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COMMITTEE D02 on PETROLEUM PRODUCTS, LIQUID FUELS, AND LUBRICANTS

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Sequence VIII Surveillance Panel Meeting Minutes
Thursday, September 28, 2023
Teams Meeting (Virtual)
9:00 - 10:00 AM CDT

Minutes recorded by Patrick Lang
Direct any comments or corrections to: patrick.lang@swri.org

The attendance list can be found as Attachment #1.

There were no membership changes brought to the attention of the panel.

Agenda:

The agenda can be found as Attachment #2.

In the spirit of saving time, we went directly into the discussion on the industry correction factor.

Pat Lang gave a brief overview of the discussion that took place on the last call. He advised that we had quite a bit of deliberation on the two industry correction factor options, and we really needed more time for the panel members to review. At the end of the call Travis mentioned that there was an additional data point that was available and could be considered in the assessment. The stats group would look at that and consider if it would be added to the data set.

At this point, Travis explained the executive summary changes on the original presentation from the last call (Attachment #3) due to the additional data point. The stats group was recommending to only change the standard deviation on the bearing weight loss, instead of changing the ICF since we can’t be sure if the severity bias is from the new bearings, stand bias, or blend batch.

Andy Ritchie asked if the test stand that produced the high BWL result would be calibrated. Rich advised that that stand would trip a precision alarm in many of the scenarios in LTMS.

Travis advised that the standard deviation change of the new blend makes sense relative to other reference oils, since we would expect the standard deviation would increase as the bearing weight loss average increases.

Amol asked if 1009 was a previous reference oil in the Sequence VIII. Rich explained that 1009 was a reference oil for a few years and it drifted severe. Since it had a target similar to 1006-2, the panel decided to stop using the oil. Andy explained that 1009-1 was rebled, blended for the VH test but was not accepted due to a severity difference which in hindsight was probably due to a fuel batch difference. The oil has been sitting for years at the TMC, and given the demise of 704-1, and 1006-2, it made sense to bring in 1009-1.

Amol asked if 1009-1 would be the only oil. Andy said that 1009-1 will be the only oil for the time being, but the panel is looking for an oil around the pass/fail limit.

Rich brought up that oil 705, (results around 21 mg) was offered to the Sequence VIII Panel years ago but it was not pursued at the time. He has a drum of it at the TMC and just wanted the panel to know. Since this is a very old oil (several categories oil), he's not sure if it is a worthwhile candidate. Pat advised that we should be looking for a newer oil. Andy Ritchie recommended that the panel consider one of the current Sequence IX Aged Oil reference oils as another reference oil for the Sequence VIII. Rich cautioned that those oils are in limited quantities but reblends are in process.

At this point, Pat showed the summary of the two ICF options that were documented in the 9-21-23 minutes. He asked if there were any questions or further discussion needed.

Andy Ritchie stated he would like to make a motion to implement Option #2; Mike Deegan from Ford agreed to second the following motion:

<u>Motion #1</u>: (Andy Ritchie/Mike Deegan)

The Sequence VIII panel approves the reintroduction of the Sequence VIII test as a calibrated test with the use of an industry correction factor (ICF) of -3.6 mg and the reblend of 1009-1 with an LTMS mean of 16.2 mg/std dev 3.48 mg.

Reference oil 1009-1 is approved for use as the sole reference oil for the Sequence VIII test (oils 1006-2 and 704-1 will no longer be assigned for calibration purposes). The 03-22 bearing are approved for use.

The panel will revisit ICF and reference oil target upon completion of four valid and chartable calibration tests. Effective October 5, 2023.

<u>Discussion</u>:

Bob Campbell expressed concern that we are not choosing the correct option with the proposed motion. He pointed out that there are three data points on 1009-1 on the new bearing batch that are more severe than the current 06-16 bearing batch and only one result showing there to be no batch influence. This suggest that the new bearing batch is performing different and that we should be choosing Option #1 in the proposal which would give a larger ICF.

The group advised that they are leaning towards the smaller ICF since it is the more conservative approach. Robert Stockwell stated that Brad from GM and and Mike from Ford were leaning toward option 2. Since the OEM's were leaning toward option 2, most people agreed with that choice.

Bob advised he wasn't looking to stop the current motion from moving forward, he just wanted the panel to reconsider what the data is really telling us. Essentially, we are putting a stake in the ground with this decision, and we don't want to have to move it.

Travis stated that if we look at additional results within a short period of time, then we can agree as a group we can move the stake in the ground if we didn't get it right the first time.

Amol asked if the more conservative approach is actually more severe for referencing. Travis stated that the approach will not be more severe since the ICF and target updates will bring industry to center, on either approach.

As a way to help address Bob's concern, it was agreed that we would review the ICF's after four valid and chartable calibration tests are reported to the TMC (wording to this end shown in the motion above).

The motion passed:
Vote: 11/3/0 (approve/waive/negative)

A second motion was entertained to address the stripped viscosity:

<u>Motion #2:</u> (Andy Ritchie/Mike Deegan)

The Sequence VIII Surveillance Panel also approves the use of an industry correction factor (ICF) of -0.14 cSt on stripped viscosity for reference oil 1009-1 and an LTMS mean of 9.73 cSt with a std dev of 0.07 cSt.

The panel will revisit ICF and reference oil target upon completion of four valid and chartable calibration tests. Effective October 5, 2023.

Vote: 12/1/0 (approve/waive/negative) (one voting member left call for this last motion so total vote count is less 1).

<u>Adjournment:</u>

The meeting was adjourned at approximately 10:05 AM CDT.

<u>Next Meeting</u>:

The next meeting will be scheduled as needed.

Attachment #1

Attendance List

√ = present

9-28-23
Virtual MTG

ASTM SEQUENCE VIII SURVEILLANCE PANEL
VOTING MEMBERSHIP ATTENDANCE RECORD

Name	Address	Attendance	Vote #1	Vote #2
Alfanso, Adrian	Intertek 5404 Bandera Road San Antonio, TX 78238 Phone:210-647-9429 adrian.alfonso@intertek.com	✓	A	A
Bowden, Jason	OH Technologies, Inc. P.O. Box 5039 Mentor, OH 44061-5039 Phone: 440-354-7007 dhbowden@ohtech.com	✓	W	W
Savant, Amol	Valvoline 21st and Front Streets Ashland, KY 41101 Phone: 606-585-8982 acsavant@valvolineglobal.com	✓	W	A
Maddock, Ben	Afton Chemical 500 Spring Street P.O. Box 2158 Richmond, VA 23218 Ben.Maddock@aftonchemical.com	✓	W	A
Grundza, Rich	ASTM/TMC Phone: 412-365-1031 reg@astmtmc.org	✓	A	A
Hsu, Jeff	Shell Projects and Technology-USA 3333 Hwy 6 Houston, TX 77082 Phone:281-544-8619 J.Hsu@shell.com	✓	A	A
Hairston, William	Haltermann Solutions 15600 W. Hardy Road Houston, TX 77060 Phone No: 832-647-9264 whhairston@haltermann.com			
Riou, Joseph	Southwest Research Institute 6220 Culebra Road P.O. Box 28510 San Antonio, TX 78228-0510 Phone: 210-522-6266 jriou@swri.org	✓	A	A

ASTM SEQUENCE VIII SURVEILLANCE PANEL
VOTING MEMBERSHIP ATTENDANCE RECORD

Name	Address	Attendance	Vote 1	Vote 2
Lanctot, Dan	Test Engineering Inc. 12718 Cimarron Path San Antonio, TX 78249-3423 Phone: 210-690-1958 dlanctot@tei-net.com	✓	A	—
Kowalski, Teri	Toyota Motor North America, Inc. 1555 Woodridge Ann Arbor, Mi 48105 Phone: 734-995-4032 Cell: 734-355-8082 teri.kowalski@tema.toyota.com			
Cosgrove, Bradley	GM Global Propulsion Systems Phone: 313-590-2186 Bradley.Cosgrove@gm.com	✓	A	A
Rubas, Paul	ExxonMobil Research and Engineering Company 600 Billingsport Rd. Paulsboro, NJ 08066 Email: paul.j.rubas@exxonmobil.com	✓	A	A
Tang, Haiying	Stellantis Phone: 248-512-0593 haiying.tang@stellantis.com			
Stockwell, Robert	Chevron Oronite Company LLC 4502 Centerview Drive Suite 210 San Antonio, TX 78228 Phone: 210-232-3188 Robert.stockwell@chevron.com	✓	A	A
Agudelo, Jorge	BP Lubricants USA 1500 Valley Rd Wayne, NJ 07470 Jorge.Agudelo@BP.com			

ASTM SEQUENCE VIII SURVEILLANCE PANEL
VOTING MEMBERSHIP ATTENDANCE RECORD

Name	Address	Attendance	Vote 1	Vote 2
Deegan, Mike	Ford Motor Company 17228 Federal Drive Allen Park, MI 48101 Phone: 313-805-8942 mdeegan@ford.com	✓	A	A
Ritchie, Andy	Infineum P.O. Box 735 1900 East Linden Ave. Linden, NJ 07036-0735 Phone: 908-474-2097 andrew.ritchie@infineum.com	✓	A	A
Szappanos, George	Lubrizol Corporation 29400 Lakeland Blvd. Wickliffe, OH 44092 Phone: 440-347-2631 George.szappanos@lubrizol.com	✓	A	A

~~13~~ 14

18 Voting members

11 A

3 W

0 N

ASTM SEQUENCE VIII SURVEILLANCE PANEL
NON- VOTING MEMBERSHIP and GUESTS ATTENDANCE RECORD

Name	Address	Phone/Fax/Email	Attendance
Amanda Stone	Afton	✓	
Ricardo Affinito	Oronite	✓	
Todd Dvorak	Infineum	✓	
Jo Martinez	Oronite		
Travis Kostan	SwRI	✓	
Seth Demel	Shell	✓	
Manindra	Infineum	✓	
Bob Campbell	Afton	✓	

Attachment #2

Agenda

1. Welcome

2. Attendance

3. Approval of the minutes from the September 21, 2023, virtual meeting. Minutes posted to TMC website.

4. Review of the matrix data.

   a. Second review of stats group recommendation for the industry correction factor (ICF) presented at the 9-21-23 virtual meeting (Travis Kostan)

5. Next Meeting will be at call of the chair

6. Adjournment

Attachment # 3

Stats Group ICF Matrix Recommendation (rev 1)

Sequence VIII Correction Factor Matrix, RO 1009-1 Intro, and Bearing Batch Intro

STATS GROUP

SEPTEMBER 2023

Stats Group

- Amanda Stone, Afton
- Amy Ross, Valvoline
- Ricardo Affinito, Chevron Oronite
- Jo Martinez, Chevron Oronite
- Todd Dvorak, Infineum
- Martin Chadwick, Intertek
- Phil Scinto, Lubrizol
- Seth Demel, Shell
- Travis Kostan, SwRI
- Richard Grundza, TMC

Executive Summary

Based on raw standard deviation, including the latest 25.7 mg result on 1009-1 with the new bearings (result not added to ICF estimation based on statisticians' recommendation).

