

Mack T-12 – Impact of New Parts and ICF Review

Preliminary SP Discussion

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Performance you can rely on.



- Dataset – LTMS 2021/06/24
 - 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)
 - Total number of tests: 127

- General comments

- Proposed correction factors by parameter with plots before and after ICF
 - Calculations

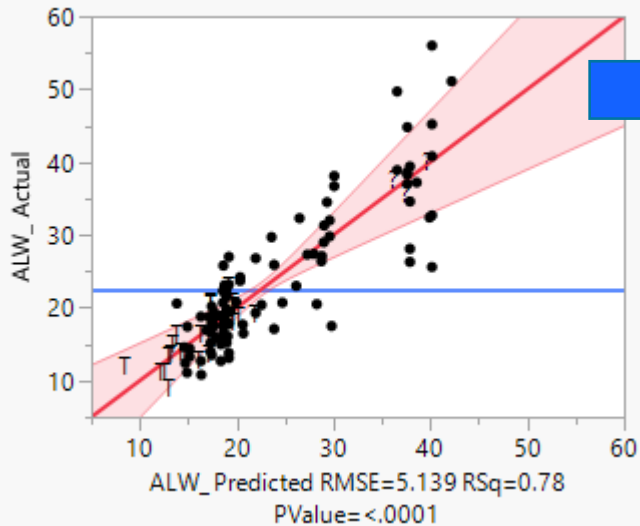
- Appendix 1: Targets and Standard Deviation by parameter
- Appendix 2: Current ICF

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.

Liner Wear

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

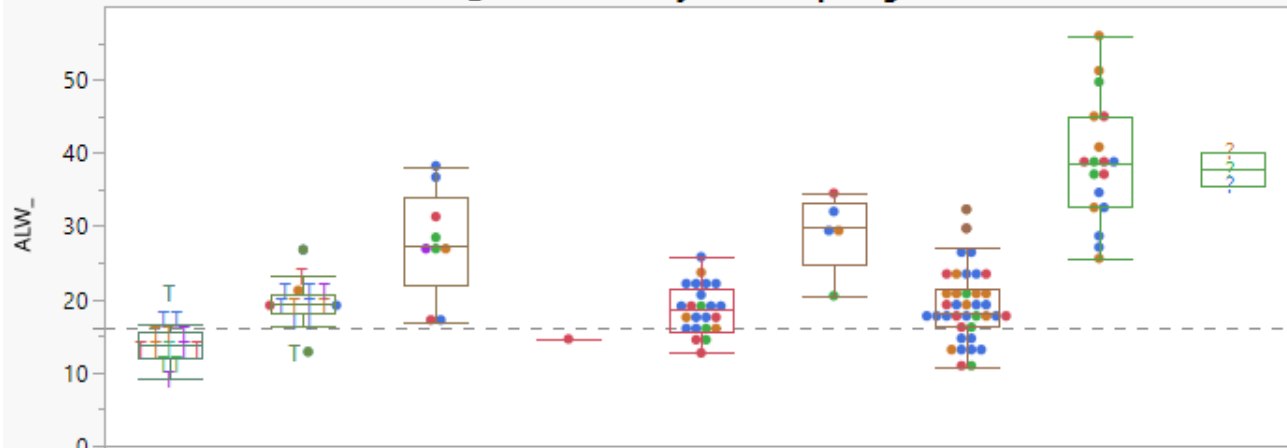
Keeping original scale => Multiplicative
Transformed scale => Additive

