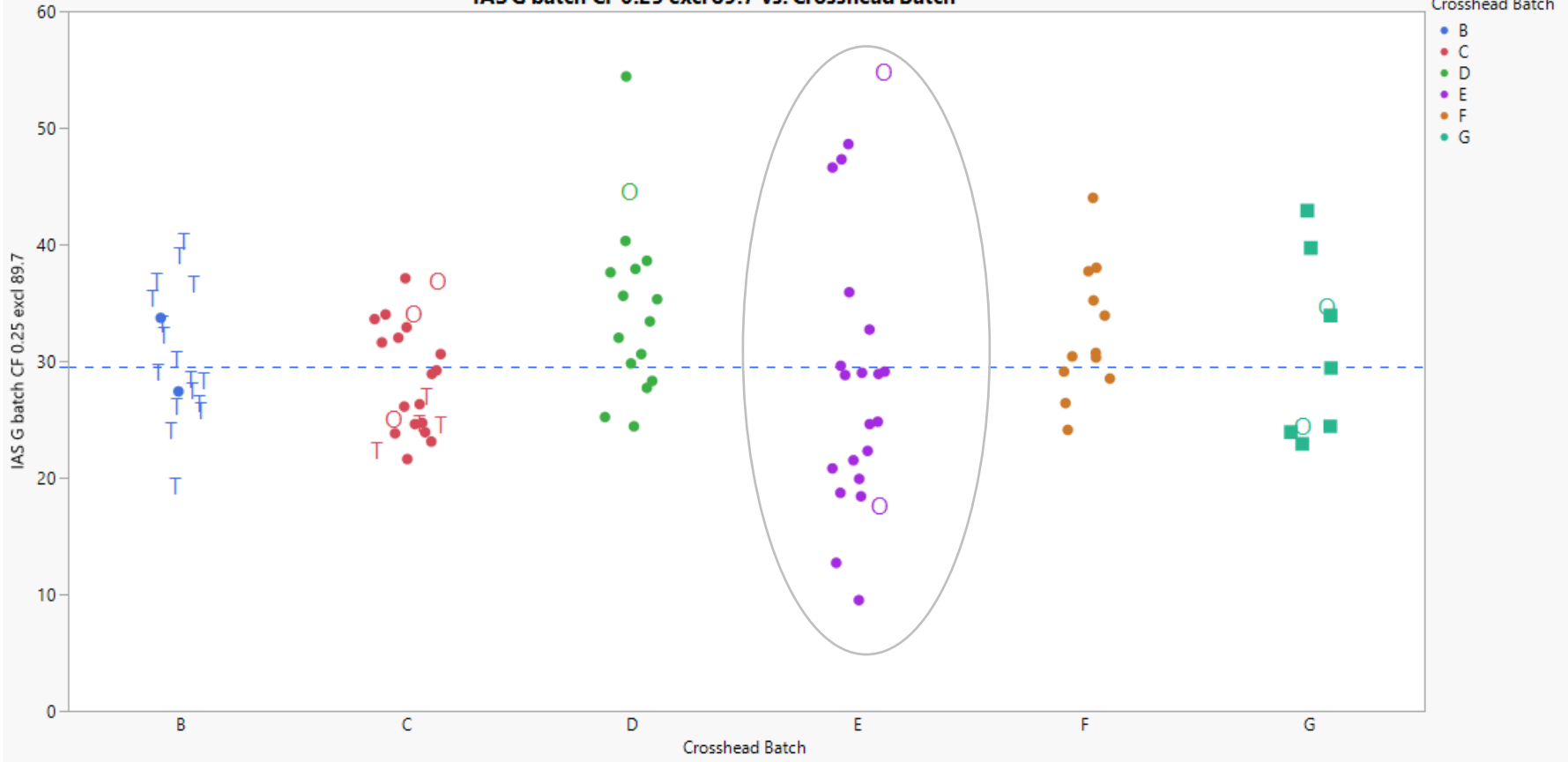
- No change
 - Assumes that crosshead batch E introduces high variability that does not seem to be currently present. Calculations exclude E crosshead batch.
 - Next slides show graphical representation of the data and calculations to justify maintaining the current standard deviation

Including the two donated tests "N" would give $n=23$; std dev = 6.23 mg

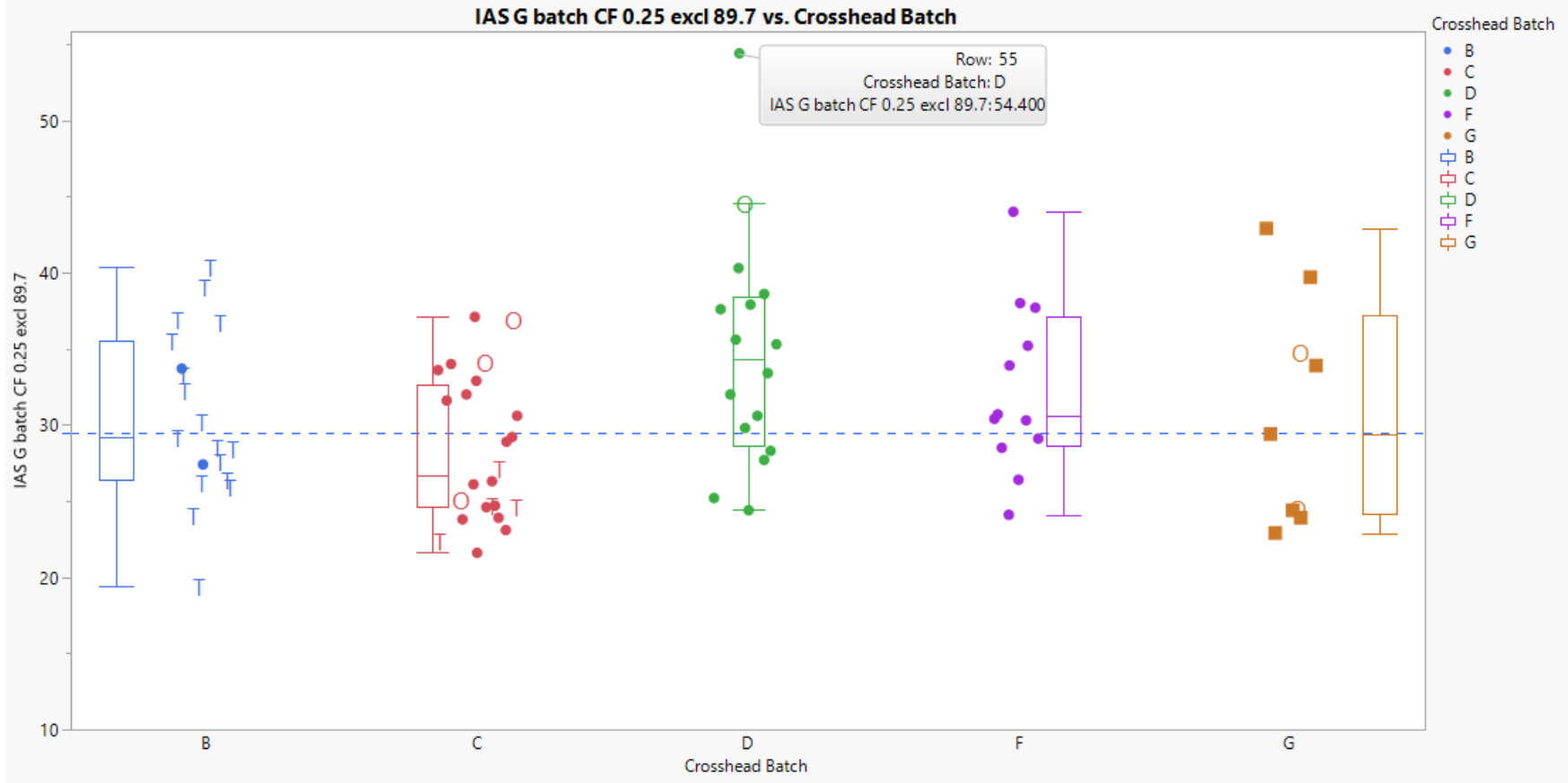
There was clearly increased variability at the time batch E hardware was in use that does not seem to be present in prior or more recent data



