

# Mack T-12 – Impact of New Parts and ICF Review *SP Discussion (3 Test ICF Determination)*

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Performance you can rely on.



# Summary of proposal



- Includes: Lab A (159933), Lab D (159843) and Lab G (159551)

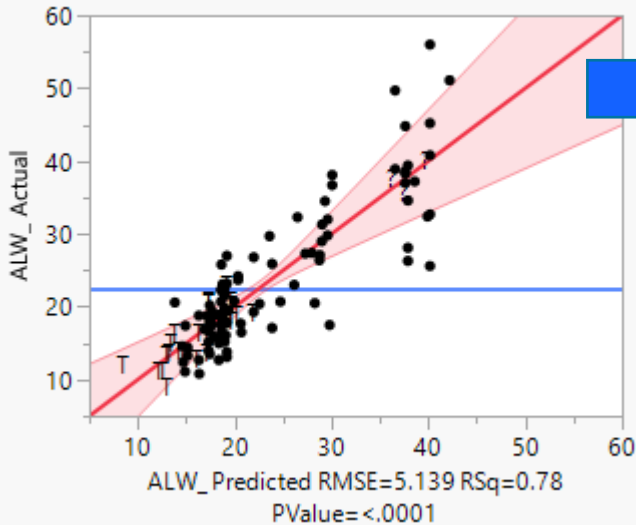
ALW	In ALW		Lab	original ALW	In ALW	afterCF	Original scale after CF
Predicted	3.6615		G	40.1	3.6914	2.8149	16.7
TARGET	2.7850		D	37.7	3.6297	2.7531	15.7
additive ICF	-0.8765		A	35.6	3.5723	2.6958	14.8
Oil Consumption	In OILCON		Lab	original OILCON	In OILCON	afterCF	Original scale after CF
Predicted	4.5102		G	94.7	4.5507	4.1335	62.4
TARGET	4.0930		D	87.2	4.4682	4.0510	57.5
additive ICF	-0.4172		A	96.7	4.5716	4.1544	63.7
	option 1	option 2					
Top Ring Weight Loss	Keep current CF as is (0.846 based on mean)	Update CF to 0.75 also based on current mean					
PB	Keep current CF as is						
PB2	Keep current CF as is						

- Summary of proposal
- Dataset – LTMS 2021/08/26
  - Tests on Reference oil 821 and re-blends
  - Exclusions:
    - Exclude tests with Chart = N (except W/ X/ Y/ P/ F4945E)
    - Testkeys: 98459, 98867 (goofy tests)
    - 109182 (thrown out last time)
    - 110864 (VUXPB)
    - 158884 & 164848 (Lab B tests on W/ X/ Y/ P/ F4945E)
  - Total number of tests: 127
- General comments
- Proposed correction factors by parameter with plots before and after ICF
  - Calculations
- Appendix 1: Targets and Standard Deviation by parameter
- Appendix 2: Current ICF

# General comments

- Latest batch of parts:
  - Cyl.Liner/TopRing/Rodbearing/MainBearing/PistonCrown[ W/ X/ Y/ P/ F4945E]
- Original precision matrix
  - LTMS adopted use natural logarithm transformations for Pb, Pb2, and OC.
  - Liner Wear and Top Ring Weight Loss were not transformed.
- This review indicates that CLW and TRWL need LN transformation.

Actual by Predicted Plot



High results raise the question about transforming or not liner wear. This discussion is not new... last time SP decided not to transform liner wear

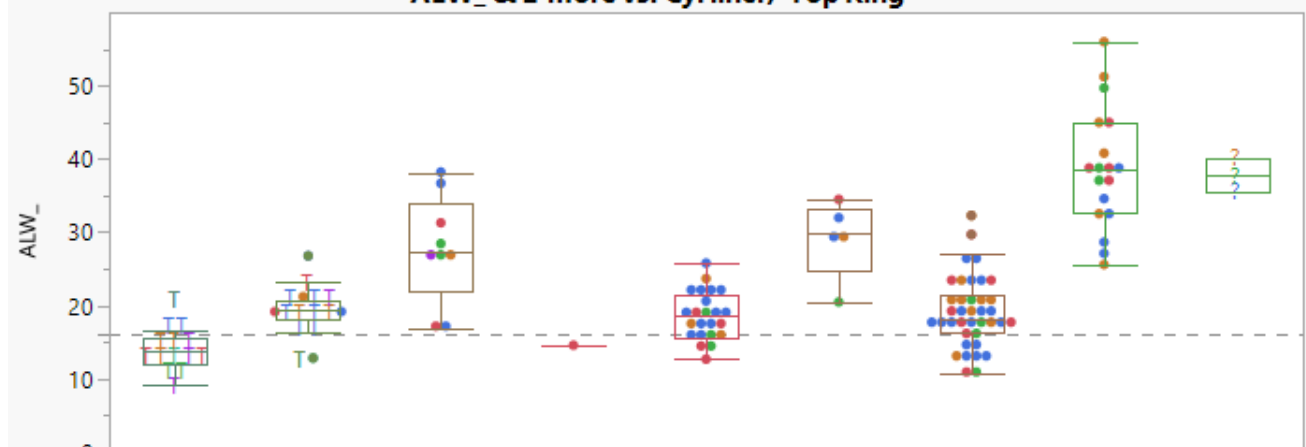
Keeping original scale => Multiplicative  
Transformed scale => Additive

