ISB Viscosity LTMS Targets Review

Statistics Group

July 16, 2025

Statistics Group

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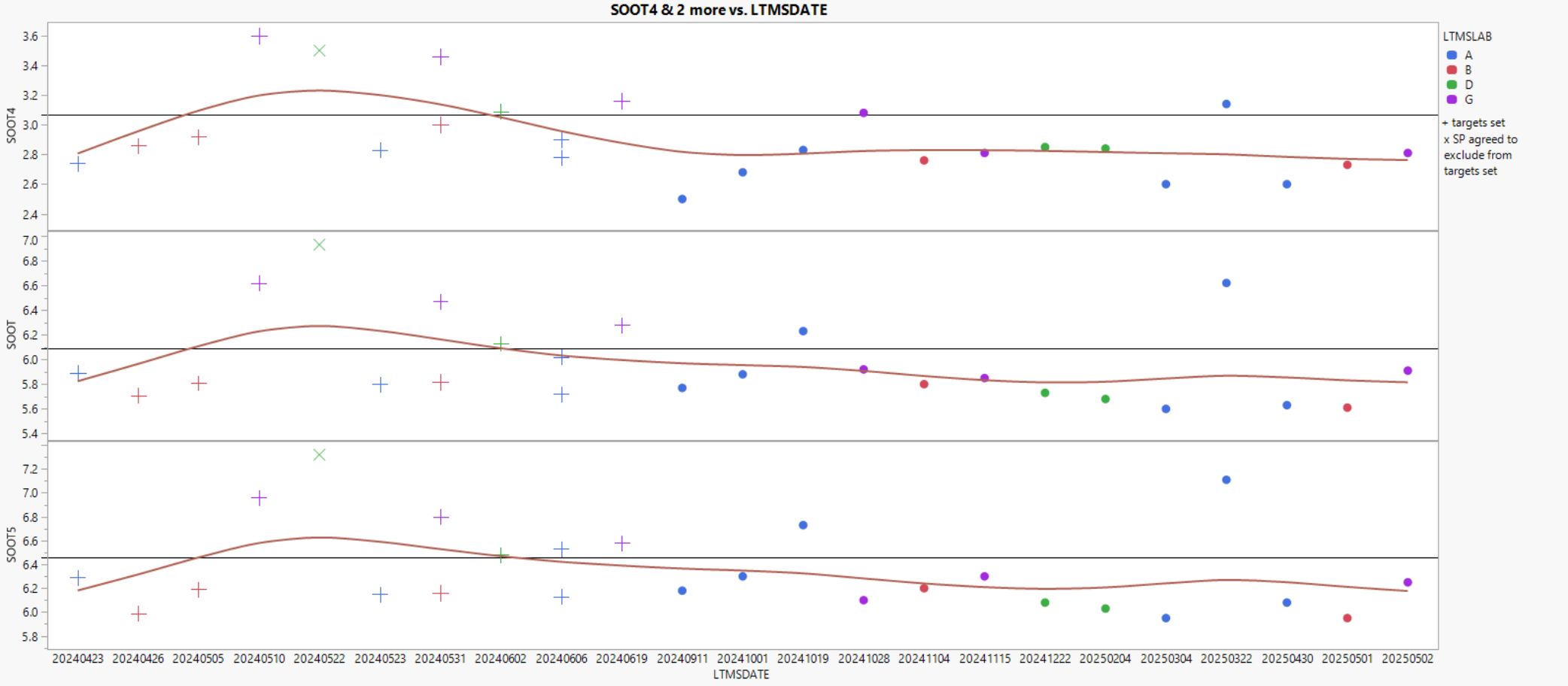
Summary

- Severity shift in the ISBV156 test (822-2) around July/August 2024
  - Shift is still within the current LTMS performance range (results are severe of target)
- Current (n=11) and updated (n=24) targets below

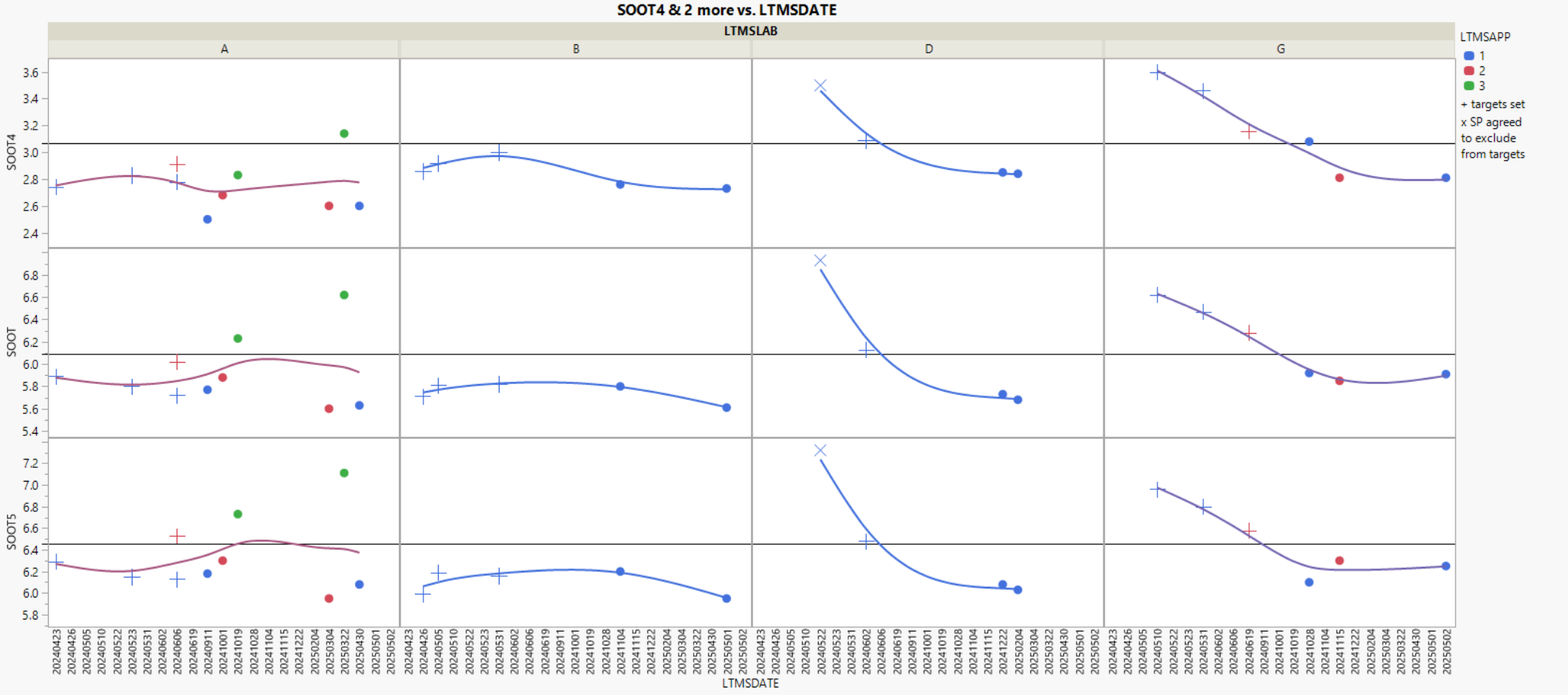
ISBV156		Soot @4 cSt		Soot @12 cSt		Soot @15 cSt		MRV	
Oil	n	mean	s	mean	s	mean	s	mean	s
822-2	11	3.07	0.271	6.09	0.301	6.46	0.293	14125	827.9
	24	2.91	0.258	5.99	0.315	6.37	0.338	14547	719.9

ISBV108		Soot @4 cSt		Soot @12 cSt		Soot @15 cSt		MRV	
Oil	n	mean	s	mean	s	mean	s	mean	s
834	11	3.81	0.220	4.40	0.257	4.48	0.296	7522	373.5
	24	3.76	0.195	4.37	0.232	4.45	0.251	7494	428.4

