T12 ICF Analysis

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Executive Summary

- For each T12 parameter, ICF estimates calculated via several methods are provided.
- The differences between the Target and STVN / STWN groups are at least borderline statistically significant by most of the methods considered.

General Analysis Information

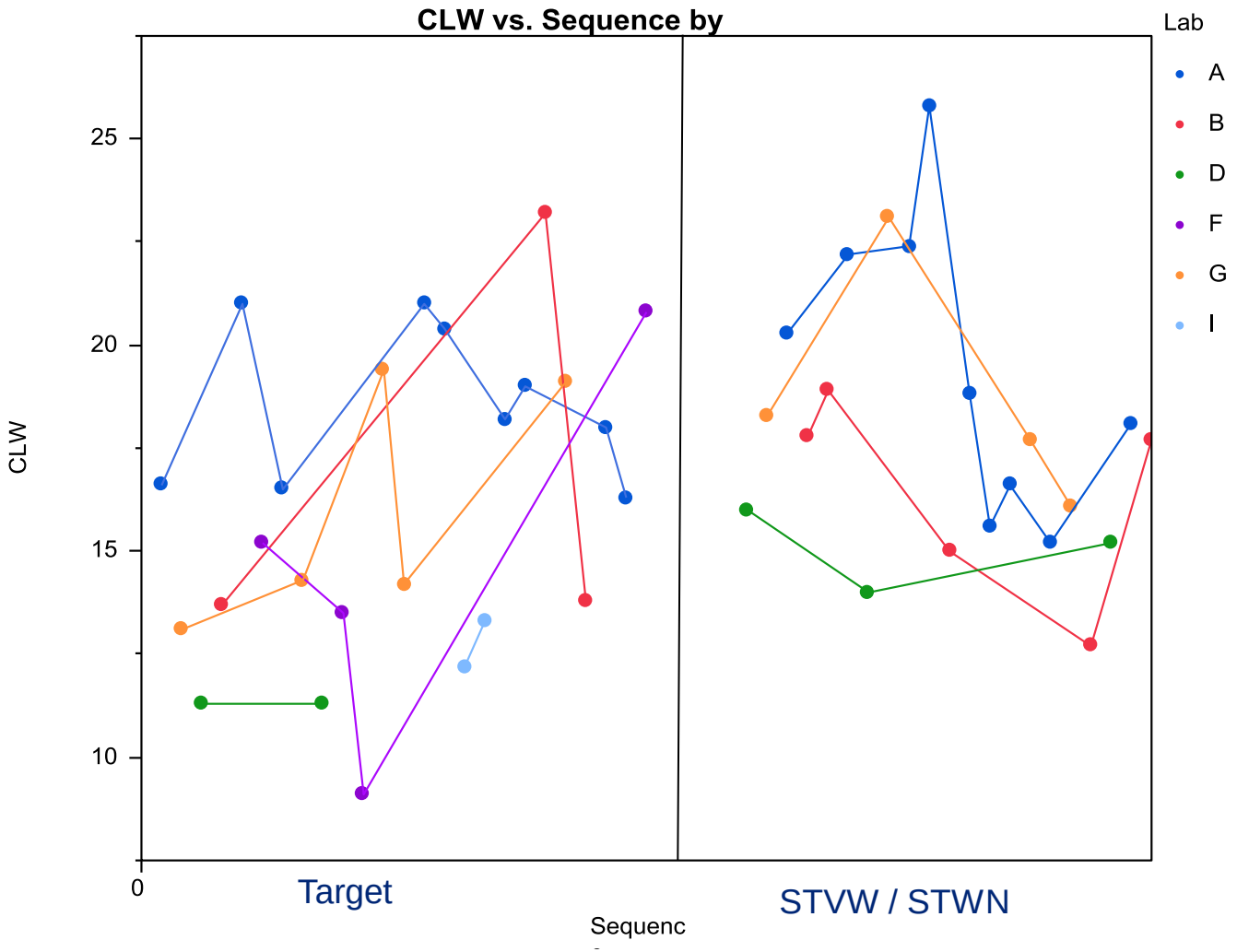
- Data used in plots and models are unadjusted RO 821, 821-1 and 821-2 and not ICF or SA adjusted. Data utilized in Severity Adjustment method includes all ROs.
- Much of the analysis compares the Target set to the STVN / STWN set. For brevity purposes, the term in models to differentiate the two is labeled Hardware though there could be other influencing factors such as time.
- Plots and models do not include RO data between the Target set and the STVN / STWN set.
- Summary data are provided for subsets of the STVN / STWN set, however, recommend using the entire STVN / STWN set.