General Comments:

- The new bearing batch can be accepted.
- A lot of assumptions have been made with little data. We should re-evaluate soon once additional data becomes available.

Bearing Weight Loss:

- Option #1:
  - Apply an industry correction factor of -4.9 mg for tests moving forward.
  - 1009-1 will have an LTMS mean of 14.9 mg and a standard deviation of ~~3.01~~ 3.48 mg.
  - This is the option to choose if you think the bearings might be more severe and we should only consider a re-blend difference on the same hardware.
- Option #2:
  - Apply an industry correction factor of -3.6 mg for tests moving forward.
  - 1009-1 will have an LTMS mean of 16.2 mg and a standard deviation of ~~3.01~~ 3.48 mg.
  - This is the option to choose if you believe the new bearings are the same and we can use all data to estimate the difference due to the oil re-blend.
- Based on the methodology used, with both options there is some evidence that this may slightly over correct candidates < 10 mg and may under correct candidates > 20 mg (no candidate data offered > 20mg to study).
- Severity adjustment standard deviation should be updated from 4.8 to 3.0.

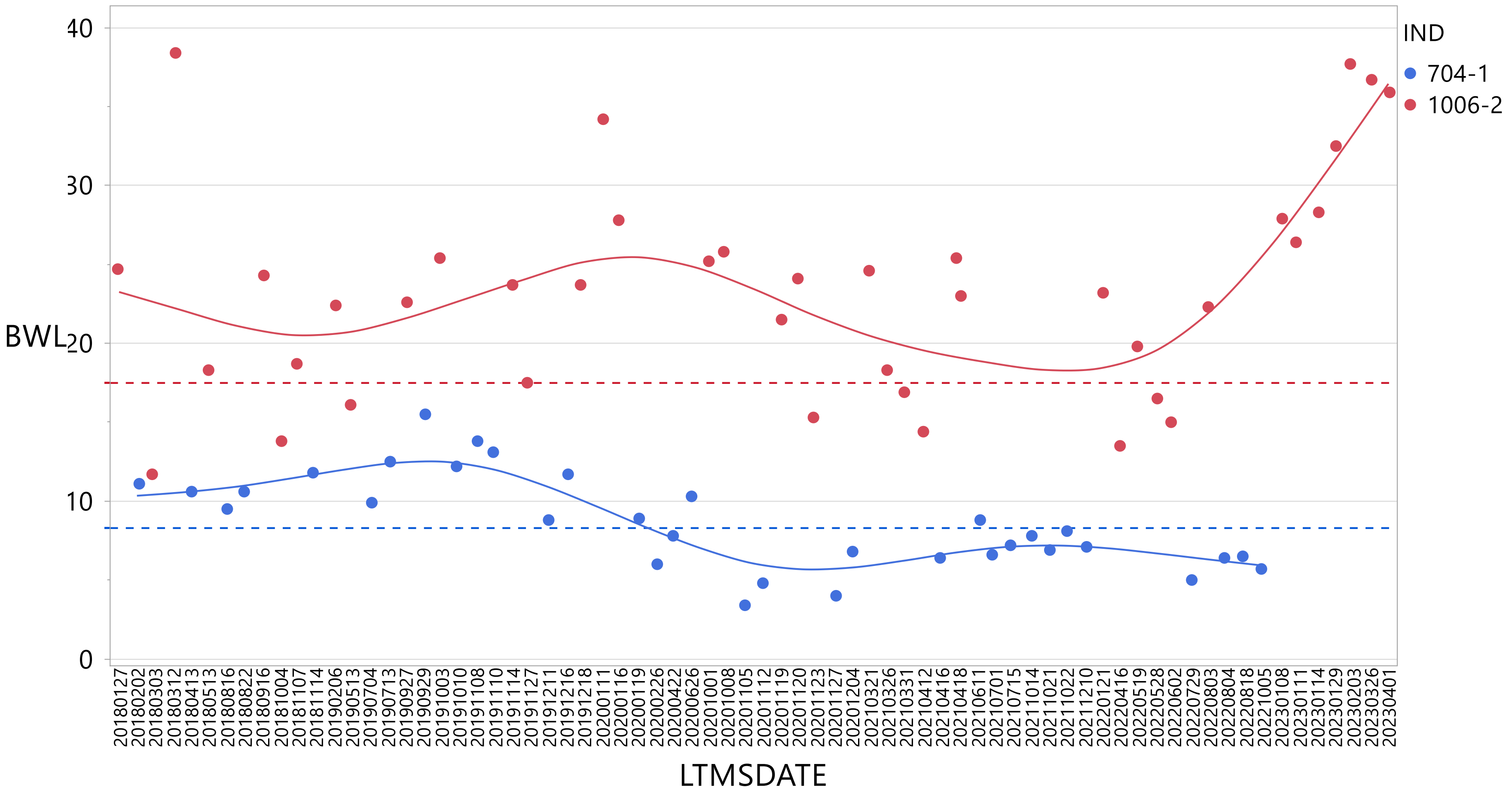
Stripped Viscosity:

- It is recommended to apply and industry correction factor of -0.14 cSt for tests moving forward.
- 1009-1 is recommended to have an LTMS mean of 9.73 cSt and a standard deviation of 0.07 cSt.

Bearing Weight Loss (BWL)

BWL Since 2018

The dashed lines are the oil targets, and all data is shown for operationally valid tests only.



Timeline

- <u>December 2022 - January 2023:</u>
  - Both labs starting producing 1006-2 results > 25.
- <u>January 2023 - April 2023:</u>
  - More than 20 experimental runs in total were conducted between the two labs varying parts, fuel, and oil retains on 1006-2 to try to return severity to a normal level with no success (both labs averaged slightly over 30 mg.
  - Two tests on 1009-1 resulted in 17.4 mg and 18.7 mg and one test on 704-1 of 12.5 suggested that the test was indeed severe but not as bad for oils with a lower target performance.
- <u>May 2023:</u>
  - With 704-1 nearly depleted, SP agreed to run two 1009 tests to determined the feasibility of introducing 1009-1 as a reference oil moving forward. (results were 18.3 and 16.4).
- <u>June 2023:</u>
  - SP agrees to run the rest of the stats group matrix (an additional 8 runs), which is shown on the following slide.

TOTAL BEARING WEIGHT LOSS
Unit of Measure: mg
CRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
704-1	8.3	2.32
1006	15.9	4.85
1006-2	17.5	4.23

Sequence VIII Reference Oil Targets					
		Effective Dates		TBWL	
Oil	n	From[1]	To[2]	$\overline{X}$	s
1009	5	1-7-03	1-23-05	12.8	2.00
	11	1-24-05	5-21-21	13.8	2.14

Test Matrix

The matrix below was the recommended matrix. The data generated from these tests, and possibly including some of the previously generated data, could be used to:

1. Estimate an industry correction factor.
2. Introduce 1009-1 as the sole reference oil moving forward (704-1 supply depleted).
3. Prove-out the 03-22 bearing batch.

A1	A2	B1	B2
1009	704-1	1009	1009-1
704-1	1009-1	704-1	704-1
1009-1	1009-1	1009-1	1009-1

- Yellow highlighted = 06-16 (current) bearing batch
- Green highlighted = 03-22 (new) bearing batch

Test Matrix

During the test matrix, there was a higher than normal result on the second run in stand B1 producing 16.5 mg BWL. Following this test, clear mechanical wear was seen on the third run in the stand. A couple of additional runs were made on the stand which also exhibited mechanical wear, and the lab has requested to have the analysis completed without the final data point from this stand.

- Yellow highlighted = 06-16 (current) bearing batch
- Green highlighted = 03-22 (new) bearing batch

Requested Matrix

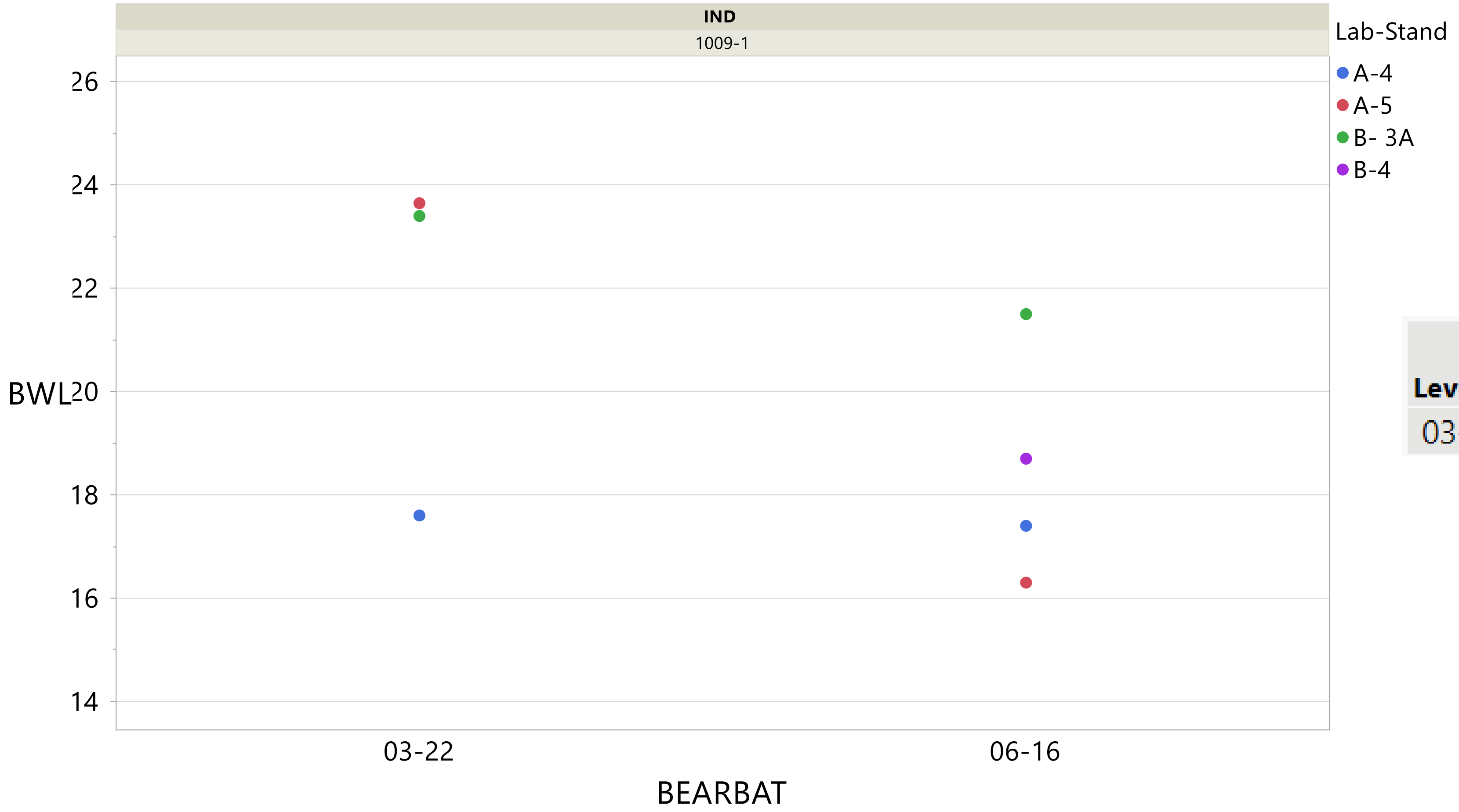
A1		A2		B1		B2	
1009	✓	704-1	✓	1009	✓	1009-1	✓
704-1	✓	1009-1	✓	704-1	?	704-1	✓
1009-1	✓	1009-1	✓	1009-1	X	1009-1	✓