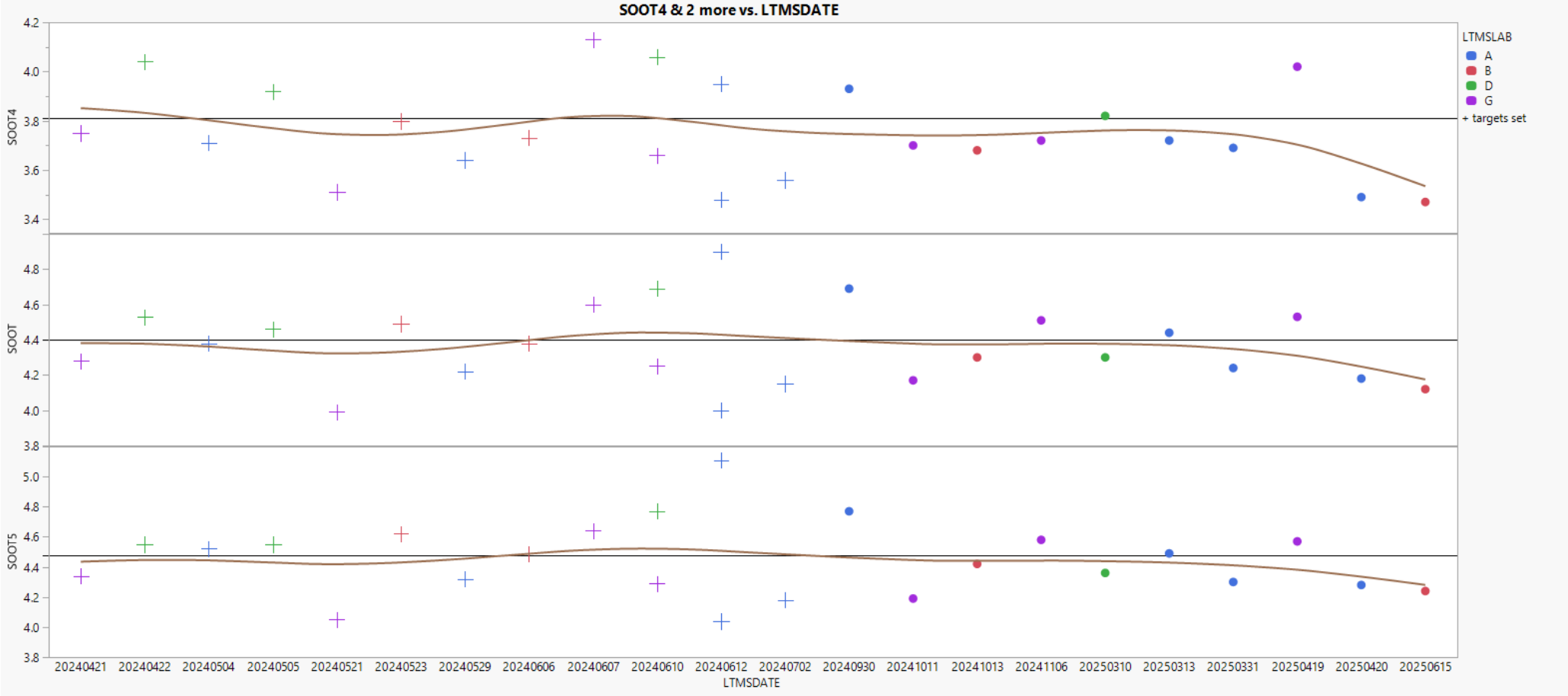
ISBV156 RO 822-2



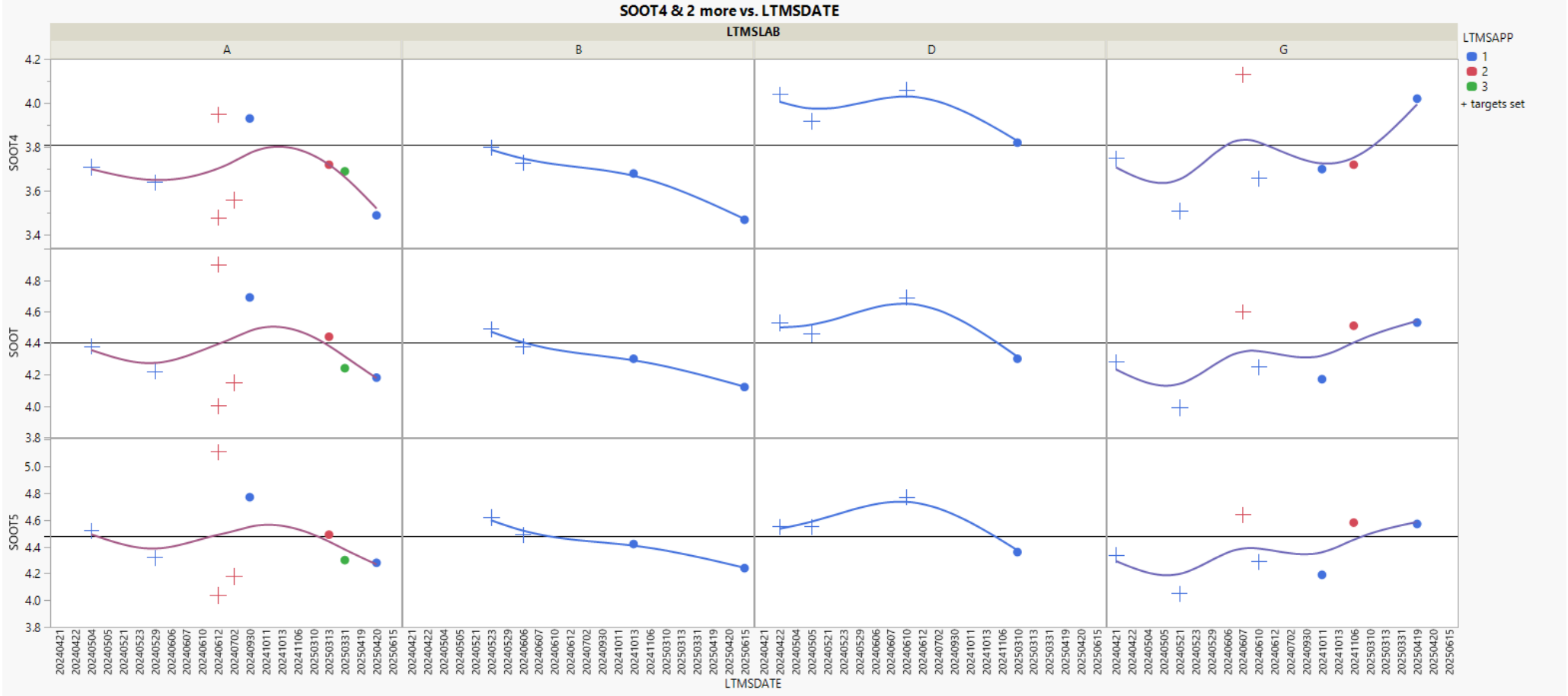
ISBV156 RO 822-2 by lab



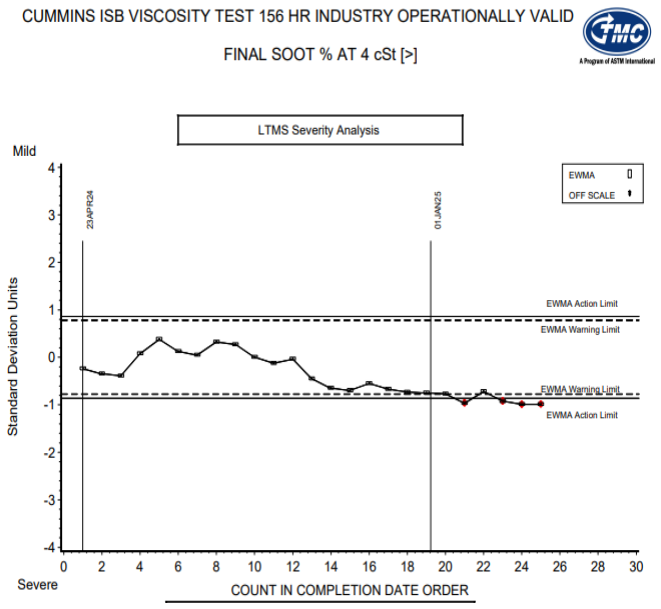
ISBV108 RO 834

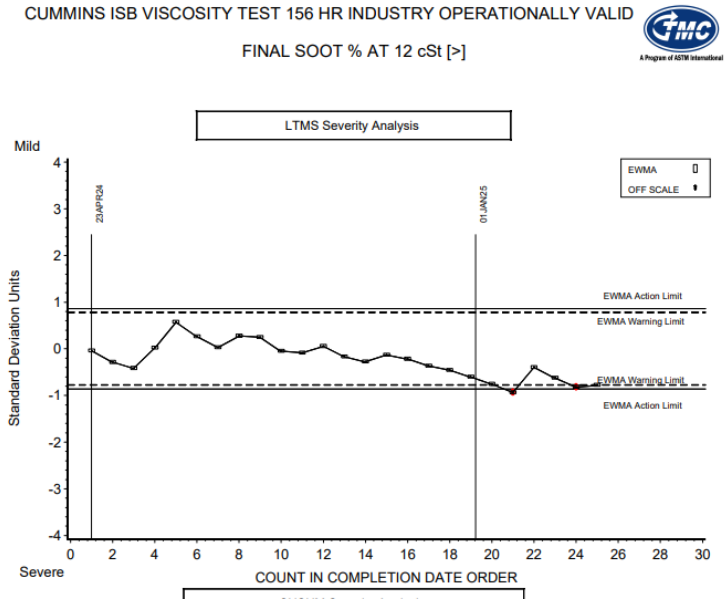


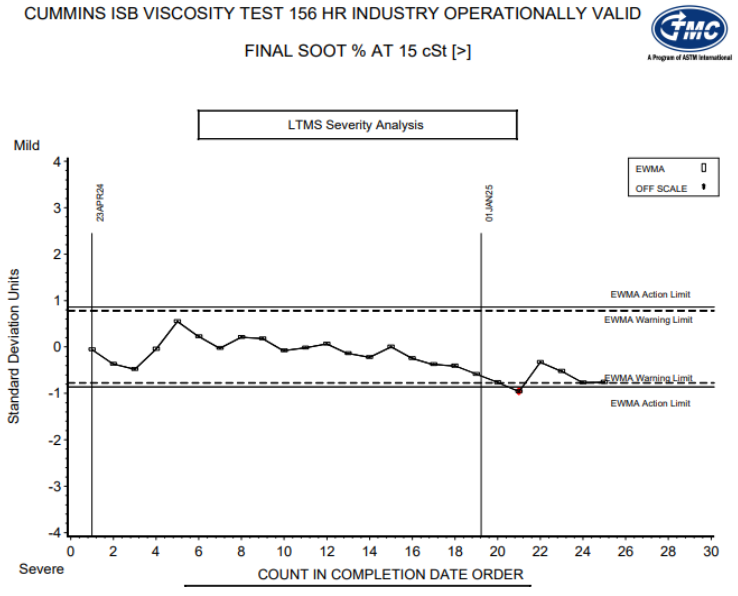
ISBV108 RO 834 by lab



industry control charts







appendix

statistical models

ISBV156 (RO 822-2)

N=24

soot at 4cSt viscosity increase fixed model 822-2

Summary of Fit

RSquare	0.532078
RSquare Adj	0.366929
Root Mean Square Error	0.204426
Mean of Response	2.89875
Observations (or Sum Wgts)	24

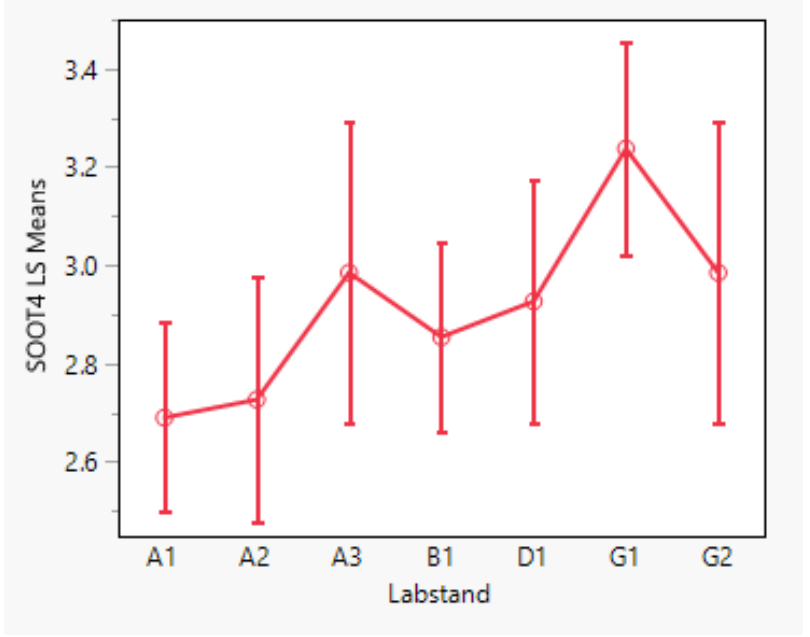
Analysis of Variance

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	2.9149762	0.04445	65.58	<.0001*
Labstand[A1]	-0.224976	0.089139	-2.52	0.0219*
Labstand[A2]	-0.18831	0.109205	-1.72	0.1028
Labstand[A3]	0.0700238	0.130003	0.54	0.5971
Labstand[B1]	-0.060976	0.089139	-0.68	0.5032
Labstand[D1]	0.0116905	0.109205	0.11	0.9160
Labstand[G1]	0.3225238	0.097151	3.32	0.0041*

