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Revision 0

Summary of FY11 Sulfate Retention Studies for Defense Waste Processing Facility Glass

K. M. Fox
T. B. Edwards

March 2012

Savannah River National Laboratory
Savannah River Nuclear Solutions, LLC
Aiken, SC 29808

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EXECUTIVE SUMMARY

This report describes the results of studies related to the incorporation of sulfate in high level waste (HLW) borosilicate glass produced at the Savannah River Site (SRS) Defense Waste Processing Facility (DWPF). A group of simulated HLW glasses produced for earlier sulfate retention studies was selected for full chemical composition measurements to determine whether there is any clear link between composition and sulfate retention over the compositional region evaluated. In addition, the viscosity of several glasses was measured to support future efforts in modeling sulfate solubility as a function of predicted viscosity. The intent of these studies was to develop a better understanding of sulfate retention in borosilicate HLW glass to allow for higher loadings of sulfate containing waste.

Based on the results of these and other studies, the ability to improve sulfate solubility in DWPF borosilicate glasses lies in reducing the connectivity of the glass network structure. This can be achieved, as an example, by increasing the concentration of alkali species in the glass. However, this must be balanced with other effects of reduced network connectivity, such as reduced viscosity, potentially lower chemical durability, and in the case of higher sodium and aluminum concentrations, the propensity for nepheline crystallization. Future DWPF processing is likely to target higher waste loadings and higher sludge sodium concentrations, meaning that alkali concentrations in the glass will already be relatively high. It is therefore unlikely that there will be the ability to target significantly higher total alkali concentrations in the glass solely to support increased sulfate solubility without the increased alkali concentration causing failure of other Product Composition Control System (PCCS) constraints, such as low viscosity and durability.

No individual components were found to provide a significant improvement in sulfate retention (i.e., an increase of the magnitude necessary to have a dramatic impact on blending, washing, or waste loading strategies for DWPF) for the glasses studied here. In general, the concentrations of those species that significantly improve sulfate solubility in a borosilicate glass must be added in relatively large concentrations (e.g., 13 to 38 wt % or more of the frit) in order to have a substantial impact. For DWPF, these concentrations would constitute too large of a portion of the frit to be practical. Therefore, it is unlikely that specific additives may be introduced into the DWPF glass via the frit to significantly improve sulfate solubility.

The results presented here continue to show that sulfate solubility or retention is a function of individual glass compositions, rather than a property of a broad glass composition region. It would therefore be inappropriate to set a single sulfate concentration limit for a range of DWPF glass compositions. Sulfate concentration limits should continue to be identified and implemented for each sludge batch. The current PCCS limit is 0.4 wt % SO_4^{2-} in glass, although frit development efforts have led to an increased limit of 0.6 wt % for recent sludge batches. Slightly higher limits (perhaps 0.7-0.8 wt %) may be possible for future sludge batches.

An opportunity for allowing a higher sulfate concentration limit at DWPF may lay lie in improving the laboratory experiments used to set this limit. That is, there are several differences between the crucible-scale testing currently used to define a limit for DWPF operation and the actual conditions within the DWPF melter. In particular, no allowance is currently made for sulfur partitioning (volatility versus retention) during melter processing as the sulfate limit is set for a specific sludge batch. A better understanding of the partitioning of sulfur in a bubbled melter operating with a cold cap as well as the impacts of sulfur on the off-gas system may allow a higher sulfate concentration limit to be established for the melter feed. This approach would

have to be taken carefully to ensure that a sulfur salt layer is not formed on top of the melt pool while allowing higher sulfur based feeds to be processed through DWPF.

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
DWPF	Defense Waste Processing Facility
HLW	High Level Waste
ICP-AES	Inductively Coupled Plasma – Atomic Emission Spectroscopy
LM	Lithium Metaborate
PCCS	Product Composition Control System
PF	Peroxide Fusion
SB7b	Sludge Batch 7b
SRNL	Savannah River National Laboratory
SRS	Savannah River Site

1.0 Introduction

Jantzen and Smith provide a review of the potential impacts of sulfur to the Defense Waste Processing Facility (DWPF) melting process.[1] In summary, sulfur has a low solubility in borosilicate glass. This low solubility can result in the formation of a molten sulfate salt gall layer on top of the melt pool to which cesium and strontium can partition. This sulfate gall layer can accelerate corrosion of the melter components, can reduce the effectiveness of Joule heating due to its low resistance, and can potentially lead to steam excursions. As the glass cools, the gall layer can form inclusions or a separate phase in the glass, which can impact radionuclide release. A sulfate concentration limit is set for each sludge batch processed at the DWPF in order to avoid these issues.

This report describes the results of studies related to the incorporation of sulfate in high level waste (HLW) borosilicate glass produced at the DWPF. A group of simulated HLW glasses produced for earlier sulfate retention studies was selected for full chemical composition measurements to determine whether there is any clear link between composition and sulfate retention over the compositional region evaluated. These results are evaluated, and comparisons are made both within the data set and among several reports available in the literature on sulfate solubility in borosilicate glass. In addition, the viscosity of several glasses was measured to enhance efforts to model sulfate solubility as a function of predicted viscosity. The intent of these studies was to develop a better understanding of sulfate retention in borosilicate HLW glass to allow for higher loadings of sulfate containing waste.

This work was initiated by Technical Task Requests[2,3] and performed following Task Technical and Quality Assurance Plans.[4,5]

2.0 Experimental Procedure

2.1 Chemical Composition Impacts

A database of 199 simulated waste glasses[a] fabricated at the Savannah River National Laboratory (SRNL) in support of sulfate retention studies was used as the basis for selecting a group of glass compositions for further analysis. The database consists of targeted compositions, visual observations of sulfate retention, and measured sulfate concentration values. No other chemical composition data had been measured for these glasses. These glasses were fabricated in support of earlier sulfate retention guidance produced for the DWPF.[6-8]

A down-selection process was performed as follows to select a reasonably sized subset of the 199 glass compositions for further analysis. JMP software[9] was used to support the selection process and the subsequent analyses presented in this report. First, those glass compositions that targeted a sulfate (SO_4^{2-}) concentration of 1.2 wt % were selected as being of interest since this concentration is twice the limit set for the current processing of Sludge Batches 7a and 7b,[8,10] as well as previous batches, at the DWPF. This yielded 41 compositions. A scatterplot of the concentrations of the major oxides in these 41 glasses showed a fairly good distribution across the compositional space, as shown in Figure 2-1. The visual observations of the glasses are represented on the plot as follows: blue points represent glasses with clean surfaces (no visible sulfate or crystallization) after cooling, red points represent glasses with a surface layer of spinel crystallization after cooling, green points represent glasses with a yellow sulfate gall surface layer after cooling, and orange points represent glasses with a white surface film (assumed to be sulfate

[a] See SRNL-NB-2011-00056 for a complete listing of these data.

salts) after cooling. The visual observations did not affect the selection process, but will be used later to aid in the analysis of the composition data.

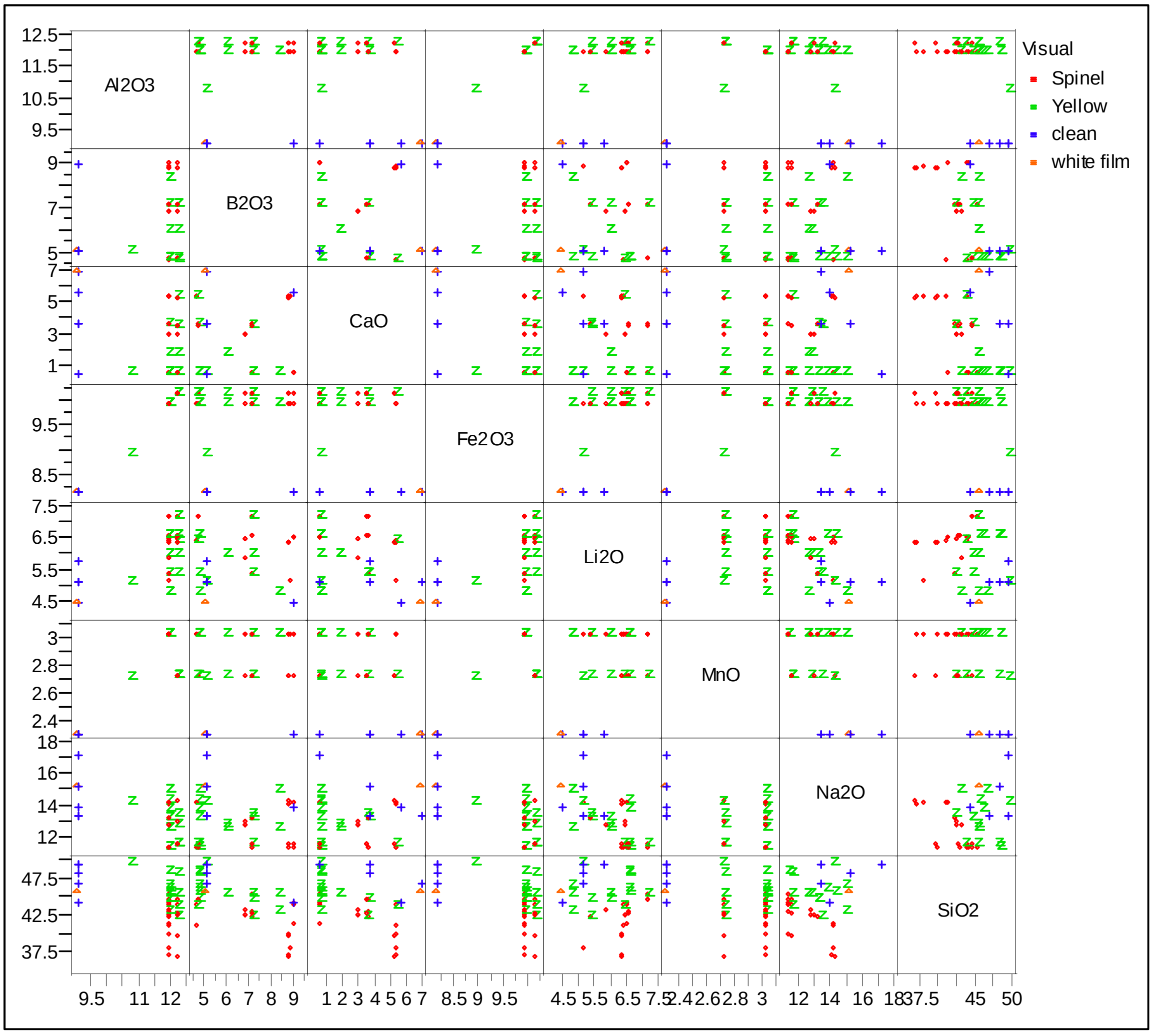


Figure 2-1. Scatterplot of Major Oxides (wt %) in 41 Selected Glass Compositions. Green Data Points Indicate Those Glasses with Visible Sulfate Gall on the Surface after Melting.

Further compositional variation was sought by selecting those glasses in the database of 199 with the minimum and maximum targeted concentrations of Al_2O_3, B_2O_3, CaO, Fe_2O_3, K_2O, Li_2O, MnO, Na_2O, and SiO_2. This yielded 31 glasses from the database. The targeted sulfate concentrations of these glasses are given in Table 2-1.

Table 2-1. Distribution of Targeted Sulfate Concentrations in 31 Selected Glasses.

SO_4^{2-} (wt %)	Number of Glasses
0.074	1
0.104	1
0.6	2
0.9	2
1	5
1.2	12
2	8

The 12 glasses with targeted sulfate concentrations of 1.2 wt % are included in the group of 41 selected earlier. Those glasses with targeted sulfate concentrations of greater than 1.2 wt % or less than 0.6 wt % are outside the range of interest for this study. Therefore, nine additional glass compositions were added to the group of 41 selected earlier. A scatterplot of the 50 selected glass compositions, Figure 2-2, shows additional coverage in concentrations of the major oxides as well as sulfate.

Figure 2-2. Scatterplot of Major Oxides (wt %) in 50 Selected Glass Compositions. Orange Data Points Indicate Those Glasses with Visible Sulfate Gall on the Surface after Melting.

A statistical partitioning routine was used to identify potential trends among the major oxides of targeted glass compositions and the visual observations of a yellow sulfate layer on some of the glasses after melting. The results are shown in Figure 2-3. This preliminary analysis shows that higher CaO concentrations may play a role in improved retention of sulfate in the glasses. Similar results are shown in Figure 2-4 for the 41 glasses that all targeted 1.2 wt % SO_4^{2-}. The distribution of targeted CaO concentrations in the 50 glasses, Figure 2-5, shows that the partitioning results are not simply a result of a skewed distribution. The distribution also shows that the range of CaO concentrations included in this data set is likely sufficient to indicate any true trends among CaO concentrations and sulfate retention. Measuring the full chemical composition of the 50 selected glasses will allow for further analysis.

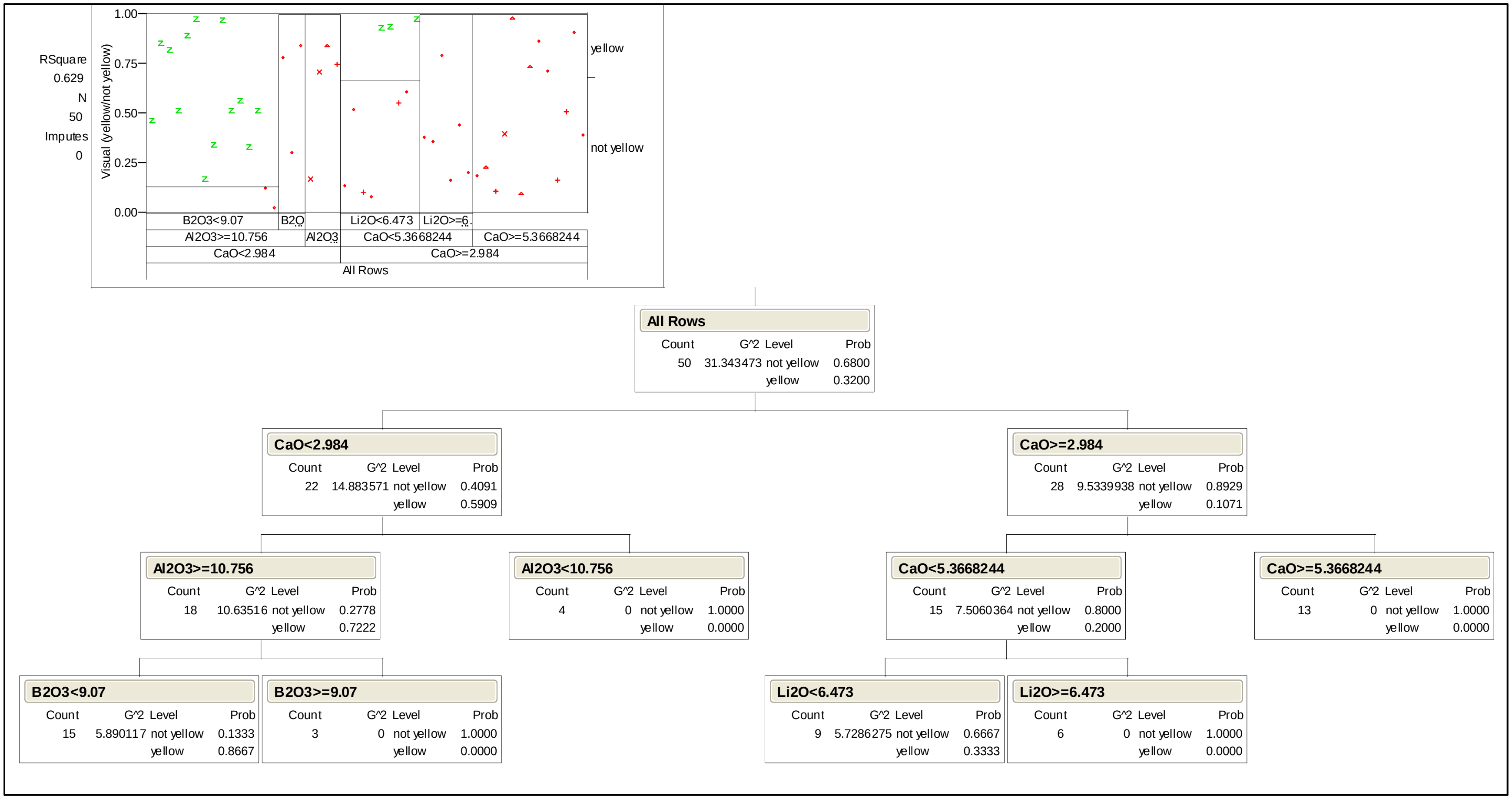


Figure 2-3. Partitioning of 50 Glasses by Targeted Composition Based on Visual Observations of Yellow Sulfate Layer.

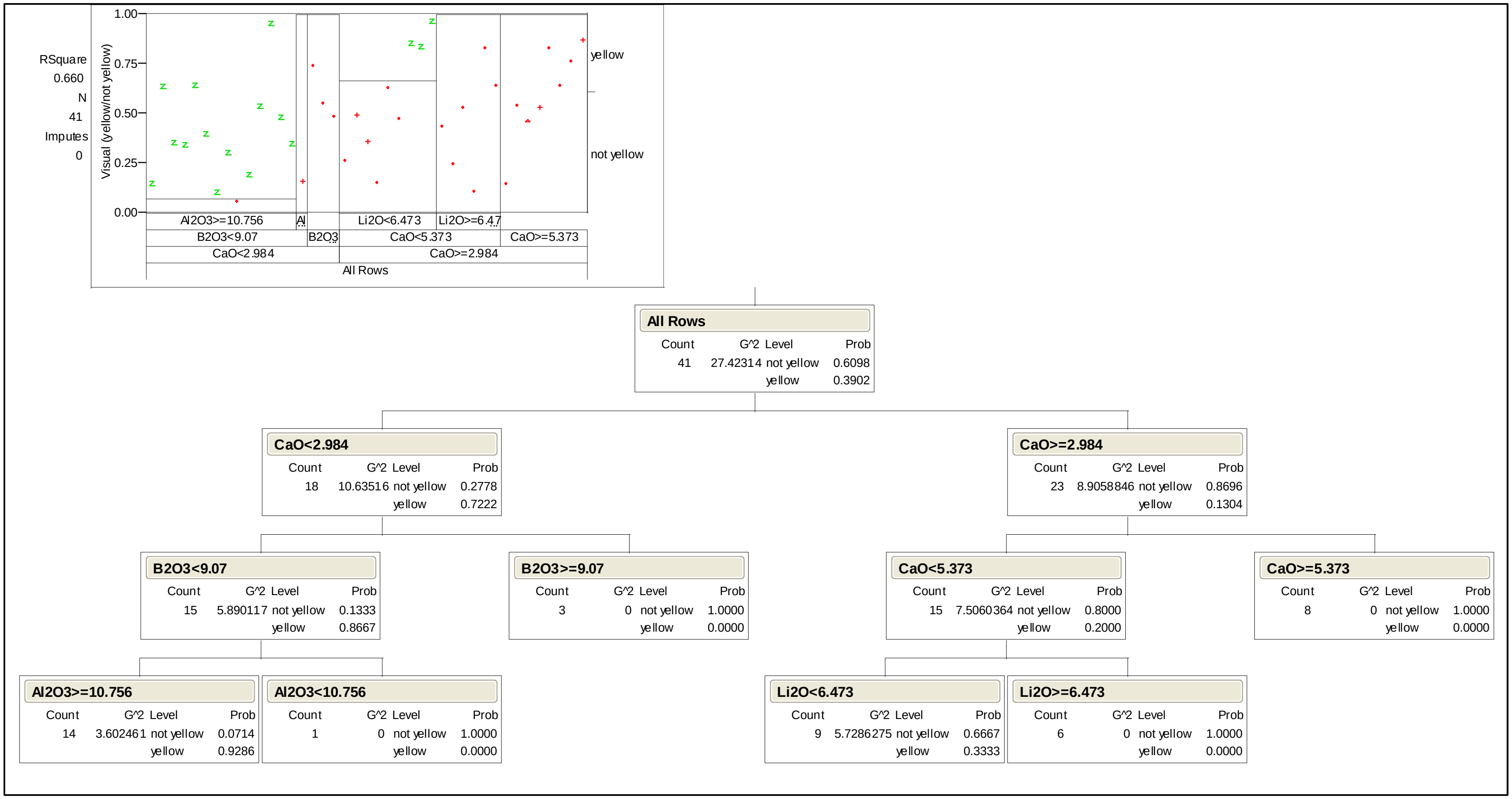


Figure 2-4. Partitioning of 41 Glasses Targeting 1.2 wt % SO_4^{2-} by Targeted Composition Based on Visual Observations of Yellow Sulfate Layer.

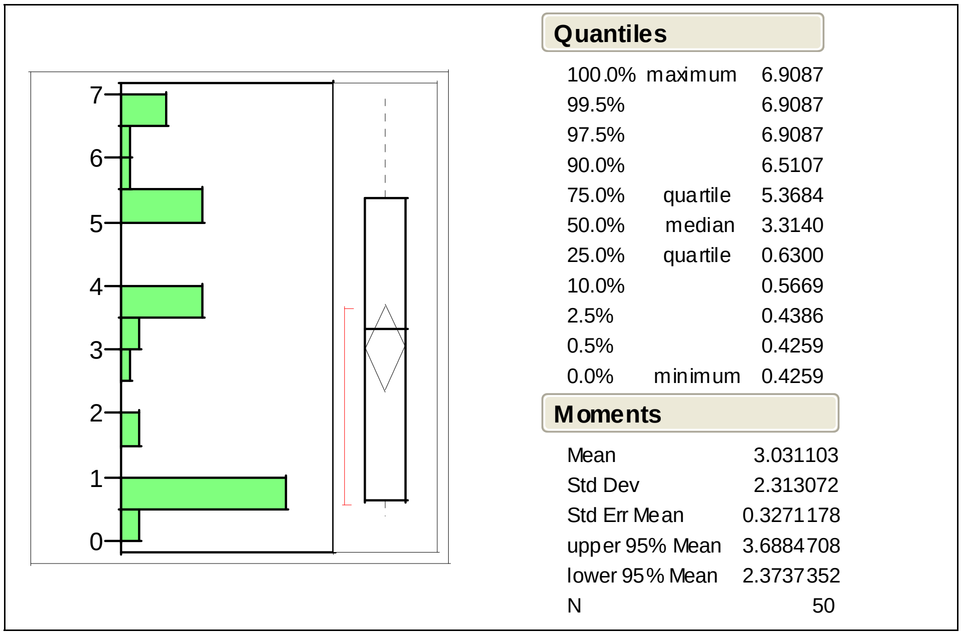


Figure 2-5. Distribution of Targeted CaO Concentrations in 50 Selected Glasses.

An analytical plan was prepared and issued to support the chemical composition analysis of the 50 selected glass compositions.[11] In summary, representative samples of each glass were prepared for analysis in duplicate by sodium peroxide fusion (PF) and lithium-metaborate fusion (LM). Each of the samples was analyzed, twice for each element of interest, by Inductively Coupled Plasma – Atomic Emission Spectroscopy (ICP-AES). Glass standards were also intermittently measured to assess the performance of the ICP-AES instrument over the course of these analyses.

Concurrent with this task, a modeling study was undertaken at the University of Sheffield with the goal of predicting sulfate solubility in waste glasses using cation field strength relationships. An extensive data set of 290 glasses was provided to Sheffield by SRNL to support this task.[a] The outcome of the modeling work will be summarized and compared with the experimental results in Section 4.0.

2.2 Influence of Viscosity

Jantzen and Smith have proposed a relationship between sulfate solubility and predicted viscosity for DWPF-type glass compositions.[1] Viscosity data were measured for several of the glasses included in the present study to support future efforts in modeling sulfate solubility as a function of predicted viscosity. However, an evaluation of these models is outside the scope of the present task. The data will be documented in this report for future use.

The viscosity of the selected glasses was measured following Procedure A of the ASTM C 965 standard.[12] Orton high temperature rotating spindle viscometers were used with platinum crucibles and spindles. The crucibles were specially designed to operate with small quantities of glass to support measurements of radioactive glasses when necessary.[13,14] A well characterized standard glass was used to determine the appropriate spindle constants.[14,15] Measurements were taken over a range of temperatures from 1050 to 1250 °C in 50 °C intervals. Measurements at

[a] See data in SRNL-L3100-2011-00038, transmitted by email to the University of Sheffield March 1, 2011.

1150 °C were taken at three different times during the procedure to provide an opportunity to identify the effects of any crystallization or volatilization that may have occurred during the test. The data were fit to a Fulcher equation[16,17] to provide a measured viscosity value at the nominal DWPF melt temperature of 1150 °C.

3.0 Results

3.1 Chemical Composition Impacts

The measured versus targeted compositions of the study glasses are presented and compared in this section. Measurements for samples of the Batch 1[18] and the low-activity reference material (LRM)[19] standard glasses that were included in the analytical plan along with the study glasses are also discussed. 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 was reduced to half of that detection limit as the oxide concentration was determined.[20] In the discussions that follow, the analytical sequences of the measurements are explored, the measurements of the standards are investigated, and the measurements for each glass are reviewed. In addition, the average chemical composition for each glass is determined, and comparisons are made between the measurements and the targeted compositions of the glasses.

Table A-1 and Table A-2 Appendix A provide the elemental concentration measurements from the study glasses that were digested using LM, and Table A-3 in Appendix A provides the measurements from the samples of these glasses digested using PF. Measurements for samples of the standard Batch 1 and LRM glasses that were included in the analytical plan along with the study glasses are also provided in these tables. Exhibit A-1 in Appendix A provides plots of the sample measurements for each oxide over both preparation methods. The plots are in analytical sequence with different symbols and colors being used to represent each of the study glasses and the standard glass. In general, there does not appear to be any gross patterns or trends due to the analytical sequence. Further opportunity for a review of the measurements for each glass is provided in the discussions that follow.

Exhibit A-2 in Appendix A provides plots of the oxide concentration measurements by Glass ID (including the Batch 1 and LRM standards) by analytical solution or Lab ID for both preparation methods for the study glasses. The different symbols and colors being used to represent the glasses are discernible in this exhibit. These plots show the individual measurements across the duplicates of each preparation method and the two ICP-AES calibrations for each glass for each oxide. The results are grouped by analytical block and arranged by targeted concentration to facilitate the interpretation of the measurements. A review of the plots presented in this exhibit reveals the repeatability of the four individual values for each oxide for each glass. In general, there appears to be good repeatability of these measurements for each of the oxides for each of the glasses. There is one slightly high measurement for Al_2O_3 for glass BS-01. The first LM preparation for glass BC-05 resulted in a low measurement for CaO. The first PF preparation for glass BC-05 resulted in a slightly high measurement for SiO_2. There were slightly high measurements for Ce_2O_3 and La_2O_3 for glass BS-08. There were slightly high measurements for BaO, Ce_2O_3, and La_2O_3 for glass QB-35. Scatter in the B_2O_3 and SiO_2 measurements for the glasses measured in the W series appears somewhat greater than that of the other four series. Also, the data for the LM preparations of glasses QB-22 and QB-37 appear to have been reversed. This issue was corrected for the following analyses. The Na_2O values for glass QB-37 are high. The values of CaO for glasses QB-33 and QB-37 (after swapping with QB-22) are unusually low. These values were replaced by the CaO measurements from the PF preparation for these two glasses in the following analyses. All of the other data were used as reported. The data suggest no other significant issues in the batching of the study glasses or in the analytical process used to provide representative measurements of their compositions.

Exhibit A-3 in Appendix A provides statistical analyses of the results for the Batch 1 and LRM standards that were included with the study glasses by analytical block/sub-block for each oxide of interest over both preparation methods. The results include analysis of variance (ANOVA) investigations looking for statistically significant differences among the means of these groups for each of the oxides. The reference values for the oxide concentrations of the standards are given in the header for each set of measurements in the exhibit. The results from the statistical tests for the Batch 1 standard included with the study glasses may be summarized as follows: Al_2O_3 in Series W and X, B_2O_3 in Series X, BaO in Series V, CaO in Series W and X, Cr_2O_3 in Series V and W, Fe_2O_3 in Series X, K_2O in Series T, Li_2O in Series X, MnO in Series W and X, Na_2O in Series W and X, SiO_2 in Series W and X, SO_4 in Series U, TiO_2 in Series W, and ZrO_2 in Series V and X have measurements that indicate an ICP-AES calibration effect on the block averages at the 5% significance level. The results from the statistical tests for the LRM standard included with the study glasses may be summarized as follows: Al_2O_3 in Series T and X, B_2O_3 in Series X, CaO in Series T, V, W, and X, Cr_2O_3 in Series T and W, Fe_2O_3 in Series W, K_2O in Series T and X, Li_2O in Series X, MgO in Series T, V, and W, MnO in Series V, W, and X, Na_2O in Series T, W, and X, NiO in Series V and W, PbO in Series V and W, SiO_2 in Series V and X, SO_4 in Series T, TiO_2 in Series W and X, and ZrO_2 in Series W have measurements that indicate an ICP-AES calibration effect on the block averages at the 5% significance level. Note that some of these effects are artifacts of the detection limits where the standards do not contain the particular element of interest. While statistically significant, the practical impact of these calibration effects is minimal.

All of the measurements for each oxide for each of the 50 study glasses (i.e., all of the measurements in Appendix A Table A-1, Table A-2, and Table A-3) were averaged to determine a representative chemical composition for each glass. A sum of oxides was also computed for each glass based upon the measured values. Exhibit A-4 in Appendix A provides plots showing results for each glass for each oxide to help highlight the comparisons among the measured and targeted values. Some observations from the plots of Exhibit A-4 are offered: The Cr_2O_3 values are slightly high for glasses LT-04, LT-10, and QB-03. The Na_2O values are high for glass QB-37 and low for QB-33. There is some scatter in the SiO_2 data. The SO_4^{2-} values are generally low for the study glasses, which may indicate volatility during melting since the measured SO_4^{2-} concentration for the LRM standard glass is very close to the reference value. There are some small differences between measured and targeted concentrations of the minor (<1 wt %) components. The sums of oxides are generally low for the study glasses, although they remain within the DWPF Product Composition Control System (PCCS) acceptable range of 95-105 wt %. In general, there appear to have been only minor difficulties in meeting the targeted concentrations for the study glasses.

Table A-4 in Appendix A provides a summary of the average measured compositions as well as the targeted compositions and the associated differences and relative differences. Note that the targeted sums of oxides for the Batch 1 and LRM reference glasses do not sum to 100% due to an incomplete coverage of the oxides in these glasses. All of the sums of oxides for the study glasses fall within the PCCS acceptable interval of 95 to 105 wt %. Entries in Table A-4 show the relative differences between the measured 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 again suggest only minor difficulties in meeting the targeted compositions for the study glasses.

3.2 Influence of Viscosity

Viscosity data were collected for 14 of the study glasses. A review of the measured data showed no evidence of crystallization or significant volatilization occurring during the viscosity measurements. That is, there was no hysteresis in the measured viscosity as a function of temperature. Glass LL03 had measured viscosity values that were similar at temperatures of 1200 °C and 1250 °C. Fulcher fits were made both with and without the 1250 °C data. This was not found to have a significant impact on the Fulcher fit, thus all of the data were included in calculating a measured viscosity for LL03 at 1150 °C. Complete data from the fitting of Fulcher equations to the measured viscosity data are included as Appendix B.

4.0 Discussion

4.1 Chemical Composition Impacts

The measured composition data for the 50 glasses were reviewed to identify any impacts on sulfate retention in the glasses. A comparison of the targeted and measured sulfate concentrations of the 50 glasses showed that the mean difference was 0.038 wt %, with a standard error of 0.005 wt %. This indicates that there were no serious issues with sulfate retention for most all of the glasses.

Partitioning of the glass compositions based on the visual observations and the measured sulfate concentrations reveals mixed results, as shown in Figure 4-1. Of the 25 glasses with measured sulfate concentrations greater than 1.089 wt %, 21 glasses were free of a visible yellow sulfate surface layer after melting. This indicates that there is a glass composition region that is able to retain considerably more sulfate than the current DWPF limit of 0.6 wt %. However, note also that for the 25 glasses with measured sulfate concentrations of less than 1.089 wt %, 12 glasses exhibited a sulfate surface layer after melting. Sulfate solubility in this series of glasses appears to be a function of the individual compositions, rather than a general property applicable to the entire region. This indicates that it would be inappropriate to set a single sulfate concentration limit for a broad range of DWPF glass compositions.

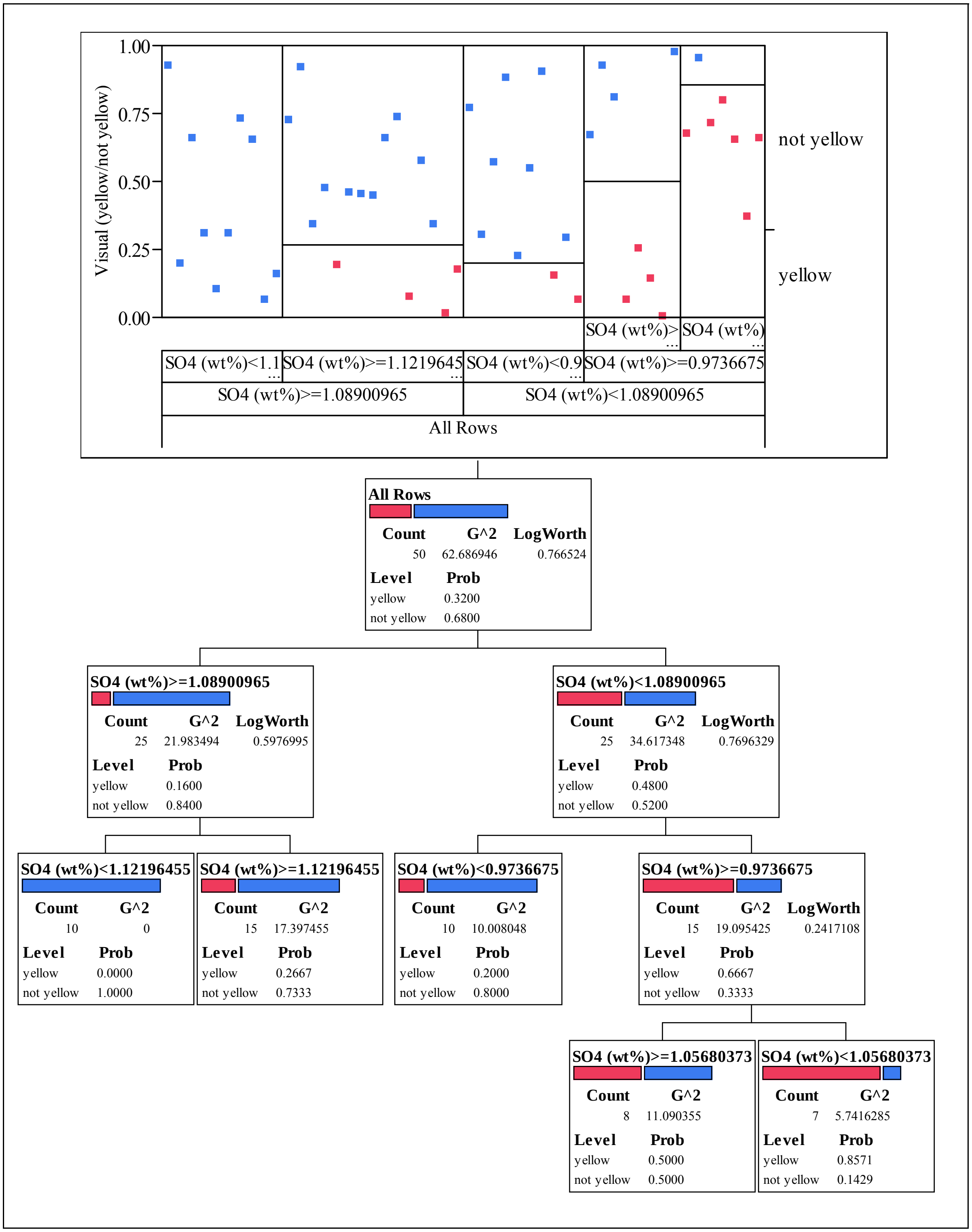


Figure 4-1. Partitioning of Glass Compositions Based on Measured Sulfate Concentration and Visual Observations of Sulfate Surface Layers.

As discussed earlier in Section 2.1, partitioning of the glasses based on their targeted compositions and visual observations showed that higher CaO concentrations may play a role in improved retention of sulfate in the glasses (see Figure 2-3 and Figure 2-4). To determine whether this observation would hold true using the measured compositions, the glasses were partitioned by measured CaO concentration using the visual observations of the presence or absence of sulfate surface layers. The results are shown in Figure 4-2. Based on the measured CaO data, there again appears to be a relationship between increased CaO concentrations and increased sulfate retention (i.e., lack of a yellow sulfate surface layer). However, this observation is confounded in that further partitioning shows that all of the glasses with CaO concentrations of less than 0.61 wt % were also free of any sulfate surface layer, despite their relatively high sulfate concentrations. While these results provide some indication that CaO may improve sulfate retention, the effect is not well defined for the glasses in this study.

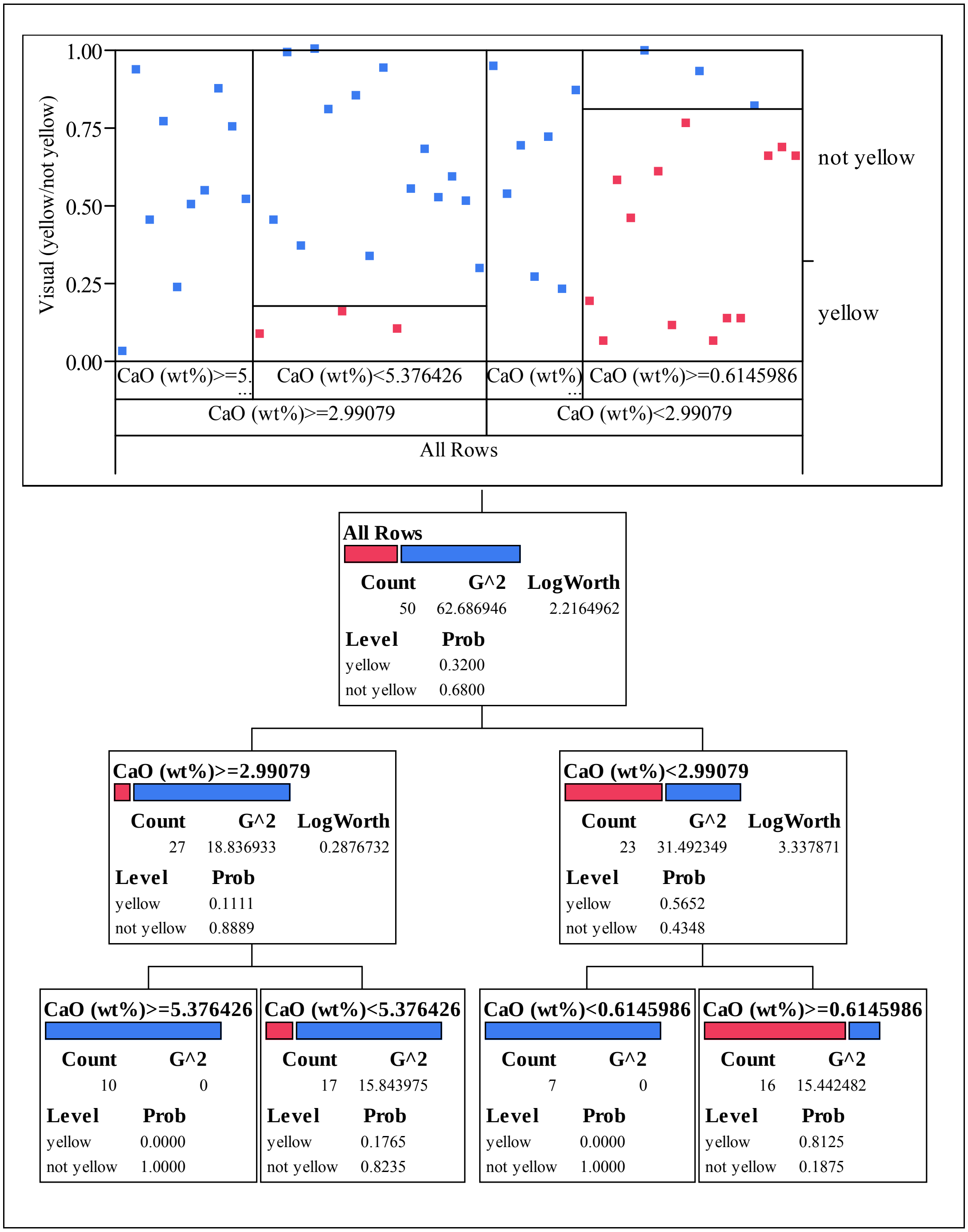


Figure 4-2. Partitioning of Glass Compositions Based on Measured CaO Concentration and Visual Observations of Sulfate Surface Layers.

Next, a partitioning routine was used to evaluate the glasses based on the measured concentrations of all the major oxides and the visual observations. The results are shown in Figure 4-3. At the first split, all 15 of the glasses with measured MnO concentrations below 2.67 wt % were free of a sulfate surface layer after melting. Of the remaining 35 glasses, the majority of those 15 glasses with SiO_2 concentrations of less than 43.64 wt % were also free of a sulfate surface layer after melting.

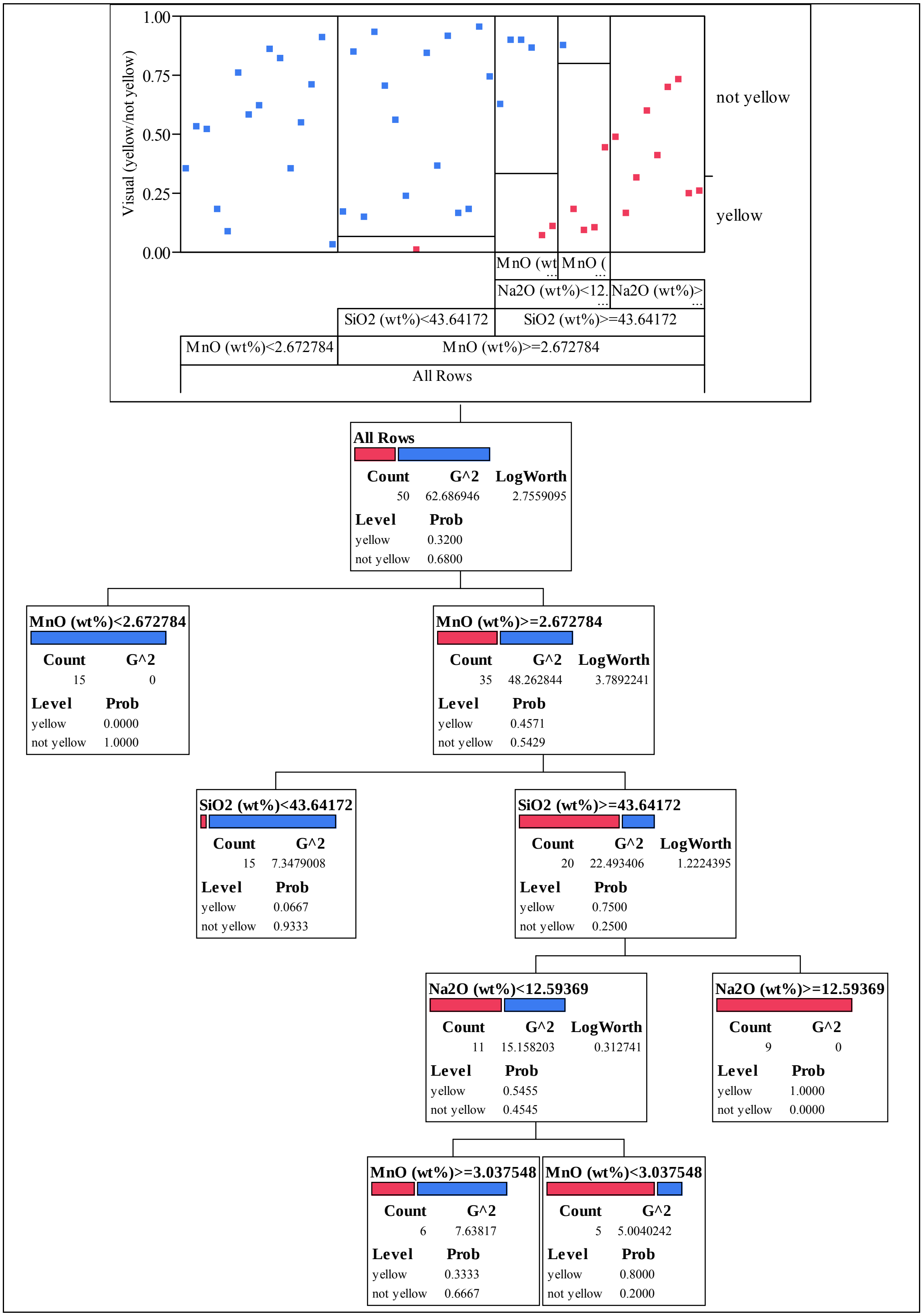


Figure 4-3. Partitioning of Glass Compositions Based on Measured Concentrations of Major Oxides and Visual Observations of Sulfate Surface Layers.

Thus far, these evaluations have been based on the observation of the presence or absence of a yellow sulfate layer on the surface of the glasses after melting. Another way to evaluate the impact of composition on sulfate retention is to look for trends between the ratio of the measured to the targeted sulfate concentration and the overall composition of each glass. For example, consider Figure 4-4, which plots the ratio of measured to targeted sulfate concentration on the vertical axis and the measured MnO concentration (a), or the measured SiO_2 concentration (b) on the horizontal axis. A ratio of 1.0 on the vertical axis would indicate that all of the targeted sulfate was retained in the glass. A review of the plots in Figure 4-4 shows that, in general, the amount of sulfate retained in the glasses is somewhat reduced as the concentration of either MnO or SiO_2 in the glasses increases. This appears to be in agreement with the partitioning results shown earlier in Figure 4-3.

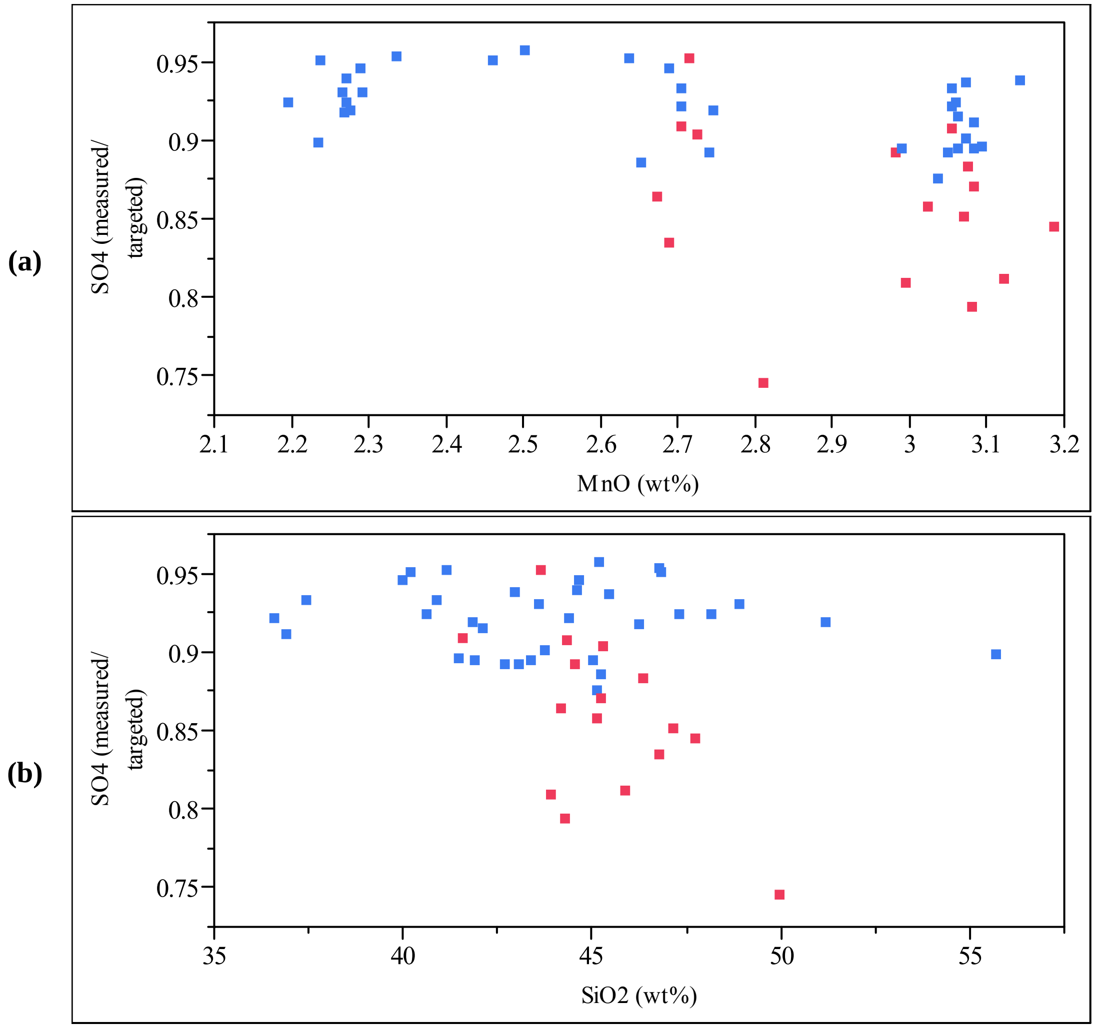
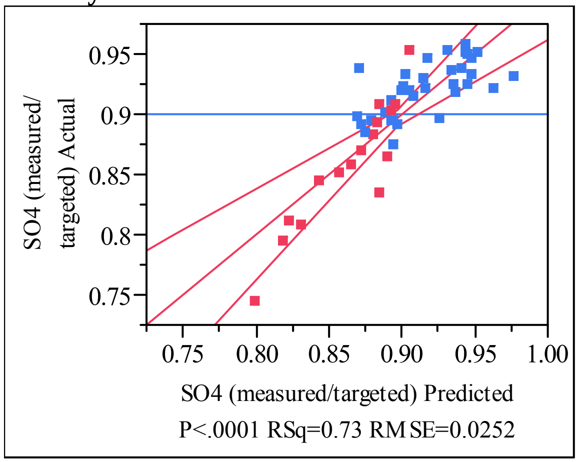


Figure 4-4. Plots of the Ratio of Measured to Targeted Sulfate Concentration versus (a) MnO Concentration and (b) SiO_2 Concentration. The Red Data Points Represent Glasses with a Visible Sulfate Surface Layer after Melting. The Blue Data Points Represent Glasses with No Visible Sulfate Layer.

The relationships between the measured concentrations of the major oxides and the ratio of measured to targeted sulfate concentration were evaluated to determine which of those oxides had statistically significant impacts. The results of a stepwise regression analysis, as shown in Figure 4-5, indicated that Al_2O_3, B_2O_3, Li_2O, MnO, NiO, and SiO_2 had statistically significant impacts on the ratio of measured to targeted sulfate concentration. The oxides CaO, Fe_2O_3, and Na_2O were also included in the analysis but were found not to have a statistically significant impact for the compositions studied. This may be an unintended consequence of the selection process, since CaO, Fe_2O_3, and Na_2O are typically shown to influence sulfate retention (see the summaries provided by Jantzen and coauthors[1,21]). The influences of Li_2O and NiO were positive in the stepwise regression analysis, indicating that they improved the amount of sulfate retained. The influences of Al_2O_3, B_2O_3, MnO, and SiO_2 were negative, indicating that they reduced the amount of sulfate retained. These relationships are shown graphically in the plots of Figure 4-6.

Actual by Predicted Plot



Summary of Fit

RSquare	0.727135
RSquare Adj	0.689061
Root Mean Square Error	0.025167
Mean of Response	0.899621
Observations (or Sum Wgts)	50

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	6	0.07257654	0.012096	19.0978
Error	43	0.02723514	0.000633	**Prob > F**
C. Total	49	0.09981168		<.0001

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	1.4637789	0.106451	13.75	<.0001
Al_2O_3 (wt %)	-0.02569	0.007199	-3.57	0.0009
B_2O_3 (wt %)	-0.005881	0.002557	-2.30	0.0264
Li_2O (wt %)	0.0301459	0.005558	5.42	<.0001
MnO (wt %)	-0.078346	0.032649	-2.40	0.0208
NiO (wt %)	0.3073975	0.077223	3.98	0.0003
SiO_2 (wt %)	-0.010882	0.001432	-7.60	<.0001

Figure 4-5. Results of Stepwise Regression Analysis of the Influence of the Concentrations of the Major Oxides on the Ratio of Measured to Targeted Sulfate Concentration.

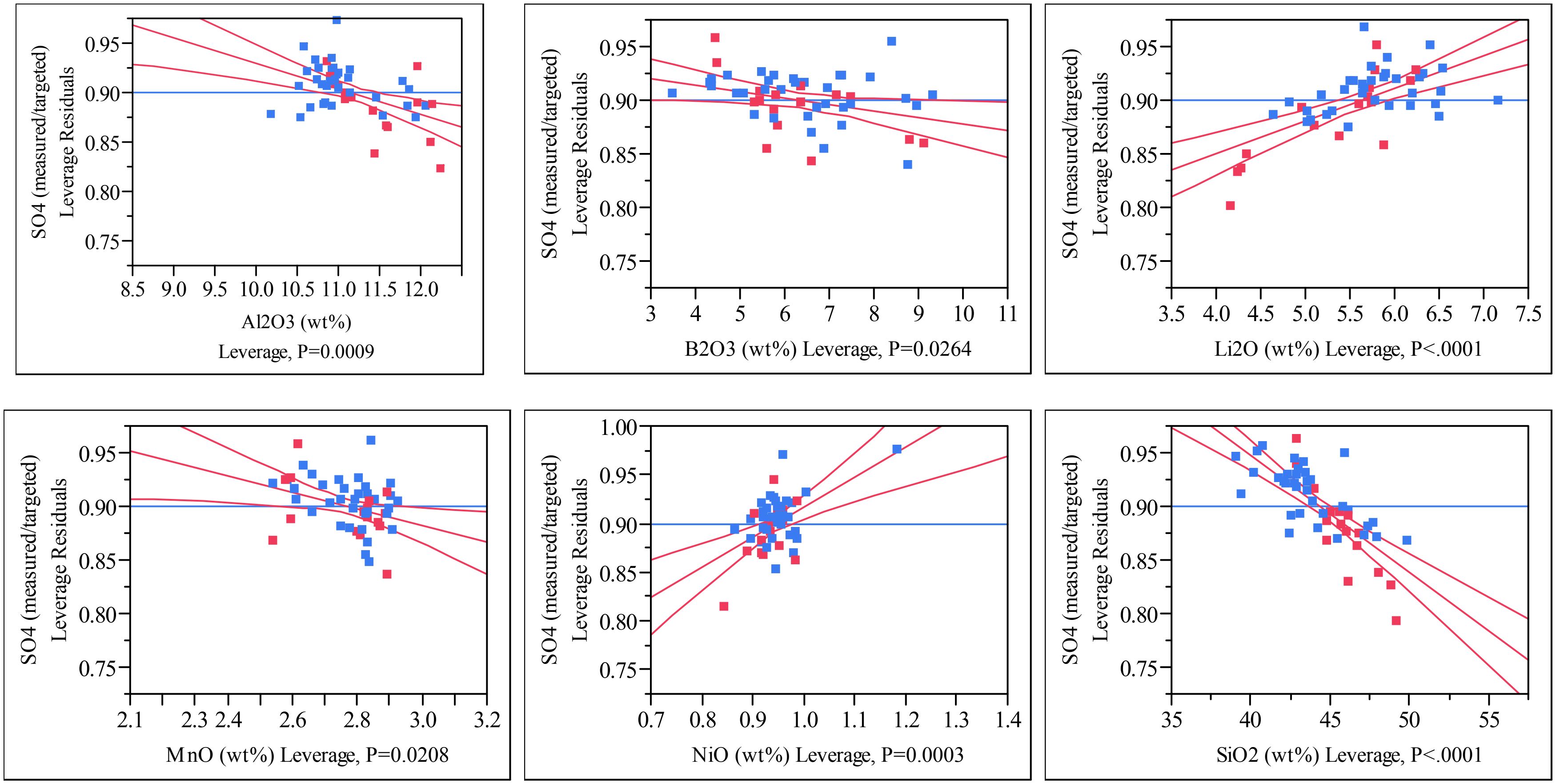


Figure 4-6. Graphical Results of Stepwise Regression Analysis of the Influence of the Concentrations of the Major Oxides on the Ratio of Measured to Targeted Sulfate Concentration.

These results are consistent with those represented in Figure 4-3 and Figure 4-4 in that increased MnO and SiO_2 concentrations appear to lead to reduced sulfate retention. Partitioning of the measured glass compositions using only those oxides that had a statistically significant impact on sulfate retention and the visual observations, as shown in Figure 4-7, again reinforces the finding that higher concentrations of MnO, SiO_2, and Al_2O_3 lead to reduced sulfate retention, while higher Li_2O concentrations can increase sulfate retention.

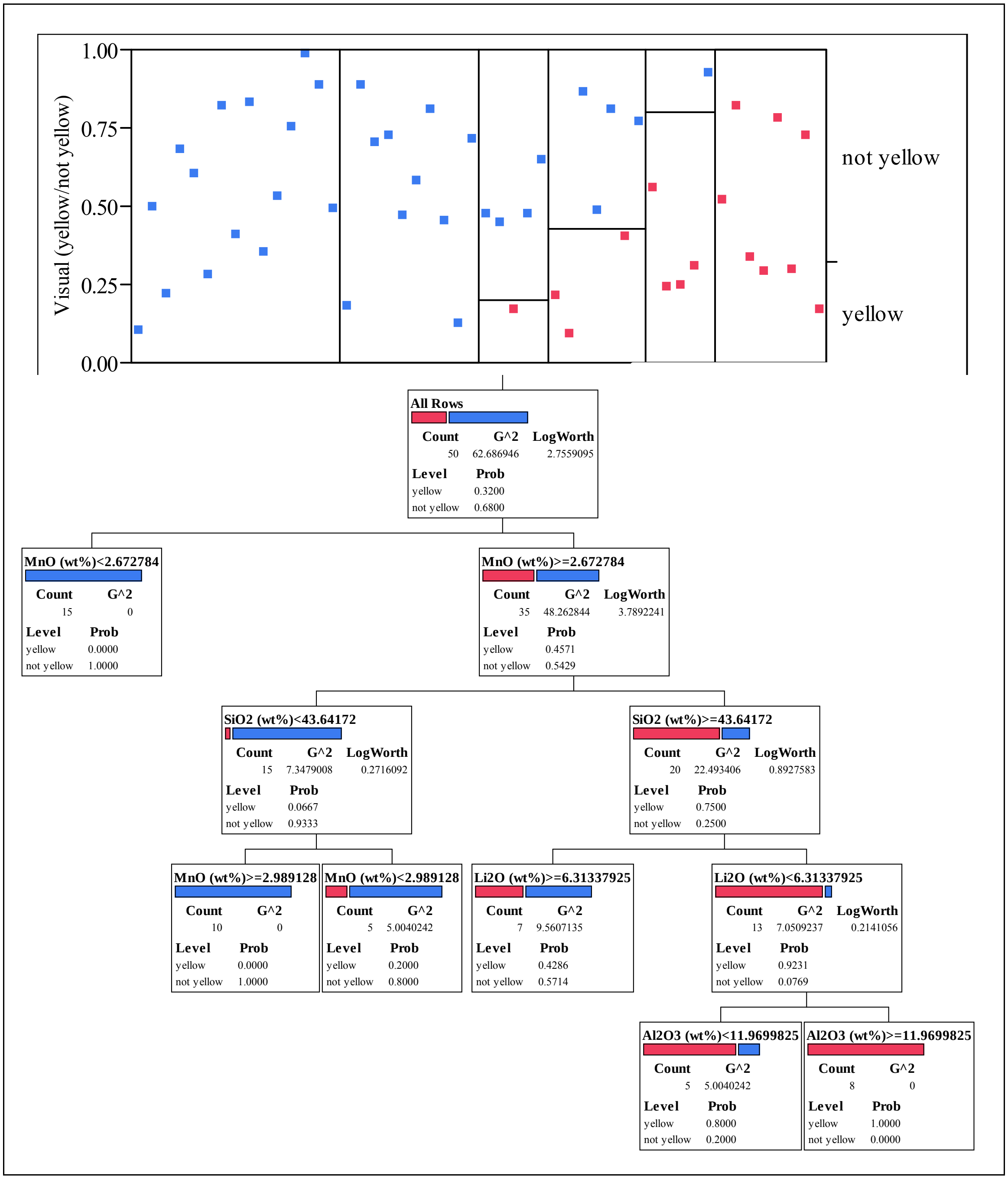


Figure 4-7. Partitioning of Glass Compositions Based on Measured Concentrations of Major Oxides with Statistically Significant Impacts on Sulfate Retention and Visual Observations of Sulfate Surface Layers.

These results, particularly for the glass network former SiO_2, are consistent with the recent findings by Manara et al. that the incorporation of sulfates in borosilicate glasses is favored by network depolymerization (i.e., a reduction in the concentration of the glass forming oxides).[22] This is also consistent with previous sulfate solubility work on DWPF glasses by Jantzen and coauthors. [1,21] Although it was not found to be statistically significant for the glasses studied here, the potential impact of CaO in improving sulfate retention is also in agreement with these findings, as CaO is a glass network modifier that reduces network polymerization. Schreiber and coauthors have shown improved sulfate retention with CaO additions, while Feng and coauthors observed the opposite effect.[1] The results of the present study seem to show a reduced sulfate solubility with increased concentrations of MnO and Al_2O_3, which are considered intermediate glass network formers.[23] Langowski has reported decreased sulfate retention with increased Al_2O_3 concentrations.[24]

Further corroboration of these results is provided by the findings of the cation field strength modeling effort completed at the University of Sheffield. The final report of the Sheffield study is included as Appendix C. In summary, the model demonstrated that enhanced sulfate solubility occurs at low values of cation field strength, with SiO_2 concentration exhibiting the strongest effect. Of the data set modeled by Sheffield, the glasses with less than approximately 45 mol % SiO_2 did not exhibit the formation of a yellow sulfate surface layer. Their report recommends that additional data be obtained for glasses in this compositional region to enable further experimental validation of the model results.

4.2 Influence of Viscosity

The measured viscosity of each of the 14 glasses is given in Table 4-1. The model predicted viscosity values for each glass along with their upper and lower 95% confidence intervals are also given in the table. These values are presented graphically in Figure 4-8. Four of the glasses have measured viscosities that fall below the lower 95% confidence bound, and are therefore not predictable by the current model. It is important to note that some of the study glasses have measured B_2O_3, CaO, Cr_2O_3, Li_2O, MgO, SiO_2, and ZnO concentrations that are outside of the development region for the current PCCS viscosity model.[25] Some of the study glasses also have measured B_2O_3, CaO, Li_2O, and SiO_2 concentrations that fall outside of the range of the model validation region.[25] Therefore, the current model is not necessarily expected to correctly predict the viscosities of these glasses. The measured viscosity data, along with the measured compositions discussed earlier, should be used in future efforts for modeling sulfate retention as a function of predicted viscosity.

Table 4-1. Predicted and Measured Viscosities and Sulfate Concentrations of the Study Glasses.

Glass ID	Measured Viscosity (Fit at 1150 °C) (P)	Predicted Viscosity (P)	Lower 95% CI (P)	Upper 95%CI (P)	Predictable?
AB-06	69.69	51.87	35.39	76.04	Yes
AF-04	13.91	13.63	9.24	20.11	Yes
BC-05	13.78	32.45	22.11	47.62	No
BC-06	18.78	13.65	9.25	20.14	Yes
BC-07	9.03	7.85	5.29	11.64	Yes
BC-08	16.54	19.74	13.42	29.05	Yes
BC-09	22.2	26.32	17.92	38.67	Yes
LL-03	8.54	14.00	9.49	20.65	No
LL-05	21.29	24.99	17.01	36.72	Yes
LL-06	8.99	9.52	6.43	14.09	Yes
LL-10	27.82	38.81	26.46	56.93	Yes
LL-11	27.51	43.34	29.56	63.55	No
LL-12	13.17	22.16	15.07	32.58	No
LT-01	73.94	91.65	62.53	134.34	Yes

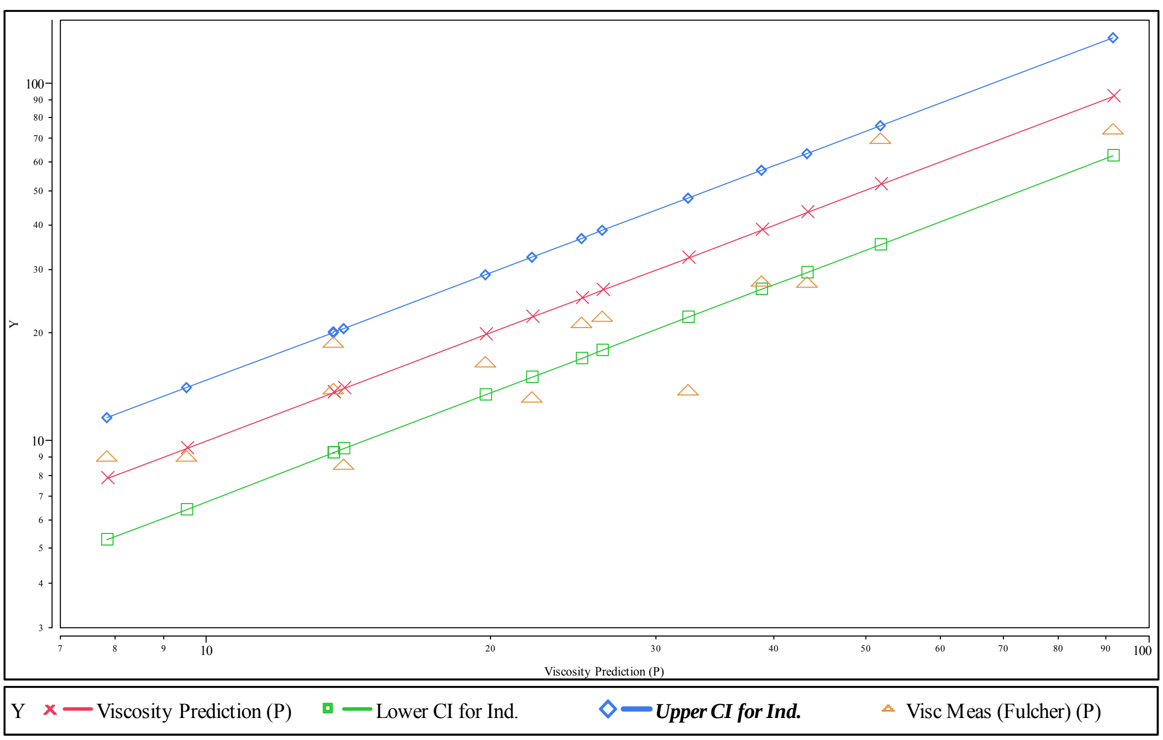


Figure 4-8. Plot of Measured and Model Predicted Viscosities of the Study Glasses.

5.0 Conclusions

Partitioning of the study glass compositions based on the visual observations and the measured sulfate concentrations revealed mixed results in terms of the impact of glass composition on sulfate retention. There is a composition region among the glasses studied here that is able to retain considerably more sulfate (>1.0 wt %) than the current DWPF limit of 0.6 wt %. However, for the 25 glasses with measured sulfate concentrations of less than 1.089 wt %, 12 glasses exhibited a sulfate surface layer after melting. This indicates that it would be inappropriate to try to identify an acceptable sulfate concentration for a broad range of glass compositions (e.g., a single sulfate concentration limit for all glass compositions to be processed at the DWPF). In other words, sulfate solubility in this series of glasses, as well as other DWPF-type compositions,[1] appears to be a function of the individual compositions, rather than a general property applicable to a large compositional region.

Partitioning of the glasses based on their targeted compositions and visual observations showed that higher CaO concentrations may play a role in improved retention of sulfate in the glasses. Based on the measured CaO data, there indeed appears to be a relationship between increased CaO concentrations and increased sulfate retention (i.e., lack of a yellow sulfate surface layer). However, this observation is confounded in that further partitioning shows that all of the glasses with CaO concentrations of less than 0.61 wt % were also free of any sulfate surface layer, despite their relatively high sulfate concentrations. While these results provide some indication that CaO may improve sulfate retention, the effect is not well defined for the compositional region studied.

The results of a stepwise regression analysis indicated that Al_2O_3, B_2O_3, Li_2O, MnO, NiO, and SiO_2 had statistically significant impacts on the ratio of measured to targeted sulfate concentration. The oxides CaO, Fe_2O_3, and Na_2O were included in the analysis but were found not to have a statistically significant impact for these compositions. The influences of Li_2O and NiO were positive, indicating that they improved the amount of sulfate retained. The influences of Al_2O_3, B_2O_3, MnO, and SiO_2 were negative, indicating that they reduced the amount of sulfate retained. The influences of all these components are generally consistent with findings described by others in the technical literature (see for example the summaries provided by Jantzen and coauthors[1,21]). Further corroboration of these results is provided by the findings of the cation field strength modeling effort completed at the University of Sheffield (see Appendix C). The model demonstrated that enhanced sulfate solubility occurs at low values of cation field strength, with SiO_2 concentration exhibiting the strongest effect.

6.0 Recommendations

Based on the results of these and other studies, the ability to improve sulfate solubility in DWPF borosilicate glasses lies in reducing the connectivity of the glass network structure. This can be achieved, as an example, by increasing the concentration of alkali species in the glass. However, this must be balanced with other effects of reduced network connectivity, such as reduced viscosity, potentially lower chemical durability, and in the case of higher sodium and aluminum concentrations, the propensity for nepheline crystallization. Future DWPF processing is likely to target higher waste loadings and higher sludge sodium concentrations, meaning that alkali concentrations in the glass will already be relatively high. It is therefore unlikely that there will be the ability to target significantly higher total alkali concentrations in the glass solely to support increased sulfate solubility without the increased alkali concentration causing failure of other PCCS constraints, such as low viscosity and durability.

No individual components were found to provide a significant improvement in sulfate retention (i.e., an increase of the magnitude necessary to have a dramatic impact on blending, washing, or waste loading strategies for DWPF) for the glasses studied here. In general, the concentrations of those species that improve sulfate solubility in a borosilicate glass must be added in relatively large concentrations in order to have a substantial impact. For example, additions of BaO at 15 wt % of the glass,[26] CaO at 5 to 10 wt % of the glass,[27] and V_2O_5 at 5 to 10 wt % of the glass[22,27] have been shown to significantly improve sulfate solubility in borosilicate glasses. For DWPF, these concentrations would equate to about 13 to 38 wt % of the frit composition at 40% waste loading, which is far too high to be practical. Therefore, it is unlikely that specific additives may be introduced into the DWPF glass via the frit to significantly improve sulfate solubility.

The results presented here continue to show that sulfate solubility or retention is a function of individual glass compositions, rather than a property of a broad glass composition region. It would therefore be inappropriate to set a single sulfate concentration limit for a range of DWPF glass compositions. Sulfate concentration limits should continue to be identified and implemented for each sludge batch. The current PCCS limit is 0.4 wt % SO_4^{2-} in glass, although frit development efforts have led to an increased limit of 0.6 wt % for recent sludge batches. Slightly higher limits (perhaps 0.7-0.8 wt %) may be possible for future sludge batches.

An opportunity for allowing a higher sulfate concentration limit at DWPF may lay lie in improving the laboratory experiments used to set this limit. That is, there are several differences between the crucible-scale testing currently used to define a limit for DWPF operation and the actual conditions within the DWPF melter. In particular, no allowance is currently made for sulfur partitioning (volatility versus retention) during melter processing as the sulfate limit is set for a specific sludge batch. A better understanding of the partitioning of sulfur in a bubbled melter operating with a cold cap as well as the impacts of sulfur on the off-gas system may allow a higher sulfate concentration limit to be established for the melter feed. This approach would have to be taken carefully to ensure that a sulfur salt layer is not formed on top of the melt pool while allowing higher sulfur concentration feeds to be processed through DWPF.

7.0 References

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Appendix A. Tables and Exhibits Supporting the Analysis of the Chemical Composition Measurements of the Glasses Selected to Identify Compositional Influences on Sulfate Retention

Table A-1. Measured Elemental Concentrations for Glasses Prepared Using Lithium Metaborate (part 1)

Series	Glass ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt %)	Ba (wt %)	Ca (wt %)	Ce (wt %)	Cr (wt %)	Cu (wt %)	Fe (wt %)	K (wt %)	La (wt %)
T	Batch 1	1	1	1	BCHLM111	2.59	0.126	0.943	<0.010	0.077	0.312	9.03	3.03	<0.010
T	LRM	1	1	2	LRMLM111	5.32	<0.010	0.438	<0.010	0.137	<0.010	1.04	1.28	<0.010
T	BC-03	1	1	3	t10LM21	6.49	0.040	0.545	0.042	0.089	0.037	6.86	<0.100	0.033
T	BC-01	1	1	4	t04LM11	6.52	0.037	0.519	0.040	0.089	0.034	6.73	<0.100	0.028
T	BC-02	1	1	5	t02LM11	6.45	0.037	0.516	0.040	0.095	0.034	6.73	<0.100	0.029
T	AF-02	1	1	6	t03LM11	6.44	0.036	0.498	0.043	0.093	0.033	7.02	<0.100	0.028
T	AF-05	1	1	7	t06LM21	6.37	0.038	2.25	0.039	0.094	0.037	6.82	<0.100	0.028
T	Batch 1	1	1	8	BCHLM112	2.54	0.124	0.928	<0.010	0.077	0.312	8.88	2.96	<0.010
T	LRM	1	1	9	LRMLM112	5.22	<0.010	0.430	<0.010	0.138	<0.010	1.02	1.24	<0.010
T	BC-01	1	1	10	t04LM21	6.23	0.037	0.492	0.040	0.089	0.034	6.47	<0.100	0.028
T	AF-05	1	1	11	t06LM11	6.34	0.038	2.24	0.039	0.094	0.038	6.78	<0.100	0.028
T	BC-02	1	1	12	t02LM21	6.13	0.036	0.488	0.045	0.093	0.034	6.44	<0.100	0.029
T	BC-03	1	1	13	t10LM11	6.15	0.038	0.502	0.041	0.089	0.037	6.55	<0.100	0.033
T	AF-02	1	1	14	t03LM21	6.18	0.035	0.483	0.040	0.091	0.033	6.75	<0.100	0.027
T	Batch 1	1	1	15	BCHLM113	2.46	0.121	0.889	<0.010	0.075	0.301	8.62	2.78	<0.010
T	LRM	1	1	16	LRMLM113	5.07	<0.010	0.417	<0.010	0.135	<0.010	0.99	1.19	<0.010
T	Batch 1	1	2	1	BCHLM121	2.44	0.125	0.874	<0.010	0.077	0.310	8.55	2.82	<0.010
T	LRM	1	2	2	LRMLM121	5.22	<0.010	0.400	<0.010	0.139	<0.010	1.02	1.23	<0.010
T	AF-05	1	2	3	t06LM22	6.29	0.036	2.19	0.037	0.095	0.037	6.74	<0.100	0.028
T	AF-05	1	2	4	t06LM12	6.44	0.037	2.24	0.037	0.096	0.037	6.89	<0.100	0.027
T	AF-02	1	2	5	t03LM12	6.57	0.034	0.485	0.040	0.095	0.033	7.14	<0.100	0.027
T	BC-01	1	2	6	t04LM12	6.67	0.035	0.505	0.038	0.090	0.034	6.89	<0.100	0.028
T	BC-02	1	2	7	t02LM12	6.53	0.036	0.495	0.038	0.097	0.034	6.82	<0.100	0.029
T	Batch 1	1	2	8	BCHLM122	2.62	0.125	0.930	<0.010	0.077	0.313	9.14	2.70	<0.010
T	LRM	1	2	9	LRMLM122	5.26	<0.010	0.403	<0.010	0.140	<0.010	1.02	1.24	<0.010
T	BC-02	1	2	10	t02LM22	6.43	0.036	0.493	0.042	0.096	0.034	6.72	<0.100	0.029
T	BC-03	1	2	11	t10LM22	6.38	0.039	0.508	0.040	0.091	0.037	6.75	<0.100	0.033
T	AF-02	1	2	12	t03LM22	6.40	0.035	0.475	0.038	0.095	0.033	7.00	<0.100	0.028
T	BC-03	1	2	13	t10LM12	6.47	0.037	0.506	0.038	0.091	0.037	6.86	<0.100	0.033
T	BC-01	1	2	14	t04LM22	6.40	0.036	0.478	0.038	0.091	0.034	6.63	<0.100	0.028
T	Batch 1	1	2	15	BCHLM123	2.55	0.125	0.906	<0.010	0.077	0.314	8.95	2.74	<0.010
T	LRM	1	2	16	LRMLM123	5.10	<0.010	0.388	<0.010	0.140	<0.010	1.00	1.22	<0.010
T	Batch 1	2	1	1	BCHLM211	2.63	0.123	0.881	<0.010	0.076	0.309	9.23	2.70	<0.010
T	LRM	2	1	2	LRMLM211	5.38	<0.010	0.354	<0.010	0.136	<0.010	1.02	1.18	<0.010
T	AF-04	2	1	3	t01LM21	6.55	0.029	3.99	0.037	0.089	0.032	6.92	<0.100	0.031
T	BC-04	2	1	4	t05LM21	6.52	0.033	3.98	0.035	0.096	0.031	6.90	<0.100	0.031
T	BC-04	2	1	5	t05LM11	6.56	0.033	4.00	0.035	0.100	0.031	7.01	<0.100	0.032
T	AF-01	2	1	6	t07LM21	6.61	0.041	0.439	0.033	0.098	0.036	7.15	<0.100	0.027
T	AB-06	2	1	7	t08LM11	6.02	0.025	0.408	0.031	0.085	0.035	6.39	<0.100	0.021
T	Batch 1	2	1	8	BCHLM212	2.67	0.121	0.911	<0.010	0.075	0.303	9.37	2.62	<0.010
T	LRM	2	1	9	LRMLM212	5.53	<0.010	0.371	<0.010	0.134	<0.010	1.05	1.15	<0.010
T	AB-06	2	1	10	t08LM21	6.12	0.026	0.425	0.033	0.087	0.050	6.47	<0.100	0.022

Table A-1. Measured Elemental Concentrations for Glasses Prepared Using Lithium Metaborate (part 1) (continued)

Series	Glass ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt %)	Ba (wt %)	Ca (wt %)	Ce (wt %)	Cr (wt %)	Cu (wt %)	Fe (wt %)	K (wt %)	La (wt %)
T	AF-04	2	1	11	t01LM11	6.75	0.030	4.12	0.038	0.092	0.033	7.09	<0.100	0.032
T	AF-03	2	1	12	t09LM11	6.68	0.040	0.445	0.036	0.096	0.044	7.05	<0.100	0.027
T	AF-01	2	1	13	t07LM11	6.56	0.042	0.442	0.034	0.097	0.036	7.08	<0.100	0.028
T	AF-03	2	1	14	t09LM21	6.57	0.041	0.455	0.036	0.097	0.040	6.92	<0.100	0.027
T	Batch 1	2	1	15	BCHLM213	2.62	0.125	0.879	<0.010	0.078	0.313	9.21	2.73	<0.010
T	LRM	2	1	16	LRMLM213	5.40	<0.010	0.359	<0.010	0.138	<0.010	1.02	1.19	<0.010
T	Batch 1	2	2	1	BCHLM221	2.65	0.123	0.950	<0.010	0.076	0.305	9.22	2.60	<0.010
T	LRM	2	2	2	LRMLM221	5.35	<0.010	0.422	<0.010	0.137	<0.010	1.05	1.15	<0.010
T	AB-06	2	2	3	t08LM22	5.82	0.028	0.464	0.032	0.086	0.051	6.23	<0.100	0.023
T	AF-04	2	2	4	t01LM22	6.30	0.030	3.88	0.036	0.088	0.032	6.69	<0.100	0.031
T	AB-06	2	2	5	t08LM12	5.87	0.027	0.463	0.032	0.087	0.037	6.29	<0.100	0.023
T	BC-04	2	2	6	t05LM12	6.51	0.035	4.04	0.035	0.102	0.033	6.97	<0.100	0.033
T	AF-01	2	2	7	t07LM22	6.45	0.043	0.495	0.033	0.100	0.037	7.02	<0.100	0.029
T	Batch 1	2	2	8	BCHLM222	2.55	0.124	0.903	<0.010	0.077	0.306	8.90	2.64	<0.010
T	LRM	2	2	9	LRMLM222	5.24	<0.010	0.412	<0.010	0.136	<0.010	1.04	1.16	<0.010
T	AF-03	2	2	10	t09LM12	6.47	0.040	0.498	0.034	0.095	0.044	6.84	<0.100	0.027
T	AF-04	2	2	11	t01LM12	6.38	0.031	3.95	0.037	0.091	0.033	6.79	<0.100	0.032
T	AF-03	2	2	12	t09LM22	6.48	0.041	0.518	0.035	0.096	0.039	6.84	<0.100	0.027
T	BC-04	2	2	13	t05LM22	6.38	0.035	3.97	0.034	0.096	0.032	6.74	<0.100	0.032
T	AF-01	2	2	14	t07LM12	6.55	0.043	0.513	0.033	0.096	0.036	7.07	<0.100	0.028
T	Batch 1	2	2	15	BCHLM223	2.64	0.123	0.943	<0.010	0.076	0.305	9.13	2.59	<0.010
T	LRM	2	2	16	LRMLM223	5.34	<0.010	0.421	<0.010	0.136	<0.010	1.05	1.15	<0.010
U	Batch 1	1	1	1	BCHLM111	2.50	0.125	0.825	<0.010	0.076	0.313	8.80	2.71	<0.010
U	LRM	1	1	2	LRMLM111	5.04	<0.010	0.333	<0.010	0.137	<0.010	0.99	1.20	<0.010
U	BC-09	1	1	3	u10LM21	6.13	0.035	2.07	0.034	0.093	0.058	6.52	<0.100	0.027
U	BS-05	1	1	4	u04LM11	6.29	0.032	1.25	0.038	0.103	0.040	6.60	<0.100	0.028
U	BS-01	1	1	5	u02LM11	6.22	0.037	0.440	0.038	0.092	0.038	6.67	<0.100	0.026
U	BC-05	1	1	6	u03LM11	6.30	0.032	1.25	0.038	0.103	0.047	6.62	<0.100	0.028
U	BS-02	1	1	7	u06LM21	6.29	0.036	2.50	0.037	0.087	0.038	6.75	<0.100	0.029
U	Batch 1	1	1	8	BCHLM112	2.56	0.125	0.837	<0.010	0.077	0.316	8.74	2.75	<0.010
U	LRM	1	1	9	LRMLM112	5.16	<0.010	0.340	<0.010	0.138	<0.010	1.08	1.21	<0.010
U	BS-05	1	1	10	u04LM21	6.29	0.031	1.25	0.038	0.104	0.042	6.61	<0.100	0.028
U	BS-02	1	1	11	u06LM11	6.62	0.035	2.63	0.036	0.086	0.047	7.11	<0.100	0.028
U	BS-01	1	1	12	u02LM21	7.12	0.039	0.447	0.039	0.097	0.038	7.65	<0.100	0.027
U	BC-09	1	1	13	u10LM11	6.24	0.036	2.11	0.035	0.094	0.045	6.62	<0.100	0.028
U	BC-05	1	1	14	u03LM21	6.61	0.035	3.95	0.037	0.096	0.034	6.87	<0.100	0.032
U	Batch 1	1	1	15	BCHLM113	2.52	0.130	0.878	<0.010	0.079	0.329	8.85	2.89	<0.010
U	LRM	1	1	16	LRMLM113	5.07	<0.010	0.354	<0.010	0.143	<0.010	1.00	1.28	<0.010
U	Batch 1	1	2	1	BCHLM121	2.57	0.123	0.823	<0.010	0.075	0.310	8.93	2.71	<0.010
U	LRM	1	2	2	LRMLM121	5.16	<0.010	0.333	<0.010	0.136	<0.010	1.09	1.19	<0.010
U	BS-02	1	2	3	u06LM22	6.41	0.033	2.60	0.034	0.084	0.045	6.86	<0.100	0.027
U	BS-02	1	2	4	u06LM12	6.31	0.032	2.55	0.033	0.084	0.035	6.80	<0.100	0.026
U	BC-05	1	2	5	u03LM12	6.40	0.029	1.31	0.035	0.102	0.044	6.76	<0.100	0.026

Table A-1. Measured Elemental Concentrations for Glasses Prepared Using Lithium Metaborate (part 1) (continued)

Series	Glass ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt %)	Ba (wt %)	Ca (wt %)	Ce (wt %)	Cr (wt %)	Cu (wt %)	Fe (wt %)	K (wt %)	La (wt %)
U	BS-05	1	2	6	u04LM12	6.52	0.030	1.34	0.036	0.103	0.038	6.86	<0.100	0.026
U	BS-01	1	2	7	u02LM12	6.41	0.035	0.434	0.036	0.092	0.037	6.92	<0.100	0.024
U	Batch 1	1	2	8	BCHLM122	2.66	0.125	0.837	<0.010	0.076	0.316	9.22	2.76	<0.010
U	LRM	1	2	9	LRMLM122	5.28	<0.010	0.335	<0.010	0.137	<0.010	1.18	1.21	<0.010
U	BS-01	1	2	10	u02LM22	6.49	0.036	0.436	0.036	0.096	0.037	7.00	<0.100	0.025
U	BC-09	1	2	11	u10LM22	6.42	0.034	2.20	0.033	0.094	0.058	6.84	<0.100	0.026
U	BC-05	1	2	12	u03LM22	6.45	0.032	3.87	0.034	0.095	0.032	6.74	<0.100	0.029
U	BC-09	1	2	13	u10LM12	6.34	0.033	2.17	0.033	0.092	0.043	6.76	<0.100	0.026
U	BS-05	1	2	14	u04LM22	6.40	0.030	1.31	0.036	0.105	0.042	6.79	<0.100	0.027
U	Batch 1	1	2	15	BCHLM123	2.64	0.126	0.849	<0.010	0.077	0.319	9.08	2.78	<0.010
U	LRM	1	2	16	LRMLM123	5.27	<0.010	0.342	<0.010	0.139	<0.010	1.07	1.22	<0.010
U	Batch 1	2	1	1	BCHLM211	2.50	0.127	0.823	<0.010	0.077	0.311	8.80	2.70	<0.010
U	LRM	2	1	2	LRMLM211	5.15	<0.010	0.333	<0.010	0.137	<0.010	1.08	1.19	<0.010
U	BC-08	2	1	3	u01LM21	6.25	0.036	3.80	0.035	0.103	0.038	6.81	<0.100	0.030
U	BC-06	2	1	4	u05LM21	6.27	0.043	0.442	0.036	0.092	0.036	6.65	<0.100	0.027
U	BC-06	2	1	5	u05LM11	6.26	0.044	0.439	0.036	0.094	0.045	6.64	<0.100	0.028
U	BC-07	2	1	6	u07LM21	6.36	0.038	3.86	0.037	0.097	0.043	6.92	<0.100	0.030
U	BS-04	2	1	7	u08LM11	6.37	0.041	2.56	0.038	0.116	0.039	6.86	<0.100	0.033
U	Batch 1	2	1	8	BCHLM212	2.60	0.128	0.842	<0.010	0.078	0.318	9.12	2.75	<0.010
U	LRM	2	1	9	LRMLM212	5.22	<0.010	0.342	<0.010	0.140	<0.010	1.04	1.22	<0.010
U	BS-04	2	1	10	u08LM21	6.40	0.041	2.60	0.038	0.114	0.038	6.89	<0.100	0.032
U	BC-08	2	1	11	u01LM11	6.39	0.036	3.93	0.036	0.102	0.036	6.92	<0.100	0.030
U	BS-03	2	1	12	u09LM11	6.32	0.033	0.425	0.034	0.097	0.039	7.07	<0.100	0.024
U	BC-07	2	1	13	u07LM11	6.43	0.038	3.88	0.036	0.096	0.038	7.50	<0.100	0.029
U	BS-03	2	1	14	u09LM21	6.37	0.034	0.447	0.034	0.100	0.051	7.33	<0.100	0.024
U	Batch 1	2	1	15	BCHLM213	2.65	0.126	0.827	<0.010	0.077	0.312	9.20	2.67	<0.010
U	LRM	2	1	16	LRMLM213	5.23	<0.010	0.341	<0.010	0.139	<0.010	1.04	1.20	<0.010
U	Batch 1	2	2	1	BCHLM221	2.58	0.124	0.819	<0.010	0.075	0.309	8.89	2.68	<0.010
U	LRM	2	2	2	LRMLM221	5.18	<0.010	0.334	<0.010	0.137	<0.010	1.03	1.20	<0.010
U	BS-04	2	2	3	u08LM22	6.30	0.039	2.54	0.036	0.112	0.036	6.78	<0.100	0.030
U	BC-08	2	2	4	u01LM22	6.22	0.035	3.77	0.034	0.102	0.036	6.74	<0.100	0.028
U	BS-04	2	2	5	u08LM12	6.28	0.040	2.52	0.037	0.114	0.037	6.76	<0.100	0.030
U	BC-06	2	2	6	u05LM12	6.28	0.043	0.442	0.035	0.093	0.043	6.66	<0.100	0.026
U	BC-07	2	2	7	u07LM22	6.27	0.037	3.80	0.035	0.096	0.041	6.82	<0.100	0.028
U	Batch 1	2	2	8	BCHLM222	2.56	0.125	0.831	<0.010	0.076	0.312	8.81	2.73	<0.010
U	LRM	2	2	9	LRMLM222	5.17	<0.010	0.340	<0.010	0.138	<0.010	1.11	1.22	<0.010
U	BS-03	2	2	10	u09LM12	6.25	0.032	0.421	0.033	0.096	0.037	6.99	<0.100	0.022
U	BC-08	2	2	11	u01LM12	6.32	0.035	3.87	0.035	0.100	0.034	6.86	<0.100	0.028
U	BS-03	2	2	12	u09LM22	6.31	0.033	0.455	0.033	0.099	0.050	7.22	<0.100	0.023
U	BC-06	2	2	13	u05LM22	6.30	0.042	0.446	0.035	0.091	0.034	6.66	<0.100	0.025
U	BC-07	2	2	14	u07LM12	6.31	0.036	3.79	0.035	0.095	0.036	7.35	<0.100	0.028
U	Batch 1	2	2	15	BCHLM223	2.54	0.126	0.834	<0.010	0.076	0.314	8.91	2.77	<0.010
U	LRM	2	2	16	LRMLM223	5.28	<0.010	0.344	<0.010	0.138	<0.010	1.13	1.24	<0.010

Table A-1. Measured Elemental Concentrations for Glasses Prepared Using Lithium Metaborate (part 1) (continued)

Series	Glass ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt %)	Ba (wt %)	Ca (wt %)	Ce (wt %)	Cr (wt %)	Cu (wt %)	Fe (wt %)	K (wt %)	La (wt %)
V	Batch 1	1	1	1	BCHLM111	2.56	0.124	0.895	<0.010	0.077	0.309	8.95	2.65	<0.010
V	LRM	1	1	2	LRMLM111	5.16	<0.010	0.410	<0.010	0.130	<0.010	1.02	1.31	<0.010
V	LL-06	1	1	3	v10LM21	6.37	0.028	3.85	0.032	0.087	0.036	6.82	<0.100	0.025
V	LL-10	1	1	4	v04LM11	6.26	0.028	0.438	0.034	0.086	0.031	6.61	<0.100	0.024
V	BS-08	1	1	5	v02LM11	6.29	0.037	0.502	0.040	0.086	0.032	6.38	<0.100	0.027
V	LL-05	1	1	6	v03LM11	6.57	0.031	2.24	0.035	0.080	0.031	7.00	<0.100	0.025
V	LL-12	1	1	7	v06LM21	6.61	0.026	3.99	0.033	0.080	0.027	7.00	<0.100	0.025
V	Batch 1	1	1	8	BCHLM112	2.59	0.124	0.908	<0.010	0.077	0.309	9.03	2.64	<0.010
V	LRM	1	1	9	LRMLM112	5.25	<0.010	0.412	<0.010	0.133	<0.010	1.04	1.30	<0.010
V	LL-10	1	1	10	v04LM21	6.22	0.028	0.429	0.034	0.085	0.029	6.60	<0.100	0.024
V	LL-12	1	1	11	v06LM11	6.07	0.025	3.68	0.034	0.080	0.027	6.47	<0.100	0.025
V	BS-08	1	1	12	v02LM21	6.04	0.037	0.471	0.041	0.085	0.031	6.13	<0.100	0.027
V	LL-06	1	1	13	v10LM11	6.12	0.028	3.70	0.032	0.088	0.035	6.54	<0.100	0.024
V	LL-05	1	1	14	v03LM21	6.58	0.031	2.20	0.034	0.081	0.031	6.99	<0.100	0.024
V	Batch 1	1	1	15	BCHLM113	2.45	0.125	0.857	<0.010	0.078	0.313	8.49	2.70	<0.010
V	LRM	1	1	16	LRMLM113	4.99	<0.010	0.389	<0.010	0.134	<0.010	0.974	1.31	<0.010
V	Batch 1	1	2	1	BCHLM121	2.53	0.127	0.887	<0.010	0.077	0.310	8.84	2.66	<0.010
V	LRM	1	2	2	LRMLM121	5.10	<0.010	0.404	<0.010	0.133	<0.010	1.00	1.28	<0.010
V	LL-12	1	2	3	v06LM22	6.30	0.028	3.77	0.032	0.080	0.027	6.70	<0.100	0.026
V	LL-12	1	2	4	v06LM12	6.22	0.029	3.75	0.032	0.081	0.028	6.64	<0.100	0.026
V	LL-05	1	2	5	v03LM12	6.29	0.034	2.13	0.033	0.081	0.032	6.75	<0.100	0.025
V	LL-10	1	2	6	v04LM12	6.22	0.031	0.425	0.032	0.087	0.030	6.62	<0.100	0.025
V	BS-08	1	2	7	v02LM12	6.07	0.047	0.480	0.062	0.087	0.033	6.21	<0.100	0.054
V	Batch 1	1	2	8	BCHLM122	2.51	0.127	0.871	<0.010	0.078	0.311	8.84	2.68	<0.010
V	LRM	1	2	9	LRMLM122	5.09	<0.010	0.395	<0.010	0.134	<0.010	1.01	1.30	<0.010
V	BS-08	1	2	10	v02LM22	6.15	0.040	0.475	0.040	0.086	0.032	6.30	<0.100	0.028
V	LL-06	1	2	11	v10LM22	6.34	0.031	3.75	0.031	0.088	0.038	6.85	<0.100	0.026
V	LL-05	1	2	12	v03LM22	6.20	0.034	2.04	0.032	0.081	0.032	6.72	<0.100	0.026
V	LL-06	1	2	13	v10LM12	6.30	0.030	3.70	0.030	0.088	0.036	6.85	<0.100	0.025
V	LL-10	1	2	14	v04LM22	6.10	0.031	0.410	0.032	0.085	0.030	6.60	<0.100	0.025
V	Batch 1	1	2	15	BCHLM123	2.51	0.128	0.860	<0.010	0.077	0.313	8.91	2.68	<0.010
V	LRM	1	2	16	LRMLM123	5.06	<0.010	0.387	<0.010	0.134	<0.010	1.04	1.31	<0.010
V	Batch 1	2	1	1	BCHLM211	2.49	0.125	0.832	<0.010	0.077	0.311	8.81	2.66	<0.010
V	LRM	2	1	2	LRMLM211	5.14	<0.010	0.355	<0.010	0.134	<0.010	0.98	1.30	<0.010
V	LL-11	2	1	3	v01LM21	6.26	0.033	3.76	0.034	0.099	0.029	6.90	<0.100	0.029
V	BS-09	2	1	4	v05LM21	6.14	0.032	2.54	0.041	0.107	0.036	6.69	<0.100	0.029
V	BS-09	2	1	5	v05LM11	6.15	0.033	2.53	0.035	0.108	0.037	6.67	<0.100	0.029
V	BS-07	2	1	6	v07LM21	6.26	0.037	2.57	0.037	0.099	0.034	6.72	<0.100	0.030
V	LL-03	2	1	7	v08LM11	4.73	0.021	4.30	0.029	0.078	0.036	5.10	<0.100	0.025
V	Batch 1	2	1	8	BCHLM212	2.57	0.125	0.859	<0.010	0.077	0.313	9.19	2.70	<0.010
V	LRM	2	1	9	LRMLM212	5.32	<0.010	0.369	<0.010	0.134	<0.010	1.02	1.33	<0.010
V	LL-03	2	1	10	v08LM21	4.86	0.021	4.42	0.029	0.078	0.031	5.25	<0.100	0.025
V	LL-11	2	1	11	v01LM11	6.49	0.033	3.90	0.034	0.099	0.029	7.15	<0.100	0.028

Table A-1. Measured Elemental Concentrations for Glasses Prepared Using Lithium Metaborate (part 1) (continued)

Series	Glass ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt %)	Ba (wt %)	Ca (wt %)	Ce (wt %)	Cr (wt %)	Cu (wt %)	Fe (wt %)	K (wt %)	La (wt %)
V	BS-06	2	1	12	v09LM11	6.28	0.029	0.427	0.037	0.100	0.032	6.44	<0.100	0.024
V	BS-07	2	1	13	v07LM11	6.34	0.036	2.61	0.037	0.098	0.036	6.87	<0.100	0.029
V	BS-06	2	1	14	v09LM21	6.54	0.030	0.448	0.037	0.100	0.031	6.70	<0.100	0.025
V	Batch 1	2	1	15	BCHLM213	2.50	0.123	0.839	<0.010	0.076	0.307	8.96	2.63	<0.010
V	LRM	2	1	16	LRMLM213	5.15	<0.010	0.352	<0.010	0.132	<0.010	0.994	1.28	<0.010
V	Batch 1	2	2	1	BCHLM221	2.45	0.124	0.866	<0.010	0.076	0.309	8.54	2.67	<0.010
V	LRM	2	2	2	LRMLM221	5.14	<0.010	0.418	<0.010	0.131	<0.010	1.03	1.29	<0.010
V	LL-03	2	2	3	v08LM22	4.66	0.020	4.28	0.028	0.077	0.030	4.97	<0.100	0.025
V	LL-11	2	2	4	v01LM22	6.25	0.032	3.81	0.033	0.097	0.028	6.84	<0.100	0.028
V	LL-03	2	2	5	v08LM12	4.65	0.020	4.28	0.029	0.077	0.034	4.96	<0.100	0.024
V	BS-09	2	2	6	v05LM12	6.16	0.032	2.60	0.035	0.106	0.035	6.63	<0.100	0.029
V	BS-07	2	2	7	v07LM22	6.20	0.036	2.61	0.037	0.098	0.033	6.62	<0.100	0.029
V	Batch 1	2	2	8	BCHLM222	2.55	0.124	0.903	<0.010	0.075	0.309	8.89	2.67	<0.010
V	LRM	2	2	9	LRMLM222	5.14	<0.010	0.418	<0.010	0.132	<0.010	1.03	1.30	<0.010
V	BS-06	2	2	10	v09LM12	6.29	0.029	0.498	0.038	0.100	0.031	6.37	<0.100	0.025
V	LL-11	2	2	11	v01LM12	6.40	0.032	3.89	0.034	0.098	0.028	6.99	<0.100	0.029
V	BS-06	2	2	12	v09LM22	6.44	0.030	0.502	0.038	0.100	0.030	6.54	<0.100	0.025
V	BS-09	2	2	13	v05LM22	6.31	0.032	2.67	0.040	0.106	0.035	6.84	<0.100	0.029
V	BS-07	2	2	14	v07LM12	6.23	0.036	2.62	0.037	0.097	0.035	6.86	<0.100	0.030
V	Batch 1	2	2	15	BCHLM223	2.60	0.124	0.918	<0.010	0.075	0.310	9.02	2.70	<0.010
V	LRM	2	2	16	LRMLM223	5.24	<0.010	0.423	<0.010	0.132	<0.010	1.05	1.31	<0.010
W	Batch 1	1	1	1	BCHLM111	2.61	0.122	0.858	<0.010	0.075	0.301	8.70	2.78	<0.010
W	LRM	1	1	2	LRMLM111	5.07	<0.010	0.432	<0.010	0.133	<0.010	1.19	1.29	<0.010
W	LT-12	1	1	3	w10LM21	6.30	0.029	2.51	0.031	0.094	0.033	6.68	<0.100	0.027
W	LT-01	1	1	4	w04LM11	4.68	0.029	0.353	0.028	0.069	0.028	4.89	<0.100	0.020
W	LT-11	1	1	5	w02LM11	6.22	0.028	0.416	0.036	0.085	0.033	6.83	<0.100	0.024
W	LT-10	1	1	6	w03LM11	6.25	0.027	2.52	0.034	0.146	0.033	6.68	<0.100	0.026
W	QB-03	1	1	7	w06LM21	4.55	0.024	4.73	0.030	0.167	0.036	5.31	0.201	0.023
W	Batch 1	1	1	8	BCHLM112	2.58	0.126	0.854	<0.010	0.077	0.316	8.60	2.73	<0.010
W	LRM	1	1	9	LRMLM112	5.04	<0.010	0.430	<0.010	0.134	<0.010	1.14	1.31	<0.010
W	LT-01	1	1	10	w04LM21	4.62	0.030	0.351	0.028	0.071	0.030	4.81	<0.100	0.021
W	QB-03	1	1	11	w06LM11	4.69	0.025	4.83	0.030	0.172	0.039	5.42	0.204	0.024
W	LT-11	1	1	12	w02LM21	6.29	0.028	0.440	0.035	0.088	0.037	6.90	<0.100	0.025
W	LT-12	1	1	13	w10LM11	6.27	0.030	2.52	0.032	0.095	0.037	6.65	<0.100	0.027
W	LT-10	1	1	14	w03LM21	6.16	0.025	2.47	0.034	0.140	0.030	6.57	<0.100	0.026
W	Batch 1	1	1	15	BCHLM113	2.58	0.126	0.849	<0.010	0.077	0.313	8.56	2.75	<0.010
W	LRM	1	1	16	LRMLM113	5.10	<0.010	0.435	<0.010	0.135	<0.010	1.16	1.30	<0.010
W	Batch 1	1	2	1	BCHLM121	2.69	0.124	0.904	<0.010	0.076	0.307	9.04	2.65	<0.010
W	LRM	1	2	2	LRMLM121	5.25	<0.010	0.460	<0.010	0.132	<0.010	1.19	1.27	<0.010
W	QB-03	1	2	3	w06LM22	4.78	0.026	4.89	0.029	0.165	0.036	5.59	0.199	0.024
W	QB-03	1	2	4	w06LM12	4.89	0.027	5.01	0.029	0.170	0.036	5.70	0.205	0.023
W	LT-10	1	2	5	w03LM12	6.53	0.027	2.66	0.033	0.142	0.032	6.99	<0.100	0.026
W	LT-01	1	2	6	w04LM12	4.85	0.031	0.379	0.027	0.070	0.028	5.05	<0.100	0.020

Table A-1. Measured Elemental Concentrations for Glasses Prepared Using Lithium Metaborate (part 1) (continued)

Series	Glass ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt %)	Ba (wt %)	Ca (wt %)	Ce (wt %)	Cr (wt %)	Cu (wt %)	Fe (wt %)	K (wt %)	La (wt %)
W	LT-11	1	2	7	w02LM12	6.46	0.029	0.448	0.034	0.085	0.032	7.08	<0.100	0.024
W	Batch 1	1	2	8	BCHLM122	2.67	0.123	0.899	<0.010	0.076	0.304	8.92	2.72	<0.010
W	LRM	1	2	9	LRMLM122	5.29	<0.010	0.467	<0.010	0.132	<0.010	1.19	1.27	<0.010
W	LT-11	1	2	10	w02LM22	6.48	0.030	0.469	0.034	0.088	0.037	7.12	<0.100	0.025
W	LT-12	1	2	11	w10LM22	6.50	0.031	2.64	0.030	0.094	0.033	6.88	<0.100	0.026
W	LT-10	1	2	12	w03LM22	6.34	0.026	2.57	0.033	0.137	0.030	6.73	<0.100	0.025
W	LT-12	1	2	13	w10LM12	6.48	0.031	2.63	0.031	0.093	0.035	6.85	<0.100	0.026
W	LT-01	1	2	14	w04LM22	4.76	0.031	0.373	0.027	0.071	0.030	4.96	<0.100	0.020
W	Batch 1	1	2	15	BCHLM123	2.64	0.123	0.888	<0.010	0.075	0.304	8.77	2.83	<0.010
W	LRM	1	2	16	LRMLM123	5.12	<0.010	0.451	<0.010	0.133	<0.010	1.15	1.30	<0.010
W	Batch 1	2	1	1	BCHLM211	2.62	0.124	0.859	<0.010	0.076	0.306	8.88	2.86	<0.010
W	LRM	2	1	2	LRMLM211	5.11	<0.010	0.450	<0.010	0.132	<0.010	1.15	1.28	<0.010
W	LT-04	2	1	3	w01LM21	6.21	0.027	0.406	0.031	0.109	0.041	6.53	<0.100	0.023
W	LOL-12	2	1	4	w05LM21	4.52	0.030	0.316	0.060	0.037	0.036	5.34	<0.100	0.025
W	LOL-12	2	1	5	w05LM11	4.37	0.030	0.301	0.060	0.037	0.042	5.16	<0.100	0.025
W	LT-05	2	1	6	w07LM21	6.21	0.028	1.227	0.035	0.097	0.036	6.58	<0.100	0.024
W	QB-04	2	1	7	w08LM11	4.69	0.032	4.75	0.024	0.096	0.024	5.47	0.196	0.021
W	Batch 1	2	1	8	BCHLM212	2.59	0.124	0.851	<0.010	0.076	0.306	8.70	2.87	<0.010
W	LRM	2	1	9	LRMLM212	5.12	<0.010	0.425	<0.010	0.135	<0.010	1.14	1.32	<0.010
W	QB-04	2	1	10	w08LM21	4.68	0.032	4.74	0.024	0.096	0.025	5.44	0.198	0.022
W	LT-04	2	1	11	w01LM11	6.26	0.028	0.412	0.032	0.114	0.048	6.50	<0.100	0.024
W	LT-06	2	1	12	w09LM11	6.15	0.029	2.47	0.031	0.102	0.031	6.73	<0.100	0.027
W	LT-05	2	1	13	w07LM11	6.13	0.029	1.205	0.035	0.097	0.032	6.46	<0.100	0.024
W	LT-06	2	1	14	w09LM21	6.23	0.030	2.49	0.031	0.103	0.035	6.84	<0.100	0.027
W	Batch 1	2	1	15	BCHLM213	2.57	0.128	0.846	<0.010	0.078	0.319	8.62	2.77	<0.010
W	LRM	2	1	16	LRMLM213	4.99	<0.010	0.412	<0.010	0.136	<0.010	1.11	1.32	<0.010
W	Batch 1	2	2	1	BCHLM221	2.62	0.123	0.900	<0.010	0.075	0.307	8.68	2.66	<0.010
W	LRM	2	2	2	LRMLM221	5.11	<0.010	0.482	<0.010	0.131	<0.010	1.19	1.28	<0.010
W	QB-04	2	2	3	w08LM22	4.73	0.030	4.79	0.023	0.094	0.023	5.52	0.193	0.020
W	LT-04	2	2	4	w01LM22	6.31	0.026	0.472	0.031	0.109	0.038	6.64	<0.100	0.022
W	QB-04	2	2	5	w08LM12	4.75	0.030	4.80	0.023	0.094	0.022	5.53	0.193	0.020
W	LOL-12	2	2	6	w05LM12	4.62	0.028	0.382	0.059	0.036	0.041	5.46	<0.100	0.024
W	LT-05	2	2	7	w07LM22	6.36	0.027	1.31	0.034	0.094	0.035	6.77	<0.100	0.023
W	Batch 1	2	2	8	BCHLM222	2.67	0.120	0.918	<0.010	0.073	0.296	8.90	2.76	<0.010
W	LRM	2	2	9	LRMLM222	5.22	<0.010	0.493	<0.010	0.131	<0.010	1.22	1.28	<0.010
W	LT-06	2	2	10	w09LM12	6.36	0.027	2.60	0.030	0.101	0.029	7.04	<0.100	0.026
W	LT-04	2	2	11	w01LM12	6.56	0.026	0.498	0.031	0.110	0.046	6.86	<0.100	0.023
W	LT-06	2	2	12	w09LM22	6.47	0.028	2.62	0.030	0.100	0.033	7.17	<0.100	0.026
W	LOL-12	2	2	13	w05LM22	4.57	0.028	0.381	0.059	0.036	0.034	5.42	<0.100	0.024
W	LT-05	2	2	14	w07LM12	6.28	0.027	1.29	0.034	0.095	0.030	6.68	<0.100	0.023
W	Batch 1	2	2	15	BCHLM223	2.63	0.121	0.904	<0.010	0.074	0.300	8.75	2.69	<0.010
W	LRM	2	2	16	LRMLM223	5.24	<0.010	0.495	<0.010	0.129	<0.010	1.22	1.26	<0.010
X	Batch 1	1	1	1	BCHLM111	2.63	0.122	0.873	<0.010	0.074	0.299	8.84	2.78	<0.010

Table A-1. Measured Elemental Concentrations for Glasses Prepared Using Lithium Metaborate (part 1) (continued)

Series	Glass ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt %)	Ba (wt %)	Ca (wt %)	Ce (wt %)	Cr (wt %)	Cu (wt %)	Fe (wt %)	K (wt %)	La (wt %)
X	LRM	1	1	2	LRMLM111	5.16	<0.010	0.440	<0.010	0.132	<0.010	1.40	1.23	<0.010
X	QB-34	1	1	3	x10LM21	4.71	0.025	4.84	0.028	0.102	0.026	5.94	0.192	0.022
X	QB-37	1	1	4	x04LM11	5.44	0.029	4.72	0.030	0.118	0.029	6.28	0.223	0.027
X	QB-32	1	1	5	x02LM11	4.64	0.024	0.366	0.027	0.099	0.025	5.47	0.197	0.016
X	QB-22	1	1	6	x03LM11	4.71	0.025	0.395	0.027	0.101	0.026	5.57	0.201	0.016
X	QB-35	1	1	7	x06LM21	4.68	0.021	4.78	0.028	0.086	0.025	5.45	0.188	0.023
X	Batch 1	1	1	8	BCHLM112	2.66	0.122	0.882	<0.010	0.074	0.300	8.91	2.80	<0.010
X	LRM	1	1	9	LRMLM112	5.24	<0.010	0.449	<0.010	0.133	<0.010	1.17	1.23	<0.010
X	QB-37	1	1	10	x04LM21	5.44	0.029	4.73	0.029	0.118	0.028	6.27	0.224	0.026
X	QB-35	1	1	11	x06LM11	4.83	0.021	4.93	0.028	0.086	0.025	5.58	0.198	0.023
X	QB-32	1	1	12	x02LM21	4.82	0.025	0.393	0.027	0.101	0.026	5.68	0.203	0.016
X	QB-34	1	1	13	x10LM11	4.74	0.024	4.90	0.028	0.102	0.030	5.98	0.201	0.022
X	QB-22	1	1	14	x03LM21	4.75	0.025	0.378	0.027	0.101	0.026	5.58	0.207	0.016
X	Batch 1	1	1	15	BCHLM113	2.62	0.124	0.869	<0.010	0.075	0.307	8.79	2.72	<0.010
X	LRM	1	1	16	LRMLM113	5.18	<0.010	0.441	<0.010	0.134	<0.010	1.16	1.25	<0.010
X	Batch 1	1	2	1	BCHLM121	2.60	0.125	0.885	<0.010	0.077	0.309	8.66	2.78	<0.010
X	LRM	1	2	2	LRMLM121	5.06	<0.010	0.463	<0.010	0.136	<0.010	1.16	1.27	<0.010
X	QB-35	1	2	3	x06LM22	4.50	0.039	4.59	0.083	0.088	0.027	5.24	0.195	0.081
X	QB-35	1	2	4	x06LM12	4.68	0.023	4.78	0.030	0.089	0.026	5.55	0.204	0.024
X	QB-22	1	2	5	x03LM12	4.62	0.027	0.420	0.028	0.103	0.028	5.45	0.207	0.017
X	QB-37	1	2	6	x04LM12	5.44	0.031	4.72	0.031	0.120	0.030	6.28	0.228	0.028
X	QB-32	1	2	7	x02LM12	4.74	0.027	0.411	0.028	0.102	0.027	5.60	0.206	0.017
X	Batch 1	1	2	8	BCHLM122	2.64	0.124	0.902	<0.010	0.076	0.304	8.78	2.82	<0.010
X	LRM	1	2	9	LRMLM122	5.16	<0.010	0.477	<0.010	0.135	<0.010	1.18	1.25	<0.010
X	QB-32	1	2	10	x02LM22	4.65	0.027	0.411	0.028	0.102	0.027	5.47	0.204	0.017
X	QB-34	1	2	11	x10LM22	4.72	0.026	4.85	0.029	0.103	0.028	5.93	0.191	0.023
X	QB-22	1	2	12	x03LM22	4.64	0.026	0.407	0.027	0.101	0.027	5.45	0.203	0.016
X	QB-34	1	2	13	x10LM12	4.77	0.025	4.71	0.029	0.102	0.030	5.76	0.196	0.023
X	QB-37	1	2	14	x04LM22	5.36	0.030	4.67	0.030	0.119	0.029	6.18	0.222	0.027
X	Batch 1	1	2	15	BCHLM123	2.61	0.122	0.892	<0.010	0.074	0.299	8.63	2.77	<0.010
X	LRM	1	2	16	LRMLM123	5.10	<0.010	0.472	<0.010	0.133	<0.010	1.17	1.26	<0.010
X	Batch 1	2	1	1	BCHLM211	2.59	0.124	0.861	<0.010	0.077	0.309	8.69	2.90	<0.010
X	LRM	2	1	2	LRMLM211	4.99	<0.010	0.450	<0.010	0.136	<0.010	1.13	1.26	<0.010
X	QB-19	2	1	3	x01LM21	5.11	0.028	0.409	0.031	0.110	0.030	5.91	0.223	0.022
X	QB-33	2	1	4	x05LM21	4.48	0.023	2.49	0.027	0.084	0.023	5.10	0.217	0.023
X	QB-33	2	1	5	x05LM11	4.55	0.024	2.54	0.028	0.086	0.023	5.21	0.212	0.024
X	QB-36	2	1	6	x07LM21	4.52	0.021	2.53	0.025	0.100	0.041	5.35	0.202	0.022
X	QB-20	2	1	7	x08LM11	5.09	0.026	3.67	0.030	0.114	0.032	5.94	0.224	0.027
X	Batch 1	2	1	8	BCHLM212	2.55	0.124	0.844	<0.010	0.076	0.308	8.49	2.89	<0.010
X	LRM	2	1	9	LRMLM212	4.92	<0.010	0.421	<0.010	0.137	<0.010	1.11	1.29	<0.010
X	QB-20	2	1	10	x08LM21	5.15	0.027	3.71	0.030	0.116	0.031	6.00	0.229	0.026
X	QB-19	2	1	11	x01LM11	5.06	0.028	0.408	0.031	0.111	0.030	5.88	0.228	0.022
X	SPS-02	2	1	12	x09LM11	6.15	0.045	0.602	0.093	0.052	0.051	7.23	<0.100	0.032

Table A-1. Measured Elemental Concentrations for Glasses Prepared Using Lithium Metaborate (part 1) (continued)

Series	Glass ID	Block	Sub-Blk	Sequence	Lab ID	Al (wt %)	Ba (wt %)	Ca (wt %)	Ce (wt %)	Cr (wt %)	Cu (wt %)	Fe (wt %)	K (wt %)	La (wt %)
X	QB-36	2	1	13	x07LM11	4.64	0.021	2.60	0.025	0.101	0.034	5.38	0.204	0.022
X	SPS-02	2	1	14	x09LM21	6.15	0.044	0.604	0.093	0.052	0.051	7.19	<0.100	0.032
X	Batch 1	2	1	15	BCHLM213	2.56	0.125	0.851	<0.010	0.077	0.316	8.60	2.74	<0.010
X	LRM	2	1	16	LRMLM213	4.97	<0.010	0.426	<0.010	0.136	<0.010	1.12	1.29	<0.010
X	Batch 1	2	2	1	BCHLM221	2.63	0.125	0.867	<0.010	0.076	0.310	8.85	2.68	<0.010
X	LRM	2	2	2	LRMLM221	5.11	<0.010	0.429	<0.010	0.131	0.004	1.15	1.28	<0.010
X	QB-20	2	2	3	x08LM22	5.26	0.027	3.78	0.030	0.113	0.030	6.15	0.225	0.025
X	QB-19	2	2	4	x01LM22	5.32	0.029	0.424	0.031	0.109	0.029	6.17	0.223	0.021
X	QB-20	2	2	5	x08LM12	5.20	0.027	3.76	0.030	0.113	0.031	6.10	0.222	0.027
X	QB-33	2	2	6	x05LM12	4.60	0.025	2.56	0.029	0.085	0.022	5.28	0.213	0.023
X	QB-36	2	2	7	x07LM22	4.65	0.022	2.61	0.025	0.100	0.041	5.50	0.202	0.022
X	Batch 1	2	2	8	BCHLM222	2.60	0.124	0.860	<0.010	0.076	0.307	8.74	2.88	<0.010
X	LRM	2	2	9	LRMLM222	5.07	<0.010	0.427	<0.010	0.134	0.006	1.24	1.29	<0.010
X	SPS-02	2	2	10	x09LM12	6.26	0.045	0.619	0.092	0.052	0.050	7.35	<0.100	0.031
X	QB-19	2	2	11	x01LM12	5.25	0.029	0.414	0.032	0.110	0.031	6.10	0.228	0.021
X	SPS-02	2	2	12	x09LM22	6.26	0.045	0.610	0.093	0.052	0.051	7.37	<0.100	0.031
X	QB-33	2	2	13	x05LM22	4.60	0.024	2.58	0.027	0.083	0.023	5.24	0.218	0.023
X	QB-36	2	2	14	x07LM12	4.67	0.022	2.62	0.026	0.101	0.034	5.44	0.207	0.022
X	Batch 1	2	2	15	BCHLM223	2.60	0.124	0.860	<0.010	0.076	0.309	8.77	2.84	<0.010
X	LRM	2	2	16	LRMLM223	5.02	<0.010	0.423	<0.010	0.135	0.007	1.12	1.31	<0.010

Table A-2. Measured Elemental Concentrations for the Glasses Prepared Using Lithium Metaborate (part 2)

Series	Glass ID	Block	Sub-Blk	Sequence	Lab ID	Mg (wt %)	Mn (wt %)	Na (wt %)	Ni (wt %)	Pb (wt %)	S (wt %)	Ti (wt %)	Zn (wt %)	Zr (wt %)
T	Batch 1	1	1	1	BCHLM111	0.860	1.35	6.79	0.535	<0.020	<0.050	0.384	<0.010	0.067
T	LRM	1	1	2	LRMLM111	0.062	0.060	16.6	0.137	0.083	0.089	0.061	<0.010	0.642
T	BC-03	1	1	3	t10LM21	0.222	2.40	11.1	0.737	<0.020	0.370	<0.010	0.027	0.086
T	BC-01	1	1	4	t04LM11	0.171	2.40	8.73	0.760	<0.020	0.347	<0.010	0.028	0.076
T	BC-02	1	1	5	t02LM11	0.194	2.39	8.68	0.764	<0.020	0.360	<0.010	0.025	0.087
T	AF-02	1	1	6	t03LM11	0.194	2.33	11.3	0.767	<0.020	0.333	<0.010	0.024	0.090
T	AF-05	1	1	7	t06LM21	0.197	2.36	9.69	0.742	<0.020	0.372	<0.010	0.028	0.089
T	Batch 1	1	1	8	BCHLM112	0.843	1.32	6.67	0.529	<0.020	<0.050	0.377	<0.010	0.067
T	LRM	1	1	9	LRMLM112	0.063	0.060	16.1	0.136	0.082	0.089	0.061	<0.010	0.643
T	BC-01	1	1	10	t04LM21	0.171	2.30	8.25	0.752	<0.020	0.357	<0.010	0.027	0.081
T	AF-05	1	1	11	t06LM11	0.199	2.36	9.67	0.738	<0.020	0.377	<0.010	0.028	0.088
T	BC-02	1	1	12	t02LM21	0.192	2.29	8.20	0.755	<0.020	0.369	<0.010	0.024	0.088
T	BC-03	1	1	13	t10LM11	0.223	2.30	10.4	0.734	<0.020	0.389	<0.010	0.033	0.088
T	AF-02	1	1	14	t03LM21	0.192	2.25	10.7	0.751	<0.020	0.344	<0.010	0.024	0.092
T	Batch 1	1	1	15	BCHLM113	0.817	1.28	6.38	0.512	<0.020	<0.050	0.360	<0.010	0.065
T	LRM	1	1	16	LRMLM113	0.061	0.058	15.6	0.133	0.080	0.090	0.059	<0.010	0.628
T	Batch 1	1	2	1	BCHLM121	0.818	1.27	6.35	0.533	<0.020	<0.050	0.378	<0.010	0.066
T	LRM	1	2	2	LRMLM121	0.062	0.059	16.13	0.137	0.082	0.086	0.061	<0.010	0.649
T	AF-05	1	2	3	t06LM22	0.198	2.34	9.54	0.750	<0.020	0.356	<0.010	0.028	0.089
T	AF-05	1	2	4	t06LM12	0.200	2.39	9.77	0.758	<0.020	0.359	<0.010	0.029	0.089
T	AF-02	1	2	5	t03LM12	0.197	2.38	11.5	0.777	<0.020	0.321	<0.010	0.025	0.091
T	BC-01	1	2	6	t04LM12	0.173	2.45	8.89	0.779	<0.020	0.339	<0.010	0.029	0.077
T	BC-02	1	2	7	t02LM12	0.196	2.42	8.76	0.784	<0.020	0.352	<0.010	0.025	0.088
T	Batch 1	1	2	8	BCHLM122	0.872	1.36	6.86	0.534	<0.020	<0.050	0.377	<0.010	0.066
T	LRM	1	2	9	LRMLM122	0.062	0.059	16.3	0.138	0.083	0.081	0.061	<0.010	0.654
T	BC-02	1	2	10	t02LM22	0.196	2.39	8.60	0.778	<0.020	0.354	<0.010	0.025	0.089
T	BC-03	1	2	11	t10LM22	0.227	2.36	10.8	0.755	<0.020	0.370	<0.010	0.028	0.088
T	AF-02	1	2	12	t03LM22	0.198	2.32	11.1	0.789	<0.020	0.334	<0.010	0.025	0.094
T	BC-03	1	2	13	t10LM12	0.227	2.40	10.9	0.755	<0.020	0.374	<0.010	0.034	0.089
T	BC-01	1	2	14	t04LM22	0.173	2.36	8.47	0.772	<0.020	0.347	<0.010	0.028	0.082
T	Batch 1	1	2	15	BCHLM123	0.857	1.33	6.66	0.534	<0.020	<0.050	0.383	<0.010	0.067
T	LRM	1	2	16	LRMLM123	0.062	0.059	15.7	0.139	0.082	0.084	0.061	<0.010	0.655
T	Batch 1	2	1	1	BCHLM211	0.850	1.35	6.94	0.531	<0.020	<0.050	0.386	<0.010	0.065
T	LRM	2	1	2	LRMLM211	0.061	0.058	16.7	0.135	0.081	0.082	0.060	<0.010	0.646
T	AF-04	2	1	3	t01LM21	0.180	2.39	11.0	0.741	<0.020	0.366	<0.010	0.021	0.090
T	BC-04	2	1	4	t05LM21	0.188	2.36	8.83	0.742	<0.020	0.357	<0.010	0.030	0.098
T	BC-04	2	1	5	t05LM11	0.194	2.40	8.88	0.777	<0.020	0.371	<0.010	0.031	0.099
T	AF-01	2	1	6	t07LM21	0.194	2.43	11.9	0.781	<0.020	0.324	<0.010	0.026	0.091
T	AB-06	2	1	7	t08LM11	0.162	2.18	11.4	0.675	<0.020	0.298	<0.010	0.019	0.068
T	Batch 1	2	1	8	BCHLM212	0.862	1.37	7.11	0.524	<0.020	<0.050	0.376	<0.010	0.064
T	LRM	2	1	9	LRMLM212	0.060	0.059	17.3	0.132	0.079	0.084	0.058	<0.010	0.633
T	AB-06	2	1	10	t08LM21	0.168	2.21	11.8	0.696	<0.020	0.309	<0.010	0.020	0.071

Table A-2. Measured Elemental Concentrations for the Glasses Prepared Using Lithium Metaborate (part 2) (continued)

Series	Glass ID	Block	Sub-Blk	Sequence	Lab ID	Mg (wt %)	Mn (wt %)	Na (wt %)	Ni (wt %)	Pb (wt %)	S (wt %)	Ti (wt %)	Zn (wt %)	Zr (wt %)
T	AF-04	2	1	11	t01LM11	0.185	2.45	11.4	0.771	<0.020	0.376	<0.010	0.022	0.097
T	AF-03	2	1	12	t09LM11	0.199	2.41	10.0	0.793	<0.020	0.319	<0.010	0.025	0.087
T	AF-01	2	1	13	t07LM11	0.197	2.40	11.7	0.800	<0.020	0.331	<0.010	0.024	0.099
T	AF-03	2	1	14	t09LM21	0.200	2.37	9.79	0.798	<0.020	0.329	<0.010	0.026	0.100
T	Batch 1	2	1	15	BCHLM213	0.848	1.34	6.95	0.541	<0.020	<0.050	0.390	<0.010	0.066
T	LRM	2	1	16	LRMLM213	0.061	0.058	16.9	0.136	0.081	0.083	0.059	<0.010	0.654
T	Batch 1	2	2	1	BCHLM221	0.889	1.38	6.92	0.525	<0.020	<0.050	0.378	<0.010	0.065
T	LRM	2	2	2	LRMLM221	0.061	0.059	16.5	0.136	0.082	0.087	0.061	<0.010	0.641
T	AB-06	2	2	3	t08LM22	0.164	2.15	11.0	0.678	<0.020	0.303	<0.010	0.020	0.071
T	AF-04	2	2	4	t01LM22	0.177	2.34	10.5	0.729	<0.020	0.359	<0.010	0.022	0.089
T	AB-06	2	2	5	t08LM12	0.163	2.17	11.0	0.678	<0.020	0.299	<0.010	0.020	0.070
T	BC-04	2	2	6	t05LM12	0.196	2.41	8.78	0.779	<0.020	0.366	<0.010	0.032	0.101
T	AF-01	2	2	7	t07LM22	0.196	2.41	11.5	0.779	<0.020	0.325	<0.010	0.027	0.092
T	Batch 1	2	2	8	BCHLM222	0.856	1.33	6.60	0.523	<0.020	<0.050	0.377	<0.010	0.066
T	LRM	2	2	9	LRMLM222	0.061	0.058	16.2	0.134	0.080	0.080	0.060	<0.010	0.638
T	AF-03	2	2	10	t09LM12	0.193	2.38	9.69	0.764	<0.020	0.311	<0.010	0.025	0.084
T	AF-04	2	2	11	t01LM12	0.180	2.37	10.7	0.744	<0.020	0.358	<0.010	0.022	0.094
T	AF-03	2	2	12	t09LM22	0.195	2.38	9.67	0.771	<0.020	0.313	<0.010	0.026	0.098
T	BC-04	2	2	13	t05LM22	0.187	2.35	8.65	0.726	<0.020	0.349	<0.010	0.030	0.096
T	AF-01	2	2	14	t07LM12	0.192	2.43	11.6	0.772	<0.020	0.320	<0.010	0.024	0.097
T	Batch 1	2	2	15	BCHLM223	0.881	1.38	6.95	0.522	<0.020	<0.050	0.378	<0.010	0.065
T	LRM	2	2	16	LRMLM223	0.061	0.058	16.6	0.134	0.079	0.083	0.060	<0.010	0.637
U	Batch 1	1	1	1	BCHLM111	0.808	1.32	6.56	0.536	<0.020	<0.050	0.394	<0.010	0.066
U	LRM	1	1	2	LRMLM111	0.061	0.058	15.3	0.135	0.080	0.086	0.059	<0.010	0.652
U	BC-09	1	1	3	u10LM21	0.179	2.30	9.15	0.749	<0.020	0.371	<0.010	0.022	0.088
U	BS-05	1	1	4	u04LM11	0.206	2.34	9.19	0.805	<0.020	0.364	<0.010	0.027	0.091
U	BS-01	1	1	5	u02LM11	0.196	2.32	8.28	0.770	<0.020	0.345	<0.010	0.028	0.089
U	BC-05	1	1	6	u03LM11	0.206	2.34	9.20	0.807	<0.020	0.356	<0.010	0.027	0.092
U	BS-02	1	1	7	u06LM21	0.196	2.33	8.35	0.766	<0.020	0.376	<0.010	0.026	0.092
U	Batch 1	1	1	8	BCHLM112	0.810	1.36	6.49	0.538	<0.020	<0.050	0.393	<0.010	0.067
U	LRM	1	1	9	LRMLM112	0.061	0.058	15.5	0.137	0.081	0.089	0.059	<0.010	0.660
U	BS-05	1	1	10	u04LM21	0.205	2.35	9.25	0.806	<0.020	0.362	<0.010	0.027	0.091
U	BS-02	1	1	11	u06LM11	0.193	2.45	8.78	0.747	<0.020	0.373	<0.010	0.025	0.087
U	BS-01	1	1	12	u02LM21	0.201	2.66	9.46	0.795	<0.020	0.354	<0.010	0.029	0.091
U	BC-09	1	1	13	u10LM11	0.184	2.34	9.25	0.779	<0.020	0.381	<0.010	0.022	0.096
U	BC-05	1	1	14	u03LM21	0.206	2.45	8.68	0.796	<0.020	0.388	<0.010	0.024	0.101
U	Batch 1	1	1	15	BCHLM113	0.838	1.32	6.55	0.558	<0.020	<0.050	0.412	<0.010	0.069
U	LRM	1	1	16	LRMLM113	0.063	0.060	15.4	0.141	0.084	0.082	0.063	<0.010	0.686
U	Batch 1	1	2	1	BCHLM121	0.803	1.37	6.68	0.531	<0.020	<0.050	0.381	<0.010	0.064
U	LRM	1	2	2	LRMLM121	0.059	0.058	15.4	0.135	0.079	0.078	0.058	<0.010	0.650
U	BS-02	1	2	3	u06LM22	0.191	2.40	8.50	0.741	<0.020	0.356	<0.010	0.024	0.086
U	BS-02	1	2	4	u06LM12	0.190	2.37	8.34	0.735	<0.020	0.354	<0.010	0.024	0.087
U	BC-05	1	2	5	u03LM12	0.202	2.42	9.34	0.793	<0.020	0.344	<0.010	0.025	0.090

Table A-2. Measured Elemental Concentrations for the Glasses Prepared Using Lithium Metaborate (part 2) (continued)

Series	Glass ID	Block	Sub-Blk	Sequence	Lab ID	Mg (wt %)	Mn (wt %)	Na (wt %)	Ni (wt %)	Pb (wt %)	S (wt %)	Ti (wt %)	Zn (wt %)	Zr (wt %)
U	BS-05	1	2	6	u04LM12	0.206	2.45	9.61	0.798	<0.020	0.348	<0.010	0.026	0.090
U	BS-01	1	2	7	u02LM12	0.195	2.43	8.51	0.765	<0.020	0.338	<0.010	0.027	0.088
U	Batch 1	1	2	8	BCHLM122	0.817	1.41	6.86	0.536	<0.020	<0.050	0.388	<0.010	0.065
U	LRM	1	2	9	LRMLM122	0.060	0.058	15.7	0.135	0.080	0.080	0.058	<0.010	0.651
U	BS-01	1	2	10	u02LM22	0.199	2.46	8.56	0.783	<0.020	0.344	<0.010	0.027	0.088
U	BC-09	1	2	11	u10LM22	0.183	2.44	9.52	0.769	<0.020	0.384	<0.010	0.022	0.089
U	BC-05	1	2	12	u03LM22	0.202	2.42	8.44	0.779	<0.020	0.379	<0.010	0.022	0.098
U	BC-09	1	2	13	u10LM12	0.181	2.41	9.35	0.770	<0.020	0.363	<0.010	0.021	0.094
U	BS-05	1	2	14	u04LM22	0.207	2.41	9.32	0.813	<0.020	0.360	<0.010	0.026	0.092
U	Batch 1	1	2	15	BCHLM123	0.824	1.40	6.73	0.544	<0.020	<0.050	0.393	<0.010	0.067
U	LRM	1	2	16	LRMLM123	0.061	0.059	16.0	0.137	0.081	0.081	0.059	<0.010	0.669
U	Batch 1	2	1	1	BCHLM211	0.805	1.32	6.53	0.532	<0.020	<0.050	0.382	<0.010	0.067
U	LRM	2	1	2	LRMLM211	0.061	0.059	15.4	0.136	0.082	0.078	0.060	<0.010	0.651
U	BC-08	2	1	3	u01LM21	0.215	2.36	10.3	0.779	<0.020	0.370	<0.010	0.026	0.092
U	BC-06	2	1	4	u05LM21	0.198	2.36	10.5	0.734	<0.020	0.371	<0.010	0.026	0.090
U	BC-06	2	1	5	u05LM11	0.203	2.36	10.4	0.762	<0.020	0.378	<0.010	0.026	0.092
U	BC-07	2	1	6	u07LM21	0.197	2.38	10.4	0.768	<0.020	0.374	<0.010	0.024	0.085
U	BS-04	2	1	7	u08LM11	0.198	2.41	8.47	0.817	<0.020	0.371	<0.010	0.030	0.079
U	Batch 1	2	1	8	BCHLM212	0.813	1.37	6.77	0.541	<0.020	<0.050	0.396	<0.010	0.068
U	LRM	2	1	9	LRMLM212	0.062	0.060	15.7	0.139	0.084	0.084	0.062	<0.010	0.668
U	BS-04	2	1	10	u08LM21	0.196	2.42	8.51	0.807	<0.020	0.371	<0.010	0.029	0.087
U	BC-08	2	1	11	u01LM11	0.212	2.40	10.7	0.756	<0.020	0.372	<0.010	0.028	0.087
U	BS-03	2	1	12	u09LM11	0.213	2.35	8.41	0.750	<0.020	0.348	<0.010	0.024	0.091
U	BC-07	2	1	13	u07LM11	0.197	2.39	10.5	0.824	<0.020	0.372	<0.010	0.024	0.106
U	BS-03	2	1	14	u09LM21	0.219	2.38	8.58	0.790	<0.020	0.358	<0.010	0.025	0.092
U	Batch 1	2	1	15	BCHLM213	0.802	1.39	6.84	0.532	<0.020	<0.050	0.382	<0.010	0.067
U	LRM	2	1	16	LRMLM213	0.062	0.060	15.8	0.138	0.082	0.084	0.061	<0.010	0.664
U	Batch 1	2	2	1	BCHLM221	0.799	1.35	6.61	0.529	<0.020	0.017	0.382	<0.010	0.065
U	LRM	2	2	2	LRMLM221	0.060	0.058	15.7	0.135	0.080	0.083	0.060	<0.010	0.667
U	BS-04	2	2	3	u08LM22	0.194	2.38	8.37	0.801	<0.020	0.361	<0.010	0.027	0.086
U	BC-08	2	2	4	u01LM22	0.214	2.34	10.3	0.782	<0.020	0.372	<0.010	0.024	0.090
U	BS-04	2	2	5	u08LM12	0.196	2.37	8.35	0.811	<0.020	0.367	<0.010	0.028	0.076
U	BC-06	2	2	6	u05LM12	0.203	2.37	10.5	0.765	<0.020	0.380	<0.010	0.025	0.091
U	BC-07	2	2	7	u07LM22	0.197	2.35	10.3	0.770	<0.020	0.372	<0.010	0.022	0.084
U	Batch 1	2	2	8	BCHLM222	0.805	1.34	6.54	0.532	<0.020	0.009	0.381	<0.010	0.066
U	LRM	2	2	9	LRMLM222	0.060	0.058	15.5	0.136	0.082	0.082	0.060	<0.010	0.669
U	BS-03	2	2	10	u09LM12	0.213	2.32	8.28	0.754	<0.020	0.347	<0.010	0.022	0.090
U	BC-08	2	2	11	u01LM12	0.212	2.38	10.5	0.755	<0.020	0.374	<0.010	0.026	0.086
U	BS-03	2	2	12	u09LM22	0.220	2.36	8.36	0.794	<0.020	0.358	<0.010	0.024	0.092
U	BC-06	2	2	13	u05LM22	0.197	2.37	10.6	0.738	<0.020	0.376	<0.010	0.024	0.089
U	BC-07	2	2	14	u07LM12	0.195	2.34	10.3	0.822	<0.020	0.375	<0.010	0.022	0.105
U	Batch 1	2	2	15	BCHLM223	0.811	1.34	6.58	0.536	<0.020	0.014	0.390	<0.010	0.067
U	LRM	2	2	16	LRMLM223	0.061	0.059	15.7	0.138	0.082	0.084	0.061	<0.010	0.663

Table A-2. Measured Elemental Concentrations for the Glasses Prepared Using Lithium Metaborate (part 2) (continued)

Series	Glass ID	Block	Sub-Blk	Sequence	Lab ID	Mg (wt %)	Mn (wt %)	Na (wt %)	Ni (wt %)	Pb (wt %)	S (wt %)	Ti (wt %)	Zn (wt %)	Zr (wt %)
V	Batch 1	1	1	1	BCHLM111	0.803	1.35	6.70	0.530	<0.020	<0.050	0.380	<0.010	0.065
V	LRM	1	1	2	LRMLM111	0.060	0.056	15.6	0.130	0.079	0.078	0.060	<0.010	0.630
V	LL-06	1	1	3	v10LM21	0.224	2.12	10.5	0.693	<0.020	0.373	<0.010	0.023	0.078
V	LL-10	1	1	4	v04LM11	0.163	2.07	8.20	0.699	<0.020	0.354	<0.010	0.020	0.089
V	BS-08	1	1	5	v02LM11	0.202	2.36	9.73	0.777	<0.020	0.360	<0.010	0.023	0.083
V	LL-05	1	1	6	v03LM11	0.177	2.18	9.79	0.695	<0.020	0.366	<0.010	0.022	0.077
V	LL-12	1	1	7	v06LM21	0.172	2.17	8.73	0.698	<0.020	0.375	<0.010	0.022	0.100
V	Batch 1	1	1	8	BCHLM112	0.803	1.36	6.82	0.529	<0.020	<0.050	0.380	<0.010	0.066
V	LRM	1	1	9	LRMLM112	0.059	0.056	15.9	0.130	0.079	0.083	0.058	<0.010	0.622
V	LL-10	1	1	10	v04LM21	0.163	2.06	8.17	0.706	<0.020	0.356	<0.010	0.021	0.089
V	LL-12	1	1	11	v06LM11	0.172	2.01	8.06	0.688	<0.020	0.376	<0.010	0.022	0.079
V	BS-08	1	1	12	v02LM21	0.201	2.27	9.36	0.773	<0.020	0.364	<0.010	0.023	0.084
V	LL-06	1	1	13	v10LM11	0.223	2.04	10.2	0.695	<0.020	0.380	<0.010	0.023	0.078
V	LL-05	1	1	14	v03LM21	0.177	2.17	9.80	0.698	<0.020	0.369	<0.010	0.021	0.079
V	Batch 1	1	1	15	BCHLM113	0.811	1.28	6.45	0.535	<0.020	<0.050	0.388	<0.010	0.066
V	LRM	1	1	16	LRMLM113	0.059	0.056	15.1	0.131	0.079	0.077	0.059	<0.010	0.628
V	Batch 1	1	2	1	BCHLM121	0.804	1.34	6.63	0.529	<0.020	<0.050	0.381	<0.010	0.066
V	LRM	1	2	2	LRMLM121	0.059	0.057	15.3	0.130	0.079	0.084	0.058	<0.010	0.618
V	LL-12	1	2	3	v06LM22	0.171	2.08	8.23	0.684	<0.020	0.376	<0.010	0.023	0.080
V	LL-12	1	2	4	v06LM12	0.173	2.07	8.14	0.699	<0.020	0.375	<0.010	0.023	0.101
V	LL-05	1	2	5	v03LM12	0.178	2.09	9.19	0.691	<0.020	0.373	<0.010	0.022	0.079
V	LL-10	1	2	6	v04LM12	0.165	2.06	7.99	0.705	<0.020	0.355	<0.010	0.022	0.091
V	BS-08	1	2	7	v02LM12	0.202	2.29	9.21	0.776	<0.020	0.363	<0.010	0.024	0.093
V	Batch 1	1	2	8	BCHLM122	0.805	1.33	6.44	0.530	<0.020	<0.050	0.382	<0.010	0.067
V	LRM	1	2	9	LRMLM122	0.059	0.057	15.1	0.132	0.079	0.082	0.059	<0.010	0.626
V	BS-08	1	2	10	v02LM22	0.202	2.32	9.16	0.778	<0.020	0.366	<0.010	0.024	0.085
V	LL-06	1	2	11	v10LM22	0.226	2.12	10.1	0.699	<0.020	0.381	<0.010	0.024	0.079
V	LL-05	1	2	12	v03LM22	0.178	2.07	8.87	0.692	<0.020	0.374	<0.010	0.022	0.081
V	LL-06	1	2	13	v10LM12	0.223	2.10	9.96	0.698	<0.020	0.374	<0.010	0.024	0.079
V	LL-10	1	2	14	v04LM22	0.164	2.03	7.62	0.707	<0.020	0.354	<0.010	0.021	0.090
V	Batch 1	1	2	15	BCHLM123	0.808	1.33	6.30	0.535	<0.020	<0.050	0.390	<0.010	0.067
V	LRM	1	2	16	LRMLM123	0.059	0.057	14.5	0.132	0.079	0.081	0.060	<0.010	0.628
V	Batch 1	2	1	1	BCHLM211	0.804	1.29	6.56	0.531	<0.020	<0.050	0.380	<0.010	0.066
V	LRM	2	1	2	LRMLM211	0.059	0.056	15.5	0.130	0.078	0.078	0.058	<0.010	0.622
V	LL-11	2	1	3	v01LM21	0.175	2.06	8.25	0.715	<0.020	0.395	<0.010	0.022	0.088
V	BS-09	2	1	4	v05LM21	0.190	2.28	9.38	0.790	<0.020	0.367	<0.010	0.024	0.090
V	BS-09	2	1	5	v05LM11	0.192	2.28	9.36	0.801	<0.020	0.369	<0.010	0.024	0.091
V	BS-07	2	1	6	v07LM21	0.197	2.32	9.42	0.781	<0.020	0.357	<0.010	0.026	0.089
V	LL-03	2	1	7	v08LM11	0.149	1.73	8.84	0.593	<0.020	0.292	<0.010	0.020	0.070
V	Batch 1	2	1	8	BCHLM212	0.805	1.33	6.72	0.533	<0.020	<0.050	0.389	<0.010	0.067
V	LRM	2	1	9	LRMLM212	0.059	0.056	15.9	0.131	0.079	0.086	0.059	<0.010	0.631
V	LL-03	2	1	10	v08LM21	0.149	1.79	9.08	0.606	<0.020	0.288	<0.010	0.020	0.069
V	LL-11	2	1	11	v01LM11	0.175	2.13	8.52	0.713	<0.020	0.401	<0.010	0.022	0.093

Table A-2. Measured Elemental Concentrations for the Glasses Prepared Using Lithium Metaborate (part 2) (continued)

Series	Glass ID	Block	Sub-Blk	Sequence	Lab ID	Mg (wt %)	Mn (wt %)	Na (wt %)	Ni (wt %)	Pb (wt %)	S (wt %)	Ti (wt %)	Zn (wt %)	Zr (wt %)
V	BS-06	2	1	12	v09LM11	0.190	2.33	9.84	0.770	<0.020	0.357	<0.010	0.026	0.098
V	BS-07	2	1	13	v07LM11	0.195	2.36	9.51	0.779	<0.020	0.346	<0.010	0.026	0.089
V	BS-06	2	1	14	v09LM21	0.194	2.42	10.2	0.788	<0.020	0.364	<0.010	0.027	0.107
V	Batch 1	2	1	15	BCHLM213	0.794	1.30	6.52	0.525	<0.020	<0.050	0.375	<0.010	0.065
V	LRM	2	1	16	LRMLM213	0.058	0.055	15.3	0.128	0.077	0.079	0.057	<0.010	0.616
V	Batch 1	2	2	1	BCHLM221	0.801	1.30	6.40	0.530	<0.020	<0.050	0.381	<0.010	0.064
V	LRM	2	2	2	LRMLM221	0.058	0.055	15.4	0.128	0.076	0.075	0.057	<0.010	0.618
V	LL-03	2	2	3	v08LM22	0.149	1.75	8.76	0.601	<0.020	0.282	<0.010	0.018	0.069
V	LL-11	2	2	4	v01LM22	0.174	2.09	8.27	0.711	<0.020	0.394	<0.010	0.021	0.085
V	LL-03	2	2	5	v08LM12	0.148	1.75	8.77	0.589	<0.020	0.277	<0.010	0.018	0.068
V	BS-09	2	2	6	v05LM12	0.190	2.33	9.46	0.794	<0.020	0.365	<0.010	0.023	0.089
V	BS-07	2	2	7	v07LM22	0.195	2.34	9.41	0.774	<0.020	0.341	<0.010	0.025	0.087
V	Batch 1	2	2	8	BCHLM222	0.801	1.35	6.65	0.530	<0.020	<0.050	0.381	<0.010	0.064
V	LRM	2	2	9	LRMLM222	0.058	0.055	15.4	0.128	0.076	0.078	0.057	<0.010	0.622
V	BS-06	2	2	10	v09LM12	0.192	2.36	9.95	0.777	<0.020	0.363	<0.010	0.026	0.098
V	LL-11	2	2	11	v01LM12	0.175	2.13	8.46	0.717	<0.020	0.404	<0.010	0.021	0.092
V	BS-06	2	2	12	v09LM22	0.196	2.42	10.2	0.801	<0.020	0.366	<0.010	0.026	0.107
V	BS-09	2	2	13	v05LM22	0.189	2.37	9.66	0.789	<0.020	0.373	<0.010	0.023	0.089
V	BS-07	2	2	14	v07LM12	0.197	2.35	9.48	0.787	<0.020	0.351	<0.010	0.025	0.088
V	Batch 1	2	2	15	BCHLM223	0.803	1.37	6.75	0.530	<0.020	<0.050	0.389	<0.010	0.065
V	LRM	2	2	16	LRMLM223	0.058	0.055	15.7	0.129	0.078	0.081	0.058	<0.010	0.626
W	Batch 1	1	1	1	BCHLM111	0.789	1.35	6.58	0.520	<0.020	<0.050	0.387	<0.010	0.065
W	LRM	1	1	2	LRMLM111	0.059	0.056	15.0	0.130	0.078	0.082	0.059	<0.010	0.625
W	LT-12	1	1	3	w10LM21	0.185	2.09	8.26	0.719	<0.020	0.376	<0.010	0.021	0.088
W	LT-01	1	1	4	w04LM11	0.123	1.72	6.34	0.586	<0.020	0.276	<0.010	0.020	0.072
W	LT-11	1	1	5	w02LM11	0.179	2.06	8.16	0.711	<0.020	0.377	<0.010	0.020	0.082
W	LT-10	1	1	6	w03LM11	0.170	2.08	8.20	0.737	<0.020	0.405	<0.010	0.022	0.078
W	QB-03	1	1	7	w06LM21	0.164	1.75	9.24	0.703	<0.020	0.327	<0.010	0.023	0.078
W	Batch 1	1	1	8	BCHLM112	0.817	1.34	6.50	0.545	<0.020	<0.050	0.399	<0.010	0.068
W	LRM	1	1	9	LRMLM112	0.060	0.057	14.8	0.133	0.079	0.093	0.060	<0.010	0.638
W	LT-01	1	1	10	w04LM21	0.125	1.69	6.23	0.590	<0.020	0.292	<0.010	0.021	0.067
W	QB-03	1	1	11	w06LM11	0.166	1.79	9.57	0.705	<0.020	0.331	<0.010	0.024	0.084
W	LT-11	1	1	12	w02LM21	0.183	2.09	8.27	0.735	<0.020	0.395	<0.010	0.021	0.085
W	LT-12	1	1	13	w10LM11	0.187	2.09	8.21	0.726	<0.020	0.400	<0.010	0.022	0.087
W	LT-10	1	1	14	w03LM21	0.164	2.05	8.03	0.708	<0.020	0.395	<0.010	0.022	0.076
W	Batch 1	1	1	15	BCHLM113	0.817	1.33	6.44	0.542	<0.020	<0.050	0.398	<0.010	0.068
W	LRM	1	1	16	LRMLM113	0.060	0.057	14.9	0.132	0.079	0.083	0.061	<0.010	0.640
W	Batch 1	1	2	1	BCHLM121	0.798	1.38	6.78	0.528	<0.020	<0.050	0.381	<0.010	0.065
W	LRM	1	2	2	LRMLM121	0.059	0.056	15.6	0.129	0.077	0.076	0.057	<0.010	0.615
W	QB-03	1	2	3	w06LM22	0.162	1.83	9.72	0.685	<0.020	0.311	<0.010	0.024	0.076
W	QB-03	1	2	4	w06LM12	0.165	1.87	10.1	0.695	<0.020	0.320	<0.010	0.024	0.083
W	LT-10	1	2	5	w03LM12	0.166	2.16	8.59	0.713	<0.020	0.383	<0.010	0.022	0.076
W	LT-01	1	2	6	w04LM12	0.123	1.77	6.60	0.581	<0.020	0.270	<0.010	0.021	0.071

Table A-2. Measured Elemental Concentrations for the Glasses Prepared Using Lithium Metaborate (part 2) (continued)

Series	Glass ID	Block	Sub-Blk	Sequence	Lab ID	Mg (wt %)	Mn (wt %)	Na (wt %)	Ni (wt %)	Pb (wt %)	S (wt %)	Ti (wt %)	Zn (wt %)	Zr (wt %)
W	LT-11	1	2	7	w02LM12	0.177	2.14	8.53	0.699	<0.020	0.366	<0.010	0.020	0.080
W	Batch 1	1	2	8	BCHLM122	0.791	1.37	6.78	0.521	<0.020	<0.050	0.377	<0.010	0.065
W	LRM	1	2	9	LRMLM122	0.059	0.056	15.7	0.130	0.077	0.077	0.057	<0.010	0.614
W	LT-11	1	2	10	w02LM22	0.180	2.15	8.59	0.718	<0.020	0.370	<0.010	0.021	0.083
W	LT-12	1	2	11	w10LM22	0.183	2.16	8.58	0.710	<0.020	0.376	<0.010	0.022	0.085
W	LT-10	1	2	12	w03LM22	0.161	2.09	8.38	0.687	<0.020	0.372	<0.010	0.022	0.073
W	LT-12	1	2	13	w10LM12	0.183	2.15	8.60	0.702	<0.020	0.374	<0.010	0.022	0.084
W	LT-01	1	2	14	w04LM22	0.123	1.74	6.49	0.575	<0.020	0.273	<0.010	0.021	0.065
W	Batch 1	1	2	15	BCHLM123	0.795	1.36	6.69	0.521	<0.020	<0.050	0.382	<0.010	0.066
W	LRM	1	2	16	LRMLM123	0.060	0.057	15.2	0.131	0.077	0.082	0.058	<0.010	0.622
W	Batch 1	2	1	1	BCHLM211	0.795	1.34	6.63	0.525	<0.020	<0.050	0.384	<0.010	0.065
W	LRM	2	1	2	LRMLM211	0.058	0.056	15.1	0.130	0.080	0.085	0.058	<0.010	0.619
W	LT-04	2	1	3	w01LM21	0.171	2.03	8.12	0.733	<0.020	0.350	<0.010	0.021	0.083
W	LOL-12	2	1	4	w05LM21	0.131	1.74	10.5	0.703	<0.020	0.204	0.260	0.025	0.062
W	LOL-12	2	1	5	w05LM11	0.131	1.69	10.2	0.699	<0.020	0.201	0.262	0.025	0.063
W	LT-05	2	1	6	w07LM21	0.189	2.04	8.98	0.732	<0.020	0.367	<0.010	0.018	0.098
W	QB-04	2	1	7	w08LM11	0.167	1.75	11.1	0.712	<0.020	0.323	<0.010	0.022	0.091
W	Batch 1	2	1	8	BCHLM212	0.800	1.32	6.56	0.525	<0.020	<0.050	0.381	<0.010	0.066
W	LRM	2	1	9	LRMLM212	0.059	0.057	15.2	0.132	0.078	0.078	0.059	<0.010	0.629
W	QB-04	2	1	10	w08LM21	0.167	1.74	11.0	0.714	<0.020	0.328	<0.010	0.022	0.094
W	LT-04	2	1	11	w01LM11	0.176	2.03	8.20	0.752	<0.020	0.359	<0.010	0.023	0.088
W	LT-06	2	1	12	w09LM11	0.181	2.02	9.49	0.771	<0.020	0.380	<0.010	0.020	0.085
W	LT-05	2	1	13	w07LM11	0.189	2.01	8.87	0.730	<0.020	0.370	<0.010	0.018	0.097
W	LT-06	2	1	14	w09LM21	0.182	2.05	9.56	0.737	<0.020	0.377	<0.010	0.020	0.083
W	Batch 1	2	1	15	BCHLM213	0.824	1.31	6.57	0.547	<0.020	<0.050	0.401	<0.010	0.068
W	LRM	2	1	16	LRMLM213	0.060	0.058	14.8	0.134	0.080	0.081	0.060	<0.010	0.635
W	Batch 1	2	2	1	BCHLM221	0.799	1.36	6.59	0.529	<0.020	<0.050	0.379	<0.010	0.064
W	LRM	2	2	2	LRMLM221	0.057	0.055	15.1	0.128	0.076	0.075	0.058	<0.010	0.615
W	QB-04	2	2	3	w08LM22	0.164	1.80	11.0	0.705	<0.020	0.311	<0.010	0.021	0.092
W	LT-04	2	2	4	w01LM22	0.170	2.10	8.28	0.732	<0.020	0.345	<0.010	0.020	0.082
W	QB-04	2	2	5	w08LM12	0.164	1.80	11.2	0.705	<0.020	0.312	<0.010	0.021	0.089
W	LOL-12	2	2	6	w05LM12	0.129	1.82	10.7	0.690	<0.020	0.191	0.258	0.024	0.061
W	LT-05	2	2	7	w07LM22	0.186	2.13	9.22	0.726	<0.020	0.352	<0.010	0.017	0.096
W	Batch 1	2	2	8	BCHLM222	0.781	1.39	6.72	0.513	<0.020	<0.050	0.370	<0.010	0.064
W	LRM	2	2	9	LRMLM222	0.057	0.055	15.4	0.128	0.076	0.078	0.057	<0.010	0.614
W	LT-06	2	2	10	w09LM12	0.177	2.14	9.76	0.755	<0.020	0.370	<0.010	0.019	0.082
W	LT-04	2	2	11	w01LM12	0.170	2.17	8.56	0.729	<0.020	0.346	<0.010	0.021	0.085
W	LT-06	2	2	12	w09LM22	0.179	2.17	9.88	0.725	<0.020	0.371	<0.010	0.019	0.080
W	LOL-12	2	2	13	w05LM22	0.129	1.80	10.6	0.690	<0.020	0.196	0.256	0.024	0.061
W	LT-05	2	2	14	w07LM12	0.185	2.10	9.06	0.723	<0.020	0.361	<0.010	0.017	0.095
W	Batch 1	2	2	15	BCHLM223	0.787	1.37	6.59	0.521	<0.020	<0.050	0.377	<0.010	0.064
W	LRM	2	2	16	LRMLM223	0.057	0.055	15.4	0.128	0.076	0.085	0.057	<0.010	0.610
X	Batch 1	1	1	1	BCHLM111	0.785	1.34	6.69	0.515	<0.020	<0.050	0.374	<0.010	0.064

Table A-2. Measured Elemental Concentrations for the Glasses Prepared Using Lithium Metaborate (part 2) (continued)

Series	Glass ID	Block	Sub-Blk	Sequence	Lab ID	Mg (wt %)	Mn (wt %)	Na (wt %)	Ni (wt %)	Pb (wt %)	S (wt %)	Ti (wt %)	Zn (wt %)	Zr (wt %)
X	LRM	1	1	2	LRMLM111	0.059	0.056	15.4	0.134	0.078	0.083	0.057	<0.010	0.631
X	QB-34	1	1	3	x10LM21	0.156	1.76	9.73	0.698	<0.020	0.368	<0.010	0.020	0.068
X	QB-37	1	1	4	x04LM11	0.152	2.04	12.5	0.795	<0.020	0.320	<0.010	0.024	0.082
X	QB-32	1	1	5	x02LM11	0.204	1.74	12.4	0.693	<0.020	0.373	<0.010	0.018	0.068
X	QB-22	1	1	6	x03LM11	0.204	1.76	12.6	0.701	<0.020	0.375	<0.010	0.019	0.069
X	QB-35	1	1	7	x06LM21	0.151	1.76	11.0	0.678	<0.020	0.369	<0.010	0.018	0.069
X	Batch 1	1	1	8	BCHLM112	0.787	1.35	6.77	0.516	<0.020	<0.050	0.375	<0.010	0.065
X	LRM	1	1	9	LRMLM112	0.059	0.056	15.6	0.133	0.078	0.082	0.057	<0.010	0.631
X	QB-37	1	1	10	x04LM21	0.151	2.04	12.4	0.781	<0.020	0.319	<0.010	0.023	0.081
X	QB-35	1	1	11	x06LM11	0.151	1.80	11.3	0.677	<0.020	0.378	<0.010	0.018	0.069
X	QB-32	1	1	12	x02LM21	0.206	1.80	12.8	0.710	<0.020	0.383	<0.010	0.018	0.069
X	QB-34	1	1	13	x10LM11	0.155	1.76	9.85	0.680	<0.020	0.363	<0.010	0.020	0.067
X	QB-22	1	1	14	x03LM21	0.204	1.77	12.6	0.701	<0.020	0.378	<0.010	0.018	0.070
X	Batch 1	1	1	15	BCHLM113	0.799	1.34	6.68	0.526	<0.020	<0.050	0.378	<0.010	0.065
X	LRM	1	1	16	LRMLM113	0.059	0.056	15.4	0.135	0.077	0.082	0.057	<0.010	0.641
X	Batch 1	1	2	1	BCHLM121	0.802	1.34	6.57	0.530	<0.020	<0.050	0.382	<0.010	0.066
X	LRM	1	2	2	LRMLM121	0.060	0.058	15.0	0.136	0.079	0.083	0.060	<0.010	0.644
X	QB-35	1	2	3	x06LM22	0.153	1.71	10.5	0.692	<0.020	0.376	<0.010	0.019	0.093
X	QB-35	1	2	4	x06LM12	0.152	1.77	10.9	0.680	<0.020	0.379	<0.010	0.019	0.071
X	QB-22	1	2	5	x03LM12	0.208	1.75	12.2	0.715	<0.020	0.382	<0.010	0.020	0.071
X	QB-37	1	2	6	x04LM12	0.154	2.06	12.4	0.800	<0.020	0.328	<0.010	0.025	0.083
X	QB-32	1	2	7	x02LM12	0.209	1.80	12.6	0.709	<0.020	0.374	<0.010	0.020	0.070
X	Batch 1	1	2	8	BCHLM122	0.794	1.36	6.69	0.521	<0.020	<0.050	0.382	<0.010	0.066
X	LRM	1	2	9	LRMLM122	0.060	0.057	15.3	0.135	0.079	0.087	0.059	<0.010	0.637
X	QB-32	1	2	10	x02LM22	0.206	1.76	12.3	0.705	<0.020	0.372	<0.010	0.019	0.070
X	QB-34	1	2	11	x10LM22	0.156	1.78	9.68	0.692	<0.020	0.366	<0.010	0.020	0.068
X	QB-22	1	2	12	x03LM22	0.201	1.76	12.3	0.688	<0.020	0.368	<0.010	0.018	0.069
X	QB-34	1	2	13	x10LM12	0.153	1.73	9.42	0.671	<0.020	0.357	<0.010	0.020	0.067
X	QB-37	1	2	14	x04LM22	0.150	2.03	12.2	0.779	<0.020	0.314	<0.010	0.024	0.081
X	Batch 1	1	2	15	BCHLM123	0.781	1.34	6.57	0.511	<0.020	<0.050	0.372	<0.010	0.065
X	LRM	1	2	16	LRMLM123	0.059	0.057	15.1	0.131	0.077	0.080	0.058	<0.010	0.619
X	Batch 1	2	1	1	BCHLM211	0.802	1.33	6.58	0.527	<0.020	<0.050	0.384	<0.010	0.067
X	LRM	2	1	2	LRMLM211	0.060	0.058	14.8	0.132	0.080	0.082	0.060	<0.010	0.641
X	QB-19	2	1	3	x01LM21	0.185	1.91	12.9	0.790	<0.020	0.327	<0.010	0.024	0.091
X	QB-33	2	1	4	x05LM21	0.144	1.67	9.17	0.682	<0.020	0.364	<0.010	0.023	0.072
X	QB-33	2	1	5	x05LM11	0.148	1.70	9.29	0.699	<0.020	0.375	<0.010	0.023	0.073
X	QB-36	2	1	6	x07LM21	0.153	1.70	10.5	0.711	<0.020	0.387	<0.010	0.023	0.072
X	QB-20	2	1	7	x08LM11	0.156	1.88	10.7	0.777	<0.020	0.314	<0.010	0.024	0.097
X	Batch 1	2	1	8	BCHLM212	0.802	1.30	6.45	0.526	<0.020	<0.050	0.380	<0.010	0.067
X	LRM	2	1	9	LRMLM212	0.059	0.058	14.6	0.131	0.079	0.083	0.059	<0.010	0.640
X	QB-20	2	1	10	x08LM21	0.155	1.89	10.8	0.776	<0.020	0.318	<0.010	0.024	0.101
X	QB-19	2	1	11	x01LM11	0.186	1.90	12.8	0.805	<0.020	0.337	<0.010	0.024	0.080
X	SPS-02	2	1	12	x09LM11	0.170	2.36	9.03	1.033	<0.020	0.187	<0.010	0.026	0.105

