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TARGETING AND ESTIMATING WASTE LOADINGS AT DWPF: A SENSITIVITY ANALYSIS

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Statistical Consulting Section
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EXECUTIVE SUMMARY

Waste Loading (WL) is a measure (expressed as a percentage) of the Defense Waste Processing Facility (DWPF) glass product that comes from high level waste. In this report, the DWPF calculations used to target WL during blending decisions and those used to estimate WL during processing are investigated to assess the sensitivities of these calculations to the random uncertainties of their inputs. For the calculations used to target WLs, the uncertainties in the inputs lead to an uncertainty, at approximately 95% confidence, in the targeted WL of ±1.05 to ±1.75 percentage points depending on how the random errors in the inputs are represented. For the calculations used to estimate the WL for a given Slurry Mix Evaporator (SME) batch, the random uncertainties of the inputs to this calculation lead to an uncertainty, at approximately 95% confidence, in the estimated WL of ±1.50 percentage points.

Since one would expect to see agreement between the WL calculations of the targeting process and the WL calculations of the estimating process, comparisons between these WLs for SME batches 234 through 265 were conducted. The comparisons suggested that the targeted WLs and estimated WLs for these batches did not track each other as closely as would be expected based upon their random variations as outlined in this report. In an effort to reconcile the targeted and estimated WLs some issues were identified:

- During the blending process, the Li_2O content planned for the next SME batch is normalized using the sum of oxides for the 16 elements being tracked (i.e., the presence of minor oxides that might account for ~ 1 or 2% of the SME is not accounted for). This may lead to the targeted WL being understated.

- If there is a small (~1.5%) bias in the measured Li_2O content of the SME samples due to the Hydragard®/peanut vial sampling system (as seen in a prototypical test of this system conducted by Steimke in 1995), it could have an effect on the estimated WL (the WL value as a percentage could be overstated ~1%) and to a lesser extent on the targeted WL (the targeted WL value as a percentage could be overstated ~0.4%).

- The normalization of the Li_2O content of each SME sample using the sample's sum of oxides, while not suggested by the data (i.e., there does not appear to be a correlation between a low lithium recovery and a low sum of oxides for the SME samples), may actually be lessening the impact of the potential bias in the Li_2O measurements for the SME samples.

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LIST OF ACRONYMS

DWPF	Defense Waste Processing Facility
HLW	high-level waste
LCL	lower confidence limit
MFT	Melter Feed Tank
Prep	preparation
%RSD	Percent Relative Standard Deviation
SCS	Statistical Consulting Section
SME	Slurry Mix Evaporator
SRAT	Sludge Receipt and Adjustment Tank
SRS	Savannah River Site
Std Dev	Standard Deviation
TTR	Technical Task Request
UCL	upper confidence limit
WL	Waste Loading

1.0 INTRODUCTION AND BACKGROUND

The Defense Waste Processing Facility (DWPF) at the Department of Energy's Savannah River Site (SRS) in Aiken, South Carolina, has been immobilizing high-level radioactive waste (HLW) in borosilicate glass since 1996. The flowsheet for the DWPF operation involves combining each process batch of HLW sludge with an appropriate amount of glass formers called frit. The HLW and frit are combined with the heel in the Slurry Mix Evaporator (SME), and the chemical composition of this blend is determined via sampling. In fact, the SME is a hold-point for the process, and the blending and sampling of its contents are critical steps in the DWPF process control strategy.

Currently, each of the SME samples (which number at least 4) is vitrified and analyzed for its chemical composition. The resulting measurements are used by DWPF to ensure that the SME batch meets objectives of processability and product quality. Through relationships provided by glass-composition/glass property models (e.g., those for durability, viscosity, and liquidus temperature), the product quality and processability of the SME batch are predicted, and these predictions are judged against operational constraints to ensure that the constraints are met with high confidence [1].

The same SME measurements are used to estimate the waste loading (WL) attained for the SME batch. WL is a measure of the amount (expressed as a percentage) of the glass product that comes from HLW, and the rule is the higher the WL the better, tempered by the need for the material in the SME to meet process and quality constraints and to have an acceptable melt rate (i.e., for the SME material to have no adverse impact on the DWPF's melter performance). Thus, WL and melt rate are the two important factors for achieving optimal waste throughput where waste throughput is an overall metric for how quickly a tank of HLW is processed (i.e., the faster a canister of glass is poured the better and the larger the percentage of HLW in the canister the better). Once again, the WL for a SME batch is estimated from the chemical composition measurements of the SME samples, the same samples used for the SME acceptability decision.

DWPF relies on its blending strategy (i.e., the decisions made by DWPF Process Engineering on the amount of frit to add into the SME heel along with the amount of HLW sludge transferred to the SME from the Sludge Receipt and Adjustment Tank (SRAT)) to meet the processability, product quality, and WL objectives for each SME batch. The strategy relies on measurements of the SRAT composition, of the frit composition, and of the SME heel composition as well as estimates of volumes or pounds of the additions and transfers. The measurements are used to predict the composition of the resulting SME on a glass basis. Predictions generated using the models relating glass composition to process and property models are judged against the SME acceptability criteria for the batch. Thus, the blending strategy yields a SME batch that is predicted to satisfy the process and product quality constraints as well a one that attains the WL target for the batch.

Note that the processes of targeting a WL for a batch and of estimating the WL attained for a batch both rely on measurements and as such are inherently uncertain. That is, there is uncertainty in the WL targets and estimates due to uncertainties in the measurements on which they are based. The goal of this report is to explore the sensitivities of the WL targets and estimates to uncertainties in the inputs to these important metrics of the DWPF operation. Section 2 provides the results from this study. Exploring the blending calculations employed by DWPF Process Engineering, Section 2.1 addresses the uncertainties of the targeted WL. Section 2.2 investigates the uncertainties associated with estimating the WL for a SME batch. In this section, one measure of the uncertainty in the estimated WL is obtained using the 4 SME samples. Also, in this section, a more complete uncertainty analysis is conducted by introducing uncertainties for the frit composition. Section 3 provides the conclusions from this study while Section 4 provides the list of references. An appendix provides supporting tables and exhibits.

The sensitivity study was initiated as part of the response to the Technical Task Request (TTR) [2] issued by DWPF Process Engineering, and the calculations and analyses were conducted using the statistical software package JMP® Version 5 [3].

2.0 RESULTS

This part of the report provides the main discussion points of the sensitivity study. In the first sub-section that follows, the calculations used to target a WL during the SME blending process are investigated, the inputs to the calculations are identified, random uncertainties for the values of these inputs are estimated, and the impact of these random uncertainties on the targeted WL is assessed. Section 2.2 explores how WL is estimated for a SME batch and information available from samples of recent SME batches (234 through 265). The variation of these data offers some insight into the uncertainty of the estimated WL for a specific SME batch. The random uncertainties of the inputs for the calculations used to estimate WL and their impact on the uncertainty of the WL values are explored in Section 2.3. Section 2.4 attempts to reconcile the targeted and estimated WLs for the SME batches in light of the uncertainties identified in the earlier sections. Finally, in Section 2.5, the impact on estimated WLs of a potential bias in the measurement of the SME samples is investigated.

2.1 TARGETING A WL FOR A SME BATCH

Targeting WL is part of the strategy that is utilized by DWPF Process Engineering as they plan the blending for each SME batch. Table A1 in the Appendix provides the WLs targeted by this process for batches 234 through 265 (batches produced during the processing of Sludge Batch 2 with Frit 320). Also, included in this table are the concentrations of the Li_2O component of Frit 320 that were used in these blending calculations. The Li_2O values are but one of the inputs used in the targeting of DWPF WLs, and the impact of the random uncertainties of these values along with the other inputs is one step along the path followed by this investigation.

All of the calculations associated with DWPF's blending process are not listed in detail as part of this report. But to provide an opportunity for the reproducibility of the results presented here, the blending for SME Batch 261 is mimicked in this report with its input values and resulting targeted WL. A JMP simulation is set up to introduce uncertainties for the inputs and to record their impacts on the resulting targeted WL. The uncertainty for each input is represented by setting up the input as a random variable that is normally distributed with a mean value equal to the nominal value for the input and a relative standard deviation representative of the uncertainty for the input. Table A2 in the Appendix provides an overview of the inputs, their nominal values, and the uncertainty (relative standard deviation) assumed for each. In this table, two views of the uncertainties are provided. In the first column of relative standard deviations, the estimates of the analytical uncertainties are taken from Edwards [4] and represent the relative standard deviation of a single measurement (i.e., n = 1). In the last column of relative standard deviations, the estimates are adjusted to reflect the number of samples used to determine the average values for the inputs. For the SRAT composition information, the number of samples is 6, and for the SME heel composition information, the number of samples is 4. An error number is also indicated as part of the information appearing in the first column of this table. From this information, there are 11 different error sources that are being studied for the targeting phase of the WL determinations. Numbering the error sources allows for selective activation of the error sources so that their individual as well as collective impacts can be studied.

An initial investigation of the impacts of random uncertainties of the critical inputs to the WL targeting is provided in Exhibits A1 and A2 in the Appendix. These analyses are conducted with estimates of the analytical uncertainties not adjusted for the number of samples taken (i.e., all of the uncertainties are interpreted as if each of the inputs was based on a sample of size 1). This should be considered as a worst case scenario for the compositional uncertainties, since the compositions of the SRAT and the SME heel are usually based on 6 and 4 samples, respectively. Exhibit A3 in the Appendix provides an opportunity to see how the random uncertainty of each input affects the values for that input in the simulation.

Exhibit A1 provides a plot that shows the WLs that result from 1000 perturbations (i.e., 1000 runs of the simulation) of the inputs by each error number category. The relative size of the bars in this exhibit provides insight into the comparative impacts of the error sources on WL. The 95% confidence intervals (each interval is defined by a lower confidence limit, LCL, and an upper confidence limit, UCL) for the targeted WLs from Exhibit A2 are summarized by error number in Table 2-1. Thus, with all of the probable errors activated for the worst case scenario, the 95% confidence interval for the 32.4% targeted waste loading for SME Batch 261 is given by (30.5, 34.1).

Table 2-1 Simulation Results for SME Batch 261's WL Target of 32.4% with Larger Analytical Uncertainties

Active Error Indicator	Active Error Descriptor (1000 runs each)	95% LCL	95% UCL	WL Uncertainty
0	All (0)	30.6	34.1	1.75
1	Heel calcine solids (1)	32.4	32.4	0.00
2	Heel SpG (2)	32.4	32.4	0.00
3	Heel Chem Comps (3)	31.1	33.7	1.30
4	Heel Volume (4)	32.4	32.4	0.00
5	SRAT wt% solids (5)	31.7	33.1	0.70
6	SRAT SpG (6)	32.1	32.6	0.25
7	SRAT Chem Comps (7)	32.0	32.9	0.45
8	SRAT Volume (8)	32.2	32.6	0.20
9	Frit Chem Comps (9)	31.7	33.1	0.70
10	Frit lbs (10)	32.2	32.6	0.20
11	Frit lbs from Can Decon (11)	32.34	32.43	0.04

Running the simulations after adjusting these uncertainties to reflect the number of samples that are typically used in determining the associated input (i.e., 4 samples for SME heel measurements and 6 for SRAT transfer measurements) leads to Exhibits A4 and A5 in the Appendix. These analyses are conducted with the estimates of the analytical uncertainties as provided in the last column of Table A2, as relative standard deviations reduced by a factor of $\sqrt{n}$. Exhibit A6 in the Appendix provides an opportunity to see how the uncertainty of each input affects the values for that input in the simulation. The 95% confidence intervals for the targeted WLs from Exhibit A4 are summarized in Table 2-2. Thus, with all of the probable errors activated for the best case scenario, the 95% confidence interval for the 32.4% targeted waste loading for SME Batch 261 is given by (31.3, 33.4).

Table 2-2 Simulation Results for SME Batch 261's WL Target of 32.4% with Smaller Analytical Uncertainties

Active Error Indicator	Active Error Descriptor (1000 runs each)	95% LCL	95% UCL	WL Uncertainty
0	All (0)	31.3	33.4	1.05
1	Heel calcine solids (1)	32.4	32.4	0.00
2	Heel SpG (2)	32.4	32.4	0.00
3	Heel Chem Comps (3)	31.7	33.0	0.65
4	Heel Volume (4)	32.4	32.4	0.00
5	SRAT wt% solids (5)	32.1	32.7	0.30
6	SRAT SpG (6)	32.3	32.5	0.10
7	SRAT Chem Comps (7)	32.2	32.6	0.20
8	SRAT Volume (8)	32.2	32.6	0.20
9	Frit Chem Comps (9)	31.7	33.1	0.70
10	Frit lbs (10)	32.2	32.6	0.20
11	Frit lbs from Can Decon (11)	32.3	32.4	0.05

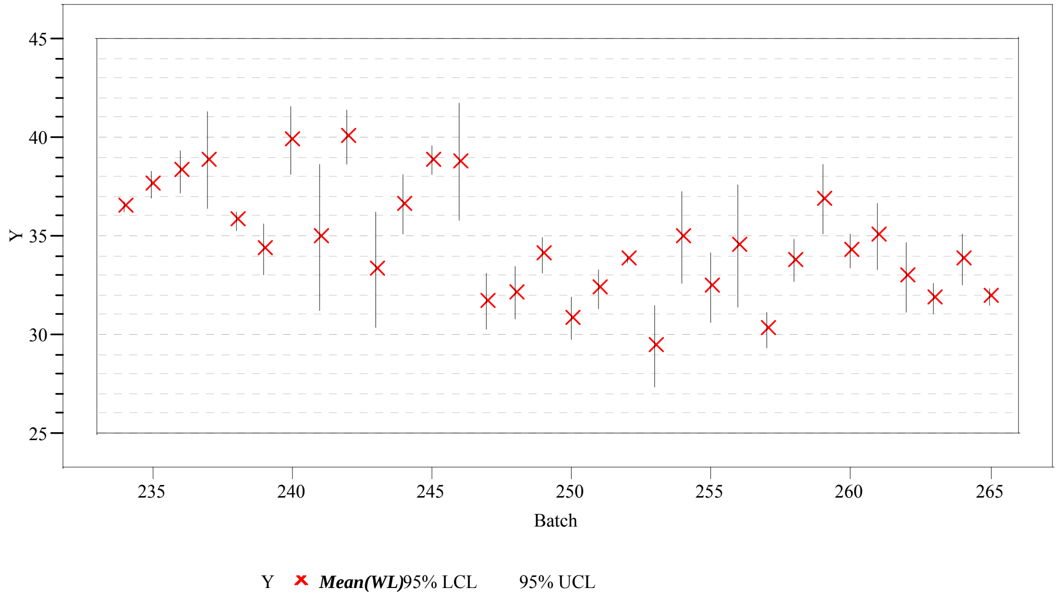
2.2 ESTIMATING THE WL ATTAINED FOR A SME BATCH

Table A3 in the Appendix provides information on estimated WLs for SME batches 234 through 265. This information is part of the SME acceptability spreadsheets, and the data presented represent the 4 samples for each of the SME batches. Included in this table are the batch number, the elemental lithium (Li) content for the sample (as a weight percent, wt%), sum of oxides (wt%) for the sample, the Li_2O content (wt%) for the sample, and the Li_2O content of the frit for the frit lot(s) used for that SME batch. This information is used to estimate the WL for each of the four samples for each SME batch through the formula given by Equation (1):

$$WL = 100 \cdot \left(1 - \frac{Li_2O / (\text{Sum of Oxides})}{\text{Frit}_{Li_2O} / 100} \right) \quad (1)$$

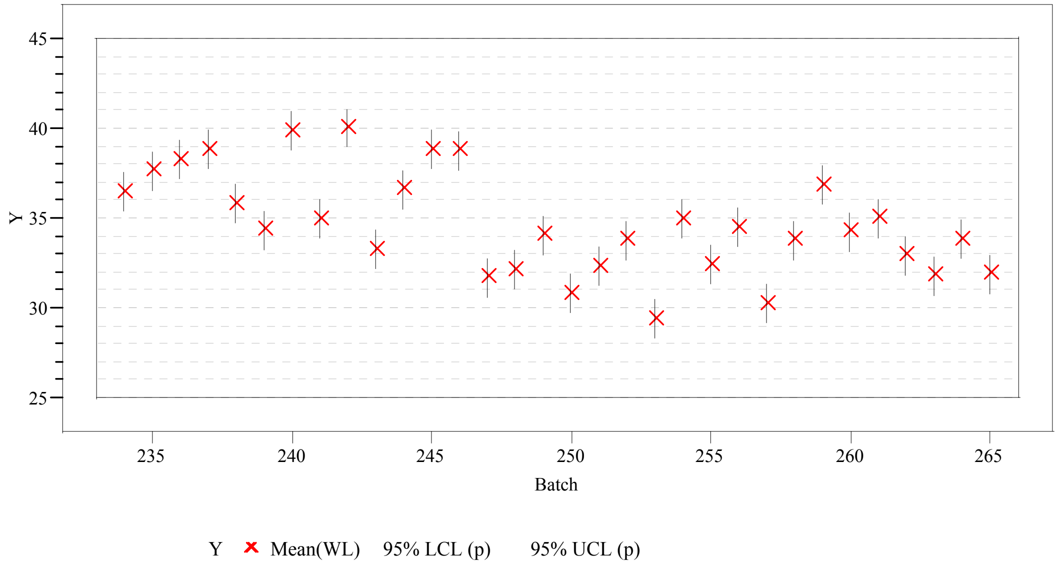
The average of the 4 WLs is used as the estimated WL for the SME batch. If the four WLs are assumed to be a random sample of the possible WLs that might have been determined for the SME batch, they may be used to construct a 95% confidence interval for the true WL (under the additional assumption of normality for these random variables). Figure 2-1 provides a plot of these 95% confidence intervals covering SME batches 233 through 265. The plotted "x" represents the estimated WL with the vertical bar around this symbol representing the confidence interval for the WL. The length of the confidence intervals for the various batches differs due to the differences in the scatter (i.e., the standard deviation) of the 4 sample results for a given SME batch.

Figure 2-1 Estimated WLs by SME Batch with 95% Confidence Intervals Based upon 4 Samples



In Figure 2-2 the individual standard deviations have been pooled, and the pooled standard deviation used in determining the 95% confidence interval for the WL of each SME batch. In this case, the lengths of the confidence intervals are all the same, and the interval is given by WL±1.1 with 1.1 representing the uncertainty of the estimated WL. Thus, using this approach for SME Batch 261, the estimated WL would be 35±1.1 or (33.9, 36.1) with 95% confidence.

Figure 2-2 Estimated WLs by SME Batch with 95% Confidence Intervals Based upon 4 Samples and a Pooled Estimate of the Standard Deviation



2.3 UNCERTAINTIES IN ESTIMATING THE WL ATTAINED FOR A SME BATCH

The uncertainty of the estimated WL also can be approached in a manner similar to that used for the targeted WL. The inputs to Equation (1) provide the starting place; their nominal values and estimated random uncertainties for SME Batch 261 are provided in Table A4 in the Appendix. The last row of this table provides the nominal Li_2O content in the frit lot(s) used for this batch. The percent relative standard deviation (% RSD) for this value was estimated using the Li_2O frit values from Table A3. The %RSD's for the elemental measurements are the same as those in the first %RSD column of Table A2.

Exhibit A7 and Exhibit A8 in Appendix A provide the results of this simulation. Exhibit A7 provides a summary plot of the impact on the uncertainty of the estimated WL based upon the contribution of the different error categories. Exhibit A8 provides histograms and descriptive statistics for these results. Exhibit A9 in the Appendix provides a look at the impact of the input uncertainties on the values of the inputs to this determination. Table 2-3 provides 95% confidence intervals for the estimated WL based upon the information of Exhibit A8. For SME Batch 261, the 95% confidence interval for the estimated WL is 35.0±1.5 or (33.5, 36.5) based on the random uncertainties of the inputs.

Table 2-3 Simulation Results for Uncertainties in Estimated WL for SME Batch 261

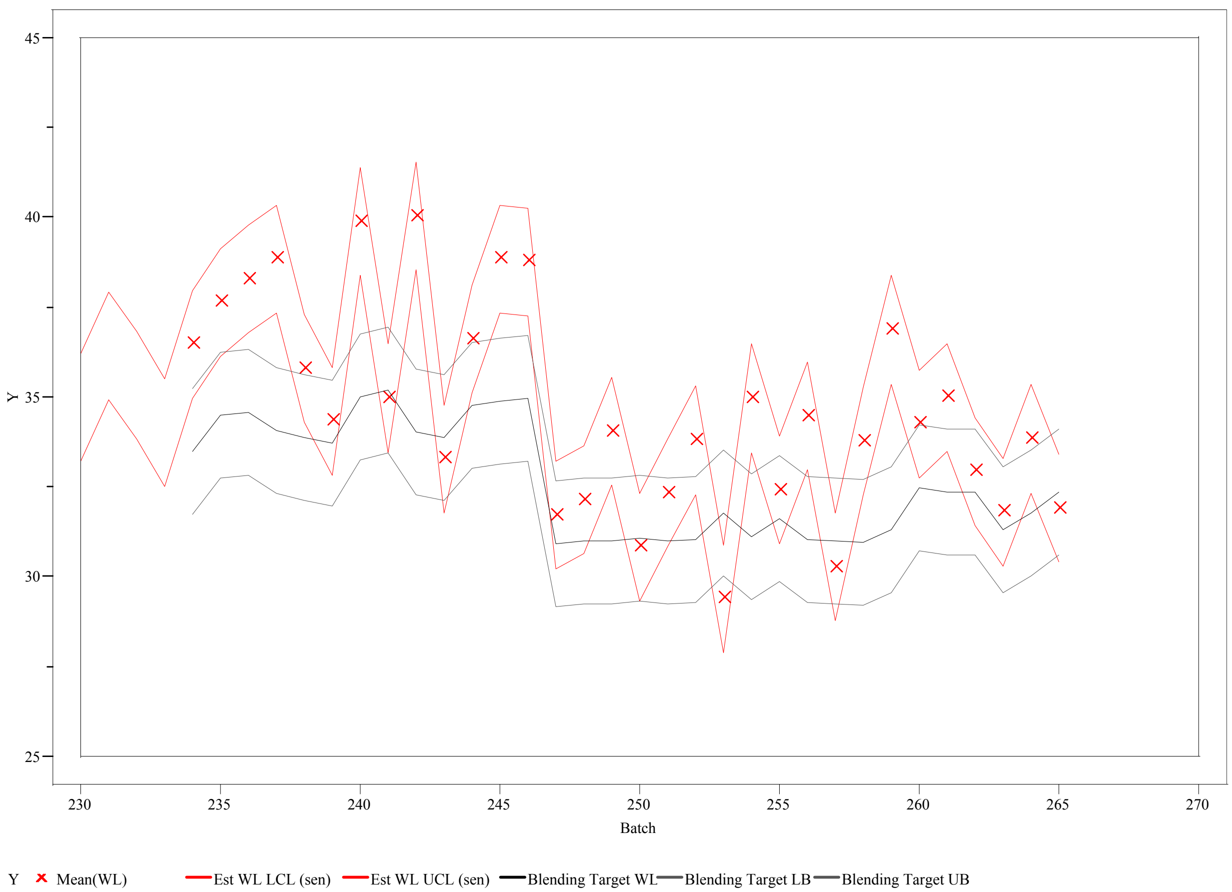
Active Error Indicator	Active Error Descriptor (1000 runs each)	95% LCL	95% UCL	WL Uncertainty
0	All (0)	33.5	36.5	1.50
1	Aluminum (1)	34.9	35.1	0.10
2	Boron (2)	34.9	35.1	0.10
3	Calcium (3)	34.9	35.1	0.10
4	Chromium (4)	35.0	35.0	0.00
5	Copper (5)	35.0	35.0	0.00
6	Iron (6)	34.7	35.3	0.30
7	Potassium (7)	35.0	35.0	0.00
8	Lithium (8)	33.9	36.1	1.10
9	Magnesium (9)	35.0	35.0	0.00
10	Manganese (10)	35.0	35.0	0.00
11	Sodium (11)	34.5	35.4	0.45
12	Nickel (12)	34.9	35.1	0.10
13	Silicon (13)	34.4	35.6	0.60
14	Titanium (14)	35.0	35.0	0.00
15	Uranium (15)	34.7	35.3	0.30
16	Zirconium (16)	35.0	35.0	0.00
17	Frit 320 Li_2O (17)	34.7	35.3	0.30

2.4 CONTRASTING TARGETED AND ESTIMATED WASTE LOADINGS

The results of the investigation suggest that the targeted WL for SME Batch 261 was in the interval (30.5, 34.1) with 95% confidence (this is the worst case scenario for analytical uncertainties) while the estimated WL for this batch was in the interval (33.5, 36.5) with the same confidence. Thus, these two intervals overlap somewhat at the low end of the estimated value and the high end of the targeted value. For the best case scenario, where the confidence interval for the targeted WL was (31.3, 33.4), this interval does not overlap with the interval for the estimated WL.

How do the targeted and estimated waste loadings compare for other recent DWPF batches? Figure 2-3 provides a plot of the targeted and estimated WLs for batches 234 through 265. For most of the batches considered the estimated WLs are larger than the targeted WLs. There is some overlap of the confidence bands for the pairs of values but not as much as might be expected. One aspect common to both targeting and estimating WL is the normalization of the SME composition, whether the composition is targeted as part of the SME blending process or measured as part of the assessment of a SME batch. For SME blending, the normalization is inherent in the determination of the wt% Li_2O as the ratio of the pounds of Li_2O to the total pounds of the 16 oxides that currently are being monitored (see Table 2-3 for a listing of the corresponding cations). For the SME assessment, the normalization is explicitly handled in the calculation of WL for each sample by dividing the measured Li_2O by the corresponding sum of oxides.

Figure 2-3 Plot of Targeted and Estimated Waste Loadings by Batch Number with Uncertainty Bands from Sensitivity Study



The normalization step in these processes, whether explicit or implicit, warrants a closer look. For the SME assessment (i.e., the estimation of WL), the normalization of the Li_2O measurement for a sample by dividing by the corresponding sum of oxides suggests that a low sum of oxides for a sample may imply a lower Li_2O measurement for that sample. Exhibit A10 in the Appendix provides a series of plots and linear regressions of Li_2O versus sum of oxides for samples from SME batches 227 through 265. The results for these 39 batches may be summarized as follows: only 6 of the 39 batches revealed a statistically significant (at ~5% significance level) correlation between the Li_2O content and total sum of oxides for a sample. There is little indication from these data that a low sum of oxides for a sample indicates a low Li_2O recovery for the sample.

As stated above, the targeted WL is driven by the planned Li_2O concentration for the batch that is determined by the ratio of the pounds of Li_2O to the total pounds of the 16 oxides that are monitoring for the blending process. Can minor oxides that are not accounted for during this normalization affect the targeted WL? Table 2-4 attempts to provide insight into the answer for this question by revisiting the targeted WL for each batch from 233 through 265. For each of these batches, four values of WL are provided: the original targeted WL and three WL values adjusted to reflect 1, 2, and 3 wt% for minor oxides in the final glass product. These minor oxides are not part of the 16 currently being measured and, therefore, do not contribute to the sum of oxides. Thus, even if the measured values for the 16 oxides were unbiased relative to their true values, the sum of oxides would always be less than 100%; that is, the sum of the measurements for these 16 oxides would recover less than 100%.

Table 2-4 Impact of the Sum of the Concentrations of the 16 Oxides Being Monitored on Targeted WL

Batch	Blending Targeted WL	Targeted WL Assuming 99% Recovery	Targeted WL Assuming 98% Recovery	Targeted WL Assuming 97% Recovery
234	33.49	34.15	34.82	35.48
235	34.52	35.17	35.83	36.48
236	34.60	35.25	35.91	36.56
237	34.09	34.75	35.40	36.06
238	33.90	34.56	35.23	35.89
239	33.75	34.41	35.07	35.74
240	35.03	35.68	36.33	36.98
241	35.22	35.87	36.51	37.16
242	34.04	34.70	35.36	36.02
243	33.90	34.56	35.23	35.89
244	34.77	35.43	36.08	36.73
245	34.92	35.57	36.22	36.87
246	34.99	35.64	36.29	36.94
247	30.94	31.63	32.32	33.01
248	31.00	31.69	32.38	33.07
249	31.02	31.71	32.40	33.09
250	31.10	31.79	32.48	33.17
251	31.00	31.69	32.38	33.07
252	31.07	31.75	32.44	33.13
253	31.80	32.48	33.16	33.84
254	31.12	31.81	32.50	33.19
255	31.62	32.31	32.99	33.67
256	31.05	31.74	32.43	33.12
257	31.01	31.70	32.39	33.08
258	30.97	31.66	32.35	33.04
259	31.32	32.01	32.70	33.38
260	32.48	33.15	33.83	34.50
261	32.39	33.06	33.74	34.41
262	32.39	33.07	33.74	34.42
263	31.31	31.99	32.68	33.37
264	31.77	32.46	33.14	33.82
265	32.38	33.05	33.73	34.41

Note that as the concentration of the group of minor oxides in the glass product increases from 1 to 3 wt% (i.e., the recovery decreases from 99 to 97%) there is a dramatic effect on the targeted WL. Even if the minors are at only 2 wt%, the resulting adjustment increases WL by over a percentage point. For example, the targeted WL for SME Batch 261 goes from 32.38% to 33.64%.

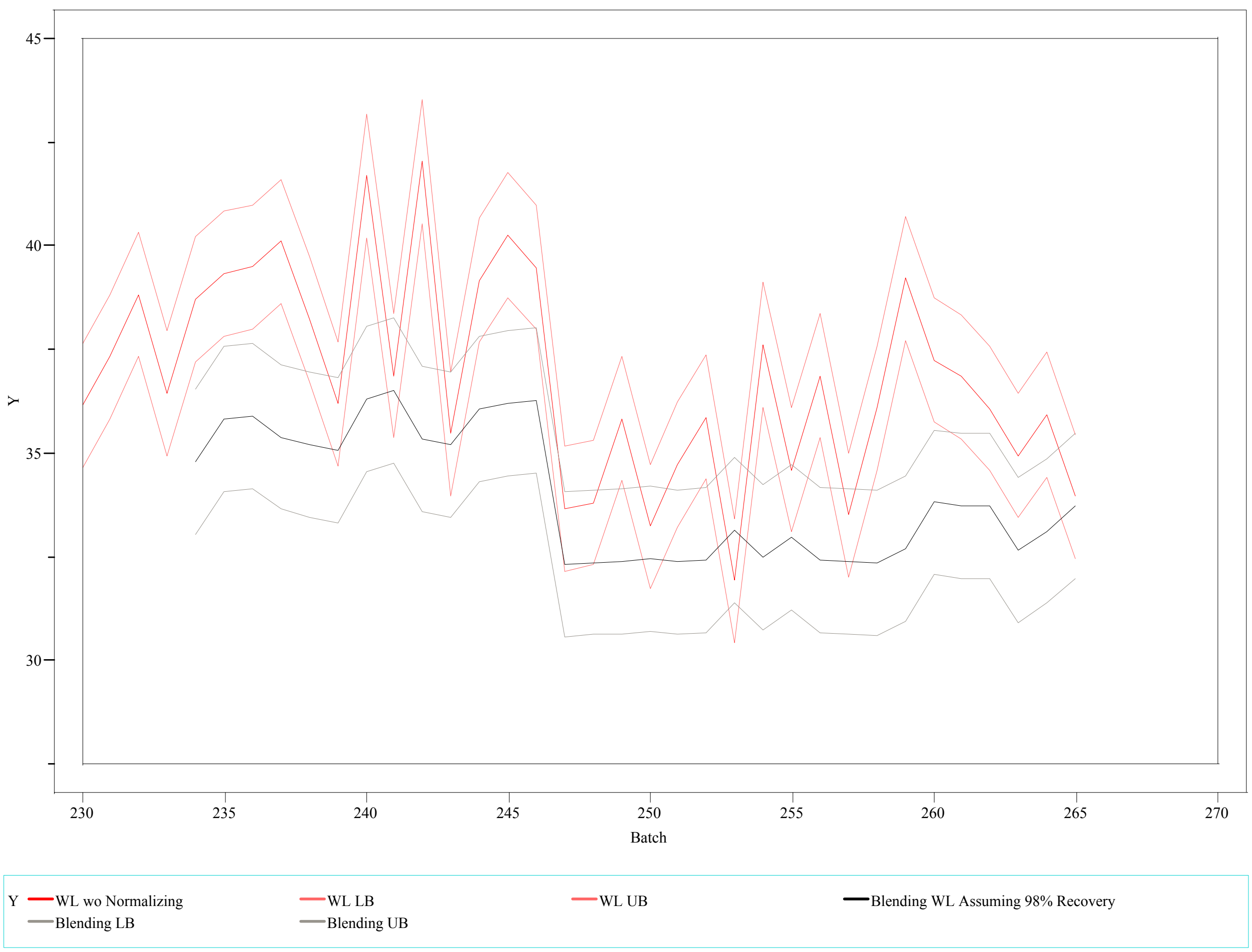
The presence of minor oxides also affects the estimation of WL determined for each of the SME samples. Since the sum of oxides for each sample is used to normalize the Li_2O content of the sample, if the sum of oxides for the 16 monitored oxides is inherently low, the Li_2O content is being inflated and the estimated WL is understated. Table 2-5 explores the effects of less than 100% recovery of the oxides by monitoring only the set of 16 routinely measured oxides. Once again, the minors are assumed to represent 1, 2, and 3 wt% of the final glass product, and the normalization of the Li_2O content of each sample is adjusted appropriately.

Table 2-5 Impact of the Sum of the 16 Oxides Being Monitored on Estimated WL

Batch	Estimated WL for Batch	Estimated WL Assuming 99% Recovery	Estimated WL Assuming 98% Recovery	Estimated WL Assuming 97% Recovery
227	32.38	33.06	33.74	34.41
228	31.95	32.63	33.31	33.99
229	31.42	32.11	32.79	33.48
230	34.74	35.39	36.04	36.69
231	36.42	37.06	37.70	38.33
232	35.37	36.01	36.66	37.30
233	34.02	34.68	35.34	36.00
234	36.48	37.12	37.76	38.39
235	37.65	38.28	38.90	39.52
236	38.30	38.92	39.53	40.15
237	38.86	39.47	40.09	40.70
238	35.81	36.45	37.10	37.74
239	34.35	35.01	35.67	36.32
240	39.89	40.49	41.09	41.69
241	34.98	35.63	36.28	36.93
242	40.04	40.64	41.24	41.84
243	33.30	33.97	34.63	35.30
244	36.62	37.25	37.89	38.52
245	38.87	39.48	40.09	40.70
246	38.79	39.40	40.01	40.63
247	31.72	32.40	33.08	33.76
248	32.15	32.82	33.50	34.18
249	34.06	34.72	35.38	36.04
250	30.84	31.53	32.23	32.92
251	32.35	33.02	33.70	34.38
252	33.81	34.47	35.14	35.80
253	29.41	30.11	30.82	31.53
254	34.98	35.63	36.28	36.93
255	32.42	33.10	33.77	34.45
256	34.49	35.15	35.80	36.46
257	30.28	30.97	31.67	32.37
258	33.79	34.45	35.12	35.78
259	36.89	37.52	38.15	38.78
260	34.28	34.93	35.59	36.25
261	35.00	35.65	36.30	36.95
262	32.94	33.61	34.28	34.95
263	31.82	32.51	33.19	33.87
264	33.85	34.51	35.17	35.84
265	31.92	32.60	33.28	33.96

Based upon the earlier results, the normalization of the Li_2O in a SME sample by the sum of oxides for the sample may not be necessary; thus, the role of minor oxides may have a potentially bigger impact on the targeted WL. To investigate this possibility in more detail, one additional comparison is provided in the form of Figure 2-4. In this figure, the targeted WLs adjusted for 98% recovery are compared to estimate WLs by batch with the calculation of the estimated WLs not involving a normalization step. Uncertainty limits (at 95% confidence) are added to the plot for the targeted WLs based upon the ±1.75 value in Table 2-1. Uncertainty limits (at 95% confidence) are added to the plot for the estimated WL based upon the ±1.50 value in Table 2-3. This is a conservative bound on these errors since errors in the sum of oxides do not come into play without the normalization step. Although some improvement is seen in the comparisons of the targeted versus estimated WLs for these batches, there are still some batches for which the two uncertainty bands do not overlap.

Figure 2-4 Plot of Targeted and Estimated Waste Loadings Adjusted for 98% Recovery by Batch Number



2.5 IMPACT OF A POTENTIAL BIAS ON WL'S

In the analyses conducted above, the sensitivity of estimated WLs to random variations in the inputs to the estimation process was investigated. This section considers the impact of a potential bias in one of the inputs, namely the Li_2O content in the SME samples. The discussion presented here is motivated by a result presented in [5], which indicates that in prototypical testing the DWPF sampling mechanism yielded samples slightly (~1.5%) low in Li_2O content. The impact of such a bias on the reporting of the DWPF glass product was investigated and found to be acceptable as documented in DWPF's Wasteform Qualification Report [6]. The question to be addressed in this section is how big of an impact could a 1.5% bias in the Li_2O measurement have on the estimated WL? To answer the question, the information presented in Table A.3 for SME batches 234 through 265 was revisited. Assuming that the Li_2O measurements of the SME samples are biased low by 1.5%, an adjustment was made to each of these measured values: the value was multiplied by 1.015. WLs were then estimated using the adjusted Li_2O values, both normalized and not normalized, and the resulting values are presented in Table 2-6. To facilitate the comparisons, WLs computed using the unadjusted, not-normalized Li_2O values are also presented in this table.

