WSRC-STI-2007-00659
Revision 0

REFINEMENT OF THE NEPHELINE DISCRIMINATOR: RESULTS OF A PHASE I STUDY

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Process Science and Engineering
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Prepared for the U.S. Department of Energy Under
Contract Number DEAC09-96SR18500

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U.S. Department of Energy

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Keywords: *high level waste glass, nepheline, durability*

Retention: *permanent*

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EXECUTIVE SUMMARY

The performance of a glass used for immobilization of high-level nuclear waste (HLW) is generally quantified by its resistance to chemical degradation, or durability. The durability of a HLW glass is dependent on its composition. If crystalline phases form within a glass during cooling, the composition of the residual glass network is altered, therefore affecting the durability of the glass. Crystallization of nepheline ($NaAlSiO_4$) has been shown to adversely impact the durability of HLW glasses since it removes glass forming species (in this case, Al and Si) from the glass network. The propensity for nepheline crystallization in a HLW glass increases with increasing concentrations of Al_2O_3 and Na_2O in the glass. Nepheline crystallization is therefore of concern for processing of HLW at the Defense Waste Processing Facility (DWPF) since the sludge waste streams at the Savannah River Site (SRS) can contain high concentrations of Al_2O_3 and Na_2O.

Currently, a 'nepheline discriminator' is included as a process control constraint at the DWPF. The nepheline discriminator relates the concentrations of SiO_2, Na_2O and Al_2O_3 (as weight percentages in glass) to a critical value of 0.62. The discriminator defines a boundary line on the SiO_2-Na_2O-Al_2O_3 ternary diagram above which (or toward the SiO_2 corner of the ternary) nepheline is not predicted to crystallize in the glass upon quenching or slow cooling.

The current equation uses only the concentrations of the SiO_2, Na_2O and Al_2O_3 components in the glass in predicting whether or not nepheline is likely to crystallize. However, several other components have been shown to impact the propensity for nepheline crystallization, including B_2O_3 and CaO among others. Therefore, the potential exists to further refine the nepheline discriminator to include these components. In addition, recently studied HLW glasses with relatively high Al_2O_3 compositions of 25 wt % or greater and nepheline discriminator values well below 0.62 have been shown to be free of nepheline crystallization upon quenching and slow cooling. Thus, the current nepheline discriminator equation also appears to be conservative for some HLW glass compositions. Refining the nepheline discriminator to include other important components and to reduce conservatism may provide access to high Al_2O_3 concentration glass compositions for the DWPF, which could in turn allow access to higher waste loadings, decreased washing and improved waste throughput.

The objective of this study was to develop and characterize a series of HLW glass compositions based on a projected composition of Sludge Batch 5 (SB5), the next sludge batch to be processed in the DWPF. The selected glass compositions all had nepheline discriminator values below the current limit of 0.62. They cover a range of locations on the SiO_2-Na_2O-Al_2O_3 diagram. They also include varying amounts of B_2O_3 and CaO to support an evaluation of the impact of these components on the propensity for nepheline crystallization.

The results described in this report confirm that some conservatism exists in the current nepheline discriminator. Several glass compositions, particularly compositions that target higher Al_2O_3 concentrations, were shown to be very durable (i.e., PCT responses that were more than an order of magnitude better than that of the Environmental Assessment benchmark glass) while their nepheline discriminator values were well below the current nepheline discriminator limit of 0.62. Increased concentrations of B_2O_3 and increased concentrations of CaO were shown to improve durability responses and suppress the formation of nepheline. This provides incentive to revise the nepheline discriminator to reduce some of this conservatism and incorporate the influence of B_2O_3. The revised nepheline discriminator could potentially change from a constant line on the SiO_2-Na_2O-Al_2O_3 ternary diagram to a sloped line, where the slope varies with B_2O_3

concentration, thus allowing access to higher concentrations of Al_2O_3 in glass. Additional data will be required to support development and possible implementation of this revision. A Phase II study will be required to provide the necessary data, and recommendations for a Phase II study are included at the end of this report.

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LIST OF ABBREVIATIONS

ANOVA	Analysis Of VAriance
ARM	Approved Reference Material
bc	bias-corrected
CCC	Canister Centerline Cooling
DWPF	Defense Waste Processing Facility
EA	Environmental Assessment
HLW	High Level Waste
ICP-AES	Inductively Coupled Plasma – Atomic Emission Spectroscopy
LM	Lithium Metaborate
LWO	Liquid Waste Organization
NL	Normalized Leachate
PCT	Product Consistency Test
PF	Peroxide Fusion
ppm	parts per million
PSAL	Process Science Analytical Laboratory
SB5	Sludge Batch 5
SRS	Savannah River Site
XRD	X-ray Diffraction

1.0 Introduction

The performance of a glass used for immobilization of high-level nuclear waste (HLW) is generally quantified by its resistance to chemical degradation, or durability. The durability of a HLW glass is dependent upon its composition. If crystalline phases form within a glass during cooling, the composition of the residual glass network is altered, therefore affecting the durability of the glass. Crystallization of nepheline ($NaAlSiO_4$) has been shown to adversely impact the durability of HLW glasses since it removes glass forming species (in this case, Al and Si) from the glass network.[1] The propensity for nepheline crystallization in a HLW glass increases with increasing concentrations of Al_2O_3 and Na_2O in the glass.[2] Nepheline crystallization is therefore of concern for processing of HLW at the Defense Waste Processing Facility (DWPF) since the sludge waste streams at the Savannah River Site (SRS) can contain high concentrations of Al_2O_3 and Na_2O.

Currently, a 'nepheline discriminator' is included as a process control constraint at the DWPF.[3] This constraint uses the equation that was first proposed by Li[2] and later verified as applicable to DWPF-type glasses.[4-8] The nepheline discriminator is given as Equation 1, and relates the concentrations of SiO_2, Na_2O and Al_2O_3 (as weight percentages in glass) to a critical value of 0.62.

$$\frac{SiO_2}{SiO_2 + Na_2O + Al_2O_3} > 0.62 \qquad (1)$$

This equation defines a boundary line on the SiO_2-Na_2O-Al_2O_3 ternary diagram above which (or toward the SiO_2 corner of the ternary, see Figure 1-1) nepheline is not predicted to crystallize in the glass upon quenching or slow cooling.

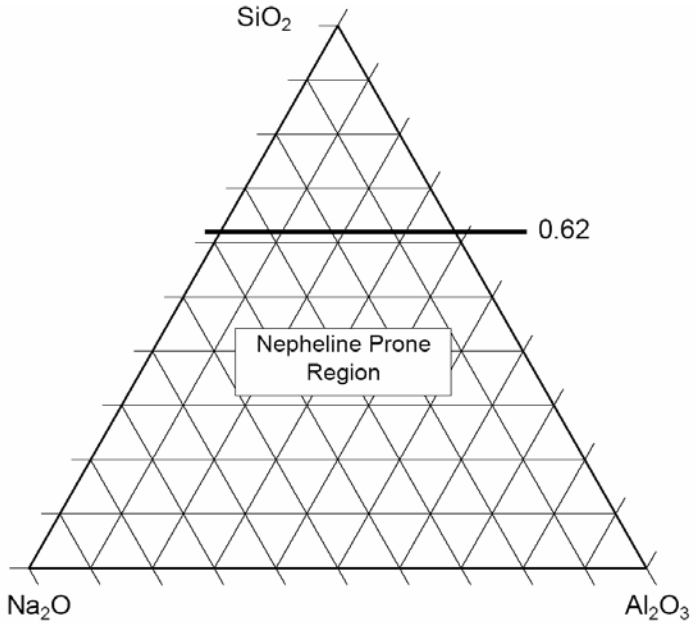

Figure 1-1. Ternary SiO_2-Na_2O-Al_2O_3 diagram showing the location of the current nepheline discriminator. Glasses below the 0.62 line are considered prone to nepheline crystallization.

The current equation uses only the concentrations of the SiO_2, Na_2O and Al_2O_3 components in the glass in predicting whether or not nepheline is likely to crystallize. However, several other components have been shown to impact the propensity for nepheline crystallization, including B_2O_3 and CaO (potential DWPF frit components), among others.[1, 2, 5, 9, 10] Therefore, the potential exists to further refine the nepheline discriminator to include these components. In addition, recently studied HLW glasses with relatively high Al_2O_3 compositions of 25 wt % or greater and nepheline discriminator values well below 0.62 have been shown to be free of nepheline crystallization upon quenching and slow cooling.[11] Thus, the current nepheline discriminator equation also appears to be conservative for some HLW glass compositions. Refining the nepheline discriminator to include other important components and to reduce conservatism may provide access to high Al_2O_3 concentration glass compositions for the DWPF, which could in turn allow access to higher waste loadings, decreased washing and improved waste throughput.

The objective of this study was to develop and characterize a series of HLW glass compositions based on a projected composition of Sludge Batch 5 (SB5), the next sludge batch to be processed in the DWPF. The selected glass compositions all had nepheline discriminator values below the current limit of 0.62. They cover a range of locations on the SiO_2-Na_2O-Al_2O_3 diagram. They also include varying amounts of B_2O_3 and CaO to support an evaluation of the impact of these components on the propensity for nepheline crystallization. A more thorough discussion of the selection process and fabrication of these glasses will be given in Section 2.0. Section 3.0 describes the measured properties (chemical composition and crystalline phase content) and durability of each glass. The Product Consistency Test (PCT) was used to evaluate the durability of each glass, after both quenching and slow cooling. X-ray diffraction was used to identify any crystalline phases within the glasses. Section 0 provides an evaluation of these data, as well as a discussion of how the results may be used to guide refinement of the nepheline discriminator. Section 5.0 offers recommendations for the next phase of this study, which will provide the additional experimental data necessary to recommend implementation of a revised nepheline discriminator in the DWPF process control system.

This study is performed in response to Technical Task Request HLW-DWPF-TTR-2007-0007,[12] under Task Technical and Quality Assurance Plan WSRC-STI-2006-00321.[13]

2.0 Experimental Procedure

2.1 Glass Selection Strategy

Glass compositions for this study were selected to have nepheline discriminator values that were intentionally below the current limit of 0.62. Ten points were selected on the SiO_2-Na_2O-Al_2O_3 ternary diagram in order to cover a broad range of ratios of these components. The location of these ten points is shown graphically in Figure 2-1.

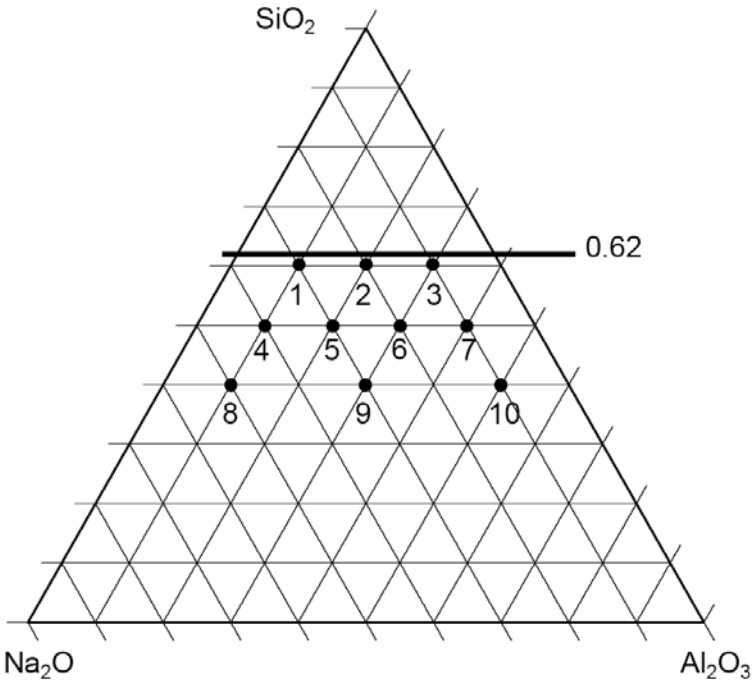

Figure 2-1. Location of the ten composition points selected on the SiO_2-Na_2O-Al_2O_3 ternary diagram.

The nepheline discriminator values and the ratios of SiO_2 to Na_2O to Al_2O_3 for each of these points are given in Table 2-1.

Table 2-1. Description of the ten composition points selected on the SiO_2-Na_2O-Al_2O_3 ternary diagram.

Point on Ternary	Nepheline Discriminator Value	Na_2O (wt %)	Al_2O_3 (wt %)	SiO_2 (wt %)
1	0.60	30	10	60
2	0.60	20	20	60
3	0.60	10	30	60
4	0.50	40	10	50
5	0.50	30	20	50
6	0.50	20	30	50
7	0.50	10	40	50
8	0.40	50	10	40
9	0.40	30	30	40
10	0.40	10	50	40

The effects of B_2O_3 and CaO on the propensity for nepheline crystallization are of primary interest to this study. These components were combined with the SiO_2 to Na_2O to Al_2O_3 ratios described in Table 2-1 at concentrations of 4 and 18 wt % (for B_2O_3) and 2 and 12 wt % (for CaO). It was also desirable that the glasses studied be similar in composition to SB5, the next HLW batch scheduled for processing in the DWPF. A projected SB5 composition provided by the Liquid Waste Organization (LWO)[14] was used to develop a set of components, labeled 'Others,' to be included in the glasses.[a] The projection was modified by first converting all the elemental concentrations to calcined oxides. Next the values for ThO_2 and U_3O_8 were removed, since the study glasses will be non-radioactive simulants. The values for Al_2O_3, CaO, Na_2O and SiO_2 were then removed, since these components are already included as part of the experimental design. The projected composition was then renormalized without these components to produce the 'Others' composition, which is given in Table 2-2.

1.0

[a] Note that this projection was issued in February 2007 and did not include the possible impacts of aluminum dissolution on SB5.

Table 2-2. Composition of the SB5 'Others' grouping.

Sludge Component	Projected SB5 Blend as Calcined Oxides (wt %)	'Others' Composition (SB5 Blend without Al_2O_3, CaO, Na_2O, SiO_2, ThO_2 and U_3O_8) (wt %)
Al_2O_3	30.58	-
BaO	0.11	0.306
CaO	2.09	-
Ce_2O_3	0.23	0.642
Cr_2O_3	0.20	0.561
CuO	0.07	0.206
Fe_2O_3	24.30	67.325
K_2O	0.16	0.429
La_2O_3	0.03	0.096
MgO	1.41	3.911
MnO	5.20	14.413
Na_2O	22.65	-
NiO	2.31	6.387
PbO	0.10	0.266
SO_4^{2-}	1.16	3.203
SiO_2	1.82	-
ThO_2	0.01	-
TiO_2	0.51	1.418
U_3O_8	6.75	-
ZnO	0.07	0.205
ZrO_2	0.23	0.630

The SiO_2 to Na_2O to Al_2O_3 ratios were combined with the B_2O_3 and CaO additions, plus the 'Others' components at a fixed concentration of 16 wt % to develop 40 glass compositions. These combinations are given in Table 2-3. The 'Others' category was then expanded to provide the complete glass compositions. The target compositions for the 40 study glasses are listed in Table 2-4.

Table 2-3. Glass compositions including the B_2O_3 and CaO components, and the Others category.

Point on Ternary	B_2O_3 (wt %)	CaO (wt %)	Na_2O (wt %)	Al_2O_3 (wt %)	SiO_2 (wt %)	Others (wt %)	Sum (wt %)
1	4	2	23.4	7.8	46.8	16	100
1	18	2	19.2	6.4	38.4	16	100
1	4	12	20.4	6.8	40.8	16	100
1	18	12	16.2	5.4	32.4	16	100
2	4	2	15.6	15.6	46.8	16	100
2	18	2	12.8	12.8	38.4	16	100
2	4	12	13.6	13.6	40.8	16	100
2	18	12	10.8	10.8	32.4	16	100
3	4	2	7.8	23.4	46.8	16	100
3	18	2	6.4	19.2	38.4	16	100
3	4	12	6.8	20.4	40.8	16	100
3	18	12	5.4	16.2	32.4	16	100
4	4	2	31.2	7.8	39	16	100
4	18	2	25.6	6.4	32	16	100
4	4	12	27.2	6.8	34	16	100
4	18	12	21.6	5.4	27	16	100
5	4	2	23.4	15.6	39	16	100
5	18	2	19.2	12.8	32	16	100
5	4	12	20.4	13.6	34	16	100
5	18	12	16.2	10.8	27	16	100
6	4	2	15.6	23.4	39	16	100
6	18	2	12.8	19.2	32	16	100
6	4	12	13.6	20.4	34	16	100
6	18	12	10.8	16.2	27	16	100
7	4	2	7.8	31.2	39	16	100
7	18	2	6.4	25.6	32	16	100
7	4	12	6.8	27.2	34	16	100
7	18	12	5.4	21.6	27	16	100
8	4	2	39	7.8	31.2	16	100
8	18	2	32	6.4	25.6	16	100
8	4	12	34	6.8	27.2	16	100
8	18	12	27	5.4	21.6	16	100
9	4	2	23.4	23.4	31.2	16	100
9	18	2	19.2	19.2	25.6	16	100
9	4	12	20.4	20.4	27.2	16	100
9	18	12	16.2	16.2	21.6	16	100
10	4	2	7.8	39	31.2	16	100
10	18	2	6.4	32	25.6	16	100
10	4	12	6.8	34	27.2	16	100
10	18	12	5.4	27	21.6	16	100

Table 2-4. Target compositions (wt %) of the 40 nepheline study glasses.

Glass ID	Point	Al_2O_3	B_2O_3	BaO	CaO	Ce_2O_3	Cr_2O_3	CuO	Fe_2O_3	K_2O	La_2O_3	MgO	MnO	Na_2O	NiO	PbO	SO_4^{2-}	SiO_2	TiO_2	ZnO	ZrO_2
SB5NEPH-01	1	7.80	4.00	0.05	2.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	23.40	1.02	0.04	0.51	46.80	0.23	0.03	0.10
SB5NEPH-02	1	6.40	18.00	0.05	2.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	19.20	1.02	0.04	0.51	38.40	0.23	0.03	0.10
SB5NEPH-03	1	6.80	4.00	0.05	12.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	20.40	1.02	0.04	0.51	40.80	0.23	0.03	0.10
SB5NEPH-04	1	5.40	18.00	0.05	12.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	16.20	1.02	0.04	0.51	32.40	0.23	0.03	0.10
SB5NEPH-05	2	15.60	4.00	0.05	2.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	15.60	1.02	0.04	0.51	46.80	0.23	0.03	0.10
SB5NEPH-06	2	12.80	18.00	0.05	2.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	12.80	1.02	0.04	0.51	38.40	0.23	0.03	0.10
SB5NEPH-07	2	13.60	4.00	0.05	12.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	13.60	1.02	0.04	0.51	40.80	0.23	0.03	0.10
SB5NEPH-08	2	10.80	18.00	0.05	12.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	10.80	1.02	0.04	0.51	32.40	0.23	0.03	0.10
SB5NEPH-09	3	23.40	4.00	0.05	2.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	7.80	1.02	0.04	0.51	46.80	0.23	0.03	0.10
SB5NEPH-10	3	19.20	18.00	0.05	2.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	6.40	1.02	0.04	0.51	38.40	0.23	0.03	0.10
SB5NEPH-11	3	20.40	4.00	0.05	12.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	6.80	1.02	0.04	0.51	40.80	0.23	0.03	0.10
SB5NEPH-12	3	16.20	18.00	0.05	12.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	5.40	1.02	0.04	0.51	32.40	0.23	0.03	0.10
SB5NEPH-13	4	7.80	4.00	0.05	2.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	31.20	1.02	0.04	0.51	39.00	0.23	0.03	0.10
SB5NEPH-14	4	6.40	18.00	0.05	2.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	25.60	1.02	0.04	0.51	32.00	0.23	0.03	0.10
SB5NEPH-15	4	6.80	4.00	0.05	12.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	27.20	1.02	0.04	0.51	34.00	0.23	0.03	0.10
SB5NEPH-16	4	5.40	18.00	0.05	12.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	21.60	1.02	0.04	0.51	27.00	0.23	0.03	0.10
SB5NEPH-17	5	15.60	4.00	0.05	2.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	23.40	1.02	0.04	0.51	39.00	0.23	0.03	0.10
SB5NEPH-18	5	12.80	18.00	0.05	2.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	19.20	1.02	0.04	0.51	32.00	0.23	0.03	0.10
SB5NEPH-19	5	13.60	4.00	0.05	12.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	20.40	1.02	0.04	0.51	34.00	0.23	0.03	0.10
SB5NEPH-20	5	10.80	18.00	0.05	12.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	16.20	1.02	0.04	0.51	27.00	0.23	0.03	0.10
SB5NEPH-21	6	23.40	4.00	0.05	2.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	15.60	1.02	0.04	0.51	39.00	0.23	0.03	0.10
SB5NEPH-22	6	19.20	18.00	0.05	2.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	12.80	1.02	0.04	0.51	32.00	0.23	0.03	0.10
SB5NEPH-23	6	20.40	4.00	0.05	12.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	13.60	1.02	0.04	0.51	34.00	0.23	0.03	0.10
SB5NEPH-24	6	16.20	18.00	0.05	12.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	10.80	1.02	0.04	0.51	27.00	0.23	0.03	0.10
SB5NEPH-25	7	31.20	4.00	0.05	2.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	7.80	1.02	0.04	0.51	39.00	0.23	0.03	0.10
SB5NEPH-26	7	25.60	18.00	0.05	2.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	6.40	1.02	0.04	0.51	32.00	0.23	0.03	0.10
SB5NEPH-27	7	27.20	4.00	0.05	12.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	6.80	1.02	0.04	0.51	34.00	0.23	0.03	0.10
SB5NEPH-28	7	21.60	18.00	0.05	12.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	5.40	1.02	0.04	0.51	27.00	0.23	0.03	0.10
SB5NEPH-29	8	7.80	4.00	0.05	2.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	39.00	1.02	0.04	0.51	31.20	0.23	0.03	0.10
SB5NEPH-30	8	6.40	18.00	0.05	2.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	32.00	1.02	0.04	0.51	25.60	0.23	0.03	0.10
SB5NEPH-31	8	6.80	4.00	0.05	12.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	34.00	1.02	0.04	0.51	27.20	0.23	0.03	0.10
SB5NEPH-32	8	5.40	18.00	0.05	12.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	27.00	1.02	0.04	0.51	21.60	0.23	0.03	0.10
SB5NEPH-33	9	23.40	4.00	0.05	2.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	23.40	1.02	0.04	0.51	31.20	0.23	0.03	0.10
SB5NEPH-34	9	19.20	18.00	0.05	2.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	19.20	1.02	0.04	0.51	25.60	0.23	0.03	0.10
SB5NEPH-35	9	20.40	4.00	0.05	12.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	20.40	1.02	0.04	0.51	27.20	0.23	0.03	0.10
SB5NEPH-36	9	16.20	18.00	0.05	12.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	16.20	1.02	0.04	0.51	21.60	0.23	0.03	0.10
SB5NEPH-37	10	39.00	4.00	0.05	2.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	7.80	1.02	0.04	0.51	31.20	0.23	0.03	0.10
SB5NEPH-38	10	32.00	18.00	0.05	2.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	6.40	1.02	0.04	0.51	25.60	0.23	0.03	0.10
SB5NEPH-39	10	34.00	4.00	0.05	12.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	6.80	1.02	0.04	0.51	27.20	0.23	0.03	0.10
SB5NEPH-40	10	27.00	18.00	0.05	12.00	0.10	0.09	0.03	10.77	0.07	0.02	0.63	2.31	5.40	1.02	0.04	0.51	21.60	0.23	0.03	0.10

2.2 Glass Fabrication

Each of the study glasses was prepared from the proper proportions of reagent-grade metal oxides, carbonates, boric acid and salts in 150 g batches.[15] The raw materials were thoroughly mixed and placed into platinum/rhodium, 250 ml crucibles. The batch was placed into a high-temperature furnace at the target melt temperature of 1150°C.[16] The melt temperature had to be increased for some of the more refractory glass compositions, up to a maximum of 1450 °C. Melt temperatures for each glass are included later in Table 3-1. The crucible was removed from the furnace after an isothermal hold at the melt temperature for 1 hour. The glass was poured onto a clean, stainless steel plate and allowed to air cool (quench). The glass pour patty was used as a sampling stock for the various property measurements, including chemical composition and durability testing.

Approximately 25 g of each glass was heat-treated to simulate cooling along the centerline of a DWPF-type canister[17] to gauge the effects of thermal history on the product performance. This cooling schedule is referred to as the centerline canister cooling (CCC) curve. Visual observations on both quenched and CCC glasses were documented.

2.3 Property Measurements

This section provides a general discussion of the chemical composition analyses, the PCTs, and the XRD analyses of the study glasses.

2.3.1 *Compositional Analysis*

To confirm that the as-fabricated glasses met the target compositions, a representative sample from each quenched glass was submitted to the SRNL Process Science Analytical Laboratory (PSAL) for chemical analysis under the auspices of an analytical plan.[18] The plan identified the cations to be analyzed and the two dissolution techniques, sodium peroxide fusion (PF) and lithium-metaborate (LM), to be used. The samples prepared by LM were used to measure aluminum (Al), barium (Ba), calcium (Ca), cerium (Ce), chromium (Cr), copper (Cu), potassium (K), lanthanum (La), magnesium (Mg), manganese (Mn), sodium (Na), nickel (Ni), lead (Pb), sulfur (S), titanium (Ti), zinc (Zn), and zirconium (Zr) concentrations. Samples prepared by PF were used to measure boron (B), iron (Fe), lithium (Li), and silicon (Si) concentrations. Each glass was prepared in duplicate for each of the two cation dissolution techniques. All of the prepared samples were analyzed twice for each element of interest by Inductively Coupled Plasma – Atomic Emission Spectroscopy (ICP-AES), with the instrumentation being re-calibrated between the duplicate analyses. The analytical plan was developed in such a way as to provide the opportunity to evaluate potential sources of bias and error. Glass standards were also intermittently measured to assess the performance of the ICP-AES instrument over the course of these analyses.

2.3.2 *X-Ray Diffraction Analysis*

Representative samples for all quenched and CCC glasses were submitted to SRNL Analytical Development for XRD analysis. Samples were run under conditions providing a detection limit of approximately 0.5 vol %. That is, if crystals (or undissolved batch material) were present at 0.5 vol % or greater, the diffractometer would not only be capable of detecting the crystals but would also allow a qualitative determination of the type of crystal(s) present. Otherwise, a characteristically high background signal (amorphous hump) devoid of crystalline spectral peaks indicates that the glass product is free of crystallization, suggesting either a completely amorphous product or that the degree of crystallization is below the detection limit.

2.3.3 *Product Consistency Test (PCT)*

The PCT Method-A[19] was performed in triplicate on each quenched and CCC glass to assess chemical durability. Also included in the experimental test matrix was the Environmental Assessment (EA) benchmark glass,[20] the Approved Reference Material (ARM) glass, and blanks from the sample cleaning batch. Samples were ground, washed, and prepared according to the standard procedure.[19] Fifteen milliliters of Type-I ASTM water were added to 1.5 g of glass in stainless steel vessels. The vessels were closed, sealed, and placed in an oven at 90 ± 2 °C where the samples were maintained at temperature for 7 days. Once cooled, the resulting solutions were sampled (filtered and acidified), then labeled and analyzed by PSAL under the auspices of an analytical plan.[21] The aim of the plan was to provide an opportunity to assess the consistency (repeatability) of the PCT and analytical procedures in evaluating the chemical durability of the glasses. Normalized release rates were calculated based on target, measured, and bias-corrected (bc) compositions using the average of the common logarithms of the leachate concentrations.

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3.0 Results and Discussion

3.1 A Statistical Review of the Chemical Composition Measurements

In this section, the measured versus targeted compositions of the study glasses (Glass Identifiers SB5NEPH-01 through SB5NEPH-40) are presented and compared. The targeted compositions for these glasses are provided in Table 2-4, as well as Table A1 of Appendix A. Chemical composition measurements for these glasses were conducted by the PSAL under the auspices of analytical plans.[18] For each study glass, measurements were obtained from samples prepared in duplicate by the LM and PF dissolution methods. All of the prepared samples were analyzed (twice for each element of interest) by ICP-AES, with the instrumentation being re-calibrated between the duplicate analyses.

Table A2 in Appendix A provides the elemental concentration measurements derived from the samples prepared using LM, and Table A3 in Appendix A provides the measurements derived from the samples prepared using PF. Measurements for the standard (Batch 1) samples that were included in the PSAL analytical plans are also provided in these two tables.

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

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

3.1.1 *Measurements in Analytical Sequence*

Exhibit A1 in Appendix A provides plots of the measurements generated by the PSAL for samples prepared using the LM method. The plots are in analytical sequence with different symbols and colors being used to represent each of the study and standard glasses. Similar plots for the samples prepared using the PF method are provided in Exhibit A2 in Appendix A. These plots include all of the measurement data from Tables A2 and A3. While these plots provide only a limited opportunity for revealing patterns in these data, there is an indication of one glass, SB5NEPH-11, with TiO_2 values near zero that stands out. In general, the review of these plots indicates no significant patterns or trends in the analytical process over the course of these measurements, and there appear to be no dramatic outliers in these chemical composition measurements.

3.1.2 *Batch 1 and Uranium Standard Results*

In this section, the PSAL measurements of the chemical compositions of the Batch 1 samples are reviewed. These measurements are investigated across the ICP-AES analytical sets and blocks, and the results are used to bias correct the measurements for the study glasses.

Exhibit A3 in Appendix A provides statistical analyses of the Batch 1 results generated by the LM prep method by set/block/sub-block for each oxide of interest. The results include analysis of variance (ANOVA) investigations looking for statistically significant differences between the

means of these groups for each of the oxides for the standard. The reference value for the oxide concentration of the standard is given in the header for each set of measurements in the exhibit. The results from the statistical tests for the Batch 1 standard may be summarized as follows: Al_2O_3, BaO, CaO, Cr_2O_3, CuO, K_2O, MgO, MnO, Na_2O, NiO, TiO_2, and ZrO_2 have measurements that indicate a significant ICP-AES calibration effect on the block averages at the 5% significance level.

Exhibit A4 in Appendix A provides a similar set of analyses for the measurements derived from samples prepared via the PF method. The reference value for the oxide concentration of the standard is given in the header for each set of measurements in the exhibit. The results from the statistical tests for the Batch 1 standard may be summarized as follows: B_2O_3, Fe_2O_3, Li_2O and SiO_2 have measurements that indicate significant ICP-AES calibration effects on the block averages at the 5% significance level.

Thus, some of these results provide incentive for adjusting the measurements by the effects of the ICP-AES calibration. Therefore, the oxide measurements of the study glasses are to be bias corrected for the effect of the ICP-AES calibration on each of the analytical sets, blocks and sub-blocks. The basis for this bias correction is presented as part of Exhibits A3 and A4 – the average measurement for Batch 1 for each ICP-AES set/block/sub-block for Al_2O_3, B_2O_3, BaO, CaO, Cr_2O_3, CuO, Fe_2O_3, Li_2O, MgO, MnO, Na_2O, NiO, SiO_2, and TiO_2. The Batch 1 results were used to conduct the bias correction as long as the reference value for the oxide concentration in the Batch 1 glass was greater than or equal to 0.1 wt%. Thus, applying this approach and based upon the information in the exhibits, the Batch 1 results were used to bias correct the Al_2O_3, B_2O_3, BaO, CaO, Cr_2O_3, CuO, Fe_2O_3, K_2O, Li_2O, MgO, MnO, Na_2O, NiO, SiO_2, and TiO_2 measurements. No bias correction was conducted for Ce_2O_3, La_2O_3, PbO, SO_4^{2-}, ZnO, or ZrO_2.

The bias correction was conducted as follows. For each oxide, let $\overline{a}_{ij}$ be the average measurement for the i^{th} oxide at analytical block j for Batch 1, and let t_i be the reference value for the i^{th} oxide for Batch 1. (The averages and reference values are provided in Exhibits A3 and A4.) Let $\overline{c}_{ijk}$ be the average measurement for the i^{th} oxide at analytical block j for the k^{th} glass. The bias adjustment was conducted following Equation 2:

$$\overline{c}_{ijk} \bullet \left(1 - \frac{\overline{a}_{ij} - t_i}{\overline{a}_{ij}}\right) = \overline{c}_{ijk} \bullet \frac{t_i}{\overline{a}_{ij}} \qquad (2)$$

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

3.1.3 *Composition Measurements by Glass Number*

Exhibits A5 and A6 in Appendix A provide plots of the oxide concentration measurements by Lab ID within Glass ID (including Batch 1) grouped by target values for the measured and bias-corrected values for the LM and PF preparation methods, respectively. Different symbols and colors are used to represent the different glasses. These plots show the individual measurements

across the duplicates of each preparation method and the two ICP-AES calibrations. A review of the plots presented in these exhibits reveals the repeatability of the four individual, oxide values for each glass. A small amount of scatter is present in the MnO and NiO measurements. Scatter is present in the Fe_2O_3 measurements on the order of 0.5 wt %. This is not expected to have a significant impact on the outcome of the study. For two glasses (SB5NEPH-9 and SB5NEPH-10) in Set 1, three glasses (SB5NEPH-25, SB5NEPH-26, and SB5NEPH-28) in Set 3, and four glasses (SB5NEPH-37 through SB5NEPH-40) in Set 4, the SO_4^{2-} values reported were at the detection limit. This is likely due to the compositionally and thermally (melt temperature) dependent solubility of SO_4^{2-} in these glasses, and will not have a significant influence on the outcome of this study. In Set 2, one of the glasses (SB5NEPH-11) had TiO_2 measurements at the detection limit. It is possible that TiO_2 was omitted from this glass during batching, which is not seen as having any significant impact on the outcome of this study.

3.1.4 *Measured versus Targeted Compositions*

The four measurements for each oxide for each glass (over both preparation methods) were averaged to determine a representative chemical composition for each glass. These determinations were conducted both for the measured and for the bias-corrected data. A sum of oxides was also computed for each glass based upon both the measured and bias-corrected values. Exhibit A7 in Appendix A provides plots showing results for each glass for each oxide to help highlight the comparisons among the measured, bias-corrected, and targeted values. Some scatter for the measured Cr_2O_3, Fe_2O_3, MnO, NiO and ZrO_2 concentrations is apparent in these plots, although it should not have a significant impact on the outcome of the study.

Table A4 in Appendix A provides a summary of the average compositions as well as the targeted compositions and some associated differences and relative differences. Notice that the targeted sums of oxides for the Batch 1 standard do not sum to 100% due to an incomplete coverage of the oxides in the Batch 1 (Glass # 100) samples. All of the sums of oxides (both measured and bias-corrected) for the study glasses fall within the interval of 95 to 105 wt % except for study glass SB5NEPH-31. Entries in Table A4 show the relative differences between the measured or bias-corrected values and the targeted values. These differences are shaded when they are greater than or equal to 5%. Overall, these comparisons between the measured and targeted compositions suggest only minor difficulties in hitting the targeted compositions for some of the oxides for some of the glasses, none of which should influence the conclusions of this report.

3.2 Homogeneity

Visual observations were recorded for each glass after melting and quenching, and also after completion of the CCC heat treatment. The surface of the glass pour patty and the glass remaining in the crucible were observed for the quenched glasses. Both the surface and a cross-sectional fracture surface (described as ‘bulk’) were observed for the CCC versions of the glasses. In describing the appearance of the glasses, terms such as clean or shiny indicate that the glass was free of any visible crystallization. Terms such as metallic, silvery, dull or hazy are used to describe crystallization visible on the surface of the glasses. The visual observations for all of the glasses are summarized in Table 3-1. In addition, any crystalline phases identified by XRD are listed on the right side of the table.

Table 3-1. Summary of the visual observations and XRD results for the nepheline study glasses.

Glass ID	Heat Treatment	T_{Melt} (°C)	Visual Observations	XRD Phase Identification
SB5NEPH-01	quenched	1150	patty: black, shiny and homogeneous; crucible: clean	amorphous
SB5NEPH-02	quenched	1150	patty: black, shiny and homogeneous; crucible: clean	amorphous
SB5NEPH-03	quenched	1150	patty: black, shiny and homogeneous; crucible: clean	amorphous
SB5NEPH-04	quenched	1150	patty: black, shiny and homogeneous; crucible: clean	amorphous
SB5NEPH-05	quenched	1300	patty: black, shiny and homogeneous; crucible: clean	amorphous
SB5NEPH-06	quenched	1150	patty: clean; crucible: four spots of undissolved material	Trevorite [$NiFe_2O_4$]
SB5NEPH-07	quenched	1300	patty: black, shiny and homogeneous; crucible: clean	amorphous
SB5NEPH-08	quenched	1150	patty: clean, black and shiny; crucible: four small spots of undissolved material	amorphous
SB5NEPH-09	quenched	1450	patty: chocolate brown color black and shiny bulk, clean and shiny; crucible: line of foam at melt line	Trevorite [$NiFe_2O_4$]
SB5NEPH-10	quenched	1450	patty: chocolate brown surface, black and shiny bulk; crucible: chocolate brown color on surface, no undissolved material	Trevorite [$NiFe_2O_4$]
SB5NEPH-11	quenched	1300	patty: dark brown, shiny, bulk clean; crucible: one spot of undissolved material	Trevorite [$NiFe_2O_4$]
SB5NEPH-12	quenched	1300	patty: clean; crucible: clean	amorphous
SB5NEPH-13	quenched	1150	patty: shiny/silver surface, bulk clean; crucible: clean with bubbles	possible Gregoryite [Na_2CO_3]
SB5NEPH-14	quenched	1150	patty: clean; crucible: clean	amorphous
SB5NEPH-15	quenched	1150	patty: shiny, silvery surface, bulk clean; crucible: silvery surface, slight yellow tint on walls	amorphous
SB5NEPH-16	quenched	1150	patty: dark brown, clean; crucible: clean	amorphous
SB5NEPH-17	quenched	1300	patty: silvery/metallic surface, bulk clean; crucible: clean with slight metallic haze on surface	amorphous

Table 3-1. Summary of the visual observations and XRD results for the nepheline study glasses. (continued)

Glass ID	Heat Treatment	T_{Melt} (°C)	Visual Observations	XRD Phase Identification
SB5NEPH-18	quenched	1300	patty: dark brown, shiny and clean; crucible: clean	amorphous
SB5NEPH-19	quenched	1300	patty: silvery/metallic haze on surface, bulk clean; crucible: clean	amorphous
SB5NEPH-20	quenched	1300	patty: dark brown, shiny, clean; crucible: clean	amorphous
SB5NEPH-21	quenched	1450	patty: dark brown, shiny surface, bulk crystallized; crucible: chocolate brown	Magnetite [$Fe^{2+}Fe_2^{3+}O_4$]
SB5NEPH-22	quenched	1300	patty: chocolate brown, shiny, bulk chocolate brown with crystals; crucible: chocolate brown	Magnetite [$Fe^{2+}Fe_2^{3+}O_4$]
SB5NEPH-23	quenched	1300	patty: silvery/metallic haze on surface, bulk clean; crucible: metallic haze	Bunsenite [NiO]
SB5NEPH-24	quenched	1150	patty: black and shiny, bulk clean; crucible: clean	amorphous
SB5NEPH-25	quenched	1450	patty: light haze, crystals throughout bulk; crucible: haze but no undissolved material	Trevorite [$NiFe_2O_4$], Corundum [Al_2O_3]
SB5NEPH-26	quenched	1300	patty: brownish haze, crystals in bulk; crucible: one spot of undissolved material with haze on surface	Trevorite [$NiFe_2O_4$], Hematite [Fe_2O_3]
SB5NEPH-27	quenched	1300	patty: black and shiny, crystals in bulk; crucible: clean	Iron Aluminum Oxide [$(Fe_{.78}Al_{.22})(Al_{1.78}Fe_{.22})O_4$]
SB5NEPH-28	quenched	1300	patty: black and shiny, bulk clean; crucible: clean	amorphous
SB5NEPH-29	quenched	1150	patty: golden/bronze haze with some green and purple streaks on surface, bulk clean; crucible: haze on surface, no undissolved material	Thermonatrite [$Na_2CO_3 \cdot H_2O$], Gregoryite [Na_2CO_3]
SB5NEPH-30	quenched	1150	patty: light, silvery haze on surface, bulk clean; crucible: clean	amorphous
SB5NEPH-31	quenched	1150	patty: bronze/golden haze with green and purple swirls, bulk devitrified; crucible: bronze haze on surface and devitrified	Thermonatrite [$Na_2CO_3 \cdot H_2O$], Sodium aluminum silicate [$(Na_2O)_{.33}NaAlSiO_4$], Calcium silicate [$Ca_2(SiO_4)$]
SB5NEPH-32	quenched	1150	patty: silvery haze on surface, bulk clean; crucible: clean	amorphous
SB5NEPH-33	quenched	1300	patty: chocolate brown, dull surface, bulk devitrified; crucible: chocolate brown and devitrified	Sodium aluminum silicate [$Na_{1.55}Al_{1.55}Si_{.45}O_4$], Magnetite [$Fe^{2+}Fe_2^{3+}O_4$]

Table 3-1. Summary of the visual observations and XRD results for the nepheline study glasses. (continued)

Glass ID	Heat Treatment	T_{Melt} (°C)	Visual Observations	XRD Phase Identification
SB5NEPH-34	quenched	1300	patty: dark brown, shiny surface, a few chocolate brown swirls, bulk clean; crucible: clean	Bunsenite [NiO]
SB5NEPH-35	quenched	1300	patty: shiny surface with hazy swirls, bulk chocolate brown and crystallized; crucible: clean	Sodium aluminum silicate [$Na_{1.55}Al_{1.55}Si_{.45}O_4$], Calcium iron oxide [$Ca_2Fe_2O_5$]
SB5NEPH-36	quenched	1300	patty: black, shiny and clean, bulk clean; crucible: clean	Nepheline [$NaAlSiO_4$], Jacobsite [$MnFe_2O_4$], Calcium Borate [$Ca_2B_2O_5$]
SB5NEPH-37	quenched	1450	patty: completely crystallized surface and bulk; crucible: crystallized	Trevorite [$NiFe_2O_4$], Corundum [Al_2O_3]
SB5NEPH-38	quenched	1300	patty: dark, chocolate brown and completely crystallized; crucible: crystallized	Trevorite [$NiFe_2O_4$], Corundum [Al_2O_3], Hematite [Fe_2O_3], Mullite [$Al_{2.4}Si_{0.6}O_{4.8}$]
SB5NEPH-39	quenched	1450	patty: chocolate brown surface, bulk crystallized; crucible: clean	Bunsenite [NiO], Magnetite [$Fe^{2+}Fe_2^{3+}O_4$]
SB5NEPH-40	quenched	1300	patty: black, shiny and clean; crucible: clean	amorphous
SB5NEPH-01	CCC	1150	surface: golden/bronze, shiny; bulk: clean	amorphous
SB5NEPH-02	CCC	1150	surface: black, shiny and clean; bulk: clean	amorphous
SB5NEPH-03	CCC	1150	silvery/hazy surface with lots of crystals; bulk: clean	Combeite [$Na_4Ca_4(Si_6O_{18})$], Nepheline [$Na_6K_{1.2}Al_{7.2}Si_{8.8}O_{32}$]
SB5NEPH-04	CCC	1150	surface: black, shiny and clean; bulk: clean	amorphous
SB5NEPH-05	CCC	1300	surface: shiny film with crystals; bulk: chocolate brown, full of crystals	Magnetite [$Fe^{2+}Fe_2^{3+}O_4$]
SB5NEPH-06	CCC	1150	surface: black, shiny and clean; bulk: crystals	Magnetite [$Fe^{2+}Fe_2^{3+}O_4$]
SB5NEPH-07	CCC	1300	surface: spotty crystals; bulk: crystals	Magnetite [$Fe^{2+}Fe_2^{3+}O_4$], Aegirine [$NaFe^{3+}(SiO_3)_2$]
SB5NEPH-08	CCC	1150	surface: black and shiny with splotches of crystals; bulk: clean	amorphous
SB5NEPH-09	CCC	1450	surface: dull silver matte finish; bulk: devitrified, purple/brown color	Magnetite [$Fe^{2+}Fe_2^{3+}O_4$], Hercynite [$Fe^{2+}Al_2O_4$]
SB5NEPH-10	CCC	1450	surface: swirls of hazy crystals; bulk: crystallized	Trevorite [$NiFe_2O_4$]
SB5NEPH-11	CCC	1300	surface: dull, matte; bulk: devitrified	Magnetite [$Fe^{2+}Fe_2^{3+}O_4$], Anorthite [$Ca_{.66}Na_{.34}Al_{1.66}Si_{2.34}O_8$]
SB5NEPH-12	CCC	1300	surface: black, shiny, small crystals; bulk: crystallized	Magnetite [$Fe^{2+}Fe_2^{3+}O_4$]
SB5NEPH-13	CCC	1150	surface: dull/silvery, crystallized; bulk: clean	Sodium Magnesium Silicon Oxide [$Na_{1.74}(Mg_{0.865}Si_{1.135}O_4)$]

Table 3-1. Summary of the visual observations and XRD results for the nepheline study glasses. (continued)

Glass ID	Heat Treatment	T_{Melt} (°C)	Visual Observations	XRD Phase Identification
SB5NEPH-14	CCC	1150	surface: golden/purple, shiny surface; bulk: clean	amorphous
SB5NEPH-15	CCC	1150	surface: dull, crystallized; bulk: devitrified	Magnetite [$Fe^{2+}Fe_2^{3+}O_4$], Sodium magnesium silicon oxide [$Na_{1.74}(Mg_{0.865}Si_{1.135}O_4)$], Combeite [$Na_4Ca_4(Si_6O_{18})$]
SB5NEPH-16	CCC	1150	surface: crystallized, shiny with gold flecks; bulk: clean	amorphous
SB5NEPH-17	CCC	1300	surface: dull, completely crystallized; bulk: devitrified	Nepheline [$Na_6K_{1.2}Al_{7.2}Si_{8.8}O_{32}$]
SB5NEPH-18	CCC	1300	surface: shiny with a few splotches of crystals; bulk: chocolate brown, crystallized	Bunsenite [NiO]
SB5NEPH-19	CCC	1300	surface: dull, matte, devitrified; bulk: devitrified	Nepheline [$Na(AlSiO_4)$], Combeite [$Na_{4.24}Ca_{3.8}(Si_6O_{18})$], Magnetite [$Fe^{2+}Fe_2^{3+}O_4$], Jacobsite [$MnFe_2O_4$]
SB5NEPH-20	CCC	1300	surface: black, shiny with splotches of crystals; bulk: clean	amorphous
SB5NEPH-21	CCC	1450	surface: dull, matte; bulk: devitrified	Nepheline [$NaAlSiO_4$], Magnetite [$Fe^{2+}Fe_2^{3+}O_4$]
SB5NEPH-22	CCC	1300	surface: black, shiny, very light swirls; bulk: crystallized	Magnetite [$Fe^{2+}Fe_2^{3+}O_4$]
SB5NEPH-23	CCC	1300	surface: devitrified; bulk: devitrified	Magnetite [$Fe^{2+}Fe_2^{3+}O_4$], Nepheline [$NaAlSiO_4$], Aegirine $NaFe^{3+}(SiO_3)_2$
SB5NEPH-24	CCC	1150	surface: black and shiny with a few swirls of crystals; bulk: crystallized	Magnetite [$Fe^{2+}Fe_2^{3+}O_4$]
SB5NEPH-25	CCC	1450	surface: dull silver and devitrified; bulk: devitrified	Magnetite [$Fe^{2+}Fe_2^{3+}O_4$], Nickel aluminum oxide [$NiAl_2O_4$], Corundum [Al_2O_3]
SB5NEPH-26	CCC	1300	surface: dull, matte; bulk: devitrified	Trevorite [$NiFe_2O_4$], Aluminum borate [$Al_4B_2O_9$]
SB5NEPH-27	CCC	1300	surface: dulle, matte; bulk: devitrified	Nepheline [$NaAlSiO_4$], Anorthite [$Ca(Al_2Si_2O_8)$], Magnetite [$Fe^{2+}Fe_2^{3+}O_4$]
SB5NEPH-28	CCC	1300	surface: black and shiny, a few crystals; bulk: crystallized	Magnetite [$Fe^{2+}Fe_2^{3+}O_4$]
SB5NEPH-29	CCC	1150	surface: dimpled and crystallized; bulk: devitrified	Sodium silicate [Na_2SiO_3], Sodium iron oxide [$NaFeO_2$], Sodium magnesium aluminum silicate [$Na_3MgAlSi_2O_8$], Silicon oxide [SiO_2]

Table 3-1. Summary of the visual observations and XRD results for the nepheline study glasses. (continued)

Glass ID	Heat Treatment	T_{Melt} (°C)	Visual Observations	XRD Phase Identification
SB5NEPH-30	CCC	1150	surface: dull, matte, crystallized; bulk: devitrified	Sodium aluminum silicate [$Na_{1.75}Al_{1.75}Si_{0.25}O_4$], Tincalconite [$Na_2B_4O_7{\cdot}5H_2O$], Thermonatrite [$Na_2CO_3{\cdot}H_2O$], Borax [$Na_2B_4O_5(OH)_4(H_2O)_8$], Sodium borate [$Na_4B_{10}O_{17}$]
SB5NEPH-31	CCC	1150	surface: shiny but crystallized; bulk: devitrified	Sodium aluminum silicate [$(Na_2O)_{0.33}NaAlSiO_4$], Thermonatrite [$Na_2CO_3{\cdot}H_2O$], Rankinite [$Ca_3Si_2O_7$], Calcium silicate [$Ca_2(SiO_4)$]
SB5NEPH-32	CCC	1150	surface: devitrified layer with golden crystals; bulk: black and shiny with crystals	Sodium aluminum silicate oxide [$Na_{1.67}Al(SiO_4)O_{0.33}$], Jacobsite [$MnFe_2O_4$], Calcium borate [$Ca_2B_2O_5$], Calcium borate [$Ca(B_4O_7)$], plus unidentifiable
SB5NEPH-33	CCC	1300	surface: dull, matte brown; bulk: devitrified	Nepheline [$NaAlSiO_4$], Magnetite [$Fe^{2+}Fe_2^{3+}O_4$], Aegirine [$NaFe(Si_2O_6)$]
SB5NEPH-34	CCC	1300	surface: crystallized; bulk: devitrified	Nepheline [$NaAlSiO_4$], Magnetite [$Fe^{2+}Fe_2^{3+}O_4$], Jacobsite [$MnFe_2O_4$]
SB5NEPH-35	CCC	1300	surface: black, matte; bulk: devitrified	Nepheline [$NaAlSiO_4$], Sodium aluminum silicate [$Na_{1.55}Al_{1.55}Si_{.45}O_4$], Sodium aluminum silicate [$Na_6(AlSiO_4)_6$], Nekoite [$Ca_3Si_6O_{12}(OH)_6{\cdot}5H_2O$], Manganese iron oxide [$Mn_{.43}Fe_{2.57}Fe_{2.57}O_4$], Calcium silicate [$Ca_2SiO_4$]
SB5NEPH-36	CCC	1300	surface: dull, matte, crystallized; bulk: devitrified	amorphous
SB5NEPH-37	CCC	1450	did not melt completely, dull matte surface, bulk devitrified	Trevorite [$NiFe_2O_4$], Aluminum oxide [Al_2O_3], Hematite [Fe_2O_3]
SB5NEPH-38	CCC	1300	did not melt completely, devitrified	Trevorite [$NiFe_2O_4$], Aluminum oxide [Al_2O_3], Hematite [Fe_2O_3], Aluminum borate [$Al_4B_2O_9$]
SB5NEPH-39	CCC	1450	did not melt completely, devitrified	Nepheline [$NaAlSiO_4$], Calcium aluminum iron oxide carbonate hydroxide hydrate [$Ca_8Al_2Fe_2O_{12}CO_3(OH)_2{\cdot}22H_2O$], Calcium aluminum oxide hydrate [$Ca_2Al_2O_5{\cdot}6H_2O$]
SB5NEPH-40	CCC	1300	surface: black and shiny; bulk: crystallized	Trevorite [$NiFe_2O_4$]

In general, the visual observations indicate that the amount of crystallization increased as the nepheline discriminator value of the glasses decreased. In some cases (e.g., the quenched versions of SB5NEPH-19, SB5NEPH-30, etc.), crystallization was noted during visual observation of the glasses but not identified by XRD. This is likely due to the volume fraction of crystallization being lower than what was detectible via XRD.

Nepheline or other crystalline phases that are expected to have the same impact on durability as nepheline (e.g., Anorthite [$Ca_{.66}Na_{.34}Al_{1.66}Si_{2.34}O_8$]), were detected in several of the glasses and are highlighted in Table 3-1. Several of the other crystalline phases detected, such as trevorite and magnetite, have been shown to have little impact on the durability of DWPF-type glasses[22] and are not of concern to this study. Further discussion on the glasses that contained nepheline will be provided below in combination with the PCT results.

3.3 A Statistical Review of the PCT Results

The study glasses, after being batched and fabricated, were subjected to the 7-day PCT Method-A.[19] Both heat treatments (quenched and CCC) for each study glass were subjected to the PCT in triplicate. PCTs were also conducted in triplicate for samples of the EA glass and for samples of the ARM glass. Blanks (samples consisting only of ASTM Type-I water) were also submitted for the PCT.

Four analytical plans were provided to the PSAL to support the measurement of the compositions of the solutions resulting from the PCTs.[21] Samples of a multi-element, standard solution were included in the analytical plans (as a check on the accuracy of the ICP-AES used for these measurements). In this and the following sections, the measurements generated by the PSAL for these PCTs are presented and reviewed.

Table B1 in Appendix B provides the elemental leachate concentration measurements determined by the PSAL for the solution samples generated by the PCTs by analytical set. One of the quality control checkpoints for the PCT procedure is solution-weight loss over the course of the 7-day test. There were some water loss problems for the third set of PCTs. Sets 1, 2, and 4 had no problems. The following PCTs had water loss problems: all three solutions of the quenched version of SB5NEPH-26 (Lab IDs J32, J20, and J05), SB5NEPH-26CCC-2 and -3 (Lab IDs J23 and J02), and the first solution of the quenched version of SB5NEPH-27 (Lab ID J11). In addition, the PCTs for the CCC version of SB5-NEPH-29 (Lab IDs J58, J33, and J22) all formed gel, indicating significant leaching but not allowing for an appropriate measurement for the PCT. Any measurement in Table B1 below the detection limit of the analytical procedure (indicated by a "<") was replaced by one half of the detection limit in subsequent analyses. In addition to adjustments for detection limits, the values were adjusted for the dilution factors: the factor for the study glasses, the blanks, and the ARM glass in Table B1 was 1.6667 and the factor for EA was 16.6667. Table B2 in Appendix B provides the resulting measurements.

In the sections that follow, the analytical sequence of the measurements over the four sets of PCTs is explored, the measurements of the standards are investigated and used to assess the overall accuracy of the ICP-AES measurement process, the measurements for each glass are reviewed, plots are provided that explore the effects of heat treatment on the PCTs for these glasses, and the PCTs are normalized using the compositions (targeted, measured, and bias-corrected) presented in Table A4 in Appendix A.

3.3.1 *Measurements in Analytical Sequence*

Exhibits B1 and B2 in Appendix B provide plots of the leachate concentrations (ppm) in analytical sequence as generated by the PSAL for all of the data and for the data from only the study glasses, respectively. A different color and symbol are used for each study glass or standard. No issues with the leachate measurements are seen in these plots.

3.3.2 *Results for the Samples of the Multi-Element Solution Standard*

Exhibit B3 in Appendix B provides analyses of the PSAL measurements of the samples of the multi-element solution standard by analytical set by ICP-AES block. An ANOVA investigating for statistically significant differences among the block averages for these samples for each element of interest is included in these exhibits. These results indicate a statistically significant (at approximately a 5% level) difference among the Li average measurements, among the Na average measurements, and among the Si average measurements over these sets and blocks. However, no bias correction of the PCT results for the study glasses was conducted. This approach was taken since the triplicate PCTs for a single study glass were placed in different ICP-AES blocks. Averaging the concentration measurements for each set of triplicates helps to minimize the impact of the ICP-AES effects.

Table 3-2 summarizes the average measurements and the reference values for the four primary elements of interest. The results indicate consistent and accurate measurements from the PSAL processes used to conduct these analyses.

Table 3-2. Results from samples of the multi-element solution standard.

Analytical Set	Analytical Block	Avg B (ppm)	Avg Li (ppm)	Avg Na (ppm)	Avg Si (ppm)
1	1	20.8	9.7	81.9	49.8
	2	21.0	10.3	83.8	51.9
	3	20.3	9.7	85.0	48.0
2	1	21.7	10.0	85.5	49.7
	2	20.8	9.6	85.5	48.8
	3	19.7	9.7	85.4	48.9
3	1	22.0	9.8	82.8	48.9
	2	20.1	9.7	80.2	48.7
	3	20.7	9.7	81.8	48.1
4	1	21.8	9.9	82.6	51.5
	2	21.2	9.6	82.9	47.4
	3	20.1	9.8	80.9	48.9
	Grand Average	**20.9**	**9.8**	**83.2**	**49.2**
	Reference Value	**20**	**10**	**81**	**50**
	% Difference	**4.33%**	**-2.05%**	**2.71%**	**-1.57%**

3.3.3 *Measurements by Glass Number*

Exhibit B4 in Appendix B provides plots of the leachate concentrations for each type of submitted sample by analytical set: the study glasses by heat treatment and the benchmark glasses (EA (101), ARM (102), the multi-element solution standard (100), and blanks (103)). These plots allow for the assessment of the repeatability of the measurements, which suggests some scatter in

the triplicate values for some analytes for some of the glasses. Also, note that some differences between the values for the two heat treatments for some glasses are evident.

PCT results for the ARM and EA benchmark glasses are provided in Table 3-3. All but two of the measured values for the ARM benchmark glass fell within the defined control limits.[23] One of the ARM triplicate samples in each of the third and fourth PCT sets had a measured B concentration that was greater than the control limit. According to the ASTM standard,[19] the PCT values reported in this study should be bias corrected using the measured values for the ARM glass before comparisons are made with other reports. This bias correction is expected to have no significant impact on the results presented here and was therefore not performed at this time. The average NL [B] for the EA glass measured in this study was 18.94 g/L, which is higher than the reference value of 16.695 g/L.[20] Some variation in the measured leach rate of the EA glass is apparent in other recent investigations,[24-29] and should not impact the conclusions of this study.

Table 3-3. PCT results for the ARM and EA benchmark glasses.

Set	Glass ID	log NL [B (g/L)]	log NL [Li(g/L)]	log NL [Na (g/L)]	log NL [Si (g/L)]	NL [B (g/L)]	NL [Li(g/L)]	NL [Na (g/L)]	NL [Si (g/L)]
1	ARM	-0.229	-0.377	0.066	-0.639	0.59	0.42	1.16	0.23
2	ARM	-0.229	-0.383	0.076	-0.646	0.59	0.41	1.19	0.23
3	ARM	-0.225	-0.384	0.056	-0.651	0.60	0.41	1.14	0.22
4	ARM	-0.223	-0.384	0.059	-0.645	0.60	0.41	1.15	0.23
1	EA	1.250	0.973	1.132	0.593	17.77	9.40	13.56	3.92
2	EA	1.291	0.984	1.249	0.598	19.54	9.63	17.75	3.96
3	EA	1.271	0.982	1.169	0.588	18.68	9.60	14.77	3.88
4	EA	1.296	0.979	1.139	0.596	19.77	9.52	13.77	3.95

3.3.4 *Normalized PCT Results*

PCT leachate concentrations are typically normalized using the cation composition (expressed as a weight percent) in the glass to obtain a grams-per-liter (g/L) leachate concentration. Two of the three replicate PCTs for a glass (whether the quenched or the CCC version) must be available for this computation to be completed. Otherwise, no PCT can be reported for the glass. As mentioned earlier, water loss and gelling issues prevent the reporting of normalized release rates for glasses SB5NEPH-26 quenched, SB5NEPH-26 CCC and SB5NEPH-29 CCC. The normalization of the PCTs is usually conducted using the measured compositions of the glasses. This is the preferred normalization process for the PCTs. For completeness, the targeted cation and the bias-corrected cation compositions were also used to conduct this normalization.

As is the usual convention, the common logarithm of the normalized PCT (normalized leachate, NL) for each element of interest was determined and used for comparison. To accomplish this computation, one must:

1. Determine the common logarithm of the elemental leachate concentration for each of the triplicates and each of the elements of interest (these values are provided in Table B2 of Appendix B),

2. Average the common logarithms over the triplicates for each element of interest, and then

Normalizing Using Measured Composition (preferred method)

3. Subtract a quantity equal to 1 plus the common logarithm of the average cation measured concentration (expressed as a weight percent of the glass) from the average computed in step 2.

Or Normalizing Using Target Composition

3. Subtract a quantity equal to 1 plus the common logarithm of the target cation concentration (expressed as a weight percent of the glass) from the average computed in step 2.

Or Normalizing Using Measured Bias-Corrected Composition

3. Subtract a quantity equal to 1 plus the common logarithm of the measured bias-corrected cation concentration (expressed as a weight percent of the glass) from the average computed in step 2.

Exhibit B5 in Appendix B provides scatter plots for these results and offers an opportunity to investigate the consistency in the leaching across the elements for the glasses of this study. All combinations of the normalizations of the PCTs (i.e., those generated using the targeted, measured, and bias-corrected compositional views) and both heat treatments are represented in the series of scatter plots. Consistency in the leaching across the elements is typically demonstrated by a high degree of linear correlation among the values for pairs of these elements. The smallest correlation in this plot is between B and Si, with a value of ~58%, which is a lower correlation than typically seen for a set of PCTs. This indicates some inconsistency in the degree of leaching that occurred for B relative to Si, and is likely due to the large variation in the glass compositions studied. This inconsistency will not impact the conclusions of this study.

Table 3-4 summarizes the normalized PCTs for the glasses of this study. The glasses are listed by analytical set, glass identifier, heat treatment and compositional view. Normalized release data for Li are not shown since the study glasses did not contain Li.

Table 3-4. Normalized PCT Results by Glass ID and Compositional View.

Set	Glass ID	Heat Treatment	Compositional View	log NL [B (g/L)]	log NL [Na (g/L)]	log NL [Si (g/L)]	NL [B (g/L)]	NL [Na (g/L)]	NL [Si (g/L)]
1	SB5NEPH-01	CCC	targeted	0.068	0.255	-0.174	1.17	1.80	0.67
1	SB5NEPH-01	CCC	measured	0.067	0.255	-0.173	1.17	1.80	0.67
1	SB5NEPH-01	CCC	measured bc	0.054	0.264	-0.180	1.13	1.84	0.66
1	SB5NEPH-01	quenched	targeted	-0.003	0.276	-0.168	0.99	1.89	0.68
1	SB5NEPH-01	quenched	measured	-0.004	0.276	-0.166	0.99	1.89	0.68
1	SB5NEPH-01	quenched	measured bc	-0.017	0.284	-0.174	0.96	1.92	0.67
1	SB5NEPH-02	CCC	targeted	0.833	0.730	-0.451	6.81	5.38	0.35
1	SB5NEPH-02	CCC	measured	0.822	0.734	-0.454	6.64	5.42	0.35
1	SB5NEPH-02	CCC	measured bc	0.815	0.743	-0.467	6.53	5.53	0.34
1	SB5NEPH-02	quenched	targeted	0.888	0.790	-0.469	7.74	6.17	0.34
1	SB5NEPH-02	quenched	measured	0.878	0.794	-0.472	7.55	6.22	0.34
1	SB5NEPH-02	quenched	measured bc	0.870	0.802	-0.485	7.41	6.34	0.33
1	SB5NEPH-03	CCC	targeted	0.219	0.340	-0.402	1.66	2.19	0.40
1	SB5NEPH-03	CCC	measured	0.220	0.339	-0.406	1.66	2.18	0.39
1	SB5NEPH-03	CCC	measured bc	0.207	0.347	-0.413	1.61	2.23	0.39
1	SB5NEPH-03	quenched	targeted	-0.155	0.200	-0.575	0.70	1.58	0.27
1	SB5NEPH-03	quenched	measured	-0.154	0.199	-0.579	0.70	1.58	0.26
1	SB5NEPH-03	quenched	measured bc	-0.167	0.208	-0.586	0.68	1.61	0.26
1	SB5NEPH-04	CCC	targeted	0.485	0.573	-0.398	3.06	3.74	0.40
1	SB5NEPH-04	CCC	measured	0.478	0.570	-0.407	3.01	3.72	0.39
1	SB5NEPH-04	CCC	measured bc	0.465	0.579	-0.415	2.92	3.79	0.38
1	SB5NEPH-04	quenched	targeted	0.480	0.556	-0.431	3.02	3.60	0.37
1	SB5NEPH-04	quenched	measured	0.473	0.553	-0.440	2.97	3.57	0.36
1	SB5NEPH-04	quenched	measured bc	0.460	0.562	-0.447	2.88	3.65	0.36
1	SB5NEPH-05	CCC	targeted	-0.559	-0.445	-0.700	0.28	0.36	0.20
1	SB5NEPH-05	CCC	measured	-0.547	-0.450	-0.695	0.28	0.35	0.20
1	SB5NEPH-05	CCC	measured bc	-0.560	-0.439	-0.703	0.28	0.36	0.20
1	SB5NEPH-05	quenched	targeted	-0.390	-0.279	-0.605	0.41	0.53	0.25
1	SB5NEPH-05	quenched	measured	-0.378	-0.285	-0.600	0.42	0.52	0.25
1	SB5NEPH-05	quenched	measured bc	-0.391	-0.273	-0.607	0.41	0.53	0.25
1	SB5NEPH-06	CCC	targeted	0.067	-0.051	-0.629	1.17	0.89	0.23
1	SB5NEPH-06	CCC	measured	0.056	-0.063	-0.637	1.14	0.87	0.23
1	SB5NEPH-06	CCC	measured bc	0.048	-0.054	-0.650	1.12	0.88	0.22
1	SB5NEPH-06	quenched	targeted	-0.589	-0.411	-0.786	0.26	0.39	0.16
1	SB5NEPH-06	quenched	measured	-0.599	-0.423	-0.794	0.25	0.38	0.16
1	SB5NEPH-06	quenched	measured bc	-0.607	-0.414	-0.807	0.25	0.39	0.16
1	SB5NEPH-07	CCC	targeted	-0.566	-0.454	-0.972	0.27	0.35	0.11
1	SB5NEPH-07	CCC	measured	-0.575	-0.462	-0.972	0.27	0.34	0.11
1	SB5NEPH-07	CCC	measured bc	-0.583	-0.451	-0.985	0.26	0.35	0.10
1	SB5NEPH-07	quenched	targeted	-0.519	-0.415	-0.981	0.30	0.38	0.10
1	SB5NEPH-07	quenched	measured	-0.529	-0.423	-0.981	0.30	0.38	0.10
1	SB5NEPH-07	quenched	measured bc	-0.536	-0.412	-0.994	0.29	0.39	0.10
1	SB5NEPH-08	CCC	targeted	-0.288	-0.232	-0.993	0.52	0.59	0.10
1	SB5NEPH-08	CCC	measured	-0.293	-0.243	-1.004	0.51	0.57	0.10
1	SB5NEPH-08	CCC	measured bc	-0.306	-0.231	-1.012	0.49	0.59	0.10
1	SB5NEPH-08	quenched	targeted	-0.207	-0.124	-0.983	0.62	0.75	0.10
1	SB5NEPH-08	quenched	measured	-0.212	-0.135	-0.994	0.61	0.73	0.10
1	SB5NEPH-08	quenched	measured bc	-0.225	-0.123	-1.001	0.60	0.75	0.10
1	SB5NEPH-09	CCC	targeted	-0.714	-0.547	-1.027	0.19	0.28	0.09
1	SB5NEPH-09	CCC	measured	-0.735	-0.568	-1.014	0.18	0.27	0.10

Table 3-4. Normalized PCT Results by Glass ID and Compositional View. (continued)

Set	Glass ID	Heat Treatment	Compositional View	log NL [B (g/L)]	log NL [Na (g/L)]	log NL [Si (g/L)]	NL [B (g/L)]	NL [Na (g/L)]	NL [Si (g/L)]
1	SB5NEPH-09	CCC	measured bc	-0.742	-0.556	-1.027	0.18	0.28	0.09
1	SB5NEPH-09	quenched	targeted	-0.749	-0.896	-1.145	0.18	0.13	0.07
1	SB5NEPH-09	quenched	measured	-0.770	-0.917	-1.131	0.17	0.12	0.07
1	SB5NEPH-09	quenched	measured bc	-0.777	-0.906	-1.144	0.17	0.12	0.07
1	SB5NEPH-10	CCC	targeted	-0.604	-0.615	-0.909	0.25	0.24	0.12
1	SB5NEPH-10	CCC	measured	-0.618	-0.641	-0.908	0.24	0.23	0.12
1	SB5NEPH-10	CCC	measured bc	-0.626	-0.629	-0.921	0.24	0.23	0.12
1	SB5NEPH-10	quenched	targeted	-0.760	-0.845	-1.036	0.17	0.14	0.09
1	SB5NEPH-10	quenched	measured	-0.775	-0.870	-1.034	0.17	0.13	0.09
1	SB5NEPH-10	quenched	measured bc	-0.782	-0.859	-1.047	0.17	0.14	0.09
2	SB5NEPH-11	CCC	targeted	-0.080	-0.476	-1.219	0.83	0.33	0.06
2	SB5NEPH-11	CCC	measured	-0.089	-0.496	-1.232	0.82	0.32	0.06
2	SB5NEPH-11	CCC	measured bc	-0.098	-0.490	-1.240	0.80	0.32	0.06
2	SB5NEPH-11	quenched	targeted	-0.378	-0.822	-1.255	0.42	0.15	0.06
2	SB5NEPH-11	quenched	measured	-0.387	-0.842	-1.268	0.41	0.14	0.05
2	SB5NEPH-11	quenched	measured bc	-0.397	-0.836	-1.276	0.40	0.15	0.05
2	SB5NEPH-12	CCC	targeted	-0.656	-0.580	-1.207	0.22	0.26	0.06
2	SB5NEPH-12	CCC	measured	-0.665	-0.593	-1.215	0.22	0.26	0.06
2	SB5NEPH-12	CCC	measured bc	-0.675	-0.587	-1.223	0.21	0.26	0.06
2	SB5NEPH-12	quenched	targeted	-0.529	-0.487	-1.297	0.30	0.33	0.05
2	SB5NEPH-12	quenched	measured	-0.539	-0.500	-1.305	0.29	0.32	0.05
2	SB5NEPH-12	quenched	measured bc	-0.548	-0.495	-1.313	0.28	0.32	0.05
2	SB5NEPH-13	CCC	targeted	0.751	0.989	0.314	5.63	9.74	2.06
2	SB5NEPH-13	CCC	measured	0.747	1.001	0.313	5.59	10.03	2.05
2	SB5NEPH-13	CCC	measured bc	0.737	1.007	0.305	5.46	10.17	2.02
2	SB5NEPH-13	quenched	targeted	0.571	0.948	0.289	3.72	8.88	1.95
2	SB5NEPH-13	quenched	measured	0.567	0.961	0.288	3.69	9.14	1.94
2	SB5NEPH-13	quenched	measured bc	0.557	0.967	0.280	3.61	9.27	1.90
2	SB5NEPH-14	CCC	targeted	1.205	1.106	0.140	16.03	12.75	1.38
2	SB5NEPH-14	CCC	measured	1.204	1.118	0.134	16.01	13.11	1.36
2	SB5NEPH-14	CCC	measured bc	1.202	1.119	0.127	15.92	13.14	1.34
2	SB5NEPH-14	quenched	targeted	1.325	1.203	0.225	21.12	15.97	1.68
2	SB5NEPH-14	quenched	measured	1.324	1.215	0.219	21.09	16.41	1.65
2	SB5NEPH-14	quenched	measured bc	1.322	1.216	0.212	20.97	16.45	1.63
2	SB5NEPH-15	CCC	targeted	1.054	1.515	0.439	11.32	32.75	2.75
2	SB5NEPH-15	CCC	measured	1.048	1.537	0.445	11.16	34.46	2.79
2	SB5NEPH-15	CCC	measured bc	1.045	1.538	0.438	11.10	34.54	2.74
2	SB5NEPH-15	quenched	targeted	0.452	0.938	0.044	2.83	8.67	1.11
2	SB5NEPH-15	quenched	measured	0.446	0.960	0.050	2.79	9.12	1.12
2	SB5NEPH-15	quenched	measured bc	0.443	0.961	0.043	2.77	9.14	1.11
2	SB5NEPH-16	CCC	targeted	0.761	0.799	-0.223	5.77	6.30	0.60
2	SB5NEPH-16	CCC	measured	0.765	0.838	-0.223	5.82	6.89	0.60
2	SB5NEPH-16	CCC	measured bc	0.762	0.839	-0.230	5.79	6.90	0.59
2	SB5NEPH-16	quenched	targeted	0.730	0.786	-0.246	5.37	6.11	0.57
2	SB5NEPH-16	quenched	measured	0.733	0.825	-0.247	5.41	6.69	0.57
2	SB5NEPH-16	quenched	measured bc	0.731	0.826	-0.254	5.38	6.70	0.56
2	SB5NEPH-17	CCC	targeted	1.101	0.888	0.104	12.62	7.73	1.27
2	SB5NEPH-17	CCC	measured	1.096	0.893	0.094	12.47	7.81	1.24
2	SB5NEPH-17	CCC	measured bc	1.086	0.899	0.086	12.19	7.92	1.22
2	SB5NEPH-17	quenched	targeted	-0.027	0.136	-0.281	0.94	1.37	0.52
2	SB5NEPH-17	quenched	measured	-0.033	0.141	-0.291	0.93	1.38	0.51
2	SB5NEPH-17	quenched	measured bc	-0.042	0.147	-0.299	0.91	1.40	0.50
2	SB5NEPH-18	CCC	targeted	0.600	0.562	-0.641	3.99	3.65	0.23
2	SB5NEPH-18	CCC	measured	0.592	0.569	-0.650	3.91	3.71	0.22
2	SB5NEPH-18	CCC	measured bc	0.590	0.570	-0.657	3.89	3.72	0.22
2	SB5NEPH-18	quenched	targeted	0.632	0.519	-0.647	4.28	3.31	0.23
2	SB5NEPH-18	quenched	measured	0.623	0.526	-0.656	4.20	3.36	0.22
2	SB5NEPH-18	quenched	measured bc	0.621	0.527	-0.663	4.18	3.36	0.22

Table 3-4. Normalized PCT Results by Glass ID and Compositional View. (continued)

Set	Glass ID	Heat Treatment	Compositional View	log NL [B (g/L)]	log NL [Na (g/L)]	log NL [Si (g/L)]	NL [B (g/L)]	NL [Na (g/L)]	NL [Si (g/L)]
2	SB5NEPH-19	CCC	targeted	0.701	0.978	-0.283	5.02	9.51	0.52
2	SB5NEPH-19	CCC	measured	0.686	0.991	-0.292	4.85	9.79	0.51
2	SB5NEPH-19	CCC	measured bc	0.684	0.992	-0.299	4.83	9.81	0.50
2	SB5NEPH-19	quenched	targeted	-0.074	0.336	-0.567	0.84	2.17	0.27
2	SB5NEPH-19	quenched	measured	-0.089	0.348	-0.576	0.81	2.23	0.27
2	SB5NEPH-19	quenched	measured bc	-0.092	0.349	-0.583	0.81	2.23	0.26
2	SB5NEPH-20	CCC	targeted	0.056	0.204	-0.821	1.14	1.60	0.15
2	SB5NEPH-20	CCC	measured	0.053	0.201	-0.829	1.13	1.59	0.15
2	SB5NEPH-20	CCC	measured bc	0.043	0.207	-0.837	1.10	1.61	0.15
2	SB5NEPH-20	quenched	targeted	0.458	0.558	-0.753	2.87	3.61	0.18
2	SB5NEPH-20	quenched	measured	0.454	0.555	-0.760	2.85	3.59	0.17
2	SB5NEPH-20	quenched	measured bc	0.445	0.561	-0.768	2.78	3.64	0.17
3	SB5NEPH-21	CCC	targeted	1.172	0.339	-0.869	14.85	2.18	0.14
3	SB5NEPH-21	CCC	measured	1.187	0.337	-0.873	15.37	2.17	0.13
3	SB5NEPH-21	CCC	measured bc	1.166	0.344	-0.885	14.67	2.21	0.13
3	SB5NEPH-21	quenched	targeted	-0.517	-0.436	-0.716	0.30	0.37	0.19
3	SB5NEPH-21	quenched	measured	-0.502	-0.438	-0.720	0.31	0.36	0.19
3	SB5NEPH-21	quenched	measured bc	-0.522	-0.431	-0.732	0.30	0.37	0.19
3	SB5NEPH-22	CCC	targeted	0.021	-0.069	-0.544	1.05	0.85	0.29
3	SB5NEPH-22	CCC	measured	0.011	-0.078	-0.560	1.03	0.84	0.28
3	SB5NEPH-22	CCC	measured bc	-0.009	-0.071	-0.571	0.98	0.85	0.27
3	SB5NEPH-22	quenched	targeted	-0.303	-0.302	-0.616	0.50	0.50	0.24
3	SB5NEPH-22	quenched	measured	-0.312	-0.311	-0.632	0.49	0.49	0.23
3	SB5NEPH-22	quenched	measured bc	-0.333	-0.304	-0.643	0.46	0.50	0.23
3	SB5NEPH-23	CCC	targeted	-0.120	-0.734	-1.174	0.76	0.18	0.07
3	SB5NEPH-23	CCC	measured	-0.109	-0.738	-1.178	0.78	0.18	0.07
3	SB5NEPH-23	CCC	measured bc	-0.122	-0.730	-1.184	0.75	0.19	0.07
3	SB5NEPH-23	quenched	targeted	-0.564	-0.407	-1.067	0.27	0.39	0.09
3	SB5NEPH-23	quenched	measured	-0.553	-0.411	-1.071	0.28	0.39	0.08
3	SB5NEPH-23	quenched	measured bc	-0.566	-0.403	-1.077	0.27	0.40	0.08
3	SB5NEPH-24	CCC	targeted	-0.463	-0.425	-1.182	0.34	0.38	0.07
3	SB5NEPH-24	CCC	measured	-0.467	-0.429	-1.185	0.34	0.37	0.07
3	SB5NEPH-24	CCC	measured bc	-0.480	-0.421	-1.191	0.33	0.38	0.06
3	SB5NEPH-24	quenched	targeted	-0.046	0.061	-1.266	0.90	1.15	0.05
3	SB5NEPH-24	quenched	measured	-0.051	0.057	-1.270	0.89	1.14	0.05
3	SB5NEPH-24	quenched	measured bc	-0.064	0.065	-1.276	0.86	1.16	0.05
3	SB5NEPH-25	CCC	targeted	-0.864	-0.783	-1.021	0.14	0.16	0.10
3	SB5NEPH-25	CCC	measured	-0.875	-0.800	-1.037	0.13	0.16	0.09
3	SB5NEPH-25	CCC	measured bc	-0.888	-0.794	-1.043	0.13	0.16	0.09
3	SB5NEPH-25	quenched	targeted	-0.232	-0.836	-1.133	0.59	0.15	0.07
3	SB5NEPH-25	quenched	measured	-0.242	-0.854	-1.149	0.57	0.14	0.07
3	SB5NEPH-25	quenched	measured bc	-0.256	-0.847	-1.155	0.56	0.14	0.07
3	SB5NEPH-26	CCC	targeted	.	.	.			
3	SB5NEPH-26	CCC	measured	.	.	.			
3	SB5NEPH-26	CCC	measured bc	.	.	.			
3	SB5NEPH-26	quenched	targeted	.	.	.			
3	SB5NEPH-26	quenched	measured	.	.	.			
3	SB5NEPH-26	quenched	measured bc	.	.	.			
3	SB5NEPH-27	CCC	targeted	1.303	0.286	-2.472	20.07	1.93	0.00
3	SB5NEPH-27	CCC	measured	1.310	0.282	-2.477	20.39	1.91	0.00
3	SB5NEPH-27	CCC	measured bc	1.289	0.290	-2.489	19.46	1.95	0.00
3	SB5NEPH-27	quenched	targeted	-0.446	-0.892	-1.291	0.36	0.13	0.05
3	SB5NEPH-27	quenched	measured	-0.439	-0.897	-1.296	0.36	0.13	0.05
3	SB5NEPH-27	quenched	measured bc	-0.459	-0.889	-1.308	0.35	0.13	0.05
3	SB5NEPH-28	CCC	targeted	-0.459	-0.812	-1.258	0.35	0.15	0.06
3	SB5NEPH-28	CCC	measured	-0.467	-0.823	-1.259	0.34	0.15	0.06
3	SB5NEPH-28	CCC	measured bc	-0.480	-0.815	-1.265	0.33	0.15	0.05
3	SB5NEPH-28	quenched	targeted	-0.512	-0.577	-1.412	0.31	0.27	0.04

Table 3-4. Normalized PCT Results by Glass ID and Compositional View. (continued)

Set	Glass ID	Heat Treatment	Compositional View	log NL [B (g/L)]	log NL [Na (g/L)]	log NL [Si (g/L)]	NL [B (g/L)]	NL [Na (g/L)]	NL [Si (g/L)]
3	SB5NEPH-28	quenched	measured	-0.520	-0.588	-1.413	0.30	0.26	0.04
3	SB5NEPH-28	quenched	measured bc	-0.533	-0.580	-1.419	0.29	0.26	0.04
3	SB5NEPH-29	CCC	targeted	.	.	.			
3	SB5NEPH-29	CCC	measured	.	.	.			
3	SB5NEPH-29	CCC	measured bc	.	.	.			
3	SB5NEPH-29	quenched	targeted	2.009	1.855	1.205	102.07	71.62	16.04
3	SB5NEPH-29	quenched	measured	2.029	1.887	1.218	107.01	77.07	16.53
3	SB5NEPH-29	quenched	measured bc	2.009	1.894	1.207	102.12	78.27	16.09
3	SB5NEPH-30	CCC	targeted	0.600	1.158	0.484	3.99	14.38	3.05
3	SB5NEPH-30	CCC	measured	0.605	1.180	0.484	4.03	15.13	3.05
3	SB5NEPH-30	CCC	measured bc	0.585	1.187	0.473	3.84	15.37	2.97
3	SB5NEPH-30	quenched	targeted	1.995	1.859	0.930	98.78	72.31	8.50
3	SB5NEPH-30	quenched	measured	1.999	1.881	0.930	99.77	76.07	8.52
3	SB5NEPH-30	quenched	measured bc	1.979	1.888	0.919	95.21	77.26	8.29
4	SB5NEPH-31	CCC	targeted	1.659	1.736	0.793	45.56	54.45	6.21
4	SB5NEPH-31	CCC	measured	1.685	1.776	0.815	48.37	59.71	6.52
4	SB5NEPH-31	CCC	measured bc	1.674	1.781	0.814	47.16	60.33	6.52
4	SB5NEPH-31	quenched	targeted	1.854	1.865	0.752	71.50	73.32	5.65
4	SB5NEPH-31	quenched	measured	1.880	1.905	0.773	75.92	80.41	5.93
4	SB5NEPH-31	quenched	measured bc	1.869	1.910	0.773	74.02	81.25	5.93
4	SB5NEPH-32	CCC	targeted	0.459	0.765	0.004	2.88	5.82	1.01
4	SB5NEPH-32	CCC	measured	0.462	0.769	0.003	2.90	5.88	1.01
4	SB5NEPH-32	CCC	measured bc	0.455	0.783	0.003	2.85	6.06	1.01
4	SB5NEPH-32	quenched	targeted	1.263	1.286	-0.005	18.34	19.33	0.99
4	SB5NEPH-32	quenched	measured	1.266	1.291	-0.007	18.46	19.53	0.98
4	SB5NEPH-32	quenched	measured bc	1.260	1.304	-0.007	18.19	20.14	0.99
4	SB5NEPH-33	CCC	targeted	1.486	1.275	0.087	30.58	18.85	1.22
4	SB5NEPH-33	CCC	measured	1.491	1.275	0.085	30.95	18.86	1.21
4	SB5NEPH-33	CCC	measured bc	1.484	1.289	0.085	30.50	19.45	1.22
4	SB5NEPH-33	quenched	targeted	1.921	1.335	-0.365	83.35	21.63	0.43
4	SB5NEPH-33	quenched	measured	1.926	1.335	-0.368	84.35	21.64	0.43
4	SB5NEPH-33	quenched	measured bc	1.920	1.349	-0.368	83.12	22.32	0.43
4	SB5NEPH-34	CCC	targeted	0.821	0.574	-0.960	6.62	3.75	0.11
4	SB5NEPH-34	CCC	measured	0.815	0.582	-0.972	6.53	3.82	0.11
4	SB5NEPH-34	CCC	measured bc	0.804	0.586	-0.973	6.37	3.86	0.11
4	SB5NEPH-34	quenched	targeted	0.469	0.376	-0.623	2.94	2.38	0.24
4	SB5NEPH-34	quenched	measured	0.463	0.384	-0.635	2.91	2.42	0.23
4	SB5NEPH-34	quenched	measured bc	0.452	0.388	-0.636	2.83	2.44	0.23
4	SB5NEPH-35	CCC	targeted	0.819	1.012	-0.022	6.59	10.28	0.95
4	SB5NEPH-35	CCC	measured	0.824	1.008	-0.020	6.67	10.19	0.95
4	SB5NEPH-35	CCC	measured bc	0.818	1.021	-0.020	6.57	10.50	0.95
4	SB5NEPH-35	quenched	targeted	0.147	0.106	-0.875	1.40	1.28	0.13
4	SB5NEPH-35	quenched	measured	0.152	0.102	-0.872	1.42	1.27	0.13
4	SB5NEPH-35	quenched	measured bc	0.145	0.116	-0.872	1.40	1.31	0.13
4	SB5NEPH-36	CCC	targeted	1.526	1.451	-1.390	33.59	28.27	0.04
4	SB5NEPH-36	CCC	measured	1.531	1.444	-1.393	34.00	27.79	0.04
4	SB5NEPH-36	CCC	measured bc	1.525	1.457	-1.393	33.50	28.66	0.04
4	SB5NEPH-36	quenched	targeted	0.432	0.516	-1.054	2.70	3.28	0.09
4	SB5NEPH-36	quenched	measured	0.437	0.508	-1.056	2.74	3.22	0.09
4	SB5NEPH-36	quenched	measured bc	0.431	0.522	-1.056	2.70	3.33	0.09
4	SB5NEPH-37	CCC	targeted	0.011	-0.648	-0.912	1.03	0.23	0.12
4	SB5NEPH-37	CCC	measured	0.008	-0.667	-0.929	1.02	0.22	0.12
4	SB5NEPH-37	CCC	measured bc	-0.003	-0.663	-0.930	0.99	0.22	0.12
4	SB5NEPH-37	quenched	targeted	-0.358	-0.597	-0.947	0.44	0.25	0.11
4	SB5NEPH-37	quenched	measured	-0.361	-0.617	-0.965	0.44	0.24	0.11
4	SB5NEPH-37	quenched	measured bc	-0.372	-0.612	-0.965	0.42	0.24	0.11
4	SB5NEPH-38	CCC	targeted	0.196	0.106	-0.529	1.57	1.28	0.30
4	SB5NEPH-38	CCC	measured	0.179	0.084	-0.545	1.51	1.21	0.29

Table 3-4. Normalized PCT Results by Glass ID and Compositional View. (continued)

Set	Glass ID	Heat Treatment	Compositional View	log NL [B (g/L)]	log NL [Na (g/L)]	log NL [Si (g/L)]	NL [B (g/L)]	NL [Na (g/L)]	NL [Si (g/L)]
4	SB5NEPH-38	CCC	measured bc	0.168	0.088	-0.545	1.47	1.23	0.28
4	SB5NEPH-38	quenched	targeted	-0.479	-0.530	-0.963	0.33	0.29	0.11
4	SB5NEPH-38	quenched	measured	-0.495	-0.553	-0.979	0.32	0.28	0.10
4	SB5NEPH-38	quenched	measured bc	-0.506	-0.548	-0.980	0.31	0.28	0.10
4	SB5NEPH-39	CCC	targeted	1.394	0.296	-2.183	24.76	1.98	0.01
4	SB5NEPH-39	CCC	measured	1.397	0.279	-2.192	24.95	1.90	0.01
4	SB5NEPH-39	CCC	measured bc	1.386	0.284	-2.193	24.33	1.92	0.01
4	SB5NEPH-39	quenched	targeted	-0.399	-0.891	-1.293	0.40	0.13	0.05
4	SB5NEPH-39	quenched	measured	-0.396	-0.907	-1.302	0.40	0.12	0.05
4	SB5NEPH-39	quenched	measured bc	-0.407	-0.903	-1.302	0.39	0.13	0.05
4	SB5NEPH-40	CCC	targeted	-0.501	-0.748	-1.261	0.32	0.18	0.05
4	SB5NEPH-40	CCC	measured	-0.503	-0.773	-1.267	0.31	0.17	0.05
4	SB5NEPH-40	CCC	measured bc	-0.509	-0.760	-1.266	0.31	0.17	0.05
4	SB5NEPH-40	quenched	targeted	-0.386	-0.552	-1.508	0.41	0.28	0.03
4	SB5NEPH-40	quenched	measured	-0.388	-0.577	-1.514	0.41	0.27	0.03
4	SB5NEPH-40	quenched	measured bc	-0.395	-0.563	-1.514	0.40	0.27	0.03

3.3.5 *PCT Response as a Function of Composition*

The PCT results may be easier to interpret when represented graphically. Figure 3-1 presents the measured normalized releases for boron as a function of each quenched glass composition's location on the SiO_2-Na_2O-Al_2O_3 ternary diagram and the concentrations of B_2O_3 and CaO.

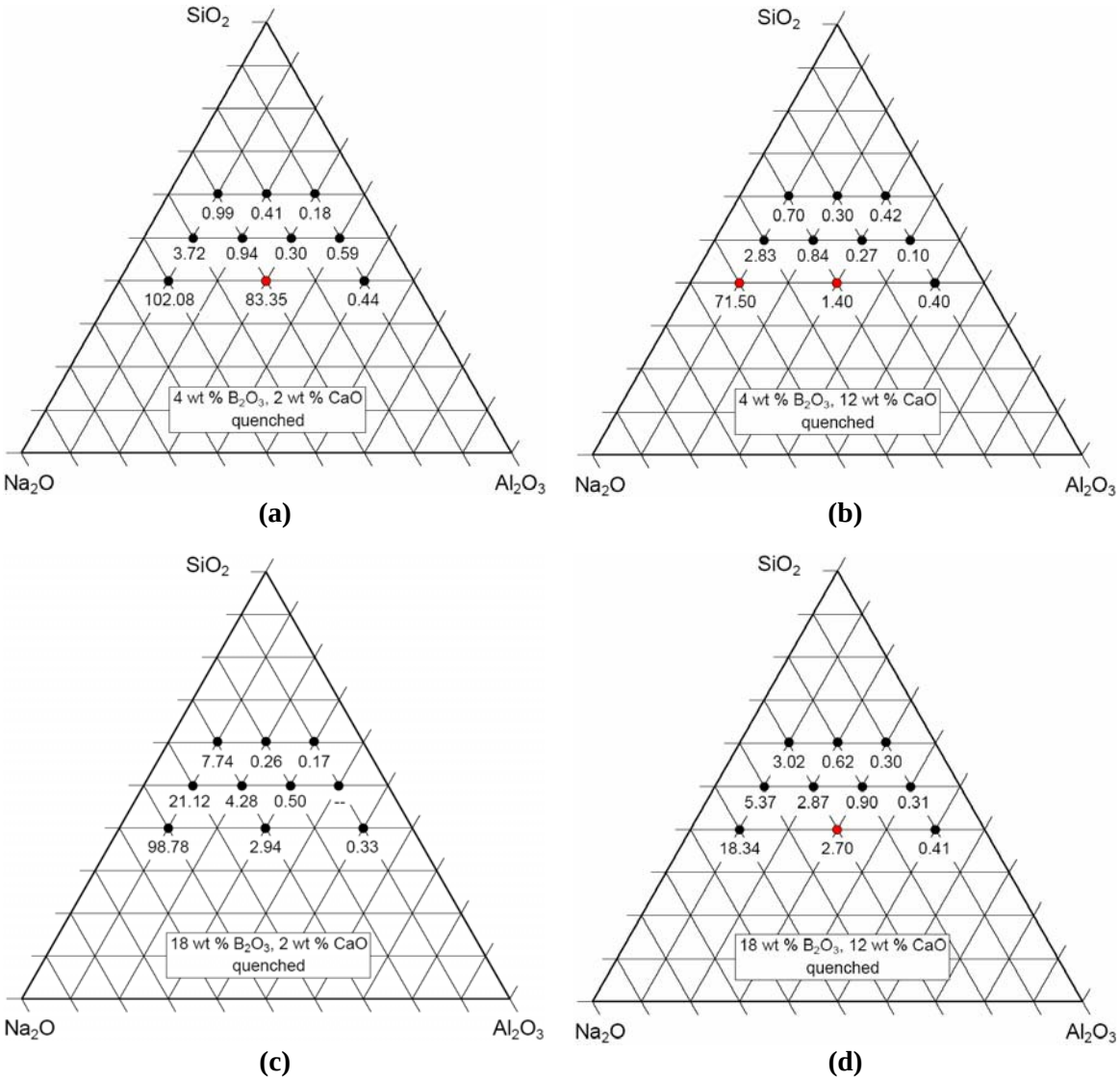

Figure 3-1. PCT responses (NL [B], in g/L) for the quenched versions of the study glasses as a function of location on the SiO_2-Na_2O-Al_2O_3 ternary diagram and with varying concentrations of B_2O_3 and CaO. Compositions where nepheline was detected by XRD are indicated in red.

A review of these figures shows that several of the quenched glass compositions with nepheline discriminator values below the current limit of 0.62 have NL [B] values that are well below that of the benchmark EA glass (16.695 g/L).[20] This indicates the potential to target glass compositions with higher concentrations of Al_2O_3 while continuing to produce durable glasses. In general, the durability of all the quenched glasses decreases as the composition moves toward the Na_2O corner of the ternary. All of the quenched glasses at Point 8 (refer to Figure 2-1), the closest to the Na_2O corner of the ternary, have NL [B] values that are greater than that of the EA benchmark glass.

Increasing the CaO concentration improved the durability of most of the quenched glasses, particularly those with low Al_2O_3 concentrations (the left side of the ternary) and those with the

highest Na_2O concentrations. The most significant difference was seen at Point 9 on the ternary diagram, where the NL [B] was reduced from 83.35 g/L (2 wt % CaO) to 1.40 g/L (12 wt % CaO).

Increasing the B_2O_3 concentration from 4 wt % to 18 wt % appears to have had a mixed effect on the NL [B] values for the quenched glasses (compare Figure 3-1 (a) and (b) to (c) and (d)). When the B_2O_3 concentration is increased but the CaO concentration is kept constant, the number of compositions where nepheline was detected by XRD was reduced. However, several of the compositions had higher NL [B] values when the B_2O_3 concentration was increased, although the higher values remained below that of the EA benchmark glass (with one exception). A few compositions, particularly the composition closest to the Na_2O corner of the ternary diagram, had reduced NL [B] values when the B_2O_3 concentration was increased. The NL [B] for the quenched glass at Point 8 with 18 wt % B_2O_3 and 12 wt % CaO was reduced to 18.34 g/L. While still greater than EA, this is considerably better than the NL [B] of 71.50 g/L at Point 8 for the 4 wt % B_2O_3, 12 wt % CaO case.

Compositions where nepheline (or crystalline phases that are expected to have a similar effect as nepheline, refer to Table 3-1) was detected by XRD are indicated in red in Figure 3-1. The detection of nepheline does not appear to correlate directly to the NL [B] response for these glasses. This may indicate that other compositional effects beyond crystallization – particularly very high alkali concentrations – influenced the durability of some of the study glasses.

Similar diagrams for the CCC versions of the glasses are shown in Figure 3-2.

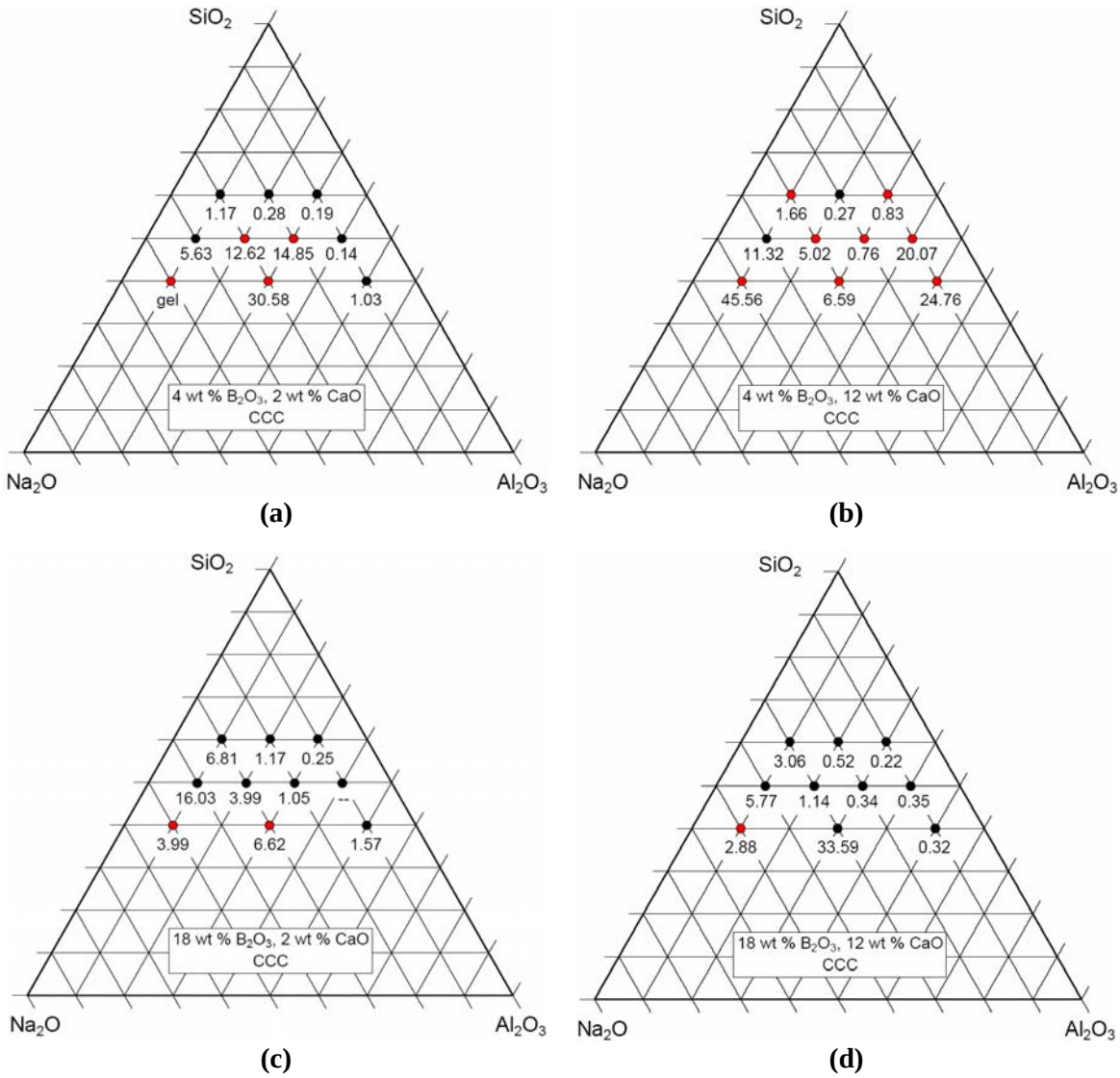

Figure 3-2. PCT responses (NL [B], in g/L) for the CCC versions of the study glasses as a function of location on the SiO_2-Na_2O-Al_2O_3 ternary diagram and with varying concentrations of B_2O_3 and CaO. Compositions where nepheline was detected by XRD are indicated in red.

Again, many of the study glasses with nepheline discriminator values below the current limit of 0.62 have NL [B] values that are well below that of the EA benchmark glass (16.695 g/L). The trend of increasing NL [B] as the glass composition moves toward the Na_2O corner of the ternary diagram continues for the CCC versions of the study glasses. The durability of the glass at Point 8 for the 4 wt % B_2O_3, 2 wt % CaO case (Figure 3-2 (a)) was so poor that the glass gelled during preparation for the PCT. When the B_2O_3 concentration was increased to 18 wt %, the glass compositions at this point had NL [B] values that were acceptable (Figure 3-2 (c) and (d)).

The effects of increasing CaO concentration from 2 to 12 wt % were mixed for the CCC glasses. The number of compositions where nepheline formed (as indicated by the red points in Figure 3-2) increased when the CaO concentration was increased and the B_2O_3 concentration was

held at 4 wt %. The changes in NL [B] response were mixed, depending on the location of the glass composition on the ternary diagram. The effects of increasing B_2O_3 concentration from 4 to 18 wt % were clearer. The increased B_2O_3 concentration significantly reduced the number of glass compositions where nepheline crystallized. The NL [B] responses for most of the glasses were reduced to values below that of the EA benchmark glass, although there were a few exceptions.

There is improved correlation between the formation of nepheline and an increase in NL [B] values for the CCC versions of the study glasses, although some compositions continue to show elevated NL [B] values where no nepheline was detected. This is again likely to effects of the extremes in composition, particularly high Na_2O concentrations, which are represented by some of the study glasses. Note that several of the CCC versions of the study glasses have NL [B] values that are lower than their quenched counterparts. This may be due to the type of crystalline phases that formed within the glasses. If crystalline phases that remove the alkali from the glass without removing the glass forming components form during the CCC thermal treatment, PCT response may improve. Quantitative XRD studies would aid in understanding this behavior.

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4.0 Conclusions

The results of this study confirm that some conservatism exists in the current nepheline discriminator. Several glass compositions, particularly compositions that target higher Al_2O_3 concentrations, were shown to be very durable (i.e., PCT responses that were more than an order of magnitude better than that of the EA benchmark glass) while their nepheline discriminator values were well below the current nepheline discriminator limit of 0.62. Increased concentrations of B_2O_3, and, to a degree, increased concentrations of CaO were shown to improve durability responses and suppress the formation of nepheline. Recently a smaller, yet similar study provided supporting results.[11] These provide incentive to continue the investigation into the possibility of a revision to the nepheline discriminator to reduce some of this conservatism and incorporate the influence of B_2O_3 at a minimum.

Figure 4-1 shows an example of the potential change to the nepheline discriminator. The revised nepheline discriminator could potentially change from a constant line on the SiO_2-Na_2O-Al_2O_3 ternary diagram (Figure 4-1 (a)) to a sloped line, where the slope varies with B_2O_3 concentration, thus allowing access to higher concentrations of Al_2O_3 in glass (Figure 4-1 (b)). Additional data will be required to support development and possible implementation of this revision. A Phase II study will be required to provide the necessary data, and recommendations for a Phase II study are included in the following section.

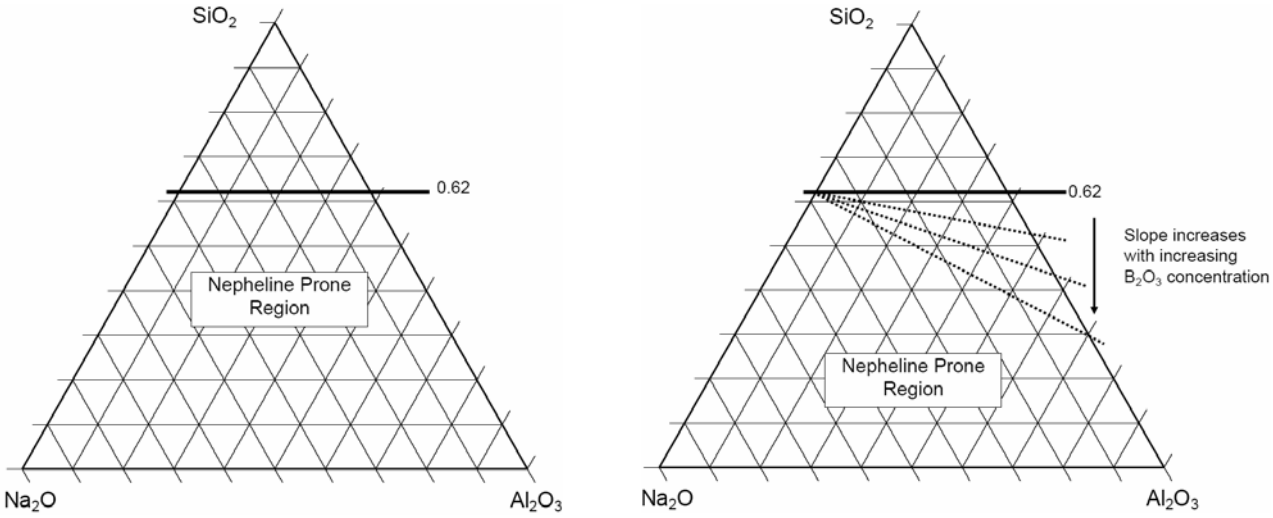

Figure 4-1. The current nepheline discriminator plotted on the SiO_2-Na_2O-Al_2O_3 ternary diagram (a), and a potential example of the refined nepheline discriminator (b), where the slope of the line identifying the nepheline prone region increases with increasing B_2O_3 concentration.

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5.0 Recommendations

A second phase of this study should be undertaken to provide the data necessary to support the possible revision to the nepheline discriminator as currently implemented in the DWPF process control system. The study described here (Phase I) evaluated a relatively wide range of glass compositions in order to provide the data necessary to identify conservatism in, and compositional impacts on, the current nepheline discriminator. These glass compositions were intentionally chosen to challenge the nepheline discriminator and therefore represent compositional regions that would be restricted from processing at the DWPF by the current control models. The second phase should focus on a smaller range of glass compositions that more closely resemble those likely to be processed in completing SRS waste disposition missions.

The impact of B_2O_3 and CaO concentrations should continue to be an important focus of the study. Consideration should be given to the practicality of adding a relatively large amount of B_2O_3 to a frit for DWPF processing. The glass compositions did not contain Li_2O during this phase in order to focus only on the effects of Na_2O. The second phase should include Li_2O as a variable since the frits utilized at DWPF typically contain this component. Finally, the glasses in this study were melted over a range of temperatures, some of which were well above the operating temperature of the DWPF melter. This decision was made again to allow access to a wide range of glass compositions. The second phase study should more closely consider the effects of both melting temperature and the CCC thermal treatment on nepheline crystallization.

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Appendix A

Tables and Exhibits Supporting the Analysis of the Chemical Composition Measurements of the SB5-Nepheline Study Glasses

Table A1. Targeted Oxide Concentrations (wt %) for the Nepheline Study Glasses.