Impact on proposed ICF is small: see three test results using the new set of parts corrected by both methods below

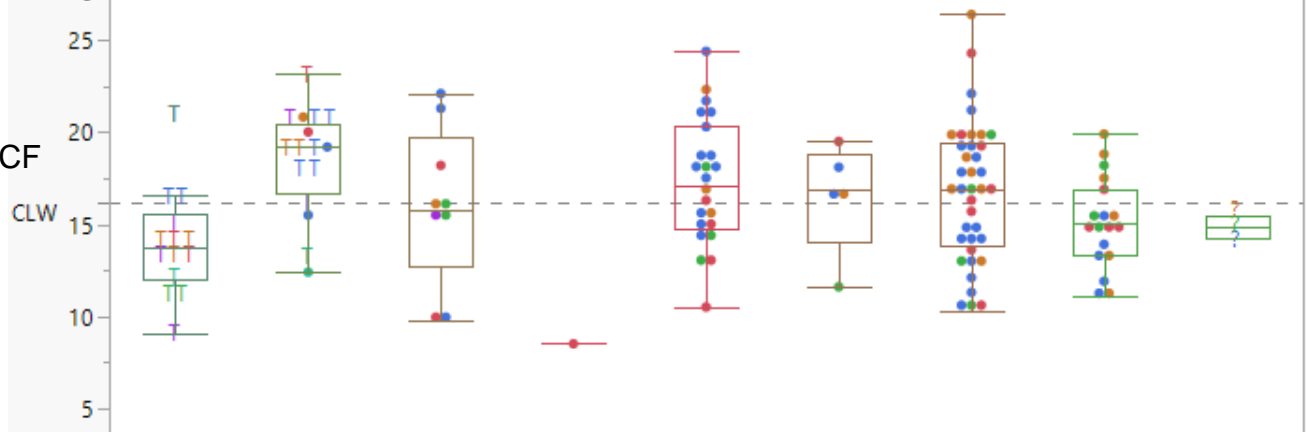
					No Transf. Option 1		LN Option 2	
	ALW	ln ALW	Lab	original ALW	after CF	ln	afterCF	Original scale after CF
<b>Predicted</b>	38.87	3.662	G	40.1	16.113	3.6914	2.8149	16.691
<b>Target</b>	16.2	2.785	D	37.7	15.72	3.6297	2.7531	15.692
<b>ICF</b>	0.417 (1)	-0.877 (2)	A	35.6	14.83	3.5723	2.6958	14.818
1	MULTIPLICATIVE							
2	ADDITIVE							

### ALW\_ & 2 more vs. Cyl liner/ Top Ring

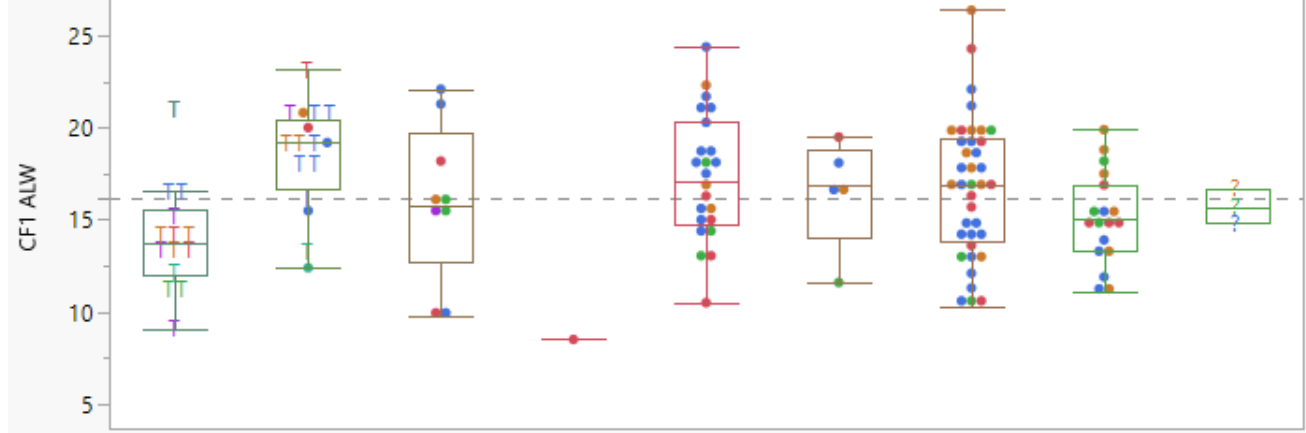
Before ICF



After current ICF



Proposed ICF based on Option 2



Proposed ICF based on LN (option2)