Table A-2. Measured Elemental Concentrations for the Glasses Prepared Using Lithium Metaborate (part 2) (continued)

Series	Glass ID	Block	Sub-Blk	Sequence	Lab ID	Mg (wt %)	Mn (wt %)	Na (wt %)	Ni (wt %)	Pb (wt %)	S (wt %)	Ti (wt %)	Zn (wt %)	Zr (wt %)
X	QB-36	2	1	13	x07LM11	0.154	1.74	10.8	0.701	<0.020	0.386	<0.010	0.023	0.073
X	SPS-02	2	1	14	x09LM21	0.170	2.36	9.03	1.025	<0.020	0.189	<0.010	0.028	0.104
X	Batch 1	2	1	15	BCHLM213	0.812	1.32	6.51	0.536	<0.020	<0.050	0.384	<0.010	0.067
X	LRM	2	1	16	LRMLM213	0.060	0.057	14.7	0.136	0.080	0.082	0.059	<0.010	0.643
X	Batch 1	2	2	1	BCHLM221	0.802	1.34	6.72	0.533	<0.020	<0.050	0.384	<0.010	0.065
X	LRM	2	2	2	LRMLM221	0.058	0.055	15.1	0.128	0.076	0.081	0.056	<0.010	0.614
X	QB-20	2	2	3	x08LM22	0.152	1.93	11.1	0.756	<0.020	0.307	<0.010	0.023	0.100
X	QB-19	2	2	4	x01LM22	0.182	1.98	13.5	0.776	<0.020	0.318	<0.010	0.024	0.090
X	QB-20	2	2	5	x08LM12	0.154	1.92	11.0	0.771	<0.020	0.316	<0.010	0.024	0.096
X	QB-33	2	2	6	x05LM12	0.146	1.72	9.43	0.692	<0.020	0.370	<0.010	0.023	0.073
X	QB-36	2	2	7	x07LM22	0.152	1.74	10.9	0.705	<0.020	0.376	<0.010	0.022	0.071
X	Batch 1	2	2	8	BCHLM222	0.797	1.33	6.64	0.523	<0.020	<0.050	0.378	<0.010	0.066
X	LRM	2	2	9	LRMLM222	0.059	0.056	15.1	0.134	0.078	0.081	0.057	<0.010	0.633
X	SPS-02	2	2	10	x09LM12	0.168	2.40	9.25	1.021	<0.020	0.186	<0.010	0.026	0.104
X	QB-19	2	2	11	x01LM12	0.183	1.96	13.3	0.797	<0.020	0.330	<0.010	0.024	0.079
X	SPS-02	2	2	12	x09LM22	0.169	2.40	9.22	1.018	<0.020	0.186	<0.010	0.026	0.103
X	QB-33	2	2	13	x05LM22	0.142	1.71	9.50	0.670	<0.020	0.364	<0.010	0.022	0.071
X	QB-36	2	2	14	x07LM12	0.153	1.75	10.9	0.699	<0.020	0.377	<0.010	0.022	0.073
X	Batch 1	2	2	15	BCHLM223	0.798	1.33	6.65	0.523	<0.020	<0.050	0.377	<0.010	0.066
X	LRM	2	2	16	LRMLM223	0.059	0.056	14.9	0.136	0.078	0.083	0.058	<0.010	0.641

Table A-3. Measured Elemental Concentrations for the Glasses Prepared Using Peroxide Fusion

Series	Glass ID	Block	Sub-Blk	Sequence	Lab ID	B (wt %)	Li (wt %)	Si (wt %)
T	Batch 1	1	1	1	BCHPF111	2.45	1.99	22.4
T	LRM	1	1	2	LRMPF111	2.63	<0.100	25.5
T	BC-04	1	1	3	t05PF21	1.64	2.98	20.2
T	AB-06	1	1	4	t08PF21	1.77	2.43	23.5
T	AF-01	1	1	5	t07PF21	1.59	2.25	21.7
T	AF-01	1	1	6	t07PF11	1.57	2.24	21.4
T	AF-03	1	1	7	t09PF21	2.74	2.20	20.6
T	Batch 1	1	1	8	BCHPF112	2.53	2.11	24.3
T	LRM	1	1	9	LRMPF112	2.57	<0.100	25.9
T	BC-04	1	1	10	t05PF11	1.67	3.01	20.6
T	AB-06	1	1	11	t08PF11	1.75	2.43	23.7
T	AF-02	1	1	12	t03PF11	2.77	2.21	20.5
T	AF-02	1	1	13	t03PF21	2.66	2.15	20.6
T	AF-03	1	1	14	t09PF11	2.77	2.22	21.0
T	Batch 1	1	1	15	BCHPF113	2.43	2.06	23.7
T	LRM	1	1	16	LRMPF113	2.51	<0.100	25.4
T	Batch 1	1	2	1	BCHPF121	2.46	1.97	23.0
T	LRM	1	2	2	LRMPF121	2.34	<0.100	24.2
T	AF-02	1	2	3	t03PF12	2.65	2.10	20.7
T	BC-04	1	2	4	t05PF12	1.47	2.85	20.8
T	AF-03	1	2	5	t09PF22	2.65	2.14	20.5
T	AF-03	1	2	6	t09PF12	2.65	2.13	20.7
T	AB-06	1	2	7	t08PF22	1.62	2.33	23.1
T	Batch 1	1	2	8	BCHPF122	2.34	2.00	23.7
T	LRM	1	2	9	LRMPF122	2.31	<0.100	24.9
T	AF-01	1	2	10	t07PF22	1.49	2.15	21.3
T	AF-02	1	2	11	t03PF22	2.54	2.08	20.3
T	AF-01	1	2	12	t07PF12	1.47	2.17	21.4
T	BC-04	1	2	13	t05PF22	1.47	2.89	20.2
T	AB-06	1	2	14	t08PF12	1.57	2.32	23.1
T	Batch 1	1	2	15	BCHPF123	2.36	2.02	24.1
T	LRM	1	2	16	LRMPF123	2.34	<0.100	25.1
T	Batch 1	2	1	1	BCHPF211	2.36	1.93	22.4
T	LRM	2	1	2	LRMPF211	2.39	<0.100	24.5
T	BC-03	2	1	3	t10PF21	1.46	2.86	20.7
T	AF-04	2	1	4	t01PF21	2.62	2.22	17.3
T	AF-05	2	1	5	t06PF11	2.10	2.57	19.9
T	BC-01	2	1	6	t04PF21	1.40	2.84	21.7
T	BC-01	2	1	7	t04PF11	1.40	2.85	21.9
T	Batch 1	2	1	8	BCHPF212	2.36	2.01	23.5
T	LRM	2	1	9	LRMPF212	2.45	<0.100	25.4
T	BC-02	2	1	10	t02PF21	2.80	2.88	20.3
T	AF-04	2	1	11	t01PF11	2.65	2.24	17.4
T	BC-02	2	1	12	t02PF11	2.85	2.96	20.8
T	BC-03	2	1	13	t10PF11	1.43	2.88	20.8
T	AF-05	2	1	14	t06PF21	2.05	2.55	19.8
T	Batch 1	2	1	15	BCHPF213	2.30	1.98	23.1
T	LRM	2	1	16	LRMPF213	2.39	<0.100	25.2
T	Batch 1	2	2	1	BCHPF221	2.46	2.01	22.7
T	LRM	2	2	2	LRMPF221	2.51	<0.100	24.6
T	BC-02	2	2	3	t02PF12	2.87	2.96	20.3
T	AF-04	2	2	4	t01PF12	2.63	2.24	16.9
T	BC-03	2	2	5	t10PF22	1.50	2.93	20.7
T	BC-01	2	2	6	t04PF12	1.51	2.98	22.4
T	AF-05	2	2	7	t06PF12	2.16	2.63	20.1
T	Batch 1	2	2	8	BCHPF222	2.28	1.98	22.3
T	LRM	2	2	9	LRMPF222	2.26	<0.100	23.5
T	AF-04	2	2	10	t01PF22	2.75	2.33	17.4
T	BC-02	2	2	11	t02PF22	2.73	2.86	19.7
T	BC-03	2	2	12	t10PF12	1.48	2.92	20.7
T	BC-01	2	2	13	t04PF22	1.49	2.96	22.2
T	AF-05	2	2	14	t06PF22	2.14	2.64	20.0
T	Batch 1	2	2	15	BCHPF223	2.41	2.06	23.3
T	LRM	2	2	16	LRMPF223	2.58	<0.100	26.4
U	Batch 1	1	1	1	BCHPF111	2.48	1.97	23.3
U	LRM	1	1	2	LRMPF111	2.46	<0.100	24.8

Table A-3. Measured Elemental Concentrations for the Glasses Prepared Using Peroxide Fusion (continued)

Series	Glass ID	Block	Sub-Blk	Sequence	Lab ID	B (wt %)	Li (wt %)	Si (wt %)
U	BC-06	1	1	3	u05PF21	2.91	2.90	19.1
U	BS-04	1	1	4	u08PF21	2.31	2.90	19.9
U	BC-07	1	1	5	u07PF21	2.74	2.79	16.9
U	BC-07	1	1	6	u07PF11	2.67	2.73	17.5
U	BS-03	1	1	7	u09PF21	2.28	3.18	21.3
U	Batch 1	1	1	8	BCHPF112	2.33	1.93	23.1
U	LRM	1	1	9	LRMPF112	2.40	<0.100	25.2
U	BC-06	1	1	10	u05PF11	2.81	2.82	19.1
U	BS-04	1	1	11	u08PF11	2.21	2.82	19.2
U	BC-05	1	1	12	u03PF11	2.68	2.76	20.9
U	BC-05	1	1	13	u03PF21	2.71	2.77	19.3
U	BS-03	1	1	14	u09PF11	2.29	3.19	21.1
U	Batch 1	1	1	15	BCHPF113	2.31	1.93	23.3
U	LRM	1	1	16	LRMPF113	2.40	<0.100	24.9
U	Batch 1	1	2	1	BCHPF121	2.38	1.90	23.5
U	LRM	1	2	2	LRMPF121	2.34	<0.100	25.1
U	BC-05	1	2	3	u03PF12	2.73	2.83	21.3
U	BC-06	1	2	4	u05PF12	2.78	2.88	19.1
U	BS-03	1	2	5	u09PF22	2.16	3.15	21.1
U	BS-03	1	2	6	u09PF12	2.18	3.17	20.9
U	BS-04	1	2	7	u08PF22	2.17	2.89	19.5
U	Batch 1	1	2	8	BCHPF122	2.24	1.92	24.2
U	LRM	1	2	9	LRMPF122	2.30	<0.100	25.5
U	BC-07	1	2	10	u07PF22	2.88	2.95	16.8
U	BC-05	1	2	11	u03PF22	2.65	2.77	18.8
U	BC-07	1	2	12	u07PF12	2.84	2.95	17.2
U	BC-06	1	2	13	u05PF22	2.88	2.99	19.2
U	BS-04	1	2	14	u08PF12	2.27	3.00	18.9
U	Batch 1	1	2	15	BCHPF123	2.44	2.03	23.9
U	LRM	1	2	16	LRMPF123	2.37	<0.100	25.7
U	Batch 1	2	1	1	BCHPF211	2.43	1.94	23.1
U	LRM	2	1	2	LRMPF211	2.29	<0.100	25.2
U	BC-09	2	1	3	u10PF21	2.08	2.84	19.3
U	BC-08	2	1	4	u01PF21	1.43	2.83	18.9
U	BS-02	2	1	5	u06PF11	1.47	3.23	21.8
U	BS-05	2	1	6	u04PF21	1.83	2.67	21.0
U	BS-05	2	1	7	u04PF11	1.72	2.55	20.9
U	Batch 1	2	1	8	BCHPF212	2.35	1.97	23.9
U	LRM	2	1	9	LRMPF212	2.44	<0.100	25.7
U	BS-01	2	1	10	u02PF21	1.53	2.95	22.1
U	BC-08	2	1	11	u01PF11	1.47	2.93	19.3
U	BS-01	2	1	12	u02PF11	1.55	3.02	21.9
U	BC-09	2	1	13	u10PF11	2.19	2.99	19.6
U	BS-02	2	1	14	u06PF21	1.43	3.23	20.7
U	Batch 1	2	1	15	BCHPF213	2.33	1.97	24.2
U	LRM	2	1	16	LRMPF213	2.43	<0.100	25.6
U	Batch 1	2	2	1	BCHPF221	2.50	1.99	23.5
U	LRM	2	2	2	LRMPF221	2.39	<0.100	25.4
U	BS-01	2	2	3	u02PF12	1.49	2.91	22.6
U	BC-08	2	2	4	u01PF12	1.47	2.91	19.1
U	BC-09	2	2	5	u10PF22	1.95	2.75	20.0
U	BS-05	2	2	6	u04PF12	1.77	2.61	21.5
U	BS-02	2	2	7	u06PF12	1.36	3.10	20.7
U	Batch 1	2	2	8	BCHPF222	2.22	1.90	23.3
U	LRM	2	2	9	LRMPF222	2.34	<0.100	25.3
U	BC-08	2	2	10	u01PF22	1.39	2.77	18.7
U	BS-01	2	2	11	u02PF22	1.44	2.88	22.7
U	BC-09	2	2	12	u10PF12	2.04	2.86	19.8
U	BS-05	2	2	13	u04PF22	1.79	2.65	21.2
U	BS-02	2	2	14	u06PF22	1.34	3.09	21.0
U	Batch 1	2	2	15	BCHPF223	2.20	1.88	23.5
U	LRM	2	2	16	LRMPF223	2.22	<0.100	25.7
V	Batch 1	1	1	1	BCHPF111	2.42	1.95	22.8
V	LRM	1	1	2	LRMPF111	2.44	<0.100	24.6
V	BS-09	1	1	3	v05PF21	2.30	2.38	19.8
V	LL-03	1	1	4	v08PF21	3.24	3.39	20.4

Table A-3. Measured Elemental Concentrations for the Glasses Prepared Using Peroxide Fusion (continued)

Series	Glass ID	Block	Sub-Blk	Sequence	Lab ID	B (wt %)	Li (wt %)	Si (wt %)
V	BS-07	1	1	5	v07PF21	1.58	2.48	22.0
V	BS-07	1	1	6	v07PF11	1.51	2.42	21.3
V	BS-06	1	1	7	v09PF21	1.52	2.99	21.8
V	Batch 1	1	1	8	BCHPF112	2.33	1.93	22.7
V	LRM	1	1	9	LRMPF112	2.39	<0.100	24.2
V	BS-09	1	1	10	v05PF11	2.30	2.36	19.9
V	LL-03	1	1	11	v08PF11	3.28	3.41	20.7
V	LL-05	1	1	12	v03PF11	2.12	2.83	19.5
V	LL-05	1	1	13	v03PF21	2.06	2.79	19.2
V	BS-06	1	1	14	v09PF11	1.54	3.03	22.1
V	Batch 1	1	1	15	BCHPF113	2.34	1.93	22.9
V	LRM	1	1	16	LRMPF113	2.36	<0.100	23.8
V	Batch 1	1	2	1	BCHPF121	2.39	1.97	22.7
V	LRM	1	2	2	LRMPF121	2.38	<0.100	23.8
V	LL-05	1	2	3	v03PF12	2.16	2.91	19.8
V	BS-09	1	2	4	v05PF12	2.22	2.36	19.5
V	BS-06	1	2	5	v09PF22	1.46	2.96	21.3
V	BS-06	1	2	6	v09PF12	1.47	2.99	21.5
V	LL-03	1	2	7	v08PF22	3.39	3.56	20.4
V	Batch 1	1	2	8	BCHPF122	2.23	1.91	22.1
V	LRM	1	2	9	LRMPF122	2.30	<0.100	23.8
V	BS-07	1	2	10	v07PF22	1.44	2.36	20.4
V	LL-05	1	2	11	v03PF22	2.12	2.89	19.7
V	BS-07	1	2	12	v07PF12	1.44	2.40	20.7
V	BS-09	1	2	13	v05PF22	2.17	2.35	19.1
V	LL-03	1	2	14	v08PF12	3.11	3.36	20.0
V	Batch 1	1	2	15	BCHPF123	2.34	1.99	23.0
V	LRM	1	2	16	LRMPF123	2.37	<0.100	24.2
V	Batch 1	2	1	1	BCHPF211	2.53	2.07	23.3
V	LRM	2	1	2	LRMPF211	2.48	<0.100	24.2
V	LL-06	2	1	3	v10PF21	2.82	2.93	17.4
V	LL-11	2	1	4	v01PF21	1.54	2.87	20.0
V	LL-12	2	1	5	v06PF11	2.79	2.91	18.4
V	LL-10	2	1	6	v04PF21	2.77	2.92	21.0
V	LL-10	2	1	7	v04PF11	2.72	2.86	21.6
V	Batch 1	2	1	8	BCHPF212	2.29	1.96	21.8
V	LRM	2	1	9	LRMPF212	2.35	<0.100	23.5
V	BS-08	2	1	10	v02PF21	2.33	2.71	20.5
V	LL-11	2	1	11	v01PF11	1.55	2.92	20.3
V	BS-08	2	1	12	v02PF11	2.32	2.73	20.6
V	LL-06	2	1	13	v10PF11	2.77	2.89	17.2
V	LL-12	2	1	14	v06PF21	2.75	2.87	18.2
V	Batch 1	2	1	15	BCHPF213	2.42	2.04	22.9
V	LRM	2	1	16	LRMPF213	2.45	<0.100	23.9
V	Batch 1	2	2	1	BCHPF221	2.35	1.94	23.2
V	LRM	2	2	2	LRMPF221	2.42	<0.100	25.6
V	BS-08	2	2	3	v02PF12	2.23	2.69	21.1
V	LL-11	2	2	4	v01PF12	1.45	2.92	21.1
V	LL-06	2	2	5	v10PF22	2.73	2.89	17.9
V	LL-10	2	2	6	v04PF12	2.85	2.97	21.3
V	LL-12	2	2	7	v06PF12	2.77	2.91	19.4
V	Batch 1	2	2	8	BCHPF222	2.36	2.00	23.8
V	LRM	2	2	9	LRMPF222	2.41	<0.100	25.4
V	LL-11	2	2	10	v01PF22	1.39	2.78	20.2
V	BS-08	2	2	11	v02PF22	2.20	2.65	21.1
V	LL-06	2	2	12	v10PF12	2.65	2.83	17.5
V	LL-10	2	2	13	v04PF22	2.73	2.92	20.7
V	LL-12	2	2	14	v06PF22	2.68	2.84	18.8
V	Batch 1	2	2	15	BCHPF223	2.35	1.97	23.6
V	LRM	2	2	16	LRMPF223	2.41	<0.100	25.7
W	Batch 1	1	1	1	BCHPF111	2.45	1.99	23.5
W	LRM	1	1	2	LRMPF111	2.48	<0.100	24.9
W	LOL-12	1	1	3	w05PF21	1.64	2.41	24.1
W	QB-04	1	1	4	w08PF21	1.50	1.96	20.9
W	LT-05	1	1	5	w07PF21	1.76	2.63	20.7
W	LT-05	1	1	6	w07PF11	1.78	2.63	20.4

Table A-3. Measured Elemental Concentrations for the Glasses Prepared Using Peroxide Fusion (continued)

Series	Glass ID	Block	Sub-Blk	Sequence	Lab ID	B (wt %)	Li (wt %)	Si (wt %)
W	LT-06	1	1	7	w09PF21	2.05	2.31	19.3
W	Batch 1	1	1	8	BCHPF112	2.14	1.91	23.5
W	LRM	1	1	9	LRMPF112	2.18	<0.100	24.9
W	LOL-12	1	1	10	w05PF11	1.66	2.42	23.4
W	QB-04	1	1	11	w08PF11	1.53	2.05	21.0
W	LT-10	1	1	12	w03PF11	1.37	3.12	20.4
W	LT-10	1	1	13	w03PF21	1.36	3.13	20.2
W	LT-06	1	1	14	w09PF11	2.05	2.29	19.2
W	Batch 1	1	1	15	BCHPF113	2.22	1.94	23.6
W	LRM	1	1	16	LRMPF113	2.25	<0.100	25.3
W	Batch 1	1	2	1	BCHPF121	2.42	1.96	24.5
W	LRM	1	2	2	LRMPF121	2.34	<0.100	26.1
W	LT-10	1	2	3	w03PF12	1.52	3.14	21.5
W	LOL-12	1	2	4	w05PF12	1.65	2.36	24.3
W	LT-06	1	2	5	w09PF22	2.18	2.33	19.7
W	LT-06	1	2	6	w09PF12	2.13	2.28	19.5
W	QB-04	1	2	7	w08PF22	1.53	1.94	20.8
W	Batch 1	1	2	8	BCHPF122	2.21	1.88	24.6
W	LRM	1	2	9	LRMPF122	2.37	<0.100	26.2
W	LT-05	1	2	10	w07PF22	1.81	2.57	20.9
W	LT-10	1	2	11	w03PF22	1.44	3.15	20.9
W	LT-05	1	2	12	w07PF12	1.83	2.60	20.6
W	LOL-12	1	2	13	w05PF22	1.55	2.31	23.9
W	QB-04	1	2	14	w08PF12	1.58	2.01	20.8
W	Batch 1	1	2	15	BCHPF123	2.41	1.95	24.3
W	LRM	1	2	16	LRMPF123	2.41	<0.100	25.4
W	Batch 1	2	1	1	BCHPF211	2.52	1.98	24.0
W	LRM	2	1	2	LRMPF211	2.53	<0.100	25.4
W	LT-12	2	1	3	w10PF21	2.39	2.98	19.6
W	LT-04	2	1	4	w01PF21	1.62	2.97	22.0
W	QB-03	2	1	5	w06PF11	1.64	2.28	21.6
W	LT-01	2	1	6	w04PF21	1.85	3.50	25.4
W	LT-01	2	1	7	w04PF11	1.82	3.45	25.6
W	Batch 1	2	1	8	BCHPF212	2.41	1.96	23.8
W	LRM	2	1	9	LRMPF212	2.41	<0.100	25.3
W	LT-11	2	1	10	w02PF21	2.32	3.21	20.9
W	LT-04	2	1	11	w01PF11	1.58	2.97	22.0
W	LT-11	2	1	12	w02PF11	2.31	3.25	20.6
W	LT-12	2	1	13	w10PF11	2.35	2.97	19.8
W	QB-03	2	1	14	w06PF21	1.65	2.32	21.0
W	Batch 1	2	1	15	BCHPF213	2.38	2.00	23.5
W	LRM	2	1	16	LRMPF213	2.48	<0.100	24.6
W	Batch 1	2	2	1	BCHPF221	2.31	1.89	23.3
W	LRM	2	2	2	LRMPF221	2.25	<0.100	24.9
W	LT-11	2	2	3	w02PF12	2.09	3.09	21.6
W	LT-04	2	2	4	w01PF12	1.38	2.85	21.6
W	LT-12	2	2	5	w10PF22	2.07	2.83	20.6
W	LT-01	2	2	6	w04PF12	1.56	3.26	26.8
W	QB-03	2	2	7	w06PF12	1.39	2.15	22.7
W	Batch 1	2	2	8	BCHPF222	2.17	1.88	23.7
W	LRM	2	2	9	LRMPF222	2.15	<0.100	25.4
W	LT-04	2	2	10	w01PF22	1.40	2.82	21.9
W	LT-11	2	2	11	w02PF22	2.14	3.18	21.6
W	LT-12	2	2	12	w10PF12	2.18	2.91	20.5
W	LT-01	2	2	13	w04PF22	1.63	3.39	26.3
W	QB-03	2	2	14	w06PF22	1.48	2.25	22.2
W	Batch 1	2	2	15	BCHPF223	2.25	1.93	23.4
W	LRM	2	2	16	LRMPF223	2.27	<0.100	25.4
X	Batch 1	1	1	1	BCHPF111	2.43	1.95	23.9
X	LRM	1	1	2	LRMPF111	2.42	0.03	25.4
X	QB-33	1	1	3	x05PF21	2.67	2.01	21.7
X	QB-20	1	1	4	x08PF21	2.52	1.78	18.7
X	QB-36	1	1	5	x07PF21	1.52	2.22	21.4
X	QB-36	1	1	6	x07PF11	1.59	2.23	22.0
X	SPS-02	1	1	7	x09PF21	1.51	2.06	21.1
X	Batch 1	1	1	8	BCHPF112	2.39	1.96	24.1

Table A-3. Measured Elemental Concentrations for the Glasses Prepared Using Peroxide Fusion (continued)

Series	Glass ID	Block	Sub-Blk	Sequence	Lab ID	B (wt %)	Li (wt %)	Si (wt %)
X	LRM	1	1	9	LRMPF112	2.39	0.03	25.8
X	QB-33	1	1	10	x05PF11	2.73	1.95	22.1
X	QB-20	1	1	11	x08PF11	2.46	1.76	18.5
X	QB-22	1	1	12	x03PF11	1.46	1.79	19.2
X	QB-22	1	1	13	x03PF21	1.47	1.82	19.6
X	SPS-02	1	1	14	x09PF11	1.50	2.07	21.0
X	Batch 1	1	1	15	BCHPF113	2.39	1.96	23.8
X	LRM	1	1	16	LRMPF113	2.48	0.04	25.5
X	Batch 1	1	2	1	BCHPF121	2.32	1.93	23.4
X	LRM	1	2	2	LRMPF121	2.38	0.02	24.7
X	QB-22	1	2	3	x03PF12	1.35	1.74	18.8
X	QB-33	1	2	4	x05PF12	2.63	1.92	22.3
X	SPS-02	1	2	5	x09PF22	1.43	2.05	21.4
X	SPS-02	1	2	6	x09PF12	1.38	2.03	21.5
X	QB-20	1	2	7	x08PF22	2.31	1.70	19.1
X	Batch 1	1	2	8	BCHPF122	2.22	1.89	23.8
X	LRM	1	2	9	LRMPF122	2.31	0.02	25.3
X	QB-36	1	2	10	x07PF22	1.47	2.22	22.0
X	QB-22	1	2	11	x03PF22	1.38	1.80	19.4
X	QB-36	1	2	12	x07PF12	1.47	2.19	22.2
X	QB-33	1	2	13	x05PF22	2.54	1.97	22.4
X	QB-20	1	2	14	x08PF12	2.46	1.80	18.9
X	Batch 1	1	2	15	BCHPF123	2.31	1.94	23.6
X	LRM	1	2	16	LRMPF123	2.40	0.02	24.9
X	Batch 1	2	1	1	BCHPF211	2.47	2.02	23.5
X	LRM	2	1	2	LRMPF211	2.44	0.05	24.5
X	QB-34	2	1	3	x10PF21	1.64	2.29	21.7
X	QB-19	2	1	4	x01PF21	1.51	2.17	20.8
X	QB-35	2	1	5	x06PF11	1.58	2.00	21.6
X	QB-37	2	1	6	x04PF21	1.55	2.57	22.8
X	QB-37	2	1	7	x04PF11	1.55	2.58	22.7
X	Batch 1	2	1	8	BCHPF212	2.49	2.05	23.1
X	LRM	2	1	9	LRMPF212	2.48	0.05	24.3
X	QB-32	2	1	10	x02PF21	1.68	2.33	23.4
X	QB-19	2	1	11	x01PF11	1.48	2.13	20.7
X	QB-32	2	1	12	x02PF11	1.59	2.28	22.5
X	QB-34	2	1	13	x10PF11	1.61	2.33	21.9
X	QB-35	2	1	14	x06PF21	1.64	2.08	21.0
X	Batch 1	2	1	15	BCHPF213	2.50	2.08	23.4
X	LRM	2	1	16	LRMPF213	2.54	0.05	24.7
X	Batch 1	2	2	1	BCHPF221	2.41	1.98	23.8
X	LRM	2	2	2	LRMPF221	2.38	0.07	25.0
X	QB-32	2	2	3	x02PF12	1.42	2.14	23.0
X	QB-19	2	2	4	x01PF12	1.36	2.02	21.5
X	QB-34	2	2	5	x10PF22	1.47	2.17	21.8
X	QB-37	2	2	6	x04PF12	1.50	2.52	22.2
X	QB-35	2	2	7	x06PF12	1.54	1.96	20.8
X	Batch 1	2	2	8	BCHPF222	2.29	1.94	23.7
X	LRM	2	2	9	LRMPF222	2.30	0.06	25.0
X	QB-19	2	2	10	x01PF22	1.51	2.14	21.5
X	QB-32	2	2	11	x02PF22	1.53	2.20	22.5
X	QB-34	2	2	12	x10PF12	1.48	2.20	21.1
X	QB-37	2	2	13	x04PF22	1.50	2.52	22.3
X	QB-35	2	2	14	x06PF22	1.50	1.96	20.0
X	Batch 1	2	2	15	BCHPF223	2.29	1.95	23.6
X	LRM	2	2	16	LRMPF223	2.37	0.06	24.6

Table A-4. Average Measured Chemical Compositions versus Targeted Compositions by Oxide by Glass ID

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Diff of Measured	% Diff of Measured
AB-06	Al_2O_3	11.2567	10.7560	0.5007	4.7%
AB-06	B_2O_3	5.4014	5.1200	0.2814	5.5%
AB-06	BaO	0.0296	0.0420	-0.0124	-29.5%
AB-06	CaO	0.6156	0.5650	0.0506	9.0%
AB-06	Ce_2O_3	0.0375	0.0350	0.0025	7.1%
AB-06	Cr_2O_3	0.1261	0.1370	-0.0109	-8.0%
AB-06	CuO	0.0541	0.0370	0.0171	46.2%
AB-06	Fe_2O_3	9.0714	8.9250	0.1464	1.6%
AB-06	K_2O	0.0602	0.0090	0.0512	568.9%
AB-06	La_2O_3	0.0261	0.0310	-0.0049	-15.8%
AB-06	Li_2O	5.1185	5.1200	-0.0015	0.0%
AB-06	MgO	0.2724	0.3220	-0.0496	-15.4%
AB-06	MnO	2.8116	2.7170	0.0946	3.5%
AB-06	Na_2O	15.2324	14.2750	0.9574	6.7%
AB-06	NiO	0.8675	0.9990	-0.1315	-13.2%
AB-06	PbO	0.0108	0.0080	0.0028	35.0%
AB-06	SiO_2	49.9527	49.5680	0.3847	0.8%
AB-06	SO_4	0.9055	1.2000	-0.2945	-24.5%
AB-06	TiO_2	0.0083	0.0000	0.0083	
AB-06	ZnO	0.0246	0.0230	0.0016	7.0%
AB-06	ZrO_2	0.0946	0.1110	-0.0164	-14.8%
AB-06	Sum	101.9776	100.0000	1.9776	2.0%
AF-01	Al_2O_3	12.3621	11.9930	0.3691	3.1%
AF-01	B_2O_3	4.9264	4.8000	0.1264	2.6%
AF-01	BaO	0.0472	0.0470	0.0002	0.4%
AF-01	CaO	0.6608	0.6300	0.0308	4.9%
AF-01	Ce_2O_3	0.0389	0.0390	-0.0001	-0.3%
AF-01	Cr_2O_3	0.1429	0.1520	-0.0091	-6.0%
AF-01	CuO	0.0454	0.0420	0.0034	8.1%
AF-01	Fe_2O_3	10.1223	9.9510	0.1713	1.7%
AF-01	K_2O	0.0602	0.0100	0.0502	502.0%
AF-01	La_2O_3	0.0328	0.0340	-0.0012	-3.5%
AF-01	Li_2O	4.7418	4.8000	-0.0582	-1.2%
AF-01	MgO	0.3230	0.3590	-0.0360	-10.0%
AF-01	MnO	3.1215	3.0300	0.0915	3.0%
AF-01	Na_2O	15.7379	15.0070	0.7309	4.9%
AF-01	NiO	0.9964	1.1140	-0.1176	-10.6%
AF-01	PbO	0.0108	0.0090	0.0018	20.0%
AF-01	SiO_2	45.8880	46.6340	-0.7460	-1.6%
AF-01	SO_4	0.9737	1.2000	-0.2263	-18.9%
AF-01	TiO_2	0.0083	0.0000	0.0083	
AF-01	ZnO	0.0314	0.0260	0.0054	20.8%
AF-01	ZrO_2	0.1280	0.1240	0.0040	3.2%
AF-01	Sum	100.3996	100.0010	0.3986	0.4%
AF-02	Al_2O_3	12.0881	11.9930	0.0951	0.8%
AF-02	B_2O_3	8.5488	8.4000	0.1488	1.8%
AF-02	BaO	0.0391	0.0470	-0.0079	-16.8%
AF-02	CaO	0.6790	0.6300	0.0490	7.8%
AF-02	Ce_2O_3	0.0471	0.0390	0.0081	20.8%
AF-02	Cr_2O_3	0.1367	0.1520	-0.0153	-10.1%
AF-02	CuO	0.0413	0.0420	-0.0007	-1.7%
AF-02	Fe_2O_3	9.9757	9.9510	0.0247	0.2%
AF-02	K_2O	0.0602	0.0100	0.0502	502.0%
AF-02	La_2O_3	0.0323	0.0340	-0.0017	-5.0%
AF-02	Li_2O	4.5964	4.8000	-0.2036	-4.2%
AF-02	MgO	0.3238	0.3590	-0.0352	-9.8%
AF-02	MnO	2.9956	3.0300	-0.0344	-1.1%

Table A-4. Average Measured Chemical Compositions versus Targeted Compositions by Oxide by Glass ID (continued)

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Diff of Measured	% Diff of Measured
AF-02	Na_2O	15.0302	15.0070	0.0232	0.2%
AF-02	NiO	0.9811	1.1140	-0.1329	-11.9%
AF-02	PbO	0.0108	0.0090	0.0018	20.0%
AF-02	SiO_2	43.9091	43.0340	0.8751	2.0%
AF-02	SO_4	0.9976	1.2000	-0.2024	-16.9%
AF-02	TiO_2	0.0083	0.0000	0.0083	
AF-02	ZnO	0.0305	0.0260	0.0045	17.3%
AF-02	ZrO_2	0.1239	0.1240	-0.0001	-0.1%
AF-02	Sum	100.6557	100.0010	0.6547	0.7%
AF-03	Al_2O_3	12.3762	11.9930	0.3832	3.2%
AF-03	B_2O_3	8.7018	8.4000	0.3018	3.6%
AF-03	BaO	0.0452	0.0470	-0.0018	-3.8%
AF-03	CaO	0.6702	0.6300	0.0402	6.4%
AF-03	Ce_2O_3	0.0413	0.0390	0.0023	5.9%
AF-03	Cr_2O_3	0.1403	0.1520	-0.0117	-7.7%
AF-03	CuO	0.0523	0.0420	0.0103	24.5%
AF-03	Fe_2O_3	9.8828	9.9510	-0.0682	-0.7%
AF-03	K_2O	0.0602	0.0100	0.0502	502.0%
AF-03	La_2O_3	0.0317	0.0340	-0.0023	-6.8%
AF-03	Li_2O	4.6772	4.8000	-0.1228	-2.6%
AF-03	MgO	0.3263	0.3590	-0.0327	-9.1%
AF-03	MnO	3.0795	3.0300	0.0495	1.6%
AF-03	Na_2O	13.1936	12.6070	0.5866	4.7%
AF-03	NiO	0.9945	1.1140	-0.1195	-10.7%
AF-03	PbO	0.0108	0.0090	0.0018	20.0%
AF-03	SiO_2	44.2835	45.4340	-1.1505	-2.5%
AF-03	SO_4	0.9527	1.2000	-0.2473	-20.6%
AF-03	TiO_2	0.0083	0.0000	0.0083	
AF-03	ZnO	0.0317	0.0260	0.0057	21.9%
AF-03	ZrO_2	0.1246	0.1240	0.0006	0.5%
AF-03	Sum	99.6846	100.0010	-0.3164	-0.3%
AF-04	Al_2O_3	12.2723	11.9930	0.2793	2.3%
AF-04	B_2O_3	8.5730	8.9300	-0.3570	-4.0%
AF-04	BaO	0.0335	0.0470	-0.0135	-28.7%
AF-04	CaO	5.5758	5.4250	0.1508	2.8%
AF-04	Ce_2O_3	0.0433	0.0390	0.0043	11.0%
AF-04	Cr_2O_3	0.1315	0.1520	-0.0205	-13.5%
AF-04	CuO	0.0407	0.0420	-0.0013	-3.1%
AF-04	Fe_2O_3	9.8256	9.9510	-0.1254	-1.3%
AF-04	K_2O	0.0602	0.0100	0.0502	502.0%
AF-04	La_2O_3	0.0369	0.0340	0.0029	8.5%
AF-04	Li_2O	4.8602	5.1690	-0.3088	-6.0%
AF-04	MgO	0.2993	0.3590	-0.0597	-16.6%
AF-04	MnO	3.0827	3.0300	0.0527	1.7%
AF-04	Na_2O	14.6932	14.1820	0.5112	3.6%
AF-04	NiO	0.9496	1.1140	-0.1644	-14.8%
AF-04	PbO	0.0108	0.0090	0.0018	20.0%
AF-04	SiO_2	36.9029	38.1650	-1.2621	-3.3%
AF-04	SO_4	1.0928	1.2000	-0.1072	-8.9%
AF-04	TiO_2	0.0083	0.0000	0.0083	
AF-04	ZnO	0.0271	0.0260	0.0011	4.2%
AF-04	ZrO_2	0.1249	0.1240	0.0009	0.7%
AF-04	Sum	98.6448	100.0010	-1.3562	-1.4%
AF-05	Al_2O_3	12.0172	11.9930	0.0242	0.2%
AF-05	B_2O_3	6.8020	6.8930	-0.0910	-1.3%
AF-05	BaO	0.0416	0.0470	-0.0054	-11.5%
AF-05	CaO	3.1202	3.0600	0.0602	2.0%

Table A-4. Average Measured Chemical Compositions versus Targeted Compositions by Oxide by Glass ID (continued)

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Diff of Measured	% Diff of Measured
AF-05	Ce_2O_3	0.0445	0.0390	0.0055	14.1%
AF-05	Cr_2O_3	0.1385	0.1520	-0.0135	-8.9%
AF-05	CuO	0.0466	0.0420	0.0046	11.0%
AF-05	Fe_2O_3	9.7327	9.9510	-0.2183	-2.2%
AF-05	K_2O	0.0602	0.0100	0.0502	502.0%
AF-05	La_2O_3	0.0325	0.0340	-0.0015	-4.4%
AF-05	Li_2O	5.5922	5.8750	-0.2828	-4.8%
AF-05	MgO	0.3292	0.3590	-0.0298	-8.3%
AF-05	MnO	3.0505	3.0300	0.0205	0.7%
AF-05	Na_2O	13.0318	12.8120	0.2198	1.7%
AF-05	NiO	0.9506	1.1140	-0.1634	-14.7%
AF-05	PbO	0.0108	0.0090	0.0018	20.0%
AF-05	SiO_2	42.6790	43.2310	-0.5520	-1.3%
AF-05	SO_4	1.0965	1.2000	-0.1035	-8.6%
AF-05	TiO_2	0.0083	0.0000	0.0083	
AF-05	ZnO	0.0352	0.0260	0.0092	35.4%
AF-05	ZrO_2	0.1199	0.1240	-0.0041	-3.3%
AF-05	Sum	98.9400	100.0010	-1.0610	-1.1%
Batch 1	Al_2O_3	4.8784	4.8770	0.0014	0.0%
Batch 1	B_2O_3	7.6043	7.7770	-0.1727	-2.2%
Batch 1	BaO	0.1389	0.1510	-0.0121	-8.0%
Batch 1	CaO	1.2227	1.2200	0.0027	0.2%
Batch 1	Ce_2O_3	0.0059	0.0000	0.0059	
Batch 1	Cr_2O_3	0.1114	0.1070	0.0044	4.1%
Batch 1	CuO	0.3873	0.3990	-0.0117	-2.9%
Batch 1	Fe_2O_3	12.6748	12.8390	-0.1642	-1.3%
Batch 1	K_2O	3.3030	3.3270	-0.0240	-0.7%
Batch 1	La_2O_3	0.0059	0.0000	0.0059	
Batch 1	Li_2O	4.2351	4.4290	-0.1939	-4.4%
Batch 1	MgO	1.3483	1.4190	-0.0707	-5.0%
Batch 1	MnO	1.7328	1.7260	0.0068	0.4%
Batch 1	Na_2O	8.9599	9.0030	-0.0431	-0.5%
Batch 1	NiO	0.6740	0.7510	-0.0770	-10.3%
Batch 1	PbO	0.0108	0.0000	0.0108	
Batch 1	SiO_2	50.1131	50.2200	-0.1069	-0.2%
Batch 1	SO_4	0.0731	0.0000	0.0731	
Batch 1	TiO_2	0.6388	0.6770	-0.0382	-5.6%
Batch 1	ZnO	0.0062	0.0000	0.0062	
Batch 1	ZrO_2	0.0890	0.0980	-0.0090	-9.2%
Batch 1	Sum	98.2137	99.0200	-0.8063	-0.8%
BC-01	Al_2O_3	12.1967	11.9930	0.2037	1.7%
BC-01	B_2O_3	4.6689	4.8000	-0.1311	-2.7%
BC-01	BaO	0.0405	0.0470	-0.0065	-13.8%
BC-01	CaO	0.6975	0.6300	0.0675	10.7%
BC-01	Ce_2O_3	0.0457	0.0390	0.0067	17.2%
BC-01	Cr_2O_3	0.1312	0.1520	-0.0208	-13.7%
BC-01	CuO	0.0426	0.0420	0.0006	1.4%
BC-01	Fe_2O_3	9.5504	9.9510	-0.4006	-4.0%
BC-01	K_2O	0.0602	0.0100	0.0502	502.0%
BC-01	La_2O_3	0.0328	0.0340	-0.0012	-3.5%
BC-01	Li_2O	6.2596	6.5990	-0.3394	-5.1%
BC-01	MgO	0.2852	0.3590	-0.0738	-20.6%
BC-01	MnO	3.0698	3.0300	0.0398	1.3%
BC-01	Na_2O	11.5726	11.4070	0.1656	1.5%
BC-01	NiO	0.9744	1.1140	-0.1396	-12.5%
BC-01	PbO	0.0108	0.0090	0.0018	20.0%
BC-01	SiO_2	47.1716	48.4350	-1.2634	-2.6%

Table A-4. Average Measured Chemical Compositions versus Targeted Compositions by Oxide by Glass ID (continued)

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Diff of Measured	% Diff of Measured
BC-01	SO_4	1.0411	1.2000	-0.1589	-13.2%
BC-01	TiO_2	0.0083	0.0000	0.0083	
BC-01	ZnO	0.0349	0.0260	0.0089	34.2%
BC-01	ZrO_2	0.1067	0.1240	-0.0173	-14.0%
BC-01	Sum	98.0014	100.0010	-1.9996	-2.0%
BC-02	Al_2O_3	12.0645	11.9930	0.0715	0.6%
BC-02	B_2O_3	9.0560	9.0830	-0.0270	-0.3%
BC-02	BaO	0.0405	0.0470	-0.0065	-13.8%
BC-02	CaO	0.6968	0.6300	0.0668	10.6%
BC-02	Ce_2O_3	0.0483	0.0390	0.0093	23.8%
BC-02	Cr_2O_3	0.1392	0.1520	-0.0128	-8.4%
BC-02	CuO	0.0426	0.0420	0.0006	1.4%
BC-02	Fe_2O_3	9.5468	9.9510	-0.4042	-4.1%
BC-02	K_2O	0.0602	0.0100	0.0502	502.0%
BC-02	La_2O_3	0.0340	0.0340	0.0000	0.0%
BC-02	Li_2O	6.2757	6.5320	-0.2563	-3.9%
BC-02	MgO	0.3225	0.3590	-0.0365	-10.2%
BC-02	MnO	3.0634	3.0300	0.0334	1.1%
BC-02	Na_2O	11.5389	11.3930	0.1459	1.3%
BC-02	NiO	0.9801	1.1140	-0.1339	-12.0%
BC-02	PbO	0.0108	0.0090	0.0018	20.0%
BC-02	SiO_2	43.3743	44.2330	-0.8587	-1.9%
BC-02	SO_4	1.0748	1.2000	-0.1252	-10.4%
BC-02	TiO_2	0.0083	0.0000	0.0083	
BC-02	ZnO	0.0308	0.0260	0.0048	18.5%
BC-02	ZrO_2	0.1189	0.1240	-0.0051	-4.1%
BC-02	Sum	98.5274	100.0010	-1.4736	-1.5%
BC-03	Al_2O_3	12.0408	11.9930	0.0478	0.4%
BC-03	B_2O_3	4.7252	4.7940	-0.0688	-1.4%
BC-03	BaO	0.0430	0.0470	-0.0040	-8.5%
BC-03	CaO	0.7209	0.6300	0.0909	14.4%
BC-03	Ce_2O_3	0.0471	0.0390	0.0081	20.8%
BC-03	Cr_2O_3	0.1315	0.1520	-0.0205	-13.5%
BC-03	CuO	0.0463	0.0420	0.0043	10.2%
BC-03	Fe_2O_3	9.6576	9.9510	-0.2934	-2.9%
BC-03	K_2O	0.0602	0.0100	0.0502	502.0%
BC-03	La_2O_3	0.0387	0.0340	0.0047	13.8%
BC-03	Li_2O	6.2380	6.5880	-0.3500	-5.3%
BC-03	MgO	0.3727	0.3590	0.0137	3.8%
BC-03	MnO	3.0537	3.0300	0.0237	0.8%
BC-03	Na_2O	14.5584	14.2850	0.2734	1.9%
BC-03	NiO	0.9483	1.1140	-0.1657	-14.9%
BC-03	PbO	0.0108	0.0090	0.0018	20.0%
BC-03	SiO_2	44.3370	45.5750	-1.2380	-2.7%
BC-03	SO_4	1.1257	1.2000	-0.0743	-6.2%
BC-03	TiO_2	0.0083	0.0000	0.0083	
BC-03	ZnO	0.0380	0.0260	0.0120	46.2%
BC-03	ZrO_2	0.1185	0.1240	-0.0055	-4.4%
BC-03	Sum	98.3210	100.0020	-1.6810	-1.7%
BC-04	Al_2O_3	12.2676	11.9930	0.2746	2.3%
BC-04	B_2O_3	5.0311	4.6740	0.3571	7.6%
BC-04	BaO	0.0380	0.0470	-0.0090	-19.1%
BC-04	CaO	5.5933	5.4260	0.1673	3.1%
BC-04	Ce_2O_3	0.0407	0.0390	0.0017	4.4%
BC-04	Cr_2O_3	0.1440	0.1520	-0.0080	-5.3%
BC-04	CuO	0.0397	0.0420	-0.0023	-5.5%
BC-04	Fe_2O_3	9.8721	9.9510	-0.0789	-0.8%

Table A-4. Average Measured Chemical Compositions versus Targeted Compositions by Oxide by Glass ID (continued)

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Diff of Measured	% Diff of Measured
BC-04	K_2O	0.0602	0.0100	0.0502	502.0%
BC-04	La_2O_3	0.0375	0.0340	0.0035	10.3%
BC-04	Li_2O	6.3134	6.4230	-0.1096	-1.7%
BC-04	MgO	0.3171	0.3590	-0.0419	-11.7%
BC-04	MnO	3.0731	3.0300	0.0431	1.4%
BC-04	Na_2O	11.8422	11.3730	0.4692	4.1%
BC-04	NiO	0.9620	1.1140	-0.1520	-13.6%
BC-04	PbO	0.0108	0.0090	0.0018	20.0%
BC-04	SiO_2	43.7487	43.9750	-0.2263	-0.5%
BC-04	SO_4	1.0808	1.2000	-0.1192	-9.9%
BC-04	TiO_2	0.0083	0.0000	0.0083	
BC-04	ZnO	0.0383	0.0260	0.0123	47.3%
BC-04	ZrO_2	0.1331	0.1240	0.0091	7.3%
BC-04	Sum	100.6519	100.0010	0.6509	0.7%
BC-05	Al_2O_3	12.3384	11.9930	0.3454	2.9%
BC-05	B_2O_3	8.6696	8.8450	-0.1754	-2.0%
BC-05	BaO	0.0374	0.0470	-0.0096	-20.4%
BC-05	CaO	5.4709	5.3800	0.0909	1.7%
BC-05	Ce_2O_3	0.0416	0.0390	0.0026	6.7%
BC-05	Cr_2O_3	0.1396	0.1520	-0.0124	-8.2%
BC-05	CuO	0.0413	0.0420	-0.0007	-1.7%
BC-05	Fe_2O_3	9.7291	9.9510	-0.2219	-2.2%
BC-05	K_2O	0.0602	0.0100	0.0502	502.0%
BC-05	La_2O_3	0.0358	0.0340	0.0018	5.3%
BC-05	Li_2O	5.9904	6.3610	-0.3706	-5.8%
BC-05	MgO	0.3383	0.3590	-0.0207	-5.8%
BC-05	MnO	3.1441	3.0300	0.1141	3.8%
BC-05	Na_2O	11.5389	11.3620	0.1769	1.6%
BC-05	NiO	1.0021	1.1140	-0.1119	-10.0%
BC-05	PbO	0.0108	0.0090	0.0018	20.0%
BC-05	SiO_2	42.9464	39.9220	3.0244	7.6%
BC-05	SO_4	1.1489	1.2000	-0.0511	-4.3%
BC-05	TiO_2	0.0083	0.0000	0.0083	
BC-05	ZnO	0.0286	0.0260	0.0026	10.0%
BC-05	ZrO_2	0.1344	0.1240	0.0104	8.4%
BC-05	Sum	102.8552	100.0000	2.8552	2.9%
BC-06	Al_2O_3	11.8613	11.9930	-0.1317	-1.1%
BC-06	B_2O_3	9.1606	9.0700	0.0906	1.0%
BC-06	BaO	0.0480	0.0470	0.0010	2.1%
BC-06	CaO	0.6188	0.6300	-0.0112	-1.8%
BC-06	Ce_2O_3	0.0416	0.0390	0.0026	6.7%
BC-06	Cr_2O_3	0.1352	0.1520	-0.0168	-11.1%
BC-06	CuO	0.0494	0.0420	0.0074	17.6%
BC-06	Fe_2O_3	9.5111	9.9510	-0.4399	-4.4%
BC-06	K_2O	0.0602	0.0100	0.0502	502.0%
BC-06	La_2O_3	0.0311	0.0340	-0.0029	-8.5%
BC-06	Li_2O	6.2380	6.5230	-0.2850	-4.4%
BC-06	MgO	0.3321	0.3590	-0.0269	-7.5%
BC-06	MnO	3.0537	3.0300	0.0237	0.8%
BC-06	Na_2O	14.1540	14.2440	-0.0900	-0.6%
BC-06	NiO	0.9541	1.1140	-0.1599	-14.4%
BC-06	PbO	0.0108	0.0090	0.0018	20.0%
BC-06	SiO_2	40.9141	41.4050	-0.4909	-1.2%
BC-06	SO_4	1.1272	1.2000	-0.0728	-6.1%
BC-06	TiO_2	0.0083	0.0000	0.0083	
BC-06	ZnO	0.0314	0.0260	0.0054	20.8%
BC-06	ZrO_2	0.1222	0.1240	-0.0018	-1.5%

Table A-4. Average Measured Chemical Compositions versus Targeted Compositions by Oxide by Glass ID (continued)

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Diff of Measured	% Diff of Measured
BC-06	Sum	98.4633	100.0020	-1.5387	-1.5%
BC-07	Al_2O_3	11.9842	11.9930	-0.0088	-0.1%
BC-07	B_2O_3	8.9594	8.8330	0.1264	1.4%
BC-07	BaO	0.0416	0.0470	-0.0054	-11.5%
BC-07	CaO	5.3624	5.3730	-0.0106	-0.2%
BC-07	Ce_2O_3	0.0419	0.0390	0.0029	7.4%
BC-07	Cr_2O_3	0.1403	0.1520	-0.0117	-7.7%
BC-07	CuO	0.0494	0.0420	0.0074	17.6%
BC-07	Fe_2O_3	10.2188	9.9510	0.2678	2.7%
BC-07	K_2O	0.0602	0.0100	0.0502	502.0%
BC-07	La_2O_3	0.0337	0.0340	-0.0003	-0.9%
BC-07	Li_2O	6.1465	6.3520	-0.2055	-3.2%
BC-07	MgO	0.3259	0.3590	-0.0331	-9.2%
BC-07	MnO	3.0537	3.0300	0.0237	0.8%
BC-07	Na_2O	13.9855	14.1390	-0.1535	-1.1%
BC-07	NiO	1.0129	1.1140	-0.1011	-9.1%
BC-07	PbO	0.0108	0.0090	0.0018	20.0%
BC-07	SiO_2	36.5820	37.1740	-0.5920	-1.6%
BC-07	SO_4	1.1182	1.2000	-0.0818	-6.8%
BC-07	TiO_2	0.0083	0.0000	0.0083	
BC-07	ZnO	0.0286	0.0260	0.0026	10.0%
BC-07	ZrO_2	0.1283	0.1240	0.0043	3.5%
BC-07	Sum	99.2927	100.0010	-0.7083	-0.7%
BC-08	Al_2O_3	11.8944	11.9930	-0.0986	-0.8%
BC-08	B_2O_3	4.6367	4.6670	-0.0303	-0.6%
BC-08	BaO	0.0396	0.0470	-0.0074	-15.7%
BC-08	CaO	5.3764	5.4190	-0.0426	-0.8%
BC-08	Ce_2O_3	0.0410	0.0390	0.0020	5.1%
BC-08	Cr_2O_3	0.1487	0.1520	-0.0033	-2.2%
BC-08	CuO	0.0451	0.0420	0.0031	7.4%
BC-08	Fe_2O_3	9.7684	9.9510	-0.1826	-1.8%
BC-08	K_2O	0.0602	0.0100	0.0502	502.0%
BC-08	La_2O_3	0.0340	0.0340	0.0000	0.0%
BC-08	Li_2O	6.1573	6.4140	-0.2567	-4.0%
BC-08	MgO	0.3536	0.3590	-0.0054	-1.5%
BC-08	MnO	3.0601	3.0300	0.0301	1.0%
BC-08	Na_2O	14.0866	14.1770	-0.0904	-0.6%
BC-08	NiO	0.9773	1.1140	-0.1367	-12.3%
BC-08	PbO	0.0108	0.0090	0.0018	20.0%
BC-08	SiO_2	40.6467	41.1940	-0.5473	-1.3%
BC-08	SO_4	1.1145	1.2000	-0.0855	-7.1%
BC-08	TiO_2	0.0083	0.0000	0.0083	
BC-08	ZnO	0.0324	0.0260	0.0064	24.6%
BC-08	ZrO_2	0.1199	0.1240	-0.0041	-3.3%
BC-08	Sum	98.6121	100.0010	-1.3889	-1.4%
BC-09	Al_2O_3	11.8708	11.9930	-0.1222	-1.0%
BC-09	B_2O_3	6.6491	6.8550	-0.2059	-3.0%
BC-09	BaO	0.0385	0.0470	-0.0085	-18.1%
BC-09	CaO	2.9908	3.0460	-0.0552	-1.8%
BC-09	Ce_2O_3	0.0395	0.0390	0.0005	1.3%
BC-09	Cr_2O_3	0.1363	0.1520	-0.0157	-10.3%
BC-09	CuO	0.0638	0.0420	0.0218	51.9%
BC-09	Fe_2O_3	9.5575	9.9510	-0.3935	-4.0%
BC-09	K_2O	0.0602	0.0100	0.0502	502.0%
BC-09	La_2O_3	0.0314	0.0340	-0.0026	-7.6%
BC-09	Li_2O	6.1573	6.4730	-0.3157	-4.9%
BC-09	MgO	0.3014	0.3590	-0.0576	-16.0%

Table A-4. Average Measured Chemical Compositions versus Targeted Compositions by Oxide by Glass ID (continued)

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Diff of Measured	% Diff of Measured
BC-09	MnO	3.0634	3.0300	0.0334	1.1%
BC-09	Na_2O	12.5600	12.7980	-0.2380	-1.9%
BC-09	NiO	0.9757	1.1140	-0.1383	-12.4%
BC-09	PbO	0.0108	0.0090	0.0018	20.0%
BC-09	SiO_2	42.0907	42.6990	-0.6083	-1.4%
BC-09	SO_4	1.1227	1.2000	-0.0773	-6.4%
BC-09	TiO_2	0.0083	0.0000	0.0083	
BC-09	ZnO	0.0271	0.0260	0.0011	4.2%
BC-09	ZrO_2	0.1239	0.1240	-0.0001	-0.1%
BC-09	Sum	97.8793	100.0010	-2.1217	-2.1%
BS-01	Al_2O_3	12.3951	11.9930	0.4021	3.4%
BS-01	B_2O_3	4.8379	4.8000	0.0379	0.8%
BS-01	BaO	0.0410	0.0470	-0.0060	-12.8%
BS-01	CaO	0.6146	0.6300	-0.0154	-2.4%
BS-01	Ce_2O_3	0.0436	0.0390	0.0046	11.8%
BS-01	Cr_2O_3	0.1378	0.1520	-0.0142	-9.3%
BS-01	CuO	0.0469	0.0420	0.0049	11.7%
BS-01	Fe_2O_3	10.0937	9.9510	0.1427	1.4%
BS-01	K_2O	0.0602	0.0100	0.0502	502.0%
BS-01	La_2O_3	0.0299	0.0340	-0.0041	-12.1%
BS-01	Li_2O	6.3295	6.5990	-0.2695	-4.1%
BS-01	MgO	0.3279	0.3590	-0.0311	-8.7%
BS-01	MnO	3.1860	3.0300	0.1560	5.1%
BS-01	Na_2O	11.7310	11.4070	0.3240	2.8%
BS-01	NiO	0.9903	1.1140	-0.1237	-11.1%
BS-01	PbO	0.0108	0.0090	0.0018	20.0%
BS-01	SiO_2	47.7599	48.4350	-0.6751	-1.4%
BS-01	SO_4	1.0343	1.2000	-0.1657	-13.8%
BS-01	TiO_2	0.0083	0.0000	0.0083	
BS-01	ZnO	0.0345	0.0260	0.0085	32.7%
BS-01	ZrO_2	0.1202	0.1240	-0.0038	-3.1%
BS-01	Sum	99.8337	100.0010	-0.1673	-0.2%
BS-02	Al_2O_3	12.1070	11.9930	0.1140	1.0%
BS-02	B_2O_3	4.5079	4.8000	-0.2921	-6.1%
BS-02	BaO	0.0380	0.0470	-0.0090	-19.1%
BS-02	CaO	3.5959	3.6300	-0.0341	-0.9%
BS-02	Ce_2O_3	0.0410	0.0390	0.0020	5.1%
BS-02	Cr_2O_3	0.1246	0.1520	-0.0274	-18.0%
BS-02	CuO	0.0516	0.0420	0.0096	22.9%
BS-02	Fe_2O_3	9.8363	9.9510	-0.1147	-1.2%
BS-02	K_2O	0.0602	0.0100	0.0502	502.0%
BS-02	La_2O_3	0.0323	0.0340	-0.0017	-5.0%
BS-02	Li_2O	6.8085	7.2000	-0.3915	-5.4%
BS-02	MgO	0.3192	0.3590	-0.0398	-11.1%
BS-02	MnO	3.0827	3.0300	0.0527	1.7%
BS-02	Na_2O	11.4479	11.4070	0.0409	0.4%
BS-02	NiO	0.9509	1.1140	-0.1631	-14.6%
BS-02	PbO	0.0108	0.0090	0.0018	20.0%
BS-02	SiO_2	45.0323	44.8340	0.1983	0.4%
BS-02	SO_4	1.0928	1.2000	-0.1072	-8.9%
BS-02	TiO_2	0.0083	0.0000	0.0083	
BS-02	ZnO	0.0308	0.0260	0.0048	18.5%
BS-02	ZrO_2	0.1189	0.1240	-0.0051	-4.1%
BS-02	Sum	99.2979	100.0010	-0.7031	-0.7%
BS-03	Al_2O_3	11.9275	11.9930	-0.0655	-0.5%
BS-03	B_2O_3	7.1723	7.2000	-0.0277	-0.4%
BS-03	BaO	0.0368	0.0470	-0.0102	-21.7%

Table A-4. Average Measured Chemical Compositions versus Targeted Compositions by Oxide by Glass ID (continued)

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Diff of Measured	% Diff of Measured
BS-03	CaO	0.6115	0.6300	-0.0185	-2.9%
BS-03	Ce_2O_3	0.0392	0.0390	0.0002	0.5%
BS-03	Cr_2O_3	0.1432	0.1520	-0.0088	-5.8%
BS-03	CuO	0.0554	0.0420	0.0134	31.9%
BS-03	Fe_2O_3	10.2259	9.9510	0.2749	2.8%
BS-03	K_2O	0.0602	0.0100	0.0502	502.0%
BS-03	La_2O_3	0.0273	0.0340	-0.0067	-19.7%
BS-03	Li_2O	6.8301	7.2000	-0.3699	-5.1%
BS-03	MgO	0.3586	0.3590	-0.0004	-0.1%
BS-03	MnO	3.0375	3.0300	0.0075	0.2%
BS-03	Na_2O	11.3333	11.4070	-0.0737	-0.6%
BS-03	NiO	0.9824	1.1140	-0.1316	-11.8%
BS-03	PbO	0.0108	0.0090	0.0018	20.0%
BS-03	SiO_2	45.1392	45.4340	-0.2948	-0.6%
BS-03	SO_4	1.0568	1.2000	-0.1432	-11.9%
BS-03	TiO_2	0.0083	0.0000	0.0083	
BS-03	ZnO	0.0296	0.0260	0.0036	13.8%
BS-03	ZrO_2	0.1233	0.1240	-0.0007	-0.6%
BS-03	Sum	99.2093	100.0010	-0.7917	-0.8%
BS-04	Al_2O_3	11.9747	11.9930	-0.0183	-0.2%
BS-04	B_2O_3	7.2126	7.2000	0.0126	0.2%
BS-04	BaO	0.0449	0.0470	-0.0021	-4.5%
BS-04	CaO	3.5750	3.6300	-0.0550	-1.5%
BS-04	Ce_2O_3	0.0436	0.0390	0.0046	11.8%
BS-04	Cr_2O_3	0.1666	0.1520	0.0146	9.6%
BS-04	CuO	0.0469	0.0420	0.0049	11.7%
BS-04	Fe_2O_3	9.7541	9.9510	-0.1969	-2.0%
BS-04	K_2O	0.0602	0.0100	0.0502	502.0%
BS-04	La_2O_3	0.0367	0.0340	0.0027	7.9%
BS-04	Li_2O	6.2488	6.6000	-0.3512	-5.3%
BS-04	MgO	0.3250	0.3590	-0.0340	-9.5%
BS-04	MnO	3.0924	3.0300	0.0624	2.1%
BS-04	Na_2O	11.3569	11.4070	-0.0501	-0.4%
BS-04	NiO	1.0295	1.1140	-0.0845	-7.6%
BS-04	PbO	0.0108	0.0090	0.0018	20.0%
BS-04	SiO_2	41.4489	43.0340	-1.5851	-3.7%
BS-04	SO_4	1.1010	1.2000	-0.0990	-8.3%
BS-04	TiO_2	0.0083	0.0000	0.0083	
BS-04	ZnO	0.0355	0.0260	0.0095	36.5%
BS-04	ZrO_2	0.1108	0.1240	-0.0132	-10.6%
BS-04	Sum	97.6833	100.0010	-2.3177	-2.3%
BS-05	Al_2O_3	12.0456	11.9930	0.0526	0.4%
BS-05	B_2O_3	5.7234	6.0000	-0.2766	-4.6%
BS-05	BaO	0.0343	0.0470	-0.0127	-27.0%
BS-05	CaO	1.8015	1.8300	-0.0285	-1.6%
BS-05	Ce_2O_3	0.0433	0.0390	0.0043	11.0%
BS-05	Cr_2O_3	0.1516	0.1520	-0.0004	-0.3%
BS-05	CuO	0.0507	0.0420	0.0087	20.7%
BS-05	Fe_2O_3	9.6004	9.9510	-0.3506	-3.5%
BS-05	K_2O	0.0602	0.0100	0.0502	502.0%
BS-05	La_2O_3	0.0320	0.0340	-0.0020	-5.9%
BS-05	Li_2O	5.6406	6.0000	-0.3594	-6.0%
BS-05	MgO	0.3416	0.3590	-0.0174	-4.8%
BS-05	MnO	3.0827	3.0300	0.0527	1.7%
BS-05	Na_2O	12.5937	12.6070	-0.0133	-0.1%
BS-05	NiO	1.0250	1.1140	-0.0890	-8.0%
BS-05	PbO	0.0108	0.0090	0.0018	20.0%

Table A-4. Average Measured Chemical Compositions versus Targeted Compositions by Oxide by Glass ID (continued)

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Diff of Measured	% Diff of Measured
BS-05	SiO_2	45.2462	45.4340	-0.1878	-0.4%
BS-05	SO_4	1.0740	1.2000	-0.1260	-10.5%
BS-05	TiO_2	0.0083	0.0000	0.0083	
BS-05	ZnO	0.0330	0.0260	0.0070	26.9%
BS-05	ZrO_2	0.1229	0.1240	-0.0011	-0.9%
BS-05	Sum	98.7219	100.0010	-1.2791	-1.3%
BS-06	Al_2O_3	12.0692	11.9930	0.0762	0.6%
BS-06	B_2O_3	4.8218	4.8000	0.0218	0.5%
BS-06	BaO	0.0329	0.0470	-0.0141	-30.0%
BS-06	CaO	0.6559	0.6300	0.0259	4.1%
BS-06	Ce_2O_3	0.0439	0.0390	0.0049	12.6%
BS-06	Cr_2O_3	0.1462	0.1520	-0.0058	-3.8%
BS-06	CuO	0.0388	0.0420	-0.0032	-7.6%
BS-06	Fe_2O_3	9.3109	9.9510	-0.6401	-6.4%
BS-06	K_2O	0.0602	0.0100	0.0502	502.0%
BS-06	La_2O_3	0.0290	0.0340	-0.0050	-14.7%
BS-06	Li_2O	6.4426	6.6000	-0.1574	-2.4%
BS-06	MgO	0.3201	0.3590	-0.0389	-10.8%
BS-06	MnO	3.0763	3.0300	0.0463	1.5%
BS-06	Na_2O	13.5440	13.8070	-0.2630	-1.9%
BS-06	NiO	0.9976	1.1140	-0.1164	-10.4%
BS-06	PbO	0.0108	0.0090	0.0018	20.0%
BS-06	SiO_2	46.3693	46.0340	0.3353	0.7%
BS-06	SO_4	1.0860	1.2000	-0.1140	-9.5%
BS-06	TiO_2	0.0083	0.0000	0.0083	
BS-06	ZnO	0.0327	0.0260	0.0067	25.8%
BS-06	ZrO_2	0.1385	0.1240	0.0145	11.7%
BS-06	Sum	99.2350	100.0010	-0.7660	-0.8%
BS-07	Al_2O_3	11.8235	11.9930	-0.1695	-1.4%
BS-07	B_2O_3	4.8057	4.8000	0.0057	0.1%
BS-07	BaO	0.0405	0.0470	-0.0065	-13.8%
BS-07	CaO	3.6414	3.6300	0.0114	0.3%
BS-07	Ce_2O_3	0.0433	0.0390	0.0043	11.0%
BS-07	Cr_2O_3	0.1432	0.1520	-0.0088	-5.8%
BS-07	CuO	0.0432	0.0420	0.0012	2.9%
BS-07	Fe_2O_3	9.6755	9.9510	-0.2755	-2.8%
BS-07	K_2O	0.0602	0.0100	0.0502	502.0%
BS-07	La_2O_3	0.0346	0.0340	0.0006	1.8%
BS-07	Li_2O	5.1993	5.4000	-0.2007	-3.7%
BS-07	MgO	0.3250	0.3590	-0.0340	-9.5%
BS-07	MnO	3.0246	3.0300	-0.0054	-0.2%
BS-07	Na_2O	12.7453	13.2070	-0.4617	-3.5%
BS-07	NiO	0.9929	1.1140	-0.1211	-10.9%
BS-07	PbO	0.0108	0.0090	0.0018	20.0%
BS-07	SiO_2	45.1392	44.8340	0.3052	0.7%
BS-07	SO_4	1.0448	1.2000	-0.1552	-12.9%
BS-07	TiO_2	0.0083	0.0000	0.0083	
BS-07	ZnO	0.0317	0.0260	0.0057	21.9%
BS-07	ZrO_2	0.1192	0.1240	-0.0048	-3.9%
BS-07	Sum	98.9525	100.0010	-1.0485	-1.0%
BS-08	Al_2O_3	11.5968	11.9930	-0.3962	-3.3%
BS-08	B_2O_3	7.3092	7.2000	0.1092	1.5%
BS-08	BaO	0.0449	0.0470	-0.0021	-4.5%
BS-08	CaO	0.6744	0.6300	0.0444	7.0%
BS-08	Ce_2O_3	0.0536	0.0390	0.0146	37.4%
BS-08	Cr_2O_3	0.1257	0.1520	-0.0263	-17.3%
BS-08	CuO	0.0401	0.0420	-0.0019	-4.5%

Table A-4. Average Measured Chemical Compositions versus Targeted Compositions by Oxide by Glass ID (continued)

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Diff of Measured	% Diff of Measured
BS-08	Fe_2O_3	8.9428	9.9510	-1.0082	-10.1%
BS-08	K_2O	0.0602	0.0100	0.0502	502.0%
BS-08	La_2O_3	0.0399	0.0340	0.0059	17.4%
BS-08	Li_2O	5.8021	6.0000	-0.1979	-3.3%
BS-08	MgO	0.3346	0.3590	-0.0244	-6.8%
BS-08	MnO	2.9827	3.0300	-0.0473	-1.6%
BS-08	Na_2O	12.6240	13.2070	-0.5830	-4.4%
BS-08	NiO	0.9875	1.1140	-0.1265	-11.4%
BS-08	PbO	0.0108	0.0090	0.0018	20.0%
BS-08	SiO_2	44.5509	44.8340	-0.2831	-0.6%
BS-08	SO_4	1.0883	1.2000	-0.1117	-9.3%
BS-08	TiO_2	0.0083	0.0000	0.0083	
BS-08	ZnO	0.0293	0.0260	0.0033	12.7%
BS-08	ZrO_2	0.1165	0.1240	-0.0075	-6.0%
BS-08	Sum	97.4224	100.0010	-2.5786	-2.6%
BS-09	Al_2O_3	11.6960	11.9930	-0.2970	-2.5%
BS-09	B_2O_3	7.2367	7.2000	0.0367	0.5%
BS-09	BaO	0.0360	0.0470	-0.0110	-23.4%
BS-09	CaO	3.6169	3.6300	-0.0131	-0.4%
BS-09	Ce_2O_3	0.0442	0.0390	0.0052	13.3%
BS-09	Cr_2O_3	0.1560	0.1520	0.0040	2.6%
BS-09	CuO	0.0448	0.0420	0.0028	6.7%
BS-09	Fe_2O_3	9.5897	9.9510	-0.3613	-3.6%
BS-09	K_2O	0.0602	0.0100	0.0502	502.0%
BS-09	La_2O_3	0.0340	0.0340	0.0000	0.0%
BS-09	Li_2O	5.0862	5.4000	-0.3138	-5.8%
BS-09	MgO	0.3155	0.3590	-0.0435	-12.1%
BS-09	MnO	2.9891	3.0300	-0.0409	-1.3%
BS-09	Na_2O	12.7588	13.2070	-0.4482	-3.4%
BS-09	NiO	1.0097	1.1140	-0.1043	-9.4%
BS-09	PbO	0.0108	0.0090	0.0018	20.0%
BS-09	SiO_2	41.8768	42.4340	-0.5572	-1.3%
BS-09	SO_4	1.1040	1.2000	-0.0960	-8.0%
BS-09	TiO_2	0.0083	0.0000	0.0083	
BS-09	ZnO	0.0293	0.0260	0.0033	12.7%
BS-09	ZrO_2	0.1212	0.1240	-0.0028	-2.3%
BS-09	Sum	97.8244	100.0010	-2.1766	-2.2%
LL-03	Al_2O_3	8.9279	8.9950	-0.0671	-0.7%
LL-03	B_2O_3	10.4808	10.3050	0.1758	1.7%
LL-03	BaO	0.0229	0.0350	-0.0121	-34.6%
LL-03	CaO	6.0445	6.0060	0.0385	0.6%
LL-03	Ce_2O_3	0.0337	0.0290	0.0047	16.2%
LL-03	Cr_2O_3	0.1133	0.1140	-0.0007	-0.6%
LL-03	CuO	0.0410	0.0310	0.0100	32.3%
LL-03	Fe_2O_3	7.2486	7.4630	-0.2144	-2.9%
LL-03	K_2O	0.0602	0.0080	0.0522	652.5%
LL-03	La_2O_3	0.0290	0.0260	0.0030	11.5%
LL-03	Li_2O	7.3844	7.4110	-0.0266	-0.4%
LL-03	MgO	0.2467	0.2700	-0.0233	-8.6%
LL-03	MnO	2.2661	2.2720	-0.0059	-0.3%
LL-03	Na_2O	11.9467	12.2420	-0.2953	-2.4%
LL-03	NiO	0.7600	0.8350	-0.0750	-9.0%
LL-03	PbO	0.0108	0.0070	0.0038	54.3%
LL-03	SiO_2	43.5882	42.9390	0.6492	1.5%
LL-03	SO_4	0.8531	0.9000	-0.0469	-5.2%
LL-03	TiO_2	0.0083	0.0000	0.0083	
LL-03	ZnO	0.0237	0.0190	0.0047	24.7%

Table A-4. Average Measured Chemical Compositions versus Targeted Compositions by Oxide by Glass ID (continued)

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Diff of Measured	% Diff of Measured
LL-03	ZrO_2	0.0932	0.0930	0.0002	0.2%
LL-03	Sum	100.1830	100.0000	0.1830	0.2%
LL-05	Al_2O_3	12.1117	12.2370	-0.1253	-1.0%
LL-05	B_2O_3	6.8101	6.8550	-0.0449	-0.7%
LL-05	BaO	0.0363	0.0420	-0.0057	-13.6%
LL-05	CaO	3.0118	2.9840	0.0278	0.9%
LL-05	Ce_2O_3	0.0392	0.0350	0.0042	12.0%
LL-05	Cr_2O_3	0.1180	0.1370	-0.0190	-13.9%
LL-05	CuO	0.0394	0.0380	0.0014	3.7%
LL-05	Fe_2O_3	9.8149	10.1540	-0.3391	-3.3%
LL-05	K_2O	0.0602	0.0090	0.0512	568.9%
LL-05	La_2O_3	0.0293	0.0310	-0.0017	-5.5%
LL-05	Li_2O	6.1465	6.4730	-0.3265	-5.0%
LL-05	MgO	0.2943	0.3240	-0.0297	-9.2%
LL-05	MnO	2.7470	2.7310	0.0160	0.6%
LL-05	Na_2O	12.6881	13.0060	-0.3179	-2.4%
LL-05	NiO	0.8831	1.0040	-0.1209	-12.0%
LL-05	PbO	0.0108	0.0080	0.0028	35.0%
LL-05	SiO_2	41.8233	42.5980	-0.7747	-1.8%
LL-05	SO_4	1.1100	1.2000	-0.0900	-7.5%
LL-05	TiO_2	0.0083	0.0000	0.0083	
LL-05	ZnO	0.0271	0.0230	0.0041	17.8%
LL-05	ZrO_2	0.1067	0.1120	-0.0053	-4.7%
LL-05	Sum	97.9162	100.0010	-2.0848	-2.1%
LL-06	Al_2O_3	11.8708	12.2370	-0.3662	-3.0%
LL-06	B_2O_3	8.8306	8.8330	-0.0024	0.0%
LL-06	BaO	0.0327	0.0420	-0.0093	-22.1%
LL-06	CaO	5.2470	5.3110	-0.0640	-1.2%
LL-06	Ce_2O_3	0.0366	0.0350	0.0016	4.6%
LL-06	Cr_2O_3	0.1283	0.1370	-0.0087	-6.4%
LL-06	CuO	0.0454	0.0380	0.0074	19.5%
LL-06	Fe_2O_3	9.6719	10.1540	-0.4821	-4.7%
LL-06	K_2O	0.0602	0.0090	0.0512	568.9%
LL-06	La_2O_3	0.0293	0.0310	-0.0017	-5.5%
LL-06	Li_2O	6.2111	6.3520	-0.1409	-2.2%
LL-06	MgO	0.3715	0.3240	0.0475	14.7%
LL-06	MnO	2.7051	2.7310	-0.0259	-0.9%
LL-06	Na_2O	13.7361	14.3470	-0.6109	-4.3%
LL-06	NiO	0.8860	1.0040	-0.1180	-11.8%
LL-06	PbO	0.0108	0.0080	0.0028	35.0%
LL-06	SiO_2	37.4378	37.0720	0.3658	1.0%
LL-06	SO_4	1.1295	1.2000	-0.0705	-5.9%
LL-06	TiO_2	0.0083	0.0000	0.0083	
LL-06	ZnO	0.0293	0.0230	0.0063	27.4%
LL-06	ZrO_2	0.1060	0.1120	-0.0060	-5.4%
LL-06	Sum	98.5841	100.0000	-1.4159	-1.4%
LL-10	Al_2O_3	11.7149	12.2370	-0.5221	-4.3%
LL-10	B_2O_3	8.9111	9.0830	-0.1719	-1.9%
LL-10	BaO	0.0329	0.0420	-0.0091	-21.7%
LL-10	CaO	0.5954	0.5680	0.0274	4.8%
LL-10	Ce_2O_3	0.0387	0.0350	0.0037	10.6%
LL-10	Cr_2O_3	0.1253	0.1370	-0.0117	-8.5%
LL-10	CuO	0.0376	0.0380	-0.0004	-1.1%
LL-10	Fe_2O_3	9.4467	10.1540	-0.7073	-7.0%
LL-10	K_2O	0.0602	0.0090	0.0512	568.9%
LL-10	La_2O_3	0.0287	0.0310	-0.0023	-7.4%
LL-10	Li_2O	6.2811	6.5320	-0.2509	-3.8%

Table A-4. Average Measured Chemical Compositions versus Targeted Compositions by Oxide by Glass ID (continued)

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Diff of Measured	% Diff of Measured
LL-10	MgO	0.2715	0.3240	-0.0525	-16.2%
LL-10	MnO	2.6534	2.7310	-0.0776	-2.8%
LL-10	Na_2O	10.7773	11.6010	-0.8237	-7.1%
LL-10	NiO	0.8962	1.0040	-0.1078	-10.7%
LL-10	PbO	0.0108	0.0080	0.0028	35.0%
LL-10	SiO_2	45.2462	44.1310	1.1152	2.5%
LL-10	SO_4	1.0628	1.2000	-0.1372	-11.4%
LL-10	TiO_2	0.0083	0.0000	0.0083	
LL-10	ZnO	0.0261	0.0230	0.0031	13.5%
LL-10	ZrO_2	0.1212	0.1120	0.0092	8.2%
LL-10	Sum	98.3465	100.0000	-1.6535	-1.7%
LL-11	Al_2O_3	11.9983	12.2370	-0.2387	-2.0%
LL-11	B_2O_3	4.7735	4.6740	0.0995	2.1%
LL-11	BaO	0.0363	0.0420	-0.0057	-13.6%
LL-11	CaO	5.3729	5.3640	0.0089	0.2%
LL-11	Ce_2O_3	0.0395	0.0350	0.0045	12.9%
LL-11	Cr_2O_3	0.1436	0.1370	0.0066	4.8%
LL-11	CuO	0.0357	0.0380	-0.0023	-6.1%
LL-11	Fe_2O_3	9.9650	10.1540	-0.1890	-1.9%
LL-11	K_2O	0.0602	0.0090	0.0512	568.9%
LL-11	La_2O_3	0.0334	0.0310	0.0024	7.7%
LL-11	Li_2O	6.1842	6.4230	-0.2388	-3.7%
LL-11	MgO	0.2898	0.3240	-0.0342	-10.6%
LL-11	MnO	2.7147	2.7310	-0.0163	-0.6%
LL-11	Na_2O	11.2895	11.5820	-0.2925	-2.5%
LL-11	NiO	0.9086	1.0040	-0.0954	-9.5%
LL-11	PbO	0.0108	0.0080	0.0028	35.0%
LL-11	SiO_2	43.6417	43.8730	-0.2313	-0.5%
LL-11	SO_4	1.1939	1.2000	-0.0061	-0.5%
LL-11	TiO_2	0.0083	0.0000	0.0083	
LL-11	ZnO	0.0268	0.0230	0.0038	16.5%
LL-11	ZrO_2	0.1209	0.1120	0.0089	7.9%
LL-11	Sum	98.8477	100.0010	-1.1533	-1.2%
LL-12	Al_2O_3	11.9039	12.2370	-0.3331	-2.7%
LL-12	B_2O_3	8.8467	8.8450	0.0017	0.0%
LL-12	BaO	0.0301	0.0420	-0.0119	-28.3%
LL-12	CaO	5.3135	5.3180	-0.0045	-0.1%
LL-12	Ce_2O_3	0.0384	0.0350	0.0034	9.7%
LL-12	Cr_2O_3	0.1173	0.1370	-0.0197	-14.4%
LL-12	CuO	0.0341	0.0380	-0.0039	-10.3%
LL-12	Fe_2O_3	9.5826	10.1540	-0.5714	-5.6%
LL-12	K_2O	0.0602	0.0090	0.0512	568.9%
LL-12	La_2O_3	0.0299	0.0310	-0.0011	-3.5%
LL-12	Li_2O	6.2057	6.3610	-0.1553	-2.4%
LL-12	MgO	0.2852	0.3240	-0.0388	-12.0%
LL-12	MnO	2.6889	2.7310	-0.0421	-1.5%
LL-12	Na_2O	11.1749	11.5700	-0.3951	-3.4%
LL-12	NiO	0.8809	1.0040	-0.1231	-12.3%
LL-12	PbO	0.0108	0.0080	0.0028	35.0%
LL-12	SiO_2	40.0049	39.8210	0.1839	0.5%
LL-12	SO_4	1.1250	1.2000	-0.0750	-6.3%
LL-12	TiO_2	0.0083	0.0000	0.0083	
LL-12	ZnO	0.0280	0.0230	0.0050	21.7%
LL-12	ZrO_2	0.1216	0.1120	0.0096	8.6%
LL-12	Sum	98.4909	100.0000	-1.5091	-1.5%
LOL-12	Al_2O_3	8.5405	8.7388	-0.1983	-2.3%
LOL-12	B_2O_3	5.2323	5.4400	-0.2077	-3.8%

Table A-4. Average Measured Chemical Compositions versus Targeted Compositions by Oxide by Glass ID (continued)

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Diff of Measured	% Diff of Measured
LOL-12	BaO	0.0324	0.0448	-0.0124	-27.7%
LOL-12	CaO	0.4827	0.4259	0.0568	13.3%
LOL-12	Ce_2O_3	0.0697	0.0705	-0.0008	-1.1%
LOL-12	Cr_2O_3	0.0533	0.0372	0.0161	43.3%
LOL-12	CuO	0.0479	0.0366	0.0113	30.9%
LOL-12	Fe_2O_3	7.6417	7.8280	-0.1863	-2.4%
LOL-12	K_2O	0.0602	0.0302	0.0300	99.3%
LOL-12	La_2O_3	0.0287	0.0359	-0.0072	-20.1%
LOL-12	Li_2O	5.1131	5.4400	-0.3269	-6.0%
LOL-12	MgO	0.2156	0.2240	-0.0084	-3.8%
LOL-12	MnO	2.2757	2.3131	-0.0374	-1.6%
LOL-12	Na_2O	14.1540	14.6170	-0.4630	-3.2%
LOL-12	NiO	0.8850	0.9653	-0.0803	-8.3%
LOL-12	PbO	0.0108	0.0100	0.0008	8.0%
LOL-12	SiO_2	51.1828	52.3775	-1.1947	-2.3%
LOL-12	SO_4	0.5932	0.6000	-0.0068	-1.1%
LOL-12	TiO_2	0.4320	0.4457	-0.0137	-3.1%
LOL-12	ZnO	0.0305	0.0235	0.0070	29.8%
LOL-12	ZrO_2	0.0834	0.0826	0.0008	1.0%
LOL-12	Sum	97.1657	99.7867	-2.6210	-2.6%
LRM	Al_2O_3	9.7643	10.0000	-0.2357	-2.4%
LRM	B_2O_3	7.6972	8.0000	-0.3028	-3.8%
LRM	BaO	0.0056	0.0050	0.0006	12.0%
LRM	CaO	0.5683	0.5000	0.0683	13.7%
LRM	Ce_2O_3	0.0059	0.0000	0.0059	
LRM	Cr_2O_3	0.1974	0.2000	-0.0026	-1.3%
LRM	CuO	0.0063	.		
LRM	Fe_2O_3	1.5609	1.0000	0.5609	56.1%
LRM	K_2O	1.5112	1.5000	0.0112	0.7%
LRM	La_2O_3	0.0059	.		
LRM	Li_2O	0.1041	0.1000	0.0041	4.1%
LRM	MgO	0.0992	0.1000	-0.0008	-0.8%
LRM	MnO	0.0739	0.1000	-0.0261	-26.1%
LRM	Na_2O	20.9306	20.0000	0.9306	4.7%
LRM	NiO	0.1695	0.1000	0.0695	69.5%
LRM	PbO	0.0855	0.1000	-0.0145	-14.5%
LRM	SiO_2	53.5146	55.0000	-1.4854	-2.7%
LRM	SO_4	0.2464	0.2400	0.0064	2.7%
LRM	TiO_2	0.0984	0.1000	-0.0016	-1.6%
LRM	ZnO	0.0062	0.0000	0.0062	
LRM	ZrO_2	0.8611	1.0000	-0.1389	-13.9%
LRM	Sum	97.5124	98.0450	-0.5326	-0.5%
LT-01	Al_2O_3	8.9326	8.9950	-0.0624	-0.7%
LT-01	B_2O_3	5.5221	5.6000	-0.0779	-1.4%
LT-01	BaO	0.0338	0.0350	-0.0012	-3.4%
LT-01	CaO	0.5093	0.4720	0.0373	7.9%
LT-01	Ce_2O_3	0.0322	0.0290	0.0032	11.0%
LT-01	Cr_2O_3	0.1027	0.1140	-0.0113	-9.9%
LT-01	CuO	0.0363	0.0310	0.0053	17.1%
LT-01	Fe_2O_3	7.0448	7.4630	-0.4182	-5.6%
LT-01	K_2O	0.0602	0.0080	0.0522	652.5%
LT-01	La_2O_3	0.0237	0.0260	-0.0023	-8.8%
LT-01	Li_2O	7.3199	7.7000	-0.3801	-4.9%
LT-01	MgO	0.2048	0.2700	-0.0652	-24.1%
LT-01	MnO	2.2338	2.2720	-0.0382	-1.7%
LT-01	Na_2O	8.6474	9.0550	-0.4076	-4.5%
LT-01	NiO	0.7419	0.8350	-0.0931	-11.1%

Table A-4. Average Measured Chemical Compositions versus Targeted Compositions by Oxide by Glass ID (continued)

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Diff of Measured	% Diff of Measured
LT-01	PbO	0.0108	0.0070	0.0038	54.3%
LT-01	SiO_2	55.6753	56.0760	-0.4007	-0.7%
LT-01	SO_4	0.8321	0.9000	-0.0679	-7.5%
LT-01	TiO_2	0.0083	0.0000	0.0083	
LT-01	ZnO	0.0258	0.0190	0.0068	35.8%
LT-01	ZrO_2	0.0929	0.0930	-0.0001	-0.1%
LT-01	Sum	98.0908	100.0000	-1.9092	-1.9%
LT-04	Al_2O_3	11.9700	12.2370	-0.2670	-2.2%
LT-04	B_2O_3	4.8138	4.8000	0.0138	0.3%
LT-04	BaO	0.0299	0.0420	-0.0121	-28.8%
LT-04	CaO	0.6254	0.5680	0.0574	10.1%
LT-04	Ce_2O_3	0.0366	0.0350	0.0016	4.6%
LT-04	Cr_2O_3	0.1615	0.1370	0.0245	17.9%
LT-04	CuO	0.0541	0.0380	0.0161	42.4%
LT-04	Fe_2O_3	9.4825	10.1540	-0.6715	-6.6%
LT-04	K_2O	0.0602	0.0090	0.0512	568.9%
LT-04	La_2O_3	0.0270	0.0310	-0.0040	-12.9%
LT-04	Li_2O	6.2488	6.6000	-0.3512	-5.3%
LT-04	MgO	0.2848	0.3240	-0.0392	-12.1%
LT-04	MnO	2.6889	2.7310	-0.0421	-1.5%
LT-04	Na_2O	11.1749	11.6150	-0.4401	-3.8%
LT-04	NiO	0.9372	1.0040	-0.0668	-6.7%
LT-04	PbO	0.0108	0.0080	0.0028	35.0%
LT-04	SiO_2	46.7972	48.3320	-1.5348	-3.2%
LT-04	SO_4	1.0486	1.2000	-0.1514	-12.6%
LT-04	TiO_2	0.0083	0.0000	0.0083	
LT-04	ZnO	0.0265	0.0230	0.0035	15.2%
LT-04	ZrO_2	0.1141	0.1120	0.0021	1.9%
LT-04	Sum	96.6011	100.0000	-3.3989	-3.4%
LT-05	Al_2O_3	11.7999	12.2370	-0.4371	-3.6%
LT-05	B_2O_3	5.7797	6.0000	-0.2203	-3.7%
LT-05	BaO	0.0310	0.0420	-0.0110	-26.2%
LT-05	CaO	1.7602	1.7680	-0.0078	-0.4%
LT-05	Ce_2O_3	0.0404	0.0350	0.0054	15.4%
LT-05	Cr_2O_3	0.1399	0.1370	0.0029	2.1%
LT-05	CuO	0.0416	0.0380	0.0036	9.5%
LT-05	Fe_2O_3	9.4682	10.1540	-0.6858	-6.8%
LT-05	K_2O	0.0602	0.0090	0.0512	568.9%
LT-05	La_2O_3	0.0276	0.0310	-0.0034	-11.0%
LT-05	Li_2O	5.6137	6.0000	-0.3863	-6.4%
LT-05	MgO	0.3105	0.3240	-0.0135	-4.2%
LT-05	MnO	2.6728	2.7310	-0.0582	-2.1%
LT-05	Na_2O	12.1758	12.8150	-0.6392	-5.0%
LT-05	NiO	0.9261	1.0040	-0.0779	-7.8%
LT-05	PbO	0.0108	0.0080	0.0028	35.0%
LT-05	SiO_2	44.1765	45.3320	-1.1555	-2.5%
LT-05	SO_4	1.0860	1.2000	-0.1140	-9.5%
LT-05	TiO_2	0.0083	0.0000	0.0083	
LT-05	ZnO	0.0218	0.0230	-0.0012	-5.2%
LT-05	ZrO_2	0.1304	0.1120	0.0184	16.4%
LT-05	Sum	96.2815	100.0000	-3.7185	-3.7%
LT-06	Al_2O_3	11.9086	12.2370	-0.3284	-2.7%
LT-06	B_2O_3	6.7698	7.2000	-0.4302	-6.0%
LT-06	BaO	0.0318	0.0420	-0.0102	-24.3%
LT-06	CaO	3.5610	3.5680	-0.0070	-0.2%
LT-06	Ce_2O_3	0.0357	0.0350	0.0007	2.0%
LT-06	Cr_2O_3	0.1484	0.1370	0.0114	8.3%

Table A-4. Average Measured Chemical Compositions versus Targeted Compositions by Oxide by Glass ID (continued)

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Diff of Measured	% Diff of Measured
LT-06	CuO	0.0401	0.0380	0.0021	5.5%
LT-06	Fe_2O_3	9.9293	10.1540	-0.2247	-2.2%
LT-06	K_2O	0.0602	0.0090	0.0512	568.9%
LT-06	La_2O_3	0.0311	0.0310	0.0001	0.3%
LT-06	Li_2O	4.9571	5.4000	-0.4429	-8.2%
LT-06	MgO	0.2981	0.3240	-0.0259	-8.0%
LT-06	MnO	2.7051	2.7310	-0.0259	-0.9%
LT-06	Na_2O	13.0385	13.4150	-0.3765	-2.8%
LT-06	NiO	0.9506	1.0040	-0.0534	-5.3%
LT-06	PbO	0.0108	0.0080	0.0028	35.0%
LT-06	SiO_2	41.5559	42.3320	-0.7761	-1.8%
LT-06	SO_4	1.1220	1.2000	-0.0780	-6.5%
LT-06	TiO_2	0.0083	0.0000	0.0083	
LT-06	ZnO	0.0243	0.0230	0.0013	5.7%
LT-06	ZrO_2	0.1114	0.1120	-0.0006	-0.5%
LT-06	Sum	97.2979	100.0000	-2.7021	-2.7%
LT-10	Al_2O_3	11.9416	12.2370	-0.2954	-2.4%
LT-10	B_2O_3	4.5803	4.8000	-0.2197	-4.6%
LT-10	BaO	0.0293	0.0420	-0.0127	-30.2%
LT-10	CaO	3.5750	3.5680	0.0070	0.2%
LT-10	Ce_2O_3	0.0392	0.0350	0.0042	12.0%
LT-10	Cr_2O_3	0.2065	0.1370	0.0695	50.7%
LT-10	CuO	0.0391	0.0380	0.0011	2.9%
LT-10	Fe_2O_3	9.6398	10.1540	-0.5142	-5.1%
LT-10	K_2O	0.0602	0.0090	0.0512	568.9%
LT-10	La_2O_3	0.0302	0.0310	-0.0008	-2.6%
LT-10	Li_2O	6.7493	7.2000	-0.4507	-6.3%
LT-10	MgO	0.2740	0.3240	-0.0500	-15.4%
LT-10	MnO	2.7051	2.7310	-0.0259	-0.9%
LT-10	Na_2O	11.1884	11.6150	-0.4266	-3.7%
LT-10	NiO	0.9051	1.0040	-0.0989	-9.9%
LT-10	PbO	0.0108	0.0080	0.0028	35.0%
LT-10	SiO_2	44.3905	44.7320	-0.3415	-0.8%
LT-10	SO_4	1.1647	1.2000	-0.0353	-2.9%
LT-10	TiO_2	0.0083	0.0000	0.0083	
LT-10	ZnO	0.0274	0.0230	0.0044	19.1%
LT-10	ZrO_2	0.1023	0.1120	-0.0097	-8.7%
LT-10	Sum	97.6671	100.0000	-2.3329	-2.3%
LT-11	Al_2O_3	12.0219	12.2370	-0.2151	-1.8%
LT-11	B_2O_3	7.1321	7.2000	-0.0679	-0.9%
LT-11	BaO	0.0321	0.0420	-0.0099	-23.6%
LT-11	CaO	0.6202	0.5680	0.0522	9.2%
LT-11	Ce_2O_3	0.0407	0.0350	0.0057	16.3%
LT-11	Cr_2O_3	0.1264	0.1370	-0.0106	-7.7%
LT-11	CuO	0.0435	0.0380	0.0055	14.5%
LT-11	Fe_2O_3	9.9829	10.1540	-0.1711	-1.7%
LT-11	K_2O	0.0602	0.0090	0.0512	568.9%
LT-11	La_2O_3	0.0287	0.0310	-0.0023	-7.4%
LT-11	Li_2O	6.8516	7.2000	-0.3484	-4.8%
LT-11	MgO	0.2981	0.3240	-0.0259	-8.0%
LT-11	MnO	2.7244	2.7310	-0.0066	-0.2%
LT-11	Na_2O	11.3064	11.6150	-0.3086	-2.7%
LT-11	NiO	0.9108	1.0040	-0.0932	-9.3%
LT-11	PbO	0.0108	0.0080	0.0028	35.0%
LT-11	SiO_2	45.2997	45.3320	-0.0323	-0.1%
LT-11	SO_4	1.1295	1.2000	-0.0705	-5.9%
LT-11	TiO_2	0.0083	0.0000	0.0083	

Table A-4. Average Measured Chemical Compositions versus Targeted Compositions by Oxide by Glass ID (continued)

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Diff of Measured	% Diff of Measured
LT-11	ZnO	0.0255	0.0230	0.0025	10.9%
LT-11	ZrO_2	0.1114	0.1120	-0.0006	-0.5%
LT-11	Sum	98.7653	100.0000	-1.2347	-1.2%
LT-12	Al_2O_3	12.0692	12.2370	-0.1678	-1.4%
LT-12	B_2O_3	7.2367	7.2000	0.0367	0.5%
LT-12	BaO	0.0338	0.0420	-0.0082	-19.5%
LT-12	CaO	3.6029	3.5680	0.0349	1.0%
LT-12	Ce_2O_3	0.0363	0.0350	0.0013	3.7%
LT-12	Cr_2O_3	0.1374	0.1370	0.0004	0.3%
LT-12	CuO	0.0432	0.0380	0.0052	13.7%
LT-12	Fe_2O_3	9.6719	10.1540	-0.4821	-4.7%
LT-12	K_2O	0.0602	0.0090	0.0512	568.9%
LT-12	La_2O_3	0.0311	0.0310	0.0001	0.3%
LT-12	Li_2O	6.2919	6.6000	-0.3081	-4.7%
LT-12	MgO	0.3060	0.3240	-0.0180	-5.6%
LT-12	MnO	2.7406	2.7310	0.0096	0.4%
LT-12	Na_2O	11.3401	11.6150	-0.2749	-2.4%
LT-12	NiO	0.9089	1.0040	-0.0951	-9.5%
LT-12	PbO	0.0108	0.0080	0.0028	35.0%
LT-12	SiO_2	43.0534	42.9320	0.1214	0.3%
LT-12	SO_4	1.1429	1.2000	-0.0571	-4.8%
LT-12	TiO_2	0.0083	0.0000	0.0083	
LT-12	ZnO	0.0271	0.0230	0.0041	17.8%
LT-12	ZrO_2	0.1162	0.1120	0.0042	3.8%
LT-12	Sum	98.8688	100.0000	-1.1312	-1.1%
QB-03	Al_2O_3	8.9326	9.1312	-0.1986	-2.2%
QB-03	B_2O_3	4.9586	5.1200	-0.1614	-3.2%
QB-03	BaO	0.0285	0.0369	-0.0084	-22.8%
QB-03	CaO	6.8071	6.9087	-0.1016	-1.5%
QB-03	Ce_2O_3	0.0346	0.0301	0.0045	15.0%
QB-03	Cr_2O_3	0.2463	0.1395	0.1068	76.6%
QB-03	CuO	0.0460	0.0322	0.0138	42.9%
QB-03	Fe_2O_3	7.8705	8.2116	-0.3411	-4.2%
QB-03	K_2O	0.2436	0.2477	-0.0041	-1.7%
QB-03	La_2O_3	0.0276	0.0258	0.0018	7.0%
QB-03	Li_2O	4.8440	5.1200	-0.2760	-5.4%
QB-03	MgO	0.2724	0.2801	-0.0077	-2.7%
QB-03	MnO	2.3371	2.3235	0.0136	0.6%
QB-03	Na_2O	13.0183	13.3731	-0.3548	-2.7%
QB-03	NiO	0.8869	0.9767	-0.0898	-9.2%
QB-03	PbO	0.0108	0.0079	0.0029	36.7%
QB-03	SiO_2	46.7972	46.9128	-0.1156	-0.2%
QB-03	SO_4	0.9654	1.0000	-0.0346	-3.5%
QB-03	TiO_2	0.0083	0.0000	0.0083	
QB-03	ZnO	0.0296	0.0229	0.0067	29.3%
QB-03	ZrO_2	0.1084	0.0992	0.0092	9.3%
QB-03	Sum	98.4738	100.0000	-1.5262	-1.5%
QB-04	Al_2O_3	8.9043	9.1312	-0.2269	-2.5%
QB-04	B_2O_3	4.9425	5.1200	-0.1775	-3.5%
QB-04	BaO	0.0346	0.0369	-0.0023	-6.2%
QB-04	CaO	6.6742	6.9087	-0.2345	-3.4%
QB-04	Ce_2O_3	0.0275	0.0301	-0.0026	-8.6%
QB-04	Cr_2O_3	0.1389	0.1395	-0.0006	-0.4%
QB-04	CuO	0.0294	0.0322	-0.0028	-8.7%
QB-04	Fe_2O_3	7.8491	8.2116	-0.3625	-4.4%
QB-04	K_2O	0.2349	0.2477	-0.0128	-5.2%
QB-04	La_2O_3	0.0243	0.0258	-0.0015	-5.8%

Table A-4. Average Measured Chemical Compositions versus Targeted Compositions by Oxide by Glass ID (continued)

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Diff of Measured	% Diff of Measured
QB-04	Li_2O	4.2843	4.4800	-0.1957	-4.4%
QB-04	MgO	0.2744	0.2801	-0.0057	-2.0%
QB-04	MnO	2.2887	2.3235	-0.0348	-1.5%
QB-04	Na_2O	14.9291	15.2931	-0.3640	-2.4%
QB-04	NiO	0.9022	0.9767	-0.0745	-7.6%
QB-04	PbO	0.0108	0.0079	0.0029	36.7%
QB-04	SiO_2	44.6579	45.6328	-0.9749	-2.1%
QB-04	SO_4	0.9542	1.0000	-0.0458	-4.6%
QB-04	TiO_2	0.0083	0.0000	0.0083	
QB-04	ZnO	0.0268	0.0229	0.0039	17.0%
QB-04	ZrO_2	0.1236	0.0992	0.0244	24.6%
QB-04	Sum	97.3199	100.0000	-2.6801	-2.7%
QB-19	Al_2O_3	9.7971	10.1748	-0.3777	-3.7%
QB-19	B_2O_3	4.7172	4.8000	-0.0828	-1.7%
QB-19	BaO	0.0318	0.0411	-0.0093	-22.6%
QB-19	CaO	0.5789	0.5668	0.0121	2.1%
QB-19	Ce_2O_3	0.0366	0.0335	0.0031	9.3%
QB-19	Cr_2O_3	0.1608	0.1555	0.0053	3.4%
QB-19	CuO	0.0376	0.0359	0.0017	4.7%
QB-19	Fe_2O_3	8.5996	9.1501	-0.5505	-6.0%
QB-19	K_2O	0.2716	0.2760	-0.0044	-1.6%
QB-19	La_2O_3	0.0252	0.0288	-0.0036	-12.5%
QB-19	Li_2O	4.5534	4.8000	-0.2466	-5.1%
QB-19	MgO	0.3051	0.3121	-0.0070	-2.2%
QB-19	MnO	2.5017	2.5890	-0.0873	-3.4%
QB-19	Na_2O	17.6925	18.2752	-0.5827	-3.2%
QB-19	NiO	1.0078	1.0883	-0.0805	-7.4%
QB-19	PbO	0.0108	0.0088	0.0020	22.7%
QB-19	SiO_2	45.1927	46.5279	-1.3352	-2.9%
QB-19	SO_4	0.9827	1.0000	-0.0173	-1.7%
QB-19	TiO_2	0.0083	0.0000	0.0083	
QB-19	ZnO	0.0299	0.0255	0.0044	17.3%
QB-19	ZrO_2	0.1148	0.1105	0.0043	3.9%
QB-19	Sum	96.6561	100.0000	-3.3439	-3.3%
QB-20	Al_2O_3	9.7782	10.1748	-0.3966	-3.9%
QB-20	B_2O_3	7.8485	8.4000	-0.5515	-6.6%
QB-20	BaO	0.0299	0.0411	-0.0112	-27.3%
QB-20	CaO	5.2190	5.3668	-0.1478	-2.8%
QB-20	Ce_2O_3	0.0351	0.0335	0.0016	4.8%
QB-20	Cr_2O_3	0.1666	0.1555	0.0111	7.1%
QB-20	CuO	0.0388	0.0359	0.0029	8.1%
QB-20	Fe_2O_3	8.6461	9.1501	-0.5040	-5.5%
QB-20	K_2O	0.2710	0.2760	-0.0050	-1.8%
QB-20	La_2O_3	0.0308	0.0288	0.0020	6.9%
QB-20	Li_2O	3.7891	4.2000	-0.4109	-9.8%
QB-20	MgO	0.2558	0.3121	-0.0563	-18.0%
QB-20	MnO	2.4597	2.5890	-0.1293	-5.0%
QB-20	Na_2O	14.6932	15.2752	-0.5820	-3.8%
QB-20	NiO	0.9798	1.0883	-0.1085	-10.0%
QB-20	PbO	0.0108	0.0088	0.0020	22.7%
QB-20	SiO_2	40.2188	41.7279	-1.5091	-3.6%
QB-20	SO_4	0.9400	1.0000	-0.0600	-6.0%
QB-20	TiO_2	0.0083	0.0000	0.0083	
QB-20	ZnO	0.0296	0.0255	0.0041	16.1%
QB-20	ZrO_2	0.1331	0.1105	0.0226	20.5%
QB-20	Sum	95.5822	100.0000	-4.4178	-4.4%
QB-22	Al_2O_3	10.2411	10.1748	0.0663	0.7%

Table A-4. Average Measured Chemical Compositions versus Targeted Compositions by Oxide by Glass ID (continued)

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Diff of Measured	% Diff of Measured
QB-22	B_2O_3	4.5562	4.8000	-0.2438	-5.1%
QB-22	BaO	0.0332	0.0411	-0.0079	-19.2%
QB-22	CaO	6.5902	6.5668	0.0234	0.4%
QB-22	Ce_2O_3	0.0351	0.0335	0.0016	4.8%
QB-22	Cr_2O_3	0.1736	0.1555	0.0181	11.6%
QB-22	CuO	0.0363	0.0359	0.0004	1.1%
QB-22	Fe_2O_3	8.9392	9.1501	-0.2109	-2.3%
QB-22	K_2O	0.2701	0.2760	-0.0059	-2.1%
QB-22	La_2O_3	0.0317	0.0288	0.0029	10.1%
QB-22	Li_2O	3.8483	4.2000	-0.3517	-8.4%
QB-22	MgO	0.2516	0.3121	-0.0605	-19.4%
QB-22	MnO	2.6373	2.5890	0.0483	1.9%
QB-22	Na_2O	16.6815	16.4752	0.2063	1.3%
QB-22	NiO	1.0037	1.0883	-0.0846	-7.8%
QB-22	PbO	0.0108	0.0088	0.0020	22.7%
QB-22	SiO_2	41.1815	42.9279	-1.7464	-4.1%
QB-22	SO_4	0.9594	1.0000	-0.0406	-4.1%
QB-22	TiO_2	0.0083	0.0000	0.0083	
QB-22	ZnO	0.0299	0.0255	0.0044	17.3%
QB-22	ZrO_2	0.1104	0.1105	-0.0001	-0.1%
QB-22	Sum	97.6295	100.0000	-2.3705	-2.4%
QB-32	Al_2O_3	8.9043	9.0791	-0.1748	-1.9%
QB-32	B_2O_3	5.0069	5.1200	-0.1131	-2.2%
QB-32	BaO	0.0287	0.0367	-0.0080	-21.8%
QB-32	CaO	0.5530	0.5058	0.0472	9.3%
QB-32	Ce_2O_3	0.0322	0.0299	0.0023	7.7%
QB-32	Cr_2O_3	0.1476	0.1388	0.0088	6.3%
QB-32	CuO	0.0329	0.0320	0.0009	2.8%
QB-32	Fe_2O_3	7.9420	8.1647	-0.2227	-2.7%
QB-32	K_2O	0.2439	0.2463	-0.0024	-1.0%
QB-32	La_2O_3	0.0194	0.0257	-0.0063	-24.5%
QB-32	Li_2O	4.8171	5.1200	-0.3029	-5.9%
QB-32	MgO	0.3420	0.2785	0.0635	22.8%
QB-32	MnO	2.2919	2.3102	-0.0183	-0.8%
QB-32	Na_2O	16.8837	17.1440	-0.2603	-1.5%
QB-32	NiO	0.8962	0.9711	-0.0749	-7.7%
QB-32	PbO	0.0108	0.0079	0.0029	36.7%
QB-32	SiO_2	48.8830	49.4680	-0.5850	-1.2%
QB-32	SO_4	1.1250	1.2000	-0.0750	-6.3%
QB-32	TiO_2	0.0083	0.0000	0.0083	
QB-32	ZnO	0.0233	0.0227	0.0006	2.6%
QB-32	ZrO_2	0.0935	0.0986	-0.0051	-5.2%
QB-32	Sum	98.2858	100.0000	-1.7142	-1.7%
QB-33	Al_2O_3	8.6114	9.0791	-0.4677	-5.2%
QB-33	B_2O_3	8.5086	8.9600	-0.4514	-5.0%
QB-33	BaO	0.0268	0.0367	-0.0099	-27.0%
QB-33	CaO	5.4800	5.6258	-0.1458	-2.6%
QB-33	Ce_2O_3	0.0325	0.0299	0.0026	8.7%
QB-33	Cr_2O_3	0.1235	0.1388	-0.0153	-11.0%
QB-33	CuO	0.0285	0.0320	-0.0035	-10.9%
QB-33	Fe_2O_3	7.4452	8.1647	-0.7195	-8.8%
QB-33	K_2O	0.2590	0.2463	0.0127	5.2%
QB-33	La_2O_3	0.0273	0.0257	0.0016	6.2%
QB-33	Li_2O	4.2251	4.4800	-0.2549	-5.7%
QB-33	MgO	0.2405	0.2785	-0.0380	-13.6%
QB-33	MnO	2.1950	2.3102	-0.1152	-5.0%
QB-33	Na_2O	12.6004	13.9440	-1.3436	-9.6%

Table A-4. Average Measured Chemical Compositions versus Targeted Compositions by Oxide by Glass ID (continued)

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Diff of Measured	% Diff of Measured
QB-33	NiO	0.8726	0.9711	-0.0985	-10.1%
QB-33	PbO	0.0108	0.0079	0.0029	36.7%
QB-33	SiO_2	47.3320	44.3480	2.9840	6.7%
QB-33	SO_4	1.1032	1.2000	-0.0968	-8.1%
QB-33	TiO_2	0.0083	0.0000	0.0083	
QB-33	ZnO	0.0283	0.0227	0.0056	24.7%
QB-33	ZrO_2	0.0976	0.0986	-0.0010	-1.0%
QB-33	Sum	99.2566	100.0000	-0.7434	-0.7%
QB-34	Al_2O_3	8.9468	9.0791	-0.1323	-1.5%
QB-34	B_2O_3	4.9908	5.1200	-0.1292	-2.5%
QB-34	BaO	0.0279	0.0367	-0.0088	-24.0%
QB-34	CaO	6.7511	6.9058	-0.1547	-2.2%
QB-34	Ce_2O_3	0.0334	0.0299	0.0035	11.7%
QB-34	Cr_2O_3	0.1494	0.1388	0.0106	7.6%
QB-34	CuO	0.0357	0.0320	0.0037	11.6%
QB-34	Fe_2O_3	8.4388	8.1647	0.2741	3.4%
QB-34	K_2O	0.2349	0.2463	-0.0114	-4.6%
QB-34	La_2O_3	0.0264	0.0257	0.0007	2.7%
QB-34	Li_2O	4.8386	5.1200	-0.2814	-5.5%
QB-34	MgO	0.2570	0.2785	-0.0215	-7.7%
QB-34	MnO	2.2693	2.3102	-0.0409	-1.8%
QB-34	Na_2O	13.0352	13.3040	-0.2688	-2.0%
QB-34	NiO	0.8720	0.9711	-0.0991	-10.2%
QB-34	PbO	0.0108	0.0079	0.0029	36.7%
QB-34	SiO_2	46.2624	46.9080	-0.6456	-1.4%
QB-34	SO_4	1.0890	1.2000	-0.1110	-9.3%
QB-34	TiO_2	0.0083	0.0000	0.0083	
QB-34	ZnO	0.0249	0.0227	0.0022	9.7%
QB-34	ZrO_2	0.0912	0.0986	-0.0074	-7.5%
QB-34	Sum	98.3939	100.0000	-1.6061	-1.6%
QB-35	Al_2O_3	8.8287	9.0791	-0.2504	-2.8%
QB-35	B_2O_3	5.0391	5.1200	-0.0809	-1.6%
QB-35	BaO	0.0290	0.0367	-0.0077	-21.0%
QB-35	CaO	6.6742	6.9058	-0.2316	-3.4%
QB-35	Ce_2O_3	0.0495	0.0299	0.0196	65.6%
QB-35	Cr_2O_3	0.1275	0.1388	-0.0113	-8.1%
QB-35	CuO	0.0322	0.0320	0.0002	0.6%
QB-35	Fe_2O_3	7.7990	8.1647	-0.3657	-4.5%
QB-35	K_2O	0.2364	0.2463	-0.0099	-4.0%
QB-35	La_2O_3	0.0443	0.0257	0.0186	72.4%
QB-35	Li_2O	4.3058	4.4800	-0.1742	-3.9%
QB-35	MgO	0.2516	0.2785	-0.0269	-9.7%
QB-35	MnO	2.2725	2.3102	-0.0377	-1.6%
QB-35	Na_2O	14.7269	15.2240	-0.4971	-3.3%
QB-35	NiO	0.8675	0.9711	-0.1036	-10.7%
QB-35	PbO	0.0108	0.0079	0.0029	36.7%
QB-35	SiO_2	44.6044	45.6280	-1.0236	-2.2%
QB-35	SO_4	1.1250	1.2000	-0.0750	-6.3%
QB-35	TiO_2	0.0083	0.0000	0.0083	
QB-35	ZnO	0.0230	0.0227	0.0003	1.3%
QB-35	ZrO_2	0.1020	0.0986	0.0034	3.4%
QB-35	Sum	97.1579	100.0000	-2.8421	-2.8%
QB-36	Al_2O_3	8.7295	9.0791	-0.3496	-3.9%
QB-36	B_2O_3	4.8701	5.1200	-0.2499	-4.9%
QB-36	BaO	0.0240	0.0367	-0.0127	-34.6%
QB-36	CaO	3.6239	3.7058	-0.0819	-2.2%
QB-36	Ce_2O_3	0.0296	0.0299	-0.0003	-1.0%

Table A-4. Average Measured Chemical Compositions versus Targeted Compositions by Oxide by Glass ID (continued)

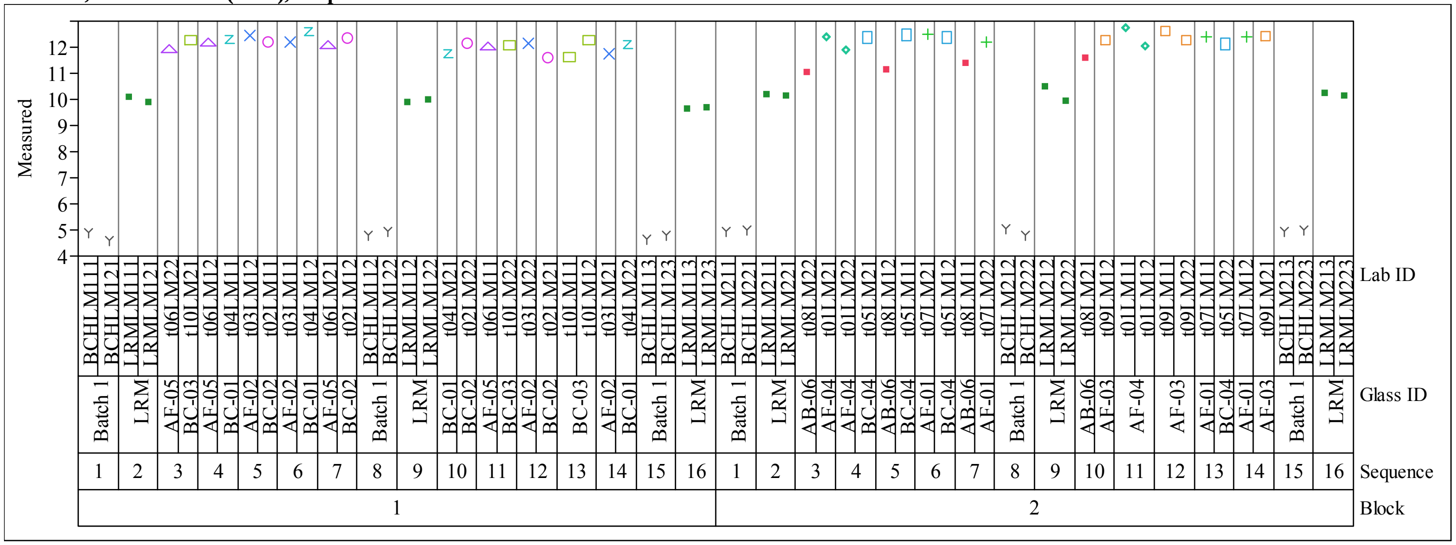
Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Diff of Measured	% Diff of Measured
QB-36	Cr_2O_3	0.1469	0.1388	0.0081	5.8%
QB-36	CuO	0.0469	0.0320	0.0149	46.6%
QB-36	Fe_2O_3	7.7454	8.1647	-0.4193	-5.1%
QB-36	K_2O	0.2454	0.2463	-0.0009	-0.4%
QB-36	La_2O_3	0.0258	0.0257	0.0001	0.4%
QB-36	Li_2O	4.7687	5.1200	-0.3513	-6.9%
QB-36	MgO	0.2537	0.2785	-0.0248	-8.9%
QB-36	MnO	2.2370	2.3102	-0.0732	-3.2%
QB-36	Na_2O	14.5247	15.2240	-0.6993	-4.6%
QB-36	NiO	0.8958	0.9711	-0.0753	-7.8%
QB-36	PbO	0.0108	0.0079	0.0029	36.7%
QB-36	SiO_2	46.8507	48.1880	-1.3373	-2.8%
QB-36	SO_4	1.1429	1.2000	-0.0571	-4.8%
QB-36	TiO_2	0.0083	0.0000	0.0083	
QB-36	ZnO	0.0280	0.0227	0.0053	23.3%
QB-36	ZrO_2	0.0976	0.0986	-0.0010	-1.0%
QB-36	Sum	96.3058	100.0000	-3.6942	-3.7%
QB-37	Al_2O_3	8.8429	9.0791	-0.2362	-2.6%
QB-37	B_2O_3	4.9103	5.1200	-0.2097	-4.1%
QB-37	BaO	0.0287	0.0367	-0.0080	-21.8%
QB-37	CaO	3.6650	3.7058	-0.0408	-1.1%
QB-37	Ce_2O_3	0.0319	0.0299	0.0020	6.7%
QB-37	Cr_2O_3	0.1484	0.1388	0.0096	6.9%
QB-37	CuO	0.0335	0.0320	0.0015	4.7%
QB-37	Fe_2O_3	7.8812	8.1647	-0.2835	-3.5%
QB-37	K_2O	0.2463	0.2463	0.0000	0.0%
QB-37	La_2O_3	0.0191	0.0257	-0.0066	-25.7%
QB-37	Li_2O	5.4845	5.7600	-0.2755	-4.8%
QB-37	MgO	0.3387	0.2785	0.0602	21.6%
QB-37	MnO	2.2725	2.3102	-0.0377	-1.6%
QB-37	Na_2O	16.7489	13.3040	3.4449	25.9%
QB-37	NiO	0.8923	0.9711	-0.0788	-8.1%
QB-37	PbO	0.0108	0.0079	0.0029	36.7%
QB-37	SiO_2	48.1343	49.4680	-1.3337	-2.7%
QB-37	SO_4	1.1257	1.2000	-0.0743	-6.2%
QB-37	TiO_2	0.0083	0.0000	0.0083	
QB-37	ZnO	0.0233	0.0227	0.0006	2.6%
QB-37	ZrO_2	0.0942	0.0986	-0.0044	-4.5%
QB-37	Sum	100.9409	100.0000	0.9409	0.9%
SPS-02	Al_2O_3	11.7243	12.1846	-0.4603	-3.8%
SPS-02	B_2O_3	4.6850	4.8000	-0.1150	-2.4%
SPS-02	BaO	0.0500	0.0625	-0.0125	-20.0%
SPS-02	CaO	0.8518	0.8517	0.0001	0.0%
SPS-02	Ce_2O_3	0.1086	0.1082	0.0004	0.4%
SPS-02	Cr_2O_3	0.0760	0.0675	0.0085	12.6%
SPS-02	CuO	0.0635	0.0522	0.0113	21.6%
SPS-02	Fe_2O_3	10.4154	11.5766	-1.1612	-10.0%
SPS-02	K_2O	0.0602	0.0267	0.0335	125.5%
SPS-02	La_2O_3	0.0369	0.0465	-0.0096	-20.6%
SPS-02	Li_2O	4.4188	4.8000	-0.3812	-7.9%
SPS-02	MgO	0.2807	0.3190	-0.0383	-12.0%
SPS-02	MnO	3.0731	3.1475	-0.0744	-2.4%
SPS-02	Na_2O	12.3106	12.9211	-0.6105	-4.7%
SPS-02	NiO	1.3034	1.4531	-0.1497	-10.3%
SPS-02	PbO	0.0108	0.0135	-0.0027	-20.0%
SPS-02	SiO_2	45.4601	46.6858	-1.2257	-2.6%
SPS-02	SO_4	0.5602	0.6000	-0.0398	-6.6%

Table A-4. Average Measured Chemical Compositions versus Targeted Compositions by Oxide by Glass ID (continued)

Glass ID	Oxide	Measured (wt %)	Targeted (wt %)	Diff of Measured	% Diff of Measured
SPS-02	TiO_2	0.0083	0.0069	0.0014	20.3%
SPS-02	ZnO	0.0330	0.0279	0.0051	18.3%
SPS-02	ZrO_2	0.1405	0.1473	-0.0068	-4.6%
SPS-02	Sum	95.6712	99.8986	-4.2274	-4.2%

Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series

Series=T, Oxide=Al2O3 (wt%), Prep Method=LM



Series=T, Oxide=B2O3 (wt%), Prep Method=PF

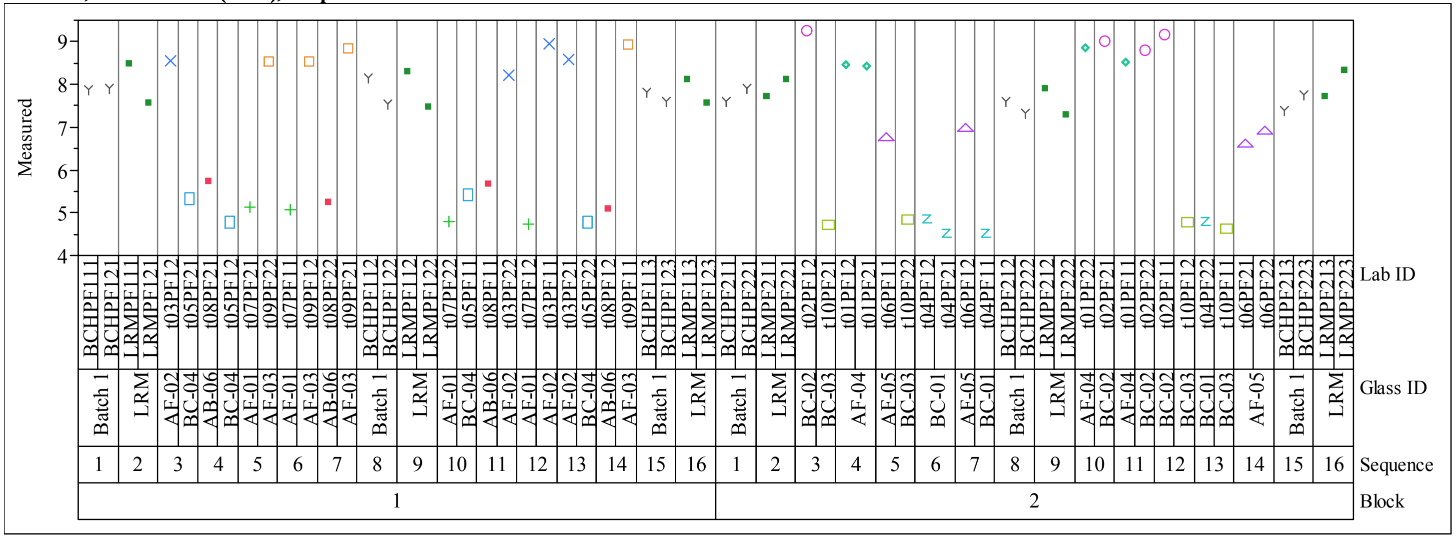
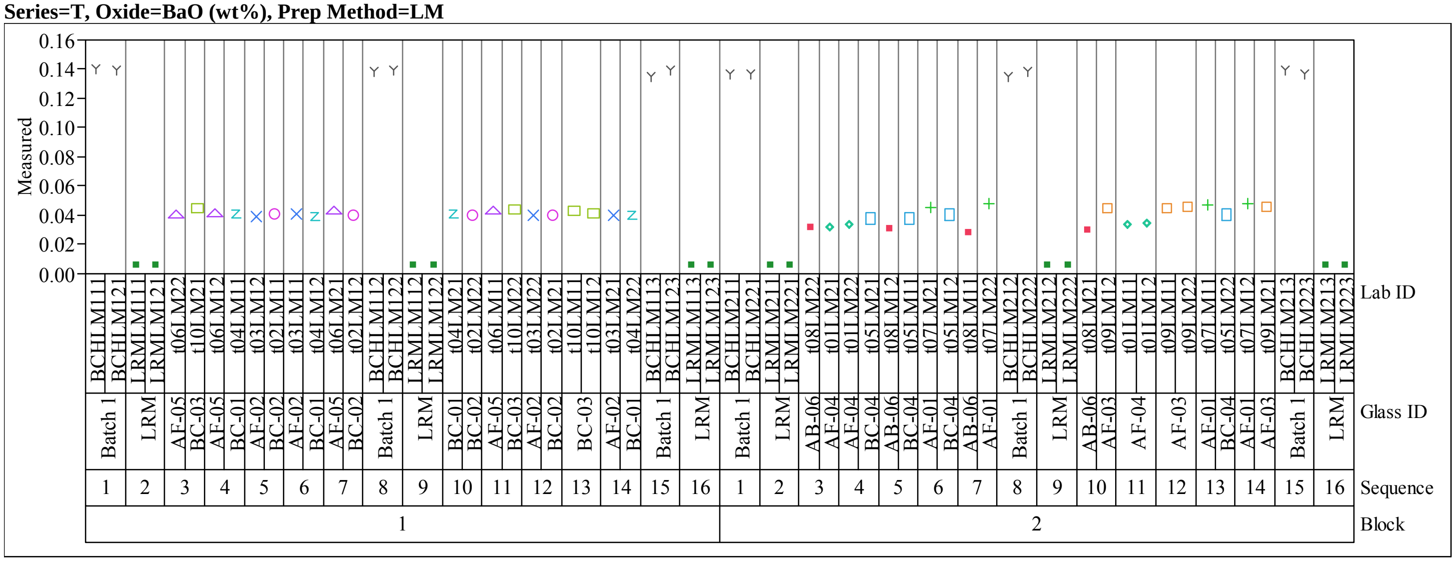


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=T, Oxide=BaO (wt%), Prep Method=LM



Series=T, Oxide=CaO (wt%), Prep Method=LM

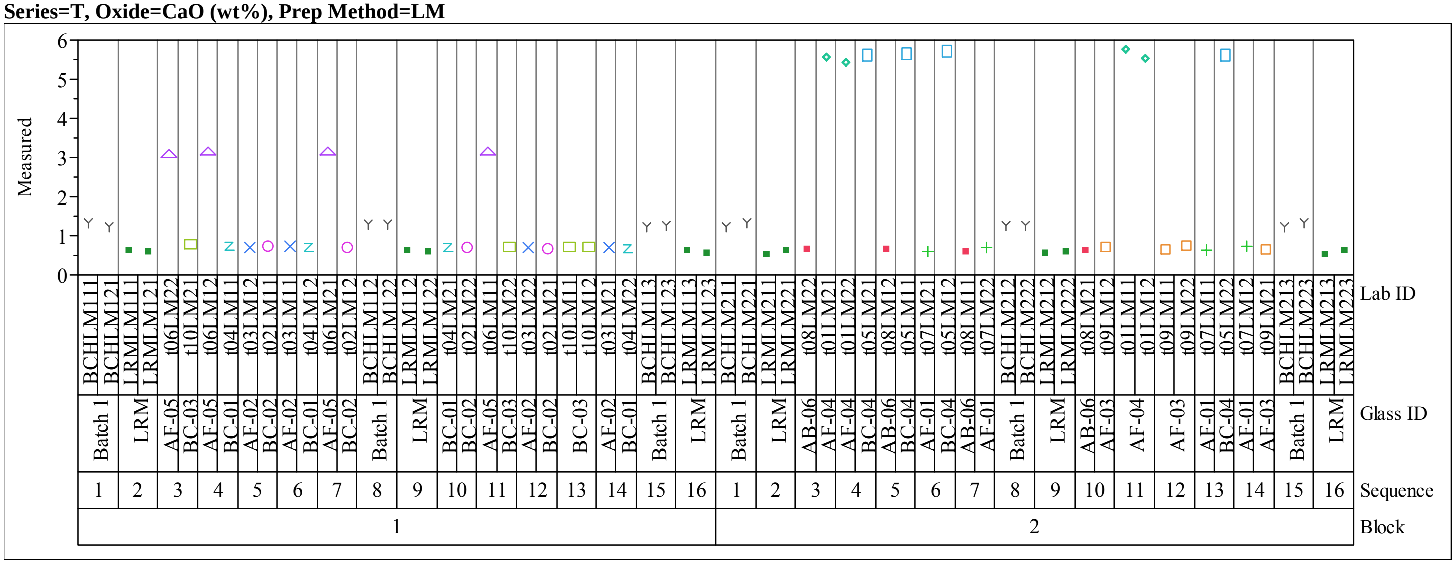
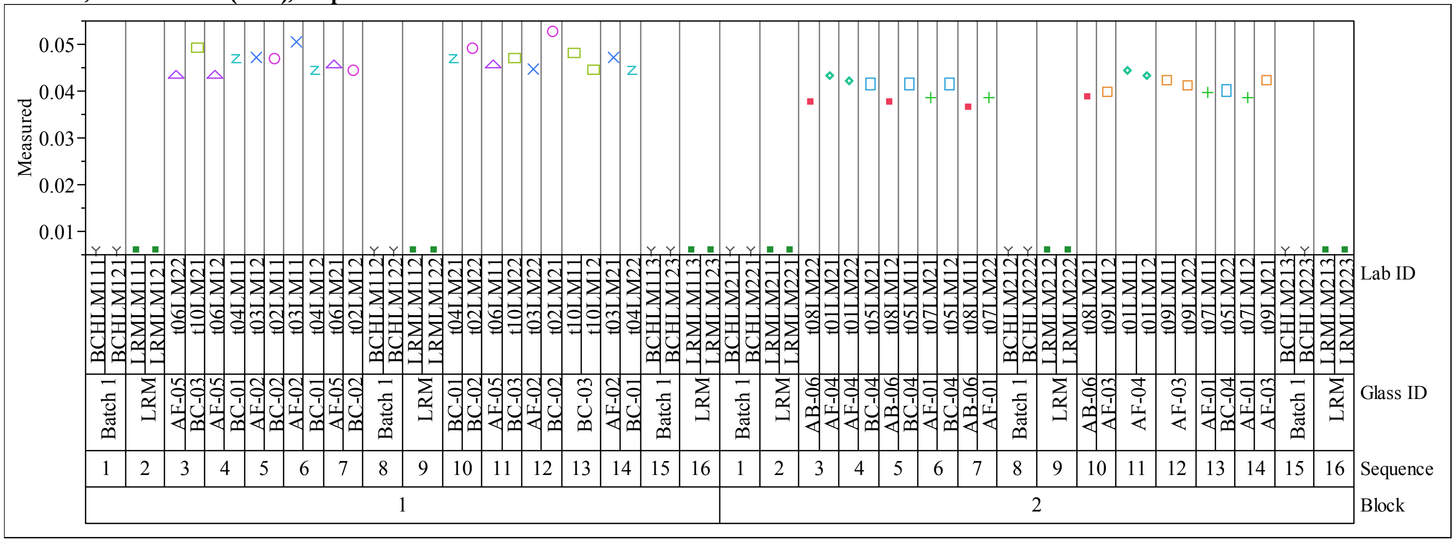


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=T, Oxide=Ce2O3 (wt%), Prep Method=LM



Series=T, Oxide=Cr2O3 (wt%), Prep Method=LM

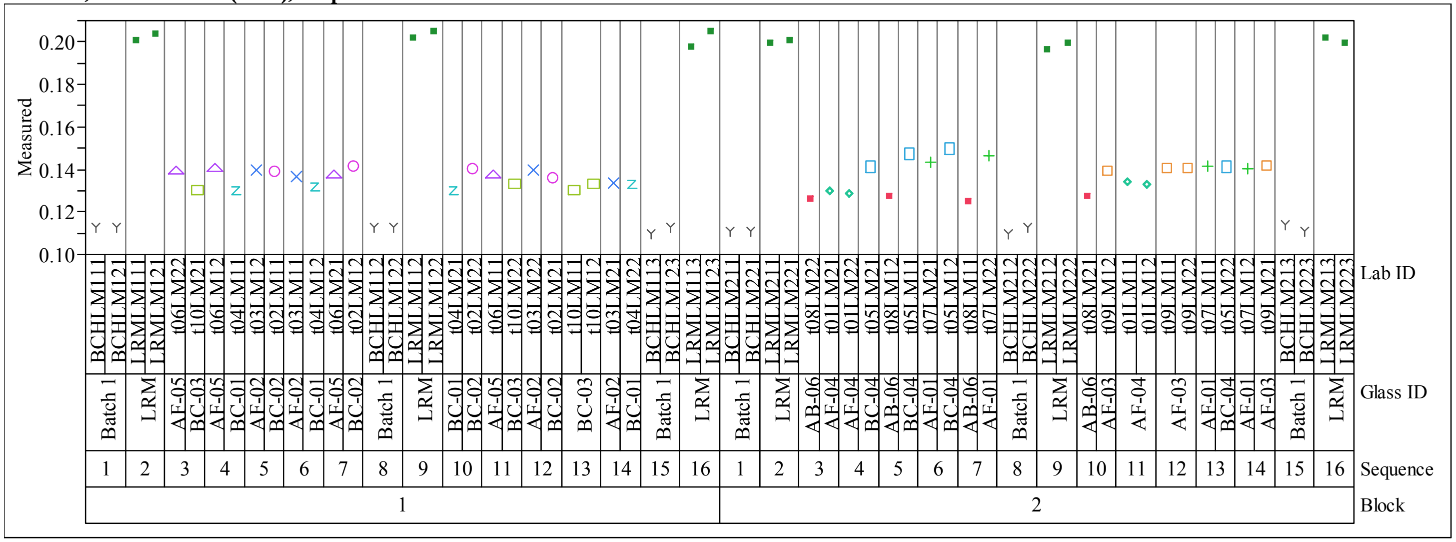
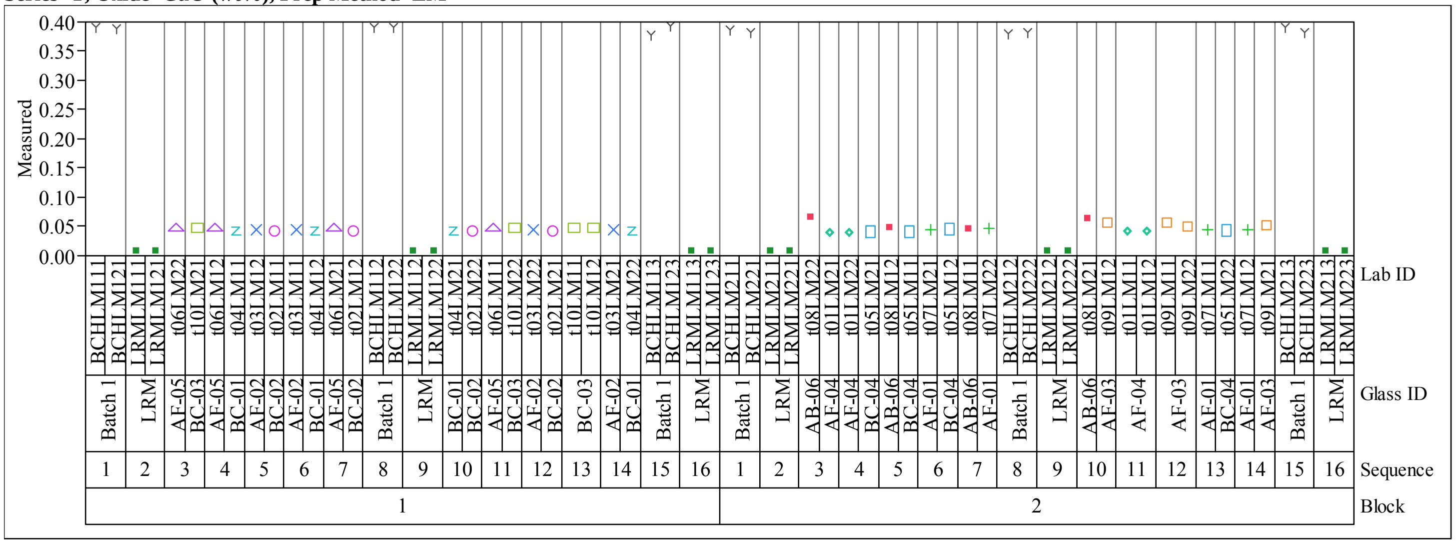


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=T, Oxide=CuO (wt%), Prep Method=LM



Series=T, Oxide=Fe2O3 (wt%), Prep Method=LM

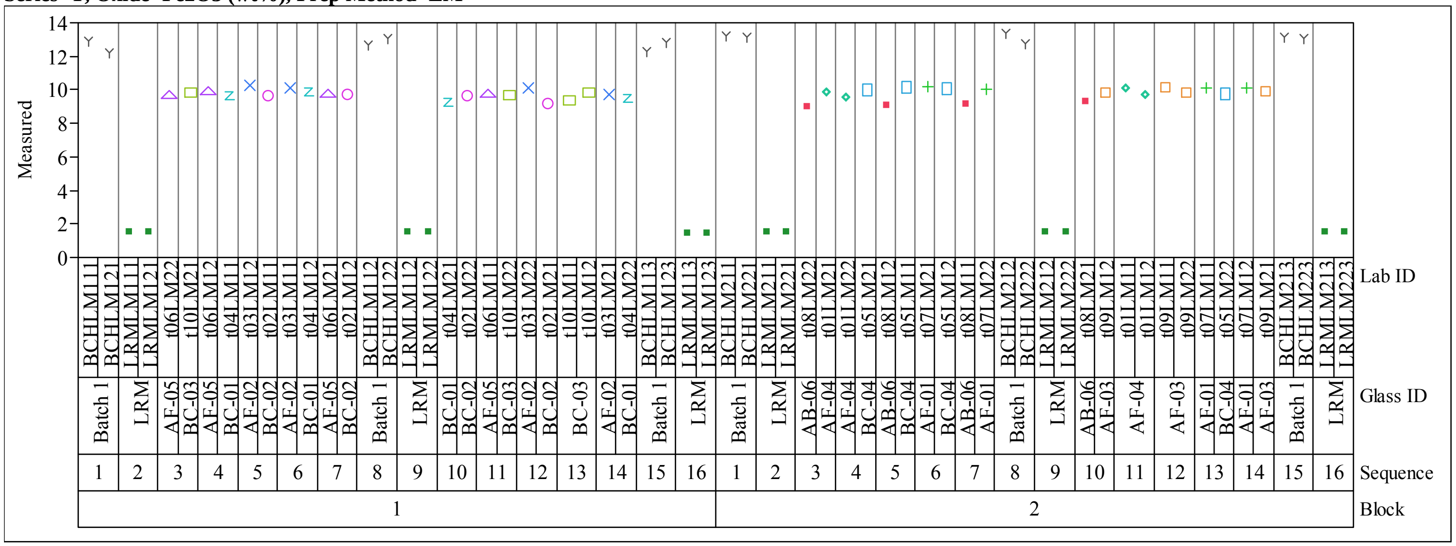
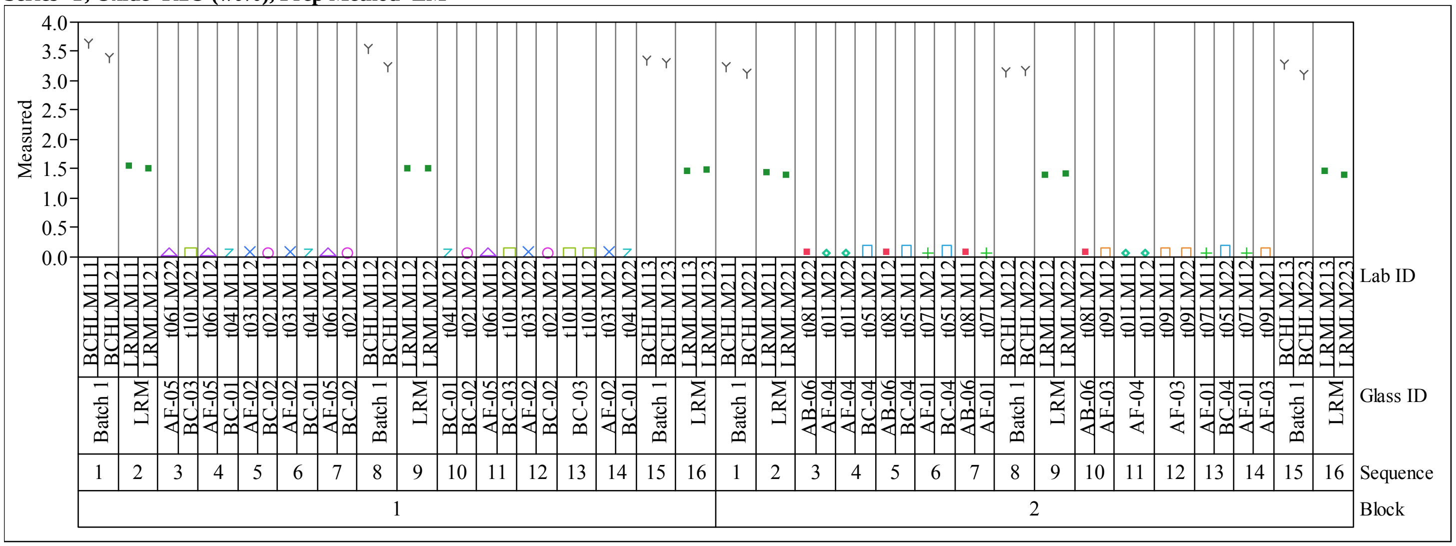


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=T, Oxide=K2O (wt%), Prep Method=LM



Series=T, Oxide=La2O3 (wt%), Prep Method=LM

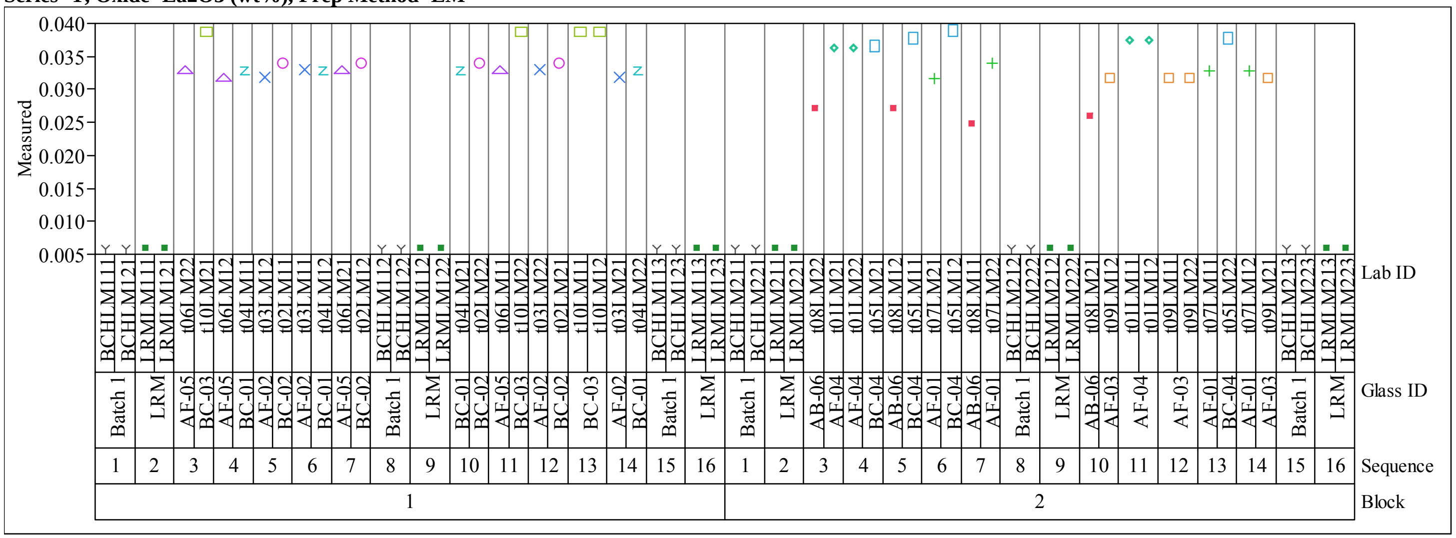
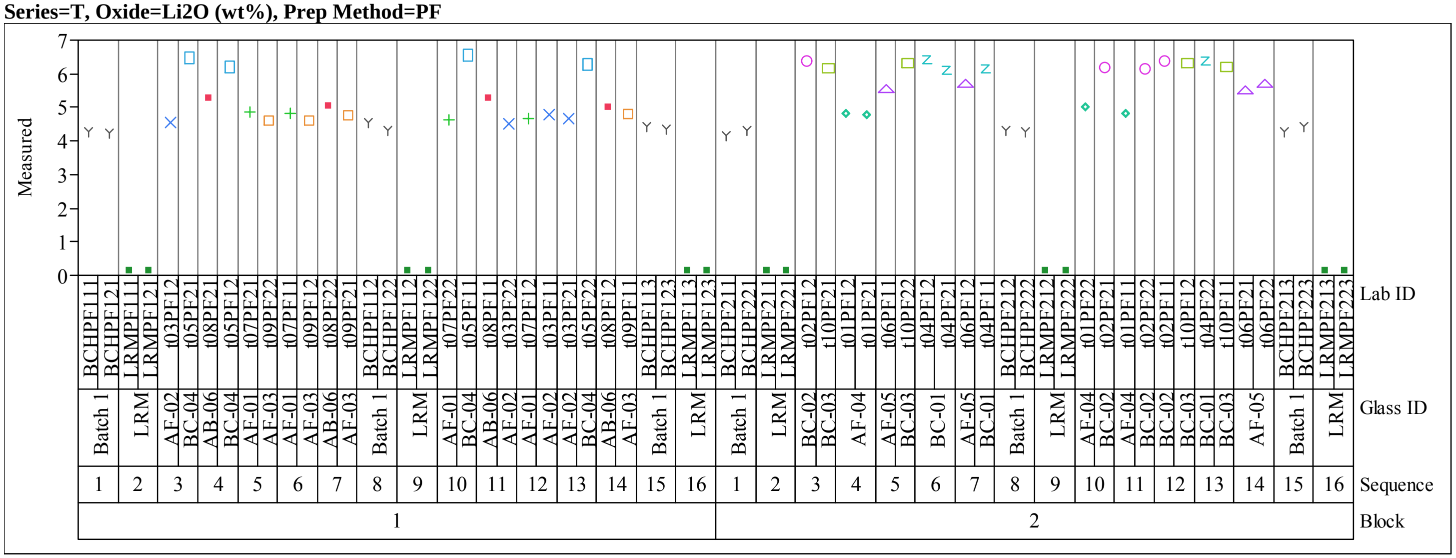


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=T, Oxide=Li2O (wt%), Prep Method=PF



Series=T, Oxide=MgO (wt%), Prep Method=LM

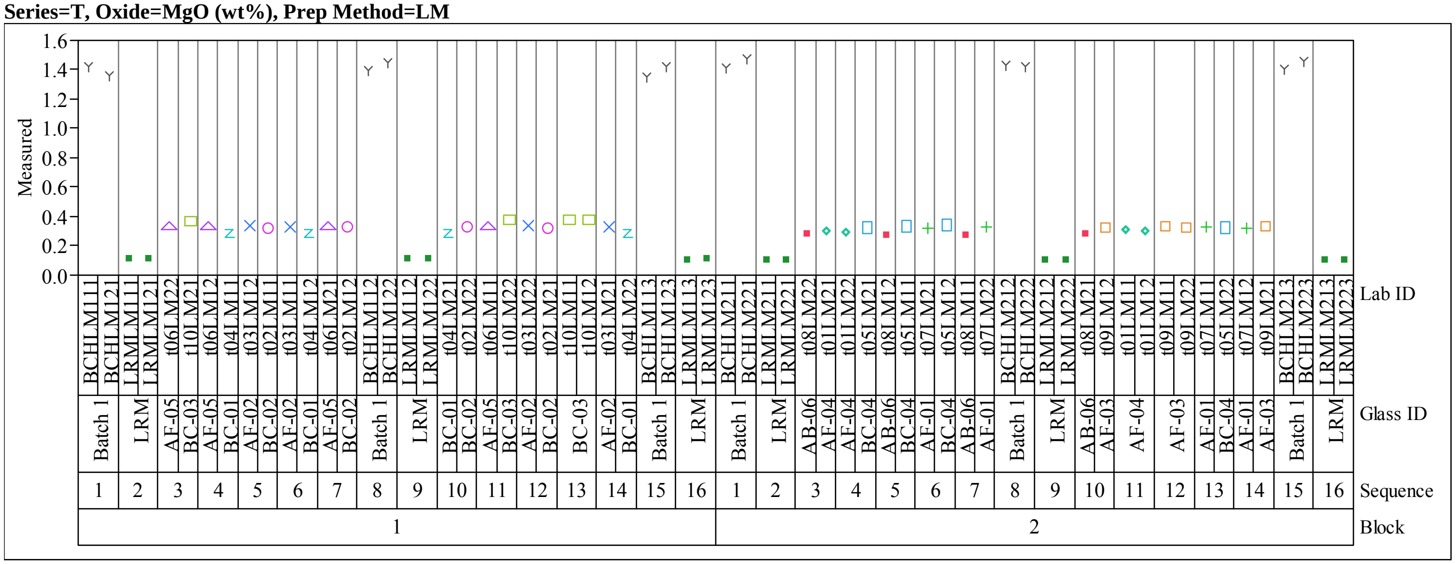
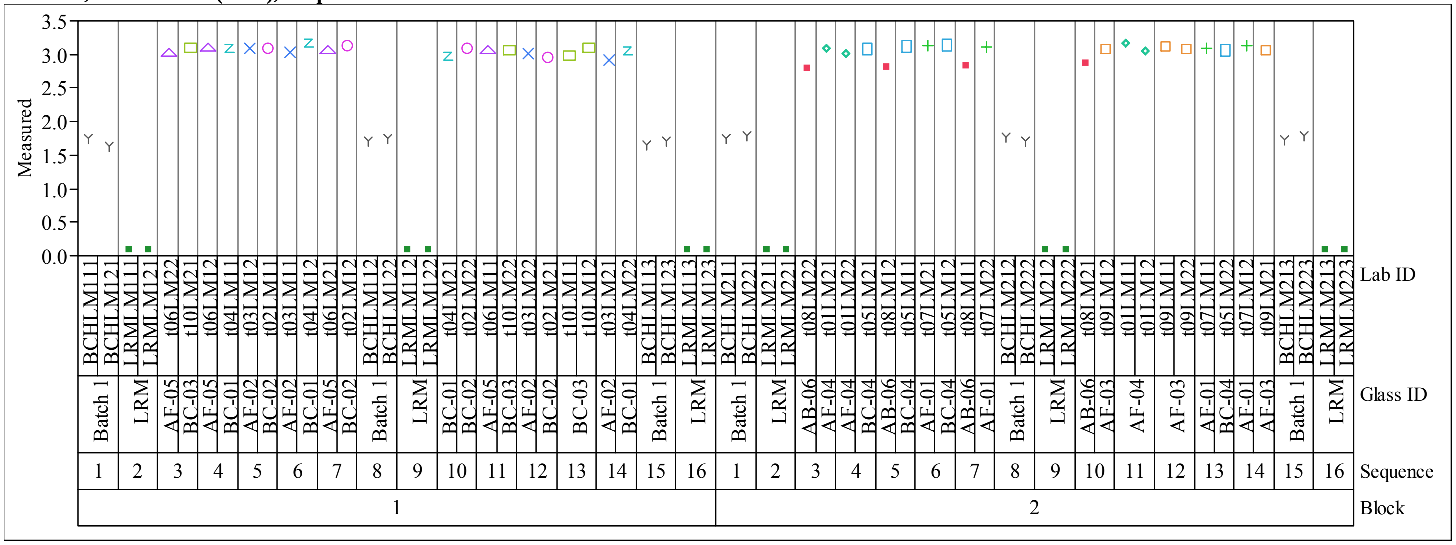


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=T, Oxide=MnO (wt%), Prep Method=LM



Series=T, Oxide=Na2O (wt%), Prep Method=LM

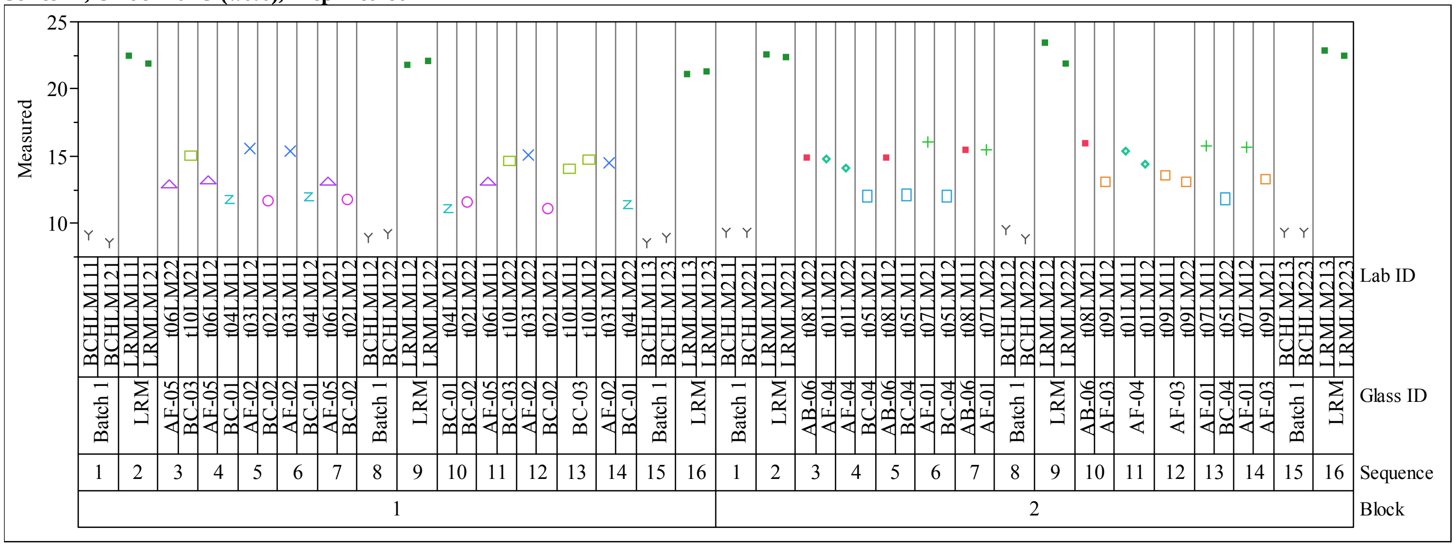
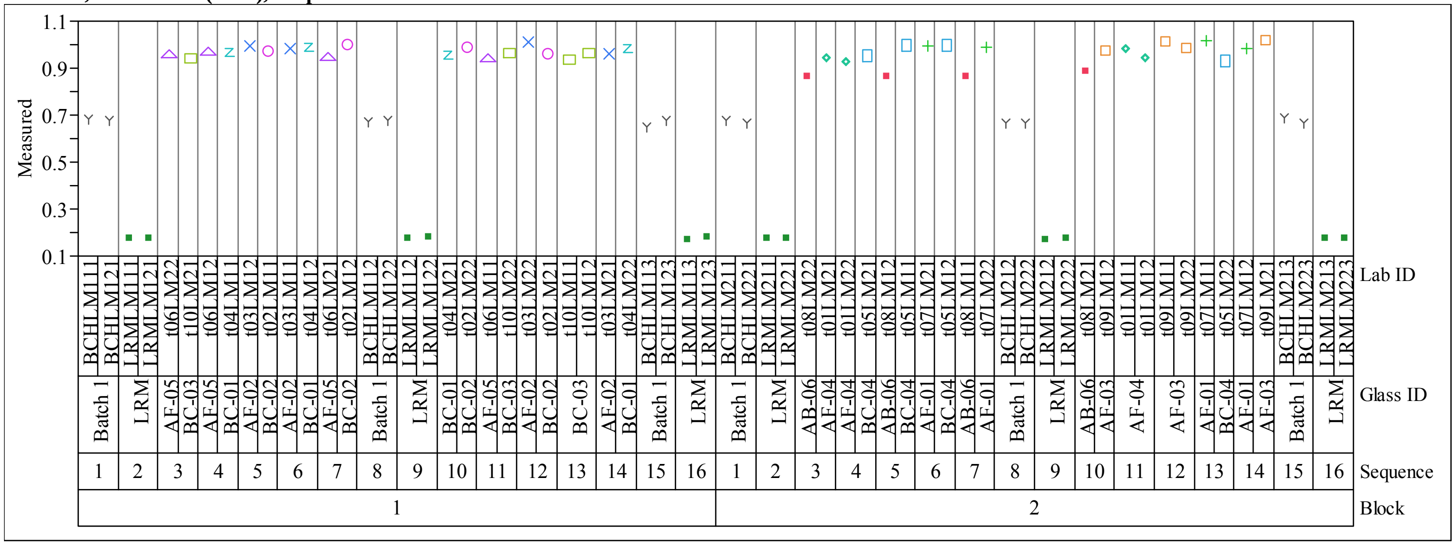