Other recent data

A1	A2	B1	B2
1009-1	--	1009-1	704-1

Bearing Batch

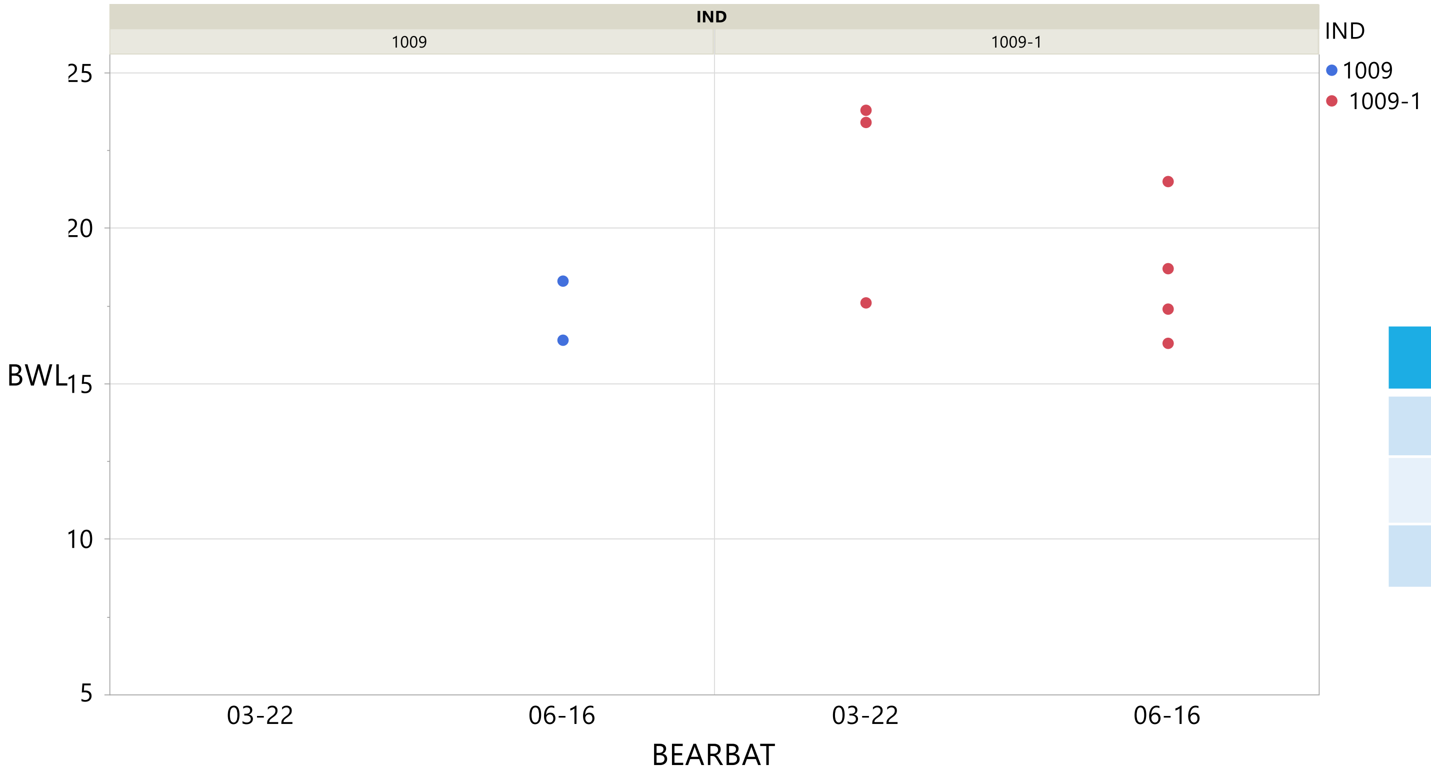
It is unclear if the new bearing batch is different at this time, but the current estimated difference is 3.1 mg.
It is not recommended to add in this difference at this time as an additional contribution to the ICF.



Level	- Level	Difference	p-Value
03-22	06-16	3.058333	0.2077

1009-1 vs. 1009

Using data generated only on identical hardware for the estimated re-blend difference results in a target update to 14.9 mg. Using all data on 1009-1 results in a target update of 16.2.



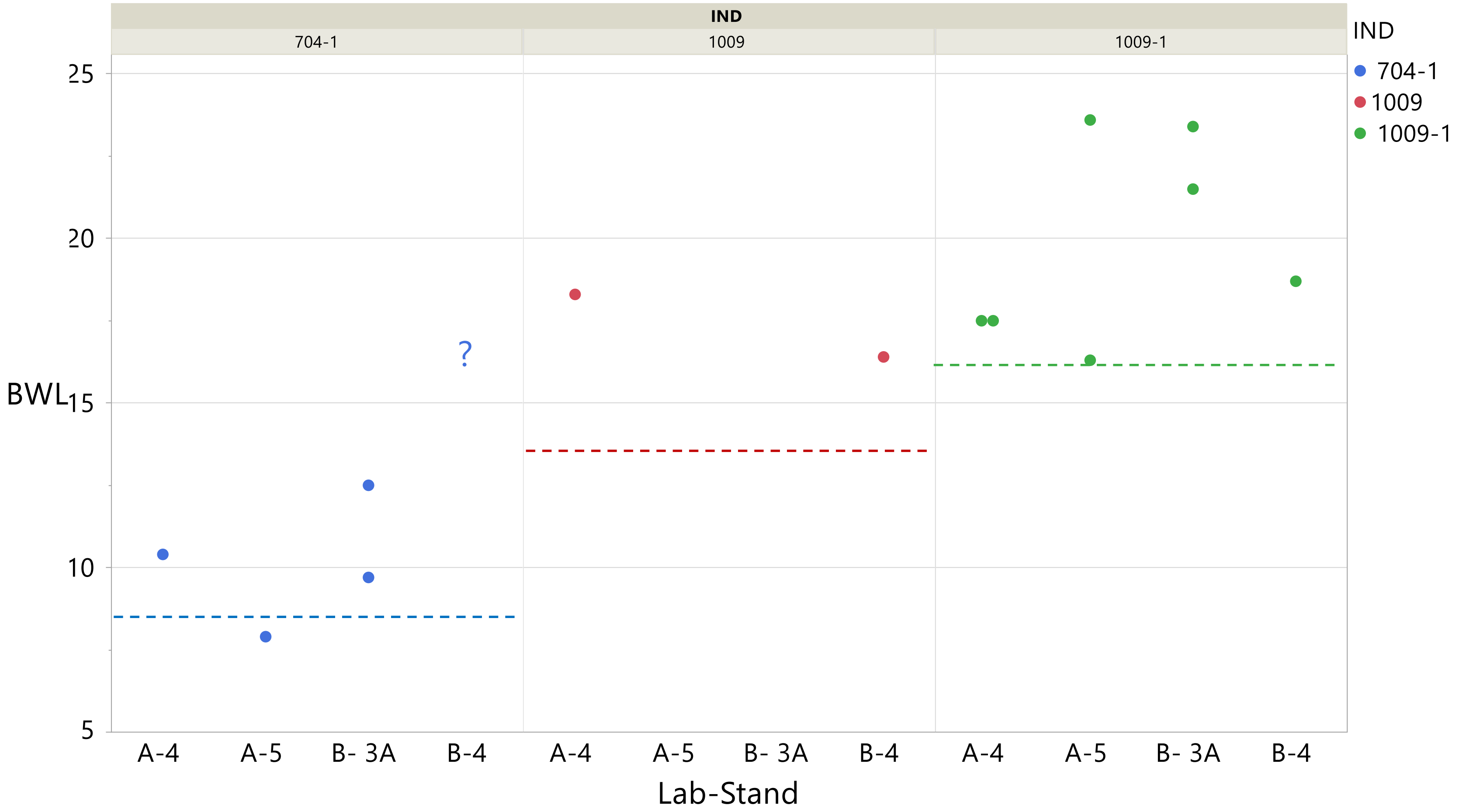
- 1009 Average: 17.4
- 1009-1 All Data: 19.8 (+2.4 mg)
- 1009-1 06-16 Only: 18.5 (+1.1 mg)

Oil	Data Used	LTMS Mean	Std. Dev.
1009	LTMS Target	13.8	2.14
1009-1	All Data (n=7)	13.8+2.4 = 16.2	3.01
1009-1	06-16 Only (n=4)	13.8+1.1 = 14.9	2.77 (pooled)