IAS G batch CF 0.25 excl 89.7 vs. Crosshead Batch



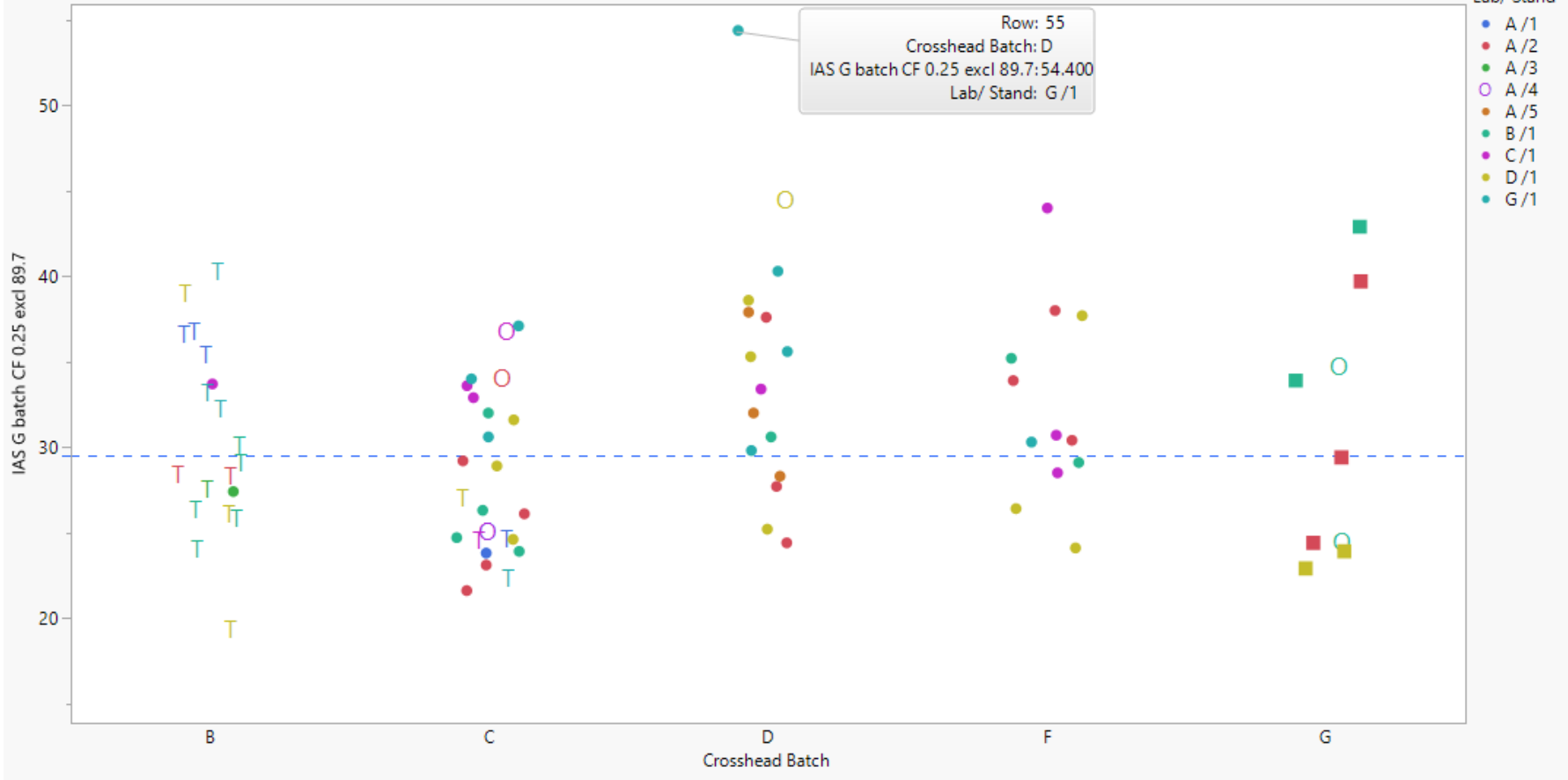
After removing E crosshead batch



By Lab/Stand



IAS G batch CF 0.25 excl 89.7 vs. Crosshead Batch



After removing E crosshead batch (n=80) and ignoring the Lab/Stand effect provides us with a RMSE = 5.705

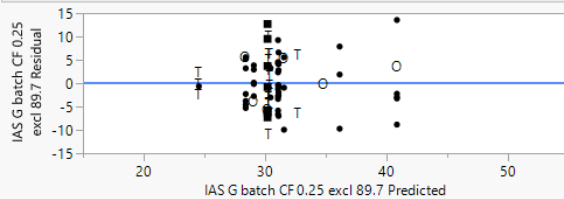


Observing the RMSE from the model without Lab/Stand may be useful to understanding

Response IAS G batch CF 0.25 excl 89.7

Whole Model

Residual by Predicted Plot



Summary of Fit

RSquare	0.311747
RSquare Adj	0.188478
Root Mean Square Error	5.705126
Mean of Response	31.00625
Observations (or Sum Wgts)	80

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Model	12	987.7797	82.3150	2.5290	
Error	67	2180.7471	32.5485		0.0082*
C. Total	79	3168.5269			

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob> t	VIF	
Intercept	29.446071	2.676015	11.00	<.0001*	.	
Xhead Screw Rod Valve Filter[B M-11 EGR]	-1.486071	1.852443	-0.80	0.4253	2.0018292	
Xhead Screw Rod Valve Filter[BB M-11 EGR]	1.0039286	3.779025	0.27	0.7913	4.5576416	
Xhead Screw Rod Valve Filter[BBB M-11 EGR]	-1.303214	2.14336	-0.61	0.5452	2.2512321	
Xhead Screw Rod Valve Filter[CBB M-11 EGR]	-7.206071	2.478693	-2.91	0.0049*	2.6049173	
Xhead Screw Rod Valve Filter[CCB M-11 EGR]	-3.346071	1.932077	-1.73	0.0879	2.0643849	
Xhead Screw Rod Valve Filter[CCC ISM ASTM 2nd batch]	-2.679405	2.289059	-1.17	0.2459	2.3966545	
Xhead Screw Rod Valve Filter[CCC M-11 EGR]	-0.196071	2.738632	-0.07	0.9431	2.9235653	
Xhead Screw Rod Valve Filter[DCBD ISM ASTM 3rd Batch]	9.1039286	2.289059	3.98	0.0002*	2.3966545	
Xhead Screw Rod Valve Filter[DCC ISM ASTM 3rd Batch]	-0.686071	1.852443	-0.37	0.7123	2.0018292	
Xhead Screw Rod Valve Filter[FDCF ISM ASTM 4th Batch]	-0.646071	1.932077	-0.33	0.7391	2.0643849	
Xhead Screw Rod Valve Filter[FECF ISM ASTM 4th Batch]	4.3872619	3.124166	1.40	0.1648	3.4635359	
IND[830-2]		2.3	3.0256	0.76	0.4498	8.1

Effect Tests

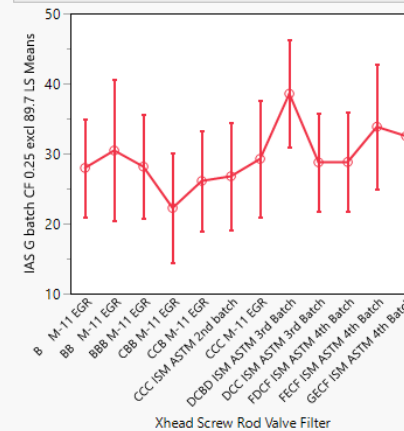
Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Xhead Screw Rod Valve Filter	11	11	982.00161	2.7428	0.0055*
IND	1	1	18.80889	0.5779	0.4498

Xhead Screw Rod Valve Filter

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
B M-11 EGR	27.960000	3.5226556	30.2600
BB M-11 EGR	30.450000	5.0426668	32.7500
BBB M-11 EGR	28.142857	3.7153784	30.4429
CBB M-11 EGR	22.240000	3.9577707	24.5400
CCB M-11 EGR	26.100000	3.5736189	28.4000
CCC ISM ASTM 2nd batch	26.766667	3.8182457	29.0667
CCC M-11 EGR	29.250000	4.1582895	31.5500
DCBD ISM ASTM 3rd Batch	38.550000	3.8182457	40.8500
DCC ISM ASTM 3rd Batch	28.760000	3.5226556	31.0600
FDCF ISM ASTM 4th Batch	28.800000	3.5736189	31.1000
FECF ISM ASTM 4th Batch	33.833333	4.4725545	36.1333
GECF ISM ASTM 4th Batch	32.500000	3.0256001	30.7111