ICF Estimate Methods

- Models:
  - Data utilized was 25 Target tests and 21 STVN / STWN tests.
  - Each T12 parameter was regressed on:
    - Hardware and a separate Lab term for the two Hardware sets (Separate Lab).
    - Hardware and the same Lab term for the two Hardware sets (Same Lab).
    - Hardware with no Lab term (No Lab).
  - Lab effects were not included in original target calculation (except for CWL (Lab)) – comparison of STVN / STWN accounting for lab effects with original targets is not recommended.
- Severity Adjustment:
  - For each lab, the severity adjustments calculated from the RO test prior to the start of the STVN / STWN tests were applied to each of the STVN / STWN results.
  - This method assumes the ICF placed the industry on target and the Zi had reached stability.
  - Severity Adjustments were calculated using the current “dead zone” as well as the “Continuous” methods.

Cylinder Liner Wear

CLW Plot



There appears to be a lab effect.

CLW Summary Statistics

CLW - Target Data Set

Lab	n	Average
A	9	18.6
B	3	16.9
D	2	11.3
F	4	14.7
G	5	16.0
I	2	12.8
Avg Lab	6	15.0
Avg Test	25	16.2
Std Dev		3.7
RMSE		3.2
Lab p-Value		0.06

CLW - STVN / STWN Data Set

Lab	All (Last 21)		STVN		STWN		Last 10	
	n	Average	n	Average	n	Average	n	Average
A	9	19.4	1	20.3	8	19.3	5	16.9
B	5	16.4	1	17.8	4	16.1	2	15.2
D	3	15.1	1	16.0	2	14.6	1	15.2
G	4	18.8	1	18.3	3	19.0	2	16.9
Avg Lab	4	17.4	4	18.1	4	17.2	4	16.0
Avg Test	21	18.0	4	18.1	17	17.9	10	16.4
Std Dev		3.3		1.8		3.9		1.8
RMSE		3.0				3.4		2.0
Lab p-Value		0.13				0.24		0.70

- The above tables provide a comparison of labs and overall averages for the target data set as well as the STVN / STWN hardware set and subsets thereof.
- For the target data set, there is a substantial difference between the average taking labs into account (15.0) versus simple average (16.2).