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=T, Oxide=NiO (wt%), Prep Method=LM



Series=T, Oxide=PbO (wt%), Prep Method=LM

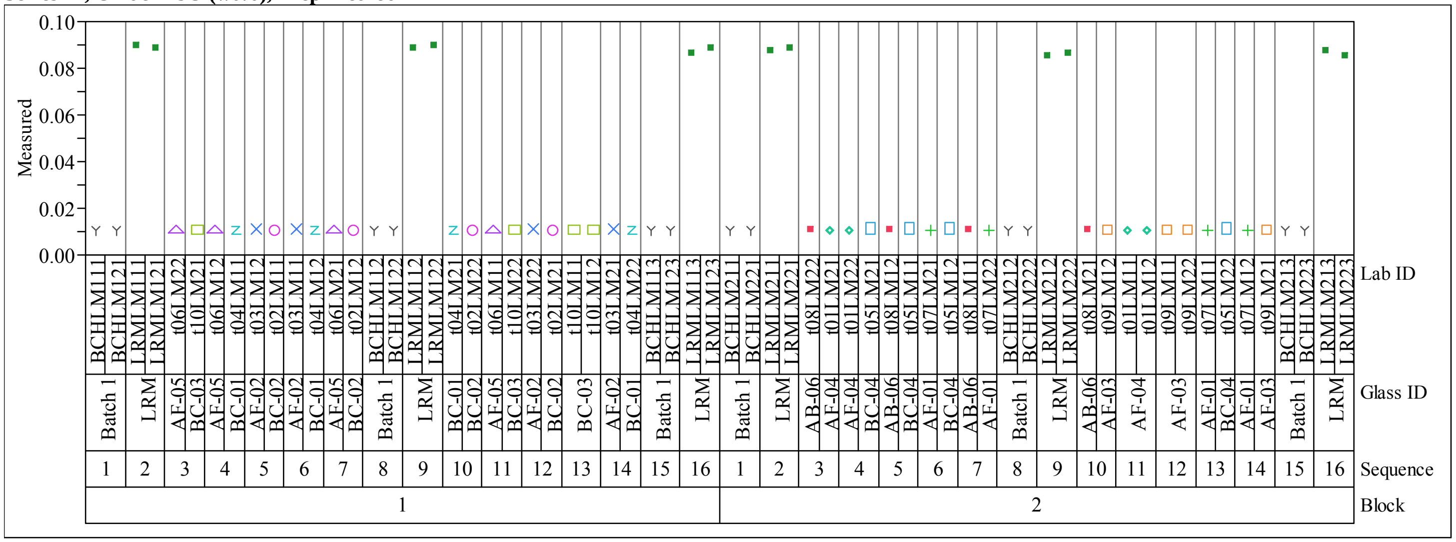
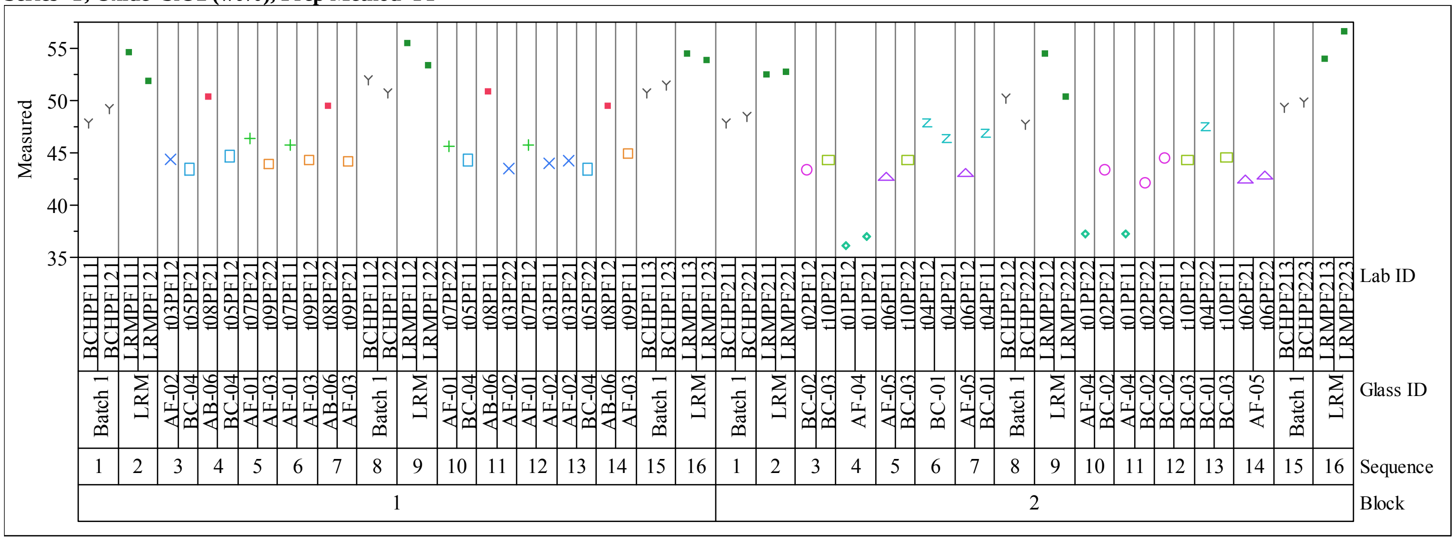


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=T, Oxide=SiO2 (wt%), Prep Method=PF



Series=T, Oxide=SO4 (wt%), Prep Method=LM

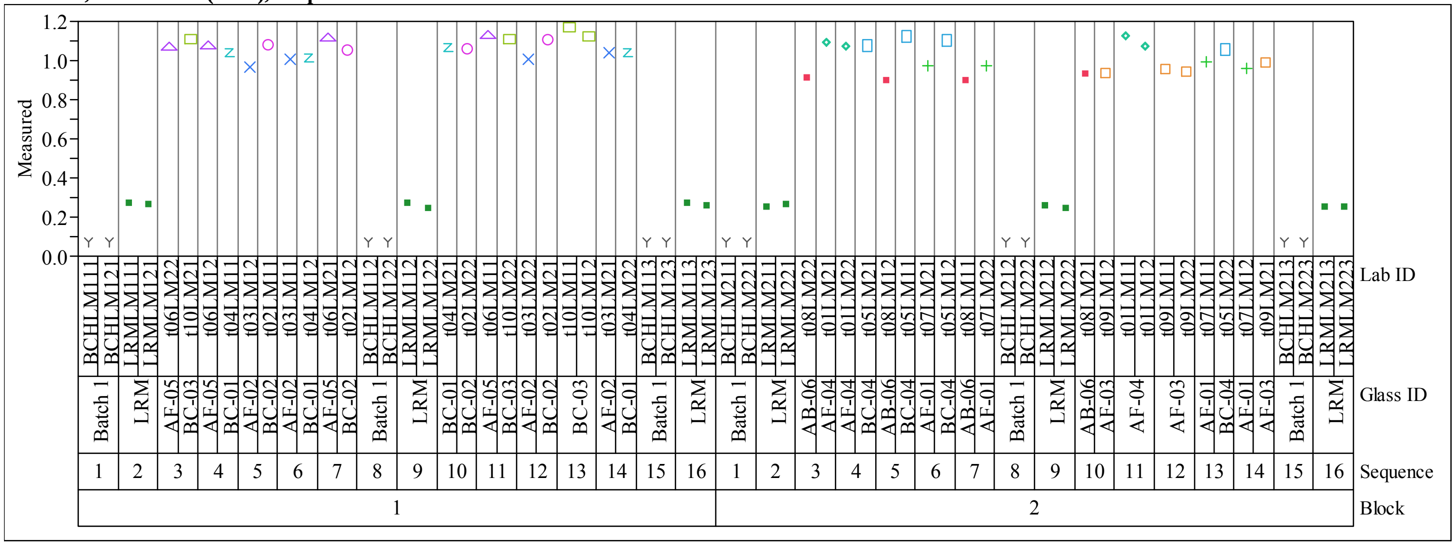
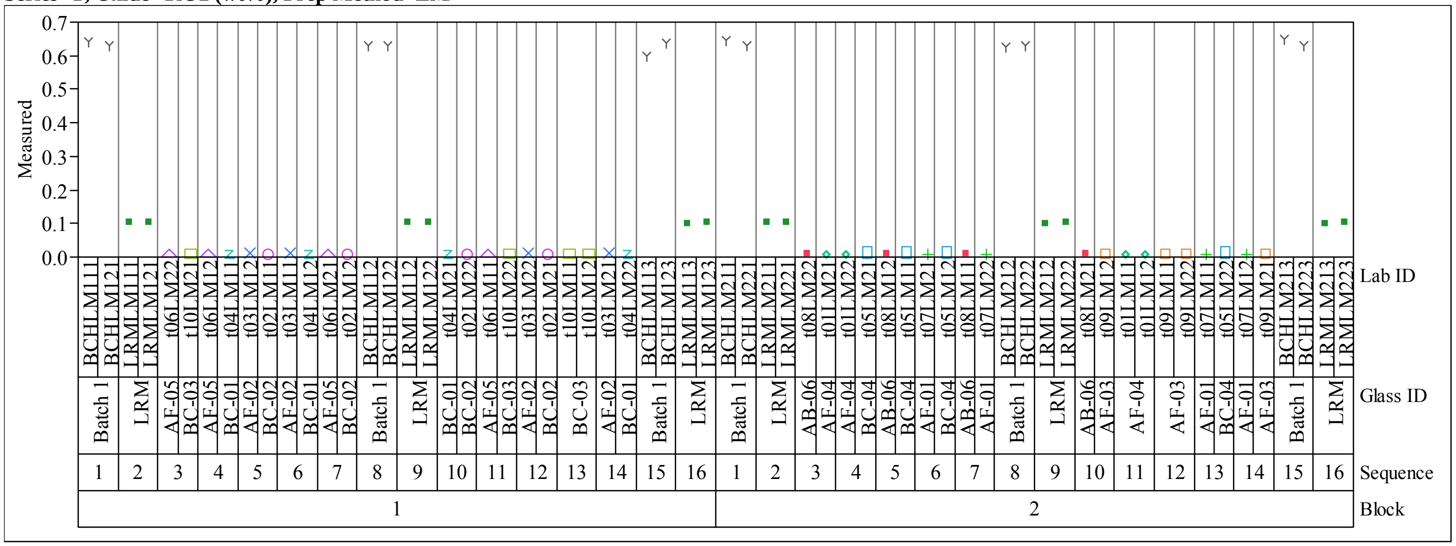


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=T, Oxide=TiO2 (wt%), Prep Method=LM



Series=T, Oxide=ZnO (wt%), Prep Method=LM

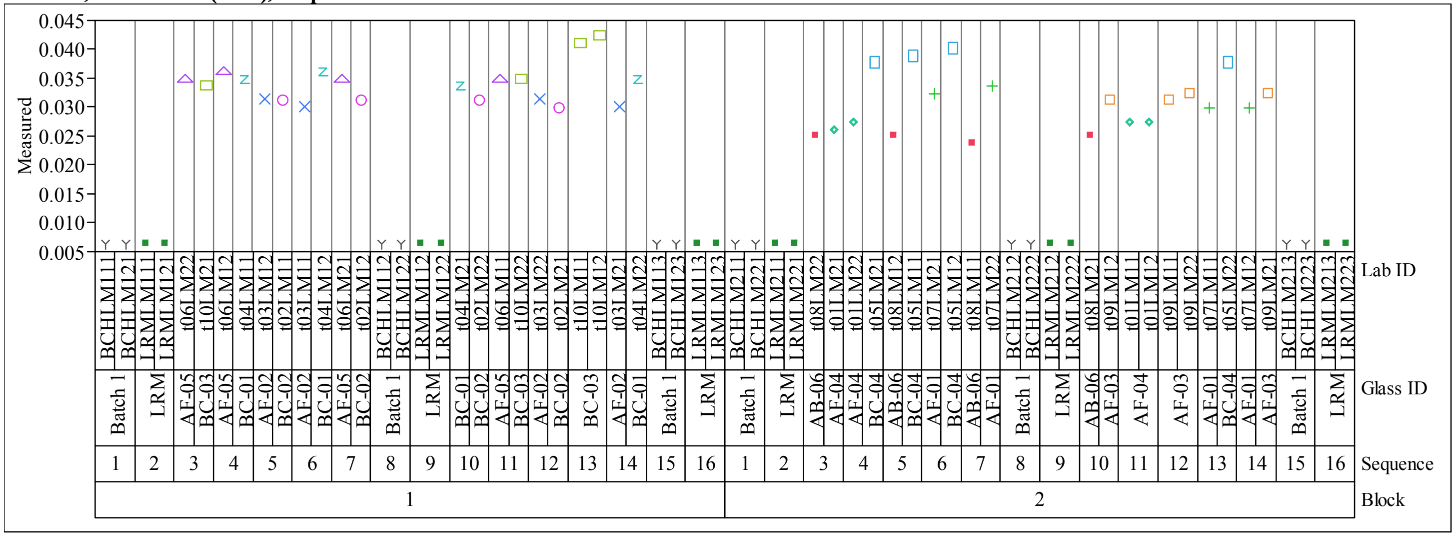
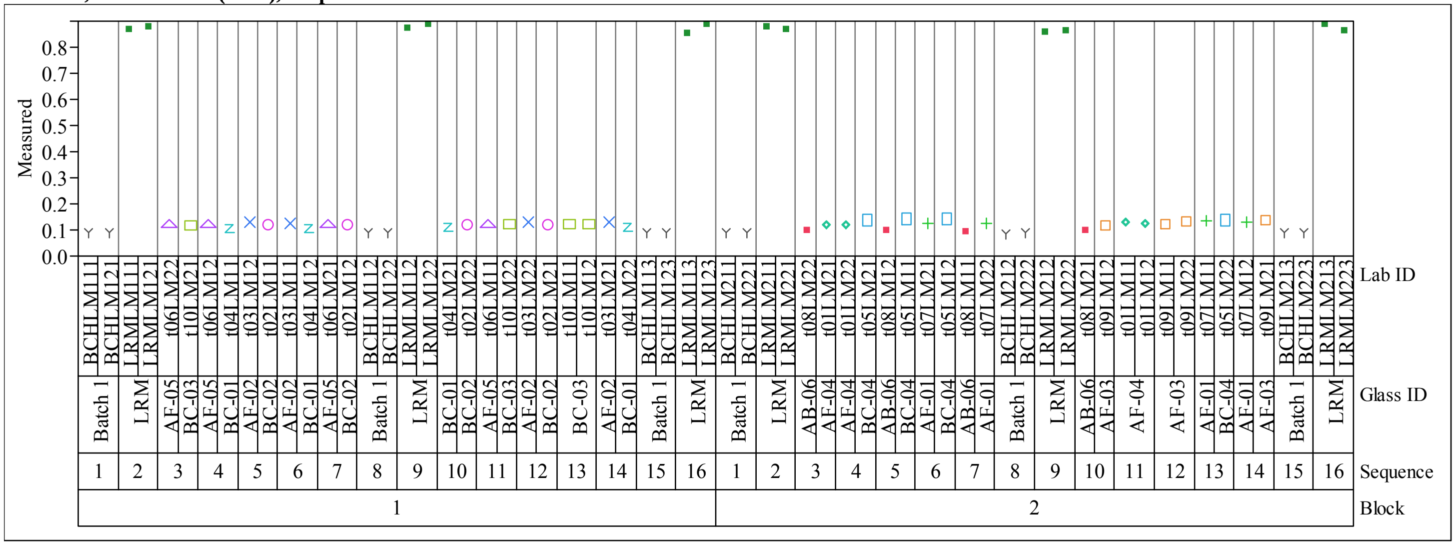


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=T, Oxide=ZrO2 (wt%), Prep Method=LM



Series=U, Oxide=Al2O3 (wt%), Prep Method=LM

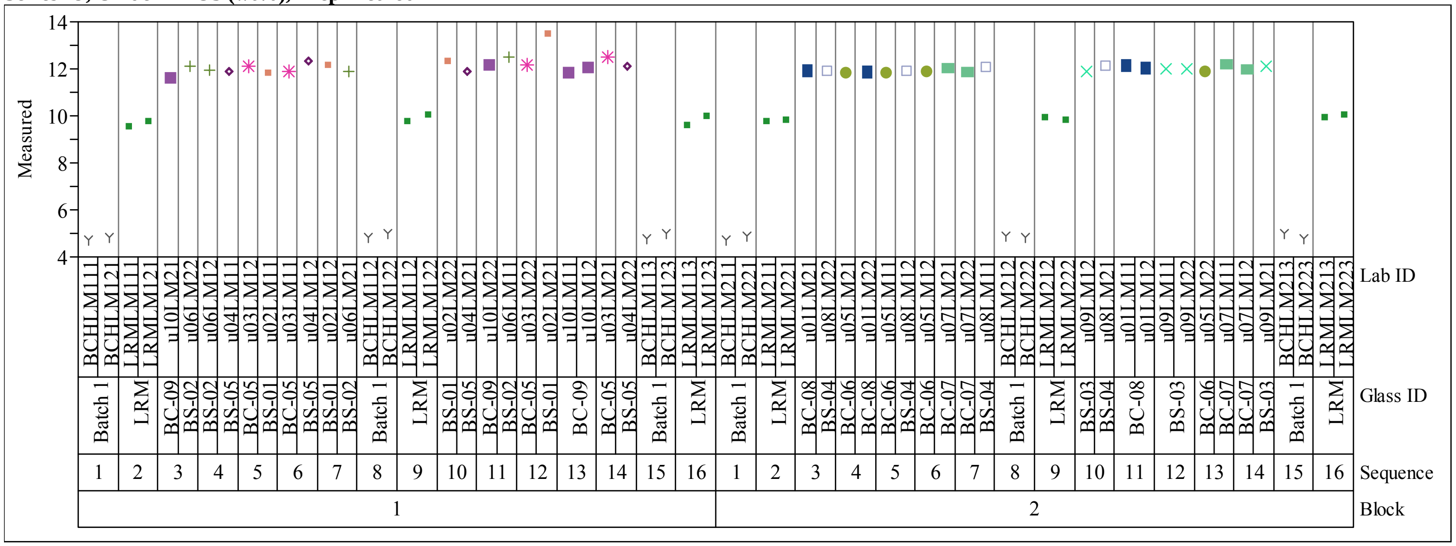
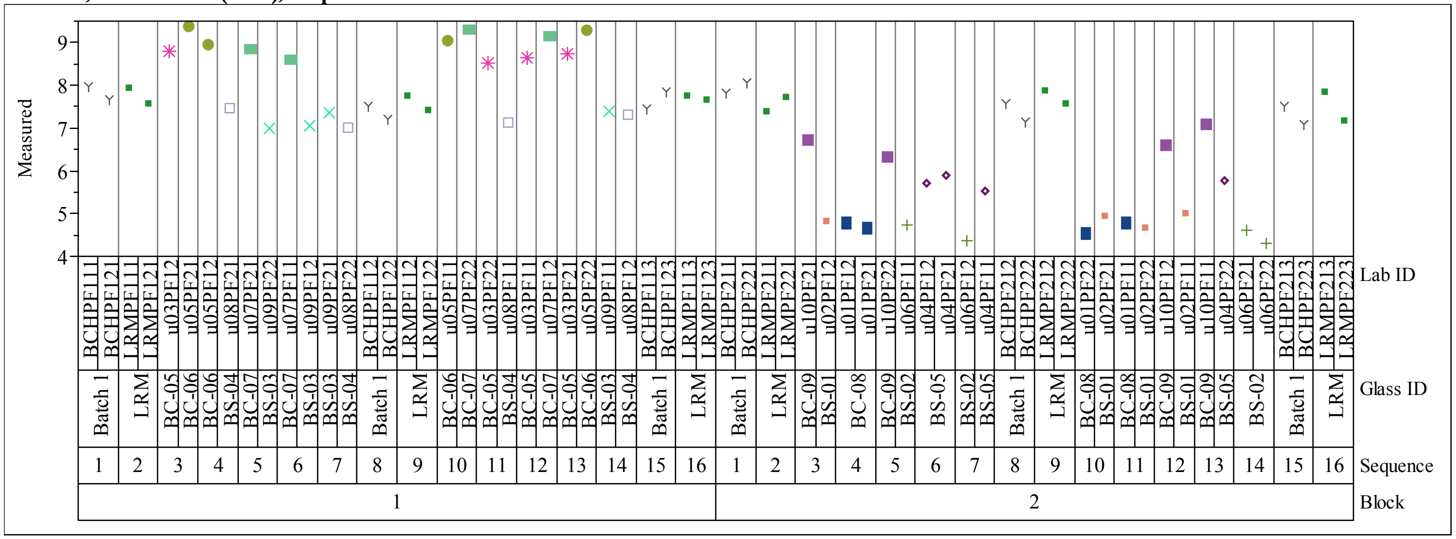


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=U, Oxide=B2O3 (wt%), Prep Method=PF



Series=U, Oxide=BaO (wt%), Prep Method=LM

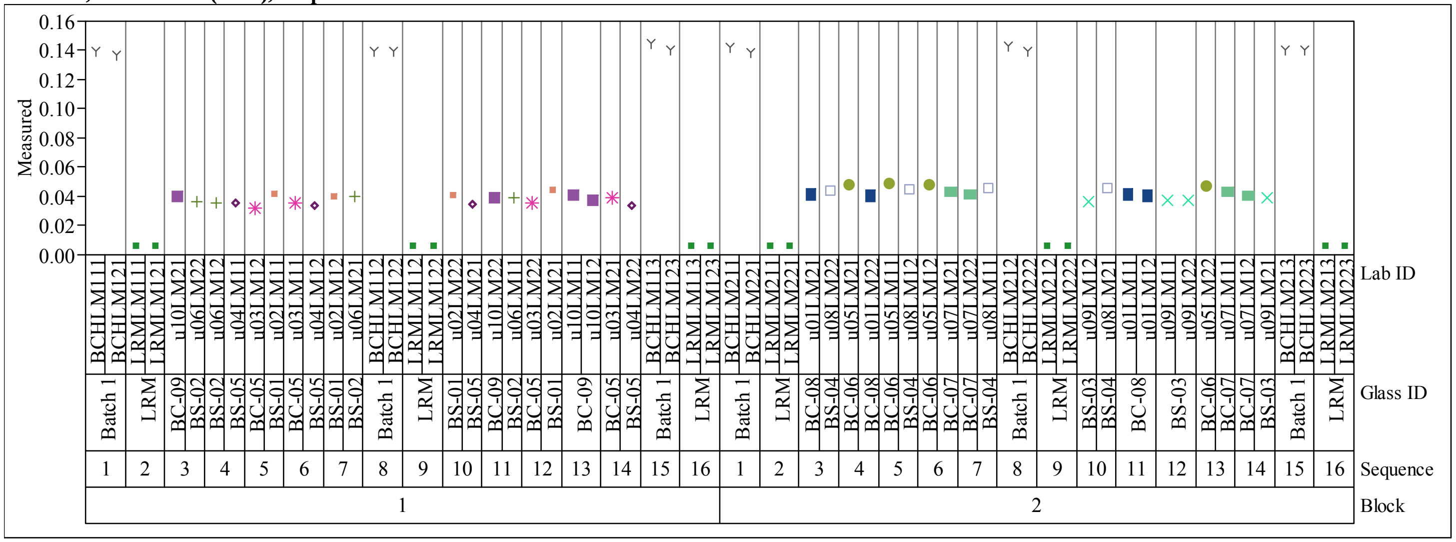
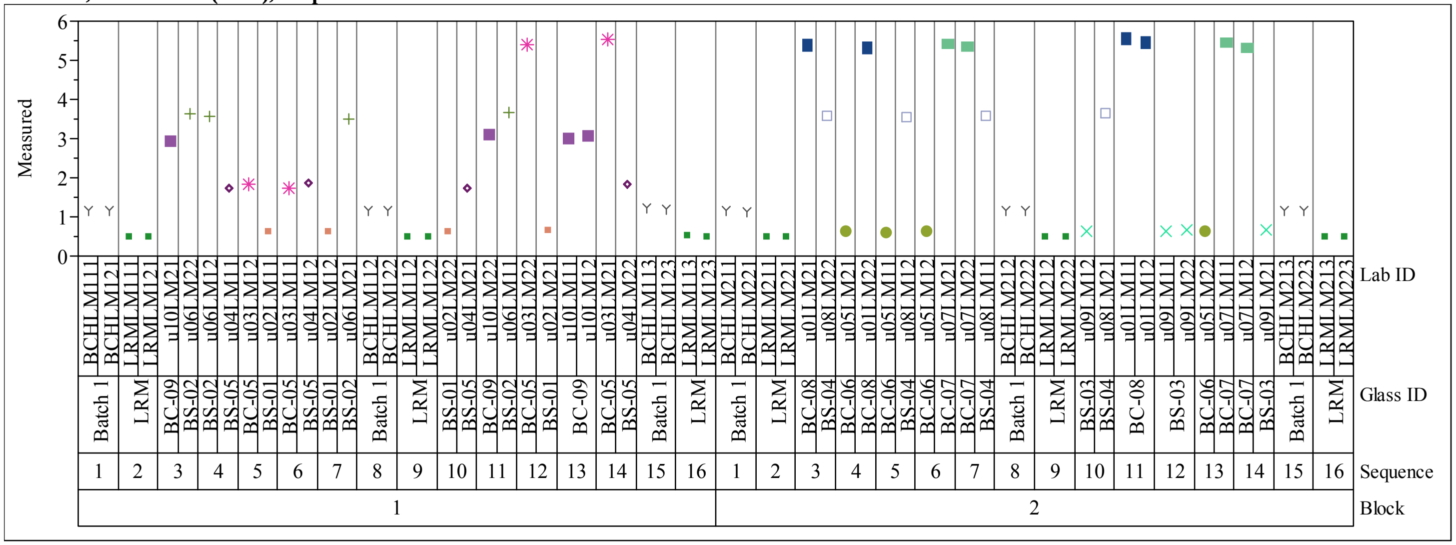


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=U, Oxide=CaO (wt%), Prep Method=LM



Series=U, Oxide=Ce2O3 (wt%), Prep Method=LM

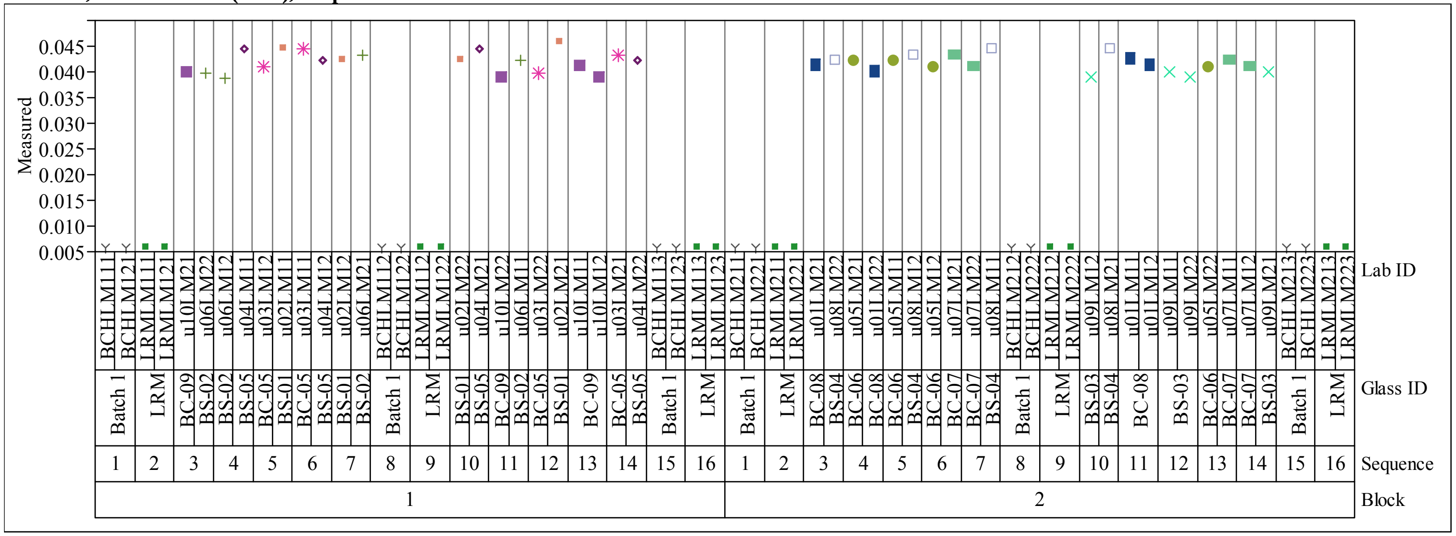
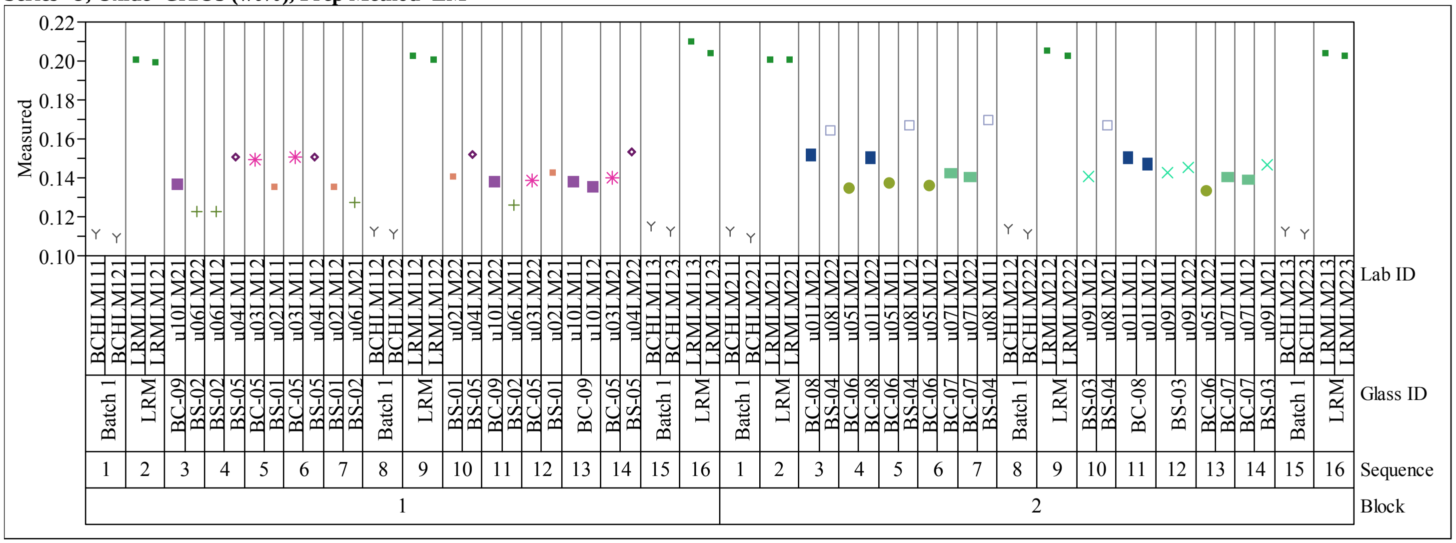


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=U, Oxide=Cr2O3 (wt%), Prep Method=LM



Series=U, Oxide=CuO (wt%), Prep Method=LM

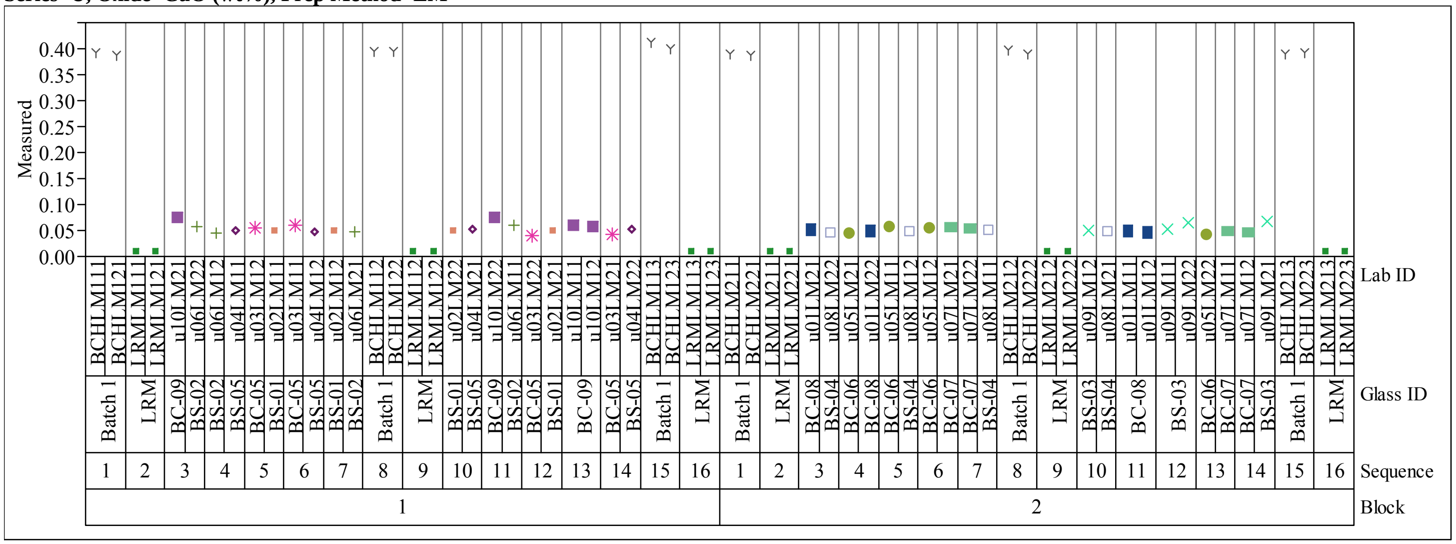
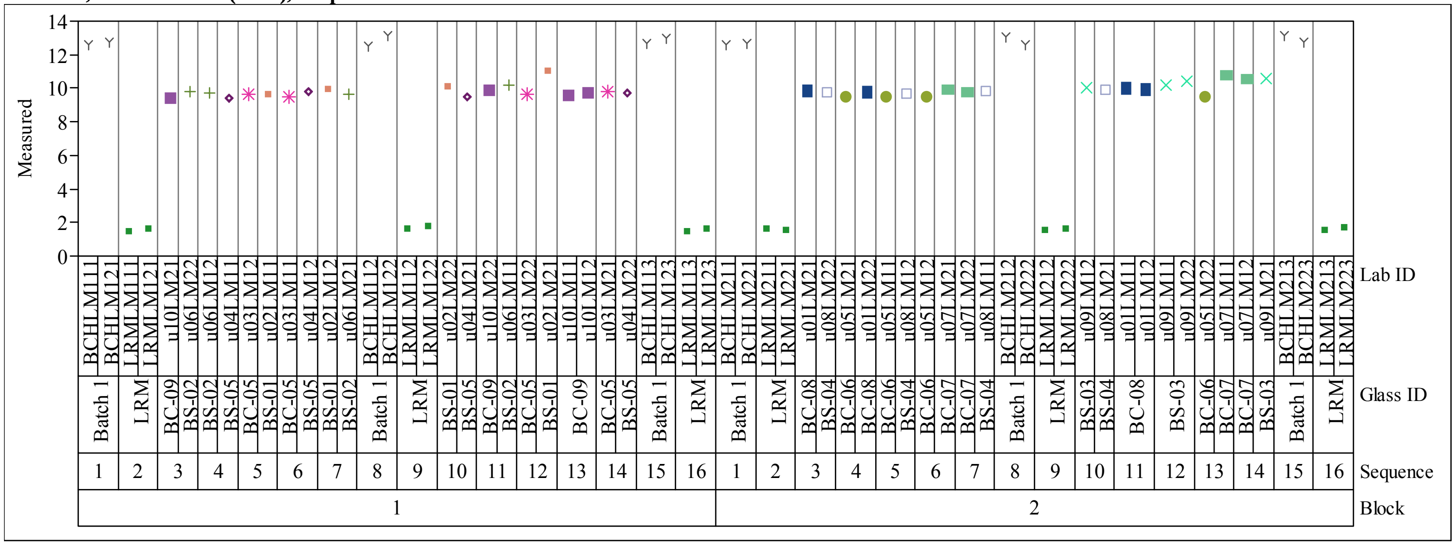


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=U, Oxide=Fe2O3 (wt%), Prep Method=LM



Series=U, Oxide=K2O (wt%), Prep Method=LM

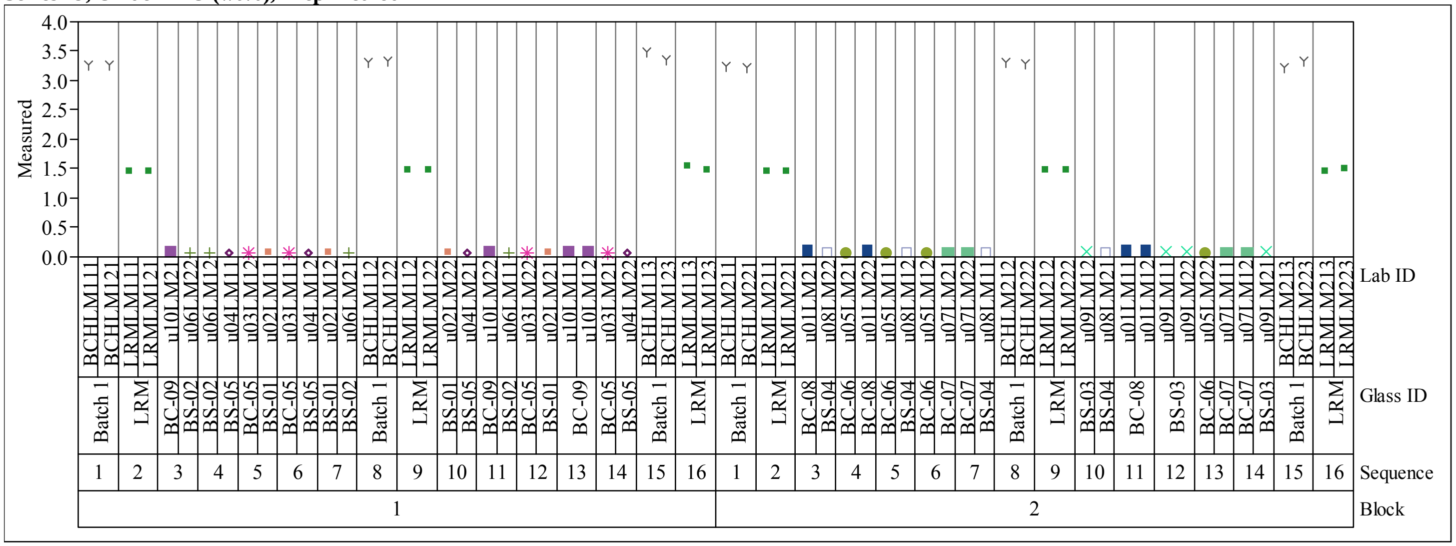
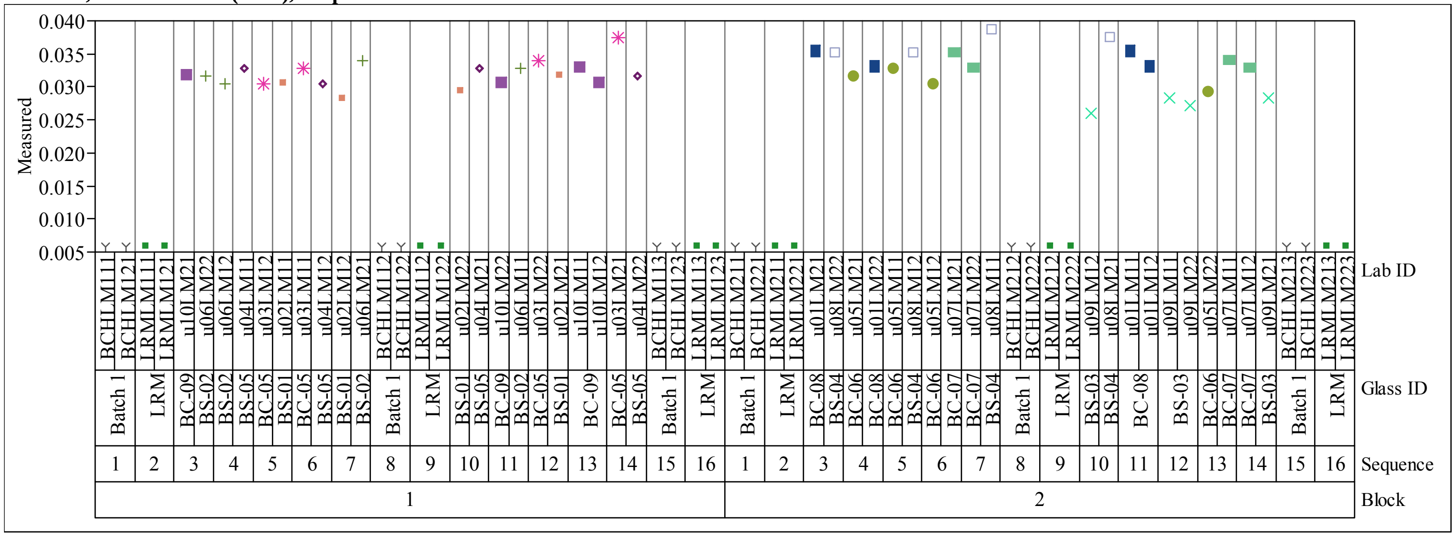


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=U, Oxide=La2O3 (wt%), Prep Method=LM



Series=U, Oxide=Li2O (wt%), Prep Method=PF

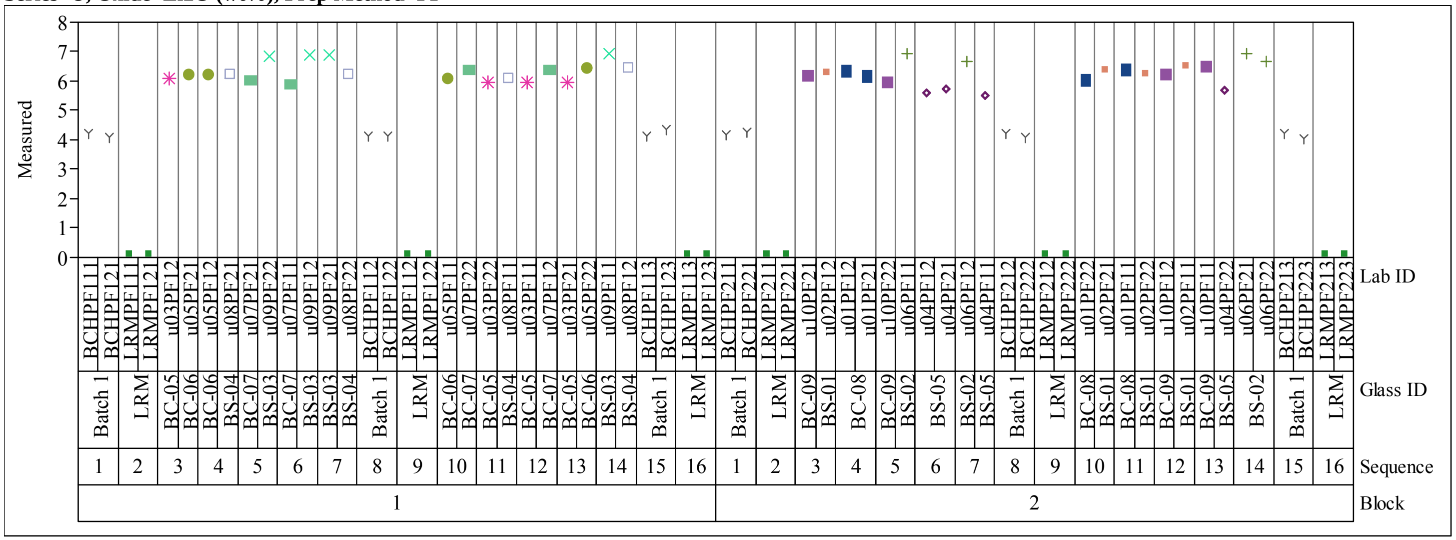
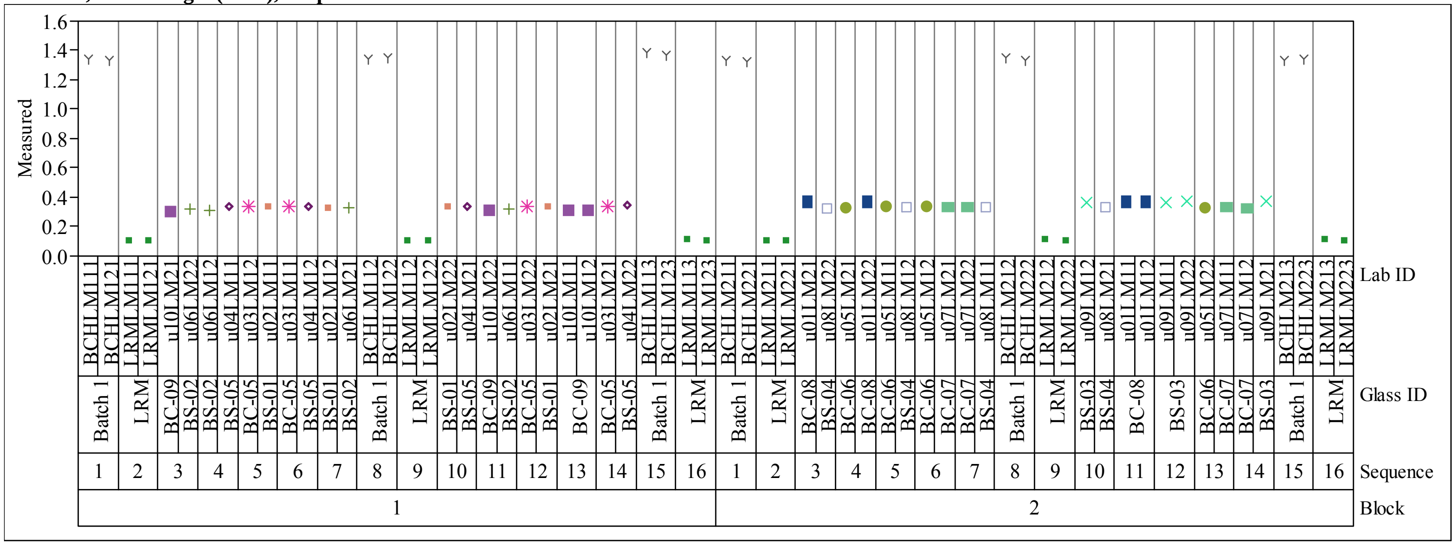


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=U, Oxide=MgO (wt%), Prep Method=LM



Series=U, Oxide=MnO (wt%), Prep Method=LM

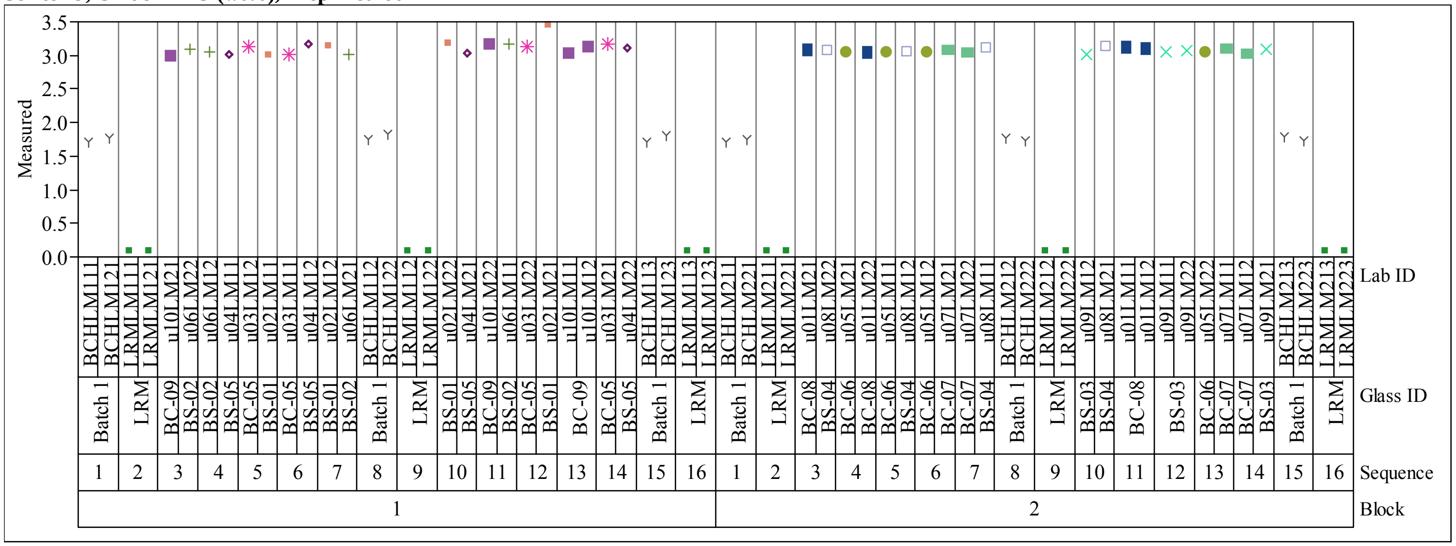
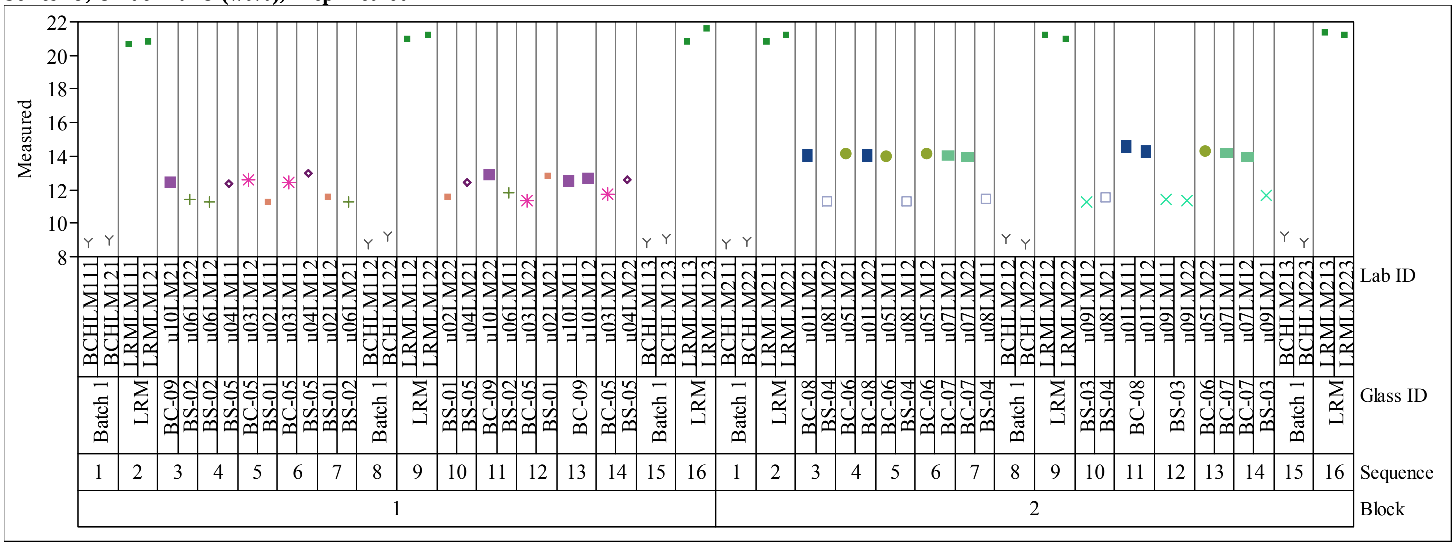


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=U, Oxide=Na2O (wt%), Prep Method=LM



Series=U, Oxide=NiO (wt%), Prep Method=LM

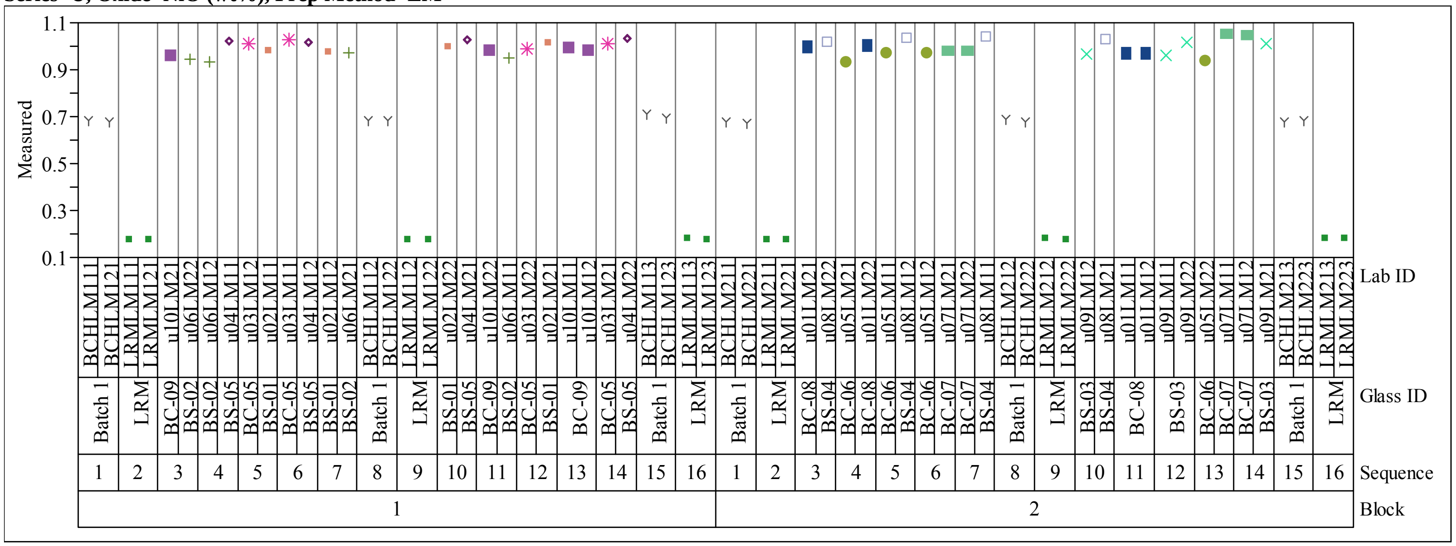
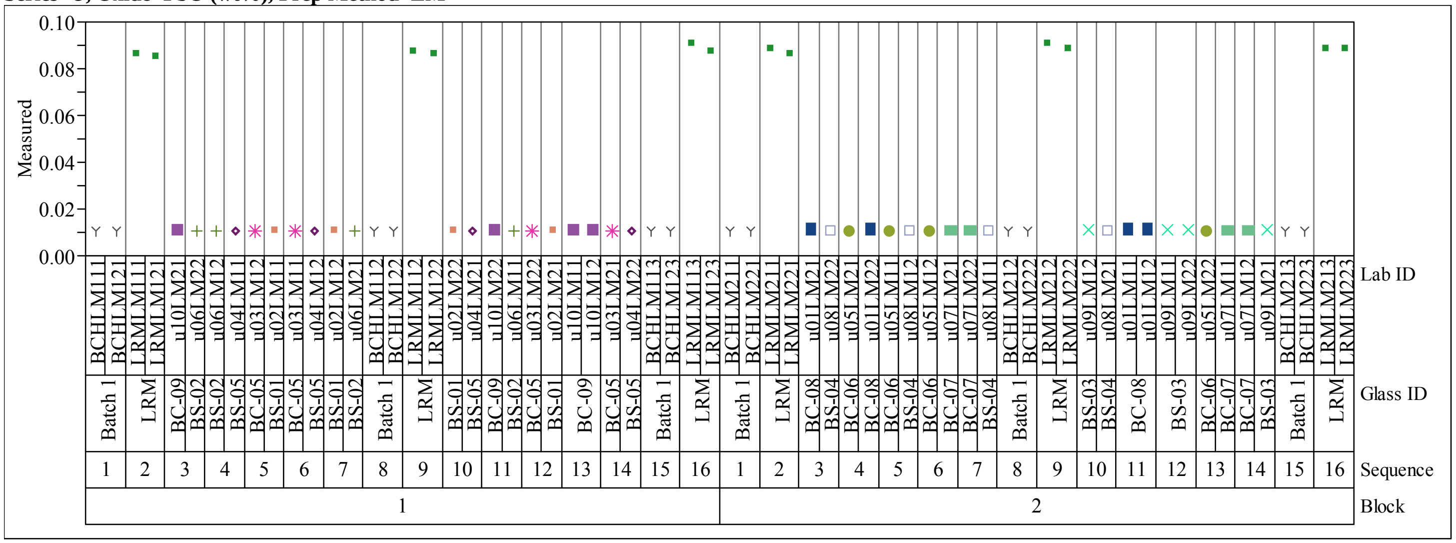


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=U, Oxide=PbO (wt%), Prep Method=LM



Series=U, Oxide=SiO2 (wt%), Prep Method=PF

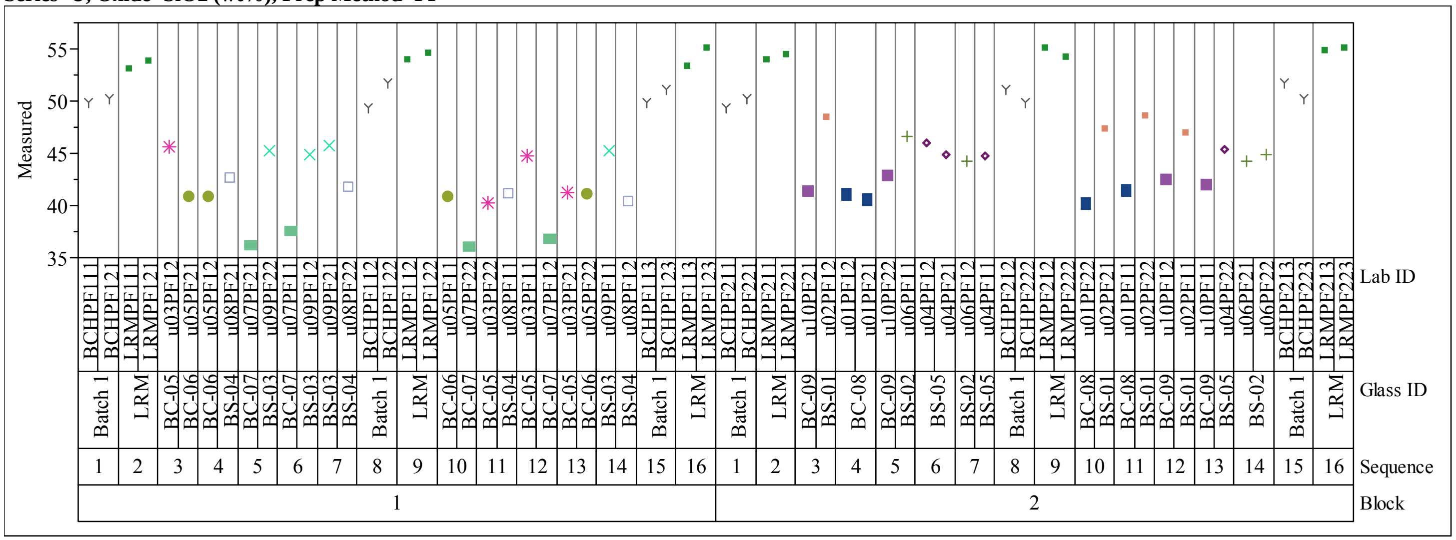
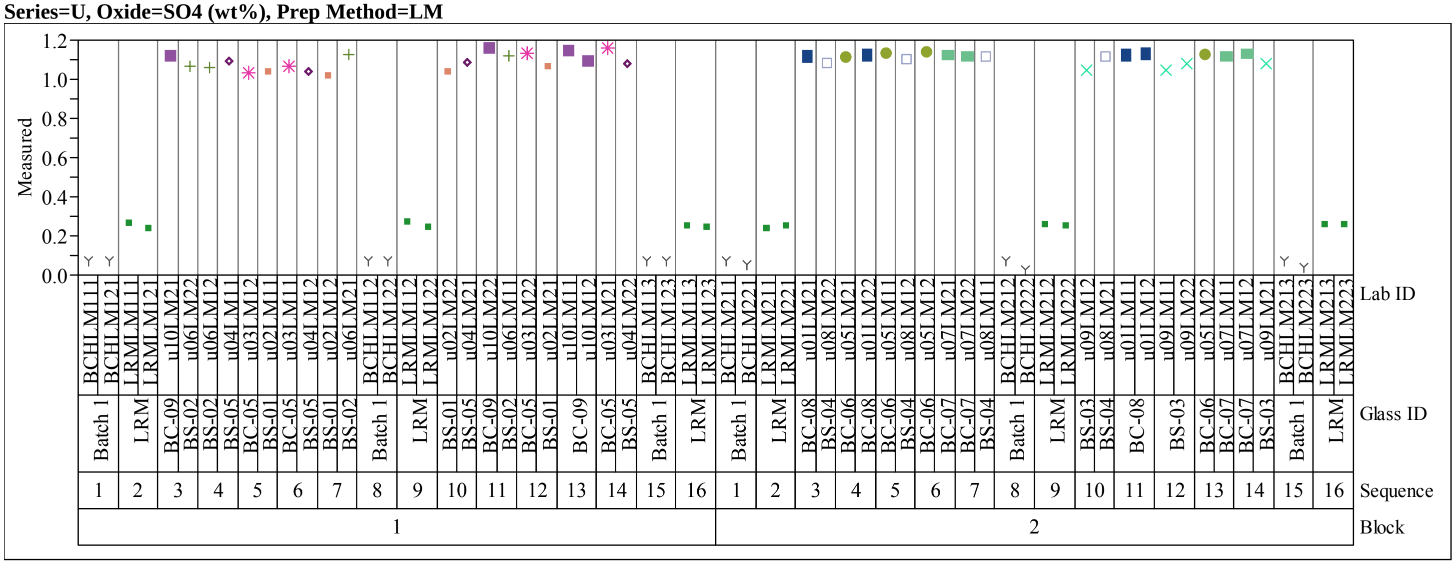


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=U, Oxide=SO4 (wt%), Prep Method=LM



Series=U, Oxide=TiO2 (wt%), Prep Method=LM

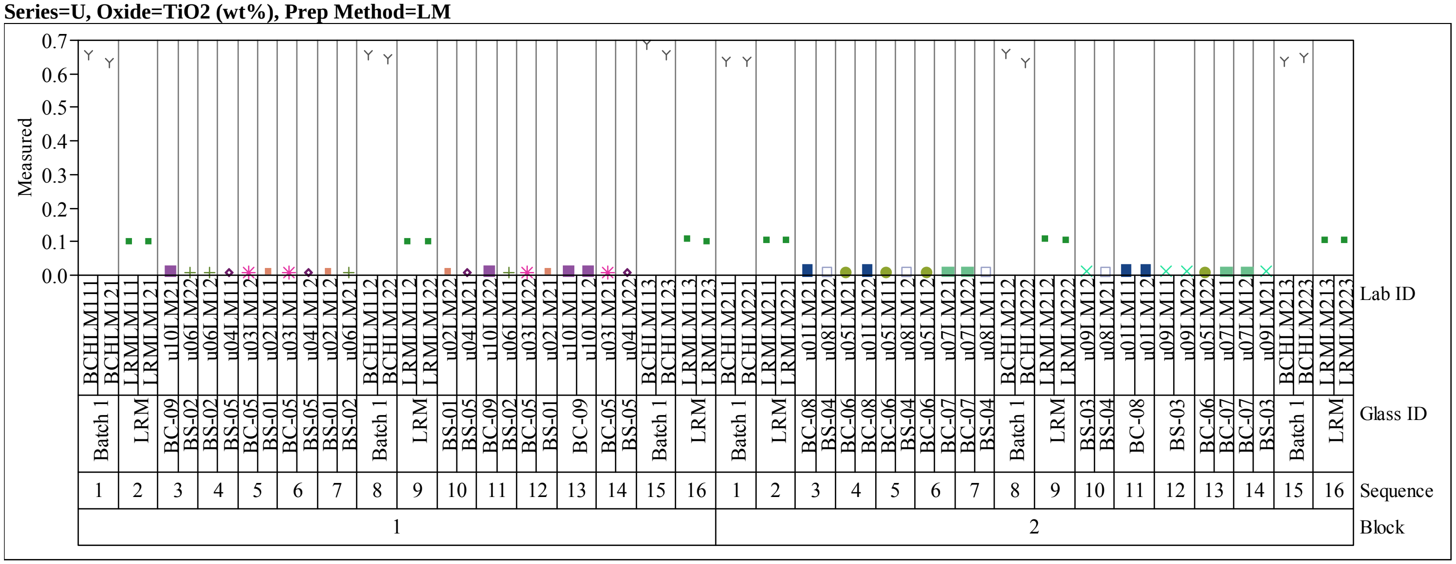
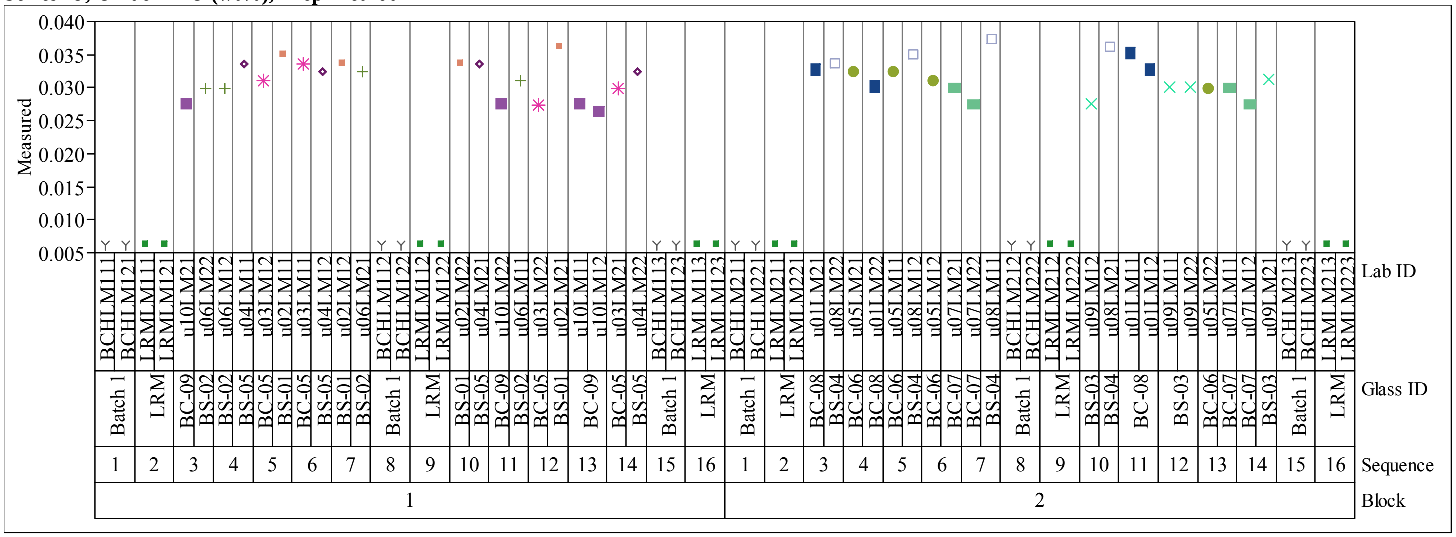


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=U, Oxide=ZnO (wt%), Prep Method=LM



Series=U, Oxide=ZrO2 (wt%), Prep Method=LM

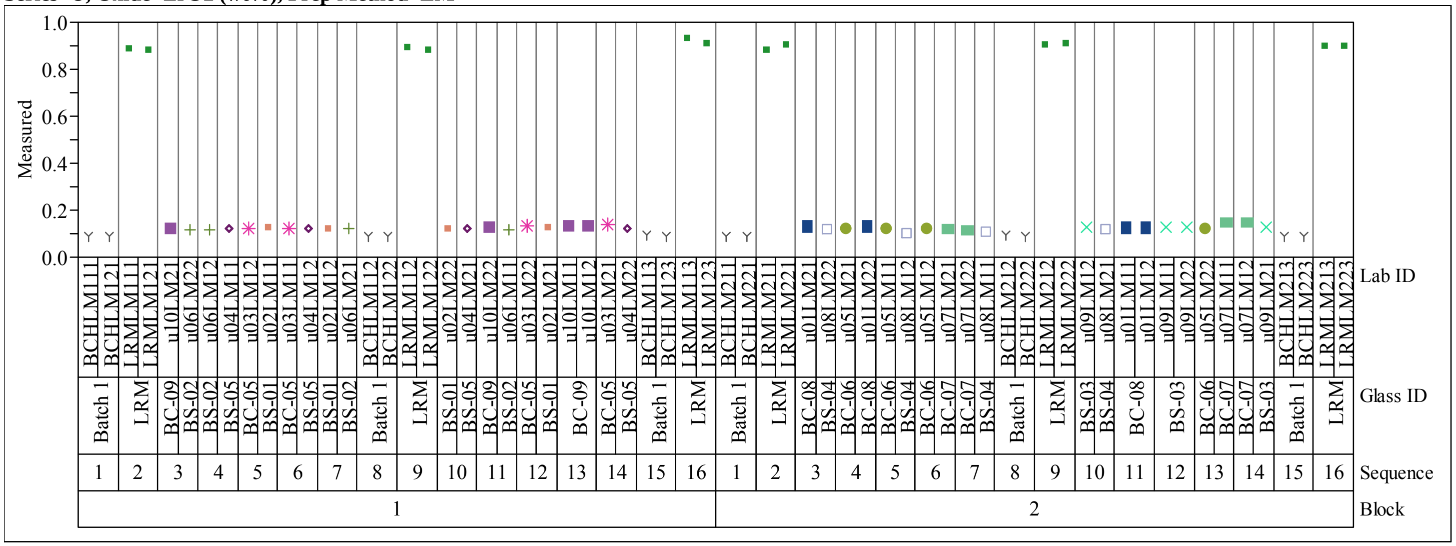
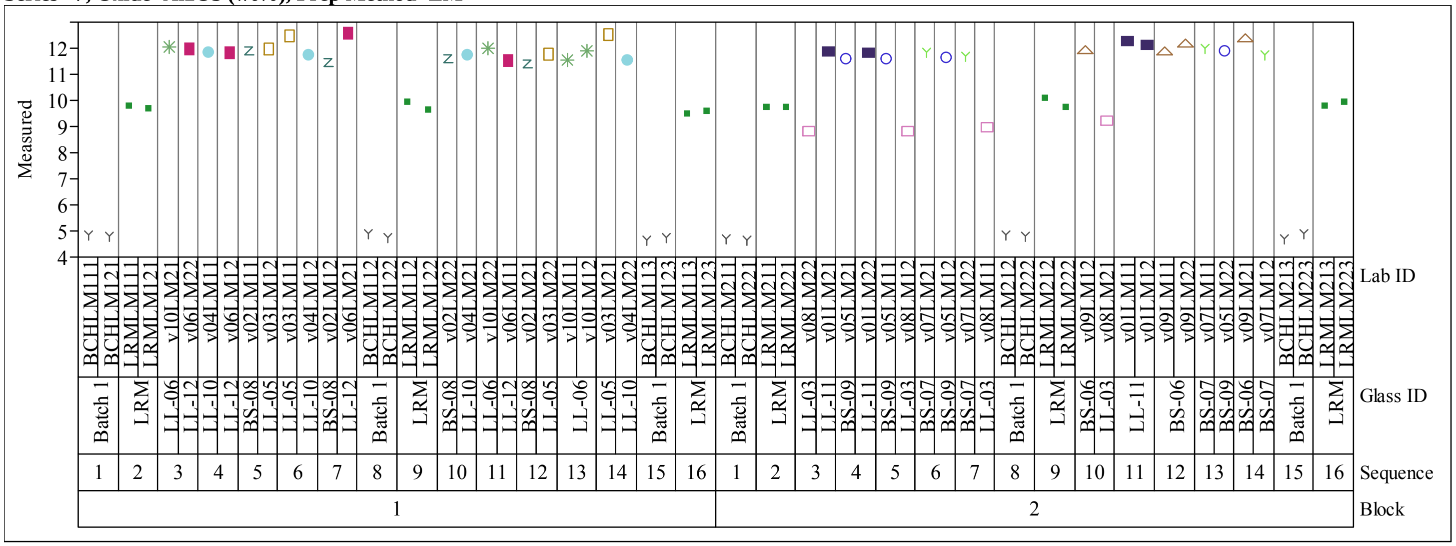


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=V, Oxide=Al2O3 (wt%), Prep Method=LM



Series=V, Oxide=B2O3 (wt%), Prep Method=PF

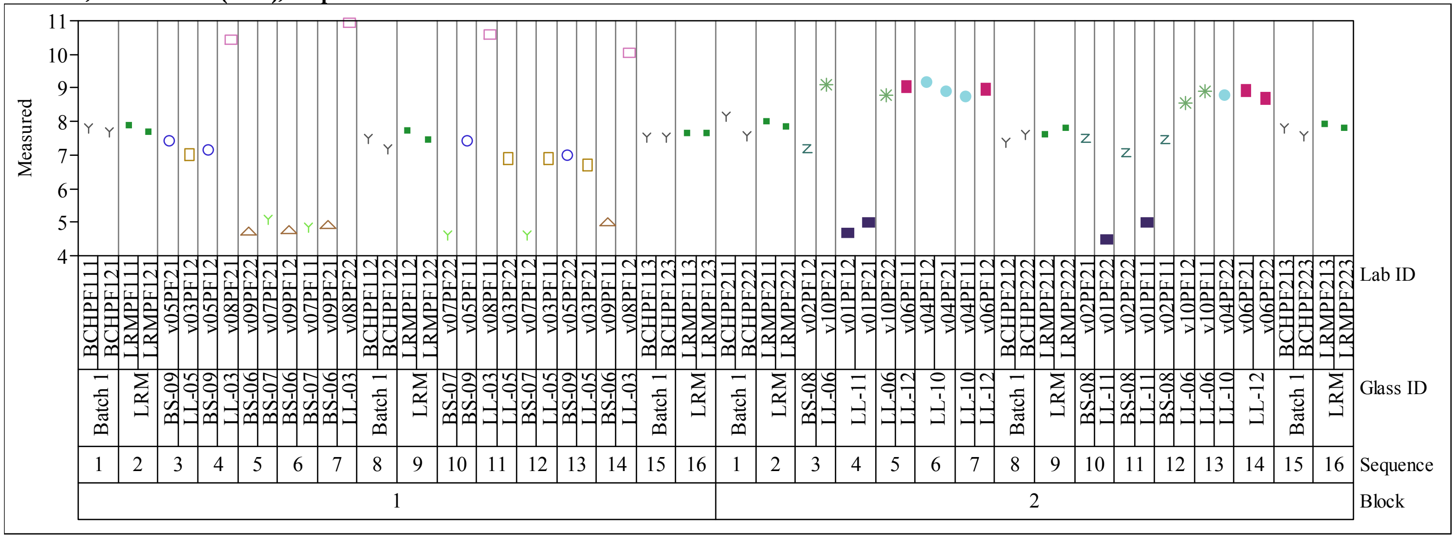
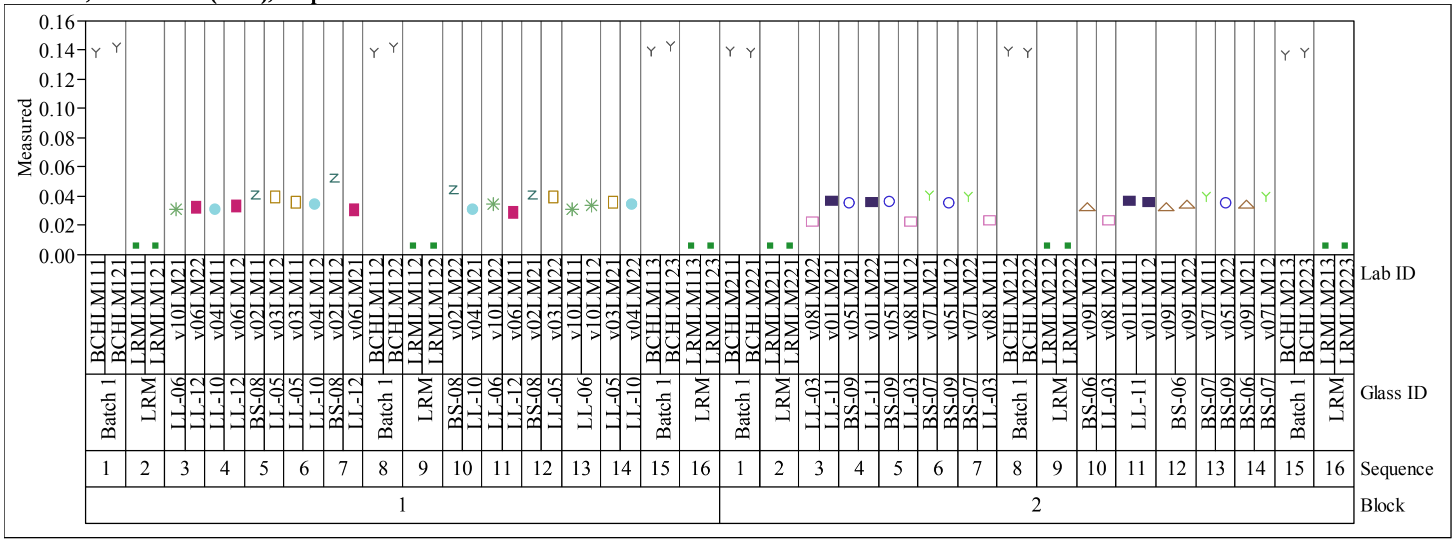


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=V, Oxide=BaO (wt%), Prep Method=LM



Series=V, Oxide=CaO (wt%), Prep Method=LM

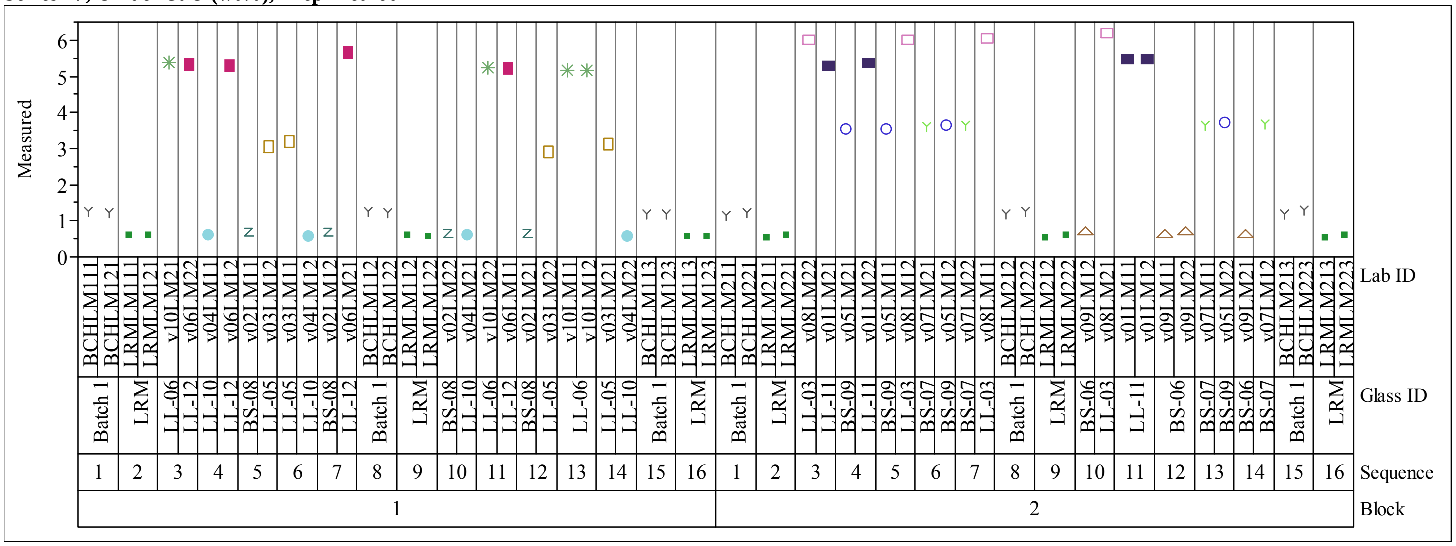
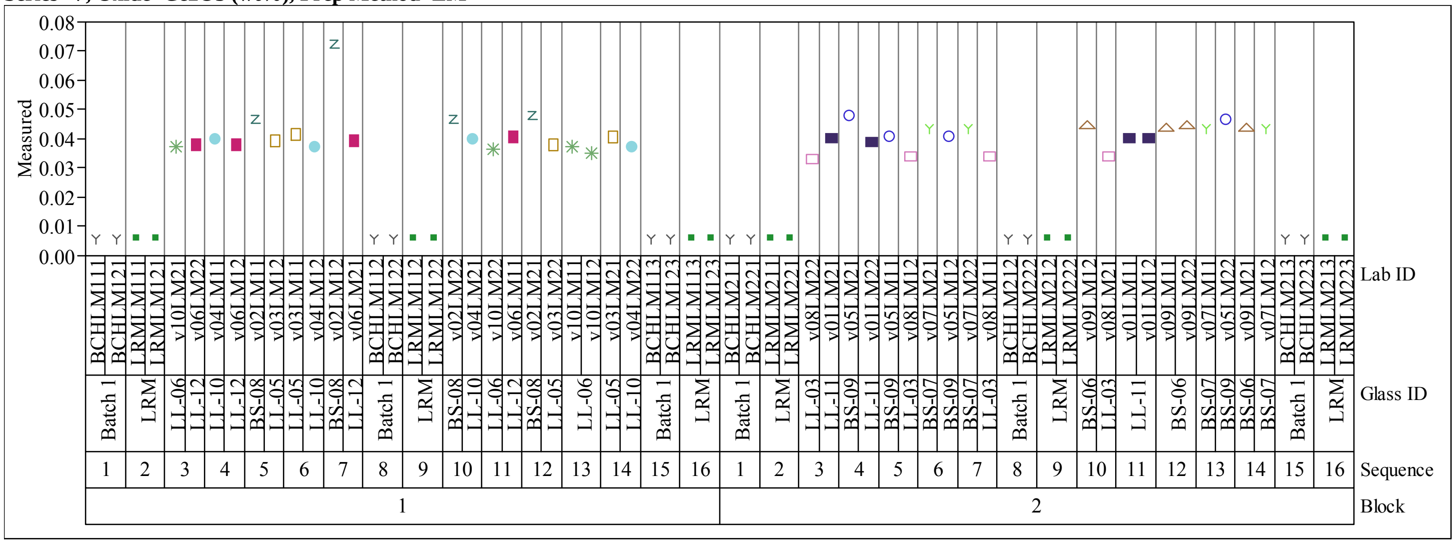


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=V, Oxide=Ce2O3 (wt%), Prep Method=LM



Series=V, Oxide=Cr2O3 (wt%), Prep Method=LM

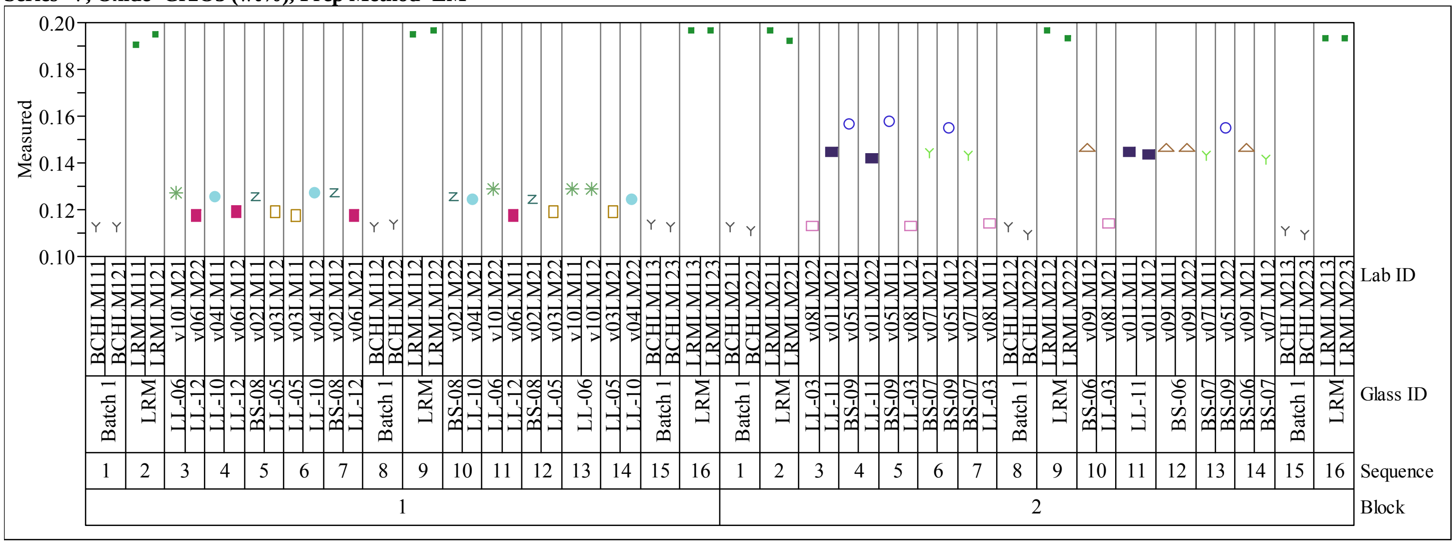
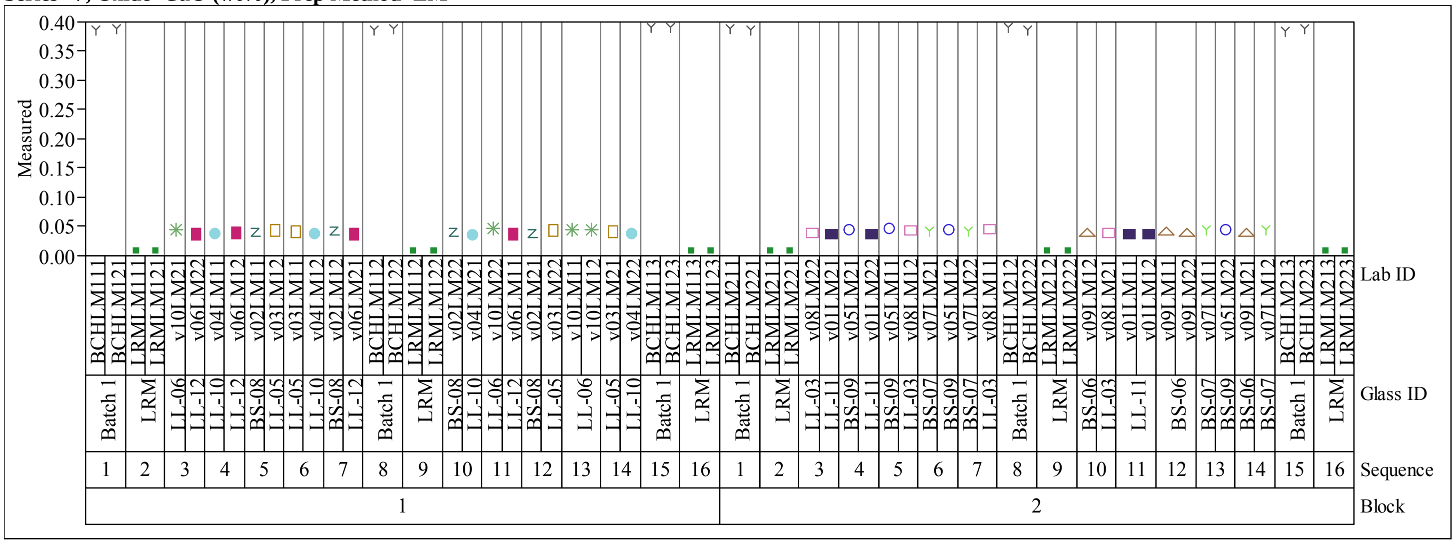


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=V, Oxide=CuO (wt%), Prep Method=LM



Series=V, Oxide=Fe2O3 (wt%), Prep Method=LM

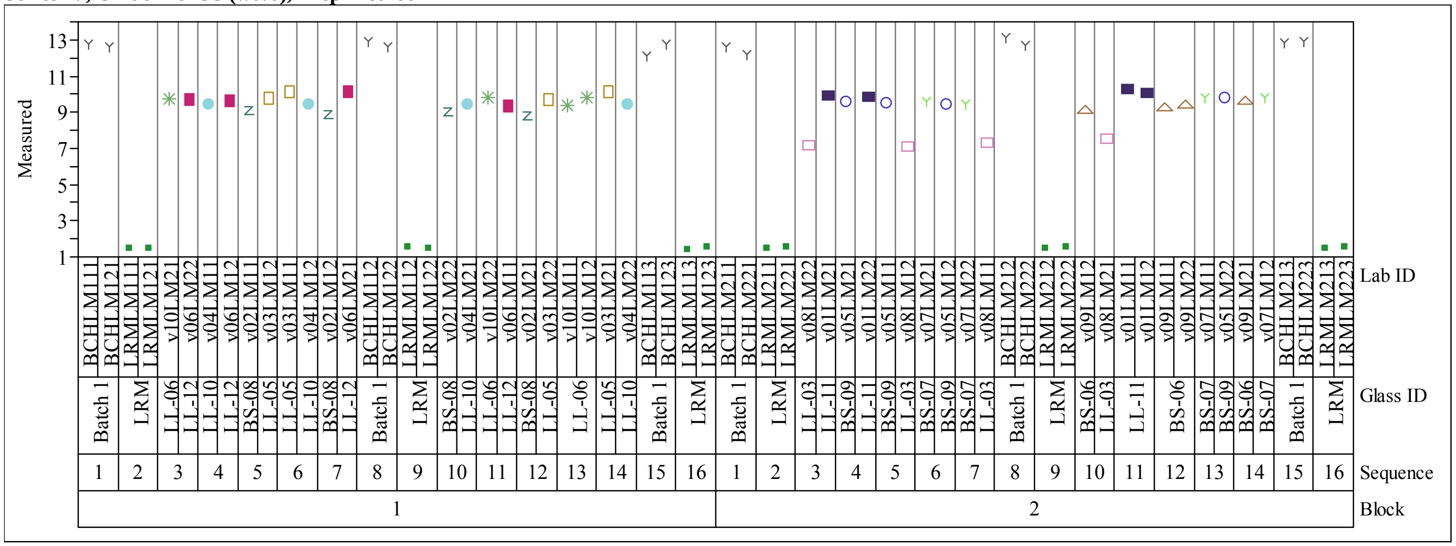
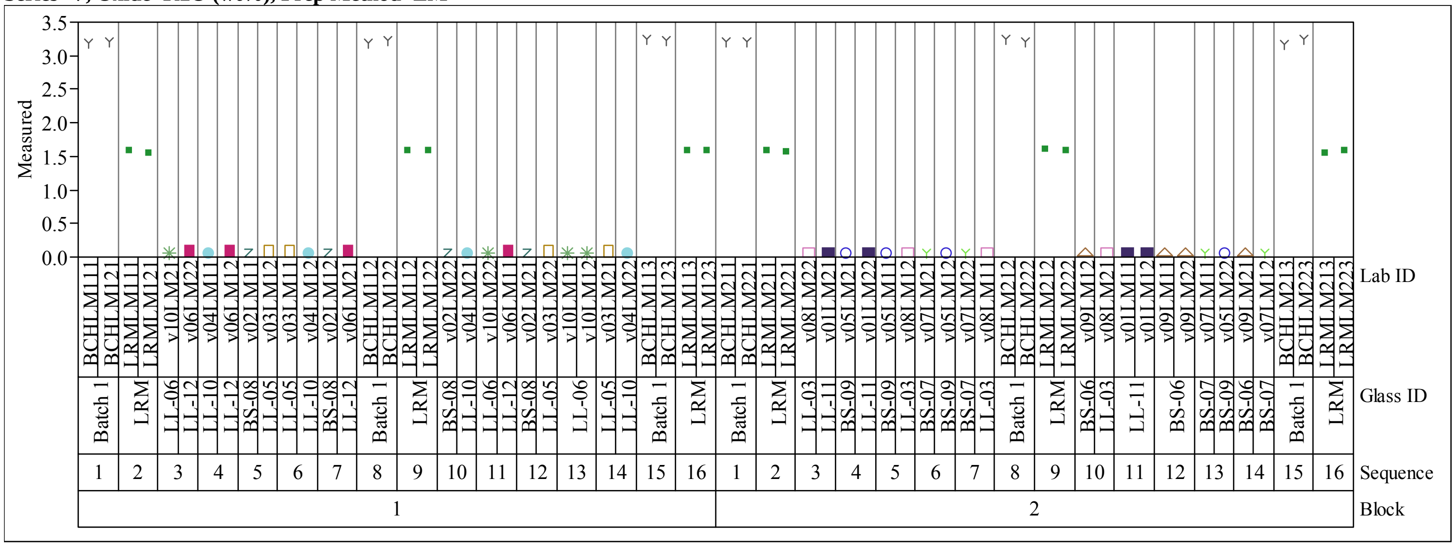


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=V, Oxide=K2O (wt%), Prep Method=LM



Series=V, Oxide=La2O3 (wt%), Prep Method=LM

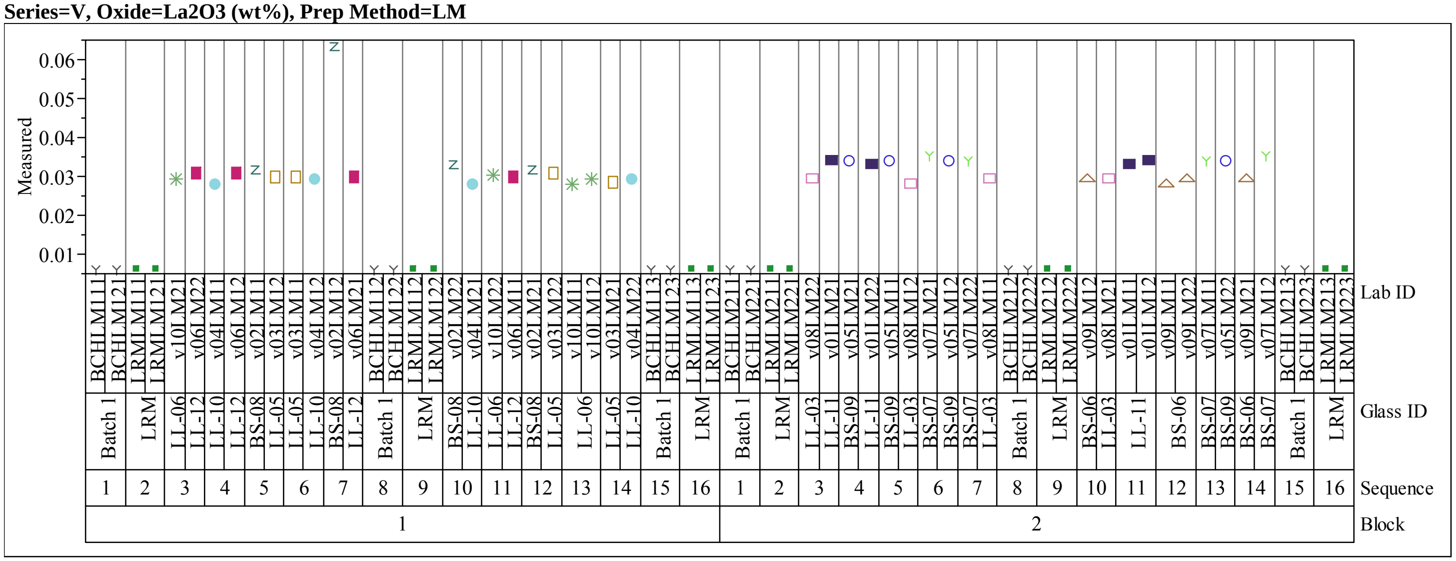
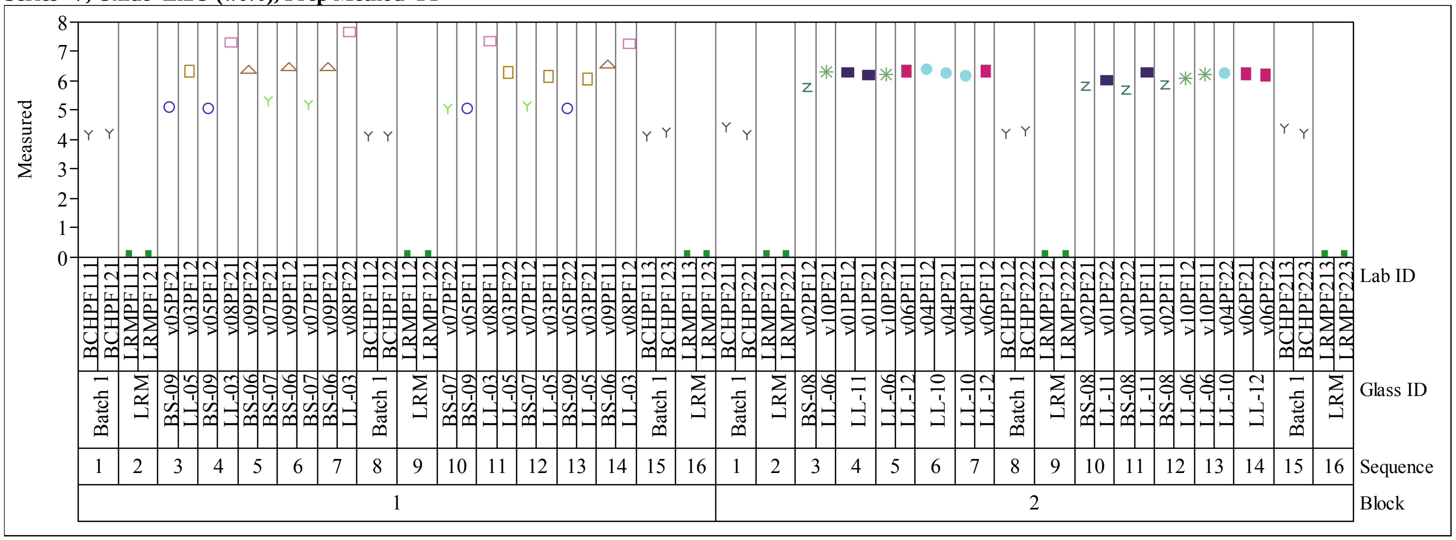


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=V, Oxide=Li2O (wt%), Prep Method=PF



Series=V, Oxide=MgO (wt%), Prep Method=LM

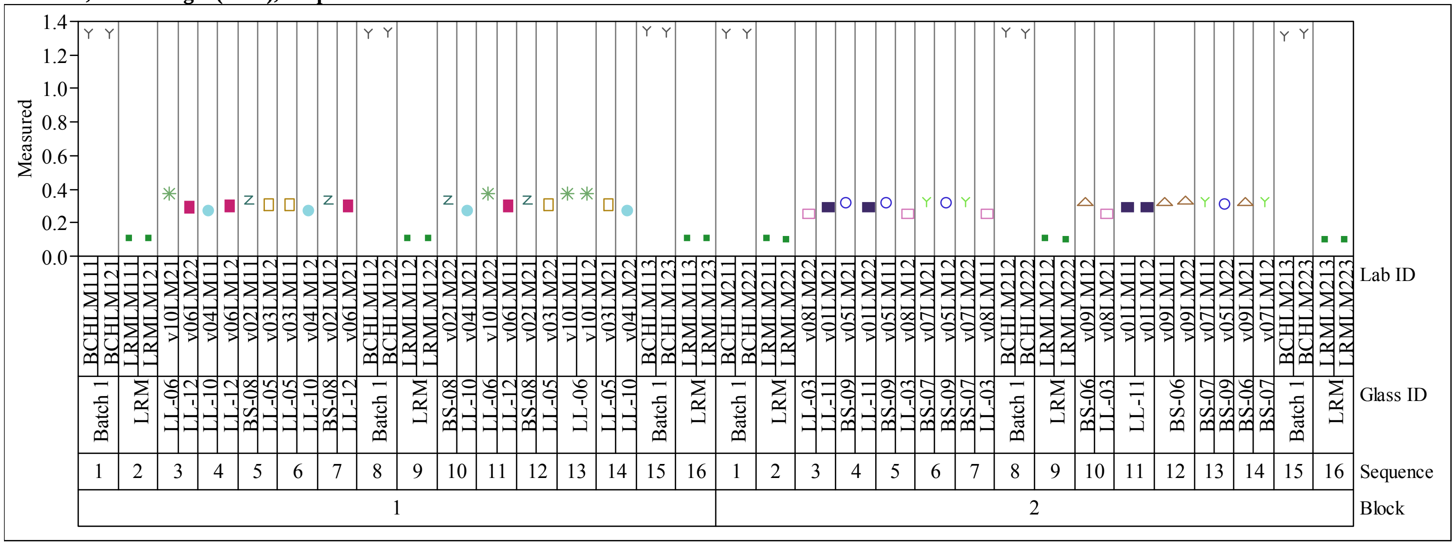
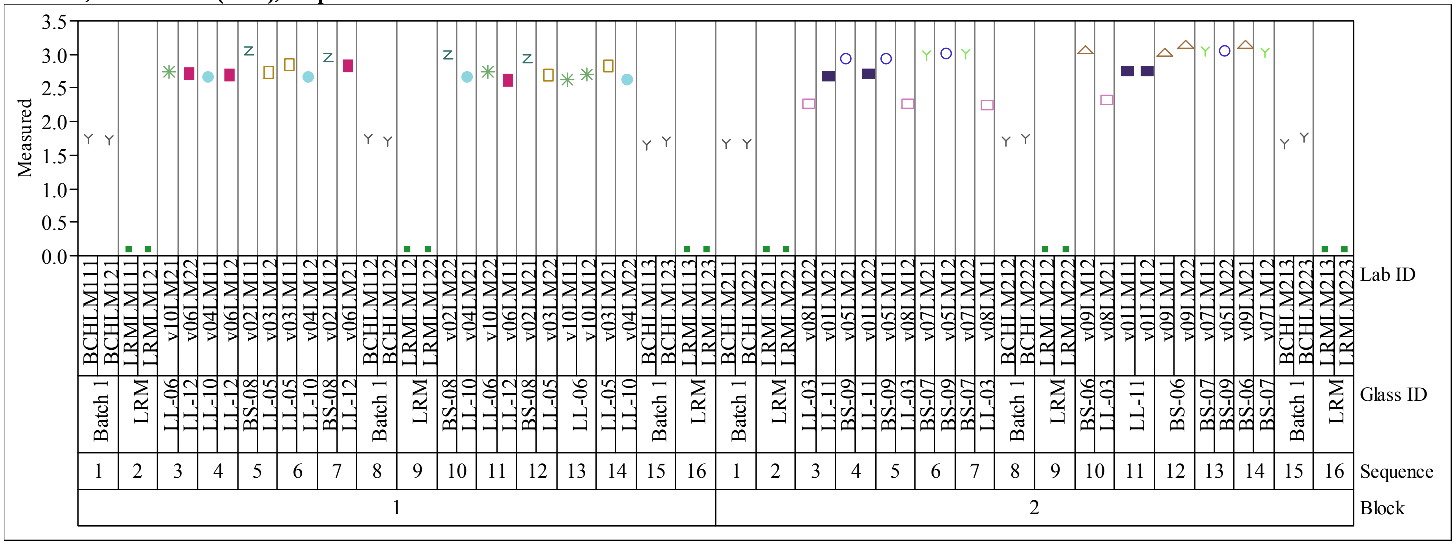


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=V, Oxide=MnO (wt%), Prep Method=LM



Series=V, Oxide=Na2O (wt%), Prep Method=LM

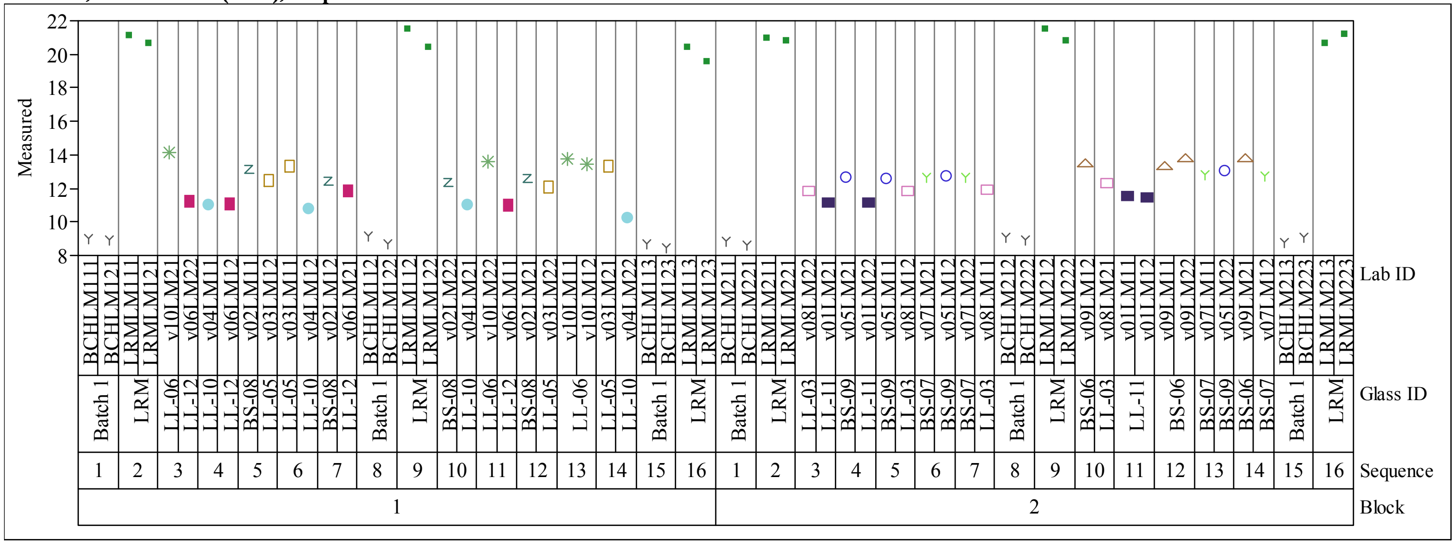
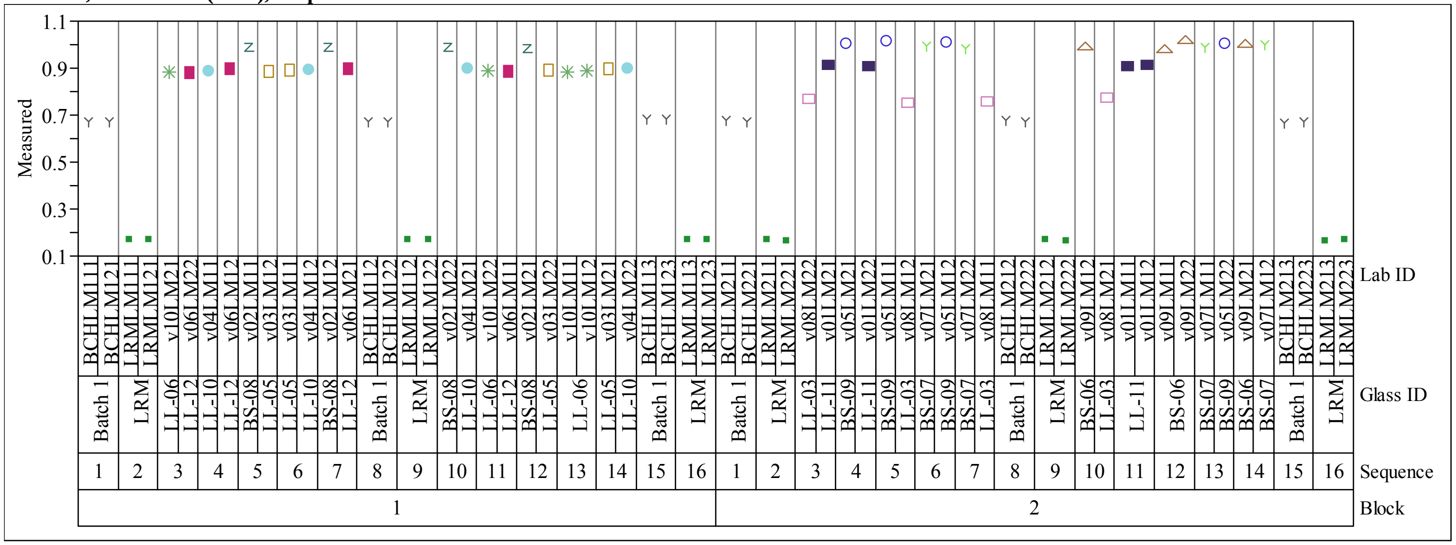


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=V, Oxide=NiO (wt%), Prep Method=LM



Series=V, Oxide=PbO (wt%), Prep Method=LM

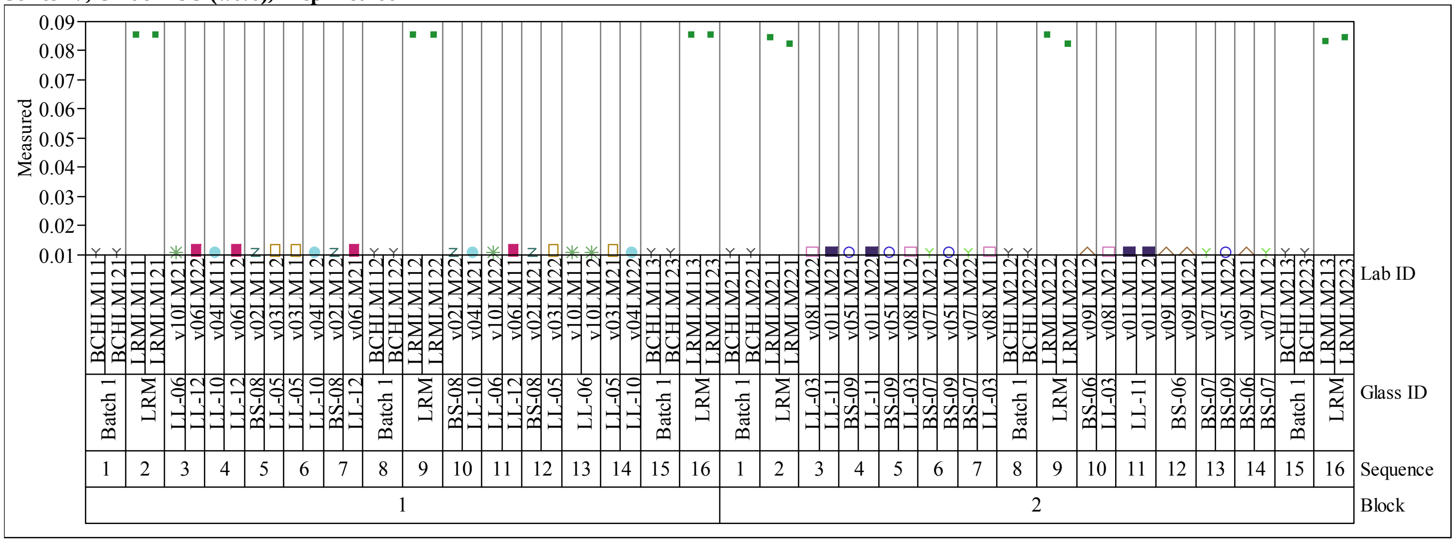
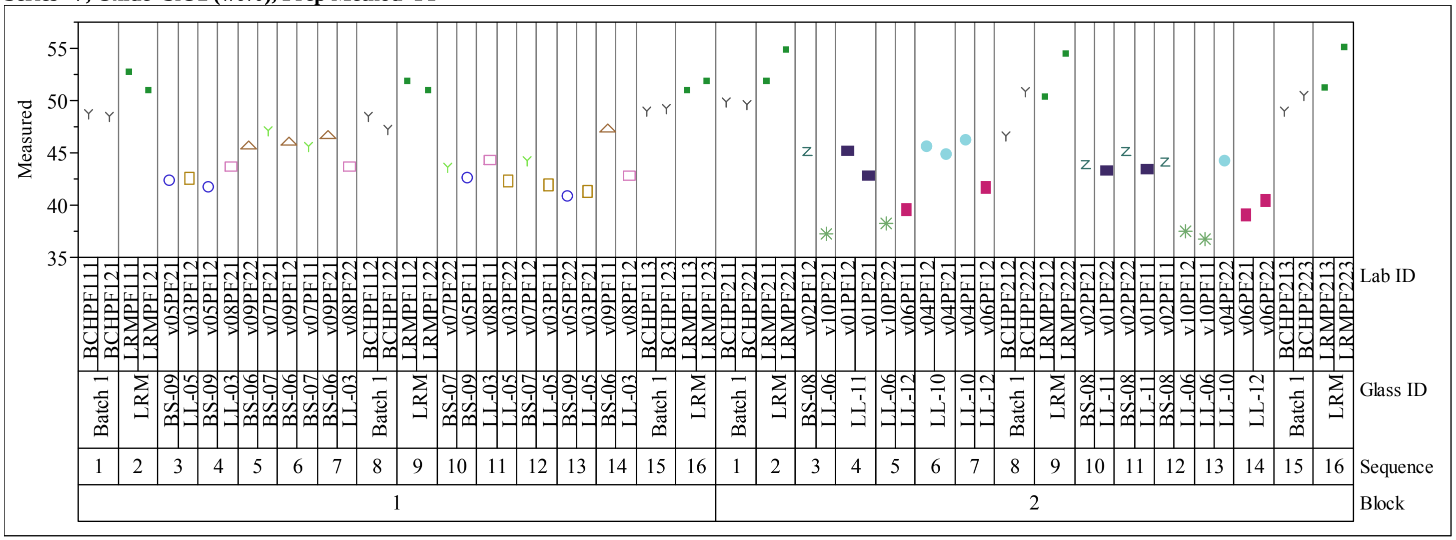


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=V, Oxide=SiO2 (wt%), Prep Method=PF



Series=V, Oxide=SO4 (wt%), Prep Method=LM

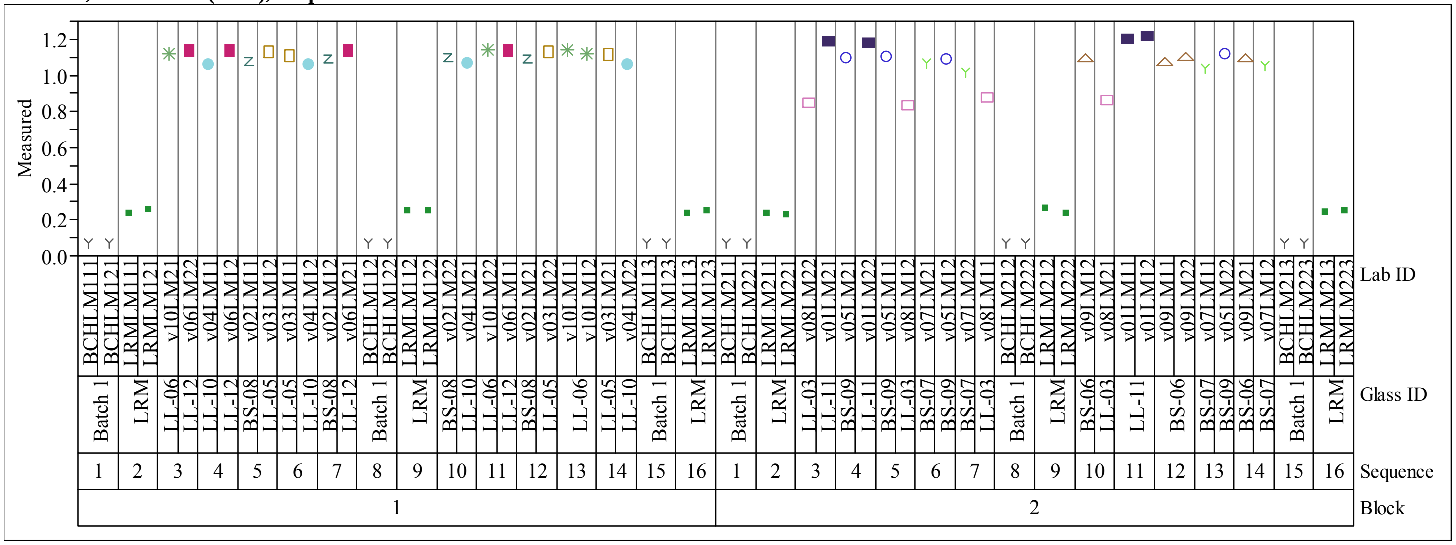
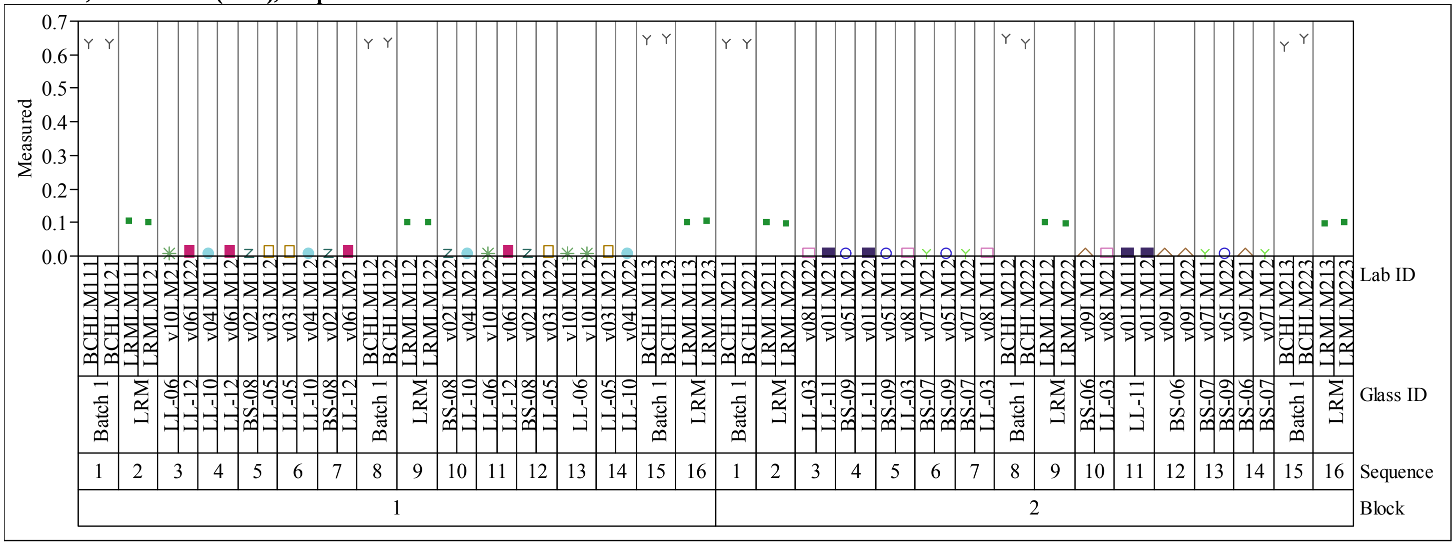


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=V, Oxide=TiO2 (wt%), Prep Method=LM



Series=V, Oxide=ZnO (wt%), Prep Method=LM

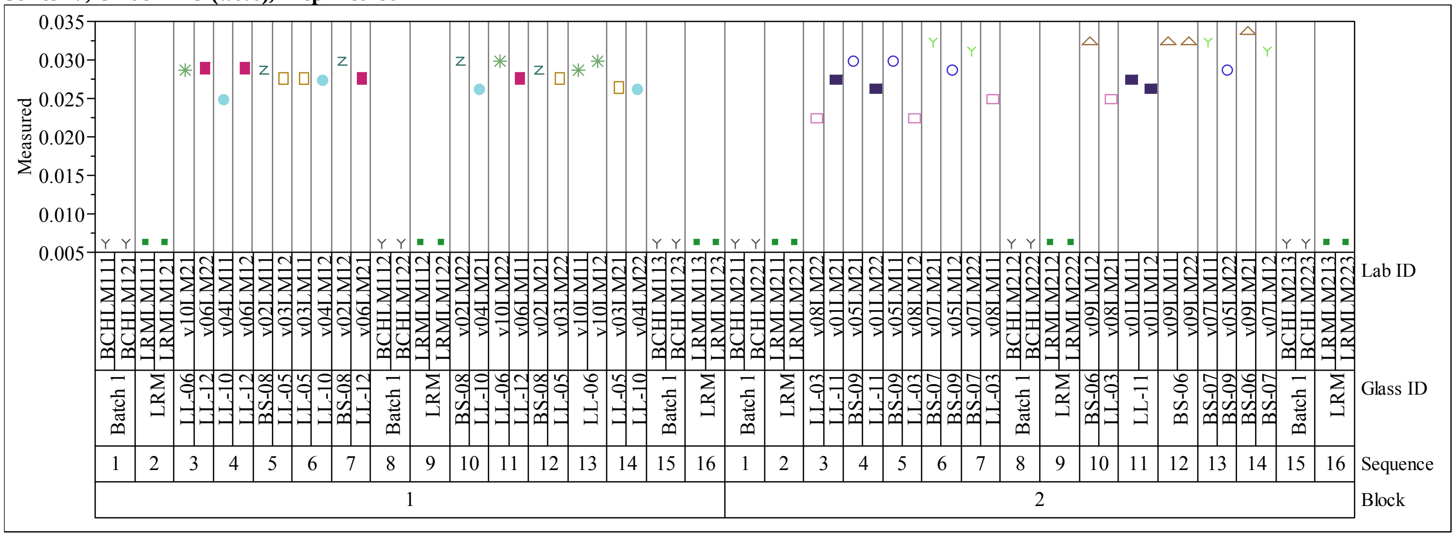
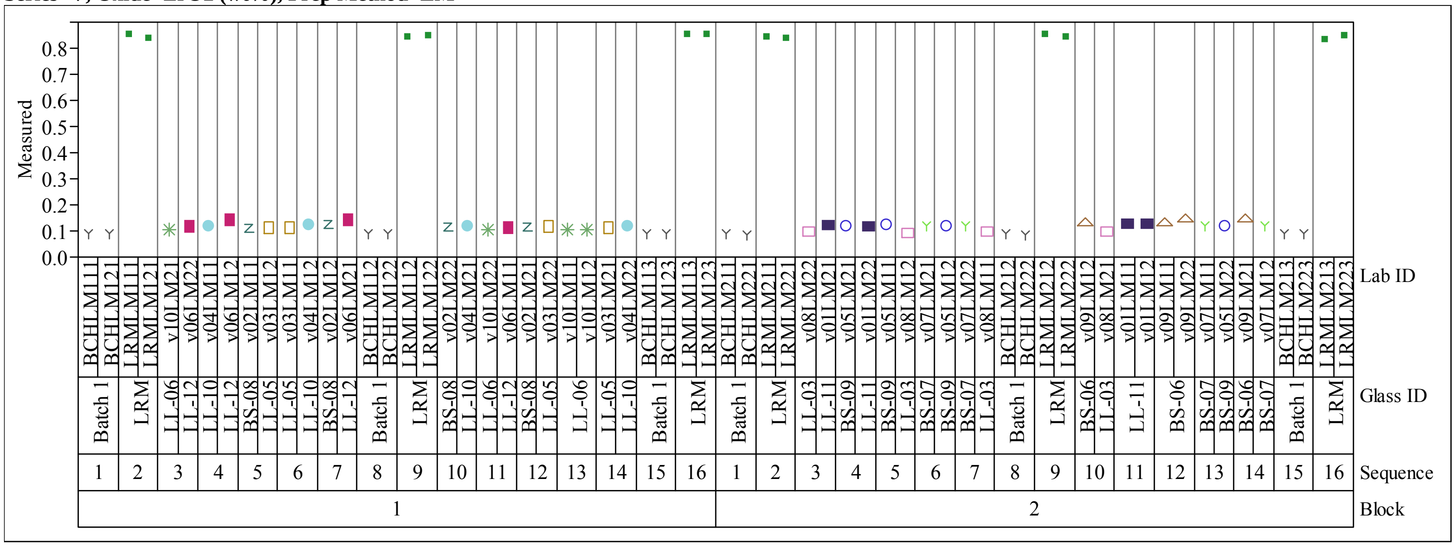


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=V, Oxide=ZrO2 (wt%), Prep Method=LM



Series=W, Oxide=Al2O3 (wt%), Prep Method=LM

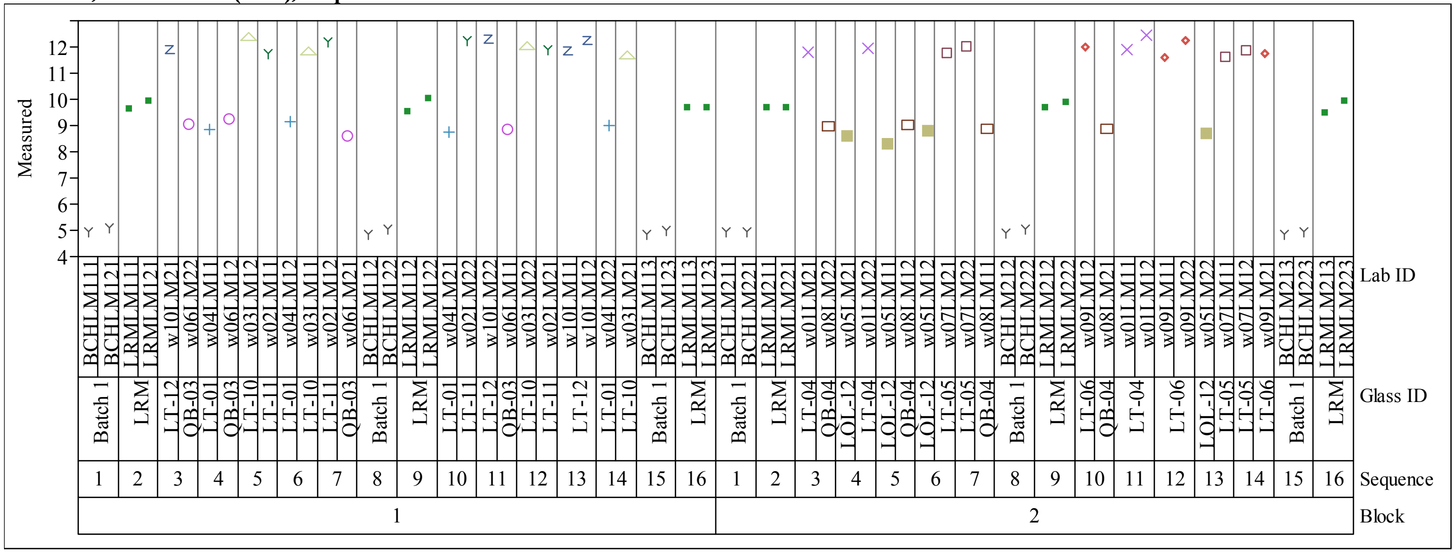
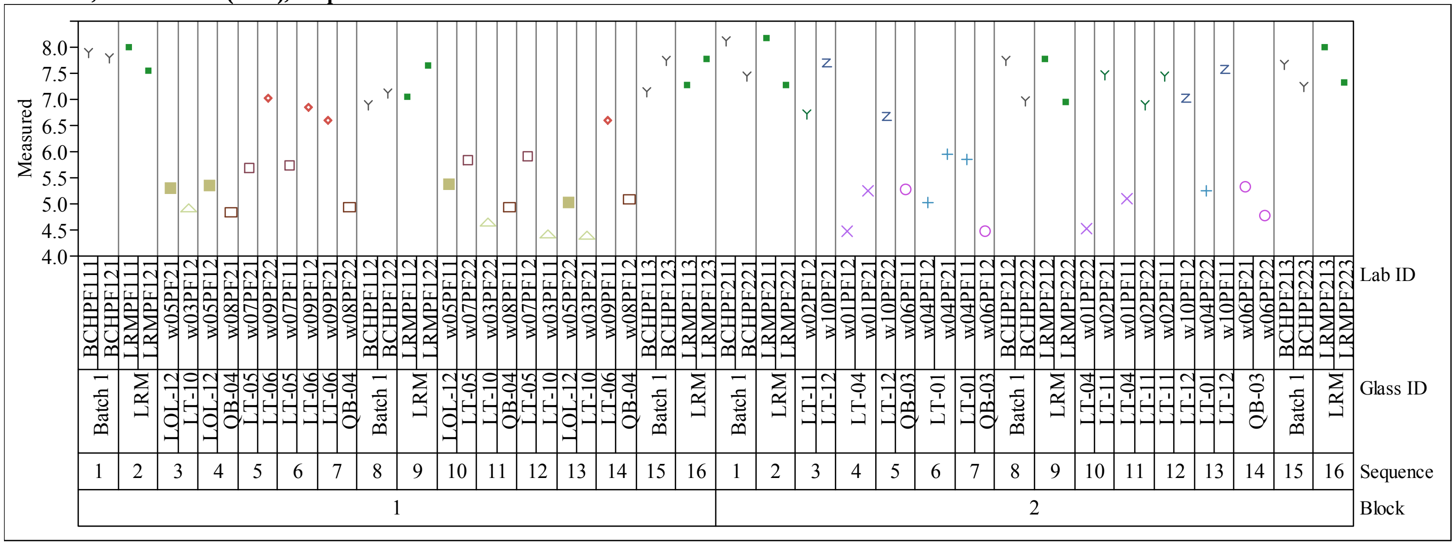


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=W, Oxide=B2O3 (wt%), Prep Method=PF



Series=W, Oxide=BaO (wt%), Prep Method=LM

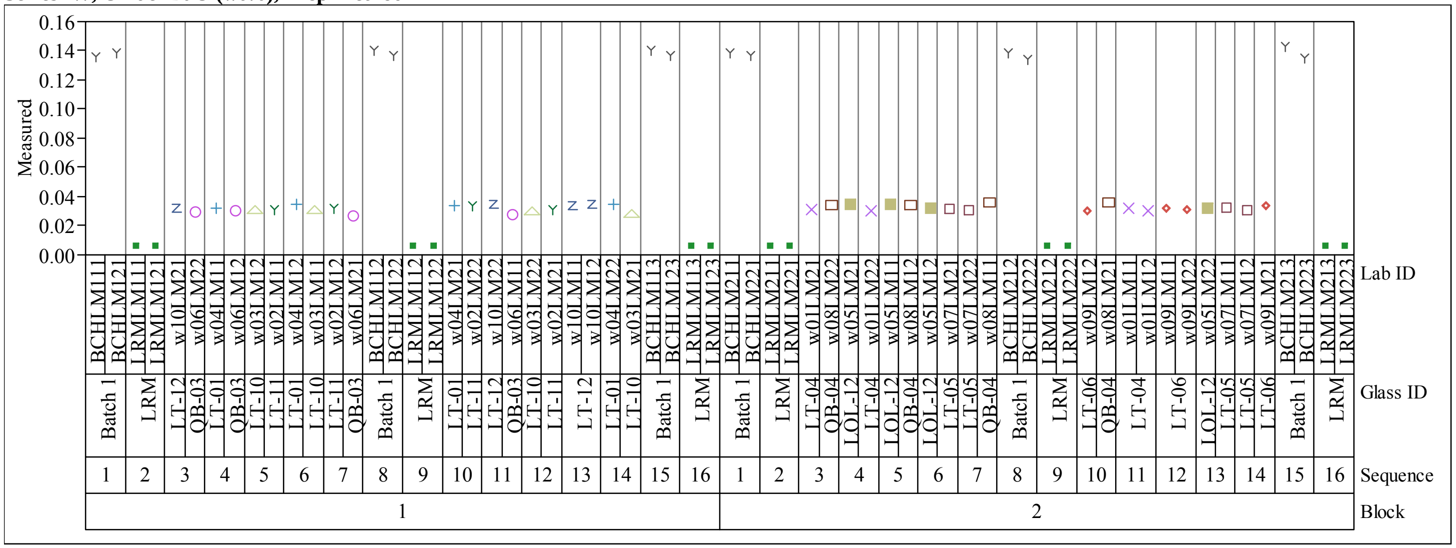
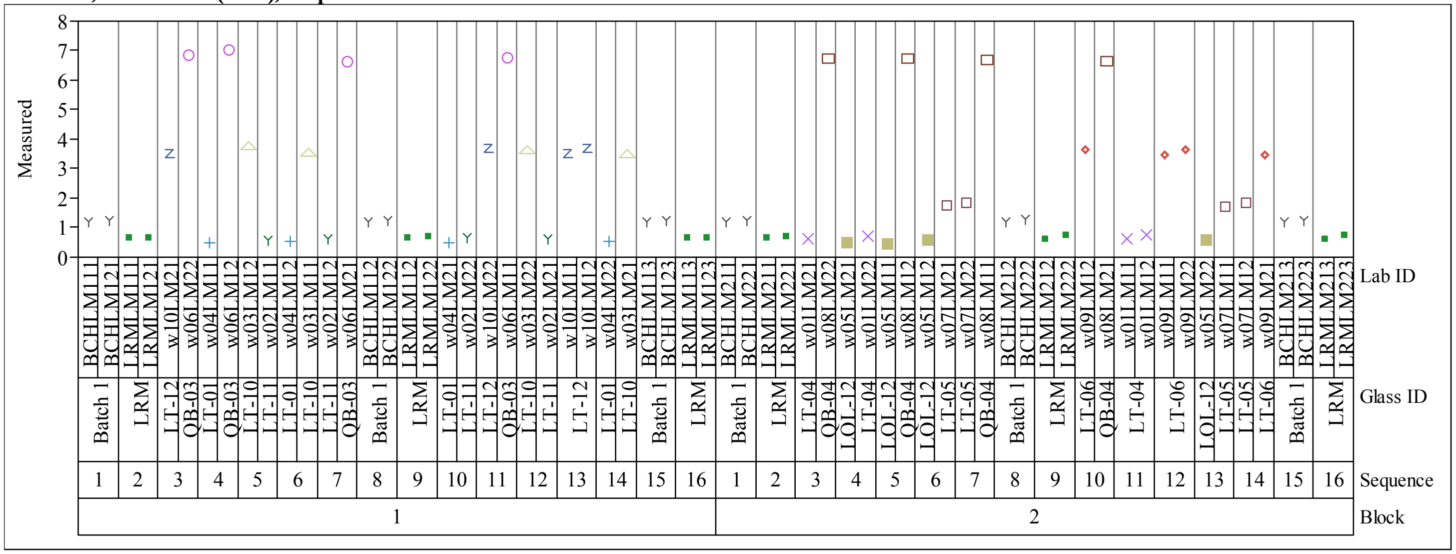


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=W, Oxide=CaO (wt%), Prep Method=LM



Series=W, Oxide=Ce2O3 (wt%), Prep Method=LM

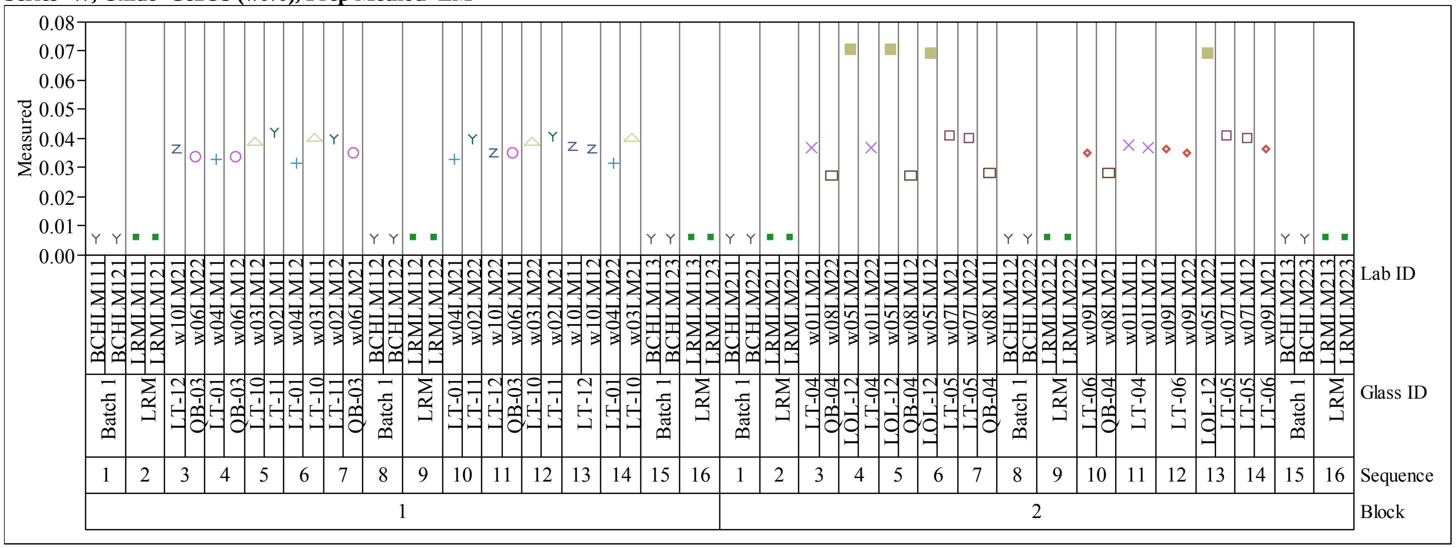
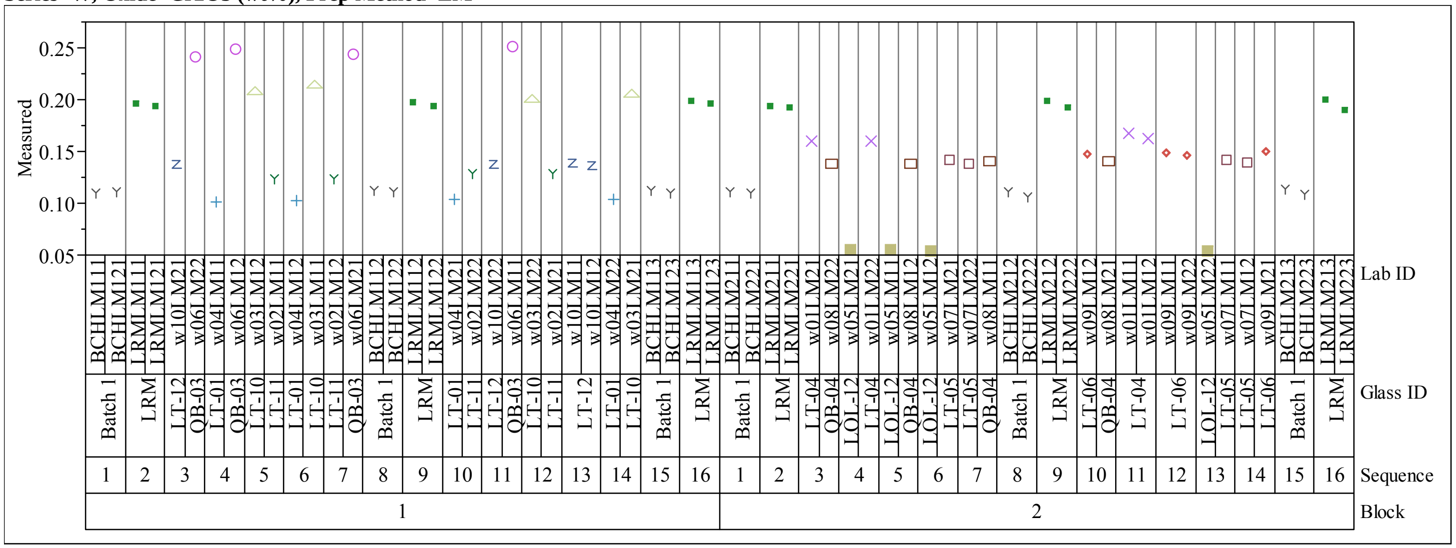


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=W, Oxide=Cr2O3 (wt%), Prep Method=LM



Series=W, Oxide=CuO (wt%), Prep Method=LM

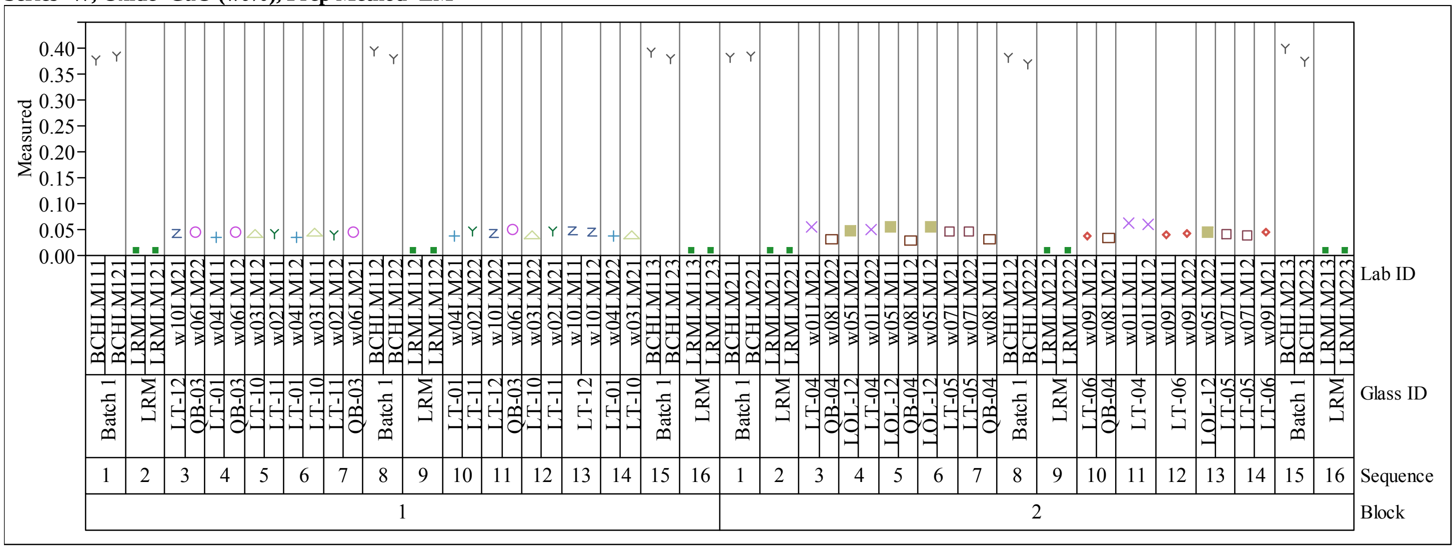
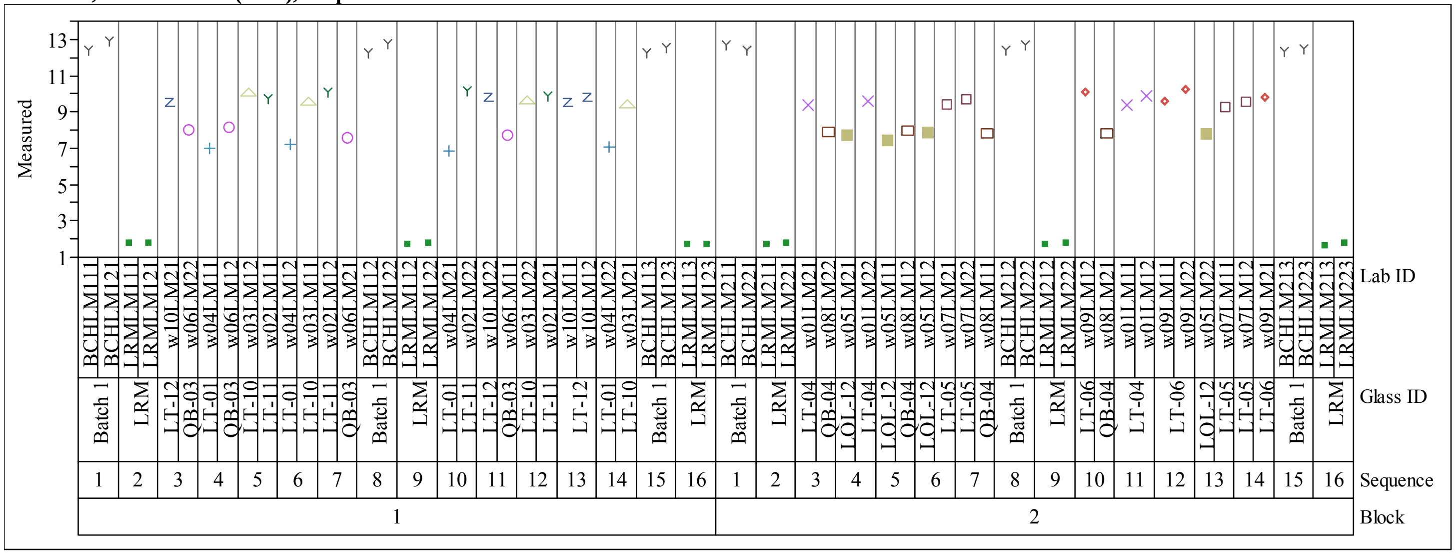


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=W, Oxide=Fe2O3 (wt%), Prep Method=LM



Series=W, Oxide=K2O (wt%), Prep Method=LM

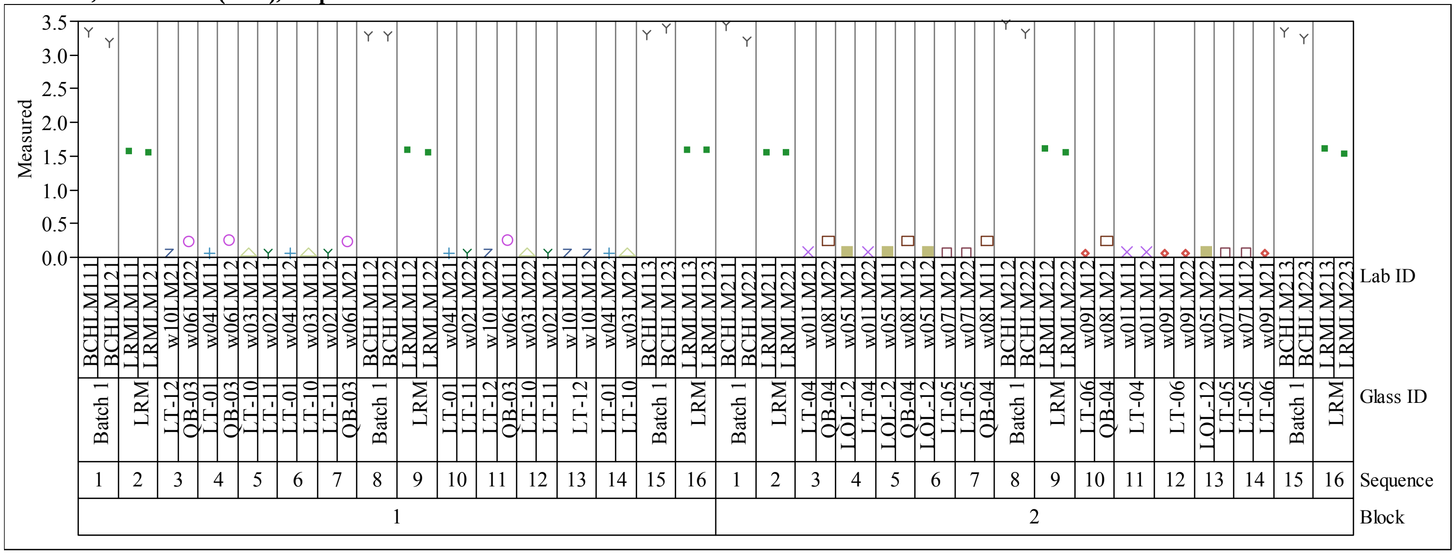
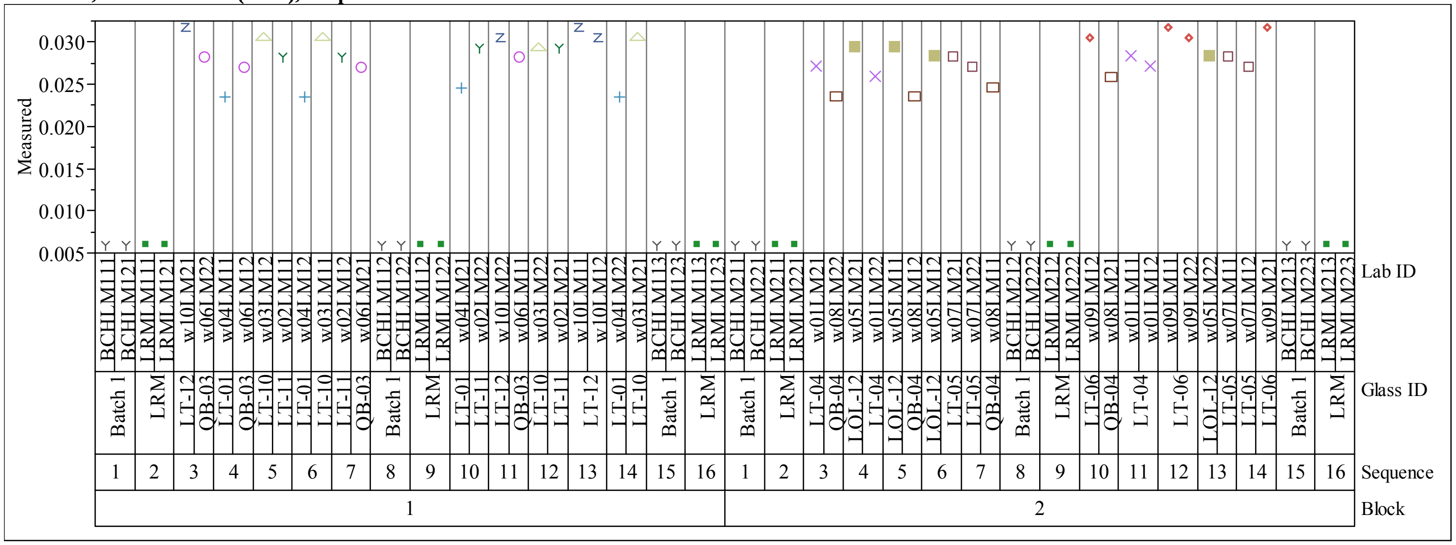


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=W, Oxide=La2O3 (wt%), Prep Method=LM



Series=W, Oxide=Li2O (wt%), Prep Method=PF

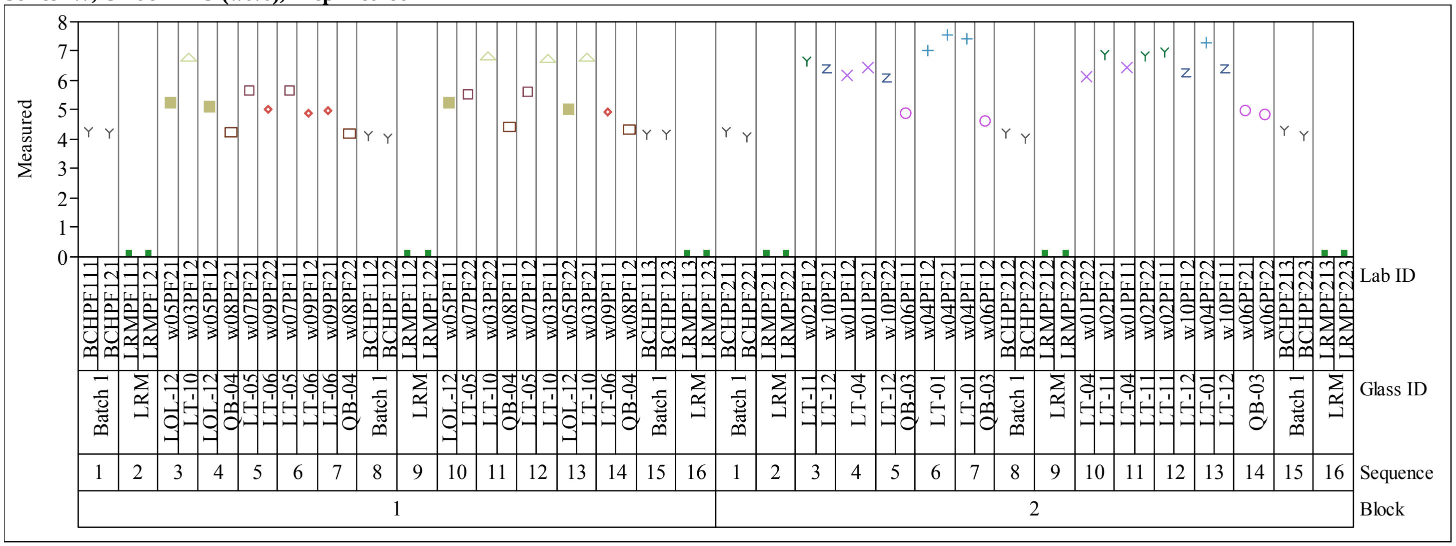
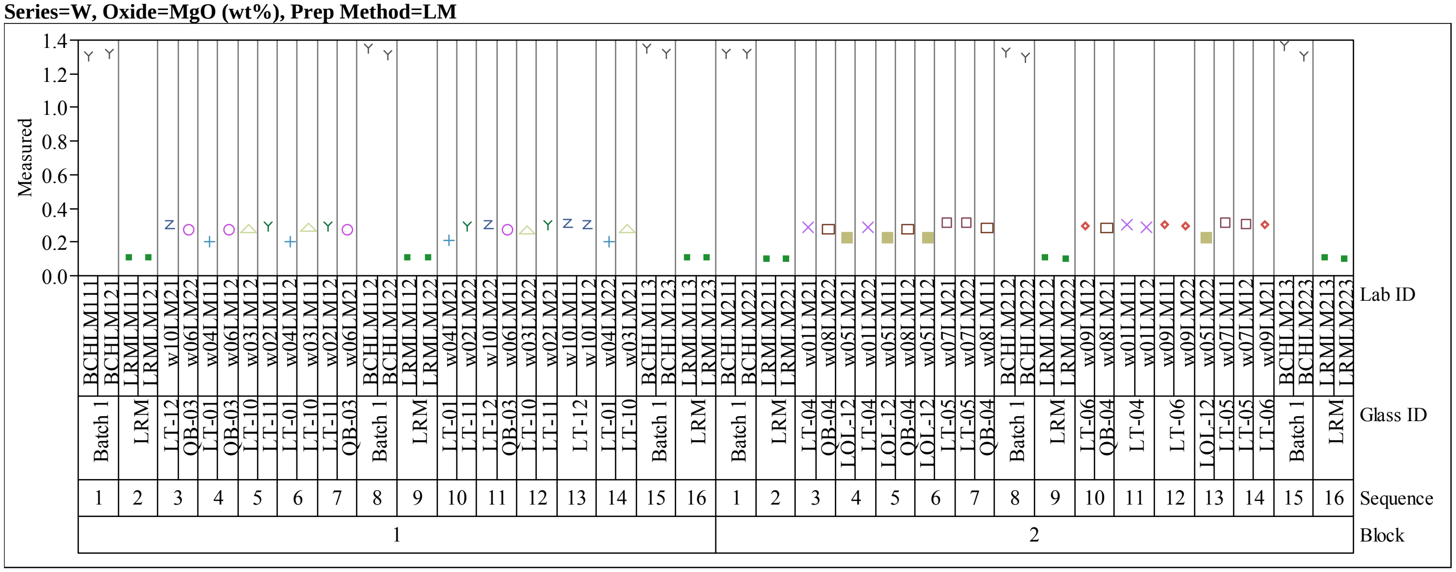


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=W, Oxide=MgO (wt%), Prep Method=LM



Series=W, Oxide=MnO (wt%), Prep Method=LM

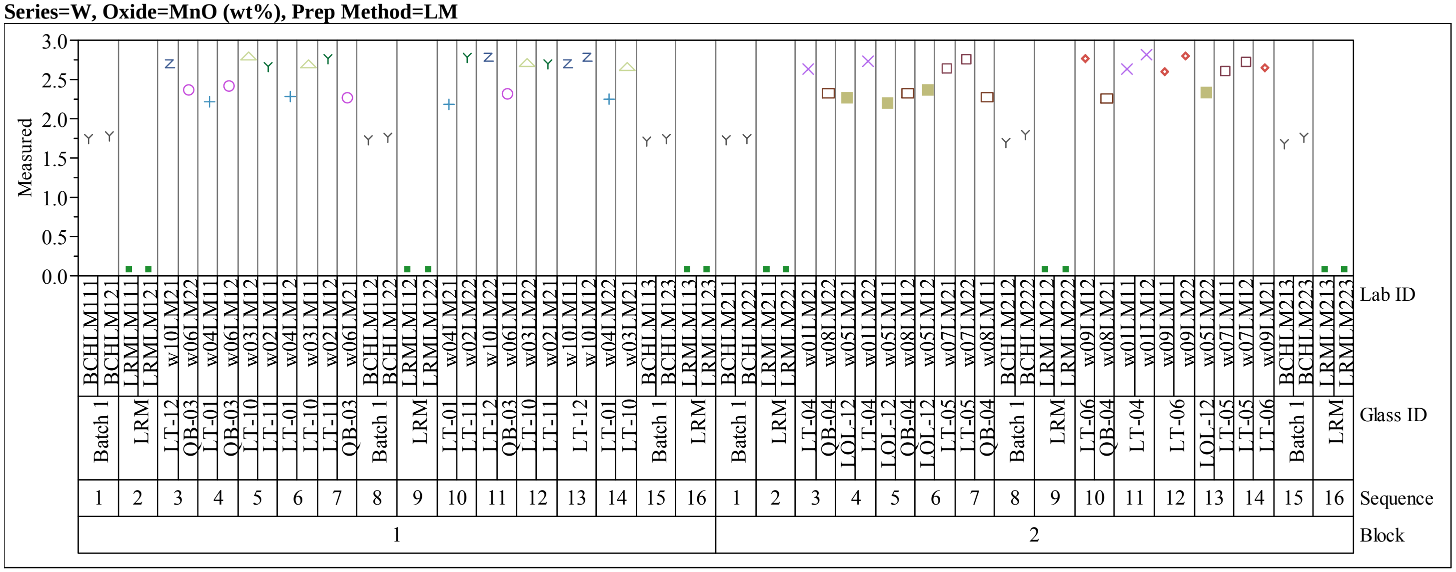
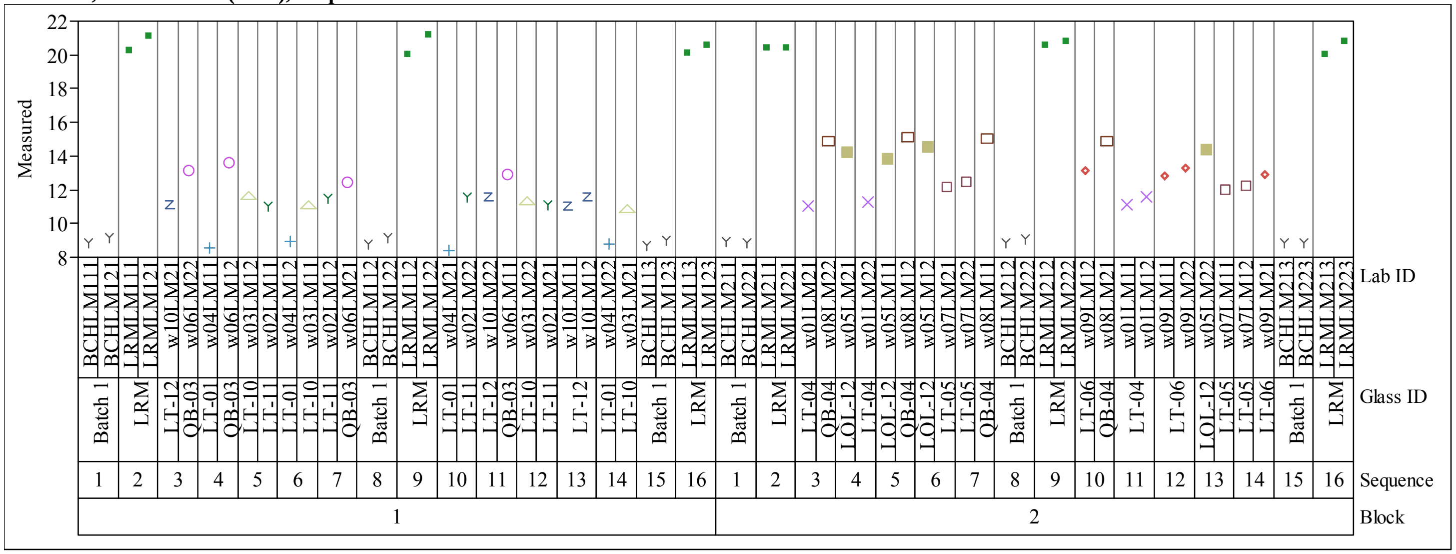