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Labstand	6	6	0.80783417	3.2218	0.0267*



soot at 12cSt viscosity increase fixed model 822-2

Summary of Fit

RSquare	0.590167
RSquare Adj	0.445519
Root Mean Square Error	0.224802
Mean of Response	5.9375
Observations (or Sum Wgts)	24

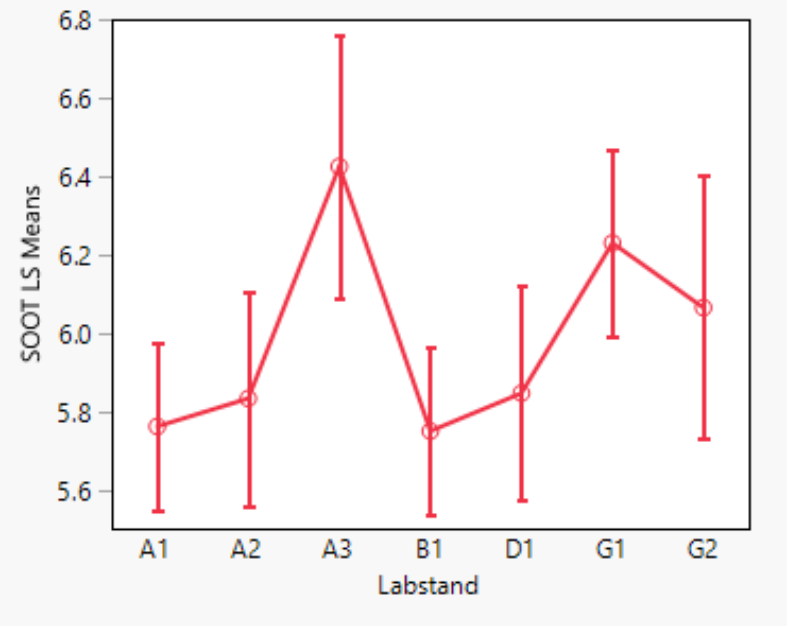
Analysis of Variance

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	5.9874286	0.04888	122.49	<.0001*
Labstand[A1]	-0.225429	0.098024	-2.30	0.0344*
Labstand[A2]	-0.154095	0.12009	-1.28	0.2167
Labstand[A3]	0.4375714	0.142961	3.06	0.0071*
Labstand[B1]	-0.237429	0.098024	-2.42	0.0269*
Labstand[D1]	-0.140762	0.12009	-1.17	0.2573
Labstand[G1]	0.2425714	0.106834	2.27	0.0365*

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Labstand	6	6	1.2371367	4.0800	0.0102*



soot at 15cSt viscosity increase fixed model 822-2

Summary of Fit

RSquare	0.571551
RSquare Adj	0.420333
Root Mean Square Error	0.243207
Mean of Response	6.313333
Observations (or Sum Wgts)	24