Least Squares Means Plot



IND

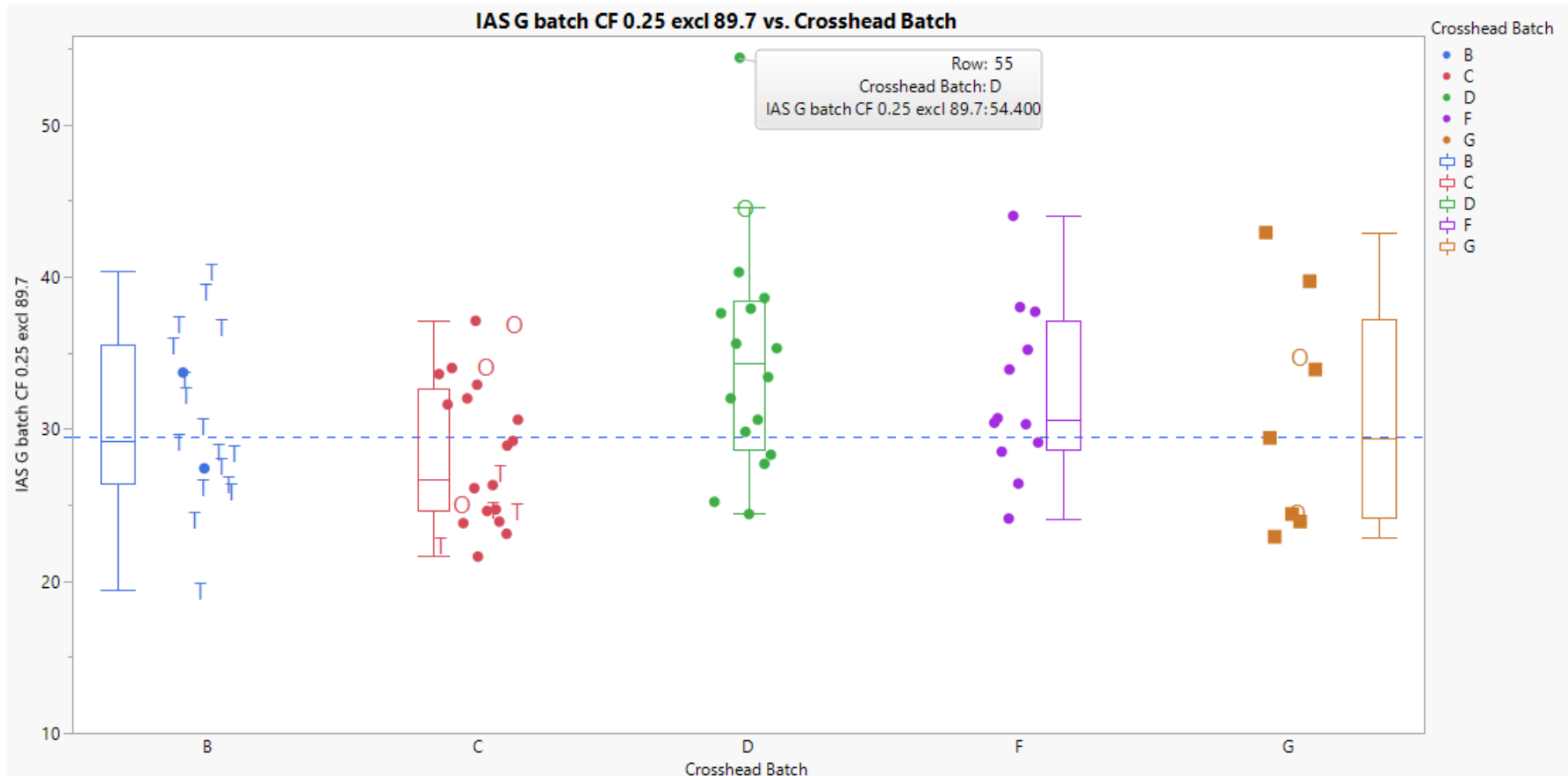
Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
830-2	31.746071	0.8480408	31.0958
830-3	27.146071	5.6490222	30.2000

Removing high value from batch D: standard deviation is equal to 5.7894
Keeping high value from batch D: standard deviation is equal to versus 6.3331
Note that these estimates ignore parts change



This is to show that after eliminating batch E, there is no need to update the standard deviation. Please, also look at slide 28.



Variability seems similar across these batches

Average Sludge rating (merits)

Average Sludge rating (merits): *square symbols** correspond to G Xhead



Data Available at SP meeting 04/16/2020

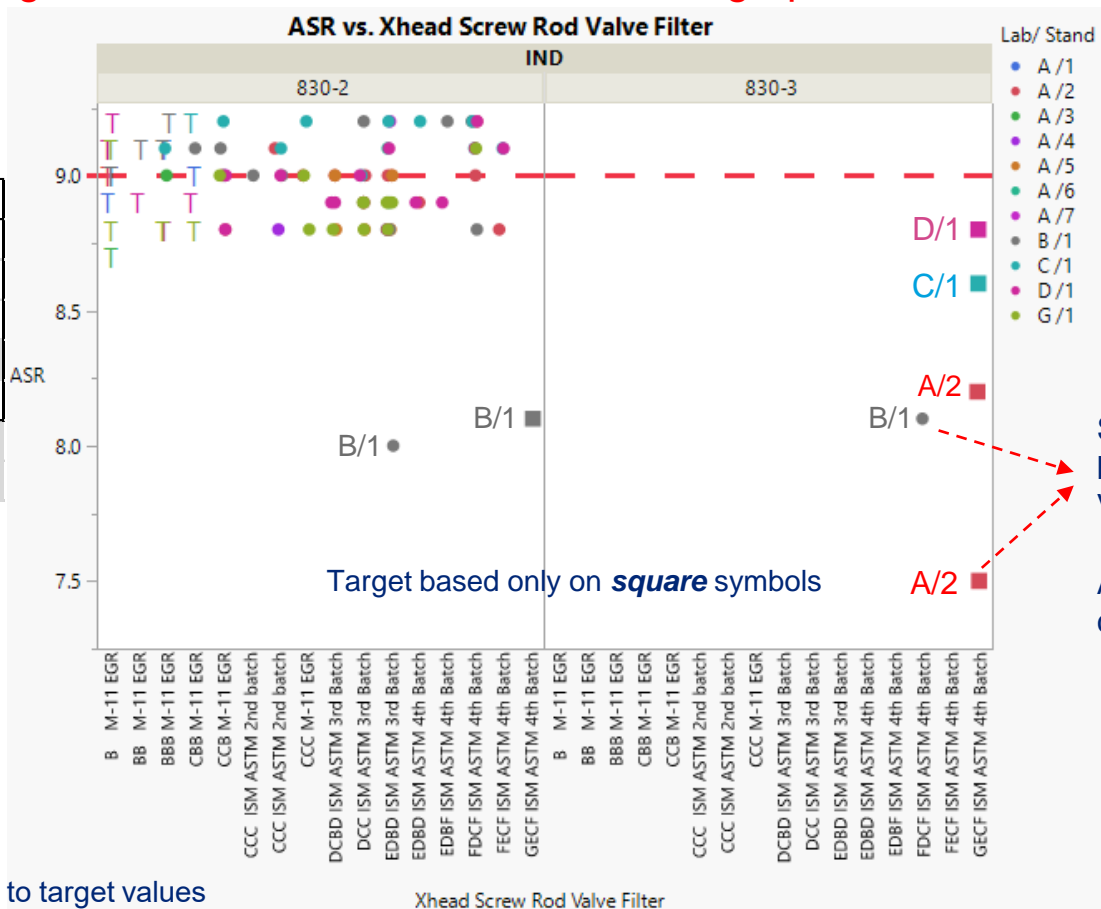
Consensus reached: redefine target and standard deviation

- Target: Simple Mean (n=5) ASR = 8.24
- Standard deviation: Sample Stdev (n=5) ASR = 0.503

Current Target & Stand. Dev. are based on table/graph below* G Xhead (n=5)

G Xhead (04/2020)

Lab	ASR	Oil
D/1	8.8	830-3
A/2	7.5	830-3
C/1	8.6	830-3
B/1	8.1	830-2
A/2	8.2	830-3
avg	8.24	
std	0.503	



Since 04/2020 these tests became "chart=N" VAL = AG & AI
A/2 = 7.5 is part of the current Target = 8.24