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

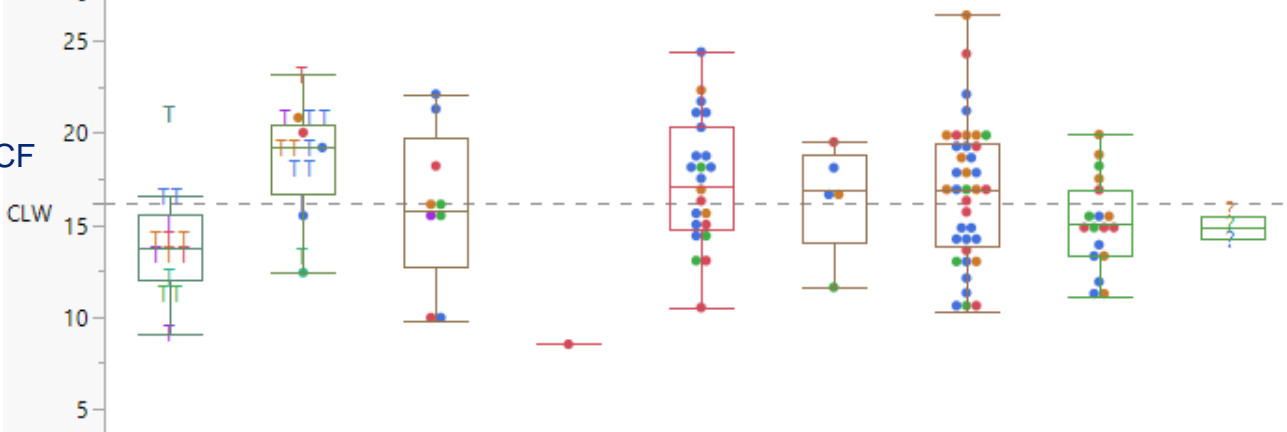
				No Transf. Option 1			LN Option 2		
				original ALW	afterCF	ln	afterCF	Original scale after CF	
Predicted	ALW	38.87	3.662	G	40.1	16.713	3.6914	2.8149	16.691
Target		16.2	2.785	D	37.7	15.712	3.6297	2.7531	15.692
ICF		0.417 (1)	-0.877 (2)	A	35.6	14.837	3.5723	2.6958	14.818
1 MULTIPLICATIVE									
2 ADDITIVE									

ALW_ & 2 more vs. Cyl liner/ Top Ring

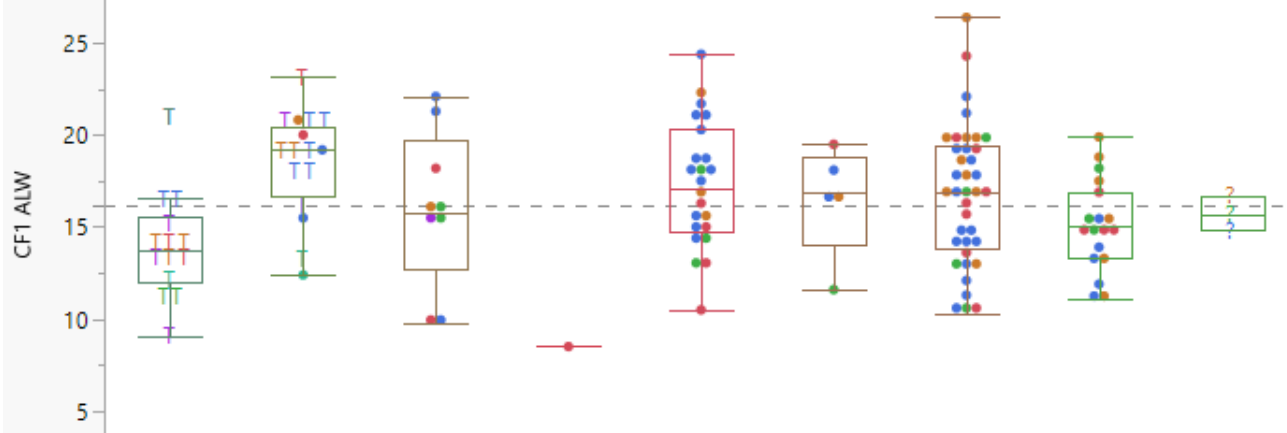
Before ICF



After current ICF



Proposed ICF based on Options 1 or 2 (similar final results)



- A
- B
- D
- F
- G
- I
- ⊠ ALW_
- ⊠ CLW
- ⊠ CFI ALW

Proposed ICF based on LN (option2)

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			
								Original scale
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
IND 2[821-3]	-0.022785	0.095152	-0.24	0.8112	0 D		37.7	3.62966
IND 2[821-4]	-0.08177	0.095674	-0.85	0.3946	0 A		35.6	3.572346
LTMSLAB[A]	0.0828572	0.041648	1.99	0.0492	0.25			after CF
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			