Glass ID	Al_2O_3	B_2O_3	BaO	CaO	Ce_2O_3	Cr_2O_3	CuO	Fe_2O_3	K_2O	La_2O_3	MgO	MnO	Na_2O	NiO	PbO	SO_4	SiO_2	TiO_2	ZnO	ZrO_2	Sum
SB5NEPH-01	7.800	4.000	0.049	2.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	23.400	1.022	0.043	0.513	46.800	0.227	0.033	0.101	100.000
SB5NEPH-02	6.400	18.000	0.049	2.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	19.200	1.022	0.043	0.513	38.400	0.227	0.033	0.101	100.000
SB5NEPH-03	6.800	4.000	0.049	12.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	20.400	1.022	0.043	0.513	40.800	0.227	0.033	0.101	100.000
SB5NEPH-04	5.400	18.000	0.049	12.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	16.200	1.022	0.043	0.513	32.400	0.227	0.033	0.101	100.000
SB5NEPH-05	15.600	4.000	0.049	2.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	15.600	1.022	0.043	0.513	46.800	0.227	0.033	0.101	100.000
SB5NEPH-06	12.800	18.000	0.049	2.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	12.800	1.022	0.043	0.513	38.400	0.227	0.033	0.101	100.000
SB5NEPH-07	13.600	4.000	0.049	12.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	13.600	1.022	0.043	0.513	40.800	0.227	0.033	0.101	100.000
SB5NEPH-08	10.800	18.000	0.049	12.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	10.800	1.022	0.043	0.513	32.400	0.227	0.033	0.101	100.000
SB5NEPH-09	23.400	4.000	0.049	2.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	7.800	1.022	0.043	0.513	46.800	0.227	0.033	0.101	100.000
SB5NEPH-10	19.200	18.000	0.049	2.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	6.400	1.022	0.043	0.513	38.400	0.227	0.033	0.101	100.000
SB5NEPH-11	20.400	4.000	0.049	12.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	6.800	1.022	0.043	0.513	40.800	0.227	0.033	0.101	100.000
SB5NEPH-12	16.200	18.000	0.049	12.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	5.400	1.022	0.043	0.513	32.400	0.227	0.033	0.101	100.000
SB5NEPH-13	7.800	4.000	0.049	2.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	31.200	1.022	0.043	0.513	39.000	0.227	0.033	0.101	100.000
SB5NEPH-14	6.400	18.000	0.049	2.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	25.600	1.022	0.043	0.513	32.000	0.227	0.033	0.101	100.000
SB5NEPH-15	6.800	4.000	0.049	12.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	27.200	1.022	0.043	0.513	34.000	0.227	0.033	0.101	100.000
SB5NEPH-16	5.400	18.000	0.049	12.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	21.600	1.022	0.043	0.513	27.000	0.227	0.033	0.101	100.000
SB5NEPH-17	15.600	4.000	0.049	2.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	23.400	1.022	0.043	0.513	39.000	0.227	0.033	0.101	100.000
SB5NEPH-18	12.800	18.000	0.049	2.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	19.200	1.022	0.043	0.513	32.000	0.227	0.033	0.101	100.000
SB5NEPH-19	13.600	4.000	0.049	12.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	20.400	1.022	0.043	0.513	34.000	0.227	0.033	0.101	100.000
SB5NEPH-20	10.800	18.000	0.049	12.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	16.200	1.022	0.043	0.513	27.000	0.227	0.033	0.101	100.000
SB5NEPH-21	23.400	4.000	0.049	2.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	15.600	1.022	0.043	0.513	39.000	0.227	0.033	0.101	100.000
SB5NEPH-22	19.200	18.000	0.049	2.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	12.800	1.022	0.043	0.513	32.000	0.227	0.033	0.101	100.000
SB5NEPH-23	20.400	4.000	0.049	12.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	13.600	1.022	0.043	0.513	34.000	0.227	0.033	0.101	100.000
SB5NEPH-24	16.200	18.000	0.049	12.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	10.800	1.022	0.043	0.513	27.000	0.227	0.033	0.101	100.000
SB5NEPH-25	31.200	4.000	0.049	2.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	7.800	1.022	0.043	0.513	39.000	0.227	0.033	0.101	100.000
SB5NEPH-26	25.600	18.000	0.049	2.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	6.400	1.022	0.043	0.513	32.000	0.227	0.033	0.101	100.000
SB5NEPH-27	27.200	4.000	0.049	12.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	6.800	1.022	0.043	0.513	34.000	0.227	0.033	0.101	100.000
SB5NEPH-28	21.600	18.000	0.049	12.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	5.400	1.022	0.043	0.513	27.000	0.227	0.033	0.101	100.000
SB5NEPH-29	7.800	4.000	0.049	2.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	39.000	1.022	0.043	0.513	31.200	0.227	0.033	0.101	100.000
SB5NEPH-30	6.400	18.000	0.049	2.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	32.000	1.022	0.043	0.513	25.600	0.227	0.033	0.101	100.000
SB5NEPH-31	6.800	4.000	0.049	12.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	34.000	1.022	0.043	0.513	27.200	0.227	0.033	0.101	100.000
SB5NEPH-32	5.400	18.000	0.049	12.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	27.000	1.022	0.043	0.513	21.600	0.227	0.033	0.101	100.000
SB5NEPH-33	23.400	4.000	0.049	2.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	23.400	1.022	0.043	0.513	31.200	0.227	0.033	0.101	100.000
SB5NEPH-34	19.200	18.000	0.049	2.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	19.200	1.022	0.043	0.513	25.600	0.227	0.033	0.101	100.000
SB5NEPH-35	20.400	4.000	0.049	12.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	20.400	1.022	0.043	0.513	27.200	0.227	0.033	0.101	100.000
SB5NEPH-36	16.200	18.000	0.049	12.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	16.200	1.022	0.043	0.513	21.600	0.227	0.033	0.101	100.000
SB5NEPH-37	39.000	4.000	0.049	2.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	7.800	1.022	0.043	0.513	31.200	0.227	0.033	0.101	100.000
SB5NEPH-38	32.000	18.000	0.049	2.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	6.400	1.022	0.043	0.513	25.600	0.227	0.033	0.101	100.000
SB5NEPH-39	34.000	4.000	0.049	12.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	6.800	1.022	0.043	0.513	27.200	0.227	0.033	0.101	100.000
SB5NEPH-40	27.000	18.000	0.049	12.000	0.103	0.090	0.033	10.772	0.069	0.015	0.626	2.306	5.400	1.022	0.043	0.513	21.600	0.227	0.033	0.101	100.000

Table A2. Measured Elemental Concentrations (wt %) for Samples Prepared Using Lithium Metaborate. (continued)

Set	Glass ID	Block	Sub Block	Seq.	ID Check	Al (wt%)	Ba (wt%)	Ca (wt%)	Ce (wt%)	Cr (wt%)	Cu (wt%)	K (wt%)	La (wt%)	Mg (wt%)	Mn (wt%)	Na (wt%)	Ni (wt%)	Pb (wt%)	S (wt%)	Ti (wt%)	Zn (wt%)	Zr (wt%)
1	Batch 1	1	1	1	BCHLM1111	2.49	0.126	0.818	<0.010	0.074	0.312	2.57	<0.100	0.836	1.32	6.61	0.558	<0.010	<0.100	0.388	<0.010	0.063
1	SB5NEPH-02	1	1	2	R06LM11	3.38	0.04	1.42	0.08	0.062	0.026	0.051	<0.100	0.381	1.81	13.9	0.759	0.035	0.166	0.134	0.023	0.064
1	SB5NEPH-01	1	1	3	R01LM21	4.17	0.039	1.42	0.078	0.062	0.032	0.049	<0.100	0.384	1.82	17.1	0.757	0.035	0.169	0.138	0.022	0.068
1	SB5NEPH-06	1	1	4	R03LM11	6.82	0.039	1.42	0.081	0.058	0.027	0.06	<0.100	0.381	1.81	9.55	0.731	0.033	0.121	0.135	0.024	0.063
1	SB5NEPH-02	1	1	5	R06LM21	3.41	0.039	1.44	0.08	0.063	0.028	0.049	<0.100	0.38	1.81	14.2	0.753	0.032	0.163	0.133	0.023	0.067
1	SB5NEPH-04	1	1	6	R07LM11	2.88	0.037	8.67	0.078	0.061	0.028	0.052	<0.100	0.378	1.79	12	0.768	0.033	0.147	0.135	0.022	0.053
1	Batch 1	1	1	7	BCHLM1112	2.49	0.124	0.823	<0.010	0.074	0.313	2.59	<0.100	0.82	1.33	6.68	0.551	<0.010	<0.100	0.389	<0.010	0.062
1	SB5NEPH-01	1	1	8	R01LM11	4.19	0.039	1.44	0.077	0.075	0.027	0.057	<0.100	0.378	1.8	17.2	0.743	0.037	0.172	0.137	0.024	0.064
1	SB5NEPH-03	1	1	9	R10LM11	3.67	0.038	8.7	0.078	0.061	0.024	0.05	<0.100	0.376	1.8	15.3	0.742	0.029	0.174	0.134	0.023	0.068
1	SB5NEPH-06	1	1	10	R03LM21	6.88	0.039	1.42	0.081	0.06	0.026	0.05	<0.100	0.378	1.81	9.77	0.729	0.034	0.109	0.135	0.023	0.067
1	SB5NEPH-03	1	1	11	R10LM21	3.61	0.038	8.58	0.078	0.061	0.029	0.05	<0.100	0.373	1.77	15	0.744	0.029	0.172	0.133	0.023	0.068
1	SB5NEPH-04	1	1	12	R07LM21	2.9	0.036	8.72	0.076	0.059	0.029	0.05	<0.100	0.365	1.8	12	0.737	0.031	0.145	0.131	0.022	0.065
1	Batch 1	1	1	13	BCHLM1113	2.55	0.125	0.842	<0.010	0.074	0.321	2.67	<0.100	0.829	1.32	6.82	0.555	<0.010	<0.100	0.391	<0.010	0.062
1	Batch 1	2	1	1	BCHLM1211	2.48	0.125	0.811	<0.010	0.075	0.312	2.49	<0.100	0.824	1.33	6.76	0.553	<0.010	<0.100	0.391	<0.010	0.064
1	SB5NEPH-09	2	1	2	R04LM11	12.8	0.042	1.44	0.084	0.061	0.026	0.054	<0.100	0.395	1.87	6.06	0.749	0.032	<0.100	0.137	0.025	0.071
1	SB5NEPH-08	2	1	3	R08LM21	5.65	0.04	8.52	0.083	0.059	0.031	0.054	<0.100	0.381	1.81	8.09	0.735	0.03	0.16	0.135	0.024	0.069
1	SB5NEPH-05	2	1	4	R02LM21	8.59	0.041	1.43	0.084	0.055	0.027	0.06	<0.100	0.393	1.82	11.8	0.747	0.035	0.129	0.143	0.026	0.069
1	SB5NEPH-08	2	1	5	R08LM11	5.77	0.042	8.7	0.088	0.062	0.031	0.061	<0.100	0.4	1.83	8.29	0.773	0.034	0.17	0.142	0.027	0.073
1	SB5NEPH-09	2	1	6	R04LM21	12.9	0.042	1.44	0.085	0.062	0.026	0.056	<0.100	0.397	1.86	6.12	0.742	0.032	<0.100	0.138	0.025	0.071
1	Batch 1	2	1	7	BCHLM1211	2.52	0.126	0.815	<0.010	0.075	0.313	2.52	<0.100	0.821	1.33	6.9	0.552	<0.010	<0.100	0.389	<0.010	0.064
1	SB5NEPH-07	2	1	8	R09LM11	7.18	0.042	8.48	0.085	0.067	0.027	0.056	<0.100	0.389	1.79	10.2	0.755	0.036	0.132	0.138	0.022	0.074
1	SB5NEPH-10	2	1	9	R05LM21	10.5	0.041	1.45	0.084	0.042	0.027	0.054	<0.100	0.398	1.86	5.08	0.755	0.033	<0.100	0.143	0.024	0.073
1	SB5NEPH-10	2	1	10	R05LM11	10.4	0.04	1.43	0.082	0.042	0.024	0.053	<0.100	0.391	1.86	5.06	0.756	0.032	<0.100	0.14	0.024	0.071
1	SB5NEPH-05	2	1	11	R02LM11	8.37	0.04	1.42	0.082	0.055	0.027	0.055	<0.100	0.383	1.81	11.8	0.74	0.033	0.12	0.139	0.026	0.069
1	SB5NEPH-07	2	1	12	R09LM21	7.28	0.04	8.62	0.081	0.063	0.027	0.058	<0.100	0.368	1.79	10.3	0.71	0.034	0.135	0.132	0.024	0.07
1	Batch 1	2	1	13	BCHLM1213	2.52	0.125	0.811	<0.010	0.074	0.313	2.52	<0.100	0.818	1.33	6.89	0.547	<0.010	<0.100	0.389	<0.010	0.064
1	Batch 1	1	2	1	BCHLM1121	2.5	0.126	0.815	<0.010	0.075	0.312	2.55	<0.100	0.822	1.33	6.88	0.555	<0.010	<0.100	0.388	<0.010	0.063
1	SB5NEPH-02	1	2	2	R06LM12	3.38	0.041	1.41	0.082	0.063	0.026	0.048	<0.100	0.381	1.79	14	0.754	0.035	0.161	0.134	0.022	0.066
1	SB5NEPH-03	1	2	3	R10LM12	3.65	0.04	8.72	0.08	0.062	0.025	0.047	<0.100	0.377	1.8	15.1	0.743	0.03	0.17	0.135	0.022	0.07
1	SB5NEPH-01	1	2	4	R01LM12	4.43	0.04	1.51	0.078	0.075	0.028	0.053	<0.100	0.378	1.9	18.3	0.74	0.036	0.168	0.136	0.023	0.065
1	SB5NEPH-04	1	2	5	R07LM22	2.91	0.038	8.73	0.078	0.059	0.03	0.048	<0.100	0.367	1.81	12.1	0.74	0.032	0.143	0.133	0.022	0.066
1	SB5NEPH-06	1	2	6	R03LM22	7.01	0.041	1.43	0.083	0.061	0.027	0.048	<0.100	0.38	1.83	9.92	0.731	0.035	0.113	0.136	0.023	0.069
1	Batch 1	1	2	7	BCHLM1122	2.54	0.126	0.826	<0.010	0.074	0.314	2.57	<0.100	0.822	1.33	6.95	0.553	<0.010	<0.100	0.389	<0.010	0.064
1	SB5NEPH-01	1	2	8	R01LM22	4.08	0.039	1.39	0.077	0.061	0.031	0.044	<0.100	0.367	1.75	16.9	0.723	0.034	0.158	0.134	0.021	0.067
1	SB5NEPH-06	1	2	9	R03LM12	6.95	0.04	1.44	0.082	0.059	0.028	0.056	<0.100	0.378	1.81	9.78	0.725	0.034	0.117	0.135	0.023	0.064
1	SB5NEPH-04	1	2	10	R07LM12	2.95	0.039	8.95	0.08	0.062	0.029	0.05	<0.100	0.378	1.81	12.3	0.763	0.033	0.142	0.136	0.021	0.054
1	SB5NEPH-02	1	2	11	R06LM22	3.44	0.041	1.44	0.083	0.064	0.029	0.048	<0.100	0.38	1.81	14.4	0.753	0.032	0.162	0.134	0.022	0.069
1	SB5NEPH-03	1	2	12	R10LM22	3.67	0.04	8.75	0.08	0.062	0.03	0.049	<0.100	0.374	1.8	15.3	0.743	0.029	0.167	0.134	0.022	0.07
1	Batch 1	1	2	13	BCHLM1123	2.54	0.125	0.816	<0.010	0.074	0.312	2.58	<0.100	0.819	1.33	6.95	0.549	<0.010	<0.100	0.391	<0.010	0.063
1	Batch 1	2	2	1	BCHLM1221	2.51	0.126	0.81	<0.010	0.075	0.313	2.55	<0.100	0.828	1.34	6.78	0.555	<0.010	<0.100	0.387	<0.010	0.064
1	SB5NEPH-05	2	2	2	R02LM22	8.41	0.039	1.41	0.081	0.053	0.026	0.056	<0.100	0.383	1.81	11.6	0.726	0.034	0.126	0.137	0.025	0.067
1	SB5NEPH-08	2	2	3	R08LM22	5.69	0.039	8.53	0.082	0.058	0.031	0.051	<0.100	0.378	1.82	8.06	0.729	0.031	0.16	0.133	0.023	0.069
1	SB5NEPH-09	2	2	4	R04LM12	12.8	0.041	1.45	0.085	0.061	0.026	0.053	<0.100	0.399	1.87	6.06	0.753	0.032	<0.100	0.139	0.025	0.073
1	SB5NEPH-07	2	2	5	R09LM22	7.27	0.04	8.6	0.081	0.064	0.027	0.056	<0.100	0.372	1.8	10.3	0.716	0.036	0.129	0.131	0.024	0.071
1	SB5NEPH-10	2	2	6	R05LM22	10.4	0.04	1.43	0.083	0.041	0.027	0.051	<0.100	0.394	1.86	5	0.747	0.033	<0.100	0.141	0.024	0.073
1	Batch 1	2	2	7	BCHLM1222	2.52	0.126	0.814	<0.010	0.075	0.314	2.55	<0.100	0.832	1.33	6.84	0.555	<0.010	<0.100	0.391	<0.010	0.065

Table A2. Measured Elemental Concentrations (wt %) for Samples Prepared Using Lithium Metaborate. (continued)

Set	Glass ID	Block	Sub Block	Seq.	ID Check	Al (wt%)	Ba (wt%)	Ca (wt%)	Ce (wt%)	Cr (wt%)	Cu (wt%)	K (wt%)	La (wt%)	Mg (wt%)	Mn (wt%)	Na (wt%)	Ni (wt%)	Pb (wt%)	S (wt%)	Ti (wt%)	Zn (wt%)	Zr (wt%)
1	SB5NEPH-05	2	2	8	R02LM12	8.26	0.04	1.4	0.083	0.055	0.028	0.054	<0.100	0.39	1.81	11.7	0.75	0.034	0.123	0.141	0.026	0.07
1	SB5NEPH-09	2	2	9	R04LM22	12.7	0.04	1.43	0.084	0.06	0.026	0.055	<0.100	0.392	1.86	6.05	0.732	0.031	<0.100	0.136	0.025	0.071
1	SB5NEPH-07	2	2	10	R09LM12	7.27	0.04	8.6	0.082	0.065	0.026	0.052	<0.100	0.379	1.8	10.3	0.735	0.035	0.134	0.134	0.021	0.073
1	SB5NEPH-10	2	2	11	R05LM12	10.3	0.04	1.43	0.083	0.042	0.024	0.052	<0.100	0.397	1.86	5.01	0.765	0.032	<0.100	0.144	0.024	0.072
1	SB5NEPH-08	2	2	12	R08LM12	5.84	0.039	8.81	0.083	0.059	0.03	0.056	<0.100	0.382	1.84	8.38	0.737	0.034	0.16	0.134	0.025	0.07
1	Batch 1	2	2	13	BCHLM1223	2.56	0.126	0.819	<0.010	0.075	0.316	2.56	<0.100	0.824	1.34	6.98	0.553	<0.010	<0.100	0.389	<0.010	0.065
2	Batch 1	1	1	1	BCHLM2111	2.48	0.124	0.821	<0.010	0.074	0.309	2.52	<0.100	0.82	1.33	6.64	0.55	<0.010	<0.100	0.387	<0.010	0.064
2	SB5NEPH-17	1	1	2	S05lLM21	8.24	0.041	1.41	0.081	0.065	0.031	0.058	<0.100	0.383	1.83	17	0.744	0.034	0.159	0.134	0.028	0.07
2	SB5NEPH-20	1	1	3	S06LM11	5.74	0.04	8.59	0.08	0.062	0.031	0.05	<0.100	0.38	1.82	12.1	0.75	0.033	0.101	0.133	0.024	0.067
2	SB5NEPH-12	1	1	4	S04LM11	8.58	0.039	8.59	0.082	0.052	0.037	0.053	<0.100	0.378	1.81	4.08	0.741	0.033	0.095	0.139	0.027	0.072
2	SB5NEPH-13	1	1	5	S07LM11	4.04	0.039	1.43	0.08	0.062	0.039	0.053	<0.100	0.384	1.81	22.3	0.751	0.032	0.168	0.135	0.022	0.072
2	SB5NEPH-13	1	1	6	S07LM21	4.06	0.04	1.44	0.081	0.062	0.039	0.055	<0.100	0.385	1.81	22.3	0.755	0.031	0.168	0.136	0.022	0.07
2	Batch 1	1	1	7	BCHLM2112	2.52	0.126	0.837	<0.010	0.075	0.313	2.51	<0.100	0.825	1.34	6.8	0.553	<0.010	<0.100	0.391	<0.010	0.066
2	SB5NEPH-12	1	1	8	S04LM21	8.59	0.039	8.56	0.082	0.051	0.036	0.052	<0.100	0.375	1.81	4.14	0.733	0.032	0.095	0.138	0.028	0.07
2	SB5NEPH-11	1	1	9	S02LM11	11.1	0.04	8.67	0.081	0.049	0.028	0.056	<0.100	0.374	1.83	5.37	0.707	0.033	0.132	0.003	0.023	0.085
2	SB5NEPH-17	1	1	10	S05LM11	8.27	0.041	1.41	0.081	0.065	0.032	0.055	<0.100	0.385	1.83	17.1	0.75	0.033	0.16	0.133	0.027	0.072
2	SB5NEPH-20	1	1	11	S06LM21	5.79	0.039	8.69	0.08	0.061	0.034	0.051	<0.100	0.378	1.84	12.1	0.745	0.031	0.099	0.133	0.024	0.067
2	SB5NEPH-11	1	1	12	S02LM21	10.8	0.04	8.57	0.08	0.047	0.028	0.056	<0.100	0.368	1.79	5.22	0.704	0.032	0.13	0.002	0.022	0.069
2	Batch 1	1	1	13	BCHLM2113	2.52	0.124	0.843	<0.010	0.074	0.308	2.5	<0.100	0.819	1.34	6.79	0.55	<0.010	<0.100	0.389	<0.010	0.065
2	Batch 1	2	1	1	BCHLM2211	2.49	0.127	0.839	<0.010	0.076	0.312	2.53	<0.100	0.823	1.33	6.56	0.554	<0.010	<0.100	0.392	<0.010	0.065
2	SB5NEPH-19	2	1	2	S03LM11	7.12	0.041	8.44	0.082	0.063	0.037	0.058	<0.100	0.39	1.8	14.6	0.754	0.034	0.172	0.14	0.026	0.072
2	SB5NEPH-19	2	1	3	S03LM21	7.1	0.041	8.43	0.081	0.063	0.038	0.056	<0.100	0.387	1.79	14.6	0.759	0.033	0.174	0.138	0.025	0.072
2	SB5NEPH-14	2	1	4	S09LM21	3.32	0.037	1.44	0.08	0.065	0.03	0.056	<0.100	0.392	1.81	18.2	0.768	0.037	0.176	0.137	0.025	0.071
2	SB5NEPH-15	2	1	5	S08LM11	3.47	0.04	8.27	0.08	0.06	0.031	0.054	<0.100	0.38	1.76	19	0.752	0.032	0.18	0.135	0.026	0.071
2	SB5NEPH-18	2	1	6	S01LM11	6.69	0.044	1.42	0.082	0.065	0.029	0.054	<0.100	0.395	1.8	13.9	0.784	0.035	0.129	0.141	0.026	0.076
2	Batch 1	2	1	7	BCHLM2212	2.49	0.13	0.838	<0.010	0.078	0.315	2.54	<0.100	0.843	1.33	6.72	0.573	<0.010	<0.100	0.395	<0.010	0.066
2	SB5NEPH-16	2	1	8	S10LM21	2.71	0.041	8.04	0.08	0.062	0.041	0.055	<0.100	0.387	1.7	14.8	0.774	0.035	0.183	0.136	0.031	0.07
2	SB5NEPH-14	2	1	9	S09LM11	3.39	0.037	1.48	0.081	0.066	0.032	0.055	<0.100	0.396	1.82	18.5	0.78	0.038	0.181	0.138	0.025	0.073
2	SB5NEPH-15	2	1	10	S08LM21	3.52	0.04	8.39	0.08	0.061	0.034	0.056	<0.100	0.383	1.78	19.2	0.762	0.033	0.177	0.137	0.027	0.072
2	SB5NEPH-16	2	1	11	S10LM11	2.62	0.041	7.78	0.079	0.062	0.039	0.054	<0.100	0.387	1.66	14.3	0.77	0.034	0.181	0.135	0.031	0.07
2	SB5NEPH-18	2	1	12	S01LM21	6.75	0.044	1.44	0.082	0.066	0.028	0.053	<0.100	0.394	1.8	14.1	0.785	0.035	0.126	0.139	0.026	0.073
2	Batch 1	2	1	13	BCHLM2213	2.51	0.13	0.852	<0.010	0.077	0.315	2.55	<0.100	0.843	1.33	6.77	0.572	<0.010	<0.100	0.396	<0.010	0.067
2	Batch 1	1	2	1	BCHLM2121	2.51	0.126	0.834	<0.010	0.075	0.311	2.53	<0.100	0.825	1.33	6.69	0.555	<0.010	<0.100	0.392	<0.010	0.064
2	SB5NEPH-13	1	2	2	S07LM12	4.07	0.04	1.45	0.081	0.063	0.039	0.053	<0.100	0.383	1.81	22.4	0.753	0.032	0.172	0.134	0.022	0.07
2	SB5NEPH-11	1	2	3	S02LM22	10.8	0.04	8.48	0.08	0.048	0.028	0.054	<0.100	0.368	1.79	5.15	0.705	0.033	0.128	0.002	0.023	0.067
2	SB5NEPH-13	1	2	4	S07LM22	4.18	0.041	1.48	0.082	0.064	0.04	0.054	<0.100	0.393	1.86	22.9	0.771	0.034	0.17	0.137	0.023	0.071
2	SB5NEPH-20	1	2	5	S06LM12	5.79	0.04	8.66	0.08	0.062	0.031	0.05	<0.100	0.379	1.84	12.1	0.748	0.033	0.097	0.133	0.025	0.067
2	SB5NEPH-12	1	2	6	S04LM22	8.62	0.039	8.64	0.082	0.051	0.036	0.051	<0.100	0.376	1.82	4.17	0.734	0.032	0.095	0.138	0.029	0.071
2	Batch 1	1	2	7	BCHLM2122	2.54	0.127	0.848	<0.010	0.076	0.312	2.52	<0.100	0.82	1.35	6.85	0.554	<0.010	<0.100	0.391	<0.010	0.065
2	SB5NEPH-17	1	2	8	S05LM22	8.39	0.041	1.44	0.081	0.065	0.031	0.056	<0.100	0.381	1.83	17.3	0.74	0.033	0.156	0.134	0.028	0.069
2	SB5NEPH-11	1	2	9	S02LM12	11	0.041	8.69	0.081	0.05	0.028	0.055	<0.100	0.374	1.82	5.38	0.709	0.034	0.136	0.002	0.023	0.084
2	SB5NEPH-17	1	2	10	S05LM12	8.35	0.041	1.43	0.082	0.066	0.032	0.054	<0.100	0.387	1.83	17.3	0.756	0.034	0.161	0.136	0.028	0.072
2	SB5NEPH-12	1	2	11	S04LM12	8.63	0.04	8.68	0.083	0.052	0.037	0.052	<0.100	0.38	1.82	4.12	0.745	0.033	0.101	0.139	0.028	0.07
2	SB5NEPH-20	1	2	12	S06LM22	5.73	0.04	8.6	0.08	0.062	0.034	0.05	<0.100	0.379	1.82	12.1	0.746	0.032	0.099	0.132	0.025	0.067
2	Batch 1	1	2	13	BCHLM2123	2.54	0.126	0.851	<0.010	0.075	0.312	2.54	<0.100	0.825	1.34	6.84	0.554	<0.010	<0.100	0.391	<0.010	0.066
2	Batch 1	2	2	1	BCHLM2221	2.51	0.127	0.84	<0.010	0.076	0.313	2.54	<0.100	0.825	1.34	6.65	0.553	<0.010	<0.100	0.39	<0.010	0.064

Table A2. Measured Elemental Concentrations (wt %) for Samples Prepared Using Lithium Metaborate. (continued)

Set	Glass ID	Block	Sub Block	Seq.	ID Check	Al (wt%)	Ba (wt%)	Ca (wt%)	Ce (wt%)	Cr (wt%)	Cu (wt%)	K (wt%)	La (wt%)	Mg (wt%)	Mn (wt%)	Na (wt%)	Ni (wt%)	Pb (wt%)	S (wt%)	Ti (wt%)	Zn (wt%)	Zr (wt%)
2	SB5NEPH-15	2	2	2	S08LM12	3.53	0.039	8.48	0.08	0.058	0.032	0.054	<0.100	0.371	1.77	19.2	0.729	0.03	0.166	0.133	0.026	0.069
2	SB5NEPH-19	2	2	3	S03LM12	7.15	0.04	8.54	0.082	0.061	0.037	0.056	<0.100	0.379	1.79	14.8	0.73	0.031	0.159	0.136	0.025	0.071
2	SB5NEPH-16	2	2	4	S10LM22	2.73	0.04	8.12	0.079	0.06	0.041	0.054	<0.100	0.378	1.71	14.8	0.747	0.033	0.174	0.135	0.03	0.069
2	SB5NEPH-15	2	2	5	S08LM22	3.55	0.039	8.49	0.081	0.059	0.034	0.054	<0.100	0.373	1.78	19.3	0.736	0.032	0.169	0.135	0.026	0.071
2	SB5NEPH-18	2	2	6	S01LM22	6.77	0.042	1.44	0.082	0.064	0.028	0.051	<0.100	0.384	1.81	14	0.759	0.032	0.119	0.136	0.025	0.072
2	Batch 1	2	2	7	BCHLM2222	2.51	0.127	0.845	<0.010	0.076	0.31	2.5	<0.100	0.825	1.34	6.68	0.553	<0.010	<0.100	0.39	<0.010	0.065
2	SB5NEPH-19	2	2	8	S03LM22	7.21	0.04	8.56	0.081	0.061	0.038	0.055	<0.100	0.377	1.8	14.8	0.737	0.031	0.164	0.135	0.025	0.07
2	SB5NEPH-14	2	2	9	S09LM12	3.43	0.036	1.49	0.081	0.063	0.032	0.053	<0.100	0.385	1.83	18.7	0.752	0.036	0.166	0.136	0.024	0.071
2	SB5NEPH-16	2	2	10	S10LM12	2.7	0.04	8.04	0.08	0.06	0.04	0.052	<0.100	0.375	1.69	14.7	0.742	0.033	0.168	0.133	0.03	0.069
2	SB5NEPH-14	2	2	11	S09LM22	3.38	0.036	1.47	0.08	0.063	0.03	0.055	<0.100	0.381	1.82	18.5	0.74	0.036	0.169	0.134	0.025	0.07
2	SB5NEPH-18	2	2	12	S01LM12	6.79	0.042	1.43	0.082	0.063	0.029	0.052	<0.100	0.382	1.82	14.1	0.749	0.033	0.118	0.135	0.025	0.075
2	Batch 1	2	2	13	BCHLM2223	2.54	0.126	0.854	<0.010	0.075	0.312	2.54	<0.100	0.825	1.34	6.78	0.55	<0.010	<0.100	0.39	<0.010	0.064
3	Batch 1	1	1	1	BCHLM3111	2.52	0.127	0.838	<0.010	0.075	0.313	2.53	<0.100	0.823	1.34	6.74	0.553	<0.010	<0.100	0.39	<0.010	0.065
3	SB5NEPH-28	1	1	2	T07LM11	11.5	0.039	8.6	0.082	0.046	0.031	0.051	<0.100	0.38	1.81	4.12	0.702	0.036	<0.100	0.134	0.025	0.068
3	SB5NEPH-24	1	1	3	T10LM11	8.51	0.041	8.45	0.08	0.063	0.025	0.053	<0.100	0.373	1.81	8.07	0.732	0.029	0.106	0.133	0.024	0.071
3	SB5NEPH-27	1	1	4	T09LM21	13.9	0.036	8.38	0.082	0.056	0.027	0.053	<0.100	0.369	1.77	5	0.668	0.03	0.136	0.133	0.026	0.072
3	SB5NEPH-23	1	1	5	T05LM11	10.7	0.038	8.41	0.08	0.05	0.026	0.053	<0.100	0.364	1.77	10.19	0.713	0.037	0.121	0.128	0.023	0.069
3	SB5NEPH-23	1	1	6	T05LM21	10.9	0.038	8.53	0.08	0.049	0.027	0.054	<0.100	0.364	1.81	10.18	0.714	0.037	0.122	0.13	0.023	0.069
3	Batch 1	1	1	7	BCHLM3112	2.51	0.126	0.842	<0.010	0.075	0.309	2.5	<0.100	0.819	1.33	6.81	0.552	<0.010	<0.100	0.387	<0.010	0.064
3	SB5NEPH-28	1	1	8	T07LM21	11.4	0.039	8.58	0.081	0.043	0.031	0.05	<0.100	0.375	1.71	4.1	0.64	0.036	<0.100	0.126	0.024	0.067
3	SB5NEPH-26	1	1	9	T01LM11	13.6	0.042	1.43	0.082	0.047	0.027	0.054	<0.100	0.383	1.82	4.85	0.677	0.03	<0.100	0.126	0.023	0.068
3	SB5NEPH-27	1	1	10	T09LM11	14.1	0.035	8.5	0.081	0.058	0.029	0.054	<0.100	0.366	1.76	5.11	0.641	0.03	0.131	0.131	0.025	0.07
3	SB5NEPH-24	1	1	11	T10LM21	8.42	0.041	8.41	0.08	0.061	0.025	0.051	<0.100	0.369	1.72	7.92	0.695	0.029	0.11	0.129	0.023	0.069
3	SB5NEPH-26	1	1	12	T01LM21	13.6	0.042	2.04	0.082	0.047	0.03	0.054	<0.100	0.387	1.83	4.91	0.682	0.029	<0.100	0.127	0.023	0.071
3	Batch 1	1	1	13	BCHLM3113	2.52	0.127	0.855	<0.010	0.076	0.311	2.52	<0.100	0.815	1.33	6.88	0.554	<0.010	<0.100	0.385	<0.010	0.065
3	Batch 1	2	1	1	BCHLM3211	2.47	0.126	0.823	<0.010	0.075	0.31	2.5	<0.100	0.822	1.32	6.67	0.551	<0.010	<0.100	0.386	<0.010	0.063
3	SB5NEPH-29	2	1	2	T02LM11	4	0.04	1.41	0.078	0.06	0.027	0.051	<0.100	0.362	1.73	27.02	0.718	0.031	0.167	0.126	0.023	0.067
3	SB5NEPH-30	2	1	3	T08LM21	3.37	0.039	1.45	0.079	0.06	0.034	0.051	<0.100	0.374	1.77	22.6	0.729	0.036	0.168	0.13	0.029	0.067
3	SB5NEPH-22	2	1	4	T04LM11	10.2	0.045	1.42	0.079	0.046	0.027	0.05	<0.100	0.374	1.76	9.7	0.621	0.032	<0.100	0.138	0.022	0.071
3	SB5NEPH-25	2	1	5	T03LM11	16	0.04	1.41	0.083	0.054	0.028	0.052	<0.100	0.373	1.79	6.07	0.686	0.031	<0.100	0.136	0.024	0.069
3	SB5NEPH-22	2	1	6	T04LM21	10.1	0.045	1.41	0.079	0.046	0.028	0.05	<0.100	0.372	1.75	9.56	0.625	0.031	<0.100	0.136	0.022	0.071
3	Batch 1	2	1	7	BCHLM3212	2.49	0.124	0.822	<0.010	0.074	0.304	2.62	<0.100	0.811	1.33	6.68	0.541	<0.010	<0.100	0.381	<0.010	0.063
3	SB5NEPH-25	2	1	8	T03LM21	15.7	0.04	1.37	0.082	0.051	0.027	0.051	<0.100	0.372	1.71	5.85	0.629	0.032	<0.100	0.126	0.023	0.066
3	SB5NEPH-21	2	1	9	T06LM21	12.5	0.043	1.43	0.081	0.048	0.025	0.055	<0.100	0.372	1.76	11.63	0.679	0.03	<0.100	0.13	0.022	0.071
3	SB5NEPH-29	2	1	10	T02LM21	4.02	0.039	1.38	0.074	0.054	0.027	0.049	<0.100	0.36	1.55	26.72	0.63	0.032	0.16	0.11	0.022	0.064
3	SB5NEPH-30	2	1	11	T08LM11	3.33	0.039	1.43	0.078	0.06	0.031	0.047	<0.100	0.372	1.74	22.24	0.729	0.035	0.164	0.13	0.028	0.066
3	SB5NEPH-21	2	1	12	T06LM11	12.3	0.043	1.4	0.081	0.049	0.028	0.052	<0.100	0.372	1.74	11.48	0.679	0.031	<0.100	0.131	0.022	0.075
3	Batch 1	2	1	13	BCHLM3213	2.52	0.126	0.843	<0.010	0.075	0.309	2.5	<0.100	0.817	1.33	6.81	0.551	<0.010	<0.100	0.388	<0.010	0.064
3	Batch 1	1	2	1	BCHLM3121	2.49	0.128	0.846	<0.010	0.076	0.31	2.51	<0.100	0.827	1.32	6.83	0.553	<0.010	<0.100	0.392	<0.010	0.065
3	SB5NEPH-27	1	2	2	T09LM22	14.1	0.038	8.41	0.082	0.056	0.027	0.053	<0.100	0.372	1.77	5.1	0.666	0.031	0.132	0.131	0.027	0.072
3	SB5NEPH-26	1	2	3	T01LM12	13.7	0.044	1.47	0.084	0.048	0.028	0.055	<0.100	0.393	1.84	5.03	0.684	0.031	<0.100	0.128	0.024	0.069
3	SB5NEPH-23	1	2	4	T05LM22	11	0.04	8.6	0.08	0.05	0.028	0.054	<0.100	0.368	1.82	10.26	0.711	0.038	0.12	0.13	0.023	0.07
3	SB5NEPH-26	1	2	5	T01LM22	13.7	0.044	2.07	0.083	0.047	0.031	0.054	<0.100	0.389	1.84	4.96	0.678	0.03	<0.100	0.127	0.024	0.072
3	SB5NEPH-28	1	2	6	T07LM22	11.5	0.041	8.59	0.082	0.043	0.032	0.05	<0.100	0.381	1.73	4.09	0.641	0.038	<0.100	0.129	0.025	0.068
3	Batch 1	1	2	7	BCHLM3122	2.52	0.127	0.853	<0.010	0.076	0.309	2.48	<0.100	0.822	1.33	6.71	0.55	<0.010	<0.100	0.385	<0.010	0.066
3	SB5NEPH-24	1	2	8	T10LM12	8.88	0.043	8.73	0.081	0.063	0.026	0.052	<0.100	0.376	1.83	8.37	0.729	0.03	0.109	0.132	0.024	0.071

Table A2. Measured Elemental Concentrations (wt %) for Samples Prepared Using Lithium Metaborate. (continued)

Set	Glass ID	Block	Sub Block	Seq.	ID Check	Al (wt%)	Ba (wt%)	Ca (wt%)	Ce (wt%)	Cr (wt%)	Cu (wt%)	K (wt%)	La (wt%)	Mg (wt%)	Mn (wt%)	Na (wt%)	Ni (wt%)	Pb (wt%)	S (wt%)	Ti (wt%)	Zn (wt%)	Zr (wt%)
3	SB5NEPH-23	1	2	9	T05LM12	10.7	0.039	8.38	0.08	0.05	0.027	0.053	<0.100	0.365	1.77	10.09	0.704	0.037	0.117	0.129	0.023	0.07
3	SB5NEPH-27	1	2	10	T09LM12	14.3	0.038	8.58	0.083	0.058	0.03	0.054	<0.100	0.372	1.77	5.17	0.645	0.031	0.13	0.132	0.026	0.072
3	SB5NEPH-28	1	2	11	T07LM12	11.6	0.041	8.6	0.082	0.046	0.031	0.05	<0.100	0.383	1.81	4.15	0.702	0.036	<0.100	0.134	0.026	0.069
3	SB5NEPH-24	1	2	12	T10LM22	8.52	0.043	8.44	0.08	0.062	0.026	0.052	<0.100	0.373	1.73	7.97	0.694	0.03	0.105	0.13	0.023	0.07
3	Batch 1	1	2	13	BCHLM3123	2.53	0.128	0.862	<0.010	0.077	0.313	2.53	<0.100	0.824	1.32	6.85	0.555	<0.010	<0.100	0.392	<0.010	0.067
3	Batch 1	2	2	1	BCHLM3221	2.53	0.125	0.861	<0.010	0.075	0.309	2.54	<0.100	0.819	1.35	6.88	0.551	<0.010	<0.100	0.386	<0.010	0.064
3	SB5NEPH-30	2	2	2	T08LM12	3.39	0.039	1.46	0.078	0.059	0.03	0.047	<0.100	0.371	1.78	22.5	0.728	0.034	0.166	0.13	0.028	0.066
3	SB5NEPH-22	2	2	3	T04LM22	10.3	0.046	1.44	0.079	0.046	0.027	0.05	<0.100	0.373	1.78	9.65	0.624	0.032	<0.100	0.136	0.022	0.072
3	SB5NEPH-30	2	2	4	T08LM22	3.42	0.039	1.48	0.079	0.059	0.033	0.051	<0.100	0.373	1.8	22.93	0.728	0.036	0.167	0.129	0.028	0.068
3	SB5NEPH-29	2	2	5	T02LM22	4.05	0.039	1.4	0.073	0.054	0.025	0.048	<0.100	0.357	1.57	26.62	0.628	0.032	0.163	0.109	0.022	0.066
3	SB5NEPH-21	2	2	6	T06LM22	12.5	0.043	1.46	0.08	0.048	0.024	0.053	<0.100	0.369	1.79	11.59	0.674	0.031	<0.100	0.128	0.022	0.071
3	Batch 1	2	2	7	BCHLM3222	2.58	0.125	0.89	<0.010	0.075	0.311	2.55	<0.100	0.818	1.36	6.86	0.55	<0.010	<0.100	0.387	<0.010	0.065
3	SB5NEPH-21	2	2	8	T06LM12	12.7	0.043	1.47	0.081	0.049	0.027	0.052	<0.100	0.372	1.78	11.77	0.679	0.031	<0.100	0.13	0.022	0.075
3	SB5NEPH-22	2	2	9	T04LM12	10.4	0.045	1.48	0.079	0.046	0.026	0.049	<0.100	0.372	1.79	9.81	0.618	0.032	<0.100	0.137	0.021	0.07
3	SB5NEPH-29	2	2	10	T02LM12	4.07	0.04	1.46	0.078	0.06	0.026	0.05	<0.100	0.36	1.76	27.19	0.714	0.033	0.165	0.126	0.022	0.067
3	SB5NEPH-25	2	2	11	T03LM12	16.5	0.04	1.46	0.082	0.054	0.027	0.052	<0.100	0.372	1.83	6.17	0.684	0.031	<0.100	0.134	0.024	0.07
3	SB5NEPH-25	2	2	12	T03LM22	16.1	0.04	1.43	0.082	0.051	0.026	0.051	<0.100	0.371	1.74	6.02	0.63	0.031	<0.100	0.126	0.023	0.067
3	Batch 1	2	2	13	BCHLM3223	2.57	0.124	0.903	<0.010	0.074	0.306	2.66	<0.100	0.805	1.36	6.8	0.537	<0.010	<0.100	0.382	<0.010	0.063
4	Batch 1	1	1	1	BCHLM4111	2.52	0.124	0.846	<0.010	0.075	0.306	2.6	<0.100	0.814	1.33	6.7	0.542	<0.010	<0.100	0.385	<0.010	0.066
4	SB5NEPH-33	1	1	2	U10LM21	12.3	0.039	1.4	0.081	0.06	0.027	0.053	<0.100	0.381	1.81	17	0.738	0.033	0.151	0.137	0.025	0.07
4	SB5NEPH-35	1	1	3	U04LM21	10.7	0.038	8.59	0.08	0.061	0.031	0.053	<0.100	0.374	1.78	15.3	0.722	0.031	0.162	0.133	0.027	0.069
4	SB5NEPH-36	1	1	4	U01LM11	8.49	0.039	8.52	0.082	0.059	0.038	0.051	<0.100	0.378	1.79	12.2	0.718	0.033	0.116	0.133	0.029	0.071
4	SB5NEPH-33	1	1	5	U10LM11	12.5	0.039	1.43	0.081	0.061	0.027	0.054	<0.100	0.385	1.81	17.5	0.737	0.033	0.151	0.136	0.025	0.074
4	SB5NEPH-40	1	1	6	U06LM11	14.5	0.04	8.69	0.081	0.044	0.029	0.055	<0.100	0.381	1.81	4.24	0.661	0.033	<0.100	0.134	0.025	0.072
4	Batch 1	1	1	7	BCHLM4112	2.54	0.125	0.841	<0.010	0.075	0.31	2.62	<0.100	0.821	1.34	6.82	0.545	<0.010	<0.100	0.384	<0.010	0.07
4	SB5NEPH-32	1	1	8	U05LM21	2.93	0.037	8.55	0.08	0.062	0.028	0.052	<0.100	0.377	1.78	19.7	0.734	0.033	0.176	0.133	0.022	0.067
4	SB5NEPH-40	1	1	9	U06LM21	14.3	0.039	8.56	0.08	0.042	0.027	0.052	<0.100	0.376	1.78	4.14	0.632	0.032	<0.100	0.132	0.024	0.071
4	SB5NEPH-32	1	1	10	U05LM11	2.93	0.037	8.61	0.08	0.062	0.029	0.052	<0.100	0.378	1.79	19.9	0.735	0.034	0.171	0.133	0.022	0.069
4	SB5NEPH-35	1	1	11	U04LM11	10.6	0.038	8.55	0.08	0.061	0.029	0.068	<0.100	0.372	1.76	15.1	0.727	0.029	0.161	0.133	0.026	0.072
4	SB5NEPH-36	1	1	12	U01LM21	8.49	0.039	8.49	0.082	0.06	0.035	0.051	<0.100	0.375	1.79	12.1	0.719	0.035	0.116	0.133	0.028	0.076
4	Batch 1	1	1	13	BCHLM4113	2.54	0.124	0.849	<0.010	0.074	0.31	2.64	<0.100	0.815	1.34	6.81	0.543	<0.010	<0.100	0.384	<0.010	0.07
4	Batch 1	2	1	1	BCHLM4211	2.46	0.124	0.777	<0.010	0.075	0.306	2.6	<0.100	0.817	1.32	6.67	0.541	<0.010	<0.100	0.385	<0.010	0.065
4	SB5NEPH-31	2	1	2	U08LM21	3.48	0.037	8.14	0.077	0.059	0.032	0.05	<0.100	0.345	1.67	23	0.64	0.033	0.162	0.127	0.024	0.064
4	SB5NEPH-37	2	1	3	U09LM11	20.2	0.04	1.36	0.083	0.051	0.026	0.053	<0.100	0.357	1.81	6.07	0.741	0.032	<0.100	0.134	0.024	0.06
4	SB5NEPH-34	2	1	4	U02LM11	10.1	0.039	1.37	0.084	0.058	0.028	0.05	<0.100	0.378	1.79	14	0.725	0.033	0.122	0.135	0.024	0.069
4	SB5NEPH-31	2	1	5	U08LM11	3.47	0.037	8.19	0.077	0.058	0.031	0.05	<0.100	0.344	1.65	23.3	0.635	0.032	0.159	0.128	0.024	0.067
4	SB5NEPH-34	2	1	6	U02LM21	10.26	0.039	1.39	0.085	0.058	0.029	0.051	<0.100	0.379	1.82	14.1	0.729	0.033	0.118	0.136	0.025	0.072
4	Batch 1	2	1	7	BCHLM4212	2.43	0.124	0.817	<0.010	0.075	0.309	2.61	<0.100	0.822	1.32	6.78	0.541	<0.010	<0.100	0.388	<0.010	0.068
4	SB5NEPH-39	2	1	8	U03LM21	17.9	0.038	8.48	0.083	0.043	0.027	0.052	<0.100	0.371	1.79	5.31	0.693	0.033	<0.100	0.132	0.024	0.07
4	SB5NEPH-38	2	1	9	U07LM11	16.8	0.043	1.39	0.085	0.059	0.028	0.052	<0.100	0.39	1.81	5.01	0.763	0.033	<0.100	0.137	0.025	0.07
4	SB5NEPH-37	2	1	10	U09LM21	20.3	0.04	1.37	0.083	0.051	0.026	0.053	<0.100	0.36	1.81	6.15	0.757	0.032	<0.100	0.135	0.024	0.063
4	SB5NEPH-39	2	1	11	U03LM11	17.6	0.037	8.46	0.083	0.044	0.027	0.051	<0.100	0.372	1.78	5.2	0.692	0.033	<0.100	0.131	0.024	0.069
4	SB5NEPH-38	2	1	12	U07LM21	16.5	0.042	1.37	0.084	0.057	0.028	0.052	<0.100	0.386	1.78	4.91	0.745	0.032	<0.100	0.136	0.024	0.071
4	Batch 1	2	1	13	BCHLM4213	2.49	0.125	0.783	<0.010	0.075	0.311	2.61	<0.100	0.828	1.31	6.78	0.542	<0.010	<0.100	0.391	<0.010	0.069
4	Batch 1	1	2	1	BCHLM4121	2.58	0.125	0.869	<0.010	0.074	0.305	2.6	<0.100	0.81	1.35	6.91	0.544	<0.010	<0.100	0.383	<0.010	0.066
4	SB5NEPH-36	1	2	2	U01LM12	8.74	0.04	8.7	0.081	0.058	0.038	0.051	<0.100	0.373	1.83	12.3	0.714	0.032	0.117	0.132	0.028	0.067

Table A2. Measured Elemental Concentrations (wt %) for Samples Prepared Using Lithium Metaborate. (continued)

Set	Glass ID	Block	Sub Block	Seq.	ID Check	Al (wt%)	Ba (wt%)	Ca (wt%)	Ce (wt%)	Cr (wt%)	Cu (wt%)	K (wt%)	La (wt%)	Mg (wt%)	Mn (wt%)	Na (wt%)	Ni (wt%)	Pb (wt%)	S (wt%)	Ti (wt%)	Zn (wt%)	Zr (wt%)
4	SB5NEPH-35	1	2	3	U04LM22	11	0.039	8.84	0.08	0.06	0.032	0.054	<0.100	0.371	1.81	15.4	0.718	0.029	0.166	0.133	0.026	0.07
4	SB5NEPH-33	1	2	4	U10LM12	12.6	0.04	1.45	0.081	0.059	0.028	0.054	<0.100	0.379	1.81	17.5	0.731	0.031	0.152	0.136	0.025	0.073
4	SB5NEPH-40	1	2	5	U06LM12	14.9	0.04	8.88	0.08	0.043	0.029	0.055	<0.100	0.379	1.83	4.37	0.658	0.031	<0.100	0.134	0.025	0.071
4	SB5NEPH-32	1	2	6	U05LM22	2.99	0.038	8.64	0.08	0.06	0.029	0.053	<0.100	0.374	1.77	19.6	0.732	0.032	0.174	0.133	0.022	0.071
4	Batch 1	1	2	7	BCHLM4122	2.73	0.124	0.934	<0.010	0.074	0.306	2.62	<0.100	0.819	1.37	7.29	0.545	<0.010	<0.100	0.386	<0.010	0.068
4	SB5NEPH-36	1	2	8	U01LM22	8.76	0.039	8.79	0.081	0.058	0.036	0.052	<0.100	0.373	1.79	12.3	0.717	0.034	0.122	0.132	0.028	0.073
4	SB5NEPH-40	1	2	9	U06LM22	14.7	0.04	8.81	0.08	0.041	0.028	0.054	<0.100	0.374	1.78	4.23	0.63	0.031	<0.100	0.132	0.024	0.071
4	SB5NEPH-35	1	2	10	U04LM12	10.9	0.039	8.8	0.079	0.059	0.03	0.07	<0.100	0.368	1.76	15.3	0.718	0.028	0.161	0.133	0.025	0.071
4	SB5NEPH-32	1	2	11	U05LM12	3.03	0.038	8.88	0.08	0.06	0.03	0.052	<0.100	0.374	1.78	20.1	0.731	0.032	0.175	0.132	0.021	0.068
4	SB5NEPH-33	1	2	12	U10LM22	12.7	0.04	1.46	0.082	0.058	0.028	0.056	<0.100	0.378	1.79	17.4	0.731	0.032	0.152	0.137	0.024	0.073
4	Batch 1	1	2	13	BCHLM4123	2.61	0.124	0.893	<0.010	0.074	0.305	2.62	<0.100	0.813	1.33	6.8	0.542	<0.010	<0.100	0.381	<0.010	0.067
4	Batch 1	2	2	1	BCHLM4221	2.5	0.123	0.844	<0.010	0.073	0.306	2.64	<0.100	0.814	1.3	6.69	0.545	<0.010	<0.100	0.379	<0.010	0.064
4	SB5NEPH-39	2	2	2	U03LM12	17.8	0.036	8.57	0.079	0.042	0.024	0.048	<0.100	0.366	1.77	5.27	0.695	0.031	<0.100	0.129	0.023	0.065
4	SB5NEPH-34	2	2	3	U02LM12	10.1	0.038	1.44	0.081	0.056	0.026	0.046	<0.100	0.373	1.78	14	0.724	0.032	0.11	0.132	0.023	0.068
4	SB5NEPH-39	2	2	4	U03LM22	17.7	0.036	8.52	0.079	0.042	0.025	0.049	<0.100	0.367	1.78	5.18	0.698	0.032	<0.100	0.129	0.023	0.071
4	SB5NEPH-37	2	2	5	U09LM12	19.8	0.039	1.41	0.079	0.049	0.023	0.051	<0.100	0.355	1.76	5.97	0.744	0.032	<0.100	0.132	0.023	0.059
4	SB5NEPH-38	2	2	6	U07LM22	16.3	0.041	1.42	0.079	0.055	0.025	0.05	<0.100	0.379	1.75	5	0.749	0.03	<0.100	0.132	0.023	0.067
4	Batch 1	2	2	7	BCHLM4222	2.53	0.122	0.856	<0.010	0.073	0.3	2.64	<0.100	0.809	1.3	6.76	0.543	<0.010	<0.100	0.381	<0.010	0.066
4	SB5NEPH-38	2	2	8	U07LM12	16.4	0.041	1.44	0.08	0.057	0.025	0.05	<0.100	0.383	1.75	5.06	0.771	0.031	<0.100	0.134	0.024	0.065
4	SB5NEPH-34	2	2	9	U02LM22	10.1	0.038	1.44	0.08	0.056	0.026	0.049	<0.100	0.371	1.75	13.9	0.729	0.031	0.111	0.132	0.023	0.069
4	SB5NEPH-31	2	2	10	U08LM22	3.49	0.036	8.2	0.073	0.057	0.03	0.048	<0.100	0.34	1.61	22.7	0.643	0.031	0.162	0.125	0.023	0.065
4	SB5NEPH-31	2	2	11	U08LM12	3.49	0.035	8.19	0.072	0.056	0.027	0.048	<0.100	0.336	1.6	23	0.637	0.03	0.157	0.124	0.023	0.064
4	SB5NEPH-37	2	2	12	U09LM22	20.1	0.038	1.43	0.078	0.049	0.023	0.052	<0.100	0.35	1.75	6.02	0.755	0.031	<0.100	0.131	0.023	0.061
4	Batch 1	2	2	13	BCHLM4223	2.55	0.121	0.868	<0.010	0.073	0.299	2.66	<0.100	0.803	1.3	6.81	0.541	<0.010	<0.100	0.377	<0.010	0.064

Table A3. Measured Elemental Concentrations (wt %) for Samples Prepared Using Peroxide Fusion. (continued)

Set	Glass ID	Block	Sub-Block	Sequence	Lab ID	B (wt%)	Fe (wt%)	Li (wt%)	Si (wt%)
1	Batch 1	1	1	1	BCHPF1111	2.39	8.7	2	22.7
1	SB5NEPH-09	1	1	2	R04PF21	1.3	8.11	<0.100	21.6
1	SB5NEPH-06	1	1	3	R03PF11	5.86	7.36	<0.100	18.8
1	SB5NEPH-10	1	1	4	R05PF11	5.84	8	<0.100	18.2
1	SB5NEPH-02	1	1	5	R06PF21	5.73	7.72	<0.100	18.1
1	SB5NEPH-06	1	1	6	R03PF21	5.73	7	<0.100	18.2
1	Batch 1	1	1	7	BCHPF1112	2.37	8.82	2.01	22.9
1	SB5NEPH-02	1	1	8	R06PF11	5.77	7.62	<0.100	18.2
1	SB5NEPH-10	1	1	9	R05PF21	5.79	7.87	<0.100	17.9
1	SB5NEPH-07	1	1	10	R09PF11	1.3	7.69	<0.100	19.5
1	SB5NEPH-09	1	1	11	R04PF11	1.28	7.87	<0.100	21.3
1	SB5NEPH-07	1	1	12	R09PF21	1.21	7.42	<0.100	19
1	Batch 1	1	1	13	BCHPF1113	2.31	8.82	2.02	23
1	Batch 1	1	2	1	BCHPF1121	2.41	8.54	2.02	22.6
1	SB5NEPH-09	1	2	2	R04PF22	1.33	7.85	<0.100	21.2
1	SB5NEPH-07	1	2	3	R09PF22	1.27	7.19	<0.100	18.9
1	SB5NEPH-10	1	2	4	R05PF12	5.73	7.65	<0.100	17.8
1	SB5NEPH-02	1	2	5	R06PF12	5.71	7.46	<0.100	18.2
1	SB5NEPH-10	1	2	6	R05PF22	5.75	7.67	<0.100	17.7
1	Batch 1	1	2	7	BCHPF1122	2.39	8.53	2.03	22.7
1	SB5NEPH-02	1	2	8	R06PF22	5.71	7.58	<0.100	17.9
1	SB5NEPH-06	1	2	9	R03PF12	5.71	6.84	<0.100	18.2
1	SB5NEPH-07	1	2	10	R09PF12	1.3	7.22	<0.100	18.9
1	SB5NEPH-09	1	2	11	R04PF12	1.3	7.64	<0.100	20.8
1	SB5NEPH-06	1	2	12	R03PF22	5.63	6.86	<0.100	17.9
1	Batch 1	1	2	13	BCHPF1123	2.37	8.62	2.02	22.8
1	Batch 1	2	1	1	BCHPF1211	2.39	8.95	2.03	23.1
1	SB5NEPH-04	2	1	2	R07PF11	5.77	7.58	<0.100	15.6
1	SB5NEPH-03	2	1	3	R10PF11	1.26	7.31	<0.100	19.3
1	SB5NEPH-04	2	1	4	R07PF21	5.76	7.64	<0.100	15.7
1	SB5NEPH-01	2	1	5	R01PF11	1.26	7.52	<0.100	21.5
1	SB5NEPH-08	2	1	6	R08PF11	5.65	7.34	<0.100	15.6
1	Batch 1	2	1	7	BCHPF1212	2.33	8.89	2.01	23.1
1	SB5NEPH-01	2	1	8	R01PF21	1.28	7.63	<0.100	22.3
1	SB5NEPH-05	2	1	9	R02PF21	1.22	7.58	<0.100	22.1
1	SB5NEPH-05	2	1	10	R02PF11	1.21	7.56	<0.100	21.4
1	SB5NEPH-08	2	1	11	R08PF21	5.72	7.5	<0.100	15.7
1	SB5NEPH-03	2	1	12	R10PF21	1.21	7.25	<0.100	19.1
1	Batch 1	2	1	13	BCHPF1213	2.4	8.72	2.05	23.3
1	Batch 1	2	2	1	BCHPF1221	2.36	8.88	2.03	23
1	SB5NEPH-04	2	2	2	R07PF22	5.65	7.42	<0.100	15.4
1	SB5NEPH-03	2	2	3	R10PF12	1.25	7.52	<0.100	19.5
1	SB5NEPH-05	2	2	4	R02PF12	1.21	7.53	<0.100	21.2
1	SB5NEPH-08	2	2	5	R08PF22	5.63	7.46	<0.100	15.4
1	SB5NEPH-08	2	2	6	R08PF12	5.63	7.43	<0.100	15.5
1	Batch 1	2	2	7	BCHPF1222	2.3	8.85	2.02	23
1	SB5NEPH-03	2	2	8	R10PF22	1.24	7.44	<0.100	19.1
1	SB5NEPH-01	2	2	9	R01PF22	1.23	7.55	<0.100	21.9
1	SB5NEPH-01	2	2	10	R01PF12	1.21	7.54	<0.100	21.5
1	SB5NEPH-04	2	2	11	R07PF12	5.56	7.34	<0.100	15.2
1	SB5NEPH-05	2	2	12	R02PF22	1.2	7.54	<0.100	21.8
1	Batch 1	2	2	13	BCHPF1223	2.29	8.82	2.02	23
2	Batch 1	1	1	1	BCHPF2111	2.36	8.83	2.02	23.2
2	SB5NEPH-17	1	1	2	S05PF21	1.22	7.43	<0.100	18.6
2	SB5NEPH-20	1	1	3	S06PF11	5.66	7.66	<0.100	12.9
2	SB5NEPH-12	1	1	4	S04PF11	5.67	7.68	<0.100	15.4
2	SB5NEPH-13	1	1	5	S07PF11	1.24	7.81	<0.100	18.4
2	SB5NEPH-13	1	1	6	S07PF21	1.21	7.6	<0.100	18.4
2	Batch 1	1	1	7	BCHPF2112	2.3	8.8	2.02	23.2
2	SB5NEPH-12	1	1	8	S04PF21	5.6	7.49	<0.100	15.2
2	SB5NEPH-11	1	1	9	S02PF11	1.25	7.18	<0.100	19.8
2	SB5NEPH-17	1	1	10	S05PF11	1.22	7.55	<0.100	18.7
2	SB5NEPH-20	1	1	11	S06PF21	5.7	7.83	<0.100	13.1
2	SB5NEPH-11	1	1	12	S02PF21	1.25	7.24	<0.100	20
2	Batch 1	1	1	13	BCHPF2113	2.35	8.78	2.02	23.2
2	Batch 1	1	2	1	BCHPF2121	2.43	8.79	2.04	23
2	SB5NEPH-13	1	2	2	S07PF12	1.29	7.39	<0.100	18.1
2	SB5NEPH-11	1	2	3	S02PF22	1.29	6.85	<0.100	19.4

Table A3. Measured Elemental Concentrations (wt %) for Samples Prepared Using Peroxide Fusion. (continued)

Set	Glass ID	Block	Sub-Block	Sequence	Lab ID	B (wt%)	Fe (wt%)	Li (wt%)	Si (wt%)
2	SB5NEPH-13	1	2	4	S07PF22	1.27	7.37	<0.100	18.3
2	SB5NEPH-20	1	2	5	S06PF12	5.59	7.18	<0.100	12.6
2	SB5NEPH-12	1	2	6	S04PF22	5.94	7.65	<0.100	15.8
2	Batch 1	1	2	7	BCHPF2122	2.37	8.55	2.04	22.8
2	SB5NEPH-17	1	2	8	S05PF22	1.32	7.44	<0.100	18.6
2	SB5NEPH-11	1	2	9	S02PF12	1.28	6.9	<0.100	19.4
2	SB5NEPH-17	1	2	10	S05PF12	1.27	7.33	<0.100	18.7
2	SB5NEPH-12	1	2	11	S04PF12	5.65	7.33	<0.100	15.3
2	SB5NEPH-20	1	2	12	S06PF22	5.61	7.36	<0.100	12.8
2	Batch 1	1	2	13	BCHPF2123	2.36	8.66	2.05	22.9
2	Batch 1	2	1	1	BCHPF2211	2.4	8.24	1.99	22.1
2	SB5NEPH-19	2	1	2	S03PF11	1.3	6.76	<0.100	15.7
2	SB5NEPH-19	2	1	3	S03PF21	1.26	6.99	<0.100	16
2	SB5NEPH-14	2	1	4	S09PF21	5.35	6.99	<0.100	14.4
2	SB5NEPH-15	2	1	5	S08PF11	1.23	6.95	<0.100	15.2
2	SB5NEPH-18	2	1	6	S01PF11	5.58	7.34	<0.100	14.8
2	Batch 1	2	1	7	BCHPF2212	2.33	8.39	1.99	22.2
2	SB5NEPH-16	2	1	8	S10PF21	5.49	7.43	<0.100	12.4
2	SB5NEPH-14	2	1	9	S09PF11	5.49	7.21	<0.100	14.8
2	SB5NEPH-15	2	1	10	S08PF21	1.27	7.27	<0.100	15.3
2	SB5NEPH-16	2	1	11	S10PF11	5.37	7.31	<0.100	12.2
2	SB5NEPH-18	2	1	12	S01PF21	5.65	7.67	<0.100	15.1
2	Batch 1	2	1	13	BCHPF2213	2.4	9.05	2.03	23.2
2	Batch 1	2	2	1	BCHPF2221	2.43	9.11	2.06	23.5
2	SB5NEPH-15	2	2	2	S08PF12	1.28	7.73	<0.100	16.5
2	SB5NEPH-19	2	2	3	S03PF12	1.29	7.42	<0.100	16.6
2	SB5NEPH-16	2	2	4	S10PF22	5.67	7.78	<0.100	13
2	SB5NEPH-15	2	2	5	S08PF22	1.26	7.42	<0.100	15.7
2	SB5NEPH-18	2	2	6	S01PF22	5.69	7.69	<0.100	15.4
2	Batch 1	2	2	7	BCHPF2222	2.39	8.99	2.05	23.6
2	SB5NEPH-19	2	2	8	S03PF22	1.29	7.6	<0.100	16.7
2	SB5NEPH-14	2	2	9	S09PF12	5.73	7.89	<0.100	15.7
2	SB5NEPH-16	2	2	10	S10PF12	5.66	7.92	<0.100	12.9
2	SB5NEPH-14	2	2	11	S09PF22	5.82	8.04	<0.100	15.8
2	SB5NEPH-18	2	2	12	S01PF12	5.88	8.17	<0.100	15.8
2	Batch 1	2	2	13	BCHPF2223	2.46	9.45	2.06	24
3	Batch 1	1	1	1	BCHPF3111	2.36	8.81	2.02	23.2
3	SB5NEPH-27	1	1	2	T09PF21	1.24	7.11	<0.100	16.4
3	SB5NEPH-21	1	1	3	T06PF11	1.2	7.19	<0.100	18.7
3	SB5NEPH-22	1	1	4	T04PF11	5.69	6.81	<0.100	15.5
3	SB5NEPH-29	1	1	5	T02PF11	1.19	7.31	<0.100	14.3
3	SB5NEPH-21	1	1	6	T06PF21	1.19	7.18	<0.100	18.6
3	Batch 1	1	1	7	BCHPF3112	2.28	8.64	2	23
3	SB5NEPH-22	1	1	8	T04PF21	5.75	6.92	<0.100	15.6
3	SB5NEPH-27	1	1	9	T09PF11	1.22	7.01	<0.100	16.3
3	SB5NEPH-29	1	1	10	T02PF21	1.15	7.28	<0.100	14.2
3	SB5NEPH-30	1	1	11	T08PF11	5.57	7.44	<0.100	12.1
3	SB5NEPH-30	1	1	12	T08PF21	5.62	7.39	<0.100	12.1
3	Batch 1	1	1	13	BCHPF3113	2.28	8.58	2.02	22.9
3	Batch 1	1	2	1	BCHPF3121	2.36	8.65	2.01	22.9
3	SB5NEPH-29	1	2	2	T02PF12	1.21	7.35	<0.100	14.1
3	SB5NEPH-22	1	2	3	T04PF22	5.71	6.92	<0.100	15.5
3	SB5NEPH-30	1	2	4	T08PF22	5.5	7.16	<0.100	11.8
3	SB5NEPH-22	1	2	5	T04PF12	5.7	6.88	<0.100	15.4
3	SB5NEPH-29	1	2	6	T02PF22	1.19	7.22	<0.100	14
3	Batch 1	1	2	7	BCHPF3122	2.31	8.73	2	22.8
3	SB5NEPH-21	1	2	8	T06PF12	1.22	7	<0.100	18.2
3	SB5NEPH-27	1	2	9	T09PF22	1.23	6.86	<0.100	15.9
3	SB5NEPH-27	1	2	10	T09PF12	1.2	6.64	<0.100	15.7
3	SB5NEPH-30	1	2	11	T08PF12	5.45	7.16	<0.100	11.8
3	SB5NEPH-21	1	2	12	T06PF22	1.19	6.95	<0.100	18.1
3	Batch 1	1	2	13	BCHPF3123	2.24	8.38	1.99	22.3
3	Batch 1	2	1	1	BCHPF3211	2.34	8.67	2.01	22.9
3	SB5NEPH-28	2	1	2	T07PF11	5.69	7.35	<0.100	12.7
3	SB5NEPH-25	2	1	3	T03PF21	1.29	7.48	<0.100	19.1
3	SB5NEPH-28	2	1	4	T07PF21	5.71	7.37	<0.100	12.7
3	SB5NEPH-26	2	1	5	T01PF21	5.82	6.85	<0.100	15.7
3	SB5NEPH-24	2	1	6	T10PF21	5.66	7.51	<0.100	12.9

Table A3. Measured Elemental Concentrations (wt %) for Samples Prepared Using Peroxide Fusion. (continued)

Set	Glass ID	Block	Sub-Block	Sequence	Lab ID	B (wt%)	Fe (wt%)	Li (wt%)	Si (wt%)
3	Batch 1	2	1	7	BCHPF3212	2.35	8.9	2.04	23.3
3	SB5NEPH-24	2	1	8	T10PF11	5.67	7.41	<0.100	12.8
3	SB5NEPH-25	2	1	9	T03PF11	1.29	7.47	<0.100	18.9
3	SB5NEPH-23	2	1	10	T05PF11	1.22	7.24	<0.100	16.1
3	SB5NEPH-26	2	1	11	T01PF11	5.75	6.82	<0.100	15.5
3	SB5NEPH-23	2	1	12	T05PF21	1.22	7.32	<0.100	16.2
3	Batch 1	2	1	13	BCHPF3213	2.28	8.7	2.03	23
3	Batch 1	2	2	1	BCHPF3221	2.4	8.84	2.07	23.6
3	SB5NEPH-25	2	2	2	T03PF22	1.27	7.42	<0.100	18.9
3	SB5NEPH-25	2	2	3	T03PF12	1.24	7.39	<0.100	18.8
3	SB5NEPH-26	2	2	4	T01PF22	5.78	6.8	<0.100	15.5
3	SB5NEPH-28	2	2	5	T07PF22	5.69	7.26	<0.100	12.6
3	SB5NEPH-24	2	2	6	T10PF12	5.63	7.22	<0.100	12.6
3	Batch 1	2	2	7	BCHPF3222	2.35	8.62	2.06	23.1
3	SB5NEPH-28	2	2	8	T07PF12	5.68	7.14	<0.100	12.6
3	SB5NEPH-23	2	2	9	T05PF12	1.22	7.14	<0.100	16.1
3	SB5NEPH-23	2	2	10	T05PF22	1.19	7.08	<0.100	15.8
3	SB5NEPH-26	2	2	11	T01PF12	5.71	6.51	<0.100	15.2
3	SB5NEPH-24	2	2	12	T10PF22	5.62	7.17	<0.100	12.6
3	Batch 1	2	2	13	BCHPF3223	2.34	8.47	2.05	23.1
4	Batch 1	1	1	1	BCHPF4111	2.42	9	2.07	23.6
4	SB5NEPH-33	1	1	2	U10PF21	1.23	7.5	<0.100	14.8
4	SB5NEPH-40	1	1	3	U06PF21	5.66	7.36	<0.100	10.4
4	SB5NEPH-32	1	1	4	U05PF11	5.6	7.99	<0.100	10.3
4	SB5NEPH-40	1	1	5	U06PF11	5.72	7.38	<0.100	10.4
4	SB5NEPH-33	1	1	6	U10PF11	1.22	7.56	<0.100	14.8
4	Batch 1	1	1	7	BCHPF4112	2.36	9.17	2.07	23.7
4	SB5NEPH-35	1	1	8	U04PF21	1.23	7.86	<0.100	12.7
4	SB5NEPH-36	1	1	9	U01PF11	5.51	7.76	<0.100	10.2
4	SB5NEPH-32	1	1	10	U05PF21	5.58	7.72	<0.100	10.2
4	SB5NEPH-36	1	1	11	U01PF21	5.61	7.72	<0.100	10.3
4	SB5NEPH-35	1	1	12	U04PF11	1.21	7.63	<0.100	12.6
4	Batch 1	1	1	13	BCHPF4113	2.35	8.75	2.08	23.4
4	Batch 1	1	2	1	BCHPF4121	2.43	8.82	2.06	23.5
4	SB5NEPH-36	1	2	2	U01PF22	5.58	7.61	<0.100	10.2
4	SB5NEPH-33	1	2	3	U10PF12	1.27	7.32	<0.100	14.7
4	SB5NEPH-35	1	2	4	U04PF12	1.24	7.57	<0.100	12.6
4	SB5NEPH-32	1	2	5	U05PF12	5.6	7.48	<0.100	10.1
4	SB5NEPH-35	1	2	6	U04PF22	1.23	7.59	<0.100	12.7
4	Batch 1	1	2	7	BCHPF4122	2.36	8.91	2.09	23.5
4	SB5NEPH-33	1	2	8	U10PF22	1.19	7.14	<0.100	14.4
4	SB5NEPH-40	1	2	9	U06PF22	5.55	6.79	<0.100	10.1
4	SB5NEPH-40	1	2	10	U06PF12	5.54	6.75	<0.100	10
4	SB5NEPH-36	1	2	11	U01PF12	5.39	7.16	<0.100	9.9
4	SB5NEPH-32	1	2	12	U05PF22	5.44	7.1	<0.100	9.9
4	Batch 1	1	2	13	BCHPF4123	2.36	8.7	2.08	23.2
4	Batch 1	2	1	1	BCHPF4211	2.42	9.16	2.06	23.8
4	SB5NEPH-38	2	1	2	U07PF11	5.94	8.07	<0.100	12.6
4	SB5NEPH-31	2	1	3	U08PF11	1.18	7.32	<0.100	12.2
4	SB5NEPH-39	2	1	4	U03PF11	1.25	7.68	<0.100	13.1
4	SB5NEPH-31	2	1	5	U08PF21	1.16	7.36	<0.100	12.2
4	SB5NEPH-39	2	1	6	U03PF21	1.24	7.6	<0.100	13.1
4	Batch 1	2	1	7	BCHPF4212	2.36	9.18	2.07	23.6
4	SB5NEPH-38	2	1	8	U07PF21	5.85	7.89	<0.100	12.5
4	SB5NEPH-37	2	1	9	U09PF21	1.28	7.52	<0.100	15.5
4	SB5NEPH-34	2	1	10	U02PF21	5.72	7.69	<0.100	12.5
4	SB5NEPH-34	2	1	11	U02PF11	5.72	7.52	<0.100	12.3
4	SB5NEPH-37	2	1	12	U09PF11	1.23	7.28	<0.100	15.1
4	Batch 1	2	1	13	BCHPF4213	2.3	8.86	2.06	23.4
4	Batch 1	2	2	1	BCHPF4221	2.38	8.7	2.03	23
4	SB5NEPH-31	2	2	2	U08PF22	1.18	6.89	<0.100	12
4	SB5NEPH-31	2	2	3	U08PF12	1.16	6.95	<0.100	12
4	SB5NEPH-34	2	2	4	U02PF12	5.64	7.39	<0.100	12.3
4	SB5NEPH-38	2	2	5	U07PF22	5.77	7.58	<0.100	12.4
4	SB5NEPH-37	2	2	6	U09PF22	1.25	7.28	<0.100	15.2
4	Batch 1	2	2	7	BCHPF4222	2.36	8.87	2.05	23.5
4	SB5NEPH-38	2	2	8	U07PF12	5.68	7.27	<0.100	12.2
4	SB5NEPH-34	2	2	9	U02PF22	5.58	7.18	<0.100	12.1

Table A3. Measured Elemental Concentrations (wt %) for Samples Prepared Using Peroxide Fusion. (continued)

Set	Glass ID	Block	Sub-Block	Sequence	Lab ID	B (wt%)	Fe (wt%)	Li (wt%)	Si (wt%)
4	SB5NEPH-39	2	2	10	U03PF12	1.23	7.14	<0.100	12.7
4	SB5NEPH-37	2	2	11	U09PF12	1.24	7.07	<0.100	15
4	SB5NEPH-39	2	2	12	U03PF22	1.21	7.36	<0.100	13
4	Batch 1	2	2	13	BCHPF4223	2.31	8.76	2.05	23.4

Table A4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass. (continued)
(100 -Batch 1)

Set	Glass #	Oxide	Measured (wt %)	Measured Bias-Corrected (wt %)	Targeted (wt %)	Diff of Measured	Diff of Meas BC	% Diff of Measured	% Diff of Meas BC
1	1	Al_2O_3	7.9690	8.1675	7.8000	0.1690	0.3675	2.2%	4.7%
1	1	B_2O_3	4.0088	4.1285	4.0000	0.0088	0.1285	0.2%	3.2%
1	1	BaO	0.0438	0.0473	0.0490	-0.0052	-0.0017	-10.6%	-3.5%
1	1	CaO	2.0148	2.1339	2.0000	0.0148	0.1339	0.7%	6.7%
1	1	Ce_2O_3	0.0908	0.0908	0.1030	-0.0122	-0.0122	-11.9%	-11.9%
1	1	Cr_2O_3	0.0998	0.0985	0.0900	0.0098	0.0085	10.8%	9.4%
1	1	CuO	0.0369	0.0375	0.0330	0.0039	0.0045	11.9%	13.6%
1	1	Fe_2O_3	10.8085	10.9655	10.7720	0.0365	0.1935	0.3%	1.8%
1	1	K_2O	0.0611	0.0652	0.0690	-0.0079	-0.0038	-11.4%	-5.5%
1	1	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
1	1	Li_2O	0.1076	0.1093	0.0000	0.1076	0.1093		
1	1	MgO	0.6248	0.6483	0.6260	-0.0012	0.0223	-0.2%	3.6%
1	1	MnO	2.3468	2.3646	2.3060	0.0408	0.0586	1.8%	2.5%
1	1	Na_2O	23.4215	22.9546	23.4000	0.0215	-0.4454	0.1%	-1.9%
1	1	NiO	0.9426	1.0050	1.0220	-0.0794	-0.0170	-7.8%	-1.7%
1	1	PbO	0.0382	0.0382	0.0430	-0.0048	-0.0048	-11.1%	-11.1%
1	1	SiO_2	46.6367	47.4278	46.8000	-0.1633	0.6278	-0.3%	1.3%
1	1	SO_4	0.4996	0.4996	0.5130	-0.0134	-0.0134	-2.6%	-2.6%
1	1	TiO_2	0.2273	0.2369	0.2270	0.0003	0.0099	0.1%	4.4%
1	1	ZnO	0.0280	0.0280	0.0330	-0.0050	-0.0050	-15.1%	-15.1%
1	1	ZrO_2	0.0892	0.0892	0.1010	-0.0118	-0.0118	-11.7%	-11.7%
1	1	Sum	100.1544	101.1947	100.0020	0.1524	1.1927	0.2%	1.2%
1	2	Al_2O_3	6.4290	6.5893	6.4000	0.0290	0.1893	0.5%	3.0%
1	2	B_2O_3	18.4500	18.7776	18.0000	0.4500	0.7776	2.5%	4.3%
1	2	BaO	0.0449	0.0485	0.0490	-0.0041	-0.0005	-8.3%	-1.0%
1	2	CaO	1.9974	2.1153	2.0000	-0.0026	0.1153	-0.1%	5.8%
1	2	Ce_2O_3	0.0952	0.0952	0.1030	-0.0078	-0.0078	-7.6%	-7.6%
1	2	Cr_2O_3	0.0921	0.0909	0.0900	0.0021	0.0009	2.3%	1.0%
1	2	CuO	0.0341	0.0346	0.0330	0.0011	0.0016	3.4%	4.9%
1	2	Fe_2O_3	10.8586	11.2453	10.7720	0.0866	0.4733	0.8%	4.4%
1	2	K_2O	0.0590	0.0630	0.0690	-0.0100	-0.0060	-14.5%	-8.7%
1	2	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
1	2	Li_2O	0.1076	0.1098	0.0000	0.1076	0.1098		
1	2	MgO	0.6310	0.6547	0.6260	0.0050	0.0287	0.8%	4.6%
1	2	MnO	2.3306	2.3483	2.3060	0.0246	0.0423	1.1%	1.8%
1	2	Na_2O	19.0405	18.6633	19.2000	-0.1595	-0.5367	-0.8%	-2.8%
1	2	NiO	0.9604	1.0241	1.0220	-0.0616	0.0021	-6.0%	0.2%
1	2	PbO	0.0361	0.0361	0.0430	-0.0069	-0.0069	-16.1%	-16.1%
1	2	SiO_2	38.7213	39.8969	38.4000	0.3213	1.4969	0.8%	3.9%
1	2	SO_4	0.4883	0.4883	0.5130	-0.0247	-0.0247	-4.8%	-4.8%
1	2	TiO_2	0.2231	0.2326	0.2270	-0.0039	0.0056	-1.7%	2.5%
1	2	ZnO	0.0280	0.0280	0.0330	-0.0050	-0.0050	-15.1%	-15.1%
1	2	ZrO_2	0.0898	0.0898	0.1010	-0.0112	-0.0112	-11.1%	-11.1%
1	2	Sum	100.7758	102.6903	100.0020	0.7738	2.6883	0.8%	2.7%
1	3	Al_2O_3	6.8967	7.0686	6.8000	0.0967	0.2686	1.4%	3.9%
1	3	B_2O_3	3.9927	4.1132	4.0000	-0.0073	0.1132	-0.2%	2.8%
1	3	BaO	0.0435	0.0470	0.0490	-0.0055	-0.0020	-11.1%	-4.1%
1	3	CaO	12.1556	12.8737	12.0000	0.1556	0.8737	1.3%	7.3%
1	3	Ce_2O_3	0.0925	0.0925	0.1030	-0.0105	-0.0105	-10.2%	-10.2%
1	3	Cr_2O_3	0.0899	0.0887	0.0900	-0.0001	-0.0013	-0.1%	-1.4%
1	3	CuO	0.0338	0.0343	0.0330	0.0008	0.0013	2.4%	4.0%
1	3	Fe_2O_3	10.5512	10.7044	10.7720	-0.2208	-0.0676	-2.0%	-0.6%
1	3	K_2O	0.0590	0.0630	0.0690	-0.0100	-0.0060	-14.5%	-8.7%
1	3	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
1	3	Li_2O	0.1076	0.1093	0.0000	0.1076	0.1093		
1	3	MgO	0.6219	0.6453	0.6260	-0.0041	0.0193	-0.7%	3.1%
1	3	MnO	2.3145	2.3320	2.3060	0.0085	0.0260	0.4%	1.1%
1	3	Na_2O	20.4559	20.0519	20.4000	0.0559	-0.3481	0.3%	-1.7%
1	3	NiO	0.9455	1.0081	1.0220	-0.0765	-0.0139	-7.5%	-1.4%
1	3	PbO	0.0315	0.0315	0.0430	-0.0115	-0.0115	-26.7%	-26.7%
1	3	SiO_2	41.1815	41.8812	40.8000	0.3815	1.0812	0.9%	2.6%
1	3	SO_4	0.5115	0.5115	0.5130	-0.0015	-0.0015	-0.3%	-0.3%
1	3	TiO_2	0.2235	0.2330	0.2270	-0.0035	0.0060	-1.5%	2.6%
1	3	ZnO	0.0280	0.0280	0.0330	-0.0050	-0.0050	-15.1%	-15.1%
1	3	ZrO_2	0.0932	0.0932	0.1010	-0.0078	-0.0078	-7.7%	-7.7%

Table A4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass. (continued)
(100 -Batch 1)

Set	Glass #	Oxide	Measured (wt %)	Measured Bias-Corrected (wt %)	Targeted (wt %)	Diff of Measured	Diff of Meas BC	% Diff of Measured	% Diff of Meas BC
1	3	Sum	100.4882	102.0691	100.0020	0.4862	2.0671	0.5%	2.1%
1	4	Al_2O_3	5.4984	5.6354	5.4000	0.0984	0.2354	1.8%	4.4%
1	4	B_2O_3	18.3051	18.8534	18.0000	0.3051	0.8534	1.7%	4.7%
1	4	BaO	0.0419	0.0452	0.0490	-0.0071	-0.0038	-14.6%	-7.8%
1	4	CaO	12.2675	12.9924	12.0000	0.2675	0.9924	2.2%	8.3%
1	4	Ce_2O_3	0.0914	0.0914	0.1030	-0.0116	-0.0116	-11.3%	-11.3%
1	4	Cr_2O_3	0.0881	0.0869	0.0900	-0.0019	-0.0031	-2.2%	-3.4%
1	4	CuO	0.0363	0.0369	0.0330	0.0033	0.0039	10.0%	11.7%
1	4	Fe_2O_3	10.7156	10.8712	10.7720	-0.0564	0.0992	-0.5%	0.9%
1	4	K_2O	0.0602	0.0643	0.0690	-0.0088	-0.0047	-12.7%	-6.9%
1	4	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
1	4	Li_2O	0.1076	0.1093	0.0000	0.1076	0.1093		
1	4	MgO	0.6169	0.6401	0.6260	-0.0091	0.0141	-1.5%	2.3%
1	4	MnO	2.3274	2.3451	2.3060	0.0214	0.0391	0.9%	1.7%
1	4	Na_2O	16.3108	15.9869	16.2000	0.1108	-0.2131	0.7%	-1.3%
1	4	NiO	0.9569	1.0203	1.0220	-0.0651	-0.0017	-6.4%	-0.2%
1	4	PbO	0.0347	0.0347	0.0430	-0.0083	-0.0083	-19.2%	-19.2%
1	4	SiO_2	33.1057	33.6664	32.4000	0.7057	1.2664	2.2%	3.9%
1	4	SO_4	0.4322	0.4322	0.5130	-0.0808	-0.0808	-15.8%	-15.8%
1	4	TiO_2	0.2231	0.2326	0.2270	-0.0039	0.0056	-1.7%	2.5%
1	4	ZnO	0.0271	0.0271	0.0330	-0.0059	-0.0059	-18.0%	-18.0%
1	4	ZrO_2	0.0804	0.0804	0.1010	-0.0206	-0.0206	-20.4%	-20.4%
1	4	Sum	101.3859	103.3107	100.0020	1.3839	3.3087	1.4%	3.3%
1	5	Al_2O_3	15.8860	16.2829	15.6000	0.2860	0.6829	1.8%	4.4%
1	5	B_2O_3	3.8961	4.0133	4.0000	-0.1039	0.0133	-2.6%	0.3%
1	5	BaO	0.0447	0.0481	0.0490	-0.0043	-0.0009	-8.9%	-1.9%
1	5	CaO	1.9799	2.1225	2.0000	-0.0201	0.1225	-1.0%	6.1%
1	5	Ce_2O_3	0.0966	0.0966	0.1030	-0.0064	-0.0064	-6.2%	-6.2%
1	5	Cr_2O_3	0.0797	0.0779	0.0900	-0.0103	-0.0121	-11.5%	-13.4%
1	5	CuO	0.0338	0.0344	0.0330	0.0008	0.0014	2.4%	4.1%
1	5	Fe_2O_3	10.7978	10.9546	10.7720	0.0258	0.1826	0.2%	1.7%
1	5	K_2O	0.0678	0.0739	0.0690	-0.0012	0.0049	-1.8%	7.2%
1	5	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
1	5	Li_2O	0.1076	0.1093	0.0000	0.1076	0.1093		
1	5	MgO	0.6422	0.6665	0.6260	0.0162	0.0405	2.6%	6.5%
1	5	MnO	2.3403	2.3463	2.3060	0.0343	0.0403	1.5%	1.7%
1	5	Na_2O	15.8053	15.3917	15.6000	0.2053	-0.2083	1.3%	-1.3%
1	5	NiO	0.9426	1.0069	1.0220	-0.0794	-0.0151	-7.8%	-1.5%
1	5	PbO	0.0366	0.0366	0.0430	-0.0064	-0.0064	-14.8%	-14.8%
1	5	SiO_2	46.2624	47.0469	46.8000	-0.5376	0.2469	-1.1%	0.5%
1	5	SO_4	0.3730	0.3730	0.5130	-0.1400	-0.1400	-27.3%	-27.3%
1	5	TiO_2	0.2335	0.2434	0.2270	0.0065	0.0164	2.9%	7.2%
1	5	ZnO	0.0321	0.0321	0.0330	-0.0009	-0.0009	-2.9%	-2.9%
1	5	ZrO_2	0.0929	0.0929	0.1010	-0.0081	-0.0081	-8.1%	-8.1%
1	5	Sum	99.8093	101.1084	100.0020	-0.1927	1.1064	-0.2%	1.1%
1	6	Al_2O_3	13.0659	13.3913	12.8000	0.2659	0.5913	2.1%	4.6%
1	6	B_2O_3	18.4581	18.7868	18.0000	0.4581	0.7868	2.5%	4.4%
1	6	BaO	0.0444	0.0479	0.0490	-0.0046	-0.0011	-9.4%	-2.3%
1	6	CaO	1.9974	2.1154	2.0000	-0.0026	0.1154	-0.1%	5.8%
1	6	Ce_2O_3	0.0958	0.0958	0.1030	-0.0072	-0.0072	-7.0%	-7.0%
1	6	Cr_2O_3	0.0870	0.0858	0.0900	-0.0030	-0.0042	-3.4%	-4.6%
1	6	CuO	0.0338	0.0343	0.0330	0.0008	0.0013	2.4%	4.0%
1	6	Fe_2O_3	10.0293	10.3848	10.7720	-0.7427	-0.3872	-6.9%	-3.6%
1	6	K_2O	0.0644	0.0688	0.0690	-0.0046	-0.0002	-6.6%	-0.4%
1	6	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
1	6	Li_2O	0.1076	0.1098	0.0000	0.1076	0.1098		
1	6	MgO	0.6289	0.6526	0.6260	0.0029	0.0266	0.5%	4.2%
1	6	MnO	2.3435	2.3613	2.3060	0.0375	0.0553	1.6%	2.4%
1	6	Na_2O	13.1497	12.8883	12.8000	0.3497	0.0883	2.7%	0.7%
1	6	NiO	0.9277	0.9891	1.0220	-0.0943	-0.0329	-9.2%	-3.2%
1	6	PbO	0.0366	0.0366	0.0430	-0.0064	-0.0064	-14.8%	-14.8%
1	6	SiO_2	39.0957	40.2813	38.4000	0.6957	1.8813	1.8%	4.9%
1	6	SO_4	0.3445	0.3445	0.5130	-0.1685	-0.1685	-32.8%	-32.8%
1	6	TiO_2	0.2256	0.2352	0.2270	-0.0014	0.0082	-0.6%	3.6%
1	6	ZnO	0.0289	0.0289	0.0330	-0.0041	-0.0041	-12.3%	-12.3%

Table A4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass. (continued)
(100 -Batch 1)

Set	Glass #	Oxide	Measured (wt %)	Measured Bias-Corrected (wt %)	Targeted (wt %)	Diff of Measured	Diff of Meas BC	% Diff of Measured	% Diff of Meas BC
1	6	ZrO_2	0.0888	0.0888	0.1010	-0.0122	-0.0122	-12.1%	-12.1%
1	6	Sum	100.9123	103.0859	100.0020	0.9103	3.0839	0.9%	3.1%
1	7	Al_2O_3	13.6989	14.0405	13.6000	0.0989	0.4405	0.7%	3.2%
1	7	B_2O_3	4.0893	4.1614	4.0000	0.0893	0.1614	2.2%	4.0%
1	7	BaO	0.0452	0.0487	0.0490	-0.0038	-0.0003	-7.7%	-0.7%
1	7	CaO	11.9981	12.8625	12.0000	-0.0019	0.8625	0.0%	7.2%
1	7	Ce_2O_3	0.0963	0.0963	0.1030	-0.0067	-0.0067	-6.5%	-6.5%
1	7	Cr_2O_3	0.0946	0.0926	0.0900	0.0046	0.0026	5.2%	2.9%
1	7	CuO	0.0335	0.0340	0.0330	0.0005	0.0010	1.5%	3.2%
1	7	Fe_2O_3	10.5512	10.9251	10.7720	-0.2208	0.1531	-2.0%	1.4%
1	7	K_2O	0.0669	0.0730	0.0690	-0.0021	0.0040	-3.1%	5.7%
1	7	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
1	7	Li_2O	0.1076	0.1098	0.0000	0.1076	0.1098		
1	7	MgO	0.6252	0.6489	0.6260	-0.0008	0.0229	-0.1%	3.7%
1	7	MnO	2.3177	2.3236	2.3060	0.0117	0.0176	0.5%	0.8%
1	7	Na_2O	13.8507	13.4881	13.6000	0.2507	-0.1119	1.8%	-0.8%
1	7	NiO	0.9277	0.9909	1.0220	-0.0943	-0.0311	-9.2%	-3.0%
1	7	PbO	0.0380	0.0380	0.0430	-0.0050	-0.0050	-11.7%	-11.7%
1	7	SiO_2	40.8071	42.0451	40.8000	0.0071	1.2451	0.0%	3.1%
1	7	SO_4	0.3970	0.3970	0.5130	-0.1160	-0.1160	-22.6%	-22.6%
1	7	TiO_2	0.2231	0.2326	0.2270	-0.0039	0.0056	-1.7%	2.5%
1	7	ZnO	0.0283	0.0283	0.0330	-0.0047	-0.0047	-14.2%	-14.2%
1	7	ZrO_2	0.0973	0.0973	0.1010	-0.0037	-0.0037	-3.7%	-3.7%
1	7	Sum	100.1523	102.7921	100.0020	0.1503	2.7901	0.2%	2.8%
1	8	Al_2O_3	10.8410	11.1112	10.8000	0.0410	0.3112	0.4%	2.9%
1	8	B_2O_3	18.2166	18.7643	18.0000	0.2166	0.7643	1.2%	4.2%
1	8	BaO	0.0447	0.0481	0.0490	-0.0043	-0.0009	-8.9%	-1.9%
1	8	CaO	12.0891	12.9600	12.0000	0.0891	0.9600	0.7%	8.0%
1	8	Ce_2O_3	0.0984	0.0984	0.1030	-0.0046	-0.0046	-4.5%	-4.5%
1	8	Cr_2O_3	0.0870	0.0851	0.0900	-0.0030	-0.0049	-3.4%	-5.5%
1	8	CuO	0.0385	0.0391	0.0330	0.0055	0.0061	16.6%	18.6%
1	8	Fe_2O_3	10.6262	10.7806	10.7720	-0.1458	0.0086	-1.4%	0.1%
1	8	K_2O	0.0669	0.0730	0.0690	-0.0021	0.0040	-3.1%	5.7%
1	8	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
1	8	Li_2O	0.1076	0.1093	0.0000	0.1076	0.1093		
1	8	MgO	0.6389	0.6631	0.6260	0.0129	0.0371	2.1%	5.9%
1	8	MnO	2.3564	2.3625	2.3060	0.0504	0.0565	2.2%	2.4%
1	8	Na_2O	11.0603	10.7708	10.8000	0.2603	-0.0292	2.4%	-0.3%
1	8	NiO	0.9461	1.0107	1.0220	-0.0759	-0.0113	-7.4%	-1.1%
1	8	PbO	0.0347	0.0347	0.0430	-0.0083	-0.0083	-19.2%	-19.2%
1	8	SiO_2	33.2661	33.8302	32.4000	0.8661	1.4302	2.7%	4.4%
1	8	SO_4	0.4868	0.4868	0.5130	-0.0262	-0.0262	-5.1%	-5.1%
1	8	TiO_2	0.2268	0.2365	0.2270	-0.0002	0.0095	-0.1%	4.2%
1	8	ZnO	0.0308	0.0308	0.0330	-0.0022	-0.0022	-6.6%	-6.6%
1	8	ZrO_2	0.0949	0.0949	0.1010	-0.0061	-0.0061	-6.0%	-6.0%
1	8	Sum	101.4166	103.6485	100.0020	1.4146	3.6465	1.4%	3.6%
1	9	Al_2O_3	24.1856	24.7894	23.4000	0.7856	1.3894	3.4%	5.9%
1	9	B_2O_3	4.1939	4.2680	4.0000	0.1939	0.2680	4.8%	6.7%
1	9	BaO	0.0461	0.0496	0.0490	-0.0029	0.0006	-6.0%	1.2%
1	9	CaO	2.0148	2.1600	2.0000	0.0148	0.1600	0.7%	8.0%
1	9	Ce_2O_3	0.0990	0.0990	0.1030	-0.0040	-0.0040	-3.9%	-3.9%
1	9	Cr_2O_3	0.0892	0.0872	0.0900	-0.0008	-0.0028	-0.9%	-3.1%
1	9	CuO	0.0325	0.0331	0.0330	-0.0005	0.0001	-1.4%	0.3%
1	9	Fe_2O_3	11.2482	11.6479	10.7720	0.4762	0.8759	4.4%	8.1%
1	9	K_2O	0.0657	0.0716	0.0690	-0.0033	0.0026	-4.9%	3.8%
1	9	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
1	9	Li_2O	0.1076	0.1098	0.0000	0.1076	0.1098		
1	9	MgO	0.6563	0.6811	0.6260	0.0303	0.0551	4.8%	8.8%
1	9	MnO	2.4081	2.4143	2.3060	0.1021	0.1083	4.4%	4.7%
1	9	Na_2O	8.1857	7.9715	7.8000	0.3857	0.1715	4.9%	2.2%
1	9	NiO	0.9467	1.0113	1.0220	-0.0753	-0.0107	-7.4%	-1.0%
1	9	PbO	0.0342	0.0342	0.0430	-0.0088	-0.0088	-20.5%	-20.5%
1	9	SiO_2	45.4066	46.7839	46.8000	-1.3934	-0.0161	-3.0%	0.0%
1	9	SO_4	0.1498	0.1498	0.5130	-0.3632	-0.3632	-70.8%	-70.8%
1	9	TiO_2	0.2294	0.2391	0.2270	0.0023	0.0121	1.0%	5.3%

Table A4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass. (continued)
(100 -Batch 1)

Set	Glass #	Oxide	Measured (wt %)	Measured Bias-Corrected (wt %)	Targeted (wt %)	Diff of Measured	Diff of Meas BC	% Diff of Measured	% Diff of Meas BC
1	9	ZnO	0.0311	0.0311	0.0330	-0.0019	-0.0019	-5.7%	-5.7%
1	9	ZrO_2	0.0966	0.0966	0.1010	-0.0044	-0.0044	-4.4%	-4.4%
1	9	Sum	100.2857	102.7871	100.0020	0.2837	2.7851	0.3%	2.8%
1	10	Al_2O_3	19.6508	20.1415	19.2000	0.4508	0.9415	2.3%	4.9%
1	10	B_2O_3	18.6030	18.9337	18.0000	0.6030	0.9337	3.3%	5.2%
1	10	BaO	0.0449	0.0484	0.0490	-0.0041	-0.0006	-8.3%	-1.3%
1	10	CaO	2.0079	2.1525	2.0000	0.0079	0.1525	0.4%	7.6%
1	10	Ce_2O_3	0.0972	0.0972	0.1030	-0.0058	-0.0058	-5.6%	-5.6%
1	10	Cr_2O_3	0.0610	0.0597	0.0900	-0.0290	-0.0303	-32.2%	-33.7%
1	10	CuO	0.0319	0.0325	0.0330	-0.0011	-0.0005	-3.3%	-1.7%
1	10	Fe_2O_3	11.1481	11.5440	10.7720	0.3761	0.7720	3.5%	7.2%
1	10	K_2O	0.0632	0.0690	0.0690	-0.0058	0.0000	-8.3%	0.0%
1	10	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
1	10	Li_2O	0.1076	0.1098	0.0000	0.1076	0.1098		
1	10	MgO	0.6550	0.6798	0.6260	0.0290	0.0538	4.6%	8.6%
1	10	MnO	2.4016	2.4078	2.3060	0.0956	0.1018	4.1%	4.4%
1	10	Na_2O	6.7906	6.6128	6.4000	0.3905	0.2128	6.1%	3.3%
1	10	NiO	0.9617	1.0273	1.0220	-0.0603	0.0053	-5.9%	0.5%
1	10	PbO	0.0350	0.0350	0.0430	-0.0080	-0.0080	-18.6%	-18.6%
1	10	SiO_2	38.2935	39.4553	38.4000	-0.1065	1.0553	-0.3%	2.7%
1	10	SO_4	0.1498	0.1498	0.5130	-0.3632	-0.3632	-70.8%	-70.8%
1	10	TiO_2	0.2369	0.2469	0.2270	0.0099	0.0199	4.3%	8.8%
1	10	ZnO	0.0299	0.0299	0.0330	-0.0031	-0.0031	-9.5%	-9.5%
1	10	ZrO_2	0.0976	0.0976	0.1010	-0.0034	-0.0034	-3.4%	-3.4%
1	10	Sum	101.5258	103.9890	100.0020	1.5238	3.9870	1.5%	4.0%
2	11	Al_2O_3	20.6428	21.1580	20.4000	0.2428	0.7580	1.2%	3.7%
2	11	B_2O_3	4.0812	4.1738	4.0000	0.0812	0.1738	2.0%	4.3%
2	11	BaO	0.0449	0.0484	0.0490	-0.0041	-0.0006	-8.3%	-1.2%
2	11	CaO	12.0366	12.5097	12.0000	0.0366	0.5097	0.3%	4.2%
2	11	Ce_2O_3	0.0943	0.0943	0.1030	-0.0087	-0.0087	-8.5%	-8.5%
2	11	Cr_2O_3	0.0709	0.0693	0.0900	-0.0191	-0.0207	-21.2%	-22.9%
2	11	CuO	0.0351	0.0359	0.0330	0.0021	0.0029	6.2%	8.9%
2	11	Fe_2O_3	10.0687	10.3500	10.7720	-0.7033	-0.4220	-6.5%	-3.9%
2	11	K_2O	0.0666	0.0729	0.0690	-0.0024	0.0039	-3.5%	5.7%
2	11	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
2	11	Li_2O	0.1076	0.1090	0.0000	0.1076	0.1090		
2	11	MgO	0.6152	0.6402	0.6260	-0.0108	0.0142	-1.7%	2.3%
2	11	MnO	2.3338	2.3311	2.3060	0.0278	0.0251	1.2%	1.1%
2	11	Na_2O	7.1174	7.0234	6.8000	0.3174	0.2234	4.7%	3.3%
2	11	NiO	0.8987	0.9597	1.0220	-0.1233	-0.0623	-12.1%	-6.1%
2	11	PbO	0.0355	0.0355	0.0430	-0.0075	-0.0075	-17.3%	-17.3%
2	11	SiO_2	42.0372	42.8105	40.8000	1.2372	2.0105	3.0%	4.9%
2	11	SO_4	0.3940	0.3940	0.5130	-0.1190	-0.1190	-23.2%	-23.2%
2	11	TiO_2	0.0038	0.0039	0.2270	-0.2232	-0.2231	-98.3%	-98.3%
2	11	ZnO	0.0283	0.0283	0.0330	-0.0047	-0.0047	-14.2%	-14.2%
2	11	ZrO_2	0.1030	0.1030	0.1010	0.0020	0.0020	2.0%	2.0%
2	11	Sum	100.8743	103.0097	100.0020	0.8723	3.0077	0.9%	3.0%
2	12	Al_2O_3	16.2591	16.6646	16.2000	0.0591	0.4646	0.4%	2.9%
2	12	B_2O_3	18.4017	18.8189	18.0000	0.4017	0.8189	2.2%	4.5%
2	12	BaO	0.0438	0.0472	0.0490	-0.0052	-0.0018	-10.6%	-3.6%
2	12	CaO	12.0576	12.5309	12.0000	0.0576	0.5309	0.5%	4.4%
2	12	Ce_2O_3	0.0963	0.0963	0.1030	-0.0067	-0.0067	-6.5%	-6.5%
2	12	Cr_2O_3	0.0753	0.0736	0.0900	-0.0147	-0.0164	-16.4%	-18.2%
2	12	CuO	0.0457	0.0469	0.0330	0.0127	0.0139	38.5%	42.0%
2	12	Fe_2O_3	10.7764	11.0790	10.7720	0.0044	0.3070	0.0%	2.9%
2	12	K_2O	0.0626	0.0687	0.0690	-0.0064	-0.0003	-9.2%	-0.5%
2	12	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
2	12	Li_2O	0.1076	0.1090	0.0000	0.1076	0.1090		
2	12	MgO	0.6256	0.6510	0.6260	-0.0004	0.0250	-0.1%	4.0%
2	12	MnO	2.3435	2.3407	2.3060	0.0375	0.0347	1.6%	1.5%
2	12	Na_2O	5.5639	5.4902	5.4000	0.1639	0.0902	3.0%	1.7%
2	12	NiO	0.9394	1.0032	1.0220	-0.0826	-0.0188	-8.1%	-1.8%
2	12	PbO	0.0350	0.0350	0.0430	-0.0080	-0.0080	-18.6%	-18.6%
2	12	SiO_2	32.9987	33.6103	32.4000	0.5987	1.2103	1.8%	3.7%
2	12	SO_4	0.2891	0.2891	0.5130	-0.2239	-0.2239	-43.6%	-43.6%

Table A4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass. (continued)
(100 -Batch 1)

Set	Glass #	Oxide	Measured (wt %)	Measured Bias-Corrected (wt %)	Targeted (wt %)	Diff of Measured	Diff of Meas BC	% Diff of Measured	% Diff of Meas BC
2	12	TiO_2	0.2310	0.2403	0.2270	0.0040	0.0133	1.8%	5.9%
2	12	ZnO	0.0349	0.0349	0.0330	0.0019	0.0019	5.6%	5.6%
2	12	ZrO_2	0.0956	0.0956	0.1010	-0.0054	-0.0054	-5.4%	-5.4%
2	12	Sum	101.1416	103.3841	100.0020	1.1396	3.3821	1.1%	3.4%
2	13	Al_2O_3	7.7233	7.9157	7.8000	-0.0767	0.1157	-1.0%	1.5%
2	13	B_2O_3	4.0329	4.1240	4.0000	0.0329	0.1240	0.8%	3.1%
2	13	BaO	0.0447	0.0481	0.0490	-0.0043	-0.0009	-8.9%	-1.8%
2	13	CaO	2.0288	2.1084	2.0000	0.0288	0.1084	1.4%	5.4%
2	13	Ce_2O_3	0.0949	0.0949	0.1030	-0.0081	-0.0081	-7.9%	-7.9%
2	13	Cr_2O_3	0.0917	0.0897	0.0900	0.0017	-0.0003	1.9%	-0.3%
2	13	CuO	0.0491	0.0504	0.0330	0.0161	0.0174	48.9%	52.7%
2	13	Fe_2O_3	10.7835	11.0850	10.7720	0.0115	0.3130	0.1%	2.9%
2	13	K_2O	0.0647	0.0710	0.0690	-0.0043	0.0020	-6.2%	2.8%
2	13	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
2	13	Li_2O	0.1076	0.1090	0.0000	0.1076	0.1090		
2	13	MgO	0.6405	0.6665	0.6260	0.0145	0.0405	2.3%	6.5%
2	13	MnO	2.3532	2.3504	2.3060	0.0472	0.0444	2.0%	1.9%
2	13	Na_2O	30.2963	29.8950	31.2000	-0.9037	-1.3050	-2.9%	-4.2%
2	13	NiO	0.9639	1.0293	1.0220	-0.0581	0.0073	-5.7%	0.7%
2	13	PbO	0.0347	0.0347	0.0430	-0.0083	-0.0083	-19.2%	-19.2%
2	13	SiO_2	39.1492	39.8712	39.0000	0.1492	0.8712	0.4%	2.2%
2	13	SO_4	0.5078	0.5078	0.5130	-0.0052	-0.0052	-1.0%	-1.0%
2	13	TiO_2	0.2260	0.2351	0.2270	-0.0010	0.0081	-0.4%	3.6%
2	13	ZnO	0.0277	0.0277	0.0330	-0.0053	-0.0053	-16.1%	-16.1%
2	13	ZrO_2	0.0956	0.0956	0.1010	-0.0054	-0.0054	-5.4%	-5.4%
2	13	Sum	99.3750	100.4682	100.0020	-0.6270	0.4662	-0.6%	0.5%
2	14	Al_2O_3	6.3865	6.5717	6.4000	-0.0135	0.1717	-0.2%	2.7%
2	14	B_2O_3	18.0234	18.1216	18.0000	0.0234	0.1216	0.1%	0.7%
2	14	BaO	0.0408	0.0431	0.0490	-0.0082	-0.0059	-16.8%	-12.0%
2	14	CaO	2.0568	2.1232	2.0000	0.0568	0.1232	2.8%	6.2%
2	14	Ce_2O_3	0.0943	0.0943	0.1030	-0.0087	-0.0087	-8.5%	-8.5%
2	14	Cr_2O_3	0.0939	0.0901	0.0900	0.0039	0.0001	4.3%	0.1%
2	14	CuO	0.0388	0.0395	0.0330	0.0058	0.0065	17.6%	19.8%
2	14	Fe_2O_3	10.7692	10.8924	10.7720	-0.0028	0.1204	0.0%	1.1%
2	14	K_2O	0.0660	0.0719	0.0690	-0.0030	0.0029	-4.4%	4.2%
2	14	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
2	14	Li_2O	0.1076	0.1091	0.0000	0.1076	0.1091		
2	14	MgO	0.6442	0.6636	0.6260	0.0182	0.0376	2.9%	6.0%
2	14	MnO	2.3500	2.3531	2.3060	0.0440	0.0471	1.9%	2.0%
2	14	Na_2O	24.9043	24.8500	25.6000	-0.6957	-0.7500	-2.7%	-2.9%
2	14	NiO	0.9671	1.0207	1.0220	-0.0549	-0.0013	-5.4%	-0.1%
2	14	PbO	0.0396	0.0396	0.0430	-0.0034	-0.0034	-7.9%	-7.9%
2	14	SiO_2	32.4639	32.9806	32.0000	0.4639	0.9806	1.4%	3.1%
2	14	SO_4	0.5183	0.5183	0.5130	0.0053	0.0053	1.0%	1.0%
2	14	TiO_2	0.2273	0.2352	0.2270	0.0003	0.0082	0.1%	3.6%
2	14	ZnO	0.0308	0.0308	0.0330	-0.0022	-0.0022	-6.6%	-6.6%
2	14	ZrO_2	0.0962	0.0962	0.1010	-0.0048	-0.0048	-4.7%	-4.7%
2	14	Sum	99.9776	101.0037	100.0020	-0.0244	1.0017	0.0%	1.0%
2	15	Al_2O_3	6.6463	6.8391	6.8000	-0.1537	0.0391	-2.3%	0.6%
2	15	B_2O_3	4.0571	4.0802	4.0000	0.0571	0.0802	1.4%	2.0%
2	15	BaO	0.0441	0.0467	0.0490	-0.0049	-0.0023	-10.0%	-4.8%
2	15	CaO	11.7638	12.1433	12.0000	-0.2362	0.1433	-2.0%	1.2%
2	15	Ce_2O_3	0.0940	0.0940	0.1030	-0.0090	-0.0090	-8.7%	-8.7%
2	15	Cr_2O_3	0.0870	0.0834	0.0900	-0.0030	-0.0066	-3.4%	-7.3%
2	15	CuO	0.0410	0.0418	0.0330	0.0080	0.0088	24.2%	26.6%
2	15	Fe_2O_3	10.4976	10.6273	10.7720	-0.2744	-0.1447	-2.5%	-1.3%
2	15	K_2O	0.0657	0.0716	0.0690	-0.0033	0.0026	-4.9%	3.7%
2	15	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
2	15	Li_2O	0.1076	0.1091	0.0000	0.1076	0.1091		
2	15	MgO	0.6248	0.6436	0.6260	-0.0012	0.0176	-0.2%	2.8%
2	15	MnO	2.2887	2.2917	2.3060	-0.0173	-0.0143	-0.8%	-0.6%
2	15	Na_2O	25.8479	25.7916	27.2000	-1.3521	-1.4084	-5.0%	-5.2%
2	15	NiO	0.9477	1.0002	1.0220	-0.0743	-0.0218	-7.3%	-2.1%
2	15	PbO	0.0342	0.0342	0.0430	-0.0088	-0.0088	-20.5%	-20.5%
2	15	SiO_2	33.5335	34.0768	34.0000	-0.4665	0.0768	-1.4%	0.2%

Table A4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass. (continued)
(100 -Batch 1)

Set	Glass #	Oxide	Measured (wt %)	Measured Bias-Corrected (wt %)	Targeted (wt %)	Diff of Measured	Diff of Meas BC	% Diff of Measured	% Diff of Meas BC
2	15	SO_4	0.5183	0.5183	0.5130	0.0053	0.0053	1.0%	1.0%
2	15	TiO_2	0.2252	0.2330	0.2270	-0.0018	0.0060	-0.8%	2.7%
2	15	ZnO	0.0327	0.0327	0.0330	-0.0003	-0.0003	-1.0%	-1.0%
2	15	ZrO_2	0.0956	0.0956	0.1010	-0.0054	-0.0054	-5.4%	-5.4%
2	15	Sum	97.6112	98.9127	100.0020	-2.3908	-1.0893	-2.4%	-1.1%
2	16	Al_2O_3	5.0828	5.2301	5.4000	-0.3172	-0.1699	-5.9%	-3.1%
2	16	B_2O_3	17.8624	17.9617	18.0000	-0.1376	-0.0383	-0.8%	-0.2%
2	16	BaO	0.0452	0.0478	0.0490	-0.0038	-0.0012	-7.7%	-2.4%
2	16	CaO	11.1866	11.5474	12.0000	-0.8134	-0.4526	-6.8%	-3.8%
2	16	Ce_2O_3	0.0931	0.0931	0.1030	-0.0099	-0.0099	-9.6%	-9.6%
2	16	Cr_2O_3	0.0892	0.0855	0.0900	-0.0008	-0.0045	-0.9%	-5.0%
2	16	CuO	0.0504	0.0513	0.0330	0.0174	0.0183	52.7%	55.6%
2	16	Fe_2O_3	10.8800	11.0145	10.7720	0.1080	0.2425	1.0%	2.3%
2	16	K_2O	0.0647	0.0706	0.0690	-0.0043	0.0016	-6.2%	2.3%
2	16	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
2	16	Li_2O	0.1076	0.1091	0.0000	0.1076	0.1091		
2	16	MgO	0.6331	0.6521	0.6260	0.0071	0.0261	1.1%	4.2%
2	16	MnO	2.1821	2.1850	2.3060	-0.1239	-0.1210	-5.4%	-5.2%
2	16	Na_2O	19.7482	19.7051	21.6000	-1.8518	-1.8949	-8.6%	-8.8%
2	16	NiO	0.9649	1.0183	1.0220	-0.0571	-0.0037	-5.6%	-0.4%
2	16	PbO	0.0364	0.0364	0.0430	-0.0066	-0.0066	-15.5%	-15.5%
2	16	SiO_2	27.0087	27.4472	27.0000	0.0087	0.4472	0.0%	1.7%
2	16	SO_4	0.5288	0.5288	0.5130	0.0158	0.0158	3.1%	3.1%
2	16	TiO_2	0.2248	0.2326	0.2270	-0.0022	0.0056	-1.0%	2.5%
2	16	ZnO	0.0380	0.0380	0.0330	0.0050	0.0050	15.0%	15.0%
2	16	ZrO_2	0.0939	0.0939	0.1010	-0.0071	-0.0071	-7.0%	-7.0%
2	16	Sum	96.9793	98.2072	100.0020	-3.0227	-1.7948	-3.0%	-1.8%
2	17	Al_2O_3	15.7065	16.0978	15.6000	0.1065	0.4978	0.7%	3.2%
2	17	B_2O_3	4.0490	4.1401	4.0000	0.0490	0.1401	1.2%	3.5%
2	17	BaO	0.0458	0.0493	0.0490	-0.0032	0.0003	-6.6%	0.7%
2	17	CaO	1.9904	2.0684	2.0000	-0.0096	0.0684	-0.5%	3.4%
2	17	Ce_2O_3	0.0952	0.0952	0.1030	-0.0078	-0.0078	-7.6%	-7.6%
2	17	Cr_2O_3	0.0954	0.0933	0.0900	0.0054	0.0033	6.0%	3.7%
2	17	CuO	0.0394	0.0404	0.0330	0.0064	0.0074	19.5%	22.5%
2	17	Fe_2O_3	10.6334	10.9320	10.7720	-0.1386	0.1600	-1.3%	1.5%
2	17	K_2O	0.0672	0.0736	0.0690	-0.0018	0.0046	-2.7%	6.7%
2	17	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
2	17	Li_2O	0.1076	0.1090	0.0000	0.1076	0.1090		
2	17	MgO	0.6368	0.6626	0.6260	0.0108	0.0366	1.7%	5.9%
2	17	MnO	2.3629	2.3601	2.3060	0.0569	0.0541	2.5%	2.3%
2	17	Na_2O	23.1519	22.8453	23.4000	-0.2481	-0.5547	-1.1%	-2.4%
2	17	NiO	0.9512	1.0158	1.0220	-0.0708	-0.0062	-6.9%	-0.6%
2	17	PbO	0.0361	0.0361	0.0430	-0.0069	-0.0069	-16.1%	-16.1%
2	17	SiO_2	39.8979	40.6353	39.0000	0.8979	1.6353	2.3%	4.2%
2	17	SO_4	0.4763	0.4763	0.5130	-0.0367	-0.0367	-7.1%	-7.1%
2	17	TiO_2	0.2239	0.2329	0.2270	-0.0031	0.0059	-1.4%	2.6%
2	17	ZnO	0.0345	0.0345	0.0330	0.0015	0.0015	4.7%	4.7%
2	17	ZrO_2	0.0956	0.0956	0.1010	-0.0054	-0.0054	-5.4%	-5.4%
2	17	Sum	100.7556	102.1523	100.0020	0.7536	2.1503	0.8%	2.2%
2	18	Al_2O_3	12.7541	13.1242	12.8000	-0.0459	0.3242	-0.4%	2.5%
2	18	B_2O_3	18.3534	18.4567	18.0000	0.3534	0.4567	2.0%	2.5%
2	18	BaO	0.0480	0.0508	0.0490	-0.0010	0.0018	-2.0%	3.6%
2	18	CaO	2.0044	2.0690	2.0000	0.0044	0.0690	0.2%	3.5%
2	18	Ce_2O_3	0.0960	0.0960	0.1030	-0.0070	-0.0070	-6.8%	-6.8%
2	18	Cr_2O_3	0.0943	0.0904	0.0900	0.0043	0.0004	4.7%	0.5%
2	18	CuO	0.0357	0.0364	0.0330	0.0027	0.0034	8.1%	10.2%
2	18	Fe_2O_3	11.0337	11.1717	10.7720	0.2617	0.3997	2.4%	3.7%
2	18	K_2O	0.0632	0.0689	0.0690	-0.0058	-0.0001	-8.3%	-0.1%
2	18	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
2	18	Li_2O	0.1076	0.1091	0.0000	0.1076	0.1091		
2	18	MgO	0.6447	0.6641	0.6260	0.0187	0.0381	3.0%	6.1%
2	18	MnO	2.3338	2.3369	2.3060	0.0278	0.0309	1.2%	1.3%
2	18	Na_2O	18.9057	18.8646	19.2000	-0.2943	-0.3354	-1.5%	-1.7%
2	18	NiO	0.9789	1.0331	1.0220	-0.0431	0.0111	-4.2%	1.1%
2	18	PbO	0.0364	0.0364	0.0430	-0.0066	-0.0066	-15.5%	-15.5%

Table A4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass. (continued)
(100 -Batch 1)

Set	Glass #	Oxide	Measured (wt %)	Measured Bias-Corrected (wt %)	Targeted (wt %)	Diff of Measured	Diff of Meas BC	% Diff of Measured	% Diff of Meas BC
2	18	SiO_2	32.6778	33.2123	32.0000	0.6778	1.2123	2.1%	3.8%
2	18	SO_4	0.3685	0.3685	0.5130	-0.1445	-0.1445	-28.2%	-28.2%
2	18	TiO_2	0.2298	0.2378	0.2270	0.0028	0.0108	1.2%	4.8%
2	18	ZnO	0.0317	0.0317	0.0330	-0.0013	-0.0013	-3.8%	-3.8%
2	18	ZrO_2	0.1000	0.1000	0.1010	-0.0010	-0.0010	-1.0%	-1.0%
2	18	Sum	100.9564	102.2171	100.0020	0.9544	2.2151	1.0%	2.2%
2	19	Al_2O_3	13.5005	13.8921	13.6000	-0.0995	0.2921	-0.7%	2.1%
2	19	B_2O_3	4.1376	4.1613	4.0000	0.1376	0.1613	3.4%	4.0%
2	19	BaO	0.0452	0.0478	0.0490	-0.0038	-0.0012	-7.7%	-2.4%
2	19	CaO	11.8827	12.2661	12.0000	-0.1173	0.2661	-1.0%	2.2%
2	19	Ce_2O_3	0.0955	0.0955	0.1030	-0.0075	-0.0075	-7.3%	-7.3%
2	19	Cr_2O_3	0.0906	0.0869	0.0900	0.0006	-0.0031	0.7%	-3.4%
2	19	CuO	0.0469	0.0478	0.0330	0.0139	0.0148	42.3%	44.9%
2	19	Fe_2O_3	10.2831	10.4056	10.7720	-0.4889	-0.3664	-4.5%	-3.4%
2	19	K_2O	0.0678	0.0739	0.0690	-0.0012	0.0049	-1.8%	7.1%
2	19	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
2	19	Li_2O	0.1076	0.1091	0.0000	0.1076	0.1091		
2	19	MgO	0.6355	0.6547	0.6260	0.0095	0.0287	1.5%	4.6%
2	19	MnO	2.3177	2.3208	2.3060	0.0117	0.0148	0.5%	0.6%
2	19	Na_2O	19.8156	19.7724	20.4000	-0.5844	-0.6276	-2.9%	-3.1%
2	19	NiO	0.9480	1.0006	1.0220	-0.0740	-0.0214	-7.2%	-2.1%
2	19	PbO	0.0347	0.0347	0.0430	-0.0083	-0.0083	-19.2%	-19.2%
2	19	SiO_2	34.7636	35.3292	34.0000	0.7636	1.3292	2.2%	3.9%
2	19	SO_4	0.5011	0.5011	0.5130	-0.0119	-0.0119	-2.3%	-2.3%
2	19	TiO_2	0.2289	0.2369	0.2270	0.0019	0.0099	0.9%	4.4%
2	19	ZnO	0.0314	0.0314	0.0330	-0.0016	-0.0016	-4.8%	-4.8%
2	19	ZrO_2	0.0962	0.0962	0.1010	-0.0048	-0.0048	-4.7%	-4.7%
2	19	Sum	99.6891	101.2227	100.0020	-0.3129	1.2207	-0.3%	1.2%
2	20	Al_2O_3	10.8882	11.1599	10.8000	0.0882	0.3599	0.8%	3.3%
2	20	B_2O_3	18.1602	18.5761	18.0000	0.1602	0.5761	0.9%	3.2%
2	20	BaO	0.0444	0.0478	0.0490	-0.0046	-0.0012	-9.4%	-2.4%
2	20	CaO	12.0821	12.5568	12.0000	0.0821	0.5568	0.7%	4.6%
2	20	Ce_2O_3	0.0937	0.0937	0.1030	-0.0093	-0.0093	-9.0%	-9.0%
2	20	Cr_2O_3	0.0903	0.0883	0.0900	0.0003	-0.0017	0.3%	-1.9%
2	20	CuO	0.0407	0.0417	0.0330	0.0077	0.0087	23.3%	26.4%
2	20	Fe_2O_3	10.7335	11.0327	10.7720	-0.0385	0.2607	-0.4%	2.4%
2	20	K_2O	0.0605	0.0663	0.0690	-0.0085	-0.0027	-12.3%	-3.8%
2	20	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
2	20	Li_2O	0.1076	0.1090	0.0000	0.1076	0.1090		
2	20	MgO	0.6285	0.6540	0.6260	0.0025	0.0280	0.4%	4.5%
2	20	MnO	2.3629	2.3601	2.3060	0.0569	0.0541	2.5%	2.3%
2	20	Na_2O	16.3108	16.0952	16.2000	0.1108	-0.1048	0.7%	-0.6%
2	20	NiO	0.9509	1.0154	1.0220	-0.0711	-0.0066	-7.0%	-0.6%
2	20	PbO	0.0347	0.0347	0.0430	-0.0083	-0.0083	-19.2%	-19.2%
2	20	SiO_2	27.4900	27.9959	27.0000	0.4900	0.9959	1.8%	3.7%
2	20	SO_4	0.2966	0.2966	0.5130	-0.2164	-0.2164	-42.2%	-42.2%
2	20	TiO_2	0.2214	0.2303	0.2270	-0.0056	0.0033	-2.5%	1.5%
2	20	ZnO	0.0305	0.0305	0.0330	-0.0025	-0.0025	-7.6%	-7.6%
2	20	ZrO_2	0.0905	0.0905	0.1010	-0.0105	-0.0105	-10.4%	-10.4%
2	20	Sum	100.7767	102.6343	100.0020	0.7747	2.6323	0.8%	2.6%
3	21	Al_2O_3	23.6188	24.1293	23.4000	0.2188	0.7293	0.9%	3.1%
3	21	B_2O_3	3.8639	4.0488	4.0000	-0.1361	0.0488	-3.4%	1.2%
3	21	BaO	0.0480	0.0519	0.0490	-0.0010	0.0029	-2.0%	6.0%
3	21	CaO	2.0148	2.0509	2.0000	0.0148	0.0509	0.7%	2.5%
3	21	Ce_2O_3	0.0946	0.0946	0.1030	-0.0084	-0.0084	-8.2%	-8.2%
3	21	Cr_2O_3	0.0709	0.0695	0.0900	-0.0191	-0.0205	-21.2%	-22.8%
3	21	CuO	0.0325	0.0337	0.0330	-0.0005	0.0007	-1.4%	2.0%
3	21	Fe_2O_3	10.1223	10.5305	10.7720	-0.6497	-0.2415	-6.0%	-2.2%
3	21	K_2O	0.0638	0.0688	0.0690	-0.0052	-0.0002	-7.5%	-0.2%
3	21	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
3	21	Li_2O	0.1076	0.1104	0.0000	0.1076	0.1104		
3	21	MgO	0.6156	0.6461	0.6260	-0.0104	0.0201	-1.7%	3.2%
3	21	MnO	2.2822	2.2738	2.3060	-0.0238	-0.0322	-1.0%	-1.4%
3	21	Na_2O	15.6604	15.4196	15.6000	0.0604	-0.1804	0.4%	-1.2%
3	21	NiO	0.8624	0.9308	1.0220	-0.1596	-0.0912	-15.6%	-8.9%