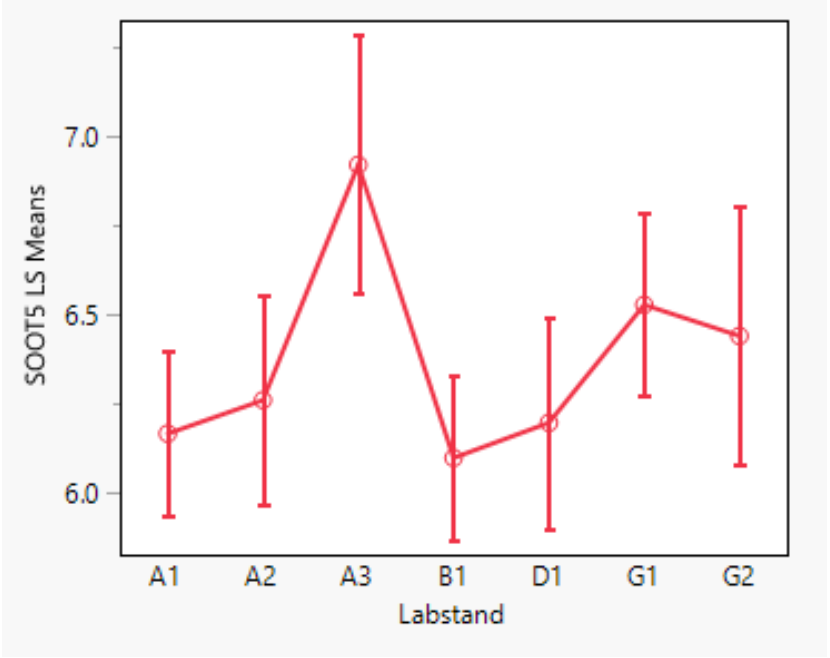
Analysis of Variance

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	6.3725952	0.052882	120.51	<.0001*
Labstand[A1]	-0.206595	0.106049	-1.95	0.0681
Labstand[A2]	-0.112595	0.129922	-0.87	0.3982
Labstand[A3]	0.5474048	0.154665	3.54	0.0025*
Labstand[B1]	-0.274595	0.106049	-2.59	0.0191*
Labstand[D1]	-0.175929	0.129922	-1.35	0.1934
Labstand[G1]	0.1549048	0.115581	1.34	0.1978

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Labstand	6	6	1.3413917	3.7797	0.0142*



MRV viscosity fixed model 822-2

Summary of Fit

RSquare	0.380289
RSquare Adj	0.161567
Root Mean Square Error	655.2578
Mean of Response	14558.33
Observations (or Sum Wgts)	24

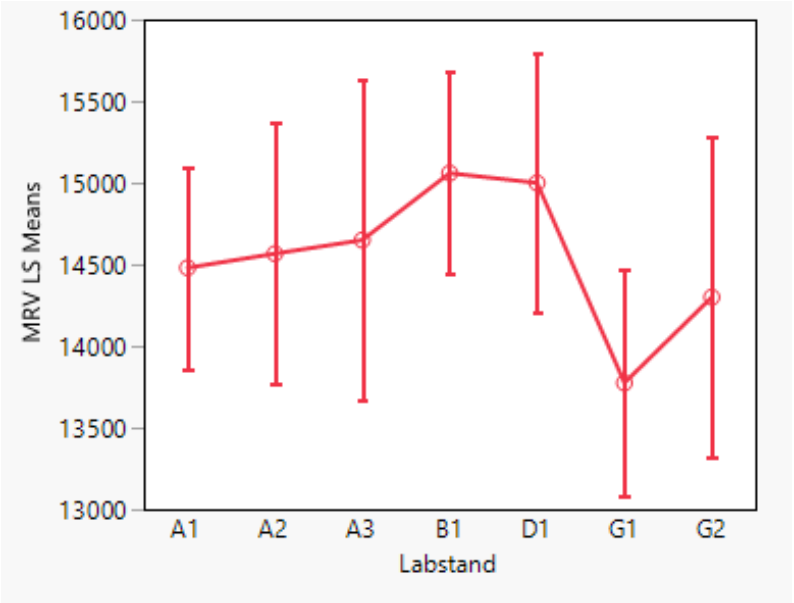
Analysis of Variance

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	14547.381	142.4774	102.10	<.0001*
Labstand[A1]	-67.38095	285.7225	-0.24	0.8164
Labstand[A2]	19.285714	350.0415	0.06	0.9567
Labstand[A3]	102.61905	416.7057	0.25	0.8084
Labstand[B1]	512.61905	285.7225	1.79	0.0906
Labstand[D1]	452.61905	350.0415	1.29	0.2133
Labstand[G1]	-772.381	311.4028	-2.48	0.0239*

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Labstand	6	6	4479166.7	1.7387	0.1725



random effects model 822-2

Soot4								
Random Ef	Var Ratio	SQRoot	ır Compone	Std Error	95% Lowe	95% Upper	Wald p-Val	Pct of Total
Labstand	0.631747		0.025794	0.021194	-0.01575	0.067334	0.2236	38.716
Residual		0.202	0.04083	0.013713	0.023227	0.089929		61.284
Total		0.258	0.066624	0.023679	0.036858	0.155147		100
Soot								
Random Ef	Var Ratio	SQRoot	ır Compone	Std Error	95% Lowe	95% Upper	Wald p-Val	Pct of Total
Labstand	0.949423		0.048322	0.03849	-0.02712	0.123761	0.2093	48.703
Residual		0.226	0.050896	0.017557	0.028579	0.115027		51.297
Total		0.315	0.099219	0.039572	0.051676	0.262712		100
Soot15								
Random Ef	Var Ratio	SQRoot	ır Compone	Std Error	95% Lowe	95% Upper	Wald p-Val	Pct of Total
Labstand	0.899901		0.054181	0.0454	-0.0348	0.143165	0.2327	47.366
Residual		0.245	0.060208	0.02101	0.033615	0.13763		52.634
Total		0.338	0.114389	0.045991	0.059317	0.305858		100
MRV								
Random Ef	Var Ratio	SQRoot	ır Compone	Std Error	95% Lowe	95% Upper	Wald p-Val	Pct of Total
Labstand	0.251064		104015.1	125130	-141235	349265.4	0.4058	20.068
Residual		643.659	414296.5	137746.4	236833.2	903873.5		79.932
Total		719.939	518311.6	163364.4	303839	1077759		100

ISBV108 (RO 834)

N=24

soot at 4cSt viscosity increase fixed model 834

Summary of Fit

RSquare	0.354472
RSquare Adj	0.126639
Root Mean Square Error	0.179915
Mean of Response	3.7575
Observations (or Sum Wgts)	24

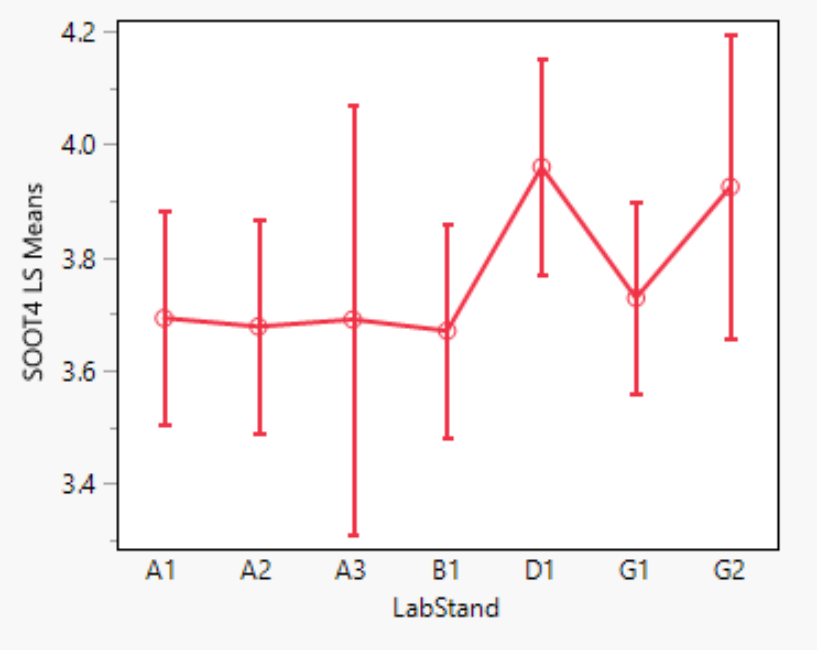
Analysis of Variance

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	3.7632857	0.042233	89.11	<.0001*
LabStand[A1]	-0.070786	0.086971	-0.81	0.4270
LabStand[A2]	-0.085786	0.086971	-0.99	0.3378
LabStand[A3]	-0.073286	0.157812	-0.46	0.6483
LabStand[B1]	-0.093286	0.086971	-1.07	0.2984
LabStand[D1]	0.1967143	0.086971	2.26	0.0371*
LabStand[G1]	-0.035286	0.080049	-0.44	0.6649