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=W, Oxide=Na2O (wt%), Prep Method=LM



Series=W, Oxide=NiO (wt%), Prep Method=LM

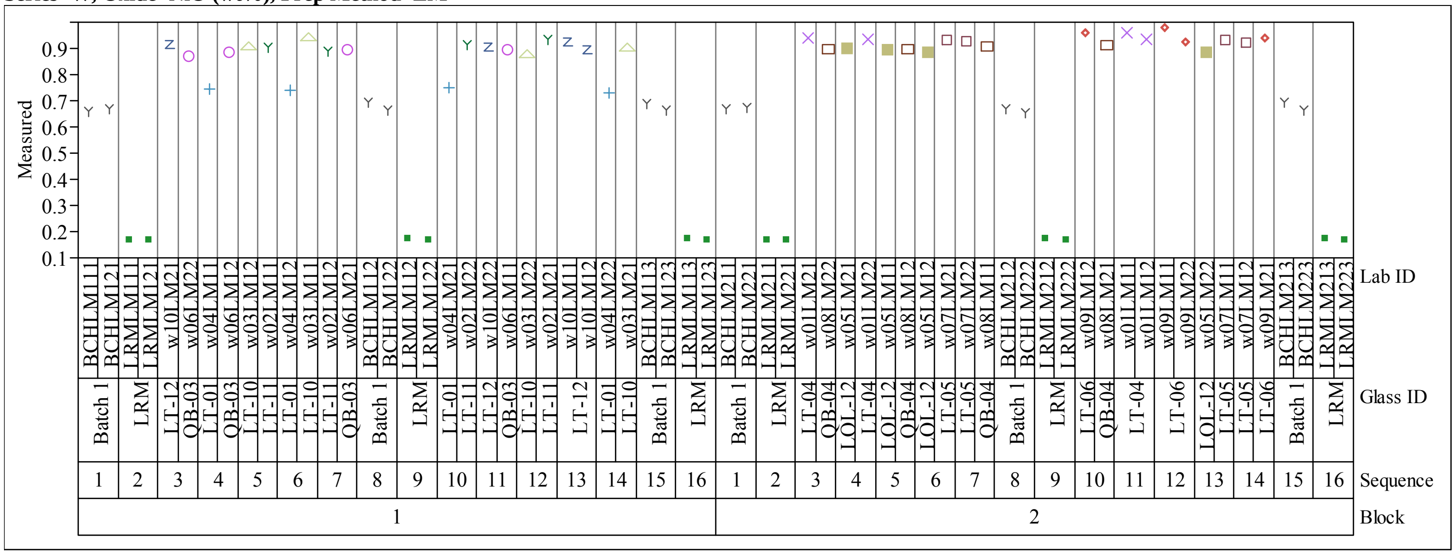
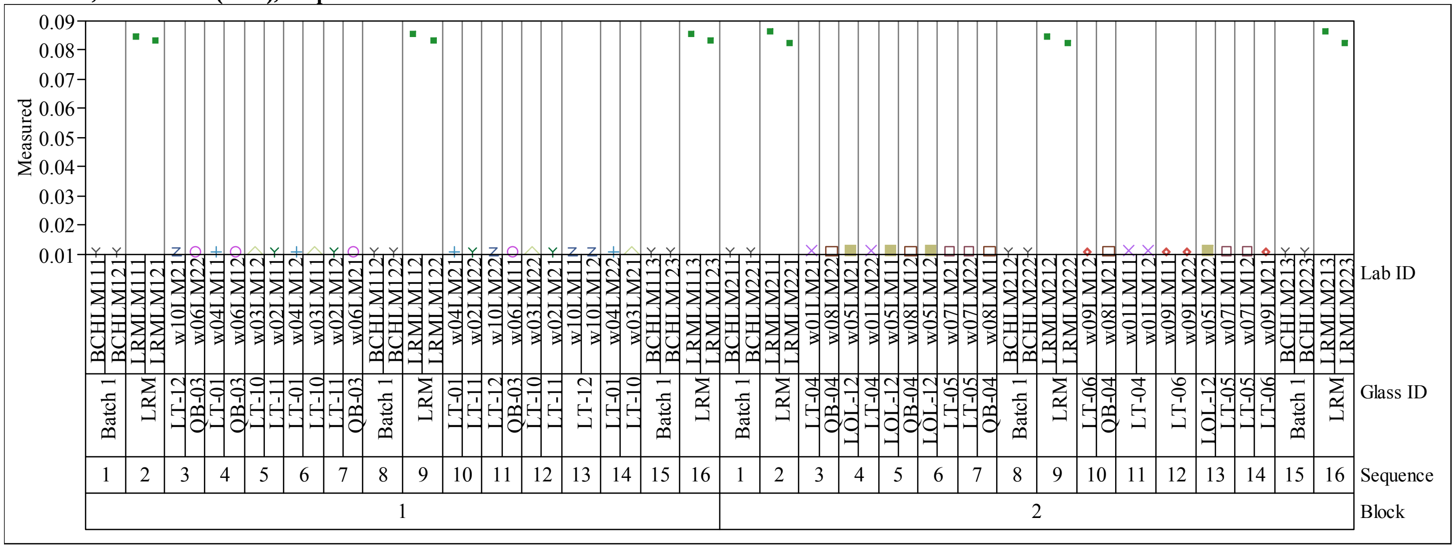


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=W, Oxide=PbO (wt%), Prep Method=LM



Series=W, Oxide=SiO2 (wt%), Prep Method=PF

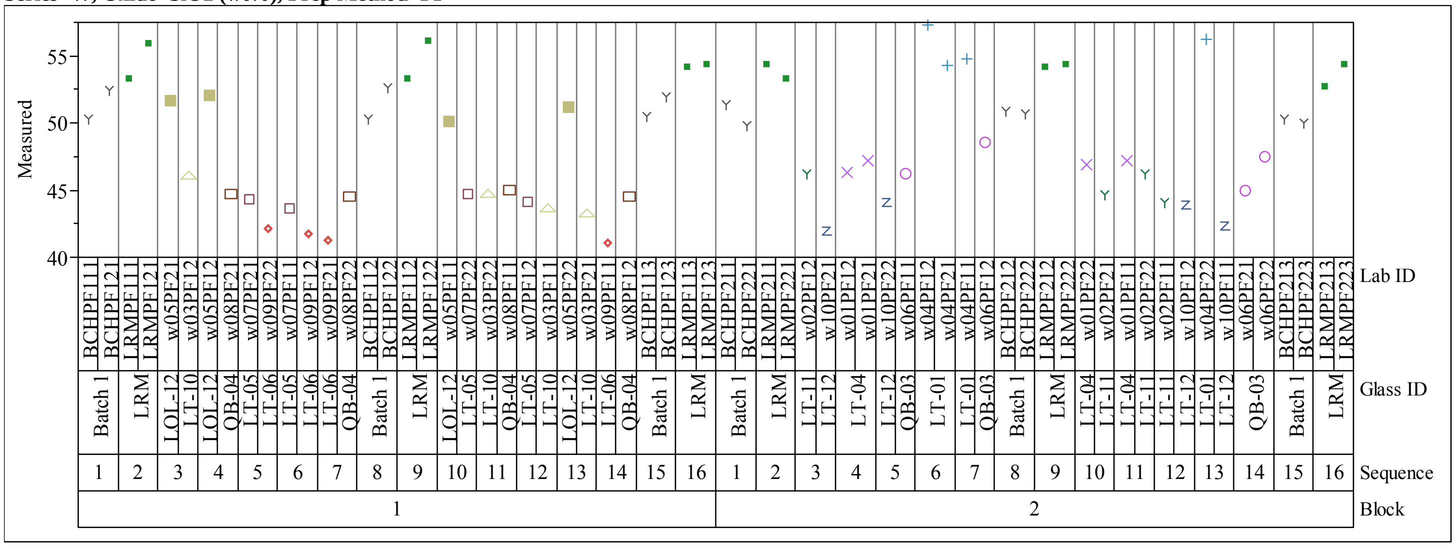
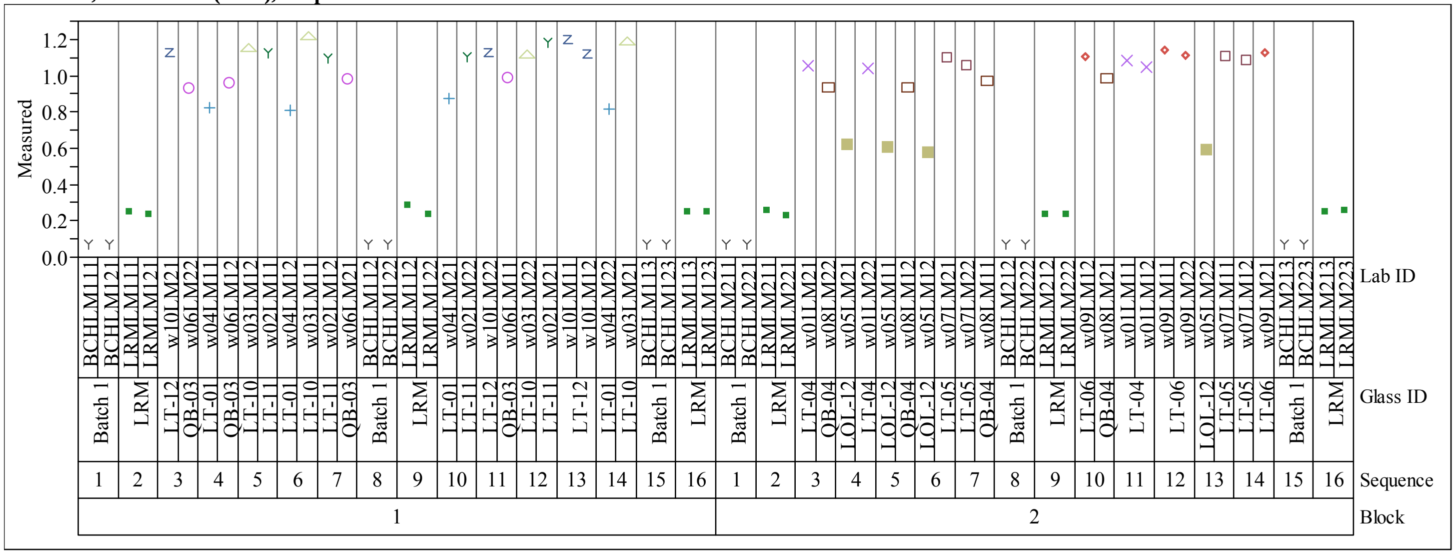


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=W, Oxide=SO4 (wt%), Prep Method=LM



Series=W, Oxide=TiO2 (wt%), Prep Method=LM

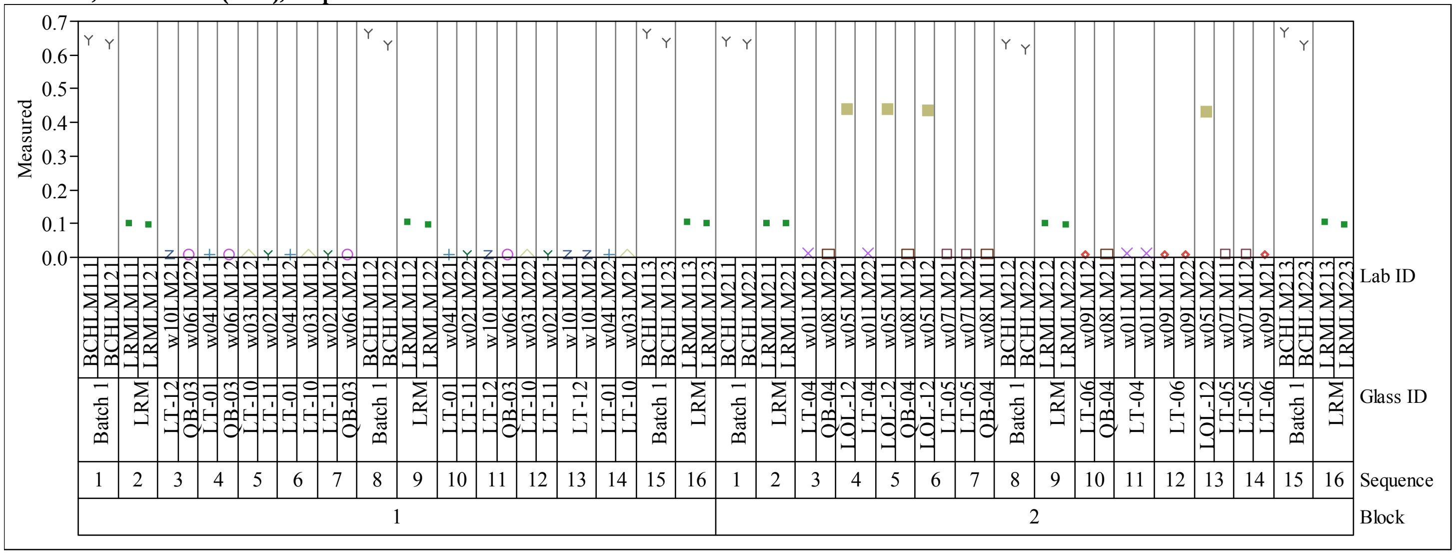
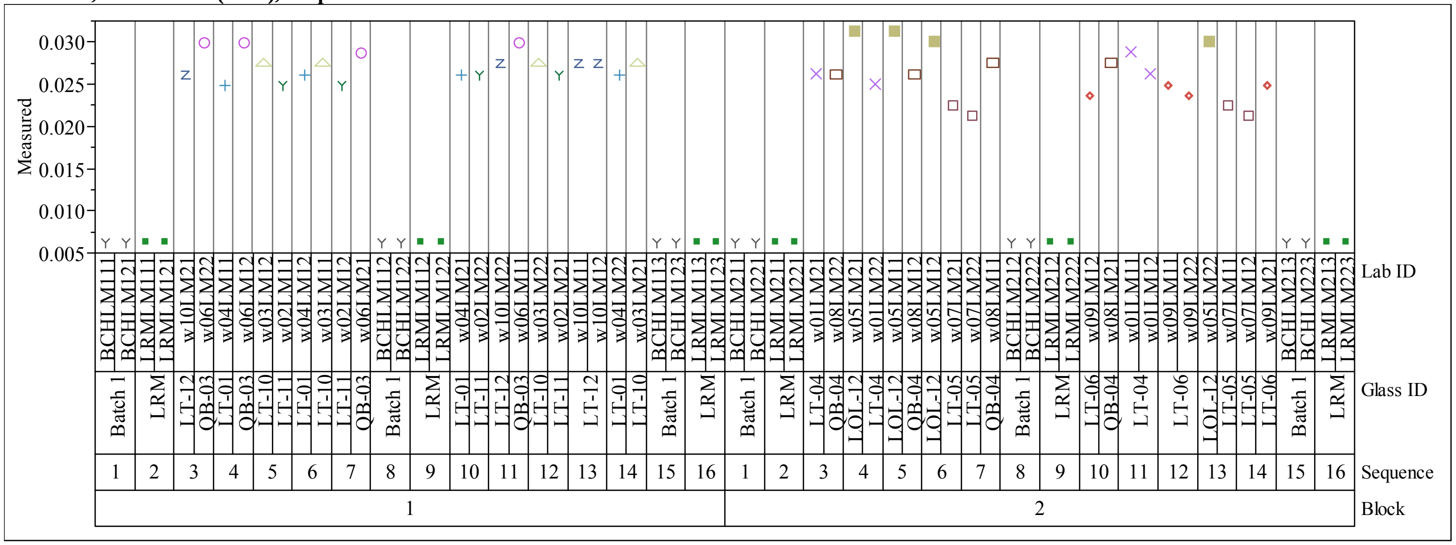


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=W, Oxide=ZnO (wt%), Prep Method=LM



Series=W, Oxide=ZrO2 (wt%), Prep Method=LM

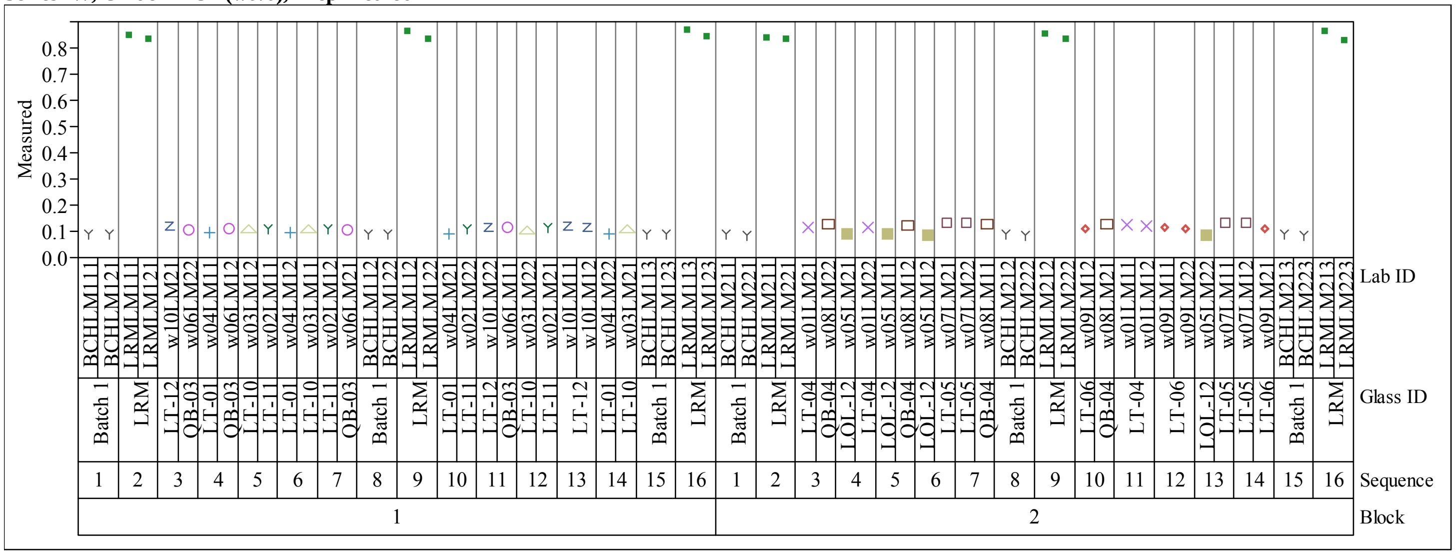
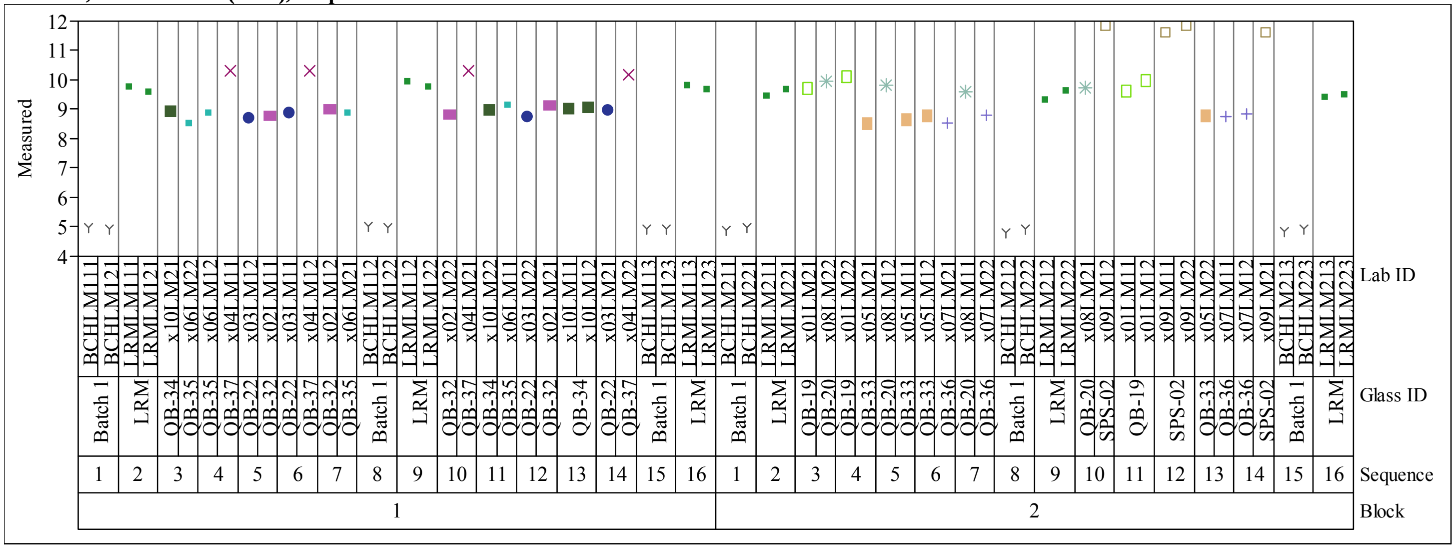


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=X, Oxide=Al2O3 (wt%), Prep Method=LM



Series=X, Oxide=B2O3 (wt%), Prep Method=PF

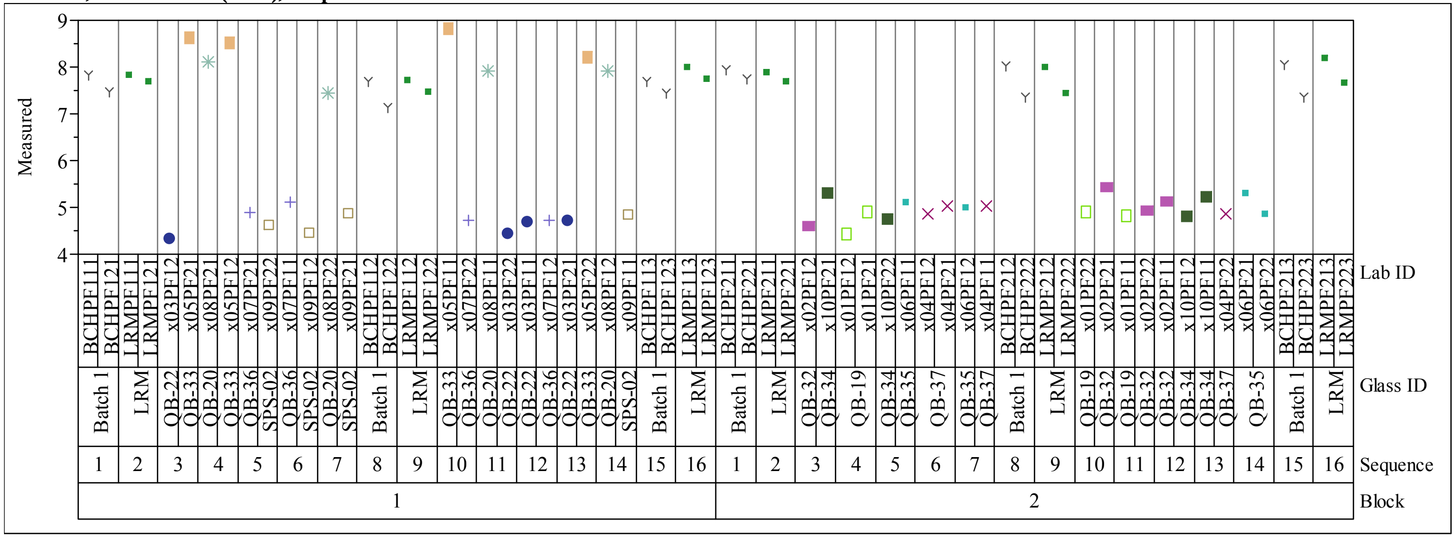
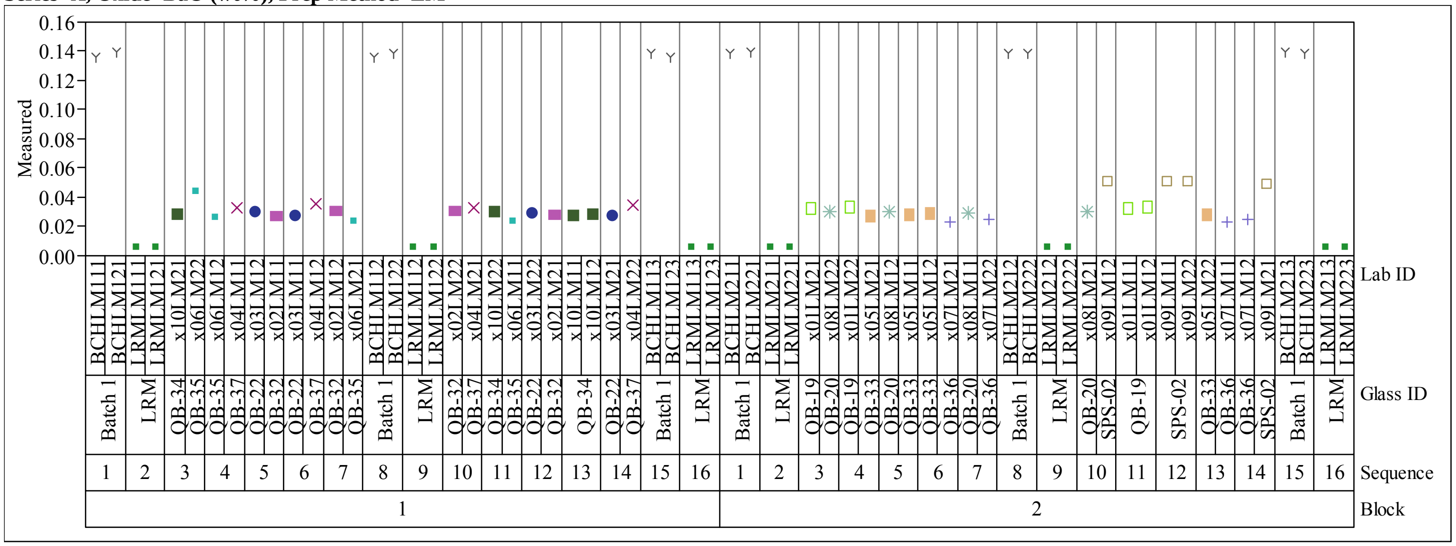


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=X, Oxide=BaO (wt%), Prep Method=LM



Series=X, Oxide=CaO (wt%), Prep Method=LM

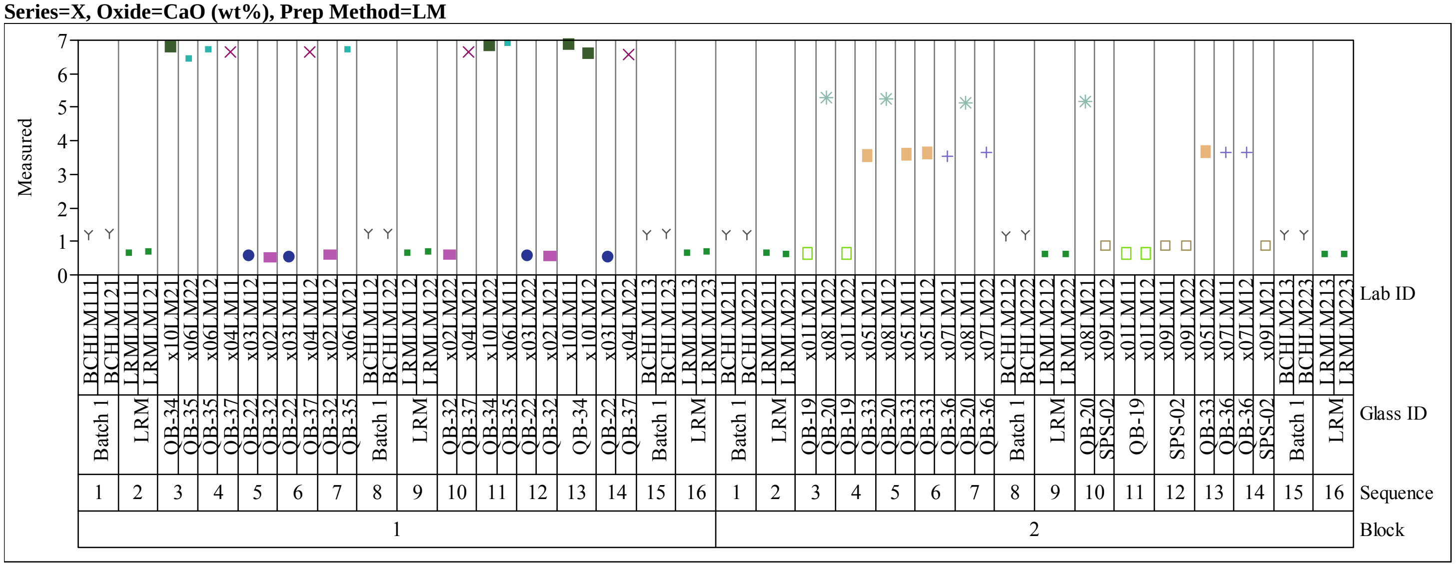
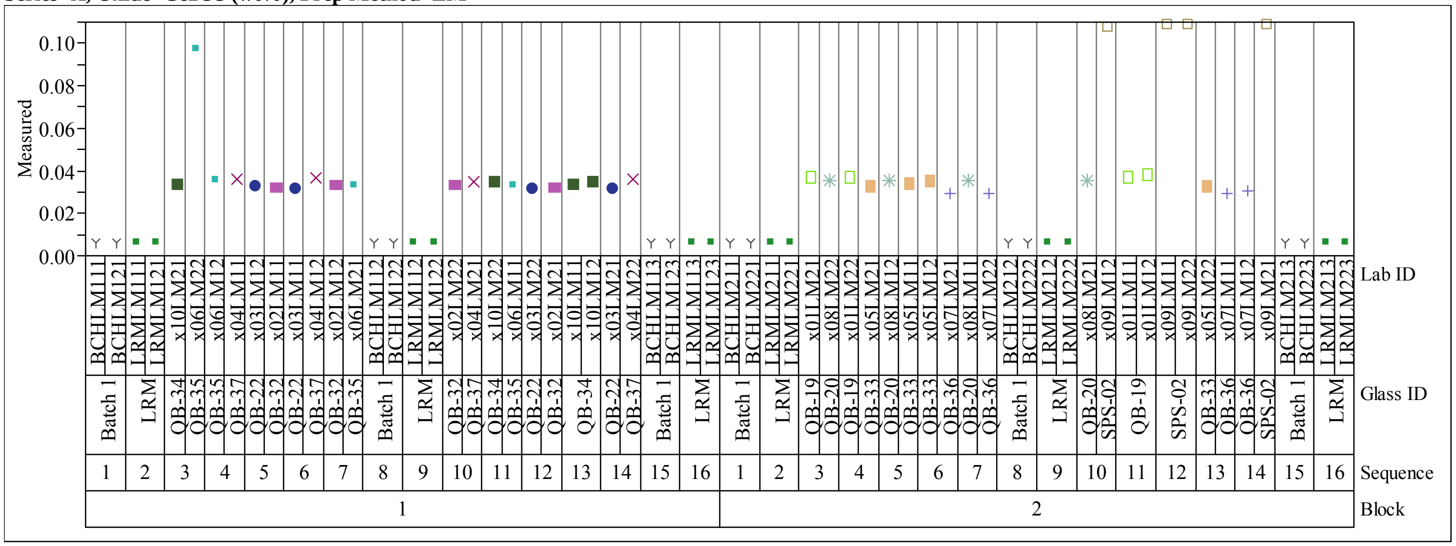


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=X, Oxide=Ce2O3 (wt%), Prep Method=LM



Series=X, Oxide=Cr2O3 (wt%), Prep Method=LM

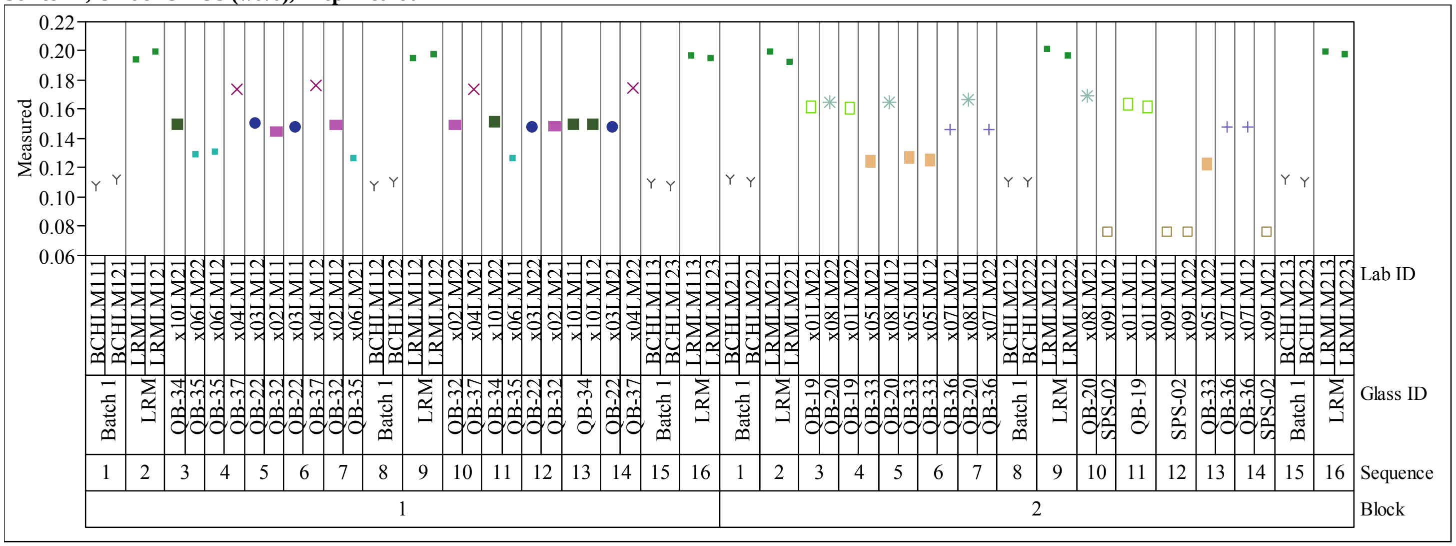
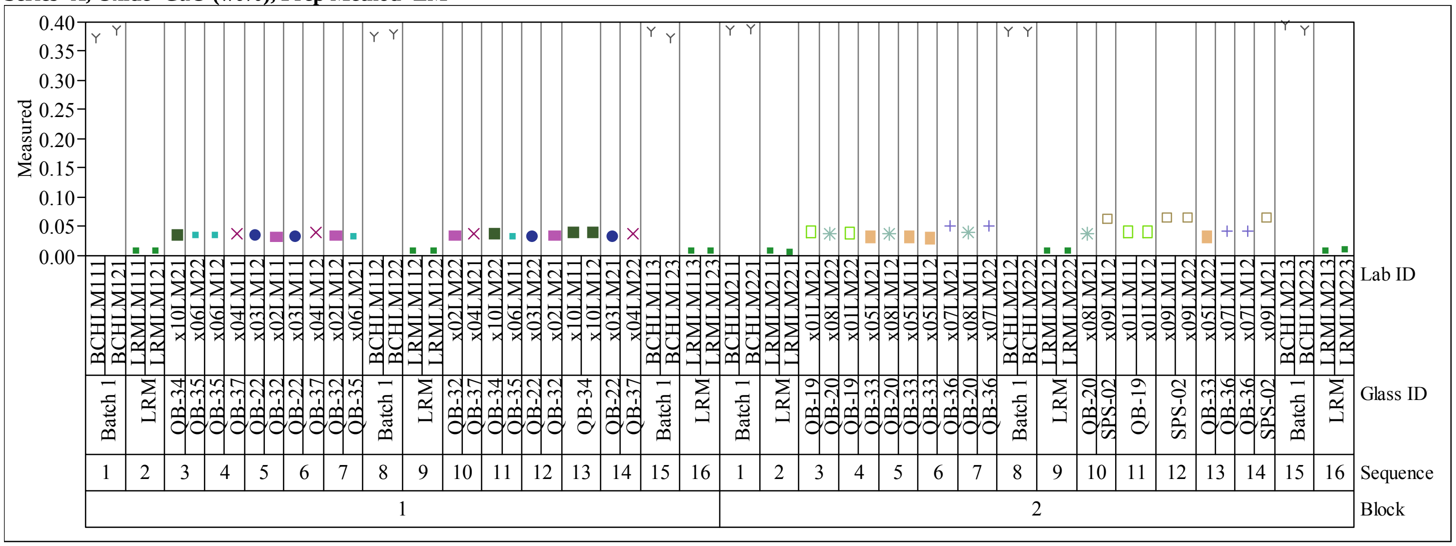


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=X, Oxide=CuO (wt%), Prep Method=LM



Series=X, Oxide=Fe2O3 (wt%), Prep Method=LM

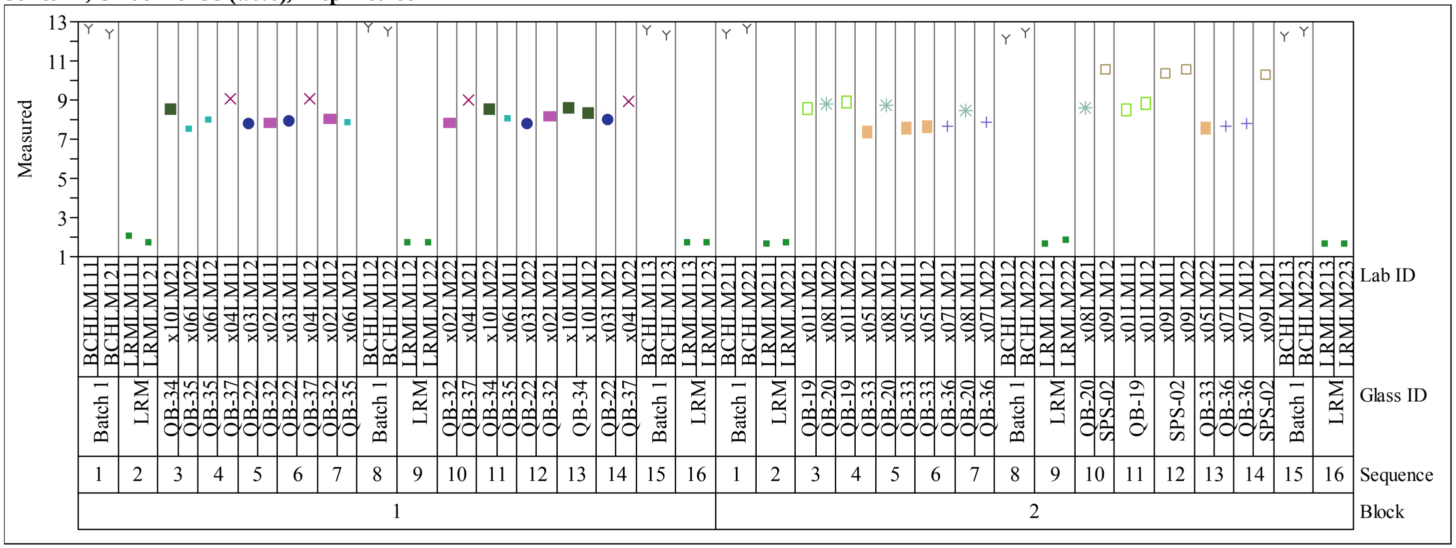
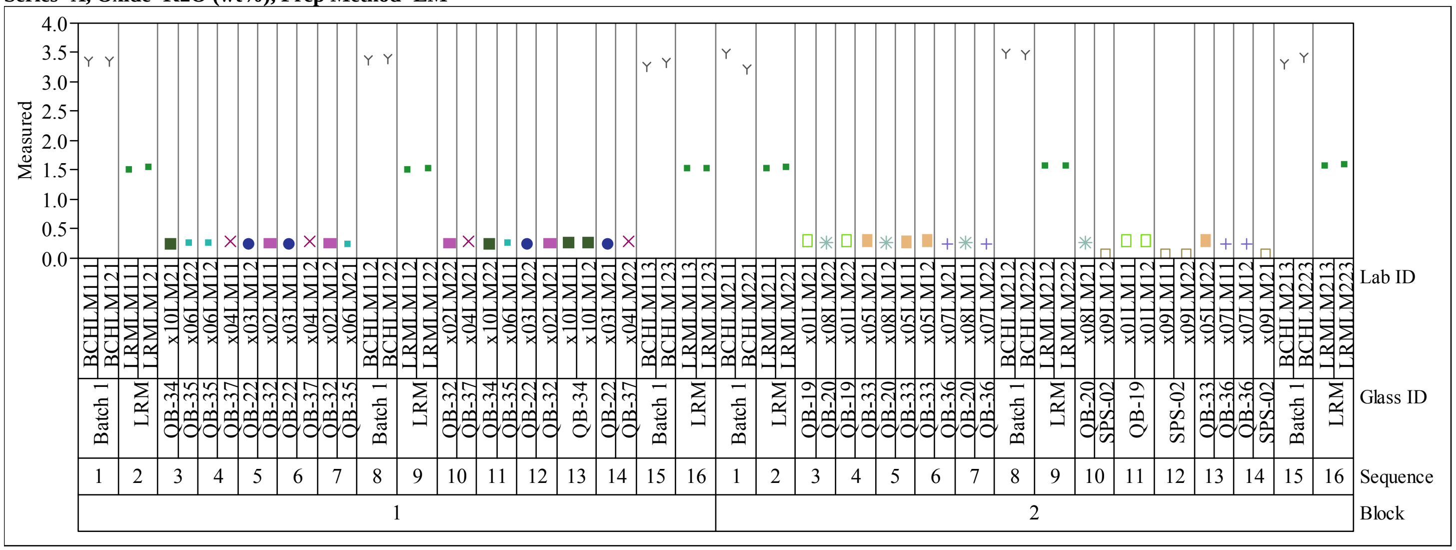


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=X, Oxide=K2O (wt%), Prep Method=LM



Series=X, Oxide=La2O3 (wt%), Prep Method=LM

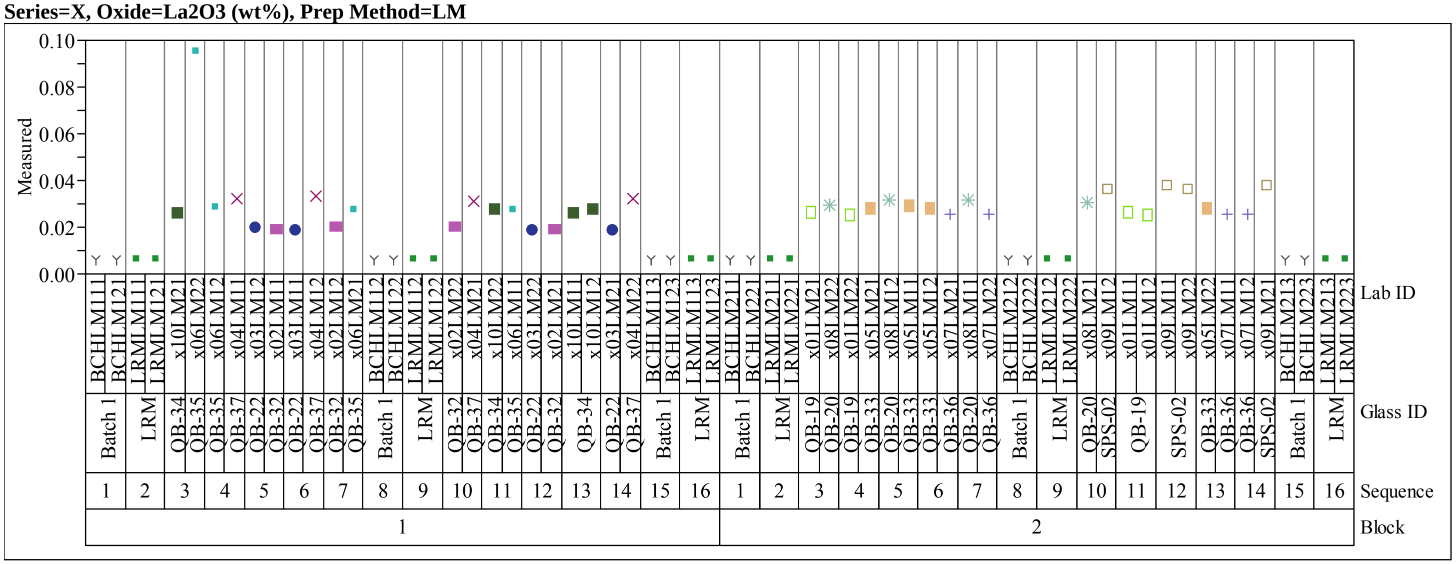
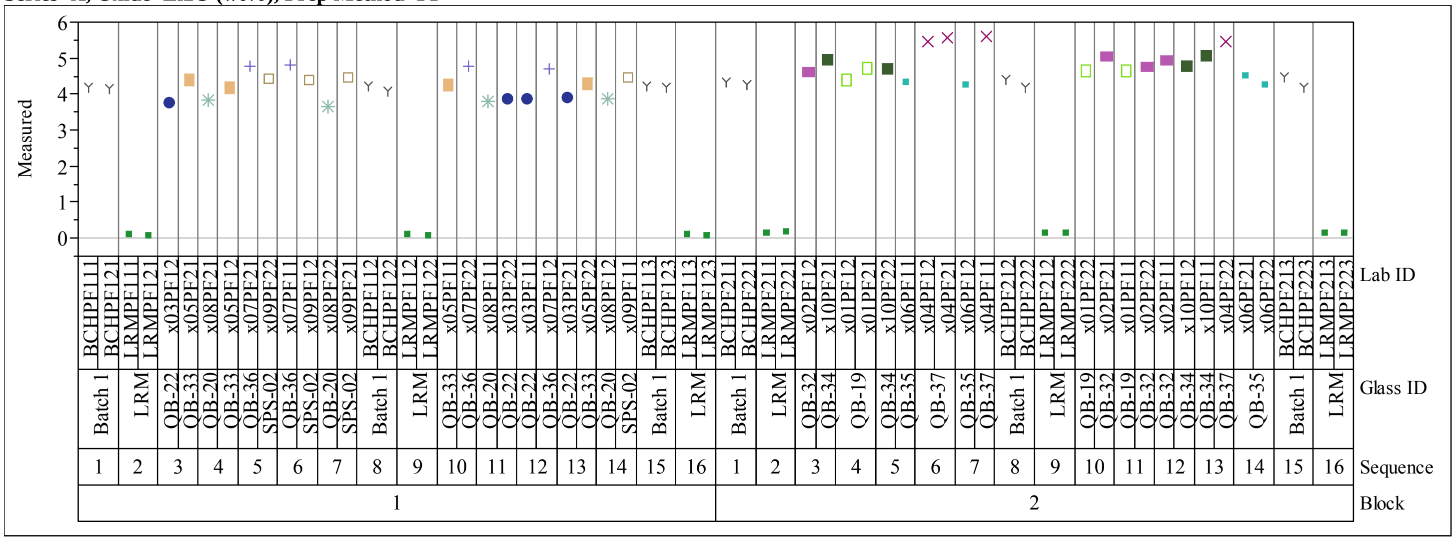


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=X, Oxide=Li2O (wt%), Prep Method=PF



Series=X, Oxide=MgO (wt%), Prep Method=LM

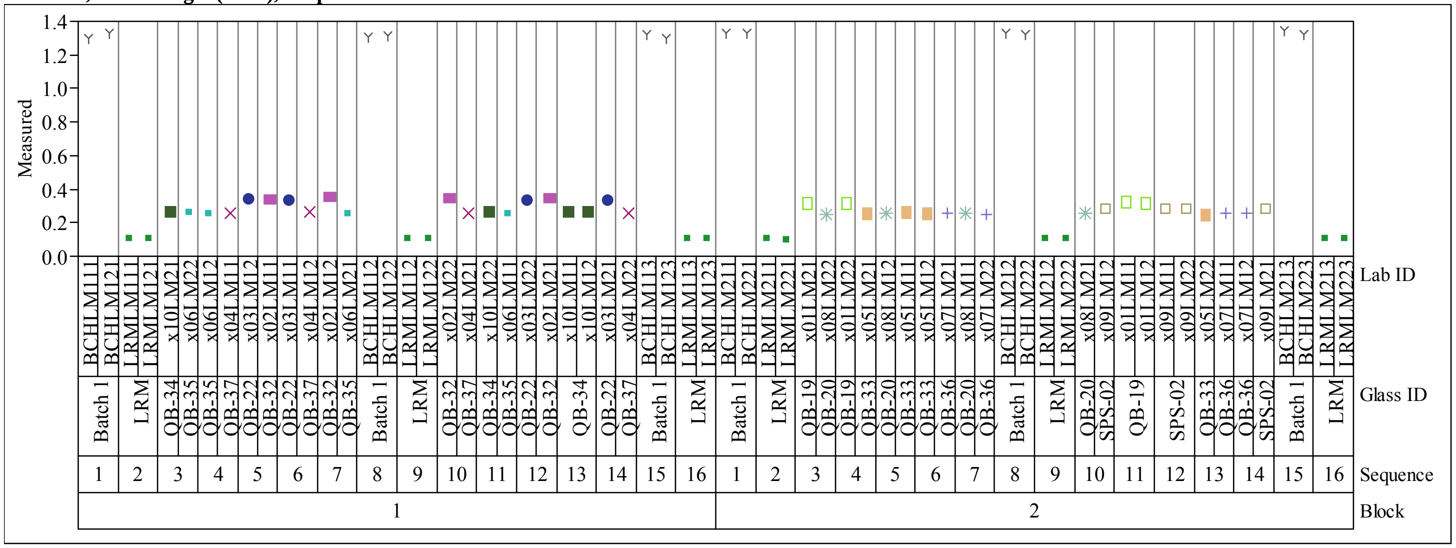
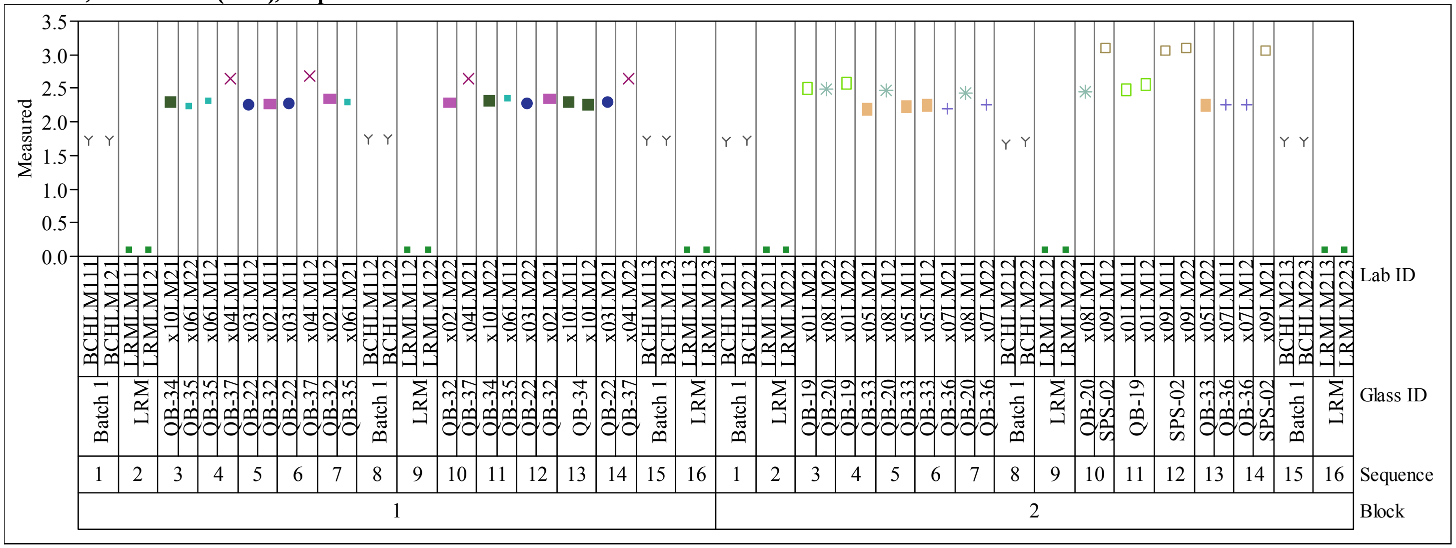


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=X, Oxide=MnO (wt%), Prep Method=LM



Series=X, Oxide=Na2O (wt%), Prep Method=LM

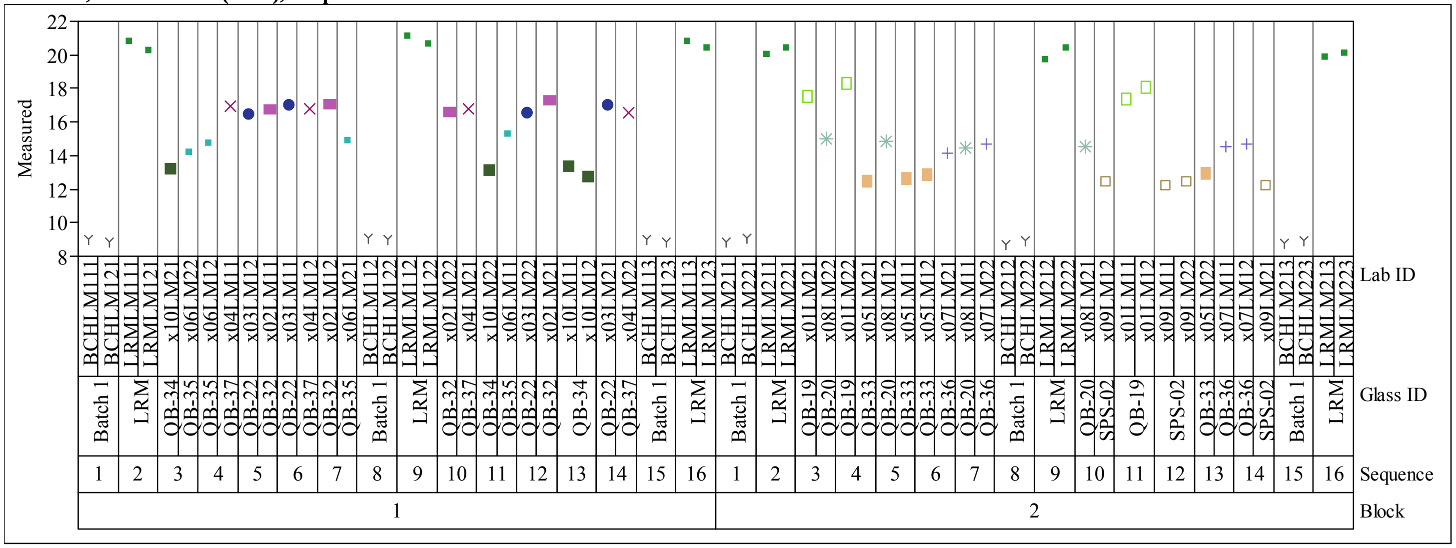
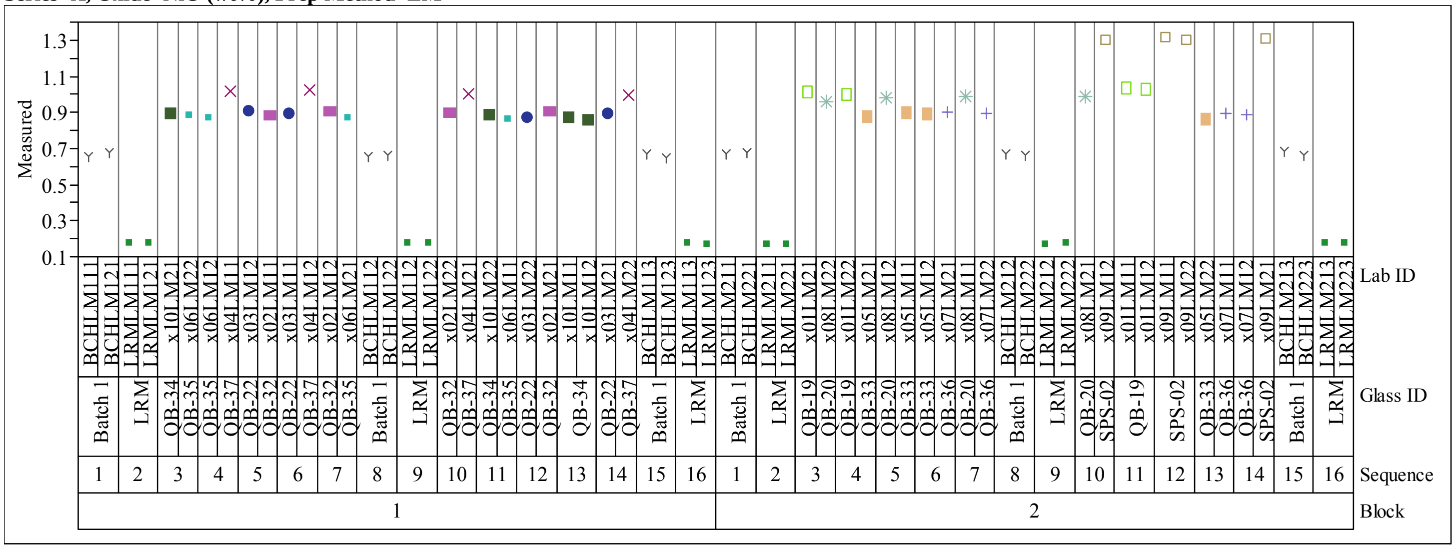


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=X, Oxide=NiO (wt%), Prep Method=LM



Series=X, Oxide=PbO (wt%), Prep Method=LM

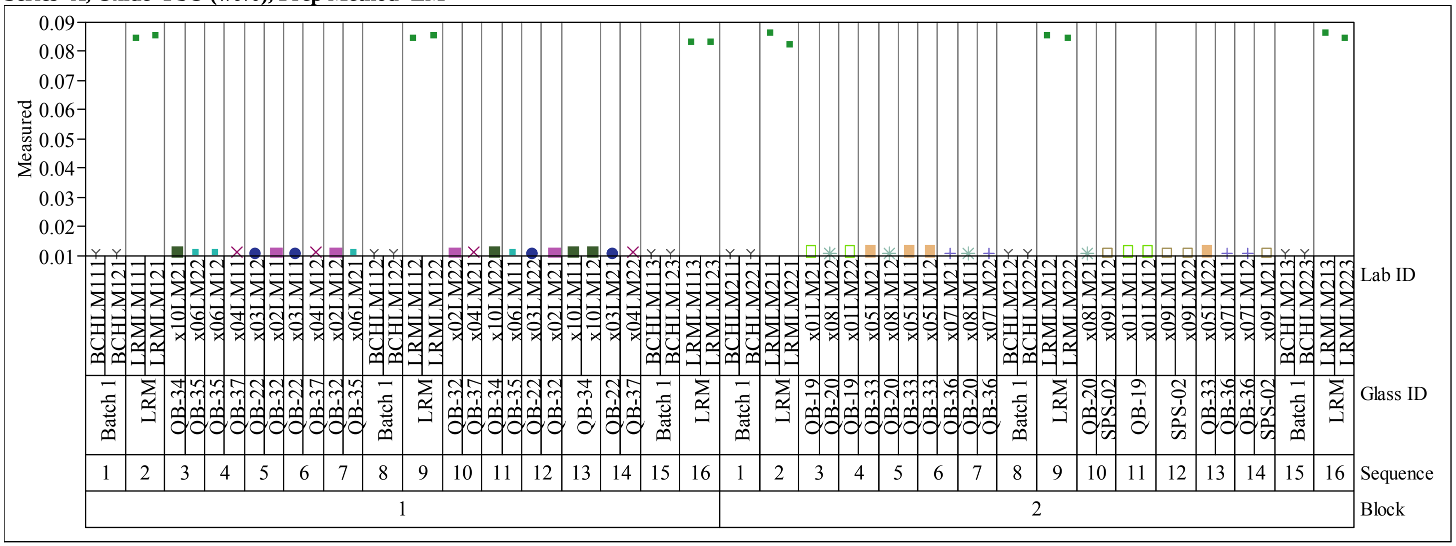
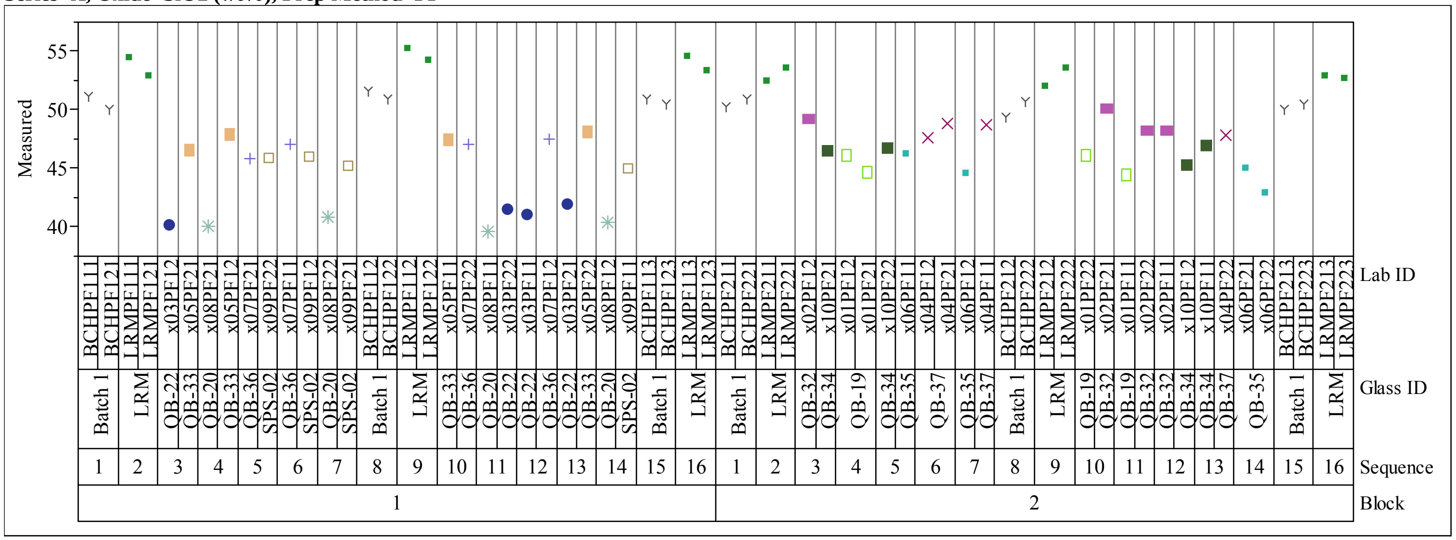


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=X, Oxide=SiO2 (wt%), Prep Method=PF



Series=X, Oxide=SO4 (wt%), Prep Method=LM

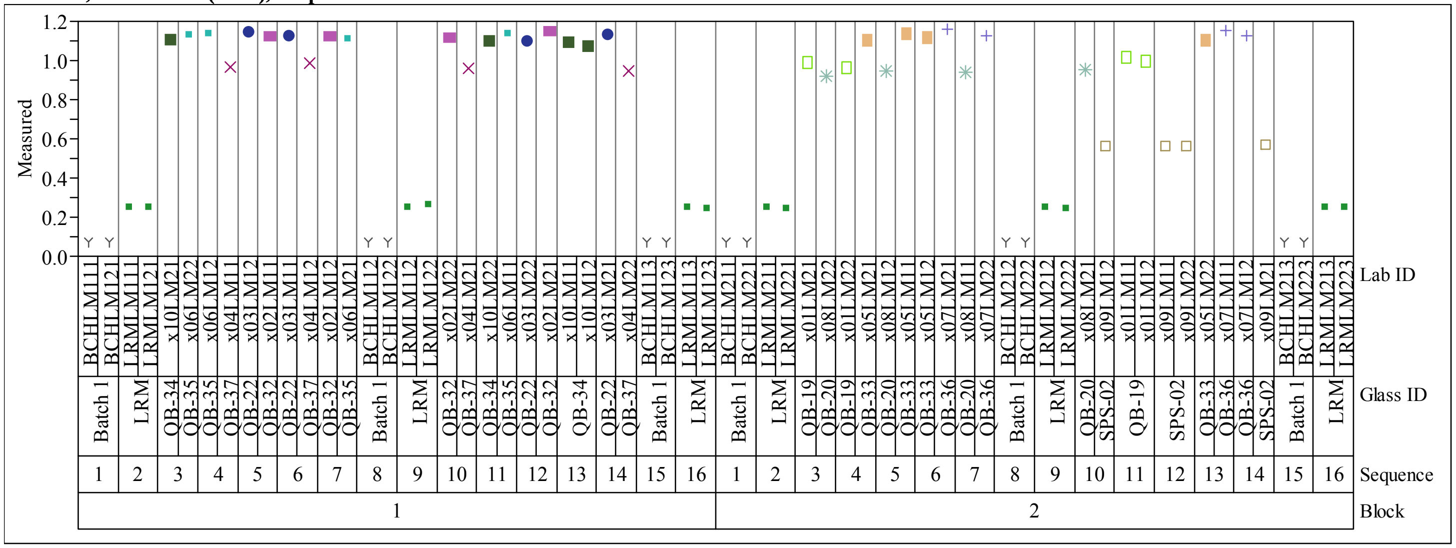
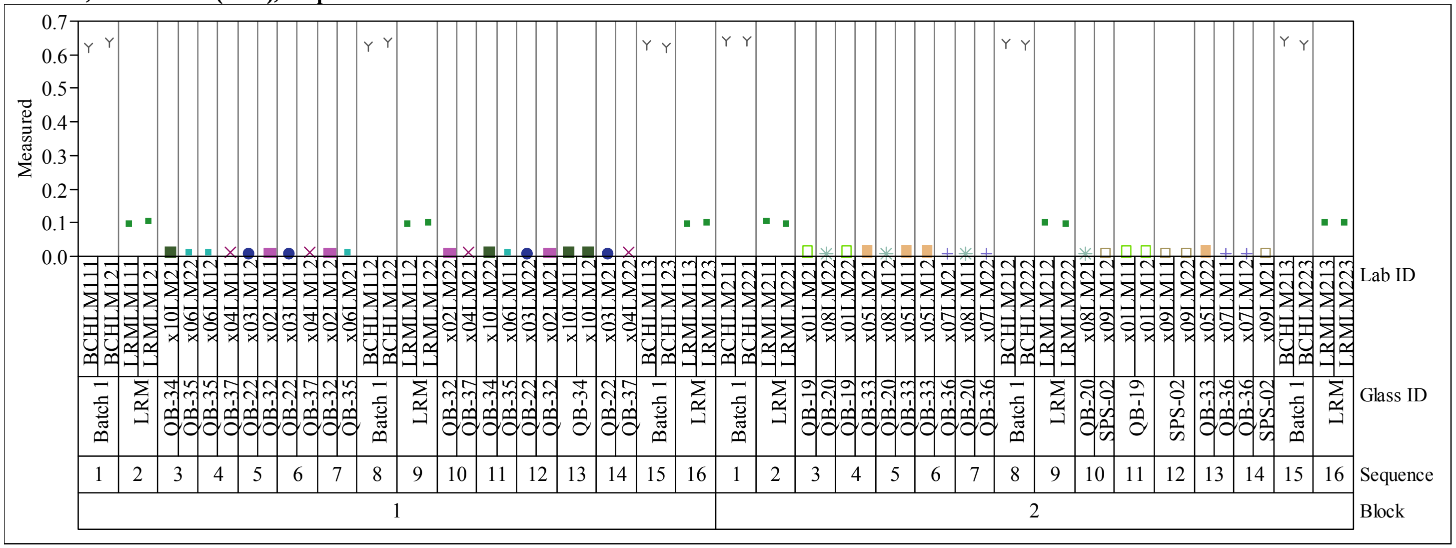


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=X, Oxide=TiO2 (wt%), Prep Method=LM



Series=X, Oxide=ZnO (wt%), Prep Method=LM

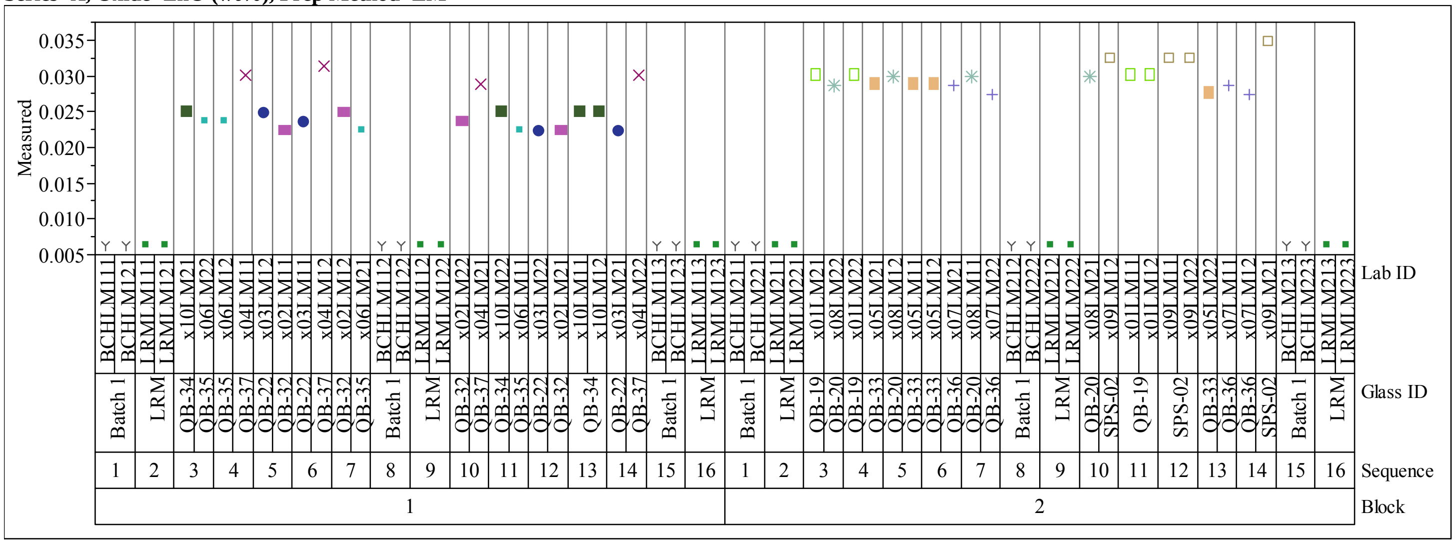


Exhibit A-1. Measurements of Glasses in Analytical Sequence by Oxide within Preparation Method and by Analytical Series (continued)

Series=X, Oxide=ZrO2 (wt%), Prep Method=LM

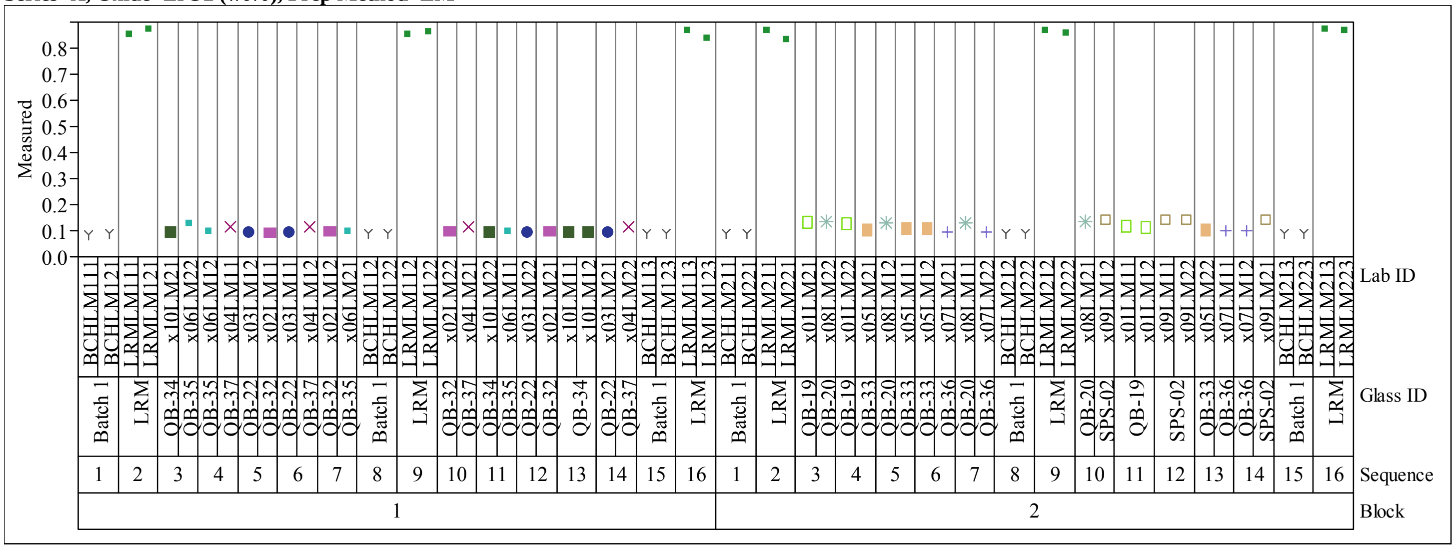
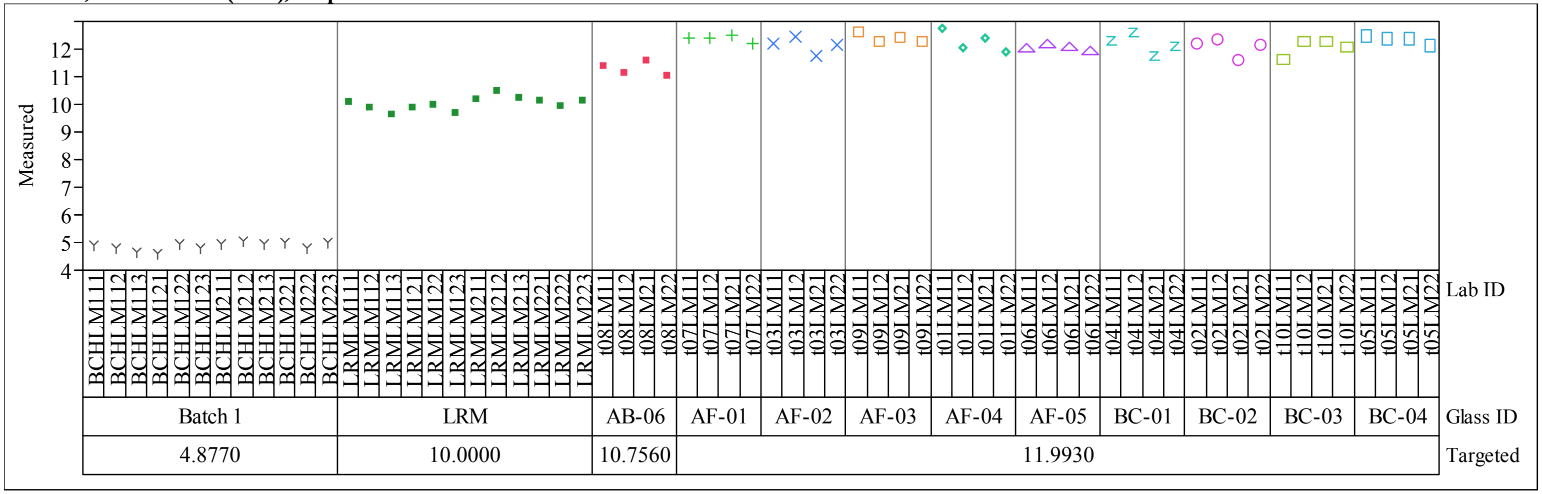


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series

Series=T, Oxide=Al2O3 (wt%), Prep Method=LM



Series=T, Oxide=B2O3 (wt%), Prep Method=PF

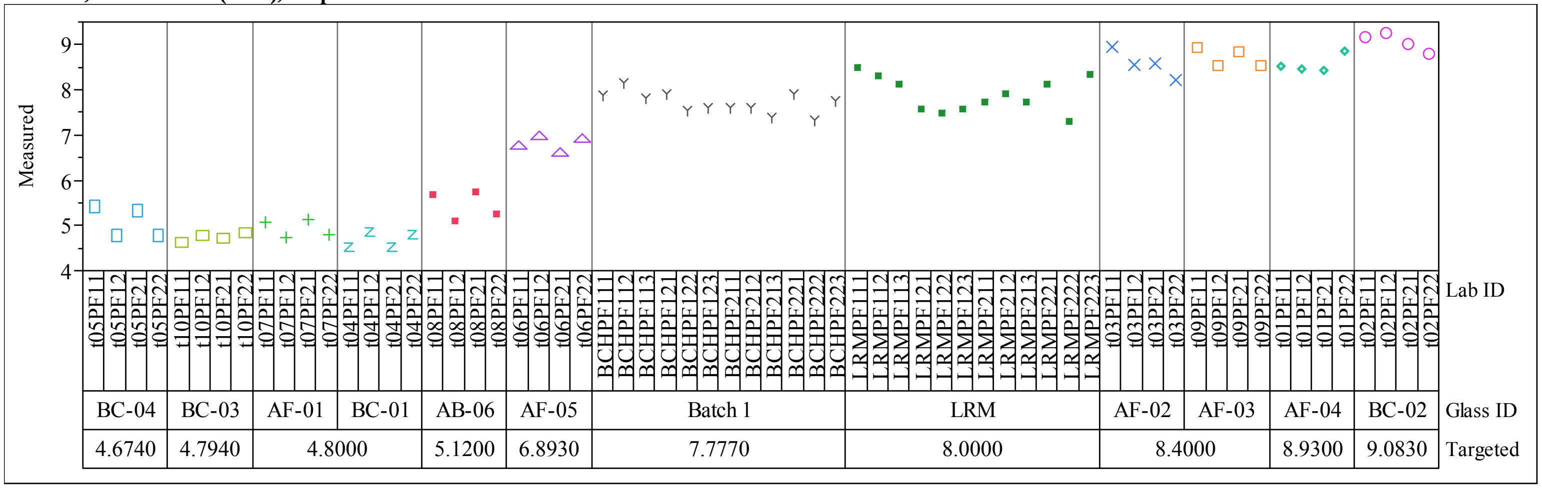
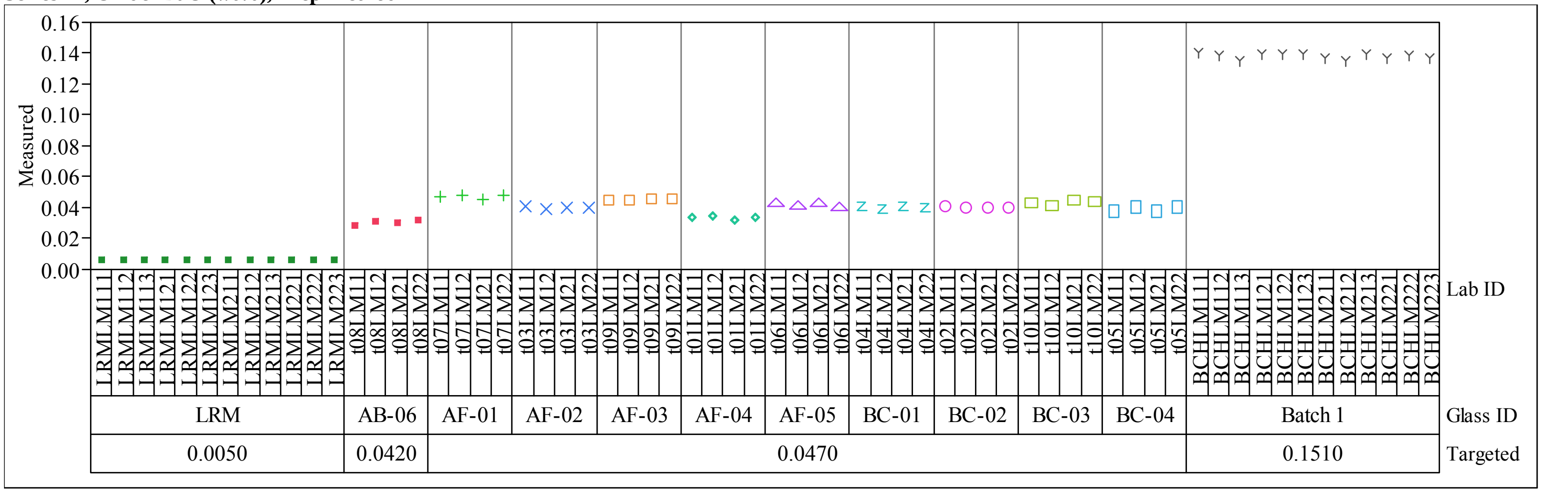


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=T, Oxide=BaO (wt%), Prep Method=LM



Series=T, Oxide=CaO (wt%), Prep Method=LM

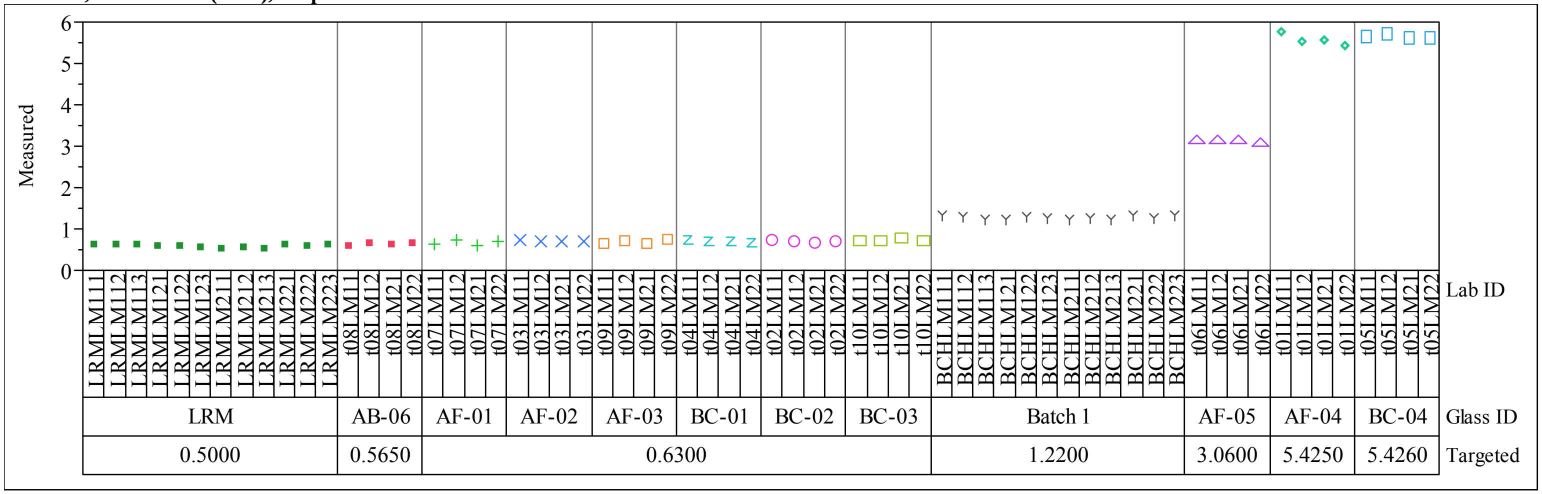
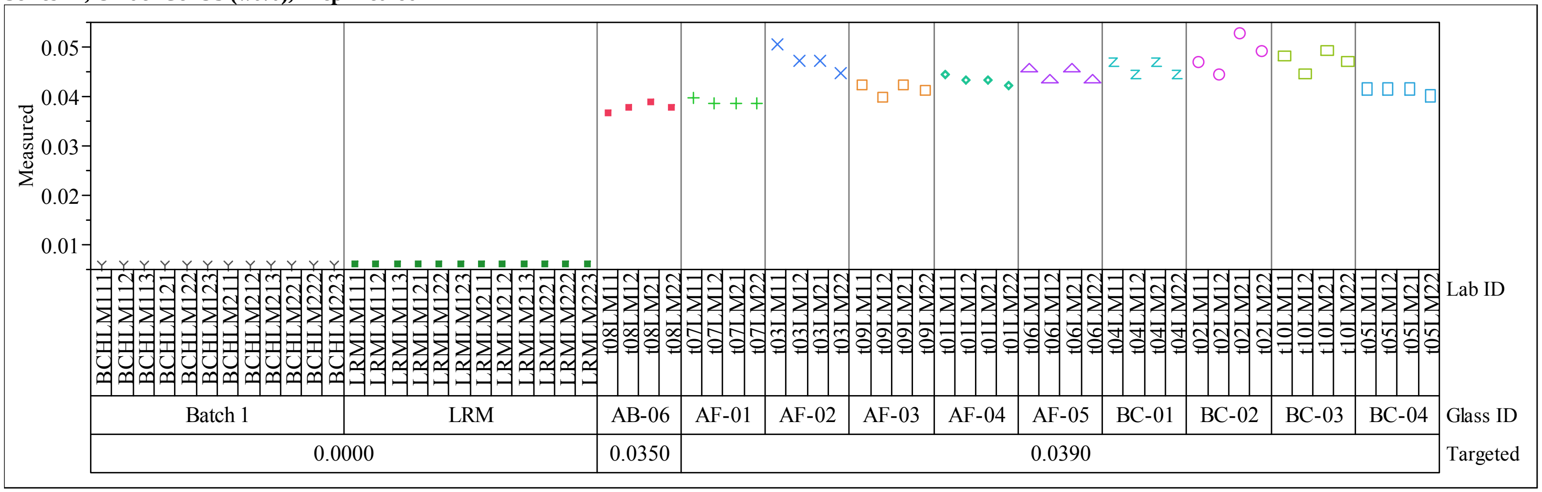


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=T, Oxide=Ce2O3 (wt%), Prep Method=LM



Series=T, Oxide=Cr2O3 (wt%), Prep Method=LM

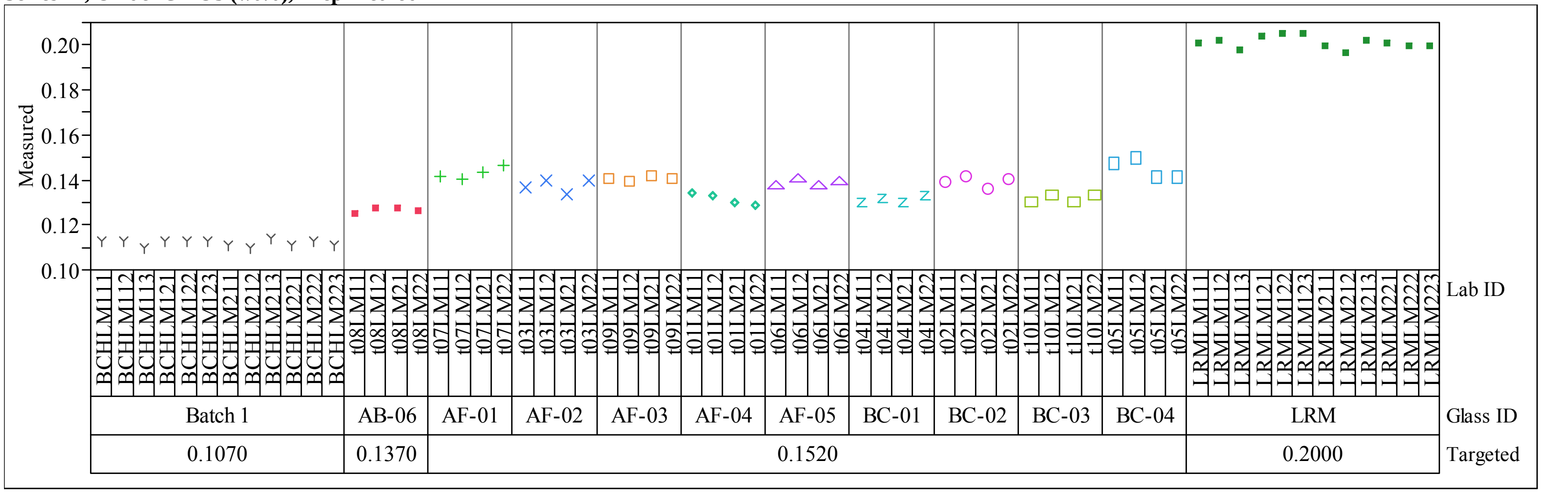
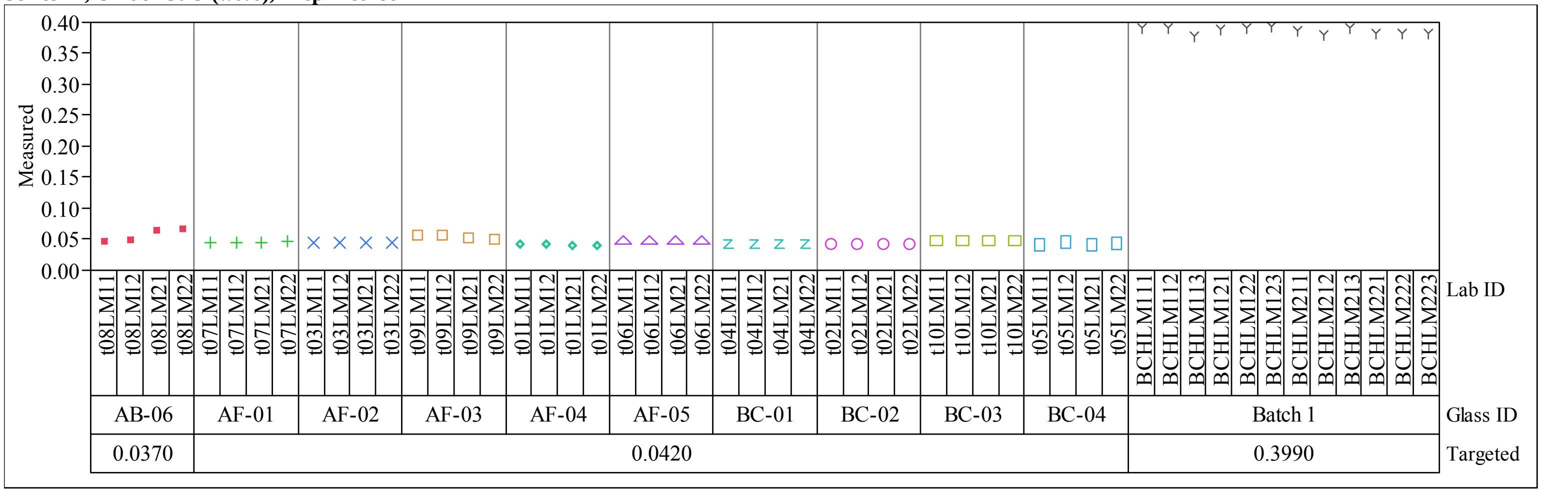


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=T, Oxide=CuO (wt%), Prep Method=LM



Series=T, Oxide=Fe2O3 (wt%), Prep Method=LM

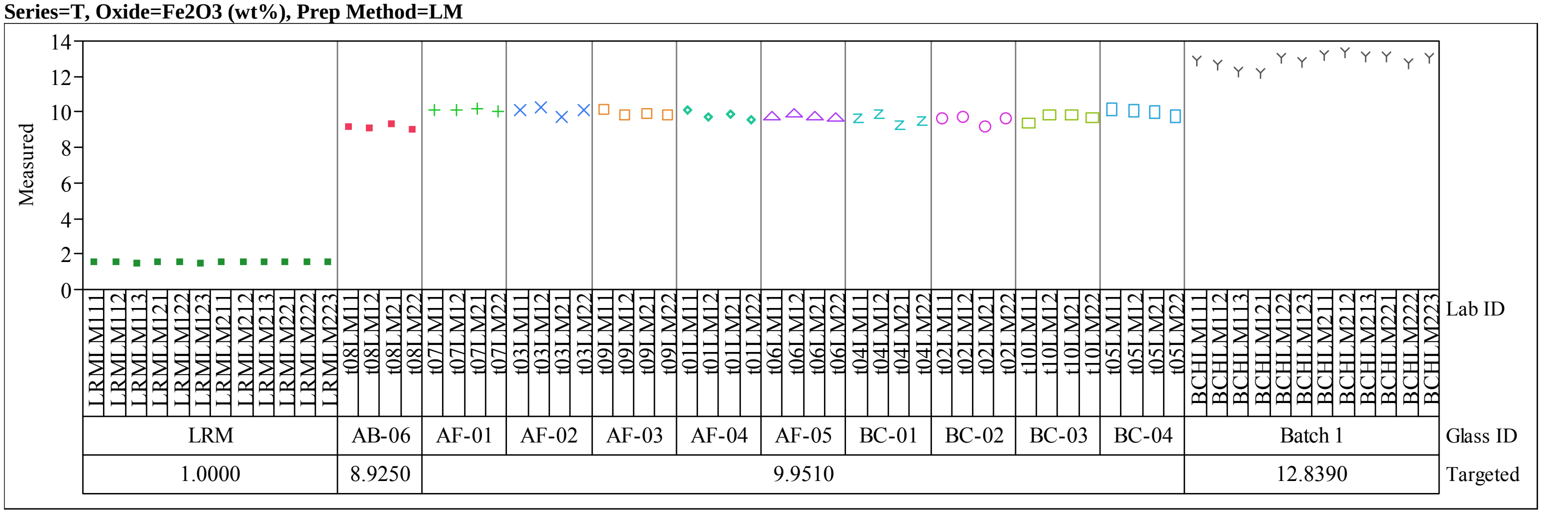
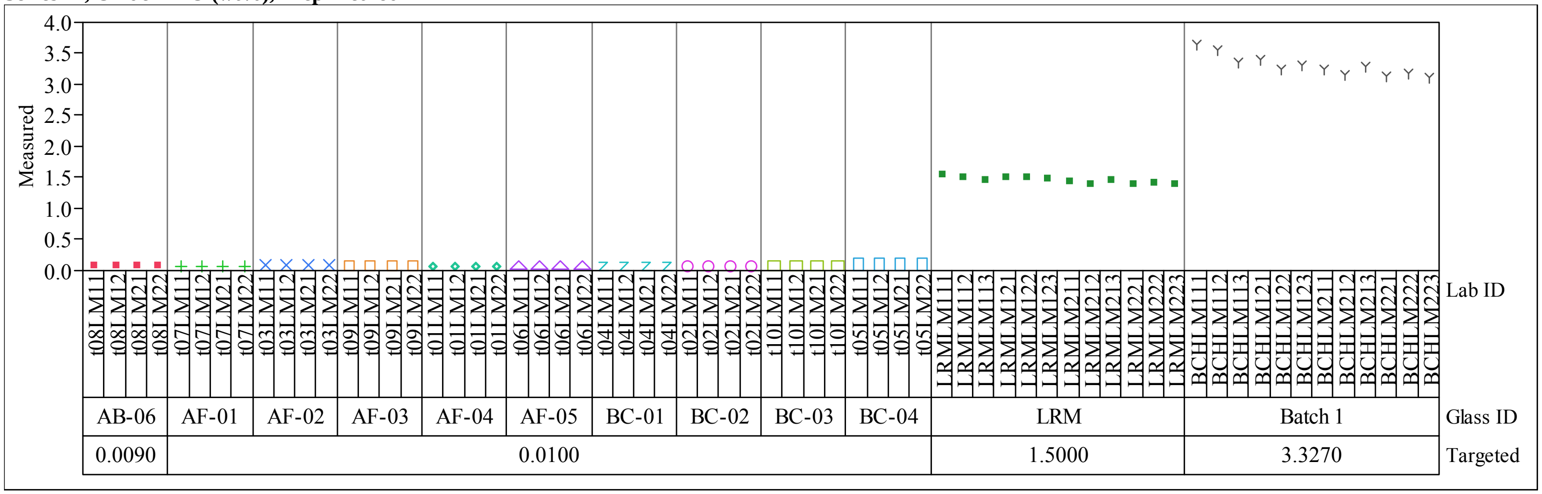


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=T, Oxide=K2O (wt%), Prep Method=LM



Series=T, Oxide=La2O3 (wt%), Prep Method=LM

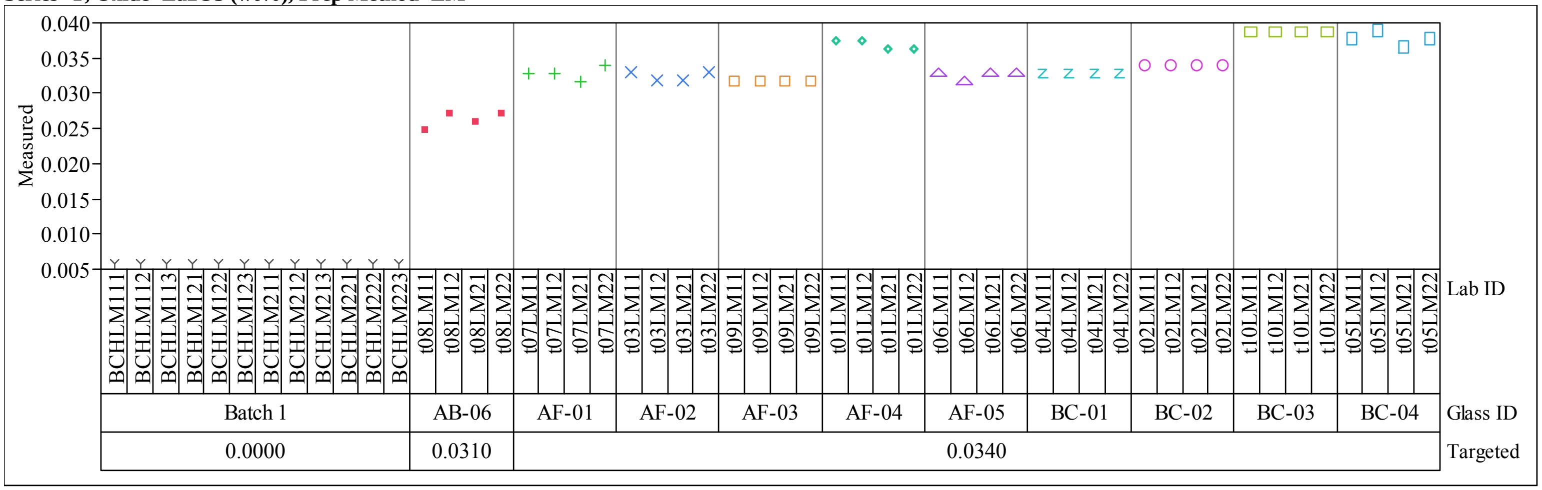
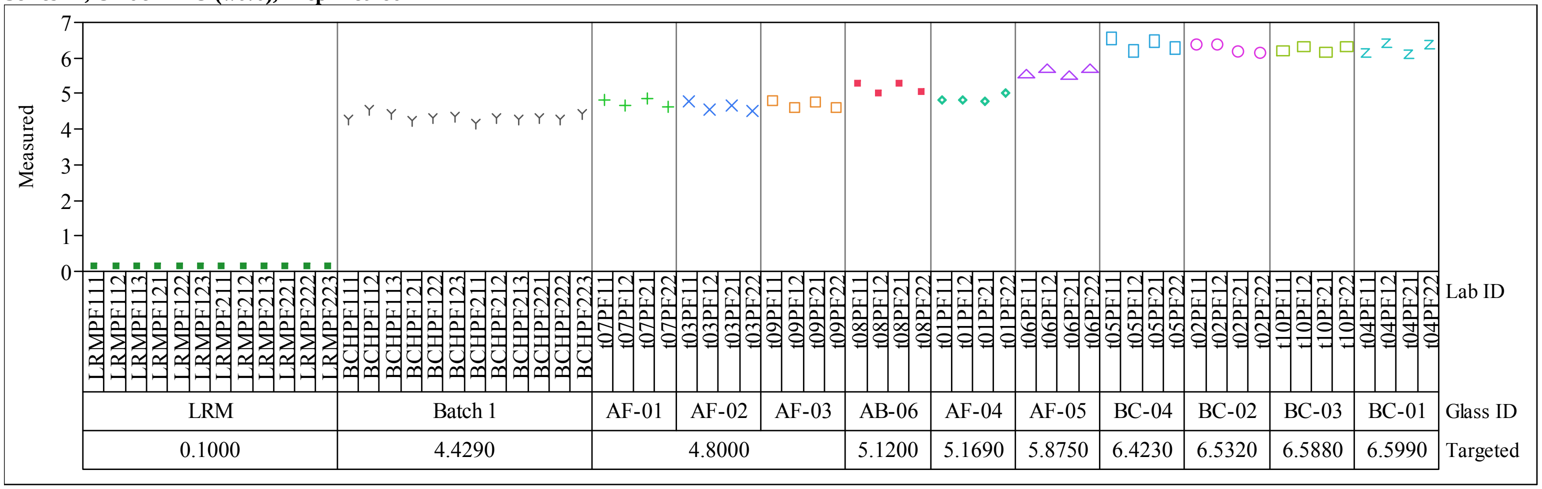


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=T, Oxide=Li2O (wt%), Prep Method=PF



Series=T, Oxide=MgO (wt%), Prep Method=LM

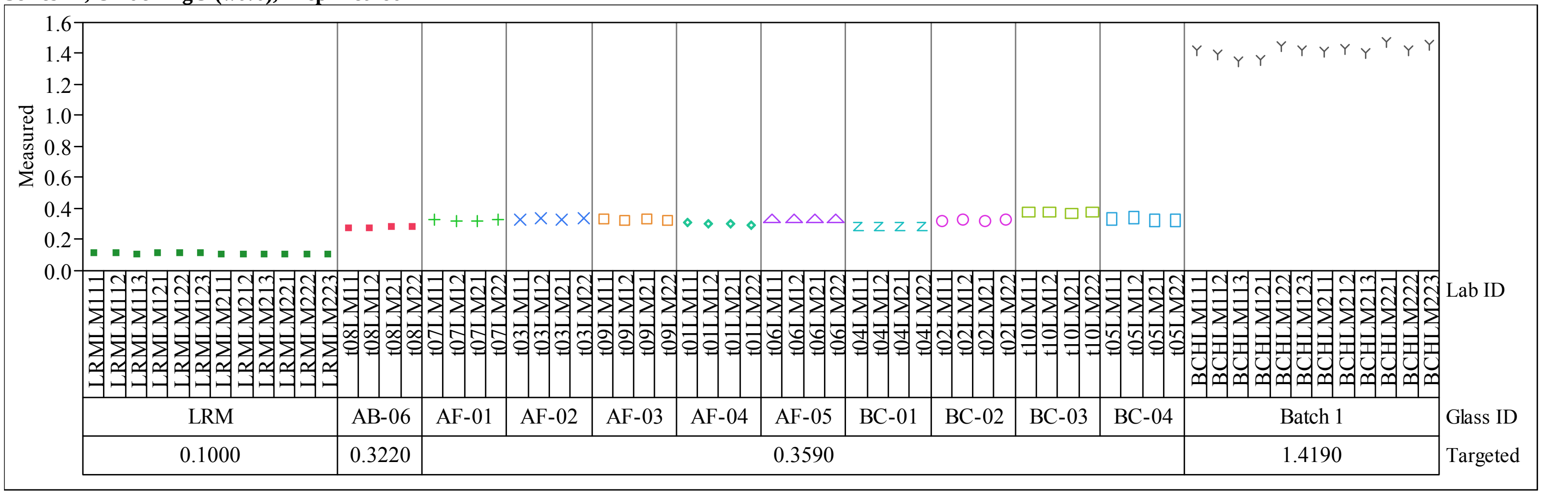
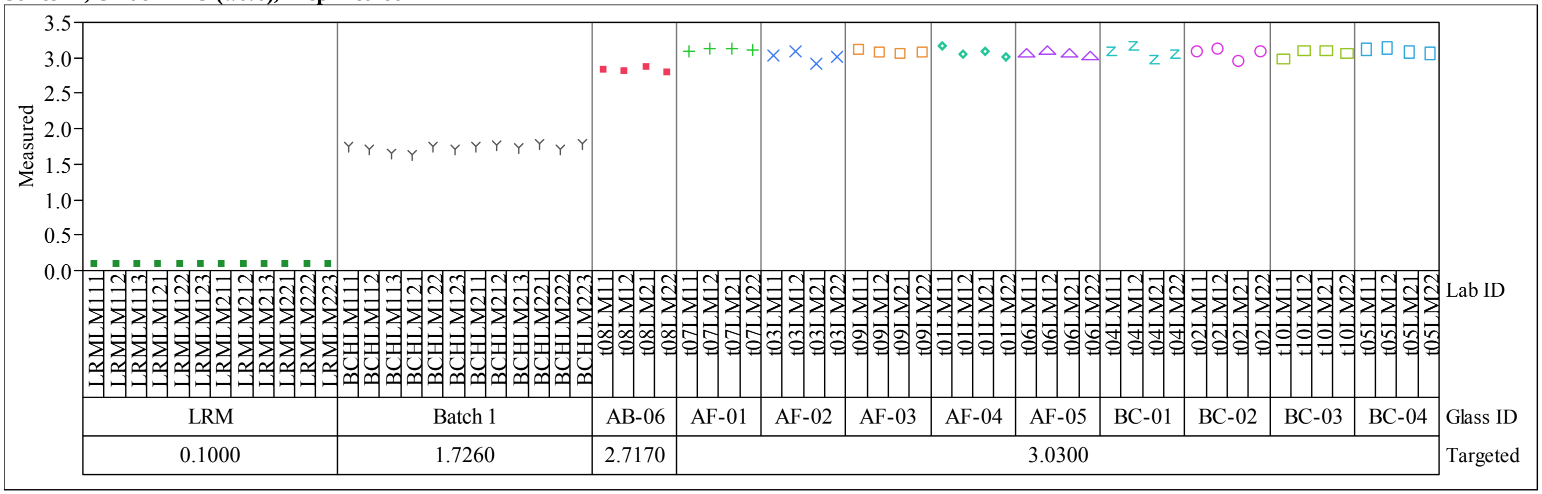


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=T, Oxide=MnO (wt%), Prep Method=LM



Series=T, Oxide=Na2O (wt%), Prep Method=LM

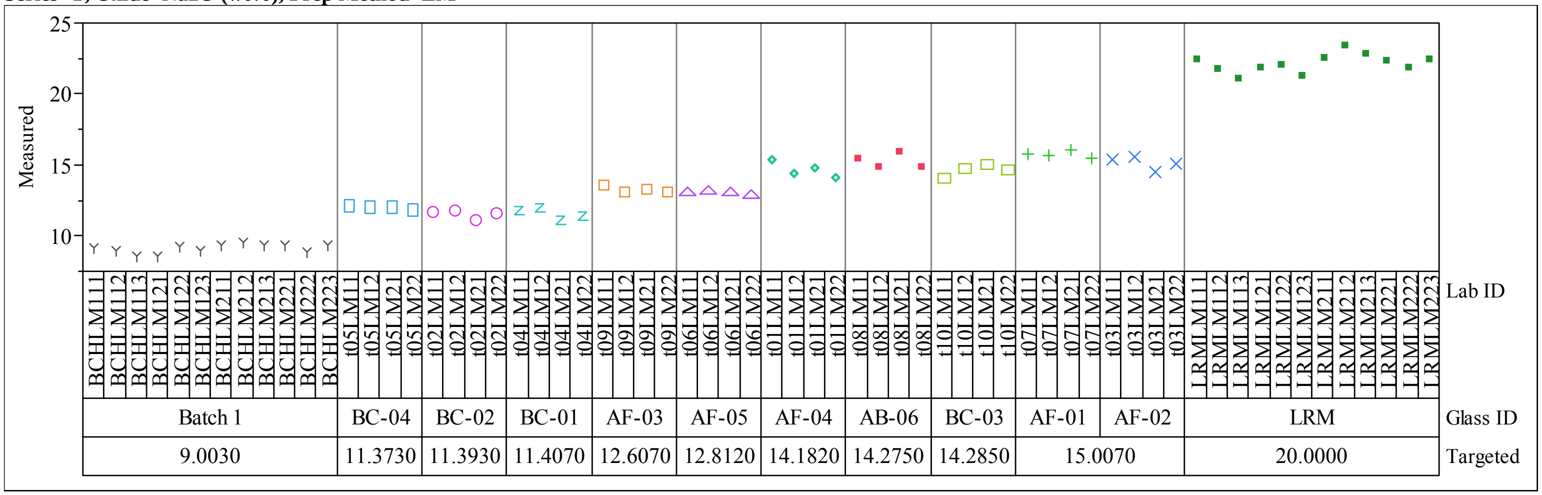
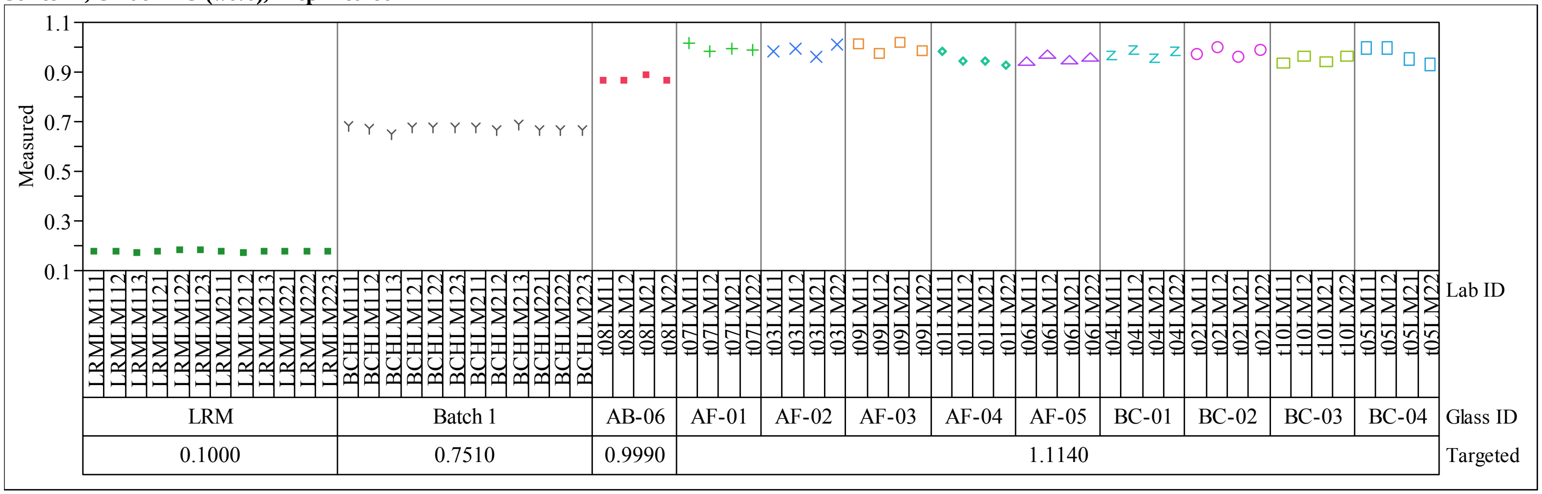


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=T, Oxide=NiO (wt%), Prep Method=LM



Series=T, Oxide=PbO (wt%), Prep Method=LM

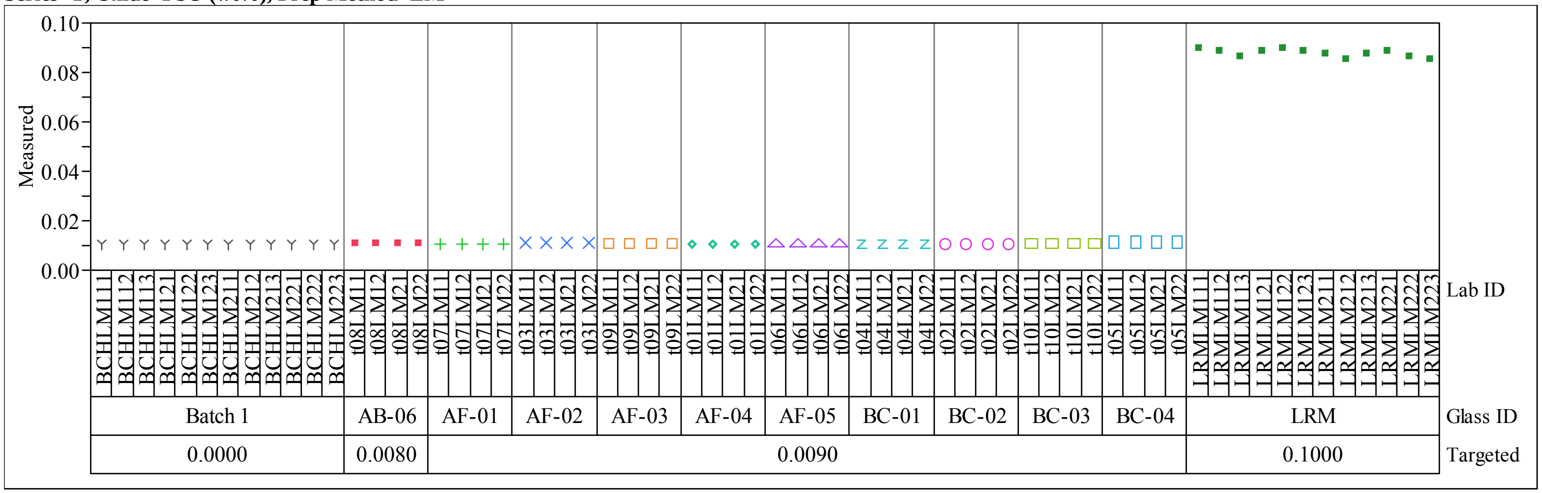
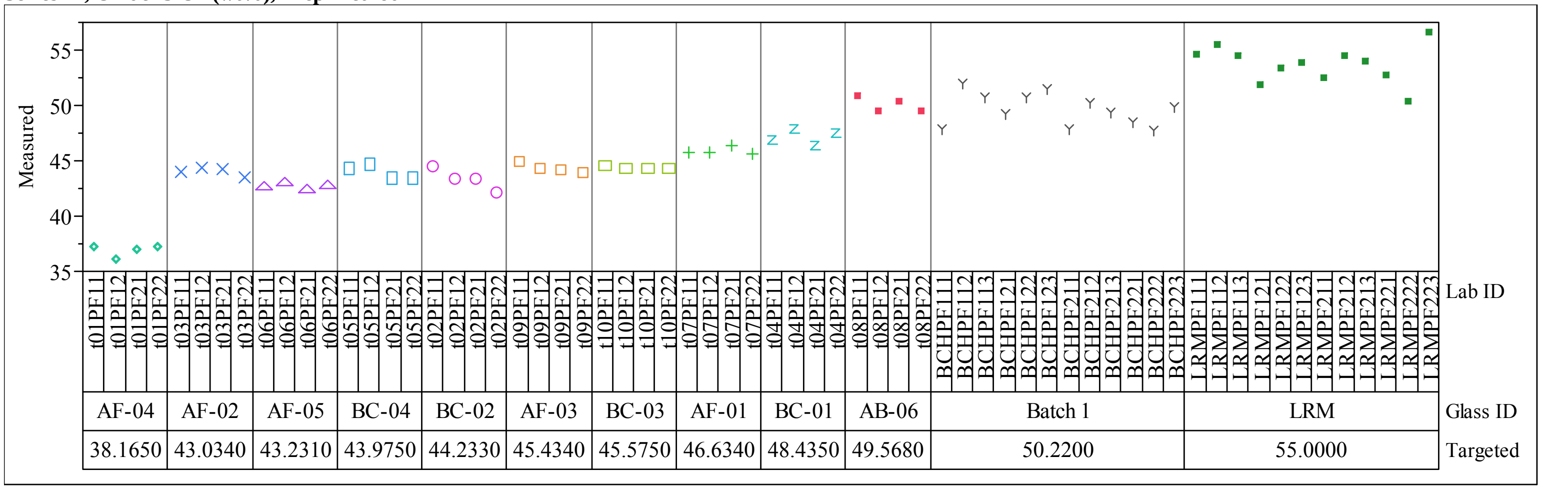


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=T, Oxide=SiO2 (wt%), Prep Method=PF



Series=T, Oxide=SO4 (wt%), Prep Method=LM

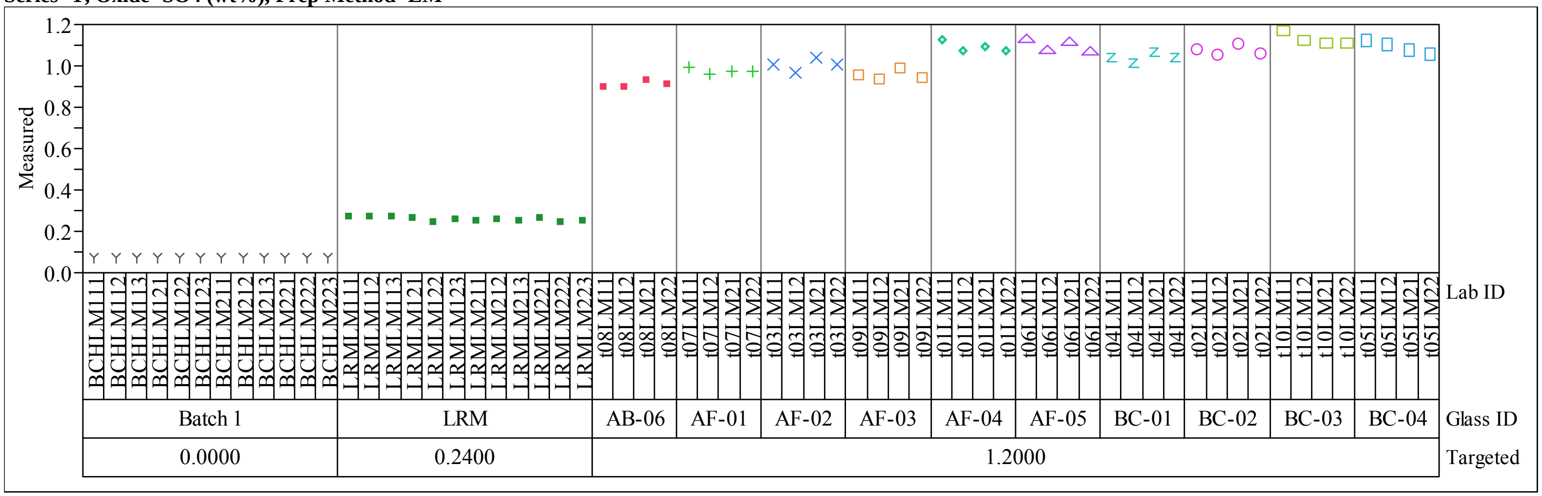
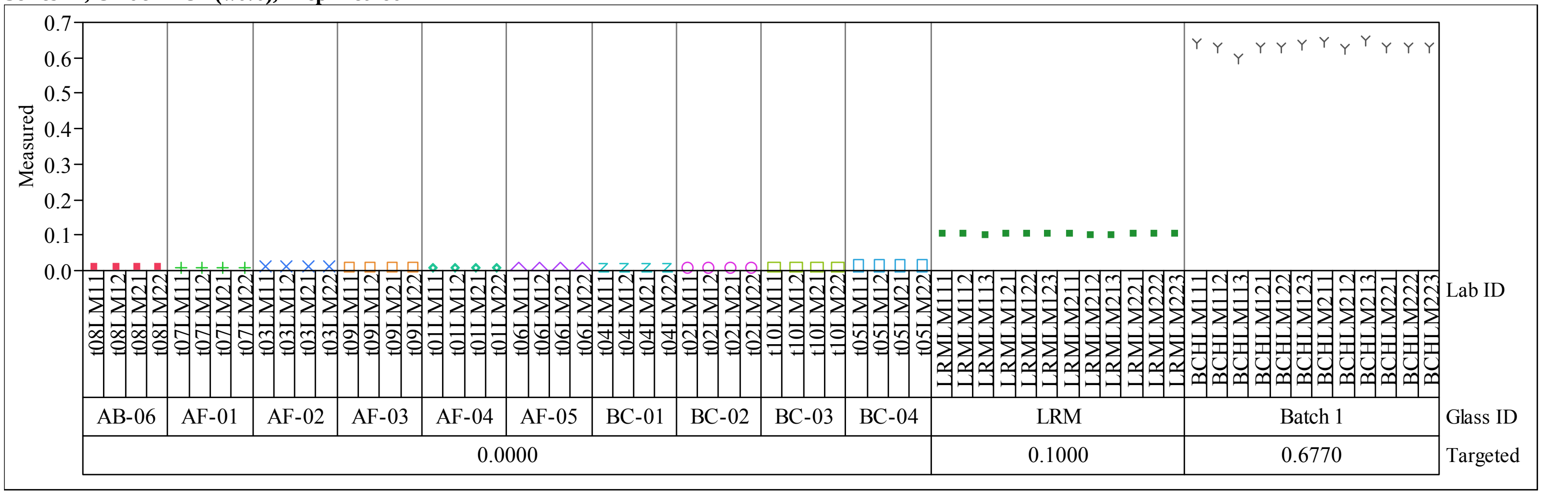


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=T, Oxide=TiO2 (wt%), Prep Method=LM



Series=T, Oxide=ZnO (wt%), Prep Method=LM

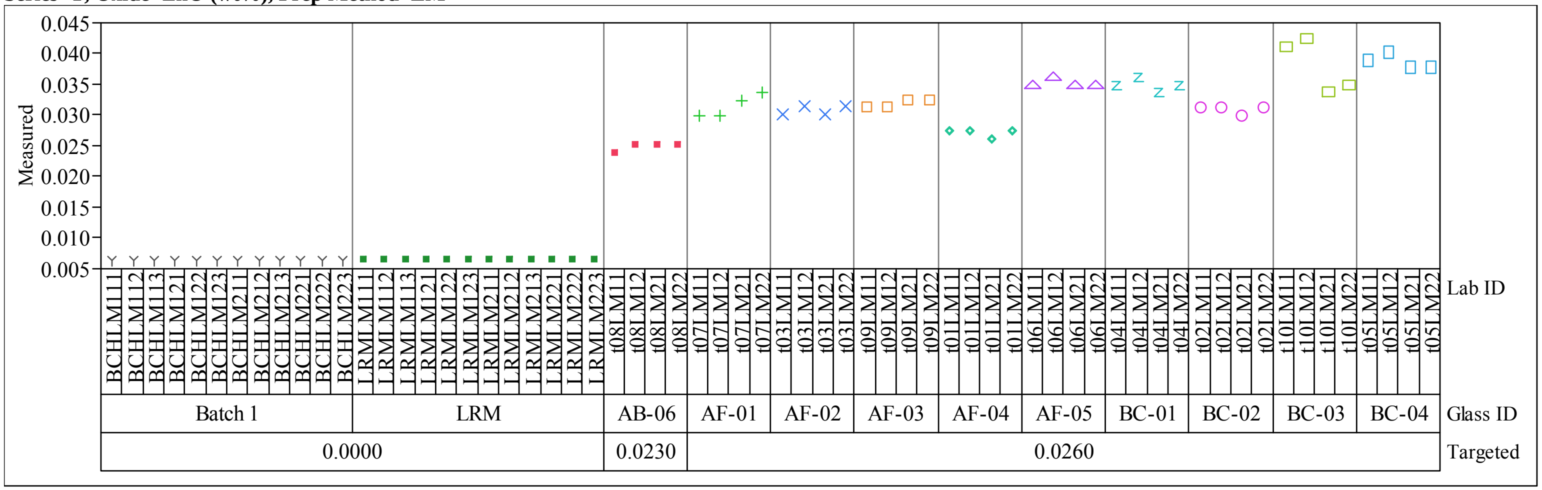
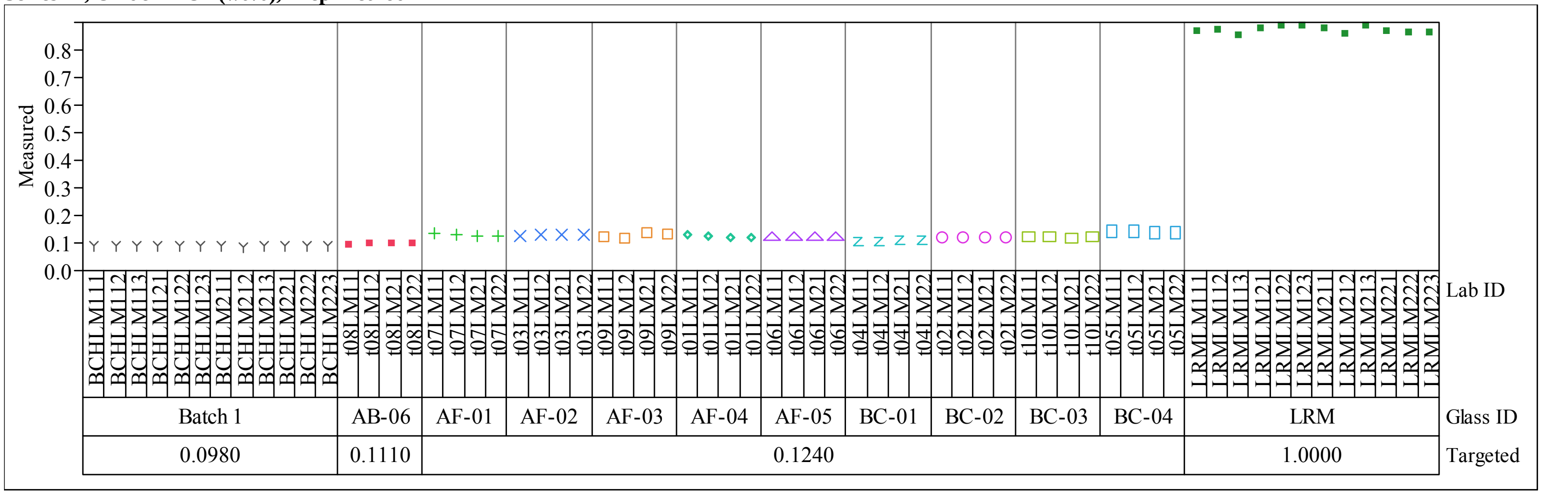


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=T, Oxide=ZrO2 (wt%), Prep Method=LM



Series=U, Oxide=Al2O3 (wt%), Prep Method=LM

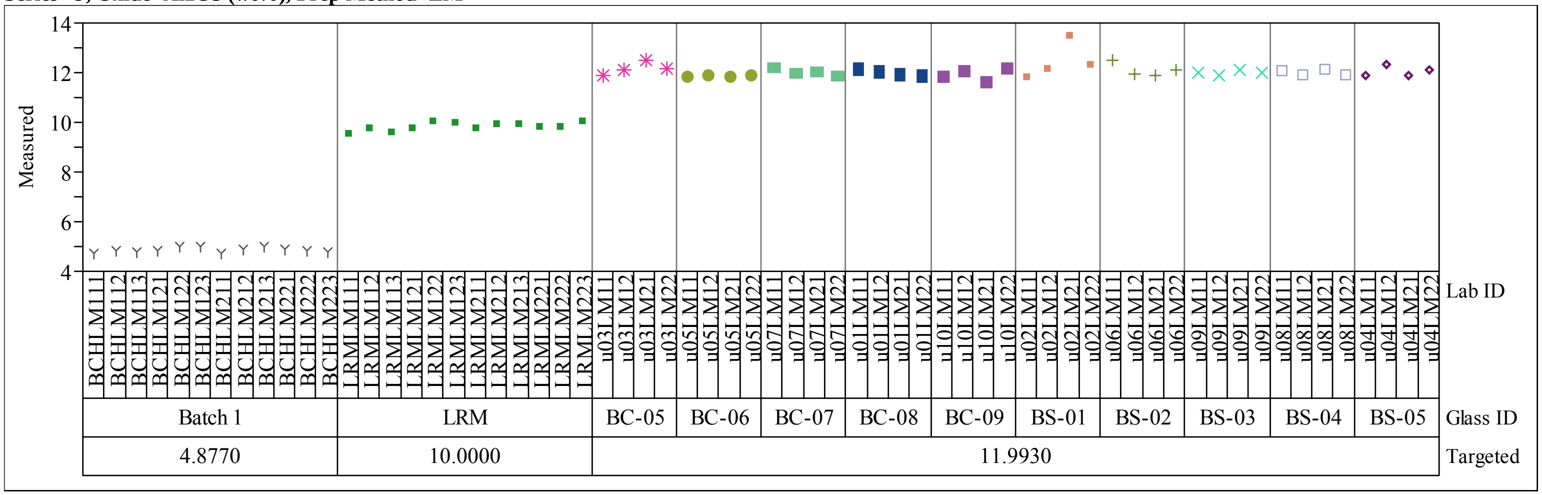
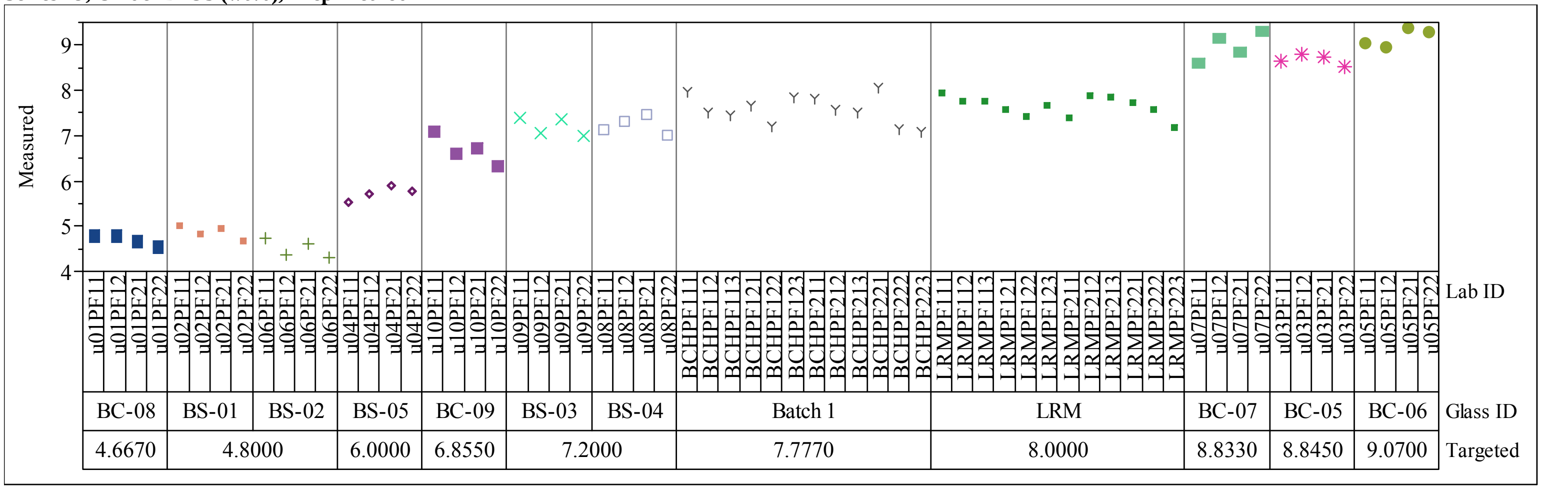


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=U, Oxide=B2O3 (wt%), Prep Method=PF



Series=U, Oxide=BaO (wt%), Prep Method=LM

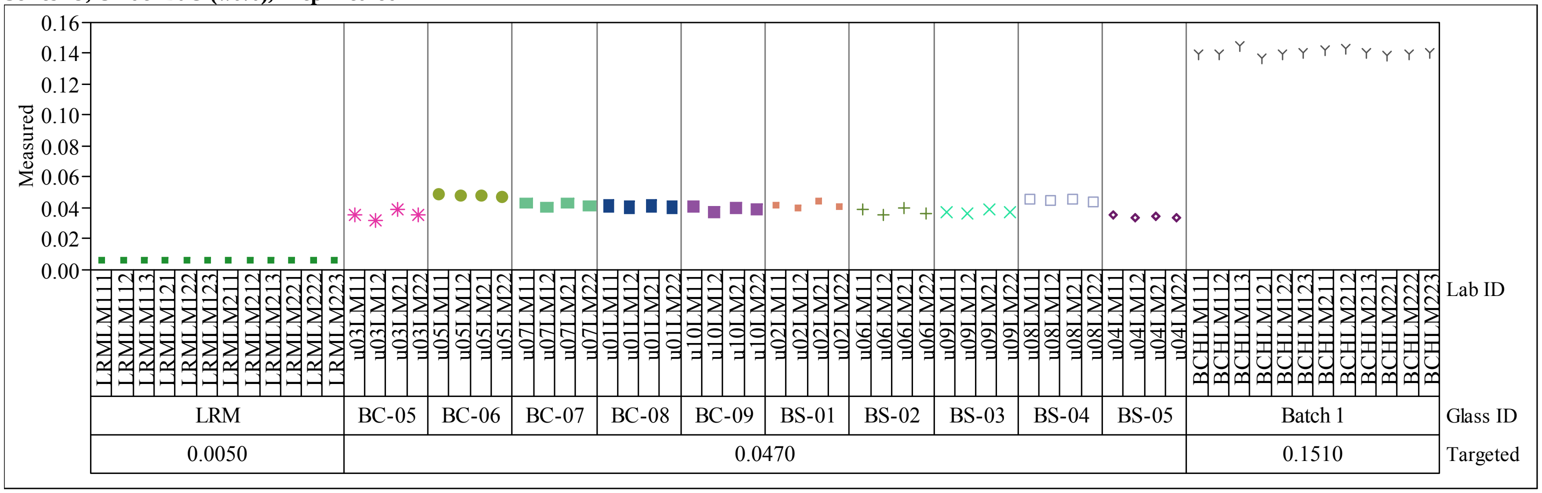
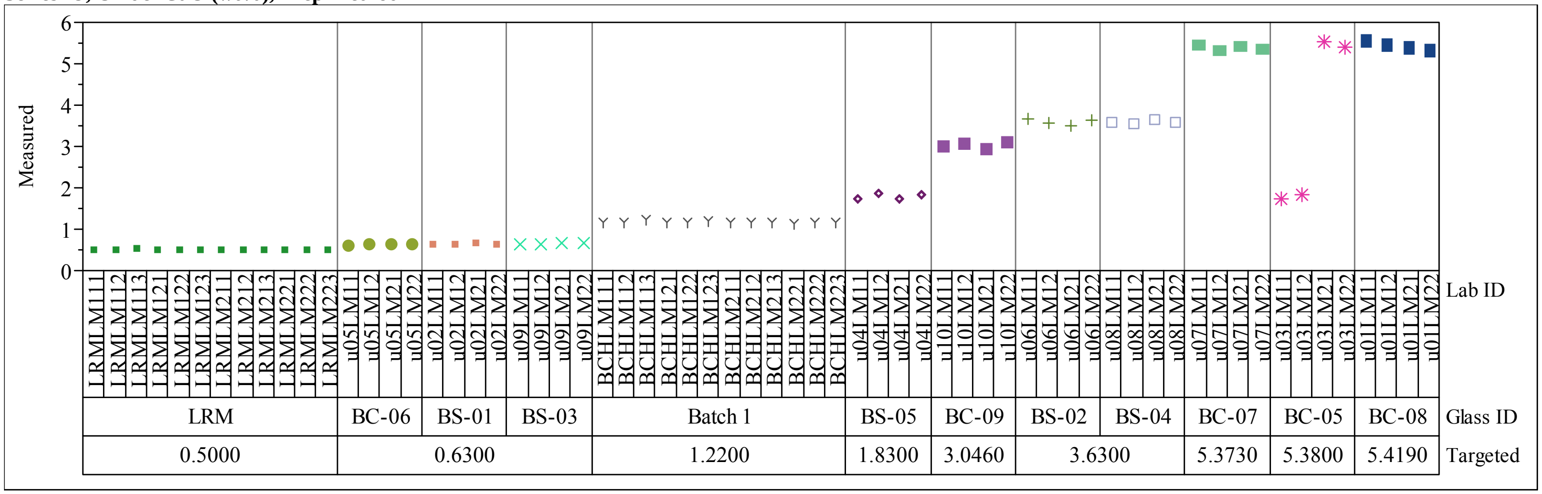


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=U, Oxide=CaO (wt%), Prep Method=LM



Series=U, Oxide=Ce2O3 (wt%), Prep Method=LM

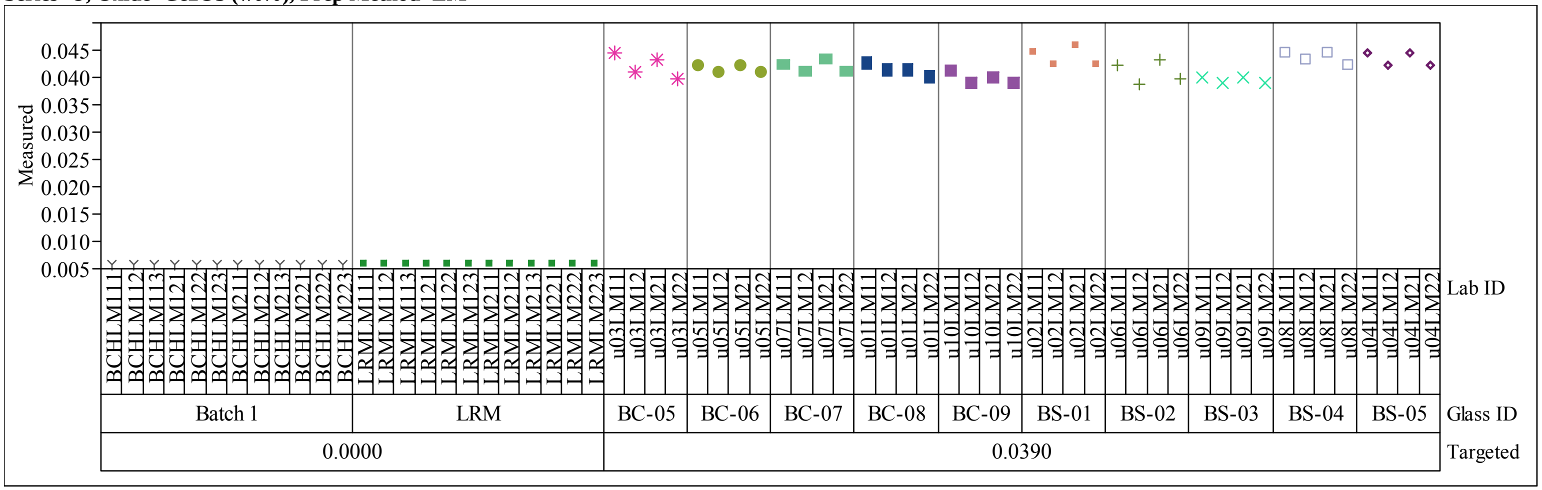
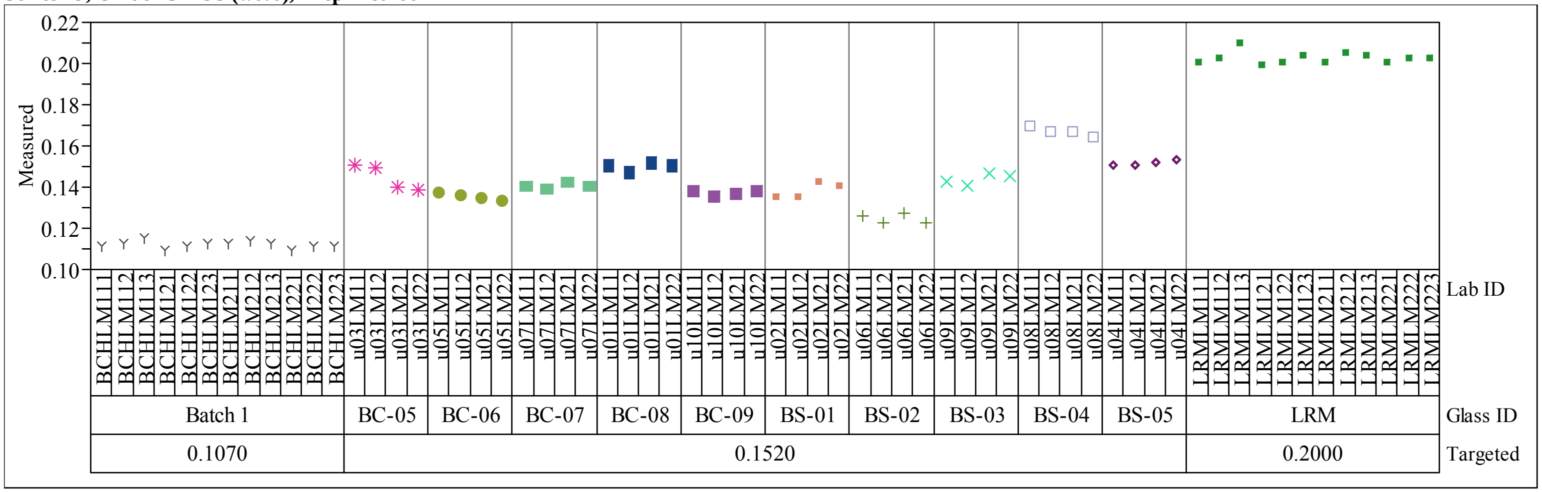


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=U, Oxide=Cr2O3 (wt%), Prep Method=LM



Series=U, Oxide=CuO (wt%), Prep Method=LM

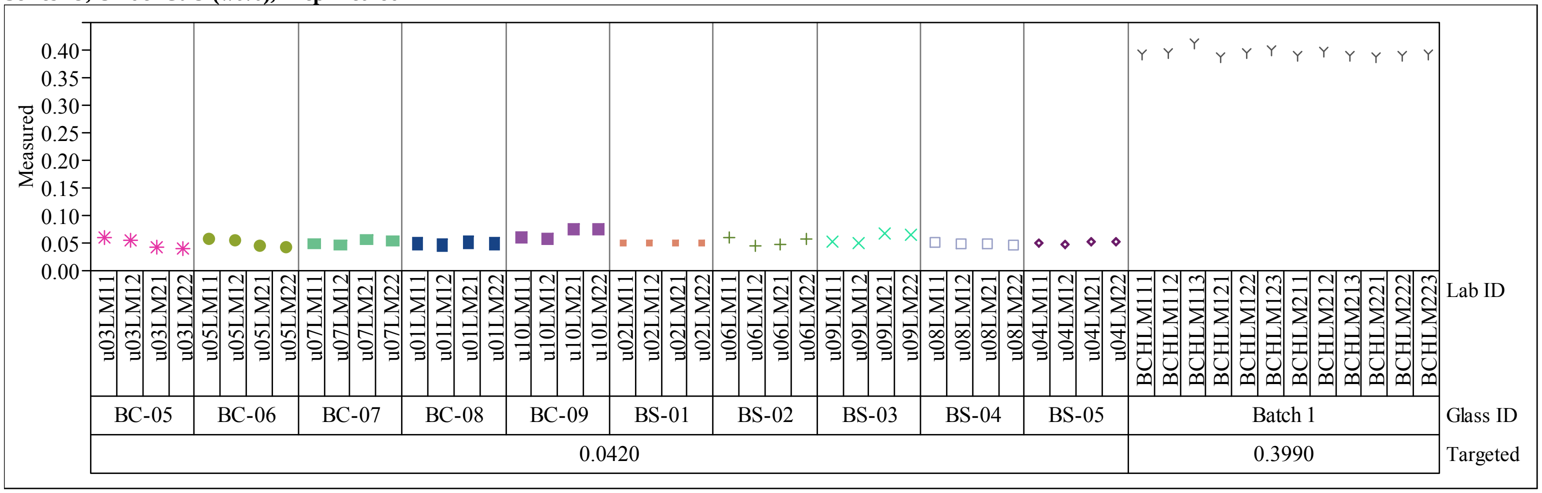
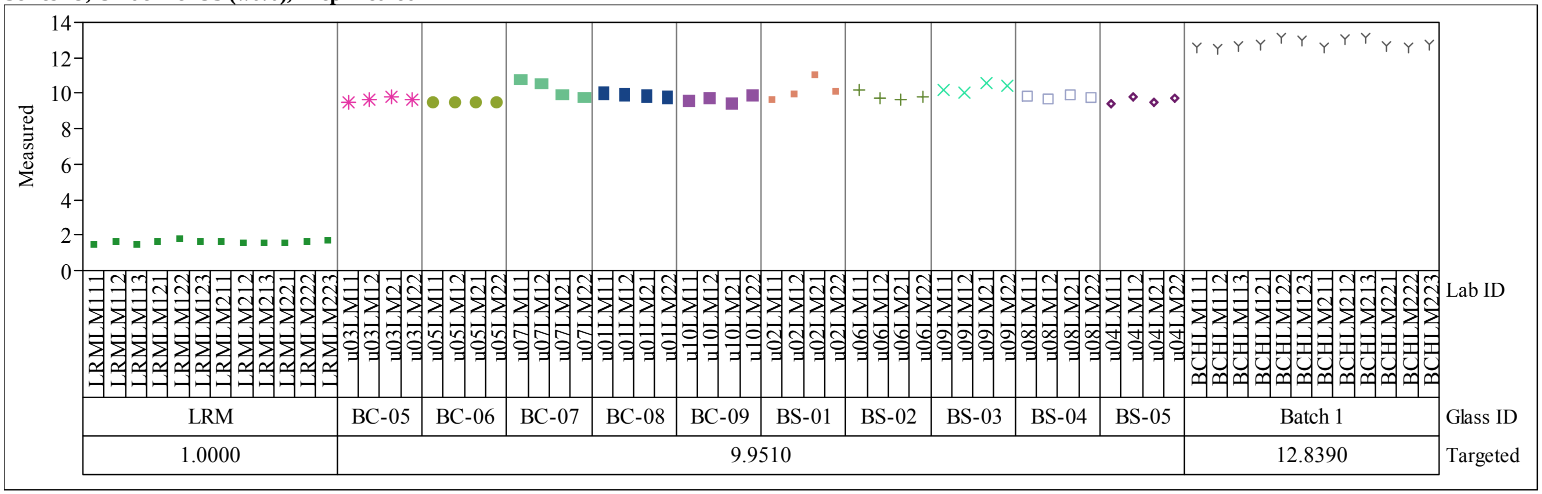


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=U, Oxide=Fe2O3 (wt%), Prep Method=LM



Series=U, Oxide=K2O (wt%), Prep Method=LM

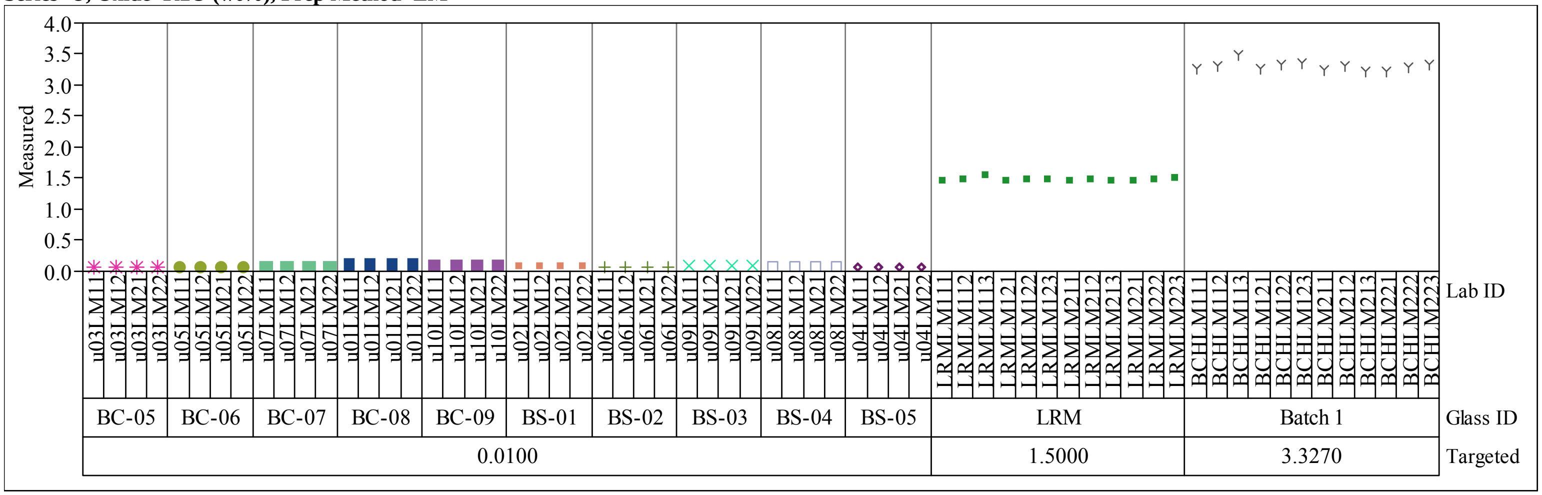
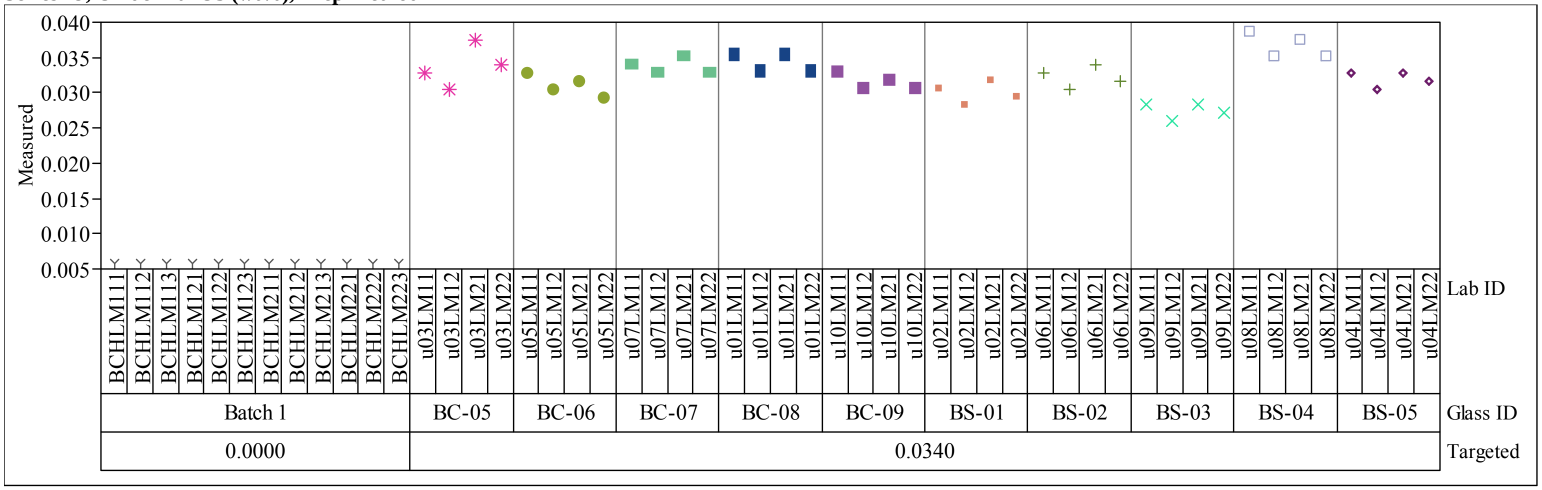


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=U, Oxide=La2O3 (wt%), Prep Method=LM



Series=U, Oxide=Li2O (wt%), Prep Method=PF

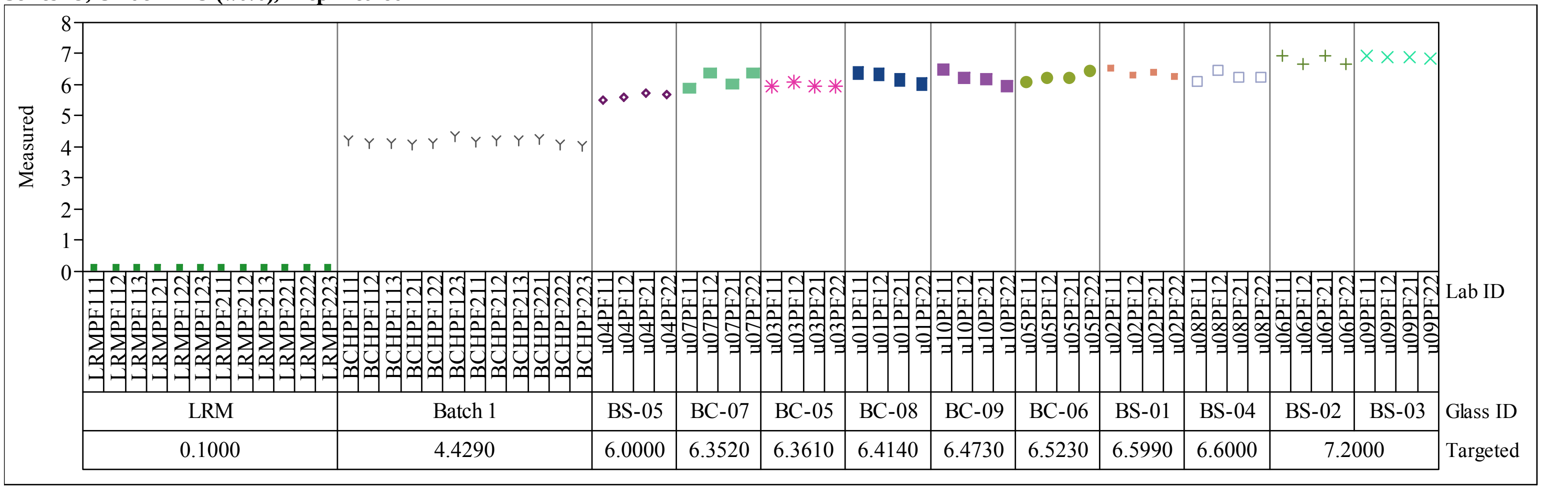
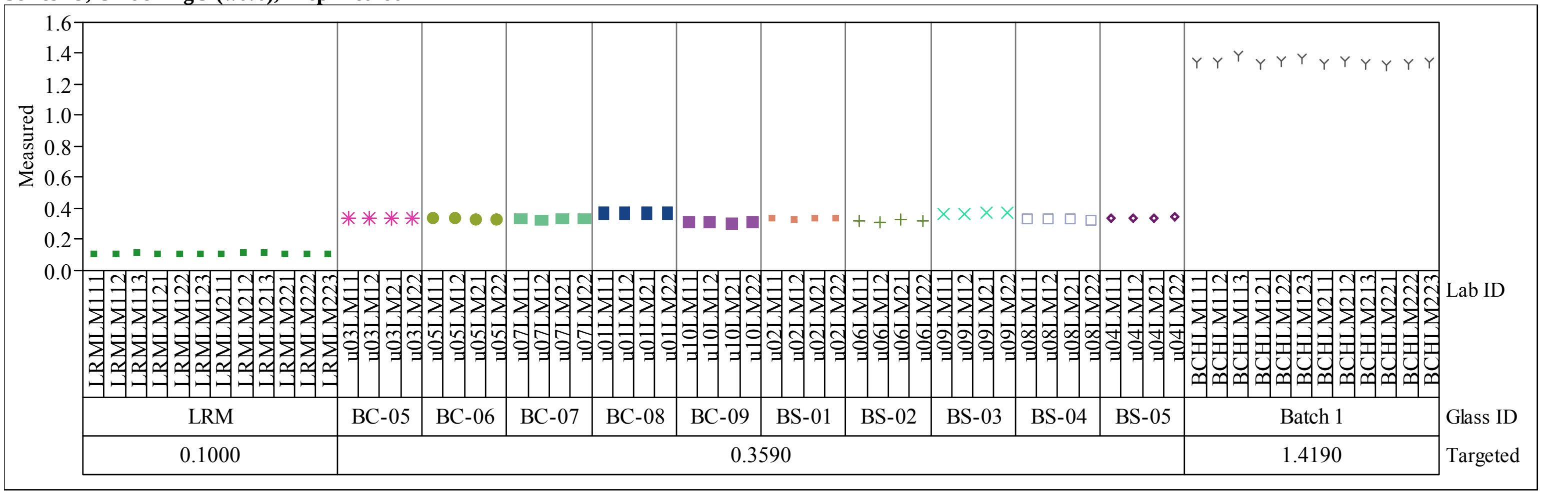


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=U, Oxide=MgO (wt%), Prep Method=LM



Series=U, Oxide=MnO (wt%), Prep Method=LM

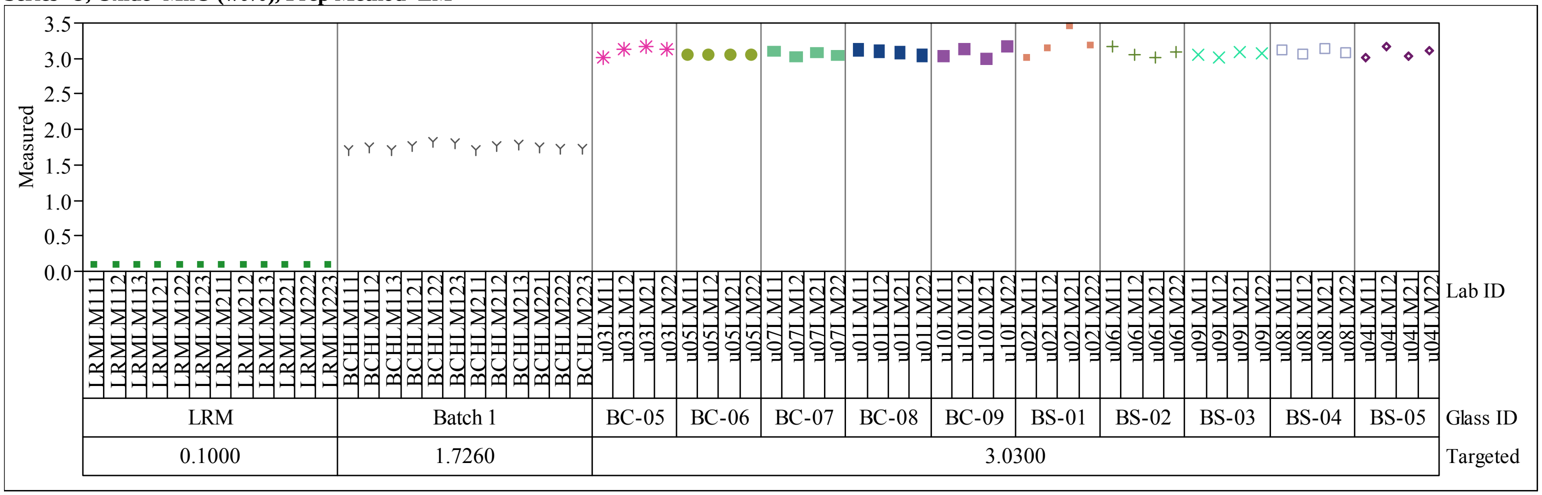
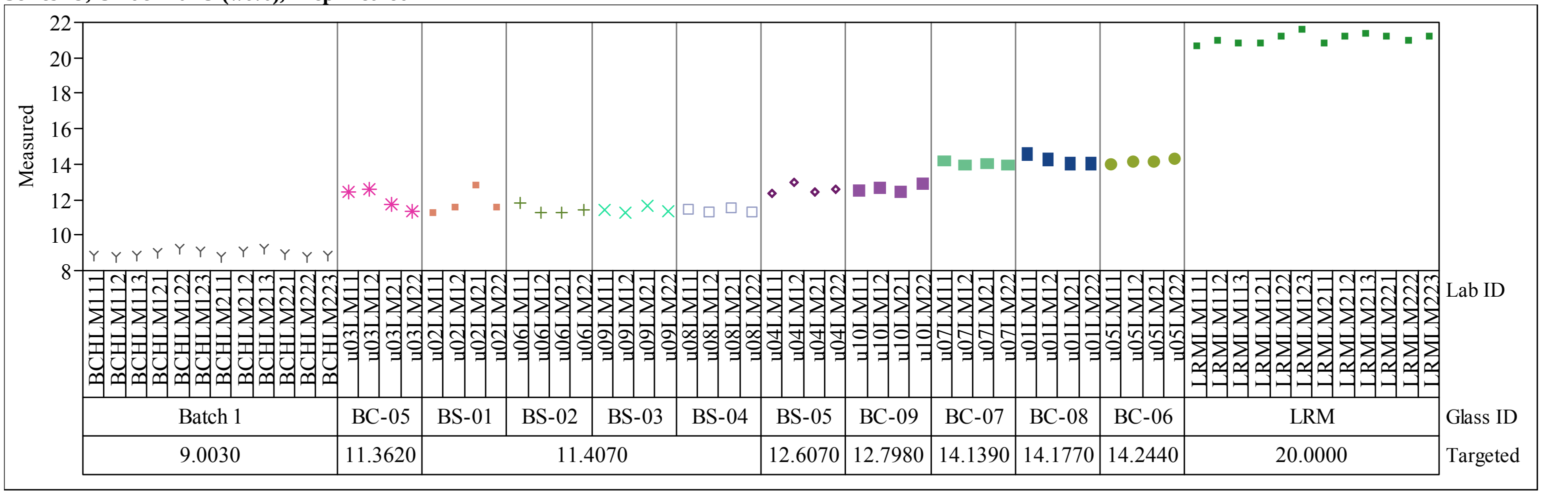


