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SULFATE RETENTION IN HIGH LEVEL WASTE (HLW) SLUDGE BATCH 4 (SB4) GLASSES: A PRELIMINARY ASSESSMENT

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Prepared for the U.S. Department of Energy Under
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EXECUTIVE SUMMARY

Early projections of the Sludge Batch 4 (SB4) composition predicted relatively high concentrations of alumina (Al_2O_3, 23.5 wt%) and sulfate (SO_4^{2-}, 1.2 wt%) in the sludge. A high concentration of Al_2O_3 in the sludge, combined with Na_2O additions in the frit, raises the potential for nepheline crystallization in the glass. However, strategic frit development efforts at the Savannah River National Laboratory (SRNL) have shown that frits containing a relatively high concentration of B_2O_3 can both suppress nepheline crystallization and improve melt rates. A high sulfate concentration is a concern to the DWPF as it can lead to the formation of sulfate inclusions in the glass and/or the formation of a molten, sulfate-rich phase atop the melt pool. To avoid these issues, a sulfate concentration limit of 0.4 wt% SO_4^{2-} in glass was originally set in the Product Composition Control System (PCCS) used at DWPF. It was later shown that this limit could be increased to 0.6 wt% SO_4^{2-} in glass for the Frit 418, Sludge Batch 3 (SB3) system.

Two frits have been evaluated for use with the early projections of SB4. Frit 418, which has been used previously with SB3, has been shown to produce glasses with SB4 that have an acceptable and predictable durability. Frit 503, a high boron concentration frit, has also been shown to produce durable glasses with SB4, and has advantages in melt rate over Frit 418. The applicability of the current 0.6 wt% sulfate limit to the SB4 / Frit 418 or Frit 503 system, and/or the possibility of increasing the sulfate limit for SB4 are the subjects of this study.

Ten glasses were fabricated in the laboratory using the May 2006 SB4 composition projection and Frits 418 and 503 at 38% waste loading. The glasses were intentionally spiked to relatively high sulfate concentrations of between 0.6 and 0.8 wt% in the glass (as compared to the nominal value of 0.49 wt%). The glasses were batched from laboratory chemicals and melted following standard SRNL procedures. No sulfur salt layer was visually observed on any of the study glasses after pouring and quenching. The measured compositions of each of the glasses met the target values. The LRM glass standard results indicated that sulfate concentration was measured accurately in this study. Sulfate volatilization occurred in all of the study glasses, as evidenced by measured sulfate concentrations that fell below the targeted values. However, the glasses that targeted the highest sulfate concentrations using either Frit 418 or Frit 503 retained sulfate at concentrations at or above the previous limit of 0.6 wt% established for SB3 processing. These results imply that this same limit may be extended to SB4 processing. Note however that these results are based on a SB4 composition projection provided in May 2006, and therefore should not be used as the sole technical basis for establishing the sulfate limit. Additional experimental work should be undertaken to verify these results using the most current composition projection for SB4.

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LIST OF ABBREVIATIONS

ANOVA	ANalysis Of VAriance
ASTM	American Society for Testing and Materials
bc	bias-corrected
DWPF	Defense Waste Processing Facility
HLW	High Level Waste
ICP-AES	Inductively Coupled Plasma – Atomic Emission Spectroscopy
LM	Lithium-Metaborate
LRM	Low-level waste Reference Material
LWO	Liquid Waste Operations
PCCS	Product Composition Control System
PF	Peroxide Fusion
PSAL	Process Science Analytical Laboratory
SB3 / SB4	Sludge Batch 3 / Sludge Batch 4
SRNL	Savannah River National Laboratory
WL	Waste Loading (weight percent)

1.0 Introduction

Early projections of the Sludge Batch 4 (SB4) composition predicted relatively high concentrations of alumina (Al_2O_3) and sulfate (SO_4^{2-}) in the sludge.[1] This raises several issues with regard to frit development for production of a durable, vitrified waste form at the Defense Waste Processing Facility (DWPF).

A high concentration of Al_2O_3 in the sludge, combined with relatively high Na_2O concentrations from the sludge or frit, raises the potential for nepheline crystallization in the glass. Nepheline crystallization can have a strongly negative impact on chemical durability of the glass. However, strategic frit development efforts at the Savannah River National Laboratory (SRNL) have shown that frits containing a relatively high concentration of B_2O_3 can both suppress nepheline crystallization and improve melt rates.[2-6]

A high sulfate concentration is a concern to the DWPF as it can lead to the formation of sulfate inclusions in the glass and/or the formation of a molten, sulfate-rich phase atop the melt pool. To avoid these issues, a sulfate concentration limit of 0.4 wt% SO_4^{2-} in glass was originally set in the Product Composition Control System (PCCS) used at DWPF.[7, 8] It was later shown that this limit could be increased to 0.6 wt% SO_4^{2-} in glass for the Frit 418 / SB3 system.[9]

Two frits have been evaluated for use with the early projections of SB4.[10] Frit 418, which has been used previously with Sludge Batch 3 (SB3), has been shown to produce glasses with SB4 that have an acceptable and predictable durability.[11] Frit 503, a high boron concentration frit, has also been shown to produce durable glasses with SB4,[2, 12] and has advantages in melt rate over Frit 418.[6]

The applicability of the current sulfate limit to the SB4 / Frit 418 or Frit 503 system, and/or the possibility of increasing the sulfate limit for SB4 are the subjects of this study. It should be noted that the data presented in this report are not sufficient to provide a technical basis for DWPF operation but do provide valuable insight into the compositional effects of SO_4^{2-} solubility for the compositional region of interest as defined by SB4.

Glasses based on both Frit 418 and Frit 503 with SB4 at 38% waste loading (WL) were made with spiked SO_4^{2-} concentrations of up to 0.8 wt%. Chemical composition measurements along with a thorough statistical analysis of the errors associated with these measurements were used to evaluate the amount of sulfate retained in the study glasses after melting and quenching.

It should be noted that more recent projections of the SB4 composition[13] have indicated reduced concentrations of SO_4^{2-}, to a point where sulfate solubility is not of major concern for processing of this sludge batch. However, the data presented here remain relevant to SB4 processing (i.e., can be used to establish the technical basis for the SB4 SO_4^{2-} limit once a frit recommendation is made), and will aid in frit development for future sludge batches.

This work was initiated by a Technical Task Request[14] and is covered by a Technical Task and Quality Assurance Plan.[15]

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2.0 Experimental Procedure

2.1 Glass Selection

Ten glass compositions were selected for this study. A Blend 1, 0.96 M Na^+ sludge composition was used in defining the glasses, as this was the most recent composition projection for SB4 available at the time these experiments were undertaken.[a] The nominal SO_4^{2-} concentration in this projection was 1.3 wt%. A high B_2O_3 frit (Frit 503) was chosen for this study based on preliminary melt rate experiments[6] and the assessments associated with projected operating windows.[16] The melt rate experiments showed a significant improvement in melt rate for Frit 503 / SB4 glasses compared with earlier, lower B_2O_3 frits.[6] A second frit, Frit 418, was also included in this study, as SRNL has identified this frit as being viable for use during the transition from SB3 to SB4 at DWPF.[10] The compositions of both frits are given in Table 2-1.

Table 2-1. Compositions of Frits Used in the Sulfate Study (in wt%).

Frit ID	B_2O_3	Li_2O	Na_2O	SiO_2
418	8	8	8	76
503	14	8	4	74

The frits and sludge were combined at a waste loading of 38 wt%, as this WL is seen as a likely upper bound for DWPF processing of SB4. At 38 wt% WL, the nominal SO_4^{2-} concentration for SB4 glass is 0.49 wt%, using either Frit 418 or Frit 503. These compositions were then adjusted (or spiked) with increased SO_4^{2-} concentrations with the intent of measuring the amount of SO_4^{2-} that can be retained in the Frit 418 and Frit 503 / SB4 systems. Targeted sulfate concentrations in the glass were spiked to 0.60, 0.65, 0.70, 0.75 and 0.80 wt%, and the remaining glass components were renormalized.

The target compositions of the five Frit 418 / SB4 glasses are listed in Table 2-2. The target compositions for the five Frit 503 / SB4 glasses are listed in Table 2-3.

[a] Projected compositions provided by H. Shah on 5/9/06. For more details, see pages 28 - 33 of WSRC-NB-2006-00017.

Table 2-2. Target Compositions of the Frit 418 Sulfate Study Glasses (in wt%).

Glass IDs	SB4SULFA-01	SB4SULFA-02	SB4SULFA-03	SB4SULFA-04	SB4SULFA-05
Al_2O_3	8.93	8.92	8.92	8.91	8.91
B_2O_3	4.95	4.95	4.95	4.95	4.94
BaO	0.05	0.05	0.05	0.05	0.05
CaO	0.90	0.90	0.90	0.90	0.90
Ce_2O_3	0.06	0.06	0.06	0.06	0.06
Cr_2O_3	0.08	0.08	0.08	0.08	0.08
CuO	0.02	0.02	0.02	0.02	0.02
Fe_2O_3	10.04	10.03	10.03	10.02	10.02
K_2O	0.12	0.12	0.12	0.12	0.12
La_2O_3	0.04	0.04	0.04	0.04	0.04
Li_2O	4.95	4.95	4.95	4.95	4.94
MgO	0.96	0.96	0.96	0.96	0.96
MnO	2.07	2.07	2.07	2.06	2.06
Na_2O	13.97	13.96	13.96	13.95	13.94
NiO	0.59	0.59	0.59	0.59	0.59
PbO	0.04	0.04	0.04	0.04	0.04
SO_4^{2-}	0.60	0.65	0.70	0.75	0.80
SiO_2	48.56	48.54	48.52	48.49	48.47
ThO_2	0.02	0.02	0.02	0.02	0.02
TiO_2	0.01	0.01	0.01	0.01	0.01
U_3O_8	2.91	2.91	2.91	2.91	2.91
ZnO	0.04	0.04	0.04	0.04	0.04
ZrO_2	0.09	0.09	0.09	0.09	0.09
Sum	100.00	100.00	100.00	100.00	100.00

Table 2-3. Target Compositions of the Frit 503 Sulfate Study Glasses (in wt%).

Glass IDs	SB4SULFA-06	SB4SULFA-07	SB4SULFA-08	SB4SULFA-09	SB4SULFA-10
Al_2O_3	8.93	8.92	8.92	8.91	8.91
B_2O_3	8.67	8.67	8.66	8.66	8.65
BaO	0.05	0.05	0.05	0.05	0.05
CaO	0.90	0.90	0.90	0.90	0.90
Ce_2O_3	0.06	0.06	0.06	0.06	0.06
Cr_2O_3	0.08	0.08	0.08	0.08	0.08
CuO	0.02	0.02	0.02	0.02	0.02
Fe_2O_3	10.04	10.03	10.03	10.02	10.02
K_2O	0.12	0.12	0.12	0.12	0.12
La_2O_3	0.04	0.04	0.04	0.04	0.04
Li_2O	4.95	4.95	4.95	4.95	4.94
MgO	0.96	0.96	0.96	0.96	0.96
MnO	2.07	2.07	2.07	2.06	2.06
Na_2O	11.49	11.49	11.48	11.48	11.47
NiO	0.59	0.59	0.59	0.59	0.59
PbO	0.04	0.04	0.04	0.04	0.04
SO_4^{2-}	0.60	0.65	0.70	0.75	0.80
SiO_2	47.33	47.30	47.28	47.25	47.23
ThO_2	0.02	0.02	0.02	0.02	0.02
TiO_2	0.01	0.01	0.01	0.01	0.01
U_3O_8	2.91	2.91	2.91	2.91	2.91
ZnO	0.04	0.04	0.04	0.04	0.04
ZrO_2	0.09	0.09	0.09	0.09	0.09
Sum	100.00	100.00	100.00	100.00	100.00

2.2 Glass Fabrication

Each sulfate study glass was prepared from the proper proportions of reagent-grade metal oxides, carbonates, boric acid, and salts in 150 g batches.[17] The raw materials were thoroughly mixed and placed into a 95% platinum/5% gold, 250 mL crucible. The crucibles were placed into a high-temperature furnace at the target melt temperature of 1150°C.[18] After an isothermal hold at 1150°C for 1.0 h, the crucibles were removed from the furnace. The glass was poured onto a clean stainless steel plate and allowed to air cool (quench). Visual observations of the quenched glasses and the emptied crucibles were documented.[a] The glass pour patty was used as a sampling stock for the chemical composition measurements.

2.3 Analysis of Glass Composition

To confirm that the as-fabricated glasses corresponded to the defined target compositions and to determine the amount of sulfate retained in the glasses after melting, a representative sample from each glass was submitted to the SRNL Process Science Analytical Laboratory (PSAL) for chemical analysis under the auspices of an analytical plan. The plan (see Appendix A) identified the cations to be analyzed and the two dissolution techniques, sodium peroxide fusion (PF) and lithium-metaborate (LM), to be used. The samples prepared by LM were used to measure barium

[a] WSRC-NB-2005-00004 (see page 142) contains the visual observations of the quenched glasses.

(Ba), calcium (Ca), cerium (Ce), chromium (Cr), copper (Cu), potassium (K), lanthanum (La), magnesium (Mg), manganese (Mn), sodium (Na), lead (Pb), sulfur (S), thorium (Th), titanium (Ti), zinc (Zn), and zirconium (Zr) concentrations. Samples prepared by PF were used to measure aluminum (Al), boron (B), iron (Fe), lithium (Li), nickel (Ni), silicon (Si), and uranium (U) concentrations. Each glass was prepared in duplicate for each cation dissolution technique (PF and LM). All of the prepared samples were analyzed (twice for each element of interest) by Inductively Coupled Plasma – Atomic Emission Spectroscopy (ICP-AES) with the instrumentation being re-calibrated between the duplicate analyses. The analytical plan was developed in such a way as to provide the opportunity to evaluate potential sources of error. Glass standards were also intermittently measured to assess the performance of the ICP-AES instrument over the course of these analyses. However, the standards typically used for high level waste (HLW) glass analysis at SRNL do not contain sulfur. Additional samples of the low-level waste reference material (LRM) glass,[19-21] which contains 0.24 wt% SO_4^{2-}, were also included in the analytical plan to help verify the SO_4^{2-} measurements from PSAL.

3.0 Results and Discussion

3.1 Visual Observations

Prior to discussing the results, a few words regarding the terminology used to describe the appearance of the glasses are warranted. The use of "clean" or "homogeneous" for visual observations indicates that the sample was classified as a single-phase, amorphous system (i.e., no evidence of crystallization). The description "undissolved material" is indicative of batch chemicals that were not incorporated into the melt before pouring and quenching. Bubbles observed in the glass that remained in the crucible after pouring are likely formed during decomposition of some of the batch chemicals during the melting process.

Table 3-1 contains the visual observations for each of the ten study glasses after pouring and quenching. All of the pour patties appeared amorphous and homogeneous, with no sulfur salt layer apparent on any of the glasses. The lack of a salt layer indicates that either sulfur retention in the glass was good, or some degree of volatilization has occurred. The chemical composition measurements will provide a quantitative measure of the sulfur retention. Small amounts of undissolved batch material were observed in some of the glass remaining in the crucibles. The chemical composition measurements will show that the undissolved batch material had little impact on the composition of the quenched glasses.

Table 3-1. Visual Observations for the Sulfate Study Glasses.

Glass ID	Frit ID	Target SO_4^{2-} (wt%)	Visual Observations
SB4SULFA-01	418	0.60	Patty – Clean, homogeneous; Crucible – clean with bubbles
SB4SULFA-02	418	0.65	Patty – Clean, homogeneous; Crucible – clean with bubbles
SB4SULFA-03	418	0.70	Patty – Clean, homogeneous; Crucible – clean with bubbles
SB4SULFA-04	418	0.75	Patty – Clean, homogeneous; Crucible – about four tiny spots of undissolved material, bubbles
SB4SULFA-05	418	0.80	Patty – Clean, homogeneous; Crucible – about five tiny spots of undissolved material, bubbles
SB4SULFA-06	503	0.60	Patty – Clean, homogeneous; Crucible – clean with bubbles
SB4SULFA-07	503	0.65	Patty – Clean, homogeneous; Crucible – clean with bubbles
SB4SULFA-08	503	0.70	Patty – Clean, homogeneous; Crucible – one spot of undissolved material, bubbles
SB4SULFA-09	503	0.75	Patty – Clean, homogeneous; Crucible – clean with bubbles
SB4SULFA-10	503	0.80	Patty – Clean, homogeneous; Crucible – four tiny spots of undissolved material, bubbles

3.2 Chemical Composition Measurements

This section provides a statistical review of the chemical composition measurements. The measured versus targeted compositions of the ten glasses (SB4SULFA-01 through SB4SULFA-10) are presented and compared. The targeted compositions for these glasses are provided in Table 2-2 and Table 2-3, as well as Table B1 of Appendix B. A sum of oxides column is provided in this table as well. Chemical composition measurements for the study glasses were conducted by the PSAL following the analytical plan provided in the Appendix A.

Two dissolution methods, LM and PF, were utilized in measuring these chemical compositions. For each study glass, measurements were obtained from samples prepared in duplicate by each of these dissolution methods. All of the prepared samples were analyzed twice for each element of interest by ICP-AES with the instrumentation being re-calibrated between the duplicate analyses. Note that the analytical plan had indicated that aluminum and nickel would be measured by PF. As these measurements were conducted, a decision was made by PSAL personnel to obtain the measurements for these two elements from the LM dissolution method instead.

Table B2 in Appendix B provides the elemental concentration measurements derived from the samples prepared using LM, and Table B3 in Appendix B provides the measurements derived from the samples prepared using PF. Measurements for standards (Batch 1 and a uranium standard, U_{std}) that were included in the PSAL analytical plan along with the study glasses are also provided in these two tables.

The elemental concentrations were converted to oxide concentrations by multiplying the values for each element by the gravimetric factor for the corresponding oxide. During this process, an elemental concentration that was determined to be below the detection limit of the analytical procedures used by the PSAL was reduced to half of that detection limit as the oxide concentration was determined.

In the sections that follow, the analytical sequences of the measurements are explored, the measurements of the standards are investigated and used for bias correction, the measurements for each glass are reviewed, the average chemical compositions (measured and bias-corrected) for each glass are determined, and comparisons are made between the measurements and the targeted compositions for the glasses.

3.2.1 *Measurements in Analytical Sequence*

Exhibit B1 in Appendix B provides plots of the measurements generated by the PSAL for samples prepared using the LM method. The plots are in analytical sequence with different symbols and colors being used to represent each of the study and standard glasses. Similar plots for the samples prepared using the PF method are provided in Exhibit B2 in Appendix B. These plots include all of the measurement data from Tables B2 and B3. There are several points of interest for these plots. The plots reveal one or more anomalies in the measurements for the LRM samples for CaO, Cr_2O_3, La_2O_3, PbO, and ZrO_2 for the LM preparation method and for B_2O_3 for the PF preparation method. However, the LRM glass was used only to assess the ability of the ICP-AES method to correctly measure SO_4^{2-} concentration, which is discussed further in Section 3.3. Also, in general, there appears to be more scatter in the SiO_2 values early in the analytical sequence as opposed to later in the analytical sequence. A closer look at some of these anomalies will be provided in the discussion that follows.

3.2.2 *Batch 1 and Uranium Standard Results*

In this section, the PSAL measurements of the chemical compositions of the Batch 1 and uranium standard (U_{std}) glasses are reviewed. These measurements are investigated across the ICP-AES analytical blocks, and the results are used to bias correct the measurements for the study glasses.

Exhibit B3 in Appendix B provides statistical analyses of the Batch 1 and U_{std} results generated by the LM prep method by block/sub-block for each oxide of interest. The results include analysis of variance (ANOVA) investigations looking for statistically significant differences between the means of these groups for each of the oxides for each of the standards. The results from the statistical tests for the Batch 1 standard reveal no indication of a significant ICP-AES calibration effect on the block averages at the 5% significance level. For the U_{std}, only MgO has measurements that indicate a significant ICP-AES calibration effect on the block averages at the 5% significance level. The reference values for the oxide concentrations of the standard are given in the header for each set of measurements in the exhibit.

Exhibit B4 in Appendix B provides a similar set of analyses for the measurements derived from samples prepared via the PF method. The results from the statistical tests for the Batch 1 standard may be summarized as follows: Fe_2O_3 and SiO_2 have measurements that indicate significant ICP-AES calibration effects on the block averages at the 5% significance level. For the U_{std}, Fe_2O_3, SiO_2, and U_3O_8 have measurements that indicate significant ICP-AES calibration effects on the block averages at the 5% significance level. The reference values for the oxide concentrations of the standard are given in the headers for each set of measurements in the exhibit.

Thus, some of these results provide incentive for adjusting the measurements by the effects of the ICP-AES calibration. Therefore, the oxide measurements of the study glasses are to be bias corrected for the effect of the ICP-AES calibration on each of the analytical blocks and sub-blocks. The basis for this bias correction is presented as part of Exhibits B3 and B4 – the average measurement for Batch 1 for each ICP-AES block/sub-block for Al_2O_3, B_2O_3, BaO, CaO, Cr_2O_3, CuO, Fe_2O_3, Li_2O, MgO, MnO, Na_2O, NiO, SiO_2, and TiO_2 and the average measurement for U_{std} for each ICP-AES set/block for U_3O_8. The Batch 1 results served as the basis for bias correcting all of the oxides (that were bias corrected) except uranium. The U_{std} results were used to bias correct for uranium. For the other oxides, the Batch 1 results were used to conduct the bias correction as long as the reference value for the oxide concentration in the Batch 1 glass was greater than or equal to 0.1 wt%. Thus, applying this approach and based upon the information in the exhibits, the Batch 1 results were used to bias correct the Al_2O_3, B_2O_3, BaO, CaO, Cr_2O_3, CuO, Fe_2O_3, K_2O, Li_2O, MgO, MnO, Na_2O, NiO, SiO_2, and TiO_2 measurements. No bias correction was conducted for the Ce_2O_3, La_2O_3, PbO, ThO_2, ZnO, or ZrO_2 measurements. Measurements of SO_4^{2-} will be discussed separately in Section 3.3.

The bias correction was conducted as follows. For each oxide, let $\bar{a}_{ij}$ be the average measurement for the i^{th} oxide at analytical block j for Batch 1 (or U_{std} for uranium), and let t_i be the reference value for the i^{th} oxide for Batch 1 (or for U_{std} if uranium). (The averages and reference values are provided in Exhibits B3 and B4.) Let $\bar{c}_{ijk}$ be the average measurement for the i^{th} oxide at analytical block j for the k^{th} glass. The bias adjustment was conducted as follows

$$\bar{c}_{ijk} \bullet \left(1 - \frac{\bar{a}_{ij} - t_i}{\bar{a}_{ij}}\right) = \bar{c}_{ijk} \bullet \frac{t_i}{\bar{a}_{ij}}$$

Bias-corrected measurements are indicated by a "bc" suffix, and such adjustments were performed for all of the oxides of this study except for Ce_2O_3, La_2O_3, PbO, SO_4^{2-}, ThO_2, ZnO, and ZrO_2. Both measured and measured "bc" values are included in the discussion that follows. In these discussions bias-corrected values for Ce_2O_3, La_2O_3, PbO, SO_4^{2-}, ThO_2, ZnO, and ZrO_2 are included for completeness (e.g., to allow a sum of oxides to be computed for the bias-corrected results). These bias-corrected values are the same as the original Ce_2O_3, La_2O_3, PbO, SO_4^{2-}, ThO_2, ZnO, and ZrO_2 values.

3.2.3 *Composition Measurements by Glass Number*

Exhibits B5 and B6 in Appendix B provide plots of the oxide concentration measurements by Glass Number (including Batch 1, labeled as glass numbered 100, U_{std}, labeled as glass numbered 200, and LRM, labeled as glass numbered 300) by ICP-AES calibration block/sub-block for the measured and bias-corrected (bc) values for the LM and PF preparation methods, respectively. Different symbols and colors are used to represent the different glasses. These plots show the individual measurements across the duplicates of each preparation method and the two ICP-AES calibrations. A review of the plots presented in these exhibits reveals the repeatability of the four individual, oxide values for each study glass as well as the repeatability of the measurements of the standards. Observations from these plots include: one of the CaO measurements for U_{std} appears low and two of the ZnO measurements for glass SB4SULFA-08 appear high. Several observations for the LRM results were noted: one high value for each of CaO, Cr_2O_3, PbO, and ZrO_2 measurements, two high values for each of B_2O_3 and La_2O_3 measurements, and two low B_2O_3 values as well. The SO_4^{2-} values for the LRM glass are discussed separately in Section 3.3 since it was used as a standard. None of these issues are seen as having any significant impact on the conclusions of this report.

3.2.4 *Measured versus Targeted Compositions*

The four measurements for each oxide for each glass (over both preparation methods) were averaged to determine a representative chemical composition for each glass. These determinations were conducted both for the measured and for the bias-corrected data. A sum of oxides was also computed for each glass based upon both the measured and bias-corrected values. Exhibit B7 in Appendix B provides plots showing results for each glass for each oxide to help highlight the comparisons among the measured, bias-corrected, and targeted values.

Some observations from the plots of Exhibit B7 are offered: For every study glass except SB4SULFA-06, the average measured Al_2O_3 values are above the targeted values for this oxide. For nearly every study glass, the average measured Fe_2O_3 values, MgO values, NiO values, and SiO_2 values are less than their respective targeted concentrations. The ThO_2 concentrations for all of the study glasses are slightly above target, as well as the ZnO concentration for glass SB4SULFA-08. In general, bias-correcting helps move the MgO, NiO, and SiO_2 measurements towards their respective targets, and improves the sum of oxides.

Table B4 in Appendix B provides a summary of the average compositions as well as the targeted compositions and some associated differences and relative differences. Notice that the targeted sums of oxides for the standard glasses do not sum to 100% due to an incomplete coverage of the oxides in the Batch 1 (Glass # 100), U_{std} (Glass # 200), and LRM (Glass # 300) glasses. All of the sums of oxides (both measured and bias-corrected) for the study glasses fall within the interval of 95 to 105 wt%. Entries in Table B4 show the relative differences between the measured or bias-corrected values and the targeted values. These differences are shaded when they are greater than or equal to 5%. Overall, these comparisons between the measured and targeted compositions suggest only minor difficulties in meeting the targeted compositions for some of the oxides for some of the study glasses.

As noted in the discussion above, there were several anomalies observed in the measurements for the six LRM samples that were included in this analysis. Figure 3-1 provides a closer look at the measurements of this standard glass. In this plot the six samples are labeled 1 through 6, and all of the oxides are shown. The large scatter in the B_2O_3, SiO_2, and ZrO_2 measurements noted above is revealed in this plot as well. There is also some scatter in the Fe_2O_3 values for sample #4. None of these issues are seen as having any significant impact on the conclusions of this report since the LRM glass was included as a standard for sulfur, as discussed in the following section.

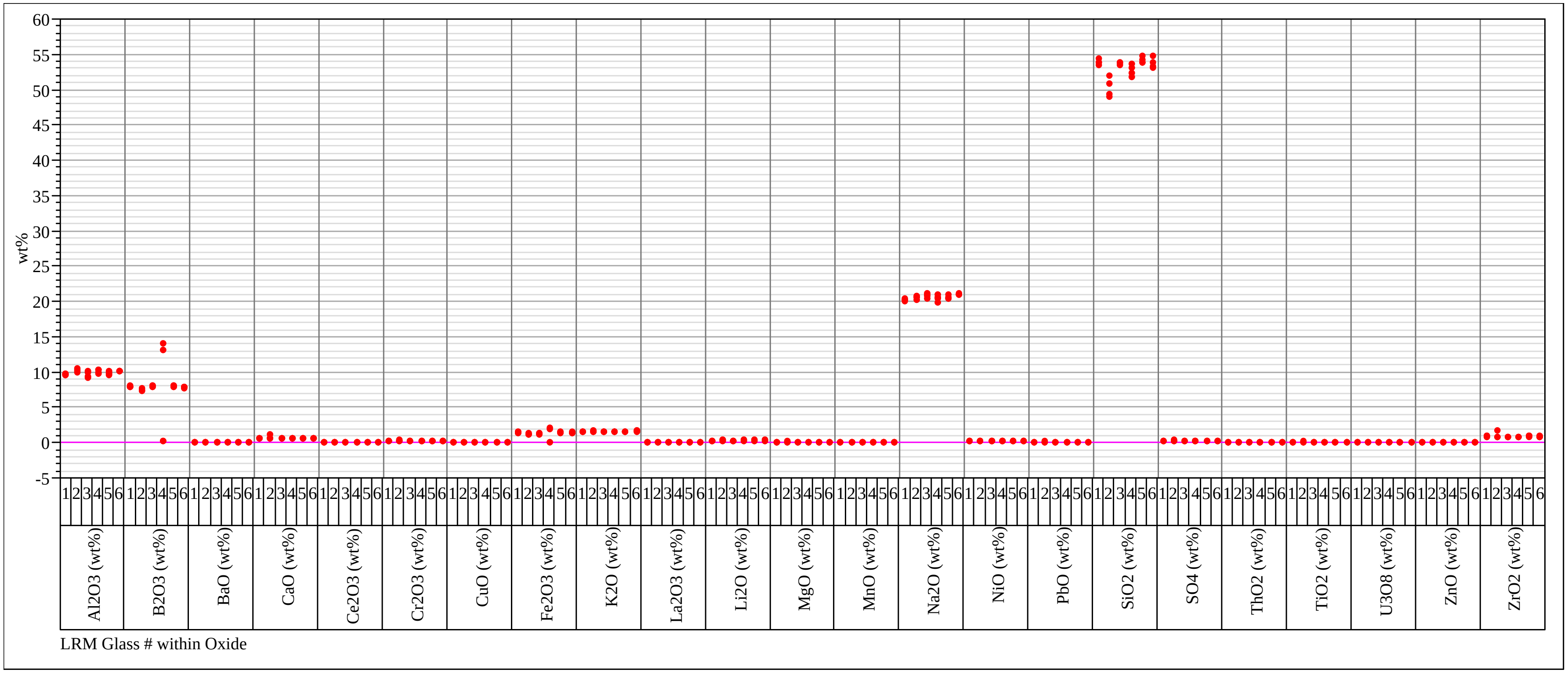

Figure 3-1. Measured Concentrations for the 6 LRM Samples by Oxide

3.3 Assessment of SO_4^{2-} Values

The targeted SO_4^{2-} concentrations for the study glasses are all in the range of 0.6 to 0.8 wt%. The SO_4^{2-} measurements versus these targets are reflected in Figure 3-2, a plot of the measured (red crosses) versus targeted (blue line) SO_4^{2-} values for each of the glasses in the analytical plan as well as each of the standards. The Batch 1 and U_{std} standard glasses do not contain sulfur. Therefore the target SO_4^{2-} concentration for these two glasses is shown as zero in Figure 3-2, and the measured values are shown as half of the ICP-AES detection limit. A third standard, the LRM glass, was included in this study since it contains a known amount (0.24 wt%) of SO_4^{2-}. Six specimens of this standard were included throughout the series of measurements since the concentration of SO_4^{2-} retained in the experimental glasses is critical to this study.

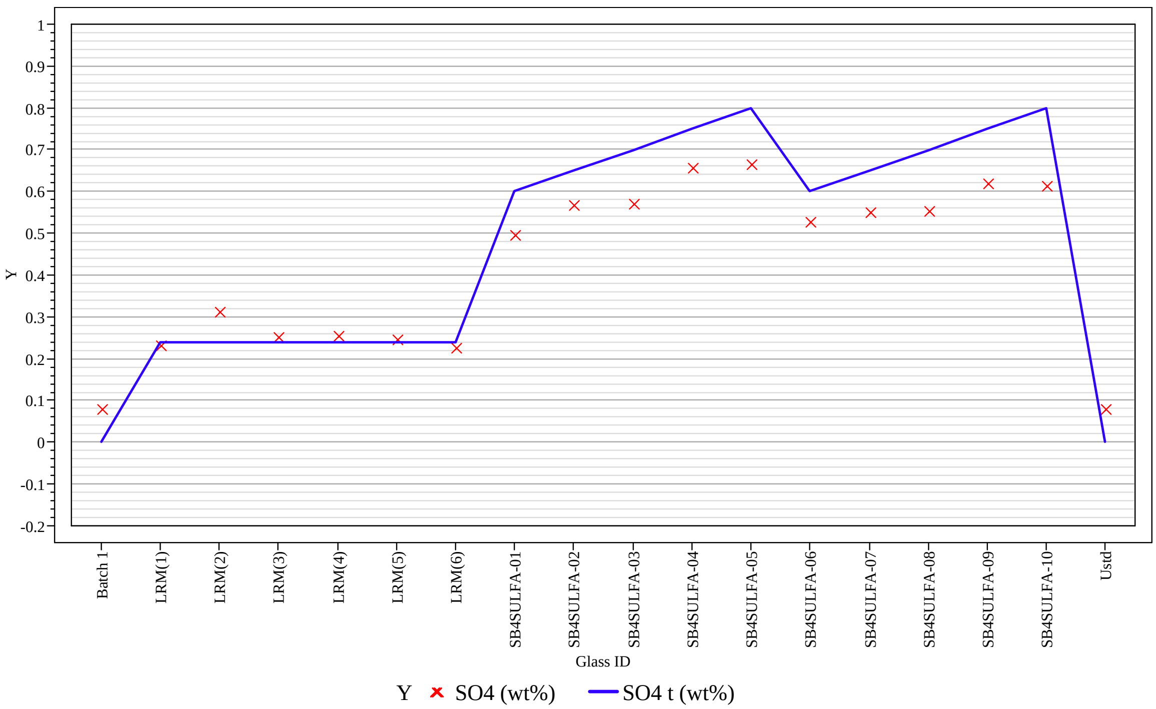

Figure 3-2. SO_4^{2-} Values for Glasses in the Analytical Plan by Glass ID

The target SO_4^{2-} concentration for the LRM glass was 0.24 wt%, and the average measured concentration was 0.25 wt%. The measurements for the LRM samples indicate good sulfate recovery for these analyses, which provides confidence in the sulfate measurements for the study glasses. No bias correction was performed for the SO_4^{2-} values. The averages of the sulfate measurements for all of the study glasses fall consistently below the targeted concentrations. From Table B4, the percent differences range from 12.6% to 23.8% below their respective targets for the study glasses. Over the study glasses, the measured sulfate concentrations range from 0.49% to 0.66%. These results indicate that some sulfate volatilized during the melting of these glasses. However, the four glasses with the highest sulfate concentrations, SB4SULFA-04 and SB4SULFA-05 (Frit 418-based) and SB4SULFA-09 and SB4SULFA-10 (Frit 503-based) retained sulfate at concentrations greater than the limit of 0.6 wt% established for SB3.[9]

These data provide insight into the possible SO_4^{2-} retention in SB4 based glasses. The data suggest that the 0.6 wt% SO_4^{2-} limit is feasible for this system.

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4.0 Conclusions and Recommendations

Ten glasses were fabricated in the laboratory using the May 2006 SB4 composition projection and Frits 418 and 503. The glasses were intentionally spiked to relatively high sulfate concentrations of between 0.6 and 0.8 wt% in the glass (as compared to the nominal value of 0.49 wt%). The glasses were batched and melted following standard SRNL procedures. No sulfur salt layer was visually observed on any of the study glasses after pouring and quenching. The measured compositions of each of the glasses met the target values. The LRM glass standard results indicated that sulfate concentration was measured accurately in this study. Sulfate volatilization occurred in all of the study glasses, as evidenced by measured sulfate concentrations that fell below the targeted values. However, the glasses that targeted the highest sulfate concentrations using either Frit 418 or Frit 503 retained sulfate at concentrations at or above the previous limit of 0.6 wt% established for SB3 processing. These results imply that this same limit may be extended to SB4 processing. Note however that these results are based on a SB4 composition projection provided in May 2006, and may not be technically applicable to revised compositions since sulfate solubility is strongly dependent on glass composition. Upon finalization of the SB4 projected composition, an additional assessment should be performed to ensure that the 0.6 wt% SO_4^{2-} limit is still viable.

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Appendix A

An Analytical Plan for Measuring the Chemical Compositions of Glasses from the Sulfate Solubility Study for SB4 (U)

(SRNL-SCS-2006-00022)

SRNL-SCS-2006-00022

July 3, 2006

To: K. M. Fox, SRNL

cc:

D. R.	Best, 786-1A (wo)	I. A.	Reamer, 999-1W
S. P.	Harris, 773-42A	P. A.	Toole, 786-1A (wo)
C. C.	Herman, 999-W	R. C.	Tuckfield, 773-42A
D. K.	Peeler, 999-W	R. J.	Workman, 999-1W

From: T. B. Edwards, 773-42A (5-5148)
Statistical Consulting Section

wo – without glass identifiers

S. P. Harris, Technical Reviewer — 7/10/2006 Date

R. C. Tuckfield, Manager
Statistical Consulting Section — 7/10/2006 Date

AN ANALYTICAL PLAN FOR MEASURING THE CHEMICAL COMPOSITIONS OF GLASSES FROM THE SULFATE SOLUBILITY STUDY FOR SB4 (U)

1.0 EXECUTIVE SUMMARY

Frit development efforts are underway at the Savannah River National Laboratory (SRNL) to support the processing of Sludge Batch 4 (SB4) at the Defense Waste Processing Facility (DWPF). One of the questions being considered during these efforts is the sulfate (SO_4^{2-}) solubility for the SB4 glass system. Since the solubility of SO_4^{2-} is expected to be linked to the frit selected for use with SB4 and Frits 418 and 503 are the leading candidates for such use, these frits were utilized in the selection of ten glasses for this study. The glasses are to be batched and fabricated, and samples are to be taken from each of the study glasses. The samples are to be submitted to SRNL's Process Science Analytical Laboratory (PSAL) for chemical analysis. This memorandum provides an analytical plan to direct and support these measurements at PSAL.

2.0 INTRODUCTION

Frit development efforts are underway at the Savannah River National Laboratory (SRNL) to support the processing of Sludge Batch 4 (SB4) at the Defense Waste Processing Facility (DWPF). One of the questions being considered during these efforts is the sulfate (SO_4^{2-}) solubility for the SB4 glass system. Since the solubility of SO_4^{2-} is expected to be linked to the frit selected for use with SB4 and Frits 418 and 503 are the leading candidates for such use [1], these frits were utilized to select ten glasses for this study. The glasses were selected from the frit development assessments presented in [2] for the 0.96 M sodium projection of SB4 Blend 1. The glasses are to be batched and fabricated, and samples are to be taken from each of the study glasses. The samples are to be submitted to SRNL's Process Science Analytical Laboratory (PSAL) for chemical analysis. This memorandum provides an analytical plan to direct and support these measurements at PSAL.

3.0 ANALYTICAL PLAN

The analytical procedures used by PSAL to determine cation concentrations for a glass sample include steps for sample preparation and for instrument calibration. Each glass is to be prepared in duplicate by each of two dissolution methods: lithium metaborate fusion (LM) and sodium peroxide fusion (PF).

The primary measurements of interest are to be acquired as follows. The samples prepared by LM are to be measured for barium (Ba), calcium (Ca), cerium (Ce), chromium (Cr), copper (Cu), potassium (K), lanthanum (La), magnesium (Mg), manganese (Mn), sodium (Na), lead (Pb), sulfur (S), thorium (Th), titanium (Ti), zinc (Zn), and zirconium (Zr) concentrations. Samples prepared by PF are to be measured for aluminum (Al), boron (B), iron (Fe), lithium (Li), nickel (Ni), silicon (Si), and uranium (U) concentrations. Samples dissolved by both preparation methods are to be measured using Inductively Coupled Plasma – Atomic Emission Spectrometry (ICP-AES). It should be noted that some of these elements are minor components that may be near the detection limits for most, if not all, of the study glasses.

Randomizing the preparation steps and blocking and randomizing the measurements for the ICP-AES are of primary concern in the development of this analytical plan. The sources of uncertainty for the analytical procedure used by PSAL to determine the cation concentrations for the submitted glass samples are dominated by the dissolution step in the preparation of the sample and by the calibrations of the ICP-AES.

Samples of glass standards will be included in the analytical plan to provide an opportunity for checking the performance of the instrumentation over the course of the analyses and for potential bias correction. Specifically, several samples of Waste Compliance Plan (WCP) Batch 1 (BCH) [3] and a uranium standard glass (Ustd) are included in this analytical plan. The reference compositions of these glasses are provided in Table 1.

In addition, samples of the Low-Activity Reference Material (LRM) standard glass (which contains sulfur – see [4] for details on the chemical composition of this glass) are to be included in the set of samples submitted to PSAL. The measurements of this glass will be used to provide insight into the uncertainty of PSAL's sulfur measurements. The LRM samples are to be labeled in the same manner as the study glasses, but with their labels known. The labels are being provided to assist in the interpretation of the sums of oxides for the glasses. Since some of the elements present in LRM are not listed above (i.e., they will not be measured by PSAL), the measured sum of oxides for LRM may fall below 95% (i.e., the target sum of oxides for LRM for the elements listed above is only around 97.7%).