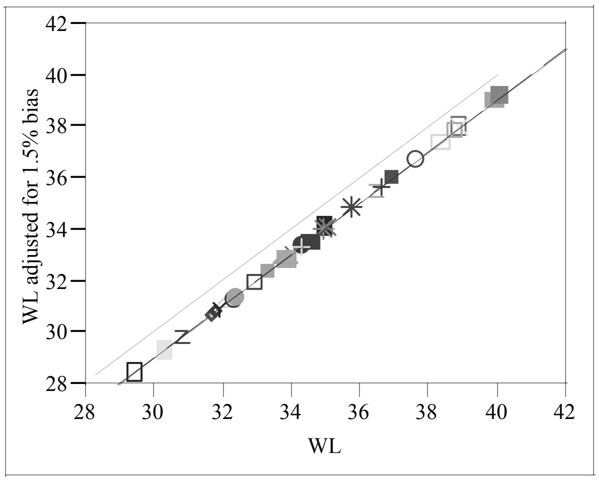
Table 2-6 Impact of a 1.5% Li_2O Bias on Estimated WL

Batch	Estimated WL for Batch	Estimated WL Without Normalizing Li_2O	Estimated WL After Adjusting for a 1.5% Li_2O Bias and Normalizing	Estimated WL After Adjusting for a 1.5% Li_2O Bias Without Normalizing
234	36.48	38.72	35.53	37.81
235	37.65	39.35	36.72	38.44
236	38.30	39.50	37.37	38.59
237	38.86	40.12	37.95	39.23
238	35.81	38.24	34.85	37.32
239	34.35	36.21	33.37	35.25
240	39.89	41.71	38.99	40.83
241	34.98	36.88	34.00	35.94
242	40.04	42.05	39.15	41.18
243	33.30	35.48	32.30	34.51
244	36.62	39.18	35.67	38.27
245	38.87	40.28	37.95	39.38
246	38.79	39.49	37.87	38.58
247	31.72	33.67	30.69	32.68
248	32.15	33.82	31.13	32.83
249	34.06	35.85	33.07	34.88
250	30.84	33.25	29.80	32.25
251	32.35	34.74	31.33	33.76
252	33.81	35.89	32.82	34.93
253	29.41	31.95	28.35	30.93
254	34.98	37.63	34.01	36.69
255	32.42	34.61	31.41	33.63
256	34.49	36.88	33.51	35.93
257	30.28	33.53	29.23	32.53
258	33.79	36.10	32.80	35.15
259	36.89	39.23	35.94	38.32
260	34.28	37.26	33.29	36.32
261	35.00	36.86	34.03	35.92
262	32.94	36.10	31.94	35.14
263	31.82	34.95	30.80	33.98
264	33.85	35.94	32.86	34.98
265	31.92	33.97	30.90	32.98

The question of interest from the data in Table 2-6 is: How much of an impact does a potential 1.5% bias in the Li_2O sample measurements have on the resulting WL calculation. This question is addressed by Figure 2-5, which provides a direct comparison between the unadjusted and adjusted WL values (i.e., a comparison between columns 2 and 4 of Table 2-6).

Figure 2-5 A Linear Fit of the WLs Calculated Using the Adjusted Li_2O Values Versus the Unadjusted WLs

Linear Fit: WL adjusted for 1.5% bias = -0.979 + 1 WL

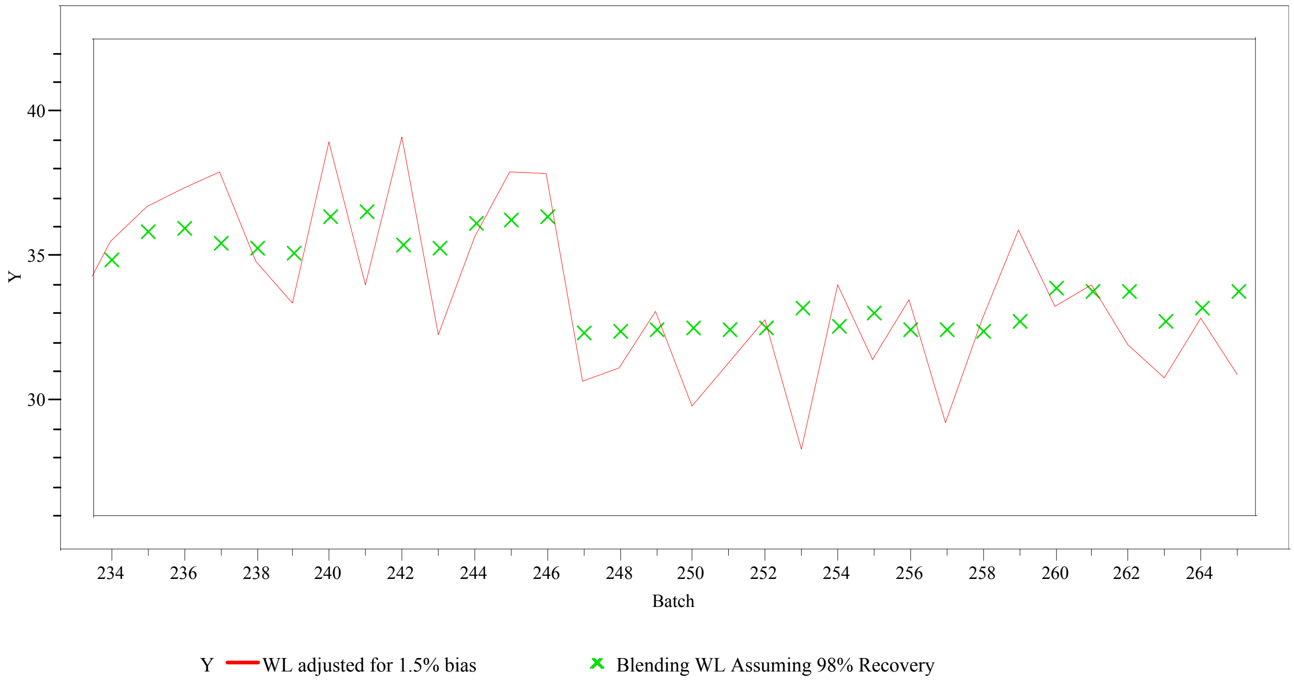


The dashed, diagonal line of Figure 2-5 represents situation where the adjusted and unadjusted WLs are equal. Since the plotted points and the fitted line are below the diagonal, the adjusted WLs are consistently less than their unadjusted counterparts. From the equation of the fitted model above the figure, the estimated WLs calculated using the bias-corrected Li_2O values are on-average 0.98 smaller than those reported by DWPF. Thus, for a reported WL of 34%, if the WL were to be calculated using a bias-corrected value for Li_2O, the resulting WL would be ~ 33%.

How about the impact of the potential Li_2O bias in the SME sampling on WL targeting? Since the blending process accounts for the SME heel, any bias in Li_2O content of the heel would have an effect on WL targeting. Since the heel accounts for ~40% of the total mass (of the 16 elements being tracked) determined during the blending process, the effect of a 1.5% bias would not be as significant in WL targeting as it is in the estimating of the WL at the SME. For the case where the SME heel accounts for ~40%, the WL targeted by the blending process would be overstated by ~ 0.39 (i.e., a nominal target of 34%, would actually be only ~33.6%).

Another question of interest is the impact of the potential bias in explaining the gap between the targeted versus estimated WLs. Figure 2-6 provides a plot of the fourth column of Table 2-4 (i.e., the Blend WL Assuming 98% Recovery) and the fourth column of Table 2-6 (i.e., the Estimated WL After Correcting for a 1.5% Li_2O Bias and Normalizing) versus SME batch number. Even without the introduction of any uncertainties, these two plots are seen to overlap to a great extent.

Figure 2-6 Targeted versus Estimated WLs for SME Batches 234 through 265



From the discussion above, it is obvious that even a small ~1.5% bias in the Li_2O measurements of SME samples can have a significant impact on the targeting and estimating of WLs. As seen in Figure 2-6, adjusting the targeted WL for a less than perfect recovery (98% for this situation) using the 16 oxides being tracked and adjusting the estimated WL for a 1.5% bias while also normalizing by the sum of oxides seem to bring these two processes more in line. Thus, the normalization of the Li_2O content in each SME sample by the sample's sum of oxides (since this almost always leads to a larger Li_2O value) may be off-setting to some extent the effects of a Li_2O measurement that is biased low due to the sampling mechanism.

3.0 CONCLUSIONS

In this report, the calculations used to target WL during blending decisions and those used to estimate WL during SME processing are investigated to explore the sensitivities of these calculations to the random uncertainties of their inputs. For the calculations used to target WLs, the random uncertainties in the inputs lead to an uncertainty, at approximately 95% confidence, in the targeted WL of ±1.05 to ±1.75 points depending on how the errors in the inputs are represented. For the calculations used to estimate the WL for a given SME batch, the random uncertainties of the inputs to this calculation lead to an uncertainty, at approximately 95% confidence, in the estimated WL of ±1.50 points.

Since one would expect to see agreement between the WL calculations of the targeting process and the WL calculations of the estimating process, comparisons between these WLs for SME batches 234 through 265 were conducted. The comparisons suggested that the targeted WLs and estimated WLs for these batches did not track each other as closely as would be expected based upon their random variations as outlined in this report. In an effort to reconcile the targeted and estimated WLs some issues were identified:

- During the blending process, the Li_2O content planned for the next SME batch is normalized using the sum of oxides for the 16 elements being tracked (i.e., the presence of minor oxides that might account for ~ 1 or 2% of the SME is not accounted for). This may lead to the targeted WL being understated.

- If there is a small (~1.5%) bias in the measured Li_2O content of the SME samples due to the Hydragard®/peanut vial sampling system (as seen in a prototypical test of this system conducted by Steimke in 1995), it could have an effect on the estimated WL (the WL value as a percentage could be overstated ~1%) and to a lesser extent on the targeted WL (the targeted WL value as a percentage could be overstated ~0.4%).

- The normalization of the Li_2O content of each SME sample using the sample's sum of oxides, while not suggested by the data (i.e., there does not appear to be a correlation between a low lithium recovery and a low sum of oxides for the SME samples), may actually be lessening the impact of the potential bias in the Li_2O measurements for the SME samples.

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4.0 REFERENCES

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[2] Patel, P.M., “Technical Task Request: Statistical Analysis of DWPF Process Data and Lab Analytical Data (U),” HLW/DWPF/TTR-03-0020, Revision 0, December 9, 2003.

[3] SAS Institute, **JMP®: Statistics and Graphics Guide**, Version 5, SAS Institute, Inc., Cary, NC, 2002.

[4] Edwards, T.B., “A Statistical Review of Analytical Laboratory Measurements from DWPF’s Macrobatch 1and Macrobatch 2 (U),” WSRC-TR-2003-00045, Revision 0, January 22, 2003.

[5] Steimke, J.L., "Results from Tests of TFL Hydragard Loop (U)," WSRC-TR-94-0598, March, 1995.

[6] Plodinec, M.J., S.L. Marra, T.B. Edwards, and C.J. Coleman, “Reporting the Chemical Composition of the DWPF Product (U),” WSRC-IM-91-116-2, Revision 1, December, 1995.

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APPENDIX: Tables and Exhibits

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Table A1. WL Targets for Batches 234 through 265

Batch Number	Targeted WL	Li2O (wt%) in Frit 320
234	33.49	8.0450
235	34.52	8.1025
236	34.60	8.1025
237	34.09	8.1090
238	33.90	8.1090
239	33.75	8.1090
240	35.03	8.1090
241	35.22	8.1090
242	34.04	8.1090
243	33.90	8.1090
244	34.77	8.1090
245	34.92	8.1136
246	34.99	8.1136
247	30.94	8.1136
248	31.00	8.1136
249	31.02	8.1136
250	31.10	8.1163
251	31.00	8.1163
252	31.07	8.1163
253	31.80	8.1163
254	31.12	8.1163
255	31.62	8.1163
256	31.05	8.1163
257	31.01	8.1163
258	30.97	8.1163
259	31.32	8.1163
260	32.48	8.1163
261	32.39	8.1163
262	32.39	8.1163
263	31.31	8.1163
264	31.77	8.1163
265	32.10	8.1163

Table A2. Inputs and Their Uncertainties for Targeting WL

Input	Nominal Value in Blending for SME Batch 261	Norminal +/- Normal Error with % Relative Standard Deviation Assuming n=1 Sample	Norminal +/- Normal Error with % Relative Standard Deviation Assuming Nominal # of Samples
(1) SME Heel Calcined wt% solids wt% (s) rand	41.253333	1.6	0.800
(2) SME Heel Specific gravity spgr rand	1.41575	1.1	0.550
(3) SME Heel Aluminum wt% (v) rand	2.55575	4.1	2.050
(3) SME Heel Boron wt% (v) rand	1.5445	3.5	1.750
(3) SME Heel Calcium wt% (v) rand	0.89225	6	3.000
(3) SME Heel Chromium wt% (v) rand	0.074	17.1	8.550
(3) SME Heel Copper wt% (v) rand	0.02425	15.2	7.600
(3) SME Heel Iron wt% (v) rand	9.413	3.3	1.650
(3) SME Heel Potassium wt% (v) rand	0.16325	20	10.000
(3) SME Heel Lithium wt% (v) rand	2.35175	2.1	1.050
(3) SME Heel Magnesium wt% (v) rand	0.676	3.5	1.750
(3) SME Heel Manganese wt% (v) rand	1.131	3.8	1.900
(3) SME Heel Sodium wt% (v) rand	8.046	6	3.000
(3) SME Heel Nickel wt% (v) rand	0.468	17.7	8.850
(3) SME Heel Silicon wt% (v) rand	22.203625	2.1	1.050
(3) SME Heel Titanium wt% (v) rand	0.0365	25	12.500
(3) SME Heel Uranium wt% (v) rand	3.29175	9.5	4.750
(3) SME Heel Zirconium wt% (v) rand	0.068	15.6	7.800
(4) SME Heel Volume (gals) rand	2915	1	1
(5) SRAT Total wt% solids wt% (s) rand	24.1305746	2.9	1.184
(6) SRAT Specific gravity spgr rand	1.18191447	1.1	0.449
(7) SRAT Aluminum wt% (s) rand	5.1704	3.6	1.470
(7) SRAT Boron wt% (s) rand	0.0308	25	10.206
(7) SRAT Calcium wt% (s) rand	2.1828	5.7	2.327
(7) SRAT Chromium wt% (s) rand	0.1408	25	10.206
(7) SRAT Copper wt% (s) rand	0.0456	25	10.206
(7) SRAT Iron wt% (s) rand	20.941	3.6	1.470
(7) SRAT Potassium wt% (s) rand	0.0634	25	10.206
(7) SRAT Lithium wt% (s) rand	0.063	25	10.206
(7) SRAT Magnesium wt% (s) rand	1.6738	3.4	1.388
(7) SRAT Manganese wt% (s) rand	2.7936	3.3	1.347
(7) SRAT Sodium wt% (s) rand	6.431	3.4	1.388
(7) SRAT Nickel wt% (s) rand	1.0484	11.6	4.736
(7) SRAT Silicon wt% (s) rand	0.96	22	8.981
(7) SRAT Titanium wt% (s) rand	0.0152	8.1	3.307
(7) SRAT Uranium wt% (s) rand	6.8894	5.3	2.164
(7) SRAT Zirconium wt% (s) rand	0.065	9	3.674
(8) SRAT Volume (gals) rand	3900	1	1
(9) Frit 320 Aluminum wt% (v) rand	0.24907861	2	2
(9) Frit 320 Boron wt% (v) rand	2.47043302	1.1	1.1
(9) Frit 320 Calcium wt% (v) rand	0.10720514	2	2
(9) Frit 320 Chromium wt% (v) rand	0.0013684	2	2
(9) Frit 320 Copper wt% (v) rand	0	2	2
(9) Frit 320 Iron wt% (v) rand	0.03326678	2	2
(9) Frit 320 Potassium wt% (v) rand	0.01302293	2	2
(9) Frit 320 Lithium wt% (v) rand	3.77056582	1.2	1.2
(9) Frit 320 Magnesium wt% (v) rand	0.03501377	2	2
(9) Frit 320 Manganese wt% (v) rand	0.00077446	2	2
(9) Frit 320 Sodium wt% (v) rand	8.94772848	1	1
(9) Frit 320 Nickel wt% (v) rand	0.00088404	2	2
(9) Frit 320 Silicon wt% (v) rand	33.1835196	0.5	0.5
(9) Frit 320 Titanium wt% (v) rand	0.03615785	2	2
(9) Frit 320 Uranium wt% (v) rand	0	-	-
(9) Frit 320 Zirconium wt% (v) rand	0.00666278	2	2
(10) Frit 320 (lbs) rand	13000	1	1
(11) Frit lbs from 5 Can Decon rand	1000	2.5	2.5

Table A3. Estimated WLs for Batches 234 through 265

Batch	Li (wt%)	Sum of Oxides	Li2O (wt%)	Li2O (wt%) in Frit	% WL
234	2.296	97.460	4.943	7.980	36.44
234	2.259	96.300	4.863	7.980	36.72
234	2.262	96.020	4.870	7.980	36.45
234	2.268	96.110	4.883	7.980	36.33
235	2.269	97.250	4.885	8.110	38.06
235	2.300	97.520	4.952	8.110	37.39
235	2.275	97.350	4.898	8.110	37.96
235	2.295	96.990	4.941	8.110	37.19
236	2.302	98.170	4.956	8.190	38.36
236	2.304	98.370	4.960	8.190	38.43
236	2.339	98.190	5.036	8.190	37.38
236	2.261	97.470	4.868	8.190	39.02
237	2.208	98.430	4.754	8.180	40.96
237	2.263	97.540	4.872	8.180	38.94
237	2.286	97.360	4.922	8.180	38.20
237	2.343	98.420	5.044	8.180	37.34
238	2.356	96.110	5.072	8.180	35.49
238	2.339	96.010	5.036	8.180	35.88
238	2.352	96.270	5.064	8.180	35.70
238	2.339	96.460	5.036	8.180	36.18
239	2.388	97.640	5.141	8.120	35.15
239	2.414	98.050	5.197	8.120	34.72
239	2.415	97.470	5.199	8.120	34.31
239	2.407	95.580	5.182	8.120	33.23
240	2.203	98.460	4.743	8.190	41.19
240	2.259	96.800	4.863	8.190	38.65
240	2.200	96.740	4.736	8.190	40.22
240	2.208	95.930	4.754	8.190	39.50
241	2.358	97.450	5.077	8.270	37.01
241	2.416	99.210	5.201	8.270	36.60
241	2.485	98.530	5.350	8.270	34.34
241	2.439	93.320	5.251	8.270	31.96
242	2.182	97.170	4.698	8.100	40.32
242	2.243	96.420	4.829	8.100	38.17
242	2.188	96.420	4.711	8.100	39.69
242	2.205	96.620	4.747	8.100	39.34
243	2.478	99.760	5.335	8.110	34.06
243	2.468	97.550	5.313	8.110	32.84
243	2.320	95.210	4.995	8.110	35.31
243	2.456	94.470	5.288	8.110	30.99
244	2.375	96.700	5.113	8.163	35.22
244	2.311	96.840	4.975	8.163	37.06
244	2.296	95.900	4.943	8.163	36.85
244	2.242	94.380	4.827	8.163	37.35
245	2.254	98.580	4.853	8.125	39.41
245	2.258	98.090	4.861	8.125	39.01
245	2.266	97.430	4.878	8.125	38.37
245	2.238	96.690	4.818	8.125	38.67
246	2.377	98.330	5.117	8.220	36.69
246	2.309	99.500	4.971	8.220	39.22
246	2.405	101.810	5.178	8.220	38.13
246	2.150	95.640	4.629	8.220	41.12

Table A3. Estimated WLs for Batches 234 through 265

Batch	Li (wt%)	Sum of Oxides	Li2O (wt%)	Li2O (wt%) in Frit	% WL
247	2.548	97.780	5.486	8.153	31.19
247	2.496	96.620	5.374	8.153	31.78
247	2.564	98.050	5.520	8.153	30.95
247	2.439	96.050	5.251	8.153	32.94
248	2.446	97.790	5.266	8.027	32.91
248	2.435	97.250	5.242	8.027	32.84
248	2.495	97.310	5.371	8.027	31.23
248	2.493	97.760	5.367	8.027	31.60
249	2.454	98.350	5.283	8.088	33.59
249	2.423	97.220	5.216	8.088	33.66
249	2.378	97.060	5.120	8.088	34.78
249	2.386	96.550	5.137	8.088	34.22
250	2.534	97.600	5.455	8.167	31.56
250	2.539	96.220	5.466	8.167	30.44
250	2.552	97.850	5.494	8.167	31.24
250	2.503	94.440	5.389	8.167	30.13
251	2.403	96.900	5.173	7.885	32.29
251	2.378	96.580	5.120	7.885	32.77
251	2.421	96.510	5.212	7.885	31.50
251	2.359	95.890	5.079	7.885	32.83
252	2.443	97.370	5.260	8.148	33.71
252	2.432	96.950	5.236	8.148	33.72
252	2.425	96.920	5.221	8.148	33.89
252	2.406	96.200	5.180	8.148	33.92
253	2.535	98.890	5.458	8.028	31.25
253	2.603	97.430	5.604	8.028	28.35
253	2.509	95.210	5.402	8.028	29.33
253	2.504	94.170	5.391	8.028	28.69
254	2.355	97.380	5.070	8.238	36.80
254	2.366	95.870	5.094	8.238	35.50
254	2.418	95.120	5.206	8.238	33.57
254	2.408	95.420	5.184	8.238	34.05
255	2.519	97.600	5.423	8.170	31.99
255	2.470	96.400	5.318	8.170	32.48
255	2.481	95.170	5.341	8.170	31.30
255	2.456	97.920	5.288	8.170	33.91
256	2.503	96.730	5.389	8.158	31.71
256	2.367	96.200	5.096	8.158	35.06
256	2.343	97.040	5.044	8.158	36.29
256	2.355	95.470	5.070	8.158	34.90
257	2.450	95.610	5.275	7.982	30.88
257	2.457	95.440	5.290	7.982	30.56
257	2.496	95.590	5.374	7.982	29.57
257	2.455	94.710	5.285	7.982	30.09
258	2.396	97.340	5.158	8.015	33.88
258	2.324	95.580	5.003	8.015	34.69
258	2.397	96.970	5.161	8.015	33.60
258	2.398	96.130	5.163	8.015	33.00
259	2.309	97.740	4.971	8.070	36.97
259	2.263	97.690	4.872	8.070	38.20
259	2.314	95.710	4.982	8.070	35.50
259	2.225	94.020	4.790	8.070	36.87
260	2.389	96.530	5.143	8.070	33.98

Table A3. Estimated WLs for Batches 234 through 265

Batch	Li (wt%)	Sum of Oxides	Li2O (wt%)	Li2O (wt%) in Frit	% WL
260	2.338	96.110	5.033	8.070	35.10
260	2.356	95.060	5.072	8.070	33.88
260	2.324	94.150	5.003	8.070	34.15
261	2.323	98.170	5.001	8.010	36.40
261	2.377	96.680	5.117	8.010	33.91
261	2.334	96.420	5.025	8.010	34.94
261	2.362	97.300	5.085	8.010	34.75
262	2.398	95.830	5.163	8.127	33.71
262	2.387	95.880	5.139	8.127	34.05
262	2.437	95.480	5.247	8.127	32.39
262	2.427	94.040	5.225	8.127	31.63
263	2.412	96.000	5.193	7.978	32.20
263	2.419	95.860	5.208	7.978	31.91
263	2.394	95.130	5.154	7.978	32.09
263	2.417	94.670	5.204	7.978	31.11
264	2.378	98.410	5.120	7.982	34.82
264	2.353	96.520	5.066	7.982	34.24
264	2.389	96.540	5.143	7.982	33.25
264	2.380	95.940	5.124	7.982	33.09
265	2.434	97.120	5.240	7.906	31.75
265	2.456	97.850	5.288	7.906	31.65
265	2.433	97.840	5.238	7.906	32.28
265	2.376	95.140	5.115	7.906	32.00

Table A4. Nominal Values and Uncertainties for Inputs to the Estimation of WL for SME Batch 261

Element	Sample 1	Sample 2	Sample 3	Sample 4	%RSD
Aluminum	2.59	2.681	2.802	2.685	4.1
Boron	1.489	1.46	1.388	1.458	3.5
Calcium	1.118	1.015	0.975	0.984	6
Chromium	0.092	0.074	0.074	0.077	17.1
Copper	0.026	0.024	0.025	0.024	15.2
Iron	10.654	9.722	10.018	10.105	3.3
Potassium	0.159	0.123	0.453	0.14	20
Lithium	2.323	2.377	2.334	2.362	2.1
Magnesium	0.905	0.815	0.773	0.794	3.5
Manganese	1.417	1.278	1.256	1.275	3.8
Sodium	8.673	8.586	8.387	8.576	6
Nickel	0.58	0.498	0.496	0.52	17.7
Silicon	21.5525	21.8955	21.535	21.916	2.1
Titanium	0.034	0.033	0.031	0.033	25
Uranium	3.657	3.386	3.569	3.474	9.5
Zirconium	0.066	0.065	0.068	0.066	15.6
Frit Li_2O		**Nominal**	**8.01**	**%RSD**	**0.25**

Exhibit A1. Overview of Impact of Uncertainties on Measured WLs
(assuming analytical uncertainties with only 1 sample)

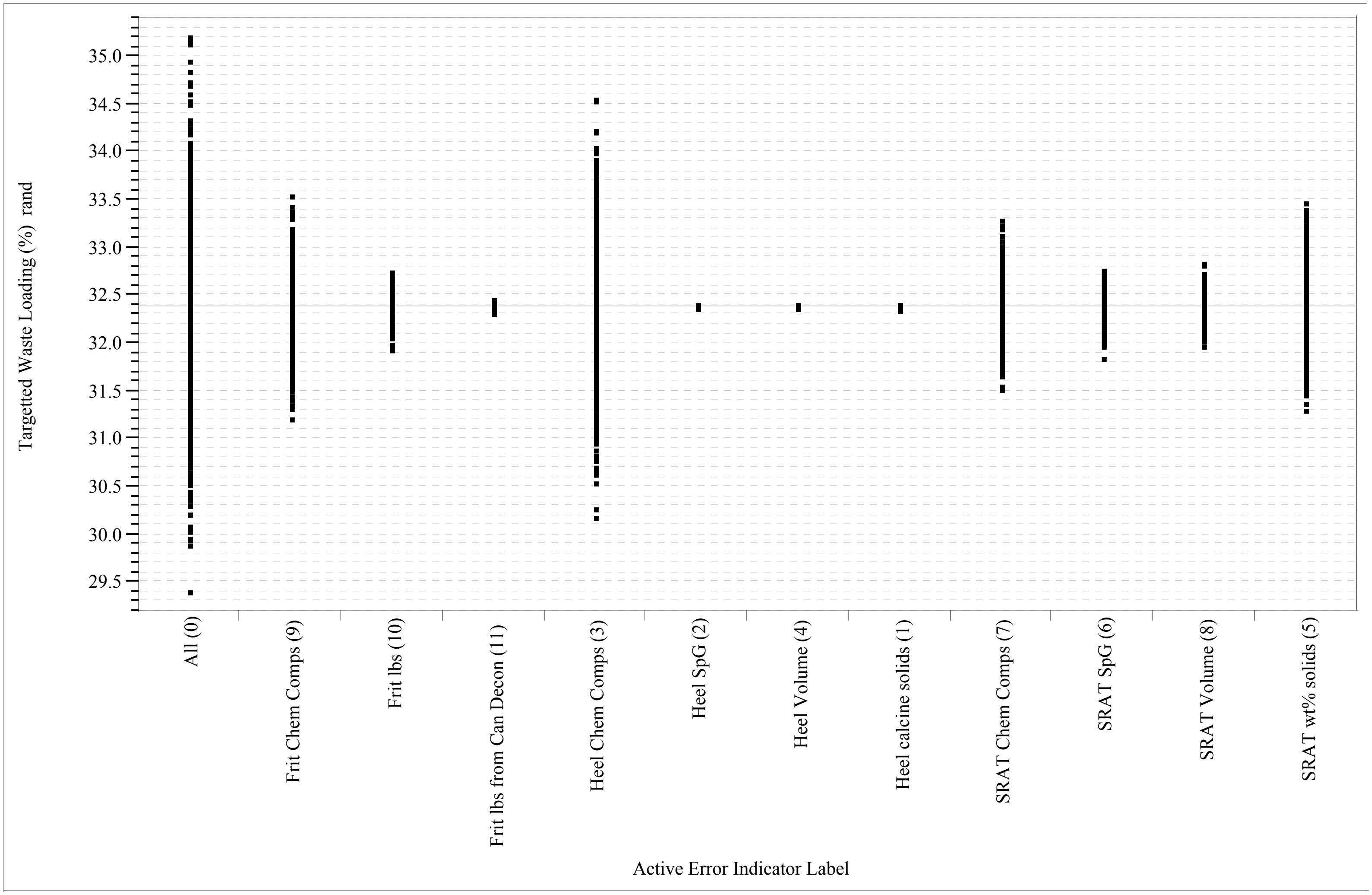
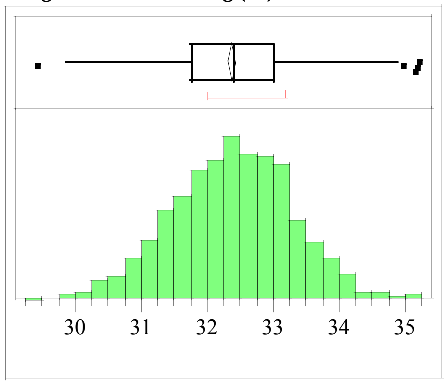


Exhibit A2. Histograms and Other Descriptive Statistics for WLs with Analytical Uncertainties Assuming 1 Sample

Active Error Indicator Label=All (0)
Distributions
Targeted Waste Loading (%) rand



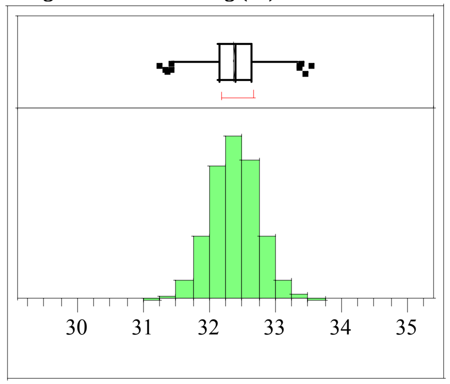
Quantiles

100.0%	maximum	35.204
99.5%		34.843
97.5%		34.059
90.0%		33.506
75.0%	quartile	33.002
50.0%	median	32.405
25.0%	quartile	31.757
10.0%		31.203
2.5%		30.558
0.5%		30.037
0.0%	minimum	29.405

Moments

Mean	32.373504
Std Dev	0.8988659
Std Err Mean	0.0284246
upper 95% Mean	32.429283
lower 95% Mean	32.317726
N	1000

Active Error Indicator Label=Frit Chem Comps (9)
Distributions
Targeted Waste Loading (%) rand



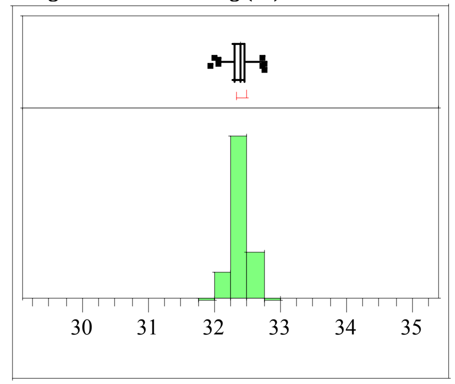
Quantiles

100.0%	maximum	33.547
99.5%		33.366
97.5%		33.092
90.0%		32.834
75.0%	quartile	32.632
50.0%	median	32.396
25.0%	quartile	32.149
10.0%		31.930
2.5%		31.685
0.5%		31.421
0.0%	minimum	31.220

Moments

Mean	32.386018
Std Dev	0.3550432
Std Err Mean	0.0112275
upper 95% Mean	32.40805
lower 95% Mean	32.363986
N	1000

Active Error Indicator Label=Frit lbs (10)
Distributions
Targeted Waste Loading (%) rand



Quantiles

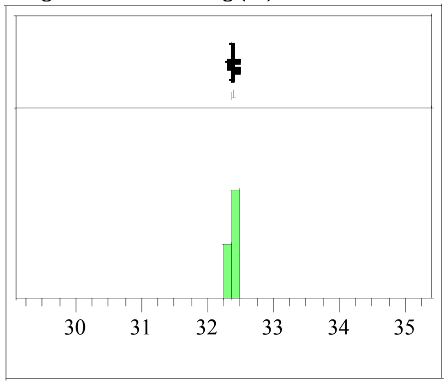
100.0%	maximum	32.752
99.5%		32.719
97.5%		32.635
90.0%		32.551
75.0%	quartile	32.476
50.0%	median	32.398
25.0%	quartile	32.312
10.0%		32.241
2.5%		32.153
0.5%		32.071
0.0%	minimum	31.931

Moments

Mean	32.396082
Std Dev	0.1224269
Std Err Mean	0.0038715
upper 95% Mean	32.403679
lower 95% Mean	32.388485
N	1000

Exhibit A2. Histograms and Other Descriptive Statistics for WLs with Analytical Uncertainties Assuming 1 Sample

Active Error Indicator Label=Frit lbs from Can Decon (11)
Distributions
Targeted Waste Loading (%) rand



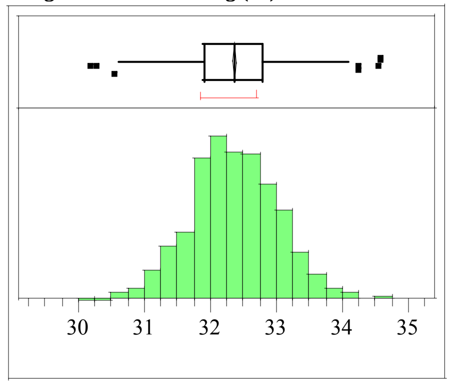
Quantiles

100.0%	maximum	32.457
99.5%		32.450
97.5%		32.434
90.0%		32.418
75.0%	quartile	32.402
50.0%	median	32.386
25.0%	quartile	32.370
10.0%		32.355
2.5%		32.341
0.5%		32.327
0.0%	minimum	32.314

Moments

Mean	32.385901
Std Dev	0.0239868
Std Err Mean	0.0007585
upper 95% Mean	32.38739
lower 95% Mean	32.384413
N	1000

Active Error Indicator Label=Heel Chem Comps (3)
Distributions
Targeted Waste Loading (%) rand



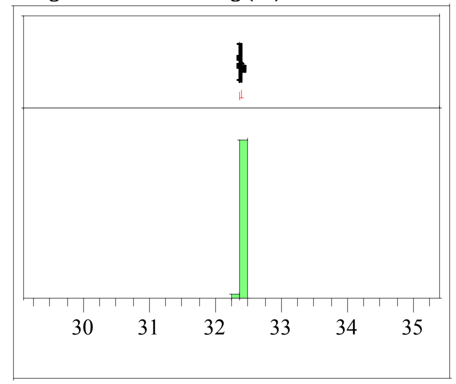
Quantiles

100.0%	maximum	34.567
99.5%		34.222
97.5%		33.662
90.0%		33.198
75.0%	quartile	32.794
50.0%	median	32.363
25.0%	quartile	31.930
10.0%		31.539
2.5%		31.073
0.5%		30.651
0.0%	minimum	30.177

Moments

Mean	32.368519
Std Dev	0.6613395
Std Err Mean	0.0209134
upper 95% Mean	32.409558
lower 95% Mean	32.32748
N	1000

Active Error Indicator Label=Heel SpG (2)
Distributions
Targeted Waste Loading (%) rand



Quantiles

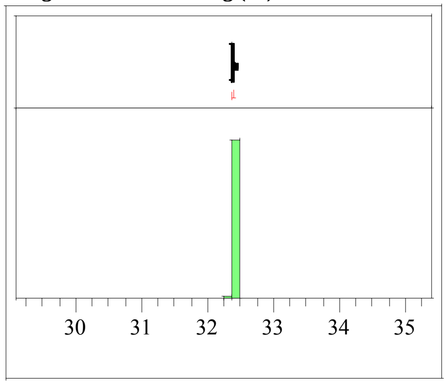
100.0%	maximum	32.408
99.5%		32.402
97.5%		32.397
90.0%		32.394
75.0%	quartile	32.390
50.0%	median	32.386
25.0%	quartile	32.382
10.0%		32.378
2.5%		32.374
0.5%		32.371
0.0%	minimum	32.368

Moments

Mean	32.386068
Std Dev	0.0059989
Std Err Mean	0.0001897
upper 95% Mean	32.38644
lower 95% Mean	32.385696
N	1000

Exhibit A2. Histograms and Other Descriptive Statistics for WLs with Analytical Uncertainties Assuming 1 Sample

Active Error Indicator Label=Heel Volume (4)
Distributions
Targeted Waste Loading (%) rand



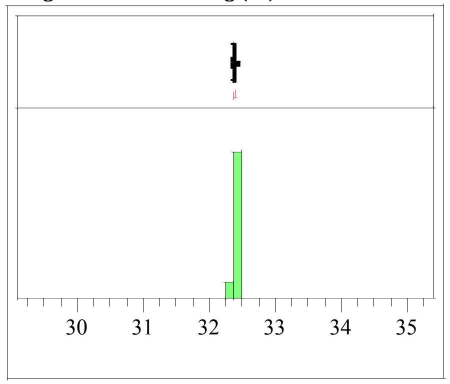
Quantiles

100.0%	maximum	32.404
99.5%		32.402
97.5%		32.396
90.0%		32.393
75.0%	quartile	32.390
50.0%	median	32.386
25.0%	quartile	32.382
10.0%		32.379
2.5%		32.375
0.5%		32.372
0.0%	minimum	32.371

Moments

Mean	32.386078
Std Dev	0.0056239
Std Err Mean	0.0001778
upper 95% Mean	32.386427
lower 95% Mean	32.385729
N	1000

Active Error Indicator Label=Heel calcine solids (1)
Distributions
Targeted Waste Loading (%) rand