CLW ICF Estimates

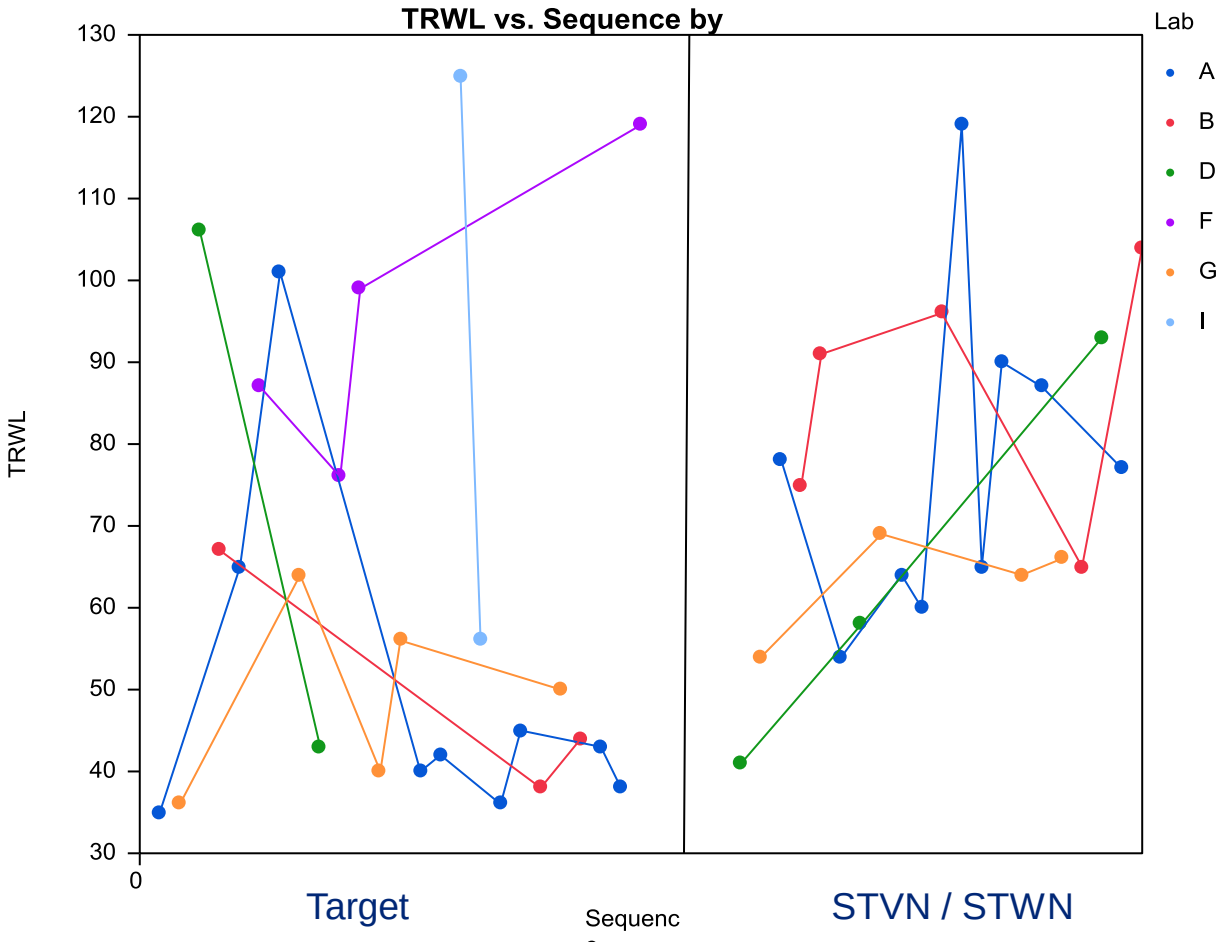
CLW (Stand) Industry Correction Factors Estimated by Various Methods

Statistic	Current	Models with Various Lab Terms			Severity Adjustment	
		Separate Lab	Same Lab	No Lab	Current	Continuous
Target	16.2	15.0	15.1	16.2		
STVN/STWN (n = 21)		17.4	16.5	18.0	15.1	15.1
Difference p-Value		0.03	0.16	0.09		
ICF (Model Target)		0.862	0.915	0.900	1.00	1.00
ICF (Current Target)	0.83	0.929	0.980	0.901	1.07	1.07

- The p-Value for the difference between the Target group and the STVN / STWN group ranges from 0.03 to 0.16 depending whether Lab is in the model.
- ICF estimates vary widely with the estimates from the Severity Adjustment method resulting in the highest estimates.

Top Ring Weight Loss

TRWL Plot



- Lab effect is again apparent.