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
LabStand	6	6	0.30217000	1.5558	0.2201



soot at 12cSt viscosity increase fixed model 834

Summary of Fit

RSquare	0.200588
RSquare Adj	-0.08156
Root Mean Square Error	0.235234
Mean of Response	4.366667
Observations (or Sum Wgts)	24

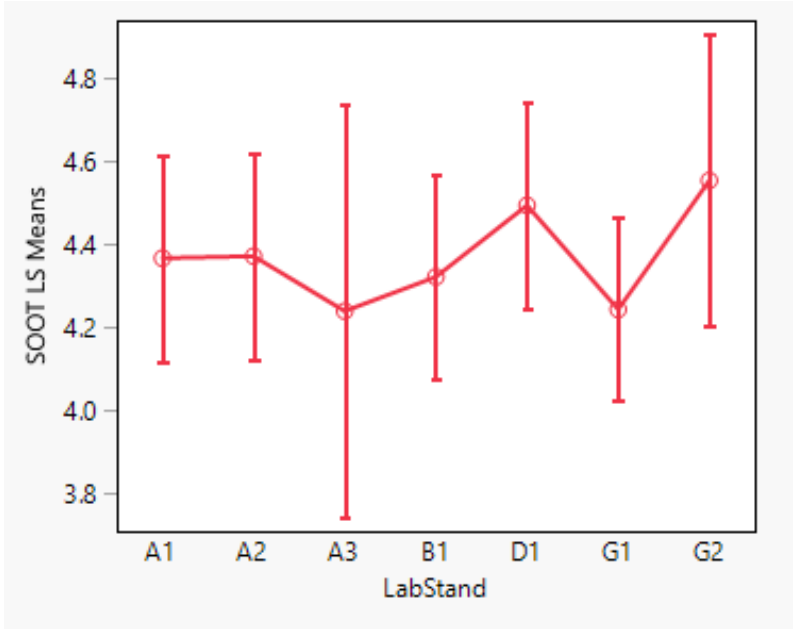
Analysis of Variance

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	4.3709286	0.055218	79.16	<.0001*
LabStand[A1]	-0.003429	0.113712	-0.03	0.9763
LabStand[A2]	0.0015714	0.113712	0.01	0.9891
LabStand[A3]	-0.130929	0.206335	-0.63	0.5342
LabStand[B1]	-0.048429	0.113712	-0.43	0.6755
LabStand[D1]	0.1240714	0.113712	1.09	0.2904
LabStand[G1]	-0.126929	0.104662	-1.21	0.2418

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
LabStand	6	6	0.23603833	0.7109	0.6456



soot at 15cSt viscosity increase fixed model 834

Summary of Fit

RSquare	0.181629
RSquare Adj	-0.10721
Root Mean Square Error	0.258844
Mean of Response	4.444583
Observations (or Sum Wgts)	24

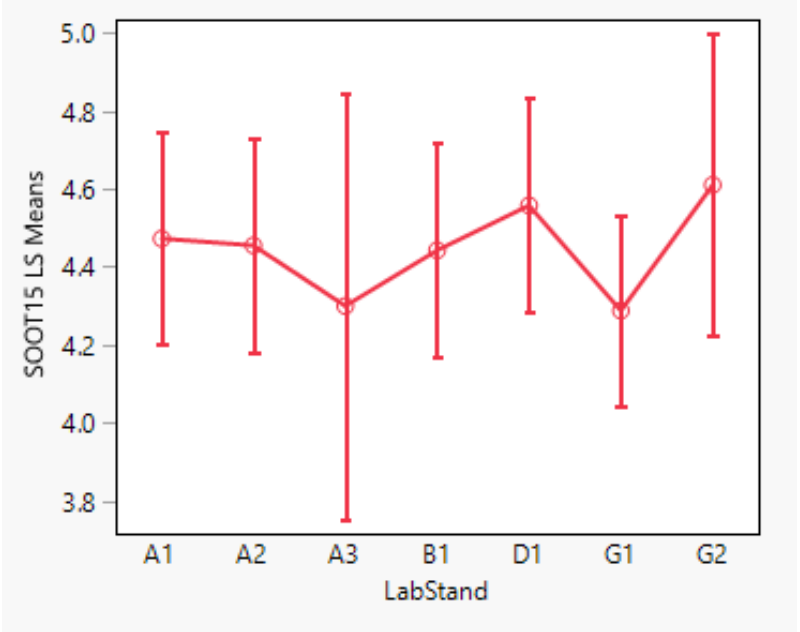
Analysis of Variance

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	4.4465	0.060761	73.18	<.0001*
LabStand[A1]	0.026	0.125125	0.21	0.8379
LabStand[A2]	0.0085	0.125125	0.07	0.9466
LabStand[A3]	-0.1465	0.227045	-0.65	0.5274
LabStand[B1]	-0.004	0.125125	-0.03	0.9749
LabStand[D1]	0.111	0.125125	0.89	0.3874
LabStand[G1]	-0.1585	0.115167	-1.38	0.1866

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
LabStand	6	6	0.25279083	0.6288	0.7054



MRV viscosity fixed model 834

Summary of Fit

RSquare	0.572825
RSquare Adj	0.422057
Root Mean Square Error	310.2769
Mean of Response	7578.75
Observations (or Sum Wgts)	24

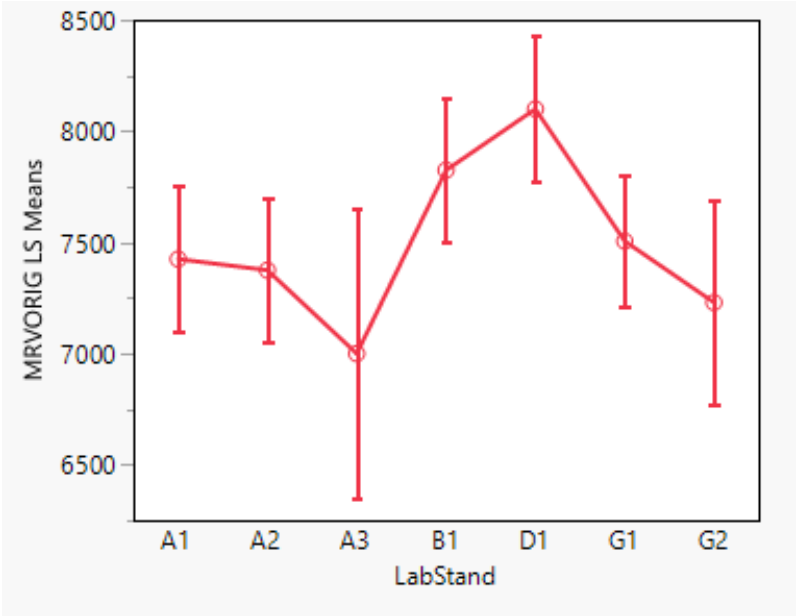
Analysis of Variance

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	7494.4286	72.83386	102.90	<.0001*
LabStand[A1]	-69.42857	149.9872	-0.46	0.6493
LabStand[A2]	-119.4286	149.9872	-0.80	0.4369
LabStand[A3]	-494.4286	272.1586	-1.82	0.0869
LabStand[B1]	330.57143	149.9872	2.20	0.0416*
LabStand[D1]	605.57143	149.9872	4.04	0.0009*
LabStand[G1]	11.571429	138.0503	0.08	0.9342

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
LabStand	6	6	2194642.5	3.7994	0.0139*