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=U, Oxide=Na2O (wt%), Prep Method=LM



Series=U, Oxide=NiO (wt%), Prep Method=LM

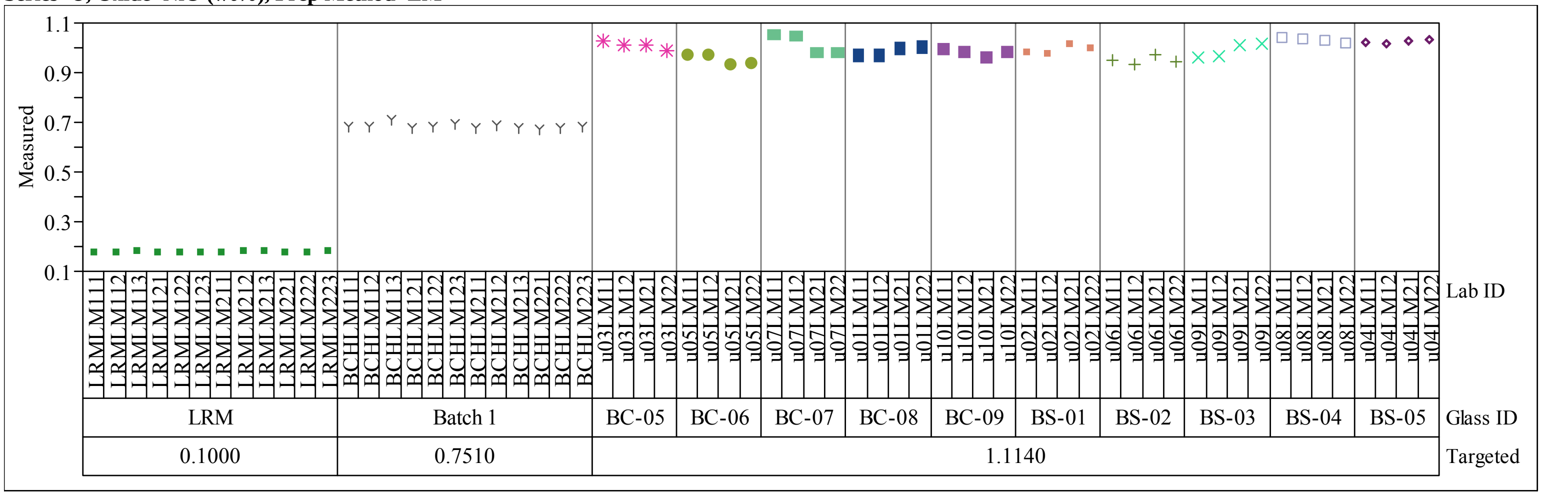
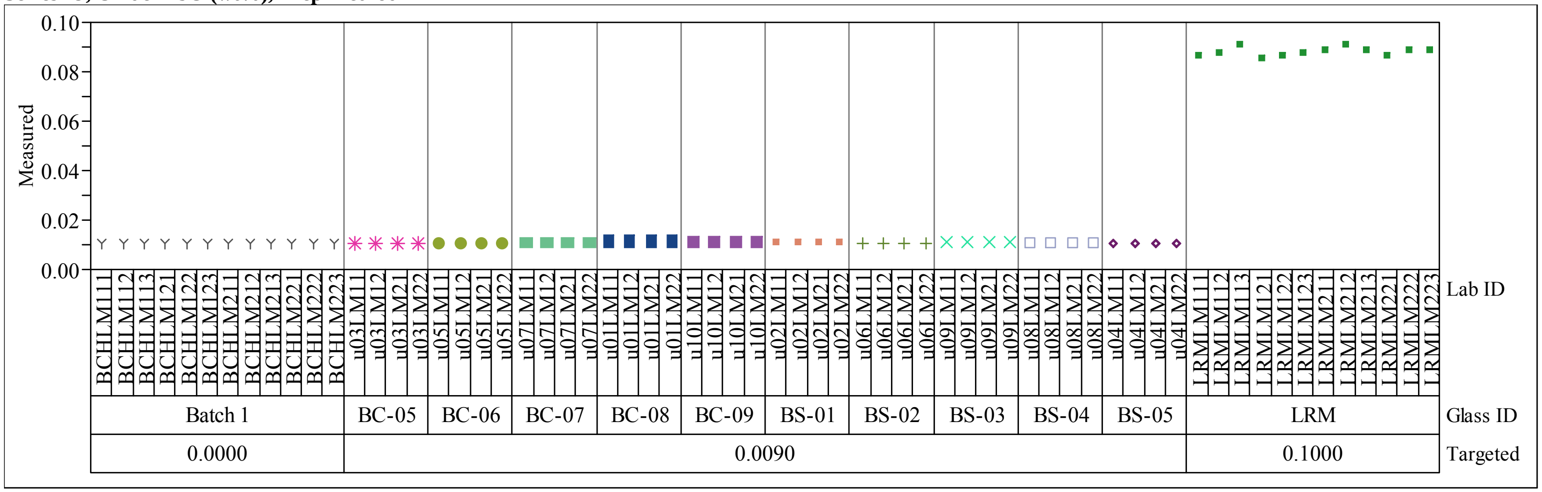


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=U, Oxide=PbO (wt%), Prep Method=LM



Series=U, Oxide=SiO2 (wt%), Prep Method=PF

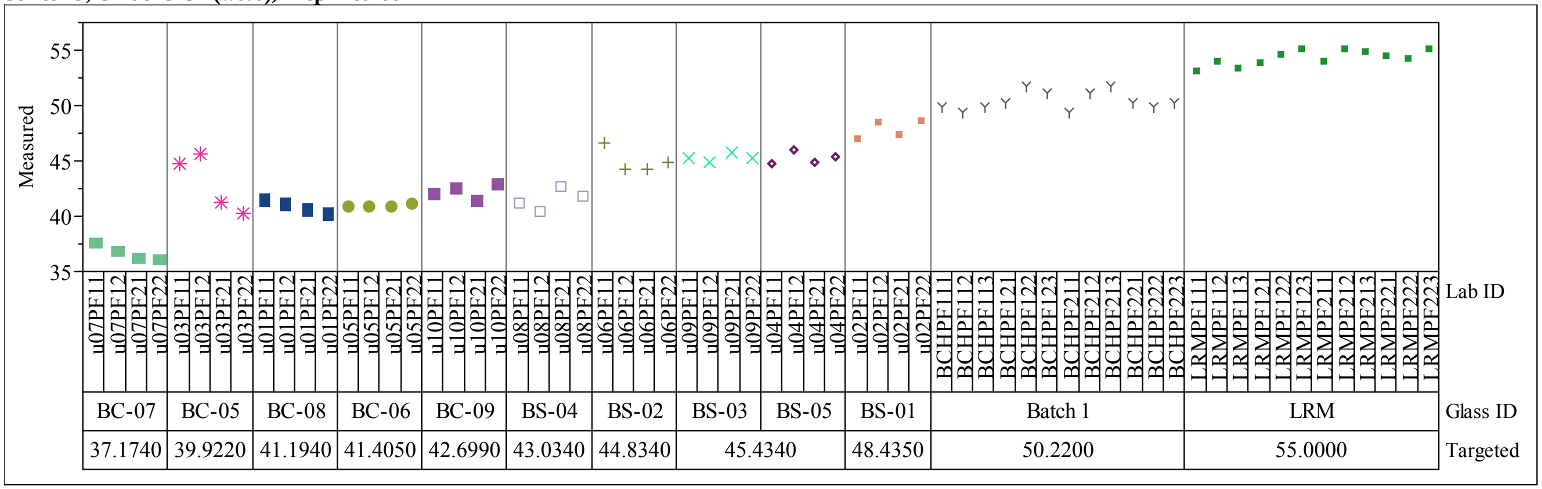
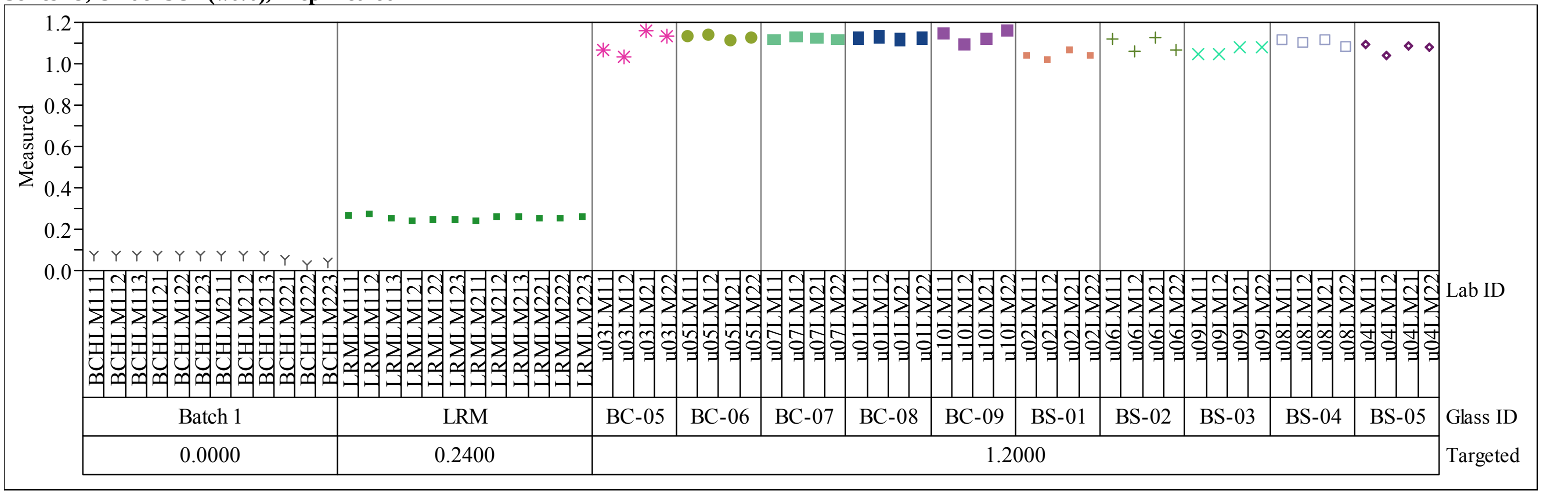


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=U, Oxide=SO4 (wt%), Prep Method=LM



Series=U, Oxide=TiO2 (wt%), Prep Method=LM

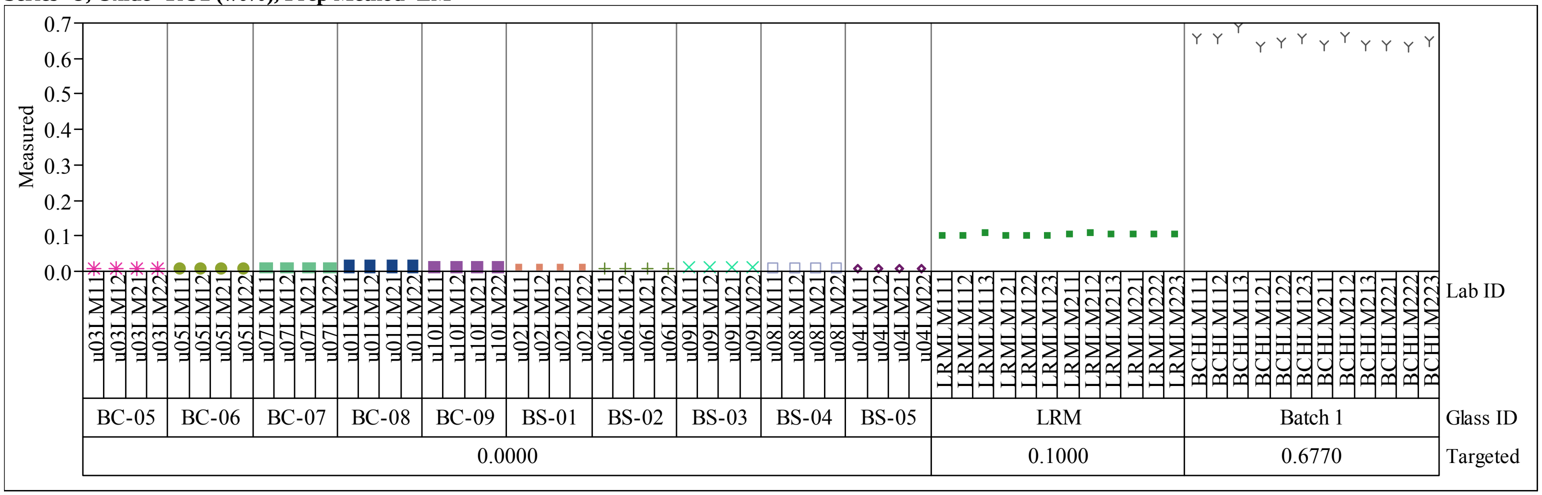
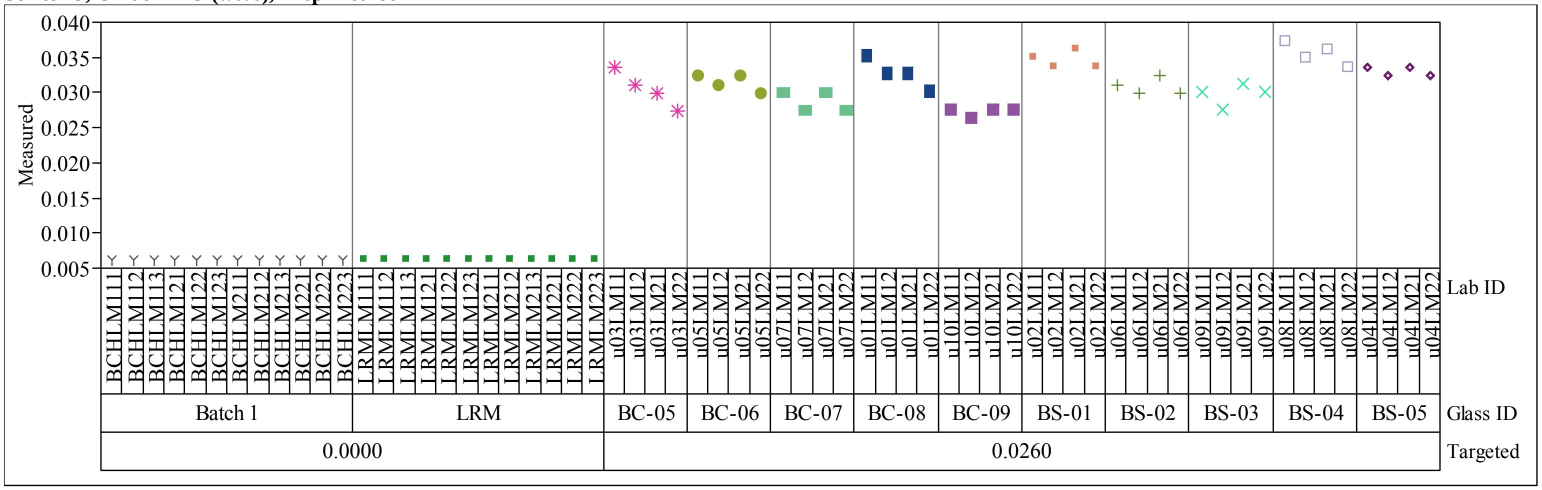


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=U, Oxide=ZnO (wt%), Prep Method=LM



Series=U, Oxide=ZrO2 (wt%), Prep Method=LM

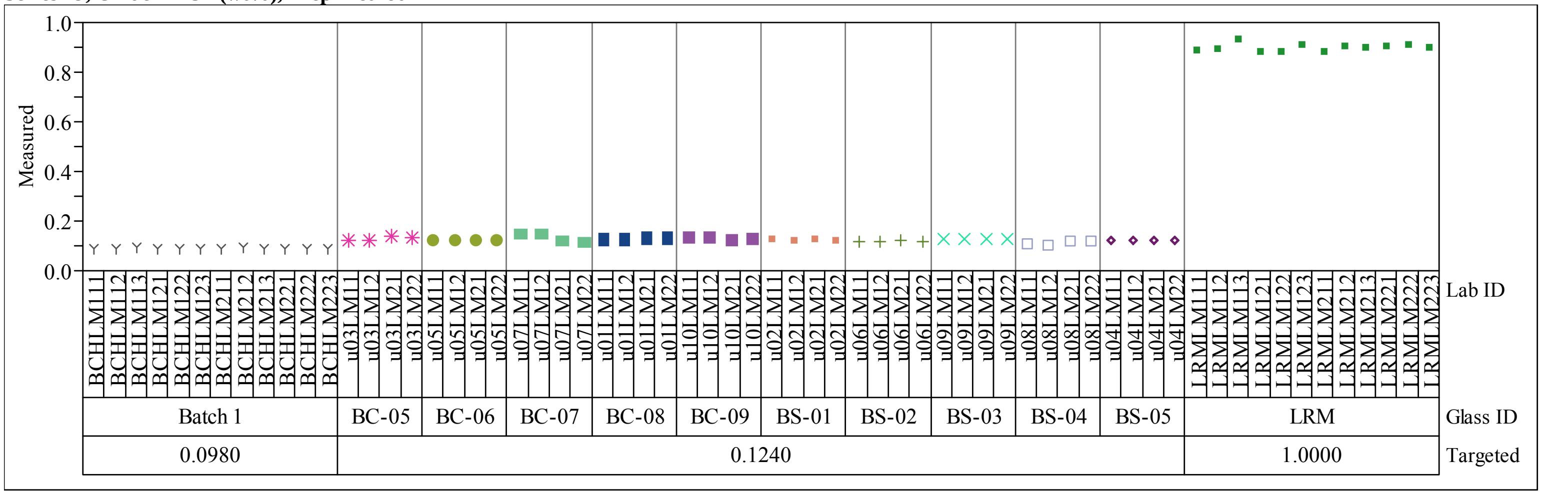
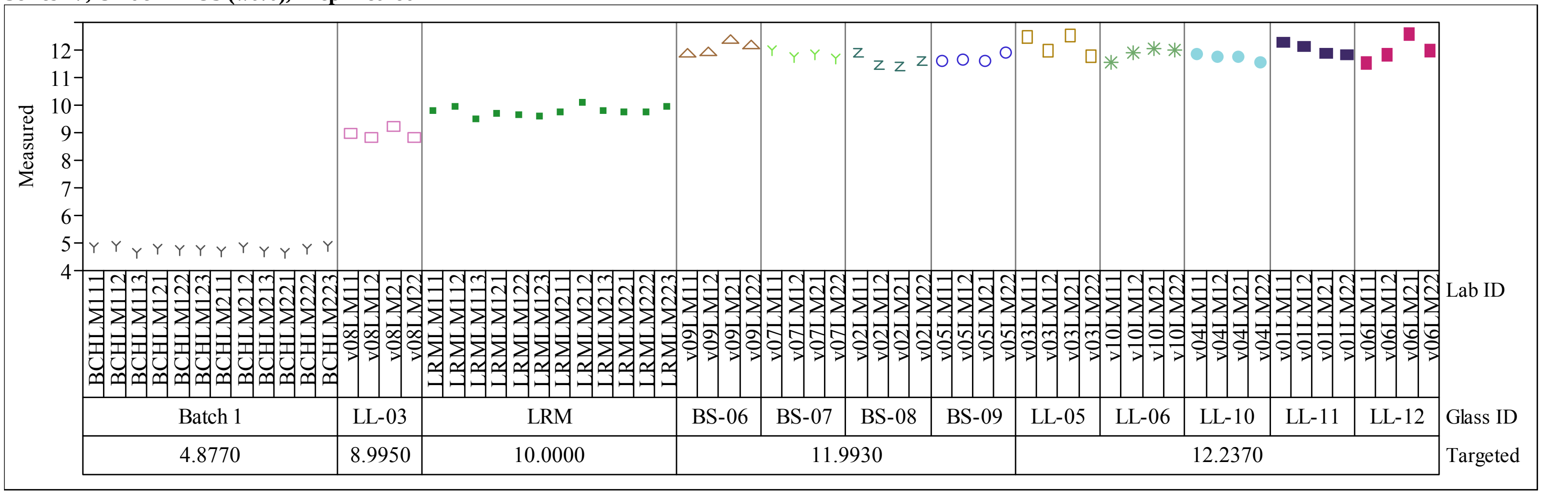


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=V, Oxide=Al2O3 (wt%), Prep Method=LM



Series=V, Oxide=B2O3 (wt%), Prep Method=PF

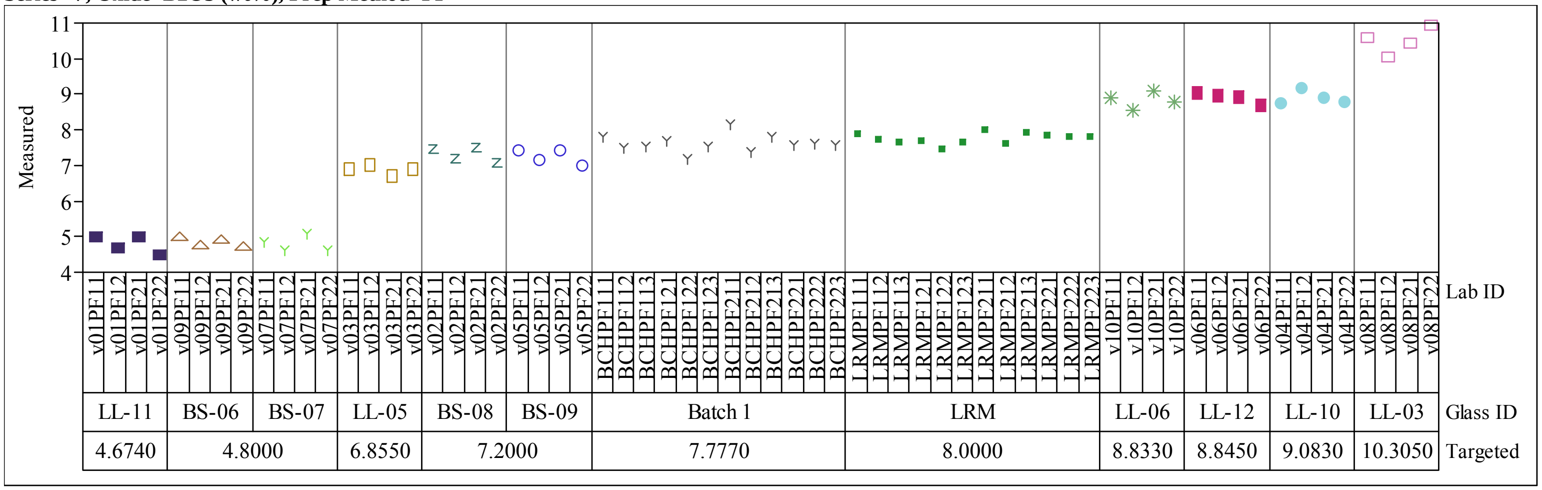
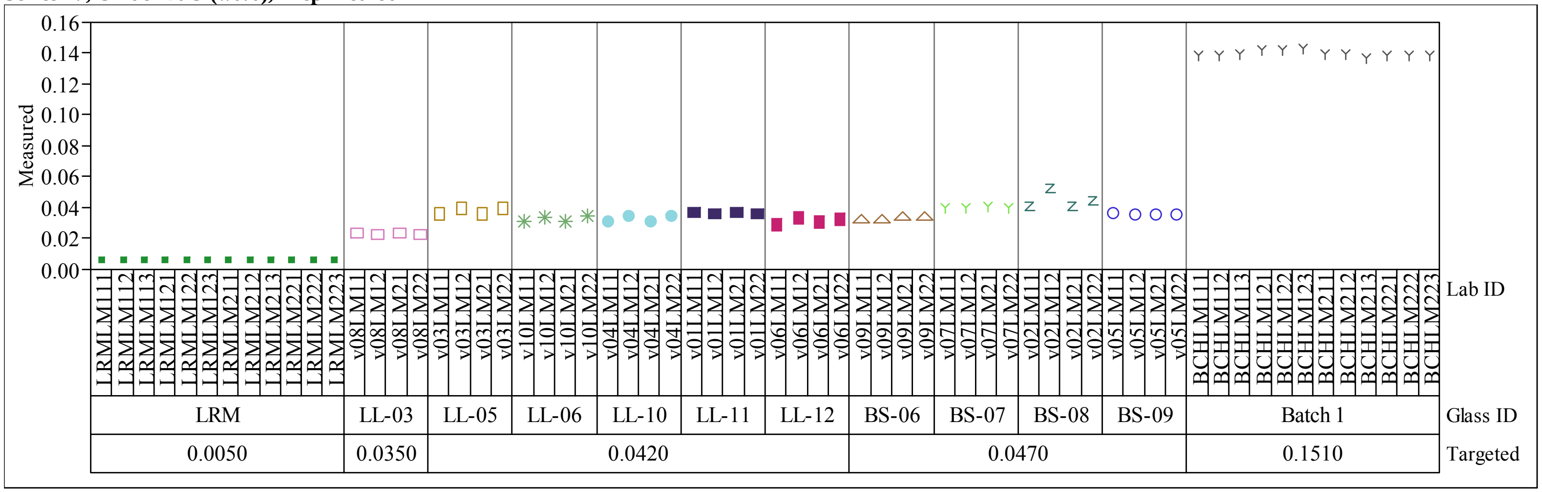


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=V, Oxide=BaO (wt%), Prep Method=LM



Series=V, Oxide=CaO (wt%), Prep Method=LM

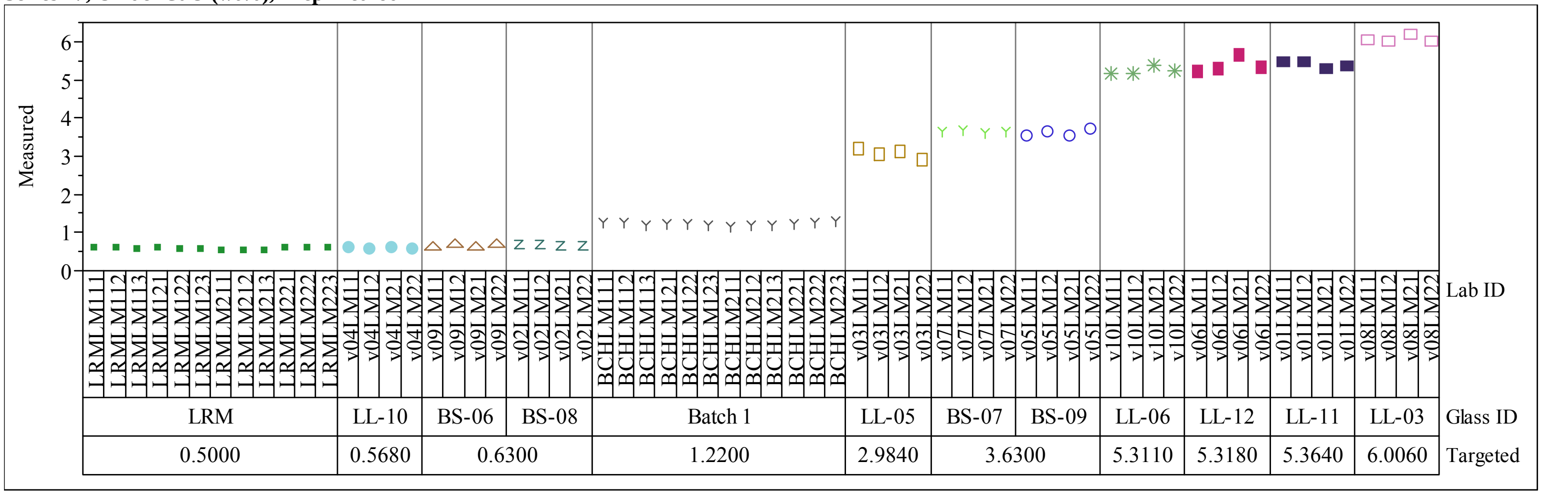
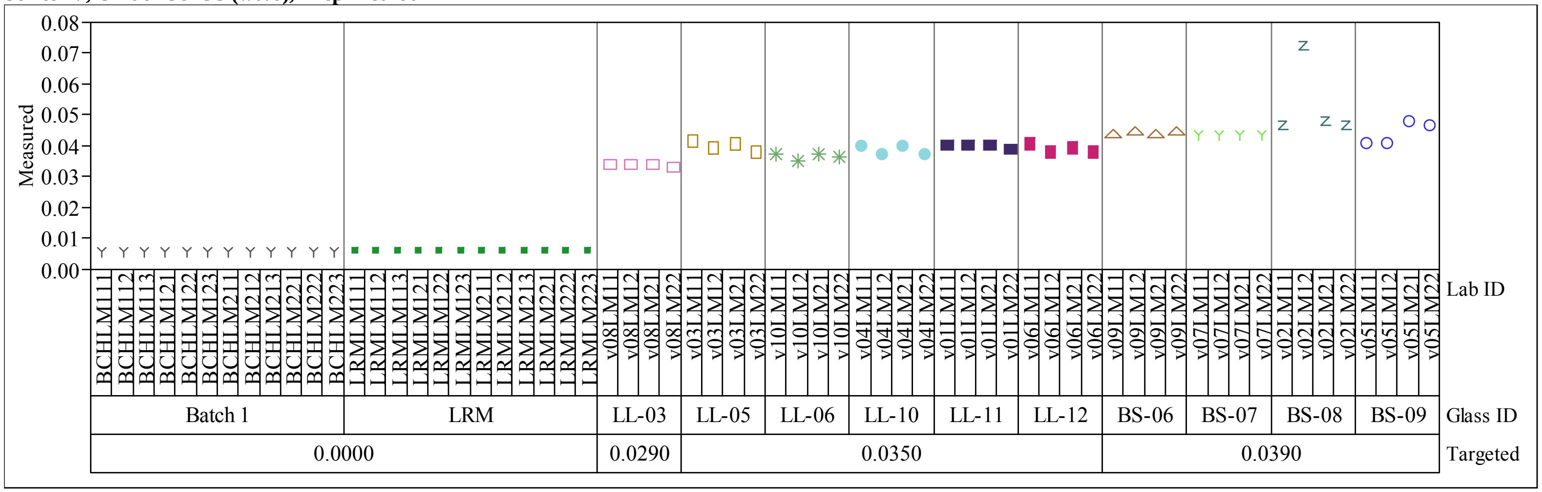


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=V, Oxide=Ce2O3 (wt%), Prep Method=LM



Series=V, Oxide=Cr2O3 (wt%), Prep Method=LM

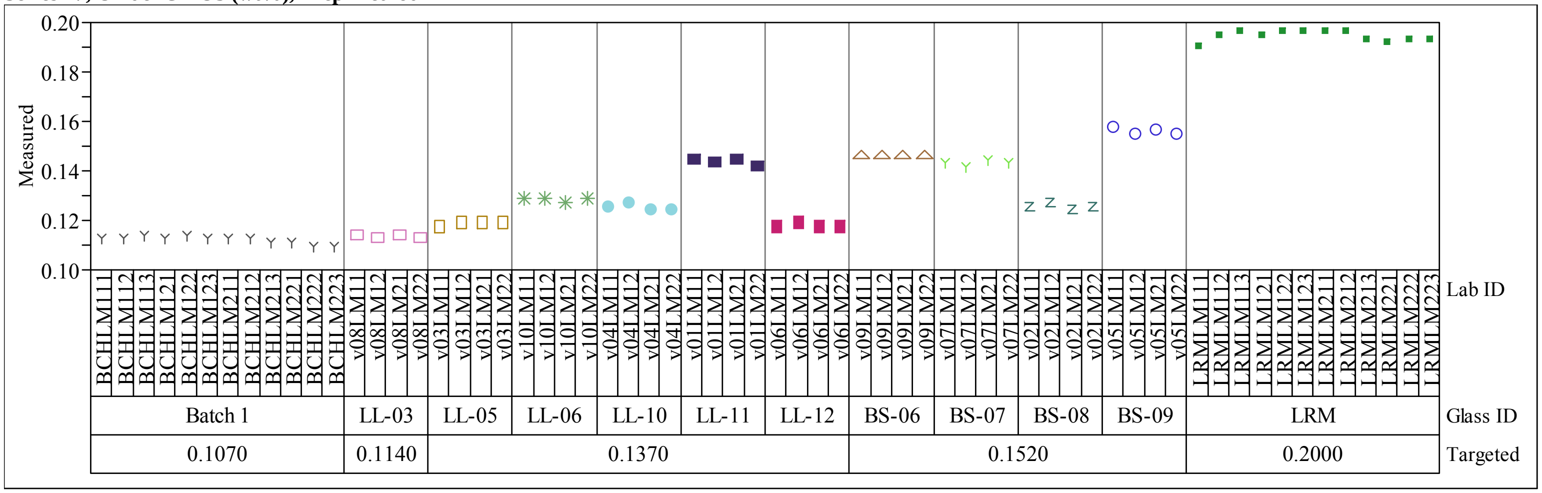
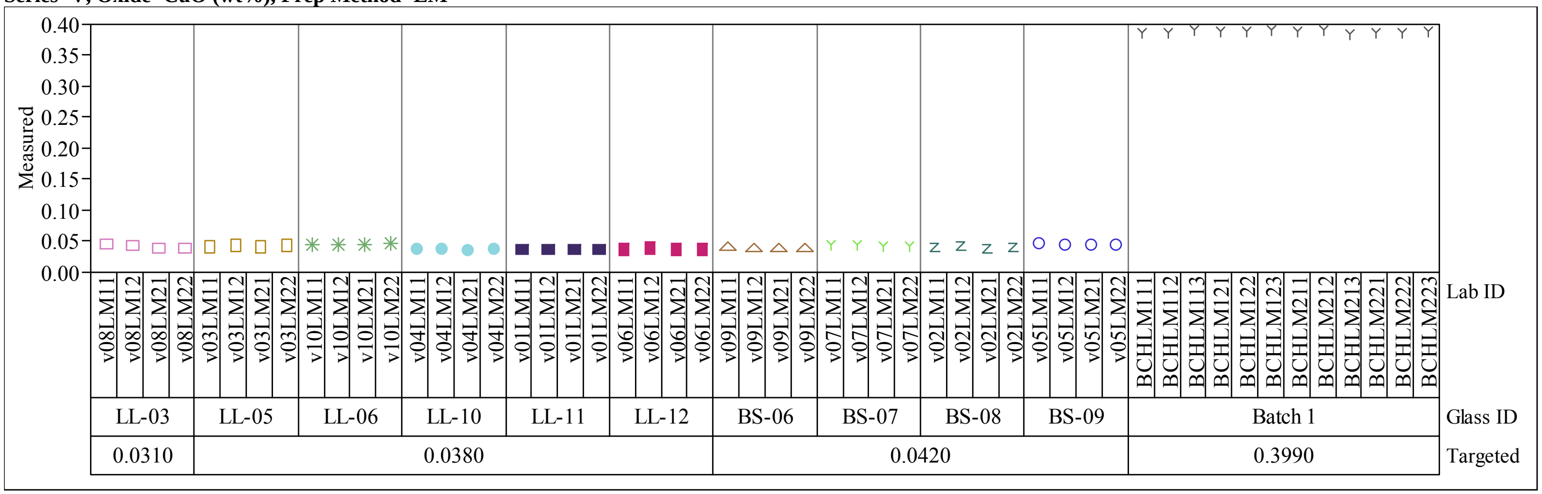


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=V, Oxide=CuO (wt%), Prep Method=LM



Series=V, Oxide=Fe2O3 (wt%), Prep Method=LM

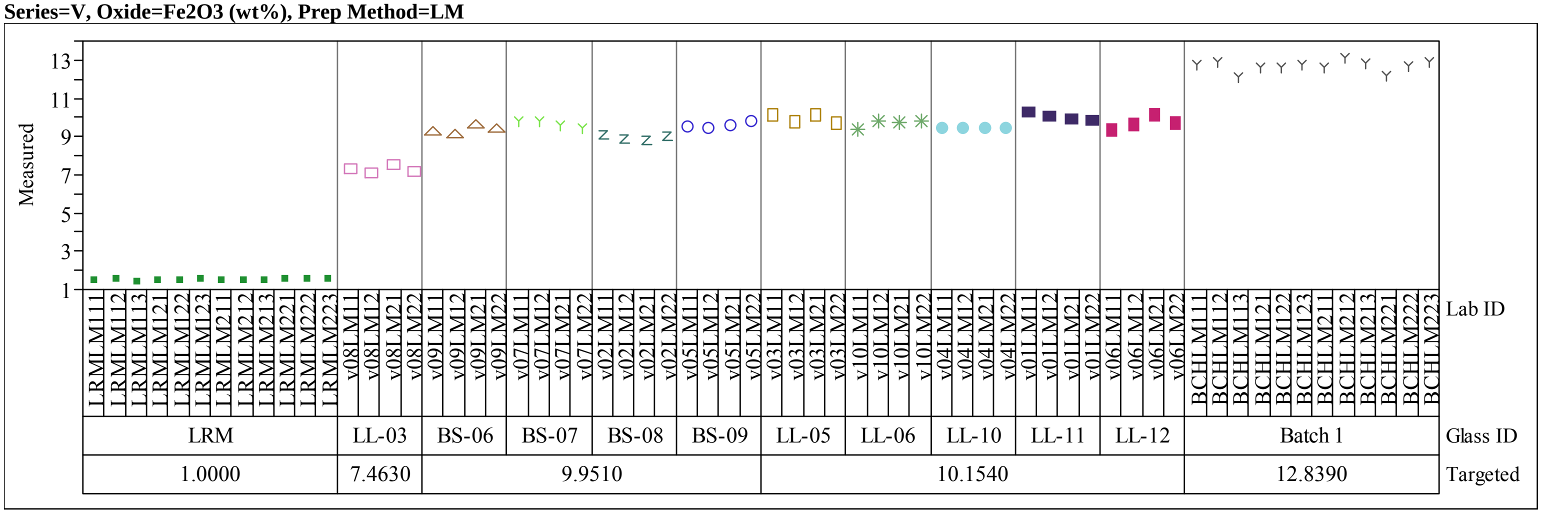
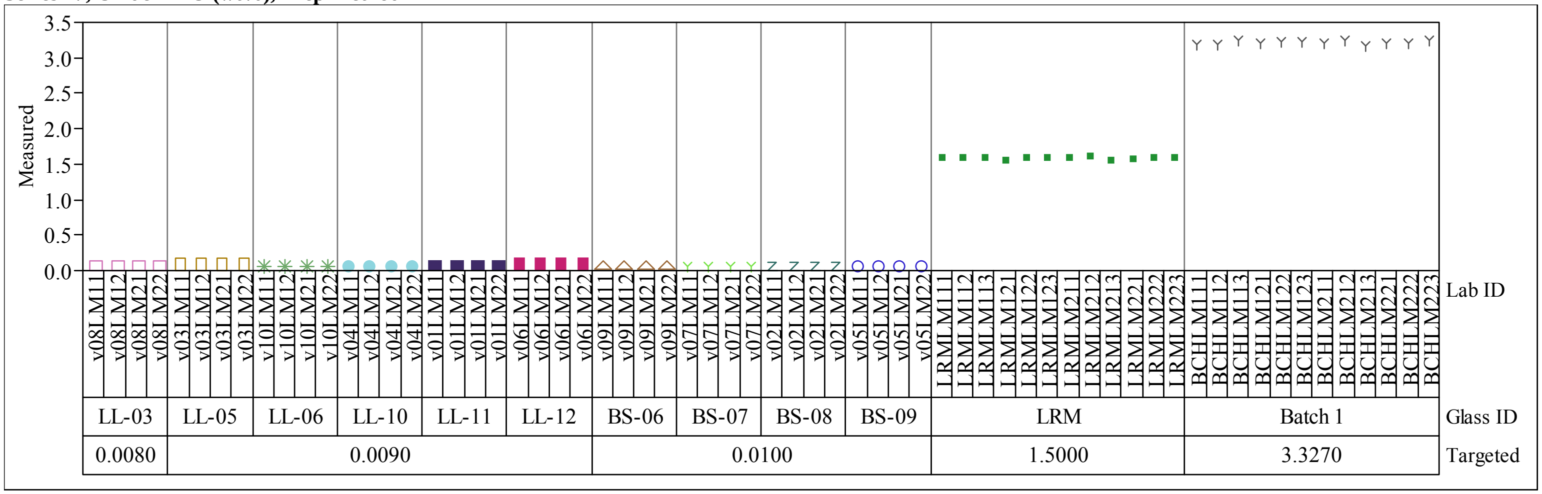


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=V, Oxide=K2O (wt%), Prep Method=LM



Series=V, Oxide=La2O3 (wt%), Prep Method=LM

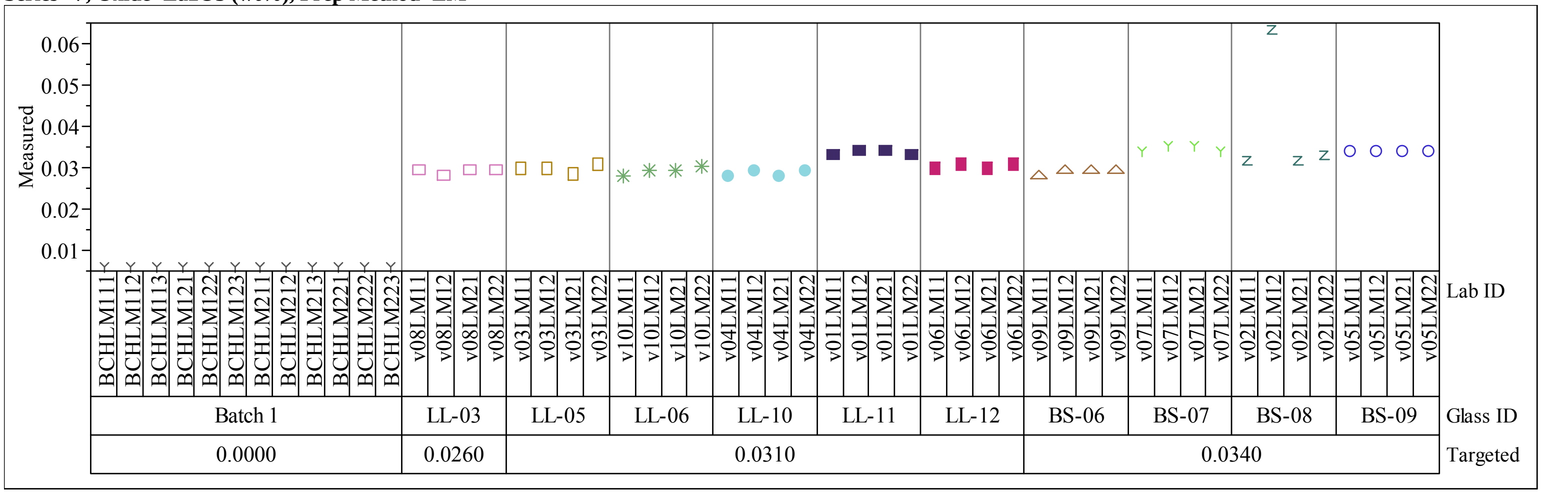
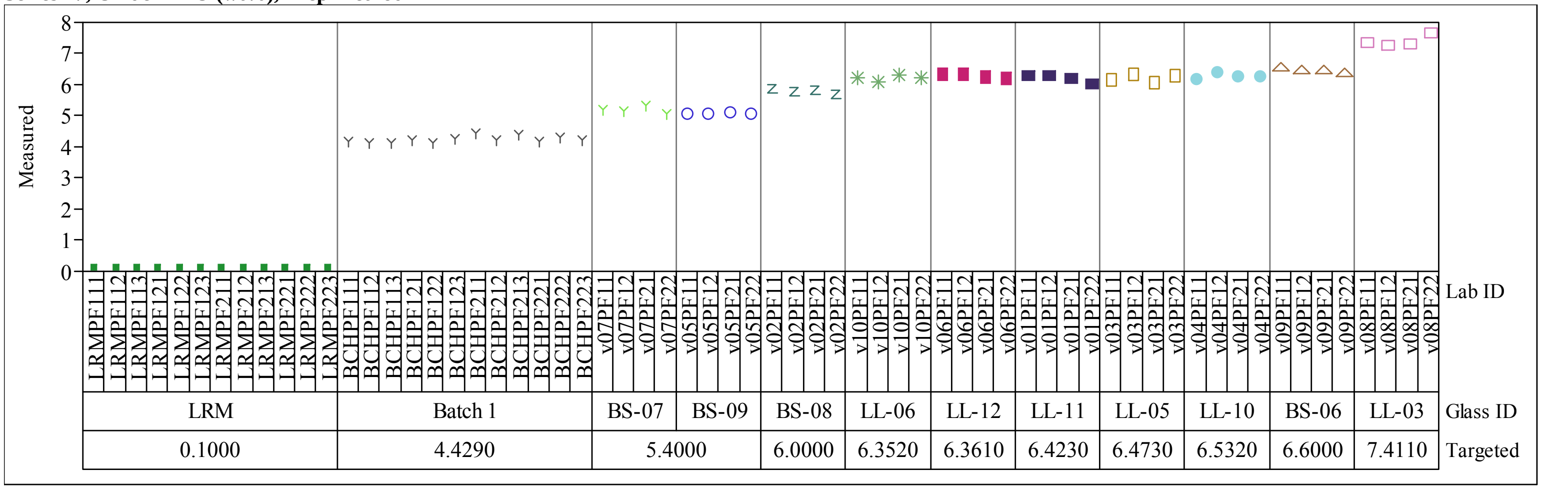


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=V, Oxide=Li2O (wt%), Prep Method=PF



Series=V, Oxide=MgO (wt%), Prep Method=LM

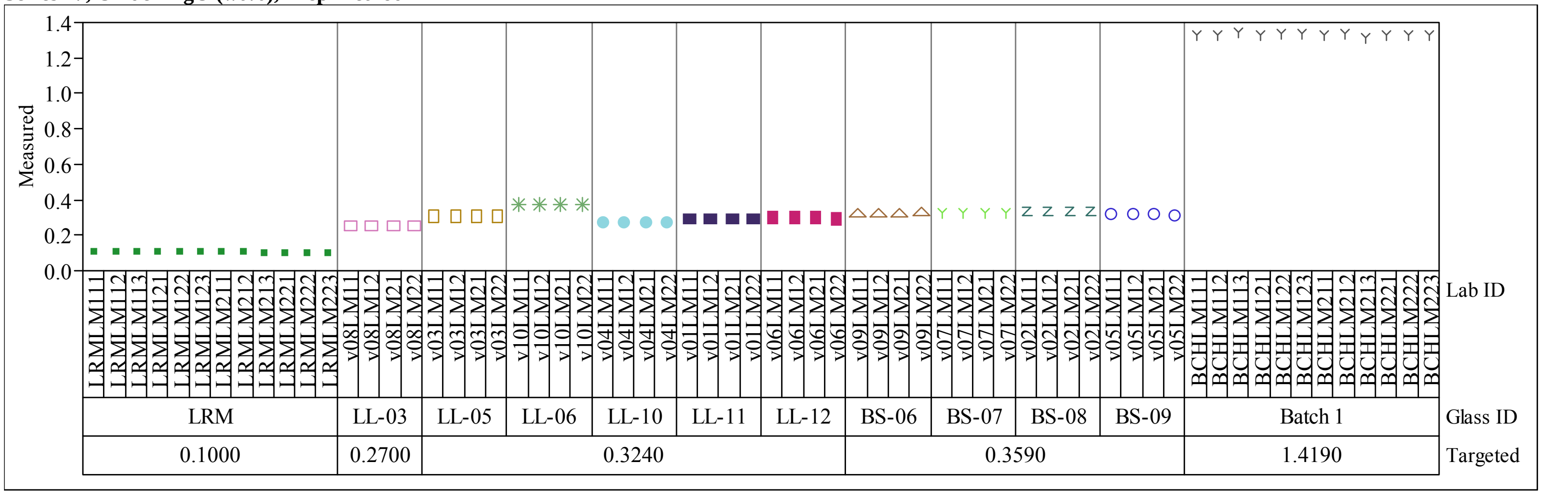
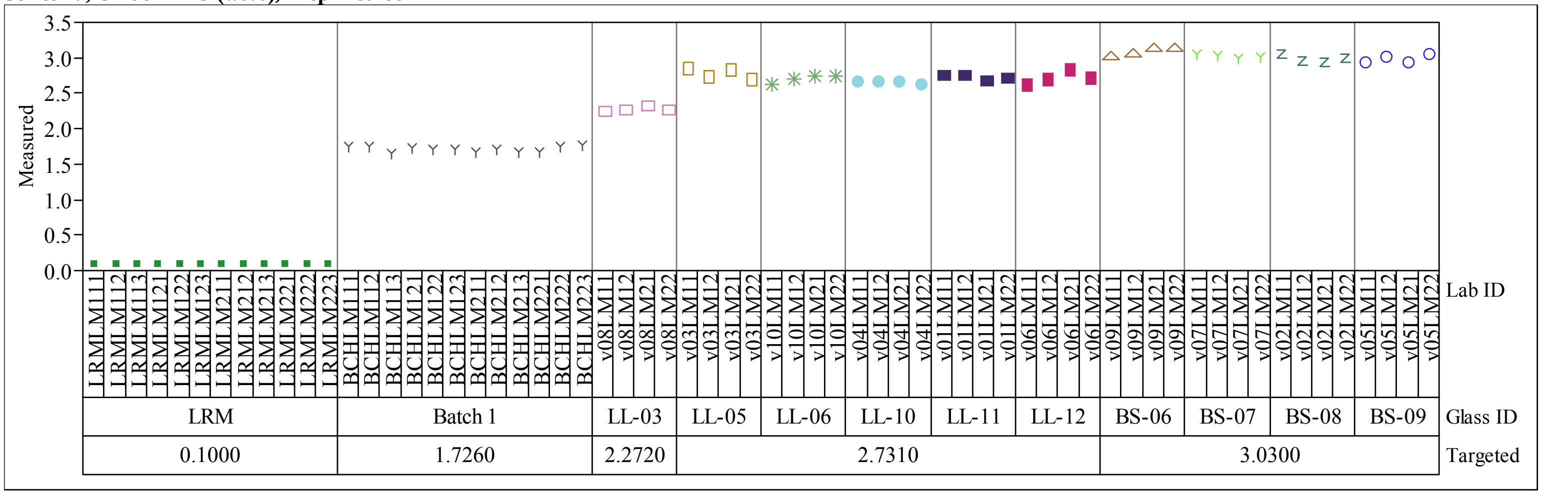


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=V, Oxide=MnO (wt%), Prep Method=LM



Series=V, Oxide=Na2O (wt%), Prep Method=LM

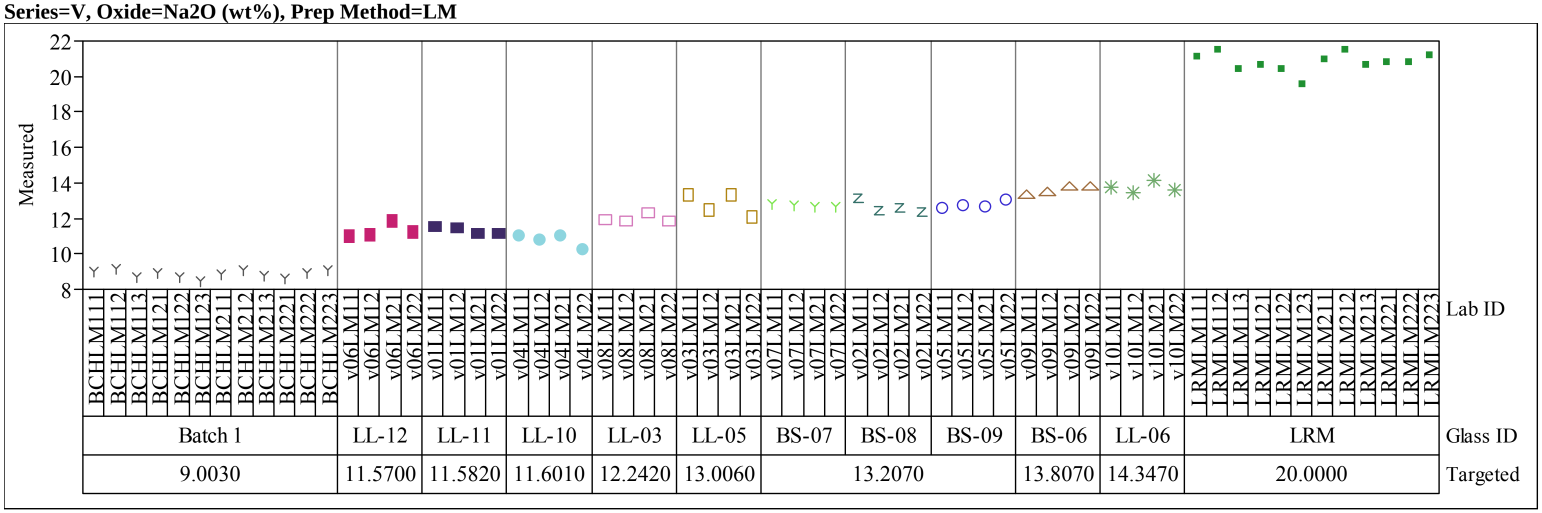
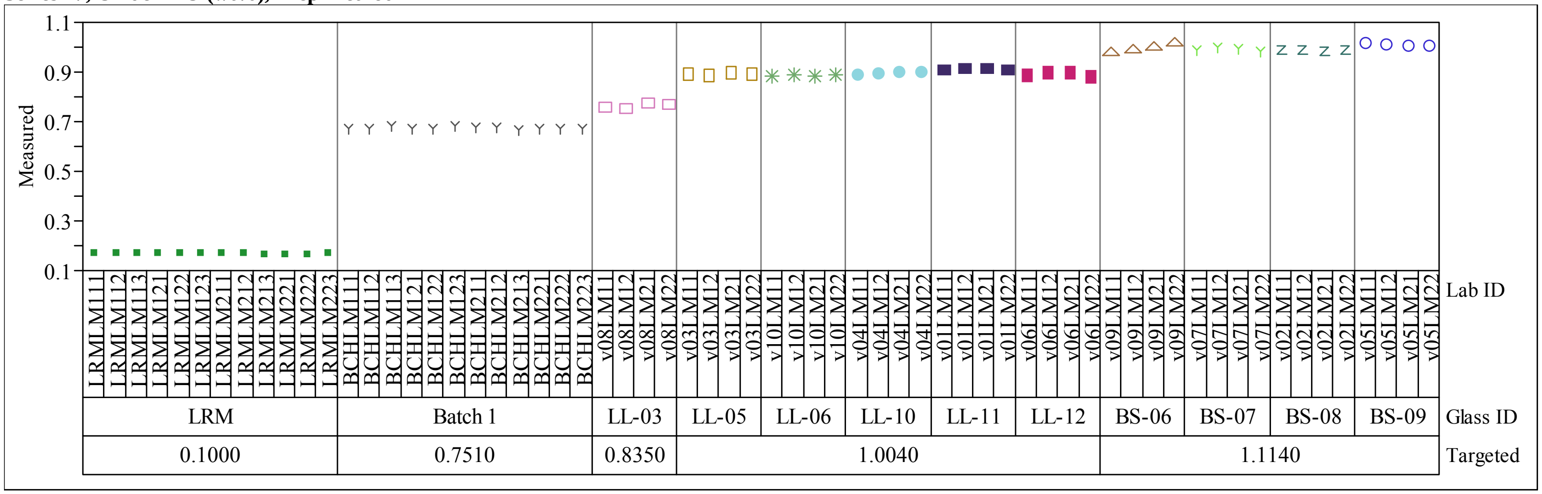


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=V, Oxide=NiO (wt%), Prep Method=LM



Series=V, Oxide=PbO (wt%), Prep Method=LM

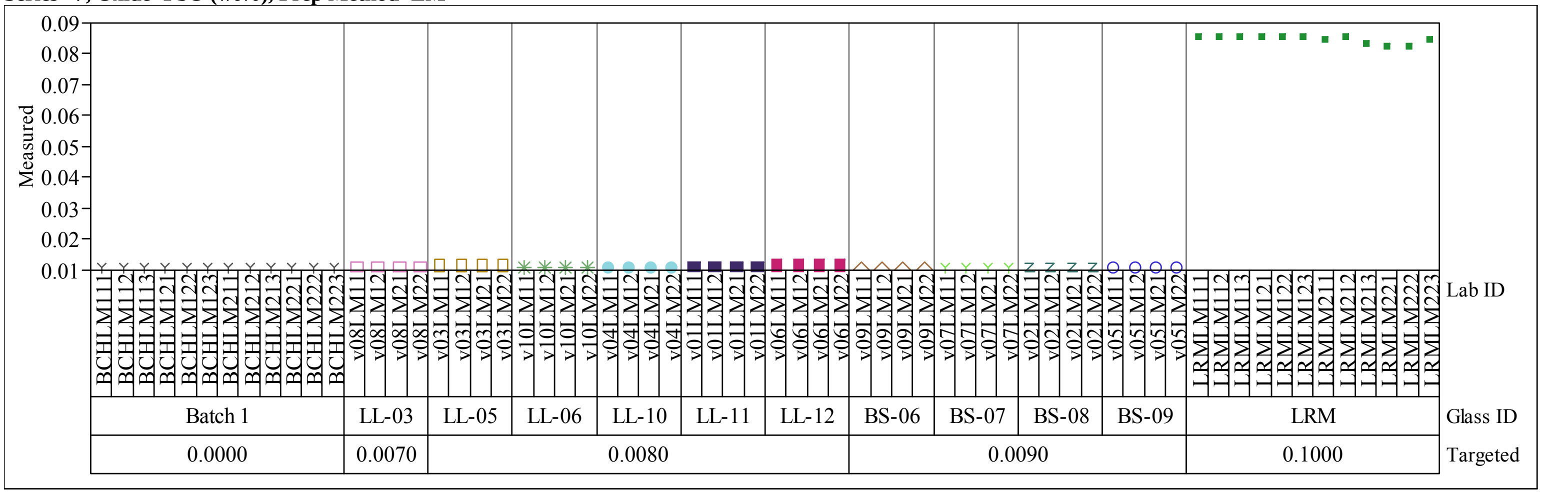
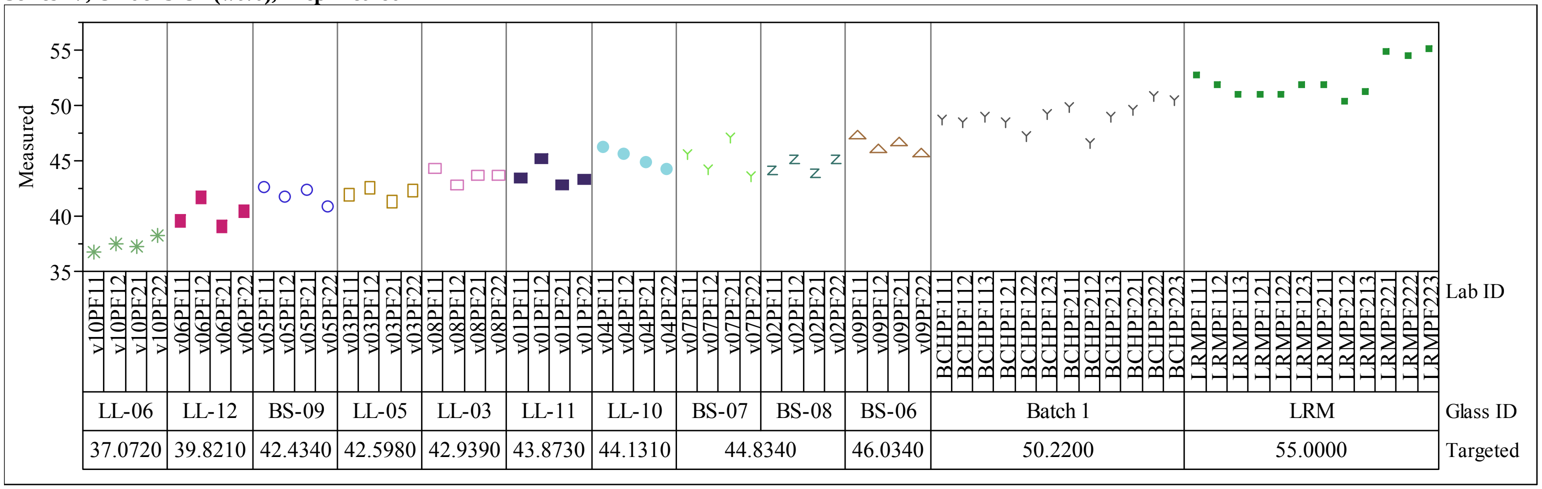


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=V, Oxide=SiO2 (wt%), Prep Method=PF



Series=V, Oxide=SO4 (wt%), Prep Method=LM

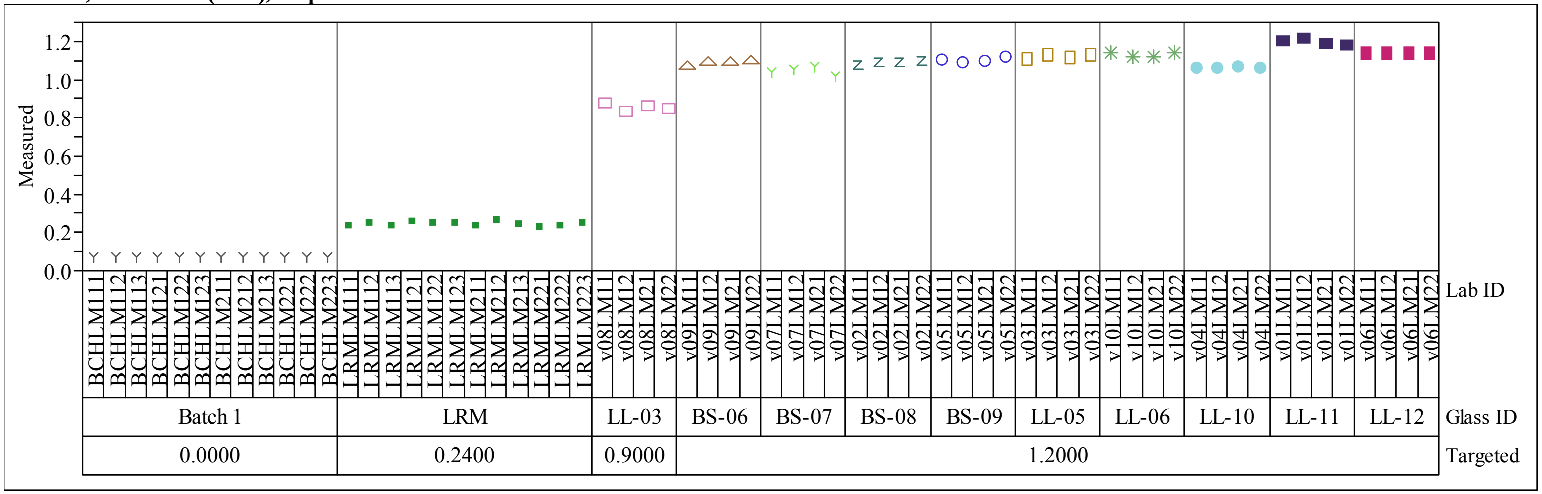
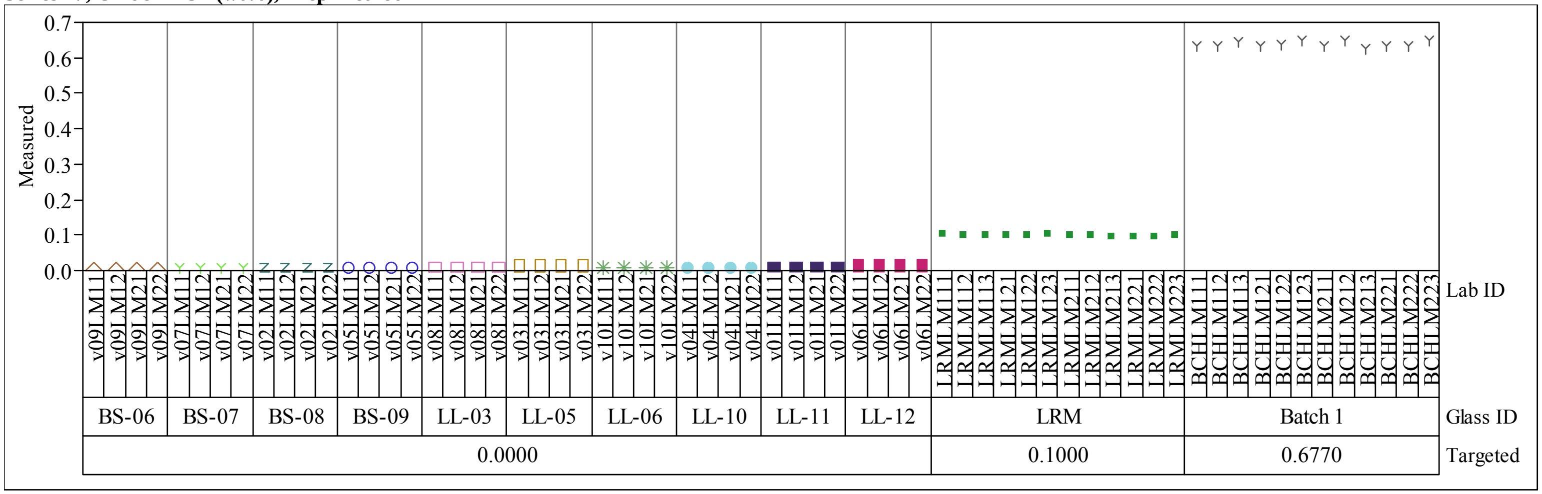


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=V, Oxide=TiO2 (wt%), Prep Method=LM



Series=V, Oxide=ZnO (wt%), Prep Method=LM

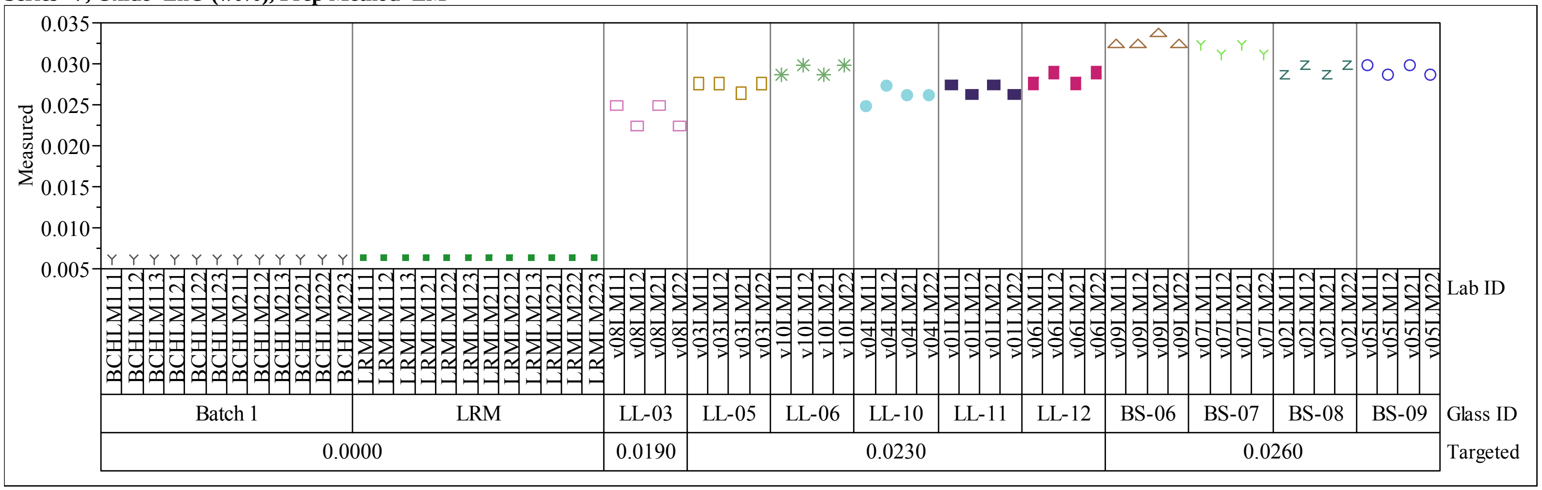
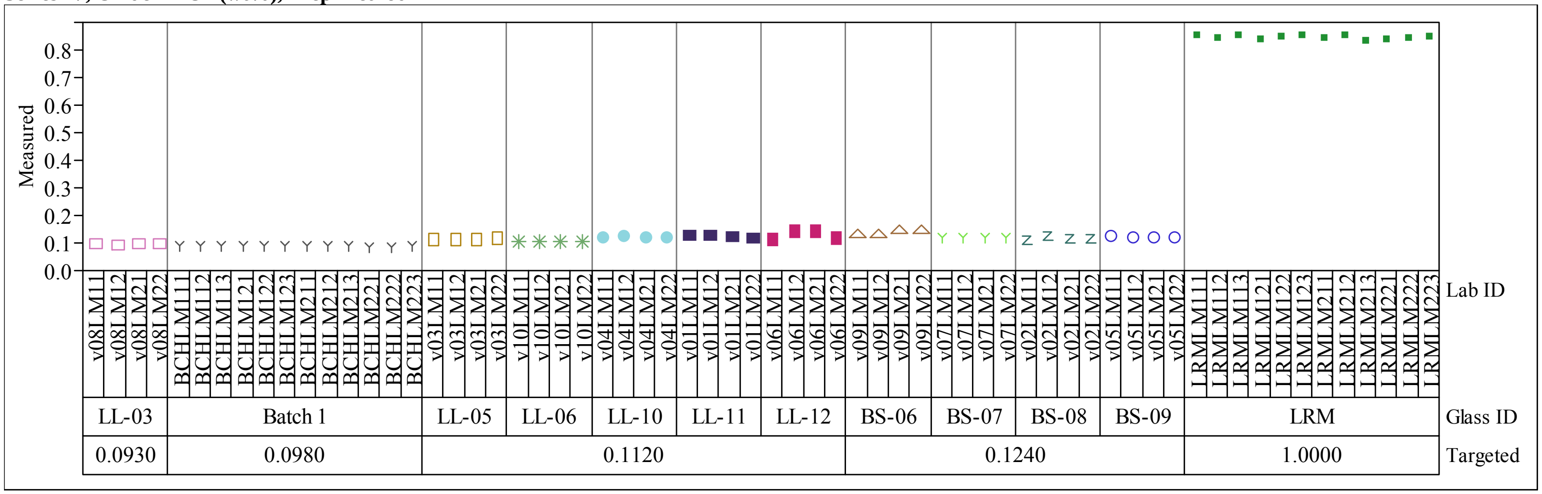


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=V, Oxide=ZrO2 (wt%), Prep Method=LM



Series=W, Oxide=Al2O3 (wt%), Prep Method=LM

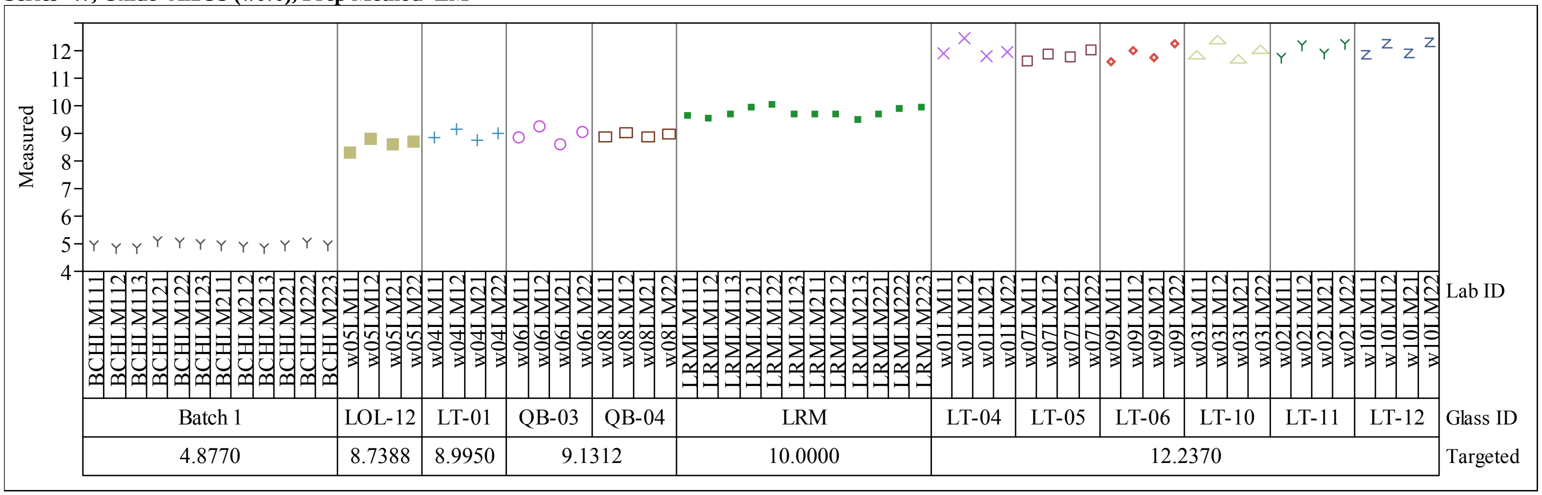
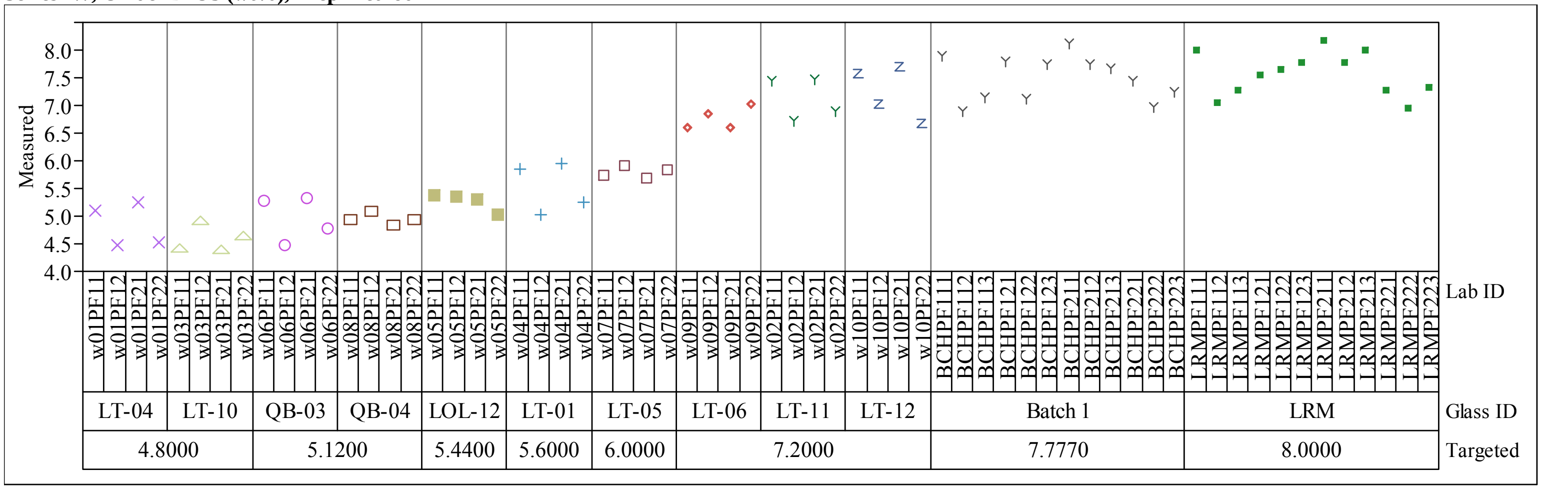


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=W, Oxide=B2O3 (wt%), Prep Method=PF



Series=W, Oxide=BaO (wt%), Prep Method=LM

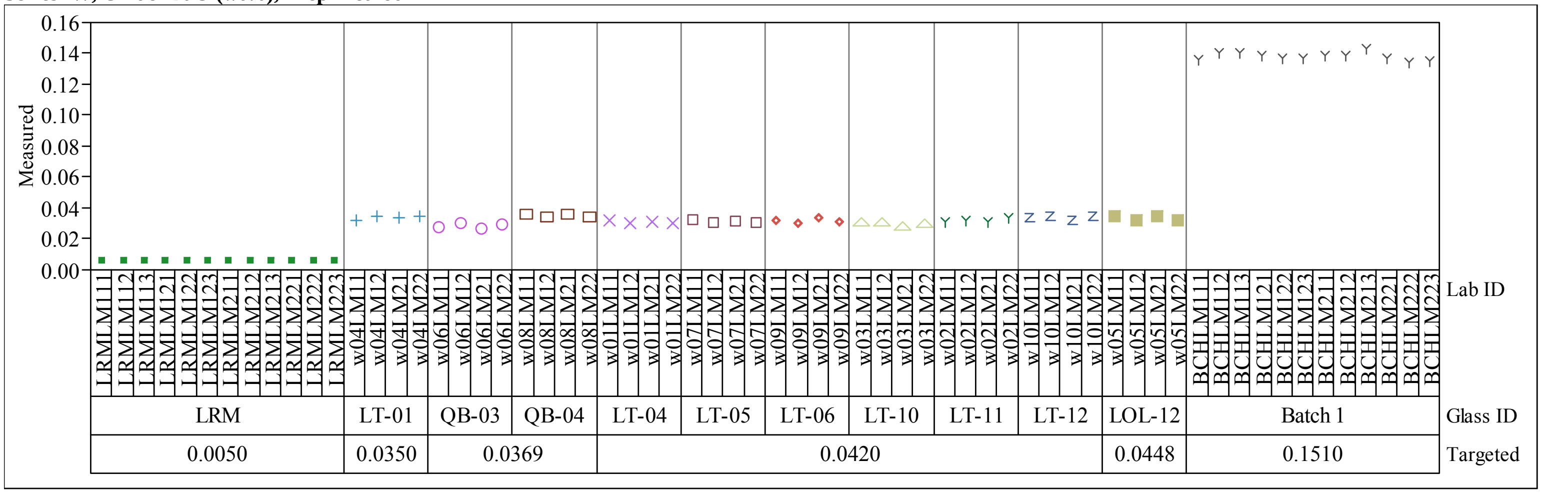
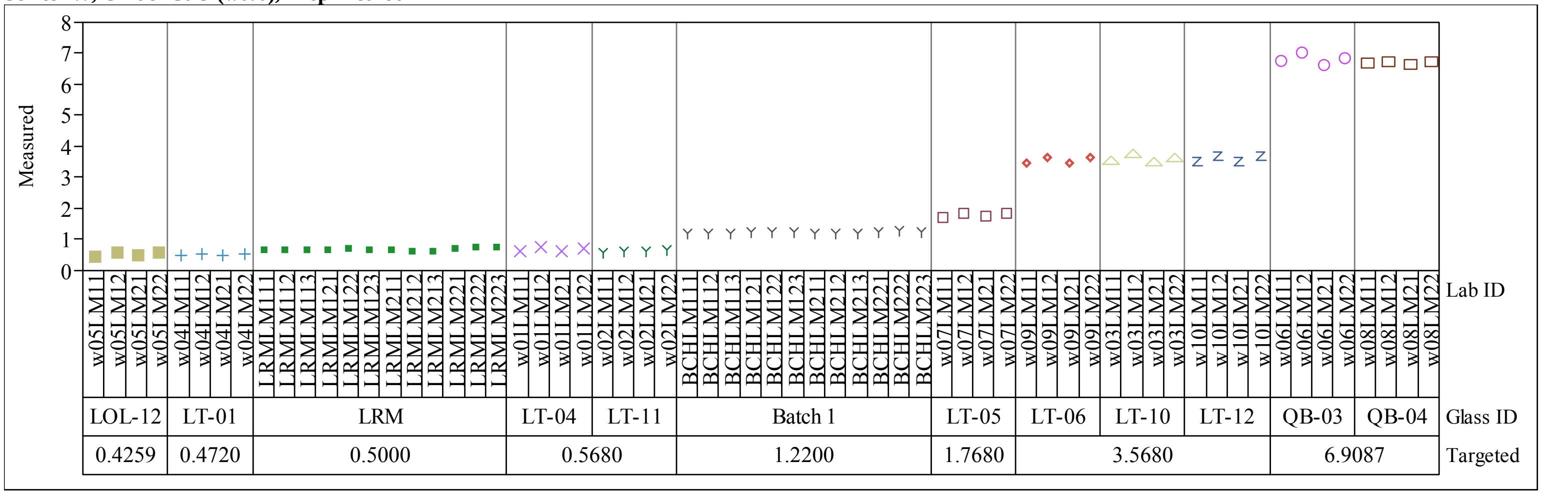


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=W, Oxide=CaO (wt%), Prep Method=LM



Series=W, Oxide=Ce2O3 (wt%), Prep Method=LM

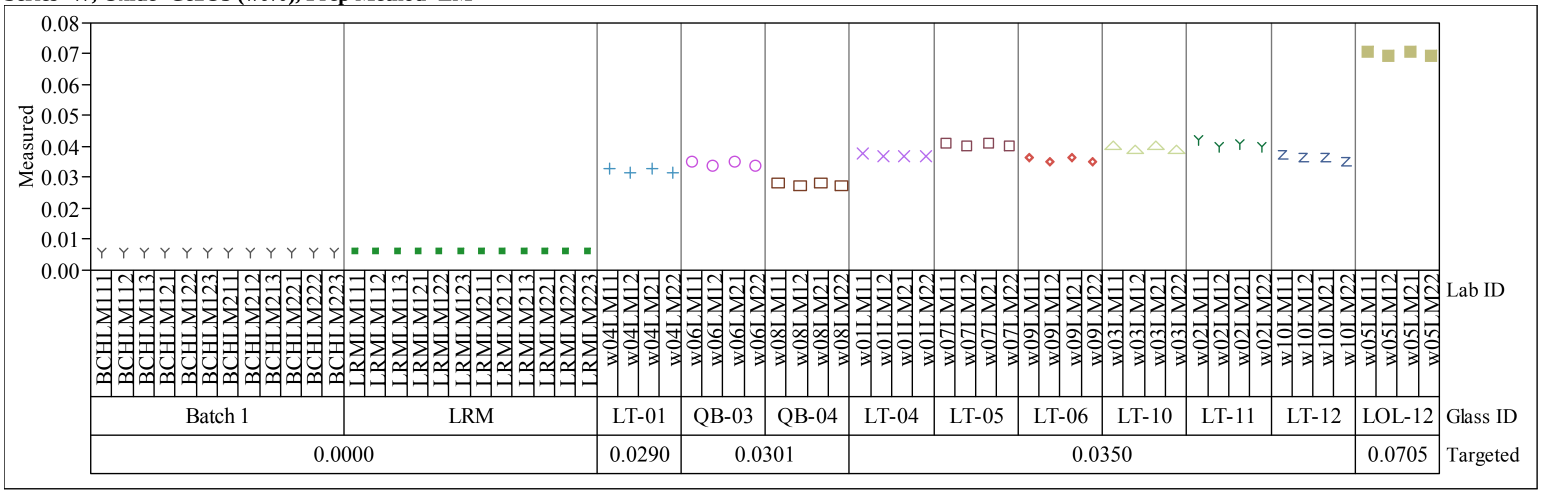
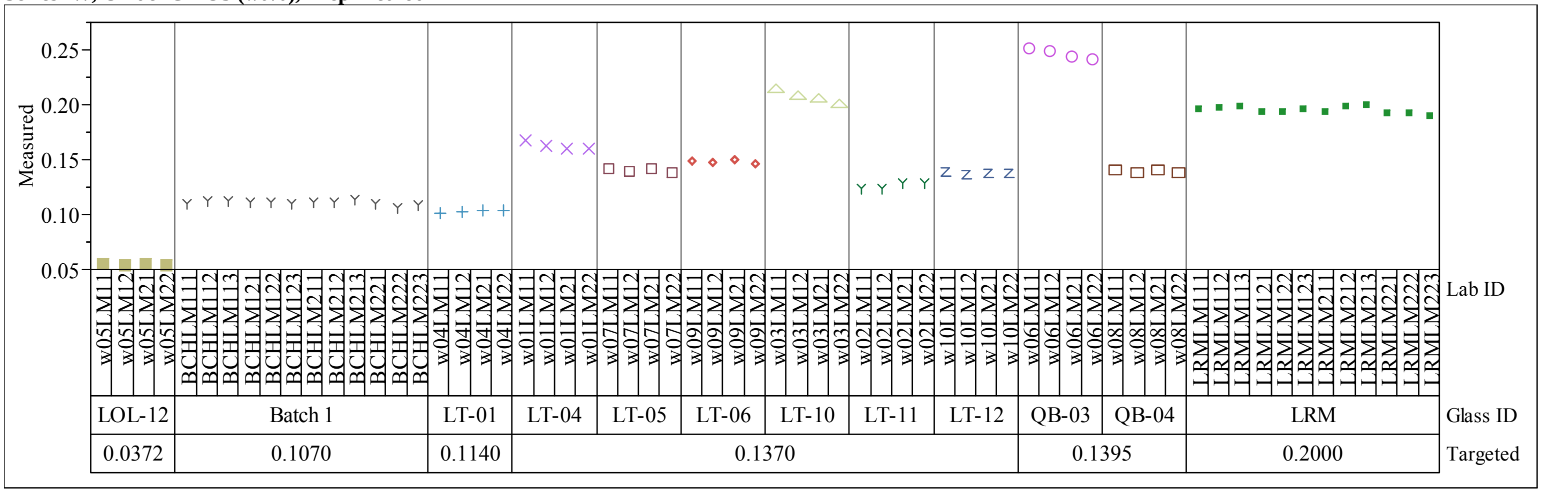


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=W, Oxide=Cr2O3 (wt%), Prep Method=LM



Series=W, Oxide=CuO (wt%), Prep Method=LM

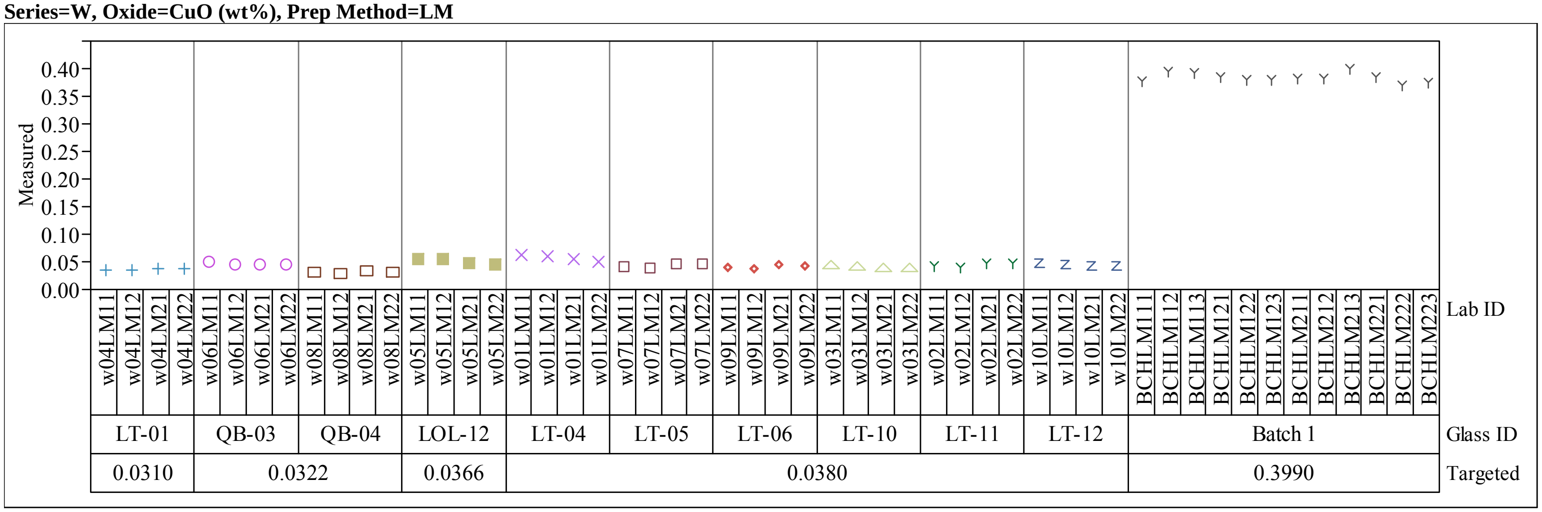
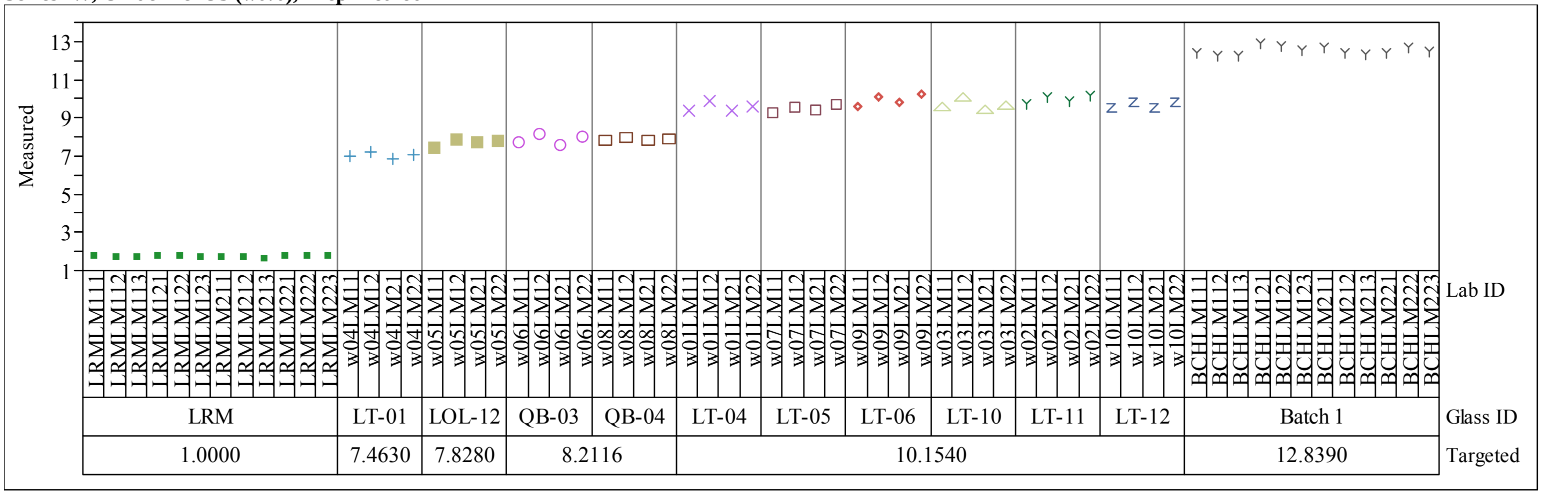


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=W, Oxide=Fe2O3 (wt%), Prep Method=LM



Series=W, Oxide=K2O (wt%), Prep Method=LM

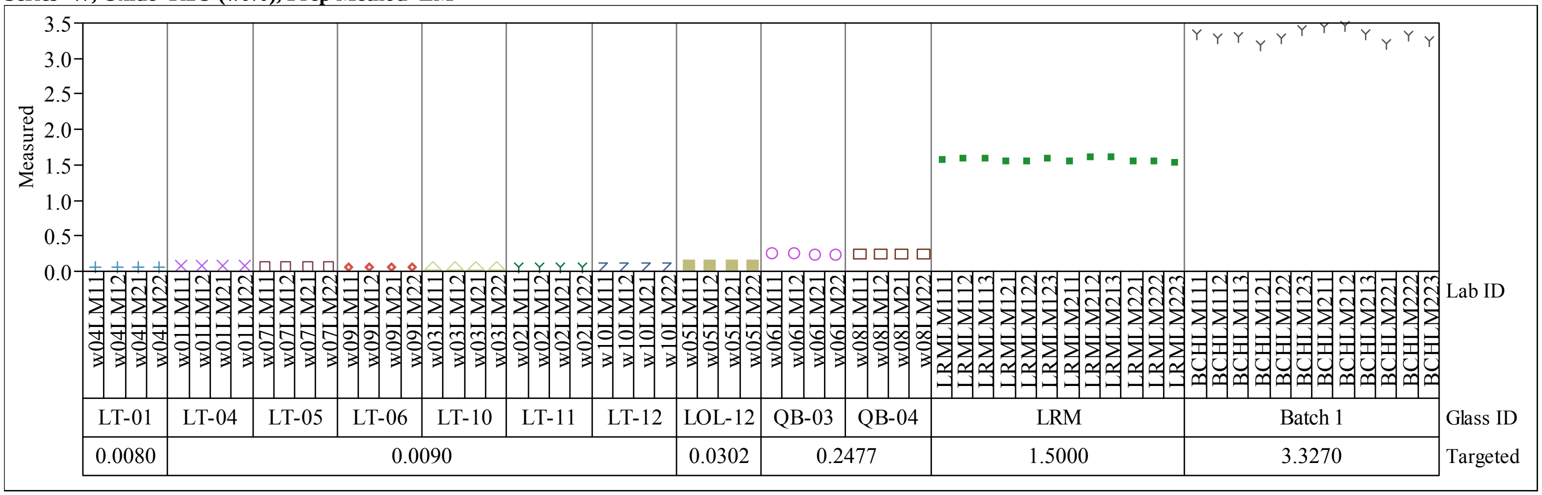
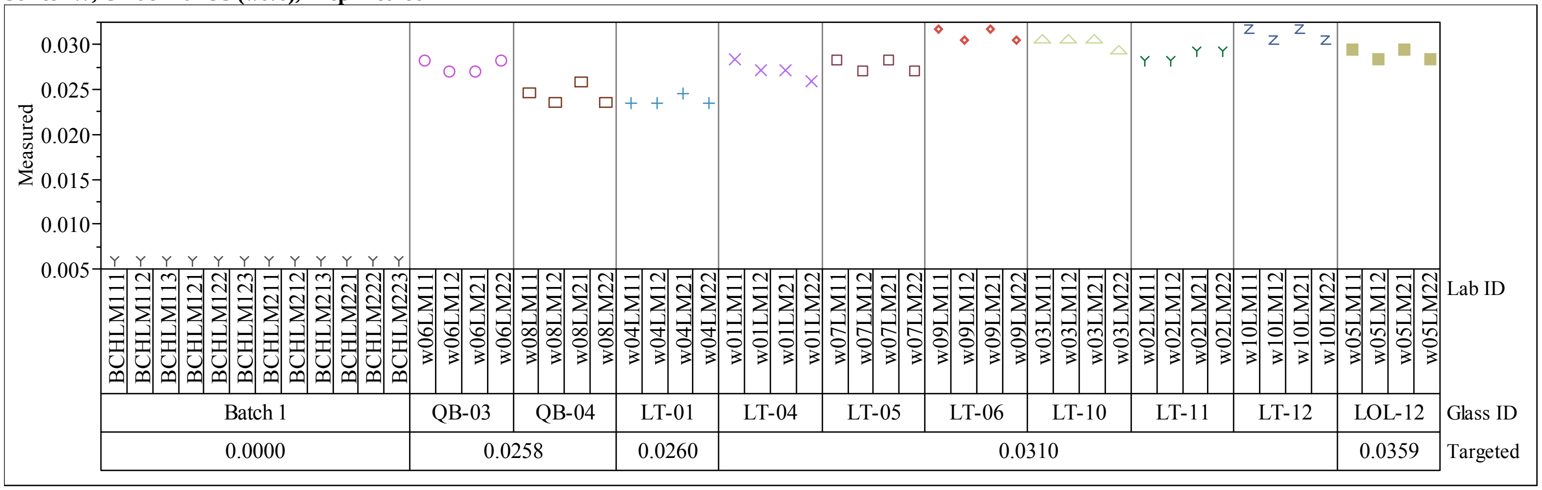


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=W, Oxide=La2O3 (wt%), Prep Method=LM



Series=W, Oxide=Li2O (wt%), Prep Method=PF

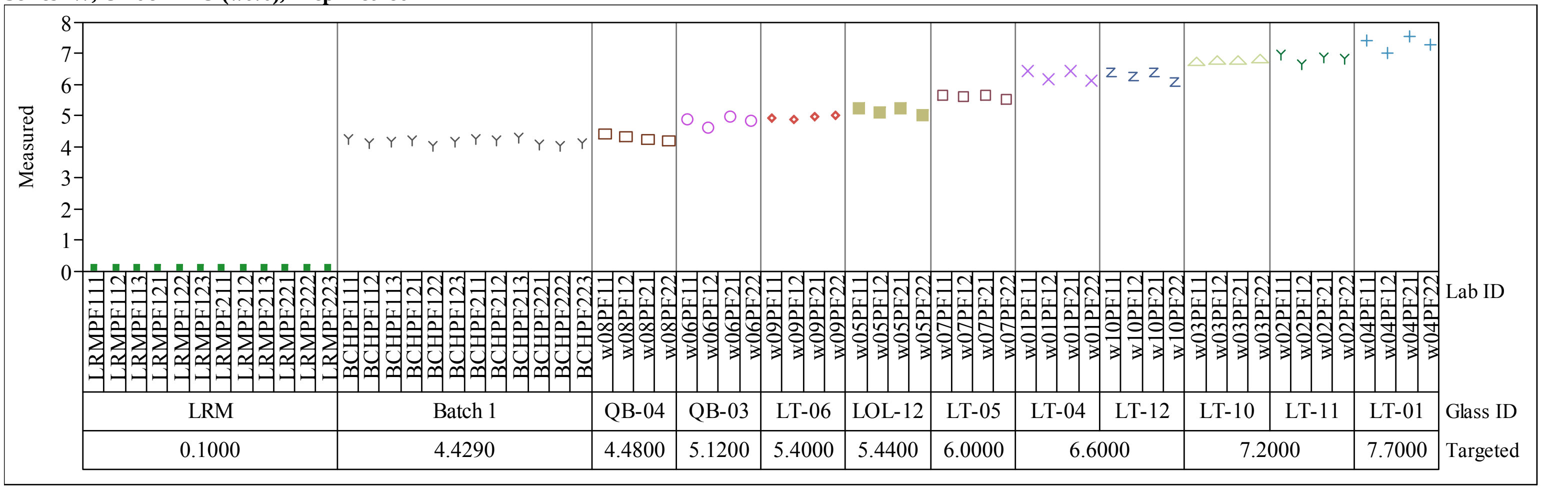
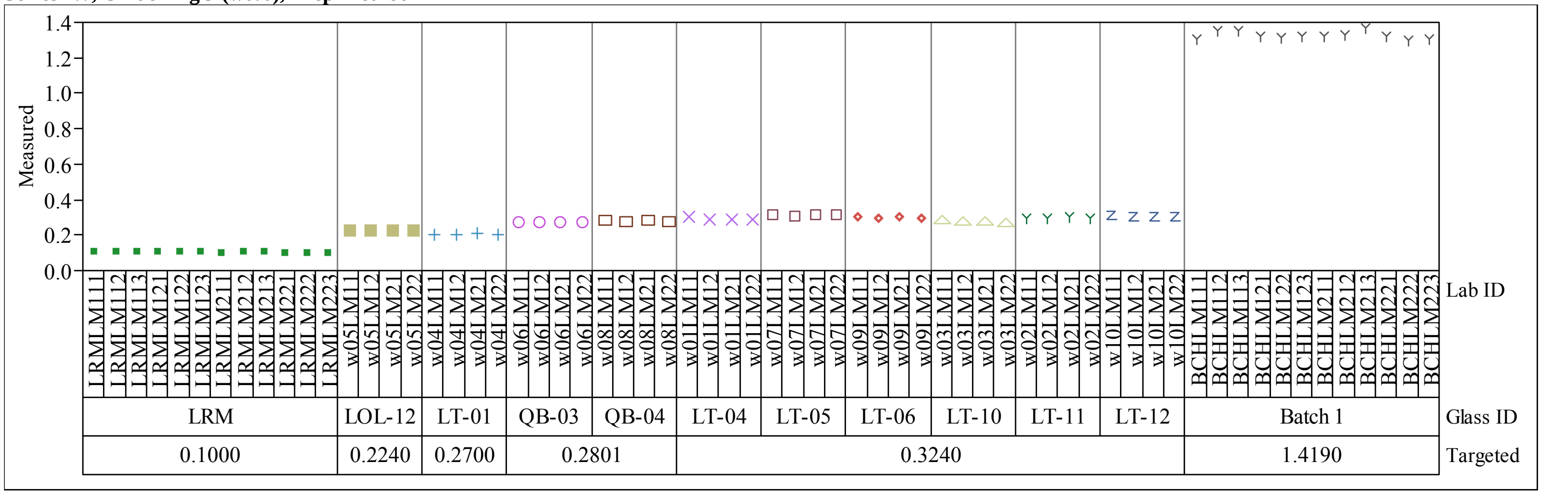


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=W, Oxide=MgO (wt%), Prep Method=LM



Series=W, Oxide=MnO (wt%), Prep Method=LM

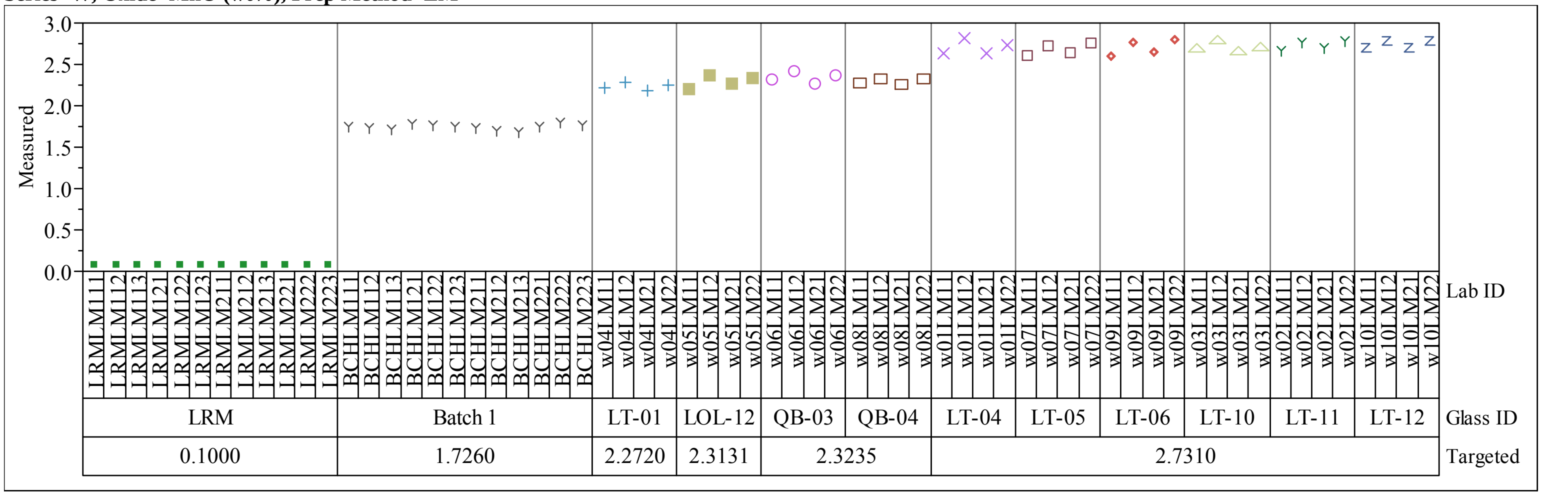
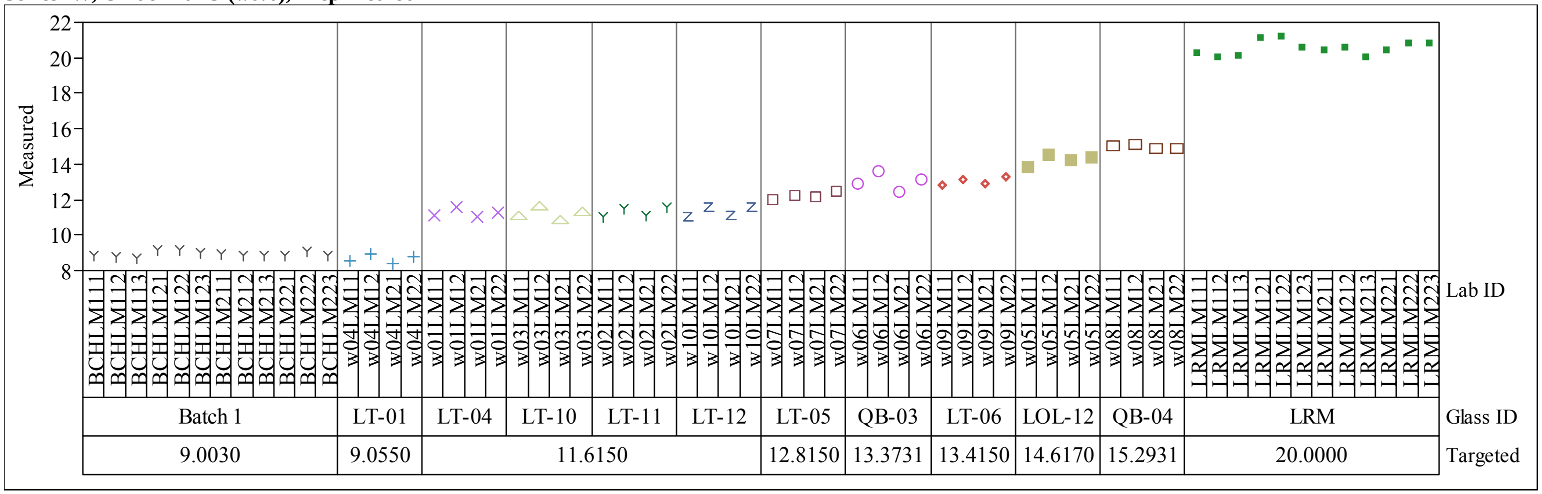


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=W, Oxide=Na2O (wt%), Prep Method=LM



Series=W, Oxide=NiO (wt%), Prep Method=LM

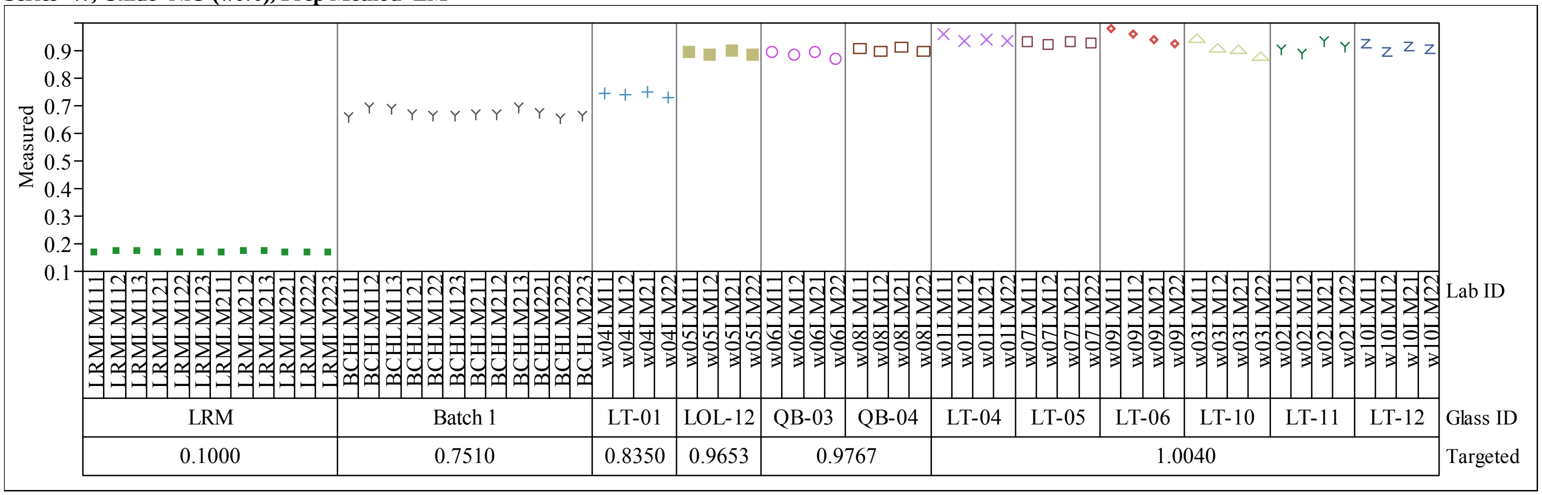
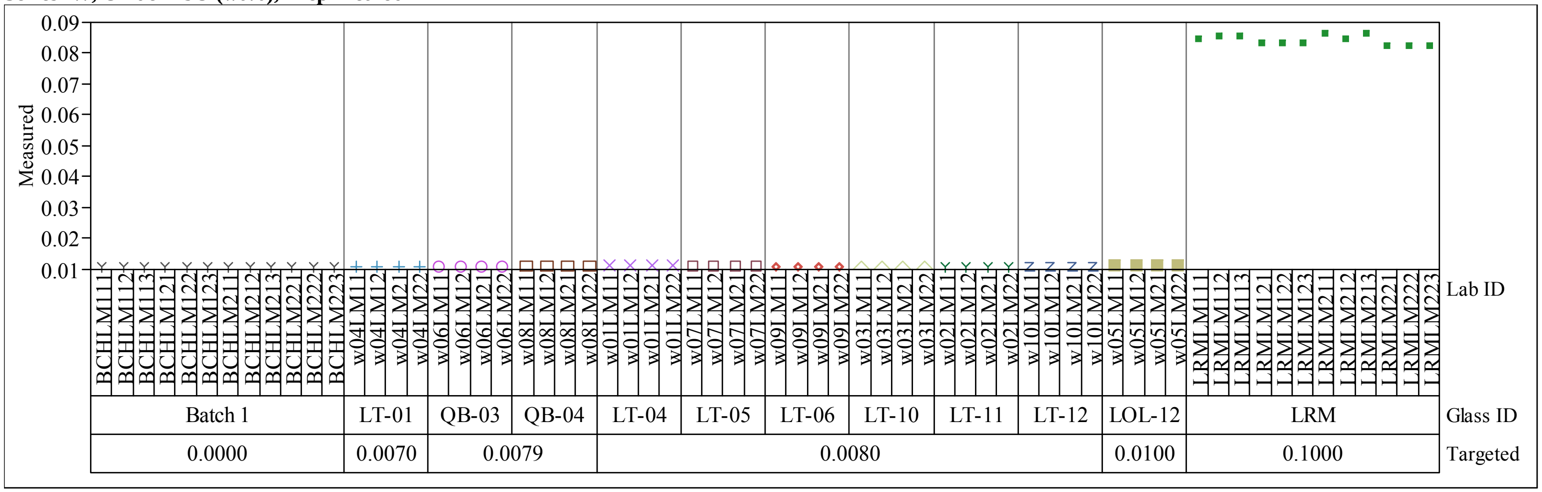


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=W, Oxide=PbO (wt%), Prep Method=LM



Series=W, Oxide=SiO2 (wt%), Prep Method=PF

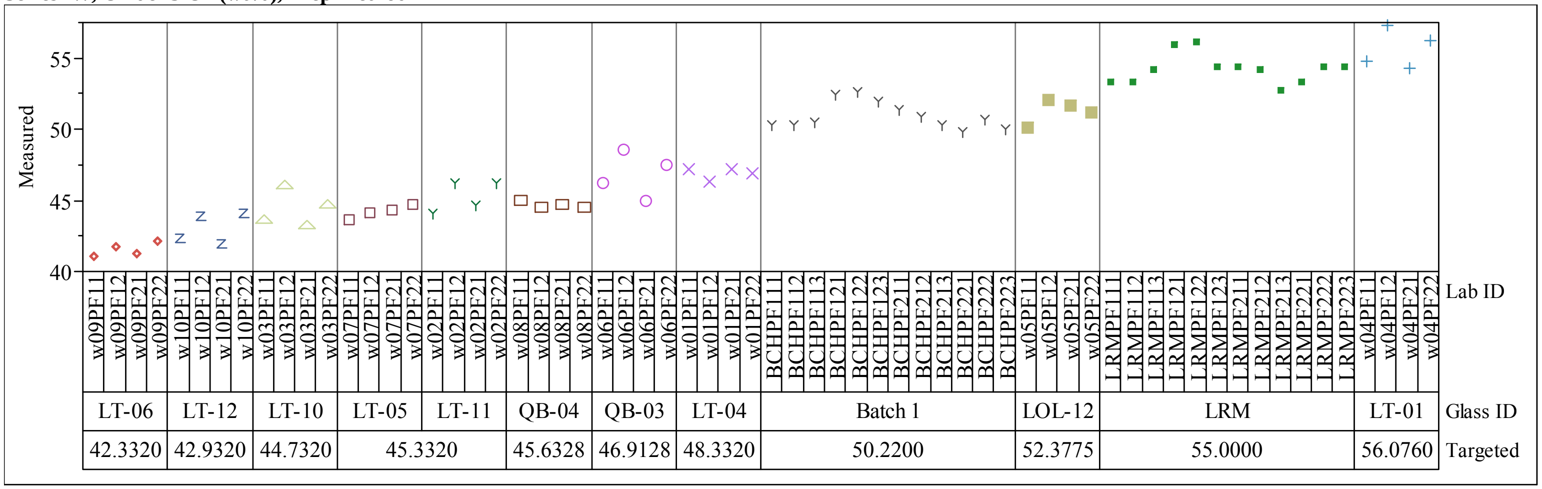
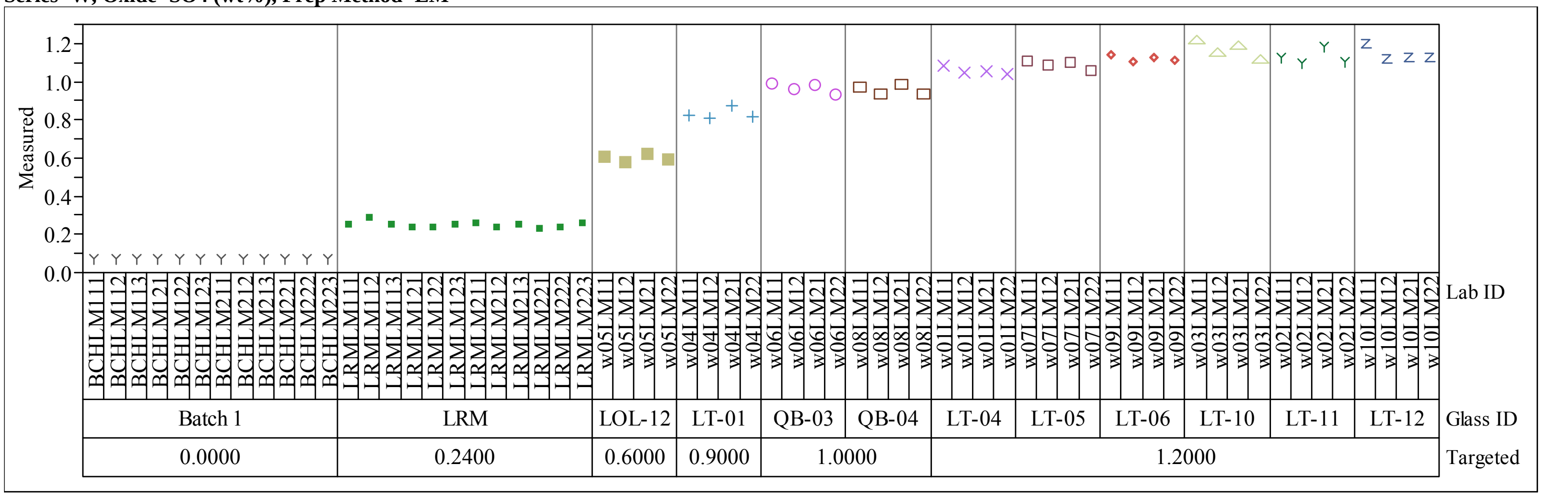


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=W, Oxide=SO4 (wt%), Prep Method=LM



Series=W, Oxide=TiO2 (wt%), Prep Method=LM

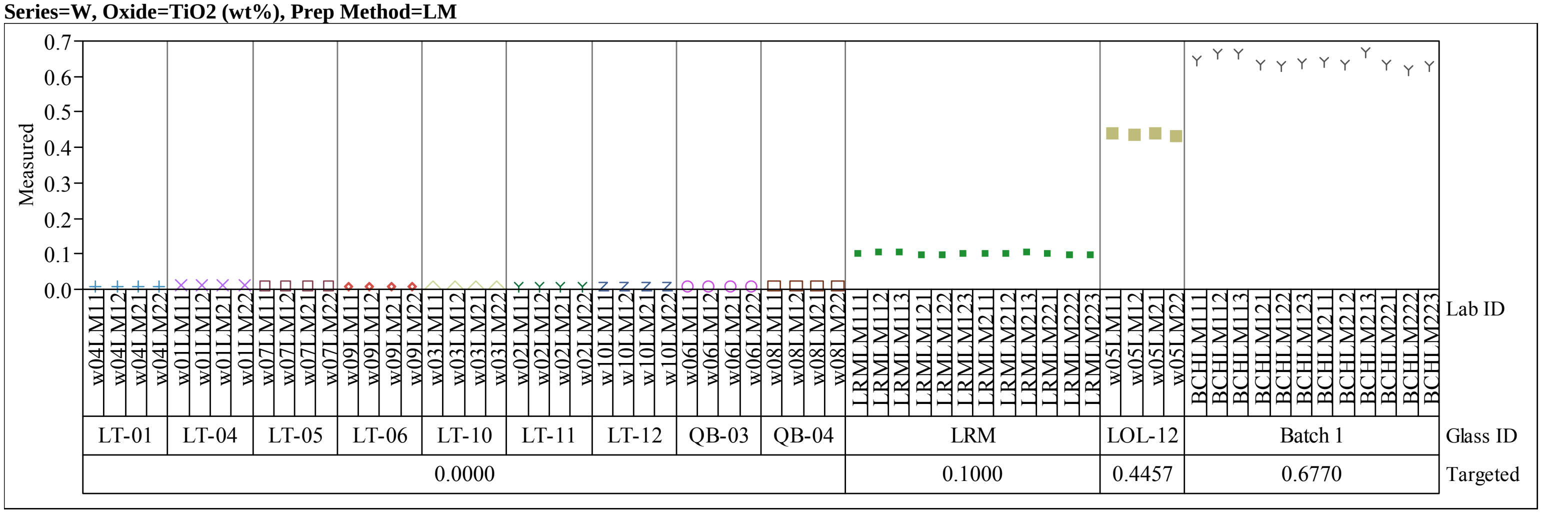
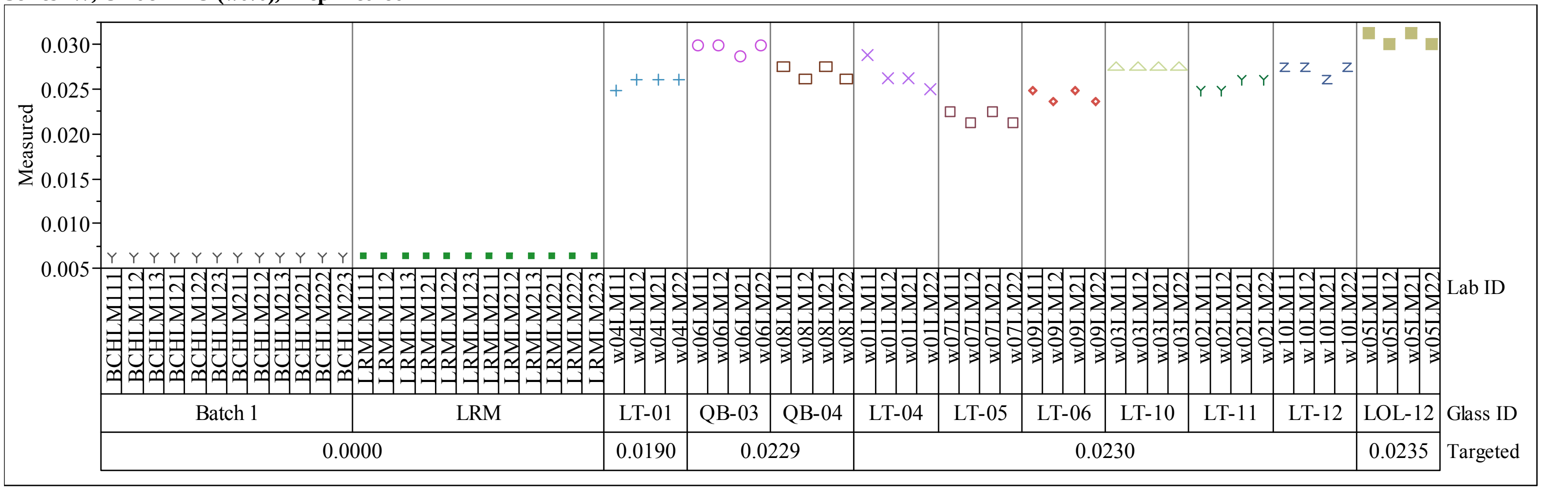


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=W, Oxide=ZnO (wt%), Prep Method=LM



Series=W, Oxide=ZrO2 (wt%), Prep Method=LM

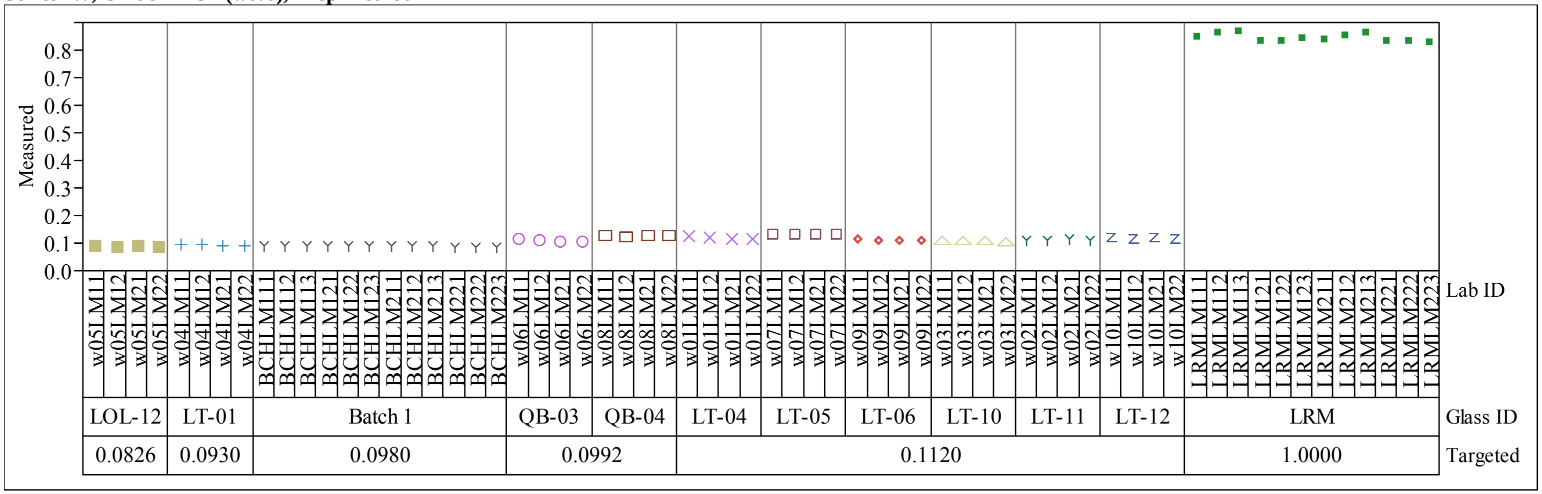
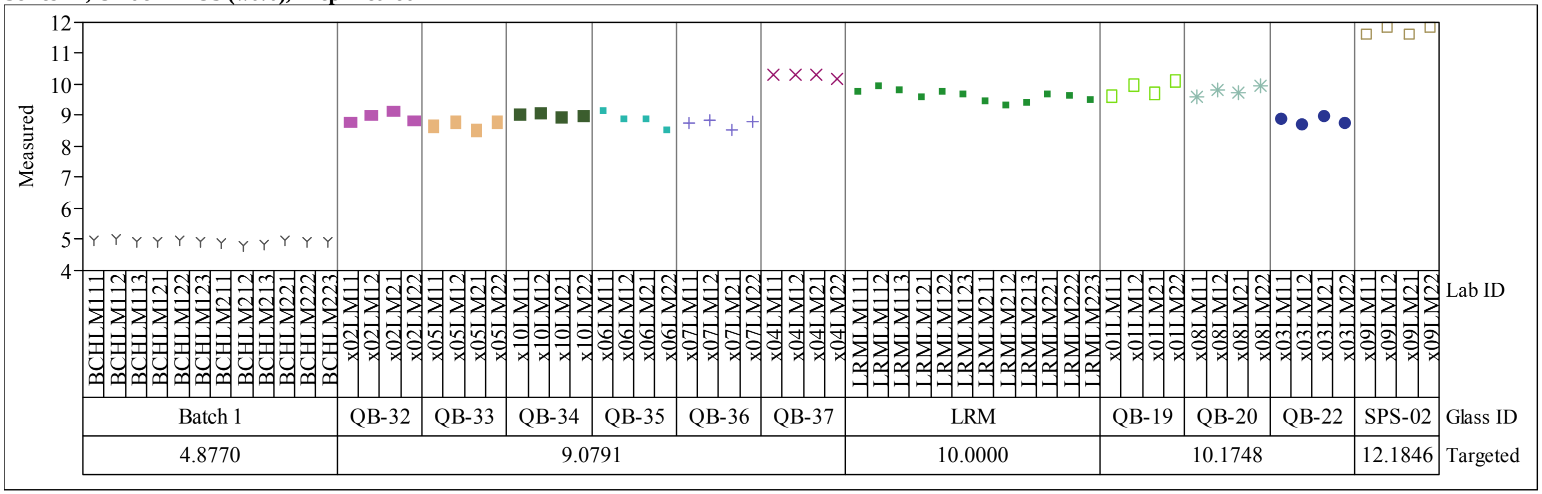


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=X, Oxide=Al2O3 (wt%), Prep Method=LM



Series=X, Oxide=B2O3 (wt%), Prep Method=PF

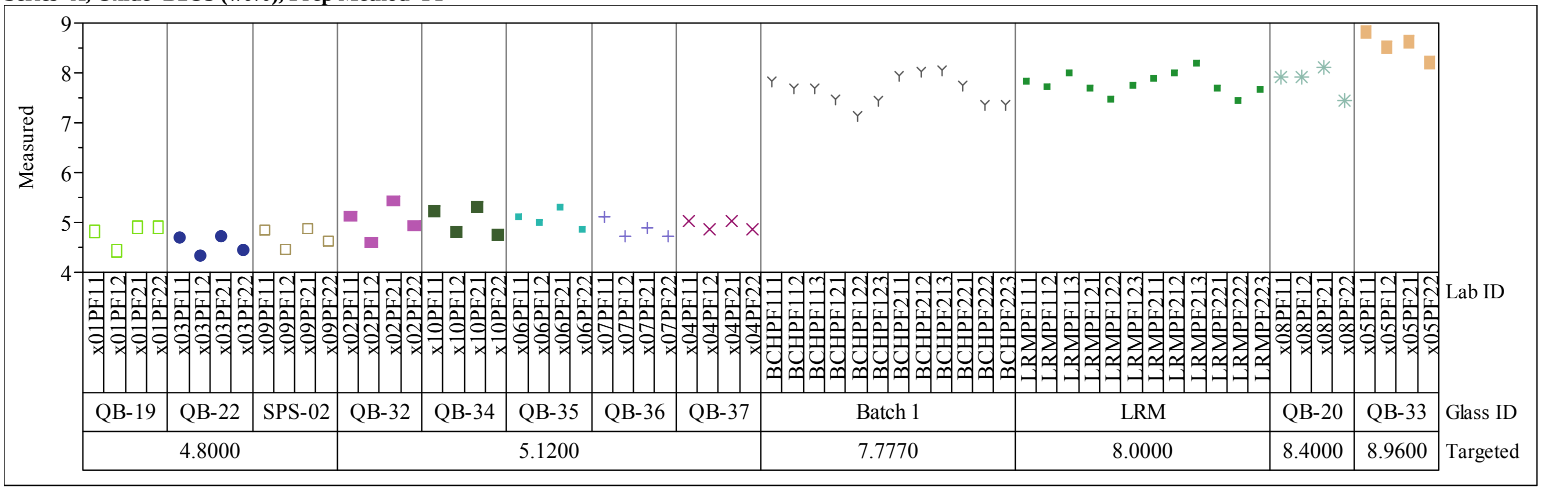
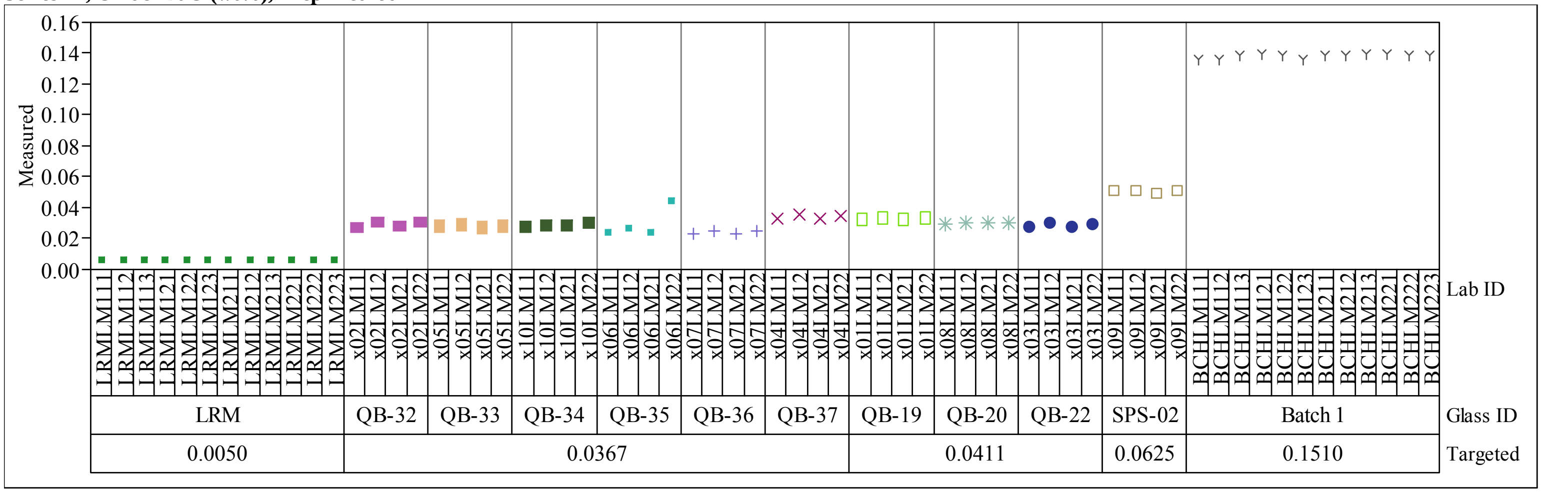


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=X, Oxide=BaO (wt%), Prep Method=LM



Series=X, Oxide=CaO (wt%), Prep Method=LM

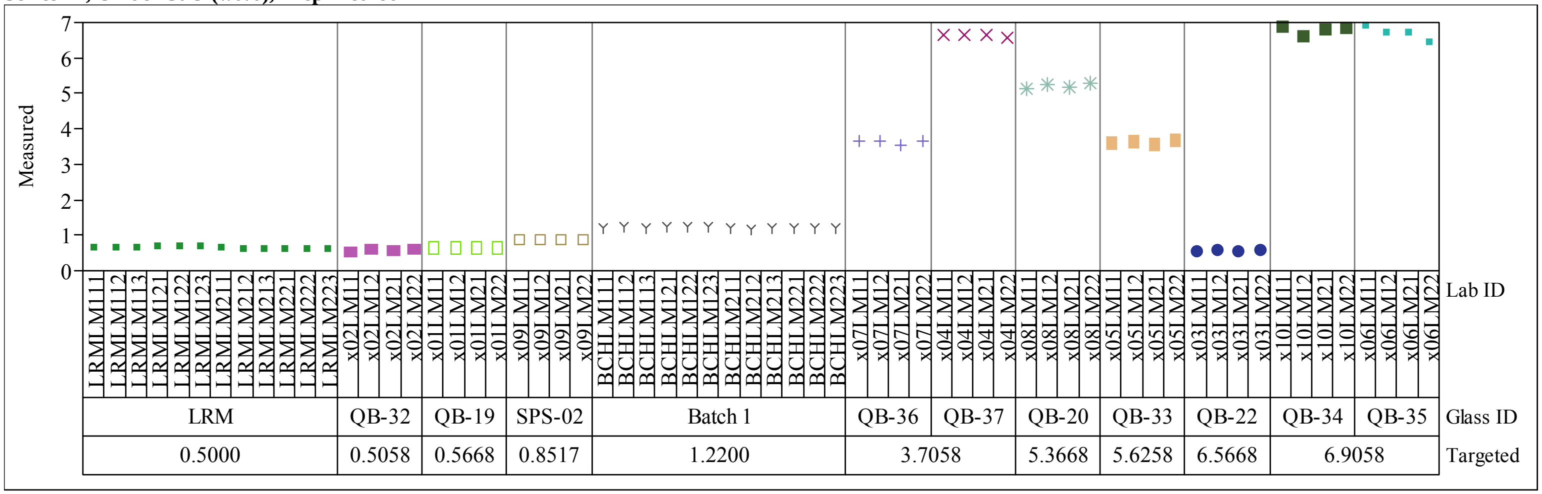
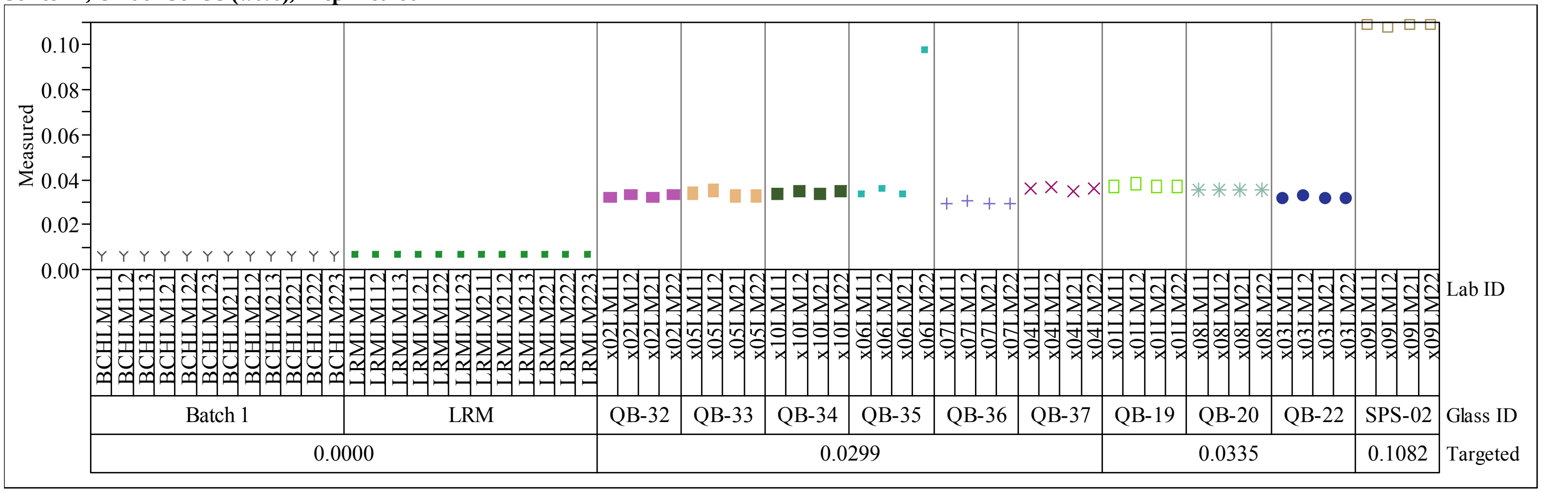


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=X, Oxide=Ce2O3 (wt%), Prep Method=LM



Series=X, Oxide=Cr2O3 (wt%), Prep Method=LM

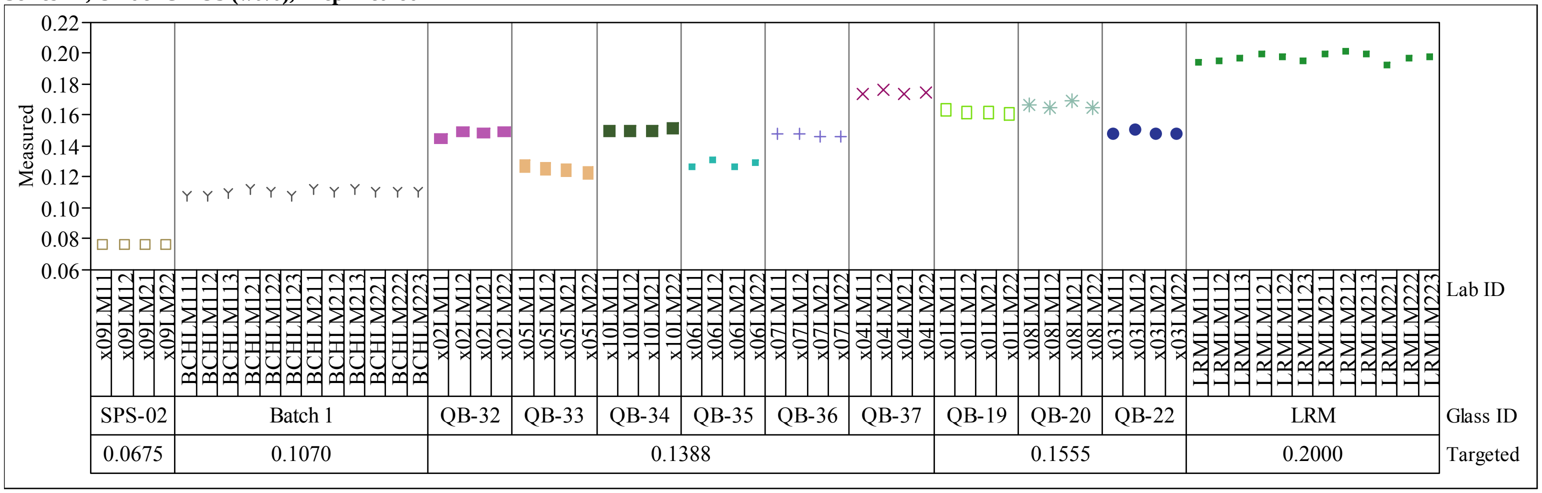
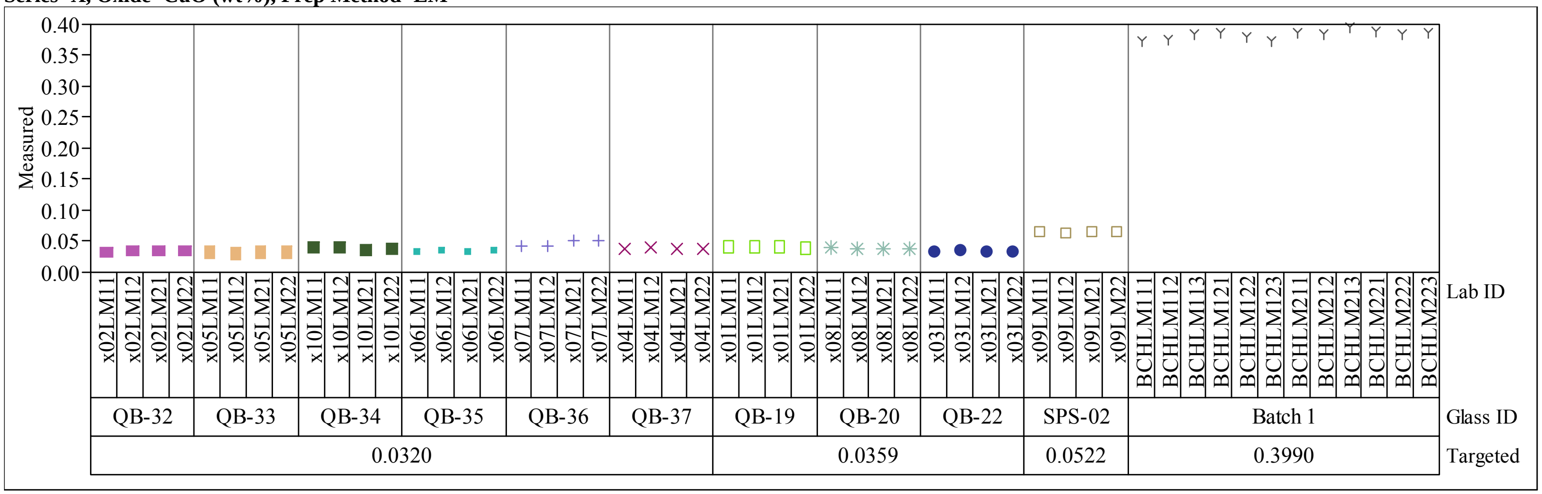


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=X, Oxide=CuO (wt%), Prep Method=LM



Series=X, Oxide=Fe2O3 (wt%), Prep Method=LM

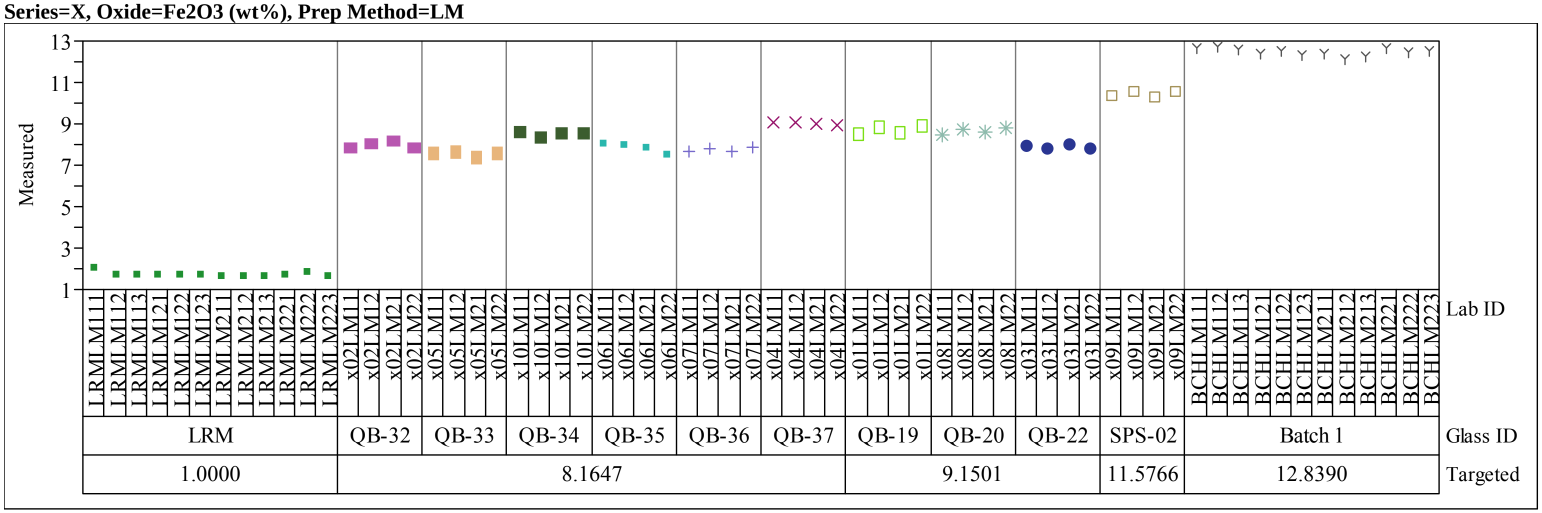
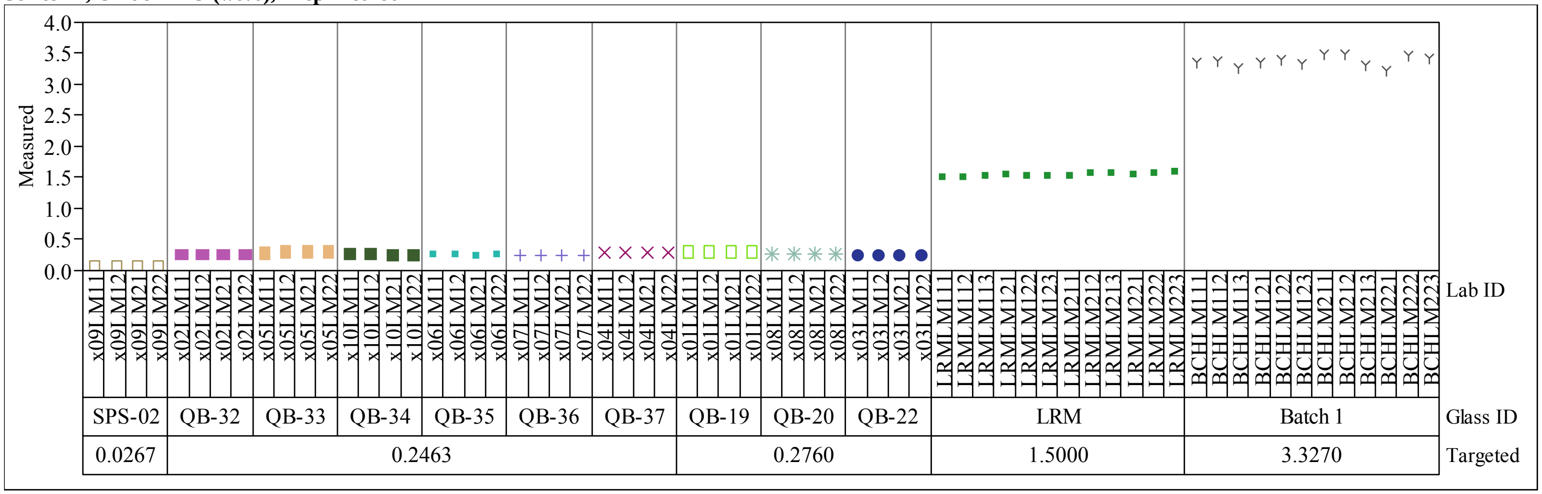


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=X, Oxide=K2O (wt%), Prep Method=LM



Series=X, Oxide=La2O3 (wt%), Prep Method=LM

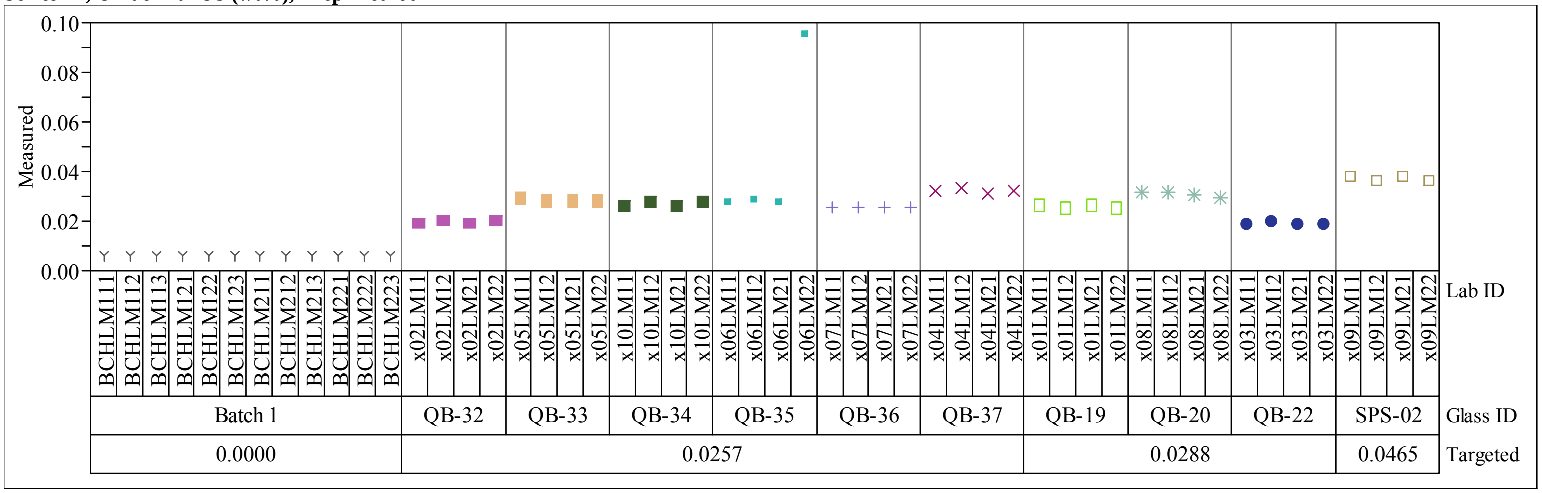
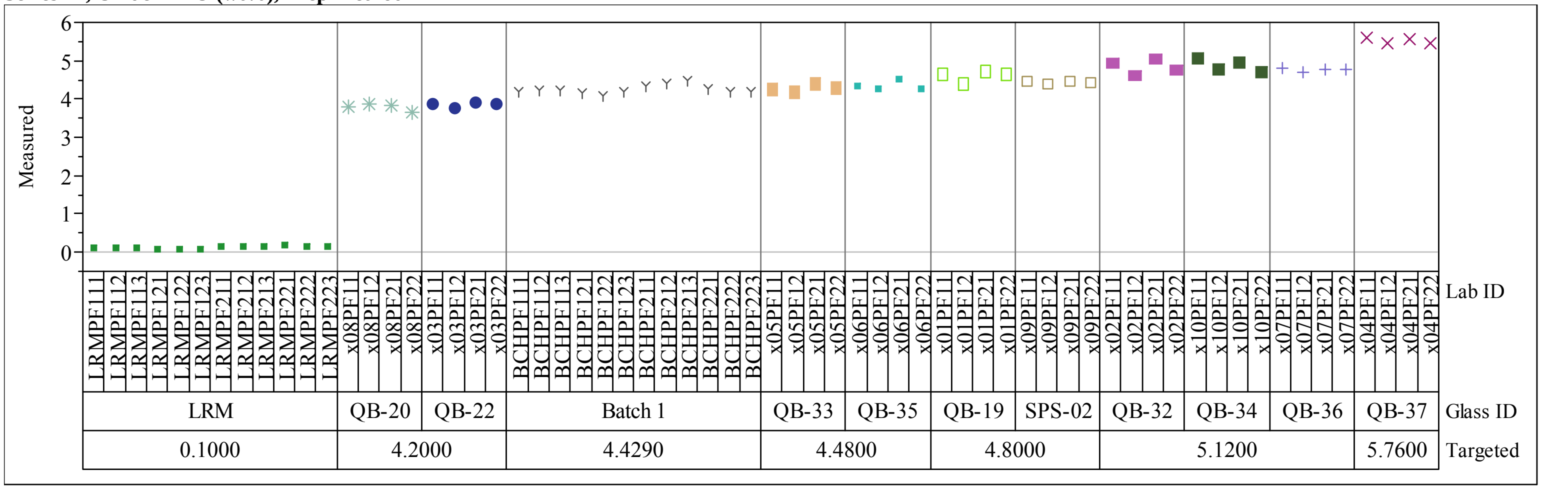


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=X, Oxide=Li2O (wt%), Prep Method=PF



Series=X, Oxide=MgO (wt%), Prep Method=LM

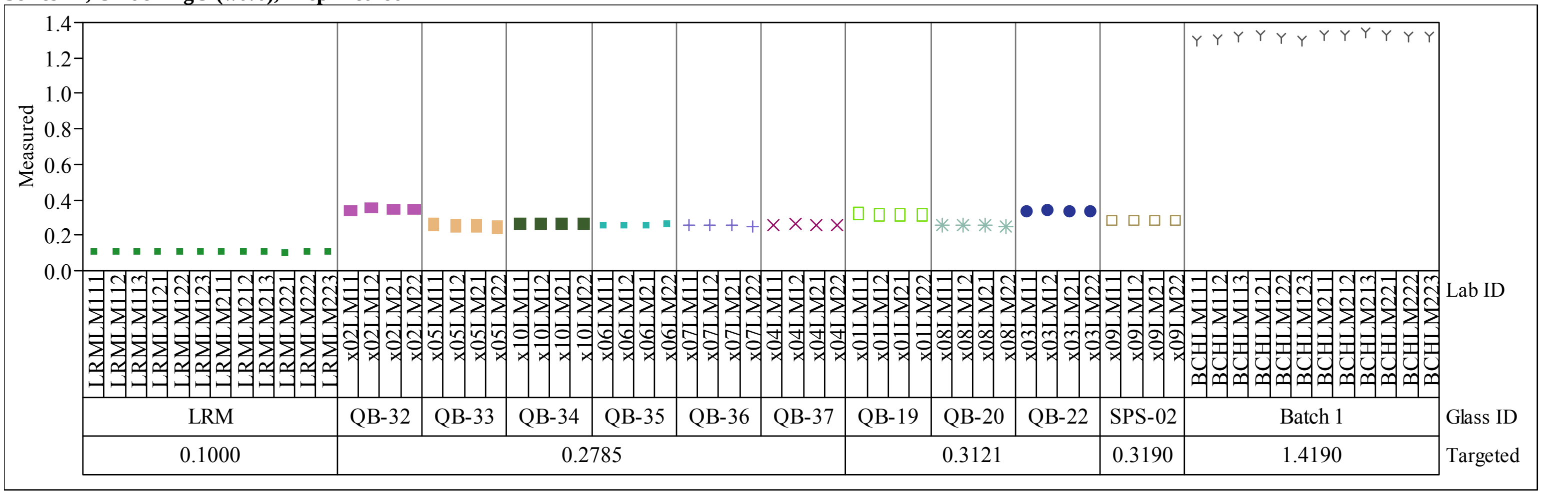
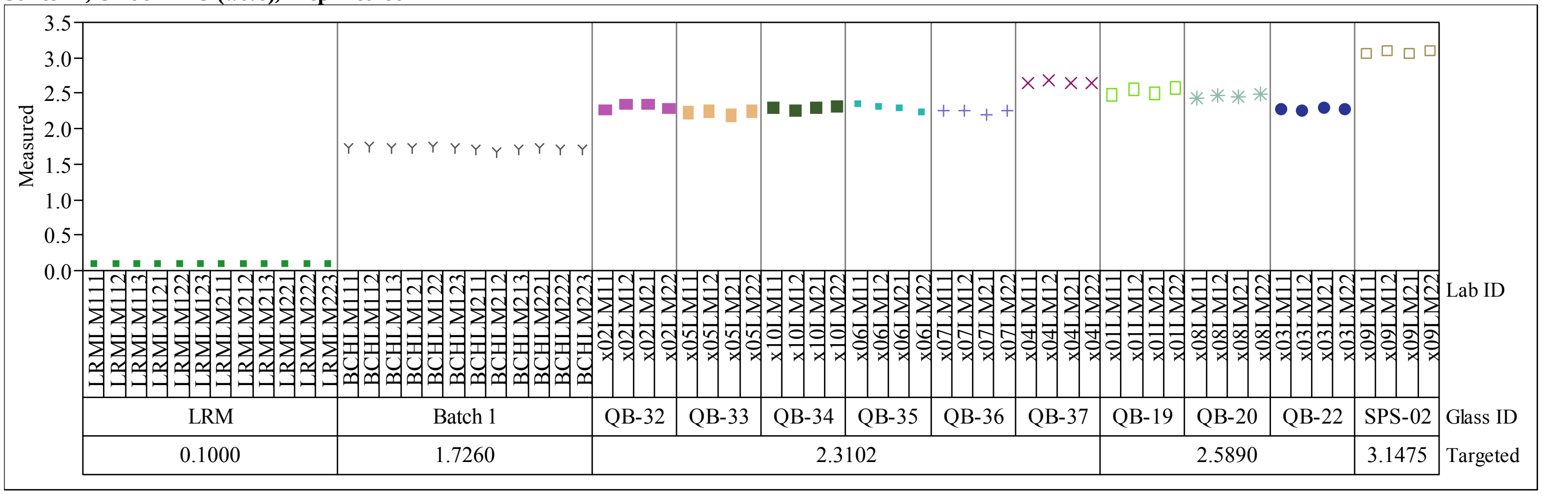


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=X, Oxide=MnO (wt%), Prep Method=LM



Series=X, Oxide=Na2O (wt%), Prep Method=LM

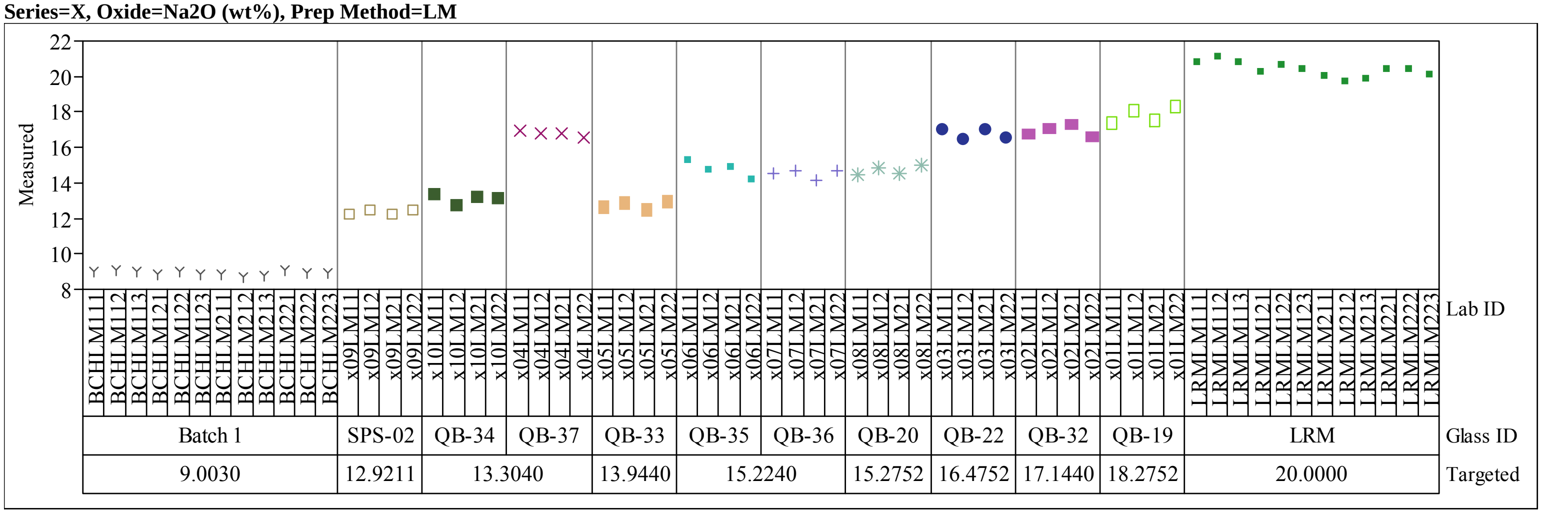
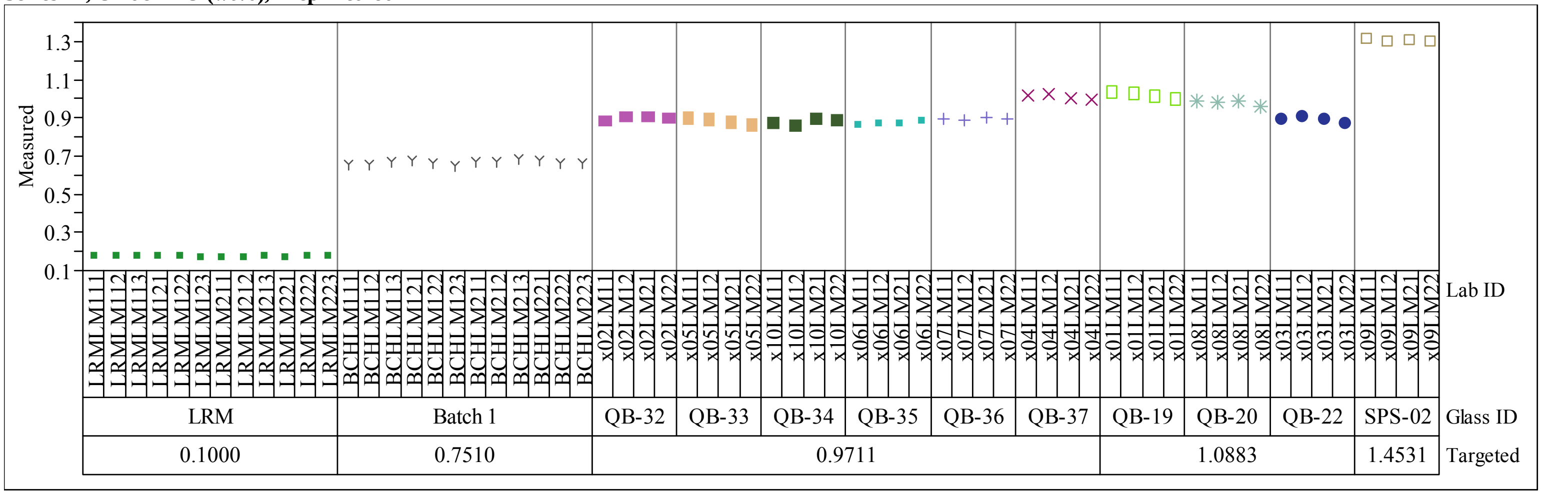