Table 1: Oxide Compositions of WCP Batch 1 (BCH) and Ustd

Oxide/ Anion	BCH (wt %)	Ustd (wt %)
Al_2O_3	4.877	4.1
B_2O_3	7.777	9.209
BaO	0.151	0
CaO	1.22	1.301
Cr_2O_3	0.107	0
Cs_2O	0.06	0
CuO	0.399	0
Fe_2O_3	12.839	13.196
K_2O	3.327	2.999
Li_2O	4.429	3.057
MgO	1.419	1.21
MnO	1.726	2.892
Na_2O	9.003	11.795
Nd_2O_3	0.147	0
NiO	0.751	1.12
RuO_2	0.0214	0
SiO_2	50.22	45.353
SO_3	0	0
TiO_2	0.677	1.049
U_3O_8	0	2.406
ZrO_2	0.098	0

Each glass sample submitted to PSAL will be prepared in duplicate by the LM and PF dissolution methods. Every prepared sample will be read twice by ICP-AES, with the instrument being calibrated before each of these two sets of readings. This will lead to four measurements for each cation of interest for each submitted glass.

Table 2 presents identifying codes, M01 through M16, for the 10 glasses fabricated for this study and the 6 samples of the LRM standard that have been included. The table provides a naming convention that is to be used in analyzing the glasses and reporting the measurements of their compositions.[3]

[3] Renaming these samples helps to ensure that they will be processed as blind samples within PSAL. Table 2 is not shown in its entirety in the copies going to PSAL. However, note that the LRM glasses are to be identified.

Table 2: Glass Identifiers to Establish Blind Samples for PSAL

Glass ID	Sample ID	Glass ID	Sample ID
SB4SULFA-01	M03	SB4SULFA-09	M11
SB4SULFA-02	M15	SB4SULFA-10	M06
SB4SULFA-03	M05	LRM(1)	M12
SB4SULFA-04	M02	LRM(2)	M09
SB4SULFA-05	M13	LRM(3)	M10
SB4SULFA-06	M16	LRM(4)	M08
SB4SULFA-07	M04	LRM(5)	M01
SB4SULFA-08	M07	LRM(6)	M14

3.1 PREPARATION OF THE SAMPLES

Each of the 16 glasses included in this analytical plan is to be prepared in duplicate by the LM and PF dissolution methods. Thus, the total number of prepared glass samples is determined by $16 \cdot 2 \cdot 2 = 64$, not including the samples of the BCH and Ustd glass standards that are to be prepared.

Table 3 provides blocking and (random) sequencing schema for conducting the preparation steps of the analytical procedures. One block of preparation work is provided for each preparation method to facilitate the scheduling of activities by work shift. The identifier for each of the prepared samples indicates the sample identifier (ID), preparation method, and duplicate number.

Table 3: Preparation Blocks by Dissolution Method

LM (Lithium Metaborate)	PF (Peroxide Fusion)
M03LM1	M10PF1
M10LM1	M06PF1
M03LM2	M10PF2
M07LM1	M07PF1
M04LM1	M07PF2
M09LM1	M02PF1
M08LM1	M08PF1
M13LM1	M11PF1
M11LM1	M06PF2
M04LM2	M08PF2
M10LM2	M15PF1
M16LM1	M03PF1
M14LM1	M03PF2
M11LM2	M01PF1
M14LM2	M05PF1
M07LM2	M16PF1
M15LM1	M13PF1
M09LM2	M11PF2
M01LM1	M13PF2
M08LM2	M12PF1
M13LM2	M15PF2
M16LM2	M14PF1
M02LM1	M09PF1
M06LM1	M02PF2
M05LM1	M05PF2
M15LM2	M04PF1
M12LM1	M12PF2
M12LM2	M14PF2
M02LM2	M01PF2
M05LM2	M16PF2
M01LM2	M09PF2
M06LM2	M04PF2

3.2 ICP-AES Calibration Blocks

The glass samples prepared by the LM and PF dissolution methods are to be analyzed using ICP-AES instrumentation calibrated for the particular preparation method. After the initial set of cation concentration measurements, the ICP-AES instrumentation is to be recalibrated and a second set of concentration measurements for the cations determined.

Randomized plans for measuring cation concentrations in the LM-prepared and PF-prepared samples are provided in Table 4. The cations to be measured are specified as part of the table. In the tables, the sample identifiers for the study glasses have been modified by the addition of a suffix (a “1”or a “2”) to indicate whether the measurement was made during the first or second (respectively) calibration of the ICP-AES instrumentation. The identifiers for the BCH and Ustd samples have been modified to indicate the ICP-AES calibration block and that each of these prepared samples is to be read 3 times (mirrored in the corresponding suffix of 1, 2, or 3) per calibration block.

Table 4: ICP-AES Blocks & Calibration Groups by Preparation Method

LM Glass Samples				**PF Glass Samples**			
Used to Measure Elemental Ba, Ca, Ce, Cr, Cu, K, La, Mg, Mn, Na, Pb, S, Th, Ti, Zn, & Zr				Used to Measure Elemental Al, B, Fe, Li, Ni, Si, & U			
LM Calibration Blocks				**PF Calibration Blocks**			
Block 1-1	**Block 1-2**	**Block 2-1**	**Block 2-2**	**Block 1-1**	**Block 1-2**	**Block 2-1**	**Block 2-2**
BCHLM111	BCHLM121	BCHLM211	BCHLM221	BCHPF111	BCHPF121	BCHPF211	BCHPF221
UstdLM111	UstdLM121	UstdLM211	UstdLM221	UstdPF111	UstdPF121	UstdPF211	UstdPF221
M03LM11	M10LM12	M06LM21	M09LM12	M05PF21	M04PF22	M16PF11	M13PF22
M10LM21	M05LM22	M16LM21	M02LM12	M09PF21	M08PF22	M13PF11	M14PF12
M14LM11	M15LM22	M02LM21	M06LM12	M08PF21	M06PF12	M12PF21	M13PF12
M13LM21	M12LM22	M09LM21	M09LM22	M08PF11	M09PF12	M10PF21	M16PF22
M05LM21	M15LM12	M04LM11	M07LM12	M09PF11	M04PF12	M10PF11	M16PF12
M03LM21	M13LM12	M07LM11	M04LM22	M11PF21	M02PF22	M01PF21	M01PF12
M12LM21	M01LM22	M08LM11	M07LM22	M07PF11	M06PF22	M03PF11	M01PF22
M12LM11	M14LM12	M11LM11	M08LM12	M02PF11	M07PF22	M14PF21	M10PF22
BCHLM112	BCHLM122	BCHLM212	BCHLM222	BCHPF112	BCHPF122	BCHPF212	BCHPF222
UstdLM112	UstdLM122	UstdLM212	UstdLM222	UstdPF112	UstdPF122	UstdPF212	UstdPF222
M05LM11	M12LM12	M06LM11	M08LM22	M02PF21	M11PF12	M13PF21	M10PF12
M13LM11	M14LM22	M09LM11	M02LM22	M04PF11	M08PF12	M03PF21	M12PF22
M15LM11	M03LM22	M11LM21	M11LM12	M11PF11	M02PF12	M16PF21	M15PF12
M01LM21	M03LM12	M16LM11	M16LM22	M06PF11	M05PF12	M01PF11	M03PF12
M14LM21	M01LM12	M07LM21	M11LM22	M06PF21	M09PF22	M15PF21	M14PF22
M10LM11	M13LM22	M08LM21	M16LM12	M07PF21	M05PF22	M12PF11	M03PF22
M15LM21	M05LM12	M04LM21	M04LM12	M05PF11	M07PF12	M15PF11	M15PF22
M01LM11	M10LM22	M02LM11	M06LM22	M04PF21	M11PF22	M14PF11	M12PF12
BCHLM113	BCHLM123	BCHLM213	BCHLM223	BCHPF113	BCHPF123	BCHPF213	BCHPF223
UstdLM113	UstdLM123	UstdLM213	UstdLM223	UstdPF113	UstdPF123	UstdPF213	UstdPF223

4.0 CONCLUDING COMMENTS

In summary, this analytical plan identifies two preparation blocks in Table 3 and eight ICP-AES calibration blocks in Table 4 for use by PSAL. The sequencing of the activities associated with each of the steps in the analytical procedures has been randomized. The size of each of the blocks was selected so that it could be completed in a single work shift.

If a problem is discovered while measuring samples in a calibration block, the instrument should be re-calibrated and the block of samples re-measured in its entirety. If for some reason the measurements are not conducted in the sequences presented in this report, a record should be made of the actual order used along with any explanative comments.

The analytical plan indicated in the preceding tables should be modified by the personnel of PSAL to include any calibration check standards and/or other standards that are part of their routine operating procedures. It is also recommended that the solutions resulting from each of the prepared samples be archived for some period, considering the “shelf-life” of the solutions, in case questions arise during data analysis. This would allow for the solutions to be rerun without additional preparations, thus minimizing cost.

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Appendix B

Tables and Exhibits Supporting the Analysis of the Chemical Composition Measurements of the SB4 Sulfate Study Glasses

Table B1. Targeted Oxide Concentrations (in wt%) for the SB4 Sulfate Solubility Study Glasses

Glass #	Al_2O_3	B_2O_3	BaO	CaO	Ce_2O_3	Cr_2O_3	CuO	Fe_2O_3	K_2O	La_2O_3	Li_2O	MgO	MnO	Na_2O	NiO	PbO	SO_4^{2-}	SiO_2	ThO_2	TiO_2	U_3O_8	ZnO	ZrO_2	Sum
SB4SULFA-01	8.93	4.95	0.05	0.90	0.06	0.08	0.02	10.04	0.12	0.04	4.95	0.96	2.07	13.97	0.59	0.04	0.60	48.56	0.02	0.01	2.91	0.04	0.09	100
SB4SULFA-02	8.92	4.95	0.05	0.90	0.06	0.08	0.02	10.03	0.12	0.04	4.95	0.96	2.07	13.96	0.59	0.04	0.65	48.54	0.02	0.01	2.91	0.04	0.09	100
SB4SULFA-03	8.92	4.95	0.05	0.90	0.06	0.08	0.02	10.03	0.12	0.04	4.95	0.96	2.07	13.96	0.59	0.04	0.70	48.52	0.02	0.01	2.91	0.04	0.09	100
SB4SULFA-04	8.91	4.95	0.05	0.90	0.06	0.08	0.02	10.02	0.12	0.04	4.95	0.96	2.06	13.95	0.59	0.04	0.75	48.49	0.02	0.01	2.91	0.04	0.09	100
SB4SULFA-05	8.91	4.94	0.05	0.90	0.06	0.08	0.02	10.02	0.12	0.04	4.94	0.96	2.06	13.94	0.59	0.04	0.80	48.47	0.02	0.01	2.91	0.04	0.09	100
SB4SULFA-06	8.93	8.67	0.05	0.90	0.06	0.08	0.02	10.04	0.12	0.04	4.95	0.96	2.07	11.49	0.59	0.04	0.60	47.33	0.02	0.01	2.91	0.04	0.09	100
SB4SULFA-07	8.92	8.67	0.05	0.90	0.06	0.08	0.02	10.03	0.12	0.04	4.95	0.96	2.07	11.49	0.59	0.04	0.65	47.30	0.02	0.01	2.91	0.04	0.09	100
SB4SULFA-08	8.92	8.66	0.05	0.90	0.06	0.08	0.02	10.03	0.12	0.04	4.95	0.96	2.07	11.48	0.59	0.04	0.70	47.28	0.02	0.01	2.91	0.04	0.09	100
SB4SULFA-09	8.91	8.66	0.05	0.90	0.06	0.08	0.02	10.02	0.12	0.04	4.95	0.96	2.06	11.48	0.59	0.04	0.75	47.25	0.02	0.01	2.91	0.04	0.09	100
SB4SULFA-10	8.91	8.65	0.05	0.90	0.06	0.08	0.02	10.02	0.12	0.04	4.94	0.96	2.06	11.47	0.59	0.04	0.80	47.23	0.02	0.01	2.91	0.04	0.09	100

Table B2. Measured Elemental Concentrations (in wt%) for Samples Prepared Using Lithium Metaborate

Glass ID	Laboratory ID	Block	Sub-Block	Analytical Sequence	Al	Ba	Ca	Ce	Cr	Cu	K	La	Mg	Mn	Na	Ni	Pb	S	Th	Ti	Zn	Zr
Batch 1	BCHLM111	1	1	1	2.49	0.124	0.879	<0.010	0.067	0.325	2.89	<0.010	0.802	1.29	6.87	0.551	<0.020	<0.050	<0.100	0.380	<0.010	0.064
Ustd	UstdLM111	1	1	2	2.59	0.136	0.885	<0.010	0.070	0.331	3.00	<0.010	0.875	1.29	7.17	0.545	<0.020	<0.050	<0.100	0.385	<0.010	<0.010
SB4SULFA-01	M03LM11	1	1	3	2.49	0.135	0.904	<0.010	0.073	0.333	2.93	<0.010	0.876	1.19	7.03	0.505	<0.020	<0.050	<0.100	0.402	<0.010	0.070
LRM(3)	M10LM21	1	1	4	2.51	0.124	0.887	<0.010	0.068	0.325	2.90	<0.010	0.795	1.25	6.93	0.532	<0.020	<0.050	<0.100	0.375	<0.010	0.065
LRM(6)	M14LM11	1	1	5	2.54	0.122	0.897	<0.010	0.067	0.328	2.97	<0.010	0.790	1.25	7.13	0.531	<0.020	<0.050	<0.100	0.383	<0.010	0.067
SB4SULFA-05	M13LM21	1	1	6	2.51	0.120	0.899	<0.010	0.066	0.328	2.94	<0.010	0.787	1.17	7.08	0.503	<0.020	<0.050	<0.100	0.377	<0.010	0.066
SB4SULFA-03	M05LM21	1	1	7	2.49	0.120	0.874	<0.010	0.064	0.322	2.87	<0.010	0.797	1.33	6.83	0.574	<0.020	<0.050	<0.100	0.369	<0.010	0.063
SB4SULFA-01	M03LM21	1	1	8	2.48	0.121	0.883	<0.010	0.065	0.327	2.83	<0.010	0.799	1.33	6.85	0.571	<0.020	<0.050	<0.100	0.379	<0.010	0.063
LRM(1)	M12LM21	1	1	9	2.48	0.127	0.887	<0.010	0.067	0.328	2.86	<0.010	0.844	1.28	6.91	0.541	<0.020	<0.050	<0.100	0.390	<0.010	0.066
LRM(1)	M12LM11	1	1	10	2.50	0.123	0.881	<0.010	0.068	0.325	2.89	<0.010	0.802	1.28	6.90	0.550	<0.020	<0.050	<0.100	0.378	<0.010	0.065
Batch 1	BCHLM112	1	1	11	2.49	0.125	0.884	<0.010	0.069	0.326	2.91	<0.010	0.806	1.23	7.01	0.531	<0.020	<0.050	<0.100	0.381	<0.010	0.067
Ustd	UstdLM112	1	1	12	2.50	0.121	0.888	<0.010	0.067	0.325	2.90	<0.010	0.791	1.24	7.00	0.530	<0.020	<0.050	<0.100	0.377	<0.010	0.065
SB4SULFA-03	M05LM11	1	1	13	5.15	<0.010	0.382	<0.010	0.131	<0.010	1.30	<0.010	0.059	<0.010	15.0	0.124	0.070	0.087	<0.100	0.057	<0.010	0.662
SB4SULFA-05	M13LM11	1	1	14	5.06	<0.010	0.374	<0.010	0.132	<0.010	1.27	0.010	0.062	<0.010	15.0	0.125	0.073	0.078	<0.100	0.059	<0.010	0.678
SB4SULFA-02	M15LM11	1	1	15	5.12	<0.010	0.385	<0.010	0.125	<0.010	1.29	<0.010	0.056	<0.010	14.9	0.123	0.068	0.073	<0.100	0.055	<0.010	0.645
LRM(5)	M01LM21	1	1	16	5.08	<0.010	0.381	<0.010	0.122	<0.010	1.27	<0.010	0.056	<0.010	15.1	0.134	0.069	0.065	<0.100	0.056	<0.010	0.651
LRM(6)	M14LM21	1	1	17	5.26	<0.010	0.827	<0.010	0.245	<0.010	1.29	0.012	0.109	<0.010	15.0	0.147	0.128	0.145	<0.100	0.106	<0.010	1.213
LRM(3)	M10LM11	1	1	18	5.50	<0.010	0.418	<0.010	0.127	<0.010	1.32	<0.010	0.056	<0.010	15.3	0.178	0.064	0.094	<0.100	0.055	<0.010	0.643
SB4SULFA-02	M15LM21	1	1	19	5.57	<0.010	0.415	<0.010	0.130	<0.010	1.36	<0.010	0.059	<0.010	15.4	0.178	0.071	0.096	<0.100	0.057	<0.010	0.639
LRM(5)	M01LM11	1	1	20	5.32	<0.010	0.415	<0.010	0.125	<0.010	1.33	<0.010	0.057	<0.010	15.3	0.135	0.066	0.078	<0.100	0.056	<0.010	0.604
Batch 1	BCHLM113	1	1	21	5.29	<0.010	0.394	<0.010	0.126	<0.010	1.34	<0.010	0.056	<0.010	15.4	0.131	0.067	0.090	<0.100	0.056	<0.010	0.650
Ustd	UstdLM113	1	1	22	4.96	<0.010	0.392	<0.010	0.120	<0.010	1.28	<0.010	0.053	<0.010	15.5	0.110	0.052	0.101	<0.100	0.052	<0.010	0.600
Batch 1	BCHLM121	1	2	1	4.91	<0.010	0.388	<0.010	0.113	<0.010	1.27	<0.010	0.049	<0.010	15.2	0.118	0.051	0.071	<0.100	0.048	<0.010	0.575
Ustd	UstdLM121	1	2	2	5.33	<0.010	0.403	<0.010	0.122	<0.010	1.35	<0.010	0.053	<0.010	15.7	0.122	0.067	0.070	<0.100	0.054	<0.010	0.644
LRM(3)	M10LM12	1	2	3	5.16	<0.010	0.413	<0.010	0.135	<0.010	1.26	<0.010	0.054	<0.010	14.7	0.145	0.064	0.080	<0.100	0.053	<0.010	0.632
SB4SULFA-03	M05LM22	1	2	4	5.43	<0.010	0.459	<0.010	0.130	<0.010	1.32	<0.010	0.060	<0.010	15.3	0.145	0.069	0.082	<0.100	0.056	<0.010	0.631
SB4SULFA-02	M15LM22	1	2	5	5.25	<0.010	0.409	<0.010	0.141	<0.010	1.32	<0.010	0.059	<0.010	15.2	0.128	0.067	0.085	<0.100	0.056	<0.010	0.640
LRM(1)	M12LM22	1	2	6	5.49	<0.010	0.460	<0.010	0.128	<0.010	1.35	<0.010	0.060	<0.010	15.6	0.137	0.067	0.089	<0.100	0.057	<0.010	0.616
SB4SULFA-02	M15LM12	1	2	7	5.32	<0.010	0.374	<0.010	0.136	<0.010	1.33	<0.010	0.068	<0.010	15.5	0.149	0.072	0.083	<0.100	0.061	<0.010	0.704
SB4SULFA-05	M13LM12	1	2	8	5.12	<0.010	0.418	<0.010	0.135	<0.010	1.28	<0.010	0.068	<0.010	15.3	0.126	0.065	0.094	<0.100	0.058	<0.010	0.668
LRM(5)	M01LM22	1	2	9	5.29	<0.010	0.372	<0.010	0.128	<0.010	1.32	<0.010	0.062	<0.010	15.2	0.155	0.070	0.082	<0.100	0.057	<0.010	0.671
LRM(6)	M14LM12	1	2	10	5.10	<0.010	0.416	<0.010	0.122	<0.010	1.28	<0.010	0.060	<0.010	15.1	0.125	0.067	0.064	<0.100	0.053	<0.010	0.624
Batch 1	BCHLM122	1	2	11	5.38	<0.010	0.406	<0.010	0.124	<0.010	1.37	<0.010	0.057	<0.010	15.5	0.135	0.060	0.088	<0.100	0.056	<0.010	0.646
Ustd	UstdLM122	1	2	12	5.33	<0.010	0.395	<0.010	0.136	<0.010	1.35	<0.010	0.064	<0.010	15.6	0.122	0.073	0.083	<0.100	0.062	<0.010	0.685
LRM(1)	M12LM12	1	2	13	5.41	<0.010	0.414	<0.010	0.123	<0.010	1.38	<0.010	0.055	<0.010	15.7	0.131	0.064	0.060	<0.100	0.055	<0.010	0.645
LRM(6)	M14LM22	1	2	14	5.33	<0.010	0.402	<0.010	0.124	<0.010	1.34	<0.010	0.056	<0.010	15.5	0.126	0.074	0.067	<0.100	0.057	<0.010	0.641
SB4SULFA-01	M03LM22	1	2	15	4.94	0.040	0.701	0.035	0.049	0.020	0.122	0.030	0.515	1.58	10.7	0.424	0.026	0.177	0.114	<0.010	0.028	0.051
SB4SULFA-01	M03LM12	1	2	16	4.93	0.040	0.690	0.035	0.051	0.020	0.116	0.031	0.546	1.54	10.8	0.425	0.024	0.169	0.121	<0.010	0.028	0.053
LRM(5)	M01LM12	1	2	17	4.94	0.038	0.698	0.033	0.050	0.019	0.118	0.028	0.528	1.57	10.9	0.418	0.027	0.155	0.116	<0.010	0.027	0.053
SB4SULFA-05	M13LM22	1	2	18	4.93	0.037	0.711	0.033	0.049	0.019	0.125	0.027	0.510	1.52	10.9	0.413	0.023	0.156	0.111	<0.010	0.027	0.052
SB4SULFA-03	M05LM12	1	2	19	4.90	0.041	0.675	0.041	0.053	0.020	0.110	0.031	0.594	1.57	10.8	0.429	0.027	0.185	0.132	<0.010	0.031	0.055
LRM(3)	M10LM22	1	2	20	5.34	0.041	0.712	0.040	0.058	0.020	0.123	0.030	0.563	1.59	11.2	0.441	0.020	0.207	0.126	<0.010	0.030	0.055

Table B2. Measured Elemental Concentrations (in wt%) for Samples Prepared Using Lithium Metaborate (continued)

Glass ID	Laboratory ID	Block	Sub-Block	Analytical Sequence	Al	Ba	Ca	Ce	Cr	Cu	K	La	Mg	Mn	Na	Ni	Pb	S	Th	Ti	Zn	Zr
Batch 1	BCHLM123	1	2	21	5.37	0.037	0.704	0.037	0.054	0.019	0.123	0.027	0.525	1.59	11.2	0.442	0.027	0.165	0.118	<0.010	0.027	0.052
Ustd	UstdLM123	1	2	22	4.91	0.037	0.676	0.037	0.050	0.019	0.111	0.027	0.555	1.58	10.8	0.431	0.027	0.196	0.127	<0.010	0.029	0.054
Batch 1	BCHLM211	2	1	1	4.82	0.039	0.722	0.039	0.057	0.021	0.132	0.030	0.526	1.54	10.0	0.422	0.023	0.186	0.117	<0.010	0.037	0.061
Ustd	UstdLM211	2	1	2	4.89	0.041	0.680	0.040	0.060	0.018	0.115	0.031	0.576	1.56	10.4	0.423	0.029	0.200	0.127	<0.010	0.031	0.064
SB4SULFA-10	M06LM21	2	1	3	4.84	0.036	0.724	0.036	0.055	0.020	0.134	0.027	0.511	1.59	10.0	0.432	0.028	0.173	0.115	<0.010	0.036	0.062
SB4SULFA-06	M16LM21	2	1	4	4.92	0.035	0.693	0.037	0.054	0.016	0.118	0.026	0.517	1.54	10.6	0.429	0.031	0.196	0.120	<0.010	0.028	0.060
SB4SULFA-04	M02LM21	2	1	5	4.93	0.036	0.655	0.033	0.054	0.017	0.110	0.027	0.568	1.70	10.5	0.461	0.023	0.226	0.116	<0.010	0.028	0.059
LRM(2)	M09LM21	2	1	6	4.97	0.035	0.710	0.033	0.052	0.018	0.129	0.026	0.536	1.62	10.8	0.434	0.023	0.220	0.111	<0.010	0.029	0.057
SB4SULFA-07	M04LM11	2	1	7	5.01	0.038	0.705	0.035	0.053	0.018	0.128	0.028	0.521	1.61	10.8	0.443	0.025	0.207	0.110	<0.010	0.030	0.058
SB4SULFA-08	M07LM11	2	1	8	4.97	0.040	0.662	0.036	0.058	0.018	0.110	0.029	0.579	1.60	10.8	0.441	0.030	0.218	0.120	<0.010	0.030	0.062
LRM(4)	M08LM11	2	1	9	4.92	0.044	0.712	0.039	0.055	0.021	0.120	0.033	0.553	1.55	10.7	0.418	0.025	0.229	0.125	<0.010	0.030	0.055
SB4SULFA-09	M11LM11	2	1	10	4.95	0.047	0.726	0.040	0.055	0.020	0.122	0.033	0.584	1.56	10.8	0.431	0.031	0.242	0.126	<0.010	0.031	0.057
Batch 1	BCHLM212	2	1	11	4.91	0.042	0.736	0.036	0.052	0.019	0.125	0.030	0.535	1.58	10.7	0.427	0.028	0.214	0.119	<0.010	0.029	0.055
Ustd	UstdLM212	2	1	12	4.95	0.041	0.724	0.037	0.052	0.020	0.123	0.029	0.527	1.50	10.9	0.403	0.027	0.199	0.119	<0.010	0.028	0.054
SB4SULFA-10	M06LM11	2	1	13	3.95	0.035	0.712	0.033	0.046	0.018	0.123	0.027	0.548	1.69	8.92	0.471	0.021	0.173	0.119	<0.010	0.028	0.059
LRM(2)	M09LM11	2	1	14	3.89	0.036	0.698	0.034	0.047	0.020	0.117	0.028	0.574	1.71	8.87	0.491	0.028	0.193	0.124	<0.010	0.029	0.061
SB4SULFA-09	M11LM21	2	1	15	3.97	0.040	0.717	0.036	0.050	0.018	0.122	0.030	0.560	1.64	9.09	0.447	0.026	0.161	0.125	<0.010	0.031	0.062
SB4SULFA-06	M16LM11	2	1	16	3.98	0.040	0.700	0.037	0.049	0.021	0.117	0.030	0.564	1.60	9.26	0.455	0.026	0.173	0.126	<0.010	0.030	0.063
SB4SULFA-08	M07LM21	2	1	17	4.83	0.034	0.655	0.030	0.051	0.017	0.114	0.028	0.554	1.67	8.77	0.447	0.029	0.178	0.123	<0.010	0.027	0.060
LRM(4)	M08LM21	2	1	18	4.89	0.034	0.700	0.030	0.051	0.026	0.127	0.030	0.531	1.59	8.85	0.460	0.024	0.197	0.118	<0.010	0.027	0.062
SB4SULFA-07	M04LM21	2	1	19	4.97	0.036	0.691	0.032	0.052	0.026	0.125	0.031	0.520	1.55	9.06	0.442	0.022	0.177	0.118	<0.010	0.028	0.062
SB4SULFA-04	M02LM11	2	1	20	4.93	0.036	0.665	0.033	0.053	0.017	0.113	0.030	0.544	1.56	9.12	0.418	0.031	0.176	0.122	<0.010	0.028	0.062
Batch 1	BCHLM213	2	1	21	4.85	0.033	0.699	0.032	0.048	0.021	0.121	0.029	0.529	1.70	8.67	0.453	0.027	0.188	0.116	<0.010	0.069	0.054
Ustd	UstdLM213	2	1	22	5.05	0.033	0.694	0.031	0.048	0.020	0.122	0.028	0.533	1.63	9.04	0.456	0.023	0.191	0.116	<0.010	0.028	0.058
Batch 1	BCHLM221	2	2	1	4.94	0.037	0.695	0.035	0.051	0.021	0.120	0.031	0.536	1.59	8.98	0.433	0.024	0.189	0.117	<0.010	0.071	0.058
Ustd	UstdLM221	2	2	2	5.11	0.037	0.687	0.033	0.051	0.020	0.120	0.030	0.538	1.54	9.33	0.418	0.023	0.167	0.119	<0.010	0.029	0.061
LRM(2)	M09LM12	2	2	3	4.85	0.033	0.737	0.032	0.046	0.021	0.124	0.028	0.525	1.67	8.74	0.455	0.028	0.202	0.118	<0.010	0.029	0.063
SB4SULFA-04	M02LM12	2	2	4	4.85	0.034	0.737	0.033	0.046	0.021	0.128	0.028	0.531	1.66	8.81	0.457	0.026	0.209	0.116	<0.010	0.031	0.060
SB4SULFA-10	M06LM12	2	2	5	4.91	0.037	0.734	0.035	0.050	0.021	0.122	0.031	0.534	1.59	9.01	0.425	0.026	0.205	0.119	<0.010	0.032	0.064
LRM(2)	M09LM22	2	2	6	4.96	0.038	0.729	0.036	0.049	0.021	0.124	0.031	0.542	1.59	9.12	0.433	0.026	0.206	0.119	<0.010	0.033	0.062
SB4SULFA-08	M07LM12	2	2	7	4.95	0.035	0.664	0.030	0.051	0.018	0.112	0.028	0.555	1.67	8.83	0.445	0.025	0.202	0.120	<0.010	0.026	0.052
SB4SULFA-07	M04LM22	2	2	8	4.86	0.035	0.670	0.030	0.052	0.018	0.111	0.028	0.549	1.64	8.75	0.442	0.024	0.206	0.120	<0.010	0.028	0.052
SB4SULFA-08	M07LM22	2	2	9	4.86	0.039	0.665	0.033	0.056	0.018	0.108	0.030	0.561	1.60	8.84	0.432	0.024	0.216	0.121	0.012	0.030	0.055
LRM(4)	M08LM12	2	2	10	5.01	0.038	0.675	0.032	0.053	0.019	0.113	0.030	0.539	1.55	9.11	0.418	0.022	0.190	0.121	<0.010	0.028	0.054
Batch 1	BCHLM222	2	2	11	2.10	<0.010	0.968	<0.010	0.156	<0.010	2.64	<0.010	0.662	2.13	8.70	0.793	<0.020	<0.050	<0.100	0.521	<0.010	<0.010
Ustd	UstdLM222	2	2	12	2.11	<0.010	0.704	<0.010	0.168	<0.010	2.68	<0.010	0.744	2.06	8.92	0.769	<0.020	<0.050	<0.100	0.583	<0.010	0.003
LRM(4)	M08LM22	2	2	13	2.13	<0.010	0.988	<0.010	0.173	<0.010	2.68	<0.010	0.734	1.99	9.12	0.748	<0.020	<0.050	<0.100	0.573	<0.010	<0.010
SB4SULFA-04	M02LM22	2	2	14	2.11	<0.010	0.974	<0.010	0.155	<0.010	2.64	<0.010	0.652	2.11	8.77	0.778	<0.020	<0.050	<0.100	0.528	<0.010	<0.010
SB4SULFA-09	M11LM12	2	2	15	2.12	<0.010	0.982	<0.010	0.155	<0.010	2.68	<0.010	0.647	2.06	8.92	0.769	<0.020	<0.050	<0.100	0.528	<0.010	<0.010
SB4SULFA-06	M16LM22	2	2	16	2.12	<0.010	0.996	<0.010	0.150	<0.010	2.70	<0.010	0.621	1.97	9.03	0.732	<0.020	<0.050	<0.100	0.512	<0.010	<0.010
SB4SULFA-09	M11LM22	2	2	17	2.11	<0.010	0.959	<0.010	0.157	<0.010	2.64	<0.010	0.673	2.17	8.78	0.807	<0.020	<0.050	<0.100	0.533	<0.010	<0.010
SB4SULFA-06	M16LM12	2	2	18	2.09	<0.010	0.967	<0.010	0.154	<0.010	2.60	<0.010	0.661	2.17	8.76	0.809	<0.020	<0.050	<0.100	0.525	<0.010	<0.010

Table B2. Measured Elemental Concentrations (in wt%) for Samples Prepared Using Lithium Metaborate (continued)

Glass ID	Laboratory ID	Block	Sub-Block	Analytical Sequence	Al	Ba	Ca	Ce	Cr	Cu	K	La	Mg	Mn	Na	Ni	Pb	S	Th	Ti	Zn	Zr
SB4SULFA-07	M04LM12	2	2	19	2.10	<0.010	0.975	<0.010	0.162	<0.010	2.63	<0.010	0.696	2.15	8.93	0.790	<0.020	<0.050	<0.100	0.550	<0.010	<0.010
SB4SULFA-10	M06LM22	2	2	20	2.11	<0.010	0.967	<0.010	0.156	<0.010	2.64	<0.010	0.654	2.15	8.84	0.804	<0.020	<0.050	<0.100	0.526	<0.010	<0.010
Batch 1	BCHLM223	2	2	21	2.10	<0.010	0.960	<0.010	0.158	<0.010	2.65	<0.010	0.672	2.07	8.89	0.761	<0.020	<0.050	<0.100	0.523	<0.010	<0.010
Ustd	UstdLM223	2	2	22	2.12	<0.010	0.972	<0.010	0.154	<0.010	2.66	<0.010	0.658	2.08	8.99	0.772	<0.020	<0.050	<0.100	0.518	<0.010	<0.010

Table B3. Measured Elemental Concentrations (in wt%) for Samples Prepared Using Peroxide Fusion

Glass ID	PSAL ID	Block	Sub-Block	Analytical Sequence	B	Fe	Li	Si	U
Batch 1	BCHPF111	1	1	1	2.35	8.70	2.03	22.4	<0.100
Ustd	UstdPF111	1	1	2	2.97	8.45	1.45	19.9	1.84
SB4SULFA-03	M05PF21	1	1	3	1.50	6.16	2.32	22.2	2.29
LRM(2)	M09PF21	1	1	4	2.27	0.77	0.152	22.9	<0.100
LRM(4)	M08PF21	1	1	5	<0.100	<0.100	0.111	25.1	<0.100
LRM(4)	M08PF11	1	1	6	4.09	1.38	0.194	24.5	<0.100
LRM(2)	M09PF11	1	1	7	2.29	0.77	0.157	23.1	<0.100
SB4SULFA-09	M11PF21	1	1	8	2.59	5.72	2.20	20.7	2.17
SB4SULFA-08	M07PF11	1	1	9	2.62	5.86	2.25	20.5	2.22
SB4SULFA-04	M02PF11	1	1	10	1.53	5.87	2.23	21.6	2.19
Batch 1	BCHPF112	1	1	11	2.34	8.43	1.97	22.1	<0.100
Ustd	UstdPF112	1	1	12	2.71	7.88	1.42	19.1	1.75
SB4SULFA-04	M02PF21	1	1	13	1.56	5.70	2.22	21.2	2.15
SB4SULFA-07	M04PF11	1	1	14	2.59	5.84	2.20	20.7	2.20
SB4SULFA-09	M11PF11	1	1	15	2.61	5.78	2.19	20.7	2.22
SB4SULFA-10	M06PF11	1	1	16	2.66	6.01	2.21	20.9	2.29
SB4SULFA-10	M06PF21	1	1	17	2.61	5.73	2.22	20.7	2.22
SB4SULFA-08	M07PF21	1	1	18	2.54	5.80	2.20	20.5	2.26
SB4SULFA-03	M05PF11	1	1	19	1.46	5.63	2.22	21.1	2.26
SB4SULFA-07	M04PF21	1	1	20	2.54	5.68	2.21	20.5	2.23
Batch 1	BCHPF113	1	1	21	2.34	8.32	1.97	21.8	<0.100
Ustd	Ustdpf113	1	1	22	2.73	7.86	1.42	19.0	1.80
Batch 1	BCHPF121	1	2	1	2.65	8.95	2.02	23.1	<0.100
Ustd	UstdPF121	1	2	2	2.94	8.56	1.43	20.4	1.87
SB4SULFA-07	M04PF22	1	2	3	2.70	6.06	2.26	21.4	2.24
LRM(4)	M08PF22	1	2	4	<0.100	<0.100	0.111	24.8	<0.100
SB4SULFA-10	M06PF12	1	2	5	2.75	6.40	2.26	21.8	2.37
LRM(2)	M09PF12	1	2	6	2.38	0.88	0.142	24.3	<0.100
SB4SULFA-07	M04PF12	1	2	7	2.70	6.25	2.26	21.6	2.31
SB4SULFA-04	M02PF22	1	2	8	1.54	6.04	2.27	22.2	2.24
SB4SULFA-10	M06PF22	1	2	9	2.69	6.15	2.27	21.6	2.30
SB4SULFA-08	M07PF22	1	2	10	2.65	6.07	2.26	21.3	2.27
Batch 1	BCHPF122	1	2	11	2.45	8.98	2.01	23.1	<0.100
Ustd	UstdPF122	1	2	12	2.81	8.43	1.44	20.4	1.86
SB4SULFA-09	M11PF12	1	2	13	2.80	6.24	2.24	21.6	2.30
LRM(4)	M08PF12	1	2	14	4.34	1.49	0.180	24.2	<0.100
SB4SULFA-04	M02PF12	1	2	15	1.60	6.14	2.27	22.3	2.32
SB4SULFA-03	M05PF12	1	2	16	1.54	6.10	2.28	22.2	2.30
LRM(2)	M09PF22	1	2	17	2.33	0.80	0.135	23.8	<0.100
SB4SULFA-03	M05PF22	1	2	18	1.55	6.18	2.33	22.6	2.34
SB4SULFA-08	M07PF12	1	2	19	2.67	6.25	2.29	21.6	2.35
SB4SULFA-09	M11PF22	1	2	20	2.69	6.06	2.25	21.6	2.29
Batch 1	BCHPF123	1	2	21	2.43	8.77	2.01	22.9	<0.100
Ustd	UstdPF123	1	2	22	2.79	8.45	1.43	20.1	1.88
Batch 1	BCHPF211	2	1	1	2.66	9.15	2.02	23.0	<0.100
Ustd	UstdPF211	2	1	2	2.96	8.74	1.45	20.1	1.89
SB4SULFA-06	M16PF11	2	1	3	2.84	6.52	2.31	22.2	2.43
SB4SULFA-05	M13PF11	2	1	4	1.63	6.27	2.31	22.4	2.33
LRM(1)	M12PF21	2	1	5	2.50	1.02	0.133	25.0	<0.100
LRM(3)	M10PF21	2	1	6	2.48	0.93	0.132	25.1	<0.100
LRM(3)	M10PF11	2	1	7	2.47	0.92	0.133	25.0	<0.100
LRM(5)	M01PF21	2	1	8	2.49	1.00	0.150	25.2	<0.100
SB4SULFA-01	M03PF11	2	1	9	1.53	6.57	2.25	22.2	2.33
LRM(6)	M14PF21	2	1	10	2.45	1.04	0.164	25.2	<0.100
Batch 1	BCHPF212	2	1	11	2.41	8.87	2.02	22.8	<0.100
Ustd	UstdPF212	2	1	12	2.82	8.62	1.44	20.1	1.90
SB4SULFA-05	M13PF21	2	1	13	1.62	6.15	2.27	22.8	2.37
SB4SULFA-01	M03PF21	2	1	14	1.54	6.60	2.24	22.1	2.37
SB4SULFA-06	M16PF21	2	1	15	2.76	6.62	2.31	22.3	2.41
LRM(5)	M01PF11	2	1	16	2.47	1.10	0.180	25.3	<0.100
SB4SULFA-02	M15PF21	2	1	17	1.59	6.81	2.34	22.6	2.38
LRM(1)	M12PF11	2	1	18	2.44	1.01	0.131	25.2	<0.100
SB4SULFA-02	M15PF11	2	1	19	1.50	7.02	2.27	21.8	2.37
LRM(6)	M14PF11	2	1	20	2.42	0.95	0.143	24.8	<0.100
Batch 1	BCHPF213	2	1	21	2.41	9.01	2.03	22.9	<0.100

Table B3. Measured Elemental Concentrations (in wt%) for Samples Prepared Using Peroxide Fusion (continued)