- A
- B
- D
- F
- G
- I
- ⊠ ALW\_
- ⊠ CLW
- ⊠ CF1 ALW

# Calculations

## Option 2

LN ALW

Expanded Estimates  
Nominal factors expanded to all levels

Term	Estimate	Std Error	t Ratio	Prob> t		TARGET	ICF	ADDITIVE
Intercept	3.0611582	0.043346	70.62	<.0001	1	3.661537525	2.785011242	-0.87653
IND 2[ PC10E/821]	-0.054345	0.1335	-0.41	0.6847	1			
IND 2[ 821-1]	0.0639349	0.076048	0.84	0.4023	0 Lab	original ALW	ln	afterCF
IND 2[ 821-2]	0.0949662	0.072975	1.3	0.1959	0 G	40.1	3.691376	2.8148501
IND 2[ 821-3]	-0.022785	0.095152	-0.24	0.8112	0 D	37.7	3.62966	2.7531338
IND 2[ 821-4]	-0.08177	0.095674	-0.85	0.3946	0 A	35.6	3.572346	2.6958194
LTMSLAB[A]	0.0828572	0.041648	1.99	0.0492	0.25			
LTMSLAB[B]	0.0699692	0.04956	1.41	0.1609	0.25			
LTMSLAB[D]	-0.029196	0.055989	-0.52	0.6031	0.25	A	pred	
LTMSLAB[F]	-0.000995	0.089015	-0.01	0.9911	0	G	39.7806	
LTMSLAB[G]	0.1204297	0.047683	2.53	0.013	0.25	B	41.30369	
LTMSLAB[I]	-0.243065	0.111571	-2.18	0.0315	0	D	39.2712	
Cyl liner/ Top Ring[ N/ N]	-0.419427	0.145599	-2.88	0.0048	0		35.56372 ln	
Cyl liner/ Top Ring[ P/ P]	-0.132461	0.126019	-1.05	0.2955	0		38.9798	3.6630436
Cyl liner/ Top Ring[ R/ R]	0.1101179	0.104	1.06	0.292	0			
Cyl liner/ Top Ring[ S/ R]	-0.514041	0.209355	-2.46	0.0157	0			
Cyl liner/ Top Ring[ S/ T]	-0.302596	0.079831	-3.79	0.0002	0			
Cyl liner/ Top Ring[ U/ U]	0.2540285	0.132339	1.92	0.0575	0			
Cyl liner/ Top Ring[ V/ U]	-0.169721	0.092629	-1.83	0.0696	0			
Cyl liner/ Top Ring[ V/ X]	0.5803891	0.108193	5.36	<.0001	0			
Cyl liner/ Top Ring[ W/ X]	0.5937093	0.147882	4.01	0.0001	1			