Correction Factor Using 16.2 Target for 1009-1

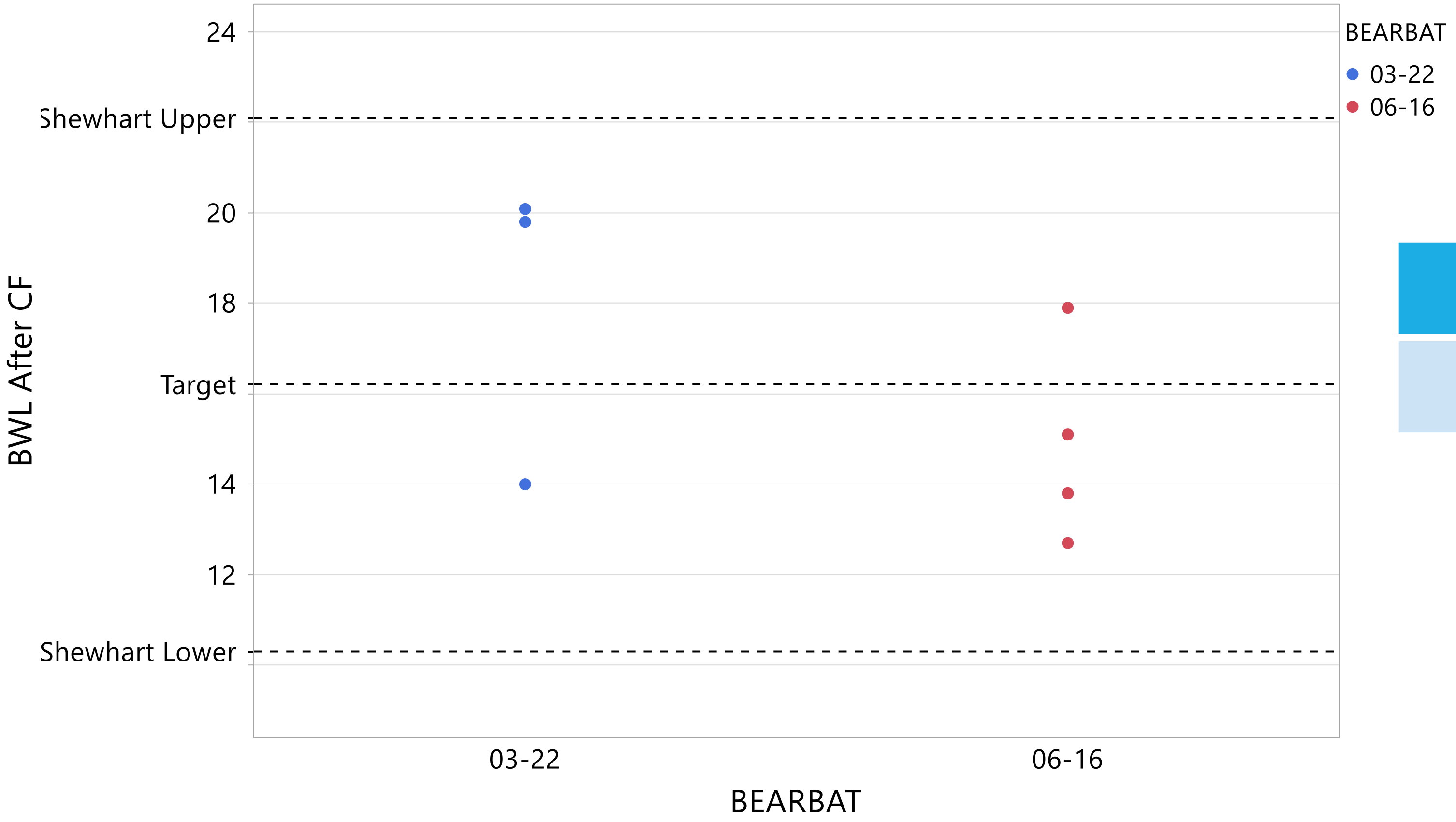
To estimate an ICF we consider all data and 1009-1 only. It is recommended to use the 1009-1 only difference of 3.6 mg as the ICF. Though 1009-1 is further from target than 704-1, it is less than the difference seen in 1006-2. This suggests we might slightly over correct candidates < 10 mg (solid passes anyway), but may potentially under correct candidates > 20 mg.

Method	All Data w/o high 704-1	All Data w/ high 704-1	1009-1 Only
Avg. difference from target	3.0	3.4	3.6



1009-1 Data After Correction Factor of -3.6 mg

The graph below shows the data after the -3.6 mg correction factor, along with the Shewhart severity upper and lower limits.

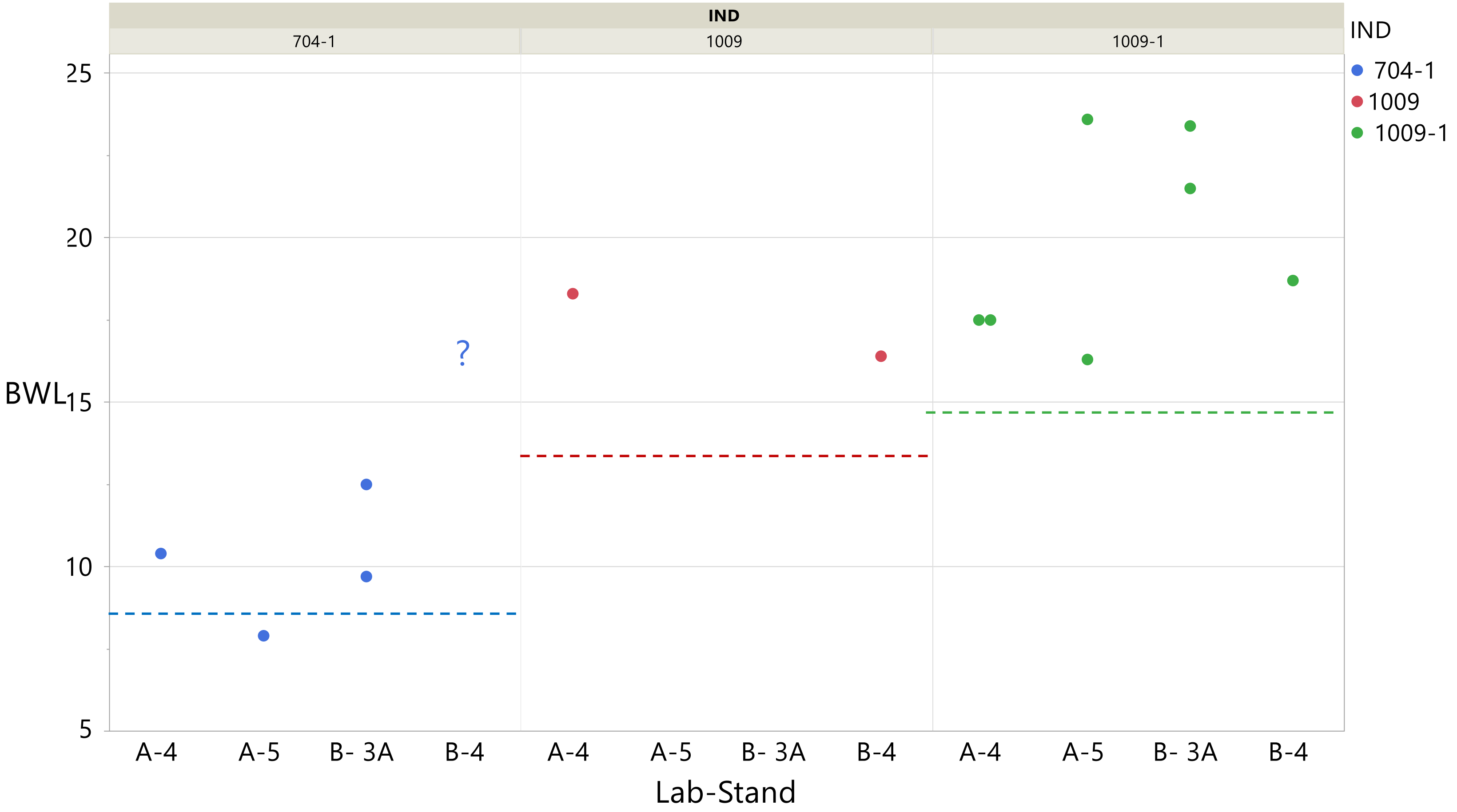


Oil	Mean	Std. Dev.
1009-1	16.2	3.01

Correction Factor Using 14.9 Target for 1009-1

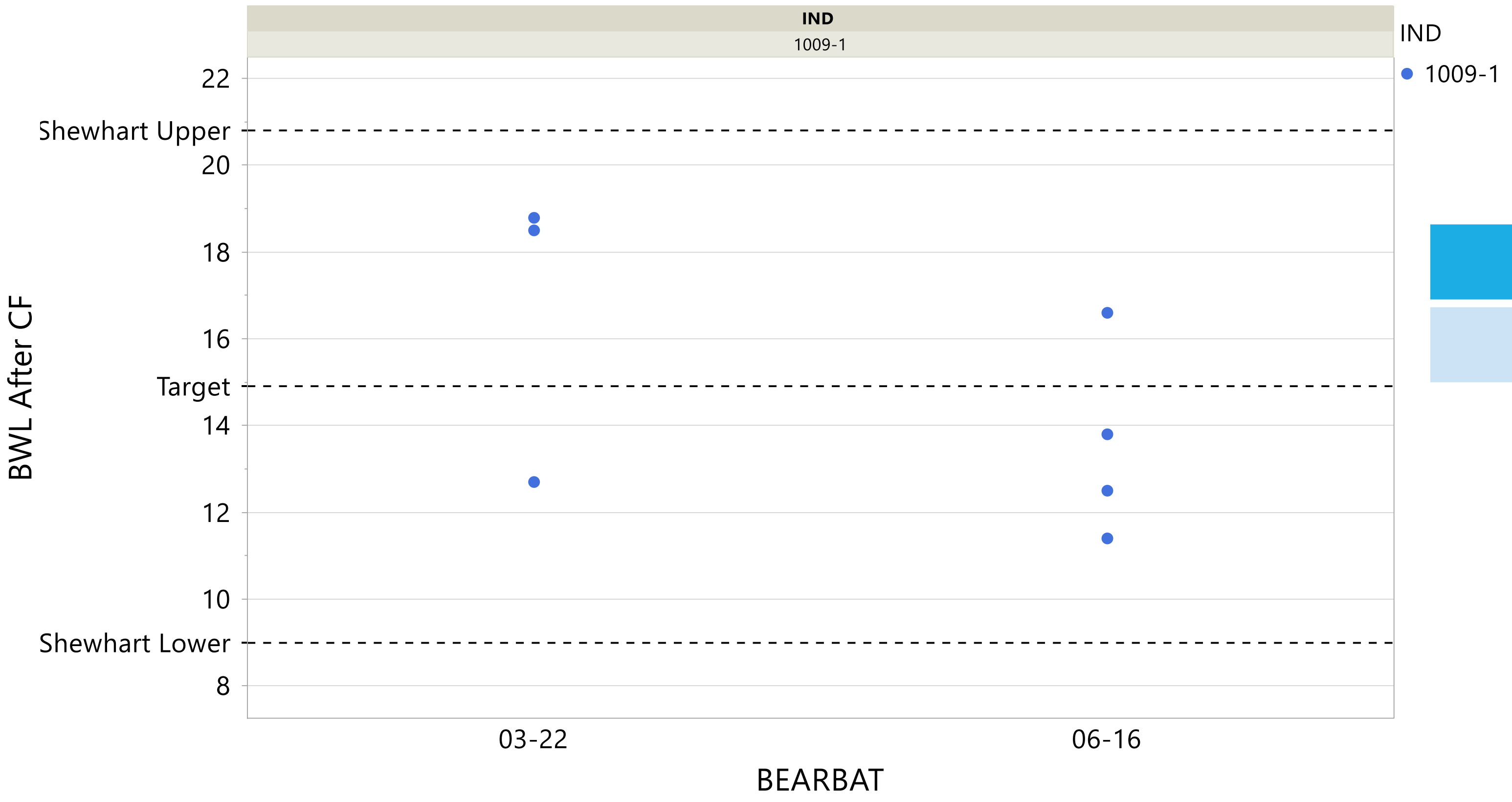
To estimate an ICF we again consider all data and 1009-1 only. It is recommended to use the 1009-1 only difference of 4.9 mg as the ICF.