TRWL Summary Statistics

TRWL - Target Data Set

Lab	n	Average
A	9	49.4
B	3	49.7
D	2	74.5
F	4	95.3
G	5	49.2
I	2	90.5
Avg Lab	6	68.1
Avg Test	25	62.0
Std Dev		28.2
RMSE		22.9
Lab p-Value		0.02

TRWL - STVN / STWN Data Set

Lab	All (Last 21)		STVN		STWN		Last 10	
	n	Average	n	Average	n	Average	n	Average
A	9	77.1	1	78.0	8	77.0	5	87.6
B	5	86.2	1	75.0	4	89.0	2	84.5
D	3	64.0	1	41.0	2	75.5	1	93.0
G	4	63.3	1	54.0	3	66.3	2	65.0
Avg Lab	4	72.6	4	62.0	4	77.0	4	82.5
Avg Test	21	74.8	4	62.0	17	77.8	10	83.0
Std Dev		19.1		17.6		18.6		19.0
RMSE		18.3				18.9		19.9
Lab p-Value		0.23				0.49		0.57

- For the target data set, there is a substantial difference between the average taking labs into account (68.2) versus simple average (62.0).
- For the STVN / STWN data set, the range of lab averages is large though lab effect is not statistically significant.

TRWL ICF Estimates

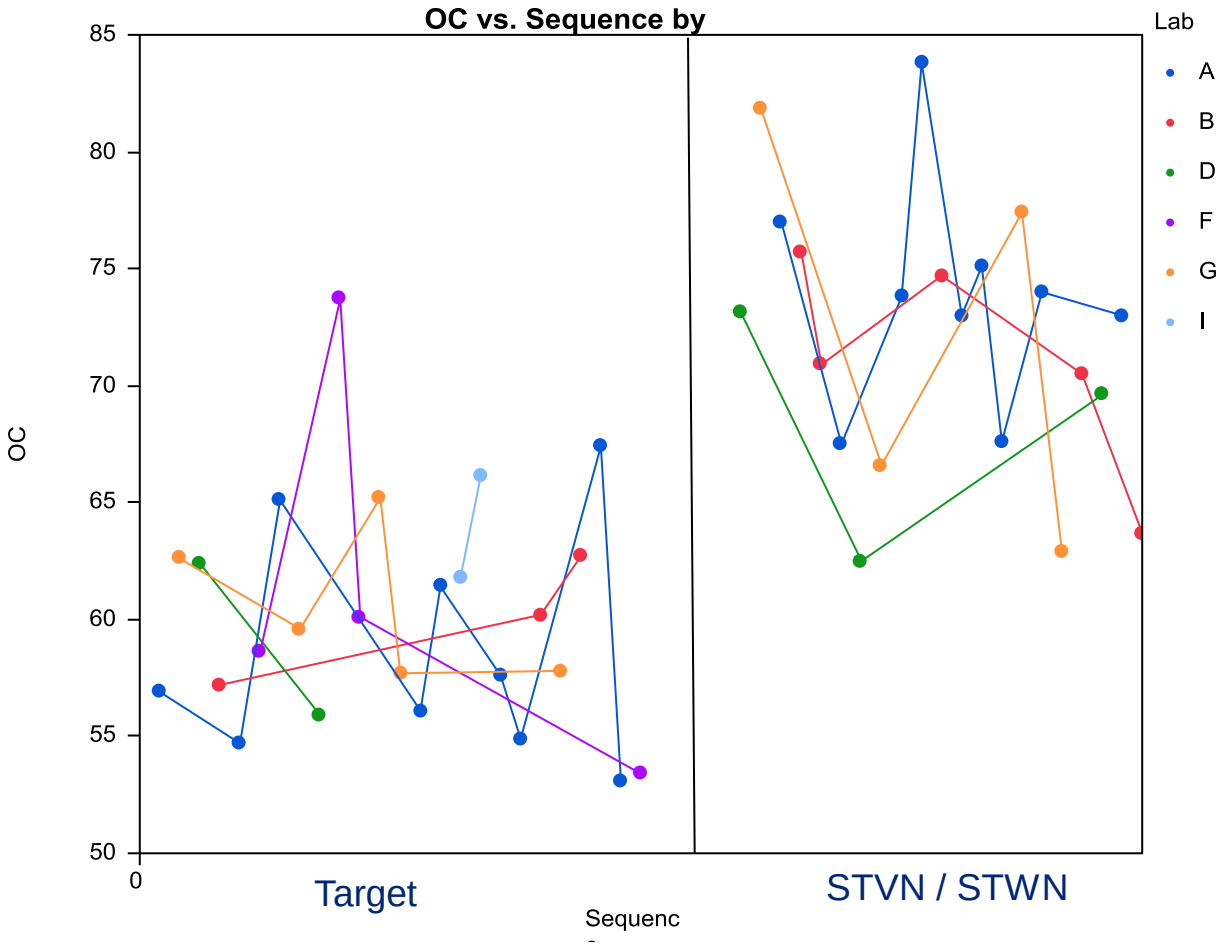
TRWL Industry Correction Factors Estimated by Various Methods