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=X, Oxide=NiO (wt%), Prep Method=LM



Series=X, Oxide=PbO (wt%), Prep Method=LM

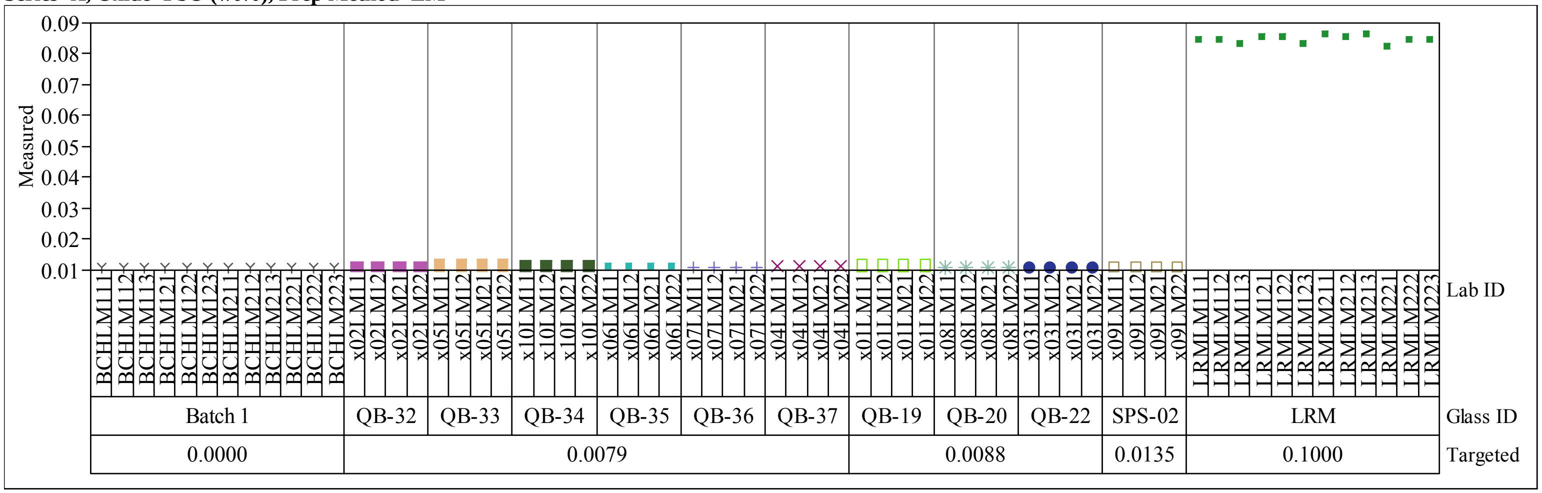
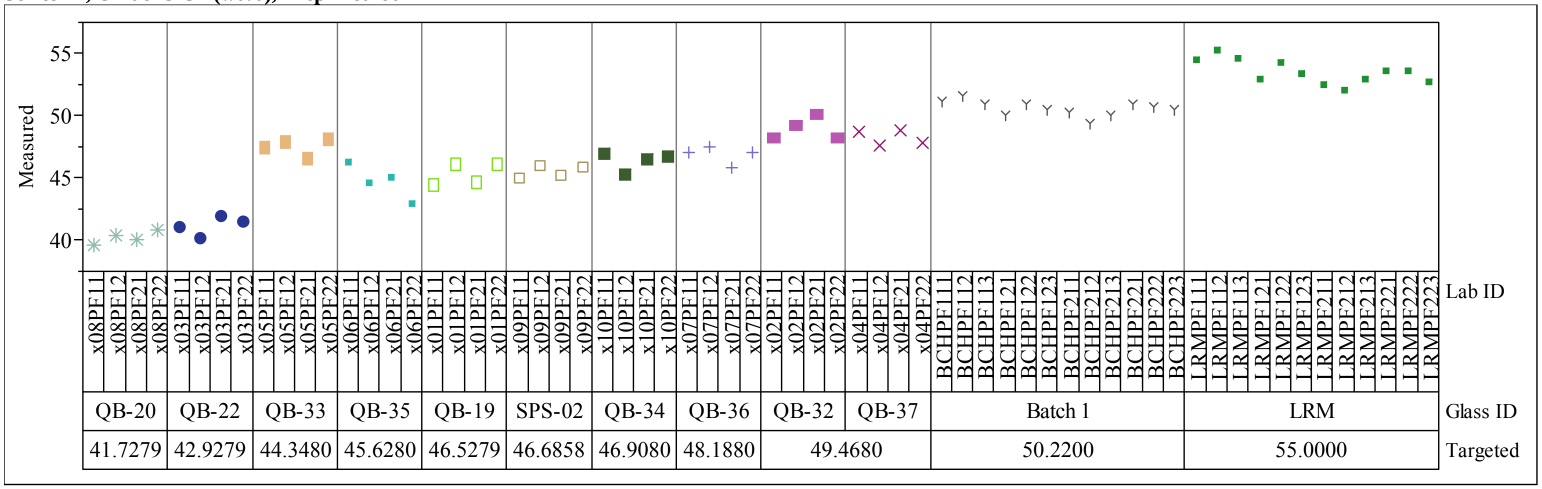


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=X, Oxide=SiO2 (wt%), Prep Method=PF



Series=X, Oxide=SO4 (wt%), Prep Method=LM

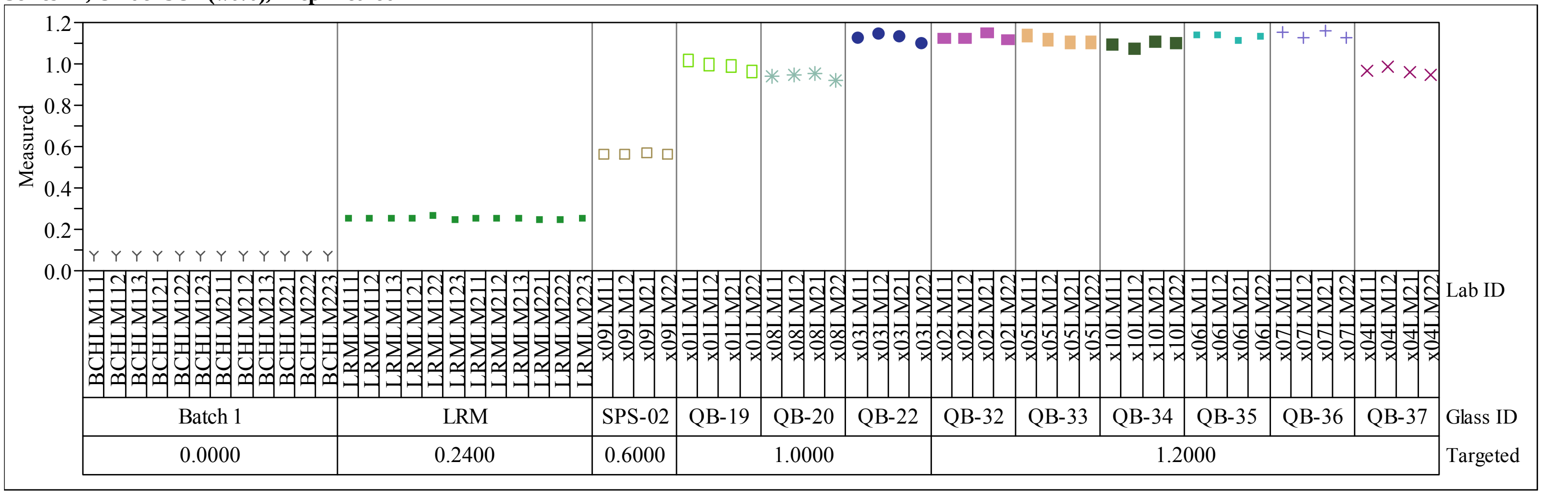
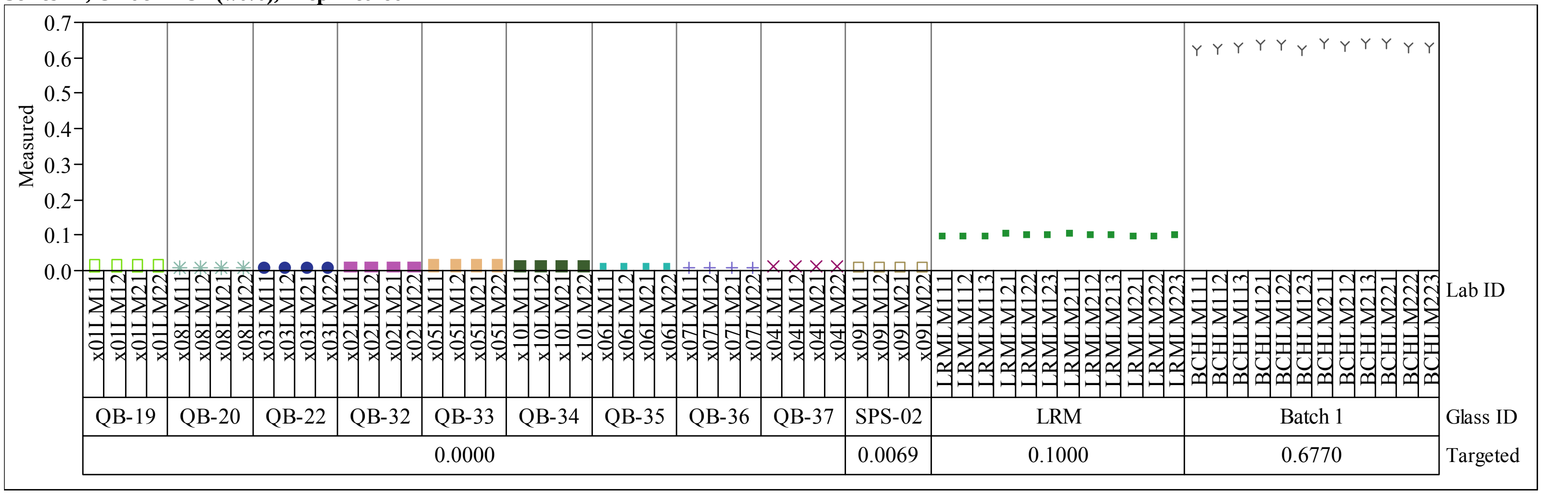


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=X, Oxide=TiO2 (wt%), Prep Method=LM



Series=X, Oxide=ZnO (wt%), Prep Method=LM

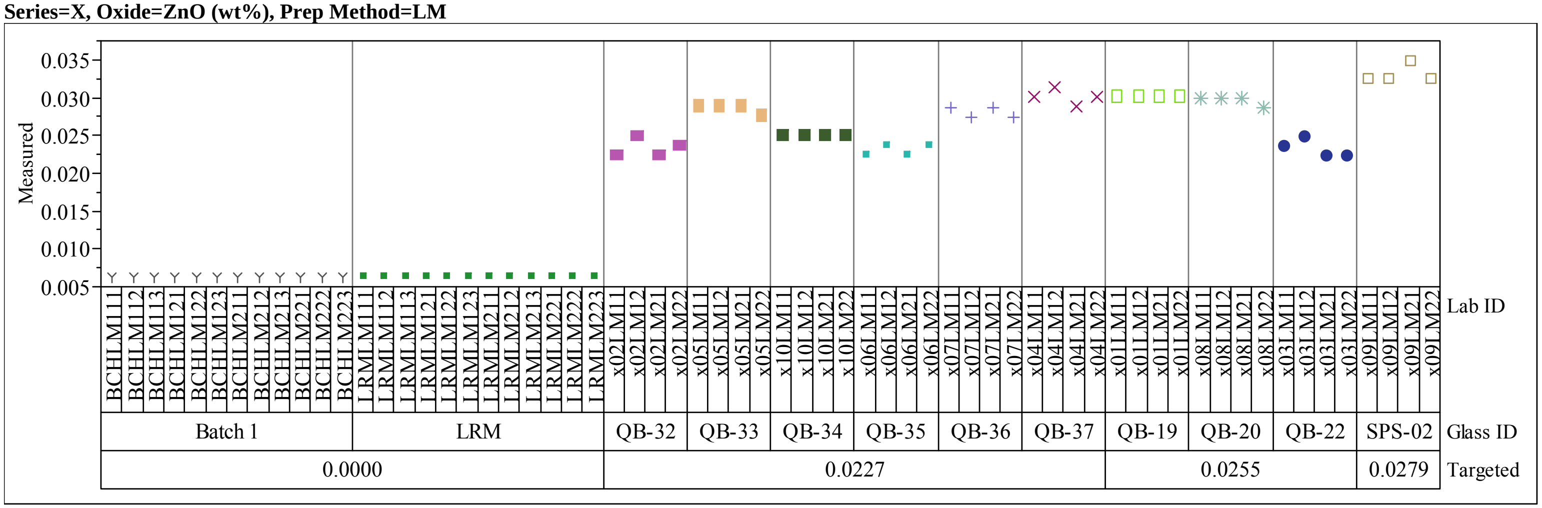


Exhibit A-2. Measurements by Lab ID within Glass ID by Targeted Concentration for Each Oxide for Each Prep by Analytical Series (continued)

Series=X, Oxide=ZrO2 (wt%), Prep Method=LM

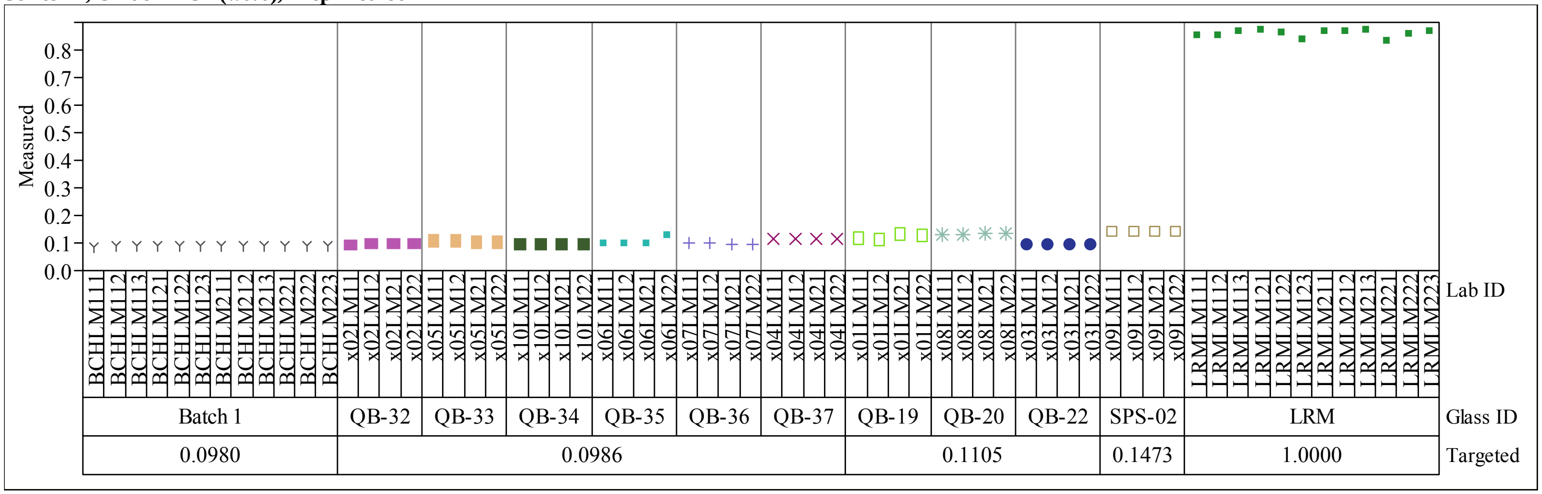
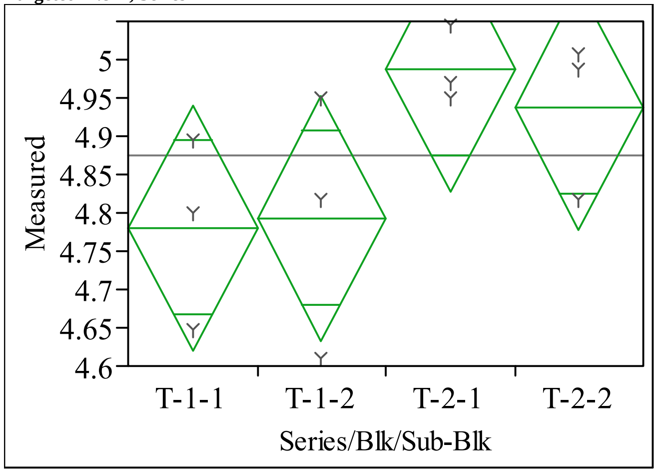


Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Al2O3 (wt%), Targeted=4.877, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.455964
Adj Rsquare	0.251951
Root Mean Square Error	0.120494
Mean of Response	4.87491
Observations (or Sum Wgts)	12

Analysis of Variance

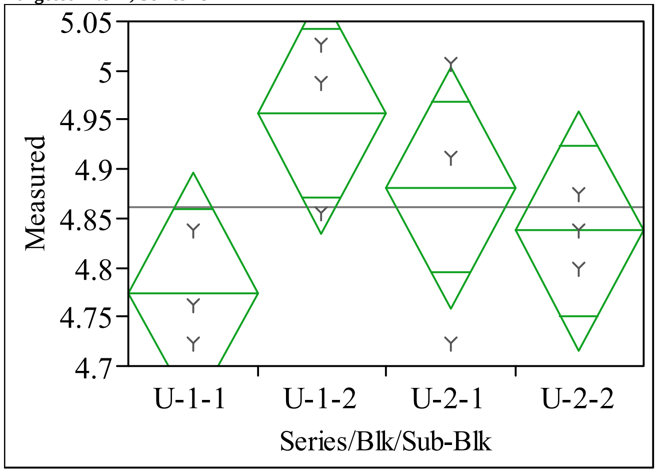
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.09734773	0.032449	2.2350	0.1615
Error	8	0.11615084	0.014519		
C. Total	11	0.21349857			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	4.78044	0.06957	4.6200	4.9409
T-1-2	3	4.79303	0.06957	4.6326	4.9535
T-2-1	3	4.98828	0.06957	4.8279	5.1487
T-2-2	3	4.93789	0.06957	4.7775	5.0983

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Al2O3 (wt%), Targeted=4.877, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.441584
Adj Rsquare	0.232178
Root Mean Square Error	0.091597
Mean of Response	4.862313
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.05307713	0.017692	2.1087	0.1774
Error	8	0.06711995	0.008390		
C. Total	11	0.12019708			

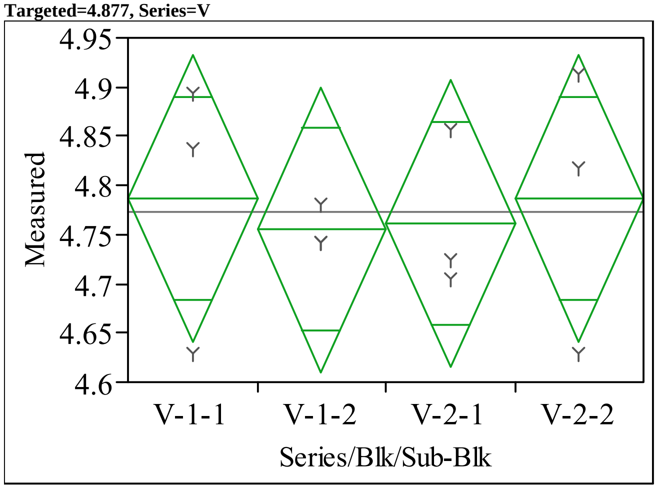
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	4.77414	0.05288	4.6522	4.8961
U-1-2	3	4.95679	0.05288	4.8348	5.0787
U-2-1	3	4.88121	0.05288	4.7593	5.0032
U-2-2	3	4.83712	0.05288	4.7152	4.9591

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Al2O3 (wt%), Targeted=4.877, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.025344
Adj Rsquare	-0.34015
Root Mean Square Error	0.108954
Mean of Response	4.772562
Observations (or Sum Wgts)	12

Analysis of Variance

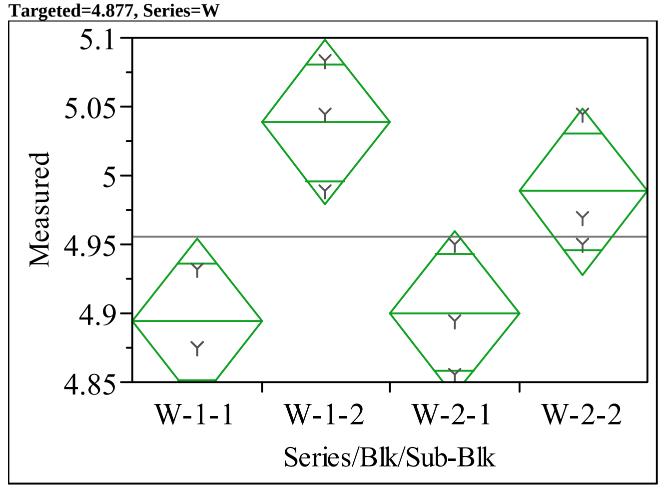
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00246940	0.000823	0.0693	0.9747
Error	8	0.09496759	0.011871		
C. Total	11	0.09743699			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	4.78673	0.06290	4.6417	4.9318
V-1-2	3	4.75524	0.06290	4.6102	4.9003
V-2-1	3	4.76154	0.06290	4.6165	4.9066
V-2-2	3	4.78673	0.06290	4.6417	4.9318

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Al2O3 (wt%), Targeted=4.877, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.733725
Adj Rsquare	0.633872
Root Mean Square Error	0.044979
Mean of Response	4.955214
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.04459788	0.014866	7.3480	0.0110
Error	8	0.01618495	0.002023		
C. Total	11	0.06078283			

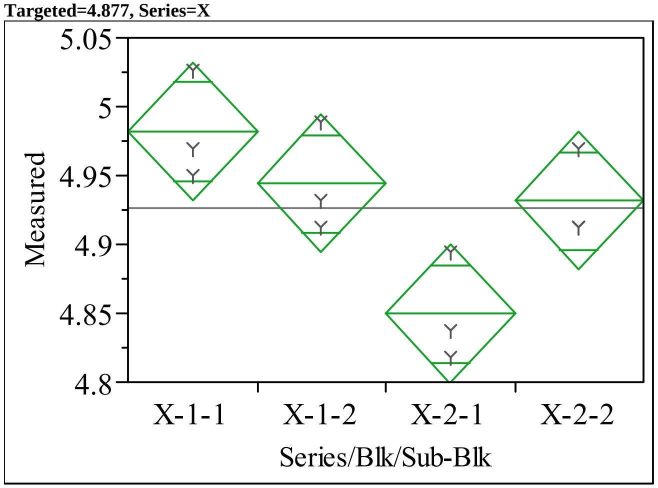
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	4.89381	0.02597	4.8339	4.9537
W-1-2	3	5.03867	0.02597	4.9788	5.0986
W-2-1	3	4.90010	0.02597	4.8402	4.9600
W-2-2	3	4.98828	0.02597	4.9284	5.0482

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Al2O3 (wt%), Targeted=4.877, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.709751
Adj Rsquare	0.600907
Root Mean Square Error	0.03779
Mean of Response	4.926871
Observations (or Sum Wgts)	12

Analysis of Variance

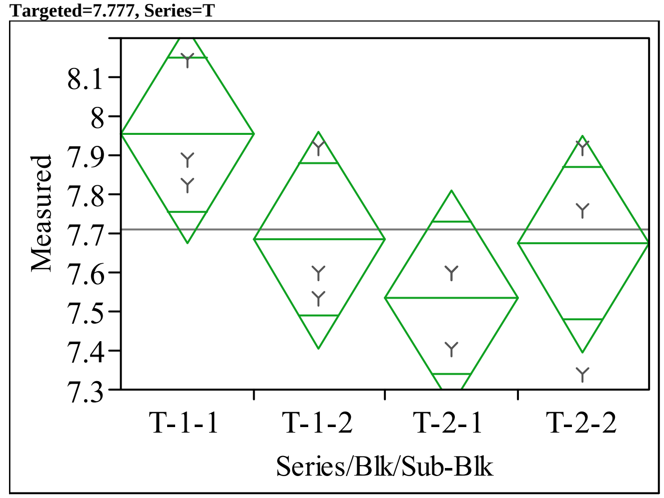
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.02793690	0.009312	6.5208	0.0153
Error	8	0.01142467	0.001428		
C. Total	11	0.03936157			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	4.98198	0.02182	4.9317	5.0323
X-1-2	3	4.94419	0.02182	4.8939	4.9945
X-2-1	3	4.84972	0.02182	4.7994	4.9000
X-2-2	3	4.93160	0.02182	4.8813	4.9819

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=B2O3 (wt%), Targeted=7.777, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.442041
Adj Rsquare	0.232806
Root Mean Square Error	0.208466
Mean of Response	7.711661
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.27543672	0.091812	2.1127	0.1769
Error	8	0.34766542	0.043458		
C. Total	11	0.62310214			

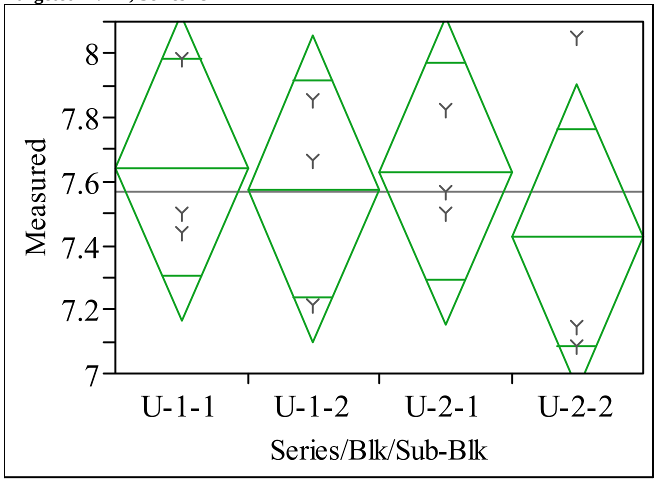
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	7.95315	0.12036	7.6756	8.2307
T-1-2	3	7.68483	0.12036	7.4073	7.9624
T-2-1	3	7.53457	0.12036	7.2570	7.8121
T-2-2	3	7.67410	0.12036	7.3965	7.9516

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=B2O3 (wt%), Targeted=7.777, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.078126
Adj Rsquare	-0.26758
Root Mean Square Error	0.360356
Mean of Response	7.569448
Observations (or Sum Wgts)	12

Analysis of Variance

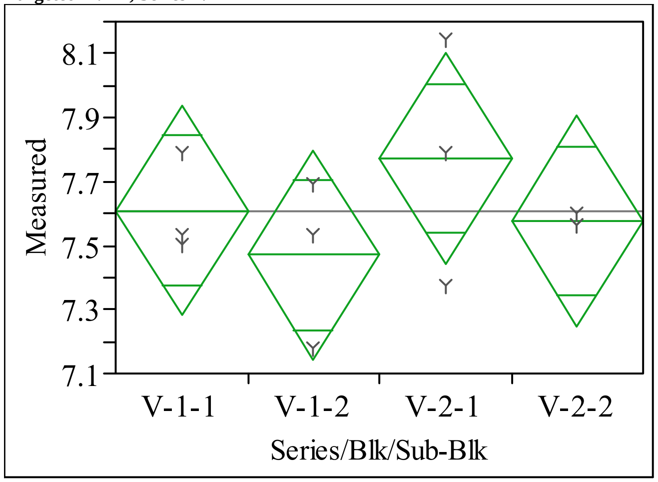
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.0880395	0.029347	0.2260	0.8757
Error	8	1.0388492	0.129856		
C. Total	11	1.1268887			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	7.64190	0.20805	7.1621	8.1217
U-1-2	3	7.57750	0.20805	7.0977	8.0573
U-2-1	3	7.63116	0.20805	7.1514	8.1109
U-2-2	3	7.42724	0.20805	6.9475	7.9070

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=B2O3 (wt%), Targeted=7.777, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.221443
Adj Rsquare	-0.07052
Root Mean Square Error	0.247325
Mean of Response	7.607014
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.13918712	0.046396	0.7585	0.5481
Error	8	0.48935808	0.061170		
C. Total	11	0.62854521			

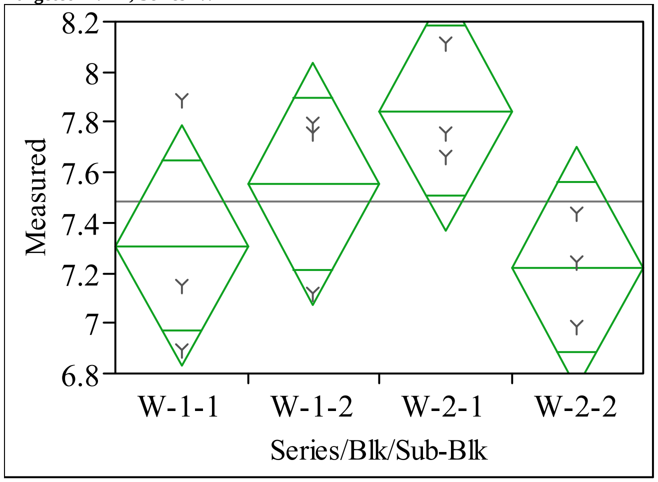
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	7.60970	0.14279	7.2804	7.9390
V-1-2	3	7.47017	0.14279	7.1409	7.7994
V-2-1	3	7.77069	0.14279	7.4414	8.1000
V-2-2	3	7.57750	0.14279	7.2482	7.9068

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=B2O3 (wt%), Targeted=7.777, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.402938
Adj Rsquare	0.17904
Root Mean Square Error	0.361074
Mean of Response	7.483584
Observations (or Sum Wgts)	12

Analysis of Variance

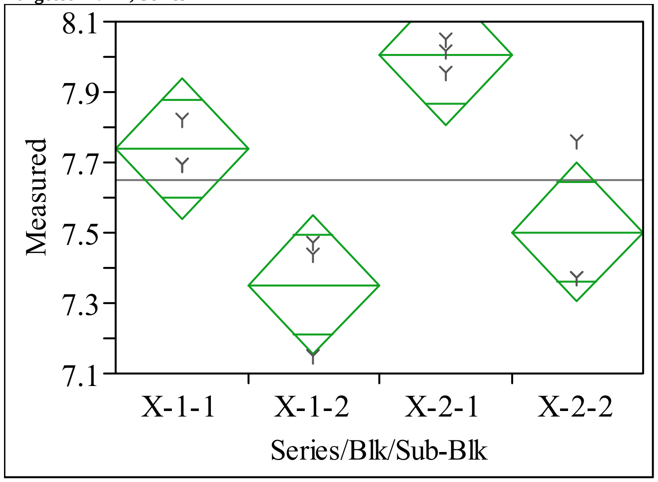
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.7038842	0.234628	1.7996	0.2251
Error	8	1.0429963	0.130375		
C. Total	11	1.7468805			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	7.30917	0.20847	6.8284	7.7899
W-1-2	3	7.55603	0.20847	7.0753	8.0368
W-2-1	3	7.84582	0.20847	7.3651	8.3265
W-2-2	3	7.22331	0.20847	6.7426	7.7040

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=B2O3 (wt%), Targeted=7.777, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.805191
Adj Rsquare	0.732138
Root Mean Square Error	0.149301
Mean of Response	7.649946
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.73706105	0.245687	11.0220	0.0033
Error	8	0.17832540	0.022291		
C. Total	11	0.91538646			

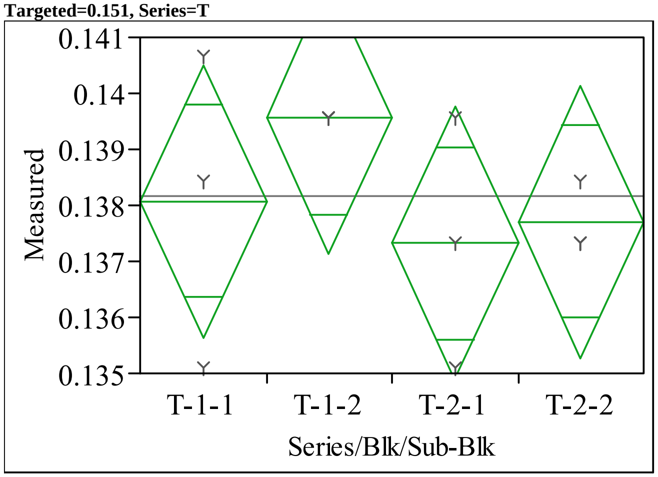
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	7.73849	0.08620	7.5397	7.9373
X-1-2	3	7.35211	0.08620	7.1533	7.5509
X-2-1	3	8.00682	0.08620	7.8080	8.2056
X-2-2	3	7.50237	0.08620	7.3036	7.7011

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=BaO (wt%), Targeted=0.151, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.244838
Adj Rsquare	-0.03835
Root Mean Square Error	0.001823
Mean of Response	0.138167
Observations (or Sum Wgts)	12

Analysis of Variance

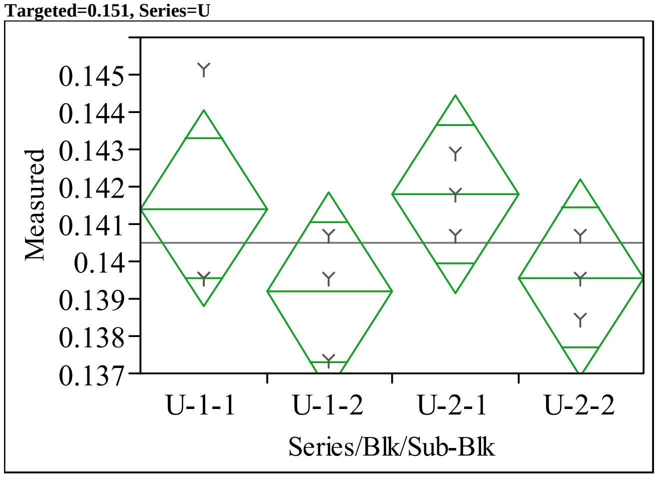
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00000862	2.874e-6	0.8646	0.4980
Error	8	0.00002659	3.3242e-6		
C. Total	11	0.00003522			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	0.138074	0.00105	0.13565	0.14050
T-1-2	3	0.139563	0.00105	0.13714	0.14199
T-2-1	3	0.137330	0.00105	0.13490	0.13976
T-2-2	3	0.137702	0.00105	0.13527	0.14013

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=BaO (wt%), Targeted=0.151, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.327434
Adj Rsquare	0.075221
Root Mean Square Error	0.001987
Mean of Response	0.140493
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00001537	5.1248e-6	1.2982	0.3400
Error	8	0.00003158	3.9475e-6		
C. Total	11	0.00004695			

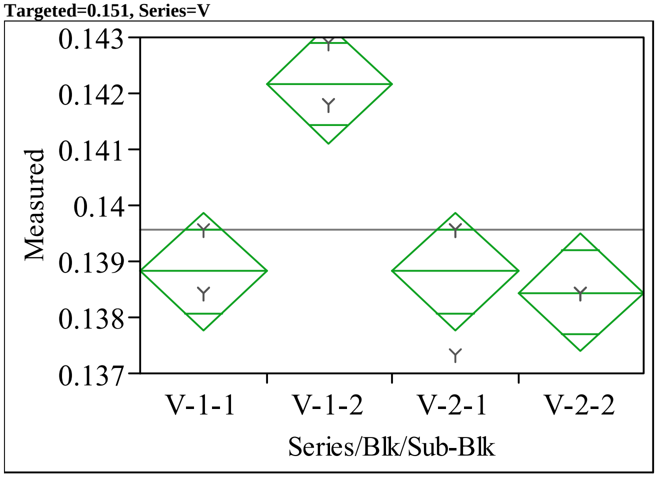
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	0.141423	0.00115	0.13878	0.14407
U-1-2	3	0.139190	0.00115	0.13655	0.14184
U-2-1	3	0.141796	0.00115	0.13915	0.14444
U-2-2	3	0.139563	0.00115	0.13692	0.14221

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=BaO (wt%), Targeted=0.151, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.846154
Adj Rsquare	0.788462
Root Mean Square Error	0.000789
Mean of Response	0.139563
Observations (or Sum Wgts)	12

Analysis of Variance

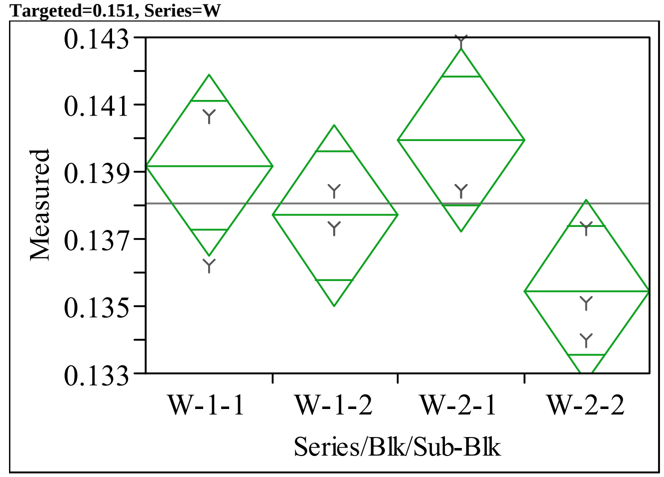
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00002742	9.1415e-6	14.6667	0.0013
Error	8	0.00000499	6.2329e-7		
C. Total	11	0.00003241			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	0.138818	0.00046	0.13777	0.13987
V-1-2	3	0.142168	0.00046	0.14112	0.14322
V-2-1	3	0.138818	0.00046	0.13777	0.13987
V-2-2	3	0.138446	0.00046	0.13739	0.13950

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=BaO (wt%), Targeted=0.151, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.512195
Adj Rsquare	0.329268
Root Mean Square Error	0.002038
Mean of Response	0.138074
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00003490	0.000012	2.8000	0.1086
Error	8	0.00003324	4.155e-6		
C. Total	11	0.00006815			

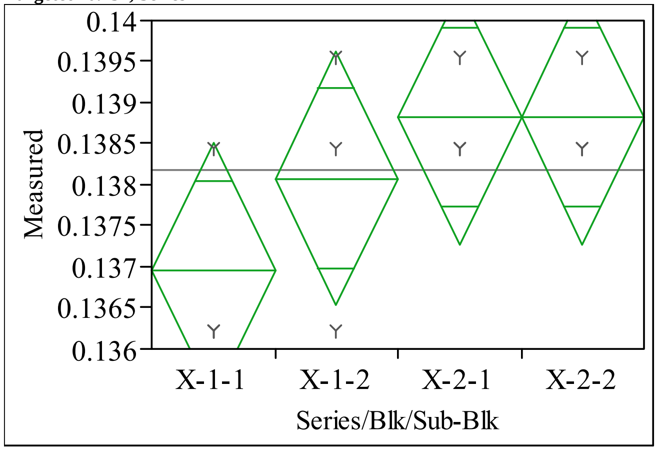
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	0.139190	0.00118	0.13648	0.14190
W-1-2	3	0.137702	0.00118	0.13499	0.14042
W-2-1	3	0.139935	0.00118	0.13722	0.14265
W-2-2	3	0.135469	0.00118	0.13275	0.13818

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=BaO (wt%), Targeted=0.151, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.391813
Adj Rsquare	0.163743
Root Mean Square Error	0.001162
Mean of Response	0.138167
Observations (or Sum Wgts)	12

Analysis of Variance

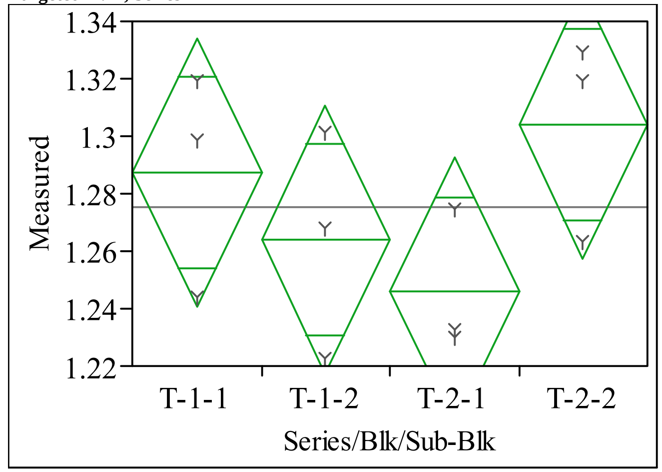
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00000696	2.32e-6	1.7179	0.2402
Error	8	0.00001080	1.3505e-6		
C. Total	11	0.00001776			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	0.136957	0.00067	0.13541	0.13850
X-1-2	3	0.138074	0.00067	0.13653	0.13962
X-2-1	3	0.138818	0.00067	0.13727	0.14037
X-2-2	3	0.138818	0.00067	0.13727	0.14037

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=CaO (wt%), Targeted=1.22, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.373823
Adj Rsquare	0.139007
Root Mean Square Error	0.035194
Mean of Response	1.275254
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00591554	0.001972	1.5920	0.2660
Error	8	0.00990888	0.001239		
C. Total	11	0.01582442			

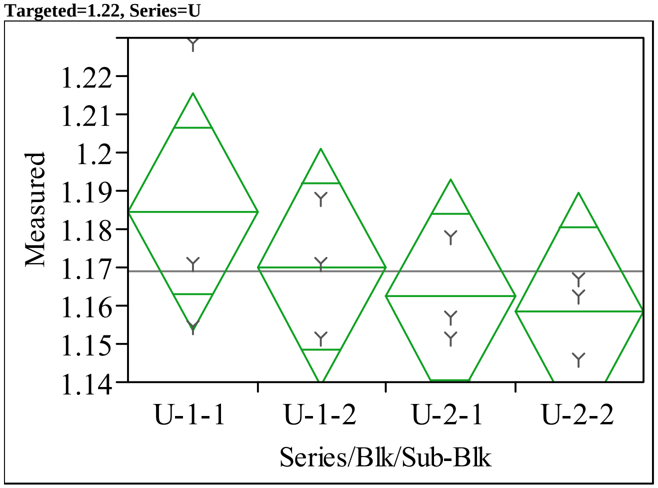
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	1.28726	0.02032	1.2404	1.3341
T-1-2	3	1.26394	0.02032	1.2171	1.3108
T-2-1	3	1.24575	0.02032	1.1989	1.2926
T-2-2	3	1.30405	0.02032	1.2572	1.3509

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=CaO (wt%), Targeted=1.22, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.217676
Adj Rsquare	-0.0757
Root Mean Square Error	0.023256
Mean of Response	1.168915
Observations (or Sum Wgts)	12

Analysis of Variance

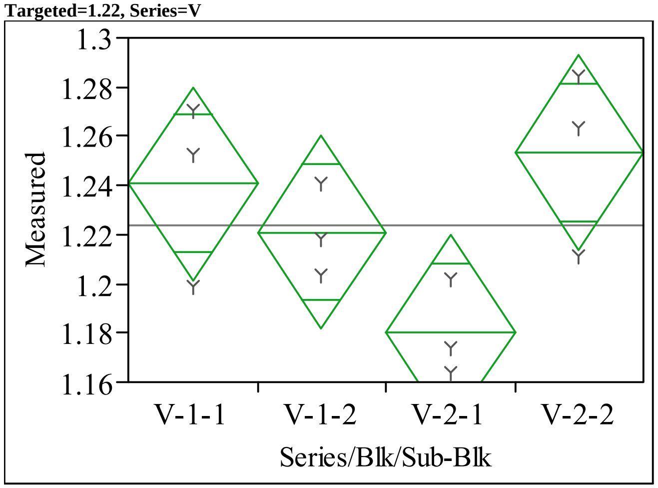
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00120386	0.000401	0.7420	0.5563
Error	8	0.00432665	0.000541		
C. Total	11	0.00553051			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	1.18466	0.01343	1.1537	1.2156
U-1-2	3	1.17020	0.01343	1.1392	1.2012
U-2-1	3	1.16227	0.01343	1.1313	1.1932
U-2-2	3	1.15854	0.01343	1.1276	1.1895

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=CaO (wt%), Targeted=1.22, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.566995
Adj Rsquare	0.404618
Root Mean Square Error	0.029676
Mean of Response	1.223717
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00922546	0.003075	3.4918	0.0698
Error	8	0.00704533	0.000881		
C. Total	11	0.01627079			

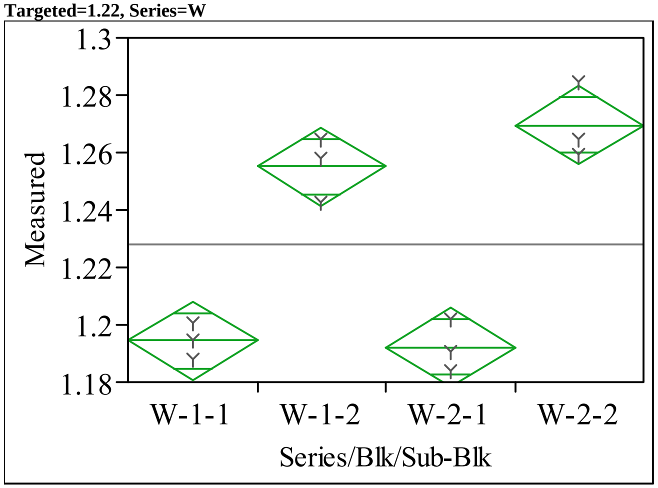
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	1.24062	0.01713	1.2011	1.2801
V-1-2	3	1.22104	0.01713	1.1815	1.2605
V-2-1	3	1.17999	0.01713	1.1405	1.2195
V-2-2	3	1.25322	0.01713	1.2137	1.2927

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=CaO (wt%), Targeted=1.22, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.944423
Adj Rsquare	0.923582
Root Mean Square Error	0.010369
Mean of Response	1.227798
Observations (or Sum Wgts)	12

Analysis of Variance

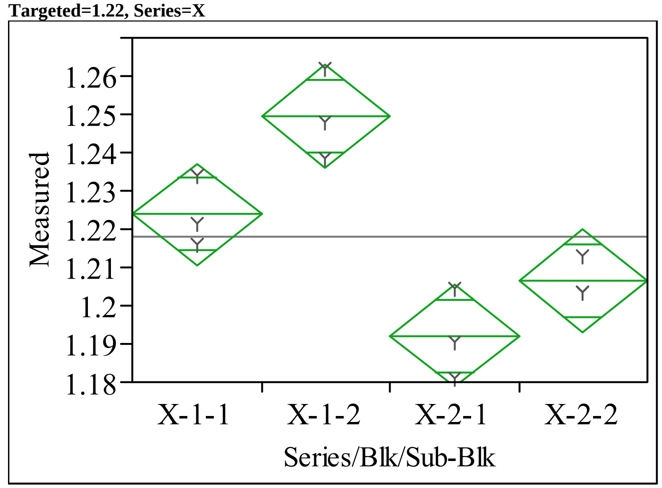
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.01461599	0.004872	45.3151	<.0001
Error	8	0.00086011	0.000108		
C. Total	11	0.01547610			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	1.19445	0.00599	1.1806	1.2083
W-1-2	3	1.25508	0.00599	1.2413	1.2689
W-2-1	3	1.19212	0.00599	1.1783	1.2059
W-2-2	3	1.26954	0.00599	1.2557	1.2833

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=CaO (wt%), Targeted=1.22, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.871276
Adj Rsquare	0.823004
Root Mean Square Error	0.010057
Mean of Response	1.218004
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00547716	0.001826	18.0495	0.0006
Error	8	0.00080921	0.000101		
C. Total	11	0.00628637			

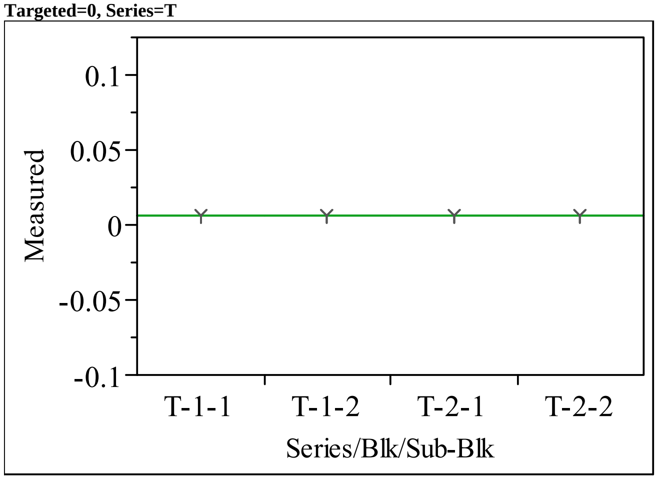
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	1.22383	0.00581	1.2104	1.2372
X-1-2	3	1.24949	0.00581	1.2361	1.2629
X-2-1	3	1.19212	0.00581	1.1787	1.2055
X-2-2	3	1.20658	0.00581	1.1932	1.2200

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Ce2O3 (wt%), Targeted=0, Series=T



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

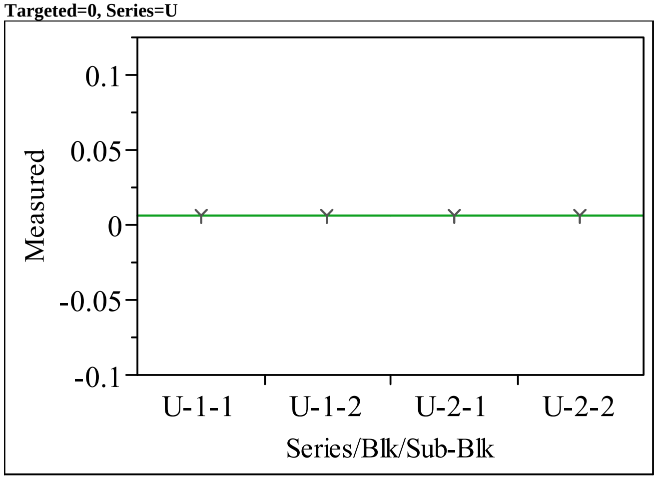
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Ce2O3 (wt%), Targeted=0, Series=U



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
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

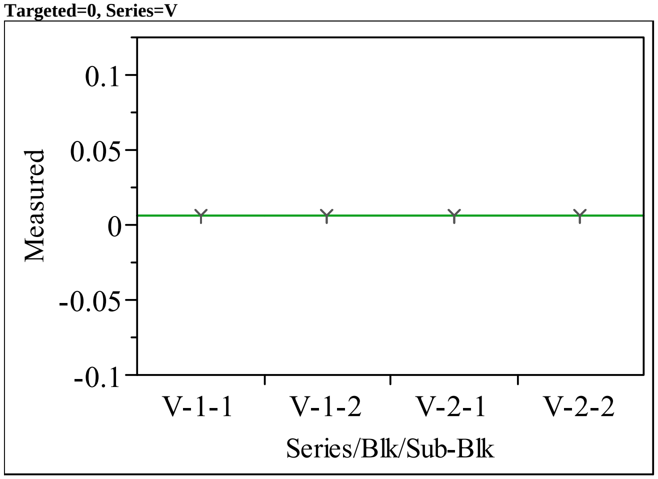
Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Ce2O3 (wt%), Targeted=0, Series=V



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

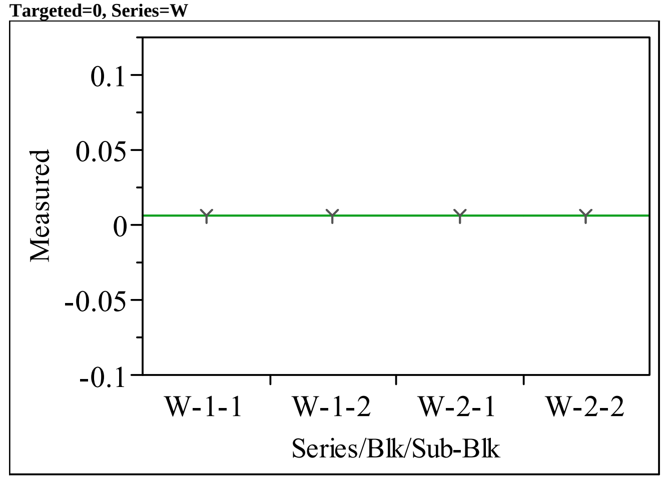
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Ce2O3 (wt%), Targeted=0, Series=W



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
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

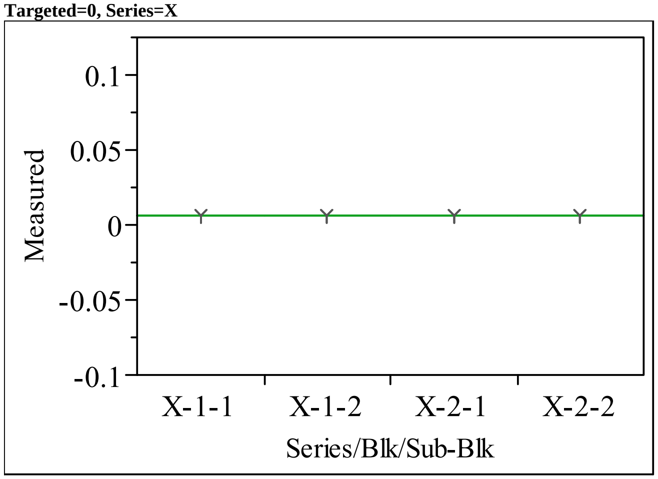
Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Ce2O3 (wt%), Targeted=0, Series=X



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

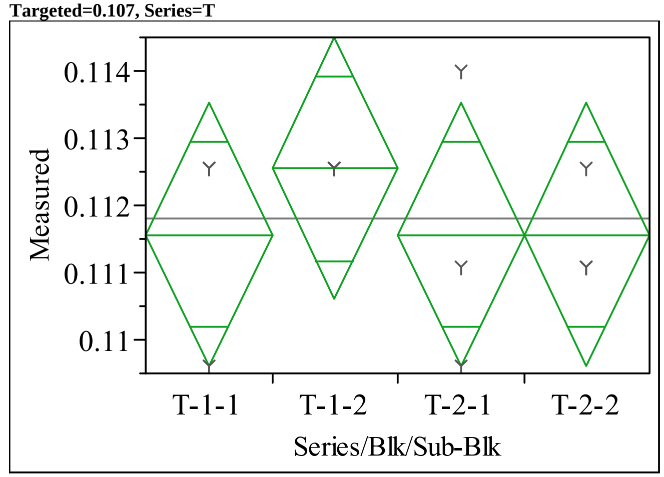
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Cr2O3 (wt%), Targeted=0.107, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.111111
Adj Rsquare	-0.22222
Root Mean Square Error	0.001462
Mean of Response	0.111812
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00000214	7.1209e-7	0.3333	0.8018
Error	8	0.00001709	2.1363e-6		
C. Total	11	0.00001923			

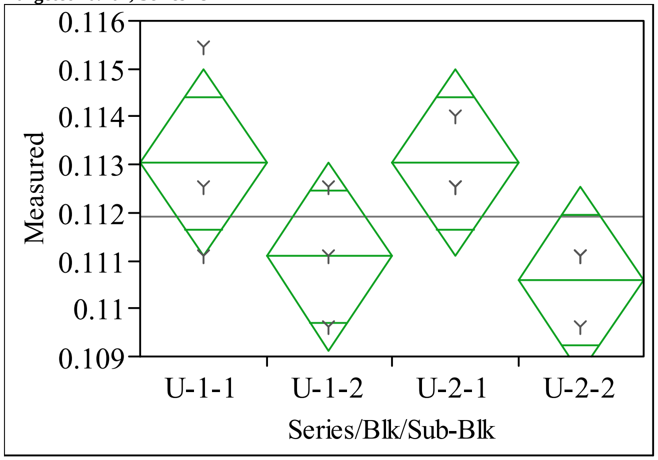
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	0.111569	0.00084	0.10962	0.11351
T-1-2	3	0.112543	0.00084	0.11060	0.11449
T-2-1	3	0.111569	0.00084	0.10962	0.11351
T-2-2	3	0.111569	0.00084	0.10962	0.11351

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Cr2O3 (wt%), Targeted=0.107, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.463687
Adj Rsquare	0.26257
Root Mean Square Error	0.001462
Mean of Response	0.111934
Observations (or Sum Wgts)	12

Analysis of Variance

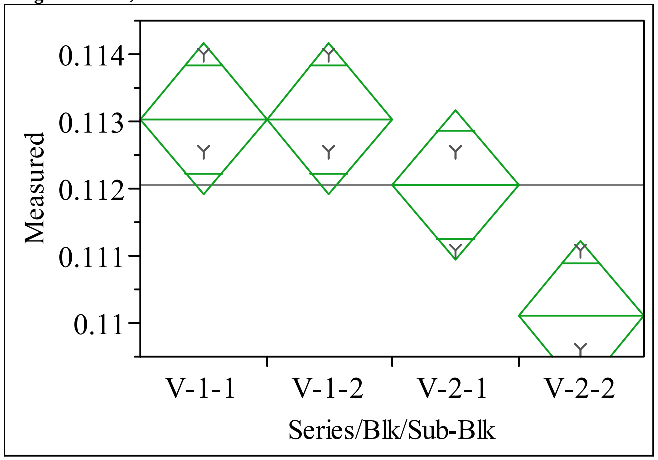
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00001478	4.9253e-6	2.3056	0.1534
Error	8	0.00001709	2.1363e-6		
C. Total	11	0.00003187			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	0.113030	0.00084	0.11108	0.11498
U-1-2	3	0.111082	0.00084	0.10914	0.11303
U-2-1	3	0.113030	0.00084	0.11108	0.11498
U-2-2	3	0.110594	0.00084	0.10865	0.11254

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Cr2O3 (wt%), Targeted=0.107, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.75
Adj Rsquare	0.65625
Root Mean Square Error	0.000844
Mean of Response	0.112056
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00001709	5.6967e-6	8.0000	0.0086
Error	8	0.00000570	7.1209e-7		
C. Total	11	0.00002279			

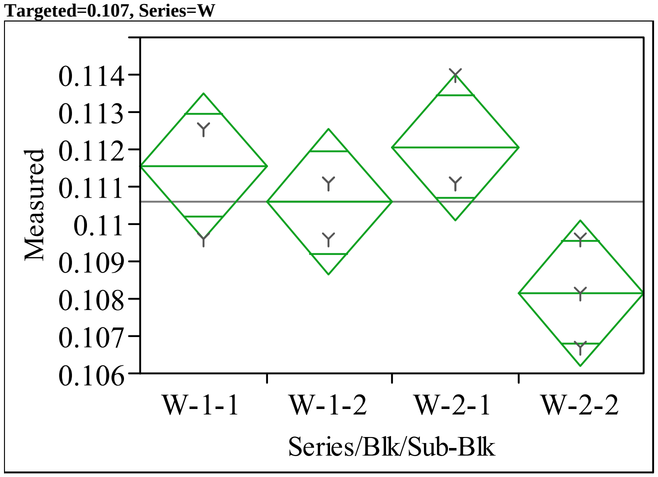
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	0.113030	0.00049	0.11191	0.11415
V-1-2	3	0.113030	0.00049	0.11191	0.11415
V-2-1	3	0.112056	0.00049	0.11093	0.11318
V-2-2	3	0.110107	0.00049	0.10898	0.11123

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Cr2O3 (wt%), Targeted=0.107, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.612903
Adj Rsquare	0.467742
Root Mean Square Error	0.001462
Mean of Response	0.110594
Observations (or Sum Wgts)	12

Analysis of Variance

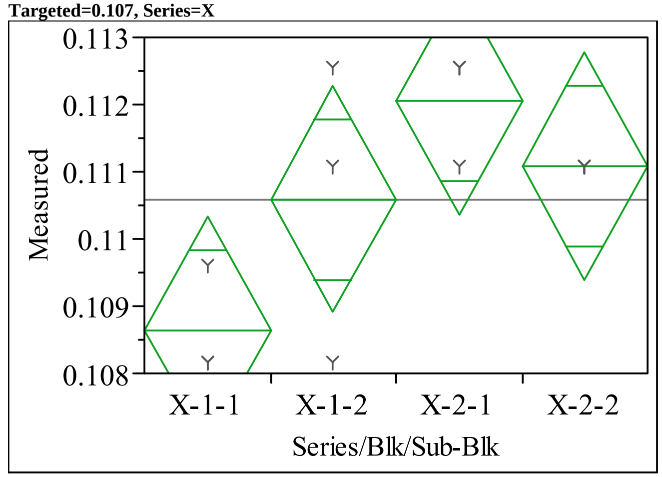
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00002706	9.0198e-6	4.2222	0.0459
Error	8	0.00001709	2.1363e-6		
C. Total	11	0.00004415			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	0.111569	0.00084	0.10962	0.11351
W-1-2	3	0.110594	0.00084	0.10865	0.11254
W-2-1	3	0.112056	0.00084	0.11011	0.11400
W-2-2	3	0.108158	0.00084	0.10621	0.11010

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Cr2O3 (wt%), Targeted=0.107, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.590909
Adj Rsquare	0.4375
Root Mean Square Error	0.001266
Mean of Response	0.110594
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00001851	6.1715e-6	3.8519	0.0565
Error	8	0.00001282	1.6022e-6		
C. Total	11	0.00003133			

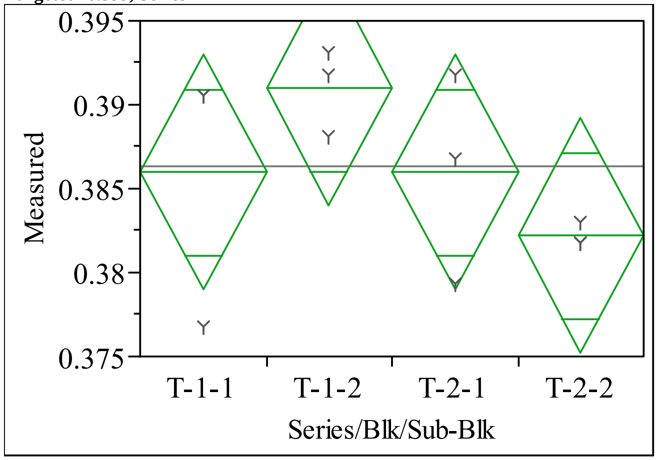
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	0.108646	0.00073	0.10696	0.11033
X-1-2	3	0.110594	0.00073	0.10891	0.11228
X-2-1	3	0.112056	0.00073	0.11037	0.11374
X-2-2	3	0.111082	0.00073	0.10940	0.11277

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=CuO (wt%), Targeted=0.399, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.345483
Adj Rsquare	0.100039
Root Mean Square Error	0.005249
Mean of Response	0.386285
Observations (or Sum Wgts)	12

Analysis of Variance

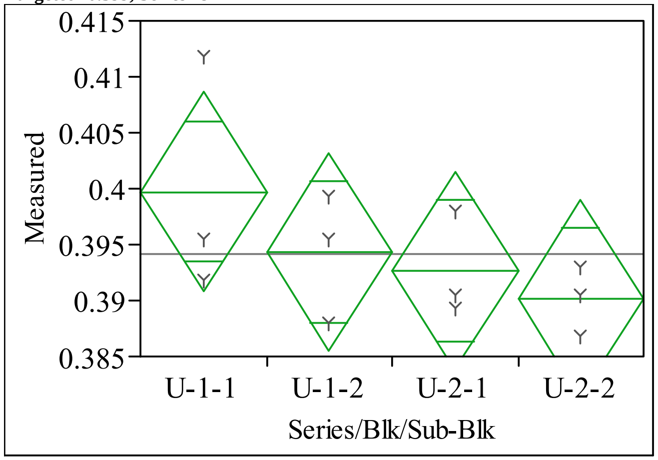
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00011635	0.000039	1.4076	0.3099
Error	8	0.00022043	0.000028		
C. Total	11	0.00033678			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	0.385972	0.00303	0.37898	0.39296
T-1-2	3	0.390979	0.00303	0.38399	0.39797
T-2-1	3	0.385972	0.00303	0.37898	0.39296
T-2-2	3	0.382216	0.00303	0.37523	0.38920

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=CuO (wt%), Targeted=0.399, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.293935
Adj Rsquare	0.029161
Root Mean Square Error	0.006683
Mean of Response	0.394213
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00014873	0.000050	1.1101	0.4002
Error	8	0.00035728	0.000045		
C. Total	11	0.00050601			

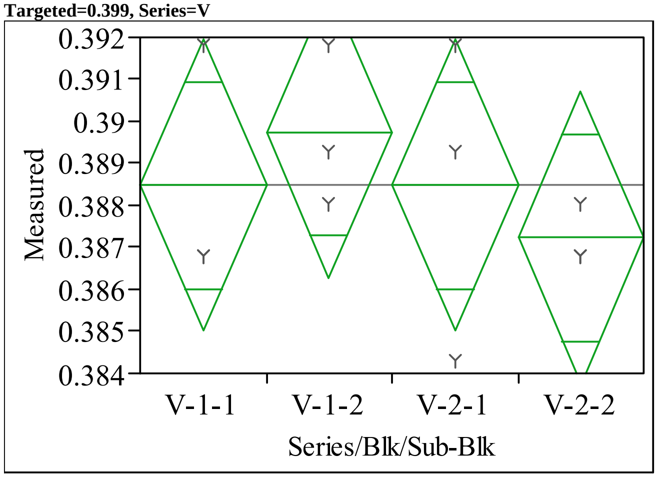
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	0.399741	0.00386	0.39084	0.40864
U-1-2	3	0.394317	0.00386	0.38542	0.40321
U-2-1	3	0.392648	0.00386	0.38375	0.40155
U-2-2	3	0.390144	0.00386	0.38125	0.39904

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=CuO (wt%), Targeted=0.399, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.147541
Adj Rsquare	-0.17213
Root Mean Square Error	0.002606
Mean of Response	0.388475
Observations (or Sum Wgts)	12

Analysis of Variance

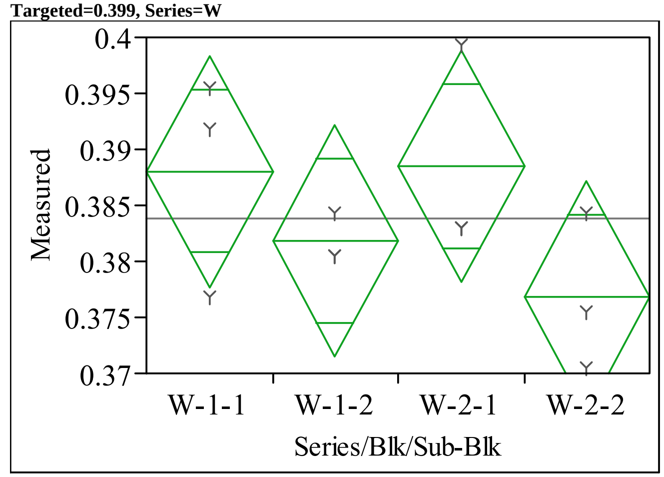
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00000940	3.134e-6	0.4615	0.7168
Error	8	0.00005432	6.7903e-6		
C. Total	11	0.00006372			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	0.388475	0.00150	0.38501	0.39194
V-1-2	3	0.389727	0.00150	0.38626	0.39320
V-2-1	3	0.388475	0.00150	0.38501	0.39194
V-2-2	3	0.387223	0.00150	0.38375	0.39069

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=CuO (wt%), Targeted=0.399, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.367589
Adj Rsquare	0.130435
Root Mean Square Error	0.00775
Mean of Response	0.383781
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00027932	0.000093	1.5500	0.2753
Error	8	0.00048055	0.000060		
C. Total	11	0.00075987			

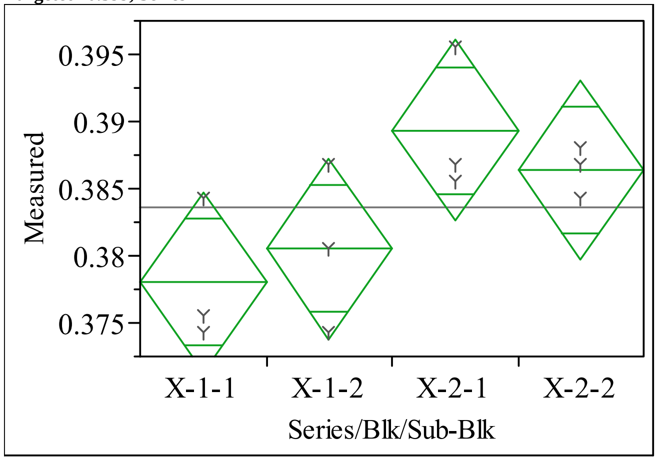
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	0.388058	0.00447	0.37774	0.39838
W-1-2	3	0.381799	0.00447	0.37148	0.39212
W-2-1	3	0.388475	0.00447	0.37816	0.39879
W-2-2	3	0.376792	0.00447	0.36647	0.38711

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=CuO (wt%), Targeted=0.399, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.541386
Adj Rsquare	0.369406
Root Mean Square Error	0.005059
Mean of Response	0.383572
Observations (or Sum Wgts)	12

Analysis of Variance

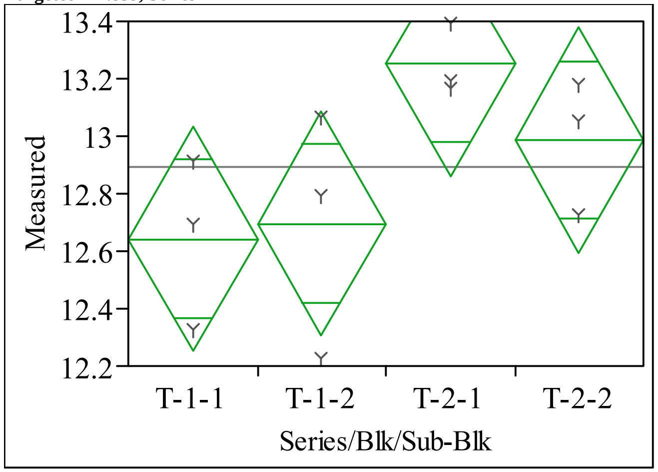
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00024171	0.000081	3.1480	0.0865
Error	8	0.00020476	0.000026		
C. Total	11	0.00044647			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	0.378044	0.00292	0.37131	0.38478
X-1-2	3	0.380547	0.00292	0.37381	0.38728
X-2-1	3	0.389310	0.00292	0.38257	0.39605
X-2-2	3	0.386389	0.00292	0.37965	0.39312

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Fe2O3 (wt%), Targeted=12.839, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.510757
Adj Rsquare	0.327291
Root Mean Square Error	0.293495
Mean of Response	12.8947
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.7194176	0.239806	2.7839	0.1098
Error	8	0.6891147	0.086139		
C. Total	11	1.4085324			

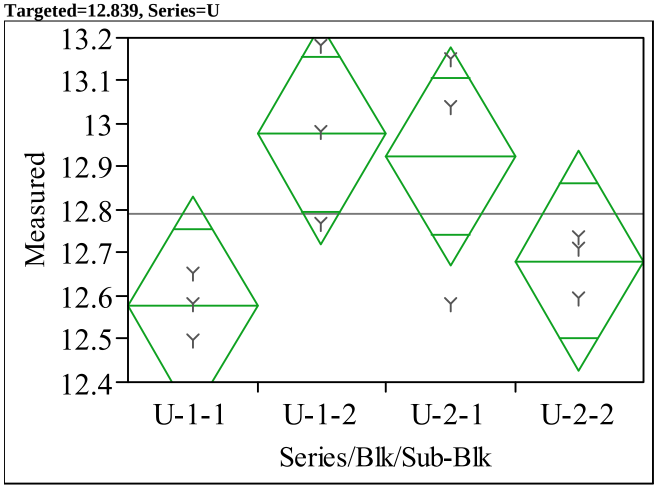
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	12.6433	0.16945	12.253	13.034
T-1-2	3	12.6957	0.16945	12.305	13.086
T-2-1	3	13.2533	0.16945	12.863	13.644
T-2-2	3	12.9864	0.16945	12.596	13.377

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Fe2O3 (wt%), Targeted=12.839, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.530504
Adj Rsquare	0.354442
Root Mean Square Error	0.19137
Mean of Response	12.78986
Observations (or Sum Wgts)	12

Analysis of Variance

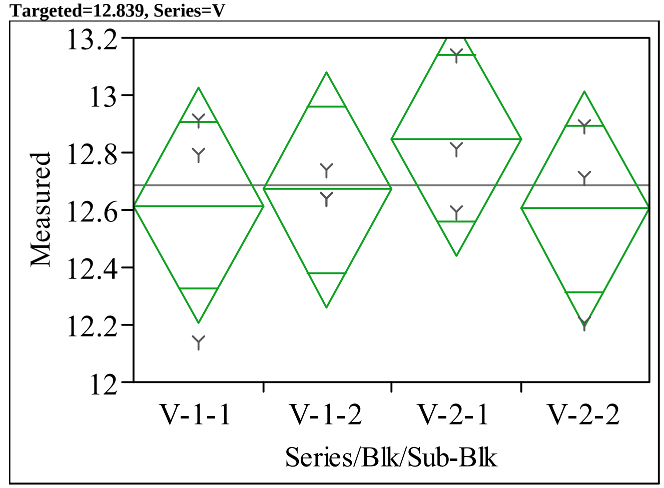
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.33104965	0.110350	3.0132	0.0943
Error	8	0.29297937	0.036622		
C. Total	11	0.62402902			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	12.5766	0.11049	12.322	12.831
U-1-2	3	12.9769	0.11049	12.722	13.232
U-2-1	3	12.9245	0.11049	12.670	13.179
U-2-2	3	12.6814	0.11049	12.427	12.936

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Fe2O3 (wt%), Targeted=12.839, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.131473
Adj Rsquare	-0.19422
Root Mean Square Error	0.30733
Mean of Response	12.68501
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.11438119	0.038127	0.4037	0.7545
Error	8	0.75561423	0.094452		
C. Total	11	0.86999541			

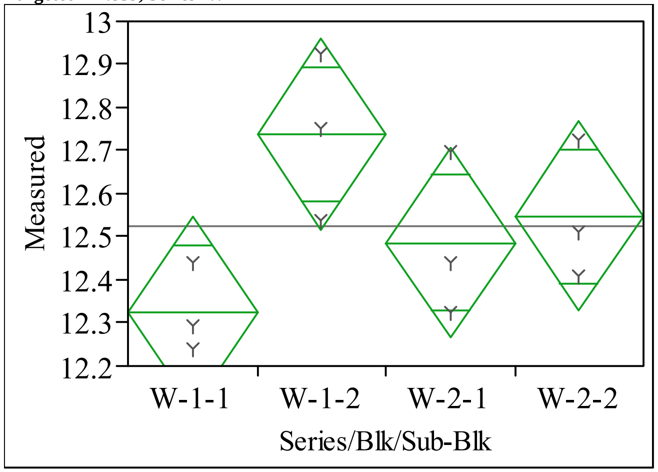
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	12.6147	0.17744	12.206	13.024
V-1-2	3	12.6719	0.17744	12.263	13.081
V-2-1	3	12.8482	0.17744	12.439	13.257
V-2-2	3	12.6052	0.17744	12.196	13.014

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Fe2O3 (wt%), Targeted=12.839, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.545429
Adj Rsquare	0.374965
Root Mean Square Error	0.165911
Mean of Response	12.52417
Observations (or Sum Wgts)	12

Analysis of Variance

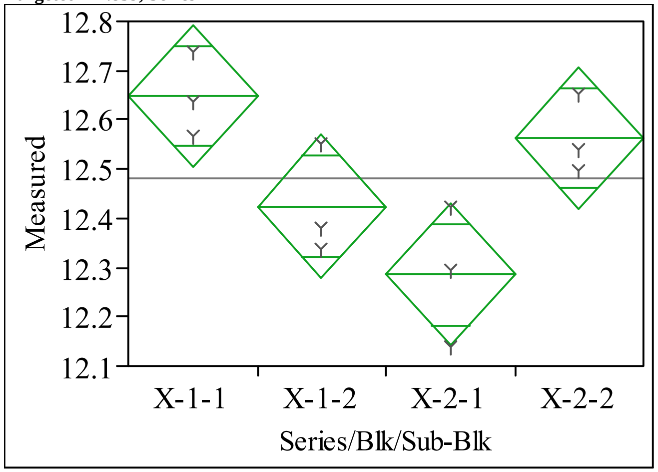
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.26422651	0.088076	3.1997	0.0837
Error	8	0.22021147	0.027526		
C. Total	11	0.48443798			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	12.3240	0.09579	12.103	12.545
W-1-2	3	12.7386	0.09579	12.518	12.960
W-2-1	3	12.4860	0.09579	12.265	12.707
W-2-2	3	12.5480	0.09579	12.327	12.769

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Fe2O3 (wt%), Targeted=12.839, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.705755
Adj Rsquare	0.595413
Root Mean Square Error	0.108883
Mean of Response	12.48009
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.22748485	0.075828	6.3961	0.0161
Error	8	0.09484355	0.011855		
C. Total	11	0.32232840			

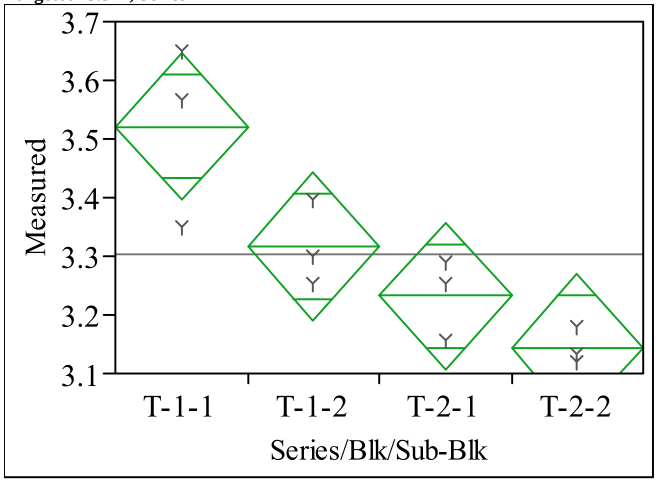
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	12.6481	0.06286	12.503	12.793
X-1-2	3	12.4241	0.06286	12.279	12.569
X-2-1	3	12.2859	0.06286	12.141	12.431
X-2-2	3	12.5623	0.06286	12.417	12.707

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=K2O (wt%), Targeted=3.327, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.768819
Adj Rsquare	0.682126
Root Mean Square Error	0.093889
Mean of Response	3.303616
Observations (or Sum Wgts)	12

Analysis of Variance

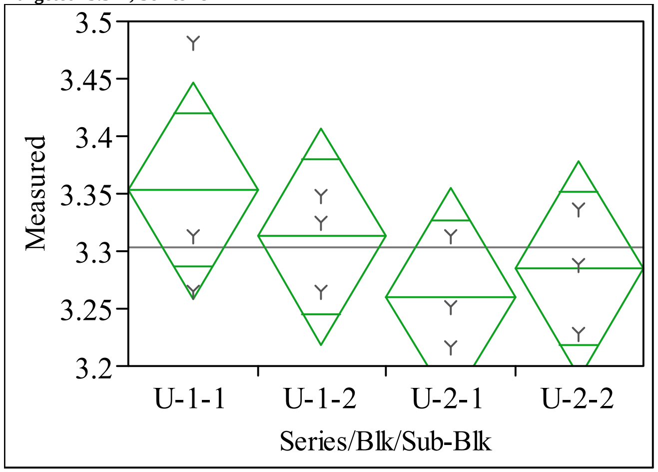
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.23452776	0.078176	8.8683	0.0063
Error	8	0.07052157	0.008815		
C. Total	11	0.30504933			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	3.52145	0.05421	3.3964	3.6464
T-1-2	3	3.31667	0.05421	3.1917	3.4417
T-2-1	3	3.23234	0.05421	3.1073	3.3573
T-2-2	3	3.14401	0.05421	3.0190	3.2690

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=K2O (wt%), Targeted=3.327, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.259982
Adj Rsquare	-0.01752
Root Mean Square Error	0.07101
Mean of Response	3.302612
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.01417203	0.004724	0.9369	0.4667
Error	8	0.04033950	0.005042		
C. Total	11	0.05451153			

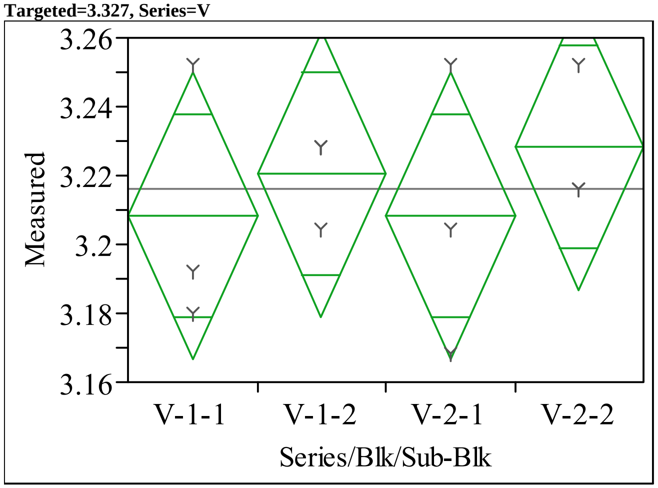
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	3.35280	0.04100	3.2583	3.4473
U-1-2	3	3.31265	0.04100	3.2181	3.4072
U-2-1	3	3.26045	0.04100	3.1659	3.3550
U-2-2	3	3.28454	0.04100	3.1900	3.3791

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=K2O (wt%), Targeted=3.327, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.1
Adj Rsquare	-0.2375
Root Mean Square Error	0.031296
Mean of Response	3.216282
Observations (or Sum Wgts)	12

Analysis of Variance

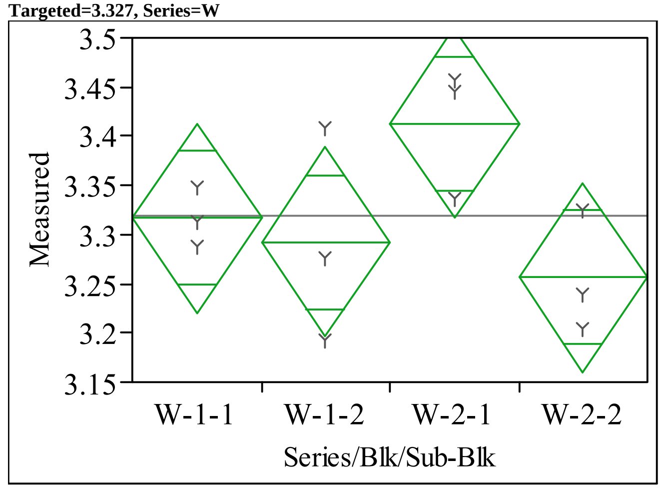
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00087064	0.000290	0.2963	0.8272
Error	8	0.00783573	0.000979		
C. Total	11	0.00870637			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	3.20825	0.01807	3.1666	3.2499
V-1-2	3	3.22030	0.01807	3.1786	3.2620
V-2-1	3	3.20825	0.01807	3.1666	3.2499
V-2-2	3	3.22833	0.01807	3.1867	3.2700

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=K2O (wt%), Targeted=3.327, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.489087
Adj Rsquare	0.297495
Root Mean Square Error	0.07261
Mean of Response	3.319677
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.04037578	0.013459	2.5528	0.1286
Error	8	0.04217751	0.005272		
C. Total	11	0.08255329			

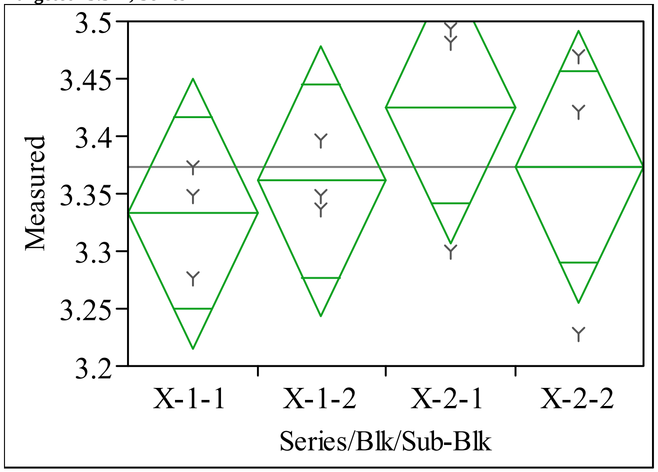
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	3.31667	0.04192	3.2200	3.4133
W-1-2	3	3.29257	0.04192	3.1959	3.3892
W-2-1	3	3.41303	0.04192	3.3164	3.5097
W-2-2	3	3.25644	0.04192	3.1598	3.3531

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=K2O (wt%), Targeted=3.327, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.176172
Adj Rsquare	-0.13276
Root Mean Square Error	0.088656
Mean of Response	3.37288
Observations (or Sum Wgts)	12

Analysis of Variance

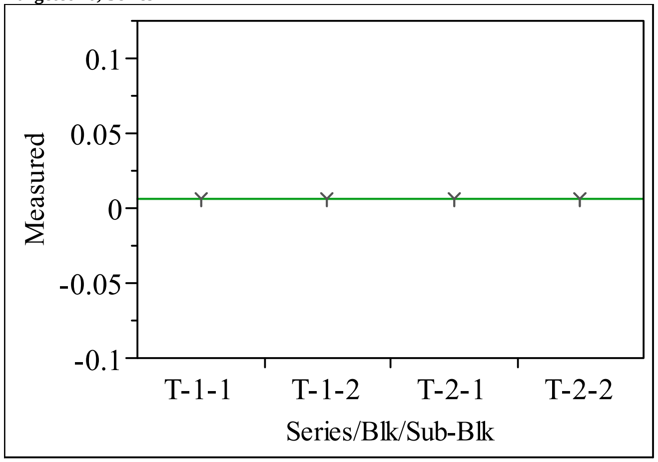
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.01344650	0.004482	0.5703	0.6501
Error	8	0.06287932	0.007860		
C. Total	11	0.07632582			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	3.33273	0.05119	3.2147	3.4508
X-1-2	3	3.36083	0.05119	3.2428	3.4789
X-2-1	3	3.42508	0.05119	3.3070	3.5431
X-2-2	3	3.37288	0.05119	3.2548	3.4909

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=La2O3 (wt%), Targeted=0, Series=T



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
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

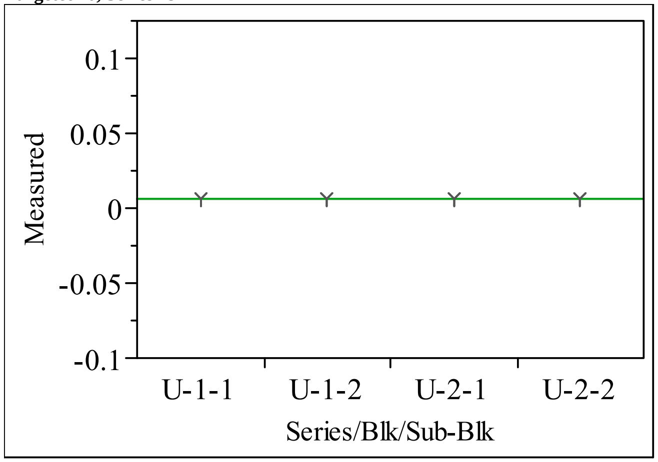
Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=La2O3 (wt%), Targeted=0, Series=U



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

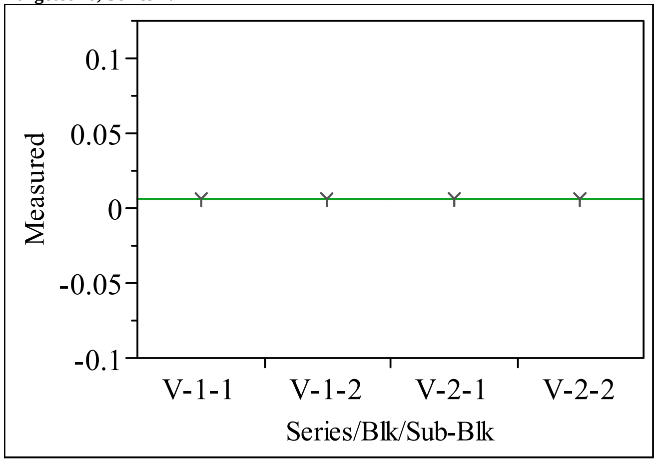
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=La2O3 (wt%), Targeted=0, Series=V



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
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

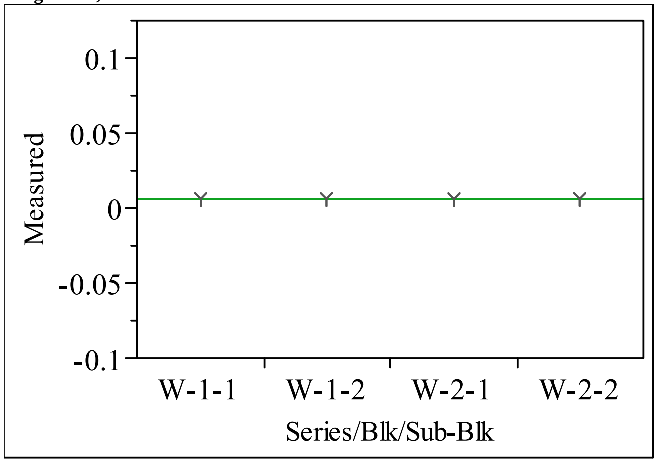
Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=La2O3 (wt%), Targeted=0, Series=W



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

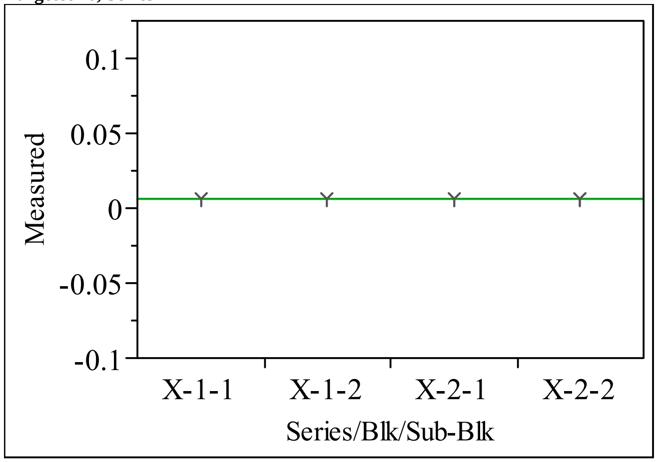
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=La2O3 (wt%), Targeted=0, Series=X



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
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

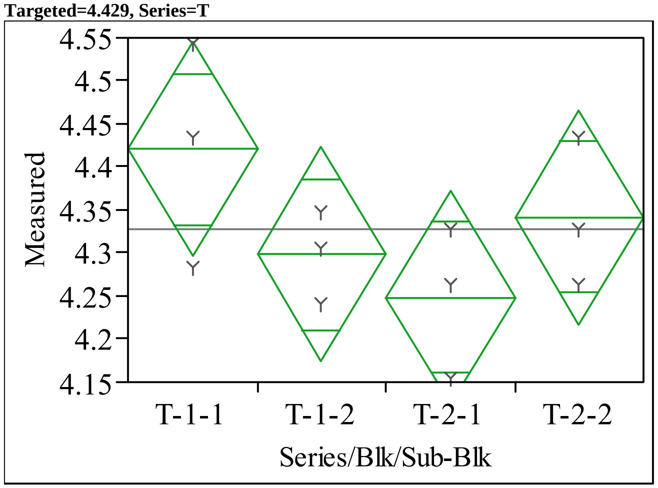
Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Li2O (wt%), Targeted=4.429, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.406824
Adj Rsquare	0.184383
Root Mean Square Error	0.09343
Mean of Response	4.327329
Observations (or Sum Wgts)	12

Analysis of Variance

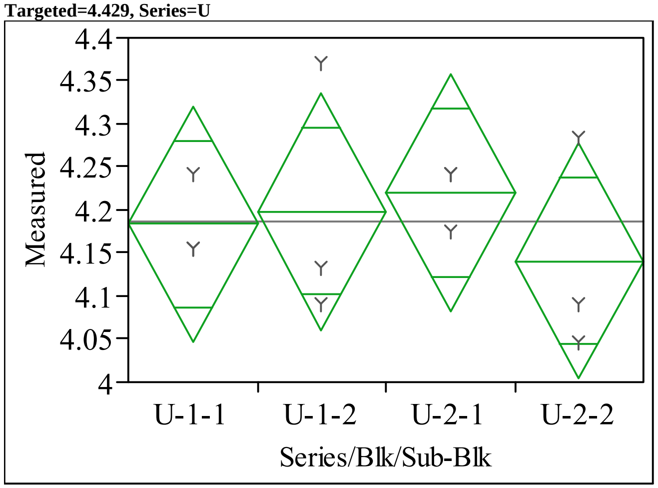
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.04789478	0.015965	1.8289	0.2200
Error	8	0.06983367	0.008729		
C. Total	11	0.11772845			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	4.42062	0.05394	4.2962	4.5450
T-1-2	3	4.29862	0.05394	4.1742	4.4230
T-2-1	3	4.24839	0.05394	4.1240	4.3728
T-2-2	3	4.34168	0.05394	4.2173	4.4661

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Li2O (wt%), Targeted=4.429, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.105327
Adj Rsquare	-0.23017
Root Mean Square Error	0.103062
Mean of Response	4.185596
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.01000383	0.003335	0.3139	0.8151
Error	8	0.08497460	0.010622		
C. Total	11	0.09497843			

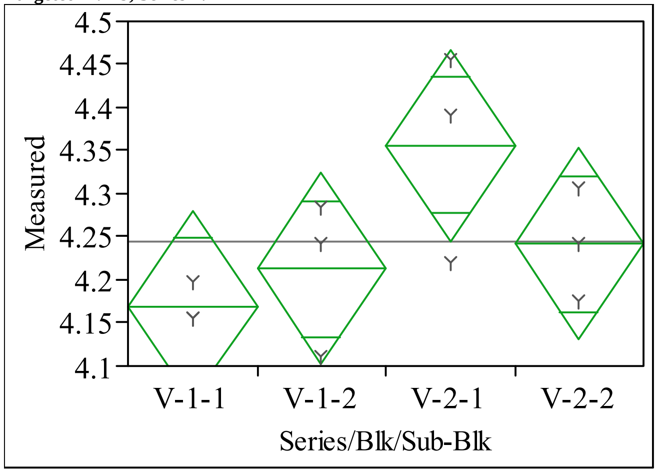
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	4.18380	0.05950	4.0466	4.3210
U-1-2	3	4.19815	0.05950	4.0609	4.3354
U-2-1	3	4.21968	0.05950	4.0825	4.3569
U-2-2	3	4.14074	0.05950	4.0035	4.2780

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Li2O (wt%), Targeted=4.429, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.507524
Adj Rsquare	0.322845
Root Mean Square Error	0.083381
Mean of Response	4.244801
Observations (or Sum Wgts)	12

Analysis of Variance

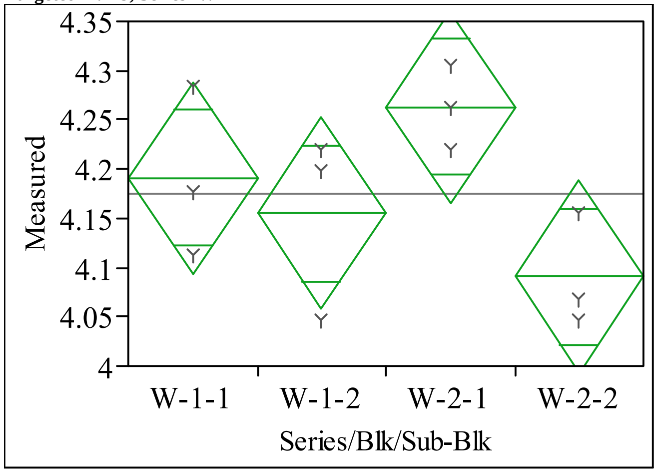
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.05731923	0.019106	2.7481	0.1125
Error	8	0.05561974	0.006952		
C. Total	11	0.11293897			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	4.16945	0.04814	4.0584	4.2805
V-1-2	3	4.21251	0.04814	4.1015	4.3235
V-2-1	3	4.35603	0.04814	4.2450	4.4670
V-2-2	3	4.24121	0.04814	4.1302	4.3522

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Li2O (wt%), Targeted=4.429, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.519654
Adj Rsquare	0.339525
Root Mean Square Error	0.073272
Mean of Response	4.174832
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.04646566	0.015489	2.8849	0.1026
Error	8	0.04295080	0.005369		
C. Total	11	0.08941646			

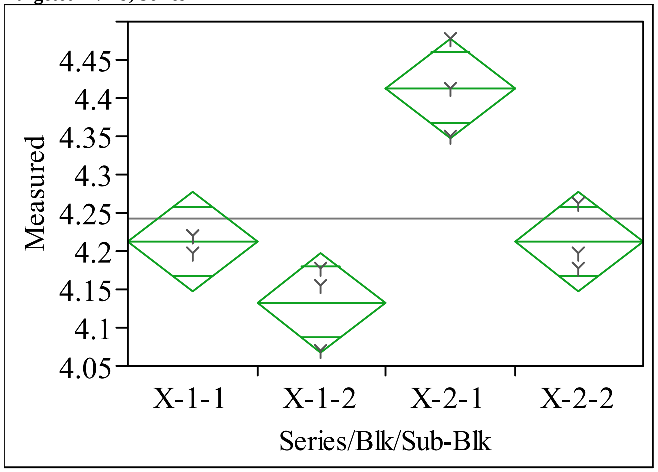
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	4.19098	0.04230	4.0934	4.2885
W-1-2	3	4.15510	0.04230	4.0575	4.2526
W-2-1	3	4.26274	0.04230	4.1652	4.3603
W-2-2	3	4.09051	0.04230	3.9930	4.1881

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Li2O (wt%), Targeted=4.429, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.870395
Adj Rsquare	0.821793
Root Mean Square Error	0.048936
Mean of Response	4.243007
Observations (or Sum Wgts)	12

Analysis of Variance

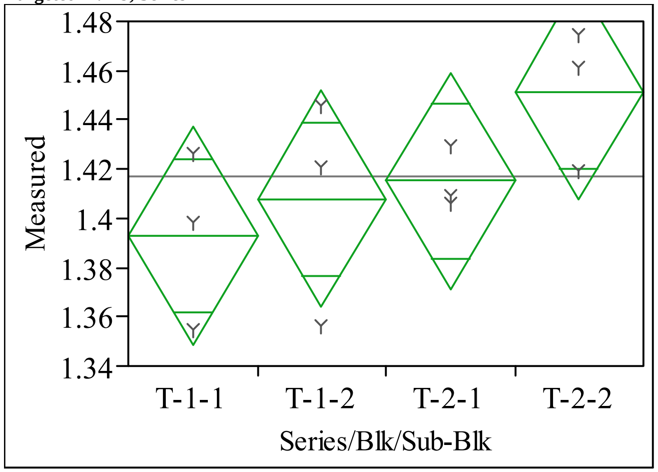
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.12865928	0.042886	17.9086	0.0007
Error	8	0.01915791	0.002395		
C. Total	11	0.14781719			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	4.21251	0.02825	4.1474	4.2777
X-1-2	3	4.13357	0.02825	4.0684	4.1987
X-2-1	3	4.41345	0.02825	4.3483	4.4786
X-2-2	3	4.21251	0.02825	4.1474	4.2777

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=MgO (wt%), Targeted=1.419, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.387912
Adj Rsquare	0.158379
Root Mean Square Error	0.033163
Mean of Response	1.416879
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00557577	0.001859	1.6900	0.2457
Error	8	0.00879804	0.001100		
C. Total	11	0.01437381			

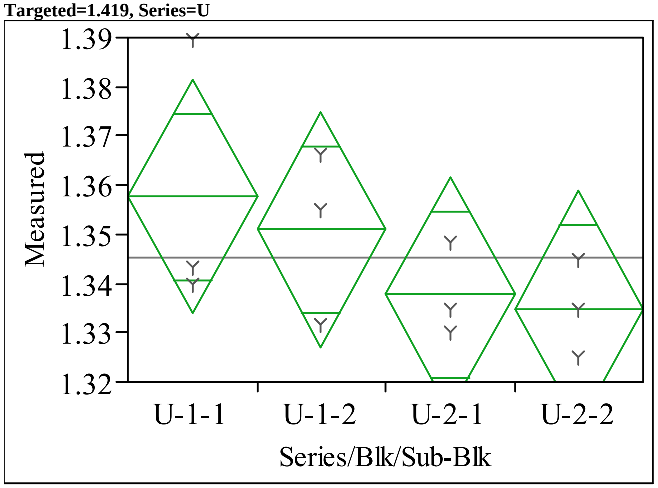
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	1.39297	0.01915	1.3488	1.4371
T-1-2	3	1.40790	0.01915	1.3637	1.4520
T-2-1	3	1.41508	0.01915	1.3709	1.4592
T-2-2	3	1.45157	0.01915	1.4074	1.4957

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=MgO (wt%), Targeted=1.419, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.290655
Adj Rsquare	0.024651
Root Mean Square Error	0.01786
Mean of Response	1.345296
Observations (or Sum Wgts)	12

Analysis of Variance

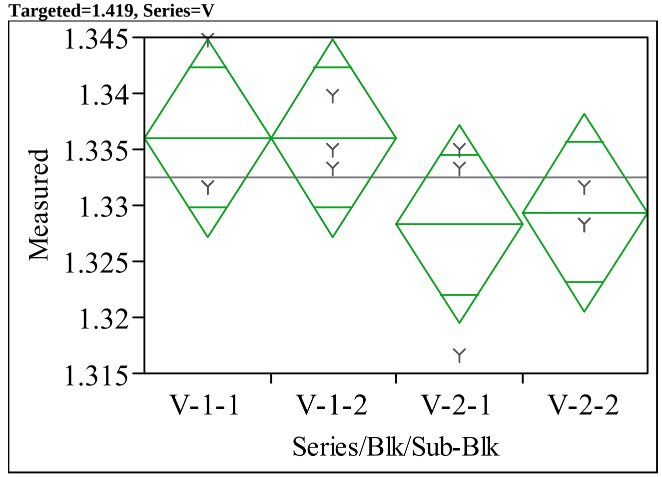
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00104567	0.000349	1.0927	0.4064
Error	8	0.00255196	0.000319		
C. Total	11	0.00359763			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	1.35759	0.01031	1.3338	1.3814
U-1-2	3	1.35096	0.01031	1.3272	1.3747
U-2-1	3	1.33770	0.01031	1.3139	1.3615
U-2-2	3	1.33493	0.01031	1.3112	1.3587

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=MgO (wt%), Targeted=1.419, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.308108
Adj Rsquare	0.048649
Root Mean Square Error	0.006633
Mean of Response	1.332444
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00015675	0.000052	1.1875	0.3741
Error	8	0.00035199	0.000044		
C. Total	11	0.00050874			

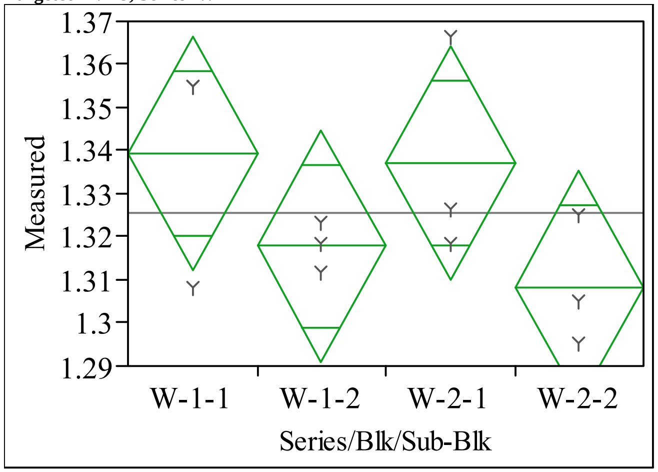
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	1.33604	0.00383	1.3272	1.3449
V-1-2	3	1.33604	0.00383	1.3272	1.3449
V-2-1	3	1.32830	0.00383	1.3195	1.3371
V-2-2	3	1.32940	0.00383	1.3206	1.3382

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=MgO (wt%), Targeted=1.419, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.382524
Adj Rsquare	0.15097
Root Mean Square Error	0.020276
Mean of Response	1.325673
Observations (or Sum Wgts)	12

Analysis of Variance

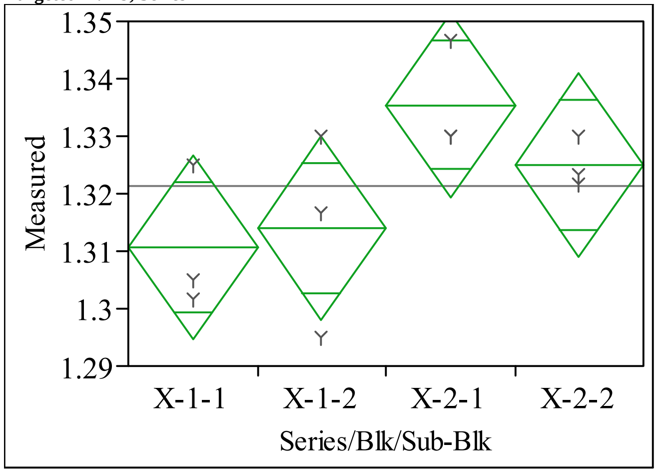
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00203749	0.000679	1.6520	0.2533
Error	8	0.00328895	0.000411		
C. Total	11	0.00532644			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	1.33935	0.01171	1.3124	1.3663
W-1-2	3	1.31780	0.01171	1.2908	1.3448
W-2-1	3	1.33714	0.01171	1.3101	1.3641
W-2-2	3	1.30840	0.01171	1.2814	1.3354

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=MgO (wt%), Targeted=1.419, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.498956
Adj Rsquare	0.311065
Root Mean Square Error	0.012016
Mean of Response	1.321251
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00115017	0.000383	2.6556	0.1198
Error	8	0.00115498	0.000144		
C. Total	11	0.00230515			

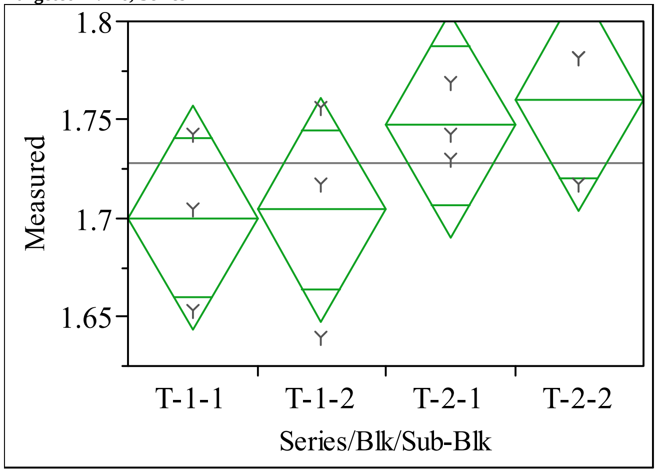
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	1.31061	0.00694	1.2946	1.3266
X-1-2	3	1.31393	0.00694	1.2979	1.3299
X-2-1	3	1.33548	0.00694	1.3195	1.3515
X-2-2	3	1.32498	0.00694	1.3090	1.3410

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=MnO (wt%), Targeted=1.726, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.360775
Adj Rsquare	0.121065
Root Mean Square Error	0.042824
Mean of Response	1.728056
Observations (or Sum Wgts)	12

Analysis of Variance

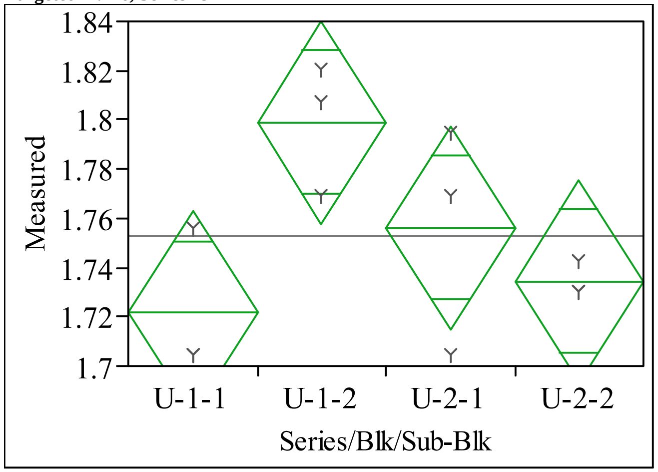
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00828041	0.002760	1.5051	0.2857
Error	8	0.01467134	0.001834		
C. Total	11	0.02295175			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	1.70008	0.02472	1.6431	1.7571
T-1-2	3	1.70438	0.02472	1.6474	1.7614
T-2-1	3	1.74742	0.02472	1.6904	1.8044
T-2-2	3	1.76034	0.02472	1.7033	1.8174

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=MnO (wt%), Targeted=1.726, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.575058
Adj Rsquare	0.415704
Root Mean Square Error	0.030962
Mean of Response	1.752804
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.01037830	0.003459	3.6087	0.0651
Error	8	0.00766911	0.000959		
C. Total	11	0.01804741			

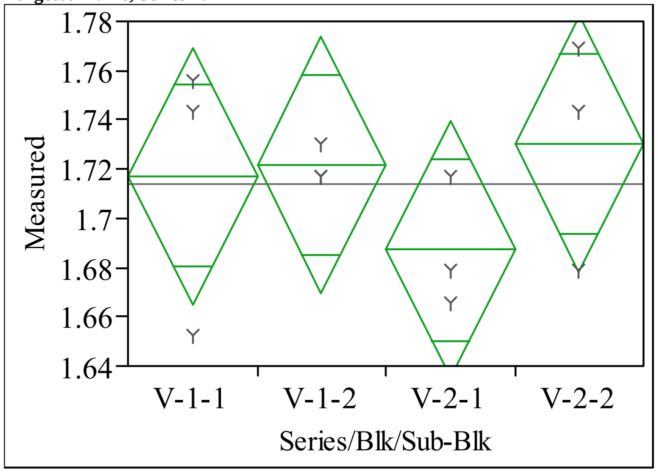
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	1.72160	0.01788	1.6804	1.7628
U-1-2	3	1.79907	0.01788	1.7579	1.8403
U-2-1	3	1.75603	0.01788	1.7148	1.7973
U-2-2	3	1.73451	0.01788	1.6933	1.7757

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=MnO (wt%), Targeted=1.726, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.205059
Adj Rsquare	-0.09304
Root Mean Square Error	0.039093
Mean of Response	1.714068
Observations (or Sum Wgts)	12

Analysis of Variance

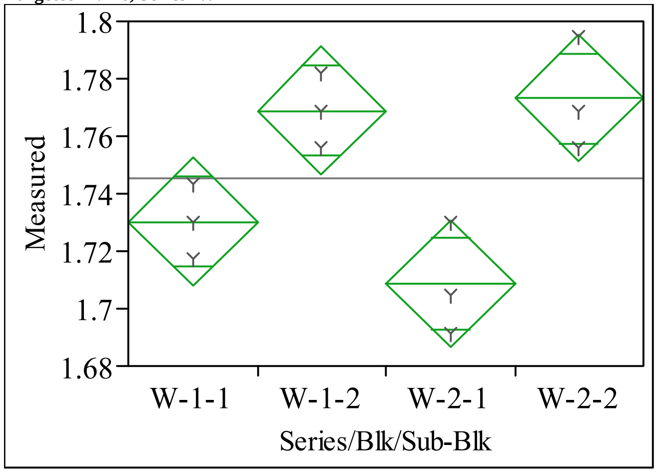
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00315378	0.001051	0.6879	0.5844
Error	8	0.01222611	0.001528		
C. Total	11	0.01537990			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	1.71730	0.02257	1.6652	1.7693
V-1-2	3	1.72160	0.02257	1.6696	1.7736
V-2-1	3	1.68717	0.02257	1.6351	1.7392
V-2-2	3	1.73021	0.02257	1.6782	1.7823

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=MnO (wt%), Targeted=1.726, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.796954
Adj Rsquare	0.720812
Root Mean Square Error	0.016669
Mean of Response	1.745272
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00872500	0.002908	10.4667	0.0038
Error	8	0.00222293	0.000278		
C. Total	11	0.01094793			

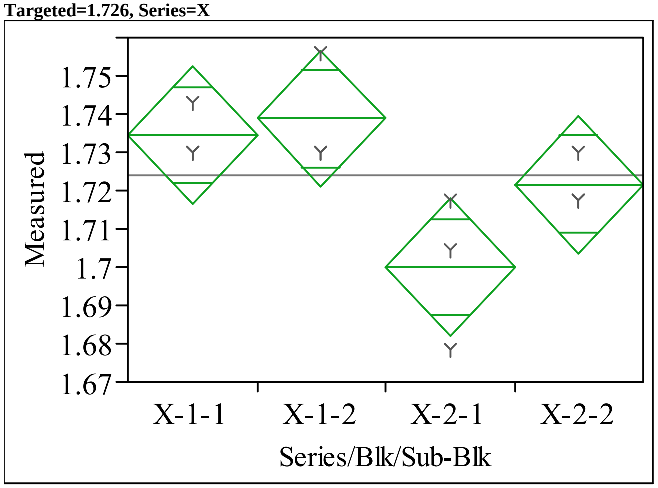
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	1.73021	0.00962	1.7080	1.7524
W-1-2	3	1.76894	0.00962	1.7468	1.7911
W-2-1	3	1.70869	0.00962	1.6865	1.7309
W-2-2	3	1.77325	0.00962	1.7511	1.7954

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=MnO (wt%), Targeted=1.726, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.653333
Adj Rsquare	0.523333
Root Mean Square Error	0.013439
Mean of Response	1.723752
Observations (or Sum Wgts)	12

Analysis of Variance

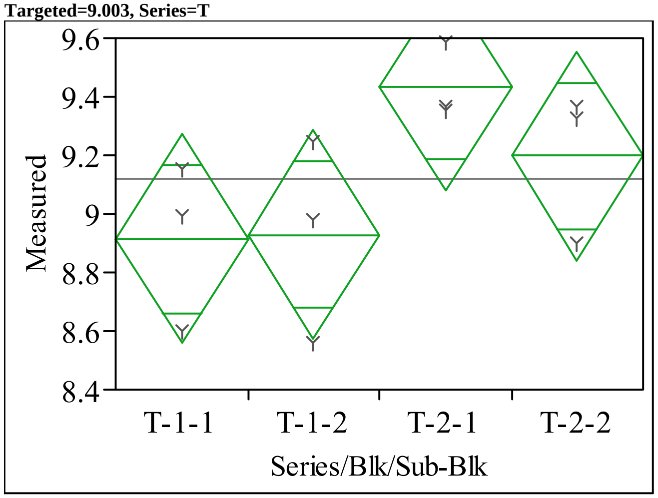
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00272309	0.000908	5.0256	0.0302
Error	8	0.00144490	0.000181		
C. Total	11	0.00416799			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	1.73451	0.00776	1.7166	1.7524
X-1-2	3	1.73882	0.00776	1.7209	1.7567
X-2-1	3	1.70008	0.00776	1.6822	1.7180
X-2-2	3	1.72160	0.00776	1.7037	1.7395

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Na2O (wt%), Targeted=9.003, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.492494
Adj Rsquare	0.302179
Root Mean Square Error	0.267231
Mean of Response	9.11922
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.5543984	0.184799	2.5878	0.1255
Error	8	0.5712975	0.071412		
C. Total	11	1.1256959			

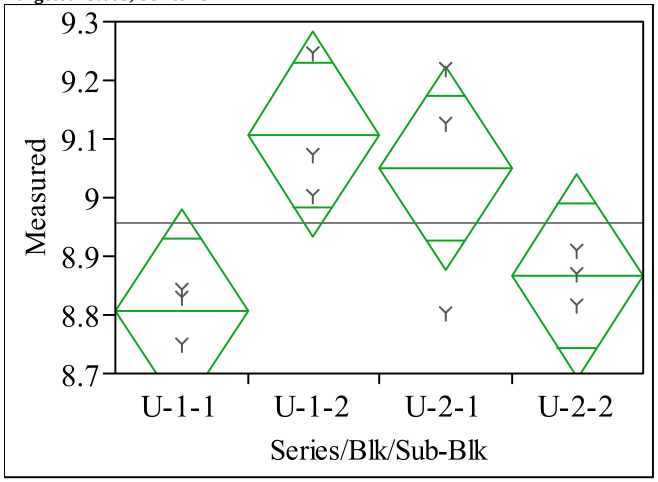
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	8.91477	0.15429	8.5590	9.2706
T-1-2	3	8.92825	0.15429	8.5725	9.2840
T-2-1	3	9.43600	0.15429	9.0802	9.7918
T-2-2	3	9.19785	0.15429	8.8421	9.5536

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Na2O (wt%), Targeted=9.003, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.576743
Adj Rsquare	0.418022
Root Mean Square Error	0.130925
Mean of Response	8.95746
Observations (or Sum Wgts)	12

Analysis of Variance

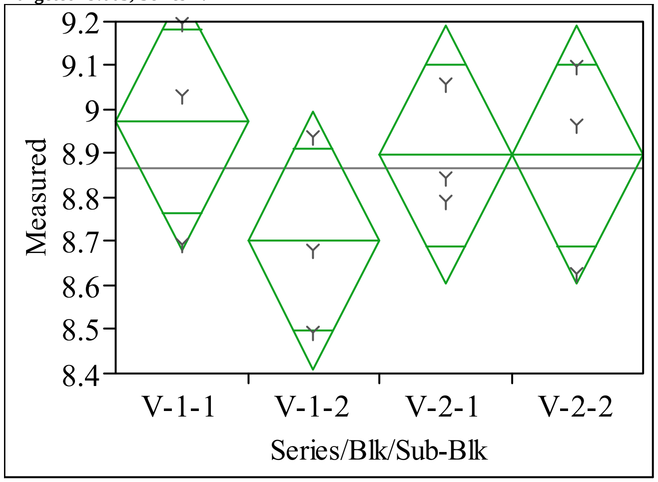
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.18685886	0.062286	3.6337	0.0641
Error	8	0.13713078	0.017141		
C. Total	11	0.32398964			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	8.80693	0.07559	8.6326	8.9812
U-1-2	3	9.10799	0.07559	8.9337	9.2823
U-2-1	3	9.04957	0.07559	8.8753	9.2239
U-2-2	3	8.86535	0.07559	8.6910	9.0397

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Na2O (wt%), Targeted=9.003, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.235104
Adj Rsquare	-0.05173
Root Mean Square Error	0.220231
Mean of Response	8.867593
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.11926259	0.039754	0.8196	0.5186
Error	8	0.38801227	0.048502		
C. Total	11	0.50727487			

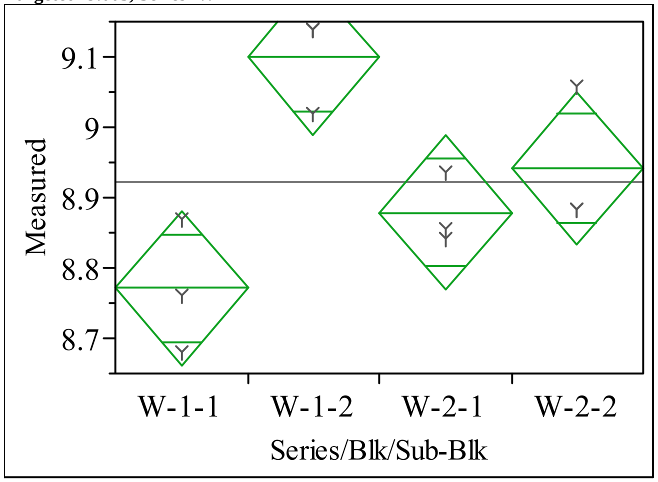
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	8.97319	0.12715	8.6800	9.2664
V-1-2	3	8.70359	0.12715	8.4104	8.9968
V-2-1	3	8.89680	0.12715	8.6036	9.1900
V-2-2	3	8.89680	0.12715	8.6036	9.1900

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Na2O (wt%), Targeted=9.003, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.759984
Adj Rsquare	0.669978
Root Mean Square Error	0.081718
Mean of Response	8.922637
Observations (or Sum Wgts)	12

Analysis of Variance

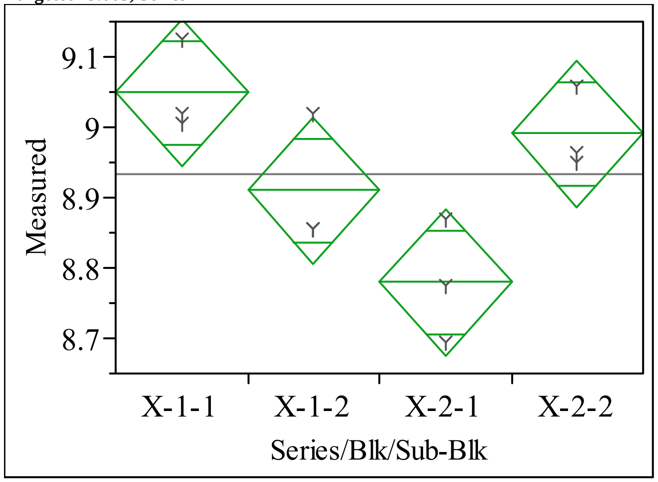
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.16915724	0.056386	8.4437	0.0073
Error	8	0.05342286	0.006678		
C. Total	11	0.22258010			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	8.77099	0.04718	8.6622	8.8798
W-1-2	3	9.09900	0.04718	8.9902	9.2078
W-2-1	3	8.87883	0.04718	8.7700	8.9876
W-2-2	3	8.94173	0.04718	8.8329	9.0505

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=Na2O (wt%), Targeted=9.003, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.716407
Adj Rsquare	0.61006
Root Mean Square Error	0.077924
Mean of Response	8.932747
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.12271509	0.040905	6.7365	0.0140
Error	8	0.04857725	0.006072		
C. Total	11	0.17129234			

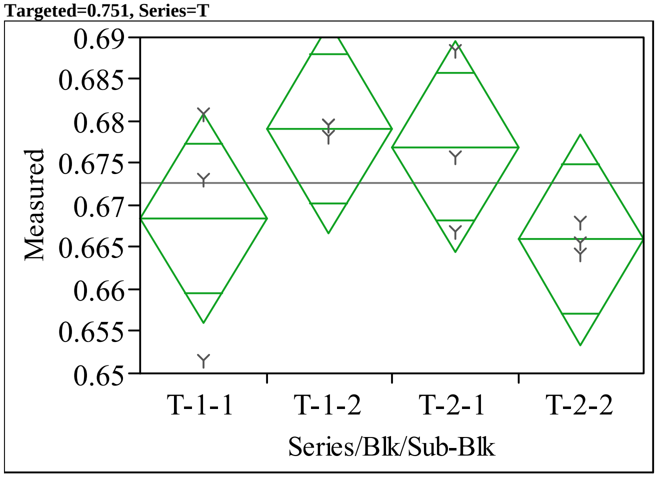
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	9.04957	0.04499	8.9458	9.1533
X-1-2	3	8.91028	0.04499	8.8065	9.0140
X-2-1	3	8.77997	0.04499	8.6762	8.8837
X-2-2	3	8.99116	0.04499	8.8874	9.0949

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=NiO (wt%), Targeted=0.751, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.3423
Adj Rsquare	0.095663
Root Mean Square Error	0.009394
Mean of Response	0.672622
Observations (or Sum Wgts)	12

Analysis of Variance

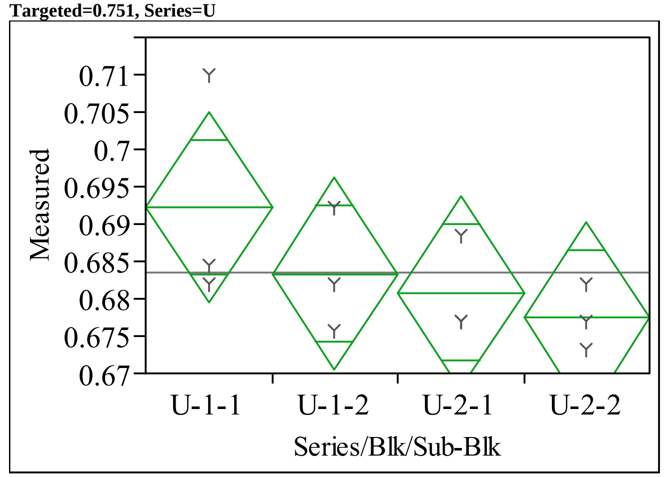
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00036744	0.000122	1.3879	0.3151
Error	8	0.00070600	0.000088		
C. Total	11	0.00107343			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	0.668487	0.00542	0.65598	0.68099
T-1-2	3	0.679091	0.00542	0.66658	0.69160
T-2-1	3	0.676970	0.00542	0.66446	0.68948
T-2-2	3	0.665942	0.00542	0.65343	0.67845

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=NiO (wt%), Targeted=0.751, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.327412
Adj Rsquare	0.075192
Root Mean Square Error	0.009656
Mean of Response	0.683439
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00036312	0.000121	1.2981	0.3400
Error	8	0.00074594	0.000093		
C. Total	11	0.00110906			

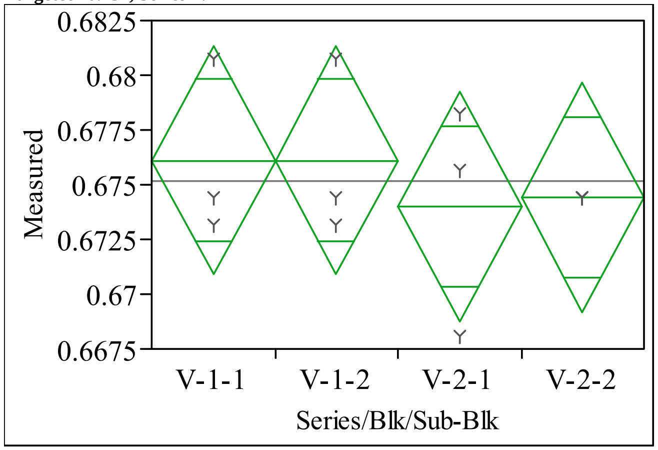
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	0.692240	0.00558	0.67938	0.70510
U-1-2	3	0.683333	0.00558	0.67048	0.69619
U-2-1	3	0.680788	0.00558	0.66793	0.69364
U-2-2	3	0.677394	0.00558	0.66454	0.69025

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=NiO (wt%), Targeted=0.751, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.083417
Adj Rsquare	-0.2603
Root Mean Square Error	0.003922
Mean of Response	0.675167
Observations (or Sum Wgts)	12

Analysis of Variance

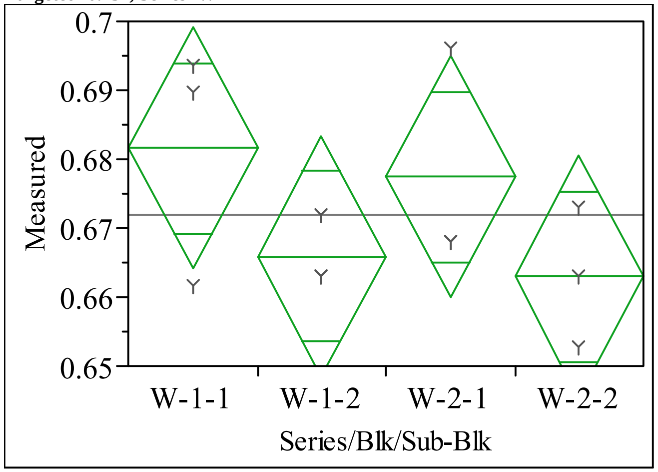
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00001120	3.733e-6	0.2427	0.8642
Error	8	0.00012306	0.000015		
C. Total	11	0.00013426			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	0.676122	0.00226	0.67090	0.68134
V-1-2	3	0.676122	0.00226	0.67090	0.68134
V-2-1	3	0.674001	0.00226	0.66878	0.67922
V-2-2	3	0.674425	0.00226	0.66920	0.67965

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=NiO (wt%), Targeted=0.751, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.342002
Adj Rsquare	0.095253
Root Mean Square Error	0.013163
Mean of Response	0.671986
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00072043	0.000240	1.3860	0.3156
Error	8	0.00138608	0.000173		
C. Total	11	0.00210652			

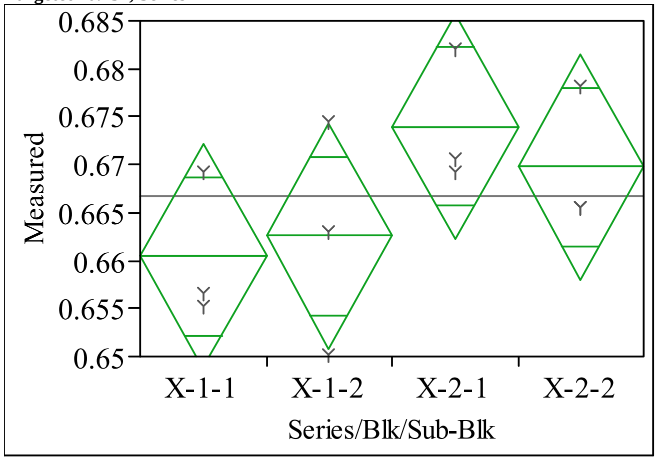
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	0.681636	0.00760	0.66411	0.69916
W-1-2	3	0.665942	0.00760	0.64842	0.68347
W-2-1	3	0.677394	0.00760	0.65987	0.69492
W-2-2	3	0.662973	0.00760	0.64545	0.68050

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=NiO (wt%), Targeted=0.751, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.366413
Adj Rsquare	0.128818
Root Mean Square Error	0.008793
Mean of Response	0.666684
Observations (or Sum Wgts)	12

Analysis of Variance

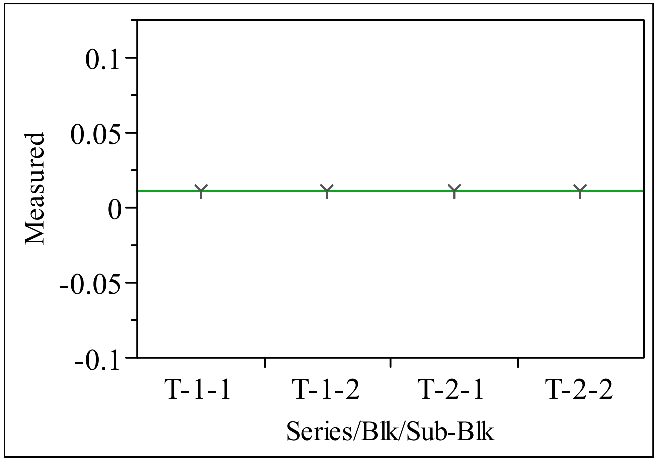
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00035772	0.000119	1.5422	0.2771
Error	8	0.00061856	0.000077		
C. Total	11	0.00097628			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	0.660428	0.00508	0.64872	0.67213
X-1-2	3	0.662548	0.00508	0.65084	0.67426
X-2-1	3	0.674001	0.00508	0.66229	0.68571
X-2-2	3	0.669759	0.00508	0.65805	0.68147

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=PbO (wt%), Targeted=0, Series=T



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
Series/Blk/Sub-Blk	3	0	0	0.0000	1.0000
Error	8	3.6111e-35	4.514e-36		
C. Total	11	3.6111e-35			

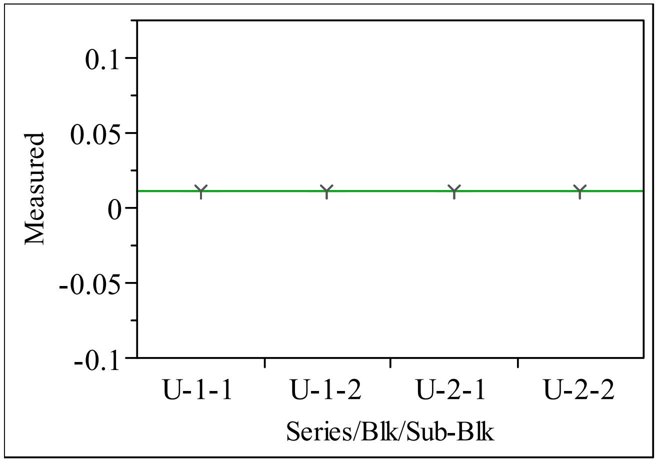
Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=PbO (wt%), Targeted=0, Series=U



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

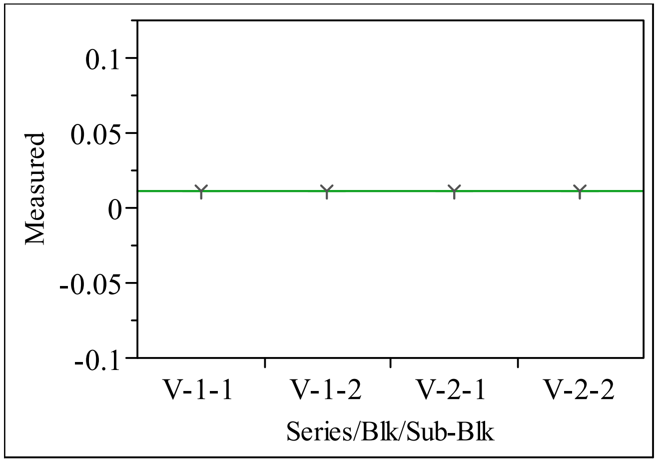
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	0.0000	1.0000
Error	8	3.6111e-35	4.514e-36		
C. Total	11	3.6111e-35			

Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=PbO (wt%), Targeted=0, Series=V



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
Series/Blk/Sub-Blk	3	0	0	0.0000	1.0000
Error	8	3.6111e-35	4.514e-36		
C. Total	11	3.6111e-35			

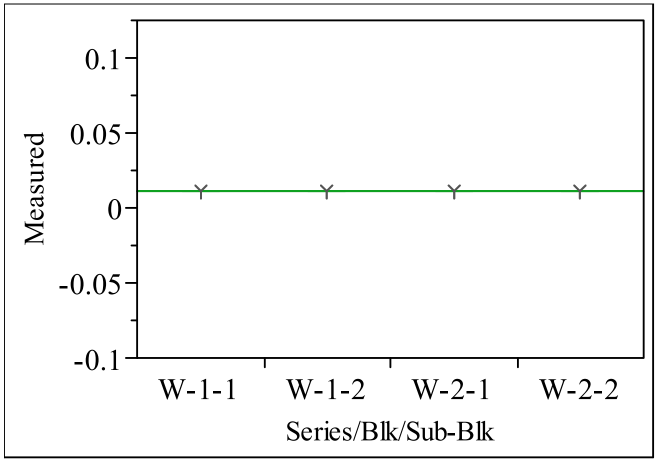
Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=PbO (wt%), Targeted=0, Series=W



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

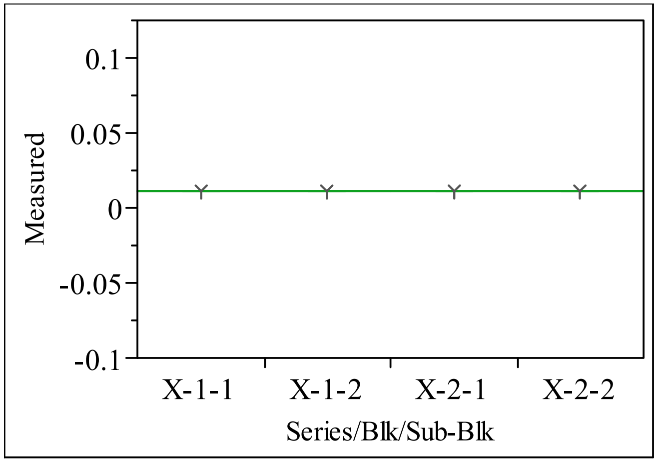
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	0.0000	1.0000
Error	8	3.6111e-35	4.514e-36		
C. Total	11	3.6111e-35			

Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=PbO (wt%), Targeted=0, Series=X



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
Series/Blk/Sub-Blk	3	0	0	0.0000	1.0000
Error	8	3.6111e-35	4.514e-36		
C. Total	11	3.6111e-35			

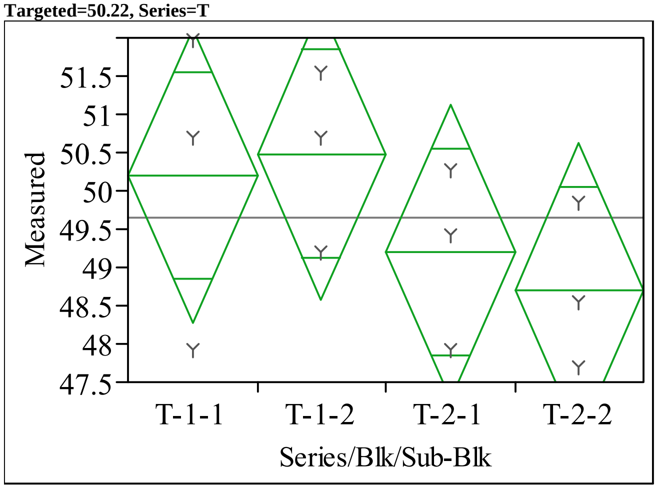
Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=SiO2 (wt%), Targeted=50.22, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.274663
Adj Rsquare	0.002662
Root Mean Square Error	1.441715
Mean of Response	49.64959
Observations (or Sum Wgts)	12

Analysis of Variance

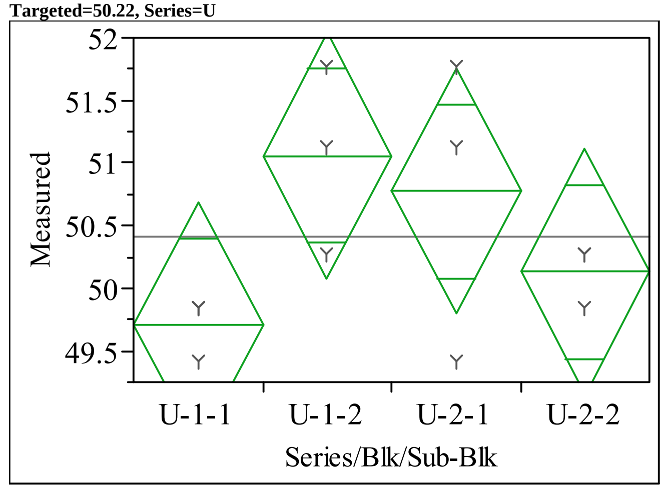
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	6.296645	2.09888	1.0098	0.4373
Error	8	16.628330	2.07854		
C. Total	11	22.924975			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	50.2022	0.83237	48.283	52.122
T-1-2	3	50.4875	0.83237	48.568	52.407
T-2-1	3	49.2039	0.83237	47.284	51.123
T-2-2	3	48.7047	0.83237	46.785	50.624

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=SiO2 (wt%), Targeted=50.22, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.438735
Adj Rsquare	0.228261
Root Mean Square Error	0.735911
Mean of Response	50.41617
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	3.3866873	1.12890	2.0845	0.1807
Error	8	4.3325189	0.54156		
C. Total	11	7.7192062			

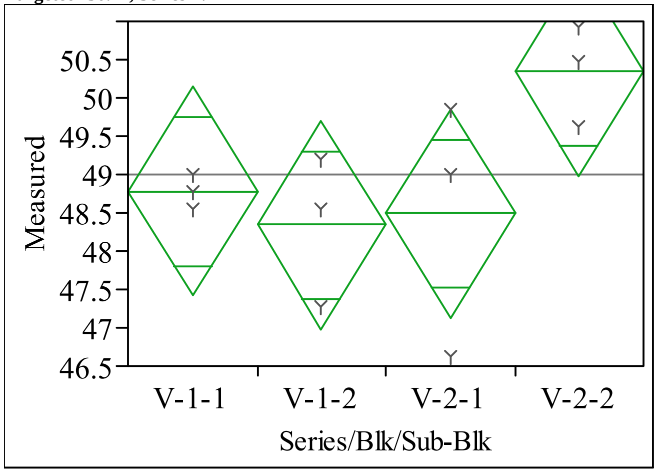
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	49.7031	0.42488	48.723	50.683
U-1-2	3	51.0580	0.42488	50.078	52.038
U-2-1	3	50.7727	0.42488	49.793	51.752
U-2-2	3	50.1309	0.42488	49.151	51.111

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=SiO2 (wt%), Targeted=50.22, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.47619
Adj Rsquare	0.279762
Root Mean Square Error	1.024112
Mean of Response	48.98997
Observations (or Sum Wgts)	12

Analysis of Variance

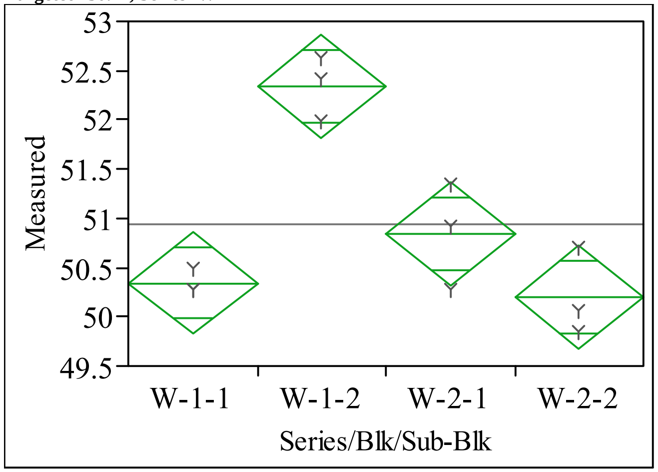
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	7.627674	2.54256	2.4242	0.1408
Error	8	8.390442	1.04881		
C. Total	11	16.018116			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	48.7760	0.59127	47.413	50.140
V-1-2	3	48.3482	0.59127	46.985	49.712
V-2-1	3	48.4908	0.59127	47.127	49.854
V-2-2	3	50.3449	0.59127	48.981	51.708

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=SiO2 (wt%), Targeted=50.22, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.875921
Adj Rsquare	0.829391
Root Mean Square Error	0.390581
Mean of Response	50.93317
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	8.6154580	2.87182	18.8250	0.0006
Error	8	1.2204279	0.15255		
C. Total	11	9.8358858			

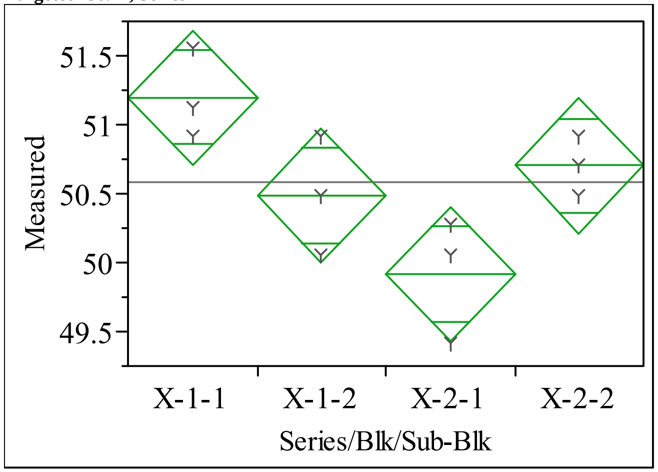
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	50.3449	0.22550	49.825	50.865
W-1-2	3	52.3415	0.22550	51.822	52.862
W-2-1	3	50.8440	0.22550	50.324	51.364
W-2-2	3	50.2022	0.22550	49.682	50.722

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=SiO2 (wt%), Targeted=50.22, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.704329
Adj Rsquare	0.593453
Root Mean Square Error	0.365355
Mean of Response	50.57662
Observations (or Sum Wgts)	12

Analysis of Variance

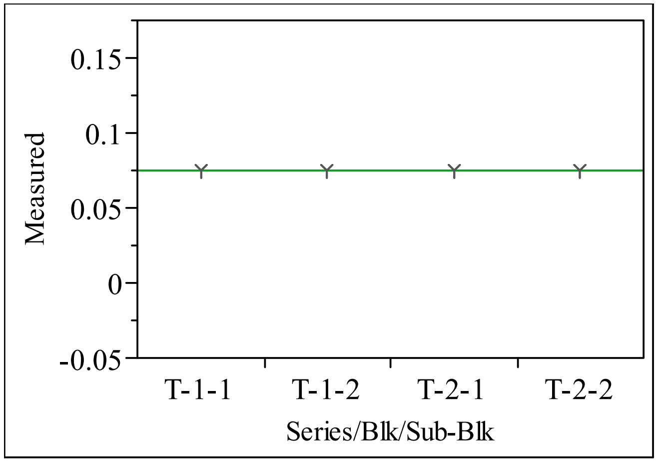
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	2.5438293	0.847943	6.3524	0.0164
Error	8	1.0678744	0.133484		
C. Total	11	3.6117037			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	51.2006	0.21094	50.714	51.687
X-1-2	3	50.4875	0.21094	50.001	50.974
X-2-1	3	49.9170	0.21094	49.431	50.403
X-2-2	3	50.7014	0.21094	50.215	51.188

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=SO4 (wt%), Targeted=0, Series=T



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
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

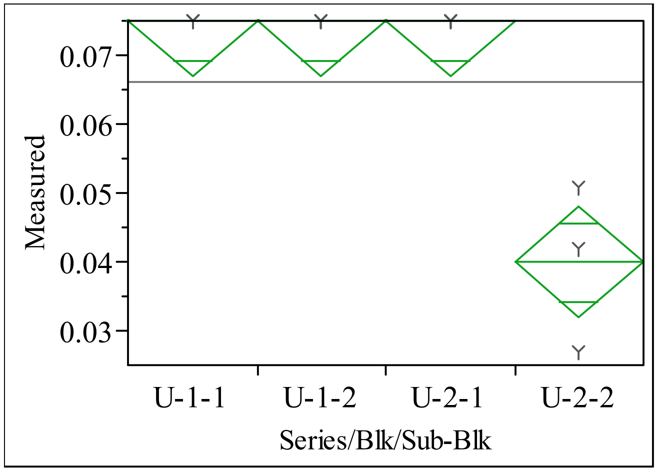
Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=SO4 (wt%), Targeted=0, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.903614
Adj Rsquare	0.86747
Root Mean Square Error	0.006054
Mean of Response	0.066159
Observations (or Sum Wgts)	12

Analysis of Variance

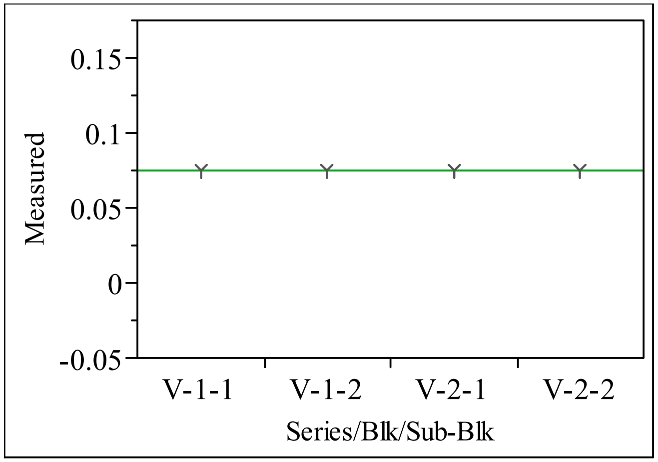
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00274872	0.000916	25.0000	0.0002
Error	8	0.00029320	0.000037		
C. Total	11	0.00304192			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	0.074898	0.00350	0.06684	0.08296
U-1-2	3	0.074898	0.00350	0.06684	0.08296
U-2-1	3	0.074898	0.00350	0.06684	0.08296
U-2-2	3	0.039945	0.00350	0.03189	0.04801

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=SO4 (wt%), Targeted=0, Series=V



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
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

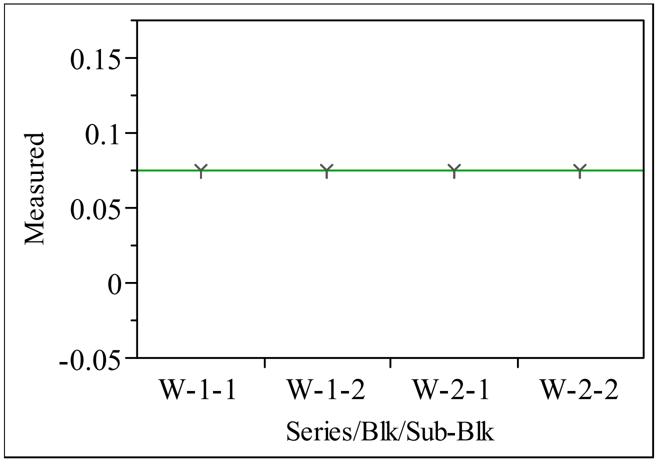
Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=SO4 (wt%), Targeted=0, Series=W



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

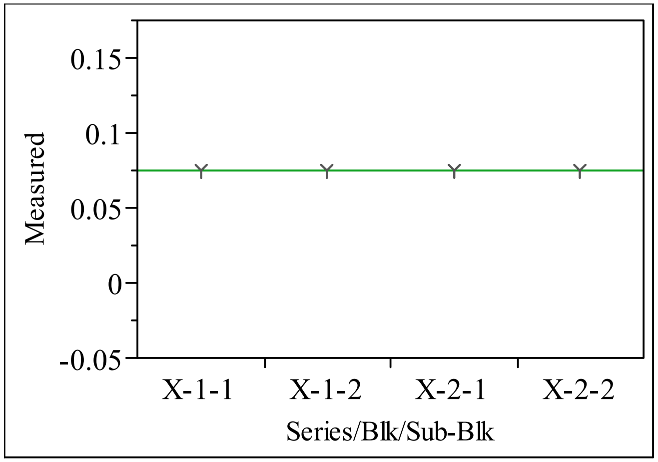
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=SO4 (wt%), Targeted=0, Series=X



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
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

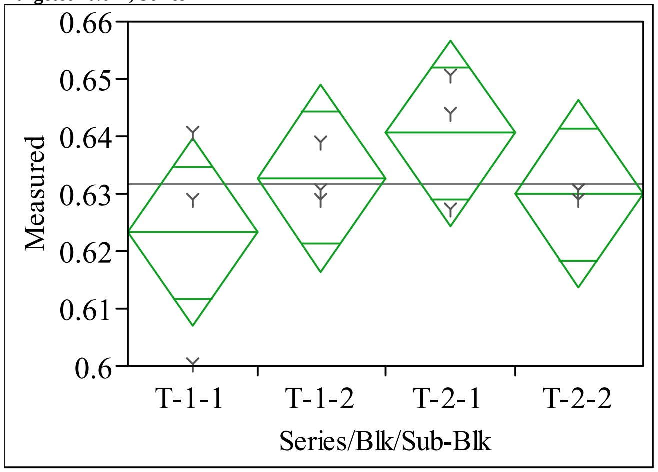
Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=TiO2 (wt%), Targeted=0.677, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.276906
Adj Rsquare	0.005746
Root Mean Square Error	0.012229
Mean of Response	0.631616
Observations (or Sum Wgts)	12

Analysis of Variance

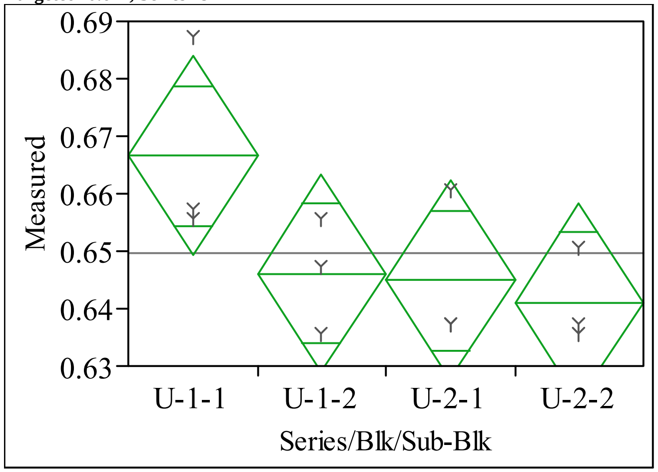
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00045814	0.000153	1.0212	0.4329
Error	8	0.00119636	0.000150		
C. Total	11	0.00165450			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	0.623276	0.00706	0.60699	0.63956
T-1-2	3	0.632728	0.00706	0.61645	0.64901
T-2-1	3	0.640512	0.00706	0.62423	0.65679
T-2-2	3	0.629948	0.00706	0.61367	0.64623

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=TiO2 (wt%), Targeted=0.677, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.471214
Adj Rsquare	0.272919
Root Mean Square Error	0.012929
Mean of Response	0.649686
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00119172	0.000397	2.3763	0.1458
Error	8	0.00133732	0.000167		
C. Total	11	0.00252904			

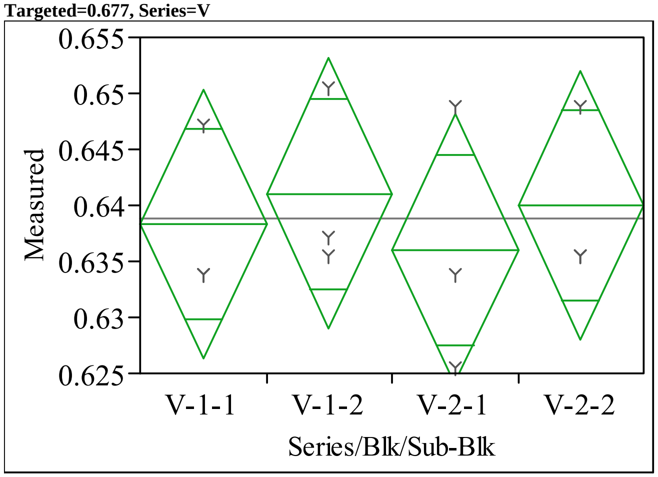
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	0.666644	0.00746	0.64943	0.68386
U-1-2	3	0.646072	0.00746	0.62886	0.66329
U-2-1	3	0.644960	0.00746	0.62775	0.66217
U-2-2	3	0.641068	0.00746	0.62385	0.65828

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=TiO2 (wt%), Targeted=0.677, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.061333
Adj Rsquare	-0.29067
Root Mean Square Error	0.009034
Mean of Response	0.638844
Observations (or Sum Wgts)	12

Analysis of Variance

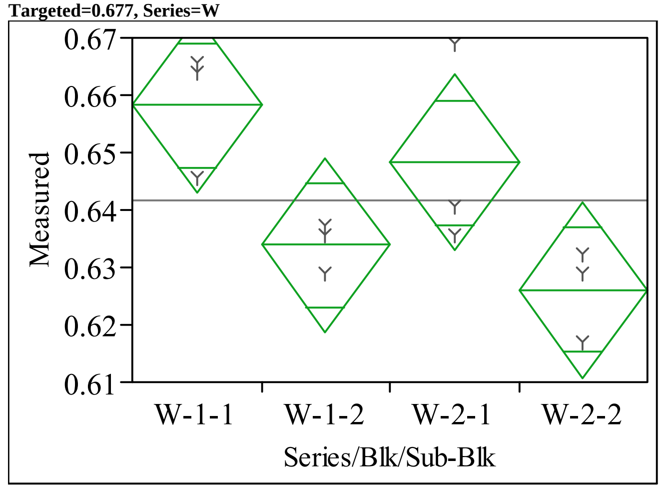
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00004266	0.000014	0.1742	0.9108
Error	8	0.00065290	0.000082		
C. Total	11	0.00069556			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	0.638288	0.00522	0.62626	0.65032
V-1-2	3	0.641068	0.00522	0.62904	0.65310
V-2-1	3	0.636064	0.00522	0.62404	0.64809
V-2-2	3	0.639956	0.00522	0.62793	0.65198

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=TiO2 (wt%), Targeted=0.677, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.639697
Adj Rsquare	0.504583
Root Mean Square Error	0.011496
Mean of Response	0.641624
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00187707	0.000626	4.7345	0.0350
Error	8	0.00105725	0.000132		
C. Total	11	0.00293432			

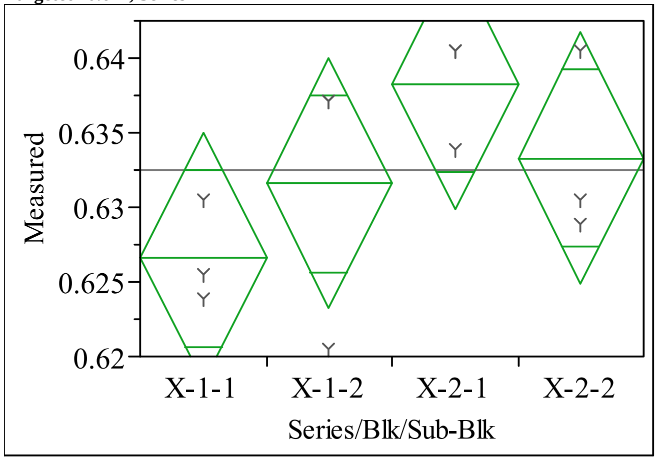
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	0.658304	0.00664	0.64300	0.67361
W-1-2	3	0.633840	0.00664	0.61853	0.64915
W-2-1	3	0.648296	0.00664	0.63299	0.66360
W-2-2	3	0.626056	0.00664	0.61075	0.64136

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=TiO2 (wt%), Targeted=0.677, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.395431
Adj Rsquare	0.168717
Root Mean Square Error	0.006315
Mean of Response	0.63245
Observations (or Sum Wgts)	12

Analysis of Variance

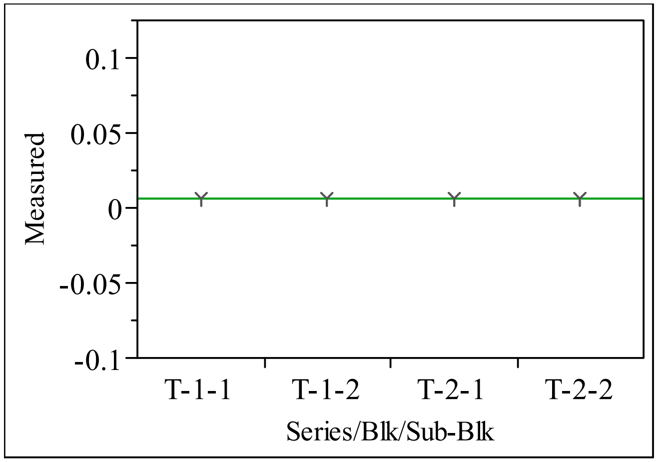
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00020867	0.000070	1.7442	0.2352
Error	8	0.00031903	0.000040		
C. Total	11	0.00052770			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	0.626612	0.00365	0.61820	0.63502
X-1-2	3	0.631616	0.00365	0.62321	0.64002
X-2-1	3	0.638288	0.00365	0.62988	0.64670
X-2-2	3	0.633284	0.00365	0.62488	0.64169

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=ZnO (wt%), Targeted=0, Series=T



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
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

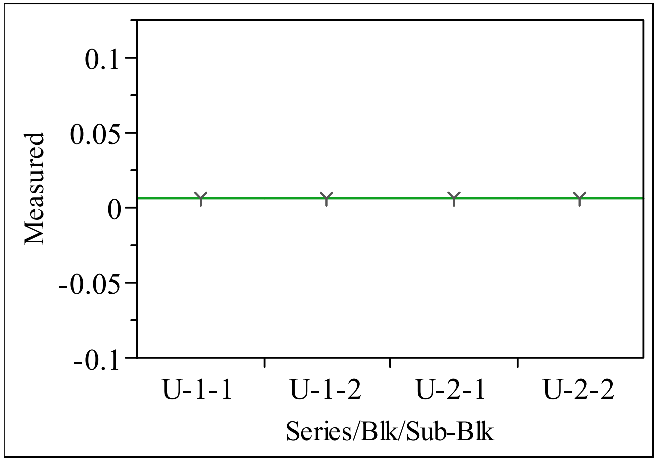
Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=ZnO (wt%), Targeted=0, Series=U