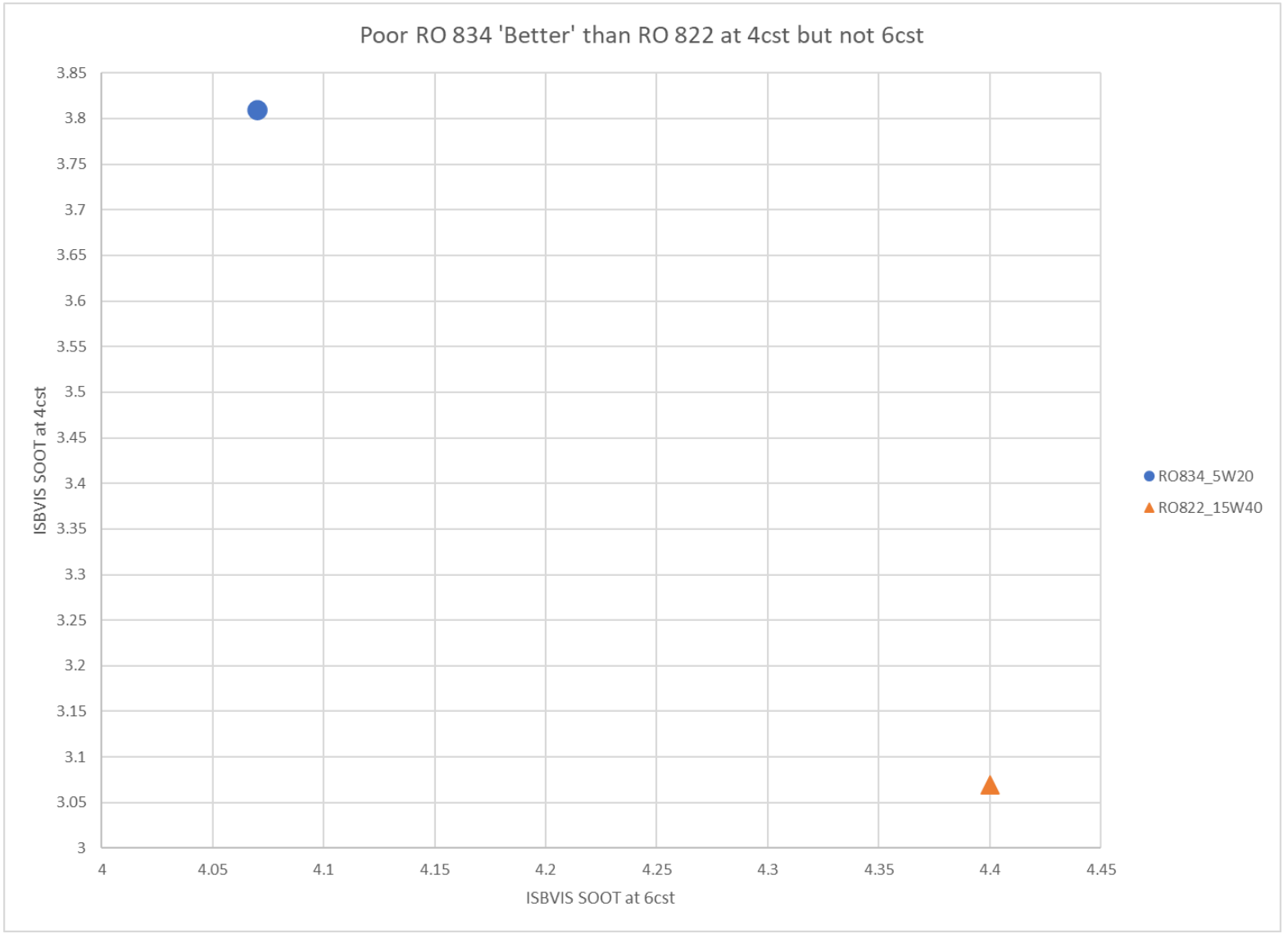
random effects model
834

Soot4								
Random Ef	Var Ratio	SQRoot	Var Compo	Std Error	95% Lowe	95% Uppe	Wald p-Val	Pct of Total
LabStand	0.189367		0.006026	0.009399	-0.0124	0.024447	0.5215	15.922
Residual		0.178	0.03182	0.010751	0.018049	0.070482		84.078
Total		0.195	0.037845	0.011849	0.022254	0.078243		100
Soot								
Random Ef	Var Ratio	SQRoot	Var Compo	Std Error	95% Lowe	95% Uppe	Wald p-Val	Pct of Total
LabStand	-0.05318		-0.00285	0.007404	-0.01736	0.011661	0.7002	0
Residual		0.232	0.05361	0.017561	0.030865	0.115366		100
Total		0.232	0.05361	0.017561	0.030865	0.115366		100
Soot15								
Random Ef	Var Ratio	SQRoot	Var Compo	Std Error	95% Lowe	95% Uppe	Wald p-Val	Pct of Total
LabStand	-0.0498		-0.00315	0.008141	-0.0191	0.01281	0.6992	0
Residual		0.251	0.063171	0.020396	0.036619	0.134172		100
Total		0.251	0.063171	0.020396	0.036619	0.134172		100
MRV								
Random Ef	Var Ratio	SQRoot	Var Compo	Std Error	95% Lowe	95% Uppe	Wald p-Val	Pct of Total
LabStand	0.877769		85806.51	72410.15	-56114.8	227727.8	0.236	46.745
Residual		312.7	97755.23	33851.51	54786.04	221765.7		53.255
Total		428.4	183561.7	73755.16	95219.38	490429.9		100

Soot at 6cSt

Reference Oil Plots 4cst vs 6cst

- It is unsettling that the Poor RO (834) has higher Soot than the Borderline RO (822: 15W-40) at 4cst



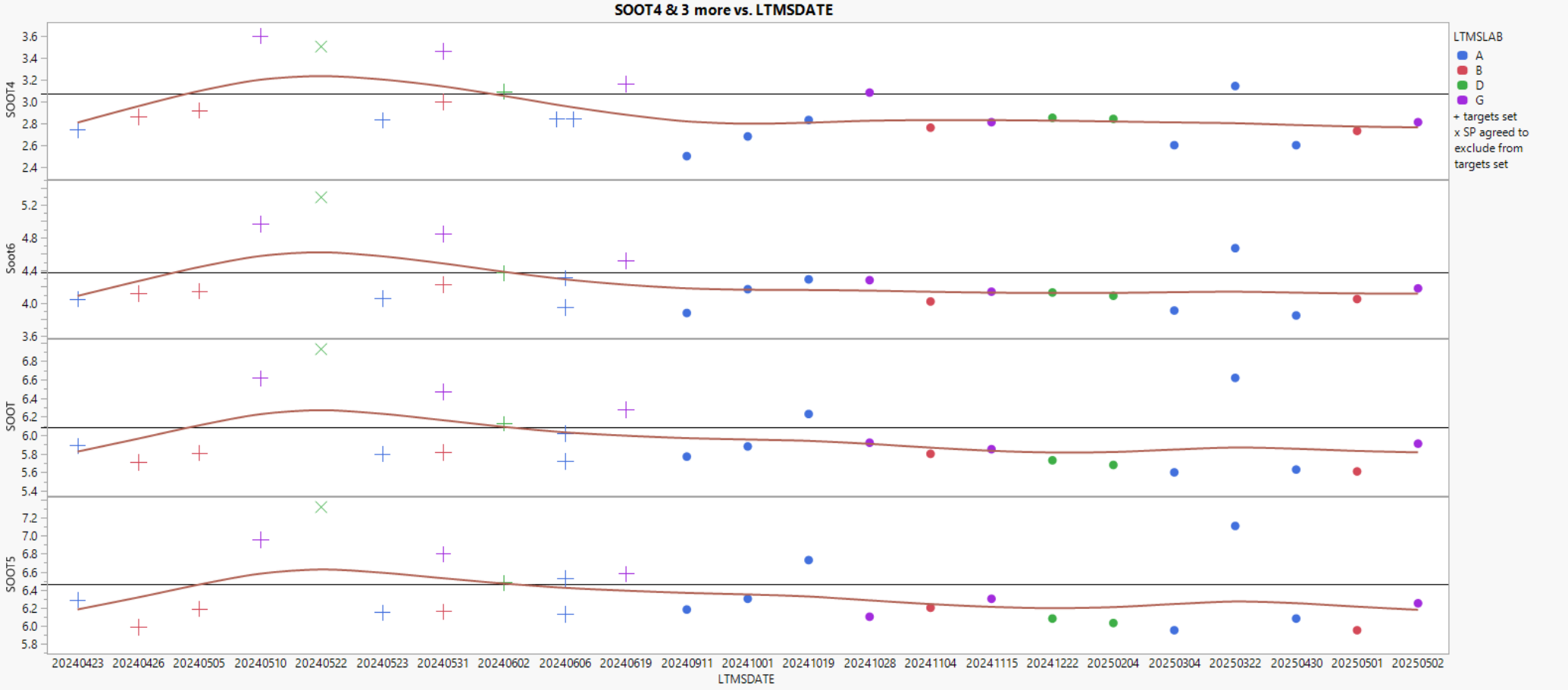
LTMS Targets for SOOT at 6cSt

Used the same dataset and techniques used in setting targets for 4cst, 12cst, 15cst and MRV