## Ignore option 1

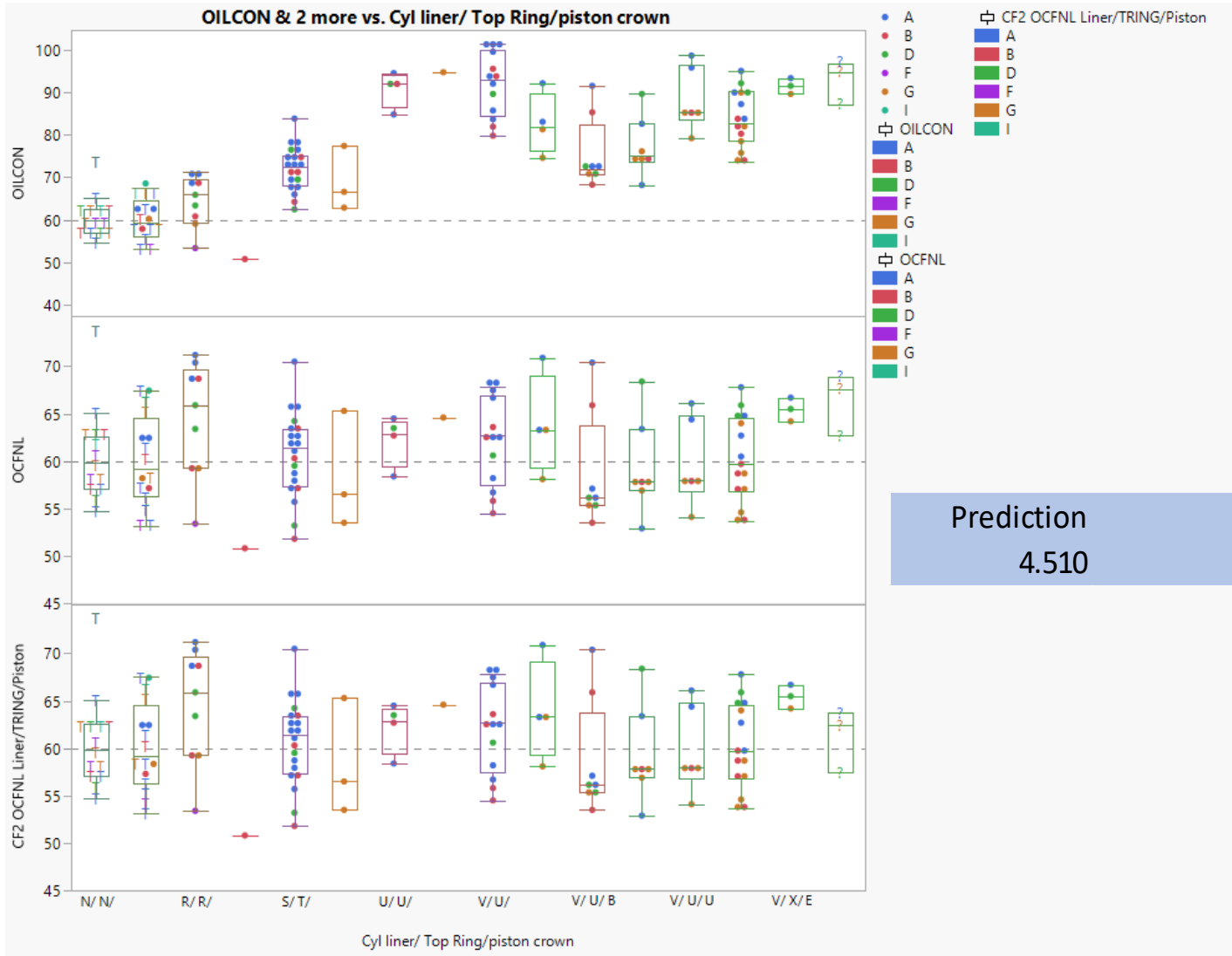
## Option 1

ALW

Expanded Estimates  
Nominal factors expanded to all levels

Term	Estimate	Std Error	t Ratio	Prob> t		TARGET	ICF	MULTIPLICATIVE
Intercept	23.6462	1.035699	22.83	<.0001	1	38.86983	16.2	0.416776
IND 2[ PC10E/821]	-0.94013	3.189835	-0.29	0.7688	1			
IND 2[ 821-1]	1.66949	1.817076	0.92	0.3602	0 Lab	original ALW	afterCF	
IND 2[ 821-2]	2.00868	2.74365	1.15	0.2518	0 G	40.1	16.71271	
IND 2[ 821-3]	-0.78656	2.27358	-0.35	0.73	0 D	37.7	15.71245	
IND 2[ 821-4]	-1.95149	2.28602	-0.85	0.3952	0 A	35.6	14.83722	
LTMSLAB[A]	0.96765	0.995131	0.97	0.333	0.25			
LTMSLAB[B]	1.145503	1.184182	0.97	0.3355	0.25			
LTMSLAB[D]	-0.60582	1.337793	-0.45	0.6516	0.25			
LTMSLAB[F]	0.054285	2.126909	0.03	0.9797	0			
LTMSLAB[G]	2.373053	1.139325	2.08	0.0396	0.25			
LTMSLAB[I]	-3.93467	2.665858	-1.48	0.142	0			
Cyl liner/ Top Ring[ N/ N]	-9.24391	3.478934	-2.66	0.0091	0			
Cyl liner/ Top Ring[ P/ P]	-4.58515	3.011082	-1.52	0.1307	0			
Cyl liner/ Top Ring[ R/ R]	1.605452	2.484972	0.65	0.5196	0			
Cyl liner/ Top Ring[ S/ R]	-11.8612	5.002306	-2.37	0.0195	0			
Cyl liner/ Top Ring[ S/ T]	-7.82435	1.907475	-4.1	<.0001	0			
Cyl liner/ Top Ring[ U/ U]	5.330743	3.162084	1.69	0.0947	0			
Cyl liner/ Top Ring[ V/ U]	-4.41269	2.213261	-1.99	0.0487	0			
Cyl liner/ Top Ring[ V/ X]	15.79744	2.585145	6.11	<.0001	0			
Cyl liner/ Top Ring[ W/ X]	15.19365	3.533469	4.3	<.0001	1			