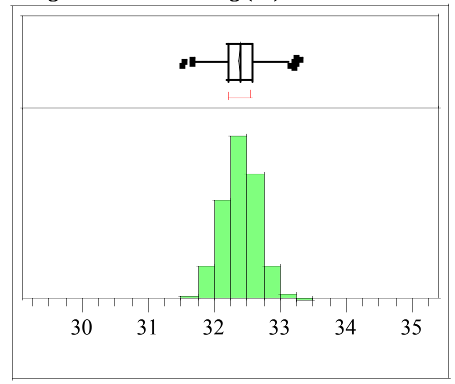
Quantiles

100.0%	maximum	32.409
99.5%		32.407
97.5%		32.403
90.0%		32.397
75.0%	quartile	32.392
50.0%	median	32.386
25.0%	quartile	32.380
10.0%		32.375
2.5%		32.369
0.5%		32.364
0.0%	minimum	32.359

Moments

Mean	32.3858
Std Dev	0.008539
Std Err Mean	0.00027
upper 95% Mean	32.38633
lower 95% Mean	32.38527
N	1000

Active Error Indicator Label=SRAT Chem Comps (7)
Distributions
Targeted Waste Loading (%) rand



Quantiles

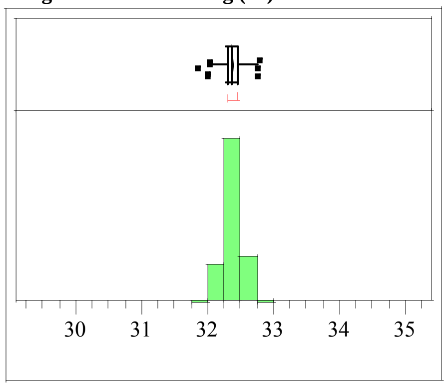
100.0%	maximum	33.299
99.5%		33.213
97.5%		32.911
90.0%		32.724
75.0%	quartile	32.573
50.0%	median	32.390
25.0%	quartile	32.216
10.0%		32.045
2.5%		31.854
0.5%		31.705
0.0%	minimum	31.522

Moments

Mean	32.390796
Std Dev	0.2672311
Std Err Mean	0.0084506
upper 95% Mean	32.407379
lower 95% Mean	32.374213
N	1000

Exhibit A2. Histograms and Other Descriptive Statistics for WLs with Analytical Uncertainties Assuming 1 Sample

Active Error Indicator Label=SRAT SpG (6)
Distributions
Targeted Waste Loading (%) rand



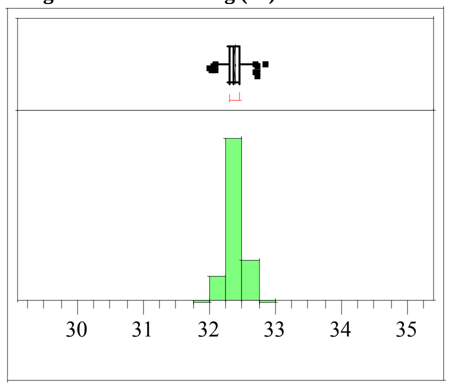
Quantiles

100.0%	maximum	32.771
99.5%		32.724
97.5%		32.639
90.0%		32.554
75.0%	quartile	32.469
50.0%	median	32.383
25.0%	quartile	32.296
10.0%		32.212
2.5%		32.126
0.5%		32.034
0.0%	minimum	31.854

Moments

Mean	32.383917
Std Dev	0.1325667
Std Err Mean	0.0041921
upper 95% Mean	32.392144
lower 95% Mean	32.375691
N	1000

Active Error Indicator Label=SRAT Volume (8)
Distributions
Targeted Waste Loading (%) rand



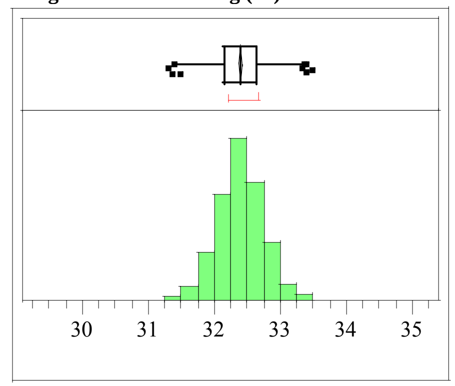
Quantiles

100.0%	maximum	32.836
99.5%		32.710
97.5%		32.629
90.0%		32.553
75.0%	quartile	32.466
50.0%	median	32.386
25.0%	quartile	32.315
10.0%		32.243
2.5%		32.159
0.5%		32.084
0.0%	minimum	31.983

Moments

Mean	32.392537
Std Dev	0.1199607
Std Err Mean	0.0037935
upper 95% Mean	32.399981
lower 95% Mean	32.385093
N	1000

Active Error Indicator Label=SRAT wt% solids (5)
Distributions
Targeted Waste Loading (%) rand



Quantiles

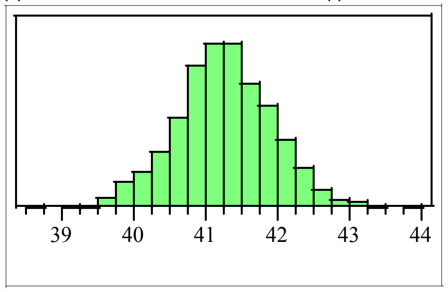
100.0%	maximum	33.477
99.5%		33.354
97.5%		33.104
90.0%		32.850
75.0%	quartile	32.630
50.0%	median	32.398
25.0%	quartile	32.166
10.0%		31.948
2.5%		31.686
0.5%		31.473
0.0%	minimum	31.309

Moments

Mean	32.397053
Std Dev	0.3512802
Std Err Mean	0.0111085
upper 95% Mean	32.418851
lower 95% Mean	32.375254
N	1000

Exhibit A3. Histograms and Other Descriptive Statistics for Inputs to WL Targeting Assuming 1 Sample

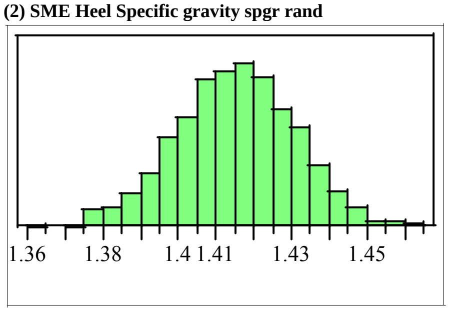
Active Error Indicator Label=All (0)
Distributions
(1) SME Heel Calcined wt% solids wt% (s) rand



Moments

Mean	41.263233
Std Dev	0.6674493
Std Err Mean	0.0211066
upper 95% Mean	41.304652
lower 95% Mean	41.221815
N	1000

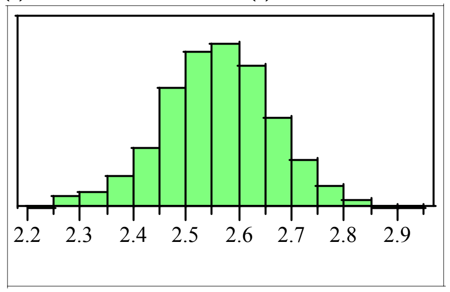
(2) SME Heel Specific gravity spgr rand



Moments

Mean	1.4152176
Std Dev	0.0155526
Std Err Mean	0.0004918
upper 95% Mean	1.4161828
lower 95% Mean	1.4142525
N	1000

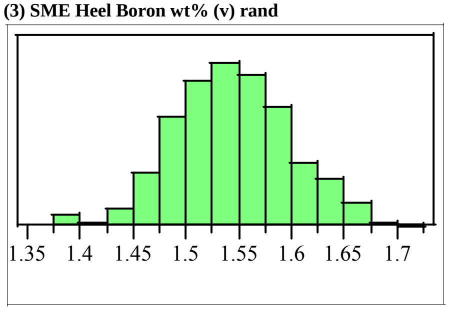
(3) SME Heel Aluminum wt% (v) rand



Moments

Mean	2.5613386
Std Dev	0.1052363
Std Err Mean	0.0033279
upper 95% Mean	2.567869
lower 95% Mean	2.5548082
N	1000

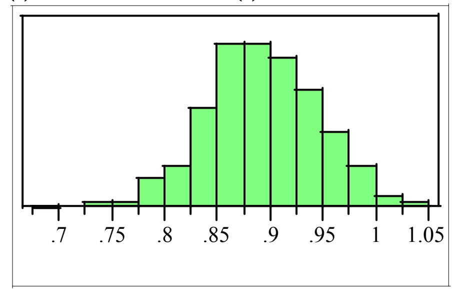
(3) SME Heel Boron wt% (v) rand



Moments

Mean	1.5441049
Std Dev	0.0549486
Std Err Mean	0.0017376
upper 95% Mean	1.5475147
lower 95% Mean	1.5406951
N	1000

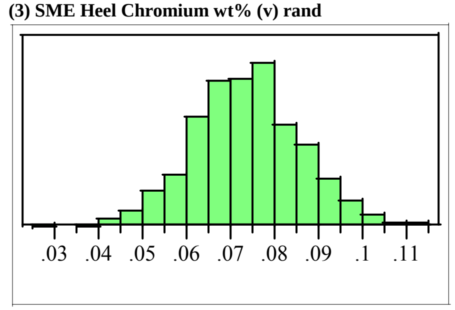
(3) SME Heel Calcium wt% (v) rand



Moments

Mean	0.8931166
Std Dev	0.0524099
Std Err Mean	0.0016573
upper 95% Mean	0.8963689
lower 95% Mean	0.8898643
N	1000

(3) SME Heel Chromium wt% (v) rand

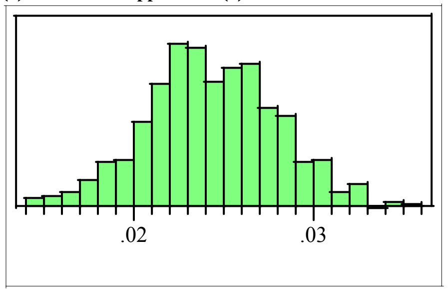


Moments

Mean	0.0736697
Std Dev	0.0122386
Std Err Mean	0.000387
upper 95% Mean	0.0744291
lower 95% Mean	0.0729102
N	1000

Exhibit A3. Histograms and Other Descriptive Statistics for Inputs to WL Targeting Assuming 1 Sample

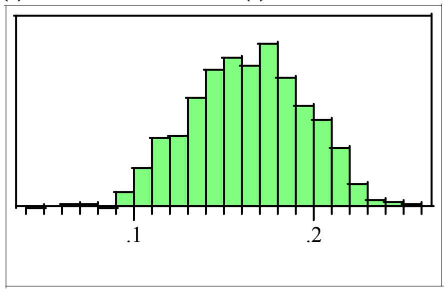
(3) SME Heel Copper wt% (v) rand



Moments

Mean	0.0243482
Std Dev	0.0036602
Std Err Mean	0.0001157
upper 95% Mean	0.0245753
lower 95% Mean	0.024121
N	1000

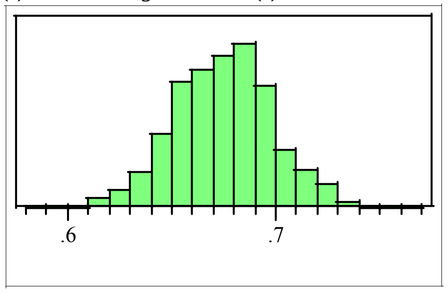
(3) SME Heel Potassium wt% (v) rand



Moments

Mean	0.163642
Std Dev	0.0322151
Std Err Mean	0.0010187
upper 95% Mean	0.1656411
lower 95% Mean	0.1616429
N	1000

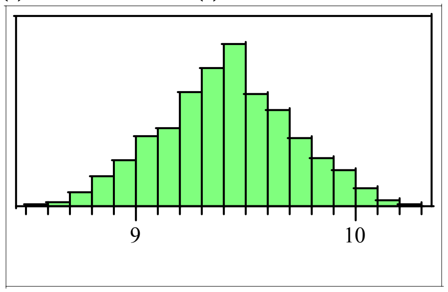
(3) SME Heel Magnesium wt% (v) rand



Moments

Mean	0.6748296
Std Dev	0.0238275
Std Err Mean	0.0007535
upper 95% Mean	0.6763082
lower 95% Mean	0.673351
N	1000

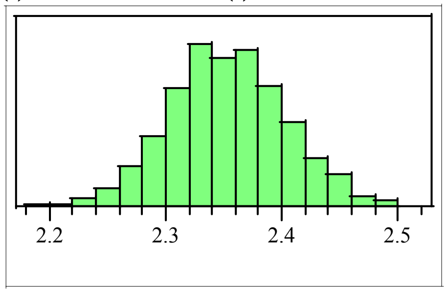
(3) SME Heel Iron wt% (v) rand



Moments

Mean	9.4117924
Std Dev	0.3054719
Std Err Mean	0.0096599
upper 95% Mean	9.4307484
lower 95% Mean	9.3928365
N	1000

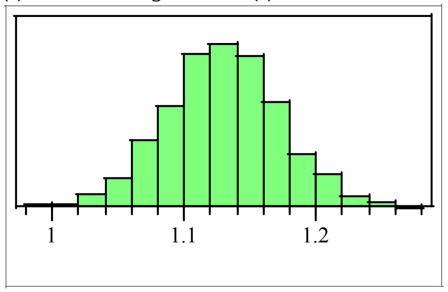
(3) SME Heel Lithium wt% (v) rand



Moments

Mean	2.3527693
Std Dev	0.0505763
Std Err Mean	0.0015994
upper 95% Mean	2.3559078
lower 95% Mean	2.3496308
N	1000

(3) SME Heel Manganese wt% (v) rand

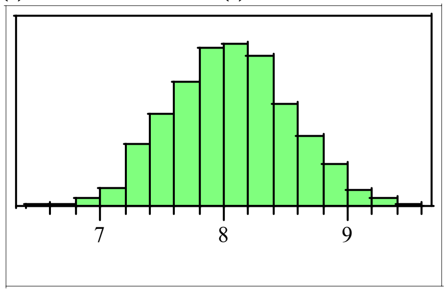


Moments

Mean	1.1293235
Std Dev	0.0435915
Std Err Mean	0.0013785
upper 95% Mean	1.1320285
lower 95% Mean	1.1266184
N	1000

Exhibit A3. Histograms and Other Descriptive Statistics for Inputs to WL Targeting Assuming 1 Sample

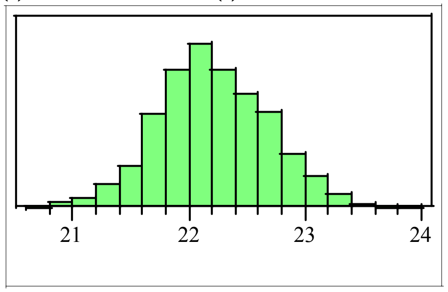
(3) SME Heel Sodium wt% (v) rand



Moments

Mean	8.0565664
Std Dev	0.4821181
Std Err Mean	0.0152459
upper 95% Mean	8.0864841
lower 95% Mean	8.0266487
N	1000

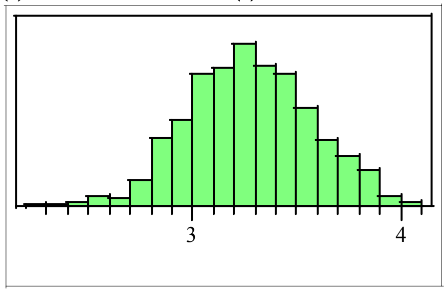
(3) SME Heel Silicon wt% (v) rand



Moments

Mean	22.210143
Std Dev	0.4733793
Std Err Mean	0.0149696
upper 95% Mean	22.239518
lower 95% Mean	22.180768
N	1000

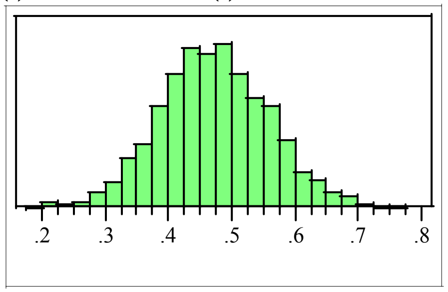
(3) SME Heel Uranium wt% (v) rand



Moments

Mean	3.2731949
Std Dev	0.3044525
Std Err Mean	0.0096276
upper 95% Mean	3.2920876
lower 95% Mean	3.2543022
N	1000

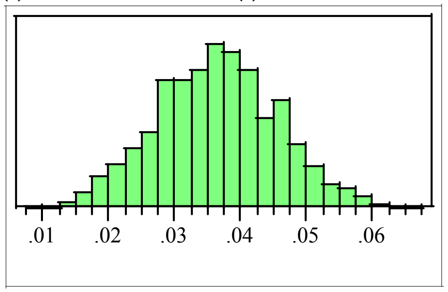
(3) SME Heel Nickel wt% (v) rand



Moments

Mean	0.4722485
Std Dev	0.0858191
Std Err Mean	0.0027138
upper 95% Mean	0.477574
lower 95% Mean	0.466923
N	1000

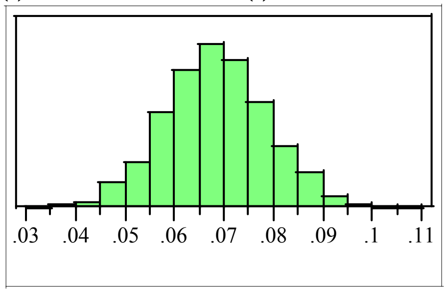
(3) SME Heel Titanium wt% (v) rand



Moments

Mean	0.0364449
Std Dev	0.0091673
Std Err Mean	0.0002899
upper 95% Mean	0.0370138
lower 95% Mean	0.035876
N	1000

(3) SME Heel Zirconium wt% (v) rand

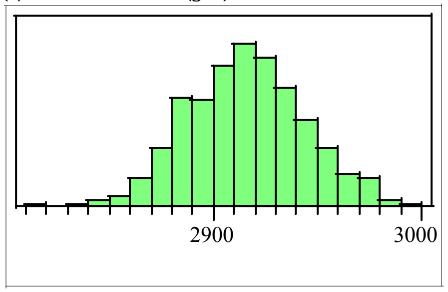


Moments

Mean	0.0683398
Std Dev	0.0104777
Std Err Mean	0.0003313
upper 95% Mean	0.06899
lower 95% Mean	0.0676896
N	1000

Exhibit A3. Histograms and Other Descriptive Statistics for Inputs to WL Targeting Assuming 1 Sample

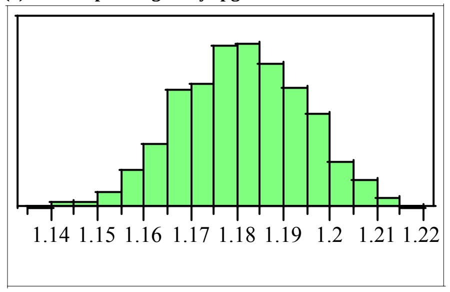
(4) SME Heel Volume (gals) rand



Moments

Mean	2915.5008
Std Dev	28.622453
Std Err Mean	0.9051214
upper 95% Mean	2917.277
lower 95% Mean	2913.7246
N	1000

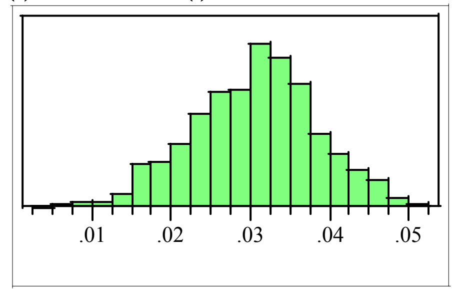
(6) SRAT Specific gravity spgr rand



Moments

Mean	1.1810913
Std Dev	0.0131407
Std Err Mean	0.0004155
upper 95% Mean	1.1819068
lower 95% Mean	1.1802759
N	1000

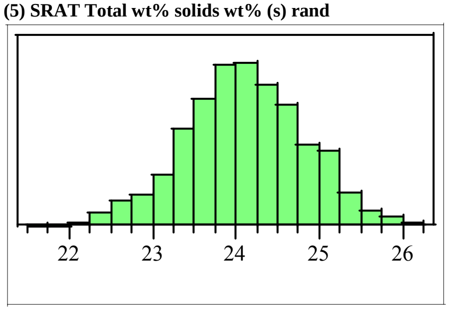
(7) SRAT Boron wt% (s) rand



Moments

Mean	0.0305799
Std Dev	0.0078732
Std Err Mean	0.000249
upper 95% Mean	0.0310684
lower 95% Mean	0.0300913
N	1000

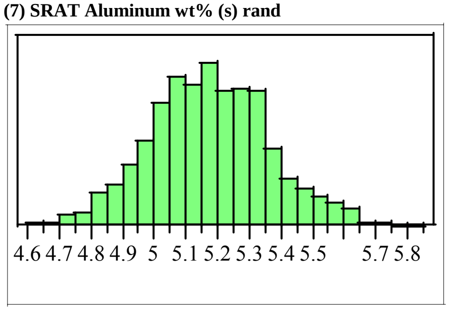
(5) SRAT Total wt% solids wt% (s) rand



Moments

Mean	24.107526
Std Dev	0.7105275
Std Err Mean	0.0224689
upper 95% Mean	24.151618
lower 95% Mean	24.063435
N	1000

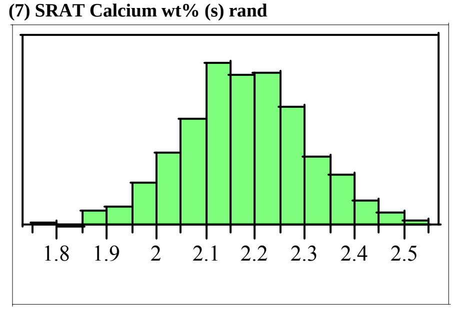
(7) SRAT Aluminum wt% (s) rand



Moments

Mean	5.1748174
Std Dev	0.1892908
Std Err Mean	0.0059859
upper 95% Mean	5.1865637
lower 95% Mean	5.163071
N	1000

(7) SRAT Calcium wt% (s) rand

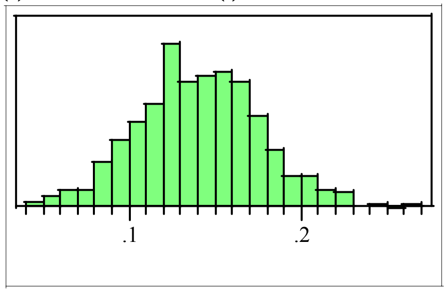


Moments

Mean	2.1782042
Std Dev	0.1255322
Std Err Mean	0.0039697
upper 95% Mean	2.185994
lower 95% Mean	2.1704143
N	1000

Exhibit A3. Histograms and Other Descriptive Statistics for Inputs to WL Targeting Assuming 1 Sample

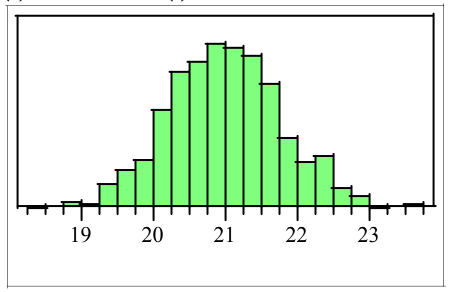
(7) SRAT Chromium wt% (s) rand



Moments

Mean	0.1404361
Std Dev	0.0356621
Std Err Mean	0.0011277
upper 95% Mean	0.1426491
lower 95% Mean	0.1382231
N	1000

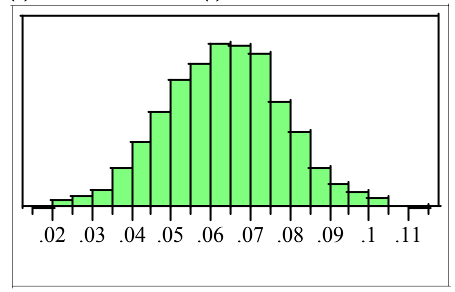
(7) SRAT Iron wt% (s) rand



Moments

Mean	20.992091
Std Dev	0.771214
Std Err Mean	0.0243879
upper 95% Mean	21.039948
lower 95% Mean	20.944233
N	1000

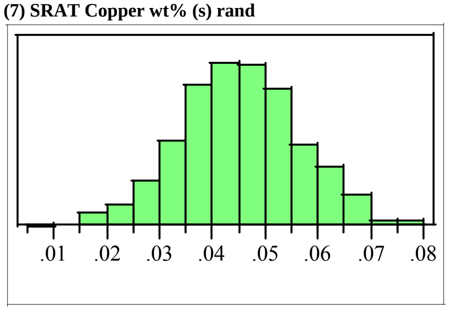
(7) SRAT Lithium wt% (s) rand



Moments

Mean	0.06335
Std Dev	0.0149035
Std Err Mean	0.0004713
upper 95% Mean	0.0642749
lower 95% Mean	0.0624252
N	1000

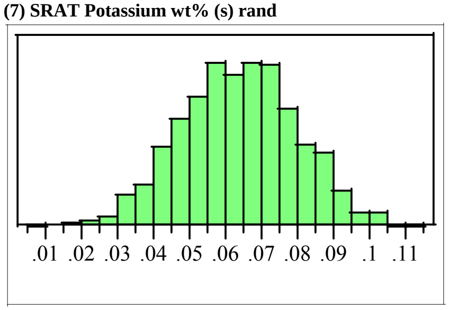
(7) SRAT Copper wt% (s) rand



Moments

Mean	0.0452202
Std Dev	0.0112898
Std Err Mean	0.000357
upper 95% Mean	0.0459207
lower 95% Mean	0.0445196
N	1000

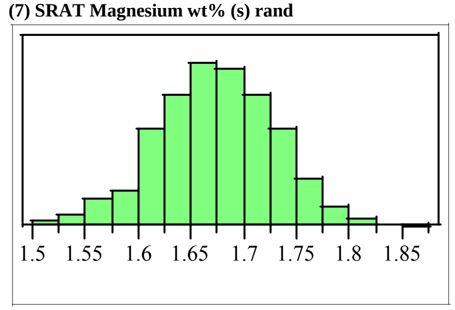
(7) SRAT Potassium wt% (s) rand



Moments

Mean	0.0638027
Std Dev	0.0157818
Std Err Mean	0.0004991
upper 95% Mean	0.064782
lower 95% Mean	0.0628233
N	1000

(7) SRAT Magnesium wt% (s) rand

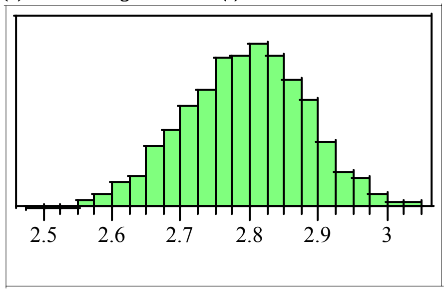


Moments

Mean	1.6737464
Std Dev	0.0547707
Std Err Mean	0.001732
upper 95% Mean	1.6771452
lower 95% Mean	1.6703476
N	1000

Exhibit A3. Histograms and Other Descriptive Statistics for Inputs to WL Targeting Assuming 1 Sample

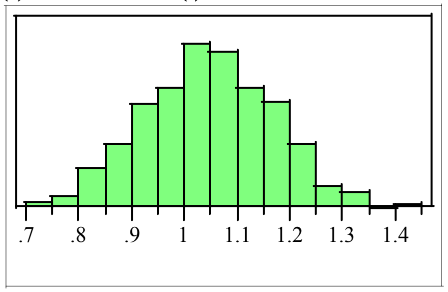
(7) SRAT Manganese wt% (s) rand



Moments

Mean	2.793822
Std Dev	0.088917
Std Err Mean	0.0028118
upper 95% Mean	2.7993397
lower 95% Mean	2.7883042
N	1000

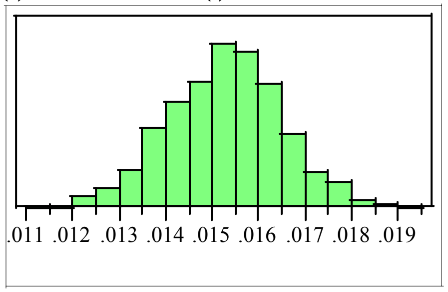
(7) SRAT Nickel wt% (s) rand



Moments

Mean	1.0473038
Std Dev	0.1223274
Std Err Mean	0.0038683
upper 95% Mean	1.0548948
lower 95% Mean	1.0397128
N	1000

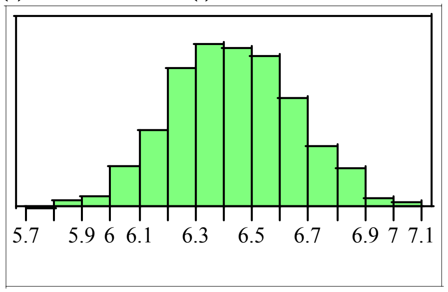
(7) SRAT Titanium wt% (s) rand



Moments

Mean	0.015275
Std Dev	0.0012272
Std Err Mean	0.0000388
upper 95% Mean	0.0153512
lower 95% Mean	0.0151988
N	1000

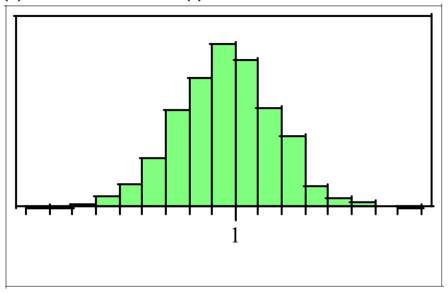
(7) SRAT Sodium wt% (s) rand



Moments

Mean	6.4341759
Std Dev	0.2244619
Std Err Mean	0.0070981
upper 95% Mean	6.4481049
lower 95% Mean	6.420247
N	1000

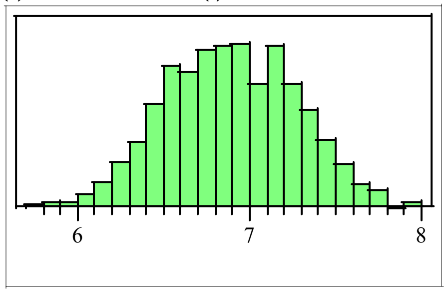
(7) SRAT Silicon wt% (s) rand



Moments

Mean	0.9594981
Std Dev	0.2111732
Std Err Mean	0.0066779
upper 95% Mean	0.9726024
lower 95% Mean	0.9463938
N	1000

(7) SRAT Uranium wt% (s) rand

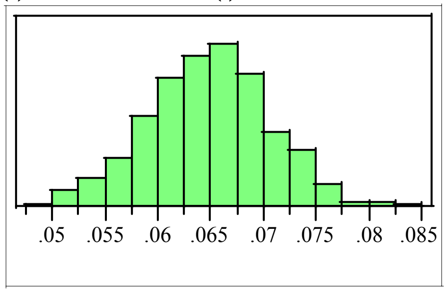


Moments

Mean	6.8926389
Std Dev	0.3819288
Std Err Mean	0.0120776
upper 95% Mean	6.9163394
lower 95% Mean	6.8689384
N	1000

Exhibit A3. Histograms and Other Descriptive Statistics for Inputs to WL Targeting Assuming 1 Sample

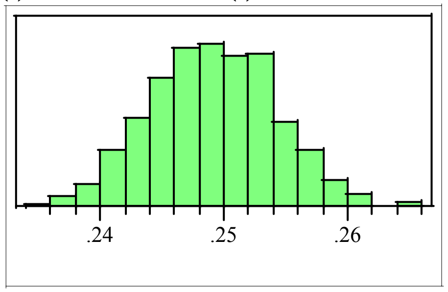
(7) SRAT Zirconium wt% (s) rand



Moments

Mean	0.0648119
Std Dev	0.0058987
Std Err Mean	0.0001865
upper 95% Mean	0.065178
lower 95% Mean	0.0644459
N	1000

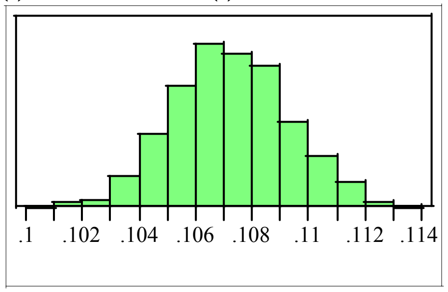
(9) Frit 320 Aluminum wt% (v) rand



Moments

Mean	0.2491261
Std Dev	0.0050682
Std Err Mean	0.0001603
upper 95% Mean	0.2494406
lower 95% Mean	0.2488116
N	1000

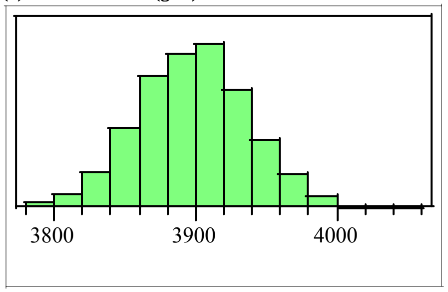
(9) Frit 320 Calcium wt% (v) rand



Moments

Mean	0.1072404
Std Dev	0.0020347
Std Err Mean	0.0000643
upper 95% Mean	0.1073667
lower 95% Mean	0.1071141
N	1000

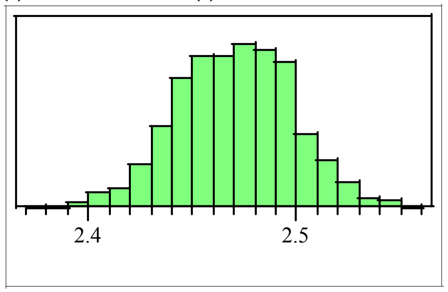
(8) SRAT Volume (gals) rand



Moments

Mean	3898.2007
Std Dev	38.986737
Std Err Mean	1.2328689
upper 95% Mean	3900.62
lower 95% Mean	3895.7813
N	1000

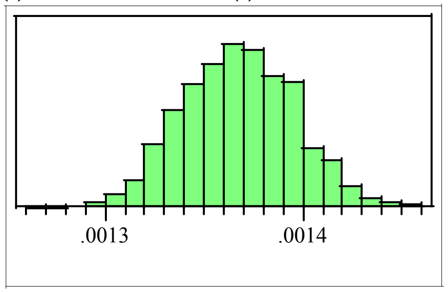
(9) Frit 320 Boron wt% (v) rand



Moments

Mean	2.4702883
Std Dev	0.0276483
Std Err Mean	0.0008743
upper 95% Mean	2.472004
lower 95% Mean	2.4685726
N	1000

(9) Frit 320 Chromium wt% (v) rand

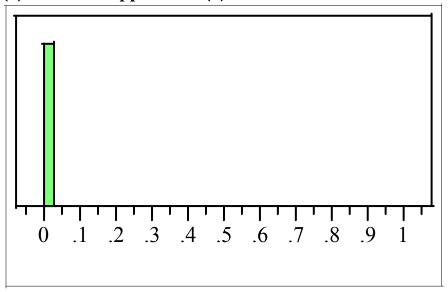


Moments

Mean	0.0013675
Std Dev	0.0000283
Std Err Mean	8.9531e-7
upper 95% Mean	0.0013693
lower 95% Mean	0.0013657
N	1000

Exhibit A3. Histograms and Other Descriptive Statistics for Inputs to WL Targeting Assuming 1 Sample

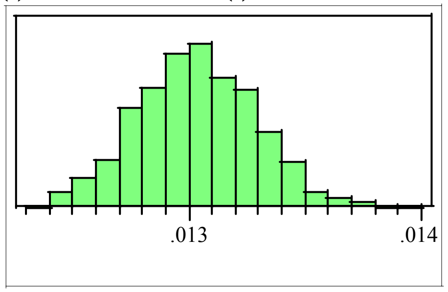
(9) Frit 320 Copper wt% (v) rand



Moments

Mean	0
Std Dev	0
Std Err Mean	0
upper 95% Mean	0
lower 95% Mean	0
N	1000

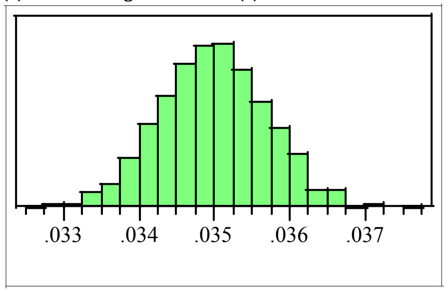
(9) Frit 320 Potassium wt% (v) rand



Moments

Mean	0.0130336
Std Dev	0.0002525
Std Err Mean	0.000008
upper 95% Mean	0.0130493
lower 95% Mean	0.0130179
N	1000

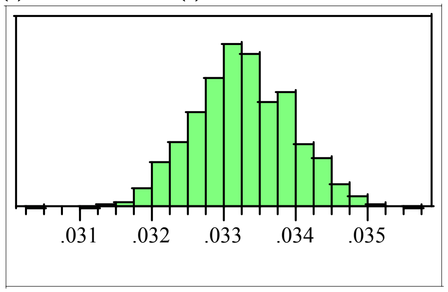
(9) Frit 320 Magnesium wt% (v) rand



Moments

Mean	0.0349885
Std Dev	0.0007124
Std Err Mean	0.0000225
upper 95% Mean	0.0350327
lower 95% Mean	0.0349443
N	1000

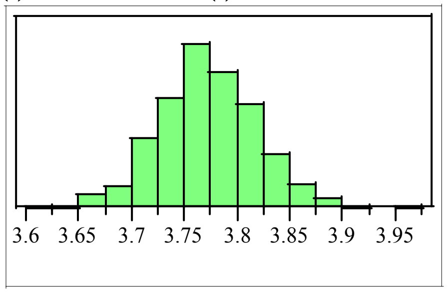
(9) Frit 320 Iron wt% (v) rand



Moments

Mean	0.0332671
Std Dev	0.0006818
Std Err Mean	0.0000216
upper 95% Mean	0.0333094
lower 95% Mean	0.0332248
N	1000