Statistic	Current	Models with Various Lab Terms			Severity Adjustment	
		Separate Lab	Same Lab	No Lab	Current	Continuous
Target	62	68.1	66.4	62.0		
STVN/STWN (n = 21)		72.6	88.0	74.8	74.8	72.6
Difference p-Value		0.51	0.003	0.09		
ICF (Model Target)		0.937	0.755	0.830		
ICF (Current Target)	0.92	0.854	0.705	0.829	0.829	0.855

- The difference in the TRWL of the Target and STVN / STWN groups is statistically significant for the model with the same Lab term for both groupings and with no Lab term (borderline).
- ICF estimates range from 0.705 to 0.937

Oil Consumption

OC Plot



There is an obvious shift in severity for STVN / STWN relative to Target

TRNOC (Ln[OC]) Summary Statistics

Ln(OC) - Target Data Set

Lab	n	Average
A	9	4.067
B	3	4.094
D	2	4.079
F	4	4.111
G	5	4.103
I	2	4.158
Avg Lab	6	4.102
Avg Test	25	4.093
Std Dev		0.079
RMSE		0.084
Lab p-Value		0.79

Ln(OC) - STVN / STWN Data Set

Lab	All (Last 21)		STVN		STWN		Last 10	
	n	Average	n	Average	n	Average	n	Average
A	9	4.300	1	4.344	8	4.295	5	4.284
B	5	4.262	1	4.327	4	4.246	2	4.205
D	3	4.223	1	4.292	2	4.189	1	4.243
G	4	4.273	1	4.404	3	4.230	2	4.245
Avg Lab	4	4.265	4	4.342	4	4.240	4	4.244
Avg Test	21	4.275	4	4.342	17	4.259	10	4.256
Std Dev		0.079		0.047		0.078		0.069
RMSE		0.081				0.075		4.256
Lab p-Value		0.54				0.30		0.66

- For each data set, the simple average and average taking lab into account are similar.
- The STVN average is directionally higher than that of STWN though the difference is not statistically significant.