# Oil Consumption: Proposed ICF keeps current LN transformation



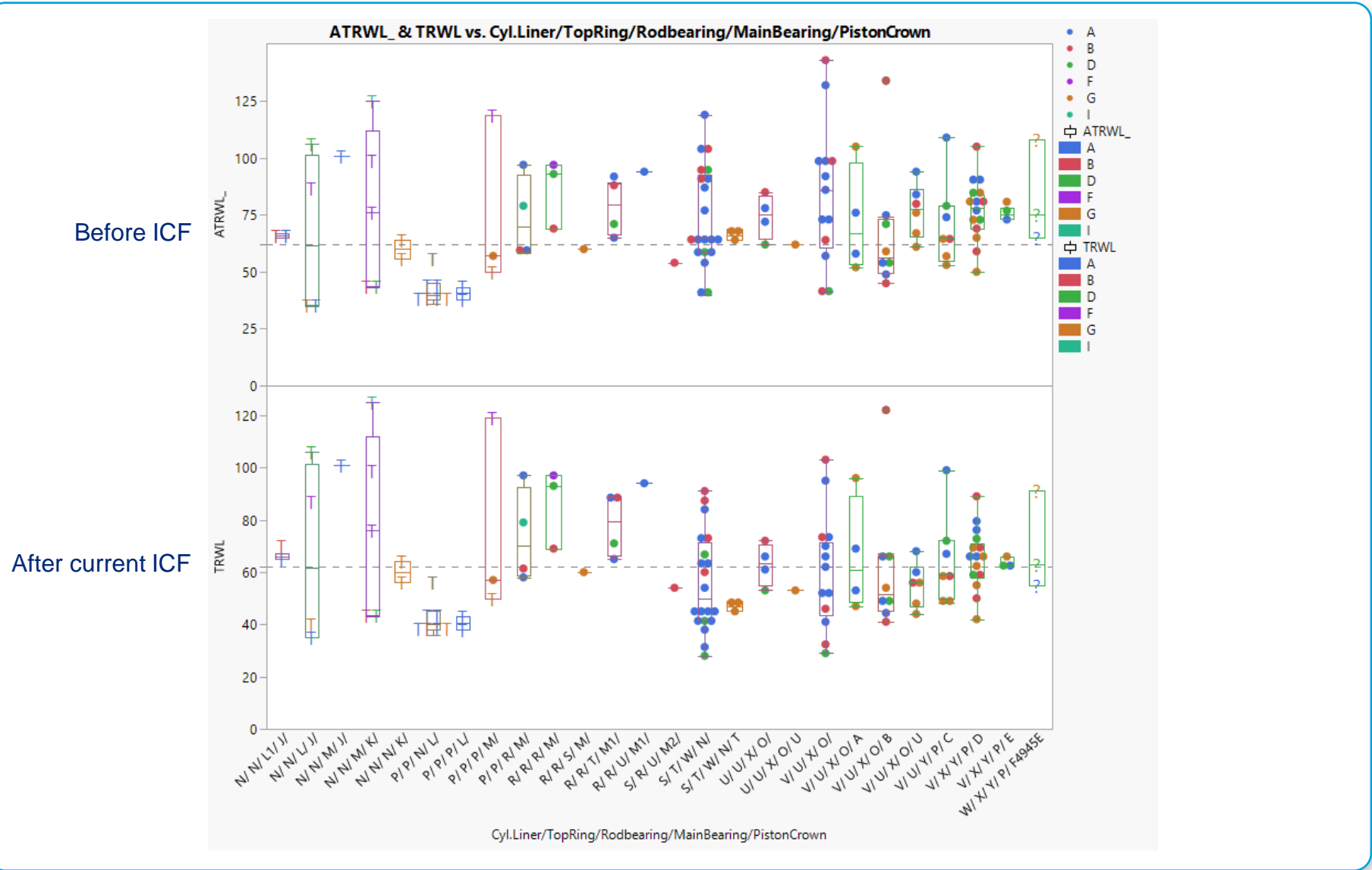
Prediction	TARGET	ICF
4.510	4.093	-0.417