'T' symbols correspond to target values

Current data: G Xhead – 11 tests

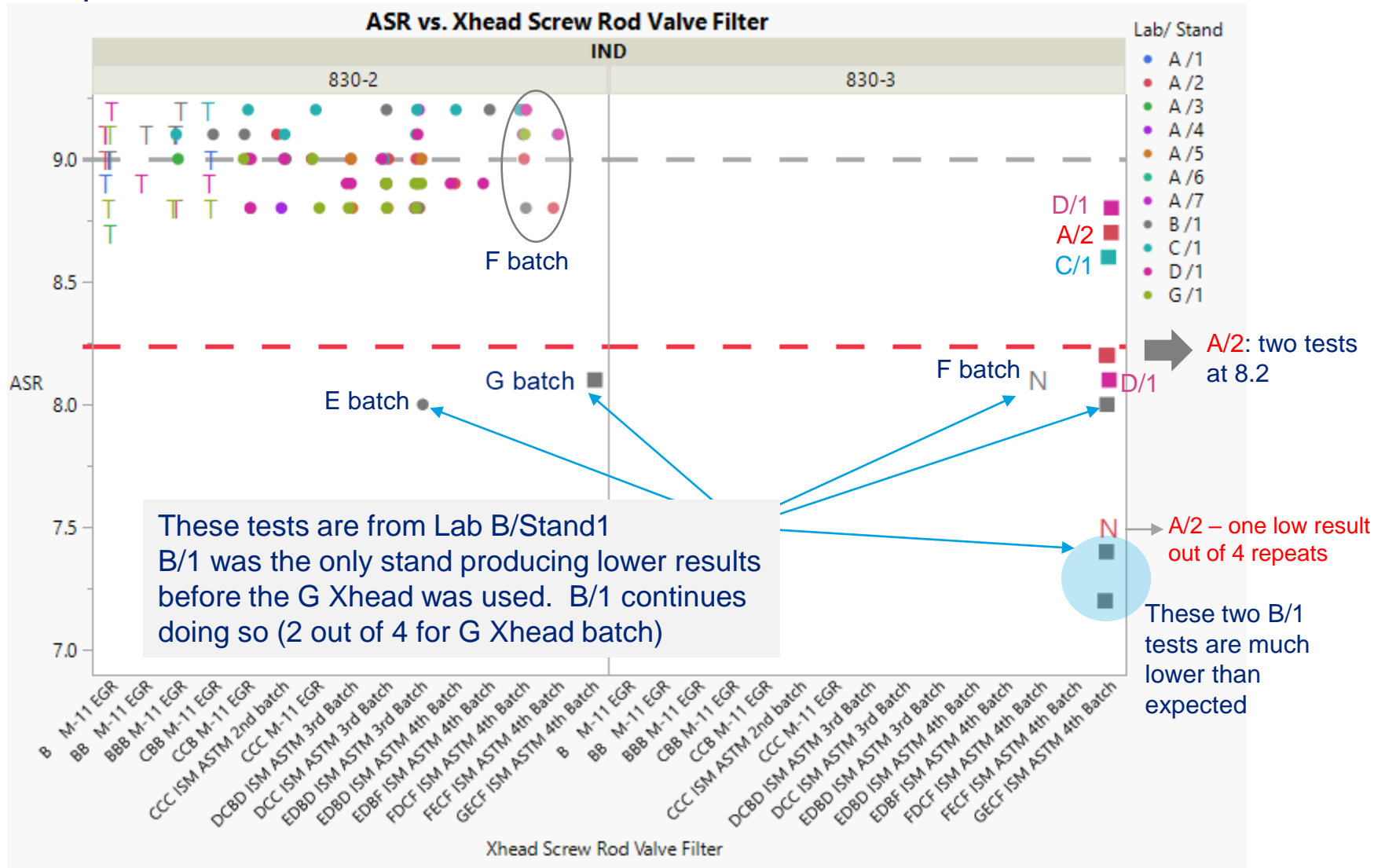


Lab/Stand	ASR	Oil	VAL	Chart	Part of the current target and std. dev. Calculations
B /1	8.1	830-2	OC	Y	yes
A /2	7.5	830-3	AI	N	yes
A /2	8.2	830-3	AC	Y	yes
C /1	8.6	830-3	AC	Y	yes
D /1	8.8	830-3	AC	Y	yes
B /1	7.2	830-3	OC	Y	no
B /1	8	830-3	AC	Y	no
A /2	8.7	830-3	AC	Y	no
D /1	8.1	830-3	AC	Y	no
B /1	7.4	830-3	AC	Y	no
A /2	8.2	830-3	AC	Y	no

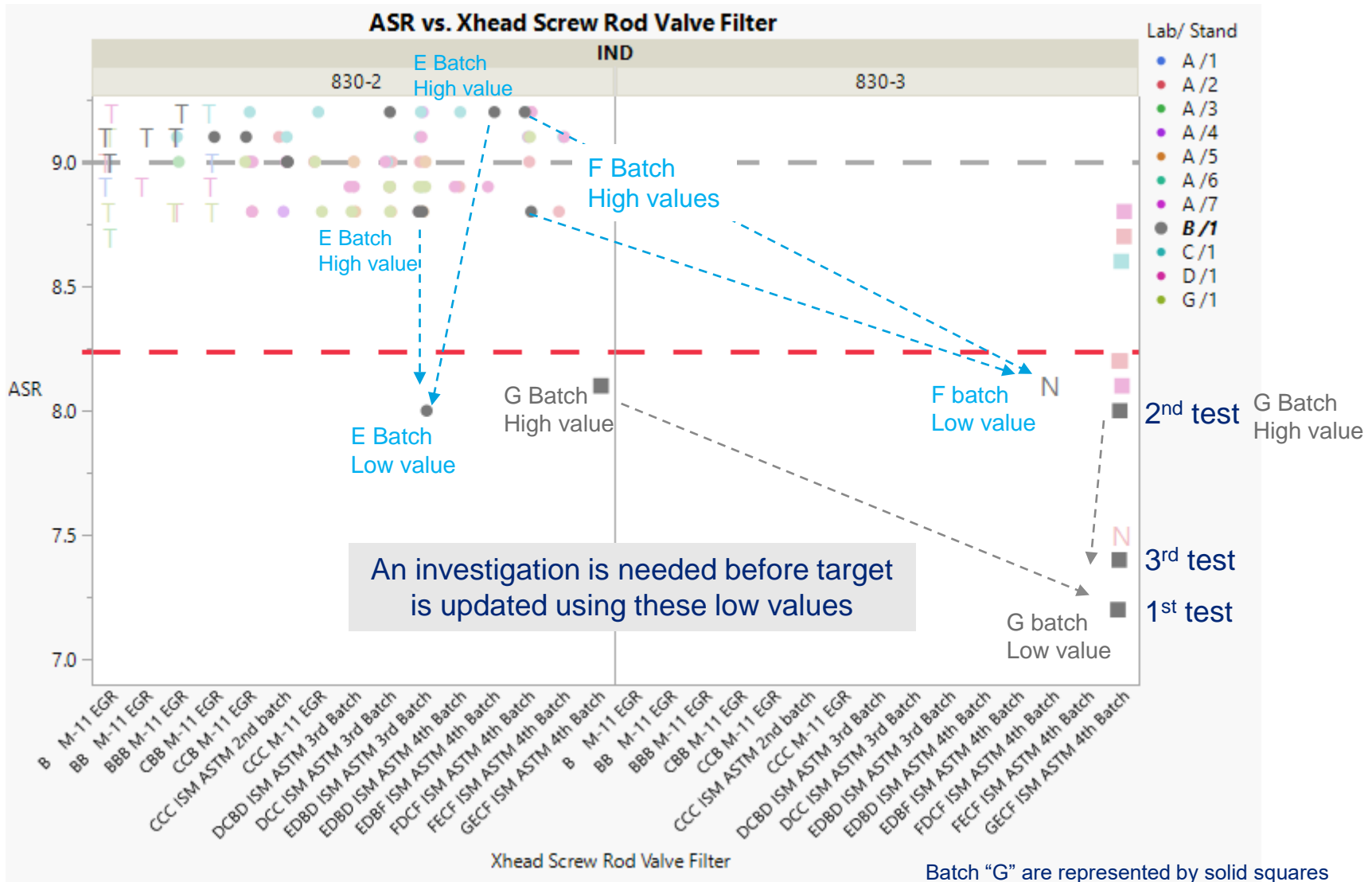
Since 04/2020,

- Lab A/ Stand 2, originally providing (7.5, 8.2), ran two additional tests (8.7; 8.2), making their low run (7.5 merits) seem more atypical within lab
- Lab B/Stand 1 ran three additional tests totaling four: 8.1; 7.2; 8.0; 7.4
- The two low B/1 test results emphasized potential issues with B/1 performance over time – see next two slides

G Xhead batch: Total of 11 tests (chart Yes = 10) **square symbols** correspond to G Xheads



B/1 tests are highlighted below. B/1 produced Sludge at ~ 8 merits for batches E and F, before the G Xhead was used. B/1 continued doing so for batch G. Why does B/1 produce lower values?



ASR

Concerns about using RMSE from a model remain.
New parts seem to have taken the test to region with more variability

- **ASR: SP meeting 04/16/2020**
 - Target: Simple Mean ASR = 8.24. SP decided to use all five tests available.
 - Current standard deviation: Sample Stdev for ASR (n=5) = 0.503
 - Since 04/2020, A/2 became chart=N, Val = AI.
 - **Excluding A/2 = 7.5, the mean would be 8.4 and the stand. dev. would be 0.33**
- **ASR: 02/2022:**
 - B/1 was the only stand producing Sludge at 8 merits before the G Xhead was used. B/1 has generated 7.2 and 7.4 merits for G Xhead batch (2 out of 4 tests). These values lower the mean and increase standard deviation estimates considerably.
 - **An investigation is needed, before targets and standard deviation are updated.**

Before updating Sludge target and std dev. investigate B/1 test results				
Options	sample size	mean	standard deviation	data
current state	5	8.24	0.503	data from SP meeting 04/2020
1	8	8.34	0.3114	chart = Yes; exclude B/1 = 7.4 & 7.2
2	10	8.13	0.5187	chart = Yes
3	11	8.07	0.5274	all data available, including chart =N (A/2= 7.5)
4	9	8.24	0.4035	include chart =N (A/2 = 7.5); exclude B/1 = 7.4 & 7.2

Appendix: details about IAS

A quick look at the impact of C/1 IAS test result in the calculation of the standard deviation



including C/1 IAS = 89.7

excluding C/1 IAS = 89.7

Xhead Screw Rod Valve Filter	N Rows	Mean(IAS)	Std Dev(IAS)
B M-11 EGR	10	30.26	6.2011
BB M-11 EGR	2	32.75	8.9803
BBB M-11 EGR	7	30.44	4.2637
CBB M-11 EGR	5	24.54	1.7009
CCB M-11 EGR	9	28.4	4.7932
CCC ISM ASTM 2nd batch	6	29.07	3.0572
CCC M-11 EGR	4	31.55	7.2877
DCBD ISM ASTM 3rd Batch	6	40.85	7.75
DCC ISM ASTM 3rd Batch	10	31.06	5.0425
EDBD ISM ASTM 3rd Batch	17	29.24	12.895
EDBD ISM ASTM 4th Batch	3	22.53	11.287
EDBF ISM ASTM 4th Batch	2	28.85	0.0707
FDCF ISM ASTM 4th Batch	9	31.1	4.0196
FECF ISM ASTM 4th Batch	3	36.13	8.9473
GECF ISM ASTM 4th Batch	10	41.41	18.876