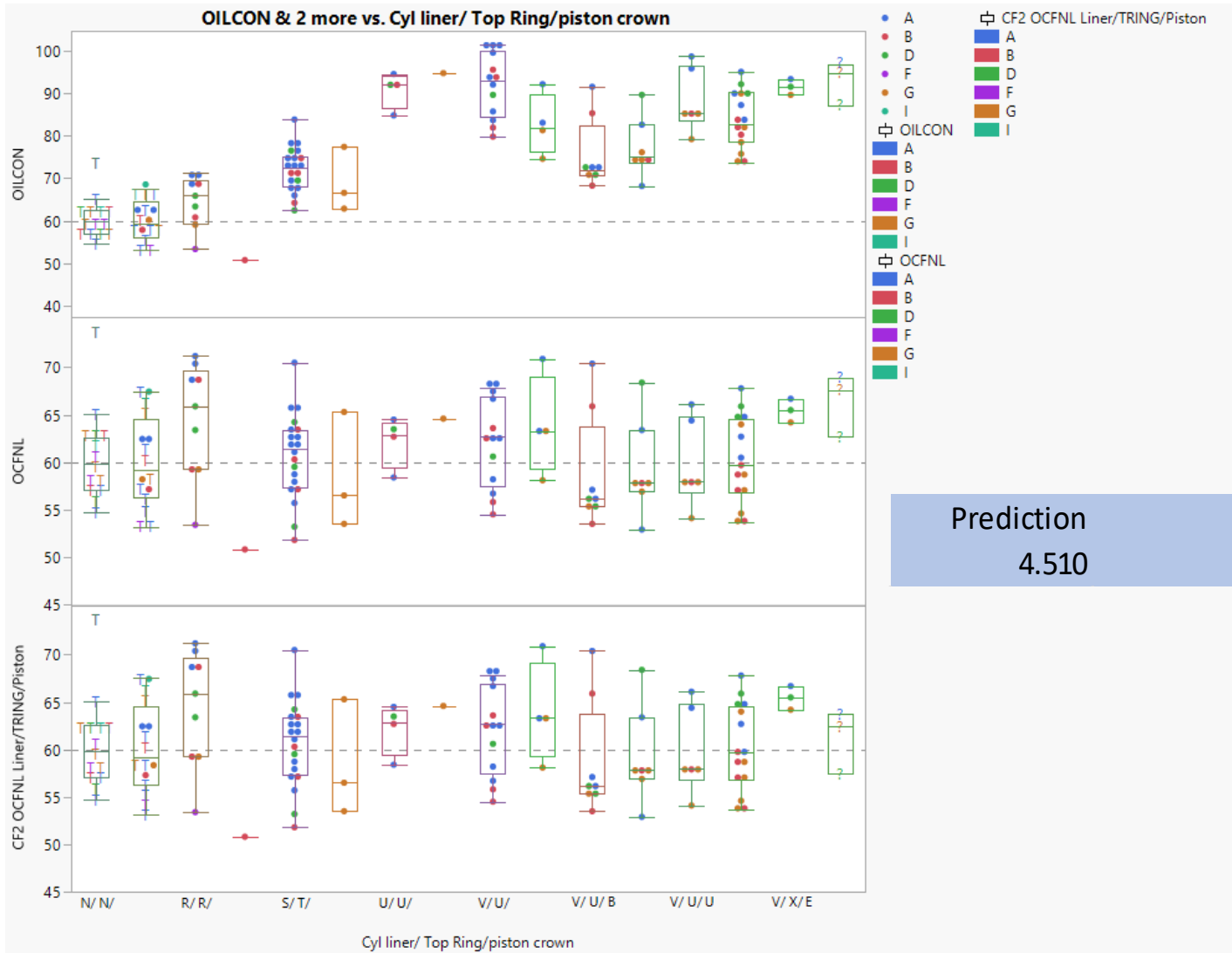
Option 1

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			
								original
IND 2[821-1]	1.669492	1.817076	0.92	0.3602	0 Lab	original ALW	afterCF	
IND 2[821-2]	2.00868	1.74365	1.15	0.2518	0 G		40.1	16.71271
IND 2[821-3]	-0.78656	2.273558	-0.35	0.73	0 D		37.7	15.71245
IND 2[821-4]	-1.95149	2.286024	-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	0.1428	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