Table A4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass. (continued)
(100 -Batch 1)

Set	Glass #	Oxide	Measured (wt %)	Measured Bias-Corrected (wt %)	Targeted (wt %)	Diff of Measured	Diff of Meas BC	% Diff of Measured	% Diff of Meas BC
3	21	PbO	0.0331	0.0331	0.0430	-0.0099	-0.0099	-23.0%	-23.0%
3	21	SiO_2	39.3631	40.4379	39.0000	0.3631	1.4379	0.9%	3.7%
3	21	SO_4	0.1498	0.1498	0.5130	-0.3632	-0.3632	-70.8%	-70.8%
3	21	TiO_2	0.2164	0.2282	0.2270	-0.0106	0.0012	-4.7%	0.5%
3	21	ZnO	0.0274	0.0274	0.0330	-0.0056	-0.0056	-17.0%	-17.0%
3	21	ZrO_2	0.0986	0.0986	0.1010	-0.0024	-0.0024	-2.4%	-2.4%
3	21	Sum	99.4050	101.4924	100.0020	-0.5970	1.4904	-0.6%	1.5%
3	22	Al_2O_3	19.3674	19.7856	19.2000	0.1674	0.5856	0.9%	3.0%
3	22	B_2O_3	18.3937	19.2738	18.0000	0.3937	1.2738	2.2%	7.1%
3	22	BaO	0.0505	0.0547	0.0490	0.0015	0.0057	3.1%	11.6%
3	22	CaO	2.0114	2.0475	2.0000	0.0114	0.0475	0.6%	2.4%
3	22	Ce_2O_3	0.0925	0.0925	0.1030	-0.0105	-0.0105	-10.2%	-10.2%
3	22	Cr_2O_3	0.0672	0.0659	0.0900	-0.0228	-0.0241	-25.3%	-26.8%
3	22	CuO	0.0338	0.0350	0.0330	0.0008	0.0020	2.4%	5.9%
3	22	Fe_2O_3	9.8399	10.2377	10.7720	-0.9321	-0.5343	-8.7%	-5.0%
3	22	K_2O	0.0599	0.0646	0.0690	-0.0091	-0.0044	-13.1%	-6.3%
3	22	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
3	22	Li_2O	0.1076	0.1104	0.0000	0.1076	0.1104		
3	22	MgO	0.6181	0.6487	0.6260	-0.0079	0.0227	-1.3%	3.6%
3	22	MnO	2.2854	2.2771	2.3060	-0.0206	-0.0289	-0.9%	-1.3%
3	22	Na_2O	13.0486	12.8480	12.8000	0.2486	0.0480	1.9%	0.4%
3	22	NiO	0.7915	0.8542	1.0220	-0.2305	-0.1678	-22.6%	-16.4%
3	22	PbO	0.0342	0.0342	0.0430	-0.0088	-0.0088	-20.5%	-20.5%
3	22	SiO_2	33.1592	34.0674	32.0000	1.1592	2.0674	3.6%	6.5%
3	22	SO_4	0.1498	0.1498	0.5130	-0.3632	-0.3632	-70.8%	-70.8%
3	22	TiO_2	0.2281	0.2405	0.2270	0.0011	0.0135	0.5%	5.9%
3	22	ZnO	0.0271	0.0271	0.0330	-0.0059	-0.0059	-18.0%	-18.0%
3	22	ZrO_2	0.0959	0.0959	0.1010	-0.0051	-0.0051	-5.0%	-5.0%
3	22	Sum	100.5205	103.0691	100.0020	0.5185	3.0671	0.5%	3.1%
3	23	Al_2O_3	20.4538	20.9915	20.4000	0.0538	0.5915	0.3%	2.9%
3	23	B_2O_3	3.9041	4.0245	4.0000	-0.0959	0.0245	-2.4%	0.6%
3	23	BaO	0.0433	0.0460	0.0490	-0.0057	-0.0030	-11.7%	-6.1%
3	23	CaO	11.8652	12.1811	12.0000	-0.1348	0.1811	-1.1%	1.5%
3	23	Ce_2O_3	0.0937	0.0937	0.1030	-0.0093	-0.0093	-9.0%	-9.0%
3	23	Cr_2O_3	0.0727	0.0702	0.0900	-0.0173	-0.0198	-19.2%	-22.0%
3	23	CuO	0.0338	0.0347	0.0330	0.0008	0.0017	2.4%	5.0%
3	23	Fe_2O_3	10.2867	10.6176	10.7720	-0.4853	-0.1544	-4.5%	-1.4%
3	23	K_2O	0.0644	0.0709	0.0690	-0.0046	0.0019	-6.6%	2.7%
3	23	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
3	23	Li_2O	0.1076	0.1084	0.0000	0.1076	0.1084		
3	23	MgO	0.6057	0.6308	0.6260	-0.0203	0.0048	-3.2%	0.8%
3	23	MnO	2.3145	2.3292	2.3060	0.0085	0.0232	0.4%	1.0%
3	23	Na_2O	13.7226	13.4714	13.6000	0.1226	-0.1286	0.9%	-0.9%
3	23	NiO	0.9041	0.9652	1.0220	-0.1179	-0.0568	-11.5%	-5.6%
3	23	PbO	0.0401	0.0401	0.0430	-0.0029	-0.0029	-6.7%	-6.7%
3	23	SiO_2	34.3358	34.7943	34.0000	0.3358	0.7943	1.0%	2.3%
3	23	SO_4	0.3595	0.3595	0.5130	-0.1535	-0.1535	-29.9%	-29.9%
3	23	TiO_2	0.2156	0.2252	0.2270	-0.0114	-0.0018	-5.0%	-0.8%
3	23	ZnO	0.0286	0.0286	0.0330	-0.0044	-0.0044	-13.2%	-13.2%
3	23	ZrO_2	0.0939	0.0939	0.1010	-0.0071	-0.0071	-7.0%	-7.0%
3	23	Sum	99.6045	101.2354	100.0020	-0.3975	1.2334	-0.4%	1.2%
3	24	Al_2O_3	16.2166	16.6430	16.2000	0.0166	0.4430	0.1%	2.7%
3	24	B_2O_3	18.1763	18.7364	18.0000	0.1763	0.7364	1.0%	4.1%
3	24	BaO	0.0469	0.0499	0.0490	-0.0021	0.0009	-4.3%	1.8%
3	24	CaO	11.9037	12.2201	12.0000	-0.0963	0.2201	-0.8%	1.8%
3	24	Ce_2O_3	0.0940	0.0940	0.1030	-0.0090	-0.0090	-8.7%	-8.7%
3	24	Cr_2O_3	0.0910	0.0878	0.0900	0.0010	-0.0022	1.1%	-2.4%
3	24	CuO	0.0319	0.0327	0.0330	-0.0011	-0.0003	-3.3%	-0.8%
3	24	Fe_2O_3	10.4761	10.8127	10.7720	-0.2959	0.0407	-2.7%	0.4%
3	24	K_2O	0.0626	0.0689	0.0690	-0.0064	-0.0001	-9.2%	-0.2%
3	24	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
3	24	Li_2O	0.1076	0.1084	0.0000	0.1076	0.1084		
3	24	MgO	0.6181	0.6437	0.6260	-0.0079	0.0177	-1.3%	2.8%
3	24	MnO	2.2887	2.3032	2.3060	-0.0173	-0.0028	-0.8%	-0.1%
3	24	Na_2O	10.8952	10.6959	10.8000	0.0952	-0.1041	0.9%	-1.0%

Table A4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass. (continued)
(100 -Batch 1)

Set	Glass #	Oxide	Measured (wt %)	Measured Bias-Corrected (wt %)	Targeted (wt %)	Diff of Measured	Diff of Meas BC	% Diff of Measured	% Diff of Meas BC
3	24	NiO	0.9067	0.9679	1.0220	-0.1153	-0.0541	-11.3%	-5.3%
3	24	PbO	0.0318	0.0318	0.0430	-0.0112	-0.0112	-26.1%	-26.1%
3	24	SiO_2	27.2226	27.5866	27.0000	0.2226	0.5866	0.8%	2.2%
3	24	SO_4	0.3221	0.3221	0.5130	-0.1909	-0.1909	-37.2%	-37.2%
3	24	TiO_2	0.2185	0.2283	0.2270	-0.0085	0.0013	-3.7%	0.6%
3	24	ZnO	0.0293	0.0293	0.0330	-0.0037	-0.0037	-11.4%	-11.4%
3	24	ZrO_2	0.0949	0.0949	0.1010	-0.0061	-0.0061	-6.0%	-6.0%
3	24	Sum	99.8932	101.8162	100.0020	-0.1088	1.8142	-0.1%	1.8%
3	25	Al_2O_3	30.3737	31.0278	31.2000	-0.8263	-0.1722	-2.6%	-0.6%
3	25	B_2O_3	4.0973	4.2239	4.0000	0.0973	0.2239	2.4%	5.6%
3	25	BaO	0.0447	0.0483	0.0490	-0.0043	-0.0007	-8.9%	-1.4%
3	25	CaO	1.9834	2.0188	2.0000	-0.0166	0.0188	-0.8%	0.9%
3	25	Ce_2O_3	0.0963	0.0963	0.1030	-0.0067	-0.0067	-6.5%	-6.5%
3	25	Cr_2O_3	0.0767	0.0752	0.0900	-0.0133	-0.0148	-14.7%	-16.4%
3	25	CuO	0.0338	0.0350	0.0330	0.0008	0.0020	2.4%	5.9%
3	25	Fe_2O_3	10.6370	10.9797	10.7720	-0.1350	0.2077	-1.3%	1.9%
3	25	K_2O	0.0620	0.0669	0.0690	-0.0070	-0.0021	-10.1%	-3.1%
3	25	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
3	25	Li_2O	0.1076	0.1084	0.0000	0.1076	0.1084		
3	25	MgO	0.6169	0.6474	0.6260	-0.0091	0.0214	-1.5%	3.4%
3	25	MnO	2.2822	2.2738	2.3060	-0.0238	-0.0322	-1.0%	-1.4%
3	25	Na_2O	8.1251	7.9997	7.8000	0.3251	0.1997	4.2%	2.6%
3	25	NiO	0.8364	0.9026	1.0220	-0.1856	-0.1194	-18.2%	-11.7%
3	25	PbO	0.0337	0.0337	0.0430	-0.0093	-0.0093	-21.7%	-21.7%
3	25	SiO_2	40.4863	41.0265	39.0000	1.4863	2.0265	3.8%	5.2%
3	25	SO_4	0.1498	0.1498	0.5130	-0.3632	-0.3632	-70.8%	-70.8%
3	25	TiO_2	0.2177	0.2295	0.2270	-0.0093	0.0025	-4.1%	1.1%
3	25	ZnO	0.0293	0.0293	0.0330	-0.0037	-0.0037	-11.4%	-11.4%
3	25	ZrO_2	0.0919	0.0919	0.1010	-0.0091	-0.0091	-9.1%	-9.1%
3	25	Sum	100.4402	102.1231	100.0020	0.4382	2.1211	0.4%	2.1%
3	26	Al_2O_3	25.7917	26.4697	25.6000	0.1917	0.8697	0.7%	3.4%
3	26	B_2O_3	18.5627	19.1347	18.0000	0.5627	1.1347	3.1%	6.3%
3	26	BaO	0.0480	0.0511	0.0490	-0.0010	0.0021	-2.0%	4.2%
3	26	CaO	2.4521	2.5173	2.0000	0.4521	0.5173	22.6%	25.9%
3	26	Ce_2O_3	0.0969	0.0969	0.1030	-0.0061	-0.0061	-5.9%	-5.9%
3	26	Cr_2O_3	0.0691	0.0667	0.0900	-0.0209	-0.0233	-23.3%	-25.9%
3	26	CuO	0.0363	0.0372	0.0330	0.0033	0.0042	10.0%	12.8%
3	26	Fe_2O_3	9.6433	9.9535	10.7720	-1.1287	-0.8185	-10.5%	-7.6%
3	26	K_2O	0.0653	0.0719	0.0690	-0.0037	0.0029	-5.3%	4.1%
3	26	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
3	26	Li_2O	0.1076	0.1084	0.0000	0.1076	0.1084		
3	26	MgO	0.6434	0.6701	0.6260	0.0174	0.0441	2.8%	7.0%
3	26	MnO	2.3661	2.3812	2.3060	0.0601	0.0752	2.6%	3.3%
3	26	Na_2O	6.6558	6.5340	6.4000	0.2558	0.1340	4.0%	2.1%
3	26	NiO	0.8656	0.9241	1.0220	-0.1564	-0.0979	-15.3%	-9.6%
3	26	PbO	0.0323	0.0323	0.0430	-0.0107	-0.0107	-24.8%	-24.8%
3	26	SiO_2	33.1057	33.5480	32.0000	1.1057	1.5480	3.5%	4.8%
3	26	SO_4	0.1498	0.1498	0.5130	-0.3632	-0.3632	-70.8%	-70.8%
3	26	TiO_2	0.2118	0.2213	0.2270	-0.0152	-0.0057	-6.7%	-2.5%
3	26	ZnO	0.0293	0.0293	0.0330	-0.0037	-0.0037	-11.4%	-11.4%
3	26	ZrO_2	0.0946	0.0946	0.1010	-0.0064	-0.0064	-6.4%	-6.4%
3	26	Sum	101.0861	103.1504	100.0020	1.0841	3.1484	1.1%	3.1%
3	27	Al_2O_3	26.6420	27.3424	27.2000	-0.5580	0.1424	-2.1%	0.5%
3	27	B_2O_3	3.9363	4.1247	4.0000	-0.0637	0.1247	-1.6%	3.1%
3	27	BaO	0.0410	0.0436	0.0490	-0.0080	-0.0054	-16.3%	-11.0%
3	27	CaO	11.8477	12.1630	12.0000	-0.1523	0.1630	-1.3%	1.4%
3	27	Ce_2O_3	0.0960	0.0960	0.1030	-0.0070	-0.0070	-6.8%	-6.8%
3	27	Cr_2O_3	0.0833	0.0804	0.0900	-0.0067	-0.0096	-7.4%	-10.6%
3	27	CuO	0.0354	0.0363	0.0330	0.0024	0.0033	7.2%	9.9%
3	27	Fe_2O_3	9.8721	10.2698	10.7720	-0.8999	-0.5022	-8.4%	-4.7%
3	27	K_2O	0.0644	0.0709	0.0690	-0.0046	0.0019	-6.6%	2.7%
3	27	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
3	27	Li_2O	0.1076	0.1104	0.0000	0.1076	0.1104		
3	27	MgO	0.6132	0.6385	0.6260	-0.0128	0.0125	-2.1%	2.0%
3	27	MnO	2.2822	2.2967	2.3060	-0.0238	-0.0093	-1.0%	-0.4%

Table A4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass. (continued)
(100 -Batch 1)

Set	Glass #	Oxide	Measured (wt %)	Measured Bias-Corrected (wt %)	Targeted (wt %)	Diff of Measured	Diff of Meas BC	% Diff of Measured	% Diff of Meas BC
3	27	Na_2O	6.8681	6.7424	6.8000	0.0681	-0.0576	1.0%	-0.8%
3	27	NiO	0.8335	0.8898	1.0220	-0.1885	-0.1322	-18.4%	-12.9%
3	27	PbO	0.0329	0.0329	0.0430	-0.0101	-0.0101	-23.6%	-23.6%
3	27	SiO_2	34.3892	35.3272	34.0000	0.3892	1.3272	1.1%	3.9%
3	27	SO_4	0.3962	0.3962	0.5130	-0.1168	-0.1168	-22.8%	-22.8%
3	27	TiO_2	0.2198	0.2296	0.2270	-0.0072	0.0026	-3.2%	1.1%
3	27	ZnO	0.0324	0.0324	0.0330	-0.0006	-0.0006	-1.9%	-1.9%
3	27	ZrO_2	0.0966	0.0966	0.1010	-0.0044	-0.0044	-4.4%	-4.4%
3	27	Sum	98.5485	101.0783	100.0020	-1.4535	1.0763	-1.5%	1.1%
3	28	Al_2O_3	21.7293	22.3005	21.6000	0.1292	0.7005	0.6%	3.2%
3	28	B_2O_3	18.3293	18.8937	18.0000	0.3293	0.8937	1.8%	5.0%
3	28	BaO	0.0447	0.0475	0.0490	-0.0043	-0.0015	-8.9%	-3.1%
3	28	CaO	12.0226	12.3427	12.0000	0.0226	0.3427	0.2%	2.9%
3	28	Ce_2O_3	0.0958	0.0958	0.1030	-0.0072	-0.0072	-7.0%	-7.0%
3	28	Cr_2O_3	0.0650	0.0628	0.0900	-0.0250	-0.0272	-27.7%	-30.2%
3	28	CuO	0.0391	0.0401	0.0330	0.0061	0.0071	18.5%	21.6%
3	28	Fe_2O_3	10.4082	10.7431	10.7720	-0.3638	-0.0289	-3.4%	-0.3%
3	28	K_2O	0.0605	0.0666	0.0690	-0.0085	-0.0024	-12.3%	-3.5%
3	28	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
3	28	Li_2O	0.1076	0.1084	0.0000	0.1076	0.1084		
3	28	MgO	0.6297	0.6558	0.6260	0.0037	0.0298	0.6%	4.8%
3	28	MnO	2.2790	2.2934	2.3060	-0.0270	-0.0126	-1.2%	-0.5%
3	28	Na_2O	5.5470	5.4455	5.4000	0.1470	0.0455	2.7%	0.8%
3	28	NiO	0.8542	0.9119	1.0220	-0.1678	-0.1101	-16.4%	-10.8%
3	28	PbO	0.0393	0.0393	0.0430	-0.0037	-0.0037	-8.6%	-8.6%
3	28	SiO_2	27.0621	27.4233	27.0000	0.0621	0.4233	0.2%	1.6%
3	28	SO_4	0.1498	0.1498	0.5130	-0.3632	-0.3632	-70.8%	-70.8%
3	28	TiO_2	0.2181	0.2278	0.2270	-0.0089	0.0008	-3.9%	0.4%
3	28	ZnO	0.0311	0.0311	0.0330	-0.0019	-0.0019	-5.7%	-5.7%
3	28	ZrO_2	0.0919	0.0919	0.1010	-0.0091	-0.0091	-9.1%	-9.1%
3	28	Sum	99.8630	102.0296	100.0020	-0.1390	2.0276	-0.1%	2.0%
3	29	Al_2O_3	7.6241	7.7891	7.8000	-0.1759	-0.0109	-2.3%	-0.1%
3	29	B_2O_3	3.8156	3.9982	4.0000	-0.1844	-0.0018	-4.6%	0.0%
3	29	BaO	0.0441	0.0477	0.0490	-0.0049	-0.0013	-10.0%	-2.6%
3	29	CaO	1.9764	2.0121	2.0000	-0.0236	0.0121	-1.2%	0.6%
3	29	Ce_2O_3	0.0887	0.0887	0.1030	-0.0143	-0.0143	-13.9%	-13.9%
3	29	Cr_2O_3	0.0833	0.0817	0.0900	-0.0067	-0.0083	-7.4%	-9.2%
3	29	CuO	0.0329	0.0340	0.0330	-0.0001	0.0010	-0.4%	3.0%
3	29	Fe_2O_3	10.4225	10.8436	10.7720	-0.3495	0.0716	-3.2%	0.7%
3	29	K_2O	0.0596	0.0643	0.0690	-0.0094	-0.0047	-13.6%	-6.8%
3	29	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
3	29	Li_2O	0.1076	0.1104	0.0000	0.1076	0.1104		
3	29	MgO	0.5966	0.6261	0.6260	-0.0294	0.0001	-4.7%	0.0%
3	29	MnO	2.1337	2.1260	2.3060	-0.1723	-0.1800	-7.5%	-7.8%
3	29	Na_2O	36.2444	35.6886	39.0000	-2.7557	-3.3114	-7.1%	-8.5%
3	29	NiO	0.8558	0.9236	1.0220	-0.1662	-0.0984	-16.3%	-9.6%
3	29	PbO	0.0345	0.0345	0.0430	-0.0085	-0.0085	-19.8%	-19.8%
3	29	SiO_2	30.2711	31.0993	31.2000	-0.9289	-0.1007	-3.0%	-0.3%
3	29	SO_4	0.4906	0.4906	0.5130	-0.0224	-0.0224	-4.4%	-4.4%
3	29	TiO_2	0.1964	0.2071	0.2270	-0.0306	-0.0199	-13.5%	-8.8%
3	29	ZnO	0.0277	0.0277	0.0330	-0.0053	-0.0053	-16.1%	-16.1%
3	29	ZrO_2	0.0892	0.0892	0.1010	-0.0118	-0.0118	-11.7%	-11.7%
3	29	Sum	95.2533	96.4409	100.0020	-4.7487	-3.5611	-4.7%	-3.6%
3	30	Al_2O_3	6.3818	6.5197	6.4000	-0.0182	0.1197	-0.3%	1.9%
3	30	B_2O_3	17.8221	18.6748	18.0000	-0.1779	0.6748	-1.0%	3.7%
3	30	BaO	0.0435	0.0471	0.0490	-0.0055	-0.0019	-11.1%	-3.9%
3	30	CaO	2.0358	2.0728	2.0000	0.0358	0.0728	1.8%	3.6%
3	30	Ce_2O_3	0.0919	0.0919	0.1030	-0.0111	-0.0111	-10.7%	-10.7%
3	30	Cr_2O_3	0.0870	0.0853	0.0900	-0.0030	-0.0047	-3.4%	-5.3%
3	30	CuO	0.0401	0.0414	0.0330	0.0071	0.0084	21.4%	25.6%
3	30	Fe_2O_3	10.4189	10.8390	10.7720	-0.3531	0.0670	-3.3%	0.6%
3	30	K_2O	0.0590	0.0636	0.0690	-0.0100	-0.0054	-14.5%	-7.8%
3	30	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
3	30	Li_2O	0.1076	0.1104	0.0000	0.1076	0.1104		
3	30	MgO	0.6177	0.6483	0.6260	-0.0083	0.0223	-1.3%	3.6%

Table A4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass. (continued)
(100 -Batch 1)

Set	Glass #	Oxide	Measured (wt %)	Measured Bias-Corrected (wt %)	Targeted (wt %)	Diff of Measured	Diff of Meas BC	% Diff of Measured	% Diff of Meas BC
3	30	MnO	2.2887	2.2803	2.3060	-0.0173	-0.0257	-0.8%	-1.1%
3	30	Na_2O	30.4210	29.9529	32.0000	-1.5790	-2.0471	-4.9%	-6.4%
3	30	NiO	0.9270	1.0005	1.0220	-0.0950	-0.0215	-9.3%	-2.1%
3	30	PbO	0.0380	0.0380	0.0430	-0.0050	-0.0050	-11.7%	-11.7%
3	30	SiO_2	25.5646	26.2629	25.6000	-0.0354	0.6629	-0.1%	2.6%
3	30	SO_4	0.4981	0.4981	0.5130	-0.0149	-0.0149	-2.9%	-2.9%
3	30	TiO_2	0.2164	0.2282	0.2270	-0.0106	0.0012	-4.7%	0.5%
3	30	ZnO	0.0352	0.0352	0.0330	0.0022	0.0022	6.6%	6.6%
3	30	ZrO_2	0.0902	0.0902	0.1010	-0.0108	-0.0108	-10.7%	-10.7%
3	30	Sum	97.8433	99.6390	100.0020	-2.1587	-0.3630	-2.2%	-0.4%
4	31	Al_2O_3	6.5802	6.8128	6.8000	-0.2198	0.0128	-3.2%	0.2%
4	31	B_2O_3	3.7673	3.8637	4.0000	-0.2327	-0.1363	-5.8%	-3.4%
4	31	BaO	0.0405	0.0444	0.0490	-0.0085	-0.0046	-17.4%	-9.3%
4	31	CaO	11.4455	12.1259	12.0000	-0.5545	0.1259	-4.6%	1.0%
4	31	Ce_2O_3	0.0876	0.0876	0.1030	-0.0154	-0.0154	-15.0%	-15.0%
4	31	Cr_2O_3	0.0840	0.0831	0.0900	-0.0060	-0.0069	-6.6%	-7.6%
4	31	CuO	0.0376	0.0392	0.0330	0.0046	0.0062	13.8%	18.8%
4	31	Fe_2O_3	10.1938	10.2584	10.7720	-0.5782	-0.5136	-5.4%	-4.8%
4	31	K_2O	0.0590	0.0621	0.0690	-0.0100	-0.0069	-14.5%	-10.0%
4	31	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
4	31	Li_2O	0.1076	0.1079	0.0000	0.1076	0.1079		
4	31	MgO	0.5659	0.5938	0.6260	-0.0601	-0.0322	-9.6%	-5.1%
4	31	MnO	2.1079	2.1535	2.3060	-0.1981	-0.1525	-8.6%	-6.6%
4	31	Na_2O	31.0040	30.6846	34.0000	-2.9960	-3.3154	-8.8%	-9.8%
4	31	NiO	0.8128	0.8848	1.0220	-0.2092	-0.1372	-20.5%	-13.4%
4	31	PbO	0.0339	0.0339	0.0430	-0.0091	-0.0091	-21.1%	-21.1%
4	31	SiO_2	25.8855	25.9128	27.2000	-1.3145	-1.2872	-4.8%	-4.7%
4	31	SO_4	0.4793	0.4793	0.5130	-0.0337	-0.0337	-6.6%	-6.6%
4	31	TiO_2	0.2102	0.2224	0.2270	-0.0168	-0.0046	-7.4%	-2.0%
4	31	ZnO	0.0293	0.0293	0.0330	-0.0037	-0.0037	-11.4%	-11.4%
4	31	ZrO_2	0.0878	0.0878	0.1010	-0.0132	-0.0132	-13.1%	-13.1%
4	31	Sum	93.6782	94.6261	100.0020	-6.3238	-5.3759	-6.3%	-5.4%
4	32	Al_2O_3	5.6118	5.6006	5.4000	0.2118	0.2006	3.9%	3.7%
4	32	B_2O_3	17.8865	18.1520	18.0000	-0.1135	0.1520	-0.6%	0.8%
4	32	BaO	0.0419	0.0455	0.0490	-0.0071	-0.0035	-14.6%	-7.1%
4	32	CaO	12.1311	12.1375	12.0000	0.1311	0.1375	1.1%	1.1%
4	32	Ce_2O_3	0.0937	0.0937	0.1030	-0.0093	-0.0093	-9.0%	-9.0%
4	32	Cr_2O_3	0.0892	0.0878	0.0900	-0.0008	-0.0022	-0.9%	-2.4%
4	32	CuO	0.0363	0.0377	0.0330	0.0033	0.0047	10.0%	14.2%
4	32	Fe_2O_3	10.8264	10.9314	10.7720	0.0544	0.1594	0.5%	1.5%
4	32	K_2O	0.0629	0.0664	0.0690	-0.0061	-0.0026	-8.8%	-3.7%
4	32	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
4	32	Li_2O	0.1076	0.1067	0.0000	0.1076	0.1067		
4	32	MgO	0.6231	0.6539	0.6260	-0.0029	0.0279	-0.5%	4.5%
4	32	MnO	2.2983	2.2871	2.3060	-0.0077	-0.0189	-0.3%	-0.8%
4	32	Na_2O	26.7241	25.9174	27.0000	-0.2759	-1.0826	-1.0%	-4.0%
4	32	NiO	0.9327	1.0128	1.0220	-0.0893	-0.0092	-8.7%	-0.9%
4	32	PbO	0.0353	0.0353	0.0430	-0.0077	-0.0077	-18.0%	-18.0%
4	32	SiO_2	21.6604	21.6520	21.6000	0.0604	0.0520	0.3%	0.2%
4	32	SO_4	0.5213	0.5213	0.5130	0.0083	0.0083	1.6%	1.6%
4	32	TiO_2	0.2214	0.2341	0.2270	-0.0056	0.0071	-2.5%	3.1%
4	32	ZnO	0.0271	0.0271	0.0330	-0.0059	-0.0059	-18.0%	-18.0%
4	32	ZrO_2	0.0929	0.0929	0.1010	-0.0081	-0.0081	-8.1%	-8.1%
4	32	Sum	100.0827	99.7520	100.0020	0.0807	-0.2500	0.1%	-0.2%
4	33	Al_2O_3	23.6660	23.6203	23.4000	0.2660	0.2203	1.1%	0.9%
4	33	B_2O_3	3.9524	4.0110	4.0000	-0.0476	0.0110	-1.2%	0.3%
4	33	BaO	0.0441	0.0480	0.0490	-0.0049	-0.0010	-10.0%	-2.1%
4	33	CaO	2.0079	2.0087	2.0000	0.0079	0.0087	0.4%	0.4%
4	33	Ce_2O_3	0.0952	0.0952	0.1030	-0.0078	-0.0078	-7.6%	-7.6%
4	33	Cr_2O_3	0.0870	0.0856	0.0900	-0.0030	-0.0044	-3.4%	-4.8%
4	33	CuO	0.0344	0.0357	0.0330	0.0014	0.0027	4.3%	8.3%
4	33	Fe_2O_3	10.5512	10.6552	10.7720	-0.2208	-0.1168	-2.0%	-1.1%
4	33	K_2O	0.0653	0.0690	0.0690	-0.0037	0.0000	-5.3%	0.0%
4	33	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
4	33	Li_2O	0.1076	0.1067	0.0000	0.1076	0.1067		

Table A4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass. (continued)
(100 -Batch 1)

Set	Glass #	Oxide	Measured (wt %)	Measured Bias-Corrected (wt %)	Targeted (wt %)	Diff of Measured	Diff of Meas BC	% Diff of Measured	% Diff of Meas BC
4	33	MgO	0.6314	0.6626	0.6260	0.0054	0.0366	0.9%	5.9%
4	33	MnO	2.3306	2.3193	2.3060	0.0246	0.0133	1.1%	0.6%
4	33	Na_2O	23.3878	22.6802	23.4000	-0.0122	-0.7198	-0.1%	-3.1%
4	33	NiO	0.9343	1.0146	1.0220	-0.0877	-0.0074	-8.6%	-0.7%
4	33	PbO	0.0347	0.0347	0.0430	-0.0083	-0.0083	-19.2%	-19.2%
4	33	SiO_2	31.3942	31.3825	31.2000	0.1942	0.1825	0.6%	0.6%
4	33	SO_4	0.4539	0.4539	0.5130	-0.0591	-0.0591	-11.5%	-11.5%
4	33	TiO_2	0.2277	0.2408	0.2270	0.0007	0.0138	0.3%	6.1%
4	33	ZnO	0.0308	0.0308	0.0330	-0.0022	-0.0022	-6.6%	-6.6%
4	33	ZrO_2	0.0979	0.0979	0.1010	-0.0031	-0.0031	-3.0%	-3.0%
4	33	Sum	100.1932	99.7113	100.0020	0.1912	-0.2907	0.2%	-0.3%
4	34	Al_2O_3	19.1595	19.8386	19.2000	-0.0405	0.6386	-0.2%	3.3%
4	34	B_2O_3	18.2407	18.7074	18.0000	0.2407	0.7074	1.3%	3.9%
4	34	BaO	0.0430	0.0472	0.0490	-0.0060	-0.0018	-12.3%	-3.7%
4	34	CaO	1.9729	2.0886	2.0000	-0.0271	0.0886	-1.4%	4.4%
4	34	Ce_2O_3	0.0966	0.0966	0.1030	-0.0064	-0.0064	-6.2%	-6.2%
4	34	Cr_2O_3	0.0833	0.0824	0.0900	-0.0067	-0.0076	-7.4%	-8.4%
4	34	CuO	0.0341	0.0356	0.0330	0.0011	0.0026	3.4%	7.9%
4	34	Fe_2O_3	10.6441	10.7130	10.7720	-0.1279	-0.0590	-1.2%	-0.5%
4	34	K_2O	0.0590	0.0621	0.0690	-0.0100	-0.0069	-14.5%	-10.0%
4	34	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
4	34	Li_2O	0.1076	0.1079	0.0000	0.1076	0.1079		
4	34	MgO	0.6223	0.6529	0.6260	-0.0037	0.0269	-0.6%	4.3%
4	34	MnO	2.3048	2.3548	2.3060	-0.0012	0.0488	-0.1%	2.1%
4	34	Na_2O	18.8720	18.6776	19.2000	-0.3280	-0.5224	-1.7%	-2.7%
4	34	NiO	0.9248	1.0067	1.0220	-0.0972	-0.0153	-9.5%	-1.5%
4	34	PbO	0.0347	0.0347	0.0430	-0.0083	-0.0083	-19.2%	-19.2%
4	34	SiO_2	26.3134	26.3411	25.6000	0.7134	0.7411	2.8%	2.9%
4	34	SO_4	0.3453	0.3453	0.5130	-0.1677	-0.1677	-32.7%	-32.7%
4	34	TiO_2	0.2231	0.2361	0.2270	-0.0039	0.0091	-1.7%	4.0%
4	34	ZnO	0.0296	0.0296	0.0330	-0.0034	-0.0034	-10.4%	-10.4%
4	34	ZrO_2	0.0939	0.0939	0.1010	-0.0071	-0.0071	-7.0%	-7.0%
4	34	Sum	100.2634	101.6107	100.0020	0.2614	1.6087	0.3%	1.6%
4	35	Al_2O_3	20.4066	20.3656	20.4000	0.0066	-0.0344	0.0%	-0.2%
4	35	B_2O_3	3.9524	4.0110	4.0000	-0.0476	0.0110	-1.2%	0.3%
4	35	BaO	0.0430	0.0468	0.0490	-0.0060	-0.0022	-12.3%	-4.6%
4	35	CaO	12.1660	12.1711	12.0000	0.1660	0.1711	1.4%	1.4%
4	35	Ce_2O_3	0.0934	0.0934	0.1030	-0.0096	-0.0096	-9.3%	-9.3%
4	35	Cr_2O_3	0.0881	0.0867	0.0900	-0.0019	-0.0033	-2.2%	-3.6%
4	35	CuO	0.0382	0.0396	0.0330	0.0052	0.0066	15.7%	20.1%
4	35	Fe_2O_3	10.9551	11.0640	10.7720	0.1831	0.2920	1.7%	2.7%
4	35	K_2O	0.0738	0.0779	0.0690	0.0048	0.0089	6.9%	12.9%
4	35	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
4	35	Li_2O	0.1076	0.1067	0.0000	0.1076	0.1067		
4	35	MgO	0.6156	0.6461	0.6260	-0.0104	0.0201	-1.7%	3.2%
4	35	MnO	2.2951	2.2839	2.3060	-0.0109	-0.0221	-0.5%	-1.0%
4	35	Na_2O	20.5907	19.9680	20.4000	0.1907	-0.4320	0.9%	-2.1%
4	35	NiO	0.9178	0.9966	1.0220	-0.1042	-0.0254	-10.2%	-2.5%
4	35	PbO	0.0315	0.0315	0.0430	-0.0115	-0.0115	-26.7%	-26.7%
4	35	SiO_2	27.0621	27.0528	27.2000	-0.1379	-0.1472	-0.5%	-0.5%
4	35	SO_4	0.4868	0.4868	0.5130	-0.0262	-0.0262	-5.1%	-5.1%
4	35	TiO_2	0.2218	0.2346	0.2270	-0.0052	0.0076	-2.3%	3.3%
4	35	ZnO	0.0324	0.0324	0.0330	-0.0006	-0.0006	-1.9%	-1.9%
4	35	ZrO_2	0.0952	0.0952	0.1010	-0.0058	-0.0058	-5.7%	-5.7%
4	35	Sum	100.3320	99.9493	100.0020	0.3300	-0.0527	0.3%	-0.1%
4	36	Al_2O_3	16.2875	16.2543	16.2000	0.0875	0.0543	0.5%	0.3%
4	36	B_2O_3	17.7819	18.0458	18.0000	-0.2181	0.0458	-1.2%	0.3%
4	36	BaO	0.0438	0.0477	0.0490	-0.0052	-0.0013	-10.6%	-2.7%
4	36	CaO	12.0681	12.0732	12.0000	0.0681	0.0732	0.6%	0.6%
4	36	Ce_2O_3	0.0955	0.0955	0.1030	-0.0075	-0.0075	-7.3%	-7.3%
4	36	Cr_2O_3	0.0859	0.0846	0.0900	-0.0041	-0.0054	-4.6%	-6.0%
4	36	CuO	0.0460	0.0478	0.0330	0.0130	0.0148	39.4%	44.7%
4	36	Fe_2O_3	10.8121	10.9183	10.7720	0.0401	0.1463	0.4%	1.4%
4	36	K_2O	0.0617	0.0652	0.0690	-0.0073	-0.0038	-10.5%	-5.6%
4	36	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%

Table A4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass. (continued)
(100 -Batch 1)

Set	Glass #	Oxide	Measured (wt %)	Measured Bias-Corrected (wt %)	Targeted (wt %)	Diff of Measured	Diff of Meas BC	% Diff of Measured	% Diff of Meas BC
4	36	Li_2O	0.1076	0.1067	0.0000	0.1076	0.1067		
4	36	MgO	0.6214	0.6522	0.6260	-0.0046	0.0262	-0.7%	4.2%
4	36	MnO	2.3242	2.3127	2.3060	0.0182	0.0067	0.8%	0.3%
4	36	Na_2O	16.4793	15.9806	16.2000	0.2793	-0.2194	1.7%	-1.4%
4	36	NiO	0.9124	0.9907	1.0220	-0.1096	-0.0313	-10.7%	-3.1%
4	36	PbO	0.0361	0.0361	0.0430	-0.0069	-0.0069	-16.1%	-16.1%
4	36	SiO_2	21.7139	21.7057	21.6000	0.1139	0.1057	0.5%	0.5%
4	36	SO_4	0.3528	0.3528	0.5130	-0.1602	-0.1602	-31.2%	-31.2%
4	36	TiO_2	0.2210	0.2337	0.2270	-0.0060	0.0067	-2.6%	3.0%
4	36	ZnO	0.0352	0.0352	0.0330	0.0022	0.0022	6.6%	6.6%
4	36	ZrO_2	0.0969	0.0969	0.1010	-0.0041	-0.0041	-4.0%	-4.0%
4	36	Sum	100.2419	100.1943	100.0020	0.2399	0.1923	0.2%	0.2%
4	37	Al_2O_3	37.9790	39.3269	39.0000	-1.0211	0.3269	-2.6%	0.8%
4	37	B_2O_3	4.0249	4.1279	4.0000	0.0249	0.1279	0.6%	3.2%
4	37	BaO	0.0438	0.0481	0.0490	-0.0052	-0.0009	-10.6%	-1.8%
4	37	CaO	1.9484	2.0628	2.0000	-0.0516	0.0628	-2.6%	3.1%
4	37	Ce_2O_3	0.0946	0.0946	0.1030	-0.0084	-0.0084	-8.2%	-8.2%
4	37	Cr_2O_3	0.0731	0.0723	0.0900	-0.0169	-0.0177	-18.8%	-19.7%
4	37	CuO	0.0307	0.0320	0.0330	-0.0023	-0.0010	-7.1%	-3.0%
4	37	Fe_2O_3	10.4189	10.4874	10.7720	-0.3531	-0.2846	-3.3%	-2.6%
4	37	K_2O	0.0629	0.0662	0.0690	-0.0061	-0.0028	-8.8%	-4.1%
4	37	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
4	37	Li_2O	0.1076	0.1079	0.0000	0.1076	0.1079		
4	37	MgO	0.5895	0.6186	0.6260	-0.0365	-0.0074	-5.8%	-1.2%
4	37	MnO	2.3016	2.3514	2.3060	-0.0044	0.0454	-0.2%	2.0%
4	37	Na_2O	8.1588	8.0747	7.8000	0.3588	0.2747	4.6%	3.5%
4	37	NiO	0.9534	1.0379	1.0220	-0.0686	0.0159	-6.7%	1.6%
4	37	PbO	0.0342	0.0342	0.0430	-0.0088	-0.0088	-20.5%	-20.5%
4	37	SiO_2	32.5174	32.5519	31.2000	1.3174	1.3519	4.2%	4.3%
4	37	SO_4	0.1498	0.1498	0.5130	-0.3632	-0.3632	-70.8%	-70.8%
4	37	TiO_2	0.2218	0.2348	0.2270	-0.0052	0.0078	-2.3%	3.4%
4	37	ZnO	0.0293	0.0293	0.0330	-0.0037	-0.0037	-11.4%	-11.4%
4	37	ZrO_2	0.0821	0.0821	0.1010	-0.0189	-0.0189	-18.8%	-18.8%
4	37	Sum	99.8803	101.6493	100.0020	-0.1217	1.6473	-0.1%	1.6%
4	38	Al_2O_3	31.1768	32.2840	32.0000	-0.8233	0.2840	-2.6%	0.9%
4	38	B_2O_3	18.7076	19.1861	18.0000	0.7076	1.1861	3.9%	6.6%
4	38	BaO	0.0466	0.0512	0.0490	-0.0024	0.0022	-4.9%	4.5%
4	38	CaO	1.9659	2.0815	2.0000	-0.0341	0.0815	-1.7%	4.1%
4	38	Ce_2O_3	0.0960	0.0960	0.1030	-0.0070	-0.0070	-6.8%	-6.8%
4	38	Cr_2O_3	0.0833	0.0824	0.0900	-0.0067	-0.0076	-7.4%	-8.4%
4	38	CuO	0.0332	0.0346	0.0330	0.0002	0.0016	0.5%	4.9%
4	38	Fe_2O_3	11.0123	11.0810	10.7720	0.2403	0.3090	2.2%	2.9%
4	38	K_2O	0.0614	0.0646	0.0690	-0.0076	-0.0044	-11.0%	-6.4%
4	38	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
4	38	Li_2O	0.1076	0.1079	0.0000	0.1076	0.1079		
4	38	MgO	0.6376	0.6690	0.6260	0.0116	0.0430	1.9%	6.9%
4	38	MnO	2.2887	2.3383	2.3060	-0.0173	0.0323	-0.8%	1.4%
4	38	Na_2O	6.7333	6.6638	6.4000	0.3333	0.2638	5.2%	4.1%
4	38	NiO	0.9633	1.0486	1.0220	-0.0587	0.0266	-5.7%	2.6%
4	38	PbO	0.0339	0.0339	0.0430	-0.0091	-0.0091	-21.1%	-21.1%
4	38	SiO_2	26.5808	26.6085	25.6000	0.9808	1.0085	3.8%	3.9%
4	38	SO_4	0.1498	0.1498	0.5130	-0.3632	-0.3632	-70.8%	-70.8%
4	38	TiO_2	0.2248	0.2379	0.2270	-0.0022	0.0109	-1.0%	4.8%
4	38	ZnO	0.0299	0.0299	0.0330	-0.0031	-0.0031	-9.5%	-9.5%
4	38	ZrO_2	0.0922	0.0922	0.1010	-0.0088	-0.0088	-8.7%	-8.7%
4	38	Sum	101.0835	102.9997	100.0020	1.0815	2.9977	1.1%	3.0%
4	39	Al_2O_3	33.5386	34.7255	34.0000	-0.4614	0.7255	-1.4%	2.1%
4	39	B_2O_3	3.9685	4.0701	4.0000	-0.0315	0.0701	-0.8%	1.8%
4	39	BaO	0.0410	0.0451	0.0490	-0.0080	-0.0039	-16.3%	-8.1%
4	39	CaO	11.9037	12.6102	12.0000	-0.0963	0.6102	-0.8%	5.1%
4	39	Ce_2O_3	0.0949	0.0949	0.1030	-0.0081	-0.0081	-7.9%	-7.9%
4	39	Cr_2O_3	0.0625	0.0618	0.0900	-0.0275	-0.0282	-30.6%	-31.3%
4	39	CuO	0.0322	0.0337	0.0330	-0.0008	0.0007	-2.3%	2.0%
4	39	Fe_2O_3	10.6441	10.7122	10.7720	-0.1279	-0.0598	-1.2%	-0.6%
4	39	K_2O	0.0602	0.0633	0.0690	-0.0088	-0.0057	-12.7%	-8.2%

Table A4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass. (continued)
(100 -Batch 1)

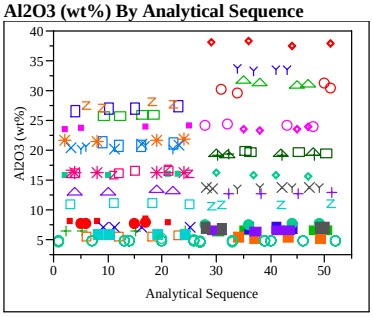
Set	Glass #	Oxide	Measured (wt %)	Measured Bias-Corrected (wt %)	Targeted (wt %)	Diff of Measured	Diff of Meas BC	% Diff of Measured	% Diff of Meas BC
4	39	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
4	39	Li_2O	0.1076	0.1079	0.0000	0.1076	0.1079		
4	39	MgO	0.6119	0.6421	0.6260	-0.0141	0.0161	-2.3%	2.6%
4	39	MnO	2.2983	2.3483	2.3060	-0.0077	0.0423	-0.3%	1.8%
4	39	Na_2O	7.0635	6.9907	6.8000	0.2635	0.1907	3.9%	2.8%
4	39	NiO	0.8838	0.9620	1.0220	-0.1382	-0.0600	-13.5%	-5.9%
4	39	PbO	0.0347	0.0347	0.0430	-0.0083	-0.0083	-19.2%	-19.2%
4	39	SiO_2	27.7574	27.7864	27.2000	0.5574	0.5864	2.0%	2.2%
4	39	SO_4	0.1498	0.1498	0.5130	-0.3632	-0.3632	-70.8%	-70.8%
4	39	TiO_2	0.2173	0.2299	0.2270	-0.0097	0.0029	-4.3%	1.3%
4	39	ZnO	0.0293	0.0293	0.0330	-0.0037	-0.0037	-11.4%	-11.4%
4	39	ZrO_2	0.0929	0.0929	0.1010	-0.0081	-0.0081	-8.1%	-8.1%
4	39	Sum	99.6510	101.8493	100.0020	-0.3510	1.8473	-0.4%	1.8%
4	40	Al_2O_3	27.5867	27.5313	27.0000	0.5867	0.5313	2.2%	2.0%
4	40	B_2O_3	18.0878	18.3564	18.0000	0.0878	0.3564	0.5%	2.0%
4	40	BaO	0.0444	0.0483	0.0490	-0.0046	-0.0007	-9.4%	-1.5%
4	40	CaO	12.2220	12.2277	12.0000	0.2220	0.2277	1.9%	1.9%
4	40	Ce_2O_3	0.0940	0.0940	0.1030	-0.0090	-0.0090	-8.7%	-8.7%
4	40	Cr_2O_3	0.0621	0.0612	0.0900	-0.0279	-0.0288	-31.0%	-32.0%
4	40	CuO	0.0354	0.0367	0.0330	0.0024	0.0037	7.2%	11.3%
4	40	Fe_2O_3	10.1080	10.2055	10.7720	-0.6640	-0.5665	-6.2%	-5.3%
4	40	K_2O	0.0650	0.0687	0.0690	-0.0040	-0.0003	-5.7%	-0.5%
4	40	La_2O_3	0.0586	0.0586	0.0150	0.0436	0.0436	290.9%	290.9%
4	40	Li_2O	0.1076	0.1067	0.0000	0.1076	0.1067		
4	40	MgO	0.6260	0.6570	0.6260	0.0000	0.0310	0.0%	5.0%
4	40	MnO	2.3242	2.3128	2.3060	0.0182	0.0068	0.8%	0.3%
4	40	Na_2O	5.7223	5.5485	5.4000	0.3223	0.1485	6.0%	2.7%
4	40	NiO	0.8211	0.8916	1.0220	-0.2009	-0.1304	-19.7%	-12.8%
4	40	PbO	0.0342	0.0342	0.0430	-0.0088	-0.0088	-20.5%	-20.5%
4	40	SiO_2	21.8743	21.8655	21.6000	0.2743	0.2655	1.3%	1.2%
4	40	SO_4	0.1498	0.1498	0.5130	-0.3632	-0.3632	-70.8%	-70.8%
4	40	TiO_2	0.2218	0.2346	0.2270	-0.0052	0.0076	-2.3%	3.3%
4	40	ZnO	0.0305	0.0305	0.0330	-0.0025	-0.0025	-7.6%	-7.6%
4	40	ZrO_2	0.0962	0.0962	0.1010	-0.0048	-0.0048	-4.7%	-4.7%
4	40	Sum	100.3721	100.6158	100.0020	0.3701	0.6138	0.4%	0.6%
1	100	Al_2O_3	4.7584	4.8770	4.8770	-0.1186	0.0000	-2.4%	0.0%
1	100	B_2O_3	7.5963	7.7770	7.7770	-0.1807	0.0000	-2.3%	0.0%
1	100	BaO	0.1401	0.1510	0.1510	-0.0109	0.0000	-7.2%	0.0%
1	100	CaO	1.1450	1.2200	1.2200	-0.0750	0.0000	-6.1%	0.0%
1	100	Ce_2O_3	0.0059	0.0059	0.0000	0.0059	0.0059		
1	100	Cr_2O_3	0.1089	0.1070	0.1070	0.0019	0.0000	1.8%	0.0%
1	100	CuO	0.3928	0.3990	0.3990	-0.0062	0.0000	-1.6%	0.0%
1	100	Fe_2O_3	12.5266	12.8390	12.8390	-0.3124	0.0000	-2.4%	0.0%
1	100	K_2O	3.0838	3.3270	3.3270	-0.2432	0.0000	-7.3%	0.0%
1	100	La_2O_3	0.0586	0.0586	0.0000	0.0586	0.0586		
1	100	Li_2O	4.3524	4.4290	4.4290	-0.0766	0.0000	-1.7%	0.0%
1	100	MgO	1.3674	1.4190	1.4190	-0.0516	0.0000	-3.6%	0.0%
1	100	MnO	1.7173	1.7260	1.7260	-0.0087	0.0000	-0.5%	0.0%
1	100	Na_2O	9.2158	9.0030	9.0030	0.2128	0.0000	2.4%	0.0%
1	100	NiO	0.7037	0.7510	0.7510	-0.0473	0.0000	-6.3%	0.0%
1	100	PbO	0.0054	0.0054	0.0000	0.0054	0.0054		
1	100	SiO_2	49.0613	50.2200	50.2200	-1.1587	0.0000	-2.3%	0.0%
1	100	SO_4	0.1498	0.1498	0.0000	0.1498	0.1498		
1	100	TiO_2	0.6494	0.6770	0.6770	-0.0276	0.0000	-4.1%	0.0%
1	100	ZnO	0.0062	0.0062	0.0000	0.0062	0.0062		
1	100	ZrO_2	0.0859	0.0859	0.0980	-0.0121	-0.0121	-12.4%	-12.4%
1	100	Sum	97.1309	99.2338	99.0200	-1.8891	0.2138	-1.9%	0.2%
2	100	Al_2O_3	4.7489	4.8770	4.8770	-0.1281	0.0000	-2.6%	0.0%
2	100	B_2O_3	7.6687	7.7770	7.7770	-0.1083	0.0000	-1.4%	0.0%
2	100	BaO	0.1414	0.1510	0.1510	-0.0096	0.0000	-6.3%	0.0%
2	100	CaO	1.1779	1.2200	1.2200	-0.0421	0.0000	-3.5%	0.0%
2	100	Ce_2O_3	0.0059	0.0059	0.0000	0.0059	0.0059		
2	100	Cr_2O_3	0.1105	0.1070	0.1070	0.0035	0.0000	3.2%	0.0%
2	100	CuO	0.3904	0.3990	0.3990	-0.0086	0.0000	-2.2%	0.0%
2	100	Fe_2O_3	12.5861	12.8390	12.8390	-0.2529	0.0000	-2.0%	0.0%

Table A4. Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by SB4 Variability Study Glass. (continued)
(100 -Batch 1)

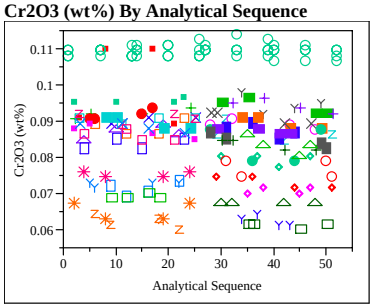
Set	Glass #	Oxide	Measured (wt %)	Measured Bias-Corrected (wt %)	Targeted (wt %)	Diff of Measured	Diff of Meas BC	% Diff of Measured	% Diff of Meas BC
2	100	K_2O	3.0436	3.3270	3.3270	-0.2834	0.0000	-8.5%	0.0%
2	100	La_2O_3	0.0586	0.0586	0.0000	0.0586	0.0586		
2	100	Li_2O	4.3722	4.4290	4.4290	-0.0568	0.0000	-1.3%	0.0%
2	100	MgO	1.3706	1.4190	1.4190	-0.0484	0.0000	-3.4%	0.0%
2	100	MnO	1.7259	1.7260	1.7260	-0.0001	0.0000	0.0%	0.0%
2	100	Na_2O	9.0732	9.0030	9.0030	0.0702	0.0000	0.8%	0.0%
2	100	NiO	0.7074	0.7510	0.7510	-0.0436	0.0000	-5.8%	0.0%
2	100	PbO	0.0054	0.0054	0.0000	0.0054	0.0054		
2	100	SiO_2	49.3643	50.2200	50.2200	-0.8557	0.0000	-1.7%	0.0%
2	100	SO_4	0.1498	0.1498	0.0000	0.1498	0.1498		
2	100	TiO_2	0.6525	0.6770	0.6770	-0.0245	0.0000	-3.6%	0.0%
2	100	ZnO	0.0062	0.0062	0.0000	0.0062	0.0062		
2	100	ZrO_2	0.0879	0.0879	0.0980	-0.0101	-0.0101	-10.3%	-10.3%
2	100	Sum	97.4474	99.2358	99.0200	-1.5726	0.2158	-1.6%	0.2%
3	100	Al_2O_3	4.7631	4.8770	4.8770	-0.1139	0.0000	-2.3%	0.0%
3	100	B_2O_3	7.4836	7.7770	7.7770	-0.2934	0.0000	-3.8%	0.0%
3	100	BaO	0.1408	0.1510	0.1510	-0.0102	0.0000	-6.8%	0.0%
3	100	CaO	1.1938	1.2200	1.2200	-0.0262	0.0000	-2.2%	0.0%
3	100	Ce_2O_3	0.0059	0.0059	0.0000	0.0059	0.0059		
3	100	Cr_2O_3	0.1100	0.1070	0.1070	0.0030	0.0000	2.8%	0.0%
3	100	CuO	0.3874	0.3990	0.3990	-0.0116	0.0000	-2.9%	0.0%
3	100	Fe_2O_3	12.3895	12.8390	12.8390	-0.4495	0.0000	-3.5%	0.0%
3	100	K_2O	3.0557	3.3270	3.3270	-0.2713	0.0000	-8.2%	0.0%
3	100	La_2O_3	0.0586	0.0586	0.0000	0.0586	0.0586		
3	100	Li_2O	4.3596	4.4290	4.4290	-0.0694	0.0000	-1.6%	0.0%
3	100	MgO	1.3573	1.4190	1.4190	-0.0617	0.0000	-4.3%	0.0%
3	100	MnO	1.7238	1.7260	1.7260	-0.0022	0.0000	-0.1%	0.0%
3	100	Na_2O	9.1574	9.0030	9.0030	0.1544	0.0000	1.7%	0.0%
3	100	NiO	0.6997	0.7510	0.7510	-0.0513	0.0000	-6.8%	0.0%
3	100	PbO	0.0054	0.0054	0.0000	0.0054	0.0054		
3	100	SiO_2	49.2217	50.2200	50.2200	-0.9983	0.0000	-2.0%	0.0%
3	100	SO_4	0.1498	0.1498	0.0000	0.1498	0.1498		
3	100	TiO_2	0.6451	0.6770	0.6770	-0.0319	0.0000	-4.7%	0.0%
3	100	ZnO	0.0062	0.0062	0.0000	0.0062	0.0062		
3	100	ZrO_2	0.0871	0.0871	0.0980	-0.0109	-0.0109	-11.1%	-11.1%
3	100	Sum	97.0015	99.2350	99.0200	-2.0185	0.2150	-2.0%	0.2%
4	100	Al_2O_3	4.7993	4.8770	4.8770	-0.0777	0.0000	-1.6%	0.0%
4	100	B_2O_3	7.6231	7.7770	7.7770	-0.1539	0.0000	-2.0%	0.0%
4	100	BaO	0.1382	0.1510	0.1510	-0.0128	0.0000	-8.5%	0.0%
4	100	CaO	1.1866	1.2200	1.2200	-0.0334	0.0000	-2.7%	0.0%
4	100	Ce_2O_3	0.0059	0.0059	0.0000	0.0059	0.0059		
4	100	Cr_2O_3	0.1084	0.1070	0.1070	0.0014	0.0000	1.3%	0.0%
4	100	CuO	0.3832	0.3990	0.3990	-0.0158	0.0000	-4.0%	0.0%
4	100	Fe_2O_3	12.7339	12.8390	12.8390	-0.1051	0.0000	-0.8%	0.0%
4	100	K_2O	3.1581	3.3270	3.3270	-0.1689	0.0000	-5.1%	0.0%
4	100	La_2O_3	0.0586	0.0586	0.0000	0.0586	0.0586		
4	100	Li_2O	4.4439	4.4290	4.4290	0.0149	0.0000	0.3%	0.0%
4	100	MgO	1.3522	1.4190	1.4190	-0.0668	0.0000	-4.7%	0.0%
4	100	MnO	1.7119	1.7260	1.7260	-0.0141	0.0000	-0.8%	0.0%
4	100	Na_2O	9.1911	9.0030	9.0030	0.1881	0.0000	2.1%	0.0%
4	100	NiO	0.6908	0.7510	0.7510	-0.0602	0.0000	-8.0%	0.0%
4	100	PbO	0.0054	0.0054	0.0000	0.0054	0.0054		
4	100	SiO_2	50.2022	50.2200	50.2200	-0.0178	0.0000	0.0%	0.0%
4	100	SO_4	0.1498	0.1498	0.0000	0.1498	0.1498		
4	100	TiO_2	0.6400	0.6770	0.6770	-0.0370	0.0000	-5.5%	0.0%
4	100	ZnO	0.0062	0.0062	0.0000	0.0062	0.0062		
4	100	ZrO_2	0.0904	0.0904	0.0980	-0.0076	-0.0076	-7.8%	-7.8%
4	100	Sum	98.6791	99.2383	99.0200	-0.3409	0.2183	-0.3%	0.2%

Exhibit A1. Oxide Measurements in Analytical Sequence for Samples Prepared Using the LM Method. (continued)

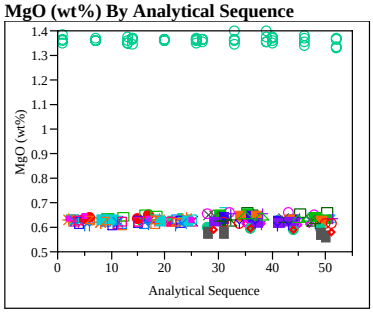
Al2O3 (wt%) By Analytical Sequence



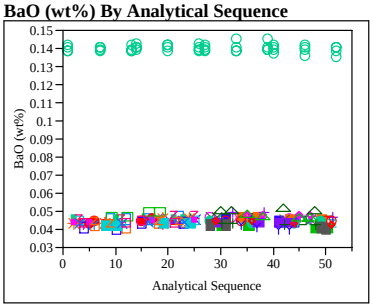
Cr2O3 (wt%) By Analytical Sequence



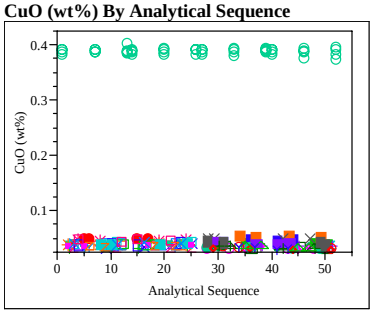
MgO (wt%) By Analytical Sequence



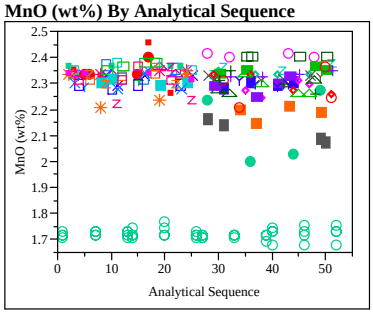
BaO (wt%) By Analytical Sequence



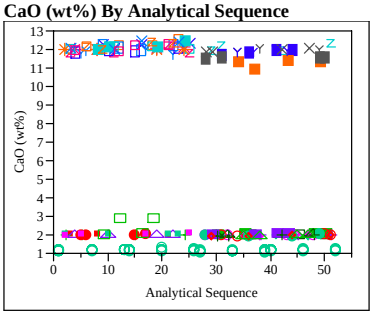
CuO (wt%) By Analytical Sequence



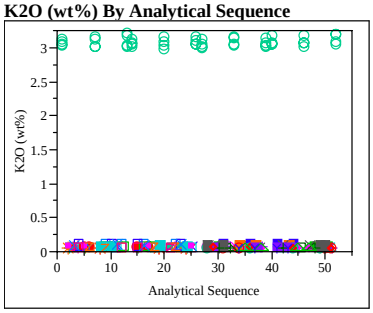
MnO (wt%) By Analytical Sequence



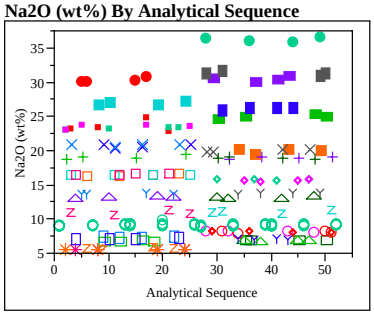
CaO (wt%) By Analytical Sequence



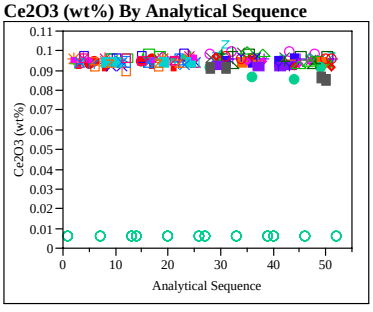
K2O (wt%) By Analytical Sequence



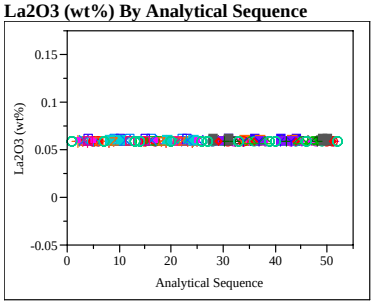
Na2O (wt%) By Analytical Sequence



Ce2O3 (wt%) By Analytical Sequence



La2O3 (wt%) By Analytical Sequence



NiO (wt%) By Analytical Sequence

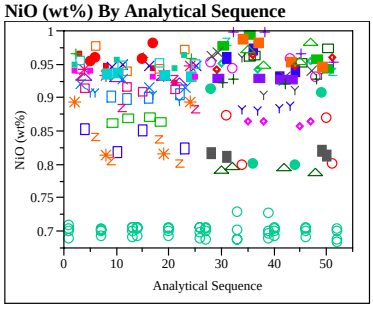
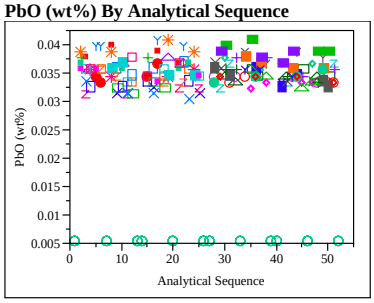
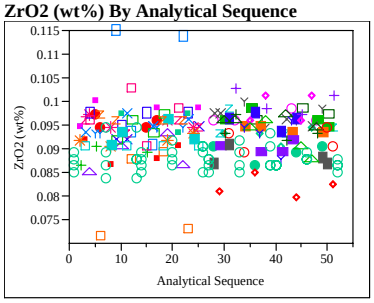


Exhibit A1. Oxide Measurements in Analytical Sequence for Samples Prepared Using the LM Method. (continued)

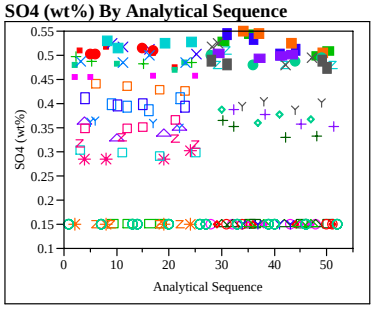
PbO (wt%) By Analytical Sequence



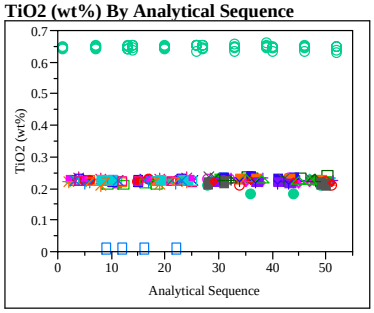
ZrO2 (wt%) By Analytical Sequence



SO4 (wt%) By Analytical Sequence



TiO2 (wt%) By Analytical Sequence



ZnO (wt%) By Analytical Sequence

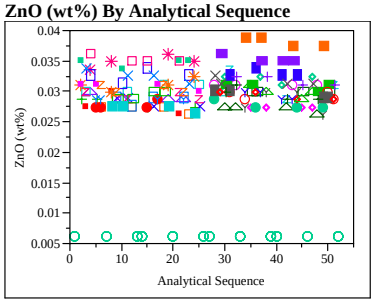
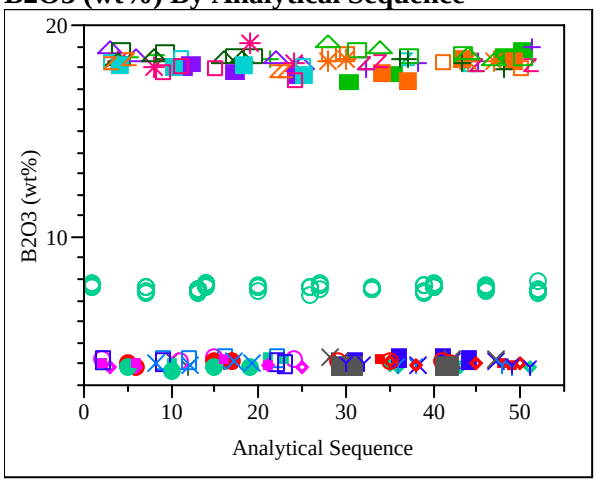
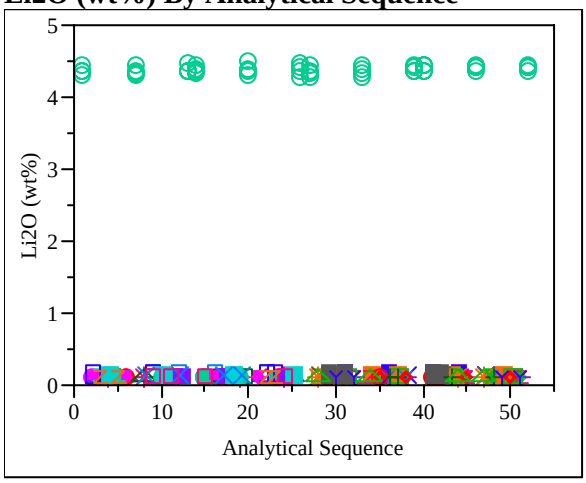


Exhibit A2. Oxide Measurements in Analytical Sequence for Samples Prepared Using the PF Method.

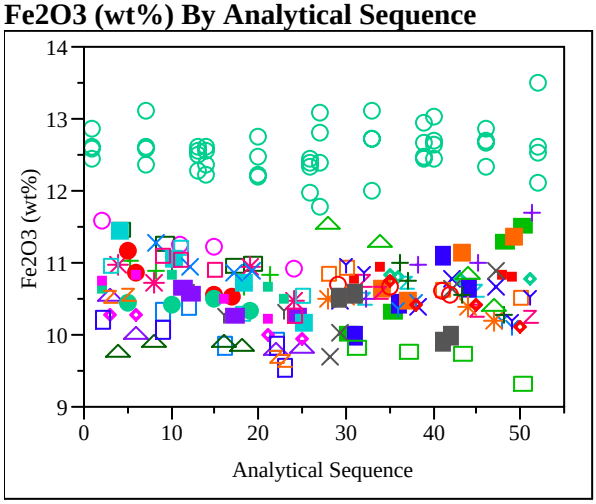
B2O3 (wt%) By Analytical Sequence



Li2O (wt%) By Analytical Sequence



Fe2O3 (wt%) By Analytical Sequence



SiO2 (wt%) By Analytical Sequence

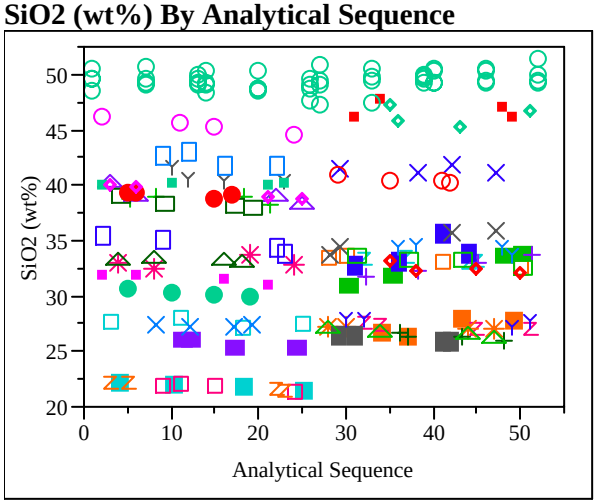
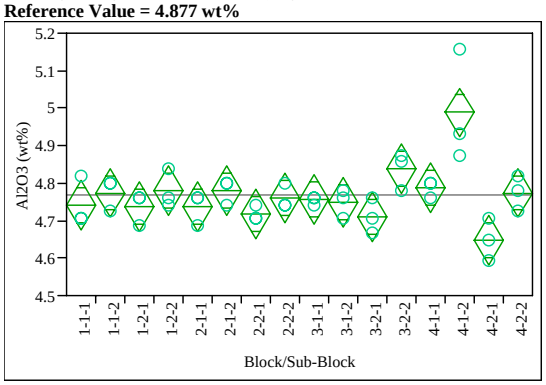


Exhibit A3. PSAL Measurements by Analytical Block for Samples of the Batch 1 Standard Glass Prepared Using the LM Method. (continued)

Oneway Analysis of Al2O3 (wt%) By Block/Sub-Block
Reference Value = 4.877 wt%



Oneway Anova
Summary of Fit

Rsquare	0.699026
Adj Rsquare	0.557944
Root Mean Square Error	0.055892
Mean of Response	4.767445
Observations (or Sum Wgts)	48

Analysis of Variance

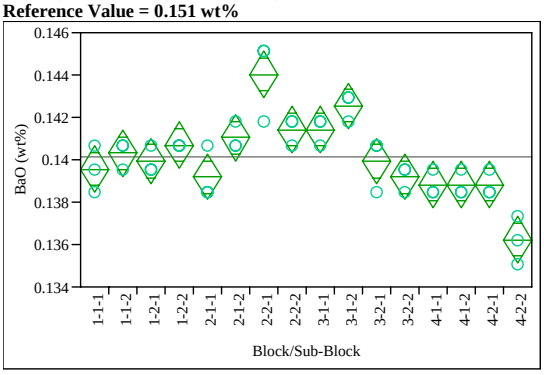
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	15	0.23217524	0.015478	4.9548	<.0001
Error	32	0.09996589	0.003124		
C. Total	47	0.33214112			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1-1	3	4.74265	0.03227	4.6769	4.8084
1-1-2	3	4.77414	0.03227	4.7084	4.8399
1-2-1	3	4.73635	0.03227	4.6706	4.8021
1-2-2	3	4.78044	0.03227	4.7147	4.8462
2-1-1	3	4.73635	0.03227	4.6706	4.8021
2-1-2	3	4.78044	0.03227	4.7147	4.8462
2-2-1	3	4.71745	0.03227	4.6517	4.7832
2-2-2	3	4.76154	0.03227	4.6958	4.8273
3-1-1	3	4.75524	0.03227	4.6895	4.8210
3-1-2	3	4.74894	0.03227	4.6832	4.8147
3-2-1	3	4.71115	0.03227	4.6454	4.7769
3-2-2	3	4.83712	0.03227	4.7714	4.9029
4-1-1	3	4.78673	0.03227	4.7210	4.8525
4-1-2	3	4.98828	0.03227	4.9225	5.0540
4-2-1	3	4.64817	0.03227	4.5824	4.7139
4-2-2	3	4.77414	0.03227	4.7084	4.8399

Std Error uses a pooled estimate of error variance

Oneway Analysis of BaO (wt%) By Block/Sub-Block
Reference Value = 0.151 wt%



Oneway Anova
Summary of Fit

Rsquare	0.84058
Adj Rsquare	0.765851
Root Mean Square Error	0.000926
Mean of Response	0.140121
Observations (or Sum Wgts)	48

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	15	0.00014460	9.6402e-6	11.2485	<.0001
Error	32	0.00002742	8.5702e-7		
C. Total	47	0.00017203			

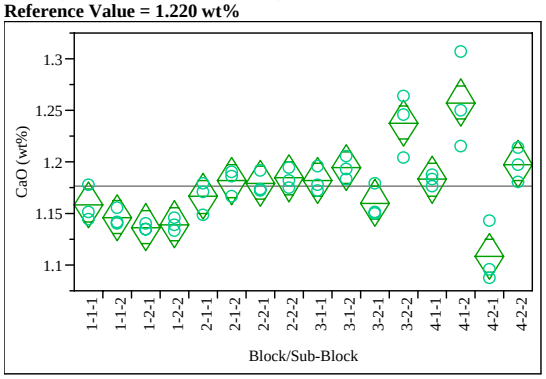
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1-1	3	0.139563	0.00053	0.13847	0.14065
1-1-2	3	0.140307	0.00053	0.13922	0.14140
1-2-1	3	0.139935	0.00053	0.13885	0.14102
1-2-2	3	0.140679	0.00053	0.13959	0.14177
2-1-1	3	0.139190	0.00053	0.13810	0.14028
2-1-2	3	0.141051	0.00053	0.13996	0.14214
2-2-1	3	0.144029	0.00053	0.14294	0.14512
2-2-2	3	0.141423	0.00053	0.14033	0.14251
3-1-1	3	0.141423	0.00053	0.14033	0.14251
3-1-2	3	0.142540	0.00053	0.14145	0.14363
3-2-1	3	0.139935	0.00053	0.13885	0.14102
3-2-2	3	0.139190	0.00053	0.13810	0.14028
4-1-1	3	0.138818	0.00053	0.13773	0.13991
4-1-2	3	0.138818	0.00053	0.13773	0.13991
4-2-1	3	0.138818	0.00053	0.13773	0.13991
4-2-2	3	0.136213	0.00053	0.13512	0.13730

Std Error uses a pooled estimate of error variance

Exhibit A3. PSAL Measurements by Analytical Block for Samples of the Batch 1 Standard Glass Prepared Using the LM Method. (continued)

Oneway Analysis of CaO (wt%) By Block/Sub-Block
Reference Value = 1.220 wt%



Oneway Anova
Summary of Fit

Rsquare	0.839348
Adj Rsquare	0.764043
Root Mean Square Error	0.019153
Mean of Response	1.175824
Observations (or Sum Wgts)	48

Analysis of Variance

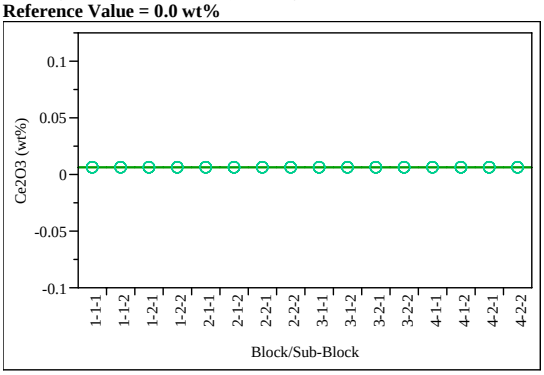
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	15	0.06133073	0.004089	11.1459	<.0001
Error	32	0.01173873	0.000367		
C. Total	47	0.07306946			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1-1	3	1.15807	0.01106	1.1355	1.1806
1-1-2	3	1.14594	0.01106	1.1234	1.1685
1-2-1	3	1.13662	0.01106	1.1141	1.1591
1-2-2	3	1.13942	0.01106	1.1169	1.1619
2-1-1	3	1.16647	0.01106	1.1439	1.1890
2-1-2	3	1.18139	0.01106	1.1589	1.2039
2-2-1	3	1.17953	0.01106	1.1570	1.2020
2-2-2	3	1.18419	0.01106	1.1617	1.2067
3-1-1	3	1.18232	0.01106	1.1598	1.2048
3-1-2	3	1.19445	0.01106	1.1719	1.2170
3-2-1	3	1.16040	0.01106	1.1379	1.1829
3-2-2	3	1.23783	0.01106	1.2153	1.2603
4-1-1	3	1.18279	0.01106	1.1603	1.2053
4-1-2	3	1.25741	0.01106	1.2349	1.2799
4-2-1	3	1.10863	0.01106	1.0861	1.1312
4-2-2	3	1.19772	0.01106	1.1752	1.2202

Std Error uses a pooled estimate of error variance

Oneway Analysis of Ce2O3 (wt%) By Block/Sub-Block
Reference Value = 0.0 wt%



Oneway Anova
Summary of Fit

Rsquare	1
Adj Rsquare	1
Root Mean Square Error	0
Mean of Response	0.005857
Observations (or Sum Wgts)	48

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	15	3.25e-34	2.167e-35	.	.
Error	32	0	0		
C. Total	47	3.25e-34			

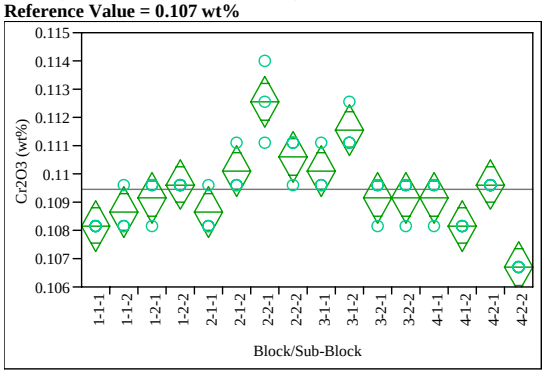
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1-1	3	0.005857	0	0.00586	0.00586
1-1-2	3	0.005857	0	0.00586	0.00586
1-2-1	3	0.005857	0	0.00586	0.00586
1-2-2	3	0.005857	0	0.00586	0.00586
2-1-1	3	0.005857	0	0.00586	0.00586
2-1-2	3	0.005857	0	0.00586	0.00586
2-2-1	3	0.005857	0	0.00586	0.00586
2-2-2	3	0.005857	0	0.00586	0.00586
3-1-1	3	0.005857	0	0.00586	0.00586
3-1-2	3	0.005857	0	0.00586	0.00586
3-2-1	3	0.005857	0	0.00586	0.00586
3-2-2	3	0.005857	0	0.00586	0.00586
4-1-1	3	0.005857	0	0.00586	0.00586
4-1-2	3	0.005857	0	0.00586	0.00586
4-2-1	3	0.005857	0	0.00586	0.00586
4-2-2	3	0.005857	0	0.00586	0.00586

Std Error uses a pooled estimate of error variance

Exhibit A3. PSAL Measurements by Analytical Block for Samples of the Batch 1 Standard Glass Prepared Using the LM Method. (continued)

Oneway Analysis of Cr2O3 (wt%) By Block/Sub-Block
Reference Value = 0.107 wt%



Oneway Anova
Summary of Fit

Rsquare	0.824027
Adj Rsquare	0.74154
Root Mean Square Error	0.000761
Mean of Response	0.109437
Observations (or Sum Wgts)	48

Analysis of Variance

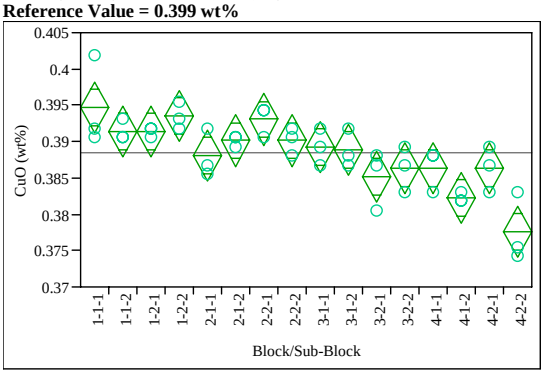
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	15	0.00008670	5.7798e-6	9.9897	<.0001
Error	32	0.00001851	5.7857e-7		
C. Total	47	0.00010521			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1-1	3	0.108158	0.00044	0.10726	0.10905
1-1-2	3	0.108646	0.00044	0.10775	0.10954
1-2-1	3	0.109133	0.00044	0.10824	0.11003
1-2-2	3	0.109620	0.00044	0.10873	0.11051
2-1-1	3	0.108646	0.00044	0.10775	0.10954
2-1-2	3	0.110107	0.00044	0.10921	0.11100
2-2-1	3	0.112543	0.00044	0.11165	0.11344
2-2-2	3	0.110594	0.00044	0.10970	0.11149
3-1-1	3	0.110107	0.00044	0.10921	0.11100
3-1-2	3	0.111569	0.00044	0.11067	0.11246
3-2-1	3	0.109133	0.00044	0.10824	0.11003
3-2-2	3	0.109133	0.00044	0.10824	0.11003
4-1-1	3	0.109133	0.00044	0.10824	0.11003
4-1-2	3	0.108158	0.00044	0.10726	0.10905
4-2-1	3	0.109620	0.00044	0.10873	0.11051
4-2-2	3	0.106697	0.00044	0.10580	0.10759

Std Error uses a pooled estimate of error variance

Oneway Analysis of CuO (wt%) By Block/Sub-Block
Reference Value = 0.399 wt%



Oneway Anova
Summary of Fit

Rsquare	0.750422
Adj Rsquare	0.633433
Root Mean Square Error	0.003007
Mean of Response	0.388423
Observations (or Sum Wgts)	48

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	15	0.00087008	0.000058	6.4144	<.0001
Error	32	0.00028937	9.043e-6		
C. Total	47	0.00115945			

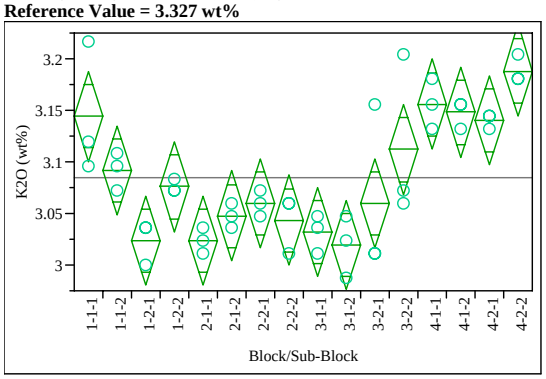
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1-1	3	0.394734	0.00174	0.39120	0.39827
1-1-2	3	0.391396	0.00174	0.38786	0.39493
1-2-1	3	0.391396	0.00174	0.38786	0.39493
1-2-2	3	0.393482	0.00174	0.38995	0.39702
2-1-1	3	0.388058	0.00174	0.38452	0.39159
2-1-2	3	0.390144	0.00174	0.38661	0.39368
2-2-1	3	0.393065	0.00174	0.38953	0.39660
2-2-2	3	0.390144	0.00174	0.38661	0.39368
3-1-1	3	0.389310	0.00174	0.38577	0.39285
3-1-2	3	0.388893	0.00174	0.38536	0.39243
3-2-1	3	0.385137	0.00174	0.38160	0.38867
3-2-2	3	0.386389	0.00174	0.38285	0.38993
4-1-1	3	0.386389	0.00174	0.38285	0.38993
4-1-2	3	0.382216	0.00174	0.37868	0.38575
4-2-1	3	0.386389	0.00174	0.38285	0.38993
4-2-2	3	0.377626	0.00174	0.37409	0.38116

Std Error uses a pooled estimate of error variance

Exhibit A3. PSAL Measurements by Analytical Block for Samples of the Batch 1 Standard Glass Prepared Using the LM Method. (continued)

Oneway Analysis of K2O (wt%) By Block/Sub-Block
Reference Value = 3.327 wt%



Oneway Anova
Summary of Fit

Rsquare	0.760622
Adj Rsquare	0.648414
Root Mean Square Error	0.036883
Mean of Response	3.085282
Observations (or Sum Wgts)	48

Analysis of Variance

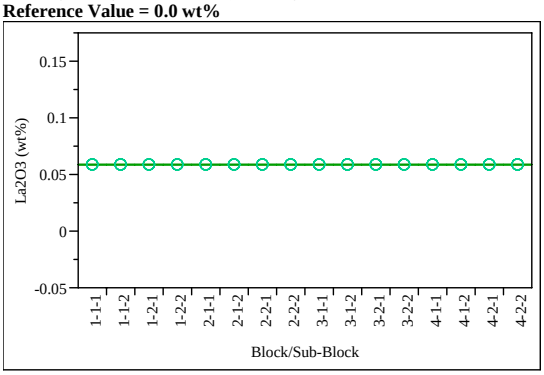
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	15	0.13832241	0.009221	6.7787	<.0001
Error	32	0.04353183	0.001360		
C. Total	47	0.18185424			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1-1	3	3.14401	0.02129	3.1006	3.1874
1-1-2	3	3.09181	0.02129	3.0484	3.1352
1-2-1	3	3.02355	0.02129	2.9802	3.0669
1-2-2	3	3.07575	0.02129	3.0324	3.1191
2-1-1	3	3.02355	0.02129	2.9802	3.0669
2-1-2	3	3.04764	0.02129	3.0043	3.0910
2-2-1	3	3.05968	0.02129	3.0163	3.1031
2-2-2	3	3.04362	0.02129	3.0002	3.0870
3-1-1	3	3.03158	0.02129	2.9882	3.0750
3-1-2	3	3.01953	0.02129	2.9762	3.0629
3-2-1	3	3.05968	0.02129	3.0163	3.1031
3-2-2	3	3.11188	0.02129	3.0685	3.1553
4-1-1	3	3.15605	0.02129	3.1127	3.1994
4-1-2	3	3.14802	0.02129	3.1046	3.1914
4-2-1	3	3.13999	0.02129	3.0966	3.1834
4-2-2	3	3.18817	0.02129	3.1448	3.2316

Std Error uses a pooled estimate of error variance

Oneway Analysis of La2O3 (wt%) By Block/Sub-Block
Reference Value = 0.0 wt%



Oneway Anova
Summary of Fit

Rsquare	1
Adj Rsquare	1
Root Mean Square Error	0
Mean of Response	0.05864
Observations (or Sum Wgts)	48

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	15	9.2445e-33	6.163e-34	.	.
Error	32	0	0		
C. Total	47	9.2445e-33			

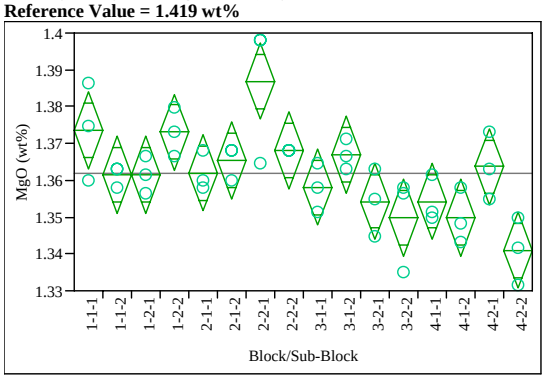
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1-1	3	0.058640	0	0.05864	0.05864
1-1-2	3	0.058640	0	0.05864	0.05864
1-2-1	3	0.058640	0	0.05864	0.05864
1-2-2	3	0.058640	0	0.05864	0.05864
2-1-1	3	0.058640	0	0.05864	0.05864
2-1-2	3	0.058640	0	0.05864	0.05864
2-2-1	3	0.058640	0	0.05864	0.05864
2-2-2	3	0.058640	0	0.05864	0.05864
3-1-1	3	0.058640	0	0.05864	0.05864
3-1-2	3	0.058640	0	0.05864	0.05864
3-2-1	3	0.058640	0	0.05864	0.05864
3-2-2	3	0.058640	0	0.05864	0.05864
4-1-1	3	0.058640	0	0.05864	0.05864
4-1-2	3	0.058640	0	0.05864	0.05864
4-2-1	3	0.058640	0	0.05864	0.05864
4-2-2	3	0.058640	0	0.05864	0.05864

Std Error uses a pooled estimate of error variance

Exhibit A3. PSAL Measurements by Analytical Block for Samples of the Batch 1 Standard Glass Prepared Using the LM Method. (continued)

Oneway Analysis of MgO (wt%) By Block/Sub-Block
Reference Value = 1.419 wt%



Oneway Anova
Summary of Fit

Rsquare	0.686572
Adj Rsquare	0.539653
Root Mean Square Error	0.008833
Mean of Response	1.361879
Observations (or Sum Wgts)	48

Analysis of Variance

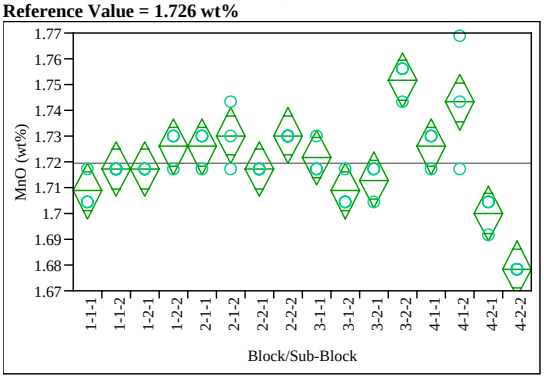
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	15	0.00546967	0.000365	4.6731	0.0001
Error	32	0.00249696	0.000078		
C. Total	47	0.00796663			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1-1	3	1.37363	0.00510	1.3632	1.3840
1-1-2	3	1.36146	0.00510	1.3511	1.3719
1-2-1	3	1.36146	0.00510	1.3511	1.3719
1-2-2	3	1.37307	0.00510	1.3627	1.3835
2-1-1	3	1.36202	0.00510	1.3516	1.3724
2-1-2	3	1.36533	0.00510	1.3549	1.3757
2-2-1	3	1.38689	0.00510	1.3765	1.3973
2-2-2	3	1.36810	0.00510	1.3577	1.3785
3-1-1	3	1.35815	0.00510	1.3478	1.3685
3-1-2	3	1.36699	0.00510	1.3566	1.3774
3-2-1	3	1.35428	0.00510	1.3439	1.3647
3-2-2	3	1.34986	0.00510	1.3395	1.3602
4-1-1	3	1.35428	0.00510	1.3439	1.3647
4-1-2	3	1.34986	0.00510	1.3395	1.3602
4-2-1	3	1.36368	0.00510	1.3533	1.3741
4-2-2	3	1.34101	0.00510	1.3306	1.3514

Std Error uses a pooled estimate of error variance

Oneway Analysis of MnO (wt%) By Block/Sub-Block
Reference Value = 1.726 wt%



Oneway Anova
Summary of Fit

Rsquare	0.828533
Adj Rsquare	0.748158
Root Mean Square Error	0.00913
Mean of Response	1.719717
Observations (or Sum Wgts)	48

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	15	0.01288952	0.000859	10.3083	<.0001
Error	32	0.00266752	0.000083		
C. Total	47	0.01555704			

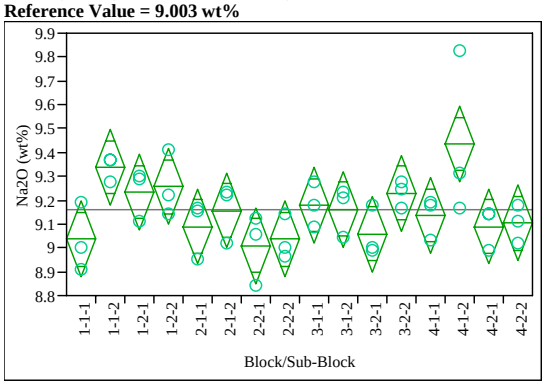
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1-1	3	1.70869	0.00527	1.6980	1.7194
1-1-2	3	1.71730	0.00527	1.7066	1.7280
1-2-1	3	1.71730	0.00527	1.7066	1.7280
1-2-2	3	1.72590	0.00527	1.7152	1.7366
2-1-1	3	1.72590	0.00527	1.7152	1.7366
2-1-2	3	1.73021	0.00527	1.7195	1.7409
2-2-1	3	1.71730	0.00527	1.7066	1.7280
2-2-2	3	1.73021	0.00527	1.7195	1.7409
3-1-1	3	1.72160	0.00527	1.7109	1.7323
3-1-2	3	1.70869	0.00527	1.6980	1.7194
3-2-1	3	1.71299	0.00527	1.7023	1.7237
3-2-2	3	1.75173	0.00527	1.7410	1.7625
4-1-1	3	1.72590	0.00527	1.7152	1.7366
4-1-2	3	1.74312	0.00527	1.7324	1.7539
4-2-1	3	1.70008	0.00527	1.6893	1.7108
4-2-2	3	1.67856	0.00527	1.6678	1.6893

Std Error uses a pooled estimate of error variance

Exhibit A3. PSAL Measurements by Analytical Block for Samples of the Batch 1 Standard Glass Prepared Using the LM Method. (continued)

Oneway Analysis of Na2O (wt%) By Block/Sub-Block
Reference Value = 9.003 wt%



Oneway Anova
Summary of Fit

Rsquare	0.515233
Adj Rsquare	0.287999
Root Mean Square Error	0.13442
Mean of Response	9.159379
Observations (or Sum Wgts)	48

Analysis of Variance

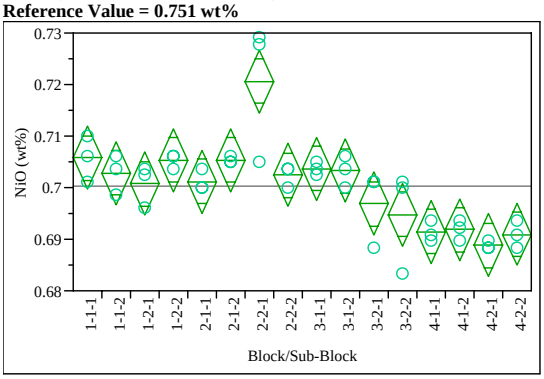
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	15	0.6145408	0.040969	2.2674	0.0255
Error	32	0.5782025	0.018069		
C. Total	47	1.1927433			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1-1	3	9.03609	0.07761	8.8780	9.1942
1-1-2	3	9.33715	0.07761	9.1791	9.4952
1-2-1	3	9.23380	0.07761	9.0757	9.3919
1-2-2	3	9.25627	0.07761	9.0982	9.4143
2-1-1	3	9.09001	0.07761	8.9319	9.2481
2-1-2	3	9.15741	0.07761	8.9993	9.3155
2-2-1	3	9.00913	0.07761	8.8511	9.1672
2-2-2	3	9.03609	0.07761	8.8780	9.1942
3-1-1	3	9.17988	0.07761	9.0218	9.3380
3-1-2	3	9.16191	0.07761	9.0038	9.3200
3-2-1	3	9.05856	0.07761	8.9005	9.2166
3-2-2	3	9.22931	0.07761	9.0712	9.3874
4-1-1	3	9.13495	0.07761	8.9769	9.2930
4-1-2	3	9.43600	0.07761	9.2779	9.5941
4-2-1	3	9.09001	0.07761	8.9319	9.2481
4-2-2	3	9.10349	0.07761	8.9454	9.2616

Std Error uses a pooled estimate of error variance

Oneway Analysis of NiO (wt%) By Block/Sub-Block
Reference Value = 0.751 wt%



Oneway Anova
Summary of Fit

Rsquare	0.766965
Adj Rsquare	0.65773
Root Mean Square Error	0.005175
Mean of Response	0.700379
Observations (or Sum Wgts)	48

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	15	0.00282098	0.000188	7.0212	<.0001
Error	32	0.00085713	0.000027		
C. Total	47	0.00367811			

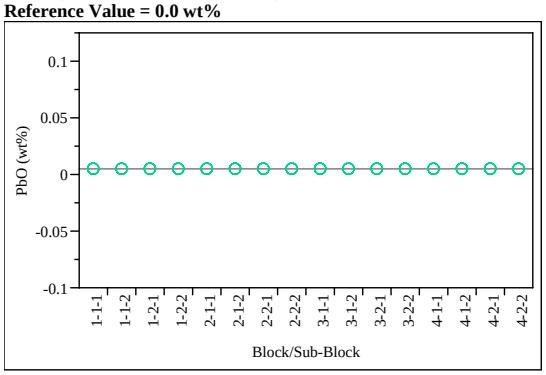
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1-1	3	0.705813	0.00299	0.69973	0.71190
1-1-2	3	0.702844	0.00299	0.69676	0.70893
1-2-1	3	0.700723	0.00299	0.69464	0.70681
1-2-2	3	0.705389	0.00299	0.69930	0.71148
2-1-1	3	0.701148	0.00299	0.69506	0.70723
2-1-2	3	0.705389	0.00299	0.69930	0.71148
2-2-1	3	0.720659	0.00299	0.71457	0.72675
2-2-2	3	0.702420	0.00299	0.69633	0.70851
3-1-1	3	0.703693	0.00299	0.69761	0.70978
3-1-2	3	0.703268	0.00299	0.69718	0.70935
3-2-1	3	0.696906	0.00299	0.69082	0.70299
3-2-2	3	0.694785	0.00299	0.68870	0.70087
4-1-1	3	0.691392	0.00299	0.68531	0.69748
4-1-2	3	0.691816	0.00299	0.68573	0.69790
4-2-1	3	0.688847	0.00299	0.68276	0.69493
4-2-2	3	0.690968	0.00299	0.68488	0.69705

Std Error uses a pooled estimate of error variance

Exhibit A3. PSAL Measurements by Analytical Block for Samples of the Batch 1 Standard Glass Prepared Using the LM Method. (continued)

Oneway Analysis of PbO (wt%) By Block/Sub-Block
Reference Value = 0.0 wt%



Oneway Anova
Summary of Fit

Rsquare	4
Adj Rsquare	5.40625
Root Mean Square Error	.
Mean of Response	0.005386
Observations (or Sum Wgts)	48

Analysis of Variance

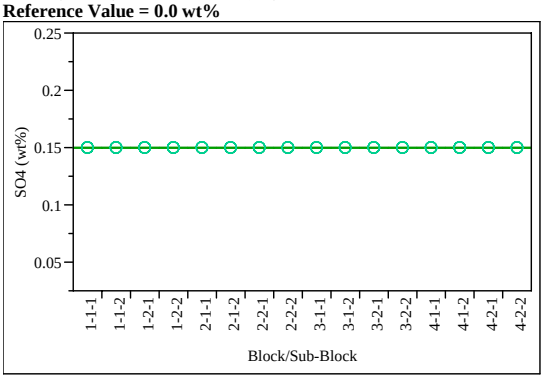
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	15	1.4444e-34	9.63e-36	-2.8444	0.0000
Error	32	-1.083e-34	-3.39e-36		
C. Total	47	3.6111e-35			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1-1	3	0.005386	.	.	.
1-1-2	3	0.005386	.	.	.
1-2-1	3	0.005386	.	.	.
1-2-2	3	0.005386	.	.	.
2-1-1	3	0.005386	.	.	.
2-1-2	3	0.005386	.	.	.
2-2-1	3	0.005386	.	.	.
2-2-2	3	0.005386	.	.	.
3-1-1	3	0.005386	.	.	.
3-1-2	3	0.005386	.	.	.
3-2-1	3	0.005386	.	.	.
3-2-2	3	0.005386	.	.	.
4-1-1	3	0.005386	.	.	.
4-1-2	3	0.005386	.	.	.
4-2-1	3	0.005386	.	.	.
4-2-2	3	0.005386	.	.	.