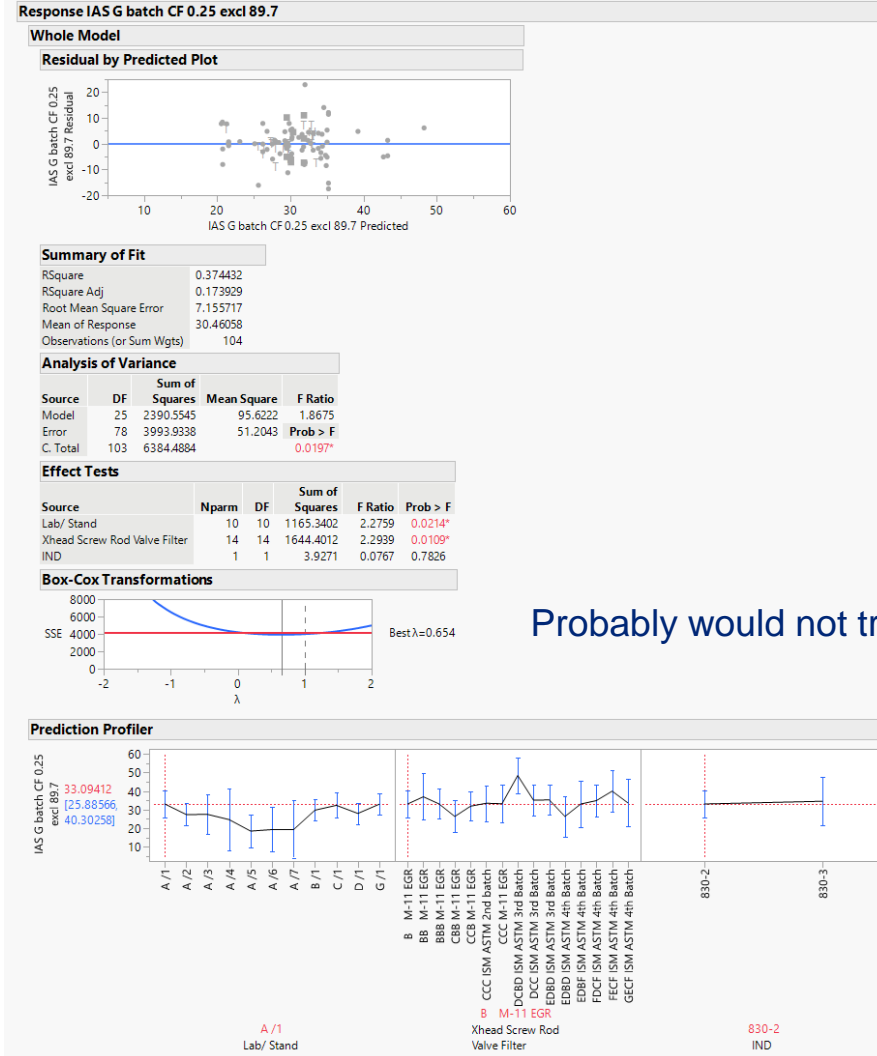
Xhead Screw Rod Valve Filter	N Rows	Mean(IAS)	Std Dev(IAS)
B M-11 EGR	10	30.26	6.2011
BB M-11 EGR	2	32.75	8.9803
BBB M-11 EGR	7	30.44	4.2637
CBB M-11 EGR	5	24.54	1.7009
CCB M-11 EGR	9	28.4	4.7932
CCC ISM ASTM 2nd batch	6	29.07	3.0572
CCC M-11 EGR	4	31.55	7.2877
DCBD ISM ASTM 3rd Batch	6	40.85	7.75
DCC ISM ASTM 3rd Batch	10	31.06	5.0425
EDBD ISM ASTM 3rd Batch	17	29.24	12.895
EDBD ISM ASTM 4th Batch	3	22.53	11.287
EDBF ISM ASTM 4th Batch	2	28.85	0.0707
FDCF ISM ASTM 4th Batch	9	31.1	4.0196
FECF ISM ASTM 4th Batch	3	36.13	8.9473
GECF ISM ASTM 4th Batch	9	36.04	8.7724

Simple standard deviation comparison

IAS*: current standard deviation is 5.7

Current RMSE is 7.16 (original scale) INCLUDING two "N" tests (validation code AI, AG)

Model: Lab/Stand; Parts, Oil; n=104



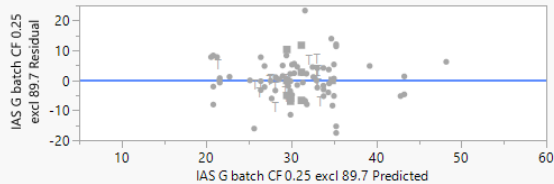
* Excluding C/1 IAS = 89.7 milligrams

IAS*: current standard deviation is 5.7
 Current RMSE is 7.20 (original scale) ONLY CHART =Yes, n=102
 Model: Lab/Stand; Parts, Oil

Response IAS G batch CF 0.25 excl 89.7

Whole Model

Residual by Predicted Plot



Summary of Fit

RSquare	0.376609
RSquare Adj	0.171546
Root Mean Square Error	7.203739
Mean of Response	30.41961
Observations (or Sum Wgts)	102

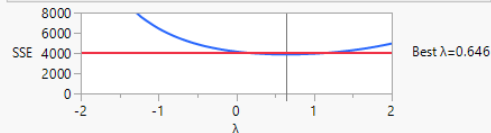
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	25	2382.6481	95.3059	1.8366
Error	76	3943.9326	51.8939	0.0230*
C. Total	101	6326.5808		

Effect Tests

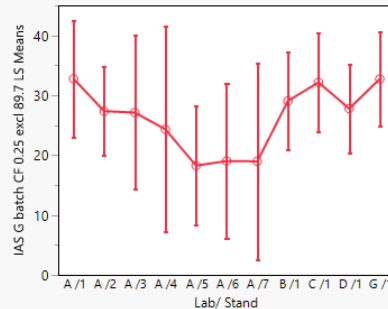
Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Lab/ Stand	10	10	1151.9850	2.2199	0.0251*
Xhead Screw Rod Valve Filter	14	14	1648.9364	2.2697	0.0120*
IND	1	1	11.4234	0.2201	0.6403

Box-Cox Transformations



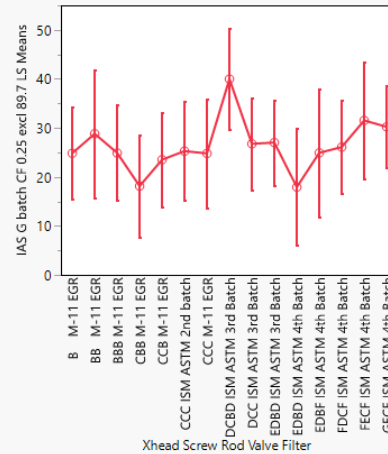
Lab/ Stand

Least Squares Means Plot



Xhead Screw Rod Valve Filter

Least Squares Means Plot

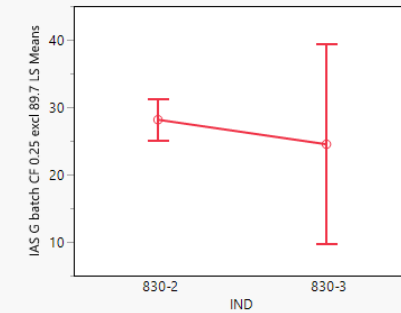


IND

Least Squares Means Table

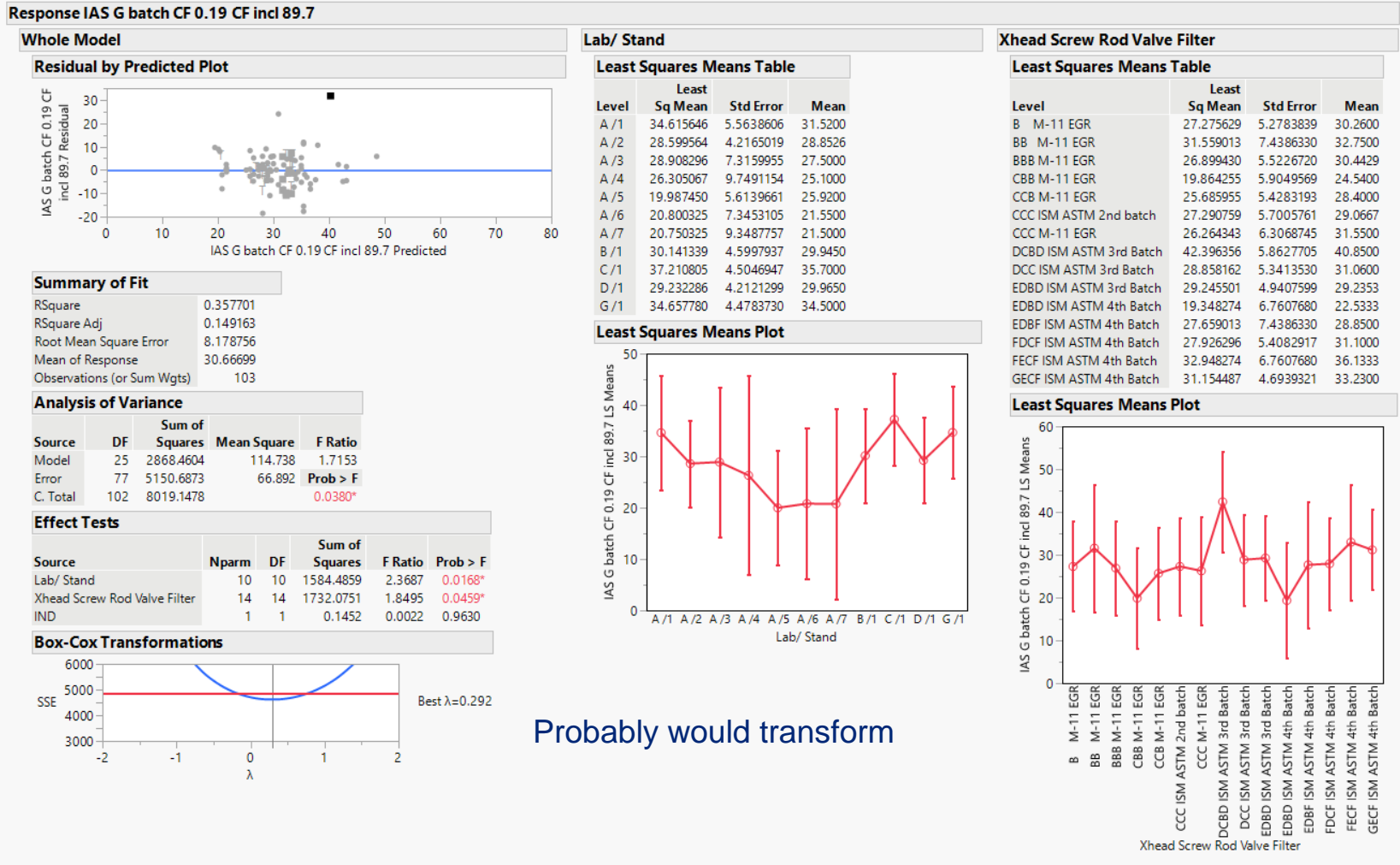
Level	Sq Mean	Std Error	Mean
830-2	28.147040	1.5280604	30.4383
830-3	24.508045	7.4479334	30.2000