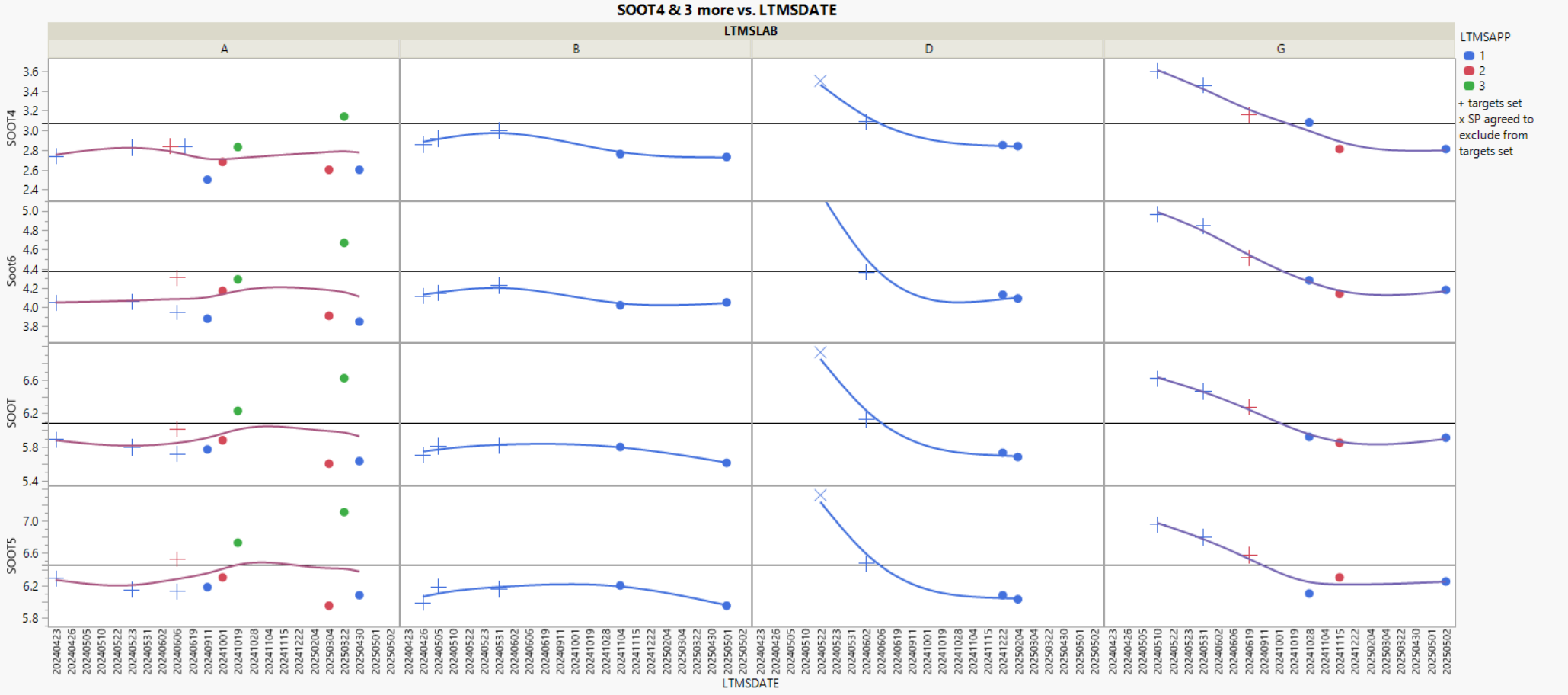
		Soot @6 cSt	
Oil	n	mean	s
822-2	11	4.38	0.315
	24	4.25	0.288