Method	All Data w/o high 704-1	All Data w/ high 704-1	1009-1 Only
Avg. difference from target	3.7	4.1	4.9



1009-1 Data After Correction Factor of -4.9 mg

The graph below shows the data after the -4.9 mg correction factor, along with the Shewhart severity upper and lower limits.



Oil	Mean	Std. Dev.
1009-1	14.9	3.01

Additional BWL Analyses

Model Predictions

Summary of Fit

RSquare	[illegible]
RSquare Adj	0.796039
Root Mean Square Error	2.282551
Mean of Response	16.43846
Observations (or Sum Wgts)	13

Analysis of Variance

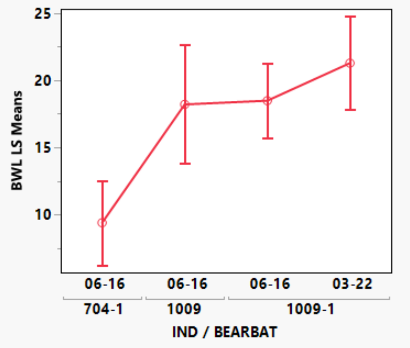
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	6	275.27055	45.8784	8.8058
Error	6	31.26022	5.2100	Prob > F
C. Total	12	306.53077		0.0090*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|	VIF
Intercept	15.821271	0.737952	21.44	<.0001*	.
IND[704-1]	-6.428374	1.124845	-5.71	0.0012*	2.5
IND[1009]	2.3765474	1.41269	1.68	0.1435	2.7
LTMSLAB[A]	-0.677796	0.684935	-0.99	0.3606	1.2
LTMSLAB[A]:LTMSAPP[4]	-0.231432	0.909695	-0.25	0.8077	1.1
LTMSLAB[B]:LTMSAPP[3A]	1.4642058	1.192468	1.23	0.2655	1.6
IND[1009-1]:BEARBAT[06-16]	-1.398098	0.909695	-1.54	0.1752	1.1

Effect Tests

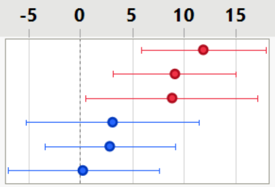
Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
IND	2	2	260.05529	24.9571	0.0012*
LTMSLAB	1	1	5.10200	0.9793	0.3606
LTMSAPP[LTMSLAB]	2	2	7.89162	0.7573	0.5090
BEARBAT[IND]	1	1	12.30622	2.3620	0.1752



Least Squares Means Table

Level	Least Sq Mean	Lower 95%	Upper 95%
[704-1] 06-16	9.4	6.2	12.5
[1009] 06-16	18.2	13.8	22.6
[1009-1] 06-16	18.5	15.7	21.3
[1009-1] 03-22	21.3	17.8	24.7

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
[1009-1] 03-22	[704-1] 06-16	11.87830	1.760790	5.78296	17.97364	0.0021*
[1009-1] 06-16	[704-1] 06-16	9.08210	1.720614	3.12584	15.03836	0.0075*
[1009] 06-16	[704-1] 06-16	8.80492	2.384935	0.54898	17.06087	0.0384*
[1009-1] 03-22	[1009] 06-16	3.07338	2.428521	-5.33345	11.48020	0.6134
[1009-1] 03-22	[1009-1] 06-16	2.79620	1.819390	-3.50200	9.09439	0.4739
[1009-1] 06-16	[1009] 06-16	0.27718	2.132058	-7.10338	7.65774	0.9991



Contrast

Test Detail

[704-1] 06-16	0
[1009] 06-16	0.5
[1009-1] 06-16	0.5
[1009-1] 03-22	-1
Estimate	-2.935
Std Error	1.8621
t Ratio	-1.576
Prob>|t|	0.1661
SS	12.941
Lower 95%	-7.491
Upper 95%	1.6217

SS	NumDF	DenDF	F Ratio	Prob > F
12.94	1	6	2.4839	0.1661

Current 1009 target: 13.8

Difference between 1009 and 1009-1 for 06-16 bearing batch = 0.3

1009-1 new target: 14.1

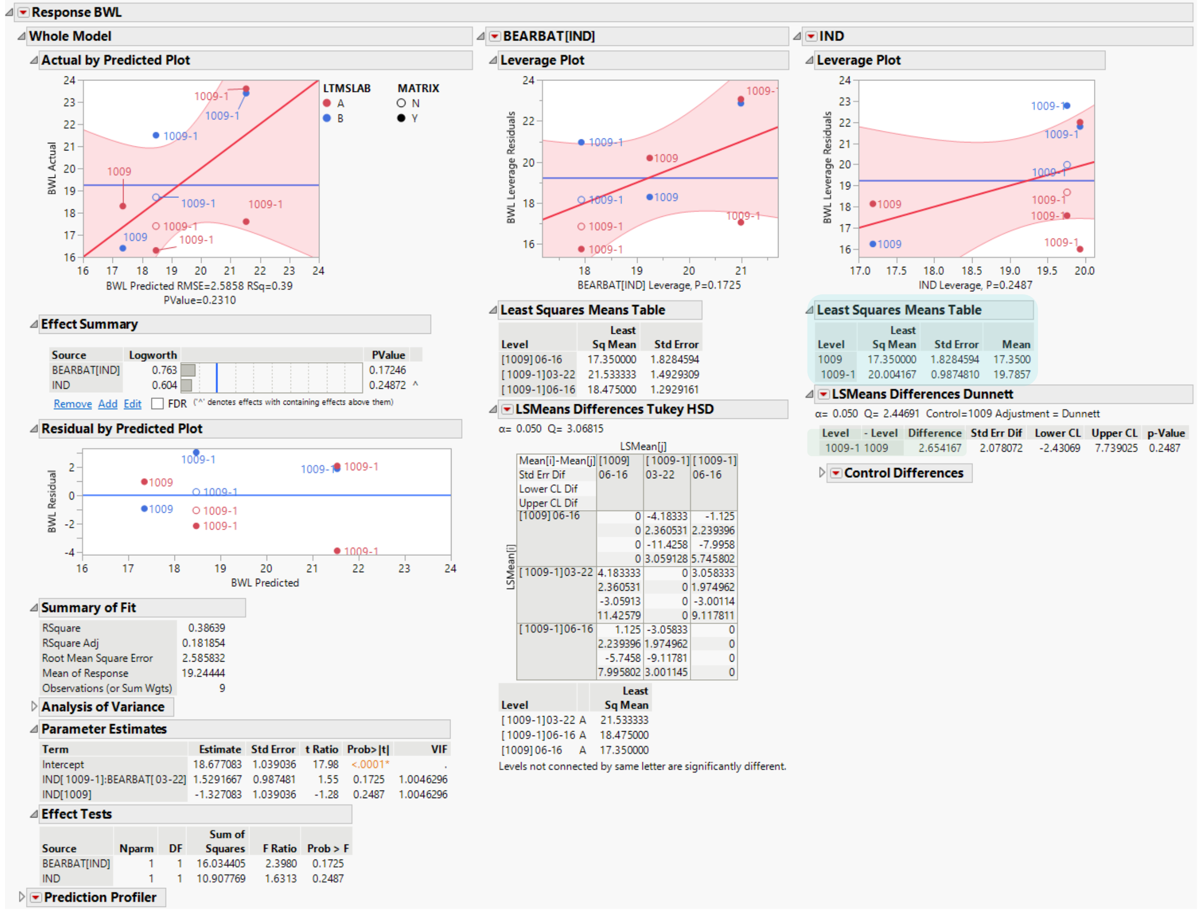
Difference between 1009 06-16 and current target: -4.4

Difference between 06-16 and 03-22 batch: -2.9

ICF = -7.3

Model Predictions

BWL (VIII) Correction/Targets Evaluation



- Data Used: All 1009 & 1009-1 Data (Matrix) + 2 Tests 1009-1 resulted in 17.4 mg and 18.7 mg (01/23 – 04/23)
- Model Used: BWL ~ IND + BEARBAT[IND]
- 1009 LSMeans = Mean = 17.4 mg, SD (assume 1009 = 1009-1) = 2.6 mg
- ICF (based on 1009) = 13.8 mg – 17.4 mg = -3.6 mg
- 1009-1 LSMeans = 20.0 mg = 17.4 mg + 2.6 mg (unadjusted)
- 1009-1 After ICF = 20.0 mg – 3.6 mg = 16.4 mg (unadjusted)
- ICF = -3.6 mg, 1009-1 LTMS mean = 16.4mg, SD = 2.6

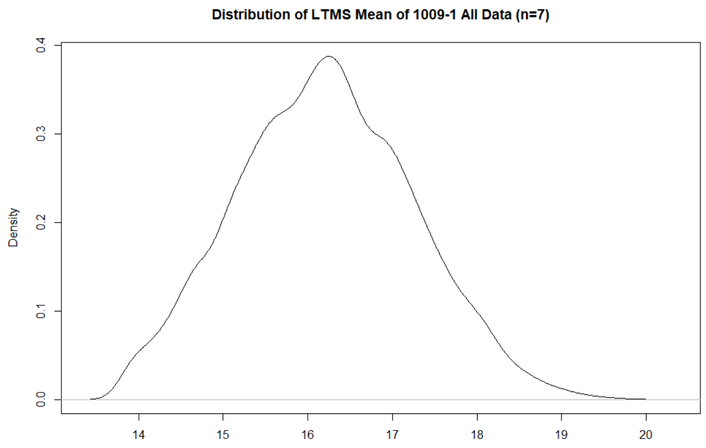
Option	Oil	Data Used	LTMS Mean	Std. Dev.	Bootstrap Est. of LTMS Mean	95% LTMS Mean Bootstrap LCB	95% LTMS Mean Bootstrap UCB	Bootstrap Est. of Std.Dev.	95% Bootstrap Est. of Std.Dev. LCB	95% Bootstrap Est. of Std.Dev. UCB
	1009	LTMS Target	13.8	2.14						
2	1009-1	All Data (n=7)	13.8+2.4 = 16.2	3.01	16.21	14.24	18.26	2.74	1.42	3.50
1	1009-1	06-16 Only (n=4)	13.8+1.1 = 14.9	2.77 (pooled)	15.02	13.85	16.97	2.51	1.45	3.20

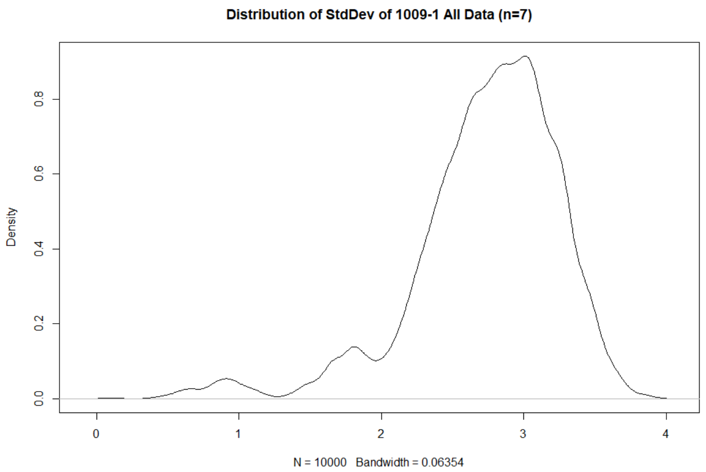
Bootstrap Simulation was done use 10000 iterations.