Glass ID	PSAL ID	Block	Sub-Block	Analytical Sequence	B	Fe	Li	Si	U
Ustd	UstdPF213	2	1	22	2.81	8.66	1.46	20.2	1.93
Batch 1	BCHPF221	2	2	1	2.56	8.93	2.01	22.9	<0.100
Ustd	UstdPF221	2	2	2	2.91	8.72	1.44	20.2	1.84
SB4SULFA-05	M13PF22	2	2	3	1.58	6.23	2.27	22.5	2.33
LRM(6)	M14PF12	2	2	4	2.46	0.90	0.140	24.9	<0.100
SB4SULFA-05	M13PF12	2	2	5	1.54	6.22	2.30	22.4	2.31
SB4SULFA-06	M16PF22	2	2	6	2.76	6.69	2.31	22.6	2.42
SB4SULFA-06	M16PF12	2	2	7	2.78	6.64	2.31	22.4	2.41
LRM(5)	M01PF12	2	2	8	2.49	1.03	0.173	25.6	<0.100
LRM(5)	M01PF22	2	2	9	2.43	0.91	0.145	25.2	<0.100
LRM(3)	M10PF22	2	2	10	2.43	0.84	0.128	25.2	<0.100
Batch 1	BCHPF222	2	2	11	2.42	9.07	2.02	23.1	<0.100
Ustd	UstdPF222	2	2	12	2.81	8.69	1.45	20.2	1.90
LRM(3)	M10PF12	2	2	13	2.49	0.84	0.129	25.2	<0.100
LRM(1)	M12PF22	2	2	14	2.46	0.93	0.129	25.2	<0.100
SB4SULFA-02	M15PF12	2	2	15	1.55	7.29	2.28	22.3	2.39
SB4SULFA-01	M03PF12	2	2	16	1.52	6.76	2.27	22.7	2.39
LRM(6)	M14PF22	2	2	17	2.45	0.99	0.162	25.6	<0.100
SB4SULFA-01	M03PF22	2	2	18	1.49	6.60	2.25	22.3	2.29
SB4SULFA-02	M15PF22	2	2	19	1.53	6.92	2.33	23.0	2.33
LRM(1)	M12PF12	2	2	20	2.44	0.95	0.125	25.4	<0.100
Batch 1	BCHPF223	2	2	21	2.41	9.24	2.04	23.2	<0.100
Ustd	UstdPF223	2	2	22	2.84	8.96	1.46	20.4	1.86

Table B4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Sulfate Study Glass

(100 -Batch 1; 200 -U std; 300 - LRM)

Glass ID	Glass #	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured	Diff of Meas. bc	% Diff of Measured	% Diff of Meas. bc
SB4SULFA-01	1	Al_2O_3	9.3247	9.5445	8.9300	0.3947	0.6145	4.4%	6.9%
SB4SULFA-01	1	B_2O_3	4.8942	4.7696	4.9500	-0.0558	-0.1804	-1.1%	-3.6%
SB4SULFA-01	1	BaO	0.0433	0.0461	0.0500	-0.0067	-0.0039	-13.5%	-7.7%
SB4SULFA-01	1	CaO	0.9794	0.9576	0.9000	0.0794	0.0576	8.8%	6.4%
SB4SULFA-01	1	Ce_2O_3	0.0398	0.0398	0.0600	-0.0202	-0.0202	-33.6%	-33.6%
SB4SULFA-01	1	Cr_2O_3	0.0727	0.0777	0.0800	-0.0073	-0.0023	-9.1%	-2.8%
SB4SULFA-01	1	CuO	0.0244	0.0237	0.0200	0.0044	0.0037	22.1%	18.5%
SB4SULFA-01	1	Fe_2O_3	9.4825	9.4144	10.0400	-0.5575	-0.6256	-5.6%	-6.2%
SB4SULFA-01	1	K_2O	0.1449	0.1362	0.1200	0.0249	0.0162	20.7%	13.5%
SB4SULFA-01	1	La_2O_3	0.0340	0.0340	0.0400	-0.0060	-0.0060	-15.0%	-15.0%
SB4SULFA-01	1	Li_2O	4.8494	4.9306	4.9500	-0.1006	-0.0194	-2.0%	-0.4%
SB4SULFA-01	1	MgO	0.8702	0.9080	0.9600	-0.0898	-0.0520	-9.4%	-5.4%
SB4SULFA-01	1	MnO	2.0046	2.1612	2.0700	-0.0654	0.0912	-3.2%	4.4%
SB4SULFA-01	1	Na_2O	14.5921	13.8531	13.9700	0.6221	-0.1169	4.5%	-0.8%
SB4SULFA-01	1	NiO	0.5345	0.5976	0.5900	-0.0556	0.0076	-9.4%	1.3%
SB4SULFA-01	1	PbO	0.0269	0.0269	0.0400	-0.0131	-0.0131	-32.7%	-32.7%
SB4SULFA-01	1	SO_4	0.4921	0.4921	0.6000	-0.1079	-0.1079	-18.0%	-18.0%
SB4SULFA-01	1	SiO_2	47.7599	48.7808	48.5600	-0.8001	0.2208	-1.6%	0.5%
SB4SULFA-01	1	ThO_2	0.1314	0.1314	0.0200	0.1114	0.1114	557.1%	557.1%
SB4SULFA-01	1	TiO_2	0.0083	0.0088	0.0100	-0.0017	-0.0012	-16.6%	-11.8%
SB4SULFA-01	1	U_3O_8	2.7652	2.9908	2.9100	-0.1448	0.0808	-5.0%	2.8%
SB4SULFA-01	1	ZnO	0.0342	0.0342	0.0400	-0.0058	-0.0058	-14.4%	-14.4%
SB4SULFA-01	1	ZrO_2	0.0706	0.0706	0.0900	-0.0194	-0.0194	-21.6%	-21.6%
SB4SULFA-01	1	Sum	99.1794	100.0299	100.0000	-0.8206	0.0299	-0.8%	0.0%
SB4SULFA-02	2	Al_2O_3	9.6931	9.9216	8.9200	0.7731	1.0016	8.7%	11.2%
SB4SULFA-02	2	B_2O_3	4.9667	4.8405	4.9500	0.0167	-0.1095	0.3%	-2.2%
SB4SULFA-02	2	BaO	0.0435	0.0464	0.0500	-0.0065	-0.0036	-12.9%	-7.2%
SB4SULFA-02	2	CaO	0.9679	0.9463	0.9000	0.0679	0.0463	7.5%	5.1%
SB4SULFA-02	2	Ce_2O_3	0.0454	0.0454	0.0600	-0.0146	-0.0146	-24.4%	-24.4%
SB4SULFA-02	2	Cr_2O_3	0.0786	0.0839	0.0800	-0.0014	0.0039	-1.8%	4.9%
SB4SULFA-02	2	CuO	0.0244	0.0237	0.0200	0.0044	0.0037	22.1%	18.5%
SB4SULFA-02	2	Fe_2O_3	10.0222	9.9500	10.0300	-0.0078	-0.0800	-0.1%	-0.8%
SB4SULFA-02	2	K_2O	0.1406	0.1322	0.1200	0.0206	0.0122	17.2%	10.2%
SB4SULFA-02	2	La_2O_3	0.0337	0.0337	0.0400	-0.0063	-0.0063	-15.7%	-15.7%
SB4SULFA-02	2	Li_2O	4.9624	5.0456	4.9500	0.0124	0.0956	0.3%	1.9%
SB4SULFA-02	2	MgO	0.9274	0.9669	0.9600	-0.0326	0.0069	-3.4%	0.7%
SB4SULFA-02	2	MnO	2.0433	2.2032	2.0700	-0.0267	0.1332	-1.3%	6.4%
SB4SULFA-02	2	Na_2O	14.8280	14.0772	13.9600	0.8680	0.1172	6.2%	0.8%
SB4SULFA-02	2	NiO	0.5545	0.6201	0.5900	-0.0355	0.0301	-6.0%	5.1%
SB4SULFA-02	2	PbO	0.0272	0.0272	0.0400	-0.0128	-0.0128	-32.0%	-32.0%
SB4SULFA-02	2	SO_4	0.5640	0.5640	0.6500	-0.0860	-0.0860	-13.2%	-13.2%
SB4SULFA-02	2	SiO_2	47.9738	48.9989	48.5400	-0.5662	0.4589	-1.2%	0.9%
SB4SULFA-02	2	ThO_2	0.1431	0.1431	0.0200	0.1231	0.1231	615.5%	615.5%
SB4SULFA-02	2	TiO_2	0.0083	0.0088	0.0100	-0.0017	-0.0012	-16.6%	-11.8%
SB4SULFA-02	2	U_3O_8	2.7918	3.0194	2.9100	-0.1182	0.1094	-4.1%	3.8%
SB4SULFA-02	2	ZnO	0.0364	0.0364	0.0400	-0.0036	-0.0036	-9.0%	-9.0%
SB4SULFA-02	2	ZrO_2	0.0729	0.0729	0.0900	-0.0171	-0.0171	-19.0%	-19.0%
SB4SULFA-02	2	Sum	100.9494	101.8074	100.0000	0.9494	1.8074	0.9%	1.8%
SB4SULFA-03	3	Al_2O_3	9.1971	9.4140	8.9200	0.2771	0.4940	3.1%	5.5%
SB4SULFA-03	3	B_2O_3	4.8701	4.8494	4.9500	-0.0799	-0.1006	-1.6%	-2.0%
SB4SULFA-03	3	BaO	0.0421	0.0449	0.0500	-0.0079	-0.0051	-15.7%	-10.2%
SB4SULFA-03	3	CaO	0.9861	0.9641	0.9000	0.0861	0.0641	9.6%	7.1%
SB4SULFA-03	3	Ce_2O_3	0.0445	0.0445	0.0600	-0.0155	-0.0155	-25.8%	-25.8%
SB4SULFA-03	3	Cr_2O_3	0.0826	0.0882	0.0800	0.0026	0.0082	3.2%	10.3%
SB4SULFA-03	3	CuO	0.0235	0.0228	0.0200	0.0035	0.0028	17.4%	13.9%
SB4SULFA-03	3	Fe_2O_3	8.6032	8.8896	10.0300	-1.4268	-1.1404	-14.2%	-11.4%
SB4SULFA-03	3	K_2O	0.1503	0.1413	0.1200	0.0303	0.0213	25.2%	17.7%
SB4SULFA-03	3	La_2O_3	0.0334	0.0334	0.0400	-0.0066	-0.0066	-16.4%	-16.4%
SB4SULFA-03	3	Li_2O	4.9248	5.0614	4.9500	-0.0252	0.1114	-0.5%	2.3%
SB4SULFA-03	3	MgO	0.8830	0.9206	0.9600	-0.0770	-0.0394	-8.0%	-4.1%
SB4SULFA-03	3	MnO	2.0110	2.1685	2.0700	-0.0590	0.0985	-2.8%	4.8%
SB4SULFA-03	3	Na_2O	13.8170	13.1173	13.9600	-0.1430	-0.8427	-1.0%	-6.0%
SB4SULFA-03	3	NiO	0.5427	0.6070	0.5900	-0.0473	0.0170	-8.0%	2.9%
SB4SULFA-03	3	PbO	0.0299	0.0299	0.0400	-0.0101	-0.0101	-25.3%	-25.3%

Table B4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Sulfate Study Glass (continued)

(100 -Batch 1; 200 -U std; 300 - LRM)

Glass ID	Glass #	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured	Diff of Meas. bc	% Diff of Measured	% Diff of Meas. bc
SB4SULFA-03	3	SO_4	0.5655	0.5655	0.7000	-0.1345	-0.1345	-19.2%	-19.2%
SB4SULFA-03	3	SiO_2	47.1181	49.0183	48.5200	-1.4019	0.4983	-2.9%	1.0%
SB4SULFA-03	3	ThO_2	0.1363	0.1363	0.0200	0.1163	0.1163	581.3%	581.3%
SB4SULFA-03	3	TiO_2	0.0083	0.0088	0.0100	-0.0017	-0.0012	-16.6%	-11.8%
SB4SULFA-03	3	U_3O_8	2.7092	3.0158	2.9100	-0.2008	0.1058	-6.9%	3.6%
SB4SULFA-03	3	ZnO	0.0411	0.0411	0.0400	0.0011	0.0011	2.7%	2.7%
SB4SULFA-03	3	ZrO_2	0.0834	0.0834	0.0900	-0.0066	-0.0066	-7.3%	-7.3%
SB4SULFA-03	3	Sum	96.9033	99.2659	100.0300	-3.1267	-0.7641	-3.1%	-0.8%
SB4SULFA-04	4	Al_2O_3	9.3908	9.7344	8.9100	0.4808	0.8244	5.4%	9.3%
SB4SULFA-04	4	B_2O_3	5.0150	4.9960	4.9500	0.0650	0.0460	1.3%	0.9%
SB4SULFA-04	4	BaO	0.0416	0.0458	0.0500	-0.0084	-0.0042	-16.8%	-8.4%
SB4SULFA-04	4	CaO	0.9557	0.9438	0.9000	0.0557	0.0438	6.2%	4.9%
SB4SULFA-04	4	Ce_2O_3	0.0401	0.0401	0.0600	-0.0199	-0.0199	-33.1%	-33.1%
SB4SULFA-04	4	Cr_2O_3	0.0793	0.0871	0.0800	-0.0007	0.0071	-0.9%	8.8%
SB4SULFA-04	4	CuO	0.0222	0.0218	0.0200	0.0022	0.0018	11.1%	8.8%
SB4SULFA-04	4	Fe_2O_3	8.4888	8.7703	10.0200	-1.5312	-1.2497	-15.3%	-12.5%
SB4SULFA-04	4	K_2O	0.1436	0.1379	0.1200	0.0236	0.0179	19.7%	14.9%
SB4SULFA-04	4	La_2O_3	0.0323	0.0323	0.0400	-0.0077	-0.0077	-19.4%	-19.4%
SB4SULFA-04	4	Li_2O	4.8386	4.9728	4.9500	-0.1114	0.0228	-2.2%	0.5%
SB4SULFA-04	4	MgO	0.9137	0.9695	0.9600	-0.0463	0.0095	-4.8%	1.0%
SB4SULFA-04	4	MnO	2.1079	2.1989	2.0600	0.0479	0.1389	2.3%	6.7%
SB4SULFA-04	4	Na_2O	14.4573	13.9602	13.9500	0.5073	0.0102	3.6%	0.1%
SB4SULFA-04	4	NiO	0.5659	0.6081	0.5900	-0.0241	0.0181	-4.1%	3.1%
SB4SULFA-04	4	PbO	0.0272	0.0272	0.0400	-0.0128	-0.0128	-32.0%	-32.0%
SB4SULFA-04	4	SO_4	0.6524	0.6524	0.7500	-0.0976	-0.0976	-13.0%	-13.0%
SB4SULFA-04	4	SiO_2	46.6902	48.5707	48.4900	-1.7998	0.0807	-3.7%	0.2%
SB4SULFA-04	4	ThO_2	0.1300	0.1300	0.0200	0.1100	0.1100	550.0%	550.0%
SB4SULFA-04	4	TiO_2	0.0083	0.0089	0.0100	-0.0017	-0.0011	-16.6%	-10.7%
SB4SULFA-04	4	U_3O_8	2.6237	2.9197	2.9100	-0.2863	0.0097	-9.8%	0.3%
SB4SULFA-04	4	ZnO	0.0364	0.0364	0.0400	-0.0036	-0.0036	-9.0%	-9.0%
SB4SULFA-04	4	ZrO_2	0.0797	0.0797	0.0900	-0.0103	-0.0103	-11.4%	-11.4%
SB4SULFA-04	4	Sum	97.3409	99.9440	100.0100	-2.6691	-0.0660	-2.7%	-0.1%
SB4SULFA-05	5	Al_2O_3	9.3200	9.5396	8.9100	0.4100	0.6296	4.6%	7.1%
SB4SULFA-05	5	B_2O_3	5.1277	4.9968	4.9400	0.1877	0.0568	3.8%	1.2%
SB4SULFA-05	5	BaO	0.0486	0.0518	0.0500	-0.0014	0.0018	-2.9%	3.5%
SB4SULFA-05	5	CaO	1.0137	0.9911	0.9000	0.1137	0.0911	12.6%	10.1%
SB4SULFA-05	5	Ce_2O_3	0.0445	0.0445	0.0600	-0.0155	-0.0155	-25.8%	-25.8%
SB4SULFA-05	5	Cr_2O_3	0.0782	0.0836	0.0800	-0.0018	0.0036	-2.3%	4.4%
SB4SULFA-05	5	CuO	0.0250	0.0243	0.0200	0.0050	0.0043	25.2%	21.5%
SB4SULFA-05	5	Fe_2O_3	8.8892	8.8256	10.0200	-1.1308	-1.1944	-11.3%	-11.9%
SB4SULFA-05	5	K_2O	0.1476	0.1387	0.1200	0.0276	0.0187	23.0%	15.6%
SB4SULFA-05	5	La_2O_3	0.0367	0.0367	0.0400	-0.0034	-0.0034	-8.4%	-8.4%
SB4SULFA-05	5	Li_2O	4.9248	5.0073	4.9400	-0.0152	0.0673	-0.3%	1.4%
SB4SULFA-05	5	MgO	0.9117	0.9505	0.9600	-0.0483	-0.0095	-5.0%	-1.0%
SB4SULFA-05	5	MnO	1.9981	2.1543	2.0600	-0.0619	0.0943	-3.0%	4.6%
SB4SULFA-05	5	Na_2O	14.5247	13.7892	13.9400	0.5847	-0.1508	4.2%	-1.1%
SB4SULFA-05	5	NiO	0.5341	0.5972	0.5900	-0.0559	0.0072	-9.5%	1.2%
SB4SULFA-05	5	PbO	0.0299	0.0299	0.0400	-0.0101	-0.0101	-25.3%	-25.3%
SB4SULFA-05	5	SO_4	0.6621	0.6621	0.8000	-0.1379	-0.1379	-17.2%	-17.2%
SB4SULFA-05	5	SiO_2	48.1877	49.2197	48.4700	-0.2823	0.7497	-0.6%	1.5%
SB4SULFA-05	5	ThO_2	0.1391	0.1391	0.0200	0.1191	0.1191	595.5%	595.5%
SB4SULFA-05	5	TiO_2	0.0083	0.0088	0.0100	-0.0017	-0.0012	-16.6%	-11.8%
SB4SULFA-05	5	U_3O_8	2.7534	2.9779	2.9100	-0.1566	0.0679	-5.4%	2.3%
SB4SULFA-05	5	ZnO	0.0367	0.0367	0.0400	-0.0033	-0.0033	-8.2%	-8.2%
SB4SULFA-05	5	ZrO_2	0.0746	0.0746	0.0900	-0.0154	-0.0154	-17.1%	-17.1%
SB4SULFA-05	5	Sum	99.5164	100.3799	100.0100	-0.4936	0.3699	-0.5%	0.4%
SB4SULFA-06	6	Al_2O_3	7.4588	7.7316	8.9300	-1.4712	-1.1984	-16.5%	-13.4%
SB4SULFA-06	6	B_2O_3	8.9674	8.7394	8.6700	0.2974	0.0694	3.4%	0.8%
SB4SULFA-06	6	BaO	0.0421	0.0464	0.0500	-0.0079	-0.0036	-15.7%	-7.2%
SB4SULFA-06	6	CaO	0.9889	0.9767	0.9000	0.0889	0.0767	9.9%	8.5%
SB4SULFA-06	6	Ce_2O_3	0.0410	0.0410	0.0600	-0.0190	-0.0190	-31.7%	-31.7%
SB4SULFA-06	6	Cr_2O_3	0.0702	0.0770	0.0800	-0.0098	-0.0030	-12.3%	-3.7%

Table B4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Sulfate Study Glass (continued)

(100 -Batch 1; 200 -U std; 300 - LRM)

Glass ID	Glass #	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured	Diff of Meas. bc	% Diff of Measured	% Diff of Meas. bc
SB4SULFA-06	6	CuO	0.0241	0.0236	0.0200	0.0041	0.0036	20.5%	18.0%
SB4SULFA-06	6	Fe_2O_3	9.4610	9.3931	10.0400	-0.5790	-0.6469	-5.8%	-6.4%
SB4SULFA-06	6	K_2O	0.1443	0.1385	0.1200	0.0243	0.0185	20.2%	15.4%
SB4SULFA-06	6	La_2O_3	0.0337	0.0337	0.0400	-0.0063	-0.0063	-15.7%	-15.7%
SB4SULFA-06	6	Li_2O	4.9732	5.0565	4.9500	0.0232	0.1065	0.5%	2.2%
SB4SULFA-06	6	MgO	0.9311	0.9880	0.9600	-0.0289	0.0280	-3.0%	2.9%
SB4SULFA-06	6	MnO	2.1434	2.2355	2.0700	0.0734	0.1655	3.5%	8.0%
SB4SULFA-06	6	Na_2O	12.1792	11.7596	11.4900	0.6892	0.2696	6.0%	2.3%
SB4SULFA-06	6	NiO	0.5930	0.6367	0.5900	0.0030	0.0467	0.5%	7.9%
SB4SULFA-06	6	PbO	0.0272	0.0272	0.0400	-0.0128	-0.0128	-32.0%	-32.0%
SB4SULFA-06	6	SO_4	0.5243	0.5243	0.6000	-0.0757	-0.0757	-12.6%	-12.6%
SB4SULFA-06	6	SiO_2	47.8668	48.8904	47.3300	0.5368	1.5604	1.1%	3.3%
SB4SULFA-06	6	ThO_2	0.1405	0.1405	0.0200	0.1205	0.1205	602.7%	602.7%
SB4SULFA-06	6	TiO_2	0.0083	0.0089	0.0100	-0.0017	-0.0011	-16.6%	-10.7%
SB4SULFA-06	6	U_3O_8	2.8507	3.0833	2.9100	-0.0593	0.1733	-2.0%	6.0%
SB4SULFA-06	6	ZnO	0.0367	0.0367	0.0400	-0.0033	-0.0033	-8.2%	-8.2%
SB4SULFA-06	6	ZrO_2	0.0827	0.0827	0.0900	-0.0073	-0.0073	-8.1%	-8.1%
SB4SULFA-06	6	Sum	99.5888	100.6715	100.0100	-0.4212	0.6615	-0.4%	0.7%
SB4SULFA-07	7	Al_2O_3	9.2680	9.6069	8.9200	0.3480	0.6869	3.9%	7.7%
SB4SULFA-07	7	B_2O_3	8.4764	8.4392	8.6700	-0.1936	-0.2308	-2.2%	-2.7%
SB4SULFA-07	7	BaO	0.0391	0.0430	0.0500	-0.0109	-0.0070	-21.8%	-14.0%
SB4SULFA-07	7	CaO	0.9483	0.9366	0.9000	0.0483	0.0366	5.4%	4.1%
SB4SULFA-07	7	Ce_2O_3	0.0366	0.0366	0.0600	-0.0234	-0.0234	-39.0%	-39.0%
SB4SULFA-07	7	Cr_2O_3	0.0756	0.0831	0.0800	-0.0044	0.0031	-5.5%	3.8%
SB4SULFA-07	7	CuO	0.0269	0.0264	0.0200	0.0069	0.0064	34.6%	31.8%
SB4SULFA-07	7	Fe_2O_3	8.5174	8.7983	10.0300	-1.5126	-1.2317	-15.1%	-12.3%
SB4SULFA-07	7	K_2O	0.1443	0.1385	0.1200	0.0243	0.0185	20.2%	15.4%
SB4SULFA-07	7	La_2O_3	0.0349	0.0349	0.0400	-0.0051	-0.0051	-12.8%	-12.8%
SB4SULFA-07	7	Li_2O	4.8063	4.9396	4.9500	-0.1437	-0.0104	-2.9%	-0.2%
SB4SULFA-07	7	MgO	0.8909	0.9453	0.9600	-0.0691	-0.0147	-7.2%	-1.5%
SB4SULFA-07	7	MnO	2.0562	2.1447	2.0700	-0.0138	0.0747	-0.7%	3.6%
SB4SULFA-07	7	Na_2O	12.0646	11.6490	11.4900	0.5746	0.1590	5.0%	1.4%
SB4SULFA-07	7	NiO	0.5621	0.6037	0.5900	-0.0279	0.0137	-4.7%	2.3%
SB4SULFA-07	7	PbO	0.0285	0.0285	0.0400	-0.0115	-0.0115	-28.6%	-28.6%
SB4SULFA-07	7	SO_4	0.5453	0.5453	0.6500	-0.1047	-0.1047	-16.1%	-16.1%
SB4SULFA-07	7	SiO_2	45.0323	46.8441	47.3000	-2.2677	-0.4559	-4.8%	-1.0%
SB4SULFA-07	7	ThO_2	0.1368	0.1368	0.0200	0.1168	0.1168	584.2%	584.2%
SB4SULFA-07	7	TiO_2	0.0083	0.0089	0.0100	-0.0017	-0.0011	-16.6%	-10.7%
SB4SULFA-07	7	U_3O_8	2.6473	2.9466	2.9100	-0.2627	0.0366	-9.0%	1.3%
SB4SULFA-07	7	ZnO	0.0342	0.0342	0.0400	-0.0058	-0.0058	-14.4%	-14.4%
SB4SULFA-07	7	ZrO_2	0.0831	0.0831	0.0900	-0.0069	-0.0069	-7.7%	-7.7%
SB4SULFA-07	7	Sum	96.4636	99.0532	100.0100	-3.5464	-0.9568	-3.5%	-1.0%
SB4SULFA-08	8	Al_2O_3	9.4239	9.7686	8.9200	0.5039	0.8486	5.6%	9.5%
SB4SULFA-08	8	B_2O_3	8.4361	8.4021	8.6600	-0.2239	-0.2579	-2.6%	-3.0%
SB4SULFA-08	8	BaO	0.0391	0.0430	0.0500	-0.0109	-0.0070	-21.8%	-14.0%
SB4SULFA-08	8	CaO	0.9707	0.9587	0.9000	0.0707	0.0587	7.9%	6.5%
SB4SULFA-08	8	Ce_2O_3	0.0384	0.0384	0.0600	-0.0216	-0.0216	-36.1%	-36.1%
SB4SULFA-08	8	Cr_2O_3	0.0723	0.0794	0.0800	-0.0077	-0.0006	-9.6%	-0.7%
SB4SULFA-08	8	CuO	0.0257	0.0251	0.0200	0.0057	0.0051	28.3%	25.6%
SB4SULFA-08	8	Fe_2O_3	8.5711	8.8549	10.0300	-1.4589	-1.1751	-14.5%	-11.7%
SB4SULFA-08	8	K_2O	0.1455	0.1397	0.1200	0.0255	0.0197	21.2%	16.4%
SB4SULFA-08	8	La_2O_3	0.0346	0.0346	0.0400	-0.0054	-0.0054	-13.5%	-13.5%
SB4SULFA-08	8	Li_2O	4.8440	4.9783	4.9500	-0.1060	0.0283	-2.1%	0.6%
SB4SULFA-08	8	MgO	0.8855	0.9397	0.9600	-0.0745	-0.0203	-7.8%	-2.1%
SB4SULFA-08	8	MnO	2.0853	2.1746	2.0700	0.0153	0.1046	0.7%	5.1%
SB4SULFA-08	8	Na_2O	12.1387	11.7204	11.4800	0.6587	0.2404	5.7%	2.1%
SB4SULFA-08	8	NiO	0.5599	0.6012	0.5900	-0.0301	0.0112	-5.1%	1.9%
SB4SULFA-08	8	PbO	0.0261	0.0261	0.0400	-0.0139	-0.0139	-34.7%	-34.7%
SB4SULFA-08	8	SO_4	0.5505	0.5505	0.7000	-0.1495	-0.1495	-21.4%	-21.4%
SB4SULFA-08	8	SiO_2	44.8718	46.6760	47.2800	-2.4082	-0.6040	-5.1%	-1.3%
SB4SULFA-08	8	ThO_2	0.1331	0.1331	0.0200	0.1131	0.1131	565.7%	565.7%
SB4SULFA-08	8	TiO_2	0.0083	0.0089	0.0100	-0.0017	-0.0011	-16.6%	-10.7%

Table B4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Sulfate Study Glass (continued)

(100 -Batch 1; 200 -U std; 300 - LRM)

Glass ID	Glass #	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured	Diff of Meas. bc	% Diff of Measured	% Diff of Meas. bc
SB4SULFA-08	8	U_3O_8	2.6827	2.9859	2.9100	-0.2273	0.0759	-7.8%	2.6%
SB4SULFA-08	8	ZnO	0.0613	0.0613	0.0400	0.0213	0.0213	53.3%	53.3%
SB4SULFA-08	8	ZrO_2	0.0780	0.0780	0.0900	-0.0120	-0.0120	-13.3%	-13.3%
SB4SULFA-08	8	Sum	96.6827	99.2785	100.0200	-3.3373	-0.7415	-3.3%	-0.7%
SB4SULFA-09	9	Al_2O_3	9.2444	9.5825	8.9100	0.3344	0.6725	3.8%	7.5%
SB4SULFA-09	9	B_2O_3	8.6052	8.5670	8.6600	-0.0548	-0.0930	-0.6%	-1.1%
SB4SULFA-09	9	BaO	0.0396	0.0436	0.0500	-0.0104	-0.0064	-20.7%	-12.7%
SB4SULFA-09	9	CaO	1.0274	1.0147	0.9000	0.1274	0.1147	14.2%	12.7%
SB4SULFA-09	9	Ce_2O_3	0.0398	0.0398	0.0600	-0.0202	-0.0202	-33.6%	-33.6%
SB4SULFA-09	9	Cr_2O_3	0.0698	0.0766	0.0800	-0.0102	-0.0034	-12.8%	-4.2%
SB4SULFA-09	9	CuO	0.0263	0.0257	0.0200	0.0063	0.0057	31.4%	28.7%
SB4SULFA-09	9	Fe_2O_3	8.5067	8.7871	10.0200	-1.5133	-1.2329	-15.1%	-12.3%
SB4SULFA-09	9	K_2O	0.1500	0.1440	0.1200	0.0300	0.0240	25.0%	20.0%
SB4SULFA-09	9	La_2O_3	0.0346	0.0346	0.0400	-0.0054	-0.0054	-13.5%	-13.5%
SB4SULFA-09	9	Li_2O	4.7794	4.9119	4.9500	-0.1706	-0.0381	-3.4%	-0.8%
SB4SULFA-09	9	MgO	0.8839	0.9379	0.9600	-0.0761	-0.0221	-7.9%	-2.3%
SB4SULFA-09	9	MnO	2.1014	2.1918	2.0600	0.0414	0.1318	2.0%	6.4%
SB4SULFA-09	9	Na_2O	12.0242	11.6099	11.4800	0.5442	0.1299	4.7%	1.1%
SB4SULFA-09	9	NiO	0.5631	0.6047	0.5900	-0.0269	0.0147	-4.6%	2.5%
SB4SULFA-09	9	PbO	0.0285	0.0285	0.0400	-0.0115	-0.0115	-28.6%	-28.6%
SB4SULFA-09	9	SO_4	0.6157	0.6157	0.7500	-0.1343	-0.1343	-17.9%	-17.9%
SB4SULFA-09	9	SiO_2	45.2462	47.0668	47.2500	-2.0038	-0.1832	-4.2%	-0.4%
SB4SULFA-09	9	ThO_2	0.1343	0.1343	0.0200	0.1143	0.1143	571.4%	571.4%
SB4SULFA-09	9	TiO_2	0.0083	0.0089	0.0100	-0.0017	-0.0011	-16.6%	-10.7%
SB4SULFA-09	9	U_3O_8	2.6473	2.9461	2.9100	-0.2627	0.0361	-9.0%	1.2%
SB4SULFA-09	9	ZnO	0.0389	0.0389	0.0400	-0.0011	-0.0011	-2.8%	-2.8%
SB4SULFA-09	9	ZrO_2	0.0841	0.0841	0.0900	-0.0059	-0.0059	-6.6%	-6.6%
SB4SULFA-09	9	Sum	96.8990	99.4951	100.0100	-3.1110	-0.5149	-3.1%	-0.5%
SB4SULFA-10	10	Al_2O_3	9.2963	9.6365	8.9100	0.3863	0.7265	4.3%	8.2%
SB4SULFA-10	10	B_2O_3	8.6213	8.5863	8.6500	-0.0287	-0.0637	-0.3%	-0.7%
SB4SULFA-10	10	BaO	0.0410	0.0452	0.0500	-0.0090	-0.0048	-17.9%	-9.7%
SB4SULFA-10	10	CaO	0.9354	0.9238	0.9000	0.0354	0.0238	3.9%	2.6%
SB4SULFA-10	10	Ce_2O_3	0.0366	0.0366	0.0600	-0.0234	-0.0234	-39.0%	-39.0%
SB4SULFA-10	10	Cr_2O_3	0.0775	0.0851	0.0800	-0.0025	0.0051	-3.2%	6.3%
SB4SULFA-10	10	CuO	0.0228	0.0224	0.0200	0.0028	0.0024	14.2%	11.9%
SB4SULFA-10	10	Fe_2O_3	8.6819	8.9681	10.0200	-1.3381	-1.0519	-13.4%	-10.5%
SB4SULFA-10	10	K_2O	0.1337	0.1284	0.1200	0.0137	0.0084	11.4%	7.0%
SB4SULFA-10	10	La_2O_3	0.0340	0.0340	0.0400	-0.0060	-0.0060	-15.0%	-15.0%
SB4SULFA-10	10	Li_2O	4.8225	4.9562	4.9400	-0.1175	0.0162	-2.4%	0.3%
SB4SULFA-10	10	MgO	0.9137	0.9695	0.9600	-0.0463	0.0095	-4.8%	1.0%
SB4SULFA-10	10	MnO	2.0853	2.1749	2.0600	0.0253	0.1149	1.2%	5.6%
SB4SULFA-10	10	Na_2O	11.9736	11.5616	11.4700	0.5036	0.0916	4.4%	0.8%
SB4SULFA-10	10	NiO	0.5526	0.5935	0.5900	-0.0374	0.0035	-6.3%	0.6%
SB4SULFA-10	10	PbO	0.0256	0.0256	0.0400	-0.0144	-0.0144	-36.0%	-36.0%
SB4SULFA-10	10	SO_4	0.6097	0.6097	0.8000	-0.1903	-0.1903	-23.8%	-23.8%
SB4SULFA-10	10	SiO_2	45.4601	47.2894	47.2300	-1.7699	0.0594	-3.7%	0.1%
SB4SULFA-10	10	ThO_2	0.1371	0.1371	0.0200	0.1171	0.1171	585.6%	585.6%
SB4SULFA-10	10	TiO_2	0.0113	0.0121	0.0100	0.0013	0.0021	12.6%	20.6%
SB4SULFA-10	10	U_3O_8	2.7063	3.0120	2.9100	-0.2037	0.1020	-7.0%	3.5%
SB4SULFA-10	10	ZnO	0.0349	0.0349	0.0400	-0.0051	-0.0051	-12.9%	-12.9%
SB4SULFA-10	10	ZrO_2	0.0719	0.0719	0.0900	-0.0181	-0.0181	-20.1%	-20.1%
SB4SULFA-10	10	Sum	97.2850	99.9146	100.0100	-2.7250	-0.0954	-2.7%	-0.1%
Batch 1	100	Al_2O_3	4.7348	4.8770	4.8770	-0.1422	0.0000	-2.9%	0.0%
Batch 1	100	B_2O_3	7.8968	7.7770	7.7770	0.1198	0.0000	1.5%	0.0%
Batch 1	100	BaO	0.1394	0.1510	0.1510	-0.0116	0.0000	-7.7%	0.0%
Batch 1	100	CaO	1.2416	1.2200	1.2200	0.0216	0.0000	1.8%	0.0%
Batch 1	100	Ce_2O_3	0.0059	0.0059	0.0000	0.0059	0.0059		
Batch 1	100	Cr_2O_3	0.0988	0.1070	0.1070	-0.0082	0.0000	-7.7%	0.0%
Batch 1	100	CuO	0.4092	0.3990	0.3990	0.0102	0.0000	2.6%	0.0%
Batch 1	100	Fe_2O_3	12.6791	12.8390	12.8390	-0.1599	0.0000	-1.2%	0.0%
Batch 1	100	K_2O	3.5024	3.3270	3.3270	0.1754	0.0000	5.3%	0.0%
Batch 1	100	La_2O_3	0.0059	0.0059	0.0000	0.0059	0.0059		

Table B4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Sulfate Study Glass (continued)
(100 -Batch 1; 200 -U std; 300 - LRM)

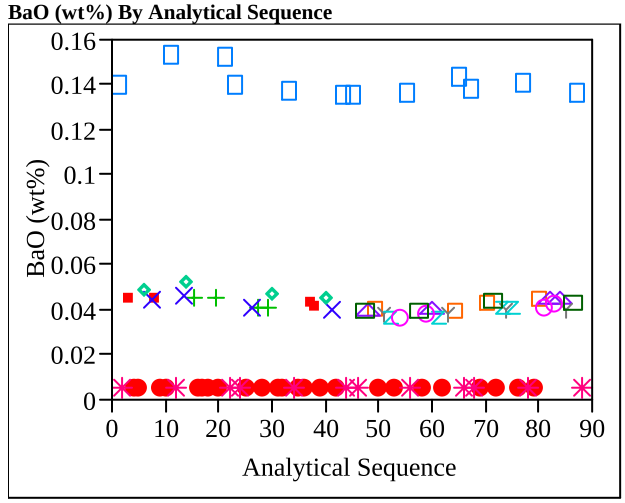
Glass ID	Glass #	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured	Diff of Meas. bc	% Diff of Measured	% Diff of Meas. bc
Batch 1	100	Li_2O	4.3327	4.4290	4.4290	-0.0963	0.0000	-2.2%	0.0%
Batch 1	100	MgO	1.3493	1.4190	1.4190	-0.0697	0.0000	-4.9%	0.0%
Batch 1	100	MnO	1.6280	1.7260	1.7260	-0.0980	0.0000	-5.7%	0.0%
Batch 1	100	Na_2O	9.4034	9.0030	9.0030	0.4004	0.0000	4.4%	0.0%
Batch 1	100	NiO	0.6855	0.7510	0.7510	-0.0655	0.0000	-8.7%	0.0%
Batch 1	100	PbO	0.0108	0.0108	0.0000	0.0108	0.0108		
Batch 1	100	SO_4	0.0749	0.0749	0.0000	0.0749	0.0749		
Batch 1	100	SiO_2	48.7226	50.2200	50.2200	-1.4974	0.0000	-3.0%	0.0%
Batch 1	100	ThO_2	0.0569	0.0569	0.0000	0.0569	0.0569		
Batch 1	100	TiO_2	0.6361	0.6770	0.6770	-0.0409	0.0000	-6.0%	0.0%
Batch 1	100	U_3O_8	0.0590	0.0647	0.0000	0.0590	0.0647		
Batch 1	100	ZnO	0.0062	0.0062	0.0000	0.0062	0.0062		
Batch 1	100	ZrO_2	0.0817	0.0817	0.0980	-0.0163	-0.0163	-16.6%	-16.6%
Batch 1	100	Sum	97.7606	99.2290	99.0200	-1.2594	0.2090	-1.3%	0.2%
U std	200	Al_2O_3	3.9868	4.1067	4.1000	-0.1132	0.0067	-2.8%	0.2%
U std	200	B_2O_3	9.1499	9.0158	9.2090	-0.0591	-0.1932	-0.6%	-2.1%
U std	200	BaO	0.0056	0.0061	0.0000	0.0056	0.0061		
U std	200	CaO	1.3306	1.3076	1.3010	0.0296	0.0066	2.3%	0.5%
U std	200	Ce_2O_3	0.0059	0.0059	0.0000	0.0059	0.0059		
U std	200	Cr_2O_3	0.2312	0.2504	0.0000	0.2312	0.2504		
U std	200	CuO	0.0063	0.0061	0.0000	0.0063	0.0061		
U std	200	Fe_2O_3	12.1548	12.3062	13.1960	-1.0412	-0.8898	-7.9%	-6.7%
U std	200	K_2O	3.1962	3.0363	2.9990	0.1972	0.0373	6.6%	1.2%
U std	200	La_2O_3	0.0059	0.0059	0.0000	0.0059	0.0059		
U std	200	Li_2O	3.1020	3.1709	3.0570	0.0450	0.1139	1.5%	3.7%
U std	200	MgO	1.1158	1.1730	1.2100	-0.0942	-0.0370	-7.8%	-3.1%
U std	200	MnO	2.7018	2.8649	2.8920	-0.1902	-0.0271	-6.6%	-0.9%
U std	200	Na_2O	11.9804	11.4709	11.7950	0.1854	-0.3241	1.6%	-2.7%
U std	200	NiO	0.9896	1.0844	1.1200	-0.1304	-0.0356	-11.6%	-3.2%
U std	200	PbO	0.0108	0.0108	0.0000	0.0108	0.0108		
U std	200	SO_4	0.0749	0.0749	0.0000	0.0749	0.0749		
U std	200	SiO_2	42.8038	44.1175	45.3530	-2.5492	-1.2355	-5.6%	-2.7%
U std	200	ThO_2	0.0569	0.0569	0.0000	0.0569	0.0569		
U std	200	TiO_2	0.8924	0.9496	1.0490	-0.1566	-0.0994	-14.9%	-9.5%
U std	200	U_3O_8	2.1933	2.4060	2.4060	-0.2127	0.0000	-8.8%	0.0%
U std	200	ZnO	0.0062	0.0062	0.0000	0.0062	0.0062		
U std	200	ZrO_2	0.0065	0.0065	0.0000	0.0065	0.0065		
U std	200	Sum	96.0075	97.4397	99.6870	-3.6795	-2.2473	-3.7%	-2.3%
LRM	300	Al_2O_3	9.9325	10.2106	10.0000	-0.0675	0.2106	-0.7%	2.1%
LRM	300	B_2O_3	7.6701	7.5256	8.0000	-0.3299	-0.4744	-4.1%	-5.9%
LRM	300	BaO	0.0056	0.0060	0.0050	0.0006	0.0010	11.7%	20.5%
LRM	300	CaO	0.5895	0.5786	0.5000	0.0895	0.0786	17.9%	15.7%
LRM	300	Ce_2O_3	0.0059	0.0059	0.0000	0.0059	0.0059		
LRM	300	Cr_2O_3	0.1937	0.2092	0.2000	-0.0063	0.0092	-3.2%	4.6%
LRM	300	CuO	0.0063	0.0061	0.0000	0.0063	0.0061		
LRM	300	Fe_2O_3	1.2838	1.2894	1.0000	0.2838	0.2894	28.4%	28.9%
LRM	300	K_2O	1.5846	1.5000	1.5000	0.0846	0.0000	5.6%	0.0%
LRM	300	La_2O_3	0.0065	0.0065	0.0000	0.0065	0.0065		
LRM	300	Li_2O	0.3121	0.3185	0.1000	0.2121	0.2185	212.1%	218.5%
LRM	300	MgO	0.1001	0.1049	0.1000	0.0001	0.0049	0.1%	4.9%
LRM	300	MnO	0.0065	0.0069	0.1000	-0.0935	-0.0931	-93.5%	-93.1%
LRM	300	Na_2O	20.6132	19.6805	20.0000	0.6132	-0.3195	3.1%	-1.6%
LRM	300	NiO	0.1723	0.1898	0.1000	0.0723	0.0898	72.3%	89.8%
LRM	300	PbO	0.0744	0.0744	0.1000	-0.0256	-0.0256	-25.6%	-25.6%
LRM	300	SO_4	0.2503	0.2503	0.2400	0.0103	0.0103	4.3%	4.3%
LRM	300	SiO_2	53.1081	54.5728	54.3700	-1.2619	0.2028	-2.3%	0.4%
LRM	300	ThO_2	0.0569	0.0569	0.0000	0.0569	0.0569		
LRM	300	TiO_2	0.0967	0.1028	0.1000	-0.0033	0.0028	-3.3%	2.8%
LRM	300	U_3O_8	0.0590	0.0644	0.0000	0.0590	0.0644		
LRM	300	ZnO	0.0062	0.0062	0.0000	0.0062	0.0062		
LRM	300	ZrO_2	0.9009	0.9009	1.0000	-0.0991	-0.0991	-9.9%	-9.9%
LRM	300	Sum	97.0348	97.6674	97.4150	-0.3802	0.2524	-0.4%	0.3%