Std Error uses a pooled estimate of error variance

Oneway Analysis of SO4 (wt%) By Block/Sub-Block
Reference Value = 0.0 wt%



Oneway Anova
Summary of Fit

Rsquare	1
Adj Rsquare	1
Root Mean Square Error	0
Mean of Response	0.149795
Observations (or Sum Wgts)	48

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	15	3.328e-31	2.219e-32	.	.
Error	32	0	0		
C. Total	47	3.328e-31			

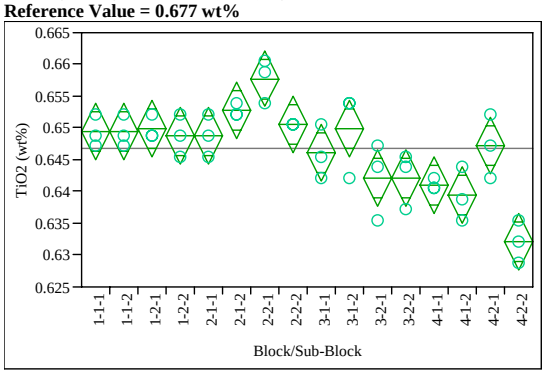
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1-1	3	0.149795	0	0.14980	0.14980
1-1-2	3	0.149795	0	0.14980	0.14980
1-2-1	3	0.149795	0	0.14980	0.14980
1-2-2	3	0.149795	0	0.14980	0.14980
2-1-1	3	0.149795	0	0.14980	0.14980
2-1-2	3	0.149795	0	0.14980	0.14980
2-2-1	3	0.149795	0	0.14980	0.14980
2-2-2	3	0.149795	0	0.14980	0.14980
3-1-1	3	0.149795	0	0.14980	0.14980
3-1-2	3	0.149795	0	0.14980	0.14980
3-2-1	3	0.149795	0	0.14980	0.14980
3-2-2	3	0.149795	0	0.14980	0.14980
4-1-1	3	0.149795	0	0.14980	0.14980
4-1-2	3	0.149795	0	0.14980	0.14980
4-2-1	3	0.149795	0	0.14980	0.14980
4-2-2	3	0.149795	0	0.14980	0.14980

Std Error uses a pooled estimate of error variance

Exhibit A3. PSAL Measurements by Analytical Block for Samples of the Batch 1 Standard Glass Prepared Using the LM Method. (continued)

Oneway Analysis of TiO2 (wt%) By Block/Sub-Block
Reference Value = 0.677 wt%



Oneway Anova
Summary of Fit

Rsquare	0.787256
Adj Rsquare	0.687532
Root Mean Square Error	0.003753
Mean of Response	0.646732
Observations (or Sum Wgts)	48

Analysis of Variance

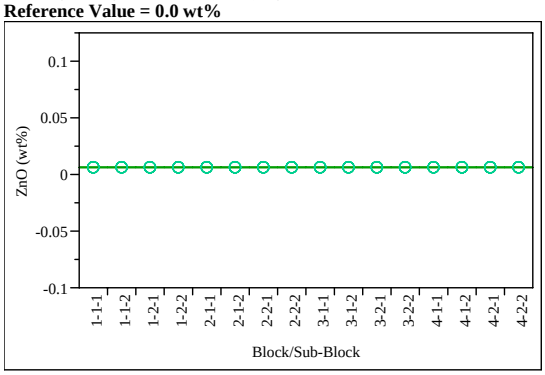
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	15	0.00166789	0.000111	7.8944	<.0001
Error	32	0.00045072	0.000014		
C. Total	47	0.00211861			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1-1	3	0.649408	0.00217	0.64499	0.65382
1-1-2	3	0.649408	0.00217	0.64499	0.65382
1-2-1	3	0.649964	0.00217	0.64555	0.65438
1-2-2	3	0.648852	0.00217	0.64444	0.65327
2-1-1	3	0.648852	0.00217	0.64444	0.65327
2-1-2	3	0.652744	0.00217	0.64833	0.65716
2-2-1	3	0.657748	0.00217	0.65333	0.66216
2-2-2	3	0.650520	0.00217	0.64611	0.65493
3-1-1	3	0.646072	0.00217	0.64166	0.65049
3-1-2	3	0.649964	0.00217	0.64555	0.65438
3-2-1	3	0.642180	0.00217	0.63777	0.64659
3-2-2	3	0.642180	0.00217	0.63777	0.64659
4-1-1	3	0.641068	0.00217	0.63665	0.64548
4-1-2	3	0.639400	0.00217	0.63499	0.64381
4-2-1	3	0.647184	0.00217	0.64277	0.65160
4-2-2	3	0.632172	0.00217	0.62776	0.63659

Std Error uses a pooled estimate of error variance

Oneway Analysis of ZnO (wt%) By Block/Sub-Block
Reference Value = 0.0 wt%



Oneway Anova
Summary of Fit

Rsquare	1
Adj Rsquare	1
Root Mean Square Error	0
Mean of Response	0.006224
Observations (or Sum Wgts)	48

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	15	3.6111e-35	2.407e-36	.	.
Error	32	0	0		
C. Total	47	3.6111e-35			

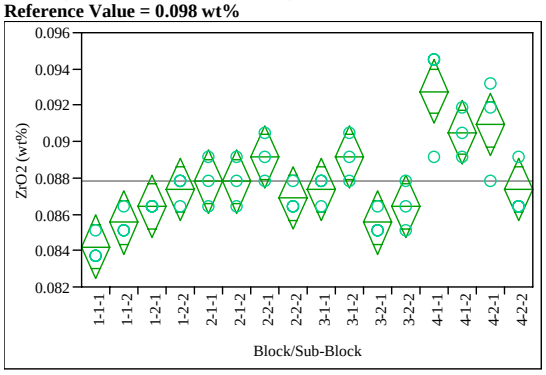
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1-1	3	0.006224	0	0.00622	0.00622
1-1-2	3	0.006224	0	0.00622	0.00622
1-2-1	3	0.006224	0	0.00622	0.00622
1-2-2	3	0.006224	0	0.00622	0.00622
2-1-1	3	0.006224	0	0.00622	0.00622
2-1-2	3	0.006224	0	0.00622	0.00622
2-2-1	3	0.006224	0	0.00622	0.00622
2-2-2	3	0.006224	0	0.00622	0.00622
3-1-1	3	0.006224	0	0.00622	0.00622
3-1-2	3	0.006224	0	0.00622	0.00622
3-2-1	3	0.006224	0	0.00622	0.00622
3-2-2	3	0.006224	0	0.00622	0.00622
4-1-1	3	0.006224	0	0.00622	0.00622
4-1-2	3	0.006224	0	0.00622	0.00622
4-2-1	3	0.006224	0	0.00622	0.00622
4-2-2	3	0.006224	0	0.00622	0.00622

Std Error uses a pooled estimate of error variance

Exhibit A3. PSAL Measurements by Analytical Block for Samples of the Batch 1 Standard Glass Prepared Using the LM Method. (continued)

Oneway Analysis of ZrO2 (wt%) By Block/Sub-Block
Reference Value = 0.098 wt%



Oneway Anova
Summary of Fit

Rsquare	0.760975
Adj Rsquare	0.648932
Root Mean Square Error	0.001472
Mean of Response	0.08783
Observations (or Sum Wgts)	48

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	15	0.00022075	0.000015	6.7918	<.0001
Error	32	0.00006934	2.167e-6		
C. Total	47	0.00029008			

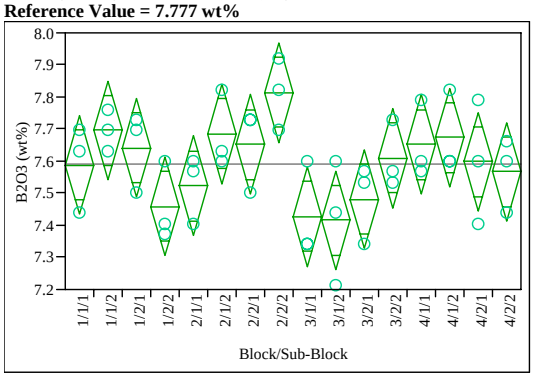
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1-1-1	3	0.084200	0.00085	0.08247	0.08593
1-1-2	3	0.085551	0.00085	0.08382	0.08728
1-2-1	3	0.086451	0.00085	0.08472	0.08818
1-2-2	3	0.087352	0.00085	0.08562	0.08908
2-1-1	3	0.087802	0.00085	0.08607	0.08953
2-1-2	3	0.087802	0.00085	0.08607	0.08953
2-2-1	3	0.089153	0.00085	0.08742	0.09088
2-2-2	3	0.086901	0.00085	0.08517	0.08863
3-1-1	3	0.087352	0.00085	0.08562	0.08908
3-1-2	3	0.089153	0.00085	0.08742	0.09088
3-2-1	3	0.085551	0.00085	0.08382	0.08728
3-2-2	3	0.086451	0.00085	0.08472	0.08818
4-1-1	3	0.092755	0.00085	0.09102	0.09449
4-1-2	3	0.090504	0.00085	0.08877	0.09223
4-2-1	3	0.090954	0.00085	0.08922	0.09268
4-2-2	3	0.087352	0.00085	0.08562	0.08908

Std Error uses a pooled estimate of error variance

Exhibit A4: PSAL Measurements by Analytical Block for Samples of the Batch 1 Standard Glass Prepared Using the PF Method. (continued)

Oneway Analysis of B2O3 (wt%) By Block/Sub-Block
Reference Value = 7.777 wt%



Oneway Anova
Summary of Fit

Rsquare	0.493306
Adj Rsquare	0.255794
Root Mean Square Error	0.131123
Mean of Response	7.592927
Observations (or Sum Wgts)	48

Analysis of Variance

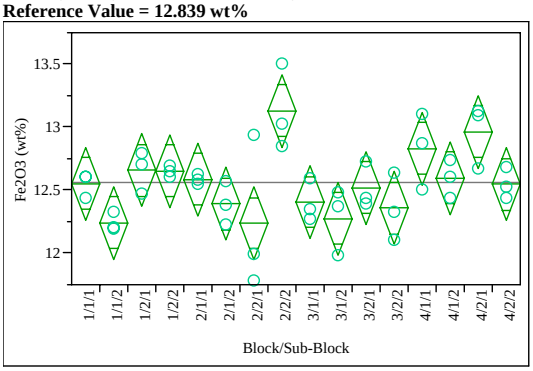
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	15	0.5356458	0.035710	2.0770	0.0406
Error	32	0.5501823	0.017193		
C. Total	47	1.0858280			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1/1	3	7.58823	0.07570	7.4340	7.7424
1/1/2	3	7.69556	0.07570	7.5414	7.8498
1/2/1	3	7.64190	0.07570	7.4877	7.7961
1/2/2	3	7.45944	0.07570	7.3052	7.6136
2/1/1	3	7.52383	0.07570	7.3696	7.6780
2/1/2	3	7.68483	0.07570	7.5306	7.8390
2/2/1	3	7.65263	0.07570	7.4984	7.8068
2/2/2	3	7.81362	0.07570	7.6594	7.9678
3/1/1	3	7.42724	0.07570	7.2730	7.5814
3/1/2	3	7.41650	0.07570	7.2623	7.5707
3/2/1	3	7.48090	0.07570	7.3267	7.6351
3/2/2	3	7.60970	0.07570	7.4555	7.7639
4/1/1	3	7.65263	0.07570	7.4984	7.8068
4/1/2	3	7.67410	0.07570	7.5199	7.8283
4/2/1	3	7.59896	0.07570	7.4448	7.7532
4/2/2	3	7.56677	0.07570	7.4126	7.7210

Std Error uses a pooled estimate of error variance

Oneway Analysis of Fe2O3 (wt%) By Block/Sub-Block
Reference Value = 12.839 wt%



Oneway Anova
Summary of Fit

Rsquare	0.597771
Adj Rsquare	0.409226
Root Mean Square Error	0.245949
Mean of Response	12.55902
Observations (or Sum Wgts)	48

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	15	2.8767465	0.191783	3.1704	0.0030
Error	32	1.9357079	0.060491		
C. Total	47	4.8124544			

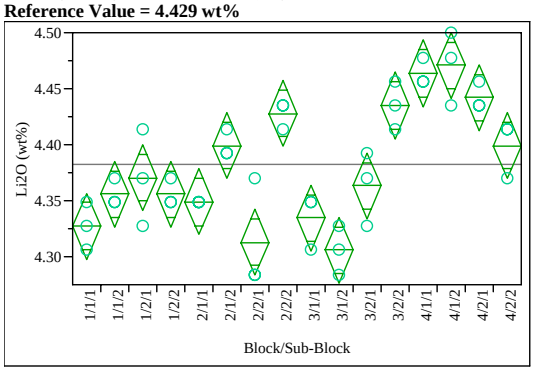
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1/1	3	12.5528	0.14200	12.264	12.842
1/1/2	3	12.2430	0.14200	11.954	12.532
1/2/1	3	12.6576	0.14200	12.368	12.947
1/2/2	3	12.6528	0.14200	12.364	12.942
2/1/1	3	12.5861	0.14200	12.297	12.875
2/1/2	3	12.3907	0.14200	12.101	12.680
2/2/1	3	12.2382	0.14200	11.949	12.527
2/2/2	3	13.1294	0.14200	12.840	13.419
3/1/1	3	12.4050	0.14200	12.116	12.694
3/1/2	3	12.2764	0.14200	11.987	12.566
3/2/1	3	12.5194	0.14200	12.230	12.809
3/2/2	3	12.3574	0.14200	12.068	12.647
4/1/1	3	12.8292	0.14200	12.540	13.118
4/1/2	3	12.5957	0.14200	12.306	12.885
4/2/1	3	12.9626	0.14200	12.673	13.252
4/2/2	3	12.5480	0.14200	12.259	12.837

Std Error uses a pooled estimate of error variance

Exhibit A4: PSAL Measurements by Analytical Block for Samples of the Batch 1 Standard Glass Prepared Using the PF Method. (continued)

Oneway Analysis of Li2O (wt%) By Block/Sub-Block
Reference Value = 4.429 wt%



Oneway Anova
Summary of Fit

Rsquare	0.863696
Adj Rsquare	0.799803
Root Mean Square Error	0.025053
Mean of Response	4.382049
Observations (or Sum Wgts)	48

Analysis of Variance

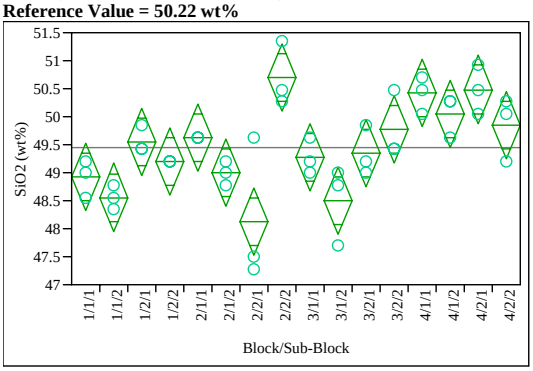
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	15	0.12726878	0.008485	13.5179	<.0001
Error	32	0.02008491	0.000628		
C. Total	47	0.14735369			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1/1	3	4.32733	0.01446	4.2979	4.3568
1/1/2	3	4.35603	0.01446	4.3266	4.3855
1/2/1	3	4.37039	0.01446	4.3409	4.3998
1/2/2	3	4.35603	0.01446	4.3266	4.3855
2/1/1	3	4.34886	0.01446	4.3194	4.3783
2/1/2	3	4.39909	0.01446	4.3696	4.4286
2/2/1	3	4.31298	0.01446	4.2835	4.3424
2/2/2	3	4.42780	0.01446	4.3983	4.4573
3/1/1	3	4.33451	0.01446	4.3050	4.3640
3/1/2	3	4.30580	0.01446	4.2763	4.3353
3/2/1	3	4.36321	0.01446	4.3337	4.3927
3/2/2	3	4.43497	0.01446	4.4055	4.4644
4/1/1	3	4.46368	0.01446	4.4342	4.4931
4/1/2	3	4.47086	0.01446	4.4414	4.5003
4/2/1	3	4.44215	0.01446	4.4127	4.4716
4/2/2	3	4.39909	0.01446	4.3696	4.4286

Std Error uses a pooled estimate of error variance

Oneway Analysis of SiO2 (wt%) By Block/Sub-Block
Reference Value = 50.22 wt%



Oneway Anova
Summary of Fit

Rsquare	0.748364
Adj Rsquare	0.63041
Root Mean Square Error	0.511124
Mean of Response	49.4624
Observations (or Sum Wgts)	48

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block/Sub-Block	15	24.862404	1.65749	6.3445	<.0001
Error	32	8.359931	0.26125		
C. Total	47	33.222335			

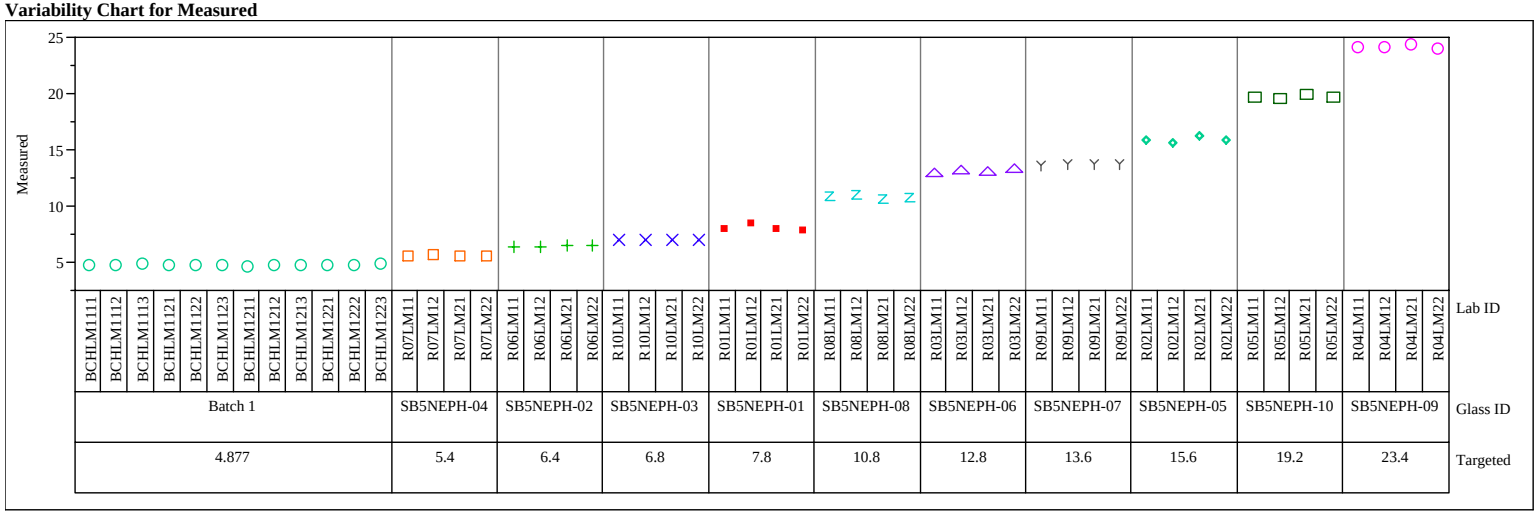
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1/1	3	48.9187	0.29510	48.318	49.520
1/1/2	3	48.5621	0.29510	47.961	49.163
1/2/1	3	49.5605	0.29510	48.959	50.162
1/2/2	3	49.2039	0.29510	48.603	49.805
2/1/1	3	49.6318	0.29510	49.031	50.233
2/1/2	3	48.9900	0.29510	48.389	49.591
2/2/1	3	48.1343	0.29510	47.533	48.735
2/2/2	3	50.7014	0.29510	50.100	51.303
3/1/1	3	49.2752	0.29510	48.674	49.876
3/1/2	3	48.4908	0.29510	47.890	49.092
3/2/1	3	49.3465	0.29510	48.745	49.948
3/2/2	3	49.7744	0.29510	49.173	50.375
4/1/1	3	50.4162	0.29510	49.815	51.017
4/1/2	3	50.0596	0.29510	49.459	50.661
4/2/1	3	50.4875	0.29510	49.886	51.089
4/2/2	3	49.8457	0.29510	49.245	50.447

Std Error uses a pooled estimate of error variance

Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=1, Oxide=Al2O3 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

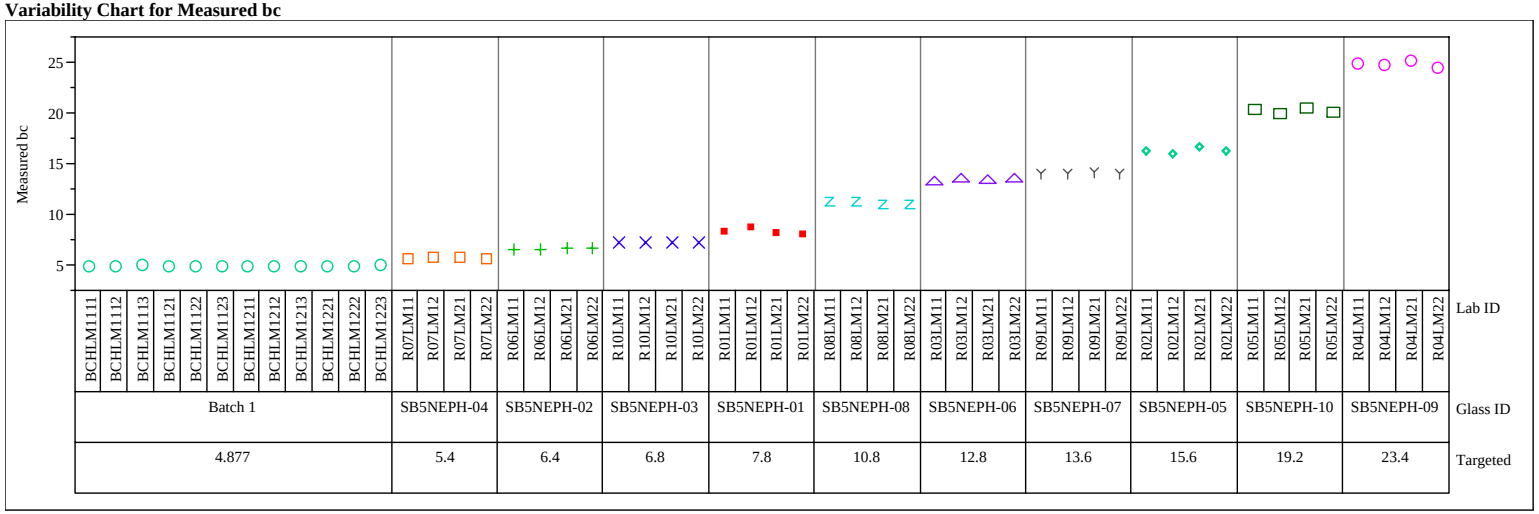
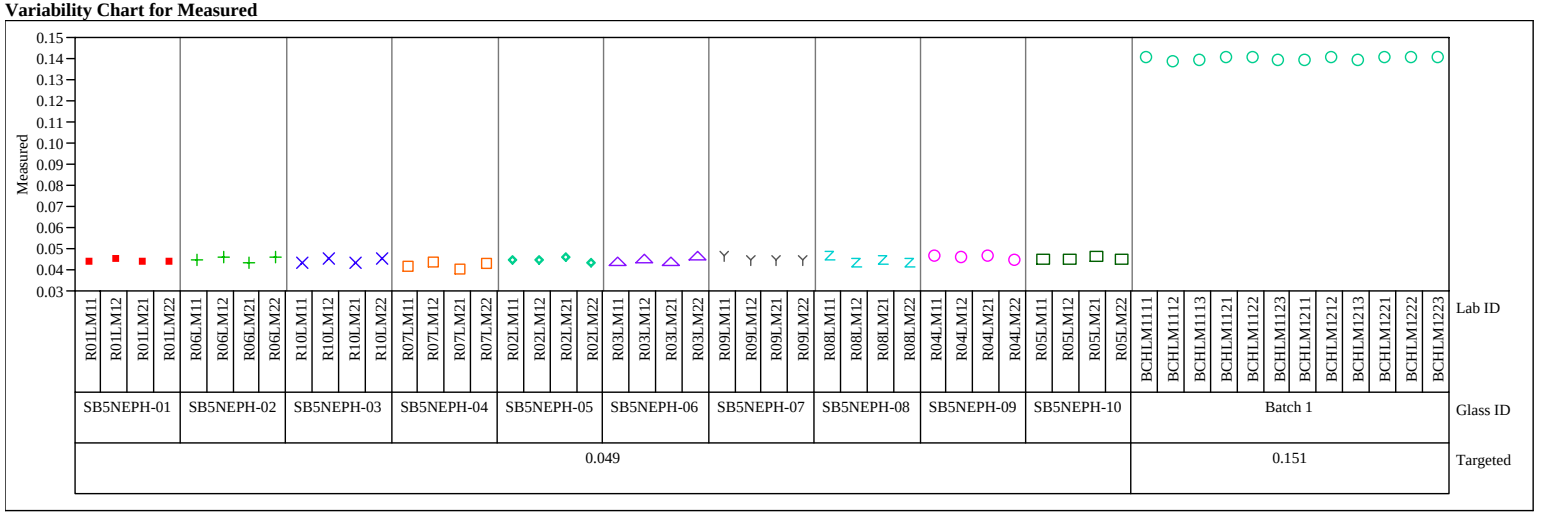


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=1, Oxide=BaO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

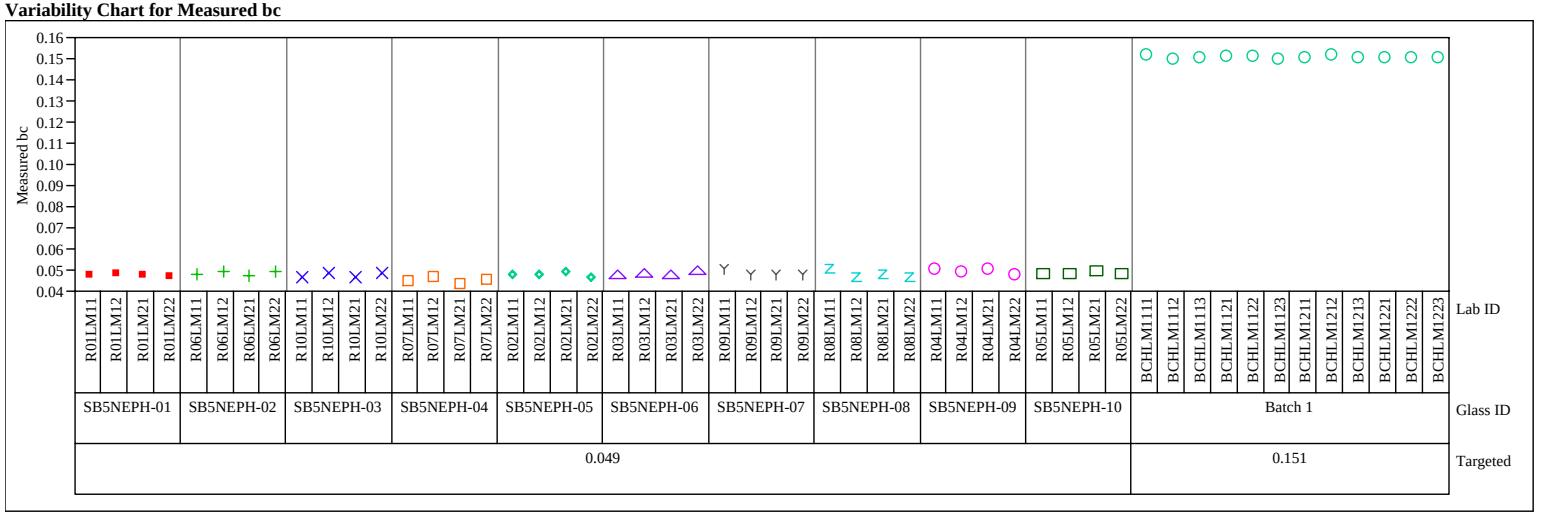
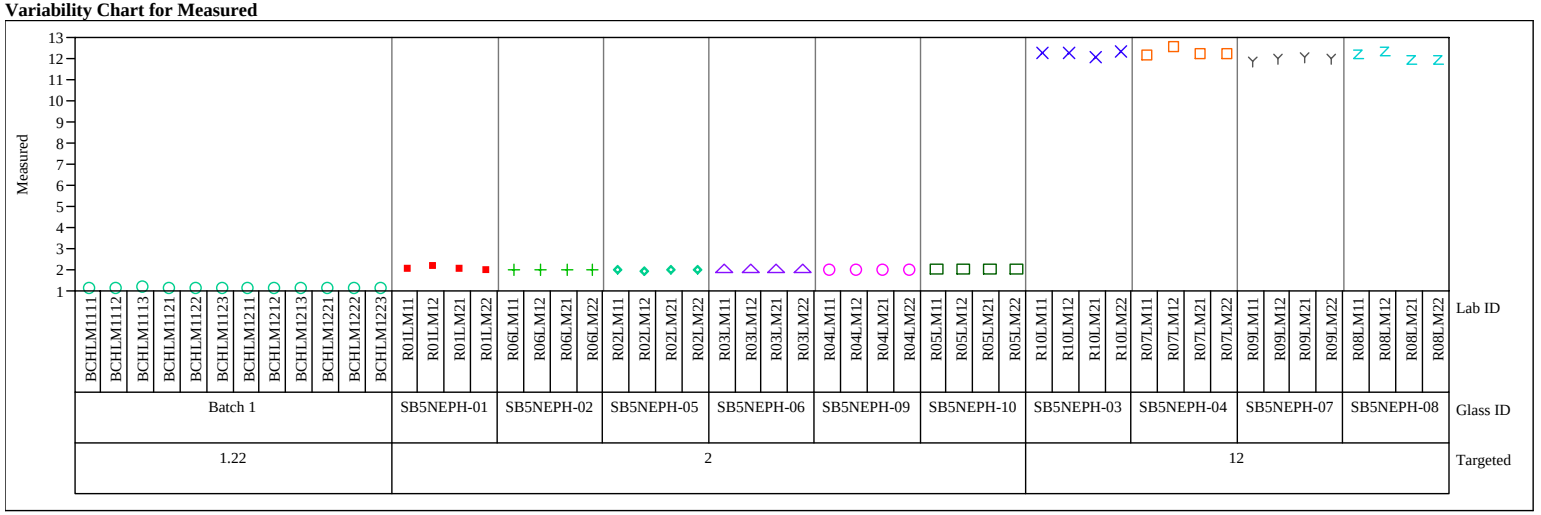


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=1, Oxide=CaO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

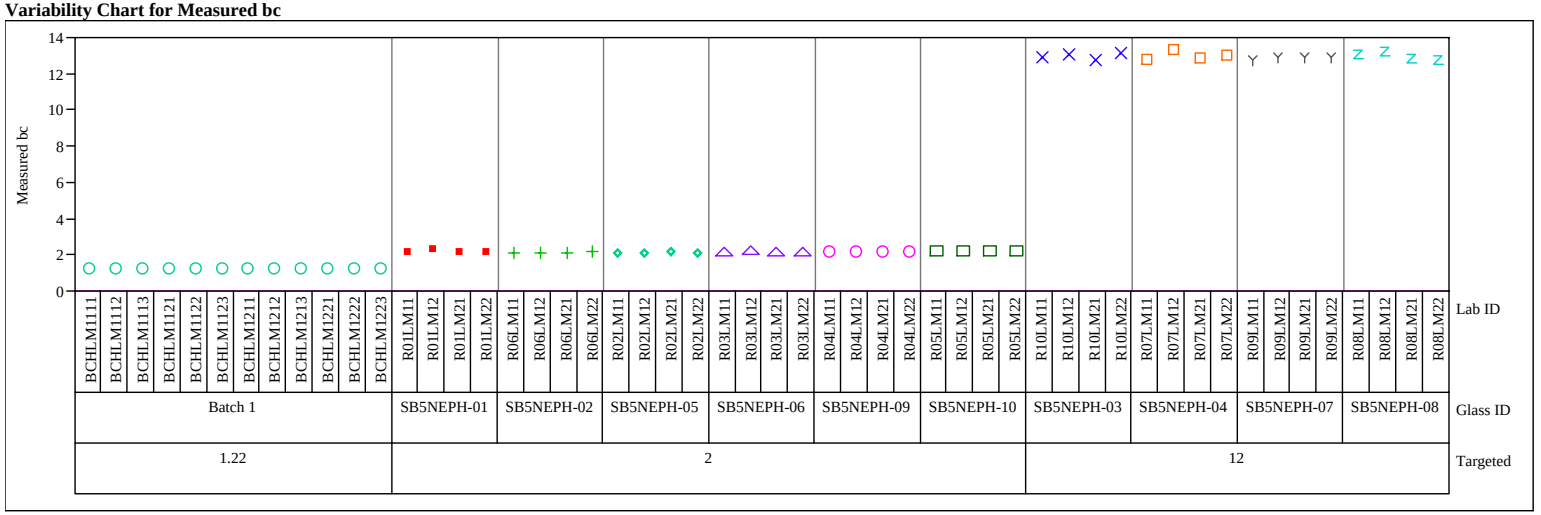
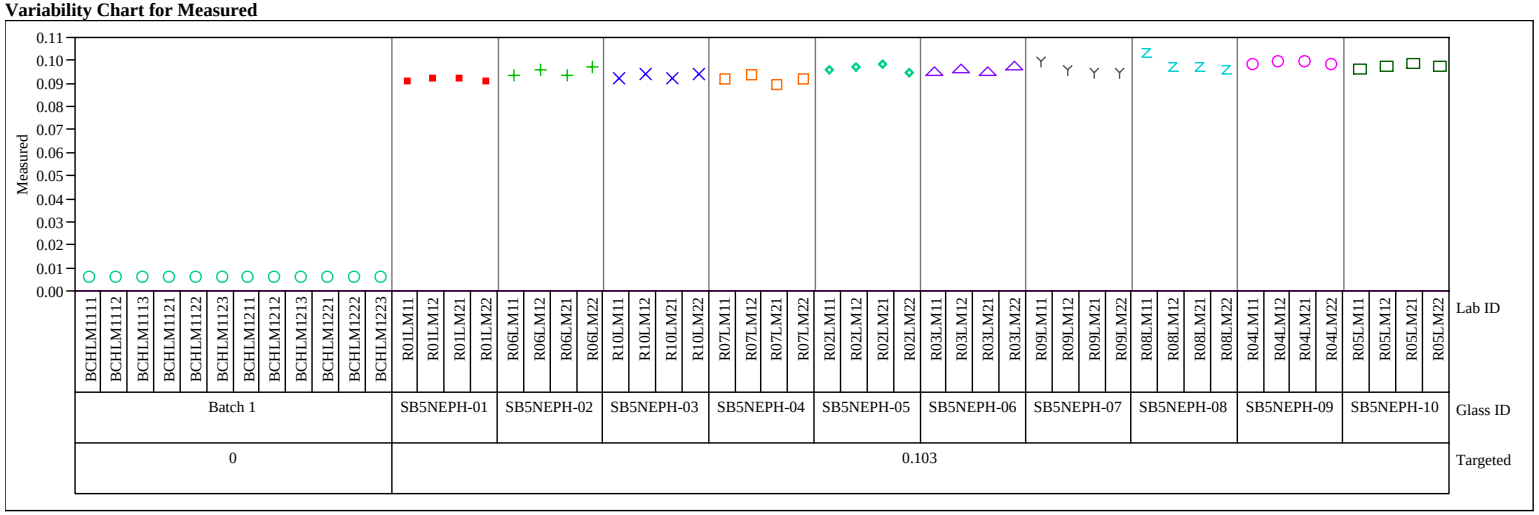


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=1, Oxide=Ce2O3 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

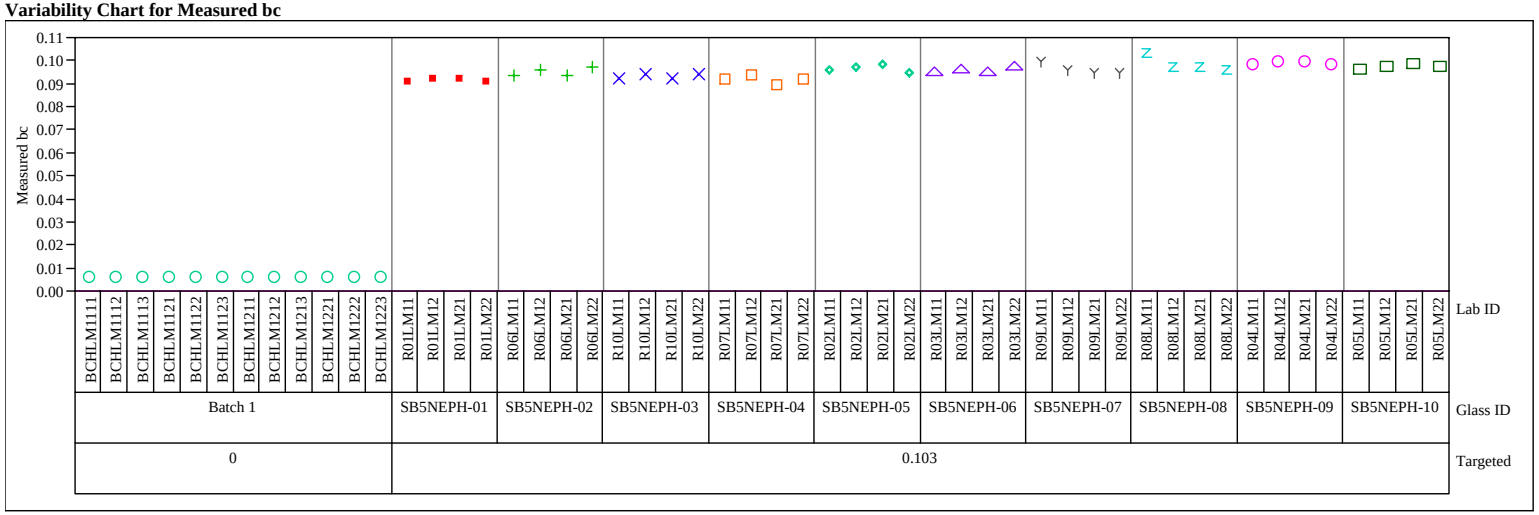
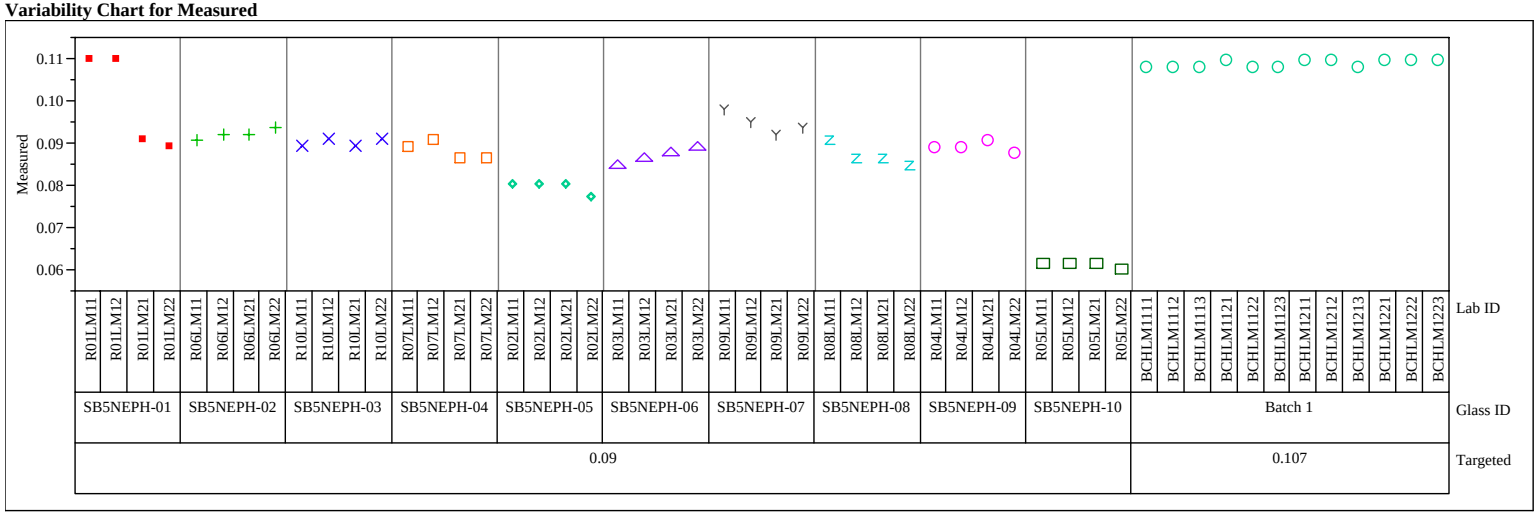


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=1, Oxide=Cr2O3 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

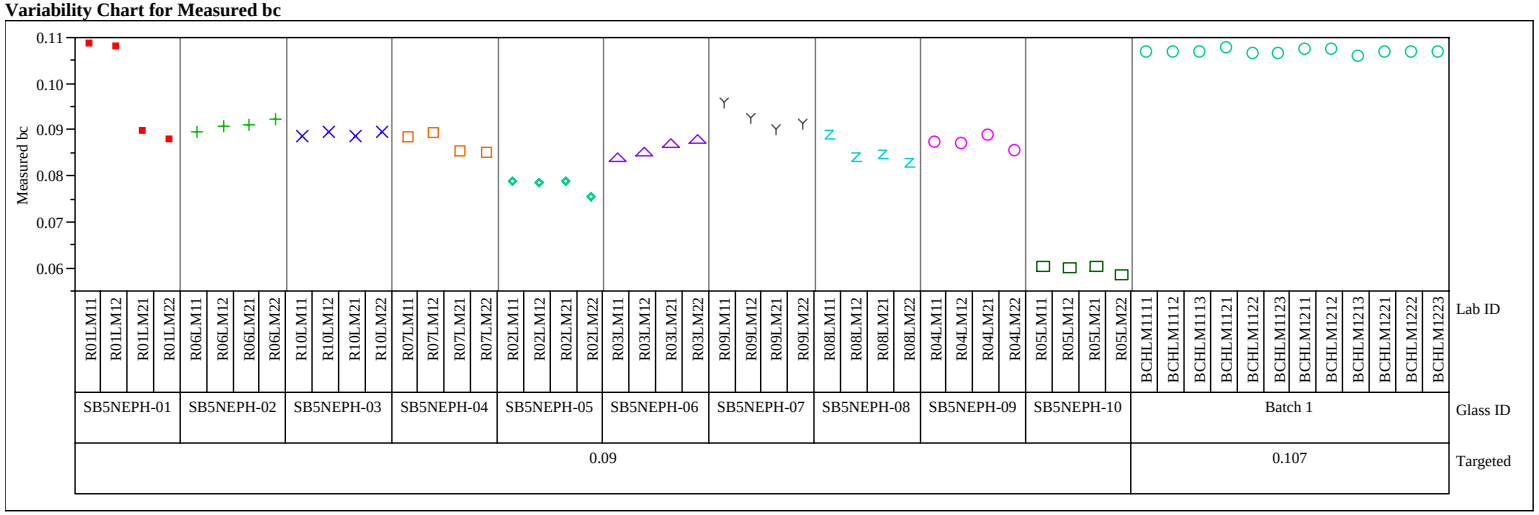
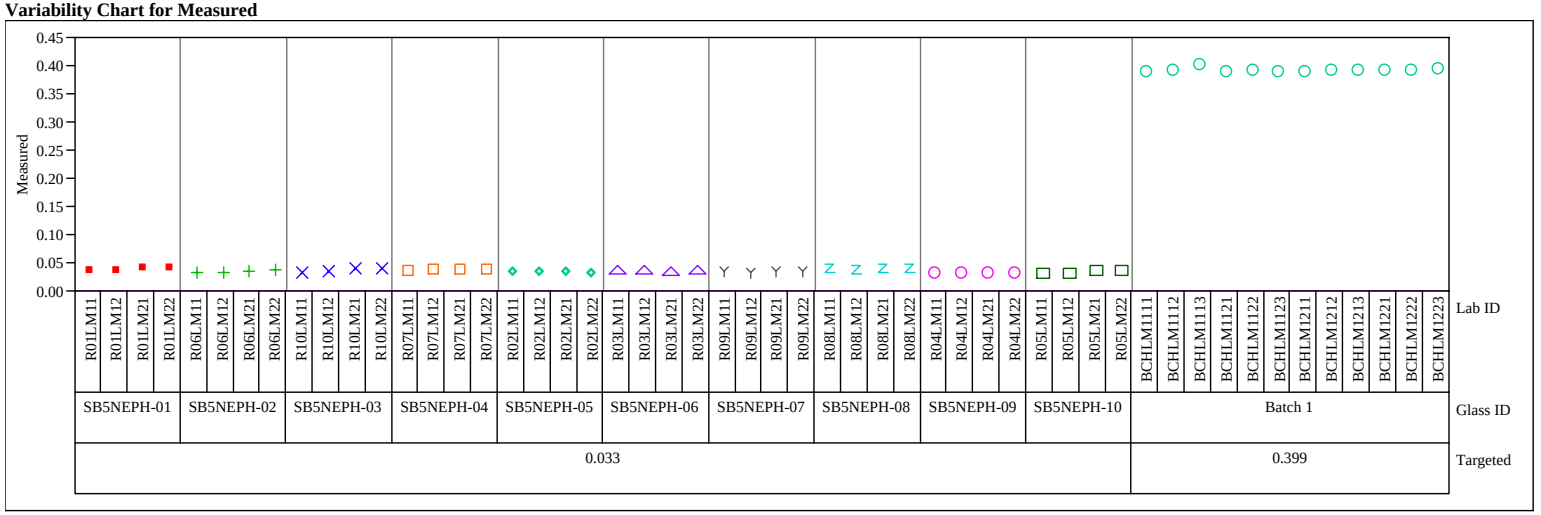


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=1, Oxide=CuO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

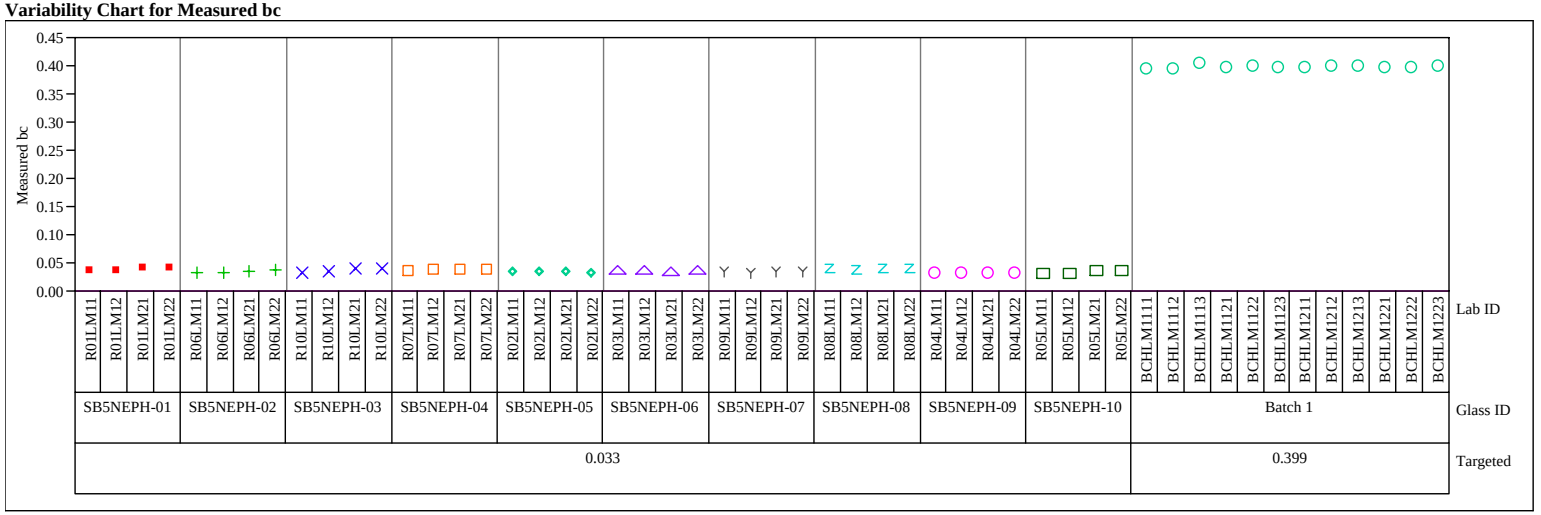
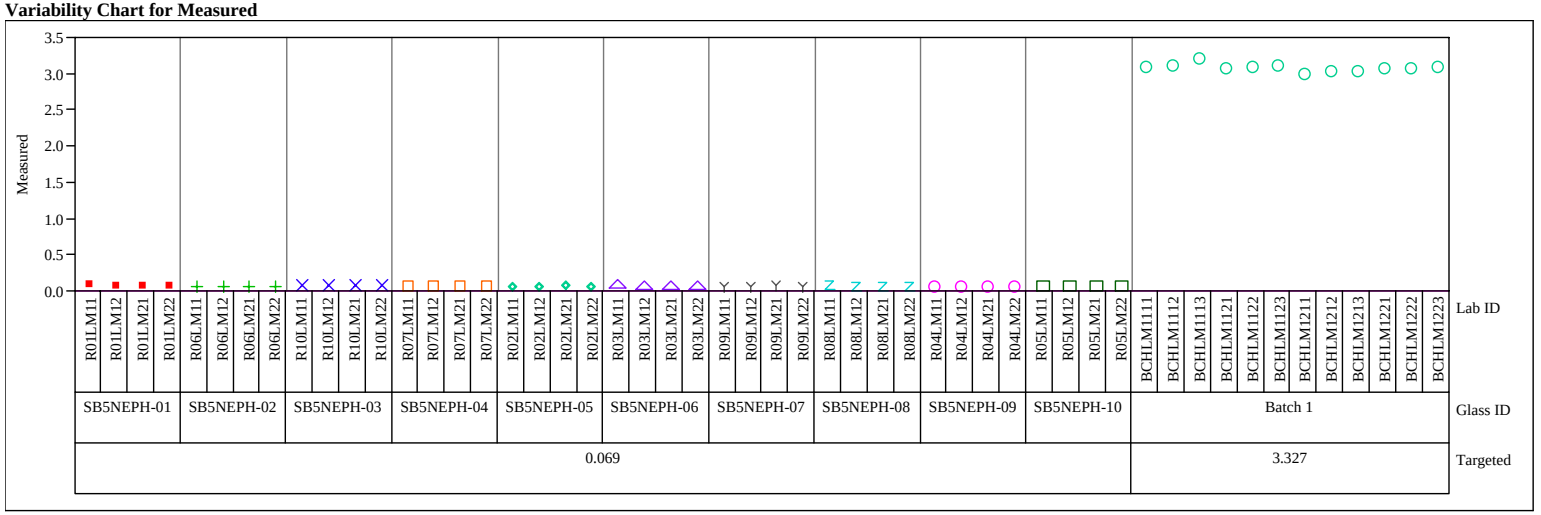


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=1, Oxide=K2O (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

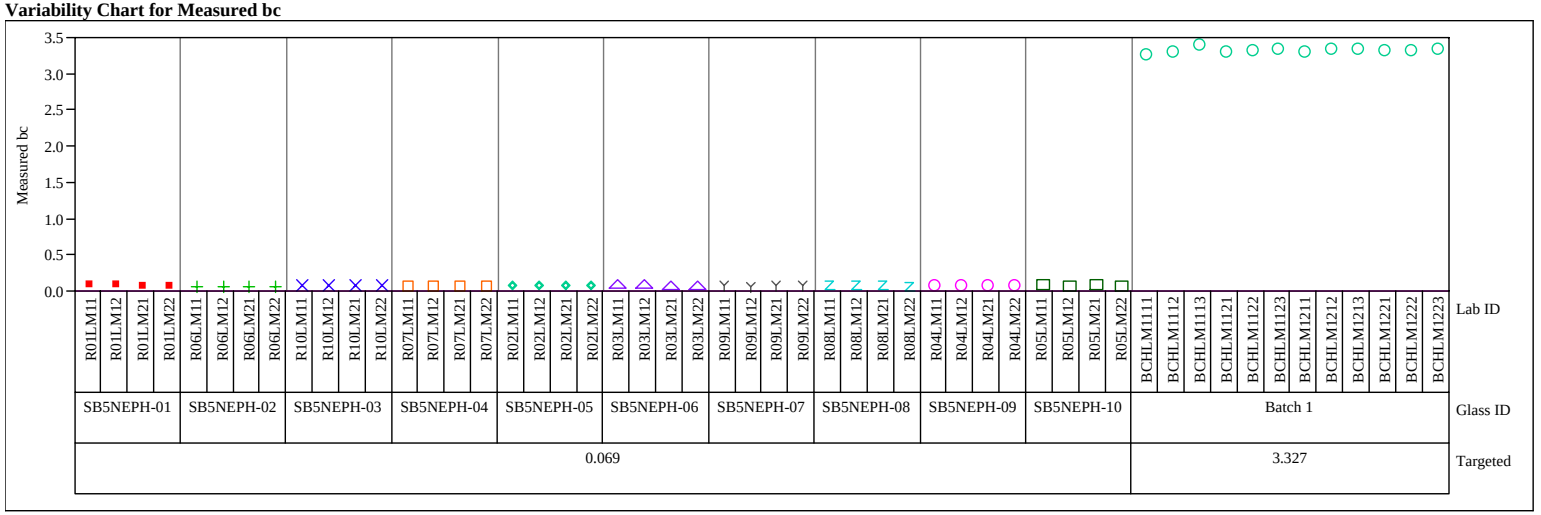
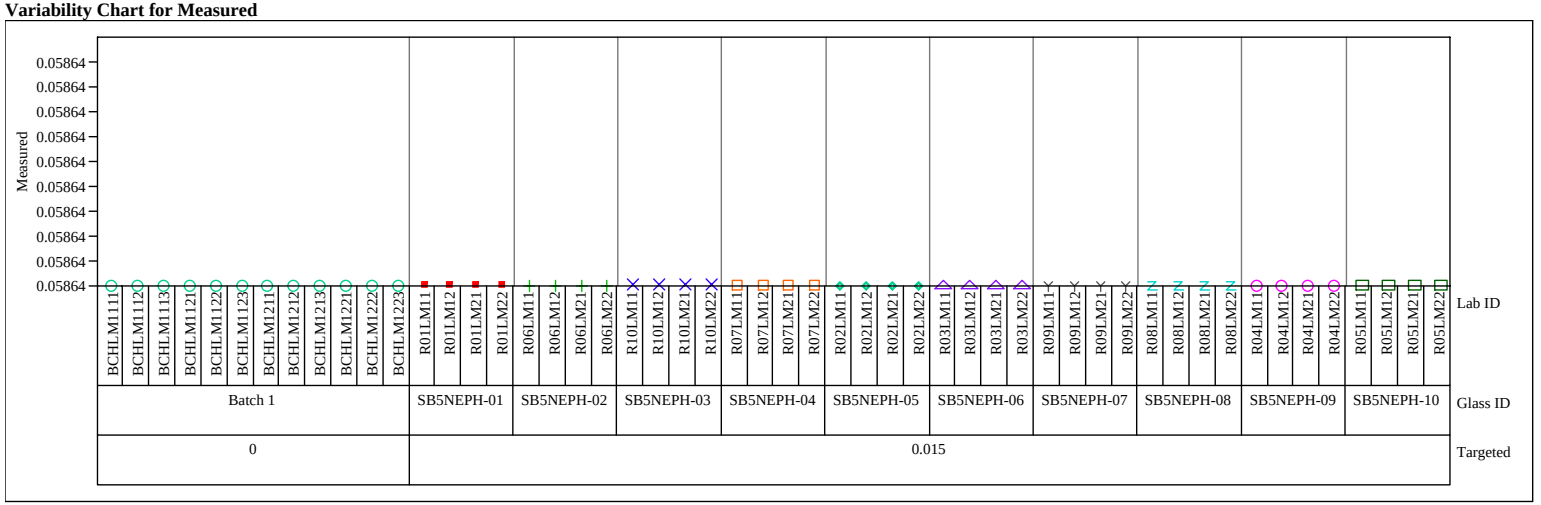


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=1, Oxide=La2O3 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

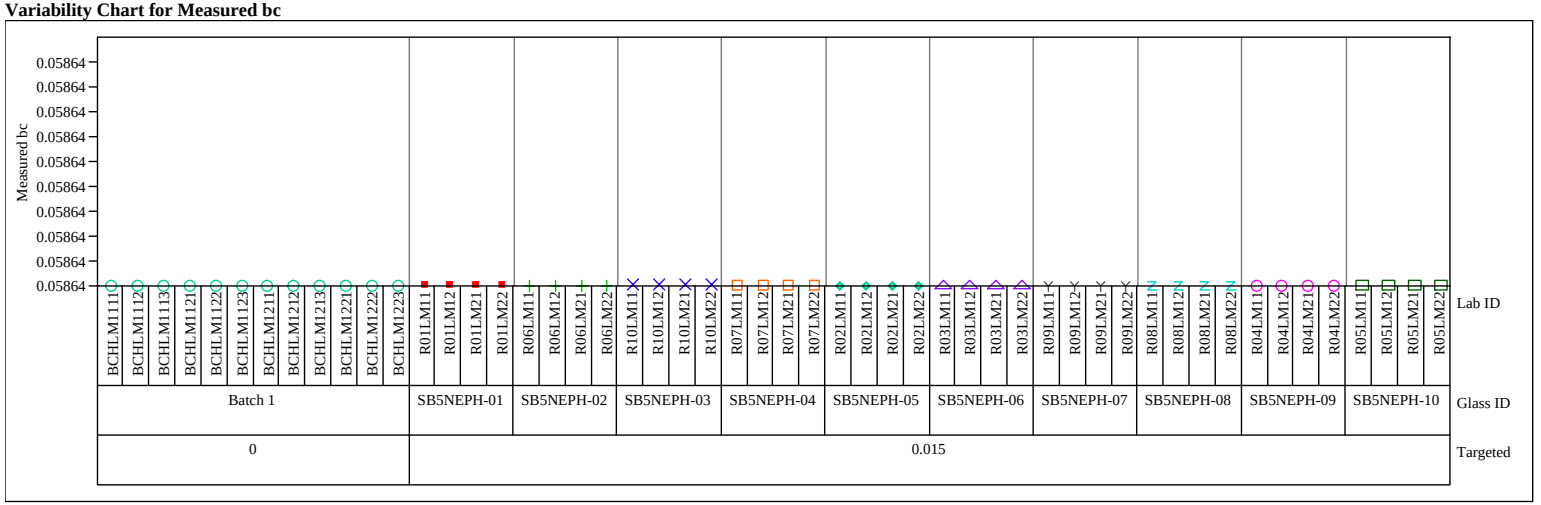
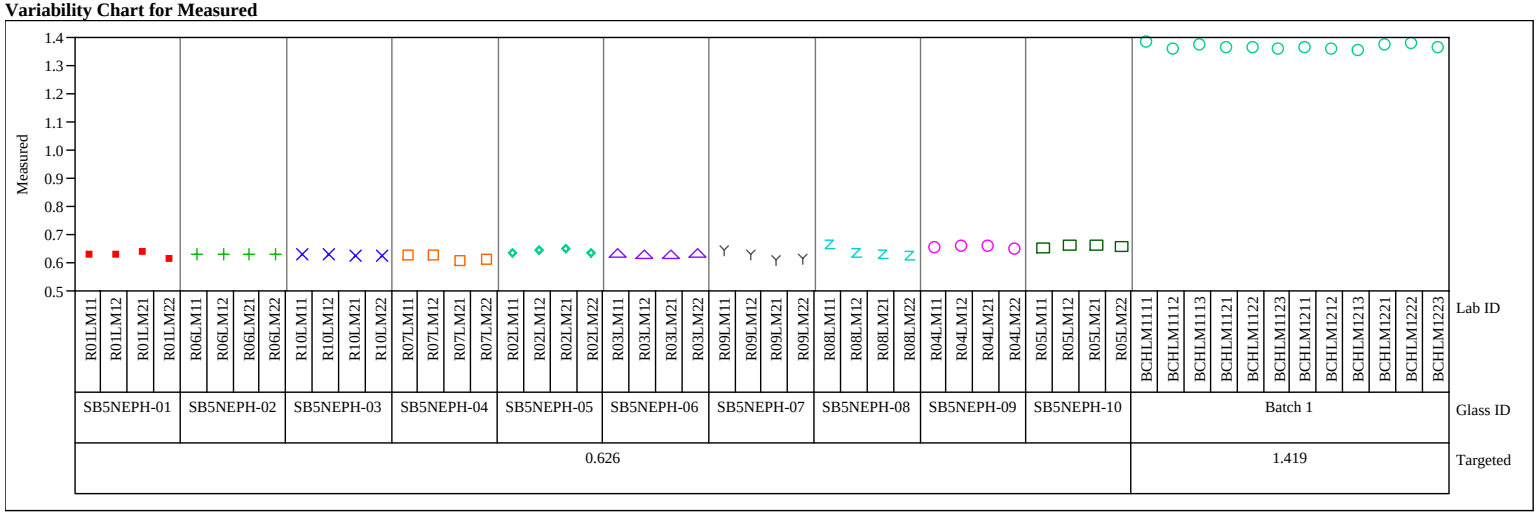


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=1, Oxide=MgO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

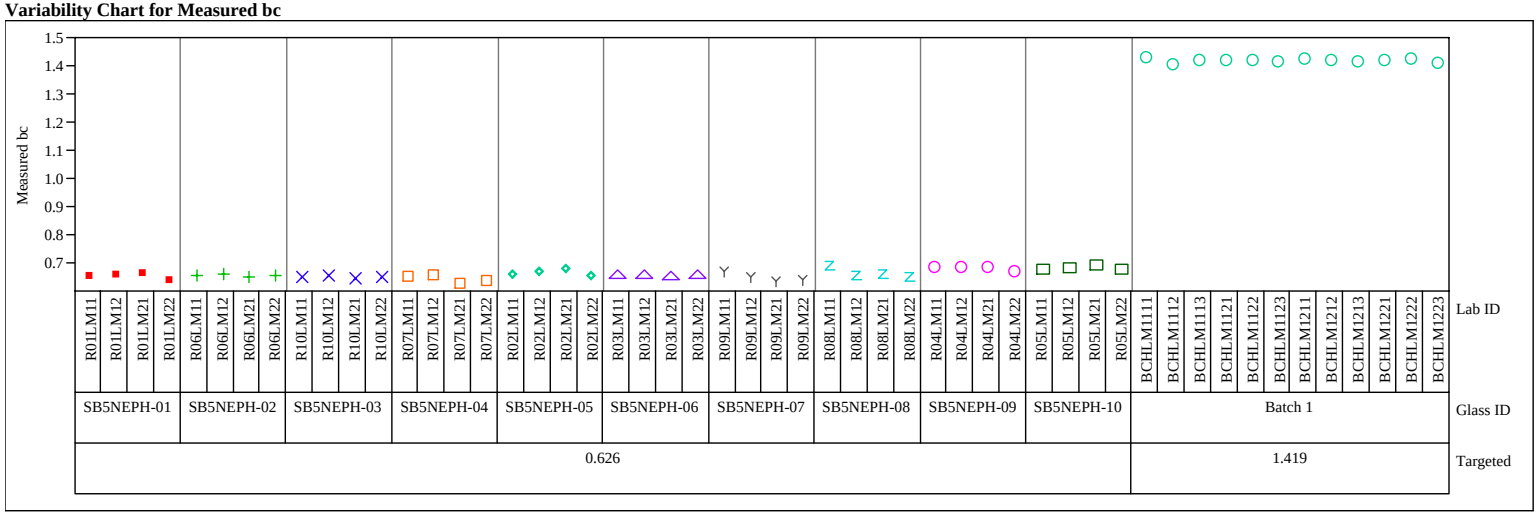
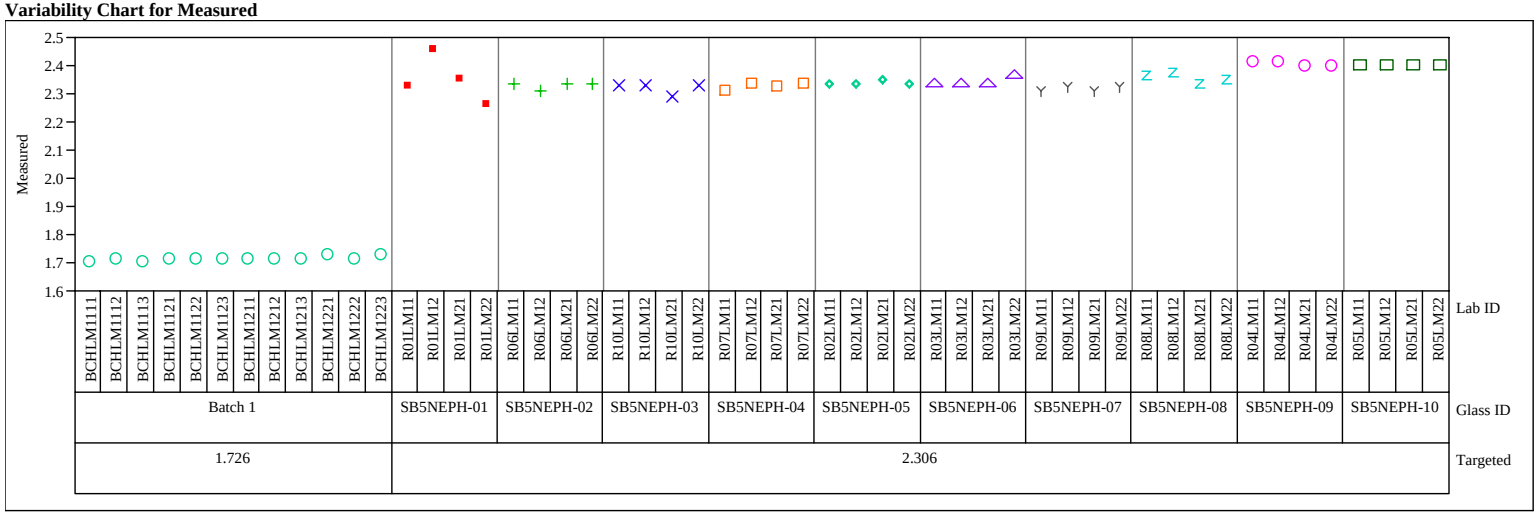


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=1, Oxide=MnO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

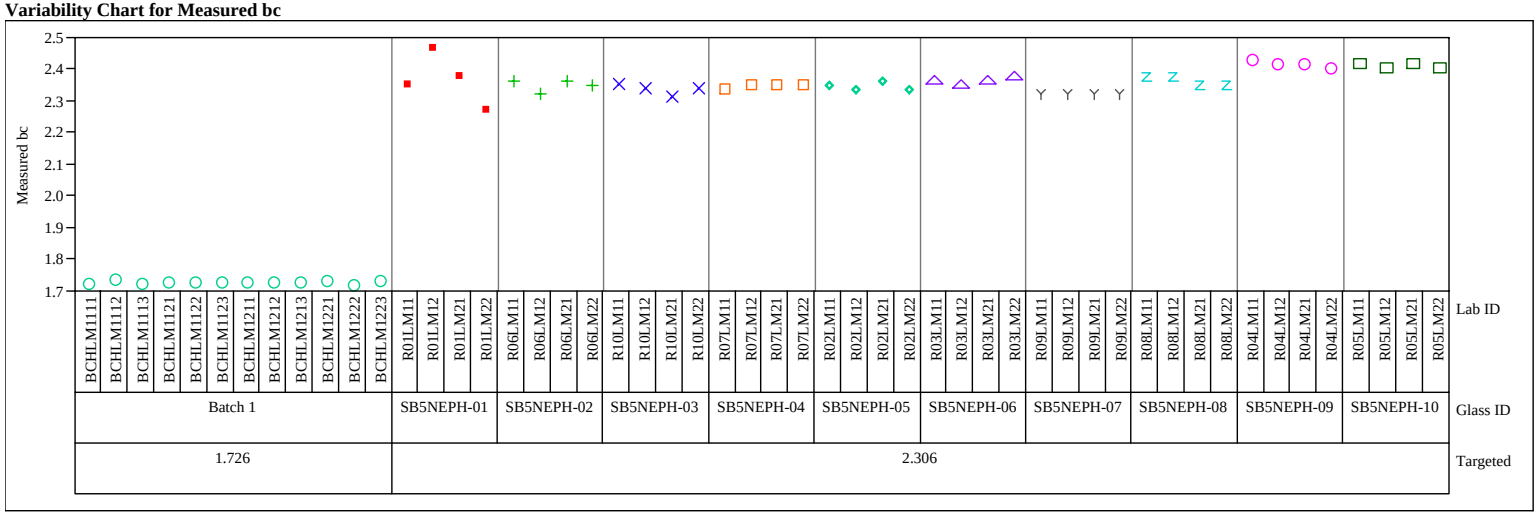
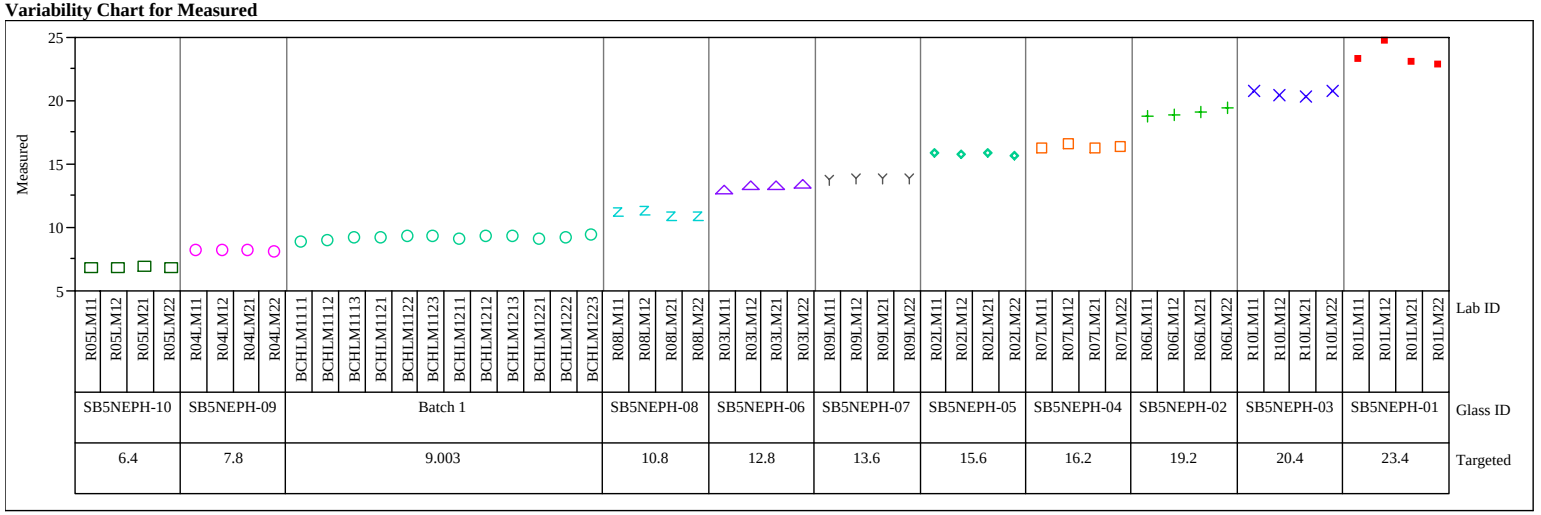


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=1, Oxide=Na2O (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

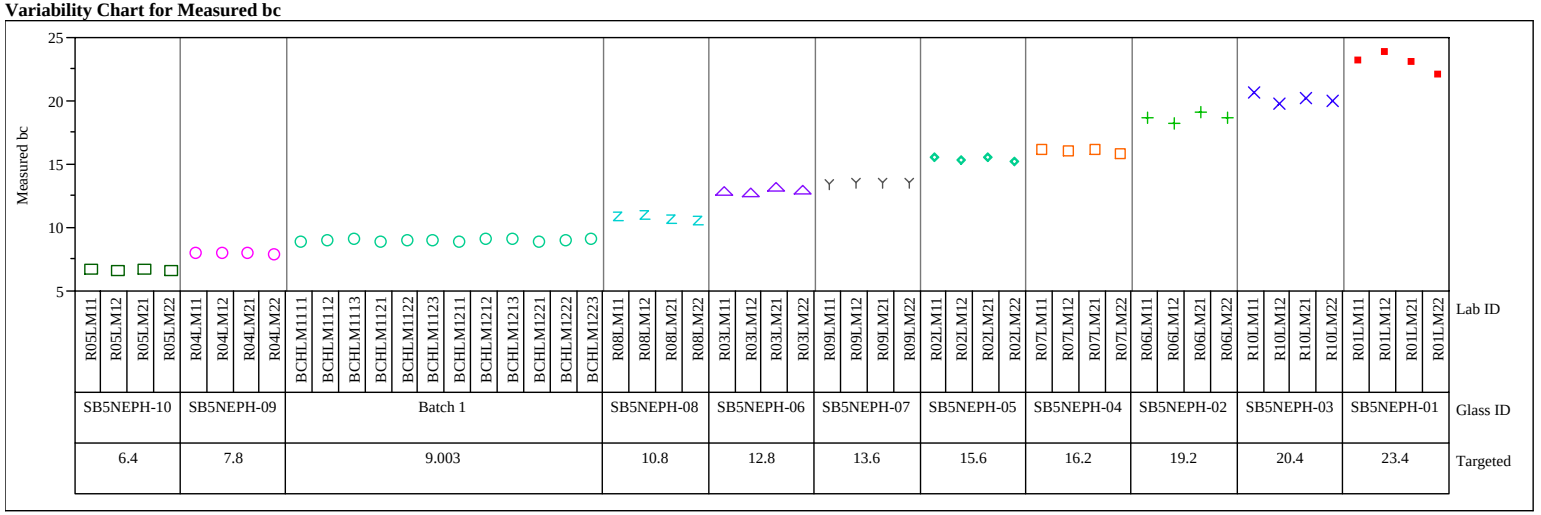
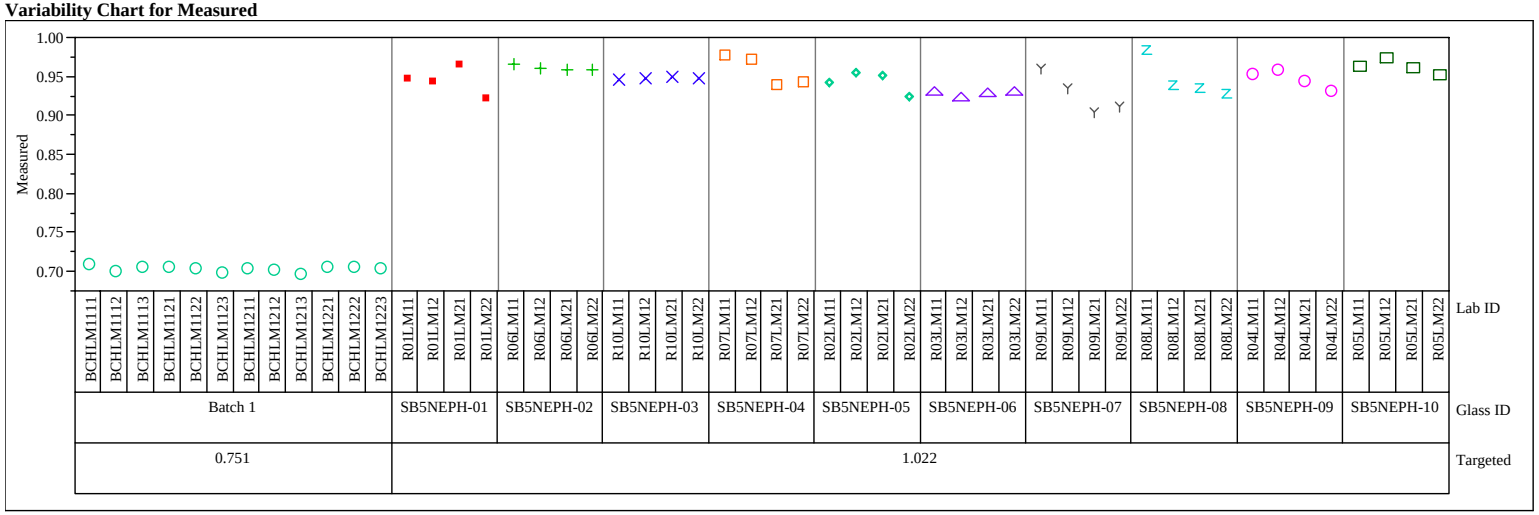


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=1, Oxide=NiO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

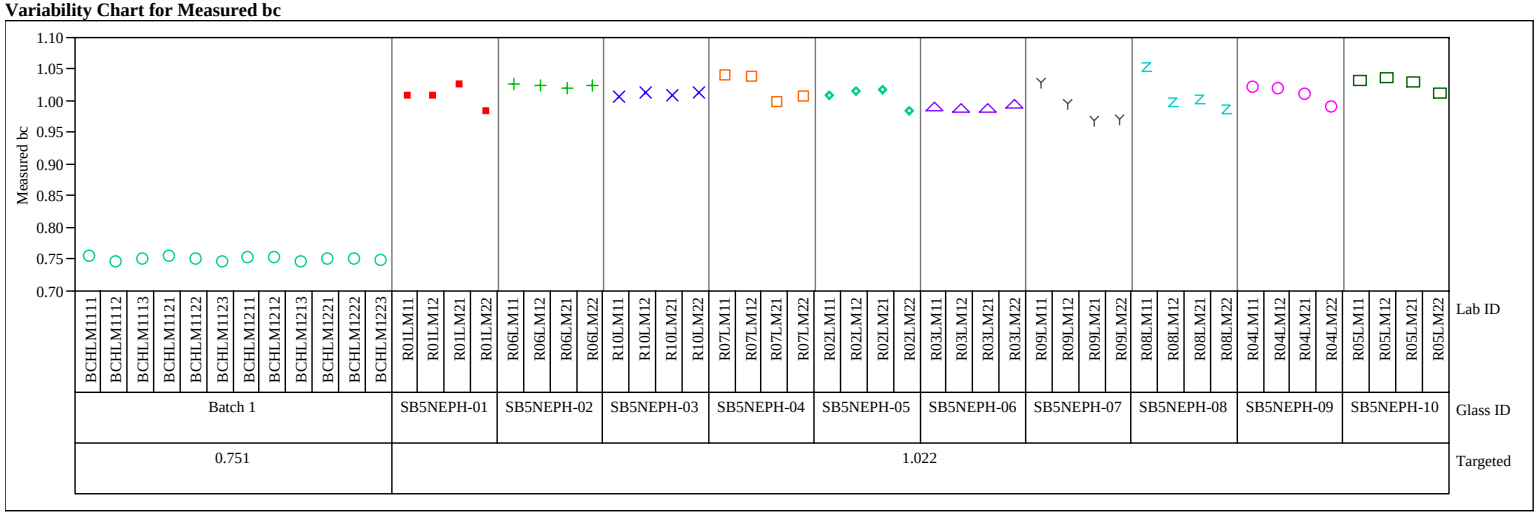
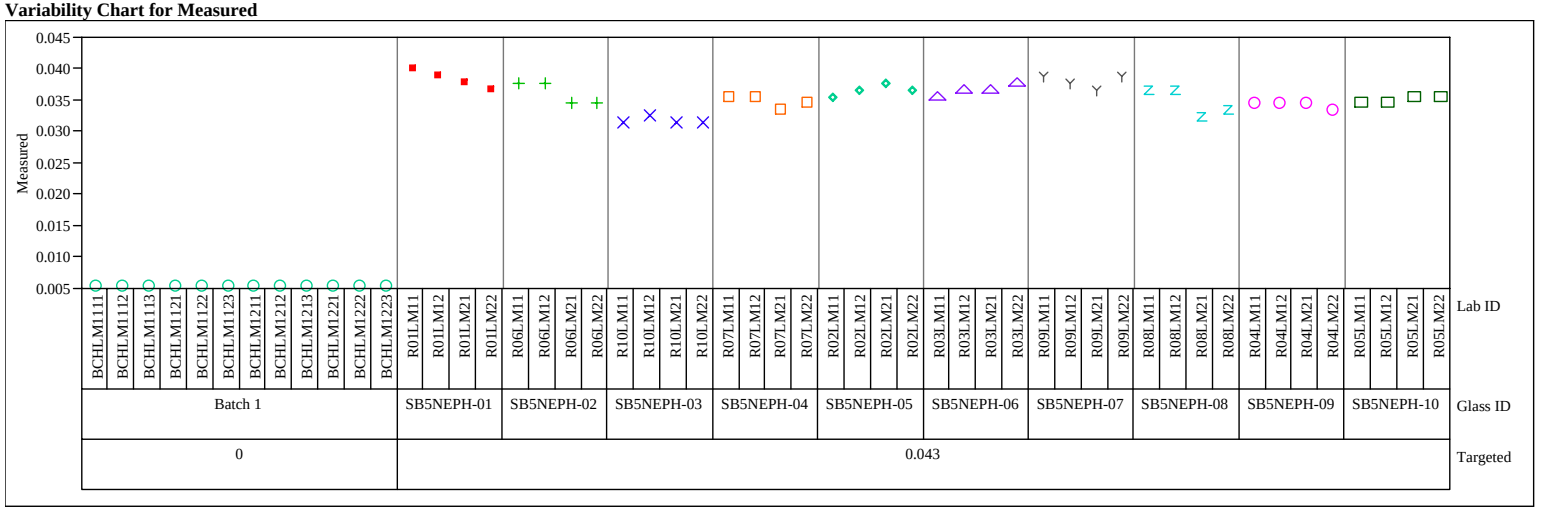


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=1, Oxide=PbO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

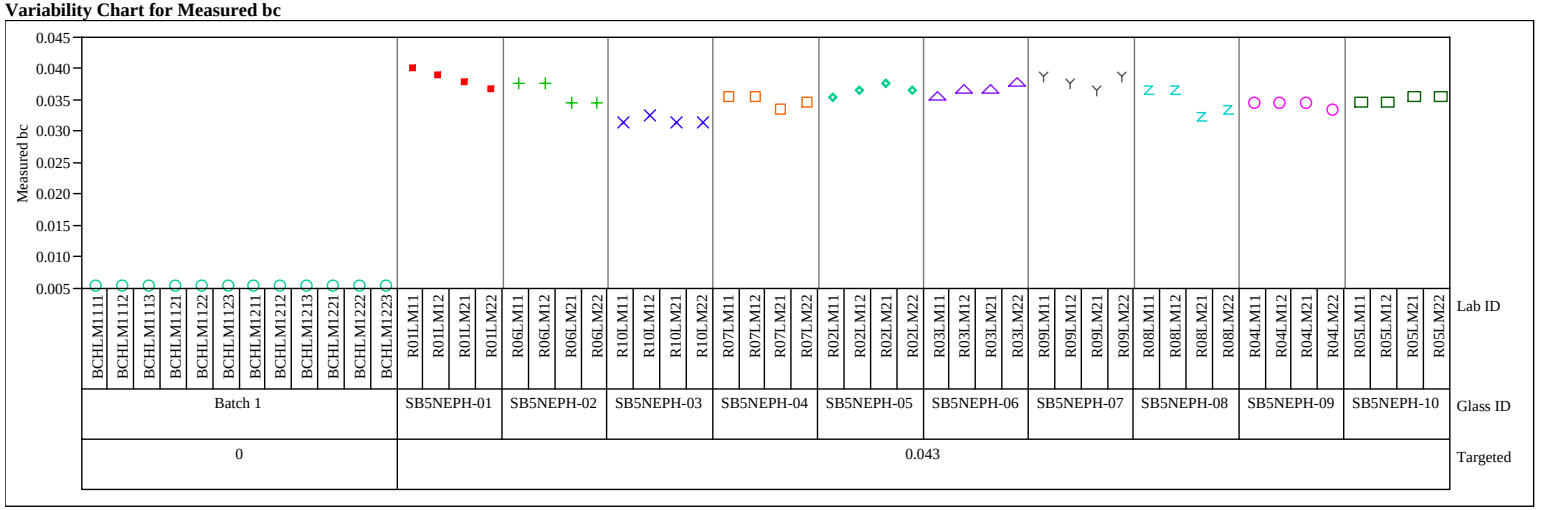
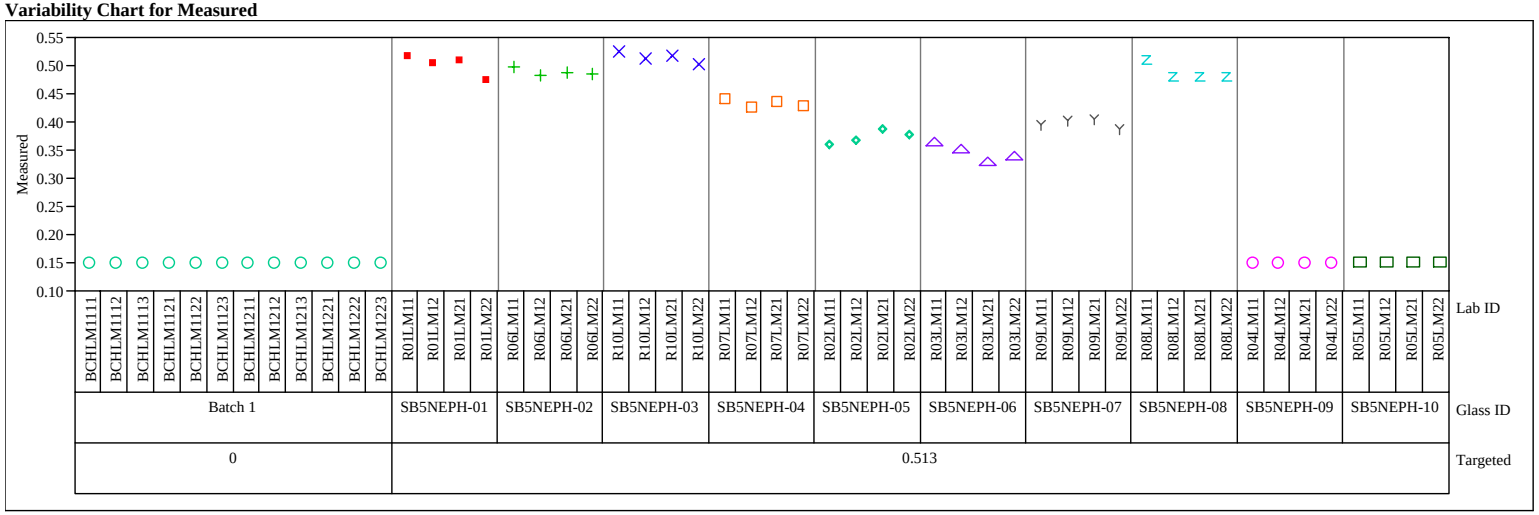


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=1, Oxide=SO4 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

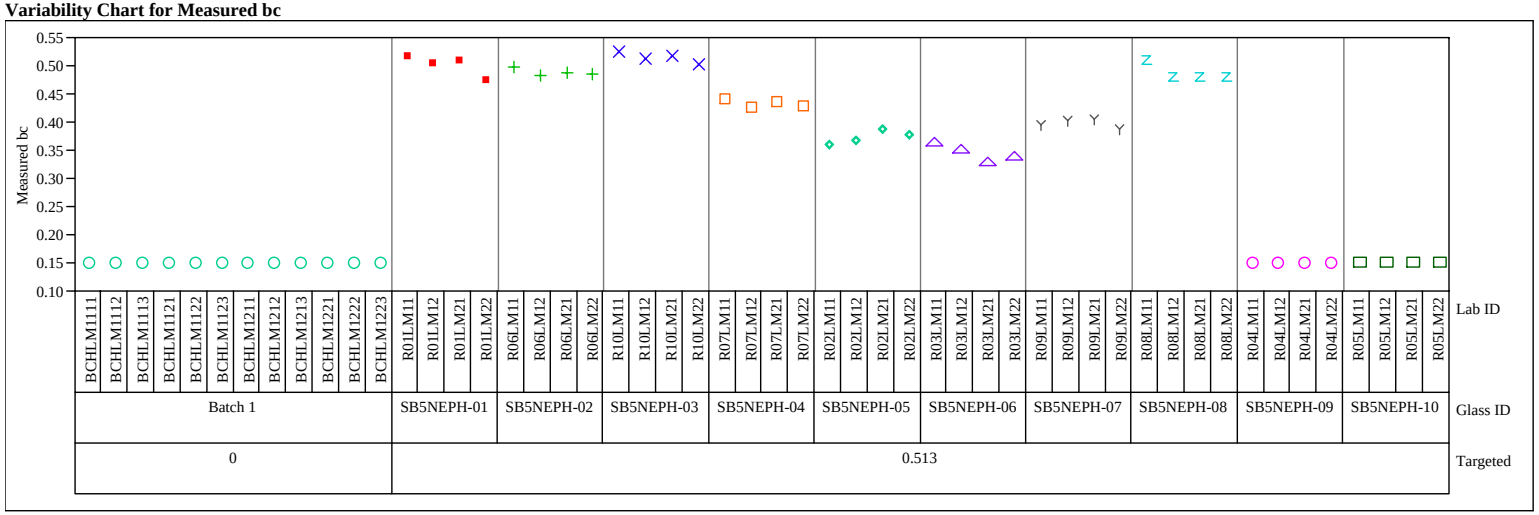
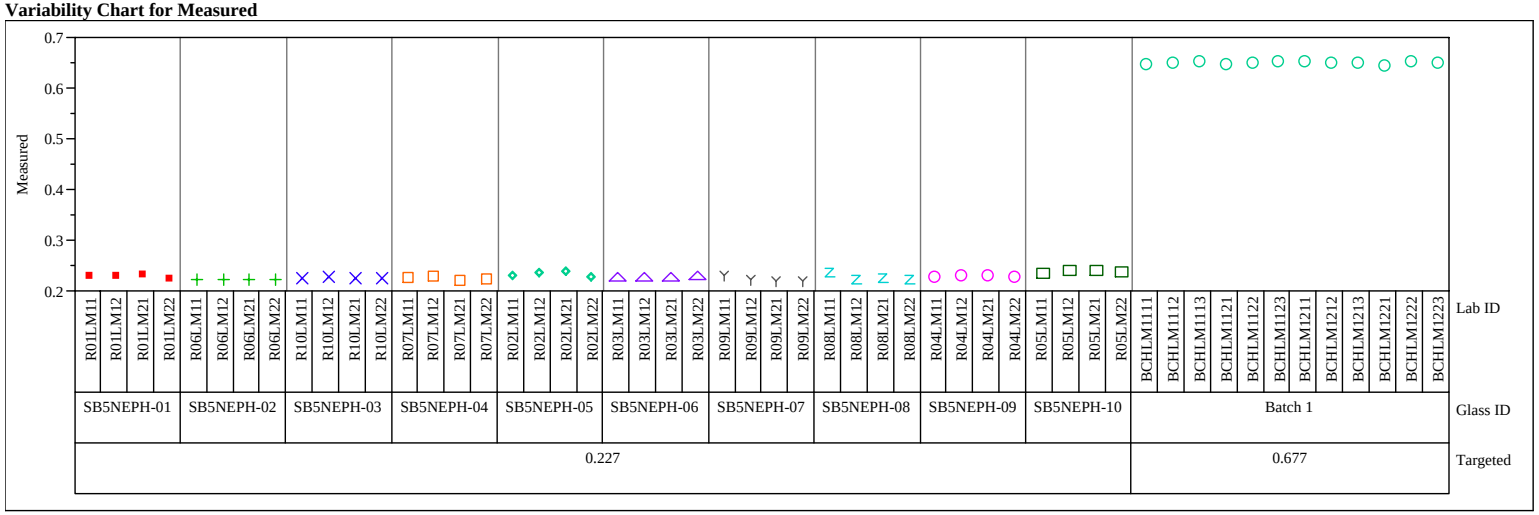


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=1, Oxide=TiO2 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

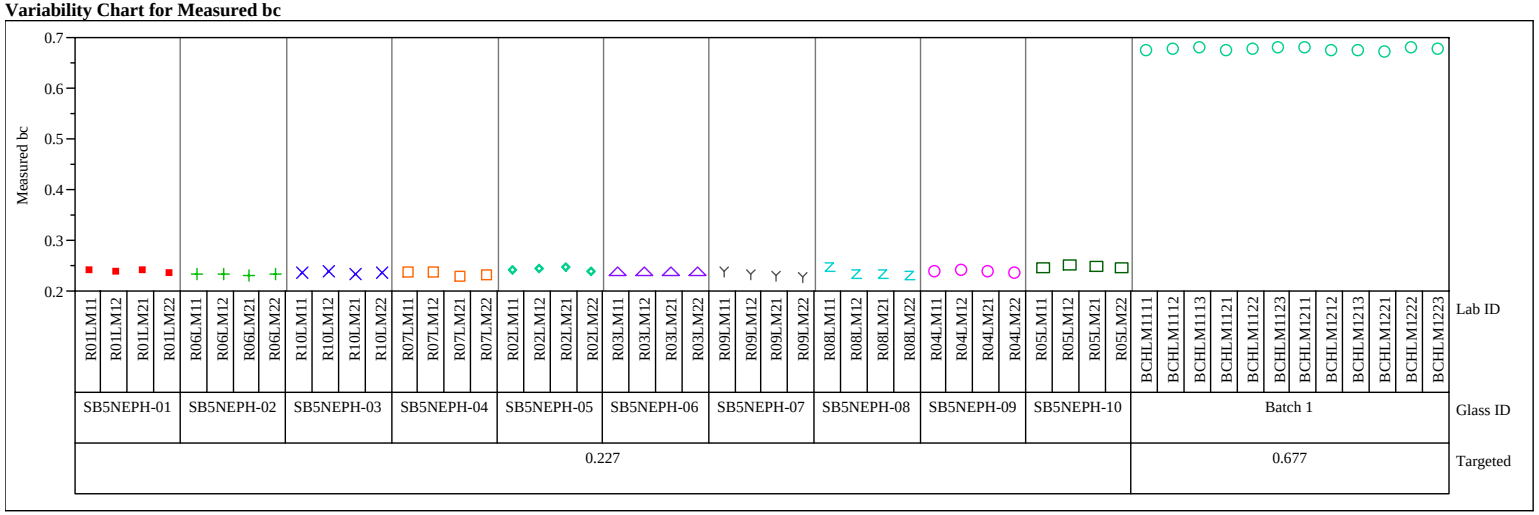
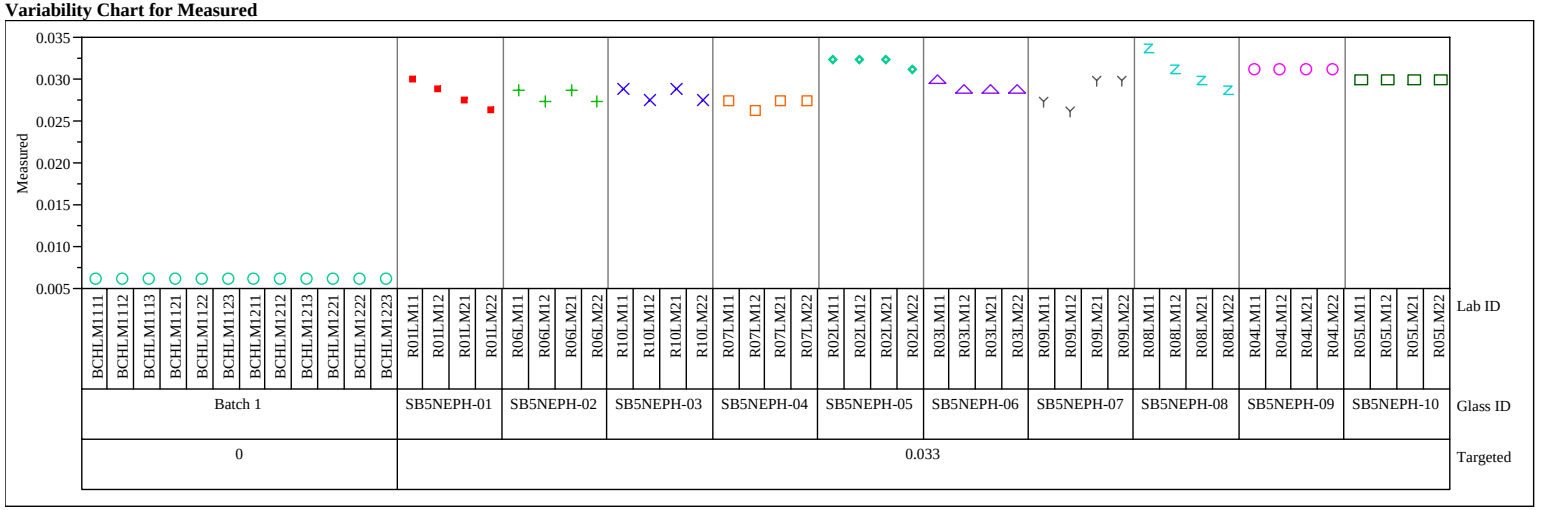


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=1, Oxide=ZnO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

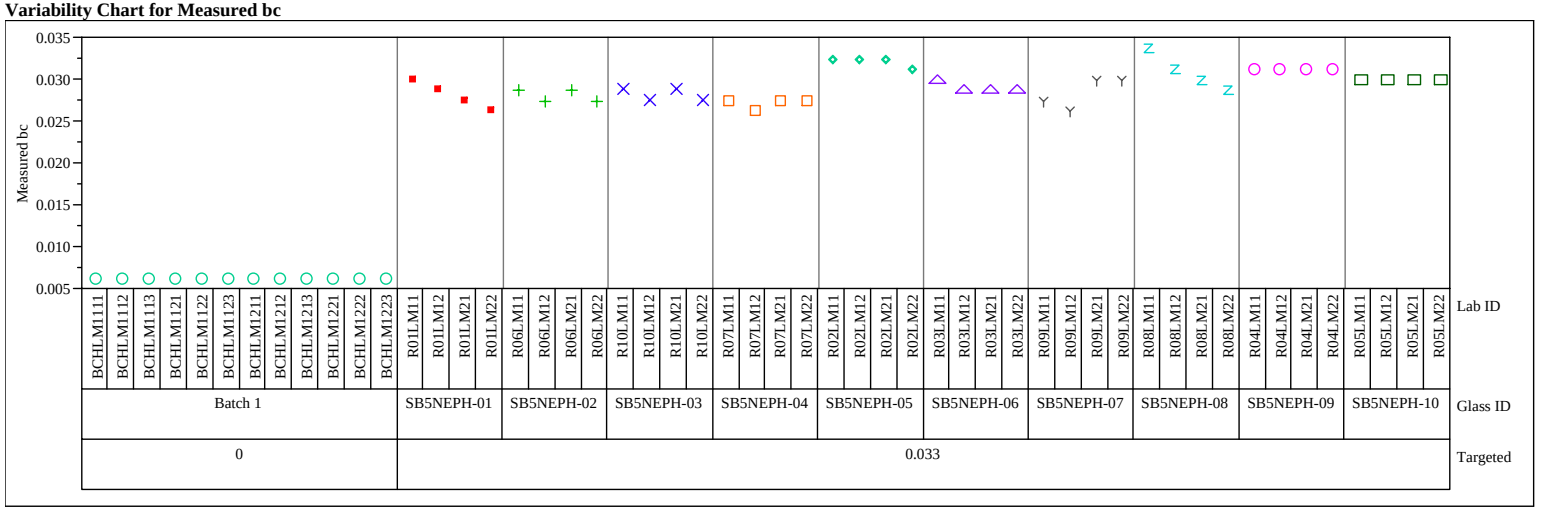
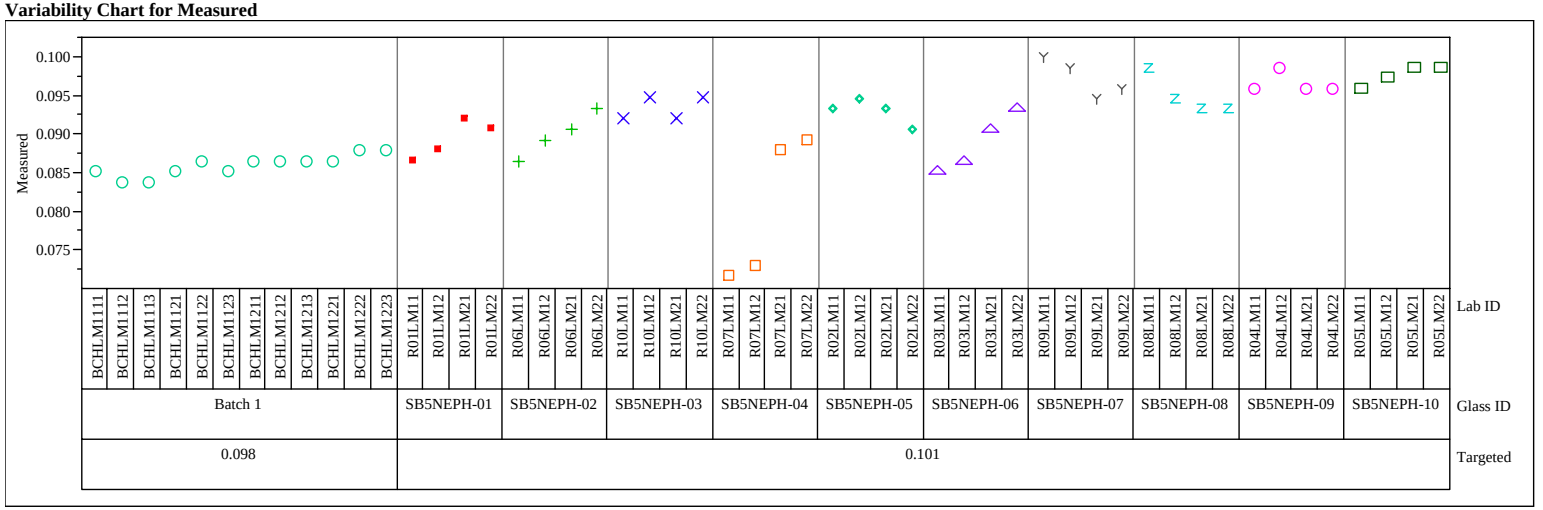


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=1, Oxide=ZrO2 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

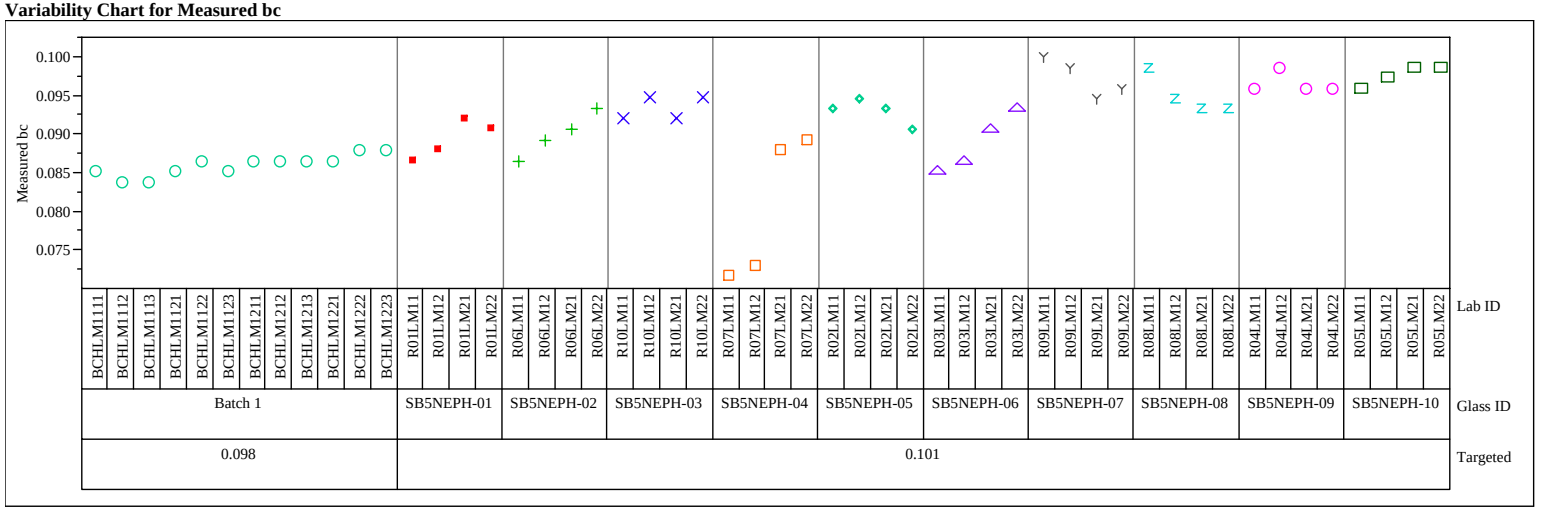
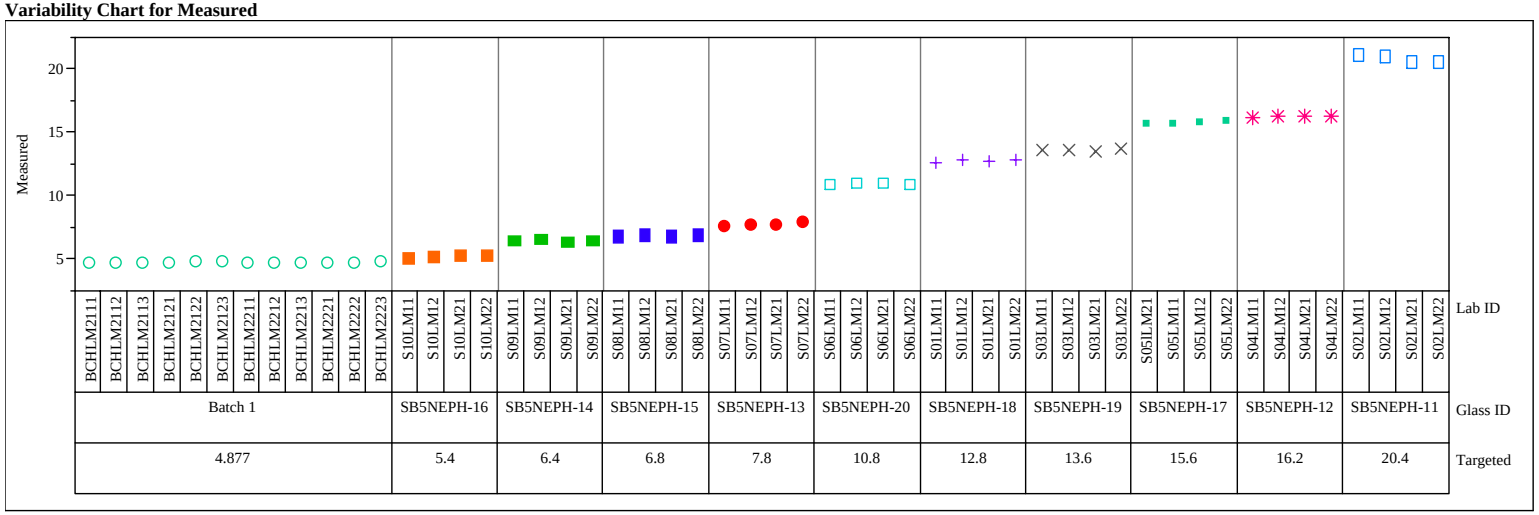


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=2, Oxide=Al2O3 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

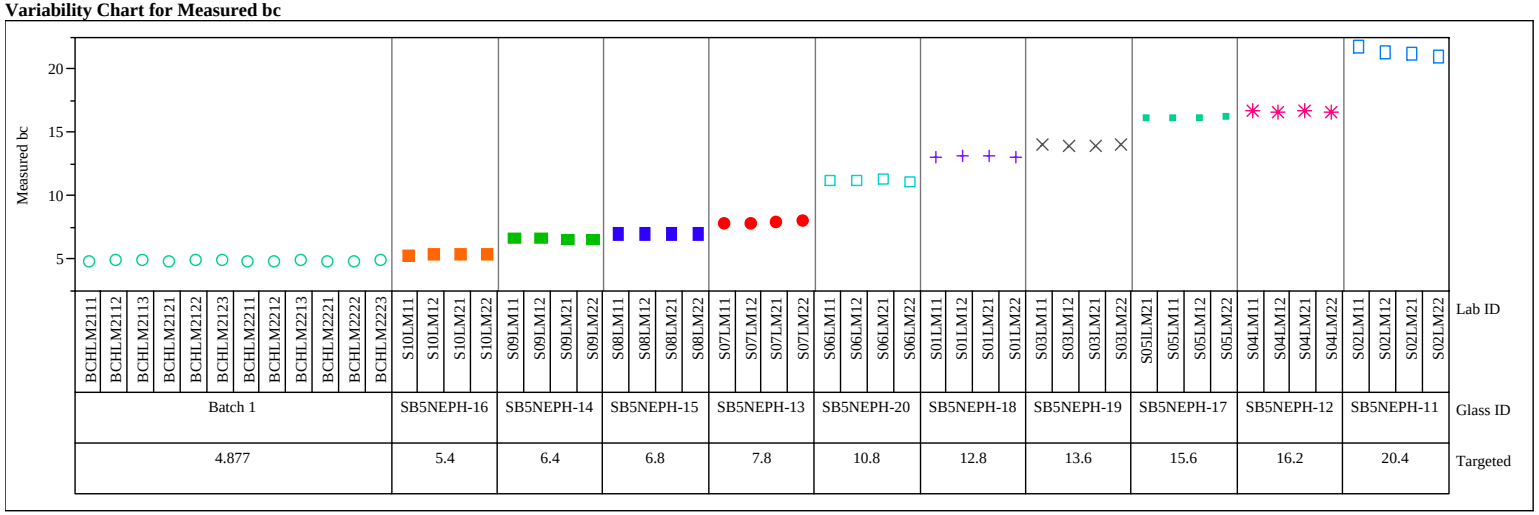
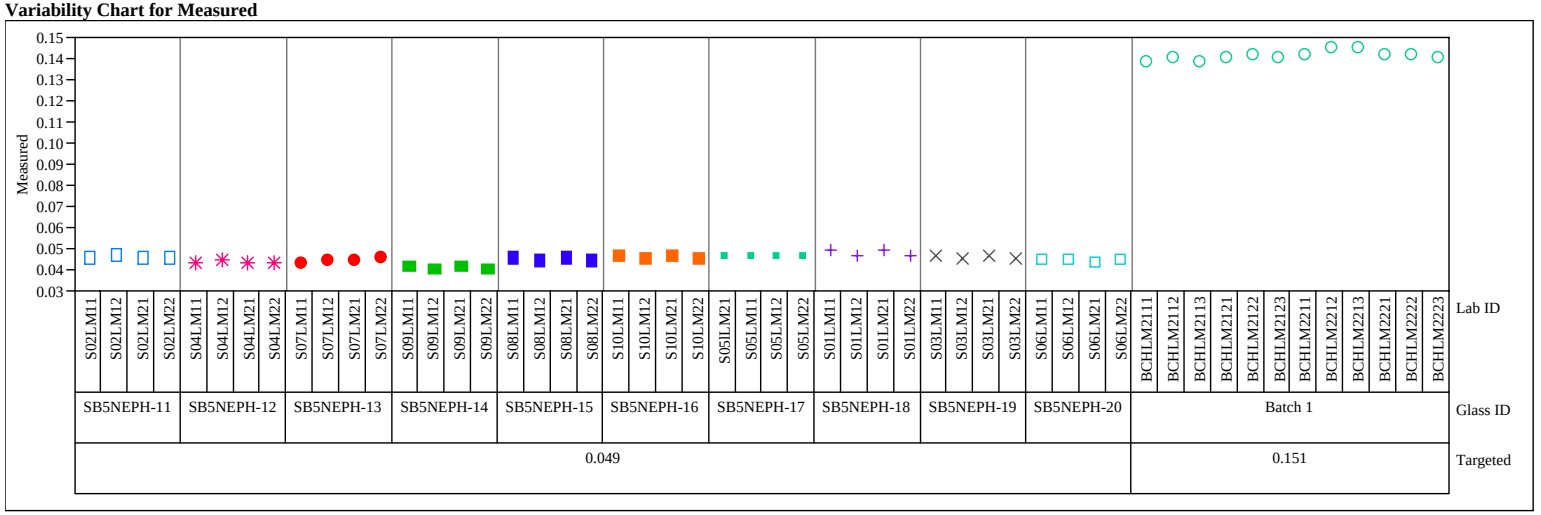


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=2, Oxide=BaO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

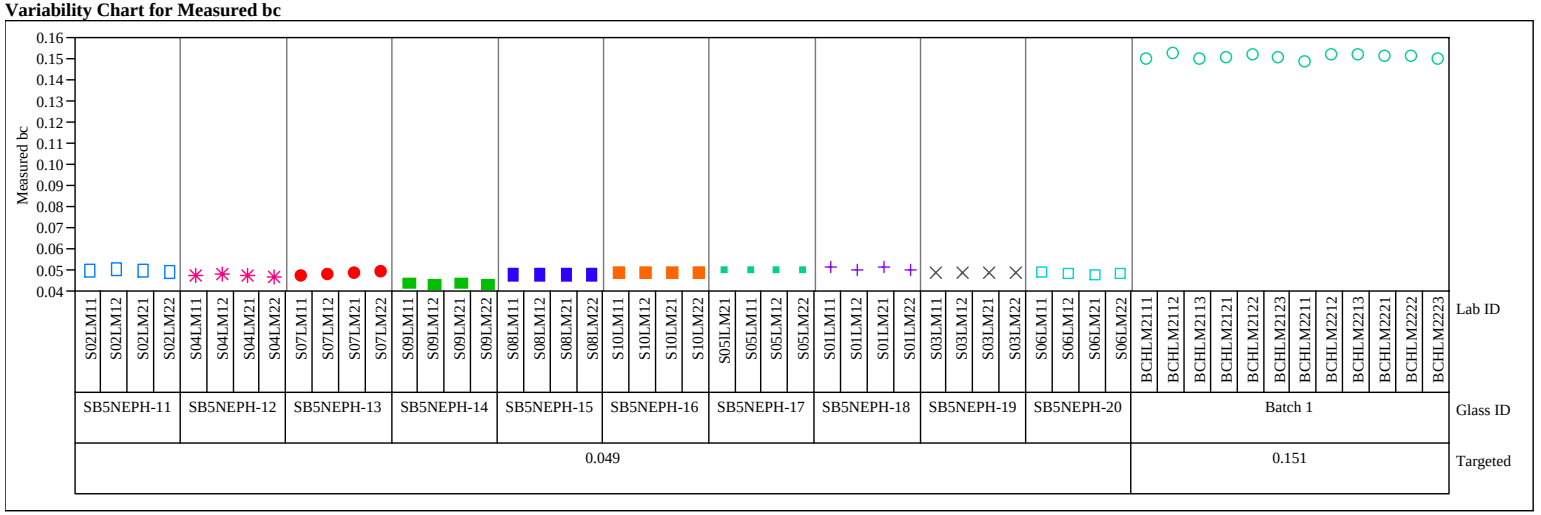
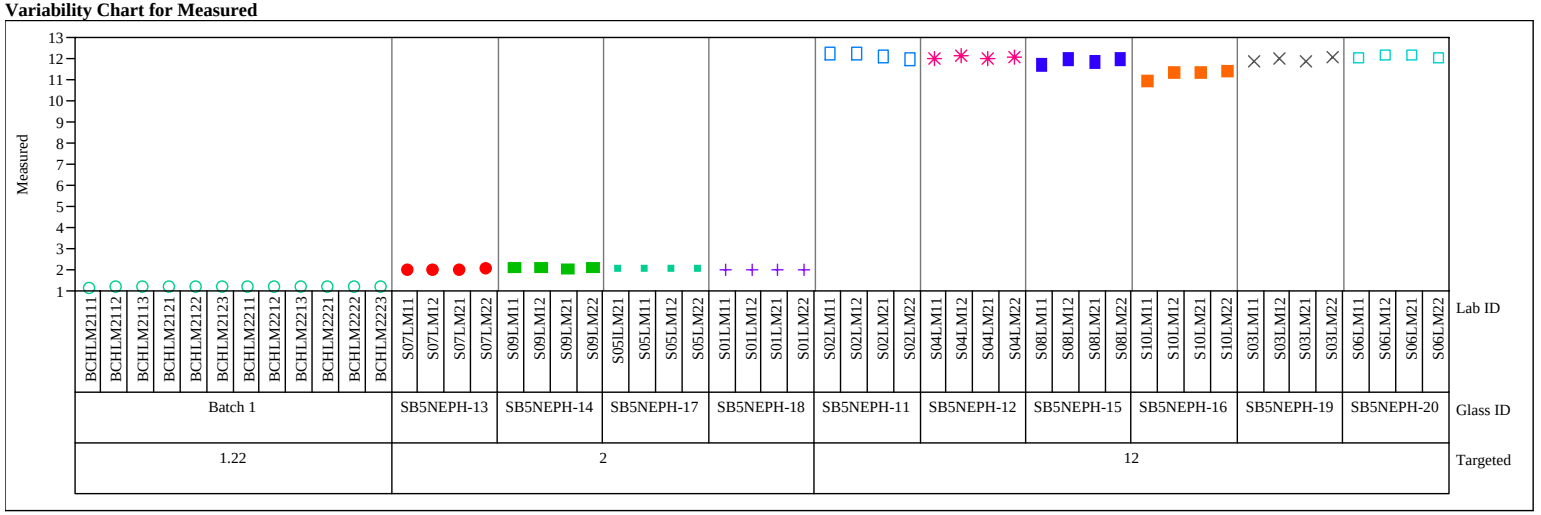


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=2, Oxide=CaO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

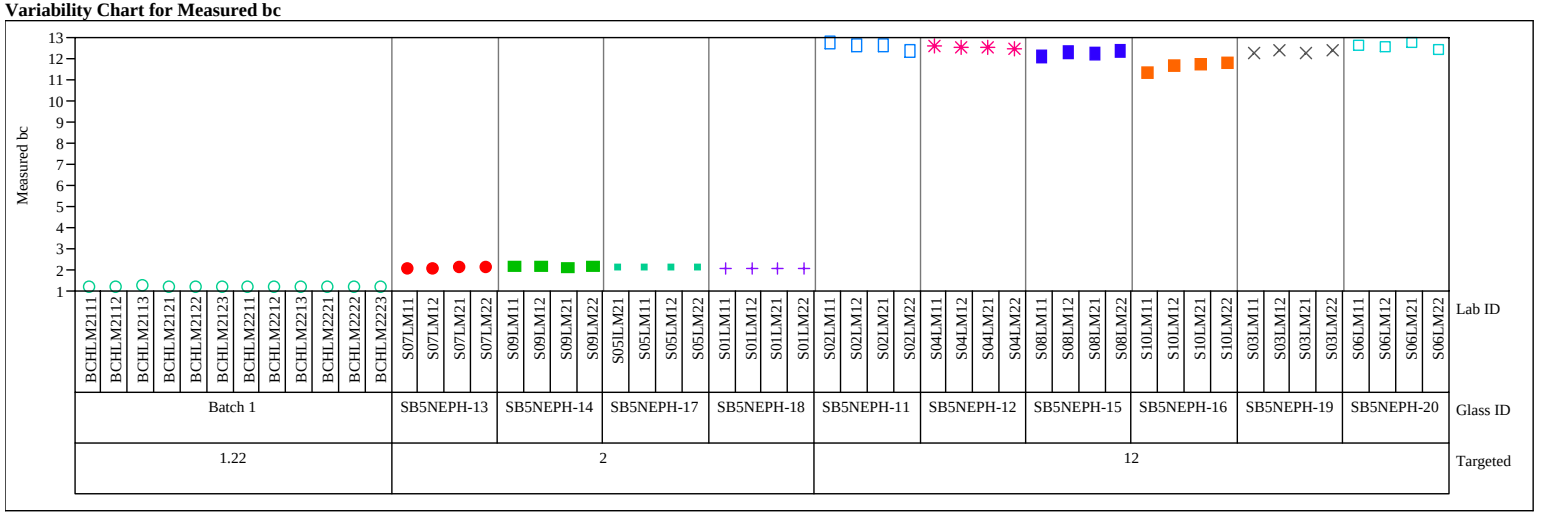
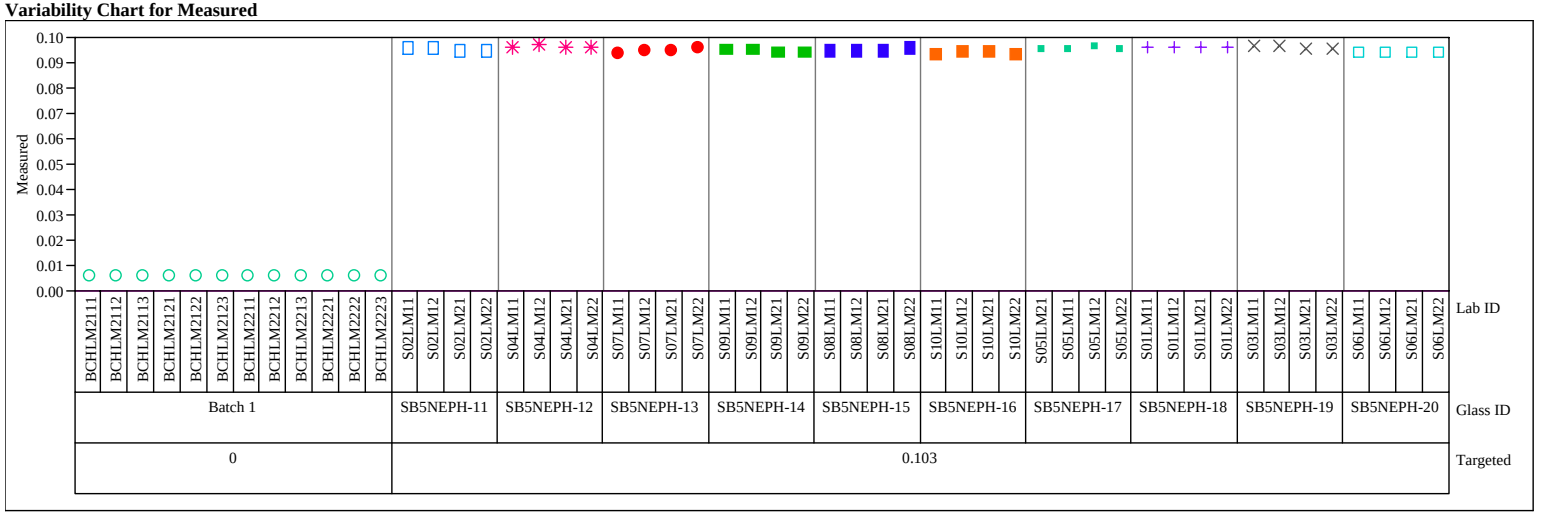


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=2, Oxide=Ce2O3 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

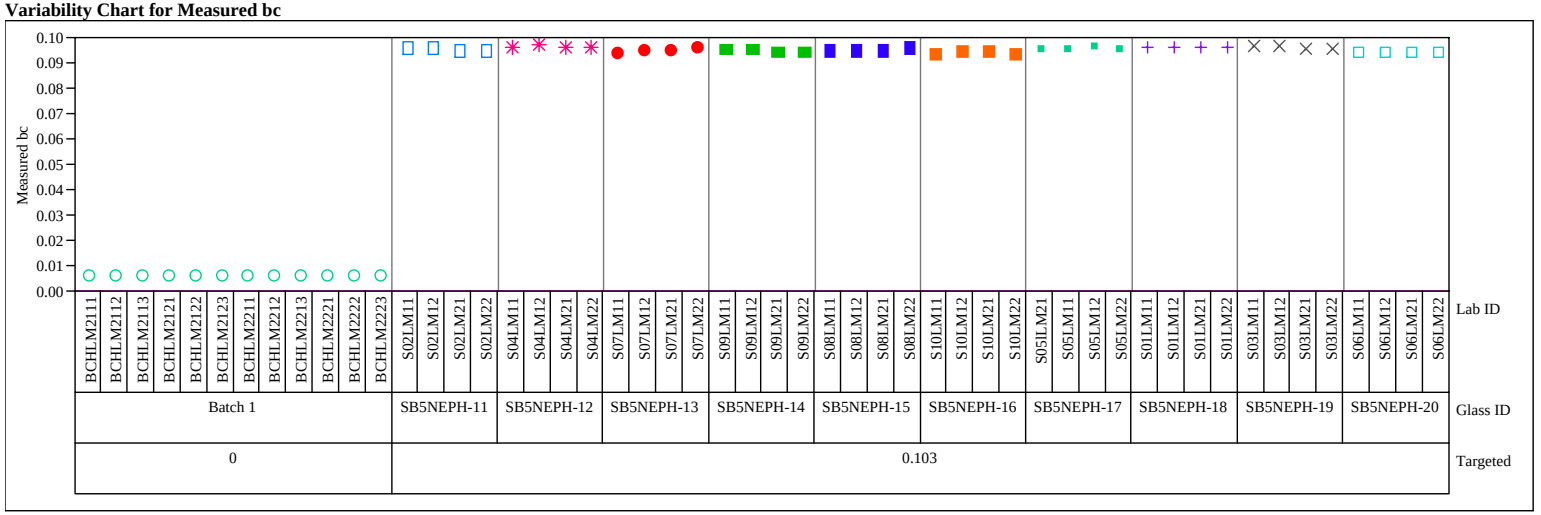
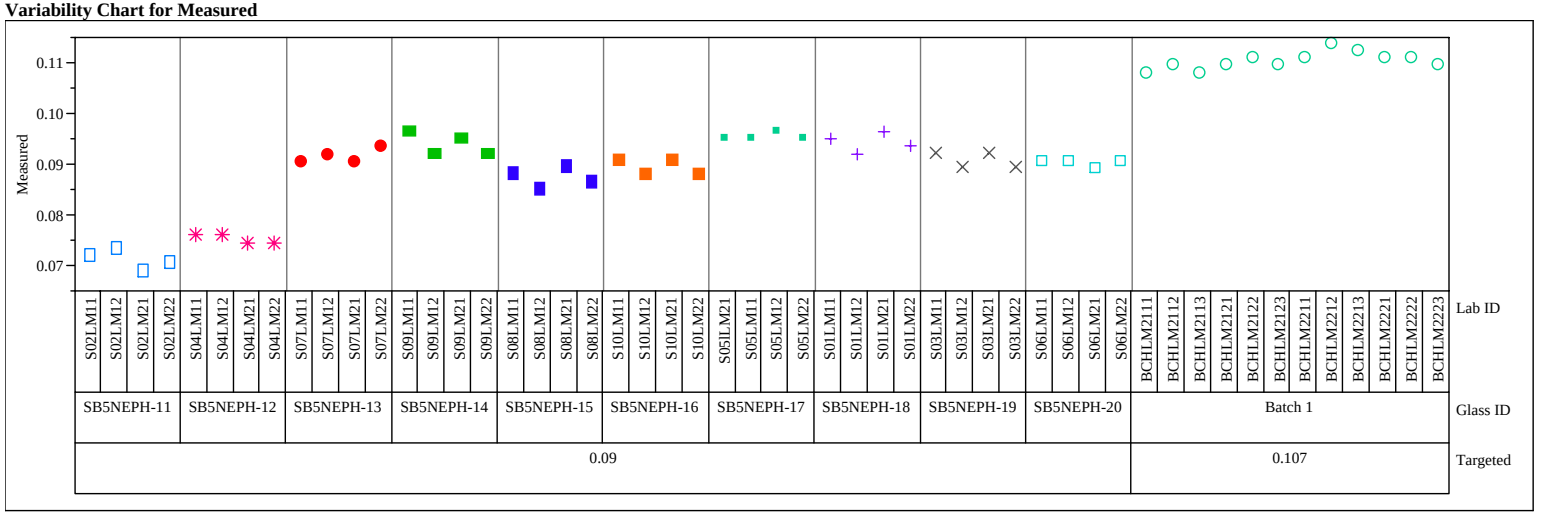


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=2, Oxide=Cr2O3 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