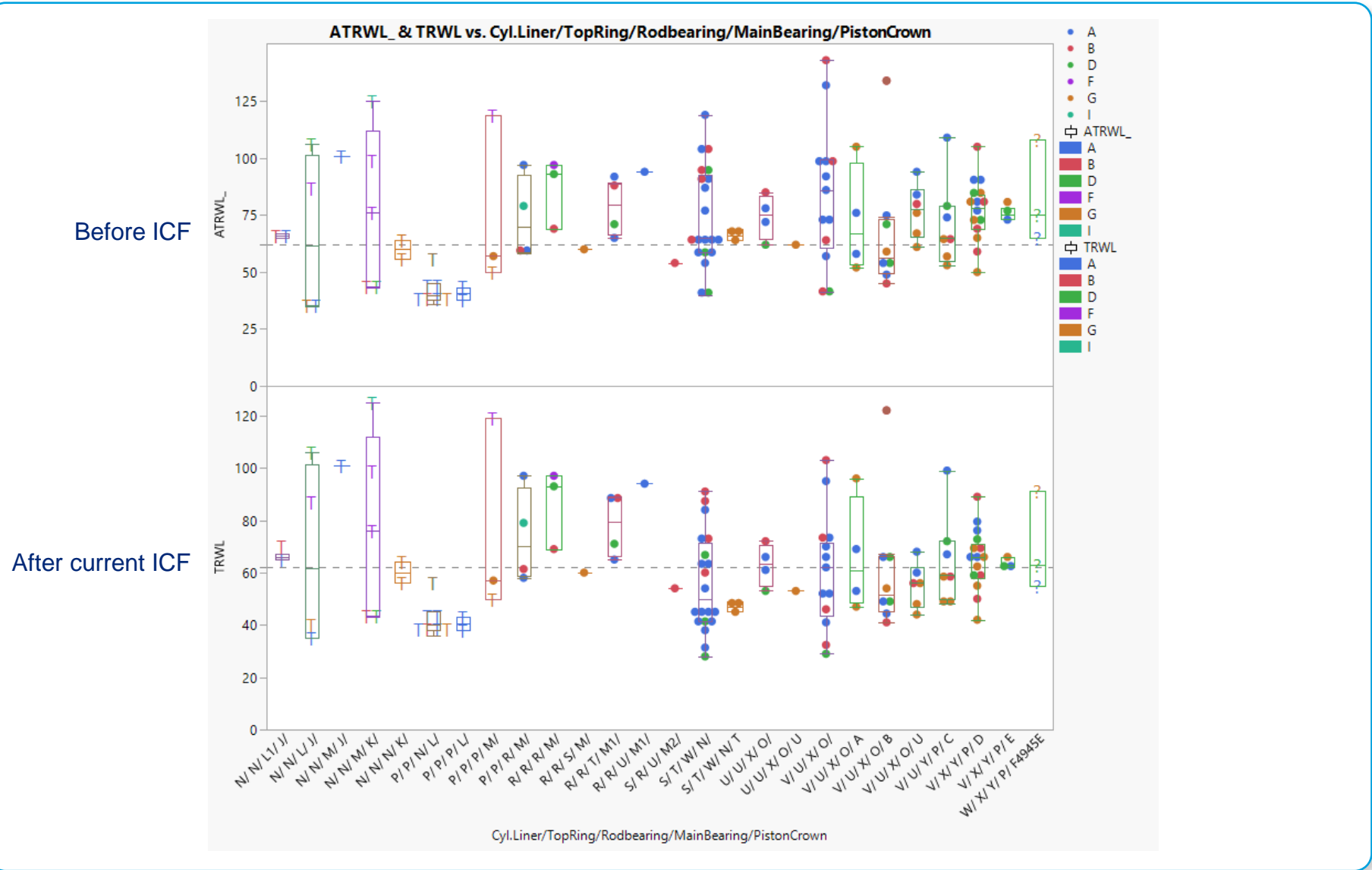


Prediction	TARGET	ICF
4.510	4.093	-0.417

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						
										Original scale	
IND 2[821-2]	0.0218347	0.027061	0.81	0.4216	0	Lab	original OILCON	In	afterCF	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