Exhibit B1. Oxide Measurements in Analytical Sequence for Samples Prepared Using the LM Method

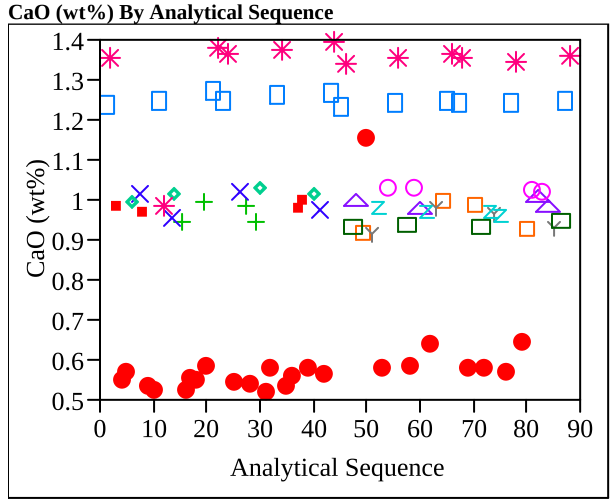
Legend

		Glass ID	N Rows
	1	Batch 1	12
	2	LRM(1)	4
	3	LRM(2)	4
	4	LRM(3)	4
	5	LRM(4)	4
	6	LRM(5)	4
	7	LRM(6)	4
	8	SB4SULFA-01	4
	9	SB4SULFA-02	4
	10	SB4SULFA-03	4
	11	SB4SULFA-04	4
	12	SB4SULFA-05	4
	13	SB4SULFA-06	4
	14	SB4SULFA-07	4
	15	SB4SULFA-08	4
	16	SB4SULFA-09	4
	17	SB4SULFA-10	4
	18	Ustd	12

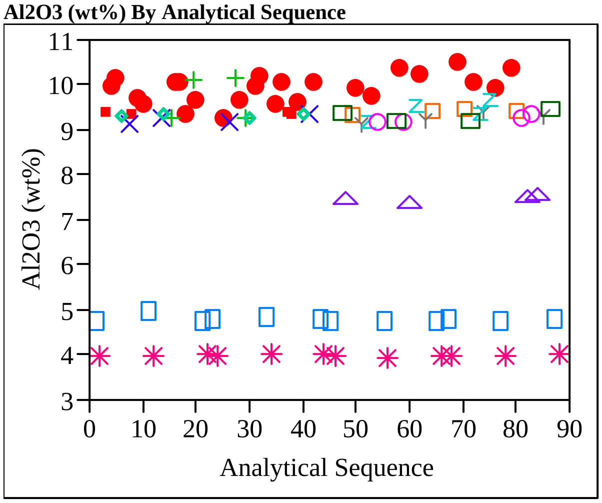
BaO (wt%) By Analytical Sequence



CaO (wt%) By Analytical Sequence



Al2O3 (wt%) By Analytical Sequence



Ce2O3 (wt%) By Analytical Sequence

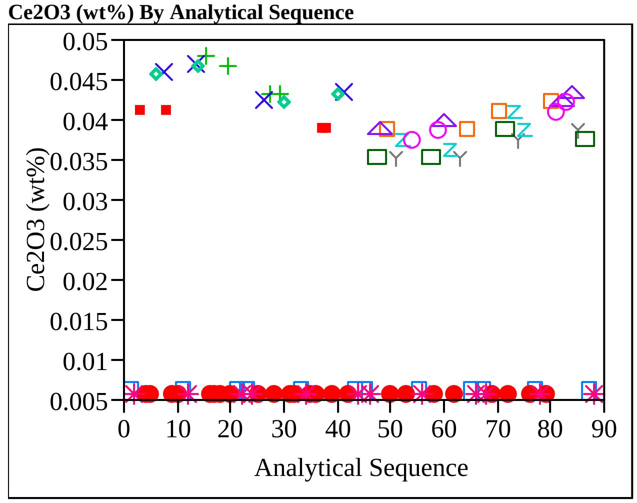
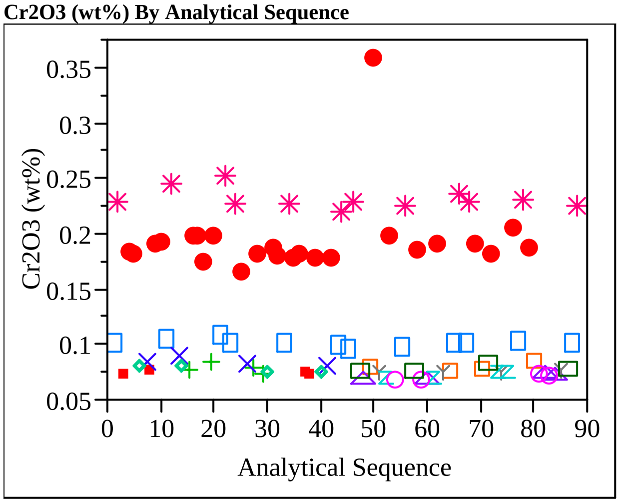
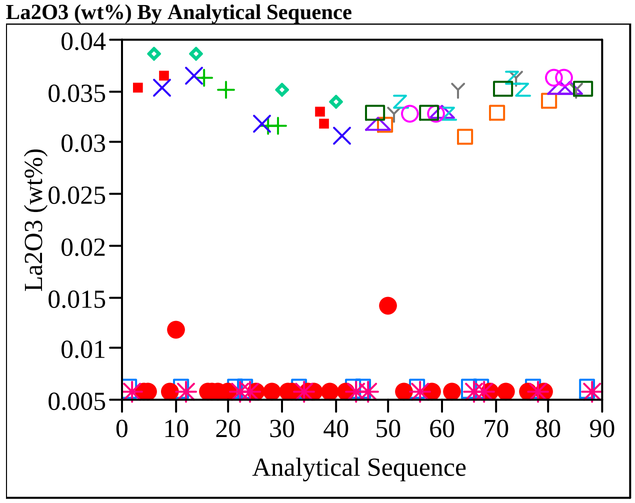
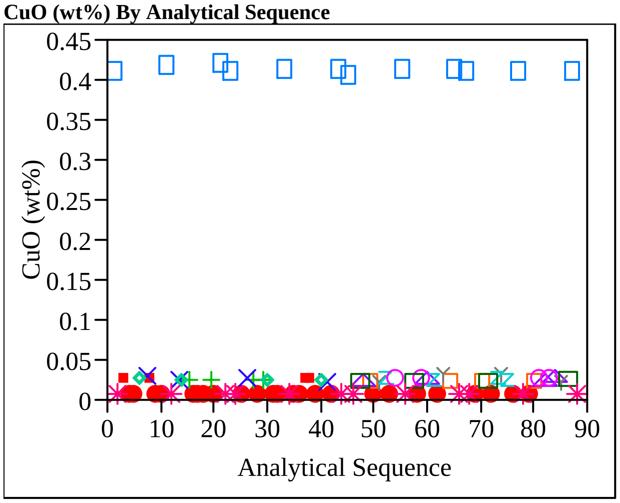
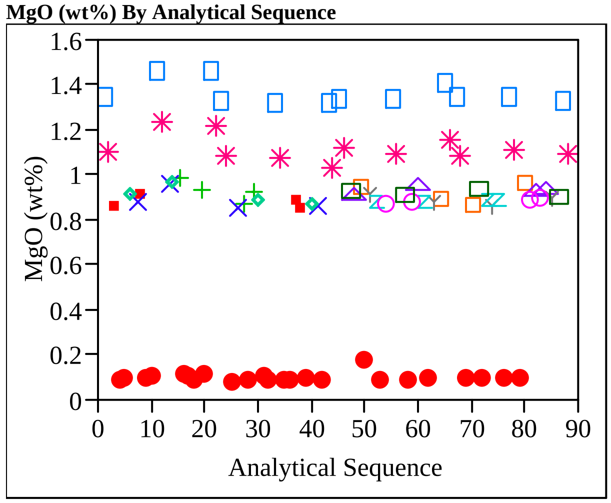


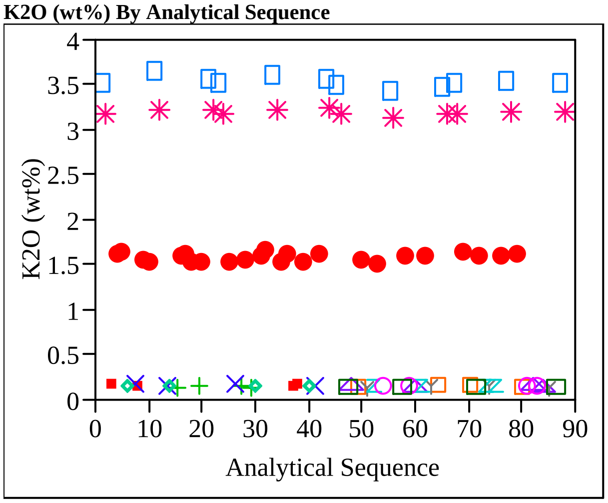
Exhibit B1. Oxide Measurements in Analytical Sequence for Samples Prepared Using the LM Method (continued)











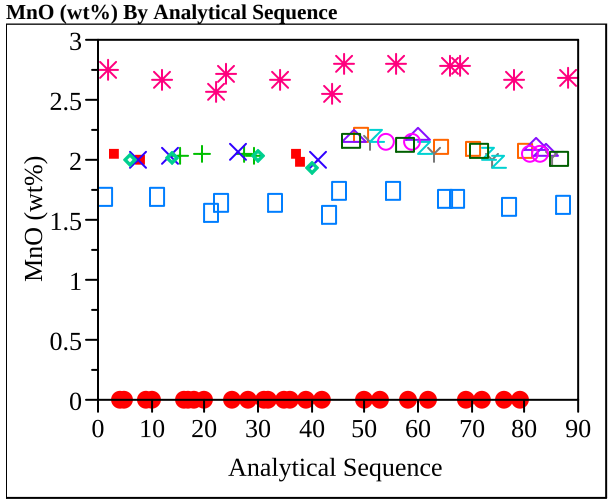
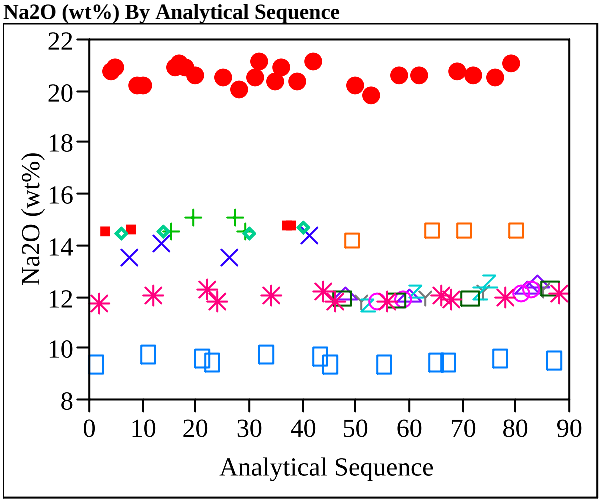
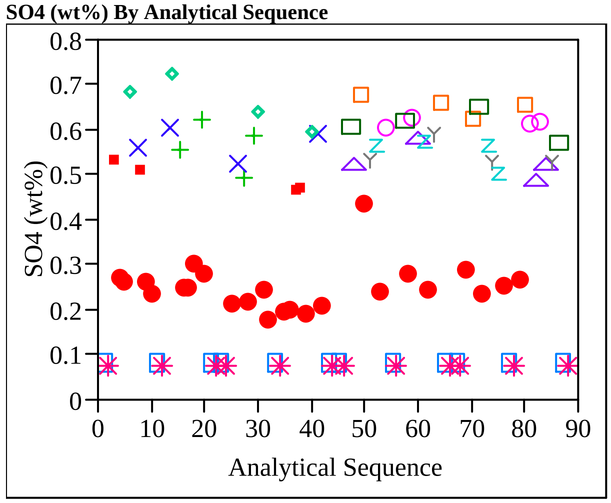


Exhibit B1. Oxide Measurements in Analytical Sequence for Samples Prepared Using the LM Method (continued)

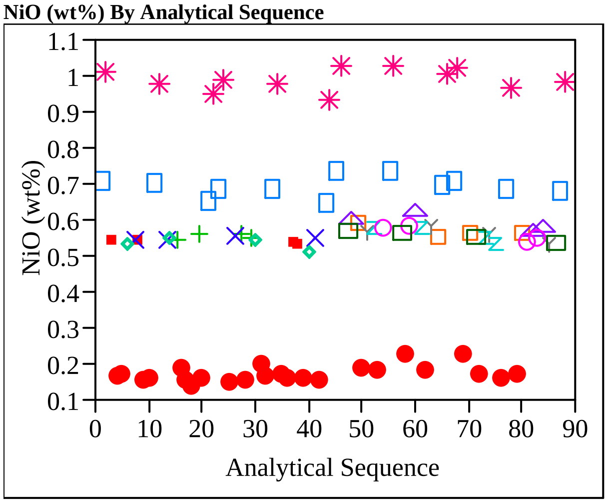
Na2O (wt%) By Analytical Sequence



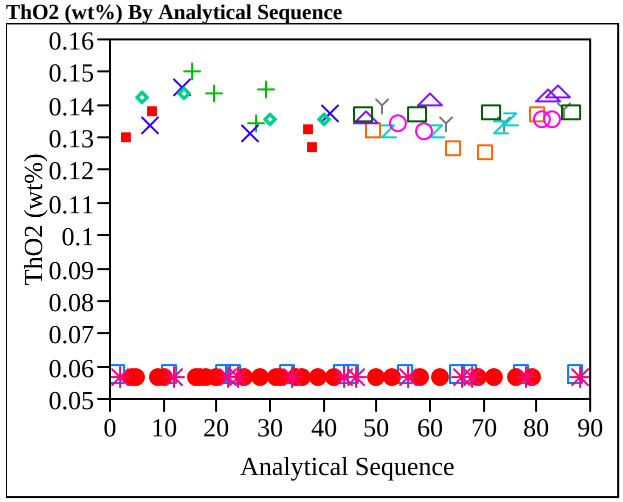
SO4 (wt%) By Analytical Sequence



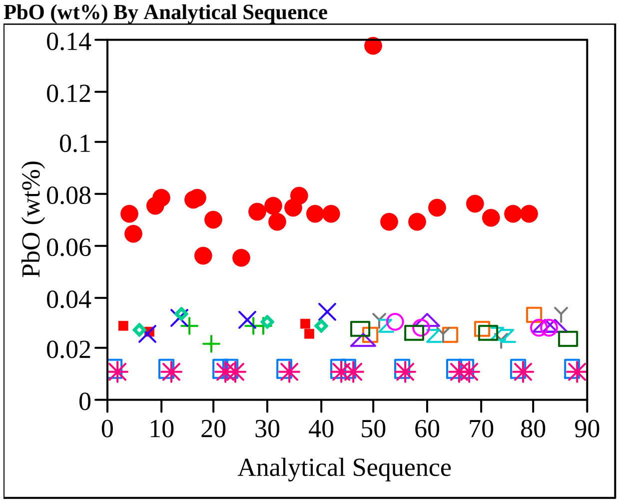
NiO (wt%) By Analytical Sequence



ThO2 (wt%) By Analytical Sequence



PbO (wt%) By Analytical Sequence



TiO2 (wt%) By Analytical Sequence

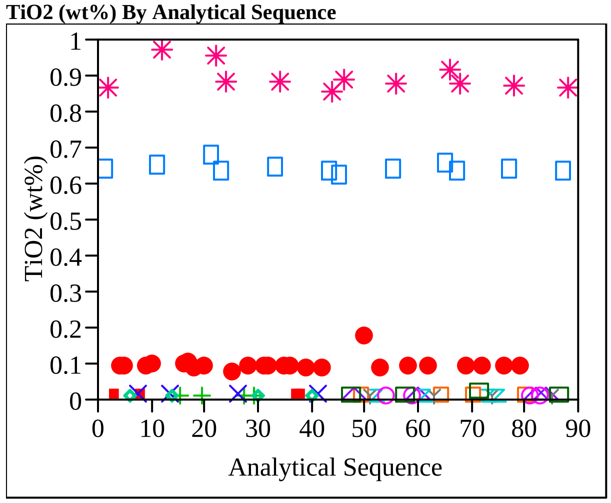
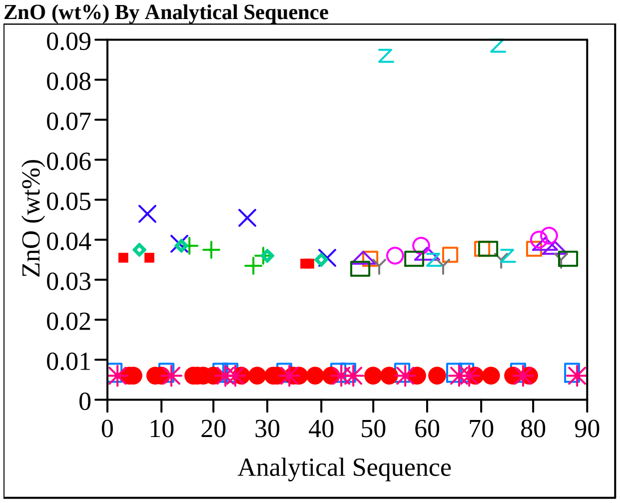


Exhibit B1. Oxide Measurements in Analytical Sequence for Samples Prepared Using the LM Method (continued)

ZnO (wt%) By Analytical Sequence



ZrO2 (wt%) By Analytical Sequence

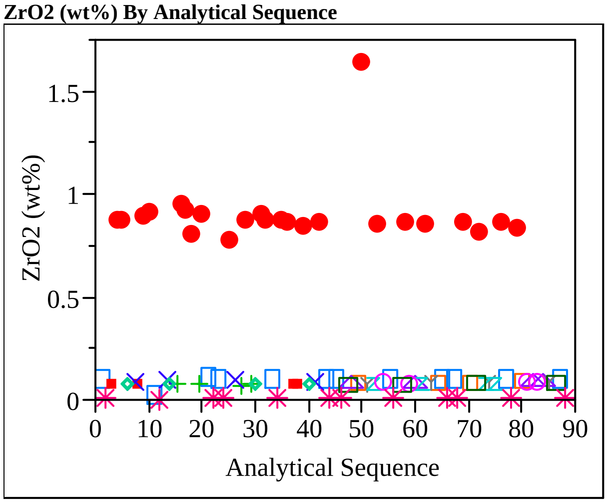
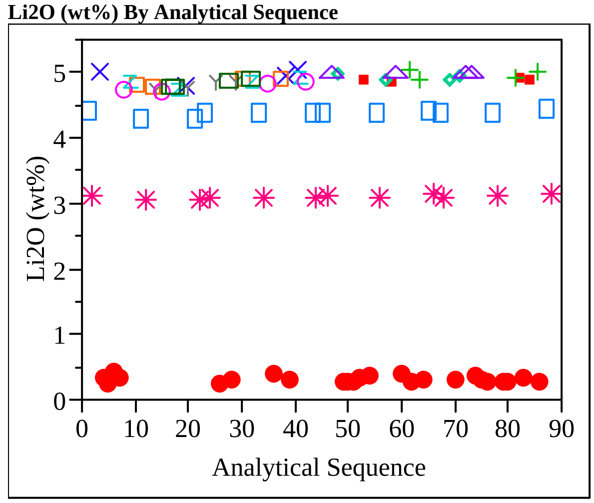


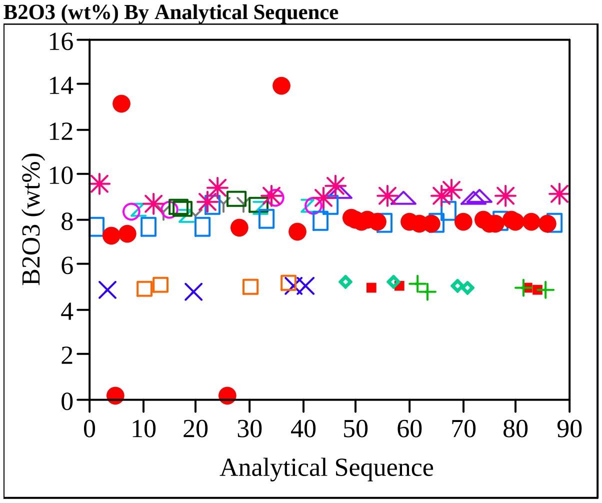
Exhibit B2. Oxide Measurements in Analytical Sequence for Samples Prepared Using the PF Method

	Glass ID	N Rows
1	Batch 1	12
2	LRM(1)	4
3	LRM(2)	4
4	LRM(3)	4
5	LRM(4)	4
6	LRM(5)	4
7	LRM(6)	4
8	SB4SULFA-01	4
9	SB4SULFA-02	4
10	SB4SULFA-03	4
11	SB4SULFA-04	4
12	SB4SULFA-05	4
13	SB4SULFA-06	4
14	SB4SULFA-07	4
15	SB4SULFA-08	4
16	SB4SULFA-09	4
17	SB4SULFA-10	4
18	Ustd	12

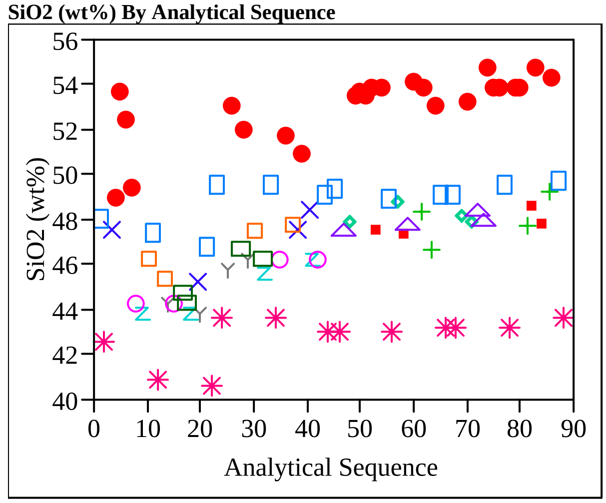
Li2O (wt%) By Analytical Sequence



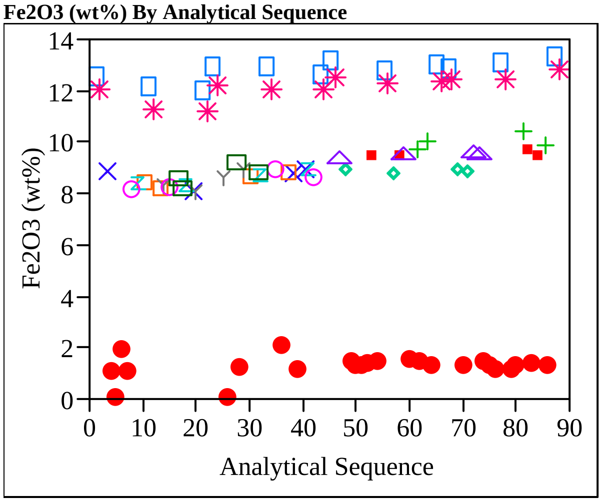
B2O3 (wt%) By Analytical Sequence



SiO2 (wt%) By Analytical Sequence



Fe2O3 (wt%) By Analytical Sequence



U3O8 (wt%) By Analytical Sequence

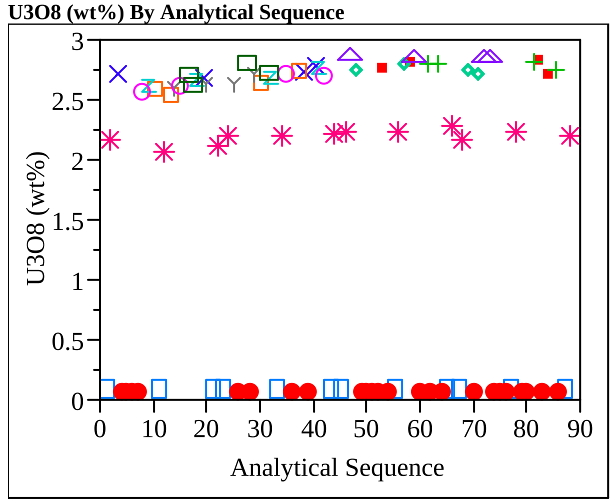
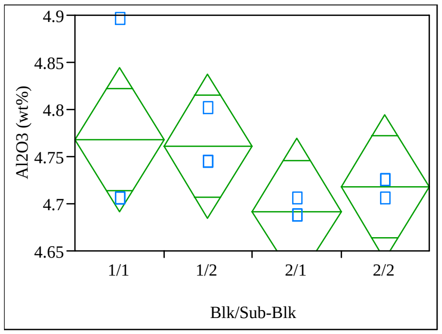


Exhibit B3. PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method

(Batch 1 – Glass #100; U std – Glass #200)

Study Glass #=100
Oneway Analysis of Al2O3 (wt%) By Blk/Sub-Blk
Reference Value = 4.877 wt%



Oneway Anova
Summary of Fit

Rsquare	0.307872
Adj Rsquare	0.048324
Root Mean Square Error	0.057467
Mean of Response	4.734772
Observations (or Sum Wgts)	12

Analysis of Variance

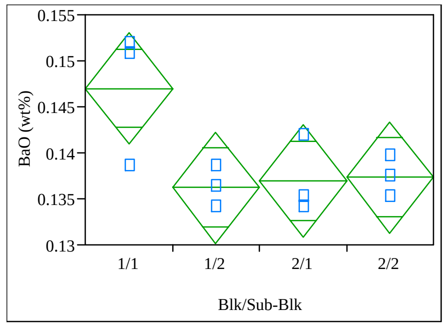
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.01175194	0.003917	1.1862	0.3745
Error	8	0.02641956	0.003302		
C. Total	11	0.03817150			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	4.76784	0.03318	4.6913	4.8443
1/2	3	4.76154	0.03318	4.6850	4.8380
2/1	3	4.69226	0.03318	4.6157	4.7688
2/2	3	4.71745	0.03318	4.6409	4.7940

Std Error uses a pooled estimate of error variance

Study Glass #=100
Oneway Analysis of BaO (wt%) By Blk/Sub-Blk
Reference Value = 0.151 wt%



Oneway Anova
Summary of Fit

Rsquare	0.585492
Adj Rsquare	0.430052
Root Mean Square Error	0.004558
Mean of Response	0.139376
Observations (or Sum Wgts)	12

Analysis of Variance

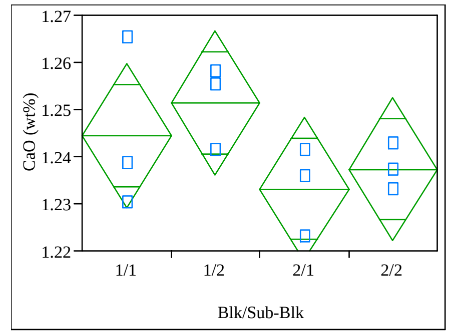
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.00023477	0.000078	3.7667	0.0593
Error	8	0.00016621	0.000021		
C. Total	11	0.00040098			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.147006	0.00263	0.14094	0.15307
1/2	3	0.136213	0.00263	0.13014	0.14228
2/1	3	0.136957	0.00263	0.13089	0.14303
2/2	3	0.137330	0.00263	0.13126	0.14340

Std Error uses a pooled estimate of error variance

Study Glass #=100
Oneway Analysis of CaO (wt%) By Blk/Sub-Blk
Reference Value = 1.22 wt%



Oneway Anova
Summary of Fit

Rsquare	0.353933
Adj Rsquare	0.111657
Root Mean Square Error	0.01146
Mean of Response	1.241557
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.00057558	0.000192	1.4609	0.2964
Error	8	0.00105066	0.000131		
C. Total	11	0.00162625			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	1.24436	0.00662	1.2291	1.2596
1/2	3	1.25135	0.00662	1.2361	1.2666
2/1	3	1.23316	0.00662	1.2179	1.2484
2/2	3	1.23736	0.00662	1.2221	1.2526

Std Error uses a pooled estimate of error variance

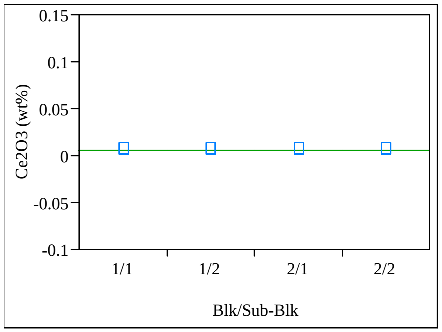
Exhibit B3. PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method (continued)

(Batch 1 – Glass #100; U std – Glass #200)

Study Glass #=100

Oneway Analysis of Ce2O3 (wt%) By Blk/Sub-Blk

Reference Value = 0.0 wt%



Oneway Anova

Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.005857
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

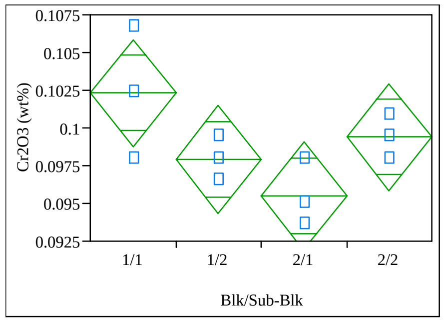
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.005857	0	0.00586	0.00586
1/2	3	0.005857	0	0.00586	0.00586
2/1	3	0.005857	0	0.00586	0.00586
2/2	3	0.005857	0	0.00586	0.00586

Std Error uses a pooled estimate of error variance

Study Glass #=100

Oneway Analysis of Cr2O3 (wt%) By Blk/Sub-Blk

Reference Value = 0.107 wt%



Oneway Anova

Summary of Fit

Rsquare	0.562244
Adj Rsquare	0.398085
Root Mean Square Error	0.002669
Mean of Response	0.09878
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.00007317	0.000024	3.4250	0.0727
Error	8	0.00005697	7.121e-6		
C. Total	11	0.00013013			

Means for Oneway Anova

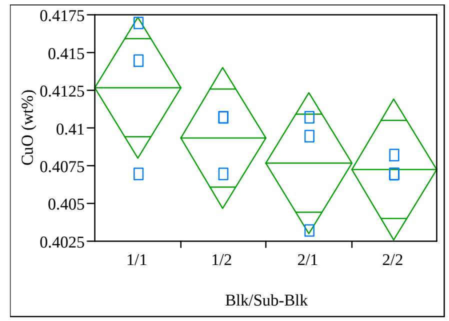
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.102312	0.00154	0.09876	0.10586
1/2	3	0.097927	0.00154	0.09437	0.10148
2/1	3	0.095491	0.00154	0.09194	0.09904
2/2	3	0.099389	0.00154	0.09584	0.10294

Std Error uses a pooled estimate of error variance

Study Glass #=100

Oneway Analysis of CuO (wt%) By Blk/Sub-Blk

Reference Value = 0.399 wt%



Oneway Anova

Summary of Fit

Rsquare	0.360275
Adj Rsquare	0.120378
Root Mean Square Error	0.003485
Mean of Response	0.409234
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.00005471	0.000018	1.5018	0.2865
Error	8	0.00009715	0.000012		
C. Total	11	0.00015187			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.412677	0.00201	0.40804	0.41732
1/2	3	0.409339	0.00201	0.40470	0.41398
2/1	3	0.407670	0.00201	0.40303	0.41231
2/2	3	0.407252	0.00201	0.40261	0.41189

Std Error uses a pooled estimate of error variance

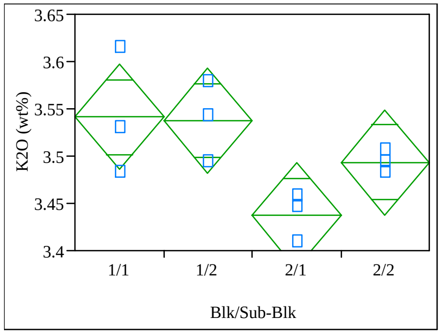
Exhibit B3. PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method (continued)

(Batch 1 – Glass #100; U std – Glass #200)

Study Glass #=100

Oneway Analysis of K2O (wt%) By Blk/Sub-Blk

Reference Value = 3.327 wt%



Oneway Anova

Summary of Fit

Rsquare	0.601501
Adj Rsquare	0.452064
Root Mean Square Error	0.042017
Mean of Response	3.502375
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.02131851	0.007106	4.0251	0.0512
Error	8	0.01412366	0.001765		
C. Total	11	0.03544217			

Means for Oneway Anova

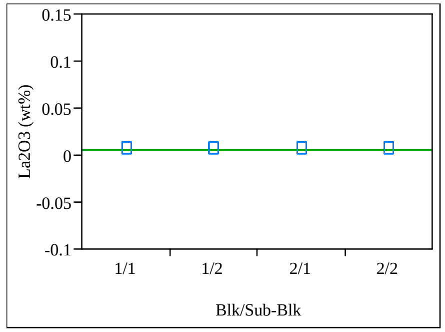
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	3.54152	0.02426	3.4856	3.5975
1/2	3	3.53751	0.02426	3.4816	3.5934
2/1	3	3.43713	0.02426	3.3812	3.4931
2/2	3	3.49334	0.02426	3.4374	3.5493

Std Error uses a pooled estimate of error variance

Study Glass #=100

Oneway Analysis of La2O3 (wt%) By Blk/Sub-Blk

Reference Value = 0.0 wt%



Oneway Anova

Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.005864
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

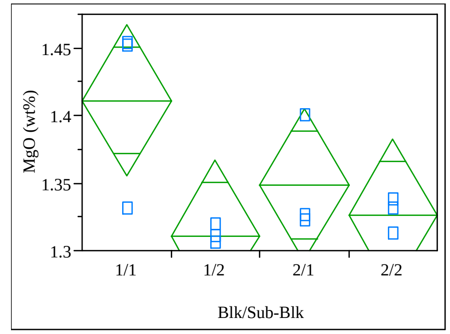
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.005864	0	0.00586	0.00586
1/2	3	0.005864	0	0.00586	0.00586
2/1	3	0.005864	0	0.00586	0.00586
2/2	3	0.005864	0	0.00586	0.00586

Std Error uses a pooled estimate of error variance

Study Glass #=100

Oneway Analysis of MgO (wt%) By Blk/Sub-Blk

Reference Value = 1.419 wt%



Oneway Anova

Summary of Fit

Rsquare	0.551571
Adj Rsquare	0.383409
Root Mean Square Error	0.042148
Mean of Response	1.349303
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.01748057	0.005827	3.2800	0.0796
Error	8	0.01421179	0.001776		
C. Total	11	0.03169236			

Means for Oneway Anova

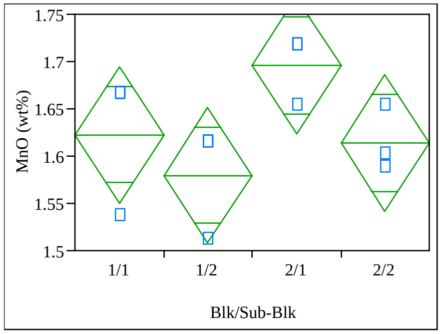
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	1.41121	0.02433	1.3551	1.4673
1/2	3	1.31116	0.02433	1.2550	1.3673
2/1	3	1.34875	0.02433	1.2926	1.4049
2/2	3	1.32609	0.02433	1.2700	1.3822

Std Error uses a pooled estimate of error variance

Exhibit B3. PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method (continued)

(Batch 1 – Glass #100; U std – Glass #200)

Study Glass #=100
Oneway Analysis of MnO (wt%) By Blk/Sub-Blk
Reference Value = 1.726 wt%



Oneway Anova
Summary of Fit

Rsquare	0.479393
Adj Rsquare	0.284165
Root Mean Square Error	0.054015
Mean of Response	1.627988
Observations (or Sum Wgts)	12

Analysis of Variance

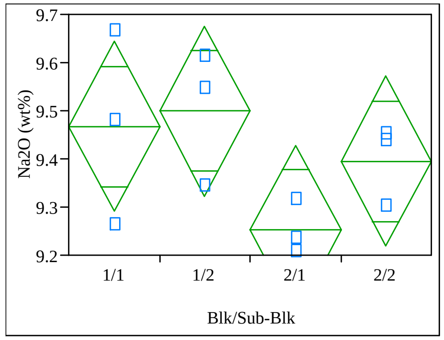
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.02149295	0.007164	2.4556	0.1377
Error	8	0.02334076	0.002918		
C. Total	11	0.04483372			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	1.62261	0.03119	1.5507	1.6945
1/2	3	1.57957	0.03119	1.5077	1.6515
2/1	3	1.69578	0.03119	1.6239	1.7677
2/2	3	1.61400	0.03119	1.5421	1.6859

Std Error uses a pooled estimate of error variance

Study Glass #=100
Oneway Analysis of Na2O (wt%) By Blk/Sub-Blk
Reference Value = 9.003 wt%



Oneway Anova
Summary of Fit

Rsquare	0.435602
Adj Rsquare	0.223953
Root Mean Square Error	0.132763
Mean of Response	9.403423
Observations (or Sum Wgts)	12

Analysis of Variance

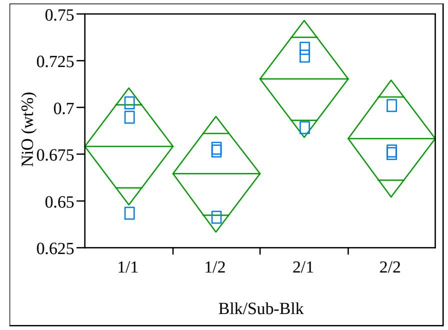
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.10882939	0.036276	2.0581	0.1843
Error	8	0.14100727	0.017626		
C. Total	11	0.24983666			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	9.46745	0.07665	9.2907	9.6442
1/2	3	9.49891	0.07665	9.3222	9.6757
2/1	3	9.25177	0.07665	9.0750	9.4285
2/2	3	9.39556	0.07665	9.2188	9.5723