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

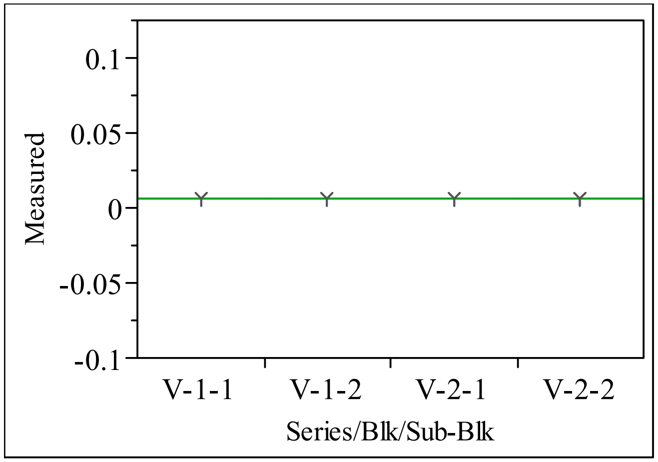
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=ZnO (wt%), Targeted=0, Series=V



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
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

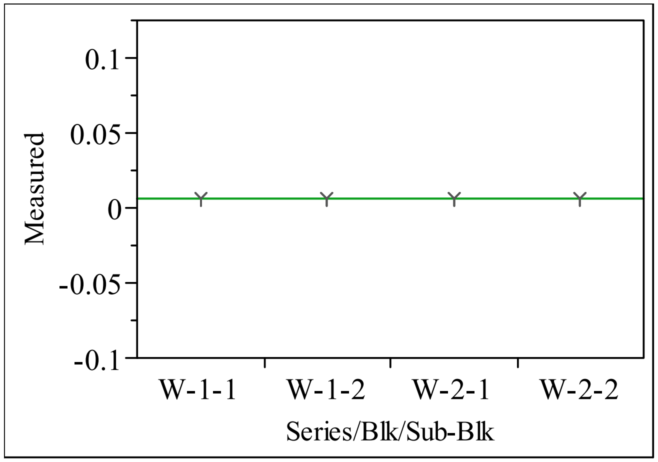
Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=ZnO (wt%), Targeted=0, Series=W



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

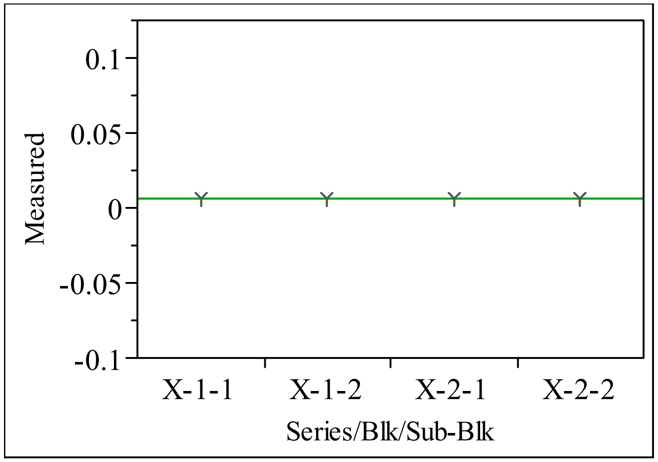
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=ZnO (wt%), Targeted=0, Series=X



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
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

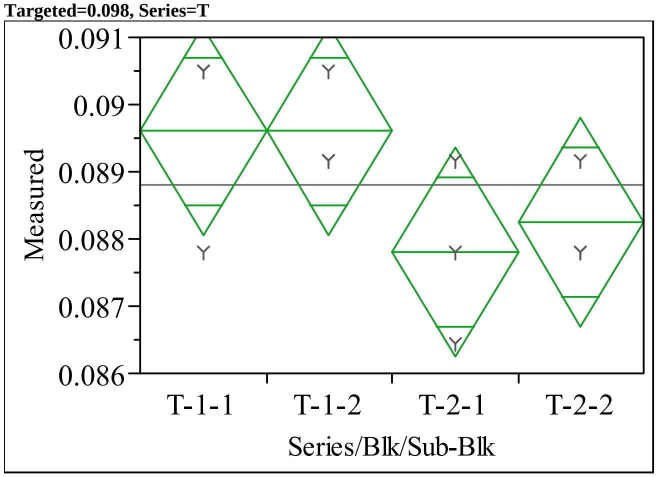
Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=ZrO2 (wt%), Targeted=0.098, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.414634
Adj Rsquare	0.195122
Root Mean Square Error	0.00117
Mean of Response	0.088815
Observations (or Sum Wgts)	12

Analysis of Variance

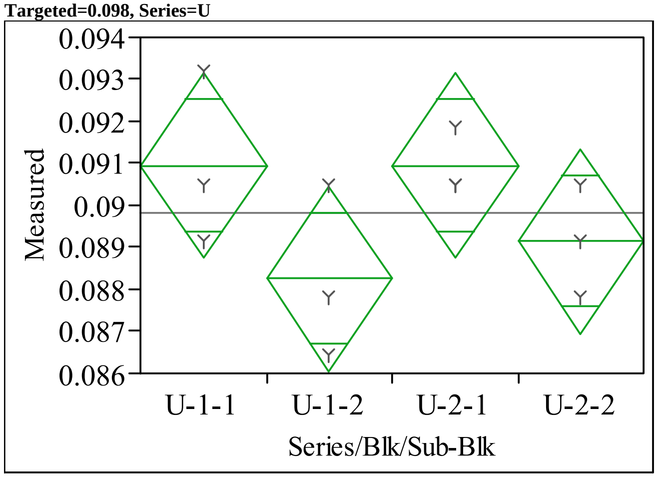
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00000775	2.5849e-6	1.8889	0.2099
Error	8	0.00001095	1.3685e-6		
C. Total	11	0.00001870			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	0.089603	0.00068	0.08805	0.09116
T-1-2	3	0.089603	0.00068	0.08805	0.09116
T-2-1	3	0.087802	0.00068	0.08624	0.08936
T-2-2	3	0.088252	0.00068	0.08669	0.08981

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=ZrO2 (wt%), Targeted=0.098, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.428571
Adj Rsquare	0.214286
Root Mean Square Error	0.001654
Mean of Response	0.089828
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00001642	5.474e-6	2.0000	0.1927
Error	8	0.00002190	2.737e-6		
C. Total	11	0.00003832			

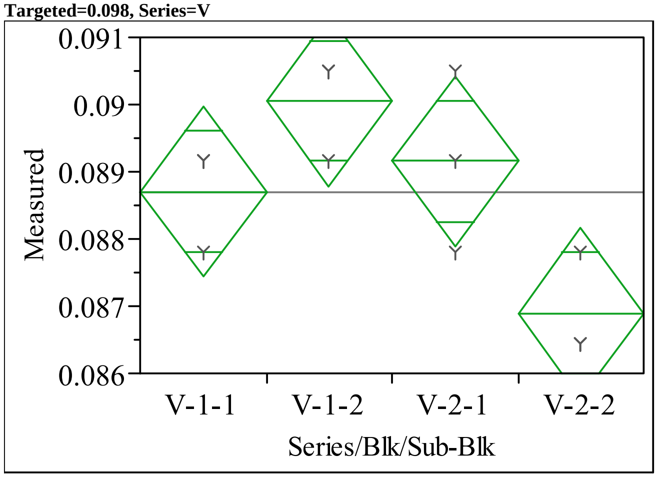
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	0.090954	0.00096	0.08875	0.09316
U-1-2	3	0.088252	0.00096	0.08605	0.09045
U-2-1	3	0.090954	0.00096	0.08875	0.09316
U-2-2	3	0.089153	0.00096	0.08695	0.09136

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=ZrO2 (wt%), Targeted=0.098, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.684211
Adj Rsquare	0.565789
Root Mean Square Error	0.000955
Mean of Response	0.088703
Observations (or Sum Wgts)	12

Analysis of Variance

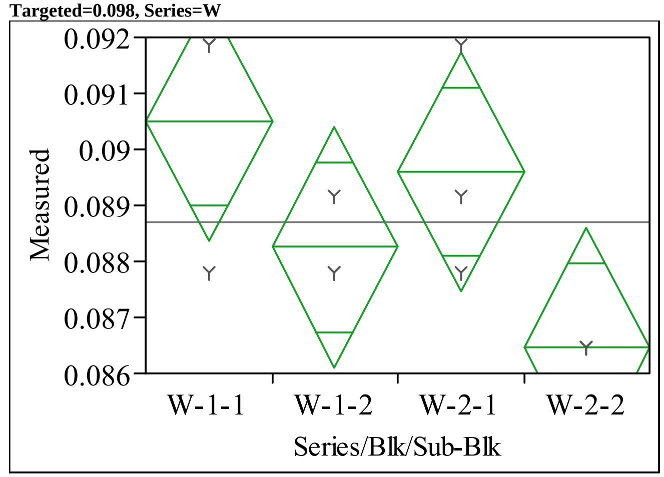
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00001581	5.2712e-6	5.7778	0.0211
Error	8	0.00000730	9.1233e-7		
C. Total	11	0.00002311			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	0.088703	0.00055	0.08743	0.08997
V-1-2	3	0.090053	0.00055	0.08878	0.09133
V-2-1	3	0.089153	0.00055	0.08788	0.09042
V-2-2	3	0.086901	0.00055	0.08563	0.08817

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=ZrO2 (wt%), Targeted=0.098, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.575
Adj Rsquare	0.415625
Root Mean Square Error	0.001608
Mean of Response	0.088703
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00002798	9.326e-6	3.6078	0.0651
Error	8	0.00002068	2.5849e-6		
C. Total	11	0.00004866			

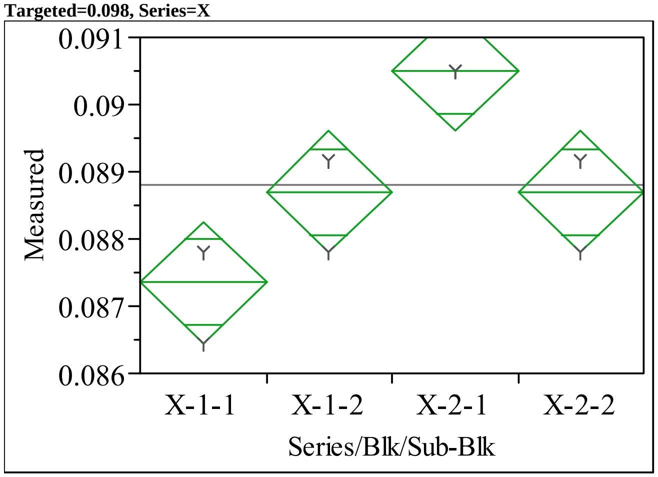
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	0.090504	0.00093	0.08836	0.09264
W-1-2	3	0.088252	0.00093	0.08611	0.09039
W-2-1	3	0.089603	0.00093	0.08746	0.09174
W-2-2	3	0.086451	0.00093	0.08431	0.08859

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=Batch 1, Oxide=ZrO2 (wt%), Targeted=0.098, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.804878
Adj Rsquare	0.731707
Root Mean Square Error	0.000675
Mean of Response	0.088815
Observations (or Sum Wgts)	12

Analysis of Variance

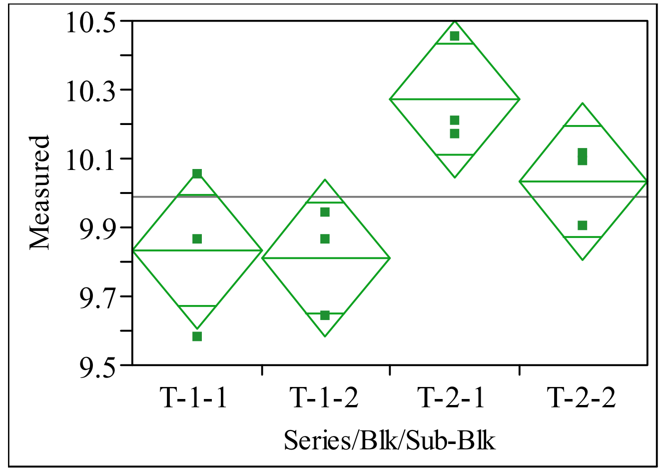
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00001505	5.0178e-6	11.0000	0.0033
Error	8	0.00000365	4.5617e-7		
C. Total	11	0.00001870			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	0.087352	0.00039	0.08645	0.08825
X-1-2	3	0.088703	0.00039	0.08780	0.08960
X-2-1	3	0.090504	0.00039	0.08960	0.09140
X-2-2	3	0.088703	0.00039	0.08780	0.08960

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Al2O3 (wt%), Targeted=10, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.636846
Adj Rsquare	0.500663
Root Mean Square Error	0.171882
Mean of Response	9.987582
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.41447166	0.138157	4.6764	0.0360
Error	8	0.23634792	0.029543		
C. Total	11	0.65081958			

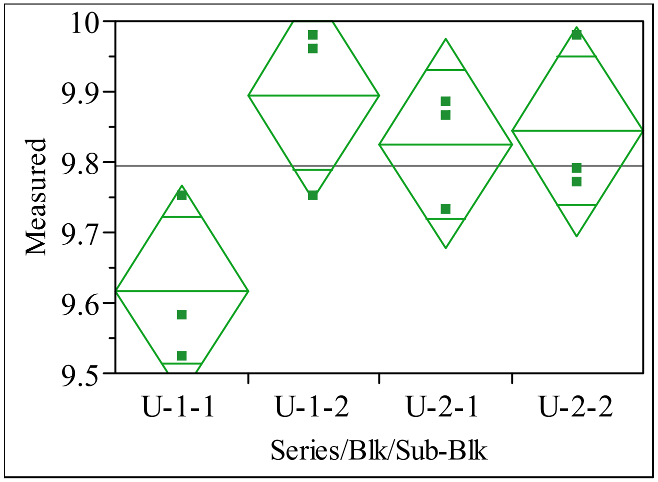
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	9.8317	0.09924	9.603	10.061
T-1-2	3	9.8128	0.09924	9.584	10.042
T-2-1	3	10.2726	0.09924	10.044	10.501
T-2-2	3	10.0332	0.09924	9.804	10.262

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Al2O3 (wt%), Targeted=10, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.574501
Adj Rsquare	0.414938
Root Mean Square Error	0.111518
Mean of Response	9.795483
Observations (or Sum Wgts)	12

Analysis of Variance

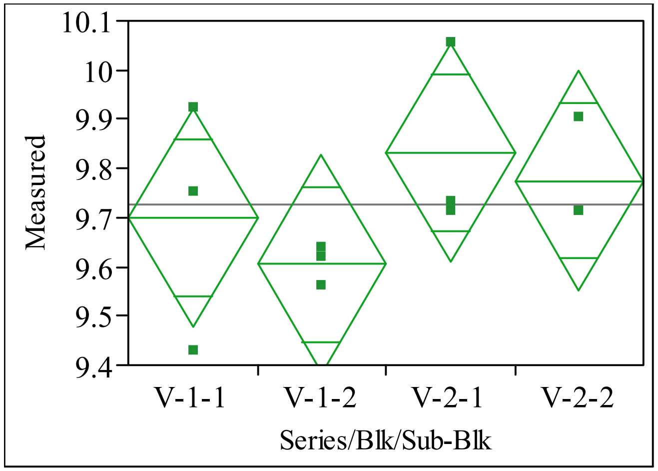
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.13432916	0.044776	3.6005	0.0654
Error	8	0.09948986	0.012436		
C. Total	11	0.23381902			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	9.61756	0.06438	9.4691	9.766
U-1-2	3	9.89468	0.06438	9.7462	10.043
U-2-1	3	9.82540	0.06438	9.6769	9.974
U-2-2	3	9.84430	0.06438	9.6958	9.993

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Al2O3 (wt%), Targeted=10, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.278776
Adj Rsquare	0.008317
Root Mean Square Error	0.167499
Mean of Response	9.727776
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.08675611	0.028919	1.0308	0.4292
Error	8	0.22444722	0.028056		
C. Total	11	0.31120333			

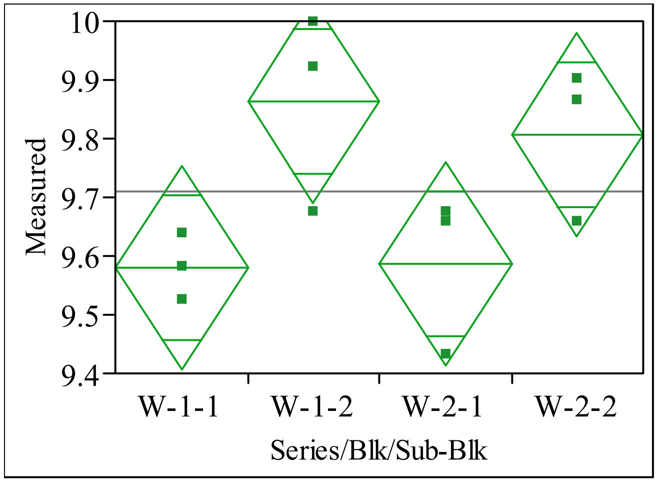
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	9.69943	0.09671	9.4764	9.922
V-1-2	3	9.60496	0.09671	9.3820	9.828
V-2-1	3	9.83170	0.09671	9.6087	10.055
V-2-2	3	9.77501	0.09671	9.5520	9.998

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Al2O3 (wt%), Targeted=10, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.590925
Adj Rsquare	0.437523
Root Mean Square Error	0.129996
Mean of Response	9.708881
Observations (or Sum Wgts)	12

Analysis of Variance

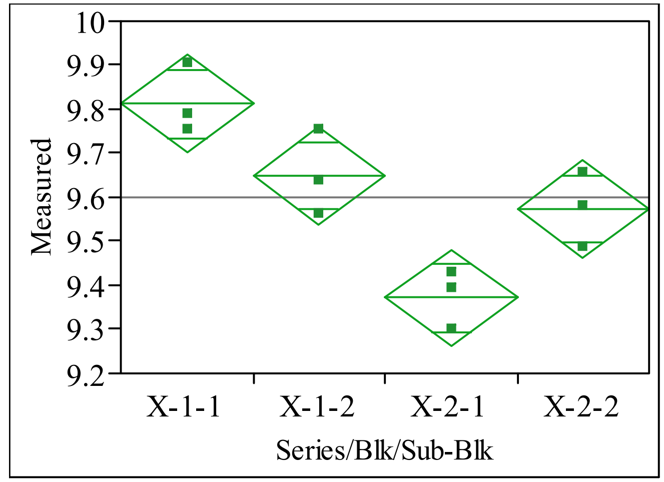
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.19529050	0.065097	3.8521	0.0565
Error	8	0.13519196	0.016899		
C. Total	11	0.33048246			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	9.57977	0.07505	9.4067	9.753
W-1-2	3	9.86319	0.07505	9.6901	10.036
W-2-1	3	9.58606	0.07505	9.4130	9.759
W-2-2	3	9.80651	0.07505	9.6334	9.980

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Al2O3 (wt%), Targeted=10, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.847338
Adj Rsquare	0.79009
Root Mean Square Error	0.082361
Mean of Response	9.601809
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.30120674	0.100402	14.8012	0.0013
Error	8	0.05426720	0.006783		
C. Total	11	0.35547393			

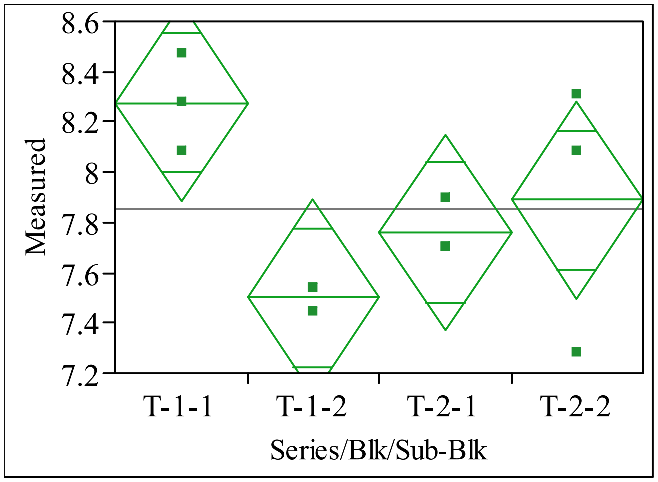
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	9.81280	0.04755	9.7031	9.9225
X-1-2	3	9.64905	0.04755	9.5394	9.7587
X-2-1	3	9.37192	0.04755	9.2623	9.4816
X-2-2	3	9.57347	0.04755	9.4638	9.6831

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=B2O3 (wt%), Targeted=8, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.57398
Adj Rsquare	0.414222
Root Mean Square Error	0.294229
Mean of Response	7.856556
Observations (or Sum Wgts)	12

Analysis of Variance

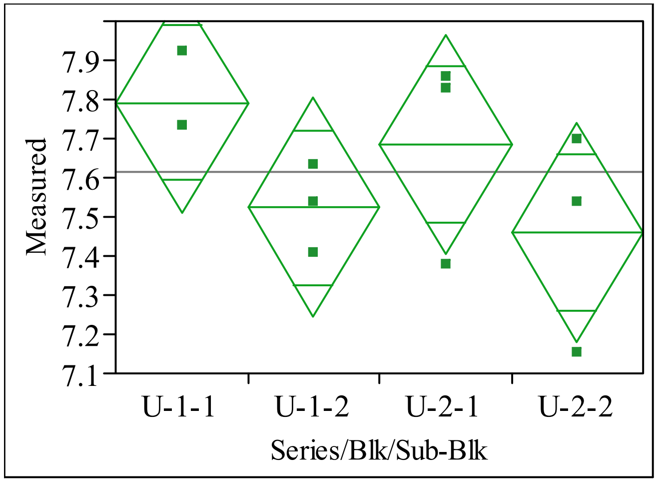
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.9330980	0.311033	3.5928	0.0657
Error	8	0.6925661	0.086571		
C. Total	11	1.6256641			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	8.27514	0.16987	7.8834	8.6669
T-1-2	3	7.50237	0.16987	7.1106	7.8941
T-2-1	3	7.75996	0.16987	7.3682	8.1517
T-2-2	3	7.88876	0.16987	7.4970	8.2805

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=B2O3 (wt%), Targeted=8, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.367837
Adj Rsquare	0.130776
Root Mean Square Error	0.210528
Mean of Response	7.615064
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.20631834	0.068773	1.5517	0.2749
Error	8	0.35457726	0.044322		
C. Total	11	0.56089560			

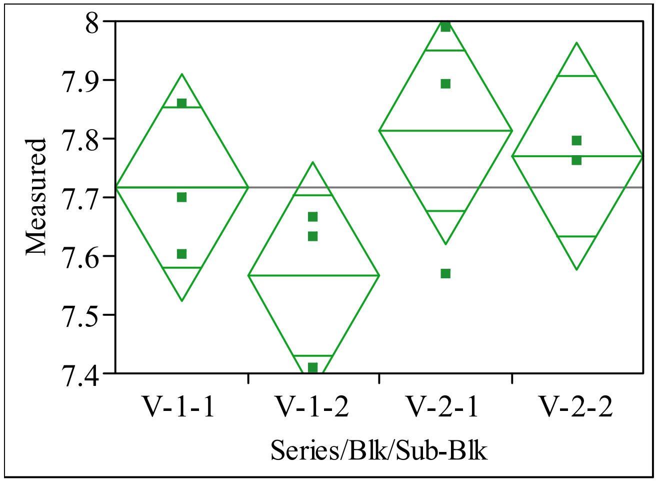
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	7.79216	0.12155	7.5119	8.0724
U-1-2	3	7.52383	0.12155	7.2435	7.8041
U-2-1	3	7.68483	0.12155	7.4045	7.9651
U-2-2	3	7.45944	0.12155	7.1791	7.7397

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=B2O3 (wt%), Targeted=8, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.380353
Adj Rsquare	0.147985
Root Mean Square Error	0.145787
Mean of Response	7.717027
Observations (or Sum Wgts)	12

Analysis of Variance

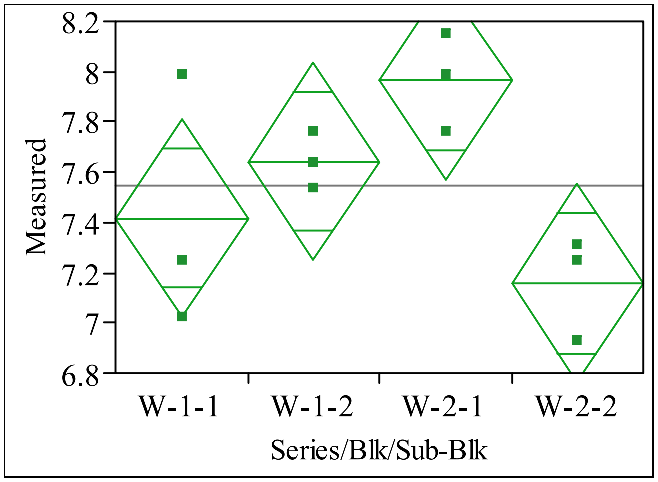
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.10436874	0.034790	1.6369	0.2564
Error	8	0.17003120	0.021254		
C. Total	11	0.27439994			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	7.71703	0.08417	7.5229	7.9111
V-1-2	3	7.56677	0.08417	7.3727	7.7609
V-2-1	3	7.81362	0.08417	7.6195	8.0077
V-2-2	3	7.77069	0.08417	7.5766	7.9648

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=B2O3 (wt%), Targeted=8, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.601186
Adj Rsquare	0.45163
Root Mean Square Error	0.295255
Mean of Response	7.545299
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	1.0512905	0.350430	4.0198	0.0513
Error	8	0.6974044	0.087176		
C. Total	11	1.7486948			

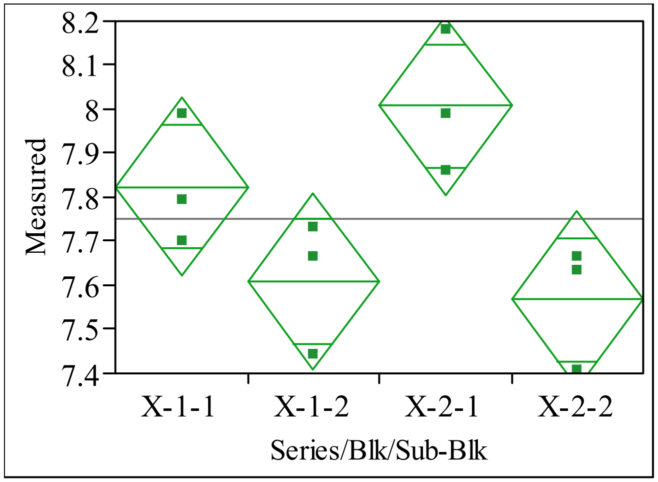
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	7.41650	0.17047	7.0234	7.8096
W-1-2	3	7.64190	0.17047	7.2488	8.0350
W-2-1	3	7.96389	0.17047	7.5708	8.3570
W-2-2	3	7.15891	0.17047	6.7658	7.5520

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=B2O3 (wt%), Targeted=8, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.673038
Adj Rsquare	0.550427
Root Mean Square Error	0.15074
Mean of Response	7.751909
Observations (or Sum Wgts)	12

Analysis of Variance

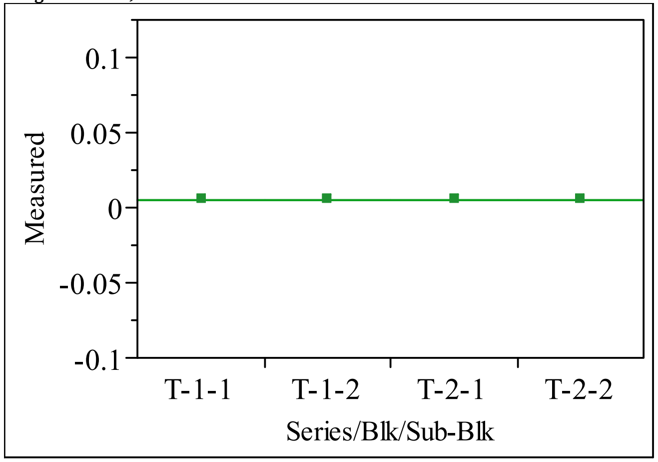
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.37418959	0.124730	5.4892	0.0242
Error	8	0.18178132	0.022723		
C. Total	11	0.55597092			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	7.82436	0.08703	7.6237	8.0250
X-1-2	3	7.60970	0.08703	7.4090	7.8104
X-2-1	3	8.00682	0.08703	7.8061	8.2075
X-2-2	3	7.56677	0.08703	7.3661	7.7675

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=BaO (wt%), Targeted=0.005, Series=T



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
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

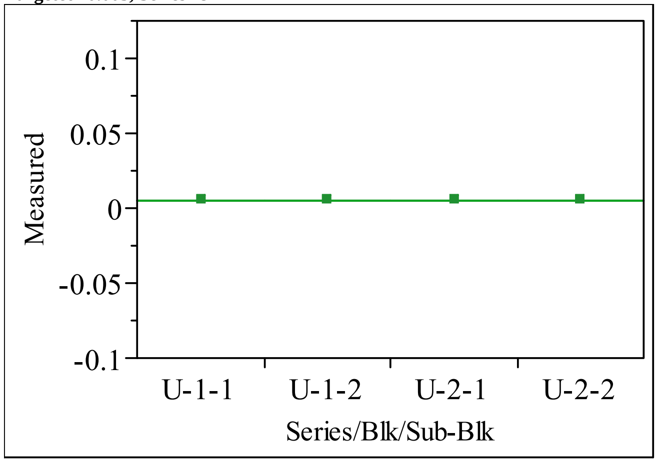
Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=BaO (wt%), Targeted=0.005, Series=U



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

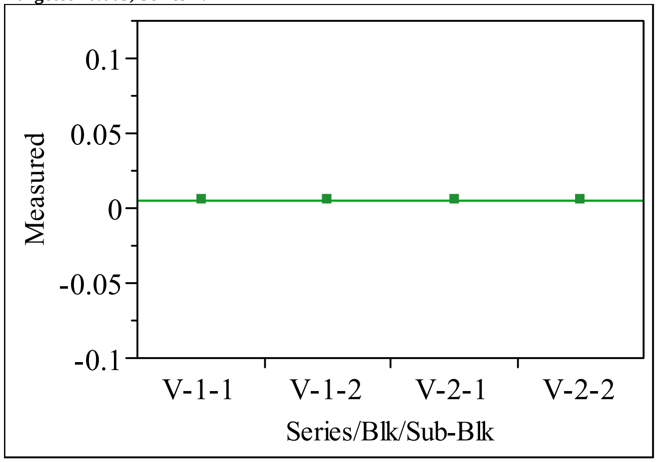
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=BaO (wt%), Targeted=0.005, Series=V



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
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

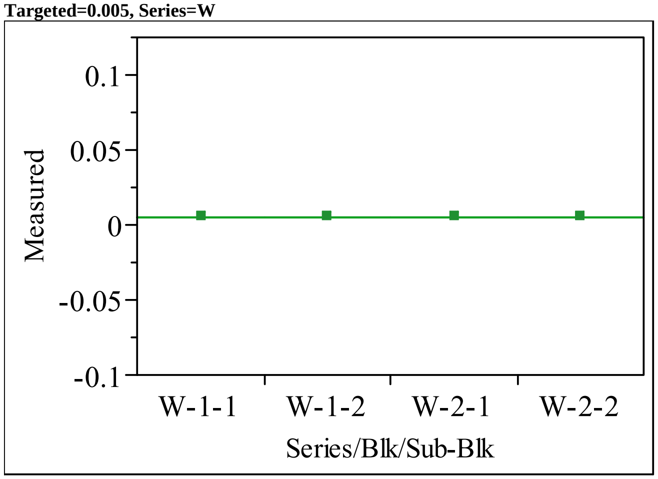
Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=BaO (wt%), Targeted=0.005, Series=W



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

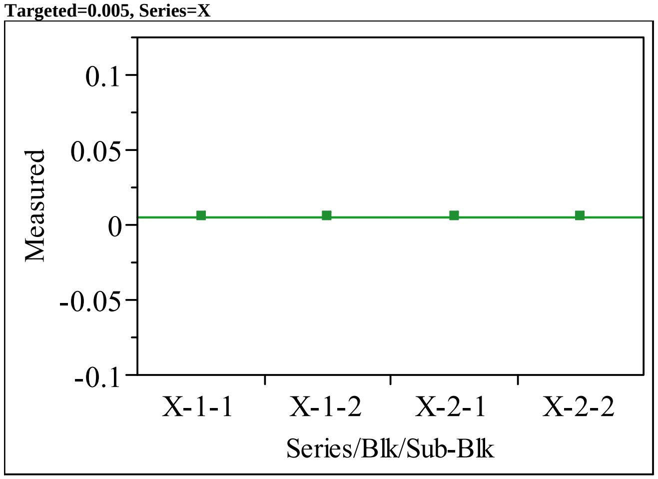
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=BaO (wt%), Targeted=0.005, Series=X



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
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

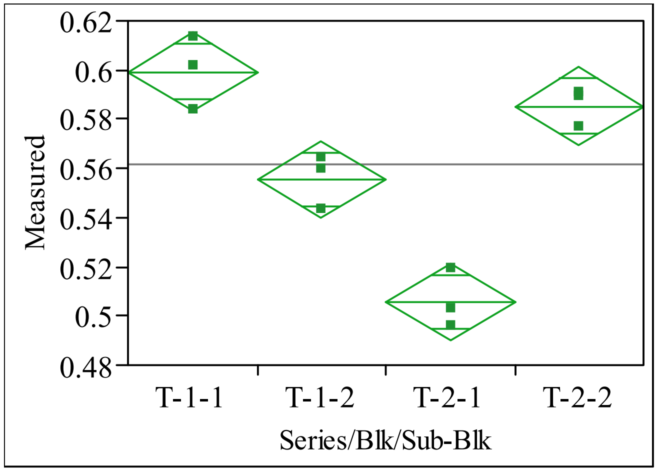
Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=CaO (wt%), Targeted=0.5, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.933445
Adj Rsquare	0.908487
Root Mean Square Error	0.011748
Mean of Response	0.561429
Observations (or Sum Wgts)	12

Analysis of Variance

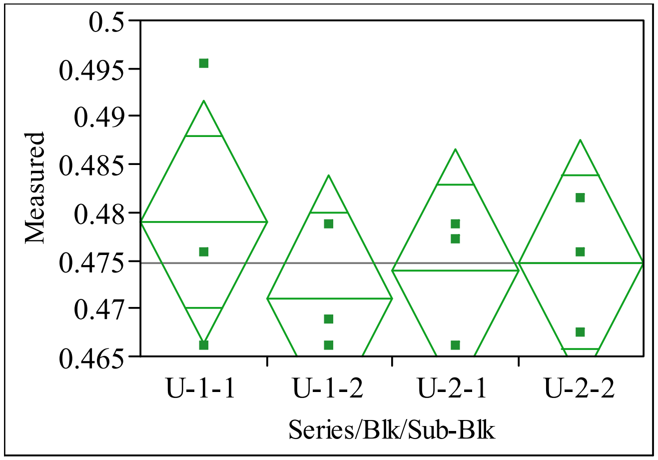
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.01548638	0.005162	37.4007	<.0001
Error	8	0.00110418	0.000138		
C. Total	11	0.01659055			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	0.599324	0.00678	0.58368	0.61497
T-1-2	3	0.555482	0.00678	0.53984	0.57112
T-2-1	3	0.505578	0.00678	0.48994	0.52122
T-2-2	3	0.585332	0.00678	0.56969	0.60097

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=CaO (wt%), Targeted=0.5, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.117426
Adj Rsquare	-0.21354
Root Mean Square Error	0.00955
Mean of Response	0.474679
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00009707	0.000032	0.3548	0.7872
Error	8	0.00072959	0.000091		
C. Total	11	0.00082666			

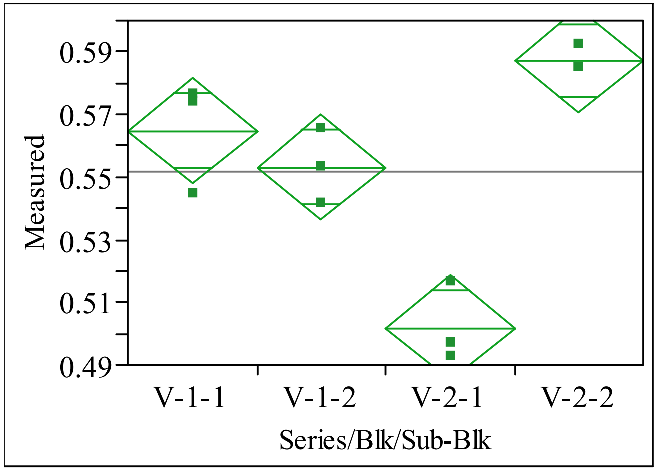
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	0.478993	0.00551	0.46628	0.49171
U-1-2	3	0.471064	0.00551	0.45835	0.48378
U-2-1	3	0.473862	0.00551	0.46115	0.48658
U-2-2	3	0.474795	0.00551	0.46208	0.48751

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=CaO (wt%), Targeted=0.5, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.902253
Adj Rsquare	0.865598
Root Mean Square Error	0.012619
Mean of Response	0.551751
Observations (or Sum Wgts)	12

Analysis of Variance

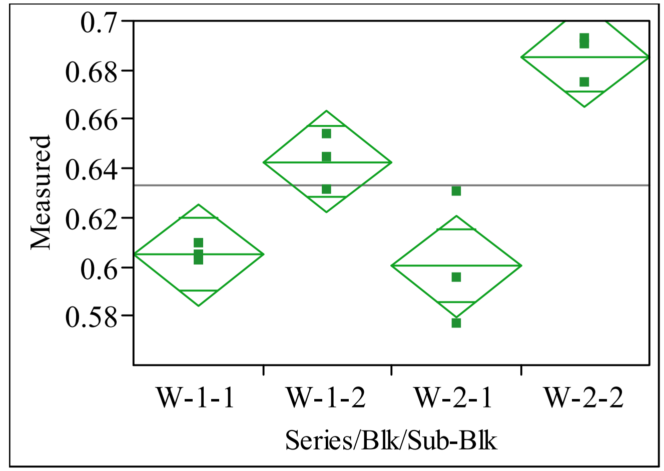
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.01175831	0.003919	24.6148	0.0002
Error	8	0.00127385	0.000159		
C. Total	11	0.01303216			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	0.564810	0.00729	0.54801	0.58161
V-1-2	3	0.553150	0.00729	0.53635	0.56995
V-2-1	3	0.501846	0.00729	0.48505	0.51865
V-2-2	3	0.587198	0.00729	0.57040	0.60400

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=CaO (wt%), Targeted=0.5, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.880139
Adj Rsquare	0.835192
Root Mean Square Error	0.015528
Mean of Response	0.633371
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.01416505	0.004722	19.5814	0.0005
Error	8	0.00192905	0.000241		
C. Total	11	0.01609410			

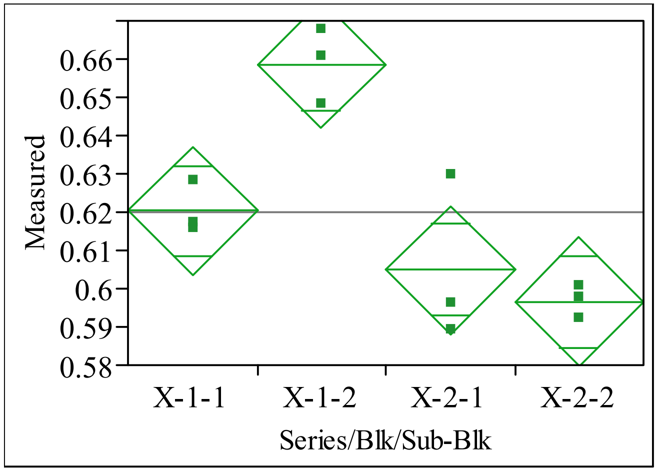
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	0.604921	0.00897	0.58425	0.62559
W-1-2	3	0.642699	0.00897	0.62203	0.66337
W-2-1	3	0.600257	0.00897	0.57958	0.62093
W-2-2	3	0.685608	0.00897	0.66493	0.70628

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=CaO (wt%), Targeted=0.5, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.842544
Adj Rsquare	0.783498
Root Mean Square Error	0.012599
Mean of Response	0.620079
Observations (or Sum Wgts)	12

Analysis of Variance

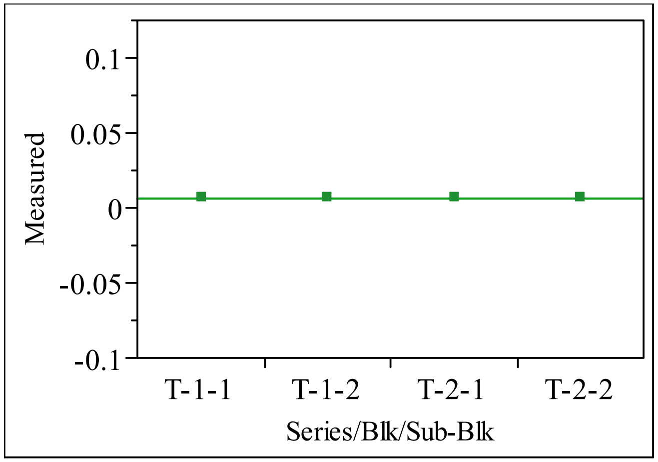
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00679539	0.002265	14.2693	0.0014
Error	8	0.00126993	0.000159		
C. Total	11	0.00806532			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	0.620312	0.00727	0.60354	0.63709
X-1-2	3	0.658557	0.00727	0.64178	0.67533
X-2-1	3	0.604921	0.00727	0.58815	0.62170
X-2-2	3	0.596526	0.00727	0.57975	0.61330

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Ce2O3 (wt%), Targeted=0, Series=T



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
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

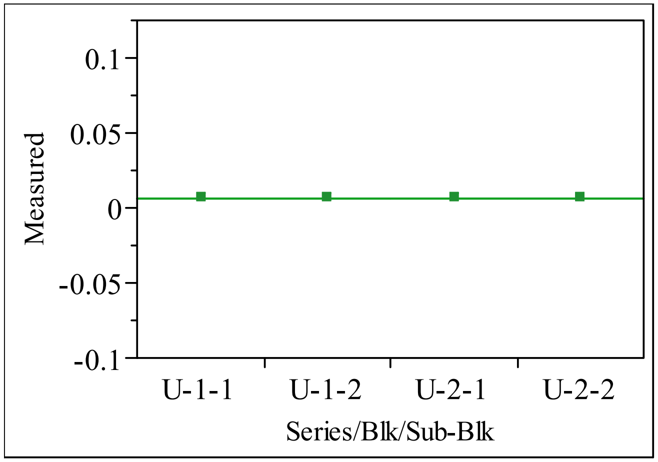
Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Ce2O3 (wt%), Targeted=0, Series=U



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

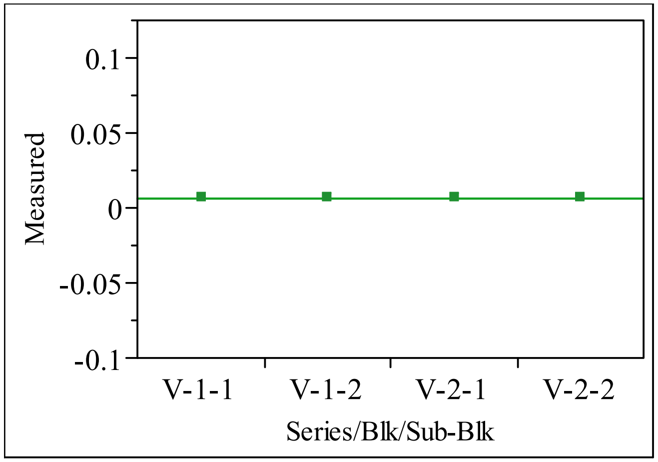
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Ce2O3 (wt%), Targeted=0, Series=V



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
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

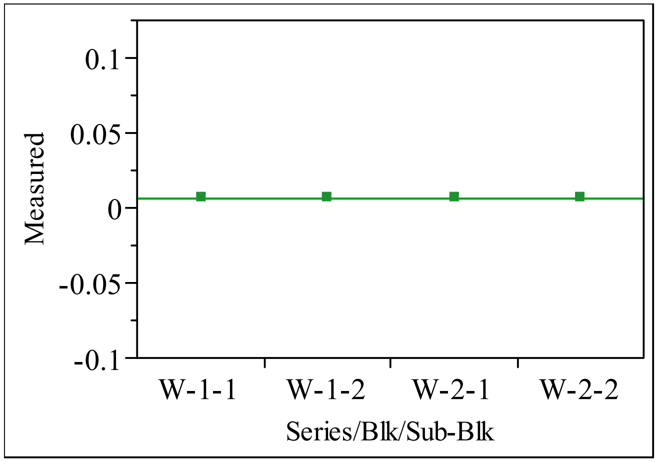
Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Ce2O3 (wt%), Targeted=0, Series=W



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

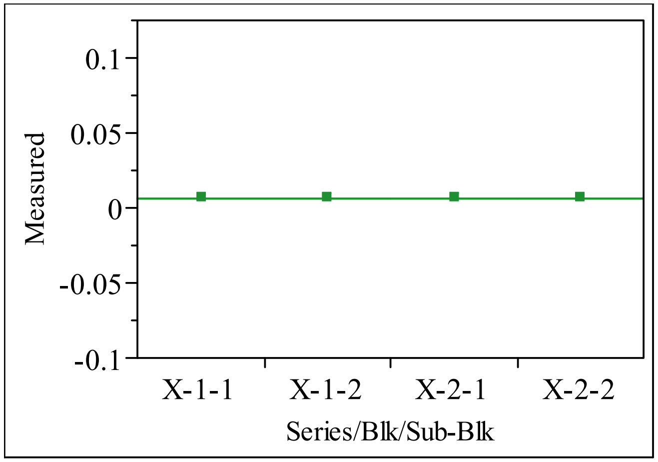
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Ce2O3 (wt%), Targeted=0, Series=X



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
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

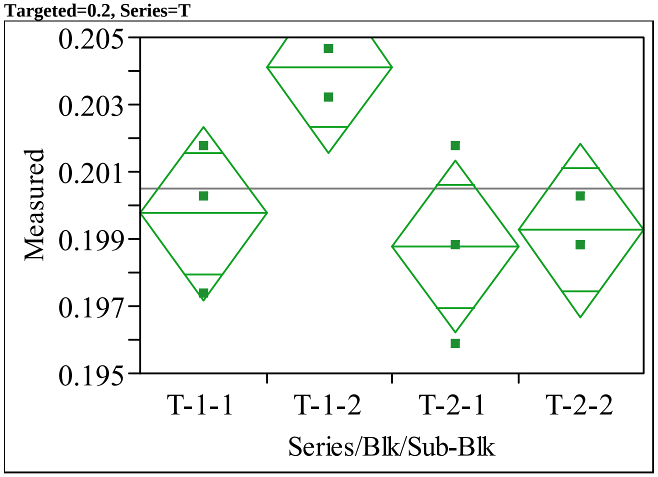
Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Cr2O3 (wt%), Targeted=0.2, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.647059
Adj Rsquare	0.514706
Root Mean Square Error	0.001934
Mean of Response	0.200483
Observations (or Sum Wgts)	12

Analysis of Variance

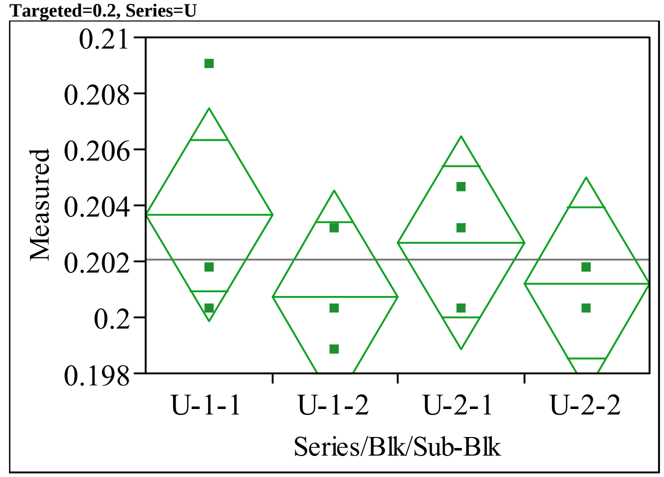
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00005483	0.000018	4.8889	0.0323
Error	8	0.00002991	3.738e-6		
C. Total	11	0.00008474			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	0.199752	0.00112	0.19718	0.20233
T-1-2	3	0.204137	0.00112	0.20156	0.20671
T-2-1	3	0.198778	0.00112	0.19620	0.20135
T-2-2	3	0.199265	0.00112	0.19669	0.20184

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Cr2O3 (wt%), Targeted=0.2, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.198257
Adj Rsquare	-0.1024
Root Mean Square Error	0.002862
Mean of Response	0.202066
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00001620	0.0000054	0.6594	0.5997
Error	8	0.00006551	8.1891e-6		
C. Total	11	0.00008171			

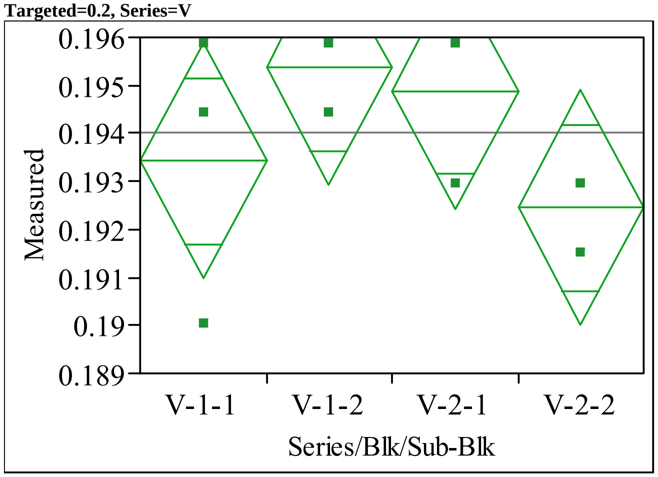
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	0.203650	0.00165	0.19984	0.20746
U-1-2	3	0.200726	0.00165	0.19692	0.20454
U-2-1	3	0.202675	0.00165	0.19887	0.20649
U-2-2	3	0.201214	0.00165	0.19740	0.20502

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Cr2O3 (wt%), Targeted=0.2, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.374486
Adj Rsquare	0.139918
Root Mean Square Error	0.001839
Mean of Response	0.194027
Observations (or Sum Wgts)	12

Analysis of Variance

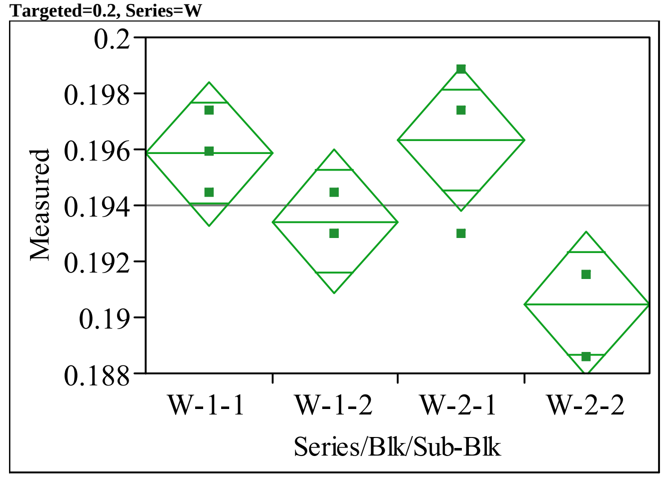
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00001620	0.0000054	1.5965	0.2650
Error	8	0.00002706	3.3824e-6		
C. Total	11	0.00004326			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	0.193418	0.00106	0.19097	0.19587
V-1-2	3	0.195367	0.00106	0.19292	0.19782
V-2-1	3	0.194880	0.00106	0.19243	0.19733
V-2-2	3	0.192444	0.00106	0.19000	0.19489

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Cr2O3 (wt%), Targeted=0.2, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.683616
Adj Rsquare	0.564972
Root Mean Square Error	0.001934
Mean of Response	0.194027
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00006462	0.000022	5.7619	0.0213
Error	8	0.00002991	3.738e-6		
C. Total	11	0.00009453			

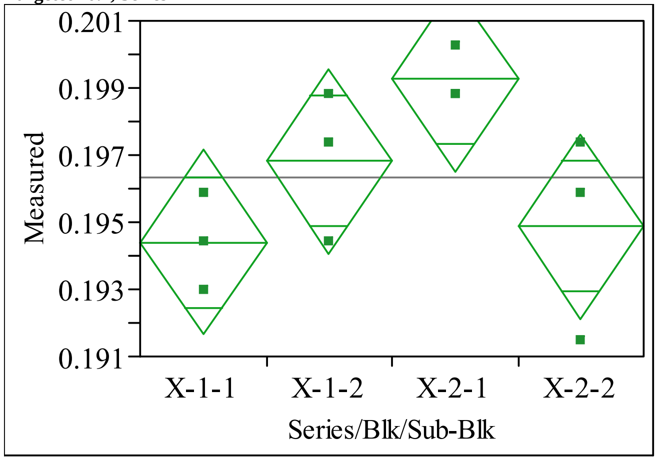
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	0.195854	0.00112	0.19328	0.19843
W-1-2	3	0.193418	0.00112	0.19084	0.19599
W-2-1	3	0.196342	0.00112	0.19377	0.19892
W-2-2	3	0.190495	0.00112	0.18792	0.19307

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Cr2O3 (wt%), Targeted=0.2, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.563636
Adj Rsquare	0.4
Root Mean Square Error	0.002067
Mean of Response	0.196342
Observations (or Sum Wgts)	12

Analysis of Variance

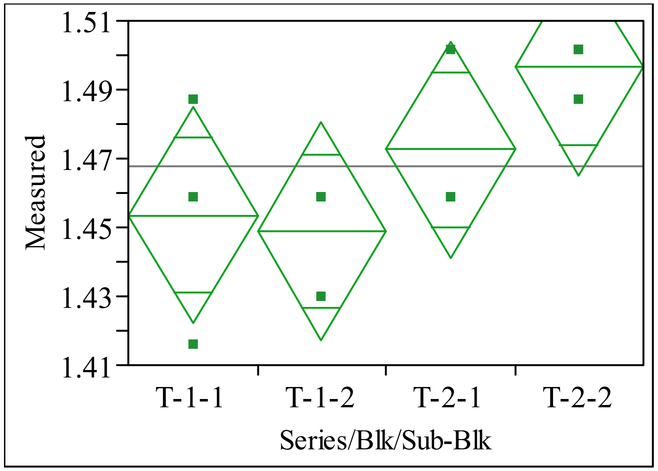
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00004415	0.000015	3.4444	0.0719
Error	8	0.00003418	4.273e-6		
C. Total	11	0.00007833			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	0.194393	0.00119	0.19164	0.19714
X-1-2	3	0.196829	0.00119	0.19408	0.19958
X-2-1	3	0.199265	0.00119	0.19651	0.20202
X-2-2	3	0.194880	0.00119	0.19213	0.19763

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Fe2O3 (wt%), Targeted=1, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.484375
Adj Rsquare	0.291016
Root Mean Square Error	0.023709
Mean of Response	1.467825
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00422435	0.001408	2.5051	0.1330
Error	8	0.00449689	0.000562		
C. Total	11	0.00872125			

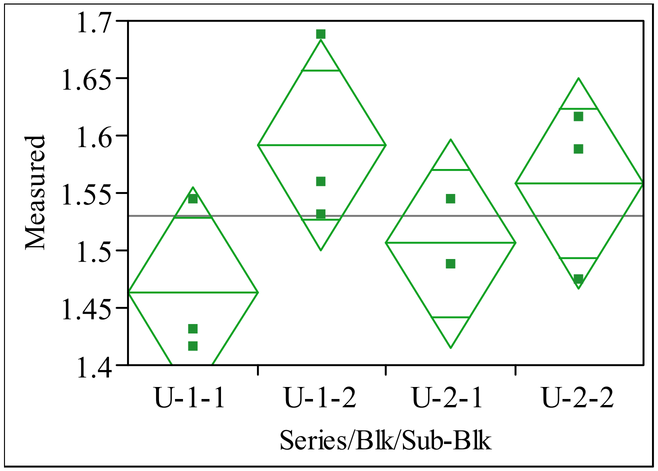
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	1.45353	0.01369	1.4220	1.4851
T-1-2	3	1.44876	0.01369	1.4172	1.4803
T-2-1	3	1.47259	0.01369	1.4410	1.5042
T-2-2	3	1.49642	0.01369	1.4649	1.5280

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Fe2O3 (wt%), Targeted=1, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.435583
Adj Rsquare	0.223926
Root Mean Square Error	0.068566
Mean of Response	1.529779
Observations (or Sum Wgts)	12

Analysis of Variance

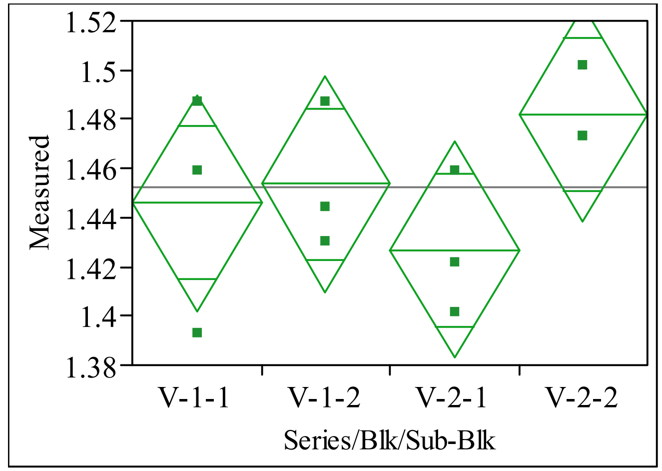
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.02902540	0.009675	2.0580	0.1843
Error	8	0.03761037	0.004701		
C. Total	11	0.06663577			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	1.46306	0.03959	1.3718	1.5543
U-1-2	3	1.59173	0.03959	1.5004	1.6830
U-2-1	3	1.50595	0.03959	1.4147	1.5972
U-2-2	3	1.55837	0.03959	1.4671	1.6497

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Fe2O3 (wt%), Targeted=1, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.353096
Adj Rsquare	0.110508
Root Mean Square Error	0.032945
Mean of Response	1.452099
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00473945	0.001580	1.4555	0.2977
Error	8	0.00868309	0.001085		
C. Total	11	0.01342254			

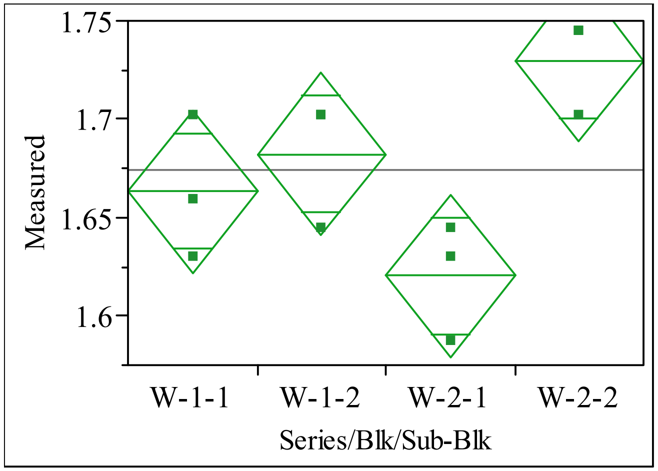
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	1.44590	0.01902	1.4020	1.4898
V-1-2	3	1.45353	0.01902	1.4097	1.4974
V-2-1	3	1.42684	0.01902	1.3830	1.4707
V-2-2	3	1.48212	0.01902	1.4383	1.5260

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Fe2O3 (wt%), Targeted=1, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.705236
Adj Rsquare	0.594699
Root Mean Square Error	0.03116
Mean of Response	1.67394
Observations (or Sum Wgts)	12

Analysis of Variance

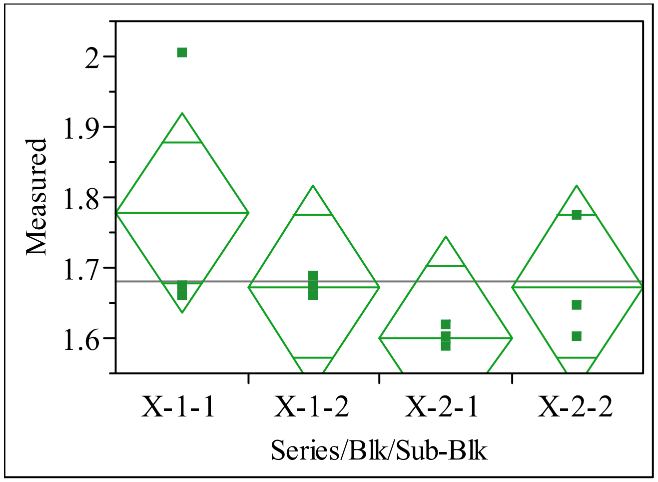
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.01858375	0.006195	6.3801	0.0162
Error	8	0.00776736	0.000971		
C. Total	11	0.02635111			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	1.66322	0.01799	1.6217	1.7047
W-1-2	3	1.68228	0.01799	1.6408	1.7238
W-2-1	3	1.62033	0.01799	1.5788	1.6618
W-2-2	3	1.72994	0.01799	1.6885	1.7714

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Fe2O3 (wt%), Targeted=1, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.340085
Adj Rsquare	0.092617
Root Mean Square Error	0.107307
Mean of Response	1.681089
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.04747288	0.015824	1.3743	0.3187
Error	8	0.09211816	0.011515		
C. Total	11	0.13959104			

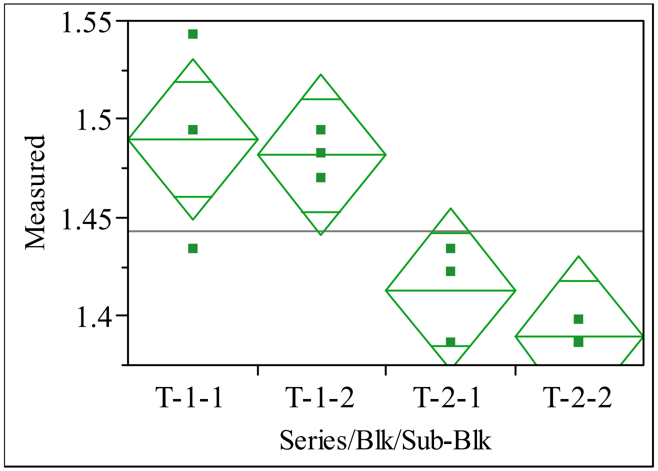
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	1.77759	0.06195	1.6347	1.9205
X-1-2	3	1.67275	0.06195	1.5299	1.8156
X-2-1	3	1.60126	0.06195	1.4584	1.7441
X-2-2	3	1.67275	0.06195	1.5299	1.8156

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=K2O (wt%), Targeted=1.5, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.747164
Adj Rsquare	0.65235
Root Mean Square Error	0.030711
Mean of Response	1.443512
Observations (or Sum Wgts)	12

Analysis of Variance

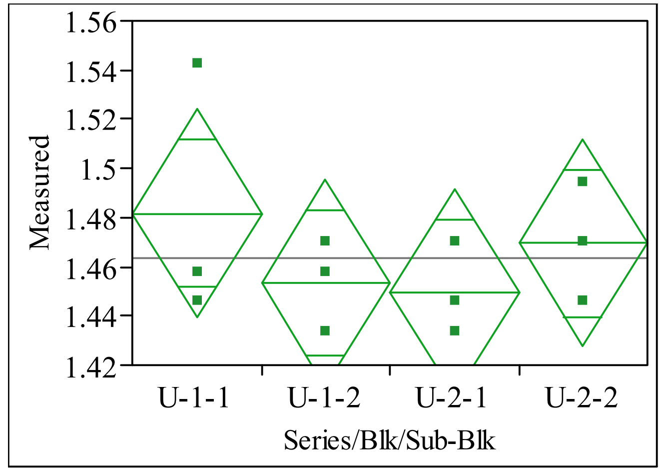
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.02229797	0.007433	7.8803	0.0090
Error	8	0.00754552	0.000943		
C. Total	11	0.02984349			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	1.48969	0.01773	1.4488	1.5306
T-1-2	3	1.48166	0.01773	1.4408	1.5225
T-2-1	3	1.41340	0.01773	1.3725	1.4543
T-2-2	3	1.38931	0.01773	1.3484	1.4302

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=K2O (wt%), Targeted=1.5, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.198068
Adj Rsquare	-0.10266
Root Mean Square Error	0.03168
Mean of Response	1.463589
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00198312	0.000661	0.6586	0.6001
Error	8	0.00802921	0.001004		
C. Total	11	0.01001232			

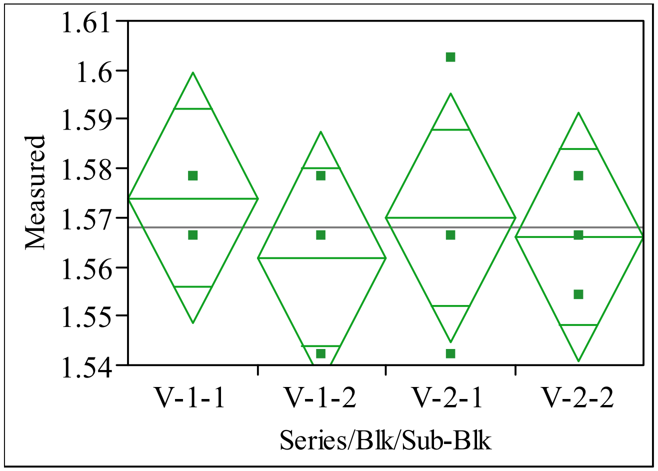
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	1.48166	0.01829	1.4395	1.5238
U-1-2	3	1.45355	0.01829	1.4114	1.4957
U-2-1	3	1.44954	0.01829	1.4074	1.4917
U-2-2	3	1.46961	0.01829	1.4274	1.5118

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=K2O (wt%), Targeted=1.5, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.076923
Adj Rsquare	-0.26923
Root Mean Square Error	0.019046
Mean of Response	1.567988
Observations (or Sum Wgts)	12

Analysis of Variance

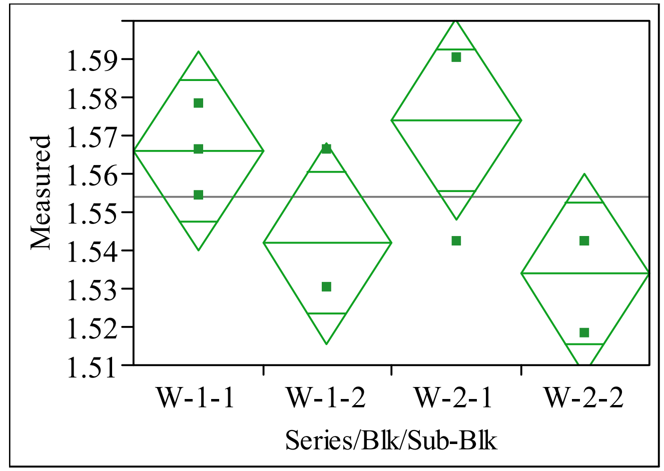
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00024184	0.000081	0.2222	0.8783
Error	8	0.00290212	0.000363		
C. Total	11	0.00314397			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	1.57401	0.01100	1.5487	1.5994
V-1-2	3	1.56196	0.01100	1.5366	1.5873
V-2-1	3	1.57000	0.01100	1.5446	1.5954
V-2-2	3	1.56598	0.01100	1.5406	1.5913

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=K2O (wt%), Targeted=1.5, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.515152
Adj Rsquare	0.333333
Root Mean Square Error	0.019671
Mean of Response	1.553934
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00328907	0.001096	2.8333	0.1062
Error	8	0.00309560	0.000387		
C. Total	11	0.00638467			

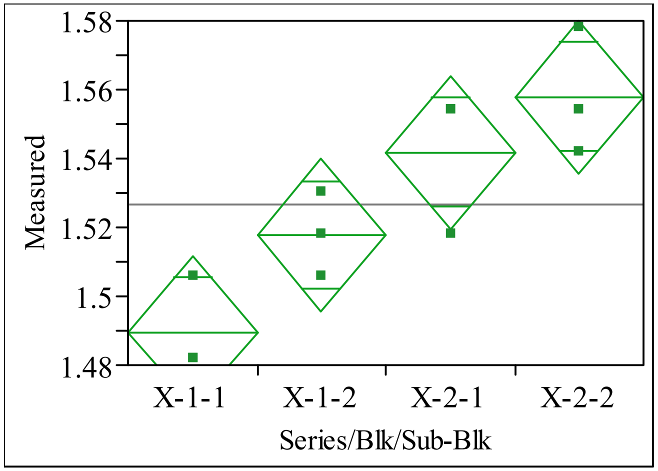
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	1.56598	0.01136	1.5398	1.5922
W-1-2	3	1.54189	0.01136	1.5157	1.5681
W-2-1	3	1.57401	0.01136	1.5478	1.6002
W-2-2	3	1.53386	0.01136	1.5077	1.5600

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=K2O (wt%), Targeted=1.5, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.781732
Adj Rsquare	0.699881
Root Mean Square Error	0.016677
Mean of Response	1.526831
Observations (or Sum Wgts)	12

Analysis of Variance

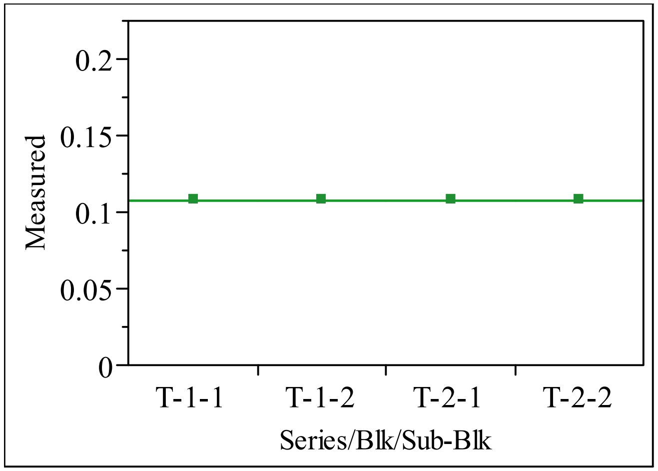
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00796874	0.002656	9.5507	0.0051
Error	8	0.00222496	0.000278		
C. Total	11	0.01019370			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	1.48969	0.00963	1.4675	1.5119
X-1-2	3	1.51780	0.00963	1.4956	1.5400
X-2-1	3	1.54189	0.00963	1.5197	1.5641
X-2-2	3	1.55795	0.00963	1.5357	1.5802

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Li2O (wt%), Targeted=0.1, Series=T



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.107645
Observations (or Sum Wgts)	12

Analysis of Variance

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

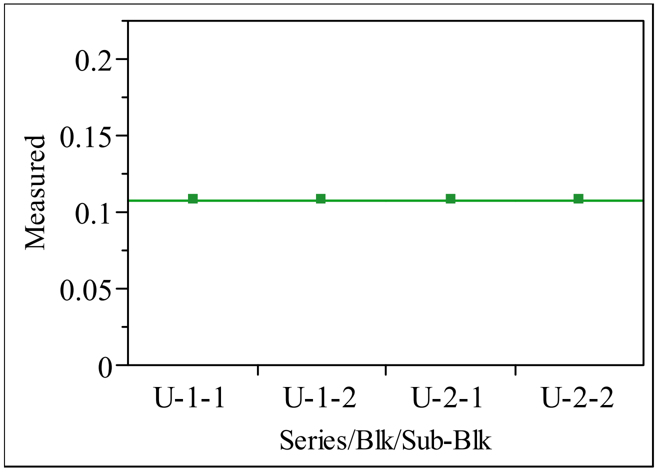
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	0.107645	0	0.10765	0.10765
T-1-2	3	0.107645	0	0.10765	0.10765
T-2-1	3	0.107645	0	0.10765	0.10765
T-2-2	3	0.107645	0	0.10765	0.10765

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Li2O (wt%), Targeted=0.1, Series=U



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.107645
Observations (or Sum Wgts)	12

Analysis of Variance

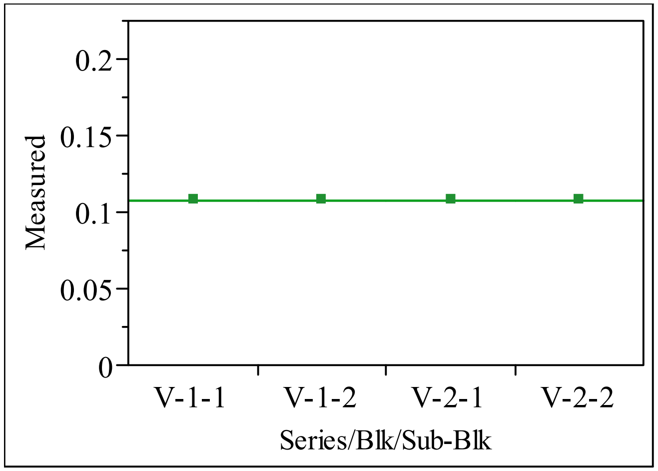
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	0.107645	0	0.10765	0.10765
U-1-2	3	0.107645	0	0.10765	0.10765
U-2-1	3	0.107645	0	0.10765	0.10765
U-2-2	3	0.107645	0	0.10765	0.10765

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Li2O (wt%), Targeted=0.1, Series=V



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.107645
Observations (or Sum Wgts)	12

Analysis of Variance

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

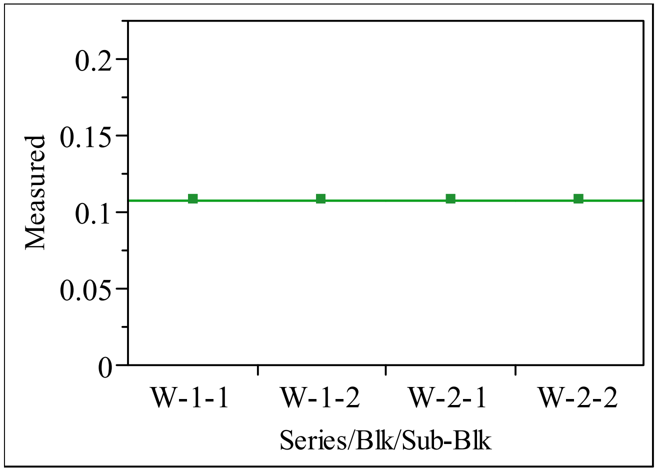
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	0.107645	0	0.10765	0.10765
V-1-2	3	0.107645	0	0.10765	0.10765
V-2-1	3	0.107645	0	0.10765	0.10765
V-2-2	3	0.107645	0	0.10765	0.10765

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Li2O (wt%), Targeted=0.1, Series=W



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.107645
Observations (or Sum Wgts)	12

Analysis of Variance

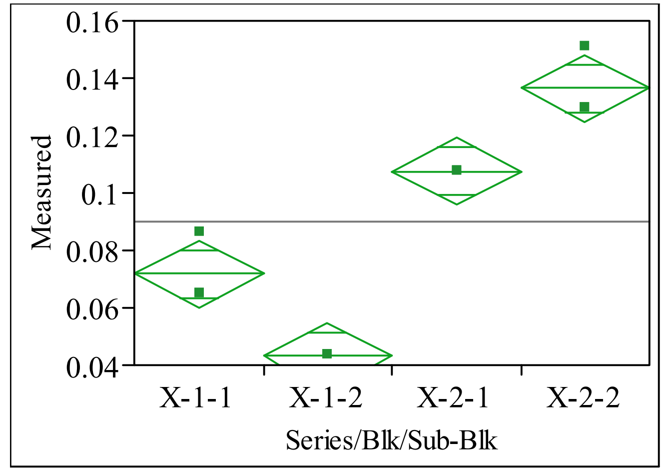
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	0.107645	0	0.10765	0.10765
W-1-2	3	0.107645	0	0.10765	0.10765
W-2-1	3	0.107645	0	0.10765	0.10765
W-2-2	3	0.107645	0	0.10765	0.10765

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Li2O (wt%), Targeted=0.1, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.960396
Adj Rsquare	0.945545
Root Mean Square Error	0.008789
Mean of Response	0.089704
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.01498643	0.004995	64.6667	<.0001
Error	8	0.00061800	0.000077		
C. Total	11	0.01560443			

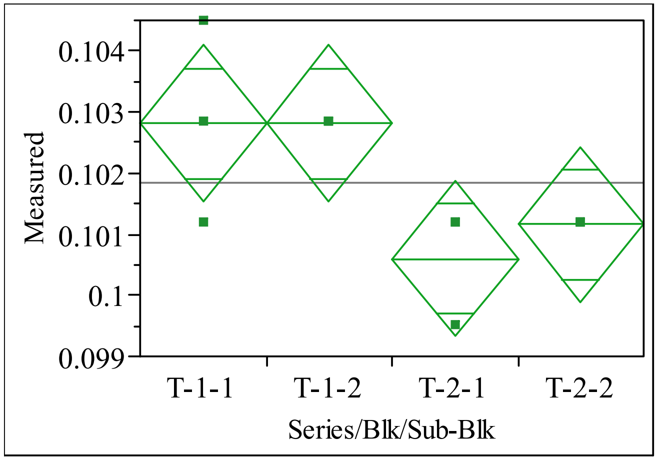
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	0.071763	0.00507	0.06006	0.08346
X-1-2	3	0.043058	0.00507	0.03136	0.05476
X-2-1	3	0.107645	0.00507	0.09594	0.11935
X-2-2	3	0.136350	0.00507	0.12465	0.14805

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=MgO (wt%), Targeted=0.1, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.614458
Adj Rsquare	0.46988
Root Mean Square Error	0.000957
Mean of Response	0.101847
Observations (or Sum Wgts)	12

Analysis of Variance

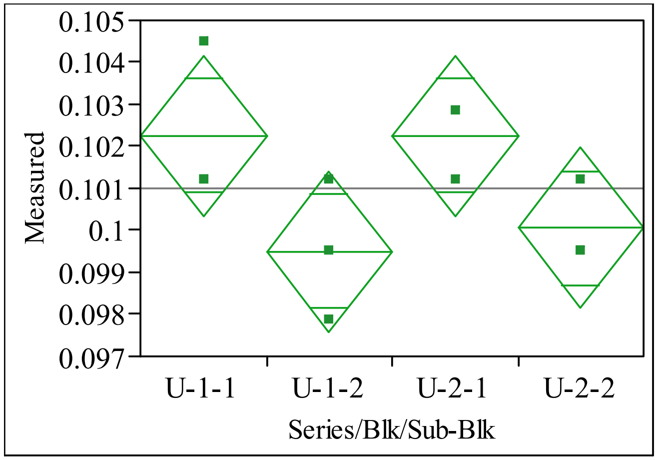
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00001169	3.8958e-6	4.2500	0.0452
Error	8	0.00000733	9.1665e-7		
C. Total	11	0.00001902			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	0.102815	0.00055	0.10154	0.10409
T-1-2	3	0.102815	0.00055	0.10154	0.10409
T-2-1	3	0.100604	0.00055	0.09933	0.10188
T-2-2	3	0.101156	0.00055	0.09988	0.10243

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=MgO (wt%), Targeted=0.1, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.535484
Adj Rsquare	0.36129
Root Mean Square Error	0.001436
Mean of Response	0.101018
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00001902	6.3402e-6	3.0741	0.0907
Error	8	0.00001650	2.0625e-6		
C. Total	11	0.00003552			

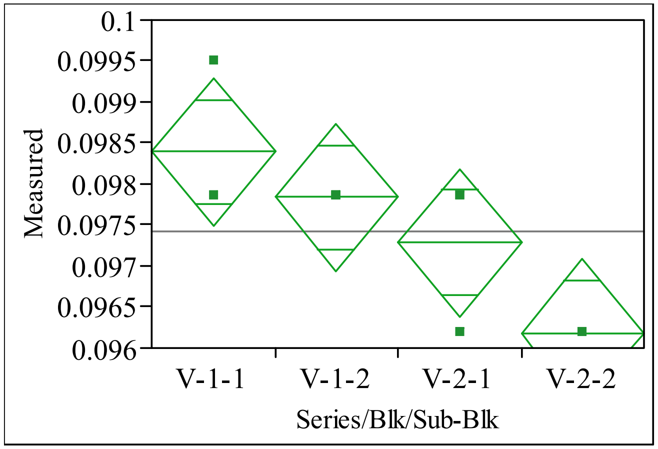
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	0.102262	0.00083	0.10035	0.10417
U-1-2	3	0.099498	0.00083	0.09759	0.10141
U-2-1	3	0.102262	0.00083	0.10035	0.10417
U-2-2	3	0.100051	0.00083	0.09814	0.10196

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=MgO (wt%), Targeted=0.1, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.686275
Adj Rsquare	0.568627
Root Mean Square Error	0.000677
Mean of Response	0.097425
Observations (or Sum Wgts)	12

Analysis of Variance

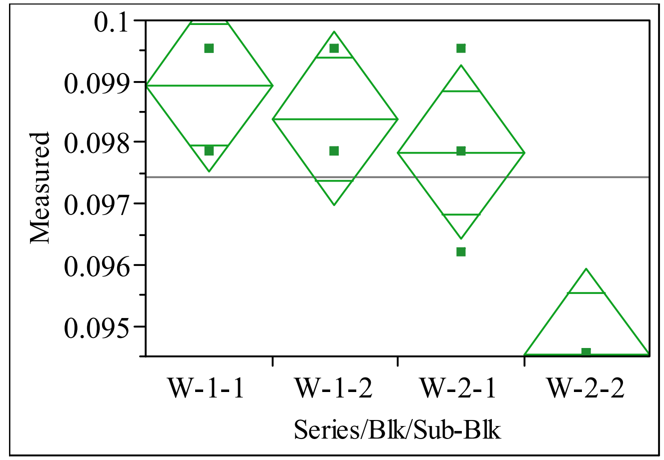
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00000802	2.6736e-6	5.8333	0.0206
Error	8	0.00000367	4.5833e-7		
C. Total	11	0.00001169			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	0.098392	0.00039	0.09749	0.09929
V-1-2	3	0.097840	0.00039	0.09694	0.09874
V-2-1	3	0.097287	0.00039	0.09639	0.09819
V-2-2	3	0.096181	0.00039	0.09528	0.09708

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=MgO (wt%), Targeted=0.1, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.794872
Adj Rsquare	0.717949
Root Mean Square Error	0.00107
Mean of Response	0.097425
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00003552	0.000012	10.3333	0.0040
Error	8	0.00000917	1.146e-6		
C. Total	11	0.00004469			

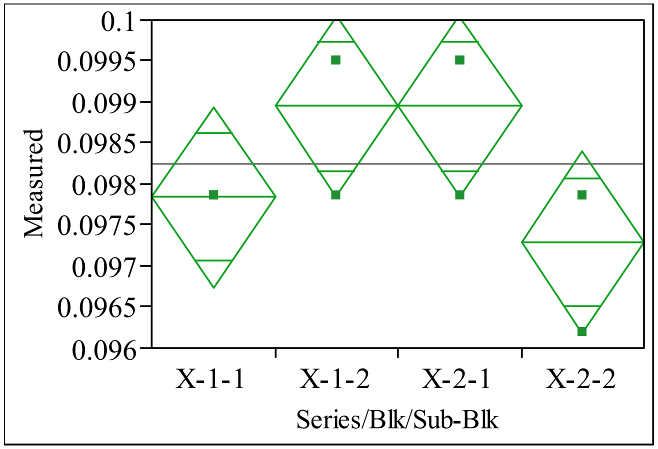
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	0.098945	0.00062	0.09752	0.10037
W-1-2	3	0.098392	0.00062	0.09697	0.09982
W-2-1	3	0.097840	0.00062	0.09641	0.09926
W-2-2	3	0.094523	0.00062	0.09310	0.09595

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=MgO (wt%), Targeted=0.1, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.529412
Adj Rsquare	0.352941
Root Mean Square Error	0.000829
Mean of Response	0.098254
Observations (or Sum Wgts)	12

Analysis of Variance

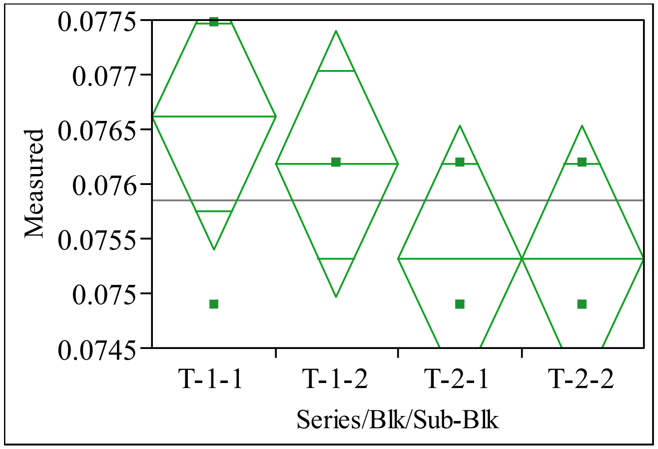
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00000619	2.0625e-6	3.0000	0.0951
Error	8	0.00000550	6.8749e-7		
C. Total	11	0.00001169			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	0.097840	0.00048	0.09674	0.09894
X-1-2	3	0.098945	0.00048	0.09784	0.10005
X-2-1	3	0.098945	0.00048	0.09784	0.10005
X-2-2	3	0.097287	0.00048	0.09618	0.09839

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=MnO (wt%), Targeted=0.1, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.36
Adj Rsquare	0.12
Root Mean Square Error	0.000913
Mean of Response	0.075858
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00000375	1.2504e-6	1.5000	0.2869
Error	8	0.00000667	8.336e-7		
C. Total	11	0.00001042			

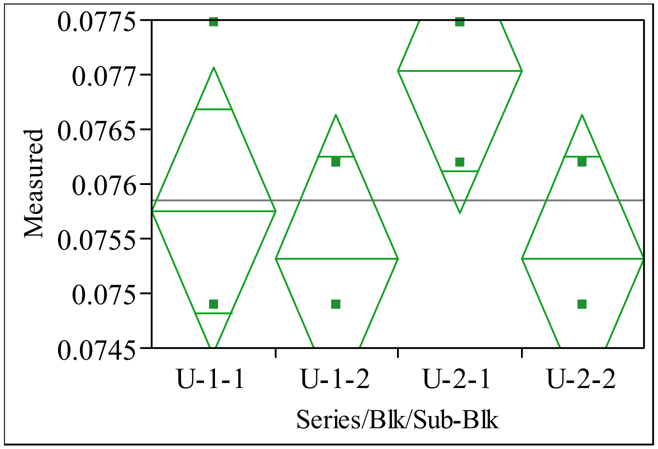
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	0.076611	0.00053	0.07540	0.07783
T-1-2	3	0.076181	0.00053	0.07497	0.07740
T-2-1	3	0.075320	0.00053	0.07410	0.07654
T-2-2	3	0.075320	0.00053	0.07410	0.07654

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=MnO (wt%), Targeted=0.1, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.434343
Adj Rsquare	0.222222
Root Mean Square Error	0.000986
Mean of Response	0.075858
Observations (or Sum Wgts)	12

Analysis of Variance

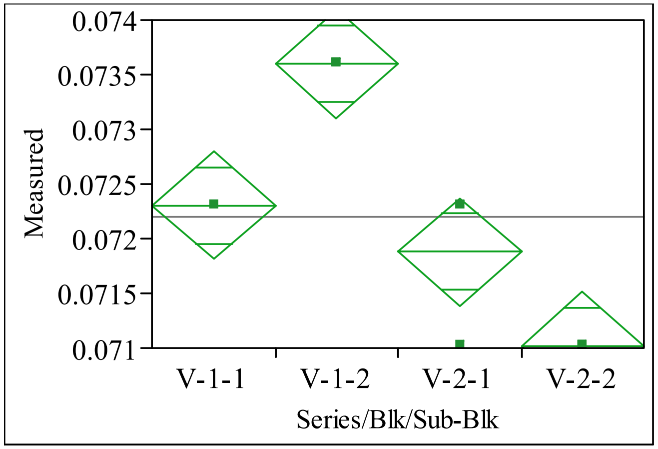
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00000597	1.9914e-6	2.0476	0.1858
Error	8	0.00000778	9.7253e-7		
C. Total	11	0.00001375			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	0.075750	0.00057	0.07444	0.07706
U-1-2	3	0.075320	0.00057	0.07401	0.07663
U-2-1	3	0.077042	0.00057	0.07573	0.07835
U-2-2	3	0.075320	0.00057	0.07401	0.07663

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=MnO (wt%), Targeted=0.1, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.903614
Adj Rsquare	0.86747
Root Mean Square Error	0.000373
Mean of Response	0.0722
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00001042	3.4733e-6	25.0000	0.0002
Error	8	0.00000111	1.3893e-7		
C. Total	11	0.00001153			

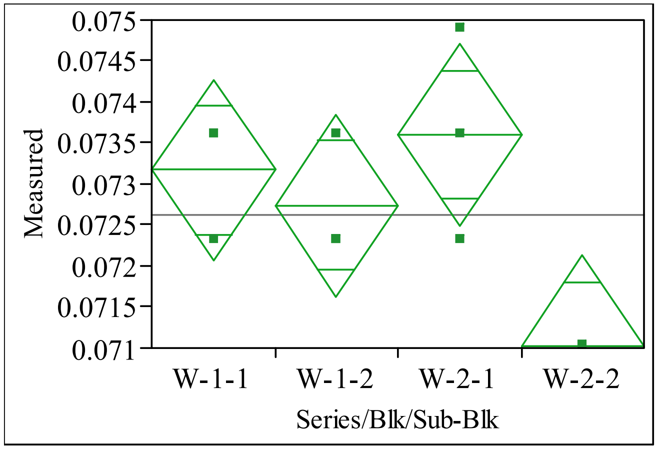
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	0.072307	0.00022	0.07181	0.07280
V-1-2	3	0.073598	0.00022	0.07310	0.07409
V-2-1	3	0.071877	0.00022	0.07138	0.07237
V-2-2	3	0.071016	0.00022	0.07052	0.07151

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=MnO (wt%), Targeted=0.1, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.674797
Adj Rsquare	0.552846
Root Mean Square Error	0.000833
Mean of Response	0.07263
Observations (or Sum Wgts)	12

Analysis of Variance

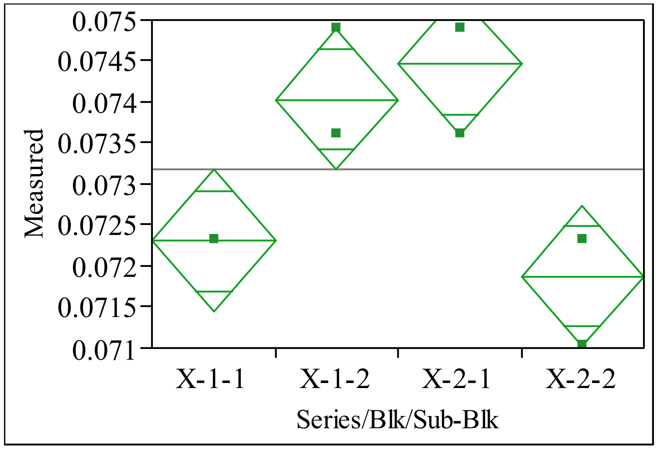
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00001153	3.8438e-6	5.5333	0.0237
Error	8	0.00000556	6.9467e-7		
C. Total	11	0.00001709			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	0.073168	0.00048	0.07206	0.07428
W-1-2	3	0.072738	0.00048	0.07163	0.07385
W-2-1	3	0.073598	0.00048	0.07249	0.07471
W-2-2	3	0.071016	0.00048	0.06991	0.07213

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=MnO (wt%), Targeted=0.1, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.8125
Adj Rsquare	0.742188
Root Mean Square Error	0.000646
Mean of Response	0.073168
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00001445	4.8163e-6	11.5556	0.0028
Error	8	0.00000333	4.168e-7		
C. Total	11	0.00001778			

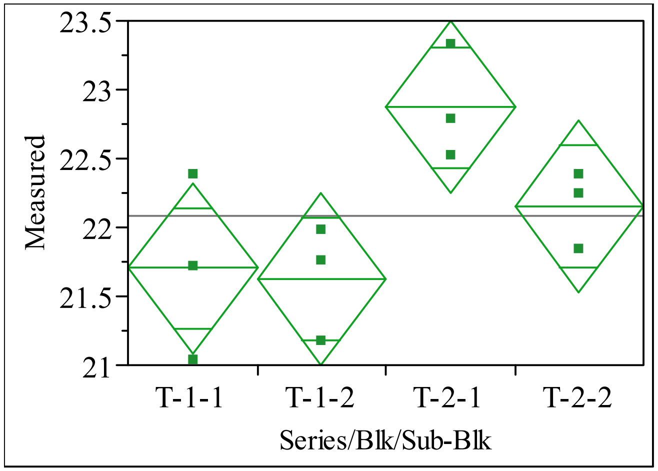
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	0.072307	0.00037	0.07145	0.07317
X-1-2	3	0.074029	0.00037	0.07317	0.07489
X-2-1	3	0.074459	0.00037	0.07360	0.07532
X-2-2	3	0.071877	0.00037	0.07102	0.07274

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Na2O (wt%), Targeted=20, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.626195
Adj Rsquare	0.486018
Root Mean Square Error	0.468078
Mean of Response	22.0881
Observations (or Sum Wgts)	12

Analysis of Variance

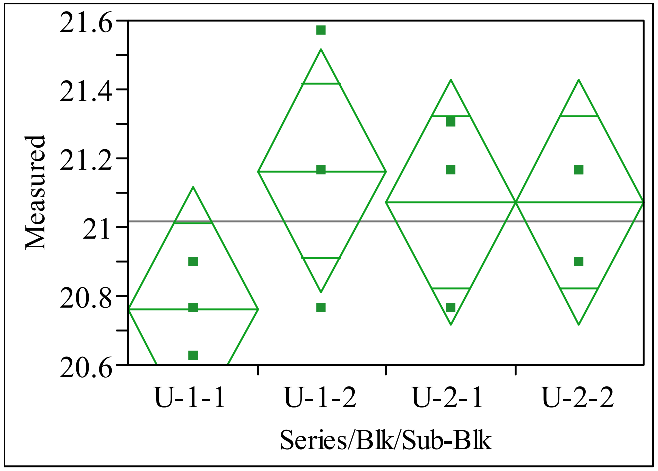
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	2.9362432	0.978748	4.4672	0.0402
Error	8	1.7527785	0.219097		
C. Total	11	4.6890217			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	21.7028	0.27025	21.080	22.326
T-1-2	3	21.6264	0.27025	21.003	22.250
T-2-1	3	22.8711	0.27025	22.248	23.494
T-2-2	3	22.1521	0.27025	21.529	22.775

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Na2O (wt%), Targeted=20, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.332149
Adj Rsquare	0.081705
Root Mean Square Error	0.266777
Mean of Response	21.01757
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.28316537	0.094388	1.3262	0.3320
Error	8	0.56935925	0.071170		
C. Total	11	0.85252463			

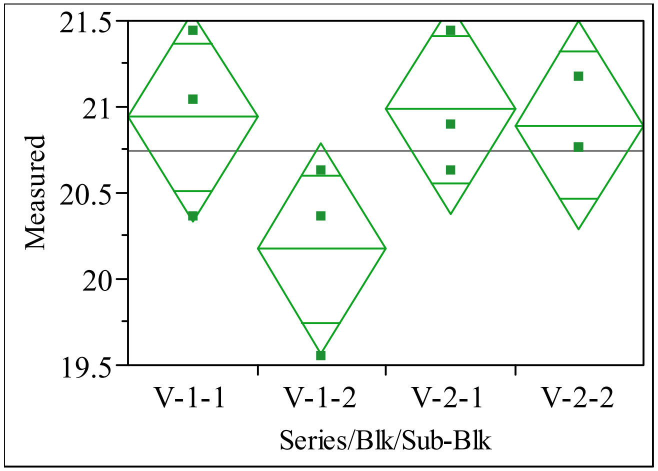
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	20.7592	0.15402	20.404	21.114
U-1-2	3	21.1636	0.15402	20.808	21.519
U-2-1	3	21.0737	0.15402	20.719	21.429
U-2-2	3	21.0737	0.15402	20.719	21.429

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Na2O (wt%), Targeted=20, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.442142
Adj Rsquare	0.232946
Root Mean Square Error	0.457129
Mean of Response	20.74797
Observations (or Sum Wgts)	12

Analysis of Variance

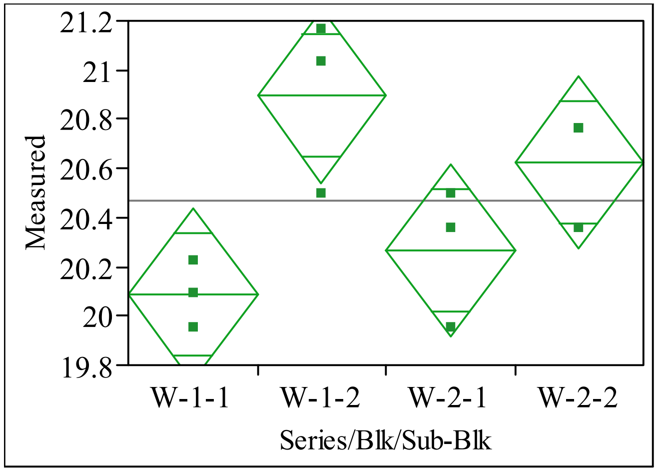
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	1.3249717	0.441657	2.1135	0.1768
Error	8	1.6717357	0.208967		
C. Total	11	2.9967073			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	20.9389	0.26392	20.330	21.548
V-1-2	3	20.1751	0.26392	19.566	20.784
V-2-1	3	20.9839	0.26392	20.375	21.592
V-2-2	3	20.8940	0.26392	20.285	21.503

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Na2O (wt%), Targeted=20, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.679443
Adj Rsquare	0.559233
Root Mean Square Error	0.263924
Mean of Response	20.46713
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	1.1811176	0.393706	5.6522	0.0224
Error	8	0.5572452	0.069656		
C. Total	11	1.7383628			

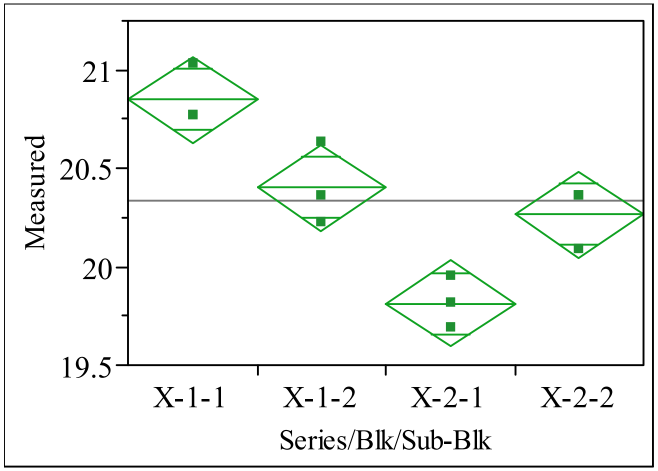
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	20.0852	0.15238	19.734	20.437
W-1-2	3	20.8940	0.15238	20.543	21.245
W-2-1	3	20.2649	0.15238	19.914	20.616
W-2-2	3	20.6244	0.15238	20.273	20.976

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=Na2O (wt%), Targeted=20, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.881967
Adj Rsquare	0.837705
Root Mean Square Error	0.165096
Mean of Response	20.33233
Observations (or Sum Wgts)	12

Analysis of Variance

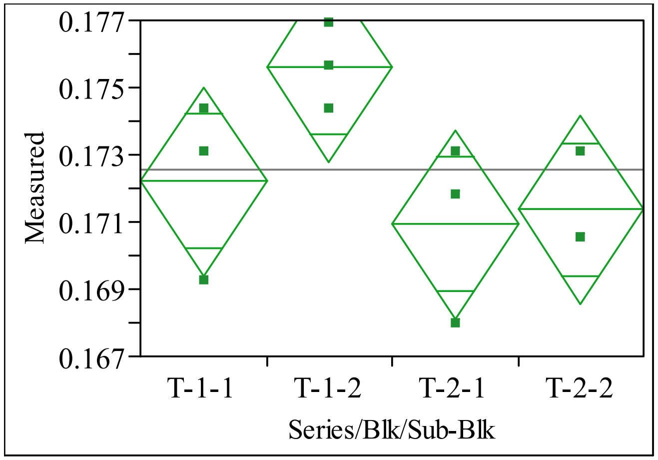
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	1.6293366	0.543112	19.9259	0.0005
Error	8	0.2180525	0.027257		
C. Total	11	1.8473891			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	20.8491	0.09532	20.629	21.069
X-1-2	3	20.3997	0.09532	20.180	20.620
X-2-1	3	19.8156	0.09532	19.596	20.035
X-2-2	3	20.2649	0.09532	20.045	20.485

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=NiO (wt%), Targeted=0.1, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.531083
Adj Rsquare	0.35524
Root Mean Square Error	0.00211
Mean of Response	0.17253
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00004035	0.000013	3.0202	0.0939
Error	8	0.00003562	4.453e-6		
C. Total	11	0.00007597			

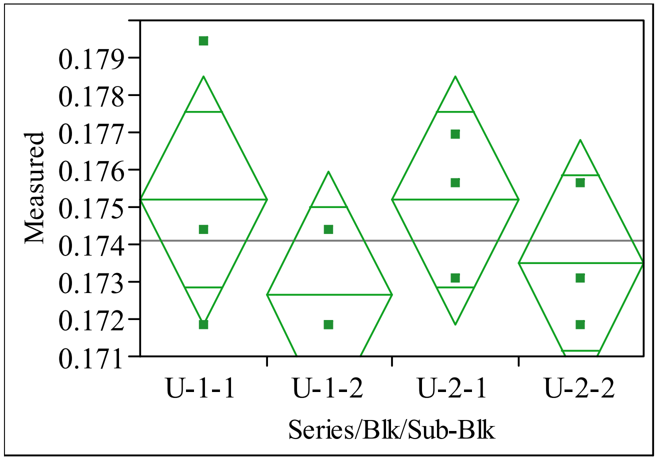
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	0.172212	0.00122	0.16940	0.17502
T-1-2	3	0.175605	0.00122	0.17280	0.17841
T-2-1	3	0.170939	0.00122	0.16813	0.17375
T-2-2	3	0.171363	0.00122	0.16855	0.17417

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=NiO (wt%), Targeted=0.1, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.226891
Adj Rsquare	-0.06303
Root Mean Square Error	0.002491
Mean of Response	0.17412
Observations (or Sum Wgts)	12

Analysis of Variance

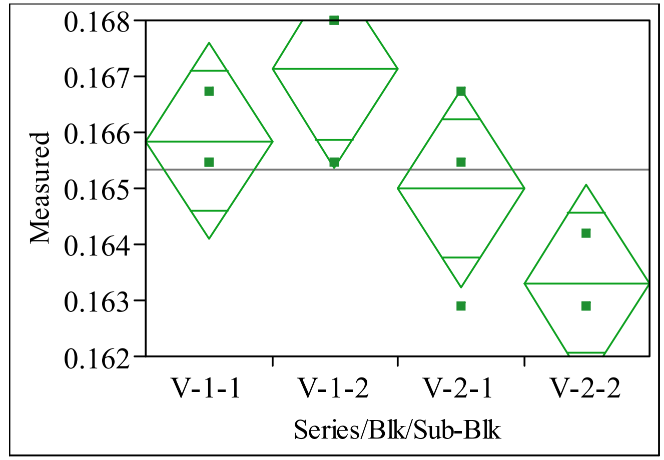
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00001457	4.8578e-6	0.7826	0.5362
Error	8	0.00004966	6.2071e-6		
C. Total	11	0.00006423			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	0.175181	0.00144	0.17186	0.17850
U-1-2	3	0.172636	0.00144	0.16932	0.17595
U-2-1	3	0.175181	0.00144	0.17186	0.17850
U-2-2	3	0.173484	0.00144	0.17017	0.17680

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=NiO (wt%), Targeted=0.1, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.621818
Adj Rsquare	0.48
Root Mean Square Error	0.001324
Mean of Response	0.165319
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00002307	7.6915e-6	4.3846	0.0420
Error	8	0.00001403	1.7542e-6		
C. Total	11	0.00003711			

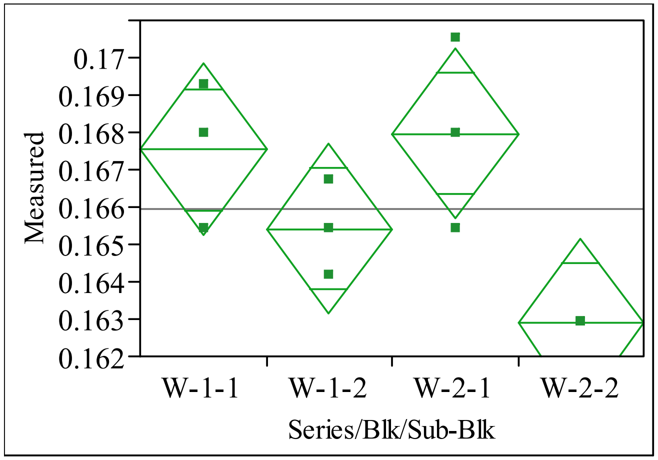
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	0.165849	0.00076	0.16409	0.16761
V-1-2	3	0.167122	0.00076	0.16536	0.16889
V-2-1	3	0.165001	0.00076	0.16324	0.16676
V-2-2	3	0.163304	0.00076	0.16154	0.16507

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=NiO (wt%), Targeted=0.1, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.673469
Adj Rsquare	0.55102
Root Mean Square Error	0.001723
Mean of Response	0.165955
Observations (or Sum Wgts)	12

Analysis of Variance

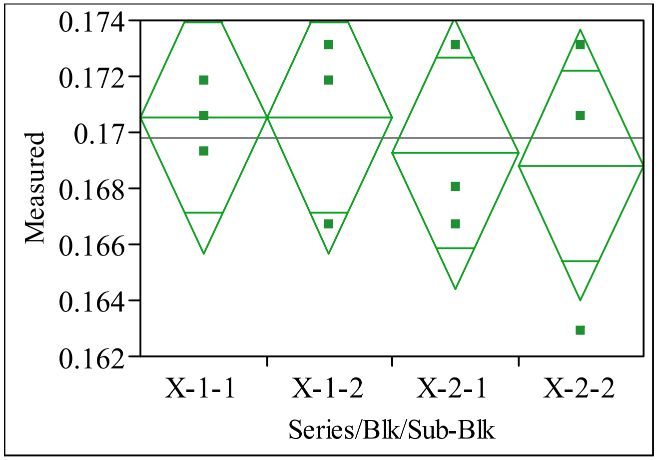
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00004898	0.000016	5.5000	0.0240
Error	8	0.00002375	2.969e-6		
C. Total	11	0.00007273			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	0.167546	0.00099	0.16525	0.16984
W-1-2	3	0.165425	0.00099	0.16313	0.16772
W-2-1	3	0.167970	0.00099	0.16568	0.17026
W-2-2	3	0.162880	0.00099	0.16059	0.16517

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=NiO (wt%), Targeted=0.1, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.061669
Adj Rsquare	-0.29021
Root Mean Square Error	0.003618
Mean of Response	0.169773
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00000688	2.294e-6	0.1753	0.9102
Error	8	0.00010471	0.000013		
C. Total	11	0.00011159			

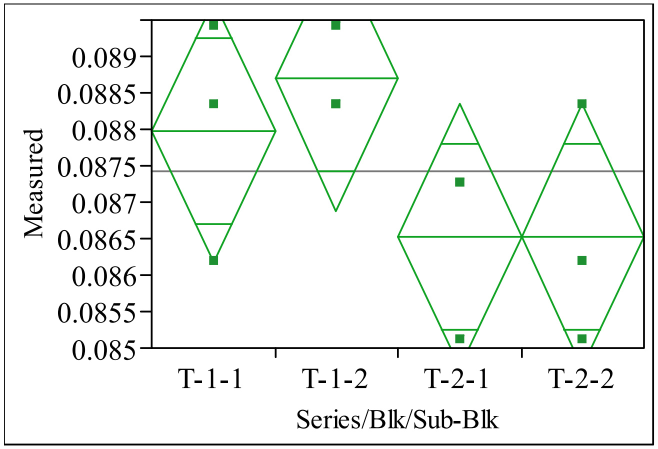
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	0.170515	0.00209	0.16570	0.17533
X-1-2	3	0.170515	0.00209	0.16570	0.17533
X-2-1	3	0.169243	0.00209	0.16443	0.17406
X-2-2	3	0.168818	0.00209	0.16400	0.17364

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=PbO (wt%), Targeted=0.1, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.415385
Adj Rsquare	0.196154
Root Mean Square Error	0.001355
Mean of Response	0.087433
Observations (or Sum Wgts)	12

Analysis of Variance

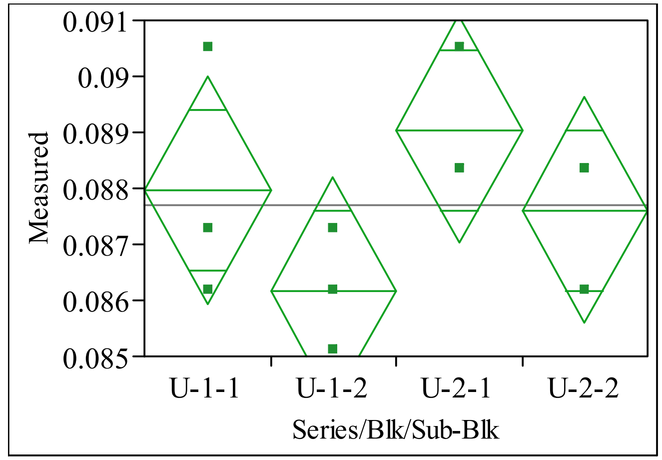
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00001044	3.4811e-6	1.8947	0.2089
Error	8	0.00001470	1.8372e-6		
C. Total	11	0.00002514			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	0.087971	0.00078	0.08617	0.08978
T-1-2	3	0.088689	0.00078	0.08688	0.09049
T-2-1	3	0.086535	0.00078	0.08473	0.08834
T-2-2	3	0.086535	0.00078	0.08473	0.08834

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=PbO (wt%), Targeted=0.1, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.405573
Adj Rsquare	0.182663
Root Mean Square Error	0.001523
Mean of Response	0.087702
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00001267	4.2224e-6	1.8194	0.2216
Error	8	0.00001857	2.3207e-6		
C. Total	11	0.00003123			

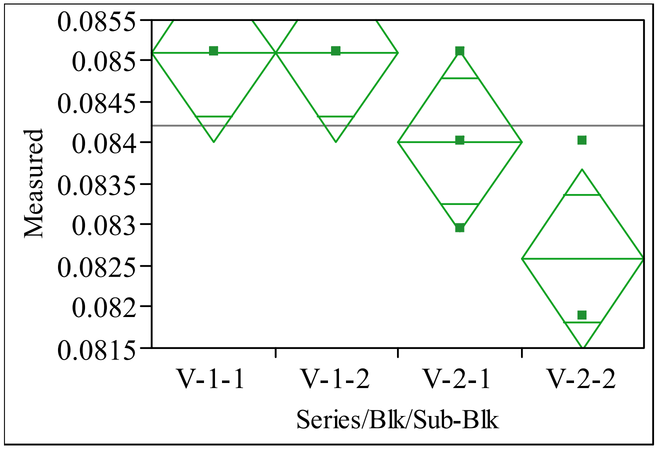
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	0.087971	0.00088	0.08594	0.09000
U-1-2	3	0.086176	0.00088	0.08415	0.08820
U-2-1	3	0.089049	0.00088	0.08702	0.09108
U-2-2	3	0.087612	0.00088	0.08558	0.08964

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=PbO (wt%), Targeted=0.1, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.702128
Adj Rsquare	0.590426
Root Mean Square Error	0.000823
Mean of Response	0.084201
Observations (or Sum Wgts)	12

Analysis of Variance

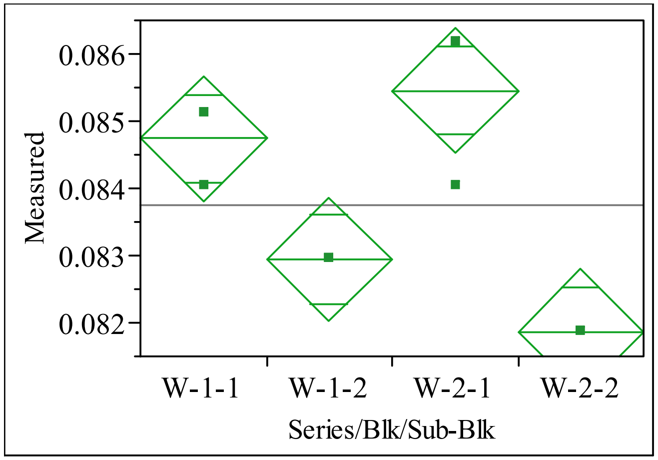
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00001276	4.2547e-6	6.2857	0.0169
Error	8	0.00000542	6.7688e-7		
C. Total	11	0.00001818			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	0.085099	0.00048	0.08400	0.08619
V-1-2	3	0.085099	0.00048	0.08400	0.08619
V-2-1	3	0.084022	0.00048	0.08293	0.08512
V-2-2	3	0.082585	0.00048	0.08149	0.08368

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=PbO (wt%), Targeted=0.1, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.862543
Adj Rsquare	0.810997
Root Mean Square Error	0.000695
Mean of Response	0.083752
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00002427	8.0903e-6	16.7333	0.0008
Error	8	0.00000387	4.8348e-7		
C. Total	11	0.00002814			

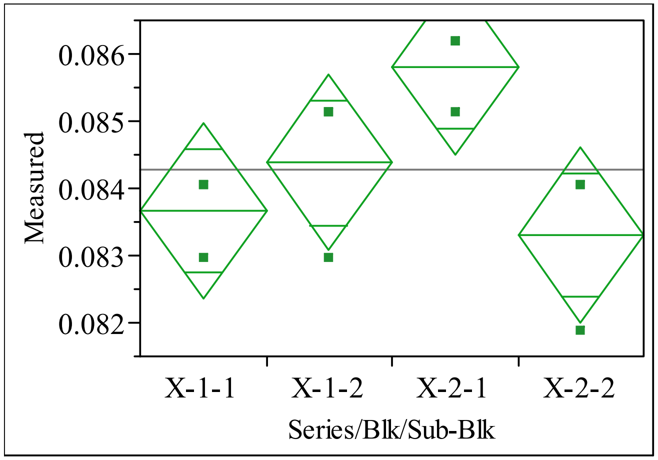
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	0.084740	0.00040	0.08381	0.08567
W-1-2	3	0.082944	0.00040	0.08202	0.08387
W-2-1	3	0.085458	0.00040	0.08453	0.08638
W-2-2	3	0.081867	0.00040	0.08094	0.08279

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=PbO (wt%), Targeted=0.1, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.589744
Adj Rsquare	0.435897
Root Mean Square Error	0.000983
Mean of Response	0.084291
Observations (or Sum Wgts)	12

Analysis of Variance

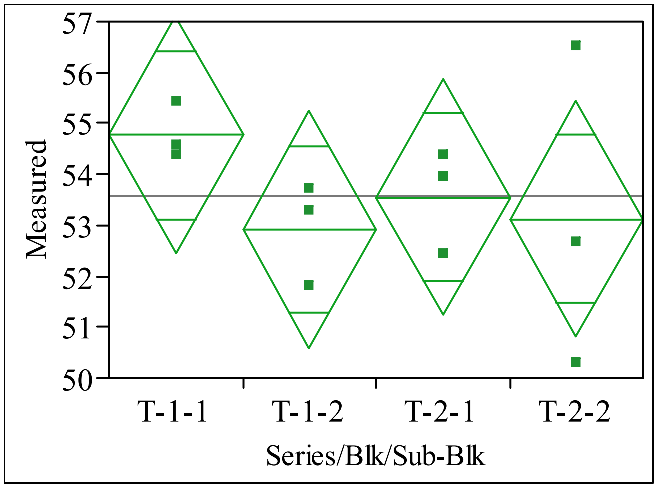
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00001112	3.7067e-6	3.8333	0.0571
Error	8	0.00000774	9.6697e-7		
C. Total	11	0.00001886			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	0.083663	0.00057	0.08235	0.08497
X-1-2	3	0.084381	0.00057	0.08307	0.08569
X-2-1	3	0.085817	0.00057	0.08451	0.08713
X-2-2	3	0.083303	0.00057	0.08199	0.08461

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=SiO2 (wt%), Targeted=55, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.202399
Adj Rsquare	-0.0967
Root Mean Square Error	1.744546
Mean of Response	53.58947
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	6.178416	2.05947	0.6767	0.5903
Error	8	24.347536	3.04344		
C. Total	11	30.525952			

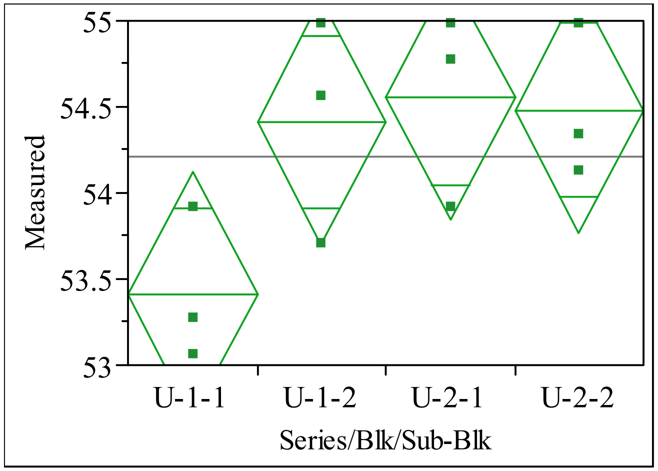
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	54.7661	1.0072	52.443	57.089
T-1-2	3	52.9120	1.0072	50.589	55.235
T-2-1	3	53.5538	1.0072	51.231	55.876
T-2-2	3	53.1260	1.0072	50.803	55.449

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=SiO2 (wt%), Targeted=55, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.532346
Adj Rsquare	0.356976
Root Mean Square Error	0.534825
Mean of Response	54.21343
Observations (or Sum Wgts)	12

Analysis of Variance

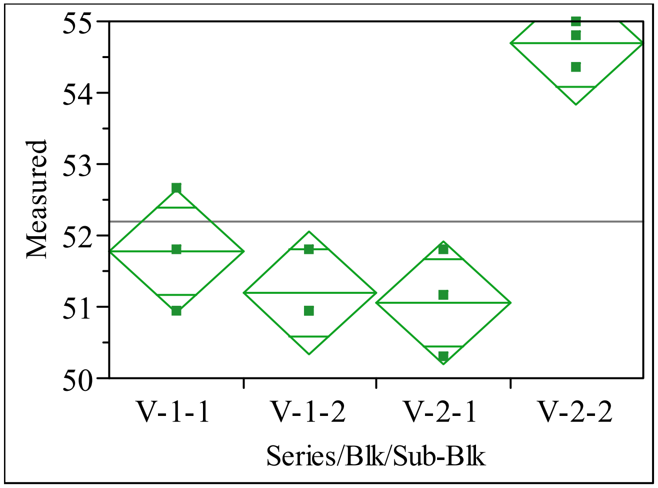
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	2.6048507	0.868284	3.0356	0.0930
Error	8	2.2883022	0.286038		
C. Total	11	4.8931530			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	53.4112	0.30878	52.699	54.123
U-1-2	3	54.4095	0.30878	53.697	55.122
U-2-1	3	54.5522	0.30878	53.840	55.264
U-2-2	3	54.4808	0.30878	53.769	55.193

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=SiO2 (wt%), Targeted=55, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.88801
Adj Rsquare	0.846014
Root Mean Square Error	0.64179
Mean of Response	52.18109
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	26.128598	8.70953	21.1451	0.0004
Error	8	3.295155	0.41189		
C. Total	11	29.423753			

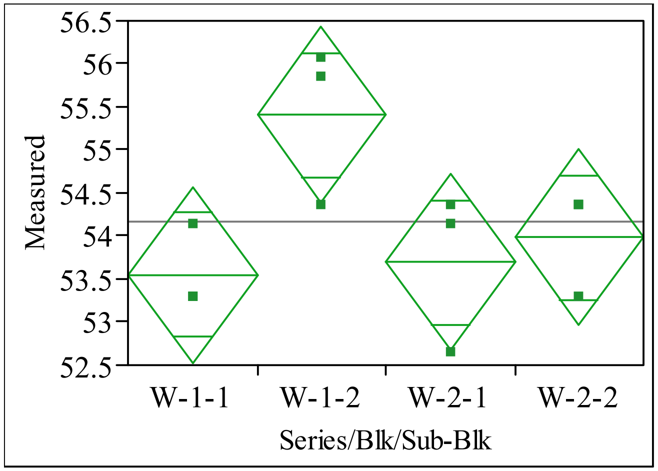
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	51.7711	0.37054	50.917	52.626
V-1-2	3	51.2006	0.37054	50.346	52.055
V-2-1	3	51.0580	0.37054	50.203	51.912
V-2-2	3	54.6948	0.37054	53.840	55.549

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=SiO2 (wt%), Targeted=55, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.579376
Adj Rsquare	0.421642
Root Mean Square Error	0.768859
Mean of Response	54.15995
Observations (or Sum Wgts)	12

Analysis of Variance

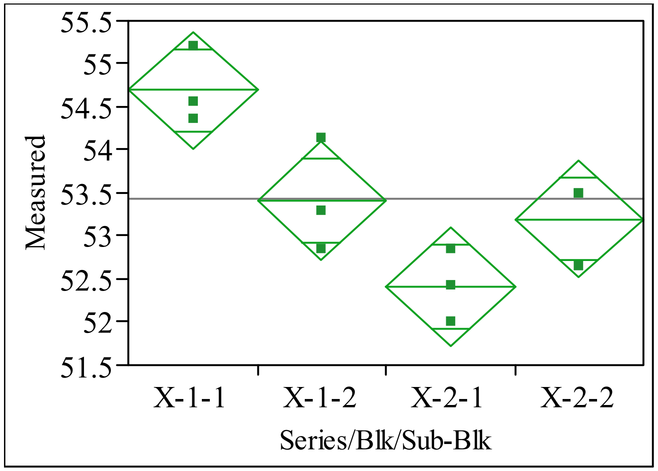
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	6.514034	2.17134	3.6731	0.0627
Error	8	4.729158	0.59114		
C. Total	11	11.243192			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	53.5538	0.44390	52.530	54.577
W-1-2	3	55.4079	0.44390	54.384	56.432
W-2-1	3	53.6964	0.44390	52.673	54.720
W-2-2	3	53.9817	0.44390	52.958	55.005

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=SiO2 (wt%), Targeted=55, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.793026
Adj Rsquare	0.715411
Root Mean Square Error	0.512986
Mean of Response	53.42902
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	8.066265	2.68876	10.2174	0.0041
Error	8	2.105238	0.26315		
C. Total	11	10.171503			

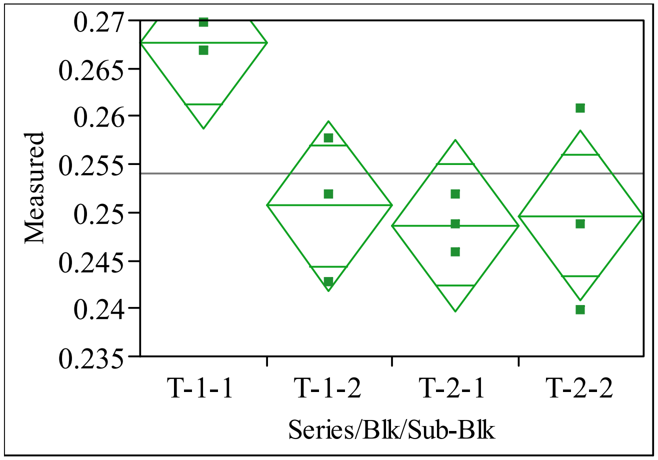
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	54.6948	0.29617	54.012	55.378
X-1-2	3	53.4112	0.29617	52.728	54.094
X-2-1	3	52.4129	0.29617	51.730	53.096
X-2-2	3	53.1973	0.29617	52.514	53.880

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=SO4 (wt%), Targeted=0.24, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.671233
Adj Rsquare	0.547945
Root Mean Square Error	0.006699
Mean of Response	0.254152
Observations (or Sum Wgts)	12

Analysis of Variance

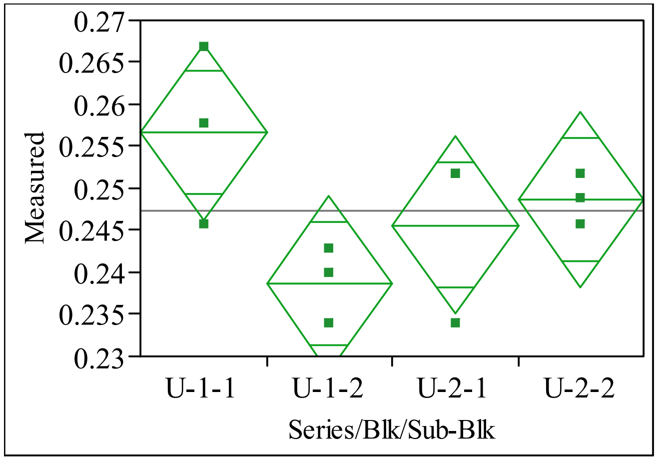
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00073299	0.000244	5.4444	0.0247
Error	8	0.00035902	0.000045		
C. Total	11	0.00109201			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	0.267634	0.00387	0.25871	0.27655
T-1-2	3	0.250657	0.00387	0.24174	0.25958
T-2-1	3	0.248660	0.00387	0.23974	0.25758
T-2-2	3	0.249658	0.00387	0.24074	0.25858

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=SO4 (wt%), Targeted=0.24, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.501127
Adj Rsquare	0.31405
Root Mean Square Error	0.007879
Mean of Response	0.247411
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00049888	0.000166	2.6787	0.1179
Error	8	0.00049664	0.000062		
C. Total	11	0.00099552			

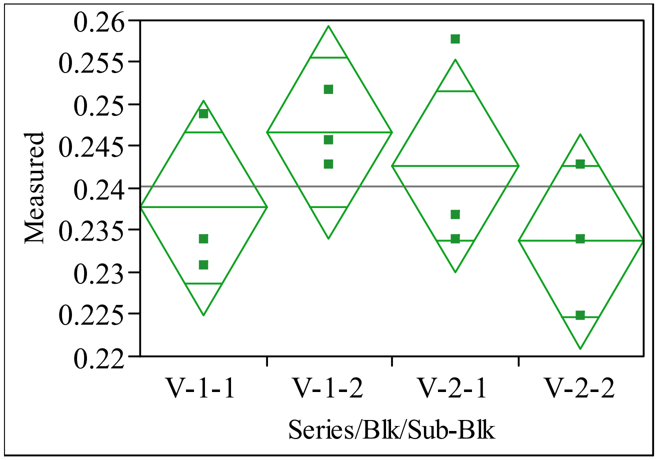
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	0.256649	0.00455	0.24616	0.26714
U-1-2	3	0.238673	0.00455	0.22818	0.24916
U-2-1	3	0.245664	0.00455	0.23517	0.25615
U-2-2	3	0.248660	0.00455	0.23817	0.25915

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=SO4 (wt%), Targeted=0.24, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.284457
Adj Rsquare	0.016129
Root Mean Square Error	0.009552
Mean of Response	0.240171
Observations (or Sum Wgts)	12

Analysis of Variance

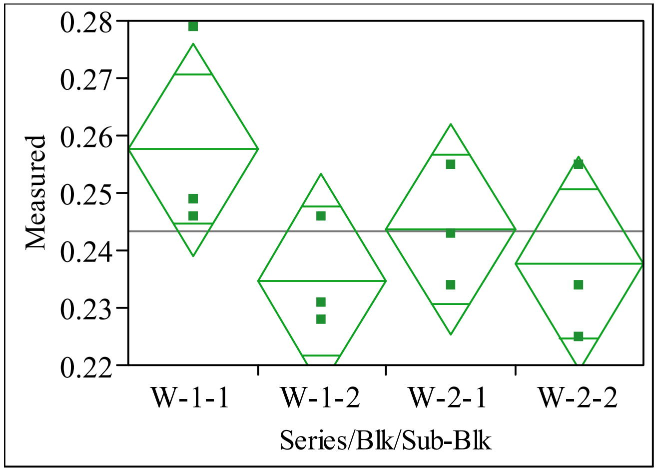
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00029021	0.000097	1.0601	0.4182
Error	8	0.00073000	0.000091		
C. Total	11	0.00102021			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	0.237675	0.00552	0.22496	0.25039
V-1-2	3	0.246662	0.00552	0.23394	0.25938
V-2-1	3	0.242668	0.00552	0.22995	0.25539
V-2-2	3	0.233680	0.00552	0.22096	0.24640

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=SO4 (wt%), Targeted=0.24, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.377376
Adj Rsquare	0.143891
Root Mean Square Error	0.013891
Mean of Response	0.243417
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00093569	0.000312	1.6163	0.2608
Error	8	0.00154377	0.000193		
C. Total	11	0.00247946			

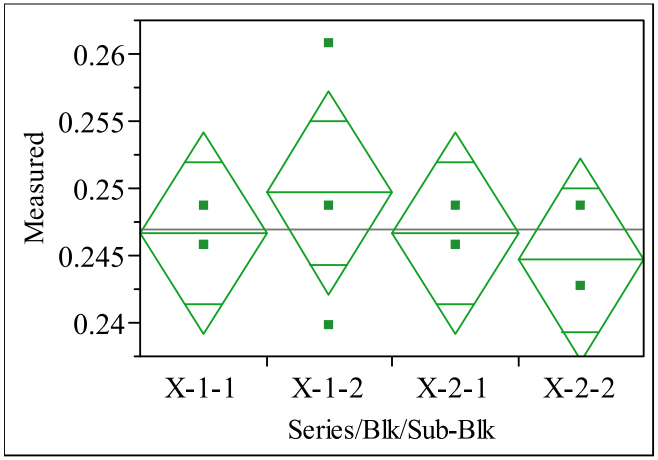
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	0.257647	0.00802	0.23915	0.27614
W-1-2	3	0.234679	0.00802	0.21618	0.25317
W-2-1	3	0.243667	0.00802	0.22517	0.26216
W-2-2	3	0.237675	0.00802	0.21918	0.25617

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=SO4 (wt%), Targeted=0.24, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.129114
Adj Rsquare	-0.19747
Root Mean Square Error	0.005671
Mean of Response	0.246912
Observations (or Sum Wgts)	12

Analysis of Variance

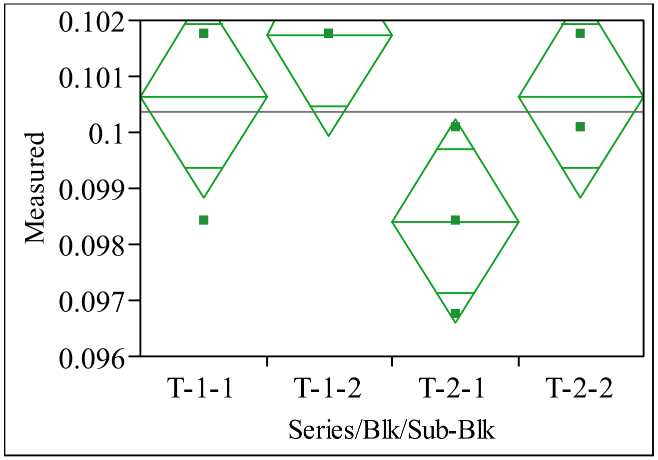
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00003815	0.000013	0.3953	0.7600
Error	8	0.00025730	0.000032		
C. Total	11	0.00029544			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	0.246662	0.00327	0.23911	0.25421
X-1-2	3	0.249658	0.00327	0.24211	0.25721
X-2-1	3	0.246662	0.00327	0.23911	0.25421
X-2-2	3	0.244665	0.00327	0.23711	0.25222

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=TiO2 (wt%), Targeted=0.1, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.542857
Adj Rsquare	0.371429
Root Mean Square Error	0.001362
Mean of Response	0.100358
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00001762	5.8736e-6	3.1667	0.0855
Error	8	0.00001484	1.8548e-6		
C. Total	11	0.00003246			

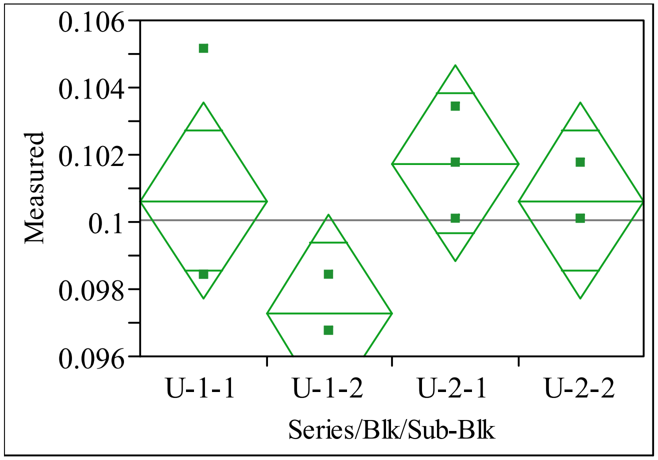
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	0.100636	0.00079	0.09882	0.10245
T-1-2	3	0.101748	0.00079	0.09993	0.10356
T-2-1	3	0.098412	0.00079	0.09660	0.10023
T-2-2	3	0.100636	0.00079	0.09882	0.10245

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=TiO2 (wt%), Targeted=0.1, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.461538
Adj Rsquare	0.259615
Root Mean Square Error	0.002207
Mean of Response	0.10008
Observations (or Sum Wgts)	12

Analysis of Variance

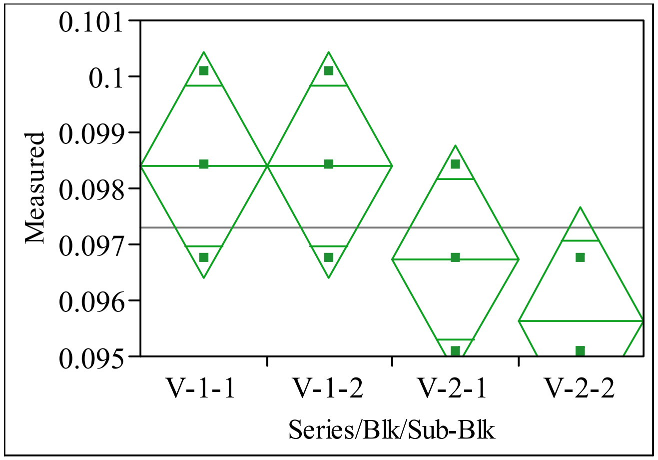
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00003339	0.000011	2.2857	0.1556
Error	8	0.00003895	4.869e-6		
C. Total	11	0.00007234			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	0.100636	0.00127	0.09770	0.10357
U-1-2	3	0.097300	0.00127	0.09436	0.10024
U-2-1	3	0.101748	0.00127	0.09881	0.10469
U-2-2	3	0.100636	0.00127	0.09770	0.10357

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=TiO2 (wt%), Targeted=0.1, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.473684
Adj Rsquare	0.276316
Root Mean Square Error	0.001523
Mean of Response	0.0973
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00001669	5.5644e-6	2.4000	0.1433
Error	8	0.00001855	2.3185e-6		
C. Total	11	0.00003524			

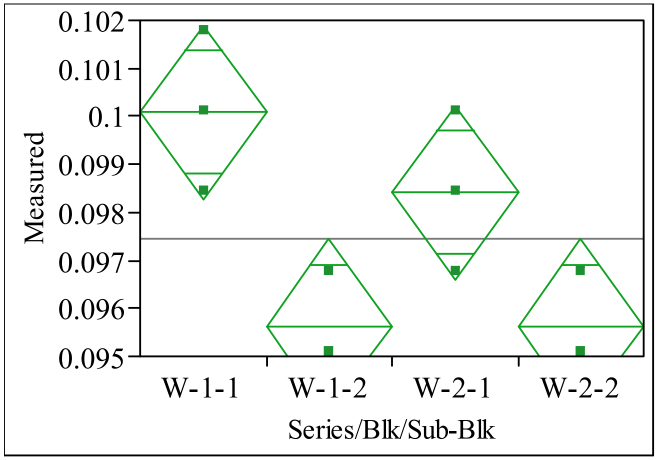
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	0.098412	0.00088	0.09638	0.10044
V-1-2	3	0.098412	0.00088	0.09638	0.10044
V-2-1	3	0.096744	0.00088	0.09472	0.09877
V-2-2	3	0.095632	0.00088	0.09360	0.09766

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=TiO2 (wt%), Targeted=0.1, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.74502
Adj Rsquare	0.649402
Root Mean Square Error	0.001362
Mean of Response	0.097439
Observations (or Sum Wgts)	12

Analysis of Variance

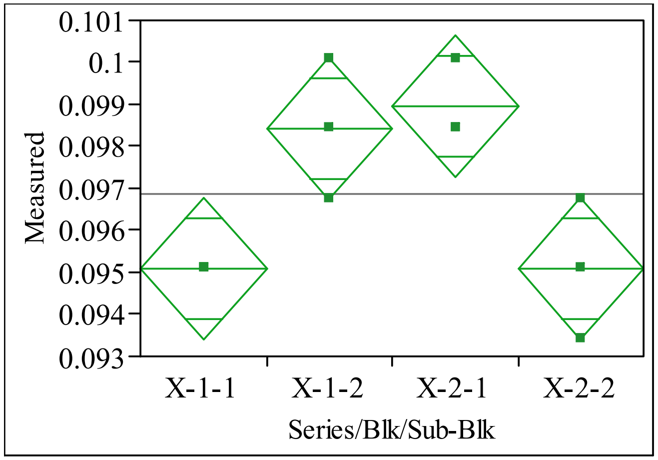
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00004336	0.000014	7.7917	0.0093
Error	8	0.00001484	1.855e-6		
C. Total	11	0.00005819			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	0.100080	0.00079	0.09827	0.10189
W-1-2	3	0.095632	0.00079	0.09382	0.09745
W-2-1	3	0.098412	0.00079	0.09660	0.10023
W-2-2	3	0.095632	0.00079	0.09382	0.09745

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=TiO2 (wt%), Targeted=0.1, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.753304
Adj Rsquare	0.660793
Root Mean Square Error	0.001274
Mean of Response	0.096883
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00003965	0.000013	8.1429	0.0082
Error	8	0.00001298	1.623e-6		
C. Total	11	0.00005263			

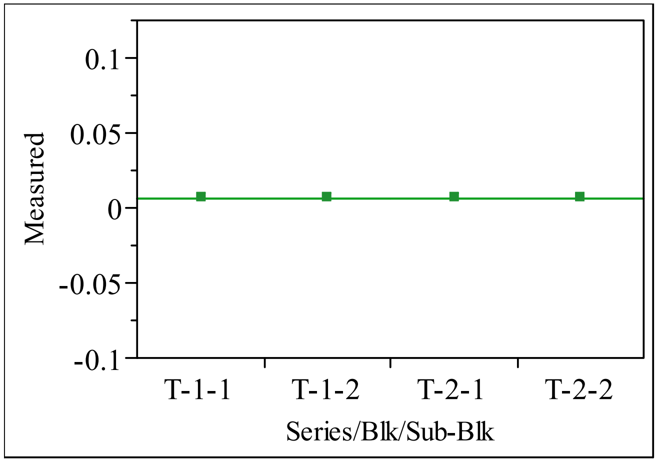
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	0.095076	0.00074	0.09338	0.09677
X-1-2	3	0.098412	0.00074	0.09672	0.10011
X-2-1	3	0.098968	0.00074	0.09727	0.10066
X-2-2	3	0.095076	0.00074	0.09338	0.09677

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=ZnO (wt%), Targeted=0, Series=T



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

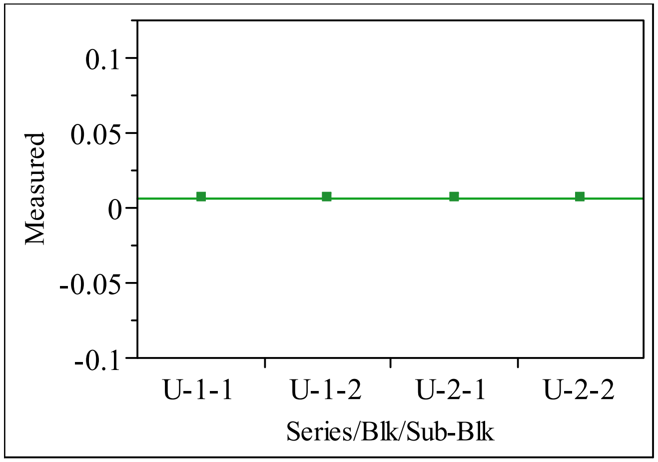
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=ZnO (wt%), Targeted=0, Series=U



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
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

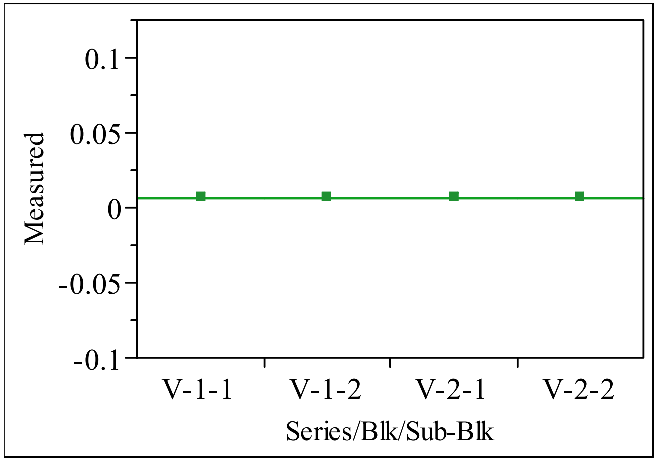
Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=ZnO (wt%), Targeted=0, Series=V



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

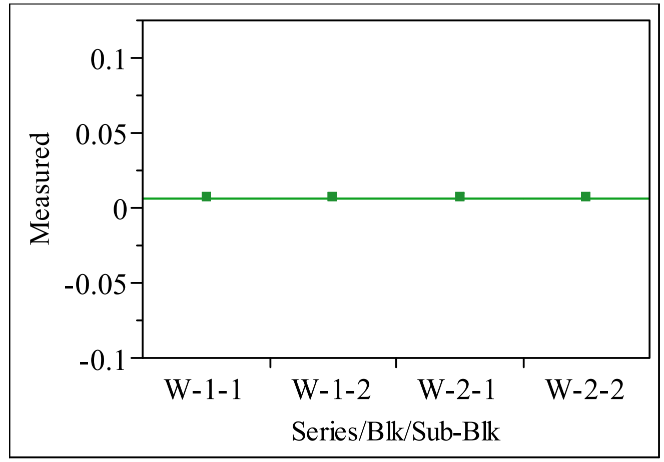
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=ZnO (wt%), Targeted=0, Series=W



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
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

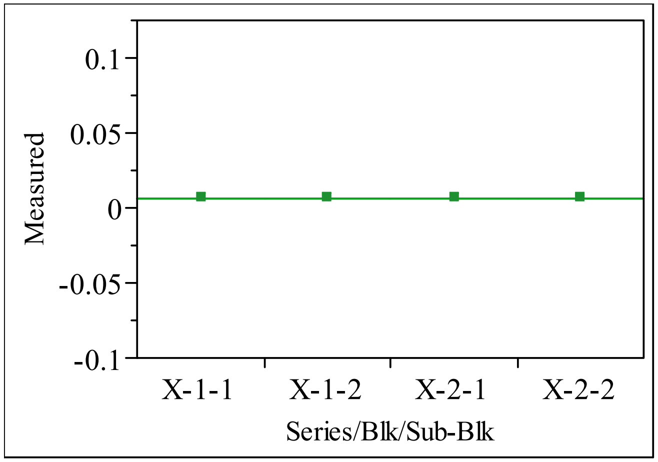
Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=ZnO (wt%), Targeted=0, Series=X



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

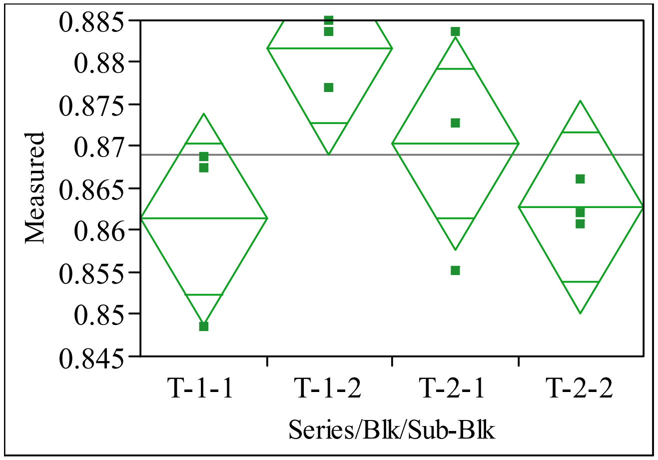
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0	0	.	.
Error	8	0	0		
C. Total	11	0			

Means for Oneway Anova

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

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=ZrO2 (wt%), Targeted=1, Series=T



Oneway Anova
Summary of Fit

Rsquare	0.51909
Adj Rsquare	0.338749
Root Mean Square Error	0.009488
Mean of Response	0.869015
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00077731	0.000259	2.8784	0.1031
Error	8	0.00072013	0.000090		
C. Total	11	0.00149744			

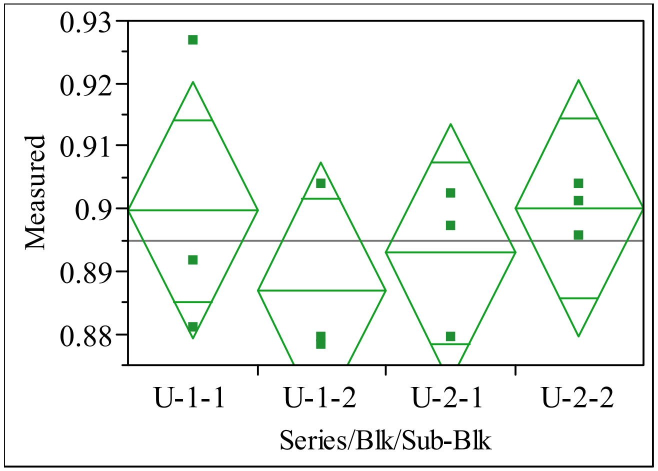
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
T-1-1	3	0.861360	0.00548	0.84873	0.87399
T-1-2	3	0.881622	0.00548	0.86899	0.89425
T-2-1	3	0.870365	0.00548	0.85773	0.88300
T-2-2	3	0.862711	0.00548	0.85008	0.87534

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=ZrO2 (wt%), Targeted=1, Series=U



Oneway Anova
Summary of Fit

Rsquare	0.154578
Adj Rsquare	-0.16246
Root Mean Square Error	0.015382
Mean of Response	0.894905
Observations (or Sum Wgts)	12

Analysis of Variance

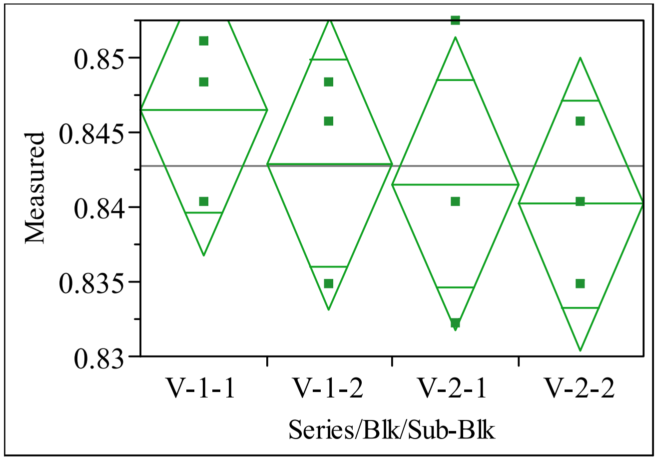
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00034608	0.000115	0.4876	0.7004
Error	8	0.00189278	0.000237		
C. Total	11	0.00223886			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
U-1-1	3	0.899633	0.00888	0.87915	0.92011
U-1-2	3	0.887025	0.00888	0.86655	0.90750
U-2-1	3	0.892879	0.00888	0.87240	0.91336
U-2-2	3	0.900083	0.00888	0.87960	0.92056

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=ZrO2 (wt%), Targeted=1, Series=V



Oneway Anova
Summary of Fit

Rsquare	0.132824
Adj Rsquare	-0.19237
Root Mean Square Error	0.007347
Mean of Response	0.842787
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00006614	0.000022	0.4085	0.7513
Error	8	0.00043184	0.000054		
C. Total	11	0.00049798			

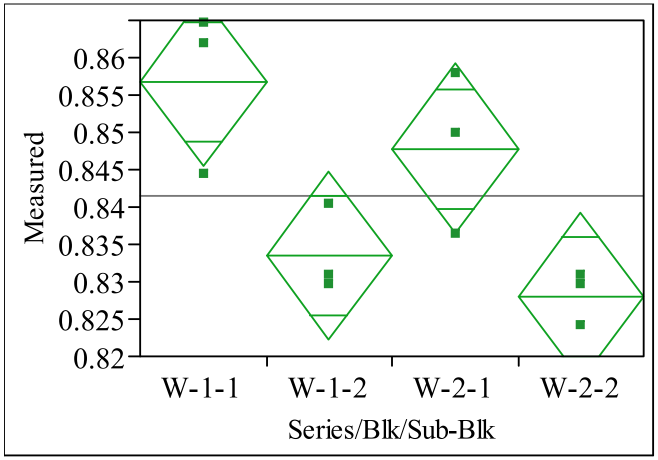
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
V-1-1	3	0.846501	0.00424	0.83672	0.85628
V-1-2	3	0.842899	0.00424	0.83312	0.85268
V-2-1	3	0.841548	0.00424	0.83177	0.85133
V-2-2	3	0.840198	0.00424	0.83042	0.84998

Std Error uses a pooled estimate of error variance

Exhibit A-3. Measurements by Analytical Series, Block and Sub-Block for the Batch 1 and LRM Standards by Oxide by Prep (continued)

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=ZrO2 (wt%), Targeted=1, Series=W



Oneway Anova
Summary of Fit

Rsquare	0.731403
Adj Rsquare	0.630679
Root Mean Square Error	0.008481
Mean of Response	0.841548
Observations (or Sum Wgts)	12

Analysis of Variance

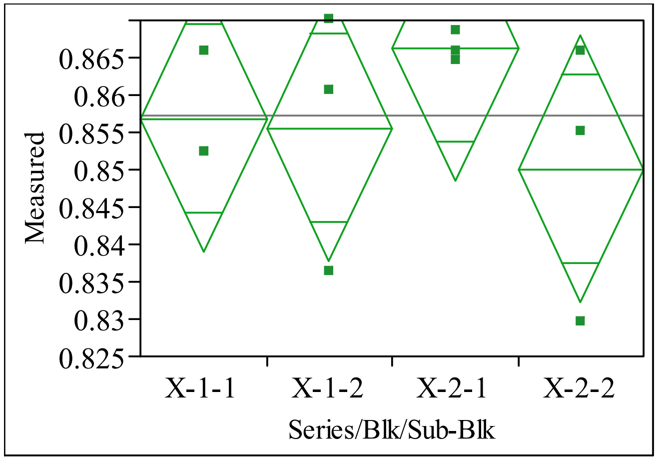
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00156678	0.000522	7.2615	0.0113
Error	8	0.00057538	0.000072		
C. Total	11	0.00214215			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
W-1-1	3	0.856857	0.00490	0.84557	0.86815
W-1-2	3	0.833444	0.00490	0.82215	0.84473
W-2-1	3	0.847852	0.00490	0.83656	0.85914
W-2-2	3	0.828040	0.00490	0.81675	0.83933

Std Error uses a pooled estimate of error variance

Oneway Analysis of Measured By Series/Blk/Sub-Blk Glass ID=LRM, Oxide=ZrO2 (wt%), Targeted=1, Series=X



Oneway Anova
Summary of Fit

Rsquare	0.22139
Adj Rsquare	-0.07059
Root Mean Square Error	0.013412
Mean of Response	0.857195
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Series/Blk/Sub-Blk	3	0.00040918	0.000136	0.7582	0.5482
Error	8	0.00143905	0.000180		
C. Total	11	0.00184823			

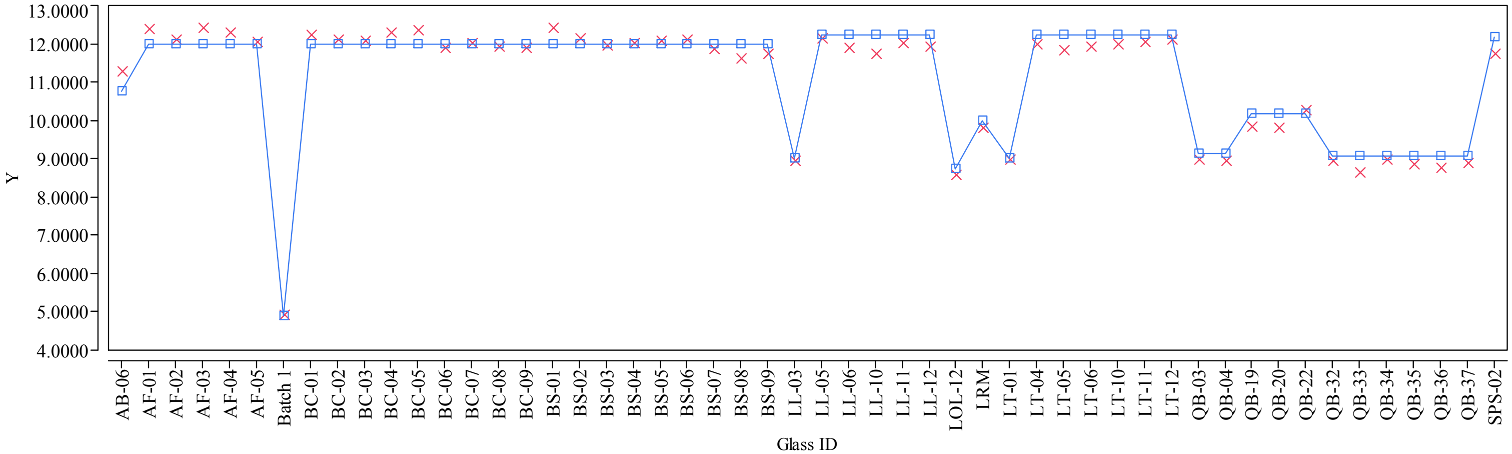
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
X-1-1	3	0.856857	0.00774	0.83900	0.87471
X-1-2	3	0.855507	0.00774	0.83765	0.87336
X-2-1	3	0.866313	0.00774	0.84846	0.88417
X-2-2	3	0.850103	0.00774	0.83225	0.86796

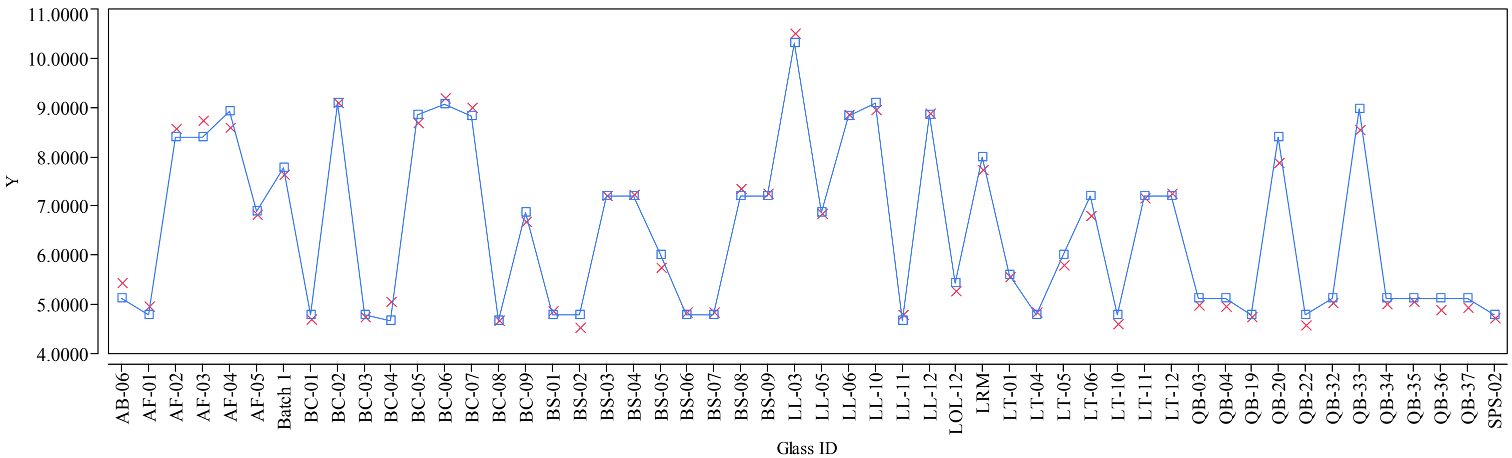
Std Error uses a pooled estimate of error variance

Exhibit A-4. Measured versus Targeted Compositions by Glass ID by Oxide.