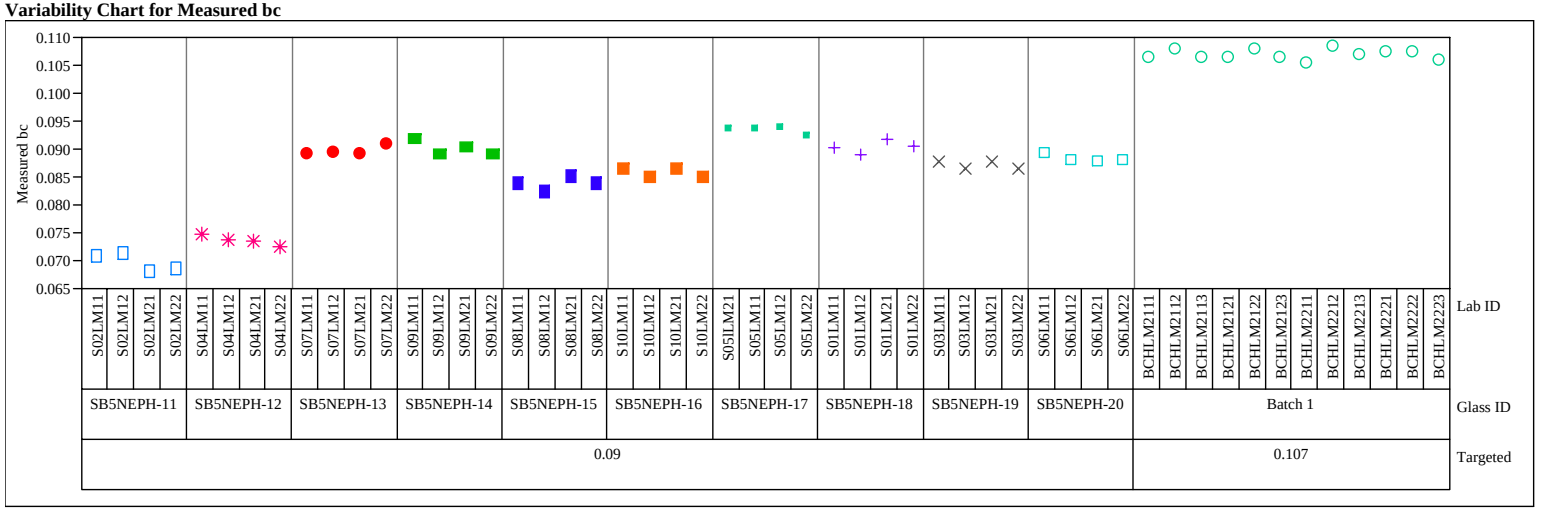
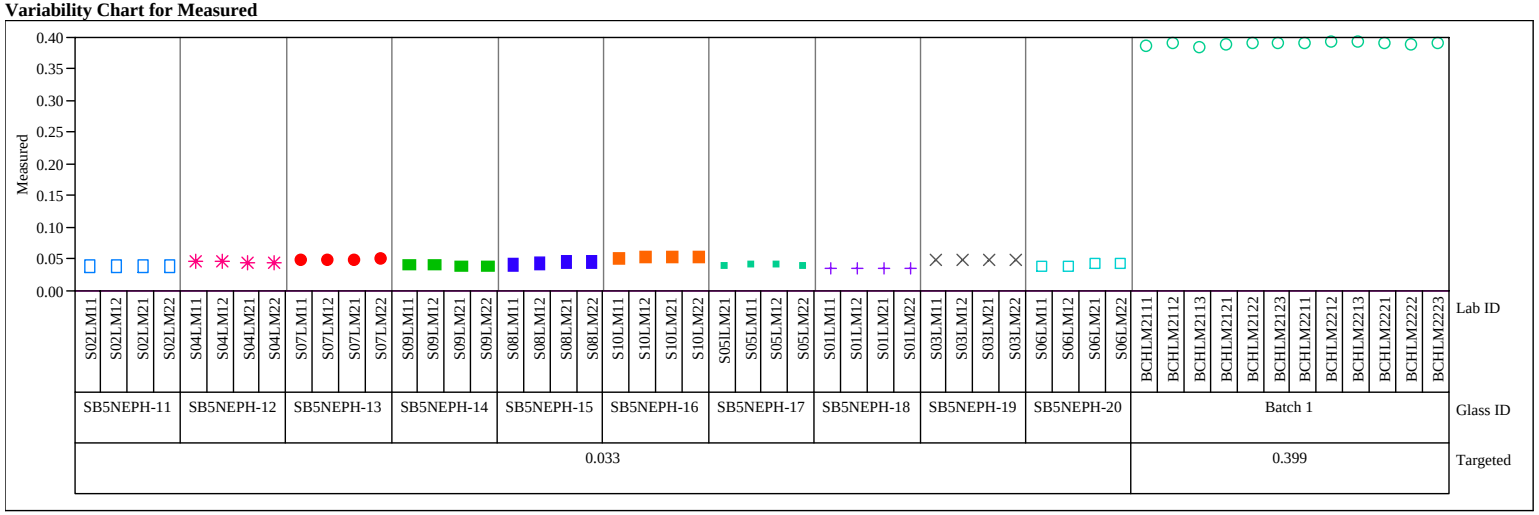


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=2, Oxide=CuO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

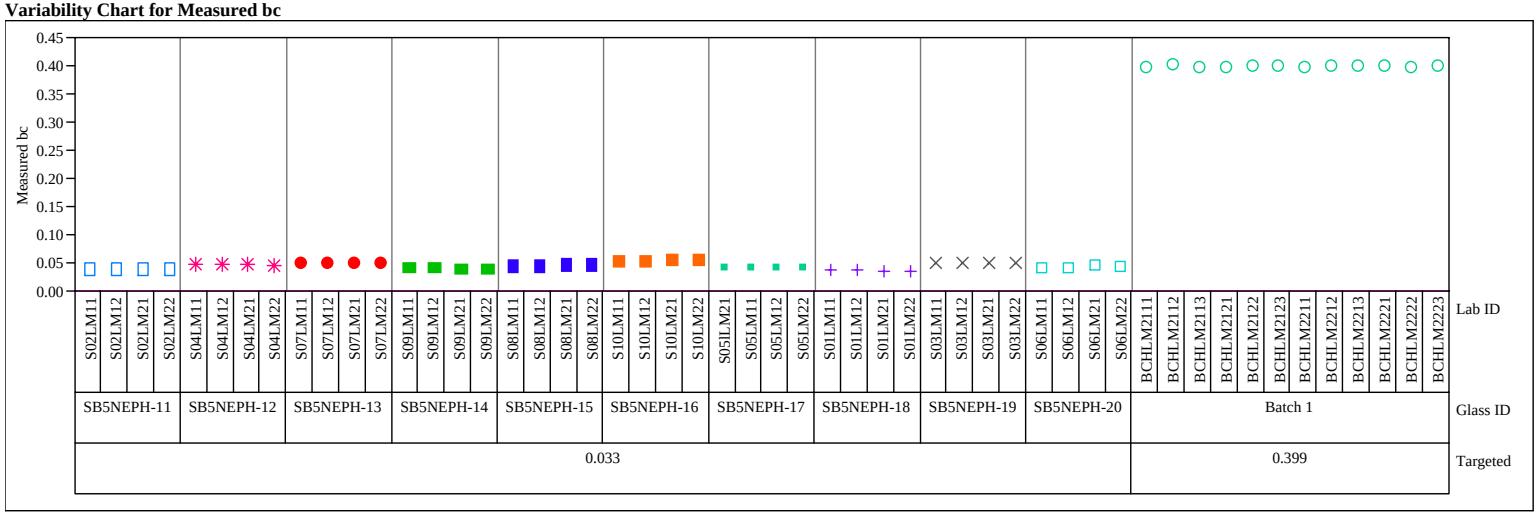
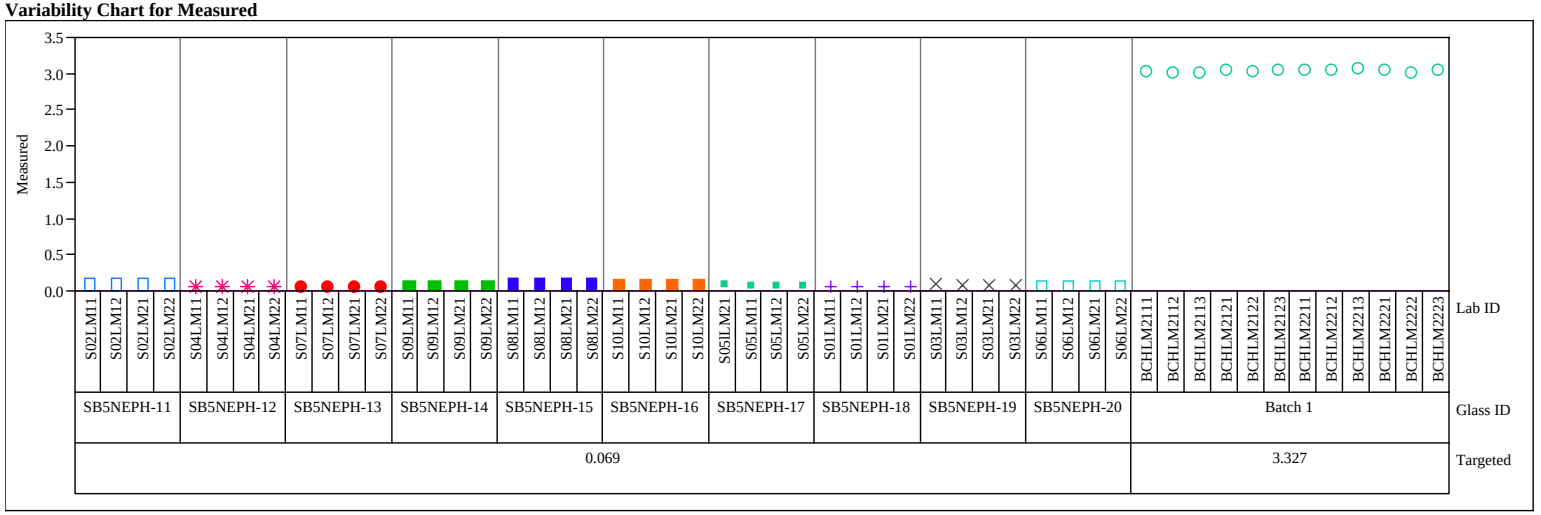


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=2, Oxide=K2O (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

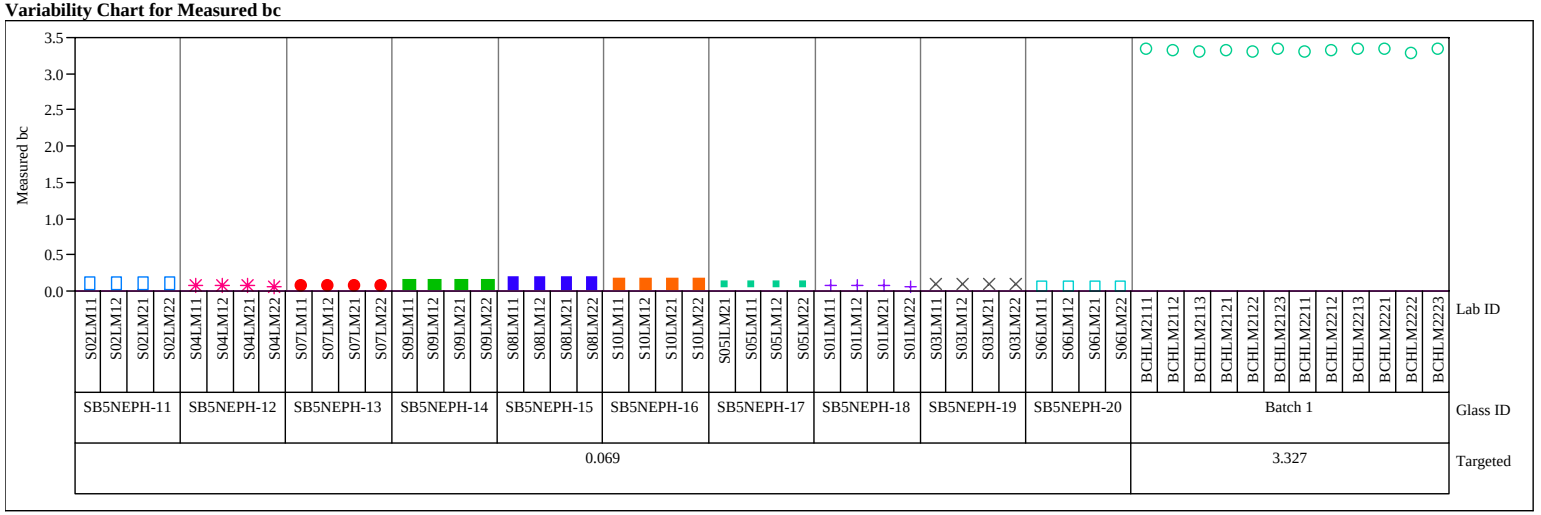
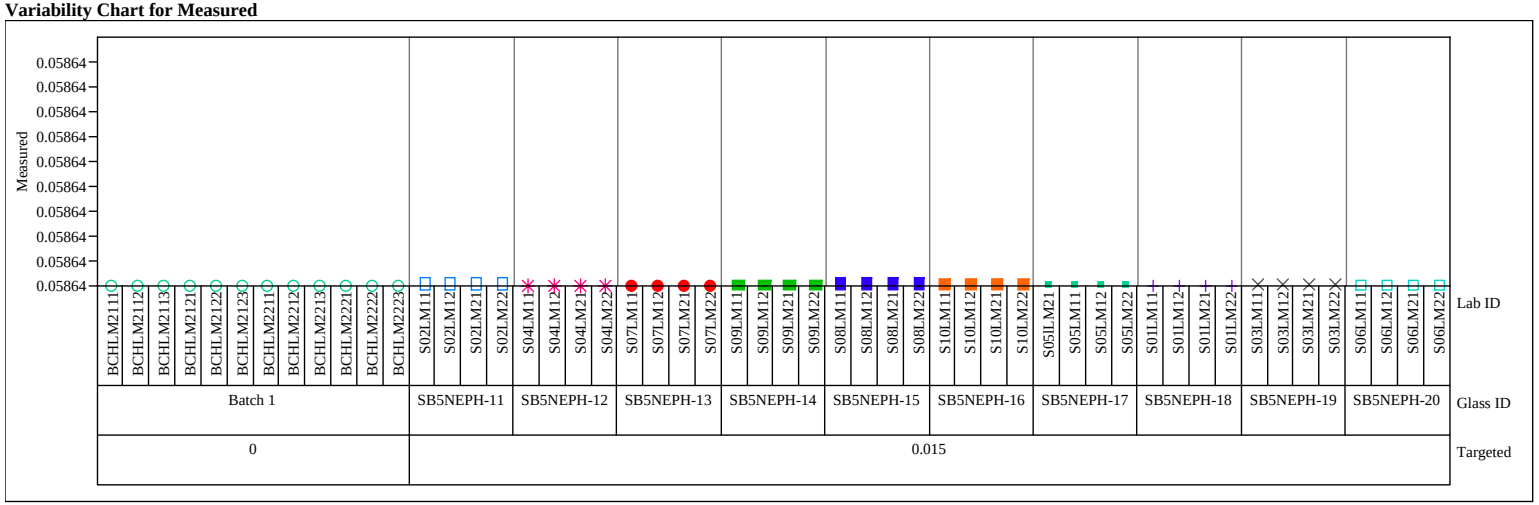


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=2, Oxide=La2O3 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

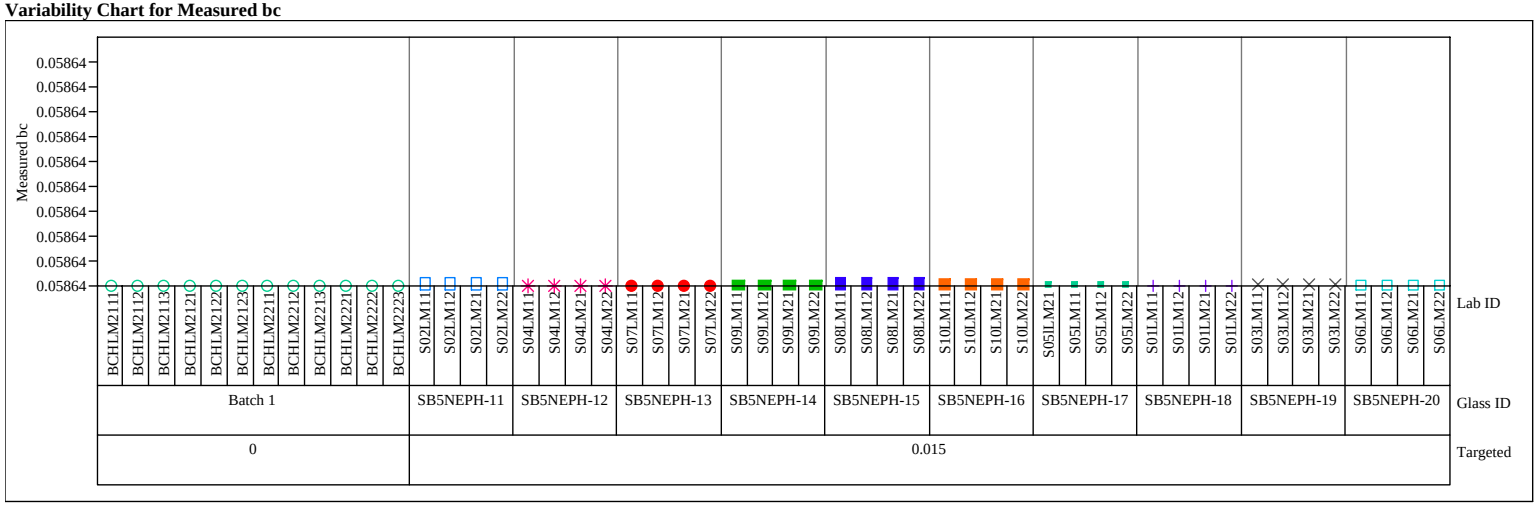
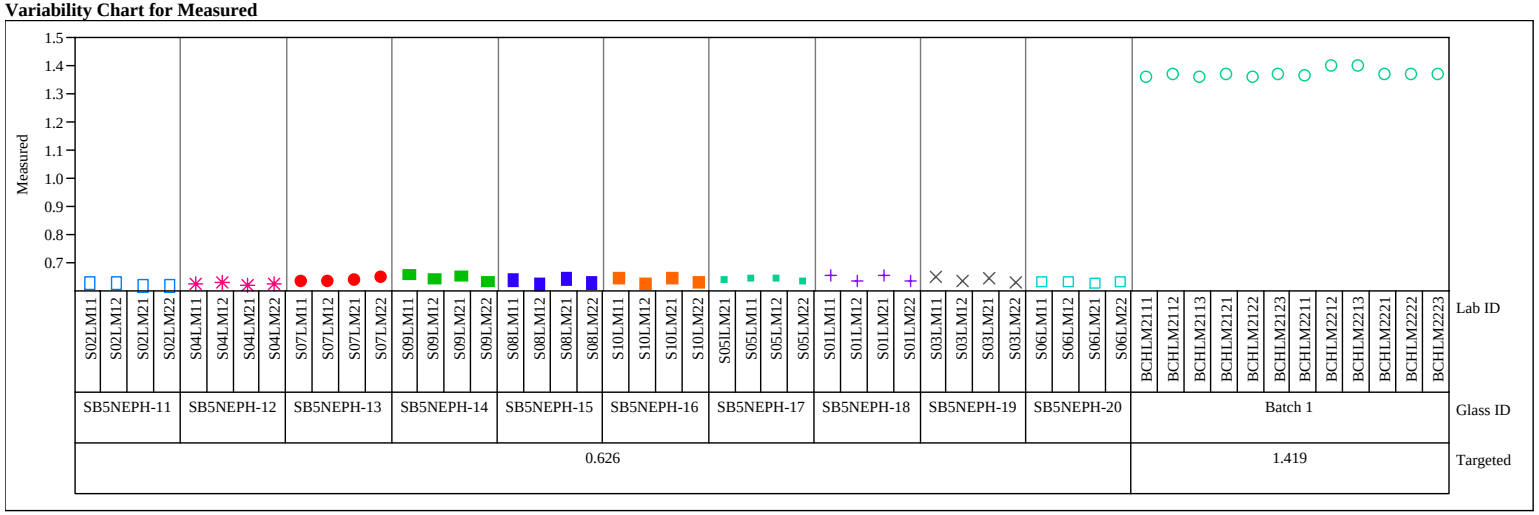


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=2, Oxide=MgO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

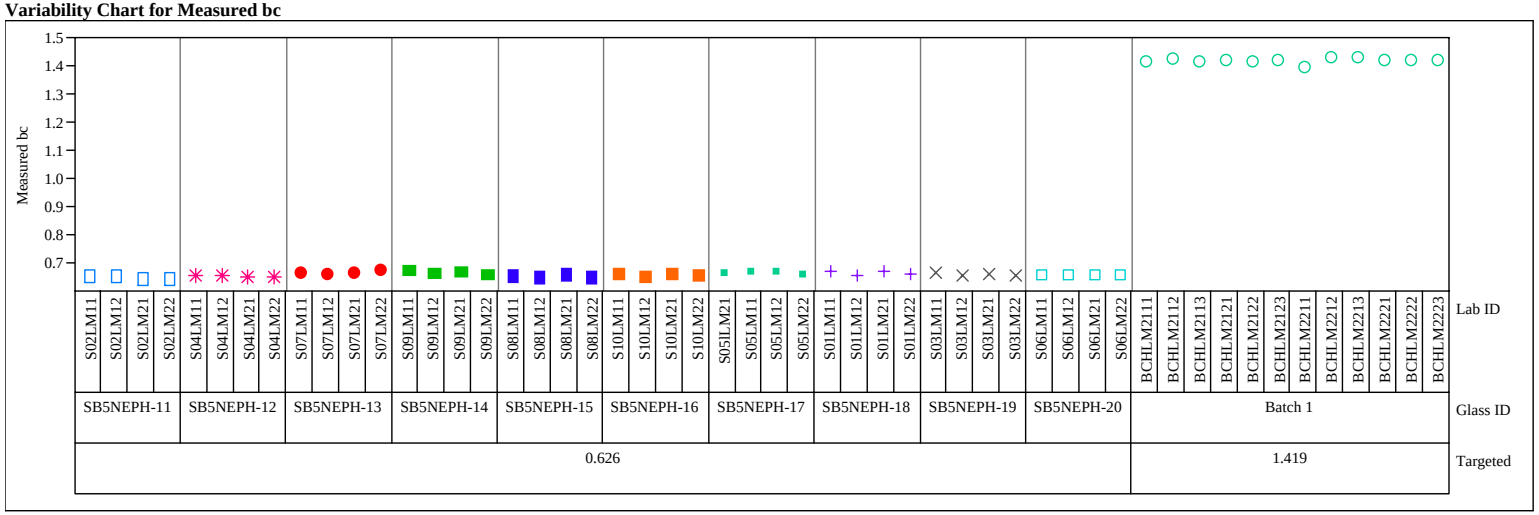
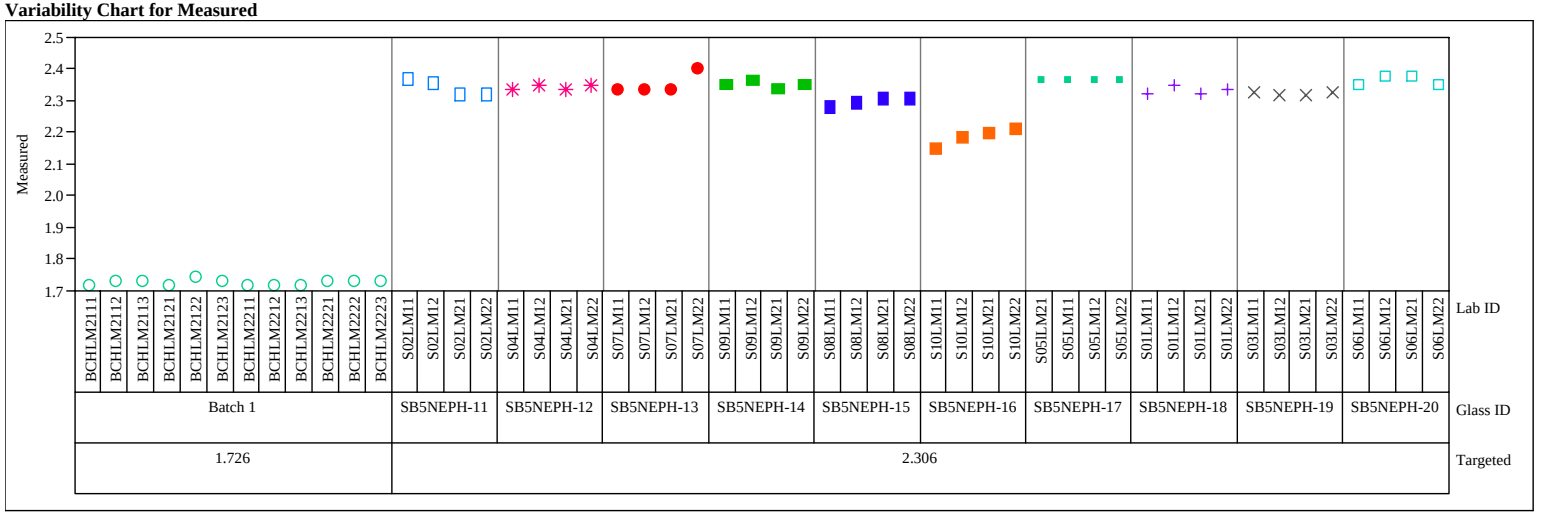


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=2, Oxide=MnO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

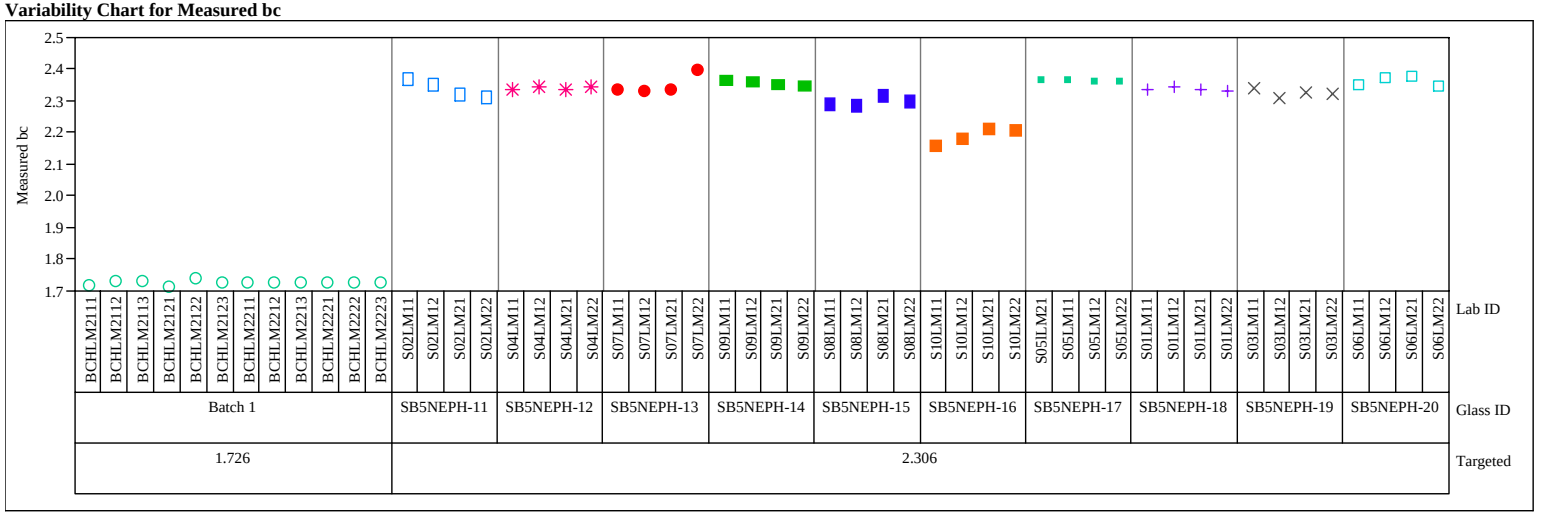
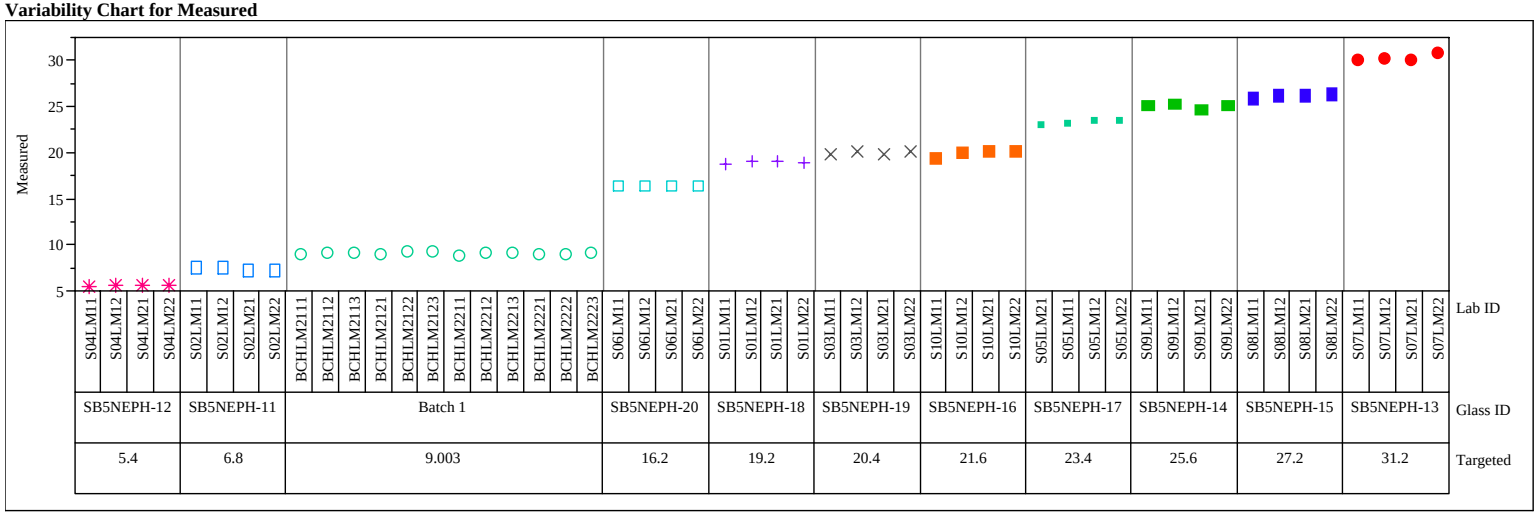


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=2, Oxide=Na2O (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

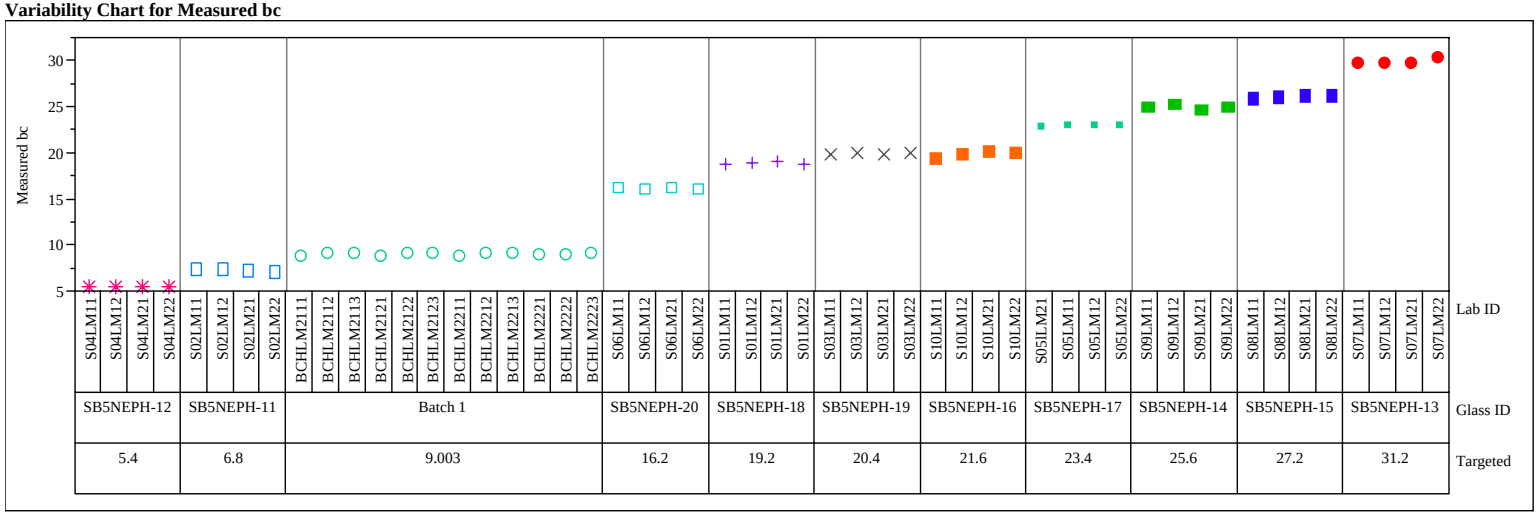
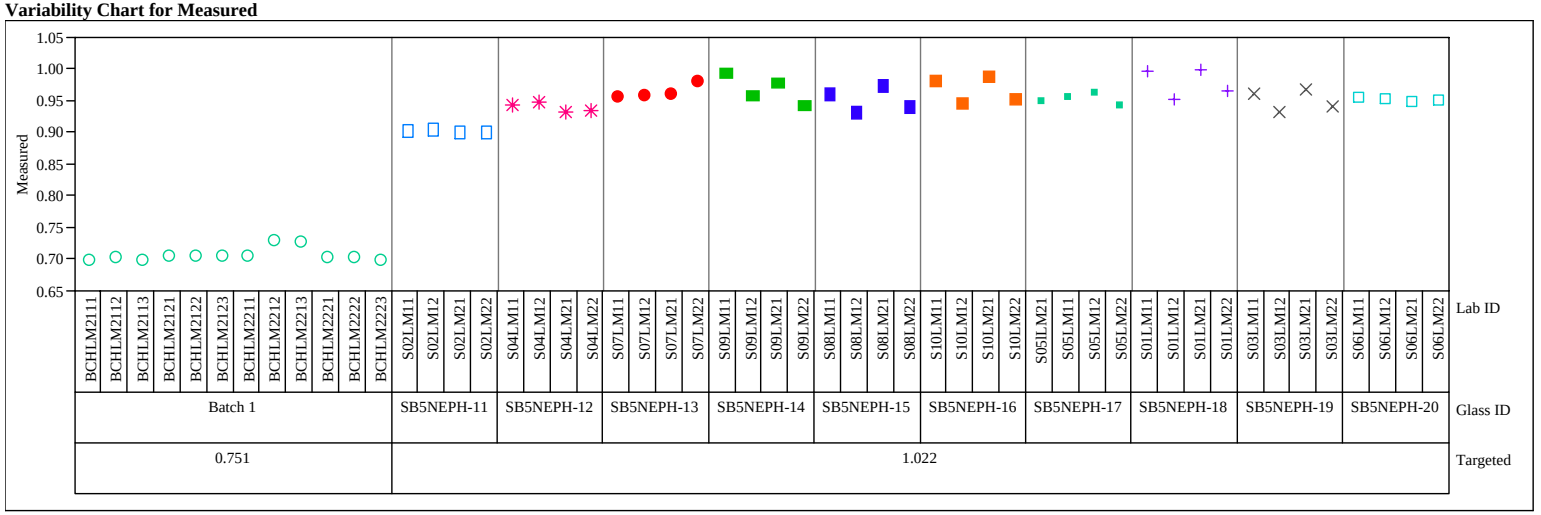


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=2, Oxide=NiO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

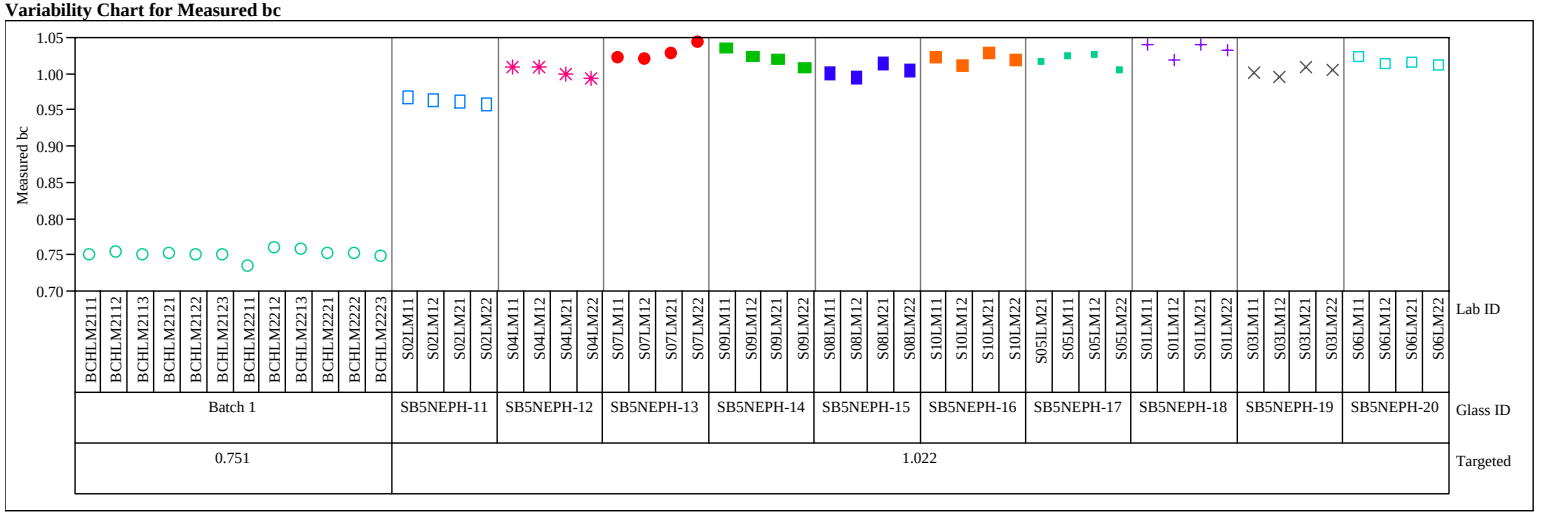
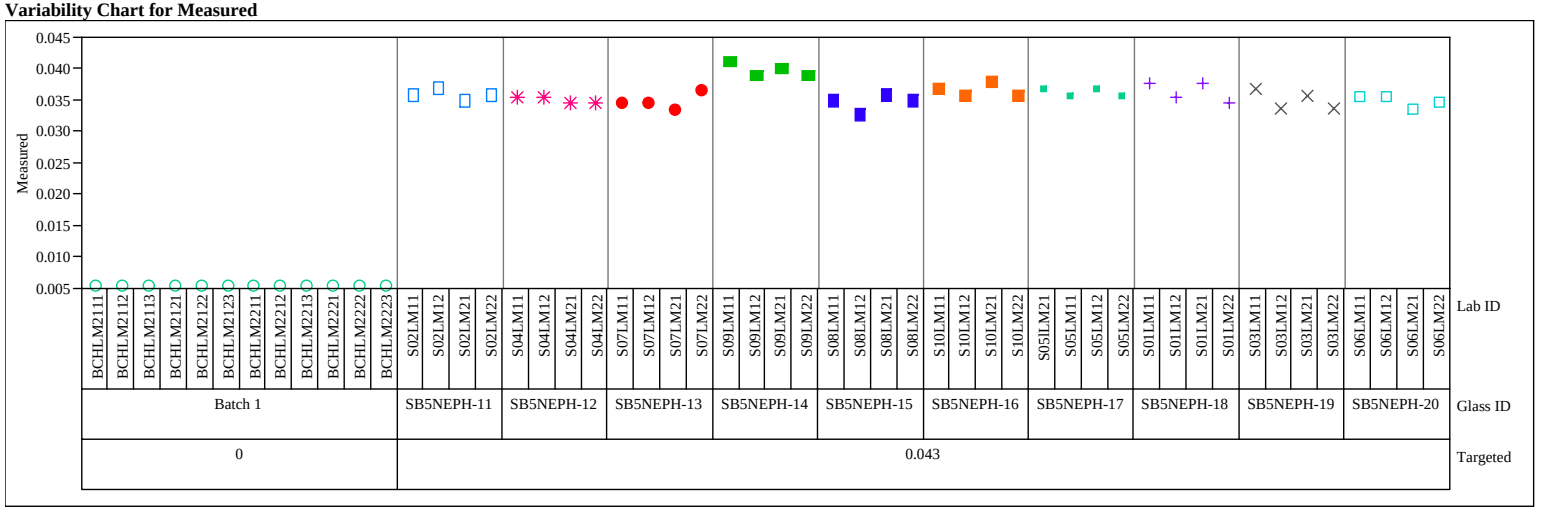


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=2, Oxide=PbO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

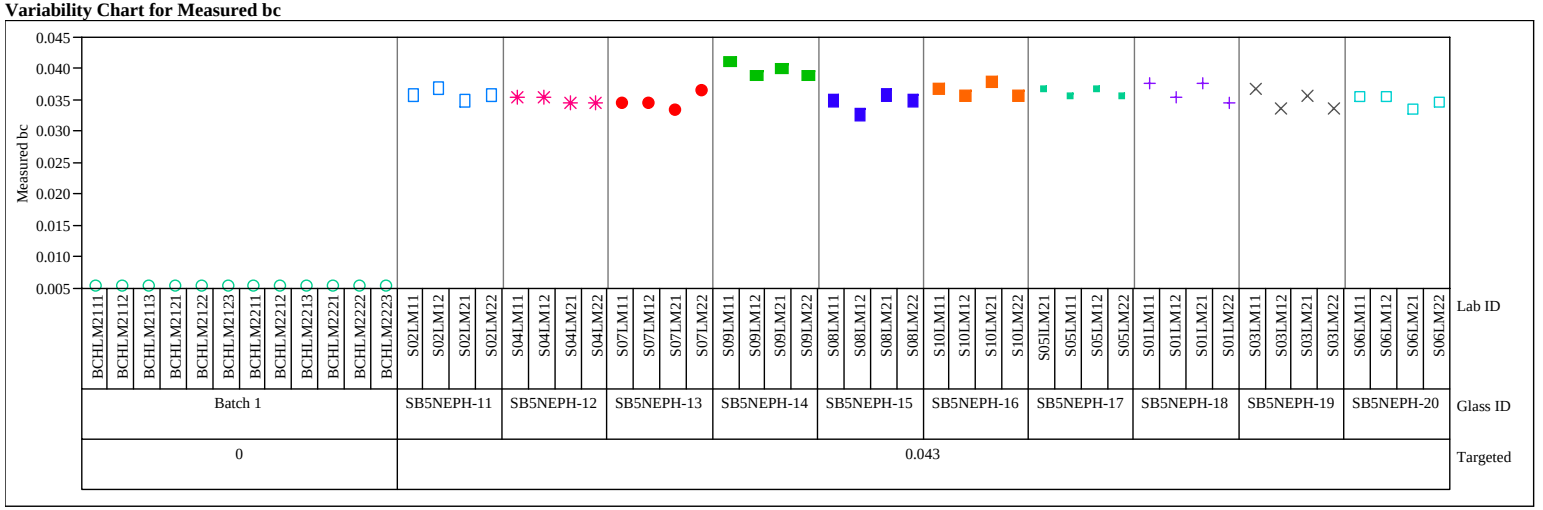
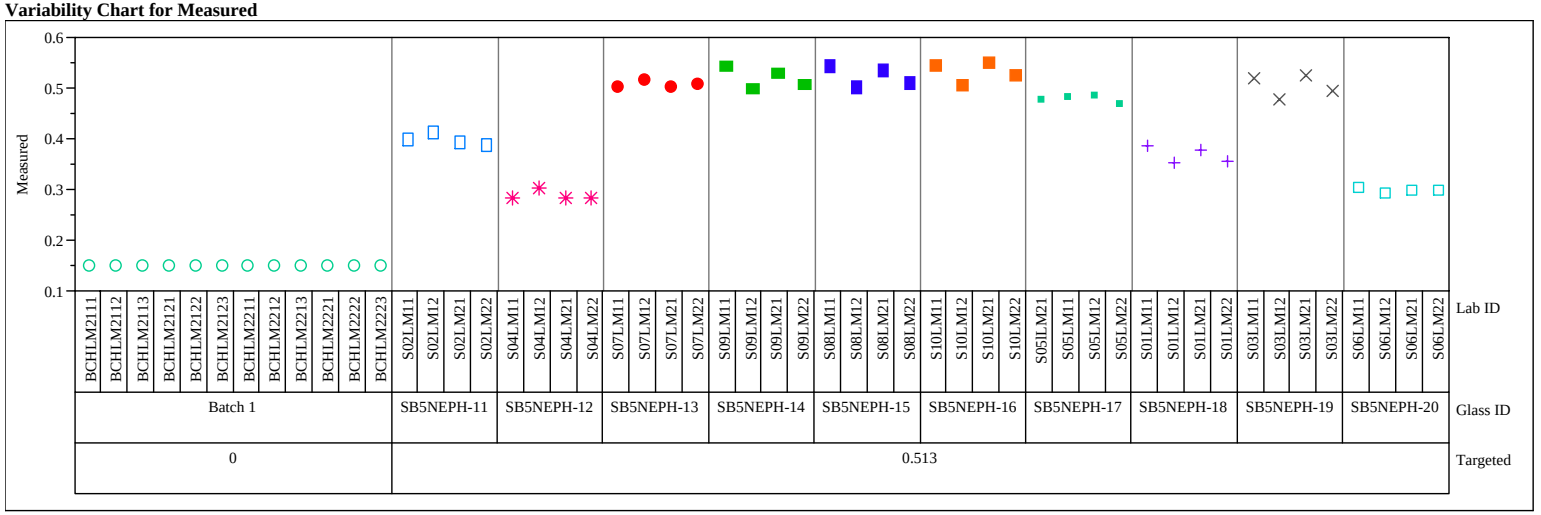


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=2, Oxide=SO4 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

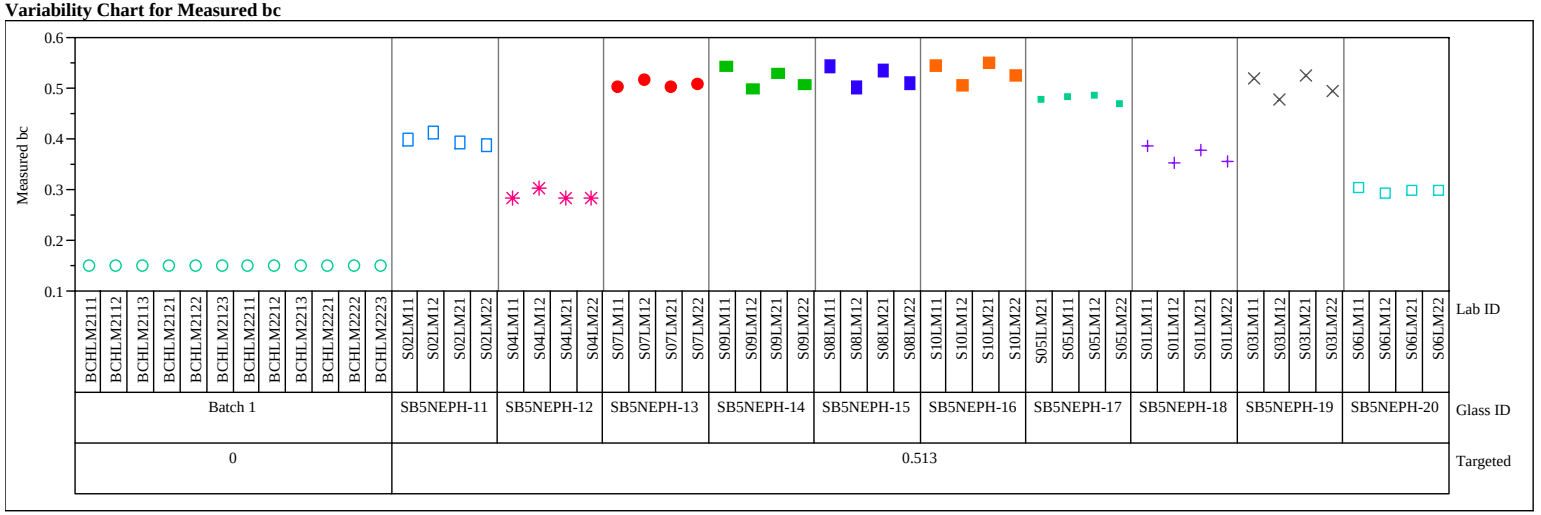
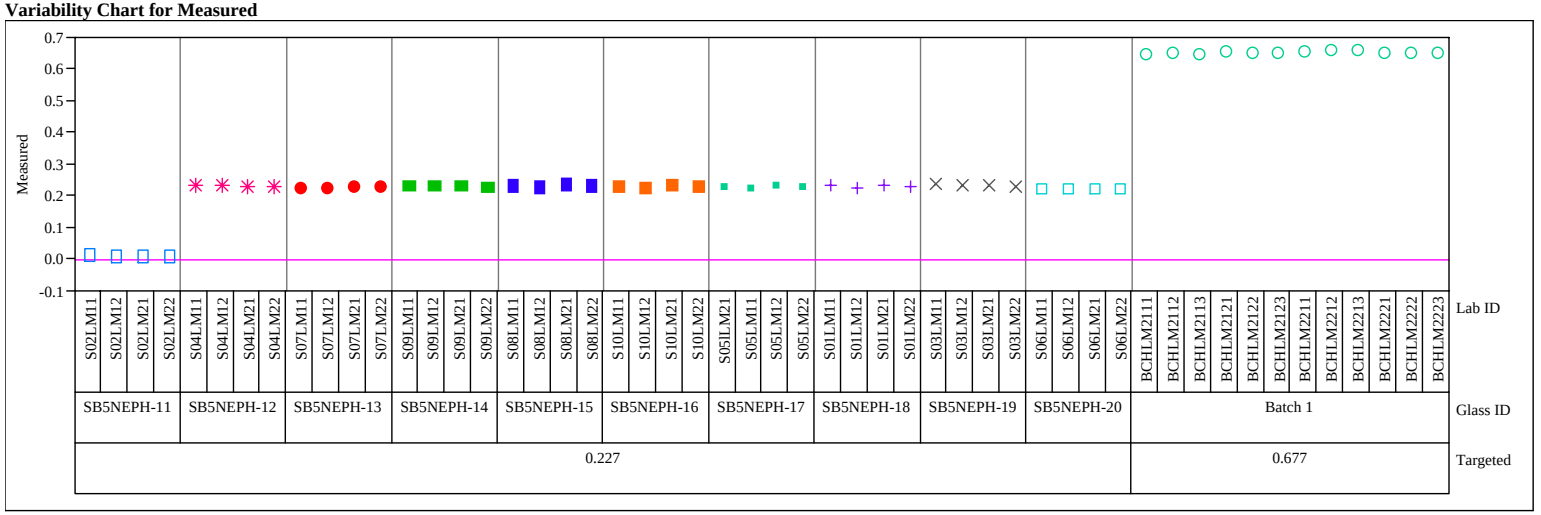


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=2, Oxide=TiO2 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

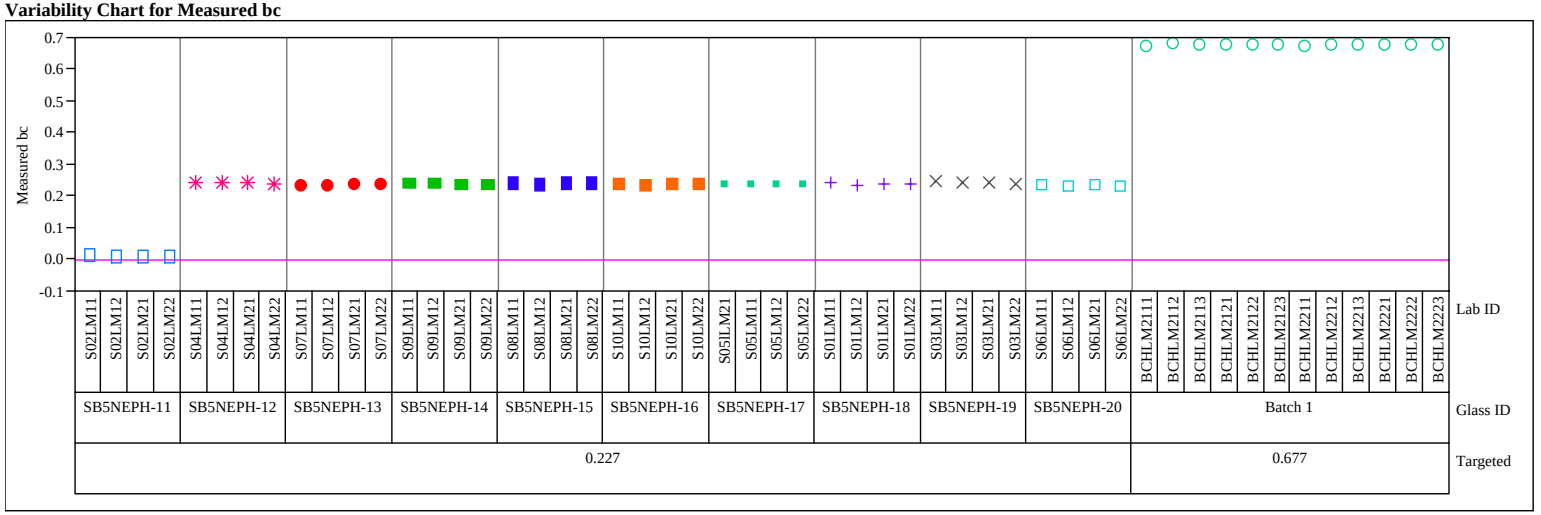
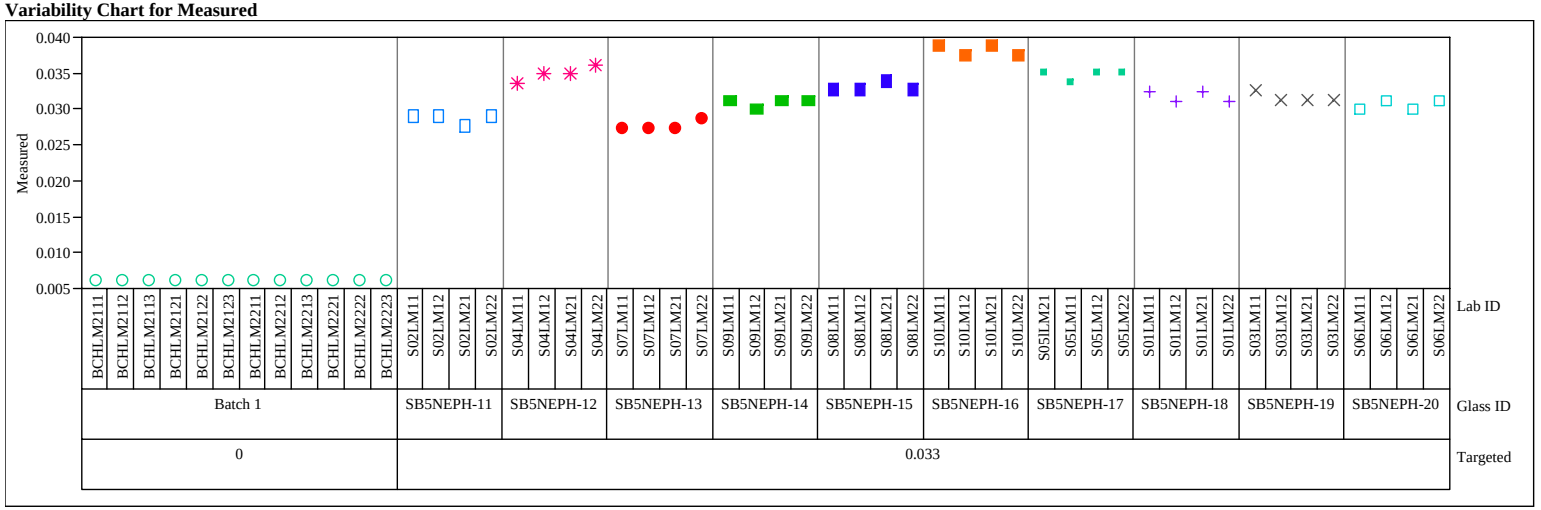


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=2, Oxide=ZnO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

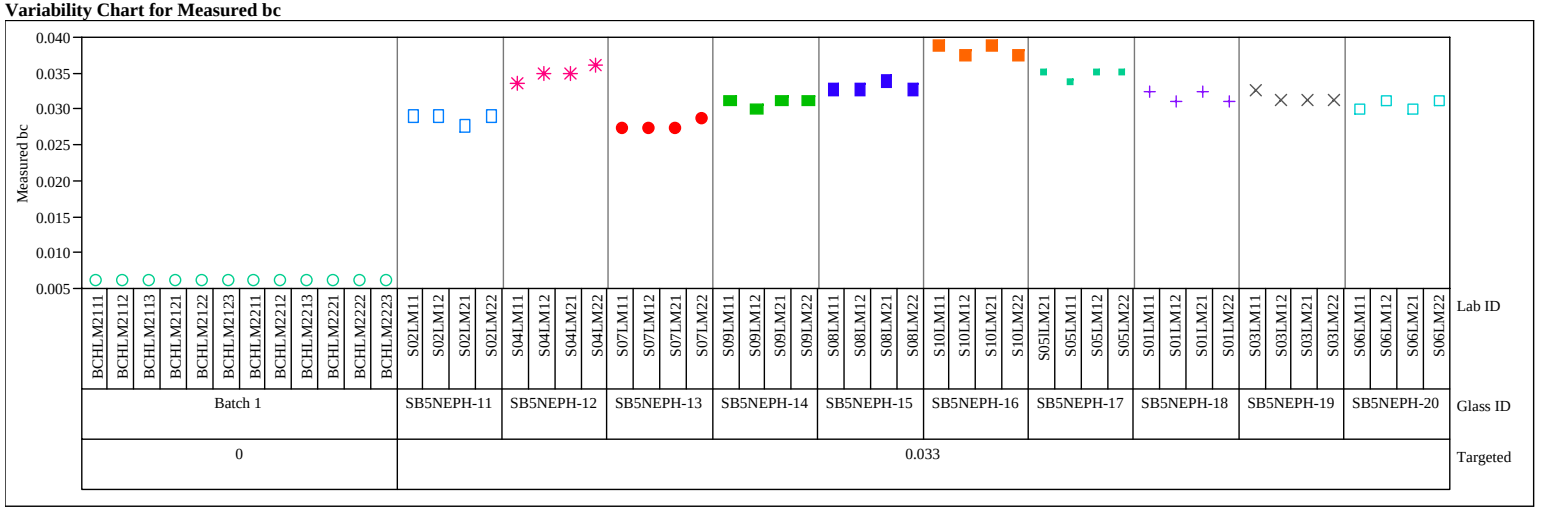
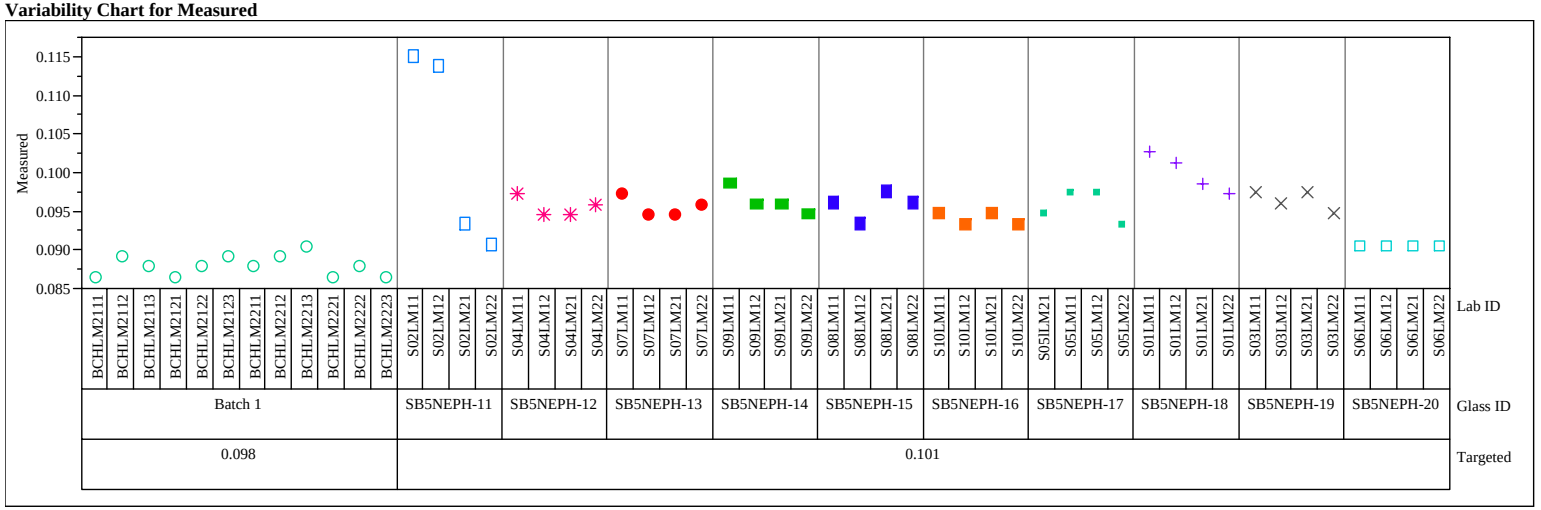


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=2, Oxide=ZrO2 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

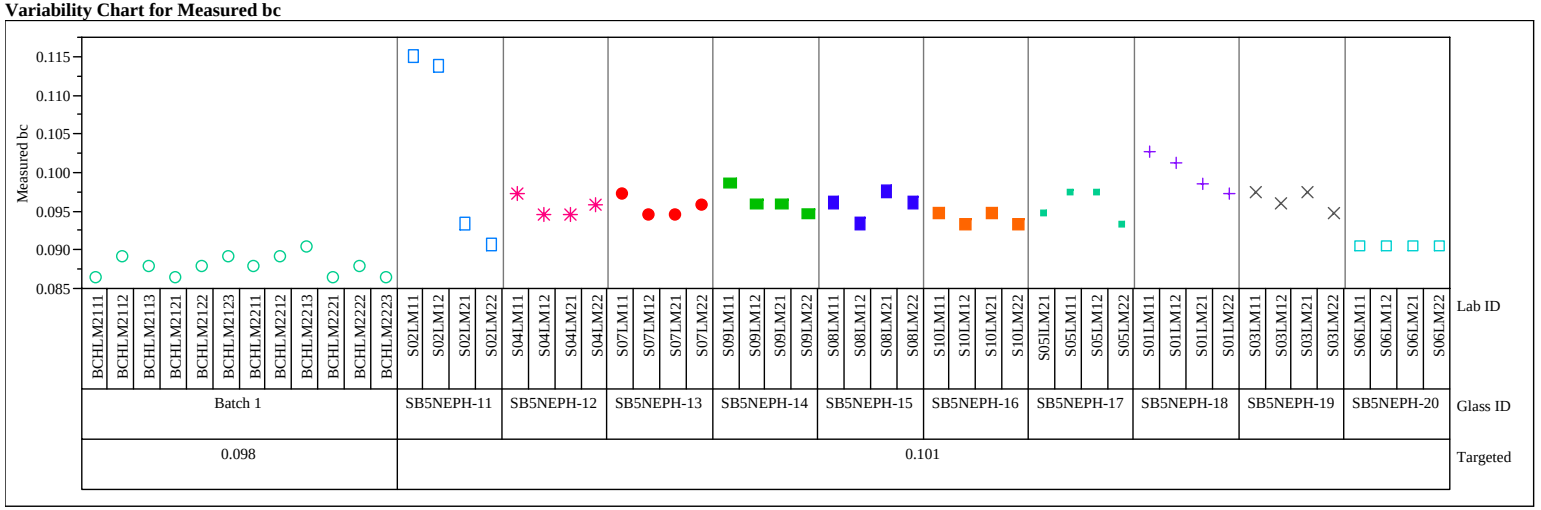
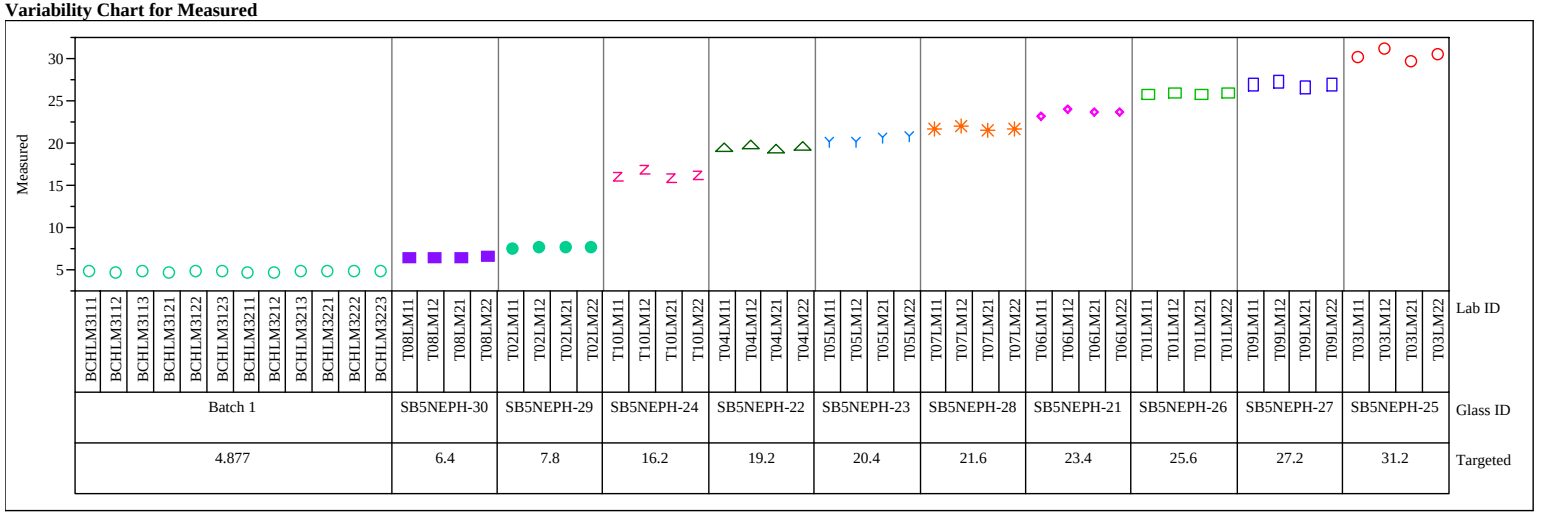


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=3, Oxide=Al2O3 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

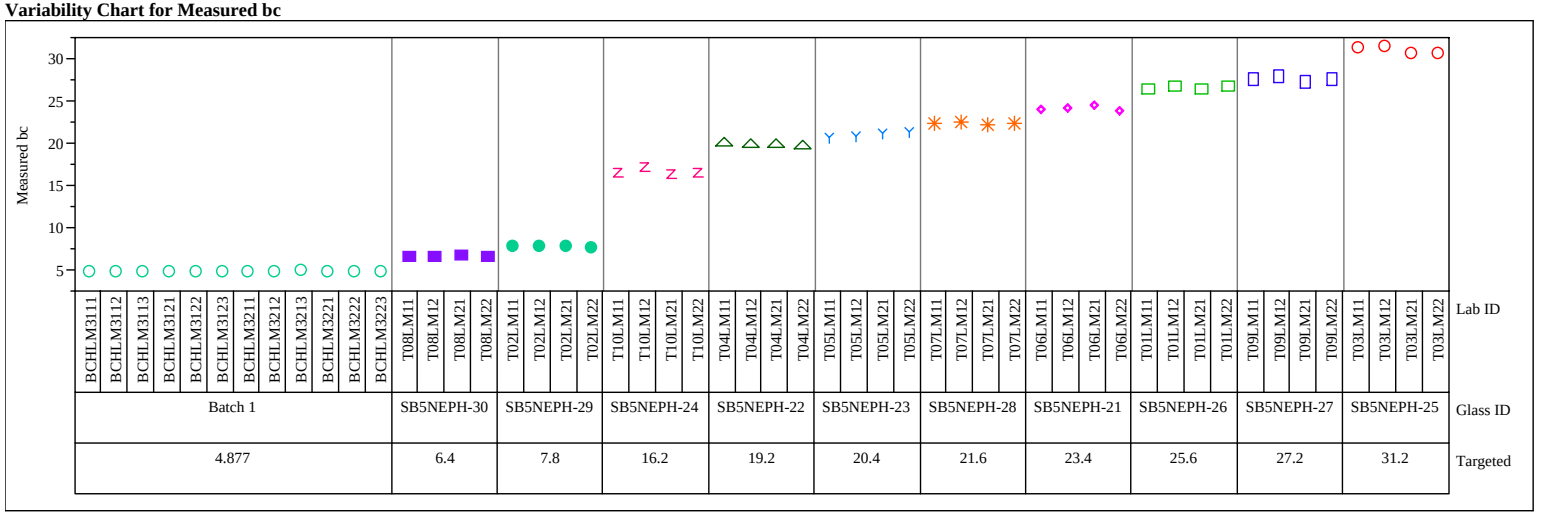
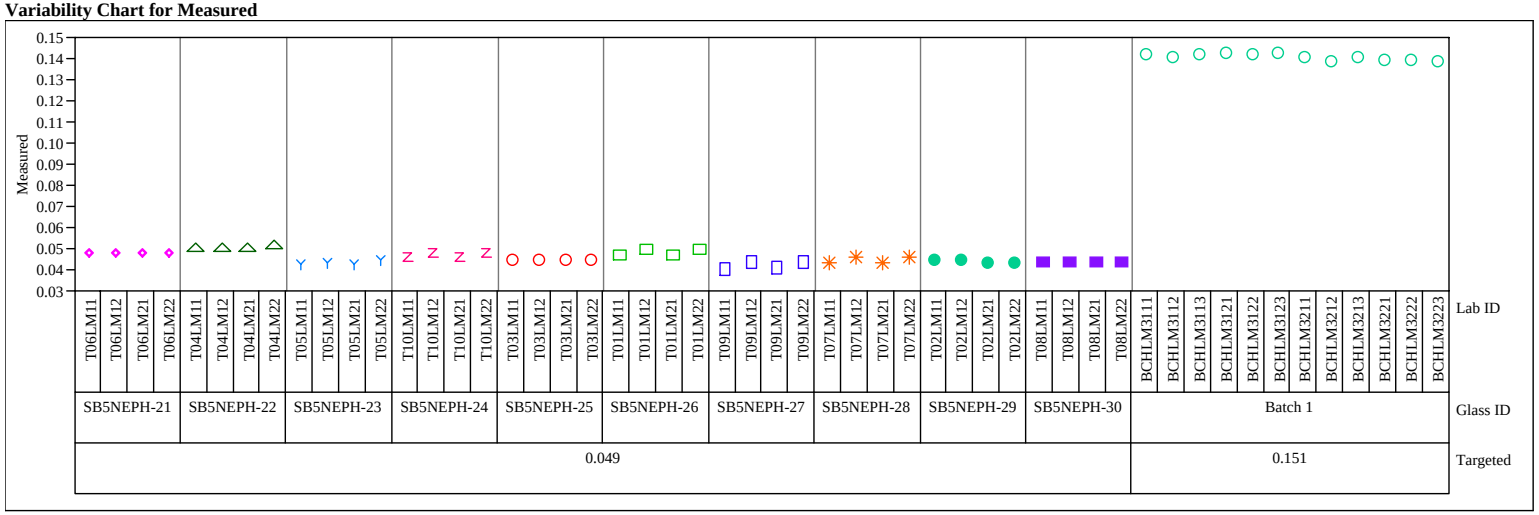


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=3, Oxide=BaO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

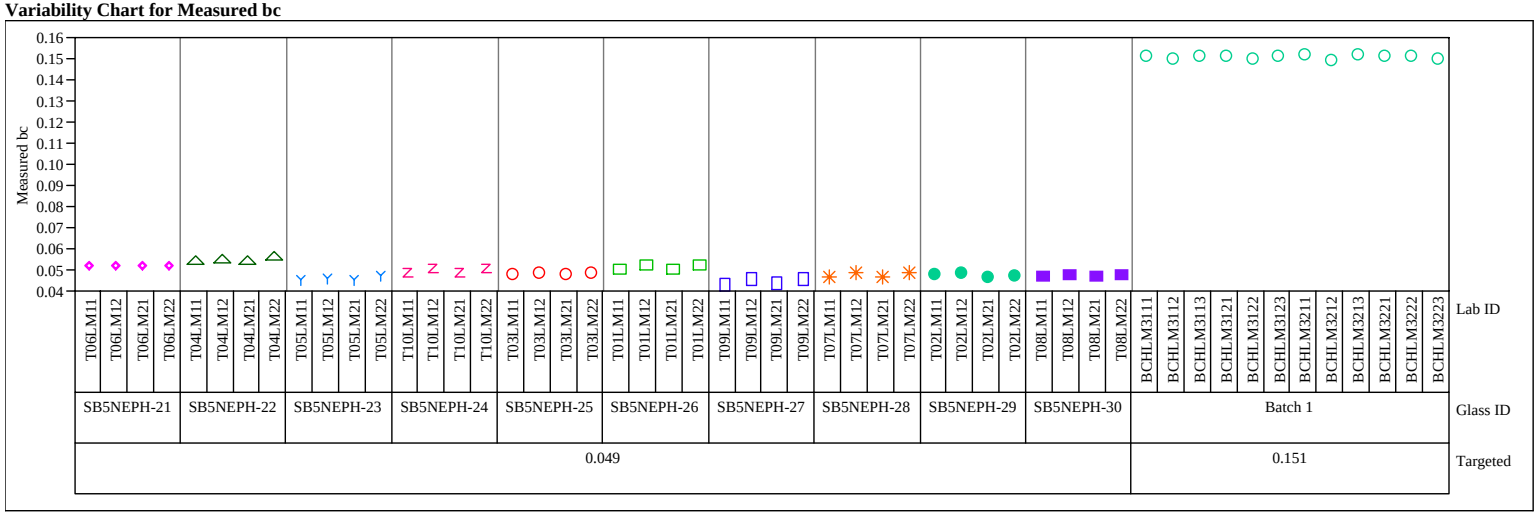
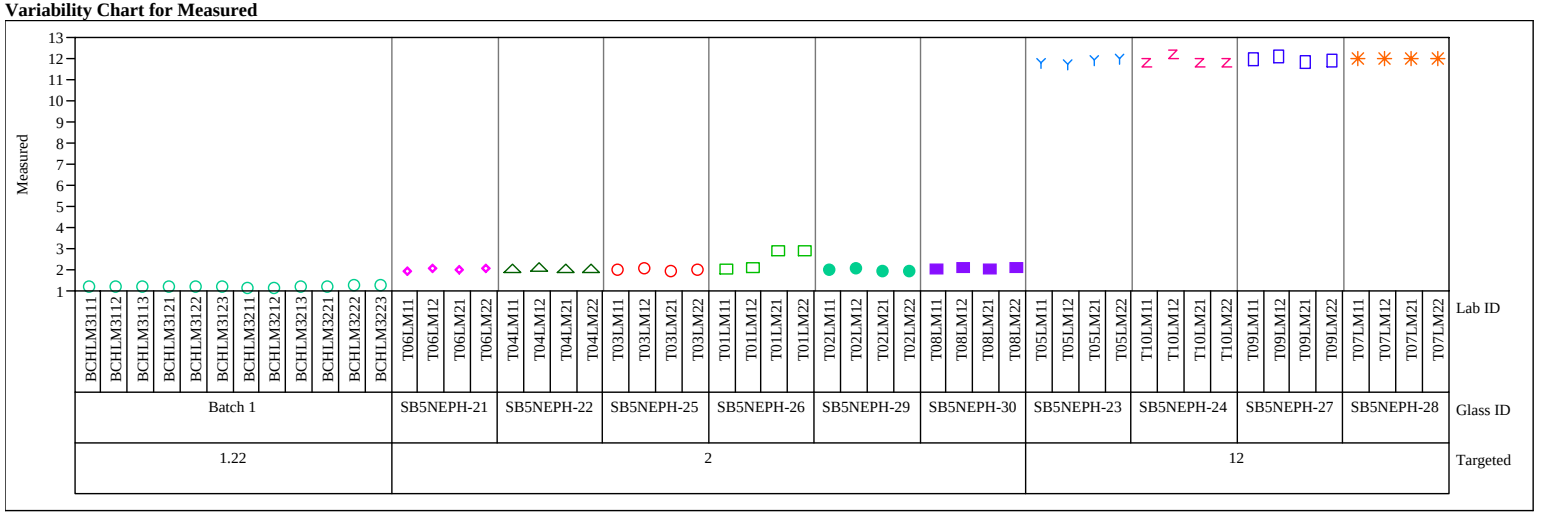


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=3, Oxide=CaO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

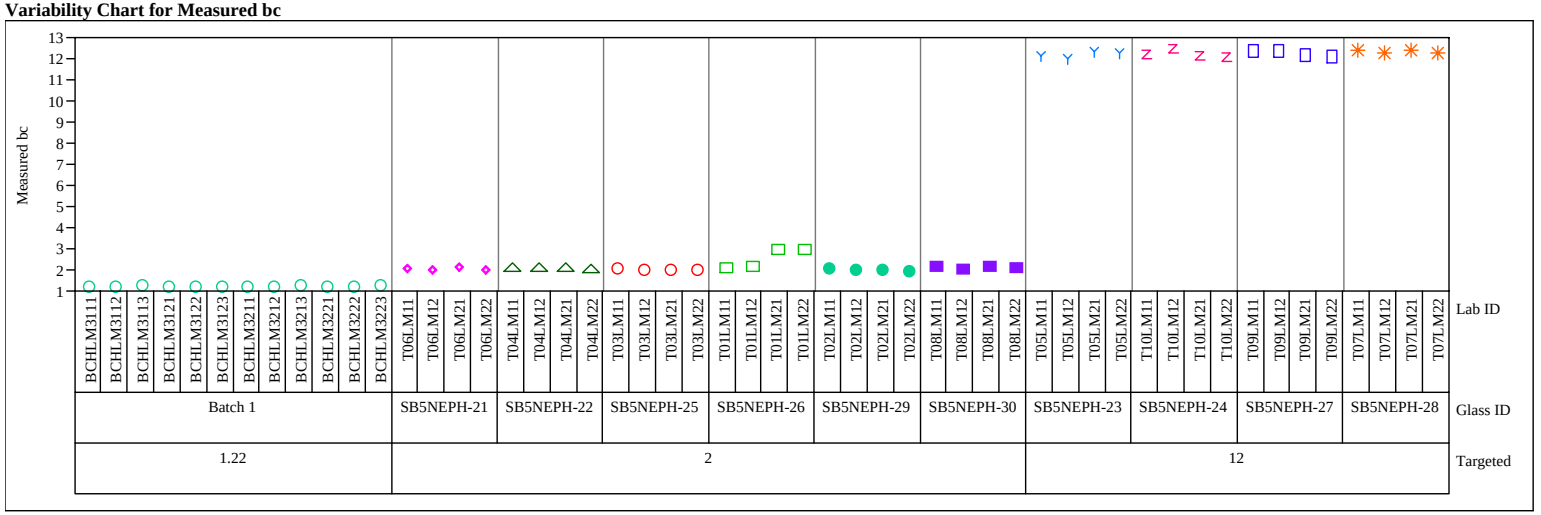
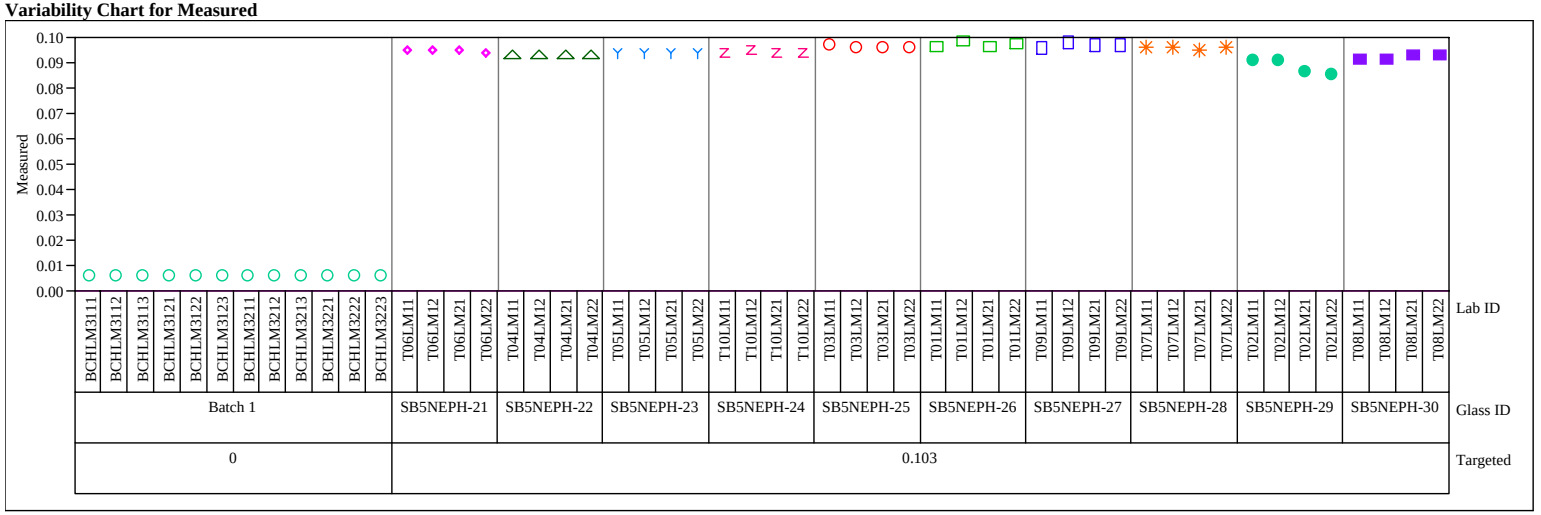


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=3, Oxide=Ce2O3 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

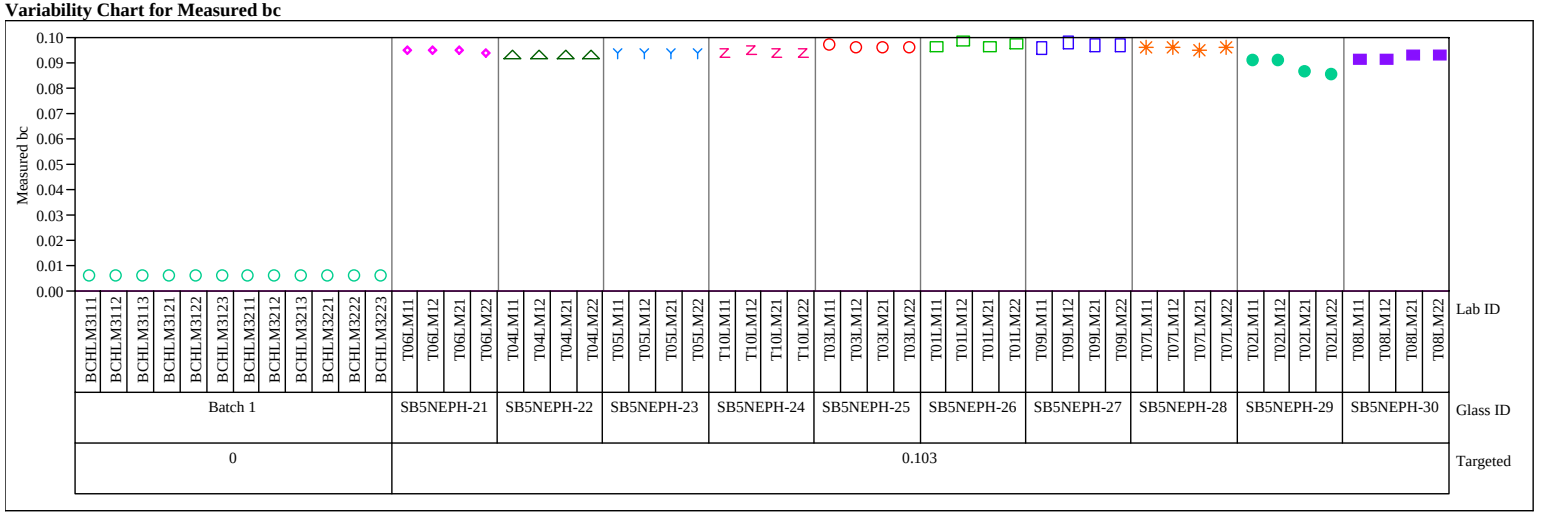
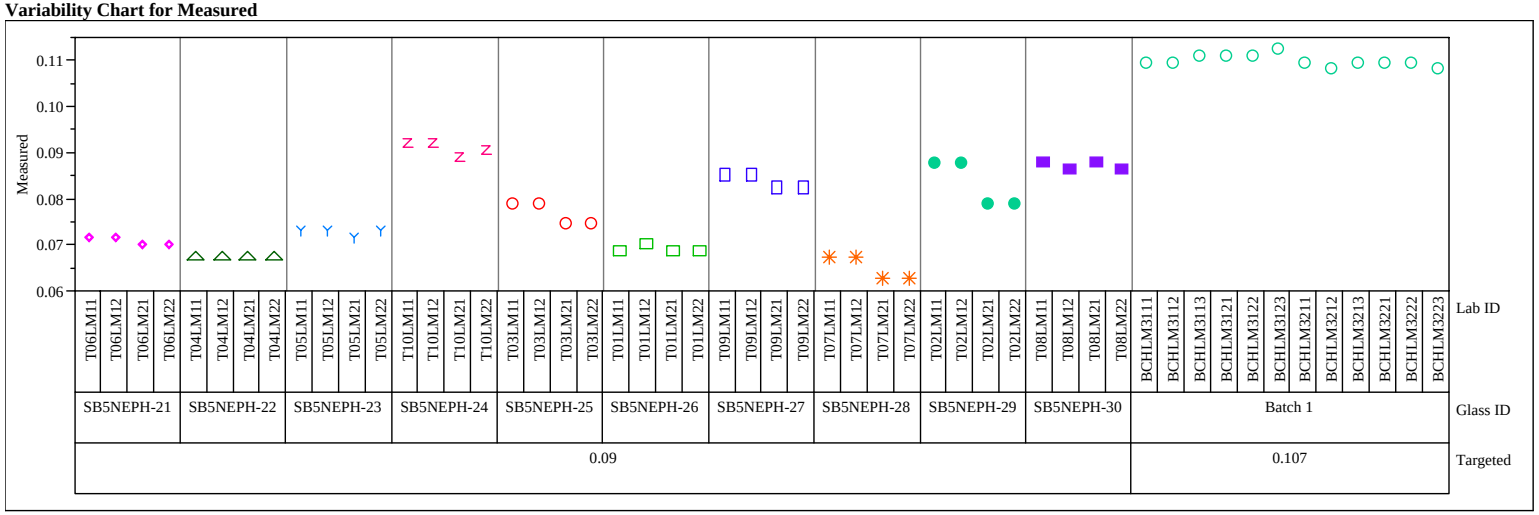


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=3, Oxide=Cr2O3 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

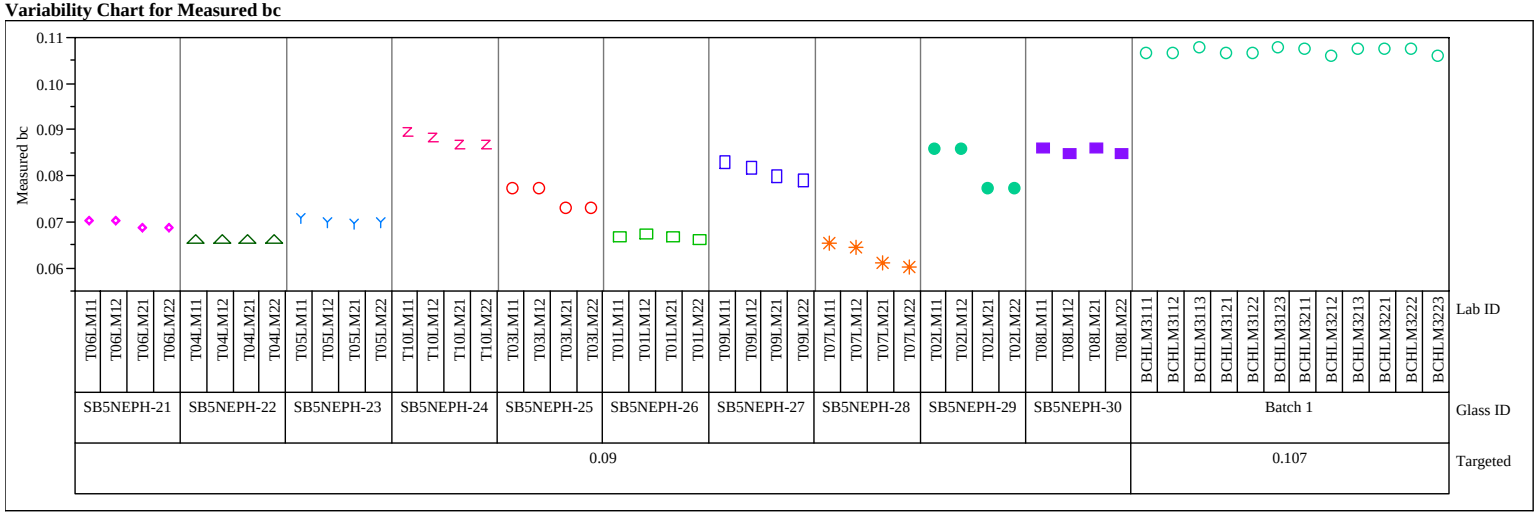
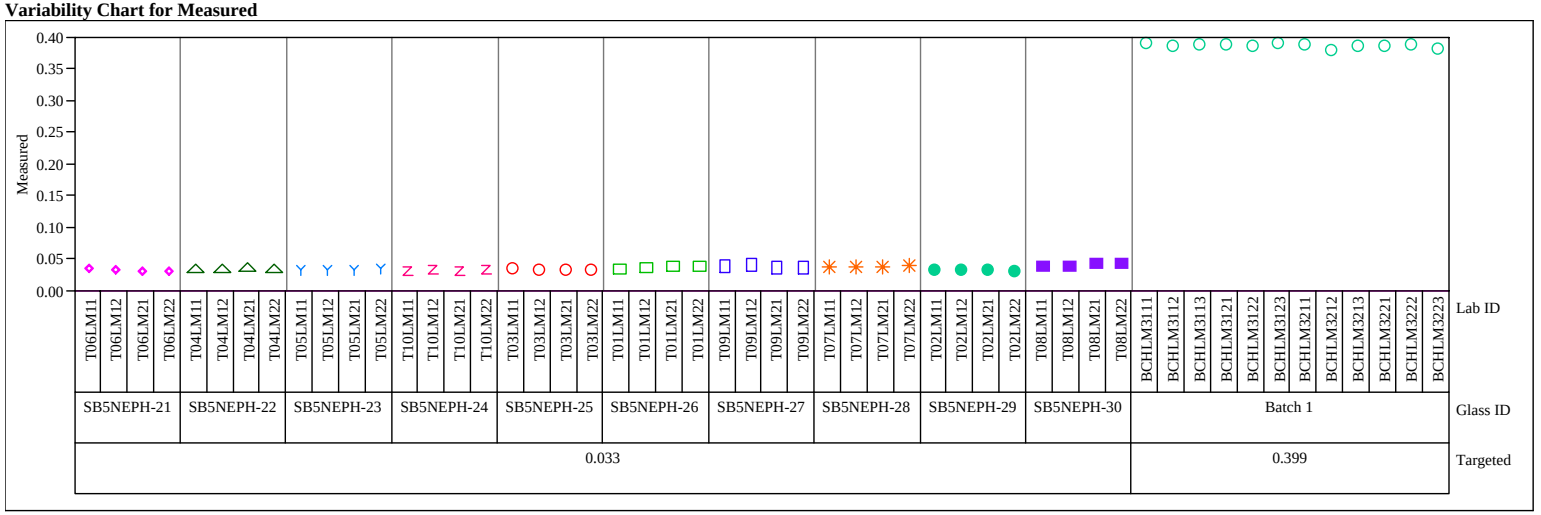


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=3, Oxide=CuO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

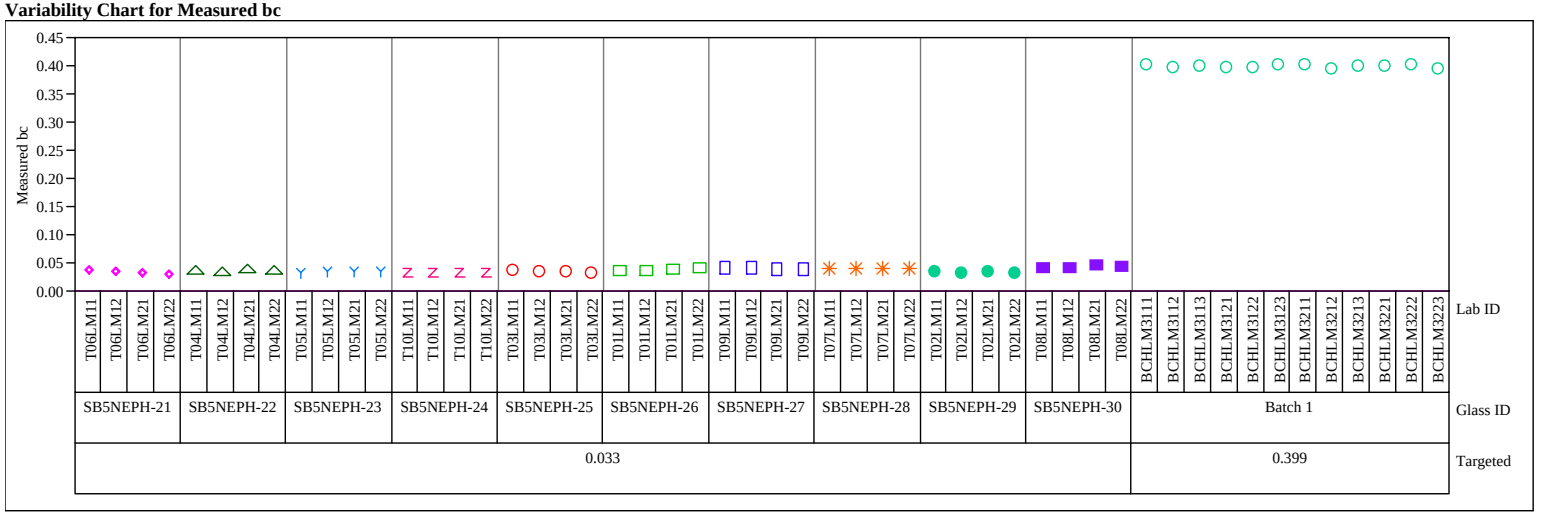
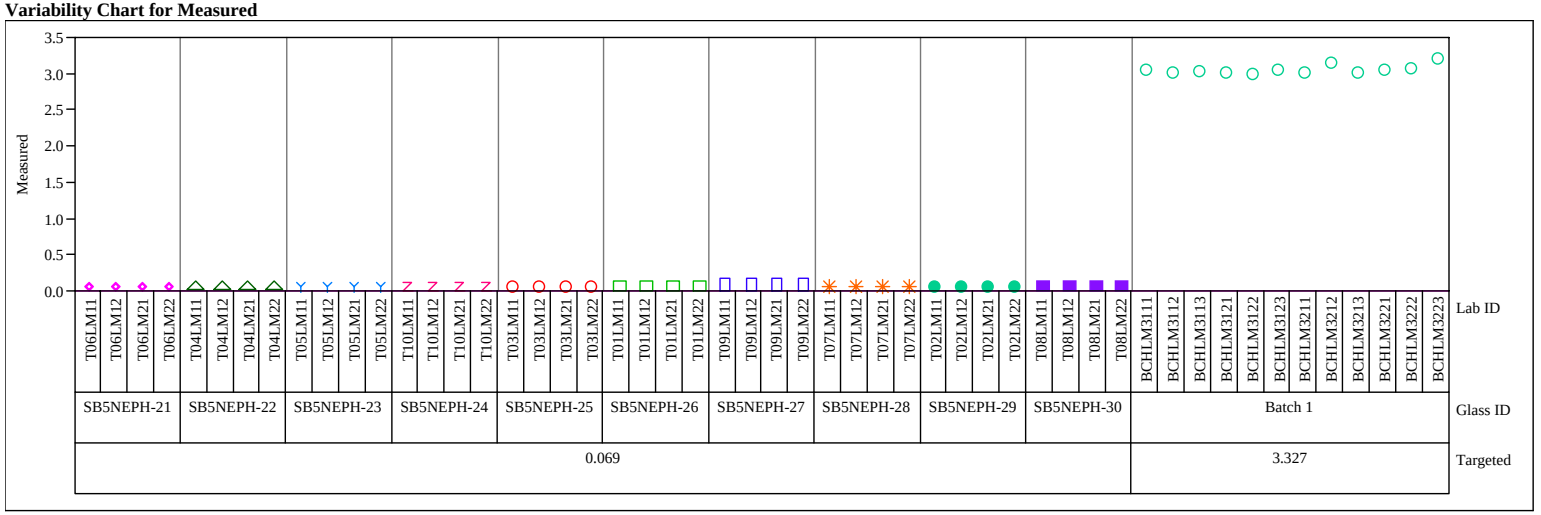


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=3, Oxide=K2O (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

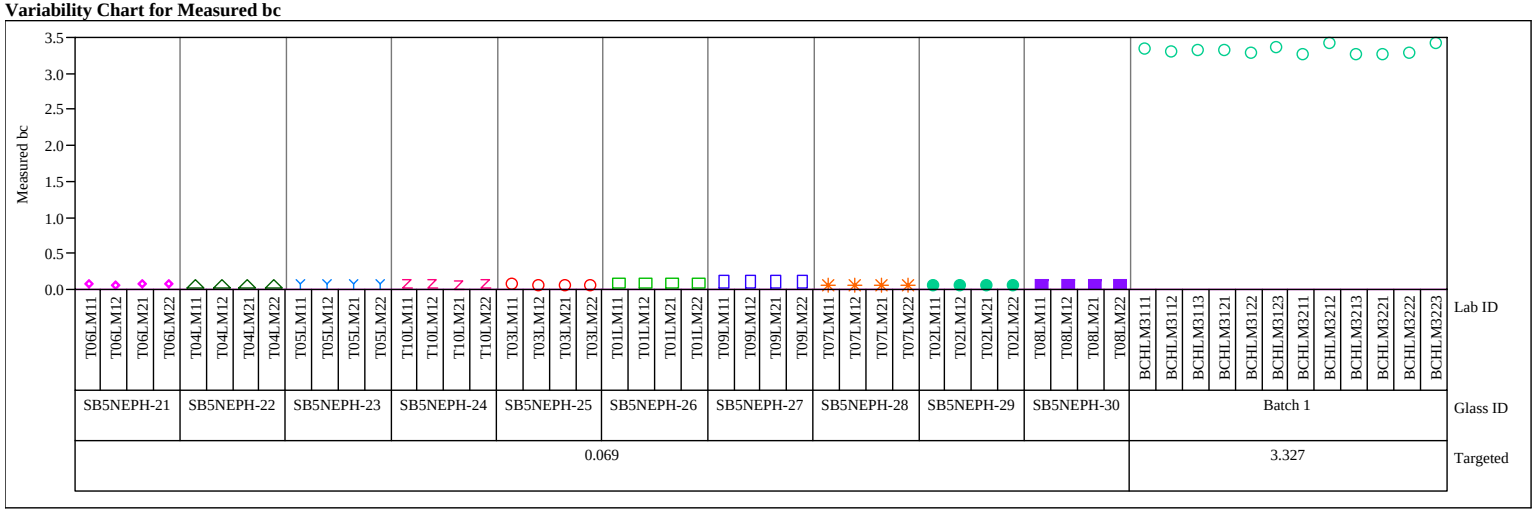
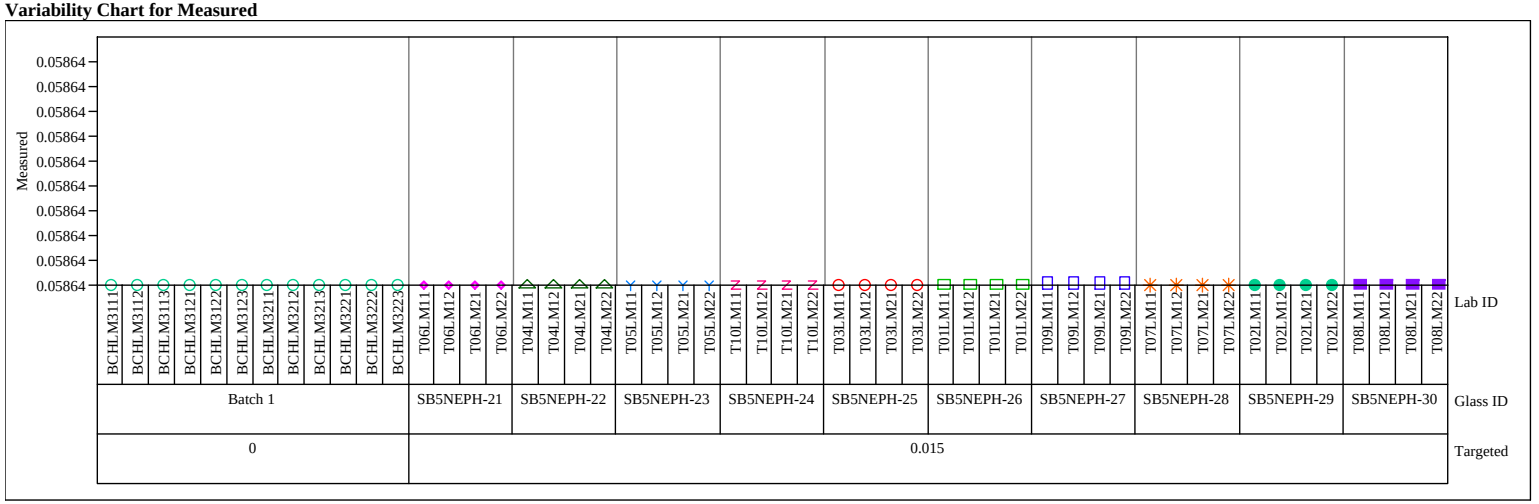


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=3, Oxide=La2O3 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

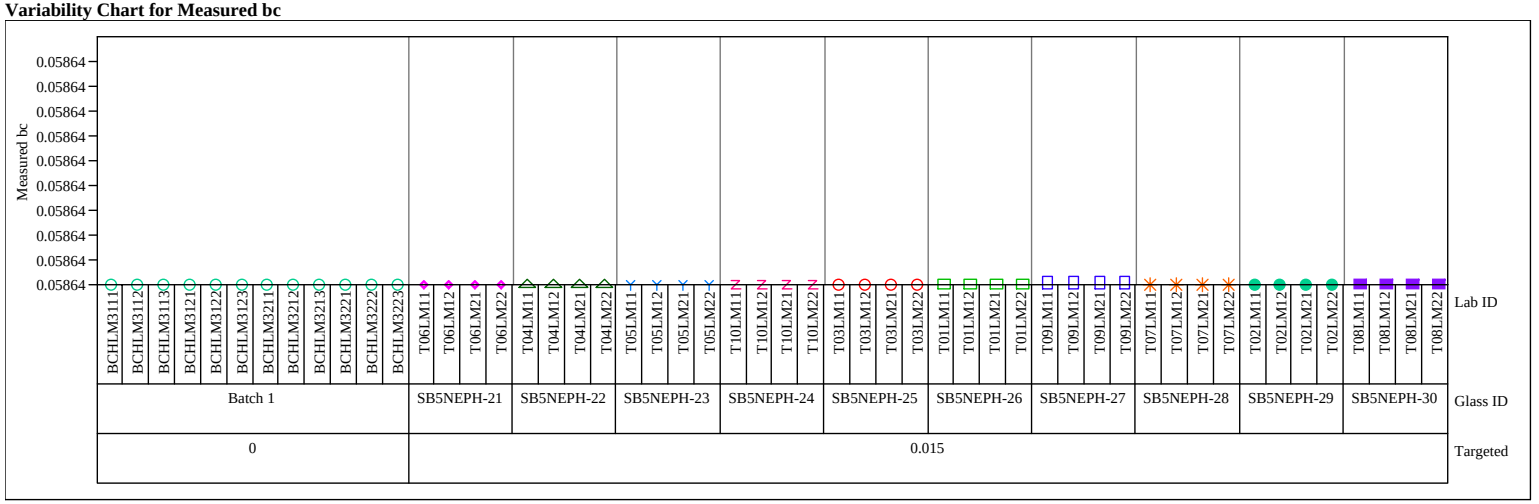
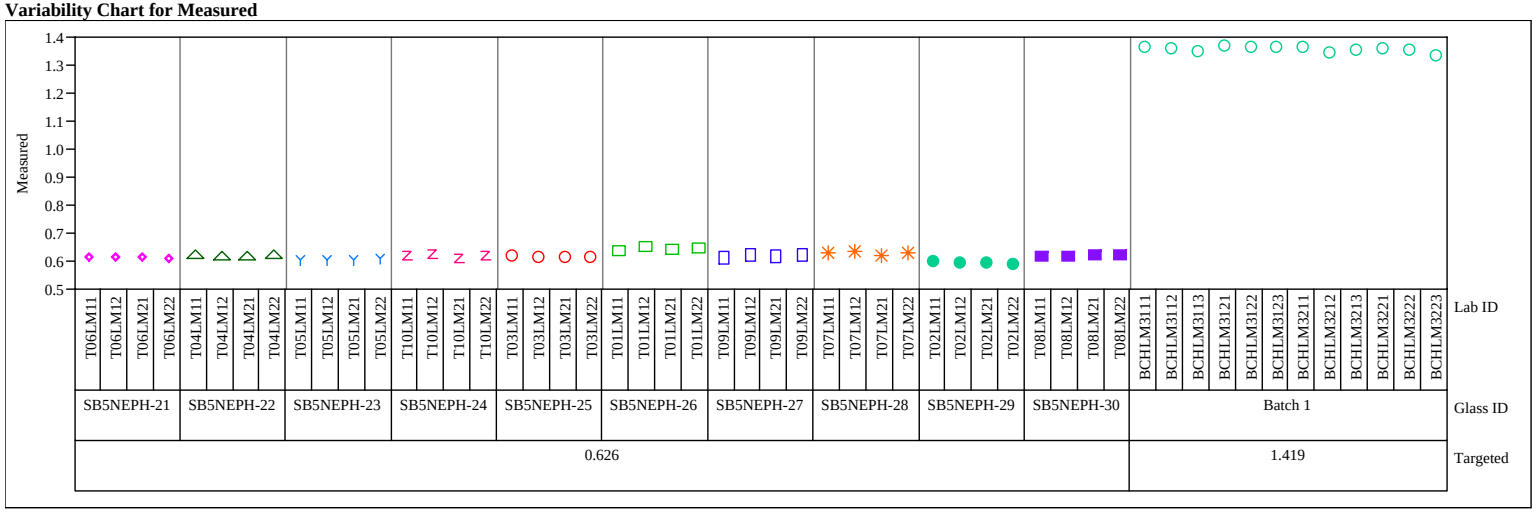


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=3, Oxide=MgO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

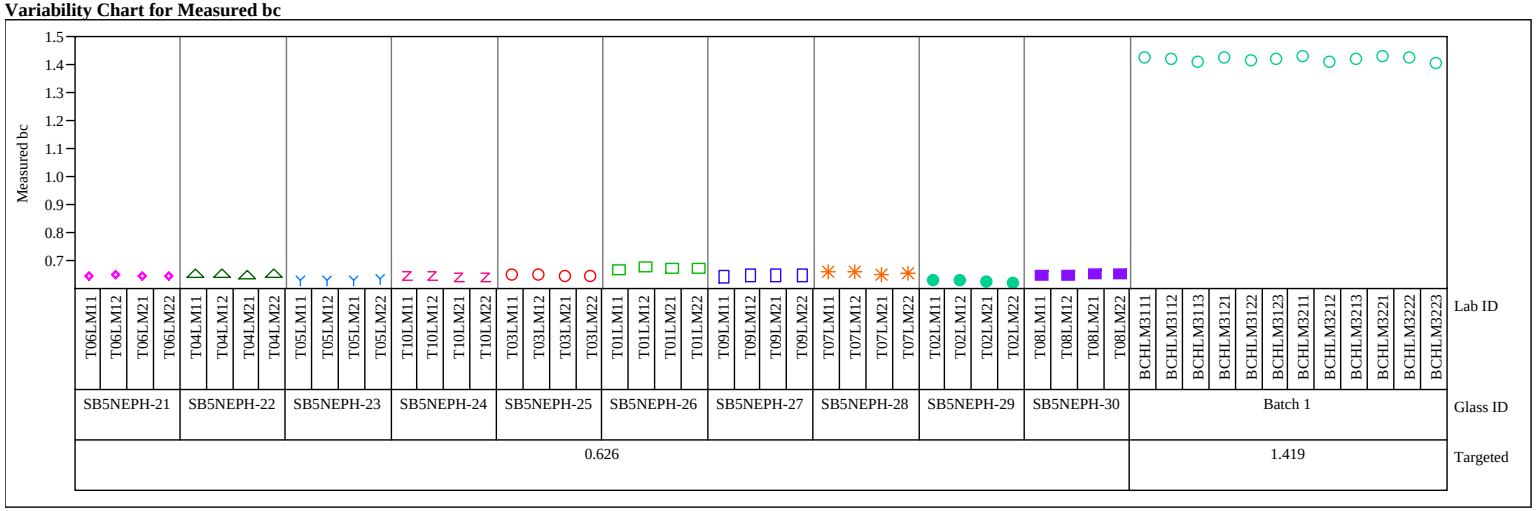
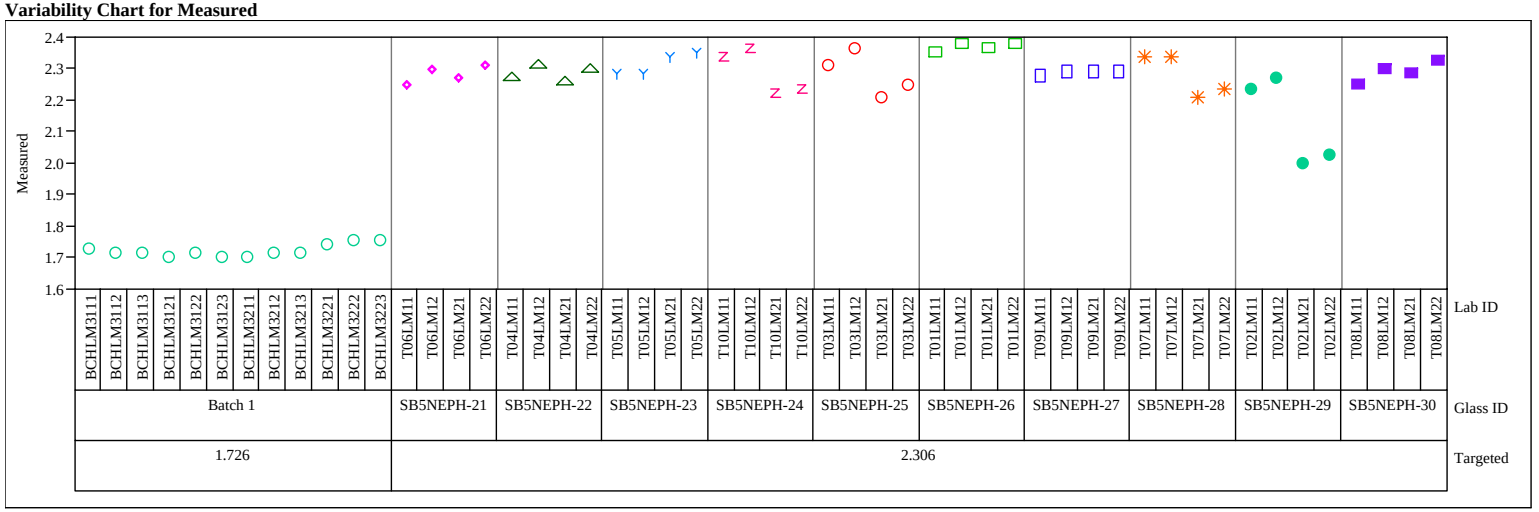


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=3, Oxide=MnO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

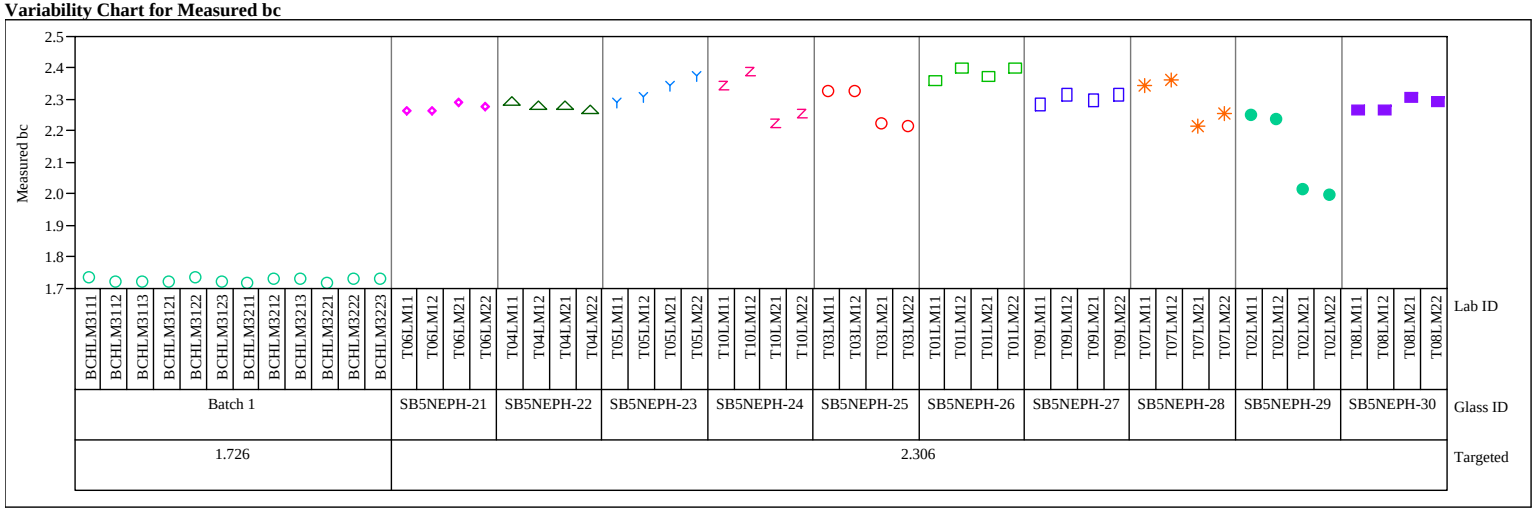
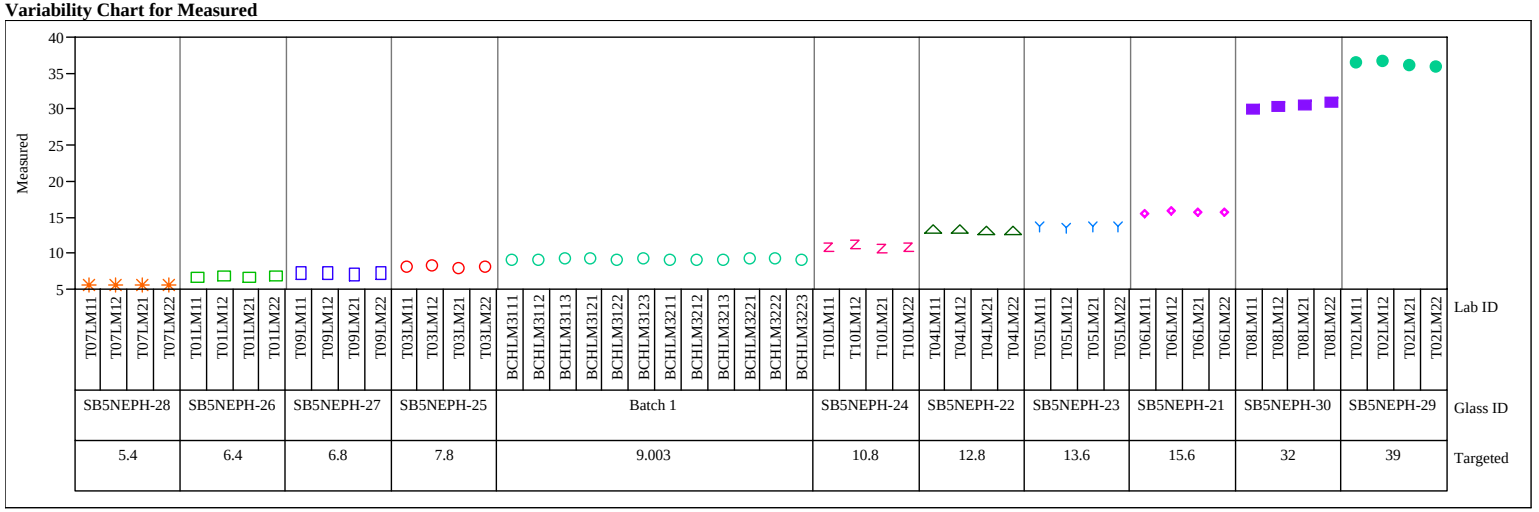