Std Error uses a pooled estimate of error variance

Study Glass #=100
Oneway Analysis of NiO (wt%) By Blk/Sub-Blk
Reference Value = 0.751 wt%



Oneway Anova
Summary of Fit

Rsquare	0.484545
Adj Rsquare	0.29125
Root Mean Square Error	0.023432
Mean of Response	0.685453
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.00412910	0.001376	2.5068	0.1329
Error	8	0.00439250	0.000549		
C. Total	11	0.00852161			

Means for Oneway Anova

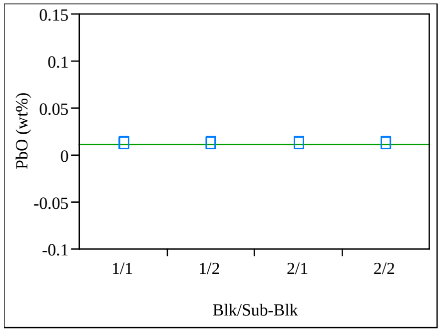
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.679091	0.01353	0.64789	0.71029
1/2	3	0.664245	0.01353	0.63305	0.69544
2/1	3	0.715145	0.01353	0.68395	0.74634
2/2	3	0.683333	0.01353	0.65214	0.71453

Std Error uses a pooled estimate of error variance

Exhibit B3. PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method (continued)

(Batch 1 – Glass #100; U std – Glass #200)

Study Glass #=100
Oneway Analysis of PbO (wt%) By Blk/Sub-Blk
Reference Value = 0.0 wt%



Oneway Anova
Summary of Fit

Rsquare	0
Adj Rsquare	-0.375
Root Mean Square Error	2.12e-18
Mean of Response	0.010772
Observations (or Sum Wgts)	12

Analysis of Variance

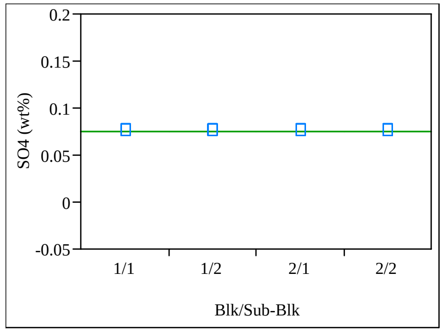
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0	0	0.0000	1.0000
Error	8	3.6111e-35	4.514e-36		
C. Total	11	3.6111e-35			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.010772	1.227e-18	0.01077	0.01077
1/2	3	0.010772	1.227e-18	0.01077	0.01077
2/1	3	0.010772	1.227e-18	0.01077	0.01077
2/2	3	0.010772	1.227e-18	0.01077	0.01077

Std Error uses a pooled estimate of error variance

Study Glass #=100
Oneway Analysis of SO4 (wt%) By Blk/Sub-Blk
Reference Value = 0.0 wt%



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.074898
Observations (or Sum Wgts)	12

Analysis of Variance

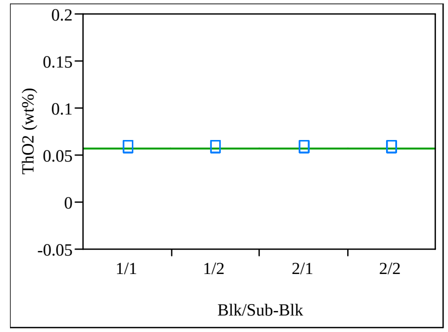
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.074898	0	0.07490	0.07490
1/2	3	0.074898	0	0.07490	0.07490
2/1	3	0.074898	0	0.07490	0.07490
2/2	3	0.074898	0	0.07490	0.07490

Std Error uses a pooled estimate of error variance

Study Glass #=100
Oneway Analysis of ThO2 (wt%) By Blk/Sub-Blk
Reference Value = 0.0 wt%



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.056895
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.056895	0	0.05690	0.05690
1/2	3	0.056895	0	0.05690	0.05690
2/1	3	0.056895	0	0.05690	0.05690
2/2	3	0.056895	0	0.05690	0.05690

Std Error uses a pooled estimate of error variance

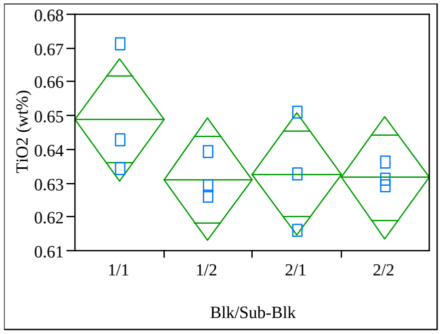
Exhibit B3. PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method (continued)

(Batch 1 – Glass #100; U std – Glass #200)

Study Glass #=100

Oneway Analysis of TiO2 (wt%) By Blk/Sub-Blk

Reference Value = 0.677 wt%



Oneway Anova

Summary of Fit

Rsquare	0.308696
Adj Rsquare	0.049457
Root Mean Square Error	0.013577
Mean of Response	0.636064
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.00065846	0.000219	1.1908	0.3730
Error	8	0.00147458	0.000184		
C. Total	11	0.00213304			

Means for Oneway Anova

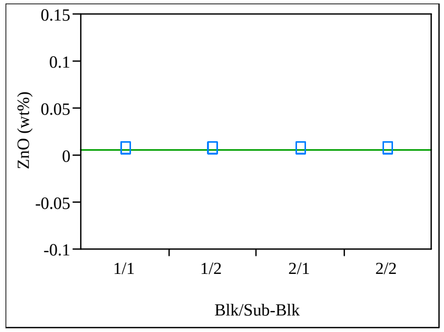
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.648852	0.00784	0.63078	0.66693
1/2	3	0.631060	0.00784	0.61298	0.64914
2/1	3	0.632728	0.00784	0.61465	0.65080
2/2	3	0.631616	0.00784	0.61354	0.64969

Std Error uses a pooled estimate of error variance

Study Glass #=100

Oneway Analysis of ZnO (wt%) By Blk/Sub-Blk

Reference Value = 0.0 wt%



Oneway Anova

Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.006224
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

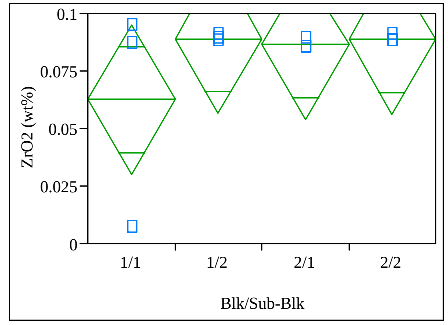
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.006224	0	0.00622	0.00622
1/2	3	0.006224	0	0.00622	0.00622
2/1	3	0.006224	0	0.00622	0.00622
2/2	3	0.006224	0	0.00622	0.00622

Std Error uses a pooled estimate of error variance

Study Glass #=100

Oneway Analysis of ZrO2 (wt%) By Blk/Sub-Blk

Reference Value = 0.098 wt%



Oneway Anova

Summary of Fit

Rsquare	0.238067
Adj Rsquare	-0.04766
Root Mean Square Error	0.024311
Mean of Response	0.081723
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.00147737	0.000492	0.8332	0.5122
Error	8	0.00472830	0.000591		
C. Total	11	0.00620567			

Means for Oneway Anova

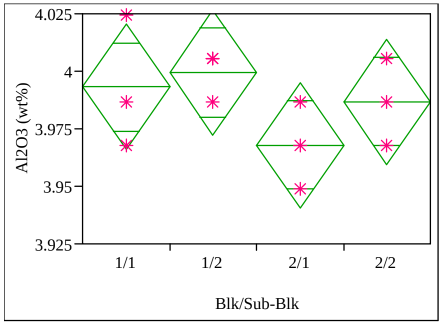
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.062587	0.01404	0.03022	0.09495
1/2	3	0.089153	0.01404	0.05679	0.12152
2/1	3	0.086451	0.01404	0.05408	0.11882
2/2	3	0.088703	0.01404	0.05634	0.12107

Std Error uses a pooled estimate of error variance

Exhibit B3. PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method (continued)

(Batch 1 – Glass #100; U std – Glass #200)

Study Glass #=200
Oneway Analysis of Al2O3 (wt%) By Blk/Sub-Blk
Reference Value = 4.1 wt%



Oneway Anova
Summary of Fit

Rsquare	0.333333
Adj Rsquare	0.083333
Root Mean Square Error	0.020409
Mean of Response	3.986845
Observations (or Sum Wgts)	12

Analysis of Variance

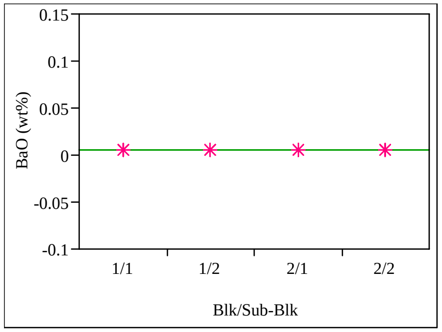
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.00166610	0.000555	1.3333	0.3300
Error	8	0.00333220	0.000417		
C. Total	11	0.00499829			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	3.99314	0.01178	3.9660	4.0203
1/2	3	3.99944	0.01178	3.9723	4.0266
2/1	3	3.96795	0.01178	3.9408	3.9951
2/2	3	3.98685	0.01178	3.9597	4.0140

Std Error uses a pooled estimate of error variance

Study Glass #=200
Oneway Analysis of BaO (wt%) By Blk/Sub-Blk
Reference Value = 0.0 wt%



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.005583
Observations (or Sum Wgts)	12

Analysis of Variance

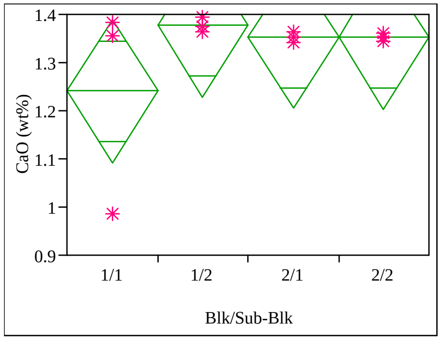
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.005583	0	0.00558	0.00558
1/2	3	0.005583	0	0.00558	0.00558
2/1	3	0.005583	0	0.00558	0.00558
2/2	3	0.005583	0	0.00558	0.00558

Std Error uses a pooled estimate of error variance

Study Glass #=200
Oneway Analysis of CaO (wt%) By Blk/Sub-Blk
Reference Value = 1.301 wt%



Oneway Anova
Summary of Fit

Rsquare	0.252839
Adj Rsquare	-0.02735
Root Mean Square Error	0.111387
Mean of Response	1.330639
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.03358865	0.011196	0.9024	0.4813
Error	8	0.09925716	0.012407		
C. Total	11	0.13284581			

Means for Oneway Anova

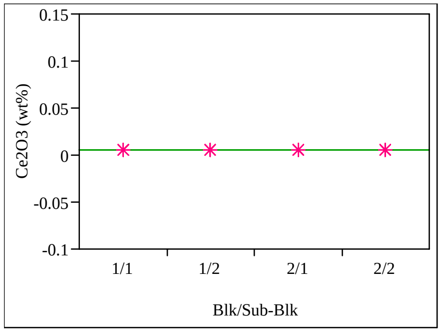
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	1.24062	0.06431	1.0923	1.3889
1/2	3	1.37681	0.06431	1.2285	1.5251
2/1	3	1.35303	0.06431	1.2047	1.5013
2/2	3	1.35209	0.06431	1.2038	1.5004

Std Error uses a pooled estimate of error variance

Exhibit B3. PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method (continued)

(Batch 1 – Glass #100; U std – Glass #200)

Study Glass #=200
Oneway Analysis of Ce2O3 (wt%) By Blk/Sub-Blk
Reference Value = 0.0 wt%



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.005857
Observations (or Sum Wgts)	12

Analysis of Variance

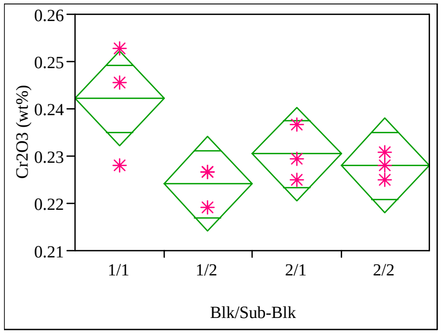
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.005857	0	0.00586	0.00586
1/2	3	0.005857	0	0.00586	0.00586
2/1	3	0.005857	0	0.00586	0.00586
2/2	3	0.005857	0	0.00586	0.00586

Std Error uses a pooled estimate of error variance

Study Glass #=200
Oneway Analysis of Cr2O3 (wt%) By Blk/Sub-Blk
Reference Value = 0.0 wt%



Oneway Anova
Summary of Fit

Rsquare	0.547088
Adj Rsquare	0.377247
Root Mean Square Error	0.007488
Mean of Response	0.231176
Observations (or Sum Wgts)	12

Analysis of Variance

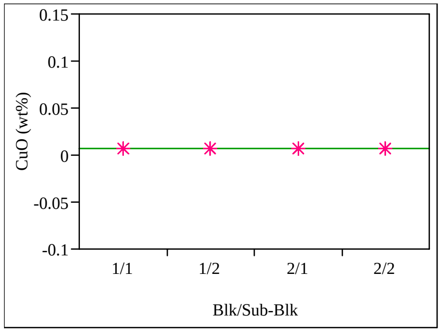
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.00054190	0.000181	3.2212	0.0826
Error	8	0.00044862	0.000056		
C. Total	11	0.00099052			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.242138	0.00432	0.23217	0.25211
1/2	3	0.224112	0.00432	0.21414	0.23408
2/1	3	0.230446	0.00432	0.22048	0.24042
2/2	3	0.228010	0.00432	0.21804	0.23798

Std Error uses a pooled estimate of error variance

Study Glass #=200
Oneway Analysis of CuO (wt%) By Blk/Sub-Blk
Reference Value = 0.0 wt%



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.006259
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

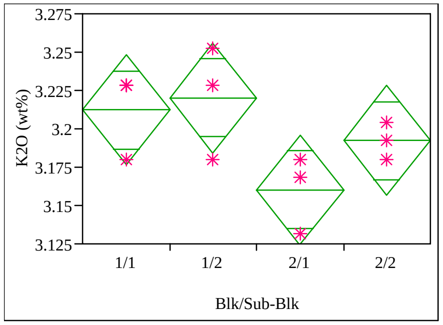
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.006259	0	0.00626	0.00626
1/2	3	0.006259	0	0.00626	0.00626
2/1	3	0.006259	0	0.00626	0.00626
2/2	3	0.006259	0	0.00626	0.00626

Std Error uses a pooled estimate of error variance

Exhibit B3. PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method (continued)

(Batch 1 – Glass #100; U std – Glass #200)

Study Glass #=200
Oneway Analysis of K2O (wt%) By Blk/Sub-Blk
Reference Value = 2.999 wt%



Oneway Anova
Summary of Fit

Rsquare	0.527559
Adj Rsquare	0.350394
Root Mean Square Error	0.026936
Mean of Response	3.196205
Observations (or Sum Wgts)	12

Analysis of Variance

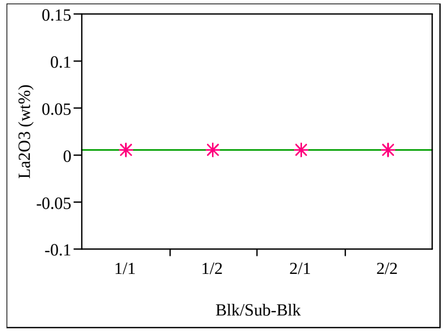
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.00648141	0.002160	2.9778	0.0965
Error	8	0.00580424	0.000726		
C. Total	11	0.01228565			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	3.21227	0.01555	3.1764	3.2481
1/2	3	3.22030	0.01555	3.1844	3.2562
2/1	3	3.16007	0.01555	3.1242	3.1959
2/2	3	3.19219	0.01555	3.1563	3.2281

Std Error uses a pooled estimate of error variance

Study Glass #=200
Oneway Analysis of La2O3 (wt%) By Blk/Sub-Blk
Reference Value = 0.0 wt%



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.005864
Observations (or Sum Wgts)	12

Analysis of Variance

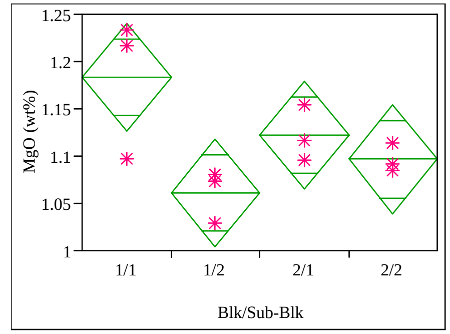
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.005864	0	0.00586	0.00586
1/2	3	0.005864	0	0.00586	0.00586
2/1	3	0.005864	0	0.00586	0.00586
2/2	3	0.005864	0	0.00586	0.00586

Std Error uses a pooled estimate of error variance

Study Glass #=200
Oneway Analysis of MgO (wt%) By Blk/Sub-Blk
Reference Value = 1.21 wt%



Oneway Anova
Summary of Fit

Rsquare	0.615574
Adj Rsquare	0.471414
Root Mean Square Error	0.042956
Mean of Response	1.11576
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.02363773	0.007879	4.2701	0.0447
Error	8	0.01476178	0.001845		
C. Total	11	0.03839951			

Means for Oneway Anova

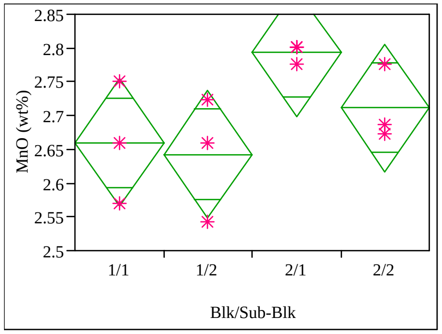
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	1.18292	0.02480	1.1257	1.2401
1/2	3	1.06131	0.02480	1.0041	1.1185
2/1	3	1.12212	0.02480	1.0649	1.1793
2/2	3	1.09669	0.02480	1.0395	1.1539

Std Error uses a pooled estimate of error variance

Exhibit B3. PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method (continued)

(Batch 1 – Glass #100; U std – Glass #200)

Study Glass #=200
Oneway Analysis of MnO (wt%) By Blk/Sub-Blk
Reference Value = 2.892 wt%



Oneway Anova
Summary of Fit

Rsquare	0.507798
Adj Rsquare	0.323222
Root Mean Square Error	0.070624
Mean of Response	2.701836
Observations (or Sum Wgts)	12

Analysis of Variance

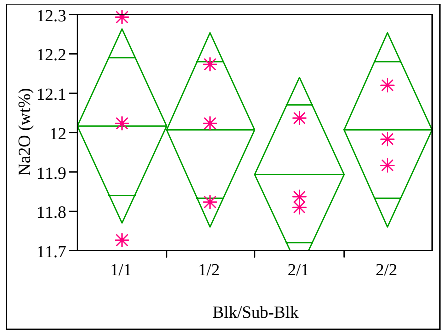
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.04116588	0.013722	2.7512	0.1122
Error	8	0.03990159	0.004988		
C. Total	11	0.08106748			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	2.65987	0.04077	2.5658	2.7539
1/2	3	2.64266	0.04077	2.5486	2.7367
2/1	3	2.79330	0.04077	2.6993	2.8873
2/2	3	2.71152	0.04077	2.6175	2.8055

Std Error uses a pooled estimate of error variance

Study Glass #=200
Oneway Analysis of Na2O (wt%) By Blk/Sub-Blk
Reference Value = 11.795 wt%



Oneway Anova
Summary of Fit

Rsquare	0.098664
Adj Rsquare	-0.23934
Root Mean Square Error	0.18536
Mean of Response	11.98035
Observations (or Sum Wgts)	12

Analysis of Variance

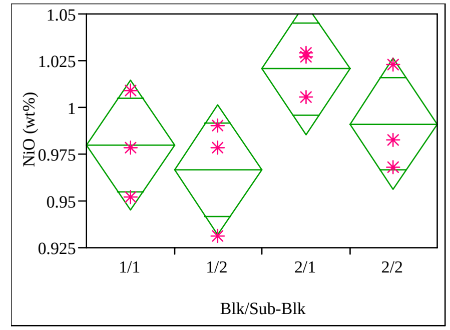
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.03008821	0.010029	0.2919	0.8303
Error	8	0.27486727	0.034358		
C. Total	11	0.30495548			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	12.0152	0.10702	11.768	12.262
1/2	3	12.0062	0.10702	11.759	12.253
2/1	3	11.8939	0.10702	11.647	12.141
2/2	3	12.0062	0.10702	11.759	12.253

Std Error uses a pooled estimate of error variance

Study Glass #=200
Oneway Analysis of NiO (wt%) By Blk/Sub-Blk
Reference Value = 1.12 wt%



Oneway Anova
Summary of Fit

Rsquare	0.461514
Adj Rsquare	0.259582
Root Mean Square Error	0.026305
Mean of Response	0.989581
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.00474442	0.001581	2.2855	0.1557
Error	8	0.00553570	0.000692		
C. Total	11	0.01028012			

Means for Oneway Anova

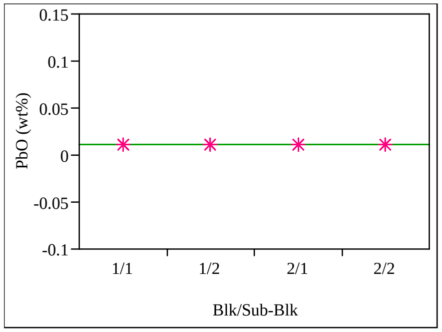
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.97983	0.01519	0.94480	1.0148
1/2	3	0.96668	0.01519	0.93165	1.0017
2/1	3	1.02055	0.01519	0.98552	1.0556
2/2	3	0.99128	0.01519	0.95626	1.0263

Std Error uses a pooled estimate of error variance

Exhibit B3. PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method (continued)

(Batch 1 – Glass #100; U std – Glass #200)

Study Glass #=200
Oneway Analysis of PbO (wt%) By Blk/Sub-Blk
Reference Value = 0.0 wt%



Oneway Anova
Summary of Fit

Rsquare	0
Adj Rsquare	-0.375
Root Mean Square Error	2.12e-18
Mean of Response	0.010772
Observations (or Sum Wgts)	12

Analysis of Variance

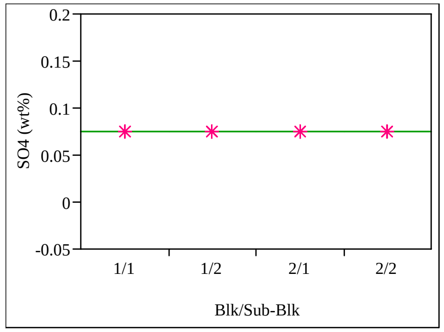
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0	0	0.0000	1.0000
Error	8	3.6111e-35	4.514e-36		
C. Total	11	3.6111e-35			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.010772	1.227e-18	0.01077	0.01077
1/2	3	0.010772	1.227e-18	0.01077	0.01077
2/1	3	0.010772	1.227e-18	0.01077	0.01077
2/2	3	0.010772	1.227e-18	0.01077	0.01077

Std Error uses a pooled estimate of error variance

Study Glass #=200
Oneway Analysis of SO4 (wt%) By Blk/Sub-Blk
Reference Value = 0.0 wt%



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.074898
Observations (or Sum Wgts)	12

Analysis of Variance

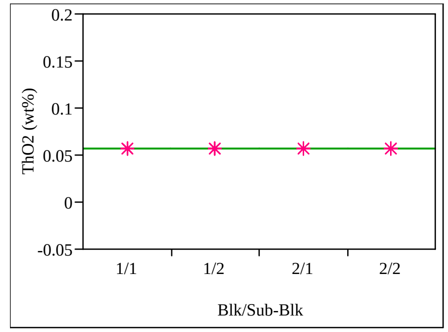
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.074898	0	0.07490	0.07490
1/2	3	0.074898	0	0.07490	0.07490
2/1	3	0.074898	0	0.07490	0.07490
2/2	3	0.074898	0	0.07490	0.07490

Std Error uses a pooled estimate of error variance

Study Glass #=200
Oneway Analysis of ThO2 (wt%) By Blk/Sub-Blk
Reference Value = 0.0 wt%



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.056895
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.056895	0	0.05690	0.05690
1/2	3	0.056895	0	0.05690	0.05690
2/1	3	0.056895	0	0.05690	0.05690
2/2	3	0.056895	0	0.05690	0.05690

Std Error uses a pooled estimate of error variance

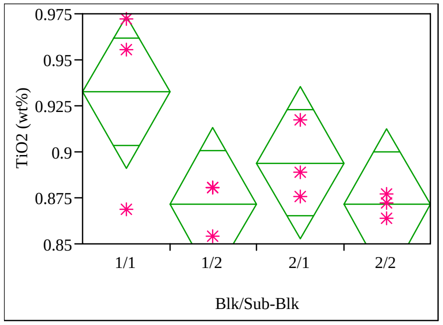
Exhibit B3. PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method (continued)

(Batch 1 – Glass #100; U std – Glass #200)

Study Glass #=200

Oneway Analysis of TiO_2 (wt%) By Blk/Sub-Blk

Reference Value = 1.049 wt%



Oneway Anova

Summary of Fit

Rsquare	0.49292
Adj Rsquare	0.302764
Root Mean Square Error	0.030899
Mean of Response	0.89238
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0.00742483	0.002475	2.5922	0.1251
Error	8	0.00763813	0.000955		
C. Total	11	0.01506296			

Means for Oneway Anova

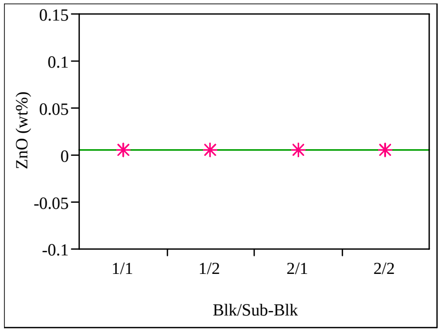
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.932412	0.01784	0.89127	0.97355
1/2	3	0.871808	0.01784	0.83067	0.91295
2/1	3	0.894048	0.01784	0.85291	0.93519
2/2	3	0.871252	0.01784	0.83011	0.91239

Std Error uses a pooled estimate of error variance

Study Glass #=200

Oneway Analysis of ZnO (wt%) By Blk/Sub-Blk

Reference Value = 0.0 wt%



Oneway Anova

Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.006224
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

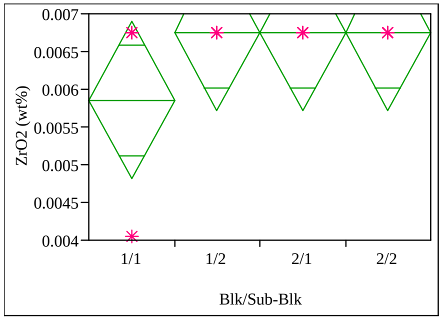
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.006224	0	0.00622	0.00622
1/2	3	0.006224	0	0.00622	0.00622
2/1	3	0.006224	0	0.00622	0.00622
2/2	3	0.006224	0	0.00622	0.00622

Std Error uses a pooled estimate of error variance

Study Glass #=200

Oneway Analysis of ZrO_2 (wt%) By Blk/Sub-Blk

Reference Value = 0.0 wt%



Oneway Anova

Summary of Fit

Rsquare	0.272727
Adj Rsquare	0
Root Mean Square Error	0.00078
Mean of Response	0.006529
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/Sub-Blk	3	1.82466e-6	6.0822e-7	1.0000	0.4411
Error	8	4.86576e-6	6.0822e-7		
C. Total	11	6.69042e-6			

Means for Oneway Anova

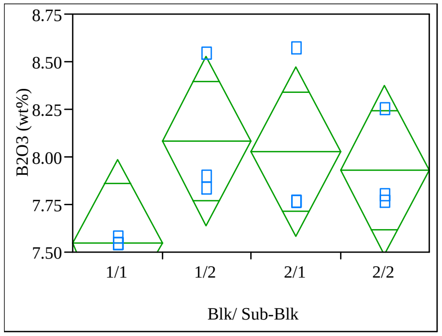
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.005853	0.00045	0.00482	0.00689
1/2	3	0.006754	0.00045	0.00572	0.00779
2/1	3	0.006754	0.00045	0.00572	0.00779
2/2	3	0.006754	0.00045	0.00572	0.00779

Std Error uses a pooled estimate of error variance

Exhibit B4: PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the PF Method

(Batch 1 – Glass #100; U std – Glass #200)

Study Glass #=100
Oneway Analysis of B2O3 (wt%) By Blk/Sub-Blk
Reference Value = 7.777 wt%



Oneway Anova
Summary of Fit

Rsquare	0.374015
Adj Rsquare	0.139271
Root Mean Square Error	0.33268
Mean of Response	7.896805
Observations (or Sum Wgts)	12

Analysis of Variance

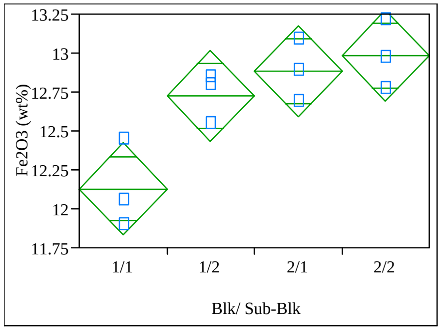
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/ Sub-Blk	3	0.5290148	0.176338	1.5933	0.2657
Error	8	0.8854064	0.110676		
C. Total	11	1.4144211			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	7.54530	0.19207	7.1024	7.9882
1/2	3	8.08195	0.19207	7.6390	8.5249
2/1	3	8.02828	0.19207	7.5854	8.4712
2/2	3	7.93169	0.19207	7.4888	8.3746

Std Error uses a pooled estimate of error variance

Study Glass #=100
Oneway Analysis of Fe2O3 (wt%) By Blk/Sub-Blk
Reference Value = 12.839 wt%



Oneway Anova
Summary of Fit

Rsquare	0.772026
Adj Rsquare	0.686536
Root Mean Square Error	0.220138
Mean of Response	12.67906
Observations (or Sum Wgts)	12

Analysis of Variance

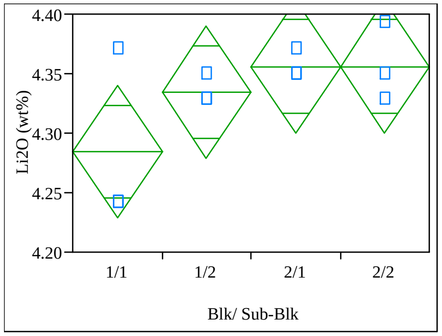
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/ Sub-Blk	3	1.3128882	0.437629	9.0306	0.0060
Error	8	0.3876866	0.048461		
C. Total	11	1.7005749			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	12.1286	0.12710	11.836	12.422
1/2	3	12.7243	0.12710	12.431	13.017
2/1	3	12.8816	0.12710	12.589	13.175
2/2	3	12.9817	0.12710	12.689	13.275

Std Error uses a pooled estimate of error variance

Study Glass #=100
Oneway Analysis of Li2O (wt%) By Blk/Sub-Blk
Reference Value = 4.429 wt%



Oneway Anova
Summary of Fit

Rsquare	0.425837
Adj Rsquare	0.210526
Root Mean Square Error	0.041691
Mean of Response	4.332711
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/ Sub-Blk	3	0.01031283	0.003438	1.9778	0.1960
Error	8	0.01390494	0.001738		
C. Total	11	0.02421776			

Means for Oneway Anova

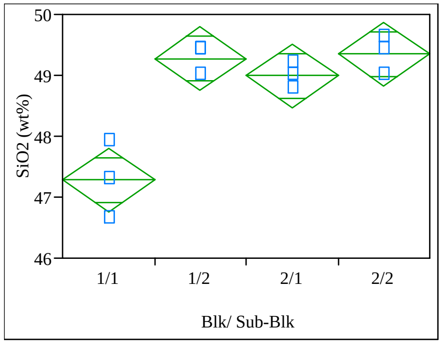
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	4.28427	0.02407	4.2288	4.3398
1/2	3	4.33451	0.02407	4.2790	4.3900
2/1	3	4.35603	0.02407	4.3005	4.4115
2/2	3	4.35603	0.02407	4.3005	4.4115

Std Error uses a pooled estimate of error variance

Exhibit B4: PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the PF Method (continued)

(Batch 1 – Glass #100; U std – Glass #200)

Study Glass #=100
Oneway Analysis of SiO2 (wt%) By Blk/Sub-Blk
Reference Value = 50.22 wt%



Oneway Anova
Summary of Fit

Rsquare	0.872423
Adj Rsquare	0.824582
Root Mean Square Error	0.395433
Mean of Response	48.72256
Observations (or Sum Wgts)	12

Analysis of Variance

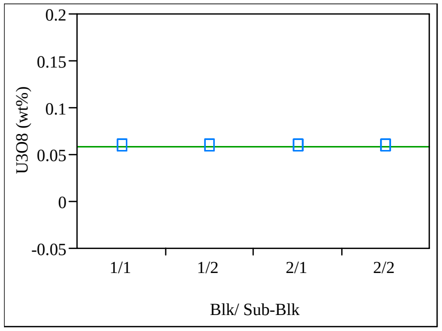
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/ Sub-Blk	3	8.5544366	2.85148	18.2358	0.0006
Error	8	1.2509386	0.15637		
C. Total	11	9.8053751			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	47.2785	0.22830	46.752	47.805
1/2	3	49.2752	0.22830	48.749	49.802
2/1	3	48.9900	0.22830	48.464	49.516
2/2	3	49.3465	0.22830	48.820	49.873

Std Error uses a pooled estimate of error variance

Study Glass #=100
Oneway Analysis of U3O8 (wt%) By Blk/Sub-Blk
Reference Value = 0.0 wt%



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.05896
Observations (or Sum Wgts)	12

Analysis of Variance

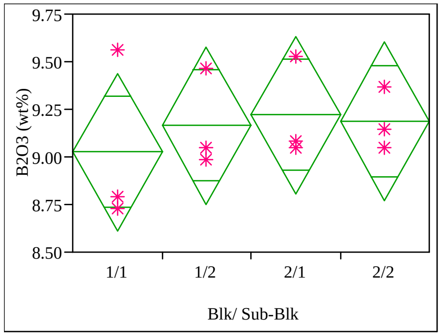
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/ Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	0.058960	0	0.05896	0.05896
1/2	3	0.058960	0	0.05896	0.05896
2/1	3	0.058960	0	0.05896	0.05896
2/2	3	0.058960	0	0.05896	0.05896

Std Error uses a pooled estimate of error variance

Study Glass #=100
Oneway Analysis of B2O3 (wt%) By Blk/Sub-Blk
Reference Value = 9.209 wt%



Oneway Anova
Summary of Fit

Rsquare	0.078002
Adj Rsquare	-0.26775
Root Mean Square Error	0.310655
Mean of Response	9.149883
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/ Sub-Blk	3	0.06531686	0.021772	0.2256	0.8760
Error	8	0.77205223	0.096507		
C. Total	11	0.83736909			

Means for Oneway Anova

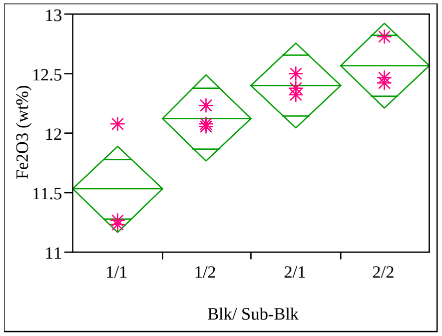
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	9.02645	0.17936	8.6129	9.4401
1/2	3	9.16598	0.17936	8.7524	9.5796
2/1	3	9.21965	0.17936	8.8060	9.6332
2/2	3	9.18745	0.17936	8.7739	9.6010

Std Error uses a pooled estimate of error variance

Exhibit B4: PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the PF Method (continued)

(Batch 1 – Glass #100; U std – Glass #200)

Study Glass #=200
Oneway Analysis of Fe2O3 (wt%) By Blk/Sub-Blk
Reference Value = 13.196 wt%



Oneway Anova
Summary of Fit

Rsquare	0.762287
Adj Rsquare	0.673144
Root Mean Square Error	0.270102
Mean of Response	12.15483
Observations (or Sum Wgts)	12

Analysis of Variance

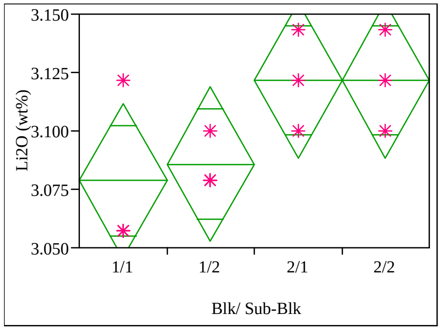
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/ Sub-Blk	3	1.8715931	0.623864	8.5513	0.0071
Error	8	0.5836422	0.072955		
C. Total	11	2.4552352			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	11.5281	0.15594	11.169	11.888
1/2	3	12.1239	0.15594	11.764	12.483
2/1	3	12.4003	0.15594	12.041	12.760
2/2	3	12.5671	0.15594	12.207	12.927

Std Error uses a pooled estimate of error variance

Study Glass #=200
Oneway Analysis of Li2O (wt%) By Blk/Sub-Blk
Reference Value = 3.057 wt%



Oneway Anova
Summary of Fit

Rsquare	0.49004
Adj Rsquare	0.298805
Root Mean Square Error	0.02486
Mean of Response	3.10197
Observations (or Sum Wgts)	12

Analysis of Variance

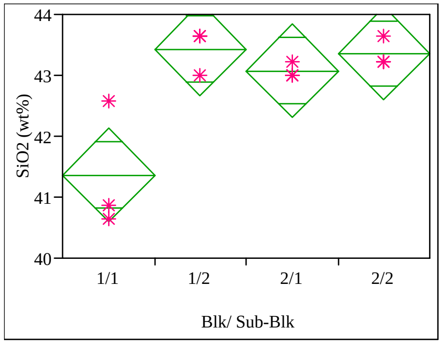
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/ Sub-Blk	3	0.00475085	0.001584	2.5625	0.1278
Error	8	0.00494398	0.000618		
C. Total	11	0.00969483			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	3.07865	0.01435	3.0455	3.1117
1/2	3	3.08582	0.01435	3.0527	3.1189
2/1	3	3.12171	0.01435	3.0886	3.1548
2/2	3	3.12171	0.01435	3.0886	3.1548

Std Error uses a pooled estimate of error variance

Study Glass #=200
Oneway Analysis of SiO2 (wt%) By Blk/Sub-Blk
Reference Value = 45.353 wt%



Oneway Anova
Summary of Fit

Rsquare	0.763185
Adj Rsquare	0.674379
Root Mean Square Error	0.576024
Mean of Response	42.80383
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/ Sub-Blk	3	8.554437	2.85148	8.5939	0.0070
Error	8	2.654431	0.33180		
C. Total	11	11.208867			

Means for Oneway Anova

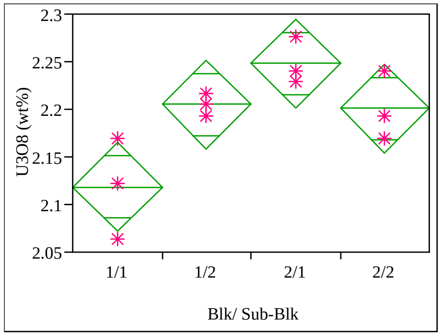
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	41.3598	0.33257	40.593	42.127
1/2	3	43.4278	0.33257	42.661	44.195
2/1	3	43.0712	0.33257	42.304	43.838
2/2	3	43.3565	0.33257	42.590	44.123

Std Error uses a pooled estimate of error variance

Exhibit B4: PSAL Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the PF Method (continued)

(Batch 1 – Glass #100; U std – Glass #200)

Study Glass #=200
Oneway Analysis of U3O8 (wt%) By Blk/Sub-Blk
Reference Value = 2.406 wt%



Oneway Anova
Summary of Fit

Rsquare	0.730769
Adj Rsquare	0.629808
Root Mean Square Error	0.034881
Mean of Response	2.193312
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Blk/ Sub-Blk	3	0.02641974	0.008807	7.2381	0.0114
Error	8	0.00973359	0.001217		
C. Total	11	0.03615333			