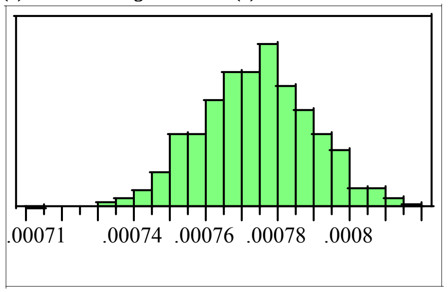
(9) Frit 320 Lithium wt% (v) rand



Moments

Mean	3.7729155
Std Dev	0.0460263
Std Err Mean	0.0014555
upper 95% Mean	3.7757716
lower 95% Mean	3.7700593
N	1000

(9) Frit 320 Manganese wt% (v) rand

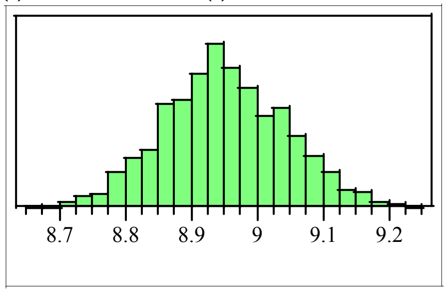


Moments

Mean	0.000774
Std Dev	0.0000155
Std Err Mean	4.9066e-7
upper 95% Mean	0.000775
lower 95% Mean	0.0007731
N	1000

Exhibit A3. Histograms and Other Descriptive Statistics for Inputs to WL Targeting Assuming 1 Sample

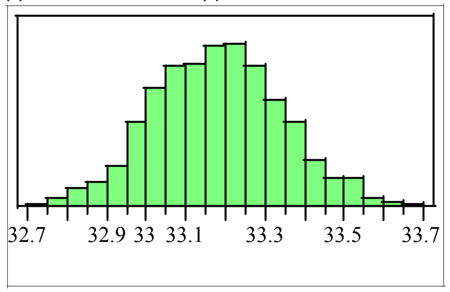
(9) Frit 320 Sodium wt% (v) rand



Moments

Mean	8.9511029
Std Dev	0.0930499
Std Err Mean	0.0029425
upper 95% Mean	8.9568771
lower 95% Mean	8.9453287
N	1000

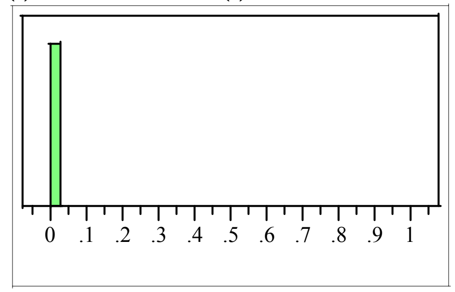
(9) Frit 320 Silicon wt% (v) rand



Moments

Mean	33.179802
Std Dev	0.1627451
Std Err Mean	0.0051465
upper 95% Mean	33.189901
lower 95% Mean	33.169703
N	1000

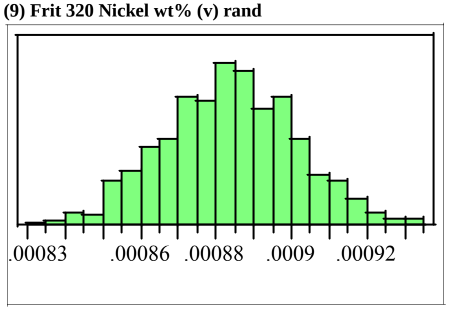
(9) Frit 320 Uranium wt% (v) rand



Moments

Mean	0
Std Dev	0
Std Err Mean	0
upper 95% Mean	0
lower 95% Mean	0
N	1000

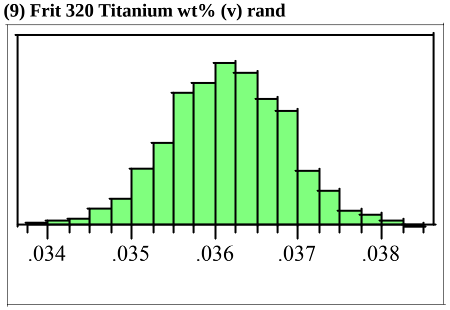
(9) Frit 320 Nickel wt% (v) rand



Moments

Mean	0.0008838
Std Dev	0.0000176
Std Err Mean	5.5725e-7
upper 95% Mean	0.0008849
lower 95% Mean	0.0008827
N	1000

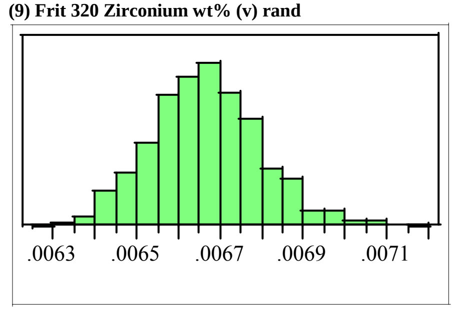
(9) Frit 320 Titanium wt% (v) rand



Moments

Mean	0.0361541
Std Dev	0.0007175
Std Err Mean	0.0000227
upper 95% Mean	0.0361986
lower 95% Mean	0.0361096
N	1000

(9) Frit 320 Zirconium wt% (v) rand

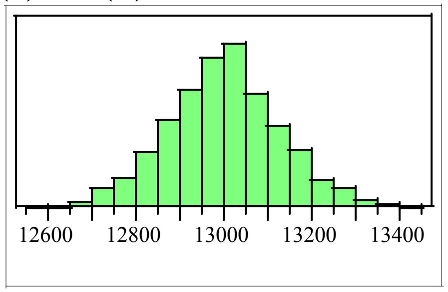


Moments

Mean	0.0066661
Std Dev	0.0001298
Std Err Mean	0.0000041
upper 95% Mean	0.0066742
lower 95% Mean	0.0066581
N	1000

Exhibit A3. Histograms and Other Descriptive Statistics for Inputs to WL Targeting Assuming 1 Sample

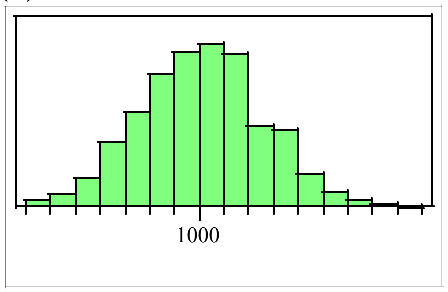
(10) Frit 320 (lbs) rand



Moments

Mean	13000.953
Std Dev	127.48042
Std Err Mean	4.0312847
upper 95% Mean	13008.864
lower 95% Mean	12993.043
N	1000

(11) Frit lbs from 5 Can Decon rand



Moments

Mean	1000.6385
Std Dev	24.744295
Std Err Mean	0.7824833
upper 95% Mean	1002.174
lower 95% Mean	999.10299
N	1000

Exhibit A4. Overview of WL Uncertainties with Analytical Uncertainties Assuming Nominal Number of Samples

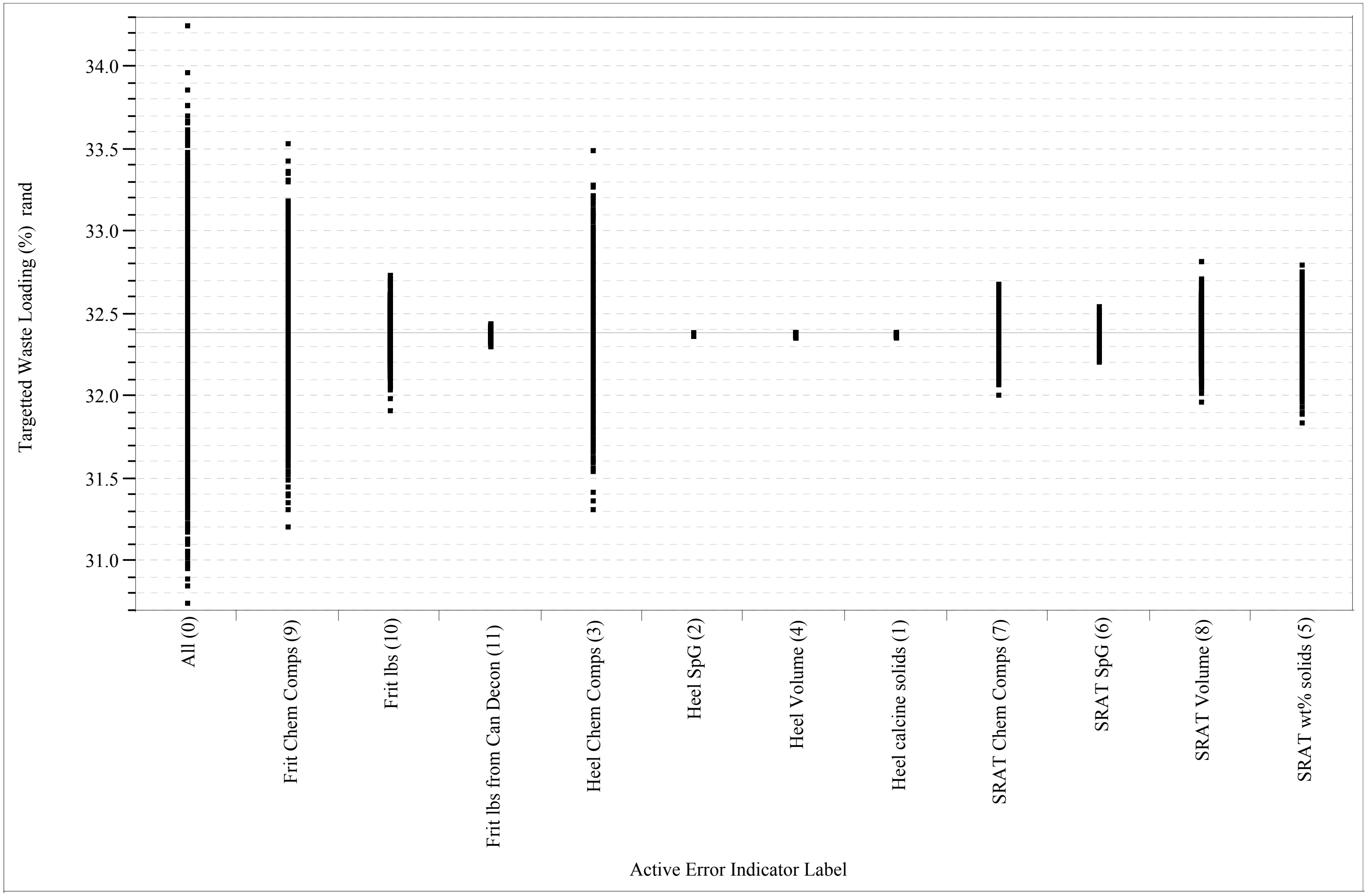
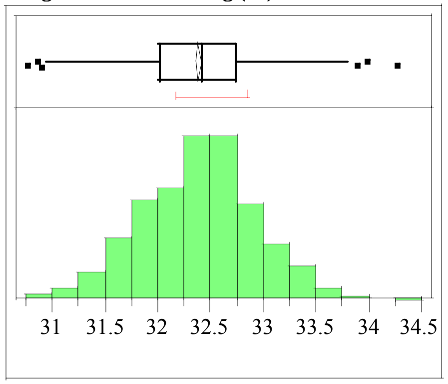


Exhibit A5. Histograms and Other Descriptive Statistics for WLs with Analytical Uncertainties Assuming Nominal Number of Samples

Active Error Indicator Label=All (0)
Distributions
Targeted Waste Loading (%) rand



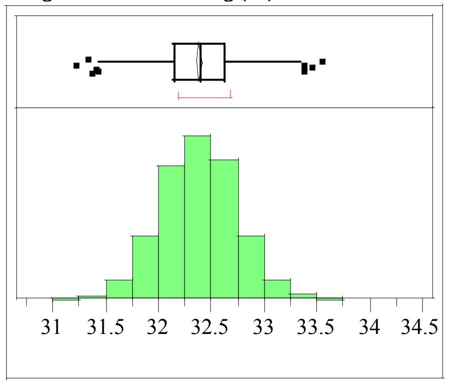
Quantiles

100.0%	maximum	34.261
99.5%		33.775
97.5%		33.426
90.0%		33.048
75.0%	quartile	32.734
50.0%	median	32.415
25.0%	quartile	32.019
10.0%		31.671
2.5%		31.333
0.5%		30.993
0.0%	minimum	30.756

Moments

Mean	32.387782
Std Dev	0.5364729
Std Err Mean	0.0169648
upper 95% Mean	32.421073
lower 95% Mean	32.354492
N	1000

Active Error Indicator Label=Frit Chem Comps (9)
Distributions
Targeted Waste Loading (%) rand



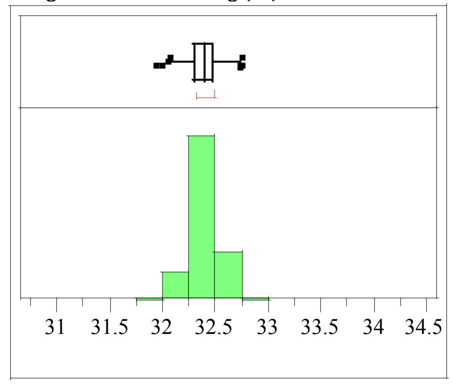
Quantiles

100.0%	maximum	33.547
99.5%		33.366
97.5%		33.092
90.0%		32.834
75.0%	quartile	32.632
50.0%	median	32.396
25.0%	quartile	32.149
10.0%		31.930
2.5%		31.685
0.5%		31.421
0.0%	minimum	31.220

Moments

Mean	32.386018
Std Dev	0.3550432
Std Err Mean	0.0112275
upper 95% Mean	32.40805
lower 95% Mean	32.363986
N	1000

Active Error Indicator Label=Frit lbs (10)
Distributions
Targeted Waste Loading (%) rand



Quantiles

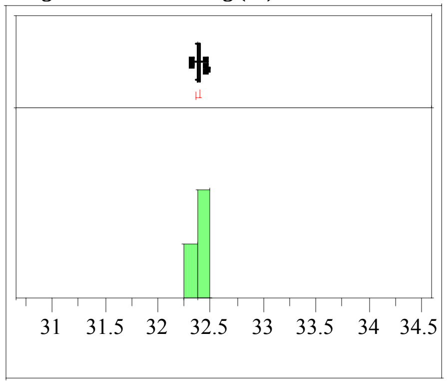
100.0%	maximum	32.752
99.5%		32.719
97.5%		32.635
90.0%		32.551
75.0%	quartile	32.476
50.0%	median	32.398
25.0%	quartile	32.312
10.0%		32.241
2.5%		32.153
0.5%		32.071
0.0%	minimum	31.931

Moments

Mean	32.396082
Std Dev	0.1224269
Std Err Mean	0.0038715
upper 95% Mean	32.403679
lower 95% Mean	32.388485
N	1000

Exhibit A5. Histograms and Other Descriptive Statistics for WLs with Analytical Uncertainties Assuming Nominal Number of Samples

Active Error Indicator Label=Frit lbs from Can Decon (11)
Distributions
Targeted Waste Loading (%) rand



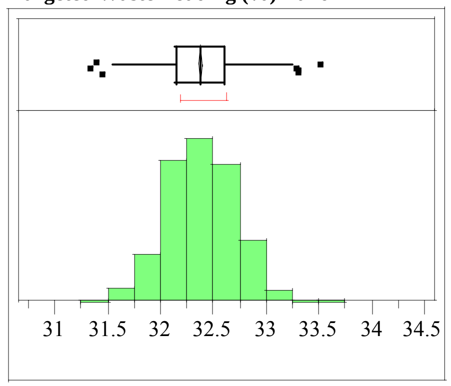
Quantiles

100.0%	maximum	32.457
99.5%		32.450
97.5%		32.434
90.0%		32.418
75.0%	quartile	32.402
50.0%	median	32.386
25.0%	quartile	32.370
10.0%		32.355
2.5%		32.341
0.5%		32.327
0.0%	minimum	32.314

Moments

Mean	32.385901
Std Dev	0.0239868
Std Err Mean	0.0007585
upper 95% Mean	32.38739
lower 95% Mean	32.384413
N	1000

Active Error Indicator Label=Heel Chem Comps (3)
Distributions
Targeted Waste Loading (%) rand



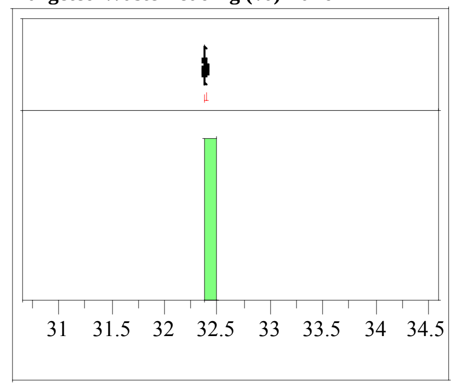
Quantiles

100.0%	maximum	33.509
99.5%		33.236
97.5%		32.984
90.0%		32.800
75.0%	quartile	32.601
50.0%	median	32.383
25.0%	quartile	32.158
10.0%		31.984
2.5%		31.746
0.5%		31.565
0.0%	minimum	31.331

Moments

Mean	32.382192
Std Dev	0.318699
Std Err Mean	0.0100781
upper 95% Mean	32.401969
lower 95% Mean	32.362416
N	1000

Active Error Indicator Label=Heel SpG (2)
Distributions
Targeted Waste Loading (%) rand



Quantiles

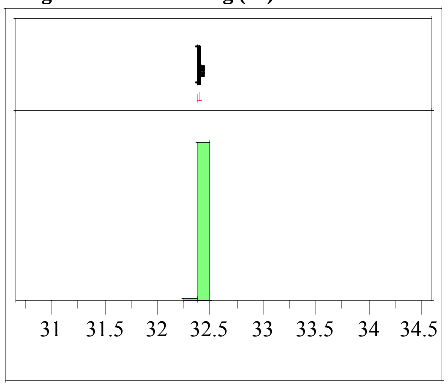
100.0%	maximum	32.396
99.5%		32.395
97.5%		32.392
90.0%		32.390
75.0%	quartile	32.388
50.0%	median	32.386
25.0%	quartile	32.384
10.0%		32.382
2.5%		32.380
0.5%		32.378
0.0%	minimum	32.376

Moments

Mean	32.386028
Std Dev	0.0030879
Std Err Mean	0.0000976
upper 95% Mean	32.38622
lower 95% Mean	32.385837
N	1000

Exhibit A5. Histograms and Other Descriptive Statistics for WLs with Analytical Uncertainties Assuming Nominal Number of Samples

Active Error Indicator Label=Heel Volume (4)
Distributions
Targeted Waste Loading (%) rand



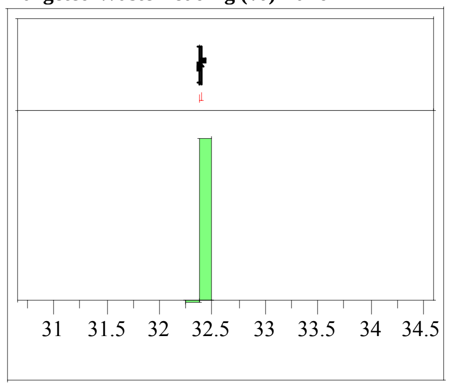
Quantiles

100.0%	maximum	32.404
99.5%		32.402
97.5%		32.396
90.0%		32.393
75.0%	quartile	32.390
50.0%	median	32.386
25.0%	quartile	32.382
10.0%		32.379
2.5%		32.375
0.5%		32.372
0.0%	minimum	32.371

Moments

Mean	32.386078
Std Dev	0.0056239
Std Err Mean	0.0001778
upper 95% Mean	32.386427
lower 95% Mean	32.385729
N	1000

Active Error Indicator Label=Heel calcine solids (1)
Distributions
Targeted Waste Loading (%) rand



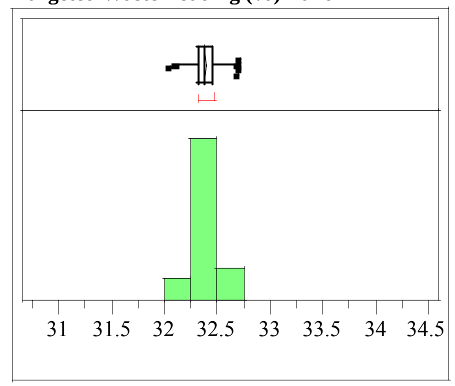
Quantiles

100.0%	maximum	32.400
99.5%		32.396
97.5%		32.395
90.0%		32.392
75.0%	quartile	32.389
50.0%	median	32.386
25.0%	quartile	32.383
10.0%		32.380
2.5%		32.378
0.5%		32.375
0.0%	minimum	32.371

Moments

Mean	32.386076
Std Dev	0.004302
Std Err Mean	0.000136
upper 95% Mean	32.386343
lower 95% Mean	32.385809
N	1000

Active Error Indicator Label=SRAT Chem Comps (7)
Distributions
Targeted Waste Loading (%) rand



Quantiles

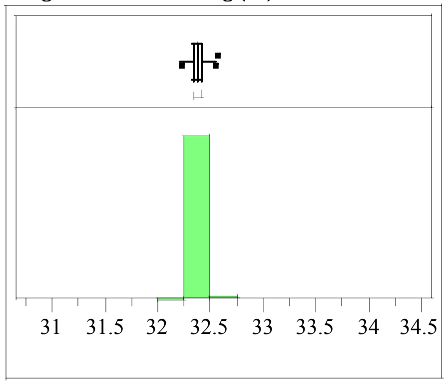
100.0%	maximum	32.697
99.5%		32.669
97.5%		32.597
90.0%		32.533
75.0%	quartile	32.456
50.0%	median	32.379
25.0%	quartile	32.316
10.0%		32.244
2.5%		32.172
0.5%		32.108
0.0%	minimum	32.022

Moments

Mean	32.383876
Std Dev	0.1083588
Std Err Mean	0.0034266
upper 95% Mean	32.390601
lower 95% Mean	32.377152
N	1000

Exhibit A5. Histograms and Other Descriptive Statistics for WLs with Analytical Uncertainties Assuming Nominal Number of Samples

Active Error Indicator Label=SRAT SpG (6)
Distributions
Targeted Waste Loading (%) rand



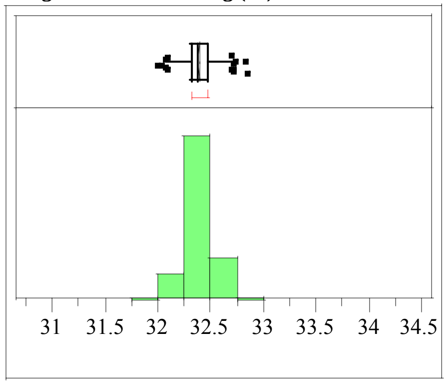
Quantiles

100.0%	maximum	32.562
99.5%		32.534
97.5%		32.487
90.0%		32.451
75.0%	quartile	32.423
50.0%	median	32.383
25.0%	quartile	32.347
10.0%		32.312
2.5%		32.280
0.5%		32.241
0.0%	minimum	32.225

Moments

Mean	32.38419
Std Dev	0.0544885
Std Err Mean	0.0017231
upper 95% Mean	32.387571
lower 95% Mean	32.380809
N	1000

Active Error Indicator Label=SRAT Volume (8)
Distributions
Targeted Waste Loading (%) rand



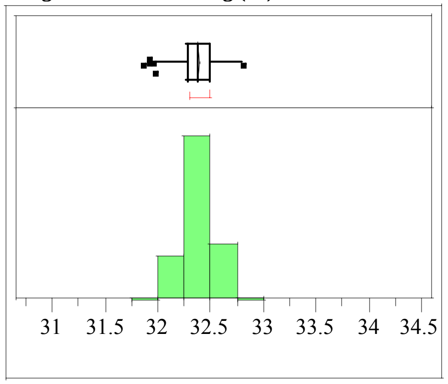
Quantiles

100.0%	maximum	32.836
99.5%		32.710
97.5%		32.629
90.0%		32.553
75.0%	quartile	32.466
50.0%	median	32.386
25.0%	quartile	32.315
10.0%		32.243
2.5%		32.159
0.5%		32.084
0.0%	minimum	31.983

Moments

Mean	32.392537
Std Dev	0.1199607
Std Err Mean	0.0037935
upper 95% Mean	32.399981
lower 95% Mean	32.385093
N	1000

Active Error Indicator Label=SRAT wt% solids (5)
Distributions
Targeted Waste Loading (%) rand



Quantiles

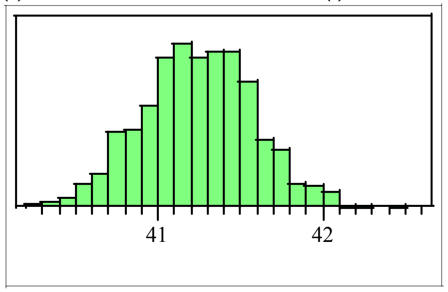
100.0%	maximum	32.809
99.5%		32.745
97.5%		32.682
90.0%		32.575
75.0%	quartile	32.486
50.0%	median	32.387
25.0%	quartile	32.291
10.0%		32.195
2.5%		32.098
0.5%		31.977
0.0%	minimum	31.857

Moments

Mean	32.3864
Std Dev	0.1460066
Std Err Mean	0.0046171
upper 95% Mean	32.39546
lower 95% Mean	32.377339
N	1000

Exhibit A6. Histograms and Other Descriptive Statistics for Inputs to WL Targeting Assuming Nominal Number of Samples

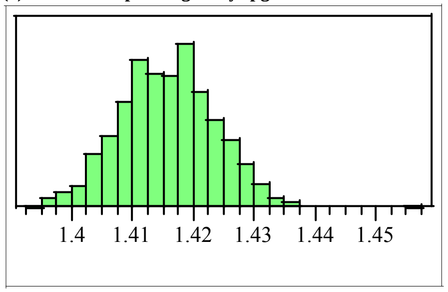
Error Indicator #=0
Distributions
(1) SME Heel Calcined wt% solids wt% (s) rand



Moments

Mean	41.241983
Std Dev	0.3356037
Std Err Mean	0.0106127
upper 95% Mean	41.262809
lower 95% Mean	41.221157
N	1000

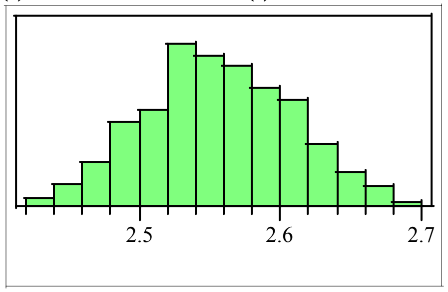
(2) SME Heel Specific gravity spgr rand



Moments

Mean	1.4157401
Std Dev	0.0077887
Std Err Mean	0.0002463
upper 95% Mean	1.4162234
lower 95% Mean	1.4152568
N	1000

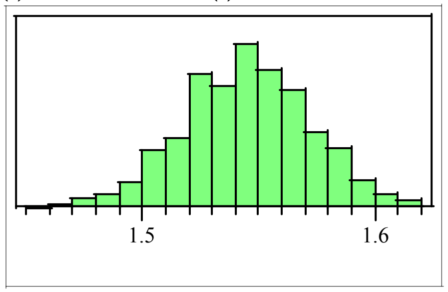
(3) SME Heel Aluminum wt% (v) rand



Moments

Mean	2.5561463
Std Dev	0.0520846
Std Err Mean	0.0016471
upper 95% Mean	2.5593784
lower 95% Mean	2.5529142
N	1000

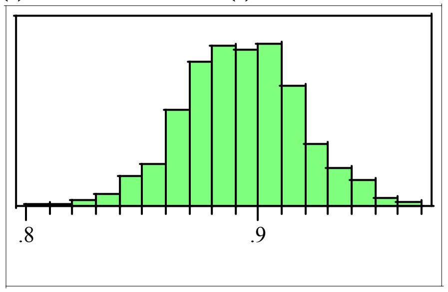
(3) SME Heel Boron wt% (v) rand



Moments

Mean	1.5447169
Std Dev	0.0269125
Std Err Mean	0.000851
upper 95% Mean	1.5463869
lower 95% Mean	1.5430468
N	1000

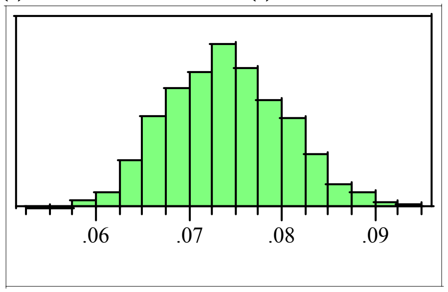
(3) SME Heel Calcium wt% (v) rand



Moments

Mean	0.8927972
Std Dev	0.0255459
Std Err Mean	0.0008078
upper 95% Mean	0.8943825
lower 95% Mean	0.891212
N	1000

(3) SME Heel Chromium wt% (v) rand

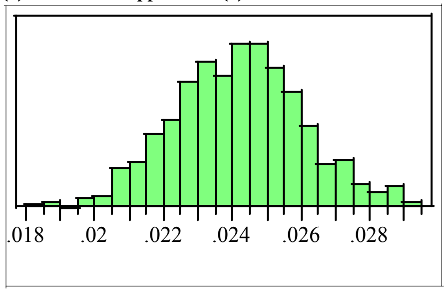


Moments

Mean	0.074057
Std Dev	0.0063134
Std Err Mean	0.0001996
upper 95% Mean	0.0744487
lower 95% Mean	0.0736652
N	1000

Exhibit A6. Histograms and Other Descriptive Statistics for Inputs to WL Targeting Assuming Nominal Number of Samples

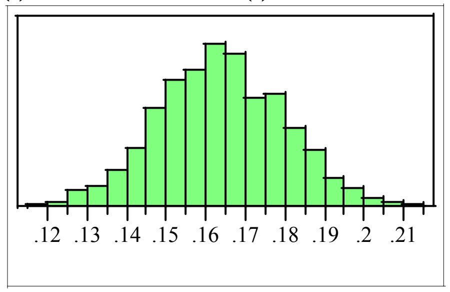
(3) SME Heel Copper wt% (v) rand



Moments

Mean	0.0241915
Std Dev	0.0018775
Std Err Mean	0.0000594
upper 95% Mean	0.024308
lower 95% Mean	0.024075
N	1000

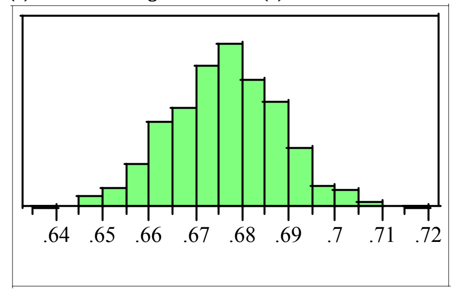
(3) SME Heel Potassium wt% (v) rand



Moments

Mean	0.1639478
Std Dev	0.0162079
Std Err Mean	0.0005125
upper 95% Mean	0.1649536
lower 95% Mean	0.1629421
N	1000

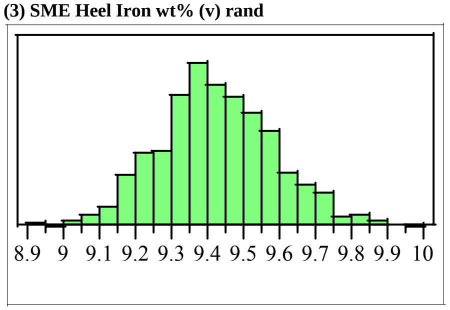
(3) SME Heel Magnesium wt% (v) rand



Moments

Mean	0.6761564
Std Dev	0.0116049
Std Err Mean	0.000367
upper 95% Mean	0.6768766
lower 95% Mean	0.6754363
N	1000

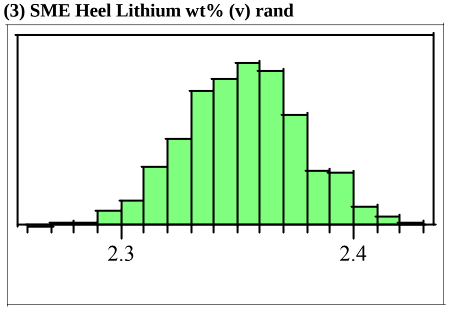
(3) SME Heel Iron wt% (v) rand



Moments

Mean	9.424205
Std Dev	0.1602945
Std Err Mean	0.005069
upper 95% Mean	9.434152
lower 95% Mean	9.4142579
N	1000

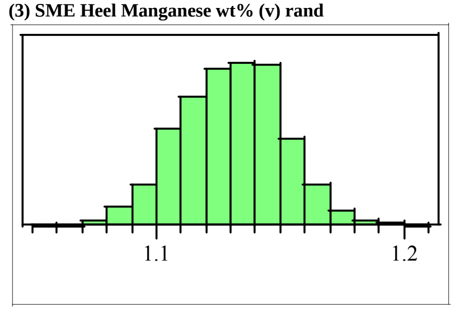
(3) SME Heel Lithium wt% (v) rand



Moments

Mean	2.3527707
Std Dev	0.0252242
Std Err Mean	0.0007977
upper 95% Mean	2.354336
lower 95% Mean	2.3512054
N	1000

(3) SME Heel Manganese wt% (v) rand

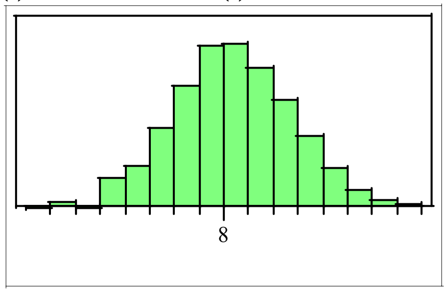


Moments

Mean	1.1299694
Std Dev	0.0210358
Std Err Mean	0.0006652
upper 95% Mean	1.1312748
lower 95% Mean	1.128664
N	1000

Exhibit A6. Histograms and Other Descriptive Statistics for Inputs to WL Targeting Assuming Nominal Number of Samples

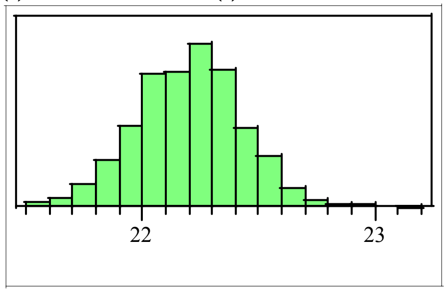
(3) SME Heel Sodium wt% (v) rand



Moments

Mean	8.0362043
Std Dev	0.2415546
Std Err Mean	0.0076386
upper 95% Mean	8.0511939
lower 95% Mean	8.0212147
N	1000

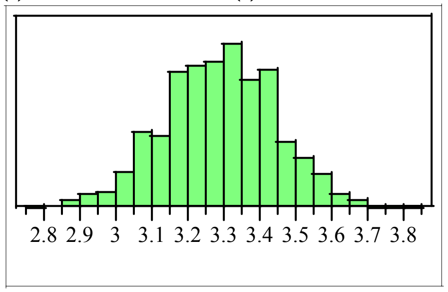
(3) SME Heel Silicon wt% (v) rand



Moments

Mean	22.201873
Std Dev	0.2282597
Std Err Mean	0.0072182
upper 95% Mean	22.216037
lower 95% Mean	22.187708
N	1000

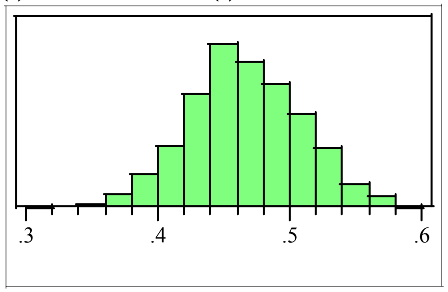
(3) SME Heel Uranium wt% (v) rand



Moments

Mean	3.2888142
Std Dev	0.1544408
Std Err Mean	0.0048838
upper 95% Mean	3.298398
lower 95% Mean	3.2792304
N	1000

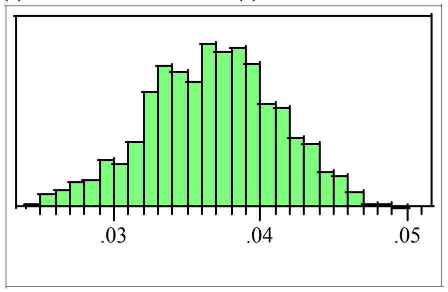
(3) SME Heel Nickel wt% (v) rand



Moments

Mean	0.4666291
Std Dev	0.0423369
Std Err Mean	0.0013388
upper 95% Mean	0.4692563
lower 95% Mean	0.4640019
N	1000

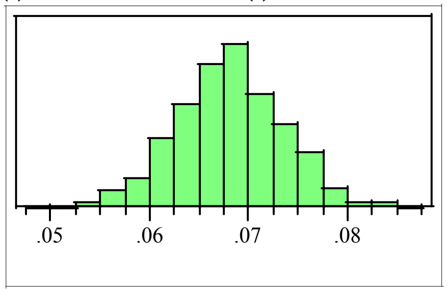
(3) SME Heel Titanium wt% (v) rand



Moments

Mean	0.0367647
Std Dev	0.0044552
Std Err Mean	0.0001409
upper 95% Mean	0.0370412
lower 95% Mean	0.0364882
N	1000

(3) SME Heel Zirconium wt% (v) rand

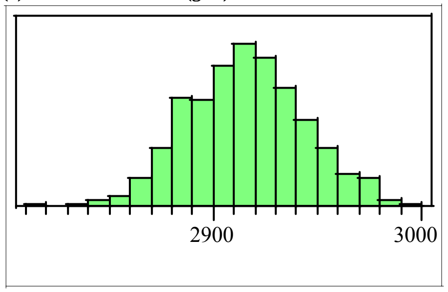


Moments

Mean	0.0680283
Std Dev	0.0054019
Std Err Mean	0.0001708
upper 95% Mean	0.0683635
lower 95% Mean	0.0676931
N	1000

Exhibit A6. Histograms and Other Descriptive Statistics for Inputs to WL Targeting Assuming Nominal Number of Samples