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=3, Oxide=Na2O (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

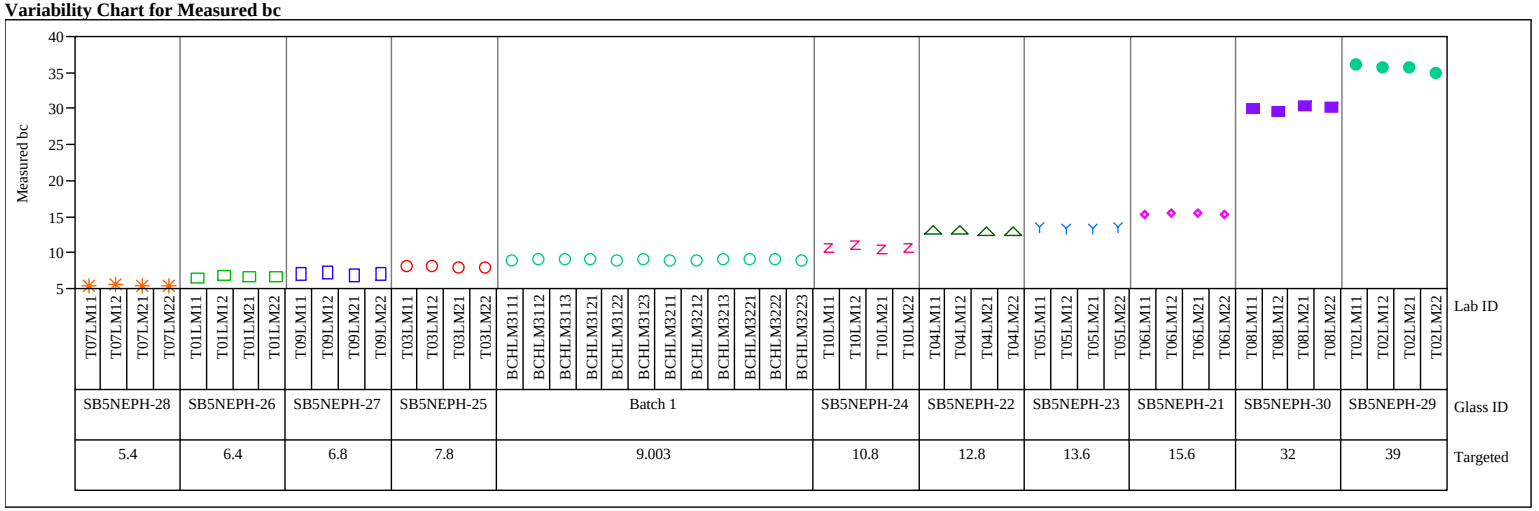
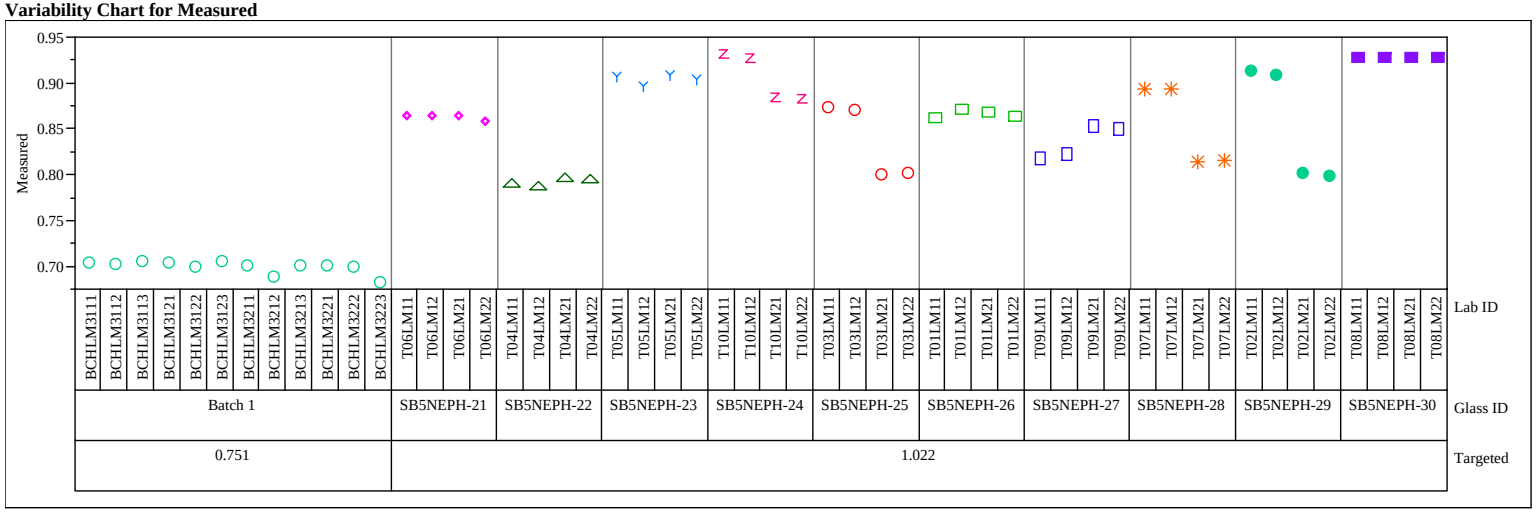


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=3, Oxide=NiO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

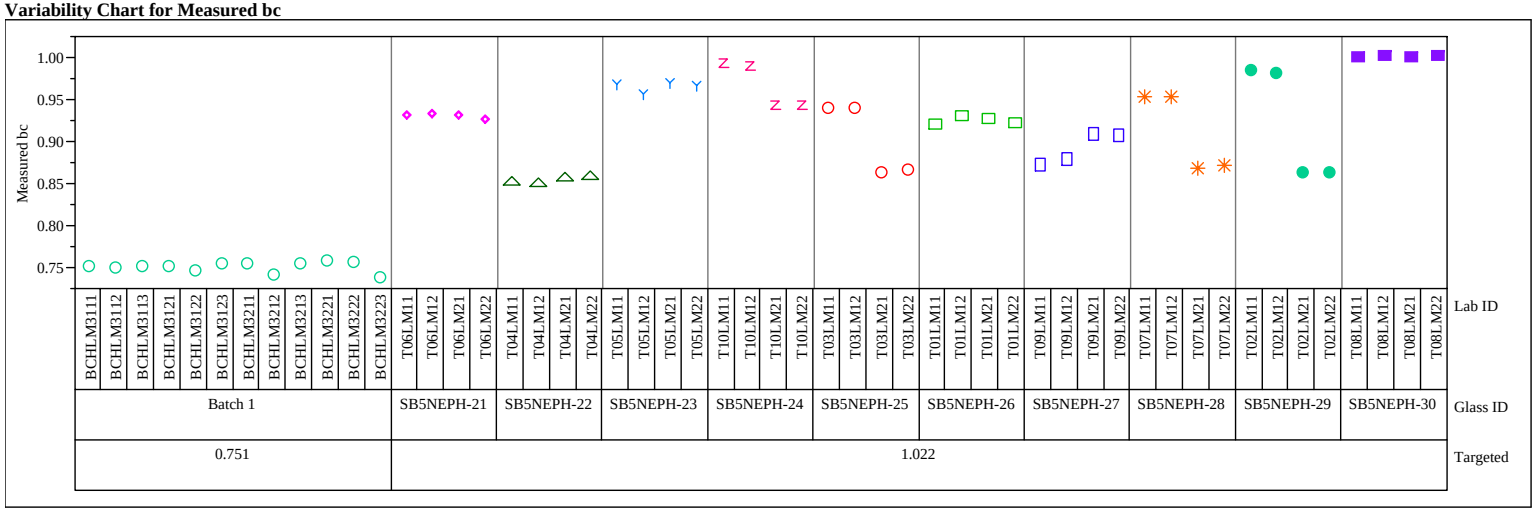
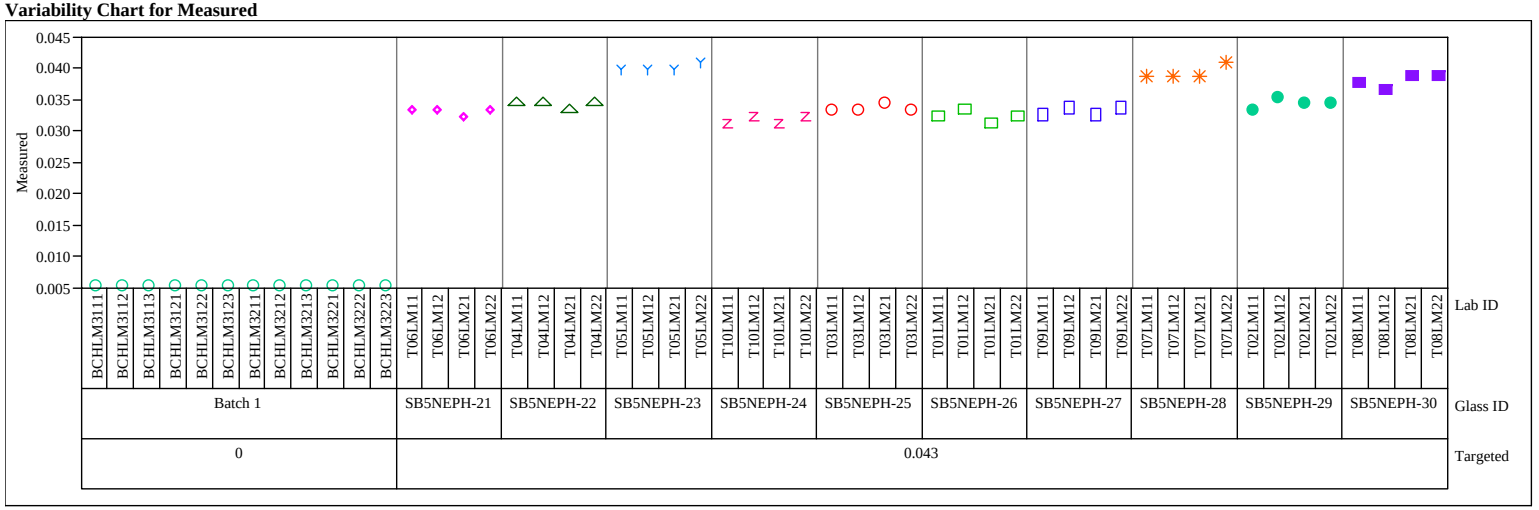


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=3, Oxide=PbO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

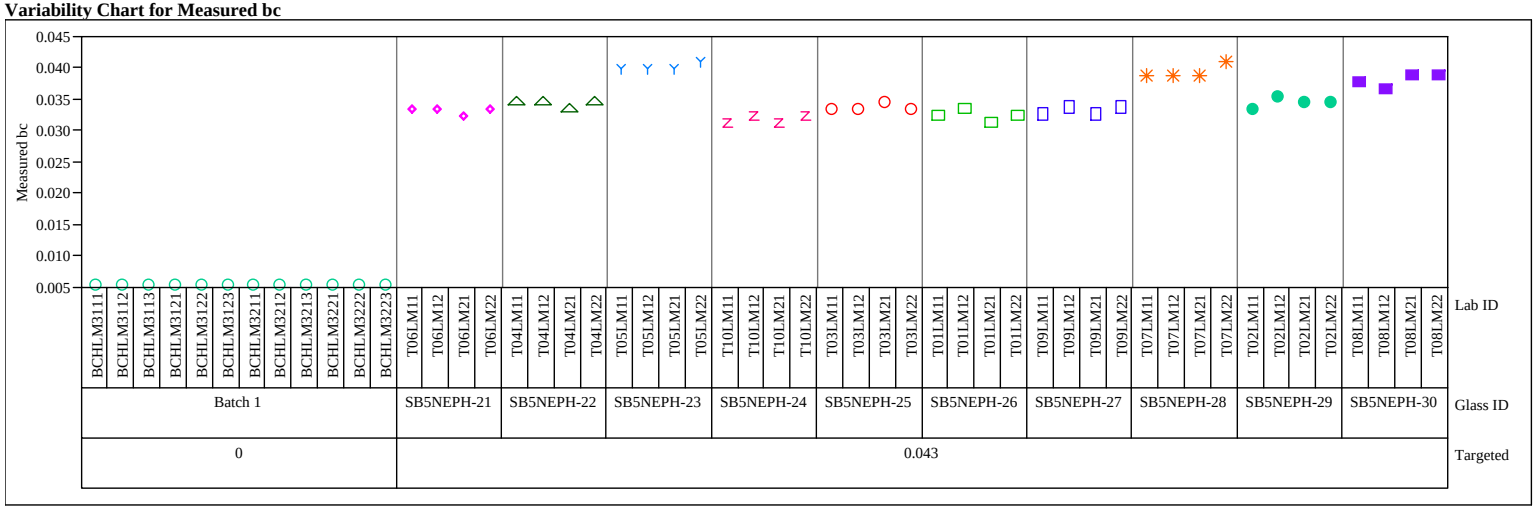
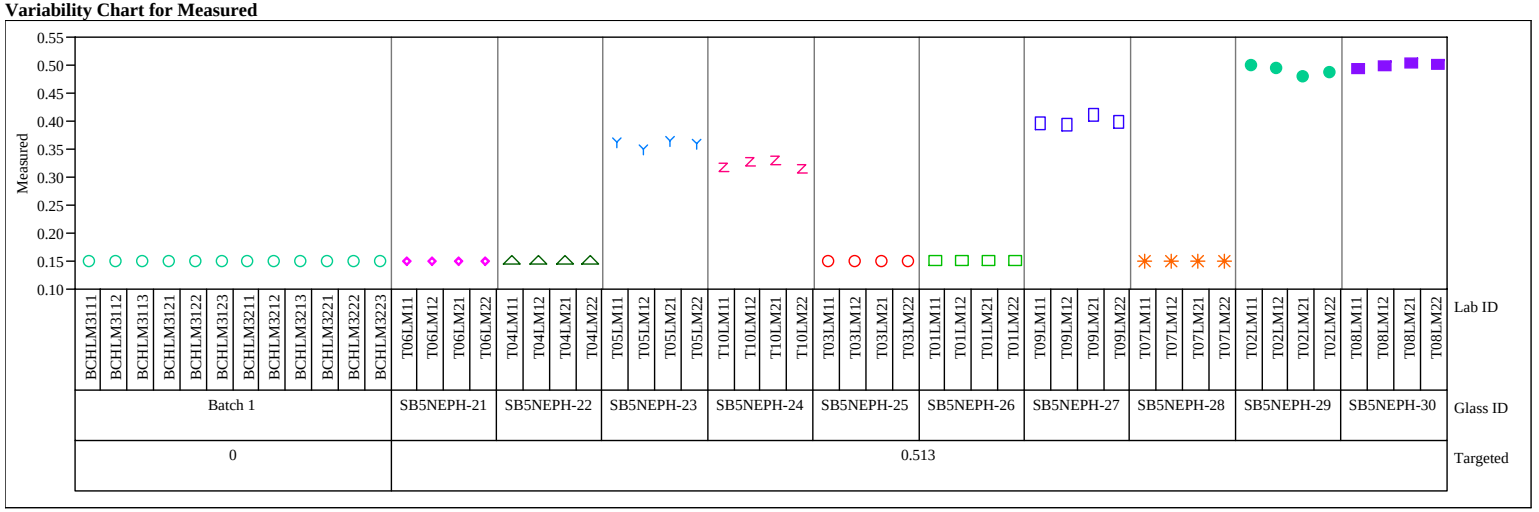


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=3, Oxide=SO4 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

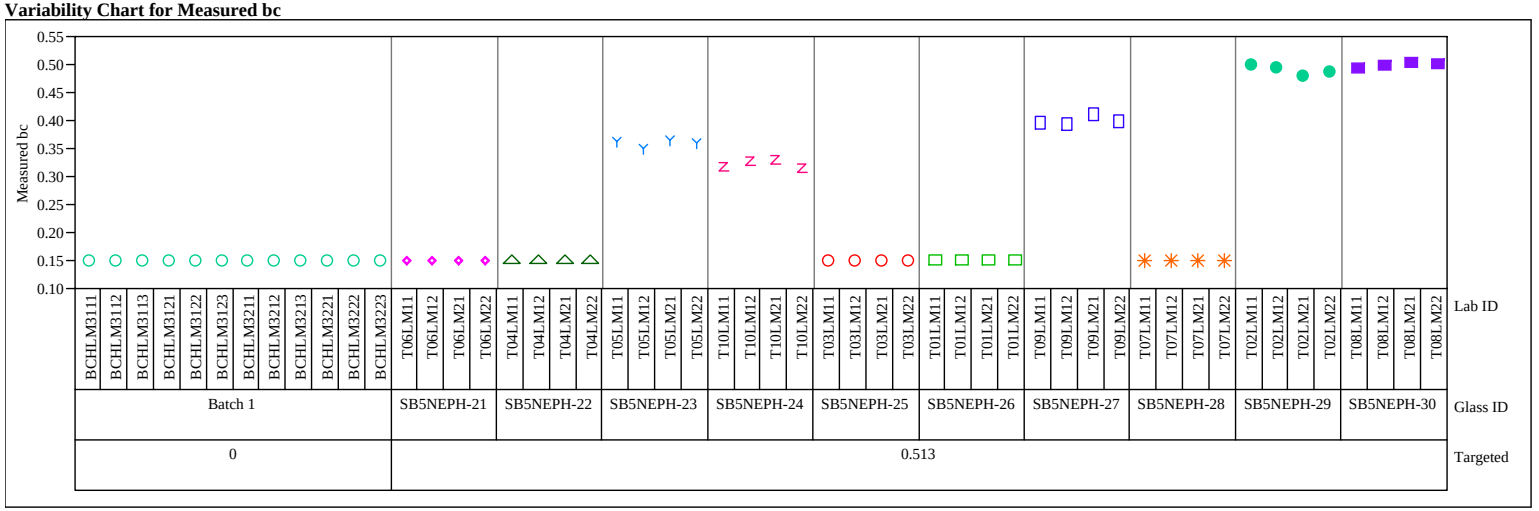
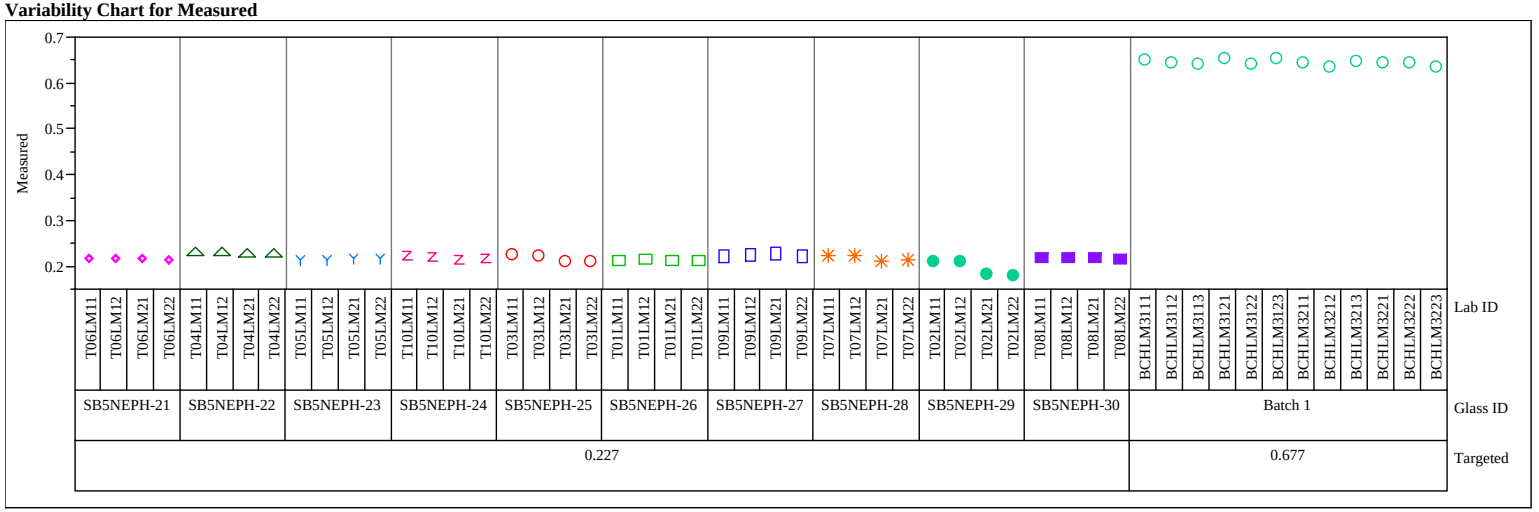


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=3, Oxide=TiO2 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

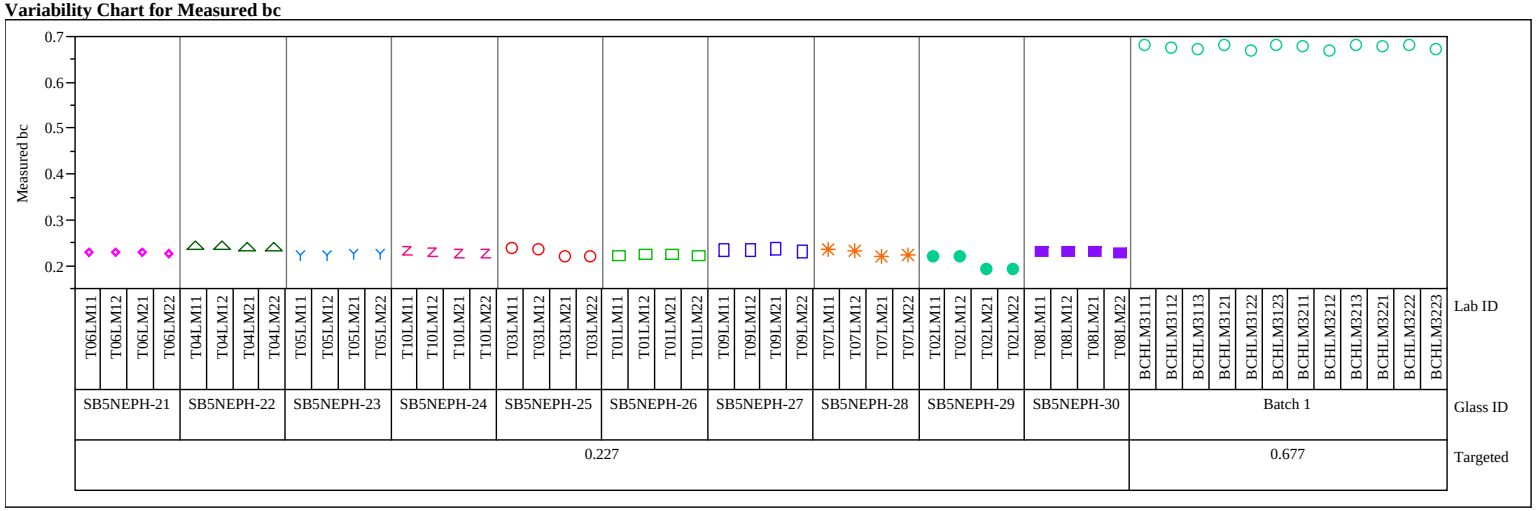
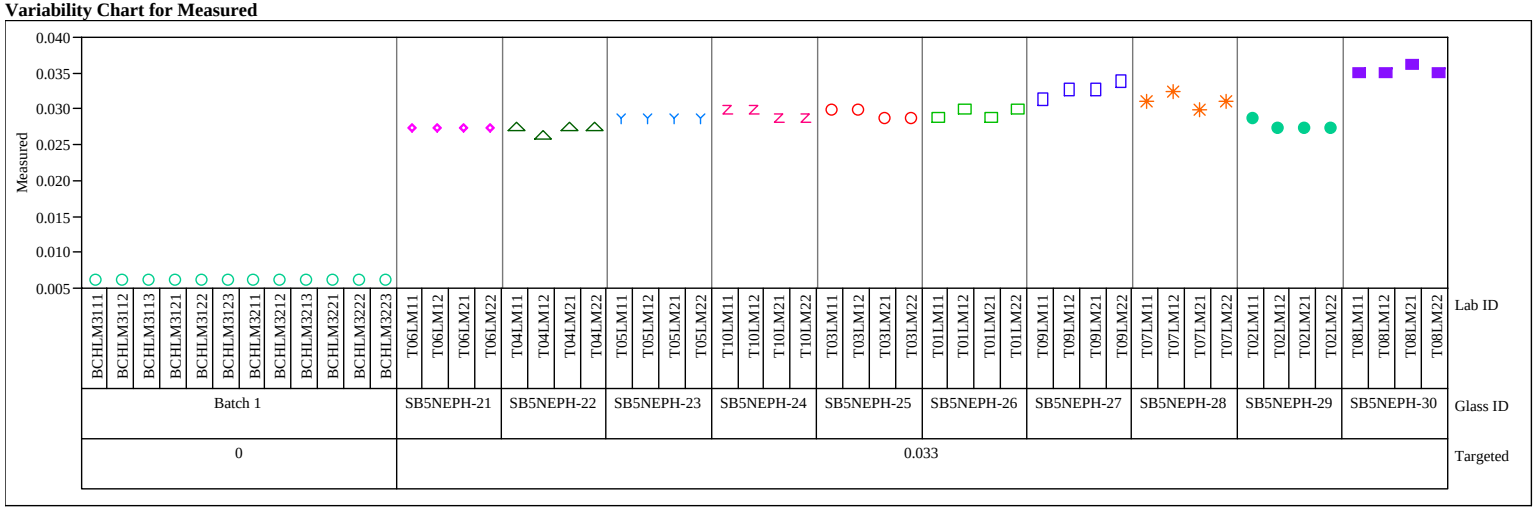


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=3, Oxide=ZnO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

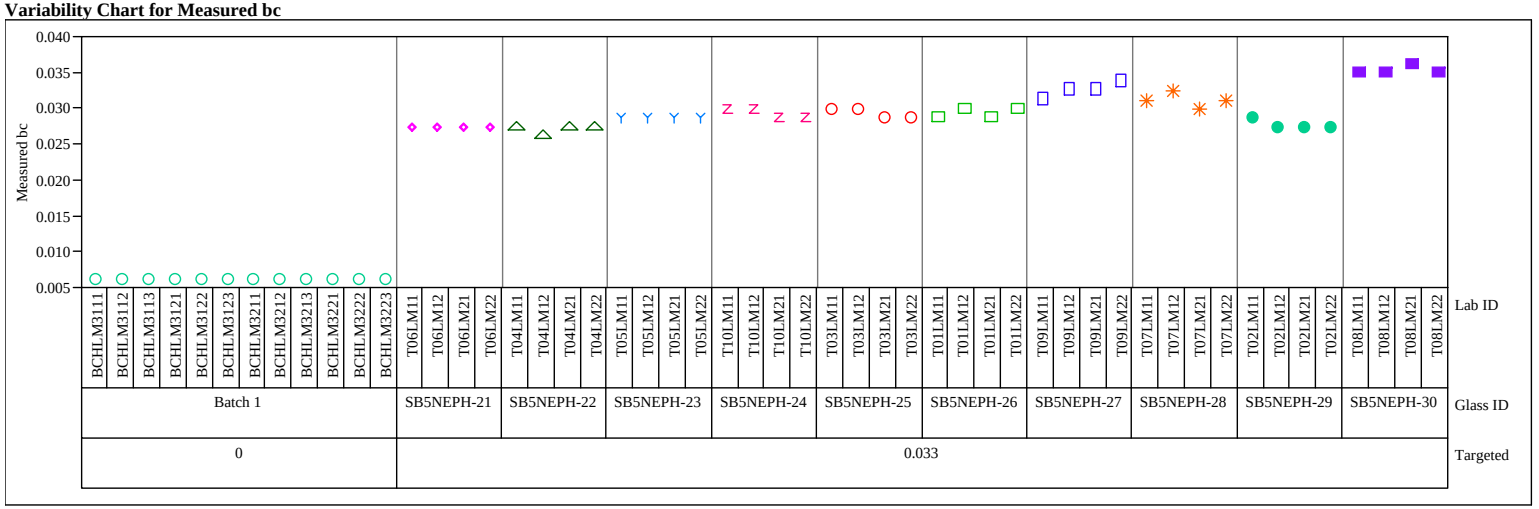
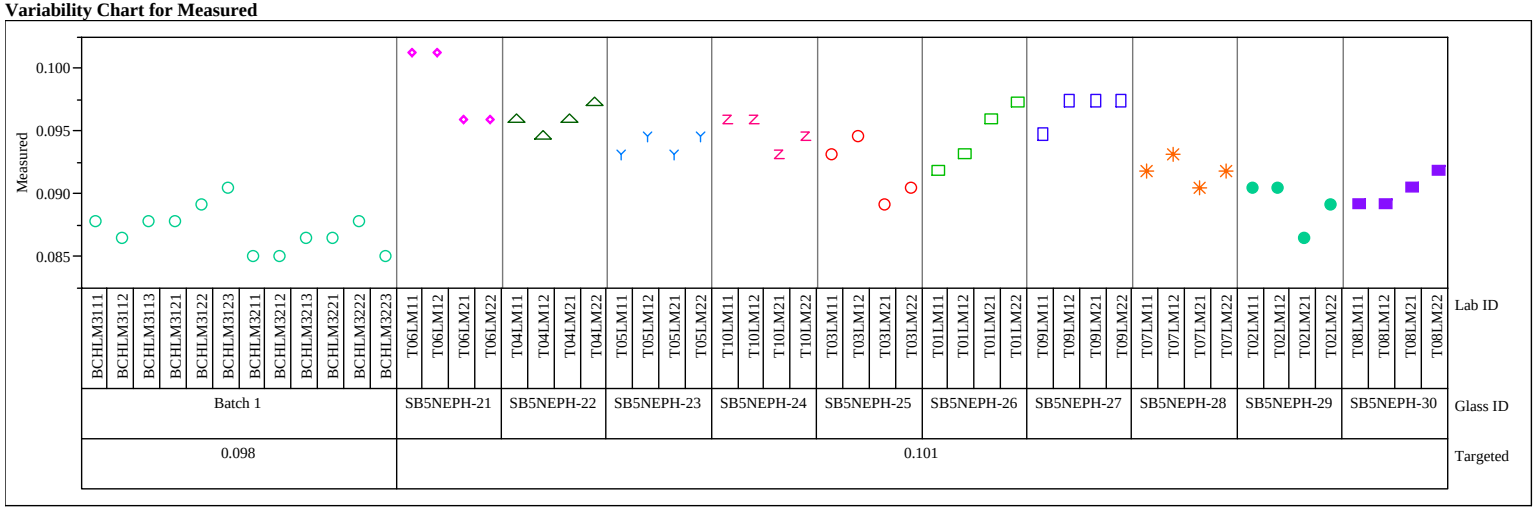


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=3, Oxide=ZrO2 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

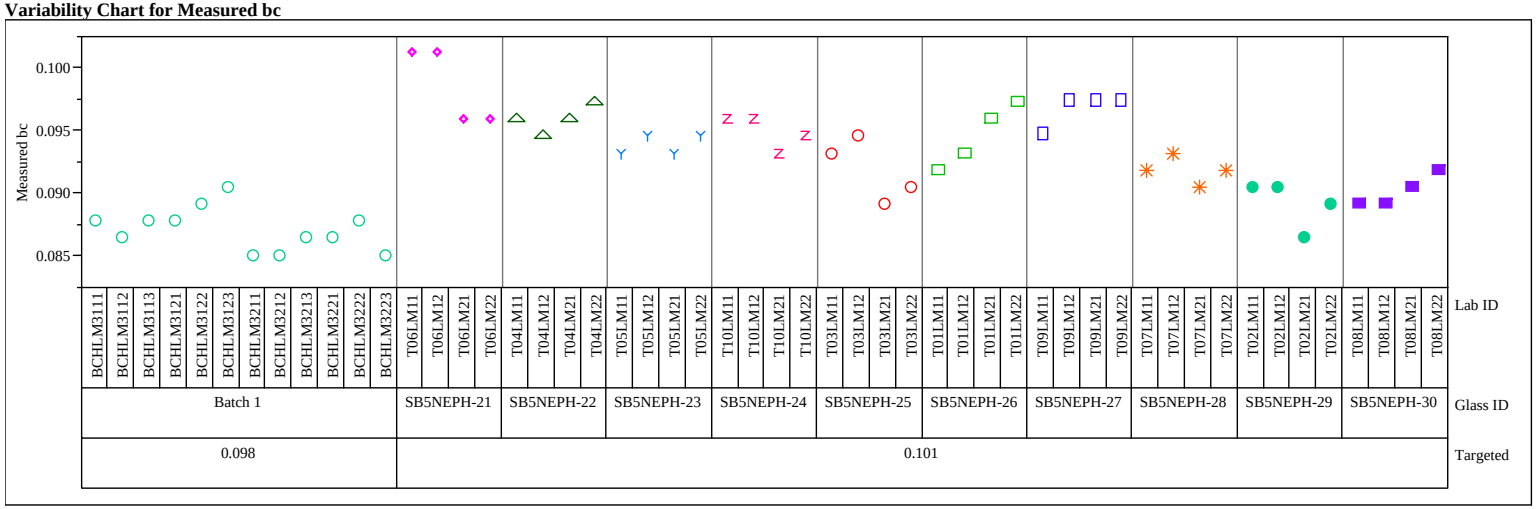
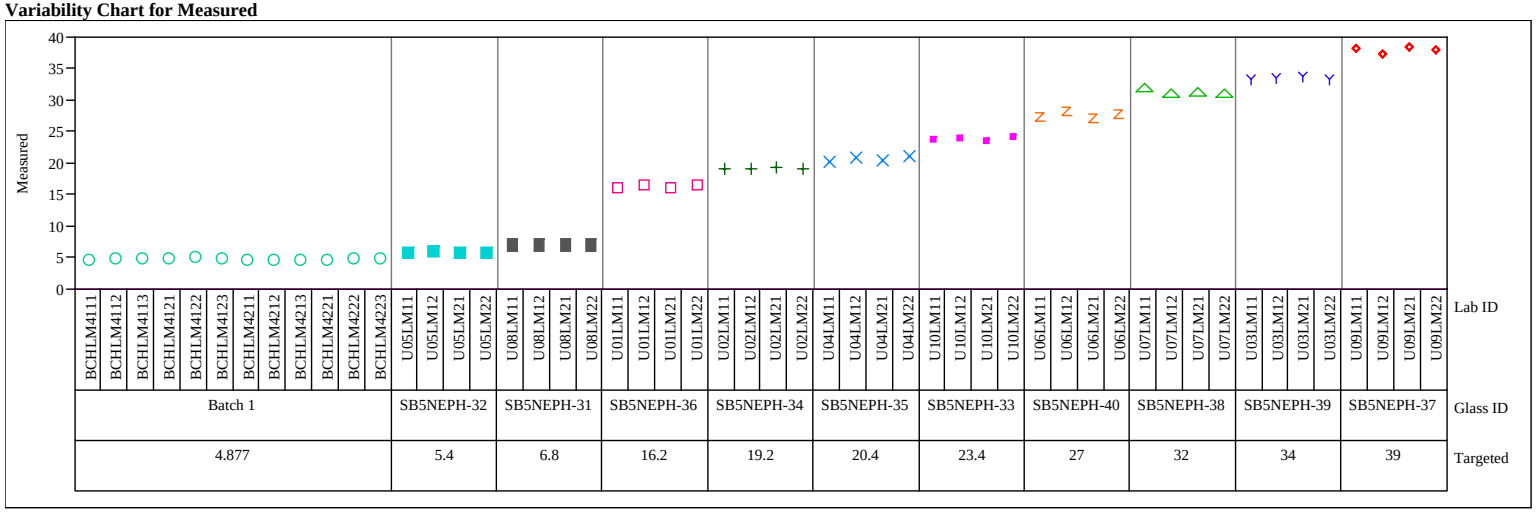


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=4, Oxide=Al2O3 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

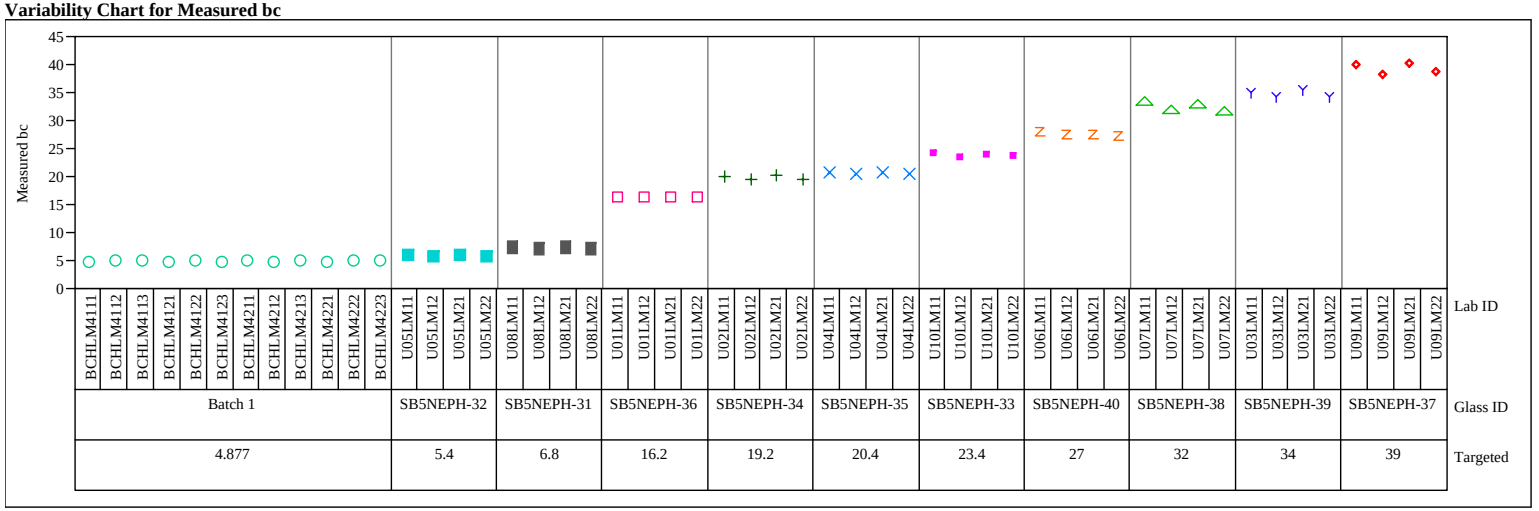
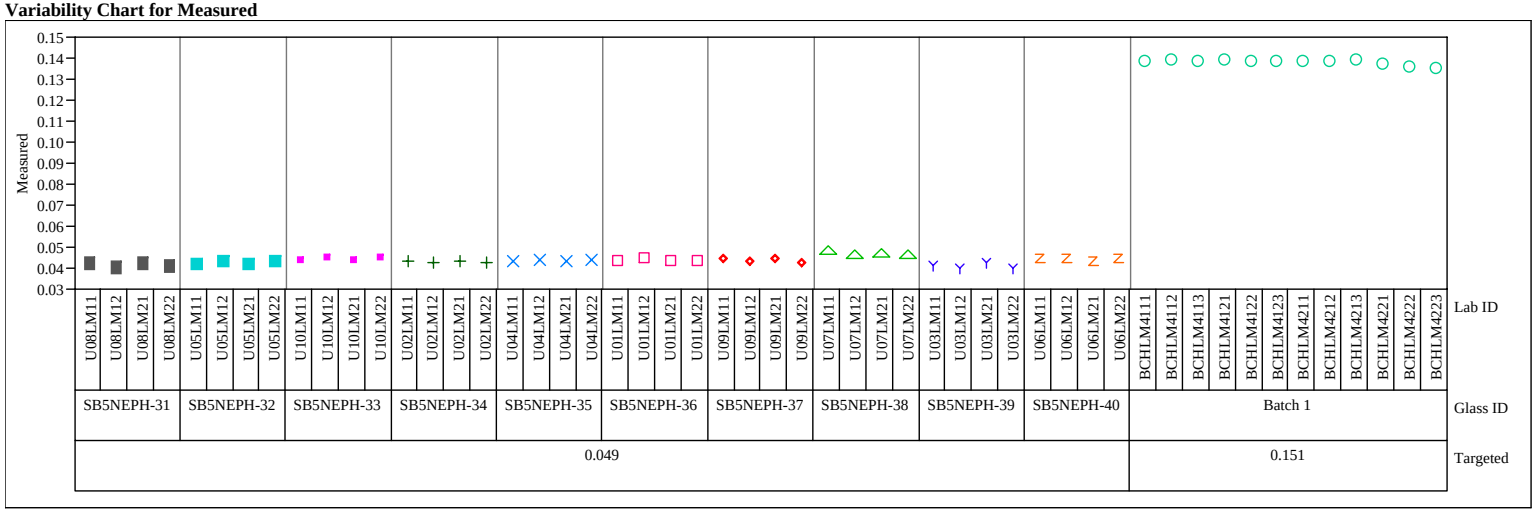


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=4, Oxide=BaO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

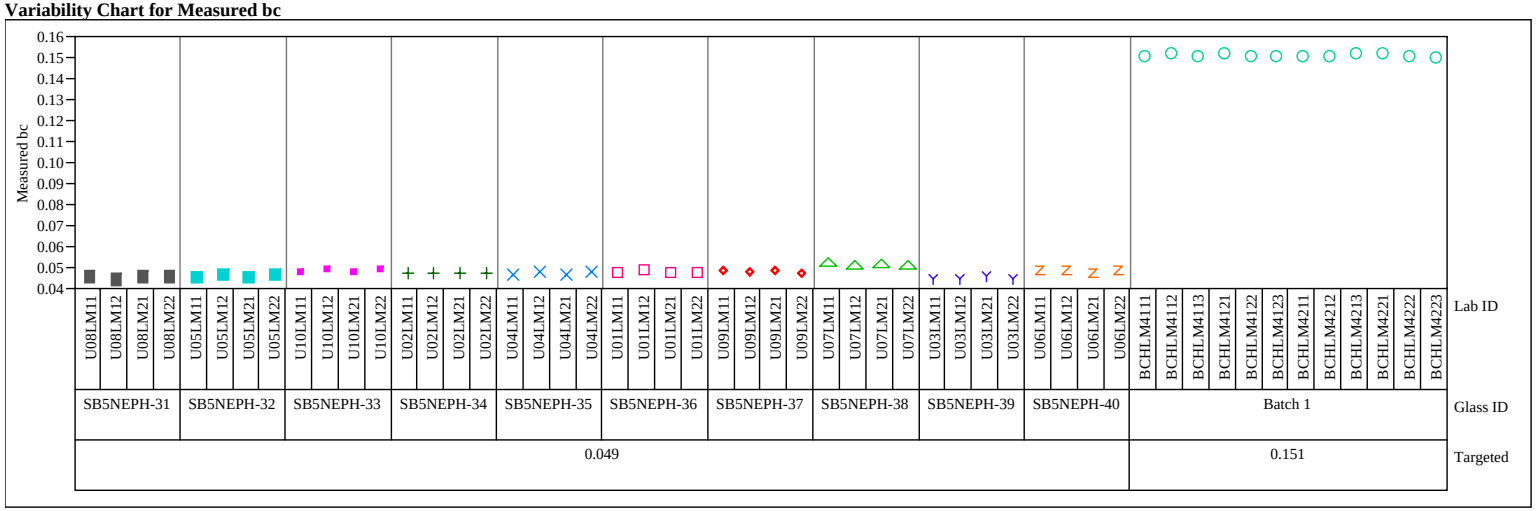
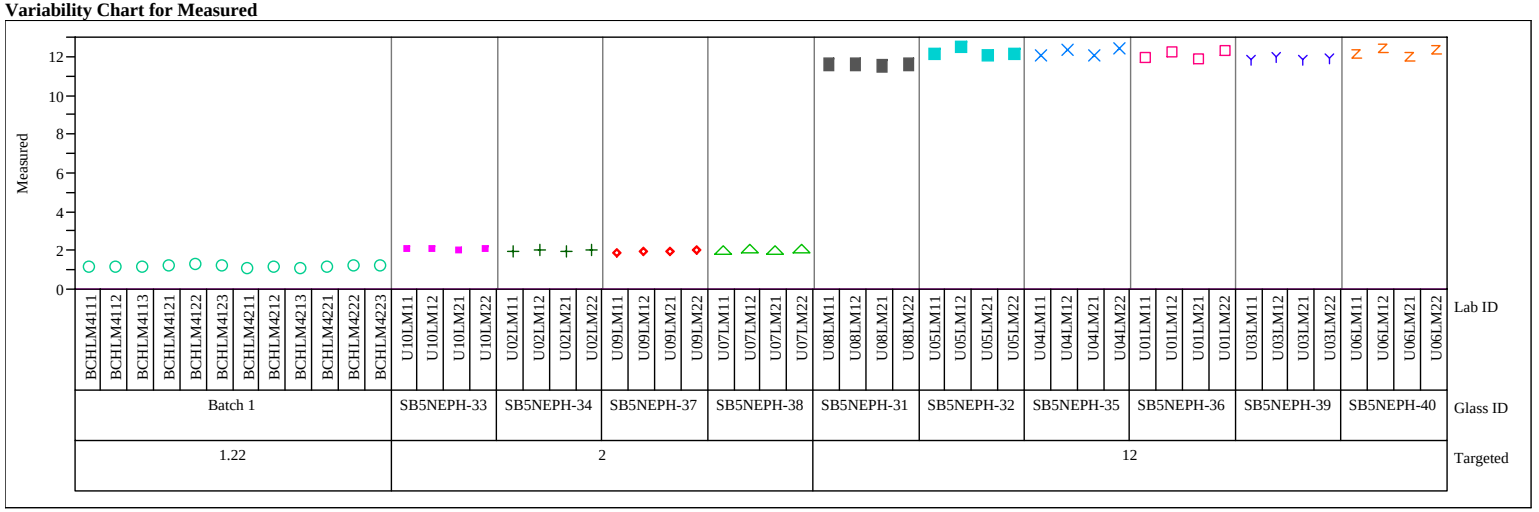


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=4, Oxide=CaO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

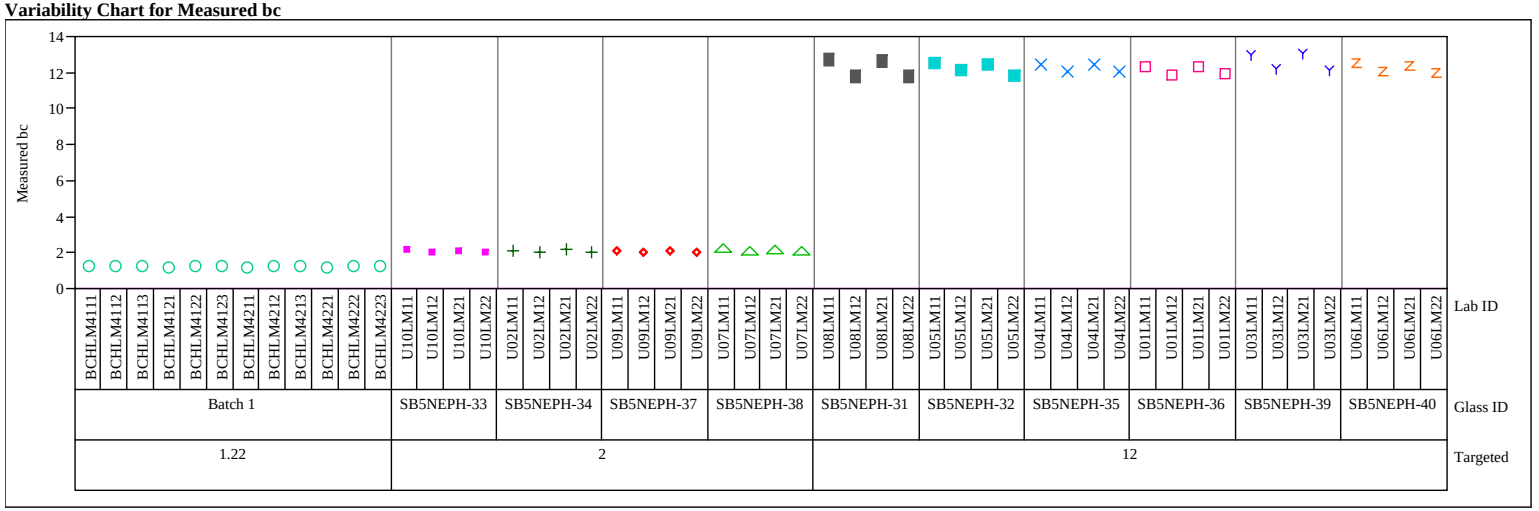
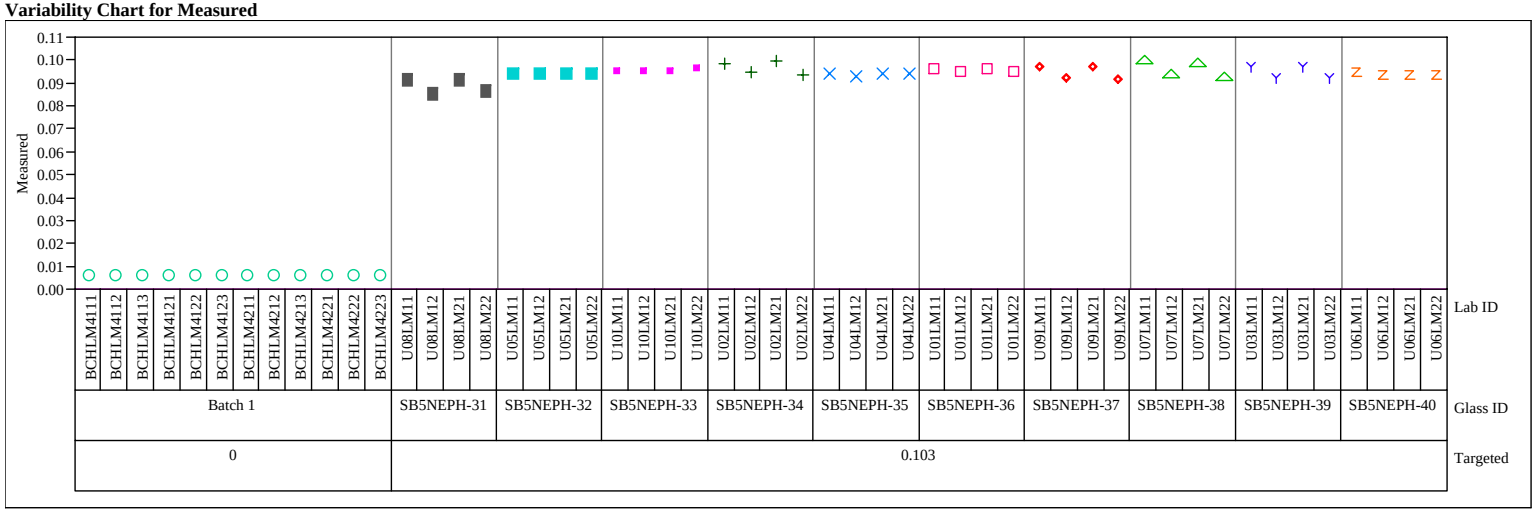


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=4, Oxide=Ce2O3 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

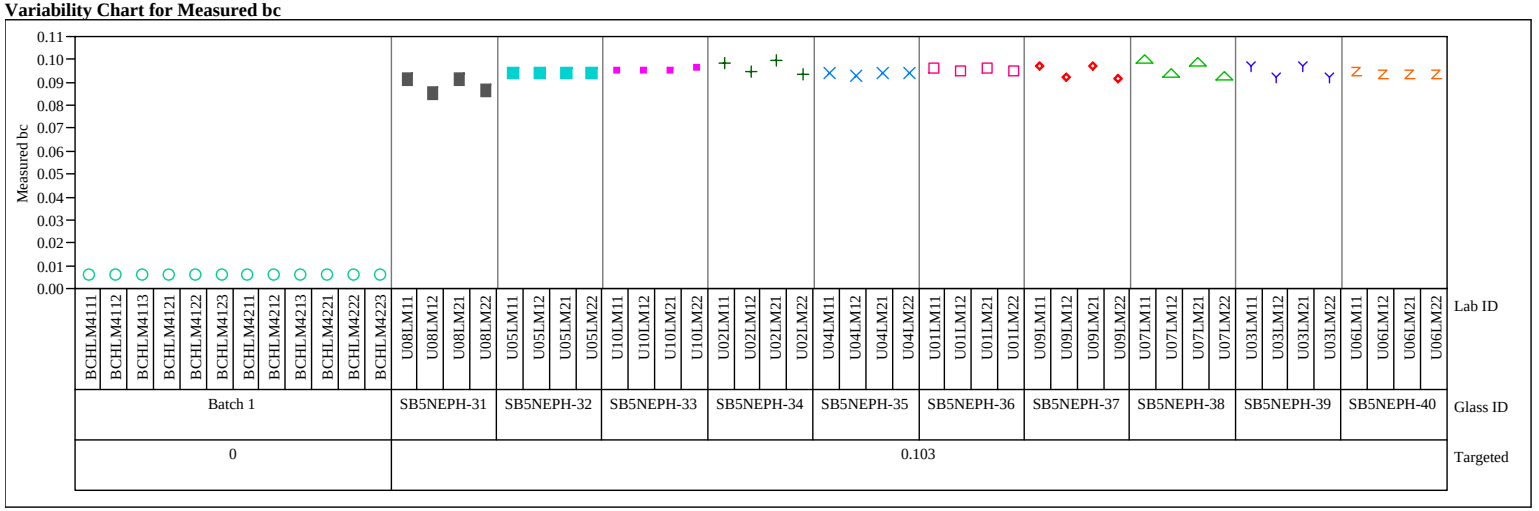
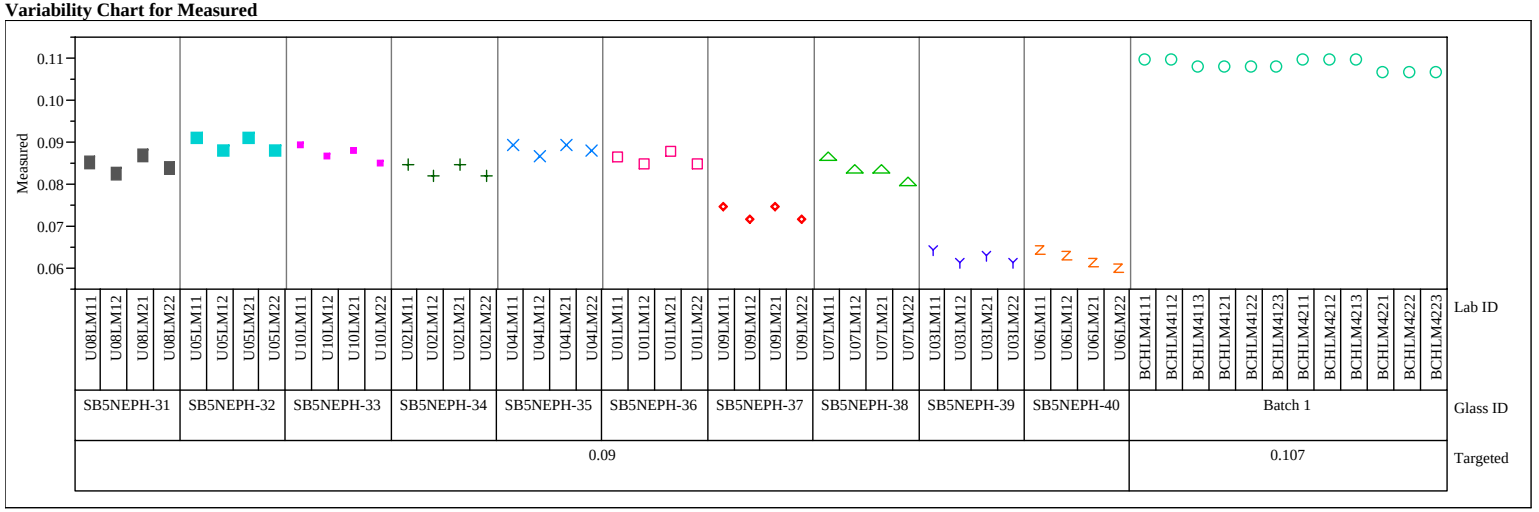


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=4, Oxide=Cr2O3 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

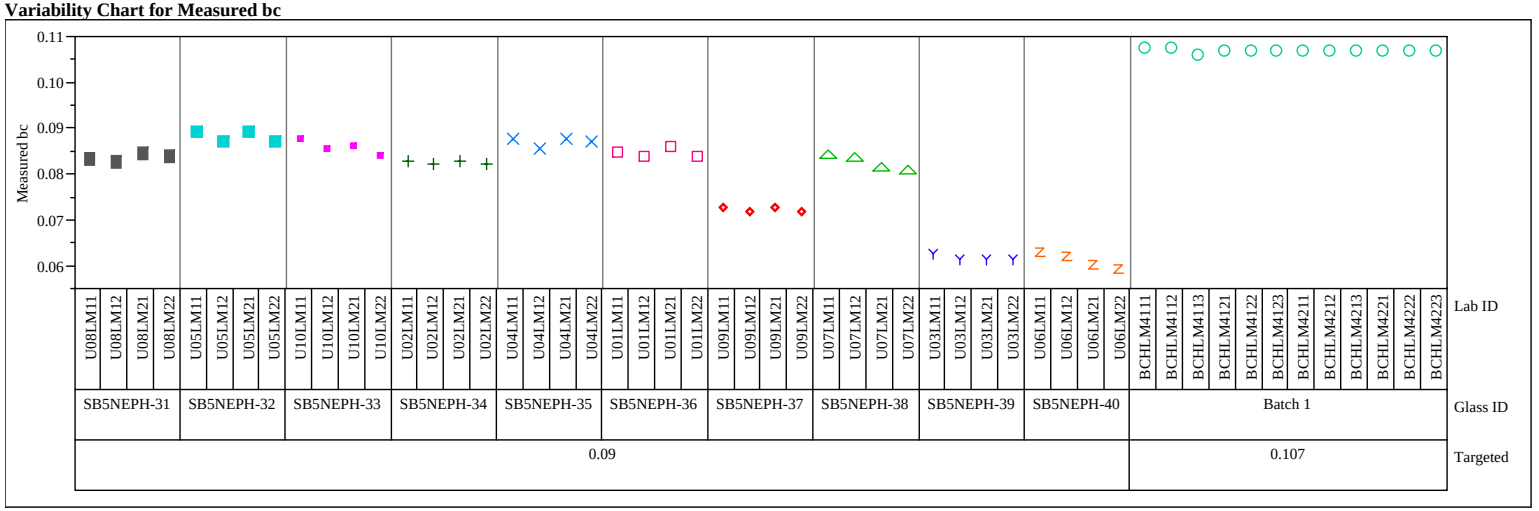
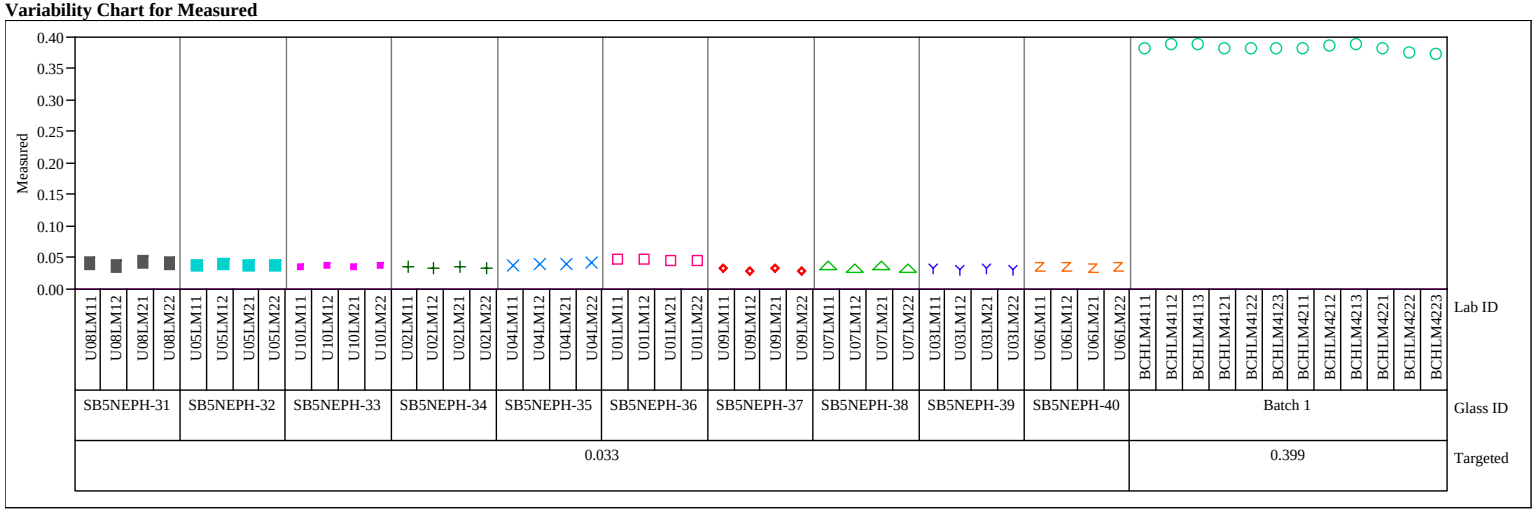


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=4, Oxide=CuO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

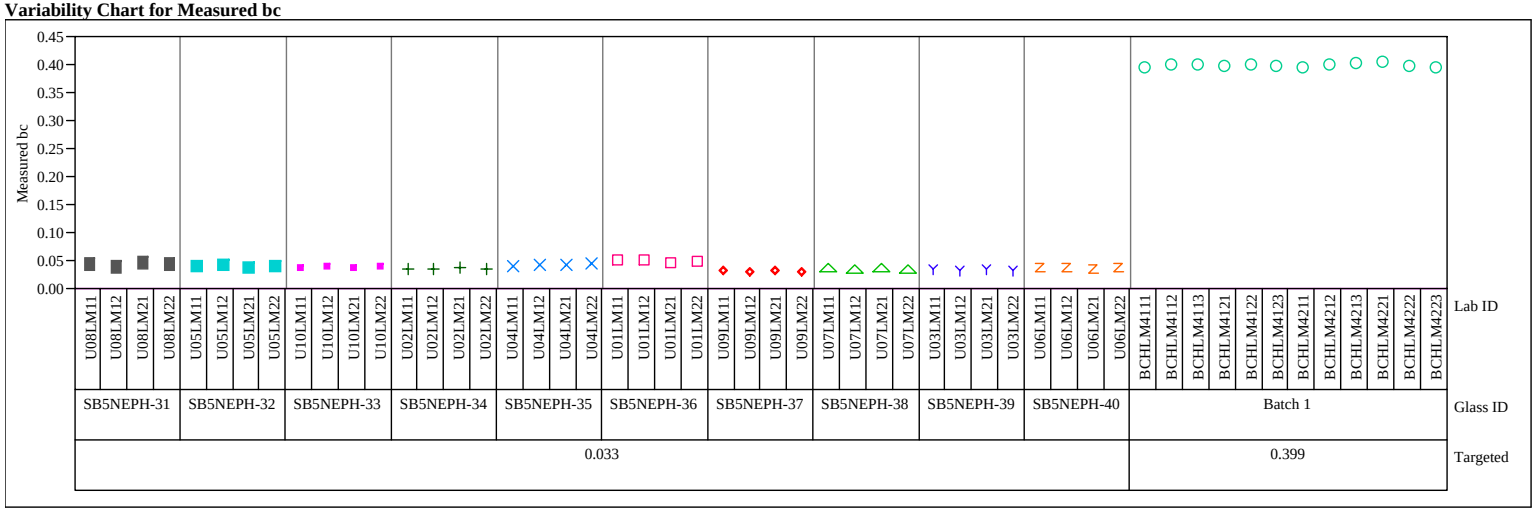
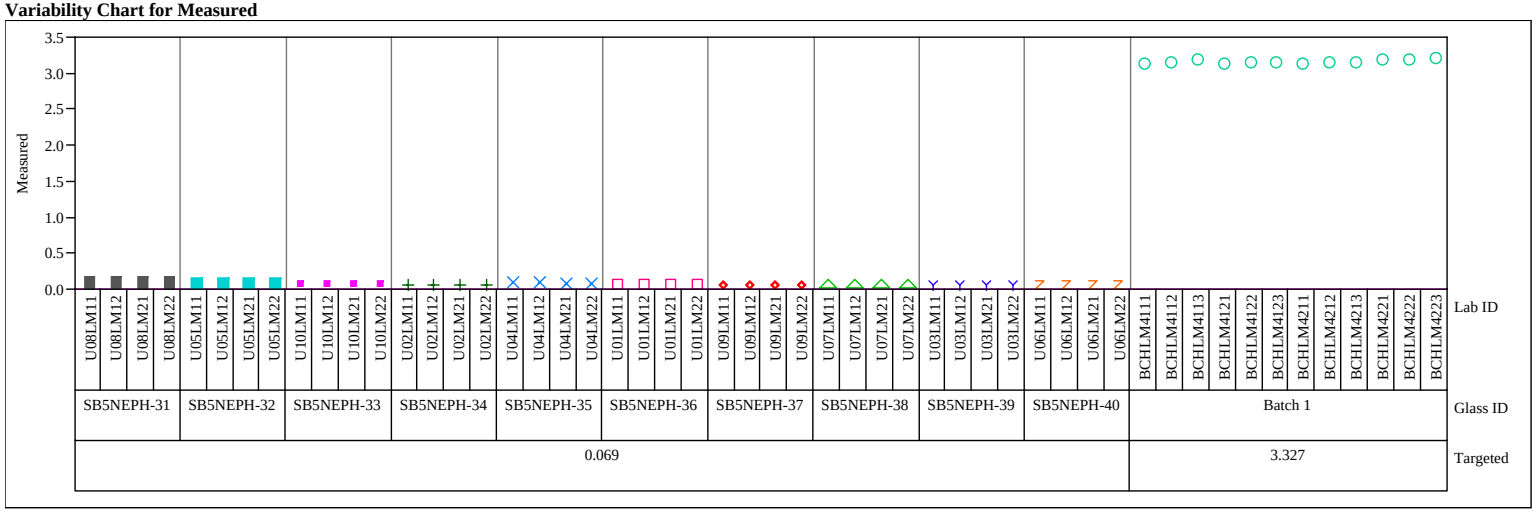


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=4, Oxide=K2O (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

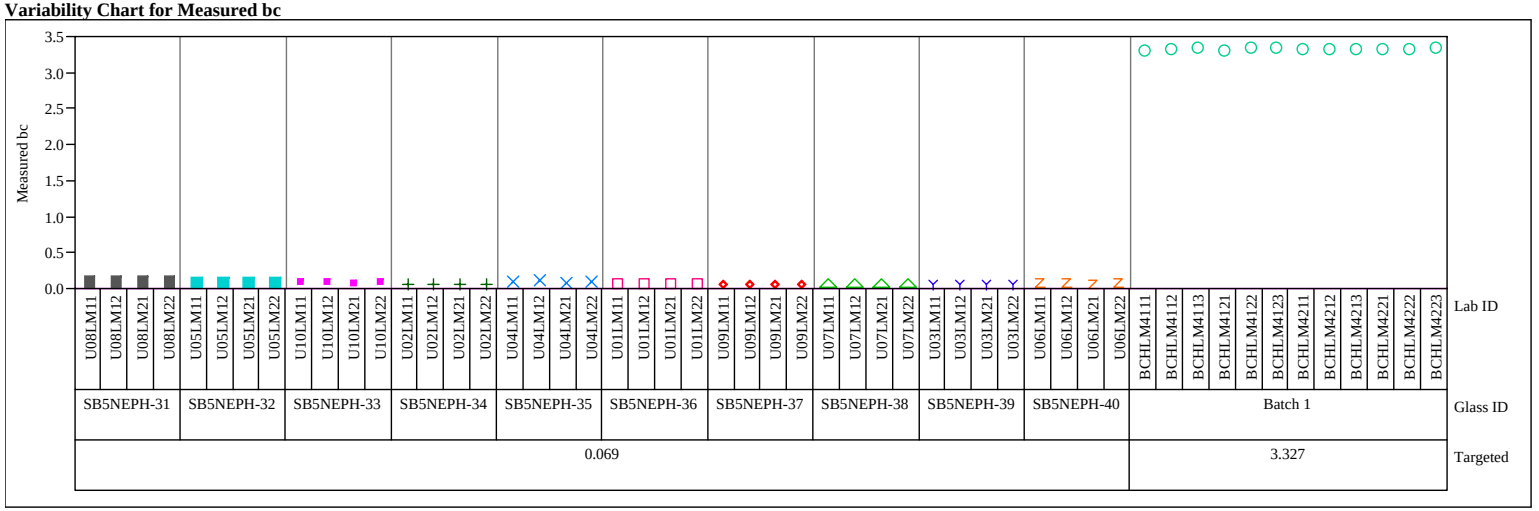
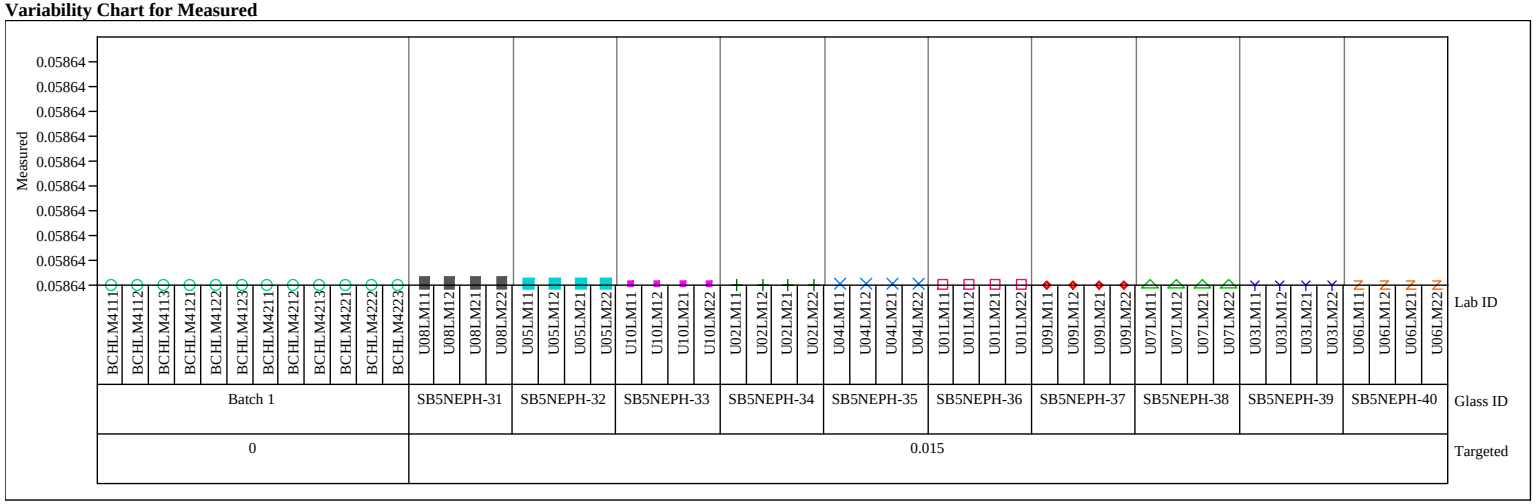


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=4, Oxide=La2O3 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

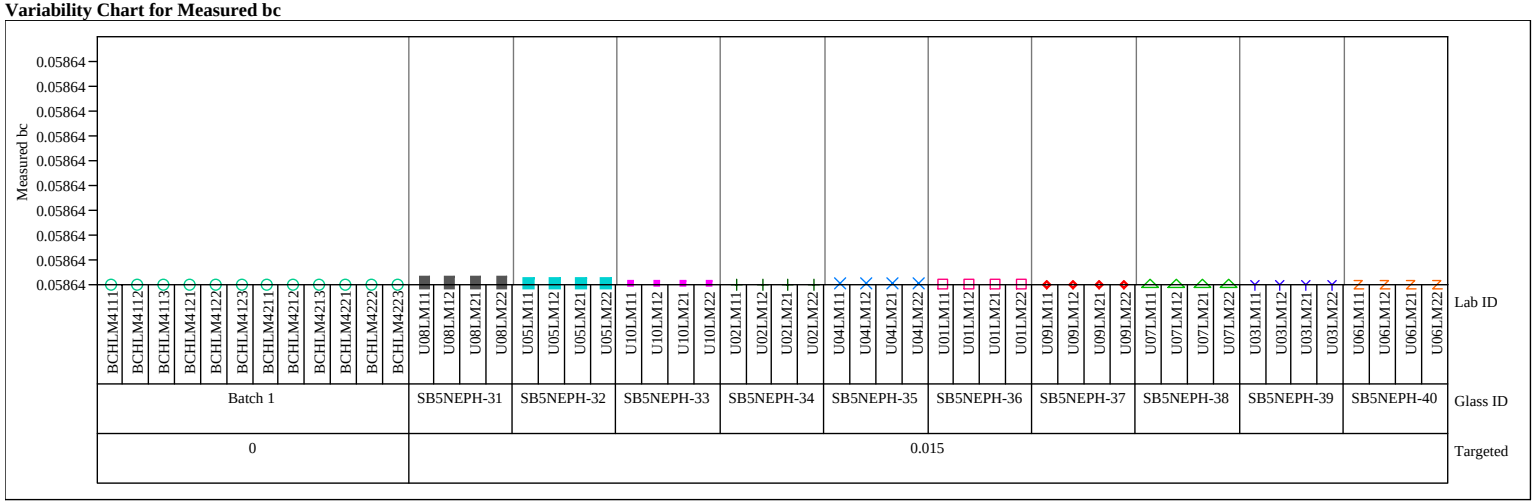
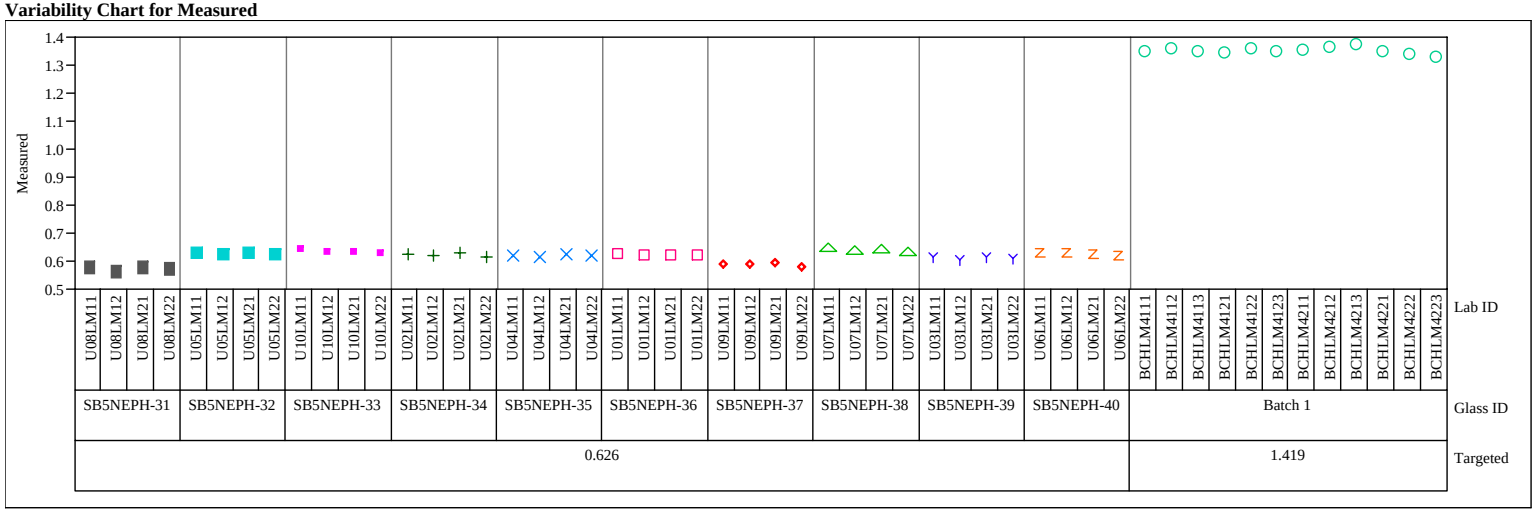


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=4, Oxide=MgO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

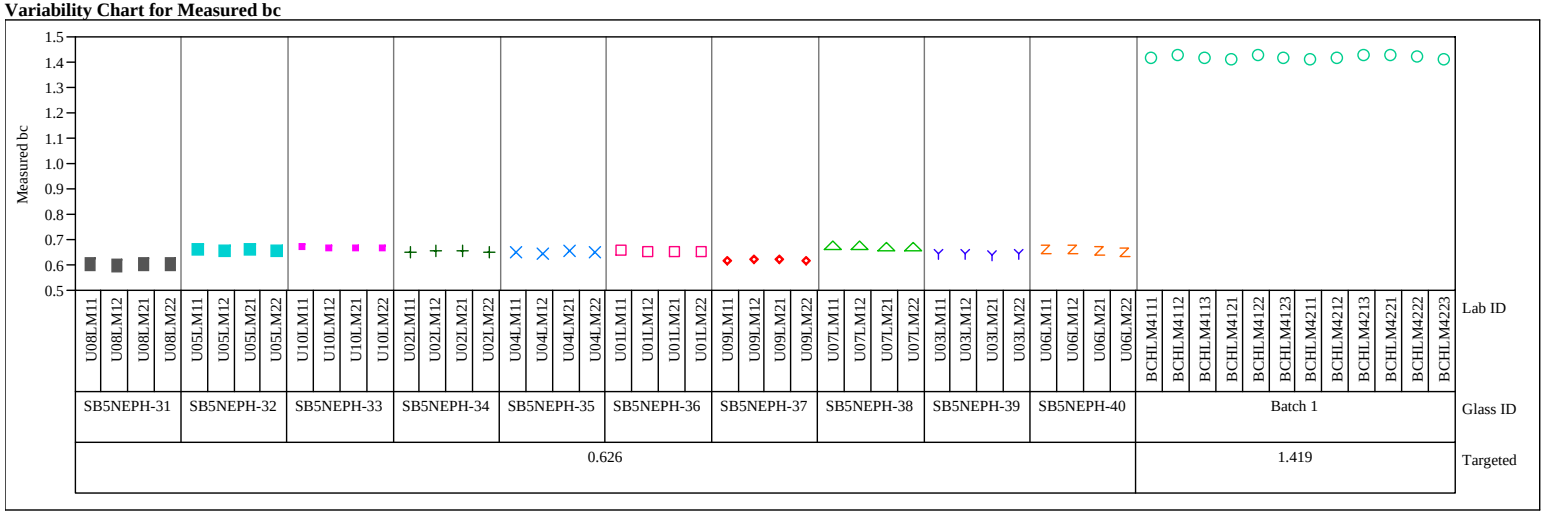
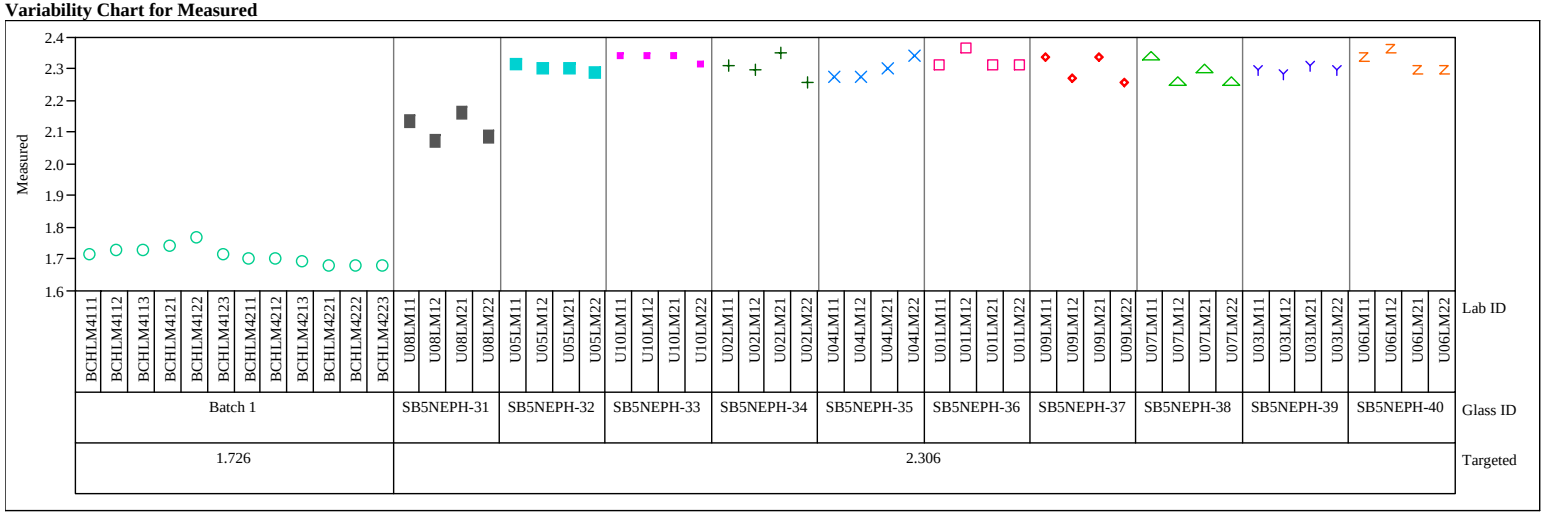


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=4, Oxide=MnO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

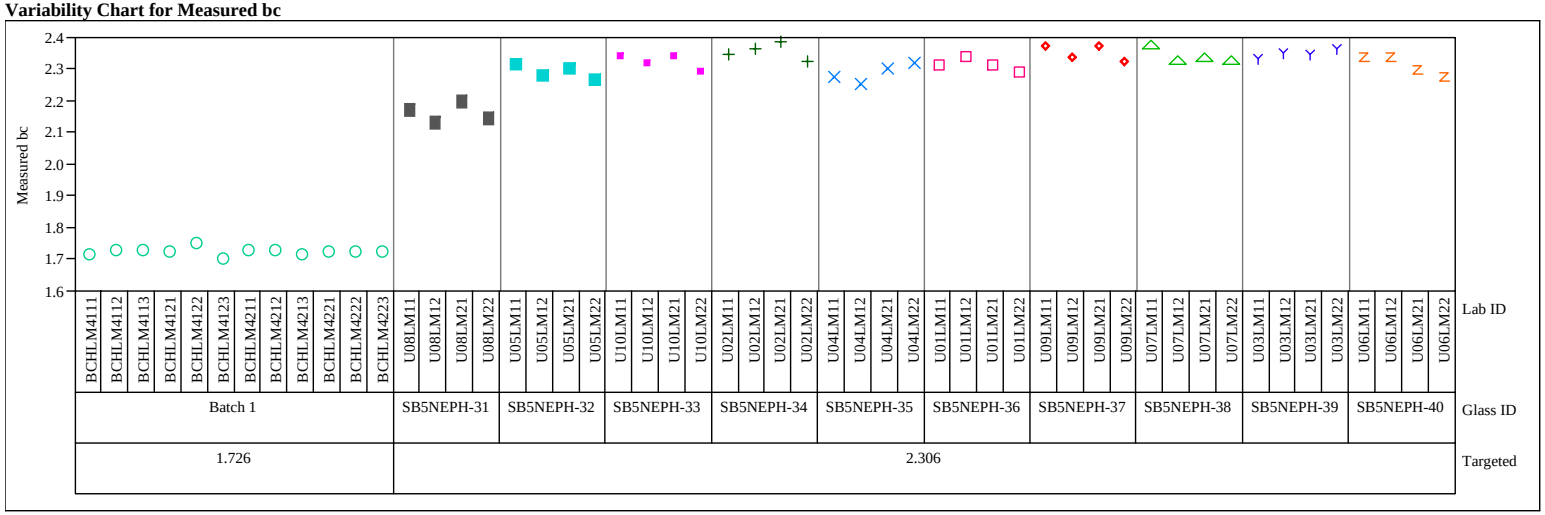
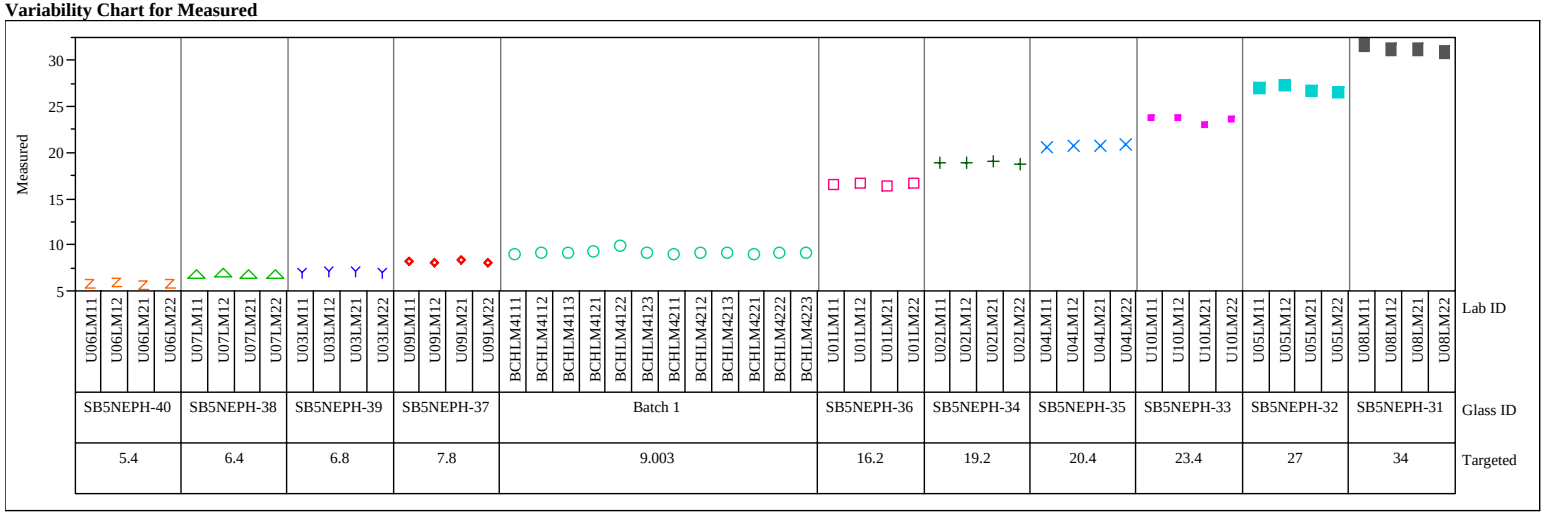


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=4, Oxide=Na2O (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

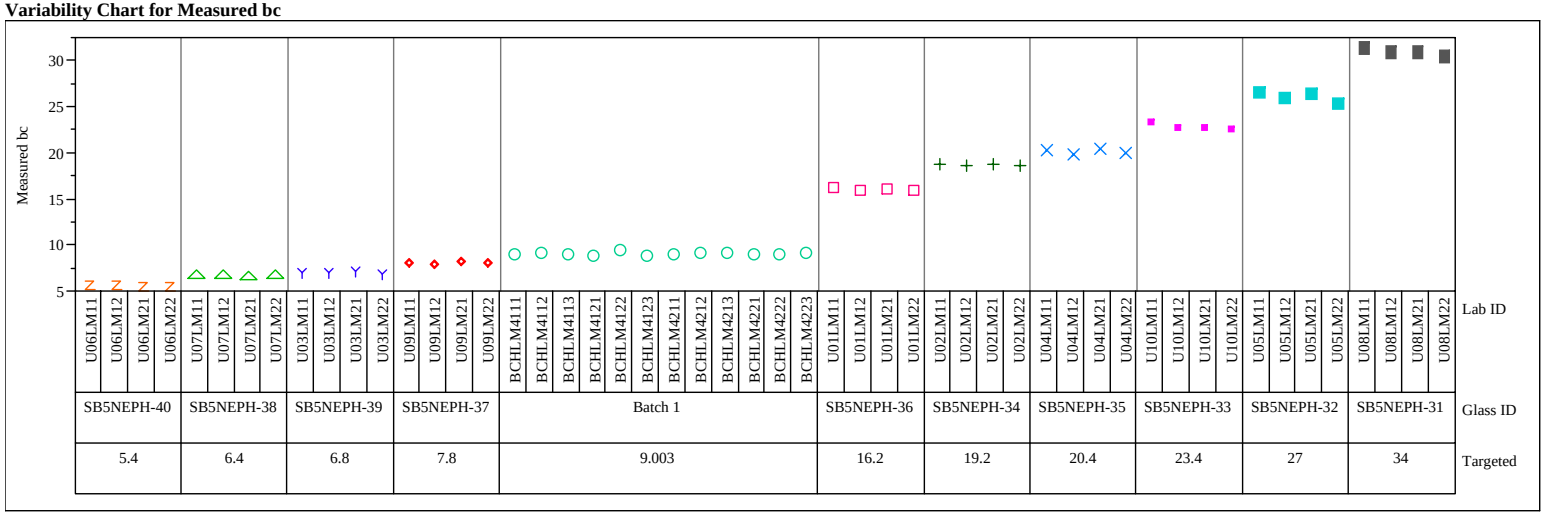
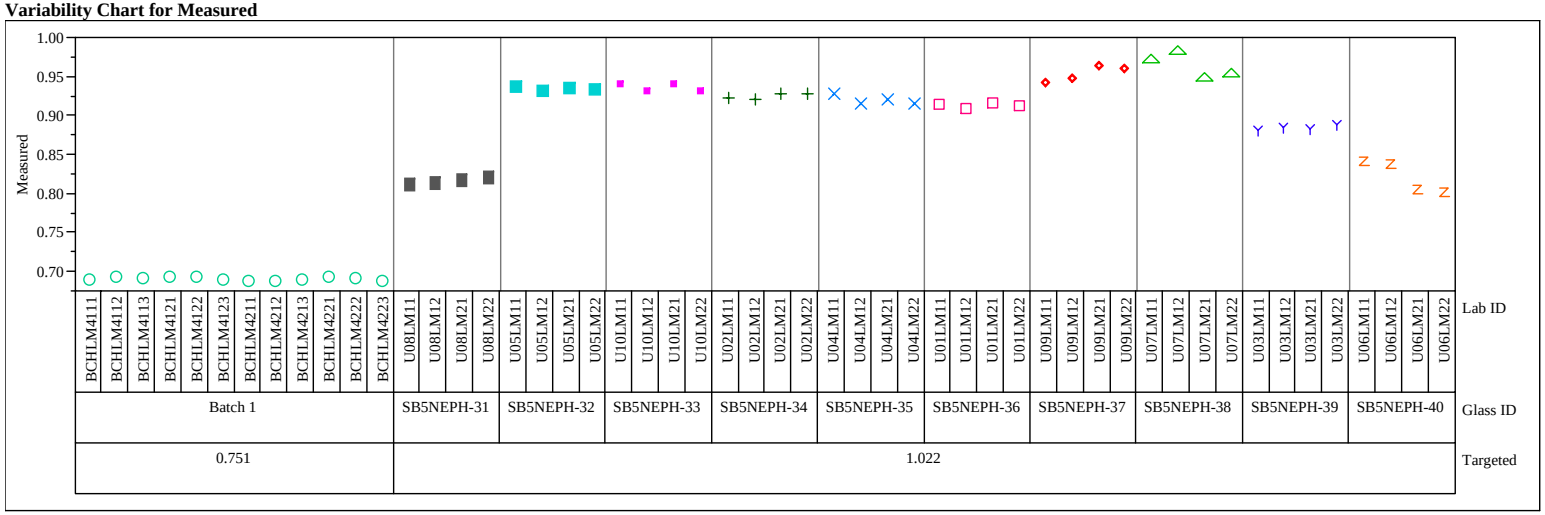


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=4, Oxide=NiO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

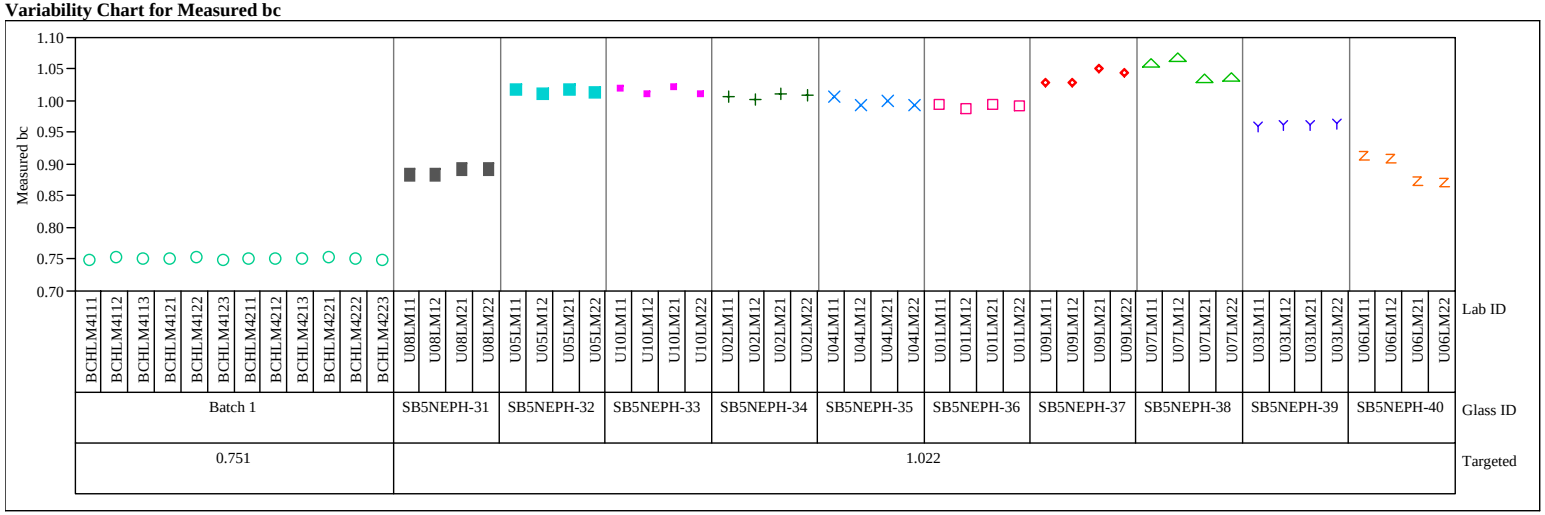
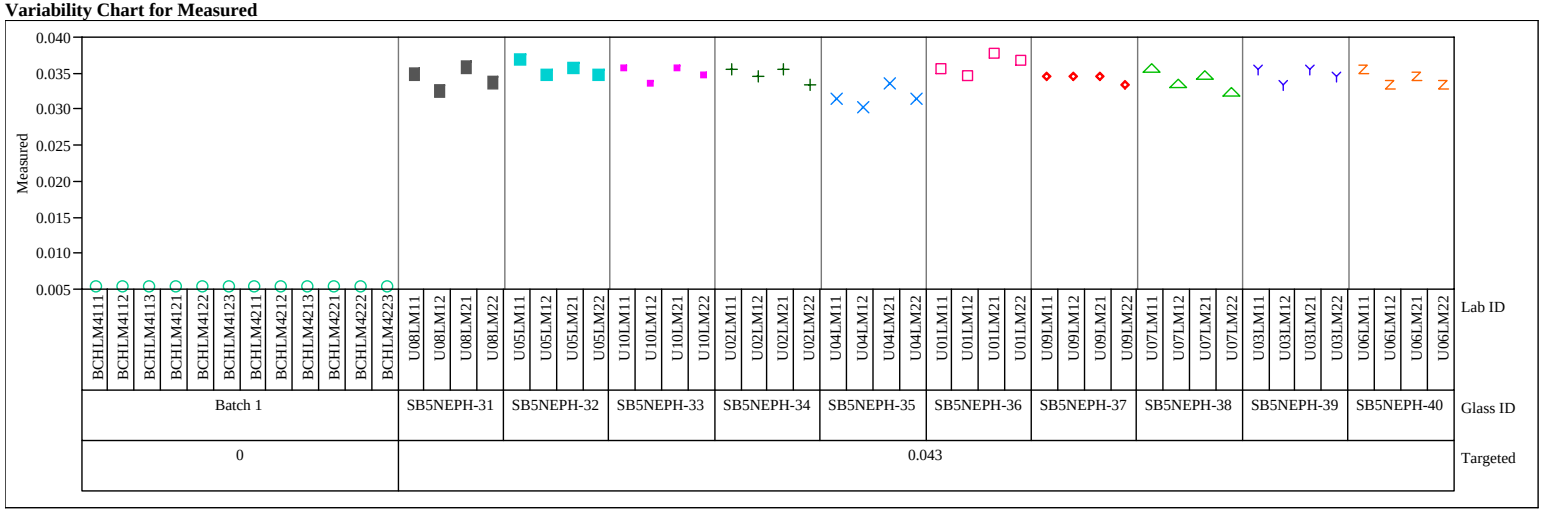


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=4, Oxide=PbO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

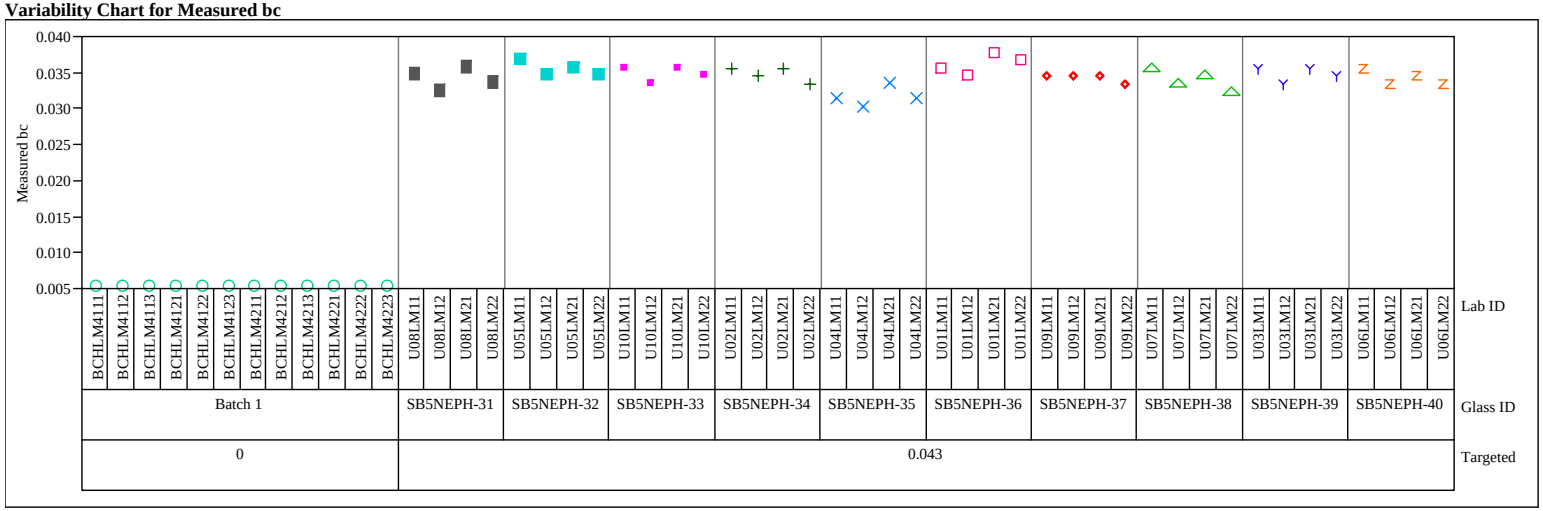
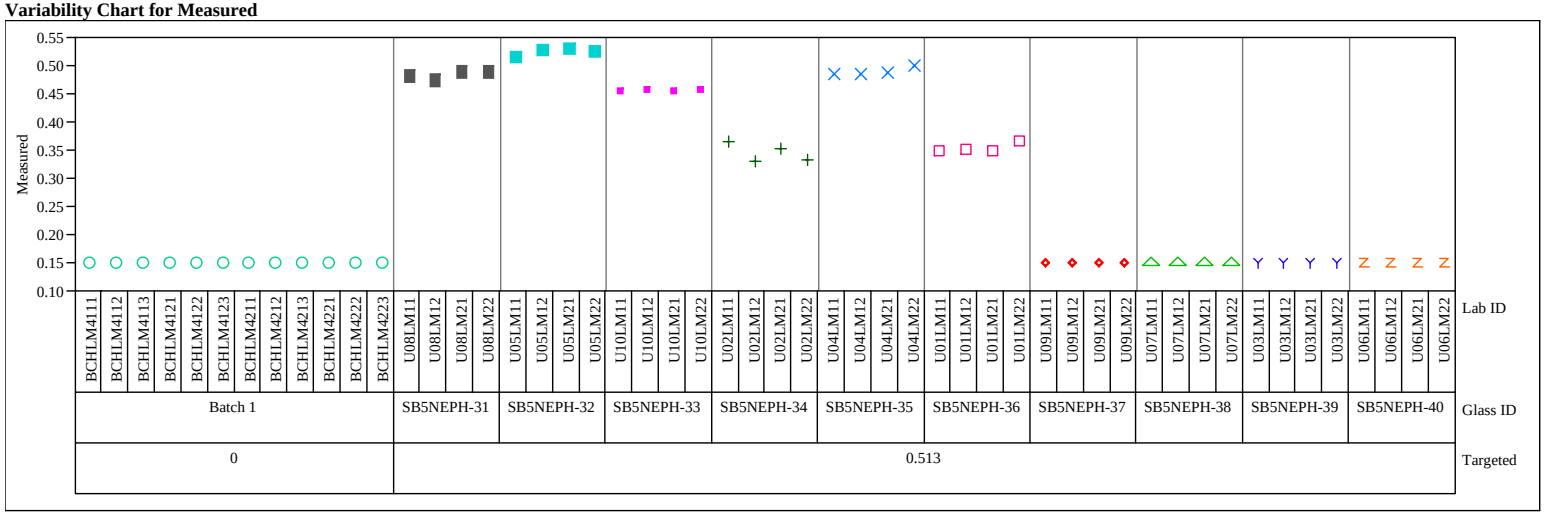


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=4, Oxide=SO4 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

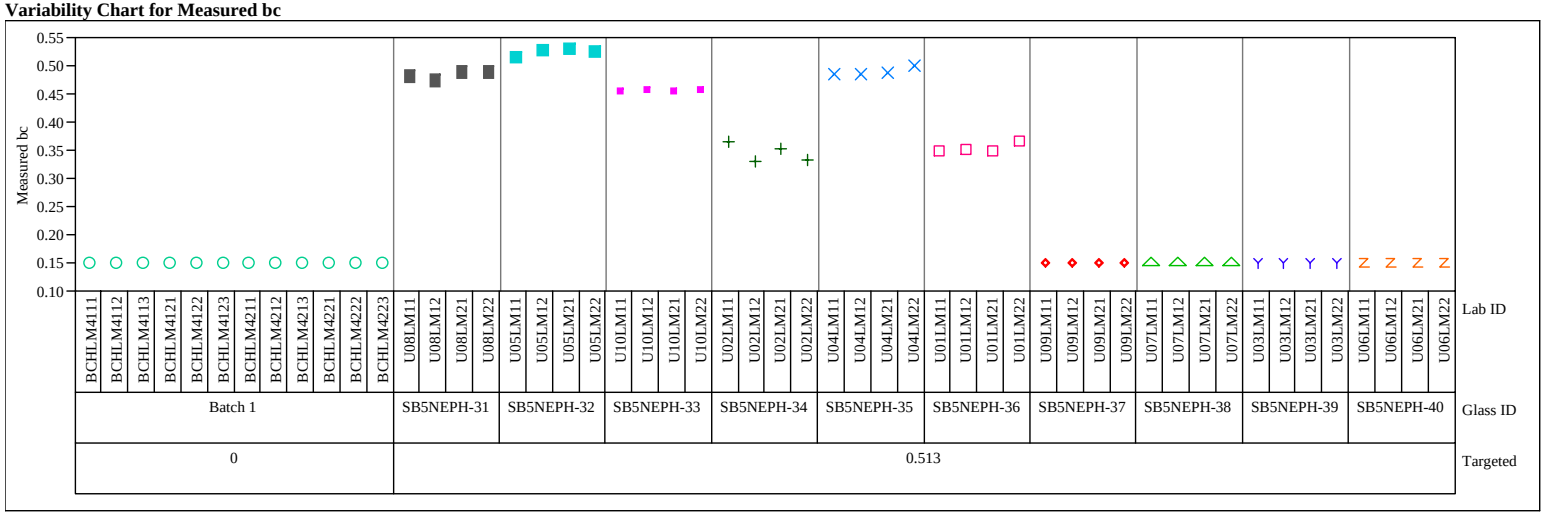
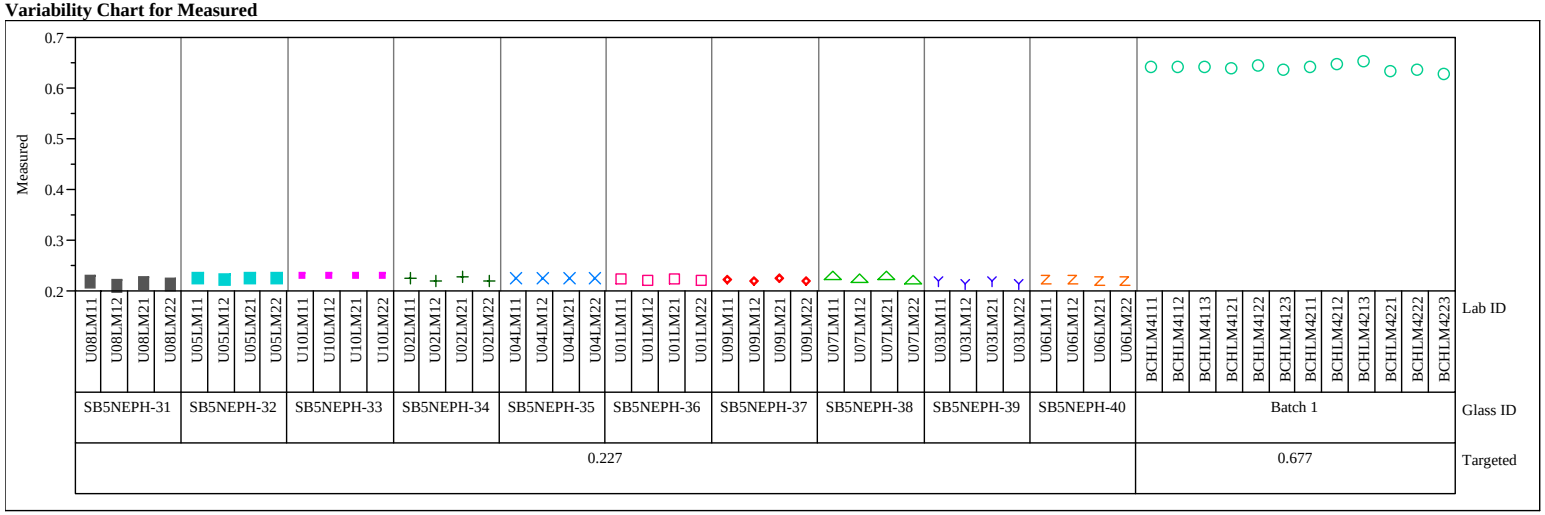


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=4, Oxide=TiO2 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

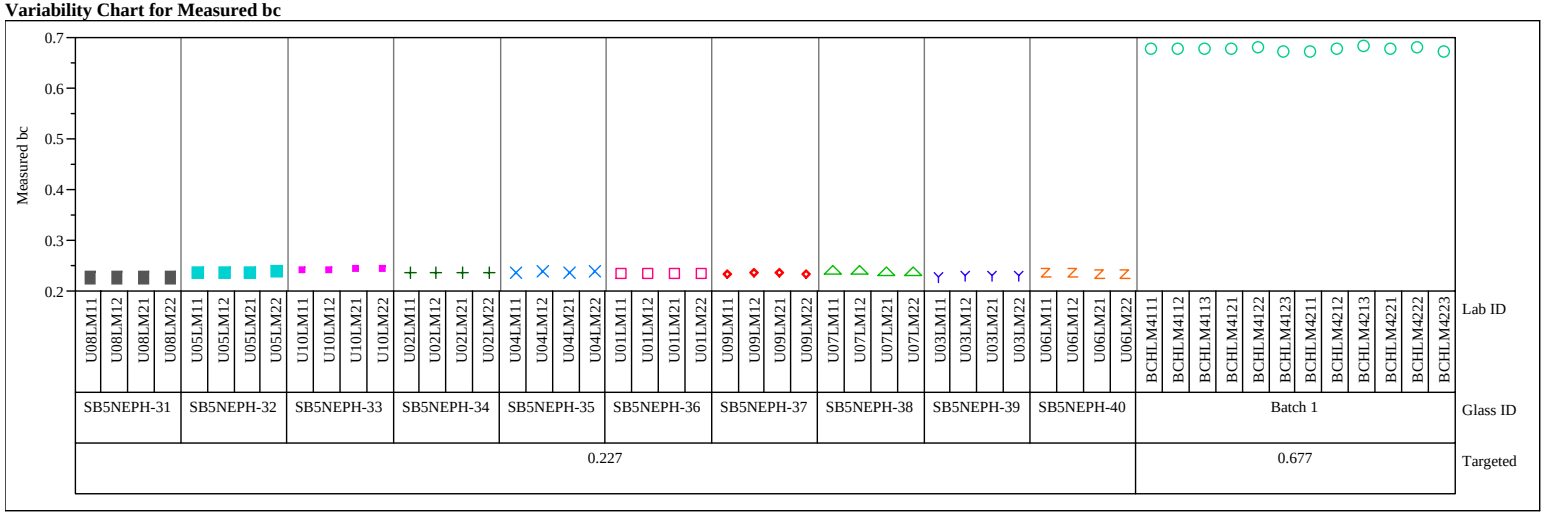
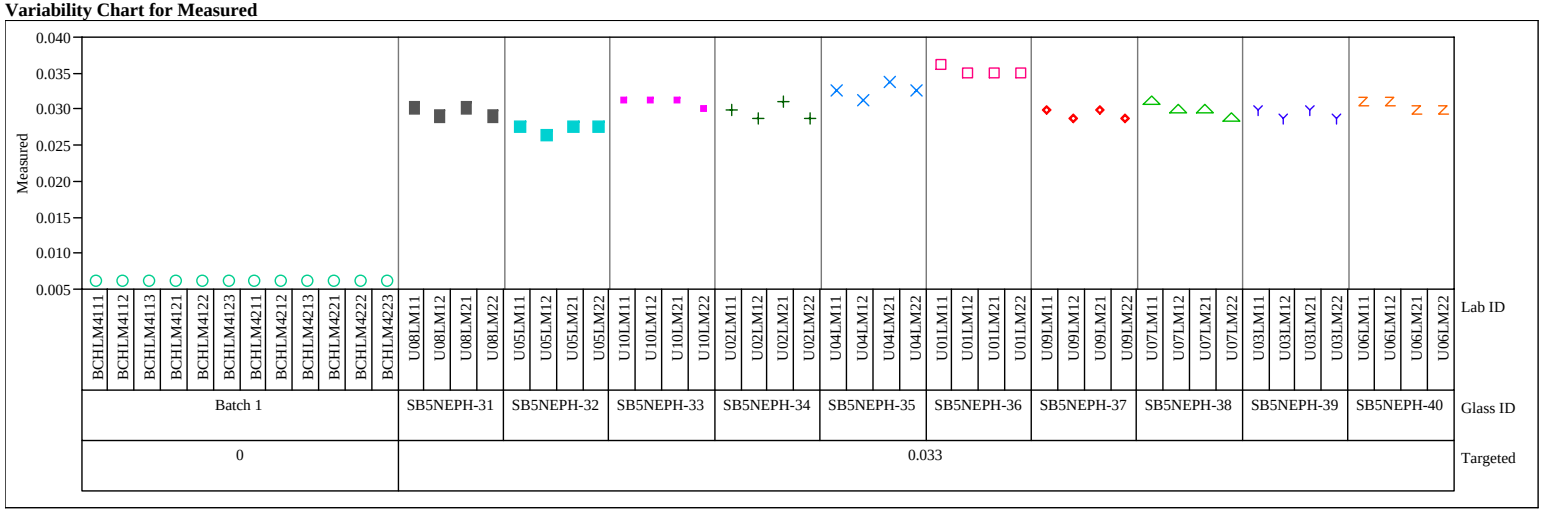


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=4, Oxide=ZnO (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

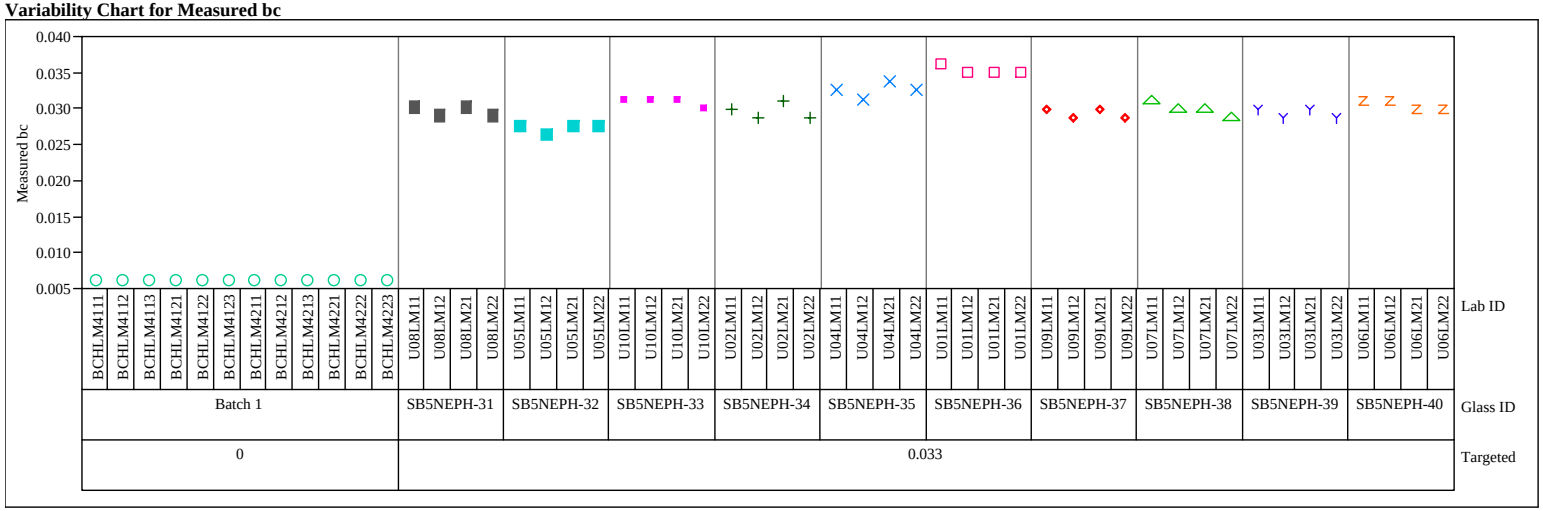
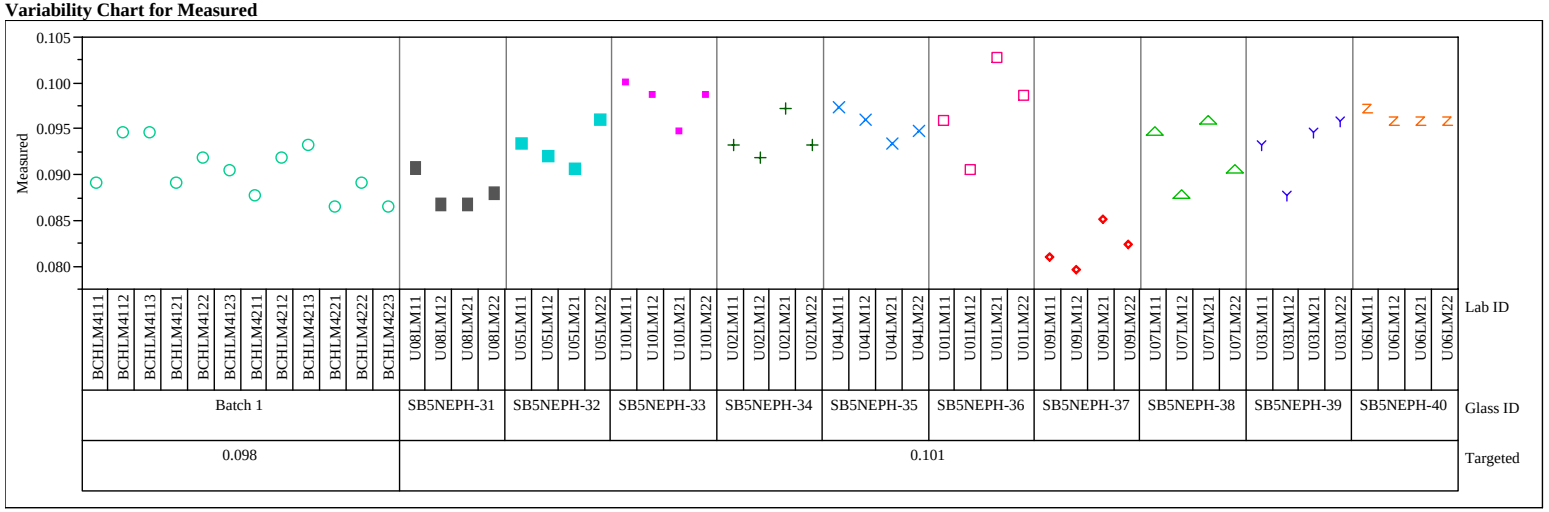