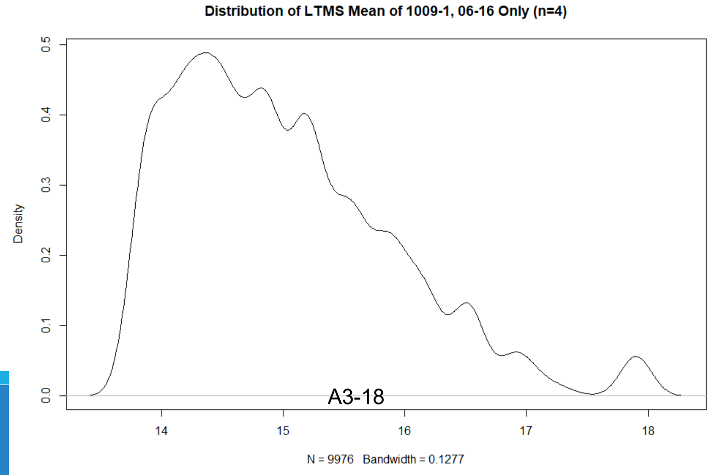
Bootstrap estimates seem to algin with estimates given by the data

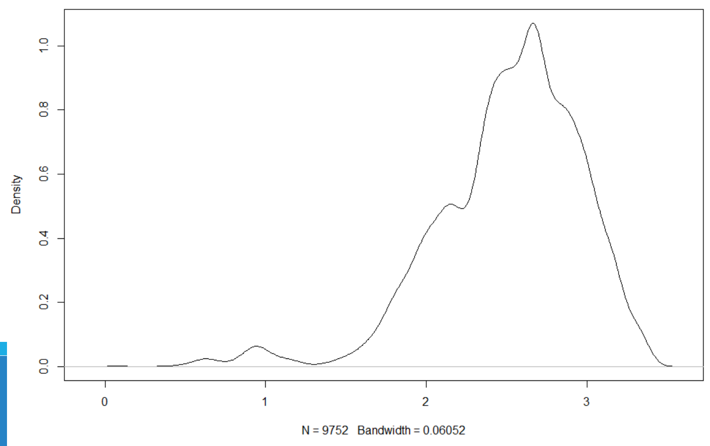
LTMS Mean has a strange distribution due to the nature of only having 4 observations to begin with. Note some iterations do not have enough data to estimate this.

Confidence intervals definitely support our unease around the uncertainty



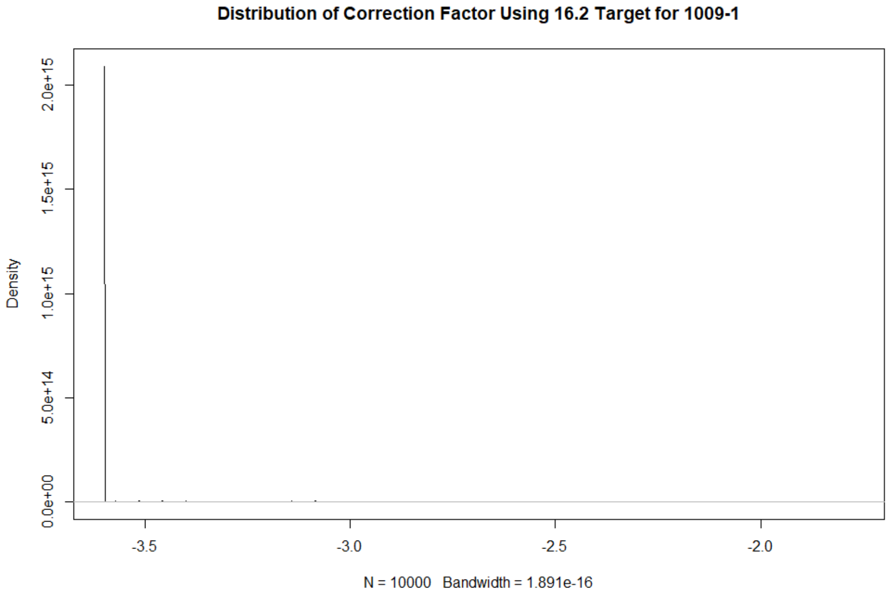


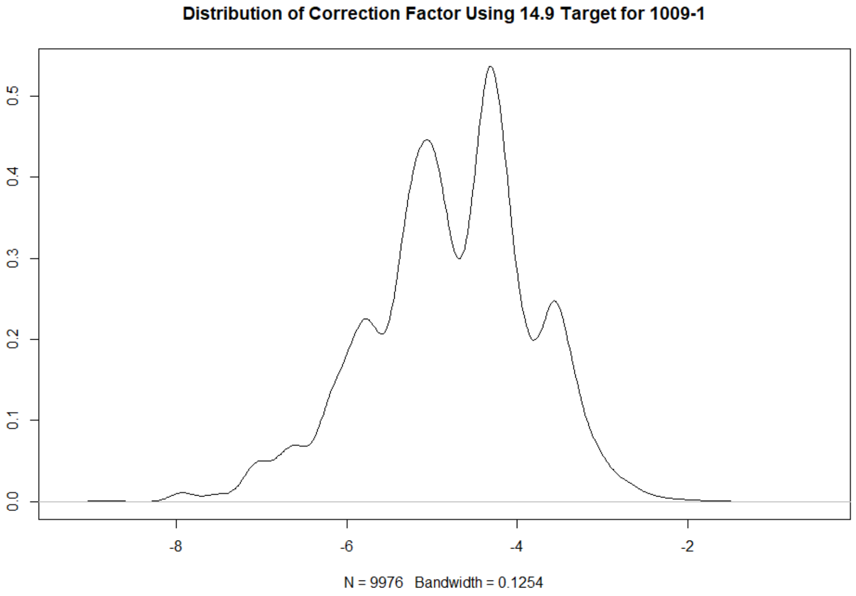




Option	Oil	Data Used	LTMS Mean	Std. Dev.	Bootstrap Est. of LTMS Mean	95% LTMS Mean Bootstrap LCB	95% LTMS Mean Bootstrap UCB	Bootstrap Est. of Std.Dev.	95% Bootstrap Est. of Std.Dev. LCB	95% Bootstrap Est. of Std.Dev. UCB
	1009	LTMS Target	13.8	2.14						
2	1009-1	All Data (n=7)	13.8+2.4 = 16.2	3.01	16.21	14.24	18.26	2.74	1.42	3.50
1	1009-1	06-16 Only (n=4)	13.8+1.1 = 14.9	2.77 (pooled)	15.02	13.85	16.97	2.51	1.45	3.20

Option	BTSP ICF Est	BtSP 95% ICF LCB	BtSP 95% ICF UCB
2	-3.6	-3.6	-3.6
1	-4.78	-6.87	-3.10





For the Correction Factor it gets messy I think due to the limited amount of data. For the All Data Estimate I think we have hit the nail on the head.

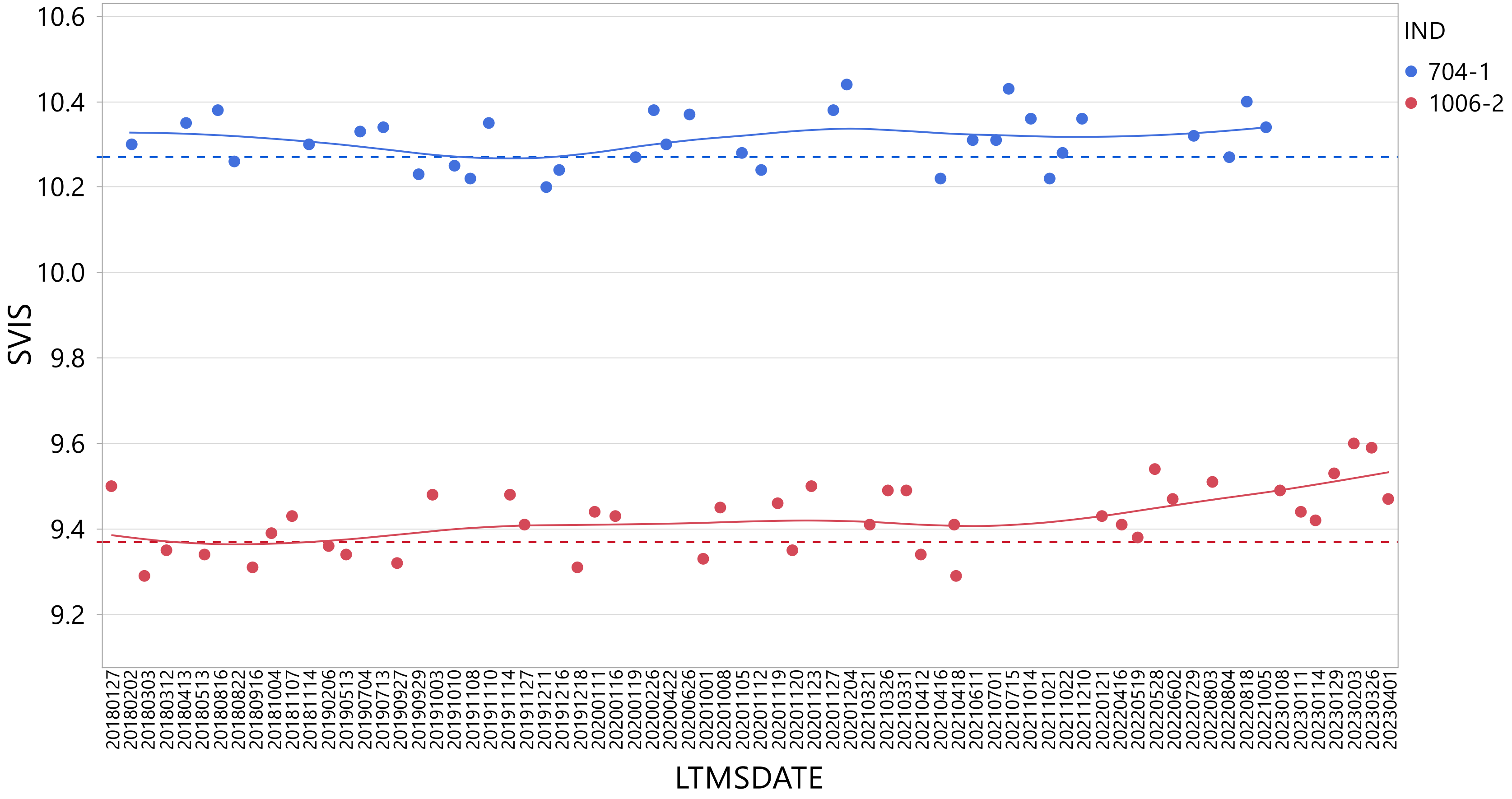
10 Hour Stripped Viscosity

SVIS Since 2018

SVIS also increased at the same time as bearing weight loss with 1006-2.