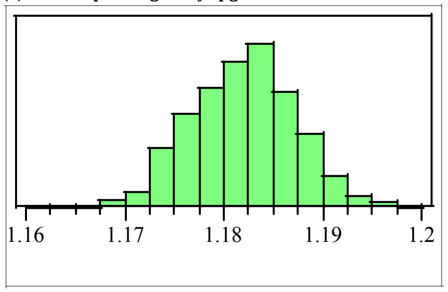
(4) SME Heel Volume (gals) rand



Moments

Mean	2915.5008
Std Dev	28.622453
Std Err Mean	0.9051214
upper 95% Mean	2917.277
lower 95% Mean	2913.7246
N	1000

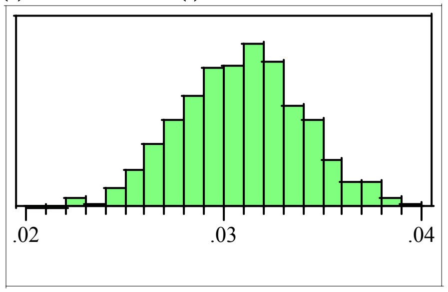
(6) SRAT Specific gravity spgr rand



Moments

Mean	1.1819565
Std Dev	0.0053166
Std Err Mean	0.0001681
upper 95% Mean	1.1822864
lower 95% Mean	1.1816266
N	1000

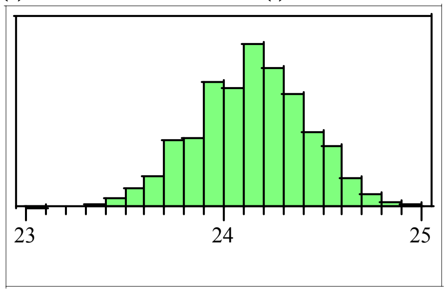
(7) SRAT Boron wt% (s) rand



Moments

Mean	0.0308722
Std Dev	0.0031258
Std Err Mean	0.0000988
upper 95% Mean	0.0310661
lower 95% Mean	0.0306782
N	1000

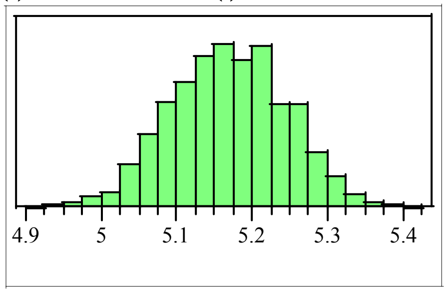
(5) SRAT Total wt% solids wt% (s) rand



Moments

Mean	24.139466
Std Dev	0.2800148
Std Err Mean	0.0088548
upper 95% Mean	24.156842
lower 95% Mean	24.122089
N	1000

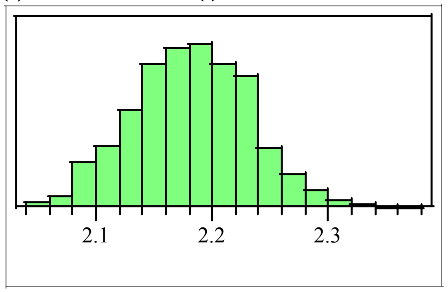
(7) SRAT Aluminum wt% (s) rand



Moments

Mean	5.1687717
Std Dev	0.0770177
Std Err Mean	0.0024355
upper 95% Mean	5.173551
lower 95% Mean	5.1639924
N	1000

(7) SRAT Calcium wt% (s) rand

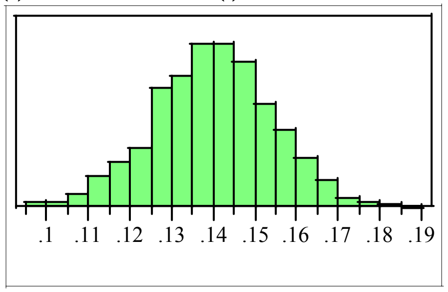


Moments

Mean	2.1818946
Std Dev	0.0500017
Std Err Mean	0.0015812
upper 95% Mean	2.1849975
lower 95% Mean	2.1787918
N	1000

Exhibit A6. Histograms and Other Descriptive Statistics for Inputs to WL Targeting Assuming Nominal Number of Samples

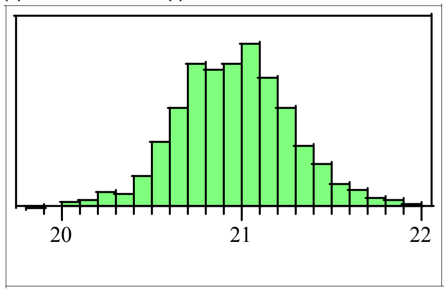
(7) SRAT Chromium wt% (s) rand



Moments

Mean	0.1399624
Std Dev	0.0144149
Std Err Mean	0.0004558
upper 95% Mean	0.1408569
lower 95% Mean	0.1390679
N	1000

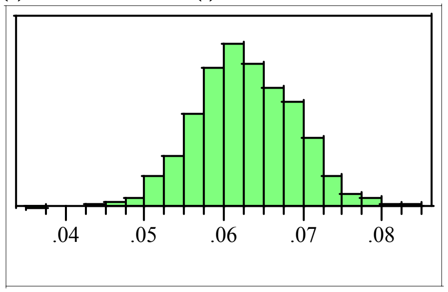
(7) SRAT Iron wt% (s) rand



Moments

Mean	20.960961
Std Dev	0.3166484
Std Err Mean	0.0100133
upper 95% Mean	20.980611
lower 95% Mean	20.941312
N	1000

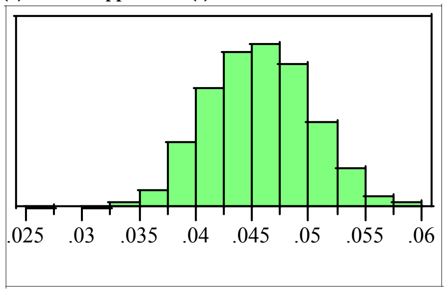
(7) SRAT Lithium wt% (s) rand



Moments

Mean	0.0628596
Std Dev	0.0064147
Std Err Mean	0.0002028
upper 95% Mean	0.0632577
lower 95% Mean	0.0624615
N	1000

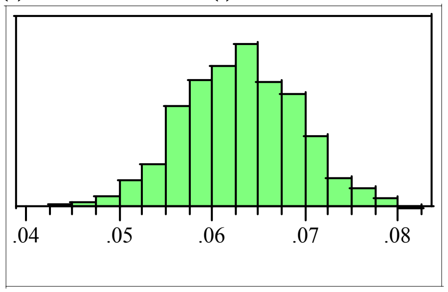
(7) SRAT Copper wt% (s) rand



Moments

Mean	0.0456142
Std Dev	0.004589
Std Err Mean	0.0001451
upper 95% Mean	0.045899
lower 95% Mean	0.0453294
N	1000

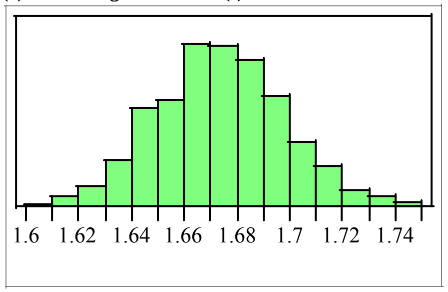
(7) SRAT Potassium wt% (s) rand



Moments

Mean	0.0629513
Std Dev	0.0062546
Std Err Mean	0.0001978
upper 95% Mean	0.0633395
lower 95% Mean	0.0625632
N	1000

(7) SRAT Magnesium wt% (s) rand

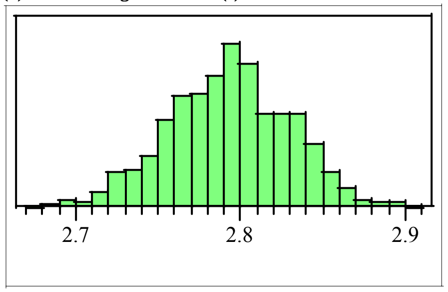


Moments

Mean	1.6735341
Std Dev	0.024372
Std Err Mean	0.0007707
upper 95% Mean	1.6750465
lower 95% Mean	1.6720217
N	1000

Exhibit A6. Histograms and Other Descriptive Statistics for Inputs to WL Targeting Assuming Nominal Number of Samples

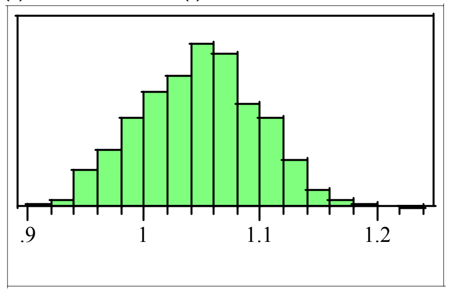
(7) SRAT Manganese wt% (s) rand



Moments

Mean	2.7928983
Std Dev	0.037048
Std Err Mean	0.0011716
upper 95% Mean	2.7951973
lower 95% Mean	2.7905993
N	1000

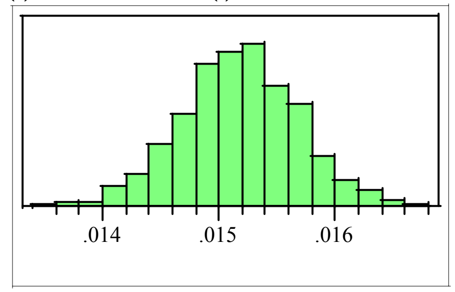
(7) SRAT Nickel wt% (s) rand



Moments

Mean	1.0470837
Std Dev	0.0504287
Std Err Mean	0.0015947
upper 95% Mean	1.050213
lower 95% Mean	1.0439543
N	1000

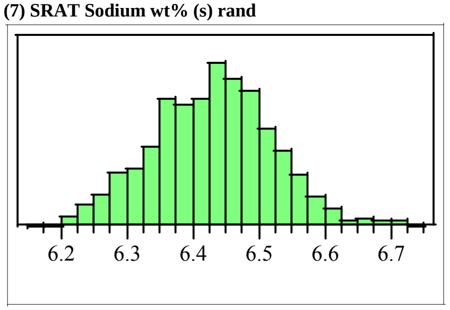
(7) SRAT Titanium wt% (s) rand



Moments

Mean	0.0151768
Std Dev	0.0005074
Std Err Mean	0.000016
upper 95% Mean	0.0152083
lower 95% Mean	0.0151453
N	1000

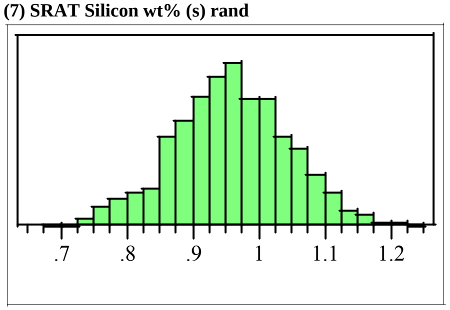
(7) SRAT Sodium wt% (s) rand



Moments

Mean	6.4305032
Std Dev	0.0907308
Std Err Mean	0.0028692
upper 95% Mean	6.4361335
lower 95% Mean	6.424873
N	1000

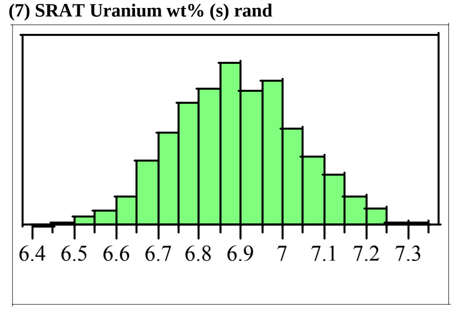
(7) SRAT Silicon wt% (s) rand



Moments

Mean	0.9589183
Std Dev	0.0869347
Std Err Mean	0.0027491
upper 95% Mean	0.964313
lower 95% Mean	0.9535236
N	1000

(7) SRAT Uranium wt% (s) rand

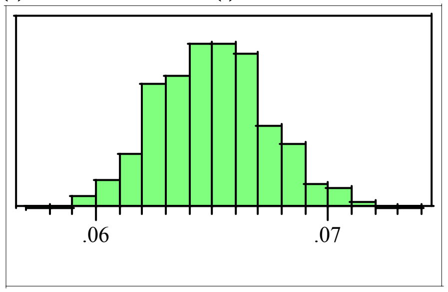


Moments

Mean	6.8888818
Std Dev	0.1491283
Std Err Mean	0.0047159
upper 95% Mean	6.8981359
lower 95% Mean	6.8796277
N	1000

Exhibit A6. Histograms and Other Descriptive Statistics for Inputs to WL Targeting Assuming Nominal Number of Samples

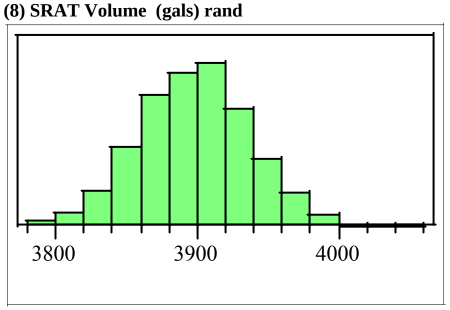
(7) SRAT Zirconium wt% (s) rand



Moments

Mean	0.0650175
Std Dev	0.002368
Std Err Mean	0.0000749
upper 95% Mean	0.0651645
lower 95% Mean	0.0648706
N	1000

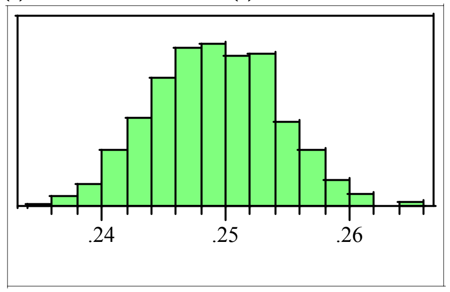
(8) SRAT Volume (gals) rand



Moments

Mean	3898.2007
Std Dev	38.986737
Std Err Mean	1.2328689
upper 95% Mean	3900.62
lower 95% Mean	3895.7813
N	1000

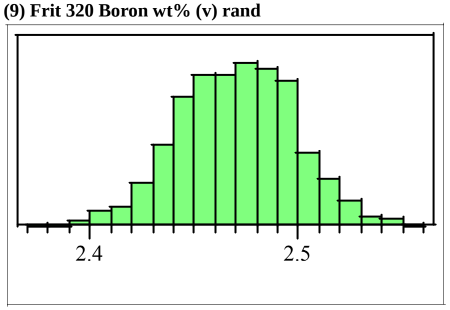
(9) Frit 320 Aluminum wt% (v) rand



Moments

Mean	0.2491261
Std Dev	0.0050682
Std Err Mean	0.0001603
upper 95% Mean	0.2494406
lower 95% Mean	0.2488116
N	1000

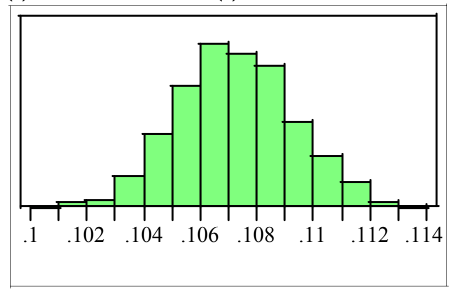
(9) Frit 320 Boron wt% (v) rand



Moments

Mean	2.4702883
Std Dev	0.0276483
Std Err Mean	0.0008743
upper 95% Mean	2.472004
lower 95% Mean	2.4685726
N	1000

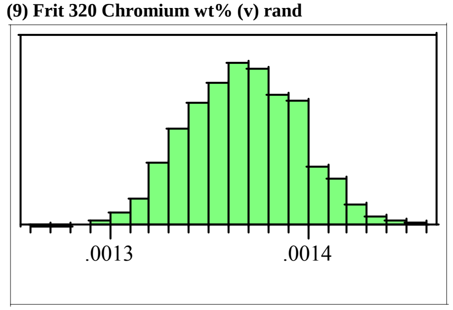
(9) Frit 320 Calcium wt% (v) rand



Moments

Mean	0.1072404
Std Dev	0.0020347
Std Err Mean	0.0000643
upper 95% Mean	0.1073667
lower 95% Mean	0.1071141
N	1000

(9) Frit 320 Chromium wt% (v) rand

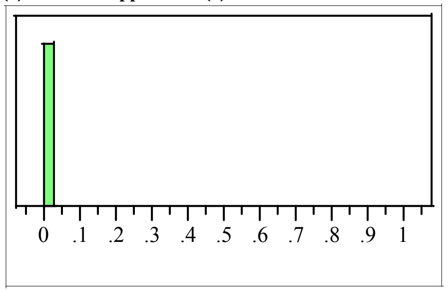


Moments

Mean	0.0013675
Std Dev	0.0000283
Std Err Mean	8.9531e-7
upper 95% Mean	0.0013693
lower 95% Mean	0.0013657
N	1000

Exhibit A6. Histograms and Other Descriptive Statistics for Inputs to WL Targeting Assuming Nominal Number of Samples

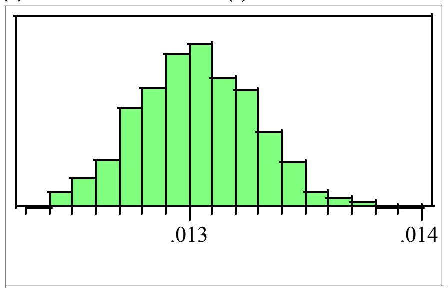
(9) Frit 320 Copper wt% (v) rand



Moments

Mean	0
Std Dev	0
Std Err Mean	0
upper 95% Mean	0
lower 95% Mean	0
N	1000

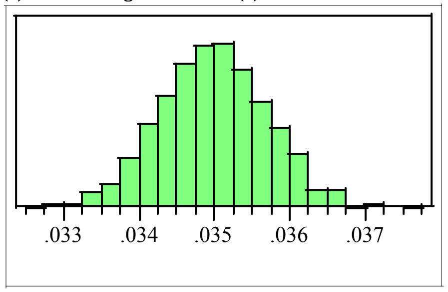
(9) Frit 320 Potassium wt% (v) rand



Moments

Mean	0.0130336
Std Dev	0.0002525
Std Err Mean	0.000008
upper 95% Mean	0.0130493
lower 95% Mean	0.0130179
N	1000

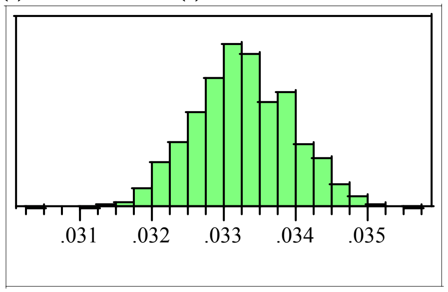
(9) Frit 320 Magnesium wt% (v) rand



Moments

Mean	0.0349885
Std Dev	0.0007124
Std Err Mean	0.0000225
upper 95% Mean	0.0350327
lower 95% Mean	0.0349443
N	1000

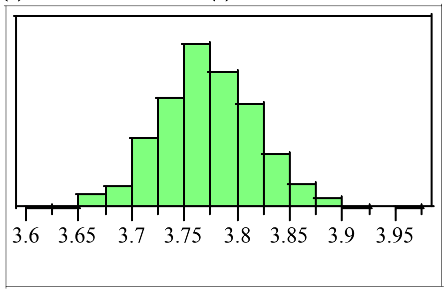
(9) Frit 320 Iron wt% (v) rand



Moments

Mean	0.0332671
Std Dev	0.0006818
Std Err Mean	0.0000216
upper 95% Mean	0.0333094
lower 95% Mean	0.0332248
N	1000

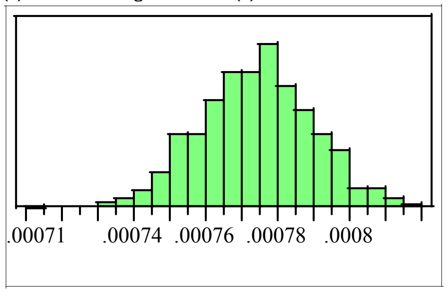
(9) Frit 320 Lithium wt% (v) rand



Moments

Mean	3.7729155
Std Dev	0.0460263
Std Err Mean	0.0014555
upper 95% Mean	3.7757716
lower 95% Mean	3.7700593
N	1000

(9) Frit 320 Manganese wt% (v) rand

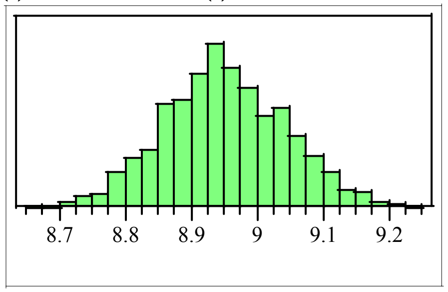


Moments

Mean	0.000774
Std Dev	0.0000155
Std Err Mean	4.9066e-7
upper 95% Mean	0.000775
lower 95% Mean	0.0007731
N	1000

Exhibit A6. Histograms and Other Descriptive Statistics for Inputs to WL Targeting Assuming Nominal Number of Samples

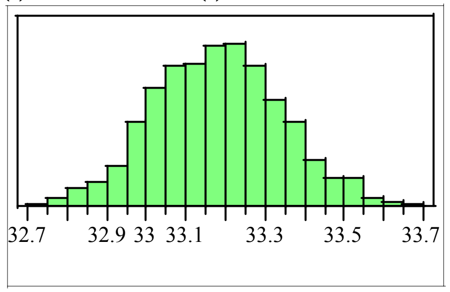
(9) Frit 320 Sodium wt% (v) rand



Moments

Mean	8.9511029
Std Dev	0.0930499
Std Err Mean	0.0029425
upper 95% Mean	8.9568771
lower 95% Mean	8.9453287
N	1000

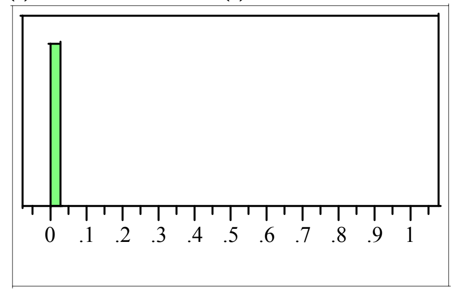
(9) Frit 320 Silicon wt% (v) rand



Moments

Mean	33.179802
Std Dev	0.1627451
Std Err Mean	0.0051465
upper 95% Mean	33.189901
lower 95% Mean	33.169703
N	1000

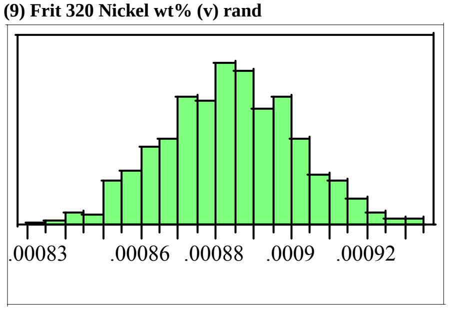
(9) Frit 320 Uranium wt% (v) rand



Moments

Mean	0
Std Dev	0
Std Err Mean	0
upper 95% Mean	0
lower 95% Mean	0
N	1000

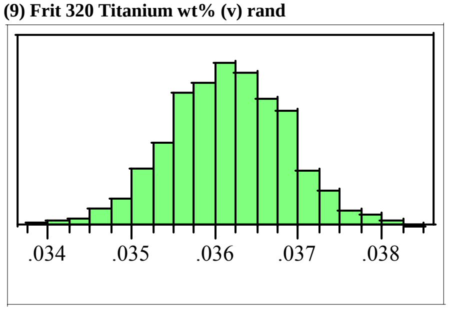
(9) Frit 320 Nickel wt% (v) rand



Moments

Mean	0.0008838
Std Dev	0.0000176
Std Err Mean	5.5725e-7
upper 95% Mean	0.0008849
lower 95% Mean	0.0008827
N	1000

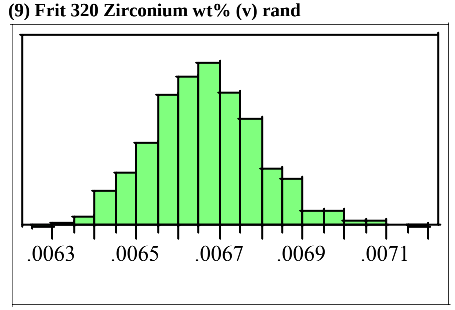
(9) Frit 320 Titanium wt% (v) rand



Moments

Mean	0.0361541
Std Dev	0.0007175
Std Err Mean	0.0000227
upper 95% Mean	0.0361986
lower 95% Mean	0.0361096
N	1000

(9) Frit 320 Zirconium wt% (v) rand

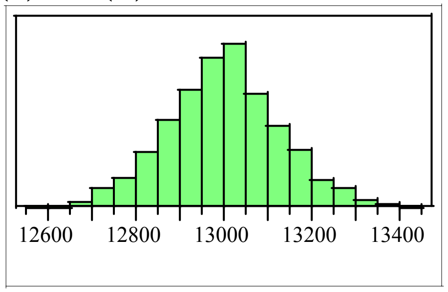


Moments

Mean	0.0066661
Std Dev	0.0001298
Std Err Mean	0.0000041
upper 95% Mean	0.0066742
lower 95% Mean	0.0066581
N	1000

Exhibit A6. Histograms and Other Descriptive Statistics for Inputs to WL Targeting Assuming Nominal Number of Samples

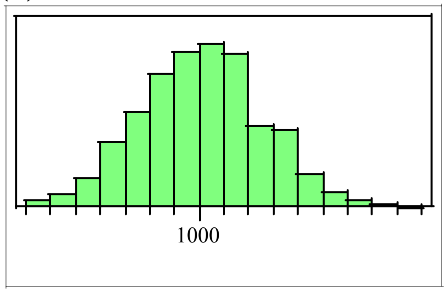
(10) Frit 320 (lbs) rand



Moments

Mean	13000.953
Std Dev	127.48042
Std Err Mean	4.0312847
upper 95% Mean	13008.864
lower 95% Mean	12993.043
N	1000

(11) Frit lbs from 5 Can Decon rand



Moments

Mean	1000.6385
Std Dev	24.744295
Std Err Mean	0.7824833
upper 95% Mean	1002.174
lower 95% Mean	999.10299
N	1000

Exhibit A7. Overview of Uncertainties of Estimated WLs

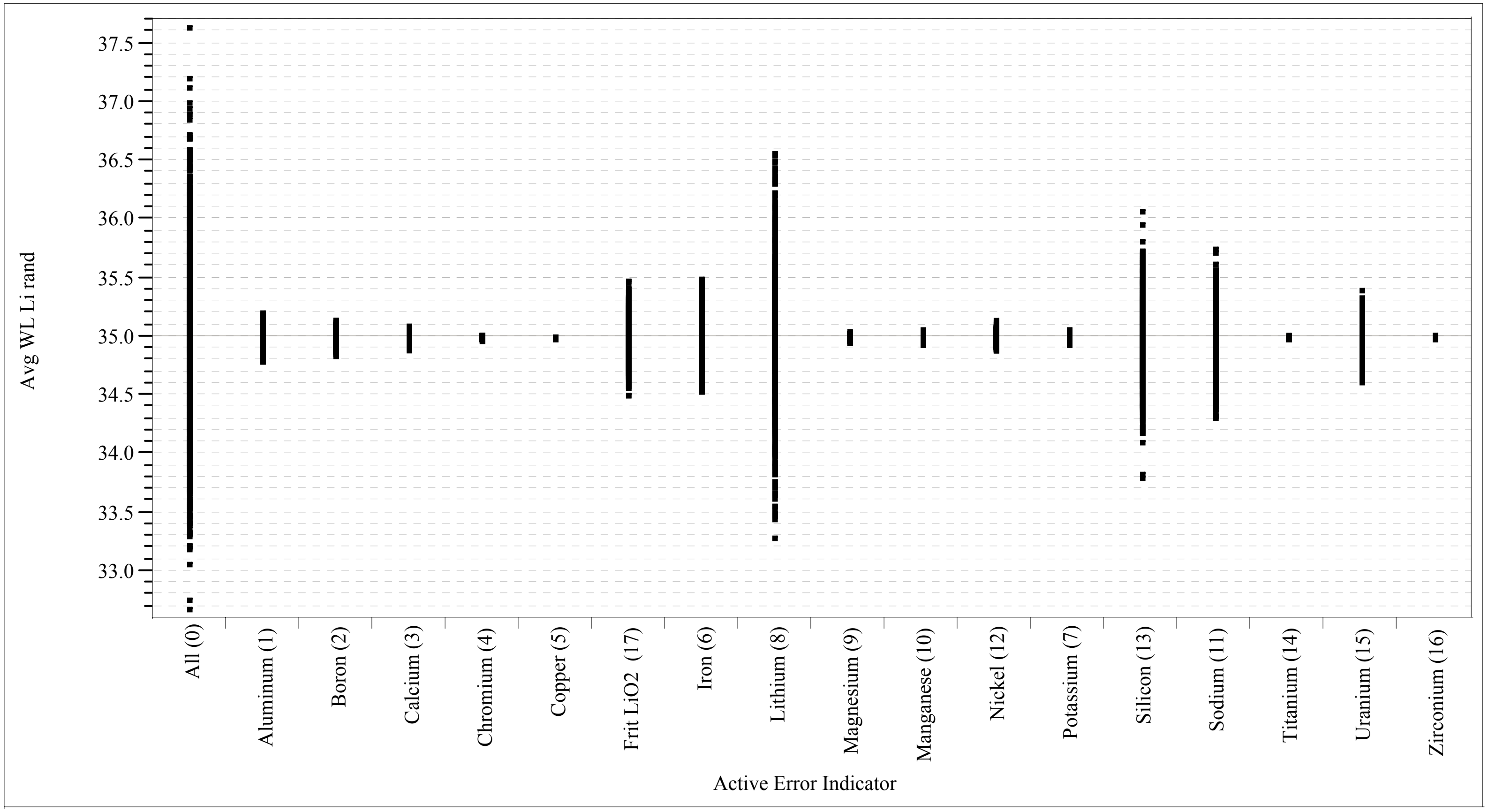
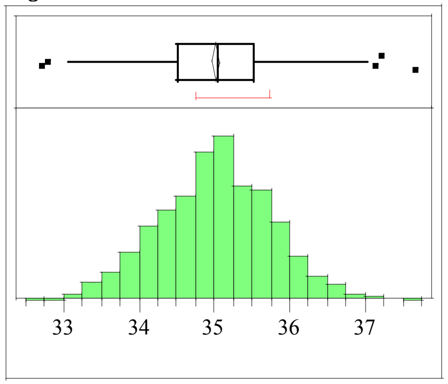


Exhibit A8. Uncertainties of Estimated WLs by Error Number

Active Error Indicator=All (0)
Distributions
Avg WL Li rand



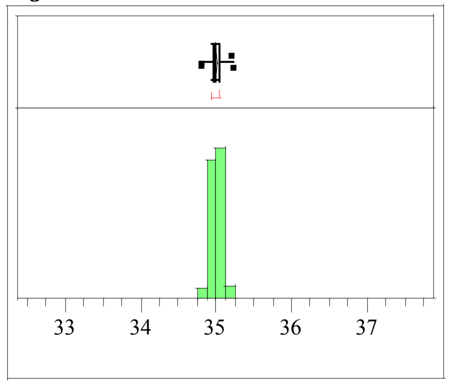
Quantiles

100.0%	maximum	37.651
99.5%		36.957
97.5%		36.457
90.0%		35.960
75.0%	quartile	35.529
50.0%	median	35.043
25.0%	quartile	34.516
10.0%		34.045
2.5%		33.548
0.5%		33.222
0.0%	minimum	32.689

Moments

Mean	35.020999
Std Dev	0.7405267
Std Err Mean	0.0234175
upper 95% Mean	35.066952
lower 95% Mean	34.975046
N	1000

Active Error Indicator=Aluminum (1)
Distributions
Avg WL Li rand



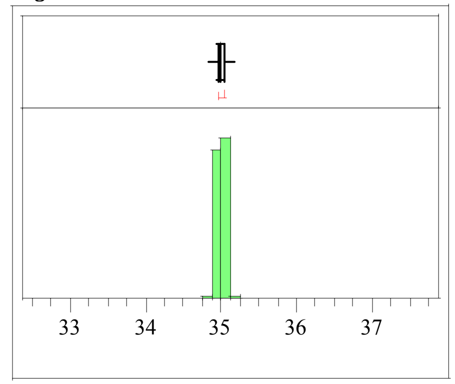
Quantiles

100.0%	maximum	35.214
99.5%		35.197
97.5%		35.138
90.0%		35.093
75.0%	quartile	35.053
50.0%	median	35.004
25.0%	quartile	34.956
10.0%		34.913
2.5%		34.866
0.5%		34.825
0.0%	minimum	34.799

Moments

Mean	35.004075
Std Dev	0.0701703
Std Err Mean	0.002219
upper 95% Mean	35.008429
lower 95% Mean	34.99972
N	1000

Active Error Indicator=Boron (2)
Distributions
Avg WL Li rand



Quantiles

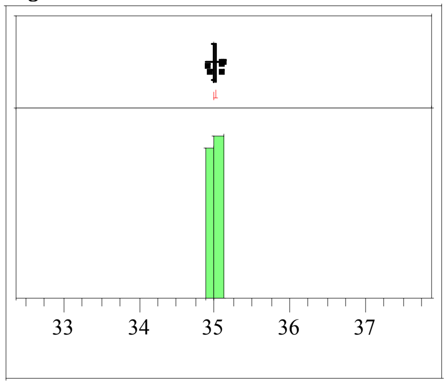
100.0%	maximum	35.152
99.5%		35.140
97.5%		35.107
90.0%		35.073
75.0%	quartile	35.042
50.0%	median	35.003
25.0%	quartile	34.964
10.0%		34.930
2.5%		34.894
0.5%		34.859
0.0%	minimum	34.849

Moments

Mean	35.002269
Std Dev	0.054675
Std Err Mean	0.001729
upper 95% Mean	35.005662
lower 95% Mean	34.998876
N	1000

Exhibit A8. Uncertainties of Estimated WLs by Error Number

Active Error Indicator=Calcium (3)
Distributions
Avg WL Li rand



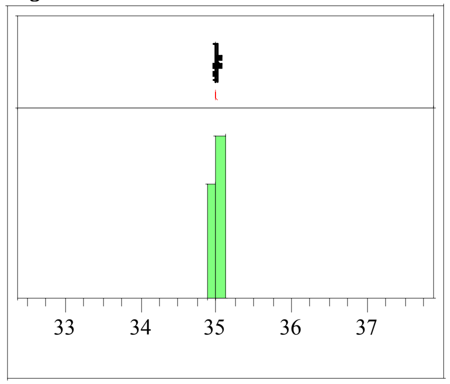
Quantiles

100.0%	maximum	35.099
99.5%		35.076
97.5%		35.057
90.0%		35.038
75.0%	quartile	35.021
50.0%	median	35.002
25.0%	quartile	34.982
10.0%		34.964
2.5%		34.945
0.5%		34.930
0.0%	minimum	34.893

Moments

Mean	35.001302
Std Dev	0.0288808
Std Err Mean	0.0009133
upper 95% Mean	35.003094
lower 95% Mean	34.99951
N	1000

Active Error Indicator=Chromium (4)
Distributions
Avg WL Li rand



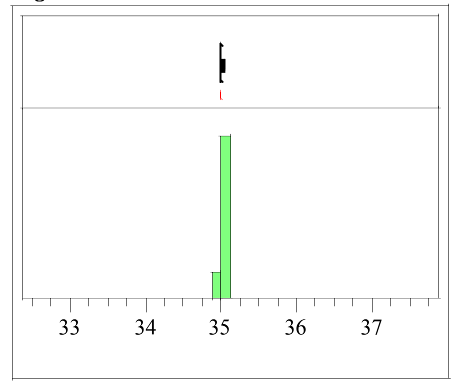
Quantiles

100.0%	maximum	35.021
99.5%		35.019
97.5%		35.015
90.0%		35.010
75.0%	quartile	35.006
50.0%	median	35.002
25.0%	quartile	34.997
10.0%		34.993
2.5%		34.988
0.5%		34.983
0.0%	minimum	34.979

Moments

Mean	35.001543
Std Dev	0.0067785
Std Err Mean	0.0002144
upper 95% Mean	35.001964
lower 95% Mean	35.001122
N	1000

Active Error Indicator=Copper (5)
Distributions
Avg WL Li rand



Quantiles

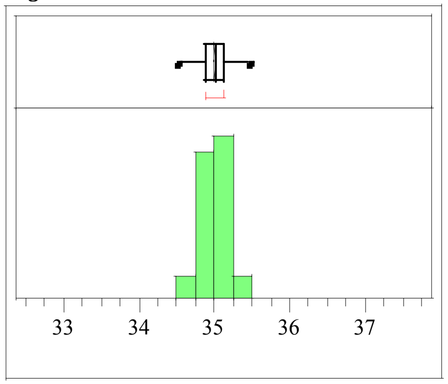
100.0%	maximum	35.007
99.5%		35.006
97.5%		35.005
90.0%		35.004
75.0%	quartile	35.003
50.0%	median	35.002
25.0%	quartile	35.001
10.0%		35.000
2.5%		34.999
0.5%		34.998
0.0%	minimum	34.996

Moments

Mean	35.001729
Std Dev	0.0016021
Std Err Mean	0.0000507
upper 95% Mean	35.001828
lower 95% Mean	35.001629
N	1000

Exhibit A8. Uncertainties of Estimated WLs by Error Number

Active Error Indicator=Frit Li2O (17)
Distributions
Avg WL Li rand



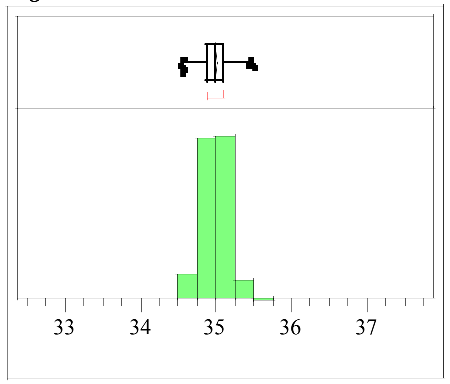
Quantiles

100.0%	maximum	35.492
99.5%		35.397
97.5%		35.309
90.0%		35.215
75.0%	quartile	35.119
50.0%	median	35.009
25.0%	quartile	34.891
10.0%		34.785
2.5%		34.684
0.5%		34.587
0.0%	minimum	34.503