Exhibit A5. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the LM Method. (continued)

Variability Gage Set=4, Oxide=ZrO2 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

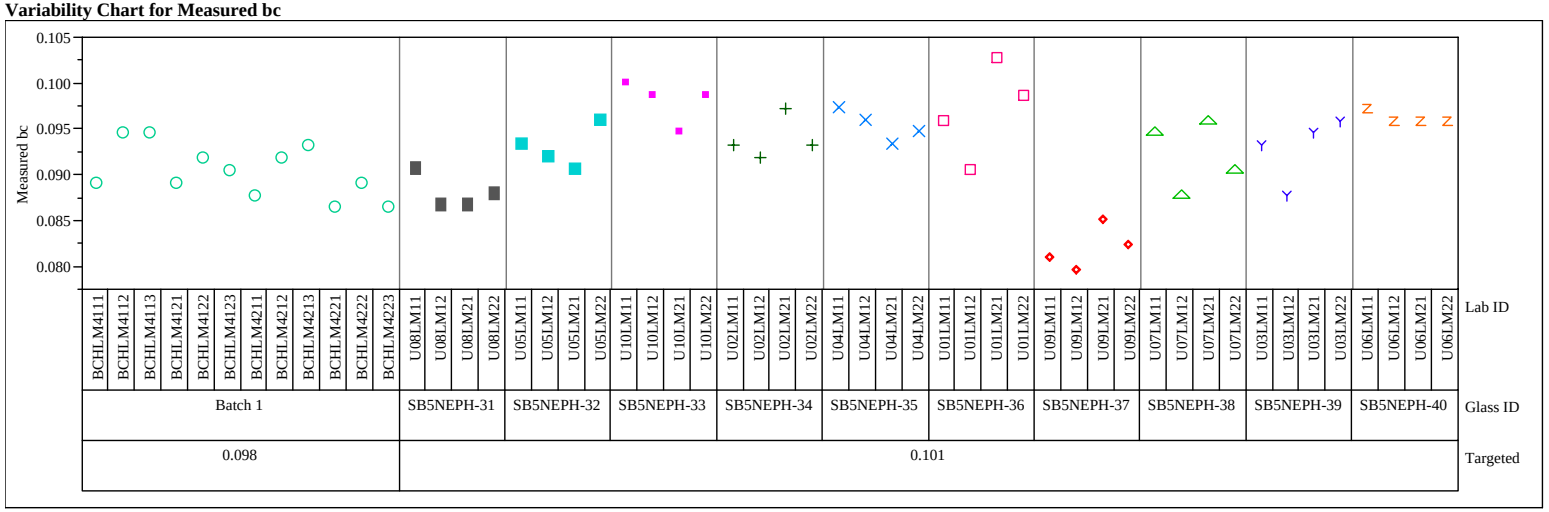
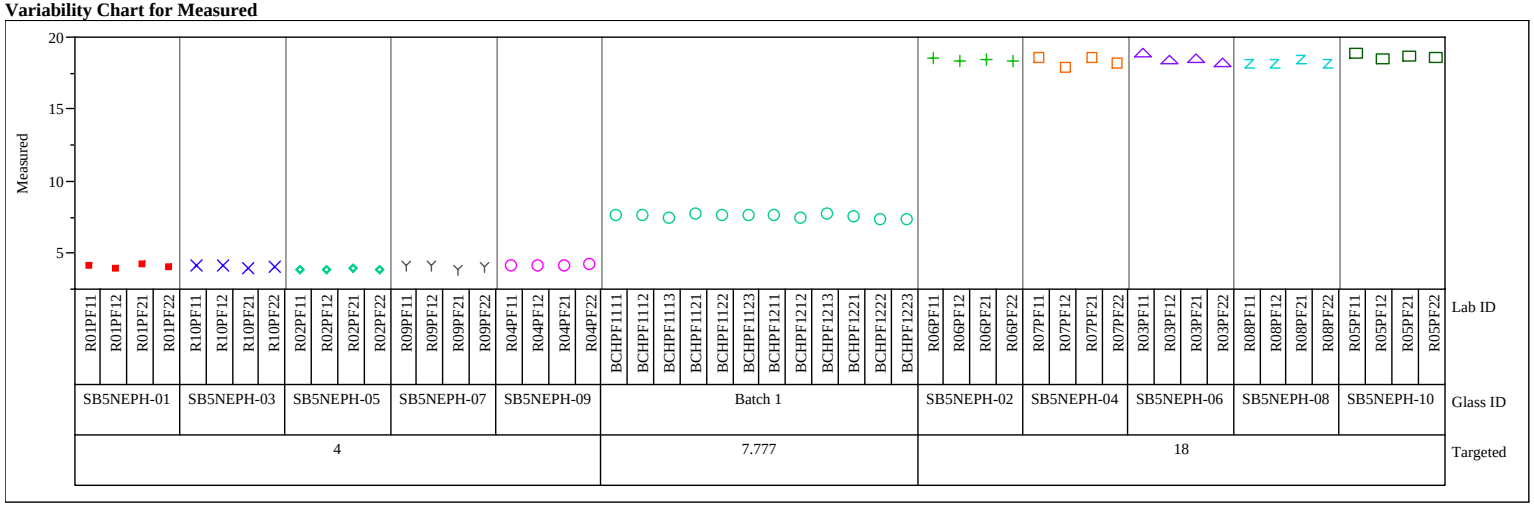


Exhibit A6. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the PF Method. (continued)

Variability Gage Set=1, Oxide=B2O3 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

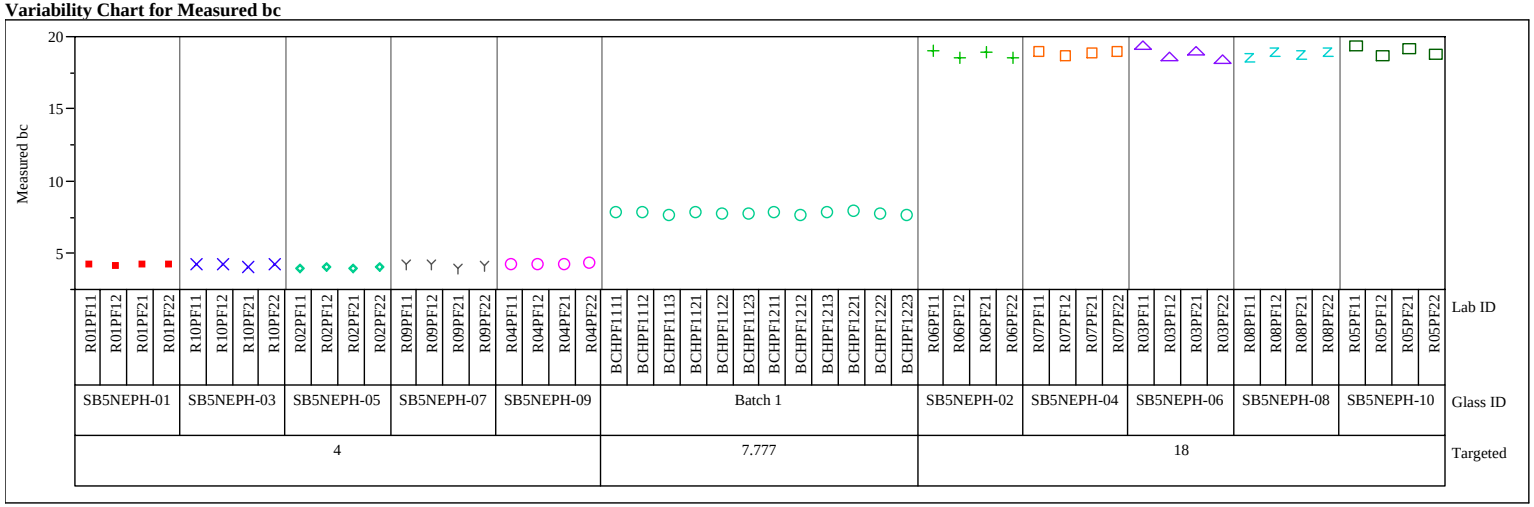
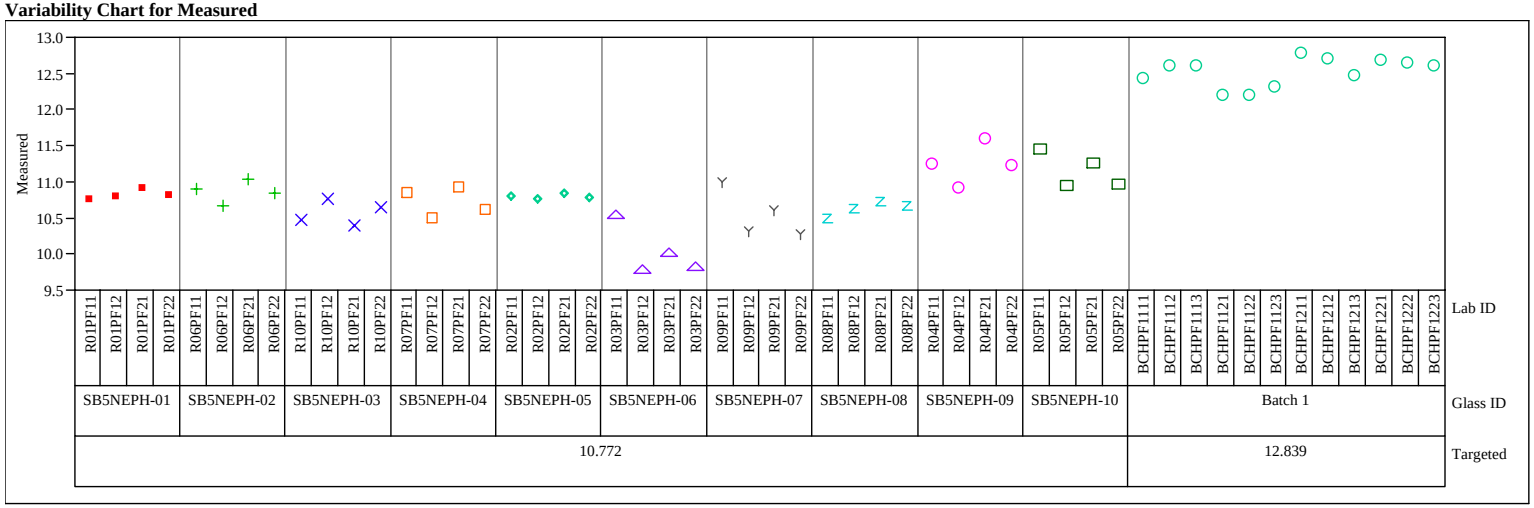


Exhibit A6. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the PF Method. (continued)

Variability Gage Set=1, Oxide=Fe2O3 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

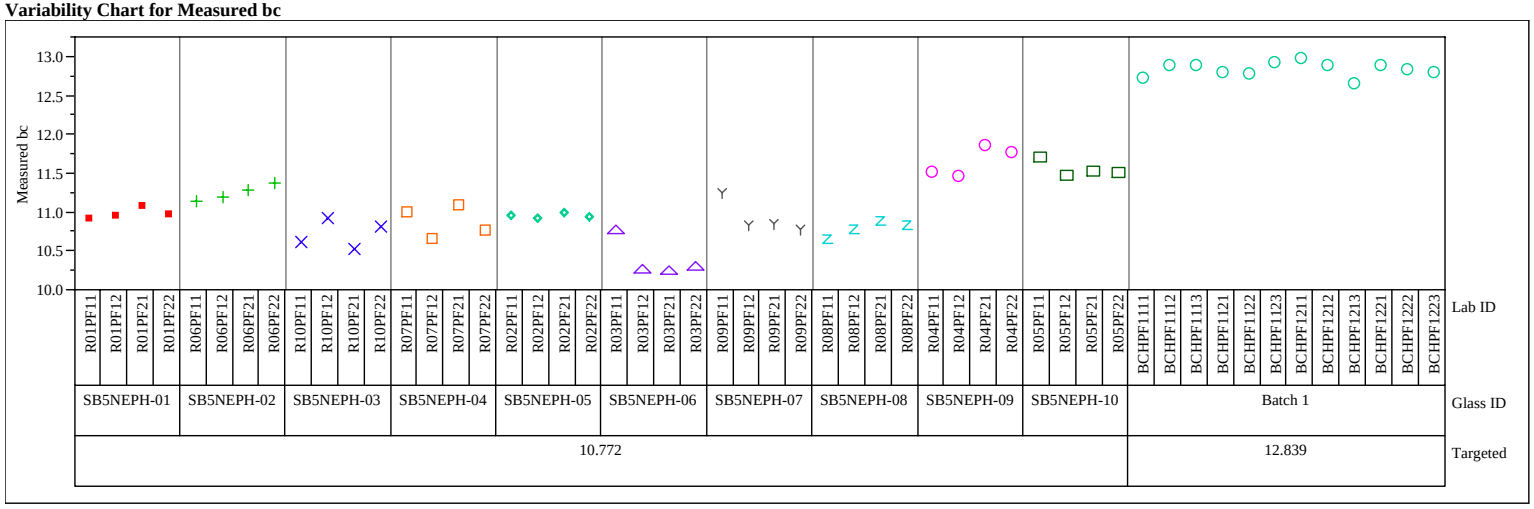
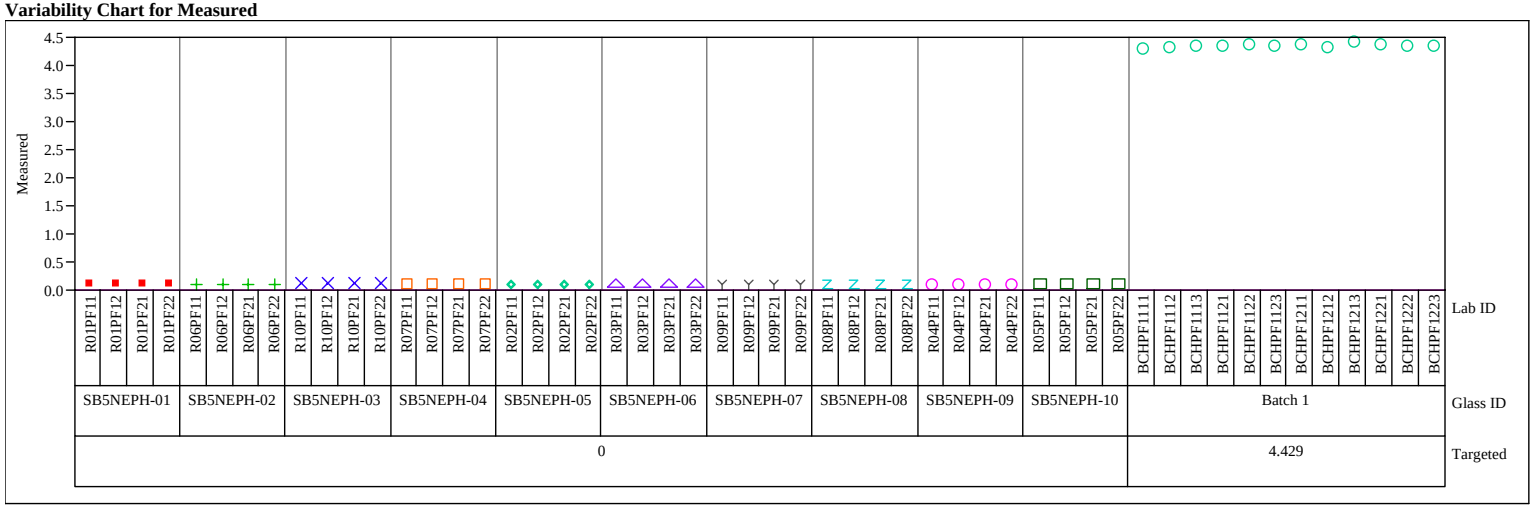


Exhibit A6. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the PF Method. (continued)

Variability Gage Set=1, Oxide=Li2O (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

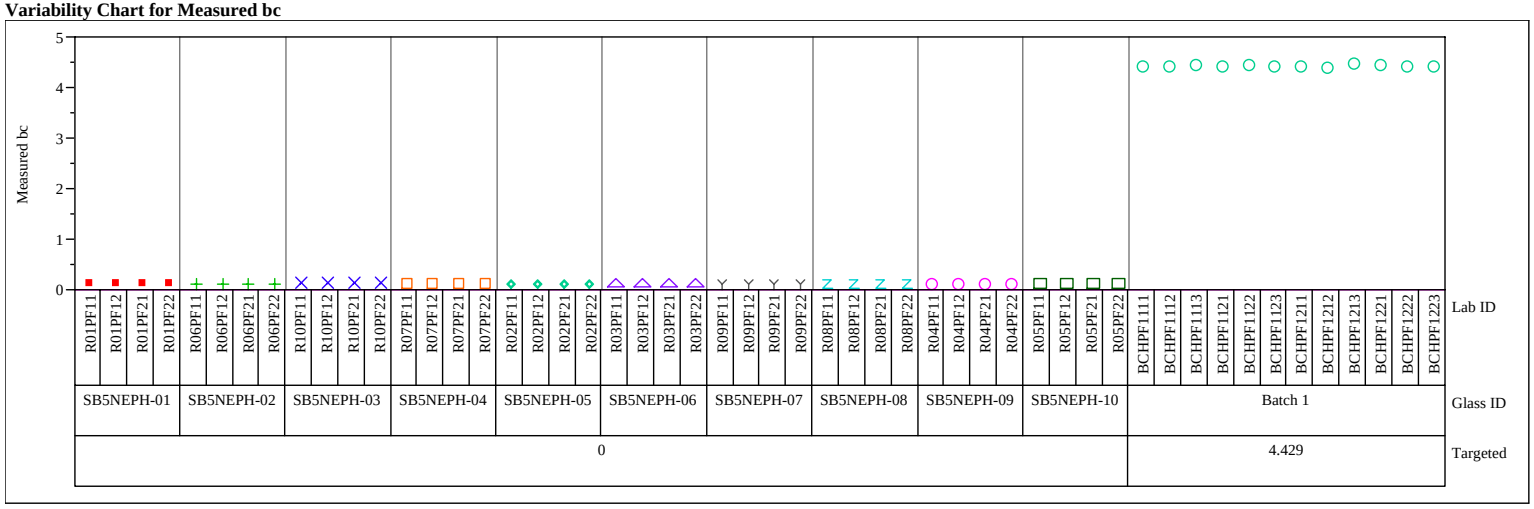
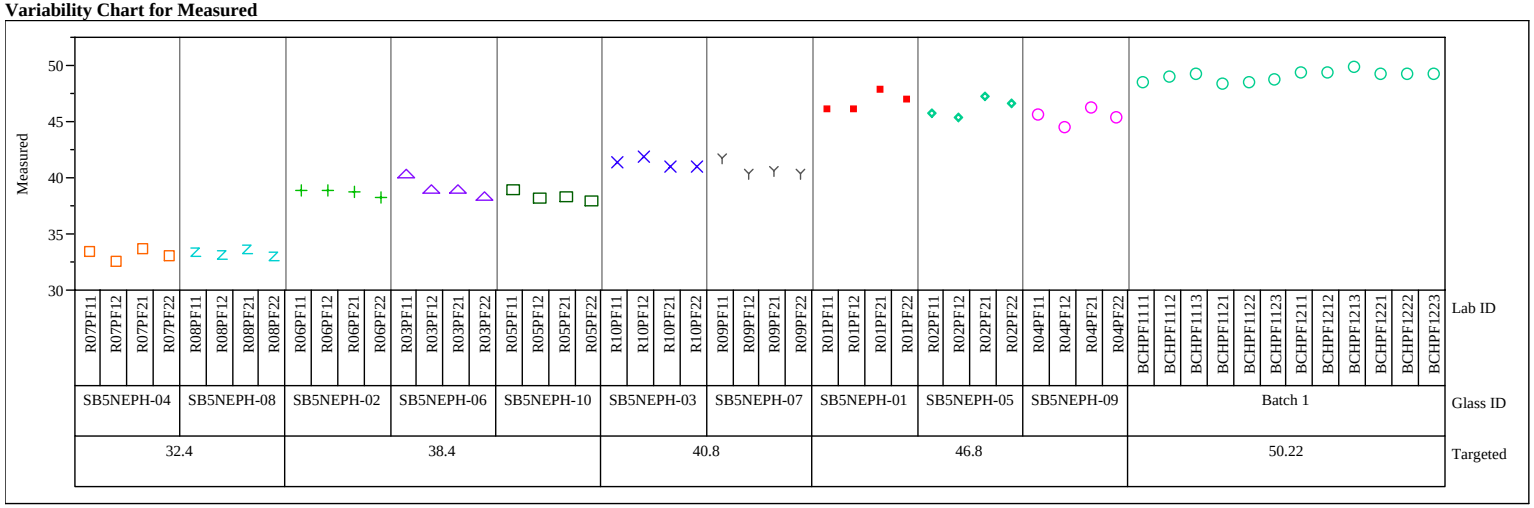


Exhibit A6. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the PF Method. (continued)

Variability Gage Set=1, Oxide=SiO2 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

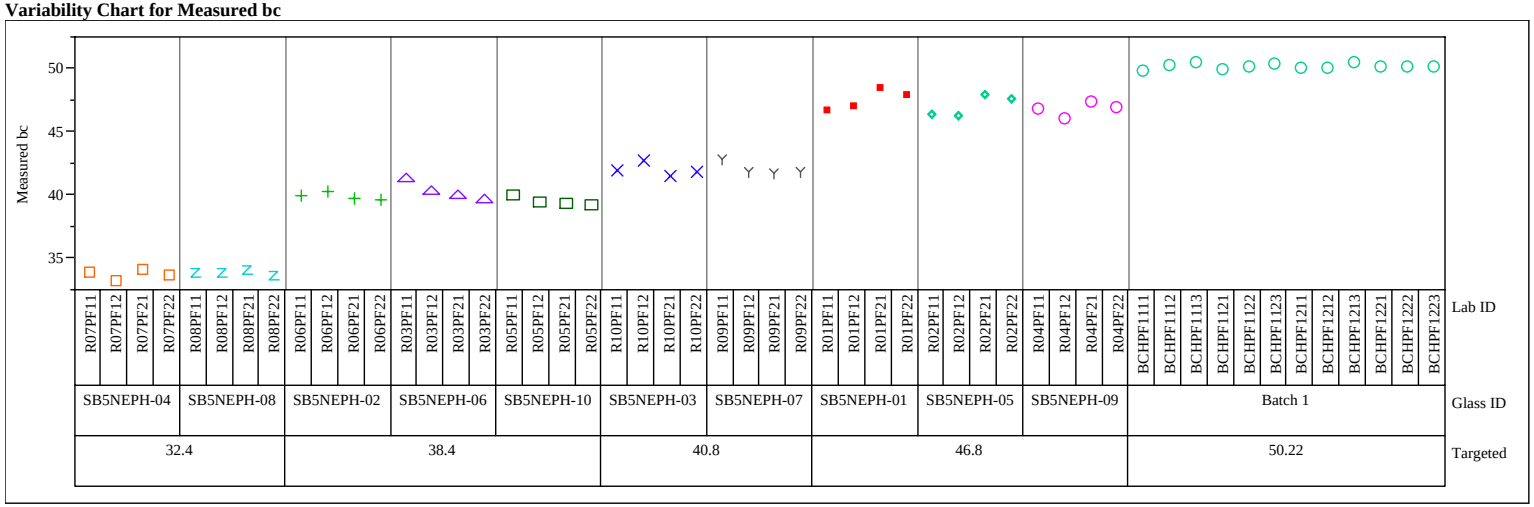
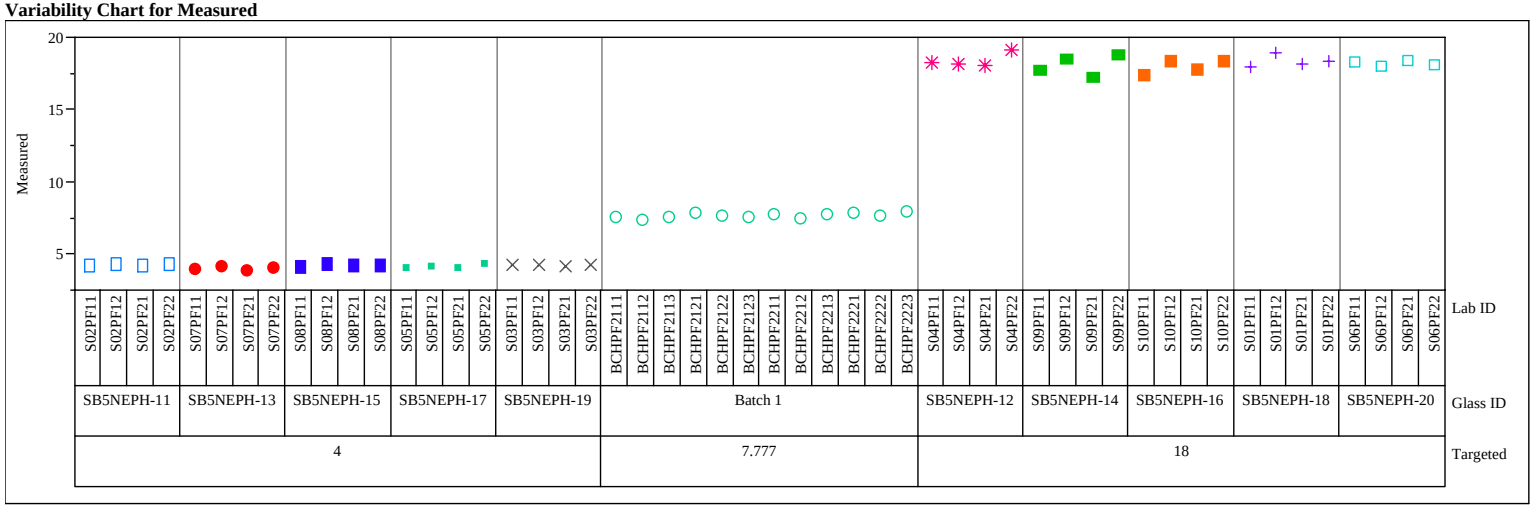


Exhibit A6. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the PF Method. (continued)

Variability Gage Set=2, Oxide=B2O3 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

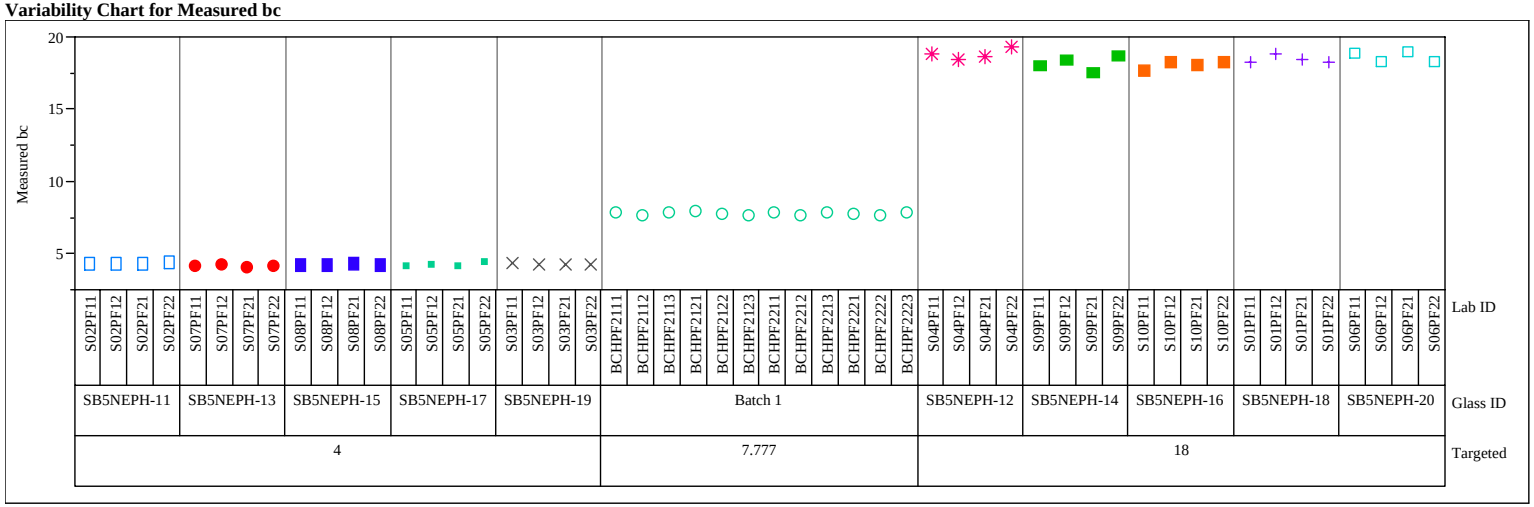
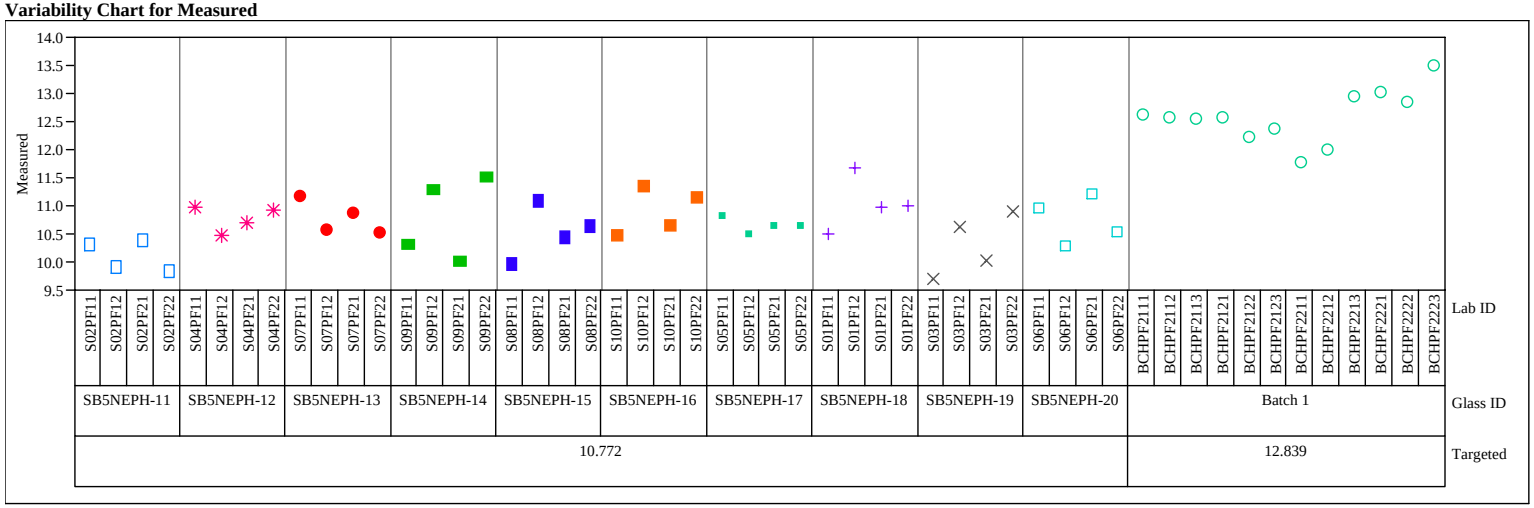


Exhibit A6. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the PF Method. (continued)

Variability Gage Set=2, Oxide=Fe2O3 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

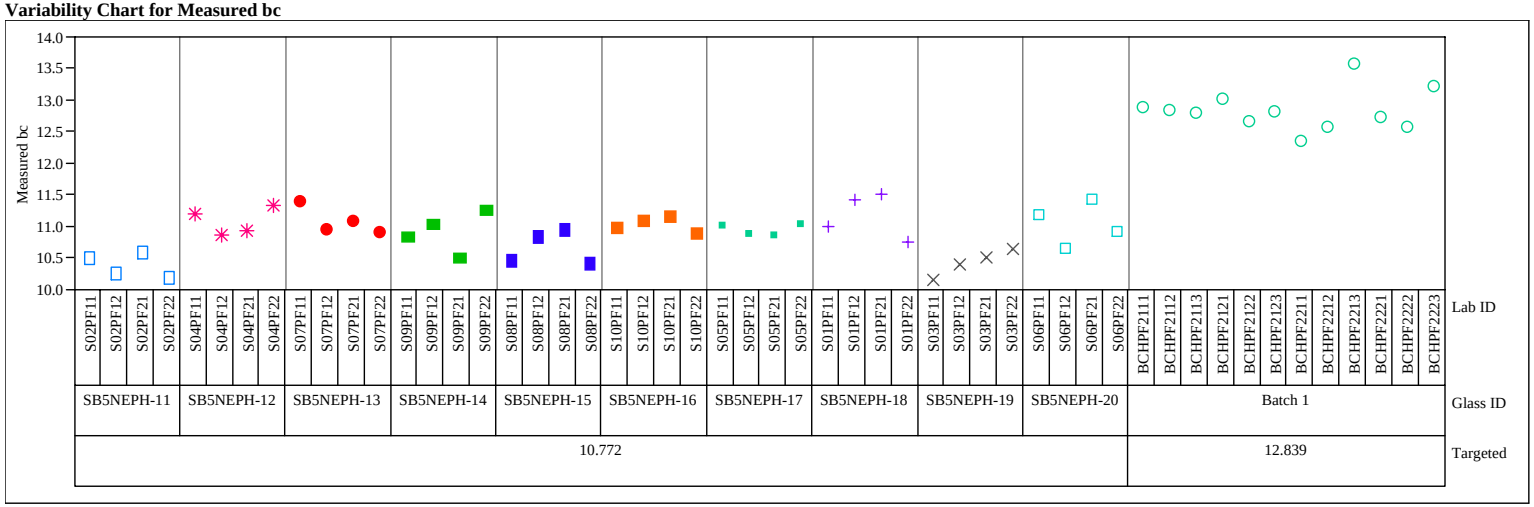
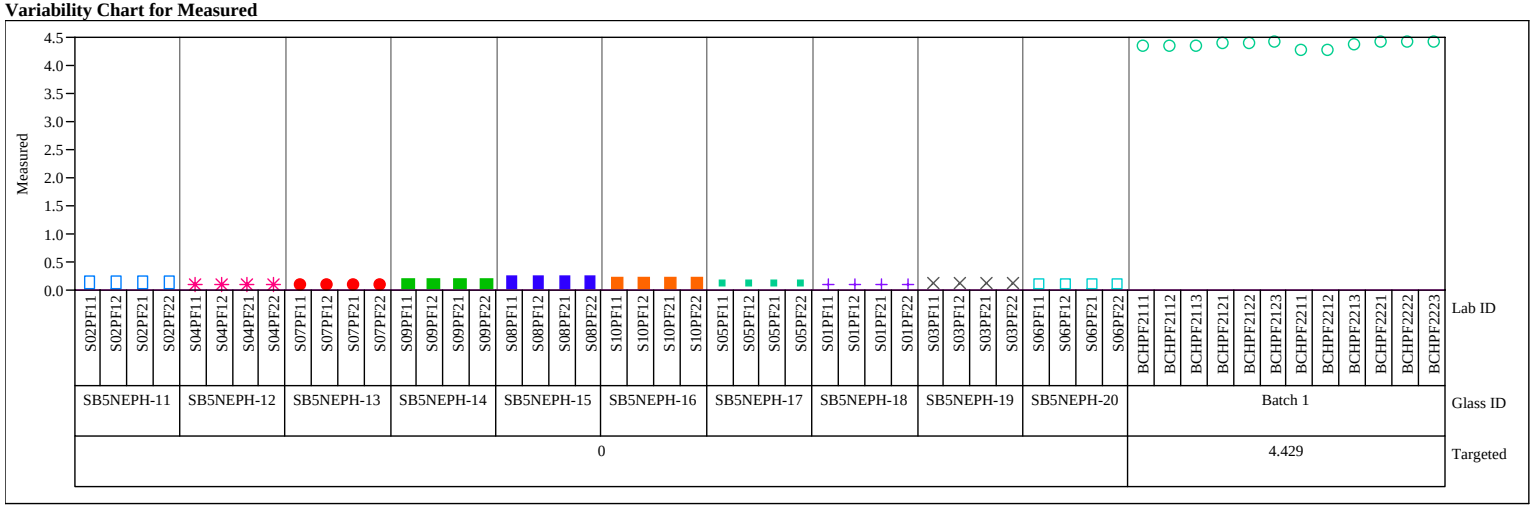


Exhibit A6. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the PF Method. (continued)

Variability Gage Set=2, Oxide=Li2O (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

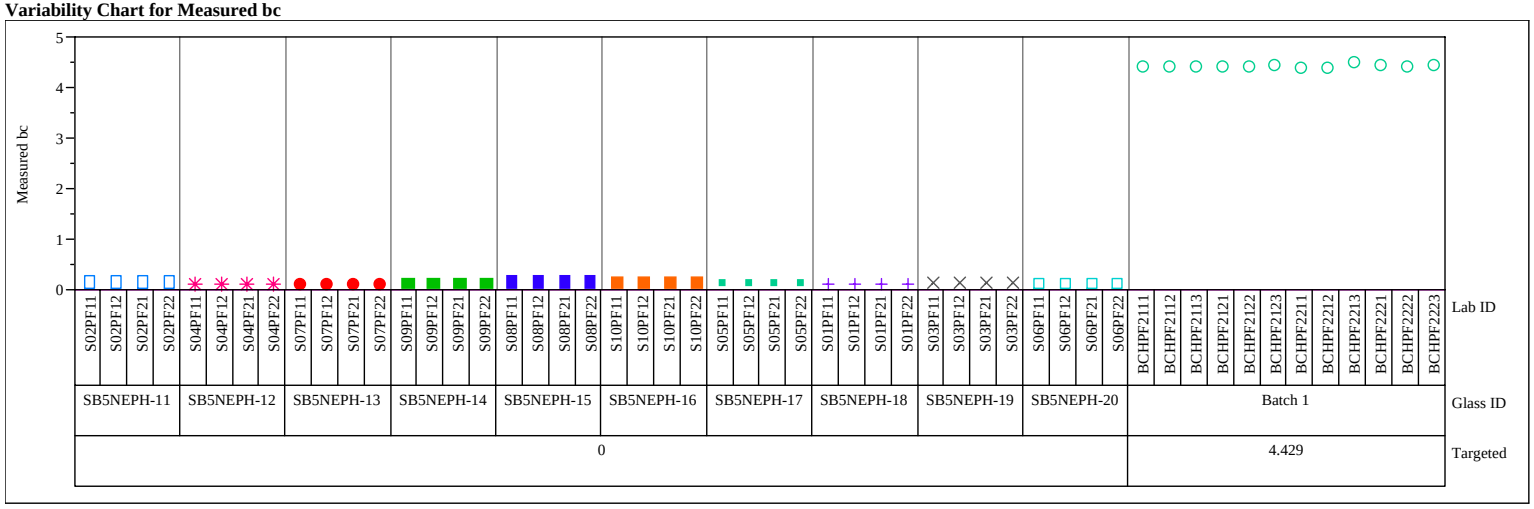
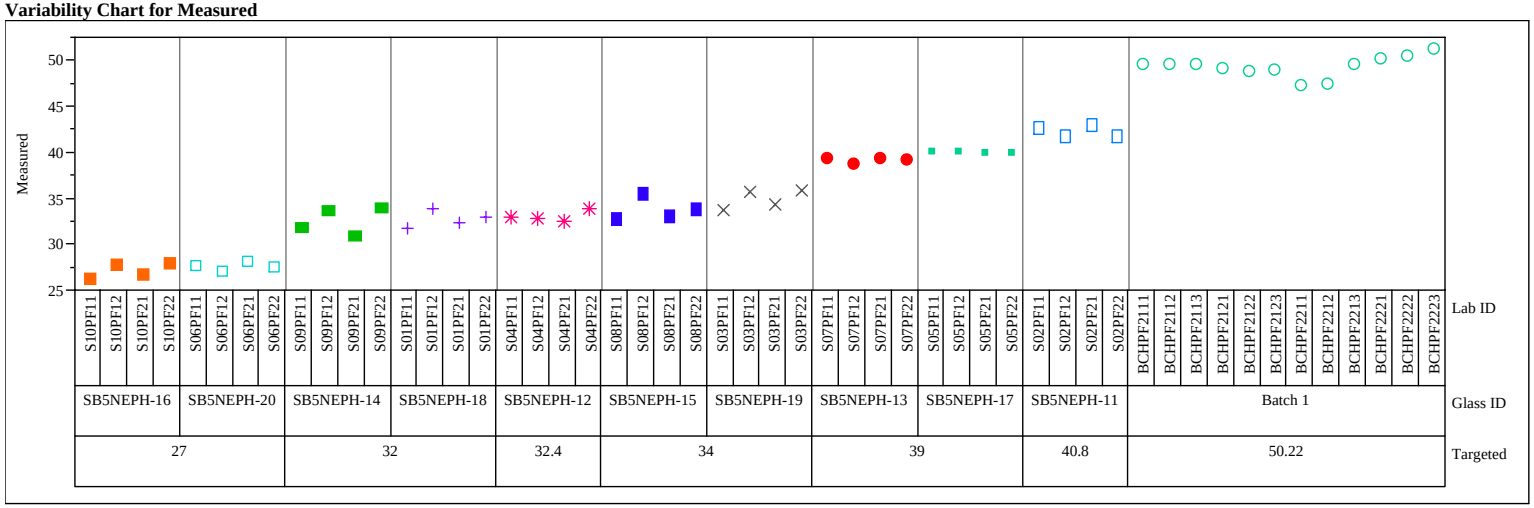


Exhibit A6. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the PF Method. (continued)

Variability Gage Set=2, Oxide=SiO2 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

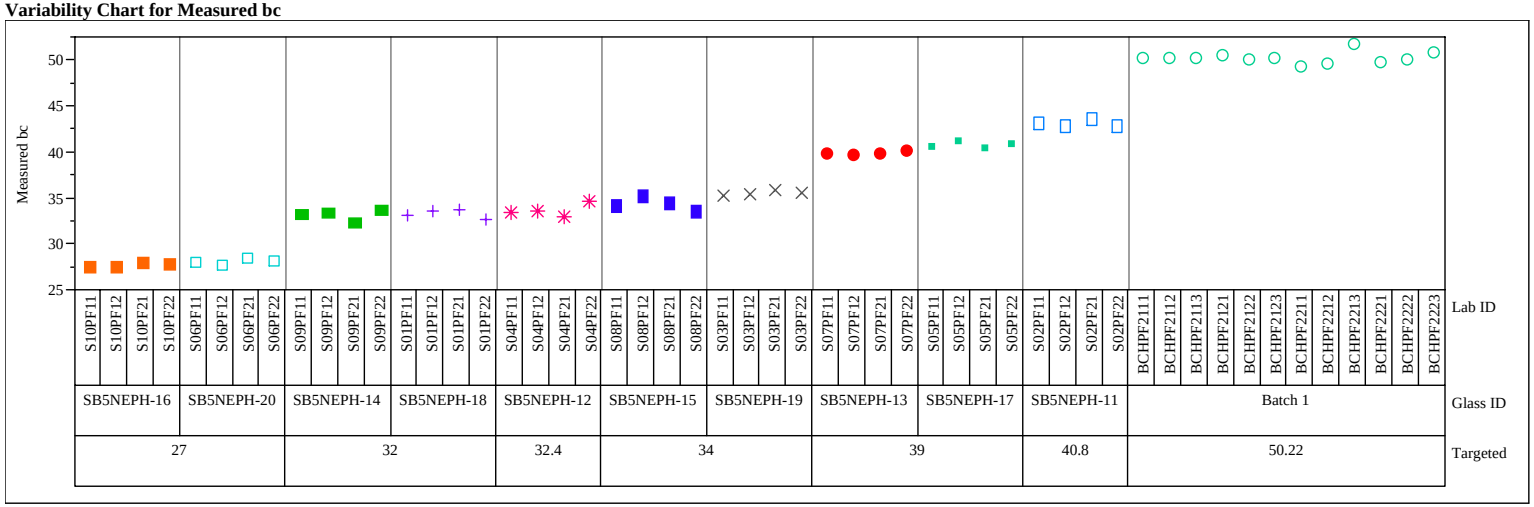
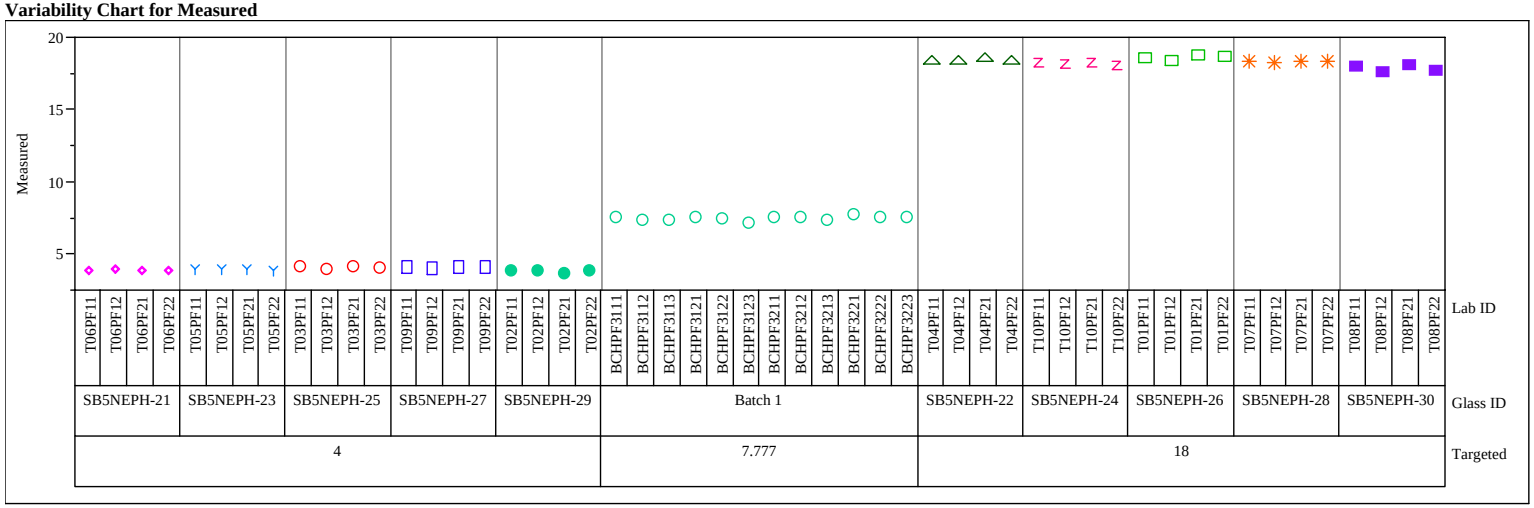


Exhibit A6. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the PF Method. (continued)

Variability Gage Set=3, Oxide=B2O3 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

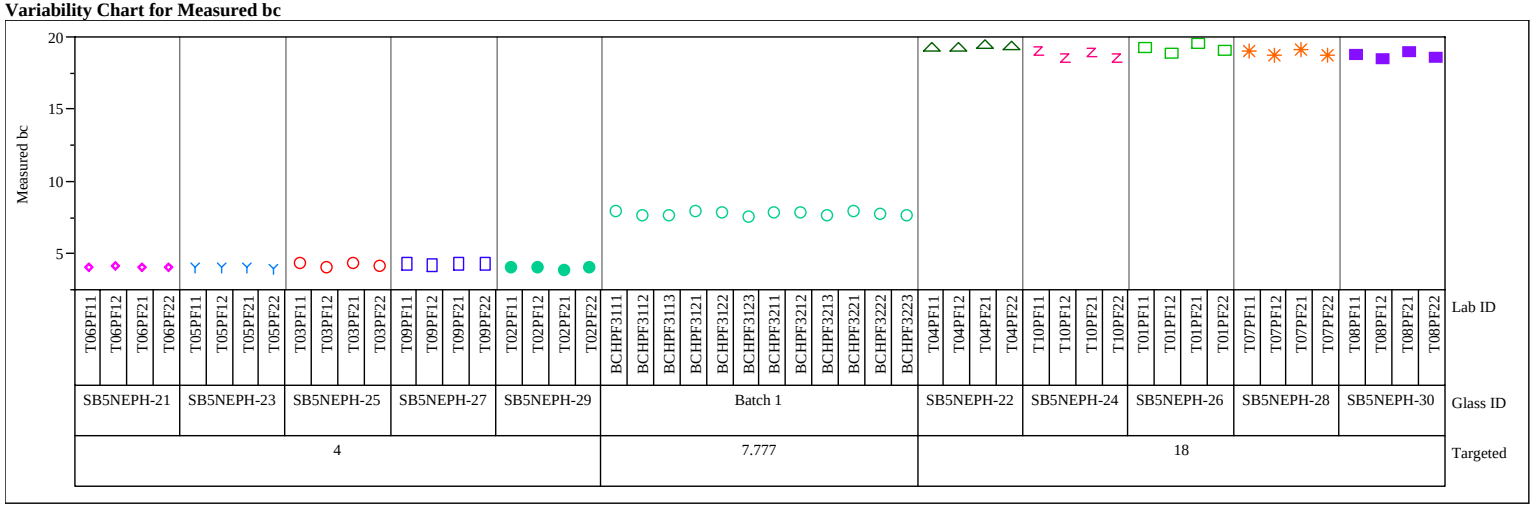
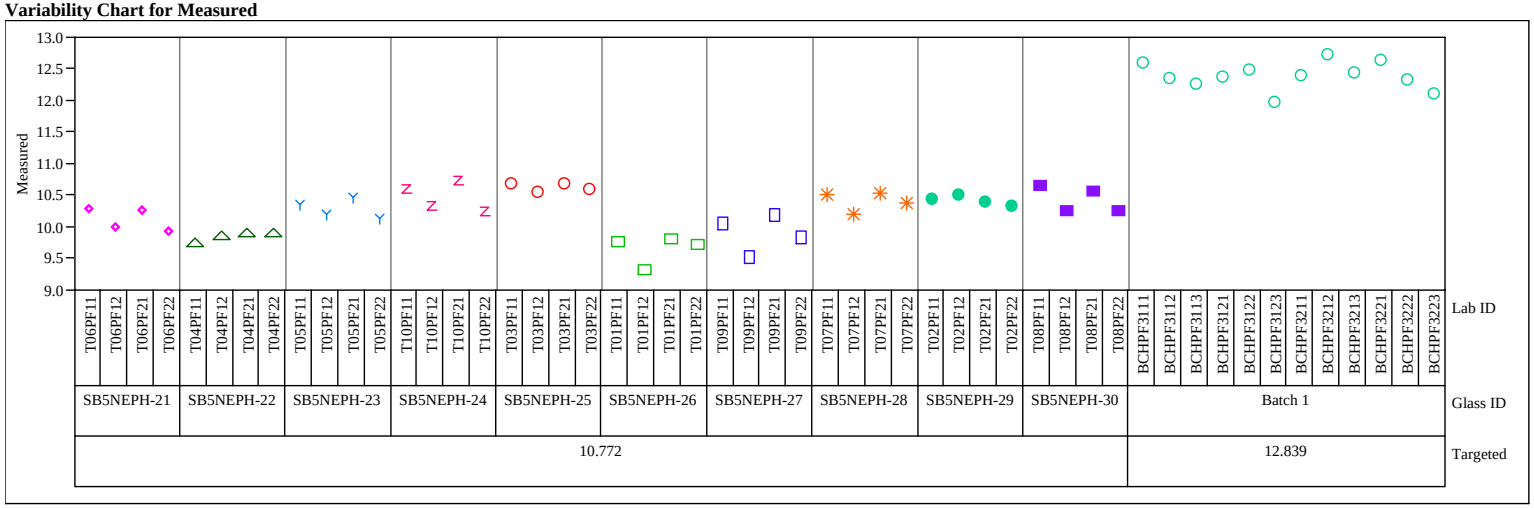


Exhibit A6. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the PF Method. (continued)

Variability Gage Set=3, Oxide=Fe2O3 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

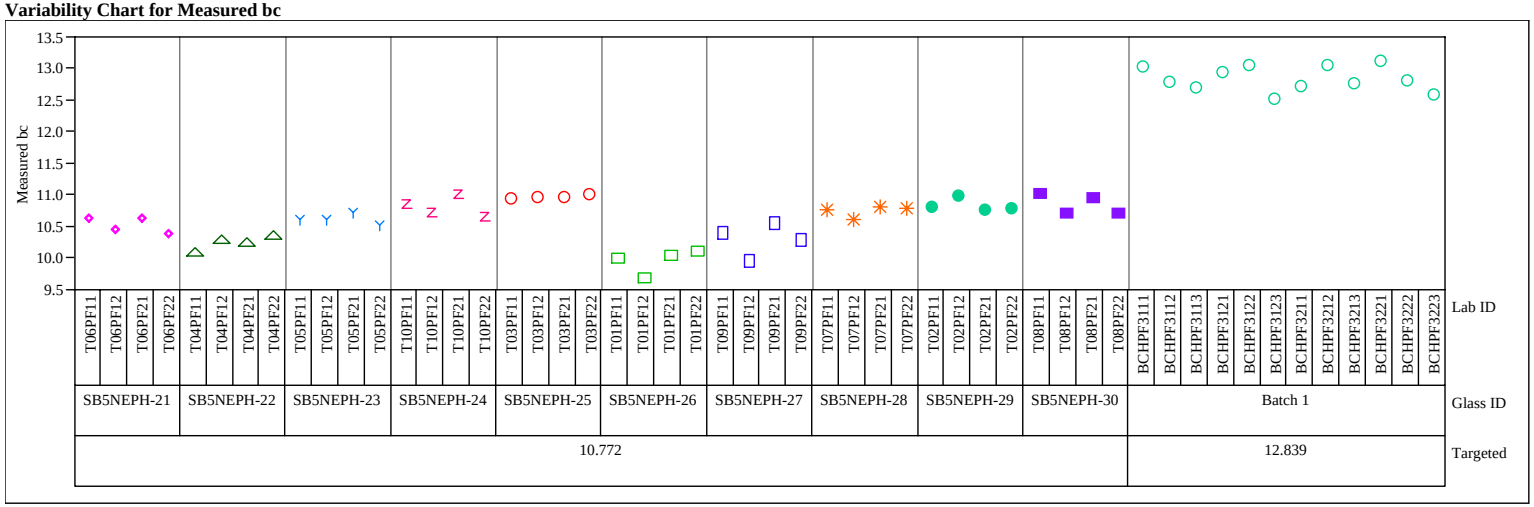
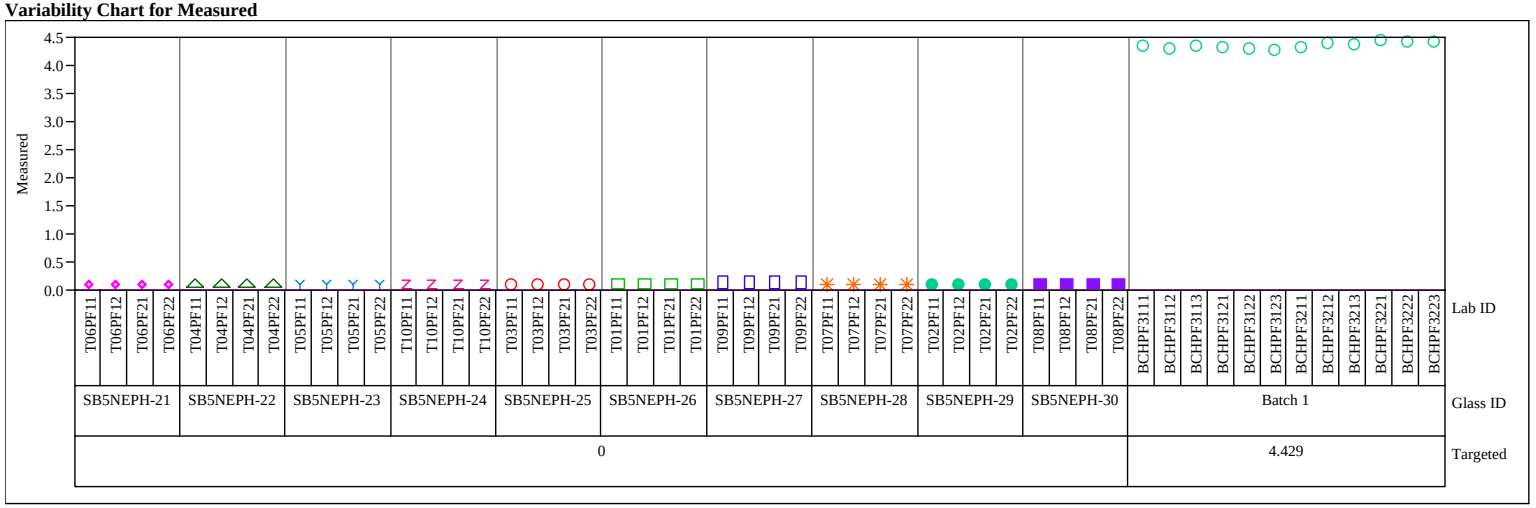


Exhibit A6. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the PF Method. (continued)

Variability Gage Set=3, Oxide=Li2O (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

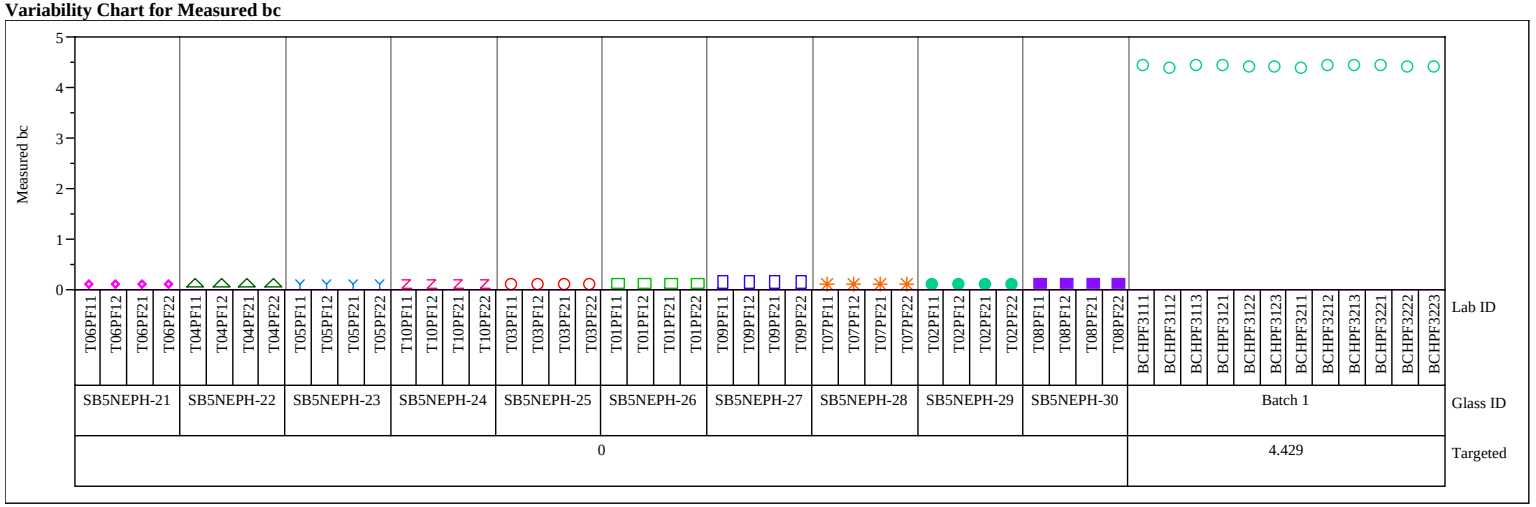
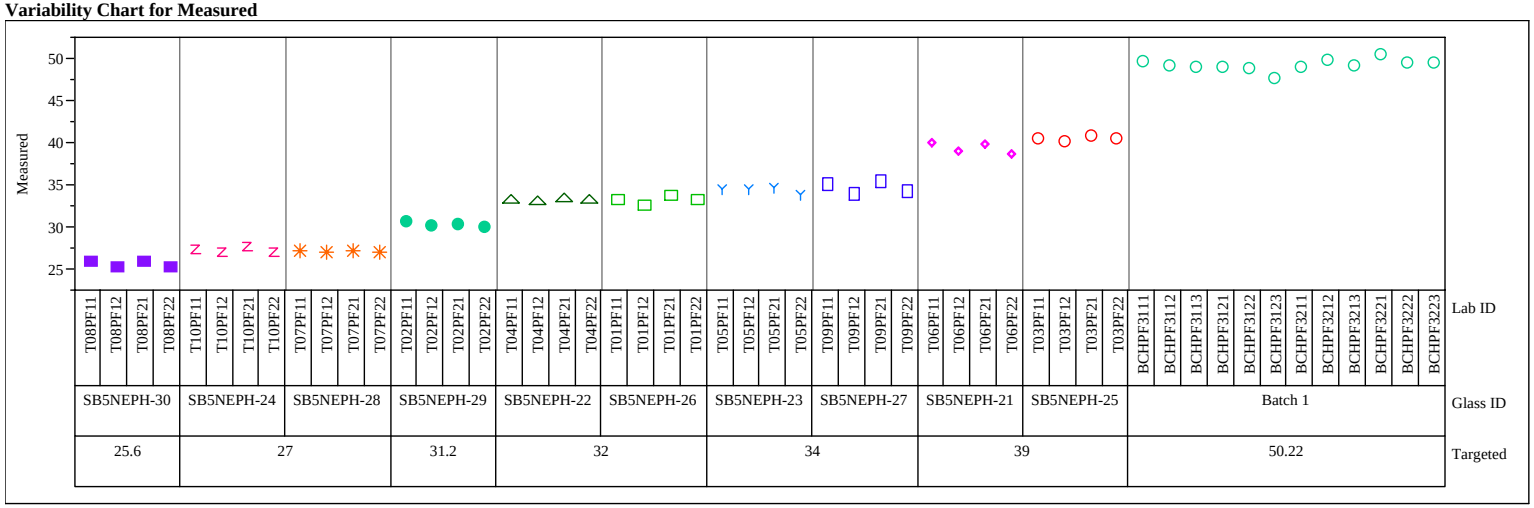


Exhibit A6. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the PF Method. (continued)

Variability Gage Set=3, Oxide=SiO2 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

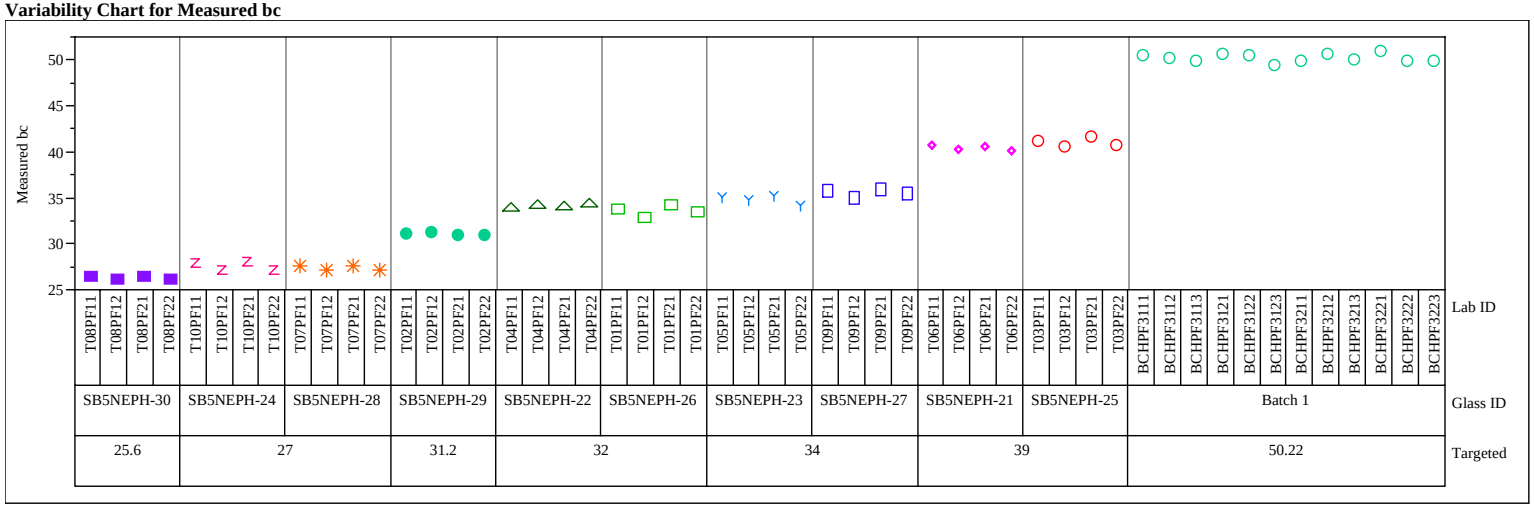
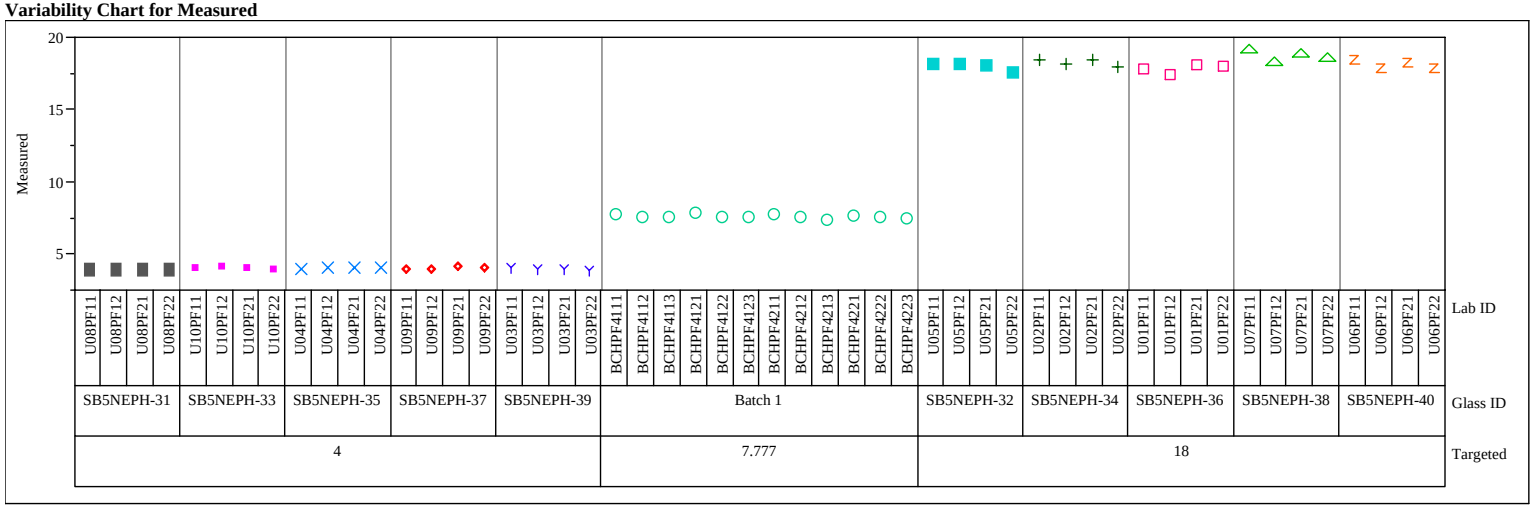


Exhibit A6. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the PF Method. (continued)

Variability Gage Set=4, Oxide=B2O3 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

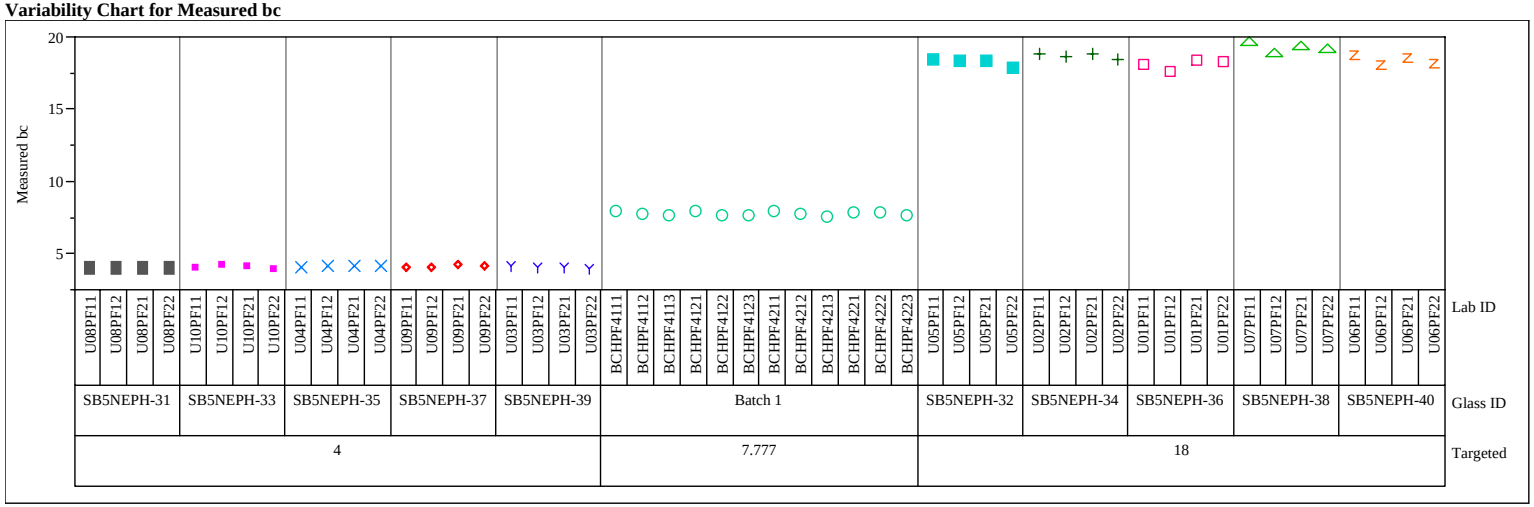
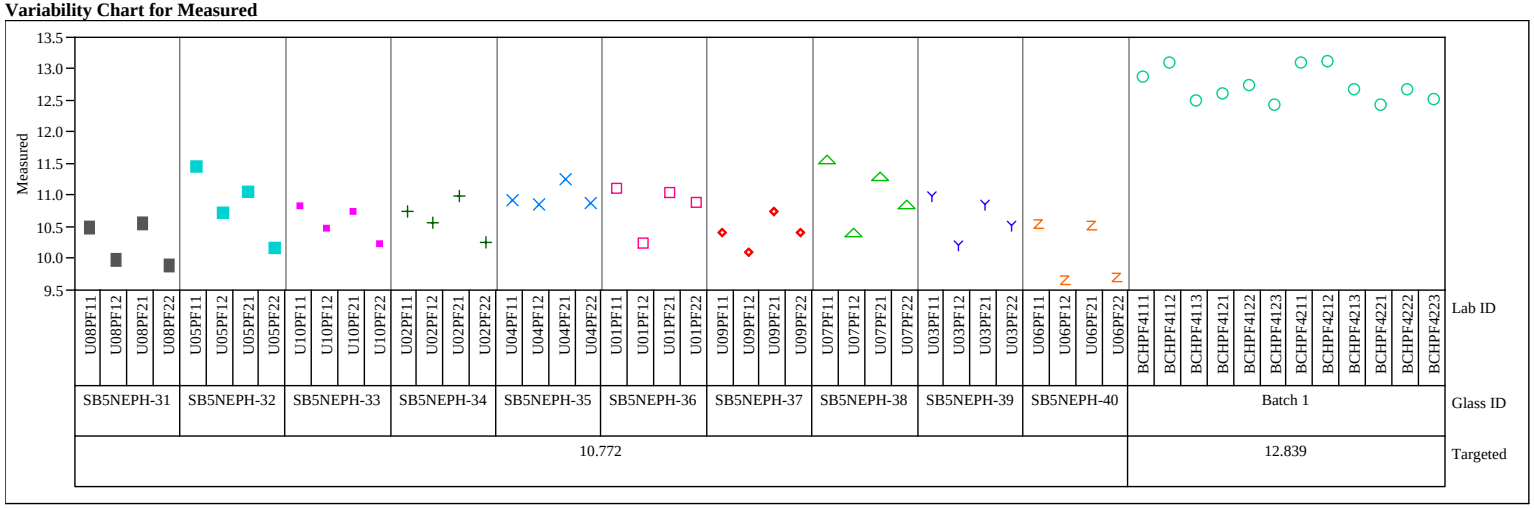


Exhibit A6. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the PF Method. (continued)

Variability Gage Set=4, Oxide=Fe2O3 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

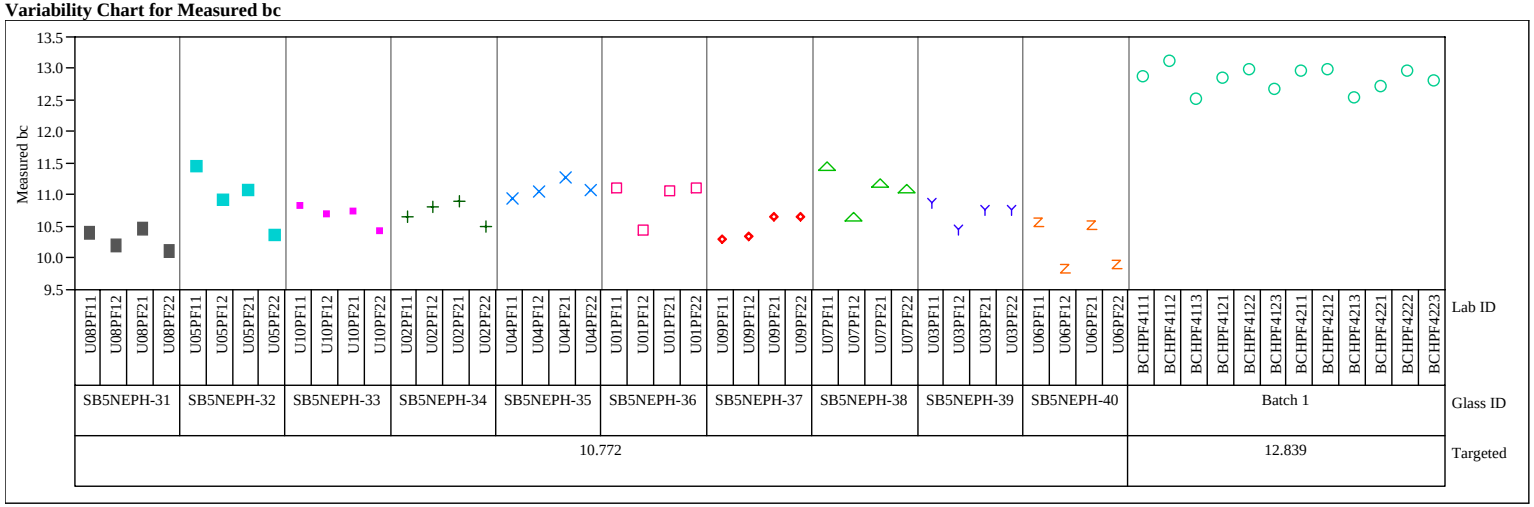
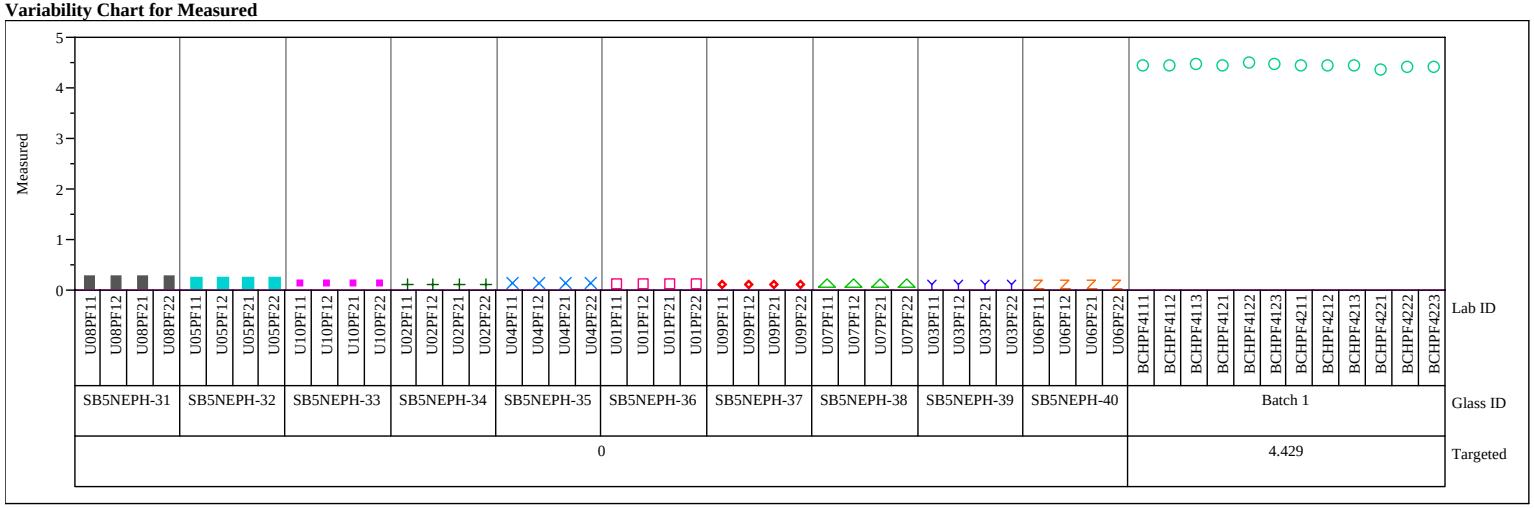


Exhibit A6. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the PF Method. (continued)

Variability Gage Set=4, Oxide=Li2O (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

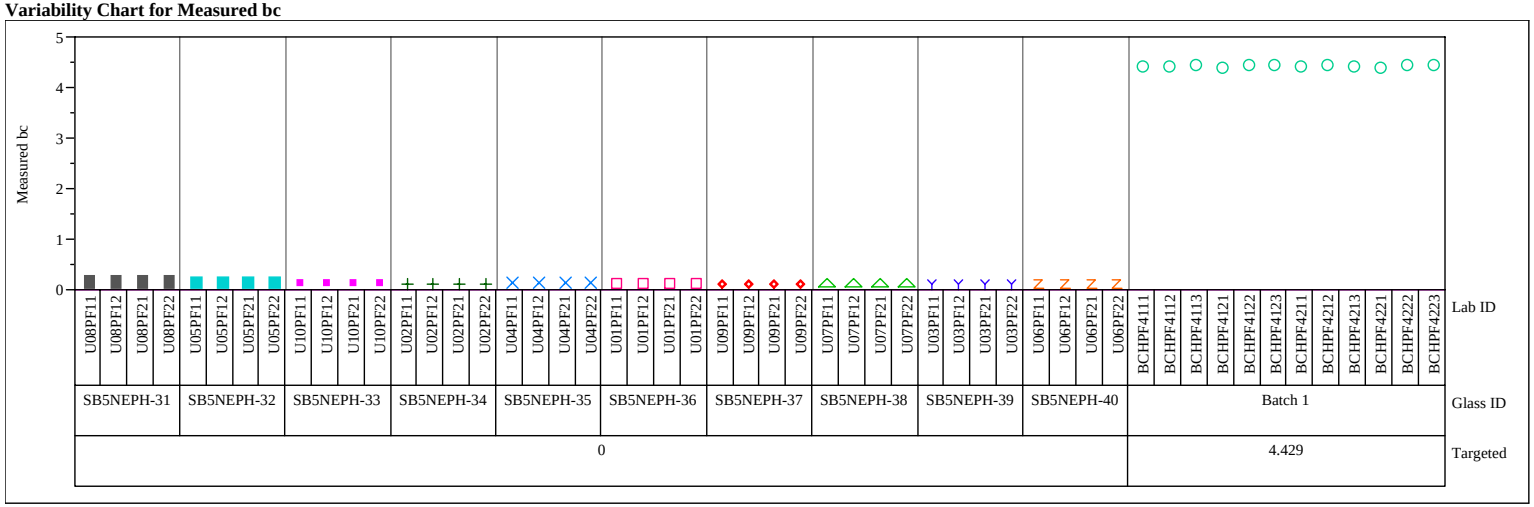
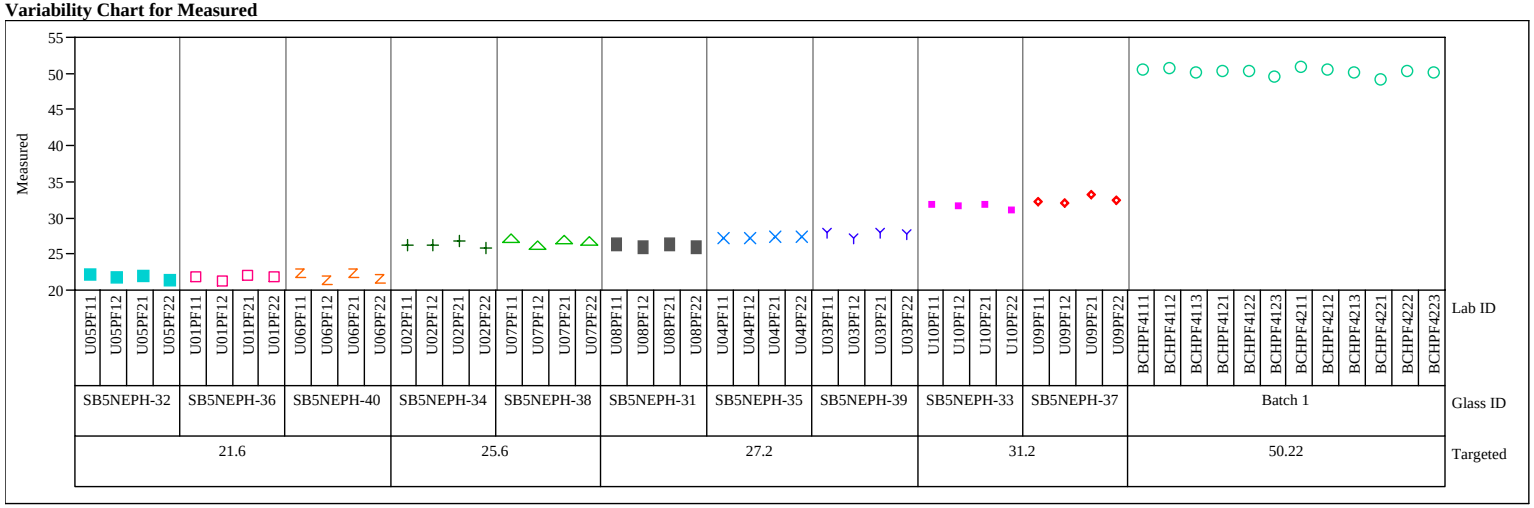


Exhibit A6. Measured and Measured Bias-Corrected Oxide Weight Percents by Lab ID within Glass ID for the Glasses Prepared Using the PF Method. (continued)

Variability Gage Set=4, Oxide=SiO2 (wt%)
Variability Chart for Measured



Variability Chart for Measured bc

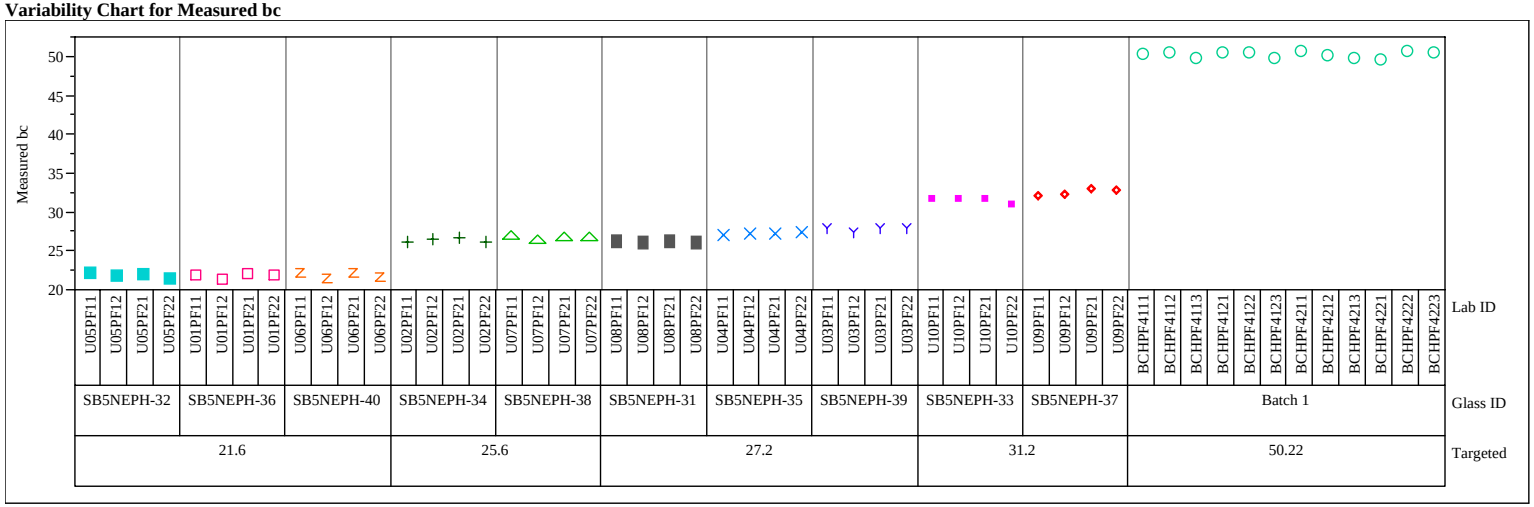
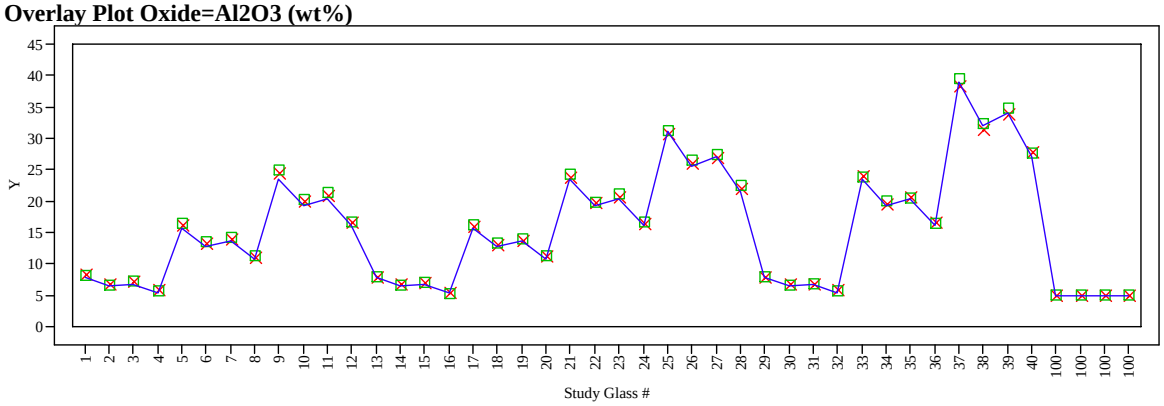
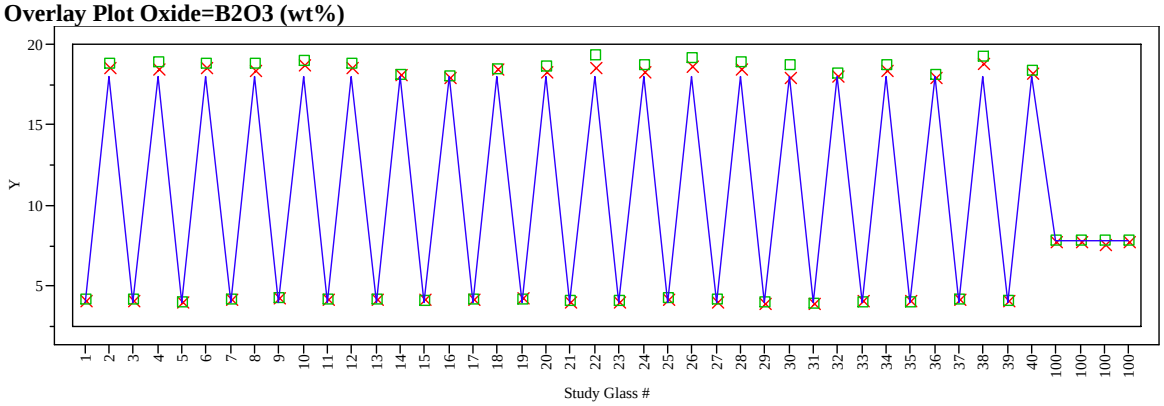


Exhibit A7. Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide. (continued)
(100 – Batch 1 for Sets 1, 2, 3, and 4)

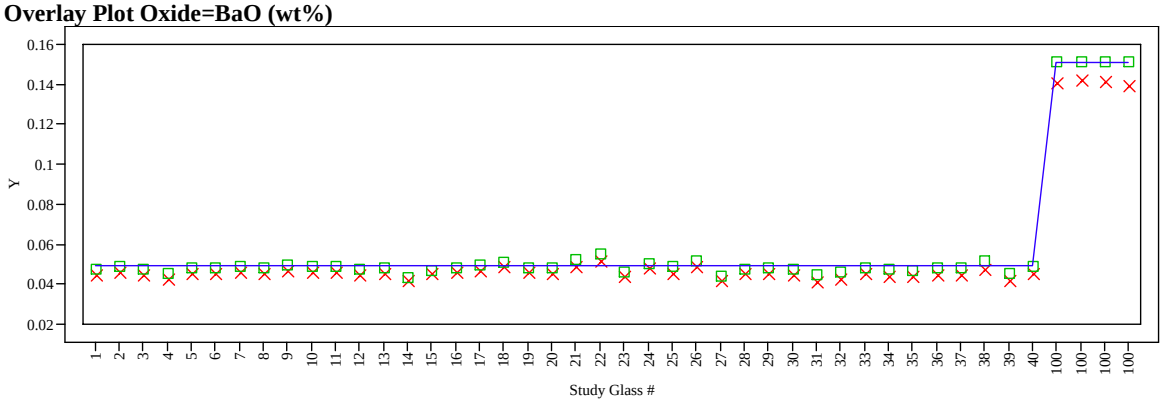
Overlay Plot Oxide=Al2O3 (wt%)



Overlay Plot Oxide=B2O3 (wt%)



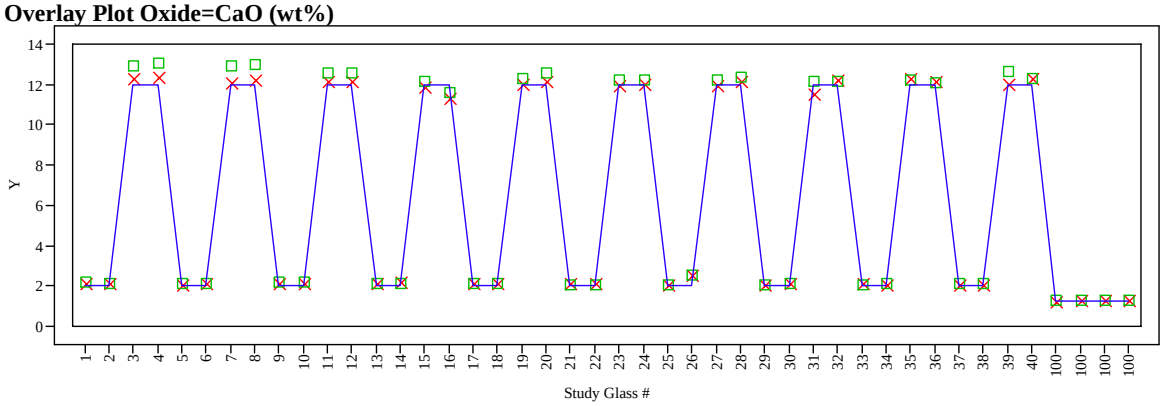
Overlay Plot Oxide=BaO (wt%)



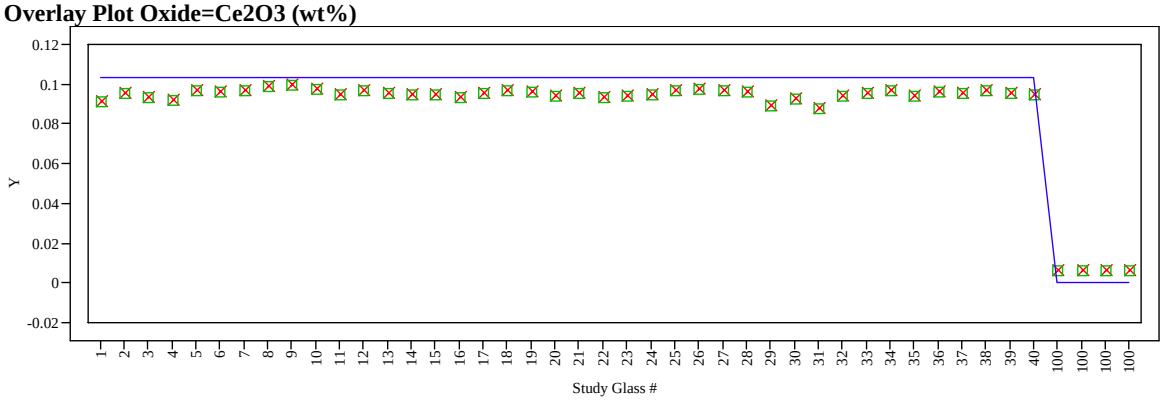
Y Measured Measured bc Targeted

Exhibit A7. Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide. (continued)
(100 – Batch 1 for Sets 1, 2, 3, and 4)

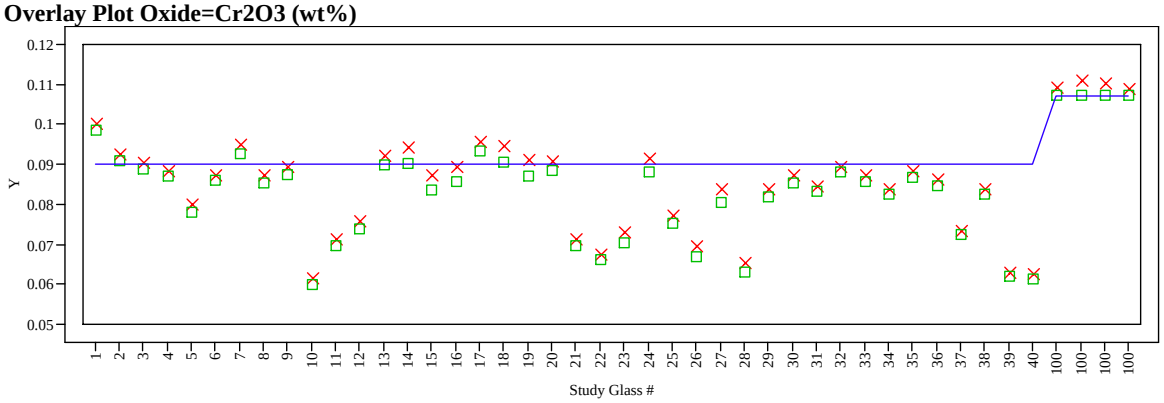
Overlay Plot Oxide=CaO (wt%)



Overlay Plot Oxide=Ce2O3 (wt%)



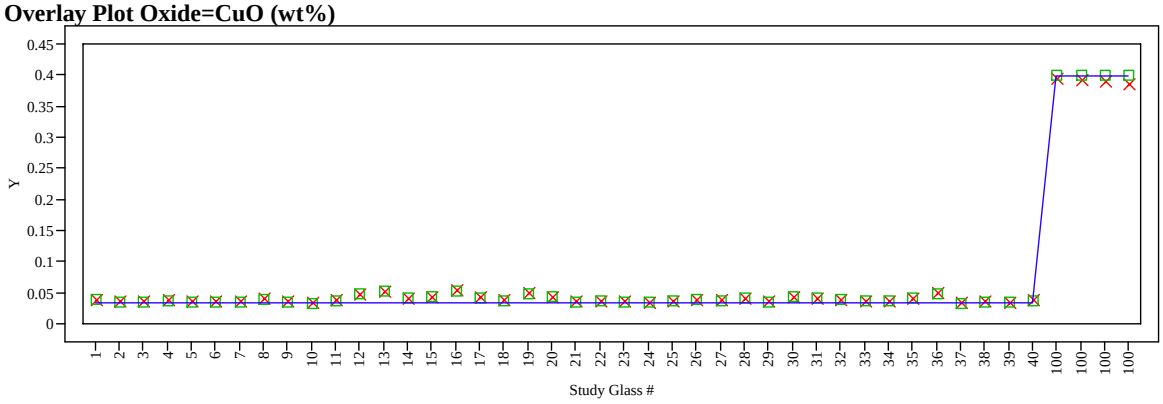
Overlay Plot Oxide=Cr2O3 (wt%)



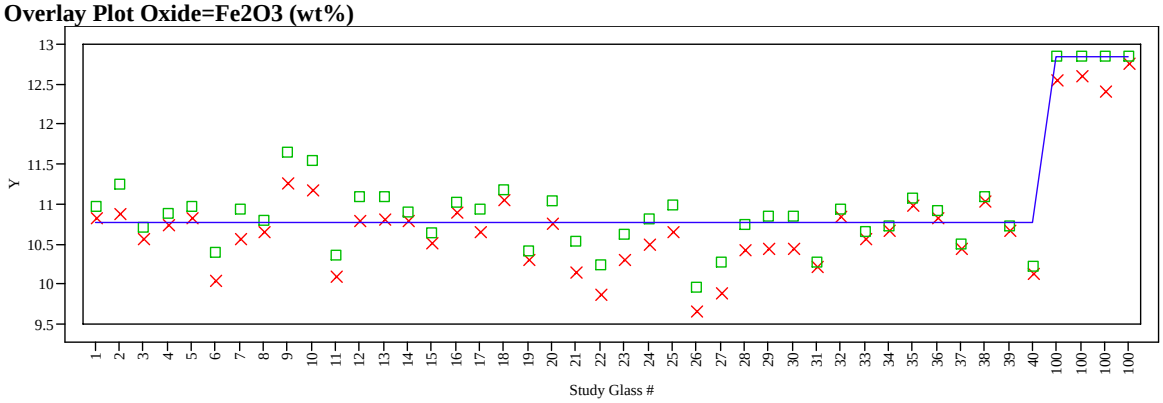
Y Measured Measured bc Targeted

Exhibit A7. Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide. (continued)
(100 – Batch 1 for Sets 1, 2, 3, and 4)

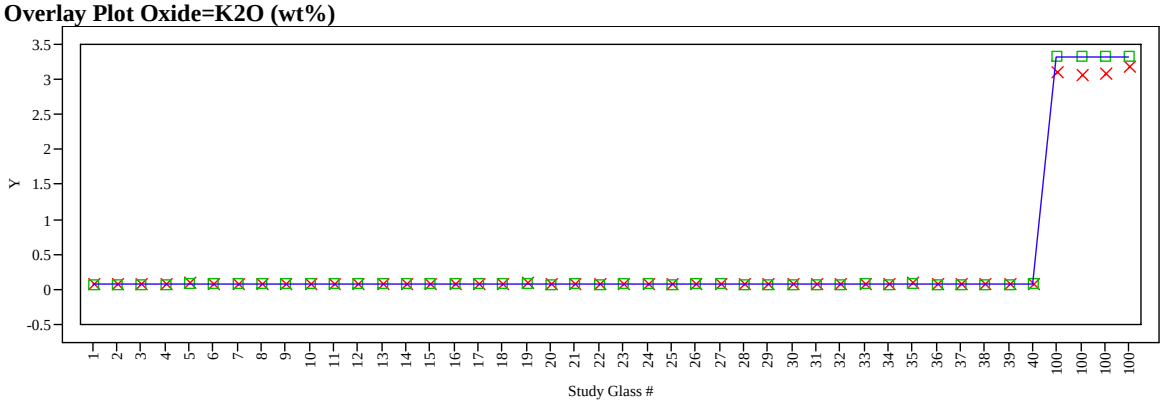
Overlay Plot Oxide=CuO (wt%)



Overlay Plot Oxide=Fe2O3 (wt%)



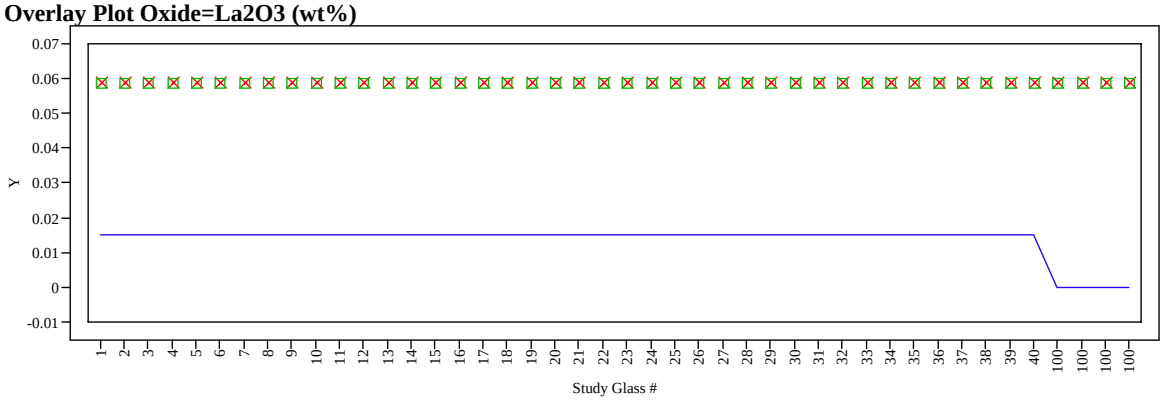
Overlay Plot Oxide=K2O (wt%)



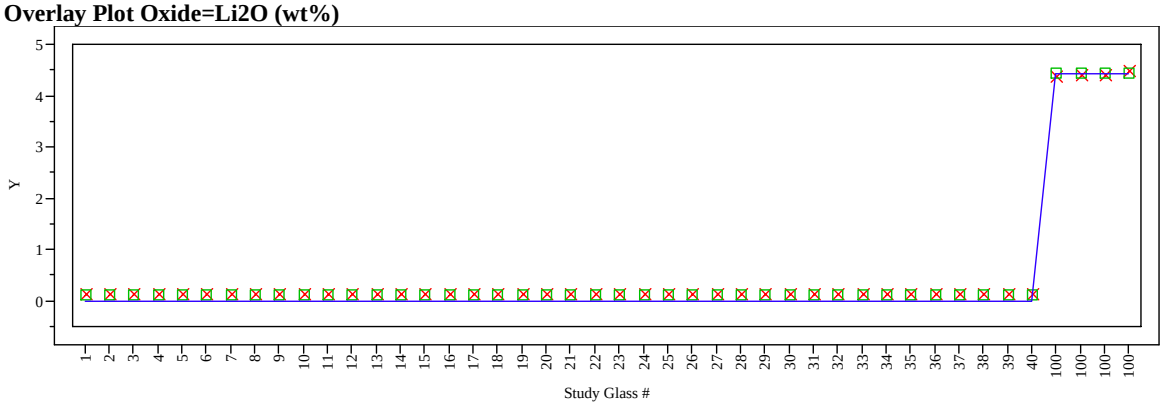
Y Measured Measured bc Targeted

Exhibit A7. Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide. (continued)
(100 – Batch 1 for Sets 1, 2, 3, and 4)

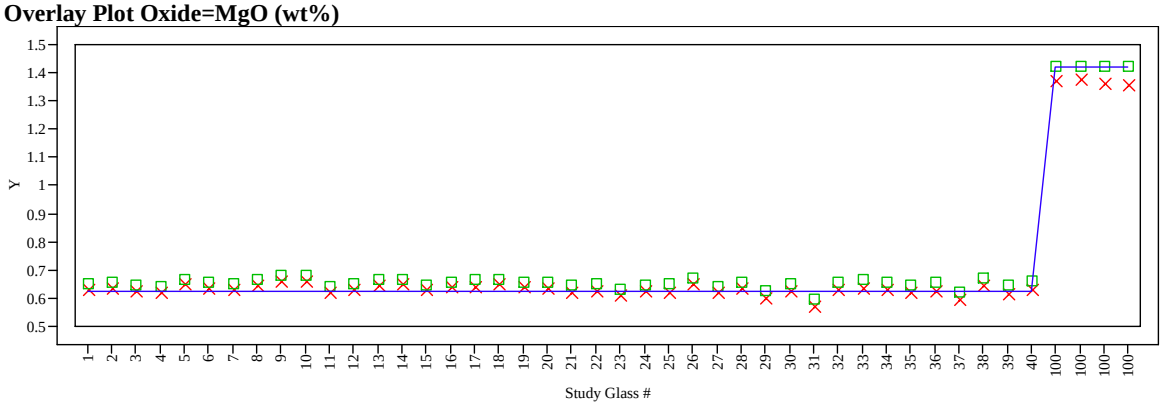
Overlay Plot Oxide=La2O3 (wt%)



Overlay Plot Oxide=Li2O (wt%)



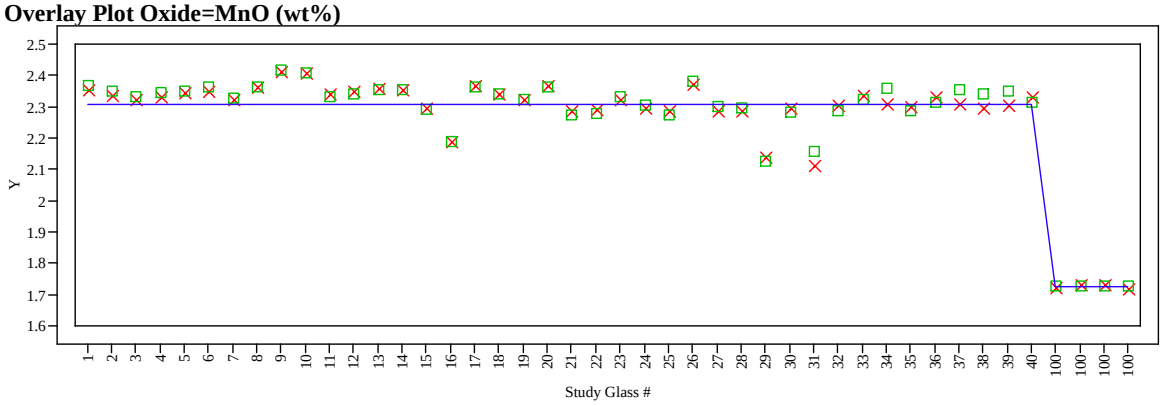
Overlay Plot Oxide=MgO (wt%)



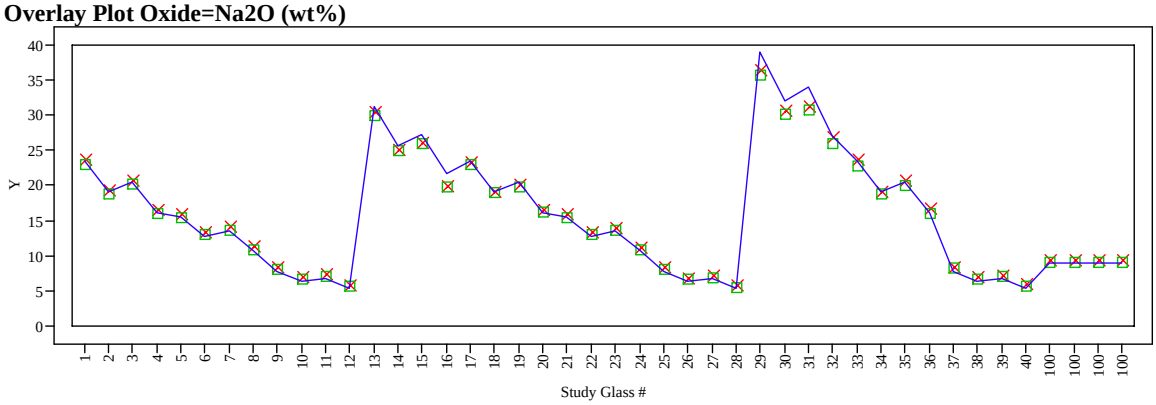
Y Measured Measured bc Targeted

Exhibit A7. Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide. (continued)
(100 – Batch 1 for Sets 1, 2, 3, and 4)

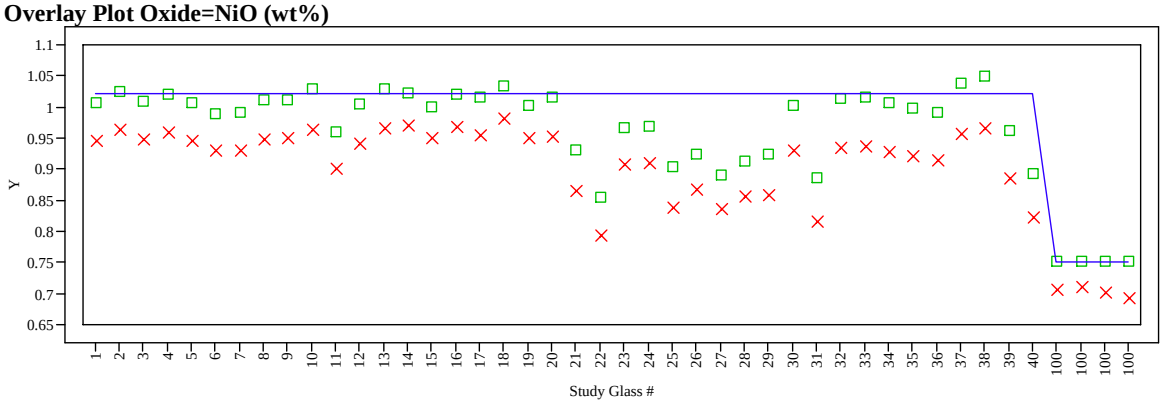
Overlay Plot Oxide=MnO (wt%)



Overlay Plot Oxide=Na2O (wt%)



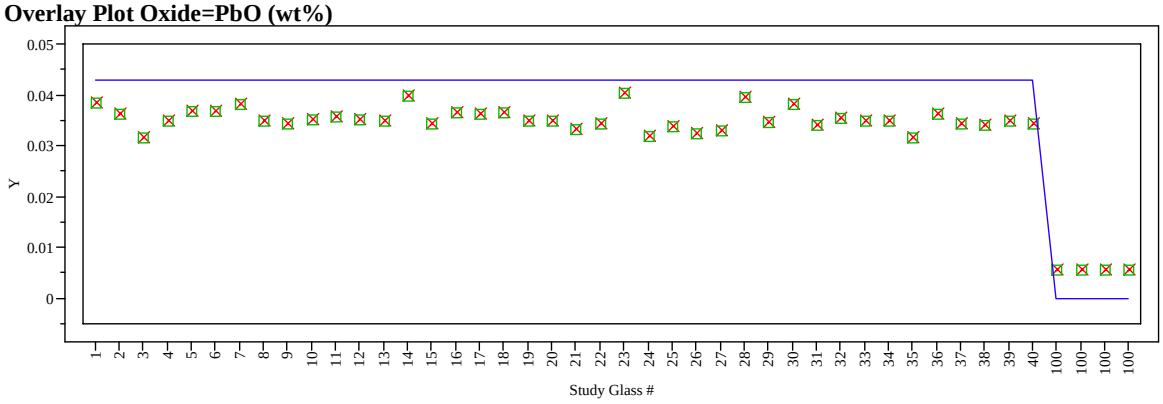
Overlay Plot Oxide=NiO (wt%)



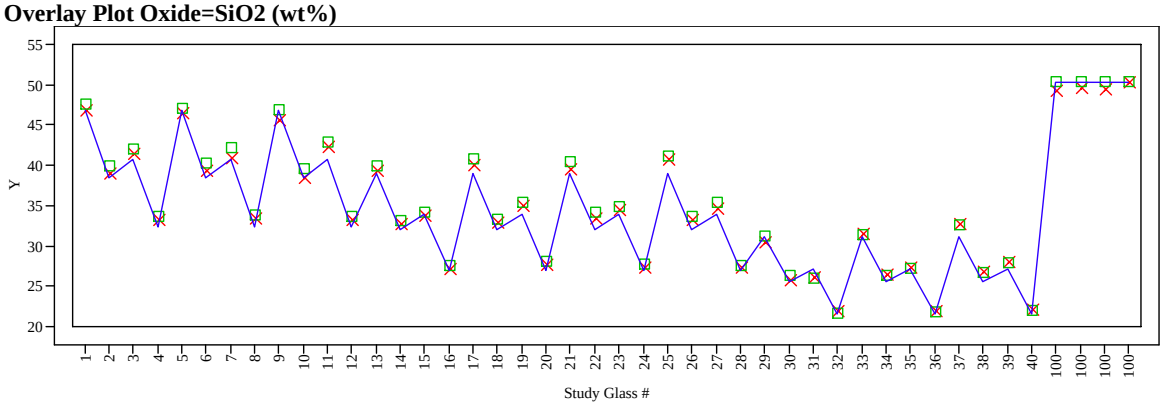
Y Measured Measured bc Targeted

Exhibit A7. Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide. (continued)
(100 – Batch 1 for Sets 1, 2, 3, and 4)

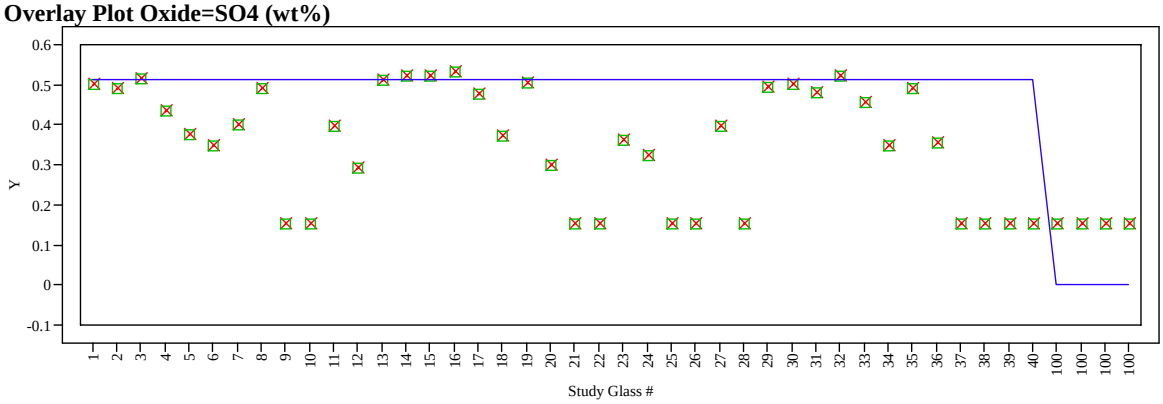
Overlay Plot Oxide=PbO (wt%)



Overlay Plot Oxide=SiO2 (wt%)