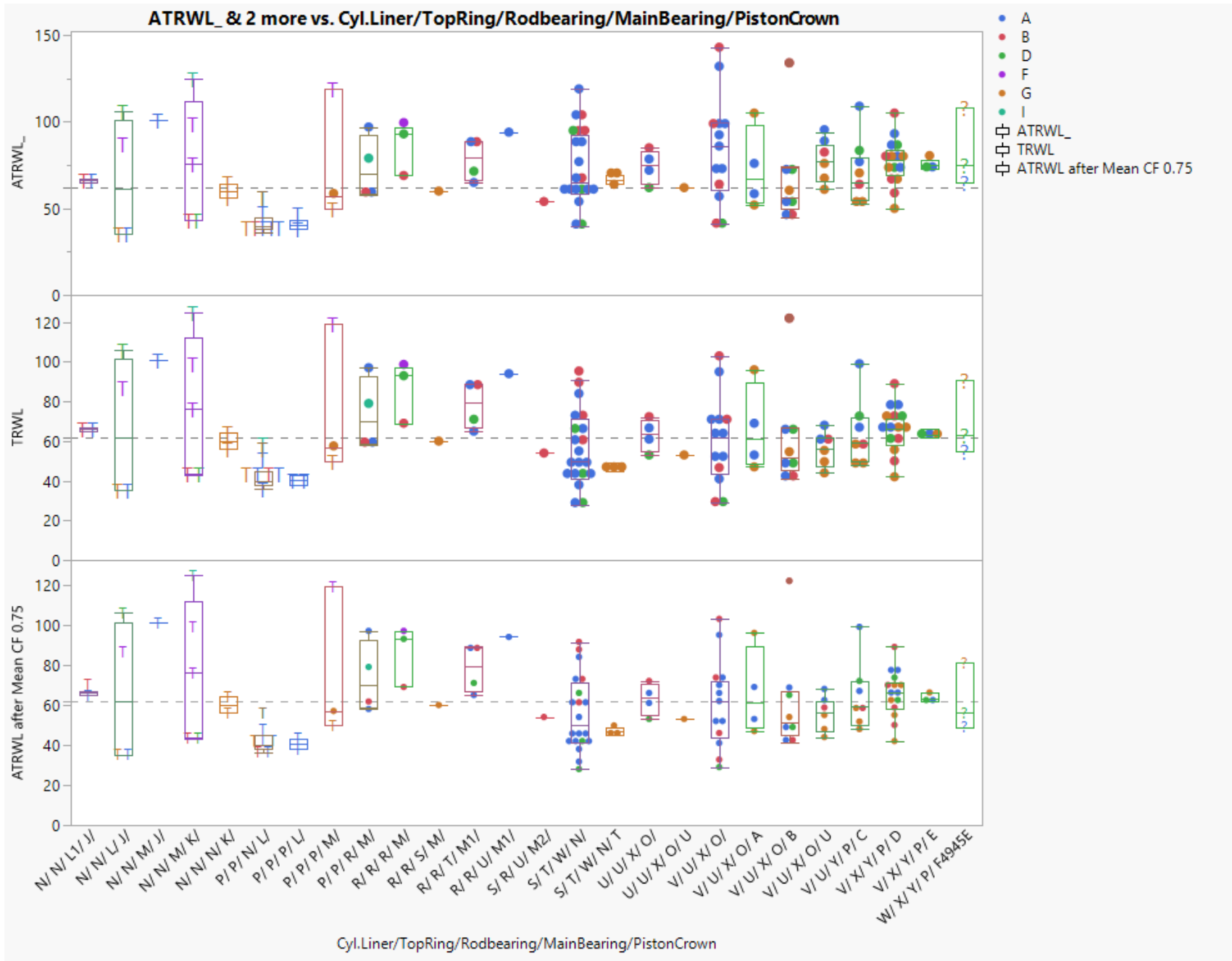
additive



LN OILCON with liner/TopRing/piston											
Expanded Estimates											
Nominal factors expanded to all levels											
Term	Estimate	Std Error	t Ratio	Prob> t			TARGET	ICF			
Intercept	4.3496831	0.018798	231.39	<.0001	1	4.510206025		4.093	-0.41721		
IND 2[ PC10E/ 821]	-0.014291	0.048649	-0.29	0.7695	1						
IND 2[ 821-1]	0.0164004	0.028113	0.58	0.5609	0						
IND 2[ 821-2]	0.0218347	0.027061	0.81	0.4216	0	Lab	original OILCON	In	afterCF	Original scale after CF	
IND 2[ 821-3]	-0.023263	0.035943	-0.65	0.5189	0	G		94.7	4.550714	4.133508	62.39642
IND 2[ 821-4]	-0.00068	0.039802	-0.02	0.9864	0	D		87.2	4.468204	4.0509983	57.45479
LTMSLAB[ A]	0.0236673	0.015347	1.54	0.1261	0.25	A		96.7	4.571613	4.1544074	63.71419
LTMSLAB[ B]	-0.032704	0.018545	-1.76	0.0808	0.25						
LTMSLAB[ D]	-0.001999	0.020707	-0.1	0.9233	0.25						
LTMSLAB[ F]	-0.032336	0.032276	-1	0.3188	0			94.3956235	4.547495		
LTMSLAB[ G]	-0.043451	0.018907	-2.3	0.0236	0.25			88.26791061	4.480377		
LTMSLAB[ I]	0.086823	0.040458	2.15	0.0342	0			89.22164559	4.491124		
Cyl liner/ Top Ring/piston crown[ N/ N/]	-0.22322	0.062009	-3.6	0.0005	0			92.00363288	4.521828		
Cyl liner/ Top Ring/piston crown[ P/ P/]	-0.258112	0.055502	-4.65	<.0001	0				4.510206		
Cyl liner/ Top Ring/piston crown[ R/ R/]	-0.195827	0.045845	-4.27	<.0001	0						
Cyl liner/ Top Ring/piston crown[ S/ R/]	-0.405483	0.083891	-4.83	<.0001	0						
Cyl liner/ Top Ring/piston crown[ S/ T/]	-0.101921	0.036739	-2.77	0.0066	0						
Cyl liner/ Top Ring/piston crown[ S/ T/ T]	-0.09651	0.054491	-1.77	0.0795	0						
Cyl liner/ Top Ring/piston crown[ U/ U/]	0.1782652	0.049069	3.63	0.0004	0						
Cyl liner/ Top Ring/piston crown[ U/ U/ U]	0.2677451	0.080838	3.31	0.0013	0						
Cyl liner/ Top Ring/piston crown[ V/ U/]	0.1783875	0.032193	5.54	<.0001	0						
Cyl liner/ Top Ring/piston crown[ V/ U/ A]	0.071164	0.047166	1.51	0.1344	0						
Cyl liner/ Top Ring/piston crown[ V/ U/ B]	-0.022036	0.037281	-0.59	0.5558	0						
Cyl liner/ Top Ring/piston crown[ V/ U/ C]	0.0074665	0.04051	0.18	0.8541	0						
Cyl liner/ Top Ring/piston crown[ V/ U/ U]	0.1470127	0.035832	4.1	<.0001	0						
Cyl liner/ Top Ring/piston crown[ V/ X/ D]	0.0905369	0.03489	2.59	0.0109	0						
Cyl liner/ Top Ring/piston crown[ V/ X/ E]	0.1740965	0.05196	3.35	0.0011	0						
Cyl liner/ Top Ring/piston crown[ W/ X/ F4945E]	0.1884356	0.05196	3.63	0.0005	1						