Means for Oneway Anova

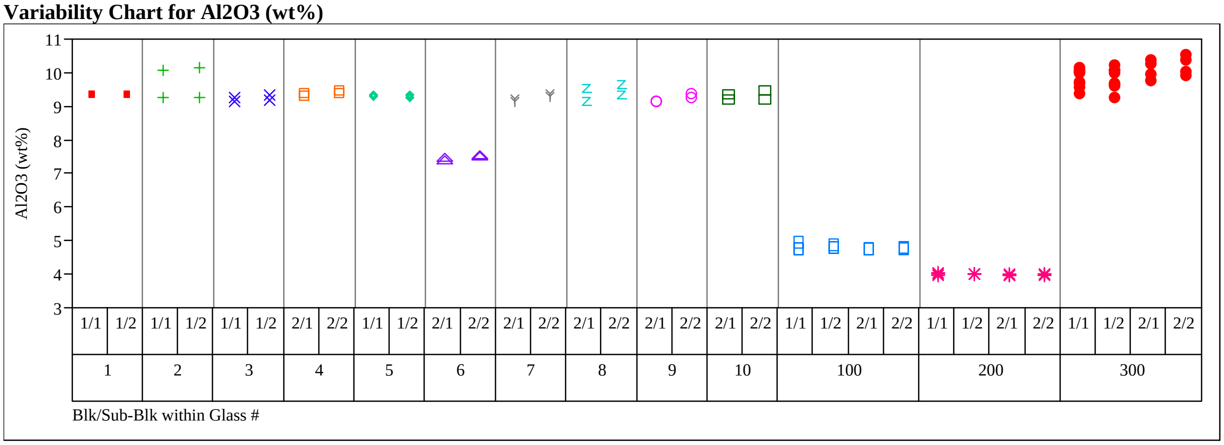
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	2.11863	0.02014	2.0722	2.1651
1/2	3	2.20510	0.02014	2.1587	2.2515
2/1	3	2.24834	0.02014	2.2019	2.2948
2/2	3	2.20117	0.02014	2.1547	2.2476

Std Error uses a pooled estimate of error variance

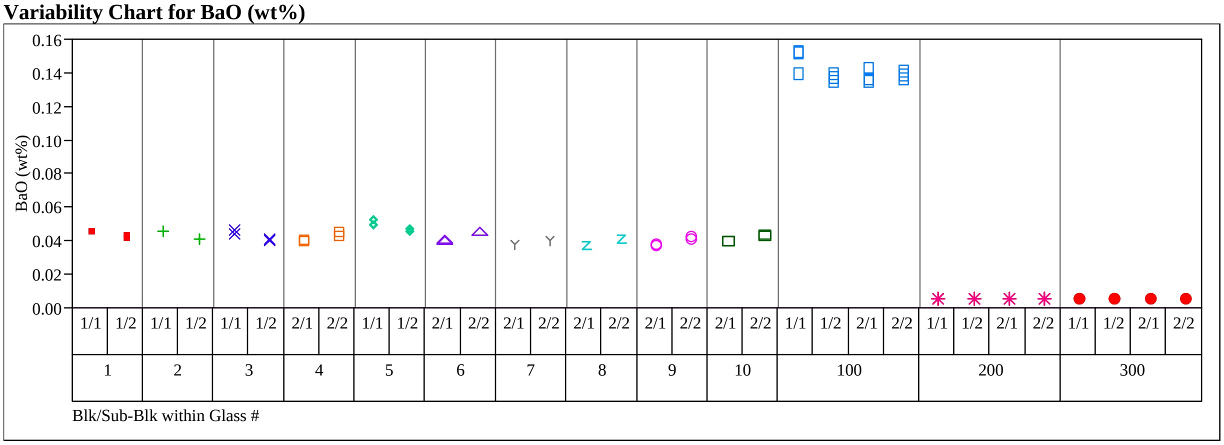
Exhibit B5. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass ID for the Glasses Prepared Using the LM Method

(100 – Batch 1; 200 – Ustd)

Variability Chart for Al2O3 (wt%)



Variability Chart for BaO (wt%)



Variability Chart for CaO (wt%)

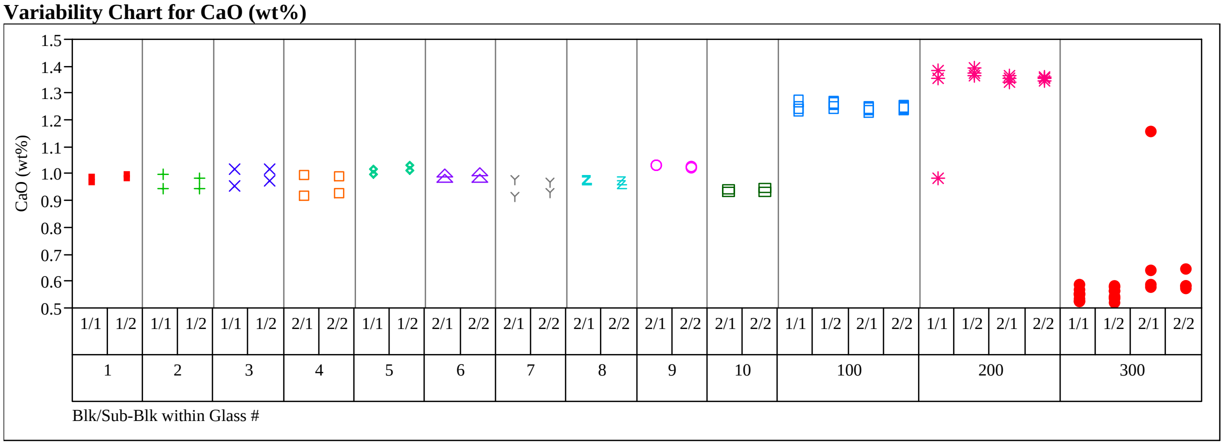
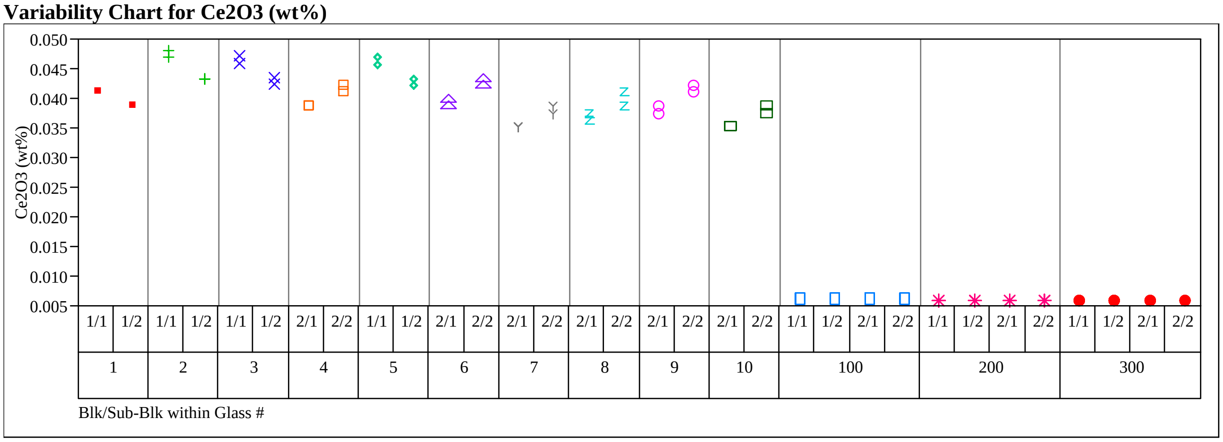
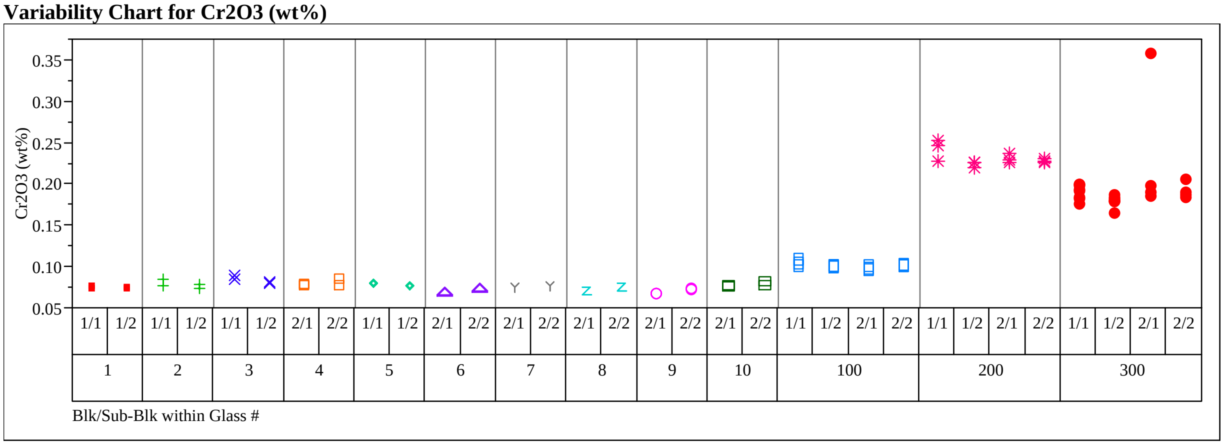


Exhibit B5. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass ID for the Glasses Prepared Using the LM Method (continued)
(100 – Batch 1; 200 – Ustd)

Variability Chart for Ce2O3 (wt%)



Variability Chart for Cr2O3 (wt%)



Variability Chart for CuO (wt%)

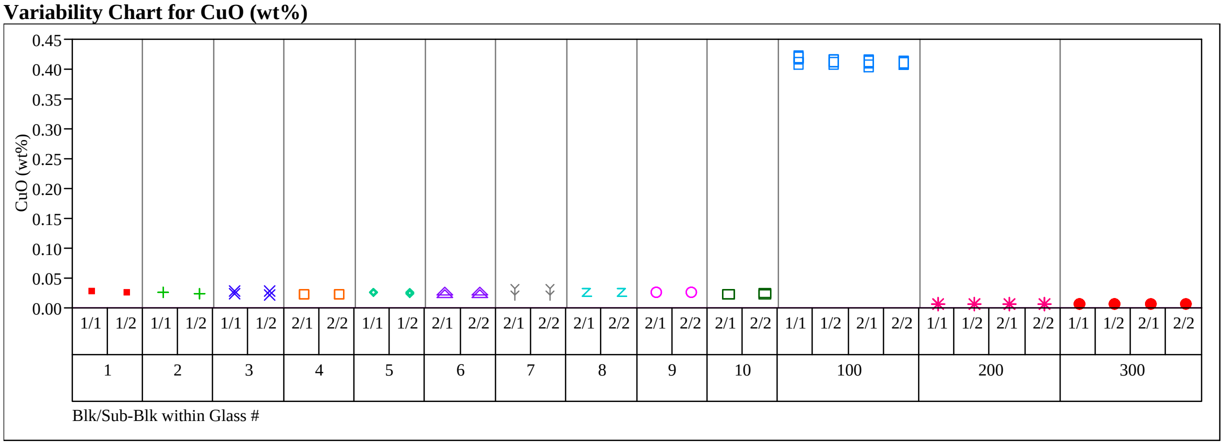
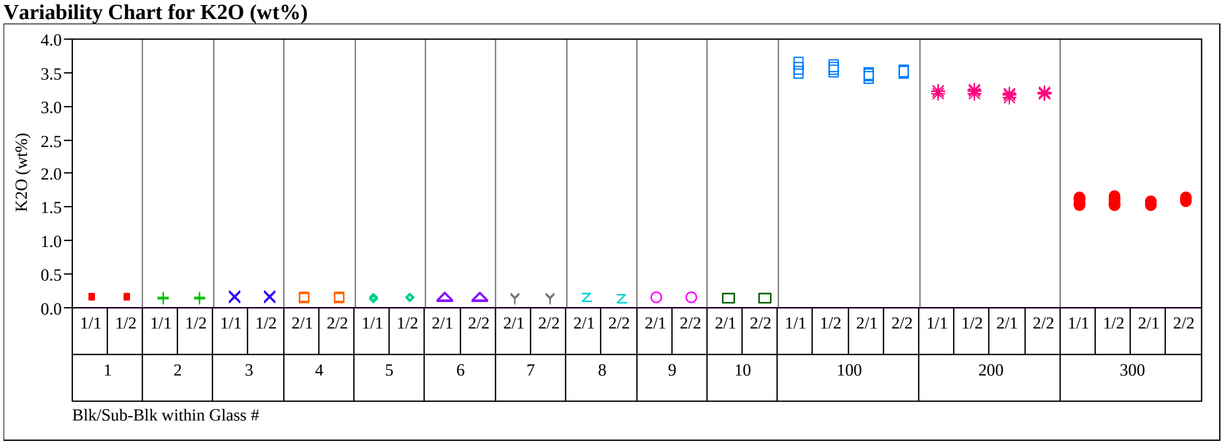
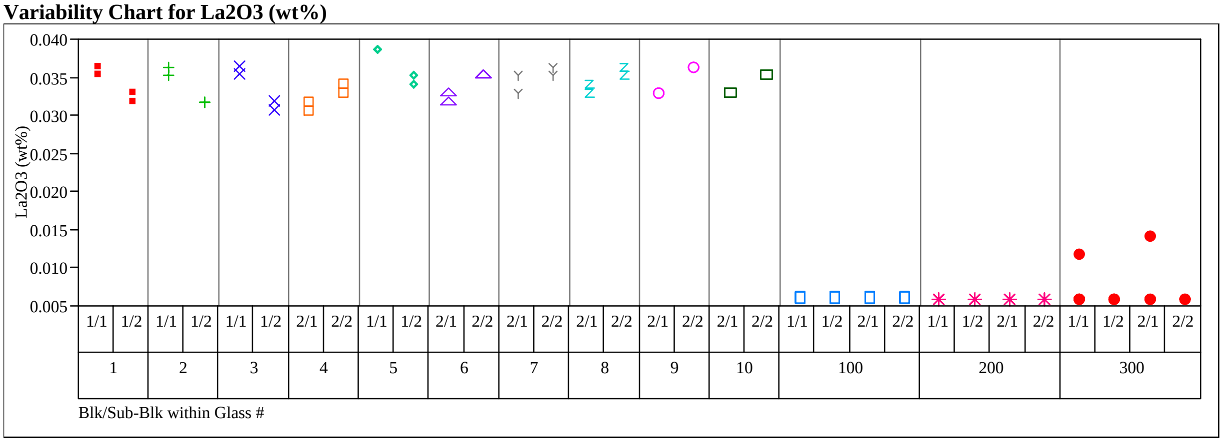


Exhibit B5. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass ID for the Glasses Prepared Using the LM Method (continued)
(100 – Batch 1; 200 – Ustd)

Variability Chart for K2O (wt%)



Variability Chart for La2O3 (wt%)



Variability Chart for MgO (wt%)

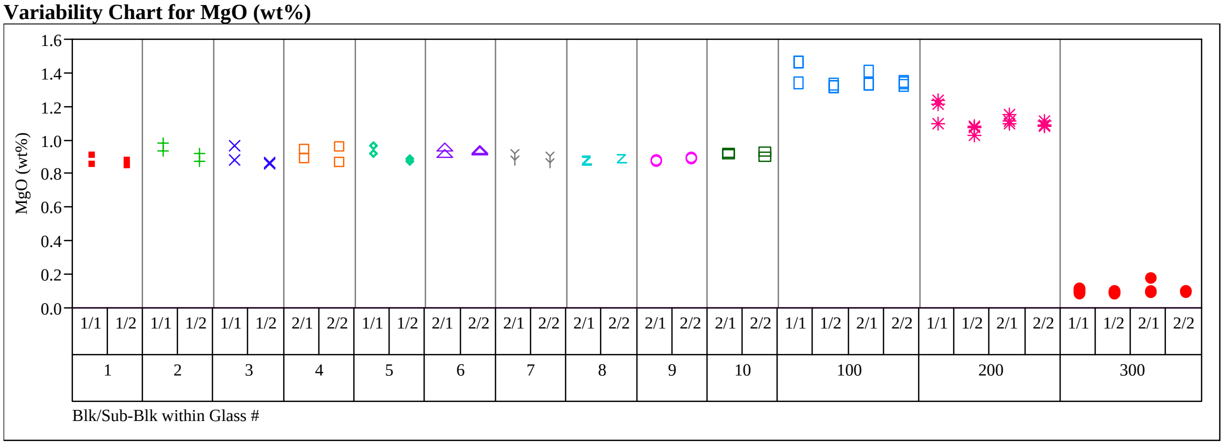
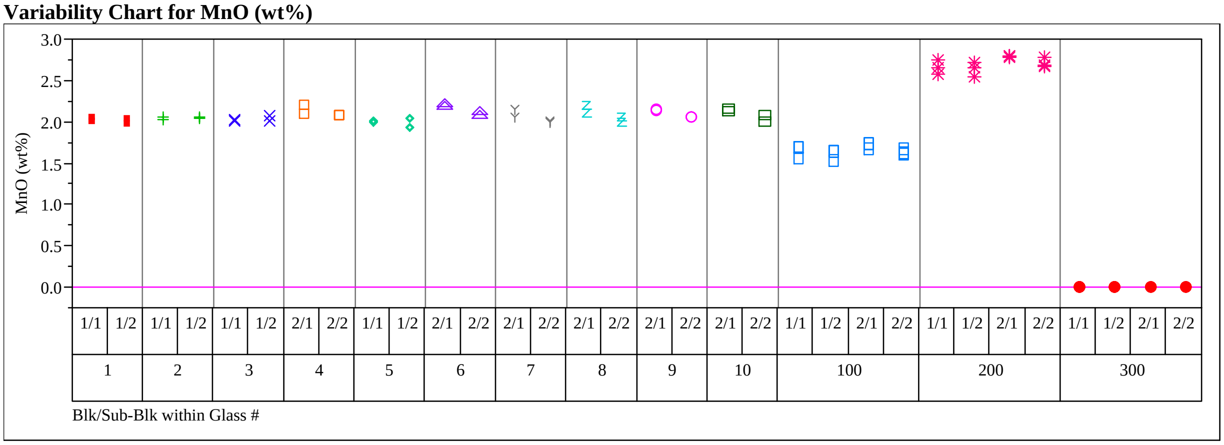
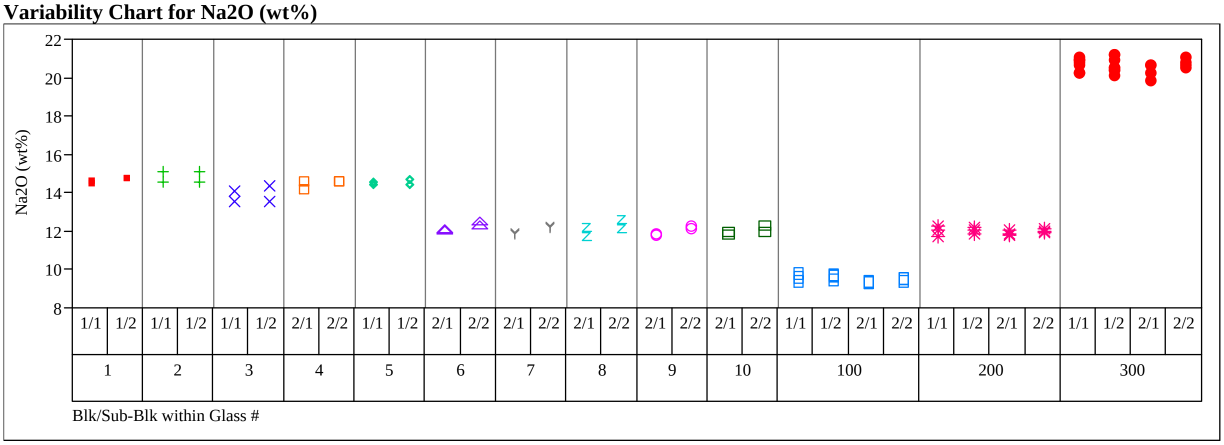


Exhibit B5. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass ID for the Glasses Prepared Using the LM Method (continued)
(100 – Batch 1; 200 – Ustd)

Variability Chart for MnO (wt%)



Variability Chart for Na2O (wt%)



Variability Chart for NiO (wt%)

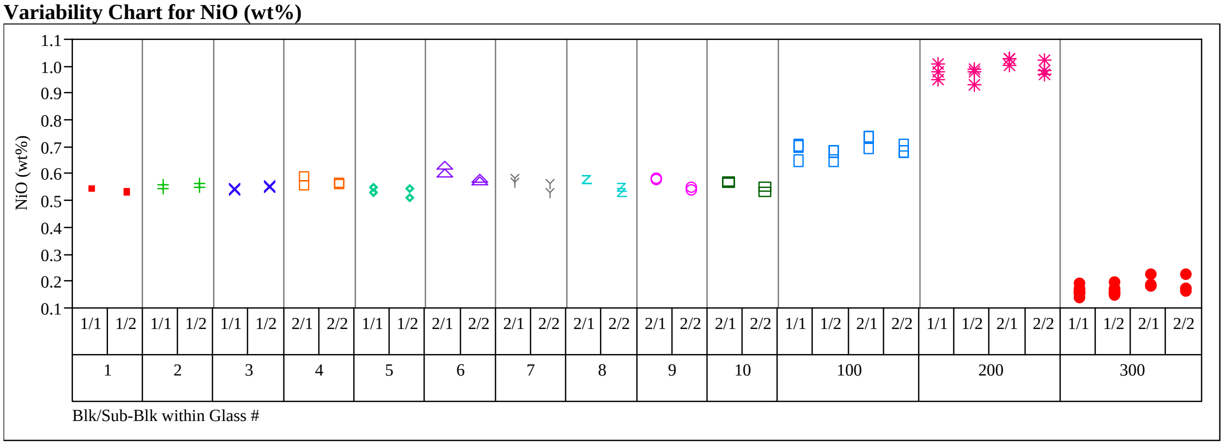
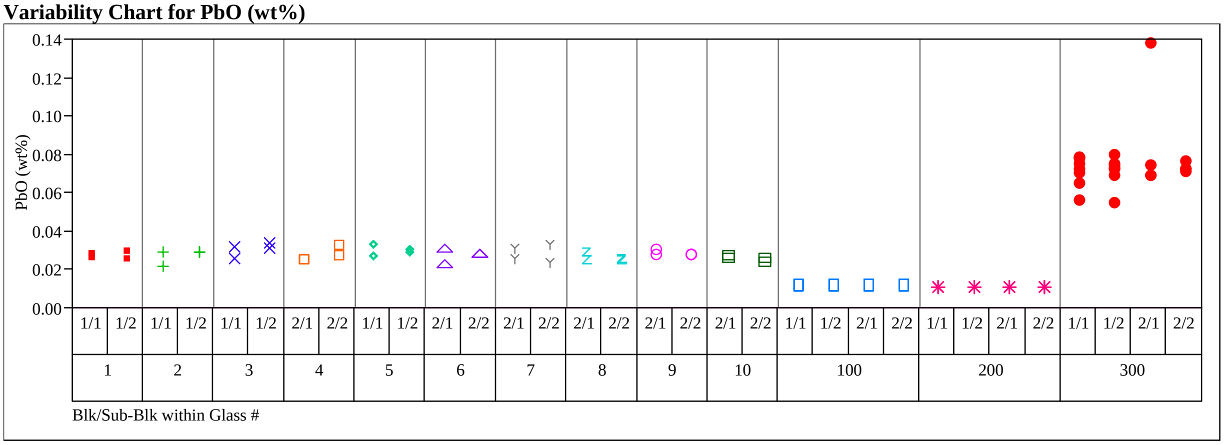


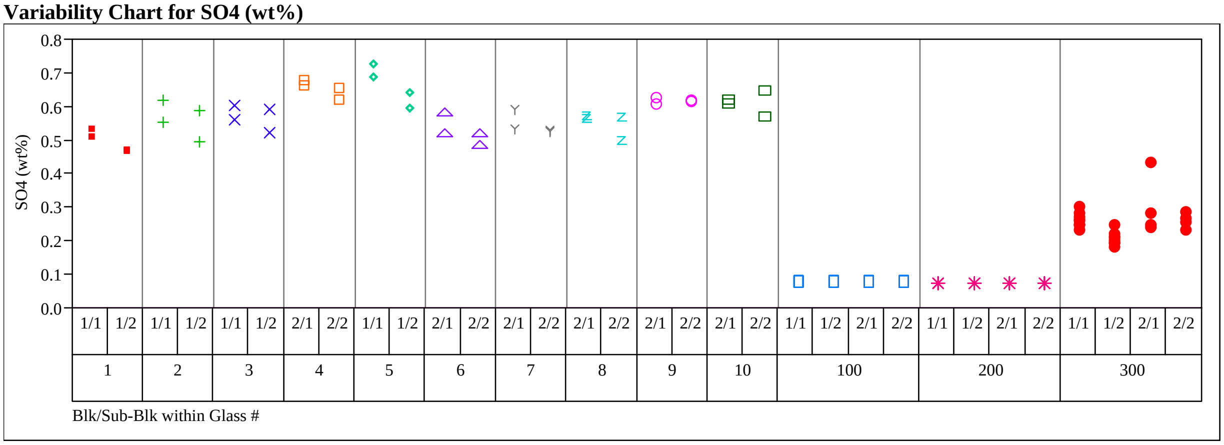
Exhibit B5. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass ID for the Glasses Prepared Using the LM Method (continued)

(100 – Batch 1; 200 – Ustd)

Variability Chart for PbO (wt%)



Variability Chart for SO4 (wt%)



Variability Chart for ThO2 (wt%)

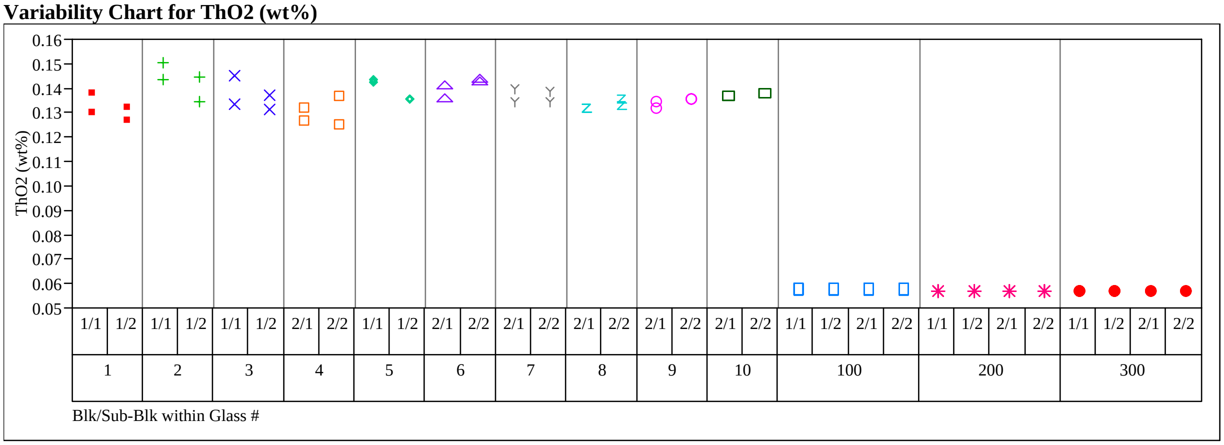
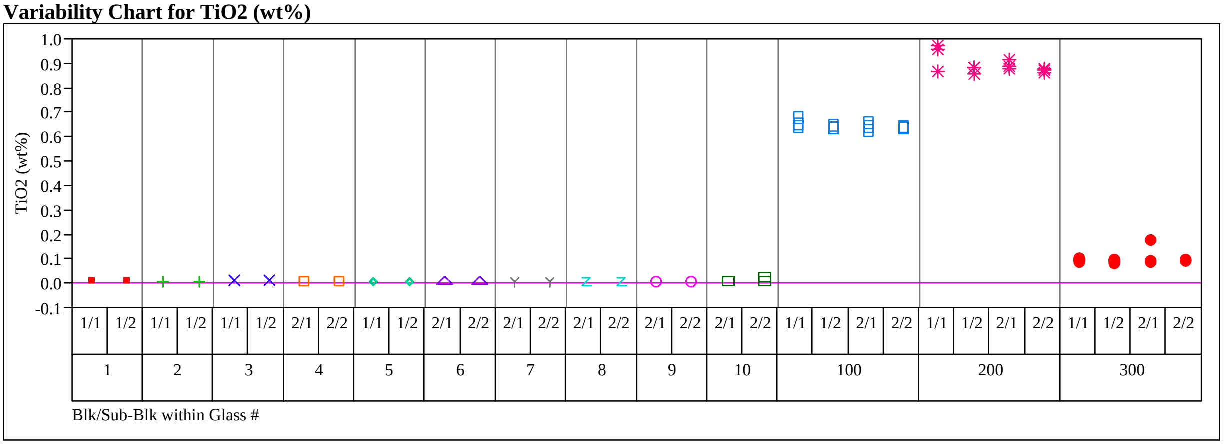
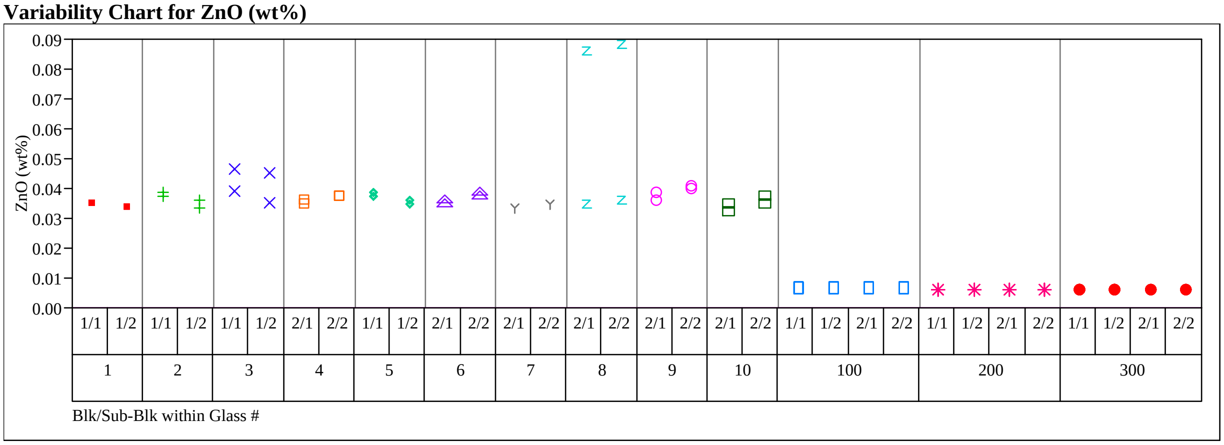


Exhibit B5. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass ID for the Glasses Prepared Using the LM Method (continued)
(100 – Batch 1; 200 – Ustd)

Variability Chart for TiO2 (wt%)



Variability Chart for ZnO (wt%)



Variability Chart for ZrO2 (wt%)

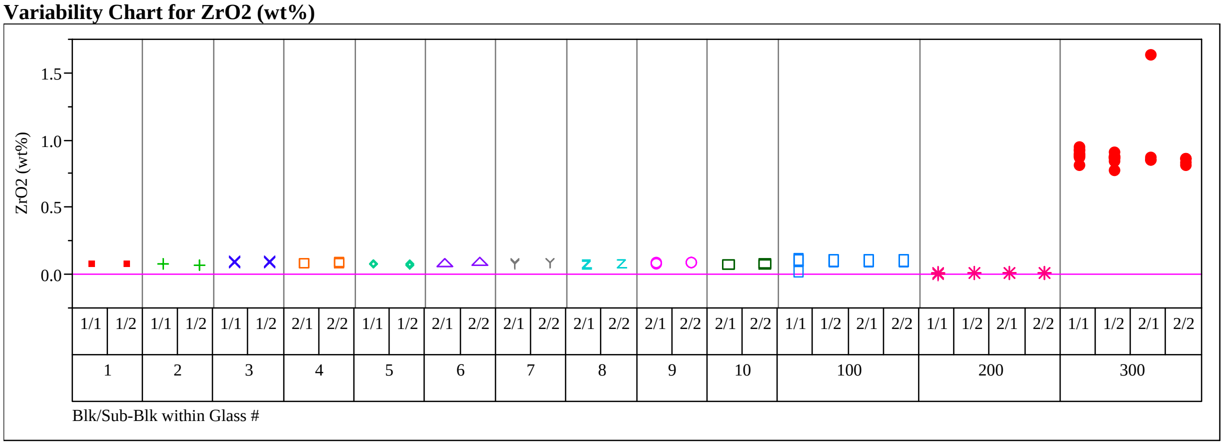
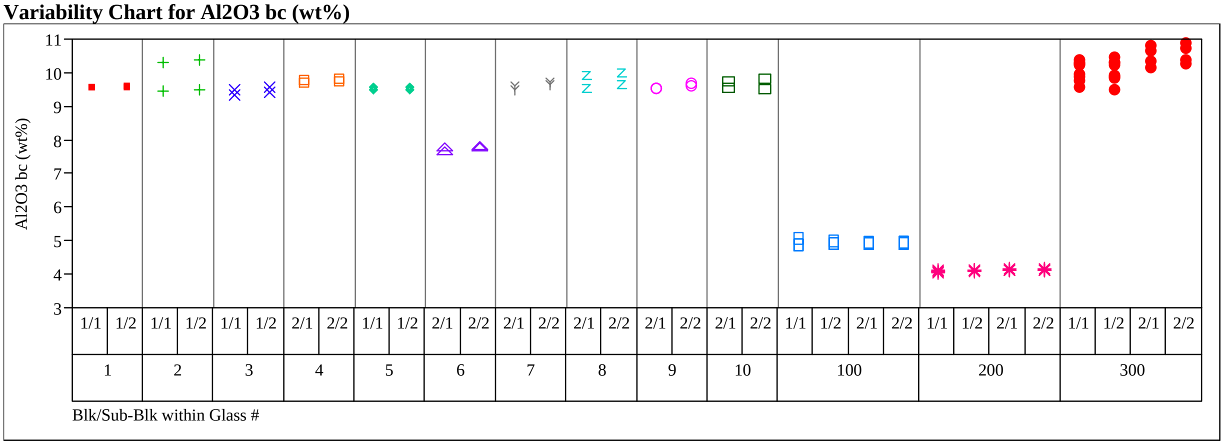
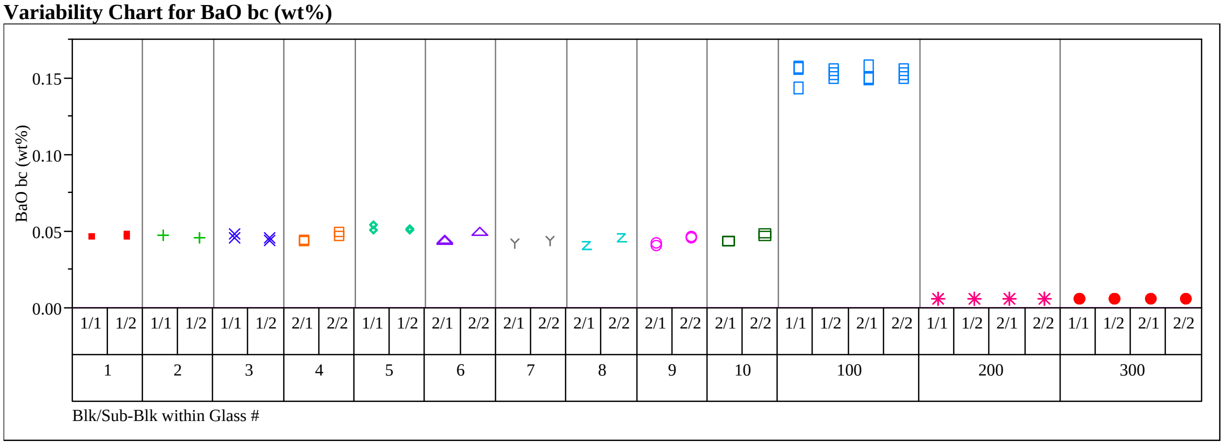


Exhibit B5. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass ID for the Glasses Prepared Using the LM Method (continued)
(100 – Batch 1; 200 – Ustd)

Variability Chart for Al2O3 bc (wt%)



Variability Chart for BaO bc (wt%)



Variability Chart for CaO bc (wt%)

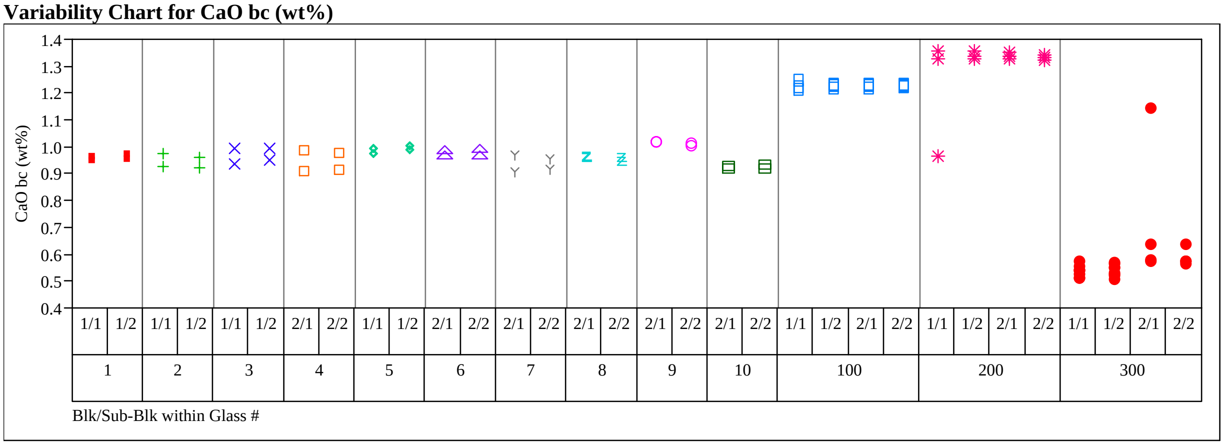
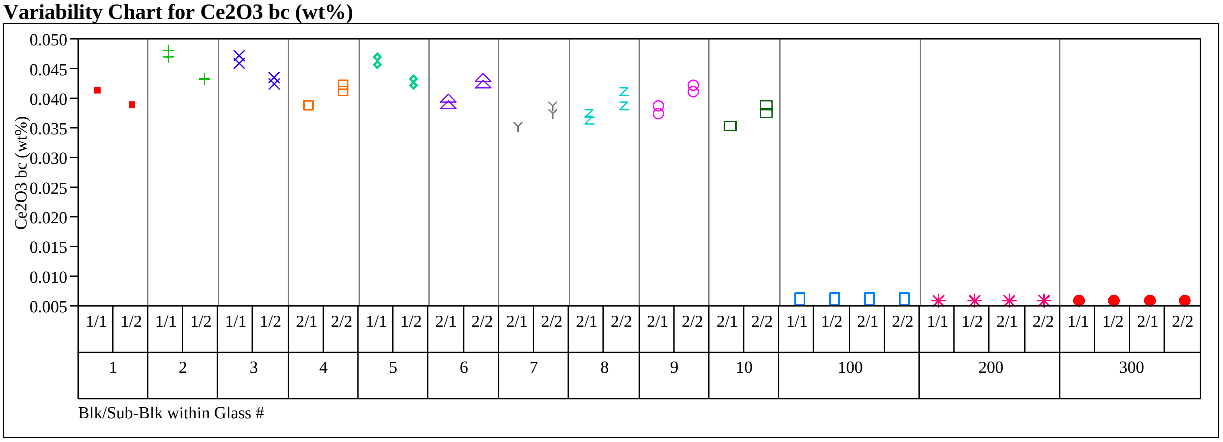
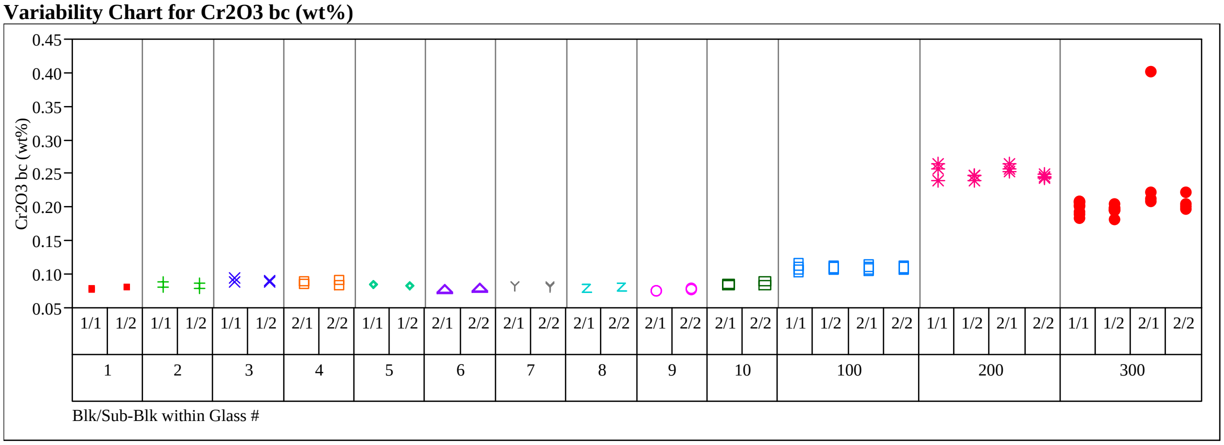