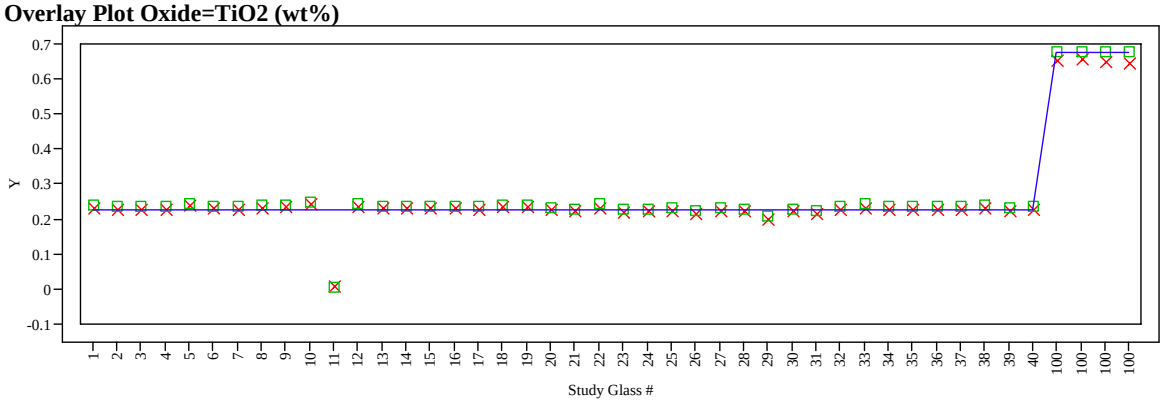
Overlay Plot Oxide=SO4 (wt%)



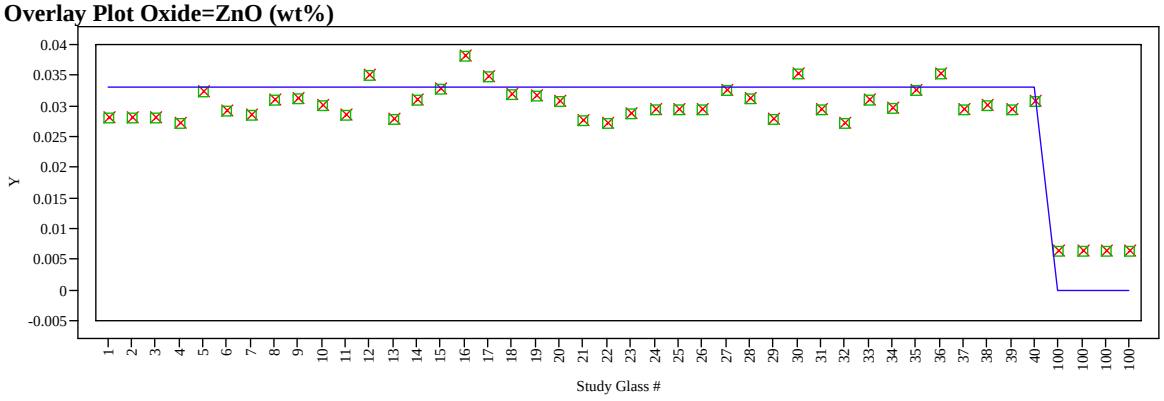
Y Measured Measured bc Targeted

Exhibit A7. Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide. (continued)
(100 – Batch 1 for Sets 1, 2, 3, and 4)

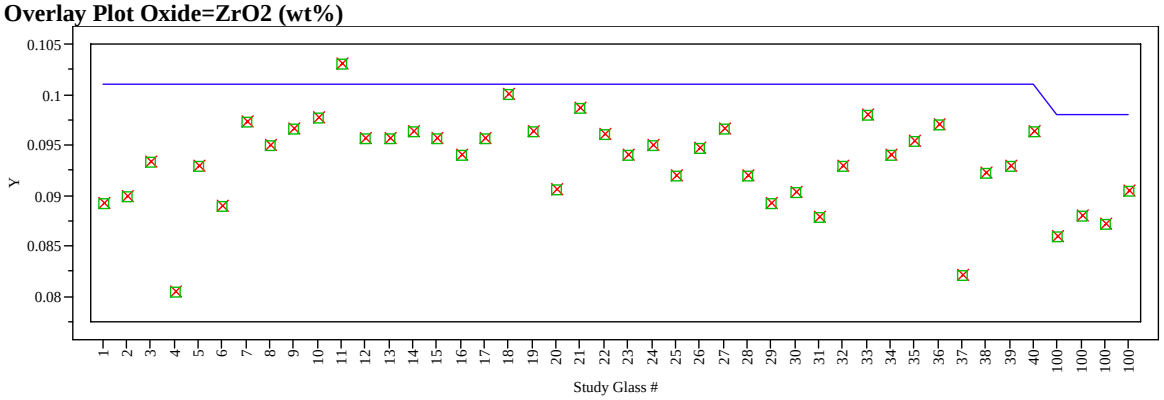
Overlay Plot Oxide=TiO2 (wt%)



Overlay Plot Oxide=ZnO (wt%)

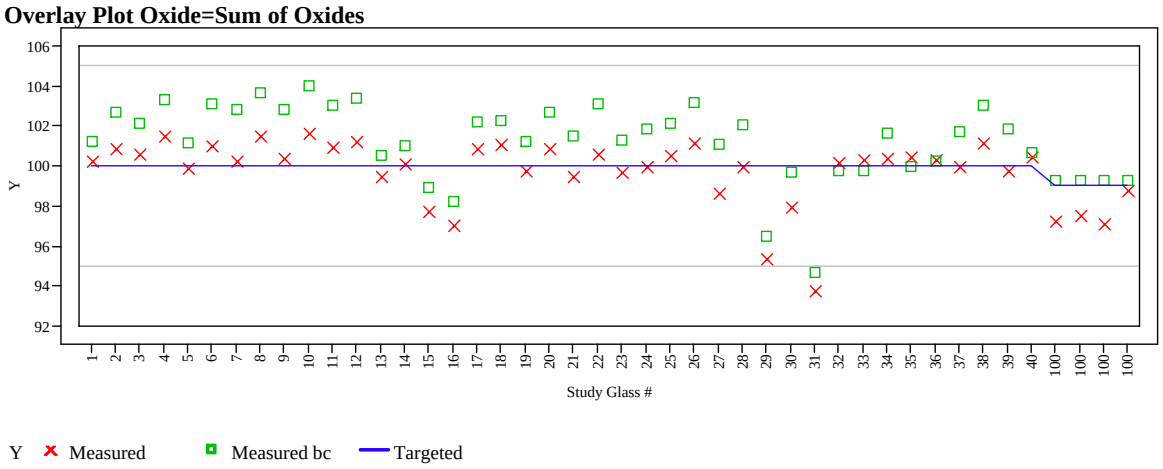


Overlay Plot Oxide=ZrO2 (wt%)



Y ✕ Measured ▫ Measured bc — Targeted

Exhibit A7. Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide. (continued)
(100 – Batch 1 for Sets 1, 2, 3, and 4)



Appendix B

Tables and Exhibits Supporting the Analysis of the PCT Results for the Nepheline Study Glasses

Table B1. Laboratory Measurements of the PCT Solutions for the Nepheline Study Glasses. (continued)

Set	Glass ID	Heat Treatment	Block	Seq	Lab ID	B ar	Li ar	Na ar	Si ar
1	Soln Std	ref	1	1	STD-11-1	21.2	9.77	82	50.3
1	SB5NEPH-05	quenched	1	2	H29	3.22	<1.00	32.7	32.2
1	SB5NEPH-08	quenched	1	3	H32	20.6	<1.00	35.2	9.09
1	SB5NEPH-05ccc	ccc	1	4	H42	2.03	<1.00	25.3	26.1
1	SB5NEPH-03ccc	ccc	1	5	H44	11.7	<1.00	205	43.5
1	ARM-1	ref	1	6	H38	10.1	7.8	21.4	34.7
1	EA	ref	1	7	H63	36.5	10.9	106	53
1	SB5NEPH-01	quenched	1	8	H56	7.55	<1.00	202	90.5
1	SB5NEPH-04	quenched	1	9	H28	107	<1.00	269	33.6
1	SB5NEPH-02	quenched	1	10	H33	275	<1.00	531	37.5
1	SB5NEPH-03	quenched	1	11	H50	7.16	<1.00	151	29.4
1	SB5NEPH-07ccc	ccc	1	12	H36	2.58	<1.00	21.9	12
1	Soln Std	ref	1	13	STD-11-2	20.6	9.65	79.3	49.5
1	SB5NEPH-02ccc	ccc	1	14	H41	243	<1.00	503	38.2
1	SB5NEPH-01ccc	ccc	1	15	H08	10.1	<1.00	185	87.7
1	SB5NEPH-04ccc	ccc	1	16	H18	109	<1.00	278	35.3
1	SB5NEPH-10	quenched	1	17	H14	7.21	<1.00	4.38	10
1	SB5NEPH-06ccc	ccc	1	18	H20	38.8	<1.00	49.6	25
1	SB5NEPH-10ccc	ccc	1	19	H25	8.8	<1.00	5.94	13.1
1	SB5NEPH-07	quenched	1	20	H12	2.29	<1.00	23.1	11.6
1	SB5NEPH-08ccc	ccc	1	21	H09	16.9	<1.00	26.3	8.91
1	SB5NEPH-09ccc	ccc	1	22	H11	1.19	<1.00	4.46	11.5
1	blank	ref	1	23	H15	<0.100	<1.00	<0.100	<0.100
1	SB5NEPH-06	quenched	1	24	H40	30.4	<1.00	42.2	23.1
1	SB5NEPH-09	quenched	1	25	H49	1.17	<1.00	4.26	10.3
1	Soln Std	ref	1	26	STD-11-3	20.7	9.63	84.3	49.6
1	Soln Std	ref	2	1	STD-12-1	21.5	10.2	85.9	51.8
1	SB5NEPH-09ccc	ccc	2	2	H61	1.28	<1.00	45.1	14.6
1	SB5NEPH-01	quenched	2	3	H23	7.22	<1.00	208	90.4
1	SB5NEPH-05	quenched	2	4	H43	2.97	<1.00	42	34.6
1	SB5NEPH-03ccc	ccc	2	5	H19	12.3	<1.00	195	48
1	SB5NEPH-04ccc	ccc	2	6	H21	99	<1.00	264	38.6
1	SB5NEPH-10ccc	ccc	2	7	H26	8.52	<1.00	8.79	15.4
1	SB5NEPH-02	quenched	2	8	H48	251	<1.00	517	41
1	SB5NEPH-02ccc	ccc	2	9	H62	215	<1.00	434	39.6
1	SB5NEPH-01ccc	ccc	2	10	H34	9.21	<1.00	211	90.3
1	SB5NEPH-08ccc	ccc	2	11	H13	17.9	<1.00	30.5	11.3
1	SB5NEPH-07ccc	ccc	2	12	H03	2.39	<1.00	19	14.6
1	Soln Std	ref	2	13	STD-12-2	20.7	10.2	83	51.5
1	SB5NEPH-03	quenched	2	14	H01	4.94	<1.00	140	33.2
1	SB5NEPH-05ccc	ccc	2	15	H58	2.1	<1.00	23.5	28.5
1	SB5NEPH-10	quenched	2	16	H39	5.34	<1.00	3.4	11.7
1	EA	ref	2	17	H16	38.4	11.7	98.7	56.1
1	SB5NEPH-04	quenched	2	18	H02	97.1	<1.00	261	35.2
1	SB5NEPH-09	quenched	2	19	H35	1.38	<1.00	7.7	12.6
1	SB5NEPH-06	quenched	2	20	H65	32.6	<1.00	45.1	26.1
1	SB5NEPH-06ccc	ccc	2	21	H17	40	<1.00	48.7	27.8
1	ARM-1	ref	2	22	H64	10.6	8.27	24.4	37.2
1	SB5NEPH-07	quenched	2	23	H57	2.18	<1.00	22.8	13.9
1	SB5NEPH-08	quenched	2	24	H10	20.7	<1.00	36.3	11.2
1	Soln Std	ref	2	25	STD-12-3	20.9	10.5	82.6	52.3
1	Soln Std	ref	3	1	STD-13-1	19.9	9.63	82.7	47.9
1	SB5NEPH-02ccc	ccc	3	2	H53	228	<1.00	444	36.7
1	SB5NEPH-09ccc	ccc	3	3	H54	1.96	<1.00	4.77	11.2
1	SB5NEPH-04	quenched	3	4	H06	100	<1.00	249	32.4
1	SB5NEPH-08ccc	ccc	3	5	H24	17.1	<1.00	27.8	7.83
1	SB5NEPH-07	quenched	3	6	H07	2.3	<1.00	23.9	10.6
1	SB5NEPH-08	quenched	3	7	H05	21.2	<1.00	36.8	8.31
1	EA	ref	3	8	H27	37.4	10.9	99.6	51.7

Table B1. Laboratory Measurements of the PCT Solutions for the Nepheline Study Glasses. (continued)

Set	Glass ID	Heat Treatment	Block	Seq	Lab ID	B ar	Li ar	Na ar	Si ar
1	SB5NEPH-01	quenched	3	9	H46	7.43	<1.00	181	86.6
1	SB5NEPH-01ccc	ccc	3	10	H52	7.13	<1.00	169	85.6
1	SB5NEPH-03ccc	ccc	3	11	H30	13.1	<1.00	196	44.8
1	SB5NEPH-03	quenched	3	12	H37	4.01	<1.00	141	28.9
1	Soln Std	ref	3	13	STD-13-2	20.4	9.87	85.9	49
1	SB5NEPH-05ccc	ccc	3	14	H51	2.05	<1.00	26.1	24.1
1	SB5NEPH-10ccc	ccc	3	15	H60	7.78	<1.00	6.33	11.6
1	SB5NEPH-05	quenched	3	16	H45	2.93	<1.00	35.4	31.1
1	SB5NEPH-06ccc	ccc	3	17	H68	38.6	<1.00	53.8	23.3
1	blank	ref	3	18	H31	<0.100	<1.00	<0.100	<0.100
1	SB5NEPH-10	quenched	3	19	H59	5.13	<1.00	4.54	8.35
1	SB5NEPH-07ccc	ccc	3	20	H55	1.35	<1.00	23.1	10.4
1	SB5NEPH-06	quenched	3	21	H66	0.653	<1.00	5.68	9.06
1	SB5NEPH-09	quenched	3	22	H22	1.45	<1.00	2.61	6.42
1	SB5NEPH-02	quenched	3	23	H67	253	<1.00	533	31.9
1	ARM-1	ref	3	24	H04	10.9	7.96	22	34.1
1	SB5NEPH-04ccc	ccc	3	25	H47	100	<1.00	268	35.2
1	Soln Std	ref	3	26	STD-13-3	20.6	9.66	86.5	47.1
2	Soln Std	ref	1	1	STD-21-1	20.6	9.89	80.9	49.3
2	SB5NEPH-17	quenched	1	2	I 55	6.5	<1.00	136	57.5
2	SB5NEPH-13ccc	ccc	1	3	I 18	39.9	<1.00	1320	221
2	blank	ref	1	4	I 02	<1.00	<1.00	<1.00	<1.00
2	SB5NEPH-14ccc	ccc	1	5	I 06	532	<1.00	1430	125
2	SB5NEPH-19	quenched	1	6	I 61	8.93	<1.00	196	25.5
2	EA	ref	1	7	I 25	41.2	11.6	163	54.4
2	SB5NEPH-11	quenched	1	8	I 56	2.77	<1.00	4.71	6.03
2	SB5NEPH-18ccc	ccc	1	9	I 42	133	<1.00	273	19.9
2	SB5NEPH-20	quenched	1	10	I 65	94.4	<1.00	250	12.5
2	SB5NEPH-11ccc	ccc	1	11	I 64	7.35	<1.00	10.2	6.53
2	SB5NEPH-12	quenched	1	12	I 05	10.3	<1.00	8.43	4.32
2	Soln Std	ref	1	13	STD-21-2	20.9	9.95	89.6	48.8
2	SB5NEPH-12ccc	ccc	1	14	I 39	6.78	<1.00	5.96	5.41
2	SB5NEPH-16	quenched	1	15	I 07	182	<1.00	597	43.4
2	SB5NEPH-18	quenched	1	16	I 29	145	<1.00	281	20
2	SB5NEPH-15	quenched	1	17	I 44	21.3	<1.00	1040	102
2	SB5NEPH-19ccc	ccc	1	18	I 63	38.7	<1.00	902	50.1
2	SB5NEPH-20ccc	ccc	1	19	I 17	37.4	<1.00	114	11.2
2	SB5NEPH-13	quenched	1	20	I 20	28.3	<1.00	1250	217
2	SB5NEPH-14	quenched	1	21	I 68	724	<1.00	1860	154
2	ARM-1	ref	1	22	I 30	13.2	8.41	24	36.7
2	SB5NEPH-15ccc	ccc	1	23	I 03	78.4	<1.00	4100	261
2	SB5NEPH-17ccc	ccc	1	24	I 12	97.6	<1.00	816	142
2	SB5NEPH-16ccc	ccc	1	25	I 01	191	<1.00	618	44.6
2	Soln Std	ref	1	26	STD-21-3	23.6	10.3	86	50.9
2	Soln Std	ref	2	1	STD-22-1	20	9.63	82.7	49.5
2	SB5NEPH-16ccc	ccc	2	2	I 31	198	<1.00	606	47
2	SB5NEPH-16	quenched	2	3	I 10	178	<1.00	577	42.4
2	SB5NEPH-12ccc	ccc	2	4	I 28	7.39	<1.00	7.51	5.21
2	SB5NEPH-12	quenched	2	5	I 62	9.6	<1.00	6.55	4.14
2	SB5NEPH-15	quenched	2	6	I 48	20.3	<1.00	1090	105
2	SB5NEPH-17ccc	ccc	2	7	I 38	90.7	<1.00	761	135
2	SB5NEPH-18ccc	ccc	2	8	I 15	134	<1.00	272	20.4
2	SB5NEPH-13	quenched	2	9	I 34	27.7	<1.00	1260	212
2	SB5NEPH-20ccc	ccc	2	10	I 57	38.2	<1.00	106	11.2
2	SB5NEPH-11ccc	ccc	2	11	I 13	6.2	<1.00	9.57	6.41
2	SB5NEPH-18	quenched	2	12	I 11	146	<1.00	295	20.2
2	Soln Std	ref	2	13	STD-22-2	21.1	9.72	87.3	49.5
2	SB5NEPH-19	quenched	2	14	I 24	5.8	<1.00	198	25.3
2	SB5NEPH-15ccc	ccc	2	15	I 52	99.1	<1.00	3980	269

Table B1. Laboratory Measurements of the PCT Solutions for the Nepheline Study Glasses. (continued)

Set	Glass ID	Heat Treatment	Block	Seq	Lab ID	B ar	Li ar	Na ar	Si ar
2	SB5NEPH-19ccc	ccc	2	16	I 33	37	<1.00	834	50.2
2	SB5NEPH-17	quenched	2	17	I 23	6.29	<1.00	145	56.4
2	SB5NEPH-14	quenched	2	18	I 36	694	<1.00	1850	151
2	SB5NEPH-14ccc	ccc	2	19	I 45	534	<1.00	1480	124
2	EA	ref	2	20	I 53	46.1	11.4	127	55.4
2	ARM-1	ref	2	21	I 51	11.3	8.63	22.7	37.8
2	SB5NEPH-11	quenched	2	22	I 14	4.65	<1.00	4.67	5.89
2	SB5NEPH-20	quenched	2	23	I 49	99	<1.00	283	13.6
2	SB5NEPH-13ccc	ccc	2	24	I 66	45.8	<1.00	1410	233
2	Soln Std	ref	2	25	STD-22-3	21.4	9.51	86.6	47.5
2	Soln Std	ref	3	1	STD-23-1	19.2	9.67	84.3	49
2	SB5NEPH-18	quenched	3	2	I 41	140	<1.00	272	20.5
2	SB5NEPH-18ccc	ccc	3	3	I 04	134	<1.00	409	21.3
2	SB5NEPH-20	quenched	3	4	I 16	95.7	<1.00	250	14.1
2	SB5NEPH-14	quenched	3	5	I 46	707	<1.00	1750	147
2	SB5NEPH-16ccc	ccc	3	6	I 37	192	<1.00	593	44.4
2	SB5NEPH-20ccc	ccc	3	7	I 21	39	<1.00	127	11.9
2	SB5NEPH-12ccc	ccc	3	8	I 26	8.13	<1.00	5.65	6.39
2	SB5NEPH-11	quenched	3	9	I 35	2.36	<1.00	4.32	7.24
2	blank	ref	3	10	I 50	<1.00	<1.00	<1.00	<1.00
2	SB5NEPH-13	quenched	3	11	I 40	27.2	<1.00	1190	210
2	SB5NEPH-19ccc	ccc	3	12	I 58	36.6	<1.00	855	48.9
2	Soln Std	ref	3	13	STD-23-2	19.5	9.63	85.2	48.4
2	SB5NEPH-19	quenched	3	14	I 59	4.78	<1.00	196	26.8
2	SB5NEPH-15ccc	ccc	3	15	I 22	77.3	<1.00	3820	256
2	SB5NEPH-17ccc	ccc	3	16	I 47	94	<1.00	841	140
2	SB5NEPH-11ccc	ccc	3	17	I 32	5.23	<1.00	10.6	7.86
2	ARM-1	ref	3	18	I 67	10.2	8.29	23.1	37.3
2	SB5NEPH-16	quenched	3	19	I 54	180	<1.00	589	43
2	SB5NEPH-15	quenched	3	20	I 60	21.7	<1.00	1020	110
2	SB5NEPH-13ccc	ccc	3	21	I 08	40.5	<1.00	1330	223
2	EA	ref	3	22	I 19	36.7	11.3	113	52.8
2	SB5NEPH-14ccc	ccc	3	23	I 09	547	<1.00	1450	123
2	SB5NEPH-17	quenched	3	24	I 43	8.39	<1.00	147	57.8
2	SB5NEPH-12	quenched	3	25	I 27	9.88	<1.00	8.67	5.39
2	Soln Std	ref	3	26	STD-23-3	20.5	9.73	86.6	49.2
3	Soln Std	ref	1	1	STD-31-1	20.4	9.63	79	48.7
3	SB5NEPH-22ccc	ccc	1	2	J38	32.8	<1.00	47	25.9
3	SB5NEPH-22	quenched	1	3	J35	16.4	<1.00	28	21.7
3	SB5NEPH-29ccc	ccc	1	4	J22-missing				
3	SB5NEPH-21	quenched	1	5	J26	1.36	<1.00	26.3	21.3
3	SB5NEPH-30ccc	ccc	1	6	J39	125	<1.00	2130	220
3	SB5NEPH-23ccc	ccc	1	7	J01	4.74	<1.00	11.3	6.24
3	SB5NEPH-27	quenched	1	8	J29	0.642	<1.00	3.95	4.75
3	blank	ref	1	9	J50	<0.100	<1.00	<0.100	<0.100
3	SB5NEPH-29	quenched	1	10	J19	739	<1.00	12500	1390
3	SB5NEPH-27ccc	ccc	1	11	J36	138	<1.00	58.8	0.225
3	SB5NEPH-25ccc	ccc	1	12	J51	4.7	<1.00	5.92	10.3
3	Soln Std	ref	1	13	STD-31-2	22.4	9.92	83.8	49.5
3	SB5NEPH-24	quenched	1	14	J04	30.4	<1.00	57.3	3.88
3	SB5NEPH-23	quenched	1	15	J59	2.33	<1.00	24.4	8.14
3	SB5NEPH-24ccc	ccc	1	16	J55	11	<1.00	18.6	4.76
3	SB5NEPH-21ccc	ccc	1	17	J24	112	<1.00	159	14.6
3	SB5NEPH-30	quenched	1	18	J62	3280	<1.00	10400	534
3	SB5NEPH-28ccc	ccc	1	19	J46	28.5	<1.00	4.3	3.87
3	ARM-1	ref	1	20	J54	23.8	7.63	22	33.3
3	SB5NEPH-28	quenched	1	21	J40	19.7	<1.00	6.9	2.82
3	SB5NEPH-25	quenched	1	22	J42	8.24	<1.00	5.54	7.94
3	SB5NEPH-26ccc	ccc	1	23	J23	18.4	<1.00	13.7	14.8

Table B1. Laboratory Measurements of the PCT Solutions for the Nepheline Study Glasses. (continued)

Set	Glass ID	Heat Treatment	Block	Seq	Lab ID	B ar	Li ar	Na ar	Si ar
3	SB5NEPH-26	quenched	1	24	J20	8.55	<1.00	6.28	6.59
3	EA	ref	1	25	J37	41.5	11.6	120	53.5
3	Soln Std	ref	1	26	STD-31-3	23.2	9.89	85.5	48.6
3	Soln Std	ref	2	1	STD-32-1	19.5	9.71	79.4	49.3
3	SB5NEPH-21ccc	ccc	2	2	J64	109	<1.00	142	14.5
3	SB5NEPH-28ccc	ccc	2	3	J03	4.66	<1.00	3.28	4.25
3	SB5NEPH-29	quenched	2	4	J17	733	<1.00	12500	1410
3	SB5NEPH-30ccc	ccc	2	5	J10	130	<1.00	1960	206
3	ARM-1	ref	2	6	J66	11.8	7.51	19.9	33.7
3	SB5NEPH-29ccc	ccc	2	7	J58-missing				
3	SB5NEPH-21	quenched	2	8	J30	3.01	<1.00	24.6	20.9
3	SB5NEPH-22	quenched	2	9	J15	16.4	<1.00	28.4	21
3	SB5NEPH-23ccc	ccc	2	10	J12	3.92	<1.00	10.8	6.38
3	SB5NEPH-27	quenched	2	11	J11	<0.100	<1.00	4.45	4.82
3	SB5NEPH-30	quenched	2	12	J34	3350	<1.00	10300	545
3	Soln Std	ref	2	13	STD-32-2	21.2	9.65	79	47.2
3	SB5NEPH-25	quenched	2	14	J65	1.86	<1.00	4.81	8.04
3	SB5NEPH-23	quenched	2	15	J28	1.54	<1.00	23.2	8.11
3	SB5NEPH-24	quenched	2	16	J08	28.5	<1.00	54	4.05
3	EA	ref	2	17	J44	37.3	11.3	109	52.6
3	SB5NEPH-26ccc	ccc	2	18	J02	11.6	<1.00	11.6	15.1
3	SB5NEPH-22ccc	ccc	2	19	J49	35.2	<1.00	49.1	25
3	SB5NEPH-26	quenched	2	20	J32	2.87	<1.00	4.88	6.76
3	SB5NEPH-25ccc	ccc	2	21	J68	<0.100	<1.00	5.67	10.3
3	SB5NEPH-24ccc	ccc	2	22	J61	9.24	<1.00	17.7	4.97
3	SB5NEPH-28	quenched	2	23	J09	6.78	<1.00	6.18	2.88
3	SB5NEPH-27ccc	ccc	2	24	J16	147	<1.00	57.5	0.341
3	Soln Std	ref	2	25	STD-32-3	19.7	9.79	82.3	49.6
3	Soln Std	ref	3	1	STD-33-1	19.8	9.73	81.2	48.7
3	SB5NEPH-28	quenched	3	2	J56	8.2	<1.00	6.07	3.11
3	SB5NEPH-22	quenched	3	3	J67	17.3	<1.00	28.8	22.5
3	SB5NEPH-30	quenched	3	4	J25	3310	<1.00	10200	782
3	SB5NEPH-26	quenched	3	5	J05	19.5	<1.00	4.56	6.74
3	SB5NEPH-27	quenched	3	6	J60	11.1	<1.00	3.81	5.01
3	blank	ref	3	7	J53	8.11	<1.00	<0.100	<0.100
3	SB5NEPH-28ccc	ccc	3	8	J06	11.9	<1.00	3.62	4.43
3	SB5NEPH-23ccc	ccc	3	9	J14	9.75	<1.00	11.4	6.56
3	SB5NEPH-27ccc	ccc	3	10	J18	165	<1.00	59.2	0.434
3	SB5NEPH-25	quenched	3	11	J57	5.44	<1.00	4.88	8.19
3	SB5NEPH-25ccc	ccc	3	12	J52	4.5	<1.00	5.6	10.7
3	Soln Std	ref	3	13	STD-33-2	22.3	9.69	83	48.6
3	EA	ref	3	14	J07	39.3	11.3	103	52.8
3	SB5NEPH-22ccc	ccc	3	15	J21	37.7	<1.00	49.6	26
3	SB5NEPH-24	quenched	3	16	J63	31.6	<1.00	54.8	4.39
3	ARM-1	ref	3	17	J47	11.4	7.88	21.8	35.1
3	SB5NEPH-29ccc	ccc	3	18	J33-missing				
3	SB5NEPH-21	quenched	3	19	J13	2.84	<1.00	25.4	20.9
3	SB5NEPH-26ccc	ccc	3	20	J27	12.4	<1.00	11.2	14.6
3	SB5NEPH-21ccc	ccc	3	21	J45	111	<1.00	154	15.3
3	SB5NEPH-23	quenched	3	22	J43	2.35	<1.00	23.6	8.28
3	SB5NEPH-29	quenched	3	23	J41	813	<1.00	12300	1410
3	SB5NEPH-24ccc	ccc	3	24	J48	15.2	<1.00	17.9	5.23
3	SB5NEPH-30ccc	ccc	3	25	J31	147	<1.00	2060	231
3	Soln Std	ref	3	26	STD-33-3	20	9.66	81.1	46.9
4	Soln Std	ref	1	1	STD-41-1	20.8	9.92	81.3	51
4	SB5NEPH-34ccc	ccc	1	2	K17	222	<1.00	315	8.43
4	ARM-1	ref	1	3	K09	12	8.04	21.2	36.6
4	SB5NEPH-39	quenched	1	4	K30	2.31	<1.00	3.59	3.91
4	SB5NEPH-37	quenched	1	5	K21	2.49	<1.00	8.05	10.3

Table B1. Laboratory Measurements of the PCT Solutions for the Nepheline Study Glasses. (continued)

Set	Glass ID	Heat Treatment	Block	Seq	Lab ID	B ar	Li ar	Na ar	Si ar
4	SB5NEPH-32ccc	ccc	1	6	K57	94.2	<1.00	692	61.7
4	SB5NEPH-31	quenched	1	7	K27	509	<1.00	10800	412
4	SB5NEPH-40	quenched	1	8	K29	13.3	<1.00	6.49	2.01
4	SB5NEPH-32	quenched	1	9	K22	635	<1.00	2280	61.4
4	SB5NEPH-31ccc	ccc	1	10	K48	322	<1.00	8020	455
4	SB5NEPH-38	quenched	1	11	K46	14.9	<1.00	7.84	8.04
4	EA	ref	1	12	K40	42.6	11.4	104	55.1
4	Soln Std	ref	1	13	STD-41-2	22.2	9.85	82.1	51.9
4	SB5NEPH-39ccc	ccc	1	14	K14	180	<1.00	59	<1.00
4	SB5NEPH-36ccc	ccc	1	15	K67	1100	<1.00	1960	2.66
4	SB5NEPH-38ccc	ccc	1	16	K65	57.8	<1.00	35.4	22.2
4	SB5NEPH-33	quenched	1	17	K32	637	<1.00	2220	38.5
4	SB5NEPH-37ccc	ccc	1	18	K26	10.6	<1.00	7.61	11.1
4	SB5NEPH-34	quenched	1	19	K42	99.3	<1.00	215	17.6
4	SB5NEPH-36	quenched	1	20	K05	95.5	<1.00	239	5.53
4	SB5NEPH-40ccc	ccc	1	21	K06	12.1	<1.00	4.46	3.52
4	SB5NEPH-33ccc	ccc	1	22	K38	233	<1.00	1960	111
4	SB5NEPH-35	quenched	1	23	K60	11.5	<1.00	115	10.6
4	blank	ref	1	24	K59	4.71	<1.00	<1.00	<1.00
4	SB5NEPH-35ccc	ccc	1	25	K44	51.4	<1.00	922	76
4	Soln Std	ref	1	26	STD-41-3	22.5	9.94	84.4	51.5
4	Soln Std	ref	2	1	STD-42-1	20.3	9.68	81.5	48.5
4	SB5NEPH-33ccc	ccc	2	2	K50	223	<1.00	1920	104
4	SB5NEPH-38	quenched	2	3	K36	10.4	<1.00	8.13	7.6
4	SB5NEPH-33	quenched	2	4	K33	614	<1.00	2210	36.8
4	ARM-1	ref	2	5	K12	15.8	7.92	20.4	35.1
4	SB5NEPH-37	quenched	2	6	K51	4.57	<1.00	8.57	9.66
4	SB5NEPH-36	quenched	2	7	K54	88.1	<1.00	225	5.1
4	SB5NEPH-36ccc	ccc	2	8	K39	1130	<1.00	2000	2.29
4	SB5NEPH-37ccc	ccc	2	9	K37	11.8	<1.00	7.84	10.3
4	SB5NEPH-31	quenched	2	10	K43	531	<1.00	11000	429
4	SB5NEPH-39ccc	ccc	2	11	K45	195	<1.00	59.5	<1.00
4	SB5NEPH-32	quenched	2	12	K34	639	<1.00	2310	58.3
4	Soln Std	ref	2	13	STD-42-2	20.2	9.58	83.9	46.8
4	SB5NEPH-40ccc	ccc	2	14	K47	11.8	<1.00	4.08	3.05
4	SB5NEPH-35ccc	ccc	2	15	K56	49.9	<1.00	958	69.8
4	SB5NEPH-34	quenched	2	16	K08	98.1	<1.00	195	16.7
4	SB5NEPH-40	quenched	2	17	K61	13.2	<1.00	7	1.72
4	SB5NEPH-39	quenched	2	18	K68	4.15	<1.00	4.05	3.81
4	EA	ref	2	19	K16	40.3	11.2	102	52.5
4	SB5NEPH-32ccc	ccc	2	20	K13	86.8	<1.00	685	58.7
4	SB5NEPH-34ccc	ccc	2	21	K24	215	<1.00	330	7.38
4	SB5NEPH-35	quenched	2	22	K64	9.53	<1.00	116	9.31
4	SB5NEPH-31ccc	ccc	2	23	K58	326	<1.00	8120	457
4	SB5NEPH-38ccc	ccc	2	24	K53	51.8	<1.00	36	20.5
4	Soln Std	ref	2	25	STD-42-3	23.1	9.55	83.4	47
4	Soln Std	ref	3	1	STD-43-1	19.9	9.77	80.6	48.9
4	SB5NEPH-36ccc	ccc	3	2	K03	1150	<1.00	2160	2.46
4	SB5NEPH-32ccc	ccc	3	3	K19	110	<1.00	722	63.2
4	SB5NEPH-40	quenched	3	4	K63	14.9	<1.00	6.77	1.92
4	EA	ref	3	5	K25	42	11.3	103	54.3
4	SB5NEPH-40ccc	ccc	3	6	K02	8.32	<1.00	4.35	3.41
4	SB5NEPH-33ccc	ccc	3	7	K23	228	<1.00	2010	106
4	SB5NEPH-37ccc	ccc	3	8	K31	3.57	<1.00	7.99	10.8
4	blank	ref	3	9	K01	1.04	<1.00	<1.00	<1.00
4	SB5NEPH-34ccc	ccc	3	10	K66	229	<1.00	317	7.82
4	SB5NEPH-39	quenched	3	11	K11	2.74	<1.00	4.06	3.94
4	ARM-1	ref	3	12	K28	11.6	8.48	23.3	37.2
4	Soln Std	ref	3	13	STD-43-2	20.2	9.75	81.9	48.5

Table B1. Laboratory Measurements of the PCT Solutions for the Nepheline Study Glasses. (continued)

Set	Glass ID	Heat Treatment	Block	Seq	Lab ID	B ar	Li ar	Na ar	Si ar
4	SB5NEPH-35ccc	ccc	3	14	K10	46.2	<1.00	921	71.7
4	SB5NEPH-34	quenched	3	15	K49	98.9	<1.00	200	17
4	SB5NEPH-39ccc	ccc	3	16	K35	179	<1.00	61	<1.00
4	SB5NEPH-31	quenched	3	17	K15	560	<1.00	11500	452
4	SB5NEPH-35	quenched	3	18	K55	10.4	<1.00	117	10.7
4	SB5NEPH-37	quenched	3	19	K20	3.06	<1.00	9.81	9.73
4	SB5NEPH-38ccc	ccc	3	20	K07	48.8	<1.00	37.7	21.1
4	SB5NEPH-38	quenched	3	21	K18	8.93	<1.00	9.29	7.82
4	SB5NEPH-36	quenched	3	22	K41	88.7	<1.00	246	5.44
4	SB5NEPH-32	quenched	3	23	K62	574	<1.00	2380	59.8
4	SB5NEPH-31ccc	ccc	3	24	K04	373	<1.00	8590	511
4	SB5NEPH-33	quenched	3	25	K52	613	<1.00	2330	38
4	Soln Std	ref	3	26	STD-43-3	20.2	9.78	80.3	49.4

Table B2. PSAL Measurements of the PCT Solutions for the Study Glasses After Appropriate Adjustments.

Set	Glass ID	Heat Treatment	Block	Seq	Lab ID	B (ppm)	Li (ppm)	Na (ppm)	Si (ppm)
1	Soln Std	ref	1	1	STD-11-1	21.20	9.77	82.00	50.30
1	SB5NEPH-05	quenched	1	2	H29	5.37	0.83	54.50	53.67
1	SB5NEPH-08	quenched	1	3	H32	34.33	0.83	58.67	15.15
1	SB5NEPH-05ccc	ccc	1	4	H42	3.38	0.83	42.17	43.50
1	SB5NEPH-03ccc	ccc	1	5	H44	19.50	0.83	341.67	72.50
1	ARM-1	ref	1	6	H38	16.83	13.00	35.67	57.83
1	EA	ref	1	7	H63	608.33	181.67	1766.67	883.34
1	SB5NEPH-01	quenched	1	8	H56	12.58	0.83	336.67	150.84
1	SB5NEPH-04	quenched	1	9	H28	178.34	0.83	448.34	56.00
1	SB5NEPH-02	quenched	1	10	H33	458.34	0.83	885.02	62.50
1	SB5NEPH-03	quenched	1	11	H50	11.93	0.83	251.67	49.00
1	SB5NEPH-07ccc	ccc	1	12	H36	4.30	0.83	36.50	20.00
1	Soln Std	ref	1	13	STD-11-2	20.60	9.65	79.30	49.50
1	SB5NEPH-02ccc	ccc	1	14	H41	405.01	0.83	838.35	63.67
1	SB5NEPH-01ccc	ccc	1	15	H08	16.83	0.83	308.34	146.17
1	SB5NEPH-04ccc	ccc	1	16	H18	181.67	0.83	463.34	58.83
1	SB5NEPH-10	quenched	1	17	H14	12.02	0.83	7.30	16.67
1	SB5NEPH-06ccc	ccc	1	18	H20	64.67	0.83	82.67	41.67
1	SB5NEPH-10ccc	ccc	1	19	H25	14.67	0.83	9.90	21.83
1	SB5NEPH-07	quenched	1	20	H12	3.82	0.83	38.50	19.33
1	SB5NEPH-08ccc	ccc	1	21	H09	28.17	0.83	43.83	14.85
1	SB5NEPH-09ccc	ccc	1	22	H11	1.98	0.83	7.43	19.17
1	blank	ref	1	23	H15	0.08	0.83	0.08	0.08
1	SB5NEPH-06	quenched	1	24	H40	50.67	0.83	70.33	38.50
1	SB5NEPH-09	quenched	1	25	H49	1.95	0.83	7.10	17.17
1	Soln Std	ref	1	26	STD-11-3	20.70	9.63	84.30	49.60
1	Soln Std	ref	2	1	STD-12-1	21.50	10.20	85.90	51.80
1	SB5NEPH-09ccc	ccc	2	2	H61	2.13	0.83	75.17	24.33
1	SB5NEPH-01	quenched	2	3	H23	12.03	0.83	346.67	150.67
1	SB5NEPH-05	quenched	2	4	H43	4.95	0.83	70.00	57.67
1	SB5NEPH-03ccc	ccc	2	5	H19	20.50	0.83	325.01	80.00
1	SB5NEPH-04ccc	ccc	2	6	H21	165.00	0.83	440.01	64.33
1	SB5NEPH-10ccc	ccc	2	7	H26	14.20	0.83	14.65	25.67
1	SB5NEPH-02	quenched	2	8	H48	418.34	0.83	861.68	68.33
1	SB5NEPH-02ccc	ccc	2	9	H62	358.34	0.83	723.35	66.00
1	SB5NEPH-01ccc	ccc	2	10	H34	15.35	0.83	351.67	150.50
1	SB5NEPH-08ccc	ccc	2	11	H13	29.83	0.83	50.83	18.83
1	SB5NEPH-07ccc	ccc	2	12	H03	3.98	0.83	31.67	24.33
1	Soln Std	ref	2	13	STD-12-2	20.70	10.20	83.00	51.50
1	SB5NEPH-03	quenched	2	14	H01	8.23	0.83	233.34	55.33
1	SB5NEPH-05ccc	ccc	2	15	H58	3.50	0.83	39.17	47.50
1	SB5NEPH-10	quenched	2	16	H39	8.90	0.83	5.67	19.50
1	EA	ref	2	17	H16	640.00	195.00	1645.00	935.00
1	SB5NEPH-04	quenched	2	18	H02	161.84	0.83	435.01	58.67
1	SB5NEPH-09	quenched	2	19	H35	2.30	0.83	12.83	21.00
1	SB5NEPH-06	quenched	2	20	H65	54.33	0.83	75.17	43.50
1	SB5NEPH-06ccc	ccc	2	21	H17	66.67	0.83	81.17	46.33
1	ARM-1	ref	2	22	H64	17.67	13.78	40.67	62.00
1	SB5NEPH-07	quenched	2	23	H57	3.63	0.83	38.00	23.17
1	SB5NEPH-08	quenched	2	24	H10	34.50	0.83	60.50	18.67
1	Soln Std	ref	2	25	STD-12-3	20.90	10.50	82.60	52.30
1	Soln Std	ref	3	1	STD-13-1	19.90	9.63	82.70	47.90
1	SB5NEPH-02ccc	ccc	3	2	H53	380.01	0.83	740.01	61.17
1	SB5NEPH-09ccc	ccc	3	3	H54	3.27	0.83	7.95	18.67
1	SB5NEPH-04	quenched	3	4	H06	166.67	0.83	415.01	54.00
1	SB5NEPH-08ccc	ccc	3	5	H24	28.50	0.83	46.33	13.05
1	SB5NEPH-07	quenched	3	6	H07	3.83	0.83	39.83	17.67
1	SB5NEPH-08	quenched	3	7	H05	35.33	0.83	61.33	13.85
1	EA	ref	3	8	H27	623.33	181.67	1660.00	861.67

Table B2. PSAL Measurements of the PCT Solutions for the Study Glasses After Appropriate Adjustments. (continued)

Set	Glass ID	Heat Treatment	Block	Seq	Lab ID	B (ppm)	Li (ppm)	Na (ppm)	Si (ppm)
1	SB5NEPH-01	quenched	3	9	H46	12.38	0.83	301.67	144.34
1	SB5NEPH-01ccc	ccc	3	10	H52	11.88	0.83	281.67	142.67
1	SB5NEPH-03ccc	ccc	3	11	H30	21.83	0.83	326.67	74.67
1	SB5NEPH-03	quenched	3	12	H37	6.68	0.83	235.00	48.17
1	Soln Std	ref	3	13	STD-13-2	20.40	9.87	85.90	49.00
1	SB5NEPH-05ccc	ccc	3	14	H51	3.42	0.83	43.50	40.17
1	SB5NEPH-10ccc	ccc	3	15	H60	12.97	0.83	10.55	19.33
1	SB5NEPH-05	quenched	3	16	H45	4.88	0.83	59.00	51.83
1	SB5NEPH-06ccc	ccc	3	17	H68	64.33	0.83	89.67	38.83
1	blank	ref	3	18	H31	0.08	0.83	0.08	0.08
1	SB5NEPH-10	quenched	3	19	H59	8.55	0.83	7.57	13.92
1	SB5NEPH-07ccc	ccc	3	20	H55	2.25	0.83	38.50	17.33
1	SB5NEPH-06	quenched	3	21	H66	1.09	0.83	9.47	15.10
1	SB5NEPH-09	quenched	3	22	H22	2.42	0.83	4.35	10.70
1	SB5NEPH-02	quenched	3	23	H67	421.68	0.83	888.35	53.17
1	ARM-1	ref	3	24	H04	18.17	13.27	36.67	56.83
1	SB5NEPH-04ccc	ccc	3	25	H47	166.67	0.83	446.68	58.67
1	Soln Std	ref	3	26	STD-13-3	20.60	9.66	86.50	47.10
2	Soln Std	ref	1	1	STD-21-1	20.60	9.89	80.90	49.30
2	SB5NEPH-17	quenched	1	2	I 55	10.83	0.83	226.67	95.84
2	SB5NEPH-13ccc	ccc	1	3	I 18	66.50	0.83	2200.04	368.34
2	blank	ref	1	4	I 02	0.83	0.83	0.83	0.83
2	SB5NEPH-14ccc	ccc	1	5	I 06	886.68	0.83	2383.38	208.34
2	SB5NEPH-19	quenched	1	6	I 61	14.88	0.83	326.67	42.50
2	EA	ref	1	7	I 25	686.67	193.33	2716.67	906.67
2	SB5NEPH-11	quenched	1	8	I 56	4.62	0.83	7.85	10.05
2	SB5NEPH-18ccc	ccc	1	9	I 42	221.67	0.83	455.01	33.17
2	SB5NEPH-20	quenched	1	10	I 65	157.34	0.83	416.68	20.83
2	SB5NEPH-11ccc	ccc	1	11	I 64	12.25	0.83	17.00	10.88
2	SB5NEPH-12	quenched	1	12	I 05	17.17	0.83	14.05	7.20
2	Soln Std	ref	1	13	STD-21-2	20.90	9.95	89.60	48.80
2	SB5NEPH-12ccc	ccc	1	14	I 39	11.30	0.83	9.93	9.02
2	SB5NEPH-16	quenched	1	15	I 07	303.34	0.83	995.02	72.33
2	SB5NEPH-18	quenched	1	16	I 29	241.67	0.83	468.34	33.33
2	SB5NEPH-15	quenched	1	17	I 44	35.50	0.83	1733.37	170.00
2	SB5NEPH-19ccc	ccc	1	18	I 63	64.50	0.83	1503.36	83.50
2	SB5NEPH-20ccc	ccc	1	19	I 17	62.33	0.83	190.00	18.67
2	SB5NEPH-13	quenched	1	20	I 20	47.17	0.83	2083.38	361.67
2	SB5NEPH-14	quenched	1	21	I 68	1206.69	0.83	3100.06	256.67
2	ARM-1	ref	1	22	I 30	22.00	14.02	40.00	61.17
2	SB5NEPH-15ccc	ccc	1	23	I 03	130.67	0.83	6833.47	435.01
2	SB5NEPH-17ccc	ccc	1	24	I 12	162.67	0.83	1360.03	236.67
2	SB5NEPH-16ccc	ccc	1	25	I 01	318.34	0.83	1030.02	74.33
2	Soln Std	ref	1	26	STD-21-3	23.60	10.30	86.00	50.90
2	Soln Std	ref	2	1	STD-22-1	20.00	9.63	82.70	49.50
2	SB5NEPH-16ccc	ccc	2	2	I 31	330.01	0.83	1010.02	78.33
2	SB5NEPH-16	quenched	2	3	I 10	296.67	0.83	961.69	70.67
2	SB5NEPH-12ccc	ccc	2	4	I 28	12.32	0.83	12.52	8.68
2	SB5NEPH-12	quenched	2	5	I 62	16.00	0.83	10.92	6.90
2	SB5NEPH-15	quenched	2	6	I 48	33.83	0.83	1816.70	175.00
2	SB5NEPH-17ccc	ccc	2	7	I 38	151.17	0.83	1268.36	225.00
2	SB5NEPH-18ccc	ccc	2	8	I 15	223.34	0.83	453.34	34.00
2	SB5NEPH-13	quenched	2	9	I 34	46.17	0.83	2100.04	353.34
2	SB5NEPH-20ccc	ccc	2	10	I 57	63.67	0.83	176.67	18.67
2	SB5NEPH-11ccc	ccc	2	11	I 13	10.33	0.83	15.95	10.68
2	SB5NEPH-18	quenched	2	12	I 11	243.34	0.83	491.68	33.67
2	Soln Std	ref	2	13	STD-22-2	21.10	9.72	87.30	49.50
2	SB5NEPH-19	quenched	2	14	I 24	9.67	0.83	330.01	42.17
2	SB5NEPH-15ccc	ccc	2	15	I 52	165.17	0.83	6633.47	448.34

Table B2. PSAL Measurements of the PCT Solutions for the Study Glasses After Appropriate Adjustments. (continued)

Set	Glass ID	Heat Treatment	Block	Seq	Lab ID	B (ppm)	Li (ppm)	Na (ppm)	Si (ppm)
2	SB5NEPH-19ccc	ccc	2	16	I 33	61.67	0.83	1390.03	83.67
2	SB5NEPH-17	quenched	2	17	I 23	10.48	0.83	241.67	94.00
2	SB5NEPH-14	quenched	2	18	I 36	1156.69	0.83	3083.40	251.67
2	SB5NEPH-14ccc	ccc	2	19	I 45	890.02	0.83	2466.72	206.67
2	EA	ref	2	20	I 53	768.33	190.00	2116.67	923.34
2	ARM-1	ref	2	21	I 51	18.83	14.38	37.83	63.00
2	SB5NEPH-11	quenched	2	22	I 14	7.75	0.83	7.78	9.82
2	SB5NEPH-20	quenched	2	23	I 49	165.00	0.83	471.68	22.67
2	SB5NEPH-13ccc	ccc	2	24	I 66	76.33	0.83	2350.05	388.34
2	Soln Std	ref	2	25	STD-22-3	21.40	9.51	86.60	47.50
2	Soln Std	ref	3	1	STD-23-1	19.20	9.67	84.30	49.00
2	SB5NEPH-18	quenched	3	2	I 41	233.34	0.83	453.34	34.17
2	SB5NEPH-18ccc	ccc	3	3	I 04	223.34	0.83	681.68	35.50
2	SB5NEPH-20	quenched	3	4	I 16	159.50	0.83	416.68	23.50
2	SB5NEPH-14	quenched	3	5	I 46	1178.36	0.83	2916.73	245.00
2	SB5NEPH-16ccc	ccc	3	6	I 37	320.01	0.83	988.35	74.00
2	SB5NEPH-20ccc	ccc	3	7	I 21	65.00	0.83	211.67	19.83
2	SB5NEPH-12ccc	ccc	3	8	I 26	13.55	0.83	9.42	10.65
2	SB5NEPH-11	quenched	3	9	I 35	3.93	0.83	7.20	12.07
2	blank	ref	3	10	I 50	0.83	0.83	0.83	0.83
2	SB5NEPH-13	quenched	3	11	I 40	45.33	0.83	1983.37	350.01
2	SB5NEPH-19ccc	ccc	3	12	I 58	61.00	0.83	1425.03	81.50
2	Soln Std	ref	3	13	STD-23-2	19.50	9.63	85.20	48.40
2	SB5NEPH-19	quenched	3	14	I 59	7.97	0.83	326.67	44.67
2	SB5NEPH-15ccc	ccc	3	15	I 22	128.84	0.83	6366.79	426.68
2	SB5NEPH-17ccc	ccc	3	16	I 47	156.67	0.83	1401.69	233.34
2	SB5NEPH-11ccc	ccc	3	17	I 32	8.72	0.83	17.67	13.10
2	ARM-1	ref	3	18	I 67	17.00	13.82	38.50	62.17
2	SB5NEPH-16	quenched	3	19	I 54	300.01	0.83	981.69	71.67
2	SB5NEPH-15	quenched	3	20	I 60	36.17	0.83	1700.03	183.34
2	SB5NEPH-13ccc	ccc	3	21	I 08	67.50	0.83	2216.71	371.67
2	EA	ref	3	22	I 19	611.67	188.33	1883.34	880.00
2	SB5NEPH-14ccc	ccc	3	23	I 09	911.68	0.83	2416.72	205.00
2	SB5NEPH-17	quenched	3	24	I 43	13.98	0.83	245.00	96.34
2	SB5NEPH-12	quenched	3	25	I 27	16.47	0.83	14.45	8.98
2	Soln Std	ref	3	26	STD-23-3	20.50	9.73	86.60	49.20
3	Soln Std	ref	1	1	STD-31-1	20.40	9.63	79.00	48.70
3	SB5NEPH-22ccc	ccc	1	2	J38	54.67	0.83	78.33	43.17
3	SB5NEPH-22	quenched	1	3	J35	27.33	0.83	46.67	36.17
3	SB5NEPH-29ccc	ccc	1	4	J22-missing	.	.	.	.
3	SB5NEPH-21	quenched	1	5	J26	2.27	0.83	43.83	35.50
3	SB5NEPH-30ccc	ccc	1	6	J39	208.34	0.83	3550.07	366.67
3	SB5NEPH-23ccc	ccc	1	7	J01	7.90	0.83	18.83	10.40
3	SB5NEPH-27	quenched	1	8	J29	1.07	0.83	6.58	7.92
3	blank	ref	1	9	J50	0.08	0.83	0.08	0.08
3	SB5NEPH-29	quenched	1	10	J19	1231.69	0.83	20833.75	2316.71
3	SB5NEPH-27ccc	ccc	1	11	J36	230.00	0.83	98.00	0.38
3	SB5NEPH-25ccc	ccc	1	12	J51	7.83	0.83	9.87	17.17
3	Soln Std	ref	1	13	STD-31-2	22.40	9.92	83.80	49.50
3	SB5NEPH-24	quenched	1	14	J04	50.67	0.83	95.50	6.47
3	SB5NEPH-23	quenched	1	15	J59	3.88	0.83	40.67	13.57
3	SB5NEPH-24ccc	ccc	1	16	J55	18.33	0.83	31.00	7.93
3	SB5NEPH-21ccc	ccc	1	17	J24	186.67	0.83	265.01	24.33
3	SB5NEPH-30	quenched	1	18	J62	5466.78	0.83	17333.68	890.02
3	SB5NEPH-28ccc	ccc	1	19	J46	47.50	0.83	7.17	6.45
3	ARM-1	ref	1	20	J54	39.67	12.72	36.67	55.50
3	SB5NEPH-28	quenched	1	21	J40	32.83	0.83	11.50	4.70
3	SB5NEPH-25	quenched	1	22	J42	13.73	0.83	9.23	13.23
3	SB5NEPH-26ccc	ccc	1	23	J23	30.67	0.83	22.83	24.67

Table B2. PSAL Measurements of the PCT Solutions for the Study Glasses After Appropriate Adjustments. (continued)

Set	Glass ID	Heat Treatment	Block	Seq	Lab ID	B (ppm)	Li (ppm)	Na (ppm)	Si (ppm)
3	SB5NEPH-26	quenched	1	24	J20	14.25	0.83	10.47	10.98
3	EA	ref	1	25	J37	691.67	193.33	2000.00	891.67
3	Soln Std	ref	1	26	STD-31-3	23.20	9.89	85.50	48.60
3	Soln Std	ref	2	1	STD-32-1	19.50	9.71	79.40	49.30
3	SB5NEPH-21ccc	ccc	2	2	J64	181.67	0.83	236.67	24.17
3	SB5NEPH-28ccc	ccc	2	3	J03	7.77	0.83	5.47	7.08
3	SB5NEPH-29	quenched	2	4	J17	1221.69	0.83	20833.75	2350.05
3	SB5NEPH-30ccc	ccc	2	5	J10	216.67	0.83	3266.73	343.34
3	ARM-1	ref	2	6	J66	19.67	12.52	33.17	56.17
3	SB5NEPH-29ccc	ccc	2	7	J58-missing	.	.	.	.
3	SB5NEPH-21	quenched	2	8	J30	5.02	0.83	41.00	34.83
3	SB5NEPH-22	quenched	2	9	J15	27.33	0.83	47.33	35.00
3	SB5NEPH-23ccc	ccc	2	10	J12	6.53	0.83	18.00	10.63
3	SB5NEPH-27	quenched	2	11	J11	0.08	0.83	7.42	8.03
3	SB5NEPH-30	quenched	2	12	J34	5583.45	0.83	17167.01	908.35
3	Soln Std	ref	2	13	STD-32-2	21.20	9.65	79.00	47.20
3	SB5NEPH-25	quenched	2	14	J65	3.10	0.83	8.02	13.40
3	SB5NEPH-23	quenched	2	15	J28	2.57	0.83	38.67	13.52
3	SB5NEPH-24	quenched	2	16	J08	47.50	0.83	90.00	6.75
3	EA	ref	2	17	J44	621.67	188.33	1816.67	876.67
3	SB5NEPH-26ccc	ccc	2	18	J02	19.33	0.83	19.33	25.17
3	SB5NEPH-22ccc	ccc	2	19	J49	58.67	0.83	81.83	41.67
3	SB5NEPH-26	quenched	2	20	J32	4.78	0.83	8.13	11.27
3	SB5NEPH-25ccc	ccc	2	21	J68	0.08	0.83	9.45	17.17
3	SB5NEPH-24ccc	ccc	2	22	J61	15.40	0.83	29.50	8.28
3	SB5NEPH-28	quenched	2	23	J09	11.30	0.83	10.30	4.80
3	SB5NEPH-27ccc	ccc	2	24	J16	245.00	0.83	95.84	0.57
3	Soln Std	ref	2	25	STD-32-3	19.70	9.79	82.30	49.60
3	Soln Std	ref	3	1	STD-33-1	19.80	9.73	81.20	48.70
3	SB5NEPH-28	quenched	3	2	J56	13.67	0.83	10.12	5.18
3	SB5NEPH-22	quenched	3	3	J67	28.83	0.83	48.00	37.50
3	SB5NEPH-30	quenched	3	4	J25	5516.78	0.83	17000.34	1303.36
3	SB5NEPH-26	quenched	3	5	J05	32.50	0.83	7.60	11.23
3	SB5NEPH-27	quenched	3	6	J60	18.50	0.83	6.35	8.35
3	blank	ref	3	7	J53	13.52	0.83	0.08	0.08
3	SB5NEPH-28ccc	ccc	3	8	J06	19.83	0.83	6.03	7.38
3	SB5NEPH-23ccc	ccc	3	9	J14	16.25	0.83	19.00	10.93
3	SB5NEPH-27ccc	ccc	3	10	J18	275.01	0.83	98.67	0.72
3	SB5NEPH-25	quenched	3	11	J57	9.07	0.83	8.13	13.65
3	SB5NEPH-25ccc	ccc	3	12	J52	7.50	0.83	9.33	17.83
3	Soln Std	ref	3	13	STD-33-2	22.30	9.69	83.00	48.60
3	EA	ref	3	14	J07	655.00	188.33	1716.67	880.00
3	SB5NEPH-22ccc	ccc	3	15	J21	62.83	0.83	82.67	43.33
3	SB5NEPH-24	quenched	3	16	J63	52.67	0.83	91.34	7.32
3	ARM-1	ref	3	17	J47	19.00	13.13	36.33	58.50
3	SB5NEPH-29ccc	ccc	3	18	J33-missing	.	.	.	.
3	SB5NEPH-21	quenched	3	19	J13	4.73	0.83	42.33	34.83
3	SB5NEPH-26ccc	ccc	3	20	J27	20.67	0.83	18.67	24.33
3	SB5NEPH-21ccc	ccc	3	21	J45	185.00	0.83	256.67	25.50
3	SB5NEPH-23	quenched	3	22	J43	3.92	0.83	39.33	13.80
3	SB5NEPH-29	quenched	3	23	J41	1355.03	0.83	20500.41	2350.05
3	SB5NEPH-24ccc	ccc	3	24	J48	25.33	0.83	29.83	8.72
3	SB5NEPH-30ccc	ccc	3	25	J31	245.00	0.83	3433.40	385.01
3	Soln Std	ref	3	26	STD-33-3	20.00	9.66	81.10	46.90
4	Soln Std	ref	1	1	STD-41-1	20.80	9.92	81.30	51.00
4	SB5NEPH-34ccc	ccc	1	2	K17	370.01	0.83	525.01	14.05
4	ARM-1	ref	1	3	K09	20.00	13.40	35.33	61.00
4	SB5NEPH-39	quenched	1	4	K30	3.85	0.83	5.98	6.52
4	SB5NEPH-37	quenched	1	5	K21	4.15	0.83	13.42	17.17

Table B2. PSAL Measurements of the PCT Solutions for the Study Glasses After Appropriate Adjustments. (continued)

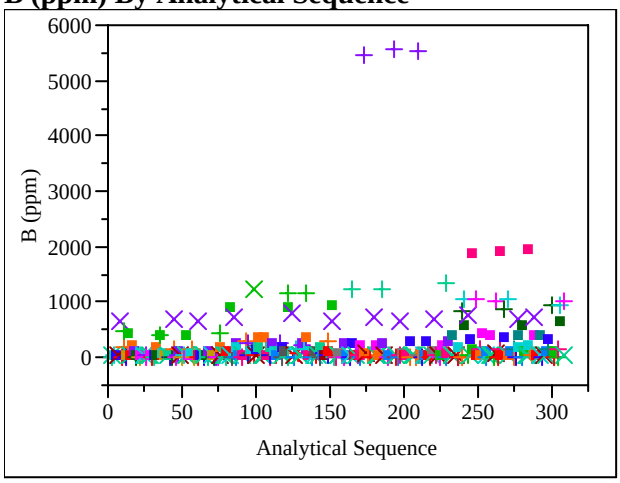
Set	Glass ID	Heat Treatment	Block	Seq	Lab ID	B (ppm)	Li (ppm)	Na (ppm)	Si (ppm)
4	SB5NEPH-32ccc	ccc	1	6	K57	157.00	0.83	1153.36	102.84
4	SB5NEPH-31	quenched	1	7	K27	848.35	0.83	18000.36	686.68
4	SB5NEPH-40	quenched	1	8	K29	22.17	0.83	10.82	3.35
4	SB5NEPH-32	quenched	1	9	K22	1058.35	0.83	3800.08	102.34
4	SB5NEPH-31ccc	ccc	1	10	K48	536.68	0.83	13366.93	758.35
4	SB5NEPH-38	quenched	1	11	K46	24.83	0.83	13.07	13.40
4	EA	ref	1	12	K40	710.00	190.00	1733.34	918.34
4	Soln Std	ref	1	13	STD-41-2	22.20	9.85	82.10	51.90
4	SB5NEPH-39ccc	ccc	1	14	K14	300.01	0.83	98.34	0.83
4	SB5NEPH-36ccc	ccc	1	15	K67	1833.37	0.83	3266.73	4.43
4	SB5NEPH-38ccc	ccc	1	16	K65	96.34	0.83	59.00	37.00
4	SB5NEPH-33	quenched	1	17	K32	1061.69	0.83	3700.07	64.17
4	SB5NEPH-37ccc	ccc	1	18	K26	17.67	0.83	12.68	18.50
4	SB5NEPH-34	quenched	1	19	K42	165.50	0.83	358.34	29.33
4	SB5NEPH-36	quenched	1	20	K05	159.17	0.83	398.34	9.22
4	SB5NEPH-40ccc	ccc	1	21	K06	20.17	0.83	7.43	5.87
4	SB5NEPH-33ccc	ccc	1	22	K38	388.34	0.83	3266.73	185.00
4	SB5NEPH-35	quenched	1	23	K60	19.17	0.83	191.67	17.67
4	blank	ref	1	24	K59	7.85	0.83	0.83	0.83
4	SB5NEPH-35ccc	ccc	1	25	K44	85.67	0.83	1536.70	126.67
4	Soln Std	ref	1	26	STD-41-3	22.50	9.94	84.40	51.50
4	Soln Std	ref	2	1	STD-42-1	20.30	9.68	81.50	48.50
4	SB5NEPH-33ccc	ccc	2	2	K50	371.67	0.83	3200.06	173.34
4	SB5NEPH-38	quenched	2	3	K36	17.33	0.83	13.55	12.67
4	SB5NEPH-33	quenched	2	4	K33	1023.35	0.83	3683.41	61.33
4	ARM-1	ref	2	5	K12	26.33	13.20	34.00	58.50
4	SB5NEPH-37	quenched	2	6	K51	7.62	0.83	14.28	16.10
4	SB5NEPH-36	quenched	2	7	K54	146.84	0.83	375.01	8.50
4	SB5NEPH-36ccc	ccc	2	8	K39	1883.37	0.83	3333.40	3.82
4	SB5NEPH-37ccc	ccc	2	9	K37	19.67	0.83	13.07	17.17
4	SB5NEPH-31	quenched	2	10	K43	885.02	0.83	18333.70	715.01
4	SB5NEPH-39ccc	ccc	2	11	K45	325.01	0.83	99.17	0.83
4	SB5NEPH-32	quenched	2	12	K34	1065.02	0.83	3850.08	97.17
4	Soln Std	ref	2	13	STD-42-2	20.20	9.58	83.90	46.80
4	SB5NEPH-40ccc	ccc	2	14	K47	19.67	0.83	6.80	5.08
4	SB5NEPH-35ccc	ccc	2	15	K56	83.17	0.83	1596.70	116.34
4	SB5NEPH-34	quenched	2	16	K08	163.50	0.83	325.01	27.83
4	SB5NEPH-40	quenched	2	17	K61	22.00	0.83	11.67	2.87
4	SB5NEPH-39	quenched	2	18	K68	6.92	0.83	6.75	6.35
4	EA	ref	2	19	K16	671.67	186.67	1700.00	875.00
4	SB5NEPH-32ccc	ccc	2	20	K13	144.67	0.83	1141.69	97.84
4	SB5NEPH-34ccc	ccc	2	21	K24	358.34	0.83	550.01	12.30
4	SB5NEPH-35	quenched	2	22	K64	15.88	0.83	193.34	15.52
4	SB5NEPH-31ccc	ccc	2	23	K58	543.34	0.83	13533.60	761.68
4	SB5NEPH-38ccc	ccc	2	24	K53	86.34	0.83	60.00	34.17
4	Soln Std	ref	2	25	STD-42-3	23.10	9.55	83.40	47.00
4	Soln Std	ref	3	1	STD-43-1	19.90	9.77	80.60	48.90
4	SB5NEPH-36ccc	ccc	3	2	K03	1916.71	0.83	3600.07	4.10
4	SB5NEPH-32ccc	ccc	3	3	K19	183.34	0.83	1203.36	105.34
4	SB5NEPH-40	quenched	3	4	K63	24.83	0.83	11.28	3.20
4	EA	ref	3	5	K25	700.00	188.33	1716.67	905.00
4	SB5NEPH-40ccc	ccc	3	6	K02	13.87	0.83	7.25	5.68
4	SB5NEPH-33ccc	ccc	3	7	K23	380.01	0.83	3350.07	176.67
4	SB5NEPH-37ccc	ccc	3	8	K31	5.95	0.83	13.32	18.00
4	blank	ref	3	9	K01	1.73	0.83	0.83	0.83
4	SB5NEPH-34ccc	ccc	3	10	K66	381.67	0.83	528.34	13.03
4	SB5NEPH-39	quenched	3	11	K11	4.57	0.83	6.77	6.57
4	ARM-1	ref	3	12	K28	19.33	14.13	38.83	62.00
4	Soln Std	ref	3	13	STD-43-2	20.20	9.75	81.90	48.50

Table B2. PSAL Measurements of the PCT Solutions for the Study Glasses After Appropriate Adjustments. (continued)

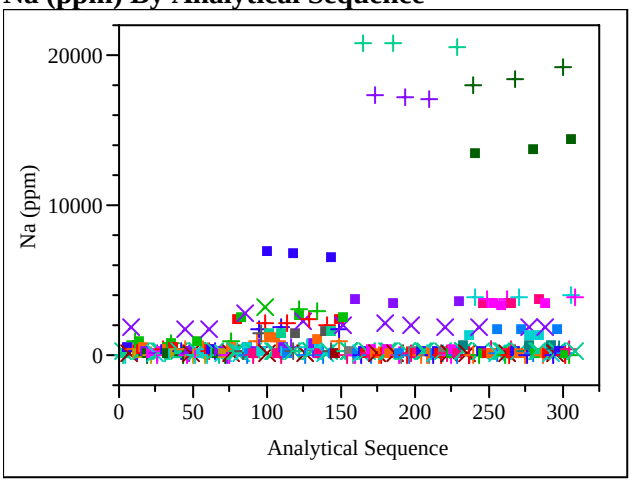
Set	Glass ID	Heat Treatment	Block	Seq	Lab ID	B (ppm)	Li (ppm)	Na (ppm)	Si (ppm)
4	SB5NEPH-35ccc	ccc	3	14	K10	77.00	0.83	1535.03	119.50
4	SB5NEPH-34	quenched	3	15	K49	164.84	0.83	333.34	28.33
4	SB5NEPH-39ccc	ccc	3	16	K35	298.34	0.83	101.67	0.83
4	SB5NEPH-31	quenched	3	17	K15	933.35	0.83	19167.05	753.35
4	SB5NEPH-35	quenched	3	18	K55	17.33	0.83	195.00	17.83
4	SB5NEPH-37	quenched	3	19	K20	5.10	0.83	16.35	16.22
4	SB5NEPH-38ccc	ccc	3	20	K07	81.33	0.83	62.83	35.17
4	SB5NEPH-38	quenched	3	21	K18	14.88	0.83	15.48	13.03
4	SB5NEPH-36	quenched	3	22	K41	147.84	0.83	410.01	9.07
4	SB5NEPH-32	quenched	3	23	K62	956.69	0.83	3966.75	99.67
4	SB5NEPH-31ccc	ccc	3	24	K04	621.68	0.83	14316.95	851.68
4	SB5NEPH-33	quenched	3	25	K52	1021.69	0.83	3883.41	63.33
4	Soln Std	ref	3	26	STD-43-3	20.20	9.78	80.30	49.40

Exhibit B1. Laboratory PCT Measurements in Analytical Sequence for Study Glasses, EA, ARM, Blanks, and Solution Standards.

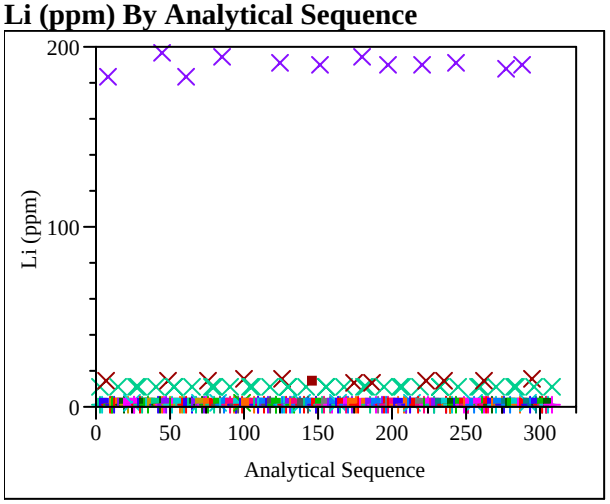
B (ppm) By Analytical Sequence



Na (ppm) By Analytical Sequence



Li (ppm) By Analytical Sequence



Si (ppm) By Analytical Sequence

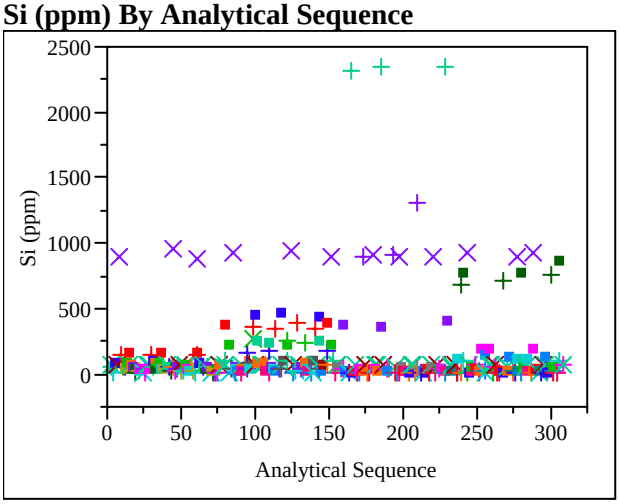
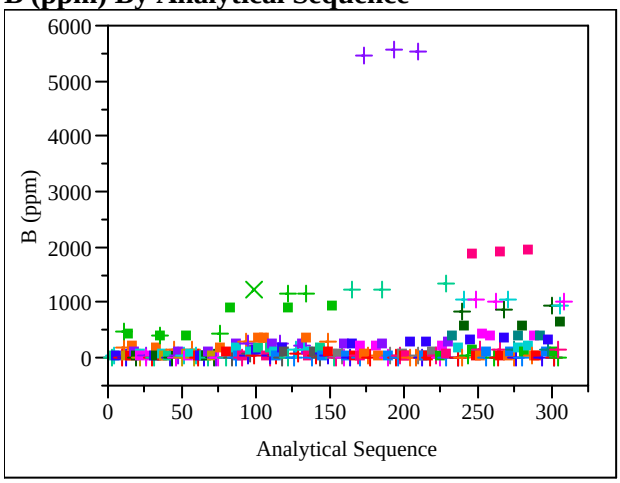
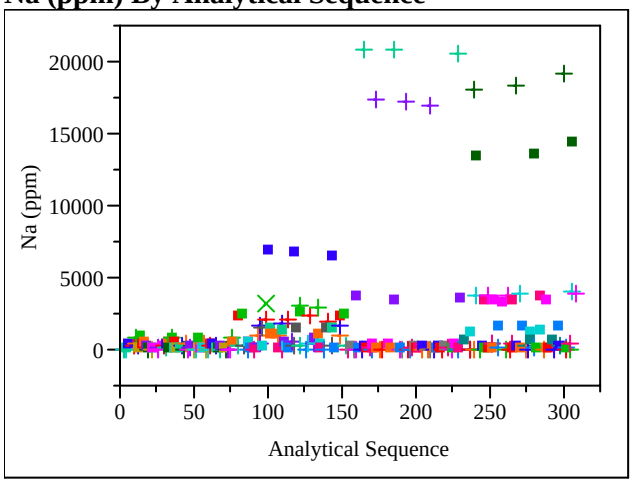


Exhibit B2. Laboratory PCT Measurements in Analytical Sequence for Study Glasses.

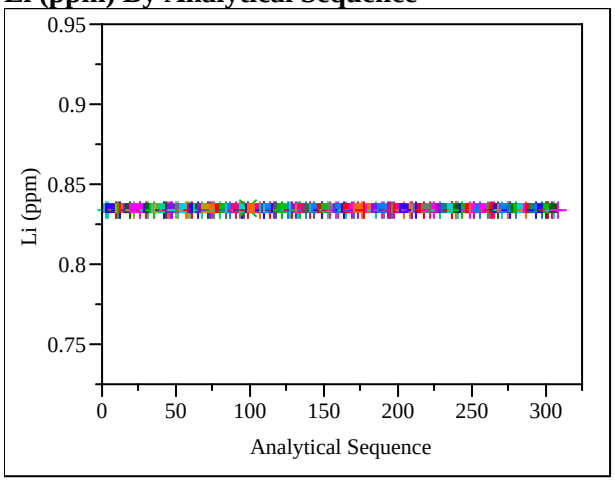
B (ppm) By Analytical Sequence



Na (ppm) By Analytical Sequence



Li (ppm) By Analytical Sequence



Si (ppm) By Analytical Sequence

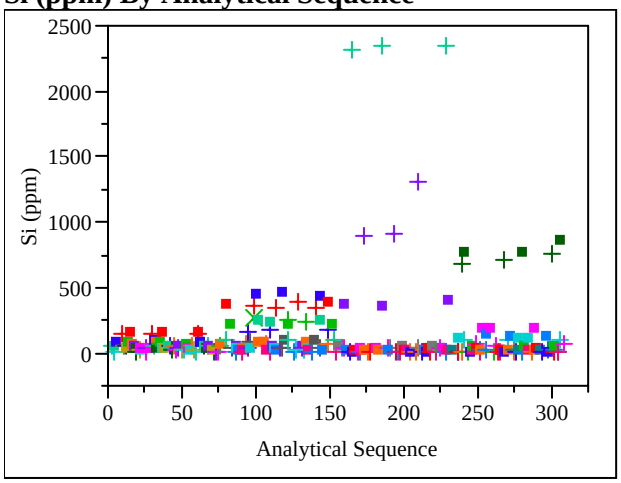
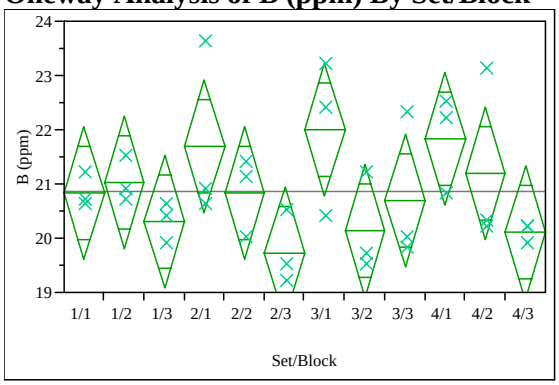


Exhibit B3. Measurements of the Multi-Element Solution Standard by ICP Block.

Oneway Analysis of B (ppm) By Set/Block



Oneway Anova Summary of Fit

Rsquare	0.40939
Adj Rsquare	0.138693
Root Mean Square Error	1.023882
Mean of Response	20.86667
Observations (or Sum Wgts)	36

Analysis of Variance

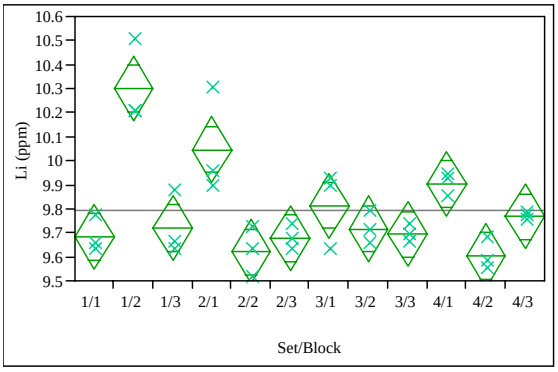
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Set/Block	11	17.440000	1.58545	1.5124	0.1912
Error	24	25.160000	1.04833		
C. Total	35	42.600000			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	20.8333	0.59114	19.613	22.053
1/2	3	21.0333	0.59114	19.813	22.253
1/3	3	20.3000	0.59114	19.080	21.520
2/1	3	21.7000	0.59114	20.480	22.920
2/2	3	20.8333	0.59114	19.613	22.053
2/3	3	19.7333	0.59114	18.513	20.953
3/1	3	22.0000	0.59114	20.780	23.220
3/2	3	20.1333	0.59114	18.913	21.353
3/3	3	20.7000	0.59114	19.480	21.920
4/1	3	21.8333	0.59114	20.613	23.053
4/2	3	21.2000	0.59114	19.980	22.420
4/3	3	20.1000	0.59114	18.880	21.320

Std Error uses a pooled estimate of error variance

Oneway Analysis of Li (ppm) By Set/Block



Oneway Anova Summary of Fit

Rsquare	0.813079
Adj Rsquare	0.727407
Root Mean Square Error	0.113358
Mean of Response	9.795278
Observations (or Sum Wgts)	36

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Set/Block	11	1.3414972	0.121954	9.4906	<.0001
Error	24	0.3084000	0.012850		
C. Total	35	1.6498972			

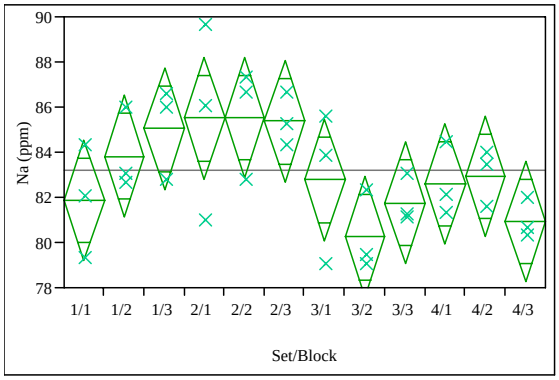
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	9.6833	0.06545	9.548	9.818
1/2	3	10.3000	0.06545	10.165	10.435
1/3	3	9.7200	0.06545	9.585	9.855
2/1	3	10.0467	0.06545	9.912	10.182
2/2	3	9.6200	0.06545	9.485	9.755
2/3	3	9.6767	0.06545	9.542	9.812
3/1	3	9.8133	0.06545	9.678	9.948
3/2	3	9.7167	0.06545	9.582	9.852
3/3	3	9.6933	0.06545	9.558	9.828
4/1	3	9.9033	0.06545	9.768	10.038
4/2	3	9.6033	0.06545	9.468	9.738
4/3	3	9.7667	0.06545	9.632	9.902

Std Error uses a pooled estimate of error variance

Exhibit B3. Measurements of the Multi-Element Solution Standard by ICP Block. (continued)

Oneway Analysis of Na (ppm) By Set/Block



Oneway Anova Summary of Fit

Rsquare	0.480515
Adj Rsquare	0.242417
Root Mean Square Error	2.253577
Mean of Response	83.19722
Observations (or Sum Wgts)	36

Analysis of Variance

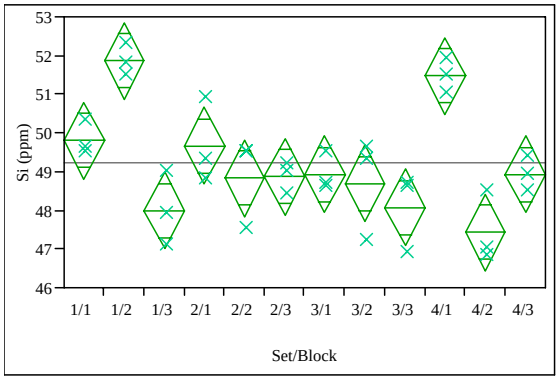
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Set/Block	11	112.74306	10.2494	2.0176	0.0729
Error	24	121.88667	5.0786		
C. Total	35	234.62972			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	81.8667	1.3011	79.181	84.552
1/2	3	83.8333	1.3011	81.148	86.519
1/3	3	85.0333	1.3011	82.348	87.719
2/1	3	85.5000	1.3011	82.815	88.185
2/2	3	85.5333	1.3011	82.848	88.219
2/3	3	85.3667	1.3011	82.681	88.052
3/1	3	82.7667	1.3011	80.081	85.452
3/2	3	80.2333	1.3011	77.548	82.919
3/3	3	81.7667	1.3011	79.081	84.452
4/1	3	82.6000	1.3011	79.915	85.285
4/2	3	82.9333	1.3011	80.248	85.619
4/3	3	80.9333	1.3011	78.248	83.619

Std Error uses a pooled estimate of error variance

Oneway Analysis of Si (ppm) By Set/Block



Oneway Anova Summary of Fit

Rsquare	0.778922
Adj Rsquare	0.677595
Root Mean Square Error	0.827647
Mean of Response	49.21389
Observations (or Sum Wgts)	36

Analysis of Variance

Source	DF	Sum of Squares	F Ratio	Mean Square	Prob > F
Set/Block	11	57.923611	7.6915	5.26573	<.0001
Error	24	16.440000		0.68500	
C. Total	35	74.363056			

Means for Oneway Anova

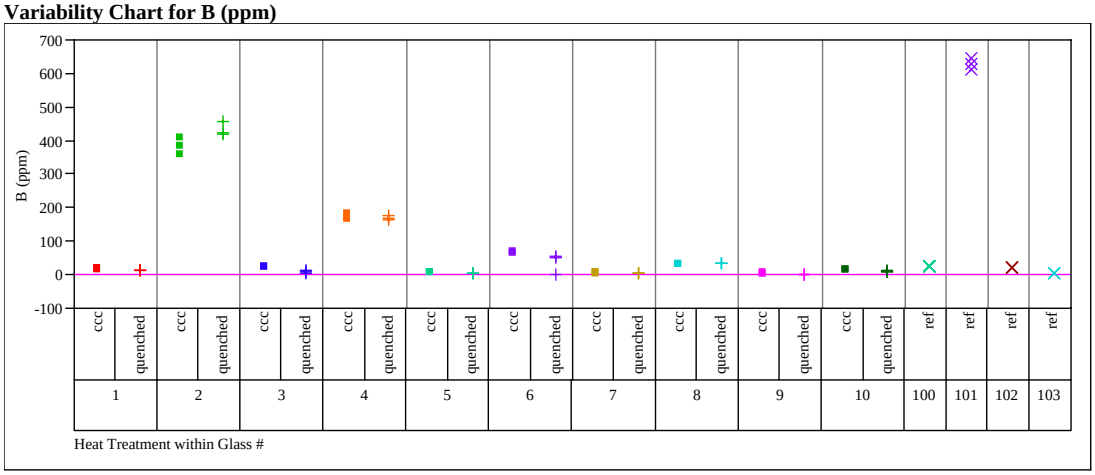
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1/1	3	49.8000	0.47784	48.814	50.786
1/2	3	51.8667	0.47784	50.880	52.853
1/3	3	48.0000	0.47784	47.014	48.986
2/1	3	49.6667	0.47784	48.680	50.653
2/2	3	48.8333	0.47784	47.847	49.820
2/3	3	48.8667	0.47784	47.880	49.853
3/1	3	48.9333	0.47784	47.947	49.920
3/2	3	48.7000	0.47784	47.714	49.686
3/3	3	48.0667	0.47784	47.080	49.053
4/1	3	51.4667	0.47784	50.480	52.453
4/2	3	47.4333	0.47784	46.447	48.420
4/3	3	48.9333	0.47784	47.947	49.920

Std Error uses a pooled estimate of error variance

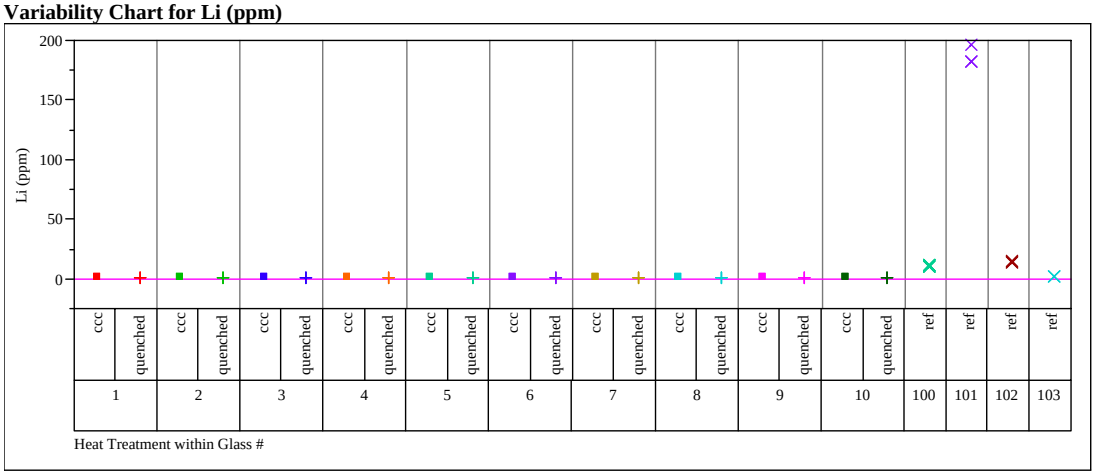
Exhibit B4. Laboratory PCT Measurements by Glass Number for Study Glasses and Standards.

(100 – Solution Standard; 101 – EA; 102 – ARM; 103 – Blanks)

Variability Gage Set=1
Variability Chart for B (ppm)



Variability Gage Set=1
Variability Chart for Li (ppm)



Variability Gage Set=1
Variability Chart for Na (ppm)

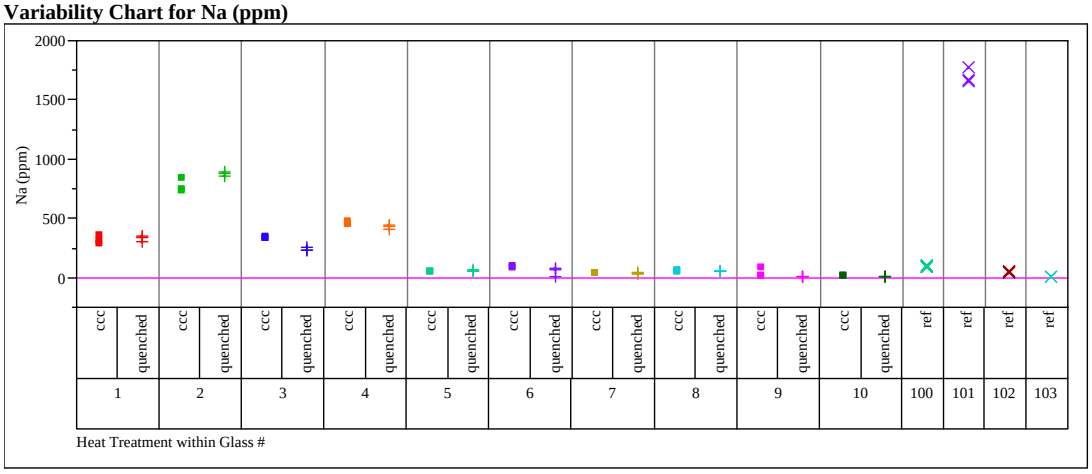
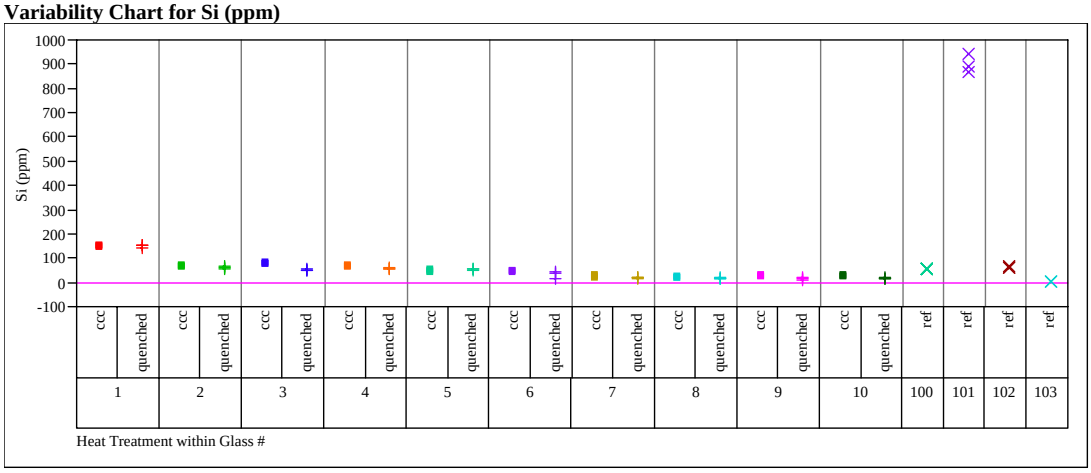
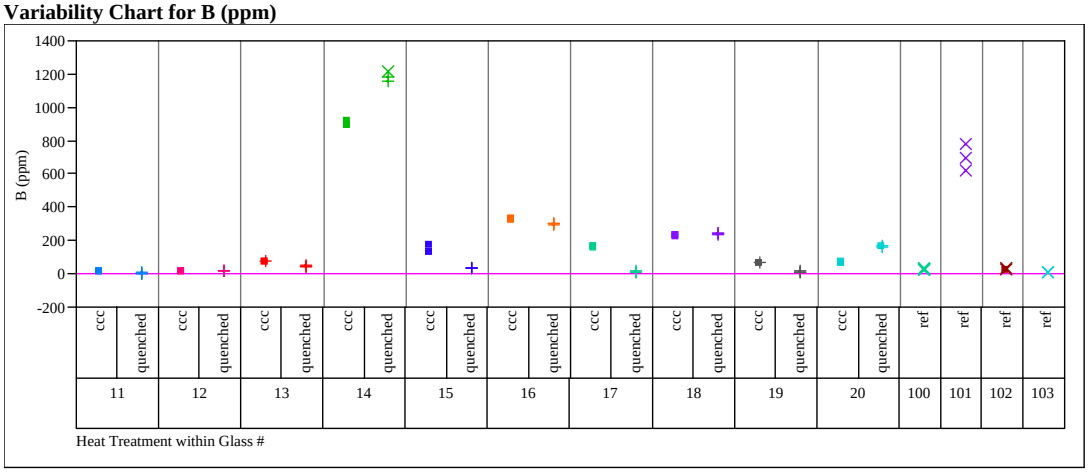


Exhibit B4. Laboratory PCT Measurements by Glass Number for Study Glasses and Standards. (continued)
(100 – Solution Standard; 101 – EA; 102 – ARM; 103 – Blanks)

Variability Gage Set=1
Variability Chart for Si (ppm)



Variability Gage Set=2
Variability Chart for B (ppm)



Variability Gage Set=2
Variability Chart for Li (ppm)

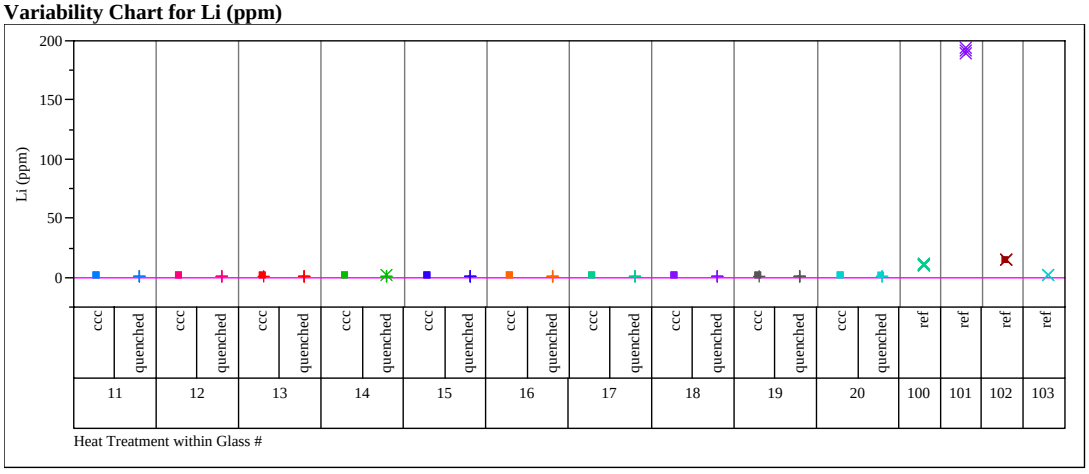
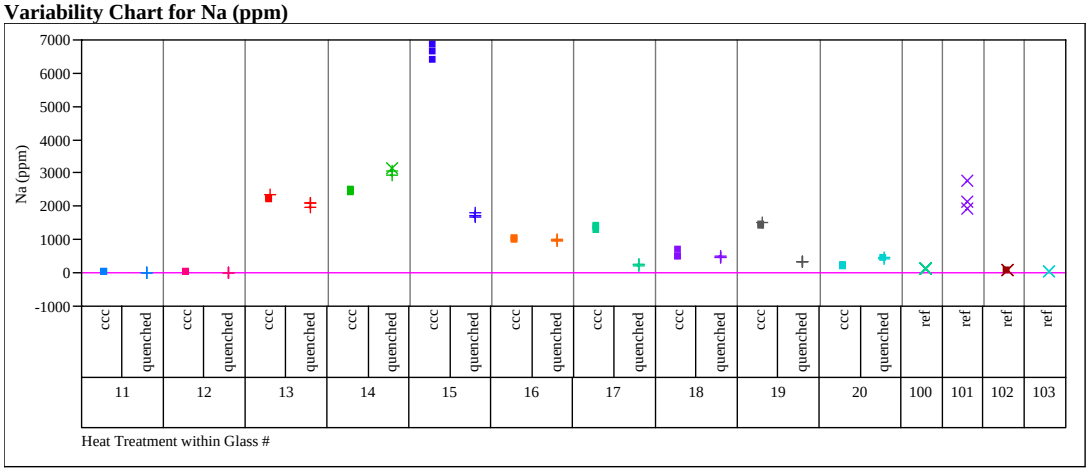
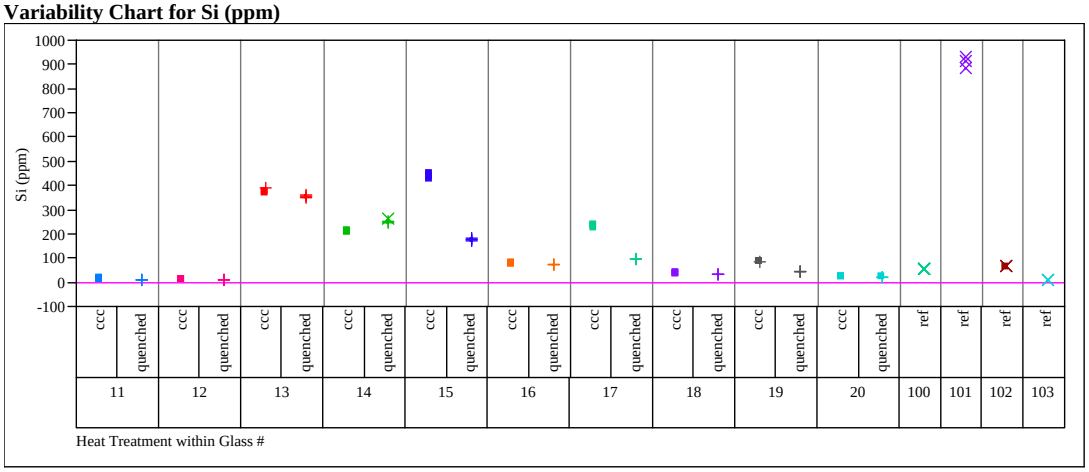


Exhibit B4. Laboratory PCT Measurements by Glass Number for Study Glasses and Standards. (continued)
(100 – Solution Standard; 101 – EA; 102 – ARM; 103 – Blanks)

Variability Gage Set=2
Variability Chart for Na (ppm)



Variability Gage Set=2
Variability Chart for Si (ppm)



Variability Gage Set=3
Variability Chart for B (ppm)

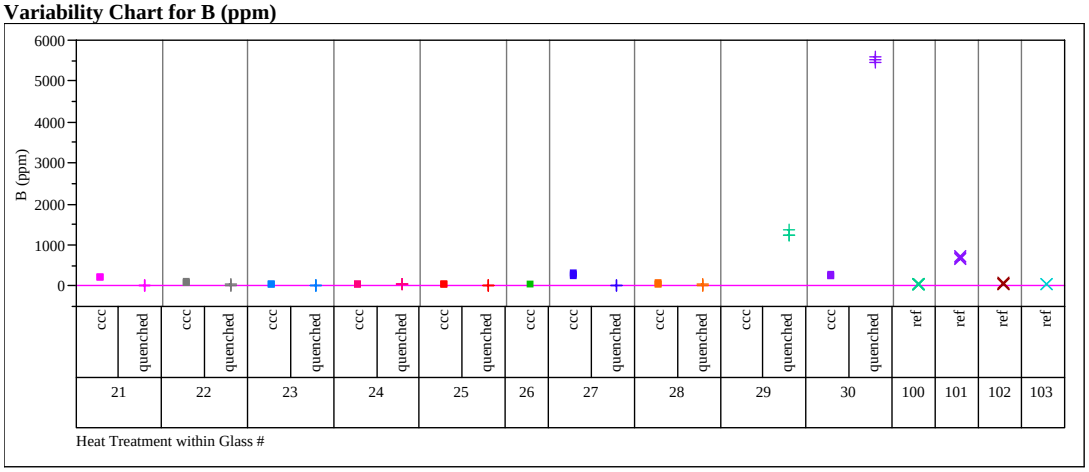
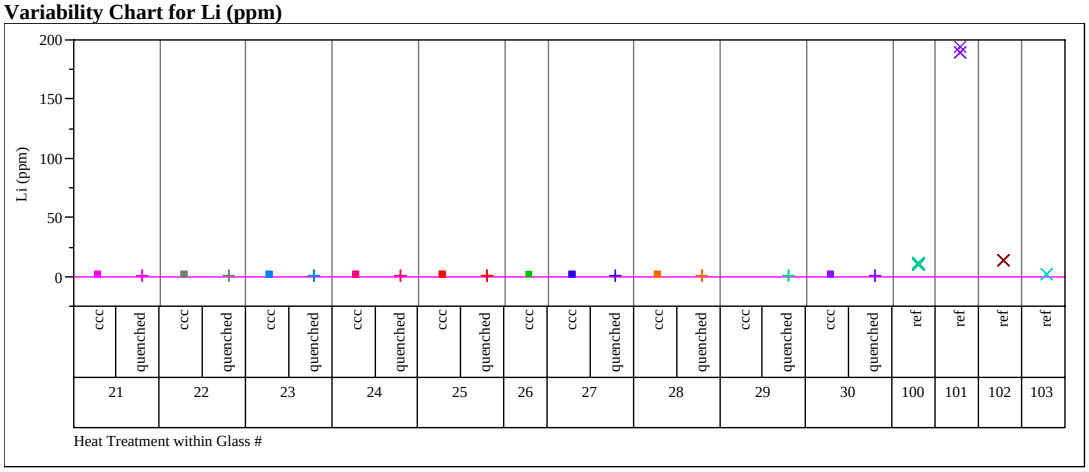
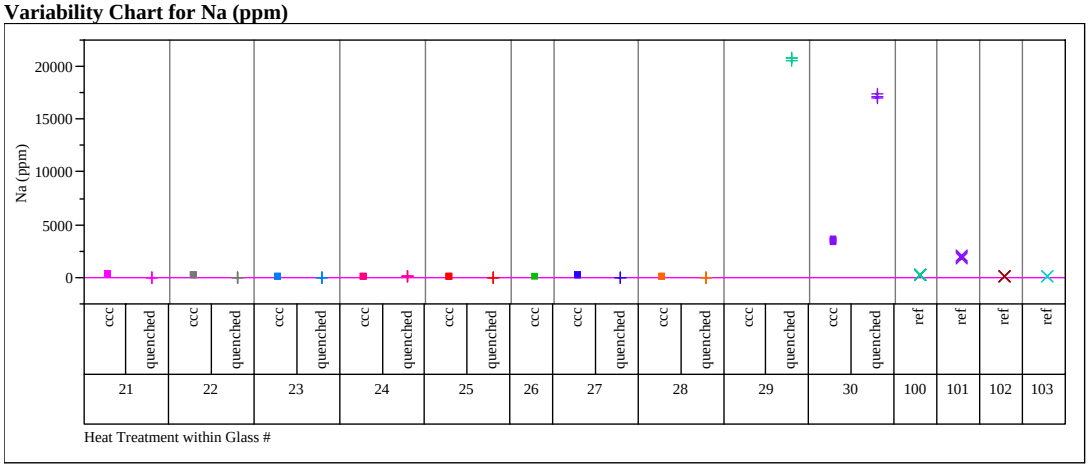


Exhibit B4. Laboratory PCT Measurements by Glass Number for Study Glasses and Standards. (continued)
(100 – Solution Standard; 101 – EA; 102 – ARM; 103 – Blanks)

Variability Gage Set=3
Variability Chart for Li (ppm)



Variability Gage Set=3
Variability Chart for Na (ppm)



Variability Gage Set=3
Variability Chart for Si (ppm)

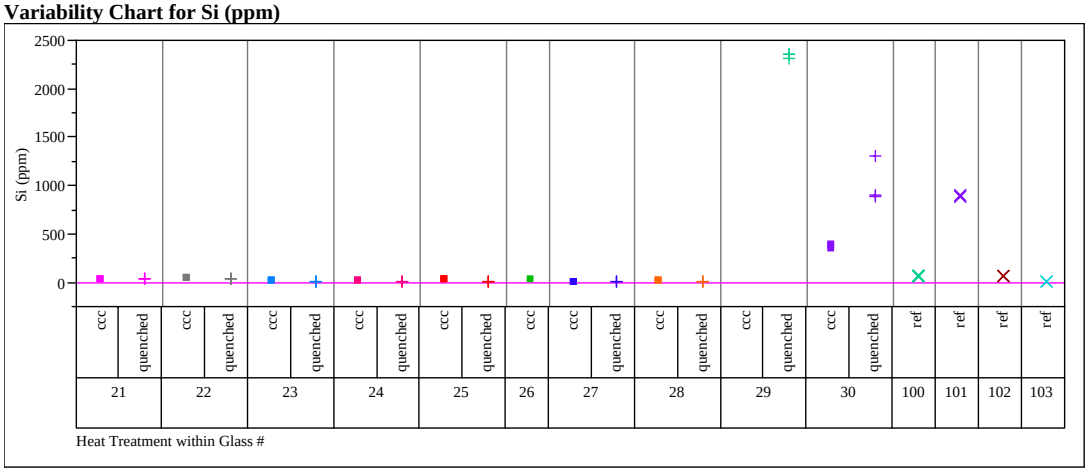
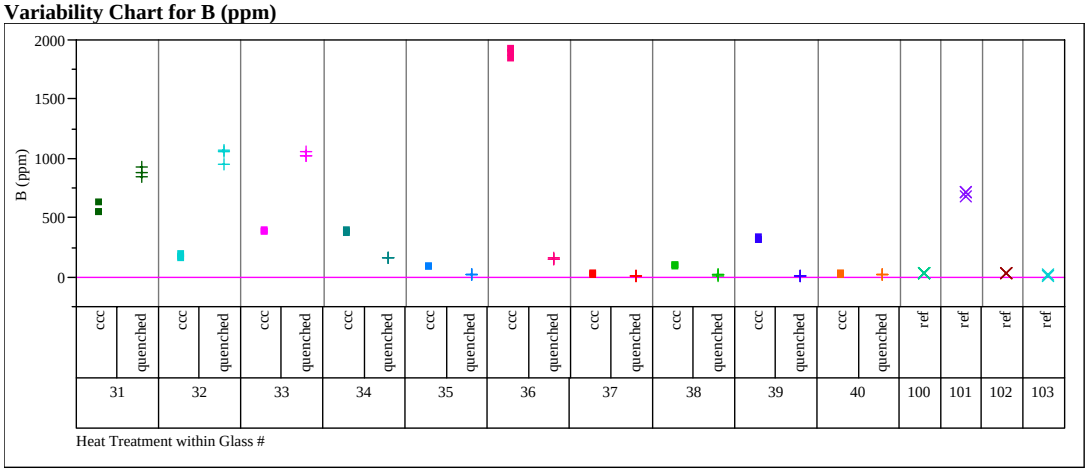
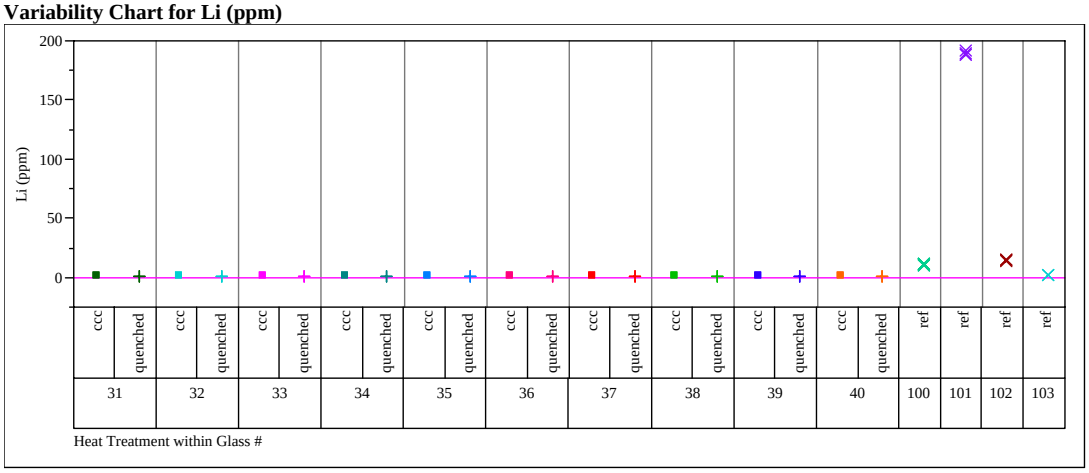


Exhibit B4. Laboratory PCT Measurements by Glass Number for Study Glasses and Standards. (continued)
(100 – Solution Standard; 101 – EA; 102 – ARM; 103 – Blanks)

Variability Gage Set=4
Variability Chart for B (ppm)



Variability Gage Set=4
Variability Chart for Li (ppm)



Variability Gage Set=4
Variability Chart for Na (ppm)

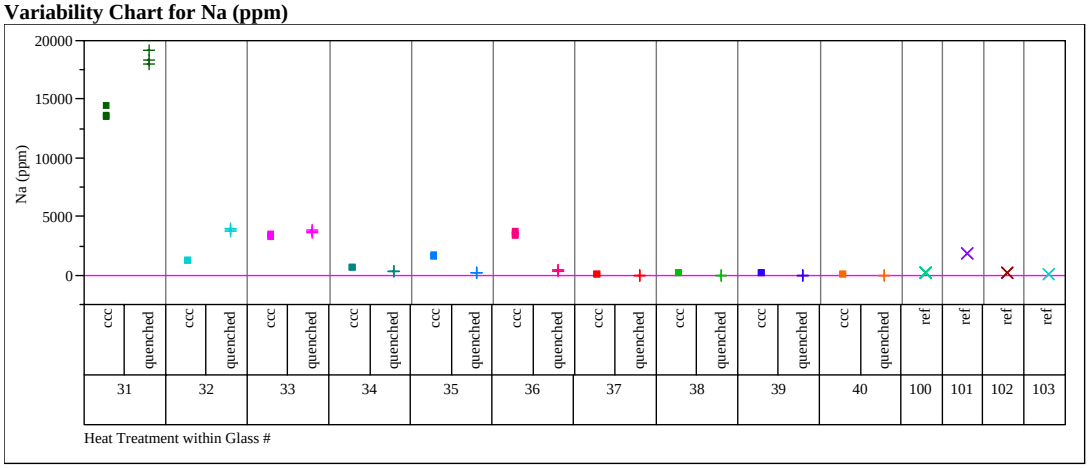


Exhibit B4. Laboratory PCT Measurements by Glass Number for Study Glasses and Standards. (continued)
(100 – Solution Standard; 101 – EA; 102 – ARM; 103 – Blanks)

Variability Gage Set=4
Variability Chart for Si (ppm)

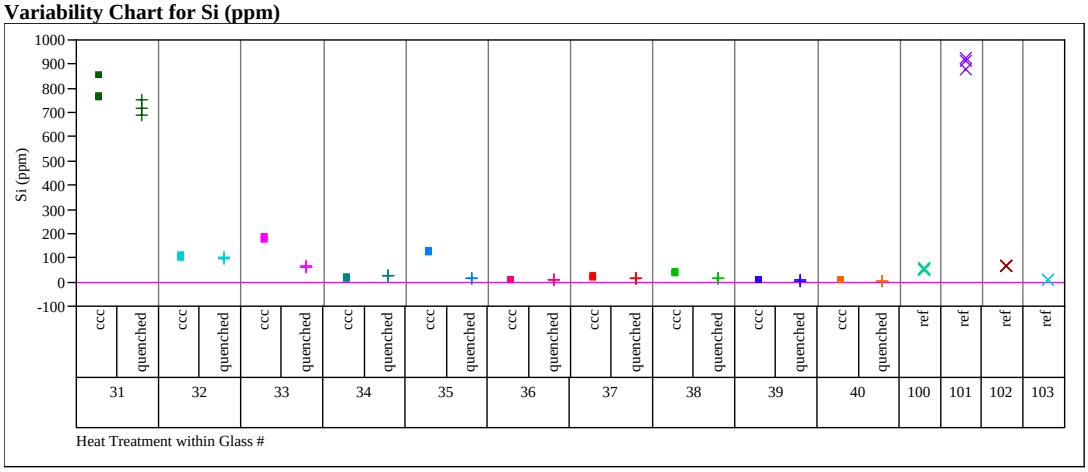


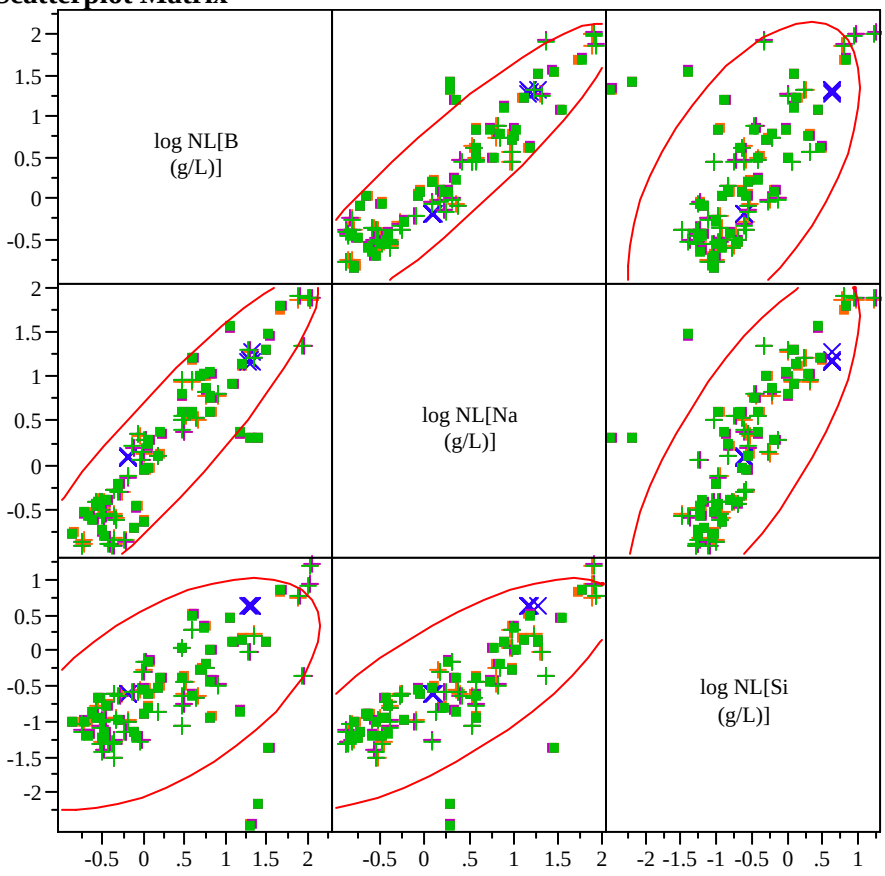
Exhibit B5. Correlations and Scatter Plots of Normalized PCTs Over All Compositional Views and Heat Treatments.

Correlations

	log NL[B (g/L)]	log NL[Na (g/L)]	log NL[Si (g/L)]
log NL[B (g/L)]	1.0000	0.9186	0.5812
log NL[Na (g/L)]	0.9186	1.0000	0.7640
log NL[Si (g/L)]	0.5812	0.7640	1.0000

6 rows not used due to missing or excluded values or frequency or weight variables missing, negative or less than one.

Scatterplot Matrix



Distribution:

A.B. Barnes, 999-W
D.R. Best, 786-1A
N.E. Bibler, 773-A
D.B. Burns, 786-5A
D.A. Crowley, 999-W
B.A. Davis, 704-27S
R.E. Edwards, 773-A
T.B. Edwards, 999-W
K.M. Fox, 999-W
J.M. Gillam, 766-H
J.C. Griffin, 773-A
B.A. Hamm, 766-H
C.C. Herman, 999-W
J.F. Iaukea, 704-30S
C.M. Jantzen, 773-A
T.M. Jones, 999-W
J.E. Marra, 773-A
R.T. McNew, 704-27S
D.H. Miller, 999-W
T.A. Nance, 773-42A
J.D. Newell, 999-W
J.E. Occhipinti, 704-S
D.K. Peeler, 999-W
F.C. Raszewski, 999-W
J.W. Ray, 704-S
I.A. Reamer, 999-1W
H.B. Shah, 766-H
M.E. Smith, 999-W
M.E. Stone, 999-W
R.J. Workman, 999-1W
A.L. Youchak, 999-W