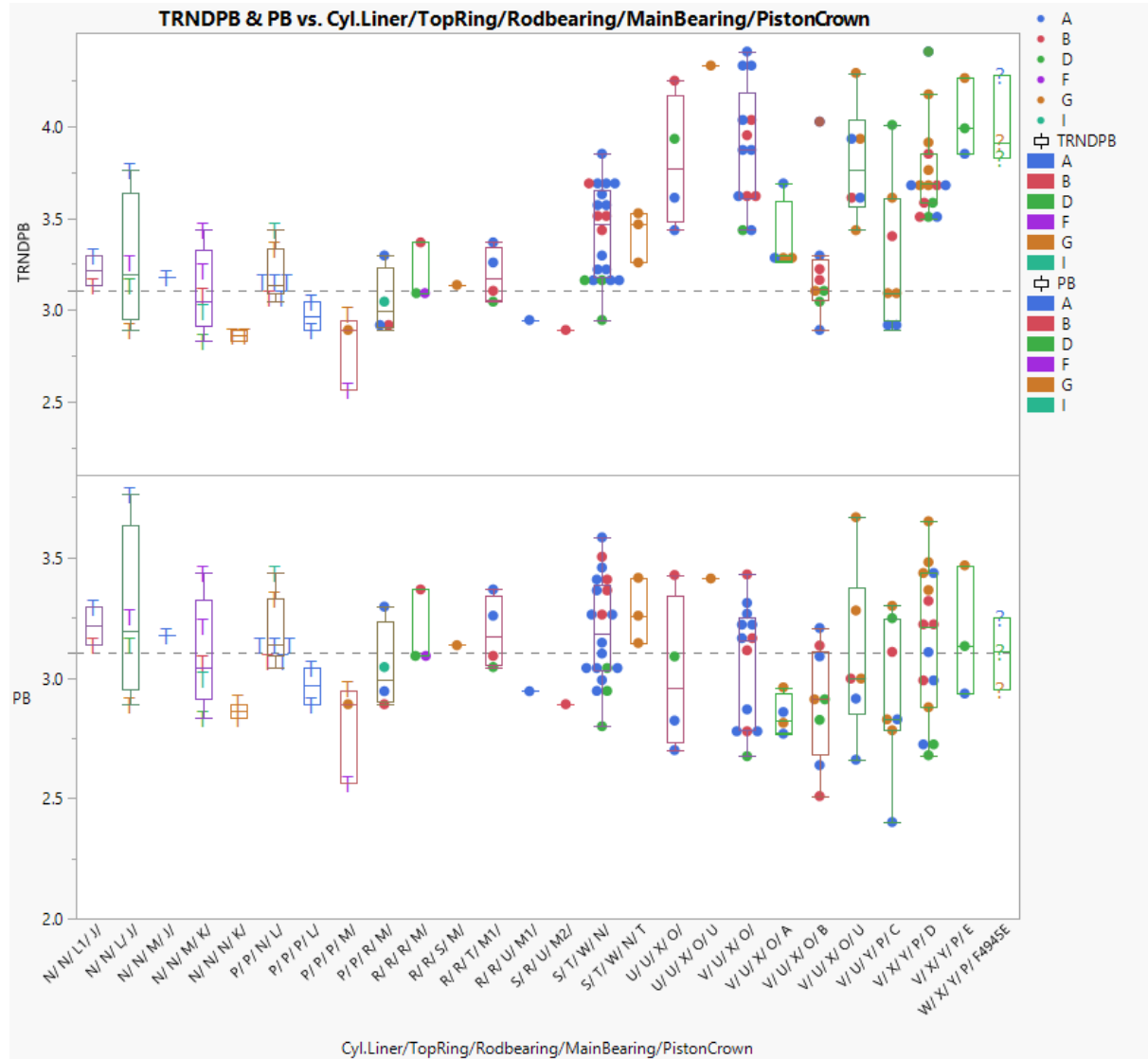
Pb Oil Consumption Correction: Keep correction as is