Exhibit B5. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass ID for the Glasses Prepared Using the LM Method (continued)
(100 – Batch 1; 200 – Ustd)

Variability Chart for Ce2O3 bc (wt%)



Variability Chart for Cr2O3 bc (wt%)



Variability Chart for CuO bc (wt%)

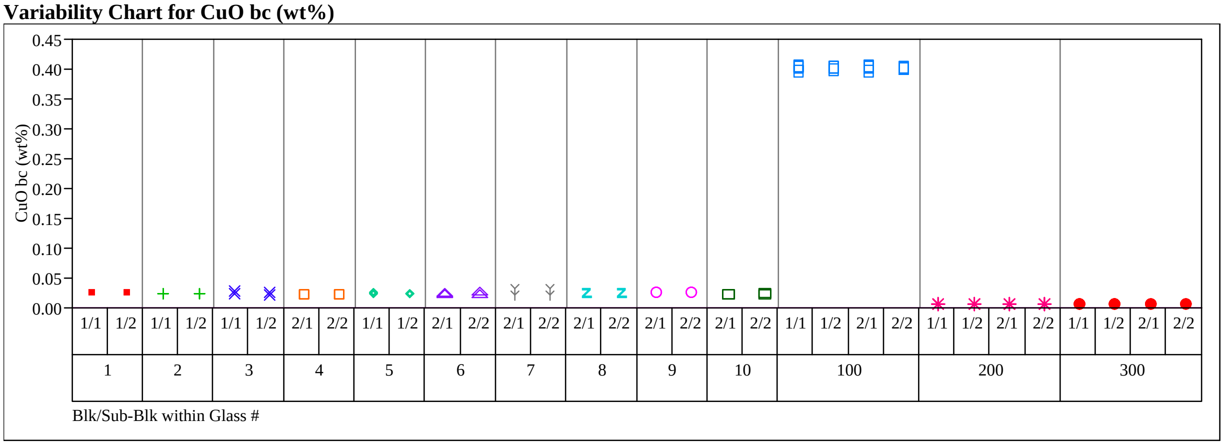
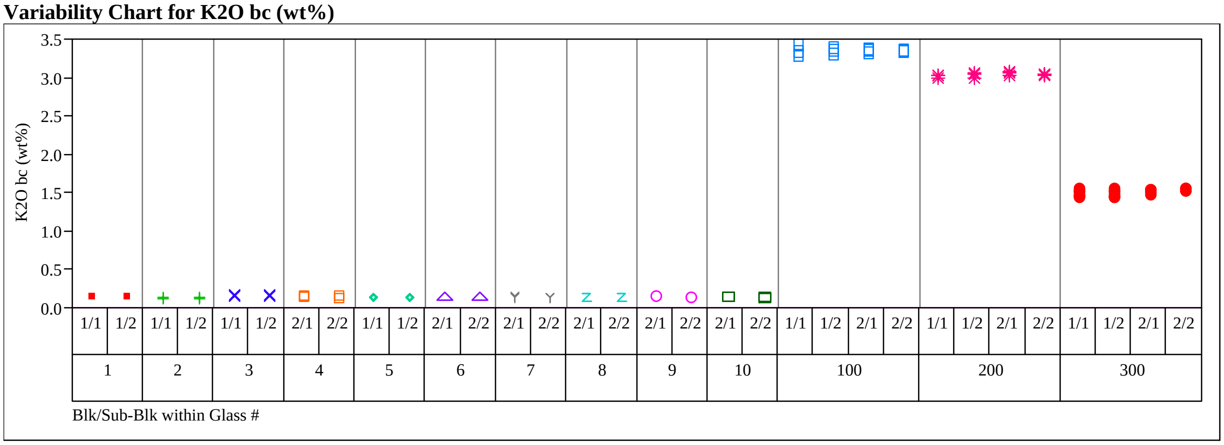
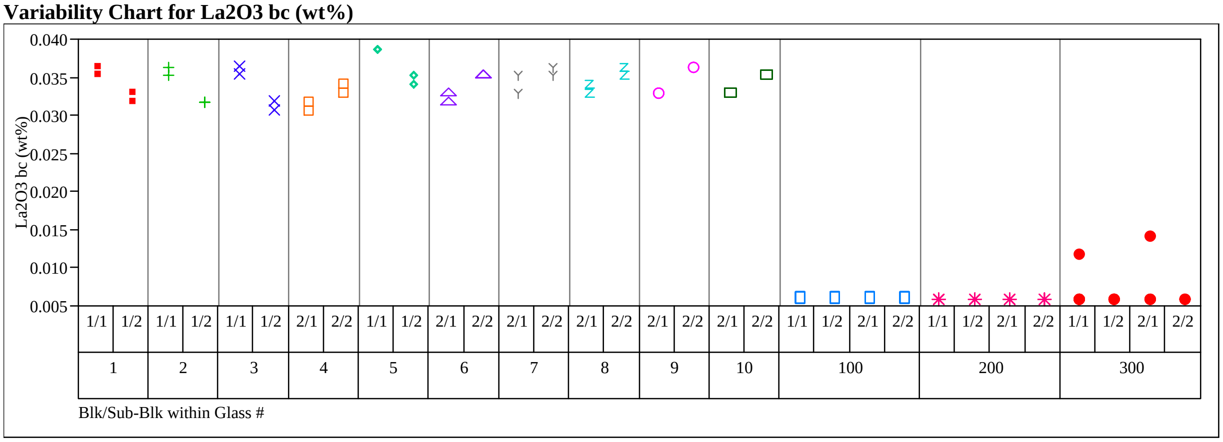


Exhibit B5. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass ID for the Glasses Prepared Using the LM Method (continued)
(100 – Batch 1; 200 – Ustd)

Variability Chart for K2O bc (wt%)



Variability Chart for La2O3 bc (wt%)



Variability Chart for MgO bc (wt%)

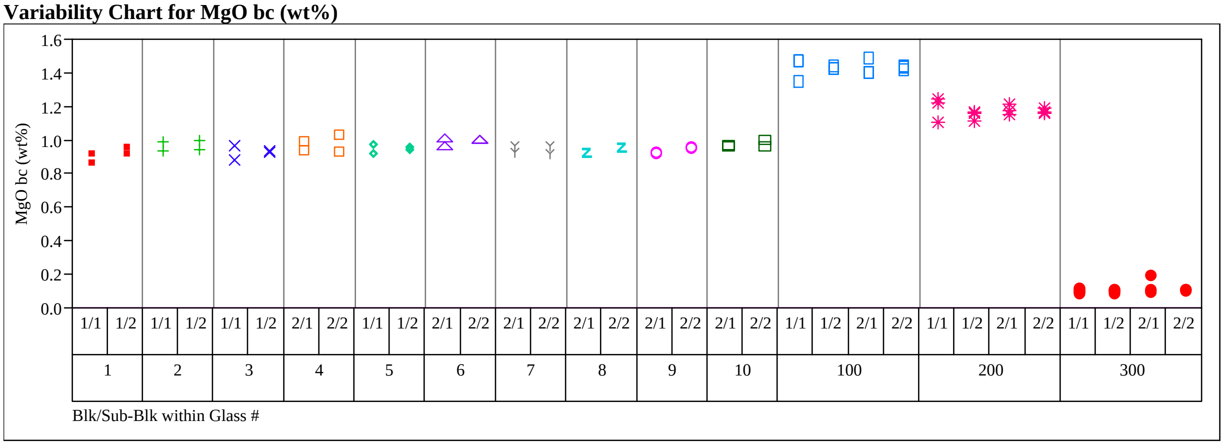
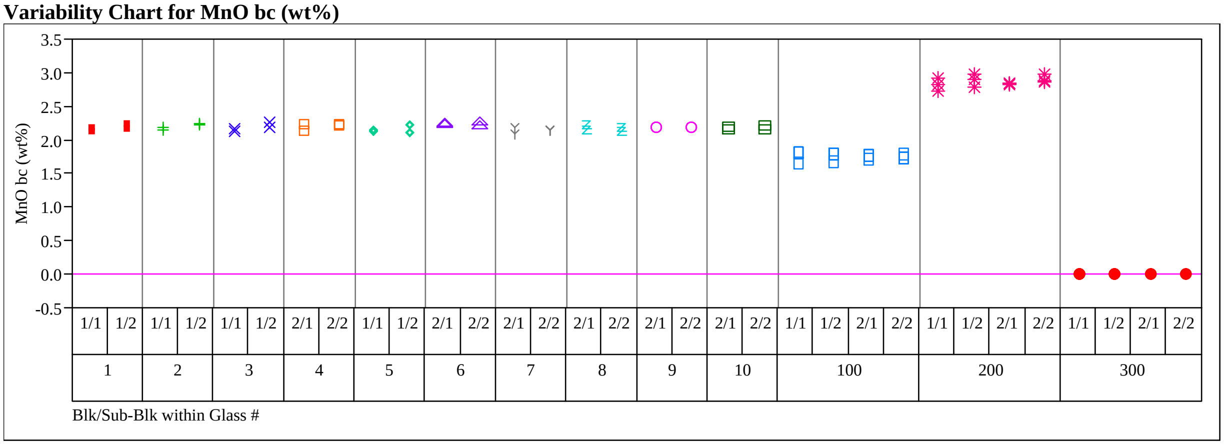


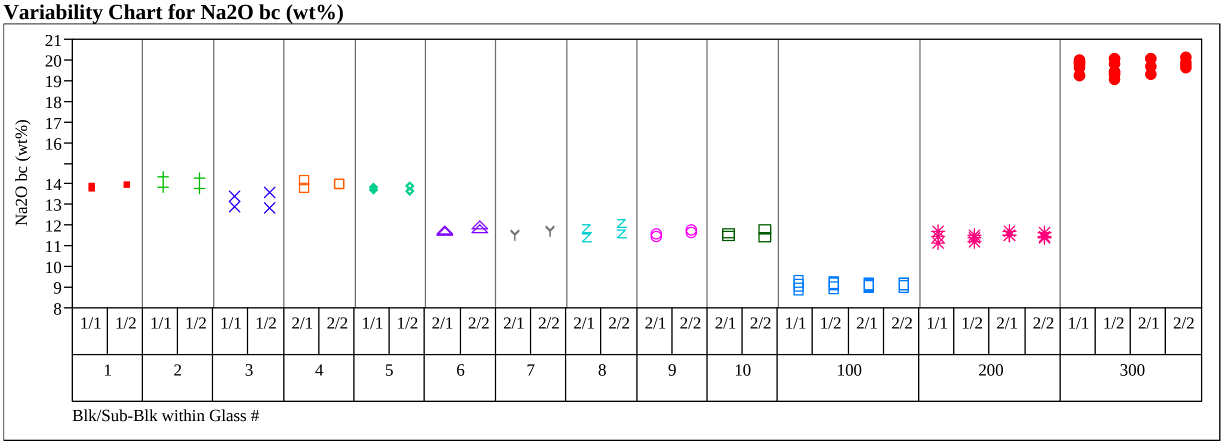
Exhibit B5. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass ID for the Glasses Prepared Using the LM Method (continued)

(100 – Batch 1; 200 – Ustd)

Variability Chart for MnO bc (wt%)



Variability Chart for Na2O bc (wt%)



Variability Chart for NiO bc (wt%)

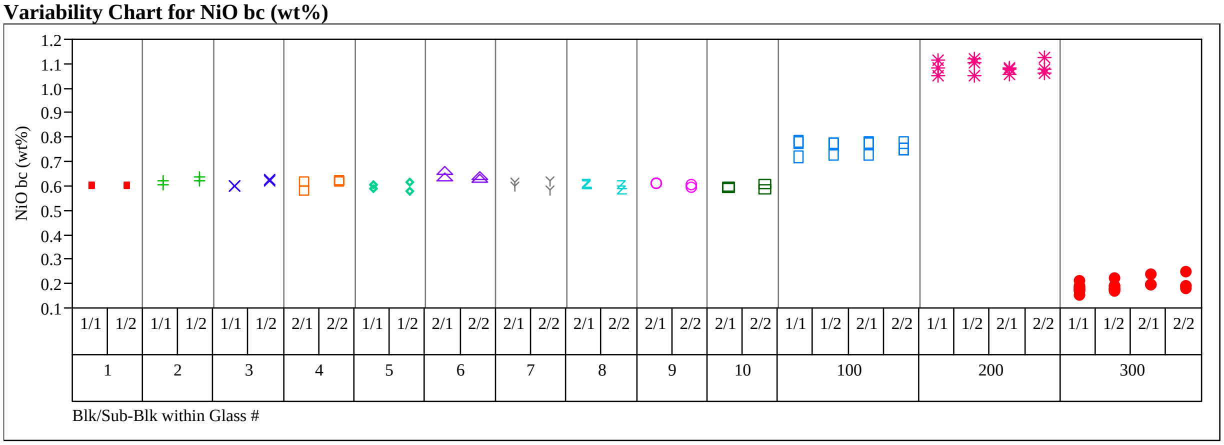
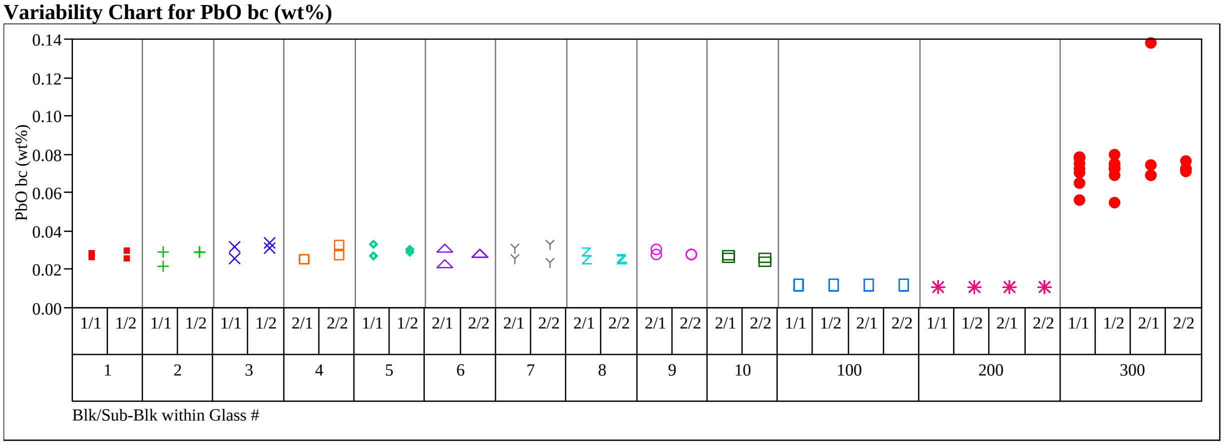


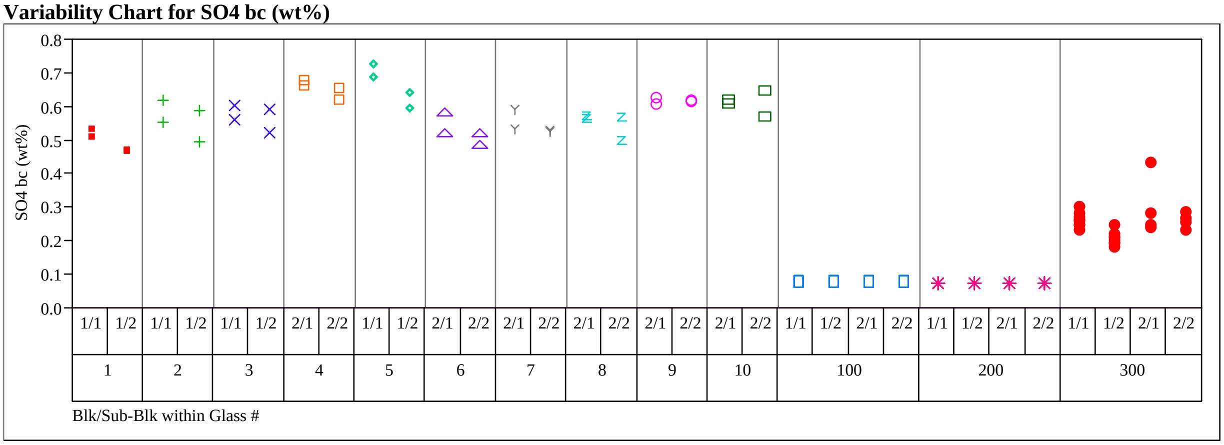
Exhibit B5. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass ID for the Glasses Prepared Using the LM Method (continued)

(100 – Batch 1; 200 – Ustd)

Variability Chart for PbO bc (wt%)



Variability Chart for SO4 bc (wt%)



Variability Chart for ThO2 bc (wt%)

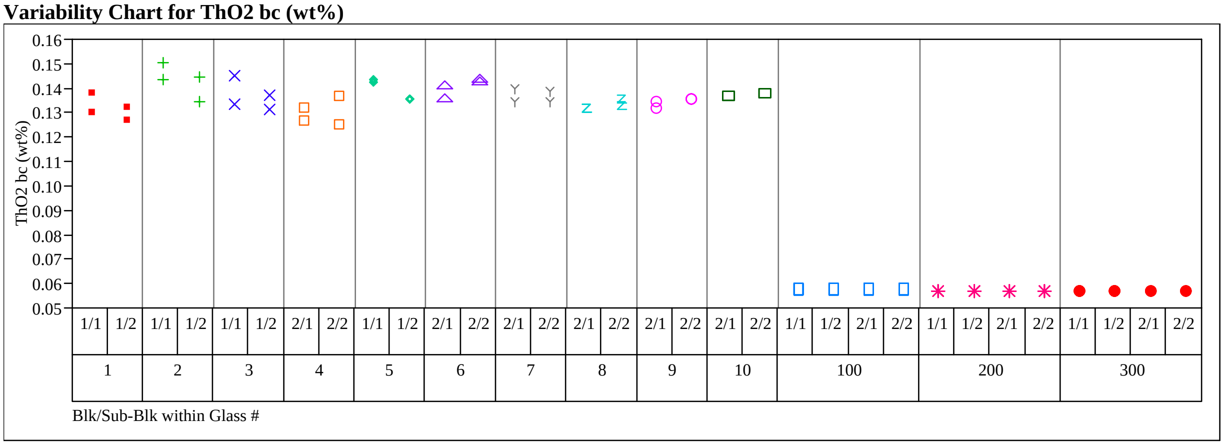
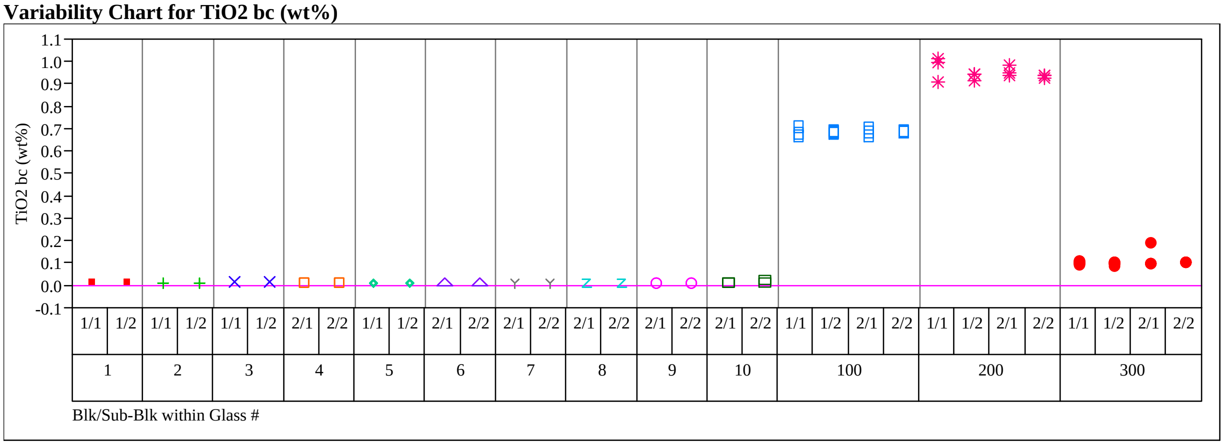


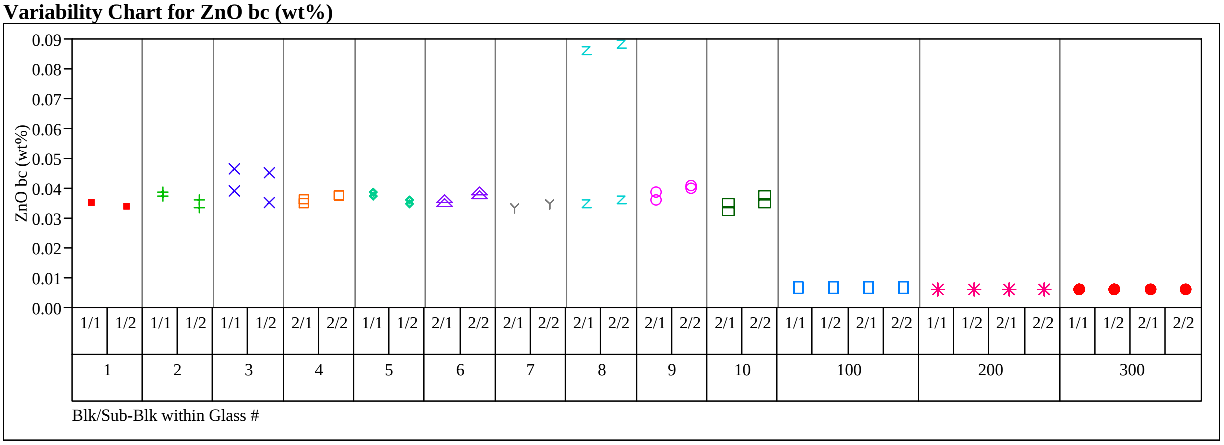
Exhibit B5. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass ID for the Glasses Prepared Using the LM Method (continued)

(100 – Batch 1; 200 – Ustd)

Variability Chart for TiO2 bc (wt%)



Variability Chart for ZnO bc (wt%)



Variability Chart for ZrO2 bc (wt%)

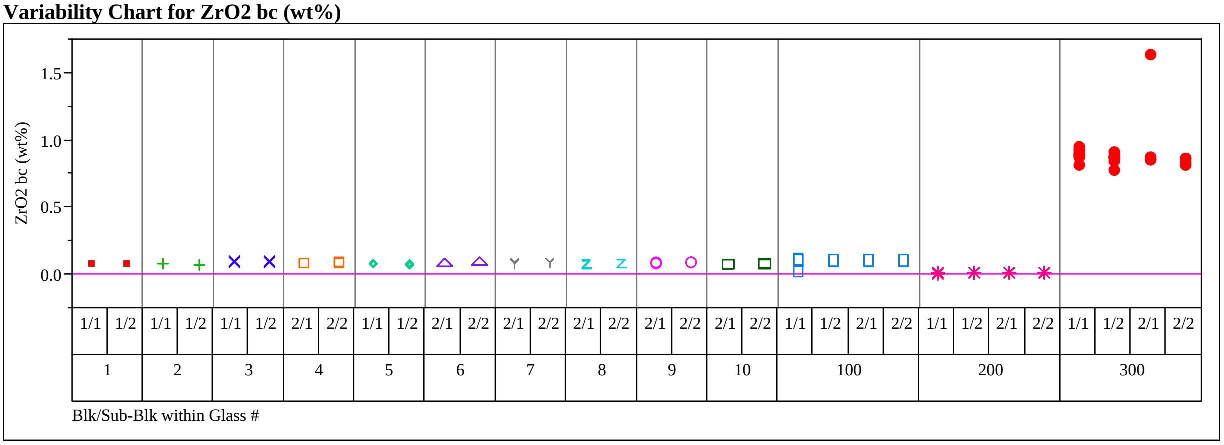
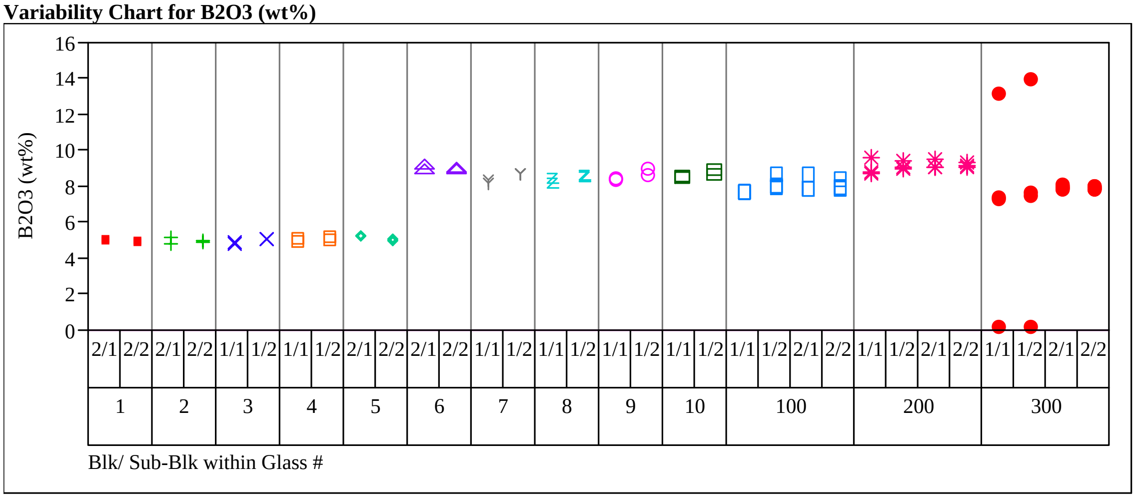


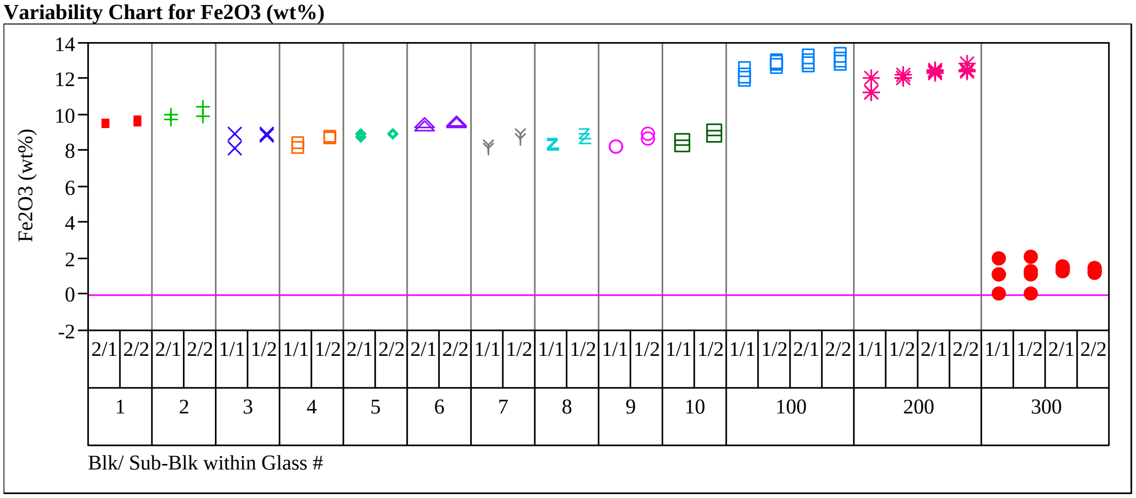
Exhibit B6. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the PF Method

(100 – Batch 1; 200 – Ustd)

Variability Chart for B2O3 (wt%)



Variability Chart for Fe2O3 (wt%)



Variability Chart for Li2O (wt%)

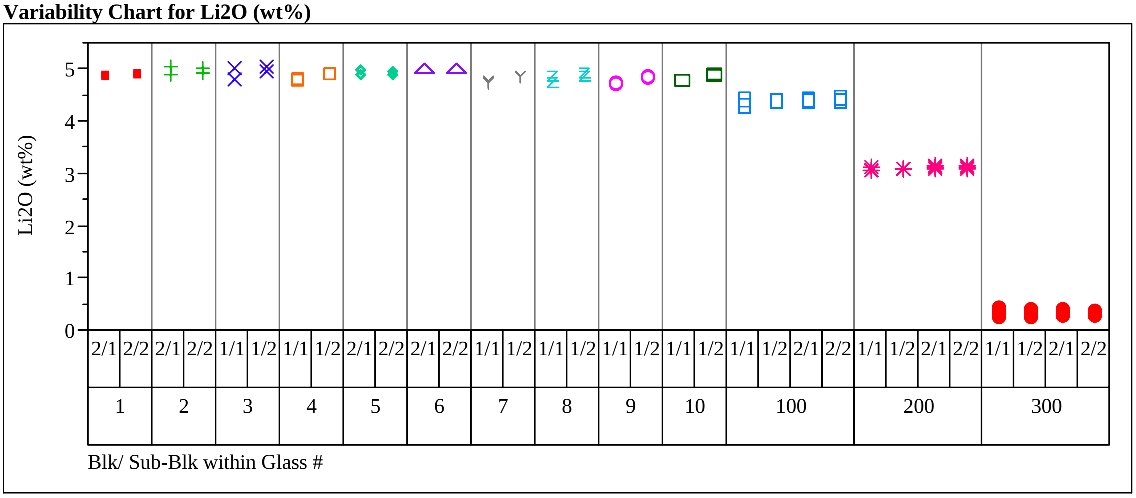
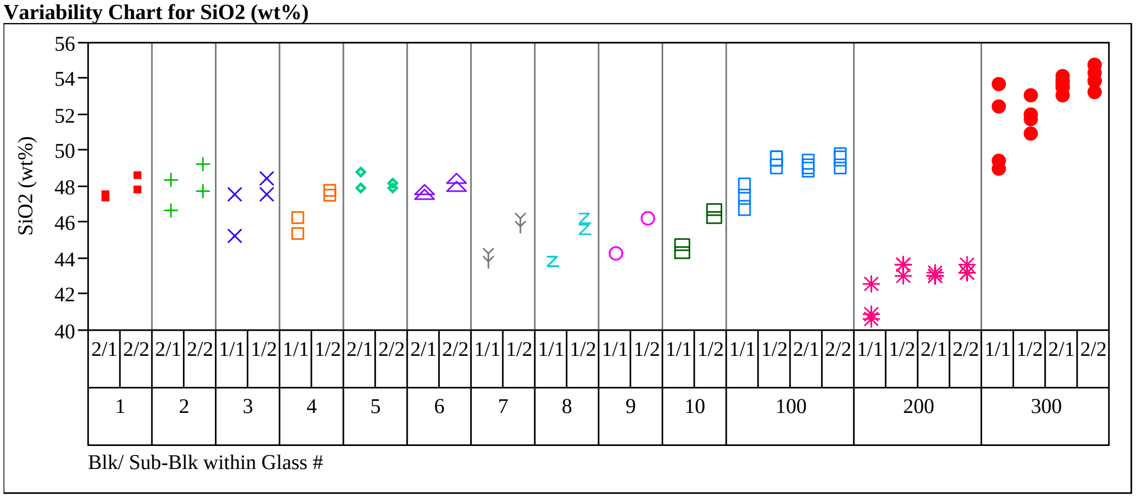


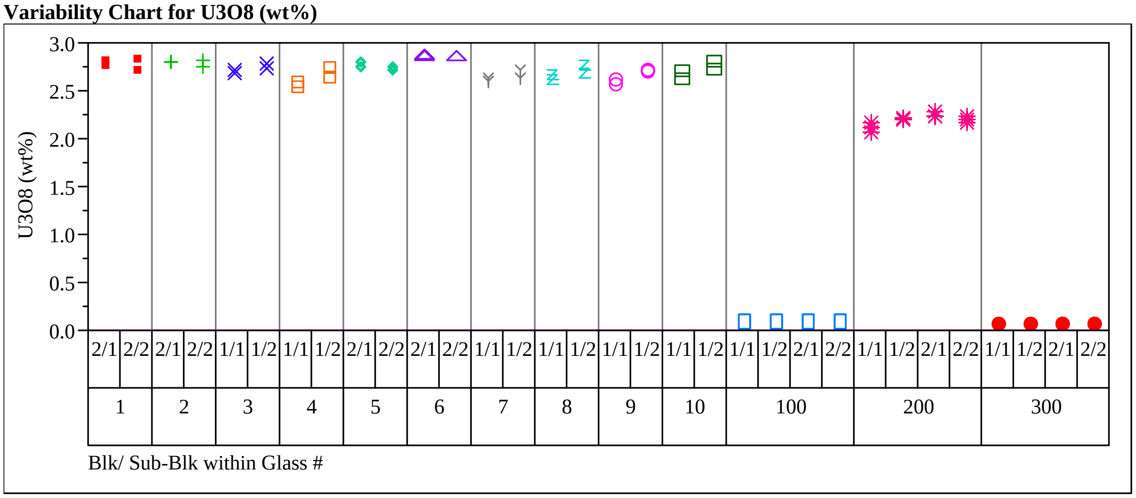
Exhibit B6. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the PF Method (continued)

(100 – Batch 1; 200 – Ustd)

Variability Chart for SiO2 (wt%)



Variability Chart for U3O8 (wt%)



Variability Chart for B2O3 bc (wt%)

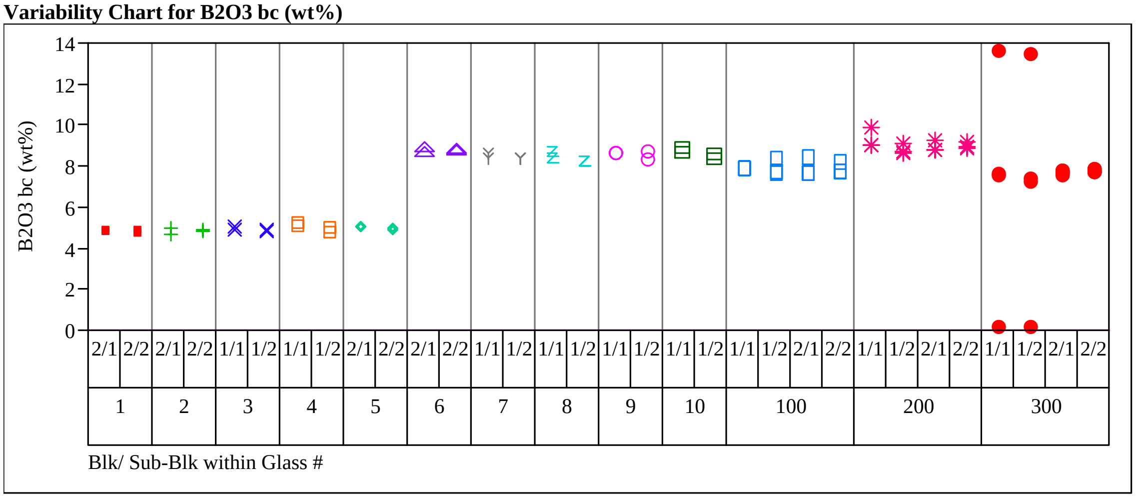
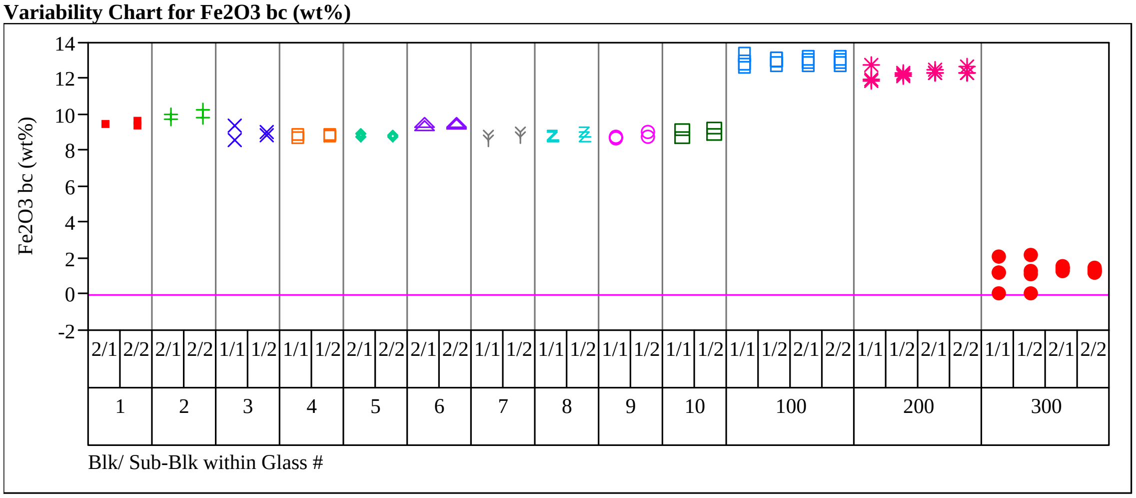


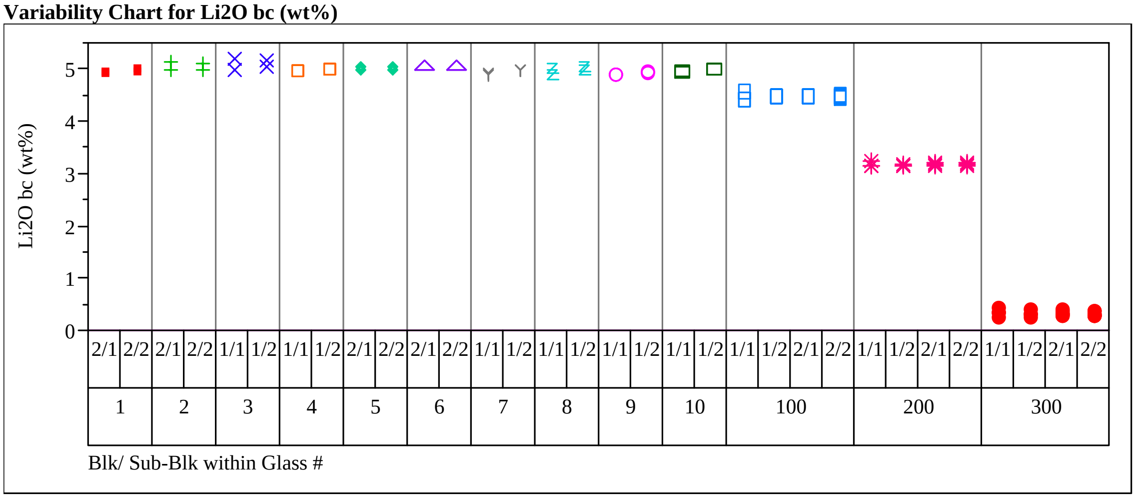
Exhibit B6. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the PF Method (continued)

(100 – Batch 1; 200 – Ustd)

Variability Chart for Fe2O3 bc (wt%)



Variability Chart for Li2O bc (wt%)



Variability Chart for SiO2 bc (wt%)

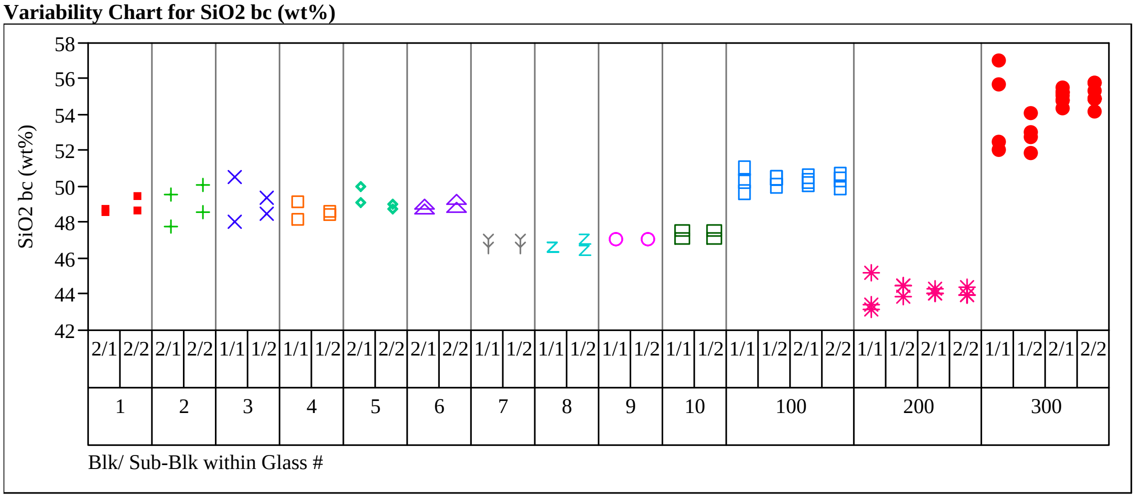


Exhibit B6. Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the PF Method (continued)

(100 – Batch 1; 200 – Ustd)

