Summary of New 1N Liner Performance

Parameter		units	N	MIN	MAX	MEAN	STD	Significant?
TGFyi	1Y3555	yi	237	-1.601	2.829	0.046	1.006	
TGFyi	New Liner	yi	5	-1.155	-0.917	-1.071	0.090	
TGF	Range	%		11	15	12.4		
TGF	Shift	%				-15.6		p=0.0139
WDNyi	1Y3555	yi	237	-2.221	3.070	-0.238	1.012	
WDNyi	New Liner	yi	5	-2.545	-0.132	-1.048	0.989	
WDN	Range	demerits		138.6	200.6	177.1		
WDN	Shift	demerits				-28.4		p=0.0776
With SA	Range	demerits		157.8	200.6	188.4		
With SA	Shift	demerits				-16.5		p=0.4174
TLHCyi	1Y3555	yi	237	-1.260	3.368	-0.138	0.955	
TLHCyi	New Liner	yi	5	0.253	1.619	0.799	0.586	
TLHC	Range	%		1	5	2.1		
TLHC	Shift	transformed				0.719		
TLHC %	Shift	%				1		p=0.0301
BSOCyi	1Y3555	yi	237	-2.689	5.978	-0.215	1.166	
BSOCyi	New Liner	yi	5	-1.680	0.320	-0.480	0.754	
BSOC	Range	g/kWh		0.08	0.23	0.17		
BSOC	Shift	g/kWh				-0.02		p=0.6142

Discussion:

The table above is laid out with the first two rows of each group showing descriptive statistics for the two liner types (1Y3555 vs New). As is the case for all TMC analysis, yi values are used to account for the differing performance levels of the several reference oils and, in the case of TLHC, to incorporate the transformation calculation. All rows after the first two refer to New Liner data.

The next row, labeled “Range”, shows the minimum, maximum, and mean values from the New Liner runs in reported units. The value shown for TLHC is the back-transformed value of the mean of the transformed values. This will be different from the mean of the percent values (2.1% vs 2.4%). Keep in mind that the *reported* units for TLHC is *transformed TLHC* , not percent.

The row following that, labeled “Shift”, the shift from target that the mean New Liner value represents. This is shown first in reported units. Again note that for TLHC this will be *transformed TLHC* and not percent. In the case of TLHC, there is an additional “Shift” line showing the offset amount back-transformed into percent. This value (1%) is provided as a point of reference only. The “Shift” values were all calculated from the mean yi for the New Liners using the same standard deviation used to generate lab severity adjustments (TGF = 14.6, WDN = 27.1, TLHC = 0.9, BSOC = 0.45).

Two of the “Shift” values would be considered significant; TGF and TLHC. TGF is mild by 15.6%; TLHC is severe by 0.719 transformed TLHC (the criteria for significance being a p-value less than 0.05).

The p-value for WDN, though not significant, is low enough to garner some attention. An assumption made here is that the New Liner data was generated by stands operating on target. A review of severity adjustments shows that for TGF, TLHC, and BSOC this is true. For WDN, however, three of the 4 labs have been producing mild WDN results irrespective of liner type. So, I severity-adjusted the 5 New Liner results and re-computed the analysis. The results are shown on the additional “Range” and “Shift” rows of the WDN table. In this scenario, the p-value becomes comfortably insignificant (0.4174).

Update following April 8 teleconference:

Updating the 1004-3 targets to include all operationally valid runs to date results in:

Variable	N	Mean	Std Dev	Minimum	Maximum
TGF	16	23.9	14.6	9	58
WDN	16	190.7	24.7	159.8	246.4
TLHCti	16	0.1806	0.3977	0	1.098612
BSOC	16	0.148	0.038	0.09	0.25

Recomputing all of the previous analysis gives:

Revised 1004-3 Targets

Parameter		units	N	MIN	MAX	MEAN	STD	Significant?
TGFyi	1Y3555	yi	237	-1.601	2.829	0.072	1.008	
TGFyi	NEW	yi	5	-0.884	-0.610	-0.788	0.104	
TGF	RANGE	%		11	15	12.4		
TGF	SHIFT	%				-11.5		p=0.0581
WDNyi	1Y3555	yi	237	-2.221	3.070	-0.203	1.013	
WDNyi	NEW	yi	5	-2.109	0.401	-0.552	1.029	
WDN	RANGE	demerits		138.6	200.6	177.1		
WDN	SHIFT	demerits				-15.0		p=0.4464
TLHCyi	1Y3555	yi	237	-1.260	3.368	-0.112	0.978	
TLHCyi	NEW	yi	5	1.289	4.051	2.394	1.184	
TLHC	RANGE	%		1	5	2.1		
TLHC	SHIFT	transformed				2.154		
TLHC %	SHIFT	%				7.6		p<.0001
BSOCyi	1Y3555	yi	237	-2.689	5.978	-0.164	1.177	
BSOCyi	NEW	yi	5	-1.790	2.158	0.579	1.489	
BSOC	RANGE	g/kWh		0.08	0.23	0.17		
BSOC	SHIFT	g/kWh				0.03		p=0.1660