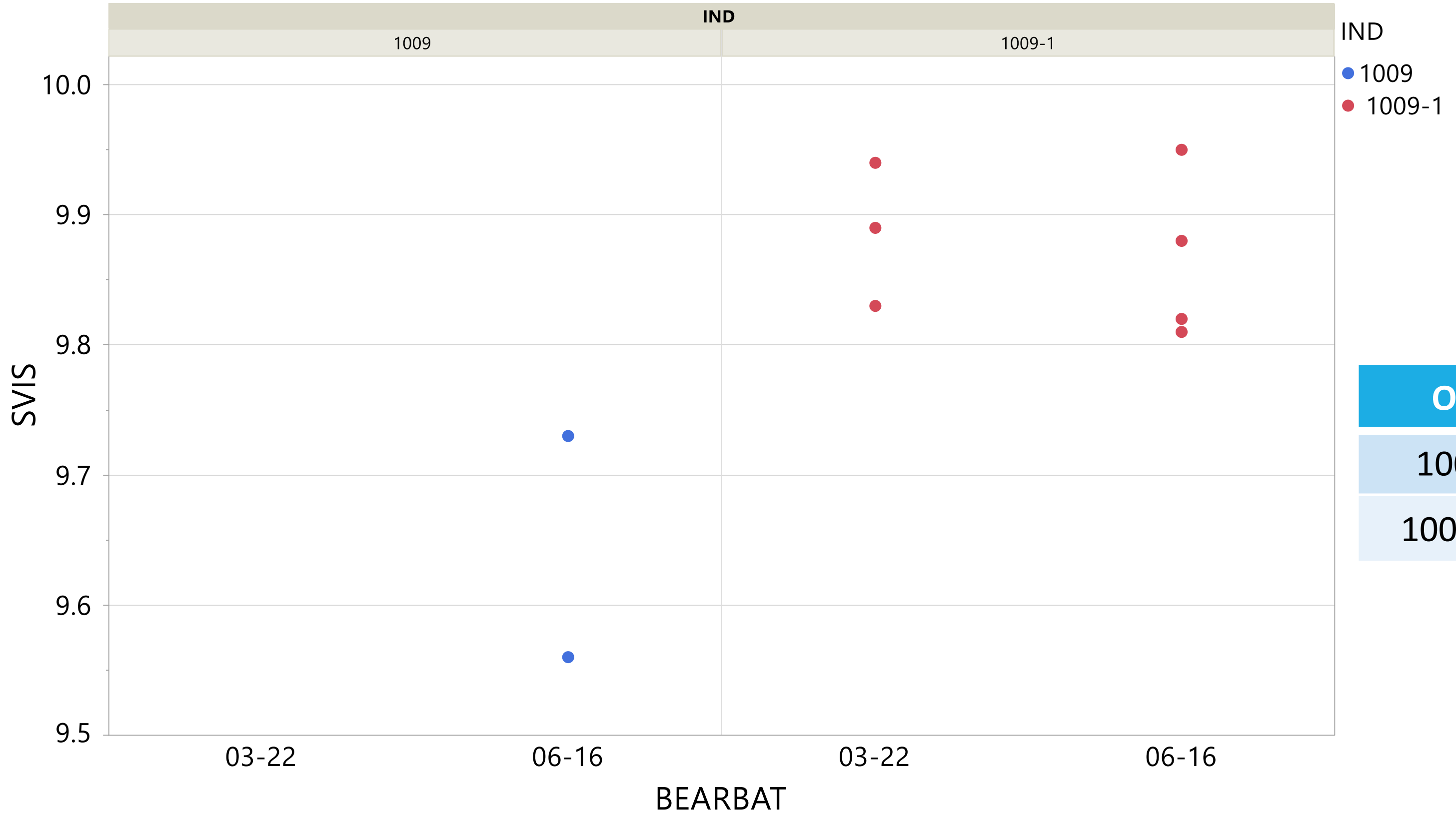
10-HOUR STRIPPED VISCOSITY
Unit of Measure: centistokes
NONCRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
704-1	10.27	0.11
1006	9.00	0.17
1006-2	9.37	0.07
1009	9.51	0.10



1009-1 vs. 1009

Consider the difference of the re-blend first. The re-blend data on both bearing batches is similar and shows an average difference from the original blend of 0.22 cSt, resulting in a target of 9.73 cSt.



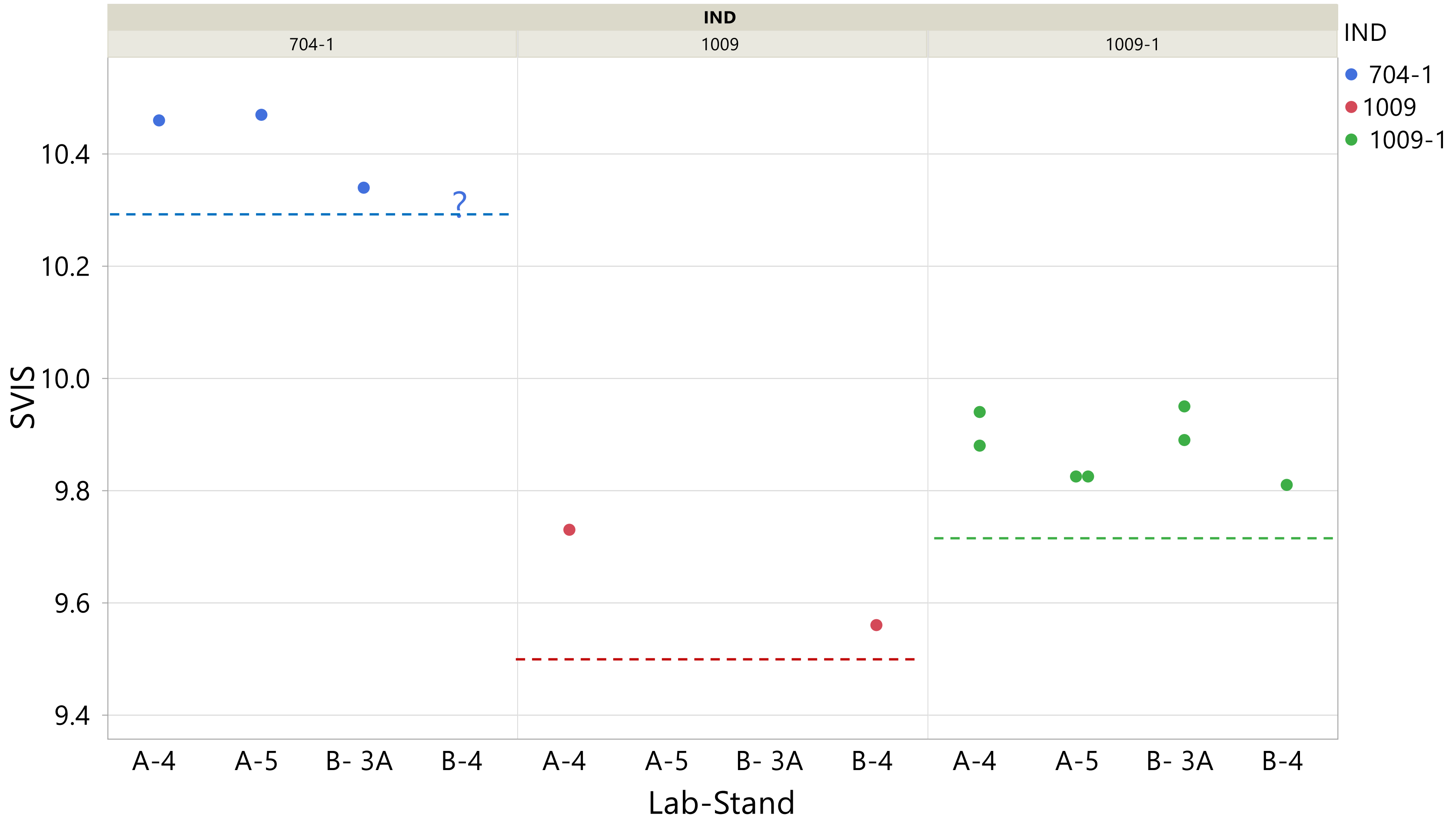
- 1009 Average: 9.65
- 1009-1 All Data: 9.87 (+0.22 cSt)
- 1009-1 06-16 Only: 9.87 (+ 0.22 cSt)

Oil	Data Used	LTMS Mean	Std. Dev.
1009	LTMS Target	9.51	0.10
1009-1	All Data	9.51 + 0.22 = 9.73	0.07