Moments

Mean	35.003879
Std Dev	0.1633252
Std Err Mean	0.0051648
upper 95% Mean	35.014014
lower 95% Mean	34.993743
N	1000

Active Error Indicator=Iron (6)
Distributions
Avg WL Li rand



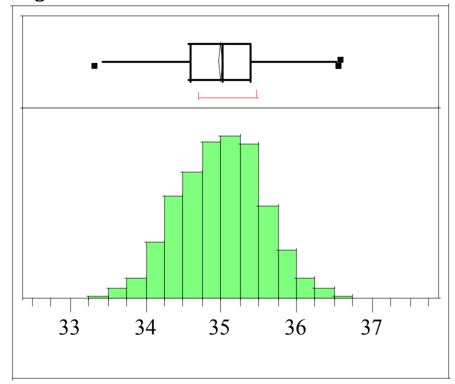
Quantiles

100.0%	maximum	35.502
99.5%		35.413
97.5%		35.298
90.0%		35.197
75.0%	quartile	35.111
50.0%	median	34.998
25.0%	quartile	34.897
10.0%		34.793
2.5%		34.684
0.5%		34.570
0.0%	minimum	34.541

Moments

Mean	34.999114
Std Dev	0.1590175
Std Err Mean	0.0050286
upper 95% Mean	35.008982
lower 95% Mean	34.989246
N	1000

Active Error Indicator=Lithium (8)
Distributions
Avg WL Li rand



Quantiles

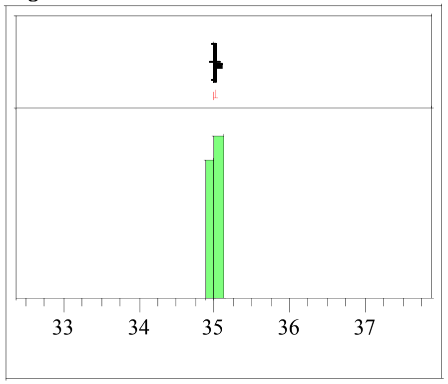
100.0%	maximum	36.573
99.5%		36.489
97.5%		36.108
90.0%		35.688
75.0%	quartile	35.379
50.0%	median	35.011
25.0%	quartile	34.603
10.0%		34.256
2.5%		33.901
0.5%		33.502
0.0%	minimum	33.296

Moments

Mean	34.994933
Std Dev	0.5683522
Std Err Mean	0.0179729
upper 95% Mean	35.030202
lower 95% Mean	34.959664
N	1000

Exhibit A8. Uncertainties of Estimated WLs by Error Number

Active Error Indicator=Magnesium (9)
Distributions
Avg WL Li rand



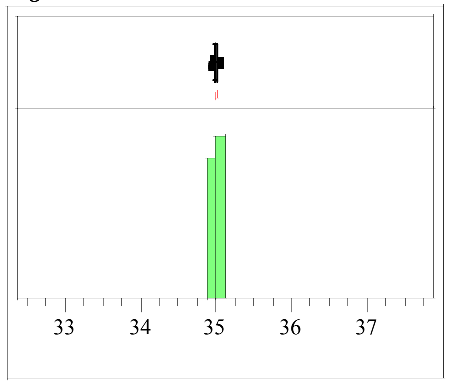
Quantiles

100.0%	maximum	35.051
99.5%		35.041
97.5%		35.032
90.0%		35.023
75.0%	quartile	35.014
50.0%	median	35.002
25.0%	quartile	34.991
10.0%		34.982
2.5%		34.972
0.5%		34.964
0.0%	minimum	34.960

Moments

Mean	35.002167
Std Dev	0.0157439
Std Err Mean	0.0004979
upper 95% Mean	35.003144
lower 95% Mean	35.00119
N	1000

Active Error Indicator=Manganese (10)
Distributions
Avg WL Li rand



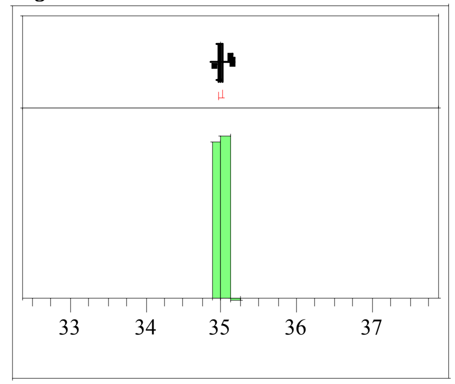
Quantiles

100.0%	maximum	35.071
99.5%		35.058
97.5%		35.044
90.0%		35.031
75.0%	quartile	35.017
50.0%	median	35.002
25.0%	quartile	34.989
10.0%		34.974
2.5%		34.960
0.5%		34.948
0.0%	minimum	34.937

Moments

Mean	35.002414
Std Dev	0.0215041
Std Err Mean	0.00068
upper 95% Mean	35.003748
lower 95% Mean	35.001079
N	1000

Active Error Indicator=Nickel (12)
Distributions
Avg WL Li rand



Quantiles

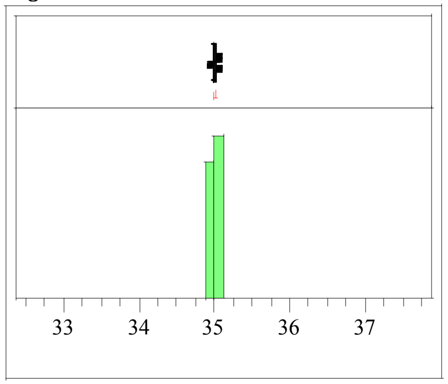
100.0%	maximum	35.147
99.5%		35.102
97.5%		35.082
90.0%		35.053
75.0%	quartile	35.029
50.0%	median	35.001
25.0%	quartile	34.975
10.0%		34.950
2.5%		34.926
0.5%		34.904
0.0%	minimum	34.894

Moments

Mean	35.001728
Std Dev	0.0395621
Std Err Mean	0.0012511
upper 95% Mean	35.004183
lower 95% Mean	34.999273
N	1000

Exhibit A8. Uncertainties of Estimated WLs by Error Number

Active Error Indicator=Potassium (7)
Distributions
Avg WL Li rand



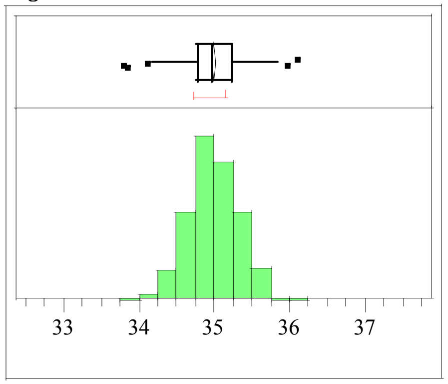
Quantiles

100.0%	maximum	35.071
99.5%		35.058
97.5%		35.047
90.0%		35.030
75.0%	quartile	35.017
50.0%	median	35.003
25.0%	quartile	34.988
10.0%		34.975
2.5%		34.960
0.5%		34.948
0.0%	minimum	34.938

Moments

Mean	35.002731
Std Dev	0.021576
Std Err Mean	0.0006823
upper 95% Mean	35.00407
lower 95% Mean	35.001392
N	1000

Active Error Indicator=Silicon (13)
Distributions
Avg WL Li rand



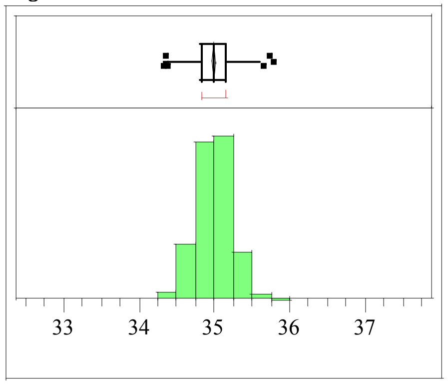
Quantiles

100.0%	maximum	36.080
99.5%		35.736
97.5%		35.638
90.0%		35.417
75.0%	quartile	35.224
50.0%	median	34.979
25.0%	quartile	34.781
10.0%		34.588
2.5%		34.374
0.5%		34.190
0.0%	minimum	33.799

Moments

Mean	34.99308
Std Dev	0.3231189
Std Err Mean	0.0102179
upper 95% Mean	35.013131
lower 95% Mean	34.973029
N	1000

Active Error Indicator=Sodium (11)
Distributions
Avg WL Li rand



Quantiles

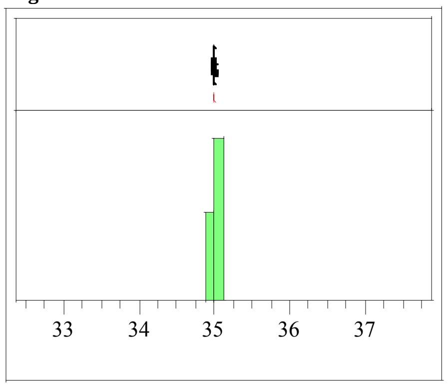
100.0%	maximum	35.765
99.5%		35.566
97.5%		35.409
90.0%		35.269
75.0%	quartile	35.144
50.0%	median	34.998
25.0%	quartile	34.840
10.0%		34.695
2.5%		34.546
0.5%		34.404
0.0%	minimum	34.325

Moments

Mean	34.992592
Std Dev	0.2252521
Std Err Mean	0.0071231
upper 95% Mean	35.00657
lower 95% Mean	34.978615
N	1000

Exhibit A8. Uncertainties of Estimated WLs by Error Number

Active Error Indicator=Titanium (14)
Distributions
Avg WL Li rand



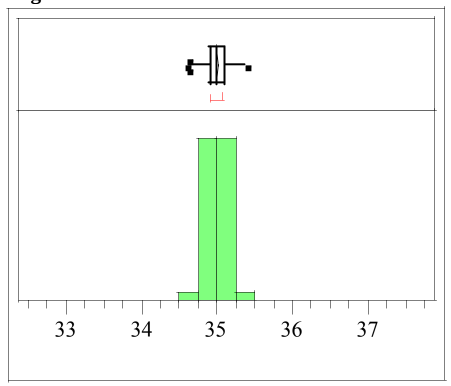
Quantiles

100.0%	maximum	35.015
99.5%		35.013
97.5%		35.011
90.0%		35.008
75.0%	quartile	35.005
50.0%	median	35.002
25.0%	quartile	34.999
10.0%		34.996
2.5%		34.993
0.5%		34.989
0.0%	minimum	34.987

Moments

Mean	35.001903
Std Dev	0.0045992
Std Err Mean	0.0001454
upper 95% Mean	35.002188
lower 95% Mean	35.001617
N	1000

Active Error Indicator=Uranium (15)
Distributions
Avg WL Li rand



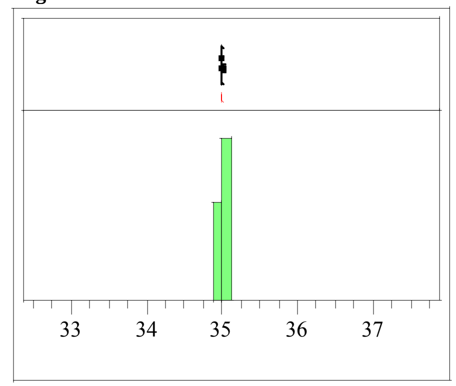
Quantiles

100.0%	maximum	35.408
99.5%		35.330
97.5%		35.256
90.0%		35.169
75.0%	quartile	35.088
50.0%	median	35.000
25.0%	quartile	34.910
10.0%		34.822
2.5%		34.745
0.5%		34.652
0.0%	minimum	34.618

Moments

Mean	34.999213
Std Dev	0.1326465
Std Err Mean	0.0041947
upper 95% Mean	35.007444
lower 95% Mean	34.990982
N	1000

Active Error Indicator=Zirconium (16)
Distributions
Avg WL Li rand



Quantiles

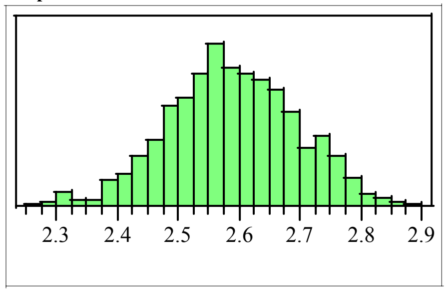
100.0%	maximum	35.017
99.5%		35.014
97.5%		35.011
90.0%		35.008
75.0%	quartile	35.005
50.0%	median	35.001
25.0%	quartile	34.998
10.0%		34.995
2.5%		34.992
0.5%		34.990
0.0%	minimum	34.986

Moments

Mean	35.001495
Std Dev	0.0047041
Std Err Mean	0.0001488
upper 95% Mean	35.001786
lower 95% Mean	35.001203
N	1000

Exhibit A9. Uncertainties of Inputs to WL Estimation

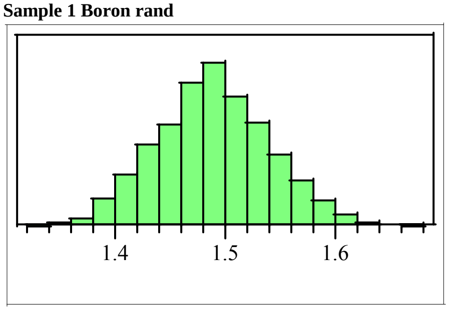
Error Indicator=0
Distributions
Sample 1 Aluminum rand



Moments

Mean	2.5893669
Std Dev	0.1069462
Std Err Mean	0.0033819
upper 95% Mean	2.5960034
lower 95% Mean	2.5827304
N	1000

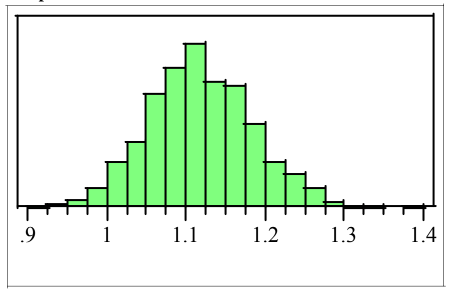
Sample 1 Boron rand



Moments

Mean	1.4894601
Std Dev	0.0513924
Std Err Mean	0.0016252
upper 95% Mean	1.4926493
lower 95% Mean	1.486271
N	1000

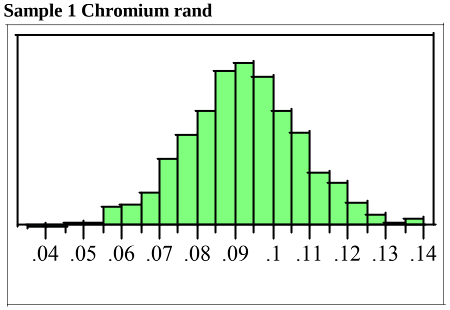
Sample 1 Calcium rand



Moments

Mean	1.1190392
Std Dev	0.0656381
Std Err Mean	0.0020757
upper 95% Mean	1.1231123
lower 95% Mean	1.114966
N	1000

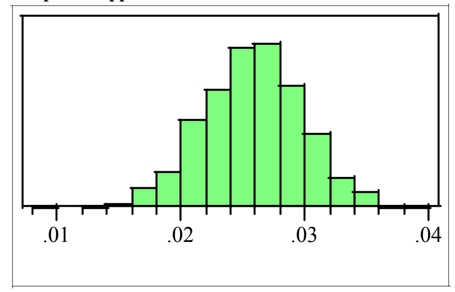
Sample 1 Chromium rand



Moments

Mean	0.0921974
Std Dev	0.015395
Std Err Mean	0.0004868
upper 95% Mean	0.0931527
lower 95% Mean	0.0912421
N	1000

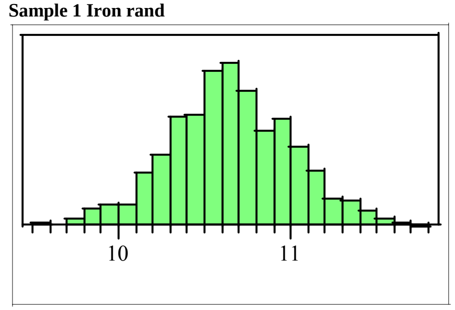
Sample 1 Copper rand



Moments

Mean	0.0258161
Std Dev	0.004015
Std Err Mean	0.000127
upper 95% Mean	0.0260652
lower 95% Mean	0.0255669
N	1000

Sample 1 Iron rand

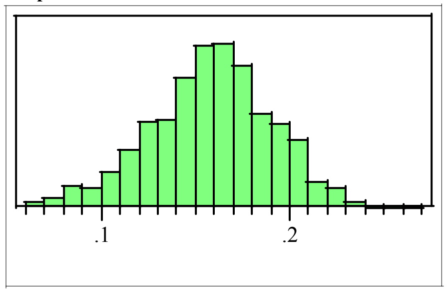


Moments

Mean	10.65507
Std Dev	0.354523
Std Err Mean	0.011211
upper 95% Mean	10.67707
lower 95% Mean	10.633071
N	1000

Exhibit A9. Uncertainties of Inputs to WL Estimation

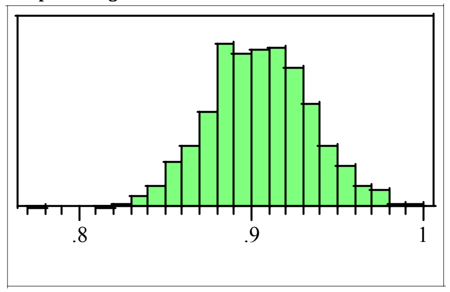
Sample 1 Potassium rand



Moments

Mean	0.158278
Std Dev	0.0322615
Std Err Mean	0.0010202
upper 95% Mean	0.1602799
lower 95% Mean	0.156276
N	1000

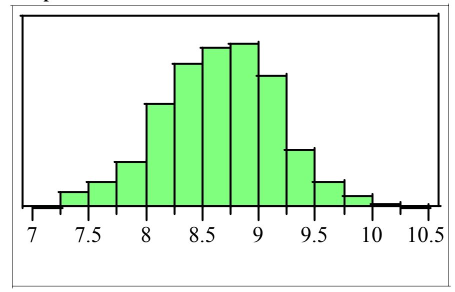
Sample 1 Magnesium rand



Moments

Mean	0.904882
Std Dev	0.0295937
Std Err Mean	0.0009358
upper 95% Mean	0.9067184
lower 95% Mean	0.9030456
N	1000

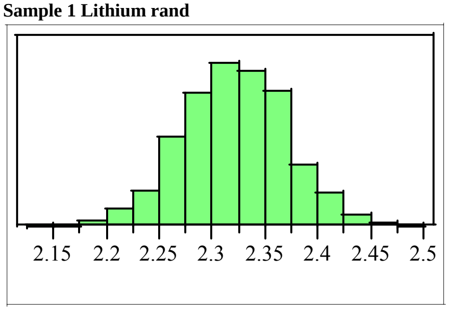
Sample 1 Sodium rand



Moments

Mean	8.6606444
Std Dev	0.5118119
Std Err Mean	0.0161849
upper 95% Mean	8.6924047
lower 95% Mean	8.6288841
N	1000

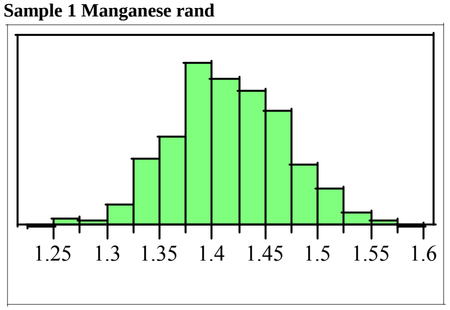
Sample 1 Lithium rand



Moments

Mean	2.3210837
Std Dev	0.0497367
Std Err Mean	0.0015728
upper 95% Mean	2.3241701
lower 95% Mean	2.3179973
N	1000

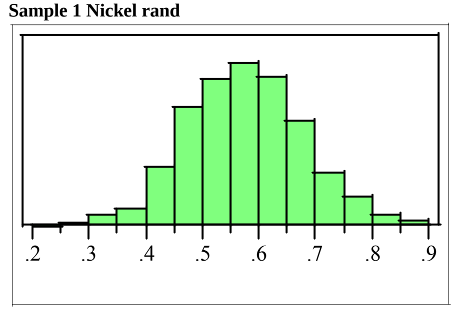
Sample 1 Manganese rand



Moments

Mean	1.4153413
Std Dev	0.0540309
Std Err Mean	0.0017086
upper 95% Mean	1.4186942
lower 95% Mean	1.4119885
N	1000

Sample 1 Nickel rand

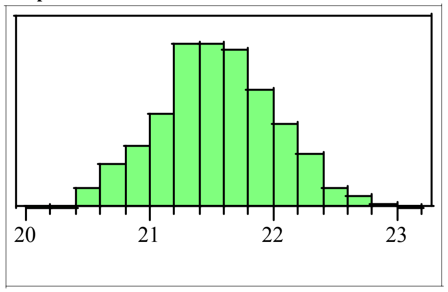


Moments

Mean	0.5749857
Std Dev	0.1046732
Std Err Mean	0.0033101
upper 95% Mean	0.5814811
lower 95% Mean	0.5684902
N	1000

Exhibit A9. Uncertainties of Inputs to WL Estimation

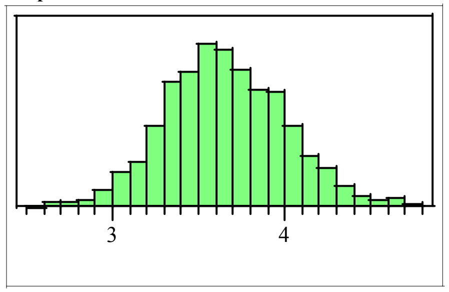
Sample 1 Silicon rand



Moments

Mean	21.552335
Std Dev	0.4753648
Std Err Mean	0.0150324
upper 95% Mean	21.581834
lower 95% Mean	21.522837
N	1000

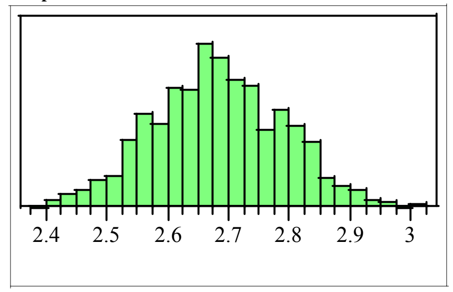
Sample 1 Uranium rand



Moments

Mean	3.6579208
Std Dev	0.3494935
Std Err Mean	0.011052
upper 95% Mean	3.6796085
lower 95% Mean	3.6362331
N	1000

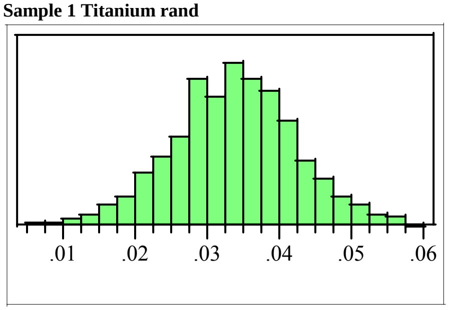
Sample 2 Aluminum rand



Moments

Mean	2.6828504
Std Dev	0.1075516
Std Err Mean	0.0034011
upper 95% Mean	2.6895245
lower 95% Mean	2.6761763
N	1000

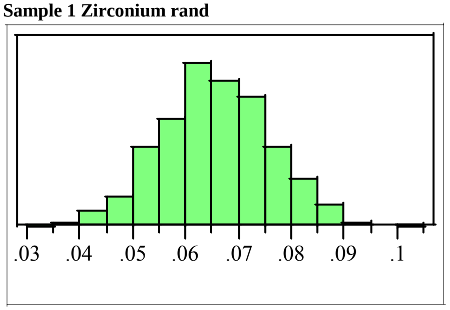
Sample 1 Titanium rand



Moments

Mean	0.0336882
Std Dev	0.0085425
Std Err Mean	0.0002701
upper 95% Mean	0.0342183
lower 95% Mean	0.0331581
N	1000

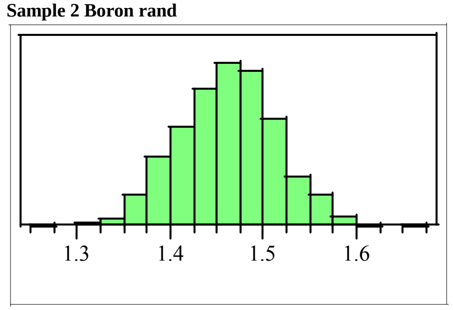
Sample 1 Zirconium rand



Moments

Mean	0.0656757
Std Dev	0.0101862
Std Err Mean	0.0003221
upper 95% Mean	0.0663078
lower 95% Mean	0.0650436
N	1000

Sample 2 Boron rand

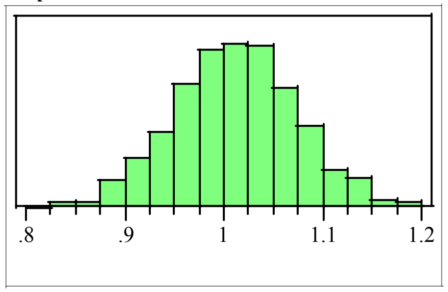


Moments

Mean	1.4614006
Std Dev	0.0523557
Std Err Mean	0.0016556
upper 95% Mean	1.4646496
lower 95% Mean	1.4581517
N	1000

Exhibit A9. Uncertainties of Inputs to WL Estimation

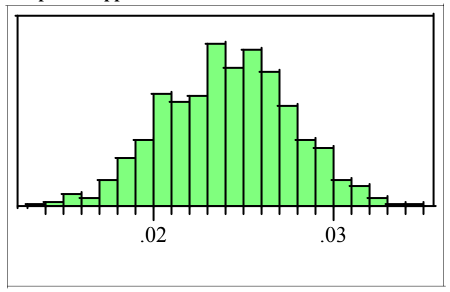
Sample 2 Calcium rand



Moments

Mean	1.0121304
Std Dev	0.0614892
Std Err Mean	0.0019445
upper 95% Mean	1.0159461
lower 95% Mean	1.0083147
N	1000

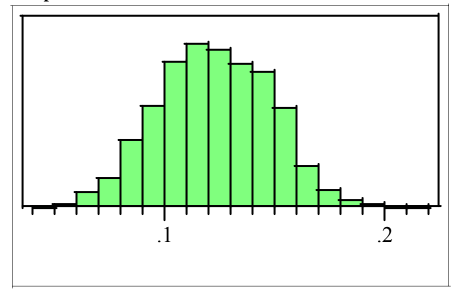
Sample 2 Copper rand



Moments

Mean	0.0241199
Std Dev	0.0035701
Std Err Mean	0.0001129
upper 95% Mean	0.0243414
lower 95% Mean	0.0238984
N	1000

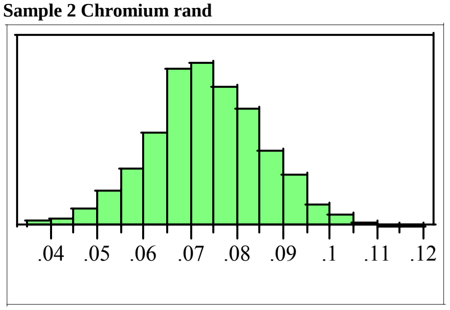
Sample 2 Potassium rand



Moments

Mean	0.1225999
Std Dev	0.0252617
Std Err Mean	0.0007988
upper 95% Mean	0.1241675
lower 95% Mean	0.1210323
N	1000

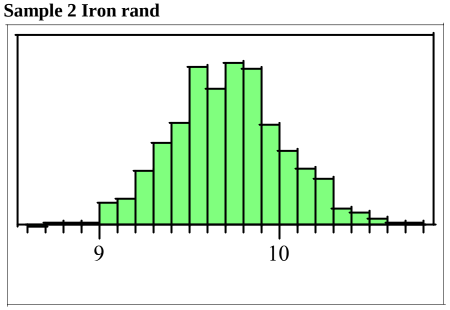
Sample 2 Chromium rand



Moments

Mean	0.0735538
Std Dev	0.0122432
Std Err Mean	0.0003872
upper 95% Mean	0.0743135
lower 95% Mean	0.072794
N	1000

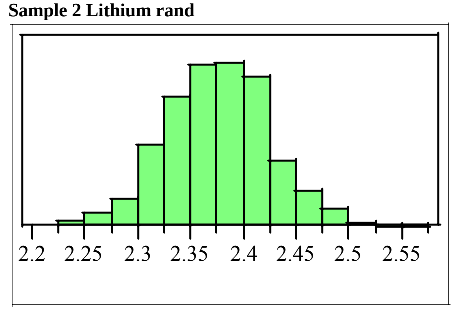
Sample 2 Iron rand



Moments

Mean	9.7166606
Std Dev	0.3163421
Std Err Mean	0.0100036
upper 95% Mean	9.7362912
lower 95% Mean	9.6970301
N	1000

Sample 2 Lithium rand

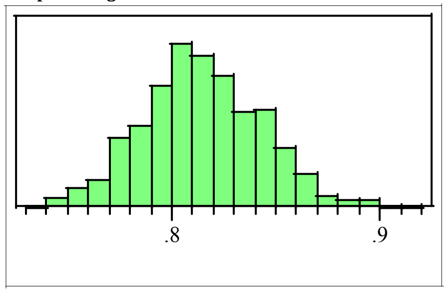


Moments

Mean	2.3764611
Std Dev	0.050104
Std Err Mean	0.0015844
upper 95% Mean	2.3795703
lower 95% Mean	2.3733519
N	1000

Exhibit A9. Uncertainties of Inputs to WL Estimation

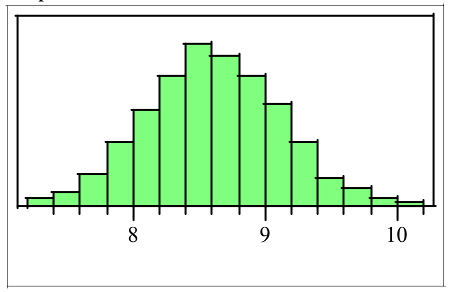
Sample 2 Magnesium rand



Moments

Mean	0.8145322
Std Dev	0.0286388
Std Err Mean	0.0009056
upper 95% Mean	0.8163094
lower 95% Mean	0.8127551
N	1000

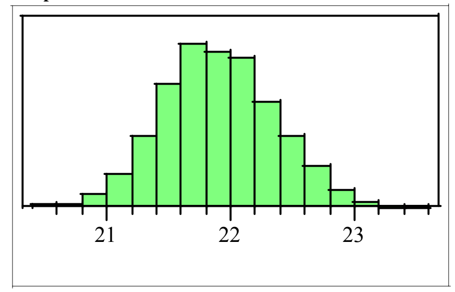
Sample 2 Sodium rand



Moments

Mean	8.6083959
Std Dev	0.513328
Std Err Mean	0.0162329
upper 95% Mean	8.6402503
lower 95% Mean	8.5765415
N	1000

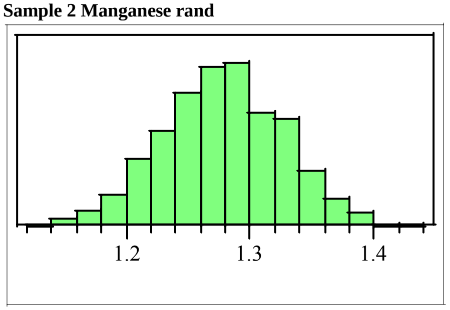
Sample 2 Silicon rand



Moments

Mean	21.896357
Std Dev	0.4558205
Std Err Mean	0.0144143
upper 95% Mean	21.924642
lower 95% Mean	21.868071
N	1000

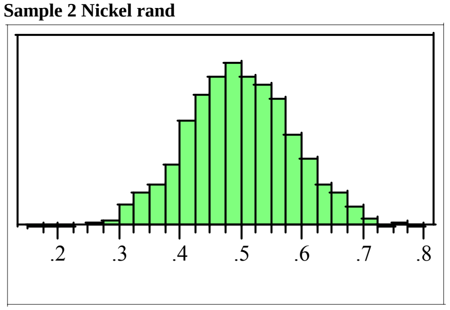
Sample 2 Manganese rand



Moments

Mean	1.2778164
Std Dev	0.0487013
Std Err Mean	0.0015401
upper 95% Mean	1.2808385
lower 95% Mean	1.2747942
N	1000

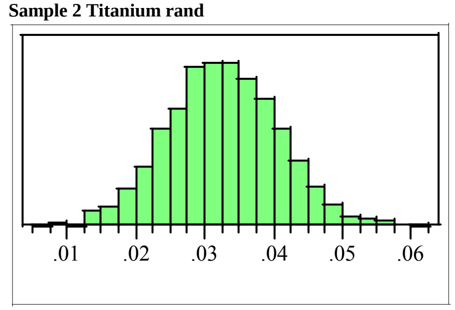
Sample 2 Nickel rand



Moments

Mean	0.4984901
Std Dev	0.0875116
Std Err Mean	0.0027674
upper 95% Mean	0.5039206
lower 95% Mean	0.4930596
N	1000

Sample 2 Titanium rand

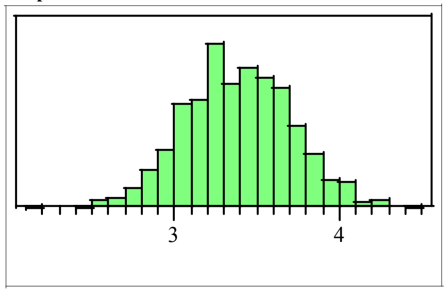


Moments

Mean	0.0326827
Std Dev	0.0080251
Std Err Mean	0.0002538
upper 95% Mean	0.0331807
lower 95% Mean	0.0321848
N	1000

Exhibit A9. Uncertainties of Inputs to WL Estimation

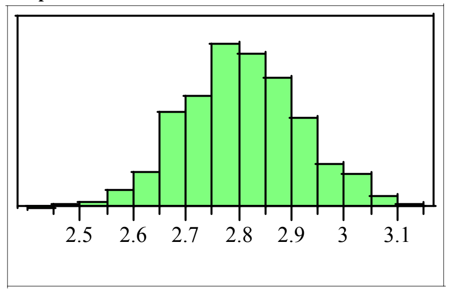
Sample 2 Uranium rand



Moments

Mean	3.3856388
Std Dev	0.3195218
Std Err Mean	0.0101042
upper 95% Mean	3.4054667
lower 95% Mean	3.365811
N	1000

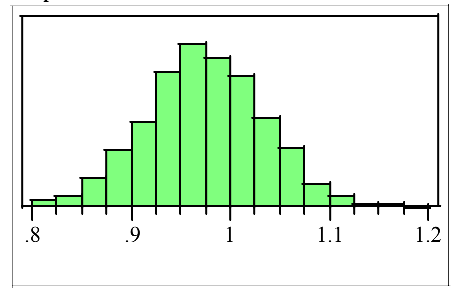
Sample 3 Aluminum rand



Moments

Mean	2.8076269
Std Dev	0.1120968
Std Err Mean	0.0035448
upper 95% Mean	2.814583
lower 95% Mean	2.8006708
N	1000

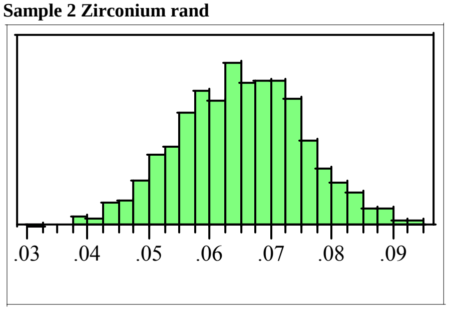
Sample 3 Calcium rand



Moments

Mean	0.9744006
Std Dev	0.0591362
Std Err Mean	0.0018701
upper 95% Mean	0.9780703
lower 95% Mean	0.9707309
N	1000

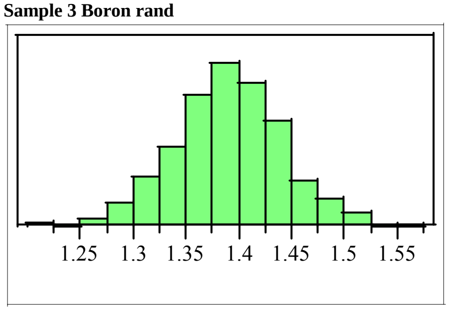
Sample 2 Zirconium rand



Moments

Mean	0.0651991
Std Dev	0.0102212
Std Err Mean	0.0003232
upper 95% Mean	0.0658333
lower 95% Mean	0.0645648
N	1000

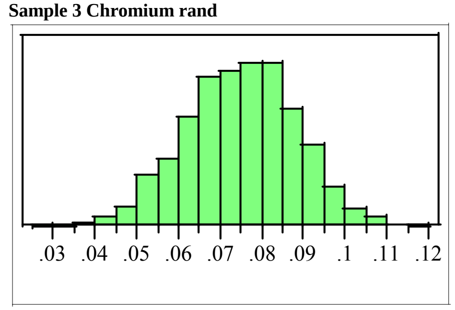
Sample 3 Boron rand



Moments

Mean	1.3910407
Std Dev	0.0513792
Std Err Mean	0.0016248
upper 95% Mean	1.3942291
lower 95% Mean	1.3878524
N	1000

Sample 3 Chromium rand

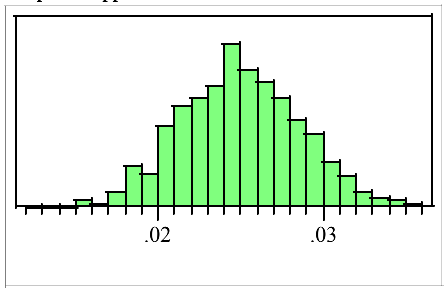


Moments

Mean	0.0749752
Std Dev	0.0131037
Std Err Mean	0.0004144
upper 95% Mean	0.0757884
lower 95% Mean	0.0741621
N	1000