Least Squares Means Plot



* Excluding C/1 IAS = 89.7 milligrams

IAS*: current standard deviation is 5.7
 Current RMSE is 8.18 (original scale) ONLY CHART =Yes, n=103
 Model: Lab/Stand; Parts, Oil



* Including C/1 IAS = 89.7 milligrams

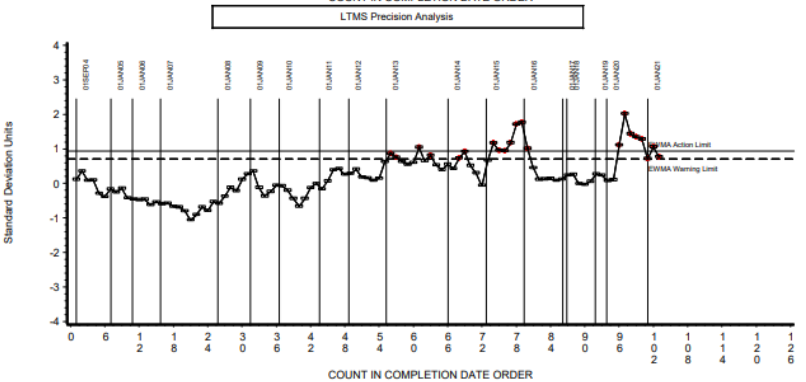
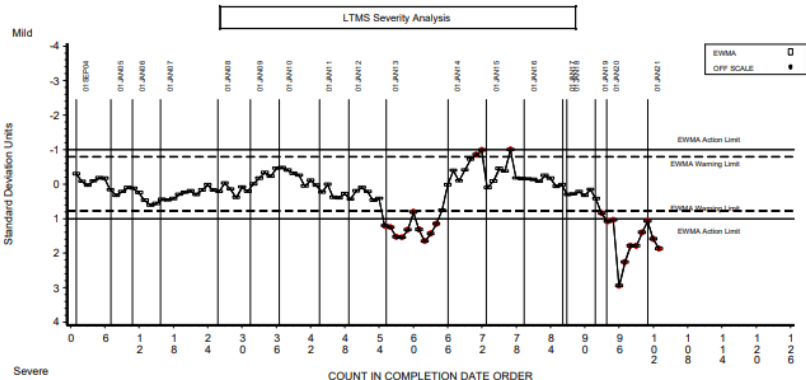
final	Ln IAS excl "N" & 89.7	n=102							
	Expanded Estimates								
	Nominal factors expanded to all levels								
Term	Estimate	Std Error	t Ratio	Prob> t					
Intercept	3.2474938	0.130006	24.98	<.0001	1	3.247494			
Lab/ Stand[A /1]	0.2066464	0.120045	1.72	0.0892	0.090909091	0.018786			
Lab/ Stand[A /2]	0.0476609	0.072502	0.66	0.5129	0.090909091	0.004333			
Lab/ Stand[A /3]	0.0331323	0.178062	0.19	0.8529	0.090909091	0.003012			
Lab/ Stand[A /4]	-0.081194	0.254394	-0.32	0.7505	0.090909091	-0.00738			
Lab/ Stand[A /5]	-0.290714	0.121183	-2.4	0.0189	0.090909091	-0.02643			
Lab/ Stand[A /6]	-0.206566	0.175768	-1.18	0.2436	0.090909091	-0.01878			
Lab/ Stand[A /7]	-0.208283	0.238274	-0.87	0.3848	0.090909091	-0.01893			
Lab/ Stand[B /1]	0.0919531	0.071509	1.29	0.2024	0.090909091	0.008359			
Lab/ Stand[C /1]	0.1546057	0.086753	1.78	0.0787	0.090909091	0.014055			
Lab/ Stand[D /1]	0.0603063	0.071469	0.84	0.4014	0.090909091	0.005482			
Lab/ Stand[G /1]	0.1924522	0.075533	2.55	0.0129	0.090909091	0.017496			
Xhead Screw Rod Valve Filter[B M-11 EGR]	-0.049064	0.086656	-0.57	0.5729	0	0			
Xhead Screw Rod Valve Filter[BB M-11 EGR]	0.0728658	0.171587	0.42	0.6723	0	0			
Xhead Screw Rod Valve Filter[BBB M-11 EGR]	-0.030337	0.100077	-0.3	0.7626	0	0			
Xhead Screw Rod Valve Filter[CBB M-11 EGR]	-0.263536	0.112576	-2.34	0.0219	0	0			
Xhead Screw Rod Valve Filter[CCB M-11 EGR]	-0.08796	0.086723	-1.01	0.3137	0	0			
Xhead Screw Rod Valve Filter[CCC ISM ASTM 2nd batch]	-0.016686	0.111361	-0.15	0.8813	0	0			
Xhead Screw Rod Valve Filter[CCC M-11 EGR]	-0.03866	0.126853	-0.3	0.7614	0	0			
Xhead Screw Rod Valve Filter[DCBD ISM ASTM 3rd Batch]	0.4118761	0.110374	3.73	0.0004	0	0			
Xhead Screw Rod Valve Filter[DCC ISM ASTM 3rd Batch]	0.0285752	0.083603	0.34	0.7334	0	0			
Xhead Screw Rod Valve Filter[EDBD ISM ASTM 3rd Batch]	-0.044412	0.073942	-0.6	0.5499	0	0			
Xhead Screw Rod Valve Filter[EDBD ISM ASTM 4th Batch]	-0.41183	0.142275	-2.89	0.005	0	0			
Xhead Screw Rod Valve Filter[EDBF ISM ASTM 4th Batch]	-0.034769	0.171587	-0.2	0.84	0	0			
Xhead Screw Rod Valve Filter[FDCF ISM ASTM 4th Batch]	0.0087327	0.085961	0.1	0.9193	0	0			
Xhead Screw Rod Valve Filter[FEFC ISM ASTM 4th Batch]	0.1567746	0.142275	1.1	0.274	0	0			
Xhead Screw Rod Valve Filter[GECF ISM ASTM 4th Batch]	0.2984292	0.24213	1.23	0.2216	1	0.298429			
IND[830-2]	0.073254	0.135403	0.54	0.5901	0.5	0.036627			
IND[830-3]	-0.073254	0.135403	-0.54	0.5901	0.5	-0.03663			
					estimated	3.545923	34.67167		
					target	29.5	3.38439		
								existing CF	
					Ln estimated -LN target	0.161533	0.41		
					ratio	CF using data after CF 0.41	0.850839		
						CF do valor original	1.282044		
						CF for LN scale	0.248455		