Correction Factor

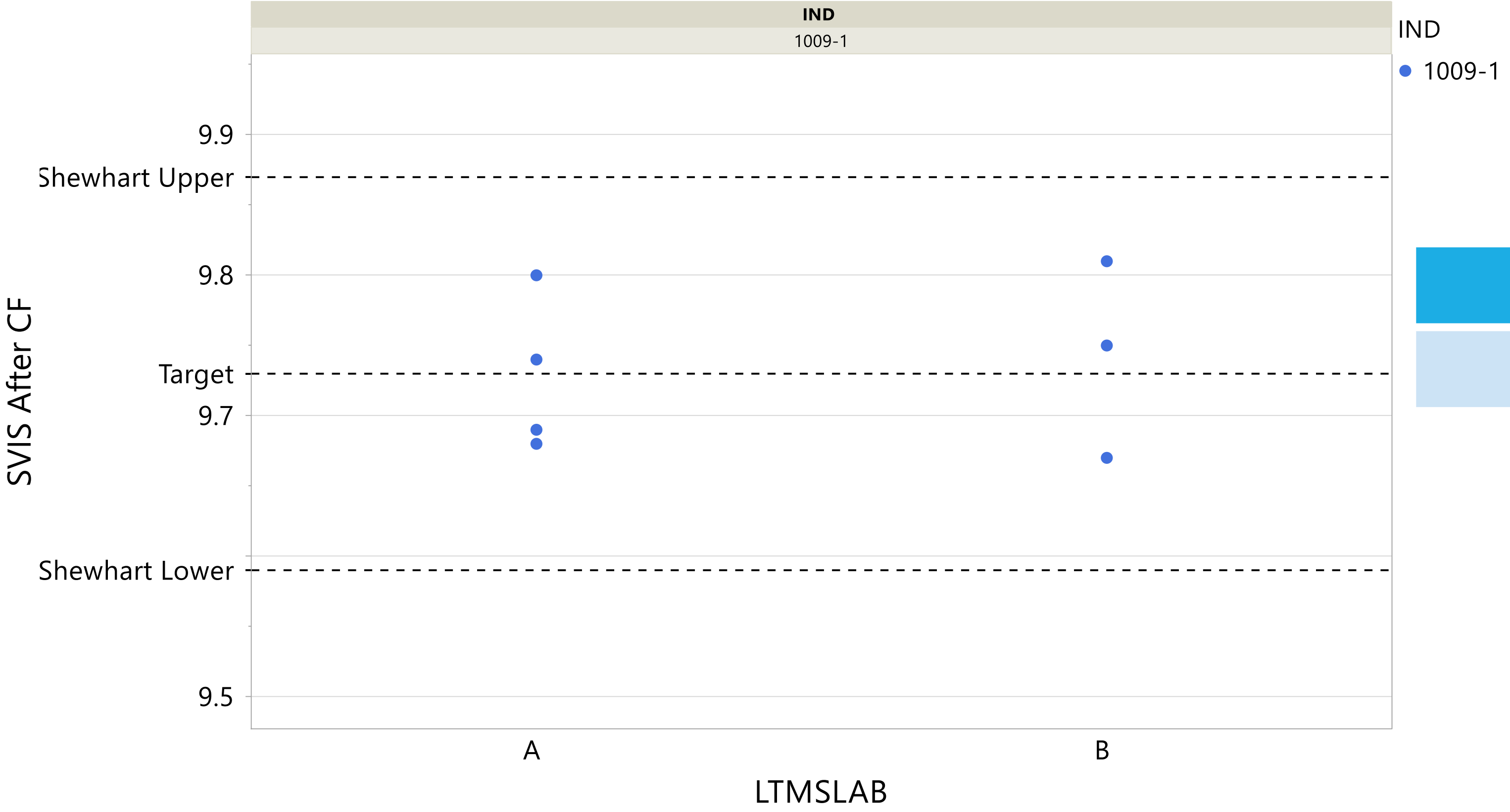
Modeling lab and stand differences seems inappropriate on the current data set. To estimate an ICF for the 06-16 bearings, we can take the average difference from target of all 6 results (recommended), or we can take an average of the two average differences.

Method	Using All Data	1009-1 Only
Avg. difference from target	-0.14	-0.14



1009-1 Data After Correction Factor of -0.14 cSt

The graph below shows the data after the -0.14 cSt correction factor, along with the Shewhart severity upper and lower limits.



Oil	Mean	Std. Dev.
1009-1	9.73	0.07

Additional 10 Hour Stripped Viscosity Analyses

Model Predictions

Summary of Fit

RSquare	0.976565
RSquare Adj	0.948444
Root Mean Square Error	0.066237
Mean of Response	9.973333
Observations (or Sum Wgts)	12

Analysis of Variance

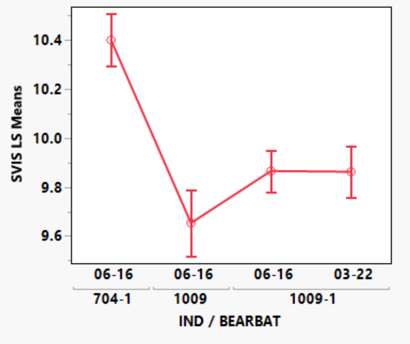
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	6	0.91413021	0.152355	34.7264
Error	5	0.02193646	0.004387	Prob > F
C. Total	11	0.93606667		0.0006*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|	VIF
Intercept	9.9717535	0.022449	444.19	<.0001*	.
IND[704-1]	0.4268924	0.034267	12.46	<.0001*	2.3
IND[1009]	-0.318628	0.041136	-7.75	0.0006*	2.7
LTMSLAB[A]	0.0279688	0.02056	1.36	0.2318	1.1
LTMSLAB[A]:LTMSAPP[4]	0.0298438	0.0264	1.13	0.3096	1.1
LTMSLAB[B]:LTMSAPP[3A]	0.0460937	0.03529	1.31	0.2484	1.4
IND[1009-1]:BEARBAT[03-22]	-0.00151	0.0264	-0.06	0.9566	1.1

Effect Tests

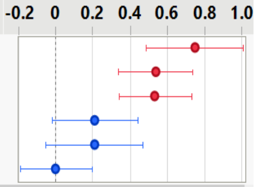
Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
IND	2	2	0.70655393	80.5228	0.0002*
LTMSLAB	1	1	0.00811850	1.8505	0.2318
LTMSAPP[LTMSLAB]	2	2	0.01511452	1.7225	0.2697
BEARBAT[IND]	1	1	0.00001436	0.0033	0.9566



Least Squares Means Table

Level	Least Sq Mean	Lower 95%	Upper 95%
[704-1] 06-16	10.40	10.29	10.50
[1009] 06-16	9.65	9.52	9.79
[1009-1] 06-16	9.87	9.78	9.95
[1009-1] 03-22	9.86	9.76	9.97

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
[704-1] 06-16	[1009] 06-16	0.7455208	0.0705791	0.485083	1.005959	0.0005*
[704-1] 06-16	[1009-1] 03-22	0.5366667	0.0540820	0.337103	0.736230	0.0007*
[704-1] 06-16	[1009-1] 06-16	0.5336458	0.0527992	0.338816	0.728476	0.0006*
[1009-1] 06-16	[1009] 06-16	0.2118750	0.0619587	-0.016754	0.440504	0.0656
[1009-1] 03-22	[1009] 06-16	0.2088542	0.0705791	-0.051584	0.469292	0.1061
[1009-1] 06-16	[1009-1] 03-22	0.0030208	0.0527992	-0.191809	0.197851	0.9999



Contrast

Test Detail

[704-1] 06-16	0
[1009] 06-16	0.5
[1009-1] 06-16	0.5
[1009-1] 03-22	-1
Estimate	-0.103
Std Error	0.0541
t Ratio	-1.903
Prob>|t|	0.1154
SS	0.0159
Lower 95%	-0.242
Upper 95%	0.0361

SS	NumDF	DenDF	F Ratio	Prob > F
0.016	1	5	3.6213	0.1154

Current 1009 target: 9.51

Difference between 1009 and 1009-1 for 06-16 bearing batch = 0.21

1009-1 new target: 9.72

Difference between 1009 06-16 and current target: -0.14

Difference between 06-16 and 03-22 batch: -0.10

ICF = -0.24

Model Predictions

SVIS (VIII) Correction/Targets Evaluation

Effect Summary

Source	Logworth	PValue
IND	2.084	0.00825
BEARBAT[IND]	0.145	0.71533

Summary of Fit

RSquare	0.714389
RSquare Adj	0.619185
Root Mean Square Error	0.074181
Mean of Response	9.823333
Observations (or Sum Wgts)	9

Analysis of Variance

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	9.7604167	0.029807	327.45	<.0001*
IND[1009-1]:BEARBAT[03-22]	0.0108333	0.028328	0.38	0.7153
IND[1009]	-0.115417	0.029807	-3.87	0.0082*

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
BEARBAT[IND]	1	1	0.00080476	0.1462	0.7153
IND	1	1	0.08250430	14.9932	0.0082*

BEARBAT[IND] Least Squares Means Table

Level	Least Sq Mean	Std Error
[1009]06-16	9.6450000	0.05245368
[1009-1]03-22	9.8866667	0.04282825
[1009-1]06-16	9.8650000	0.03709036

LSMeans Differences Tukey HSD

α= 0.050 Q= 3.06815

Mean[i]-Mean[j] / Std Err Dif / Lower CL Dif / Upper CL Dif	[1009] 06-16	[1009-1] 03-22	[1009-1] 06-16
[1009]06-16	0	-0.24167	-0.22
	0	0.067717	0.064242
	0	-0.44943	-0.41711
	0	-0.0339	-0.02289
[1009-1]03-22	0.241667	0	0.021667
	0.067717	0	0.056656
	0.0339	0	-0.15216
	0.449434	0	0.195497
[1009-1]06-16	0.22	-0.02167	0
	0.064242	0.056656	0
	0.022895	-0.1955	0
	0.417105	0.152164	0

Level		Least Sq Mean
[1009-1]03-22	A	9.8866667
[1009-1]06-16	A	9.8650000
[1009]06-16	B	9.6450000

Levels not connected by same letter are significantly different.

IND Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
1009	9.6450000	0.05245368	9.64500
1009-1	9.8758333	0.02832823	9.87429

LSMeans Differences Dunnett

α= 0.050 Q= 2.44691 Control=1009 Adjustment = Dunnett

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
1009-1	1009	0.2308333	0.0596144	0.0849621	0.3767045	0.0082*

Control Differences

- Data Used: All 1009 & 1009-1 Data (Matrix) + 2 Tests 1009-1 resulted in 9.81 cSt and 9.88 cSt (01/23 – 04/23)
- Model Used: SVIS ~ IND + BEARBAT[IND]
- 1009 LSMeans = Mean = 9.65 cSt, SD (assume 1009 = 1009-1) = 0.07 cSt
- ICF (based on 1009) = 9.51 cSt – 9.65 cSt = -0.14 cSt
- 1009-1 LSMeans = 9.88 cSt = 9.65 cSt + 0.23 cSt (unadjusted)
- 1009-1 After ICF = 9.88 cSt – 0.14 cSt = 9.74 cSt (unadjusted)
- ICF = -0.14 cSt, 1009-1 LTMS mean = 9.74 cSt, SD = 0.07 cSt