TRNOC (Ln[OC]) ICF Estimates

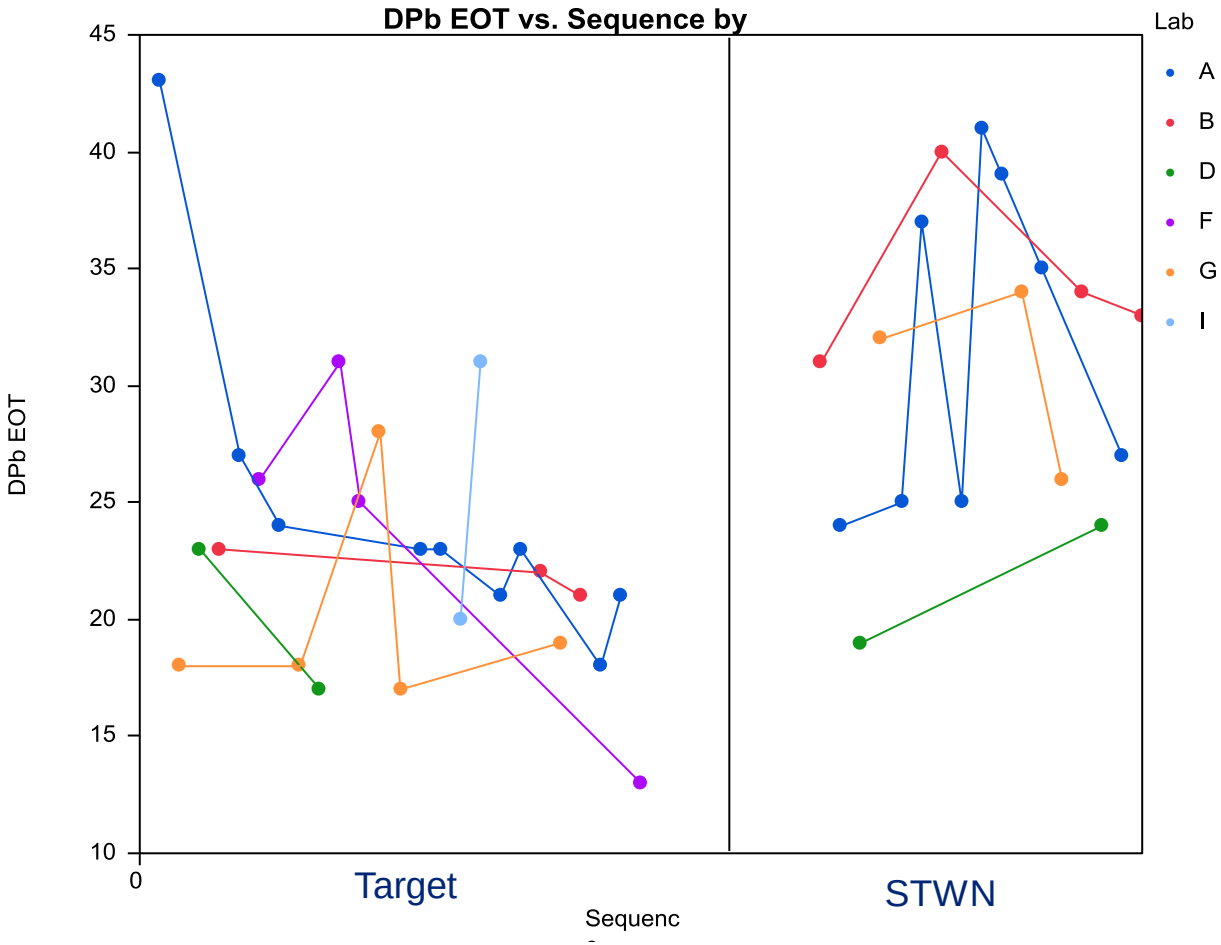
Transformed OC (TRNOC) Industry Correction Factors Estimated by Various Methods

Statistic	Current	Models with Various Lab Terms			Severity Adjustment	
		Separate Lab	Same Lab	No Lab	Current	Continuous
Target	4.093	4.102	4.095	4.093		
STVN/STWN (n = 21)		4.265	4.291	4.275	4.275	4.241
Difference p-Value		7.E-07	4.E-09	8.E-10		
ICF (Model Target)		0.9618	0.9544	0.9573		
ICF (Current Target)	0.95	0.9597	0.9539	0.9574	0.9574	0.9652

- The difference in the Ln[OC] for the two groups is strongly statistically significant.
- The ICF estimates are tightly grouped and differ little from the current ICF.

Delta Lead EOT

DPb EOT Plot



- Lab effect is apparent.