final	Ln IAS excl "N" & including 89.7	n=102							
	Expanded Estimates								
	Nominal factors expanded to all levels								
Term	Estimate	Std Error	t Ratio	Prob> t					
Intercept	3.2913769	0.136251	24.16	<.0001	1	3.291377			
Lab/ Stand[A /1]	0.2040316	0.126562	1.61	0.111	0.090909091	0.018548			
Lab/ Stand[A /2]	0.0319691	0.076253	0.42	0.6762	0.090909091	0.002906			
Lab/ Stand[A /3]	0.029191	0.187728	0.16	0.8768	0.090909091	0.002654			
Lab/ Stand[A /4]	-0.080776	0.268211	-0.3	0.7641	0.090909091	-0.00734			
Lab/ Stand[A /5]	-0.29619	0.127752	-2.32	0.0231	0.090909091	-0.02693			
Lab/ Stand[A /6]	-0.210789	0.185309	-1.14	0.2589	0.090909091	-0.01916			
Lab/ Stand[A /7]	-0.212506	0.251212	-0.85	0.4002	0.090909091	-0.01932			
Lab/ Stand[B /1]	0.0731426	0.07512	0.97	0.3333	0.090909091	0.006649			
Lab/ Stand[C /1]	0.2223948	0.088506	2.51	0.0141	0.090909091	0.020218			
Lab/ Stand[D /1]	0.0479209	0.075232	0.64	0.526	0.090909091	0.004356			
Lab/ Stand[G /1]	0.1916104	0.079635	2.41	0.0185	0.090909091	0.017419			
Xhead Screw Rod Valve Filter[B M-11 EGR]	-0.04181	0.091329	-0.46	0.6484	0	0			
Xhead Screw Rod Valve Filter[BB M-11 EGR]	0.0868245	0.180844	0.48	0.6325	0	0			
Xhead Screw Rod Valve Filter[BBB M-11 EGR]	-0.032988	0.105509	-0.31	0.7554	0	0			
Xhead Screw Rod Valve Filter[CBB M-11 EGR]	-0.271803	0.118657	-2.29	0.0247	0	0			
Xhead Screw Rod Valve Filter[CCB M-11 EGR]	-0.086674	0.091433	-0.95	0.3461	0	0			
Xhead Screw Rod Valve Filter[CCC ISM ASTM 2nd batch]	-0.018743	0.117408	-0.16	0.8736	0	0			
Xhead Screw Rod Valve Filter[CCC M-11 EGR]	-0.052903	0.133655	-0.4	0.6933	0	0			
Xhead Screw Rod Valve Filter[DCBD ISM ASTM 3rd Batch]	0.4189464	0.116344	3.6	0.0006	0	0			
Xhead Screw Rod Valve Filter[DCC ISM ASTM 3rd Batch]	0.0284537	0.088143	0.32	0.7477	0	0			
Xhead Screw Rod Valve Filter[EDBD ISM ASTM 3rd Batch]	-0.041828	0.077953	-0.54	0.5931	0	0			
Xhead Screw Rod Valve Filter[EDBD ISM ASTM 4th Batch]	-0.426707	0.149917	-2.85	0.0057	0	0			
Xhead Screw Rod Valve Filter[EDBF ISM ASTM 4th Batch]	-0.02081	0.180844	-0.12	0.9087	0	0			
Xhead Screw Rod Valve Filter[FDCF ISM ASTM 4th Batch]	0.0025422	0.090605	0.03	0.9777	0	0			
Xhead Screw Rod Valve Filter[FEFC ISM ASTM 4th Batch]	0.141898	0.149917	0.95	0.3468	0	0			
Xhead Screw Rod Valve Filter[GEFC ISM ASTM 4th Batch]	0.3156005	0.255215	1.24	0.22	1	0.315601			
IND[830-2]	0.0310101	0.142031	0.22	0.8277	0.5	0.015505			
IND[830-3]	-0.03101	0.142031	-0.22	0.8277	0.5	-0.01551			
					estimated	36.85449			
					target	29.5	3.38439		
					CF	0.800445			
								existing CF	
					Ln estimated -LN target	0.222587	0.41		
					CF using data after CF 0.41	0.800445			
					CF do valor original	1.206125			
					CF for LN scale	0.187413			

Sean graciously regenerated the plot below to exclude the high result

without the C/1 IAS = 89.7

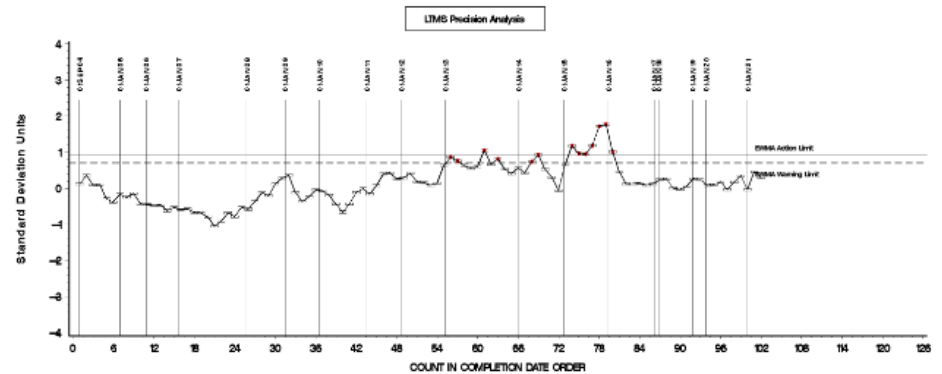
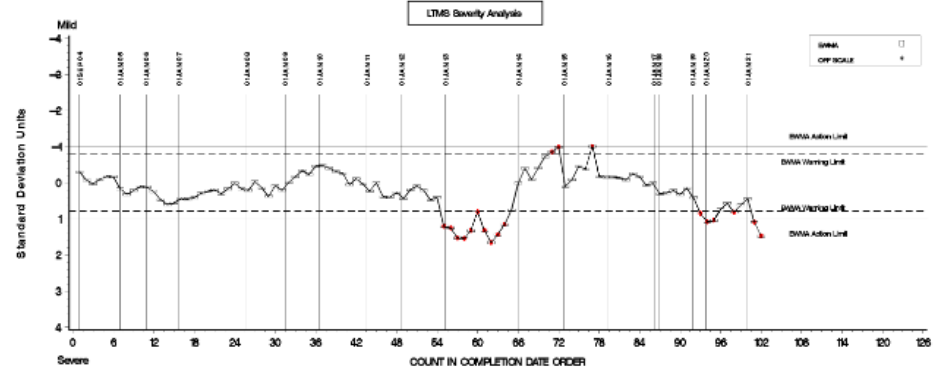
ISM INDUSTRY OPERATIONALLY VALID DATA
INJECTOR SCREW WEIGHT LOSS ADJUSTED TO 3.9% SOOT



ISM INDUSTRY OPERATIONALLY VALID DATA

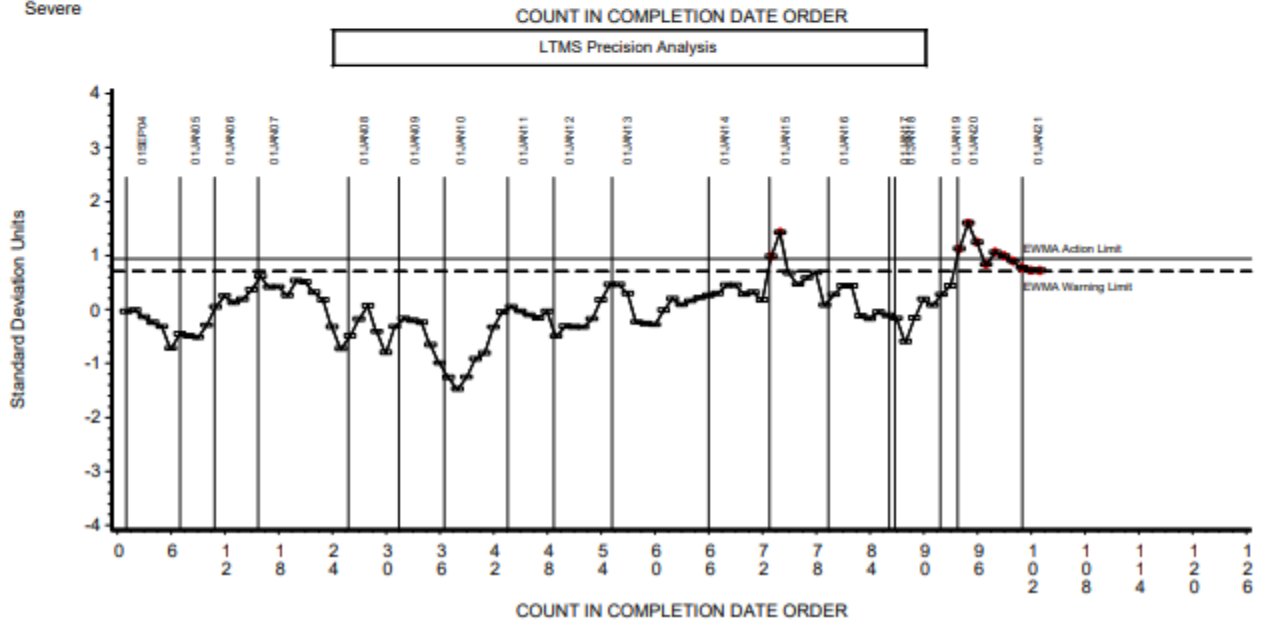
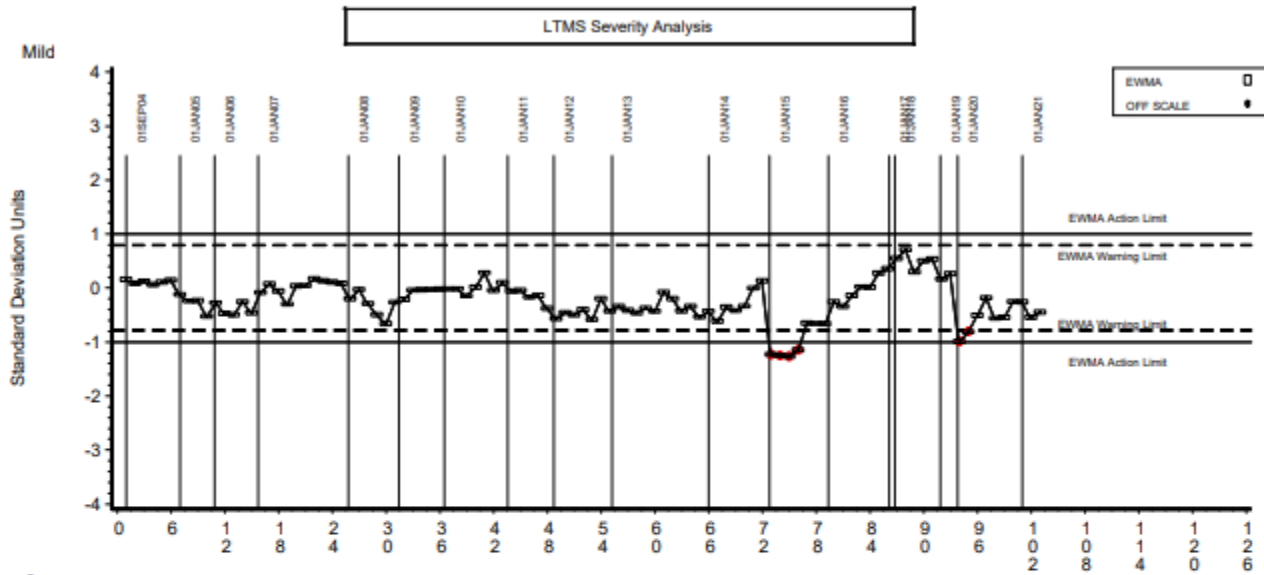