		Soot @6 cSt	
Oil	n	mean	s
834	11	4.07	0.219
	24	4.05	0.200

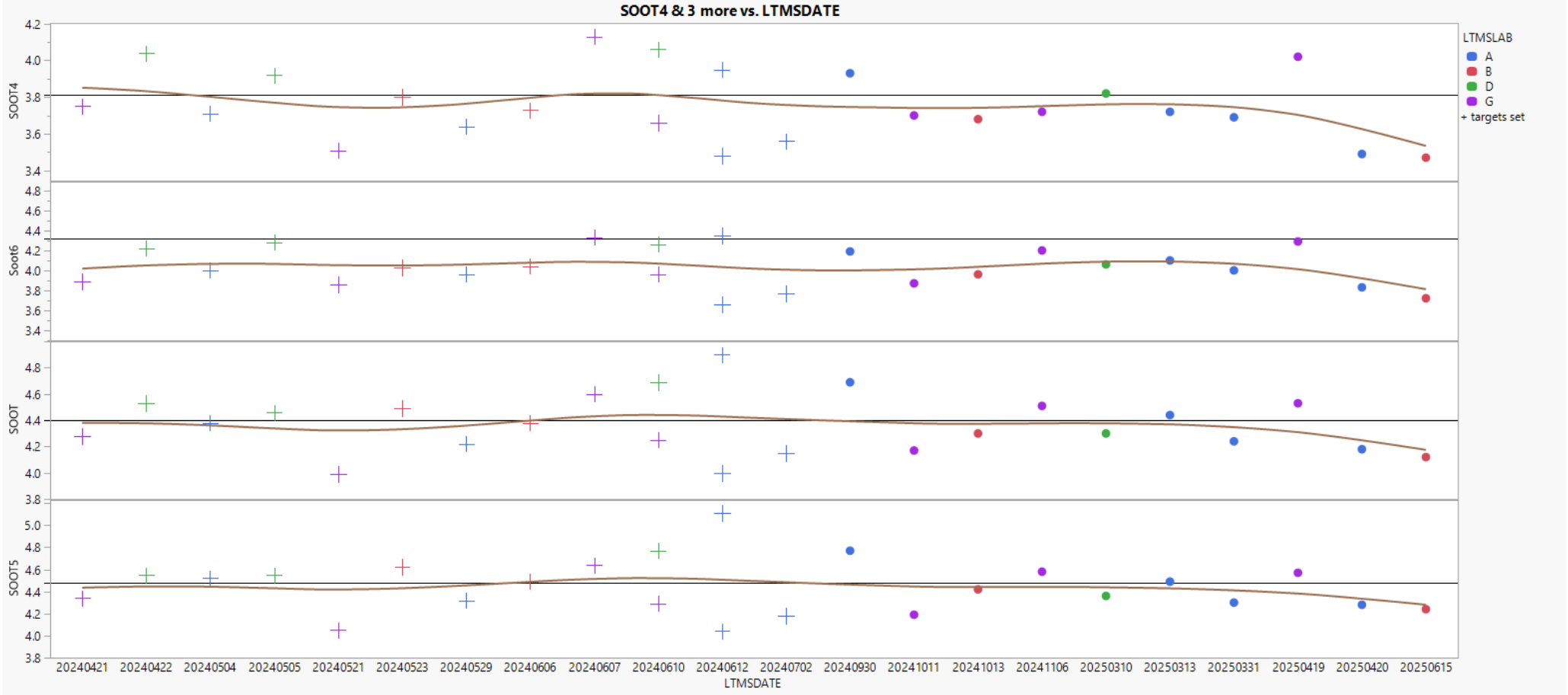
ISBV156 RO 822-2



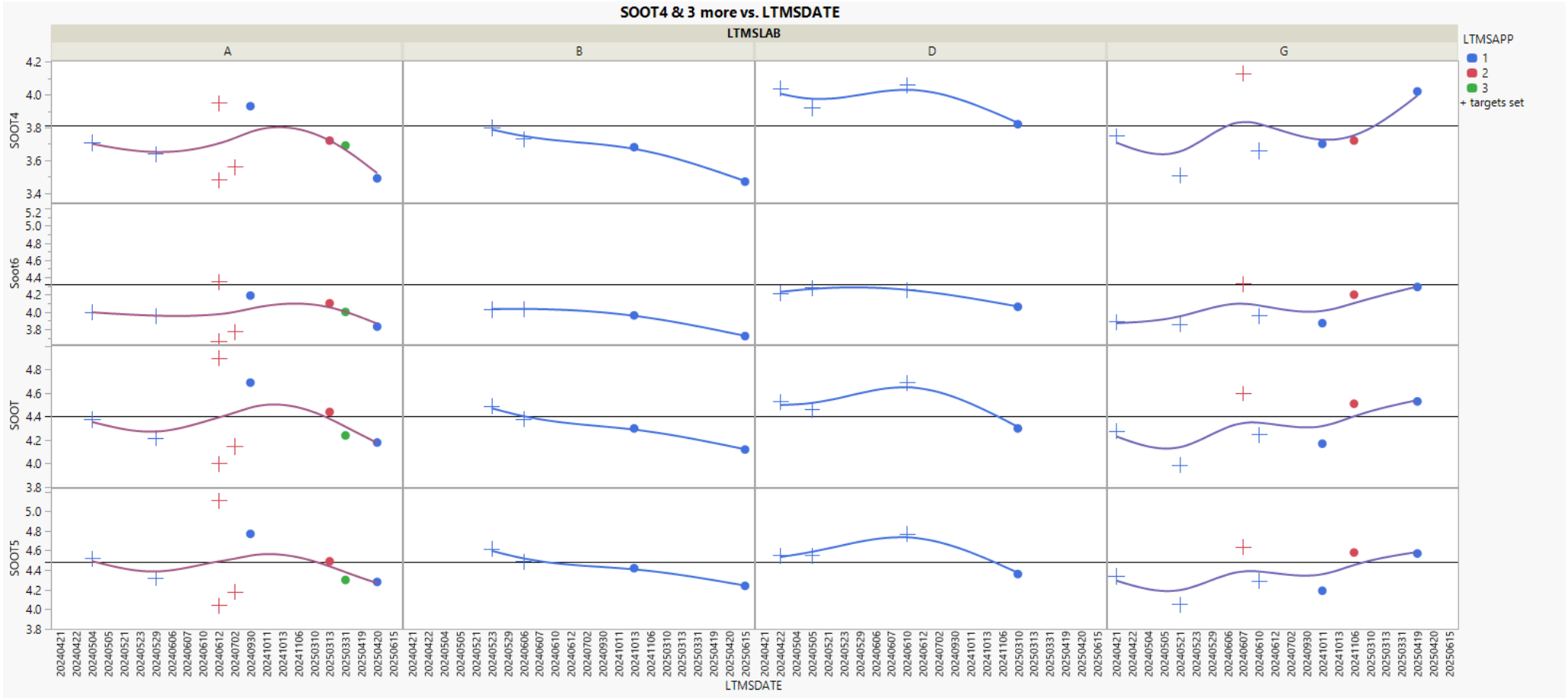
ISBV156 RO 822-2



ISBV108 RO 834



ISBV108 RO 834 by lab



Models for Soot at 6cSt RO 822-2

Summary of Fit

RSquare	0.569712
RSquare Adj	0.417846
Root Mean Square Error	0.218507
Mean of Response	4.218333
Observations (or Sum Wgts)	24

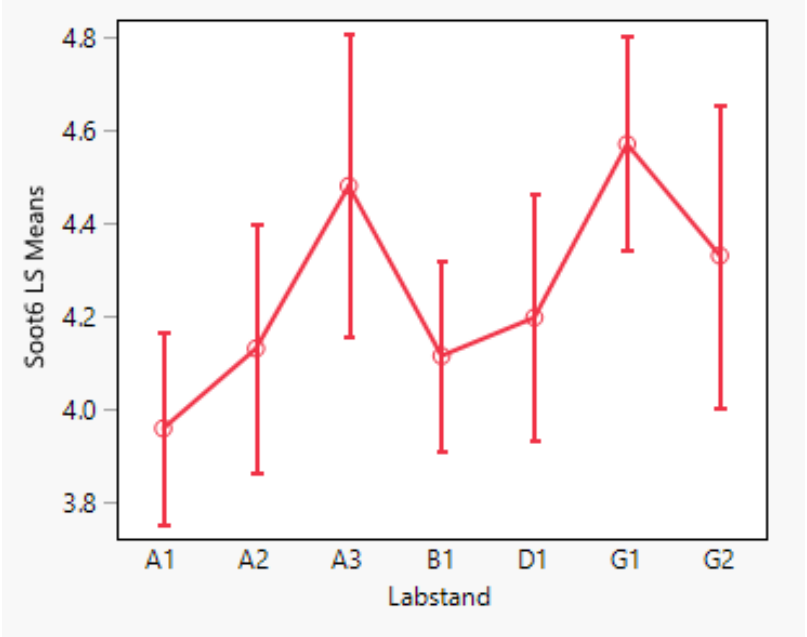
Analysis of Variance

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	4.2540952	0.047511	89.54	<.0001*
Labstand[A1]	-0.296095	0.095279	-3.11	0.0064*
Labstand[A2]	-0.124095	0.116727	-1.06	0.3026
Labstand[A3]	0.2259048	0.138957	1.63	0.1224
Labstand[B1]	-0.140095	0.095279	-1.47	0.1597
Labstand[D1]	-0.057429	0.116727	-0.49	0.6290
Labstand[G1]	0.3159048	0.103842	3.04	0.0074*

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Labstand	6	6	1.0746667	3.7514	0.0146*



Soot6								
Random Ef	Var Ratio	SQRoot	ır Compone	Std Error	95% Lowe	95% Uppe	Wald p-Val	Pct of Total
Labstand	0.770292		0.036204	0.028479	-0.01961	0.092022	0.2036	43.512
Residual		0.217	0.047001	0.015874	0.026666	0.10407		56.488
Total		0.288	0.083205	0.030827	0.045065	0.202448		100

Models for Soot at 6cSt RO 834

Summary of Fit

RSquare	0.335201
RSquare Adj	0.100566
Root Mean Square Error	0.187874
Mean of Response	4.034583
Observations (or Sum Wgts)	24

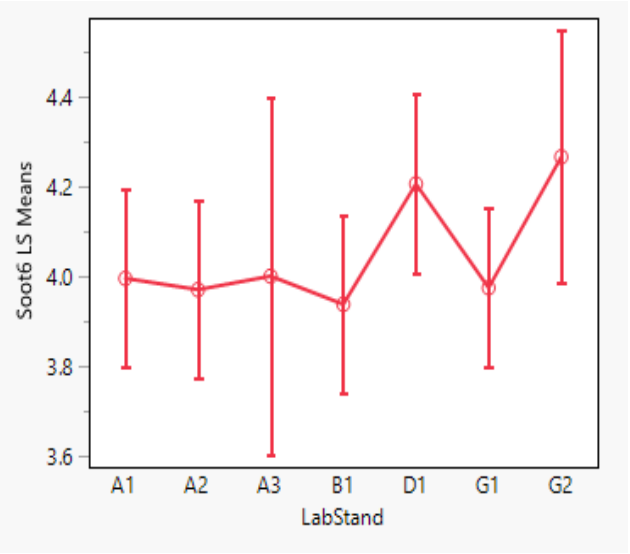
Analysis of Variance

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	4.0495	0.044101	91.82	<.0001*
LabStand[A1]	-0.0545	0.090818	-0.60	0.5564
LabStand[A2]	-0.0795	0.090818	-0.88	0.3936
LabStand[A3]	-0.0495	0.164794	-0.30	0.7675
LabStand[B1]	-0.112	0.090818	-1.23	0.2343
LabStand[D1]	0.1555	0.090818	1.71	0.1050
LabStand[G1]	-0.0755	0.08359	-0.90	0.3790

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
LabStand	6	6	0.30255083	1.4286	0.2609



Soot6								
Random Ef	Var Ratio	SQRoot	Var Compc	Std Error	95% Lowei	95% Upper	Wald p-Val	Pct of Total
LabStand	0.129409		0.004573	0.009813	-0.01466	0.023807	0.6412	11.458
Residual		0.188	0.035339	0.012123	0.019897	0.079435		88.542
Total		0.200	0.039912	0.012286	0.023651	0.081337		100

BONUS: T8-E/ISBVIS Matrix

- We need to be prepared for different types of results
  - Foolish to think that everything will work out at 4cst
- Technology 1 as a 15W-40 may be run in the T8-E to help establish correlation between the T8-E and ISBVIS
- ISBVIS Target Estimates for T1 as a 15W-40

Technology	Grade	Base Oil	LS Mean 4cst	LS Mean 5cst	LS Mean 6cst
1	15W-40	IIA	2.49	2.81	3.04
1	15W-40	IIC	2.79	3.13	3.38
1	15W-40	IIE	2.72	3.06	3.28