TRNDPB (Ln[DPb EOT]) Summary Statistics

Ln(Delta Pb EOT) - Target Data Set

Lab	n	Average
A	9	3.180
B	3	3.090
D	2	2.984
F	4	3.119
G	5	2.978
I	2	3.215
Avg Lab	6	3.094
Avg Test	25	3.106
Std Dev		0.242
RMSE		0.254
Lab p-Value		0.58

Ln(Delta Pb EOT) - STWN Data Set

Lab	All (STWN)		Last 10	
	n	Average	n	Average
A	8	3.432	5	3.489
B	4	3.536	2	3.511
D	2	3.061	1	3.178
G	3	3.417	2	3.392
Avg Lab	4	3.362	4	3.393
Avg Test	17	3.410	10	3.443
Std Dev		0.219		0.191
RMSE		0.187		0.197
Lab p-Value		0.07		0.82

- Average of STWN data set is approximately 10% higher than that of Target.

TRNDPB (Ln[DPb EOT]) ICF Estimates

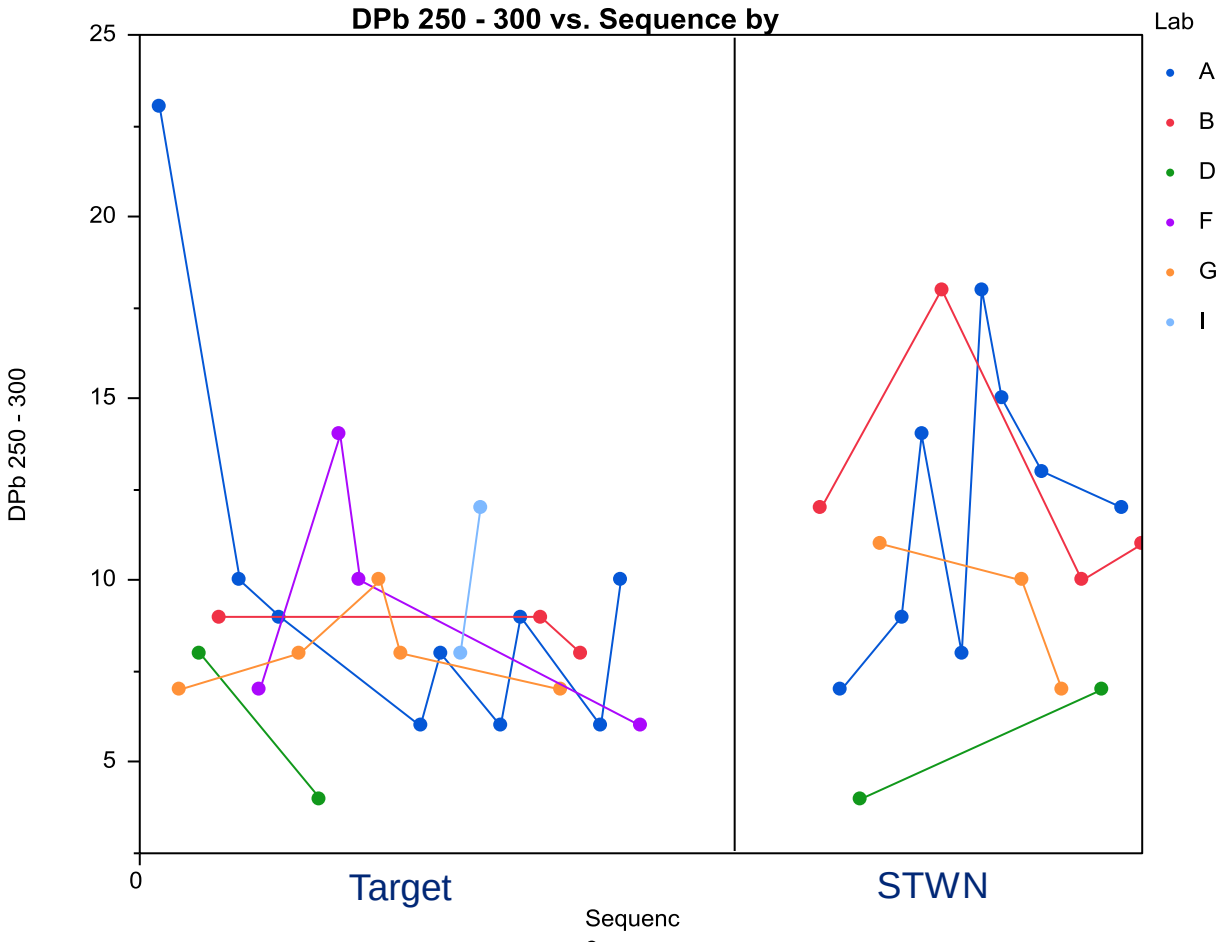
Transformed DPb EOT (TRNDPB) Industry Correction Factors Estimated by Various Methods