With these 1004-3 targets, the WDN and BSOC shifts are insignificant (as was the case before). For TLHC, the shift becomes both more pronounced and more significant. The TGF shift using these targets would be considered insignificant. However, the p-value is low enough to warrant further investigation. The question raised is: What is future testing likely to bring for TGF?

To try to answer that question, I extrapolated five tests into the future by duplicating each of the five New Liner runs completed so far. This is probably a fair approximation of what might result from five more runs. The outcome of this hypothetical is shown on the next page.

Five Additional Tests

(& revised 1004-3 targets)

Parameter		units	N	MIN	MAX	MEAN	STD	Significant?
TGFyi	1Y3555	yi	237	-1.601	2.829	0.072	1.008	
TGFyi	NEW	yi	10	-0.884	-0.610	-0.788	0.098	
TGF	RANGE	%		11	15	12.4		
TGF	SHIFT	%				-11.5		p= 0.0076
WDNyi	1Y3555	yi	237	-2.221	3.070	-0.203	1.013	
WDNyi	NEW	yi	10	-2.109	0.401	-0.552	0.970	
WDN	RANGE	demerits		138.6	200.6	177.1		
WDN	SHIFT	demerits				-15.0		p= 0.2859
TLHCyi	1Y3555	yi	237	-1.260	3.368	-0.112	0.978	
TLHCyi	NEW	yi	10	1.289	4.051	2.394	1.116	
TLHC	RANGE	%		1	5	2.1		
TLHC	SHIFT	transformed				2.154		
TLHC %	SHIFT	%				7.6		p<.0001
BSOCyi	1Y3555	yi	237	-2.689	5.978	-0.164	1.177	
BSOCyi	NEW	yi	10	-1.790	2.158	0.579	1.404	
BSOC	RANGE	g/kWh		0.08	0.23	0.17		
BSOC	SHIFT	g/kWh				0.03		p= 0.0536

Assuming that this is a reasonable approximation of future testing, the TGF shift will again become significant.

Further update to revise estimate of shift for TLHC:

Because the transformation applied to TLHC includes the natural log function, small changes to transformed test results have exponential impact on results expressed as percent. This fact was overlooked by everyone during the April 8 teleconference. Consequently, I've been asked to reexamine the TLHC shift neglecting the transformation.

Because untransformed TLHC data is not normally distributed, neglecting the transformation does compromise the analysis somewhat (there is a reason we use the transformation in the first place, after all; most statistical analyses assume that the data is normally distributed). However, the shift between the New Liner data and historic data is sufficiently large that the general results should still be valid even if the exact p-values must be taken with a grain of salt.

With the transformation removed and using the recomputed 1004-3 targets the TLHC yi shift is 2.9645. Using the untransformed equivalent of the TLHC SA standard deviation (3.7) to convert this Δ/s shift to a Δ gives 10.9686%. As before, this shift is significant.

If this shift is linear and universally applicable, then a 1Y3555 pass-limit result of 3% would be expected to produce 13.9686% on New Liners. The value to add to the transformed test result to compensate for the shift would be:

$$\ln(3\%+1) - \ln(13.9686+1) = -1.320$$

Two examples:

Rated TLHC result	14%	13%
Transformed result	ln(14%+1) = 2.708	ln(13%+1) = 2.639
Plus –1.320 shift	2.708-1.320 = 1.388	2.639-1.320 = 1.319
Reported TLHC result	$e^{(1.388)}$-1 = 3.007%	$e^{(1.319)}$-1 = 2.740%

What does adding this value to the five New Liner results look like?

Rated TLHC result of the 5 New Liner tests	Transformed	Back-transformed
1%	-0.627	-0.466%
1%	-0.627	-0.466%
2%	-0.221	-0.198%
3%	0.066	0.068%
5%	0.472	0.603%

Does adding this value to the New Liner results return TLHC performance to historic levels? Using untransformed values, the resultant p-value is 0.2338. Though not exactly correct due to the non-normal distribution of the untransformed data, this is probably good enough to deem the difference between the New Liner group and the 1Y3555's not significant.

What if the transformation is restored? The p-value then becomes 0.0675 which would make the shift still not significant.