INJECTOR SCREW WEIGHT LOSS ADJUSTED TO 3.9% SOOT



ISM INDUSTRY OPERATIONALLY VALID DATA

AVERAGE SLUDGE RATING

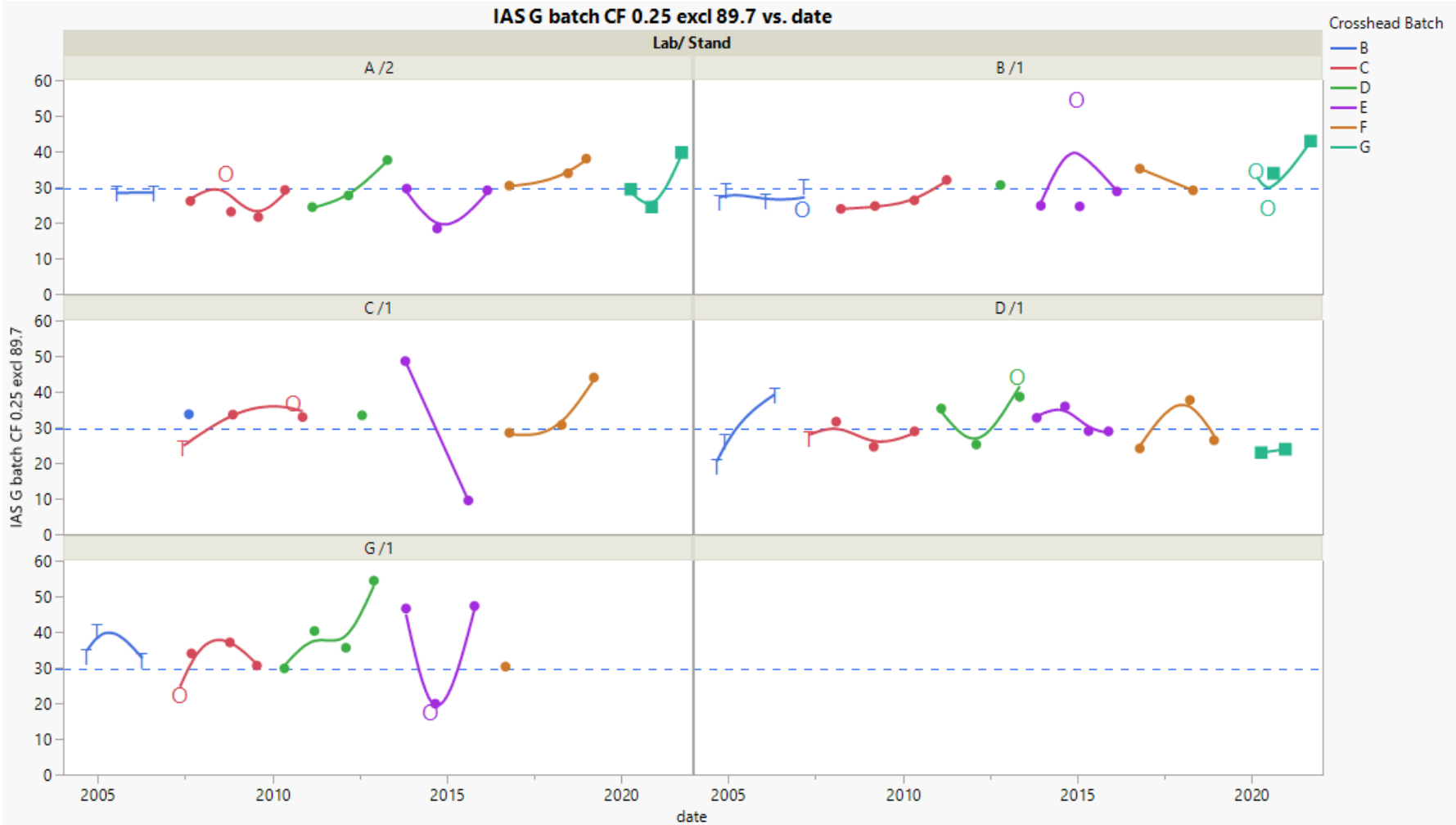


Given in confidence to XXXXX under agreement XXXXX

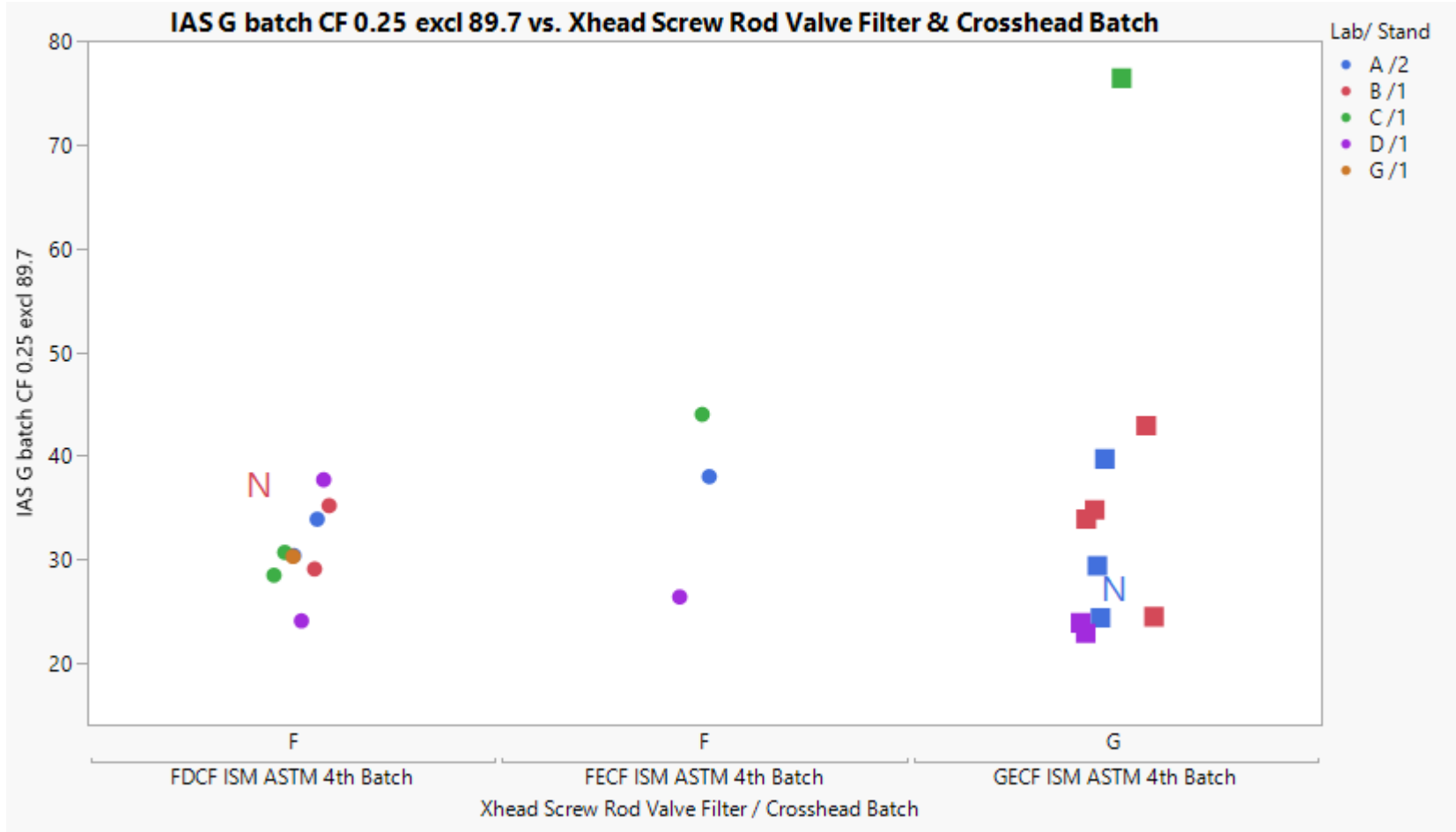
The following are the TMC validity/test designations:

Validity Designation	Definition	Test Designation	Definition
A	acceptable for intended purpose	C	calibration test
O	operationally valid, does not meet statistical criteria	D	double blind, for calibration
R	operationally invalid, 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 as determined by lab, not in stats	G	industry donated test, not for calibration
N	acceptable for intended purpose, 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

Bulk of data contributing to test variability



Recent data: Crosshead batch F and G



IAS after CF = 0.25: all data available by Lab and crosshead batches