Overlay Plot Oxide=Al2O3 (wt%)



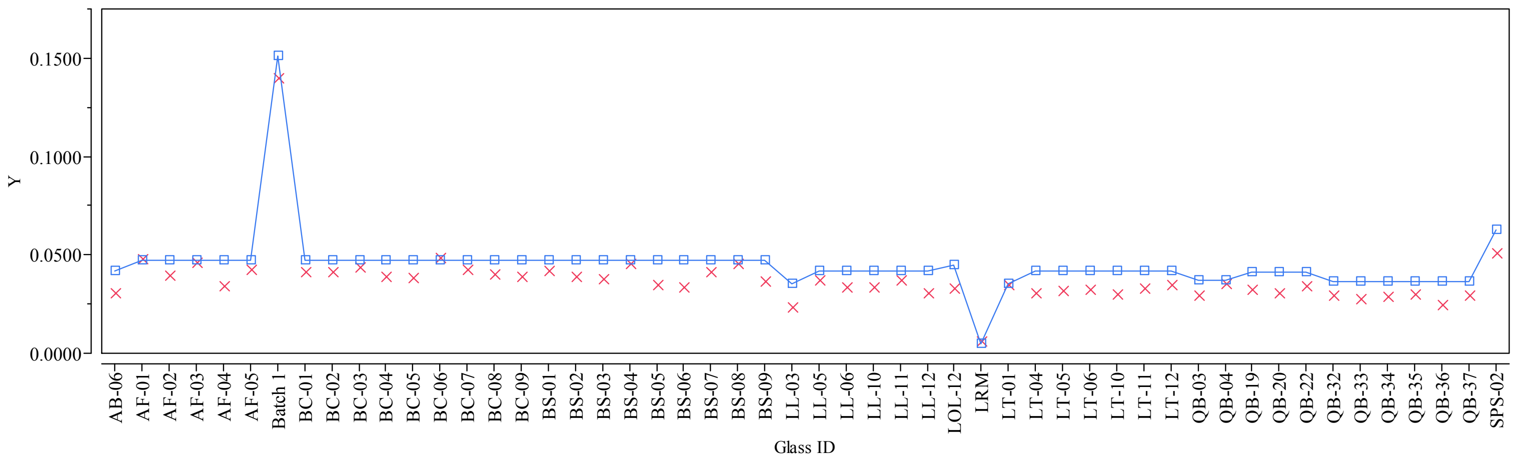
Overlay Plot Oxide=B2O3 (wt%)



Y × Measured ▫— Targeted

Exhibit A-4. Measured versus Targeted Compositions by Glass ID by Oxide. (continued)

Overlay Plot Oxide=BaO (wt%)



Overlay Plot Oxide=CaO (wt%)

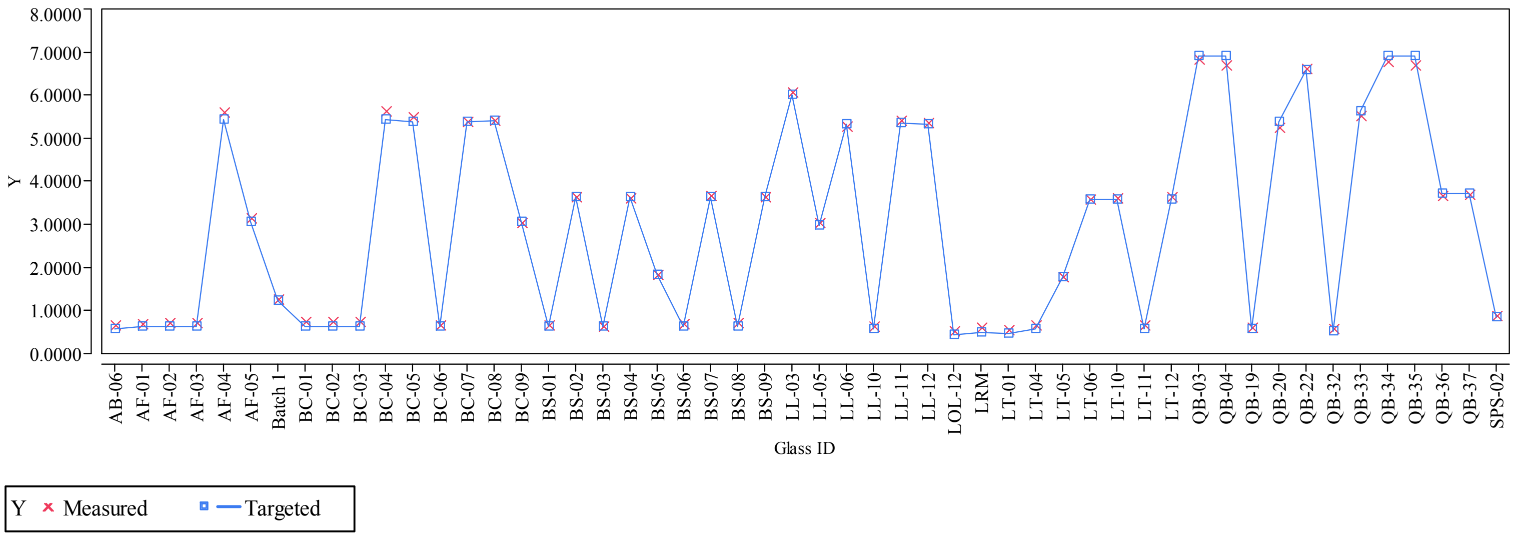
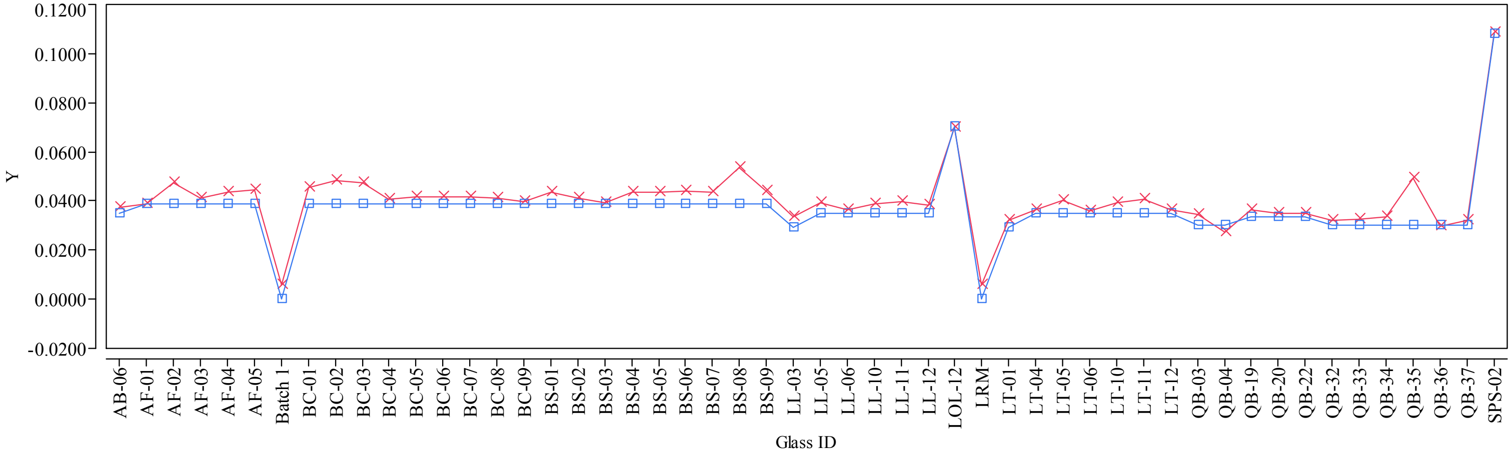


Exhibit A-4. Measured versus Targeted Compositions by Glass ID by Oxide. (continued)

Overlay Plot Oxide=Ce2O3 (wt%)



Overlay Plot Oxide=Cr2O3 (wt%)

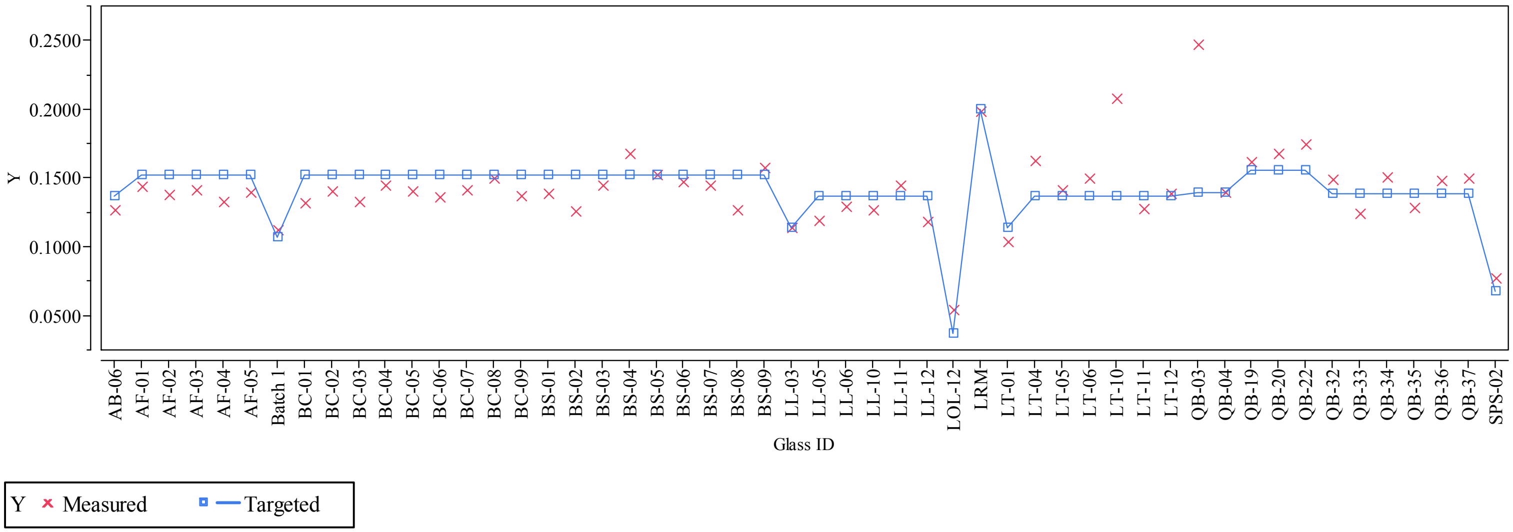
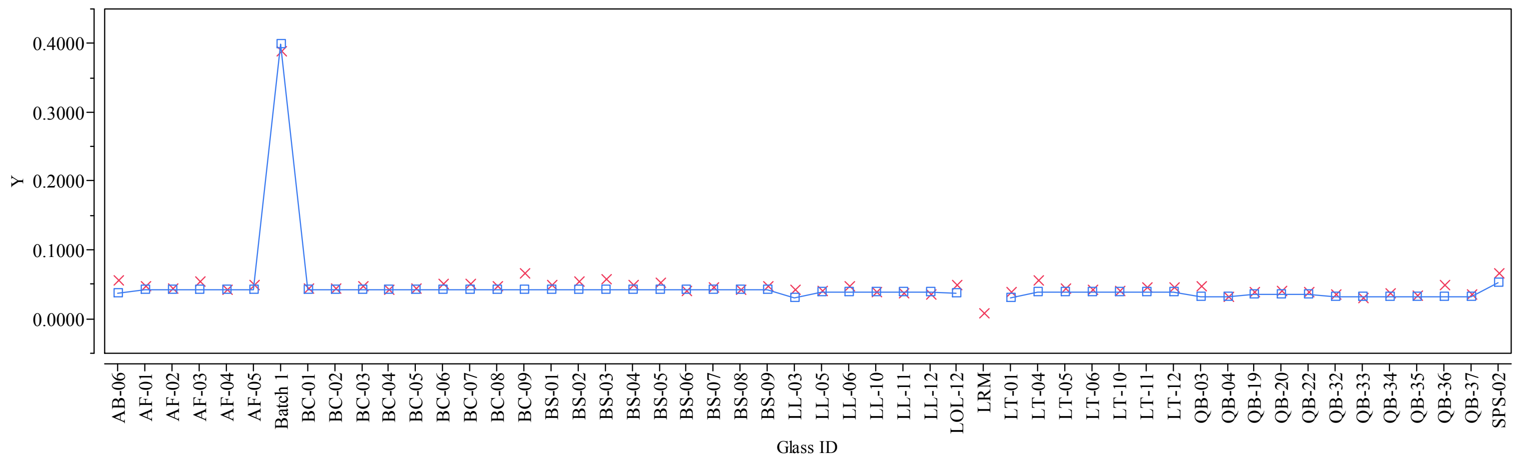


Exhibit A-4. Measured versus Targeted Compositions by Glass ID by Oxide. (continued)

Overlay Plot Oxide=CuO (wt%)



Overlay Plot Oxide=Fe2O3 (wt%)

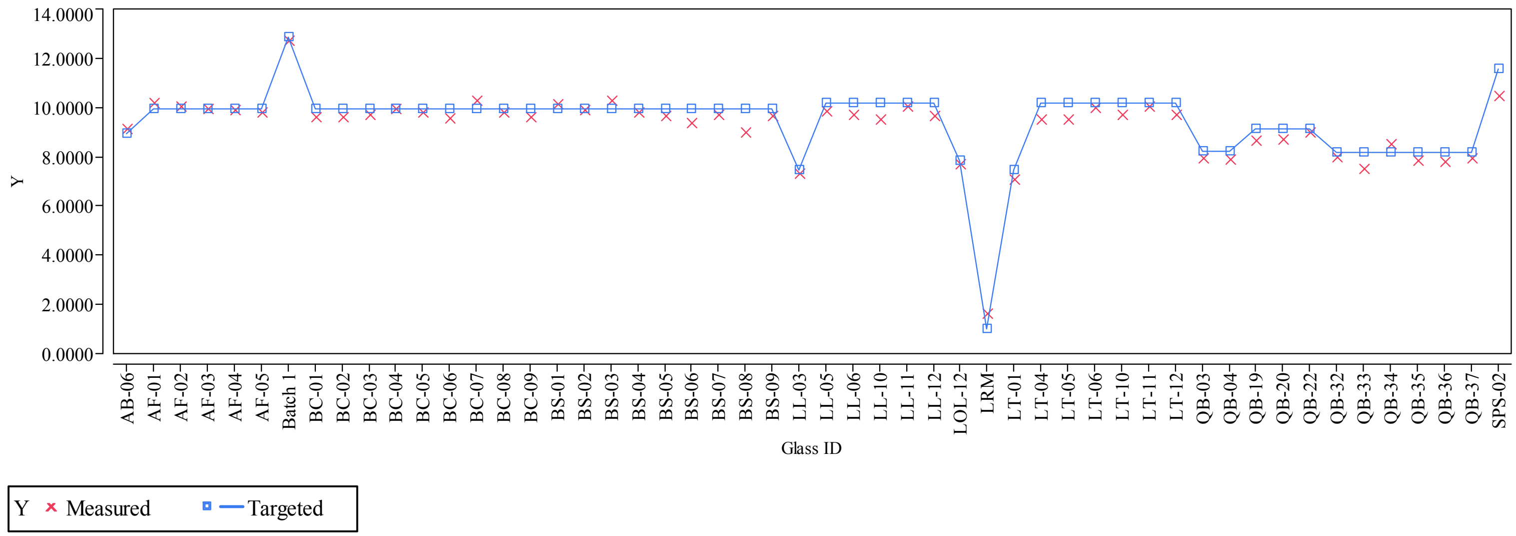
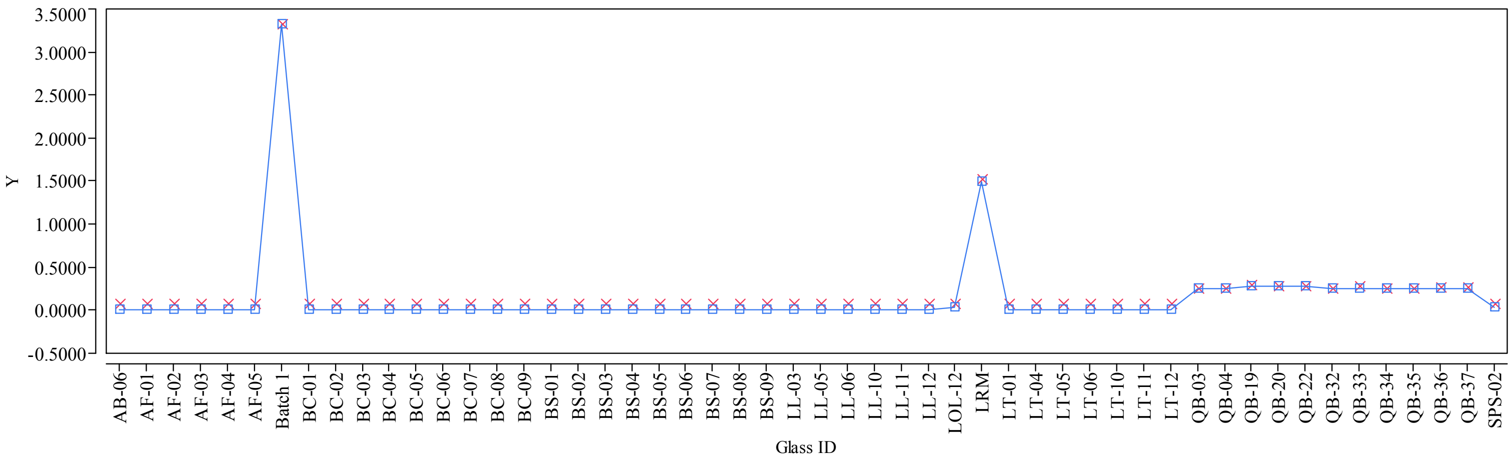


Exhibit A-4. Measured versus Targeted Compositions by Glass ID by Oxide. (continued)

Overlay Plot Oxide=K2O (wt%)



Overlay Plot Oxide=La2O3 (wt%)

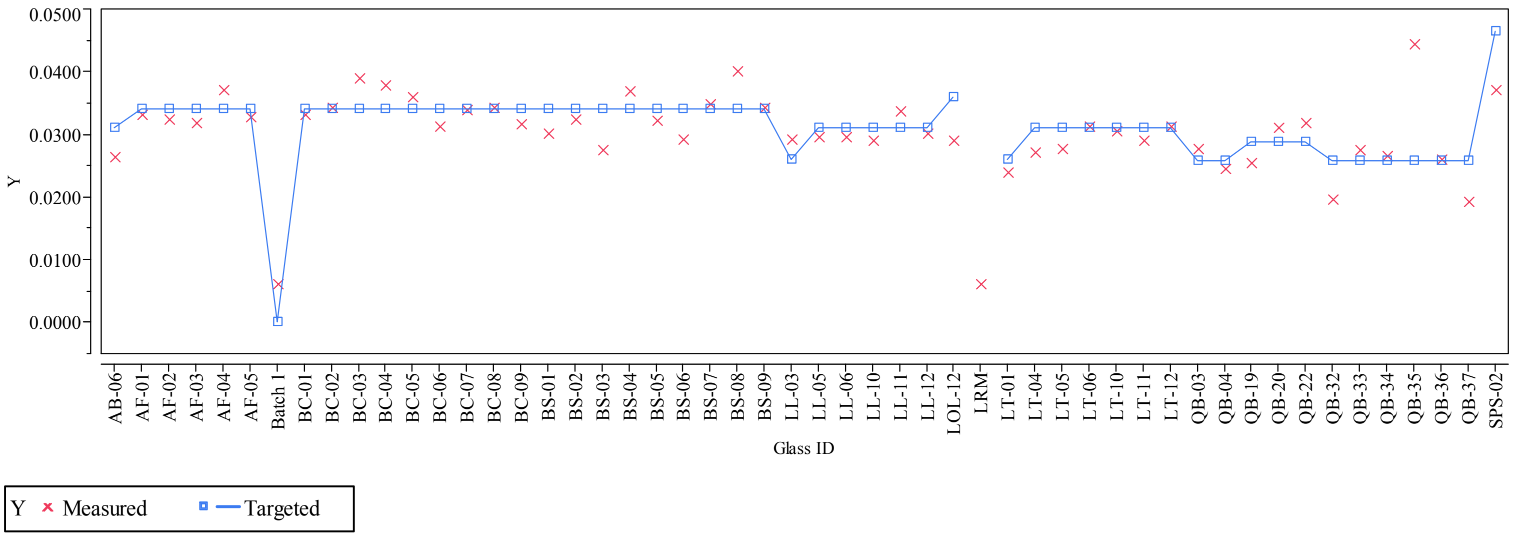
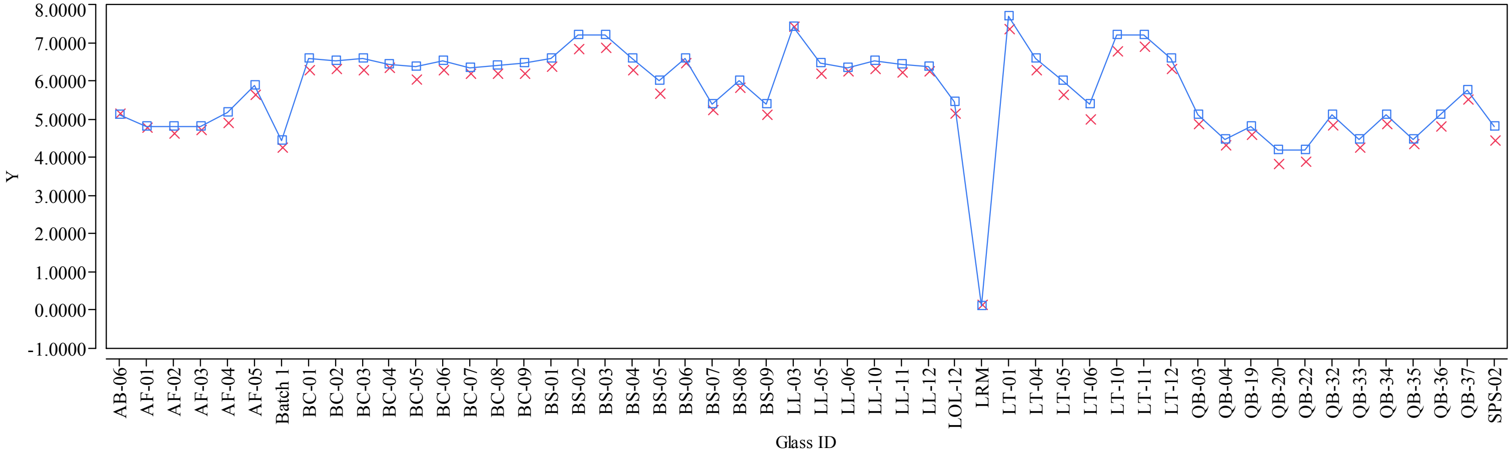


Exhibit A-4. Measured versus Targeted Compositions by Glass ID by Oxide. (continued)

Overlay Plot Oxide=Li2O (wt%)



Overlay Plot Oxide=MgO (wt%)

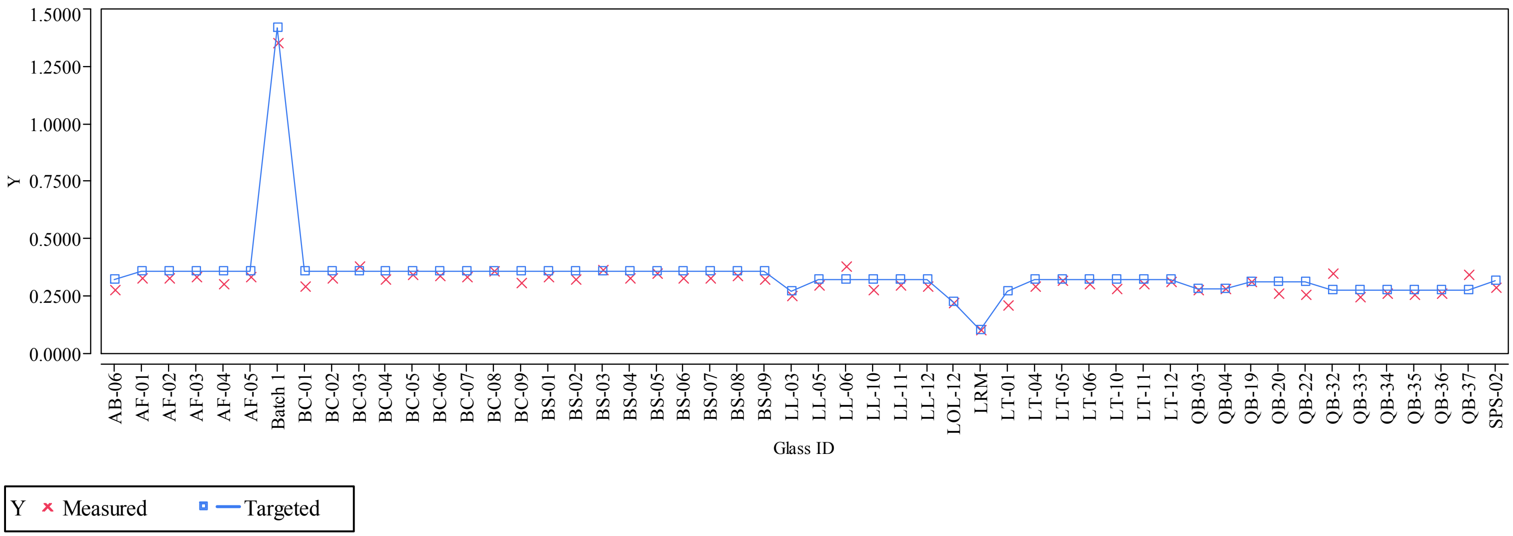
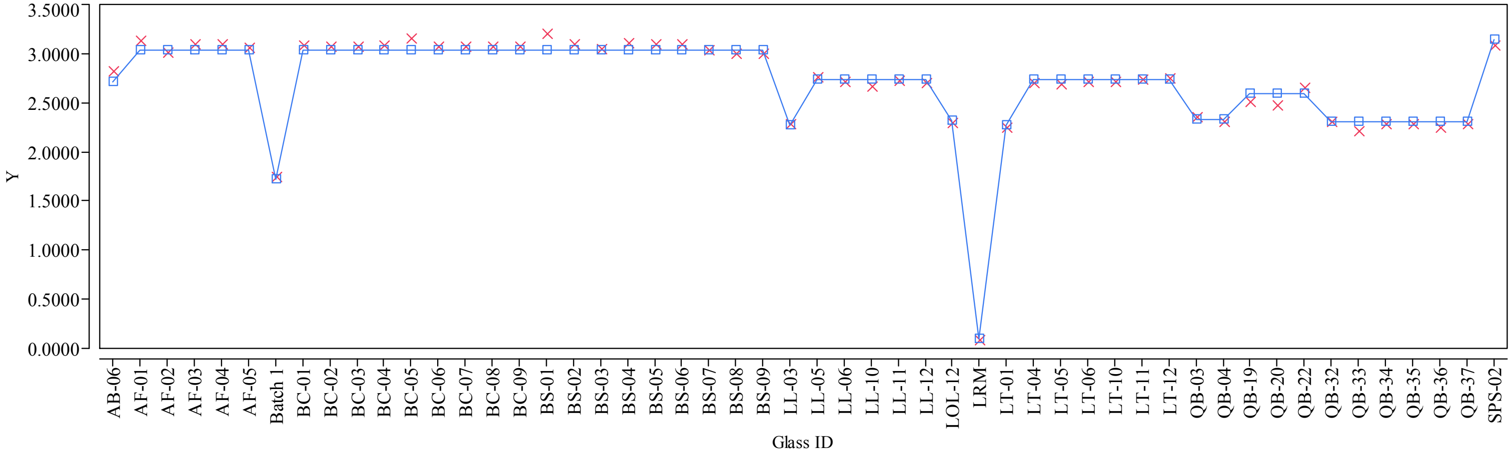


Exhibit A-4. Measured versus Targeted Compositions by Glass ID by Oxide. (continued)

Overlay Plot Oxide=MnO (wt%)



Overlay Plot Oxide=Na2O (wt%)

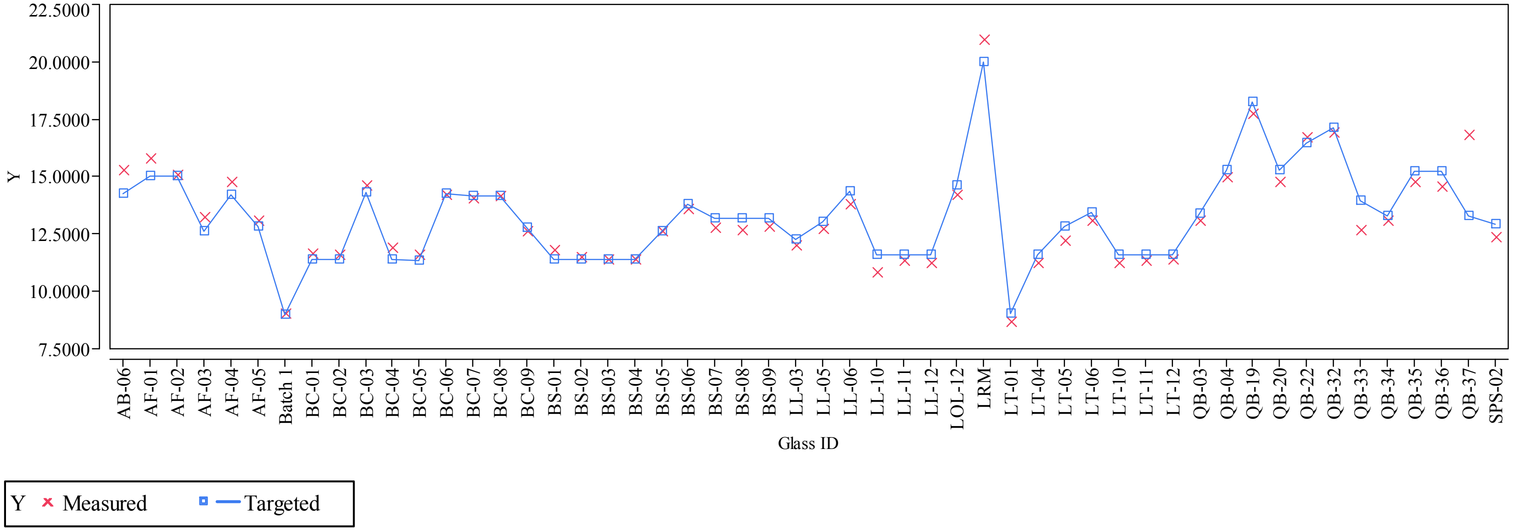
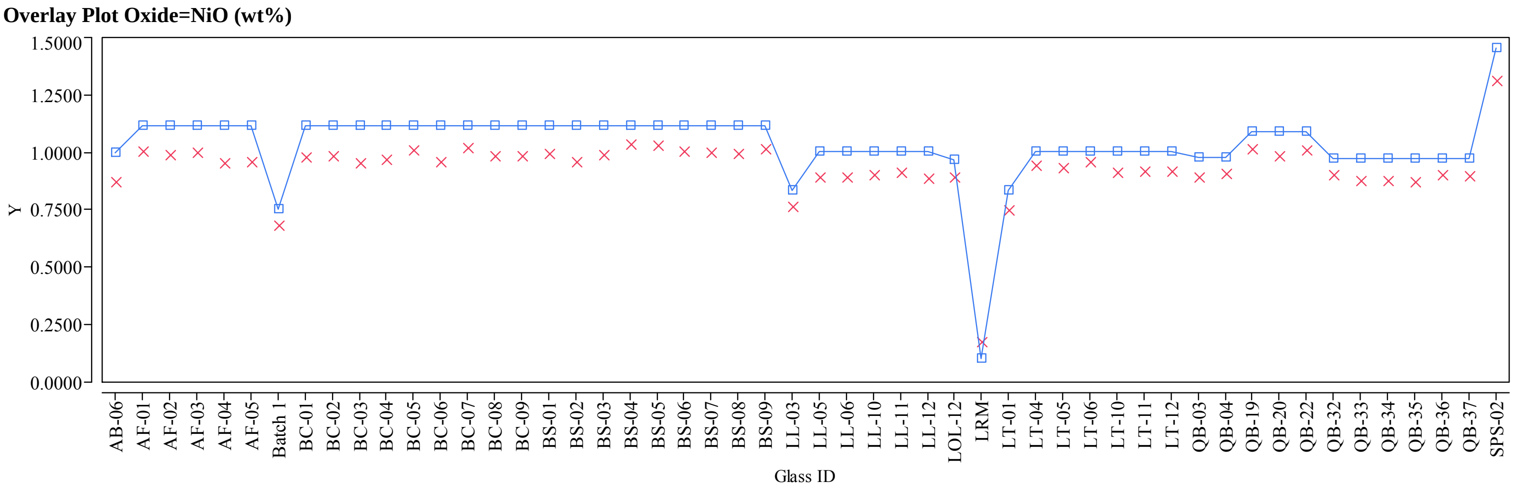


Exhibit A-4. Measured versus Targeted Compositions by Glass ID by Oxide. (continued)



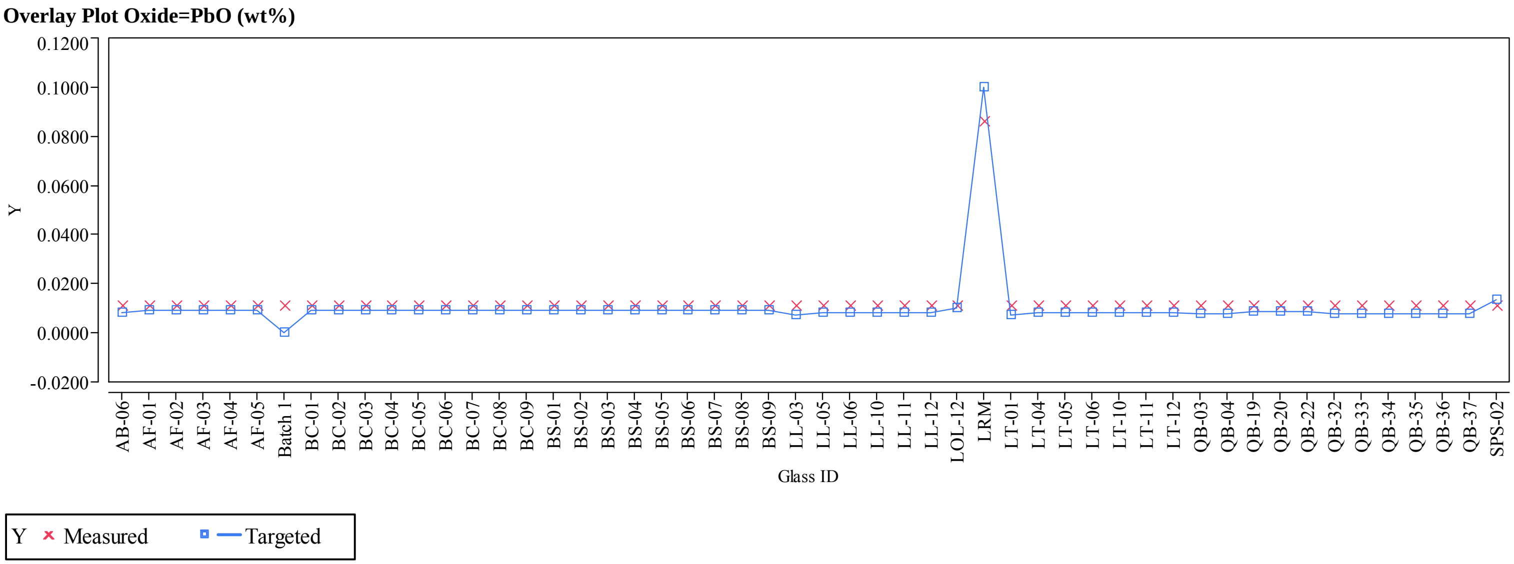
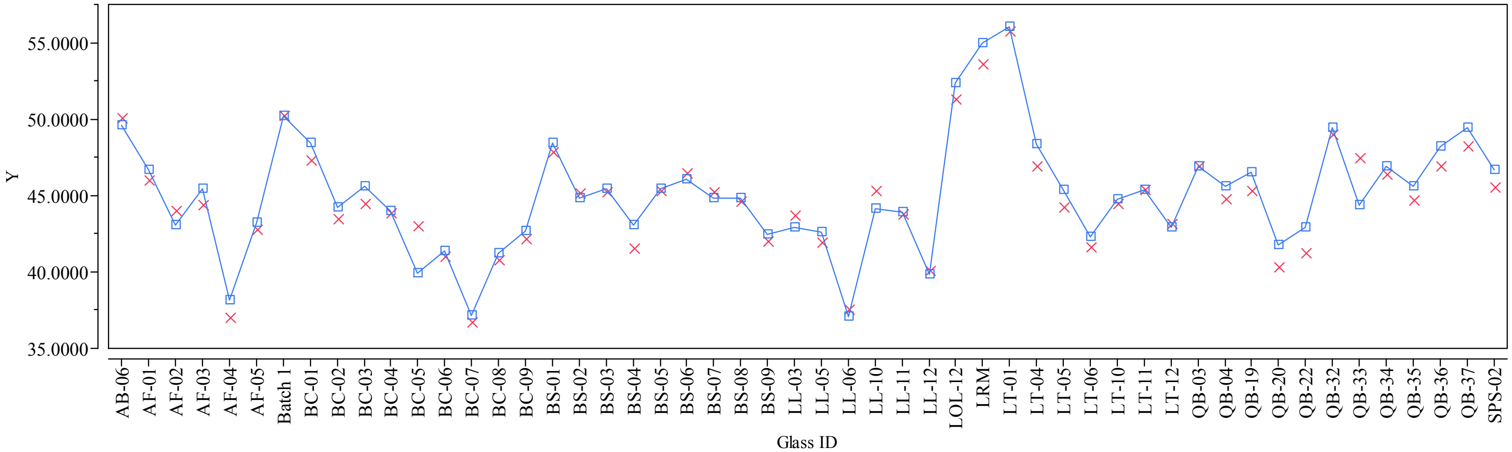


Exhibit A-4. Measured versus Targeted Compositions by Glass ID by Oxide. (continued)

Overlay Plot Oxide=SiO2 (wt%)



Overlay Plot Oxide=SO4 (wt%)

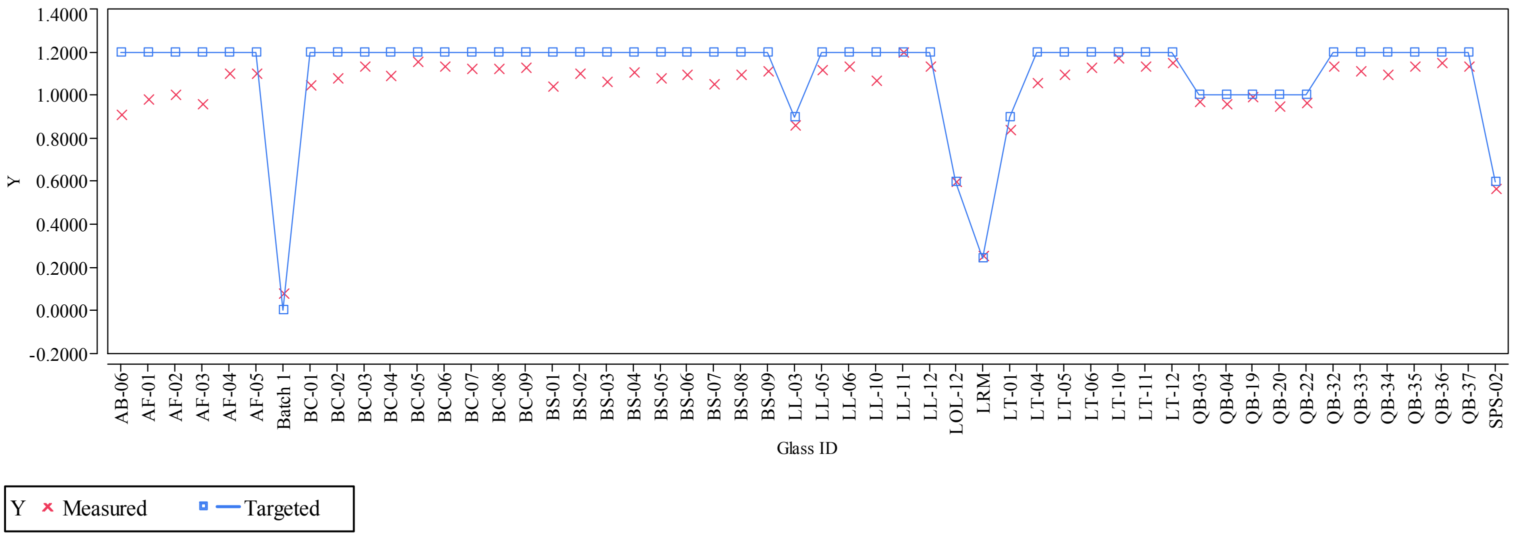
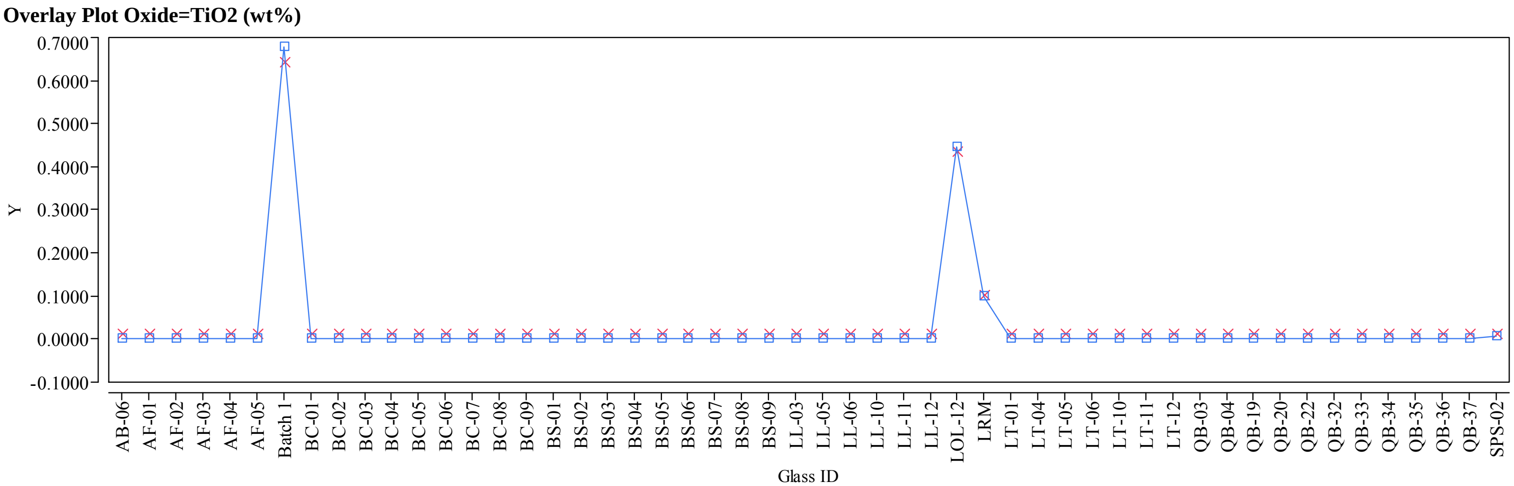


Exhibit A-4. Measured versus Targeted Compositions by Glass ID by Oxide. (continued)



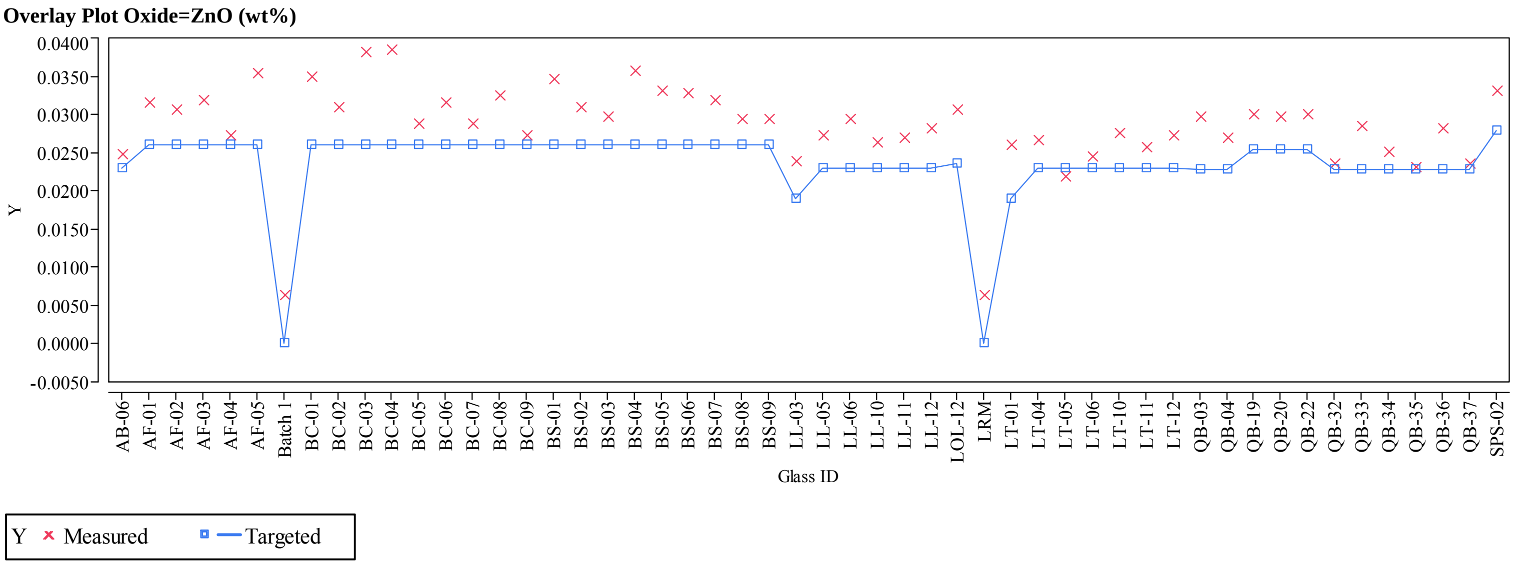
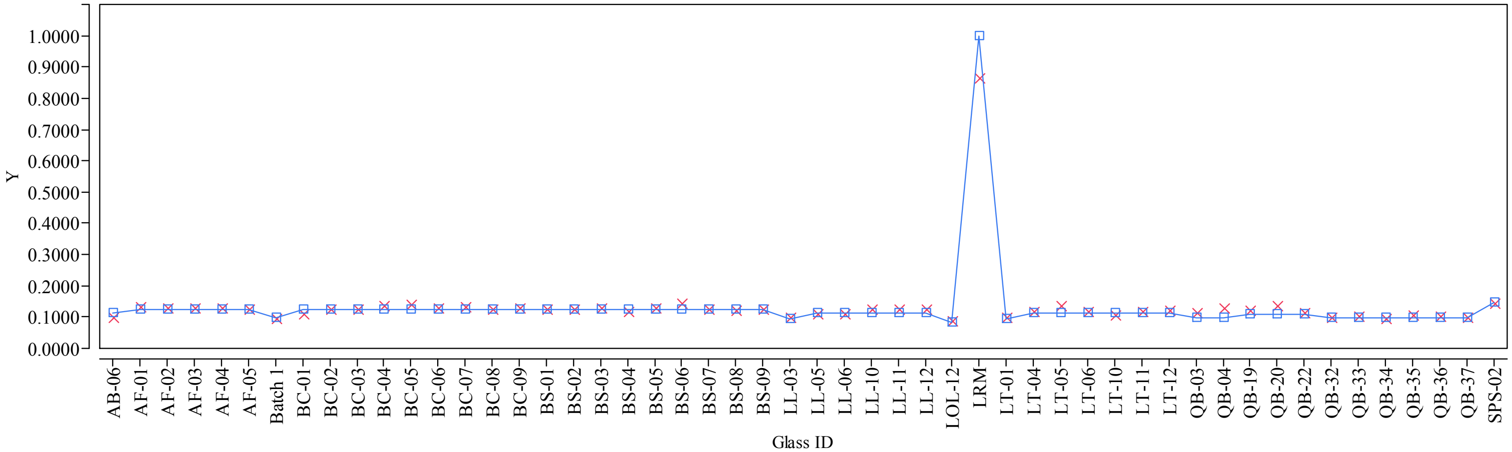
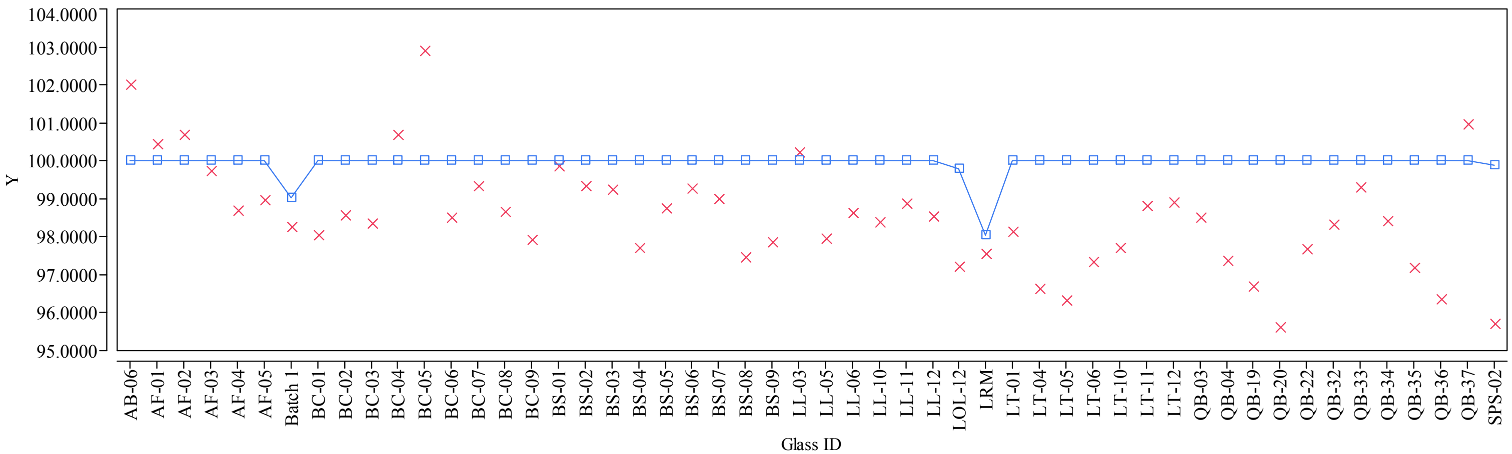


Exhibit A-4. Measured versus Targeted Compositions by Glass ID by Oxide. (continued)

Overlay Plot Oxide=ZrO2 (wt%)



Overlay Plot, Sum of Oxides



Y × Measured ▫ Targeted

Appendix B. Results from Fitting Fulcher Equations to the Viscosity Measurements for the Study Glasses

Exhibit B-1. Results of Fitting Fulcher Equations to the Measured Viscosity Data.

Nonlinear Fit Glass ID=AB06
Response: ln(n; poise), Predictor: ln(n; VTF)

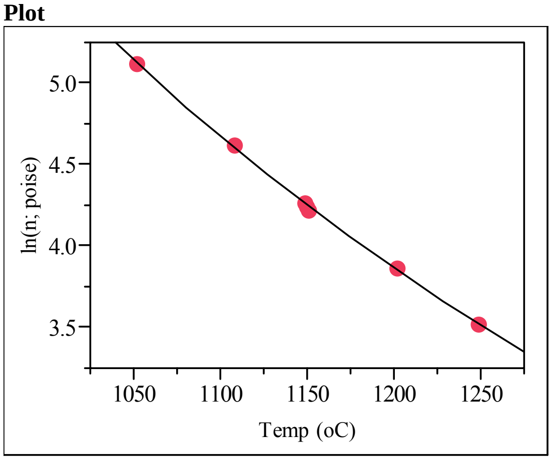
Control Panel
Converged in Gradient
Warning: 1 missing Y's.

Criterion	Current	Stop Limit
Iteration	4	60
Obj Change	5.025555e-13	1e-15
Relative Gradient	1.5945504e-9	0.000001
Gradient	2.658052e-10	0.000001

Parameter	Current Value
C	178.0228783
B	7610.9674375
A	-3.586379579

SSE
0.0007458889N
7

Edit Alpha
0.050Convergence Criterion
0.00001Goal SSE for CL
.
Plot



Parameter	Estimate	Low	High
C	178.0228783	64.1049	192.315
B	7610.9674375	3212.47	9637.41
A	-3.586379579	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0007458889	4	0.0001865	0.0136555

Parameter	Estimate	ApproxStdErr
C	178.0228783	145.194088
B	7610.9674375	2298.83505
A	-3.586379579	1.19268535

Solved By:
Analytic NR

Nonlinear Fit Glass ID=AF04
Response: ln(n; poise), Predictor: ln(n; VTF)

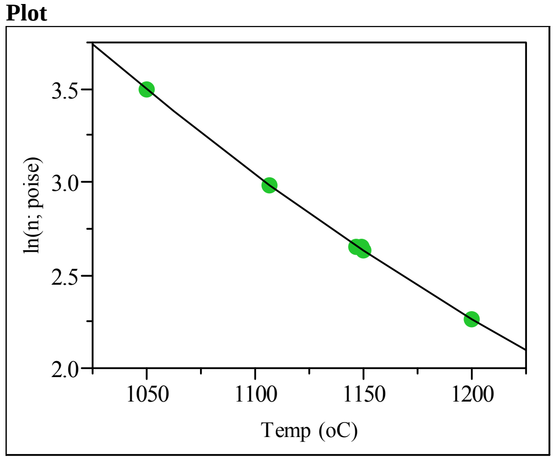
Control Panel
Converged in Gradient
Warning: 1 missing Y's.

Criterion	Current	Stop Limit
Iteration	4	60
Obj Change	8.861166e-10	1e-15
Relative Gradient	4.2165875e-9	0.000001
Gradient	4.2078323e-9	0.000001

Parameter	Current Value
C	218.73496021
B	6677.4025163
A	-4.537697175

SSE
0.0001713979N
6

Edit Alpha
0.050Convergence Criterion
0.00001Goal SSE for CL
.
Plot



Parameter	Estimate	Low	High
C	218.73496021	64.1049	192.315
B	6677.4025163	3212.47	9637.41
A	-4.537697175	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0001713979	3	5.7133e-5	0.0075586

Parameter	Estimate	ApproxStdErr
C	218.73496021	131.735563
B	6677.4025163	1964.35656
A	-4.537697175	1.09419544

Solved By:
Analytic NR

Exhibit B-1. Results of Fitting Fulcher Equations to the Measured Viscosity Data. (cont'd)

Nonlinear Fit Glass ID=BC05
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel
Converged in Gradient
Warning: 1 missing Y's.

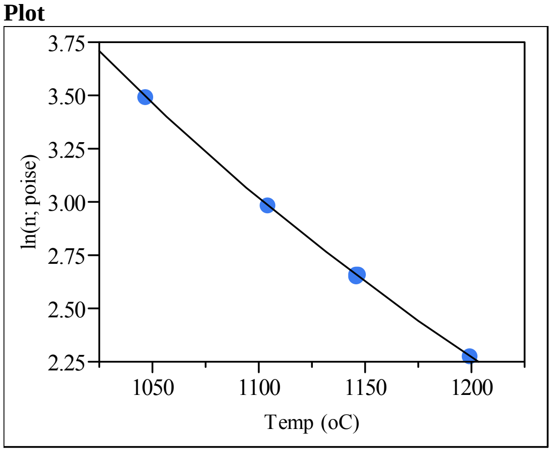
Criterion	Current	Stop Limit
Iteration	4	60
Obj Change	1.8324638e-7	1e-15
Relative Gradient	3.8285299e-7	0.000001
Gradient	3.8041189e-7	0.000001

Parameter	Current Value
C	273.71072486
B	5704.5320189
A	-3.886842524

SSE
0.0001323324N
6

Edit Alpha
0.050Convergence Criterion
0.00001Goal SSE for CL
.

Plot



Parameter	Estimate	Low	High
C	273.71072486	64.1049	192.315
B	5704.5320189	3212.47	9637.41
A	-3.886842524	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0001323324	3	4.4111e-5	0.0066416

Parameter	Estimate	ApproxStdErr
C	273.71072486	101.857362
B	5704.5320189	1386.41626
A	-3.886842524	0.82487596

Solved By:
Analytic NR

Nonlinear Fit Glass ID=BC06
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel
Converged in Gradient
Warning: 1 missing Y's.

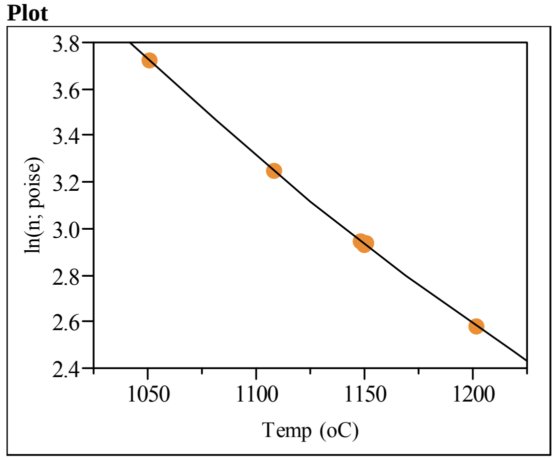
Criterion	Current	Stop Limit
Iteration	3	60
Obj Change	2.8289189e-7	1e-15
Relative Gradient	8.072411e-8	0.000001
Gradient	7.8407983e-8	0.000001

Parameter	Current Value
C	79.563855384
B	8250.0510879
A	-4.774231324

SSE
0.0000866069N
6

Edit Alpha
0.050Convergence Criterion
0.00001Goal SSE for CL
.

Plot



Parameter	Estimate	Low	High
C	79.563855384	64.1049	192.315
B	8250.0510879	3212.47	9637.41
A	-4.774231324	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0000866069	3	2.8869e-5	0.005373

Parameter	Estimate	ApproxStdErr
C	79.563855384	133.963713
B	8250.0510879	2131.04668
A	-4.774231324	1.02557406

Solved By:
Analytic NR

Exhibit B-1. Results of Fitting Fulcher Equations to the Measured Viscosity Data. (cont'd)

Nonlinear Fit Glass ID=BC07
Response: ln(n; poise), Predictor: ln(n; VTF)

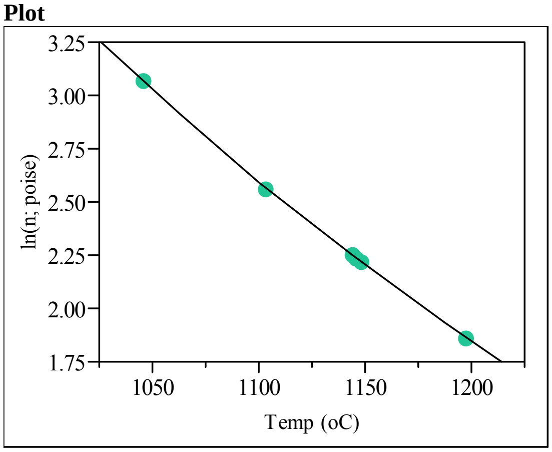
Control Panel
Converged in Gradient
Warning: 1 missing Y's.

Criterion	Current	Stop Limit
Iteration	3	60
Obj Change	2.856124e-10	1e-15
Relative Gradient	9.8883902e-9	0.000001
Gradient	4.8684573e-9	0.000001

Parameter	Current Value
C	134.91484828
B	7672.4532957
A	-5.358004634

SSE
0.0000543439N
6

Edit Alpha
0.050Convergence Criterion
0.00001Goal SSE for CL
.
Plot



Parameter	Estimate	Low	High
C	134.91484828	64.1049	192.315
B	7672.4532957	3212.47	9637.41
A	-5.358004634	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0000543439	3	1.8115e-5	0.0042561

Parameter	Estimate	ApproxStdErr
C	134.91484828	89.1394314
B	7672.4532957	1400.458
A	-5.358004634	0.71553867

Solved By:
Analytic NR

Nonlinear Fit Glass ID=BC08
Response: ln(n; poise), Predictor: ln(n; VTF)

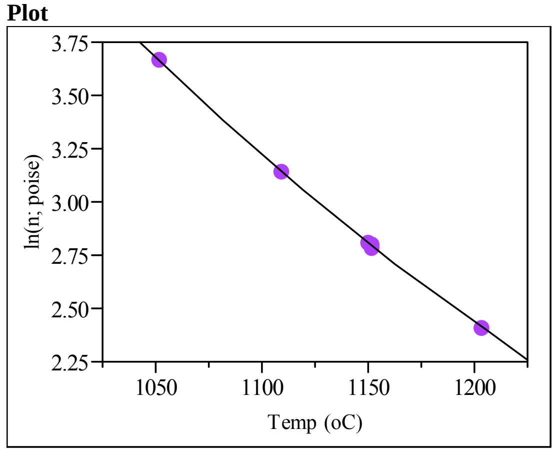
Control Panel
Converged in Gradient
Warning: 1 missing Y's.

Criterion	Current	Stop Limit
Iteration	4	60
Obj Change	1.156228e-12	1e-15
Relative Gradient	1.2861851e-9	0.000001
Gradient	3.811933e-10	0.000001

Parameter	Current Value
C	173.22789802
B	7477.1014179
A	-4.849258757

SSE
0.0000889651N
6

Edit Alpha
0.050Convergence Criterion
0.00001Goal SSE for CL
.
Plot



Parameter	Estimate	Low	High
C	173.22789802	64.1049	192.315
B	7477.1014179	3212.47	9637.41
A	-4.849258757	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0000889651	3	2.9655e-5	0.0054456

Parameter	Estimate	ApproxStdErr
C	173.22789802	102.806648
B	7477.1014179	1628.79279
A	-4.849258757	0.86105703

Solved By:
Analytic NR

Exhibit B-1. Results of Fitting Fulcher Equations to the Measured Viscosity Data. (cont'd)

Nonlinear Fit Glass ID=BC09
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel
Converged in Gradient
Warning: 1 missing Y's.

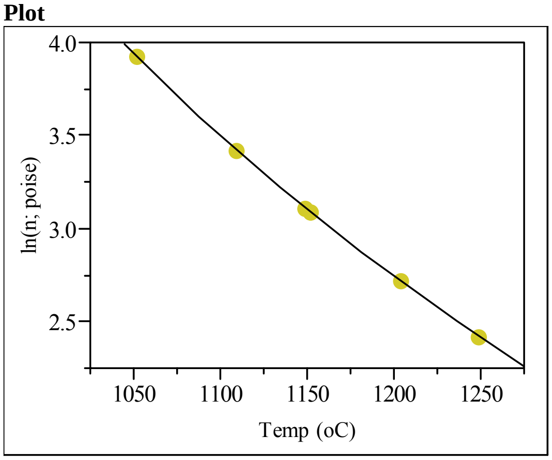
Criterion	Current	Stop Limit
Iteration	3	60
Obj Change	2.10905e-12	1e-15
Relative Gradient	1.811382e-9	0.000001
Gradient	1.748642e-10	0.000001

Parameter	Current Value
C	126.43398451
B	7937.2372452
A	-4.65418127

SSE
0.0001291312N
7

Edit Alpha
0.050Convergence Criterion
0.00001Goal SSE for CL
.

Plot



Parameter	Estimate	Low	High
C	126.43398451	64.1049	192.315
B	7937.2372452	3212.47	9637.41
A	-4.65418127	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0001291312	4	3.2283e-5	0.0056818

Parameter	Estimate	ApproxStdErr
C	126.43398451	71.4719626
B	7937.2372452	1118.96196
A	-4.65418127	0.55058024

Solved By:
Analytic NR

Nonlinear Fit Glass ID=LL02
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel
Converged in Gradient
Warning: 1 missing Y's.

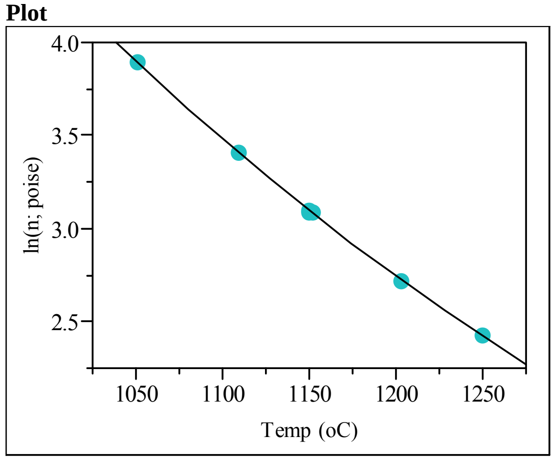
Criterion	Current	Stop Limit
Iteration	3	60
Obj Change	5.3490223e-7	1e-15
Relative Gradient	1.3509406e-7	0.000001
Gradient	1.2727533e-7	0.000001

Parameter	Current Value
C	78.351476366
B	8409.9786781
A	-4.75548928

SSE
0.0000532349N
7

Edit Alpha
0.050Convergence Criterion
0.00001Goal SSE for CL
.

Plot



Parameter	Estimate	Low	High
C	78.351476366	64.1049	192.315
B	8409.9786781	3212.47	9637.41
A	-4.75548928	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0000532349	4	0.0000133	0.0036481

Parameter	Estimate	ApproxStdErr
C	78.351476366	50.8935055
B	8409.9786781	806.072034
A	-4.75548928	0.37876233

Solved By:
Analytic NR

Exhibit B-1. Results of Fitting Fulcher Equations to the Measured Viscosity Data. (cont'd)

Nonlinear Fit Glass ID=LL03
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel
Converged in Gradient
Warning: 1 missing Y's.

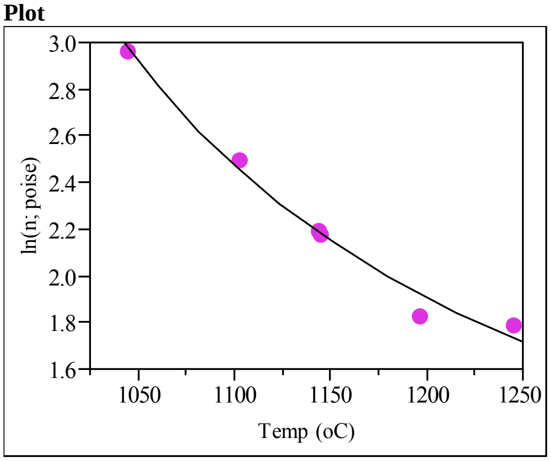
Criterion	Current	Stop Limit
Iteration	49	60
Obj Change	6.391735e-11	1e-15
Relative Gradient	1.9898894e-6	0.000001
Gradient	5.3003148e-8	0.000001

Parameter	Current Value
C	788.78131491
B	725.8594189
A	0.1406587438

SSE
0.0146802254N
7

Edit Alpha
0.050Convergence Criterion
0.00001Goal SSE for CL
.

Plot



Parameter	Estimate	Low	High
C	788.78131491	64.1049	192.315
B	725.8594189	3212.47	9637.41
A	0.1406587438	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0146802254	4	0.0036701	0.060581

Parameter	Estimate	ApproxStdErr
C	788.78131491	104.595203
B	725.8594189	468.877752
A	0.1406587438	0.70703837

Solved By:
Analytic NR

Nonlinear Fit Glass ID=LL05
Response: ln(n; poise), Predictor: ln(n; VTF)

Control Panel
Converged in Gradient
Warning: 1 missing Y's.

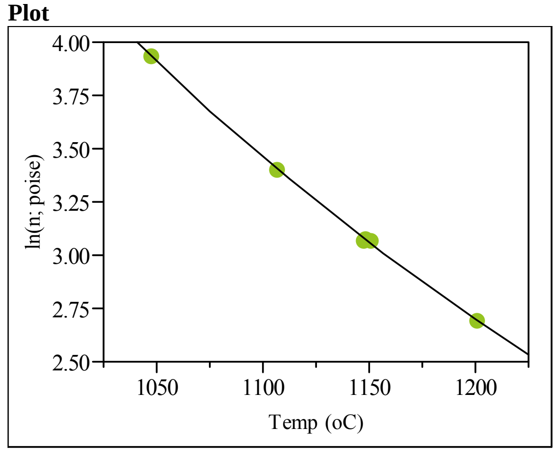
Criterion	Current	Stop Limit
Iteration	4	60
Obj Change	2.181832e-10	1e-15
Relative Gradient	7.500184e-10	0.000001
Gradient	7.276958e-10	0.000001

Parameter	Current Value
C	211.532019
B	6691.859796
A	-4.072422588

SSE
0.0001997673N
6

Edit Alpha
0.050Convergence Criterion
0.00001Goal SSE for CL
.

Plot



Parameter	Estimate	Low	High
C	211.532019	64.1049	192.315
B	6691.859796	3212.47	9637.41
A	-4.072422588	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0001997673	3	6.6589e-5	0.0081602

Parameter	Estimate	ApproxStdErr
C	211.532019	139.913835
B	6691.859796	2076.67161
A	-4.072422588	1.14883351

Solved By:
Analytic NR

Exhibit B-1. Results of Fitting Fulcher Equations to the Measured Viscosity Data. (cont'd)

Nonlinear Fit Glass ID=LL06
Response: ln(n; poise), Predictor: ln(n; VTF)

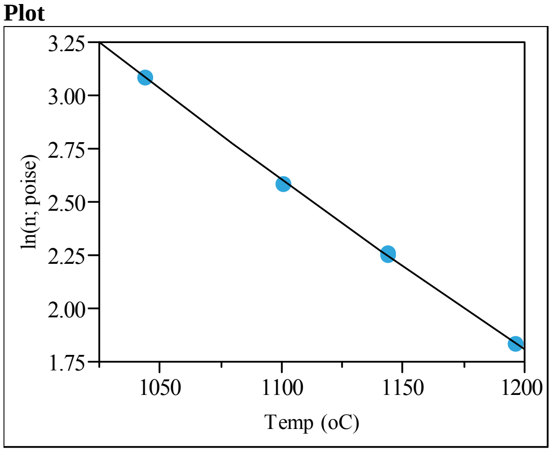
Control Panel
Converged in Gradient
Warning: 1 missing Y's.

Criterion	**Current**	**Stop Limit**
Iteration	50	60
Obj Change	5.077308e-13	1e-15
Relative Gradient	1.3785263e-9	0.000001
Gradient	3.211177e-10	0.000001

Parameter	**Current Value**
C	-783.1983161
B	29455.471751
A	-13.04080224

SSE
0.0002554953N
5

Edit Alpha
0.050Convergence Criterion
0.00001Goal SSE for CL
.
Plot



Parameter	**Estimate**	**Low**	**High**
C	-783.1983161	64.1049	192.315
B	29455.471751	3212.47	9637.41
A	-13.04080224	-5.8424	-1.9475

Solution

SSE	**DFE**	**MSE**	**RMSE**
0.0002554953	2	0.0001277	0.0113026

Parameter	**Estimate**	**ApproxStdErr**
C	-783.1983161	873.815619
B	29455.471751	27126.1355
A	-13.04080224	7.14304782

Solved By:
Analytic NR

Nonlinear Fit Glass ID=LL10
Response: ln(n; poise), Predictor: ln(n; VTF)

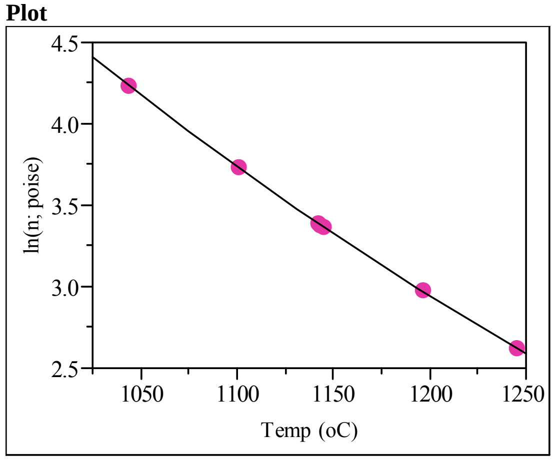
Control Panel
Converged in Gradient
Warning: 1 missing Y's.

Criterion	**Current**	**Stop Limit**
Iteration	4	60
Obj Change	6.7591639e-9	1e-15
Relative Gradient	1.754287e-9	0.000001
Gradient	1.4869478e-9	0.000001

Parameter	**Current Value**
C	-222.1220481
B	14785.39847
A	-7.449901131

SSE
0.0000821522N
7

Edit Alpha
0.050Convergence Criterion
0.00001Goal SSE for CL
.
Plot



Parameter	**Estimate**	**Low**	**High**
C	-222.1220481	64.1049	192.315
B	14785.39847	3212.47	9637.41
A	-7.449901131	-5.8424	-1.9475

Solution

SSE	**DFE**	**MSE**	**RMSE**
0.0000821522	4	2.0538e-5	0.0045319

Parameter	**Estimate**	**ApproxStdErr**
C	-222.1220481	93.2935407
B	14785.39847	2030.72189
A	-7.449901131	0.74648441

Solved By:
Analytic NR

Exhibit B-1. Results of Fitting Fulcher Equations to the Measured Viscosity Data. (cont'd)

Nonlinear Fit Glass ID=LL11
Response: ln(n; poise), Predictor: ln(n; VTF)

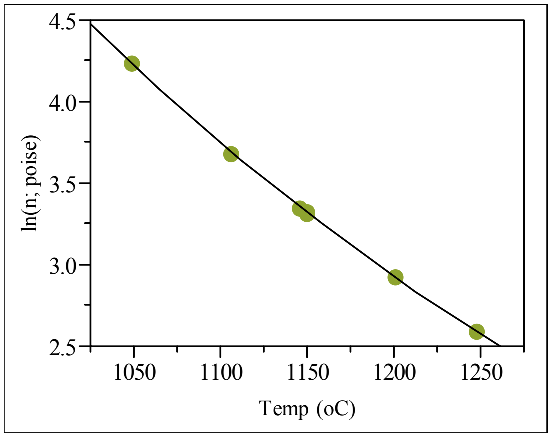
Control Panel
Converged in Gradient
Warning: 1 missing Y's.

Criterion	Current	Stop Limit
Iteration	3	60
Obj Change	2.1483063e-7	1e-15
Relative Gradient	4.2459694e-7	0.000001
Gradient	3.7227405e-7	0.000001

Parameter	Current Value
C	150.18526284
B	8133.6949935
A	-4.820784993

SSE
0.0001596202N
7

Edit Alpha
0.050Convergence Criterion
0.00001Goal SSE for CL
.
Plot



Parameter	Estimate	Low	High
C	150.18526284	64.1049	192.315
B	8133.6949935	3212.47	9637.41
A	-4.820784993	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.0001596202	4	0.0000399	0.006317

Parameter	Estimate	ApproxStdErr
C	150.18526284	68.4962168
B	8133.6949935	1128.61418
A	-4.820784993	0.57024667

Solved By:
Analytic NR

Nonlinear Fit Glass ID=LL12
Response: ln(n; poise), Predictor: ln(n; VTF)

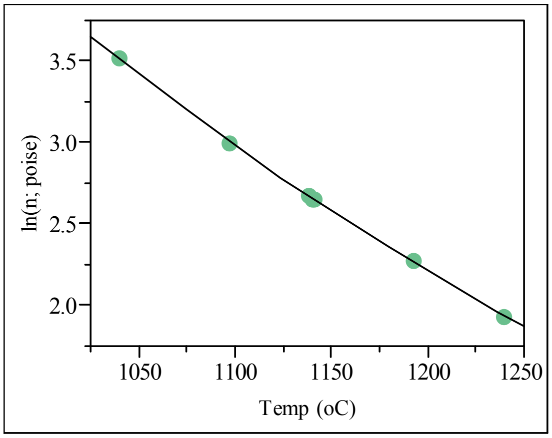
Control Panel
Converged in Gradient
Warning: 1 missing Y's.

Criterion	Current	Stop Limit
Iteration	4	60
Obj Change	6.833169e-10	1e-15
Relative Gradient	1.2963228e-8	0.000001
Gradient	3.9499926e-9	0.000001

Parameter	Current Value
C	7.4687046625
B	10014.109113
A	-6.187092912

SSE
0.000370817N
7

Edit Alpha
0.050Convergence Criterion
0.00001Goal SSE for CL
.
Plot



Parameter	Estimate	Low	High
C	7.4687046625	64.1049	192.315
B	10014.109113	3212.47	9637.41
A	-6.187092912	-5.8424	-1.9475

Solution

SSE	DFE	MSE	RMSE
0.000370817	4	0.0000927	0.0096283

Parameter	Estimate	ApproxStdErr
C	7.4687046625	139.538932
B	10014.109113	2488.98708
A	-6.187092912	1.10633863

Solved By:
Analytic NR

Exhibit B-1. Results of Fitting Fulcher Equations to the Measured Viscosity Data. (cont'd)

Nonlinear Fit Glass ID=LT01
Response: ln(n; poise), Predictor: ln(n; VTF)

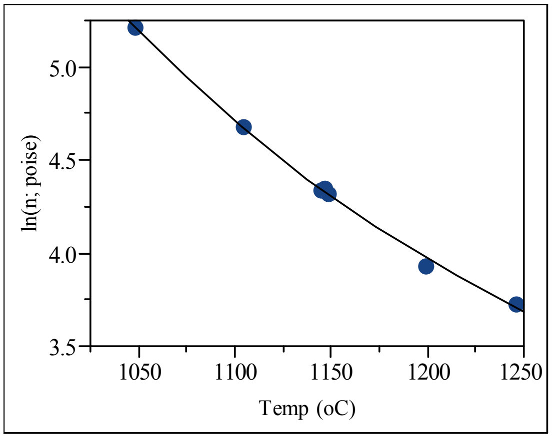
Control Panel
Converged in Gradient
Warning: 1 missing Y's.

Criterion	**Current**	**Stop Limit**
Iteration	6	60
Obj Change	3.7297425e-9	1e-15
Relative Gradient	1.1403445e-6	0.000001
Gradient	4.6407894e-7	0.000001

Parameter	**Current Value**
C	584.77110584
B	2338.7754791
A	0.1654925888

SSE
0.0032951606N
7

Edit Alpha
0.050Convergence Criterion
0.00001Goal SSE for CL
.
Plot



Parameter	**Estimate**	**Low**	**High**
C	584.77110584	64.1049	192.315
B	2338.7754791	3212.47	9637.41
A	0.1654925888	-5.8424	-1.9475

Solution

SSE	**DFE**	**MSE**	**RMSE**
0.0032951606	4	0.0008238	0.0287017

Parameter	**Estimate**	**ApproxStdErr**
C	584.77110584	105.98479
B	2338.7754791	913.893457
A	0.1654925888	0.83575494

Solved By:
Analytic NR

Appendix C. Final Report on the Modelling Sulfate Solubilities in US Radioactive Waste Borosilicate Glasses, Prepared by the University of Sheffield

Modelling Sulfate Solubilities in US Radioactive Waste Borosilicate Glasses

Final Project Report, Issue 01

22nd December 2011

Dr. Paul A. Bingham and Dr. Russell J. Hand

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Executive Summary

The Immobilisation Science Laboratory (ISL), University of Sheffield, has developed preliminary models that can predict sulfate solubility in a given waste glass composition, based on cation field strength and other compositional relationships. A combination of these preliminary models with the extensive set of data collected at the Savannah River National Laboratory (SRNL) was undertaken with the aim of further testing and validating the model whilst providing valuable information on mechanisms of enhancing sulfate solubility in glasses of interest for US radioactive waste vitrification.

Eight (2 × 2 × 2) different permutations of the ISL cation field strength index (CFSI) model were utilised (retained or batched sulfate; inclusion or omission of sulfate in CFS model; and total or normalised CFSI). In addition, the concentration ratios (i) [SiO_2] / [Balance]; (ii) [SiO_2 + B_2O_3] / [Balance]; and (iii) [SiO_2 + B_2O_3 + Al_2O_3] / [Balance] were plotted against retained and batched SO_4^{2-} with the aim of extracting additional information from the available data. A data set containing 290 glasses was modelled.

Modelling of 290 US glasses has demonstrated that enhanced sulfate solubilities do occur at low values of CFSI, and despite considerable spread in the data there is broad support for using lower field strength glasses for the purpose of providing enhanced sulfate capacities. Application of the simplest model considered here, [SiO_2] / [Balance] in mol %, provides the strongest support. It shows that, of the 290 glasses surveyed, yellow phase formation was not encountered in any of the 13 samples for which [SiO_2] / [Balance] < ca. 0.85. This ratio corresponds with glasses containing less than ~45 mol % SiO_2. Retained SO_4^{2-} contents within this compositional space were consistently close to 0.75 mol % SO_4^{2-} (typically 1 - 1.1 wt % SO_4^{2-}).

It is recommended that further work should focus on providing laboratory-scale samples doped with SO_4^{2-} with compositions within the region of interest (low cation field strength indices and SiO_2 contents below ca. 45 mol % with SO_4^{2-} contents in the range 0.6 – 1.0 mol %). This will enable experimental validation of the conclusion of this work, namely, that higher sulfate capacities are most strongly linked, compositionally, with SiO_2 content, and the additional experimental nodes will provide the necessary data for further model development and validation.

1. Background

Defense nuclear wastes within the US Department of Energy (DOE) complex contain relatively high concentrations of sulfate, which has a low solubility in borosilicate glass. This dictates that the waste be blended with lower sulfate concentration waste sources or heavily washed to reduce sulfate levels prior to vitrification. High concentrations of sulfate can also impose a limit on waste loading, which in turn hinders waste throughput for a vitrification plant. It is therefore desirable to develop enhanced borosilicate glass compositions with improved sulfate solubility.

Recent studies at Savannah River National Laboratory (SRNL) in support of the Defense Waste Processing Facility (DWPF) have identified frit additives that can be used to improve sulfate solubility in simulated waste glasses. However, due to the complexity of Savannah River waste compositions, much of this work has been done on an empirical basis, making it difficult to apply the findings to future waste compositions despite the large number of glass systems studied.

The Immobilisation Science Laboratory (ISL), University of Sheffield, has developed preliminary models that can predict sulfate solubility in a given waste glass composition, based on cation field strength and other compositional relationships. A combination of these preliminary models with the extensive set of data collected at SRNL was undertaken with the aim of further testing and validating the model whilst providing valuable information on mechanisms of enhancing sulfate solubility, thus allowing for future glass compositions to be tailored for improved sulfate solubility.

ISL has experience with high sulfate containing glasses and model development of nuclear waste glass compositions containing high concentrations of sulfate. This project consisted of the further development and application by ISL of this model, specifically in order to further develop a cation field strength model for sulfate solubility in borosilicate glasses based on data collected over the course of multiple studies already conducted at SRNL. ISL also identified and established further glass composition regions for which the model is lacking.

A sulfate glass composition database was sent by SRNL to ISL, who subsequently reviewed the data and applied the previously developed cation field strength model to the SRNL glass database. Eight different permutations of the model were utilised (retained or batched sulfate; inclusion or omission of sulfate in CFS model; and total or normalised CFSI). In addition, the concentration ratios (i) [SiO_2] / [Balance]; (ii) [SiO_2 + B_2O_3] / [Balance]; and (iii) [SiO_2 + B_2O_3 + Al_2O_3] / [Balance] were utilised in an effort to extract the maximum information from the available data.

2. Experimental Methodologies

2.1. Data supplied

In order to provide comparability between modelled data sets, only glasses prepared under similar or identical conditions were considered. The majority of data was provided to ISL in the Excel file "Data Summary Spreadsheet 3-1-11 for Sheffield" [3] supplied by A. Billings to P. A. Bingham on 1st March 2011. The spreadsheet states that this data pertains to SRNL Document Number SRNL-L3100-2011-00038. Additional data was obtained from other US sources [4-6].

Glasses considered in this study were produced under similar conditions. In [3, 5 and 6] batches were 100 or 150 grams in size and were melted at 1150 °C for 1 hour in Pt/Au crucibles with a loosely fitted lid placed over them. Glasses produced in [4] were prepared from batch sizes of 250 grams and melted at 1150 °C for 2 hours in Al_2O_3 crucibles; crucible lids were sealed with a nepheline gel. The data from the study by Peeler *et al.* [4] should therefore be compared carefully with the rest [3, 5, 6] of the modelled data.

2.2. Models used

The cation field strength index (CFSI) predictor model [1-2] was constructed in a Microsoft Excel spreadsheet. Assumptions made in the model have been stated and supported by published data for appropriate glasses. These assumptions were appraised and approved by A. Billings and K. Fox at SRNL and are reproduced and referenced in the Appendix.

The assumptions made resulted in new values of (z/a^2) for some oxides associated with the CFSI model. Moreover, four variants have been utilised here: Including S or Not Including S (i.e. to include the effects of sulfate in the glass on the value of the resulting CFSI); and total or normalised CFSI. Total CFSI is not normalised; it represents the total CFSI of the glass and is calculated according to (1). Normalised CFSI is the CFSI normalised to 1 mole-cation and is calculated according to (2).

$$CFSI_{Total} = \sum_{i=1}^{n} \left(m_i c_i \left(z / a^2 \right)_i \right) \qquad (1)$$

$$\mathrm{CFSI}_{\mathrm{Normalised}} = \frac{\sum_{i=1}^{n} m_i c_i \left(\frac{z}{a^2{}_i} \right)}{\sum_{i=1}^{n} m_i c_i} \qquad (2)$$

where m_i = mol. fraction of the *i*th oxide; c_i = number of cations in one molecule of the *i*th oxide; z = cationic charge; and a = interatomic distance in picometers. Values of $(z/a^2)_i$ were calculated for the *i*th oxide in the glass using the constants described in the Appendix. In addition, simple models were used to calculate (mol. %): (i) [SiO_2] / [Balance]; (ii) [SiO_2 + B_2O_3] / [Balance]; and (iii) [SiO_2 + B_2O_3 + Al_2O_3] / [Balance].

3. Results and Discussion

Modelling of the available experimental data has produced a total of 14 graphs (Figures 1-14). These are as follows:

CFSI models

1. Normalised CFSI (Sulfate Included) vs. Retained SO_4^{2-} (mol %)

1a. (Log plot) Normalised CFSI (Sulfate Included) vs. Retained SO_4^{2-} (mol %)

2. Normalised CFSI (Sulfate Omitted) vs. Retained SO_4^{2-} (mol %)
3. Total CFSI (Sulfate Included) vs. Retained SO_4^{2-} (mol %)
4. Total CFSI (Sulfate Omitted) vs. Retained SO_4^{2-} (mol %)
5. Normalised CFSI (Sulfate Included) vs. Batched SO_4^{2-} (mol %)
6. Normalised CFSI (Sulfate Omitted) vs. Batched SO_4^{2-} (mol %)
7. Total CFSI (Sulfate Included) vs. Batched SO_4^{2-} (mol %)
8. Total CFSI (Sulfate Omitted) vs. Batched SO_4^{2-} (mol %)

Other models

9. [SiO_2] / [Balance] (mol. %) vs. Retained SO_4^{2-} (mol %)
10. [SiO_2 + B_2O_3] / [Balance] (mol. %) vs. Retained SO_4^{2-} (mol %)
11. [SiO_2 + B_2O_3 + Al_2O_3] / [Balance] (mol. %) vs. Retained SO_4^{2-} (mol %)
12. [SiO_2] / [Balance] (mol. %) vs. Batched SO_4^{2-} (mol %)
13. [SiO_2 + B_2O_3] / [Balance] (mol. %) vs. Batched SO_4^{2-} (mol %)
14. [SiO_2 + B_2O_3 + Al_2O_3] / [Balance] (mol. %) vs. Batched SO_4^{2-} (mol %)

3.1. Cation Field Strength Index Modelling

As shown in Figures 1-8 the first comment on the results of this modelling work is that no well-defined and clear trend linking CFSI and sulfate solubility in the glasses has yet been established. However, careful visual analysis of the plots indicates a diffuse line dividing a region with higher probability of yellow sulfate phase formation and a region with a lower probability. This has been illustrated in one plot (Figure 1) for guidance purposes only. Similar lines can be drawn on all other plots. The region with lower probability corresponds to low CFSI values. This is broadly consistent with ISL's model for the effects of composition with sulfate solubility in glasses [1, 2]. As noted previously, data taken from Peeler *et al.* [4] describes samples produced under slightly different conditions to the other samples [3, 5, 6] and therefore must be considered with care. Despite this, and were these data from Peeler *et al.* [4] omitted, still the resulting relationship would not be well-defined. It is worth noting that the compositions of all studied glasses actually fall within a relatively narrow range, and the observed results may be due, at least in part, to natural scatter within a tightly-controlled compositional region. Furthermore, the relationship identified in [1, 2] identifies a linear relationship between the logarithm of sulfate solubility with CFSI, rather than linear sulfate solubility. If plotted on a log basis, it could be argued that the observed regions shown by the dotted line in Figure 1 become somewhat more well-defined (as shown in Figure 1a). However, given the relatively small differences in both composition and sulfate solubility (i.e. not order of magnitude difference as shown in [1, 2], it was felt that a linear scale was more appropriate. Indeed, as we have shown previously in [1], plotting sulfate solubility on a linear scale is sufficient to illustrate a nearly linear relationship when considering sulfate solubility differences within the same order of magnitude.

The small number of "oversaturated" melts – melts for which the sulfate solubility limit had been reached but either not exceeded or only marginally exceeded (i.e. not sufficiently to produce the yellow phase), and illustrated by white markers in all Figures, also indicate that low CFSI values favour higher sulfate capacities.

It must be concluded that, whilst broadly applicable to sulfate solubility in oxide glasses, the CFSI model does not provide a sufficiently descriptive model for sulfate capacity in US radioactive waste borosilicate glasses with a high degree of accuracy over a relatively narrow range of compositions and sulfate solubilities. This indicates that other mechanisms, which are not fully represented by cation field strength, are also at work. One possibility may be that the cation field strength scale does not directly model the interconnectedness, or degree of polymerisation, of the glass network, in this case the (boro)silicate network. It was therefore believed that some models which could more accurately represent this structural arrangement may provide clearer results. For this reason the modelling described in Section 3.2 was conducted.

3.2. Modelling using simple compositional models

In addition to CFSI modelling a number of simple measures were also considered in an effort to extract further information from the data. This has been successful, inasmuch as there was clearer identification of glass compositional regions with higher sulfate solubilities. As shown in Figures 9 and 12, the simple measure of the molar content of SiO_2 divided by the sum of the concentrations of all other constituents, [SiO_2] / [Balance] shows that the glasses lowest in SiO_2 do not exhibit yellow phase at the levels of sulfate addition included in the data. This is shown at [SiO_2] / [Balance] < 0.85, corresponding with approximately < 45 mol. % SiO_2. This is the most convincing evidence resulting from the current study, that glasses lower in SiO_2, and therefore more depolymerised with (expected) lower average values of Si Q-species (the number of bridging oxygens per Si^{4+}). Literature shows that a full and detailed understanding of the structural origins of the observed behaviour has yet to be developed. It is known that SO_4^{2-} environments in alkali borosilicate radioactive waste glasses are associated with network modifying cations such as Na^+ [7, 8] but with little or no clear link to the nature and structure of the glass-forming network. Backnaes and Deubener [9] have recently reviewed the literature on sulfur solubility as a function of melt composition, noting work by Ducea *et al.* [10], which has shown an approximately linear relationship, albeit with some spread, between SiO_2 content and sulfur solubility of a range of magmas (data which they compiled from other literature) showing a wide range of SiO_2 contents. This behaviour is consistent with the behaviour which we have observed in the US borosilicate glasses (Figures 9 and 12). We also note that the "cutoff" in yellow phase formation which we have observed in our data below ca. 45 mol % SiO_2 broadly corresponds with rapidly increasing levels of (with decreasing SiO_2 content) of "free" O^{2-} ions, i.e. oxygens not directly bonded to Si^{4+} [11, 12] and substantial changes in BO/NBO ratio and Si Q-speciation with only small further decreases in SiO_2 content [11-14].

We note that the inclusion of B_2O_3 (as the other network-forming species) and Al_2O_3 (which is abundant and primarily tetrahedrally coordinated in alkali borosilicate glasses) in the numerator of the simple models, do not further improve the observed trend in the data, as shown in Figures 10, 11, 13 and 14. However, they do not greatly detract from it either, indicating some involvement of B_2O_3 and Al_2O_3 in the determination of sulfate solubilities, consistent with the cation field strength approach. A French study [15] showed that variation in the ratio R = [Na_2O] / [B_2O_3] strongly affected sulfate solubility; however, this is expected on the basis of the cation field strength approach, on moving through compositional space from what is essentially a SiO_2-B_2O_3 glass towards what is essentially a SiO_2-Na_2O glass. Indian research also supports the view that SiO_2 content has a strong deterministic effect on sulphate solubilities. Indian barium borosilicate glasses, developed specifically as hosts for high-sulfate wastes [16], were shown to incorporate up to 3 mol. % (added) SO_4^{2-} before the onset of molten salt layer formation during melting. It is helpful to note here that these Indian glasses exhibit CFSI values which are considerably higher than would be expected if CFSI was the overriding determining factor in sulphate solubility in these glasses. This is largely due to the high (SiO_2 + B_2O_3) content. However, considering SiO_2 content alone – in this case 40 mol. %, would give a [SiO_2] / [Balance] ratio of 0.6667, which is consistent with the data modelled here, as shown in Figure 12.

4. Recommendations for further work

Generation of additional data points, particularly at SiO_2 contents corresponding with [SiO_2] / [Balance] < ca. 0.85 (ca. 45 mol. % and below), with associated SO_4^{2-} additions of 0.6 – 1.0 mol. %, are required to (i) fully confirm and (ii) define and expand upon, the observed reliance of sulfate solubility on SiO_2 content in the US alkali borosilicate glass systems under consideration here. This would lead to the use of this model to help formulate new glass compositions with enhanced capacities for sulfate. Clearly any such formulations would also need to fulfil all of the other property criteria (durability, processing behaviour, mechanical properties, etc), and these would also need to be considered in the context of the type and level of waste loading to be undertaken. Ultimately the goal would be to develop new glass frits which provide all of the benefits of existing frits but with enhanced sulfate capacities in the resulting vitrified wastes.

Report checked and signed, 22nd December 2011:

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Figure 1. Retained SO_4^{2-} (mol.%) as *f* (Normalised Cation Field Strength Index, Sulfate Included). Data from [3]; additional data from Peeler *et al* 2004 [4] and Billings & Fox 2011 [6]. Dotted line indicates regions of lower / higher probability of yellow phase formation – NB visual guide only

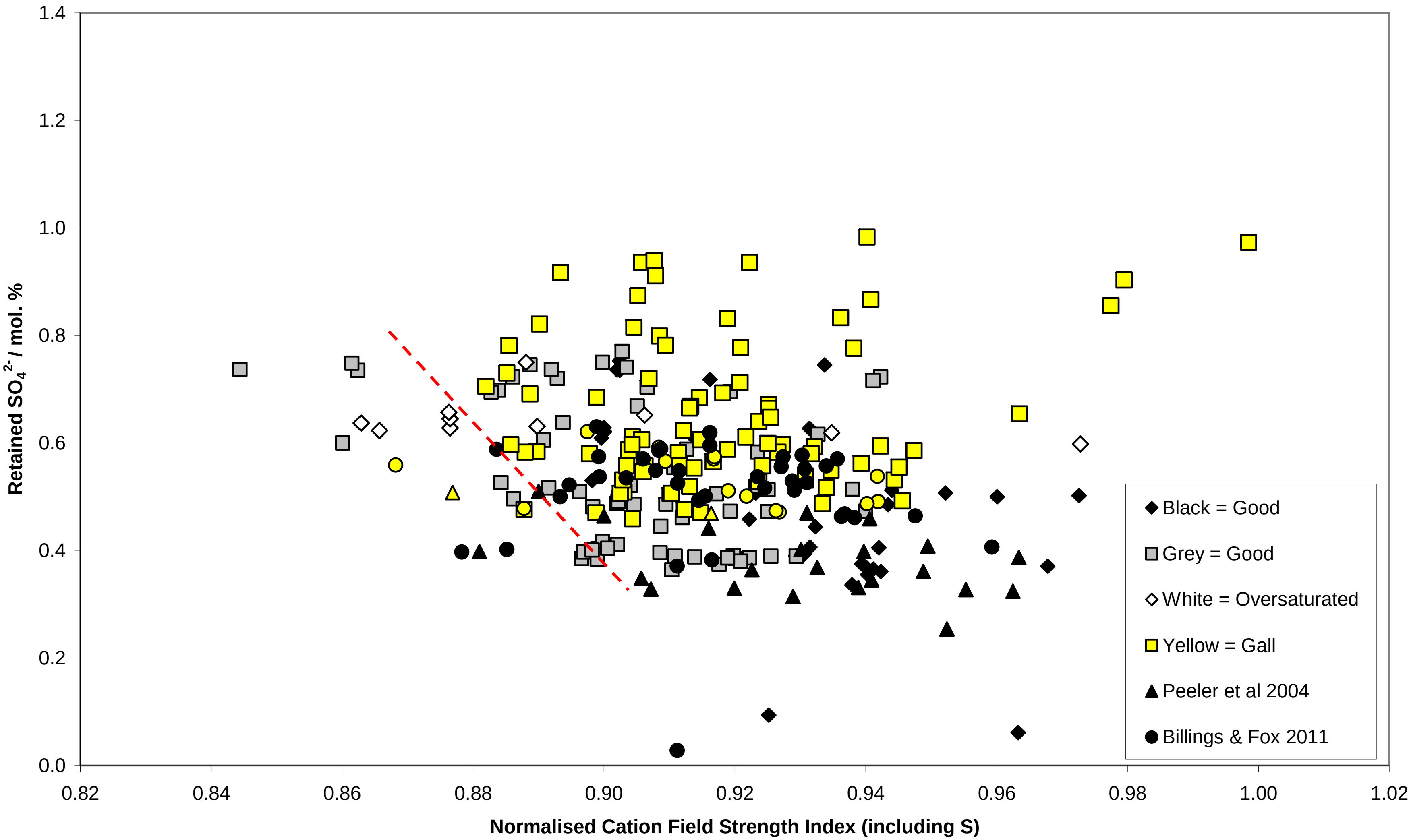


Figure 1a. Retained SO_4^{2-} (mol.%) as *f* (Normalised Cation Field Strength Index, Sulfate Included), logarithmic plot. Data from [3]; additional data from Peeler *et al* 2004 [4] and Billings & Fox 2011 [6]. Dotted line indicates regions of lower / higher probability of yellow phase, visual guide only

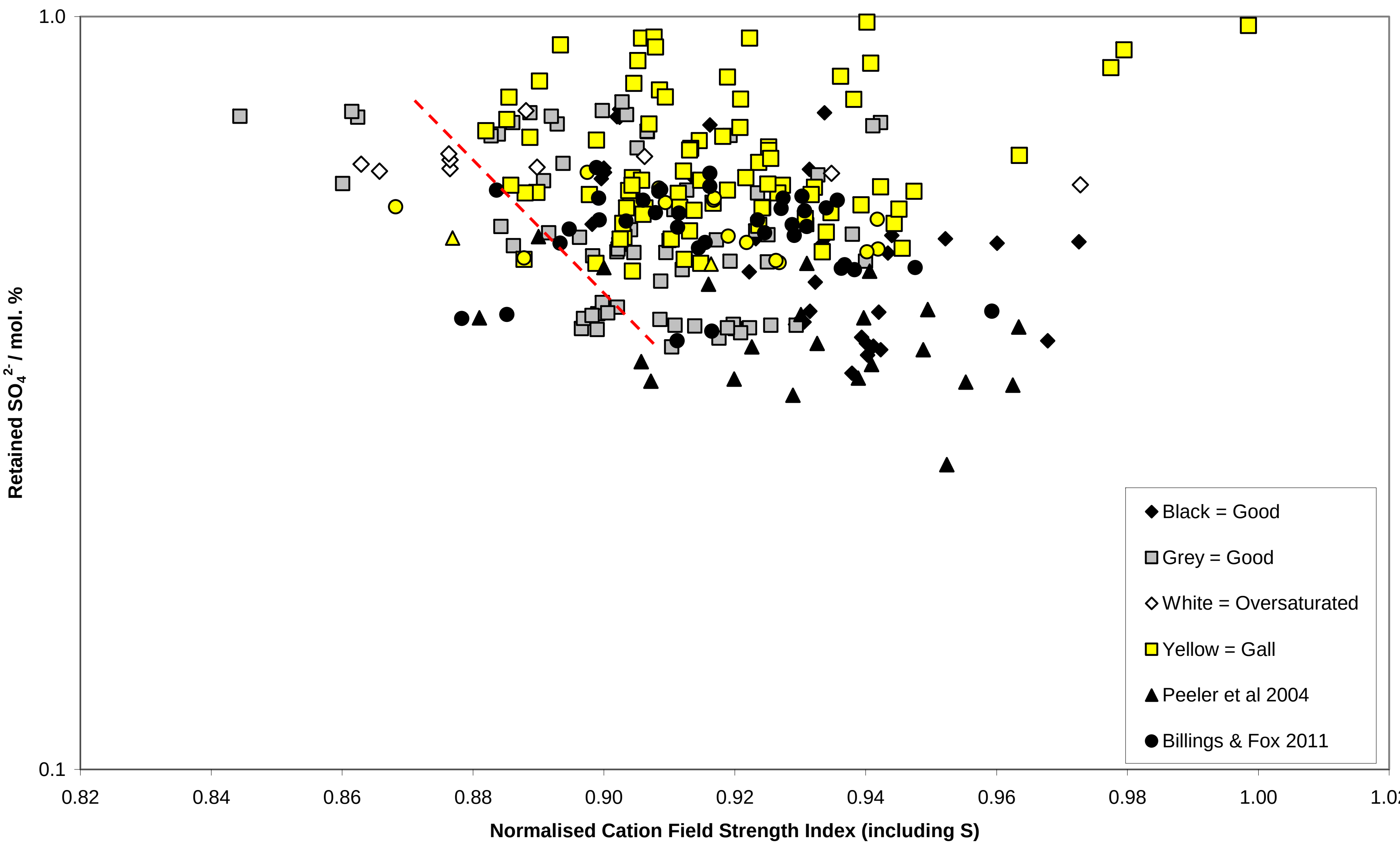


Figure 2. Retained SO_4^{2-} (mol.%) as *f* (Normalised Cation Field Strength Index, Sulfate Omitted). Data from [3]; additional data from Peeler *et al* 2004 [4] and Billings & Fox 2011 [6]

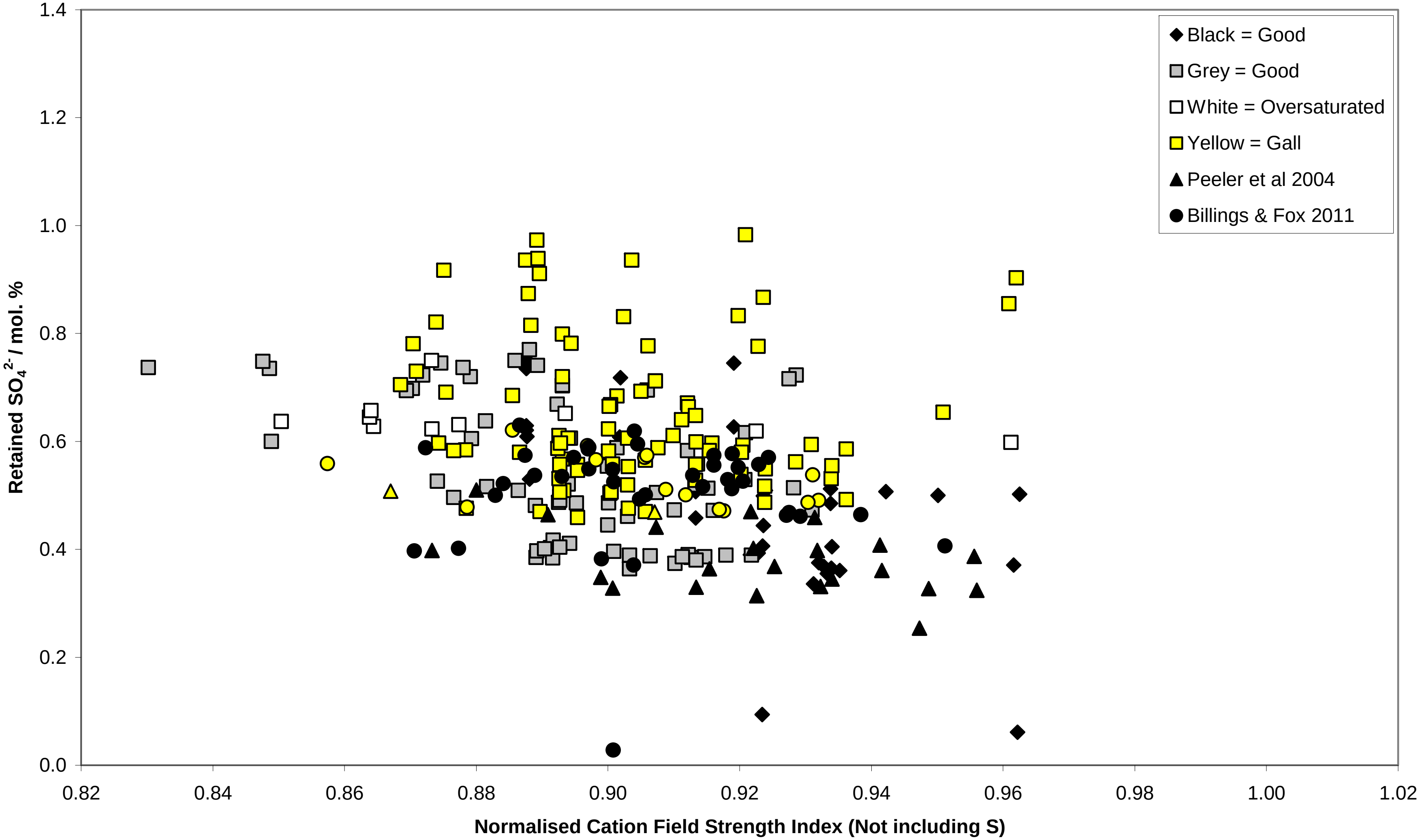


Figure 3. Retained SO_4^{2-} (mol.%) as *f* (Total Cation Field Strength Index, Sulfate Included). Data from [3]; additional data from Peeler *et al* 2004 [4] and Billings & Fox 2011 [6]

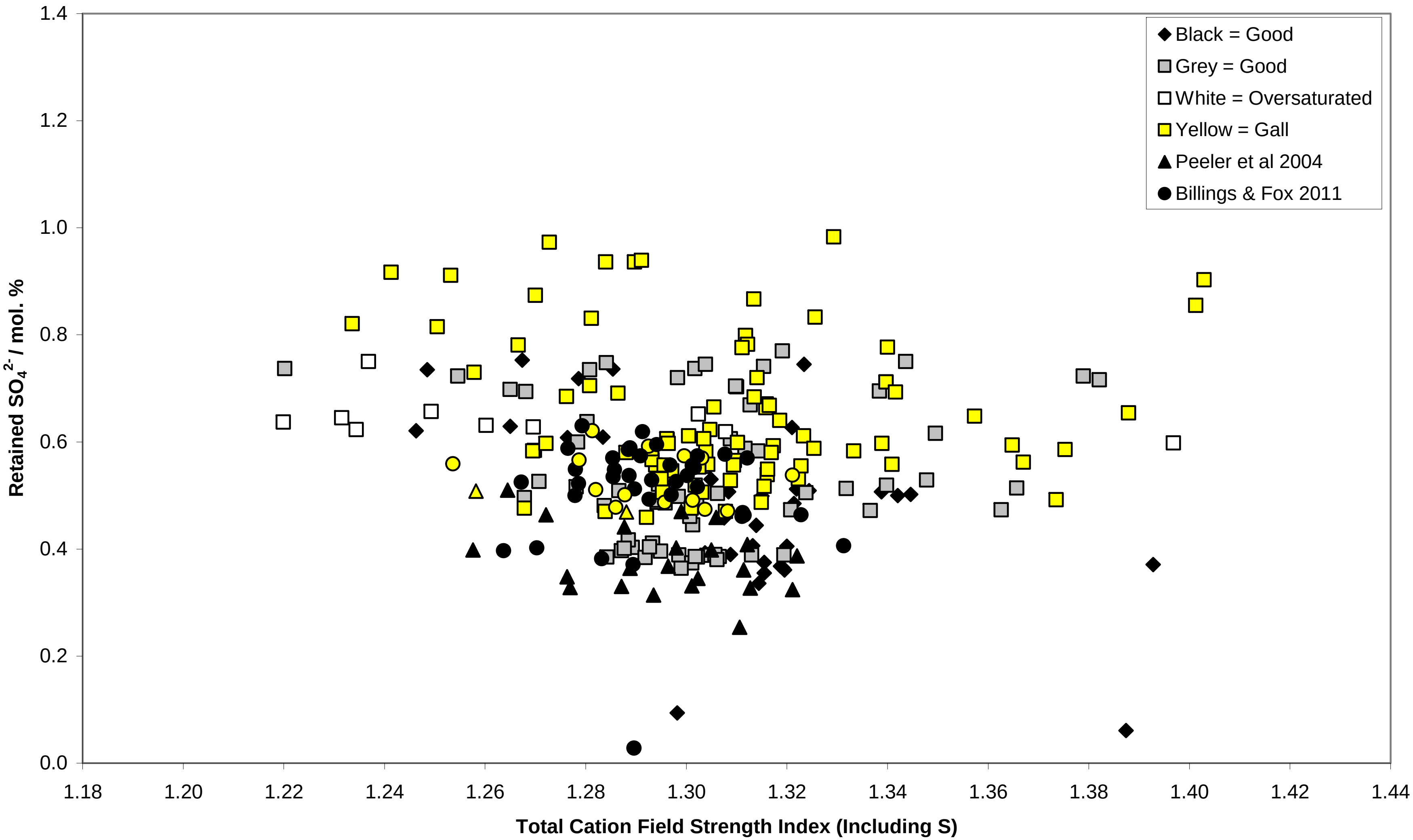


Figure 4. Retained SO_4^{2-} (mol.%) as *f* (Total Cation Field Strength Index, Sulfate Omitted). Data from [3]; additional data from Peeler *et al* 2004 [4] and Billings & Fox 2011 [6]

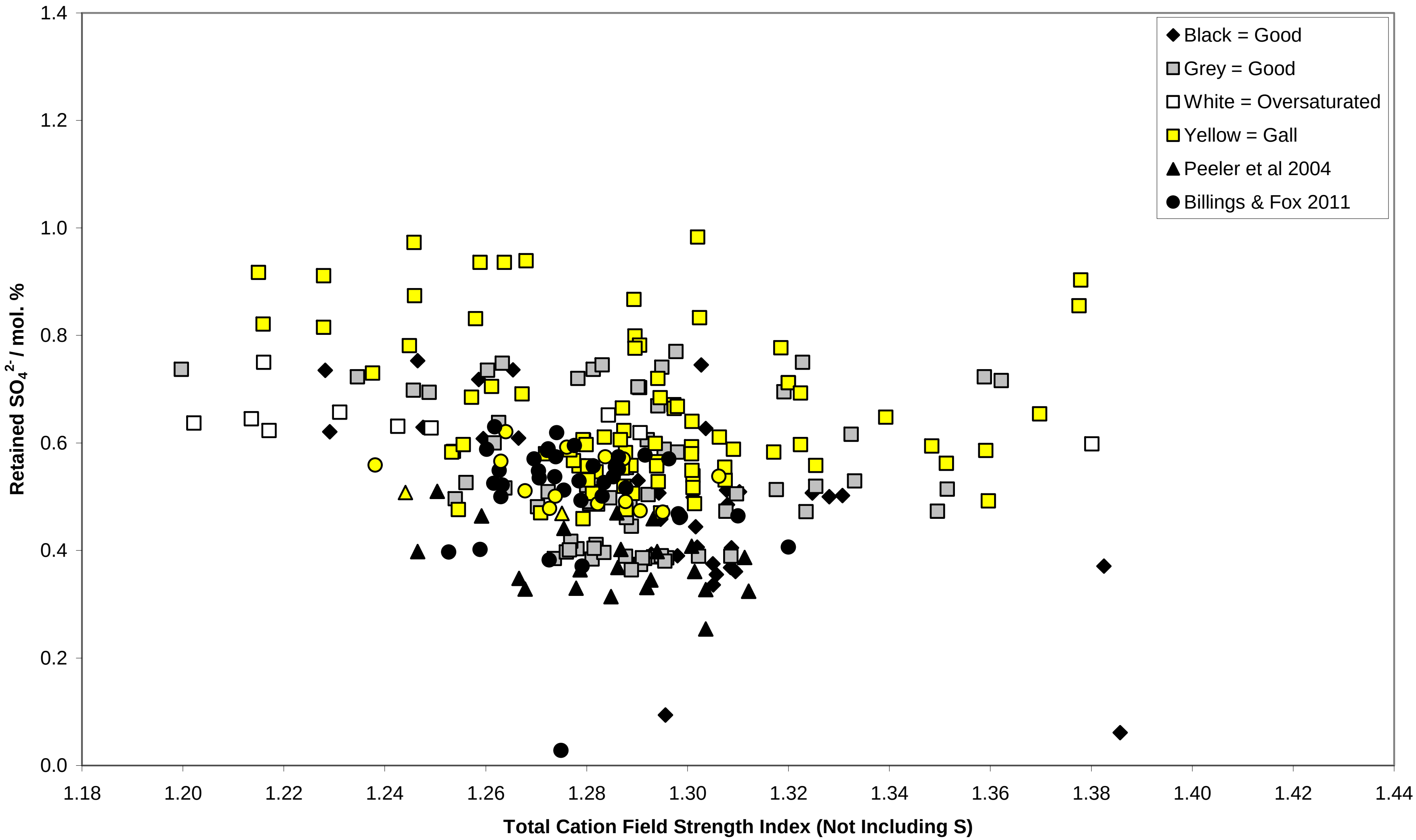


Figure 5. Added SO_4^{2-} (mol.%) as *f* (Normalised Cation Field Strength Index, Sulfate Included). Data from [3]; additional data from Peeler *et al* 2004 [4], Youchak-Billings 2008 [5] and Billings & Fox 2011 [6]

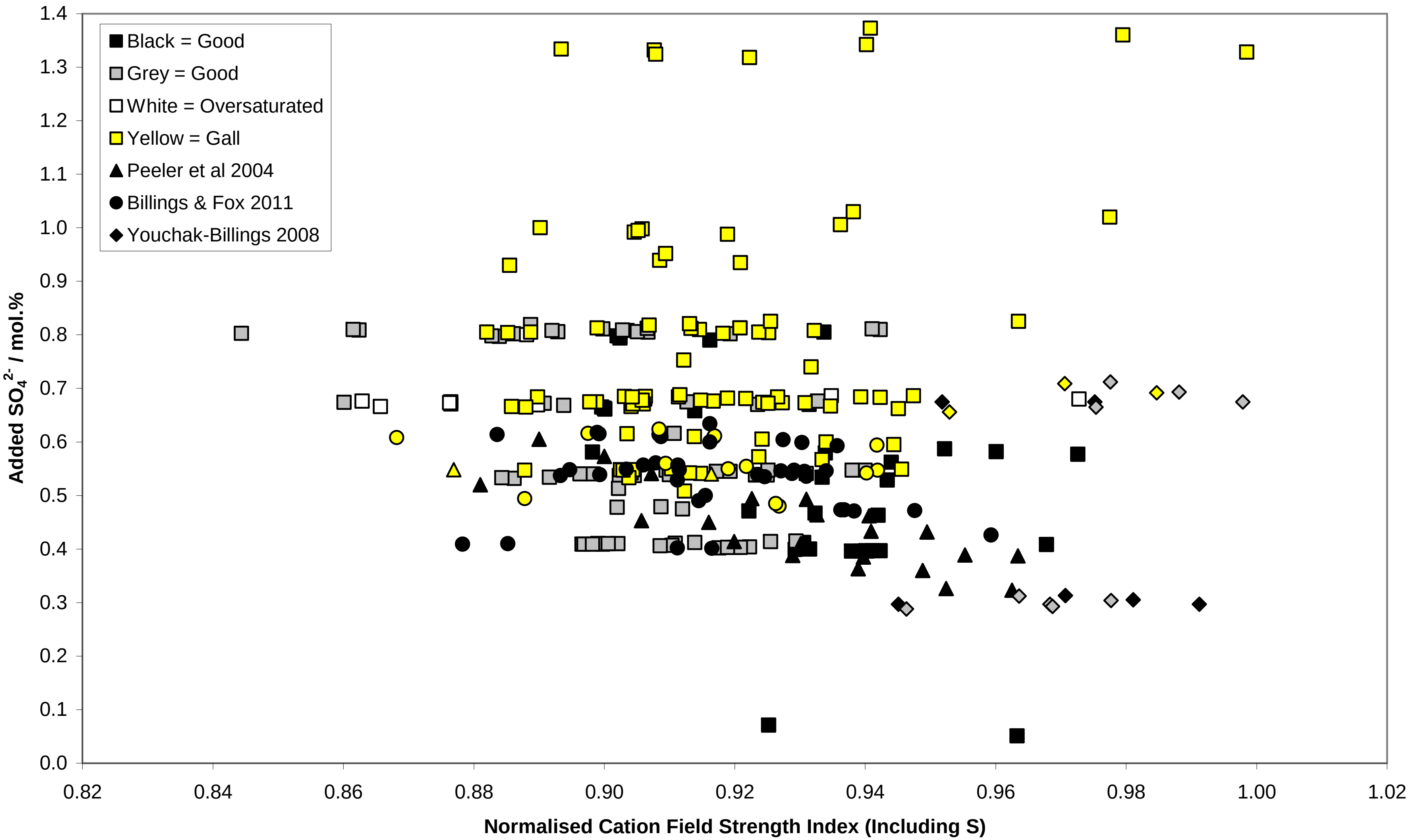


Figure 6. Added SO_4^{2-} (mol.%) as *f* (Normalised Cation Field Strength Index, Sulfate Omitted). Data from [3]; additional data from Peeler *et al* 2004 [4], Youchak-Billings 2008 [5] and Billings & Fox 2011 [6]

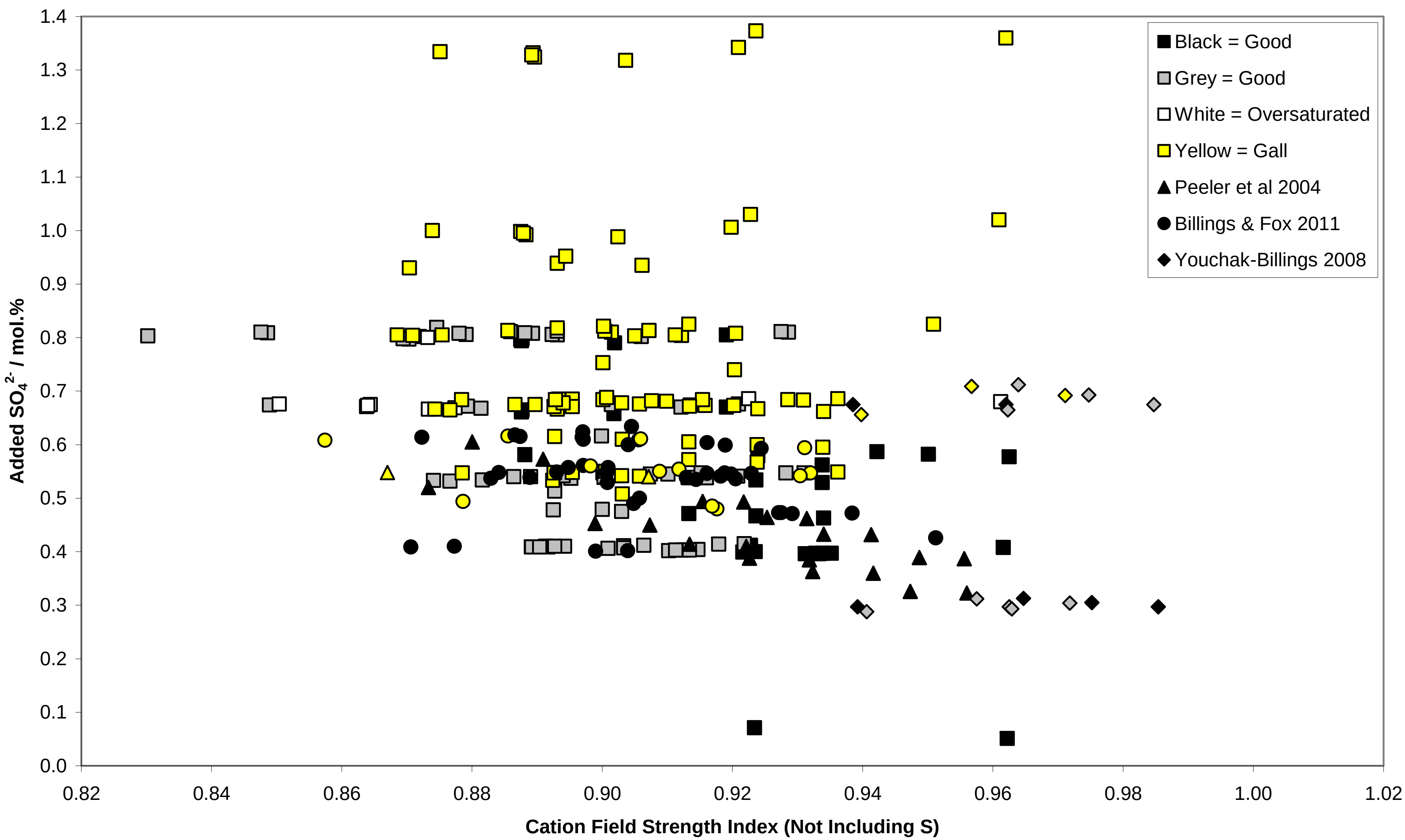


Figure 7. Added SO_4^{2-} (mol.%) as *f* (Total Cation Field Strength Index, Sulfate Included). Data from [3]; additional data from Peeler *et al* 2004 [4], Youchak-Billings 2008 [5] and Billings & Fox 2011 [6]

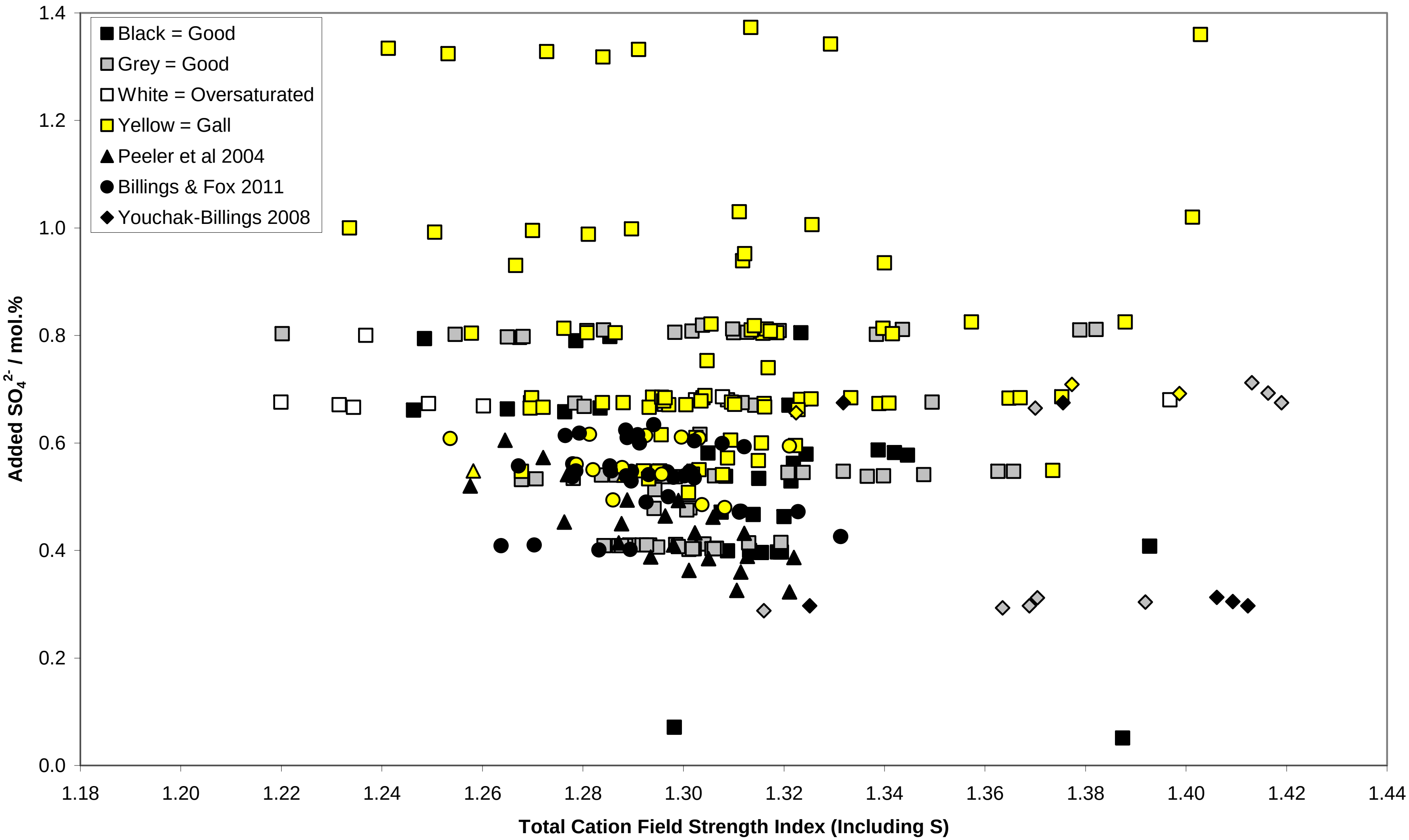


Figure 8. Added SO_4^{2-} (mol.%) as *f* (Total Cation Field Strength Index, Sulfate Omitted). Data from [3]; additional data from Peeler *et al* 2004 [4], Youchak-Billings 2008 [5] and Billings & Fox 2011 [6]

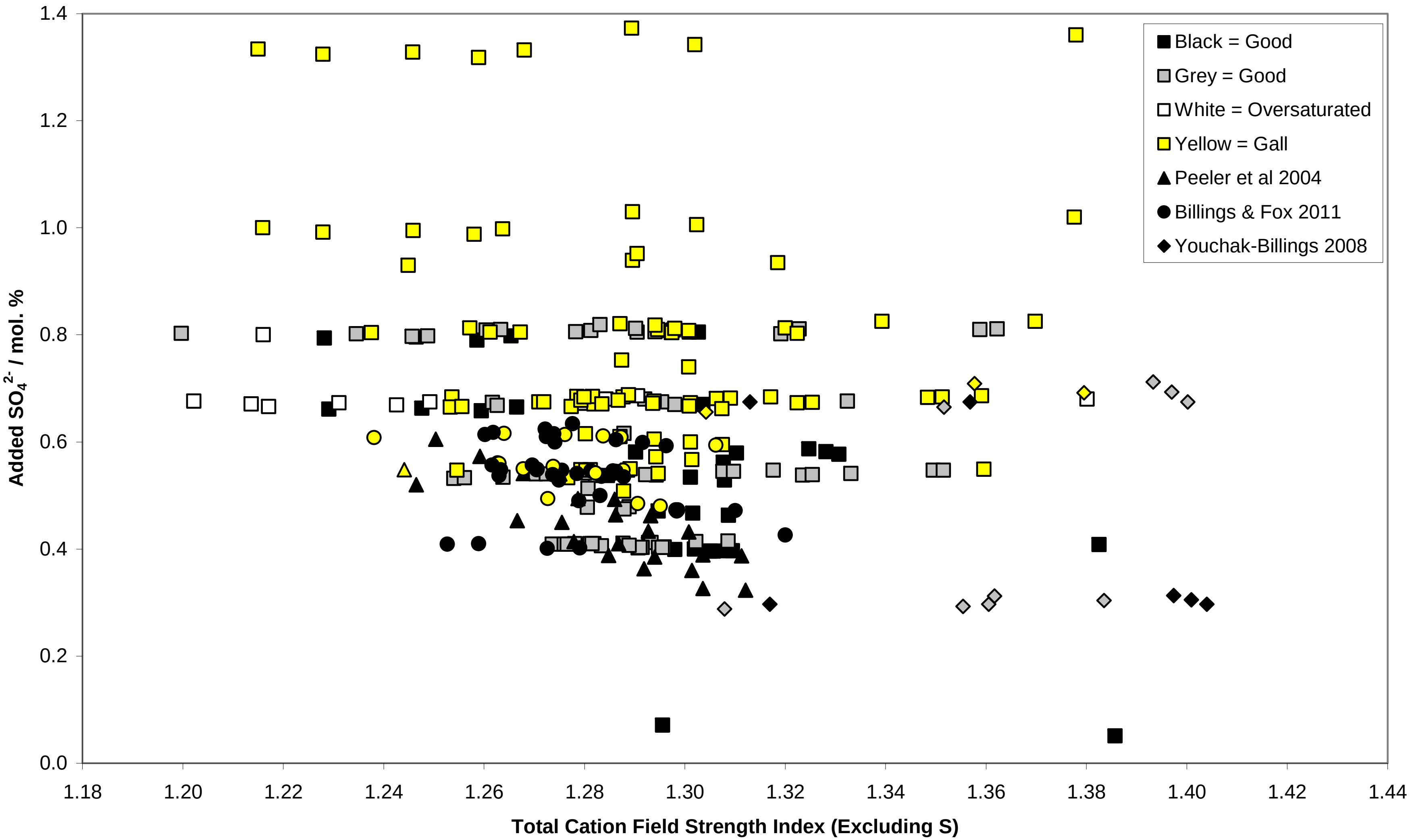


Figure 9. Retained SO_4^{2-} (mol.%) as *f* ([SiO_2] / [Balance]). Data from [3]; additional data from Peeler *et al* 2004 [4], Youchak-Billings 2008 [5] and Billings & Fox 2011 [6]. Dotted line shows regions of high / low probability of yellow phase based on available data - visual guide only.

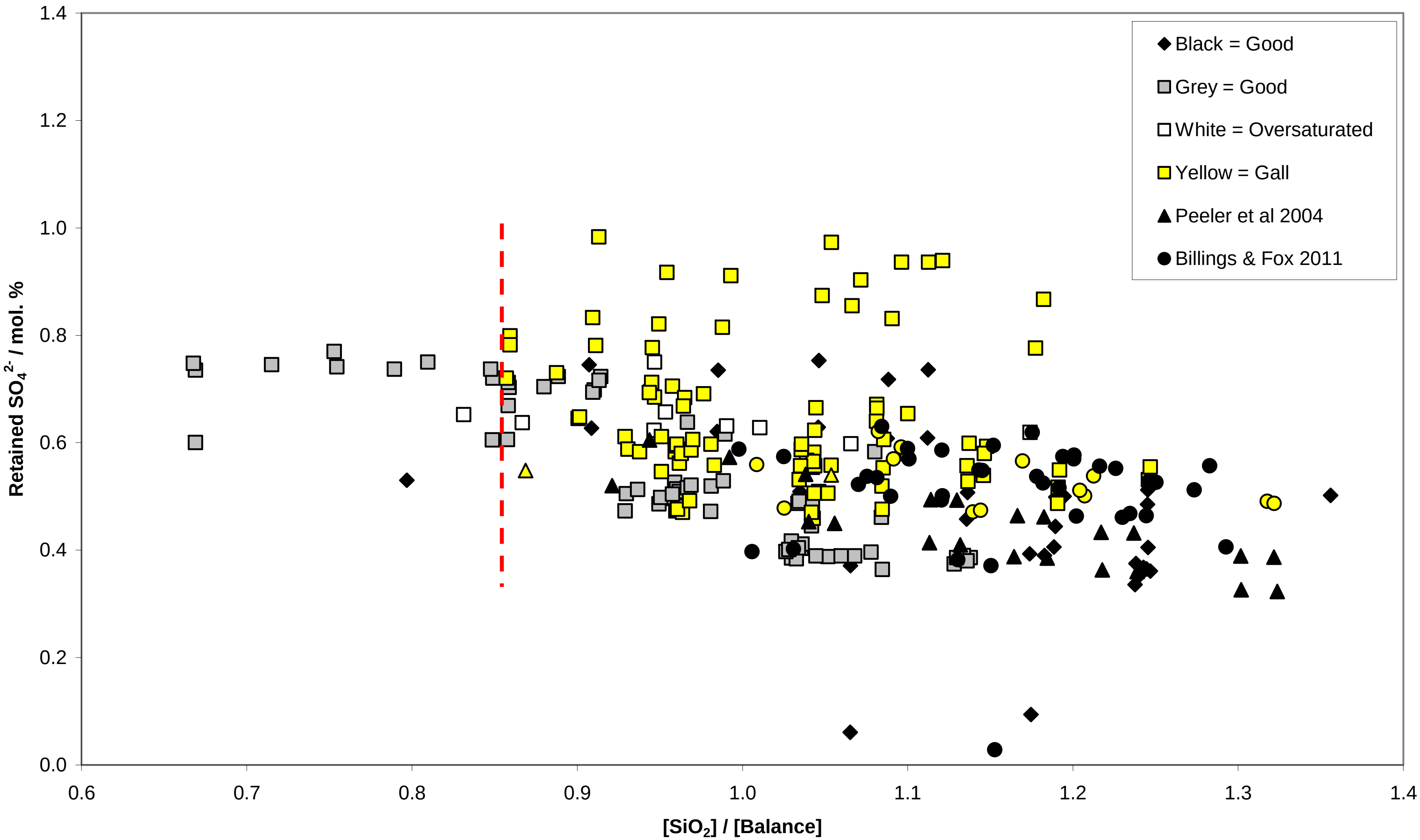


Figure 10. Retained SO_4^{2-} (mol.%) as *f* ([SiO_2 + B_2O_3] / [Balance]). Data from [3]; additional data from Peeler *et al* 2004 [4], Youchak-Billings 2008 [5] and Billings & Fox 2011 [6]

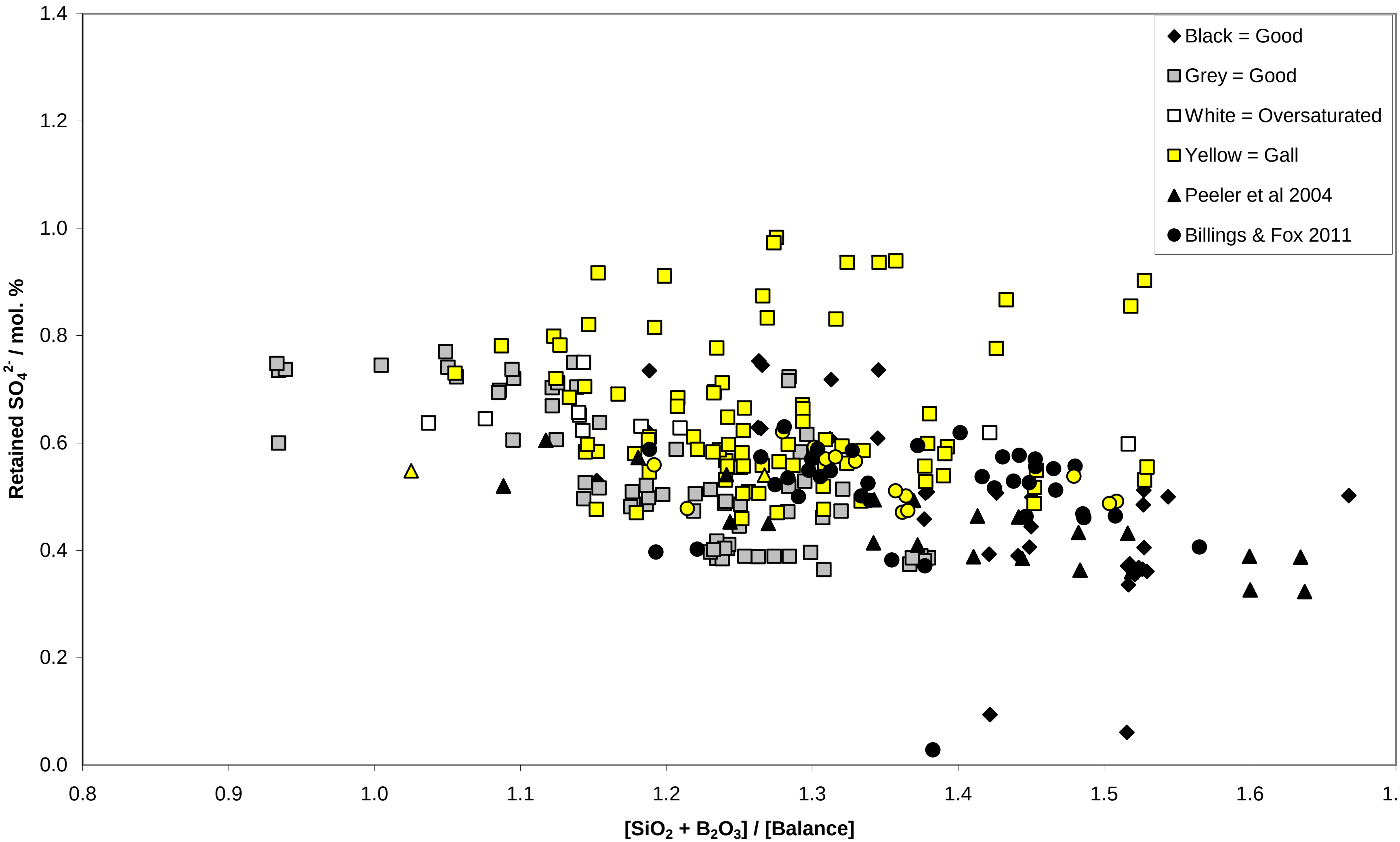


Figure 11. Retained SO_4^{2-} (mol.%) as *f* ([SiO_2 + B_2O_3 + Al_2O_3] / [Balance]). Data from [3]; additional data from Peeler *et al* 2004 [4], Youchak-Billings 2008 [5] and Billings & Fox 2011 [6]

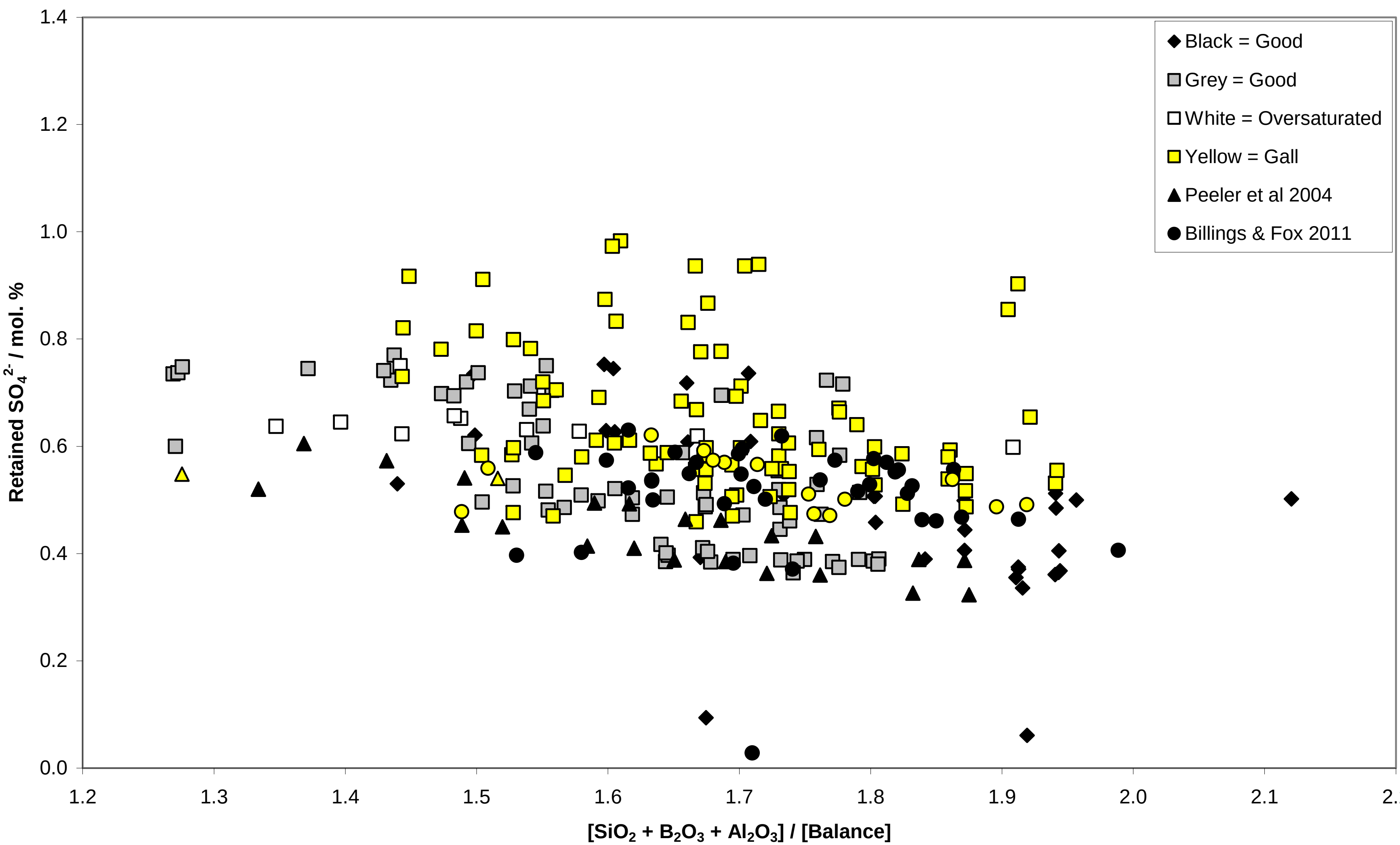


Figure 12. Added SO_4^{2-} (mol.%) as *f* ([SiO_2] / [Balance]). Data from [3]; additional data from Peeler *et al* 2004 [4], Youchak-Billings 2008 [5] and Billings & Fox 2011 [6]

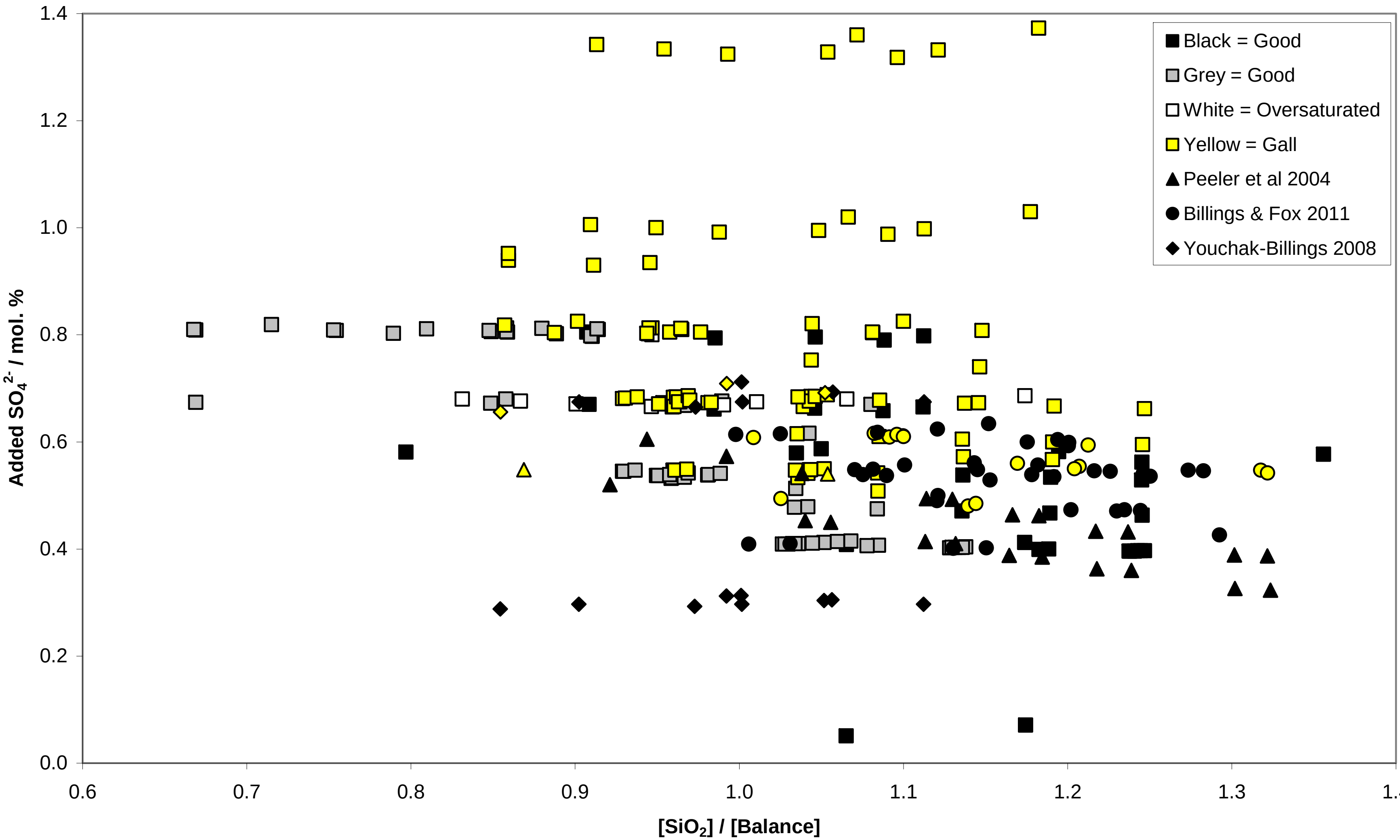


Figure 13. Added SO_4^{2-} (mol.%) as *f* ([SiO_2 + B_2O_3] / [Balance]). Data from [3]; additional data from Peeler *et al* 2004 [4], Youchak-Billings 2008 [5] and Billings & Fox 2011 [6]

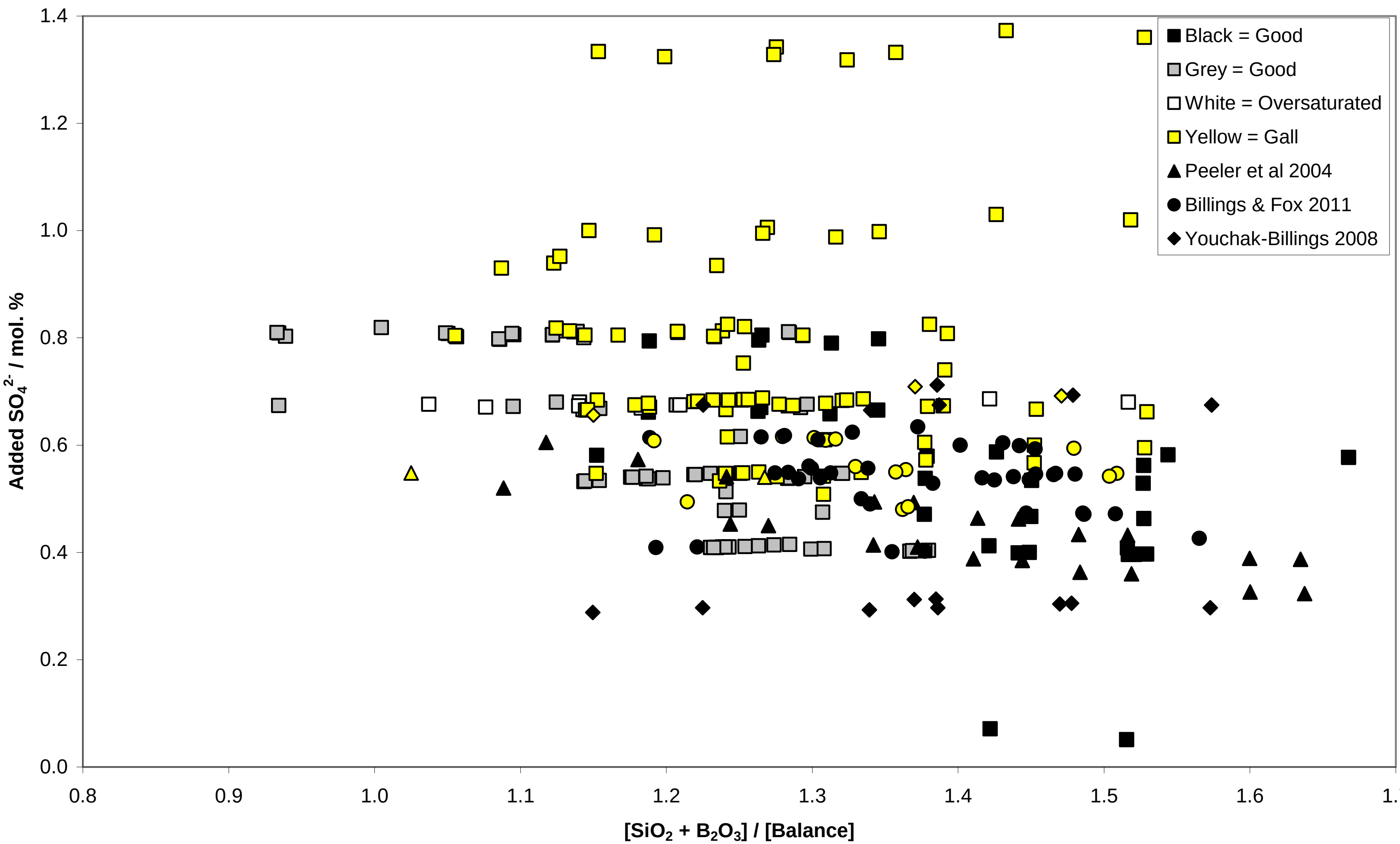
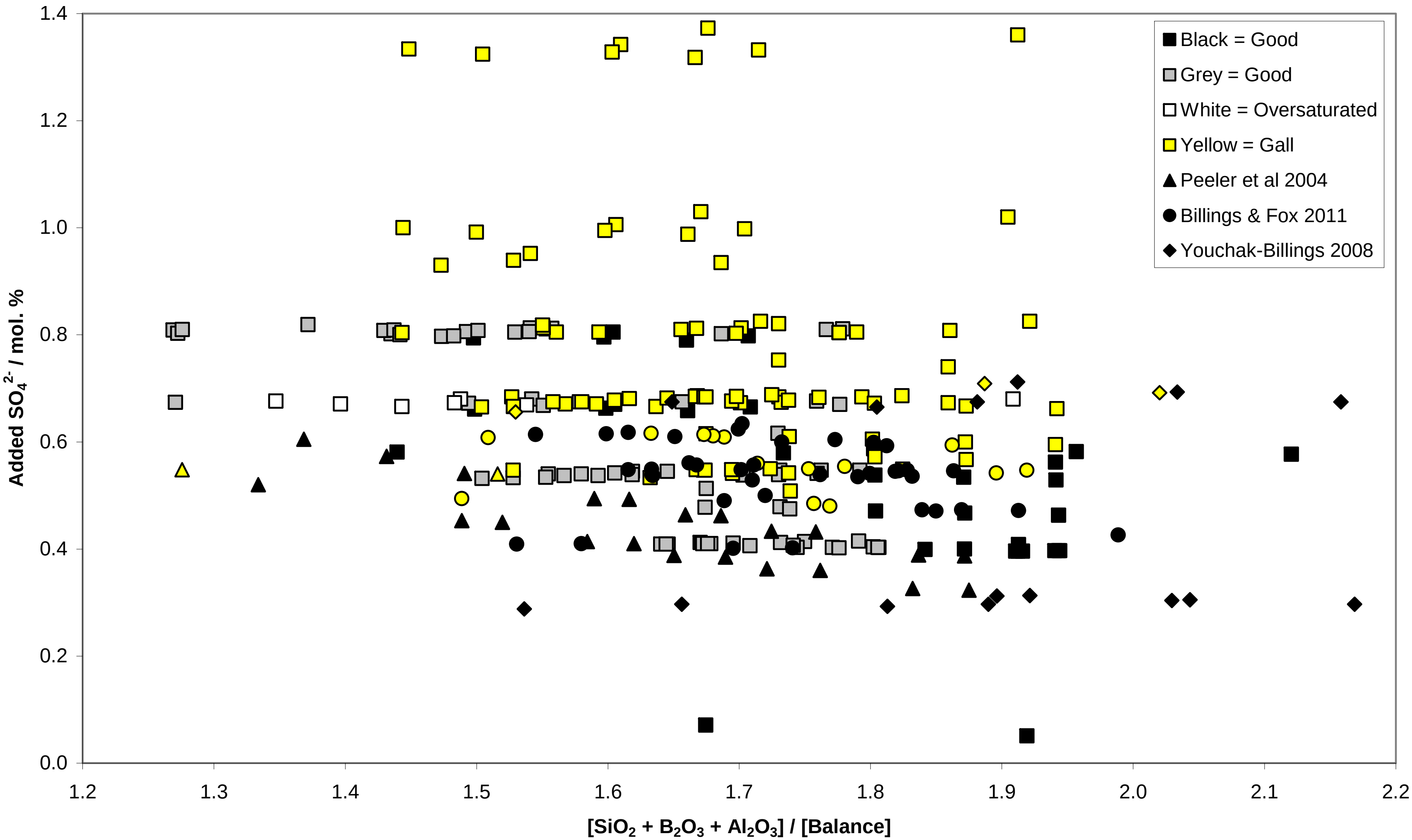


Figure 14. Added SO_4^{2-} (mol.%) as *f* ([SiO_2 + B_2O_3 + Al_2O_3] / [Balance]). Data from [3]; additional data from Peeler *et al* 2004 [4], Youchak-Billings 2008 [5] and Billings & Fox 2011 [6]



Appendix

List of assumptions made in the cation field strength index model, with data sources and references listed.

Shannon ionic radii: The data was taken from: R.D. Shannon, "Revised Effective Ionic Radii and Systematic Studies of Interatomic Distances in Halides and Chalcogenides", Acta Cryst. A32 751-767 (1976).

1) Silicon
Si^{4+} is well-known to be coordination number (CN) 4 in silicate matrices, crystalline and amorphous. Discussed in depth by Brown *et al.*, Chapter 9 in: Reviews in Mineralogy Vol. 32, Mineral Soc. of America, 1995.

2) Sodium
Na^{+} is widely held to be CN6 in oxide glasses, although with some spread in the data. As discussed in depth by Brown *et al*, Chapter 9 in: Reviews in Mineralogy Vol. 32, Mineral Soc. Of America, 1995, a Na CN of approx. 6 is spectroscopically proven.

3) Lithium
Li^{+} is widely held to be CN4 in oxide glasses, although with some data spread. As discussed in depth by Brown et al, Chapter 9 in: Reviews in Mineralogy Vol. 32, Mineral Soc. Of America, 1995, a Na CN of approx. 4 is spectroscopically proven.

4) Calcium
Ca^{2+} is widely held to be CN6 in oxide glasses, although with some data spread. As discussed in depth by Brown *et al*, Chapter 9 in: Reviews in Mineralogy Vol. 32, Mineral Soc. Of America, 1995, a Na CN of approx. 6 is spectroscopically proven. Also shown by Taniguchi *et al.*, J. Non-Cryst. Solids 211 (1997) 56-63.

5) Boron
Evidence from the following papers strongly indicates that an arbitrary assumption that 1/3 of B^{3+} is CN4 and 2/3 of B^{3+} is CN3 in all SRNL glasses considered here is a realistic assumption.

Y. Tanaka *et al.*, Phys. Chem. Glasses: Eur. J. Glass Sci. Technol. B 50 (2009) 289-293

A. Quintas *et al.*, Mat. Res. Bull. 44 (2009) 1895-1898.

A. Quintas *et al.*, Appl. Magn. Reson. 32 (2007) 613-634

E. M. Pierce *et al.*, Geochim. Cosmochim. Acta 74 (2010) 2634-2654.

D. Holland *et al.*, Appl. Magn. Reson. 32 (2007) 483-497

M. M. Islam *et al.*, Phys. Chem. Glasses: Eur. J. Glass Sci. Technol. B 51 (2010) 137-145

A. Duddridge *et al.*, Glass Technol. 44 (2003) 85-89.

6) Iron

Document SRNL-STI-2010-00191 states that a redox of Fe^{2+}/Total Fe = 0.2 is targeted in these glasses, although analysed samples in the report show values of 0 - 0.17. However, for the present data, redox was not controlled and only loose-fitting lids were used during melting. Based on this information, plus ISL experience and literature consensus, it has been assumed that iron occurs as 20% Fe^{2+} and 80% Fe^{3+} in the SRNL glasses considered here. It is also assumed that all Fe^{2+} occurs in CN6 and all Fe^{3+} occurs in CN4, again based on literature and experience. For example see:

N. J. Cassingham *et al.*, Phys. Chem. Glasses: Eur. J. Glass Sci. Technol. A 49 (2008) 21-26.

T. T. Volotinen *et al.*, Phys. Chem. Glasses: Eur. J. Glass Sci. Technol. B 49 (2008) 258-270

P. A. Bingham *et al.*, J. Non-Cryst. Solids 353 (2007) 2479-2494.

P. A. Bingham *et al.*, C. R. Chimie 5 (2002) 787-796

P. A. Bingham *et al.*, J. Non-Cryst. Solids 253 (1999) 203-209

X. C. Yang *et al.*, Physica Scripta T115 (2005) 445-447

Perhaps the closest glasses, in terms of bulk composition, to the SRNL glasses under consideration here were those studied by Cassingham *et al.* (above) and others by G. Licheri *et al.*, J. Non-Cryst. Solids 72 (1985) 211-220. Both studies show Fe^{3+} to be CN4, and over all literature Fe^{2+} is considered to be mainly CN6 in the most relevant glasses. Therefore these CN's have been selected in this study: Fe^{2+} = CN6 and Fe^{3+} = CN4.

7) Aluminium

Evidence from the following papers indicates that it is reasonable to assume all Al^{3+} is CN4 in the glasses under consideration:

A. Quintas *et al.*, Appl. Magn. Reson. 32 (2007) 613-634.

D. Holland *et al.*, Appl. Magn. Reson. 32 (2007) 483-497

Wu and Stebbins, J. Non-Cryst. Solids 355 (2009) 556-562

8) Manganese

Mn is very easily reduced from Mn^{3+} to Mn^{2+} according to electrochemical series (e.g. H. D. Schreiber, J. Non-Cryst. Solids 84 (1986) 129-141). Also D. A. McKeown *et al.*, J. Non-Cryst. Solids 328 (2003) demonstrated that Mn^{2+} is the dominant oxidation state in a wide range of US radioactive waste glasses similar in composition to those under consideration here. Therefore it is reasonable to assume that all Mn is present as Mn^{2+} in these glasses. McKeown *et al.* also showed that the average Mn CN is approximately 5, therefore it is assumed for the model that Mn is present as Mn^{2+} in 50% CN4 sites and 50% CN6 sites, averaging CN5.

9) Magnesium

Mg^{2+} is believed to be largely CN4 in silicate glasses, as discussed by the following authors:

K. Shimoda *et al.*, J. Phys. Chem. B 112 (2008) 6747-6752

M. B. Volf, Chemical Approach to Glasses, Elsevier, Amsterdam, 1984.

R. Roy, J. Am. Chem. Soc. 72 (1950) 3307-3308

Therefore it is assumed for the model that Mg^{2+} is 100% CN4 in the glasses studied.

10) Titanium

Titanium will be present in most glasses, including all those considered here, as Ti^{4+} (see H. Schreiber, J. Non-Cryst. Solids 84 (1986) 129-141). Coordination of Ti^{4+} has been studied extensively by Farges *et al.*:

F. Farges, J. Non-Cryst. Solids 244 (1999) 25-33

F. Farges *et al.*, Geochim. Cosmochim. Acta 60 (1996) 3023-3038; 3039-3053; 3055-3065

Farges and colleagues have concluded that Ti^{4+} occurs predominantly in CN5 in a wide range of glasses, therefore we have assumed that Ti^{4+} is 50% CN4 and 50% CN6, averaging at CN5, in the SRNL glasses studied here.

11) Nickel

Nickel will be present in glass in all but extremely strongly oxidising or highly reducing conditions as Ni^{2+} (see H. Schreiber, J. Non-Cryst. Solids 84 (1986) 129-141). Galoisy and Calas

(Geochim. Cosmochim. Acta 55 (1991) 1563-1574) studied the coordination of Ni^{2+} in oxide glasses and determined that Ni^{2+} occurs in a mixture of CN4 and CN5 sites. This is supported by further work by Galoisy *et al.* (Phys. Chem. Glasses: Eur. J. Glass Sci. Technol. B 46 (2005) 394-399. On the basis of the available literature we have assumed that Ni^{2+} is 75% CN4 and 25% CN6 to give a sensible average of CN 4.5

12) Zirconium

Based on work by F. Farges *et al.* (Geochim. Cosmochim. Acta 55 (1991) 1563-1574) and by A. J. Connelly *et al.* (J. Non-Cryst. Solids 357 (2011) 1647-1656), Zr^{4+} is shown to occur predominantly in CN6 sites in glasses broadly similar to those under consideration here.

13) Cerium

Cerium is assumed to be present in its Ce^{3+} form in the glasses studied as a result of its electrochemical series behaviour and mutual redox interactions with iron, as discussed by H. D. Schreiber *et al.*, J. Non-Cryst. Solids 38&39 (1980) 785-790 and H. D. Schreiber, J. Non-Cryst. Solids 84 (1986) 129-141. The CN of Ce^{3+} in alkali borosilicate radioactive waste glasses has been shown to be CN8 by Jollivet *et al.* (J. Nucl. Mater. 346 (2005) 253-265) and this has been assumed in the model.

14) Chromium

Chromium is present essentially as Cr^{3+} under atmospheric glass melting conditions as shown by electrochemical series (H. D. Schreiber, J. Non-Cryst. Solids 84 (1986) 129-141) and also by others spectroscopically:

M. Casalboni *et al.*, J. Phys. Condens. Matter 8 (1996) 9059-9069

O. Villain *et al.*, J. Non-Cryst. Solids 356 (2010) 2228-2234.

D. A. McKeown *et al.*, J. Non-Cryst. Solids 357 (2011) 2735-2743.

Cr^{3+} is also CN6 in oxide glasses as described in the above references.

Distribution:

J. W. Amoroso, 999-W
A. B. Barnes, 999-W
D. R. Best, 999-W
H. M. Boyd, 704-27S
J. M. Bricker, 704-27S
C. L. Crawford, 773-42A
T. B. Edwards, 999-W
H. H. Elder, 704-24S
T. L. Fellinger, 704-26S
S. D. Fink, 773-A
K. M. Fox, 999-W
B. J. Giddings, 786-5A
J. M. Gillam, 766-H
B. A. Hamm, 766-H
C. C. Herman, 999-W
E. W. Holtzscheiter, 704-15S
J. F. Iaukea, 704-30S
P. R. Jackson, DOE-SR, 703-46A
C. M. Jantzen, 773-A
F. C. Johnson, 999-W
M. T. Keefer, 766-H
P. A. Lee, 703-41A
S. L. Marra, 773-A
D. W. Mcilmoyle, 766-H
J. E. Occhipinti, 704-S
D. K. Peeler, 999-W
F. M. Pennebaker, 773-42A
J. W. Ray, 704-S
A. R. Shafer, 704-27S
H. B. Shah, 766-H
D. C. Sherburne, 704-S
M. E. Smith, 704-30S
A. V. Staub, 704-27S
M. E. Stone, 999-W
K. H. Subramanian, 766-H
W. R. Wilmarth, 773-A