# Top Ring Weight Loss: the plot below shows that the current ICF seems ok for now





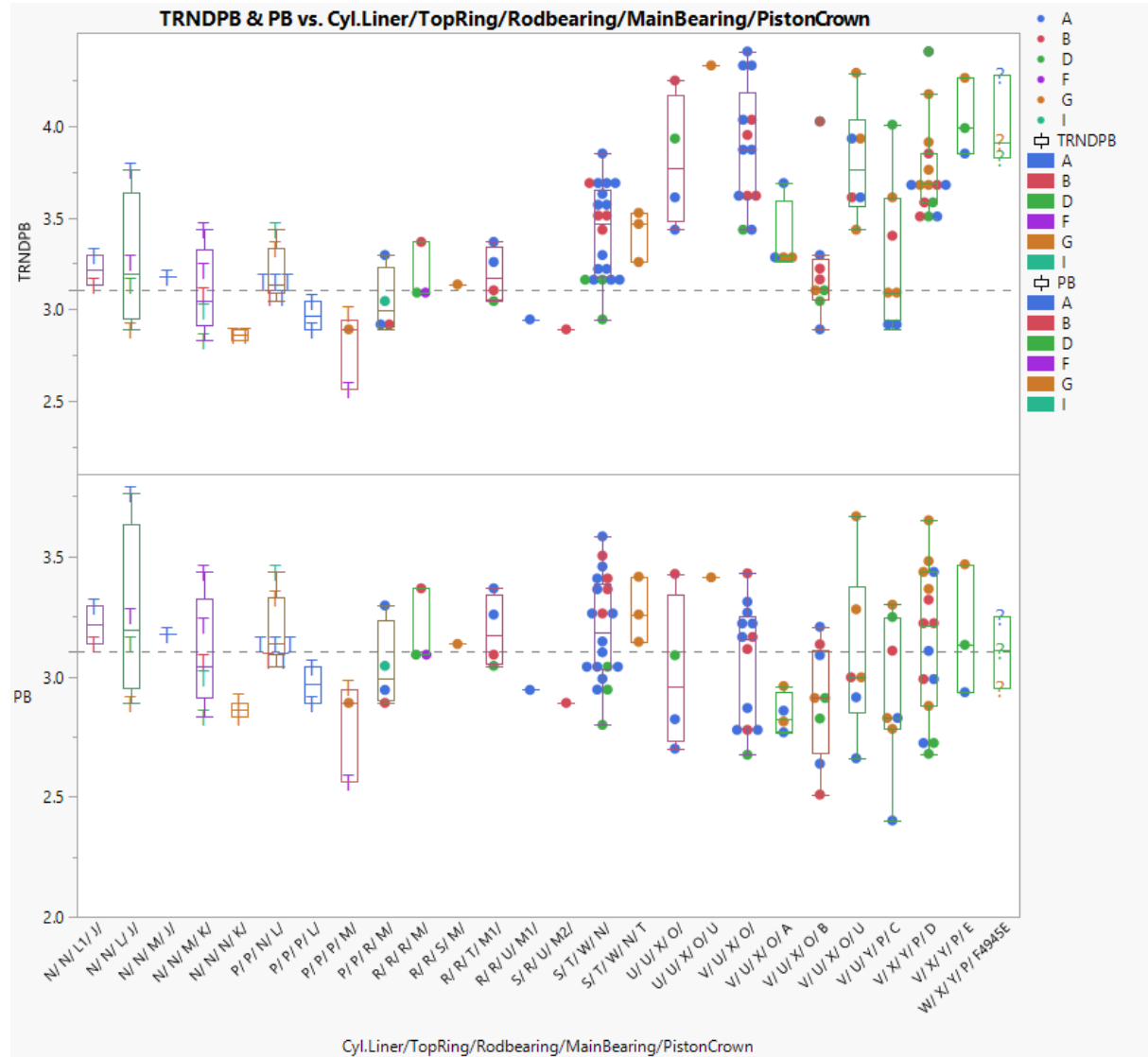
# Pb Oil Consumption Correction: Keep correction as is