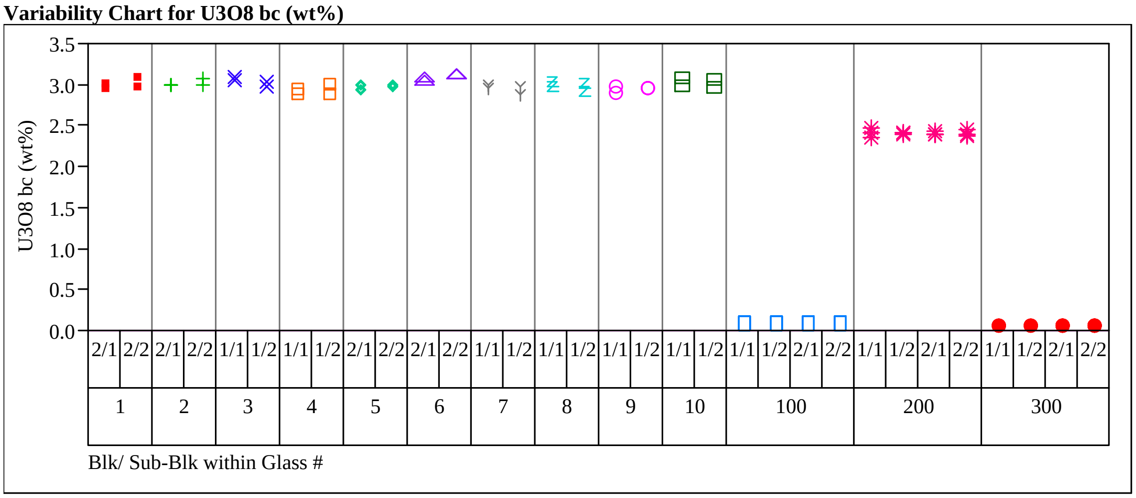
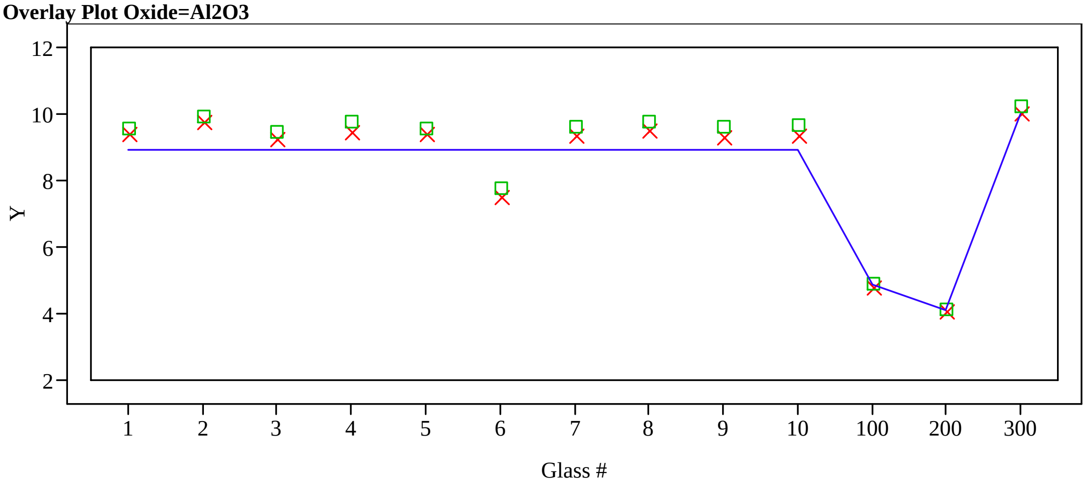


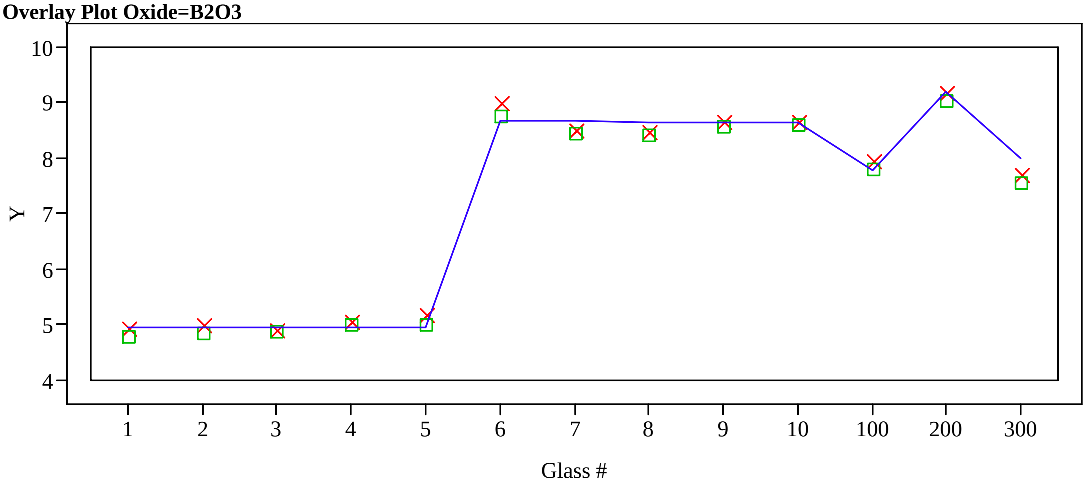
Exhibit B7. Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass ID by Oxide

(100 – Batch 1; 200 – Ustd)

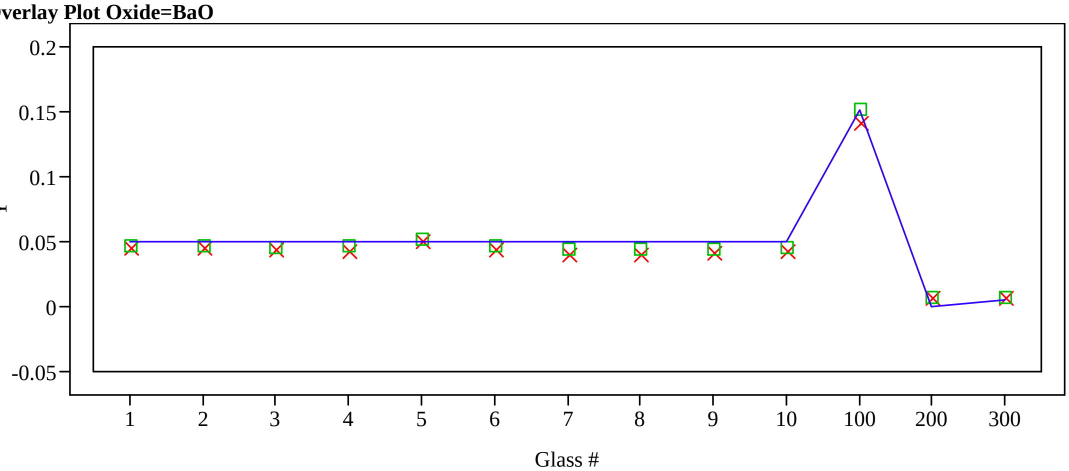
Overlay Plot Oxide=Al2O3



Overlay Plot Oxide=B2O3



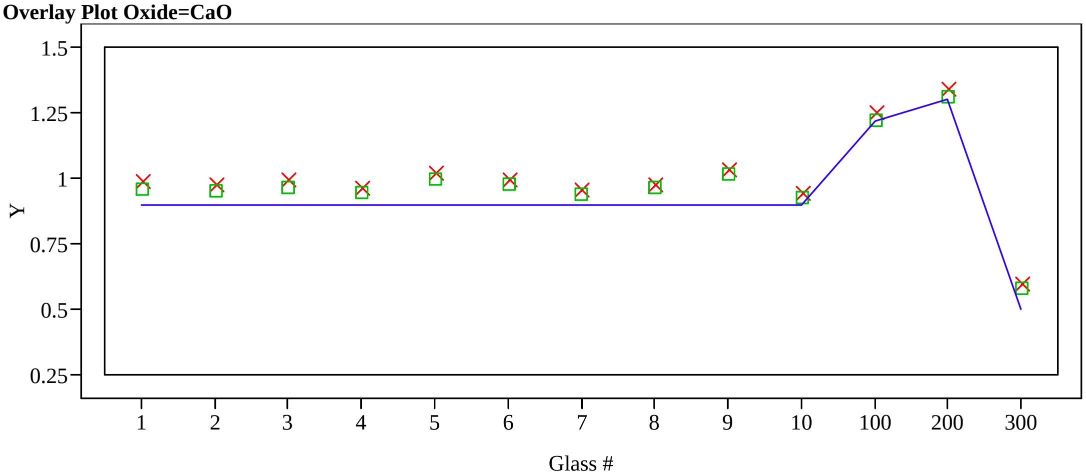
Overlay Plot Oxide=BaO



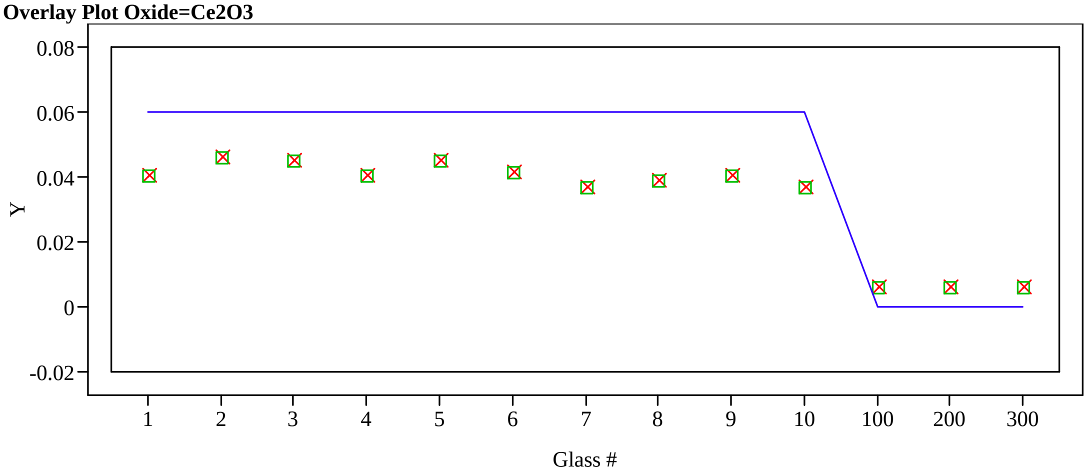
Y × Measured (wt%) ▫ Measured bc (wt%) — Targeted (wt%)

Exhibit B7. Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass ID by Oxide (continued)
(100 – Batch 1; 200 – Ustd)

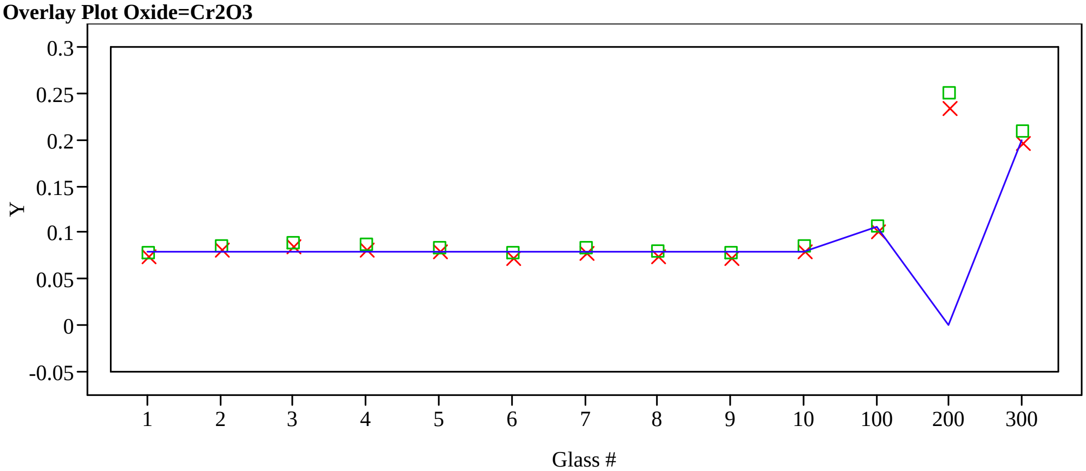
Overlay Plot Oxide=CaO



Overlay Plot Oxide=Ce2O3



Overlay Plot Oxide=Cr2O3

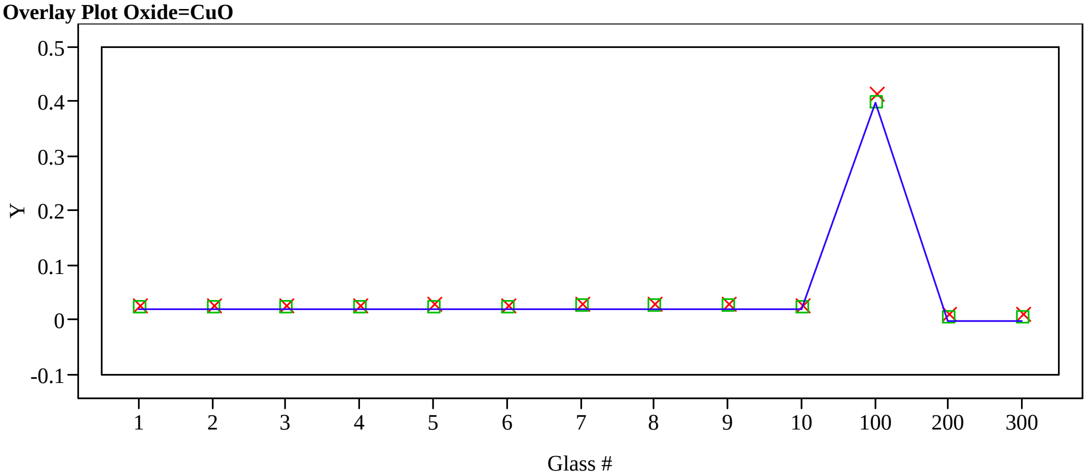


Y × Measured (wt%) ▫ Measured bc (wt%) — Targeted (wt%)

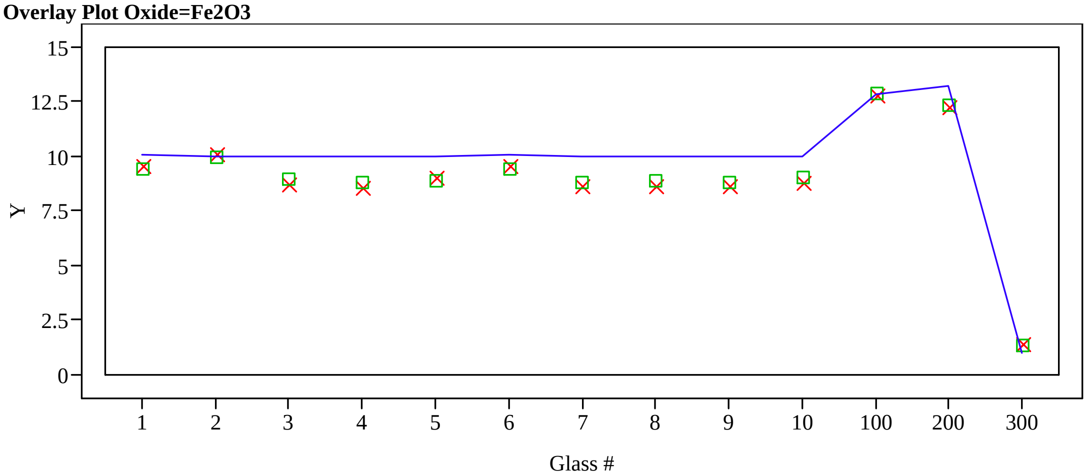
Exhibit B7. Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass ID by Oxide (continued)

(100 – Batch 1; 200 – Ustd)

Overlay Plot Oxide=CuO



Overlay Plot Oxide=Fe2O3



Overlay Plot Oxide=K2O

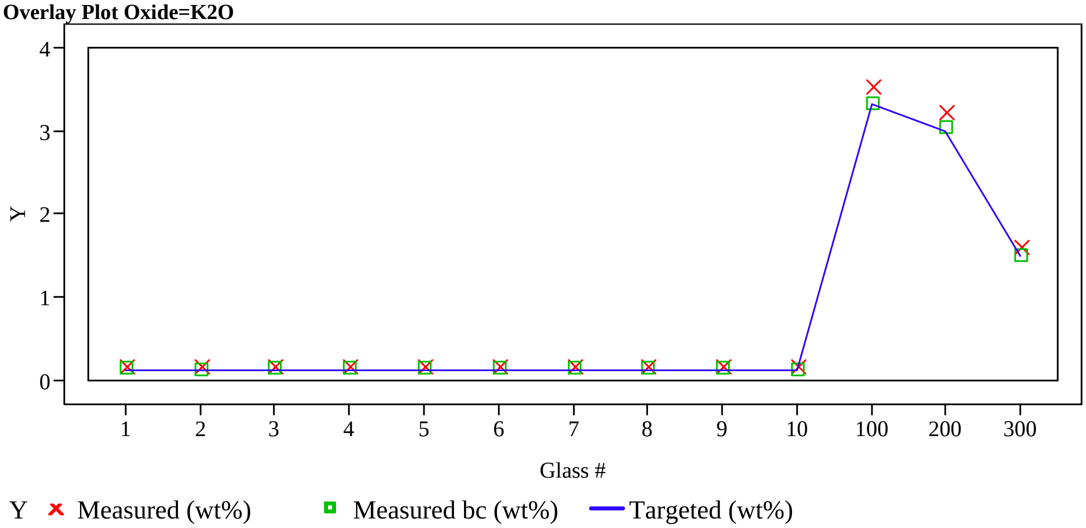
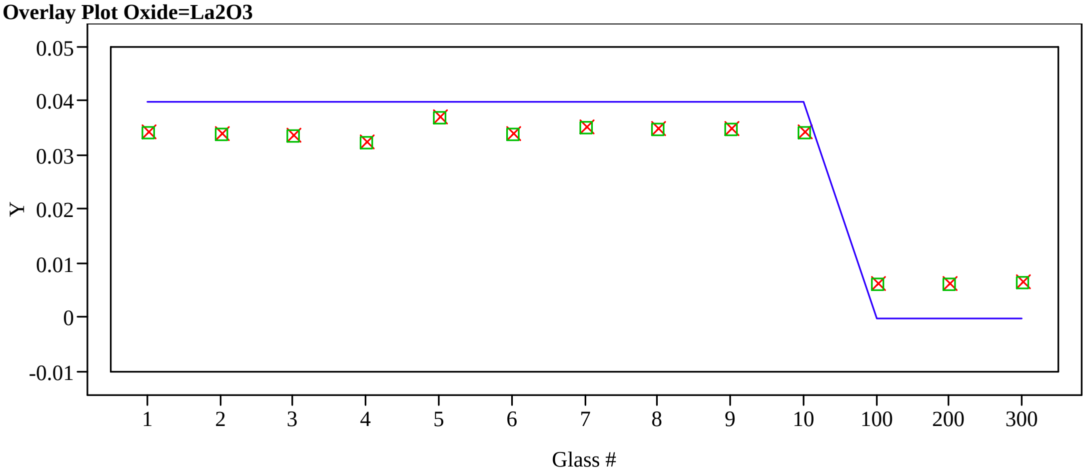


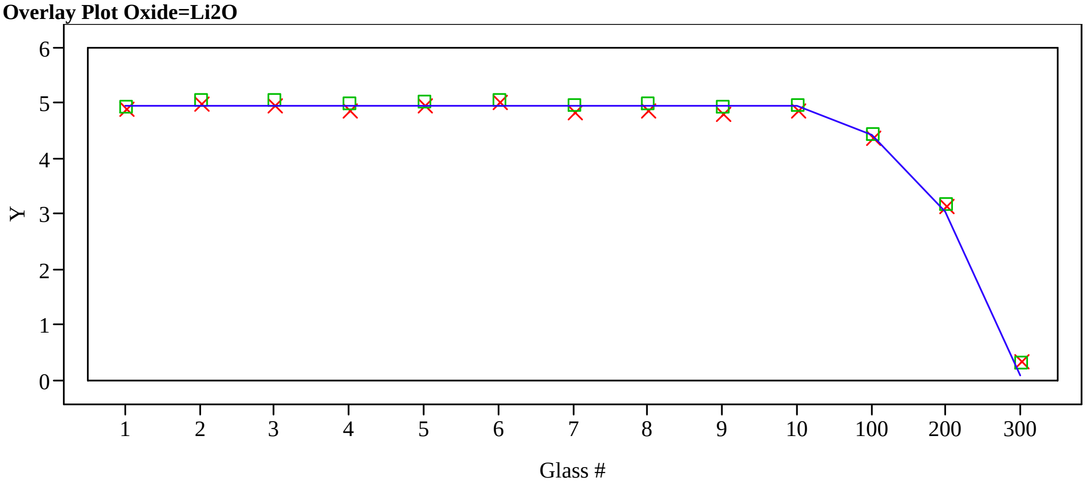
Exhibit B7. Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass ID by Oxide (continued)

(100 – Batch 1; 200 – Ustd)

Overlay Plot Oxide=La2O3



Overlay Plot Oxide=Li2O



Overlay Plot Oxide=MgO

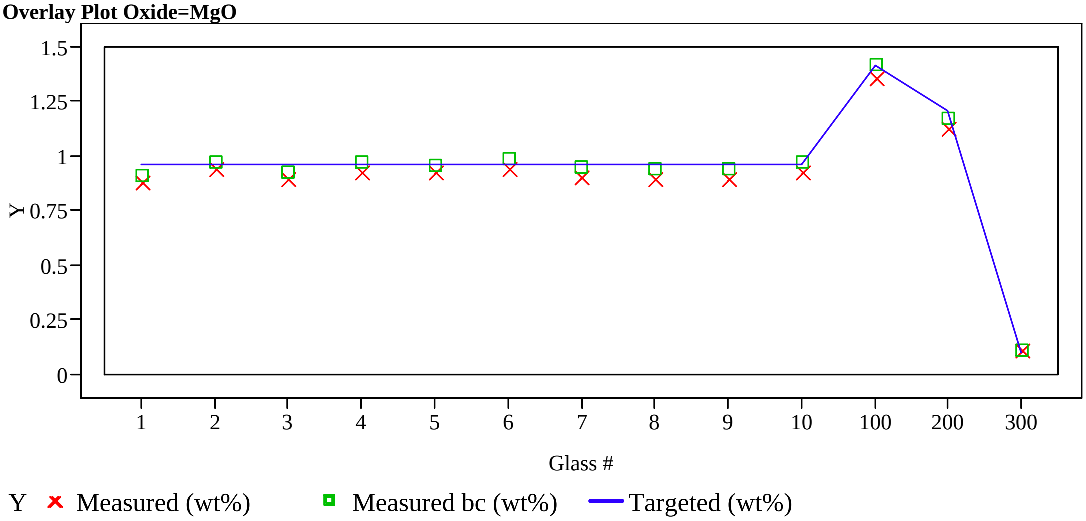
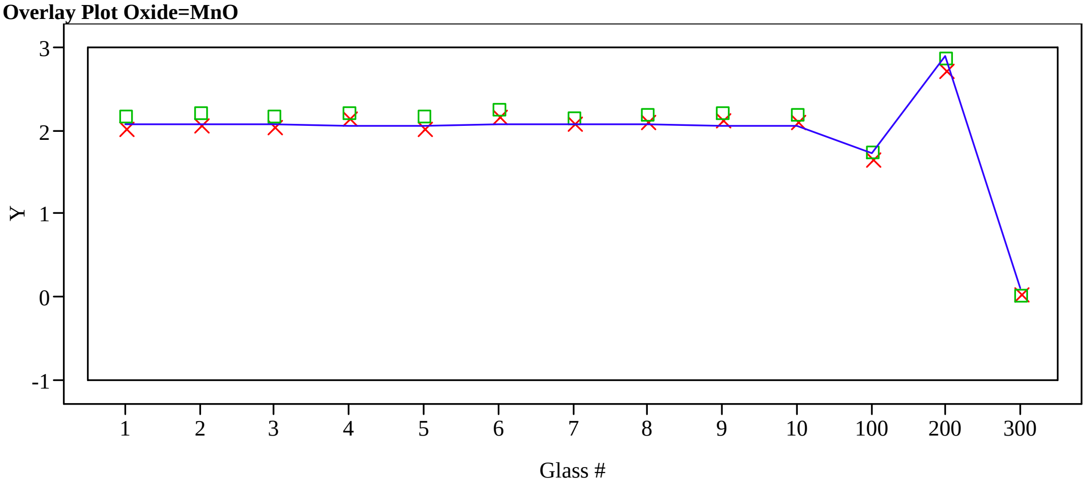


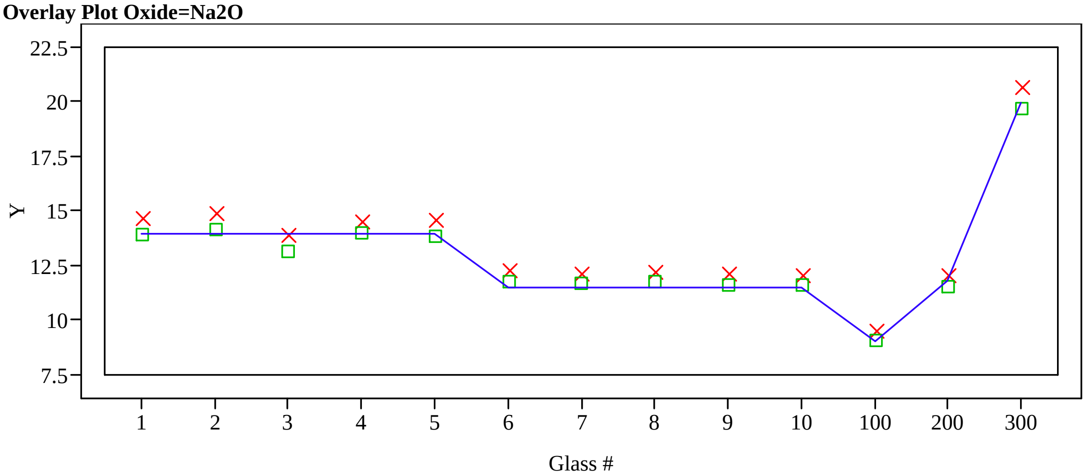
Exhibit B7. Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass ID by Oxide (continued)

(100 – Batch 1; 200 – Ustd)

Overlay Plot Oxide=MnO



Overlay Plot Oxide=Na2O



Overlay Plot Oxide=NiO

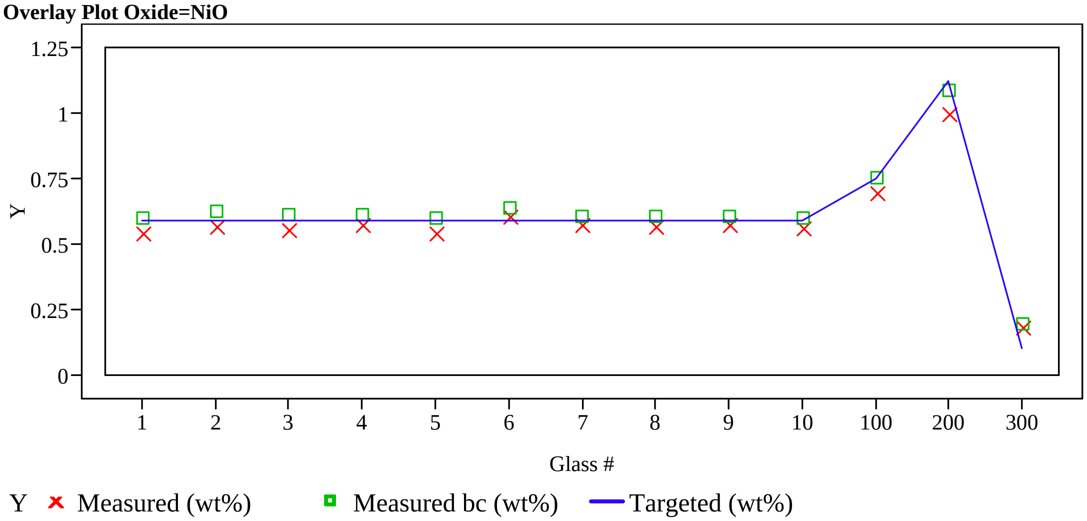


Exhibit B7. Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass ID by Oxide (continued)

(100 – Batch 1; 200 – Ustd)

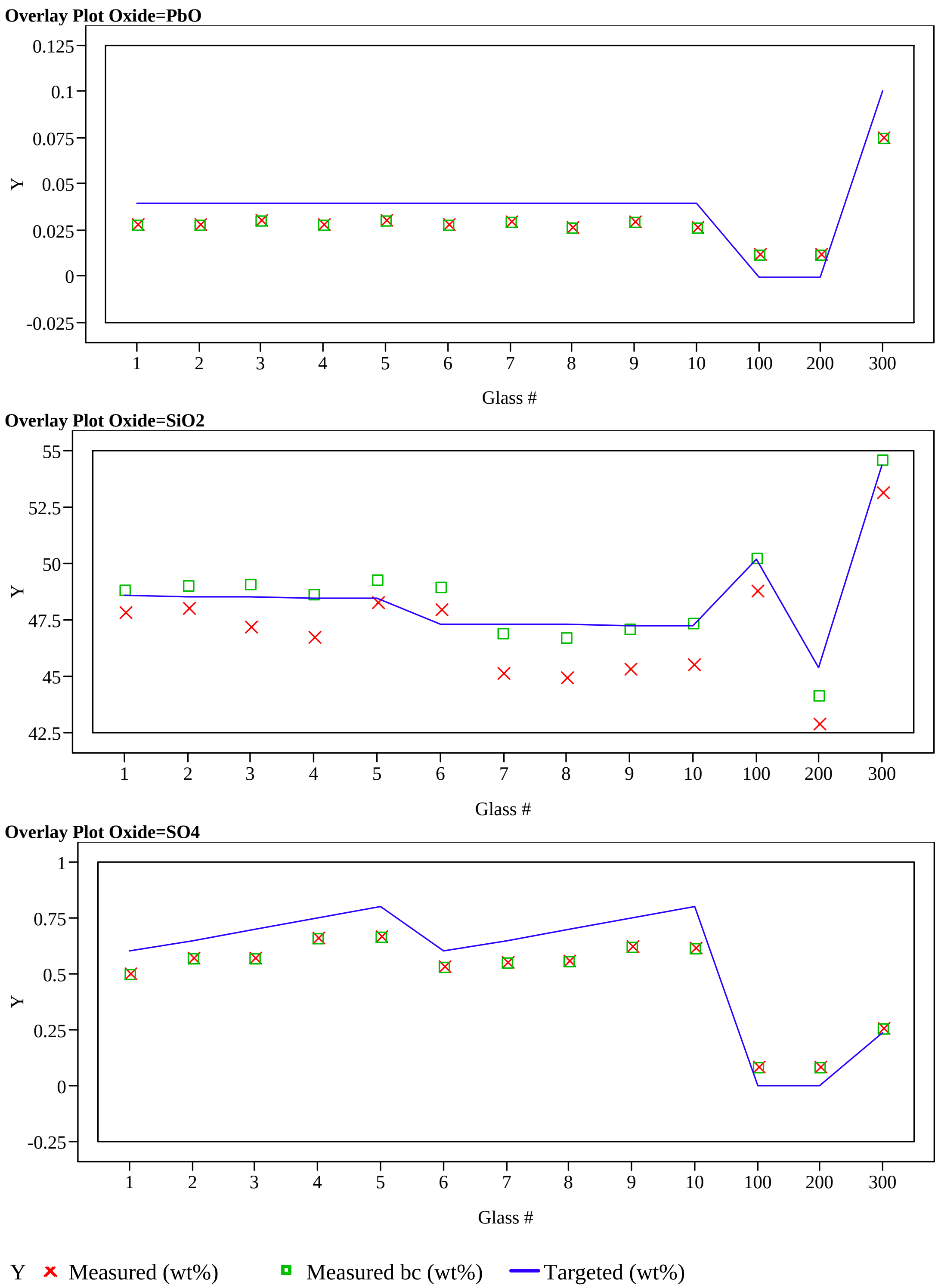
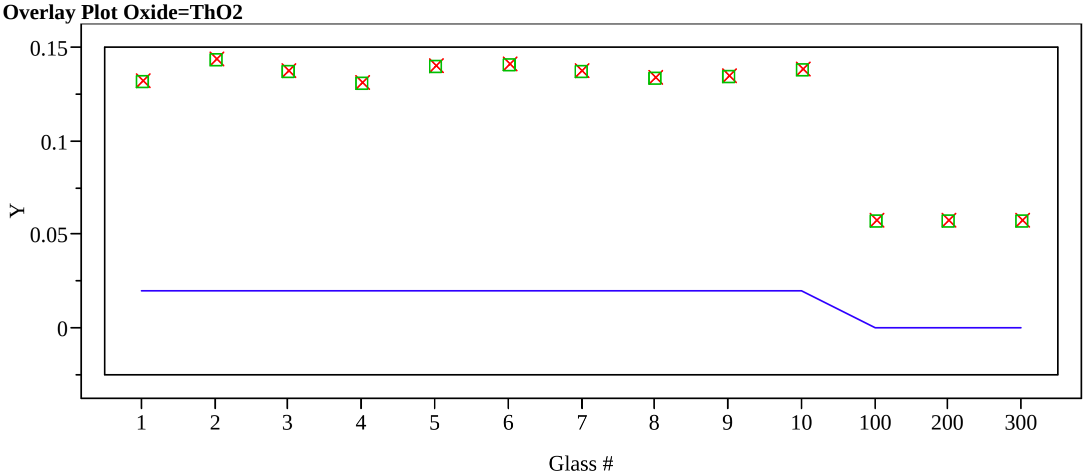
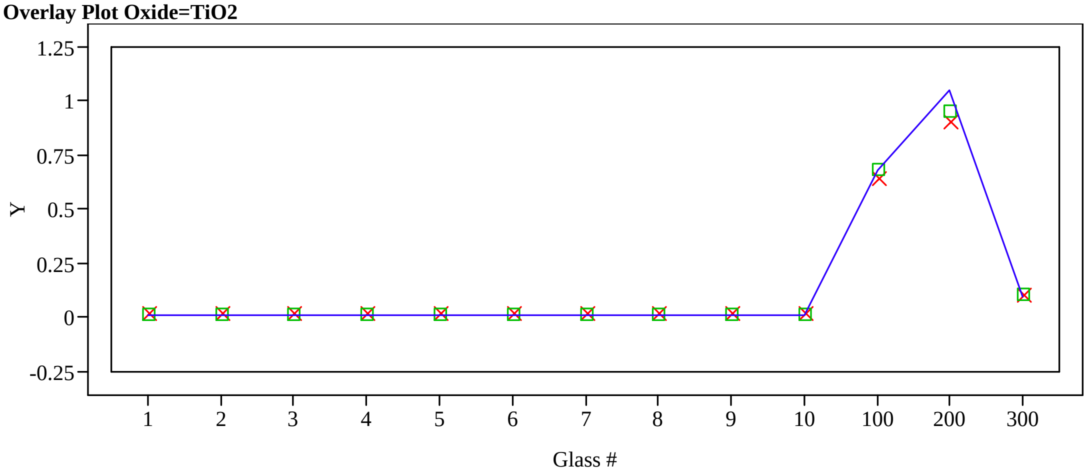


Exhibit B7. Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass ID by Oxide (continued)
(100 – Batch 1; 200 – Ustd)

Overlay Plot Oxide=ThO2



Overlay Plot Oxide=TiO2



Overlay Plot Oxide=U3O8

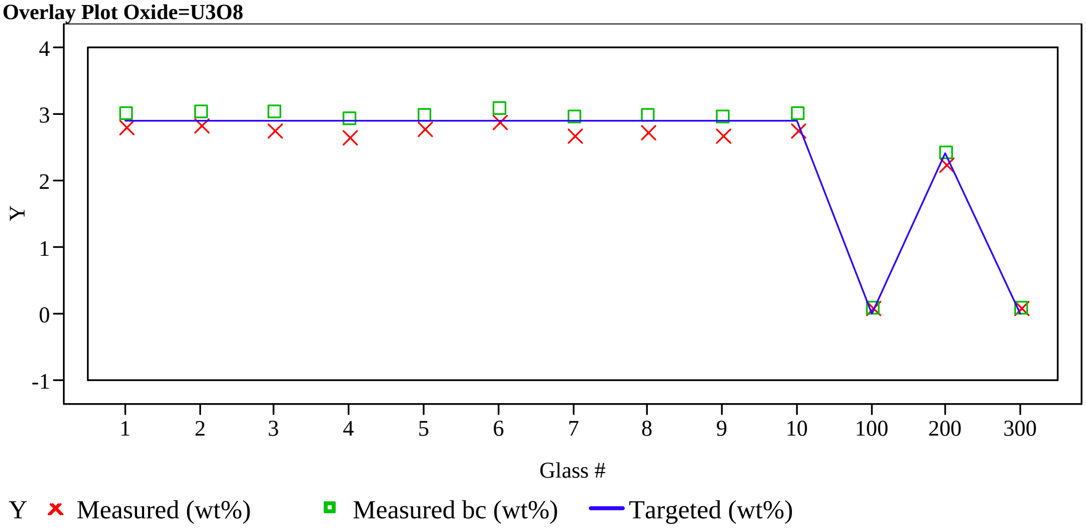
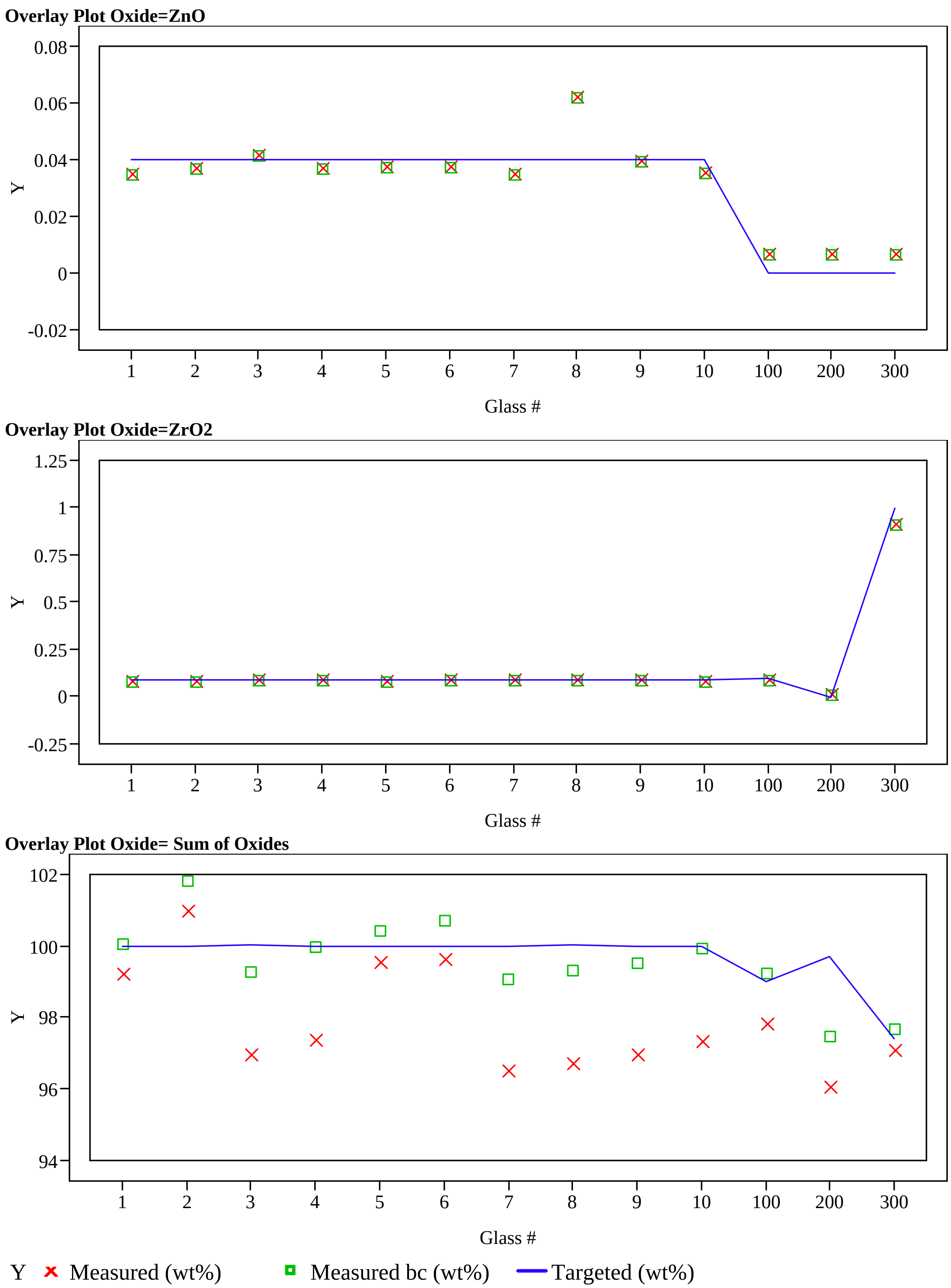


Exhibit B7. Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass ID by Oxide (continued)

(100 – Batch 1; 200 – Ustd)



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