Statistic	Current	Models with Various Lab Terms			Severity Adjustment	
		Separate Lab	Same Lab	No Lab	Current	Continuous
Target	3.106	3.094	3.092	3.106		
STWN (n = 17)		3.362	3.401	3.410	3.410	3.453
Difference p-Value		3.E-03	3.E-04	2.E-04		
ICF (Model Target)		0.9205	0.9090	0.9109		
ICF (Current Target)	0.92	0.9240	0.9132	0.9108	0.9108	0.8996

- The difference in the TRNDPB for the two groups is strongly statistically significant.
- The ICF estimates are tightly grouped and differ little from the current ICF.

Delta Lead 250 - 300

DPB2 Plot



- Lab effect is apparent in STWN data.

TRNDPB2 (Ln[DPb 250 – 300]) Summary Statistics

Ln(Delta Pb 250 - 300) - Target Data Set

Lab	n	Average
A	9	2.177
B	3	2.138
D	2	1.733
F	4	2.170
G	5	2.071
I	2	2.282
Avg Lab	6	2.095
Avg Test	25	2.122
Std Dev		0.387
RMSE		0.354
Lab p-Value		0.65

Ln(Delta Pb 250 - 300) - STWN Data Set

Lab	All (STWN)		Last 10	
	n	Average	n	Average
A	8	2.439	5	2.546
B	4	2.519	2	2.350
D	2	1.666	1	1.940
G	3	2.215	2	2.124
Avg Lab	4	2.210	4	2.241
Avg Test	17	2.327	10	2.362
Std Dev		0.340		0.314
RMSE		0.308		0.269
Lab p-Value		0.01		0.20

- Consistent with Ln(DPb EOT), the simple average of Ln(DPb 250 – 300) for the STWN data set is approximately 10% higher than that of Target.

TRNDPB2 (Ln[DPb 250 – 300]) ICF Estimates

Transformed DPb 250 - 300 (TRNDPB2) Industry Correction Factors Estimated by Various Methods

Statistic	Current	Models with Various Lab Terms			Severity Adjustment	
		Separate Lab	Same Lab	No Lab	Current	Continuous
Target	2.125	2.095	2.089	2.122		
STWN (n = 17)		2.210	2.305	2.327	2.327	2.352
Difference p-Value		0.36	0.06	0.08		
ICF (Model Target)		0.9481	0.9064	0.9118		
ICF (Current Target)	0.93	0.9616	0.9220	0.9131	0.9131	0.9036

- The differences between the Target and STWN groups are borderline statistically significant when in 2 of the 3 models considered.
- ICF estimates are centered about the current ICF.

Delta Lead 250 - 300 Industry Correction Factor

Regression analysis of Target and STVN / STWN datasets:

- Separate Lab effects for Target and STVN / STWN
  - Hardware effect (Target versus STVN / STWN) p-value = 0.36
  - Estimated Target = 2.095
  - Estimated STVN / STWN = 2.210
  - Industry Correction Factor (ICF):
    - 0.95 (Target = 2.095)
    - 0.96 (Current Target = 2.1256)
- Same Lab effect for Target and STVN / STWN
  - Hardware effect (Target versus STVN / STWN) p-value = 0.06
  - Estimated Target = 2.089
  - Estimated STVN / STWN = 2.305
  - ICF:
    - 0.91 (Target = 2.089)
    - 0.92 (Current Target = 2.125)