- updated correction is very close to current correction



PB

Before ICF



After Current ICF

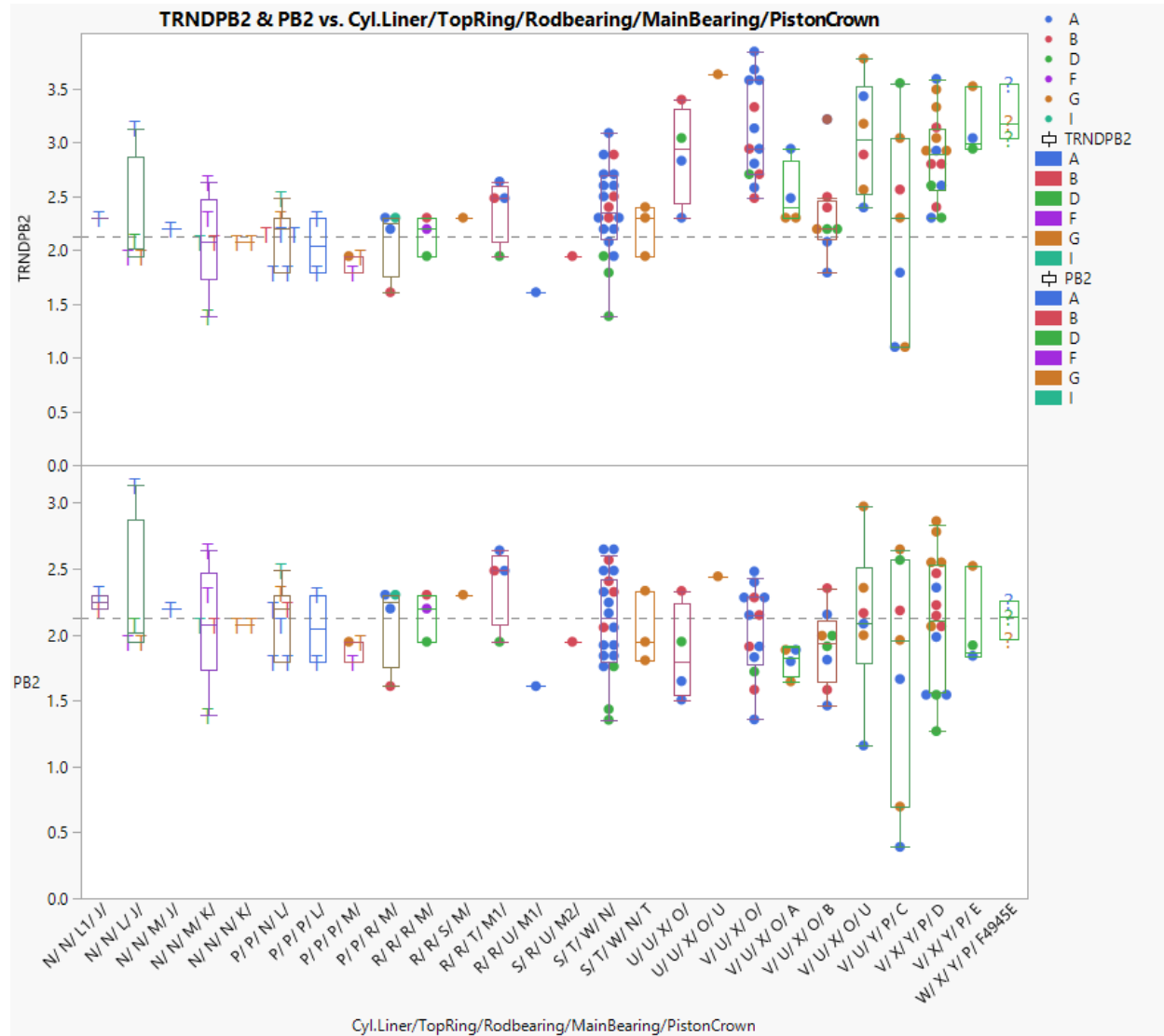
Pb2 Oil Consumption Correction: Keep correction as is

- 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

Δ PB AT END OF TEST
 Unit of Measure: LN(Δ 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

Δ PB 250 – 300 HOURS
 Unit of Measure: LN(Δ 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