Exhibit A9. Uncertainties of Inputs to WL Estimation

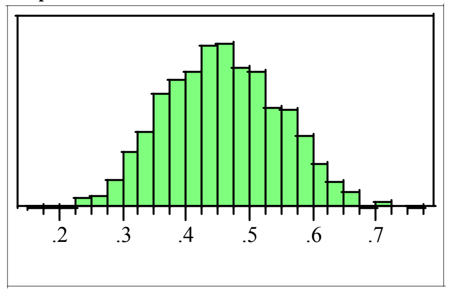
Sample 3 Copper rand



Moments

Mean	0.0249515
Std Dev	0.0036532
Std Err Mean	0.0001155
upper 95% Mean	0.0251782
lower 95% Mean	0.0247248
N	1000

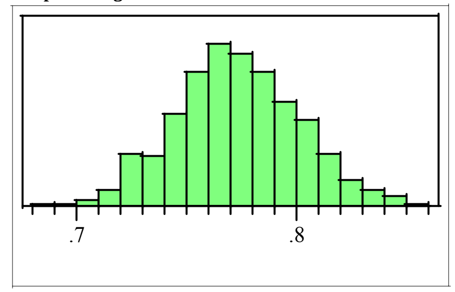
Sample 3 Potassium rand



Moments

Mean	0.457802
Std Dev	0.0914566
Std Err Mean	0.0028921
upper 95% Mean	0.4634773
lower 95% Mean	0.4521267
N	1000

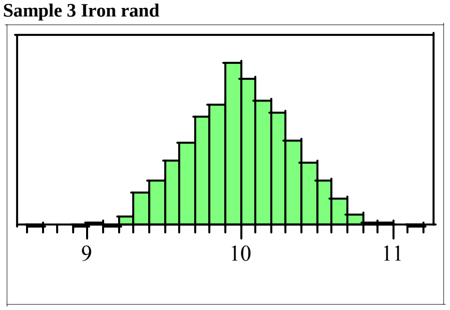
Sample 3 Magnesium rand



Moments

Mean	0.7730272
Std Dev	0.0282658
Std Err Mean	0.0008938
upper 95% Mean	0.7747812
lower 95% Mean	0.7712731
N	1000

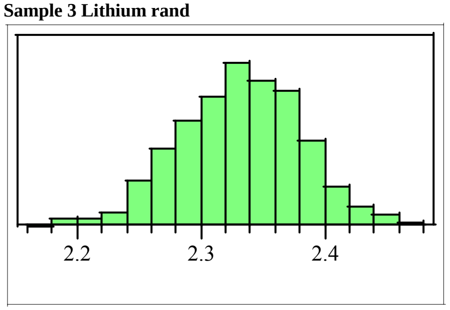
Sample 3 Iron rand



Moments

Mean	9.9989525
Std Dev	0.3389558
Std Err Mean	0.0107187
upper 95% Mean	10.019986
lower 95% Mean	9.9779187
N	1000

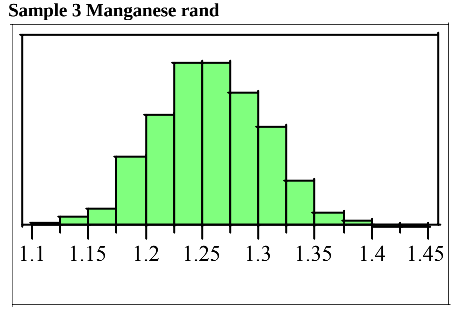
Sample 3 Lithium rand



Moments

Mean	2.3317955
Std Dev	0.0491169
Std Err Mean	0.0015532
upper 95% Mean	2.3348434
lower 95% Mean	2.3287475
N	1000

Sample 3 Manganese rand

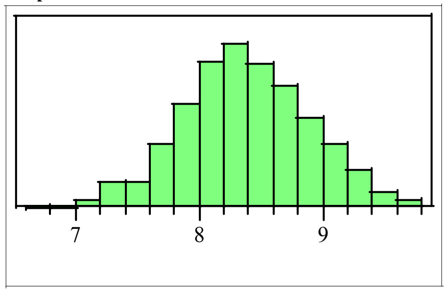


Moments

Mean	1.2577349
Std Dev	0.0479684
Std Err Mean	0.0015169
upper 95% Mean	1.2607116
lower 95% Mean	1.2547582
N	1000

Exhibit A9. Uncertainties of Inputs to WL Estimation

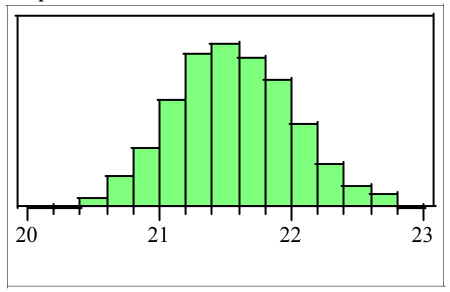
Sample 3 Sodium rand



Moments

Mean	8.3816208
Std Dev	0.5051904
Std Err Mean	0.0159755
upper 95% Mean	8.4129702
lower 95% Mean	8.3502713
N	1000

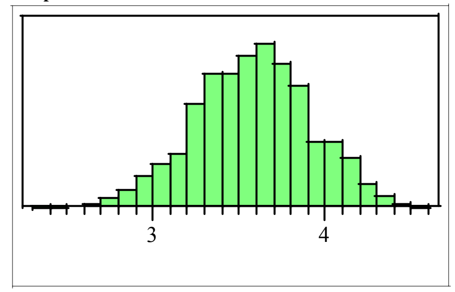
Sample 3 Silicon rand



Moments

Mean	21.56003
Std Dev	0.4570451
Std Err Mean	0.014453
upper 95% Mean	21.588392
lower 95% Mean	21.531668
N	1000

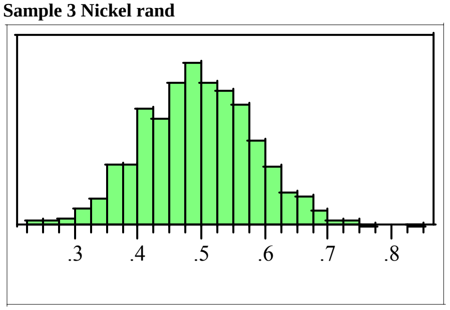
Sample 3 Uranium rand



Moments

Mean	3.5828415
Std Dev	0.3383134
Std Err Mean	0.0106984
upper 95% Mean	3.6038354
lower 95% Mean	3.5618475
N	1000

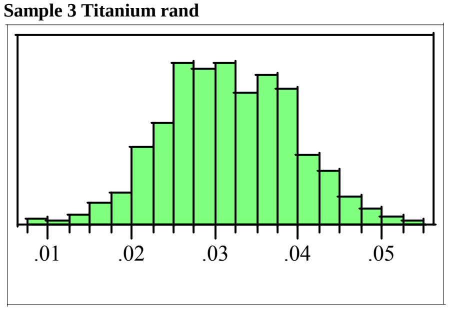
Sample 3 Nickel rand



Moments

Mean	0.4948066
Std Dev	0.0871556
Std Err Mean	0.0027561
upper 95% Mean	0.500215
lower 95% Mean	0.4893982
N	1000

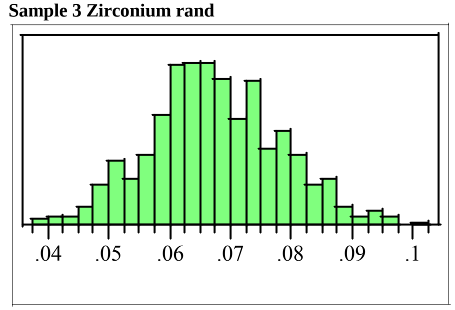
Sample 3 Titanium rand



Moments

Mean	0.0316716
Std Dev	0.0078321
Std Err Mean	0.0002477
upper 95% Mean	0.0321576
lower 95% Mean	0.0311856
N	1000

Sample 3 Zirconium rand

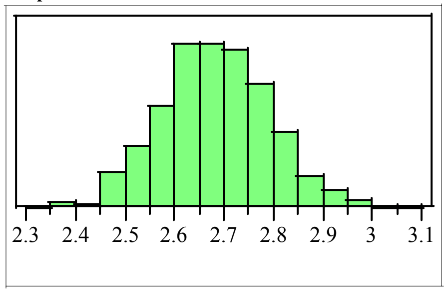


Moments

Mean	0.0675057
Std Dev	0.0108004
Std Err Mean	0.0003415
upper 95% Mean	0.0681759
lower 95% Mean	0.0668355
N	1000

Exhibit A9. Uncertainties of Inputs to WL Estimation

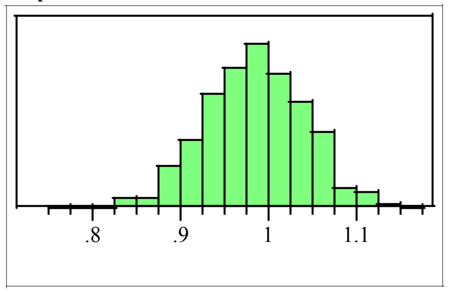
Sample 4 Aluminum rand



Moments

Mean	2.6830387
Std Dev	0.1083886
Std Err Mean	0.0034275
upper 95% Mean	2.6897647
lower 95% Mean	2.6763126
N	1000

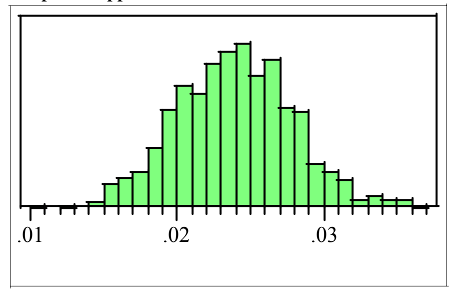
Sample 4 Calcium rand



Moments

Mean	0.9836845
Std Dev	0.0572296
Std Err Mean	0.0018098
upper 95% Mean	0.9872359
lower 95% Mean	0.9801332
N	1000

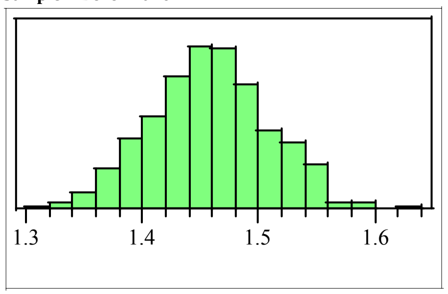
Sample 4 Copper rand



Moments

Mean	0.0239388
Std Dev	0.0039312
Std Err Mean	0.0001243
upper 95% Mean	0.0241827
lower 95% Mean	0.0236948
N	1000

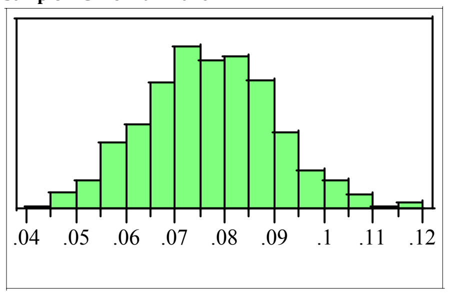
Sample 4 Boron rand



Moments

Mean	1.4583574
Std Dev	0.0512704
Std Err Mean	0.0016213
upper 95% Mean	1.4615389
lower 95% Mean	1.4551758
N	1000

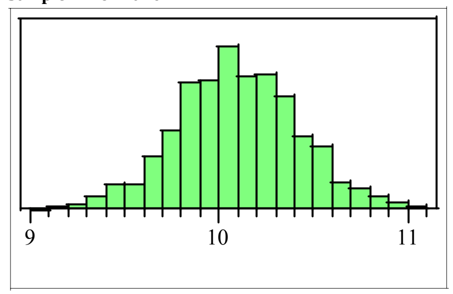
Sample 4 Chromium rand



Moments

Mean	0.077153
Std Dev	0.0132214
Std Err Mean	0.0004181
upper 95% Mean	0.0779735
lower 95% Mean	0.0763326
N	1000

Sample 4 Iron rand

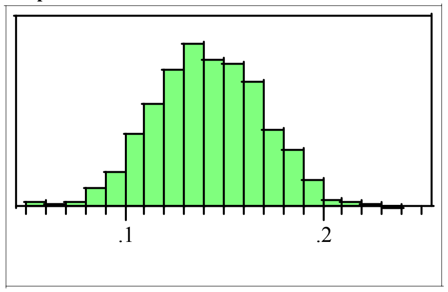


Moments

Mean	10.095789
Std Dev	0.3257001
Std Err Mean	0.0102995
upper 95% Mean	10.116
lower 95% Mean	10.075578
N	1000

Exhibit A9. Uncertainties of Inputs to WL Estimation

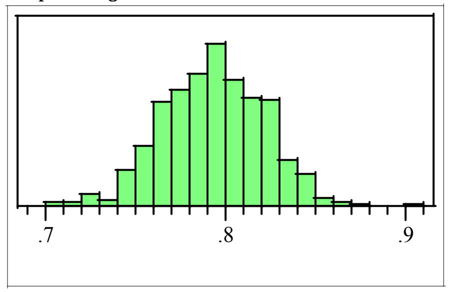
Sample 4 Potassium rand



Moments

Mean	0.1421589
Std Dev	0.0277372
Std Err Mean	0.0008771
upper 95% Mean	0.1438801
lower 95% Mean	0.1404376
N	1000

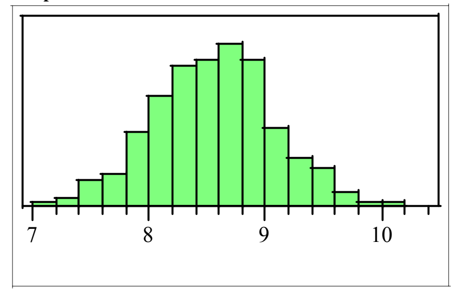
Sample 4 Magnesium rand



Moments

Mean	0.7936821
Std Dev	0.0289016
Std Err Mean	0.0009139
upper 95% Mean	0.7954756
lower 95% Mean	0.7918887
N	1000

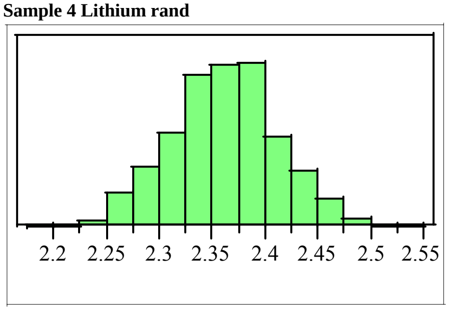
Sample 4 Sodium rand



Moments

Mean	8.5622802
Std Dev	0.5224252
Std Err Mean	0.0165205
upper 95% Mean	8.5946992
lower 95% Mean	8.5298613
N	1000

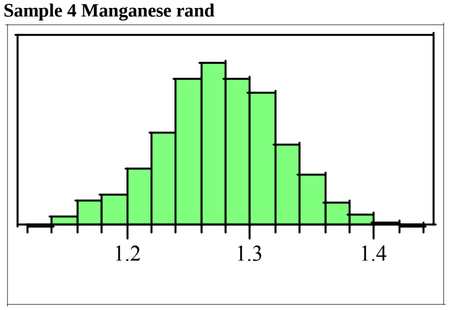
Sample 4 Lithium rand



Moments

Mean	2.3619907
Std Dev	0.0509036
Std Err Mean	0.0016097
upper 95% Mean	2.3651495
lower 95% Mean	2.3588319
N	1000

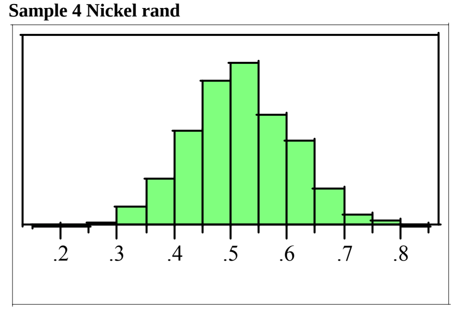
Sample 4 Manganese rand



Moments

Mean	1.2755891
Std Dev	0.0487224
Std Err Mean	0.0015407
upper 95% Mean	1.2786126
lower 95% Mean	1.2725657
N	1000

Sample 4 Nickel rand

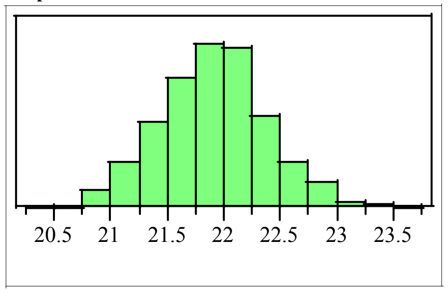


Moments

Mean	0.5165981
Std Dev	0.0926662
Std Err Mean	0.0029304
upper 95% Mean	0.5223485
lower 95% Mean	0.5108477
N	1000

Exhibit A9. Uncertainties of Inputs to WL Estimation

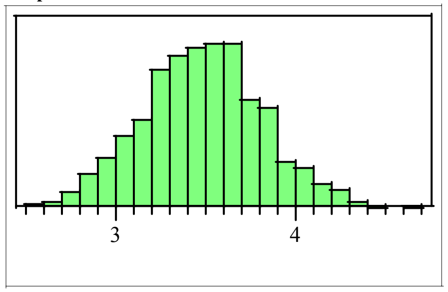
Sample 4 Silicon rand



Moments

Mean	21.903404
Std Dev	0.4733596
Std Err Mean	0.0149689
upper 95% Mean	21.932778
lower 95% Mean	21.874029
N	1000

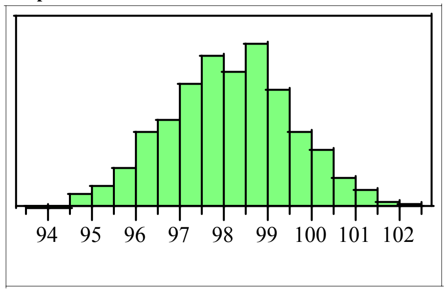
Sample 4 Uranium rand



Moments

Mean	3.4834769
Std Dev	0.3291783
Std Err Mean	0.0104095
upper 95% Mean	3.5039039
lower 95% Mean	3.4630498
N	1000

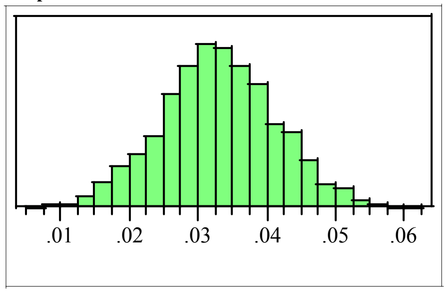
Sample 1 Sum of Oxides rand



Moments

Mean	98.141959
Std Dev	1.4251751
Std Err Mean	0.045068
upper 95% Mean	98.230398
lower 95% Mean	98.05352
N	1000

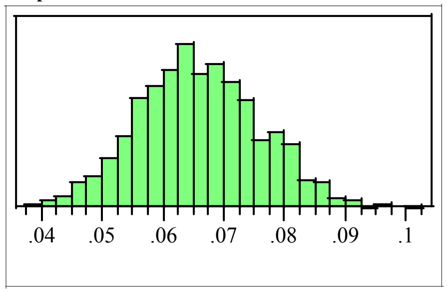
Sample 4 Titanium rand



Moments

Mean	0.0330058
Std Dev	0.0083819
Std Err Mean	0.0002651
upper 95% Mean	0.0335259
lower 95% Mean	0.0324856
N	1000

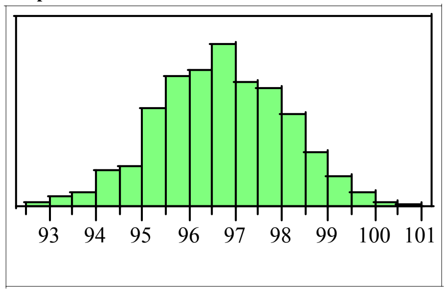
Sample 4 Zirconium rand



Moments

Mean	0.0660073
Std Dev	0.0099542
Std Err Mean	0.0003148
upper 95% Mean	0.066625
lower 95% Mean	0.0653896
N	1000

Sample 2 Sum of Oxides rand

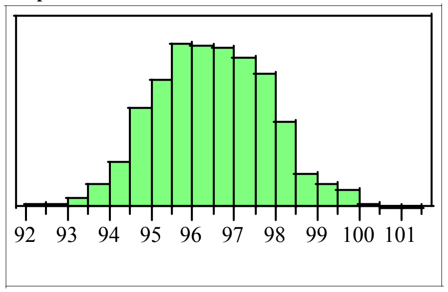


Moments

Mean	96.701304
Std Dev	1.3912741
Std Err Mean	0.043996
upper 95% Mean	96.787639
lower 95% Mean	96.614969
N	1000

Exhibit A9. Uncertainties of Inputs to WL Estimation

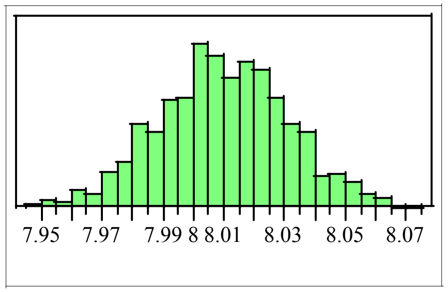
Sample 3 Sum of Oxides rand



Moments

Mean	96.4814
Std Dev	1.3820193
Std Err Mean	0.0437033
upper 95% Mean	96.567161
lower 95% Mean	96.395639
N	1000

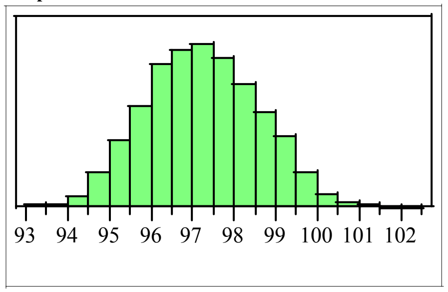
Frit Li2O rand



Moments

Mean	8.0098204
Std Dev	0.0210682
Std Err Mean	0.0006662
upper 95% Mean	8.0111278
lower 95% Mean	8.008513
N	1000

Sample 4 Sum of Oxides rand



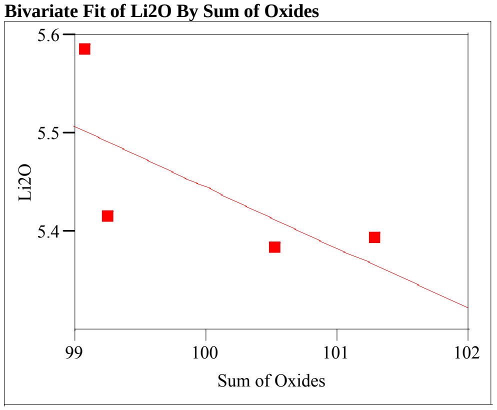
Moments

Mean	97.247048
Std Dev	1.3767123
Std Err Mean	0.0435355
upper 95% Mean	97.33248
lower 95% Mean	97.161617
N	1000

Exhibit A10. Relationships between Li_2O Content and Sum of Oxides of SME Samples

Batch=227

Bivariate Fit of Li2O By Sum of Oxides



Linear Fit

Linear Fit

Li2O = 11.598166 - 0.0615289 Sum of Oxides

Summary of Fit

RSquare	0.469648
RSquare Adj	0.204473
Root Mean Square Error	0.0847
Mean of Response	5.443608
Observations (or Sum Wgts)	4

Analysis of Variance

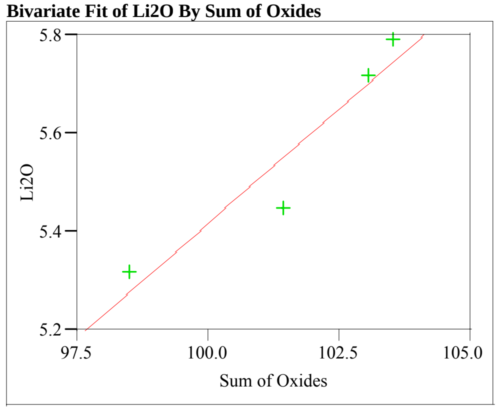
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.01270604	0.012706	1.7711
Error	2	0.01434833	0.007174	Prob > F
C. Total	3	0.02705437		0.3147

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	11.598166	4.624828	2.51	0.1290
Sum of Oxides	-0.061529	0.046234	-1.33	0.3147

Batch=228

Bivariate Fit of Li2O By Sum of Oxides



Linear Fit

Linear Fit

Li2O = -3.914883 + 0.093324 Sum of Oxides

Summary of Fit

RSquare	0.898916
RSquare Adj	0.848374
Root Mean Square Error	0.086996
Mean of Response	5.568476
Observations (or Sum Wgts)	4

Analysis of Variance

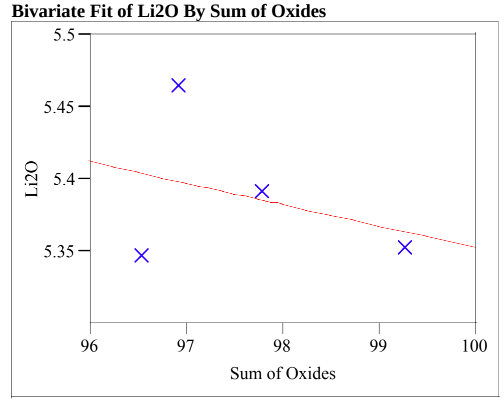
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.13460575	0.134606	17.7856
Error	2	0.01513650	0.007568	Prob > F
C. Total	3	0.14974225		0.0519

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	-3.914883	2.249103	-1.74	0.2239
Sum of Oxides	0.093324	0.022129	4.22	0.0519

Batch=229

Bivariate Fit of Li2O By Sum of Oxides



Linear Fit

Linear Fit

Li2O = 6.844091 - 0.0149152 Sum of Oxides

Summary of Fit

RSquare	0.111071
RSquare Adj	-0.33339
Root Mean Square Error	0.062806
Mean of Response	5.38817
Observations (or Sum Wgts)	4

Analysis of Variance

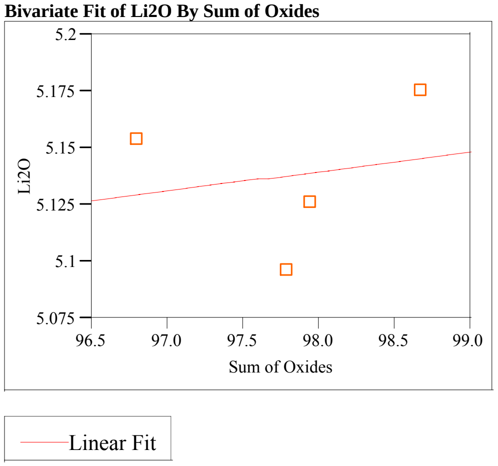
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00098573	0.000986	0.2499
Error	2	0.00788909	0.003945	Prob > F
C. Total	3	0.00887482		0.6667

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	6.844091	2.912608	2.35	0.1432
Sum of Oxides	-0.014915	0.029836	-0.50	0.6667

Exhibit A10. Relationships between Li_2O Content and Sum of Oxides of SME Samples

Batch=230
Bivariate Fit of Li2O By Sum of Oxides



Linear Fit
Li2O = 4.2871812 + 0.0086987 Sum of Oxides

Summary of Fit

RSquare	0.037846
RSquare Adj	-0.44323
Root Mean Square Error	0.041517
Mean of Response	5.137896
Observations (or Sum Wgts)	4

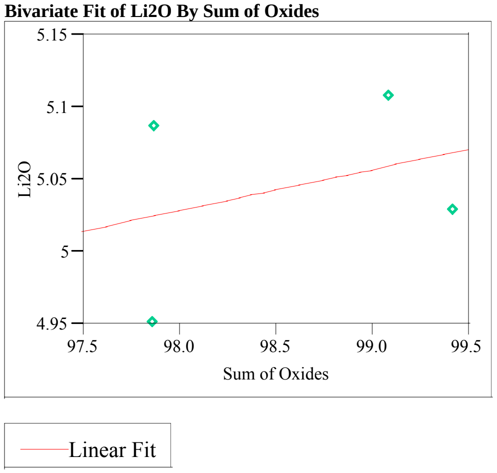
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00013560	0.000136	0.0787
Error	2	0.00344724	0.001724	Prob > F
C. Total	3	0.00358284		0.8055

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	4.2871812	3.03312	1.41	0.2931
Sum of Oxides	0.0086987	0.031013	0.28	0.8055

Batch=231
Bivariate Fit of Li2O By Sum of Oxides



Linear Fit
Li2O = 2.2605519 + 0.0282428 Sum of Oxides

Summary of Fit

RSquare	0.106645
RSquare Adj	-0.34003
Root Mean Square Error	0.081369
Mean of Response	5.044245
Observations (or Sum Wgts)	4

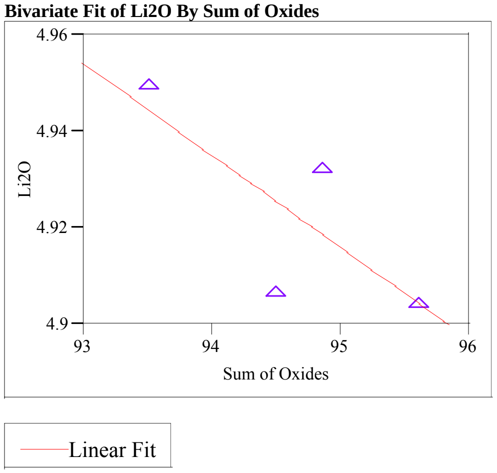
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00158076	0.001581	0.2388
Error	2	0.01324190	0.006621	Prob > F
C. Total	3	0.01482266		0.6734

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	2.2605519	5.697181	0.40	0.7299
Sum of Oxides	0.0282428	0.057801	0.49	0.6734

Batch=232
Bivariate Fit of Li2O By Sum of Oxides



Linear Fit
Li2O = 6.7293915 - 0.019088 Sum of Oxides

Summary of Fit

RSquare	0.591961
RSquare Adj	0.387941
Root Mean Square Error	0.016976
Mean of Response	4.923144
Observations (or Sum Wgts)	4

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00083615	0.000836	2.9015
Error	2	0.00057636	0.000288	Prob > F
C. Total	3	0.00141251		0.2306

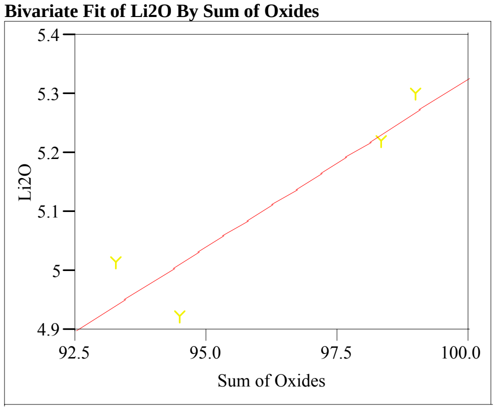
Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	6.7293915	1.060427	6.35	0.0239
Sum of Oxides	-0.019088	0.011206	-1.70	0.2306

Exhibit A10. Relationships between Li_2O Content and Sum of Oxides of SME Samples

Batch=233

Bivariate Fit of Li2O By Sum of Oxides



Linear Fit

Linear Fit

Li2O = -0.385165 + 0.0571142 Sum of Oxides

Summary of Fit

RSquare	0.843759
RSquare Adj	0.765638
Root Mean Square Error	0.084745
Mean of Response	5.11529
Observations (or Sum Wgts)	4

Analysis of Variance

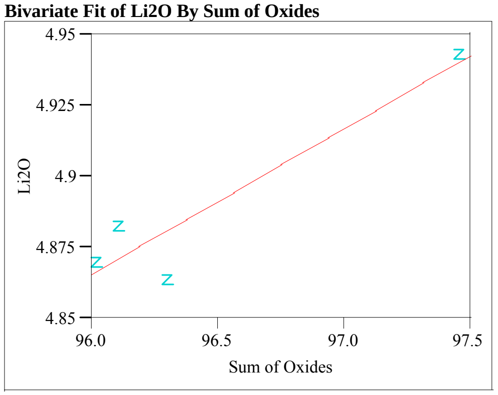
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.07756686	0.077567	10.8007
Error	2	0.01436331	0.007182	Prob > F
C. Total	3	0.09193016		0.0814

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	-0.385165	1.674218	-0.23	0.8394
Sum of Oxides	0.0571142	0.017379	3.29	0.0814

Batch=234

Bivariate Fit of Li2O By Sum of Oxides



Linear Fit

Linear Fit

Li2O = -0.059662 + 0.0513035 Sum of Oxides

Summary of Fit

RSquare	0.882189
RSquare Adj	0.823283
Root Mean Square Error	0.015312
Mean of Response	4.889774
Observations (or Sum Wgts)	4

Analysis of Variance

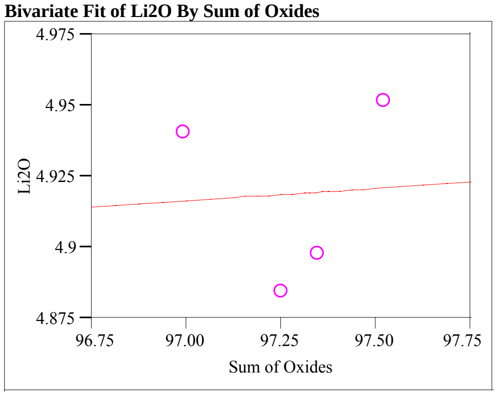
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00351137	0.003511	14.9763
Error	2	0.00046892	0.000234	Prob > F
C. Total	3	0.00398029		0.0608

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	-0.059662	1.278971	-0.05	0.9670
Sum of Oxides	0.0513035	0.013257	3.87	0.0608

Batch=235

Bivariate Fit of Li2O By Sum of Oxides



Linear Fit

Linear Fit

Li2O = 4.0977761 + 0.0084403 Sum of Oxides

Summary of Fit

RSquare	0.003311
RSquare Adj	-0.49503
Root Mean Square Error	0.039654
Mean of Response	4.918838
Observations (or Sum Wgts)	4

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00001045	0.000010	0.0066
Error	2	0.00314481	0.001572	Prob > F
C. Total	3	0.00315526		0.9425

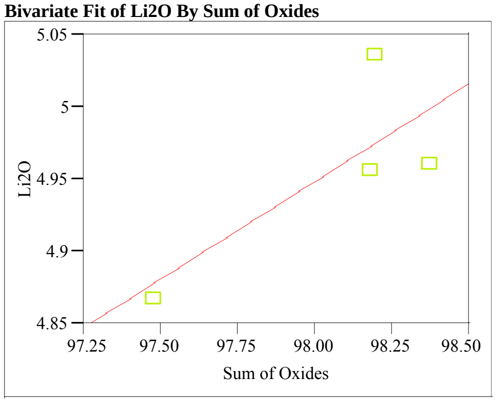
Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	4.0977761	10.0724	0.41	0.7235
Sum of Oxides	0.0084403	0.103541	0.08	0.9425

Exhibit A10. Relationships between Li_2O Content and Sum of Oxides of SME Samples

Batch=236

Bivariate Fit of Li2O By Sum of Oxides



Linear Fit

Linear Fit

Li2O = -8.316597 + 0.135352 Sum of Oxides

Summary of Fit

RSquare	0.608249
RSquare Adj	0.412373
Root Mean Square Error	0.052647
Mean of Response	4.954899
Observations (or Sum Wgts)	4

Analysis of Variance

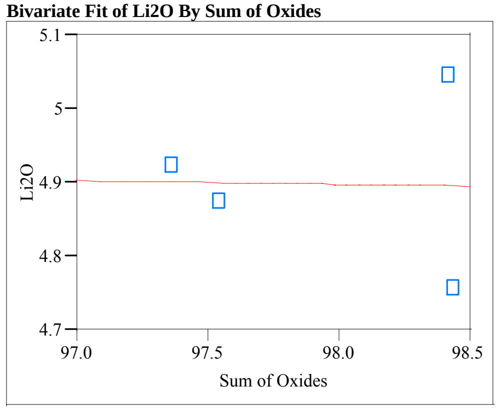
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00860708	0.008607	3.1053
Error	2	0.00554351	0.002772	Prob > F
C. Total	3	0.01415059		0.2201

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	-8.316597	7.531335	-1.10	0.3846
Sum of Oxides	0.135352	0.076809	1.76	0.2201

Batch=237

Bivariate Fit of Li2O By Sum of Oxides



Linear Fit

Linear Fit

Li2O = 5.3739087 - 0.0048608 Sum of Oxides

Summary of Fit

RSquare	0.000525
RSquare Adj	-0.49921
Root Mean Square Error	0.147384
Mean of Response	4.897848
Observations (or Sum Wgts)	4

Analysis of Variance

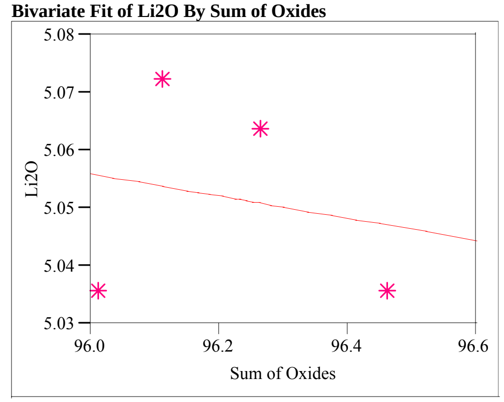
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00002280	0.000023	0.0010
Error	2	0.04344403	0.021722	Prob > F
C. Total	3	0.04346683		0.9771

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	5.3739087	14.69399	0.37	0.7496
Sum of Oxides	-0.004861	0.15003	-0.03	0.9771

Batch=238

Bivariate Fit of Li2O By Sum of Oxides



Linear Fit

Linear Fit

Li2O = 6.8897496 - 0.0191028 Sum of Oxides

Summary of Fit

RSquare	0.038863
RSquare Adj	-0.44171
Root Mean Square Error	0.022781
Mean of Response	5.05178
Observations (or Sum Wgts)	4