- updated correction is very close to current correction



## PB

Before ICF



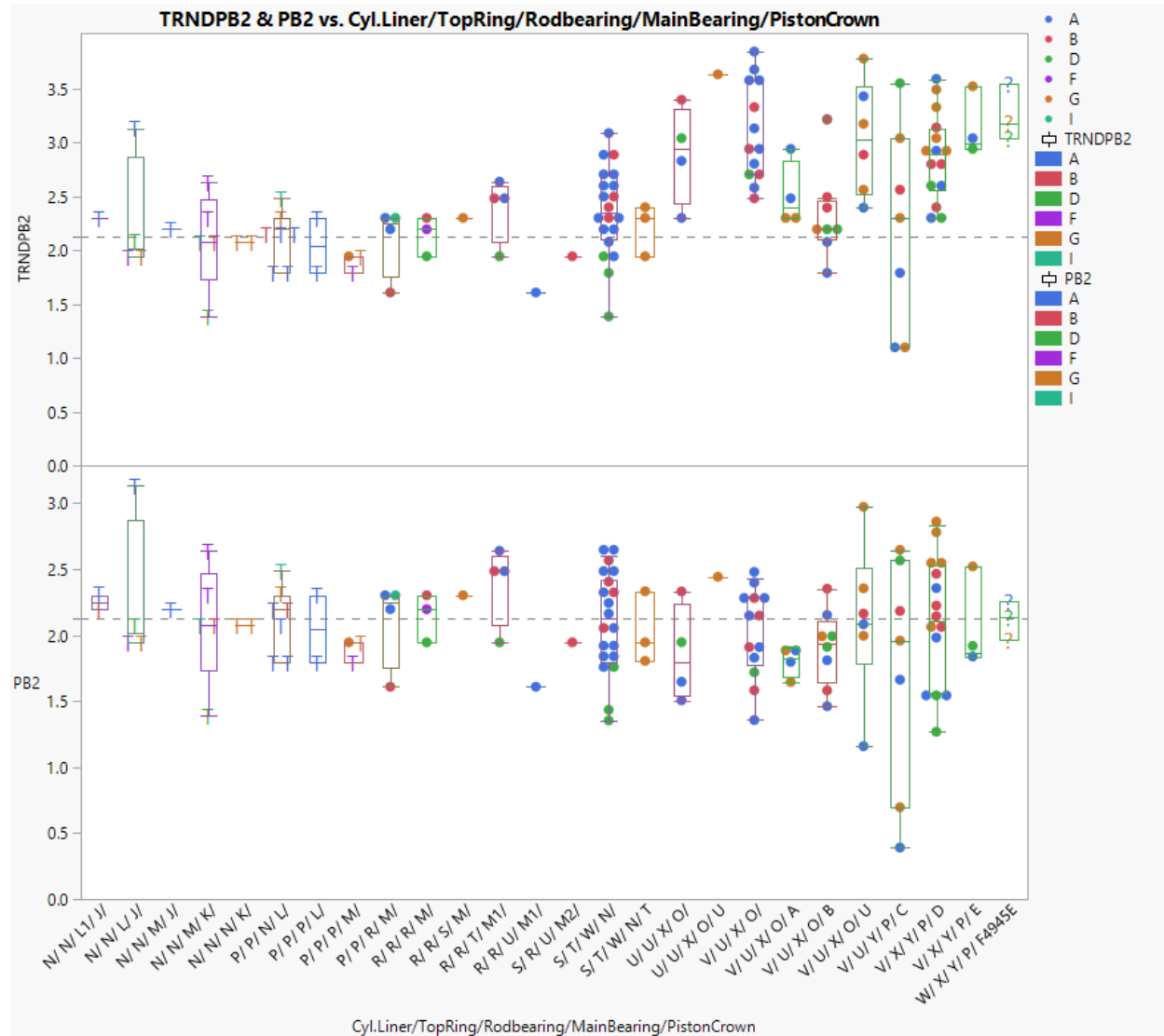
# Pb2 Oil Consumption Correction: Keep correction as is

- updated correction is very close to current correction



## PB2

Before ICF



After Current ICF

# Appendix 1: Targets and Standard Deviation by parameter

**CYLINDER LINER WEAR**  
 Unit of Measure: Micrometres  
**CRITICAL PARAMETER**  
 NORMAL K VALUE

Reference Oil	Level	Mean	Standard Deviation
821-2	Stand	16.2	3.7
821-2	Lab	15.1	2.8
821-3	Stand	16.2	3.7
821-3	Lab	15.1	2.8
821-4	Stand	16.2	3.7
821-4	Lab	15.1	2.8

**TOP RING WEIGHT LOSS**  
 Unit of Measure: Milligrams  
**CRITICAL PARAMETER**  
 EXPANDED K VALUE

Reference Oil	Mean	Standard Deviation
821-2	62.0	28.2
821-3	62.0	28.2
821-4	62.0	28.2

OIL CONSUMPTION  
 Unit of Measure: LN(OC grams/hour)  
 CRITICAL PARAMETER  
 EXPANDED K VALUE

Reference Oil	Mean	Standard Deviation
821-2	4.0930	0.0790
821-3	4.0930	0.0790
821-4	4.0930	0.0790

$\Delta$ PB AT END OF TEST  
 Unit of Measure: LN( $\Delta$ Pb ppm)  
 CRITICAL PARAMETER  
 NORMAL K VALUE

Reference Oil	Mean	Standard Deviation
821-2	3.1060	0.2420
821-3	3.1060	0.2420
821-4	3.1060	0.2420

$\Delta$ PB 250 – 300 HOURS  
 Unit of Measure: LN( $\Delta$ Pb 250-300 ppm)  
 NONCRITICAL PARAMETER  
 NORMAL K VALUE

Reference Oil	Mean	Standard Deviation
821-2	2.1250	0.3330
821-3	2.1250	0.3330
821-4	2.1250	0.3330



# Appendix 2: Current ICF



VXYPD proposed 2/23/2017					
	TRNOC	ALW_	InALW	ATRWL_	InTRWL
Predicted	4.422		3.749		
Target	4.093		2.785	62	
ICF	0.926		0.743	0.846	



mean