Analysis of Variance

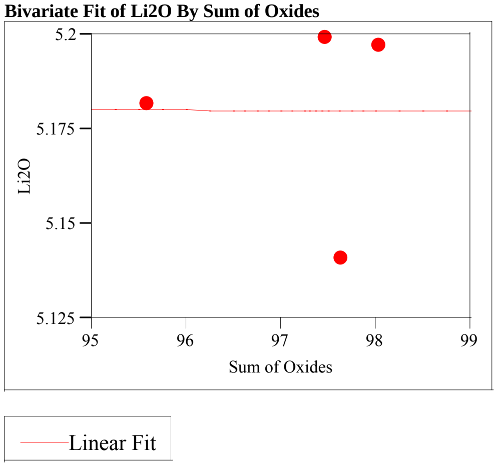
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00004197	0.000042	0.0809
Error	2	0.00103798	0.000519	Prob > F
C. Total	3	0.00107995		0.8029

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	6.8897496	6.463227	1.07	0.3981
Sum of Oxides	-0.019103	0.067175	-0.28	0.8029

Exhibit A10. Relationships between Li_2O Content and Sum of Oxides of SME Samples

Batch=239
Bivariate Fit of Li2O By Sum of Oxides



Linear Fit
Li2O = 5.1921022 - 0.0001258 Sum of Oxides

Summary of Fit

RSquare	0.000026
RSquare Adj	-0.49996
Root Mean Square Error	0.033003
Mean of Response	5.179877
Observations (or Sum Wgts)	4

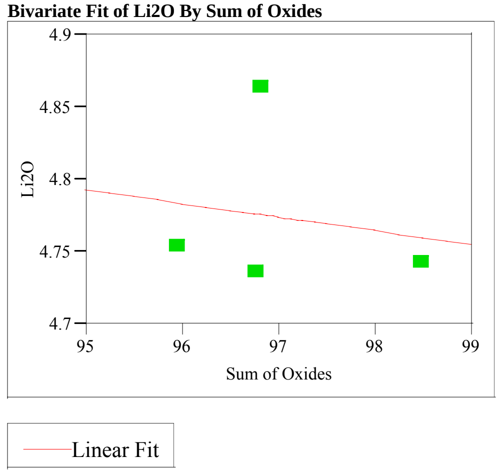
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00000006	0.000000	0.0001
Error	2	0.00217838	0.001089	Prob > F
C. Total	3	0.00217844		0.9949

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	5.1921022	1.692281	3.07	0.0918
Sum of Oxides	-0.000126	0.017412	-0.01	0.9949

Batch=240
Bivariate Fit of Li2O By Sum of Oxides



Linear Fit
Li2O = 5.6847488 - 0.0093903 Sum of Oxides

Summary of Fit

RSquare	0.027753
RSquare Adj	-0.45837
Root Mean Square Error	0.072441
Mean of Response	4.774056
Observations (or Sum Wgts)	4

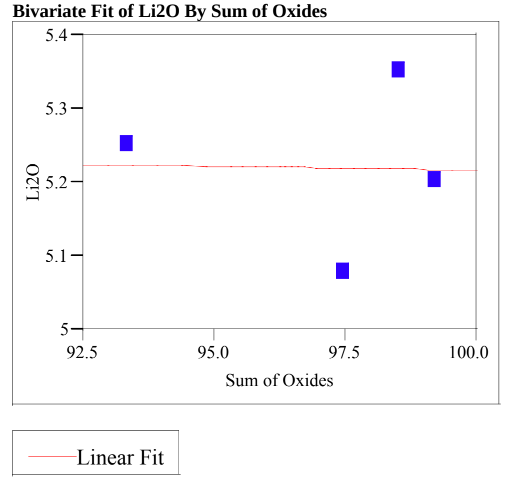
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00029959	0.000300	0.0571
Error	2	0.01049527	0.005248	Prob > F
C. Total	3	0.01079486		0.8334

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	5.6847488	3.811591	1.49	0.2744
Sum of Oxides	-0.00939	0.0393	-0.24	0.8334

Batch=241
Bivariate Fit of Li2O By Sum of Oxides



Linear Fit
Li2O = 5.3172252 - 0.001004 Sum of Oxides

Summary of Fit

RSquare	0.000544
RSquare Adj	-0.49918
Root Mean Square Error	0.139195
Mean of Response	5.219706
Observations (or Sum Wgts)	4

Analysis of Variance

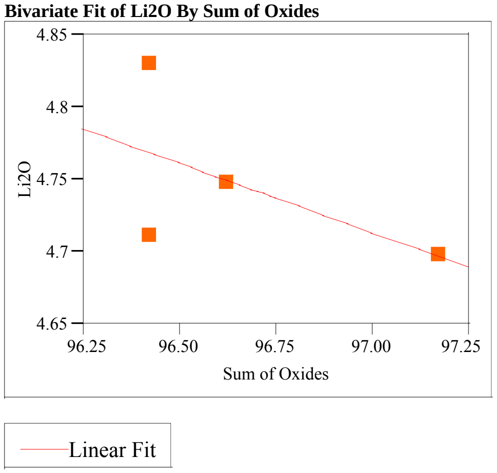
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00002109	0.000021	0.0011
Error	2	0.03875050	0.019375	Prob > F
C. Total	3	0.03877159		0.9767

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	5.3172252	2.956356	1.80	0.2139
Sum of Oxides	-0.001004	0.030429	-0.03	0.9767

Exhibit A10. Relationships between Li_2O Content and Sum of Oxides of SME Samples

Batch=242
Bivariate Fit of Li2O By Sum of Oxides



Linear Fit
Li2O = 14.008491 - 0.0958273 Sum of Oxides

Summary of Fit

RSquare	0.330238
RSquare Adj	-0.00464
Root Mean Square Error	0.059241
Mean of Response	4.746068
Observations (or Sum Wgts)	4

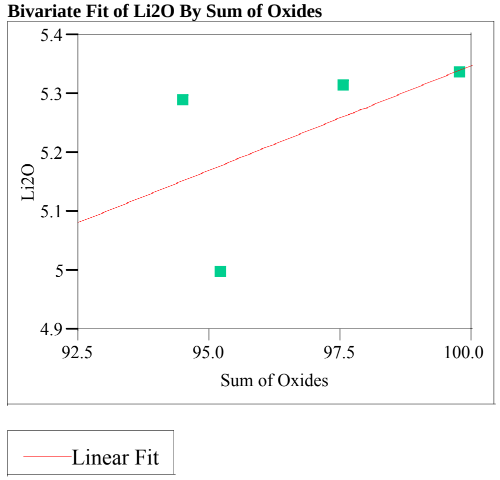
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00346079	0.003461	0.9861
Error	2	0.00701889	0.003509	Prob > F
C. Total	3	0.01047969		0.4253

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	14.008491	9.327354	1.50	0.2720
Sum of Oxides	-0.095827	0.096499	-0.99	0.4253

Batch=243
Bivariate Fit of Li2O By Sum of Oxides



Linear Fit
Li2O = 1.791165 + 0.0355723 Sum of Oxides

Summary of Fit

RSquare	0.28523
RSquare Adj	-0.07216
Root Mean Square Error	0.165438
Mean of Response	5.232623
Observations (or Sum Wgts)	4

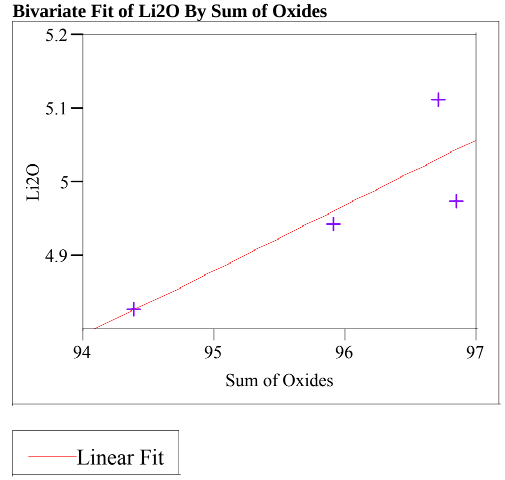
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.02184398	0.021844	0.7981
Error	2	0.05473977	0.027370	Prob > F
C. Total	3	0.07658375		0.4659

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	1.791165	3.853126	0.46	0.6877
Sum of Oxides	0.0355723	0.039818	0.89	0.4659

Batch=244
Bivariate Fit of Li2O By Sum of Oxides



Linear Fit
Li2O = -3.528828 + 0.0885128 Sum of Oxides

Summary of Fit

RSquare	0.719412
RSquare Adj	0.579117
Root Mean Square Error	0.076424
Mean of Response	4.964587
Observations (or Sum Wgts)	4

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.02995010	0.029950	5.1279
Error	2	0.01168128	0.005841	Prob > F
C. Total	3	0.04163138		0.1518

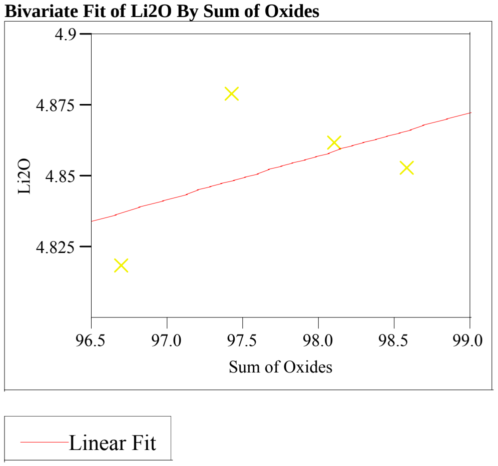
Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	-3.528828	3.750905	-0.94	0.4461
Sum of Oxides	0.0885128	0.039087	2.26	0.1518

Exhibit A10. Relationships between Li_2O Content and Sum of Oxides of SME Samples

Batch=245

Bivariate Fit of Li2O By Sum of Oxides



Linear Fit

Li2O = 3.3504045 + 0.0153763 Sum of Oxides

Summary of Fit

RSquare	0.24709
RSquare Adj	-0.12936
Root Mean Square Error	0.026942
Mean of Response	4.852637
Observations (or Sum Wgts)	4

Analysis of Variance

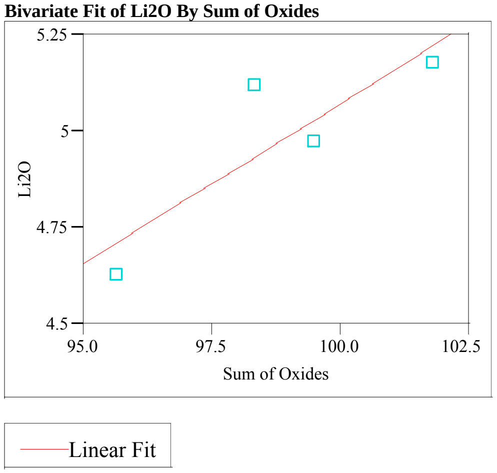
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00047643	0.000476	0.6564
Error	2	0.00145172	0.000726	Prob > F
C. Total	3	0.00192815		0.5029

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	3.3504045	1.854287	1.81	0.2125
Sum of Oxides	0.0153763	0.018979	0.81	0.5029

Batch=246

Bivariate Fit of Li2O By Sum of Oxides



Linear Fit

Li2O = -3.215316 + 0.0828688 Sum of Oxides

Summary of Fit

RSquare	0.746526
RSquare Adj	0.619789
Root Mean Square Error	0.151581
Mean of Response	4.973737
Observations (or Sum Wgts)	4

Analysis of Variance

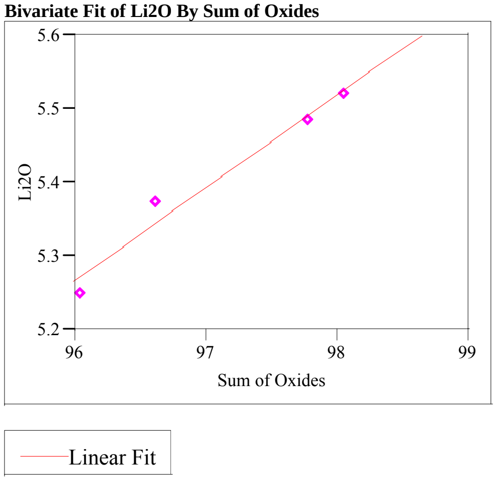
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.13534217	0.135342	5.8904
Error	2	0.04595385	0.022977	Prob > F
C. Total	3	0.18129602		0.1360

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	-3.215316	3.374991	-0.95	0.4413
Sum of Oxides	0.0828688	0.034144	2.43	0.1360

Batch=247

Bivariate Fit of Li2O By Sum of Oxides



Linear Fit

Li2O = -6.857995 + 0.1262854 Sum of Oxides

Summary of Fit

RSquare	0.969353
RSquare Adj	0.95403
Root Mean Square Error	0.026091
Mean of Response	5.407547
Observations (or Sum Wgts)	4

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.04306361	0.043064	63.2593
Error	2	0.00136149	0.000681	Prob > F
C. Total	3	0.04442511		0.0154

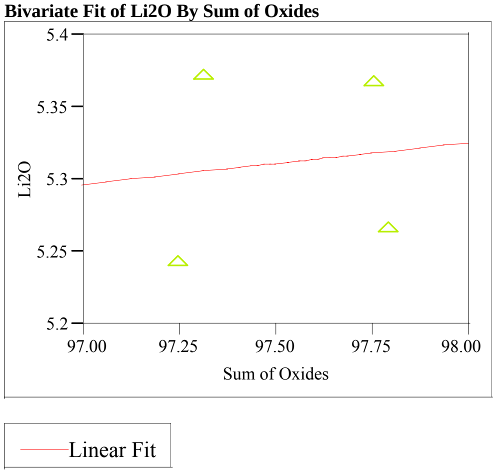
Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	-6.857995	1.542198	-4.45	0.0470
Sum of Oxides	0.1262854	0.015878	7.95	0.0154

Exhibit A10. Relationships between Li_2O Content and Sum of Oxides of SME Samples

Batch=248

Bivariate Fit of Li2O By Sum of Oxides



Linear Fit

Li2O = 2.5046377 + 0.0287829 Sum of Oxides

Summary of Fit

RSquare	0.015138
RSquare Adj	-0.47729
Root Mean Square Error	0.081704
Mean of Response	5.311743
Observations (or Sum Wgts)	4

Analysis of Variance

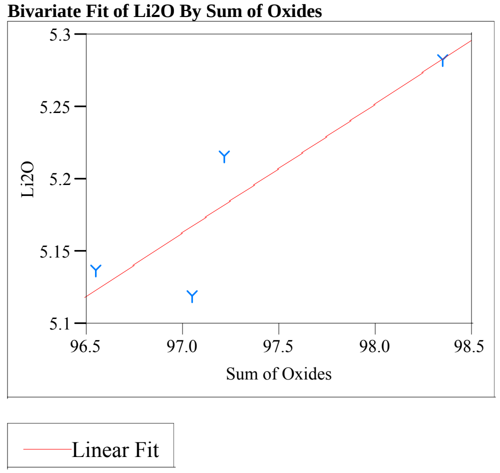
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00020522	0.000205	0.0307
Error	2	0.01335093	0.006675	Prob > F
C. Total	3	0.01355615		0.8770

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	2.5046377	16.01002	0.16	0.8900
Sum of Oxides	0.0287829	0.16416	0.18	0.8770

Batch=249

Bivariate Fit of Li2O By Sum of Oxides



Linear Fit

Li2O = -3.408634 + 0.0883675 Sum of Oxides

Summary of Fit

RSquare	0.785508
RSquare Adj	0.678262
Root Mean Square Error	0.042913
Mean of Response	5.189027
Observations (or Sum Wgts)	4

Analysis of Variance

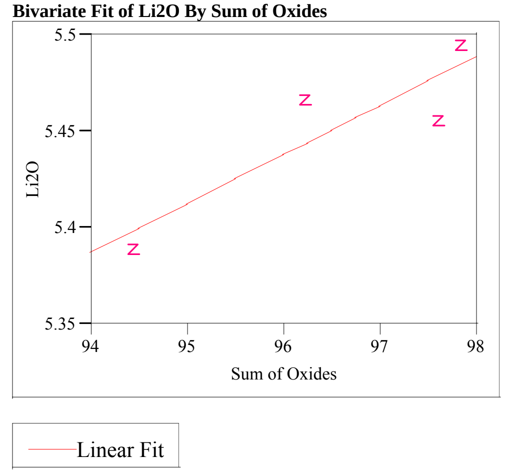
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.01348830	0.013488	7.3244
Error	2	0.00368313	0.001842	Prob > F
C. Total	3	0.01717144		0.1137

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	-3.408634	3.176913	-1.07	0.3956
Sum of Oxides	0.0883675	0.032652	2.71	0.1137

Batch=250

Bivariate Fit of Li2O By Sum of Oxides



Linear Fit

Li2O = 2.9946469 + 0.0254487 Sum of Oxides

Summary of Fit

RSquare	0.79429
RSquare Adj	0.691436
Root Mean Square Error	0.024837
Mean of Response	5.451143
Observations (or Sum Wgts)	4

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00476389	0.004764	7.7224
Error	2	0.00123378	0.000617	Prob > F
C. Total	3	0.00599766		0.1088

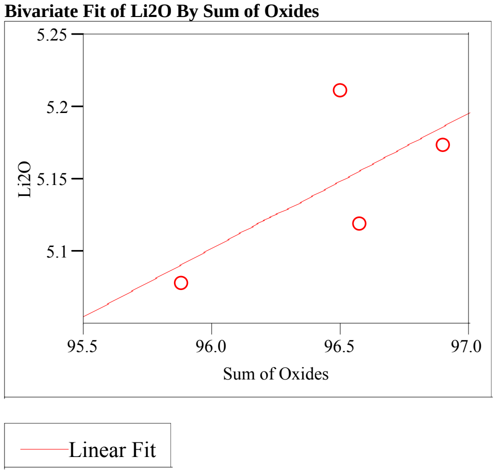
Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	2.9946469	0.884059	3.39	0.0772
Sum of Oxides	0.0254487	0.009158	2.78	0.1088

Exhibit A10. Relationships between Li_2O Content and Sum of Oxides of SME Samples

Batch=251

Bivariate Fit of Li2O By Sum of Oxides



Linear Fit

Li2O = -3.889327 + 0.0936614 Sum of Oxides

Summary of Fit

RSquare	0.457718
RSquare Adj	0.186578
Root Mean Square Error	0.052995
Mean of Response	5.145969
Observations (or Sum Wgts)	4

Analysis of Variance

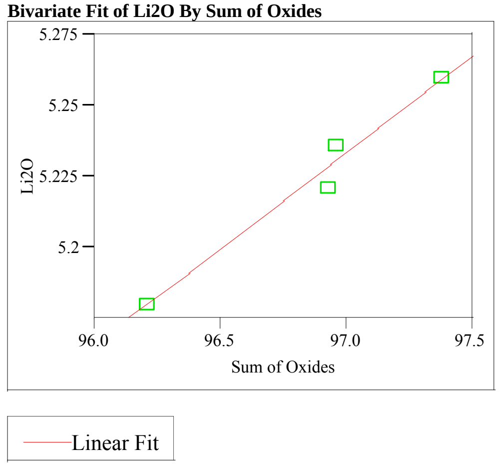
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00474106	0.004741	1.6881
Error	2	0.00561696	0.002808	Prob > F
C. Total	3	0.01035802		0.3235

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	-3.889327	6.954146	-0.56	0.6322
Sum of Oxides	0.0936614	0.072087	1.30	0.3235

Batch=252

Bivariate Fit of Li2O By Sum of Oxides



Linear Fit

Li2O = -1.359193 + 0.0679639 Sum of Oxides

Summary of Fit

RSquare	0.974115
RSquare Adj	0.961172
Root Mean Square Error	0.006595
Mean of Response	5.224012
Observations (or Sum Wgts)	4

Analysis of Variance

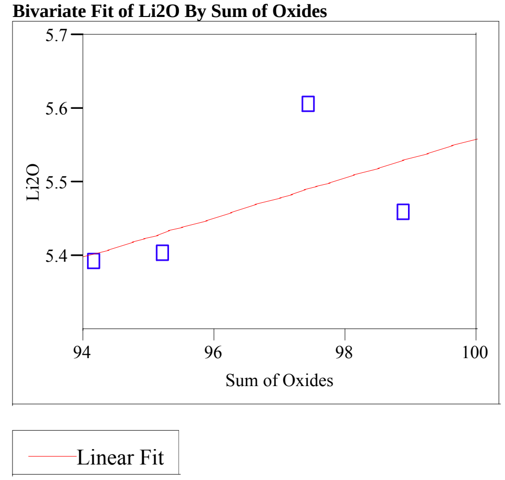
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00327338	0.003273	75.2638
Error	2	0.00008698	0.000043	Prob > F
C. Total	3	0.00336036		0.0130

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	-1.359193	0.758837	-1.79	0.2151
Sum of Oxides	0.0679639	0.007834	8.68	0.0130

Batch=253

Bivariate Fit of Li2O By Sum of Oxides



Linear Fit

Li2O = 2.8787888 + 0.0268065 Sum of Oxides

Summary of Fit

RSquare	0.339065
RSquare Adj	0.008598
Root Mean Square Error	0.097692
Mean of Response	5.463522
Observations (or Sum Wgts)	4

Analysis of Variance

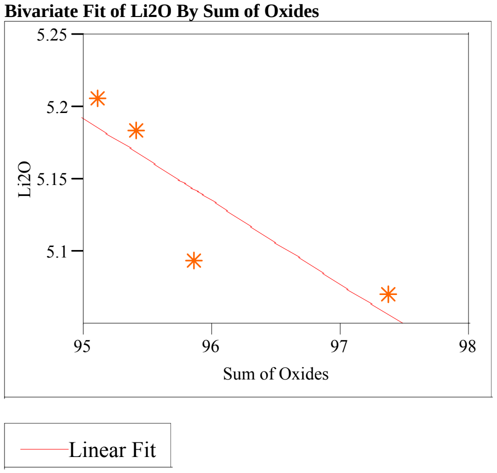
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00979200	0.009792	1.0260
Error	2	0.01908739	0.009544	Prob > F
C. Total	3	0.02887939		0.4177

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	2.8787888	2.552219	1.13	0.3765
Sum of Oxides	0.0268065	0.026464	1.01	0.4177

Exhibit A10. Relationships between Li_2O Content and Sum of Oxides of SME Samples

Batch=254
Bivariate Fit of Li2O By Sum of Oxides



Linear Fit
Li2O = 10.661639 - 0.0575656 Sum of Oxides

Summary of Fit

RSquare	0.75514
RSquare Adj	0.63271
Root Mean Square Error	0.040333
Mean of Response	5.138434
Observations (or Sum Wgts)	4

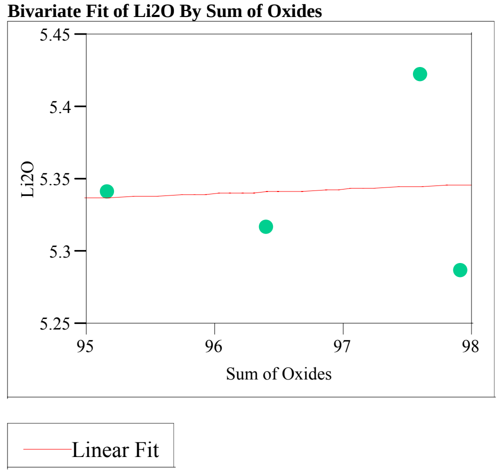
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.01003379	0.010034	6.1679
Error	2	0.00325353	0.001627	Prob > F
C. Total	3	0.01328732		0.1310

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	10.661639	2.224021	4.79	0.0409
Sum of Oxides	-0.057566	0.023179	-2.48	0.1310

Batch=255
Bivariate Fit of Li2O By Sum of Oxides



Linear Fit
Li2O = 5.0346382 + 0.0031804 Sum of Oxides

Summary of Fit

RSquare	0.004704
RSquare Adj	-0.49294
Root Mean Square Error	0.071057
Mean of Response	5.342421
Observations (or Sum Wgts)	4

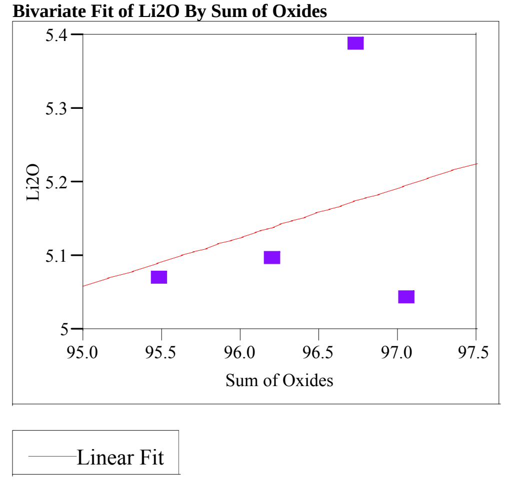
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00004772	0.000048	0.0095
Error	2	0.01009825	0.005049	Prob > F
C. Total	3	0.01014597		0.9314

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	5.0346382	3.166063	1.59	0.2528
Sum of Oxides	0.0031804	0.032714	0.10	0.9314

Batch=256
Bivariate Fit of Li2O By Sum of Oxides



Linear Fit
Li2O = -1.313879 + 0.067078 Sum of Oxides

Summary of Fit

RSquare	0.082608
RSquare Adj	-0.37609
Root Mean Square Error	0.188518
Mean of Response	5.149737
Observations (or Sum Wgts)	4

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00640033	0.006400	0.1801
Error	2	0.07107797	0.035539	Prob > F
C. Total	3	0.07747830		0.7126

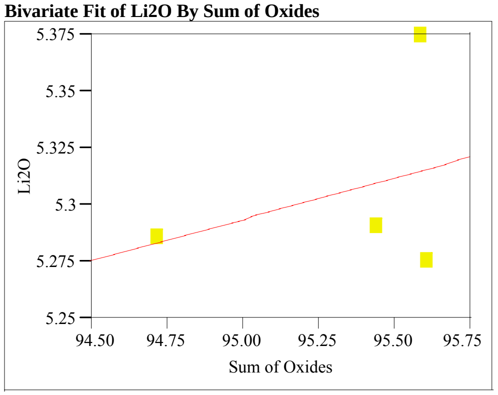
Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	-1.313879	15.23124	-0.09	0.9391
Sum of Oxides	0.067078	0.158063	0.42	0.7126

Exhibit A10. Relationships between Li_2O Content and Sum of Oxides of SME Samples

Batch=257

Bivariate Fit of Li2O By Sum of Oxides



Linear Fit

Linear Fit

Li2O = 1.8205285 + 0.0365572 Sum of Oxides

Summary of Fit

RSquare	0.114247
RSquare Adj	-0.32863
Root Mean Square Error	0.052622
Mean of Response	5.305822
Observations (or Sum Wgts)	4

Analysis of Variance

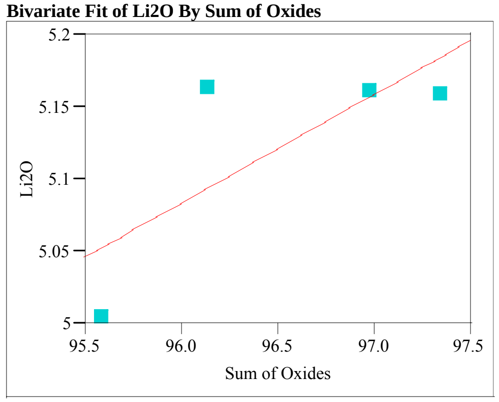
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00071434	0.000714	0.2580
Error	2	0.00553825	0.002769	Prob > F
C. Total	3	0.00625259		0.6620

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	1.8205285	6.862171	0.27	0.8156
Sum of Oxides	0.0365572	0.071977	0.51	0.6620

Batch=258

Bivariate Fit of Li2O By Sum of Oxides



Linear Fit

Linear Fit

Li2O = -2.122348 + 0.0750586 Sum of Oxides

Summary of Fit

RSquare	0.576473
RSquare Adj	0.36471
Root Mean Square Error	0.062649
Mean of Response	5.121211
Observations (or Sum Wgts)	4

Analysis of Variance

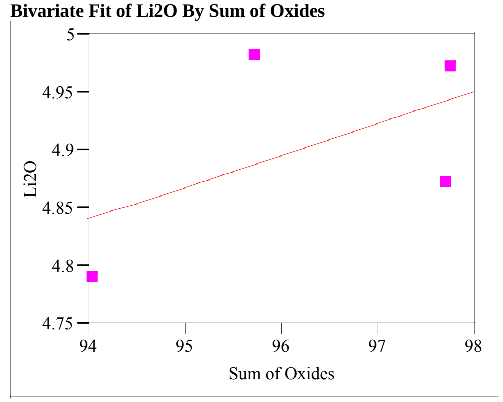
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.01068443	0.010684	2.7223
Error	2	0.00784969	0.003925	Prob > F
C. Total	3	0.01853412		0.2407

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	-2.122348	4.390346	-0.48	0.6766
Sum of Oxides	0.0750586	0.045492	1.65	0.2407

Batch=259

Bivariate Fit of Li2O By Sum of Oxides



Linear Fit

Linear Fit

Li2O = 2.2337289 + 0.0277295 Sum of Oxides

Summary of Fit

RSquare	0.299651
RSquare Adj	-0.05052
Root Mean Square Error	0.092667
Mean of Response	4.903768
Observations (or Sum Wgts)	4

Analysis of Variance

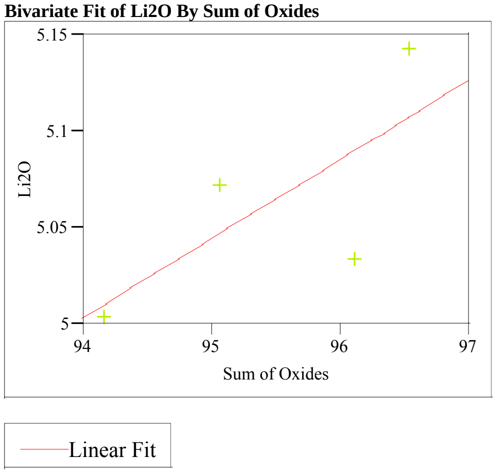
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00734819	0.007348	0.8557
Error	2	0.01717432	0.008587	Prob > F
C. Total	3	0.02452251		0.4526

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	2.2337289	2.886744	0.77	0.5200
Sum of Oxides	0.0277295	0.029976	0.93	0.4526

Exhibit A10. Relationships between Li_2O Content and Sum of Oxides of SME Samples

Batch=260
Bivariate Fit of Li2O By Sum of Oxides



Linear Fit
Li2O = 1.1498706 + 0.0409917 Sum of Oxides

Summary of Fit

RSquare	0.528325
RSquare Adj	0.292488
Root Mean Square Error	0.050842
Mean of Response	5.063083
Observations (or Sum Wgts)	4

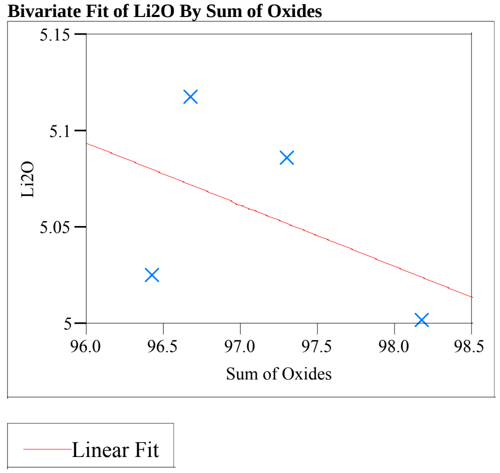
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00579074	0.005791	2.2402
Error	2	0.00516982	0.002585	Prob > F
C. Total	3	0.01096057		0.2731

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	1.1498706	2.614627	0.44	0.7031
Sum of Oxides	0.0409917	0.027387	1.50	0.2731

Batch=261
Bivariate Fit of Li2O By Sum of Oxides



Linear Fit
Li2O = 8.1612185 - 0.031954 Sum of Oxides

Summary of Fit

RSquare	0.215561
RSquare Adj	-0.17666
Root Mean Square Error	0.058055
Mean of Response	5.057162
Observations (or Sum Wgts)	4

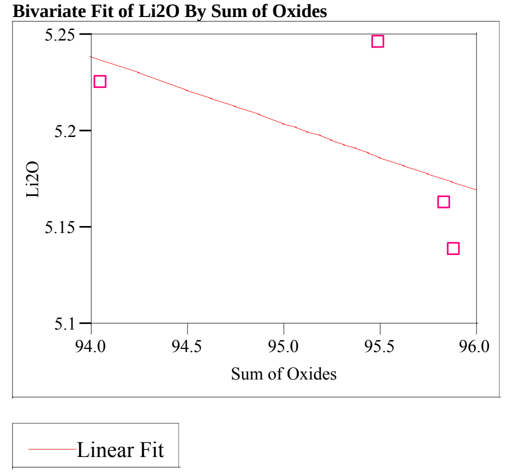
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00185237	0.001852	0.5496
Error	2	0.00674088	0.003370	Prob > F
C. Total	3	0.00859325		0.5357

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	8.1612185	4.187158	1.95	0.1906
Sum of Oxides	-0.031954	0.043103	-0.74	0.5357

Batch=262
Bivariate Fit of Li2O By Sum of Oxides



Linear Fit
Li2O = 8.521486 - 0.0349198 Sum of Oxides

Summary of Fit

RSquare	0.351198
RSquare Adj	0.026796
Root Mean Square Error	0.050121
Mean of Response	5.193333
Observations (or Sum Wgts)	4

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00271964	0.002720	1.0826
Error	2	0.00502425	0.002512	Prob > F
C. Total	3	0.00774389		0.4074

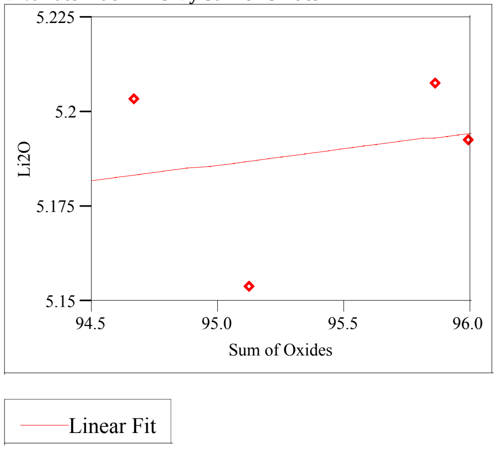
Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	8.521486	3.198763	2.66	0.1167
Sum of Oxides	-0.03492	0.033561	-1.04	0.4074

Exhibit A10. Relationships between Li_2O Content and Sum of Oxides of SME Samples

Batch=263

Bivariate Fit of Li2O By Sum of Oxides



Linear Fit

Li2O = 4.3854703 + 0.0084274 Sum of Oxides

Summary of Fit

RSquare	0.046186
RSquare Adj	-0.43072
Root Mean Square Error	0.029323
Mean of Response	5.189565
Observations (or Sum Wgts)	4

Analysis of Variance

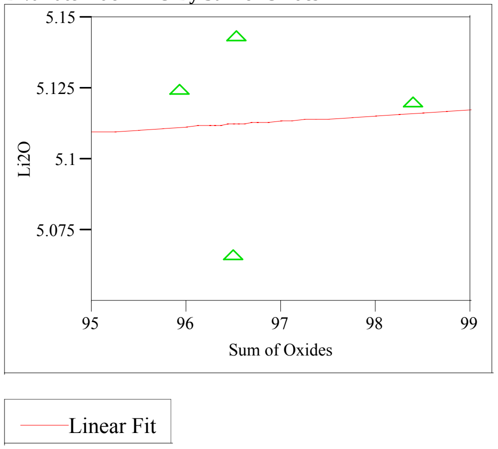
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00008327	0.000083	0.0968
Error	2	0.00171973	0.000860	Prob > F
C. Total	3	0.00180301		0.7851

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	4.3854703	2.583916	1.70	0.2317
Sum of Oxides	0.0084274	0.02708	0.31	0.7851

Batch=264

Bivariate Fit of Li2O By Sum of Oxides



Linear Fit

Li2O = 4.9223189 + 0.0019702 Sum of Oxides

Summary of Fit

RSquare	0.004083
RSquare Adj	-0.49387
Root Mean Square Error	0.040595
Mean of Response	5.113138
Observations (or Sum Wgts)	4

Analysis of Variance

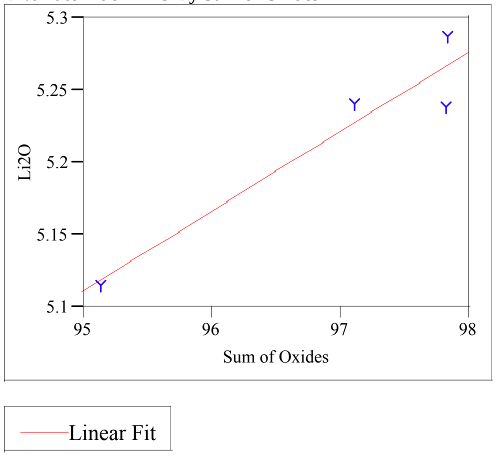
Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.00001351	0.000014	0.0082
Error	2	0.00329586	0.001648	Prob > F
C. Total	3	0.00330937		0.9361

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	4.9223189	2.107297	2.34	0.1446
Sum of Oxides	0.0019702	0.021757	0.09	0.9361

Batch=265

Bivariate Fit of Li2O By Sum of Oxides



Linear Fit

Li2O = -0.129792 + 0.0551634 Sum of Oxides

Summary of Fit

RSquare	0.912886
RSquare Adj	0.869329
Root Mean Square Error	0.026608
Mean of Response	5.220244
Observations (or Sum Wgts)	4

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.01483779	0.014838	20.9584
Error	2	0.00141592	0.000708	Prob > F
C. Total	3	0.01625371		0.0445

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	-0.129792	1.168706	-0.11	0.9217
Sum of Oxides	0.0551634	0.01205	4.58	0.0445